

Samples from

# SCIENCE & TECHNOLOGY

# BODY PARTS AND PROCESSES

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## BLOOD

- The chief transport system of animals is **blood vascular system**. It includes blood, the pumping organ – heart and blood vessels.
- Blood **transports following types of materials** –
  - **Wasteful** and Poisonous by-products of metabolism transported to kidneys for excretion.
  - **Hormones**, which regulate activities of metabolism, growth and development, are carried from organs where they are produced to other places.
  - **Oxygen** from lungs to tissues & **CO<sub>2</sub>** from tissues to lungs
  - Digested food from 'Small Intestine' i.e. ileum get into blood plasma in the form of various salts, amino acids etc. to liver and into circulatory system.
  - The substances carried by blood fight diseases, clotting of blood, healing of wounds.
  - **Temperature** is controlled to a constant value through distribution of heat by blood.
- There is 5-6 litre blood in normal human body, which makes about 7% of total weight
- **PH of blood** is **7.4** (alkaline)
- Blood consists of following components:
  1. Plasma – 60%
  2. Corpuscles – 40% (RBCs & WBCs)
  3. Platelets

## Plasma

- It is the **liquid part** of blood. It consists of 90% Water and rest is **protein (Albumin, "GammaGlobulin", Fibrogen)**, Glucose and Salts. Gamma Globulin – Rich in **antibodies** and provide immunity to certain infectious diseases. **Fibrogen** helps in **blood clotting**.

## Corpuscles

- **RBC** (Red Blood Corpuscles) are also called **Erythrocytes**. Produced in **Red Bone Marrow** and worn out RBCs are destroyed by **Liver** and **Spleen**. Blood contains a 'protein' molecule called **hemoglobin**; a carrier of O<sub>2</sub> and CO<sub>2</sub> in human system.
- **WBC** (White Blood Corpuscles) or **Leucocytes** move through tissue spaces by a process called '**Diapedesis**'. These work as a military – Destroy harmful bacteria and dead cells. These are **larger** than RBCs. An overproduction of WBCs results into a disease called **leukemia**.
- Ratio of RBC: WBC in our body is **600: 1**.
- Hemoglobin (Hb) **is red respiratory pigment present in RBC**. Hemoglobin in Males is 14-18 gm/ 100 ml of blood and in Females is 11-14 gm/ 100ml. Maximum Hemoglobin content is found in New born baby. Its 24.4–34.4 gm/ 100 ml of blood
- The organs, which produce blood corpuscles are called hemopoietic tissues and the process of their formation is called **hemopoiesis**
- People living in high altitudes have more RBCs. The **count** sharply **falls** in **anaemia** and **rises** in **polycythemia**.

<b>RBCs</b>	<b>WBCs</b>	<b>BLOOD PLATELETS</b>
Rounded or disc-like. Contain Hb, & thus transport oxygen	Colourless and amoeba like, much larger than RBCs. Provide immunity to body	Small, spherical; Clotting of blood
No nucleus	One nucleus each	Enucleated
50 lacs in no	9000	2 to 3 lacs
120 days life	1-2 weeks	Few hours

### Platelets

- Also called **Thrombocytes**, help in clotting of blood. Much smaller than RBCs
- **Blood Platelets** occur only in mammals. They are also named as megakaryocytes and having essential role in blood coagulation. They are derived in red bone marrow.

**Serum:** It is the residue blood from, which blood-clotting protein called fibrinogen has been removed. Therefore, this plasma cannot clot and stored in blood banks. Thus, Serum (plasma) **lacks Fibrinogen** (a protein).

### ANTIBODIES

1. IgM – first to come
2. IgG – longest acting
3. IgE – work in allergic reactions

### BLOOD VESSELS

- Blood vessels are of three types connected to form one continuous '**Closed**' system or a '**Loop**'. These are **Arteries** – Widest and carry blood from heart elsewhere. Arteries branch out into thinner tubes called **Arterioles** and further into even thinner **Capillaries**.
- The walls of Capillaries are just one cell thick, and so permeable to water, small molecules, dissolved food, waste products, O<sub>2</sub> and CO<sub>2</sub>, which are exchanged with tissues surrounding the capillaries. Through this process, liver is in contact with blood and the substances transported thereby. Also Alveoli of lungs picks up and expels air through these.
- Capillaries join to form **Venules** and finally veins and return the blood to the heart.

### BLOOD GROUPS

- Concept given by Carl **Landsteiner**. It is divided into four groups A, B, AB & O, based on formation of antigens and antibodies (Plasma) in the blood.
- Blood compatibility depends upon chemicals called **agglutinogen** or **antigens** on the surface of the red cells, and chemicals called **agglutinin** or **antibodies** in the plasma. There are two types of antigen: A and B; and two types of antibody: anti-A and anti-B.
- **Antigens** are the **foreign substances** that help production of antibodies.

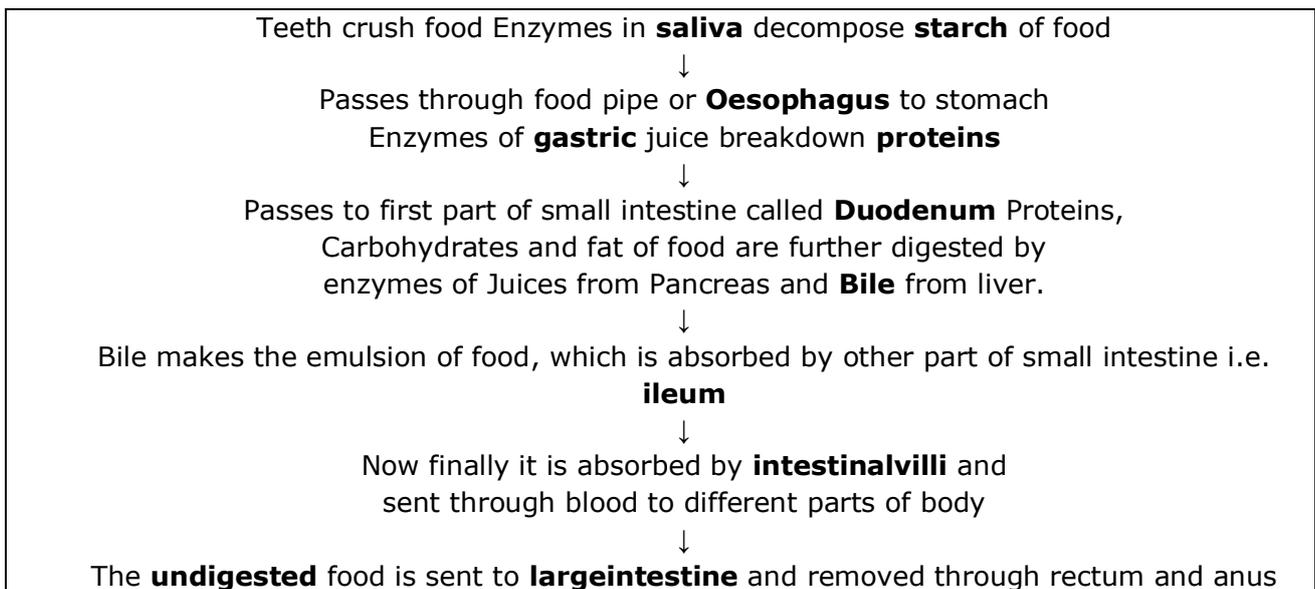
<b>Blood Group</b>	<b>Rbc Antigen</b>	<b>Plasma Antibody</b>	<b>Can Donate Blood To</b>	<b>Can Receive Blood From</b>
A	A	b	A, AB	A & O
B	B	a	B, AB	B & O
AB	A & B	–	Only AB	<b>Universal acceptor</b> (because no Antibody)
O	–	a & b	<b>Universal donor</b> (no antigen)	Only from O
<b>O<sup>+</sup> Most Common, AB<sup>-</sup> Rarest, O<sup>-</sup> Universal Donor, AB<sup>+</sup> Universal recipient</b>				

## CLOTTING OF BLOOD

- **Heparin (antithrombin)** prevents blood from clotting inside the body. It is produced naturally inside the body.
- Preservative added to blood in blood bank to prevent clotting is **Sodium Citrate** [Heparin can also be added]. **Sodium Oxylate/ Potassium Oxylate** (Chelating Agents) are also used.
- **Vitamin K** helps in the production of **Prothrombin** -, which helps in blood clotting.
- Optimum **temperature** for preserving blood in blood bank is **4°C**.
- **Clotting time** of blood for a normal human is 3-4 min.
- **Donated bloods** are used within 15 days, otherwise RBC gets reduced.
- **Rh Factor**- name taken from Rhesus monkey [experiment done on Rhesus monkey]
  - In persons with Rh Factor, **3rd antigen** besides A & B is also found.
  - Person with this antigen are said to have Rh (+) ve. **90% male** have Rh (+) ve.
  - Person without this antigen are said to have Rh (-) ve. Most Female are Rh (-) ve.
- Rh (-) patients can receive **one transfusion of Rh (+) blood without harm** because their plasma does not have an antibody to react with the incoming red cells. Subsequent transfusion, however, may be dangerous because first Rh (+) transfusion stimulates the body of the Rh (-) recipient to produce plasma antibody, which agglutinates Rh (+) blood. Rh (-) blood can be transfused into Rh (-) people any number of times without harm
- If it enters a **pregnant women's** blood, perhaps through a fault in the placenta, it will produce more antibodies and there is a danger that this will reach the embryo, destroy its red cells, a condition known as **erythroblastosis foetalis**.
- The danger can now be avoided. Rh (-) mother with a new born Rh (+) child can be injected with chemicals, which stop her body producing the Rhesus antibody.

## DIGESTION OF FOOD

- **Enzymes** are the **proteins** and share common properties. Enzymes **catalyze** every **chemical reaction** that occurs in the living system.
- Digestion mainly occurs in stomach and small intestine while absorption of food takes place in small intestine. Egestion of food occurs through large intestine and anus.



- **HCl** secreted in stomach leads to a lot of **acidic** character. To neutralize this, **mucus** is continuously secreted on walls of stomach.
- **Stomach** decomposes **Protein, LightFat**.
- **SmallIntestine** has an alkaline Medium, it decomposes **Carbohydrates, Protein** and **Fat**
- **Pigments** present in bile are Bilirubin and Biliverdin.
- Yellow colour of bile is because of these pigments.
- Excess deposition (or) no decomposition of **Bilirubin** causes **Jaundice**.
- **Yellowcolour** of urine is because of **urochrome**.

## LIVER

- The liver is found only in **vertebrates**. Newly absorbed food materials pass through the liver before being transported round the body. An **exception** is the **emulsifiedfat** in the **lacteals**, which bypasses the liver. The liver **stores** carbohydrate as glycogen, lipids, mineral salts, vitamins A, D and B<sub>12</sub>. The liver helps to keep the **bloodsugar** (glucose) level constant, which in turn helps to keep the **osmoticpressure** of the blood constant.

DIGESTIVE ACTIONS			
PLACE OF ACTION	ENZYMES	SUBSTANCE → PRODUCT ATTACKED FORMED	
Saliva in <b>Mouth</b> (slightly Acidic)	Amylase	Starch → Maltose (disaccharide)	
Gastric Juice in <b>Stomach</b> (Acidic)	Pepsinogen (inactive)+ HCl – pepsin (active)	Protein → Peptones	
	Prorennin (inactive)+ H – rennin (active)	Milk protein (casein) → Paracasein	
	Lipase	Light fat → Fatty acid and glycerol	
<b>S M A L L  I N T E S T I N E</b>	Juices from Pancreas  (Alkaline medium)	Amylase	Starch → Maltose
		Maltase	Maltose → Glucose
		Lactase	Lactose → Glucose + Galactose
		Sucrase	Sucrose → Glucose + Fructose
		Lipase	Fat → Fatty acids + Glycerol
		Trypsinogen + enterokinase – trypsin (inactive)	Protein → Polypeptides
		Chymotrypsinogen + (inactive) Trypsin – chymotrypsin (active)	Protein → Polypeptides
		Carboxipeptidase	Polypeptide → Amino acid
	Bile from liver (Alkaline medium)	It activates Lipase to emulsify fat. Makes Fat-Soluble substances water-soluble	
	Self Juices of the intestine (Alkaline medium)	Erepsin	Peptides → Amino acids
		Maltase	Maltose → Glucose
		Lactase	Lactose → Glucose + Galactose
		Sucrase	Sucrose → Glucose + Fructose
Lipase		Fat → Fatty acids + Glycerol	

- Liver manufactures a wide variety of the products. These include most of the **plasmaproteins** and bile. **Bile** is stored in the **gallbladder** and passed into the **duodenum** to help in digestion. Bile contains salts, which help in **emulsification** of fats and absorption of food. The liver converts **toxins into harmless** substances. Many of the toxic by-products of the body's own metabolism are made harmless in liver.

