GKC - SEMETER III UNITS

1. SCIENCE PART-I
2. SCIENCE PART-II
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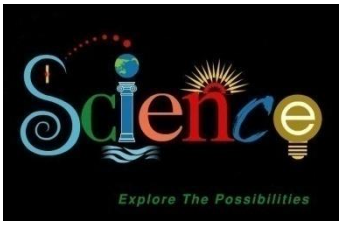
5. ENVIRONMENTAL STUDIES POLLUTION AND DISASTER MANAGEMENT

UNIT 1 SCIENCE PART-I

1. Science Part-I

1.1 Some Basic Definitions

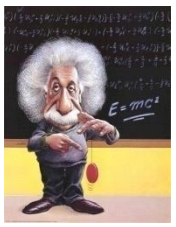
Science:



It is knowledge gained through experiments and observations, critically examined, systematised and brought under general principles. It has two main branches, namely the physical sciences and the Biological Sciences.

Physics Sciences:

It includes Physics, Chemistry and Geology.



Physics:

It is the science dealing with properties, changes, interactions etc., of matter and energy.

Chemistry:

It is the science which deals with the composition of matter, the effect of the physical forces on matter, permanent changes that take place when one type of matter is brought in contact with another, their methods of preparations and the uses.

Geology:

It is the scientific study of the Earth's outer rocks, now they are arranged and their formation.

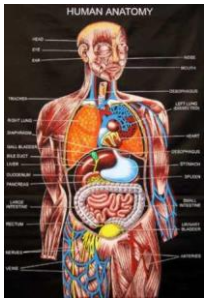
Zoology:

It is the science that deals with animals, their life, structure, growth and classification.

Botany:

It is the science that deals with plants, their life structure, growth and classification.

Human Anatomy:



It is the science of morphology or structure of man.

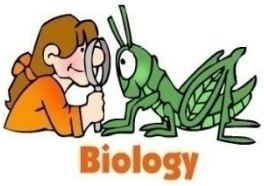
Ecology:

It is the branch of science that deals with the relationship between living organism and their environment.

Genetic Engineering:

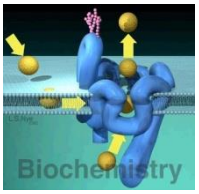
It is the branch of science that deals with heredity and variation in similar or related animals and plan.

Biology:



It is the science that deals with the origin, history, physical characteristics, life processes, habits etc. of plants and animals. It includes Botany, Zoology and their Sub-divisions.

Bio-Chemistry:

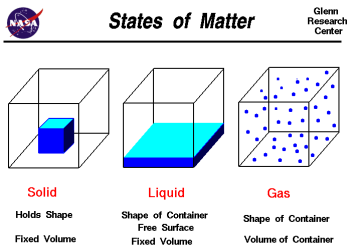


It is the branch of chemistry that deals with plants, animals and their life processes.

Bio-Technology:

Deals with application of technology in the field of biology.

Matter:

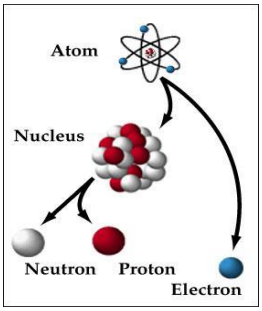


Whatever occupies space and possess weight is called matter. Matter is composed of molecules.

Molecules:

A molecule is the smallest particle of substances which can exist in a free state and has the properties of that substance. Molecules are composed of atoms.

Atom:

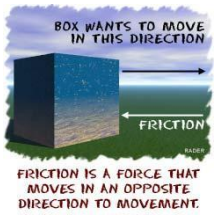


Atom is the smallest particle of an element which can take part in a chemical reaction.

Mass:

Mass is the quantity of matter contained in a body. Weight of the body is the force by which earth attracts the body.

Friction:



Friction is the force of resistance which comes into play when a body slides over a rough surface.

Speed:

It is the rate of motion. It possess magnitude only.

Velocity:

It is the speed of an object in a given direction.

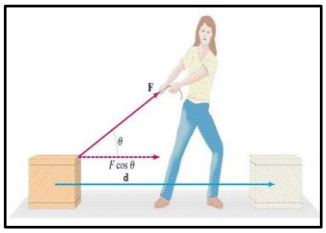
Acceleration:

It is the rate of increase of velocity.

Gravity:

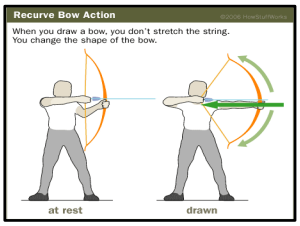
It is the pull of the earth with which it attracts bodies.

Work:



It is said to have been done only if the force applied moves the body on which it acts.

Energy:



Capacity for doing work is called energy.

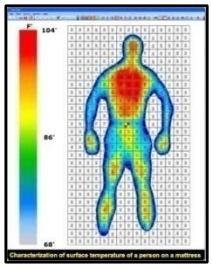
Potential Energy:

It is the energy which a body possess owing to its position.

Kinetic Energy:

It is the energy possessed by a body due its motion.

Temperature:



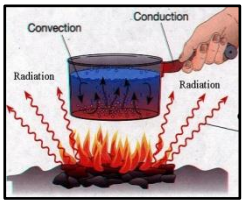
It is the degree of hotness, and it can be measured in the three different scales: Centigrade, Fahrenheit and Rea.

Conduction:

It is the process in which heat is transferred from particle to particle.

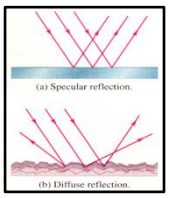
Convection:

It is the transmission of heat from one part of the body to another by actual motion of the heated particles of liquid of gas.



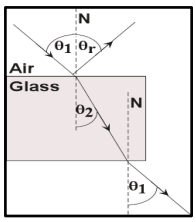
Radiation:

It is the process by which heat is transmitted from one point to another without heating the medium.



Reflection:

When a ray of light falls on a mirror it is sent back to the first medium in a certain direction according to certain laws.



Refraction:

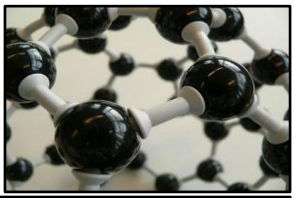
It is the phenomenon by which, when a ray of light is incident obliquely on a surface of separation between two media, part of its goes into the second medium along a path different from the direction of the incident beam obeying certain laws.

Physical Change:

It is a change in which no new products are formed. We can get back the original substance.

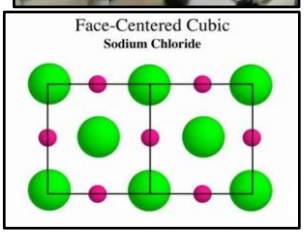
Chemical Change:

It is a permanent change in which new substances with new properties are formed. It is not possible to get back the original substance.



Element:

It cannot be split into simpler substances.



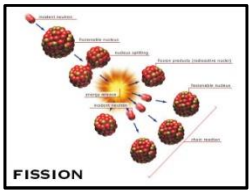
Compounds:

It can be split into simpler substances and is found by the union of two or more elements and in definite proportions by weight.

Mixture:

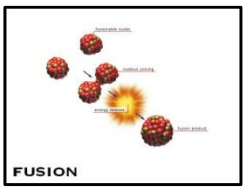
It is one in which two or more substances are mixed together in any ratio without altering their properties.

Nuclear Fission:



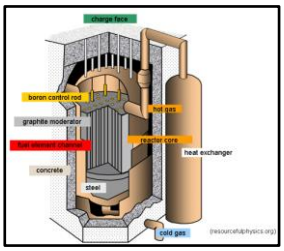
It is the bombardment of uranium with neutrons so that the uranium atoms are split into two nearly equal parts with the release of tremendous energy.

Nuclear Fusion:



It is the fusion of weight atomic nuclei like deuterium or tritium, into a nucleus of heavier mass, along with a resultant loss of their combined mass, which is converted into energy. It is the principle of Hydrogen bomb.

Atomic Reactor:



A place where nuclear energy is converted into electrical energy.

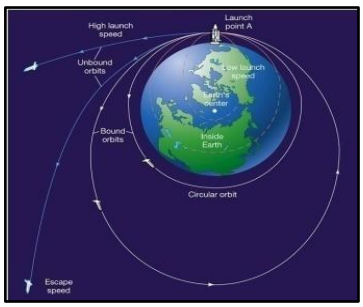
Atomic Energy:

The energy produced by either nuclear fission of fusion.

Neutron Bomb:

The devastating weapons with deadly radiation. It would not damage the buildings or tanks but kill all life. It is based on the principle of pure fusion reaction.

Escape Velocity:



The minimum velocity which can counteract the gravitational pull of the earth and take a body into an orbit.

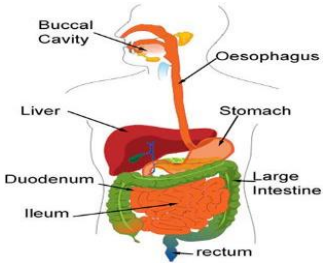
UNIT 2 SCIENCE PART-II

2. Science Part-II

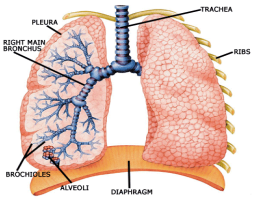
2.1 Human Physiology

Physiology is defined as the branch of science dealing with the functions of living organisms or their parts. In other others functional working of any part of the body is known as physiology viz., the working of lungs for respiration, secretion of various enzymes for digestion of food in alimentary canal etc. Human physiology deals with the working of the internal organs and their respective functions which are as follows.

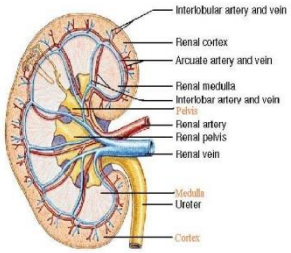
2.1.1 Alimentary Canal-For digestion of food



2.1.2 Lungs- For respiration



2.1.3 Kidney



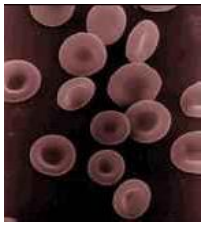
For removing the nitrogenous waste products like Urea in the form of urine.

2.1.4 Heart

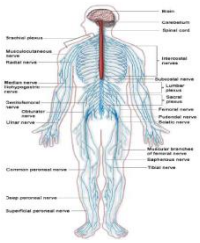
For pumping the blood in blood vessels.

2.1.5 Blood

For the distribution of oxygen and digested food to body cells.



2.1.6 Nervous System



For controlling all voluntary and involuntary activities of the body and apprising the body of the changes in environment.

2.1.7 Reproductive Organs

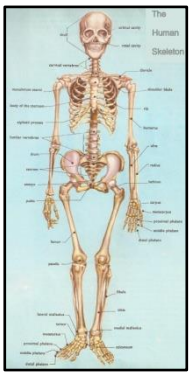
For the formation of male and female cells.

2.1.8 Body Muscles

Movement of various parts of the body.

2.1.9 Cellular Physiology

Deals with the respiration, excretion and conversion of digested food in living protoplasm and other cellular living functions.

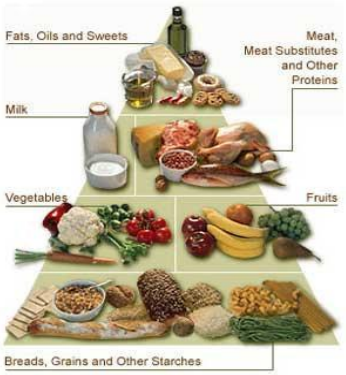


2.1.10 Skeletal System

2.2 Food and Nutrition

2.2.1 Food

Any nourishing substance that is eaten or otherwise taken into body to sustain life, provide energy and promote growth of the body.



2.2.2 Nutrition

It is the defined as the act of process of nourishing or being nourished. In other words it is the process by which organism take in all and utilize food materials.

2.2.3 Food or Nutrients

That part of food which nourishes the body, and is composed of micro and macro nutrients.

- Micronutrients:
- Macronutrients:

Carbohydrates, fats and proteins when digested give rise to glucose, essential fatty acid and essential amino acids. They are degraded to simpler compounds by digestion and while they may act as catalysts, their main functions are to provide energy and to take part in the structural make up of the body. Proteins, fats, carbohydrates, minerals vitamins and water in food are all essential to vital processes and growth but only the first two are sources of energy (1 gm of fat produces 9 cal:1 gm. of carbohydrate or protein yields about 4 cal) Micronutrients- Minerals, vitamins.

2.3 Adulteration

It is defined as mixing of inferior stuff to superior pure substance of daily use or to make impure by adding inferior substance or by extracting some of the useful materials from it.

Adulteration of essential commodities has become quite common these days. All edible substances: spices, medicines, milk and milk products, essential oils, petrol and even hard and soft drinks are adulterated in one or the other way.

The common adulterated articles are given below:

- *Food grain pulses* - General tendency is to colour the pulses and mix marble pallets to rise etc. These coloured pulses have adverse effect on the body. Mixing of water in milk and adulteration of butter with cheaper fats is well known. Ghee is adulterated with vegetable oils.

- *Medicines*- Many of the medicines are adulterated with stuffs which are harmful to body. Generally antibiotic capsules are filled with turmeric powder. All analgesics adulterated with common chalk. Many children in hospitals in Kanpur, who were administered sub-standard and spurious Glucose died.

- *Petrol*- Petrol is usually mixed with water or Kerosene.

- *Drugs and Intoxicants*- Generally Intoxicants alcohols are prepared or mixed with methylated spirit which is a poison. Many deaths have resulted from it.

- *Milk adulteration*

  In India, which is the land of cows, large quantities of milk are adulterated. Milk adulteration involves adding water to milk and removing the beneficial fats from milk. Often soya milk, starch, groundnut milk, and wheat flour are added to milk. This makes the milk less nutritious and it results in milk being useless for the consumer.

- *Adulteration of fats and oils*

  It is easy to adulterate oils and fats. But it is difficult to detect such adulteration. Ghee is often mixed with hydrogenated oils and animal fats. Synthetic colours and flavours are added to other fats to make them appear like ghee.

- *Other Adulterations:*

  Chilli powder is often mixed with brick powder, while tea leaves are often mixed with used tea leaves. These adulterations are very harmful to the consumer and they should be addressed by consumer organizations and consumers seriously.

2.4 Drugs and Their Abuses

The excessive use of any intoxicant harms the body. the excessive use of any intoxicants which as adverse effect on body is termed as ‘drug abuse’ involves three distinct phases (1) the experimental use of drugs by individuals because of fashion, (2) Psychologically dependent abusers who try to find relief from their problems through drugs or (3) who seek insight into drugs for ‘high’ kicks.

2.4.1 Psychological Dependence

A state of mind that involves feelings of satisfaction from drug addiction.

2.4.2 Physical Dependence

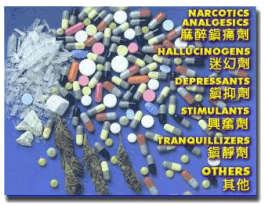
Such a state of addiction that one cannot tolerate the discontinuance of any drug.

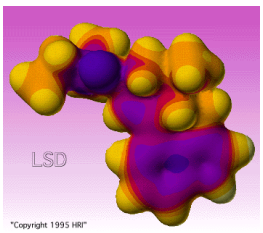
- Depressants (Control the Nervous System)

  - Opiates
  - All alcohols
  - barbiturates
  - Synthetic narcotics
  - Synthetic non-narcotic analgesics

- Minor Tranquilizers:
  - Meprobamate
  - Diazepam

- Stimulants:
  - Amphetamines
  - Methamphetamine
  - Cocaine





- Hallucinogens:
  - LSD (Lysergic acid diethylamide)
  - Mescaline, Peyote
  - DMT (Dimethyl Tryptamine)

All the drugs listed above are first taken as a status symbol but after its prolonged use a person becomes addicted to it and then it becomes his habit to take such drug i.e., psychological dependence leads to the drug abuse.

Fig 2.1: Before After Methamphetamine user

2.5 Diseases

2.5.1 Infectious Diseases

The communicable diseases which are communicated from one person to another, from one source to any person through air, water, food or touch. The infectious diseases are caused by four types of living organisms.

- Viral infectious diseases: Spread by viruses
- Bacterial infectious diseases: Spread by bacteria
- Parasite infectious diseases: Spread by parasites
- Fungal infectious diseases: Spread by fungus

Viruses - The smallest of parasites: intracellular molecular particles, with a central core of nucleic acid out of proteins i.e. Arbovirus and Myxovirus and varioe.

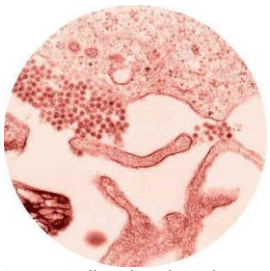


Fig 2.2: WestNile Virus(crop)

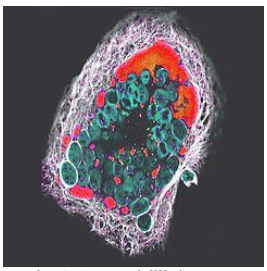


Fig 2.3: Morbillivirus

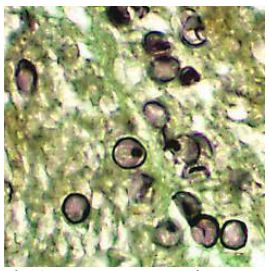


Fig 2.4: Pneumocystis pneumonia

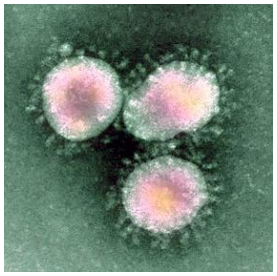


Fig 2.5: Virus

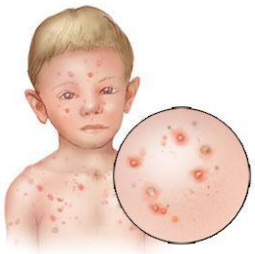


Fig 2.6: Virus disease

Bacteria - Any of numerous microscopic spherical, rod shapes or spiral organisms (plants) of the class schizomycetes eg. Entamoeba, Plasmodium, Ascaris etc.

Parasites - Any organism which derives food or benefit without giving anything in return is called parasite. Entamoeba, Plasmodium, Ascaris etc.

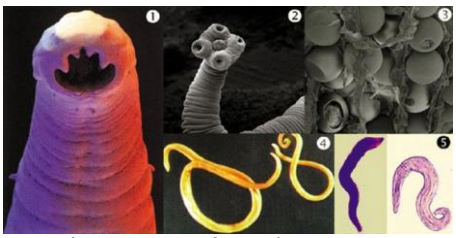


Fig 2.7: Types of parasites

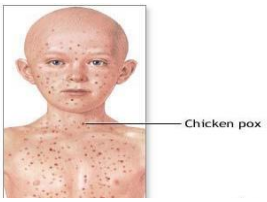
Fig 2.8: Ascarsis parasite

Fungus - Any of the plants which are devoid of chlorophyll belonging to thallophyta, like mushrooms, molds, mildews, rusts smuts etc.

2.5.2 Deficiency Diseases

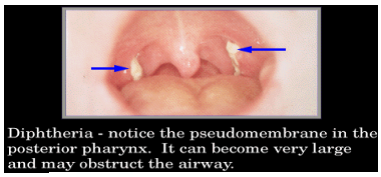
Those diseases caused by the lack of essential ingredients or vitamins in food: such as scurvy, rickets, anaemia etc.

- *Chicken Pox*- An acute infectious diseases common in childhood, caused by a virus and is highly contagious.

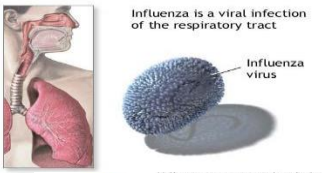


- *Common Cold*- An infectious disease or respiratory system, particularly the nose, throat and bronchi.

