SSC CGL 2018

GENERAL AWARENESS HACKBOOK

THE ULTIMATE GUIDE TO TIER 1

Compiled By: SSCHacks

SSC Hacks

Preparing you all the way

SSC CGL 2018

GENERAL AWARENESS HACKBOOK

General Awareness is the most important and scoring section of SSC CGL Tier I Exam. The best thing with this section is that you can easily solve 80-90% of the questions under this section before even the actual exam time gets over. This section is also helpful to save time for difficult sections like English, Quant and Reasoning where you can hardly solve 50-60% in the actual exam time.

For the General Awareness section, a total of 25 questions of 2 marks each will be asked. Also, remember that there is negative marking of 0.5 marks for every wrong answer. The score value of the unattempted questions is not taken into consideration while counting the total. To score high in this section, all you need to do is stay updated and remember things. If you prepare this section intelligently you will be able to tackle almost 70 – 80 % of the questions easily. On the basis of 2015, 2016 & 2017 SSC CGL papers, the best way to manage the syllabus is to divide your preparation into three major parts, which are:

- General Science
- Static General Knowledge
- Miscellaneous

Questions under General Awareness section in SSC CGL Tier 1 will be aimed at testing the candidates' general awareness of the environment around him and its application to society. Questions will also be designed to test knowledge of current events and of such matters of every day observations and experience in their scientific aspect as may be expected of any educated person. The test will also include questions relating to India and its neighboring countries especially pertaining History, Culture, Geography, Economic Scene, General Policy and Scientific Research.

All the Best!

CONTENTS

Indian History – Important Dates

BC	Event
2300–1750	Indus Valley Civilization.
From 1500	Coming of the Aryans.
1200–800	Expansion of the Aryans in the Ganga Valley.
600	Age of the 16 Mahajanapadas of northern India.
563–483	Buddha's Life-span.
540–468	Mahavir's Life-span.
362–321	Nanda dynasty.
327–326	Alexander's invasion of India. It opened a land route between India and Europe.
322	Accession of Chandragupta Maurya.
305	Defeat of Seleucus at the hands of Chandragupta Maurya.
273–232	Ashoka's reign.
261	Conquest of Kalinga.
145–101	Regin of Elara, the Chola king of Sri Lanka.
58	Beginning of Vikram era.
AD	
78	Beginning of Saka era.
78-101	Kanishka's reign.
319–320	Commencement of Gupta era.
380	Accession of Chandragupta II 'Vikramaditya'
405–411	Visit of Chinese traveller Fahien.
415	Accession of Kumargupta I.
455	Accession of Skandagupta.
606–647	Harshavardhan's reign.

MEDIEVAL

712	First invasion in Sindh by Arabs (Mohd. Bin Qasim).
836	Accession of King Bhoja of Kannauj.
985	Accession of Rajaraja, the Chola ruler.
998	Accession of Sultan Mahmud Ghazni.
1001	First invasion of India by Mahmud Ghazni who defeated Jaipal, ruler of Punjab.
1025	Destruction of Somnath Temple by Mahmud Ghazni.
1191	First battle of Tarain.
1192	Second battle of Tarain.
1206	Accession of Qutubuddin Aibak to the throne of Delhi.
1210	Death of Qutubuddin Aibak.
1221	Chengiz Khan invaded India (Mongol invasion).
1236	Accession of Razia Sultana to the throne of Delhi.
1240	Death of Razia Sultana.

1296	Accession of Alauddin Khilji.
1316	Death of Alauddin Khilji.
1325	Accession of Muhammad-bin-Tughlaq.
1327	Transfer of capital from Delhi to Devagiri (Daulatabad) in Deccan by the Muhammad-bin-Tughlaq.
1336	Foundation of Vijaynagar empire in the South.
1351	Accession of Firoz Shah Tughlaq.
1398	Timur's invasion of India.
1469	Birth of Guru Nanak.
1494	Accession of Babur in Farghana.
1497–98	First voyage of Vasco da Gama to India (discovery of sea route to India via the Cape of Good Hope)
1526	First Battle of Panipat; Babur defeated Ibrahim Lodhi; foundation of Mughal dynasty by Babur.
1527	Battle of Khanwa-Babur defeated Rana Sanga.
1530	Death of Babur and accession of Humayun.
1539	Sher Shah Suri defeated Humayun in the battle of Chausa and became India's emperor.
1555	Humayun recaptured the throne of Delhi.
1556	Second Battle of Panipat (Bairam Khan defeated Hemu).
1556	Battle of Talikota (Rakshasa-Tangadi).
1576	Battle of Haldighati-Rana Pratap was defeated by Akbar.
1582	Din-i-Ilahi founded by Akbar.
1600	English East India Company established.
1605	Death of Akbar and accession of Jahangir.
1606	Execution of Guru Arjun Dev, the 5th Guru of Sikhs.
1611	Jahangir marries Nurjahan.
1615	Sir Thomas Roe visits Jahangir.
1627	Birth of Shivaji and death of Jahangir.
1628	Shahjahan becomes emperor of India.
1631	Death of Mumtazmahal.
1634	The English permitted to trade in India (in Bengal).
1659	Accession of Aurangzeb, Shahjahan imprisoned.
1665	Shivaji imprisoned by Aurangzeb.
1666	Death of Shahjahan.
1675	Execution of Guru Teg Bahadur, the 9th Guru of Sikhs.
1680	Death of Shivaji.
1707	Death of Aurangzeb.
1708	Death of Guru Gobind Singh, the 10th Guru of Sikhs.
1739	Nadir Shah invades India.
1757	Battle of Plassey, establishment of British political rule in India at the hands of Lord Clive.
1761	Third battle of Panipat.

MODERN

1764	Battle of Buxar.
1765	Clive appointed Company's Governor in India.
1767–69	First Angle-Mysore War.
1780	Birth of Maharaja Ranjit Singh.
1780-84	Second Anglo-Mysore War.
1784	Pitt's India Act.
1790-92	Third Anglo-Mysore War.
1793	The Permanent Settlement of Bengal.
1799	Fourth Anglo-Mysore War; Death of Tipu Sultan.
1802	Treaty of Bassein.
1809	Treaty of Amritsar.
1829	Practice of Sati prohibited.
1830	Raja Rammohan Roy visits England.
1833	Death of Raja Rammohan Roy at Bristol, England.
1839	Death of Maharaja Ranjit Singh.
1839–42	First Anglo-Afghan War.
1845–46	First Anglo-Sikh War.
1852	Second Anglo-Burmese War.
1853	First Railway line opened between Bombay and Thane and a Telegraph line in Calcutta.
1857	The Sepoy Mutiny or First War of Independence.
1861	Birth of Rabindranath Tagore.
1869	Birth of Mahatma Gandhi.
1885	Foundation of Indian National Congress.
1889	Birth of Jawaharlal Nehru.
1897	Birth of Subhash Chandra Bose.
1903	Tibet Expedition.
1905	Partition of Bengal by Lord Curzon.
1906	Foundation of Muslim League.
1911	Delhi Darbar, King George V and Queen visit India; Delhi becomes the capital of India.
1914	World War I begins.
1916	Lucknow Pact signed by Muslim League and Congress, Foundation of BHU, Home Rule League founded.
1918	World War I ends.
1919	Montague-Chelmsford Reforms introduced, Jallianwala Bagh massacre at Amritsar.
1920	Khilafat Movement launched, first meeting of All-India Trade Union Congress, Hunter Commission Report on Jallianwala Bagh Massacre Published First Non-cooperation movement launched by Gandhi.
1922	Violent incidents at Chaura Chauri Gandhi calls of Non-cooperation movement.

1925	Communist Party of India organised at Kanpur.
1927	Boycott of Simon Commission, Broadcasting started in India.
1928	Death of Lala Lajpat Rai, Nehru Report.
1929	Resolution of 'Poorna Swaraj' (complete independence) passed at Lahore Session of INC.
1930	Civil disobedience movement launched, Dandhi March by Mahatma Gandhi (April 6, 1930) First round table conference held in London.
1931	Gandhi-Irwin Pact, Civil Disobedience movement suspended Second round table conference held.
1932	MacDonald announces communal award (modified by Poona Pact, September 24).
1935	Government of India Act.
1937	Provincial Autonomy, Congress forms ministries.
1938	All India Kishan Sabha formed.
1939	World War II begins (September 3), Resignation of Congress Ministries in Provinces.
1941	Escape of Subhash Chandra Bose from India and death of Rabindranath Tagore.
1942	Arrival of Cripps Mission in India, Quit India movement launched (August 8).
1943–44	SC Bose forms Provisional Government of Free India and Indian National Army in Singapore; Bengal famine.
1945	Trial of Indian National Army at Red Fort, Shimla Conference; World War II ends.
1946	British Cabinet Mission visits India; Interim government formed at the Centre. The Muslim league decides on "Direct Action" for winning Pakistan.
1947	Division of India; India and Pakistan form separate independent dominions.

Important Congress Session

Year	Place	Importance
1885	Bombay	At Gokuldas Tejpal Sanskrit College, 72 delegates attended the session.
1886	Calcutta	436 delegates attended the session.
1887	Madras	Tayabji became **first Muslim President.**
1888	Allahabad	George Yule became **first English President.**
1889	Bombay	Congress represented all areas of British India.
1890	Calcutta	Decision taken to organises session of congsess in London.
1895	Poona	Demand of a representative body only for educated class.
1898	Madras	Social reform was set as the main goal.
1907	Surat	Congress split.
1908	Madras	Constitution for the Congress fromed.
1916	Lucknow	Congress merged. Pact with Muslim League, Gandhi attended
1917	Calcutta	Annie Besant became **1st women President.**
1920	Nagpur	Gandhian programme was adopted. Change in congress constitution.
1921	Ahmedabad	Harsat Mohani demanded for complete independence.
1922	Gaya	Formation of Swaraj Party.

1923	Delhi	Abul Kalam Azad became President (Youngest President) (sp. session)
1924	Belgaum	Gandhi became President (Gandhi became President here first and last time).
1925	Kanpur	Sarojini Naidu became **1st Indian women President.**
1927	Madras	Nehru and S.C. Bose moved resolution for independence and it was passed for the 1st time.
1928	Calcutta	First All India Youth Congress.
1929	Lahore	'Poorna Swaraj' (Complete Independence) resolution and pledge for Independence day on 26 January 1930.
1931	Karachi	Resolution for Fundamental Rights and National Economic Policy.
1934	Bombay	Formation of Congress Socialist Party.
1936	Lucknow	Support for socialism through democracy.
1937	Faizpur	Demand for Constituent Assembly (First session in a village).
1938	Haripura	Purna Swaraj was to cover also princely states.
1939	Tripuri	S.C. Bose resigned due to difference with Gandhi. Dr. Rajendra Prasad was appointed in hisplace.
1940	Ramgarh	Abul Kalam Azad became President.
1946.	Meerut	J. B. Kriplani became President.
1948	Jaipur	Dr. Pattabhi Sitaramayya became President.

World History: Important Dates

BC

10000–4000	Development of settlement into cities and development of skills, such as wheel and pottery making and improved methods ofcultivation.
5500–3000	Earliest recorded date of Egyptian calender; first phonetic writing appears; Sumerians develop a city-state civilization.
3000–2000	Pharaonic rule begins in Egypt; completion of the construction of the Great Pyramid at Giza.
3000–1500	The most ancient civilization on the Indian subcontinent, the sophisticated and extensive Indus Valley Civilization, flourishes in what is today Pakistan.
900–800	Phoenicians establish Carthage: The Iliad and Odyssey was composed by the Greek poet Homer.
400–300	Pentateuch-first five Books of the Old Testament evolve in final form. 300–
251	Invention of Mayan calendar in Yucatan-more exact than older calenders.
101–51	Juleus Caesar (100–44 BC) invades Britain (55 BC) and conquers Gaul, France.
776	First Olympiad in Greece.
753	Rome founded.
490	Battle of Marathon, the Greeks defeated the Iranians/Persians.
327–26	Invasion of India by Alexander, Battle of Hydaspes.
221	Chin-Hung Ti 'Universal Emperor' in China, Great Wall of China completed.
55	Invasion of Britain by Julius Caesar, the Great Roman General.
44	Assassination of Julius Caesar by Brutus.
4	Birth of Jesus Christ.

AD

29	Crucifixation of Jesus Christ.
43	Roman conquest of Britain.
570	Birth of Prophet Muhammad at Mecca.
622	Migration of Muhammad from Mecca to Medina ("hijira"), Beginning of Hijira Era (Muhammadan calender) on July 15.
800	Charlemagne crowned Roman Emperor at St. Peter's.
871	Accession of Alfred the Great to the throne of Britain.
901	Death of King Alfred the Great.
1066	Battle of Hastings; Norman invasion of England. William the Conqueror, Duke of Normandly, defeated the English king Harold II at Hastings.
1215	Magna Carta or the Great Charter signed by King John II at Runnymede in England on June 15.
1280	Gunpowder invented by Roger Bacon.
1338	The Hundred Years War broke out; it lasted upto 1453.
1431	Joan of Arc, a brave French peasant girl, obtained victory over the English at Orleans. She was burnt alive at the stakes.
1443	The Black death *i.e.,* plagues broke out in England.
1453	The capture of Constantinople (the home of classical learning) by the Ottoman Turks compelled the Greek scholars to flee to Italy and other West European countries, where they spread the knowledge of Greek philosophy and literature. This was the beginning of Renaissance in Europe.
1486	Bartholomew Diaz rounded the cope of Good Hope.
1492	Columbus sailed on his first expedition to the West Indies which later led to the discovery of America (the New World).
1498	Vasco da Gama, a Portuguese, discovered the seat route to India via the Cape of Good Hope.
1517	Beginning of reformation.
1529–36	Reformation in England under Henry VIII.
1564	Birth of Shakespeare.
1571	Battle of Lapanto; Turks defeated by the Christian League.
1577	Drake, the famous English Admiral; started his voyage round the world for the first time and phindered Spanish ships and ports in South America.
1588	Admiral Drake defeated the Spanish 'Armada'; England became the 'Mistress of the Seas'.
1600	Establishment of the British East India Company in India (31st December).
1605	Gunpowder plot in England to blow up the English parliament.
1616	Shakespeare passes away.
1649	Trial and execution of Charles I, beginning of Commonwealth.
1649–60	The Commonwealth and the Protectorate in England.
1660	Restoration of monarchy in England.
1665	The great plague in London.
1679	Habeas Corpus Act.
1688	The Glorious or Bloodless Revolution in England. Despotic rule of the Stuarts ended, and the Parliamentary rule began. Establishment of parliamentary supremacy and abolition of the Divine Rights of Kings.

1704	Battle of Blenheim; Marlborough and Eugene inflicted a crushing defeat on the French army.
1707	Union of England and Scotland.
1763	Treaty of Paris; It ended the Seven Years War (1756–63); weakened France, made England a great colonial power.
1776	Declaration of American Independence and formation of a Federal Republic of 13 states called the Union States of America (July 4).
1783	Treaty of Versailles; England recognised the independence of the United States of America.
1789	George Washington elected First President of USA. Beginning of French Revolution; Fall of the Bastille Fort (July 14).
1798	Battle of the Nile. The English under Nelson gained victory over the French.
1805	Battle of Trafalgar; Death of Nelson.
	Battle of Austerliz – Napolean Bonaparte rounted a combined army of the Russians and the Austrians.
1815	Battle of Waterloo – Napolean was defeated and exiled to St. Helena.
	Congress of Vienna, it aimed at rearranging the map of Europe; The Vienna settlement proved unsatisfactory, because it disregarded national claims.
1821	Death of Napolean at St. Helena (May 5).
1827	Battle of Navatino; the allied fleets of England, Russia and France destroyed the Turkish fleet; This victory practically secured the independence of Greece.
1833	Emancipation Act of 1833; It abolished slavery in the British dominions.
1837	Accession of Queen Victoria to the throne of England.
1839	Introduction of Penny Postage system in England by Sir Rowland Hill: Aden annexed by England.
1854	The Crimean War began, Russia attacked Turkey; England and France came to the rescue of Turkey.
1861	American Civil War started, Abraham Lincon elected 16th President of USA.
1863	Slavery abolished in America.
1869	Suez Canal opened for traffic.
1885	General Gordon captured and slain at Khartoum.
1899	Outbreak of the Russo-Japanese war.
1905	Battle of the sea of Japan; Japan inflicted a crushing naval defeat on Russia; a wave of nationalism spread in Asia.
1911	Chinese Republican Revolution; Amundsen reached South Pole (December 14)
1914	Outbreak of World War-I (August 4)
1916	Battle of Jutland (Naval Battle). The British Grand Fleet under Admiral Jellico defeated the German Fleet under Admiral Scheer.
1917	(March/ Febuary) Revolution in Russia; the Czar abdicated and later assassinated; reformist Mensheviks came into power (Prince Lvov, Kerensky).
	(November/ October) Revolution in Russia: Revolutionary Bolsheviks came into power (Lenin).
1918	End of World War I (November 11)
1919	The Paris Conference; the Treaty of Versailles.
1920	Foundation of the League of Nations (January 10)
1921	The Irish Free State established with the status of a Dominion like Canada (December 6).

1923	Turkish Republic proclaimed with Kemal Ataturk as its First President.
1924	Lenin died, and power passed into the hands of Stalin in Russia.
1925	Treaty of Locarno (between Great Britain, France, Germany, Italy and Belgium).
1928	Kellogg Pact (signed in Paris by the principal powers of the world for the prevention of war; it had no effect).
1933	Hitler became the Chancellor of Germany.
1935	War between Italy and Abyssinia (Ethiopia); Italy annexed Abyssinia (Ethiopia); Plebiscite in Saar.
1939	Germany invaded Poland: Outbreak of World War II (September. 1).
1940	Fall of France after German invasion (June 5); Italy entered World War II (June 11).
1941	Hitler invades Russia (June 22): Framing of the Atlantic Charter (August 14); Japan attacked Pearl Harbour (Hawaii Islands) (December 7); USA entered World War II (December 8); China entered World War II (December. 10) Air raids by Japan on Rangoon (December 22).
1942	Capture of Singapore by Japanese forces (Febuary. 15); Battle of Coral Sea, Japanese fleet suffered heavy losses at the hands of the American fleet (May 3); Battle of Stalingrad (September. 19).
1943	Defeat of Germany at Stalingrad (Febuary. 8); Battle of the Bismarck Sea, America defeated Japan in a naval battle (March 4); Invasion of Italy by the Allies, Armistice between Italy and the Allies (September 3).
1944	Allied forces landed in Normandy under the supreme command of General Ike (Eisenhower); (D-Day) (June 6); Liberation of Paris (August 25).
1945	Execution of Mussolini (April 22); Unconditional surrender of Germany to the Allies (May 7); USA dropped atom bomb on Hiroshima and Nagasaki of Japan (August 6 and August 9); Unconditional surrender of Japan (August 14); World War II ended (August 14); Foundation of UNO (October 24).

Offices under Government of India

President of India

Dr. Rajendra Prasad	1950–1962
Dr. S. Radhakrishnan	1962–1967
Dr. Zakir Hussain	1967–1969 (Died)
Varahagiri Venkata Giri	1969–1969 (Acting)
Justice Md. Hidayatullah	1969–1969 (Acting)
Varahagiri Venkata Giri	1969–1974
Fakhruddin Ali Ahmed	1974–1977 (Died)
B. D. Jatti	1977–1977 (Acting)
Neelam Sanjiva Reddy	1977–1982
Giani Zail Singh	1982–1987
R. Venkataraman	1987–1992
Dr. Shankar Dayal Sharma	1992–1997
K. R. Narayanan	1997–2002
Dr. A.P.J. Abdul Kalam	2002–2007
Smt. Pratibha DeviSingh Patil	2007–2012
Pranab Mukherjee	2012-Till Date

VICE–PRESIDENTS OF INDIA

Dr. S. Radhakrishnan	1952–1962
Dr. Zakir Hussain	1962–1967
Varahagiri Venkata Giri	1967–1969
Gopal Swarup Pathak	1969–1974
B. D. Jatti	1974–1979
Justice Md. Hidayatullah	1979–1984
R. Venkataraman	1984–1987
Dr. Shanker Dayal Sharma	1987–1992
K. R. Narayanan	1992–1997
Krishan Kant	1997–2002 (Died)
Bhairon Singh Shekhawat	2002–2007
Md. Hamid Ansari	2007 –Till Date

PRIME MINISTERS OF INDIA

Jawaharlal Nehru	1947–1964 (Died)
Gulzari Lal Nanda	1964–1964 (Acting)
Lal Bahadur Shastri	1964–1966 (Died)
Gulzari Lal Nanda	1966–1966 (Acting)
Indira Gandhi	1966–1977
Morarji Desai	1977–1979
Charan Singh	1979–1980
Indira Gandhi	1980–1984 (Died)
Rajiv Gandhi	1984–1989
V. P. Singh	1989–1990
Chandra Shekhar	1990–1991
P. V. Narasimha Rao	1991–1996
Atal Bihari Vajpayee	1996–1996 (For 16 Days)
H. D. Deve Gowda	1996–1998
I. K. Gujral	1997–1998
Atal Bihari Vajpayee	1998–1999
Atal Bihari Vajpayee	1999–2004
Dr. Manmohan Singh	2004–2009
Dr. Manmohan Singh	2009–till date

DEPUTY PRIME MINISTERS OF INDIA

Sardar Patel	1947–1950
Morarji Desai	1967–1969
Charan Singh and Jagjivan Ram (jointly)	1979–1979
Y. B. Chavan	1979–1980
Devi Lal	1989–1990
Devi Lal	1990–1991
LK. Advani	2002–2004

FINANCE MINISTERS OF INDIA

R. K.Shanmukham Chetty	1947–1949
John Mathai	1949–1951
C.D. Deshmukh	1951–1957
T. T. Krishnamachari	1957–1958
Jawaharlal Nehru	1958–1959
Morarji Desai	1959–1964
T. T. Krishnamachari	1964–1966
Sachindra Chowdhary	1966–1967
Morarji Desai	1967–1970
Indira Gandhi	1970–1971
Y. B. Chavan	1971–1975
C. Subramaniam	1975–1977
H. M. Patel	1977–1978
Charan Singh	1979–1980
R. Venkataraman	1980–1982
Pranab Mukherjee	1982–1985
V.P. Singh	1985–1987
N.D. Tiwari	1988–1989
S.B. Chavan	1989–1990
Madhu Dandavate	1990–1991
Yashwant Sinha	1991–1991
Manmohan Singh	1991–1996
P. Shidambaram	1996–1998
Yashwant Sinha	1998–2002
Jaswant Singh	2002–2004
P. Chidambaram	2004–2008
Pranab Mukherjee	2009–2012
P. Chidambaram	2012-Till Date

SPEAKERS OF THE LOK SABHA

G.V. Mavalankar	1952–1956 (Died)
M. A. Ayyangar	1956–1962
Hukam Singh	1962–1967
Neelam Sanjiva Reddy	1967–1969 (Resigned)
Gurdial Singh Dhillon	1969–1975 (Resigned)
Bali Ram Bhagat	1976–1977
Neelam Sanjiya Reddy	1977–1977 (Resigned)
K.S. Hegde	1977–1980
Balram Jakhar	1980–1989
Rabi Ray	1989–1991
Shivraj V. Patil	1991–1996
P.A. Sangma	1996–1998
G.M.C. Balayogi	1998–2002 (Died)
Manohar Joshi	2002–2004
Somnath Chatterjee	2004–2009
Ms. Meira Kumar	2009–till date

CHIEF JUSTICE OF INDIA

Harilal J. Kania	1950–1951
M. Patanjali Sastri	1951–1954
M.C. Mahajan	1954–1954
B.K. Mukherjee	1954–1956
S.R. Das	1956–1959
B.P. Sinha	1959–1964
P.B. Gajendragadkar	1964–1966
A.K. Sarkar	1966–1966
K. Subba Rao	1966–1967
K.N. Wanchoo	1967–1968
M. Hidayatullah	1968–1970
J.C. Shah	1970–1971
S.M. Sikri	1971–1973
A.N. Ray	1973–1977
M.H. Beg	1977–1978
Y.V. Chandrachud	1978–1985
P.N. Bhagwati	1985–1986
R.S. Pathak	1986–1989
E.S. Venkataramaiah	1989–1989
S. Mukherjee	1989–1990
Ranganath Mishra	1990–1991
K.N. Singh	1991–1992
M.H. Kania	1991–1992
L.M. Sharma	1992–1993
M.N. Venkatachalaiah	1993–1994
A.M. Ahmadi	1994–1997
J.S. Verma	1997–1998
M.M. Punchhi	1998–1998
A.S. Anand	1998–2001
S.P. Bharucha	2001–2002
B.N. Kirpal	2002–2002
G.B. Pattanaik	2002–2002
V.N. Khare	2002–2004
S. Rajendra Babu	2004–2005
R.C. Lahoti	2004–2005
Y.K. Sabharwal	2005–2005
K.G. Balakrishnan	2007 –2010
S.H. Kapadia	2010–2012
Altamas Kabir	2012-2013
Mr. Justice R.M. Lodha	27.04.2014 to till date

CHIEF ELECTION COMMISSIONERS OF INDIA

Sukumar Sen	1950–1958
K.V.K. Sundaram	1958–1967
S.P. Sen Verma	1967–1972
Dr. Nagendra Singh	1972–1973
T. Swaminathan	1973–1977
S.L. Shakdhar	1977–1982
R.K. Trivedi	1982–1985
R.V.S. Peri Sastri	1986–1990
Smt. V.S. Rama Devi	1990–1990
T.N. Seshan	1990–1996
M.S. Gill	1996–2001
J.M. Lyngdoh	2001–2004
T.S. Krishna Murthy	2004–2005
B.B. Tandon	2005–2006
N. Gopalaswamy	2006–2009
Naveen Chawla	2009–2010
S.Y. Quraishi	2010-2012
H.S. Brahma and Syd Ahmad Zaidi	2012-Till Date

CHAIRMAN OF THE UPSC

Sir Ross Barker	1926–1932
Sir David Petrie	1932–1936
Sir Eyre Gorden	1937–1942
Sir F.W. Robertson	1942–1947
H.K. Kripalani	1947–1949
R.N. Banerjee	1949–1955
N. Govindarajan	1955–1955
V.S. Hejmadi	1955–1961
B.N. Jha	1961–1967
K.R. Damle	1967–1971
R.C.S. Sarkar	1971–1973
Dr. A.R. Kidwai	1973–1979
Dr. M.L. Shahare	1979–1985
H.K.L. Capoor	1985–1990
J.P. Gupta	1990–1992
Smt. R.M. Bathew (Kharbuli)	1992–1996
S.J.S. Chhatwal	1996–1996
J.M. Qureshi	1996–1998
Surinder Nath	1998–2002
P.C. Hota	2002–2003
Mata Prasad	2003–2005
Dr. S.R. Hashim	2005–2006
Gurbachan Jagat	2006–2007
Subir Dutta	2007–2008
D.P. Agrawal	2008–till date

COMPTROLLER AND AUDITOR–GENERALS OF INDIA

V. Narhari Rao	1948–1954
A.K. Chanda	1954–1960
Sh. A.K. Roy	1960–1966
S. Ranganathan	1966–1972
A. Baksi	1972–1984
Gian Prakash	1978–1978
T.N. Chaturvedi	1984–1990
C.G. Somiah	1990–1996
V.K. Shunglu	1996–2002
V.N. Kaul	2002–2008
Vinod Rai	2008–2013
Shashi Kant Sharma	2013-Till Date

ATTORNEY-GENERALS OF INDIA

M.C. Setalved	1950–1963
C.K. Daphtary	1963–1968
Niren De	1968–1977
S.V. Gupte	1977–1979
L.N. Sinha	1979–1983
K. Parasaran	1983–1989
Soli J. Sorabjee	1989–1990
G. Ramaswamy	1990–1992
Milon K. Banerjee	1992–1996
Ashok K. Desai	1996–1998
Soli J. Sorabjee	1998–2004
Milon K. Banerjee	2004–2009
Goolam E. Vahanvati	2009–till date

GOVERNORS OF RESERVE BANK OF INDIA

Sir Oshorne Smith	1935–1937
Sir James Taylor	1937–1943
Sir C.D. Deshmukh	1943–1949
Sir Benegal Rama Rau	1949–1957
K.G. Ambegaonkar	1957–1957
H.V.R. Lengar	1957–1962
P.C. Bhattacharya	1962–1967
L.K. Jha	1967–1970
B.N. Adarkar	1970–1970
S. Jagannathan	1970–1975
N.C. Sen Gupta	1975–1975
K.R. Puri	1975–1977
M. Narasimham	1977–1977
Dr. I.G. Patel	1977–1982
Dr. Manmohan Singh	1982–1985
A. Ghosh	1985–1985
R.N. Malhotra	1985–1990
S. Venkitaramanan	1990–1992
Dr. C. Rangarajan	1992–1997
Dr. Bimal Jalan	1997–2003
Dr. Y.V. Reddy	2003–2008

Dr. D. Subba Rao	2008–2013
Raghuram Rajan	2013-Till Date

COMMANDERS–IN–CHIEF

General Sir Roy Bucher	1948–1949
General K.M. Cariappa	1949–1953
General Maharja Rajendra Sinhji	1953–1955

CHIEFS OF ARMY STAFF

General Maharaj Rajendra Sinhji	1955–1955
General S.M. Srinagesh	1955–1957
General K.S. Thimayya	1957–1961
General P.N. Thapar	1961–1962
General J.N. Choudhuri	1962–1966
General P.P. Kumaramangalam	1966–1969
General S.H.F.J. Manekshaw	1969–1972
General S.H.F.J Manekshaw	1973–1973
General G.G. Bewoor	1973–1975
General T.N. Raina	1975–1978
General OP. Malhotra	1978–1981
General K.V. Krishna Rao	1981–1983
General A.S. Vaidya	1983–1986
General K. Sunderji	1986–1988
General V.N. Sharma	1988–1990
General S.F. Rodrigues	1990–1993
General B.C. Joshi	1993–1994
General Shankar Roychow Dhury	1994–1997
General Ved Prakash Malik	1997–2000
General S. Padmanabhan	2000–2002
General N.C. Vij	2003–2005
General J.J. Singh	2005–2007
General Deepak Kapoor	2007–2010
General V.K. Singh	2010–2012
General Bikram Singh	2012–till date

CHIEFS OF NAVAL STAFF

Rear Admiral John Talbot Savigna Hall	1947–1948
Admiral Sir Edward Parry	1948–1951
Admiral Sir Mark Pizey	1951–1955
Vice Admiral Sir Stephen Carlill	1955–1958
Vice Admiral R.D. Katari	1958–1962
Vice Admiral B.S. Soman	1962–1966
Admiral A.K. Chatterjee	1966–1970
Admiral S.M. Nanda	1970–1973
Admiral S.N. Kohli	1973–1976
Admiral J.L. Cursetji	1976–1979

Admiral R.L. Pereira	1979–1982
Admiral O.S. Dawson	1982–1984
Admiral R.H. Tahiliani	1984–1987
Admiral J.G. Nadkami	1987–1990
Admiral Ramdas	1990–1993
Admiral V.S. Shekhawat	1993–1996
Admiral Vishnu Bhagwat	1996–1998
Admiral Sushil Kumar	1998–2001
Admiral Madhvendra Singh	2001–2004
Admiral Arun Prakash	2004–2006
Admiral Suresh Mehta	2006–2009
Admiral Nirmal Kumar Verma	2009–2012
Admiral R K Dhowan	2012-Till Date

CHIEFS OF AIR STAFF

Air Marshal Sir Thomas Elmhirst	1947–1950
Air Marshal Sir Ronald Chapman	1950–1951
Air Marshal Sir Gerald Gibbs	1951–1954
Air Marshal S. Mukherjee	1954–1960
Air Marshal A.M. Engineer	1960–1964
Air Chief Marshal Arjan Singh	1964–1969
Air Chief Marshal P.C. Lal	1969–1973
Air Chief Marshal O.P. Mehra	1973–1976
Air Chief Marshal H. Moolgavkar	1976–1978
Air Chief Marshal I.H. Latif	1978–1981
Air Chief Marshal Dilbagh Singh	1981–1984
Air Chief Marshal L.M. Katre	1984–1985
Air Chief Marshal D.A. La Fontaine	1985–1988
Air Chief Marshal S.K. Mehra	1988–1991
Air Chief Marshal N.C. Suri	1991–1993
Air Chief Marshal S.K. Kaul	1993–1995
Air Chief Marshal S.K. Sareen	1996–1998
Air Chief Marshal A.Y. Tipnis	1999–2001
Air Chief Marshal S. Krishnaswamy	2001–2004
Air Chief Marshal S.P. Tyagi	2004–2007
Air Chief Marshal Fali H. Major	2007–2009
Air Chief Marshal Pradeep Vasant Naik	2009–2011
Air Chief Marshal Norman Anil Kumar Browne	2011-2013
Air Chief MarshalArup Raha	2013-Till Date

Geography of India and the world

Countries	Main Produces/Industries
Afghanistan	Dry and fresh fruits, Carpets, Wool
Australia	Wood, dairy products, wheat, meat, lead, zinc
Austria	Machinery, textiles, leather goods
Brazil	Coffee
Belgium	Glass, textiles
Chile	Copper nitrate
Canada	Wheat, newsprint, machinery
China	Silk, tea, rice
Congo	Copper, uranium, cobalt, ivory
Cuba	Sugar, tobacco, cigar
Denmark	Textiles, paper
France	Textile, wine, silk
Germany	Machinery, chemical, iron and steel equipments
Ghana	Coco, gold, coffee
India	Jute, textiles, sugar, spices, tobacco, tea, cement, mica etc.
Indonesia	Sugar, spices, rubber, rice, cinchona, petroleum
Iran	Petroleum, carpets, dry fruits
Iraq	Dates, petroleum
Italy	Mercury, textiles
Japan	Machinery, textiles, toys, silk, automobiles
Kenya	Coffee, tea, meat, sisal, hides
Kuwait	Petroleum

Countries	Main Produces/Industries *(Contd.)*
Malaysia	Rubber, tin
The Netherlands	Machinery, aircraft, electricals
Saudi Arabia	Oil, dates
Spain	Lead
Sweden	Matches, timber
Switzerland	Watches, chemicals, electricals
Taiwan	Camphor, rice
UK	Textiles, medicines, machinery, cars
USA	Petroleum, wheat, machinery, coal, automobiles, iron etc.
Russia	Petroleum, wheat, chemicals, heavy machinery, etc.
	Vietnam Tin, rice, rubber, teak, etc.

RIVER SIDE CITIES

(Afghanistan,India, Pakistan,BangladeshandMyanmar)

Town	River
Kabul (Afghanistan)	Kabul
Allahabad	Confluence of Ganga, Yamuna,

	Saraswati (invisible)
Varanasi	Ganga
Nasik	Godawari
Kolkata	Hooghly
Cuttack	Mahanadi
Patna	Ganga
Chittagong (Bangladesh)	Maiyani
Lucknow	Gomati
Jamshedpur	Subarnarekha
Haridwar	Ganga
Delhi	Yamuna
Kanpur	Ganga
Surat	Tapti
Srinagar	Jhelum
Ferozepur	Sutlej
Ludhiana	Sutlej
Karachi (Pak)	Indus
Yangon (Myanmar)	Irawady
Akyab (Myanmar)	Irawady
Vijaywada	Krishna
Lahore (Pak)	Ravi
Paris (France)	Seine
Hamburg (Germany)	Elbe
Budapest (Hungary)	Danube
Rome (Italy)	Tiber
Warsaw (Poland)	Vistula
Bristol (U.K.)	Avon
London (U.K.)	Thames
New Castle (U.K.)	Tyre
China	
Shanghai	Yang-tse-Kiang
Nanking	Yang-tse-Kiang
Chungking	Yang-tse-Kiang
Canton	Si-Kiang
Middle East and Africa	
Cairo (Egypt)	Nile
Basra (Iraq)	Tigris and Euphrates
Ankara (Turkey)	Kizil
Baghdad (Iraq)	Tigris
Khartoum (Sudan)	Blue and While Nile
Europe	
Berlin (Germany)	Spree

Belgrade	Dunube
Cologne (Germany)	Rhine
Lisbon (Portugal)	Tangus
Glasgow (Scotland)	Clyde
USA	
New York	Hudson
Philadelphia	Delaware
New Orleans	Mississippi
Monetreal (Canada)	Ottawa
Quebec (Canada)	St. Lawrence

Durand Line is the line demarcating the boundaries of India and Afghanistan. It was drawn up in 1896 by Sir Mortimer Durand.

Hindenburg Line is the boundary dividing Germany and Poland. The Germans retreated to this line in 1917 during World War I.

Mason-dixon Line is a line of demarcation between four states in the United States.

Marginal Line was the 320 km line of fortification built by France along its border with Germany before World War II, to protect its boundary from German attack.

Mannerheim Line is the line of fortification on the Russia-Finland border. Drawn up by General Mannerheim.

Macmahon Line was drawn up by Sir Henry MacMahon, demarcating the frontier of India and China. China did not recognize the MacMahon line and crossed it in 1962.

Medicine Line is the border between Canada and the United States.

Order-neisse Line is the border between Poland and Germany, running along the Order and Beisse rivers, adopted at the poland Conference (August 1945) after World War II.

Radcliffe Line was drawn up by Sir Cyril Radcliffe, demarcating the boundary between India and Pakistan.

Siegfried Line is the line of fortification drawn up by Germany on its border with France.

17th Parallel defined the boundary between North Vietnam and South Vietnam before the two were united.

24th Parallel is the line which Pakistan claims for demarcation between India and Pakistan. This, however, is not recognized by India.

26th Parallel south is a circle of latitude which croses through Africa, Australia and South America.

30th Parallel north is a line of latitude that stands one-third of the way between the equator and the North Pole.

33rd Parallel north is a circle of latitude which cuts through the southeren United States, parts of North Africa, parts of the Middle East, and China.

35th Parallel north forms the boundary between the State of North Carolina and the State of Georgia and the boundary between the State of Tennessee arid the State of Georgia the State of Alabama, and the State of Mississippi.

36°30′ Parallel north forms the boundary between the Tennessee and Commonwealth of Kentucky between the Tennessee River and the Mississippi River, the boundary between Missiouri and Arkansas west of the White River, and the northernmost boundary between the Texas and the Oklahoma.

37th Parallel north formed the southern boundary of the historic and extralegal Territory of Jefferson.

38th Parallel is the parallel of latitude which separates North Korea and South Korea.

39th Parallel north is an imaginary circle of latitude that is 39 degrees north of the Earth's equatorial plane.

40th Parallel north formed the original northern boundary of the British Colony of Maryla nd.

41th Parallel north forms the northern boundary of the State of Colorado with Nebraska and Wyoming and the southern boundary of the State of Wyoming with Colorado and Utah.

42nd Parallel north forms most of the New York - Pennsylania Border.

43rd Parallel north forms most of the boundary between the State of Nebraska and the State of South Dakota and also formed the northern border of the historic and extralegal Territory of Jefferson.

The Parallel 44° north is an imaginary circle of latitude that is 44 degrees north of the Earth's equatorial plane.

45th Parallel north is often called the halfway point between the Equator and the North Pole. The 45th parallel makes up most of the boundary between Montana and Wyoming. 45th parallel of south latitude is the east-west line that marks the theoretical halfway point between the equator and the South Pole.

49th Parallel is the boundary between USA and Canada.

New Zones that started functioning on 1st April, 2003

Zone	Headquarters
East Coast Railway	Bhubaneshwar
South Western Railway	Hubli
West Central Railway	Jabalpur
North Central Railway	Allahabad
South East Central Railway	Bilaspur

New Zones that were created on 10th October, 2002

North Western Railway	Jaipur
East Central Railway	Hajipur

Old Zones as they are after April, 2003

Western Railway	Mumbai
Central Railway	Mumbai
Easter Railway	Kolkata
Southern Railway	Chennai
Northern Railway	New Delhi
North Eastern Railway	Gorakhpur
South Central Railway	Secumderabad
South Eastern Railway	Kolkata
North-East	Guwahati

Oldest Countries

- San Marino (301 AD)
- Bulgaria (632 AD)
- Portugal (1143 AD)
- Switzerland (1291 AD)
- France (486 AD)
- Denmark (950 AD)
- Andorra (1278 AD)

Countries with Most Land Borders

(The Most Neighbouring Countries)

- China (14)
- Russian Federation 14)
- Brazil (10)
- Congo, Germany and Sudan (9)

Youngest Countries

- Montenegro (July 2006)
- East Timor (2002)
- Czech Republic (1993)
- Slovakia (1993)
- Serbia (July 2006)
- Palau (1994)
- Eritrea (1993)
- Bosnia/ Hertzegovina (1992)

Animal, Tallest	Giraffe
Archipelago Largest	Indonesia
Bird, Fastest	Swift
Bird, Largest	Ostrich
Bird, smallest	Humming Bird
Bridge, Longest	Railway Huey P. Long Bridge, Louisiana (USA)
Building Tallest in the World	Teipei 101, Taiwan
Canal, Longest irrigational	The Kalakumsky Canal
Canal, Longest	Suez Canal
Capital, Highest	La Paz (Bolivia)
City, Biggest in Area	Mount Isa (Australia)
City, Largest in Population	Tokyo
City, Costliest	Tokyo
City, Highest	Van Chuan (China)
Creature, Largest	Blue Whale
Delta, Largest	Sunderban (Bangladesh and India)
Desert, Largest (World)	Sahara (Africa)
Desert, Largest (Asia)	Gobi
Dam, Largest	Grand Coulee Dam (USA)
Dam, Highest	Hoover Dam (USA)
Diamond, Largest	The Cullinan
Dome, Largest	Astrodome, in Housten (USA)
Epic, Largest	Mahabharat
Irrigation Scheme, Largest	Lloyd Barrage, Sukkhur (Pakistan)
Island, Largest	Greenland
Sea, Largest	Mediterranean Sea
Lake, Deepest	Baikal (Siberia)
Lake, Largest (Artificial)	Lake Mead (Boulder Dam)
Lake, Highest	Titicaca (Bolivia)
Lake, Largest (Fresh Water)	Superior
Lake, Largest (Salt Water)	Caspian
Library, Largest	United States Library of Congress, Washington D.C.
Mountain Peak, Highest Everest	Nepal
Mountain Range	Andes (South America)
Museum, Largest	British Museum, London

Park, Largest	Yellow Stone National Park (USA)
Peninsula, Largest	Arabia
Place, Coldest (Habitated)	Verkhoyansk (Siberia)
Place, Dryest	Iqique (in Atacama Desert, Chile)
Place, Hottest	Azizia (Libya, Africa)
Place, Rainiest	Mausinram (Meghalaya, India)
Planet, Biggest	Jupiter
Planet, Brightest	Venus
Planet, Smallest	Pluto
Plateau, Highest	Pamir (Tibet)
Platform, Longest	Kharagpur (India)
Railway, Longest	Trans-Siberian Railway
Railway Station, Largest	Grand Central Terminal, Chicago (USA)
River, Longest	Nile (Africa)
River, Largest	Amazon (South America)
Sea-Bird, Largest	Albatross
Star, Brightest	Sirius
Statue, Tallest Statue of Motherland	Volgagrad (Russia)
Telescope, Largest Radio	New Mexico (USA)
Tramway, World's First	New York
Tunnel, Longest (Railway)	Tanna (Japan)
Tunnel, Longest (Road)	Mont Blanc Tunnel between France and Italy
Volcano, Highest	Ojos del Salado (Andes, Ecuador)
Volcano, Most Active	Maunaloa (Hawaii-USA)
Wall, Longest	Great Wall of China
Waterfall, Highest	Angel (Venezuela)
Water, Lowest Body	Dead Sea
Zoo, Largest	Kruger National Park, South Africa

Mountain Peak	Range	Date of First Ascent	Location	Height	
				Ft.	m
Everest 1	Himalayas	29.05.1953	Nepal/ Tibet	29,028	8,848
K2 (Gidwin Austen)	Karakoram	31.07.1954	Pakistan/ China	28,251	8,611
Kanchenjunga	Himalayas	25.05.1955	India/ Nepal	28,169	8.586
Lhotse I	Himalayas	18.05.1956	Nepal/ Tibet	27,940	8,516
Makalu I	Himalayas	15.05.1955	Nepal/ Tibet	27,834	8,485
Cho Oyu	Himalayas	13.05.1960	Nepal/ Tibet	26,864	8,188
Dhaulagiri	Himalayas	09.05.1956	Nepal	26,795	8,167
Manaslu I	Himalayas	19.10.1954	Nepal	26,781	8,163
Nanga Parbat	Himalayas	03.07.1653	Pakistan	26,660	8,126
Annapurna	Himalayas	03.06.1950	Nepal	26,545	8,091

Tallest Mountains (on Each Continent)

- Mount Everest 8848 m (29035 ft) Asia
- Aconcagua 6959 m (22831 ft) S. America
- Mount Kckinley 6194 m (20320 ft) N. America
- Mount Kilimanjari 5963 m (19563 ft) Africa

- Mount Elbrus 5633 m (18481 ft) Europe
- Puncak Jaya 4884 m (16023 ft) Oceania
- Vinson Massif 4897 m (16066 ft) Antarctica

Major Deserts of the World

- Antarctic, Polar, 5.5 million mi², Antarctica
- Arctic, Polar, 5.4 million mi², Alaska, Canada, Greenland, Iceland, Norway, Sweden, Finland, Russia
- Sahara, Subtropical, 3.5 million mi², Northern Africa
- Arabian, Subtropical, 1 million mi², Arabian Peninsula
- Gobi, Cold Winter, 500,000 mi², China and Mongolia
- Patagonian, Cold Winter, 260,000 mi², Argentina
- Great Victoria, Subtropical, 250,000 mi², Australia
- Kalahari, Subtropical, 220,000 mi², South Africa, Botswana, Namibia
- Great Basin, Cold Winter, 190,000 mi², United States
- Thar, Subtropical, 175,000 mi², India, Pakistan
- Chihuahuan, Subtropical, 175,000 mi², Mexico
- Great Sandy, Subtropical, 150,000 mi², Australia
- Kara-Kum, Cold Winter, 135,000 mi², Uzbekistan, Turkmenistan
- Colorado Plateau, Cold Winter, 130,000 mi², United States
- Gibson, Subtropical, 120,000 mi², Australia
- Sonoran, Subtropical, 120,000 mi², United States, Mexico

Deepest Caves of the World

- **Krubera** which is the deepest cave in the world located in, Georgia (Abkhazia). The estimated depth is 2,080 m (6,822 ft).
- **Lamprechtsofen** which is the second deepest cave located in, Austria. The estimated depth is 1,631 m (5,354 ft).
- **Gouffre Mirolda** which is third in the list of deepest caves happens to be in France and estimated depth is 1,626 m (5,335 ft).
- **Reseau Jean Bernard** which was once believed to be the deepest cave in the world is located in **Alps, in Samoens, France.** The depth of the cave is 1,062 m (5,256 ft).
    - **Torca del Cerro**, last but not least the fifth in the list of deepest caves happens to be

Torca del Cerro located in Spain with a depth of 1,589 m (5,213 ft) it is one of the deepest caves in Spain.

General Science

SCIENTIFIC INSTRUMENTS

- **Cinematography:** It is an instrument used in cinema making to throw on screen and enlarged image of photograph.
- **Crescograph:** It measures the growth in plants.
- **Cyclotron:** A charged particle accelerator which can accelerate charged particles to high energies.
- **Dynamo:** It converts mechanical energy into electrical energy.
- **Dynamometer:** It measures electric power
- **Electrometer:** It measure electricity
- **Electroscope:** It detects presence of an electric charge.
- **Endoscope:** It examines internal parts of thebody.
- **Eudiometer:** A glass tube for measuring volume changes in chemical reactions between gases.
- **Fathometer:** It measures the depth of the ocean.
- **Galvanometer:** It measures the electric current of low magnitude.
- **Hydrometer:** It measures the specific gravity ofliquids.
- **Hygrometer:** It measures humidity in air.
- **Hydrophone:** It measures sound under water.
- **Kymograph:** It graphically records physiological movements (Blood pressure and heart beat).
- **Lactometer:** It determines the purity of milk.
- **Manometer:** It measures the pressure of gases.
- **Mariner's compass:** It is an instrument used by the sailors to determine the direction.
- **Microphone:** It converts the sound waves into electrical vibrations and to magnify the sound.
- **Microscope:** It is used to obtain magnified view of small objects.
- **Odometer:** An instrument by which the distance coveredby wheeled vehicles is measured.
- **Phonograph:** An instrument for producing sound.
- **Photometer:** The instrument compares the luminous intensity of the source of light
- **Periscope:** It is used to view objects above sea level (used in sub-marines).
- **Potentiometer:** It is used for comparing electromotive force of cells.
- **Pyrometer:** It measures very high temperature.
- **Radar:** It is used for detecting the direction and range of an approaching plane by means of radio microwaves.
- **Rain Gauge:** An apparatus for recording rainfall at a particular place.
- **Radiometer:** It measures the emission of radiant energy.
- **Refractometer:** It measures· refractive index.
- **Saccharimeter:** It measures the amount of sugar in the solution.
- **Seismograph:** It measures the intensity of earthquake shocks.
- **Salinometer:** It determines salinity of solution.
- **Sextant:** This is used by navigators to find the latitude of a place by measuring the elevation above the horizon of the sun or another star.
- **Spectrometer:** It is an instrument for measuring the energy distribution of a particular type of radiation.
- **Speedometer:** It is an instrument placed in a vehicle to record its speed.
- **Sphygmomanometer:** It measures blood pressure.
- **Spherometer:** It measures the curvatures of surfaces.
- **Stereoscope:** It is used to view two dimensional pictures.
- **Stethoscope:** An instrument which is used by the doctors to hear and analyze heart and lung

sounds.

- **Straboscope:** It is used to view rapidly moving objects.
- **Tachometer:** An instrument used in measuring speeds of aero planes and motor boats.
- **Teleprinter:** This instrument receives and sends typed messages from one place to another.
- **Telescope:** It views distant objects in space.
- **Theodolite:** It measures horizontal and vertical angles.
- **Thermometer:** This instrument is used for the measurement of temperatures.
- **Thermostat:** It regulates the temperature at a particular point.
- **Viscometer:** It measures the viscosity of liquids.
- **Voltmeter:** It measures the electric potential difference between two points.
- **Altimeter:** It measures altitudes and is used in aircrafts.
- **Ammeter:** It measures strength of electric current (in amperes).
- **Audiometer:** It measures intensity of sound.
- **Anemometer:** It measures force and velocity of wind.
- **Audiophone** It is used for Improving imperfect sense of hearing.
- **Barograph:** It is used for continuous recording of atmospheric pressure.
- **Barometer:** It measures atmospheric pressure.
- **Binocular:** It is used to view distant objects
- **Bolometer:** It measures heat radiation.
- **Calorimeter:** It measures quantity of heat.
- **Carburetor:** It is used in an internal combustion engine for charging air with petrol vapour.
- **Cardiogram:** It traces movements of the heart, recorded on a cardiograph.
- **Chronometer:** It determines longitude of a place kept onboard ship.

Quantity	SI	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Work and Energy	joule	J
Electric Current	ampe	A
Temperature	kelvin	K
Intensity of Flame	candela	cd
Angle	radian	rad
Solid Angle	stereadian	sr
Force	newton	N
Area	square metre	m^2
Volume	Cubic metre	m^3
Speed	metre per second	ms^{-1}
Angle Velocity	radian per second	rad s^{-1}
Frequency	Hertz	Hz
Moment of Inertia	kilogram squre metre	kgm^2
Momentum	kilogram metre per second	kg ms^{-1}
Impulse	newton second	Ns
Angular Momentum	kilogram square metre per second	Kgm^2s^{-1}
Pressure	pascal	Pa
Power	watt	W
Surface Tension	newton per metre	Nm^{-1}
Viscosity	newton second per square m.	$N.s.m^{-2}$

Thermal Conductivity	watt per metre per degree celcius	$WM^{-1}C^{-1}$
Specific Heat Capacity	joule per kilogram per Kelvin	$Jkg^{-1}K^{-1}$
Electric Charge	coulomb	C
Potential Difference	volt	V
Electric Resistane	ohm	Ω
Electrical Capacity	farad	F
Magnetic Induction	henry	H
Quantity	**SI**	**Symbol**
Magnetic Flux	weber	Wb
Luminous Flux or photometric Power	lumen	lm
Intensity of illumination	lux	lx
Wave length	Angstrom	A
Astronomical distance	light year	ly

METALS AND THEIR ORES

Metal	Ores
Sodium (Na)	Chile, Saltpetre Trona, Borax, Common salt
Aluminium (Al)	Bauxite, Corundum, Felspar, Cryolite, Alunite, Kaolin
Potassium (K)	Nitre (Salt Peter), Carnalite
Magnesium (Mg)	Magnesite, Dolomite, Epsom salt, Kieserite, Carnalite
Calcium (Ca)	Dolomite, Calcite, Gypsum, Fluorospar, Asbestes
Strontium (Sr)	Strontianite, Silestine
Copper (Cu)	Cuprite, Copper glance, Copper pyrites
Silver (Ag)	Ruby Silver, Horn silver
Gold (Au)	Calaverite, Silvenite
Barium (Ba)	Barytes
Zinc (Zc)	Zinc Blende, Zincite, Calamine
Mercury (Hg)	Cinnabar
Tin (Sn)	Casseterite
Lead (Pb)	Galena
Antimony (Sb)	Stibenite
Cadmium (Cd)	Greenocite
Bismuth (Bi)	Bismuthite
Iron (Fe)	Haemetite, Lemonite, Magnetite, Siderite, Iron pyritesh, Copper pyrites
Cobalt (Co)	Smelite
Nickel (Ni)	Milarite
Magnese (Mn)	Pyrolusite, Magneite
Uranium (U)	Carnetite, Pitch blende

ALLOYS & THEIR USES

Alloys	Uses
Brass	In making utensils
Bronze	In making coins, bell and utensils
German Silver	In making utensils
Rolled gold	In making cheap ornaments
Gun metal	In making gun, barrels, gears and bearings
Delta metal	In making blades of aeroplane

Munz metal	In making coins
Dutch metal	In making artificial ornaments
Monel metal	For base containing container
Rose metal	For making automatic fuse
Solder	For soldering
Magnalium	For frame of aeroplane
Duralumin	For making utensils
Type metal	In printing industry
Bell metal	For casting bells, statues
Stainless steel	For making utensils and surgical cutlery
Nickel steel	For making electrical wire, automobile parts

Organisations

INTERNATIONAL ORGANISATION

UN had its origin in August, 1944 at Dumbarton Oaks Conference where the representatives of USA, UK, USSR and China met to form an association for the maintenance of international peace and security. Finally, on June 26, 1945, the charter of the United Nations was signed in a conference called at "San Fransisco", which included the representatives of 51 states. The charter then came into force on 24 Octobar, 1945; thus 24 October has been celebrated as the UN day.

Headquarters, Flag, Languages: United Nation's Headquarter is situated in Manhattan Island of New York and the European office at Geneva.

The Flag of the UNO was adopted in Octobar 1947. The flag includes white UN emblem (two bent olive branches, open at the top and between them is the world map) on a light blue background. the flag was adopted by the UNO in Octobar, 1947. Official Language of UNO are French, Chinese, English, Russian, Arabic and Spanish. While the working languages are only French and English.

Aims and Objectives of UNO: The main objectives of UNO are:

- To maintain international peace and security.
- To develop spirit of co-operation and friendly relations among the nations.
- To promote respect for human rights, dignity and freedom.
- To solve international problems of social, economic, agricultural and humanitarian character.
- To employ international machinery for the promotion of economic and social advancement of all people.

Organs of the UN

There are six main organs of UN:

1. **General Assembly:** It is the main body of UN and consists of the representatives of all the states. Each state may send 5 representatives in the general assembly but has only 1 vote. It meets regularly once a year, special and emergency sessions can also be sumoned at the request of Security Council. Decision of an important matter is taken by the 2/ 3rd majority, while in simple matters, only simple majority is enough. The assembly may discuss any matter within the scope of charter except those already referred to the Security Council. The assembly generally discusses ways of preserving peace, economic development and social progress, well being of people, peaceful use of atomic energy, human right etc. It elects its own President & Vice-President every year.

Functional of General Assembly

(i) The membership of new states is done by the general assembly on the recommendation of Security Council.

(ii) The Judges of the International Court of Justice are elected by general assembly.
(iii) It elects the non-permanent members of Security Council, members of Economic and Social Council, and certain members of Trusteeship Council.
(iv) It passes entire budget of UNO.

2. **Security Council:** It is the executive body of UN which is responsible for maintaining international peace in the world. Its session can be summoned at 24 hour notice and if functions almost continuously. The council consists of 15 members–5 permanent (USA, UK; Russia, France and China) and 10 non-permanent members which are elected for a term of 2 years by the General Assembly. the distribution of the numbers of non-permanent members are (1) Five members from Asian and African countries (2) two from latin American countries
(3) two from western Europes and other (which implies commonwealth countries) (4) and one from east European countries.
Each member of the Security Council has one vote. The approval of all permanent members is necessary. If any permanent member casts a "Veto" to show its disagreement, then no decision can be taken. The numbers of affirmative votes needed for a decision are atleast nine which includes the vote of 5 permanent members. In the event of a threat to peace or occurence of war between two or more countries, the Security Council has the power to take appropriate measures to restore peace and security.
3. **Economic and Social Council:** The Economic and Social Council (ECOSOC) is the welfare council which coordiantes the economic and social activities of the United Nations and its specialised agencies and other organisations. This council meets at least thrice a year. It is composed of 54 members. General Assembly elects one-third members of ECOSOC every year for a period of 3 years. ECOSOC takes decision by a majority of those members present and voting. ECOSOC seeks to build a world of greater prosperity, stability and justice.
4. **The Trusteeship Council:** The Prime responsibility of this council is to supervise the administration of those territories which were placed under the International Trusteeship System. This council of UNO is also known as 'Protector of Dependent People' who are not yet able to Govern themselves. It consists of member of states administering trust territories and permanent members of the security council nto administering territories. Under the charter, the member states have to accept certain obligations to promote their development and to protect their interest and security so long as the trustee territories are not able to govern themselves.
At present, USA is the only administering trust territory. So, the Trusteeship Council consists of only permanent members. This council meets at least once in a year.
5. **International Court of Justice (ICJ):** HQ-The Hague, The Netherlands
The International Court of Justice (known colloquially as the World Court or ICJ) is the primary judicial organ of the United Nations. Established in 1945 by the Charter of the United Nations, the Court began work in 1946 as the successor to the Permanent Court of International Justice. The ICJ is composed of 15 judges elected to nine year terms by the UN General Assembly and the UN Security Council from a list of persons, nominated by the national groups in the Permanent Court of Arbitration. All 192 UN members are automatically parties to the Court's statute. Article 94 establishes the duty of all UN members to comply with decisions of the Court involving them. If parties do not comply, the issue may be taken before the Security Council for enforcement action. It conducts its business in English and French.
6. **Secretariat:** All day today functions of the UN are performed by the Secretariat. the Secretariat is headed by the Secretary-General who is the chief Administrative Officer, and he is appointed by the General Assembly upon the recommendation of Security Council for a five-year term, which is renewable. It is his duty to implement all resolutions passed by the Security Council or the General Assembly. He makes the annual report of General Assembly and also bring to the notice of security council about any matter threatening the maintenance of international peace and Security.
Secretary General: Ban Ki Moom

International Monetary Fund (IMF)

HQ – Washington, D.C.

The IMF came into existence in December 1945, as one among the Bretton Wood twins when the first 29 countries signed its Articles of Agreement. The International Monetary Fund (IMF) is an international organisation that oversees the global financial system by observing exchange rates and balance of payments. An unwritten rule establishes that the IMF's managing director must be non-Italian European and that the president of the World Bank must be from the United States. IMF describes itself as "an organisation of 185 countries, Montenegro being the 185th as of January 18th, 2007.

World Bank Group

HQ–Washington, D.C.

The World Bank Group is a group of five international organisations responsible for providing finance and advice to countries for the purposes of economic development and eliminating poverty. The Bank came into formal existence on 27 December, 1945 following international ratification of the Bretton Woods agreements, it approved its first loan to France for postwar reconstruction. The World Bank Group consists of:

(i) **The International Bank for Reconstruction and Development (IBRD),** established in 1945, which provides debt financing on the basis of sovereign guarantees;

(ii) **The International Finance Corporation (IFC),** established in 1956, which provides various forms of financing without sovereign guarantees, primarily to the private sector;

(iii) **The International Development Association (IDA),** established in 1960, which provides concessional financing (interest-free loans or grants), usually with sovereign guarantees;

(iv) **The Multilateral Investment Guarantee Agency (MIGA),** established in 1988, which provides insurance against certain types of risk, including political risk, primarily to the private sector; and

(v) **The International Centre for Settlement of Investment Disputes (ICSID),** established in 1966, which works with governments to reduce investment risk.

Food and Agriculture Organisation (FAO)

HQ–Rome, Italy.

The Food and Agriculture Organisation (FAO) is a specialized agency of the United Nations that leads international efforts to defeat hunger. FAO was founded on 16 October 1945, in Quebec City, Canada. In 1951 its hadquarters were moved from Washington, D.C., United States, to Rome, Italy. As of 17 November 2007, it had 191 members (plus one member organisation, the European Community and one associate member, the Faroe Islands).

International Labour Organisation (ILO)

HQ-Geneva, Switzerland.

The International Labour Organisation (ILO) is a specialized agency of the United Nations that deals with labour issues. Founded in 1919, it was formed through the negotiations of the Treaty of Versailles, and was initially an agency of the League of Nations. The ILO hosts the International Labour Conference in Geneva every year in June. The organisation received the Nobel Peace Prize in 1969. Its secretariat is known as the International Labour Office. Its a tripartite intergovernmental body of governments, employers and workers.

United Nations Educational, Scientific and Cultural Organisation (UNESCO)

HQ-Paris, France.

UNESCO (United Nations Educational, Scientific and Cultural Organisation) is a specialized agency of the United Nations established in 1945. Its stated purpose is to contribute to peace and security by promoting international collaboration through education, science, and culture in order to further universal respect for justice, the rule of law, and the human rights and

fundamental freedoms proclaimed in the UN Charter. As of October 2007, UNESCO had 193 member states and 6 associate members.

International Civil Aviation Organisation (ICAO)

HQ–Montreal, Canada.

The International Civil Aviation Organization (ICAO), an agency of the United Nations set up in 1944, codifies the principles and techniques of international air navigation and fosters the planning and development of international air transport to ensure safe and orderly growth. The ICAO defines the protocols for air accident investigation, followed by transport safety authorities in countries signatory to the Convention on International Civil Aviation, commonly known as the Chicago Convention.

World Health Organisation (WHO)

HQ-Geneva, Switzerland.

The World Health Organisation (WHO) is a specialized agency of the United Nations that acts as a coordianting authority on international public health. Established on 7 April 1948, the agency inherited the mandate and resources of its predecessor, the Health Organization, which had been an agency of the League of Nations. WHO complies the widely followed International Classification of Diseases (ICD).

International Atomic Energy Agency (IAEA)

HQ-Vienna, Austria.

The International Atomic Energy Agency (IAEA) was established as an autonomous organisation on July 29, 1957. It seeks to promote the peaceful use of nuclear energy and to inhibit its use for military purposes. United States President Dwight D. Eisenhower envisioned, in his "Atoms for Peace" speech before the UN General Assembly in 1953, the creation of this international body to control and develop the use of atomic energy.

International Telecommunication Union (ITU)

HQ–Paris, France.

The International Telecommunication Union (ITU) is an international organisation established to standardise and regulate international radio and telecommunications. It was founded as the International Telegraph Union in Paris in May 17, 1865, and is today the World's oldest international organisation. Its main tasks include standardization, allocation of the radio spectrum, and organising interconnection arrangements between different countries to allow international phone calls.

Universal Postal Union (UPU)

HQ–Berne, Switzerland

The Universal Postal Union (UPU) is an international organisation that coordiantes postal policies between member nations, and hence the worldwide postal system. Each member country agrees to the same set of terms for conducting international postal duties. It is the second oldest, international organisation (after the ITU). It was created in 1874, under the name "General Postal Union", as a result of the Treaty of Berne signed on 9 October 1874. In 1878, the name was changed to "Universal Postal Union".

International Maritime Organisation (IMO)

HQ–London, U.K

The International Maritime Organisation (IMO), formerly known as the Inter-Governmental Maritime Consultative Organization (IMCO), was established in 1948, through the United

Nations to coordinate international maritime safety and related practices. However the IMO did not enter into full force until 1958. The IMO promotes cooperation among government and the shipping industry to improve maritime safety and to prevent marine pollution.

World Meteorological Organisation (WMO)

HQ–Geneva, Switzerland.

The World Meteorological Organisation (WMO) is a specialized agency of the United Nations. It is the UN system's authoritative voice on the state and behaviour of the Earth's atmosphere, its interaction with the oceans, and the climate produces or the resulting distribution of water resources. It originated from the International Meteorological Organisation (IMO), which was founded in 1873. Established in 1950, WMO became the specialized agency of the United Nations for meteorology (weather and climate), operational hydrology and related geophysical sciences. The WMO helped create the Intergovernmental Panel on Climate Change (IPCC). It is also directly responsible for the creation of the Global Atmosphere Watch (GAW).

Interpol (International Criminal Police Organisation)

HQ–Lyon, France

Established as International Criminal Police Commission in 1923 to assist international criminal police co-operation. Its work focuses primarily on public safety, terrorism, organised crime etc. It is the world's third largest international organisation after UN and FIFA.