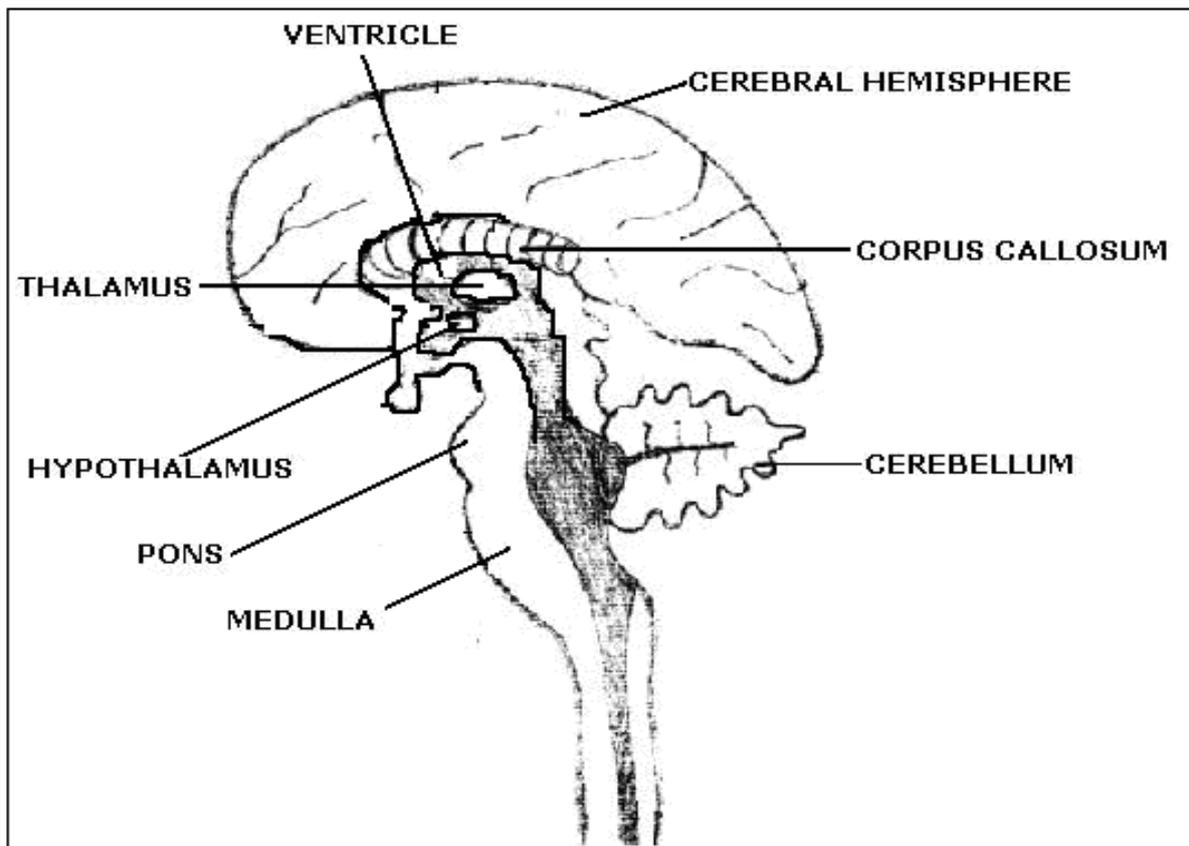
- The **small intestine absorbs about 90% of digested food** and 10% of water and minerals. In order to enhance the absorption capacity of the small intestine its epithelial lining is thrown into a number of the folds called **villi**.
- The villi have a rich supply of blood capillaries. Simple sugars and amino acids are absorbed, through the intestinal wall into the blood capillaries. These are then carried to the liver before release into general circulation. The glycerides and fatty acids are transported usually, via the lymph vessels (lacteals) and thoracic duct to the blood.

## BIO-COMMUNICATION

- For communication, two systems work in organisms- nervous and endocrine. Both of these release chemicals. The chemicals released by **nervoussystem** act quickly and help body to **respondimmediately** and are called **neurotransmitters**. Chemicals released by **endocrine** act **slowly** and are called **hormones**.
- Nervous System consists of-
  1. Central nervous system – comprising brain and spinal cord
  2. Peripheral nervous system – comprising cranial and spinal nerve
  3. Autonomic nervous system– comprising parasympathetic and sympathetic nervous system

## Brain

- Brain measures 1500 cm<sup>3</sup> in volume and 1.36 kg in weight. It is covered with a soft protective membrane called **Menings** and further by **Cranium**. Thus, Cranium is the **Brian Box**.
- **Cerebrum** is **largestpart** of brain and constitutes 2/3<sup>rd</sup> of it. It consists of two cerebral hemispheres. Cerebrum is the seat of **Consciousness**, Intelligence, Memory, Imagination and Reasoning. Receives impulses from various parts of body and initiates all **voluntaryactivities**.
- **Cerebral Cortex** or **GreyMatter** is the outer region of Cerebrum. It consists of Grayish nerve cells, consists of **furrowsandridges**.
- **Corpus Callosum** is a sheet of nervous tissues at the base of Cerebrum, **joining** its two lateral lobes. Regulates and **coordinates** the **groupmovementsof muscles** as in actions like walking. Here, like Cerebrum, **greymatter** lie **outside** and white inside.
- **Hypothalamus** contains many regulatory centres for many **physiologicalactivities** like **feeling**-Hunger, Thirst, Sexual etc.
- **Thalamus** is a group of nerve cells acting as a **RelayStation** for incoming and outgoing impulses to Cerebrum.
- **Pons** acts as a bridge that ensures the **coordination** of muscular movements on two sides of the body.
- **Medulla** is the **posterior-mostpart** of the brain where it mergeswith**SpinalCord**. Here nerve fibers of left and right cerebral hemispheres cross each other. It controls the workingof**heartandrespiratory** movements.
- **Ventricle** are the cavities that contain a **nutritivefluid** i.e. CerebrospinalFluid



- Each part of brain has a **specific role to play**:
  - Frontal Lobe - Voluntary Activities
  - Parietal Lobe - Sensory like Pain, Touch
  - Temporal Lobe - Speech, Smell
  - Occipital Lobe - Vision
  - Hippocampus - Memory
  - Amygdala - Anger
  - Cerebellum - Coordinates group movements of Muscles (Walking)
  - Medulla + Pons- Involuntary Activities (Breathing, Circulation, Respiration)
- ARAS (Ascending Leticular Activating System) – Alertness, Wakefulness
- If Anterior Damages – Polio, that is why, its called Asymmetrical Placid Paralysis.
- If Posterior Damages – Sensory Capacity Lost

### Spinal Cord

- Like a **tube** in shape, it is the downward extension of brain with same **Menings** as that of brain.
- Outer region– white matter while the **inner** region is **Grey Matter**
- Two functions:
  1. Conduct **impulses** to and from brain.
  2. Acts as a **ReflexCentre**
- Two Enlargements:
  1. **Cervical** – where nerves to upper limbs originate.
  2. **Lumbar** – where nerves to lower limbs originate.
- It is housed in **NeuralCanal** within Vertebral Column. Running along mid ventral line is **Anterior Median Fissure** and running along mid-Dorsal line is **Posterior Median**

**Septum.** Running along Centre of Spinal Cord is Central, which is continuation of Ventricles of brain and contains same fluid.

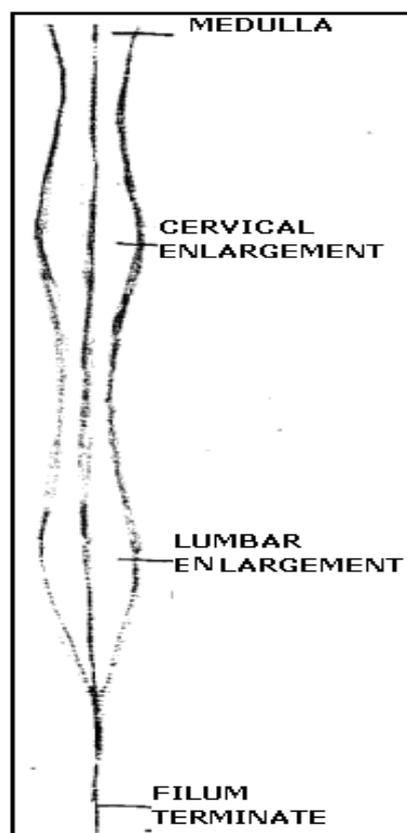
- Posterior Portion known as **Filum Terminale**

### Peripheral Nervous System

- **Spinal Nerves** are those nerves that emerge from the spinal cord. There are 31 pairs of spinal nerves, all of, which are mixed nerves (nerve consisting of both sensory and motor neurons)
- **Cranial Nerves** are those nerves that emerge from the brain. There are 12 pairs of them, some are sensory, some are motor and some are mixed nerves.

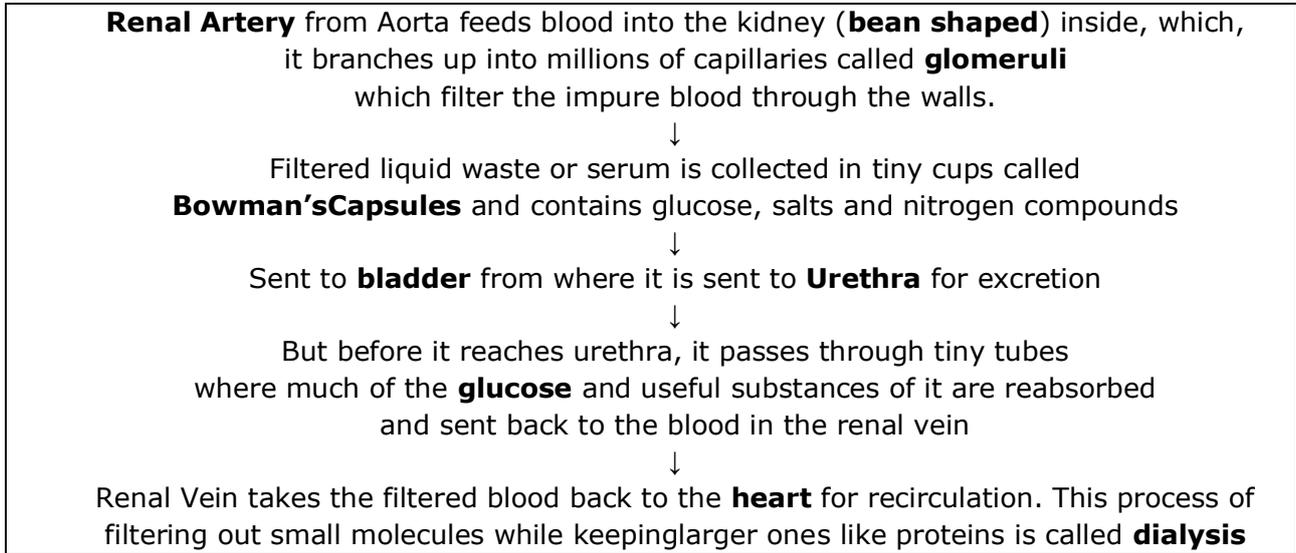
### Automatic Nervous System

- It controls the functions of the internal organs of the body automatically and unconsciously. It mainly controls heartbeat, secretion of glands and size of pupils.
- **Sympathetic** involved in Excitation and **Emotional Stress**, while the **parasympathetic** in **relaxation** of organs particularly during **sleep**.
- **Sensory Neurons** that carry impulse from **sense organ to Central Nervous System**
- **Motor Neurons** carry impulse from Central Nervous System to a muscle/ gland.
- **Mixed Nerves** are the nerves, which consist of both Sensory and Motor Neurons.
- **Nerve Impulse** travels at the speed of 50-100 m/s. These are **Electro-Chemical Messages**. Neurons are specialized to conduct them at high speed. Brain and Spinal Cord act as Central Clearing Houses for information furnished and Coordinate Activities of Body.
- **Reflex Action**: No deliberate effort on part of body is involved in any of these actions.



- **Synapse** is the **junction between two neurons** where one transmits the signal to other. There is no continuity between the two neurons at the synapse. These transmit the impulse only in one direction i.e. from axon of one neuron to cell body of other and never reverse.
- **Basic Unit**
  - Nervous System - Neuron
  - Kidney - Nephron

## KIDNEYS



- The **glomeruli** of the kidneys act as **dialysis bags**. The dialysis principle is used in construction of **artificial kidneys**.
- **Structural and functional unit** of Kidneys is **nephron**.