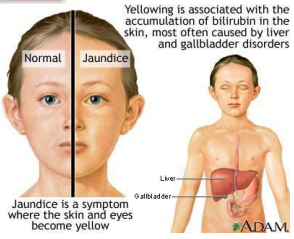
- *Diphtheria*- An acute infectious disease caused by a bacterium.



- *Influenza*- Acute infectious disease caused by a number of viruses.

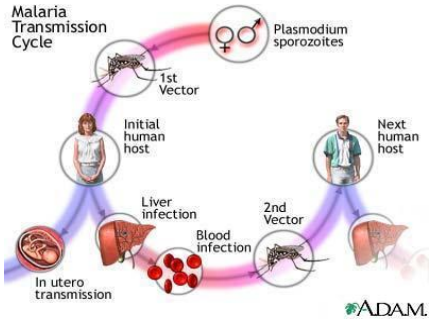


- *Jaundice*- Yellowing of the skin and whites of the eyes due to the presence of colouring matter of bile in the blood.

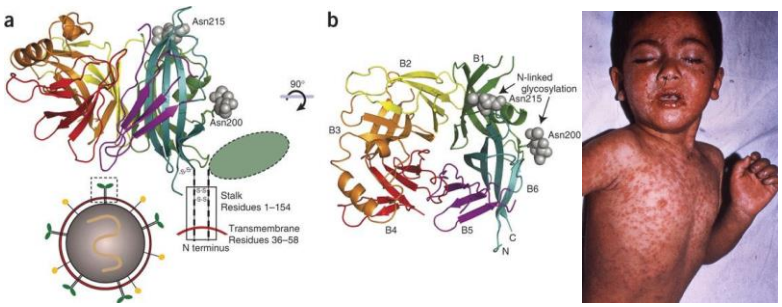


- *Leukaemia*- A serious malignant disease of the blood forming organs popularly known as blood cancer.

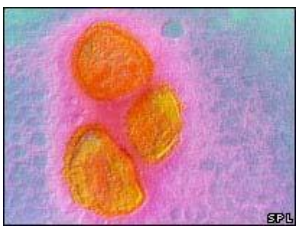
- Malaria **-** A parasitic disease that causes chills, fever and chronic ill health.

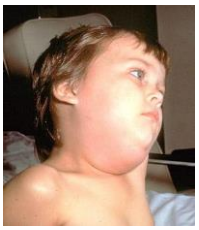


- *Measles*- Contagious virus disease that causes skin rash, fever, cold like symptoms and sometimes complications such a pneumonia.



- *Mumps*- Acute contagious disease usually affecting children in which the salivary glands become inflamed and swollen.

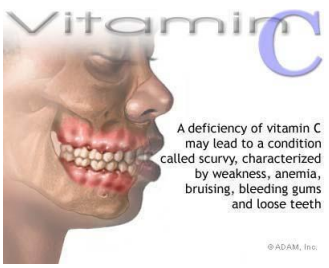




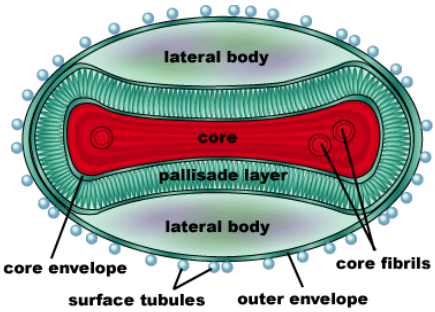
- *Rabies*- An acute usually fatal infectious disease of the central nervous system caused by a virus.

- Rickets- A softening of the bones in children due to lack of vitamin D in the diet.

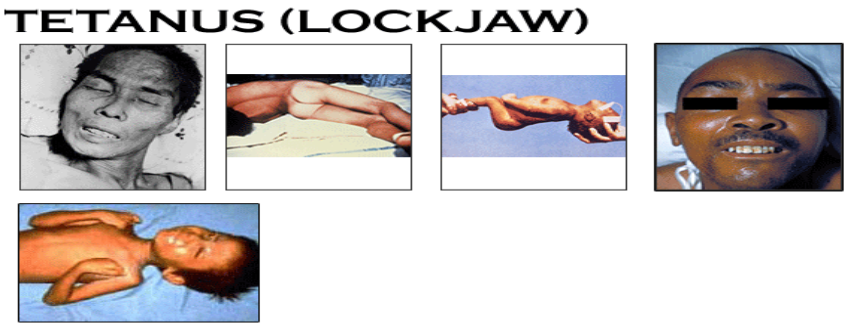

- Scurvy- A deficiency disease caused by a lack of vitamin C in the diet.



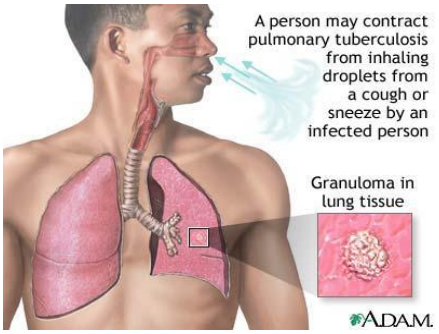
- Small Pox- Highly contagious virus disease.

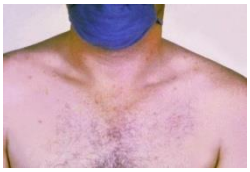


- *Tetanus*- A serious infectious disease causing spasm of the voluntary muscles.

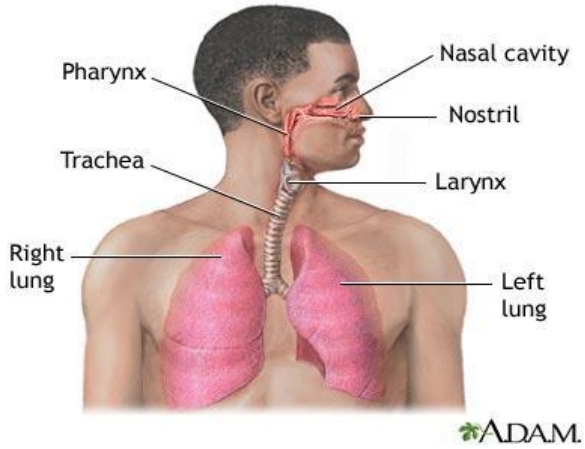


- *Tuberculosis*- An infectious disease caused by the bacterium Mycobacterium tuberculosis.





- *Typhoid Fever*- A serious sometimes fatal disease caused by a variety of salmonella bacteria.
- *Whooping Cough*- An acute contagious infection of the upper respiratory passages and bronchial tubes.



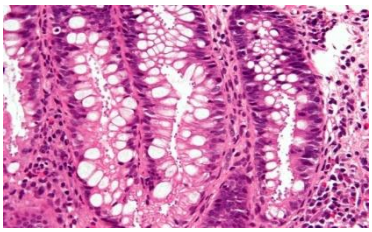
2.5.3 Common Infectious Diseases Worldwide

The following is a list of the most common infectious diseases throughout the world today. Accurate caseload numbers are difficult to determine, especially because so many of these diseases are endemic to developing countries, where many people do not have access to modern medical care. Approximately half of all deaths caused by infectious diseases each year can be attributed to just three diseases: tuberculosis, malaria, and AIDS. Together, these diseases cause over 300 million illnesses and more than 5 million deaths each year.

The list does include diseases that have received a significant amount of media attention in recent years—such as Ebola Hemorrhagic Fever or West

Nile Virus and also which in fact have infected a relatively small number of people

- *African Trypanosomiasis("sleeping sickness"):* African trypanosomiasis is spread by the tsetse fly, which is common to many African countries. The World Health Organization (WHO) estimates that nearly 450,000 cases occur each year. Symptoms of the disease include fever, headaches, joint pains, and itching in the early stage, and confusion, sensory disturbances, poor coordination, and disrupted sleep cycles in the second stage. If the disease goes untreated in its first stage, it causes irreparable neurological damage; if it goes untreated in its second stage, it is fatal.

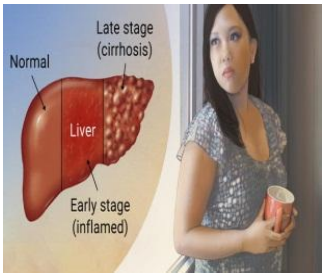


- *Cholera***:** Cholera is a disease spread mostly through contaminated drinking water and unsanitary conditions. It is endemic in the Indian subcontinent, Russia, and sub-Saharan Africa. It is an acute infection of the intestines with the bacterium *Vibrio cholerae.* Its main symptom is copious diarrhea. Between 5% and 10% of those infected with the disease will develop severe symptoms, which also include vomiting and leg cramps. In its severe form, cholera can cause death by dehydration. An estimated 200,000 cases are reported to WHO annually.

- *Cryptosporidiosis*: Cryptosporidiosis has become one of the most common causes of waterborne disease in the United States in recent years; it is also found throughout the rest of the world. It is caused by a parasite that spreads when a water source is contaminated, usually with the feces of infected animals or humans. Symptoms include diarrhea, stomach cramps, an upset stomach, and slight fever. Some people do not exhibit any symptoms.

- *Dengue:* WHO estimates that 50 million cases of dengue fever appear each year. It is spread through the bite of the *Aedesaegypti* mosquito. Recent years have seen dengue outbreaks all over Asia and Africa. Dengue fever can be mild to moderate, and occasionally severe, though it is rarely fatal. Mild cases, which usually affect infants and young children, involve a nonspecific febrile illness, while moderate cases, seen in older children and adults, display high fever, severe headaches, muscle and joint pains, and rash. Severe cases develop into dengue hemorrhagic fever, which involves high fever, hemorrhaging, and sometimes circulatory failure.

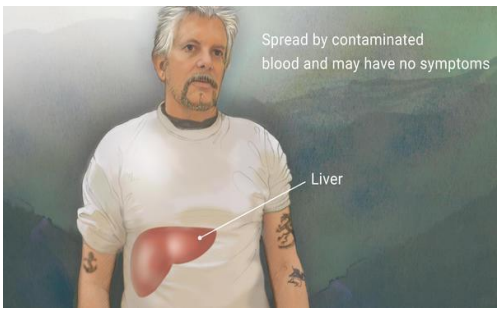
- *Hepatitis A:* Hepatitis A is a highly contagious liver disease caused by the hepatitis A virus. Spread primarily by the fecal-oral route or by ingestion of contaminated water or food, the number of annual infections worldwide is estimated at 1.4 million. Symptoms include fever, fatigue, jaundice, and dark urine. Although those exposed usually develop lifelong immunity, the best protection against Hepatitis A is vaccination



- *Hepatitis B:* Approximately 2 billion people are infected with the hepatitis B virus (HBV), making it the most common infectious disease in the world today. Over 350 million of those infected never rid themselves of the infection. Hepatitis is an inflammation of the liver that causes symptoms such as jaundice, extreme fatigue, nausea, vomiting, and stomach pain; hepatitis B is the most serious form of the disease. Chronic infections can cause cirrhosis of the liver or liver cancer in later years.

- *Hepatitis C:* Hepatitis C is a less common, and less severe, form of hepatitis. An estimated 180 million people worldwide are infected with hepatitis C virus (HCV); 3–4 million more are infected every year. The majority of HCV cases are asymptomatic, even in people who develop chronic infection.

- *Japanese Encephalitis:* Japanese encephalitis is a mosquito-borne disease endemic in Asia. Around 50,000 cases occur each year; 25% to 30% of all cases are fatal.



- *Leishmaniasis: Leishmaniasisis* a disease spread by the bite of the sandfly. It is found mostly in tropical countries. There are several types of leishmaniasis, and they vary in symptoms and severity. Visceral leishmaniasis (VL, or *kala azar*) is the most severe; left untreated, it is always fatal. Its symptoms include fever, weight loss, anemia, and a swelling of the spleen and liver. Mucocutaneousleishmaniasis (MCL, or *espundia*) produces lesions that affect the nose, mouth, and throat and can destroy their mucous membranes. Cutaneous leishmaniasis (CL) produces skin ulcers, sometimes as many as 200, that cause disability and extensive scarring. Diffuse cutaneous leishmaniasis (DCL) is similar to CL, and infected people are prone to relapses. Approximately 12 million cases of leishmaniasis exist today.

- *Meningitis:* Meningitis, often known as spinal meningitis, is an infection of the spinal cord. It is usually the result of a viral or bacterial infection. Bacterial meningitis is more severe than viral meningitis and may cause brain damage, hearing loss, and learning disabilities. An estimated 1.2 million cases of bacterial meningitis occur every year, over a tenth of which are fatal. Symptoms include severe headache, fever, nausea, vomiting, lethargy, delirium, photophobia, and a stiff neck.

- *Onchocerciasis ("river blindness"):* Onchocerciasis is caused by the larvae of *Onchocerca volvulus,* a parasitic worm that lives in the human body for years. It is endemic in Africa, where nearly all of the 18 million people infected with the disease live. Of those infected, over 6.5 million have developed dermatitis and 270,000 have gone blind. Symptoms include visual impairment, rashes, lesions, intense itching, skin depigmentation, and lymphadenitis.

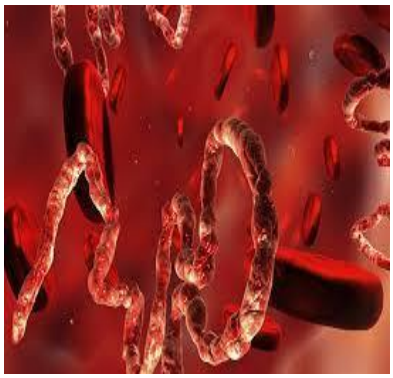
- *Pneumonia:* Pneumonia has many possible causes, but it is usually an infection of the streptococcus or mycoplasma bacteria. These bacteria can live in the human body without causing infection for years, and only surface when another illness has lowered the person's immunity to disease. *Streptococcus pneumoniae* causes streptococcal pneumonia, the most common kind, which is more severe than mycoplasmal pneumonia. *S. pneumoniae* is responsible for more than 100,000 hospitalizations for pneumonia annually, as well as 6 million cases of otitis media and over 60,000 cases of invasive diseases such as meningitis.

- *Rotavirus:* Rotavirus is the most common cause of viral gastroenteritis worldwide. It kills more than 600,000 children each year, mostly in developing countries. Symptoms include vomiting, watery diarrhea, fever, and abdominal pain.

- *Schistosomiasis:* Schistosomiasis is a parasitic disease that is endemic in many developing countries. Roughly 200 million people worldwide are

infected with the flukeworm, whose eggs cause the symptoms of the disease. Some 120 million of those infected are symptomatic, and 20 million suffer severely from the infection. Symptoms include rash and itchiness soon after becoming infected, followed by fever, chills, coughing, and muscle aches.

- *Shigellosis: Shigella* infection causes an estimated 600,000 deaths worldwide every year. It is most common in developing countries with poor sanitation. Shigella bacteria cause bacillary dysentery, or shigellosis. Symptoms include diarrhea with bloody stool, vomiting, and abdominal cramps.



- *Strep Throat*: Strep throat is caused by the streptococcus bacteria. Several million cases of strep throat occur every year. Symptoms include a sore throat, fever, headache, fatigue, and nausea.

- *Typhoid*: Typhoid fever causes an estimated 600,000 deaths annually, out of 12–17 million cases. It is usually spread through infected food or water. Symptoms include a sudden and sustained fever, severe headache, nausea, severe appetite loss, constipation, and sometimes diarrhea..

- *Tuberculosis*: Tuberculosis causes nearly 2 million deaths every year, and WHO estimates that nearly 1 billion people will be infected between 2000 and 2020 if more effective preventive procedures are not adopted. The TB bacteria are most often found in the lungs, where they can cause chest pain and a bad cough that brings up bloody phlegm. Other symptoms include fatigue, weight loss, appetite loss, chills, fever, and night sweats.

- *Yellow Fever:* Yellow fever causes an estimated 30,000 deaths each year, out of 200,000 cases. The disease has two phases. In the “acute phase,” symptoms include fever, muscle pain, headache, shivers, appetite loss, nausea, and vomiting. This lasts for 3–4 days, after which most patients recover. But 15% will enter the “toxic phase,” in which fever reappears, along

with other symptoms, including jaundice; abdominal pain; vomiting; bleeding from the mouth, nose, eyes, and stomach; and deterioration of kidney function (sometimes complete kidney failure). Half of all patients in the toxic phase die within two weeks; the other half recover.

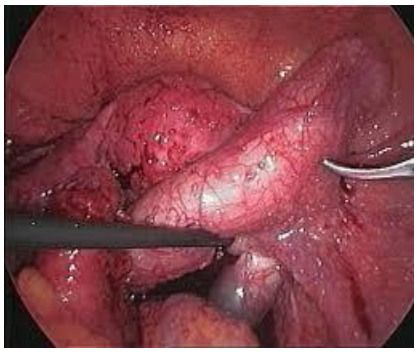
2.5.4 Diseases Spread Through Zika Virus

Zika virus disease is caused by a virus transmitted primarily by *Aedes* mosquitoes.

People with Zika virus disease can have symptoms including mild fever, skin rash, conjunctivitis, muscle and joint pain, malaise or headache. These symptoms normally last for 2-7 days.

Zika virus is a mosquito-borne flavivirus that was first identified in Uganda in 1947 in monkeys through a network that monitored yellow fever. It was later identified in humans in 1952 in Uganda and the United Republic of Tanzania. Outbreaks of Zika virus disease have been recorded in Africa, the Americas, Asia and the Pacific. From the 1960s to 1980s, human infections were found across Africa and Asia, typically accompanied by mild illness. The first large outbreak of disease caused by Zika infection was reported from the Island of Yap (Federated States of Micronesia) in 2007. In July 2015 Brazil reported an association between Zika virus infection and Guillain-Barré syndrome. In October 2015 Brazil reported an association between Zika virus infection and microcephaly.

2.5.5 Diseases Spread By Ebola Virus



The Ebola virus causes an acute, serious illness which is often fatal if untreated. Ebola virus disease (EVD) first appeared in 1976 in 2 simultaneous

outbreaks, one in what is now, Nzara, South Sudan, and the other in Yambuku, Democratic Republic of Congo. The latter occurred in a village near the Ebola River, from which the disease takes its name.

Ebola virus disease (EVD), formerly known as Ebola haemorrhagic fever, is a severe, often fatal illness in humans.

The virus is transmitted to people from wild animals and spreads in the human population through human-to-human transmission.

2.6 References

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UNIT 3 SCIENCE PART-III

3. Science Part-III

3.1 Information Technology

In the broadest sense, information technology refers to both the hardware and software that are used to store, retrieve, and manipulate information. At the lowest level you have the servers with an operating system. Installed on these servers are things like database and web serving software. The servers are connected to each other and to users via a network infrastructure. And the users accessing these servers have their own hardware, operating system, and software tools.

Information technology (IT) has been defined by the Information Technology Association of America, or the ITAA as being the study, design, development, implementation support and/or management of any computer based information systems. This relates particularly to software applications and computer hardware. Information technology deals with using electronic computers and software to convert, store, protect, process, retrieve with security or transmit any information.

IT is a wide based term and encompasses many areas. Professionals in information technology may perform a wide variety of tasks that range from installing computer applications to designing widely complex computer networks and information databases. Everything from data management, networking, engineering computer hardware, software design, database design and management and administration of systems is included in the term of information technology. When covering the aspects of IT as a whole, the use of computers and information are typically associated.

3.2 Types of Information Systems

- *Transaction Processing System (TPS):* Organizations perform routine, repetitive tasks. For example employees are paid at regular intervals, customers place purchase orders and are billed and expenses are monitored and compared to budgets.

  The information system that supports such tasks is called 'Transaction Processing System'. A TPS supports the monitoring, collection, storage and processing of the organization's basic transactions. It also provides the input data for many other applications.

- *Management Information System (MIS):* These systems access, organize, summarize and display information for supporting routine decision making in

the functional areas. A MIS provides reports about topics like operational efficiency, effectiveness and productivity. It prepares these reports by extracting information from the corporate database and processing it according to the needs of the user. MISs' are used for monitoring, planning and control. They also enable managers to detect possible problems in their early stages.