International Criminal Court (ICC)

HQ–The Hague, The Netherlands.

It is a court created under the Rome Statute of 2002 as an independent, permanent court that tries persons accused of the most serious crimes of international concern, namely genocide, crimes against humanity and war crimes. The ICC is based on a treaty, joined by 104 countries. The ICC is a court of last resort. It will not act if a case is investigated or prosecuted by a national judicial system unless the national proceedings are not genuine. In addition, the ICC only tries those accused of the gravest crimes.

Organisation for the Prohibition of Chemical Weapons (OPCW)

HQ–The Hague, The Netherlands.

The Organisation for the Prohibition of Chemical Weapons (OPCW) is an international agency. Its mission is to promote membership of the Chemical Weapons Convention treaty which entered into force in 1997 and mandated the elimination of "the scourge of chemical weapons forever and to verify the destruction of the declared chemical weapons stockpiles within stipulated deadlines".

United Nations Children's Fund (UNICEF)

HQ–New York City, USA

The United Nations Children's Fund (UNICEF) was created on December 11, 1946. In 1953, its name was shortened from United Nations International Children's Emergency Fund. UNICEF provides long-term humanitarian and developmental assistance to children and mothers in developing countries. UNICEF was awarded the Nobel Peace Prize in 1965.

United Nations Office on Drugs and Crime (UNODC)

HQ–Vienna, Austria.

United Nations Office on Drugs and Crime (UNODC) is a United Nations agency which was founded in 1997 as the Office for Drug Control and Crime Prevention with the intent to fight

drugs and crime on an international level. This intent is fulfilled through three primary functions: research, lobbying state government to adopt various crime and drug based laws and treaties and assistance of said governments on the ground level. In October 2002, the United Nations Drug Control Programme (UNDCP) was merged into the UNODC.

United Nations Conference on Trade and Development (UNCTAD)

HQ–Geneva, Switzerland.

The United Nations Conference on Trade and Development (UNCTAD) was established in 1963 as a permanent intergovernmental body, UNCTAD is the principal organ of the United Nations General Assembly dealing with trade, investment and development issues. UNCTAD has 191 member States.

United Nations Environment Programme (UNEP)

HQ–Gigiri, Nairobi, Kenya.

It was founded as a result of the United Nations Conference on the Human Environment in 1973. The World Meteorological Organisation and the UNEP established the Intergovernmental Panel on Climate Change (IPCC) in 1988. UNEP is also one of several implementing agencies for the Global Environment Facility (GEF). The year 2007 has been declared as International Year of the Dolphin by the United Nations and UNEP.

United Nations Development Programme (UNDP)

HQ–New York City, USA.

The United Nations Development Programme (UNDP), the United Nations' global development network, is the largest multilateral source of development assistance in the world. The UNDP is an executive board within the United Nations Economic and Social Council. The UNDP Administrator is the third highest ranking member of the United Nations after the United Nations Secretary-General and Deputy Secretary-General. UNDP publishes an annual Human Development Report to measure and analyze developmental progress.

United Nations High Commissioner for Refugees (UNHCR)

HQ–Geneva, Switzerland.

The United Nations High Commissioner for Refugees (UNHCR) (established December 14, 1950) protects and supports refugees at the request of a government or the United Nations and assists in their return or resettlement. It succeeded the earlier International Refugee Organisation and the even earlier United Nations Relief and Rehabilitation Administration. UNHCR was awarded the Nobel Peace Prize in 1954 and 1981. UNHCR presently has major missions in Lebanon, South Sudan, Chad/Darfur, Iraq, Afghanistan as well as Kenya to assist and provide services to IDPs and refugees.

United Nations Human Settlements Programme (UN-HABITAT)

HQ–Nairobi, Kenya.

The United Nations Human Settlements Programme (UN-HABITAT) is the United Nations agency for human settlements. It was established in 1978. It is mandated by the United Nations General Assembly to promote socially and environmentally sustainable towns and cities with the goal of providing adequate shelter for all.

United Nations Industrial Development Organisation (UNIDO)

HQ–Vienna, Austria.

The United Nations Industrial Development Organisation (UNIDCO), is a specialized agency in the United Nations system. UNIDO was established as a UN programme in 1966 and became a specialized agency of the United Nations in 1985.

United Nations Population Fund (UNFPA)

HQ–New York, USA.

The United Nations Fund for Population Activities was started in 1969 and renamed the United Nations Population Fund (UNFPA) in 1987. The United Nations Population Fund is the world's largest international source of funding for population and reproductive health programs.

World Intellectual Property Organisation (WIPO)

HQ–Geneva, Switzerland.

The World Intellectual Property Organisation (WIPO) is one of the specialized agencies of the United Nations. WIPO was created in 1967 with the stated purpose of encouraging creative activity and promoting the protection of intellectual property throughout the world. WIPO currently has 184 member states and administers 23 international treaties. Vatican City and almost all UN members are member of the WIPO. The predecessor to WIPIO was the BIRPI (French acronym for United International Bureau for the Protection of Intellectual Property), which had been set up in 1893 to administer the Berne Convention for the Protection of Library and Artistic Works and the Paris Convention for the Protection of Industrial Property. WIPO was formally created by the Convention Establishing the World Intellectual Property Organisation (signed at Stockholm on July 14, 1967 and as amended on September 28, 1979).

World Trade Organisation (WTO)

HQ–Geneva, Switzerland.

The World Trade Organisation (WTO) is an international organisation that establishes rules for international trade through consensus among its member states. It also resolves disputes between the members, which are all signatories to its set of trade agreements. Uruguay Round of General Agreement on Tariffs and Trade (GATT), negotiations culminating in the Marrakesh Agreement that established the WTO. There are 151 member states in the organisation, the latest to join being Tonga on July 27, 2007. Since its inception in 1995, the WTO has been a major focus for protests by civil society groups in many countries.

International Red Cross and Red Crescent Movement

HQ–Geneva, Switzerland.

The International Red Cross and Red Crescent Movement is an international humanitarian movement founded in 1863, whose stated mission is to protect human life and health, to ensure respect for the human being, and to prevent and alleviate human suffering, without any discrimination based on nationality, race, religious beliefs, class or political opinions. It adopted a new symbol a hollowed out red crystal on a white background in addition to the present symbols of red cross (1863) and red cresent (1876). Red star of David was used by Israel till now. Awarded the Nobel Peace prize in three times –1917, 1944 and 1963.

World Social Forum (WSF)

The World Social (WSF) is an annual meeting held by members of the anti-globalisation movement to coordiante world campaigns, share and refine organizing strategies, and inform each other about movements from around the world and their issues. It tends to meet in January when its "great capitalist rival", the World Economic Forum is meeting in Davos, Switzerland.

World Economic Forum (WEF)

The World Economic Forum (WEF) is a Geneva-based foundation whose annual meeting of top business leaders, national political leaders (presidents, prime ministers and others), and

selected intellectuals and journalists is usually held in Davos, Switzerland. There are also regional meetings throughout the year. It was founded in 1971 by Klaws M. Schwab, a business professor in Switzerland.

Global Water Partnership (GWP)

It is a network created by stakeholders including Sweden, The UNDP, World Bank and committee of Economic development of Australia. It has been established to ensure optimum use of scrace water resources in an integrated manner to benefit the world community.

Asian Development Bank (ADB)

HQ–Manila, Philippines.

The Asian Development Bank (ADB) is a regional development bank established in 1966 to promote economic and social development in Asian and Pacific countries through loans and technical assistance. It is a multilateral development financial institution owned by 66 members, 47 from the region and 19 from other parts of the globe. ADB's vision is a region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their citizens. The highest policy-making body of the bank is the Board of Governors composed of one representative from each member state. The Board of Governors also elect the bank's President who is the chairperson of the Board of Directors and manages ADB. Traditionally, and because Japan is one of the largest shareholders of the bank, the President has always been Japanese.

African Development Bank (ADBP)

HQ–Abidjan, Cote D'Ivoire.

Established officially in 1964 as a result of Monorovian Conference of 1961, under the auspices of the Economic Commission for Africa, the ADBP began operation in 1966 with. With the statute of a regional multilateral development bank, the African Development Bank engaged in promoting the economic development and social progress of its Regional Member Countries (RMCs) in Africa. The African Development Bank Group has two other entities: the African Development Fund (ADF) and the Nigeria Trust Fund (NTF).

UN Democracy Fund (UNDEF)

The UN Democracy Fund will be a voluntary fund housed in the UN Fund for International Partnerships (UNFIP), but with its own Executive Head who will report to an Advisory Board of Member States on substantive matters. In order to ensure transparency and accountability, a dedicated support office will arrange for monitoring, evaluation and auditing of the program. The idea for the Fund was first articulated by President Bush in a speech before the UN General Assembly last fall and has been embraced by the 141 nations that attended the third ministerial meeting of the Community of Democracies in Santiago, Chile in April 2005.

UN Secretaries General

Year	Name	Nation
1946-1952	Trygve Lie	Norway
1953-1960	Dag Hammarskjold	Sweden
1961-1971	U Thant	Burma
1972-1981	Kurt Waldheim	Austria
1982-1991	Javier Peres De Cuellar	Peru
1992-1996	Dr. Boutros Boutros Ghali	Egypt
1997-2006	Kofi Annan	Ghana
2007-2011	Ban Ki Moon	S. Korea (First Term)
2012-Present	Ban Ki Moon	S. Korea (Second Term)

Association of Southeast Asian Nations (ASEAN)

HQ–Jakarta, Indonesia.

The Association of Southeast Asian Nations (ASEAN) is a geopolitial and economic organisation of 10 countries, located in Southeast Asia. ASEAN was established on 8 August, 1967 in Bangkok by the five original Member Countries namely–Indonesia, Malaysia, Phillippines, Singapore, and Thailand. Brunei Darussalam joined on 8 January 1984, Vietnam on 28 July 1995, Lao PDR and Myanmar on 23 July 1997, and Cambodia on 30 April 1999.

ASEAN Plus Three (APT)

APT is a forum that functions as a coordinator of cooperation between Association of Southeast Asian Nations and the three East Asian nations of China, Japan, and South Korea. The first leaders' meeting was held in 1997 and the group's significance and importance was stregthened by the Asian Financial Crisis. The grouping was institutionalised by 1999.

ASEAN Regional Forum (ARF)

ASEAN Regional Forum is an informal multilateral dialogue of 25 members that seeks to address security issues in the Asia-Pacific region. ARF met for the first time in 1994. The current participants in the ARF are as follows: ASEAN, Australia, Canada, People's Republic of China, European, Union, India, Japan, North Korea, South Korea, Mongolia, New Zealand, Pakistan, Papua New Guinea, Russia, East Timor, and the Unites States. Bangladesh was added to ARF as the 26th member, starting from July 28, 2006.

European Union (EU)

The European Union (EU) is a supranational and intergovernmental union of 27 democratic member states in Europe. It was established under that name by the Treaty on European Union (Maastricht Treaty) signed on February 7, 1992 in Maastricht, Netherlands. The Union has a single market consisting of a customs union, a currency called the euro (adopted by 13 member states), a Common Agricultural Policy, a common trade policy and a Common Fisheries Policy. The Schengen Agreement abolished passport control and customs checks for most member states within EU's internal borders, creating, to some extent, a single area of free movement for EU citizens to live, travel, work and invest. A Common Foreign and Security Policy, and the Police and Judicial Co-operation in criminal matters have been initiated. Important EU institutions and bodies include the European Commission, the Council of the European Union, the European Council, the European Central Bank, the European Court of Justice, and the European Parliament which is directly elected by EU citizens once every five years.

Location of European Union Institutions

Brussels	:	seat of the European Commission and the Council of Ministers.
Strasbourg	:	Seat of the European Parliament.
Luxembourg	:	Seat of the European Court of Justice, the European Court of Auditors, the Secretariat of the European Parliament and the European Investment Bank.
Frankfurt	:	Seat of the European Central Bank.

Council of European Union

(a) Main EU decision making body.
(b) Also known as Council of Ministers.

(c) Represents interests of individual member states.
(d) Each member states represented by its own ministers.
(e) Presidency rotates between member states on six-monthly basis.

European Commission

(a) Proposes legislation to Council and Parliament.
(b) Manages implementation of EU legislation.
(c) Commissioners appointed on five-yearly basis by Council in agreement with member states.
(d) Appointments confirmed by parliament to which commission is answerable.

European Parliament

(a) Votes on and oversees implementation of EU budget.
(b) Considers Commission proposals on legislation.
(c) Works with Council on legislative decisions.

Caribbean Community (CARICOM)

HQ–Georgetown, Guyana

The Caribbean Community and Common market or CARICOM was established by the Treaty of Chaguaramas which came into effect on August 1, 1973. The first four signatories were Barbados, Jamaica, Guyana and Trinidad and Tobago. CARICOM replaced the 1965–1972 Caribbean Free Trade Association (CARIFTA). Currently CARICOM has 15 full members, five associate members and seven observers. From March 2004, Haiti's participation in CARICOM was suspended by its interim Prime Minister. But in early June 2006, Haiti was readmitted as a full member of the CARICOM.

Economic Community of West African States (ECOWAS)

HQ–Abuja, Nigeria.

The Economic Community of West African States (ECOWAS) is a regional group initially of sixteen countries, founded on May 28, 1975 when sixteen West African countries signed the Treaty of Lagos. Its mission is to promote economic integration.

Economic and Monetary Community of Central Africa (CEMAC)

HQ-Bangui, Central African Republic.

The Economic and Monetary Community of Central Africa (CEMAC) is an organisation of states of Central Africa established to promote economic integration among countries that share a common currency, the CFA franc. CEMAC is the successor of the Customs and Economic Union of Central Africa (UDEAC), which it completely superseded in June 1999 (through an agreement from 1994). Its six members states are Cameroon, the Central African Republic, Chad, the Republic of the Congo, Equatorial Guinea and Gabon. Equatorial Guinea joined in January 1984.

Southern African Customs Union (SACU)

HQ–Windhoek, Namibia.

SACU is the oldest customs union in the world. It was established in 1910 as a Customs Union Agreement between the then Union of South Africa and the High Commission Territories of Bechuanaland, Basutoland and Swaziland. With the advent of independence for these territories, the agreement was updated and on December 11, 1969 it was re-launched as the SACU was the signing of an agreement between the Republic of South Africa, Botswana,

Lesotho and Swaziland. The updated union officially entered into force on March 1, 1970. After Namibia's independence in 1990, it joined SACU as its fifth member.

Cooperation Council for the Arab States of the Gulf (GCC)

HQ–Riyadh.

The Cooperation Council for the Arab States of the Gulf, formerly named and still commonly called Gulf Cooperation Council (GCC) is a regional organisation involving the six Arab Gulf states with many economic and social objectives in mind. Created on May 25, 1981, the Council is comprised of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates. Not all of the countries neighboring the Persian Gulf are members of the council. Specifically, Iran and Iraq are not members. Yemen is currently (as of 2007) in negotiotions for GCC membership, and hopes to join by 2016. On the economic front, the GCC aims to create a common market by 2007 and to adopt a single currency, the Khaleeji, in 2010.

South Asian Association for Regional Cooperation (SAARC)

HQ–Kathmandu, Nepal.

South Asian Association for Regional Cooperation (SAARC) is the largest regional organisation in the world by population, covering approximately 1.5 billion people. SAARC is an economic and political organisation of eight countries in Southern Asia. The organisation was established on December 8, 1985 by India, Pakistan, Bangladesh, Sri Lanka, Nepal, Maldives and Bhutan. Afghanistan became a member (eighth) on April 3, 2007. It declared 2006–2015 as the'SAARC decade of poverty alleviation'. It was agreed in principle to the desire of China and Japan to become SAARC observers. The Islamic Republic of Iran is the only country in Southern Asia that is not a part of SAARC. In April 2006, the United States of America and South Korea made formal requests to be granted observer status. The European Union has also indicated interest in being given observer status, and made a formal request for the same to the SAARC Council of Ministers meeting in July 2006. On August 2nd, 2006 Foreign ministers of SAARC countries agreed in principle to grant observer status to the US, South Korea and the European Union.

Group of 77 (G-77)

HQ–New York, USA

The Group of 77 at the United Nations is a loose coalition of developing nations, designed to promote its members' collectives, economic and interest to create an enhanced joint negotiating capacity in the United Nations. There were 77 founding members of the organisation, but the organisation has since expanded to 130 member countries. It is modelled on the Group of 7, which now contains 8 countries. The group was founded on June 15, 1964 by the "Joint Declaration of the Seventy Seven Countries" issued at the United Nations Conference on Trade and Development (UNCTAD).

Intergovernmental Group of Twenty Four (G-24)

HQ–Washington D.C., USA

The Intergovernmental Group of Twenty-Four on International Monetary Affairs and Development (G-24) was established in 1971. Its main objective is to concert the position of developing countries on monetary and development of finance issues. It consists of countries from three regions of Africa, Latin America and the Caribbean and Asia.

North American Free Trade Area (NAFTA)

The Noth American Free Trade Area is the trade bloc created by the North American free Trade Agreement (NAFTA) and its two supplements, the North American Agreement on Environmental Cooperation (NAAEC) and the North American Agreement on Labor Cooperation (NAALC) whose members are Canada, Mexico and the United States. It came into effect on 1 January 1994. It is the world's largest free trade area.

Developing 8 (D-8)

HQ-Istanbul, Turkey.

The Developing 8 (D-8) is a group of developing countries that have formed an economic development alliance. It consists of Bangladesh, Egypt, Indonesia, Iran, Malaysia, Nigeria, Pakistan and Turkey.

Bay of Bengal Initiative for Multi Sectoral Technical and Economic Co-operation (BIMSTEC)

The organisation was formed in Bangkok, Thailand, on 6 June 1997. Initially, its name was BIST-EC (Bangladesh, India, Sri Lanka, Thailand Economic Cooperation). At that time, Myanmar was an observer, but later joined the organisation as a full member at a special ministerial meeting, held in Bangkok on 22 December 1997. Consequently, the name of the organisation was changed to BIMST-EC. Nepal was granted observer status by the second ministerial meeting in Dhaka, Bangladesh in December 1998. Later, full membership has been granted to Nepal and Bhutan in 2003. During the first summit in Bangkok on 31 July 2004, the organisation's name was changed to its current name.

Organisation for Economic Co-operation and Development (OECD)

HQ–Chateau de la Muette in Paris, France.

The Organisation for Economic Co-operation and Development (OCED) is an international organisation of those developed countries that accept the principles of representative democracy and a free market economy. It originated in 1948 as the Organisation for European Economic Co-operation (OEEC) to help administer the Marshal Plan for the reconstruction of Europe after World War II. Later its membership was extended to non-European states, and in 1961 it was reformed into the Organisation for Economic Co-operation and Development. There are currently thirty full members; of these, 24 are described as high-income countries by the World Bank.

Organisation of Petroleum Exporting Countries (OPEC)

HQ–Vienna, Austria.

The Organisation of the Petroleum Exporting Countries (OPEC) is a permanent, intergovernmental Organisation, created at the Baghdad Conference on September 10-14, 1960, by Iran, Iraq, Kuwait, Saudi Arabia and Venezuela. The five Founding Members were later joined by nine other Members Indonesia's membership currently under review as Indonesia is no longer considered by OPEC as a net oil exporter. Former Members are Gabon (full member from 1975 to 1995) and Ecuador (full member from 1963 to 1993). However Ecuador has expressed interest in rejoining. OPEC's official language is English, although the official language of a majority of OPEC member-states is Arabic, as seven current members are Arab states. Only one member nation (Nigeria) has English as an official language. From 1976-2006 OPEC gained on new member nations. In November 2006, the Angolan Government announced its intention to apply for membership and subsequently joined on 1st January 2007. Sudan has also expressed intent for joining. Russia, though a net exporter of oil, has failed to gain membership into the grouping.

Asia-Pacific Economic Cooperation (APEC)

HQ–Singapore.

The Asia-Pacific Economic Cooperation (APEC) is an economic forum for a group of Pacific Rim countries to discuss matters on regional economy, cooperation, trade and investment. The current membership of APEC consists of 21 members, which includes most countries with a coasting on the Pacific Ocean. the last countries to have joined APEC, during its sixth leader's summit in Kualalumpur, November 1998 were Peru, Russia and Vietnam.

Organisation of the Islamic Conference (OIC)

HQ–Jeddah, Saudi Arabia.

OIC is an inter-governmental organisation with a Permanent Delegation to the United Nations. It groups 57 mostly Islamic nations in the Middle East, North, West and Southern Africa, Central Asia, Europe, Southeast Asia, the Indian subcontinent and South America.

African Union (AU)

HQ-Addis Ababa, Ethiopia.

The African Union (AU) is an organisation consisting of fifty-three African States. Established in 2001, the AU was formed as a successor to the amalgamated African Economic Community (AEC) and the Organisation of African Unity (OAU). The African Union was launched in Durban on July 9, 2002, by its first president, South African Thabo Mbeki, at the first session of the Assembly of the African Union. Eventually, the AU aims to have a single currency and a signle integrated defence force, as well as other institutions of state, including a cabinet for the AU Head of State. The AU covers the entire continent except for Morocco, which opposes the membership of Western Sahara/ Sahrawi Arab Democratic Republic. However, Morocco has a special status within the AU and benefits from the services available to all AU states from the institutions of the AU.

League of Arab States

HQ-Cairo, Egypt.

The League of Arab States, or Arab League, is a voluntary association of countries whose peoples are mainly Arabic speaking. It aims to strengthen ties among member states, coordiante their policies and direct them towards the common good. The idea of the Arab League was mooted in 1942 by the British, who wanted to rally Arab countries against the Axis powers. However, idea did not take off until seven states formed the Arab League on March 22, 1945. It has 22 members, including Palestine, which the league regards as an independent state. In January 2003, Eritrea joined the Arab League as an observer.

North Atlantic Treaty Organisation (NATO)

HQ–Brussels, Belgium.

The North Atlantic Treaty Organisation (NATO) also called the North Atlantic Alliance, the Atlantic Alliance, the Western Alliance, is a military alliance established by the signing of the North Atlantic Treaty on 4 April 1949. The organisation establishes a system of collective security whereby its member states agree to mutual defense in response to an attack by any external party. The Treaty of Brussels, signed on 17 March 1948 by Belgium, the Netherlands, Luxembourg, France and the United Kingdom is considered the precursor to the NATO agreement. The 2006 NATO summit was held in Riga, Latvia, which had joined the Atlantic Alliance two years earlier. It is the first NATO summit in a former COMECON country. Membership went on expanding with the accession of seven more European countries to

NATO–Estonia, Latvia and Lithuania and also Slovenia, Slovakia, Bulgaria, and Romania thereby taking the membership to 26. These 7 countries joined NATO on 29 march 2004.

Commonwealth of Independent States (CIS)

HQ–Minsk, Belarus.

The Commonwealth of Independent States (CIS) is the international organization, or alliance, consisting of 11 former Soviet Republics: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Ukraine, and Uzbekistan and one associate member. Turkmenistan discontinued permanent membership as of August 26, 2005 and is now an associate member. The CIS is not a confederation. On December 21, 1991, the leaders of 11 of the 15 constituent republics of the Soviet Union met in Almata, Kazakhstan, and signed the charter, thus de facto ratifying the initial CIS treaty and launching the organisation.

ANZUS

The Australia, New Zealand, United States Security Treaty (ANZUS or ANZUS Treaty) is the military alliance which binds Australia and the United States, and separately Australia and New Zealand to cooperate on defence matters in the Pacific Ocean area, though today the treaty is understood to relate to attacks in any area. The treaty was concluded at San Francisco on 1 September 1951, and entered into force on 29 april 1952. The treaty bound the signatories to recognize that an armed attack in the Pacific area on any of them would endanger the peace and safety of the others.

Mercosur

HQ–Montevideo, Uruguay.

Mercosur or Mercosul is a Regional Trade Agreement (RTA) between Brazil, Argentina, Uruguay, Venezuela and Paraguay, founded in 1991 by the Treaty of Asuncion, which was later amended and updated by the 1994 Treaty of Ouro Preto. It is known as the Common Market of the South. Its purpose is to promote free trade and the fluid movement of goods, peoples, and currency. Bolivia, Chile, Colombia, Ecuador and Peru currently have associ ate member status.

Shanghia Cooperation Organisation (SCO)

HQ–Beijing, China.

The Shanghai Cooperation Organisation (SCO) is an intergovernmental organisation which was founded on June 14, 2001 by leaders of the China, Russia, Kazakhastan, Kyrgyzstan, Tajikistan and Uzbekistan. Except for Uzbekistan, the other countries had been members of the Shanghai Five; after the inclusion of Uzbekistan in 2001, the members renamed the organisation.

Benelux

Benelux is an economic union in Western Europe comprising three neighbouring monarchies. Belgium, the Netherlands and Luxembourg. The treaty establishing the Benelux Customs Union was signed in 1944 by the governments in exile of the three countries in London, and entered into force in 1947. It ceased to exist in 1960, when it was replaced by the Benelux Economic Union. A Benelux Parliament (originally referred to as Interparliamentary Consultative Council) was created in 1955. The treaty establishing the Benelux Economic Union was signed in 1958 and came into force in 1960 to promote the free movement of workers, capital, services, and goods in the region. In 1965, the treaty establishing a Benelux Court of Justice was signed and it entered into force in 1975 with seat at Brussels.

Indian Ocean Rim-Association for Regional Cooperation (IOR-ARC)

HQ–Mauritius.

The IOR-ARC, initially known as the Indian Ocean Rim Initiative, is an international organization with 18 member states. It was first established in Mauritius on March 1995 and formally launched on 6-7 March 1997. Countries with the status of dialogue partners are China, Egypt, France, Japan and United Kingdom.

Sports and Games

OLYMPIC GAMES

The origin of the ancient Olympic Games is shrouded in mystery. The first historical mention of the Game was in 776 B.C. Iphites (King of Elis) in collaboration with Cleosthenes (King of Pisa) and Lycurgus (King of Sparta) is reported to have promoted or initiated the Games at Olympia. the Olympiad celebrated that year was considered as the first and was used to date subsequent historic events. the Old Olympiads were held after every four years and the Greeks measured the time in terms of the Games started on the first new moon after the summer solstice, around mid-July/ Agusut. The Games started withsacrifices.

Only free-born male Greek citizens without a criminal record and officially registered in the Citizen Roster of his native city could contest. Slaves and women were not eligible. Slowly people from other parts of the world were allowed to participate and women were also allowed to watch the Games.

Asian Games

History: The idea of the Asian Games was first conceived by Prof. G.D. Sondhi. The suggestion for holding the Asian Games was first made in a conference of Asian countries held in New Delhi in 1947 and Jawaharlal Nehru suggested that it be called 'Asian Games'. The first Asian Games were held at New Delhi in March 1951. Since then Asian Games are held after every four years.

Venues of Asian Games

Year	Venue	Year	Venue
1951	New Delhi, India	1954	Manila, Philippines
1958	Tokyo, Japan	1962	Jakarta, Indonesia
1966	Bangkok, Thailand	1970	Bangkok, Thailand
1974	Tehran, Iran	1978	Bangkok, Thailand
1982	New Delhi, India	1986	Seoul, South Korea
1990	Beijing, China	1994	Hiroshima, Japan
1998	Bangkok, Thailand	2002	Busan (formerly-Pusan), South Korea
2006	Doha, Qatar	2010	Guangzhou, China
2014	Incheon, S. Korea (Scheduled)		

Background: First held as West Asian Games at New Delhi in 1934 in which India, Afghanistan, Palestine and Sri Lanka participated. In view of the enthusiasm it was decided to hold these games once in four years at mid-point between the Olympics. However, these games were abandoned during World War II.

It was Prof. Gurudutt Sondhi, a member of the IOC encouraged by the sport-lover Maharaja Yadvendra Singh of Patiala and supported by Pandit Nehru, tried to revive these games at the Asian

Relations Conference (ARC) convened by Pt. Nehru at New Delhi in 1947. The Asian Atheletic Federation (AAF) was formed in 1948 which decided to hold the first Atheletic Championship at New Delhi in 1949. However, the plan did not materialise.
Again in February 1949, the AAF met at New Delhi where it was renamed as 'Asian Games Federation' (AGF). The AGF then decided to rename the Asian Atheletic Championship as 'Asiatic Games'. Subsequently Pt Nehru suggested that these games be called 'Asian Games'. The first President and Secretary of AGF were Maharaja Yadvendra Singh of Patiala and Prof. G.D. Sondhi respectively.

ROPHIES AND CUPS

International Trophies

- American Cup : Yacht Racing
- Ashes : Cricket
- Benson and Hedges : Cricket
- Canada Cup : Golf
- Colombo Cup : Football
- Corbitton Cup : Table Tennis (Women)
- Davis Cup : Horse Race
- Grand National : Horse Streple Chase Race
- Jules Rimet Trophy : World Soccer Cup
- King's Cup : Air Races
- Merdeka Cup : Football
- Rydet Cup : Golf
- Swaythling Cup : Table Tennis (Men)
- Thomas Cup : Badminton
- U. Thant Cup : Tennis
- Uber Cup : Badminton (Women)
- Walker Cup : Golf
- Westchester Cup : Polo
- Wightman Cup : Lawn Tennis
- World Cup : Cricket
- World Cup : Hockey
- Reliance Cup : Cricket
- Rothman's Trophy : Cricket
- William's Cup : Basketball
- European Champions Cup : Football
- Eisenhower Cup : Golf
- Essandre Champions Cup : Hockey
- Rene Frank Trophy : Hockey
- Grand Prix : Table Tennis
- Edgbaston Cup : Lawn Tennis
- Grand Prix : Lawn Tennis
- World Cup : Weight-lifting

National Trophies

- Agarwal Cup : Badminton

- Agha Khan Cup : Hockey
- All-India Women's Guru Nanak Championship : Hockey
- Bandodkar Trophy : Football
- Bangalore Blues Challenge Cup : Basketball
- Barna-Bellack Cup : Table Tennis
- Beighton Cup : Hockey
- Bombay Gold Cup : Hockey
- Burdwan Trophy : Weight-lifting
- Charminar Trophy : Athletics
- Chadha Cup : Badminton
- C.K. Naydu Trophy : Cricket
- Chakoia Gold Trophy : Football
- Divan Cup : Badminton
- Deodhar Trophy : Cricket
- Duleep Trophy : Cricket
- DCM Cup : Football
- Durand Cup : Football
- Dhyan Chand Trophy : Hockey
- Dr. B.C. Roy Trophy : Football (Junior)
- Ezra Cup : Polo
- FA Cup : Football
- GD Birla Trophy : Cricket
- Ghulam Ahmed Trophy : Cricket
- Gurmeet Trophy : Hockey
- Guru Nanak Cup : Hockey
- Gyanuati Devi Trophy : Hockey
- Holkar Trophy : Bridge
- Irani Trophy : Cricket
- IFA Shield : Football
- Indira Gold Cup : Hockey
- Jawaharlal Challenge : Air Racing
- Jaswant Singh Trophy : Best Services Sportsman
- Kuppuswamy Naidu Trophy : Hockey
- Lady Rattan Tata Trophy : Hockey
- MCC Trophy : Hockey
- Moinuddaula Gold Cup : Cricket
- Murugappa Gold Cup : Hockey
- Modi Gold Cup : Hockey
- Narang Cup : Badminton
- Nehru Trophy : Hockey
- Nixan Gold Cup : Football
- Obaid Ullah Gold Cup : Hockey
- Prithi Singh Cup : Polo
- Rani Jhansi Trophy : Cricket
- Ranjit Trophy : Cricket

- Rangaswami Cup : Hockey
- Ranjit Singh Gold Cup : Hockey
- Rajendra Prasad Cup : Tennis
- Ramanujan Trophy : Table Tennis
- Rene Frank Trophy : Hockey
- Radha Mohan Cup : Polo
- Raghbir Singh Memorial : Football
- Rohinton Baria Trophy : Cricket
- Rovers Cup : Football
- Sanjay Gold Cup : Football
- Santosh Trophy : Football
- Sir Ashutosh Mukherjee : Football
- Subroto Cup : Football
- Scindia Gold Cup : Hockey
- Sahni Trophy : Hockey
- Sheesh Mahal Trophy : Cricket
- Todd Memorial Trophy : Football
- Tommy Eman Gold Cup : Hockey
- Vittal Trophy : Football
- Vizzy Trophy : Cricket
- Vijay Merchant Trophy : Cricket
- Wellington Trophy : Rowing
- Wills Trophy : Cricket

Places Associated with Sports

Sport Associated Places	
Baseball	Brooklyn (USA)
Boxing	1. Madison Square Garden (USA) 2. Yankee Stadium, New Delhi
Cricket	1. Aden Park (Aukland) 2. Brabourne Stadium (Mumbai) 3. Chepauk Ground (Chennai) 4. Eden Gardens (Kolkata) 5. Ferozeshah Kotla Ground (Delhi) 6. Green Park (Kanpur) 7. Leeds (London, England) 8. Lord's (London, England) 9. Nehru Stadium (Chennai and New Delhi) 10. Melbourne (Australia) 11. Old Trafford (Manchester, England) 12. Oval (London, England) 13. Wankhede Stadium (Mumbai)
Football	1. Brookland (England) 2. Wembley (London) 3. Blackheath (London)

	4. Twickenham (London) 5. Corporation Stadium (Kolkata) 6. Ambedkar Stadium (New Delhi) 7. Nehru Stadium (New Delhi) 8. Yuva Bharati Stadium (Kolkata)
Golf	Sanday Lodge (Scotland)
Greyhound Race	White City (England)
Hockey	1. Dhayn Chand Stadium (Lucknow) 2. Lal Bahadur Shastri Stadium (Hyderabad) 3. Merdeka Stadium (Kuala Lumpur) 4. National Stadium (New Delhi) 5. Nehru Stadium (New Delhi) 6. Sawai Man Singh Stadium (Jaipur) 7. Shivaji Stadium (New Delhi)
Horse Racing	1. Aintree (England) – Grand National Race 2. Doncaster (England) – Derby Race 3. Epsom (England) – Derby Race
Pole	Hurlingham (England)
Shooting	Bisley (England)
Sking	Florence (Chadwick)
Snooker	Blackpool (England)
Swimming and Rowing	1. Cape Gris Nez (Cross-channel swimming) 2. Putney-Mort-Lake (England)
Tennis	1. Wimbledon (England) 2. Forest Hill (US)

National Sports and Games

Country	*National Sport*	*Country*	*National Sport*
Australia	Tennis and Cricket	**Canada**	Lacrosse
China	Table Tennis	**England**	Cricket, Football
India	Hockey, Kabaddi	**Japan**	Judo
Malaysia	Badminton	**Scotland**	Rugby, Football
Spain	Bull Fighting	**USA**	Baseball
Former Soviet	Union Football		

Number of Players In Some Popular Sports/Games

Sports	*Number of Players (on each side or in each team)*
Baseball	9
Rugby football	15
Polo	4
Water polo	7
Kho Kho	9

Kabaddi	7
Hockey, Football (soccer), Cricket	11
Netball	7
Volleyball	6
Tennis and Table Tennis	1 or 2 (Single & Doubles respectively)
Basketball	5
Gymnastic	Several individuals compete simultaneously
Billiards/Snooker	1
Boxing/Chess	1
Bridge	2
Croquet	13 or 15
Golf	Several individuals compete simultaneously
Lacrosse	12

Ground of Sports and Games

Athletics	Track	**Badminton**	Court
Baseball	Diamond	**Boxing**	Ring
Cricket	Pitch (Field)	**Football**	Field
Golf	Course	**Handball**	Court
Hockey	Field	**Ice Hockey**	Ring
Lawn Tennis	Court	**Skating**	Ring
Wrestling	Ring Arena		

General Knowledge

POPULAR NAMES OF EMINENT PERSONS (Sobriquets)

Nickname	Person
Father of the Nation	Mahatma Gandhi
Bapu	Mahatma Gandhi
Frontier Gandhi, Badshah Khan	Khan Abdul Ghaffar Khan
Grand Old Man of India	Dadabhai Naoroji
Strong (Iron) Man	Sardar Vallabhbhai Patel
Man of Peace	Lal Bahadur Shastri
Punjab Kesari	Lala Lajpat Rai
Bengal Kesari	Ashutosh Mukherjee
Bihar Kesari	Dr. Srikrishna Singh
Andhra Kesari	T. Prakasam
Sher-e-Kashmir	Sheikh Abdullah
Bangabandhu	Sheikh Mujibur Rahman
Deshbandhu	Chittaranjan Das
Deshbandhu	C.F. Andrews
Lokmanya	Bal Gangadhar Tilak
Loknayak	Jayaprakash Narayan
Jana Nayak	Karpuri Thakur
Rajashree	Purushottam Das Tandon

Gurudev	Rabindranath Tagore
Guruji	M.S. Golvalkar
Desh Ratna	Dr. Rajendra Prasad
Ajatshatru	Dr. Rajendra Prasad
Mahamana	Pt. Madan Mohan Malaviya
Netaji	Subhash Chandra Bose
Chacha	Jawaharlal Nehru
Rajaji, C.R.	Chakravarti Rajagopalachari
Sparrow	Major General Rajinder Singh
Young Turk	Chandra Shekhar
Tau	Chaudhury Devi Lal
Sahid-e-Azam	Bhagat Singh
Nightinagle of India	Sarojini Naidu
Lady with the lamp	Florence Nightingale
Swar Kokila	Lata Mangeshkar
Udanpari	P.T. Usha
Mother	Mother Teresa
Vishwa Kavi	Rabindranath Tagore
Kaviguru	Rabindranath Tagore
Sardar	Vallabhbhai Patel
Tota-e-Hind	Amir Khushro
Lal, Bal, Pal	Lala Lajpat Rai, Bal Gangadhar Tilak and Bipin Chandra Pal
Bihar Vibhuti	Dr. Anugrah Narayan Singh
Babuji	Jagjeevan Ram
Napoleon of India	Samudra Gupta
Shakespeare of India	Mahakavi Kalidas
Machiavelli of India	Chanakya
Akbar of Kashmir	Jainul Abdin
Father of Gujarat	Ravi Shankar Maharaj
Grandfather of Indian Films	Dhundiraj Govind Phalke
Morning Star of India Renaissance	Raja Ram Mohan Roy
King maker of Indian History	Sayyed Bandhu
Anna C.N. Annadurai	
G.B.S.	George Bernard Shaw
Haryana Hurricane	Kapil Dev
Little Master	Sunil Gavaskar
Magician of Hockey	Dhyanchand
Deshpriya	Yatindra Mohan Sengupta
Kuvempu	K.V. Puttappa
Little Corporal	Napoleon Bonaparte
Man of Destiny	Napoleon Bonaparte
Fuehrer	Adolf Hitler
King Maker	Earl of Warwick
Uncle Ho	Ho Chi Minh
Bard of Avon	William Shakespeare
Li-Kwan	Pearl Buck
Father of English Poetry	Geoffery Chaucer

Grand Old Manof Britain	Willium E. Gladstone
Maiden Queen	Queen Elizabeth I
Maid of Orleans	Joan of Arc
Man of Bloodand Iron	Otto Van Bismark
II Duce	Benito Mussolini
Desert Fox	Gen. Ervin Rommel
Quaid-i-Azam	Md. Ali Jinnah

FAMOUS TOURIST SPOTS OF INDIA

Site	Location	Founder
Kanheri Caves	Mumbai	Buddhists
Elphanta Caves	Mumbai	Rashtrakutas
Ajanta Caves	Aurangabad	Gupta Rulers
Ellora Caves	Aurangabad	Buddhists
Kandaria Mahadev	Khajurao (MP)	Chandela Kings
Madan Palace	Jabalpur (MP)	Raja Madan Shah
Mrignyani Palace	Gwalior (MP)	Raja Man Singh Tomar
Dhar Fort	Dhar (MP)	Mohammad Bin Tughlaq
Golconda Fort	Hyderabad (AP)	Qutubshahi
Cochin Fort	Kerala	Portuguese
Vijay Stambh (Victory Tower)	Chittorgarh (Raj)	Rana Kumbha
Qutub Minar	Delhi	Qutub-ud-din Aibak
Adhai Din Ka Jhopda	Ajmer (Raj)	Qutub-ud-din Aibak
Hauz Khas	Delhi	Alauddin Khilji
Tughalakabad	Delhi	Ghiyasuddin Tughlaq
Firoz Shah Kotla	Delhi	Firoz Shah Tughlaq
Bundi Fort	Bundi (Raj)	Raja Nagar Singh
Pichhola Lake	Udaipur (Raj)	–
Kakaria Lake	Ahmedabad	Sultan Qutub-ud-din
Jodhpur fort	Jodhpur (Raj)	Rao Jodha Ji
Fateh Sagar	Udaipur (Raj)	Maharana Fateh Singh
Deeg Palace	Deeg (Raj)	Raja Badan Singh
Rani Ki Badi	Bundi (Raj)	Rani Nathvati
Chhatra Mahal	Undi Fort	Rani Chhatrasal
Junagarh	Bikaner (Raj)	Raja Jay Singh
Jantar-Mantar	Delhi and Jaipur	Sawai Jay Singh
Nahargarh Fort	Jaipur(Raj)	Sawai Jay Singh
Bharatpur Fort	Bharatpur (Raj)	Raja Surajmal Singh
Moti Masjid	Delhi Fort	Aurangzeb
Ummed Palace	Jodhpur (Raj)	Maharaja Ummed Singh
Aram Bagh	Agra (UP)	Babur
Red Fort	Delhi	Shahjehan
Humayun's Tomb	Delhi	Hameeda Bano Beghum (wife of Humayun)
Shalimar Bagh (Garden)	Srinagar (J&K)	Jehangir

St. George Fort	Chennai (TN)	East India Company
Sher Shah's Tomb	Sasaram (Bihar)	Son of Sher Shah
Fatehpur Sikri	Agra (UP)	Akbar
Old Fort (Purana Quila)	Delhi	Sher Shah Suri
Akbar's Tomb	Sikandera (UP)	Jehangir
Chashma-Shahi	Jammu & Kashmir	Ali Mardan Khan
Etamad-ud-daulah's Tomb	Agra (UP)	Noorjehan
Taj Mahal	Agra (UP)	Shahjehan
Nishaat Bagh	Jammu & Kashmir	Asaf Ali
Sheesh Mahal	Agra (UP)	Shahjehan
Khas Mahal	Agra (UP)	Shahjehan
Dewan-e-Khas	Agra Fort (UP)	Shahjehan
Bada Imambada	Lucknow (UP)	Nawab Asaf-Ud-Daulah
Chhota Imambada	Lucknow (UP)	Mohammad Ali Shah
Golghar	Patna (Bihar)	British Government
Padari Ki Haveli	Patna (Bihar)	Father Capuchin
Fort William	Kolkata (WB)	Lord Clive
Bibi Ka Maqbara	Aurangabad	Aurangzeb
Safderjung Ka Maqbara	Delhi	Shuja-ud-daulah
Belur Math	Kolkata (WB)	Swami Vivekanand
Anand Bhawan	Allahabad (UP)	Moti Lal Nehru
Laxman Jhula	Rishikesh (Utt)	–
Shanti Niketan	West Bengal	Rabindranath Tagore
Sabarmati Ashram	Ahmedabad	Mahatma Gandhi
Prince of Wales Museum	Mumbai	George V
Gateway of India	Mumbai	British Government
President House	Delhi	British Government
Victoria Memorial	Kolkata (WB)	-
Botanical Garden	Shivpur (WB)	-
Sunset Point	Mount Abu (Raj)	-
Char Minar	Hyderabad (AP)	Kuli Qutub Shah
Sun Temple	Konark (Orissa)	Narasingh Dev I
Jagannath Temple	Puri (Orissa)	Chola Gang Dev
Chenna Keshab Temple	Belur	Vishnu Vardhan
Laxman Temple	Chhatarpur (MP)	Chandela Rulers
Dilwada Jain Temple	Mount Abu (Raj)	Vimal Shah
Vishnupad Temple	Gaya (Bihar)	Rani Ahilya Bai
Harmindar Sahib	Patna (Bihar)	Maharaja Ranjit Singh
Kali Temple	Kolkata (WB)	Rani Ras Moni
Laxmi Narayan Temple	Delhi	Birla Family
Khirki Masjid	Delhi	Ghiyasuddin Tughlaq
Shershahi Masjid	Patna (Bihar)	Parvez Shah
Mecca Masjid	Hyderabad (AP)	Kuli Kutub Shah
Patthar Ki Masjid	Patna (Bihar)	Parvez Shah
Patthar Ki Masjid	Jammu & Kashmir	Noorjehan
Jama Masjid	Agra (UP)	Shahjehan
Moti Masjid	Agra Fort (UP)	Shahjehan
Jama Masjid	Delhi	Shahjehan

Charar-e-Sarif	Sri Nagar (J&K)	Jainul Abedin
Hajratbal Masjid	Sri Nagar (J&K)	-
Nakhuda Masjid	Kolkata (WB)	-

FAMOUS SITES of world

Site	Location
Al-Aqusa	Jerusalem
Big Ben	London
Brandenberg Gate	Berlin
Broadway	New York
Brown House	Berlin
Buckingham Palace	London
Colossium	Rome
Downing Street	London
Eiffel Tower	Paris
Fleet Street	London
Harley Street	London
Hyde Park	London
India House	London
Kaaba	Mecca
Kremlin	Moscow
Leaning Tower	Pisa (Italy)
Louvre	Paris
Merdeka Palace	Jakarta
Oval	London
Pentagon	Washington
Potala	Nanking
Pyramid	Egypt
Red Square	Moscow
Scotland Yard	London
Shew-Dragon Pagoda	Rangoon
Sphinx	Egypt
Statue of Liberty	New York
Vatican	Rome
Wailing Wall	Jerusalem
Wall Street	New York
Westminster Abbey	London
White Hall	London
White House	Washington

WONDERS OF THE WORLD

Seven Wonders of the Ancient World

1. Hanging Garden of Babylon
2. Temple of Diana at Ephesus (Rome)
3. Statue of Jupiter at Olympia
4. Pyramids of Egypt

5. Mausoleum of Mausolus (Ruler of Halicarnasus)
6. Light House of Alexandria
7. The colossus of Rhodes

Seven Wonders of the Medieval World

1. Great Wall of China
2. Porcelain Tower of Nanjing (China)
3. Colosseum of Rome (Italy)
4. Stonehenge of England
5. Leaning Tower of Pisa (Italy)
6. Catacombs of Alexandria
7. Mosque at St. Sophia (Constantinople)

Other Wonders of the World

1. The Sphinx, near Gizeh (Ghiza) in Egypt
2. The Catacombs at Rome
3. The Circus Maximus at Rome
4. The Taj Mahal at Agra (India)
5. Angkorvat Temple in Combodia
6. The Alhambra at Granada in S. Spain
7. Shew Dragon Pagoda or the Golden Pagoda at Yangon in Myanmar

New Seven Wonders of the World

(As declared on July 7, 2007 by New Seven Wonders Foundation of Switzerland, at a grand ceremony organised in 'Stadia da Lutz, Benefica Stadium in Lisban (Portugal).

1. The Taj Mahal, Agra, India
2. The Great Wall of China, China
3. The Pink Ruins of Petra, Jordan
4. The Statue of Christ the Redeemer, Brazil
5. Incan Ruins of Machu Pichu, Peru
6. The Ancient Mayan City of Chichen Itza, Mexico
7. The Colosseum of Rome, Italy

PULITZER PRIZE

Instituted in 1970 and named after the US publisher Joseph Pulitzer (1847–1911). It is conferred annually in the United States for accomplishment in journalism, literature and music under the management to the Pulitzer Prize Board at Columbia University. Each winner receives a gold medal as well as a cash award of $10,000 (raised in 2003 from $7,500).

RAMON MAGSAYSAY AWARD

Instituted in 1957 named after Ramon Magsaysay, President of the Philippines, who died in an air crash in 1957. He became world renowned figure in the 1950's for his land reform programme to defuse communist insurgency. The award is given annually on August 31st, the birth anniversary of Magsaysay, for outstanding contributions to Public Service, Community Leadership, Journalism, Literature and Creative Arts and International Understanding. It is equivalent to the Nobel Prize in

Asia. It may also be awarded to organisations/ institutions and non-Asians working for the benefit of Asia. It carries a cash prize of $50,000.

GRAMMY AWARDS

The Grammy Foundation was established in 1989 to cultivate an awareness, appreciation and advancement of the contribution of recorded music. American culture from the artistic and technical legends of the past to the still unimagined musical breakthroughs of the future generations of the music professionals. The Grammy Foundation works in partnership with its founder, the Recording Academy, to bring national attention to important issues such as the value and impact of music and arts education and the urgency of preserving rich cultural legacy.

BHARAT RATNA

Bharat Ratna is the highest national award given for exceptional work for advancement of art, literature and science or in recognition of public service of the highest order.

Recipients of Bharat Ratna

C. Rajagopalachari (1878–1972)	1954
Dr. Sarvepalli Radhakrishnan (1888–1975)	1954
Dr. C.V. Raman (1888–1970)	1954
Dr. Bhagwan Das (1869–1958)	1955
Dr. M. Visvesvaraya (1861–1962)	1955
Jawaharlal Nehru (1889–1964)	1955
Govind Ballabh Pant (1887–1961)	1957
Dr. Dhondo Keshav Karve (1858–1962)	1958
Dr. Bidhan Chandra Roy (1882–1962)	1961
Purushottam Das Tandon (1882–1962)	1961
Dr. Rajendra Prasad (1884–1963)	1962
Dr. Zakir Hussan (1897–1969)	1963
Dr. Pandurang Vaman Kane (1880–1972)	1963
Lal Bahadur Shastri (1904–1966) (Posthumous)	1966
Indira Gandhi (1917–1984)	1971
Varahagiri Venkatagiri (1884–1980)	1975
Kumaraswami Kamraj (1903–1975) (Posthumous)	1976
Mother Teresa (1910–1997)	1980
Acharya Vinobha Bhave (1895–1982)	1983
Khan Abdul Ghaffar Khan (1890–1988)	1987
Marudu Gopalan Ramachandran (1917–1987) (Posthumous)	1988
Dr. Bhim Rao Ramji Ambedkar (1891–1956) (Posthumous)	1990
Dr. Nelson Rolihlaha Mandela (1918)	1990
Rajiv Gandhi (1944-1991) (Posthumous)	1991
Sardar Vallabhbhai Patel (1875–1950)	1991
Morarji Ranchhodji Desai (1869–1995)	1991
Maulana Abul Kalam Azad (1888–1958) (Posthumous)	1992
Jahangir Ratanji Dadabhai (J.R.D.) Tata (1904–1993)	1992
Satyajit Ray (1922–1992)	1992

Aruna Asaf Ali (1909–1996 (Posthumous)	1997
Gulzari Lal Nanda (1898–1997) (Posthumous)	1997
Dr. Avul Pakir Jainulabdeen Abdul Kalam (1931)	1997
Madurai Shanmukhavadivu Subbalakshmi (1916)	1998
Chidambaram Subramaniam (1910–2000)	1998
Loknayak Jayaprakash Narayan (1902–1979) (Posthumous)	1999
Professor Amartya Sen (1933)	1999
Lokpriya Gopinath Bordoloi (1890–1950) (Posthumous)	1999
Pandit Ravi Shankar (1920)	1999
Lata Mangeshwar (1929)	2001
Ustad Bissmillah Khan (1916–2006)	2001
Pt. Bhimsen Joshi	2008
C.N.R. Rao (1934) Scientist	2014
Sachin Tendulkar (1973) Cricketer	2014

Feature: The decoration is the form of a Peepal leaf, 2 inch long, 1–1/ 8inch in width and 1/ 2 inch thick, toned in bronze. On the obverse side is embossed a replica of the sun, below which the words 'Bharat Ratna' are embossed in Hindi. On the reverse are the State Emblem and a motto in Hindi. The emblem, the sun and rim are made ofplatinum.

Discontinuation of the Award: The award was discontinued by the Janta Government (Prime Minister Morarji Desai on July 13, 1977, and those who received the award in the past were informed that they would not be allowed to use it as a title).

Revival of the Award: In January 1980 Prime Minister Indira Gandhi decided to revive this award. After the revival, Mother Teresa was the first recipient.

PADMA AWARDS

Padma Awards fall next in line after the Bharat Ratna as national awards. They were also discontinued in 1977 along with the Bharat Ratna and revived again in 1980. There are three Padma awards, viz.,

(i) **Padma Vibhushan** is the second highest national award, given for exceptional and distinguished service in any field including services rendered by government employees.
(ii) **Padma Bhushan** is the third highest national award given for distinguished service in any field.
(iii) **Padma Shri** is the fourth highest award given for distinguished service in any field.

DADA SAHEB PHALKE AWARD

Instituted in 1970, the Dada Saheb Phalke Award is awarded by the Government of India for outstanding contribution to the cause of cinema. The award is named after Dhundiraj Govind Phalke, the father of Indian cinema, who made India's first feature film **Raja Harischandra** in 1913.

The award comprises a Swarna Kamal, a cash prize of ` 1,00,000 and a shawl.

The award was first given to Devika Rani in 1969, who became the first lady recipient of the award.

Prithviraj Kapoor was the first to be honoured posthumously with the Dada Saheb Phalke Award.

List of Dada Saheb Phalke Awardees

Year	*Winner*	*Occupation*	*State*

1969	Devika Rani	Actress	Andhra Pradesh
1970	B.N. Sircar	Producer	West Bengal
1971	Prithiviraj Kapoor	Actor (posthumous)	Punjab
1972	Pankaj Mullick	Composer (Music Director)	West Bengal
1973	Ruby Myers (Sulochana)	Actress	Maharashtra
1974	B.N. Reddy	Director	Andhra Pradesh
1975	Dhirendranath Ganguly	Actor, Director	West Bengal
1976	Kanan Devi	Actress	West Bengal
1977	Nitin Bose	Cinematographer, Director, Writer	West Bengal, Maharashtra
1978	Rai Chand Boral	Composer, Director	West Bengal
1979	Sohrab Modi	Actor, Director, Producer	Maharashtra
1980	P. Jairaj	Actor, Director	
1981	Naushad Ali	Composer (Music Director)	
1982	L.V. Prasad	Actor, Director, Producer	Andhra Pradesh
1983	Durga Khote	Actress	Maharashtra
1984	Satyajit Ray	Director	West Bengal
1985	V. Shantaram	Actor, Director, Producer	Maharashtra
1986	B. Nagi Reddy	Producer	Andhra Pradesh
1987	Raj Kapoor	Actor, Director	
1988	Ashok Kumar	Actor	West Bengal, Maharashtra
1989	Lata Mangeshkar	Singer	Maharashtra
1990	A. Nageswara Rao	Actor	Andhra Pradesh
1991	Bhalji Pendharkar	Director, Producer, Writer	Maharashtra
1992	Bhupen Hazarika	Composer (Music Director)	Assam
1993	Majrooh Sultanpuri	Lyricist	
1994	Dilip Kumar	Actor	
1995	Dr. Rajkumar	Actor	Karnataka
1996	Sivaji Ganesan	Actor	Tamil Nadu
1997	Pradeep	Lyricist	
1998	B.R. Chopra	Director, Producer	
1999	Hrishikesh Mukherjee	Director, Maharashtra	West Bengal,
2000	Asha Bhosle	Singer	Maharashtra
2001	Yash Chopra	Director, Producer	Punjab
2002	Dev Ananad	Actor, Director, Producer	Punjab
2003	Mrinal Sen	Director	West Bengal
2004	Adoor Gopalakrishnan	Director	Kerala
2005	Shyam Benegal	Director	Andhra Pradesh
2006	Tapan Sinha	Director	Kolkata
2007	Manna Dey	Singer	Kolkata
2008	Y.K. Murthu	Cinematographer	
2009	D. Ramanaidu	Actor, Producer	Andhra Pradesh
2010	K. Balachander	Director	Tamilnadu
2011	Soumitra Chatterjee	Actor	West Bengal

2012	Pran	Actor	2013	Gulzar	Poet, Lyricist and Film Director
2014	Jitendra	Actor			

RAJIV GANDHI KHEL RATNA AWARD

It was launched in the year 1991-92 with the objective of honouring sports persons to enhance their dignity and place of honour in society. Under this, an amount of ` 5 lakhs is given as award for the most spectacular and outstanding performance in the field of sports by an individual sports person or a team.

SAHITYA AKADEMI AWARD

It is awarded for outstanding literary works and comprises a cash prize of ` 50,000 in each of the 22 languages that it supports, and a copper plaque.

JNANPITH AWARD

Field : **Literature**

Instituted in : 1965

Cash Value : ` 5 lakh, a citation and a Vagdevi statue

Awarded to outstanding authors of creative literature in any of the Indian languages recognised by the Constitution of India. It was sponsored by the Bharatiya Jnanpith a culturo-literary society, founded in 1944 by Shanti Prasad Jain, an eminent industrialist.

First recipient : G. Sankara Kurup (Kerala)

First women recipient : Ashapoorna Devi (Calcutta)

The earlier winners of Jnanpith Award created by Shanti Prasad Jain and Rama Jain in 1963 for promoting outstanding literary works in regional languages, include Mahadevi Verma, Firaq Gorakhpuri, Girish Karnad, Amrita Pritam, U.R. Ananthamurthy and Quarratulain Hyder. So far there have been 39 recipients of this award.