## HORMONES

- **Mixed Glands** contains both endocrine and exocrine glands.
- The special **chemicals**, which regulate **physiological processes** in humans, called '**Hormones**' are produced in special Organs called **endocrine glands**. These do not have ducts and secrete their Hormones directly to places where they are required.

Effects Of Over And Under Secretion Of Hormones		
Hormone	Over-Secretion	Under-Secretion
Growth hormone	<b>Gigantism:</b> persons grow unusually tall.	<b>Dwarfism:</b> person remains unusually small.
Thyroxine	Increased metabolic rate, leading to <b>loss of weight</b> and increased heart rate	<b>Simple goiter:</b> In <b>children</b> , physical & mental development is retarded, leading to <b>cretinism</b> . In <b>adults</b> , metabolic rate slows down, leading to mental and physical slowness & weight gain. This condition is called <b>Myxoedema</b> .
Insulin		<b>Diabetes mellitus:</b> blood sugar level becomes abnormally high- <b>hyperglycemia</b> . Sugar is excreted in the urine. This condition is also referred as <b>glycosuria</b>
Gluco-	<b>Cushing's syndrome:</b>	<b>Addison's disease:</b> bronze like pigmentation of

corticoid & Mineralo-corticoids	High blood sugar, sugar in urine, obesity, washing of limb muscles	skin, low blood sugar, low plasma sodium & high plasma potassium, increased urinary sodium, nausea & diarrhea
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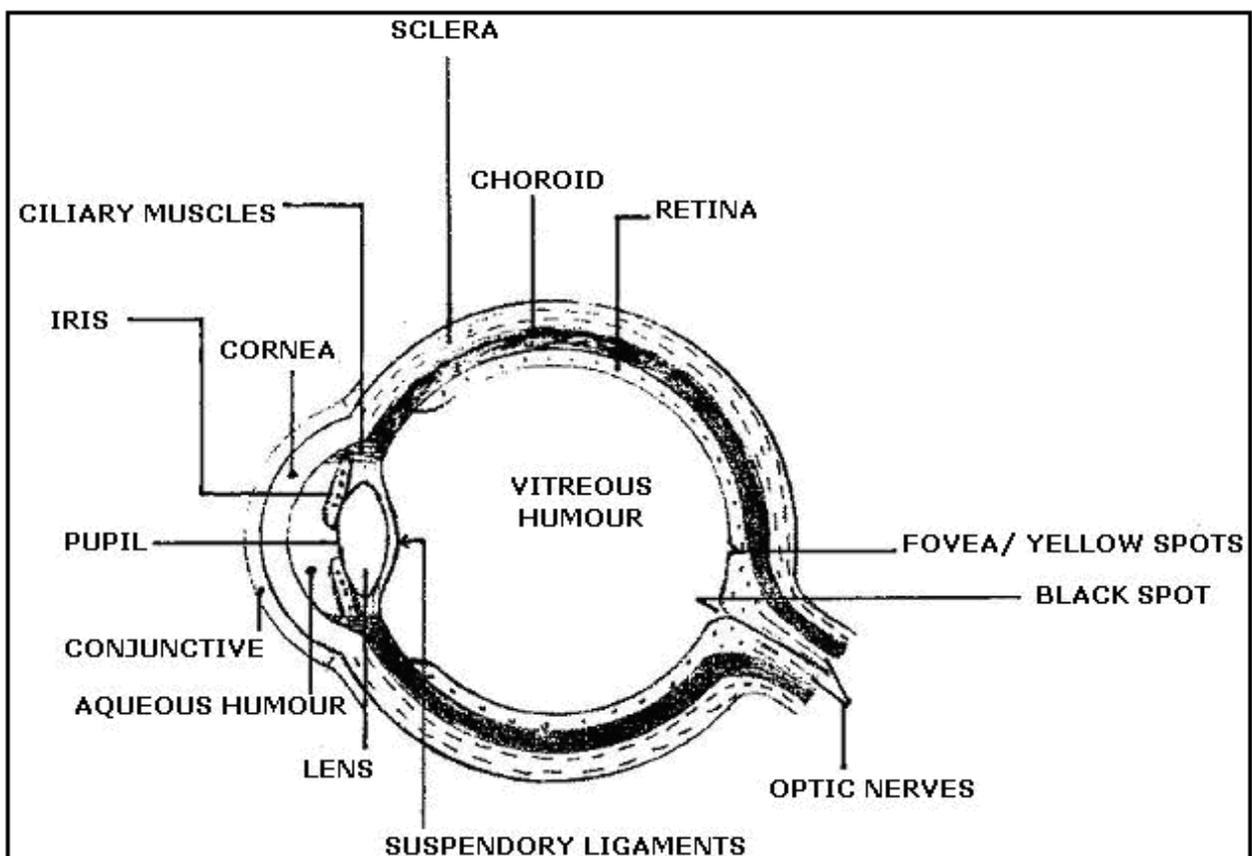
<b>ENDOCRINE GLANDS AND THEIR HORMONES</b>	
<b>PITUITARY GLAND – the ‘master gland’</b> Several of its Hormones <b>activate other glands</b> However it depends on <b>Hypothalamus</b> for its own activity	
<b>Posterior lobe</b>	<b>Antidiuretic or vasopressin-</b> controls re-absorption of water from <b>kidneys</b>
	<b>Oxytocin</b> causes uterine contractions and active <b>expulsion of milk</b> during and after birth
<b>Middle lobe</b>	<b>Melanophore</b> stimulating hormone: controls growth and development of melanocytes, which gives the <b>skin</b> its <b>colour</b>
<b>Anterior Lobe</b>	<b>Thyroid Stimulating</b> Hormone influence secreting activities of thyroid
	<b>Growth hormone</b> stimulates growth of the body
	<b>Andreno-corticotrophic</b> hormone influences adrenal cortex & defends body against <b>physiological stress</b>
	<b>Follicle stimulating</b> hormone: controls development and release of <b>sperm</b> , production of female sex hormones, <b>oestrogen</b> and development of <b>follicles</b> in the <b>ovary</b> .
	<b>Leutinizing</b> hormone: stimulates production of male sex hormone <b>testosterone</b> , release of <b>ovum</b> and <b>oestrogen</b>
	<b>Leutotropic</b> hormone or <b>Prolactin</b> : maintains <b>pregnancy</b> , helps in secretion of female sex hormone <b>progesterone</b> and stimulates <b>secretion of milk</b> from the mammary glands.

<b>OTHER IMPORTANT GLANDS AND THEIR HORMONES</b>	
<b>Thyroid</b>	Releases Thyroxin- controls general <b>metabolic</b> rate
<b>Parathyroid</b>	Releases <b>Parathormone</b> that controls distribution of <b>calcium</b> and <b>phosphates</b> - important for <b>bone development</b>
<b>Adrenal Cortex</b>	<b>Glucocorticoids</b> : regulates the metabolism of carbohydrates, proteins and fats- helps to <b>overcome stress</b>
	<b>Mineralocorticoids</b> : prevents passage of <b>sodium</b> and <b>water</b> in the <b>urine</b> and increase potassium excretion
<b>Adrenal Medulla</b>	Releases <b>Adrenaline</b> (epinephrine)- help controlling <b>emergencies</b>
	Releases <b>Noradrenalin</b> (norepinephrine)- help controlling <b>emergencies</b>

<b>EXOCRINE GLANDS, THEIR HORMONES AND FUNCTIONS</b>	
<b>GLANDS</b>	<b>HORMONES SECRETED</b>
<b>Pancreas</b>	$\alpha$ -cells secrete <b>glucagon</b> that elevates blood glucose level
	$\beta$ -cells secrete <b>insulin</b> helps to lower blood glucose level
<b>Testes</b>	Secrete <b>testosterone</b> that controls development and maintenance of male secondary sex characteristics
<b>Ovaries</b>	<b>Oestrogen</b> controls female secondary sex characteristics like menstrual cycle
	<b>Progesterone</b> controls changes in pregnancy.
Bulk of pancreas constitutes <b>exocrine</b> part called <b>pancreatic acini</b> . <b>Patches</b> of cells of <b>islets of Langerhans</b> is the <b>endocrine</b> part.	

## EYE

- **Ciliary Muscles:** These support the Iris & Suspensory Ligaments.
- **Iris:** It is a circular sheet consisting of two sets of muscles. Colour of eye depends upon its colour.
- **Pupil:** It is a circular opening at the centre whose size increases or decreases depending upon Iris. It may be of different colour in different people.
- **Conjunctiva:** Lines the Inner Walls of eyelids and front of the eye
- **Aqueous Humour:** Small Chamber in front of lens filled with 'Watery Fluid'. Large posterior chamber behind lens filled with 'Gelatinous Matter' called Vitreous Humour.
- **Sclera:** It is white portion of eye. It is tough, opaque & protective. Cornea is the extension of this layer, which is visible to us.
- **Choroid:** It is a thin & black membrane having a network of Capillaries. It not only nourishes eye but also prevents reflection of extra light within the eye by absorbing it. This layer ends up near Iris as Ciliary muscles. Iris is an extension of this layer.
- **Retina:** It is the light sensitive portion of eye. It consists of **Rods & Cones**. Rods are more numerous & found near the periphery of retina. These are sensitive to dim light but insensitive to colour.
- **BlackSpot:** Where the optic nerve leaves the eye, retina has no rods and cones. Images falling in this area can't be perceived.
- **Suspensory Ligaments:** Keep the lens in position and attached to ciliary muscles.
- **Fovea/ YellowSpot:** The cones are found at the back of retina especially in Fovea. Fovea is a yellow spot. It is the region of most distinct vision responsible for (cones):
  - Bright light vision
  - Colour vision
  - Perception of detail



## Important Facts about Eye

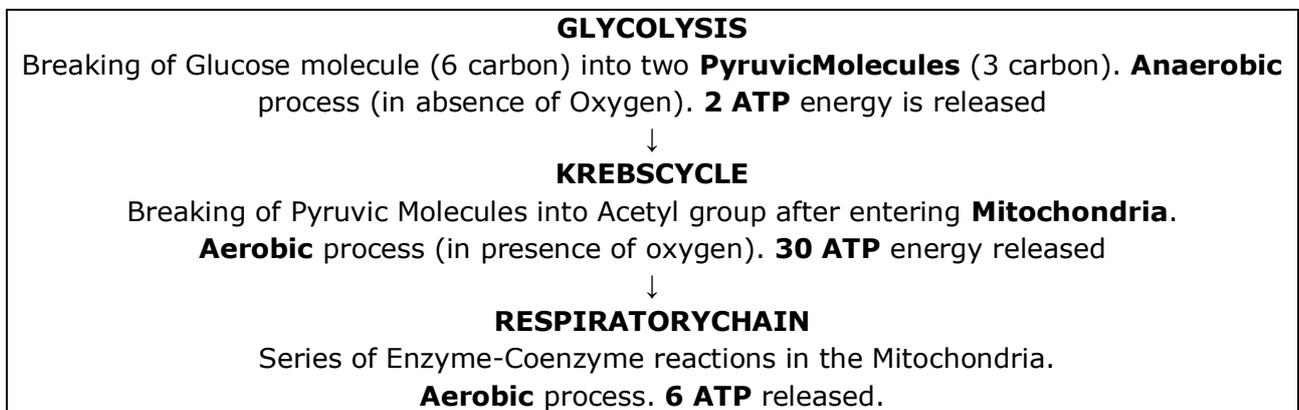
- **Selera**: Movement of eyeball in various directions
- **Rods**: 120 million (Rhodopsin); **Cones**: 6 million.
- Eye: Most sensitive to Blue-Green light of 5500 Å; Respond to lights 4000-7000 Å
- **Astigmatism**: person can't distinguish horizontal & Vertical Lines.
- **Presbyomia**: In Old age wherein lens losses elasticity.
- **Daltonism**: Colour blindness. Ishiara Chart and Snellens Chart are used to detect it
- Tear: produced by **LacrimalGland**
- **Hypercapnia**-increase in concentration of CO<sub>2</sub> in blood–Yawning, Asthma, Bronchitis
- **Hypoxia**: Low O<sub>2</sub> in blood – Anaemia (Blood's Capacity reduces)

## Eye and Camera

- **Similarities**: Lens Transparent; Real and Inverted Image; Control of Light.
- **Differences**
  1. Focal Length of eye lens can be changed by Ciliary Muscles
  2. Retina retains image only for 1/20 of a second after removal of object. While in camera, it is permanent.
  3. Retina can be used repeatedly for forming image while film cannot.