- *Support Systems:* Support systems for office employees began to emerge in the late 1960s. Airline reservation systems are the best example of this development. Electronic communication is only one aspect of what is now known as an Office Automation System (O.A.S.). Decision support system is used to provide computerized support for complex, non-routine decisions.

- *Intelligent Systems:* By the mid-1980s, managerial application of the so called artificial intelligence began, creating intelligent systems that seem to be able to replicate the thought process of humans. Expert systems are advisory systems that provide the stored knowledge of experts to non-experts, so that the latter can solve difficult problems.

3.3 Issues in Information Technology

- Personal Issues: An increase in work load and / or responsibilities can trigger job stress. Many employees feel information anxiety because other people are better than they in using computers, because they are slow in learning new technology and because of the need to continuously learn new things.

- Exposure to terminals can cause radiation exposure which is associated with cancer and other health related problems. It can also affect eyesight. Other hazards are backaches and muscle tension in the wrist and fingers.

- Social Issues: They are mainly positive issues. There is now flexibility in jobs that can greatly improve the quality of leisure time. There are also great opportunities for people with disabilities. Those who cannot type are able to use voice-operated typewriters or work from home. It has brought about major improvement in health care delivery, ranging from better diagnosis to research of new drugs, to more accurate monitoring of critically ill patients.

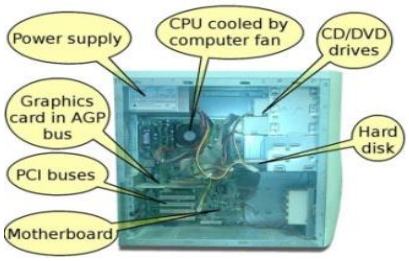
- Ethical Issues: Many companies and professional organizations develop their own code of ethics. A code of ethics is a collection of principles intended as a guide for the members of a company or an organization. There are four kinds of ethical issues - privacy, accuracy, property and accessibility. Information privacy is the right to determine when and to what extent information about oneself can be communicated to others. The issues to be considered here are electronic surveillance and personal information in databases. Millions of computer users are being monitored without their knowledge. Information about individuals is being kept in many databases. Intellectual property is the intangible property created by individual who is protected by trade secrets, patent and copyright laws.

3.4 Typical Computer Hardware

A typical computer consists of a case or chassis in a tower shape (desktop) and the following parts:

3.4.1 Motherboard

It is the "body" or mainframe of the computer, through which all other components interface.



3.4.2 Central Processing Unit (CPU)

Performs most of the calculations which enable a computer to function, sometimes referred to as the "brain" of the computer. Various processors are available in the market from different manufacturers, e.g Intel (Pentium III, Pentium IV, Dual Core, Core 2 Duo, Xeon, etc.), AMD (Athlon, Phenom, Sempron) etc.

3.4.3 Computer Fan

Used to prevent overheating of the computer; a fan is almost always attached to the CPU, and the computer cabinet will generally have several fans to maintain a constant airflow.

3.4.4 Random Access Memory (RAM)

It is also known as the physical memory of the computer. Fast-access memory that is cleared when the computer is powered-down. RAM attaches directly to the motherboard, and is used to store programs that are currently running. This memory is not in the direct control of the user but is accessed by the processor according to its own needs.

3.4.5 Internal Buses

Connections to various internal components.

- PCI
- PCI-E

- USB
- HyperTransport
- CSI
- AGP (being phased out)

3.4.6 External Bus Controllers

Used to connect to external peripherals, such as printers and input devices. These ports may also be based upon expansion cards, attached to the internal buses.

3.4.7 Power Supply

This is an enclosed box with a cooling fan that normally comes with the cabinet. It is a Switch Mode Power Supply (SMPS). It supplied controlled power to the various devices in the computer.

3.4.8 Storage Controllers

Controllers for hard disk, CD-ROM and other drives like internal Zip conventionally for a PC are IDE/ATA; the controllers sit directly on the motherboard (on-board) or on expansion cards, such as a Disk array controller. IDE is usually integrated, unlike SCSI Small Computer System Interface which can be found in some servers. The floppy drive interface is a legacy MFM interface which is now slowly disappearing. All these interfaces are gradually being phased out to be replaced by SATA and SAS.

3.4.9 Video Display Controller

Produces the output for the visual display unit. This will either be built into the motherboard or attached in its own separate slot (PCI, PCI-E, PCI-E 2.0, or AGP), in the form of a Graphics Card.

3.4.10 Removable Media Devices

- *CD (compact disc)* - the most common type of removable media, inexpensive but has a short life-span.
- *CD-ROM Drive* - a device used for reading data from a CD.
- *CD Writer* - a device used for both reading and writing data to and from a CD.
- *DVD (digital versatile disc)* - a popular type of removable media that is the same size as a CD but stores 6 times as much information. It is the most common way of transferring digital video.
- *DVD-ROM Drive* - a device used for reading data from a DVD.

- *DVD Writer* - a device used for both reading and writing data to and from a DVD.
- *DVD-RAM Drive* - a device used for rapid writing and reading of data from a special type of DVD.
- *Blu-ray* - a high-density optical disc format for the storage of digital information, including high-definition video.
- *BD-ROM Drive* - a device used for reading data from a Blu-ray disc.
- *BD Writer* - a device used for both reading and writing data to and from a Blu-ray disc.
- *HD DVD* - a high-density optical disc format and successor to the standard DVD. It was a discontinued competitor to the Blu-ray format.
- *Floppy disk* - an outdated storage device consisting of a thin disk of a flexible magnetic storage medium.
- *Zip drive* - an outdated medium-capacity removable disk storage system, first introduced by Iomega in 1994.
- *USB flash drive* - a flash memory data storage device integrated with a USB interface, typically small (approximately the size of a pen, thus also called pen drives), lightweight, rewritable, and portable.

- *Tape drive* - a device that reads and writes data on a magnetic tape, used for long term storage.

3.4.11 Internal Storage

Hardware that keeps data inside the computer for later use and remains persistent even when the computer has no power.

- *Hard disk* - for medium-term storage of data.
- *Solid-state drive* - a device similar to hard disk, but containing no *moving* parts.
- Disk *array controller* - a device to manage several hard disks, to achieve performance or reliability improvement.

3.4.12 Sound Card

Enables the computer to output sound to audio devices, as well as accept input from a microphone. Most modern computers have sound cards built-in to the motherboard, though it is common for a user to install a separate sound card as an upgrade.

3.4.13 Networking

Connects the computer to the Internet and/or other computers.

- *Modem* - for dial-up connections – it converts analog data to digital form and vice versa, has a speed limitation.

- *Network card* - for DSL/Cable internet, and/or connecting to other computers.

- *Direct Cable Connection* - Use of a null modem, connecting two computers together using their serial ports or a Laplink Cable, connecting two computers together with their parallel ports.

- *Dial* up connections broad band connections

3.4.14 Other Peripherals

In addition, hardware devices can include external components of a computer system. The following are either standard or very common.

- *Input*
    - *Keyboard* - a device, to input text and characters by depressing buttons (referred to as keys), similar to a typewriter. The most common English-language key layout is the QWERTY layout.

    - *Pointing devices*
        - Mouse - a pointing device that detects two dimensional motions relative to its supporting surface.

        - Trackball - a pointing device consisting of an exposed protruding ball housed in a socket that detects rotation about two axes.
        - Xbox 360 Controller - A controller used for Xbox 360, which with the use of the application Switchblade(tm), can be used as an additional pointing device with the left or right thumb stick.
    - *Gaming devices*
        - Joystick - a general control device that consists of a handheld stick that pivots around one end, to detect angles in two or three dimensions.
        - Gamepad - a general game controller held in the hand that relies on the digits (especially thumbs) to provide input.

- Game controller - a specific type of controller specialized for certain gaming purposes.

- *Image, Video input devices*
  - Image scanner - a device that provides input by analyzing images, printed text, handwriting, or an object.

  - Webcam - a low resolution video camera used to provide visual input that can be easily transferred over the internet.
- Audio *input devices*
  - Microphone - an acoustic sensor that provides input by converting sound into an electrical signals

- *Output: Audio-Video output devices*
  - Printer
  - Monitor
  - *Audio* output *devices*
  - Speakers
  - *Headset*

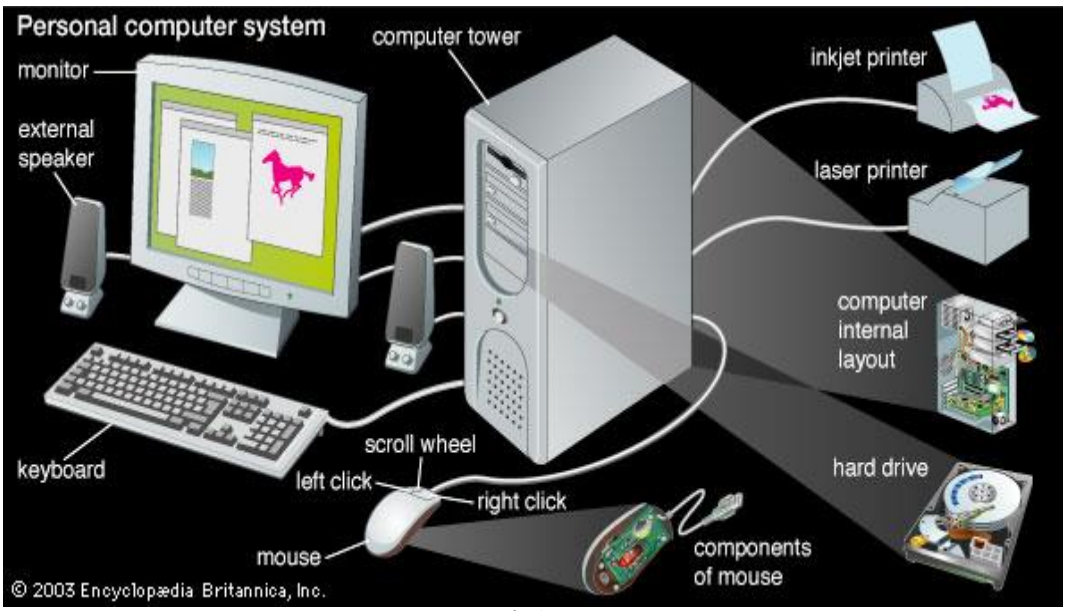


Fig 3.1

3.5 Computer Software

Computer software or just software is a general term used to describe a collection of computer programs, procedures and documentation that perform some tasks on a computer system. The term includes application software such as processors which perform productive tasks for users, system software such as operating systems, which interface with hardware to provide the necessary services for application software, and middleware which controls and co-ordinates distributed systems. Software includes websites, programs, video games etc. that are coded by programming in computer languages like C++, Matlab, Lisp, Java, HTML, etc.

Software encompasses an extremely wide array of products and technologies developed using different techniques like programming languages, scripting languages etc. The types of software includes

- Web pages developed by technologies like HTML, PHP, Perl, JSP, ASP. NET, XML
- Desktop applications like Microsoft Word, Open Office developed by technologies like C, C++, JAVA, C#, etc.
- Video games like Super Mario, Call of Duty, etc. for personal computers or video game consoles. These games can be created using CGI designed by applications like Maya, 3D Studio Max, etc.

Software usually runs on an operating system (which is software also) like Microsoft Windows, Linux, Sun Solaris etc. so that they operate as expected.

3.6 Types of Software

Practical computer systems divide software systems into three major classes: system software, programming software and application software, although the distinction is arbitrary, and often blurred.

- *System software* helps run the computer hardware and computer system. It includes operating systems, device drivers, diagnostic tools, servers, windowing systems, utilities and more. The purpose of systems software is to insulate the applications programmer as much as possible from the details of the particular computer complex being used, especially memory and other hardware features, and such accessory devices as communications, printers, readers, displays, keyboards, etc.

Fig 3.2

- *Programming software* usually provides tools to assist a programmer in writing computer programs, and software using different programming in a more convenient way. The tools include text editors, compilers, interpreters, linkers and so on.

- *Application software* allows end users to accomplish one or more specific tasks. Typical applications include industrial automation, business software, educational software, medical software and computer games.

3.7 License

Software produced for use by general public is normally made available either free or on payment.

- Free software is called Freeware and is usually available on the internet for free download. Examples of freeware: Adobe Acrobat Reader, AVG Free, Linux (Fedora), etc.

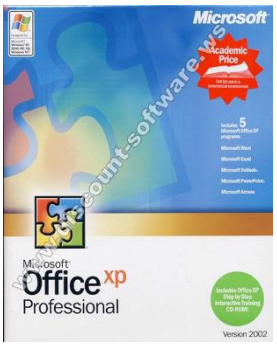


Fig 3.3

- *Software* that has to be purchased is provided with a license by the manufacturer. The software's license gives the user the right to use the software in the licensed environment. Examples: Windows (XP / Vista), MS Office, MATLAB, etc.

3.8 Computer Network

A computer network is a group of interconnected computers. Networks may be classified according to a wide variety of characteristics.

3.8.1 Network Classification

The following list presents major categories used for classifying networks.

- *Scale*

  Based on the scale networks can be classified as Local Area Network (LAN), Wide Area Network (WAN), Metropolitan Area Network (MAN), etc.

- *Connection method*

  Computer networks can also be classified according to the hardware technology that is used to connect the individual devices in the network such as Optical fibre, Ethernet, Wireless LAN etc.

  - Ethernet uses physical wiring to connect devices. Often deployed devices are hubs, switches, bridges, and/or routers.

  - Wireless LAN technology is designed to connect devices without wiring. These devices use radio waves as transmission medium.

- *Functional relationship (Network Architectures)*

  Computer networks may be classified according to the functional relationships which exist among the elements of the network, e.g., Active Networking, Client-server and Peer-to-peer (workgroup) architecture.

- *Network topology*

  The term Network Topology defines the geographic arrangement of computer networking devices. The term Topology refers to the way in which the various nodes or computers of a network are linked together. It describes the actual layout of the computer network hardware. Two or more devices connect to a link; two or more links form a topology. Topology determines the data paths that may be used between any pair of devices of the network.

  Computer networks may be classified according to the network topology upon which the network is based, such as Bus network, network, Ring, Mesh network, Star-bus network, Tree or Hierarchical topology network, etc.

3.8.2 Types of Network Topology

- *Bus Topology*

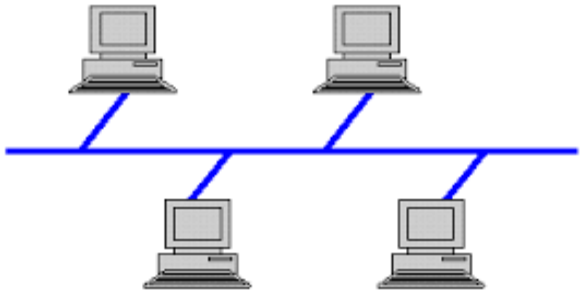


Fig 3.4

The physical Bus Network Topology is the simplest and most widely used of the network designs. It consists of one continuous length of cable (trunk) that is shared by all the nodes in the network and a terminating resistor (terminator) at each end that absorbs the signal when it reaches the end of line. Without a terminator the electrical signal would reach the end of copper wire and bounce back, causing errors on the network.

- *Ring Topology*

  The physical ring Topology is a circular loop of point-to-point links. Each device connects directly to the ring or indirectly through and interface device or drop cable. Message travel around the ring from node to node in a very organized manner. Each workstation checks the message for a matching destination address. If the address doesn't match the node simply regenerates the message and sends it on its way. If the address matches, the node accepts the message and sends a reply to the originating sender.

  In ring topology, the various nodes are connected in form of a ring or circle (physical ring), in which data flows in a circle, from one station to another station. It has no beginning or end that needs to be terminated. In this topology, each device or node has a dedicated point to point line configuration with only two devices on either side of it.

- *Star Topology*

  The physical star Topology uses a central controlling hub with dedicated legs pointing in all directions – like points of a star. Each network device has a dedicated point-to-point link to the central hub. There is no direct link between these computers and the computers can communicate via central controller only. This strategy prevents troublesome collisions and keeps the lines of communications open and free of traffic.

  The routing function is performed by the central controller which centrally controls communication between any two computers by establishing a logical path between them.

- *Mesh Topology*

  In mesh topology, each node is connected to every other node in the network *i.e.* each node has a dedicated point to point link to every other node

as shown. Dedicated means that the link carries the traffic only between two devices it connects.

In this way there exist multiple paths between two nodes of the network. In case of failure of one path, the other one can be used.

- *Tree Topology*

Tree or Hierarchical Topology: The type of Topology in which a central 'root' node, the top level of the hierarchy, is connected to one or more other nodes that are one level lower in the hierarchy i.e., the second level, with a point-to-point link between each of the second level nodes and the top level central 'root' node, while each of the second level nodes that are connected to the top level central 'root' node will also have one or more other nodes that are one level lower in the hierarchy.

- *Hybrid Topology*

The hybrid Topology is a type of Topology that is composed of one or more interconnections of two or more networks that are based upon different physical topologies in a single network that is composed of one or more interconnections of two or more networks that are based upon the same physical topology.

3.9 Internet Work

In modern practice, the interconnected networks use the Internet Protocol. There are at least three variants of internetwork, depending on who administers and who participates in them:

- Intranet
- Extranet
- Internet

Intranets and extranets may or may not have connections to the Internet. If connected to the Internet, the intranet or extranet is normally protected from being accessed from the Internet without proper authorization. The Internet is not considered to be a part of the intranet or extranet, although it may serve as a portal for access to portions of an extranet.

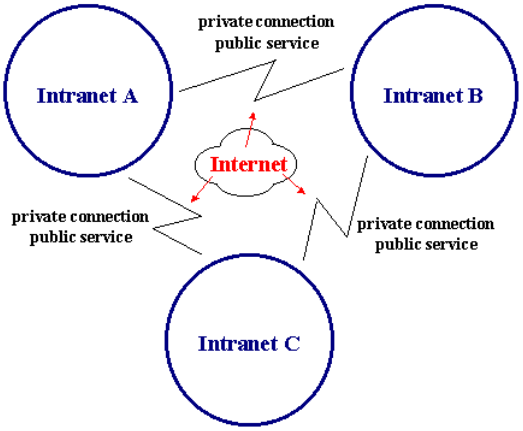


Fig 3.5

3.9.1 Intranet

An intranet is a set of networks, using the Internet Protocol and IP-based tools such as web browsers and file transfer applications that are under the control of a single administrative entity. That administrative entity closes the intranet to all but specific, authorized users. Most commonly, an intranet is the internal network of an organization. A large intranet will typically have at least one web server to provide users with organizational information.

3.9.2 Extranet

An extranet is a network or internetwork that is limited in scope to a single organization or entity but which also has limited connections to the networks of one or more other trusted organizations or entities (e.g. a company's customers may be given access to some part of its intranet creating in this way an extranet).

3.9.3 Internet

The Internet is a specific internetwork. It consists of a worldwide interconnection of governmental, academic, public, and private networks based upon the networking technologies of the Internet Protocol Suite. It is the successor of the Advanced Research Projects Agency Network (ARPANET) developed by DARPA of the U.S. Department of Defence. The Internet is also the communications backbone underlying the World Wide Web (WWW). The 'Internet' is most commonly spelled with a capital 'I' as a proper noun, for historical reasons and to distinguish it from other generic internetworks.

3.10 Applications of Information Technology

Some Areas which Information Technology has revolutionized:

3.10.1 e-Business

Electronic Business, commonly referred to as "e-Business", is defined as the utilisation of information and communication technologies (ICT) in support of all the activities of business. Commerce constitutes the exchange of products and services between businesses, groups and individuals and hence can be seen as one of the essential activities of any business. Hence, electronic commerce or e-Commerce focuses on the use of ICT to enable the external activities and relationships of the business with individuals, groups and other businesses. Electronic business methods enable companies to link their internal and external data processing systems more efficiently and flexibly, to work more closely with suppliers and partners, and to better satisfy the needs and expectations of their customers.

e-business reaches out to individual customers (like you and me) by allowing us to view images of the products on offer and select them for purchase. On payment by any of the prescribed methods, the product is sent by courier. Some of the popular sites for such businesses are: shopping.sify.com, redff.com, indiatimes.com

3.10.2 e-Learning

Electronic learning or e-Learning is a type of education where the medium of instruction is computer technology. No in-person interaction may take place in some instances. e-learning is used interchangeably in a wide variety of contexts. It refers to a planned teaching/learning experience that uses a wide spectrum of technologies, mainly Internet or computer-based, to reach learners at a distance. Lately in many Universities, e-learning defines a specific mode to attend a course or program of study where the students study online.