LIST OF JNANPITH AWARDEES

Year	*Name*	*Works*	*Language*
1965	G. Sankara Kurup	Odakkuzhal (flute)	Malayalam
1966	Tarashankar Bandopadhyaya	Ganadevta	Bengali
1967	Dr. K.V. Puttappa	Sri Ramayana Darshanam (Glimpses of Ramayana)	Kannada
1967	Umashankar Joshi	Nishitha	Gujarati
1968	Sumitranandan Pant	Chidambara	Hindi
1969	Firaq Gorakhpuri	Gul-e-Naghma	Urudu
1970	Viswanatha Satyanarayana	Ramayana Kalpavrikshamu (A resourceful tree: Ramayana)	Telugu
1971	Bishnu Dey	Smriti Satta Bhavishyat	Bengali
1972	Ramdhari Singh Dinkar	Urvashi	Hindi
1973	Dattatreya Ramachandra Bendre	Nakutanti (Four Strings)	Kannada
1973	Gopinath Mohanty	Mattimatal	Oriya
1974	Vishnu Sakharam Khandekar	Yayati	Marathi
1975	P.V. Akilandam	Chittrappavai	Tamil
1976	Asha Purna Devi	Pratham Pratisruti	Bengali
1977	K. Shivaram Karanth	Mookajjiya Kanasugalu	Kannada

		(Mookajji's dreams)	
1978	Sachchidananda Hirananda Vatsyayan	Kitni Navan Men Kitni Bar (How many times in many boats?)	Hindi
1979	Birendra Kumar Bhattacharya	Mrityunjay (Immortal)	Assamese
1980	S.K. Pottekkatt	Oru Desattinte Katha (Story of a land)	Malayalam
1981	Amrita Pritam	Kagaj te Canvas	Punjabi
1982	Mahadevi Verma	Yama	Hindi
1983	Maasti Venkatesh Ayengar	Chikkaveera Rajendra (Life and Struggle of Kodava King Chikkaveera Rajendra)	Kanada
1984	Thakazhi Sivasankara Pillai		Malayalam
1985	Pannalal Patel		Gujarati
1986	Sachindanand Rout Roy		Oriya
1987	Vishnu Vaman Shirwadkar (Kusumagraj)	("Natsamrat")	Marathi
1988	Dr. C. Narayana Reddy	Vishwambhara	Telugu
1989	Quarratulain Hyder	Akhire Shab Ke Humsafar	Urdu
1990	V.K. Gokak	Bharatha Sindhu Rashmi	Kannada
1991	Subhas Mukhopadhyay	Padati	Bengali
1992	Naresh Mehta		Hindi
1993	Sitakant Mahapatra	For outstanding contribution to the Environment of Indian literature 1973–92	Oriya
1994	U.R. Ananthamurthy		Kannada
1995	M.T. Vasudevan Nair		Malayalam
1996	Mahasweta Devi		Bengali
1997	Ali Sardar Jafri		Urdu
1998	Girish Karnad	Tuglaq	Kannada
1999	Nirmal Verma		Hindi
1999	Gurdial Singh		Punjabi
2000	Indira Goswami		Assamese
2001	Rajendra Keshavlal Shah		Gujarati
2002	D. Jayakanthan		Tamil
2003	Vinda Karandikar	Subuk Soda, Kalami Rahi and Siyah Rode Jaren Man	Marathi
2004	Rahman Rahi	Literary work in Kashmiri language	Kashmiri
2005	Kunwar Narain	For his contribution to Hindi literature	Hindi
2006	Satyavrat Shastri	For his contribution to Sanskrit literature	Sanskrit
2006	Ravindra Kelekar	For his contribution to Konkani literature	Konkani
2007	O. N. V. Kurup		Malaylam
2008	Akhlaq Mohammed Khan Shahryar		Urdu
2009	AmarKent & Shrilal Shukla		Hindi
2010	Chandrashekhara Kambara	For his contributions to Kanata literature	Kanada
2011	Pratibha ray	For his contribution to Telugu literature	Oriya

2012	Ravuri Bharadhwaja	For his contribution to Telugu literature	Telugu

Books By Indian Authors

Book Name	Author
A Million Mutinies Now	V.S. Naipaul
A Bend in the River	V.S. Naipaul
A Brush with Life	Satish Gujral
A Passage to England	Nirad C. Choudhury
A House for Mr. Biswas	V.S. Naipaul
A Prisoner's Scrapbook	L.K. Advani
A River Sutra	Gita Mehta
A Call to Honour	Jaswant Singh
A Sense of Time	H.S. Vatsyayan
A Strange and Sublime Address	Amit Chaudhary
A Bunch of Old Letter	Jawaharlal Nehru
A Suitable Boy	Vikram Seth
A Village by the Sea	Anita Desai
Agni Veena	Kazi Nazrul Islam
A Voice for Freedom	Nayantara Sehgal
Afternoon Raag	Amit Chaudhari
Ain-i-Akbari	Abdul Fazal
Ageless Body, Timeless Mind	Deepak Chopra
AK Barnama	Abdul Fazal
Amar Kosh	Amar Singh
An Autobiography	Jawaharlal Nehru
All the Prime Minister's Men	Janardhan Thakur
An Equal Music	Vikram Seth
Arthashastra	Kantilya
An Idealist View of Life	Dr. S. Radhakrishnan
Anandmath	Bankim Chandra Chatterjee
An Autobiography	Jawaharlal Nehru
Autobiography of an Unknown India	Nirad C. Choudhury
Bandicoot Run	Manohar Malgonkar
Beginning of the Beginning	Bhagwan Shri Rajneesh
Beyond Modernisation, Beyond Self	Sisir Kumar Ghose
Bhagvad Gita	S. Radhakrishnan
Border and Boundaries; women in India's Partition	Ritu Menon & Kamla Bhasin
Bharat Bharati	Maithili Saran Gupt
Breaking the Silence	Anees Jung
Bride and the Sahib and the Other Stories	Khushwant Singh
Broken Wings	Sarojini Naidu
Bubble	Mulk Raj Anand
The Bread, Beantyand Revolution	Khwaja Ahmad Abbas
By God's Decree	Kapil Dev
Chemmeen	Thakazhi Sivasankara Pillai
Chitra	Rabindranath Tagore
Circle of Reason	Amitav Ghosh

Circle of Sileance	Preeti Singh
Clear Light of Day	Anita Desai
Confessions of a Lover	Mulk Raj Anand
Conquest of Self	Mahatma Gandhi
Coolie	Mulk Raj Anand
Court Dancer	Rabindranath Tagore
Crescent Moon	Rabindranath Tagore
Days of My Years	H.P. Nanda
Death of a City	Amrita Pritam
Devdas	Sharat Chandra Chatterjee
Discovery of India	Jawaharlal Nehru
Distant Drums	Manohar Malgonkar
Divine Life	Swami Sivananda
Durgesh Nandini	Bankim Chandra Chatterjee
Dynamics of Social Change	Chandra Shekhar
Eight Lives	Rajmohan Gandhi
English August	Upamanyu Chatterjee
Essays on Gita	Sri Aurobindo Ghosh
Eternal Himalayas	Major H.P.S. Ahluwalia
Faces of Everest	Major H.P.S. Ahluwalia
Foreign Policy of India	I.K. Gujral
Forty-Nine Days	Amrita Pritam
From Rajpath to Lokpath	Vijaya Raje Schindhia
Ganadevata	Tara Shankar Bandopadhyaya
Gardener	Rabindra Nath TAgore
Ghasiram Kotwal	Vijay Tendulkar
Gitanjali	Rabindranath Tagore
Gita Rahasya	Bal Gangadhar Tilak
Glimpses of World History	Jawaharlal Nehru
Godan	Prem Chand
Geet Govinda	Jayadeva
Golden Threshold	Sarojini Naidu
Guide	R.K. Narayan
Harsha Charita	Bana Bhatta
Harvest	Manjula Padmanabhan
Heir Apparent	Dr. Karan Singh
Himalayan Blunder	Brigadier J.P. Dalvi
Hind Swaraj	M.K. Gandhi
Hindu View of Life	Dr. S. Radhakrishnan
Hinduism	Nirad C. Choudhury
History of India	Romila Thapar
Hullabaloo in a Guava Orchard	Kiran Desai
Hungary Stones	Rabindranath Tagore
I follow the Mahatma	K.M. Munshi
Idols	Sunil Gavaskar
India Divided	Rajendra Prasad
India Unbound	Gurucharan Das
India of Our Dreams	M.V. Kamath
India Wins Freedom	Abul Kalam Azad
India's Priceless Heritage	N.A. Palkhivala
Indian Philosophy	Dr. S. Radhakrishnan

Inscrutable Americans	Anurag Mathur
Ignited Minds	A.P.J. Abdul Kalam
Interpreter of Maladies	Jhumpa Lahin
It's Always Possible	Kiran Bedi
Jai Somnath	K.M. Munshi
Junglee Girl	Ginu Kamani
Kagaz Te Kanwas	Amrita Pritam
Kamasutra	S.H. Vatsayayan
Kanthapura	Raja Rao
Kapala Kundala	Bankim Chandra Chatterjee
Kashmir: A Tale of Shame	Hari Jaisingh
Kashmir: ATragedy of Errors	Talveen Singh
Kayar	Thakazhi Sivasankara Pillai
Kitni Nawon Kitni Bar	S.H. Vatsayayan
Kamayani	Jai Shankar Prasad
Kulliyat	Ghalib
Kumar Sambhava	Kalidas
Last Burden	Upamanyu Chatterjee
Lipika	Rabindranath Tagore
Life Divine	Sri Aurbindo Ghosh
Lost Child	Mulk Raj Anand
Malgudi Days	R.K. Narayan
My Days	R.K. Narayan
My India	S. Nihal Singh
My Life and Times	V.V. Giri
My Music, My Life	Pt. Ravi Shankar
My Presidential Years	R. Venkatraman
My Truth	Indira Gandhi
New Dimensions of India's Foreign Policy	A.B. Vajpayee
Nisheeth	Uma Shankar Joshi
Operation Bluestar: The True Story	Lt. Gen K.S. Brar
Our Films, Their Films	Satyajit Ray
Painter of Signs	R.K. Narayan
Panchatantra	Vishnu Sharma
Past Forward	G.R. Narayanan
Pather Panchali	Bibhuti Bhushan
Plain Speaking	N. Chandrababu Naidu
Portrait of India	Ved Mehta
Post Office	Rabindranath Tagore
Prem Pachisi	Munshi Prem Chand
Rajtarangini	Kalhana
Ram Charita Manas	Tulsidas
Ramayana	Maharishi Valmiki
Raghuvamsa	Kalidas
Ranghbhoomi	Prem Chand
Ratnavali	Harsha Vardhan
Ravi Paar (Across the Ravi)	Gulzar
Red Earth and Pouring Rain	Vikram Chandra
Ritu Samhara	Kalidas
Saket	Maithili Sharan Gupt
Secular Agenda	Arun Shorie

Seven Summers	Mulk Raj Anand
Shadow from Ladakh	Bhabhani Bhattacharya
Snakes and Ladders: Essayson India	Gita Mehta
Social Change in Modern India	M.N. Srinivas
Sultry Days	Shobha De
Sunny Days	Sunil Gavaskar
The Bride's Book of Beauty	Mulk Raj Anand
The Cat and Shakespeare	Raja Rao
The Dark Room	R.K. Narayan
The Degeneration of India	T.N. Seshan
The Glass Palace	Amitav Ghosh
The God of Small Things	Arundhati Roy
The Golden Gate	Vikram Seth
The Judgement	Kuldip Nayar
The Men whokilled Gandhi	Manohar Malgonkar
The Seven Spiritual Laws of Success	Deepak Chopra
The Songs of India	Sarojini Naidu
The Story of My Experiments with Truth	Mahatma Gandhi
The Strange and Sublime Address	Amit Chaudhuri
The Sword and the Sickle	Mulk Raj Anand
The Vendor of Sweets	R.K. Narayan
The Way of the Wizard	Deepak Chopra
The Girmitiya Saga	Girraj Kishore
Train to Pakistan	Khushwant Singh
Two Leavesanda Bud	Mulk Raj Anand
Victoria and Abdul	Shrabani Basu
Waiting for the Mahatma	R.K. Narayan
Wake Up India	Annie Besant
We, Indians	Khushwant Singh
Yama	Mahadevi Verma
Yashodhara	Maithili Sharan Gupt
Years of Pilgrimage	Dr. Raja Ramana

Books and Authors (in News)

Romancing with Life	Dev Anand
Saurabh Ganguli: The Maharaja of Cricket	Debasheesh Dutta
Mohan Das: A True Story of a man, his People and Empire Lets Kill Gandhi	Raj Mohan Gandhi Tushar Gandhi
Eat, Prey, Love	Elizabeth Gilbert
Manzilon Se Jyada Safar	V.P. Singh
A Call To Honour: In Service of Emergent India	Jaswant Singh
Vikram Sarabhai: A Life	Amrita Shah
Mr. Midnight	Jim Echison
Soldier: The Life of Colin Powell	Carren d' Young
Bangladesh: The Next Afghanistan	Hiranyam Karlekar
The Making of A Superstar	Sushmita Sengupta
Full Empowered	Pablo Neruda
Drishtikon	Arjun Munda
Amrita Shergil: A Life	Yashodhara Dalmia

Guiding Souls	Dr. A.P.J. Abdul Kalam
Nine O' Nine	Nandita Puri
Collected Plays	Girish Karnad
All My Sisters	Zudith Lenox
The Longest Race	Tom Alter
Gulab Bai: The Queen of Nautanki Theatre	Deepti Priya Mehrotra
Touch Play (Biography of Prakash Padukone)	Dev Sukumar
Out of My Comfort Zone: The Autobiography	Steev Waugh
Honeymoon	James Petterson
Da Vinci Code	Don Brown
The Broker	John Greesen
God of Small Things	Arundhati Rai
Speed Post	Shobha De
The Better Man	Anita Nayyar
Bookless in Baghdad	Shashi Thiroor
The Argumentative Indians	Dr. Amartya Sen
The Algebra of Infinite Justice	Arundhati Rai
Fire fly: AFairy Tale	Ritu Beri
Two Lives	Vikram Seth
Glass Palace	Amitav Ghosh
The Brief Historyof Time	Stephen Hawking
Freedom from Fear	Aung San Suu Kyi
Fasting, Feasting	Anita Desai
The Lord of the Flies	William Goldings
Struggle for Change	K.B. Lal
My Life	Bill Clinton
Life of Pi	Yann Martel
India in Slow Motion	Mark Tully
Ignited Minds	Dr. A.P.J. Abdul Kalam
Wings of Fire	Dr. A.P.J. Abdul Kalam
Envisioning an Empowered Nation	Dr. A.P.J. Abdul Kalam
Interpreter of Maladies	Jhumpa Lahiri
One Day Cricket, The Indian Challange	Ashish Roy
A View from Outside	P. Chidambaram
Harry Potter and the Deathly Hallows	J.K. Rawlling
The Year ofthe Roester	Guy Sorman
Above Average	Amitabh Bagchi
Dalits in India: A Profile	Sukhdeo Thorat
The Top of the Raintree	Kamalini Sengupta
Terrifying Visions: Golwalkar, the RSS and India	Jyotirmay Sharma
Frontline Pakistan: The Struggle with Militant Islam	Zahid Hussain
21st Century Journalism in India	Nalini Rajan
The Splender of Silence	Indu Sundaresan
The Leopard and the Fox: A Pakistani Tragedy	Tariq Ali
Keswan's Lamentations	S. Mukundon
India and China–A Thousand Years of Cultural Relations Maqbool Fida Hussain	Probodh ChandraBagchi
The Audacity of Hope: Thoughts on Reclaiming the	K. Bikram Singh

American Dream	Barack Obama
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I Shall Never Ask for Pardon	Memoir of Pandurang Khankhoje: Savitri Sawhney
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Open Veins of Latin America: Five Centuries of the Pillage of a Continent	Eduardo Galeano
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The 24×7 Marriage: Smart Strategies for Good Beginnings	Dr. VijayNagaswami
The Idea of Justice	Dr. Amartya Sen
Arguments for a Better World: Essays in Honour of Amartya Sen	Kaushik Basu and Ravi Kanbur
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Bold Endeavors–How Our Government Built America, and Why It must Rebuild Now	Felix Rohatyn
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Daughters of Shame	Jasvinder Sanghera Imprint Hodder, Gurgaon
Celebrating India: Reflections on Eminent Indian Muslims (1857–2007)	Meher Fatima Hussain
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Macroeconomics of Post-Reforms India, (Vol.I)	Mihir Rakshit
Money and Finance in the Indian Economy, (Vol. II)	

Out of Steppe: The Lost People of Central Asia	Daniel Metcalfe
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Democracy and Human Development in India	Naresh Gupta
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Accelerating Growth and Job Creation in South Asia	Ejaz Ghani and Sadiq Ahmed
India and Pakistan–Social, Political and Military Perspective	Rajkumar Singh
Kissinger: 1973, TheCrucial Year	Alistair Home, Simon and Schuster
The Great Divide	Ira Pande Harper Collins
Taliban: Militant Islam, Oil and Fundamentalism in Central Asia	Ahmed Rashid
India and Global Financial Crisis	Y.V. Reddy
India's Foreign Policy: The Democracy Dimension	S.D. Muni
The World Around US	Radha Burnier
Between Moernity and Nationalism: Haliae Edip's Encounter with Gandhi's India	Mushirul Hasan
The Making of African America: The Four Great Migrations	Ira Berlin
A Compendium of Kisses	Lana Citron, (beautiful Books)
The Museum of Innocence	Orhan Pamuk
The Long Shadow: Nuclear Weapons and Security in 21st Century Asia.	MuthiahAlagappa (Oxford)
Coalition Politics in India	C.P. Bhambri
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Faith: Memories of a Parliamentarian	Somnath Chatterjee

SSC CGL 2018
IMPORTANT TOPICS FOR GENERAL SCIENCE

PHYSICS

CHEMISTRY

BIOLOGY

Important Science Reasoning

ATOMIC PHYSICS

- An atom is the smallest particle of the element that can exist independently and retain all its chemical properties.
- Dalton's atomic theory, which suggested that the atom was indivisible and indestructible. But the discovery of two fundamental particles (electrons and protons) inside the atom, led to the failure of this aspect of Dalton's atomic theory.
- Thomson proposed that:
  i. An atom consists of a positively charged sphere and the electrons are embedded in it.
  ii. The negative and positive charges are equal in magnitude. So, the atom as a whole is electrically neutral.
- Rutherford's alpha-particle scattering experiment led to the discovery of the atomic nucleus. Rutherford's model of the atom proposed that a very tiny nucleus is present inside the atom and electrons revolve around this nucleus. The stability of the atom could not be explained by this model.
- Neils Bohr's model of the atom was more successful. He proposed that electrons are distributed in different shells with discrete energy around the nucleus. If the atomic shells are complete, then the atom will be stable and less reactive.
- J. Chadwick discovered presence of neutrons in the nucleus of an atom. So, the three sub-atomic particles of an atom are: (i) electrons, (ii) protons and (iii) neutrons. Electrons are negatively charged, protons are positively charged and neutrons have no charges. The mass of an electron is about 1/2000 times the mass of an hydrogen atom. The mass of a proton and a neutron is taken as one unit each.
- We know that protons are present in the nucleus of an atom. It is the number of protons of an atom, which determines its atomic number. It is denoted by 'Z'. All atoms of an element have the same atomic number, Z. In fact, elements are defined by the number of protons they possess.
- Mass of an atom is practically due to protons and neutrons alone. These are present in the nucleus of an atom. Hence protons and neutrons are also called nucleons. Therefore, the mass of an atom resides in its nucleus.
- Isotopes are atoms of the same element, which have different mass numbers.
- Isobars are atoms having the same mass number but different atomic numbers.
- To bind a nucleus together there must

be a strong attractive force of a totally different kind. It must be strong enough to overcome the repulsion between the (positively charged) protons and to bind both protons and neutrons into the tiny nuclear volume. This force is called Nuclear Force.

- The nuclear force is much stronger than the Coulomb force acting between charges or the gravitational forces between masses. The nuclear force between neutron-neutron, proton-neutron and proton-proton is approximately the same. The nuclear force does not depend on the electric charge.
- Radioactivity occurs when an atomic nucleus breaks down into smaller particles. There are three types of nuclear radiation: alpha, beta, and gamma. Alpha particles are positively charged, beta particles are negatively charged, and gamma particles have no charge. The radiations also have increasing levels of energy, first Alpha, then Beta, and finally Gamma, which is the most energetic of all these. Alpha and Beta are particles, but Gamma is a wave.
- When a radioactive nucleus changes, the remaining nucleus (and atom) is not the same as it was. It changes its identity. The term half-life describes the time it takes for half of the atoms in a sample to change, and half to remain the same.
- There is even a radioactive isotope of carbon, carbon-14. Normal carbon is carbon-12. C-14 has two extra neutrons and a half-life of 5730 years. Scientists use C-14 in a process called carbon dating. This process is not when two carbon atoms go out to the mall one night. Carbon dating is when scientists try to measure the age of very old substances. There are very small amounts of C-14 in the atmosphere. Every living thing has some C-14 in it. Scientists measure the amount of C-14 in the things they dig up to estimate how old they are. They rely on the half-life of 5730 years to date theobject.
- Fission is the splitting of an atom. Not all atoms will go through fission; as a matter of fact, very few do under normal circumstances.
- In a nuclear reaction, scientists shoot a whole bunch of neutrons at uranium-235 atoms. When one neutron hits the nucleus, the uranium becomes U-236. When it becomes 236, the uranium atom wants to split apart. After it splits, it gives off three neutrons and a lot of energy. Those neutrons hit three other U atoms in the area and cause them to become U-236. Each cycle, the reaction gets three times bigger. A reaction that, once started, continues by itself, is called a chain reaction.
- Fusion is the process of two small atomic nuclei coming together to make a larger nucleus which is stable. The simplest nuclei to use are deuterium and tritium (isotopes of hydrogen).

HEAT

- Temperature is a relative measure, or indication of hotness or coldness.
- Heat is the form of energy transferred between two (or more) systems or a system and its surroundings by virtue of temperature difference. The SI unit of heat energy transferred is expressed in joule (J) while SI unit of temperature

is kelvin (K), and °C is a commonly used unit of temperature.

- Thermometer is a device used for measuring temperatures. The two familiar temperature scales are the Fahrenheit temperature scale and the Celsius temperature scale. The Celsius temperature (tC) and the Farenheit temperare (tF) are related by: tF = (9/5) tC + 32
- In principle, there is no upper limit to temperature but there is a definite lower limit- the absolute zero. This limiting temperature is 273.16° below zero on the celsius scale of temperature.
- Clinical thermometer is used to measure our body temperature. The range of this thermometer is from 35°C to 42°C. For other purposes, we use the laboratory thermometers. The range of these thermometers is usually from −10°C to 110°C. The normal temperature of the human body is 37°C.
- The heat flows from a body at a higher temperature to a body at a lower temperature.There are three ways in which heat can flow from one object to another. These are conduction, convection and radiation.
- The process by which heat is transferred from the hotter end to the colder end of an object is known as conduction. In solids, generally, the heat is transferred by the process of conduction.
- The materials which allow heat to pass through them easily are conductors of heat. For examples, aluminum, iron and copper. The materials which do not allow heat to pass through them easily are poor conductors of heat such as plastic and wood. Poor conductors are known as insulators.
- In convention heat is carried from one place to another by the actual movement of liquid and gases. In liquids and gases the heat is transferred by convection.
- The people living in the coastal areas experience an interesting phenomenon. During the day, the land gets heated faster than the water. The air over the land becomes hotter and rises up. The cooler air from the sea rushes in towards the land to take its place. The warm air from the land moves towards the sea to complete the cycle. The air from the sea is called the sea breeze. At night it is exactly the reverse. The water cools down more slowly than the land. So, the cool air from the land moves towards the sea. This is called the land breeze.
- The transfer of heatby radiation does not require any medium. It can take place whether a medium is present or not.
- Dark-coloured objects absorb radiation better than the light-coloured objects. That is the reason we feel more comfortable in light-coloured clothes in the summer. Woollen clothes keep us warm during winter. It is so because wool is a poor conductor of heat and it has air trapped in between the fibres.
- A change in the temperature of a body causes change in its dimensions. The increase in the dimensions of a body due to the increase in its temperature is called thermal expansion. The expansion in length is called linear expansion. The expansion in area is called area expansion. The expansion in volume is called volume expansion.

- The amount of heat energy required to raise the temperature of 1g of a substancethrough 1° is called specific heat capacity of the substance. The S.I. Unit of specific heat capacity is(J/kg) K. Water has the highest specific heat capacity which is equal to 4200 (J/kg)K.
- The specific heat capacity is the property of the substance which determines the change in the temperature of the substance (undergoing no phase change) when a given quantity of heat is absorbed (or rejected) by it. It is defined as the amount of heat per unit mass absorbed or rejected by the substance to change its temperature by one unit. It depends on the nature of the substance and its temperature.
- The amount of heat energy required to raise the temperature of a given mass of substancethrough 1° is callede heat capacity or thermal capacity of the substance. It's S.I. Unit is (J/K).
- Calorimetry means measurement of heat. When a body at higher temperature is brought in contact with another body at lower temperature, the heat lost by the hot body is equal to the heat gained by the colder body, provided no heat is allowed to escape to the surroundings. A device in which heat measurement can be made is called a calorimeter.
- CHANGE OF STATE: Matter normally exists in three states: solid, liquid, and gas. A transition from one of these states to another is called a change of state. Two common changes of states are solid to liquid and liquid to gas (and vice versa). These changes can occur when the exchange of heat takes place between the substance and its surroundings.
- The change of state from solid to liquid is called melting and from liquid to solid is called fusion. It is observed that the temperature remains constant until the entire amount of the solid substance melts. That is, both the solid and liquid states of the substance coexist in thermal equilibrium during the change of states from solid to liquid.
- The temperature at which the solid and the liquid states of the substance in thermal equilibrium with each other is called its melting point. It is characteristic of the substance. It also depends on pressure. The melting point of a substance at standard atomspheric pressure is called its normal melting point.
- The change of state from liquid to vapour (or gas) is called vaporisation. It is observed that the temperature remains constant until the entire amount of the liquid is converted into vapour. That is, both the liquid and vapour states of the substance coexist in thermal equilibrium, during the change of state from liquid to vapour.
- The temperature at which the liquid and the vapour states of the substance coexist is called its boiling point. At high altitudes, atmospheric pressure is lower, reducing the boiling point of water as compared to that at sea level. On the other hand, boiling point is increased inside a pressure cooker by increasing the pressure. Hence cooking is faster.
- The boiling point of a substance at

standard atmospheric pressure is called its normal boiling point.

- However, all substances do not pass through the three states: solid-liquid-gas. There are certain substanceswhich normally pass from the solid to the vapour state directly and vice versa. The change from solid state to vapour state without passing through the liquid state is called sublimation, and the substance is said to sublime. Dry ice (solid CO2) sublimes, so also iodine. During the sublimation process both the solid and vapour states of a substance coexist in thermal equilibrium.
- Certain amount of heat energy is transferred between a substance and its surroundings when it undergoes a change of state. The amount of heat per unit mass transferred during change of state of the substance is called latent heat of the substance for the process.
- The amount of heat energy supplied to a solid at its melting point, such that it changes into liquid state without any rise in temperature is called latent heat of fusion and that for a liquid-gas state change is called the latent heat of vaporisation.
- Newton's Law of Cooling says that the rate of cooling of a body isproportional to the excess temperature of the body over the surroundings.

LIGHT

- To understand light you have to know that what we call light is what is visible to us.Visible light is the light that humans can see. Other animals can see different types of light. Dogs can see only shades of gray and some insects can see light from the ultraviolet part of the spectrum.
- As far as we know, all types of light move at one speed when in a vacuum. The speed of light in a vacuum is 299,792,458 meters per second.
- Any medium through which light can travel is an optical medium. If this medium is such that light travels with equal speed in all directions, then the medium is called a homogeneous medium. The homogeneous media through which light can pass easily, are called transperant media. The media through which light cannot pass, are called opaque media. Again the media through which light can pass partly, are called translucent media.
- LIGHT TRAVELS ALONG A STRAIGHT LINE.
- Light is reflected from all surfaces. Regular reflection takes place when light is incident on smooth, polished and regular surfaces.
- After striking the surface, the ray of light is reflected in another direction. The light ray, which strikes any surface,is called the incident ray. The ray that comes back from the surface after reflection is known as the reflected ray.
- The angle between the normal and incident ray is called the angle of incidence . The angle between the normal and the reflected ray is known as the angle of reflection.
- Two laws of reflection are:
  1. The angle of incidence is equal to the angle of reflection.
  2. Incident ray, reflected ray and the normal drawn at the point of incidence to the reflecting surface,

lie in the same plane.

- When all the parallel rays reflected from a plane surface are not parallel, the reflection is known as diffused or irregular reflection. On the other hand reflection from a smooth surface like that of a mirror is called regular reflection.
- When rays of light coming from a point of source, after reflection or refraction, actually meet at another point or appear to diverge from another point, the second point is called the image of the first point. Images may be of two types, viz., (i) real and (ii) virtual.
- An image which can be obtained on a screen is called a real image. An image which cannot be obtained on a screen is called a virtual image.
- The image formed by a plane mirror is erect. It is virtual and is of the same size as the object. The image is at the same distance behind the mirror as the object is in front of it.
- The reflecting surface of a spherical mirror may be curved inwards or outwards. A spherical mirror, whose reflecting surface is curved inwards, that is, faces towards the centre of the sphere, is called a concave mirror.
- A spherical mirror whose reflecting surface is curved outwards, is called a convex mirror.
- The centre of the reflecting surface of a spherical mirror is a point called the pole. It lies on the surface of the mirror. The pole is usually represented by the letter P.
- The reflecting surface of a spherical mirror forms a part of a sphere. This sphere has a centre. This point is called the centre of curvature of the spherical mirror. It is represented by the letter C. Please note that the centre of curvature is not a part of the mirror. It lies outside its reflecting surface. The centre of curvature of a concave mirror lies in front of it. However, it lies behind the mirror in case of a convex mirror.
- The radius of the sphere of which the reflecting surface of a spherical mirror forms a part, is called the radius of curvature of the mirror. It is represented by the letter R. You may note that the distance PC is equal tothe radius of curvature.
- Imagine a straight line passing through the pole and the centre of curvature of a spherical mirror. This line is called the principal axis.
- Concave mirrors are commonly used in torches, search-lights and vehicles headlights to get powerful parallel beams of light. They are often used as shaving mirrors to see a larger image of the face. The dentists use concave mirrors to see large images of the teeth of patients. Large concave mirrors are used to concentrate sunlight to produce heat in solar furnaces.
- Convex mirrors are commonly used as rear-view (wing) mirrors in vehicles. These mirrors are fitted on the sides of the vehicle, enabling the driver to see traffic behind him/her to facilitate safe driving. Convex mirrors are preferred because they always give an erect, though diminished, image. Also, they have a wider field of view as they are curved outwards. Thus, convex mirrors enable the driver to viewmuch larger area than would be possible with a plane mirror.

- Lenses are widely used in spectacles, telescopes and microscopes.Those lenses which feel thicker in the middle than at the edges are convex lenses. Those which feel thinner in the middle than at the edges are concave lenses. Notice that the lenses are transparent and light can pass through them.
- A convex lens converges (bends inward) the light generally falling on it. Therefore, it is called a converging lens. On the other hand, a concave lens diverges (bends outward) the light and is called a diverging lens.
- A convex lens can forms real and inverted image. When the object is placed very close to the lens, the image formed is virtual, erect and magnified. When used to see objects magnified, the convex lens is called a magnifying glass.
- A concave lens always forms erect, virtual and smaller image than the object.
- The two surfaces of the lens are parts of two spheres. The straight line joining obtained by joining two centres of the spheres is called Principal axis. Generally we use lenses whose surfaces have equal curvature. In such lenses, if we take a point on theprincipal axis inside the lens equidistant from the two surfaces, the point is called the optical centre of the lens.
- If a beam of parallel rays, travelling parallel to the principal axis of a convex lens, are refracted by the lens, the rays become converging and intersect each other at a particular point of the axis. The point is called the focus of the convex lens. The focal length of a lens is the distance between the optical centre and the focus of the lens.
- The power of a lens is a measure of the degree of convergence(in the case of a convex lens) or divergence (in the case of a concave lens). It is defined as the reciprocal of its focal length expressed in meters. The S.I. Unit of power of a lens is dioptre, the symbol being D. Thus, 1 dioptre is the power of a lens whose focal length is 1 metre. 1D = 1m–1. You may note that the power of a convex lens is positive and that of a concave lens is negative.
- The phenomenon due to which a ray of light deviates from its path , at the surface of seperation of two media, when the ray of light is travelling from one optical medium to another optical medium is called refraction of light. When a ray of light travels from an optically rare medium to an optically denser medium.
- When a ray of light travels from an optically denser medium to an optically rare medium, it bends away from the normal at the surface of seperation of two media.
- When a ray of light strikes the surface of seperation of two media normally, it does not deviate from its original path. Some indexes of refraction are diamond (2.419), glass (1.523), and water (1.33).
- Total internal reflection is the phenomenon which involves the reflection of all the incident light off the boundary. Total internal reflection only takes place when both of the following two conditions are met: (i) the light is in the more dense medium and approaching the less dense medium., and (ii) the angle of incidence

is greater than the so-called critical angle. Total internal reflection will not take place unless the incident light is traveling within the more optically dense medium towards the less optically dense medium.

- Dispersion of Light: It is the phenomenon of splitting of a beam of white light into its constituent colors on passing through prism. The order of colors from the lower end are violet, indigo, blue, green, yellow, orange and red. At one end of the band, there is red and at the other violet. The sequence of colours can be best remembered by the wordVIBGYOR' which is formed by taking the initial letter of each colour.
- A laser is just a really powerful beam of light. Laser isn't a word but an acronym. It stands for LIGHT AMPLIFICATION by STIMULATED EMISSION of RADIATION.

MAGNETISM AND ELECTRICITY

A. Magnetism

- The word magnet is derived from the name of an island in Greece calledMagnesia where magnetic ore deposits were found, as early as 600 BC. Magnetite, an iron ore, is a natural magnet. It is called lodstone.
- When a bar magnet is freely suspended, it points in the north-south direction. The tip which points to the geographic north is called the north pole and the tip which points to the geographic south is called the south pole of the magnet. There is a repulsive force when north poles (or south poles) of two magnets are brought close together. Conversely, there is an attractive force between the north pole of one magnet and the south pole of the other.
- The properties of a magnet are
  i. it attracts small piece of iron towards it.
  ii. it always cmes to rest in north-south direction when suspended freely.
  iii. like poles repel, unlike poles attracts each other
  iv. Magnetic poles always exist in pairs.
  v. the strength of a magnet is maximum at poles located near the poends
- The phenomenon due to which an unmagnetized magnetic substance behaves like a magnet, due to the presence of some other magnet, is called magnetic induction. Magnetic induction takes place first then magnetic attraction.
- Magnetic induction depends upon the nature of magnetic substance. Magnetic induction is inversely propotional to the distance between inducing magnet and the magnetic substance. More powerful the inducing magnet, the more strong will be the magnetism in magnetic substance.
- The space around the magnet where its influence can be detected is called themagnetic field.
- A curve in a magnetic field, along with a free north magnetic pole will move, is called magnetic line of force. The direction of magnetic lines of force is the direction in which free north pole will move in a magnetic field.
  - o They travel from north to south pole outside the magnet and from south to north pole inside the magnet.
  - o They mutually repel each other

o They never intersect with each other

- The earth behaves as a magnet with the magnetic field pointing approximately from the geographic south to thenorth. At a particular place on earth, the magnetic north is not usually in the direction of the geographic north. The angle between the two directions called declination.

B. Electricity

- The phenomenon due to which a suitable combination of bodies on rubbing, get electrified is called electricity. If a charge on a body is not allowed to flow, it is called the static electricity.
- Matters are made of atoms. An atom is basically composed of three different components – electrons, protons, and neutrons. An electron can be removed easily from an atom. When two objects are rubbed together, some electrons from one objectmove to another object. For example, when a plastic bar is rubbed with fur, electrons will move from the fur to the plastic stick. Therefore, plastic bar will be negatively charged and the fur will be positively charged.
- When two objects are rubbed together, some electrons from one object move to another object. For example, when a plastic bar is rubbed with fur, electrons will move from the fur to the plastic stick. Therefore, plastic bar will be negatively charged and the fur will be positively charged.
- When you bring a negatively charged object close to another object, electrons in the second object will be repelled from the first object. Therefore, that end will have a negative charge. This process is called charging by induction.
- When a negatively charged object touches a neutral body, electrons will spread on both objects and make both objects negatively charged. This process is called charging by conduction. The other case, positively charged object touching the neutral body, is just the same in principle.
- Substances can be classified into three types – insulators, conductors, and semiconductors
- Conductors are materials which electrical charges and heat energy can be transmitted very easily. Almost all metals such as gold, silver, copper, iron, and lead are good conductors.
  i. Insulators are materials which allow very little electrical charges and heat energy to flow. Plastics, glass, dry air and wood are examples of insulators.
  ii. Semiconductors are materials which allow the electrical charges to flow better than insulators, but less than conductors. Examples are silicon and germanium.
- There are two different types of electric charges namely the positive and negative charges. Like charges repel and unlike charges attract each other.
- Electric current always flows from the point of high potential. The potential difference between two conductors is equal to the work done in conducting a unit positive charges from one conductor to the other conductor through a metalic wire.
- The flow of charge is called the current and it is the rate at which electric charges pass though a conductor. The charged particle can be

either positive or negative. In order for a charge to flow, it needs a push (a force) and it is supplied by voltage, or potential difference. The charge flows from high potential energy to low potential energy.

- A closed loop of current, is called an electric circuit. The current [I] measures the amount of charge that passes a given point every second. The unit for current is Ampere [A]. 1 A means that 1 C of charge passes every second.
- When current flows through a conductor it offers some obstruction to the flow of current The obstruction offered to flow of current by the conducting wire is called its resistance in passege of electricity.
- The unit of resistance is ohm. The resistance varies in different materials. For example, gold, silver, and copper have low resistance, which means that current can flow easily through these materials. Glass, plastics, and wood have very high resistance, which means that current can not pass throught these materials easily.
- **Electromagnetism:** The branch of physics which deals with the relationship between electricity and magnetism is called electomagnetism.
- Whenever current is passed through a straight conductor it behaves like a magnet. The magnitude of magnetic effect increases with the increase in the strength of current.
- Faraday's law of induction is one of the important concepts of electricity. It looks at the way changing magnetic fields can cause current to flow in wires. Basically, it is a formula/concept that describes how potential difference (voltage difference) is created and how much is created. It's a huge concept to understand that the changing of a magnetic field can create voltage.
- He discovered that the changes in the magnetic field and the size of the field were related to the amount of current created. Scientists also use the term magnetic flux. Magnetic flux is a value that is the strength of the magnetic field multiplied by the surface area of the device.
- Coulomb's Law is one of the basic ideas of electricity in physics. The law looks at the forces created between two charged objects. As distance increases, the forces and electric fields decrease. This simple idea was converted into a relatively simple formula. The force between the objects can be positive or negative depending on whether the objects are attracted to each other or repelled.
- **Coulomb's Law:** When you have two charged particles, an electric force is created. If you have larger charges, the forces will be larger. If you use those two ideas, and add the fact that charges can attract and repel each other you will understand Coulomb's Law. It's a formula that measures the electrical forces between two objects. F=kq1q2/r2. Where "F" is the resulting force between the two charges. The distance between the two charges is "r". The "r" actually stands for "radius of separation" but you just need to know it is a distance. The"q_2" and "q_2" are values for the amount of charge in each of the particles. Scientists use Coulombs as

units to measure charge. The constant of the equation is "k."

- There are two main types of current in our world. One is direct current (DC)which is a constant stream of charges in one direction. The other is alternating current (AC) that is a stream of charges that reverses direction. The current in DC circuits is moving in a constant direction. The amount of current can change, but it will always flow from one point to another. In alternating current, the charges move in one direction for a very short time, and then they reverse direction. This happens over and over again.

MECHANICS

- **Motion:** In physics, motion is change of location or position of an object with respect to time. Mechanical motion is of two types, transitional (linear) and rotational (spin).
- **SPEED:** The speed of a moving body is the rate at which it covers distance i.e. the distance it covers per unit of time.
- **Speed:** (distance travelled/ time required.) The S.I. Unit of speed is ms.
- **VELOCITY:** The distance covered by an object in a specified direction in unit time interval is called velocity. The S.I. Unit of velocity is m/s.
- Average velocity can be calculated by dividing displacement over time.
- The instantaneous velocity shows the velocity of an object at one point.
- The difference betwwn speed and velocity is: Speed is the distance travelled by an object in a particular time. Velocity is the speed in a particular direction.
- **ACCELERATION:** When an object's velocity changes, it accelerates. Acceleration shows the change in velocity in a unit time. Velocity is measured in meters per second, m/s, so acceleration is measured in (m/s)/ s, or m/s2, which can be both positive and negative. The symbol for acceleration is a (boldface).
- When the velocity decreases the body is said to undergo retardation or deceleration.
- **Acceleration Due to Gravity:** Galileo was the first to find out that all objects falling to Earth have a constant acceleration of 9.80 m/ s2 regardless of their mass. Acceleration due to gravity is given a symbol g, which equals to 9.80 m/ s2.
- **FORCE:** Force can be defined as a push or a pull. (Technically, force is something that can accelerate objects.) . Force is measured by N (Newton). A force that causes an object with a mass of 1 kg to accelerate at 1 m/s is equivalent to 1 Newton.
- Newton's law of universal gravitation states that every massive particle in the universe attracts every other massive particle with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.
- In equation form, the gravitational force F = G(m1 m2)/ r2 where r is the distance between two bodies of masses m1and m2 and G the universal gravitational constant.

- **Centripetal Force:** For a body to move in a circle there must be a force on it directed towards the centre. This is called the centripetal force and is necessary to produce continuous change of direction in a circular motion.
- The magnitude of the centripetal force on an object of mass m moving at a speed v along a path with radius of curvature r is given by the relation F = mv2/r The direction of the force is toward the center of the circle in which the object is moving. Centrifugal force is equal and opposite to centripetal force, i.e it acts outwards.
- **WEIGHT:** the weight of a body is the force with which the earth attracts the body towards its centre. The weight of a body should not be confused with its mass, which is a measure of the quantity of matter contained in it. Mass shows the quantity, and weight shows the size of gravity. The weight of a body is maximum at the poles and minimum at equator.
- If you know your mass, you can easily find your weight because W = mg where:
- W is weight in Newton (N),
- m is mass in kg, and
- g is the acceleration of gravity in m/ s2.
- Weight is measured by Newton (N).
- It is now obvious that the value of g is maximum at poles and minimum at equator. At the centre of earth, g would be zero.
- It should be noted here that on the surface of the moon the value of the acceleration due to gravity is neraly one-sixth of that on earth, and therefore, an object on the moon would weigh only one-sixth its weight on earth.
- Newton's Laws of Motion:

1. Newtons First Law of Motion:

- Newton's first law of motion states that "An object at rest tends to stay at rest and an object in motion tends to stay in motion with the same speed and in the same direction unless acted upon by an unbalanced force." . Every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it.
- In fact, it is the natural tendency of objects to resist changes in their state of motion. This tendency to resist changes in their state of motion is described as inertia.
- **Inertia:** Inertia is the tendency of an object to resist changes in its state of motion. But what is meant by the phrase state of motion? The state of motion of an object is defined by its velocity - the speed with a direction. Thus, inertia could be redefined as follows:Inertia: tendency of an object to resist changes in its velocity.
- There are many more applications of Newton's first law of motion.
- Blood rushes from your head to your feet while quickly stopping when riding on a descending elevator.
- The head of a hammer can be tightened onto the wooden handle by banging the bottom of the handle against a hard surface.
- While riding a skateboard (or wagon or bicycle), you fly forward off the board when hitting a curb or rock or other object which abruptly halts the motion of the skateboard.

2. Newton's Second Law of Motion:

- The acceleration of an object as produced by a net force is directly proportional to the magnitude of the net force, in the same direction as the net force, and inversely proportional to the mass of the object.
- The relationship between an object's mass m, its acceleration a, and the applied force F is F = ma. Acceleration and force are vectors (as indicated by their symbols being displayed in slant bold font); in this law the direction of the force vector is the same as the direction of the acceleration vector.

3. Newton's Third Law of Motion:

- For every action, there is an equal and opposite reaction.
- The statement means that in every interaction, there is a pair of forces acting on the two interacting objects. The size of the forces on the first object equals the size of the force on the second object. The direction of the force on the first object is opposite to the direction of the force on the second object. Forces always come in pairs - equal and opposite action-reaction force pairs.
- The rocket's action is to push down on the ground with the force of its powerful engines, and the reaction is that the ground pushes the rocket upwards with an equal force.
- There's also the example of shooting a cannonball. When the cannonball is fired through the air (by the explosion), the cannon is pushed backward. The force pushing the ball out was equal to the force pushing the cannon back, but the effect on the cannon is less noticeable because it has a much larger mass. That example is similar to the kick when a gun fires a bullet forward.
- **Friction:** Friction is a force that resists the movement oof one surface over another. The force acts in the opposite direction to the way an object wants to slide. If a car needs to stop at a stop sign, it slows because of the friction between the brakes and the wheels.
- Measures of friction are based on the type of materials that are in contact. Concrete on concrete has a very high coefficient of friction.That coefficient is a measure of how easily one object moves in relationship to another.When you have a high coefficient of friction, you have a lot of friction between the materials.

PROPERTIES OF MATTERS

- **Properties of matters:** A matter can neither be created nor it can be destroyed but it can be transformed from one state to another. Matter is made of basic building blocks commonly called elements which are 112 in number. The matter is made of only one kind of element then the smallest unit of that element is called an atom. If the matter is made of two or more different elements then the smallest unit of matter is called a molecule.
- Molecule is defined as the smallest unit of matter which has independent existence and can retain complete physical and chemical properties of matters.
- According to kinetic theory of matter:
  i. molecules are in the state of continuous motion in all possible directions and hence they posses

kinetic energy which increases with the gain of heat energy or rise in temperature,

ii. the molecules always attract each other,

iii. the force of attraction between the molecules decreases with the increase in intermolecular spaces

- The molecules always attract each other. The force of attraction between the similar kind of molecules is called force of cohesion whereas the force of attraction between different kinds of molecules is called force of adhesion.
- In case of solids, the intermolecular space being very small, so intermolecular forces are very large and hence solids have definite size and shape.
- In case of liquids, the intermolecular space being large, so intermolecular forces are small and hence liquids have definite volume but no definite shape.
- In case of gases, the intermolecular space being very large, so intermolecular forces are extremely small and hence gases have neither a definite volume and nor definite shape.
- A solid has definite shape and size. In order to change (or deform) the shape or size of a body, a force is required.If you stretch a helical spring by gently pulling its ends, the length of the spring increases slightly. When you leave the ends of the spring, it regains its original size and shape. The property of a body, by virtue of which it tends to regain its original size and shape when the applied force is removed, is known as elasticity and the deformation caused is known as elastic deformation.
- However, if you apply force to a lump of putty or mud, they have no gross tendency to regain their previous shape, and they get permanently deformed. Such substances are called plastic and this property is called plasticity. Putty and mud are close to ideal plastics.
- When a force is applied on body, it is deformed to a small or large extent depending upon the nature of the material of the body and the magnitude of the deforming force. The deformation may not be noticeable visually in many materials but it is there. When a body is subjected to a deforming force, a restoring force is developed in the body. This restoring force is equal in magnitude but opposite in direction to the applied force. The restoring force per unit area is known as stress. If F is the force applied and A is the area of cross section of the body, Magnitude of the stress = F/A. The SI unit of stress is N m–2 or pascal (Pa). Stress is the restoring force per unit area and strain is the fractional change in dimension.
- **HOOKE'S LAW:** Robert Hooke, an English physicist (1635 - 1703 A.D) performed experiments on springs and found that the elongation (change in the length) produced in a body is proportional to the applied force or load. In 1676, he presented his law of elasticity, now called Hooke's law. For small deformations the stress and strain are proportional to each other. This is known as Hooke's law. Thus, stress "" strain or stress = k X strain , where k is the proportionality constant and is known as modulus of elasticity.
- The basic property of a fluid is that it can flow. The fluid does not have any

resistance to change of its shape. Thus, the shape of a fluid is governed by the shape of its container. A liquid is incompressible and has a free surface of its own. A gas is compressible and it expands to occupy all the space available to it.

- **Pascal's Law:** The French scientist Blaise Pascal observed that the pressure in a fluid at rest is the same at all points if they are at the same height.distributed uniformly throughout. We can say whenever external pressure is applied on any part of a fluid contained in a vessel, it is transmitted undiminished and equally in all directions. This is the Pascal's law for transmission of fluid pressure and has many applications in daily life. A number of devices such as hydraulic lift and hydraulic brakes are based on the Pascal's law.
- The flow of the fluid is said to be steady if at any given point, the velocity of each passing fluid particle remains constant in time.The path taken by a fluid particle under a steady flow is a streamline.
- Bernoulli's principle states when a fluid flows from one place to another without friction, its total energy (kinetic + potential + pressure) remains constant.
- You must have noticed that, oil and water do not mix; water wets you and me but not ducks; mercury does not wet glass but water sticks to it, oil rises up a cotton wick, inspiteof gravity, Sap and water rise up to the top of the leaves of the tree, hairs of a paint brush do not cling together when dry and even when dipped in water but form a fine tip when taken out of it. All these and many more such experiences are related with the free surfaces of liquids. As liquids have no definite shape but have a definite volume, they acquire a free surface when poured in a container. These surfaces possess some additional energy. This phenomenon is known as surface tension and it is concerned with only liquid as gases do not have free surfaces. Mathematically, surface tension is defined as the force acting per unit length of an imaginary line drawn on the free surface of the liquid. The surface tension is expressed in newton/meter.
- Most of the fluids are not ideal ones and offer some resistance to motion. This resistance to fluid motion is like an internal friction analogous to friction when a solid moves on a surface. It is called viscosity.

SOUND

- Sound is a form of energy and like all other energies, sound is not visible to us. It produces a sensation of hearing when it reaches our ears. Sound can not travel through vacuum.
- Sound is produced due to vibration of different objects.The matter or substance through which sound is transmitted is called a medium. It can be solid, liquid or gas. Sound moves through a medium from the point of generation to the listener.
- In longitudinal wave the individual particles of the medium move in a direction parallel to the direction of propagation of the disturbance. The particles do not move from one place

to another but they simply oscillate back and forth about their position of rest. This is exactly how a sound wave propagates, hence sound waves are longitudinal waves. Sound travels as successive compressions and rarefactions in the medium. In sound propagation, it is the energy of the sound that travels and not the particles of the medium.

- There is also another type of wave, called a transverse wave. In a transverse wave particles do not oscillate along the line of wave propagation but oscillate up and down about their mean position as the wave travels. Thus a transverse wave is the one in which the individual particles of the medium move about their mean positions in a direction perpendicular to the direction of wave propagation. Light is a transverse wave but for light, the oscillations are not of the medium particles or their pressure or density – it is not a mechanical wave.
- To and fro motion of an object is known as vibration. This motion is also calledoscillatory motion.
- Amplitude and frequency are two important properties of any sound.
- The loudness or softness of a sound is determined basically by its amplitude. The amplitude of the sound wave depends upon the force with which an object is made to vibrate.
- The change in density from one maximum value to the minimum value and again to the maximum value makes one complete oscillation.
- The distance between two consecutive compressions or two consecutive rarefaction is calledthe wavelength, ë.
- The time taken by the wave for one complete oscillation of the density or pressure of the medium is called the time period, T.
- The number of complete oscillations per unit time is called the frequency (í), í =(1/T). The frequency is expressed in hertz (Hz).
- Larger the amplitude of vibration, louder is the sound. Higher the frequency of vibration, the higher is the pitch, and shriller is the sound.
- The frequency determines the shrillness or pitch of a sound. If the frequency of vibration is higher, we say that the sound is shrill and has a higher pitch. If the frequency of vibration is lower, we say that the sound has a lower pitch.
- A sound of single frequency is called a tone whereas a sound of multiple frequencies is called a note. Of the several frequencies present in a note, the sound of the lowest frequency is called the fundamental tone. Besides the fundamental, other tones present in a note are known as overtones. Of the overtones, those which have their frequencies simple multiple of fundamental frequency, are known as harmonics. All harmonics are overtone but all overtones are not harmonics.
- Sound propagates through a medium at a finite speed. The speed of sound depends on the properties of the medium through which it travels. The speed of sound in a medium depends also on temperature and pressure of the medium. The speed of sound decreases when we go from solid to gaseous state. In any medium as we increase the temperature the speed of

sound increases. Experiment shows that the velocity of sound in air at 0 0C is about 332 metres per second.

- The velocity of sound through a gas is inversely proportional to the square root of the density of the gas.
- The law of reflection of sound states that the directions in which the sound is incident and reflected make equal angles with the normal to the reflecting surface and the three lie in the same plane.
- If we shout or clap near a suitable reflecting object such as a tall building or a mountain, we will hear the same sound again a little later. This sound which we hear is called an echo. The sensation of sound persists in ourbrain for about 0.1 second. To hear a distinct echo, the time interval between the original sound and the reflected one must be at least 0.1 second. If we take the speed of sound to be 344 m/s at a given temperature, say at 22 0C in air, the sound must go to the obstacle and reach back the ear of the listener on reflection after 0.1s. Hence, the total distance covered by the sound from the point of generation to the reflecting surface and back should be at least (344 m/s) × 0.1 s = 34.4 m. Thus, for hearing distinct echoes, the minimum distance of the obstacle from the source of sound must be half of this distance, that is, 17.2 m. This distance will change with the temperature of air. Echoes may be heard more than once due to successive or multiple reflections.
- The phenomenon of prolongation of sound due to successive reflections of sound from surronding objects is called reverberation.
- Stethoscope is a medical instrument used for listening to sounds produced within the body, chiefly in the heart or lungs. In stethoscopes the sound of the patient's heartbeat reaches the doctor's ears by multiple reflection of sound.
- The audible range of sound for human beings extends from about 20 Hz to 20000 Hz (one Hz = one cycle/s). Children under the age of five and some animals, such as dogs can hear up to 25 kHz (1 kHz = 1000 Hz).
- Sounds of frequencies below 20 Hz are called infrasonic sound or infrasound. Rhinoceroses communicate using infrasound of frequency as low as 5 Hz. Whales and elephants produce sound in the infrasound range. It is observed that some animals get disturbed before earthquakes. Earthquakes produce low-frequency infrasound before the main shock waves begin which possibly alert the animals.
- Frequencies higher than 20 kHz are called ultrasonic sound or ultrasound. Ultrasound is produced by dolphins, bats and porpoises.
- Ultrasounds can be used to detect cracks and flaws in metal blocks. Metallic components are generally used in construction of big structures like buildings, bridges, machines and also scientific equipment. The cracks or holes inside the metal blocks, which are invisible from outside reduces the strength of the structure. Ultrasonic waves are allowed to pass through the metal block and detectors are used to detect the transmitted waves. If there is even a small defect, the ultrasound gets reflected back indicating the presence of the flaw or defect.

- Ultrasonic waves are made to reflect from various parts of the heart and form the image of the heart. This technique is called 'echocardiography'.
- Ultrasound scanner is an instrument which uses ultrasonic waves for getting images of internal organs of the human body. A doctor may image the patient's organs such as the liver, gall bladder, uterus, kidney, etc. It helps the doctor to detect abnormalities, such as stones in the gall bladder and kidney or tumours in different organs. In this technique the ultrasonic waves travel through the tissues of the body and get reflected from a region where there is a change of tissue density. These waves are then converted into electrical signals that are used to generate images of the organ. These images are then displayed on a monitor or printed on a film. This technique is called 'ultrasonography'.
- The acronym SONAR stands for Sound Navigation And Ranging. Sonar is a device that uses ultrasonic waves to measure the distance, direction and speed of underwater objects.Sonar consists of a transmitter and a detector and is installed in a boat or a ship. The transmitter produces and transmits ultrasonic waves. These waves travel through water and after striking the object on the seabed, get reflected back and are sensed by the detector. The detector converts the ultrasonic waves into electrical signals which are appropriately interpreted. The distance of the object that reflected the sound wave can be calculated by knowing the speed of sound in water and the time interval between transmission and reception of the ultrasound. Let the time interval between transmission and reception of ultrasound signal be t and the speed of sound through seawater be v. The total distance, 2d travelled by the ultrasound is then, $2d = v \times t$. The above method is called echo-ranging. The sonar technique is used to determine the depth of the sea and to locate underwater hills, valleys, submarine, icebergs, sunken ship etc.
- Again if the speed of any substance, specially of an air-craft, be more than the speed of sound in air, then the speed of the substance is called supersonic speed. The ratio of the speed of a body and that of sound in air is, however, called the Mach number of the body. If the Mach number of a body is more than 1 , it is clear that the body has supersonic speed.

UNITS AND MEASUREMENT

i. Physics is a quantitative science, based on measurement of physical quantities. Certain physical quantities have been chosen as fundamental or base quantities (such as length, mass, time, electric current, thermodynamic temperature, amount of substance, and luminous intensity).

ii. Each base quantity is defined in terms of a certain basic, arbitrarily chosen but properly standardised reference standard called unit (such as metre, kilogram, second, ampere, kelvin, mole and candela). The units for the fundamental or base quantities are called fundamental or base units.

iii. Other physical quantities, derived from the base quantities, can be expressed as a combination of the base units and are called derived units.A complete set

of units, both fundamental and derived, is called a system of units.

iv. The International System of Units (SI) based on seven base units is at present internationally accepted unit system and is widely used throughout the world. The SI units are used in all physical measurements, for both the base quantities and the derived quantities obtained from them. Certain derived units are expressed by means of SI units with special names (such as joule, newton, watt, etc).

v. The SI units have well defined and internationally accepted unit symbols (such as m for metre, kg for kilogram, s for second, A for ampere, N for newton etc.). Physical measurements are usually expressed for small and large quantities in scientific notation, with powers of 10. Scientific notation and the prefixes are used to simplify measurement notation and numerical computation, giving indication to the precision of the numbers.

vi. **Unit of Length:** The SI Unit of length is metre(m). Various other metric units used for measuring length are related to the metre by either multiples or submultiples of 10. Thus,

- 1 kilometre = 1000 (or 103) m
- 1 centimetre= 1/100 (or 0-2) m
- 1 milimetre=1/1000 (or 10-3) m

Very small distance are measured in micrometre or microns (µm), angstroms(Å), nanometre (nm) and femtometre(fm).

- 1m = 106 µm
- 1m = 109 nm
- 1m =1010 Å
- 1m = 1015fm

For really large distances, the lightyear is the unit of choice. A light year is the distance light would travel in a vacuum after one year. It is equal to some nine quadrillion meters (six trillion miles). 1 light year = 9.46 × 1015m.

vii. **Unit of Mass**: The SI Unit of mass is kilogram(kg). Various other metric units used for measuring mass are related to the kilogram by either multiples or submultiples of 10. Thus,

- 1 tonne(t) = 1000 (or 103) kg
- 1 gram(g) = 1/1000 (or 0-32) kg
- 1 miligram(mg) = 10-6Kg

viii. **Unit of Time:** The SI unit of time is the second (s).

SI Base Quantities and Units:

Base Quantity	SI Units	
	Name	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermo dynamic Temperature	kelvin	K
Amount of substance	mole	mole
Luminous	candela	cd

Important Units of Measurement:

Used to Measure	Name of the Unit
Electric Current	Ampere
Wave lengthof light	Angstrom
Electric charge	Faraday
Magnetic induction	Gauss
Magnetic Flux	Maxwell
Electric Charge	Coulomb
Electric Resistance	Ohm
Electric Tension	Volt
Power	Watt
Intensity of Sound	Bel
Temperature	Celcius, Kelvin, Farenheit
Atmospheric Pressure	Bar

Quantity of heat	Calorie
Force	Dyne
Work or Energy	Joule
Work	Newton
Pressure	Pascal
Luminious Flux	Lumen

Other Measures:

- A nautical mile is now 1852 m (6080 feet), but was originally defined as one minute of arc of a great circle, or 1/60 of 1/360 of the earth's circumference. Every sixty nautical miles is then one degree of latitude anywhere on earth or one degree of longitude on the equator. This was considered a reasonable unit for use in navigation, which is why this mile is called the nautical mile. The ordinary mile is more precisely known as the statute mile; that is, the mile as defined by statute or law. Use of the nautical mile persists today in shipping, aviation, and aerospace.
- Distances in near outer space are sometimes compared to the radius of the earth: 6.4 × 106 m. Some examples: the planet Mars has ½ the radius of the earth, the size of a geosynchronous orbit is 6.5 earth radii, and the earth-moon separation is about 60 earth radii.
- The mean distance from the earth to the sun is called an astronomical unit: approximately 1.5 × 1011m. The distance from the Sun to Mars is 1.5 AU; from the Sun to Jupiter, 5.2 AU; and from the Sun to Pluto, 40 AU. The star nearest the Sun, Proxima Centauri, is about 270,000 AU away.

WAVES

- **WAVES:** There are three types of waves:
  1. Mechanical waves require a material medium to travel (air, water, ropes). These waves are divided into three different types.
     - Transverse waves cause the medium to move perpendicular to the direction of the wave.
     - Longitudinal waves cause the medium to move parallel to the direction of the wave.
     - Surface waves are both transverse waves and longitudinal waves mixed in one medium.
  2. Electromagnetic waves do not require a medium to travel (light, radio).
  3. Matter waves are produced by electrons and particles.
- A point of maximum positive displacement in a wave, is called crest, and a point of maximum negative displacement is called trough.
- Measuring Waves: Any point on a transverse wave moves up and down in a repeating pattern. The shortest time that a point takes to return to the initial position (one vibration) is called period, T.
- The number of vibrations per second is called frequency and is measured in hertz (Hz). Here's the equation for frequency: $f = 1 / T$
- The shortest distance between peaks, the highest points, and troughs, the lowest points, is the wavelength, λ.
- By knowing the frequency of a wave and its wavelength, we can find its speed. Here is the equation for the velocity of a wave: $v = \lambda f$.
- However, the velocity of a wave is only affected by the properties of the medium. It is not possible to increase the speed of a wave by increasing its

wavelength. By doing this, the number of vibrations per second decreases and therefore the velocity remains the same.

- The amplitude of a wave is the distance from a crest to where the wave is at equilibrium. The amplitude is used to measure the energy transferred by the wave. The bigger the distance, the greater the energy transferred.

WORK, POWER AND ENERGY

- When a force acting on a body produces a change in the position of the body, work is said to be done by the force. Work done on an object is defined as the magnitude of the force multiplied by the distance moved by the object in the direction of the applied force. The unit of work is joule: 1 joule = 1 newton × 1 metre. Work done on an object by a force would be zero if the displacement of the object is zero.
- Power is defined as the rate of doing work. Power = (work done) / (time taken). The SI unit of power is watt. 1 W = 1 Joule/second. The unit of power is also horse power. It is the power of an agent which can work at the rate of 550 foot pounds per second or 33,000 foot pounds pwe minute.
- An object having capability to do work is said to possess energy. Energy has the same unit as that of work.
- An object in motion possesses what is known as the kinetic energy of the object. An object of mass, m moving with velocity v has a kinetic energy of (1/2) mv^2.
- The energy possessed by a body due to its change in position or shape is called the potential energy. The gravitational potential energy of an object of mass, m raised through a height, h from the earth's surface is given by mgh.
- According to the law of conservation of energy, energy can only be transformed from one form to another; it can neither be created nor destroyed. The total energy before and after the transformation always remains constant.
- Energy exists in nature in several forms such as kinetic energy, potential energy, heat energy, chemical energy etc. The sum of the kinetic and potential energies of an object is called its mechanical energy.
- **Pressure:** Pressure is defined as force acting per unit area. Pressure = force/ area. The SI unit of pressure is newton per meter squared or Pascal.
- The same force acting on a smaller area exerts a larger pressure, and a smaller pressure on a larger area. This is the reason why a nail has a pointed tip, knives have sharp edges and buildings have wide foundations.
- All liquids and gases are fluids. A solid exerts pressure on a surface due to its weight. Similarly, fluids have weight, and they also exert pressure on the base and walls of the container in which they are enclosed. Pressure exerted in any confined mass of fluid is transmitted undiminished in all directions.
- All objects experience a force of buoyancy when they are immersed in a fluid.Objects having density less than that of the liquid in which they are immersed, float on the surface of the liquid. If the density of the object is more than the density of the liquid in

which it is immersed then it sinks in the liquid.

- **Archimedes' Principle:** When a body is immersed fully or partially in a fluid, it experiences an upward force that is equal to the weight of the fluid displaced by it.
- Archimedes' principle has many applications. It is used in designing ships and submarines. Lactometers, which are used to determine the purity of a sample of milk and hydrometers used for determining density of liquids, are based on this principle.
- **Density and Relative Density:** The mass per unit volume of a substance is called its density. The SI unit ofdensity is kilogram per meter cubed. Density= mass/volume.
- The relative density of a substance is the ratio of its density to that of water: Relative density = Density of a substance/Density of water. Since the relative density is a ratio of similar.

ACID, BASE AND SALTS

1. Acid

- The word 'acid' is derived from a Latin word, which means "sour". The sour taste of most of the fruits and vegetables is due to various types of acids present in them. The digestive fluids of most of the animals and humans also contain acids.
- An acid is a compound, which on dissolving in water yields hydronium ions (H_3O+) as the only positive ions. The characteristic property of an acid is due to the presence of these hydronium ions.
- Acids are compounds that contain Hydrogen (Hydrochloric, HCl; Sulphuric, H_2SO4; Nitric, HNO_3). However, not all compounds that contain Hydrogen are acids (Water, H_2O; Methane, CH_4). Acids are usually compounds of non metals with Hydrogen and sometimes Oxygen.
- Acids can be classified in various ways, depending on the factors mentioned below:
  1. Classification Based on the Strength of the acid.
  2. Classification Based on the Basicity of the Acid.
  3. Classification Based on the Concentration of the acid.
  4. Classification Based on the presence of Oxygen.
- The strength of an acid depends on the concentration of the hydronium ions present in a solution. Greater the number of hydronium ions present, greater is the strength of acid. However, some acids do not dissociate to any appreciable extent in water such as carbonic acid. Therefore, these acids will have a low concentration of hydronium ions.
- **Strong Acid:** An acid, which dissociates completely or almost completely in water, is classified as a strong acid. It must be noted that in these acids all the hydrogen ions (H+) combine with water molecule and exist as hydronium ions (H_3O+). Examples of strong acids are: hydrochloric acid, sulphuric acid, nitric acid etc.
- **Weak Acid:** An acid that dissociates only partially when dissolved in water, is classified as a weak acid. Most of the molecules remain in solution in molecular form itself in such acid. Examples are: acetic acid, formic acid, carbonic acid etc.
- Acids are generally sour in taste. Special type of substances are used to test whether a substance is acidic or basic. These substances are known as indicators. The indicators change their

colour when added to a solution containing an acidic or a basic substance. Turmeric, litmus, china rose petals (Gudhal), etc., are some of the naturally occurring indicators.

- The most commonly used natural indicator is litmus. It is extracted from lichens . It has a mauve (purple) colour in distilled water. When added to an acidic solution, it turns red and when added to a basic solution, it turns blue. It is available in the form of a solution, or in the form of strips of paper, known as litmus paper. Generally, it is available as red and blue litmus paper.
- The solutions which do not change the colour of either red or blue litmus are known as neutral solutions. These substances are neither acidic nor basic.
- Acids are corrosive and can burn flesh and dissolve metal.

2. Bases and Alkalis

- A Base is a substance that gives OH^- ions when dissolved in water. Bases are usually metal hydroxides (MOH). Examples include Sodium Hydroxide, NaOH, Calcium Hydroxide, $Ca(OH)_2$. The solution of a base in water is called an alkali.
- Bases and acids neutralize each other, therefore another way to define a base is 'a compound which reacts with an acid to give salt and water only'. Like acids, alkalis can be strong or weak. The more hydroxide ions they produce, the stronger the alkali.
- The acidic property of an acid is due to the presence of hydrogen ions (H^+) while that of a base or alkali, is due to the presence of hydroxyl (OH^-) ions in them. When an acid and base (alkali) combine, the positively charged hydrogen ion of the acid combines with the negatively charged hydroxyl ion of the base to form a molecule of water. Hence, the water molecule formed does not have any charge because the positive and negative charges of the hydrogen ions and hydroxyl ions get neutralized.
- The strength of a base depends on the concentration of the hydroxyl ions when it is dissolved in water.
  1. **Strong Base:** A base that dissociates completely or almost completely in water is classified as a strong base. The greater the number of hydroxyl ions the base produces, the stronger is the base. Examples: Sodium hydroxide: NaOH, Potassium hydroxide: KOH, Calcium hydroxide: $Ca(OH)_2$.
  2. **Weak Base:** A base that dissociates in water only partially is known as a weak base. Examples: Magnesium hydroxide: $Mg(OH)_2$, Ammonium hydroxide: NH_4OH.
- Bases are bitter to taste. They are soapy and slippery to touch. Strong alkalis like sodium hydroxide and potassium hydroxide are highly corrosive or caustic in nature. Sodium hydroxide and potassium hydroxide are commonly called caustic soda and caustic potash respectively. Organic tissues like skin, etc. get completely corroded by these two alkalis. However, the other alkalis are only mildly corrosive.

3. pH

- A scale for measuring hydrogen ion concentration in a solution, called pH scale has been developed. The p in pH stands for 'potenz' in German, meaning

power. On the pH scale we can measure pH from 0 (very acidic) to 14 (very alkaline). pH should be thought of simply as a number which indicates the acidic or basic nature of a solution. Higher the hydronium ion concentration, lower is the pH value. The pH of a neutral solution is 7. Values less than 7 on the pH scale represent an acidic solution. As the pH value increases from 7 to 14, it represents an increase in OH– ion concentration in the solution, that is, increase in the strength of alkali. Generally paper impregnated with the universal indicator is used for measuring pH. One such paper is shown in .

- There are chemicals that change colour at different pH values. These are called indicators. One of the most famous is Litmus. This substance turns red when the pH is less than 7 (acidic) and turns blue when the pH is greater than 7 (basic).

4. Salts

- A Salt results when an acid reacts with a base. Both are neutralised. The H+ and OH- ions combine to form water. The non metalic ions of the acid and the metal ions of the base form the salt.
- Important salts used in everyday life and industrial applications are Sodium chloride (NaCl), Sodium carbonate, (Na 2 CO3), Sodium Bicarbonate, (NaHCO3), Sodium Hydroxide (NaOH)
- The salt ions normally stay in solution. The salt crystalizes out when the water is removed. Some salts are insoluble. They will precipitate out when the acid and base are added together.
  - Salts of a strong acid and a strong base are neutral with pH value of 7. On the other hand, salts of a strong acid and weak base are acidic with pH value less than 7 and those of a strong base and weak acid are basic in nature, with pH value more than 7.

ATOMIC STRUCTURE

- An atom is the smallest particle of the element that can exist independently and retain all its chemical properties. Atoms are made up of fundamental particles: electrons, protons and neutrons.
  - **Dalton's Atomic Theory:** John Dalton provided a simple theory of matter to provide theoretical justification to the laws of chemical combinations in 1805. The basic postulates of the theory are:
- All substances are made up of tiny, indivisible particles called atoms.
- Atoms of the same element are identical in shape, size, mass and other properties.
- Each element is composed of its own kind of atoms. Atoms of different elements are different in all respects.
- Atom is the smallest unit that takes part in chemical combinations.
- Atoms combine with each other in simple whole number ratios to form compound atoms called molecules.
- Atoms cannot be created, divided or destroyed during any chemical or physical change.
- **Representation of an Atom by a Symbol:** Dalton was the first scientist to use the symbols for elements in a very specific sense. When he used a symbol for an element he also meant a

definite quantity of that element, that is, one atom of that element. A symbol signifies a shorthand representation of an atom of an element. The symbol of any element is based on the English name or Latin name (written in English alphabets) and many of the symbols are the first one or two letters of the element's name in English. The first letter of a symbol is always written as a capital letter (uppercase) and the second letter as a small letter (lowercase). Examples are: (i) hydrogen- H (ii) aluminium- Al and not AL (iii) cobalt- Co and not CO. Symbols of some elements are formed from the first letter of the name and a letter, appearing later in the name. Examples are: (i) chlorine, Cl, (ii) zinc, Zn etc.