## RESPIRATION

- Food molecules have **low energy packets** (Glucose). **Respiration** is an Energy Intensifying Process during, which 'High Energy Packets' (**ATPs**) are produced.
- **Tissue Respiration** involves three steps –



Net gain from Aerobic Phase = 30+6 = 36 ATP

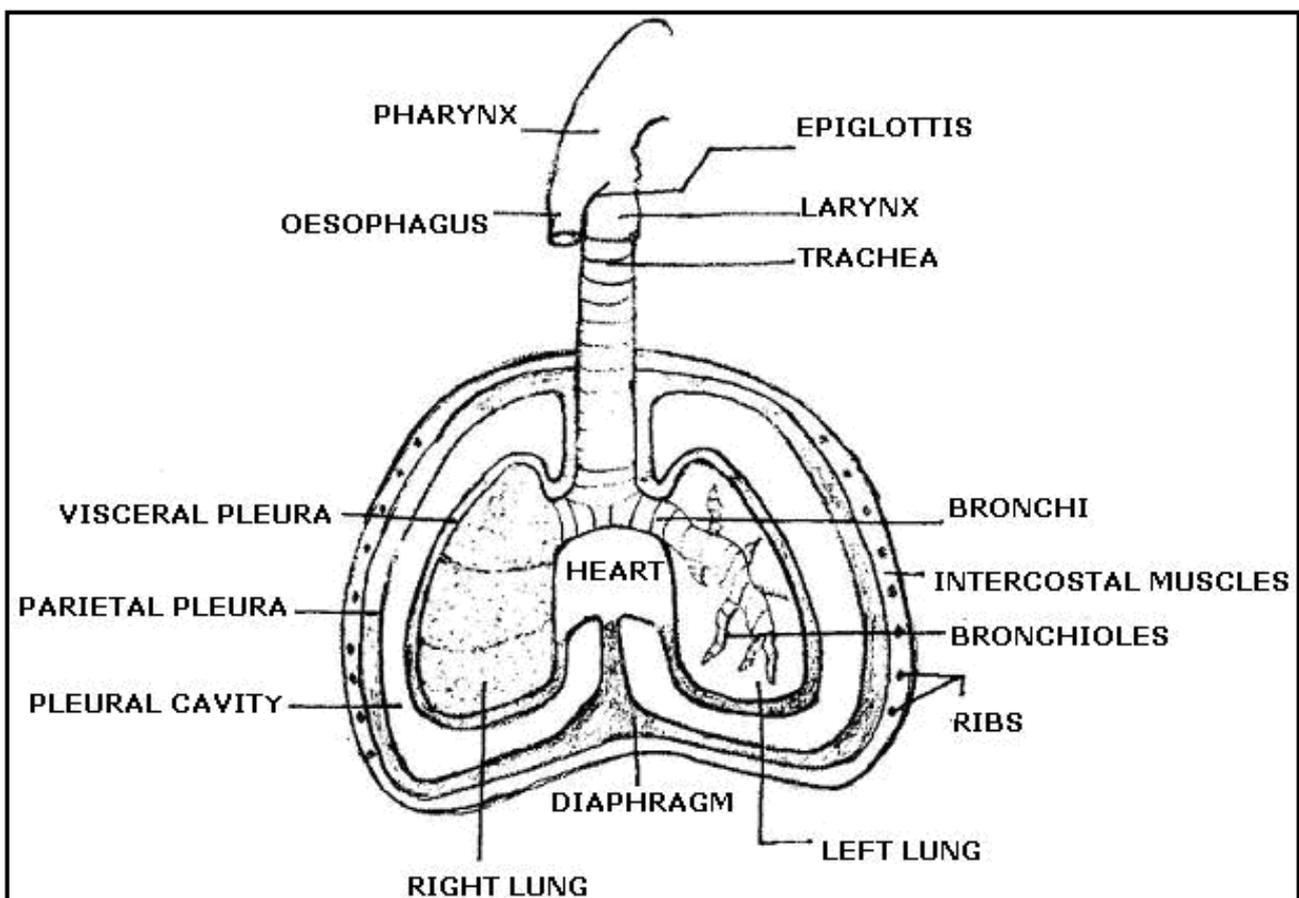
Net gain from Anaerobic Phase = 2 ATP

Thus, oxidation of **1 mole of Glucose** provides = **38 ATP** of Energy

- It simply shows that **95%** of **energy** for our cells to work comes from **Mitochondria** i.e. **AerobicEnergy**. Organisms that live by Anaerobic Respiration can obtain only about 5% of the energy of food they consume.

## LUNGS

- **Pharynx:** Digestive & respiratory tracts cross each other here.
- **Oesophagus:** or Food Pipe– a Collapsible tube.
- **VisceralPleura:** Thin, Smooth Epithelium.
- **ParietalPleura:** Inner Lining of Chest.
- **Pleural Cavity:** Containing pleural fluid to lubricate lungs
- **Epiglottis:** A flap of tissue, which closes when food is swallowed.
- **Larynx:** Also called Sound Box that decides voice, pitch etc. Males have large length & short pitch – called Adonis Apple.
- **Bronchi:** One of the two divisions of Trachea entering into a lung.
- **Bronchioles:** Small tubes, part of Bronchi.
- Right Lung contains three lobes, each lobe divided into millions of air sacs called alveoli. Left Lung contains two lobes.
- **Alveoli** are the structural and functional units of Lungs. Each alveoli has a rich network of Capillaries. During breathing, only a part of air in lungs is renewed.
  - The volume of air passing in and out at normal time is called as **Tidal Volume**, which is about 500 ml each.
  - The amount of air that remains in lungs after maximum expiration is **Residual Volume**, which is about 1200ml.
  - The volume that can be breathed out by a forceful expiration after a forceful inspiration is called **Vital Capacity**, which is about 4800 ml in males and 3100 ml in females. Total Capacity =  $4800+1200 = 6000$  ml.
  - Thin moist membrane forming an inner lining of alveoli is **Respiratory Surface**.



- The exchange of O<sub>2</sub> & CO<sub>2</sub> between Blood and Lungs takes place through **diffusion**. O<sub>2</sub> is at higher concentration in lungs than blood, so diffuses in blood and CO<sub>2</sub> is higher in blood than lungs, so diffuses in lungs.
- Blood carries most of CO<sub>2</sub> from cells to lungs as **Bicarbonate Ions**.

1gm hb has 1.34 ml O<sub>2</sub>; 100 ml blood has 14-15 gm hb

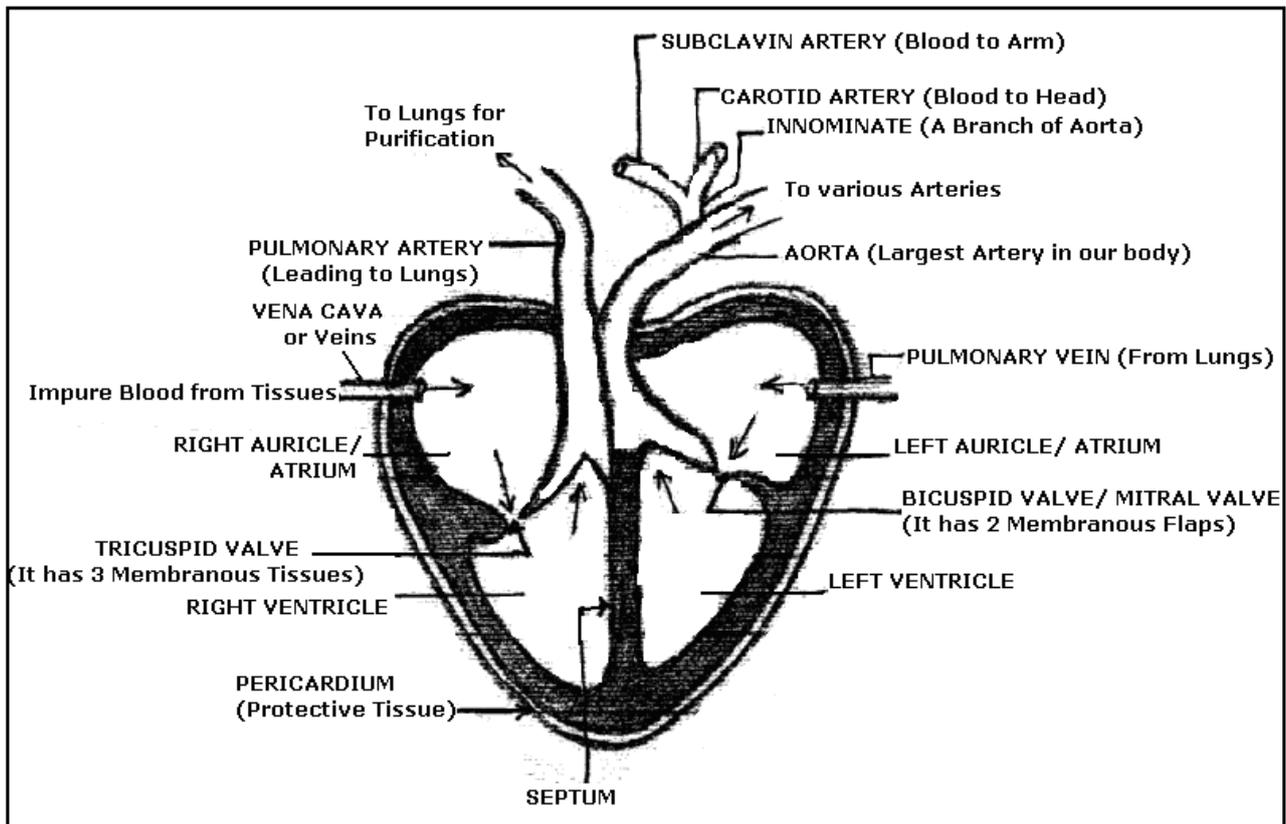
**Affinity of gases with Blood**

CO > O<sub>2</sub> > CO<sub>2</sub>

- **Hypercapnia**: increase in concentration of CO<sub>2</sub> in blood – Yawning, Asthma, Bronchitis
- **Hypoxia**: Low O<sub>2</sub> in blood – Anemia (Blood's Capacity reduces).
- Respiratory Organs in other animals –
  - Earthworms, Frog – Skin.
  - Insects – Trachea.
  - Spiders/ Scorpions – Book Lung.
  - Birds – Air Sacs.
  - Prawns, Fish – Gills.