Fig 3.6

MIT, one of the world leaders in technological education, has a system of Open Course Ware (OCW) through which any person can access the video lectures and course material used by them.

DEI has recently launched various vocational and other graduate and post-graduate courses under Distance Education Program, through which it reaches out to accredited students in different locations across India and abroad.

3.10.3 e-Governance

e-Governance refers to the use of internet technology as a platform for exchanging information, providing services and transacting with citizens, businesses, and other arms of government. e-Governance may be applied by the legislature, judiciary, or administration, in order to improve internal efficiency, the delivery of public services, or processes of democratic governance. The primary delivery models are Government-to-Citizen or Government-to-Customer (G2C), Government-to-Business (G2B), and Government-to-Government (G2G).

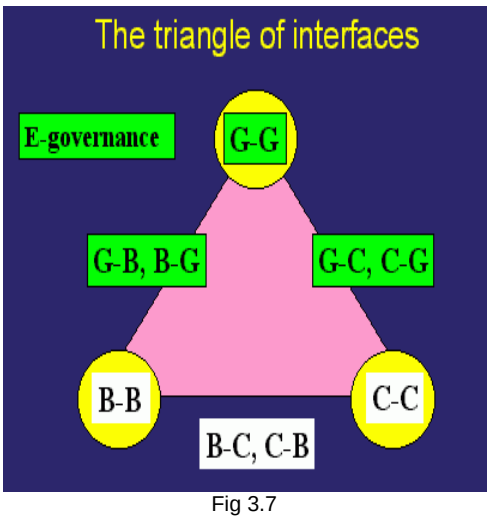


Fig 3.7

In India many features of government are computerized, e.g.

- Information regarding applications to government vacancies (e.g. school teachers, etc.) is available on the internet
- Applications for passport can be made online

3.10.4 e-Banking

e-Banking means any user with a personal computer and a browser can get connected to his bank's website to perform any of the virtual banking functions. In internet banking system the bank has a centralized database that is web-enabled. All the services that the bank has permitted on the internet are displayed in the menu. Any service can be selected and further interaction is dictated by the nature of service. The traditional branch model of bank is now giving place to an alternative delivery channels with ATM network. Once the branch offices of the bank are interconnected through terrestrial or satellite links, there would be no physical identity for any branch. It would a borderless entity permitting anytime, anywhere and anyhow banking.

3.11 Emerging Trends in Information Technology

21st century has been defined by application of and advancement in information technology. Information technology has become an integral part of our daily life. Information technology has served as a big change agent in different aspect of business and society. It has proven game changer in resolving economic and social issues.

Advancement and application of information technology are ever changing. Some of the trends in the information technology are as follows:

3.11.1 Cloud Computing

One of the most talked about concept in information technology is the cloud computing. Clouding computing is defined as utilization of computing services, i.e. software as well as hardware as a service over a network. Typically, this network is the internet.

Some of the benefit of cloud computing is as follows:

- Cloud computing reduces IT infrastructure cost of the company.
- Cloud computing promotes the concept of virtualization, which enables server and storage device to be utilized across organization.
- Cloud computing makes maintenance of software and hardware easier as installation is not required on each end user's computer.

Some issues concerning cloud computing are privacy, compliance, security, legal, abuse, IT governance, etc.

3.11.2 Mobile Application

Another emerging trend within information technology is mobile applications (software application on Smart phone, tablet, etc.)

Mobile application or mobile app has become a success since its introduction. They are designed to run on Smartphone, tablets and other mobile devices. They are available as a download from various mobile operating systems like Apple, Blackberry, Nokia, etc. Some of the mobile app are available free where as some involve download cost. The revenue collected is shared between app distributor and app developer.

3.11.3 User Interfaces

User interface has undergone a revolution since introduction of touch screen. The touch screen capability has revolutionized way end users interact with application. Touch screen enables the user to directly interact with what is

displayed and also removes any intermediate hand-held device like the mouse.

Touch screen capability is utilized in smart phones, tablet, information kiosks and other information appliances.

3.11.4 Analytics

The field of analytics has grown many folds in recent years. Analytics is a process which helps in discovering the informational patterns with data. The field of analytics is a combination of statistics, computer programming and operations research.

- The field of analytics has shown growth in the field of data analytics, predictive analytics and social analytics.
- Data analytics is tool used to support decision-making process. It converts raw data into meaningful information.
- Predictive analytics is tool used to predict future events based on current and historical information.
- Social media analytics is tool used by companies to understand and accommodate customer needs.

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UNIT 4 SCIENCE PART-IV

4. Science Part-IV

4.1 Inventions and Discoveries

4.1.1 Railway Engine (Steam Locomotive) – George Stephenson – 1814

George Stephenson is considered to be the inventor of the first steam locomotive engine for railways. Richard Trevithick's invention is considered the first tramway locomotive, however, it was a road locomotive, designed for a road and not for a railroad.


George Stephenson

Stephenson was extremely poor growing up and received little formal education. He worked in local collieries and was self-taught in reading and writing. In 1812, he became a colliery engine builder, and in 1814 he built his first locomotive for the Stockton and Darlington Railway Line which drew thirty tonnes of coal at four miles an hour. Stephenson was hired as the company engineer and soon convinced the owners to use steam motive power and built the line's first locomotive, the Locomotion. In 1825, Stephenson moved to the Liverpool and Manchester Railway, where together with his son Robert built (1826-29) he built the Rocket which travelled at 29 miles per hour.

The building of these two lines prompted immense business speculation and an expansion of the railway system which transformed the British countryside and economy

4.1.2 Cyclotron – Ernest Lawrence – 1920s

A cyclotron is any of a class of devices that accelerates charged atomic or subatomic particles in a constant magnetic field.

Ernest Lawrence, was an American physicist and Nobel laureate, best known for his invention and development of the cyclotron, a device to accelerate nuclear particles and used in the discovery of the transuranium elements. The cyclotron, led to the development of particle physics and revolutionary discoveries about the nature of the universe. He was awarded the 1939 Nobel Prize in physics and the Enrico Fermi Award in 1957.

The invention that would rocket Ernest Lawrence to international fame started out modestly as a sketch on a scrap of paper. While sitting in the library one evening, Lawrence happened to glance over a journal article and was

intrigued by one of the diagrams. The idea was to produce very high energy particles required for atomic disintegration by means of a succession of very small "pushes". Ernest Lawrence told his colleagues that he had found a method for obtaining particles of very high energy, without the use of any high voltage. The idea was surprisingly simple, but Lawrence double-checked his theory with physicists from Yale to make sure he had not overlooked a critical detail.

The first model of Lawrence's cyclotron was made out of wire and sealing wax and probably cost $25 in all. And it worked - when Lawrence applied 2,000 volts of electricity to his make-shift cyclotron, he got 80,000-volt projectiles spinning around. He had discovered a way to "smash" atoms, and in doing so he unwittingly paved the way for the U.S. nuclear weapons program that was to follow a decade later.

4.1.3 Atom Bomb – Leo Szilard – 1934

Excerpt from a Research Paper titled History of the Atom Bomb

The invention of the atom bomb is one of the most momentous inventions that humankind has seen. It would be logical to assume that the discovery of fission preceded the invention of the atomic bomb. It would be normal also to expect that no single individual could really claim to be "the inventor", since the possibility sprang naturally from a physical process, and required the efforts of many thousands to bring it into existence. But in this case, this assumption is not correct.

Leo Szilard & Ernest Lawrence - 1935
Fig 4.1

In the case of the atomic bomb there is clearly one man who is the originator of the idea. He was also the instigator of the project that led ultimately to the successful construction of the atomic bomb, and was a principal investigator in the early R&D both before and after the founding of the atomic bomb project - making a number of the key discoveries himself. By any normal standard this man is the inventor of the atomic bomb. This man is Leo Szilard.

On September 12, 1932, within seven months of the discovery of the neutron, and more than six years before the discovery of fission, Leo Szilard conceived

of the possibility of a controlled release of atomic power through a multiplying neutron chain reaction, and also realized that if such a reaction could be found, then a bomb could be built using it. On July 4, 1934 Leo Szilard filed a patent application for the atomic bomb. In his application, Szilard described not only the basic concept of neutron chain reactions but also the key concept of the critical mass. The patent was awarded to him - making Leo Szilard the legally recognized inventor of the atomic bomb.

The idea of nuclear fission and thus the atomic bomb and the nuclear reactor was first proposed in 1934 and doggedly pursued by a maverick thinker, a physicist who until 1940 did not have a full time job, and a humanist who in 1934 spent most of his time trying to get his fellow Jews out of Germany and into the West. Leo Szilard not only conceived the atomic bomb, but took such full and active responsibility for his creation that he spent much of the time from 1944 until his death in 1966 trying to prevent nuclear war.

Leo Szilard was a Hungarian Jew, who after getting a Ph.D degree in physics at the University of Berlin in 1922, was a misfit in the formal world of German physics. He rarely had a full time job until 1940; he survived mainly by teaching part-time in universities. Szilard read widely; his formal studies were not even in atomic physics; he was a self-taught outsider.

On December 21, 1938 the German chemists Otto Hahn and Fritz Strassmann split uranium. Szilard realized it would not be long before the world would understand the implications. Szilard almost single-handedly led the physics community and the U.S. government to join forces in atomic energy research.

Fearing the Nazis would build the bomb, Szilard approached Einstein with whom he had worked in Berlin and told him about the chain reaction possibility and asked him to write a letter to Roosevelt. Why did Szilard pick Einstein to write the letter? Szilard explained, “The only thing most scientists are really afraid of is to make fools of themselves; Einstein was free from such fear and this was what made his position unique for this occasion.”

President Roosevelt responded by appointing an Advisory Committee on Uranium. The Office of Scientific Research and Development was established on June 28, 1941, under the direction of Vannevar Bush, to develop atomic energy.

On December 6, the day before the bombing of Pearl Harbor, Roosevelt authorized the Manhattan Engineering District. This letter from Albert Einstein to President Franklin D. Roosevelt led to the Manhattan Engineering District, also known as "the Manhattan Project," a national crash program racing to develop atomic weapons before Nazi Germany.

4.1.4 Helicopter – Igor Sikorsky - 1931

Unlike the airplane, the helicopter had a long and trouble-plagued development. Whereas the Wright brothers get most of the credit for

developing the airplane, many more people, on several continents, contributed to the development of the helicopter.
The biggest problem with the various early helicopter designs produced by Louis and Jacques Bréguet, Igor Sikorsky, Juan de la Cierva, and others was that although they could lift off the ground, they could not be controlled in flight. Inventors did not understand the aeronautical forces facing the helicopter and did not know how to design mechanical devices to address these forces.

Igor Sikorsky and Orville Wright by Sikorsky XR-4 1942
Fig 4.2

To control a helicopter, inventors had to devise a means of directing the downward thrust of the rotors slightly off-center so the craft would move in the opposite direction. They also had to find a way to overcome the twisting motion, or torque, induced by the heavy turning rotor blades.

Igor Sikorsky is considered to be the "father" of helicopters not because he invented the first. He is called that because he invented the first successful helicopter, upon which further designs were based.

One of aviation's greatest designers, Russian born Igor Sikorsky began work on helicopters as early as 1910. By 1940, Igor Sikorsky's successful VS-300 had become the model for all modern single-rotor helicopters. He also designed and built the first military helicopter, XR-4, which he delivered to Colonel Franklin Gregory of the U.S. Army.

Igor Sikorsky's helicopters had the control to fly safely forwards and backwards, up and down, and sideways. In 1958, Igor Sikorsky's rotorcraft company made the world's first helicopter that had a boat hull and could land and takeoff from water. It could also float on the water.

4.1.5 Lift / Elevator – Elisha Otis – 1853

Primitive elevators were in use as early as the 3rd century BC, operated by human, animal, or water wheel power. From about the middle of the 19th

century, power elevators, often steam-operated, were used for conveying materials in factories, mines, and warehouses.

In 1853, American inventor Elisha Otis demonstrated a freight elevator equipped with a safety device to prevent falling in case a supporting cable should break. This increased public confidence in such devices. Otis established a company for manufacturing elevators and patented (1861) a steam elevator. In 1846, Sir William Armstrong introduced the hydraulic crane, and in the early 1870s, hydraulic machines began to replace the steam-powered elevator. The hydraulic elevator is supported by a heavy piston, moving in a cylinder, and operated by the water (or oil) pressure produced by pumps.

4.1.6 Microscope – Zaccharias Janssen – 1590

During the 1st century AD (year 100), glass had been invented and the Romans were looking through the glass and testing it. They experimented with different shapes of clear glass and one of their samples was thick in the middle and thin on the edges. They discovered that if you held one of these "lenses" over an object, the object would look larger.

Someone also discovered that you can focus the rays of the sun with one of these special "glasses" and start a fire. These early lenses were called magnifiers or burning glasses. The word lens is derived from the Latin word lentil, because they resembled the shape of a lentil bean.

These lenses were not used much until the end of the 13th century when spectacle makers were producing lenses to be worn as glasses.

The early simple "microscopes" which were really only magnifying glasses had one power, usually about 6X - 10X . One thing that was very common and interesting to look at was fleas and other tiny insects. These early magnifiers were hence called "flea glasses".

Sometime about the year 1590, two Dutch spectacle makers, Zaccharias Janssen and his father Hans started experimenting with these lenses. They put several lenses in a tube and made a very important discovery. The object near the end of the tube appeared to be greatly enlarged, much larger than any simple magnifying glass could achieve by itself! They had just invented the compound microscope (which is a microscope that uses two or more lenses).

4.1.7 Photography – Louis Jacques Mandé Daguerre – 1837

"Photography" is derived from the Greek words photos ("light") and graphein ("to draw") the word was first used by the scientist Sir John F.W. Herschel in 1839. It is a method of recording images by the action of light, or related radiation, on a sensitive material.

On a summer day in 1827, it took eight hours for Joseph Nicéphore Niépce to obtain the first fixed image. About the same time a fellow Frenchman, Louis Jacques Mandé Daguerre was experimenting to find a way to capture an image, but it would take another decade before he was able to reduce the exposure time to less than 30 minutes and keep the image from disappearing ushering in the age of modern photography.

The first true photographs were exposed on metal that had been sensitized to accept an image. Daguerréotypes, named for their French inventor L.J.M. Daguerre in 1837, were metal sheets upon which a positive silver image was affixed.

The inventor of the first process which used a negative from which multiple prints were made was William Henry Fox Talbot, a contemporary of Daguerre.

Photography advanced considerably when sensitized materials could be coated on plate glass. The first glass negatives were wet plate. They had to be developed quickly before the emulsion dried. (In the field this meant carrying along a portable process had been invented and patented which freed the photographer from the necessity of developing each print immediately.)

In 1889, George Eastman, realizing the potential of the mass market, used a newly invented film with a base that was flexible, unbreakable, and could be rolled. Emulsions coated on a cellulose nitrate film base, such as Eastman's, made the mass-produced box camera a reality. Using box cameras, amateur photographers began to document everyday life in America. Eastman's first simple camera in 1888 was a wooden, light-tight box with a simple lens and shutter that was factory-filled with film. The photographer pushed a button to produce a negative. Once the film was used up, the photographer mailed the camera with the film still in it to the Kodak factory where the film was removed from the camera, processed, and printed. The camera was then reloaded with film and returned.

In the late 1930s and early 1940s, commercially viable colour films were brought to the market. These films used the modern technology of dye-coupled colours in which a chemical process connects the three dye layers together to create an apparent colour image. This system is still used for colour.

4.1.8 Polaroid Photography – Edwin Land – 1948

Polaroid photography was invented by Edwin Land. Land was the American inventor and physicist whose one-step process for developing and printing photographs created a revolution in photography - instant photography. You can view Edwin Land's patent for the Polaroid camera on the left for the camera that allowed the photographer to remove a developing print after the picture had been snapped. Edwin Land founded the Polaroid Corporation to

manufacturer his new camera. The first Polaroid camera was sold to the public in November, 1948.

Fig 4.3

4.1.9 Fountain Pen – Lewis Waterman – 1884

Lewis Waterman Residence - 265 Macon Street, Brooklyn, New York City
Born - Decatur, Otsego County, N.Y. - 1837
Death - 1901

Invented the capillary feed in fountain pens - now universally used - that allows for even ink flow.

Though necessity may be the mother of invention, perhaps it is frustration that fuels the fire; or so it seemed for Lewis Waterman. In 1883, Lewis Waterman was an insurance broker in New York City, getting ready to sign one of his hottest contracts. In honour of the occasion, Lewis Waterman bought a new fountain pen that he considered far more stylish than a cumbersome dip pen and ink well. With the contract on the table and the pen in the client's hand, the pen refused to write, and actually leaked onto the precious document. Horrified, Lewis Waterman raced back to his office for another contract, but a competing broker had closed the deal.

Determined to never again suffer such humiliation, Waterman began to make fountain pens in his brother's workshop. Lewis Waterman used the capillarity principle which allowed air to induce a steady and even flow of ink. He christened his pen "the Regular," decorated it with wood accents, and obtained a patent for it in 1884. In his first year of operation, Waterman sold his hand-made pens out of the back of a cigar shop. He guaranteed the pens for five years and advertised in a trendy magazine, The Review of Review. The orders filtered in.

By 1899, Lewis Waterman opened a factory in Montreal and was offering a variety of designs. In 1901, upon Waterman's death, his nephew, Frank D. Waterman took the business overseas and increased sales to 350,000 pens per year. The Treaty of Versailles was signed using a solid gold Waterman

pen, a far cry from the day Lewis Waterman lost his important contract due to a leaky fountain pen.

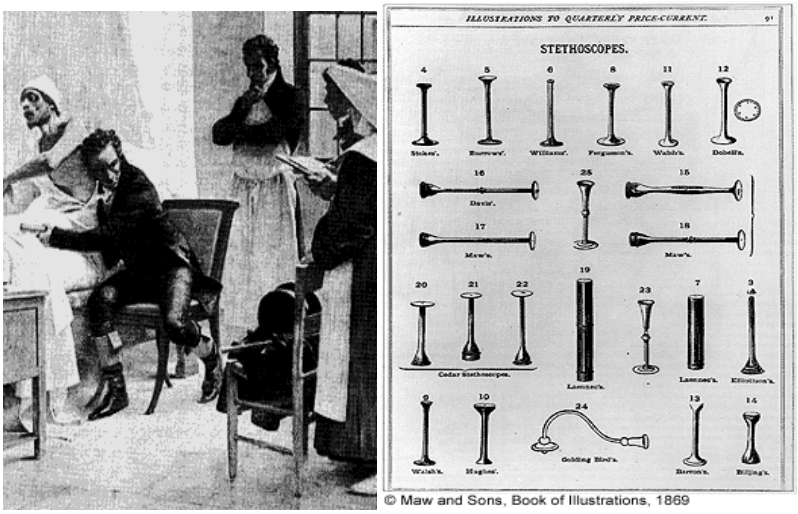
4.1.10 Ball Point Pen – Lazslo Biro – 1938

A Hungarian journalist named Laszlo Biro invented the first ballpoint pen in 1938. Biro had noticed that the type of ink used in newspaper printing dried quickly, leaving the paper dry and smudge-free. He decided to create a pen using the same type of ink. The thicker ink would not flow from a regular pen nib and Biro had to devise a new type of point. He did so by fitting his pen with a tiny ball bearing in its tip. As the pen moved along the paper, the ball rotated picking up ink from the ink cartridge and leaving it on the paper. This principle of the ballpoint pen actually dates back to an 1888 patent owned by John J. Loud for a product to mark leather. However, this patent was commercially unexploited. Laszlo Biro first patented his pen in 1938, and applied for a fresh patent in Argentina on June 10, 1943. (Laszlo Biro and his brother Georg Biro emigrated to Argentina in 1940.) The British Government bought the licensing rights to this patent for the war effort. The British Royal Air Force needed a new type of pen, one that would not leak at higher altitudes in fighter planes as the fountain pen did. Their successful performance for the Air Force brought the Biro pens into the limelight.