- Other symbols have been taken from the names of elements in Latin, German or Greek. For example, the symbol of iron is Fe from its Latin name ferrum, sodium is Na from natrium, potassium is K from kalium. Therefore, each element has a name and a unique chemical symbol.
- **Size of the Atom/ Elements:** Atoms are very small, they are smaller than anything that we can imagine or compare with. One hydrogen atom, the smallest atom known, is approximately 5 x 10 mm in diameter. Atomic radius is measured in nanometres. 1 m = 109 nm.
- **Atomic Mass:** The mass of a particular atom is taken as a standard unit and the masses of other atoms are related to this standard. Hydrogen being the lightest element and being the smallest atom was chosen and assumed to have a mass of 1. An atom of hydrogen was assigned an atomic mass equal to one atomic mass unit (a.m.u). The number does not signify the mass of an atom in grams. It is just a pure number. The masses of atoms of other elements were compared to that of hydrogen, in order to find their atomic mass relative to it. If one atom of sulphur weighs as much as 32 atoms of hydrogen, then the relative atomic mass of sulphur is 32 a.m.u. This way of defining the mass of one atom of hydrogen has its difficulties. While the mass of one atom of hydrogen is considered as 1 atomic mass unit, hydrogen gas in its natural state has 3 isotopes of atomic mass 1, 2 and 3 respectively. Thus average mass works out to be 1.00 a.m.u rather than 1 a.m.u. This in turn complicates the atomic masses of all other elements. Later on, an atom of oxygen was preferred as standard by taking its mass as 16 units. However, in 1961 for a universally accepted atomic mass unit, carbon-12 isotope was chosen as the standard reference for measuring atomic masses. One atomic mass unit is a mass unit equal to exactly onetwelfth (1/12th) the mass of one atom of carbon-12. The relative atomic masses of all elements have been found with respect to an atom of carbon-12. It is equal to 1.66 × 10-24 g.
- **Molecule:** A molecule is in general a group of two or more atoms that are chemically bonded together, that is, tightly held together by attractive forces. A molecule can be defined as the smallest particle of an element or a compound that is capable of an independent existence and shows all the properties of that substance. Atoms

of the same element or of different elements can join together to form molecules.

- The molecules of an element are constituted by the same type of atoms. Molecules of many elements, such as argon (Ar), helium (He) etc. are made up of only one atom of that element. But this is not the case with most of the nonmetals. For example, a molecule of oxygen consists of two atoms of oxygen and hence it is known as a diatomic molecule, O2. If 3 atoms of oxygen unite into a molecule, instead of the usual 2, we get ozone. The number of atoms constituting a molecule is known as its atomicity.
- Atoms of different elements join together in definite proportions to form molecules of compounds. Compounds composed of metals and nonmetals contain charged species. The charged species are known as ions. An ion is a charged particle and can be negatively or positively charged. A negatively charged ion is called an 'anion' and the positively charged ion, a 'cation'. Take, for example, sodium chloride (NaCl). Its constituent particles are positively charged sodium ions (Na^+) and negatively charged chloride ions (Cl^-). Ions may consist of a single charged atom or a group of atoms that have a net charge on them. A group of atoms carrying a charge is known as a polyatomic ion.
- **Chemical Formulae:** The chemical formula of a compound is a symbolic representation of its composition. The chemical formulae of different compounds can be written easily.
- The combining power (or capacity) of an element is known as its valency. Valency can be used to find out how the atoms of an element will combine with the atom(s) of another element to form a chemical compound. The valency of the atom of an element can be thought of as hands or arms of that atom.
- The simplest compounds, which are made up of two different elements are called binary compounds. While writing the chemical formulae for compounds, we write the constituent elements and their valencies. Then we must crossover the valencies of the combining atoms.
- The formulae of ionic compounds are simply the whole number ratio of the positive to negative ions in the structure.
- **Molecular Mass:** The molecular mass of a substance is the sum of the atomic masses of all the atoms in a molecule of the substance. It is therefore the relative mass of a molecule expressed in atomic mass units (u).
- The formula unit mass of a substance is a sum of the atomic masses of all atoms in a formula unit of a compound. Formula unit mass is calculated in the same manner as we calculate the molecular mass. The only difference is that we use the word formula unit for those substances whose constituent particles are ions. Scientists use the relative atomic mass scale to compare the masses of different atoms of elements. Atoms of carbon-12 isotopes are assigned a relative atomic mass of 12 and the relative masses of all other atoms are obtained by comparison with the mass of a carbon-12 atom.

- **Mole Concept:** Since it is not possible to calculate the weight of particles individually, a collection of such particles called mole is taken for all practical purposes. It was discovered that the number of atoms present in 12g of carbon of 12C isotope is 6.023 × 1023atoms. This is referred to as Avogadro number after the discoverer Avogadro. A mole of a gas is the amount of a substance containing 6.023 × 1023 particles. It is a basic unit of the amount or quantity of a substance. The substance may be atoms, molecules, ions or group of ions.
- Mass of 1 mole of a substance is called its molar mass. One mole of any gas at STP will have a volume of 22.4 L. This is called molar volume.
- Credit for the discovery of electron and proton goes to J.J. Thomson and E.Goldstein, respectively. J.J. Thomson proposed that electrons are embedded in a positive sphere.
- Rutherford's alpha-particle scattering experiment led to the discovery of the atomic nucleus. Rutherford's model of the atom proposed that a very tiny nucleus is present inside the atom and electrons revolve around this nucleus. The stability of the atom could not be explained by this model.
- Neils Bohr's model of the atom was more successful. He proposed that electrons are distributed in different shells with discrete energy around the nucleus. If the atomic shells are complete, then the atom will be stable and less reactive.
- J. Chadwick discovered presence of neutrons in the nucleus of an atom. So, the three sub-atomic particles of an atom are: (i) electrons, (ii) protons and (iii) neutrons. Electrons are negatively charged, protons are positively charged and neutrons have no charges.
- The discovery of the electron, proton and neutron was the starting point of new avenues of research in science, which gave physicists an insight into the structure and nature of the atoms of matter. An atom is made up of three elementary particles, namely electrons, protons and neutrons. Electrons have a negative charge, protons have a positive charge and neutrons have no charge. Neutrons are neutral. Due to the presence of equal number of negative electrons and positive protons the atom as a whole is electrically neutral. Based on the above findings, one can say that the atom has two major divisions.
- The first is the centre of an atom, called its nucleus. The protons and neutrons are located in the small nucleus at the centre of the atom. Due to the presence of protons the nucleus is positively charged.
- The second are electrons, which revolve around the nucleus in different shells (or orbits). Shells of an atom are designated as K,L,M,N,….The space around the nucleus in which the electrons revolve, determines the size of the atom.
- The maximum number of electrons present in a shell is given by the formula 2n2, where 'n' is the orbit number or energy level index, 1,2,3,… Hence the maximum number of electrons in different shells are as follows: first orbit or K-shell will be = 2.12 = 2, second orbit or L-shell will be

= 2 .22 = 8, third orbit or M-shell will be = 2 .32 = 18, fourth orbit or N-shell will be = 2 .42= 32, and so on. The maximum number of electrons that can be accommodated in the outermost orbit is 8. Electrons are not accommodated in a given shell, unless the inner shells are filled. That is, the shells are filled in a step-wise manner.

- **Valency:** The electrons present in the outermost shell of an atom are known as the valence electrons. It is the decisive shell during a chemical reaction. The electrons of only this outermost shell are involved during chemical combinations; electrons are either given out from the outermost shell, or accepted into the outermost shell, or shared with the electrons in the outermost shell of another element. Elements having same number of valence electrons in their atoms possess similar chemical properties. The number of the valence shell in an atom determines its position in the Periodic Table i.e. the period to which the element belongs. Elements having 1, 2 or 3 electrons in the valence shell are metals. Exception is H and He. Elements having 4 to 7 electrons in their valence shell are non-metals. Valency is the combining capacity of an element. It is the number of electrons in an atom that actually take part in bond formation. For example, carbon atom with an atomic number 6 has 4 valence electrons.
- **Calculation of Valency:** The number of valence electrons is the valency of the element. The valency of an element can also be calculated by finding the number of electrons required to complete octet. If the outermost shell of an atom is completely filled, its valency = 0. The outermost shells of the noble gases helium, neon, argon, krypton etc. are completely filled. Hence their valency is zero. Such elements are very un-reactive and inert by nature.
- **Atomic Number:** The nuclei of atoms is made up of protons and neutrons. These two components of the nucleus are referred to as nucleons. The electrons occupy the space outside the nucleus. Since an atom is electrically neutral, the number of protons in the nucleus is exactly equal to the number of electrons. This number is the atomic number given by the symbol Z.
- **Mass Number:** The total number of protons and neutrons present in one atom of an element is known as its mass number. Mass number = number of protons + number of neutrons.
- **Isotopes:** Isotopes are atoms of the same element, which have different mass numbers. It is interesting to note that atoms of a given atomic number can have different number of neutrons. For example, take the case of hydrogen atom, it has three atomic species, namely protium (11 H), deuterium ((21 H or D) and tritium ((31 H or T). The atomic number of each one is 1, but the mass number is 1, 2 and 3, respectively. All isotopes of an element have the same number of valence electrons thus have identical chemical properties. The physical properties of the isotopes are different due to the difference in the number of neutrons in their nuclei. The densities, melting points and boiling points etc., are slightly different.

- **Isobars:** Atoms of different elements with different atomic numbers, which have the same mass number, are known as isobars. These have different number of protons but equal sum of number of protons and neutrons.
- **Isotones:** The atoms of different elements, which have the same number of neutrons but different atomic numbers, are called isotones.
- **Radioactivity:** Radioactivity is a nuclear phenomenon. It is the spontaneous emission of radiation from the nucleus. In 1•99, the study of radioactivity was taken up by Ernest Rutherford. He placed a little radium at the bottom of a small lead box and subjected the rays that emerged from it to the action of a very strong magnetic field at right angles to their direction. He found that the rays separated into three distinct constituents. Rutherford called the three types of radiation alpha (á), beta (â) and gamma (g) rays. The á-rays were deflected in a direction opposite to that of â-rays and á-rays carried a positive charge, â-rays carried a negative charge and those which passed undeviated were neutral or uncharged were g-rays.

CHEMICAL BONDING

- Atoms are made up of three smaller particles called protons, neutrons and electrons. The protons and neutrons are found in the nucleus of the atom. Protons have a single positive charge. This is called the Atomic Number of an atom. The Atomic Number tells us the number of electrons that the atom contains. It is these electrons that determine the chemical properties of the atom and the way it combines with other atoms to form specific compounds. Electrons have a single negative charge. Normally, atoms are electrically neutral so that the number of electrons is equal to the number of protons.
- Electrons orbit around the nucleus. Electrons cannot orbit the nucleus of an atom in any orbit. The electrons are restricted to specific paths called orbitals or shells. Each shell can only hold a certain number of electrons. When a shell is full, no more electrons can go into that shell. The key to the properties of atoms is the electrons in the outer shell. A complete outer shell of electrons is a very stable condition for an atom.
- **Valency:** Hydrogen is the simplest element. It has one electron. Its outer shell only holds two electrons. Valency can be simply defined as the number of Hydrogen atoms that an element can combine with. The atoms with full electron shells (Helium, Neon, Argon) are chemically inert forming few compounds. The atoms don't even interact with each other very much. These elements are gases with very low boiling points. The atoms with a single outer electron or a single missing electron are all highly reactive. Sodium is more reactive than Magnesium. Chlorine is more reactive than Oxygen. Generally speaking, the closer an atom is to having a full electron shell, the more reactive it is. Atoms with one outer electron are more reactive than those with two outer electrons, etc. Atoms that are one electron short of a

full shell are more reactive than those that are two short.

- Chemical bonds are what hold atoms together to form the more complicated aggregates that we know as molecules and extended solids. The forces that hold bonded atoms together are basically just the same kinds of electrostatic attractions that bind the electrons of an atom to its positively-charged nucleus. chemical bonding occurs when one or more electrons are simultaneously attracted to two nuclei.
- Mainly 3 Types of bonds can be present in Chemical Compounds.
  1. ***Electrovalent or Ionic Bond:*** It is formed by Transferring of Electrons between 2 Atoms. These types of bonds are mainly formed between Metals and Non - Metals. These compounds exist in solid form. These compounds have high boiling Point, Melting Point and thermal stability.
  2. ***Covalent Bond:*** It is formed by equal sharing of Electrons between 2 Atoms. This type of bond is mainly formed between non - metals. These compounds may be solid, liquid or gas. These compounds have low boiling Point, Melting Point and thermal stability in comparison to Ionic Bond.
  3. ***Co - Ordinate or Dative Bond:*** It is formed by unequal sharing of Electrons between 2 Atoms. This bond is also called as Semi - Polar bond since; it involves Electrovalency and Covalency both. These compounds may be solid, liquid or gas. These compounds are insoluble in H2O. These compounds do not conduct Electricity. These compounds have high B.P. than Covalent Compounds but less than Electrovalent Compounds.

CHEMICAL REACTIONS AND EQUATIONS

- Atoms and Molecules, Elements and Compounds: There are about a hundred different types of atoms in the Universe. Substances made up of a single type of atom are called Elements. Some elements are made up of single atoms: Carbon©, Helium(He), Sodium(Na), Iron(Fe) etc. He, Fe, and Na are the Chemical Symbols of the elements.
- Some elements are made up of groups of atoms: Oxygen(O_2), Ozone(O_3), Chlorine(C_{13}) etc. These groups of atoms are called molecules.
- Molecules can also be made up of combinations of different types of atoms. These substances are called compounds: Common Salt(NaCl), Methane(CH_4), Ammonia(NH_3) etc. O_2, CH_4, NH_3 are the Chemical Formulas of Oxygen, Methane and Ammonia respectively. CH_4 means that a single molecule of methane contains one atom of Carbon and four atoms of Hydrogen. This chemical formula could have been written but the C_1 H_4 is never written. Similarly, a molecule of Ammonia (NH_3) contains one atom of Nitrogen and three atoms of Hydrogen.
- A change in which one or more new substances are formed is called a chemical change. A chemical change is also called a chemical reaction. The change may conveniently be

represented by a chemical equation.

- Chemical reactions occur when different atoms and molecules combine together and spit apart. For example, if Carbon (C) is burnt in Oxygen (O_2) to form Carbon Dioxide, a Chemical Reaction occurs. This reaction can be written: $C + O_2 -> C O_2$. This is called a Chemical Equation. The substances on the left hand side of the equation are called the Reactants. The substances on the right hand side are called the Products.
- There is one very important rule with chemical equations: The number of individual atoms on each side of the equation must be the same. On the left had side, there is an atom of Carbon and a molecule of Oxygen (containing two atoms). On the right hand side there is a molecule of carbon dioxide (containing one atom of carbon and two atoms of Oxygen). The number of atoms on the left hand side is equal to the number of atoms on the right hand side. All that has changed is the arrangement of the atoms. In a chemical reaction atoms are re-arranged; no atoms are destroyed or created.
- Hydrogen gas is mixed with Oxygen gas. If the mixture is sparked, it explodes to form water. This chemical reaction can be expressed as: $H_2 + O_2 -> H_2O$. On the left had side, there is a molecule of Hydrogen (containing two atoms) and a molecule of Oxygen (also containing two atoms). On the right hand side there is a molecule of water (containing two atoms of Hydrogen and one atom of Oxygen). The left hand side has one extra atom of Oxygen. This is not allowed by the Law of Conservation of Matter. Both sides must contain the same number of atoms. To make the equation conform, we must balance the equation. It is not possible to change the chemical formulas of the reactants or products. Water will always be H2O. Balancing the equation is achieved by changing the number of molecules involved. The balanced form of the above equation is: $2H_2 + O_2 -> 2H_2O$. Now, on the left had side, there are two molecules of Hydrogen (each containing two atoms making four atoms) and a molecule of Oxygen (containing two atoms). On the right hand side there are two molecule of water (each containing two atoms of Hydrogen and one atom of Oxygen making a total of four atoms of Hydrogen and two of Oxygen). The equation is now balanced. In summary, when Hydrogen reacts with Oxygen, two molecules of Hydrogen react with one molecule of Oxygen to give two molecules of water.
- The reaction goes in both directions. While the Nitrogen and Hydrogen are combining to form Ammonia, Ammonia splits to form Hydrogen and Nitrogen. A mixture of all three substances results. This type of reaction is called an Equilibrium and is represented by arrows going in both directions. $N_2 + 3H_2 -> 2NH_3$.
- It is possible to push the reaction in one direction by adding a Catalyst. A catalyst is a substance that helps a reaction without being used up. If Ammonia is removed from the equilibrium mixture, the reaction will move to produce more Ammonia so that equilibrium is attained.

- The total mass of the elements present in the products of a chemical reaction has to be equal to the total mass of the elements present in the reactants. In other words, the number of atoms of each element remains the same, before and after a chemical reaction.
- During a chemical reaction atoms of one element do not change into those of another element. Nor do atoms disappear from the mixture or appear from elsewhere. Actually, chemical reactions involve the breaking and making of bonds between atoms to produce new substances.
- In a combination reaction two or more substances combine to form a new single substance.
- Decomposition reactions are opposite to combination reactions. In a decomposition reaction, a single substance decomposes to give two or more substances.
- Reactions in which heat is given out along with the products are called exothermic reactions.
- Reactions in which energy is absorbed are known as endothermic reactions.
- When an element displaces another element from its compound, a displacement reaction occurs.
- Two different atoms or groups of atoms (ions) are exchanged in double displacement reactions.
- Precipitation reactions produce insoluble salts.
- Reactions also involve the gain or loss of oxygen or hydrogen by substances. Oxidation is the gain of oxygen or loss of hydrogen. Reduction is the loss of oxygen or gain of hydrogen. The substance that brings about oxidation and is itself reduced is termed as oxidizing agent and the substance that brings about reduction and is itself oxidized is referred to as reducing agent.There are a number of oxidation-reduction reactions that are of industrial use. The production of metals from their ores invariably involves these two processes.

MATTER AND ITS NATURE

A. Matter and Its Nature

- Anything that possesses mass, occupies space, offers resistance and can be perceived through one or more of our sense is called matter.
- Matter is made up of particles. Particles of matter have space between them and are continuously moving and attract each other.
- Matter can exist in three states-

I. Solid
II. Liquid
III. Gas.

- Solid has a definite shape, distinct boundaries and fixed volumes, Solids have a tendency to maintain their shape when subjected to outside force. Solids may break under force but it is difficult to change their shape, so they are rigid.
- Liquids have no fixed shape but have a fixed volume. They take up the shape of the container in which they are kept. Liquids flow and change shape, so they are not rigid but can be called fluid.
- A gas has no definite volume or shape. gases are highly compressible as compared to solids and liquids. The liquefied petroleum gas (LPG) cylinder that we get in our home for cooking or the oxygen supplied to hospitals in

cylinders is compressed gas. Compressed natural gas (CNG) is used as fuel these days in vehicles.

- The forces of attraction between the particles(inter-molecular force) are maximum in solids, intermediate in liquids and minimum in gases. The spaces in between the constituent particles and kinetic energy of the particles are minimum in the case of solids, intermediate in liquids and maximum in gases.
- The arrangement of particles is most ordered in the case of solids, in the case of liquids layers of particles can slip and slide over each other while for gases, there is no order, particles just move about randomly.
- In spite of above differences all kinds of matter have a common property, the property of having a mass.
- The states of matter are inter-convertible. The state of matter can be changed by changing temperature or pressure.
- On increasing the temperature of solids, the kinetic energy of the particles increases. Due to the increase in kinetic energy, the particles start vibrating with greater speed. The energy supplied by heat overcomes the forces of attraction between the particles. The particles leave their fixed positions and start moving more freely. A stage is reached when the solid melts and is converted to a liquid. The temperature at which a solid melts to become a liquid at the atmospheric pressure is called its melting point.
- The process of melting, that is, change of solid state into liquid state is also known as fusion.
- During the melting, the temperature of the system does not change after the melting point is reached, till all the ice melts. This happens even though we continue to heat the beaker, that is, we continue to supply heat. This heat gets used up in changing the state by overcoming the forces of attraction between the particles. As this heat energy is absorbed by ice without showing any rise in temperature, it is considered that it gets hidden into the contents of the beaker and is known as the latent heat.
- The amount of heat energy that is required to change 1 kg of a solid into liquid at atmospheric pressure at its melting point is known as the latent heat of fusion.
- The temperature at which a liquid starts boiling at the atmospheric pressure is known as its boiling point.
- Latent heat of vaporisation is the heat energy required to change 1 kg of a liquid to gas at atmospheric pressure at its boiling point.
- Sublimation is the change of gaseous state directly to solid state without going through liquid state, and vice versa.
- Evaporation is a surface phenomenon. Particles from the surface gain enough energy to overcome the forces of attraction present in the liquid and change into the vapour state. The rate of evaporation depends upon the surface area exposed to the atmosphere, the temperature, the humidity and the wind speed. Evaporation causes cooling.
- During summer, we perspire more because of the mechanism of our body

which keeps us cool. We know that during evaporation, the particles at the surface of the liquid gain energy from the surroundings or body surface and change into vapour. The heat energy equal to the latent heat of vaporisation is absorbed from the body leaving the body cool.

- Let us take some ice-cold water in a tumbler. Soon we will see water droplets on the outer surface of the tumbler. The water vapour present in air, on coming in contact with the cold glass of water, loses energy and gets converted to liquid state, which we see as water droplets.
- Properties such as shape, size, colour and state of a substance are called its physical properties. A change , which does not involve any alteration in composition of the substance is called a physical change. A physical change is generally reversible. In such a change no new substance is formed.
- Some substances can be obtained in pure state from their solutions by crystallisation.
- A change that alters the composition of a substance or substances taking part in the change is termed a chemical change. A chemical change is also called a chemical reaction.All new substances are formed as a result of chemical changes.
- Burning of coal, wood or leaves is a chemical change. Explosion of a firework is a chemical change. If you leave a piece of iron in the open for some time, it acquires a film of brownish substance. This substance is called rust and the process is called rusting. The process of rusting can be represented by the following equation: Iron (Fe) + Oxygen (O_2, from the air)water (H_2O) '! rust (iron oxide-Fe_2O_3) For rusting, the presence of both oxygen and water (or water vapour) is essential. It is a chemical change.
- Prevent iron articles from coming in contact with oxygen, or water, or both. One simple way is to apply a coat of paint or grease. Another way is to deposit a layer of a metal like chromium or zinc on iron. This process of depositing a layer of zinc on iron is called galvanisation.
- Stainless steel is made by mixing iron with carbon and metals like chromium, nickel and manganese. It does not rust.
- Changes attended with absorption of heat are called endothermic changes, while those which occur with evolution of heat are called exothermic changes. The reactions in which heat is absorbed are known as endothermic reactions, while chemical reactions which evolve heat are called exothermic. The compounds formed from their elements with absorption of heat are called endothermic compounds, whilst those formed from their elements with evolution of heat are called exothermic compounds.

B. Classifications

- A pure substance is one that contains one kind of materials throughout its body. A substance cannot be separated into other kinds of matter by any physical process. Mixtures are constituted by more than one kind of pure form of matter, known as a substance. Mixtures can be separated into pure substances using appropriate separation techniques

like filteration, sublimation, decantation, chromato-graphy, crystallization, etc.

- A substance is said to be homogeneous if it has one and the same composition and properties in all its parts. On the other hand, if the composition and properties are not identical throughout the body the substance is heterogeneous. A pure substance must be homogeneous.
- Pure substance are classified into elements and compounds.

  Elements: An element is a form of matter that cannot be broken down by chemical reactions into simpler substances.Robert Boyle was the first scientist to use the term element in 1661. Elements can be normally divided into metals, non-metals and metalloids.
- **Compound:** A compound is a substance composed of two or more different types of elements, chemically combined in a fixed proportion. Properties of a compound are different from its constituent elements.
  - **Symbols:** The symbol is an abbrevaiation for the full name of an element. In many cases the initial capital letter of the common name of element is used as abbrevaiation for it. H stands for Hydrogen, N for Nitrogen, etc. Two letters are used in cases of two or more elements having the same initial letter. A second prominent letter (small) from its name is added to the initial letter. Al stands for Aluminium, Cl stands for chlorine, etc. In some cases the symbols are derived by taking letter or letters from the Latin name of the element. Cu stands for Copper (Latin name Cuprum), Au stands for Gold (Latin name Aurum), etc.
  - Symbol represents one atom and naturally stands for a perfectly definite amount of the element concerned. Every substance is an aggregate of its molecules, and the symbolic representation of a molecule of the substance is called its formula. The number of atoms per molecule of the element is known as the atomicity of the molecule. If the molecule of an element contains one atom, then the molecule is represented by the symbol only, i.e., in such a case symbol represents also the formula.
  - **Valency:** The number of chemical substances, except the element themselves, are composed of two or more of these elementary materials combined together. The valency of an element is the combining capacity of an atom of the element and is measured by the number of hydrogen atoms with which it can be combined. Hydrogen is chosen as the standard of referrence because the combining capacity of hydrogen is least. Though the combining capacity of an atom of the element is by and large fixed, valancy may vary; some elements exhibit different valancies. The highest valancy known being •, the valancies range between 0 and eight. Helium, argon, etc., the so-called inert gases have no combining capacity and hence they are regarded as zero valent element. Valancy is always a whole number.
  - Compounds too like elements are represented by molecular formula. To build up the formula of a compound the symbols of the constituent elements

are written side by side and the number of atoms of each is indicated byputting numerals to the lower right of the symbols. But the subscript one is not written in formula.

C. Solution

- A solution is a homogeneous mixture of two or more substances. The major component of a solution is called the solvent, and the minor, the solute. Lemonade, soda water etc. are all examples of solutions. We can also have solid solutions (alloys) and gaseous solutions (air).
- The particles of a solution are smaller than 1 nm (10-9 metre) in diameter. So, they cannot be seen by naked eyes. The solute particles cannot be separated from the mixture by the process of filtration. The solute particles do not settle down when left undisturbed, that is, a solution isstable.
- The concentration of a solution is the amount of solute present per unit volume or per unit mass of the solution/ solvent.
- Materials that are insoluble in asolvent and have particles that are visible to naked eyes, form a suspension. A suspension is a heterogeneousmixture.

D. Alloys

- Alloys are homogeneous mixtures of metals and cannot be separated into their components by physical methods. But still, an alloy is considered as a mixture because it shows the properties of its constituents and can have variable composition. For example, brass is a mixture of approximately 30% zinc and 70% copper.
- Non-homogeneous systems, inwhich solids are dispersed in liquids, are called suspensions. A suspension is a heterogeneous mixture in which the solute particles do not dissolve but remain suspended throughout the bulk of the medium. Particles of a suspension are visible to the naked eye.
- Colloids are heterogeneous mixtures in which the particle size is too small to be seen with the naked eye, but is big enough to scatter light. Colloids are useful in industry and daily life. The particles are called the dispersed phase and the medium in which they are distributed is called the dispersion medium.

E. Metals andNon-Metals

Elements can be normally divided into metals, non-metals and metalloids. Metals usually show some or all of the following properties:

- They have a lustre (shine).Exception: Mercury, though a metal is liquid.
- They have silvery-grey or golden-yellow colour.
- They conduct heat and electricity. Silver is the best while copper stands second.
- They are ductile (can be drawn into wires).Gold is the most ductile metal.
- They are malleable (can be hammered into thin sheets). Exception: Metals like antimony and bismuth are brittle.
- They are sonorous (make a ringing sound when hit).
- Metals have high melting points. Exception:Gallium and Caesium have very low melting points.
- Metals can form positive ions bylosing

electrons to non-metals. In electrolysis metals get deposited at the negative electrode(cathode).

- Metals combine with oxygen to form basic oxides. Aluminium oxide and zinc oxide show the properties of both basic as well as acidic oxides. These oxides are known as amphoteric oxides.Different metals show different reactivities towards oxygen. Metals such as potassium and sodium react so vigorously that they catch fire if kept in the open. Hence, to protect them and to prevent accidental fires, they are kept immersed in kerosene oil.

- Different metals have different reactivities with water and dilute acids.Metals above hydrogen in the Activity series can displace hydrogen from dilute acids and formsalts.
- Metals occur in nature as free elements or in the form of their compounds.The extraction of metals fromtheir ores and then refining them for use is known as metallurgy.
- The surface of some metals, such as iron, is corroded when they are exposed to moist air for a long period of time. This phenomenon is known as corrosion.

ORGANIC CHEMISTRY

Organic chemistry is that branch of chemistry which deals with the study of compounds of carbon with hydrogen (hydrocarbons), and their derivatives. Presently about five million organic compounds are known. Organic compounds were found to contain mainly hydrogen and carbon. Therefore, organic chemistry is defined as the study of hydrocarbons and their derivatives. Most atoms are only capable of forming small molecules. However one or two can form larger molecules. By far and away the best atom for making large molecules with is Carbon. Carbon can make molecules that have tens, hundreds, thousands even millions of atoms! The huge number of possible combinations means that there are more Carbon compounds thatthose of all the other elements put together! A single Carbon atom is capable of combining with up to four other atoms. We say it has a valency of 4. Sometimes a Carbon atom will combine with fewer atoms. The Carbon atom is one of the few that will combine with itself. In other words Carbon combines with other Carbon atoms. This means that Carbon atoms can form chains and rings onto which other atoms can be attached. This leads to a huge number of different compounds. Organic Chemistry is essentially the chemistry of Carbon. Carbon compounds are classified according to how the Carbon atoms are arranged and what other groups of atoms are attached.

- **Hydrocarbons:** The simplest Organic compounds are made up of only Carbon and Hydrogen atoms only. Even these run into thousands! Compounds of Carbon and Hydrogen only are called Hydrocarbons.

1. ***Alkanes:*** In the alkanes, all four of the Carbon valency bonds are taken up with links to different atoms. These types of bonds are called single bonds and are generally stable and resistant to attack by other chemicals. Alkanes contain the maximum number of Hydrogen atoms possible. They are said to be saturated. The simplest Hydrocarbon is:
    - ***Methane:*** CH_4 This is the simplest member of a series of hydrocarbons. Each successive member of the series has one more

Carbon atom than the preceeding member.

- ***Ethane:*** C_2H_6.
- Propane–(heating fuel): C_3H_8.
  Butane – (lighter / camping fuel): C_4H_{10}.
- ***Pentane:*** C_5H_{12}.
- ***Hexane:*** C_6H_{14}.
  Polythene is a very large alkane with millions of atoms in a single molecule. Apart from being flammable, alkanes are stable compounds found underground.

2. ***Alkenes:*** Another series of compounds is called the alkenes. These have a general formula: CnH2n. These compounds are named in a similar manner to the alkanes except that the suffix is -ene. Alkenes have fewer hydrogen atoms than the alkanes. The extra valencies left over occur as double bonds between a pair of Carbon atoms. The double bonds are more reactive than single bonds making the alkenes chemically more reactive. The simplest alkenes are listed in the table below:
   - Ethene (used as an industrial starter chemical): C_2H_4.
   - Propene: C_3H_6.
   - Butene: C_4H_8.
   - Pentene: C_5H_{10}.
   - Hexene: C_6H_{12}.
3. ***Alkynes:*** A third series are the alkynes. These have the following formula: CnH_2n-2. These highly reactive substances have many industrial uses. Again the naming of these compounds is similar to the alkanes except that the suffix is -yne. Alkynes have two carbon atoms joined by a tripple bond. This is highly reactive making these compounds unstable. Examples of alkynes are:
   - Ethyne - better known as acetylene which is used for welding underwater: C_2H_2
   - Propyne: C_3H_4
   - Butyne: C_4H_6
   - Pentyne: C_5H.
   - Hexyne: C_6H_{10}
4. ***Carbon Rings:*** Alkanes, alkenes and alkynes all contain Carbon atoms in linear chains. When rings are combined with chains, the number of hydrocarbons is virtually infinite. There are also hydrocarbons arranged in rings. Some examples follow:
   - Cyclohexane - a saturated hydrocarbon with the atoms arranged in a hexagonal ring: C6H12
   - Benzene - an industrial solvent. The Benzene Ring is one of the most important structures in organic chemistry. In reality, its alternate double and single bonds are "spread around" the ring so that the molecule is symmetrical: C6H6
   - Toluene - an important solvent and starter chemical: C_7H_8
   - Naphthalene - used in moth balls. This can be depicted as two fused Benzene Rings: $C_{10}H_8$
   - **Carbon, Hydrogen and Oxygen:** When Oxygen atoms are added, the variety of compounds grows enormously. Here are some examples where each molecule has a single functional group.
1. ***Alcohols:*** Alcohols have the OH (hydroxyl) group in the molecule. A group of atoms that gives an organic series its distinctive character is called a functional group. These have a general formula: CnH2n+1OH. Examples: Methanol (wood alcohol) CH3OH, Ethanol(drinking alcohol)

C2H5OH, Phenol(carbolic acid - used as disinfectant) C6H5OH.

2. Ethers (Ethers have an O atom attached to two hydrocarbon chains) (CnH2n+1)2O. Examples: Dimethyl Ether(a gas) (CH3)2O, Diethyl Ether (a liquid used as an anaesthetic) (C2H5)2O
3. Ketones (Ketones have a CO group attached to two hydrocarbon chains) . These have a general formula: (CnH2n+1)2CO.Example: Dimethyl Ketone (Also known as acetone: nail-varnish remover), CH3COC H3
4. Aldehydes (Aldehydes have a CHO group attached to a hydrocarbon chain). These have a general formula: CnH2n+1CHO. Example: Formal-dehyde (preservative in labs) HCHO, Acetaldehyde- CH3CHO.
5. Fatty Acids (Fatty Acids contain the CO2H (or COOH) group attached to a hydrocarbon chain or ring). These have a general formula: CnH2n + 1CO2H. Example: Formic Acid(in ant bites and stinging nettles)- HCO2H, Acetic Acid(vinegar)- CH3CO2H, Butyric Acid(the rancid butter smell)- C2H5CO2H.
6. Esters (Esters are similar to Fatty Acids except that the H in the COOH group is another hydrocarbon chain. They are usually very sweet smelling liquids used in perfumes). These have a general formula: RCO2R'(R and R' are Hydrocarbon chain or rings). Examples: Methyl Methoate (essence of pear drops) - CH3CO2CH3.

- It is possible to have two or more functional groups on a molecule. These can be the same group(as in Oxalic Acid - a poison found in rhubarb leaves - which has two fatty acid groups) or different (as in Hydroxymethanoic Acid - which has a hydroxyl group and a fatty acid group): Oxalic Acid-(COOH)2, Hydroxymethanoic Acid-CH2OHCOOH.
- The most famous compounds containing Carbon, Hydrogen and Oxygen are the Carbohydrates. An example is the common sugar, Sucrose (C12H22O11).
- Isomerism: An interesting phenomenon with organic molecules is called isomerism. Let us look at two compounds introduced earlier. Dimethyl Ether: (CH3)2O and Ethanol: C2H5OH. The first is a gas which will knock you out if inhaled. The second is common alcohol drunk in spirits. Both compounds contain 2 Carbon atoms, 6 Hydrogen atoms and 1 Oxygen atom. Even though the atoms are the same, they are arranged differently. This yields two different compounds with the same number of atoms. These compounds are isomers and the phenomenon is called Isomerism. Isomerism increases the number of Organic compounds. The more Carbon atoms in a compound, the more ways of arranging the atoms and the larger number of isomers.
- **Adding Nitrogen:** Many very important organic compounds contain Nitrogen. This produces more series of compounds.

1. Amines (Amines have one or more of the Hydrogen atoms in Ammonia (NH3) replaced by a Hydrocarbon chain or ring). These have a general formula: CnH2n+1NH2. Examples: Methylamine (a pungent, water soluble

gas)- CH3NH2.

2. Cyanides (Cyanides have the CN group). These have a general formula: CnH2n+1CN. Examples: Methyl Cyanide- CH3CN.
3. Amino Acids (Amino Acids have two functional groups: the amine (HN2) group and the fatty acid (COOH) group. These have a general formula: CnH2nNH2COOH. Examples: Glycine (the simplest amino acid)- CH2NH2COOH.
4. A famous compound containing Nitrogen is Trinitro Toluene (C 6H2CH3 (NO)3) - usually abbreviated to TNT). This is an artificially made explosive.
   - The vast majority of organic compounds contain Carbon, Hydrogen, Oxygen and Nitrogen. Other types of atoms can be included to form even more compounds. These can contain atoms like Phosphorus, Sulphur (e.g. Thiamine,), Chlorine (e.g. Chlorophyll-CHCl3, Dichloro Diphenyl Trichloro Methane – DDT-C 14H9Cl15) and Iron (e.g. Haemoglobin).

PERIODIC CLASSIFICATION OF ELEMENTS

- The grouping of elements with similar properties together and the separation of elements with dissimilar properties is known as classification of elements. The table, which classifies elements on the basis of their properties, is called the periodic table. Döbereiner grouped the elements into triads and Newlands gave the Law of Octaves. Mendeléev arranged the elements in increasing order of their atomic masses and according to their chemical properties.
- Dobereiner's Triads arranged elements in an increasing order of atomic mass, in groups of three. The atomic mass of the middle element was the arithmetic mean of the other two elements of the triad.
- Newland's law of octaves states that on arranging elements in increasing order of their atomic mass, the eighth element resembles the first in physical and chemical properties, just like the eighth node on a musical scale resembles the first note.
- According to Mendeleev's periodic law, the physical and chemical properties of elements are periodic functions of their atomic mass. Mendeleev corrected the atomic masses of a few elements on the basis of their positions in the periodic table. Mendeléev even predicted the existence of some yet to be discovered elements on the basis of gaps in his Periodic Table.
- Mendeléev's Periodic Table contains vertical columns called 'groups'and horizontal rows called 'periods'. While developing the Periodic Table, there were a few instances where Mendeléev had to place an element with a slightly greater atomic mass before an element with a slightly lower atomic mass. The sequence was inverted so that elements with similar properties could be grouped together. Mendeleev's table could not assign a proper position to hydrogen or to the lanthanides and actinides and isotopes. Isotopes of all elements posed a challenge to Mendeleev's Periodic Law. Another

problem was that the atomic masses do not increase in a regular manner in going from one element to the next. So it was not possible to predict how many elements could be discovered between two elements — especially when we consider the heavier elements.

- In 1913, Henry Moseley showed that the atomic number of an element is a more fundamental property than its atomic mass. Accordingly, Mendeléev's Periodic Law was modified and atomic number was adopted as the basis of Modern Periodic Table and the Modern Periodic Law.
- The vertical columns are called groups, while the horizontal rows are called periods. The noble gases are on the extreme right of the table and on the table's extreme left, are the alkali metals. Transition elements are placed in the B subgroups in the middle of the table. The inner transition elements - lanthanides and actinides, are placed in two separate series at the bottom of the periodic table. Group number is number of electrons in the valence shell. Elements having the same valence number, are grouped together. The number of shells present in the atom gives period number.
- **Atomic size:** The term atomic size refers to the radius of an atom. The atomic size may be visualised as the distance between the centre of the nucleus and the outermost shell of an isolated atom.

PROPERTIES OF GASES

1. Properties of Gases

- First, we know that a gas has no definite volume or shape; a gas will fill whatever volume is available to it. Contrast this to the behavior of a liquid, which always has a distinct upper surface when its volume is less than that of the space it occupies.
- The other outstanding characteristic of gases is their low densities, compared with those of liquids and solids. The most remarkable property of gases, however, is that to a very good approximation, they all behave the same way in response to changes in temperature and pressure, expanding or contracting by predictable amounts. This is very different from the behavior of liquids or solids, in which the properties of each particular substance must be determined individually.
- All gases expand equally due to equally due to equal temperature difference.
- **Diffusion of gases:** The phenomenon in which a substance mixes with another because of molecular motion, even against gravity- is called diffusion.
- **The pressure of a gas:** The molecules of a gas, being in continuous motion, frequently strike the inner walls of their container. As they do so, they immediately bounce off without loss of kinetic energy, but the reversal of direction (acceleration) imparts a force to the container walls. This force, divided by the total surface area on which it acts, is the pressure of the gas.
- The unit of pressure in the SI system is the pascal (Pa), defined as a force of one newton per square metre (1 Nm–2 = 1 kg m–1 s–2.)

- Temperature and Temperature Scales: Temperature is defined as the measure of average heat. Temperature is independent of the number of particles or size and shape of the object. The water boiling temperature is same for all type of containers.
- **Thermometer:** The device which is used to define the measure of temperature of an object is Thermometer.
- **Temperature scale:** A reference scale with respect to which the temperatures can be measured is known as 'scale of temperature'. Various scales of temperatures are in use. Important scales of temperature are:
- Celsius scale
- Kelvin scale
- Fahrenheit scale
- To devise a scale of temperature, fixed reference points (temperature) are required, with respect to which all other temperatures are measured. For both Celsius and Fahrenheit Scales of temperatures, the fixed points are as follows:
- Lower fixed point: Melting point of pure ice at normal atmospheric pressure is regarded as the lower fixed point.
- Upper fixed point: Boiling point of pure water at normal atmospheric pressure is regarded as the lower fixed point.
- **Celsius scale:** In this scale the lowest fixed point is the freezing temperature of pure substance. The upper fixed point is the boiling point of water. The interval is divided into 100 divisions all are at equal distance. Every division being denoted as one degree Celsius(0C). The Celsius scale is also called as centigrade scale because the range of temperature is divided into 100 equal divisions.
- **Kelvin scale:** Another type of scale which is used to define the measure of temperature is Kelvin scale. The Kelvin scale is also known as absolute scale of temperature. The lowest fixed point is taken from the lowest temperature to which a substance to be cooled such as -273.150C. According to the scale, a temperature is denoted by simply K .
- **Absolute zero:** The temperature at which a given mass of gas does not occupy any volume or does not exert pressure is called the "absolute zero". Absolute zero i.e., 0K or -273oC is the lowest possible temperature that can be reached. At this temperature the gas has a theoretical volume of zero. In the Kelvin scale, the lowest possible temperature is taken as zero. This temperature is called as absolute zero.At the point absolute zero there is no molecular motion and there is no heat energy. At absolute zero all atomic and molecular motions stop. Hence the absolute zero is the lowest possible temperature which is denoted by 0K or -273.150 C.
- **Fahrenheit Scale of Temperature:** The lower and upper fixed points in this scale are considered as 320 F and 2120 F respectively. The interval of 1800 F is divided into 180 equal parts. Each part is known as 10 F. This is widely used by doctors.
- The volume of a gas is simply the space in which the molecules of the gas are free to move. If we have a mixture of gases, such as air, the various gases will coexist within the same volume. In

these respects, gases are very different from liquids and solids, the two condensed states of matter. The SI unit of volume is the cubic metre, but in chemistry we more commonly use the litre and the millilitre (ml). The cubic centimetre (cc) is also frequently used; it is very close to 1 milliliter (mL).

- **Compressibility:** Particles of a gas have large intermolecular spaces among them. By the application of pressure much of this space can be reduced and the particles be brought closer. Hence the volume of a gas can be greatly reduced. This is called compressing the gas.

2. Gas Laws

- All gases, irrespective of their chemical composition, obey certain laws that govern the relationship between the volume, temperature and pressure of the gases. A given mass of a gas, under definite conditions of temperature and pressure, occupies a definite volume. When any of the three variables is altered, then the other variables get altered. Thus these Gas laws establish relationships between the three variables of volume, pressure and temperature of a gas.
- **Boyle's Law:** Robert Boyle (1627 - 1691) discovered this law in 1662 and it was named after him. It can be restated as "The product of the volume and pressure of a given mass of dry gas is constant, at constant temperature". P "1/ V(at constant temperature) or PXV= K (where K is constant).
- **Charles' Law:** "At constant pressure, the volume of a given mass of gas increases or decreases by 1/273 of its original volume at 32oF, for each degree centigrade rise or lowering in temperature." Assume a given mass of gas has a volume of V1 at a temperature T1 Kelvin at a constant pressure, then, according to Charles' Law we can write: V "T or VT=K (Constant).
- **Pressure Law:** Volume remaining constant, the pressure of a given mass of gas increases or decreases by a constant fraction (=1/273) of its pressure at 00C for each degree celsius rise or fall of temperature. If the pressure of a given mass of gas at 00C be Po; then for a rise or fall of temperature of T0C, its pressure Pt is given by Pt= Po{1±(t/273)}
- **Avogadro's Law:** This is quite intuitive: the volume of a gas confined by a fixed pressure varies directly with the quantity of gas. Equal volumes of gases, measured at the same temperature and pressure, contain equal numbers of molecules. Avogadro's law thus predicts a directly proportional relation between the number of moles of a gas and its volume.
- **Gay-Lussac's Law:** When different gases react with each other chemically to produce gaseous substances, then under the same condition of temperature and pressure, the volume of the reacting gases and product gases bear a simple ration among one another.
- **Avogadro's hypothesis:** Under the same condition of pressure and temperature, equal volumes of all gases contain equal number of molecules.
- The molecular weight of an element or compound is the sum-total of the atomic weights of the atoms which

constitute a molecule of the substance. Example: The molecular formula formula of nitric acid is HNO3; hence its molecular weight = H + N + 3 × O = 1 + 1 4 + 3 × 16 = 6• (taking atomic weight of hydrogen as 1).

- **Gram-Atomic Weight:** A quantity of any substance whose mass in grams is numerically equal to its atomic weight, is called its Gram-Atomic Weight.
- **Gram-Molecular Weight:** A quantity of any substance whose mass in grams is numerically equal to its molecular weight, is called its Gram-Molecular Weight or mole.
- Molecular volume occupied by a mole of any gas is called the gram-molecular volume or molar volume. On the basis of Avogadro's hypothesis, the gram molecular volume of any gas at normal temperature and pressure is 22.4 litres.
- **Avogadro Number:** From Avogadro's hypothesis, we know equal volume of all gases contain equal number of molecules at normal temperature and pressure. Also we know that at normal temperature and pressure one mole of any gas occupies 22.4 litres. Combining the two, we can say that that, gram-molecular volume of all gases contain equal number of molecules at normal temperature and pressure. This number is known as Avogadro Number and is equal to6.06X1023.
- **The Gas Equation:** According to Boyle's Law, the volume of a gas varies inversely as the pressure, temperature remaining constant, i.e., V "1/ P and according to Charles' law, the volume of a gas varies directly as the absolute temperature, pressure remaining constant, i.e. V "T Both, these laws can be combined as: The volume of a given mass of a gas varies inversely with the pressure and directly with the temperature. V "(1/ P)XT or V "T/P or (PXV)/T = K(constant). In other words, For a given mass of a gas, if the initial conditions are P1, V1, and T1, then the altered conditions are P2, V2, and T2. Thus, (P1X V1)/ T1 = (P2X V2)/ T2
- **The ideal gas equation of state:** If the variables P, V, T and n (the number of moles) have known values, then a gas is said to be in a definite state, meaning that all other physical properties of the gas are also defined. The relation between these state variables is known as an equation of state. By combining the expressions of Boyle's, Charles', and Avogadro's laws (you should be able to do this!) we can write the very important ideal gas equation of state: PV= nRT, where the proportionality constant R is known as the gas constant. This is one of the few equations you must commit to memory in this course; you should also know the common value and units of R.
- An ideal gas is an imaginary gas that follows the gas laws and has 0 volume at 0 K i.e., the gas does not exist.

SOME COMMON ELEMENTS & COMPOUNDS

1. **Hydrogen:** Symbol H, formula H2. The first element in the periodic table and the most basic and common of all elements in the universe. Over ninety percent of all the atoms in the universe are hydrogen atoms and they are the lightest of all elements. The name hydrogen comes from the Latin word

"hydro" which means water. Scientists use the letter "H" to represent hydrogen in all chemical equations and descriptions.

- Hydrogen atom has one electron in its valence shell like alkali metals.
- Hydrogen generally shows + 1 valency like alkali metals.
- Hydrogen is a good reducing agent like other alkali metals.
- The isotopes of hydrogen: Protium has an atomic number 1, and mass number 1, Deuterium, has an atomic number 1, and mass number 2 and Tritium has an atomic number 1, and mass number 3.
- It has a vapour density of 1, which is 14.4 times lighter than air.

2. **Carbon:** The sixth element in the periodic table. It is a very stable element. Because it is stable, it can be found in many naturally occurring compounds and by itself. Scientists describe the three states of carbon as diamond, amorphous, and graphite.
   - Carbon exhibits allotropy and shows maximum catenation.
   - Normal valency of carbon is four due to the presence of four valence electrons. Thus all four bonds are generally covalent.
   - Carbon occurs both in free state as diamond, coal etc. and also in the combined form as CO_2.
   - Diamond is one of the allotropic forms of carbon and is the purest form of natural carbon. It is the hardest natural substance. Diamond is a giant framework that forms a rigid structure with no free electrons to conduct electricity.
   - Graphite is also an allotropic form of carbon, which is very soft and slippery. Graphite has a mobile cloud of electrons on the horizontal planes, which makes it a good conductor of electricity.
   - Apart from diamond and graphite, which are crystalline forms of carbon, all other forms of carbon are amorphous allotropes of carbon. Destructive distillation of coal gives products like coal gas, gas carbon, coal tar and ammonical liquor.
   - Lamp Black is also known as Soot. Soot is obtained by the incomplete combustion of carbonaceous, fuels, especially oil fuels, in limited supply of air. The soot settles on the cooler parts of the chamber, and can be collected by scrapping it.
   - Wood charcoal is obtained by the destructive distillation of wood. The chief products formed are wood charcoal, wood tar, pyroligneous acid and wood gas .
   - Sugar charcoal can be obtained by dehydrating cane sugar, either by treating it with concentrated sulphuric acid or by heating it in the absence of air.
   - Bone charcoal is a black powder called as 'ivory black'. It is porous and can adsorb colouring matter. It is mostly used in sugar industry to decolourise sugar.
3. **Nitrogen:** It is the seventh element of the periodic table located between carbon and oxygen. Almost eighty percent of Earth's atmosphere is made of nitrogen gas. Nitrogen is a clear gas that has no smell when it is in its pure form. It is not very reactive when it is in a pure molecule, but it can create

very reactive compounds when combined with other elements including hydrogen (ammonia). There are 7 electrons in a nitrogen atom.

- Nitrogen has 5 electrons in its valence shell. It has a valency of 3 with respect to hydrogen and a valency upto 5 with respect to oxygen.
- In the laboratory nitrogen is prepared by the action of heat on a mixture of ammonium nitrite and ammonium chloride. Nitrogen is collected by the downward displacement of water and is called chemical nitrogen.
- Nitrogen is a neutral gas and is neither combustible nor a supporter of combustion.

4. **Oxygen:** Symbol O, formula O2. Alone, oxygen is a colorless and odorless compound that is a gas at room temperature. Oxygen molecules are not the only form of oxygen in the atmosphere; you will also find oxygen as ozone and carbon dioxide. There are
• electrons in an oxygen atom. In the laboratory oxygen is usually obtained by heating a mixture of potassium chlorate and manganese dioxide. Manganese dioxide facilitates the decomposition of potassium chlorate, but it itself remain unchanged in mass and composition and hence acts as a catalyst in the reaction. Oxygen is non-combustible but a good supporter of combustion. An oxide is a compound of two elements, one of which is oxygen. It can be liquefied and solidified. It is employed in welding process and also used in hospitals for artificial respiration. Oxygen shows a valency of -2.
5. **Chlorine:** Chlorine belongs to group VII A. Members of this group are called halogens which means 'salt producers'. Chlorine has seven electrons in its outer most shell and so has a valency of 1. Chlorine is prepared by the oxidation of concentrated hydrochloric acid using oxidising agents like manganese dioxide, lead dioxide, trilead tetra oxide, potassium permanganate and potassium dichromate. Chlorine is a non combustible gas but supports the burning of certain metals and non-metals. Chlorine is highly reactive. It reacts with hydrogen, other non metals and metals to form the corresponding chlorides. Chlorine being an acidic gas turns moist blue litmus paper to red and then bleaches it.
6. **Water (H_2O):**
   - Water is the only substance that can exist simultaneously in all the three states of matter, i.e., solid, liquid and gaseous on this earth.
   - Pure water is a colourless, odourless and tasteless liquid.
   - The density of water is 1 g cm-3 at 4oC.
   - The boiling point of water is 100oC at a pressure of 760 mm of Hg. The melting point of ice is 0oC at a pressure of 1 atmosphere.
   - Ice has a relative density of 0.92. The specific heat capacity of water is 1 cal/g at 15oC.
   - Water is called the "Universal Solvent". Almost all substances dissolve in water to a certain extent. Hence, it known as a universal solvent. Because of this property, it is impossible to get chemically pure

water on the earth.

- Metals such as gold, silver, copper, tin, etc. do not react with water. Ordinary iron gets rusted and aluminium gets tarnished.
- Water is described as being 'hard' if it does not lather readily with soap. 'Soft water', on the other hand, is described as the one, which lathers readily with soap. Chemically, natural water is never pure and contains varying amounts of the dissolved impurities absorbed from the natural or man made environment. Temporary hardness and permanent hardness are the two types of hardness occurring in hard water: Water is said to be temporarily hard when it contains bicarbonates of calcium and magnesium (or hydrogen carbonates). This type of hardness can be easily removed by boiling. Water is said to be permanently hard when it contains sulphates and chlorides of calcium and magensium. Water becomes permanently hard when it passes over the rocks, which contain sulphates or chlorides of calcium and magnesium to form insoluble calcium bicarbonates or magnesium bicarbonates (or hydrogen carbonates). Thishardness cannot be removed by boiling.
- Heavy water is prepared either by prolonged electrolysis or by fractional distillation of ordinary water. Heavy water (D_2O) is colourless, tasteless and odourless liquid. It has all higher values for physical constants than the corresponding values of ordinary water. Fission in uranium-235 is brought by slow speed neutron. Heavy water is used for this purpose in nuclear reactors as moderators.

7. **Ammonia (NH_3):**
   - Ammonia is present in atmospheric air and in natural water in trace amounts. However in sewage water, it is present in greater proportion. Ammonia is present in the combined form as various ammonium salts. The two most popular salts are ammonium chloride and ammonium sulphate.
   - Ammonia is generally obtained from Ammoniacal liquor obtained by the destructive distillation of coal, destructive distillation of nitrogenous organic matters such as horns, hoofs, bones etc. of animals, Ammonium salts.
   - In the laboratory, ammonia is usually prepared by heating a mixture of ammonium chloride and slaked lime in the ratio of 2 : 3 by mass.
   - Ammonia is a colorless gas. Its vapor density is 8.5. Hence it is lighter than air (vapor density of air = 14.4). When cooled under pressure ammonia condenses to a colorless liquid, which boils at -33.4oC. When further cooled, it freezes to a white crystalline snow-like solid, which melts at -77.7oC. Ammonia is one of the most soluble gases in water. At 0oC and 760 mm of Hg pressure one volume of water can dissolve nearly 1200 volumes of ammonia. This high solubility of ammonia can be demonstrated by the fountain experiment. Ammonia is neither combustible in air nor does it

support combustion. However it burns in oxygen with a greenish-yellowish flame producing water and nitrogen. Ammonia reacts with the acids to form their respective ammonium salts. Ammonia is highly soluble in water and forms ammonium hydroxide.

8. **Hydrochloric Acid(HCL):**
   - Hydrochloric acid is prepared by dissolving hydrogen chloride gas in water. Hydrogen chloride is a covalent compound, but when dissolved in water it ionizes to form hydrogen ions and chloride ions
   - Hydrochloric acid is produced along with the industrial preparation of caustic soda (sodium hydroxide). During the electrolysis of sodium chloride, large quantities of hydrogen and chlorine gas are obtained as by-products. These two gases are burnt to form hydrogen chloride gas. The hydrogen chloride gas so formed is dissolved in water to form hydrochloric acid. A saturated solution of the acid has a density of 1.2 g cm-3. It contains about 40% by mass of hydrogen chloride.
   1. It turns litmus paper from blue to red.
   2. It turns methyl orange from yellow to pink.
   3. It reacts with metals to form their respective chlorides and liberates hydrogen.
   4. It reacts with bases to form their respective chlorides and water.
   5. It combines with carbonates and hydrogen carbonates to form their respective chlorides and liberate carbon dioxide.
   6. Hydrochloric acid is used in the production of dyes, drugs, paints, photographic chemicals and in the preparation of aqua-regia for dissolving metals like gold and platinum.

9. **Nitric Acid(HNO3):**
   - Nitric acid is produced in large quantities in the atmosphere during thunder storms. It is manufactured by the Ostwald's Process by the reaction of ammonia and air in presence of platinum as catalyst at 700-800o C.
   - Nitric acid is colourless in pure form. Commercial nitric acid is yellowish due to the presence of dissolved nitrogen dioxide.
   - Pure nitric acid is not very stable. Even at ordinary temperature, in presence of sunlight it undergoes slight decomposition. As the temperature increases, the rate of decomposition also increases. On strong heating it decomposes completely to give nitrogen dioxide, water and oxygen.
   - Nitric acid is a strong monobasic acid. It ionizes in water readily.
   - Nitric acid usually does not behave as an acid, with metals to form the corresponding salt and liberate hydrogen. However, magnesium and manganese are the only two metals, which react with cold and very dilute (1%) nitric acid to evolve hydrogen.
   - Nitric acid is a strong oxidizing agent. When it undergoes thermal decomposition, it yields nascent oxygen

10. **Sodium(Na):**
    - Sodium belongs to Group I in the periodic table. This group is otherwise known as the alkali metals group. Since the atomic number of sodium is 11, its electronic configuration is 2,8,1. Sodium easily loses the lone electron to attain the stable configuration of neon. Therefore alkali metals like sodium that are univalent can easily form ionic compounds.
    - Since alkali metals like sodium are highly electropositive (tendency to lose an electron and become a cation), their carbonates and bicarbonates are highly stable to the action of heat.
    - Some of the important sodium compounds are:

1. **Sodium Carbonate (Na_2CO_3):** Popularly known as washing soda or soda ash, sodium carbonate is a commercially important compound. (a) Transparent crystalline solid with ten molecules of water per molecule. (b) Soluble in water. (c) Washing soda solution is alkaline due to hydrolysis.(d) Has detergent or cleansing properties. (e) Sodium carbonate is used as washing soda in laundry as a cleansing agent, for softening hard water, in manufacturing glass, paper, soap and caustic soda.
2. **Sodium Bicarbonate ($NaHCO_3$):** Sodium bicarbonate is commonly called baking soda. Sodium bicarbonate is prepared in the laboratory by saturating a cold solution of sodium carbonate with carbon dioxide. (a) Sodium bicarbonate separates as white crystals. This is because it is very sparingly soluble in water. (b) Sodium bicarbonate is sparingly soluble in water.(c) Used in the preparation of carbon dioxide. (d) Used as a constituent of baking powder, and in effervescent drinks. Baking powder has sodium bicarbonate and tartaric or citric acid. When it is dissolved in water or heated carbon dioxide is produced. This carbon dioxide gas causes the puffiness and lightness of cakes, biscuits etc.(e) Sodium bicarbonate is used to extinguish fire as it produces carbon dioxide gas.

11. **Calcium(Ca):**
    - The elements of Group II like calcium are called the alkaline earth metals. The atomic number of calcium is 20 and its configuration is 2,8,8,2. Calcium loses two electrons and becomes Ca2+ ion with the stable configuration of argon. Calcium is therefore bivalent in nature.

Some of the important calcium compounds:

1. **Bleaching Powder (CaOCl2):** (a)Calcium oxychloride is the chemical name of bleaching powder.(b) Passing chlorine gas over dry slaked lime (Ca(OH)2), gives bleaching powder.(c) It is soluble in water. The lime present is always left behind as an insoluble salt. For this reason it is also called chloride of lime.(d) Bleaching powder is commonly used for bleaching clothes. It is also used in bleaching wood pulp in the paper industry, to disinfect drinking water, to manufacture of chloroform (CHCl3), an anaesthetic
2. **Plaster of Paris ($CaSO_4$) 2.H2O:** Chemically, plaster of paris is

known as calcium sulphate hemihydrate (hemi means half). When gypsum is heated to 120oC, it loses 75% of its water of crystallization to form plaster of Paris. It is a white powder. When mixed with water, it forms a plastic mass. After about half an hour, this mass sets into a hard solid mass constituting interlaced gypsum crystals. Plaster of Paris is used to set fractured bones due to its setting property on hydration, as a sealant in laboratories, manufacture of black-board chalk.

CELL

Components of Cell?

In the living organisms there are two types of cellular organizations. If we look at very simple organisms like bacteria and blue-greenalgae, We will discover cells that have no defined nucleus, these are **prokaryotes cells**. The cells which have definite nucleus are known as **eukaryote**. But the things which both have in common is thatthere are compartments surrounded by some type of membranes. These are called **cell membranes**.

Cell membranes : It is like a plastic bag with some tiny holes that bag holds all of the cell pieces and fluids inside the cell and keeps foreign particles outside the cell. The holes are there to let some things move in and out of the cell. Compounds called **proteins** and **phospholipids** make up most of the cell membrance.the phospholipids make the basic bag. The proteins are found around the holes and help move molecules in and out of the cell. Substances like Co_2 and O_2 can move across the cell membranes by a process called **diffusion**. Diffusion is a process of movements of substance from a region of high concentration to a region where its concentration is low. Water also obeys the law of diffusion. The movement of water molecules is called **osmosis**.

Cytoplasm : It is the fluid that fills a cell. Scientists used to call the fluid proto plasm.cytoplasm contain many specialized cell called organ cells. Each of these organ cells performs a specific function for the cell.

Cell organells : Organells are living part of the cell have definite shape, structure and functions. To keep their function different from each other these organelles use membranes bound little structure with in them selves. Some of the important organells are:

(a) Endoplasmic reticulum : It is a network of **tulsular** membranes connected at one end to the nucleus and on the other to the plasma membranes. Endoplasmic reticular (ER) are two types:-rough endoplasmic reticular (RER) and Smooth endoplasmic reticulum (SER).

Functions of ER:

- It forms the supporting skeleton frame work of the cell.
- It provides a pathway for distribution of nuclear material.
- It provides surface for various enzymatic reactions.

(b) Ribosomes : it synthesis protein, and ER sent these protein in various part of the cell. Where as SER helps in the manufacture of fats.

Functions of these proteins and fats:

- Protein and fat (lipid) help in building the cell membranes. This process is known as **membranes biogenesis.**
- Some other protein and fat functions as enzymes and hormones.
- SER plays a crucial role in detoxifying many poisons and drugs.

(c) Golgi apparatus : it is found in most

cell. It is another packaging organelle like the endoplasmic reticulum. It gathers simple molecules and combines them to make molecules that are more complex. It then takes those big molecules, packages them in vesicles and either stores them for faster use or sends them out of the cell.

Other functions:

- Its functions include the storage modifications and packaging of products in vesicles.
- It is also the organ Elle that builds lysosomes (cells digestion machines).

(d) Lysosomes: It is a kind of waste disposal system of thecell.

It helps to keep the cell clean by digesting any foreign material.

Old organs cell end up in the lysosomes.

When the cell gets damaged, lysosomes may burst and the enzymes digest their own cell. Therefore lysosomes are also known as the **"suicide ways"** of the cell.

(e) Mitochondria: It is known as the power house of the cell. The energy required for various chemical activities headed for life is released by mitochondria in the form of ATP (adenosine-tri-phosphate) molecules.

- **ATP is known as the energy currency of the cell.** The body uses energy are stored in ATP for making new chemical compounds and for mechanical work.
- Mitochondria are strange organells in the sense that they have their own DNA and ribosomes, there fore mitochondria are able to make their own protein.
- Mitochondria is absent in bacteria and the red blood cells of mammals and higher animals.

(f) Centrioles: It is a micro-tubular structure; centrioles are concerned with cell division. It initiates cell division.

(g) Plastids: These are present only in plant cells. There are two types of plastids:-chromoplastes (colour plastides) and leucoplast (white or colourless plastids).

- **Chromoplast** impart colour to flowers and fruits.
- **Leucoplasts** are in which starch, oils and protein are stored.
- **Plastids** are self replicating. i.e. they have the power to divide, as they contain DNA, RNA and ribosomes.
- Plastides contains the pigment chlorophyll that is known as **chloroplast**. It is the site for photo synthesis.

The above mentioned cell organalls are the living part of the cell but there are some non – living parts with in the cell like vacuoles and granules.

Vacuoles: it is a fluid filled spaces enclosed by membranes. It is a storage sacs for solid or liquid contents. It stores excess water, minerals, food substance, pigments and waste products. Its size in animal is small and in plant it is big. Many substances of importance in the life of the plant cell are stored in vacuoles. These are amino acids sugars. It also Contain Various organic acid and some proteins.

Granules: It is not bounded by any membranes. It store fats, proteins and carbohydrates.

Cell nucleus: The cell nucleus acts like the brain of the cell. It helps control eating, movement and reproduction. Not all cells have a nucleus. The nucleus contain, thefollowing components :

(a) Nuclear envelope: It surrounds the nucleus and all of its contents nuclear

envelope is a membrane similar to the cell membranes around the whole cell.

(b) Chromatin : When the cell is in resting state there is something called **chromatin** in the nucleus. Chromatin is made up of DNA, RNA and nucleus protein. DNA and RNA are the nucleus acids inside the cell. When the cell is going to divide, the chromatin become very compact. It condenses when the chromatin comes together we can see the chromosomes.

(c) Chromosomes: Chromosomes make organisms what they are. They carry all the information used to help a cell grow, thrive and reproduce.

- Chromosomes are made up of DNA.
- Segments of DNA in specific patterns are called **genes**.
- In prolaryotes, DNA floats in the cytoplasm in an area called the **nucleoid**.
- Chromosomes are not always visible. They usually sit around uncoiled and as loose shards called **chromation.**
- When it is time for all cells to reproduce, they condense and wrap up very tightly. The tightly round DNA in the chromosome.
- Chromosomes are usually found in pairs.
- Human Beings probably have 46 chromosomes (23 pairs).
- Peas only have 12, a dog has 78 chromosomes.
- The number of chromosomes is not related to the intelligence or complexity of the creature.

(d) Nucleolus: It is a dense spherical granule contained within the nucleus, its size is related to the synthetic activity of the cell. Neurons cell have a comparatively larger nucleate than those cell have no synthetic activity. The nucleolus stores proteins.

Cell Division

Organisms grow and reduce through **cell division**. Plants continue to grow by cell division all their lives. But in most animals cells divide more slowly once the body taken shape. There are two methods of replication **mitosis** and **meiosis**.