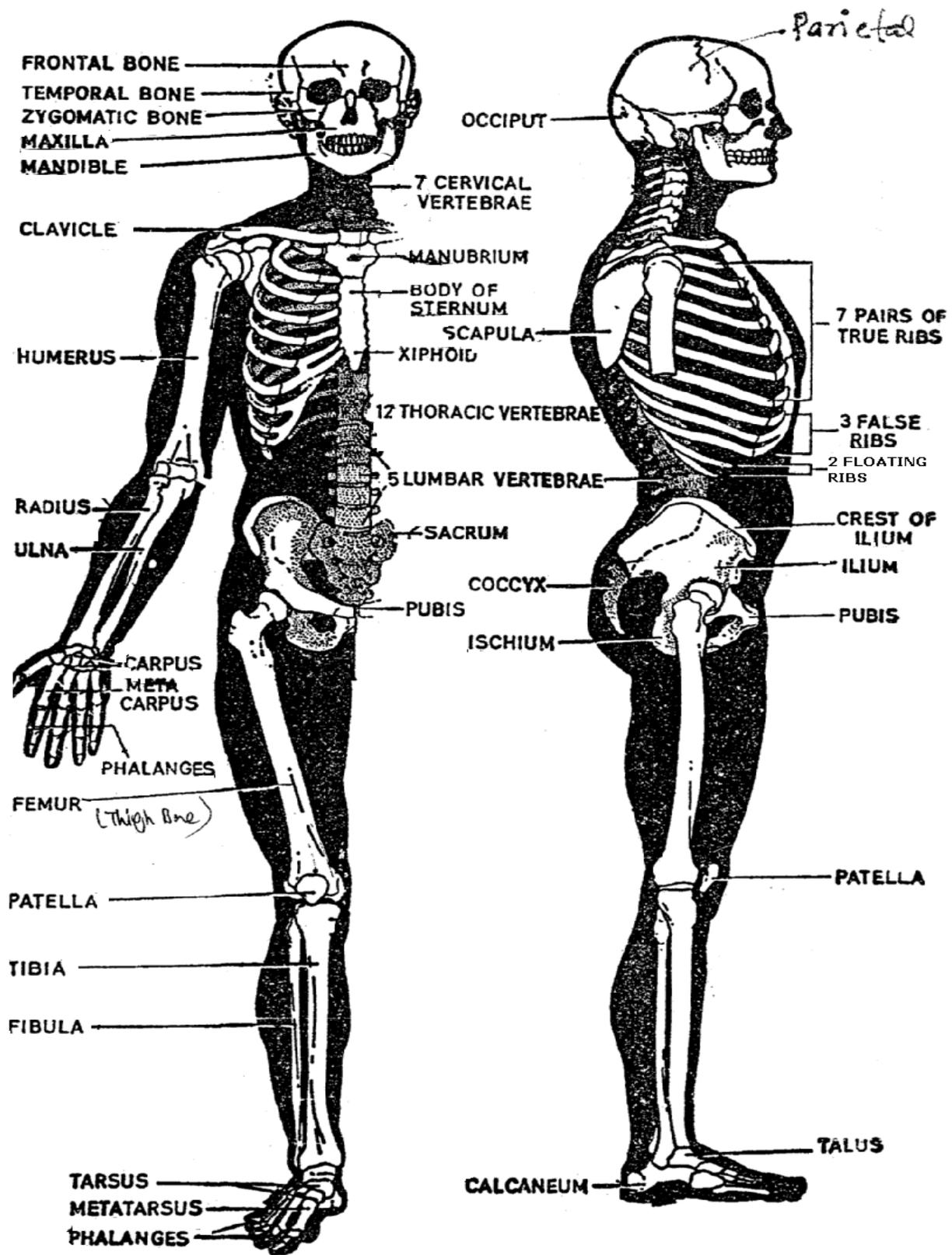
**HEART**

- **Arterial blood** carries **oxygen** and dissolved food while **venous blood** carries **CO<sub>2</sub>** and waste materials. However, the **Pulmonary artery and vein** are **exceptions** to this.
- All chambers of heart and all blood vessels are internally lined by a layer of smooth, thin flattened cells called **endothelium**, which **prevents clotting** of blood **within Circulatory System**.
- **Dorsal aorta** is the part of aorta that supplies blood to viscera and legs.
- **Artificial valves** are either **tissue based** (of pigs, cadaver) or **Mechanical** (Plastics, Ceramics).
- No communication between Left and Right compartments.
- Pumping rate of heart is about **70/ minute**. It may go upto 150/ minute during exercise or excitement.
- Pressure of blood **varies** from one part of the body to another.
- The pressure produced in ventricle when it contracts and empties itself into aorta and pulmonary artery is called **Systolic Pressure** and equal to **120 mm** of Hg. Opposite situation, when it fills the blood, the pressure is called **Diastolic Pressure** and equals **80 mm** of Hg.
- **Lymph** is another **medium of circulation** in body meant for **proteins**, which cannot re-enter the blood capillaries because of their size. It is **light yellow** and not red because it **does not contain hemoglobin**. Its composition is quite similar to blood plasma. Flows in one direction i.e. tissues to heart. Contains special white cells, for fighting diseases, called **lymphocytes**.
- **CO<sub>2</sub>** of respiration in cells is transported both by **hemoglobin** of the blood and by water, which dissolves it. Expulsion of CO<sub>2</sub> occurs in the surface of **lungs**.
- The same circulatory system **transports** both **nutrients** and **water**. So there needs to be a special mechanism of **separating** the **two**, so that only waste is excreted and nutrients are held back. This filtering work is done by **kidneys**. These are in **two** numbers.



## JOINTS

- In **hinge joints**, movement occurs in one plane only e.g. knee and elbow joints. In **ball-and-socket joints**, movement occurs in three planes e.g. hip, shoulder.
- Other joints are freely movable called **synovial joints**, example the limb joints
- Muscles are made up of Muscle **Fibre**, which in turn is made up of **Fibral** and further of **Filaments**.
- Filament is composed of two parts – **Actin** (thin, light and active part) and **Myocin** (thick and dark). These two are called contractile tissues.
- Smallest bone of our body – **Stapes** (in ear); **Largest bone**– **Femur** (thigh)
- Total no of muscles – 639; Total no of bones – 206
- **Physiologically more reactive** organ – Liver.
- **Largest endocrine** gland – Thyroid; **Smallest endocrine** gland – Pituitary
- Organ having **min. regeneration** power – Brain.
- Organ having **max. regeneration** power – Liver



## TEETH

- The **first permanent tooth** appears when a child is about 6 to 7 years old. The last permanent tooth erupts when a person is 17 to 21 years old.
- There are 32 permanent teeth, 16, in each jaw.
- They are larger than the deciduous teeth and consist of four kinds of teeth.
- The **four kinds** are (1) incisors, (2) canines (3) premolars, (4) molars.
- Each jaw has 4 incisors, 2 canines, 4 premolars, and 6 molars.
- **Incisors** are the chief biting teeth. They have a sharp straight cutting edge. In most cases, incisors have one root. The central incisors of the lower jaw are the smallest permanent teeth.
- **Canines** are used with the incisors to bite into food. They are also used to tear off pieces of food. The canine teeth resemble a dog's fangs. They have a sharp, pointed edge and one root. Canines are also called cupids or dogteeth. The upper canines are sometimes known as eyeteeth.
- **Premolars** are sometimes called *bicuspid*s because, in most cases, they have two cusps. The premolars erupt in the place of the deciduous molars.
- **Molars**, like premolars, are used to grind food. They are shaped much like premolars but are larger. The various molars normally have 3-5 cusps and 2-3 roots.
- The permanent molars do not form beneath any of the deciduous teeth. They develop as the jaws grow, which makes space for them. Some adults lack one or more of the third molars, which are commonly called **wisdom teeth**.
- In many cases, jaws do not grow large enough to provide space for wisdom teeth.
- A tooth consists of **four kinds of tissues**- (1) pulp (2) dentine (3) enamel and (4) cementum.
- **Connective tissue** surrounds the root of the tooth. This tissue, called the **periodontal ligament**, holds the root in the socket in the jaw.

# HEAT AND TEMPERATURE

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**Heat:** Heat is a form of energy arising from mechanical motion of the molecules composing a body. This is known as the **dynamically kinetic theory of heat**.

**Temperature:** Temperature is an indication of an object's internal energy level. A thermometer is used to measure temperature. Thermometers have a numbered scale so that temperature can be expressed in degrees. The two most common scales are the **Celsius or centigrade and the Fahrenheit scales**. The temperature of an object determine whether that object will take more on internal energy or lose some when its come into contact with another object.

- All things are made up of atoms or molecules, which are always moving. The motion gives every object internal energy that depends on how rapidly its atoms or molecules move.
- Temperature and heat is not the same thing. Temperature is simply an indication of the level of internal energy that an object has. Heat on the other hand, is the energy passed from one object to another.
- Temperature is measured by a thermometer. There are several types of the thermometers but the **most common is the mercury in glass type**, which measures temperature by means of the expansion and contraction of mercury.
- To fix a scale for a thermometer, a number 0 (zero) is assigned to the temperature of pure melting ice and the number 100 to the temperature of water boiling under standard atmospheric pressure of 760 mm of mercury. The space between these two is divided into 100 equal parts, **called degrees**. This is called the Celsius ( $0^{\circ}\text{C}$ ).
- On the Fahrenheit Scale of temperature, the **number 32 corresponds to  $0^{\circ}\text{C}$**  and the **number 212 to  $100^{\circ}\text{C}$** . To covert temperature from the Fahrenheit to the Celsius scale, the following relation is

$$\text{Temp in } ^{\circ}\text{C} = \frac{5}{9} (\text{F}-32)$$

Using the formula, one can easily see that at  $-40^{\circ}$ , both Celsius and Fahrenheit scales will show identical readings.

- **Absolute Zero and Kelvin scale:** In principle, there is no upper limit to temperature but there is a definite lower limit- **the 'absolute Zero'**. This limiting temperature is  **$273.16^{\circ}$  below zero on the Celsius scale** of temperature. **On the Kelvin scale absolute zero is 0 K** (it is not written as  $0^{\circ}\text{K}$ ). On Kelvin scale  $0^{\circ}\text{C}$  corresponds to 273.16 K and  $100^{\circ}\text{C}$  to 373.16 K. Degrees on the Kelvin scale are calibrated with the same sized division as on the Celsius scale. Thus, a  $10^{\circ}\text{C}$  rise of temperature is equal to 283.16 K rise of temperature.

## CLINICAL THERMOMETER

- Mercury-in-glass type thermometer is used to measure the temperature of human body. Its thermometer scale is marked from 95F to 110F or  $35^{\circ}\text{C}$  to  $43^{\circ}\text{C}$ . The **normal temperature of a healthy person is 98.4F or  $36.9^{\circ}\text{C}$** .

## USE OF MERCURY IN THERMOMETER

- It is opaque and shining; therefore temperature reading is convenient.

- It's a good conductor of heat; thus recording of temperature is easy.
- It neither sticks to glass, nor vaporizes.

**Water is not used in thermometer** because it freezes at 0°C and expands irregularly. In the countries **where the temperature falls below -40°C, alcohol thermometer** is used since alcohol freezes at -115°C but mercury freezes at -39°C.

### **SPECIFIC HEAT CAPACITY**

- The specific heat capacity of a substance is the amount of heat required to produce a 1 K (1 0°C) rise in the temperature in a mass of 1 kg.
- Heat like a other forms of energy is measured in joules (J) and the unit of specific heat capacity is the joules per kilogram Kelvin (J/ (kg K) or J (kg 0°C). In physics the word 'specific' indicates that units mass is being considered.
- The specific heat equation: heat taken in or given out = mass x specific heat capacity x Temperature change.
- Specific Heat capacity of various substances (Decreasing Order)
  - Water
  - Ice
  - Iron
  - Kerosene Oil
  - Mercury
  - Lead

### **HEAT CAPACITY**

- The heat capacity (symbol °C) of an object is the heat required for raising its temperatures by 1 K and is measured in J/K. Therefore if an object requires 1000J to raise its temperature by 2K, its heat capacity is 1000J/ 2K = 500 J/K.
- A calorie is the quantity of heat required to raise temperature of 1 gm water by 1°C.

### **UNUSUAL BEHAVIOR OF WATER**

- When water is cooled to 4°C it contracts, but as it cools from 4°C to 0°C it expands. Water therefore has a **maximum density at 4°C**. At 0°C, where water freezes, a considerable expansion occurs and every 100 cm<sup>3</sup> of water becomes 109 cm<sup>3</sup> of ice. This accounts for **bursting of water pipes** in very cold weather. Further cooling of ice causes it to contract.
- The expansion of water below 4°C is due to the fact that above 4°C water molecules form into groups, which break up when the temperature drops below 4°C. The new arrangements occupy a larger volume and this cancels out the contraction due to fall in temperature.

### **FREEZING OF PONDS**

- The behavior of water between 4°C to 0°C explains why fish survive in frozen ponds.
- Water at the top of the ponds cools first, contracts and being denser sink to the bottom. Warmer, less dense water rises to the surface to be cooled. When the whole water is at 4°C, this circulation stops. If the temperature of the surface of the water falls below 4°C, it becomes less dense and remains at the top (because it is less dense than the water at 4°C), eventually forming a layer of ice at 0°C.

## TRANSMISSION OF HEAT

Modes of Transmission of Heat (i) Conduction (ii) Convection (iii) Radiation

**Conduction:** Conduction is the flow of heat through matter; from places of higher to places of lower temperature **without movement of the matter** as a whole.

**Convection:** Convection is the flow of heat through a fluid from places of higher to places of lower temperature **by movement of fluid itself**.

**Radiation:** Radiation is the flow of heat from one place to another **by means of electromagnetic waves**. In conduction and convection, the motion of a particle transmits heat. But in radiation, heat can travel even through vacuum. In any object, the moving atoms or molecules creates waves of radiant energy. When the radiant energy strikes an object, it speeds up the atoms and molecules in that object.

## NEWTON'S LAWS OF COOLING

It states that rate at, which a hot body loses heat is directly proportional to the difference between its temperature and the surrounding temperature. Thus a hot liquid will take less time in cooling from 90°C to 80°C than in cooling from 30°C to 20°C.

## CHANGE OF STATE

- Normally the temperature of an object rises when heat flows in it, but under certain circumstances even if the heat is supplied there is no increase in temperature of that object.
- For example if heat is added to block of Ice (say at -5°C) it is absorbed by ice without changing its temp. till it fully converts from solid to liquid state 0°C. Similarly when water boils at 100°C, its temp remains constant at 100°C until all of it is converted into steam.