4.1.11 Stethoscope – Rene Theophile-Hyacinthe Laennec – 1816

The word stethoscope comes from the Greek words stethos meaning "chest", and skopos meaning "observer".

From the time it was invented in 1816 until the early 20th century, the stethoscope was the most reliable and informative tool available for diagnosing cardiovascular disease. Although other, more sophisticated diagnostic methods have come into use since then, the stethoscope has never been discarded.



© Maw and Sons, Book of Illustrations, 1869
Fig 4.4

Since the time of Hippocrates, physicians listened directly to patients' chests as they tried to assess cardiac health. The inventor of the stethoscope, Rene Theophile-Hyacinthe Laennec, relied on this method, too (see photo).

One day, when he needed to examine an obese young woman, Laennec hesitated to put his head to her chest. Remembering that you can hear a pin scraping one end of a plank by putting your ear to the other end, he came up with the idea for a stethoscope. He rolled a stack of paper into a cylinder, pressed one end to the patient's chest, and held his ear to the other end. "I was surprised and pleased to hear the beating of the heart much more clearly than if I had applied my ear directly to the chest," Laennec said in 1816.

Laennec's first manufactured stethoscope was a simple wooden tube. A succession of different designs followed this, including, eventually, a "binaural" type with two ear pieces. In 1850, George Camman substituted rubber for stiffer materials and made a more comfortable model—the forerunner of today's stethoscopes.

The use of the stethoscope led to better descriptions of heart sounds and improved ability to distinguish among various murmurs and rhythmic disturbances. It increased understanding of how blood moves through the heart in each cardiac cycle, under normal and abnormal conditions.

[Laënnec, re-inventor of the stethoscope?]
[Article in French]
Martinet X, L'Helgouarc'h JL, Roche I, Favoulet P, Goudet P, Cougard P.
Service de Chirurgie III viscérale, Hôpital Général, Dijon.

According to our common medical culture, some facts are simply unquestionable, for instance Rene Laënnec invented the stethoscope.

But was he the first one? On a recent trip to Egypt we visited the temple of Kom Ombo, built prior to the roman period and renowned as a medical care center. Today, the tourist is fascinated by the magnificent hieroglyphics on the well-preserved walls testifying to significant advances in various fields of medicine including ophthalmology and gynaecology. We were particularly interested by the bas-reliefs presenting vivid drawings of some of the first medical instruments. We easily identified curettes, scissors, a balance, forceps for dental extraction, and a surgical saw, but were captivated by two other instruments. The first one looked a lot like what Laënnec invented around 1820. The second one was amazingly similar to the instrument we use everyday, with a distal opening and flexible tubes (woven papyrus?) leading to proximal ear pieces. Our Egyptian guide was formal: the stethoscope was invented in Egypt. The scientific impact of our observations leaves something to be desired, but did make us think about the huge gap between the advancement of medical knowledge in ancient Egypt and Laënnec's (re)-invention.

4.1.12 Dynamite – Alfred Bernhardt Nobel – 1866

Swedish industrialist, engineer, and inventor, Alfred Nobel built bridges and buildings in Stockholm. His construction work inspired Nobel to research new methods of blasting rock. In 1860, the inventor first started experimenting with nitroglycerine.

In 1863, Alfred Nobel invented the Nobel patent detonator or blasting cap for detonating nitroglycerin. The Nobel patent detonator used a strong shock rather than heat combustion to ignite the explosives. The Nobel Company built the first factory to manufacture nitroglycerin and dynamite.

Nitroglycerin was first invented by Italian chemist Ascanio Sobrero in 1846. In its natural liquid state, nitroglycerin is very volatile. Albert Nobel understood this and in 1866 he discovered that mixing nitroglycerine with silica would turn the liquid into a malleable paste, called dynamite. One advantage of dynamite over nitroglycerin was that it could be cylinder-shaped for insertion into the drilling holes used for mining.

When he died in 1896, Alfred Nobel left behind a nine million dollar endowment fund. The Nobel prize is awarded yearly to people whose work helps humanity. In total, Alfred Nobel held three hundred and fifty-five patents in the fields of electrochemistry, optics, biology, and physiology.

4.1.13 Television – John Logie Baird – 1925

John Logie Baird is remembered as being an inventor of a mechanical television system. In the 1920's, John Logie Baird and American Clarence W. Hansell patented the idea of using arrays of transparent rods to transmit images for television and facsimiles respectively. Baird's 30 line images were the first demonstrations of television by reflected light rather than back-lit silhouettes. John Logie Baird based his technology on Paul Nipkow's scanning disc idea and later developments in electronics.

John Logie Baird with his mechanical TV

Fig 4.5

The television pioneer created the first televised pictures of objects in motion (1924), the first televised human face (1925) and a year later he televised the

first moving object image at the Royal Institution in London. His 1928 trans-atlantic transmission of the image of a human face was a broadcasting milestone. Colour television (1928), stereoscopic television and television by infra-red light were all demonstrated by Baird before 1930.

Fig 4.6

The credit as to who was the inventor of modern electronic television really comes down to two different people in two different places both working on the same problem at about the same time: Vladimir Kosma Zworykin, a Russian-born American inventor working for Westinghouse, and Philo Taylor Farnsworth, a privately backed farm boy from the state of Utah.

Zworykin is usually credited as being the father of modern television. This was because the patent for the heart of the TV, the electron scanning tube, was first applied for by Zworykin in 1923, under the name of an iconoscope. The iconoscope was an electronic image scanner - essentially a primitive television camera. Farnsworth was the first of the two inventors to successfully demonstrate the transmission of television signals, which he did on September 7, 1927, using a scanning tube of his own design. Farnsworth received a patent for his electron scanning tube in 1930. Zworykin was not able to duplicate Farnsworth's achievements until 1934 and his patent for a scanning tube was not issued until 1938. The truth of the matter is this, that while Zworykin applied for the patent for his iconoscope in 1923, the invention was not functional until some years later and all earlier efforts were not useful.

Philo Farnsworth with his television

Fig 4.7

4.1.14 Telephone – Alexander Graham Bell – 1876

Alexander Graham Bell (3 March 1847 – 2 August 1922) was an eminent scientist, inventor and innovator who is widely credited with the invention of the telephone. His father, grandfather and brother had all been associated with work on elocution and speech, and both his mother and wife were deaf,

profoundly influencing Bell's life's work. His research on hearing and speech further led him to experiment with hearing devices that eventually culminated in Bell being awarded the first U.S. patent for the invention of the telephone in 1876. In reflection, Bell considered his most famous invention an intrusion on his real work as a scientist and refused to have a telephone in his study. Upon Bell's death, all telephones throughout the United States "stilled their ringing for a silent minute in tribute to the man whose yearning to communicate made them possible." Many other inventions marked Bell's later life including groundbreaking work in hydrofoils and aeronautics. In 1888, Alexander Graham Bell became one of the founding members of the National Geographic Society

Antonio Meucci, an Italian immigrant is also said to have invented the telephone more than 25 years before Bell, but being unable to afford the patent fees he could not patent it though he did file a caveat (notice of intent) in 1871, 1872 and 1873

4.1.15 Typewriter – Christopher Latham Sholes – 1867

The idea behind the typewriter was to apply the concept of movable type developed by Johann Gutenberg in the invention of the printing press century to a machine for individual use. Descriptions of such mechanical writing machines date to the early eighteenth century. In 1714, a patent something like a typewriter was granted to a man named Henry Mill in England, but no example of Mills' invention survives.

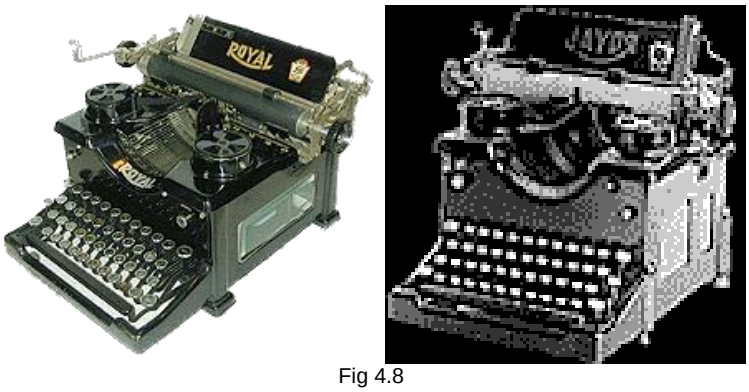


Fig 4.8

In 1829, William Burt from Detroit, Michigan patented his typographer which had characters arranged on a rotating frame. However, Burt's machine, and many of those that followed it, were cumbersome, hard to use, unreliable and often took longer to produce a letter than writing it by hand.

Finally, in 1867, a Milwaukee, Wisconsin printer-publisher-politician named Christopher Latham Sholes, with assistance from Carlos Glidden and Samuel Soule, patented what was to be the first useful typewriter.

Based on Sholes' mechanical typewriter, the first electric typewriter was built by Thomas Alva Edison in the United States in 1872, but the widespread use of electric typewriters was not common until the 1950s.

4.1.16 Transistor – William Shockley – 1947

The transistor was invented in 1947 by three American physicists at the Bell Telephone Laboratories, John Bardeen, William Shockley, and Walter Brattain. The three men received the 1956 Physics Nobel Prize for their joint invention.

The transistor proved to be a viable alternative to the vacuum tube. Transistors played a pivotal role in the advancement of electronics - their small size, low heat generation, high reliability, and small power requirements made possible the miniaturization of complex circuitry such as required by computers. During the late 1960's and 1970's individual transistors were superseded by integrated circuits in which a multiple of transistors and other components (diodes, resistors, etc.) were formed on a single tiny wafer of semi conducting material.

The First Working Transistor
Bell Labs - 1947
Fig 4.9

4.1.17 Sewing Machine – Elias Howe – 1846

Hand sewing is an art form that is over 20,000 years old. The first sewing needles were made of bones or animal horns and the first thread was made of animal sinew. Iron needles were invented in the 14th century. The first eyed needles appeared in the 15th century.

The first possible patent connected to mechanical sewing was a 1755 British patent issued to German, Charles Weisenthal. Weisenthal was issued a patent for a needle that was designed for a machine, however, the patent did not describe the rest of the machine if one existed.

The English inventor and cabinet maker, Thomas Saint was issued the first patent for a complete machine for sewing in 1790. It is not known if Saint actually built a working prototype of his invention. The patent describes an awl that punched a hole in leather and passed a needle through the hole. A later reproduction of Saint's invention based on his patent drawings did not work.

In 1810, German, Balthasar Krems invented an automatic machine for sewing caps. Krems did not patent his invention and it never functioned well.

The first functional sewing machine was invented by the French tailor, Barthelemy Thimonnier, in 1830. Thimonnier's machine used only one thread and a hooked needle that made the same chain stitch used with embroidery. The inventor was almost killed by an enraged group of French tailors who burnt down his garment factory because they feared unemployment as a result of his new invention.

In 1834, Walter Hunt built America's first (somewhat) successful sewing machine. He later lost interest in patenting because he believed his invention would cause unemployment. (Hunt's machine could only sew straight steams.) Hunt never patented and in 1846, the first American patent was issued to Elias Howe for "a process that used thread from two different sources."

Elias Howe's machine had a needle with an eye at the point. The needle was pushed through the cloth and created a loop on the other side; a shuttle on a track then slipped the second thread through the loop, creating what is called the lockstitch. However, Elias Howe later encountered problems defending his patent and marketing his invention.

4.1.18 Revolver – Samuel Colt – 1836

Nothing says "Old West" more than Samuel Colt's revolver invention. Originally patented in 1836. Many historians have gone so far as to say that Colt's invention changed the course of American history.

After patenting his revolving handgun and receiving a ringing endorsement from U.S. president Andrew Jackson, Colt's revolver still failed to take off. His manufacturing company went bankrupt, and historians generally believe sales lagged because the revolving gun invention was a bit ahead of its time.

Eventually, the start of the Mexican War triggered renewed interest in Colt's revolver invention and, during the Civil War, Samuel Colt became a major supplier of handguns for the Union army

4.1.19 Bicycle – Kirkpatrick Macmillan – 1839

For much of man’s history on earth, he had two choices for getting around, either on foot or on the back of an animal (such as horses, mules, and wooly mammoths). Bicycles were developed to add another transportation option that multiplied human efficiency by a factor of approximately five.

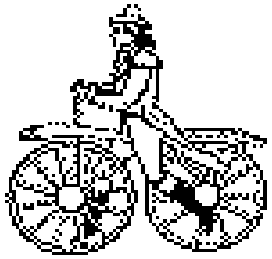


Fig 4.10

Around 1790 a French craftsman named de Sivrac developed a “Celerifere” running machine, which had two in-line wheels connected by a beam. The rider straddled the beam and propelled the Celerifere by pushing his feet on the ground, scooter fashion.

In 1817 German Baron Karl Drais von Sauerbronn added steering. Several versions appeared around France and England by the early 1800s. As a replacement for the horse, these “hobby horses” became a short-lived craze. The roads of the time were too rutted to allow for efficient wheeled transport.

In 1839 driving levers and pedals were added to a machine of the draisine type by Kirkpatrick Macmillan of Scotland. These innovations enabled the rider to propel the machine with the feet off the ground. The driving mechanism consisted of short cranks fixed to the rear wheel hub and connected by rods to long levers, which were hinged to the frame close to the head of the machine. The connecting rods were joined to the levers at about one-third of their length from the pedals. The machine was propelled by a downward and forward thrust of the foot.

Fig 4.11

But, as Kirkpatrick Macmillan lived in the Northern British Isles where people and ideas travelled slowly, his invention didn’t spread.

This sketch by daVinci made around 1490 shows a possible idea of a bicycle. But this was never actually fabricated. There is also some doubt about the authenticity of the drawing.

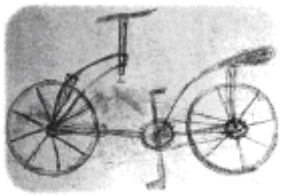


Fig 4.12

The monument to the inventor of the bicycle on the right is in Russia, where it is considered that the bicycle was invented in Russia by Efin Artamonov in 1800. But this claim is not recognized by the western world.

4.1.20 Bacteria – Antony Van Leeuwenhoek – 1677

The exact beginning of the knowledge about the existence of microorganisms can be traced back only to the latter part of the seventeenth century when Antony van Leeuwenhoek (1677) first recorded observations of microorganisms (bacteria, yeasts, and protozoa) seen in water, faeces, teeth scrapings etc. under his own microscopes which were not compound.

Leeuwenhoek (1632-1723) was basically a cloth maker and tailor by trade, was also a surveyor and the official wine taster of Defft, Holland and his interest in microscopes was probably related to the use of magnifying glasses to examine fabrics. He transmitted his findings in a series of more than two hundred letters to the Royal Society of London during his lifetime. He described such tiny creatures as "dierkens" or "animalcula viva" which were translated in English as "animalcules" by the Royal Society. Leeuwenhoek was later elected a fellow of the Royal Society.

4.1.21 Diesel Engine – Rudolph Diesel – 1893

In 1893, German inventor Rudolph Diesel published a paper entitled "The Theory and Construction of a Rational Heat Engine," which described an engine in which air is compressed by a piston to a very high pressure, causing a high temperature. Fuel is then injected and ignited by the compression temperature.

Diesel built his first engine based on that theory the same year and, though it worked only sporadically, he patented it. Within a few years, Diesel's design became the standard of the world for that type of engine and his name was attached to it.

4.1.22 Barometer – Evangelista Torricelli – 1644

A barometer is an instrument for measuring atmospheric pressure. Two common types are the aneroid barometer and the mercurial barometer (invented first). Evangelista Torricelli invented the first barometer, known as the "Torricelli's tube".

Evangelista Torricelli was born October 15, 1608, in Faenza, Italy and died October 22, 1647 in Florence, Italy. He was a physicist and mathematician. In 1641, Evangelista Torricelli moved to Florence to assist the astronomer Galileo.

Evangelista Torricelli became the first scientist to create a sustained vacuum and to discover the principle of a barometer. Torricelli realized that the variation of the height of the mercury from day to day was caused by changes in the atmospheric pressure. Torricelli built the first mercury barometer around 1644.

In 1843, the French scientist LUCIEN VIDIE invented the aneroid barometer. An aneroid barometer "registers the change in the shape of an evacuated metal cell to measure variations on the atmospheric pressure." Aneriod means fluidless, no liquids are used, the metal cell is usually made of phosphor bronze or beryllium copper.

4.1.23 Polio Vaccine – Jonas Salk

Polio (infantile paralysis) is a "disorder caused by a viral infection that affects the whole body, muscles, and nerves." If not treated quickly it could cause permanent damage or, in the most severe cases, even death.

This virus is transmitted from person to person by fluids that come out of the mouth or nose. Once it is transferred it multiplies in the throat and intestinal tract and then spreads to the blood. There is still no actual cure for this crippling virus, but Dr. Jonas Salk, who was also a scientist, spent his whole life dedicated to protect those who had not received polio.

Jonas Salk was born in New York in the year 1914. His parents were Jewish-American immigrants. His parents lacked formal education and wanted the best for Salk and his siblings. He ended up attending the City College of New York City. He intended to study law but was so intrigued by medical science that it ended up being his major in college. There he pondered whether the virus could be deprived of its ability to affect others which ended up being the basis of his work. In 1947, he accepted an appointment to the University of Pittsburgh Medical School. He knew that this was his opportunity to make the vaccine. During the next eight years he devoted his life to the polio vaccine.

4.1.24 Oxygen – Joseph Priestley – 1774

Joseph Priestley’s experiments identified the chemical nature of the gas produced when the red precipitate of mercury (HgO) was heated. Priestley observed that the gas, produced by the red precipitate of mercury, supported combustion better than the normal air. As Priestley believed in phlogiston theory, he called this new air phlogisticated air. He also found that breathing it was “peculiarly light and easy.”

It may also be noted that Carl Wilhelm Scheele (1742-86), a Swedish chemist, also discovered the same gas. He called it ‘fire air’ and he postulated that fire

air was part of atmospheric air. However, Scheele's discovery was published later.

Lavoisier recognized the true significance of the discovery. He realized that Priestley had isolated one part of the air that supports combustion and respiration and other part of the air does not. In 1779 Lavoisier finally announced that the air is composed of two gases—one that supports combustion and the other gas does not support combustion. The part that supported combustion, Lavoisier named oxygen, a name derived from Greek roots meaning "to give rise to acids." He thought all acids contain oxygen. Here Lavoisier was proved to be wrong later. It was one of those rare occasions when Lavoisier was wrong. Though Lavoisier proved wrong, the name "oxygen" has been retained. The other gas he named "azote" again from Greek root meaning "no life". Unlike oxygen, azote was renamed nitrogen in 1790.

4.1.25 Crescograph – Jagdish Chandra Bose – 1900s

A crescograph is a device for measuring growth in plants. It was invented in the early 20th century by Jagdish Chandra Bose, a Bengali Indian scientist.

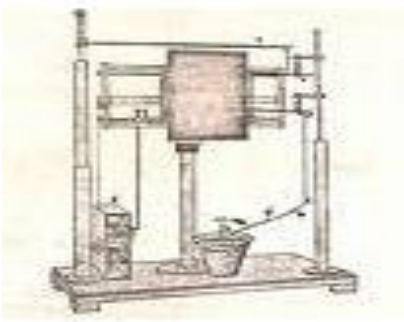


Fig 4.13

The Bose crescograph uses a series of clockwork gears and a smoked glass plate to record the movement of the tip of a plant (or its roots) at magnifications of up to 10,000. Marks are made on the plate at intervals of a few seconds, demonstrating how the rate of growth varies under varying stimuli. Bose experimented with temperature, chemicals, gasses and electricity

4.1.26 Air Conditioner

I fish only for edible fish, and hunt only for edible game, even in the laboratory," Willis Haviland Carrier once said about being practical.