(a) Mitosis: The main theme of this replication is that mitosis is the simple duplication of a cell and all of its parts. It duplicates its DNA and the two new cells (daughter cells) have the same pieces and generic code. Beyond the idea that two identical cells arecreated, there are five steps in this process. You should remember the term PMATI. It breaks down to:

1. Prophase
2. Metaphase
3. Anaphase
4. Telophase
5. Interphase.

The phases:

(i) Prophase: a cell gets the idea that it is time to divide. First it has to get everything ready. Cell need -to duplicate DNA, get certain pieces in the right position (centrioles) and generally prepare the cell for the process of mitotic division.

(ii) Metaphase: The DNA lines upalong a central axis and then DNA condensed into chromosomes.

(iii) Anaphase: Here the separation begins. Half of the chromosomes are pulled to one side of the cell half to go the other way.

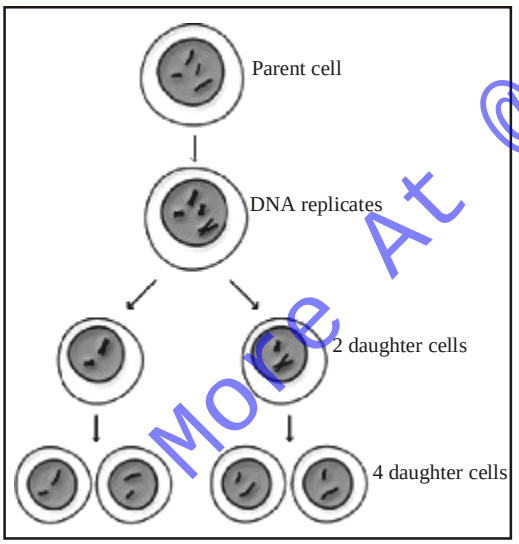
(iv) Telophase: Now the division is finishing up. We have now two

separate cells each with half of the original DNA.

(v) **Interphase:** This is the normal state of the cell.

(b) **Meiosis: It's for sexual reproduction**. The main theme of meiosis is that there are two cell division. Mitosis has one division and meiosis has two divisions in this process four cells are created where there was originally one.

Meiosis happens when its time to reproduce an organisms. The steps of meiosis are very simple. When we break it down its just two PMATI's in a row. The interphase that happens between the two proce-sses is very short and the DNA is not duplicated. Meiosis is the great process that shuffles the cell's gene-sis around. Instead of creating two new cells with equal number of chromosomes (likemitosis).



The cell does a second divi-sion soon after the first. This second divi-sion divides the number of chromo-somes in half. Scien-tists call, this process as **meiosis I and II**, but its just two PMATI's.

- **Meiosis I:** This is basically live PMATI of a regular mitosis. Pairs of chromosomes are lined up at thecentre of the cell and then pulled to each side. Meiosis is a bit different because there are some thing called **crossing-over** happens with the DNA. This crossing over is an exchange of genes. The genes are mixed up not resulting in a perfect duplicate like mitosis. The cell divides, having two new cells with a pair of chromosomes each. Since this is meiosis. There is a very short interphase and division begins again.
- **Meiosis II :** In this division the DNA that remains in the cell begins to condense and form shortchromosomes and the centre of the cell and the centrioles are in position for the duplication. Each one splits into two pieces. They don't divide up the DNA between the cells. They split the DNA that exits. Each daughter cell will get one half of the DNA needed to make a functioning cell. When it's all over we left with four haploid cells (means half the regular number) that are called **gametes**. The eventual purpose of the gametes will be to find other gametes with which they can combine.

Some important facts regarding cells :

- Nerve cells in animals are the longest cells.
- Smallest human cell is red blood cell.
- Largest human cell is female ovum.
- The single largest cell in the world is of an ostrich.
- The smallest cells are those of the mycoplasma.
- Every minute about 3 millions cells in our body die.
- Sieve tube in plants and the mature mammalian red blood cells do nothave a nucleus.
- The red blood cell carries respiratory gases.

- Sieve cells in plants transport nutrients in plants.
- The lysosomal enzymes of the sperm cells digest the limiting membranes of the ovum (egg). Thus the sperm is able to enter the ovum.
- During the transformation of tadpole into frog. The embryonic tissues like gills and tail are digested by the lysosome.
- Mitochondria contain DNA, hence capable of replication.
- Matrix is a transparent, homogenous semi-fluid substance. In its active state. It remains saturated with water.

Comparisons between
Plant Cell and Animal Cell

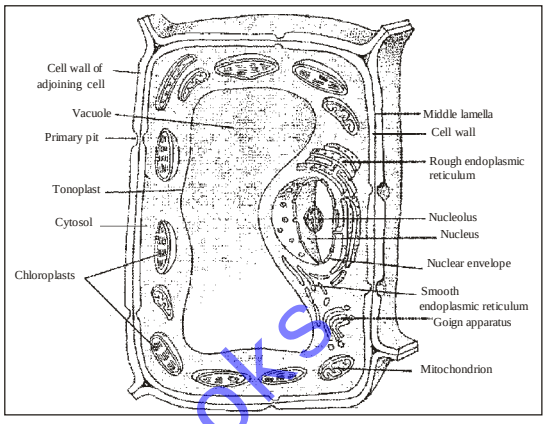


Fig. Plant cell structure

Similarities :

Part of cell	*Plant*	*Animal*
Cell membranes	present	present
Endoplasmic reticulum	present	Present but absent in RBC and embryonic cell.
Ribosome	present	Present
Mitochondria	present	Present but absent in RBC and bacteria
Golgi complex	present	Present but absent in mature RBC
Nucleus	present	present
Granules.	present	present

- Nucleus is absent in mature mammalian red blood cells and sieve tubes in the phloem tissue of vascular tube.

Plant Cell	*Animal Cell*
1. Nucleus ellipticalin shape.	1. Nucleus rounded in shape
2. Mitochondria fewer.	2. Mitochondria numereous.
3. Plant cells do not burst if placed in hypotonic solution.	3. Animal cells usually burst if placed in hopotonic solution.
4. Centrioles absent except in lower plants.	4. Centrioles present.
5. Spindle formed during cell division is anastral type.	5. Spindle formed during cell division is of amphiastral type.
6. Golgi body has distyosomes.	6. Golgi apparatus consists of a single complex.
7. Lysosomes rare.	7. Lysosomes present in animal cells.
8. Glyoxysomes present.	8. Glyxosomes absent.
9. Crystals of inorganic substances occur inside.	9. Crystals do not occur.
10. Adjacent cells connected through plasmodemata by middle lamella.	10. Adjacent cells connected by a number of junctions.
11. Cytokinesis by cell plate.	11. Cytokinesis by cleavage.

Dissimilarities :		
Cell part	Plant	Animals
Cell wall	present	absent
Lysosomes	absent	present
Centrioles	absent	present
Plastids	present	absent
vacuoles	present	absent

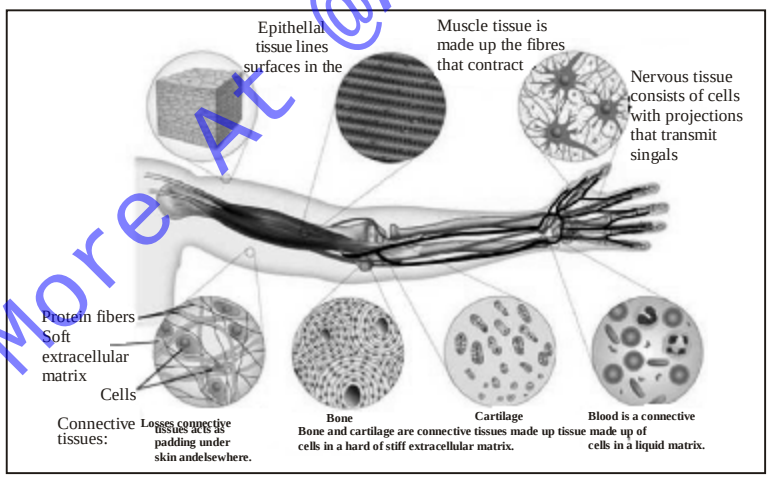
TISSUE

Epithetical Tissue

It is a tissue that is made up of tightly packed cells. Without much materials with in these cells. The reasons for the tightly packed cells are to act as a barrier against mechanical injury, invading micro-organisms and fluid loss. We can define epithetical tissue by considering two points in mind one is the number of cells layers and two the shape of the cells.

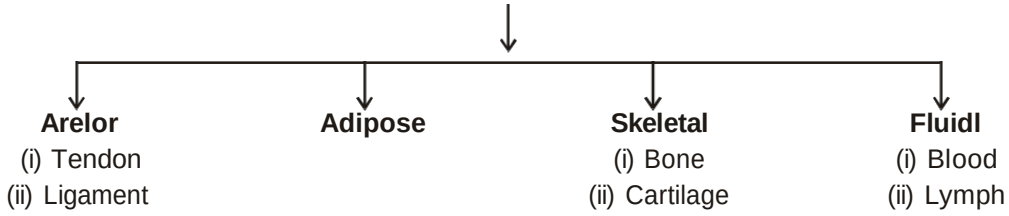
(i) On the basis of cell layers
(a) When an epithelium has a single layer of cells it is called a simple epithelium.
(b) Where as a multiple tier of cells are known as stratified epithelium.
(ii) On the basis of simple shape of cells:

- **Cuboidal :** its occurrence is in kidney tubules, salivery glands, inner lining of the cheek. Its main function is to give mechanical strength.
- **Columnar :** its occurrence is in sweat gland, tear gland, salivary gland its main function is to gives mechanical strength concerned with secretions.



- **Squamous :** when it forms a living as that of blood vessels, it is called endothelium. Its main function is to protect the underlying parts from injury, entry of germs, etc.
- **Connective tissue :** its main function is to bind and support other tissues. They have sparse populations of cells scattered through an extra cellular matrix. This extra cellular matrix is a web of fibers that is woven in a homogeneous ground substance they can be liquid, solid, or jelly like. There are a few types of connective tissue.

Connective Tissue



A. **Areolar tissue :** It fills spaces inside organs found around muscles, blood vessels and nerves. Its main function is to joins skin to muscles, support internal organs, help in the repair of tissues. Where as tendon's main function is to connect muscles to bones and ligament is connects bones to each other.

B. **Adipose tissue :** its occurrence is below skin, between internal organs and in the yellow bone Marrow. Its main function is to storage of fat and to conserve heat.

C. **Skeletal tissue :** Bone & Courtilage cartilage occurrences is in nose pic, epigotis and in intervertebral disc of mammals. Its main function is to provide support and flexibility to body part. Where as bone protects internal delicate organs provides attachments for muscles, bone marrow makes blood cells.

D. **Fluid tissue :** Blood & Lymph blood transport O_2 nutrients, hormones to tissues and organs. Where as leucocytes fight diseases and platelets help in cloting ofblood.

Lymphtransport nutrientsintothe heart and it also forms the defense system of the body.

Muscular Tissue

It is specialized for an ability to contract muscle cells. These are elongated and referred to as muscle fibers. When a stimulates is received at one end of a muscle cell, a wave of excitation is conducted through the entire cell so that all parts contract in harmony. There were three types of muscle cells: skeletal, cardiac, and smooth muscles.

Muscular tissue:

- skeletal
- cardiac
- Smooth muscle tissue.

A. **Skeletal muscle :** It attached primarily to bones. Its main function is to provide the force for locomotion and all other voluntary movements of the body.

B. **Cardiac muscle :** It occurs only in the heart. The contraction and relaxation of the heart muscles help to pump the blood and distribute it to the various parts of the body.

C. **Smooth muscles** : It can be found in stomach, intestines, and blood vessels these muscles cause slow and prolonged contractions which are involuntary.

D. **Nervous tissue** : This tissue is specialized with a capability to conduct electrical impulses and convey information from one area of the body to another. Most of the nervous tissue (98%) is located in the central nervous system. The brain and spinal cord. There are two types of nervous tissue neurons and neuroglia.

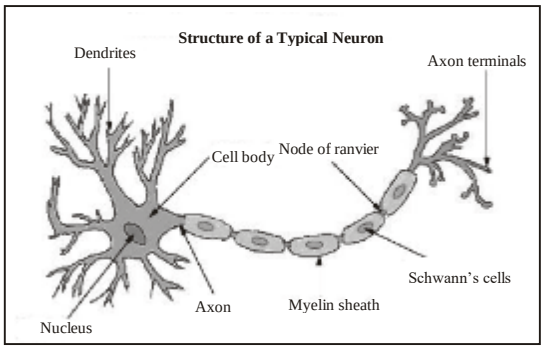
Nervous Tissue

- neurons
- neuroglia

Neurons: it actually transmit the impulses, receptor nerve ending of neurons react to various kind of stimuli and can transmit waves of excitation from the farthest point in the body to the central nervous system. You will read all the details in ChapterFour.

Important facts regarding animal tissue:-

- Muscles contain special protein called contractile protein. Which contract and relax to causemovement.



- Fat storing adipose tissue is found below the skin and between internal organs.
- Two bones are connected to each other by a tissue called ligament. Thistissue is very elastic.
- The skin, the living of the mouth, the living blood vessels, kidney tubules are all made up of epithelial tissue.
- Voluntary muscles and cardiac muscles are richly supplied with water where as involuntary muscles are poorly supplied with blood.
- Muscles tissue is composed of differtiated cells containing contractile protein.

MUSCULAR AND SKELETAL SYSTEM

Skeletal Systems of Various Animals

(i) Movement is a major characteristic of animals. This movement is a result of contraction of muscles. The skeleton helps transmit that movement. Skeletons are either a fluid-filled body cavity, exoskeletons, or internal skeletons.

(ii) **Hydrostatic skeletons** consist of fluid-filled closed chambers. Internal pressures generated by muscle contractions cause movement as well as maintain the shape of the animals, such as the sea anemone and worms. The sea anemone has one set of longitudinal muscles in the outer layer of the body and a layer of circular muscles in the inner layer of the body. The anemone can elongate or contract its body by contracting one or the other set ofmuscles.

(iii) Exoskeletons are characteristic of the **Phylum Arthropoda**. Exoskeletons are hard segments that cover the muscles and visceral organs. Muscles for movement attach to the inner surface of the exoskeleton

Exoskeletons restrict the growth of the animal, thus it must shed its exoskeleton (or molt) to form a newone that has room for growth. The bulkand weight of the exoskeleton and associated mechanical problems limits the size a animals can attain.

Note : Spiders use a combination of an exoskeleton for protection and fluid pressure for movement.

Vertebrates have developed an internal mineralized (in most cases) endoskeleton composed of bone and/ or cartilage. Muscles are on the outside of theendoskeleton.

Cartilage and bone are types of connective tissue.

- Sharks, and rays have skeletons composed entirely of cartilage;other

vertebrates have an embryonic cartilage skeleton progressively replaced by bone as they mature and develop.

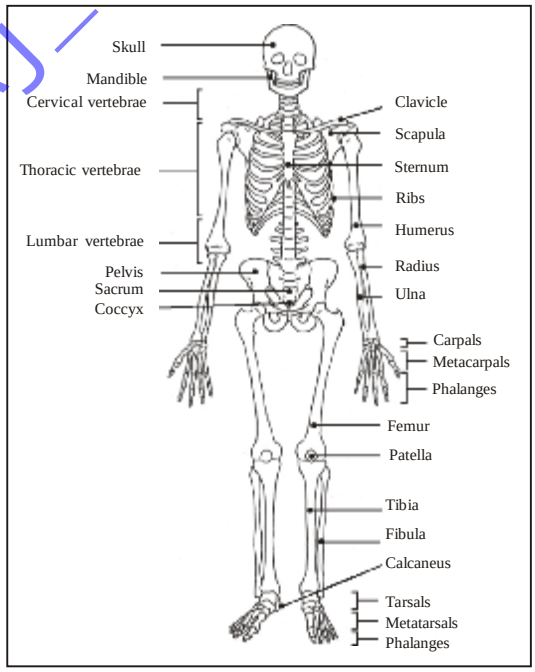
- Some areas of the human body, however, retain cartilage in the adult: in joints and flexible structures such as the ribs, trachea, nose and ears.

The Skeleton and Muscles

- The skeleton and muscles function together as the **musculoskeletal system**. This system (often treated as two separate systems, the muscular, and skeletal) plays an important homeostatic role: allowing the animal to move to more favorable external conditions.
- Certain cells in the bones produce immune cells as well as important cellular components of the blood.
- Bone also helps regulate blood calcium levels, serving as a calcium sink. Rapid muscular contraction is important in generating internal heat, another homeostatic function.

Types of Skeletons

- The axial skeleton consists of the skull, vertebral column, and rib cage.
- The appendicular skeleton contains the bones of the appendages (limbs, wings, or flippers/fins), and the pectoral and pelvic girdles.
- The human skull, or cranium, has a number of individual bones tightly fitted together at immovable joints.
- At birth many of these joints are not completely structured together as bone, leading to a number of "soft spots" or fontanels, which do not completelyjoin until the age of 14-18 months.
- The vertebral column has 33 individual vertebrae separated from each other by a cartilage disk. These disks allow a certain flexibility to the spinal column, although the disks deteriorate with age, producing back pain. The sternum is connected to all the ribs except the lower pair. Cartilage allows for the flexibility of the rib cage during breathing.
- The arms and legs are part of the appendicular skeleton.
- The upper bones of the limbs are single: humerus (arm) and femur (leg).
- Below a joint (elbow or knee), both limbs have a pair of bones (radius and ulna in the arms; tibia and fibula in legs) that connect to another joint (wrist or ankle).
- The carpals makeup the wrist joint; the tarsals are in the ankle joint.



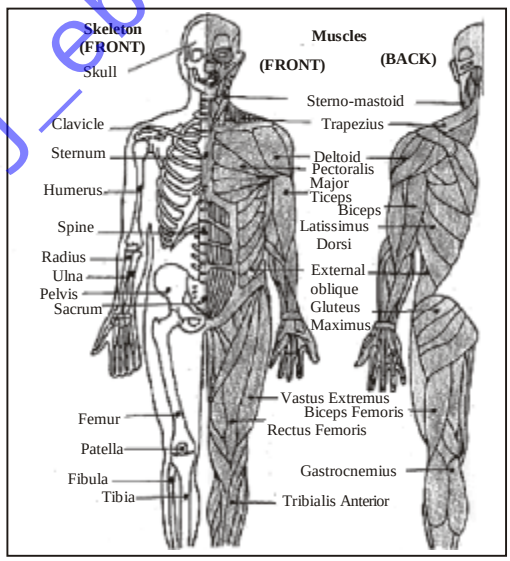
- Each hand or foot ends in 5 digits (fingers or toes) composed of metacarpals (hands) or metatarsals (feet).

- Limbs are connected to the rest of the skeleton by collections of bones known as girdles. The pectoral girdle consists of the clavicle (collar bone) and scapula (shoulder blade).
- The humerus is joined to the pectoral girdle at a joint and is held in place by muscles and ligaments. A dislocated shoulder occurs when the end of the humerus slips out of the socket of the scapula, stretching ligaments and muscles. The pelvic girdle consists of two hipbones that form a hollow cavity, the pelvis.
- The vertebral column attaches to the top of the pelvis; the femur of each leg attaches to the bottom. The pelvic girdle in land animals transfers the weight of the body to the legs and feet. Pelvic girdles in fish, which have their weight supported by water, are primitive; land animals have more developed pelvic girdles.
- Pelvic girdles in bipeds are recognizable different from those or quadrupeds.

Bone

- Although bones varygreatly in size and shape, they have certain structural similarities. Bones have cells embedded in a mineralized (calcium) matrix and collagen fibers. Compact bone forms the shafts of long bones; it also occurs on the outer side of the bone. Spongy bone formsthe inner layer.
- Compact bone has a series of Haversian canals around which concentric layers of bone cells (osteocytes) and minerals occur. New bone is formed by the osteocytes. The Haversian canals form a network of blood vessels and nerves that nourish and monitor the osteocytes.
- Spongy bone occurs at the ends of long bones and is less dense than compact bone. The spongy bone of the femur, humerus, and sternum contains red marrow, in which stem cells reproduce and form the cellular components ofthe blood and immune system. Yellow marrow, at the center of these bones, is used to store fats. The outer layer of the bones is known as the periosteum.
- The inner layer of the periosteumforms new bone or modifies existing bone to meet new conditions. It is rich innerve endings and blood and lymphatic vessels. When fractures occur, the pain is carried to the brain by nerves running through theperiosteum.

Skeletal Muscle Systems



Vertebrates move by the actions of muscles on bones. Tendons attach many skeletal muscles across joints, allowing muscle contraction to move the bones across the joint. Muscles generally work in pairs to produce movement: when one muscle flexes (or contracts) the other relaxes, a process known as **antagonism**.

Muscles have both electrical and chemical activity. There is an electrical gradient across the musclecell membrane: the outsideis morepositive than the inside. Stimulus causes an instantaneous

reversal of this polarity, causing the muscle to contract (the mechanical characteristic) producing a twitch or movement.

Skeletal Muscle Structure

- Muscle fibers are multinucleated, with the nuclei located just under the plasma membrane. Most of the cell is occupied by striated, thread-like myofibrils. Within each myofibril there are dense Z lines. A sarcomere (or muscle functional unit) extends from Z line to Z line. Each sarcomere has thick and thin filaments. The thick filaments are made of myosin and occupy the center of each sarcomere. Thin filaments are made of action and anchor to the Zline.
- Muscles contract by shortening each sarcomere. The sliding filament model of muscle contraction has thin filaments on each side of the sarcomere sliding past each other until they meet in the middle. Myosin filaments have club-shaped heads that project toward the actin filaments.
- Myosin heads attach to binding sites on the actin filaments. The myosin heads swivel toward the center of the sarcomere, detach and then reattach to the nearest active site of the actin filament. Each cycle of attachment, swiveling, and detachment shortens the sarcomere 1%. Hundreds of such cycles occur each second during muscle contraction.
- Energy for this comes from **ATP**, the energy coin of the cell. ATP binds to the cross bridges between myosin heads and actin filaments. The release of energy powers the swiveling of the myosin head. Muscles store little ATP and so must recycle the ADP into ATP rapidly. **Creatine phosphate** is a muscle storage product involved in the rapid regeneration of ADP into ATP.
- Calcium ions are required for each cycle of myosin-actin interaction. Calcium is released into the sarcomere when a muscle is stimulated to contract. This calcium uncovers the actin binding sites. When the muscle no longer needs to contract, the calcium ions are pumped from the sarcomere and back into storage.

Contraction of Nonmuscular Cells

- Actin and myosin, whose interaction causes muscle contraction, occur in many other cells. Actin is attached to the inner surface of the plasma membrane. The interaction of cytoplasmic myosin and this actin causes contraction of the cell, such a the coordinated contractions of intestinal cells to absorb nutrients.
- Some fish have modified muscles that discharge electricity. These fish have electric organs consisting of modified muscles known as electroplates. The South American electric eel has more than 6000 plates arranged into 70 columns. Maximum discharge is 100 watts.

Interaction of the Two Systems

- Vertebrates move by application of the principles of the lever. Levers amplify or increase the force or velocity of motion.
- The amount of amplification depends on thelength of thelever. There are three types of skeletal system, all interact with muscles using thelever.

THE NERVOUS SYSTEM

Divisions of the Nervous System

- The nervous system monitors and controls almost every organ system through a series of positive and

negative feedback loops.

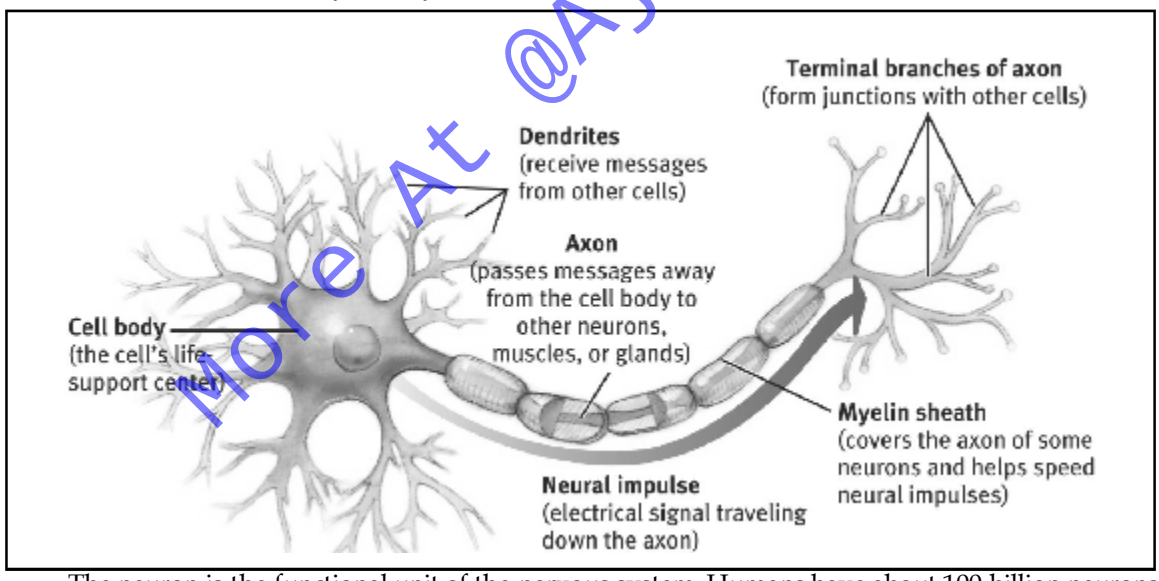
- The Central Nervous System (CNS) includes the brain and spinal cord.
- The Peripheral Nervous System (PNS) connects the CNS to other parts of the body, and is composed of nerves (bundles of neurons).
- Not all animals have highly specialized nervous systems.
- Those with simple systems tend to be either small and very mobile or large and immobile.
- Large, mobile animals have highly developed nervous systems: the evolution of nervous systems must have been an important adaptation in the evolution of body size and mobility.

Nervous System in Various Organisms

Coelenterates, cnidarians, and echinoderms have their neurons organized into a nerve net. These creatures have radial symmetry and lack a head. Although lacking a brain or either nervous system (CNS or PNS) nerve nets are capable of some complex behavior. Bilaterally symmetrical animals have a body plan that includes a defined head and a tail region. Development of bilateral symmetry is associated with cephalization, the development of a head with the accumulation of sensory organs at the front end of the organism. Flatworms have neurons associated into clusters known as ganglia, which in turn form a small brain. Vertebrates have a spinal cord in addition to a more developed brain. Chordates have a dorsalrather thanventral nervous system. Several evolutionary trends occur in chordates: spinal cord, continuation of cephalization in the form of larger and more complex brains, and development of a more elaborate nervous system.

The Neuron

Nervous tissue is composed of two main cell types: neurons and glial cells. Neurons transmit nerve messages. Glial cells are in direct contact with neurons and often surround them.



The neuron is the functional unit of the nervous system. Humans have about 100 billion neurons in their brain alone! While variable in size and shape,

a. Parts of Neuron:

All neurons have three parts.

Dendrites receive information from another cell and transmit the message to the cell body.

The cell body contains the nucleus, mitochondria and other organelles typical of eukaryotic cells.

The axon conducts messages away fromthe cell body.

b. Types of Neuron:

Three types of neurons occur. Sensory neurons typically have a long dendrite and short axon, and carry messages from sensory receptors to the central nervous system.

Motor neurons have a long axon and short dendrites and transmit messages from the central nervous system to the muscles (or to glands).

Interneurons are found only in the central nervous system where they connect neuron to neuron. Some axons are wrapped in a myelin sheath formed from the plasma membranes of specialized glial cells known as Schwann cells. Schwann cells serve as supportive, nutritive, and service facilities for neurons. The gap between Schwann cells is known as the node of Ranvier, and serves as points along the neuron for generating a signal. Signals jumping from node to node travel hundreds of times faster than signals traveling along the surface of the axon. This allows our brain to communicate with our toes in a few thousandths of a second.

The Nerve Message

The plasma membrane of neurons, likeall other cells, has an unequal distribution of ions and electrical charges between the two sides of the membrane. The outside of the membrane has a positive charge, inside has a negative charge.

Resting potential results from differences between sodium and potassium positively charged ions and negatively charged ions in the cytoplasm.

Sodium ions are more concentrated outside the membrane, while potassium ions are more concentrated inside the membrane. This imbalance is maintained by the active transport of ions to reset the membrane known as the sodium potassiumpump.

The sodium-potassium pump maintains this unequal concentration by actively transporting ions against their concentration gradients. . The action potential begins at one spot on the membrane, but spreads to adjacent areas of the membrane, propagating the message along the length of the cellmembrane. After passage of the action potential, there is a brief period, the refractory period, during which the membrane cannot be stimulated. This prevents the message from being transmitted backward along the membrane.

Steps in an Action Potential

1. At rest the outside of the membrane is more positive than the inside.
2. Sodium moves inside the cell causing an action potential, the influx of positive sodium ions makes the inside of the membrane more positive than the outside.
3. Potassium ions flow out of the cell, restoring the resting potential net charges.
4. Sodium ions are pumped out of the cell and potassium ions are pumped into the cell, restoring the original distribution of ions.

Synapses

The junction between a nerve cell and another cell is called asynapse. Messages travel within the neuron as an electrical action potential. The space between two cells is known as the synaptic cleft. To cross the synaptic cleft requires the actions of neurotransmitters. Neurotransmitters are stored in small synaptic vessicles clustered at the tip of the axon. Neurotransmitters tend to be small molecules, some are even hormones. The neurotransmitters cross the cleft, binding to receptor molecules on the next cell, prompting transmission of the message along that cell's membrane. Diseases that affect the function of signal transmission can have serious consequences. Parkinson's disease has a deficiency of the neurotransmitter dopamine. Progressive death of brain cells increases this deficit, causing tremors, rigidity and unstable posture.

Endocrine System

You will know it in detail Chapter Five.

Nervous System: The Telegraphic System of Communication and Co-Ordination

- The structural of the nervous system is a neuron. It has a nucleus and cytoplasm, forming the cell body. The cell body has elongated extension of cytoplasm. Those extension which are specialized for transmitting messages to two neuron are called 'dendrites' and the extension that transmits message from the neuron is called an 'axon'. A reflex action, or simply a reflex is a fundamental function of the nervous system.
- The chain of neurons that participants in a reflex action is called a 'reflex arc'. It consist of at least two neuron —(1) Sensory or afferent neuron which conveys the information about the stimulus to the central nervous system. (2) Motor or afferent neuron – which conveys the message from the central neuron system to the organ (effector organ) which has to respond to the stimulus.
- The function between two neurons is called a 'ganglion'.

THE ENDOCRINE SYSTEM

Hormones

The endocrine system is a collection of glands that secrete chemical messages we call hormones. These signals are passed through the blood to arrive at a target organ, which has cells possessing the appropriate receptor. Exocrine glands (not part of the endocrine system) secrete products that are passed outside the body. Sweat glands, salivary glands, and digestive glands are examples of exocrine glands. Hormones are grouped into three classes based on their structure:

1. steroids
2. peptides
3. amines

1. Steroids

Steroids are lipids derived from cholesterol. Testosterone is the male sex hormone. Estradiol, similar in structure to testosterone, is responsible for many female sex characteristics. Steroid hormones are secreted by the gonads, adrenal cortex, and placenta.

2. Peptides and 3. Amines

Peptides are short chains of amino acids; most hormones are peptides. They are secreted by the pituitary, parathyroid, heart, stomach, liver, and kidneys. Amines are derived from the amino acid tyrosineand are secreted from the thyroid and the adrenal medulla. Solubility of the various hormone classes varies.

Synthesis, Storage, and Secretion

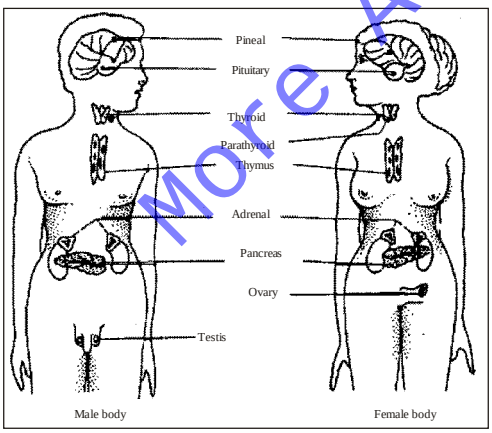
- Steroid hormones are derived from cholesterol by a biochemical reaction series. Defects along this series often lead to hormonal imbalances with serious consequences. Once synthesized, steroid hormones pass into the bloodstream; they are not stored by cells, and the rate of synthesis controls them.
- Peptide hormones are synthesized as precursor molecules and processed by the endoplasmic reticulum and Golgi where they are stored in secretory granules. When needed, the granules are dumped into the bloodstream. Different hormones can often be made from the same precursor molecule by cleaving it with a different enzyme.
- Amine hormones (notably epinephrine) are stored as granules in the cytoplasm until needed.

Evolution of Endocrine Systems

Most animals with well-developed nervous and circulatory systems have an endocrine system. Most of the similarities among the endocrine systems of crustaceans, arthropods, and vertebrates are examples of convergent evolution. The vertebrate endocrine system consists of glands (pituitary, thyroid, adrenal), and diffuse cell groups secreted in epithelial tissues. More than fifty different hormones are secreted. Endocrine glands arise during development for all threeembryologic tissuelayers (endoderm, mesoderm, ectoderm). The type of endocrine product is determined by which tissue layer a gland originated in. Glands of ectodermal and endodermal origin produce peptide and amine hormones; mesodermal-origin glands secrete hormones based on lipids.

i. Endocrine Systems and Feedback Cycles

The endocrine system uses cycles and negative feedback to regulate physiological functions. Negative feedback regulates the secretion of almost every hormone. Cycles of secretion maintain physiological and homeostatic control. These cycles can range from hours to months in duration.



ii. Mechanisms of HormoneAction

The endocrine system acts by releasing hormones that in turn trigger actions in specific target cells. Receptors on target cell membranes bind only to one type of hormone. More than fifty human hormones have been identified; all act by binding to receptor molecules. The binding hormone changes the shape of the receptor causing the response to the hormone. There are two mechanisms of hormone action on all target cells.

iii. Nonsteroid Hormones

Nonsteroid hormones (water soluble) donot enter the cell but bind to plasma membrane receptors, generating a chemical signal (second messenger) inside the target cell. Five different second messenger chemicals, including cyclic AMP have been identified. Second messengers activate other intracellular chemicals to produce the target cell response.

iv. Steroid Hormones

The second mechanism involves steroid hormones, which pass through the plasma membrane and act in a two step process. Steroid hormones bind, once inside the cell, to the nuclear membrane receptors, producing an activated hormone-receptor complex. The activated hormone-receptor complex binds to DNA and activates specific genes, increasing production of proteins.

The Nervous and Endocrine Systems

The pituitary gland (often called the master gland) is located in a small bony cavity at the base of the brain. A stalk links the pituitary to the hypothalamus, which controls release of pituitary hormones. The pituitary gland has two lobes: the anterior and posterior lobes. The anteriorpituitary is glandular. The hypothalamus contains neurons that control releases from the anterior pituitary. Seven hypothalamic hormones are released into a portal system connecting the hypothalamus and pituitary, and cause targets in the pituitary to release eight hormones.

I. Anteriol Pituitoly

Growth hormone (GH) is a peptide anterior pituitary hormone essential for growth. GH-releasing hormone stimulates release of GH. GH-inhibiting hormone suppresses the release of GH.

The hypothalamus maintains homeostatic levels of GH. Cells under the action of GH increase in size (hypertrophy) and number (hyperplasia). GH also causes increase in bone length and thickness by deposition of cartilage at the ends of bones. During adolescence, sex hormones cause replacement of cartilage by bone, halting further bone growth even though GH is still present. Too little or two much GH can cause dwarfism or gigantism, respectively. Hypothalamus receptors monitor blood levels of thyroid hormones. Low blood levels of Thyroid-stimulating hormone (TSH) cause the release of TSH-releasing hormone from the hypothalamus, which in turn causes the release of TSH from the anterior pituitary. TSH travels to the thyroid where it promotes production of thyroid hormones, which in turn regulate metabolic rates and body temperatures. Gonadotropins and prolactin are also secreted by the anterior pituitary. Gonadotropins (which include follicle-stimulating hormone, FSH, and luteinizing hormone, LH) affect the gonads by stimulating gamete formation and production of sex hormones. Prolactin is secreted near the end of pregnancy and prepares the breasts for milk production.

II. The Posterior Pituitary

The posterior pituitary stores and releases hormones into the blood. Antidiuretic hormone (ADH) and oxytocin are produced in the hypothalamus and transported by axons to the posterior pituitary where theyare dumped into the blood. ADH controls water balance in the body and blood pressure. Oxytocin is a small peptide hormone that stimulates uterine contractions during childbirth.

Biological Cycles

Biological cycles ranging from minutes to years occur throughout the animal kingdom. Cycles involve hibernation, mating behavior, body temperature and many other physiological processes.

Rhythms or cycles that show cyclic changes on a daily (or even a few hours) basis are known as circadian rhythms. Many hormones, such as ACTH-cortisol, TSH, and GH show circadian rhythms.

Thyroid secretion is usually higher in winter than in summer. Childbirth is hormonally controlled, and is highest between 2 and 7 AM. Internal cycles of hormone production are controlled by the hypothalamus, specifically the suprachiasmic nucleus (SCN). According to one model, the SCN is signaled by messages from the light-detecting retina of the eyes. The SCN signals the pineal gland in the brain to signal the hypothalamus, etc.

Endocrines: The Postal System of Communication and Co-Ordination

- Hormones are chemical substances manufactured by organs called endocrine glands or ductless glands. Ductless glands are also sometimes called 'exocrine glands'.

Endocrine Gland of the Body

- Thyroid is situated in the neck in front of the wind pipe. It manufactures two hormones: triodothyro (T_3) and tetraiodothysonine (T_4), are called tyrosine. Both these hormones contain iodine.
- Hypothyroidism (hypo, 'under')– diminished thyroid activity. Hypothyroi-dism in childhood gives rise to a conditions called cretinism.

Goiter– is called enlargement of the thyroid gland. It manifests itself as a swelling in the neck. A goiter may beassociated with increased, normal or descreased activity of the thyroid gland.

- Government of India launched the Universal salt iodisation programme in 1986.

Pancreas— the endocrine department of the pancreas is scattered throughout its substance in the form of tiny islands. The islands have been named as 'islets of Langerhans'. The islets have two major type of cells called A and B. The A cells secrete the hormone 'glucagon' while the B cells

secrete insulin. Insulin has discovered by Frederick Grand banting and Charles Herbert Best. Reduction on the quantity of effective insulin gives rise to diabetes mellitus (diabetes, siphon, mellitus of honey) commonly called simply diabetes. Food and glucose to be blood, while exercise and insulin remove it.

The six endocrine glands of the body are.

1. Thyroid
2. Pancreas
3. Adrenals
4. Gonads
5. Parathyroids
6. Pituitary

Processing of Food

- The process of digestion and absortion of food takes place in the alimentary canal.
- The alimentary canal is a 9-metre long tube extending from the hips to the anus-
- Saliva is secreted by a set of three pairs of glands situated near the month. It helps in the process a digestion. It contain an enzyme called 'anylax' which breaks down the starch in food into maltose.
- The food in the stomach is homogenised by the action of the acidic juice. The juice also contains an enzyme called pepsin, which splits proteins into smallest units called peptides.

Small Intestine:– The food, after being digested in the stomach is transferred; but by bit from the stomach into the small intestine. The first portion of the small intestine which the food enters is called the 'duodenum'. Juices from pancreas and gall bladder are discharged into the duodenum.

- Pancreatic juice contains enzymes for digestion of carbohydrates, protein as well as fat.

Bite is an essential supplement to the recreations enzyme for digestion of fats.

- Discharge of Pancreatic and binary recentions into the intestine is under the control of two hormones: 'secretin' and cholecystokinin'.

Large Intestine (colon)– The absorption of water is an important function.

Region	***Juice***	***Enzyme***	***Enzyme action***	***Enzyme action produces***
Mouth	Saliva	Amylase	Starch	Maltose
Stomach	Gastric Juice	Pepsin	Proteins	Protein fragments
Duodenum	Pancreatic Juice	Amylase	Starch	Maltose
Duodenum	Pancreatic Juice	Trypsin	Product protein fragments	Small protein fragments
Duodenum	Pancreatic Juice	Chymotrypsin	Product protein fragments	Small protein fragments and amino acids
Duodenum	Pancreatic Juice	Lipase	Fat	Fatty acids and glycerol
Small intestine similar substances	—	Disaccharisases	Maltose	Glucose and
	—	Amnopeptidose small protein fragments	Lactose^{+} and Sucrose^{++}	Very fragments and small poling amino acids.
	—	Dipeptidase	2-amino acid fragments	Amino acids

Kidneys, The Fascinating Filters

- Kidneys are often described as bean shaped.
- Each kidney is make up a about a million narrow tube-like structures called 'nephrons'. The urine formed by a kidney in a sum total of a the urine formed by its neprpons.
- A Nephron consists of a receptacle (Bowman's capsule) enclosing a bunch of capillaries (glomerular) like a closed fist. The glomerulus and Bowman's capsule filter theblood.

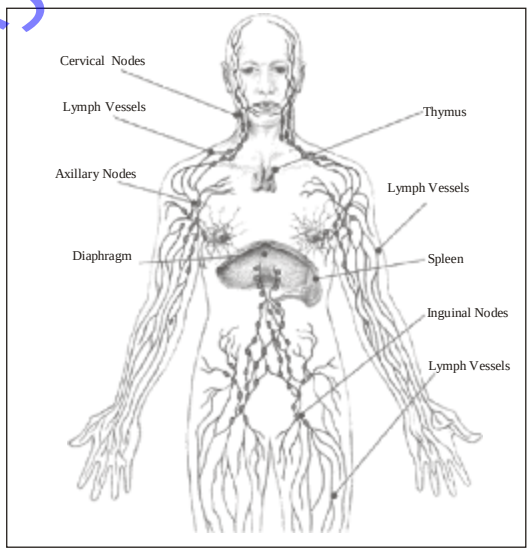
Filtration: The glomerular capillaries are fed blood by a blood vessel called 'afferent arteriole' and drained by a marrower blood vessel called the 'efferentarteriole.

- By secreting acids, the kidneys help in maintaining the acidity of the body fluids constant.
- Urine excreted is the result of these basic processes: filtration, reabrorption and secretion.
- Excessive eating (polyphagia), excessive drinking (polydipsia) and too much of urine (polyusia) are three cardinal symptoms of diabetes. The 'hypothesis' produces a chemical substance called 'antidivretic hormone (ADH). This substance travels in the bloodstream to the kidneys and increases the reabsorption of water so that the blood gets a little thinner.
- The Adrenal gland maintains the regulating salt in the body and is located in an organ lying just over the kidney. As soon as the salt (sodium) concentration become just a little less than normal, it release into the blood stream a substance called'aldosterone'.
- Renal transplantation or dialysis (artificial kidney) are the supportive measure when the damage to kidney reaches a certain point.

LYMPHATIC SYSTEM AND IMMUNITY

The Lymphatic System

- The lymphatic system is composed of lymph vessels, lymph nodes, and organs. The functions of this system include the absorbtion of excess fluid and its return to the blood stream, absorption of fat (in the villi of thesmall intestine) and the immune system function.
- Lymph vessels are closely associated with the circulatory system vessels. Larger lymph vessels are similar to veins. Lymph capillaries are scatted throughout the body. Contraction of skeletal muscle causes movement of the lymph fluid throughvalves.



- Lymph organs include the bone marrow, lymph nodes, spleen, and thymus.
- Bone marrow contains tissue that produces lymphocytes. B-lymphocytes (B-cells) mature in the bone marrow.

- T-lymphocytes (T-cells) mature in the thymus gland.
- Other blood cells such as monocytes and leukocytes are produced in the bone marrow.
- Lymph nodes are areas of concentrated lymphocytes and macrophages along the lymphatic veins.
- The spleen is similar to the lymph node except that it is larger and filled with blood.
- The spleen serves as a reservoir for blood, and filters or purifies the blood and lymph fluid that flows through it.
- If the spleen is damaged or removed, the individual is more susceptible to infections.
- The thymus secretes a hormone, thymosin, that causes pre-T-cells to mature (in the thymus) into T-cells.

Immunity

- Immunity is the body's capability to repel foreign substances and cells.
- The nonspecific responses are the first line of defense.
- Highly specific responses are the second line of defense and are tailored to an individualthreat.
- The immune response includes both specific and nonspecific components. Nonspecific responses block the entry and spread of disease-causing agents.
- Antibody-mediated and cell-mediated responses are two types of specific response.
- The immune system is associated with defense against disease-causing agents, problems in transplants and blood transfusions, and diseases resulting from over-reaction (autoimmune, allergies) and under-reaction (AIDS).

(A) General Defenses

Barriers to entry are the skin and mucous membranes.

1. **The skin** is a passive barrier to infectious agents such as bacteria and viruses. The organisms living on the skin surface are unable to penetrate the layers of dead skin at the surface. Tears and saliva secrete enzymes that breakdown bacterial cell walls. Skin glands secrete chemicals that retard the growth ofbacteria.
2. **Mucus membranes** lining the respiratory, digestive, urinary, and reproductive tracts secrete mucus that forms another barrier. Physical barriers are the first line of defense.
3. When microorganisms penetrate skin or epithelium lining respiratory, digestive, or urinary tracts, inflammation results. Damaged cells release chemical signals such as **histamine** that increase capillary blood flow into the affected area (causing the areas to become heated and reddened). The heat makes the environment unfavorable for microbes, promotes healing, raises mobility of white blood cells, and increases the metabolic rate of nearby cells. Capillaries pass fluid into intelstinal areas, causing the infected/injured area toswell.
4. Clotting factors trigger formation of many small blood clots. Finally, monocytes (a type of white blood cell) clean up dead microbes, cells, and debris.
5. If this is not enough to stop the invaders, **the complement system** and **immune response** act.
6. Protective proteins that are produced in theliver include the complement system of proteins. The complement system proteins bind to a bacterium and open pores in its membrane through which fluids and salt move, swelling and

bursting the cell. The complement system directly kills microbes, supplements inflammatory response, and works with the immune response. It complements the actions of the immune system. Complement proteins are made in the liver and become active in a sequence (C_1 activates C_2, etc.). The final five proteins form a **membrane-attack complex (MAC)** that embeds itself into the plasma membrane of the attacker.

7. Salts enter the invader, facilitating water to cross the membrane, swelling and bursting the microbe. Complementalso functions in the immune response by tagging the outer surface of invaders for attack byphagocytes.
8. **Interferon** is a species-specific chemical produced by cells that are viral attack. It alerts nearby cells to prepare for a virus. The cells that have been contacted by interferon resist all viral attacks.

(B) Specific Defenses

- The immune system also generates specific responses to specific invaders.
- The immune system is more effective than the nonspecific methods, and has a memory component that improves response time when an invader of the same type (or species) is again encountered.
- Immunity results from the production of **antibodies** specific to a given **antigen** (antibody-generators, located on the surface of aninvader).
- Antibodies bind to the antigens on invaders and kill or inactivate them in several ways.
- Most antibodies are themselves **proteins** or are a **mix of protein and polysaccharides**. Antigens can be any molecule that causes antibody production.

Lymphocytes :

White blood cells known as lymphocytes arise from mitosis of stem cells in the bone marrow. Some lymphocytes migrate to the thymus and become **T cells** that circulate in the blood and are associated with the lymph nodes and spleen.

B cells remain in the bone marrow develop before moving into the circulatory and lymph systems. **B cells produce antibodies**.

1. Antibody-mediated (humoral) immunity is regulated by B cells and the antibodies they produce. Cell-mediated immunity is controlled by T cells.
2. Antibody-mediated reactions defend against invading viruses and bacteria. Cell-mediated immunity concerns cells in the body that have been infected by viruses and bacteria, protect against parasites, fungi, and protozoans, and also kill cancerous bodycells.

Antibody-mediated Immunity :

Stages in this process are :

(i) antigen detection
(ii) activation of helper Tcells
(iii) antibody production by B cells

Each stage is directed by a specific cell type.

- **Macrophages :** Macrophages are white blood cells that continually search for foreign (nonself) antigenic molecules, viruses, or microbes. When found, the macrophages engulfs and destroys them. Small fragments of the antigenare displayed on the outer surface of the macrophage plasma membrane.
- **Helper T Cells :** Helper T cells are macrophages that become activated when they encounter the antigens now displayed on the macrophage surface. Activated T cells identify and activate B cells.
- **B Cells :** B cells divide, forming plasma

cells and B memory cells. Plasma cells make and release between 2000 and 20,000 antibody molecules per second into the blood for the next four or five days. B memory cells live for months or years, and are part of the immune memorysystem.

- **Antibodies :** Antibodies bind to specific antigens in a **lock-and-key fashion**, forming an antigen-antibody complex. Antibodies are a type of protein molecule known as **immunoglobulins**. There are five classes of immunoglobulins: IgG, IgA, IgD, IgE, and IgM.

Antibodies are Y-shaped molecules composed of two identical long polypeptide (Heavy or H chains) and two identical short polypeptides (Light or L chains). Function of antibodies includes:

(i) Recognition and binding toantigens

(ii) Inactivation of theantigen

A unique antigenic determinant recognizes and binds to a site on the antigen, leading to the destruction of the antigen in several ways. The ends of the Y are the antigen-combining site that is different for each antigen.

Helper T cells activate B cells that produce antibodies. Supressor T cells slow down and stop the immune response of B and T cells, serving as an off switch for the immunesystem. Cytotoxic (or killer) T cells destroy body cells infected with a virus or bacteria. Memory T cells remain in the body awaiting the reintroduction of the antigen.

A cell infected with a virus will display viral antigens on its plasma membrane. Killer T cells recognize the viral antigens and attach to that cell's plasma membrane. The T cells secrete proteins that punch holes in the infected cell's plasma membrane. The infected cell's cytoplasm leaks out, the cell dies, and is removed by phagocytes. Killer T cells may also bind to cells of transplanted organs.

The immune system is the major component of this defense. Lymphocytes, monocytes, lymph organs, and lymph vessels make up the system. Theimmune system is able todistinguish self from non-self. Antigens are chemicals on the surface of a cell. All cells have these. The immune system checks cells and identifies them as "self" or "non-self". Antibodies are proteins produced by certain lymphocytes in response to a specific antigen. B-lymphocytes and T-lymphocytes produce the antibodies. B-lymphocytes become plasma cells which then generate antibodies. T-lymphocytes attack cells which bear antigens they recognize. They also mediate the immune response.

Blood Types, Rh, and Antibodies

There are 30 or more known antigens on the surface of blood cells. Theseformthe blood groups or blood types. In a transfusion, the blood groups of the recipient and donor should match.

If improperly matched, the recipient's immune system will produce antibodies causing clotting of the transfused cells, blocking circulation through capillaries and producing serious or even fatal results. Individuals with blood type 'A' have the A antigen on the surface of their red blood cells, and antibodies to type B blood in their plasma. People with blood type 'B' have the B antigen on their blood cells and antibodies against type A in their plasma.

Individuals with type 'AB' blood produce have antigens for A and B on their cell surfaces and no antibodies for either blood type A or B in their plasma. Type Oindividuals have noantigens on their red blood cells but antigens of both A and B are in their plasma. People with type AB blood can receive blood of any type, So it is called as Universal Receptar.

Those with type O blood can donate to anyone. So it is called as Universal Donor. Hemolytic disease of the newborn **(HDN)** results from Rh incompatibility between an Rh^- mother and Rh^+ fetus. Rh^+ blood from the fetus enters the mother's system during birth, causing her to produceRh antibodies. The first child is usually not affected, however subsequent Rh^+ fetuses will cause a massive secondary reaction of the maternal immunesystem.

To prevent HDN, Rh- mothers are given an

Rh antibody during the first pregnancy with an Rh+ fetus and all subsequent Rh+ fetuses.

Organ Transplants and Antibodies

Success of organ transplants and skin grafts requires a matching of **histocompatibility** antigens that occur on all cells in the body.

Chromosome 6 contains a cluster ofgenes known as the **human leukocyte antigen** complex (HLA) that are critical to the outcome of such procedures. The array of HLA alleles on either copy of our chromosome 6 is known as a **haplotype.**

The large number of alleles involved mean no two individuals, even in a family, will have the same identical haplotype.

Identical twins have a 100% HLA match. The best matches are going to occur within a family. The preference order for transplants is identical twin > sibling > parent > unrelated donor.

Chances of an unrelated donor matching the recipient range between 1 in 100,000-200,000. Matches acrossracial or ethnic lines are oftenmore difficult. When HLA types are matched survival of transplanted organs dramatically increases.

Body Defences

The specialised cells which deal with germs and forcing particles by eating them up are called 'phagocytes' (phagein 'to eat'; cyte 'cell'). They are present in all tissues but are particularly concentrated in liver, spleen and bone marrow.

- Monocyter in the blood are the circulating counterparts of these cells.
- Specific acquired immunity can be categorised into two groups: humoral immunity and cellular immunity
- Lymphoid organs produce lymphocytes. These organs include principally bone marrow, thymus, lymph, nodes, spleen and some 'patches' in the wall of the small intestine.
- The two types of lymphocytes — B lymphocytes concerned with humoral immunity, and T lymphocytes concerned with cellular immunity
- Antibody production takes place in Numoral immunity. It is triggered by a protein called the antigen. It is the plasma cells which manufacture antibodies specific for the antigen presented.
- Theories which sring to explain the synthesis of specific antibodies—'in structure' and 'selective' theories. Instructive thrones postulate that all plasma cells are alike, it is the antigen that directs the plasma cells to manufacture a specific protein (antibody)
- Selective theories originally proposed by Busnet, assume that there are as many types of B cells as the antigens

Antibodies are proteins belonging to a class called 'gamma globulins' or immunoglobulins.

Hepatitis Vaccine— Three doses are required: the interval between the first and second dose being one month, and that between the second and third being six months.

Oral typhoid vaccine is available in the form of capsule under the brand name 'Typhoral'.

Blood: The Vital Fluid

Blood looks like a homogenous red fluid to the uncover edge. But when spread into a thin layer, it is found tobe asuspension of different type of cells in a liquid called the 'plasma'. Most of the cells are faint yellow and without a nucleus. A dense accumulation of these cells is responsible for the red colour of the blood. These cells are called 'erythrocytes' or red blood cells. These are also another two types of cells—the 'leucocytes' or white blood cells and 'thrombocytes' or platelets.

Plasma— is a straw coloured liquid, about 90 percent of which is water. The chief salt dissolved in plasma is sodium chloride, or common table salt. The salinity of plasma is one-third that of sea water.

- Fibrinogen is a protein which is essential for clotting of blood, another protein globulins aid in the defense mechanisms of the body.
- **Red Blood Cells:–** are the most numerous of the blood cells, they neither have a nucleus nor mitochondria, RBC are a reddish coloured protein containing iron.
- It is hemoglobin which makes it possible to deliver oxygen to tissue which need it.

  The normal quantity of hemoglobin present in blood in 12-15 g in every 100 ml of blood. A decrease in this quantity is called 'anemia'.
- The nucleus membrane of the roof of the mouth (palate) is the best region to access the quantity of hemoglobin.
- The average life span of a red cell is about four months. They are produced in the hollow of the bones (bone marrow).
- **White Blood Cells:–** WBC are far less numerous than the RBC, the ratio being one white cell to every 600 red cells. They are slightly larger than the red cells, and differ in three aspects—first, they have nuclei, secondly, they do not contain hemoglobin, and are therefore nearly colourless, finally, some white cells can move and engulf particles or bacteria the process in called 'phagocytosis'.

WBC are further subdivided in five groups.

(1) Neutroplis
(2) Eosinophils
(3) Basrophils
(4) Lymphocytes
(5) Monocytes

Platelets: are much smaller than red or white blood cells and are devoid of nuclei. They check the bleeding from an injury (harmostasis: haime 'blood'; stages 'standing' Platelets contribute to this process of harmostasis by liberating a chemical called 'sesolonies'.

- A, B, AB and O are the four blood groups. The classification is based on the type of substance present on the surface of red blood cells.

Lungs: The Life Linke

The bronchial tree consists of larynx, trachea, bronchus left lung, right lung.

Alveoli – is a cluster of thin walled air sacs which end in tiny air cells. It is covered with a tracery of capillaries. A men has about 600 million alveoli.

- Oxygen move from the alveoli into the blood and carbondioxide move out of the capillaries to entre the alveoli.

THE RESPIRATORY SYSTEM

Respiration in Single Cell Animals

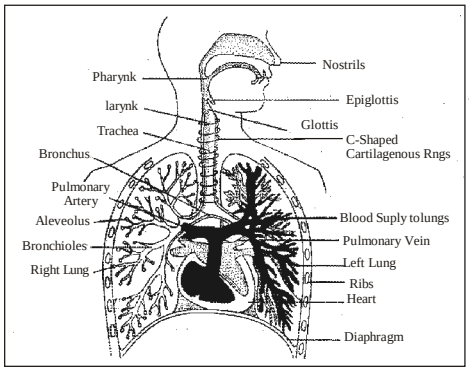
Single-celled organisms exchange gases directly across their cell membrane. However, the slow diffusion rate of oxygen relative to carbon dioxide limits the size of single-celled organisms. Simple animals that lack specialized exchange surfaces have flattened, tubular, or thin shaped body plans, which are the most efficient for gas exchange. However, these simple animals are rather small in size.

Respiration in multicellular animals

Large animals cannot maintain gas exchange by diffusion across their outer surface. They developed a variety of respiratory surfaces that all increase the surface area for exchange, thus allowing for larger bodies. A respiratory surface is covered with thin, moist epithelial cells that allow oxygen and carbon dioxide to exchange. Those gases can only cross cell membranes when they aredissolved in water or an aqueous solution, thus respiratory surfaces must be moist.

Respiratory System Principles

1. Movement of an oxygen-containing medium so it contacts a moist membrane overlying bloodvessels.



2. Diffusion of oxygen from the medium into the blood.
3. Transport of oxygento the tissues and cells of thebody.
4. Diffusion of oxygen from the blood into cells.
5. Carbon dioxide follows a reverse path.

THE CIRCULATORY SYSTEM

Circulatory Systems in Single-celled Organisms

Single-celled organisms use their cell surface as a point of exchange with the outside environment. Sponges are the simplest animals, yet even they have a transport system. Seawater is the medium of transport and is propelled in and out of the sponge by ciliary action. Simple animals, such as the hydra and planaria lack specialized organs such as hearts and blood vessels, instead using their skin as an exchange point for materials. This, however, limits the size an animal can attain. To become larger, they need specialized organs and organ systems.

Circulatory Systems in Multicellular Organisms

Multicellular animals do not have most of their cells in contact with the external environment and so have developed circulatory systems to transport nutrients, oxygen, carbon dioxide and metabolic wastes. Components of the circulatory system include

i. Blood: a connective tissue of liquid plasma and cells
ii. Heart: a muscular pump to move the blood
iii. Blood vessels: arteries, capillaries and veins that deliver blood to all tissues

Vertebrate Cardiovascular System

The vertebrate cardiovascular system includes a heart, which is a muscular pump that contracts to propel blood out to the body through arteries, and a series of blood vessels.

The upper chamber of the heart, the atrium (pl. atria), is where the blood enters the heart. Passing through a valve, blood enters the lower chamber, theventricle.

Contraction of the ventricle forces blood from the heart through an artery.

The heart muscle is composed of cardiac muscle cells.

Arteries are blood vessels that carry blood away from heart. Arterial walls are able to expand and contract. Arteries have three layers ofthick walls. Smooth muscle fibers contract, another layer of connective tissue is quite elastic, allowing the arteries to carry blood under high pressure

The aorta is the main artery leaving the heart.

The pulmonary artery is the only artery that carries oxygen-poor blood. The pulmonary artery carries deoxygenated blood to the lungs. In the lungs, gas exchange occurs, carbon dioxide diffuses out, oxygen diffuses in

Arterioles are small arteries that connect larger arteries with capillaries. Small arterioles branch into collections of capillaries known as capillary beds.

Capillaries, are thin-walled blood vessels in which gas exchange occurs.

In the capillary, the wall is only one cell layer thick.

Capillaries are concentrated into capillary beds. Some capillaries have small pores between the cells of the capillary wall, allowing materials to flow in and out of capillaries as well as the passage of white blood cells.

Changes in blood pressure also occur in the various vessels of the circulatory system.

Nutrients, wastes, and hormones are

exchanged across the thin walls of capillaries.

Capillaries are microscopic in size, although blushing is one manifestation of blood flow into capillaries. Control of blood flow into capillary beds is done by nerve-controlled sphincters.

The circulatory system functions in the delivery of oxygen, nutrient molecules, and hormones and the removal of carbon dioxide, ammonia and other metabolic wastes. Capillaries are the points of exchange between the blood and surrounding tissues. Materials cross in and out of the capillaries by passing through or between the cells that line the capillary. The extensive network of capillaries in the human body is estimated at between 50,000 and 60,000 miles long.Thoroughfare channels allow blood to bypass a capillary bed. These channels can open and close by the action of muscles that control blood flow through the channels.

Blood leaving the capillary beds flows into a progressively larger series of venules that in turn join to form veins.Veins carry blood from capillaries to the heart.With the exception of the pulmonary veins, blood in veins is oxygen-poor. The pulmonary veins carry oxygenated blood from lungs back to the heart.Venules are smaller veins that gather blood from capillary beds into veins.Pressure in veins is low, so veins depend on nearby muscular contractions to move blood along. The veins have valves that prevent back-flow of blood **Blood pressure:**

Ventricular contraction propels blood into arteries under great pressure. Blood pressure is measured in mm of mercury; healthy young adults should have pressure of ventricular systole of 120mm, and 80 mm at ventricular diastole.

Higher pressures (human 120/80 as compared to a 12/1 in lobsters) mean the volume of blood circulates faster (20 seconds in humans, 8 minutes inlobsters).

As blood gets farther from the heart, the pressure likewise decreases. Each contraction of the ventricles sends pressure through the arteries. Elasticity of lungs helps keep pulmonary pressures low. Systemic pressure is sensed by receptors in the arteries and atria. Nerve messages from these sensors communicate conditions to the medulla in the brain. Signals from the medulla regulate blood pressure.

Diseases of the Heart and Cardiovascular System

Heart Attack

Cardiac muscle cells are serviced by a system of coronary arteries. During exercise the flow through these arteries is up to five times normal flow. Blocked flowin coronary arteries can result in death of heart muscle, leading to a heart attack. Blockage of coronary arteries. is usually the result of gradual buildup of lipids and cholesterol in the inner wall of the coronary artery. Occasional chest pain, angina pectoralis, can result during periods of stress or physical exertion. Angina indicates oxygen demands are greater than capacity to deliver it and that a heart attack may occur in the future. Heart muscle cells that die are not replaced since heart muscle cells do not divide. Heart disease and coronary artery disease are the leading causes of death tody.

Hypertension, high blood pressure (the silent killer), occurs when blood pressure is consistently above 140/90. Causes in most cases are unknown, although stress, obesity, high salt intake, and smoking can add to a genetic predisposition. Luckily, when diagnosed, the condition is usually treatable with medicines and diet/exercise.

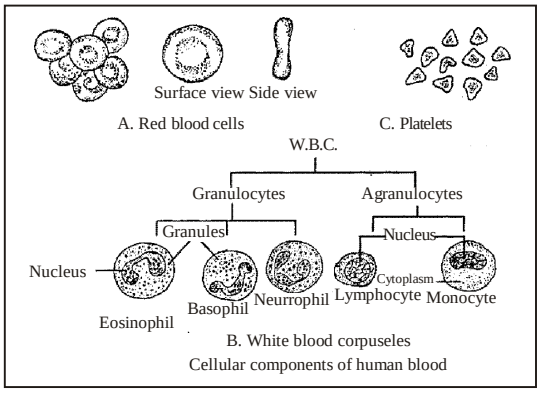
The Vascular System

Two main routes for circulation are the pulmonary (to and from the lungs) and the systemic (to and from the body). Pulmonary arteries carry blood from the heart to the lungs. In the lungs gas exchange occurs. Pulmonary veins carry blood from lungs to heart. The aorta is the main artery of systemic circuit. The vena cavaeare the main veins of the systemic circuit. Coronary arteries deliver oxygenated blood, food, etc. to the heart.

Animals often have a portal system, which begins and ends in capillaries, such as between the digestive tract and the liver. Fish pump blood from the heart to their gills, where gas exchange

occurs, and then on to the rest of the body. Mammals pump blood to the lungs for gas exchange, then back to the heart for pumpingout to the systemic circulation. Blood flows in only one direction.

Blood



Cellular components of human blood

Blood is a bright red viscous fluid which flows through all the vessels except the lymph vessels. It constitutes 8% of the total body weight. Blood is composed of two portions: formed elements(cell and cell like structures) ad plasma (liquid containing dissolvedsubstances).

Plasma:

- Plasma is the liquid component of the blood. Mammalian blood consists of a liquid (plasma) and a number of cellular and cell fragment components.
- Plasma is about 60 % of a volume of blood; cells and fragments are 40%. Plasma has 90% water and 10% dissolved materials including proteins, glucose, ions, hormones, and gases.
- It acts as a buffer, maintaining pH near 7.4. Plasma contains nutrients, wastes, salts, proteins, etc. Proteins in the blood aid in transport of large molecules such as cholesterol.
- Formed elements:

(a) Red bloodcells

- Red blood cells, also known as erythrocytes, are flattened, doubly concave cells about 7 μm in diameter that carry oxygen associated inthe cell's hemoglobin.
- Mature erythrocytes lack a nucleus. They are small, 4 to 6 million cells per cubic millimeter of blood, and have 200 millionhemoglobin molecules per cell.
- Humans have a total of 25 trillion red blood cells (about 1/3 of all the cells in the body).
- Red blood cells are continuously manufactured in red marrow of long bones, ribs, skull, and vertebrae.
- Life-span of an erythrocyte is only 120 days, after which they are destroyed in liver and spleen.
- Iron from hemoglobin is recovered and reused by red marrow. The liver degrades the heme units and secretes them as pigment inthe bile, responsible for the color of feces.
- Each second two million red blood cells are produced to replace the dead red blood cells.