## SPECIFIC LATENT HEAT OF FUSION

It is defined as amount of heat required to change 1kg of substance **from solid to liquid without change of temperature**. The heat required to convert 1kg of ice at 0°C into water at the same temp. It amounts to 336000 J of heat. This is known as specific latent heat of fusion of Ice.

## SPECIFIC LATENT HEAT OF VAPOURISATION

It is defined as the heat required for changing a unit mass of substance **from liquid to vapor state without change in temperature**. The specific latent heat of steam is 2260 J per gram.

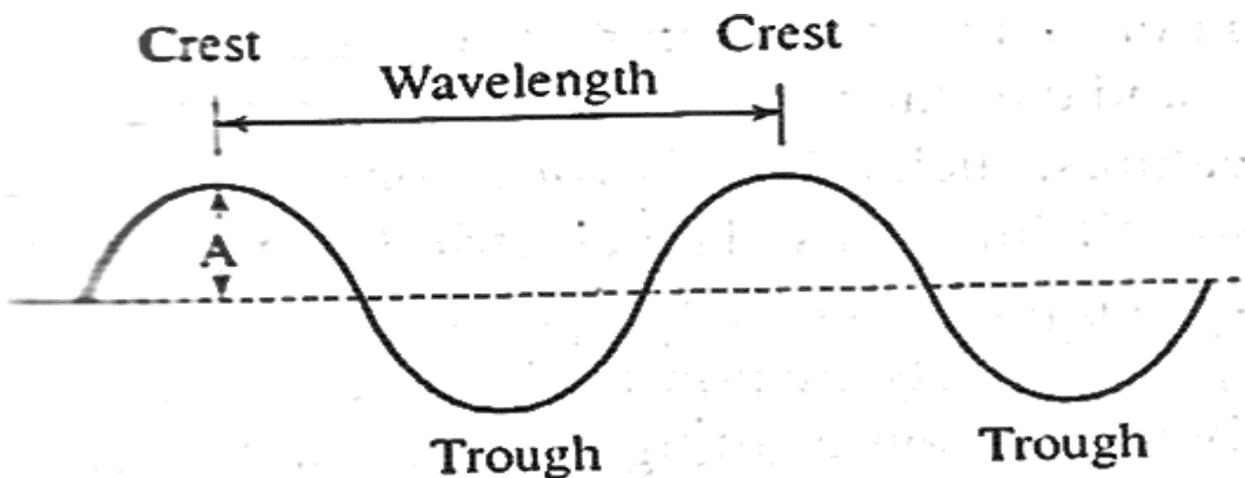
# WAVES

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- Light and sound are both propagated in the form of waves.
- Waves may be magnetic or electromagnetic. Mechanical waves are produced by a disturbance (such as a vibrating body) in the material medium, which transmits them; for example water waves, waves on springs and sound waves.
- Electromagnetic waves consist of disturbances in form of varying electric and magnetic forces. They travel more easily in vacuum than in matter; for example, radio signals and X-rays.

## FORMS OF WAVES

1. Transverse
2. Longitudinal



**Transverse:** In these waves, the motion of particles is perpendicular to the motion of waves. For example **light waves**. Highest and lowest parts of these waves are called **crest and trough** respectively. And the height or depth (from the normal) of crest or trough is called **amplitude**. The distance between adjacent crests or troughs is called **wavelength**.

**Longitudinal:** In which the motion of vibrating particles is along the direction or parallel to the motion of the wave. For example **sound waves and the waves in a coiled spring**. In a coiled spring, **compressions** are the regions where the loops of the spring are pressed together and **rarefactions** are where the loops are stretched apart. Therefore the region during one cycle in, which density of vibrating particles is maximum, is called compression and where the density of vibrating particles is minimum is called as rarefaction. The distance between the adjacent compressions (or in rarefactions) is called **wavelength**.

## FREQUENCY ( $\nu$ )

Frequency is the number of waves that pass through a point per second. It is measured in Hertz (Hz).

## SPEED OF WAVES

For all kind of waves, it is represented as  $V=v\lambda$ , where  $v$  = frequency,  $\lambda$  = wavelength.

## ELECTROMAGNETIC WAVES

These include an enormous range of frequencies from radio waves (frequencies  $<10^5$  Hz) to gamma rays (frequencies  $>10^{20}$  Hz)

### INCREASING ORDER OF FREQUENCIES

**Radio waves < Microwaves < Infrared < Visible Light < Ultraviolet Rays < X-Rays < Gamma Rays**

**$>10^{10}$   $>10^{12}$   $>10^{14}$   $>10^{15}$   $>10^{16}$   $>3 \times 10^{16}$  to  $3 \times 10^{19}$   $>10^{19}$**

- The waves with less frequency have more wavelengths whereas waves having higher frequencies have lesser wavelengths. This is because all the waves have same speed i.e.  $3 \times 10^8$  m/sec in vacuum.
- The **RADAR** (radio detection and ranging) region falls in microwave region and the frequencies at, which the Radar systems operate grade into Television and Radio frequencies.
- Radio and Television waves are radiated from antennae and can bend (diffract) around obstacles therefore can be received even if a hill or tower falls in their way. They are also **reflected by Ionosphere** thus making long distance reception possible.

# LIGHT

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- The Bodies, which themselves are a source of light, i.e. they emit light, are called **luminous**. For example the sun, a burning candle.
- Any substance through, which light passes is called a medium. A medium is said to be **homogenous** when it posses the same optical properties at all point and in all directions, i.e. has uniform structure and composition throughout, example water, glass, gold etc.
- A medium is said to be **heterogeneous** where the optical properties vary from point to point e.g. calcite, quartz, etc.
- A body through light passes freely and objects can be distinctly seen are called **transparent**, e.g. glass, water, etc. and where objects are not distinctly seen are translucent e.g. butter-paper, paraffin-wax, etc.
- Bodies, which do not allow to pass any light through them and through, which vision is not possible are **opaque**, e.g. stone, wood, etc.

## RAY AND BEAM OF LIGHT

The direction of the path taken by the light is called a ray. A number of rays constitute a beam of light. A beam of light may be converging, diverging or parallel.

## SPEED OF LIGHT

The speed is known to within a couple of miles per second. At present best value is given by  $c = 186,310 \text{ miles/sec} = 299,776 \text{ km/sec} \approx 3 \times 10^8 \text{ m/sec}$ ,  $c$  being the standard symbol for the speed of light in **vacuum**. The speed in a **transparent medium** is found to be less than  $c$ . In **air** the speed is only 0.03 per cent smaller, but in **water** it is about 25 per cent less and in **glass** about 35 per cent less than  $c$ .

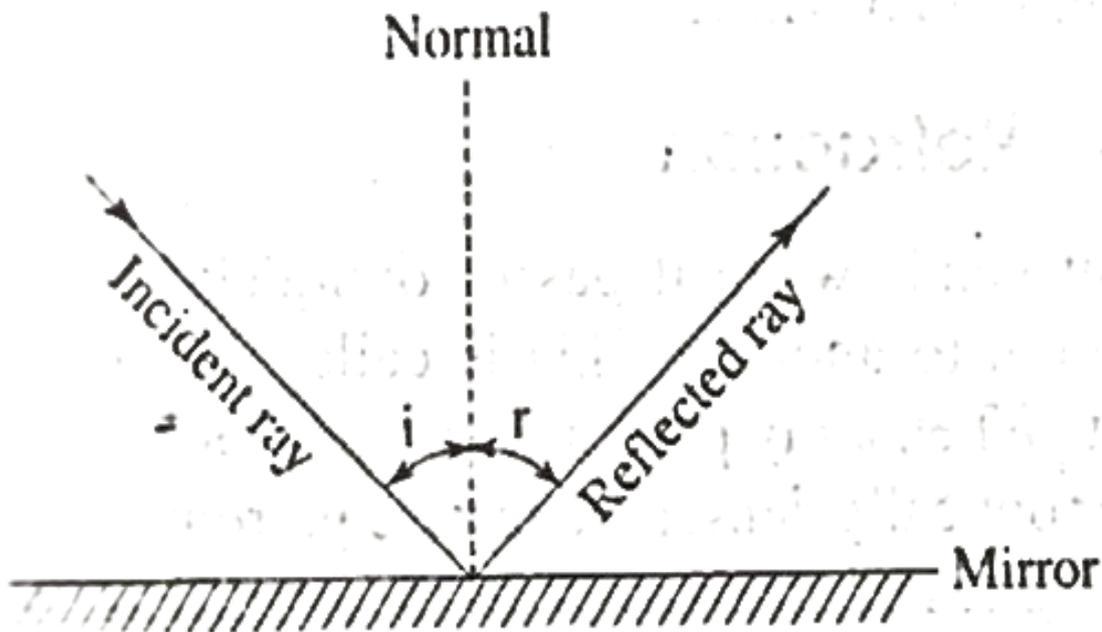
## WAVE AND PARTICLE NATURE OF LIGHT

- **Newton** proposed that **light consists of small particles** that travel in same lines through space. He called these particles **corpuscles** and his theory is called **corpuscular theory**.
- **Huygens** (Dutch physicist) proposed wave theory to explain the behavior of light. According to him light **consists of waves**.
- **Thomas Young's** (English physicist) experiment regarding interference of light proved the **wave theory of light**, he showed that due to the wave nature of light, two light beams cancel each other just like (water waves) under certain conditions.
- **James clerk Maxwell** (British physicist) propounded the **mathematical theory of electromagnetism**, according to, which light gets affected by change in electric field and magnetic field. This theory also supported wave theory of light.
- Experiments conducted by **Edward Morley and Albert Michelson**, both American physicists suggested that light travels through medium called **ether**.
- **Max Planck** (German physicist) experimented in the field of emission of light by a hot surface and predicted that the tiny emitters of light have certain values of energy, and when this value is restricted it is called **Quantized**. Quantization of light was suggested by Einstein in 1905. According to, which light comes in tiny packets of energy, called as **Quanta**. This supported the particle nature of light and particles of light came to known as **photons**.

- **Neil's Bohr** (Danish physicist) proposed about the **quantization energy of atoms**. According to him when energy is supplied to an atom, the atom accepts only certain value of energy and gets excited. In order to de-excite it gives away the extra amount of energy by emitting photons. Different types of atoms except different sets of energy therefore photons emitted from one type of atom differ in energy from photons from other type of atoms.
- Field of quantum mechanics explains how atoms and light are quantized.

## REFLECTION

When an incident ray (emanating from a point source) falls on a mirror with angle **i** to normal (perpendicular to the plane of mirror) gets reflected back at an angle **r** to the normal, then law of reflection states that **Angle i = Angle r** .



When a bundle of rays after reflection enter the eye, it appears to emanate from a point behind the mirror. The eye sees the image of source at this point. Since the light rays do not actually come from this point the image is called the **virtual image**. A **Real image** on the other hand is formed by actual intersection of rays and can be taken on a screen, which is not so in case of virtual image. An image formed in a plane mirror has the following characteristics:-

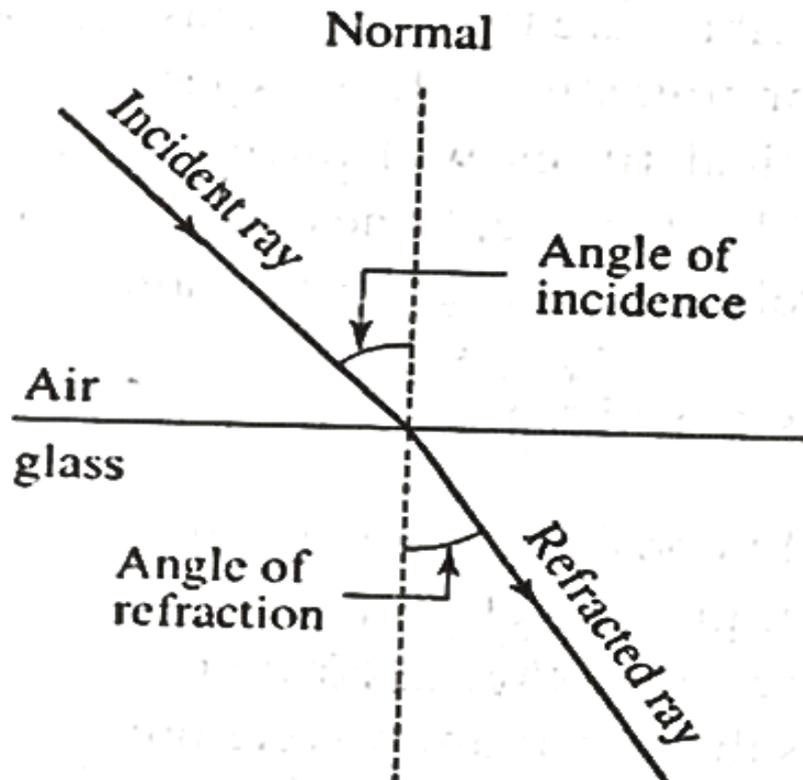
1. The image is of same size as that of object.
  2. It is formed far behind the mirror.
  3. It is virtual and laterally inverted (a person holding any object in his left hand, appears to holding it in his right hand in the image).
- When light is incident on a rough surface, the reflected rays are scattered in all directions by the many surface irregularities. This is called **diffuse reflection**.
  - **Inclined mirror:** when an object is placed between two inclined mirrors, several images of the object are formed. The number of images depends on the angle between the mirror and can be determined by using the formula

<b>No. of images = <math>\frac{360}{\text{Angle between the mirrors}} - 1</math></b>
--

Thus if an object is placed between two mirrors inclined at  $90^\circ$ , there will be a total of three images. In the case of parallel mirrors (angle =  $0^\circ$ ), there will be an infinity number of images.