In 1902, only one year after Willis Carrier graduated from Cornell University with a Masters in Engineering, his first air conditioning unit was in operation. This made one Brooklyn printing plant owner very happy. Fluctuations in heat and humidity in his plant kept causing the dimensions of his printing paper to alter and create misalignment of the coloured inks. The new air conditioning

machine created a stable environment and, as a result, aligned four-color printing became possible – all thanks to Carrier, a new employee at the Buffalo Forge Company who started working for a salary of only $10 a week.

- *The "Apparatus for Treating Air"*

  The "Apparatus for Treating Air" was the first of several patents awarded to Willis Carrier in 1906. Although he's recognized as the "father of air conditioning," the term "air conditioning" actually originated with textile engineer Stuart H.

  Cramer. Cramer used the phrase "air conditioning" in a 1906 patent claim he filed for a device that added water vapour to the air in textile plants to condition the yarn.

  Carrier disclosed his basic Rational Psychrometric Formulae to the American Society of Mechanical Engineers in 1911. The formula still stands today as the basis in all fundamental calculations for the air conditioning industry. Carrier said he received his "flash of genius" while he was waiting for a train on a foggy night. He was thinking about the problem of temperature and humidity control and by the time the train arrived, he said he had an understanding of the relationship between temperature, humidity and dew point.

- *The Carrier Engineering Corporation*

  Industries flourished with this new ability to control the temperature and humidity levels during and after production. Film, tobacco, processed meats, medical capsules, textiles and other products gained significant improvements as a result. Willis Carrier and six other engineers formed the Carrier Engineering Corporation in 1915 with starting capital of $35,000. In 1995, sales topped $5 billion. The company was dedicated to improving air conditioning technology.

- *The Centrifugal Refrigeration Machine*

  Carrier patented the centrifugal refrigeration machine in 1921. This "centrifugal chiller" was the first practical method for air conditioning large spaces. Previous refrigeration machines used reciprocating piston-driven compressors to pump refrigerant through the system, which was often toxic and flammable ammonia. Carrier designed a centrifugal compressor similar to the centrifugal turning blades of a water pump. The result was a safer and more efficient chiller.

- *Consumer Comfort*

  Cooling for human comfort rather than industrial need began in 1924 when three Carrier centrifugal chillers were installed in the J.L. Hudson Department Store in Detroit, Michigan. Shoppers flocked to the "air conditioned" store. This boom in human cooling spread from department stores to the movie theaters, most notably the Rivoli Theater in New York whose summer film

business skyrocketed when it heavily advertised cool comfort. Demand increased for smaller units and the Carrier Company obliged.

- *Residential Air Conditioners*

  Willis Carrier developed the first residential “Weathermaker” in 1928, an air conditioner for private home use. The Great Depression and World War II slowed the non-industrial use of air conditioning, but consumer sales rebounded after the war. The rest is cool and comfortable history.

4.1.27 F M Radio

Edwin Howard Armstrong

Edwin Armstrong was one of great engineers of the 20th century.

NOAA Photo Library

Edwin Howard Armstrong (1890 - 1954) was one of great engineers of the 20th century, and best known for inventing FM radio. He was born in New York City and attended Columbia University, where he later taught.

Armstrong was only eleven when Guglielmo Marconi made the first trans-Atlantic radio transmission. Enthralled, the young Armstrong began studying radio and building homemade wireless equipment, including a 125-foot antenna in his parent's backyard.

Armstrong held 42 patents.

- *FM* Radio 1933

  Edwin Armstrong is most commonly known for inventing frequency-modulated or FM radio in 1933. Frequency modulation or FM improved the audio signal of radio by controlling the noise static caused by electrical equipment and the

earth's atmosphere. Edwin Armstrong received U.S. patent 1,342,885 for a "Method of Receiving High-Frequency Oscillations Radio" for his FM technology.

In addition to frequency modulation, Edwin Armstrong should be known for inventing two other key innovations: regeneration and superheterodyning.

Every radio or television set today makes use of one or more of Edwin Armstrong's inventions.

- *Regeneration Amplification 1913*

  In 1913, Edwin Armstrong invented the regenerative or feedback circuit. Regeneration amplification worked by feeding the received radio signal through a radio tube 20,000 times per second, that increased the power of the received radio signal and allowed radio broadcasts to have a greater range.

- *Superhetrodyne Tuner*

  Edwin Armstrong invented the superhetrodyne tuner that allowed radios to tune into different radio stations.
  Later Life and Death

  Armstrong's inventions made him a rich man, and he held 42 patents in his lifetime. However, he also found himself embroiled in protracted legal disputes with RCA, which viewed FM radio as a threat to its AM radio business.

  Armstrong committed suicide in 1954, jumping to his death from his New York City apartment.

4.1.28 The History of Money

Fig 4.14

Money is anything that is commonly accepted by a group of people for the exchange of goods, services, or resources. Every country has its own system of coins and paper money.

- *Bartering and Commodity Money*

  In the beginning, people bartered. Barter is the exchange of a good or service for another good or service, a bag of rice for a bag of beans. However, what if you couldn't agree what something was worth in exchange or you didn't want what the other person had. To solve that problem humans developed what is called commodity money.

  A commodity is a basic item used by almost everyone. In the past, salt, tea, tobacco, cattle and seeds were commodities and therefore were once used as money. However, using commodities as money had other problems. Carrying bags of salt and other commodities was hard, and commodities were difficult to store or were perishable.

- *Coins and Paper Money*

  Metals objects were introduced as money around 5000 B.C. By 700 BC, the Lydians became the first in the Western world to make coins.

  Countries were soon minting their own series of coins with specific values. Metal was used because it was readily available, easy to work with and could be recycled. Since coins were given a certain value, it became easier to compare the cost of items people wanted.

  Some of the earliest known paper money dates back to China, where the issue of paper money became common from about AD 960 onwards.

- *Representative Money*

  With the introduction of paper currency and non-precious coinage, commodity money evolved into representative money. This meant that what money itself was made of no longer had to be very valuable.

  Representative money was backed by a government or bank's promise to exchange it for a certain amount of silver or gold. For example, the old British Pound bill or Pound Sterling was once guaranteed to be redeemable for a pound of sterling silver.

  For most of the nineteenth and twentieth centuries, the majority of currencies were based on representative money through the use of the gold standard.

- *Fiat Money*

  Representative money has now been replaced by fiat money. Fiat is the Latin word for "let it be done". Money is now given value by a government fiat or decree, in other *words* enforceable legal tender laws were made. By law the refusal of "legal tender" money in favour of some other form of payment is illegal.

- *$$$*

  The origin of the "$" money sign is not certain. Many historians trace the $ money sign to either the Mexican or Spanish "P's" for pesos, or piastres, or pieces of eight. The study of old manuscripts shows that the "S," gradually came to be written over the "P," looking very much like the "$" mark.

- *U.S. Money Trivia*

  On March 10, 1862 the first United States paper money was issued. The denominations were $5, $10, and $20. They became legal tender by Act of March 17, 1862. The inclusion of "In God We Trust" on all currency was required by law in 1955. The national motto first appeared on paper money in 1957 on $1 Silver Certificates, and on all Federal Reserve Notes beginning with Series 1963.

- *Electronic Banking*

  ERMA began as a project for the Bank of America in an effort to computerize the banking industry. MICR (magnetic ink character recognition) was part of ERMA. MICR allowed computers to read special numbers at the bottom of checks that allowed computerized tracking and accounting of check transactions.

4.1.29 Credit Cards

A credit card is an automatic way of offering credit to a consumer.

Fig 4.15

Credit is a method of selling goods or services without the buyer having cash in hand. A credit card is only an automatic way of offering credit to a consumer. Today, every credit card carries an identifying number that speeds shopping transactions. Imagine what a credit purchase would be like without it, the sales person would have to record your identity, billing address, and terms of repayment.

According to Encyclopedia Britannica, "the use of credit cards originated in the United States during the 1920s, when individual firms, such as oil companies and hotel chains, began issuing them to customers." However, references to credit cards have been made as far back as 1890 in Europe. Early credit cards involved sales directly between the merchant offering the credit and credit card, and that merchant's customer. Around 1938, companies started to accept each other's cards. Today, credit cards allow you to make purchases with countless third parties.

- *The Shape of Credit Cards*

  Credit cards were not always been made of plastic. There have been credit tokens made from metal coins, metal plates, and celluloid, metal, fiber, paper, and now mostly plastic cards.

- *First Bank Credit Card*

  The inventor of the first bank issued credit card was *John Biggins* of the Flatbush National Bank of Brooklyn in New York. In 1946, Biggins invented the "Charge-It" program between bank customers and local merchants. Merchants could deposit sales slips into the bank and the bank billed the customer who used the card.

- *Diners Club Credit Card*

  In 1950, the Diners Club issued their credit card in the United States. The Diners Club credit card was invented by Diners' Club founder Frank McNamara and it was intended to pay restaurant bills. A customer could eat without cash at any restaurant that would accept Diners' Club credit cards. Diners' Club would pay the restaurant and the credit card holder would repay Diners' Club. The Diners Club card was at first technically a charge card rather than a credit card since the customer had to repay the entire amount when billed by Diners Club.

  American Express issued their first credit card in 1958. Bank of America issued the BankAmericard (now Visa) bank credit card later in 1958.

- *The Popularity of Credit Cards*

  Credit cards were first promoted to traveling salesmen (more common in that era) for use on the road. By the early 1960s, more companies offered credit cards, advertising them as a time-saving device rather than a form of credit. American Express and MasterCard became huge successes overnight.

  By the mid-'70s, the U.S. Congress begin regulating the credit card industry by banning such practices as the mass mailing of active credit cards to those who had not requested them. However, not all regulations have been as consumer friendly. In 1996, the U.S. Supreme Court in Smiley vs. Citibank

lifted restrictions on the amount of late penalty fees a credit card company could charge. Deregulation has also allowed very high interest rates to be charged.

4.1.30 YouTube

YouTube was invented by Steve Chen, Chad Hurley and Jawed Karim.

YouTube was invented by Steve Chen, Chad Hurley and Jawed Karim out of a garage in Menlo Park. The inventors became millionaires when they sold their invention for 1.65 billion dollars to the search engine Google.

According to their fact sheet, YouTube was founded in February 2005, as a destination to watch and share original videos worldwide through the Web. Users can upload and share video clips on www.YouTube.com and YouTube enables video embedding that allows YouTube videos to be placed on non-YouTube pages.

- *YouTube Inventor - Steve Chen*

  Steve Chen was born in 1978 in Taiwan and immigrated to the United States when he was 15. He was educated at the University of Illinois and after graduation found employment at PayPal, where he met his fellow YouTube co-inventors and co-founders Chad Hurley and Jawed Karim. Currently, Steve Chen serves as the Chief Technology Officer at YouTube.

- *YouTube Inventor - Chad Hurley*

  Born in 1977, Chad Hurley received a Bachelor's degree in Fine Art from the University of Pennsylvania and was later employed eBay's PayPal division. Currently, Chad Hurley serves as the Chief Executive Officer at YouTube and is considered a whiz at user interface design. As a sidenote: Hurley designed Paypal's trademark logo.

- *YouTube Inventor - Jawed Karim*

  Jawed Karim also worked at Paypal, where he meet his future corporate cohorts. However, Karim has also pursued an advanced degree at Stanford University and is considered the elusive member of the threesome. According to Jawed Karim the inspiration for YouTube came from the halftime faux pas committed by Janet Jackson and Justin Timberlake, when Janet's breast was accidently exposed. Karim could not easily find that video clip online and then a few others. Not a problem he would have today.

4.2 Space Programme

Space science is an all-encompassing term that describes all of the various science fields that are concerned with the study of the Universe, generally also meaning 'excluding the Earth' and 'outside of the Earth's atmosphere

A list of major government agencies engaged in activities related to outer space and space exploration

Terminated	Founded	Country	Acronym	Name
	10 February1994	Brazil	AEB	Brazilian Space Agency
		United Kingdom		British National Space Centre
	March 1989	Canada	CSA / ASC	Canadian Space Agency
—	April 1993	People's Republic of China	CNSA	China National Space Administration
—	1926	Australia	CSIRO	Commonwealth Scientific and Industrial Research Organization
—	1975	Austria Belgium Denmark Finland France Germany Greece Ireland Italy Luxembourg Netherlands Norway Portugal Spain Sweden Switzerland United Kingdom	ESA	European Space Agency

	1969	Germany	DLR	German Aerospace Center
	August 15,1969	India	ISRO	Indian Space Research Organization
		Greece	ISARS	Institute for Space Applications and Remote Sensing
	2004	Iran	ISA	Iranian Space Agency
		Israel		Israeli Space Agency
	1988	Italy		Italian Space Agency
	October 1,2003(October 1, 1969)	Japan	JAXA (Formerly NASDA)	Japan Aerospace Exploration Agency
	1981	South Korea	KARI	Korea Aerospace Research Institute
—	1 October1958	United States	NASA	National Aeronautics and Space Administration
		France	CNES	National Center of Space Research (French: *Centre National d'Études Spatiales*)
		Indonesia	LAPAN	National Institute of Aeronautics and Space

—	1991	Argentina	CONAE	National Space Activities Commission
	1992	Ukraine	NSAU	National Space Agency of Ukraine
—	October 1991	Republic of China (Taiwan)	NSPO	National Space Organization
		Netherlands	SRON	Netherlands Institute for Space Research
		North Korea		North Korean Space Agency
		Norway		Norwegian Space Centre
		Pakistan	SUPARCO	Pakistan Space and Upper Atmosphere Research Commission
		Romania		Romanian Space Agency
	c.1992	Russia	RKA / RSA	Russian Federal Space Agency
c. 1991	c.1955	Soviet Union		Soviet space program
		Poland		Space Research Centre

		Sweden		Swedish National Space Board
		Switzerland		Swiss Space Office
—	13 December 1958	United Nations	UNOOSA	United Nations Office for Outer Space Affairs

Manned space flight + Launch capability + Operates satellites
Launch capability + Operates satellites
Operate satellites
None of the above

4.2.1 International Space Station

The International Space Station (ISS) is a research facility being assembled in space. Its on-orbit assembly began in 1998. The space station is in a low Earth orbit and can be seen from Earth with the naked eye: it has an altitude of about 350 km above the surface of the Earth, and travels at an average speed of 27,700 km per hour, completing 15.77 orbits per day.

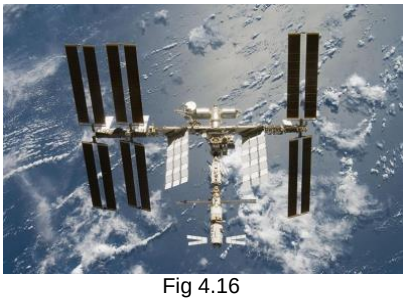


Fig 4.16

A space station is an artificial structure designed for humans to live in outer space. So far only low earth orbit (LEO) stations are implemented, also known as orbital stations. A space station is distinguished from other manned spacecraft by its lack of major propulsion or landing facilities—instead, other vehicles are used as transport to and from the station. Space stations are designed for medium-term living in orbit, for periods of weeks, months, or even years.

The ISS is a continuation of several other previously planned space stations: Russia's Mir 2, the U.S. Space Station Freedom, the European Columbus, and Kibo, the Japanese Experiment Module. The projected completion date is 2010, with the station remaining in operation at least until 2016. As of 2008, the ISS is larger than any previous space station.

The station is serviced primarily by Russian Soyuz and Progress spacecraft and by U.S. Space Shuttle orbiters. On March 9, 2008, the European Space Agency (ESA) launched an Ariane 5with the first Automated Transfer Vehicle, *Jules Verne*, toward the ISS carrying over 8,000 kilograms of cargo. Successful docking took place at 14:40 GMT on April 3, 2008.

4.2.2 First Orbital Flights

The first successful orbital launch was of the Soviet unmanned Sputnik (Satellite I) mission on October 4, 1957. The satellite weighed about 83 kg (184 pounds), and is believed to have orbited Earth at a height of about 250 km (150 miles). It had two radio transmitters (20 and 40 MHz), which emitted "beeps" that could be heard by any radio around the globe. Sputnik 1 was launched by an R-7 rocket. It incinerated upon re-entry on January 3, 1958. This success led to an escalation of the American space program, which unsuccessfully attempted to launch Vanguard 1 into orbit two months later. On January 31, 1958, the U.S. successfully orbited Explorer 1 on a Juno rocket. In the meantime, the Soviet dog Laika became the first animal in orbit on November 3, 1957.

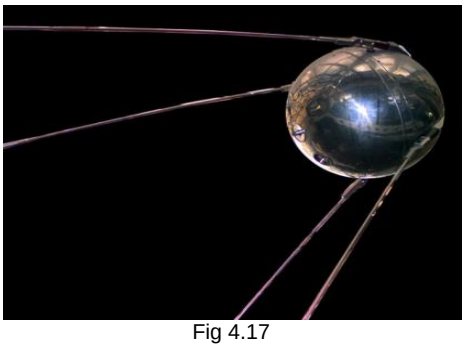


Fig 4.17

4.2.3 First Human Flights

The first human spaceflight was Vostok 1 (East 1), carrying 27 year old Russian cosmonaut Yuri Gagarin on April 12, 1961. The spacecraft completed one orbit around the globe, lasting about 1 hour and 48 minutes. Gagarin's flight resonated around the world; it was a demonstration of the advanced Soviet space program and it opened an entirely new era in space exploration — human spaceflight.

The U.S. first launched a person into space within a month of Gagarin's flight with the first Mercury flight, by Alan Shepard. Orbital flight was achieved by the United States when John Glenn's Mercury-Atlas 6 orbited the Earth on February 20, 1962.

Valentina Tereshkova, the first woman in space, orbited the Earth 48 times aboard Vostok 6 on June 16, 1963.

China first launched a person into space 42 years after the launch of Vostok 1, on October 15, 2003, with the flight of Yang Liwei aboard the Shenzhou 5 (Spaceboat 5) spacecraft.

4.3 Indian Space Program

Indian Space Program began in 1963. It was initiated primarily for scientific purposes. However, since the inception, it was proven to be beneficial for both civilian and military purposes. Especially, INSAT series of satellites made a major impact on telecommunication scenario in India.

Since 15 August 1969 the management of space research and its utilization for peaceful purposes has been controlled by the Indian Space Research Organization (ISRO). In 1972 the Indian Government set up the Space Commission and entrusted a Department of Space (DOS) with responsibility for conducting the country's space activities.

All of ISRO's commercial and marketing activities are handled by Antrix Corp. Ltd, which was created on November 1992 by ISRO. *Antrix* is a sanskrit word. The meaning of *Antrix* is space.

The Indian Space Program may be divided in two major categories. One is the Satellite Program and the other is the Launcher Program.

The Satellite program involves putting the satellites in the space and managing the same. The satellites may be lifted by Indian made launchers or it may involve the commercial launch vehicles. The Satellites are also of two different categories, communication satellites and remote sensing satellites.