(b) White BloodCells

White blood cells, also known as leukocytes, are larger than erythrocytes, have a nucleus, and lack hemoglobin. They function in the cellular immune response. White blood cells (leukocytes) are less than 1% of the blood's volume. They are made from stem cells in bone marrow.

There are five types of leukocytes, which are important components of the immune system.

(a) Neutrophils enter the tissue fluid by squeezing through capillary walls and phagocytozing foreign substances
(b) Macrophages release white blood cell growth factors, causing a population increase for white blood cells.
(c) Lymphocytes fight infection.
(d) T-cells attack cells containing viruses.
(e) B-cells produce antibodies. Antigen-antibody complexes are phagocytized by amacrophage.

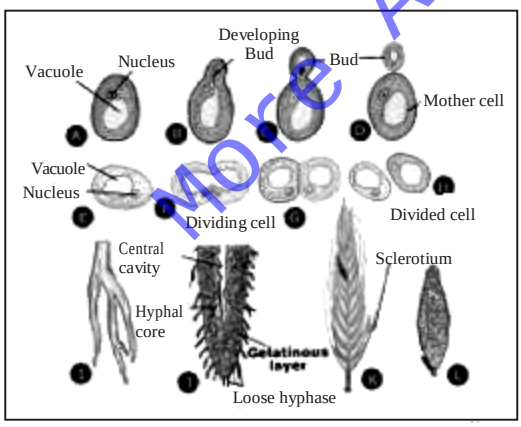
White blood cells cansqueeze through pores in the capillaries and fight infectious diseases in intestinal areas

(c) Platelets

- Platelets result from cell fragmentation and are involved with clotting.
- Platelets are cell fragments that bud off megakaryocytes in bone marrow. They carry chemicals essential to blood clotting.
- Platelets survive for 10 days before being removed by the liver and spleen.
- There are 150,000 to 300,000 platelets in eachmilliliter of blood.
- Platelets stick and adhere to tears in blood vessels; they also release clotting factors. A hemophiliac's blood cannot clot. Providing correct proteins (clotting factors) has been a common method of treating hemophiliacs. It has also led to HIV transmission due to the use of transfusions and use of contaminated blood products.

THE REPRODUCTIVE SYSTEM

Asexual reproduction



- Asexual reproduction allows an organism to rapidly produce many offspring without the time and resources committed to courtship, finding a mate, and mating.
- Fission, budding, fragmentation, and the formation of rhizomes and stolons are some of the mechanisms that allow organisms to reproduce asexually.
- The hydra produces buds;
- starfish can regenerate an entire body from a fragment of the original body.
- The lack of genetic variability in asexually reproducing populations can be detrimental when environmental conditions change quickly.

Sexual Reproduction

- In sexual reproduction new individuals are produced by the fusion of haploid gametes to form a diploid zygote.
- Sperm are male gametes, ova (ovum singular) are female gametes.
- Meiosis produces cells that are genetically distinct from each other.
- fertilization is the fusion of two such distinctive cells.
- Rotifers will reproduce asexually when conditions are favorable by having females produce eggs by mitosis. When conditions deteriorate, rotifers will reproduce sexually and encase their zygotes inside a resistant shell. Once conditions improve, these eggs hatch into diploid individuals. Rotifers thus use sexual reproduction as way to survive a deteriorating environment.
- Sexual reproduction offers the benefit of generating genetic variation among offspring, which enhances the chances of the population'ssurvival.
- Costs of this process include the need for two individuals to mate, courtship rituals, as well as a number of basic mechanisms described later.

Human Reproduction and Development

- Human reproduction employs internal

fertilization, and depends on the integrated action of hormones, the nervous system, and the reproductive system

- Gonads are sex organs that produce gametes. Male gonads are the testes, which produce sperm and male sex hormones. Female gonads are the ovaries, which produce eggs (ova) and female sex hormones.

The Male Reproductive System

- Testes are suspended outside the abdominal cavity by the scrotum, a pouch of skin that keeps the testes close or far from the body at an optimal temperature for spermdevelopment.
- Seminiferous tubules are inside each testis, and are where sperm are produced by meiosis. About 250 meters (850 feet) of tubules are packed into each testis.
- Spermatocytes inside the tubules divide by meiosis to produce spermatids that in turn develop into mature sperm.
- Sperm production begins at puberty and continues throughout life, with several hundred million sperm being produced each day. Once sperm form they move into the epididymis, where they mature and are stored.

(a) Male Sex Hormones

- The anterior pituitary produces follicle-stimulating hormone (FSH) and luteinizing hormone (LH).
- Action of LH is controlled by the gonadotropin-releasing hormone (GnRH).
- LH stimulates cells in the seminiferous tubules to secrete testosterone, which has a role in sperm production and developing male secondary sex characteristics
- FSH acts on cells to help in sperm maturation. Negative feedback by testosterone controls the actions of GnRH.

(b) Sexual Structures

- Sperm pass through the vas deferens and connect to a short ejaculatory duct that connects to the urethra.
- The urethra passes through the penis and opens to the outside
- Secretions from the seminal vesicles add fructose and prostaglandins to sperm as they pass. The prostate gland secretes a milky alkaline fluid.
- The bulbourethral gland secretes a mucus-like fluid that provides lubrication for intercourse
- Sperm and secretions make up semen.

The Female Reproductive System

- The female gonads, are ovaries, which are located within the lower abdominal cavity
- The ovary contains many follicles composed of a developing egg surrounded by an outer layer of follicle cells.
- At birth each female carries a lifetime supply of developing oocytes, each of which is in ProphaseI.
- A developing egg (secondary oocyte) is released each month from pubertyuntil menopause, a total of 400-500 eggs.

Ovarian Cycles

- After puberty the ovary cycles between a follicular phase (maturing follicles) and a luteal phase (presence of the corpus luteum).
- These cyclic phases are interrupted only by pregnancy and continue until menopause, when reproductive capability ends.
- The ovarian cycle lasts usually 28 days.
- During the first phase, the oocyte

matures within a follicle. At midpoint of the cycle, the oocyte is released from the ovary in a process known as ovulation. Following ovulation the follicle forms a corpus luteum which synthesizes and prepares hormones to prepare the uterus for pregnancy.

- The secondary oocyte passes into the oviduct (fallopian tube or uterinetube). The oviduct is connected to the uterus.
- The uterus has an inner layer, the endometrium, in which a fertilized egg implants. At the lower end of the uterus the cervix connects the uterus to the vagina. The vagina receives the penis during intercourse and serves as the birth canal.

External Genitals

- The female external genitals are collectively known as the vulva.
- The labia minora is a thin membrane of folded skin just outside the vaginal opening.
- The labia majora cover and protect the genital area.
- A clitoris, important in arousal, is a short shaft with a sensitive tip covered by a fold of skin.

Hormones and Female Cycles

- The ovarian cycle is hormonally regulated in two phases. The follicle secretes estrogen before ovulation; the corpus luteum secretes both estrogen and progesterone after ovulation.
- Hormones from the hypothalamus and anterior pituitary control the ovarian cycle. The ovarian cycle covers events in the ovary; themenstrual cycle occurs in the uterus.
- Menstrual cycles vary from between 15 and 31 days. The first day of the cycle is the first day of blood flow (day 0) known as menstruation.
- During menstruation the uterinelining is broken down and shed as menstrual flow.
- FSH and LH are secreted on day 0, beginning both the menstrual cycle and the ovarian cycle.
- Both FSH and LH stimulate the maturation of a single follicle in one of the ovaries and the secretion of estrogen. Rising levels of estrogen in the blood trigger secretion of LH, which stimulates follicle maturation and ovulation (day 14, or midcycle). LH stimulates the remaining follicle cells to form the corpus luteum, which produces both estrogen and progesterone.
- Estrogen and progesterone stimulate the development of the endometrium and preparation of the uterine inner lining for implantation of a zygote. If pregnancy does not occur, the drop in FSH and LH cause the corpus luteum to disintegrate. The drop in hormones also causes the sloughing off of the inner lining of the uterus by a series of muscle contractions of the uterus.

Sexual Responses

- Humans do not have a mating season , females are sexually receptive to the male at all times of the year. There are four stages in mating: arousal, plateau, orgasm, and resolution.
- During male arousal, blood flows into the three shafts of spongy erectile tissue inside the penis, causing it to become elongated and erect. The female arousal has the swelling of the areas around the vagina, erection of the clitoris and nipples, and secretion of lubricating fluids in thevagina.
- After insertion of the penis into the vagina, pelvic thrusts by both partners

stimulate sensory receptors in the penis, vaginal walls, and clitoris. The sperm leave the epididymis and secretions of glands form the semen. Orgasm involves contractions of muscles of the penis (male) or vagina (female) and waves of pleasurable sensations.

- Resolution reverses the previous phases: muscles relax, breathing slows, the penis returns to its normal size.

Sexually Transmitted Diseases

STDs can affect the sex partners, fetus, and newborn infants. STDs are grouped into three categories.

Category One

STDs that produce inflammation of the urethra, epididymis, cervix, or oviducts. Gonorrhea and chlamydia are the most common STDs in this category. Both diseases can be treated and cured with antibiotics, once diagnosed.

Category Two

STDs that produce sores on the external genitals. Genital herpes is the most common disease in this class. Symptoms of herpes can be treated by antiviral drugs, but the infection cannot be cured. Syphilis is a bacterially caused infection, and can, if left untreated, cause serious symptoms and death. However, the disease is curable with antibiotics.

Category Three

This class of STDs includes viral diseases that affect organ systems other than those of the reproductive system. AIDS and hepatitis B are in this category. Both can be spread by sexualcontact or blood. Infectious individuals may appear symptom-free for years after infection.

Reproduction:

Various contraceptive methods

New techniques have been developed to enhance or reduce the chances of conception. Social conventions and governing laws have developed far slower than this new technology, leading to controversy about moral, ethical, and legal grounds for the uses of such technologies.

The separation of intercourse from pregnancy uses methods blocking one of the three stages ofreproduction"

- release and transport of gametes
- fertilization
- implantation

Effectiveness

Various contraceptive methods have been developed; none of which is 100% successful at preventing pregnancy or the transmission of STDs. Abstinence is the only completely effective method.

Methods

Physical prevention (most effective) include vasectomy and tubal ligation.

(a) Vasectomy: the vas deferens connecting the testes with the urethra is cut and sealed to prevent the transport of sperm.

(b) Tubal ligation: the oviduct is cut and ends tied off to prevent eggs from reaching theuterus.

(c) Oral contraceptives: (birth control pills) It usually contain a combination of hormones that prevent release of FSH and LH, inhibiting development of the follicle so that no oocytes are released.

Time-release capsules (Norplant) can be implanted under the skin and offer long-term suppression of ovulation.

RU-486, the so-called morning after pill, interferes with implantation of the blastula into the uterine wall. Its use as a contraceptive is very controversial.

(d) Barrier methods : It employ physical (condom, diaphragm) or chemical (spermacides) means to separate the sperm from the egg. Male condoms are fitted over the erect penis; female condoms are placed inside the vagina. Only latex condoms prevent the spread of STDs.

Diaphragms cap the cervix and block passage of the sperm into the uterus. Spermicidal jellies or foams kill sperm on contact and must be placed in the vagina prior tointercourse.

Infertility

About 1 in 6 couples is infertile due to physical or physiological conditions preventing gamete production, implantation, or fertilization

Cause ofInfertility

Blocked oviducts (often from untreated STDs) are the leading cause of infertility in females. Low spermcount, lowmotility, or blocked ducts are common causes of male infertility.

Hormone therapy can cause increased egg production. Surgery can open blocked ducts. About 40 of the cases are due to male problems, 40 due to female problems and the remaining 20% are caused by some unknown agent(s). In vitro fertilization (test-tube babies) is a widely used technique to aid infertile couples.

Fertilization and Cleavage

(A) Fertilization has Three Functions

1. transmission of genes from bothparents to offspring
2. restoration of the diploid number of chromosomes reduced duringmeiosis
3. initiation of development in offspring

Steps in Fertilization

- Contact between sperm and egg
- Entry of sperm into the egg
- Fusion of egg and sperm nuclei
- Activation of development

(B) Cleavage

Cleavage is the first step in development of all multicelled organisms. Cleavage converts a single-celled zygote into a multicelled embryo by mitosis. Usually, the zygotic cytoplasm is divided among the newly formed cells. Frog embryos divide to produce 37,000 cells in a little over 40 hours. The blastula is produced by mitosis of the zygote, and is a ball of cells surrounding a fluid-filled cavity (the blastocoel). The decreasing size of cells increases their surface to volume ratio, allowing for more efficient oxygen exchange between cells and their environment. RNA and information carrying molecules are distributed to various parts of the blastula, and this molecular differentiation sets the stage for the layering of the body in the next phases of development.

Gastrulation

Gastrulation involves a series of cell migrations to positions where they will form the three primary celllayers.

- Ectoderm forms the outer layer.
- Endoderm forms the inner layer.
- Mesoderm forms the middle layer.

(a) **Mesoderm:**Ectoderm forms tissues associated with outer layers: skin, hair, sweat glands, epithelium. The brain and nervous system also develop from the ectoderm.

(b) **Mesoder:** The mesoderm forms structures associated with movement and support: body muscles, cartilage, bone, blood, and all other connective tissues. Reproductive system organs and kidneys frommesoderm.

(c) **Endoderm:**The endoderm forms tissues and organs associated with the digestive and respiratory systems. Many endocrine structures, such as the thyroid and parathyroid glands, are formed by the endoderm. The liver, pancreas, and gall bladder arise from endoderm.

Invagination

Immediately after gastrulation, the body axis of the embryo begins to appear. Chordates have the cells that will form the nervous system fold into a neural tube (which will eventually form the spinal cord). The mesoderm forms the notochord (which will eventually form the vertebrae). The mesoderm at this time forms somites, which form segmented body parts, such as the muscles of the body wall.

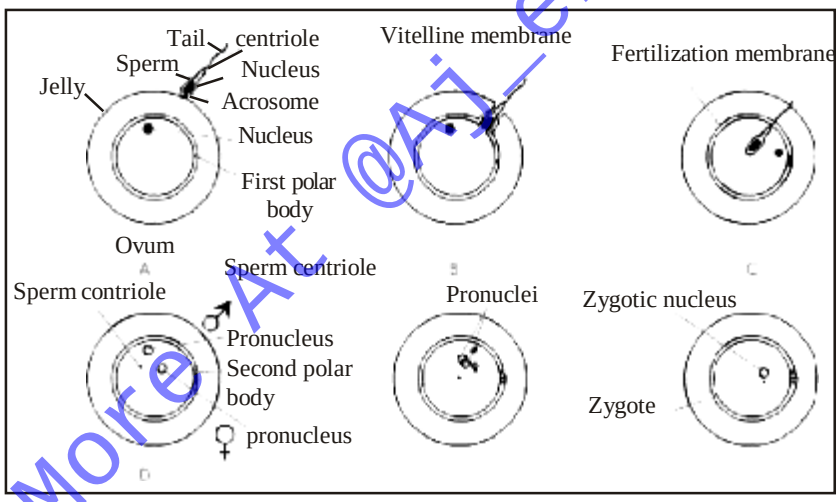
Pattern Formation and Induction

Blastulation and gastrulation establish the main body axis. Organ formation occurs in the next stage of the development of the embryo. During organ formation, cell division is accomplished by migration and aggregation. Pattern formation is the result of cells "sensing" their position in the embryo relative to other cells and to form structures appropriate to that position.

Gradients of informational molecules withinthe embryohavebeen suggested toprovide the positional information to cells. Homeobox genes are pattern genes; they coordinate with gradients of information molecules to establish the body plan and development of organs. Induction is the process in which one cell or tissue type affects the developmental fate of another cell or tissue. As a cell begins to form certain structures, certain genes are turned on, others are turned off. Induction affects patterns of gene expression through physical contact or chemical signals. Formation of the vertebrate eye is a well known example.

Various Stages of Fertilization

Fertilization, the fusion of the sperm and egg, usually occurs in the upper third of the oviduct. Thirty minutes after ejaculation, sperm are present in the oviduct, having traveled from the vagina through the uterus and into the oviduct. Sperm traverse this distance by the beating of their flagellum. Of the several hundred million sperm released in the ejaculation, only a few thousand reach the egg.



Only one sperm will fertilize the egg. One sperm fuses with receptors on the surface of the secondary oocyte, triggering a series of chemical changes in the outer oocyte membrane that prevent any other sperm from entering the oocyte. The entry of the sperm initiates Meiosis II in the oocyte. Fusion of the egg and sperm nuclei forms the diploid zygote.

Travels of a Young Zygote

Cleavage of the zygote begins while it isstill in the oviduct, producing a solid ball of cells (morula). The morula enters the uterus, continuing to divide and becomes a blastocyst.

Implantation

The uterine lining becomes enlarged and prepared for implantation of the embryo in the trophoblast layer. Twelve days after fertilization, the trophoblast has formed a two-layered chorion. Human chorionic gonadotropin (hCG) is secreted

by the chorion, and prolongs the life of the corpus luteum until the placenta begins to secrete estrogen and progesterone.

Home pregnancy tests work by detecting elevated hCG levels in the woman's urine.

Placenta

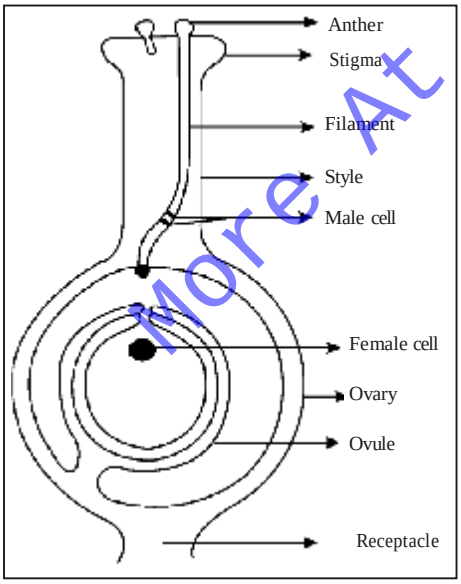
Maternal and embryonic structures interlock to form the placenta, the nourishing boundary between the mother's and embryo's systems.

The umbilical cord extends from the placenta to the embryo, and transports food to and wastes from the embryo.

PLANT REPRODUCTION

Flowering plants

Flowering plants, the angiosperms, were the last of the seed plant groups to evolve, appearing over 100 million years ago during the middle of the Age of Dinosaurs (late Jurassic). All flowering plants produce flowers and if they are sexually reproductive, they produce a diploid zygote and triploid endosperm.



Flowers

Flowers are collections of reproductive and sterile tissue arranged in a tight whorled array having very short internodes. Sterile parts of flowers are the sepals and petals. When these are similar in size and shape, they are termed tepals. Reproductive parts of the flower are the stamen (male, collectively termed the androecium) and carpel (often the carpel is referred to as the pistil, the female parts collectively termed the gynoecium).

Pollen

Pollen grains (from the greek *palynos* for dust or pollen) contain the male gametophyte (microgametophyte) phase of the plant. Pollen grains are produced by meiosis of microspore mother cells that are located along the inner edge of the anther sacs (microsporangia). The outer part of the pollen is the exine, which is composed of a complex polysaccharide, sporopollenin. Inside the pollen are two (or, at most, three) cells that comprise the malegametophyte. The tube cell (also referred to as the tube nucleus) develops into the pollen tube. The germ cell divides by mitosis to produce two sperm cells. Division of the germ cell can occur before or after pollination.

Pollination

The transfer of pollen from the anther to the female stigma is termed pollination. This is accomplished by a variety of methods. Entomophyly is the transfer of pollen by an insect. Anemophyly is the transfer of pollen by wind. Other pollinators include birds, bats, water, and humans. Some flowers (for example garden peas) develop in such a way as to pollinate themselves. Others have mechanisms to ensure pollination with another flower. Flower color is thought to indicate the nature of pollinator: red petals are thought to attract birds, yellow for bees, and white for moths. Wind pollinated flowers have reduced petals, such as oaks and grasses.

Gynoecium

The gynoecium consists of the stigma, style, and ovary containing one or more ovules. These three structures are often termed a pistil or carpel. In many plants, the pistils will fuse for all or part of their length.

The Stigma and Style

The stigma functions as a receptive surface on which pollen lands and germinates its pollen tube. Corn silk is part stigma, part style. The style serves to move the stigma some distance from the ovary. This distance is species specific.

The Ovary

The ovary contains one or more ovules, which in turn contain one female gametophyte, also referred to in angiosperms as the embryo sac. Some plants, such as cherry, have only a single ovary which produces two ovules. Only one ovule will develop into a seed.

Double Fertilization

The process of pollination being accomplished, the pollen tube grows through the stigma and style toward the ovules in the ovary. The germ cell in the pollen grain divides and releases two sperm cells which move down the pollen tube. Once the tip of the tube reaches the micropyle end of the embryo sac, the tube grows through into the embryo sac through one of the synergids which flank the egg. One sperm cell fuses with the egg, producing the zygote which will later develope into the next-generation sporophyte. The second sperm fuses with the two polar bodies located in the center of the sac, producing the nutritive triploid endosperm tissue that will provide energy for the embryo's growth and development.

Fruit

The ovary wall, after fertilization has occurred, develops into a fruit. Fruits may be fleshy, hard, multiple or single.

Note:- View the Seeds of Life site for illustrations and information about fruits and seeds. Seeds germinate, and the embryo grows into the next generation sporophyte.

THE DIGESTIVE SYSTEM

Digestive System in Various Organism

Single-celled organisms can directly take in nutrients from their outside environment. Multicellular animals, with most of their cells removed from direct contact with the outside environment, have developed specialized structures for obtaining and breaking down their food.

Animals Depend on Two Processes: Feeding and Digestion

- Animals are heterotrophs, they must absorb nutrients or ingest food sources.
- Ingestive eaters, majority of animals, use a mouth to ingest food.
- Absorptive feeders, such as tapeworms, live in a digestive system of another animal and absorb nutrients from that animal directly through their body wall.
- Filter feeders, such as oysters and mussels, collect small organisms and particles from the surrounding water
- Substrate feeders, such as earthworms and termites, eat the material (dirt or wood) they burrow through.
- Fluid feeders, such as aphids, pierce the body of a plant or animal and withdraw fluids.

Stages in the Digestive Process

Food for the most part consists of various organic macromolecules such as starch, proteins, and fats. These molecules are polymers made of individual monomer units Breaking these large molecules into smaller components involves:

1. movement: propels food through the digestive system
2. secretion: release of digestive juices in response to a specific stimulus
3. digestion: breakdown of food into molecular components small enough to cross the plasmamembrane
4. absorption: passage of the molecules into the body's interior and their passage throughout the body
5. elimination: removal of undigested food and wastes

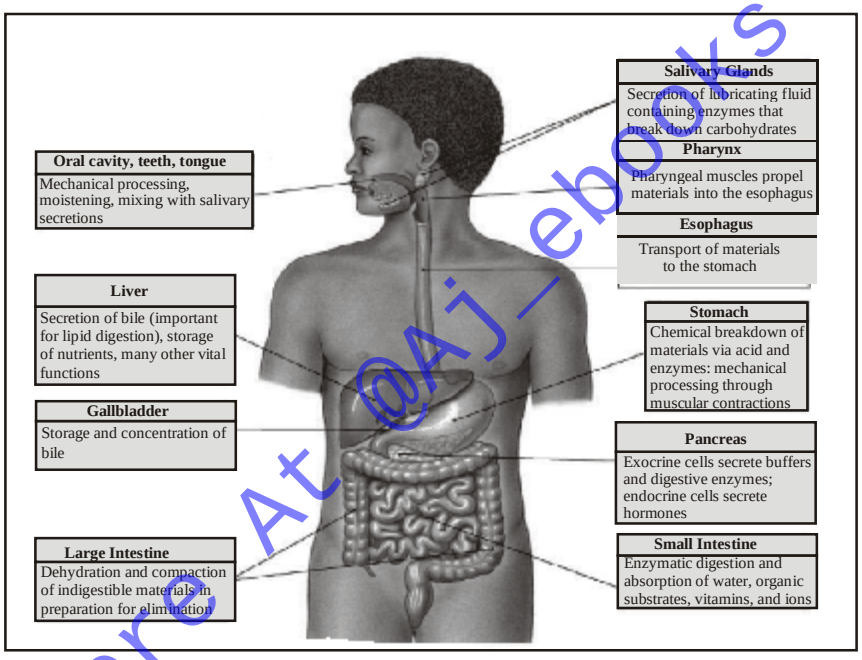
Three processes occur during what we loosely refer to as "digestion".

Digestion proper, which is the mechanical and chemical breakdown of food into particles/ molecules small enough to pass into the blood.

Absorption is the passage of food monomers into the blood stream. Assimilation is the passage of the food molecules into body cells.

The Human Digestive System

The human digestive system, is a coiled, muscular tube (6-9 meters long when fully extended) stretching from the mouth to the anus. Severalspecialized compartments occur along this length: mouth, pharynx, esophagus, stomach, small intestine, large intestine, and anus. Accessory digestive organs are connected to the main system by a series of ducts: salivary glands, parts of the pancreas, and the liver and gall bladder (bilary system).



(A) The Mouth and Pharynx

Mechanical breakdown begins in the mouth by chewing (teeth) and actions of the tongue. Chemical breakdown of starch by production of salivary amylase from the salivary glands. This mixture of food and saliva is then pushed into the pharynx and esophagus. The esophagus is a muscular tube whose muscular contractions (peristalsis) propel food to the stomach.

In the mouth, teeth, jaws and the tongue begin the mechanical breakdown of food into smaller particles.

Most vertebrates, except birds(who havelost their teeth to a hardened bill), have teeth for tearing, grinding and chewing food. Thetongue manipulates food during chewing and swallowing; mammals have tastebuds clustered on their tongues.

Salivary glands secrete salivary amylase, an enzyme that begins the breakdown of starch into glucose.

Mucus moistens food and lubricates the esophagus. Bicarbonate ions in saliva neutralize the acids infoods.

Swallowing moves food from the mouth through the pharynx into the esophagus and then to thestomach.

(b) The Stomach

During a meal, the stomach gradually fills to a capacity of 1 liter, from an empty capacity of 50-100 milliliters. At a price of discomfort, the stomach can distend to hold 2 liters or more.

Epithelial cells line inner surface of the stomach, and secrete about 2 liters of gastric juices per day.

Gastric juice contains hydrochloric acid, pepsinogen, and mucus; ingredients important in digestion.

Secretions are controlled by nervous(smells, thoughts, and caffeine) and endocrine signals.

The stomach secretes hydrochloric acid and pepsin. Hydrochloric acid (HCl) lowers pH of the stomach so pepsin is activated. Pepsin is an enzyme that controls the hydrolysis of proteins into peptides.

The stomach also mechanically churns the food. Chyme, the mix of acid and food in the stomach, leaves the stomach and enters the small intestine.

Hydrochloric acid does not directlyfunction in digestion: it kills microorganisms, lowers the stomach pH to between 1.5 and 2.5, and activates pepsinogen.

Pepsinogen is an enzyme that starts protein digestion. Pepsinogen is produced in cells that line the gastric pits. It is activated by cleaving off a portion of the molecule, producing the enzyme pepsin that splits off fragments of peptides from a protein molecule during digestion in the stomach.

Carbohydrate digestion, begun by salivary amylase in the mouth, continues in the bolus as it passes to the stomach. The bolus is brokendown into acid chyme in the lower third of the stomach, allowing the stomach's acidity to inhibit further carbohydrate breakdown. Protein digestion by pepsin begins.

Note:

(Alcohol and aspirin are absorbed through the stomach lining into the blood.)

Epithelial cells secrete mucus that forms a protective barrier between the cells and the stomach acids. Pepsin is inactivated when it comes into contact with the mucus.

Bicarbonate ions reduce acidity near the cells lining the stomach. Tight junctions link the epithelial stomach-lining cells together, further reducing or preventing stomach acids from passing.

Ulcers

Peptic ulcers result when these protective mechanisms fail. Bleeding ulcers result when tissue damage is so severe that bleeding occurs into the stomach.

Perforated ulcers are life-threatening situations where a hole has formed in thestomach wall.

At least 90% of all peptic ulcers are caused by *Helicobacter pylori*. Other factors, including stress and aspirin, can also produce ulcers.

(C) The Small Intestine

The small intestine, is where final digestion and absorption occur.

The small intestine is a coiled tube over 3 meters long. Coils and folding plus villi give this 3m tube the surface area of a 500-600m long tube.

Final digestion of proteins and carbohydrates must occur, and fats have not yet been digested.

Villi have cells that produce intestinal enzymes which complete the digestion of peptides and sugars.

The absorption process also occurs in the small intestine. Food has been broken down into particles small enough to pass into the small intestine.

Sugars and amino acids go into the bloodstream via capillaries in each villus. Glycerol and fatty acids go into the lymphatic system.

Absorption is an activetransport, requiring cellular energy.

Food is mixed in the lower part of the stomach by peristaltic waves that also propel the acid-chyme mixture against the pyloric sphincter.

Increased contractions of the stomach push

the food through the sphincter and into the small intestine as the stomach eempties over a 1 to 2 hour period.

High fat diets significantly increase this time period.

The small intestine is the major site for digestion and absorption of nutrients. The small intestine is up to 6 meters long and is 2-3 centimeters wide.

The upper part, the duodenum, is the most active in digestion. Secretions from the liver and pancreas are used for digestion in the duodenum. Epithelial cells of the duodenum secrete a watery mucus.

The pancreas secretes digestive enzymes and stomach acid-neutralizing bicarbonate.

The liver produces bile, which is stored in the gall bladder before entering the bile duct into theduodenum.

Digestion of carbohydrates, proteins, and fats continues in the small intestine. Starch and glycogen are broken down into maltose by small intestine enzymes.

Proteases are enzymes secreted by the pancreas that continue the breakdown of protein into small peptide fragments and amino acids.

Bile emulsifies fats, facilitating their breakdown into progressively smaller fat globules until they can be acted upon by lipases. Bile contains cholesterol, phospholipids, bilirubin, and a mix of salts.

Fats are completely digested in the small intestine, unlike carbohydrates and proteins.

Most absorption occurs in the duodenum and jejeunum (second third of the small intestine). The inner surface of the intestine has circular folds that more than triple the surface area for absorption.

Villi covered with epithelial cells increase the surface area by another factor of 10. The epithelial cells are lined with microvilli that further increase the surface area; a 6 meter long tube has a surface area of 300 square meters.

Each villus has a surface that is adjacent to the inside of the small intestinal opening covered in microvilli that form on top of an epithelial cell known as a brush border.

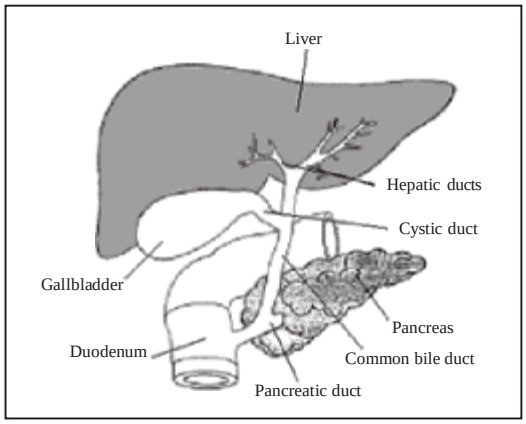
Each villus has a capillary networksupplied by a small arteriole. Absorbed substances pass through the brush border into the capillary, usually by passive transport.

Maltose, sucrose, and lactose are themain carbohydrates present in the small intestine; they are absorbed by the microvilli. Starch is broken down into two-glucose units (maltose) elsewhere. Enzymes in the cells convert these disaccharides into monosaccharides that then leave the cell and enter the capillary. Lactose intolerance results from the genetic lack of the enzyme lactase produced by the intestinal cells.

Peptide fragments and amino acids cross the epithelial cell membranes by active transport. Inside the cell they are broken into amino acids that then enter the capillary. Glutenenteropathy is the inability to absorb gluten, a protein found in wheat.

Digested fats are not very soluble. Bile salts surround fats to form micelles, that can pass into the epithelial cells. The bile salts return to the lumen to repeat the process. Fat digestion is usually completed by thetime the food reachesthe ileum (lower third) of the small intestine. Bile salts are in turn absorbed in the ileum and are recycled by the liver and gall bladder. Fats pass from the epithelial cells to the small lymph vessel that also runs through the villus.

⏩ **The Liver:**



The liver produces and sends bile to the

small intestine via the hepatic duct. Bile contains bile salts, which emulsify fats, making them susceptible to enzymatic breakdown.

In addition to digestive functions, the liver plays several other roles:

(1) detoxification of blood;
(2) synthesis of blood proteins;
(3) destruction of old erythrocytes and conversion of hemoglobin into a component of bile;
(4) production of bile;
(5) storage of glucose as glycogen, and its release when blood sugar levels drop; and
(6) production of urea from amino groups and ammonia.

Gall Bladder

The gall bladder stores excess bile for release at a later time. We can live without our gall bladders, in fact many people have had theirs removed. The drawback, however, is a need to be aware of the amount of fats in the food they eat since the stored bile of the gall bladder is no longer available.

Glycogen is a polysaccharide made of chains of glucose molecules. In plants starch is the storage form of glucose, while animals use glycogen for the same purpose. Low glucose levels in the blood cause the release of hormones, such as glucagon, that travel to the liver and stimulate the breakdown of glycogen into glucose, which is then released into the blood (raising blood glucose levels). When no glucose or glycogen is available, amino acids are converted into glucose in the liver. The process of deamination removes the amino groups from amino acids. Urea is formed and passed through the blood to the kidney for export from the body. Conversely, the hormone insulin promotes the take-up of glusose into liver cells and its formation into glycogen.

(A) Liver Diseases Jaundice occurs when the characteristic yellow tint to the skin is caused by excess hemoglobin breakdown products in the blood, a sign that the liver is not properly functioning. Jaundice may occur when liver function has been impaired by obstruction of the bile duct and by damage caused by hepatitis.

(B) Hepatitis A, B, and C are all viral diseases that can cause liver damage. Like any viral disease, the major treatment efforts focus on treatment of symptoms, not removal of the viral cause.

- Hepatitis A is usually mild malady indicated by a sudden fever, malaise, nausea, anorexia, and abdominal discomfort.
- The virus causing Hepatitis A is primarily transmitted by fecal contamination, although contaminated food and water also can promote transmission.
- Hepatitis B may be transmitted by blood and blood products as well as sexual contact. The risk of HBV infection is high among promiscuous homosexual men although it is also transmitted hetereosexually. Correct use of condoms is thought to reduce or eliminate the risk of transmission.
- Individuals with chronic hepatitis B are at an increased risk of developing primary liver cancer.
- Hepatitis C affects approximately 170 million people worldwide. The virus is transmitted primarily by blood and blood products.

Sexual transmission can occur between monogamous couples (rare) but infection is far more common in those who are promiscuous.

In rare cases, Hepatitis C causes acute disease and even liver failure. with cirrhosis from Hepatitis C also bear increased chances of developing primary liver cancer.

(C) Cirrhosis: Cirrhosis of the liver commonly occurs in alcoholics, who place the liver in a stress situation due to the amount of alcohol

to be broken down. Cirrhosis can cause the liver to become unable to perform its biochemical functions. Chemicals responsible for blood clotting are synthesized in the liver, as is albumin, the major protein in blood. The liver also makes or modifies bilecomponents.

Blood from the circulatory system passes through the liver, so many of the body's metabolic functions occur primarily there including the metabolism of cholesterol and the conversion of proteins and fats into glucose. Cirrhosis is a disease resulting from damage to liver cells due to toxins, inflammation, and other causes.

Liver cells regenerate inanabnormal pattern primarily forming nodules that are surrounded by fibrous tissue. Changes in the structure of the liver can decrease blood flow, leading to secondary complications.

Cirrhosis has many cuses, including alcoholic liver disease, severe forms of some viral hepatitis, congestive heart failure, parasitic infections (for example schistosomiasis), and long term exposure to toxins or drugs.

⏩ **The Pancreas**

The pancreas sends pancreatic juice, which neutralizes the chyme, to the small intestive through the pancreatic duct. In addition to this digestive function, the pancrease is the site of production of several hormones, such as glucagon and insulin. An recently recognized condition which is known as prediabetes, in which the body gradually loses its sensitivity to insulin, leading eventually to Type II diabetes medications, diet and behavior (in other words EXERCISE!!!) changes are thought to delay if not outright postpone the onset of diabetes if corrected soon enough.

(D) The LargeIntestine

The large intestine is made up by the colon, cecum, appendix, and rectum. Materialin thelarge intestine is mostly indigestible residue and liquid.

Movements are due to involuntary contractions that shuffle contents back and forth and propulsive contractions that move material through the large intestine.

The large intestine performs three basic functions in vertebrates:

(1) recovery of water and electrolytes from digested food;

(2) formation and storage of feces; and

(3) microbial fermentation:

The large intestine supports an amazing flora of microbes. Those microbes produce enzymes that can digest many of molecules indigestible by vertebrates. Secretions in the large intestine are an alkaline mucus that protects epithelial tissues and neutralizes acids produced by bacterial metabolism.

Water, salts, and vitamins are absorbed, the remaining contents in the lumen form feces (mostly cellulose, bacteria, bilirubin). Bacteria in the large intestine, such as *E. coli*, produce vitamins (including vitamin K) that are absorbed.

Nutrition

Nutrition deals with the composition of food, its energy content, and slowly (or not at all) synthesized organic molecules. Chemotrophs are the organisms (mostly bacteria) that derive their energy from inorganic chemical reactions. Phototrophs convert sunlight energy into sugar or other organic molecules. Heterotrophs eat to obtain energy from the breakdown of organic molecules in their food. Macronutrients are foods required on a large scale each day. These include carbohydrates, lipids, and amino acids. Water is essential, correct water balance isamust for proper functioning of the body.

Carbohydrate : The diet should contain at least 100 grams of carbohydrate every day. Recently, however, new recommendations have been developed that suggest a lowering of the amount of carbohydrate.

Protein: Proteins are polymers composed of amino acids. Proteins are found in meat, milk, poultry, fish, cereal grains and beans. They are needed for cellular growth and repair. Twenty amino acids are found in proteins, of which humans can make eleven. The remaining nine are the essential amino acids which must be supplied in thediet.

Normally proteins are not used for energy, however during starvation (or a low-carb diet) muscle proteins are broken down for energy. Excess proteincan be used for energy or converted to fats.

Lipids and fats: Lipids and fats generatethe greatest energy yield, so a large number of plants and animals store excess food energy as fats.

Lipids and fats are present in oils, meats, butter, and plants (such as avocado and peanuts). Some fatty acids, such as linoleic acid, areessential and must be included in the diet. When present in the intestine, lipids promote the uptake of vitamins A, D, E, and K.

Vitamins: Vitamins are organic molecules required for metabolic reactions. They usually cannot be made by the body and are needed in trace amounts. Vitamins may act as enzyme cofactors or coenzymes. Some vitamins are soluble in fats, some in water.

Minerals: Minerals are trace elements required for normal metabolism, as components of cells and tissues, and for nerve conduction and muscle contraction.

Theycan only beobtained from the diet. Iron (for hemoglobin), iodine (for thyroxin), calcium(for bones), and sodium (nerve messagetransmission) are examples of minerals. There is a quantitative relationship between nutrients and health. Imbalances can cause disease. Many studies have concluded nutrition is a major factor in cardiovascular disease, hypertension, and cancer.

Digestionin Animals Facts from NCERT

- Starfish feeds on animals covered by half shells of calcium carbonate. After opening the shell, the starfish pops out its stomach through its mouth to eat the soft animals inside the shell. The stomach the goes back into the body and the food is slowly digested.
- The saliva breakdown the starch into sugar.
- Liver situated in the upper part of the abdomen on the right side. It is the largest gland in the body.
- In the process of digestion carbohydrates get broken down into simple sugars such as glucose. Fats into fatty acid and glycerol. Proteins into amino acid.
- Grass eating animals chewing continuously even when they are not eating because they quickly swallow the grass and store it in a separate part of thestomach called rumen. Here thefood get partially digested and is called cud, later the cud returns to the mouth in small lumps and the animal chews it. This process is called rumination and these animals are called ruminants.
- The grass is rich in cellulose a type of carbohydrates human cannot digest cellulose.
- Amoeba is a microscopic single celled organism found in pond water. When it sensefood, it pushes out one or more finger like projection (pseudopodia) around the food particles and engulf it and then the food becomes trapped in a food vacuole.

THE EXCRETORY SYSTEM

Excretory Systems in Various Animals

Excretory systems regulate the chemical composition of bodyfluids by removing metabolic wastes and retainingthe proper amounts ofwater, salts, and nutrients. Components of thissystem in vertebrates include the kidneys, liver, lungs, and skin.

Not all animals use the same routes or excrete their wastes the same way as humans do. Excretion applies to metabolic waste products that cross a plasma membrane. Elimination is the removal offeces.

A. Nitrogen Wastes

Nitrogen wastes are by product of protein metabolism. Amino groups are removed from amino acids prior to energy conversion. The NH_2 (amino group) combines with a hydrogen ion (proton) to form ammonia (NH_3).

Ammonia is very toxic and usually is excreted directly by marine animals. Terrestrial animals usually need to conserve water. Ammonia is converted to urea, a compound the body can tolerate at higher concentrations than ammonia. Birds and insects secrete uric acid that they make through large energy expenditure but little water loss.

Amphibians and mammals secrete urea that they form in their liver. Amino groups are turned into ammonia, which in turn is converted to urea, dumped into the blood and concentrated by the kidneys.

(B) Water and Salt Balance

The excretory system is responsible for regulating water balance in various body fluids.

Osmoregulation refers to the state aquatic animals are in: they are surrounded by freshwater and must constantly deal with the influx of water.

Animals, such as crabs, have an internal salt concentration very similar to that of the surrounding ocean. Such animals are known as osmocon-formers, as there is little water transport between the inside of the animal and the isotonic outside environment. Marincompositione vertebrates, however, have internalconcentrations of salt that are about one-third of the surrounding seawater. They are said to be osmoregulators. Osmoregu-lators face two problems: prevention of water loss from the body and prevention of salts diffusing into the body. Fish deal with this by passing water out of their tissues through their gills by osmosis and salt through their gills by active transport.

Cartilaginous fish have a greater salt concentration than seawater, causing water to move into the shark by osmosis; this water is used for excretion. Freshwater fish must prevent water gain and salt loss. They do not drink water, and have their skin covered by a thin mucus. Water enters and leaves through the gills and the fish excretory system produces large amounts of dilute urine. Terrestrial animals use a variety of methods to reduce water loss: living in moist environments, developing impermeable body coverings, production of more concentrated urine. Water loss can be considerable: a person in a 100 degree Ftemperature loses 1 liter of water per hour.

Excretory SystemFunctions

1. Collect water and filter body fluids.
2. Remove and concentrate waste products from body fluids and return other substances to body fluids as necessary for homeostasis.
3. Eliminate excretory products from the body.

Invertebrate Excretory Organs

Many invertebrates such as flatworms use a nephridium as their excretory organ. At the end of each blind tubule of the nephridium is a ciliated flame cell. As fluid passes down the tubule, solutes are reabsorbed and returned to the body fluids.

Body fluids are drawn into the Malphigian tubules by osmosis due to large concentrations of potassium inside the tubule. Body fluids pass back into the body, nitrogenous wastes empty into the insect's gut. Water is reabsorbed and waste is expelled from theinsect.

The Human Excretory System

The urinary system is made-up of the kidneys, ureters, bladder, and urethra. The nephron, an evolutionary modification of the nephridium, is the kidney's functional unit. Waste is filtered from the blood and collected as urine in each kidney. Urine leaves the kidneys by ureters, and collects in the bladder. The bladder can distend to store urine that eventually leaves through theurethra.

(a) The Nephron

The nephron consists of a cup-shaped capsule containing capillaries and the glomerulus, and a long renal tube. Blood flows into the kidney through the renal artery, which branches into capillaries associated with the glomerulus. Arterial pressure causes water and solutes from the blood to filter into the capsule. Fluid flows through the proximal tubule, which include the loop of Henle, and then into the distal tubule. The distal tubule empties into a collecting

duct. Fluids and solutes are returned to the capillaries that surround the nephron tubule.

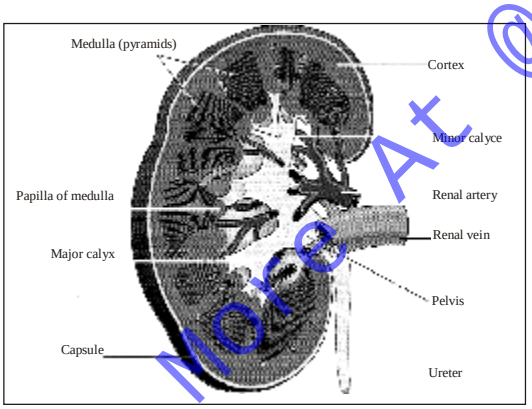
The nephron has three functions:

1. Glomerular filtration of water and solutes from theblood.
2. Tubular reabsorption of water and conserved molecules back into the blood.
3. Tubular secretion of ions and other waste products from surrounding capillaries into the distaltubule.

Nephrons filter 125 ml of body fluid per minute; filtering the entire body fluid component 16 times each day. In a 24 hour period nephrons produce 180 liters of filtrate, of which 178.5 liters are reabsorbed. The remaining 1.5 liters forms urine.

(B) Urine Production

1. Filtration in the glomerulus and nephron capsule.
2. Reabsorption in the proximal tubule.
3. Tubular secretion in the Loop of Henle.



(C) Components of the Nephron

- Glomerulus: mechanically filters blood
- Bowman's Capsule: mechanically filters blood
- Proximal Convoluted Tubule: Reabsorbs 75% of the water, salts, glucose, and amino acids
- Loop of Henle: Countercurrent exchange, which maintains the concentration gradient
- Distal Convoluted Tubule: Tubular secretion of H ions, potassium, and certain drugs.

(D) Kidney Stones

In some cases, excess wastes crystallize as kidney stones. They grow and can become a painful irritant that may require surgery or ultrasound treatments. Some stones are small enough tobe forced into the urethra, others are the size of huge, massive boulders.

(E) Kidney Functions

Kidneys perform a number of homeostatic functions:

1. Maintain volume of extracellular fluid
2. Maintain ionic balance in extracellular fluid
3. Maintain pH and osmotic concentration ofthe extracellular fluid.
4. Excrete toxic metabolic by-products such as urea, ammonia, and uric acid.

Hormone Control of Water and Salt

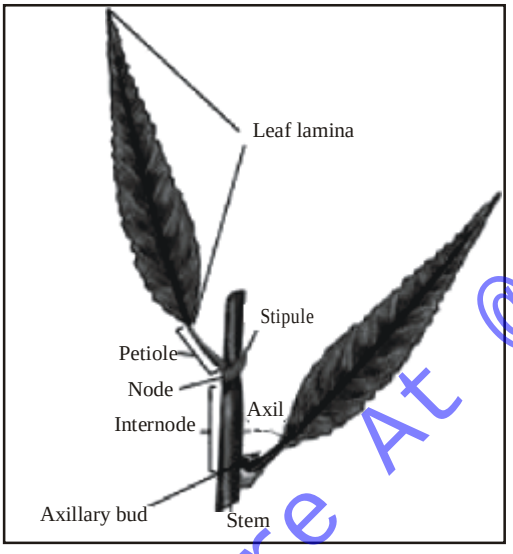
Water reabsorption is controlled by the antidiuretic hormone(ADH) in negativefeedback.

ADH is released from the pituitary gland in the brain. Dropping levels of fluid in the blood signal the hypothalamus to cause the pituitary to release ADH into the blood. ADH acts to increase water absorption in the kidneys. This puts more water back in the blood, increasing the concentration of the urine. When too much fluid is present in the blood, sensors in the heart signal the hypothalamus to cause a reduction of the amounts of ADH in the blood. This increases the amount of water absorbed by the kidneys, producing large quantities of a more dilute urine. Aldosterone, a hormone secreted by the kidneys, regulates the transfer of sodium from the nephron to the blood. When sodium levels in the blood fall, aldosterone is released into the blood, causing more sodium to pass from the nephron to the blood. This causes water to flow into the blood by osmosis. Renin is released intothe blood tocontrol aldosterone.

PHOTOSYNTHESIS

Structure of leaf

- Plants are the only photosynthetic organisms to have leaves (and not all plants have leaves). A leaf may be viewed as a solar collector crammed full of photosynthetic cells.
- The raw materials of photosynthesis, water and carbon dioxide, enter the cells of the leaf, and the products of photosynthesis, sugar and oxygen, leave the leaf.



- Water enters the root and is transported up to the leaves through specialized plant cells known as xylem.
- Land plants must guard against drying out (desiccation) and so have evolved specialized structures known as stomata to allow gas to enter and leave the leaf. Carbon dioxide cannot pass through the protective waxy layer covering the leaf (cuticle), but it canenter the leaf through an opening (the stoma; plural = stomata; Greek for hole) flanked by two guard cells.
- Likewise, oxygen produced during photosynthesis can only pass out of the leaf through the opened stomata.
- Unfortunately for the plant, while these gases are moving between the inside and outside of the leaf, a great deal water is also lost.
- Cottonwood trees, for example, will lose 100 gallons of water per hour during hot desert days. Carbon dioxide enters single-celled and aquatic autotrophs through no specialized structures.

Chlorophyll and Accessory Pigments

- A pigment is any substance that absorbs light. The color of the pigment comes from the wavelengths of light reflected (in other words, those not absorbed).
- Chlorophyll, the green pigment common to all photosynthetic cells, absorbs all wavelengths of visible light except green, which it reflects to be detected by our eyes.
- Black pigments absorb all of the wavelengths that strike them.
- White pigments/lighter colors reflect all or almost all of the energy striking them. Pigments have their own characteristic absorption spectra, the absorption pattern of a given pigment.
- Chlorophyll is a complex molecule. Several modifications of chlorophyll occur among plants and other photosynthetic organisms. All photosynthetic organisms (plants, certain protistans, prochlorobacteria, and cyanobacteria) have chlorophyll a. Accessory pigments absorb energy that chlorophyll a does not absorb. Accessory pigments include chlorophyll b (also c, d, and e in algae and protistans), xanthophylls, and carotenoids (such as beta-carotene).

Chlorophyll absorbs its energy from the Violet-Blue and Reddish orange-Red wavelengths, and little from the intermediate (Green-Yellow-Orange) wavelengths.

The Carbon Cycle

- Plants may be viewed as carbon sinks, removing carbon dioxide from the atmosphere and oceans by fixing it into organic chemicals. Plants also produce some carbon dioxide by their respiration, but this is quickly used by photosynthesis. Plants also convert energy from light into chemical energy of C-C covalent bonds. Animals are carbon dioxide producers that derive their energy from carbohydrates and other chemicals produced by plants by the process ofphotosynthesis.
- The balance between the plant carbon dioxide removal and animal carbon dioxide generation is equalized also by the formation of carbonates in the oceans. This removes excess carbon dioxide from the air and water (both of which are in equilibrium with regard to carbon dioxide). Fossil fuels, such as petroleum and coal, as well as more recent fuels such as peat and wood generate carbon dioxide when burned. Fossil fuels are formed ultimately by organic processes, and represent also a tremendous carbon sink. Human activity has greatly increased the concentration of carbon dioxide in air.

DIVERSITY IN LIVING ORGANISMS

Differentiation in Plants

(i) Thallophyta

- Plants that do not have well differentiated body design fall in this group.
- The plants in this group are commonly called algae. These plants are predominantly aquatic.

  E.g. : Spirogyra, cladophora and chara.

(ii) Bryophyte

- These are called the amphibians of the plant kingdom. There is no specialized tissue for the conduction of water and other substances from one past of the plant body to another.

  E.g. : moss (fumaria) and marchantia

(iii) Pteridopheysta

- In this group plant body is differentiated into roots, stem and leaves and has specialized tissue for the conduction of water and other substances from one plant of the plant body to another. Eg- marsilea, ferns, and horse tails.

(iv) Gymnosperms

- The plant of this group bear naked seeds and one usually perennial and evergreen and woody.

  Eg- pines such as deodar.

(v) Angiosperms

- The seeds develop inside an organ which is modified to become a fruit. These are also called flowering plants.
- Plant embryos in seeds have structures called cotyledons. Cotyledons are called seed leaves because in many instances they emerge and become green the seed germinates.
- The angiosperms are divided into two groups on the basis of the number of cotyledons present in the seed.
- Plants with seeds having a single cotyledon are called monocotyledons or monocots. Eg- paphiopedilum.
- Plants with seeds having two cotyledons are called dicots. Eg- ipomoce.

Differentation of Animals

(i) Porifera

These are non mobile animals attached to some solid support. There are holes or pores all over the body. These lead to a canal system that helps in circulating water throughout the body to bring in food and O_2. They are commonly called sponges mainly found in marine habitats.

(ii) Coelenterata

- These are animals living in water. The body is made up of two layers of cells. One makes up cells on the outside of the body and the other makes the inner living of the body.
- Some of these species live in colonies while others have a solitary life e.g. span (Hydra) jellyfish are common example.

(iii) Platyhelminthes

- There are three layers of cells from which different tissues can be made. This allow outside and inside body linings as well as some organs to be made.
- Thus there is some degree of tissues formation.
- They are either free living or parasitic. e.g. Planarians, liver flukes.

(iv) Nematode

- These are very familiar as parasitic worms causing diseases such as the worms causing elephantiasis (filaria worms) or the worms in the intestine (round or pin worms)

(v) Annelida

- They have true body cavity. This allows true organs to be packaged in the body structure. There is thus an extensive organ different ion. This differentiation occurs in a segmental fashion with the segment lined up one after the other from head to tail. Eg- Earthworms, leeches.

(vi) Arthropods

- There is an open circulatory system and so the blood does not flow in well defined blood vessels. They have joint legs.
  Eg- prawns, butterflies, houseflies, spiders, scorpions and crabs.

(vii) Mollusca

- They have an open circulatory system and kidney like organs for excretion. There is a little segmentation. There is a foot that is used for moving around. Eg- snails, and mussels, octopus.

(viii) Echinodermate

- There are spiny skinned organisms. These are exclusively free living marine animals. They have peculiar water driven tube system that they use for moving around. They have hard calcium carbonate structure that they use as skeleton.
  Eg- starfish, sea cucumber.

(ix) Protochordats

- They are marine animals.
  Eg- balanoglossus, hardemania and amphioxus.

(x) Vertebratia

- These animals have a true vertebral column & internal skeleton. These are grouped into five classes.
  Pisces
- These are fish. They are cold blooded and their hearts have only two chambers unlike the four that human have.
- Some with skeletons made entirely of cartilage, such as shark.
- Some with skeleton made of both bones and cartilages such as tuna or rohu.

(xi) Amphibian

- They have mucus glands in the skin and a three chambered heart.

Respiration is through either gills or lungs.

Eg- frogs, toades, and salamanders.

(xii) Reptilia

- These animals are cold blooded have scales and breathe through lungs. While most of them have a three chamber heart while crocodile have four heart chambers.

  Eg- snakes, turtles, lizards and crocodiles.

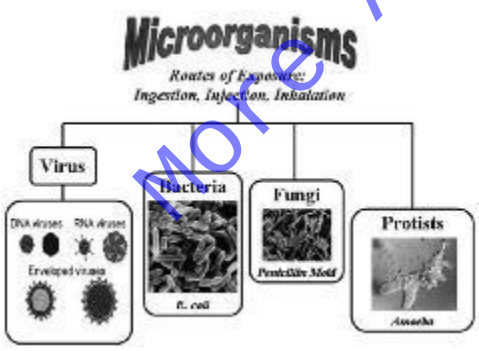
(xiii) Aves

- These are warm blooded animals and have a four chambered heart. They lay eggs. They breathe through lungs. All birds fall in this category.

(xiv) Mamalia

- They are warm blooded animals with four chambered hearts.
- They have mammary glands for the production of milk to nourish their young. They produce live young ones.
- However a few of them like platypus and the echidna lay eggs.

MICRO ORGANISMS: FRIEND AND FOE



FACTS FROM NCERT

Micro organisms are classified into four major groups. These groups are bacteria, fungi, protozoa and algae.

- **Viruses :** They reproduce only inside the cells of the host organisms which may be bacterium, plants or animal.
- Common cold, influenza and most coughs are caused by viruses.
- Serious diseases like polio and chicken pox are also caused by viruses.
- Micro organisms may be single celled like bacteria, Some algae and protozoa. Multicellular such as algae and fungi.
- Micro organisms like amoeba can live alone, while fungi and bacteria may live in colonies.

Friendly Micro Organisms

- Making of curd and breed:-milk is turned into curd by bacteria. The bacterium lacto bacillus promotes the formation ofcurd.
- Yeast reproduces rapidly and produces CO_2 during respiration. Bubbles ofthe gas fill the dough and increase its volume; this is the basis of the use of yeast in the booking industry for making breads, pastries andcakes.
- Yeast is used for commercial production of alcohol and wine. For this purpose yeast is grown as natural sugars present in grains like barley, wheat, rice, crushed fruit juiceetc.
- This process of conversion of sugar into alcohol is known as fermentation Luwis Pasteur discovered fermentation.

Medicinal Use of Micro Organisms

- The medicine which kills or stops the growth of diseases causing microorganism is called antibiotics.
- Streptomycin, tetracycline and erythromycin are some of the commonly known antibiotics. Which are made from fungi andbacteria.

- Alexander Fleming discovered penicillin.
- Antibiotics are not effective against cold and flu as these are coused by virus.

Vaccine

- When a disease carrying microbe enters our body, the body produces antibodies tofight the invader.
- The antibodies remain in the body and we are protected from the disease causing microbes. This is how a vaccine work.
- Several diseases including cholera, TB, small pox and hepatitis can be prevented by vaccination.
- Edward Jenner discovered the vaccine for small pox.

Increasing Soil Fertility

- Some bacteria and blue green algae are able to fix nitrogen from the atmosphere to enrich the soil with nitrogen and increase its fertility.
- These microbes are commonly called biological nitrogen fixer.

Harmful Microorganisms

- Microbial diseases that can spread from an infected person to a healthy person through air water, food, or physical contact are called communicable diseases. i.e.- cholera, common cold, chicken pox and TB.
- There are some insects and animals which act as carrier of disease causing microbes like house fly. Another is female anopheles mosquito which caries the parasite of malaria.
- Female aedes mosquito acts as carrier of dengu virus.
- Robert Koch discovered the bacteria (bacillus anthracis) which causes anthrax disease.
- It is a dangerous human & cattle disease.

Common Methods of Preserving Food in our Homes

- **Chemical method :** salt and edible oils are the common chemical generally used.
- Sodium benzoate and sodium metabisulphite are common preservatives. These are also used in the James and squashes to check their spoilage.

Preservation by sugar :

- Sugar reduces the moisture context which inhibits the growth of bacteria which spoil food.
- Use of oil and vinegar prevents spoilage of pickles become bacteria cannot live in such an environment.
- **Pasteurized milk :** the milk is heated to about 70°c for 15to 30 seconds and then suddenly chilled and stored.
- This process was discovered by lowise Pasteur. It is called pasteurisation.

Some Common Plant Disease Caused by Microorganisms

Plantdisease	*Microorganisms*	*Mode of transmission*
Citrus canker	Bacteria	Air
Rust of wheat	Fungi	Air, seeds
Yellow vein mosaic of bhindi	Virus	insect

Some Common Human Disease Caused by Micro Organisms

Human disease	*Causative microorganisms*	*Mode of transmission*	*Preventive measure*
Tuberculosis	Bacteria	Air	Keep the patient in complete isolation.
Measles	Virus	Air	Keep the person
Chicken pox	Virus	Air/contact	belonging of the patient
Polio	Virus	Air/Water	away from those of others Vaccination at suitable age.
Cholera	Bacteria	water/food	Maintain personal
Typhoid	Bacteria	water	hygiene and good sanitary habits. consumed properly cooked food and boiled drinking water vaccination
Hepatitis B	Virus	Water	Drink boiled drinking water vaccination.
Malaria	Protozoa	Mosquito	Spray insecticides and control breeding of mosquito.

FACTS FROM HUMAN MACHINE

- Camels have long legs which help to keep their bodies away from the heat of the Sand. They excrete small amount of urine, their dung is dry and they do not sweat. Since Camels lose very little water from their bodies, they can live for many days without water.
- Fish have slippery scales on their bodies. These scales protect the fish and also help in easy movements through water. The presence of specific features of certain habits, which enable a plant or an animal to live in its Surroundings, is called adaptation.
- There are some sea animals like squids and octopus, which do not have this streamlined shape. These animals have gills to help them use oxygen dissolved in water.
- There are some sea animals like dolphins and whales that do not have gills. They breathe in air through nostrils or blowholes that are located on the upper parts of their heads. This allows them to breathe in air when they swim near the surface of water. They can stay inside the water for a long time without breathing. They come out to the surface from time to time, to breathe in air.
- When we breathe out, the air moves from inside out body to outside. Breathing is part of a process called respiration. In respiration, some of the oxygen of the air we breathe, in used by the living body. We breathe out the Carbon dioxide produced in this process.

THE ANIMAL KINGDOM

Invertebrates

Of the million or more animal species in the world, more than 98% are invertebrates. Invertebrates don't have an internal skeleton made of bone. Many invertebrates have a fluid-filled, hydrostatic skeleton, like the jelly fish or worm. Others have a hard outer shell, like insects and crustaceans. There are many types of invertebrates. The most common invertebrates include the protozoa, annelids, echinoderms, mollusks and arthropods. Arthropods include insects, crustaceans and arachnids.

(I) Protozoa

Protozoa are simple, single-celled animals. Theyare the smallest of all animals. Most protozoa are microscopic in size, and can only be seen under a microscope. However, they do breathe, move and reproduce like multicelled animals.

There are several types of protozoa. The amoebas are clear, shapeless cells. Flagellates have a body shape looking like a hair. Although we can't see them, protozoa do a lot for us. Protozoa play a useful role in the food chain as a source of food for fish and other animals. Some protozoa are helpful to humans by eating dangerous bacteria. Unfortunately, other protozoa are parasites and can be harmful to humans by transmittingdisease.

Protozoa eat tiny algae and bacteria. Some protozoa absorb food through their cell membrane. Others surround and engulf their food or have openings to collect food. They digest their food in stomach-like compartments called vacuoles. Protozoa take in oxygen and give off carbon dioxide through the cell membrane. Protozoa reproduces by splitting in half.

(II) Worms and Leeches

There are about 9,000 species of Annelids known today, including worms and leeches. They can be found almost anywhere in the world. Annelids have existed on Earth for over 120 million years.

Annelids have bodies that are divided into segments. Theyhave very well-developed internal organs. One common characteristic of annelids is that they don't have any limbs.

Some annelids may have long bristles. Othershave shorter bristles and seem smooth, like the earthworm.

There are many types of worms.Commonly known worms include earthworms, roundworms and flatworms. Most worms are small, measuring fractions of an inch to several inches long. Other worms, such as the ribbon worm, can grow up to 100 feet in length. Some worms are considered parasites, in that they live inside the humanbody.

(III) Mollusks

Mollusks were among the first inhabitants of the Earth. Fossils of mollusks have been found in rocks and date back over 500 million years. Mollusk fossils are usually well preserved because of their hard shell. Most mollusks have a soft, skin-like organ covered with a hard outside shell. Some mollusks live on land, such as the snail and slug. Other mollusks live in water, such as the oyster, mussel, clam, squid and octopus.

Land living mollusks, like the snail, move slowly on a flat sole called a foot.Ocean living mollusks move or swim by jet propulsion. They propel themselves by ejecting water from their body. For example, the squid ejects water from a cavity within its body, and the scallop ejects water to move by clamping its shell closed.Other ocean living mollusks, like the oyster, attach themselves to rocks or other surfaces, and can't move. They feed by filtering small food particles from water that flows through them.Snail and SlugThe snail family consists of marine snails and land snails all over the world. Land snails live in many habitats from gardens and woodlands, to deserts and mountains. Marine snails are native to all the worlds oceans and seas, and many freshwater rivers and lakes. Along with slug, snails make up the gastropod class of the mollusk phylum. Snails have an external shell, large enough to withdraw their body into it. Gastropods without a shell are known as slugs.

Octopus

There are about 300 different species of octopus native to many of the world's oceans, especially coral reefs. The octopus doesn't have an internal or external skeleton, allowing it to squeeze into very small places. The octopus has eight arms or tentacles, that it uses for crawling, exploring things and catching prey. The octopus' arms have suckers capable of grasping and holding objects, such as their prey. The octopus has a hard beak in the center of its arms that it uses to tear apart its prey for eating. Like the squid, the octopus can suck water into its mantle and expel it out in a fast, strong jet. This jet propulsion

provides fast, forward movement. Also like the squid, the octopus can eject a thick cloud of ink to help it escape from predators.