## REFRACTION

When a light ray passes from one optical medium to other, it is deviated from its original path. This is called refraction of light. When a ray passes from optically rarer medium to optically denser medium, it bends towards the normal, on the other hand if a ray passes from denser to rarer medium it deviates away from the normal.



This happens because of change in speed of light in medium having different densities. E.g. speed of light in air is slightly less than that in vacuum and **speed of light in water is nearly  $0.75 c$  and in glass it is approx.  $0.66 c$ .**

## REFRACTIVE INDEX OF A MEDIUM ( $\mu$ )

$$\mu = \frac{\text{speed of light in vacuum}}{\text{Speed of light in a medium}}$$

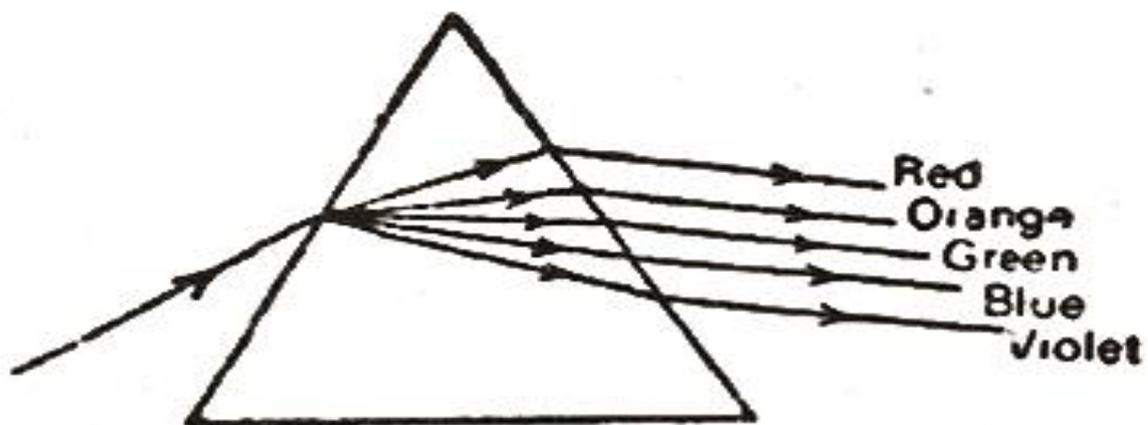
- Refraction explains the phenomenon as to why a **stone lying at bottom of a pond** appears to be at higher point than it actually is. Also the **bending of a stick, dipped in water** can be explained on the basis of the phenomenon of refraction.
- It is due to the refraction caused by the atmosphere that **sun or moon appears to be elliptical near the horizon**. This is observed because rays from the lower edge of the sun are bent more than those from the upper edge.
- **Twinkling of the stars** can be explained on the basis of the phenomenon of the refraction.
- **Mirage** (phenomenon of hot desserts) is caused by refraction as the air in the desert is hot near the ground but cools rapidly with the height. The hotter air is optically less dense.

## TOTAL INTERNAL REFLECTION

- When the angle of **incidence of light in the denser medium is greater than the critical angle of the medium**, the light do not get refracted into rarer medium but it is totally reflected to the medium of the incidence. This is known as Total Internal Reflection.
- This phenomenon finds application in **optical fibers**, which are used not only for communication purposes but also for medical examination of patient's internal body parts (**endoscopy**).

## DISPERSION

- Splitting of light into **spectrum of seven colors in accordance with their frequencies** when a light ray passes through a prism is called dispersion of light. Due to different speeds, the colors of light are refracted through different angles when narrow beam of white light passes through a glass prism.
- When sun rays passes through the droplets in the atmosphere they get split into spectrum of colors called as **rainbow**. **Violet color has min. wavelength** (max. frequency) and red color has max. Wavelength (min. frequency). The order of the colors can be explained on the basis of **VIBGYOR**.



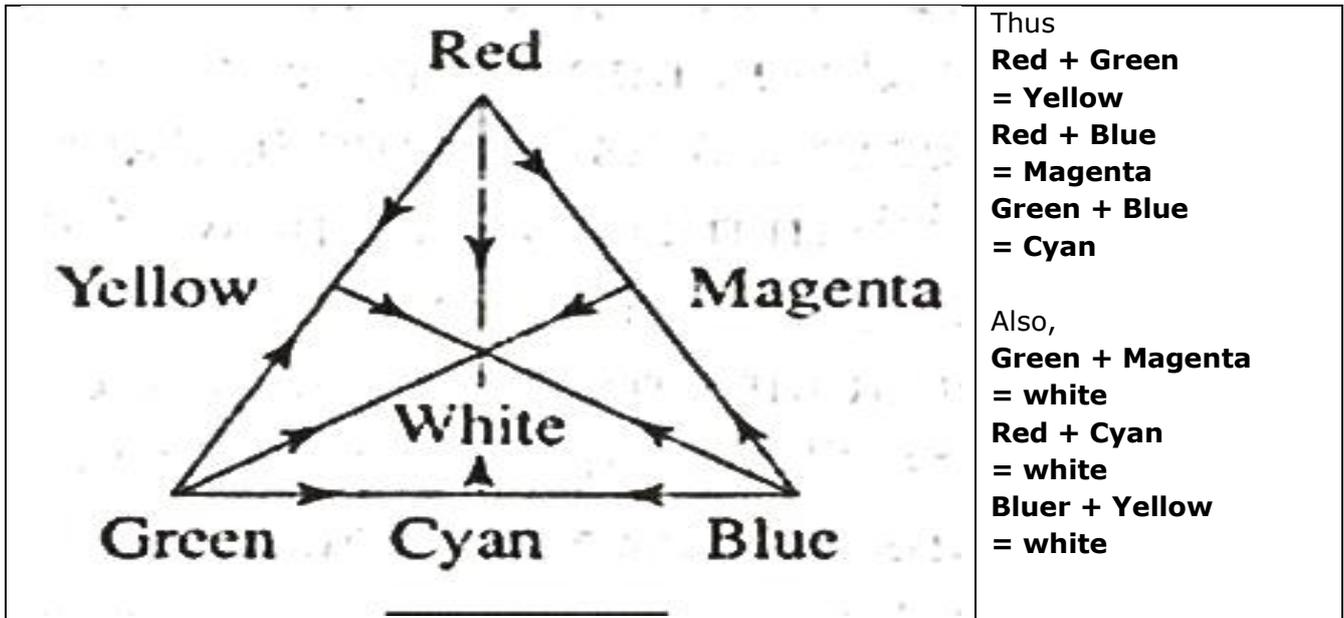
WAVELENGTH ►►

VIOLET – INDIGO – BLUE – GREEN – YELLOW – ORANGE – RED

◄◄ FREQUENCY

## COLOR OF OBJECTS

**White light is a mixture of the basic colors, red, green and blue.** All colors can be produced by mixing these three colors suitably. These three colors are also called **primary colors**. The color of an object is the color reflected by that object, out of seven colors of spectrum. E.g. a leaf appears green because chlorophyll inside it absorbs other colors except green. Colors produced by the mixing lights of primary colors can be obtained from the color triangle



Two colors when combined together results into white light are called **complimentary colors**.  
E.g. blue and yellow are complimentary colors.