The launcher program involves the design; fabrication and launching of launch vehicles. India has also developed a series of launch vehicles, after a long research and development through the painstaking ways of successes and failures. A brief of the events are presented below:

PSLV-C37/Cartosat-2 Series Satellite was successfully launched on Wednesday, February 15, 2017 at 9:28 Hrs IST from SDSC SHAR, Sriharikota. It will observe Earth and other 103 co-passenger satellites.	2017
PSLV-C30 launched 1513 kg ASTROSAT into the orbit. Along with ASTROSAT, six satellites from international customers - 76 kg LAPAN-A2 of Indonesia, 14 kg NLS-14 (Ev9) of Canada and four identical LEMUR satellites of USA together weighing about 28 kg – were launched in this PSLV flight, on 28 September, 2015	2015
• PSLV - C26 successfully launches IRNSS-1C from Sriharikota, 16 October, 2014 • PSLV-C23 successfully launches SPOT 7 and four co-	2014

passenger satellites from Sriharikota, on 30 June 2014. • PSLV - C24 successfully launches IRNSS-1B from Sriharikota, April 4 2014. GSLV-D5 successfully launches GSAT-14 from Sriharikota, January 5, 2014	
• PSLV - C25 (November 5) Mars Orbiter Mission Spacecraft, • PSLV - C22 (July 1) and • PSLV - C20 (Feb 25) were launched successfully from Sriharikota with commercial payloads.	2013
• ISRO's Polar Satellite Launch Vehicle, PSLV-C21 successfully launches SPOT 6 and PROITERES from Sriharikota, on 9 September, 2012 • PSLV-C19 successfully launches RISAT-1 from Sriharikota, 26 April, 2012	2012
• PSLV-C18 successfully launches Megha-Tropiques, Jugnu, SRMSat and VesselSat-1 from Sriharikota, on 12 October, 2011 • PSLV-C17 successfully launches GSAT-12 from Sriharikota, on 15 July, 2011 • PSLV-C16 successfully launches Three Satellites - RESOURCESAT-2, YOUTHSAT, X-SAT from Sriharikota, on 20 April, 2011	2011
• Successful launch of advanced communication satellite HYLAS (Highly Adaptable Satellite), built by ISRO on a commercial basis in partnership with EADS-Astrium of Europe, by Ariane-5 V198 from Kourou French Guiana, on 27 November, 2010 • PSLV-C15 successfully launches Five Satellites - CARTOSAT-2B, ALSAT-2A, two nanosatellites-NLS-6.1 & 6.2 and a pico-satellite- STUDSAT from Sriharikota (July 12, 2010)	2010
• PSLV-C14 successfully launches Seven Satellites - OCEANSAT-2, Four CUBESAT Satellites and Two RUBIN-9 from Sriharikota, on 23 september, 2009. • PSLV-C12 successfully launches RISAT-2 and ANUSAT from Sriharikota, on 20 april, 2009.	2009
• PSLV-C11 successfully launches CHANDRAYAAN-1 from Sriharikota (October 22, 2008). • PSLV-C9 successfully launches CARTOSAT-2A, IMS-1 and 8 foreign nano satellites from Sriharikota (April 28, 2008). • PSLV-C10 successfully launches TECSAR satellite under a commercial contract with Antrix Corporation (January 21, 2008).	2008
• Successful launch of of GSLV (GSLV-F04) with INSAT-	2007

4CR on board from SDSC SHAR (September 2, 2007). • ISRO's Polar Satellite Launch Vehicle, PSLV-C8, successfully launched Italian astronomical satellite, AGILE from Sriharikota (April 23, 2007). • Successful launch of INSAT-4B by Ariane-5 from Kourou French Guyana, (March 12, 2007). • Successful recovery of SRE-1 after manoeuvring it to re-enter the earth's atmosphere and descend over the Bay of Bengal about 140 km east of Sriharikota (January 22, 2007). • ISRO's Polar Satellite Launch Vehicle, PSLV-C7 successfully launches four satellites - India's CARTOSAT-2 and Space Capsule Recovery Experiment (SRE-1) and Indonesia's LAPAN-TUBSAT and Argentina's PEHUENSAT-1 (January 10, 2007).	
Second operational flight of GSLV (GSLV-F02) from SDSC SHAR with INSAT-4C on board. (July 10, 2006). Satellite could not be placed in orbit.	2006
• Successful launch of INSAT-4A by Ariane from Kourou French Guyana, (December 22, 2005). • ISRO's Polar Satellite Launch Vehicle, PSLV-C6, successfully launched CARTOSAT-1 and HAMSAT satellites from Sriharikota (May 5, 2005).	2005
The first operational flight of GSLV (GSLV-F01) successfully launched EDUSAT from SDSC SHAR, Sriharikota (September 20, 2004)	2004
• ISRO's Polar Satellite Launch Vehicle, PSLV-C5, successfully launched RESOURCESAT-1 (IRS-P6) satellite from Sriharikota (October 17, 2003). • Successful launch of INSAT-3E by Ariane from Kourou French Guyana, (September 28, 2003). • The Second developmental launch of GSLV-D2 with GSAT-2 on board from Sriharikota (May 8, 2003). • Successful launch of INSAT-3A by Ariane from Kourou French Guyana, (April 10, 2003).	2003
• ISRO's Polar Satellite Launch Vehicle, PSLV-C4, successfully launched KALPANA-1 satellite from Sriharikota (September 12, 2002). • Successful launch of INSAT-3C by Ariane from Kourou French Guyana, (January 24, 2002).	2002

• ISRO's Polar Satellite Launch Vehicle, PSLV-C3, successfully launched three satellites -- Technology Experiment Satellite (TES) of ISRO, BIRD of Germany and PROBA of Belgium - into their intended orbits (Oct. 22, 01). • The first developmental launch of GSLV-D1 with GSAT-1 on board from Sriharikota (April 18, 2001)	2001
INSAT-3B, the first satellite in the third generation INSAT-3 series, launched by Ariane from Kourou French Guyana, (March 22, 2000).	2000
• Indian Remote Sensing Satellite, IRS-P4 (OCEANSAT), launched by Polar Satellite Launch Vehicle (PSLV-C2) along with Korean KITSAT-3 and German DLR-TUBSAT from Sriharikota (May 26, 1999). • INSAT-2E, the last satellite in the multipurpose INSAT-2 series, launched by Ariane from Kourou French Guyana, (April 3, 1999).	1999
INSAT system capacity augmented with the readiness of INSAT-2DT acquired from ARABSAT (January 1998).	1998
• INSAT-2D, fourth satellite in the INSAT series, launched (June 4, 1997). Becomes inoperable on October 4, 1997. (An in-orbit satellite, ARABSAT-1C, since renamed INSAT-2DT, was acquired in November 1997 to partly augment the INSAT system). • First operational launch of PSLV with IRS-1D on board (September 29, 1997). Satellite placed in orbit.	1997
Third developmental launch of PSLV with IRS-P3 on board (March 21, 1996). Satellite placed in polar sunsynchronous orbit.	1996
• Launch of third operational Indian Remote Sensing Satellite, IRS-1C (December 28, 1995). • INSAT-2C, the third satellite in the INSAT-2 series, launched (December 7, 1995).	1995
• Second developmental launch of PSLV with IRS-P2 on board (October 15, 1994). Satellite successfully placed in polar sunsynchronous orbit. • Fourth developmental launch of ASLV with SROSS-C2 on board (May 4, 1994). Satellite placed in orbit.	1994
• First developmental launch of PSLV with IRS-1E on board (September 20, 1993). Satellite could not be placed in orbit. • INSAT-2B, the 2 satellite in the INSAT-2 series, launched (July 23, 1993).	1993
• INSAT-2A, the 1 satellite of the indigenously-built second-generation INSAT series, launched (July 10, 1992).	1992

• Third developmental launch of ASLV with SROSS-C on board (May 20, 1992). Satellite placed in orbit.	
Second operational Remote Sensing satellite, IRS-1B, launched (August 29, 1991).	1991
INSAT-1D launched (June 12, 1990).	1990
• INSAT-1C launched (July 21, 1988). Abandoned in November 1989. • Second developmental launch of ASLV with SROSS-2 on board (July 13, 1988). Satellite could not be placed in orbit. • Launch of first operational Indian Remote Sensing Satellite, IRS-1A (March 17, 1988).	1988
First developmental launch of ASLV with SROSS-1 satellite on board (March 24, 1987). Satellite could not be placed in orbit.	1987
Indo-Soviet manned space mission (April 1984).	1984
• INSAT-1B, launched (August 30, 1983). • 2 developmental launch of SLV-3. RS-D2 placed in orbit (April 17, 1983).	1983
INSAT-1A launched (April 10, 1982). Deactivated on September 6, 1982.	1982
• Bhaskara-II launched (November 20, 1981). • APPLE, an experimental geo-stationary communication satellite successfully launched (June 19, 1981). • RS-D1 placed in orbit (May 31, 1981) • First developmental launch of SLV-3.	1981
Second Experimental launch of SLV-3, Rohini satellite successfully placed in orbit. (July 18, 1980).	1980
• First Experimental launch of SLV-3 with Rohini Technology Payload on board (August 10, 1979). Satellite could not be placed in orbit. • Bhaskara-I, an experimental satellite for earth observations, launched (June 7, 1979).	1979
Satellite Telecommunication Experiments Project (STEP) carried out.	1977
Satellite Instructional Television Experiment (SITE) conducted.	1975-1976
ISRO First Indian Satellite, Aryabhata, launched (April 19, 1975). Becomes Government Organisation (April 1, 1975).	1975

Air-borne remote sensing experiments.	1972-1976
Space Commission and Department of Space set up (June 1, 1972). ISRO brought under DOS.	1972
Indian Space Research Organisation (ISRO) formed under Department of Atomic Energy (August 15, 1969).	1969
TERLS dedicated to the United Nations (February 2, 1968).	1968
Satellite Telecommunication Earth Station set up at Ahmedabad.	1967
Space Science & Technology Centre (SSTC) established in Thumba.	1965
First sounding rocket launched from TERLS (November 21, 1963).	1963
Indian National Committee for Space Research (INCOSPAR) formed by the Department of Atomic Energy and work on establishing Thumba Equatorial Rocket Launching Station (TERLS) started.	1962

4.3.1 Cosmonaut Rakesh Sharma - First Indian in Space

The manned space program of the Indian Space Research Organization has depended entirely upon Russia, and the first Indian cosmonaut became the 138th man into space, he spent eight days in space aboard Salyut 7. Launched along with two other Soviet cosmonauts aboard Soyuz T-11 on 2 April 1984, was then-Squadron Leader Rakesh Sharma, a 35 year old Indian Air Force pilot.

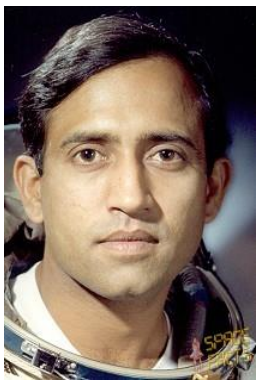


Fig 4.18

4.3.2 Other Organizations

- Vikram Sarabhai Space Centre (VSSC). ISRO's single largest facility, near Trivandrum providing the technology base for launcher & propulsion development.

- Liquid Propulsion Systems Centre (LPSC). Development branches in Bangalore and Trivandrum are supported by major test facilities at Mahendragiri for wide spectrum of liquid motors, from reaction control system thrusters to the 720kN Vikas and cryogenic engines.

- ISRO Satellite Centre (ISAC). ISRO's lead centre for the design, fabrication & testing of science, technology and applications satellites.

- ISRO Inertial Systems Unit (IISU). Provides inertial systems & components for satellites and launchers.

- SHAR Centre. The ISRO's orbital launch site and largest solid motor production and test facility.

- ISRO Telemetry, Tracking & Command Network (ISTRAC). Headquartered in Bangalore, ISTRAC operates a network of ground station to provide TTC support for launcher & satellite operations.

- Space Applications Centre (SAC). Located at Ahmedabad, SAC is ISRO's applications R&D centre, including communications, remote sensing and geodesy.

- Development & Educational Communications Unit (DECU) at Ahmedabad.

- INSAT Master Control Facility (MCF) at Hassan, 180km from Bangalore.

4.3.3 Mangalyaan

- Introduction of Mangalyaan

    - The Mars Orbiter Mission (MOM), also called *Mangalyaan* ("Mars-craft", from Sanskrit: मंगल *mangala*, "Mars" and यान *yāna*, "craft, vehicle"), is a space probe orbiting Mars since 24 September 2014.

    - It was launched on 5 November 2013 by the Indian Space Research Organisation (ISRO).

    - It is India's first interplanetary mission and ISRO has become the fourth space agency to reach Mars, after the Soviet space program, NASA, and the European Space Agency.[It is the first Asian nation to reach Mars orbit, and the first nation in the world to do so in its first attempt

- Mission objective

  One of the main objectives of the first Indian mission to Mars is to develop the technologies required for design, planning, management and operations of an interplanetary mission.

- Following are the major objectives of the mission:

    - Technological Objectives:

        - Design and realization of a Mars orbiter with a capability to survive and perform Earth bound manoeuvres, cruise phase of 300 days, Mars orbit insertion / capture, and on-orbit phase around Mars

        - Deep space communication, navigation, mission planning and management
        - Incorporate autonomous features to handle contingency situations
    - Scientific Objectives:
        - Exploration of Mars surface features, morphology, mineralogy and Martian atmosphere by indigenous scientific instruments

- What Mangalyaan is actually going to do?
    - To find methane.
    - To find the availability of water.
    - To find temperature and climatic condition in mars.
    - To find the chemical components present.

- Short description about mars
    - Name –Mangalyaan (mars craft)
    - Duration – 15 months
    - Budget – 450 crore
    - Purpose – to analysis mars.
    - Operator -ISRO
    - Launched place- Satish Dhawan Space Centre Sriharikota Andra Pradesh
    - Launch date-5 Nov 2013
    - Orbital insertion-24 Sep 2015

- Brains Behind The Mission
    - K. Radhakrishnan- Chairman Of ISRO
    - S. Ramakrishnan – Director Of Vikram Sarabhai Space Center
    - S. K. Shivakumar- Orbiting Payload Director ISAC
    - M. Annadurai- Programme Director

- Conclusion
    - CHEAPEST MARS MISSION EVER
    - Developed and deployed in 15 months
    - It takes 14 minutes for a signal from earth to reach Mars

    Six countries have tried their hands to send missions to Mars, India being the seventh. Only United States, Russia, and France were a part of this Mars club, until today. No country, until today, had ever had a successful Mars mission at the first attempt.

Fig 4.19

The picture of Mangalyaan has been printed on the new currency note of rupees 2000, w.e.f 8 November 2016, when new currency was issued.

4.4 References

- www.wikipedia.org
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UNIT 5 ENVIRONMENTAL STUDIES POLLUTION AND DISASTER MANAGEMENT

5. Environmental Studies Pollution and Disaster Management

5.1 Environment

All the biotic and abiotic factors that act on an organism, population, or ecological community and influence its survival and development constitute environment. Biotic factors include the organisms themselves, their food, and their interactions. Abiotic factors include such items as sunlight, soil, air, water, climate, and pollution.

The environment can be divided into following four Segments:

- Atmosphere - The atmosphere is the protective blanket of gases surrounding the earth, which sustains life on earth and saves it from hostile environment of outer space.
- Hydrosphere- includes all types of water resources – oceans, seas, rivers, lakes, streams, reservoirs, glaciers, polar icecaps and ground water. 97% is in the oceans; 2% locked in the polar icecaps and glaciers and 1% is freshwater.
- Lithosphere - Outer mantle of the solid earth, consisting of minerals occurring in the earth's crust and the soil
- Biosphere - denotes the realm of living organisms and their interactions with the environment, viz., atmosphere, hydrosphere and lithosphere

5.1.1 Composition of the Atmosphere

The air pollution concerns mainly the state of the troposphere (atmosphere extending to about 11 km from the earth's surface). The average percentage composition of clean dry air near sea-level is:

Major components: N_2 = 78.09, O_2 = 20.94, Water Vapour = 1-3% by volume
Minor components: Ar = 0.9, CO_2 = 0.0318,
Trace components: Ne = 0.018
Rest is He, Kr, Xe, H_2, CH_4, O_3, CO, NO_2 and SO_2

Any change in this composition results in Pollution

5.2 Pollution

Substances not naturally found in the air or at greater concentrations or in different locations from usual are referred to as *pollutants* There are many substances in the air which may impair the health of plants and animals (including humans), or reduce visibility. These arise both from natural processes and human activity.

5.2.1 Air Pollution

Air Pollution is the human introduction into the atmosphere of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or damages the environment. Air pollution causes death and respiratory disease. Air pollution is often identified with major stationary sources, but the greatest source of emissions is mobile sources, mainly automobiles. Gases such as carbon dioxide, which contribute to global warming, have recently gained recognition as pollutants by climate scientists, while they also recognize that carbon dioxide is essential for plant life through photosynthesis.

Fig 5.1

5.2.1.1 Pollutants

Pollutants can be classified as either primary or secondary. Usually, primary pollutants are substances directly emitted from a process, such as ash from a volcanic eruption, the carbon monoxide gas from a motor vehicle exhaust or sulfur dioxide released from factories.

Secondary pollutants are not emitted directly. Rather, they form in the air when primary pollutants react or interact. An important example of a secondary pollutant is ground level ozone - one of the many secondary pollutants that make up photochemical smog.

- *Major primary pollutants* produced by human activity include:
    - Sulfur oxides (SO_x) especially sulfur dioxide are emitted from burning of coal and oil.

- Nitrogen oxides (NO_x) especially nitrogen dioxide are emitted from high temperature combustion. Can be seen as the brown haze dome above or plume downwind of cities.
- Carbon monoxide is colourless, odourless, non-irritating but very poisonous gas. It is a product by incomplete combustion of fuel such as natural gas, coal or wood. Vehicular exhaust is a major source of carbon monoxide.
- Carbon dioxide (CO_2), a greenhouse gas emitted from combustion.
- Volatile organic compounds (VOC), such as hydrocarbon fuel vapours and solvents.
- Particulate matter (PM), measured as smoke and dust. PM_{10} is the fraction of suspended particles 10 micrometers in diameter and smaller that will enter the nasal cavity. $PM_{2.5}$ has a maximum particle size of 2.5 µm and will enter the bronchioles and lungs.
- Toxic metals, such as lead, cadmium and copper.
- Chlorofluorocarbons (CFCs), harmful to the ozone layer emitted from products currently banned from use.
- Ammonia (NH_3) emitted from agricultural processes.
- Odors, such as from garbage, sewage, and industrial processes
- Radioactive pollutants produced by nuclear explosions, war explosives, and natural processes such as the radioactive decay of radon.

- *Secondary pollutants include*:
  - Particulate matter formed from gaseous primary pollutants and compounds in photochemical smog, such as nitrogen dioxide.
  - Ground level ozone (O_3) formed from NOx and VOCs.
  - Peroxyacetyl nitrate (PAN) similarly formed from NO_x and VOCs.

Fig 5.2: Dust storm approaching Stratford, Texas

5.2.1.2 Sources of Air Pollution

Sources of air pollution refer to the various locations, activities or factors which are responsible for the releasing of pollutants in the atmosphere. These sources can be classified into two major categories which are:

- Anthropogenic sources (human activity) mostly related to burning different kinds of fuel
    - "Stationary Sources" as smoke stacks of power plants, manufacturing facilities, municipal waste incinerators.
    - "Mobile Sources" as motor vehicles, aircraft etc.
        - Marine vessels, such as container ships or cruise ships, and related port air pollution.
        - Burning wood, fireplaces, stoves, furnaces and incinerators.
        - Oil refining, and industrial activity in general.
        - Chemicals, dust and controlled burn practices in agriculture and forestry management, (see Dust Bowl).
        - Fumes from paint, hair spray, varnish, aerosol sprays and other solvents.
        - Waste deposition in landfills, which generate methane.
        - Military, such as nuclear weapons, toxic gases, germ warfare and rocketry.
- Natural sources
    - Dust from natural sources, usually large areas of land with little or no vegetation.
    - Methane, emitted by the digestion of food by animals, for example cattle.
    - Radon gas from radioactive decay within the Earth's crust.
    - Smoke and carbon monoxide from wildfires.
    - Volcanic activity, which produce sulfur, chlorine, and ash particulates.