(IV) Squid

There are about 300 species of squid. They are native to most of the world's oceans. The squid has a distinct head, eight arms and two tentacles. The mouth of the squid has a sharp horny beak used to kill and tear its prey into small pieces. The main body of the squid is enclosed in the mantle, which has a swimming fin along each side. However, the swimming fin is not the squid's main way of moving through the water. The squid can suck water into the mantle and expel it out in a fast, strong jet. This jet propulsion provides fast, forward movement. Although most squid are less than 2 feet in length, the giant squid can grow up to 43 feet in length.

(V) Cuttlefish

Despite their name, the cuttlefish is not a fish, but a mollusk. The cuttlefish is native to all of the oceans of the world, but are more common in shallow coastal temperate and tropical waters. The cuttlefish has an internal shell or bone, called the cuttlebone, that helps them to be buoyant. Attached to this body structure is the head with eight arms and two feeding tentacles. The cuttlefish can easily camouflage itself by changing its skin color and pattern to blend in with its background. This helps the cuttlefish to hide from predators, and the sneak up on its prey. Like the squid and octopus, the cuttlefish can eject ink in an effort to escape from predators. This ink, called sepia, was once used as a dye to create ink used by artists.

(VI) Nautilus

The nautilus is native to deep ocean waters. It has a multi-chambered shell. Each chamber is sealed and contains gas which provides the nautilus with buoyancy to float. Like the octopus, squid and cuttlefish, the nautilus uses jet propulsion to move forward. It sucks in water, then expels it in a fast, strong stream to propel itself forward. The nautilus has as many as 90 small tentacles that it uses to catch food, such as shrimp, fish or small crustaceans. It then uses its powerful beak to crush the food. The nautilus is considered a living fossil because its form has remained unchanged for over 400 million years.

(VII) Echinoderms: Starfish, Sea Urchin and Family

Echinoderms are marine animals that live in the ocean. Common echinoderms include the sea star, sea urchin, sand dollar and seacucumber. Most echinoderms have arms or spines that radiate from the center of their body. The central body contains their organs, and their mouth for feeding.

Sea stars, commonly known as the starfish, have 5 or more arms attached to their body.

On the bottom of the Starfish are small tube feet to help with movement and feeding. The starfish's mouth is underneath, and is capable of eating other sea life such as clams and mussels. Another type of echinoderm is the sea urchin. Sea urchins have many spines connected to their body. These spines help to protect them frompredators.

(a) Starfish

The starfish or sea star is native to all of the world's oceans. There are about 1,800 different species of starfish with the greatest variety living in the tropical Indo-Pacific region. Most starfish have fivearms, although some have fewer or more arms. Like other enchinoderms, starfish have small tube feet on their underneath body to help with movement and feeding. The starfish's mouth is underneath, and it has two stomachs in the mouth. The stomach sack can come out through the mouth to engulf and digest food, such as clams and mussels.

(b) Crustaceans

Crustaceans are a type of Arthropod. The name may not sound familiar, but you probably know them. You may even have eaten one.

Crustaceans live mostly in the ocean or other waters. Most commonly known crustaceans

are the crab, lobster and barnacle. Crustaceans have a hard, external shell which protects their body. Crustaceans havea head and abdomen. The head has antennae which are part of their sensory system. The abdomen includes the heart, digestive system and reproductive system.

The abdomen also has appendages, such as legs, for crawling and swimming. Many crustaceans also have claws that help with crawling and eating.

(VIII) Crab

There are about 10,000 different species of crab. The crab is native to all of the world's oceans. There are also freshwater crabs, and even some crabs that live on land. Crabs have a large, hard shell. Extending from the front of its shell are the eyes, mouth and two pairs of antennae. The crab has 5 pairs of legs extending from the side of its shell. The first pair of legs have claws or pincers used to catch and hold food. Theother pairs of legs are used for walking. Most crabs don't swim, they use their legs to walk. However, some crabs such as the Blue Crab can use their legs as paddles to swim.

(a) Lobster

Lobsters are native to most oceans of the world. The lobster habitat is rocky, sandy or muddyocean bottomand theyare generally found hiding in crevices or in burrows under rocks. Lobsters have fivepairs of legs, thefirst pair of legs are claws used to catch and hold food. Lobsters have a large exoskeleton. As lobsters grow, the must molt to shed their old exoskeleton as they grow alarger new shell.

(b) Shrimp

Shrimp are native to many of the world's oceans and lakes. They are generally found in shallow water. Their habitat includes both fresh and salt water. Although most shrimp are small, some can grow up to 9 inches in length. The shrimp has a very simple body consisting of the head and thorax, and a muscular abdomin for swimming. They have 8 pairs of legs, 5 for swimming and 3 for feeding. They also have2 pairs of antennae use for taste and smell to find food. As a crustacean, the shrimp has a thin, almost transparent, exoskeleton. The shrimp is a popular food. In addition to commercial fishing for shrimp, shrimp are also grown in shrimp farms. Shrimp are also commonly found in aquariums.

(IX) Arachnids: Spiders, Ticks and Scorpions

Arachnids are a type of arthropod. You know many of them as spiders. Common arachnids are spiders, scorpions, ticks and mites.

Like other arthropods, the arachnids have a hard exoskeleton and jointed appendages for walking. Most arachnids have 4 pairs of legs. In some, the first pair of legs may be used for holding their prey and feeding. Unlike other arthropods, arachnids do not haveantennae.

Spiders are easily recognized with their 8 legs. All legs are used for walking. The first pair of legs is also used for holding prey and feeding. The second pair of legs may also be used for holding and killing their prey. Most spiders have 8 eyes. Spiders have fangs that are used to inject poison to paralyze or kill their prey. Many spiders can produce silk threads to spin webs for catching prey, and for building an egg sack to hold and protect their eggs.

Scorpions are large arachnids, some reaching over 8 inches in length. They have 4 pairs of legs, and a pair of pincers for catching and holding their prey. Scorpions also have a sharp stinger at the end of their tail that is used to paralyze or kill insects and small animals.Mites and ticks are small arachnids that are parasites living on the blood and tissue fluid of other animals. They can occasionally transmit disease. The abdomen also has appendages, such as legs, for crawling and swimming. Many crustaceans also have claws that help with crawling and eating.

(a) Scorpion

Scorpions are native to many parts of the world. There are about 1,400 different species of scorpion. They prefer warm or hot climates, but

can even be found in cold, snowy areas. Their habitat includes deserts, grasslands and savannahs, forests, intertidal zones, mountains and caves. Scorpions arebest known for their long, segmented tail with its venom-injecting barb. The scorpion will use its venomous stinger to capture prey and defend against predators. Scorpions have four pairs of legs and a pair of pincer-like pedipalps. These pincers can also be used to catch prey and defend against predators. Scorpions are nocturnal animals. They prefer to find shelter during the day in underground holes or under rocks where it is cool. They come out atnight to hunt and feed. Most scorpions prey on insects, spiders, centipedes, and other scorpions. Large scorpions may also prey on small lizards, snakes and mice.

(b) Spider

Spiders are found world-wide on every continent except for Antarctica. There are approximately 40,000 different species of spiders. Spiders vary in size from quite small to relatively large. The Goliath Birdeater can grow up to 10 inches measuring its leg span. Most people can easily recognize a spider by its eight legs. One spider, the Daddy Long Legs, is even named after its eight long legs.

Another recognizable feature related to the spider is its web. Spiders have spinneret glands they useto build webs. Thesewebs provide shelter and help catch food. Spiders also have fangs. Many spiders can inject a venomous liquid through their fangs. This venom is capable of paralyzing or killing predators or prey. Some venom, such as fromthe Brown Recluse or Black Widow, can even be dangerous or deadly to humans. Although some people are scared of spiders, most spiders will only bite humans in self-defense. Fear of spiders is called arachnophobia. Most spiders have four pairs of eyes. This provides them with very good vision. Some spiders, such as the Tarantula, can be very hairy. While many people are scared of the tarantula, this spider is generally quite harmless. Some people even keep a tarantula as a pet.

(c) Tarantula

The tarantula is a large, hairy spider found in tropical to temperate regions of the southwestern United States, Mexico, Central America, South America, southern Europe, Asia, Africa and Australia. Tarantulas can go up to 4 inches in body size, and have a leg span of up to 12 inches.

Like other arachnids, the tarantula has eight legs, arranged in four pairs. It also has another pair of appendages used for feeling and gripping prey. The tarantula has two fangs used to inject venom into its prey, or in defense against predators. Tarantulas prefer to hunt at night. They will lay a web, but not to catch their prey. They lay strands of web on the ground to act as atrip wire. When an insect, frog, toad or mouse steps on the strand, alerting the tarantula, it will pounce on the unsuspecting victim.

Although many people find the tarantula scary, it is generally harmless to humans. They will not bite unless provoked, and if bittenthepain is usually similar to that of a bee sting. Some tarantulas have even become a popular pet.

(d) Spider Web

Spiders can produce silken thread using spinneret glands on their abdomen. This thread is very strong. It is stronger than a similar size thread of steel. Spiders use this silken thread for many things. A spider will spin a web to protect the entrance of their home from birds or wasps. A web is also used to catch insects or other food. The thread is sticky, and once an insect touches the web, it gets caught. Vibration of the web tells the spider an insect has flown or crawled into the web.

The spider will then wrap its prey in silken thread so it can't escape. The thread is also be usedto attach an egg sack to the web. This protects the eggs until theyoungareborn. Sometimes a web is used as a path between places where it is difficult to crawl. Thereare many different shaped spider webs. Some spiders spin a circular web, or orb web. Other webs look like funnels or tubes. Some webs look like a sheet.

(X) Insects

Insects are the largest group of arthropods. There are over 800,000 different types of insects. Insects are very adaptable, living almost everywhere in the world. Common insects include the fly, beetle, butterfly, moth, dragonfly, bee, wasp and praying mantis.

Insects have an exoskeleton that covers their entire body. An insect's body consists of 3 parts: the head, thorax and abdomen.

The insect's head has a pair of antennae, and a pair of compound eyes. Compound eyes are different from human eyes which have a single lens for each eye. Compound eyes have many lenses for each eye. For example, the fly has about 4,000 lenses in a single eye. This provides them with very good eyesight.

The thorax contains the legs for walking, swimming, jumping or digging. The thorax may also have wings for flying. The abdomen contains many body organs, such as the heart, respiratory system, digestive system and reproductive system. The insect's hard, exoskeleton makes it difficult for the insect to grow and get larger. This is because the exoskeleton can't grow and get larger. Many insects must molt in order to grow. Molting is the process where an insect sheds it outer skeleton. It wriggles out of this old skin, and a new, larger exoskeleton develops. Invertebrates were the first animals to evolve. The first invertebrates evolved from single-celled, food-eating microorganisms. Invertebrates are often most noted for what they lack: a backbone and a bony skeleton. Invertebrates account for 97 percent of all known species. The simplest invertebrates, in fact the simplest animals, are sponges. Most invertebrates change form as they grow, going through a process known as metamorphosis. Some species of invertebrates form large colonies. Invertebrates will eat almost anything that was or is alive. Many of the world's parasites are invertebrates.

Vertebrates

Animals with an internal skeleton made of bone are called vertebrates. Vertebrates include fish, amphibians, reptiles, birds, mammals, primates, rodents and marsupials.

Although vertebrates represent only a very small percentage of all animals, their size and mobility often allow them to dominate their environment.

(i) Fish

Almost three-forths of the world's surface is covered in water. This water is home to over 20,000 different species of fish. The earliest fossils of fish date back over 400 million years. There are a wide variety of fish — from the goby which is less than one half an inch long, to the whale shark which can be over 60 feet long. Most fish breathe through gills. Gills perform the gas exchange between the water and the fish's blood. They allow the fish to breathe oxygen in the water.

Fishes are vertebrates that have a skeleton made of either bone or cartilage. About 95% of fishes have skeletons made of bone. These bony fishes have a swim bladder, a gas-filled sac, that they can inflate or deflate allowing them to float in the water even when not swimming. Fishes with a cartilage skeleton tend to be heavier than water and sink. They must swim to keep afloat. Cartilaginous (cartilage) fish include the ray and the shark.

Most fish swim using a tail fin. Muscles in the tail fin move it from side to side, forcing water backward, and propeling the fish forward. Other fins help the fish change direction and stop. Pectoral fins on their side help them swim up and down. Dorsal and anal fins on the top and bottom keep the fish upright. Pelvic fins on the underside help steer left and right. Many fish eat plants, while others such as the shark, eat other fish. **Flying Fish** There are about 50 species of flying fish. They are found in all major oceans of the world, particularly in the warm tropical and subtropical waters of the Atlantic, Pacific, and Indian oceans. As their name implies, these fish can fly. They can't fly as well as a bird, but they can take short flights through the air. Most flying fish use their large pectoral fins as wings. The fish can take short gliding flights above the surface of the water in order to escape from predators

(a) Paddlefish

There are two different species of paddlefish: the Chinese paddlefish and the American paddlefish. The Chinese paddlefish lives in the Yangtze River in China. The American paddlefish lives in the Mississippi, Missouri, Des Moines, Yellowstone, Ohio and Oklahoma Rivers inthe United States. Themost recognizable feature of the paddlefish is its large mouth and longsnout or bill. The spatula-like snout can be half the length of its body. This is why the paddlefish is sometimes called thespoonfish

FACTS ABOUT FISH

Fish are divided into three basic groups which include cartilaginous fish, bony fish, and lobe-finned fish. Fish were the first animals to evolvebackbones.

The ray-finned fish are the largest group of fish.

Fish move by creating a wave motionthat moves the length of its body.

Fishare cold-blooded (ectothermic) animals.

Many species of cichlids brood their eggs in theirmouth.

After the eggs hatch the parent continues to use their mouth to provide shelter for their young.

Cartilaginous fish include the sea's largest and most skilled marine predators.

These include sharks, skates, rays, and chimeras. These fish have skeletons made from cartilage, not bone. The cartilaginous skeletons are more flexible than bone.

The lateral line system on some fish detects variations in water pressure.

This helps fish detect prey and avoid predators.

(II) AMPHIBIANS

Amphibians lay their eggs in water, and young amphibians tend to resemble small fish.

The tadpole, or newborn frog, is born and lives in water. It has a tail that allows it toswim like a fish. It also has gills so that it can breathe under water. As the tadpole grow into a frog, it loses its gills and tail, and develops legs for moving on land. Most amphibians can both walk and swim in water.

Depending on the species of amphibian, breathing can take place in gills, lungs, the lining of the mouth, the skin, or some combination of these.

Amphibians body temperature changes with its environment. In cold climates, amphibians hibernate during the winter.There are over 6,400 species of amphibians found worldwide, except in Antarctica and Greenland. Amphibians are vertebrates and include animals such as frogs, toads, salamanders, newts and worm-like caecilians. They can be found on land, and in fresh water. They live in a variety of habitats from deserts to rain forests, permanent ponds or high mountain meadows. Most amphibians have four limbs, but some amphibians don't have any limbs. Amphibians are cold-blooded meaning they use the environment to regulate their body temperature. Amphibians spend part of their life in water, and part of their life on land.

(III) REPTILES: AFRICAN CLAWED FROG

The African Clawed Frog is native to South Africa, the sub-Saharan in east and southern Africa, and Namibia and Angola in western Africa. Their habitat includes warm stagnant pools and quiet streams. Their name comes from the three short claws on each of its hind feet. It spends most of its time underwater, only coming to the surface to breathe. African clawed frogs don't have tongues. The frog's uses its front limbs and unwebbed fingers to push food into its mouth.

(a) Poison DartFrog

The poison dart frog is a family of frogs native to Central and South America. Their habitat is humid, tropical areas such as tropical rainforests. They may live on the ground as well as in trees. Most poison dart frogs are brightly colored, which makes them easily recognizable and warns potential predators to stay away. Why do the predators stay away? As their name implies, this frog is highly poisonous. Theysecrete

a toxin through their skin that is capable of killing a predator. Many species are critically endangered

(b) Frog

There are over 5,000 species of frogs. They are native to most of the world, except Antarctica. Generally, we think of frogs as having a short, stout body with long hind legs ideal for jumping. Most of uscanrecognize a frog's call as the familiar croaking or ribbit sound. Another common characteristics is that frogs don't have tails. The various species also have a wide range of different characteristics. Some frogs are small, such as the Coqui. Other frogs can be quite large. Some frogs are even poisonous, such as the Poison Dart Frog.

(c) Reptiles: Lizards, Snakes, and Others

Reptiles have been around for 300 million years, even during the dinosaur age. The most common reptiles include alligators, crocodiles, lizards, snakes, tortoises and turtles. Reptiles are air-breathing animals, although many live not only on land but in water. The most noticeable feature of reptiles are the scales that cover their body. The majority of reptiles lay eggs to givebirth to their young. Although reptiles breathe through lungs, some reptiles can also absorb oxygen in water through membranes in their mouth.

Reptiles are often called cold-blooded because they can't regulate their own body temperature. Their body temperature depends on the external temperature. They will lay in the sun to heat their body, or hide in the ground, under a rock or in water to cool their body.

Crocodiles and alligators are large reptiles that spend muchoftheir time onland and in water. They can walk on land using their webbed feet. They can also use their long tail to swim in water. Crocodiles feed on large animals they catch on land or in water. They have powerful jaws and teeth to tear apart their prey.Lizards and snakes are the largest group of reptiles. Lizards are four legged animals with a long tail. Many lizards can shed their tail to escape from predators. They can then grow a new tail.Some lizards, such as the chameleon, can change colors to blend into their environment. This camouflage helps to protect them frompredators.

Snakes don't have limbs. They move by slithering along the ground. Some snakes are poisonous, or venomous, such as the rattle snake, cobra, and eastern green mamba. They have fangs which bite into their prey and inject poison into the victim. Other snakes, such as the boa constrictor and the python kill their prey by crushing it.

Most snakes can dislocate their jaw, allowing them to swallow prey much larger than themselves.

(d) Alligator

The alligator is native to the United States and China. Alligators are covered with scales, head to toe. They can grow up to fifteen feet long and weigh over one thousand pounds. Based on fossils, the alligator has been on earth for 200 millionyears. They have a verystrong jaw, capable of crushing their prey. Alligators are cold-blooded. They lay eggs to produce their young.

(e) Anaconda Snake

The anaconda is a large, non-venomous snake native to tropical South America and Northern Africa. They mostly live in swampy or watery areas. The green anaconda is the biggest snake in the world, with the largest measuring up to 37.5 feet in length. The anaconda is related to the boa constrictor snake. They kill their prey by constriction or squeezing. They wrap themselves around their prey and squeeze to prevent the prey from breathing. They then swallow the animal whole.

(f) Chameleon

The chameleon is a member of the lizard family native to Africa, Madagascar, southern Europe, and Asia. There are about 135 different species of chameleon. Their habitat includes rain forest, savanna, semi-desert, and steppe land. Chameleons are best known for their ability to change color. However, they don't really change color to match their surroundings, but based on mood, such as fear or anger, and based on temperature and humidity. They are also known for their ability to move each eye separately, and for their long, sticky tongue. Their eye can rotate

360 degrees to view its prey, they its fast, sticky tongue can catch its prey.

(g) Cobra Snake

The cobra is a venomous snake native to Africa and Asia. There are about 30 different species of cobra, with the King Cobra being the world's largest venomous snake. The cobra's habitat ranges from tropical rain forests and swamps to savannas and deserts. The name cobra is Portuguese for "snake with hood." Cobra's are most famous for this hood, which is created by elongated ribs that extend the loose skin of the neck behind the snake's head. Cobras will raise the front part of their bodies and display their hood when threatened or disturbed. They will also make a hissingsound.

(h) Crocodile

The crocodile is native to tropical areas in Africa, Asia, the Americas and Australia. The crocodile is an ancient, prehistoric creature, believed to have inhabited earth for over 200 million years. The name crocodile comes from an Ancient Greek word meaning "lizard of the river." Crocodiles prefer freshwater habitats like rivers, lakes and wetlands. Crocodiles are similar to alligators and caiman. They are very fast over short distances, even out of water. They catchtheir prey by waiting for fish or land animals to come close, then rushing out to attack.

(i) Coral Snake

The coral snake is a venomous snake native to southern United States including Arizona and from Louisiana to North Carolina, including all of Florida. Coral snakes are small in size, averaging 3 feet in length. They are a very beautiful snake with their red, yellow/white, and black colored banding. They are the second most venomous snake in the United States, behind the rattlesnake.

Iguan

The iguana is a family of lizards native to tropical areas of Central and South America and the Caribbean. The green iguana, which is a popular pet, lives in tropical rainforest areas near water, suchas rivers or streams. Other iguanas live in the dry, hot desert. Like other reptiles, the iguana is cold blooded meaning they do not produce their own body heat. If an iguana is cold, it will lie on warm rocks to soak up the sun's heat. Green iguanas are omnivorous meaning they eat both plants and meat, but they mostly eat plants.

(j) Komodo Dragon

The komodo dragon is a lizard native to islands in Indonesia. They are a member of the monitor lizard family. They are the largest of the lizards, growing up to 10 feet in length and weight over 200 pounds. It is carnivorous, eating animals such as pig and deer. It is also cannibalistic, eating other komodo dragons. The komodo dragon has even been known to attack and kill humans. They are now an endangered species.

(k) Lizard

There are over 5,000 different types of lizards in the world. They are native to every continent, except Antarctica. Most lizards are small and harmless to humans. But, the large Komodo Dragon has been known to attack and kill humans. Lizards have some of the strangest characteristics. Some lizards can walk on water. Others can lose their tail to escape a predator. Others can squirt blood from their eyes. The Chameleon can change colors to match its surroundings. The Chinese Water Dragon can not only swim to escape predators, but it can remain under water for up to 25 minutes. Some lizards are small, but others such as the Monitor Lizard can grow up to 6 feet in length. Lizards such as the Gila Monster are venomous. And, some lizards such as the Gecko and the Iguana are commonpets.

(l) Mamba Snake

The black mamba is native to Africa. Their habitat is open grasslands, savannahs and woodlands. It is the largest venomous snake in Africa and the second largest venomous snake in theworld. They are considered the deadliestsnake in Africa. They are also considered fastest land snakein the world, able to reach speeds of 12 miles per hour. Although they are called the black mamba, they are generally gray, gray brown, or

olive greenin color. The nameblackmambacomes from the black color inside their mouth.

(m) Viper Snake

The viper is a family of venomous snakes found all over the world, except in Australia and Madagascar. Vipers range in size from the small dwarf viper which is 10 inches in length, to the large bushmaster at 10 feet in length. Vipers have a pair of fangs that are used to inject venom from glands in the rear of the upper jaws. These fangs are hinged, and when not in use fold backagainst the roof of the mouth.

(n) Turtle

Turtles are a reptile found in most parts of the world. Some turtles live on land, while others live in the sea. They are easily recognized by their shell. The turtle's shell is covered with scales made keratin, the same material as human fingernails. Many turtles can retract their head and limbs into their shell for protection. The largest turtle, the leatherback sea turtle, can have a shell length of 80 inches. A small turtle may be only 3 inches long. Turtles have a beak, not teeth. Female turtles lay eggs to reproduce their young.

(o) Tortoise

The tortoise is a reptile, closely related to the turtle. The tortoise is often described as a land turtle. Turtles usually live in water and have large blade-shaped flippers for swimming. Therefore, turtles find it hard to walk on land. Whereas, the tortoise has legs rather than flippers and can walk quiet well on land. Like the turtle, the tortoise has a large protective shell. Tortoises can have longer life span that humans, sometimes living to be over 150 years old.

(p) Sea Turtle

Sea turtles are native to all the world's ocean, except the Arctic Ocean. The largest sea turtles are seven feet in length and five feet in width, weighing up to 1300 pounds. Some sea turtles are believed to live to be 80 to 100 years old. Sea turtles spend much of their time under water, but must return to the surface to breathe air. All species of sea turtles are listed as threatened or endangered.

(q) Sea Snake

Sea snakes are found in warm, tropical, coastal waters of the Indian Ocean and Pacific Ocean. A few species are also found in Oceania. Sea snakes are venomous snakes, and have fangs. Sea snakes are highly adapted to living in the water. For example, they have a paddle-like tail for swimming. Althought these snakes spend most of their time in the water, they must come to the surface to breathe air

(r) Pitviper Snake

The pitviper is a family of venomous snakes found in Eastern Europe, Asia and the Americas. Their habitat ranges from desert to rainforests. Pitvipers have a deep pit between the eye and the nostril on either side of the head. This is an organ that detects heat from warm-blooded prey. Common pitvipers include the bushmaster, copperhead and rattlesnake

(s) Python Snake

The python snake is native to Africa, Asia and Australia. Burmese pythons were introduce to the Florida Everglades National Park in the 1990s. The python is one of the largest snakes in the world. The reticulated python may grow to over 30 feet long and weight over 300 pounds. The python generally feeds on small reptiles and mammals, but has been know to eat deer and other large animals. The python kills its prey by constriction. It wraps itself, or coils around itsprey suffocating the animal by preventing it from breathing.

(t) Rattlesnake

Rattlesnakes are venomous snakes native to North America and a few other parts of the Northern Hemisphere. They get their name from the rattle located at the tip of their tails that is used as a warning device when threatened. The rattle is a set of rings on the tip of their tail. When vibrated, the rattle creates a hissing sound that warns off predators. Rattlesnakes use their venomous bite to catch and kill prey such as mice, rats, small birds and other small animals.

Facts About Reptiles

There are about 8,000 species of known reptiles alivetoday.
The first reptiles appeared approximately 340 million years ago during the Carboniferous Period.
Reptiles are cold-blooded.
Reptiles have scales.
The Mesozoic Era is the 'Age of Reptiles'.
In many reptiles, the sex of the youngis determined by the temperature the embryos are exposed to during incubation.
Some of the largest reptiles alivetoday include the leatherback turtle, the Komodo dragon, and the saltwater crocodile.

(IV) Birds

There are over 8,000 species of birds. Birds have 3 major differentiating characteristics: wings for flight, feathers, and a beak rather than teeth. Birds have adapted their vertebrate skeleton for flight. Their bones and skull are very thin, making their bodies extremely light. To support flight also required other changes to their skeleton. Obvious changes are the addition of wings. Other changes are less obvious. The claws and muscles of a bird's foot are designed to lock and hold onto a perch evenwhile the bird is sleeping.A bird's respiratory system is also adapted to make it easier to breathe at high elevations, where air is thinner.

More information on birds

(a) Albatross

The Albatross is a large sea bird found near the Southern Ocean and North Pacific. The albatross is among the largest flying birds, and has the largest wing span. Its large wings are excellent for flying, but can make taking off and landing quite difficult.

(b) Swan

Swans are a family of birds native to many parts of the world includingthe Americas, Europe, Asia, Africa and Australia. Swans are the largest of the waterfowl compared to ducks and geese. The largest swan in the world is the trumpeter swan of North America whose wingspan can reach 10 feet. The habitat of the swan is ponds, lakes, coastal bays and rivers. They are easily recognized by their very long necks which are often held in a graceful curve. Their long necks allow them to feed underwater without diving

(c) Vulture

Vultures are native to the Americas, Africa, Asia, and Europe. They are scavenging birds feeding mostly on carrion, that is carcassesofdead animals. Vultures have a good sense of smell, and can smell a dead animal from great heights. One recognizable characteristic of many vultures is their bald head with no feathers

(d) Ruby-ThroatedHummingbird

The ruby-throated hummingbird isnative to: the Canadian prairies; eastern Canada, United States and Mexico; Central America; and, parts of South America. Its habitat is deciduous and pine forests and forest edges, orchards, and gardens. The hummingbird has strong flight muscles and blade-like wingsallowing it toflynot only forward, but also straight up and down, sideways, and backwards, and to hover in front of flowers as it feeds on nectar and insects.

(e) Parrot

Parrots are nativeto most warm and tropical parts of the world including Australia and the islands of the Pacific Ocean, India, southeast Asia, southern regions of North America, South America and Africa. There are about 372 different species of parrot. Parrots are one of the smartest birds. Not only can they mimic human speech, studies have shown they can associate words with their meanings and form simple sentences

(f) Ostrich

The ostrich is a large flightless bird native to Africa. It is easily recognized by its long neck and legs. The ostrich is a fast runner, capable of reaching speeds up to 45 miles per hour. A large male ostrich can weight up to 350 pounds. Matching its size, ostrich eggs are the largest of

all eggs. Penguins are a group of aquatic, flightless birds mostly living in the Southern Hemisphere, particularly the Antarctica. However, the Galápagos Penguin prefers a more temperate climate living near the equator. Penguins are easily recognizable by their black and white coloring, and their unusually upright, waddling gait. The penguin looks like it is formally dressed in a man's tuxedo. These birds have adapted for life inthe water. Their wings have become flippers allowing them to swim fast in the water.

(g) Peacock

Peacocks are large colorful pheasants. Although most people know this bird by the name peacock, this name specifically refers to the male bird. The female is called a peahen. Collectively they are referred to as peafowl. There are three species of peafowl. The blue peacock lives in India and Sri Lanka, the green peacock lives in Java and Myanmar, and the Congo peacock lives in African rain forests. The peacock is best known for its known and valued for its brilliant tail feathers. This iridescent blue-green or green colored tail plumage, also called the train, has bright spots on it called "eyes"

(h) Kiwi

The kiwi is a flightless birds native to New Zealand. It is an endangered species. They are an interesting looking bird with a plump body and a long bill. Kiwi are shy and usually nocturnal. The kiwi is a national symbol of New Zealand. They areso well knownto the world, andrepresentative of New Zealand, that all New Zealanders are called "Kiwis".

(i) Hornbill

Hornbills are a family of birds native to tropical and sub-tropical Africa and Asia. They can be found in open country as well as forested areas. The most distinctive feature of the hornbill is their heavy bill. It is long and down-curved, and often brightly-colored. Hornbills are omnivorous birds meaning they will eat fruit, insects andsmall animals. They cannot swallow food from the tip of the beak because their tongue is too short. They must toss it to the back of their throat.

(j) Great Blue Heron

The great blue heron is a large wading bird commonover most of North and Central America, as well as the West Indies and the Galápagos Islands. They live near bodies of water such as fresh and saltwater marshes, mangroveswamps, flooded meadows, lake edges, or shorelines.They build their nest in trees or bushes near the water. They are often seen standing in shallow water or at the water's edge. They use their long legs to wade through the water, and they spear fish or frogs with their long, sharp bill.

(k) Golden Eagle

The Golden Eagle is a large bird of prey living in North American and other parts of the northern hemisphere. It is one of the best known birds of prey in the Northern Hemisphere. It is powerful and strong with a wingspan of over 7 feet.

The golden eagle's eyesight is about 8 times more powerful than a human, and can spot prey from a long distance. Their talons are well designed for killing and carrying their prey. They also have a powerfulbeak for tearing into its food.

(l)Flamingo

The flamingo can be found in many parts of the world including Africa, Asia, North America, Central America, South America, and Europe. They live near large, shallow lakes or lagoons. They are best know for their pink color. They also have distinctive long legs and neck, and a curved, pink bill colored black on the end.

(m) Falcon

The falcon is a species of raptor found on every continent, except Antarctica. They live in a wide variety of habitats from tropics, deserts, and maritime to the tundra. They have excellentvision allowing them to see prey from high in the sky. Once spotting its prey, the falcon dives downafter it. Falcons have thin tapered wings enabling them to fly at high speed and to change direction rapidly. Peregrine Falcons can dive at speeds over 200 miles per hour (322 km/hr), making them the fastest-moving animal onEarth.

Facts About Birds

Theearliest known bird, Archaeopteryx lithographica, lived about 150million years ago during the Jurassic Period.
Birds are not the only animals that are capable offlight.
Flight is not a characteristic restricted to birds. Bats, which are mammals, fly with great agility and insects, which are arthropods, were fluttering through the air several million years before birds
Birds do not have teeth.
The largest of all birds is the ostrich.

(V) Mammals

Mammals have several unique characteristics that differentiate them from other animals. Most mammals havehair, or fur, covering their body. They are also capable of regulating their bodytemperature. Themammalsmetabolism controls heat production, and the sweat glands help cool the body. These allow the mammal to maintain a constant body temperature, regardless of the environmental temperature. One other difference is that mammals give birth to fully formed babies, and the female mammals produce milk to feed their young. Most mammals walk on 4 legs, with only the humans walking upright on 2 legs. Aquatic mammals have flippers, or fins, for swimming rather than legs. Common mammals include: primates, such humans and monkeys; marsupials; rodents; whales; dolphins; and,seals.

(a) Marsupials

Marsupials are best known for the Australian members of the family, the kangaroo, wallaby and the koala. The only marsupial native to North America is the Virginia opossum. There are also some marsupials native to Central America and South America.

Marsupials are members of the mammal family. However, they are different from other mammals because they have an abdominal pouch to carry their young. The marsupial female gives birth very early and the baby animal climbs from the mother's birth canal to her pouch. Here the baby marsupial continues to develop for weeks, or even months, depending on the species.

At birth, marsupial babies are not fully developed. The baby's hind legs are just nubs. The baby lives and continues to develop in the mother's pouch. The pouch, or marsupium, also has themother's mammary glands for feeding the baby. A baby kangaroo may live in its mother'spouch for 6 months. Koalas and wombats are a little different from Kangaroos. The kangaroo's pouch is on the front, while the koala and wombat pouches are on the back.

(b) Kangaroo

The kangaroo is native to Australia. It is the largest of the marsupials, and a national symbol of Australia. As a marsupial, the kangaroo differs from other mammals in having a pouch on its stomach for carrying its young. Early European explorers in Australia said the kangaroo had a head like a deer (without antlers), stood upright like a man, and hopped like a frog. Kangaroos have large, powerful hind legs, and large feet,well adapted for jumping. They can hop along at 25 miles per hour, and are capable of reaching speeds up to 45 miles per hour for short distances.

(c) Primates

Humansare part of theprimate family. Other common primates include the monkey, baboon, orangutan, chimpanzee and gorilla. While humans inhabit much of the world, most other primates live in tropical or subtropical regions of the Americas, Africa and Asia.

Primates have several distinctive features that separate them fromother mammals. Primates have well developed hands and feet, with fingers and toes. Their opposable thumb makes it easy for them to grabthings.

Primate eyes are forward in the head giving themstereoscopic vision. Thisallowsthem to judge distance. Primates also have large, highly developed brains. Their intelligence allows them to control and manipulate their environment. The highly developed visual center of the brain helps

primates distinguish colors. Their large brain also allows them to develop complex language and communication skills.Monkeys and apes walkon all four limbs, but theymay run upright using only their hind legs.

Although primates are born fully formed, they tend to have a long gestation period in their mother's womb. Parents also care for and educate their young much longer than other animals. This results in a strong bond between a baby and the mother.Primates are very social animals, and tend to form strong bonds with family and friends.

While humans are similar to monkeys in many ways, there are also several significant differences. The human brain is more than twice the size of other primates. This makes humans the most intelligent primate, with the most developed communication, language and reasoning skills. Humans are able tomake and use complex tools to help control their environment. Humans also walk upright on two legs. Although primates are born fully formed, they tend to have a long gestation period in their mother's womb.

(d) Rodents: Squirrels, Mice, Porcupines and Others

The largest family of mammals are the rodents. These mammals are named rodent, which means "gnawing animal," because of their large incisor teeth and the way they eat. The two long pairs of incisors are used like chisels to gnaw on hard foods like nuts and wood. These incisors must grow continuously since they are worn down by gnawing. There are 3 major types of rodents, represented by squirrels, mice and porcupines.

Squirrel-like rodents such as the squirrel and gopher, have bushy long tails and large eyes. They can live in trees or underground in tunnels. They may hibernate during the winter.Mouse-like rodents include the mouse, rat and hamster. Some have a long, thin tail with short legs. Others have a short tail. They mostly live above ground, although some burrow under ground. They may also hibernate during the winter. Rats and mice often live near humans, sometimes in their buildings, so they can live off human food and garbage.Porcupines differ from other mammals because they have long, sharp quills on their backs for protection.

(e) Whales and Dolphins

Although they live in the water — whales, dolphins and porpoises are mammals. Since whales and dolphins are mammals, theycannot breathe under water. They must come to the surface to breathe air. They breathe through a blowhole, or nostrils, on the top of their head. Babies are born under water and must be pushed to the surface, by the mother, so that they can take a breath. Whales and dolphins also look different from many other mammals because they don't have fur. Although, theydo havea sparsecovering of hair. The circulatory and respiratory systems have adapted to living in water. Whales and dolphins can dive deep in the water on a single breath.Whales and dolphins also have a highly developed brain. They are consider to be very intelligent.Dolphins, and some whales, can use echolocation to find food and identify objects around them. They make loud clicking and squeaking sounds that bounce off objects and echo back to the dolphin. This echo tells the dolphinabout the nearby object.

(f) Whale

The whale is a marinemammal found many ocean areas from arctic and sub-arctic to warmer waters. Whales are best known for their size, which can be up to 110 feet long. The Blue Whale is the largest known mammal to ever live, up to 110 feet long and weighing 150 tons. Thewhale breathes air into its lungs through a blowhole on the top if its head.

(g) Orca

The Orca, also known as the Killer Whale, is the largest of the dolphin family. It can be found in most of the world's oceans. Orca's have very distinction coloring with a black back, white chest and sides, and a white patch above and behind the eye. The orca is considered very intelligent and trainable. The orca's playfulness and sheer size make them a popular exhibit at aquariums and aquatic theme parks.

(h) Dolphin

Although dophins live in the water, they are a mammal. They are related to the whale and porpoise. They breathe air through a blow hole on the top of their head. They must routinely return to the surface for air. Dolphins are very friendly to humans, and are considered to be very intelligent.

(i) Seals, Seal Lions and Walrus

The seals are marine mammals. The seal family includes the seal, sea lion and the walrus. A seal's respiratory system is adapted for water. A seal can go for 40 minutes without a breath. This allows them to dive to a depth of over 2,000 feet. Seals are well designed to swim in water. Their bodies arevery streamlined and their flippers propel them quickly through the water. Seals also spend considerable time lying around on rocky islands and beaches. But they are clumsy and move slowly on land using their flippers. Baby seals are born on land after a long, 12 month gestation period. The pups developrapidly, with some able to swim within a few hours of birth.Walruses differ from seals in that they are larger and have large tusks. They can be over 10 feet long and over 3,000 pounds.

Facts About Mammals

The first Mammals are tetrapods.Mammals have four limbs, a characteristic that places them among the group of animals known as tetrapods. It should be noted that although some mammals such as whales, dugongs, and manatees havelost their hind limbs during the course of evolution, they are tetrapods bydescent.mammals appeared approximately 200 million years ago during the Jurassic Period.Mammals are warm-blooded.All mammals have hair.The Cenezoic Era is the 'Age of Mammals'.The largest mammal is the blue whale.Thesmallest mammal is the bumblebee bat.

Th Basics of Vertebrate Evolution

From Jawless Fish to Mammals

- Evolution
- Vertebrates

Vertebrates are a well-known group of animals that includes mammals, birds, reptiles, amphibians, and fish. The defining characteristic of vertebrates is their backbone, an anatomical feature that first appeared in the fossil record about 500 million years ago, during the Ordovician period.

Jawless Fish (Class Agnatha)

The first vertebrates were the jawless fish (Class Agnatha). These fish-like animals had hard bony plates that covered their bodies and as their name implies, they did not have jaws. Additionally, these early fish did not have paired fins. The jawless fish are thought to have relied on filter feeding to capture their food, and most likely would have sucked water and debris from the seafloor into their mouth, releasing water and waste out of their gills.

The jawless fish that lived during the Ordovician period all went extinct by the end of the Devonian period. Yet today there are some species of fish that lack jaws (such as lampreys, and hagfish). These modern day jawless fish are not direct survivors of the Class Agnatha but are instead distant cousins of the cartilaginous fish.

Armored Fish (Class Placodermi)

The armored fish evolved during the Silurian period. Like their predecessors, they too lacked jaw bones but possessed paired fins. The armored fish diversified during the Devonian period but declined and fell into extinction by the end of the Permian period.

Cartilaginous Fish (Class Chondrichthyes)

Cartilaginous fish, better known as sharks, skates, and rays evolved during the Silurian period. Cartilaginous fish have skeletons composed of cartilage, not bone. They also differ from other fish inthat theylack swim bladdersand lungs.

Bony Fish (Class Osteichthyes)

Members of the Class Osteichthyes first arose during the late Silurian. The majority of modern fish belong to this group. Bony fish diverged into two groups, one that evolved into modern fish, the other that evolved into lungfish, lobe-finned fish, and fleshy-finned fish. The fleshy finned fish gave rise to the amphibians.

Amphibians (Class Amphibia)

Amphibians were the first vertebrates to venture out into land. Early amphibians retained many fish-like characteristics but during the Carboniferous period amphibians diversified. They retained close ties to water though, producing fish-like eggs that lacked a hard protective coating and requiring moist environments to keep their skin damp. Additionally, amphibians underwent larval phases that were entirely aquatic and only the adult animals were able to tackle land habitats.

Reptiles (Class Reptilia)

Reptiles arose during the Carboniferous period and quickly took over as the dominant vertebrate of the land. Reptiles freed themselves from aquatic habitats where amphibians had not. Reptiles developed hard-shelled eggs that could be laid on dry land. They had dry skin made of scales that served as protection and helped retain moisture. Reptiles developed larger and more powerful legs than those of amphibians. The placement of the reptilian legs beneath the body (instead of at the side as in amphibians) enabled them greatermobility.

Birds (Class Aves)

Sometime during the early Jurassic, two groups of reptiles gained the ability to fly andone of these groups later gave rise to the birds. Birds developed a range of adaptations that enabled flight such as feathers, hollow bones, and warm-bloodedness.

Mammals (Class Mammalia)

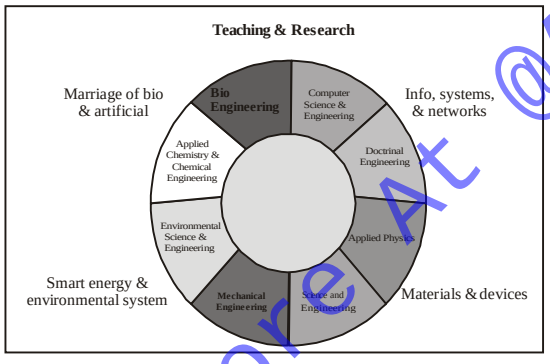
Mammals, like birds, evolved from a reptilian ancestor. Mammals developed a four-chambered heart, hair covering, and most do not lay eggs and instead give birth to live young (the exception is the monotremes).

Progression of Vertebrate Evolution

The following table shows the progression of vertebrate evolution (organisms listed at the top of the table evolved earlier than those lower in the table).

Animal Group		*Key Features*
Jawless Fish	-	no jaws- no paired fins- gave rise to placoderms, cartilaginous and bony fish
Placoderms	-	no jaws- armored fish
Cartilaginous fish	-	cartilage skeletons- no swim bladder- no lungs- internal fertilization
Bony fish	-	gills- lungs- swim bladder- some developed fleshy fins (gave rise to amphibians)
Amphibians	-	first vertebrates to venture out onto land- remained quite tied to aquatic habitats- external fertilization- eggs had no amnion or shell- moist skin
Reptiles	-	scales- hard-shelled eggs- stronger legs positioned directly beneath body
Birds	-	feathers- hollow bones
Mammals	-	fur- mammary glands- warmblooded

RADARS WORK



The word radar stands for radio detecting and ranging. It makes use of very short radio waves called microwaves. Radars work to find out how far away an Object is and in case of a moving object in what direction it is moving and at what speed.

COLOR TV PICTURE PRODUCED

The picture on a television screen is nothing but a pattern of glowing dots, or pixels. The pixels are made up of fluorescent chemicals called phosphors that are coated on the back on the screen. These glow on being hit by a beam of a single phosphorus and are lit up by a single electron beam that rapidly sweeps across the screen. In a color television how-ever, each pixel contains three phosphorus each producing a different colour-green, red and yellow. Three electron beams produced by three electron guns are used to light up the different phosphorus.

FIRE EXTINGUISHERS WORK

Fire extinguishing agents work basically in two ways – either by cooling the burning materials or by blanketing them with an inert coating that cuts off the supply of oxygen. One of the most common ones uses water which has a high heat capacity.

Foam type fire extinguishers use foaming agents that have a smothering and cooling effect on the wire. A dry chemical extinguisher sprays a very fine power of sodium bicarbonate or potassium bicarbonate or monoammonium phosphorus. These solids coat the fuel and smother the fire. A safe and effective extinguisher
for all confined fires uses carbon dioxide (co_2) which acts as an inert blanket.

LIE DETECTORS WORK

A lie detectors work on the principal that a person who tells a lie is nervous and under stress under these conditions his body undergoes some physiological changes.

These includes increases in the blood pressure, heart beat rate and perspiration on hands and soles. These changes are monitored and detected by a lie – detector.

STORAGE BATTERIES WORK

Storage batteries are devices which act as a store house of electrical energy. The electrical energy is stored in the form of a chemical charge which is reversible. The most common storage battery is the lead acid- accumulator which uses lead as electrode and sulphuric acid as an

electrolyte. Initially both the cell electrodes of the battery made of lead are coated with a layer of lead dioxide. When the battery is charged for the first time, chemical charges take place. During discharging when the battery is in use, chemical changes take place again but in the reverse way. Each cell in a lead – acid battery produces two volts and a typical car battery with six cells gives 12 volts. Nickel – iron and nickel – cadmium batteries are other kind of storage batteries which are nickel, and iron or cadmium as electrodes and potassium hydroxide aselectrolyte.

AEROPLANES FLY

Aeroplanes fly by a combination of power from the engines and lift provided by the wings. These are shaped in such a way that air flowing along the upper surface takes a longer path than the air flowing along the lower surface. As a result when an aircraft moves forward, the air flowing above the wings moves faster than the air flowing below the wings, creating a low pressure above the wing according to Bernoulli's law. This difference in pressure above and below the wings causes lift. As the speed of the aircraft on the runway increases, the lift also increases, eventually overcoming the download force of gravity. The aircraft also uses the thrust created by its engine to climb and after reaching certain height cruises along in a horizontal direction.

HELICOPTERS REMAIN STATIONARY IN MID AIR

Unlike an aeroplane, helicopters have moving wings in the shape of spinning rotor blades. Air currents passing over the upper and lower surface of the spinning blades crates low pressure above it and generate lift. The lift can be controlled by varying the pitch (angle) of the rotor blades, by increasing the pitch of the main rotor blades lift is increased and the craft climbs. Lowering the pitch of the blades lift is increased and the craft climbs. Lowering the pitch of the blades reduces lift and gravity causes the helicopter to descend. Similarly , if the pilot holds the rotor pitch in such a way the blades produce just enough lift to counteract gravity, the helicopter remains station ary in mid – air.

NIGHT VISION GLASSES WORK

Night vision glasses, used for seeing in the pitch dark night, use the little light available to form an image ofsufficient brightness to be screen.

The image is first focused, as in a camera, on to a window which is coated with special chemicals containing sodium, potassium, cadmium and oxygen compounds which emit electrons when illuminated.

Theelectrons so emitted are thenaccelerated by a series of powerful electric fields and made to fall into another screen coated with a fluorescing chemical which glows recreating a much brighter image of the original scene. Some night vision glasses make use of infrared radiation emitted by all objects even in the dark. These radiations are amplified in a similar way to make nightvision possible.

AIR POLLUTION DETECTORS WORK

Air pollution is coused by substance that is not normally part of the atmosphere's composition. Important air pollutants are sulpher dioxide, nitrogen oxides and carbon mono oxide usually emitted in automobile exhausts and power smoke. Pollution detectorswork bymaking use of the chemical or physical properties of the pollutants. For example, the detection of nitrogen oxides is based on the emission of light as a result of a chemical reaction. This phenomenon is called chemilumine-scences.

If nitrogen are present, light is emitted which can be detected by a photo detected. Sulphur dioxide is detected by introducing it into a flame and then analyzing the colour produced by an instrument called flame photometer. Carbon monoxide is detected by emission of infrared radiation of a particular frequency when excited

by an arc or a spark. An infrared spectrometer is used to detect the presence of this gas in air.

ATM WORK

An automatic teller machine (ATM) performs simple banking functions such as deposits withdrawal, cash dispensing, and transfers between accounts.An ATM is a terminal connected via telephone or dedicated telecommunication lines to larger computer system that identify the user's account on the basis of data stored in a magnetic strip on the back of a plastic ATM card commonly known as the credit card. The user operates the system using an exclusive personal identification number (PIN), assigned to him or her.

ARTIFICIAL DIAMONDS MADE

Diamond is formed in nature from graphite beneath the earth crust by the action of extreme heat and pressure. Artificial diamonds are made by mimicking the natural process by applying intense heat and pressure on graphite in the presence of iron as catalyst.

A pressure of up to 1, 00,000 kg per sq. Cm. is applied and an electric furnace is used for heating the compressed mixture up to 2500 C. On cooling, the molten mass contains, tiny artificial diamonds firmly surrounded by iron.

PEARLS CULTURED

A pearl is a biological product produced naturally by certain oysters as a defense mechanism. They are formed when a foreign body such as a sand particle enters the body of the oyster. the oysters in order to get rid of the foreign body coasts it with a material called nacre which is basically the chemical calcium carbonate. Over a period of time these layers make the pearl grow in size until they are taken out. Pearls are cultured by inserting an artificial irritant into the oyster. The oysters are then carefully tended in special beds.Cultured pearls usually take three to six years to grow to a good size.

CRUDE OIL REFINED

Crude oil that comes out of an oil well is a thick, dark liquid containing a mixture of many organic compounds. It cannot be put to use without refining. The different constituents of crude oil boil at different temperature. Refining processes may be classified as fractional distillation separates crude oil into some of its fractions depending on their boiling points. Some components are separated by solvent extraction in which an organic solvent is used to extract the substances especially solids which are then recovered by crystallization or evaporation of the solvent. Cracking is also a process used in refiners to produce useful petrochemicals. Here heat and catalyst are used to break down some of the heavier hydrocarbons to lighter, more useful fractions.

COOKING OIL REFINED

Vegetable oils are mixtures of chemicals called glycerides or esters of glycerides and long chain fatty acids. Oil is obtained by crushing oil bearing seeds such as ground nut, sunflower seeds or rapeseed, and then pressing the oil through expellers.

These mechanically extracted oils contain impurities like gums and free fatty acids (FFA), which have to beremoved to make the oils suitable cooking media. Refining of oils is done by first treating it with alkali which forms soap with the FFAs. The soaps settle out carrying with them some colouring matter. The colour and odour are removed by treating the oil with some absorbing materials like fuller's earth. Refining can also be done by extracting the pure oil with a suitable organic solvent like hexane and then removing the solvent by distillation.

PHOTOCOPIES MADE

Photocopying makes use of materials which can be electrostatically charged and which loses the charge when exposed to light. In a photocopying machine a drum made up of

selenium is first charged electrically in the dark. An image of the illuminated document to be copied is then projected on to the charged drum.

The illuminated areas in the image falling on the drum destroy the electric charge while the dark areas retain the charge. The drum is then dusted with a fine black resinous powder called toner image of the original document. The image is transferred to paper which is given the opposite charge. The toner image is finally fixed on the paper by applying heat which melts the toner and sets it into the fibers producing a permanent dry copy of the original document. The entire process is automated.

COLOR PAINTING DONE

A printed colour picture is made up of tiny dots of three primary colours-cyan, magenta, yellow, and black. For printing, there fore, the colour original is first separated by scanning into negatives for cyan, yellow, magenta and black. During scanning, a screen of dots is also used so that the images on the four negatives are in the form of fine dots which is necessary for printing.

The most popular colour printings process used these days is offsets printings. Offset printings employs specially treated aluminum plates on which the printings ink sticks only to selected areas. When the plate, made sensitive to light by chemical coating, is exposed to light through the film negative and washed, coated areas that repel water but accept oil based ink remain. The plate is mounted on a cylinder in printing machine and wetted so that only the printed areas are linked. The impression from the printing plate is first transferred to a cylinder covered with a rubber blanket which finally transfers the impression onto paper.

WE FALL ASLEEP

In humans the sleep wakefulness cycle is controlled by the hypothalamus located in the lower portion of the brain.

MEHANDI COLOUR SKIN

Mehandi or henna leaves contain a colouring matter called Lawsone. This is a dye which can bind with the protein in hair and nails. This protein is called keratin. The skin of the palms and soles also contain keratin.

BLOOD PRESERVED

Outside the body, blood coagulates in five to ten minutes. Coagulation involves alteration in one of the plasma protein called fibrinogen into an insoluble protein called fibrin with the help of calcium icons. Coagulation can, therefore, be prevented by removing the calcium icons from blood. For preservation of blood meant for transfusion, sodium citrate is added which removes calcium form blood by forming a soluble complex withit.

BODY TEMPERATURE MAINTAINED

The body has an in built temperature regulating mechanism in the shape of the hypothalamus in the brain. The heat of the blood passing through it and the messages sent from the temperature sensitive nerve endings on the skin feed information to the hypothalamus. Once region of the hypothalamus so sensitive to temperature above normal while another region is sensitive to a fall in body heat.

When the body gains too much heat it loses the extra heat by sweating. When the environment is cold, the body generates extra heat by stepping up metabolism and muscle activity such as shivering. These changes are brought by path ways controlled by the nerves that are concerned with reflex control of bodily functions.

AIDS DETECTED

AIDS is caused by a virus called human immunodeficiency virus or HIV. The presence of this virus is detected by screening the blood of a person for special kinds of proteins called

antibodies which are produced in the body in response to viral infection A characteristic feature of antibody molecules is that they are highly specific. They bind only to certain regions of the antigen. This is similar to a key fitting only a specific lock. AIDS detection tests are actually based on detecting the binding of the antibodies present in the blood with an artificially synthesized antigen attached to a solid surface.

ALCOHOLIC BEVERAGES INTOXICATE

Alcoholic beverages contain ethyl alcohol which on reaching the brain and slows down the activity of the central nervous system especially those parts of the brain that control a person's behavior.

BATS FLY IN THE SKY

Bats navigate by making use of sounds that they emit. The way these sounds bounce off from nearby objects and obstacles and return to the bat's ears enables it to gauge distance and avoid obstacles. Being in the range of 100,000 hertz, these sounds are inaudible to human ears which can hear only unto 20,000 hertz.

Bats can discriminate between faint echoes of their own sound in the presence of other sounds. Interestingly. Large bats suchas the flying fox do not use sound for navigating but rely on vision instead. They fly and feed by day and become disoriented if forced to fly in the dark.

CAMELS SURVIVE IN DESERTS

Camels can survive for days in desert with little food and no water due to their unique physiology. Contrary to the common belief, a camel does not store water serves as a reverse for energy and a source of water when in need. When the fat is utilized by the camels body, hydrogen is released which combines with oxygen to form water.

FIREFLIES GLOW

A firefly emits yellow-green light from special organs located in the lower portion of its abdomen. These organs contain in enzyme called luciferase which acts as a catalyst. When luciferin comes in contact with oxygen from air inpresence of lucifrease, it gets oxidized emitting flashes of light. The light produced is, cool.

LIZARDS WALK ON WALLS

The feet of lizards are adapted for walking on rough as well as smooth surface. The lizards have slits on their toes and these functions like suction disks helping them to cling to smooth areas such as a glass pane. The claws present on toes help the lizard to hold on to and walk on a rough surface. in this way a lizard can even walk upside down across a plastered ceiling or on a glass roof withouttrouble.

ANIMALS SEE AT NIGHT

Members of the cat family, like the tiger and cat or other nocturnal animals can see in near darkness because of the presence of large number of cells called rod cells in the retina. These cells are sensitive to dim light and help the animal to see in near darkness. Other nocturnal animals like owl and Loris have very large pupils which allow more light to enter the eyes. In addition, the retina of these animals has a layer called 'tapetum lucidum'. This reflects inwards the light falling on retina and thus help in gathering all the light available in darksurrounding.

FRUITS RIPEN

Unripe fruits are typically hard, green, and have a sour on astringent tastedue to the presence of organic acids such as malic, citric, and tartaric.

They have high amounts of large molecule carbohydrates called polysaccharides and low amount of protein. Ethylene gas which triggers the ripening process emanates from fruits and causes rapid and dramatic changes. The green color of the fruits disappears and red, or yellow

coloured pigments such as anthocyanins and carotenoids appear giving the fruits distinct colour.

The polysaccharides are broken down to smaller sugars which give the fruits the sweet taste. The fruits also begin to soften. Volatile substances are produced during ripening which gives many fruits their distinct aroma.

PLANTS CAPTURE INSECTS

Certain plants which grow in soil poor in nutrients depend on insects for their nutritional requirement. These carnivores' plants use a combination of deception and a trapping device to get theirmeals.

Some insects – eating plants like the venus fl trap (dionaea musipula) have leaves moulded into twin blade traps with teeth likeprojections on their margins which interlock to trap any insect sitting on the leaf. Leaves of another plant names drosera have glandes all over themwhich secrete a sticky substance to trap insects. The pitcher plant has fluid filled pitches – shaped structure into which unwary insects fall and drown. All insects eating plants secrete digestive juices to digest their prey.

WATER RISE IN TALL TREES

Cells in the root hairs of plant contain dissolved sugars and salts. Water surrounding the root moves into them to equalize the pressure. This is called osmosis.

The increased water pressure in root hairs forces water up-word, cell by cell through theroots and trunk to reach the leaves. In addition to this, during the growing season, a tree passes tones of water into the atmosphere from its leaves through transpiration.

This creates a partial vacuum that is quickly filled by the water being pushed up from the roots. Water molecules stick together, and as water is lost during transpiration, this cohesion causes a chain reaction that is transmitted all the way down.

ANNULAR RINGS IN PLANTS FORMED

The annular rings or the altering dark light circles seen in a cross section of a tree are produced because of differences in the rate of growth in different seasons. As it happens , the entire tissue in the trunk of a tree does not divide or grow to increase the girth of the tree. There is a layers of dividing tissue called the cambium sandwiched between the fibrous xylem (the water carrying tissue).

However, the cambium divides at different rates in different seasons. In winter, its growth is slower than in other season, say in spring, when conditions for growth are fairly favorable. Thus, the relatively small numbers of cells produced in winter remain compacted together producinga dark band while the cells produced during the spring season spread out into a boarder light band. These growth patterns are repeated at annual intervals and hence the annular rings thus indicate the age of a tree as well as the changes in climate that might have occurred in the tree's life time.

LIGHTING OCCURS

Lightening is coused by an electric discharge in thunder clouds. These are clouds that rise to great heights and have strong air currents in them. The ice crystals, water droplets and other particles present in these collide with each other and get electrically charged.

Air usually works as an insulator to prevent these electric charges from escaping. But when the charge build up in the thundercloud crosses a certain level, the insulation effect of air breaks down and causes a massive discharge which we see as flashes of lighting. As the discharges takes place, the surroundings are suddenly expands to produce the sound which we hear as thunder. Lighting can pass from one cloud to another or from a cloud to the ground.

ARTIFICIAL RAIN PRODUCED

Rain occurs when the water vapour in the clouds forms water drops or ice crystals large and heavy enough to fall to the ground. This process is hastened if the cloud has tiny particles of matter for the water vopour to condense on. Artificial rain produced byintroducing these particles into the clouds by a process called cloud seeding.

Clouds can be seeded in different ways. The seeding agent can be sprayed into a cloud from an air plane or sent up in a rocket. If the wind is strong enough, it can be dispersed in the form of smoke from the ground. At cloud temperature above 0°C solid carbon dioxide or crystals of silver dioxide is used. Water vapour in the clouds condenses around the seeding agent to form rain drops. If the temperature is below 0°C ice crystals are formed. When the ice crystals pass through air warmer than 0°C, they melt and fall as rain. Artificial rain is best produced from moisture-laden clouds. It cannot be produced from a cloudless sky.

WOOLLENS KEEP US WARM

Wool fibres are made of a particular protein (keratin) which is a bad conductor of heat and as a result does not allow heat to escape. This helps us in keeping warm during winter. These fibers are wavy in structure, the property commonly known as crimp. Crimp imparts resilience to the fibres due to which fibres quickly recover from wrinkling and crushing. Because of this wavy structures the fibres do not come perfectly close and a result a large number of air pockets are formed. The air entrapped within these pockets acts as an insulator and traps body heatinside.

CURD FORMED

This bacteria produces produces lactic acid by the fermentation of the milk sugar lactose. The lactic acid so formed by the bacteria action contains positive hydrogen ions which are attracted to the negative particles of the protein casein. As the latter are neutralized, these protein molecules no longer repel one another but coagulate. The optimum temperature at which lactobacillus acts is around 40 c. so milk is usually warmed to this temperature before setting it to curdle.

Stars Born

Stars take birth out of clouds of hydrogen, helium and dust particles present in galaxies. Due to the turbulent motion in these gas clouds, the dust particles undergo random collisions and condense under the influence of strong gravitational pull.

As the gases and dust particles begin condensing, the temperature inside rises due to increasing pressure. As the condensing mass grows bigger the gravitational pressure at the centre increases further till the intense heat raises the temperature to around 10 millions degree Celsius. At this temperature the hydrogen atoms start colliding so vigorously that they fuse with each other to form helium atoms. In the process some mass is lost. For every 1000 kg of hydrogen used up, 993 kg of helium is formed. The rest is converted into tremendous amount of energy according to the relation ship E=mc2, where E is the energy, m the mass and c the velocity of light. This energy is liberated in the form of light and heat and a star isborn.

TEMPERATURE OF SUN MEASURED

There are many ways of measuring temperature. The most common is the mercury thermometer in which an expanding Column of mercury in a glass capillary indicates the temperature. But a mercury thermometer cannot be used to measure temperature above 357°C. for measuring higher temperature such as that in a furnace, instruments called pyrometers are used. But for measuring the sun's temperature a different technique is used. It makes use of the fact that the colour at which a hot object gives off the maximum energy is directly related to the temperature of the hot body.

This is governed by a law known as Wien's law. The sun gives off light which is a mixture of several colours. When the spectrum of sunlight is analyzed by using special instruments called bolometer it is found that the maximum intensity falls in the green part of the sun's spectrum. From this and by using Wien's law, we obtains a value of 5800 k for the sun's surface temperature.

SPACESUITS PROTECT

A spacesuit is protective gear that protects an astronaut from the hostile environment of extremely low pressure, low temperature and radiation in space. It is made up of several layers of strong synthetic materials including Teflon and nylon which shield the astronauts from tiny particles called micrometeoroids. The intense solar radiations are reflected by a white plastic layer which has a metallic coating. The interior of the suit is pressurized but for which the astronaut's blood would boil off in the vacuum of space. A backpack carries water both for drinking as a well as to keep the astronaut cool. Water flows through piper in the astronaut's suit and carries away bodyheat.

FIREWORKS DISPLAY COLOURS

Fireworks are produced by metals or metal salts present in the fireworks. Metals have the property of emitting light of a particular colour while they burn. For instance, when sodium or its salts burn, yellow light is given out. Similarly, on burning, finally divided aluminum gives out bright white light. Strontium salts gives out red colour while copper and barium salts produce instance blue and green colours respectively. Fireworks manufactures make use of thisproperty of metals and their salts and use them in various combinations in crackers to produce spectacular fireworks display.

PLANTEST SPHERE SHAPED

All the planets of our solar system were formed out of the same cloud of gas and dust that gave rise to the sun, some five billion years ago. As random Collisions and gravitational forces compacted the gas and dust particles into the various planets the heat generated brought the masses into a molten state. Since surface tension ofaliquid tendstomakethe surfaceareaminimum and the sphere has the minimum surface area for a given volume, all the plants in the molten state become spherical and have retained that shape as theycooled.

SEA WATER SALTY

Sea water is salty because it containts many dissolved salts, mostly sodium chloride with small proportions of potassium, magnesium, calcium and carbonates. The salt comes mainly with river water that flows through rocks eroded by frost and rain. The gradual wearing away of mountains releases rnemicals which are carried down by rivers to the ocean comes mainly with river water that flows through rocks eroded by frost and rain. The gradual wearing away of mountains releases rnemicals which are carried down by rivers to the ocean as dissolved salts.

Some salt also enters sea water from the rocks beneath the sea bed; the river water carrying salts to the sea does not taste salty because the salts are present in extremely small concentration. Whereas in the case of the oceans, water is continuously evaporating even as more and more salt continues to be added with river water. This, over millions of years has led to the high concentration of dissolved salts in sea water.

LIGHTNING ACCOMPANIED BY THUNDER

Lightning occurs when a massive electrical discharge takes place between two oppositely charged clouds or between a charged cloud and the ground. The charges Develop in thunder clouds due to the friction of water droplets with air as the droplets move up and down with the rising and descending air currents within the cloud. During a bolt of lightening, thousands of

amperes of electricity flow through the air in a fraction of a second. This rapidly heats up the air along its path which expands very fast producing shock waves which we hear as thunder. Although the lightning and thunder are produced at the same instant, we hear the thunder later because light travels faster thansound.

SYNTHETIC FABRICS DRY TO QUICKLY

Synthetic fibers are made artifically. They are solid, smooth and straight in structure unlike a natural fiber like cotton which is hollow. So when synthetic fabrics are soaked in water, only surface of the fibers gets wet as water does not enter the body of thefiber. That iswhy thesefabrics absorb very little amount of water and dry quickly as the water drips away. Such fabrics are also known as,'dripdry'.

SOAP FORM LATHER IN HARD WATER

Soaps are salts of fatty acids. Common soaps are water soluble and potassium salts of fatty acids. Soap cannot form lather unless it dissolves in water. Hard water does not dissolve soap because the calcium and magnesium salts present in it produce insoluble substances by reacting with soap. These insoluble substances separate out as scum and reduce the effectiveness of the soap as a Cleansing agent.