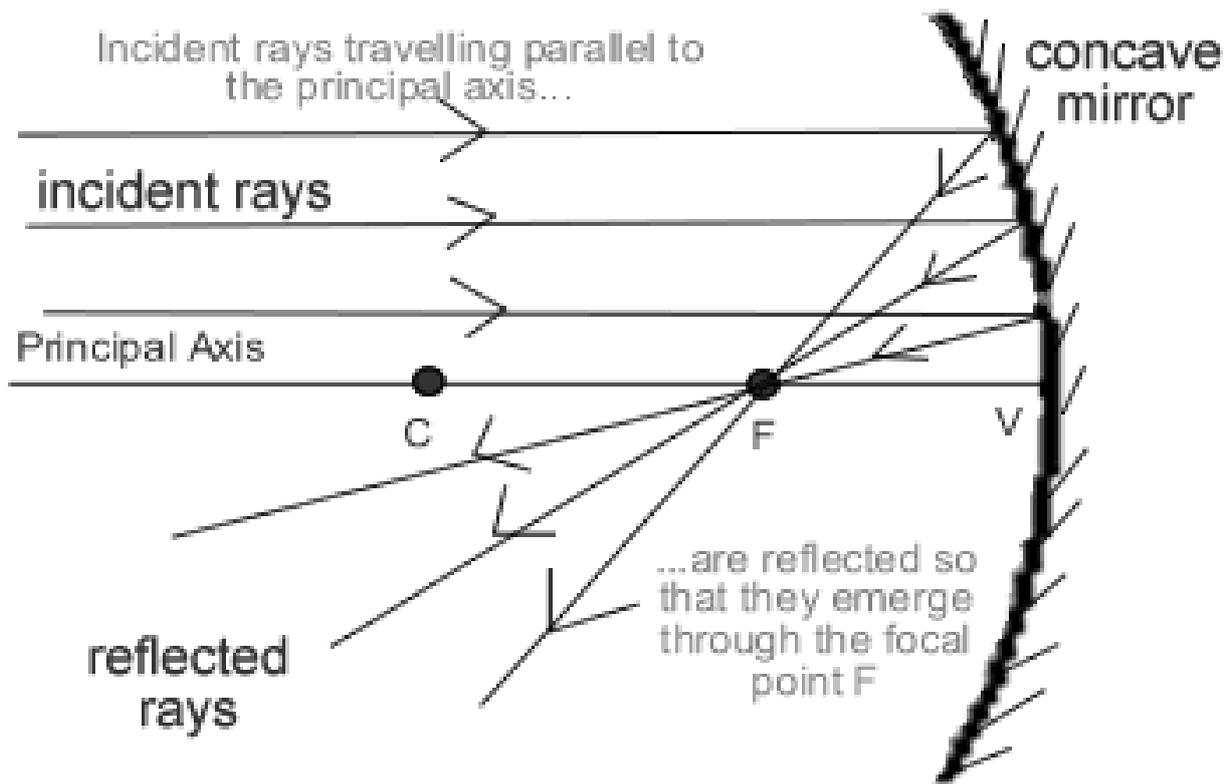
## MIRRORS AND LENSES

There are mainly two types of lenses and mirrors

1. **concave**
2. **convex**

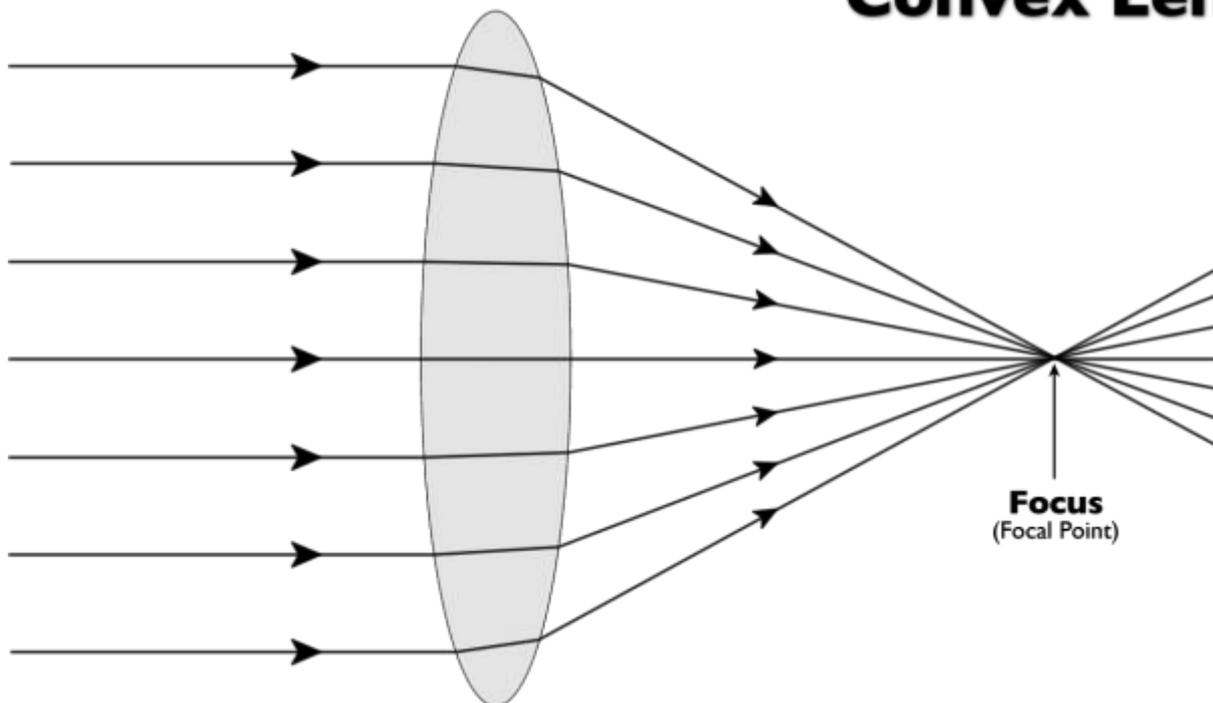
### CONCAVE AND CONVEX MIRRORS

- Mirrors find uses of phenomenon of **reflection**.
- When mirrors are made by depositing vaporized aluminum on a glass surface exposed outside, this makes a concave (converging) mirror, whereas deposition on the **inside portion of glass makes it a convex** (divergent) mirror.
- When rays fall on a concave mirror, they are converged to a point called **focus of mirror**. Because of this property they are used in **solar cookers, shaving mirrors, car headlights, torches, table lamp, and clinical usages**. They form virtual and real image depending on the position of the object.
- When an object is placed closed to the concave mirror i.e. at the distance less than the focal length of the mirror, the image is **virtual, erect and larger than the object**.
- A convex mirror always produces the virtual images, which are erect and smaller than the objects. These mirrors find **use in vehicles as rear view mirrors** because they cover wide field of view and curing **hyper-metropia of eyes**.

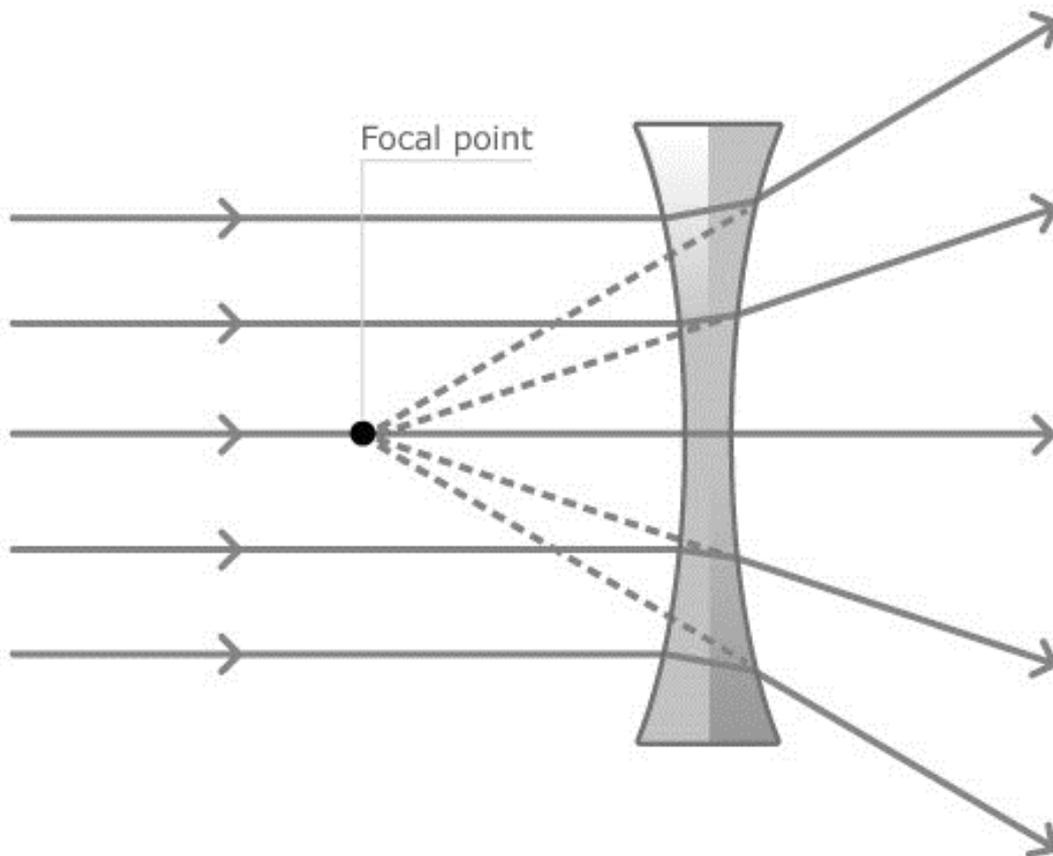


**CONCAVE AND CONVEX LENSES**

**Convex Lens**



## Refraction of light through a diverging lens



- Lenses use of the phenomenon of the **refraction**.
- When a beam of light parallel to the principal axis of a convex lens passes through the lens, it is refracted so as to converge to a point on the axis called the **principal focus F**.
- A concave lens has a **virtual principal focus behind the lens**, from, which the refracted beam seems to diverge. Since light can fall on the both faces of a lens it has two principal foci, one on each side, equidistance from c. The distance CF is the focal length ( $f$ ) of the lens and is an important property of it.

### IMAGES FORMED BY CONVEX (CONVERGING) LENS

1. When object is **placed beyond 2F**: image is formed between F and 2F, its nature is real, inverted and smaller.
2. When object is **placed at 2F**: image is formed at 2F, which is real, inverted and is of same size.
3. When object is **placed between 2F and F**: image formed is beyond 2F, which is real, inverted and larger.
4. When object is **placed between F and C**: image is formed behind the object, which is virtual, erect and larger.

## IMAGES FORMED BY CONCAVE LENS

This lens forms virtual, erect and smaller image for all object positions thus behave like a convex mirror.

Ray Diagram	Characteristics of Image
<p>The object is between the lens and the focal point.</p>	<ul style="list-style-type: none"> <li>• larger than object</li> <li>• farther from lens than object</li> <li>• upright</li> <li>• virtual</li> </ul>
<p>The object is between the focal point and twice the focal length.</p>	<ul style="list-style-type: none"> <li>• larger than object</li> <li>• farther from lens than object</li> <li>• inverted</li> <li>• real</li> </ul>
<p>The object is more than twice as far from the lens as the focal point.</p>	<ul style="list-style-type: none"> <li>• smaller than object</li> <li>• closer to lens than object</li> <li>• inverted</li> <li>• real</li> </ul>

## SCATTERING OF LIGHT

- It takes place when light falls on atoms and molecules. Sunlight is scattered by atmospheric molecules in, which the predominantly scattered colors are **violet and blue**. As our eyes are not sensitive to violet light therefore sky appears blue to our eyes.
- **Red light** is scattered the least and therefore travel more in atmosphere than any other color. In the evening and the morning sun is lower in the sky because of, which sky appears Red and Orange in color.

## INTERFERENCE OF LIGHT

- The **superposition of two or more light ways of the same kind** that pass the same point in space at same time is called interference. If waves are in same phase, **constructive interference** takes places, which results into production of a strong wave; on the other hand, waves, which are out of phase, **destructive interference** takes place and waves die out.
- The phenomenon of **beautiful colors in soap bubbles and oil films on water** can be explained on the basis of interference of white light reflected by these surfaces.

## OPTICAL ILLUSION

An optical illusion (also called a **visual illusion**) is characterized by visually perceived images that differ from objective reality. The information gathered by the eye is processed in the brain to give a perception that does **not tally with a physical measurement** of the stimulus source. There are **three main types**: literal optical illusions that create images that are different from the objects that make them, physiological ones that are the effects on the eyes and brain of excessive stimulation of a specific type (brightness, colour, size, position, tilt, movement), and cognitive illusions, the result of unconscious inferences.

As **sunrise and sunset** are calculated from the leading and trailing edges of the Sun, and not the center, the duration of a day time is slightly longer than night time (by about 10 minutes, as seen from temperate latitudes). Further, because the **light from the Sun is refracted** as it passes through the Earth's atmosphere, the Sun is still visible after it is geometrically below the horizon. Refraction also affects the apparent shape of the Sun when it is very close to the horizon. It makes things appear higher in the sky than they really are.

Light from the **bottom edge of the Sun's disk is refracted** more than light from the top, since refraction increases as the angle of elevation decreases. This raises the apparent position of the bottom edge more than the top, **reducing the apparent height of the solar disk**. Its width is unaltered, so the disk appears wider than it is high. (In reality, the Sun is almost exactly spherical.) The Sun also appears **larger on the horizon, an optical illusion**, similar to the moon illusion.

## SUNRISE

- Sunrise is the instant at, which the **upper edge of the Sun appears above the horizon in the east**. Sunrise should not be confused with dawn, which is the (variously defined) point at, which the sky begins to lighten, some time before the sun itself appears, ending twilight.
- Because atmospheric refraction causes the sun to be seen while it is still below the horizon, both sunrise and sunset are, from one point of view, optical illusions. The sun also exhibits an **optical illusion at sunrise similar to the moon illusion**.
- The apparent westward revolution of Sun around the earth after rising out of the horizon is due to the Earth's eastward rotation, a counter-clockwise revolution when viewed from above the North Pole.
- This illusion is so convincing that **most cultures had mythologies and religions** built around the geocentric model. This same effect can be seen with near-polar satellites as well.

## SUNSET

- **Sunset or sundown is the daily disappearance** of the Sun below the horizon in the west as a result of Earth's rotation.
- The time of sunset is defined in astronomy as the moment the trailing edge of the Sun's disk disappears below the horizon in the west. The ray path of light from the setting Sun is highly **distorted near the horizon because** of atmospheric refraction, making sunset appear to occur when the Sun's disk is already about one diameter below the horizon.
- **Sunset is distinct from dusk**, which is the moment at, which darkness falls, which occurs when the Sun is approximately eighteen degrees below the horizon. The period between sunset and dusk is called twilight.

- Locations north of the **Arctic Circle and south of the Antarctic Circle** experience no sunset or sunrise at least one day of the year, when the polar day or the polar night persist continuously for 24 hours.
- Sunset creates unique atmospheric conditions such as the often intense orange and red colors of the Sun and the surrounding sky.

### **TWINKLING OF STARS**

- The fact is "**stars do not twinkle**". But it is just an **optical illusion**. Stars continuously emit light. These light travels through various layers of earth atmosphere before they reach our eyes.
- Now **refractive index decreases** as we move from down through atmosphere. **So light keeps on getting bent towards normal** at each point of incidence.
- Further **atmospheric conditions** keeps on changing. Hence **light flux reaching our eyes keeps** varying and so star appears bright at some time and it appears fade at other. So stars apparently twinkles but practically they don't.

### **MOON ILLUSION**

- The moon illusion is one of the most famous of all illusions. Stated simply, **the full moon**, when just above the horizon, **appears much larger than** when it is overhead. Yet the moon, a quarter of a million miles away from the earth, always subtends the same angle wherever it is in the sky, roughly 0.5 degrees.
- The **first problem is for photographers**. A wonderful picture presents itself, with the full moon just rising above a spectacular horizon. Click, the picture is taken. Yet the result is disappointing.
- The **moon seems much smaller** in the photograph than it did when viewed with the naked eye. Even professional photographers fall for this one.
- Yet on a normal lens, 50mm on a 35mm camera, the field of view is around 50 degrees, and the width of the moon, subtending an angle of 0.5 degrees, will be 100th of the width of the photo.
- Many photographs that you see in magazines, containing both a moon and a landscape, will be composites. The **landscape will be taken with a normal lens, the moon taken with a telephoto lens**, to get a bigger image.