5.2.1.3 Health Effects

The World Health Organization states that 2.4 million people die each year from causes directly attributable to air pollution, with 1.5 million of these

deaths attributable to indoor air pollution. The health effects caused by air pollutants may range from subtle biochemical and physiological changes to difficulty in breathing, wheezing, coughing and aggravation of existing respiratory and cardiac conditions. These effects can result in increased medication use, increased doctor or emergency room visits, more hospital admissions and premature death. The human health effects of poor air quality are far reaching, but principally affect the body's respiratory system and the cardiovascular system. Individual reactions to air pollutants depend on the type of pollutant a person is exposed to, the degree of exposure, the individual's health status and genetics.

The worst short term civilian pollution crisis in India was the 1984 Bhopal Disaster. Leaked industrial vapours from the Union Carbide factory, belonging to Union Carbide, Inc., U.S.A., killed more than 2,000 people outright and injured anywhere from 150,000 to 600,000 others, some 6,000 of whom would later die from their injuries. The United Kingdom suffered its worst air pollution event when the December 4 Great Smog of 1952 formed over London. In six days more than 4,000 died, and 8,000 more died within the following months an accidental leak of anthrax spores from a biological warfare laboratory in the former USSR in 1979 near Sverdlovsk is believed to have been the cause of hundreds of civilian deaths.

- *Related Incidents*

Delhi Smog: Delhi closed down its schools, halted construction and ordered that all roads be doused with water to settle dust, as the thick blanket of 'cancerous' smog continued to choke Delhites on November 7, 2016.

Fig 5.3

Scientists for the first time detected trace amounts of ammonia in the upper troposphere, the lowest atmospheric layer of Earth on December 12, 2016.

5.2.1.4 Steps taken by the Government to control Air Pollution

- The International Day for the Preservation of the Ozone Layer is observed every year on September 16 for the preservation of the Ozone Layer.

- China passes law to levy environment tax to fight pollution: China’s top legislature has passed Environment Tax to levy environment tax on polluters,

especially on heavy industries. It will enter into force on January 1, 2018. The law aims to improve taxpayers' environmental awareness, force companies to upgrade technology and shift to cleaner production.

5.2.2 Water Pollution

When toxic substances enter lakes, streams, rivers, oceans, and other water bodies, they get dissolved or lie suspended in water or get deposited on the bed. This results in the pollution of water whereby the quality of the water deteriorates, affecting aquatic ecosystems. Pollutants can also seep down and affect the groundwater deposits.

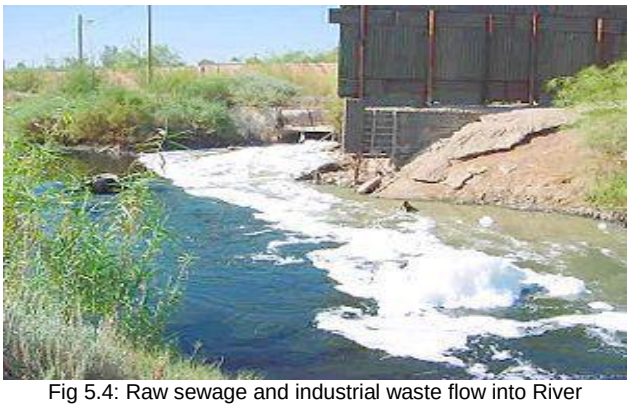

Fig 5.4: Raw sewage and industrial waste flow into River

Water pollution has many sources. The most polluting of them are the city sewage and industrial waste discharged into the rivers. The facilities to treat waste water are not adequate in any city in India. Presently, only about 10% of the waste water generated is treated; the rest is discharged as it is into our water bodies. Due to this, pollutants enter groundwater, rivers, and other water bodies. Such water, which ultimately ends up in our households, is often highly contaminated and carries disease-causing microbes. Agricultural run-off, or the water from the fields that drains into rivers, is another major water pollutant as it contains fertilizers and pesticides.

Although natural phenomena such as volcanoes, algae blooms, storms, and earthquakes also cause major changes in water quality and the ecological status of water, water is typically referred to as polluted when it impaired by anthropogenic contaminants and either does not support a human use (like serving as drinking water) or undergoes a marked shift in its ability to support its constituent biotic communities. Water pollution has many causes and characteristics.

The specific contaminants leading to pollution in water include a wide spectrum of chemicals, pathogens, and physical or sensory changes. While many of the chemicals and substances that are regulated may be naturally occurring (iron, manganese, etc.) the concentration is often the key in determining what is a natural component of water, and what is a contaminant. Many of the chemical substances are toxic. Pathogens can produce waterborne diseases in either human or animal hosts. Alteration of water's physical chemistry includes acidity, electrical conductivity, temperature, and

eutrophication. Eutrophication is the fertilization of surface water by nutrients that were previously scarce. Water pollution is a major problem in the global context. It has been suggested that it is the leading worldwide cause of deaths and diseases, and that it accounts for the deaths of more than 14,000 people daily. Contaminants may include organic and inorganic substances.

Some organic water pollutants are:

- Insecticides and herbicides, a huge range of organohalides and other chemicals
- Bacteria, often is from sewage or livestock operations
- Food processing waste, including pathogens
- Tree and brush debris from logging operations
- VOCs (volatile organic compounds), such as industrial solvents, from improper storage
- Petroleum Hydrocarbons including fuels (gasoline, diesel, jet fuels, and fuel oils) and lubricants (motor oil) from oil field operations, refineries, etc.
- Detergents
- Various chemical compounds found in personal hygiene and cosmetic products
- Disinfection by-products (DBPs) found in chemically disinfected drinking water

Some inorganic water pollutants include:

- Spill of oil over the seas is the biggest danger.
- Heavy metals including acid mine drainage
- Acidity caused by industrial discharges (especially sulfur dioxide from power plants)
- Pre-production industrial raw resin pellets, an industrial pollutant
- Chemical waste as industrial by products
- Fertilizers, in runoff from agriculture including nitrates and phosphates
- Silt in surface runoff from construction sites, logging, slash and burn practices or land clearing sites

Steps taken by the Government to control Water Pollution

- Madhya Pradesh Government has launched five months long Narmada Seva Yatra to turn the Narmada river pollution free. It was launched by Chief Minister Shivraj Singh Chouhan at Amarkantak.

- The First World Tsunami Awareness Day was observed across the world on 5 November 2016 to spread awareness among people across the world about Tsunami.

- Namami Gange Programme: The National Mission for Clean Ganga (NMCG) has approved new projects under Namami Gange programme in Haridwar (Uttarakhand) and Varanasi (Uttar Pradesh).

Fig 5.5

5.2.3 Soil Pollution

Soil pollution comprises the pollution of soils with materials, mostly chemical that are out of place or are present at concentrations higher than normal which may have adverse effects on humans or other organisms. It is difficult to define soil pollution exactly because different opinions exist on how to characterize a pollutant; while some consider the use of pesticides acceptable if their effect does not exceed the intended result, others do not consider any use of pesticides or even chemical fertilizers acceptable. However, soil pollution is also caused by means other than the direct addition of xenobiotic (man-made) chemicals such as agricultural runoff waters, industrial waste materials, acidic precipitates, and radioactive fallout.

Fig 5.6: Soil Pollution

Both organic and inorganic contaminants are important in soil. The most prominent chemical groups of organic contaminants are fuel hydrocarbons, polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), chlorinated aromatic compounds, detergents, and pesticides. Inorganic species include nitrates, phosphates, and heavy metals such as cadmium, chromium and lead; inorganic acids; and radionuclides (radioactive substances). Among the sources of these contaminants are agricultural runoffs, acidic precipitates, industrial waste materials, and radioactive fallout.

Steps taken by the Government to control Soil Pollution

- The National Green Tribunal (NGT) imposed a complete ban on burning of waste in open places across the country and announced a fine of Rs. 25,000 on each incident of bulk waste burning.

5.2.4 Noise Pollution

Noise pollution (or environmental noise) is displeasing human- or machine-created sound that disrupts the activity or balance of human or animal life. A common form of noise pollution is from transportation, principally motor vehicles. The word "noise" comes from the Latin word *nausea* meaning "seasickness", referring originally to nuisance noise.

Fig 5.7

- *Sources of Noise*

The source of most noise worldwide is transportation systems, motor vehicle noise, but also including aircraft noise and rail noise. Poor urban planning may give rise to noise pollution, since side-by-side industrial and residential buildings can result in noise pollution in the residential area. Other sources are car alarms, office equipment, factory machinery, construction work, appliances, power tools, lighting hum and audio entertainment systems

- *Human Health Effects*

Noise health effects are both health and behavioural in nature. The unwanted sound is called noise. This unwanted sound can damage physiological and psychological health. Noise pollution can cause annoyance and aggression,

hypertension, high stress levels, hearing loss, sleep disturbances, and other harmful effects. Furthermore, stress and hypertension are the leading causes to health problems, whereas tinnitus can lead to forgetfulness, severe depression and at times panic attacks. Chronic exposure to noise may cause noise-induced hearing loss.

5.2.5 Thermal Pollution

Thermal pollution is a temperature change in natural bodies of water caused by human influence. The temperature change can be upwards or downwards. In the Northern Hemisphere, a common cause of thermal pollution is the use of water as a coolant, especially in power plants. Water used as a coolant is returned to the natural environment at a higher temperature. Increases in water temperature can impact on aquatic organisms by (a) decreasing oxygen supply, (b) killing fish juveniles which are vulnerable to small fluctuations in temperature, and (c) affecting ecosystem composition. In the Southern Hemisphere, thermal pollution is commonly caused by the release of very cold water from the base of reservoirs, with severe effects on fish (particularly eggs and larvae), macroinvertebrates and river productivity.

- *Ecological Effects — Warm Water*

Warm water typically decreases the level of dissolved oxygen in the water. The decrease in levels of dissolved oxygen can harm aquatic animals such as fish, amphibians and copepods. Thermal pollution may also increase the metabolic rate of aquatic animals, as enzyme activity, resulting in these organisms consuming more food in a shorter time than if their environment were not changed. An increased metabolic rate may result in food source shortages, causing a sharp decrease in a population. Changes in the environment may also result in a migration of organisms to another, more suitable environment, and to in-migration of organisms that normally only live in warmer waters elsewhere. This leads to competition for fewer resources; the more adapted organisms moving in may have an advantage over organisms that are not used to the warmer temperature. As a result one has the problem of compromising food chains of the old and new environments. Biodiversity can be decreased as a result.

Fig 5.8: Fish killed in receiving waters

5.2.6 Flood

A flood is an overflow of an expanse of water that submerges land, a deluge. In the sense of "flowing water", the word is applied to the inflow of the tide. It is usually due to the volume of water within a body of water, such as a river or lake, exceeding the total capacity of the body, and as a result some of the water flows or sits outside of the normal perimeter of the body. It can also occur in rivers, when the strength of the river is so high it flows right out of the river channel, usually at corners or meanders.

Fig 5.9: Flooding of a creek due to heavy monsoonal rain and high tide.

- Riverine Floods
    - Slow Kinds: Runoff from sustained rainfall or rapid snowmelt exceeding the capacity of a river's channel. Causes include heavy rains from monsoons, hurricanes and tropical depressions.
    - Fast kinds: flash flood as a result of e.g. an intense thunderstorm.
- Estuarine floods

  Commonly caused by a combination of sea tidal surges caused by storm-force winds.
- Coastal floods

  Caused by severe sea storms, or as a result of another hazard (e.g. tsunami or hurricane).
- Catastrophic floods

  Caused by a significant and unexpected event e.g. dam breakage, or as a result of another hazard (e.g. earthquake or volcanic eruption).

5.2.6.1 Typical Effects

- Primary Effects
    - Physical damage- Can range anywhere from bridges, cars, buildings, sewer systems, roadways, canals and any other type of structure.

- Casualties- People and livestock die due to drowning. It can also lead to epidemics and diseases.

- Secondary Effects
  - Water supplies- Contamination of water. Clean drinking water becomes scarce.
  - Diseases- Unhygienic conditions. Spread of water-borne diseases
  - Crops and food supplies- Shortage of food crops can be caused due to loss of entire harvest.
  - Trees - Non-tolerant species can die from suffocation.

- Tertiary/long-term Effects
  - Economic- Economic hardship, due to: temporary decline in tourism, rebuilding costs, food shortage leading to price increase etc., especially to the poor.

5.2.6.2 Incidents

- Kashmir Floods: Caused by continuous torrential rainfall, the Kashmir region in September 2014 suffered from massive floods, leading to the death of around 500 people. Hundreds of people were trapped in their homes for days, without food and water. According to reports, around 2600 villages were affected in Jammu and Kashmir

Fig 5.10

- Uttarakhand Flash Floods: In the year 2013, Uttarakhand suffered from a major catastrophic natural disaster in the form of huge and deadly cloudbursts, causing flash floods in River Ganga. Sudden, heavy rains caused dangerous landslides in Uttrakhand, which killed thousands of people and thousands were reported missing. The death toll was estimated to be 5,700.

5.2.7 Earthquake

An earthquake is the result of a sudden release of energy in the Earth's crust that creates seismic waves. Earthquakes are recorded with a seismometer,

also known as a seismograph. The moment magnitude of an earthquake is conventionally reported, or the related and mostly obsolete Richter magnitude, with magnitude 3 or lower earthquakes being mostly imperceptible and magnitude 7 causing serious damage over large areas. Intensity of shaking is measured on the modified Mercalli scale.

At the Earth's surface, earthquakes manifest themselves by a shaking and sometimes displacement of the ground. When a large earthquake epicenter is located offshore, the seabed sometimes suffers sufficient displacement to cause a tsunami. The shaking in earthquakes can also trigger landslides and occasionally volcanic activity.

Fig 5.11: Tsunami in Indian Ocean, Earthquake, a Town devastated by earthquake

Incidents:

- Gujarat Earthquake: Gujarat was affected by a massive earthquake on the morning of 26 January, 2001, the day on which India was celebrating its 51st Republic Day.

Fig 5.12

- January 4, 2016: Eleven people were killed and 200 others were injured. Six people died in India and five in Bangladesh

- January 6, 2016: The disaster management experts at the Ministry of Home Affairs in India warned of mega earthquakes with a magnitude of 8.2 or greater in north India.

- February 22, 2016: Magnitude 5.5 earthquake shook Patna and other parts of Bihar today at 11:39 pm, triggering panic among people

- March 20, 2016: An avalanche triggered by earthquake claimed life of a military trooper and injured one other in frontier Kargil district of Ladakh division in Indian-controlled Kashmir.

5.2.8 Cyclone

In meteorology, a cyclone is an area of low atmospheric pressure characterized by inward spiraling winds that rotate counter clockwise in the northern hemisphere and clockwise in the southern hemisphere of the Earth. The generic term covers a wide variety of low pressure areas. The largest of the systems are cold core polar cyclones and extratropical cyclones which lie on the synoptic scale. Warm core cyclones such as tropical cyclones, mesocyclones, and polar lows lie within the smaller mesoscale. Subtropical cyclones are of intermediate size. Cyclones have also been seen on other planets outside of the Earth, such as Mars and Neptune.

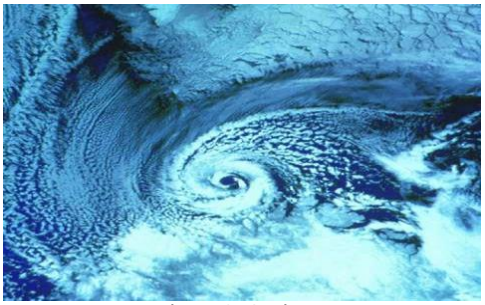

Fig 5.13: Cyclone

Incidents

- Vardah Cyclone: On Dec 12, 2016 Cyclonic storm Vardah was just a few inches away from wreaking havoc over the capital city of Tamil Nadu

Fig 5.14

5.2.9 Land Slides

A landslide is a geological phenomenon which includes a wide range of ground movement, such as rock fall, deep failure of slopes and shallow debris flows, which can occur in offshore, coastal and onshore environments. Although the action of gravity is the primary driving force for a landslide to occur, there are other contributing factors affecting the original slope stability..

Causes of Landslides

Three distinct physical events occur during a landslide: the initial slope failure, the subsequent transport, and the final deposition of the slide materials. Landslides can be triggered by gradual processes such as weathering, or by external mechanisms including:

- Undercutting of a slope by stream erosion, wave action, glaciers, or human activity such as road building,
- Intense or prolonged rainfall, rapid snowmelt, or sharp fluctuations in ground-water levels,
- Shocks or vibrations caused by earthquakes or construction activity,
- Loading on upper slopes, or
- A combination of these and other factors.

Effects of human activity

Landslides may result directly or indirectly from the activities of people. Slope failures can be triggered by construction activity that undercuts or overloads dangerous slopes, or that redirects the flow of surface or ground-water.

Poorly planned forest clearing may increase rates of surface water run-off or ground-water infiltration. Inefficient irrigation or sewage effluent disposal practices may result in increased ground-water pressures, which in turn can reduce the stability of rock and sediment.

People increase the risk of landslides by modifying the landscape, for example, by building on unstable slopes or in the path of potential landslides. Unfortunately, many people are unaware of their exposure to landslide risks.

Fig 5.15: The Thuya Creek landslide occurred in 1972

Incidents

January 14, 2016: A landslide in Darjeeling district of West Bengal state of India claimed lives of two people and injured five others.

5.2.10 Nuclear Hazards

Nuclear Weapons have devastating effects and cause casualties, destroy or disable equipment, restrict the use of terrain, and disrupt operations.

There are four main characteristics of a nuclear explosion:

- Nuclear Blast (an intense shock wave),
- Thermal Radiation (heat and light),
- Nuclear Radiation (radioactive material), and
- EMP (electrical power surge).

Effect on Humans

For the average person there are only two significant sources of radiation exposure: medical and natural.

The exposure of the human body to nuclear radiation causes damage to the cells in all parts of the body. This damage is the cause of "radiation sickness." The severity of this sickness depends on the radiation dose received, the length of exposure and the condition of the body at the time.

The early symptoms of radiation sickness will usually appear 1 - 6 hours after exposure and include headache, nausea, vomiting and diarrhea. There is no first aid for exposure to nuclear radiation.

5.2.11 Solid Waste Management

Waste management is the collection, transport, processing, recycling or disposal of waste materials. The term usually relates to materials produced by human activity, and is generally undertaken to reduce their effect on health, the environment or aesthetics. Waste management is also carried out to recover resources from it. Waste management can involve solid, liquid, gaseous or radioactive substances, with different methods and fields of expertise for each.

Municipal solid waste (MSW) refers to the materials discarded in the urban areas for which municipalities are usually held responsible for collection, transport and final disposal. MSW encompasses household refuse, institutional wastes, street sweepings, commercial wastes, as well as construction and demolition debris. In developing countries, MSW also contains varying amounts of industrial wastes from small industries, as well as dead animals, and fecal matter.

Municipal solid waste includes:

- Biodegradable waste: food and kitchen waste, green waste, paper (can also be recycled).
- Recyclable material: paper, glass, bottles, cans, metals, certain plastics, etc.
- Inert waste: construction and demolition waste, dirt, rocks, debris.
- Composite wastes: waste clothing, Tetra Paks, waste plastics such as toys.
- Domestic hazardous waste (also called "household hazardous waste") & toxic waste: medication, e-waste, paints, chemicals, light bulbs, fluorescent tubes, spray cans, fertilizer and pesticide containers, batteries, shoe polish.

Fig 5.16

Salient features of Integrated Solid Waste Management:

- Promote segregation of waste at source.
- Avoid multiple handling of waste.
- Conduct Awareness programs.
- Public/NGO Participation.
- Processing of organic waste by composting, vermi-composting, biomethenation
- Scientific disposal of inert waste in landfill site

Solid Waste Disposal:

- Source reduction: Altering the design, manufacture, or use of products and materials to reduce the amount and toxicity of what gets thrown away.
- Recycling: Sorting, collecting, and processing materials to manufacture and sell them as new products.

Fig 5.17

- Composting: Decomposing organic waste, such as food scraps and yard trimmings, with microorganisms (mainly bacteria and fungi) to produce compost. Compost is organic material that can be used as a soil amendment or as a medium to grow plants.

Fig 5.18

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