FLUORESCENT TUBES CONSUME LESS POWER

Infilament lamps a good part of the electrical energy is used up in heating the filament which in turn glows throwing light around. While in fluorescent tubes light is produced by electrical discharge in a glass tube, the inside of which is coated with a fluorescent material. The filaments at the twoends are used onlyto start thedischarge. The discharge passing through vapors of mercury produce UVradiations which exites the fluorescent.

Coating producing visible light. Since very little heating is involved in the process and most of the electrical energy is used in producing light, fluorescent tubes consume less power than filament lamps.

ICE MELTS WHEN SUBJECTED TO PRESSURE

One of the laws of fusion is that the melting point of substances which expand on freezing is lowered by the increase of pressure, while it is raised in the case of those which contract on solidification. Ice belongs to the first category of substances, that is, it expands on freezing. Ice has an open structure which collapses when subjected to pressure, producing water which occupies lesser volume. That is why ice when subjected to pressure.

THERE A DISTURBANCE ON TV WHEN WE OPERATE AN ELECTRICAL SWITCH

When an electrical switch is operated it produces a spark at the contact point. This spark emits electromagnetic radiation. Since radio and TV signals are also electromagnetic in nature, the bursts of electromagnetic radiation produced by a spark is also received by the radio or TV set. This lead to the disturbance which is heard as cracking sounds on the radio and snowy lines on the TVpicture.

COLOURED SOAPS PRODUCE WHITE BUBBLES

Foam or lather is nothing but a large collection of small soap bubbles. A sop bubble is, in turn, a very thin film of soap solutionenclosing some air. Because of the low surface tension of soap solution, the film can stretch and spread and form innumerable bubbles with a very large total surface area. Because of this, whatever slight tint present in the thin film of the coloured soap solution gets subdued. Although a soap film is

more or less transperent, the lather or foam looks white because the light striking this large collection of bubbles gets scattered. That is why all kinds of foam look white.

THINGS BURN

Burning is a chemical process in which the material burns combines with oxygen with the generation of large amounts of heat. As aresult the temperature of the burning material rises to serveral hundred degrees Celsius and it may burst into flames. Therefore, any substance that readily combines with oxygen at a few hundred degrees and produces a lot of heat will burn if ignited. Such substances such as paper, wood, cloth, plastics, rubber etc. are usually rich in carbon and hydrogen. Some volatile liquids such as alcohol, petrol, etc. catch fire easily because they produce highly combustible vapors.

A DRIED PIECE OF COTTON APPEAR DARKER WHEN WET

Cotton is a natural fibre. When woven or knitted into cloth, the fibres are loosely packed and contain lot of air spaces. When light falls on these fibres it is scattered from the boundaries of the fibres and the colour of the clot appears lighter. But when the fabric is soaked in water, the air pockets of the fibres get filled with water. This reduces the amount of Light scattered from the fibric. Therefore, more light reflected from the coloured fabric reaches to the eyeand thecoloured appear deeper. However, synthetic and silk fibres are smooth in structuture and leave no air space when woven or knitted. So the colour or silk or synthetic fabric is not altered when the fabric is soaked in water.

WATER AND OIL MIX

A phenomenon called polarity prevents oil and water from mixing. All molecules carry electrical charge which is distributed uniformly or non-uniformly over the length of the molecule. In polar compounds, the positive and negative charges are concentrated at the two ends of the molecule. When such substances are mixed together, the positive and negative regions of their molecules attract each other and as a result a clear solution is obtained. Water is a polar substance and mixes freely with other polar substances. Oil molecules, on the other hand, are non-polar. When polar and non-polar substances are mixed together, the mutual attraction of polar molecules separates out the non-plar molecules and the two substances do notmix.

ACID RAIN

Natural rain always contain small amount of dissolved carbondioxide which makes it slightly acidic. But large-scale burning of coal or oil in industries, power plants and vehicles produce large amounts of gases suchas sulphur dioxide, nitrogen oxides, etc., which are released into the atmosphere. Under favourable conditions they react with water vapour and oxygen in the atmosphere to produce sulphuric and nitric acids which is eventually come down with rain, snow or fog. The countries wrost affected by acid rains are southern Sweden, Northway, parts of central Europe and Eastern Region of North America.

AIDS

Acquired Immune Deficiency Syndrome (AIDS) is the most devastatign and fatal diseases of the 21st Century it is a viral disease caused by the Human Immune Deficiency Virus (HIV).

Economy

Financial Committees

Committees	Focus Areas
A.C. Shah Committee	NBFC
Abid Hussain Committee	Development of Capital markets
Adhyarjuna Committee	Changes in NI Act and Stamp Act
A. K. Bhuchar Committee	Coordiantion between Term Lending institutions and Commercial Banks
B. Eradi Committee	Insolvency and Wind up laws
B. Siaraman Committee	Institutional Credit for Agricultural and Rural Development.
B. Venkatappaiah Committee	All India Rural Credit Review
B.D. Shah Committee	Stock Lending Scheme
BD Thakar Committee	Job Criteria in bank loans (Approach)
Bhagwati Committee	Unemployment
Bhagwati Committee	Public Welfare
Bhave Committee	Share Transfer Reforms
Bhide Committee	Coordination between Commercial Banks and SFC's
Bhootlingam Committee	Wage, Income and Prices
C. Rao Committee	Agricultural Policy
C.E. Kamath Committee	Multi Agency approach in Agricultural Finance
Chatalier Committee	Finance to Small Scale Industry
Chesi Committee	Direct Taxes
Cook Committee	Capital Adequacy of Banks
D.R. Mehta Committee	Review Progress and recommend improvement Measures of IRDP
Damle Committee	MICR
Dandekar Committee	Regional Imbalances
Dantwala Committee	Estimation of Employments
Dave Committee	Mutual Funds (Functioning)
Dharia Committee	Public Distribution System
D.R. Gadgil Committee	Agricultural Finance
Dutta Committee	Industrial Licensing
G. Lakshmai Narayan Committee	Extension of Credit Limits on the Basis of Consortium
G. Sundaram Committee	Export Credit
Gadgil Committee (1969)	Lead Banking System
Godwala Committee	Rural Finance
Goiporia Committee	Customer Service in Banks
G.S. Dahotre Committee	Credit Requirements of Leasing Industry
G.S. Patel Committee	Carry Forward System on Stock Exchange
Hathi Committee	Soiled Banknotes
Hazari Committee (1967)	Industrial Policy

I.T. Vaz Committee	Working Capital Finance in Banks
J. Reddy Committee	Reforms in Insurance Sector
James Raj Committee	Functioning of Public Sector Banks
Jankiramanan Committee	Securities Transactions of Banks and Financial Institutions
J.V. Shetty Committee	Consortium Advances
K. Madhav Das Committee	Urban Cooperative Banks
Kalyansundaram Committee	Introduction of Factoring Services in India
Kamath Committee	Education Loan Scheme
Karve Committee	Small Scale Industry
K.B. Chore Committee	To review the Symbol of Cash Credit Q
Khanna Committee	Non Performing Assets
Khusrau Committee	Agricultural Credit
K.S. Krishnaswamy Committee	Role of Banks in Priority Sector and 20 Point Economic Programme
L.K. Jha Committee	Indirect Taxes
L.C. Gupta Committee	Financial Derivatives
Mahadevan Committee	Single Window System
Mahalanobis Committee	Income Distribution
Marathe Committee	Licensing of New Banks
M.L. Dantwala Committee	Regional Rural Banks
Mrs. K,S, Shere Committee	Electronic Fund Transfer
Nadkarni Committee	Improved Procedures for Transactions in PSU Bonds and Units
Nariman Committee	Branch Expansion Programme
Narsimhan Committee	Financial System
Omkar Goswami Committee	Industrial Sickness and Corporate Restructuring
P.R. Nayak Committee	Institutional Credit to SSI Sector
P. Selvam Committee	Non Performing Assets of Banks
P.C. Luther Committee	Productivity, Operational Efficiency and Profitability of Banks
P.D. Ojha Committee	Service Area Approach
Pendarkar Committee	Review the System of Inspection of Commercial, RRB and Urban Cooperative Banks
Pillai Committee	Pay Scales of Bank Officers
P.L. Tandon Committee	Export Strategy
P.R. Khanna Committee	Develop appropriate Supervisory Framework for NBFC
Purshottam Das Committee	Agricultural Finance and Cooperative Societies
R. Jilani Banks	Inspection System of Banks
R.S. Saria Committee	Agricultural Finance and Cooperative Societies
Raghavan Committee	Competition Law
Raja Chelliah Committee	Tax Reforms
Rajamannar Committee	Centre-State Fiscal Relationships

Rajamannar Committee	Changes in Banking Laws, Bouncing of Cheques etc.
Rakesh Mohan Committee	Petro Chemical Sector
Ram Niwas Mirdha Committee (JPC)	Securities Scam
Rangrajan Committee	Computerization of Banking Industry
Rangrajan Committee	Public Sector Disinvestment
Rashid Jilani Committee	Cash Credit System
Ray Committee	Industrial Sickness
R.G. Saraiya Committee (1972)	Banking Commission
R.H. Khan Committee	Harmonization of Banks and Ssis
R.K. Hajara Committee	Differential Interest Rates Scheme
R.K. Talwar Committee	Customer Service
R.K. Talwar Committee	Enactment Having a bearing on Agro Landings by Commercial Banks
R.N. Malhotra Committee	Reforms in Insurance Sector
R.N. Mirdha Committee	Cooperative Societies
R.V. Gupta Committee	Agricultural Credit Delivery
S. Padmanabhan Committee	Onsite supervision Function of Banks
S. Padmanabhan Committee	Inspection of Banks (By RBI)
Samal Committee	Rural Credit
S.C. Choksi Committee	Direct Tax Law
Shankar Lal Gauri Committee	Agricultural Marketing
S.K. Kalia Committee	Role of NGO and SHG in Credit
S.L. Kapoor Committee	Institutional Credit to SSI
Sodhani Committee	Foreign Exchange Markets in NRI investment in India
S.S. Nadkarni Committee	Trading in Public Sector Banks
S.S. Tarapore Committee	Capital Account Convertibility
Sukhmoy Chakravarty Committee	To review the working of Monetary System
Tambe Committee	Term Loans to SSI
Tandon Committee	Follow up of Bank Credit
Tandon Committee	Industrial Sickness
Thakkar Committee	Credit Schemes to Self employed
Thingalaya Committee	Restructuring of RRB
Tiwari Committee	Rehabilitation of sick Industrial undertakings
U.K. Sharma Committee	Lead Bank Scheme (Review)
Usha Thorat Panel	Financial Inclusion
Vaghul Committee	Mutul Fund Scheme
Varshney Committee	Revised methods for Loans (> 2 lakhs)
Venketaiya Committee	Review of Rural Financing System
Vipin Malik Committee	Consolidated Accounting by Banks
V.T. Dehejia Committee	To study credit needs of industry and trade likely to be inflated
Vyas Committee	Rural Credit

Wanchoo Committee	Direct Taxes
W.S. Saraf Committee	Technology Issues in Banking Industry
Y.H. Malegam Committee	Disclosure norms for Public Issues
Y.V. Reddy Committee	Reforms in Small Savings

Working Groups	Chairman
• Working group on benchmark Prime Lending Rate (BPLR)	Deepak Mohanty
• Working group on surveys	Deepak Mohanty
• High level committee to review lead bank scheme	Usha Thorat
• Working group to review the business correspondent model	P. Vijaya Bhaskar Rao
• High level group on systems and procedures for currency distribution	Usha Thorat
• G20 working group on enhancing sound regulation and strengthening transparency	Dr. Rakesh Mohan & Mr. Tiff Macklem
• Committee on financial sector assessment	Dr. Rakesh Mohan
• High level committee on estimation of savings and investment	Dr. C. Rangarajan
• Committee on the global financial system (CGFS) on capital flows and emerging market economies	Dr. Rakesh Mohan
• Task force for diamond Sector	A.K. Bera
• Technical advisory group on Development of HOusing Start-up index in India	Prof. Amitabh Kundu
• Working group on defraying cost of ICT solutions for RRBs	Shri G. Padmanabhan
• Working group on IT support for Urban cooperative banks	R. Gandhi
• Working group on technology upgradation of regional rural banks	Shri G. Srinivasan
• Interest rate futures	Shri V.K. Sharma
• Internal working group to study the recommendations of the NCEUS report	Kub Rao
• Working group on improvement of banking services in the union territory of lakshadweep	S. Ramaswamy
• Working group on rehabilitation of sick SMEs	Dr. K.C. Chakrabarty
• Working group on improvement of banking services in jharkhand	V.S. Das
• Working group on improvement of banking services in himachal pradesh	Dr. J. Sadakkadulla
• Internal technical group on seasonal movements in inflation	Dr. Balvant Singh
• Working group to examine the procedures and processes of agricultural loans	C.P. Swarankar
• Task force on empowering RRB boards for operational efficiency	Dr. K.G. karmakar
• Technical group set up to review legislations on money lending	Shri S.C. Gupta
• Working group to suggest measures to assist distressed farmers	Shri S.S. Johi
• Technical group on statistics for international trade in banking services	Shri K.S.R. Rao
• Technical advisory group on development of leading economic indicators for Indian economy	Dr. R.B. Barman
• Working group on savings for the eleventh five year plan (2007–2008 to 2011–12)	Dr. Rakesh Mohan

• Working group on compilation of state government liabilities	Dr. N.D. Jadhav
• Working group on improvement of banking services in Uttaranchal	V.S. Das
• Working group on cost of NRI remittances	P.K. Pain
• Working group to formulate a scheme for ensuring reasonableness of bank charges	N. Sadasivam
• Committee on Full Capital account convertibility	S.S. Tarapore
• Committee on financial sector plan for north eastern region	Smt. Usha Thorat
• Survey on impact of trade related measures on transaction costs of exports	Balwant Singh
• Advisory committee on ways and means advances to State governments	M.P. Bezbaruah
• Need and use behavior for small denomination coins	Sanal Kumar Velayudhan
• Debt sustainability at State level in India	Indira Rajaraman, shashank Bhide and R.K. Pattnaik
• Internal Group to examine issues relating to rural credit and microfinance	Shri H.R. Khan
• Working group to review export credit	Shri Anand Sinha
• Internal working Group on RRBs	Shri A.V. Sardesai
• Working group on warehouse receipts and commodity futures	Shri Prashant Saran
• Internal Group to review guidelines on credit flow to SME Sector	Shri C.S. Murthy
• Working group on Regulatory Mechanism for cards	Shri R. Gandhi
• Group on model fiscal responsibility legislation at state level	Shri H.R. Khan
• Task force on revival of cooperative credit institutions	Prof. A. Vaidyanathan
• Special group for formulation of Debt restructuring mechanism for medium enterprises	Shri G. Srinivasan
• Working group on screen based trading in government securities	Smt. Shyamala Gopinath
• Expert group on internet deployment of central database management system (CDBMS)	Prof. A. Vaidyanathan
• Report on monitoring of financial conglomerates	Dr. R.H. Patil
• Working group on development financial institutions	Shri N. Sadasivan
• Advisory Committee to advise on the administered interest rates and rationalisation of saving instruments	Dr. Rakesh Mohan
• Advisory committee on flow of credit to agriculture	Prof. V.S. Vyas
• Working group on flow of credit to SSI sector	Dr. A.S. Ganguly
• Group to study the pension liabilities of the state governments	B.K. Bhattacharya
• Rupee interest rate derivatives	Shri G. Padmanabhan
• Working group on instruments of sterlisation	Smt. Usha Thorat
• Working group on information on state government guaranteed advances and bonds	Shri G. Padmanabhan
• Working group on cheque truncation and e-cheques	Dr. Barman, ED
• Working group on introduction of credit derivatives in India	Shri B. Mahapatra
• Group to assess the fiscal risk of state government guarantees	Smt. Usha Thorat
• Advisory committee on ways and means advances to state governments	Shri C. Ramachandran
• Working group on rupee derivatives	Shri Jaspal Bindra

• Committee on computer audit	Shri A.L. Narasimhan
• Committee on payment systems	Dr. R.H. Patil
• Review group on the working of the local area bank scheme	Shri G. Ramachandran
• Technical group on statistics of international trade in services	Shri Deepak Mohanty
• Working group for suggesting operational and prudential guidelines on STRIPS (Separately Traded Registered Interest and Principal of Securities)	Shri M.R. Ramesh
• Working group on electronic money	Mr. Zarir J. Cama
• Working group on economic indicators	Dr. R.B. barman
• Information systems audit policy for the banking and financial sector	Dr.R.B. Burman
• Working group on consolidated accounting and other quantitative methods to facilitate consolidated supervision	Shri Vipin Malik
• Expert committee to review the system of administered interest rates and other related issues	Dr. Y.V. Reddy
• Inter-departmental group to study the rationalisation of current account facility with reserve bank of India	Shri K.W. Korgaonkar
• The Expert Committee on legal aspects of Bank frauds	Dr. N.L. Mitra
• The Standing Committee on international financial standards and codes standing committee on international financial standards and codes	Dr. Y.V. Reddy
• Technical group on market integrity	Shri C.R. Muralidharan
• Technical group on phasing out of non-banks from call/notice money market (March 2001)	Dr. Y.V. Reddy
• Core group on voluntary disclosure norms for state governments	Dr. Y.V. Reddy
• Task force to study the cooperative credit system and suggest measures for its strengthening	Shri Jagdish Kapoor
• Internal group to review the guidelines related to commercial paper	Dr. Y.V. Reddy
• High Power Committee on urban cooperative banks	Shri Madhav Rao
• Working group for setting up credit information bureau in India	Shri N.H. Siddiqui
• Committee for redesigning of financial statements of non-banking financial companies	Shri V.S.N. Murthy
• Working group on restructuring weak public sector banks	Shri M.S. Verma
• Working group for working out modalities on dissemination of information in electronic form	Shri Y.S.P. Thorat and Shri C.R. Gopalasundaram
• Committee on technology upgradation in the banking sector	Dr. A. Vasudevan
• Working group of EURO	Shri V. Subrahmanayam
• New monetary aggregates	Dr. Y.V. Reddy
• Committee on capital account convertibility	Shri S.S. Tarapore

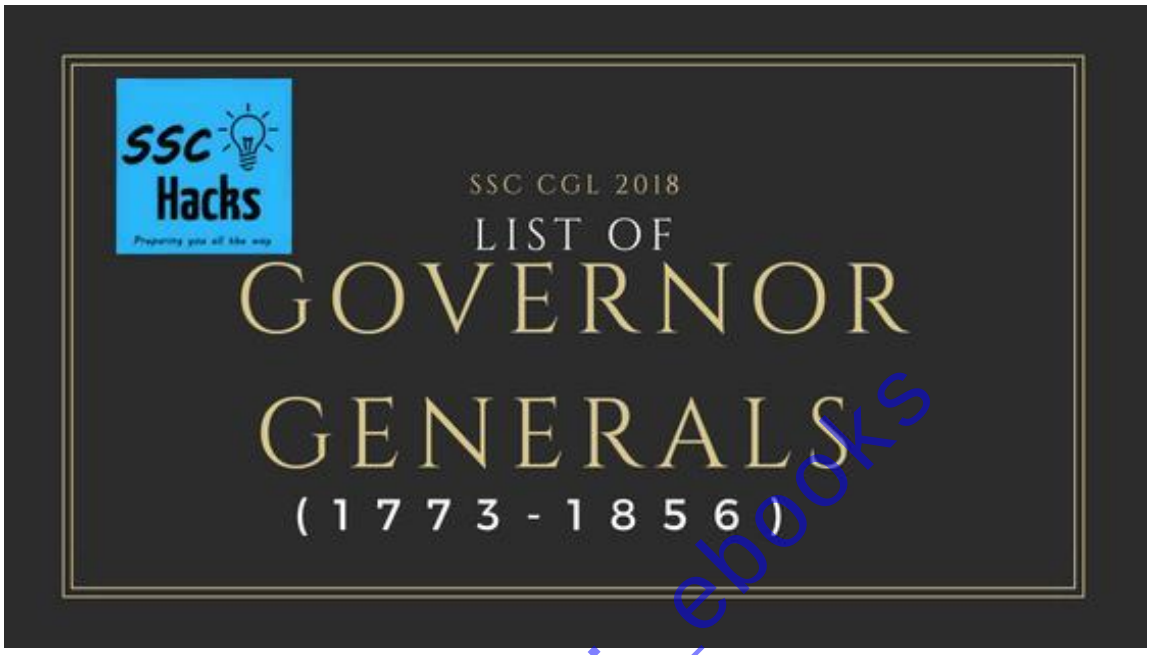
SSC CGL 2018

LIST OF GOVERNORS OF FORT WILLIAM IN BENGAL

(1757-1772)

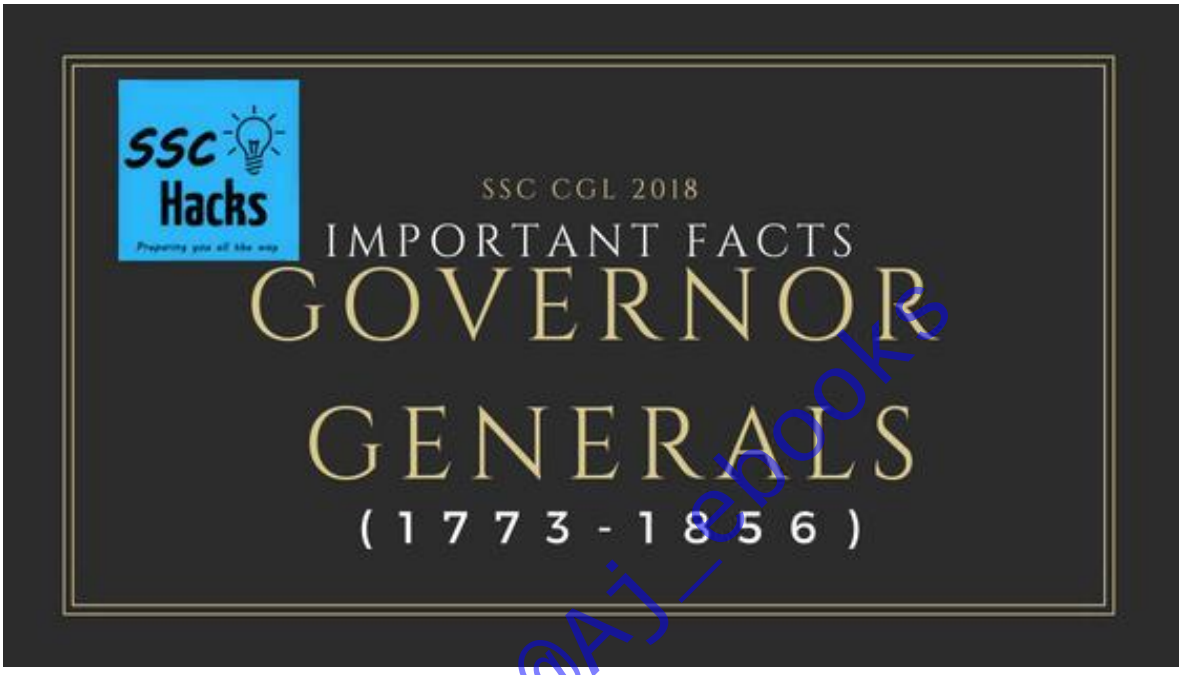
1. Roger Drake (1757)
2. Robert Clive (First Administration; 1757-1760)
3. Holwell (Officiating; 1760)
4. Henry Vansittart (1760-1765)
5. Robert Clive (Second Administration; 1765-1767)
6. Established Dual Government in Bengal from 1765-72
7. Bengal White Mutiny by white brigades at Allahabad and Monghyr
8. Harry Verelst (1767-1769)
9. Cartier (1769-72)

LIST OF GOVERNOR GENERALS (1773-1856)



1. Warren Hastings (1773-1785)
2. Lord Cornwallis (1786-1793)
3. Sir John Shore (1793-1798)
4. Lord Wellesley (1798-1805)
5. Sir George Barlow (1805-1807)
6. Lord Minto (I) (1807 -13)
7. Lord Hastings (1813-1823)
8. Lord Amherst (1823-28)
9. Lord William Cavendish – Bentinck (1828-35)
10. Sir Charles (Lord) Metcalfe (1834-1836)
11. Lord Auckland (1836-1842)
12. Lord Ellenborough (1842-1844)
13. Lord Hardinge (1844-48)
14. Lord Dalhousie (1848-56)

IMPORTANT FACTS RELATED TO GOVERNER GENERALS FROM 1773-1856



1. Warren Hastings (1773-1785)

He became the Governor in 1772 and the Governor-General in 1773 through Regulating Act of 1773. Questions related to him have been asked in the previous year examinations as well. Take a look.

- His four councilors were Clavering, Francis, Monson, and Barwell.
- He abolished Dual system (1767-1772) of administration (1772).
- He auctioned the right to collect land revenue to the highest bidder (1772).
- He divided Bengal into districts and appointed Collectors (1772).
- He helped in the Rohilla war (1774) and annexation of Rohilkhand by the Nawab of Awadh with the help of Britishers.
- The Treaty of Surat (1775) was signed between Raghunath Rao and Warren Hastings, but Council of Calcutta rejected it.
- The Nanad Kumar incident took place(1775).
- The Treaty of Purandar (1776) was signed between English and Peshwa.
- He refined Hindu and Muslim laws. A translation of the code in Sanskrit appeared in 1776 under the title of “Code of Gentoo Laws”.
- The Chait Singh (Banaras Raja) affair took place(1778).

- James Augustus Hickey started a weekly paper called Bengal Gazette or Calcutta General Advertiser (1780) in his time.
- The first Anglo-Maratha War (1776-82) and Treaty of Salbai(1782)
- Begums of Oudh / Awadh affair (1782).
- He founded the Asiatic Society of Bengal with William Jones in 1784.
- He helped pass the Pitts India Act of 1784.
- The second Anglo-Mysore War (1780-84) and Treaty of Mangalore (1785) with Tipu Sultan.
- He started Diwani and Faujdari Adalat at the district level and Sadar Diwani and Nizamat Adalats (appellate courts) at Calcutta.
- He wrote the introduction to the first English translation of the Gita by Charles Wilkins.

2. Lord Cornwallis (1786-1793)

He became the Governor-General in 1786. Questions related to him have been asked in the previous year examinations as well. Take a look.

- Sanskrit College was founded in Banaras (1791) by Jonathan Duncan.
- The New Police System was introduced in 1791.
- Third (3rd) Anglo-Mysore War, the defeat of Tipu Sultan (1790-92).
- Treaty of Seringapatam (1792).
- Cornwallis code, based on separation of powers, was introduced.
- He created the post of District Judge (1793).
- He introduced Permanent Settlement in Bengal (1793).
- He is known as the Father of the Civil Services in India.

3. Sir John Shore (1793-1798)

He became the Governor-General in 1793. Take a look about some of the important facts related to him.

- The first Charter Act was introduced (1793).
- The Battle of Kurdla, Kharda, Khadra between Nizam and the Marathas (1795).
- He planned the Permanent Settlement with Cornwallis and later succeeded him (1793).
- He was famous for his Policy of Non-Interference.

4. Lord Wellesley (1798-1805)

He became the Governor-General in 1798. Take a look about some of the important facts related to him.

- He introduced the Subsidiary Alliance system to achieve British paramountcy (1798). The states that signed the alliance were – Hyderabad (first to sign) in 1798 and then Mysore, Tanjore, Awadh, Jodhpur, Jaipur, Mecheri, Bundi, Bharatpur and Berar.
- The first treaty with Nizam was signed(1798).
- The fourth Anglo-Mysore war (1799) took place. The defeat and death of Tipu Sultan followed.

- The second Anglo-Maratha War (1803-1805) took place. The defeat of the Sindhiya,the Bhonsale, and the Holkar followed.
- The formation of Madras Presidency (1801) during his tenure after the annexation of the kingdoms of Tanjore and Carnatic.
- The Treaty of Bassein (1802) with Peshwa was signed.
- Lord Lake captured Delhi and Agra and the Mughal emperor was put under Company's protection.
- He described himself as a Bengal Tiger.

5. Sir George Barlow (1805-1807)

He became the Governor-General in 1805 for a short span of two years. Take a look about some of the important facts related to him.

- The Sepoy Mutiny of Vellore (1806) took place.
- He tried towards the oration of peace with Scindhia and Holkar.

6. Lord Minto (I) (1807 -13)

He became the Governor-General in 1807. Take a look about some of the important facts related to him.

- He sent the mission of Malcolm to Persia and that of Elphinstone to Kabul (1808).
- The Treaty of Amritsar (1809) was signed with Ranjit Singh.
- The Charter Act of 1813 was introduced.

7. Lord Hastings (1813-1823)

He became the Governor-General in 1813. Questions related to him have been asked in the previous year examinations as well. Take a look.

- The Anglo-Nepalese (Gurkha / Gorkha) war (1813-1823) took place.
- The Treaty of Sugauli / Segowlee / Sequelae (1816) between the East India Company and King of Nepal was signed.
- The Treaty of Poona (1817) with Peshwa was signed.
- The Anglo-Maratha War III (1817-1818) took place.
- The Pindari war (1817-1818) took place.
- He helped in the creation of Bombay Presidency (1818).
- The Ryotwari settlement in Madras by Thomas Munro, the Governor (1820).
- The Mahalwari system of land revenue was made in North-West province by James Thomson.
- He adopted the Policy of Intervention and War.
- He considered Rajputs as the natural allies.

8. Lord Amherst (1823-28)

He became the Governor-General in 1823. Questions related to him have been asked in the previous year examinations as well. Take a look.

- The Burmese War I (1824-1826) took place.
- The Treaty of Yandaboo (1826) with lower Burma (Pegu) was signed allowing British merchants to settle in the southern coast of Burma and Rangoon.
- He helped in the acquisition of territories in the Malay Peninsula (1824).
- He helped capture Bharatpur (1826).

9. Lord William Cavendish – Bentinck (1828-35)

He became the Governor-General in 1828. Questions related to him have been asked in the previous year examinations as well. Take a look.

- He is the Father of Modern Western Education in India.
- He helped in the abolition or prohibition of Sati (1829).
- He banned female infanticide (1829).
- He annexed Mysore (1831), Coorg (1834) and Central Chachar (1834) on the plea of misgovernment.
- Agra was named as a province (1834).
- Macaulay's minutes on Education (1835).
- English was made the official language of India (1835).
- Abolition of the provincial court of appeal and circuit set up by Cornwallis.
- Appointment of commissioners of circuit and revenue.

10. Sir Charles (Lord) Metcalfe (1834-1836)

He became the Governor-General in 1834 for a short span of two years. He passed the Press Law.

11. Lord Auckland (1836-1842)

He became the Governor-General in 1836. The First Afghan War (1836-42) took place under his rule.

12. Lord Ellenborough (1842-1844)

He became the Governor-General in 1842 for a short span of two years. Take a look about some of the important facts related to him.

- The termination of First Afghan Wars (1842).
- The annexation of Sindh (1843).
- War with Gwalior (1843).
- He abolished slavery in India (1844).

13. Lord Hardinge (1844-48)

He became the Governor-General in 1844. Take a look about some of the important facts related to him.

- The First Sikh war (1845-1846) took place.
- The Treaty of Lahore (1846) was signed to mark the end of Sikh sovereignty in India.
- Prohibition of female infanticide and human sacrifice among Gonds of central India.

14. Lord Dalhousie (1848-56)

He became the Governor-General in 1848. He was the last Governor General before the Indian Rebellion of 1857. Questions related to him have been asked in the previous year examinations as well. Take a look.

- He abolished Title and Pension.
- Sikh War II took place (1845-1846).
- The annexation of Punjab (1849).
- The Doctrine of Lapse was applied to capture Satara (1848), Jaipur and Sambalpur (1849), Baghat (1850), Udaipur (1852), Jhansi (1853) and Nagpur (1854).
- The Burmese War II (1852) took place.
- The annexation of Berar (1853).
- The Charter Act (1853).
- The introduction of Railways (32 km) between Bombay -Thana (1853) took place.
- The services of Telegraph started between Calcutta – Agra (1853)
- The postal system was introduced(1853).
- Recruitment of the Civil Service by competitive examination (1853) began.
- The Woods Dispatch Act (1854).
- The Widow Remarriage Act (1856).
- The Santhal uprising (1855-56).
- The annexation of Oudh (1856).
- Three Universities were established in Calcutta, Bombay and Madras (1857).
- He introduced the Bon-Regulation System which was the system of centralized control in newly acquired territories.
- He founded the Public Works Department (P.W.D).
- He raised the Gorkha Regiment.
- Shimla was made summer capital of British India.

SSC CGL 2018

Awards and Honours

Bharat Ratna is the highest civilian award in India. We have already covered the list of Bharat Ratna Awardees till 2018. Let us see some other important awards for the year 2018.

PADMA VIBHUSHAM

It is the second highest civilian award.

No	Name	Field	State
1	Illaiyaraja	Art-Music	Tamil Nadu
2	Ghulam Mustafa Khan	Art-Music	Maharashtra
3	Parameswaran Parameswaran	Literature and Education	Kerala

PADMA BHUSHAN

It is the third highest civilian award.

No	Name	Field	State
1	Pankaj Advani	Sports- Billiards/Snooker	Karnataka
2	Philipose Mar Chrysostom	Others-Spiritualism	Kerala
3	Mahendra Singh Dhoni	Sports-Cricket	Jharkhand
4	Alexander Kadakin **(Foreigner)**	Public Affairs	Russia
5	Ramachandran Nagaswamy	Others-Archaeology	Tamil Nadu
6	Ved Prakash Nanda (OCI)	Literature and Education	US
7	Laxman Pai	Art-Painting	Goa
8	Arvind Parikh	Art-Music	Maharashtra

9	Sharda Sinha	Art-Music	Bihar

PADMA SHRI

It is the fourth highest civilian award.

No	Name	Field	State
1	Abhay Bang **(Duo)**	Medicine	Maharashtra
2	Rani Bang **(Duo)**	Medicine	Maharashtra
3	Damodar Ganesh Bapat	Social Work	Chhattisgarh
4	Prafulla Govinda Baruah	Literature and Education-Journalism	Assam
5	Mohan Swaroop Bhatia	Art-Folk Music	Uttar Pradesh
6	Sudhanshu Biswas	Social Work	West Bengal
7	Saikhom Mirabai Chanu	Sports-Weightlifting	Manipur
8	Pandit Shyamlal Chaturvedi	Literature and Education-Journalism	Chhattisgarh
9	Jose Ma Joey Concepcion III **(Foreigner)**	Trade & Industry	Philippines
10	Langpoklakpam Subadani Devi	Art-Weaving	Manipur
11	Somdev Devvarman	Sports-Tennis	Tripura
12	Yeshi Dhoden	Medicine	Himachal Pradesh
13	Arup Kumar Dutta	Literature and Education	Assam
14	Doddarange Gowda	Art-Lyrics	Karnataka
15	Arvind Gupta	Literature and Education	Maharashtra
16	Digamber Hansda	Literature and Education	Jharkhand
17	Ramli Bin Ibrahim (Foreigner)	Art-Dance	Malaysia
18	Anwar Jalalpuri (Posthumous)	Literature and Education	Uttar Pradesh
19	Piyong Temjen Jamir	Literature and Education	Nagaland
20	Sitavva Joddati	Social Work	Karnataka
21	Malti Joshi	Literature and Education	MP
22	Manoj Joshi	Art-Acting	Maharashtra
23	Rameshwarlal Kabra	Trade & Industry	Maharashtra
24	Pran Kishore Kaul	Art	J&K
25	Bounlap Keokangna(Foreigner)	Others-Architecture	Laos
26	Vijay Kichlu	Art-Music	West Bengal

27	Tommy Koh(Foreigner)	Public Affairs	Singapore
28	Lakshmikutty	Medicine-Traditional	Kerala

29	Joyshree Goswami Mahanta	Literature and Education	Assam
30	Narayan Das Maharaj	Others-Spiritualism	Rajasthan
31	Pravakara Maharana	Art-Sculpture	Odisha
32	Hun Many (Foreigner)	Public Affairs	Cambodia
33	Nouf Marwaai(Foreigner)	Others- Yoga	Saudi Arabia
34	Zaverilal Mehta	Literature and Education-Journalism	Gujarat
35	Krishna Bihari Mishra	Literature and Education	West Bengal
36	Sisir Purushottam Misra	Art-Cinema	Maharashtra
37	Subhasini Mistry	Social Work	West Bengal
38	Somdet Phra Maha Muniwong (Foreigner)	Others-Spiritualism	Thailand
39	Keshav Rao Musalgaonkar	Literature and Education	MP
40	Dr Thant Myint – U(Foreigner)	Public Affairs	Myanmar
41	V Nanammal	Others-Yoga	Tamil Nadu
42	Sulagitti Narasamma	Social Work	Karnataka
43	Vijayalakshmi Navaneethakrishnan	Art-Folk Music	Tamil Nadu
44	I Nyoman Nuarta (Foreigner)	Art- Sculpture	Indonesia
45	Malai Haji Abdullah Bin Malai Haji Othman**(Foreigner)**	Social Work	Brunei
46	Gobaradhan Panika	Art-Weaving	Odisha
47	Bhabani Charan Pattanaik	Public Affairs	Odisha
48	Murlikant Petkar	Sports-Swimming	Maharashtra
49	Habibullo Rajabov**(Foreigner)**	Literature and Education	Tajikistan
50	M R Rajagopal	Medicine-Palliative care	Kerala
51			
52	Sampat Ramteke**(Posthumous)**	Social Work	Maharashtra
53	Chandra Sekhar Rath		Odisha
54	S S Rathore	Civil Service	Gujarat
55	Amitava Roy	Science and Engineering	West Bengal
56	Sanduk Ruit **(Foreigner)**	Medicine- Ophthalmology	Nepal
57	R Sathyanarayana	Art-Music	Karnataka
58	Pankaj M Shah	Medicine- Ophthalmology	Gujarat

59	Bhajju Shyam	Art-Painting	MP
60	Maharao Raghuveer Singh	Literature and Education	Rajasthan
61	Kidambi Srikanth	Sports-Badminton	Andhra Pradesh
62	Ibrahim Sutar	Art-Music	Karnataka
63	Siddeshwara Swamiji	Others-Spiritualism	Karnataka
64	Lentina Ao Thakkar	Social Work	Nagaland
65	Vikram Chandra Thakur	Science and Engineering	Uttarakhand
66	Rudrapatnam Narayanaswamy Tharanathan (Duo)	Art-Music	Karnataka
67	Rudrapatnam Narayanaswamy Thyagarajan (Duo)	Art-Music	Karnataka
68	Nguyen Tien Thien (Foreigner)	Others-Spiritualism	Vietnam
69	Bhagirath Prasad Tripathi	Literature and Education	UP
70	Rajagopalan Vasudevan	Science and Engineering	Bihar
71	Panatawane Gangadhar Vithobaji	Literature and Education	Maharashtra
72	Romulus Whitaker	Others-Wildlife Conservation	Tamil Nadu
73	Baba Yogendra	Art	Madhya Pradesh
74	A Zakia	Literature and Education	Mizoram

SANGEET NATAK AKADEMI AWARDS

President Ram Nath Kovind presented the Sangeet Natak Akademi Fellowships and Awards for 2016 to an eminent group of musicians, dancers, and theatre artists.

List of Sangeet Natak Akademi Fellowships Awardees

Name Of The Winner	Field	Category
Arvind Parikh	Music	Hindustani Classical Sitar Player
R Vedavalli	Music	Carnatic Vocalist
Ram Gopal Bajaj	Theatre	Acting and direction
Sunil Kothari	Dance	Indian Classical Dance

List of Sangeet Natak Akademi Awards

Name Of The Winner	Field	Category
Arvind Mulgaonkar	Music	Hindustani Tabla
Mysore M Manjunath	Music	Carnatic Violin
Nighoujam Shyamchang Singh	Music	Nata Sankirtana,
Ratnamala Prakash	Music	Sugam Sangeet
Ahmed Hussain & Mohd. Hussain	Music	Sugam Sangeet
J Vaidhyanathan	Music	Carnatic Mridangam
Kala Ramnath	Music	Hindustani Violin
Neela Ramgopal	Music	Carnatic Vocal Music
Komanakutty	Music	Carnatic Vocal Music
Padma Talwalkar	Music	Hindustani Vocal Music
Prabhakar Karekar	Music	Hindustani Vocal Music
Kalamandalam Ramachandran Unnithan	Dance	Kathakali
Maisnam Kaminikumar Singh	Dance	Manipuri Dance
Haricharan Bhuyan Borbayan	Dance	Sattriya Dance
Gopal Prasad Dubey	Dance	Chhau Dance
Anita R Ratnam	Dance	Contemporary Dance

Geeta Chandran	Dance	Bharatanatyam
Jitendra Maharaj	Dance	Khathak Dance

A B Bala Kondala Rao	Dance	Khuchipudi Dance
Ratikant Mohapatra	Dance	Odissi Dance
Gireesan V	Theatre	Acting
Oinam Biramangol Singh	Theatre	Acting
Mohan Joshi	Theatre	Acting
Anjana Puri	Theatre	Allied Theatre Acts
K Govind Bhat	Theatre	Yakshgana
Bipin Kumar	Theatre	Direction
Bipin Kumar	Theatre	Direction
Kusum Kumar	Theatre	Playwriting
Satyabrata Rout	Theatre	Direction
Yogesh Gadhavi	Music	Gujarati Folk Music
Vidyanand Saraik	Music	Folk Music From Himachal Pradesh
Chiranji Lal Tanwar	Music	Rajasthani Mand Music
Prabhitangsu Das	Puppetry	
Dattatreya Aralikatte	Puppetry	
Annabattula Lakshmi Mangatayaru & Annabattula Leela Sai	Theatre	Traditional Theatre
Gulzar Ahmad Ganie	Music	Chakri, Folk Music
Braj Kishor Dubey	Music	Folk Music
Somnath D Chari	Music	Traditional Music
Lakmidhar Rout	Art	Pala art from Bihar
Pappu Venugopal Rao	Art	Overall Contribution In Arts
Avinash Pasricha	Art	Overall Contribution In Art

63RD FILMFARE AWARDS

Category	Winner
Best Film	'Hindi Medium'
Critics' Award for Best Film	'Newton'
Best Actor In A Leading Role (Female)	Vidya Balan for 'Tumhari Sulu'
Best Actor In A Leading Role (Male)	Irrfan Khan for 'Hindi Medium'
Critics' Award for Best Actor (Male)	Rajkummar Rao for 'Trapped'
Critics' Award for Best Actor (Female)	Zaira Wasim for 'Secret Superstar'
Best Director	Ashwiny Iyer Tiwari for 'Bareilly Ki Barfi'
Best Debut Director	Konkona Sensharma for 'A Death in the Gunj'
Best Actor In A Supporting Role (Male)	Rajkummar Rao for 'Bareilly Ki Barfi'
Best Actor in a Supporting Role (Female)	Meher Vij for 'Secret Superstar'
Best Dialogue	Hitesh Kewalya for 'Shubh Mangal Saavdhan'
Best Screenplay	Shubhashish Bhutiani for 'Mukti Bhavan'
Best Original Story	Amit Masurkar for 'Newton'
Best Actor (Male) in a Short Film	Jackie Shroff for 'Khujli'
Best Actor (Female) in a Short Film	Shefali Shah for 'Juice'
People's Choice Award for Best Short Film	'Anahut'
Best Short Film (Fiction)	'Juice'
Best Short Film (Non Fiction)	'Invisible Wings'
Best Music Album	Pritam for 'Jagga Jasoos'
Best Playback Singer (Male)	Arijit Singh for 'Roke na ruke naina' - 'Badrinath Ki Dulhania'
Best Playback Singer (Female)	Meghna Mishra for Nachdi phira - Secret Superstar

Best Lyrics	Amitabh Bhattacharya for Ullu ka pattha - Jagga Jasoos
Lifetime Achievement Award	Mala Sinha and Bappi Lahiri

Best Choreography	Vijay Ganguly and Ruel Dausan Varindani for Galti se mistake - Jagga Jasoos
Best Background Score	Pritam for Jagga Jasoos
Best Action	Tom Struthers for Tiger Zinda Hai
Best Cinematography	Sirsha Ray for A Death In The Gunj
Best Editing	Nitin Baid for Trapped
Best Production Design	Parul Sondh for Daddy
Best Sound Design	Anish John for Trapped
Best Costume	Rohit Chaturvedi for A Death In The Gunj

60TH GRAMMY AWARDS

Award	Awardee
Record of the Year	"24K Magic" – Bruno Mars
Album of the Year	*24K Magic* – Bruno Mars
Song of the Year	"That's What I Like"
Best New Artist	Alessia Cara
Best Pop Solo Performance	"Shape of You" – EdSheeran
Best Pop Duo/Group Performance	Feel It Still" – Portugal. The Man
Best Traditional Pop Vocal Album	Tony Bennett Celebrates 90
Best Pop Vocal Album	÷ – Ed Sheeran
Best Dance Recording	"Tonite" – LCD Soundsystem
Best Dance/Electronic Album	*3-D The Catalogue* – Kraftwerk
Best Contemporary Instrumental Album	Prototype – Jeff Lorber Fusion
Best Rock Performance	"You Want It Darker" – Leonard Cohen
Best Metal Performance	"Sultan's Curse" – Mastodon
Best Rock Song	"Run" Foo Fighters
Best Rock Album	A Deeper Understanding – The War on Drugs
Best Alternative Music Album	Sleep Well Beast – The National
Best R&B Performance	"That's What I Like" – Bruno Mars
Best Traditional R&B Performance	"Redbone" – Childish Gambino
Best R&B Song	"That's What I Like"

OTHER IMPORTANT AWARDS AND HONOURS

Name of the Winner	Category	Organized by
The Jawaharlal Nehru Port Trust also known as Nhava Sheva	Samundra Manthan - Organisation of the Year award	Bhandarkar Shipping
Ravi Menon	the best central bank governor in Asia-Pacific for 2018	UK-based magazine 'The Banker
film and theatre actor Soumitra Chattopadhyay	France's highest order of merit the 'Legion of Honour'	France
The Matunga suburban station	Limca Book of Records for having an all-woman staff.	Mumbai Suburban Railway network
Actor Sudhir Dalvi	Janakavi P Sawlaram award	Thane Municipal Corporation and the Janakavi P Savlaram Kala Samiti
Dancer Jaishree T	Ganga Jamuna award	Thane Municipal Corporation and the Janakavi P Savlaram Kala Samiti
Arvind Parikh, R Vedavalli, Ram Gopal Bajaj and Sunil Kothari.	Sangeet Natak Akademi Fellowships and Sangeet Natak Akademi Awards	President Ram Nath Kovind
president Pranab Mukherjee	The Doctor of Literature (D.Litt.) degree.	The Chittagong University in Bangladesh
Virat Kohli	the Cricketer of the Year and ICC ODI Cricketer of the Year	International Cricket Council (ICC)
Yuzvendra Chahal	T20 Performance of the Year	International Cricket Council (ICC)
Nara Lokesh	Dr Kalam Innovation in Governance Award 2018	Dr A.P.J. Abdul Kalam Summit
Global icon Shah Rukh Khan	24th Crystal Award	World Economic Forum
Seven girls and 11 Boys	National Bravery Award 2017	Government of India and Indian Council for Child Welfare

Tamil Nadu ChiefMinister Edappadi K Palanisamy	UNESCO Award of Merit	UNESCO Asia Pacific region for thecultural heritage conservation committees
50 workers	Prime Minister's Shram Awards named Shram Ratna Award', 'Shram Bhushan Award', 'Shram Vir/Shram Virangana' ,'Shram Shree/Shram Devi Awards'	Ministry of Labour and Employment
Dr Vinod Paul, Member of NITI Aayog	IhsanDogramacı Family Health Foundation Prize	World Health Organisation (WHO)
Bollywood playback singer Asha Bhosle	Yash Chopra Memorial Award'	TSR Foundation of T. Subbarami Reddy in memory ofproducer-director Yash Chopra
Najma A Heptulla, Narayan Yadav, Dinesh Trivedi, Ghulam Nabi Azad,	Outstanding Parliamentarian Awards	The Indian Parliamentary Group
Bhartruhari Mahtab		

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The Bharat Ratna or the Jewel of India is the highest civilian award of the Republic of India. Instituted in 1954, the award is conferred in recognition of exceptional service or performance of the highest order, without distinction of race, occupation, position, or sex. The award was originally limited to achievements in the arts, literature, science, and public services, but the government expanded the criteria to include any field of human endeavour in December 2011. The recommendations for the Bharat Ratna are made by the Prime Minister to the President, with a maximum of three nominees being awarded per year. Recipients receive a Sanad or certificate signed by the President and a peepal-leaf–shaped medallion. There is no monetary grant associated with the award. Bharat Ratna recipients rank seventh in the Indian order of precedence.

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SSC CGL 2018: List of Bharat Ratna Awardees till 2018

Year	Name	Description
1954	C Rajagopalachari	C Rajagopalachari was the Governor General of independent India from 1948 to 1950. He was the first and last Indian to hold this post. He was the Chief Minister of the Madras Presidency from 1937 to 1939 during the British rule.
1954	Sarvepalli Radhakrishnan	Sarvepalli Radhakrishnan was a renowned philosopher. He was the Vice President of India from 1952 to 1962. In 1962 he was appointed as the President of India. His birthday, which falls on September 5, is celebrated as Teacher's Day in India.
1954	CV Raman	CV Raman was an internationally acclaimed scientist. Raman, who was awarded the Nobel Prize in Physics in 1930, is known around the world for his work Raman Scattering, which deals with the scattering of light and the discovery of the effect.
1955	Bhagwan Das	An Indian theosophist, Bhagwan Das co- founded the Mahatma Gandhi Kashi Vidyapith in 1921. He also assisted Madan Mohan Malaviya in the establishment of the Banaras Hindu University.
1955	M Visvesvaraya	M Visvesvaraya was an acclaimed engineer and every year his birthday, which falls on 15 September, is celebrated as Engineer's Day in India. He undertook many important projects and was the chief designer of Hyderabad's flood protection system.

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1955	Jawahar Lal Nehru	Jawahar Lal Nehru, who was a leading figure in the Indian independence movement, became the first Prime Minister of free India. He was the longest serving Prime Minister of India and held office from 1947-1964.
1957	Govind Ballabh Pant	Govind Ballabh Pant played an important role in the freedom movement and the government during British rule as well as in independent India. He twice served as the premier of the United Provinces – 1937 to 1939 and 1946 to 1950.
1958	Dhondo Keshav Karve	Karve was a social reformer and educator. He played a vital role in the upliftment of women in the country. He worked in the fields of remarriage of Hindu widows and also education of women.
1961	Bidhan Chandra Roy	Bidhan Chandra Roy was a reputed physician and was also a freedom fighter. He was the Chief Minister of Bengal from 1948 to 1962.
1961	Purushottam Das Tandon	A freedom fighter, Purushottam Das Tandon was given the title of Rajarshi. He is remembered for his campaign to provide Hindi with the official language status.
1962	Rajendra Prasad	Rajendra Prasad was the President of India from 1950 to 1962. He was a freedom fighter and was involved in the non-cooperation movement. He was also a great scholar, a lawyer, and statesman.
1963	Zakir Husain	Zakir Hussain was the Vice President of India from 1962 to 1967 and the President from 1967 to 1969. A freedom fighter, he was also the Vice Chancellor of the Aligarh Muslim University from 1948 to 1956.

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1963	Pandurang Vaman Kane	Kane was a Sanskrit scholar as well as Indologist. He is noted for his monumental work History of Dharmaśāstra: Ancient and Medieval Religious and Civil Law in India.
1966	Lal Bahadur Shastri	Lal Bahadur Shastri was the Prime Minister of India from 1964 to 1966. He led the nation in the war against Pakistan in 1965. He is famous for his slogan Jai Jawan Jai Kisan.
1971	Indira Gandhi	India Gandhi, the prime minister of India from 1966 to 1977, and 1980 to 1984, is also known as the Iron Lady of India. She liberated Bangladesh in the Indo-Pakistan War of 1971.
1975	V V Giri	A noted freedom fighter, V V Giri was the first acting president of India and was elected as the President in 1969.
1976	K Kamraj	A freedom fighter, Kamraj was the chief minister of Tamil Nadu from 1954–1963 consecutively.
1980	Mother Teresa	Mother Teresa is noted for her charity work. A Catholic nun, she founded the Missionaries of Charity. She received the Nobel Peace Prize in 1979.
1983	Vinoba Bhave	A freedom fighter and social reformer, he is famous for the Bhoodan movement, which was a Land-Gift movement. In 1958, he was awarded the Ramon Magsaysay Award.
1987	Khan Abdul Ghaffar Khan	A prominent freedom fighter, Khan Abdul Ghaffar Khan founded the Khudai Khidmatgar in 1929. a staunch follower of Mahatma Gandhi, he was also known as the Frontier Gandhi.
1988	M G Ramachandran	Ramachandran who was an actor later joined politics. He was the chief minister of Tamil Nadu during the years 1977–80, 1980–84, and 1985–87.

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1990	B R Ambedkar	A Dalit leader, B R Ambedkar vigorously campaigned against social discrimination that Dalits had to face. Following independence, Ambedkar drafter the Indian Constitution. He was also the first Law Minister of the country.
1990	Nelson Mandela	Mandela played an important role in South Africa's Anti-Apartheid Movement. He also served as the President of South Africa from 1994 to 1999. Mandela, who won the Nobel Peace Prize in 1993, is also called the Gandhi of South Africa.
1991	Rajiv Gandhi	He was the Prime Minister of India from 1984 to 1989. Sworn in at the age of 40, he was the youngest Prime Minister of India.
1991	Vallabhbhai Patel	A freedom fighter, Vallabhbhai Patel was instrumental in integrating the princely states into the Indian Union. Thus, he came to be known as the Iron Man of India.
1991	Morarji Desai	He was the Prime Minister of India from 1977-1979. Desai is the only Indian to be honored with Nishan-e-Pakistan, the highest civilian award presented by the Pakistan government.
1992	Abdul Kalam Azad	A freedom fighter, Abdul Kalam Azad was the first Minister of Education. Every year 11 November, which is Kalam's birthday, is observed as the National Education Day in India.
	JRD Tata	JRD Tata was an industrialist as well as philanthropist. Among his many achievements is the He establishment of Air India as well as institutes such as Tata Institute of Social Sciences, Tata Institute of Fundamental Research.

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1992	Satyajit Ray	One of the greatest filmmakers, Ray also received Dadasaheb Phalke Award in 1984. His most famous work is Pather Panchali.
1997	Gulzarilal Nanda	Two times deputy chairman of the Planning Commission, Nanda also served as the interim Prime Minister of India in 1964 and 1966.
1997	Aruna Asaf Ali	Aruna Asaf Ali, who played a prominent role in India's freedom struggle, became the first mayor of Delhi in 1958.
1997	A P J Abdul Kalam	Kalam was an acclaimed aerospace and defence scientist. He was the brain behind the Integrated Guided Missile Development Program. He was the President of India from 2002 to 2007.
1998	MS Subbulakshmi	Subbulakshmi was a Carnatic classical vocalist. She won the Ramon Magsaysay award, becoming the first Indian to get the honour. She is also called the Queen of Songs.
1998	Chidambaram Subramaniam	Subramaniam was India's Agriculture Minister from 1964 to 1966. He made a significant contribution towards Green Revolution.
1999	Jayaprakash Narayan	Known as Lok Nayak, Jayaprakash Narayan is known for his struggle against the government of Indira Gandhi in the 1970s. For this he initiated the Total Revolution Movement.
1999	Amartya Sen	Amartya Sen is a noted economist. Sen who has done research in a number of topics won the Nobel Memorial Prize in Economic Sciences in 1998.
1999	Gopinath Bordoloi	The Chief Minister of Assam form 1946 to 1950, Bordoloi played a prominent role in keeping Assam united with India during the partition.

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1999	Ravi Shankar	Ravi Shankar was an internationally acclaimed sitar player. He has won four Grammy Awards. He extensively collaborated with George Harrison.
2001	Lata Mangeshkar	Due to her melodious voice, Lata Mangeshkar is referred as the Nightingale of India. She holds the distinction of having sung in more than 36 languages. She won the Dadasaheb Phalke Award in 1989.
2001	Bismillah Khan	Shehnai player, Bismillah Khan achieved fame not only in India but around the world. He played a prominent role in popularizing the shehnai.
2009	Bhimsen Joshi	Bhimsen Joshi was an acclaimed vocalist from the state of Karnataka. He received the Sangeet Natak Akademi Fellowship in 1998.
2014	CNR Rao	A professor and chemist, he has significantly worked in Spectroscopy, Molecular Structure, Solid State, and Materials Chemistry.
2014	Sachin Tendulkar	One of the world's best cricket players, Sachin Tendulkar has played 664 international matches. In his career of more than two decades, he has held many records.
2015	Madan Mohan Malaviya	He founded the Banaras Hindu University. He also served as the president of the Indian National Congress. From 1924 to 1946, he was the chairman of the Hindustan Times.
2015	Atal Bihari Vajpayee	Vajpayee was the Prime Minister of India during the years 1996, 1998 and 1999 to 2004. From 1977 to 1979, he was the External Affairs Minister. In 1994, he was given the Best Parliamentarian Award.

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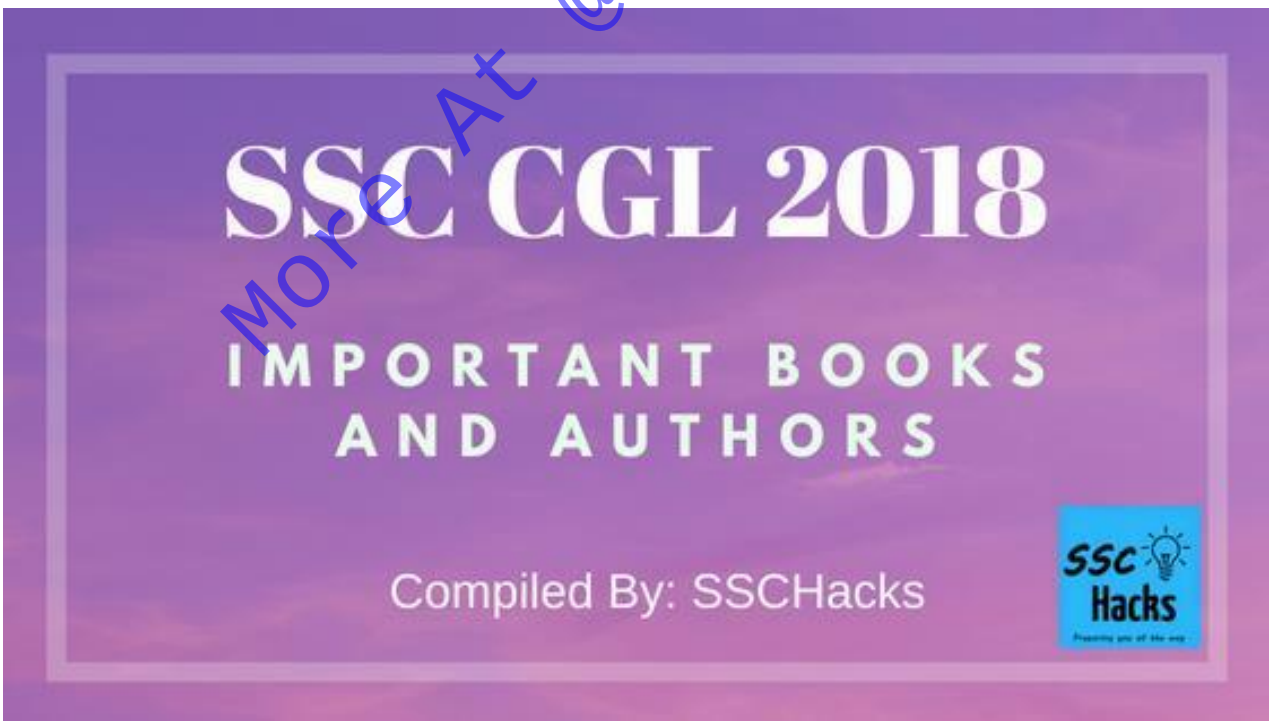
IMPORTANT BOOKS AND AUTHORS



1. Books and Authors List – Non-Fiction

Non-fiction is a category where you get to read biographies, memoirs, self-help books, business books and histories. In a research, it was found that reading nonfiction books increase your chance of becoming successful in all spheres.

Books	Authors
The trip to echo spring: On writers and Drinking	Olivia Laing
On the origin of species	Charles Darwin
The interpretation of Dreams	Sigmund Freud
Walden	Henry David Thoreau
The Discovery Of India	Jawaharlal Nehru
Bookless in Baghdad	Shashi Tharoor
The Algebra of Infinite Justice	Arundhati Roy
Two Lives	Vikram Seth
Geetanjali	Rabindranath Tagore
Silent Spring	Rachel Carson
Mythologies	Roland Barthes
The Diary of a young girl	Anne Frank
Travels of Ibn battuta	Ibn battuta

A brief history of time	Stephen Hawking
Economy and Society	Max Weber
The Rights of a man	Thomas Paine
The Symposium	Plato
The Anatomy of melancholy	Robert Burton
Lives of the poets	Samuel Johnson

2. Books and Authors List – Fiction

Imagining stories activate regions of your brain responsible for developing a better understanding of others and also creating a new perspective. Fictional books are very popular among readers so they often make the news.

Books	Authors
Wuthering Heights	Emily Bronte
The adventures of Huckleberry Finn	Mark Twain
The fault in our stars	John Green
The Alchemist	Paulo Coelho
Pride and Prejudice	Jane Austen
Lord of flies	William Golding
The Da Vinci Code	Dan Brown

The Great Gatsby	F. Scott Fitzgerald
The Guide	R K Narayan
Train to Pakistan	Khushwant Singh
Midnight's children	Salman Rushdie
The Night train at Deoli	Ruskin Bond
Shadow Lines	Amitav Ghosh
The Great Indian Novel	Shashi Tharoor
The Blue Umbrella	Ruskin Bond
The Laughing Monsters	Denis Johnson

3. Books and Authors List – Biographies

Biographies and autobiographies are a very nice mixture of both Fiction and Nonfiction, so they cater the needs of all types of readers and are a good source of encouragement for readers as they get to know about personalities who made it big by their work.

Books	Author
Steve Jobs	Walter Isaacson
The Rise Of Theodore Roosevelt	Edmund Morris
The Wright Brothers	David McCullough
Wild Swans	Jung Chang
The Audacity Of hope	Barack Obama

Tennessee Williams	John Lahr
Open	Andre Agassi
Napoleon	Andrew Roberts

4. Books and Authors – Autobiographies

Autobiographies are self-written biographies. Here are some autobiographies that have made a global impact and are related to important causes:

Books	Author
I am Malala	Malala Yousafzai
The Autobiography Of Benjamin Franklin	Benjamin Franklin
Long Walk to Freedom	Nelson Mandela
Story Of my Experiments with truth	Mahatma Gandhi
An autobiography of Agatha Christie	Agatha Christie
Wings of Fire	A P J Abdul Kalam
An autobiography	Jawaharlal Nehru
Playing It My way	Sachin Tendulkar
Straight From the Heart	Kapil Dev
Story of my Life	Hellen Keller
The Bandit Queen Of India	Phoolan Devi

Truth Love and a Little Malice	Khushwant Singh
Why I am an Atheist	Bhagat Singh
Baburnama	Babur
The autobiography of Malcolm X	Malcolm X
Up From Slavery	Robert T Washington
Unbroken	Laura Hillenbrand

Books that win Pulitzer Prize, Man Booker Prize and other prizes are important too.

Here is a list of them:

Pulitzer Prize Winning Books and Authors

2018

1. Less - Andrew Sean Greer (Fiction)
2. Cost of Living - Martyna Majok (Drama)
3. Prairie Fires – Carolyn Fraser (Autobiographies and Biographies)
4. Locking Up Our Own - Crime and Punishment in Black America - James Forman Jr. (Non-Fiction)
5. The Gulf - Jack E. Davis (History)
6. Half-Light - Frank Bidart (Poetry)

2017

1. The Underground Railroad – Colson Whitehead (Fiction)
2. The Return: Fathers, Sons and the Land in Between – Hisham Matar (Autobiographies and Biographies)

3. Drama: *Sweat* Lynn Nottage
4. History: *Blood in the Water: The Attica Prison Uprising in 1971 and Its Legacy* by Heather Ann Thompson
5. Poetry: *Olio* by Tyehimba Jess

2016

1. The Sympathizer – Viet Thanh Nguyen (Fiction)
2. Barbarian Days: A Surfing Life – William Finnegan (Biography or Autobiography)
3. Black Flags: The Rise of ISIS – Joby Warrick (Nonfiction)

2015

1. All the Light We Cannot See – Anthony Doerr (Fiction)
2. The Pope and Mussolini: The Secret History of Pius XI and the Rise of Fascism in Europe – David I. Kertzer (Autobiographies and Biographies)

Man Booker prize Winning Books and Authors

1. The Sellout – Paul Betty (Fiction)
2. A Brief History of Seven Killings – Marlon James (Fiction)
3. The Narrow Road to the Deep North – Richard Flanagan (Fiction)
4. The Luminaries – Eleanor Catton (Fiction)
5. Bring Up the Bodies – Hilary Mantel (Non-fiction)
6. The Sense of an Ending – Julian Barnes (Fiction)
7. *A Horse Walks Into a Bar (2017) – David Grossman (Novel)*