1. SENSATIONS AND RESPONSES

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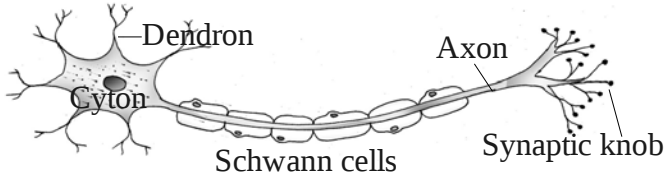
A. Stimulus : the senses that evoke responses in organisms

External stimuli :-Sound, touch, heat,pressure, cold

Internal stimuli :- Hunger, thirst, infection …

The Nervous system generates and coordinates responses through impulses.

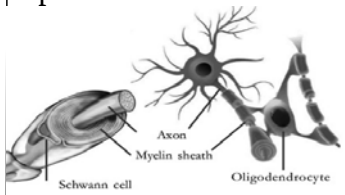
B. Neurons (nerve cells):- The structural and functional units of the nervous system.



Part of neuron	Function
Dendrite	Receives impulses
Dendron	Carries impulses from dendrite to the cell body
Cyton / Cellbody	Passes impulses to the axon. (controlling centre)
Axon	Carries impulses from the cell body to outside.
Schwann cells/ Myelin sheath	Protects the axon and increases the speed of impulse
Axonite	Carries impulses to the synaptic knob
Synaptic knob	Secretes neurotransmitter

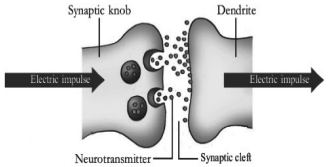
The Schwann cells of myelin sheath is formed of specialized cells called oligodendrocytes.

Myelin sheath : Provide nutrients and oxygen to the axon, accelerate impulse, act as an electric insulator. protects the axon from external shocks and gives white appearance ('white matter') to the neural parts.



The part of nerve, where myelinated neurons are present in abundance,is called as the **white matter** and the part of nerve where myelinated neurons are absent, is called as the **grey matter**.

C. Synapse : The junction between neurons or between neurons and muscles or glands.

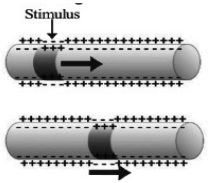


It regulates the speed and direction of impulses.

The impulses are transmitted across the synaptic cleft only through a chemical (neurotransmitter), secreted from the synaptic knobs.

Acetyl choline and Dopamine are neurotransmitters.

D. Impulse generation :



When stimulated, this ionic equilibrium (polarity) changes there and the outer surface becomes negatively charged and inner become positively charged. As a result, impulse generated.

Impulses are electrical messages conducted through nerves.

Transmission of impulse :

Impulse due to stimulus – dendrites – dendrons – cyton – axon – axonites – synaptic knob – secretion of neurotransmitter to the synaptic cleft –stimulation in the adjacent dendrites – impulse forms.

E. Types of neurons :

Sensory : Carry impulses from sense organs to the brain and spinal cord.

Motor : Carry impulses from brain and spinal cord to different organs.

Mixed : Carry impulses from brain and spinal cord to different organs and vise versa

F. Classification of human nervous system :

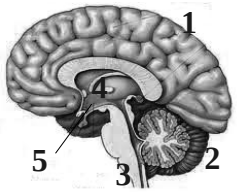
a. Central nervous system (Brain and Spinal cord)

b. Peripheral nervous system (12" Cranial nerves and 21" Spinal nerves)

* A few peripheral nerves act as Aqutonomous nervous system (Sympathetic nerves and para-sympathetic nerves)

G. Brain : Protected inside a hard skull and is covered by a three layered meninges.Cerebrospinal fluid, a fluid formed inside the meninges, also protects it.

- CSF provides nutrients and oxygen to brain tissues, regulates the pressure inside the brain and protects brain from injuries.



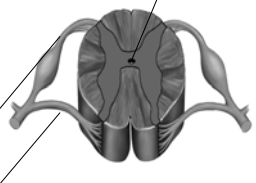
5 functional parts of brain are,

1. Cerebrum : largest part with fissures and folds. Cerebral cortex is grey coloured.
   Centre of thought, imagination, intelligence and memory. Evokes sensations, Controls voluntary movements.
2. Cerebellum: seen as 2 flaps, behind the cerebrum. Coordinates muscular activities and maintains equilibrium of the body.
3. Medulla oblongata : rod shaped lower part. Controls involuntary actions like heart beat and breathing.

4. Thalamus : seat of cerebrum.
Acts as relay station of impulses to and fro the cerebrum and also analyses the impulses.

5. Hypothalamus : seen below the thalamus.
Plays a major role in the maintenance of homeostasis.

H. Spinal cord : protected inside the vertebral column and is covered by the meninges. The central canal is filled cerebrospinal fluid.



Outer white matter while inner grey matter.
Spinal nerves originate from the spinal cord as dorsal root (sensory) and ventral root(motor).

Spinal cord transmits impulses from different parts of our body to and fro the brain., Coordinates the repeated movements during walking, running etc. Also effects certain reflex actions.

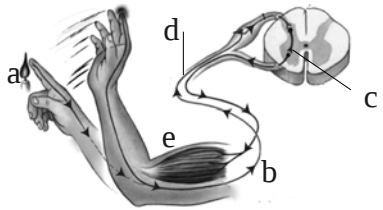
I. Reflex action : the accidental and involuntary responses of the body, in response to a stimulus.

a. Cerebral reflexes (Eg:-Blinking of eyes, sudden fright when hearing a loud noise or seeing a snake, sneezing)

b. Spinal reflexes (Eg :- On touching hot object, the hand is withdrawn, withdrawal of the leg when a spine pierce in to the feet)

Reflex arc : the pathway of impulses in a reflex action. This includes,

a. stimulus receiving receptor
b. sensory neuron c. inter neuron
d. motor neuron e. effecting muscles.



J. Autonomous nervous system :

Sympathetic and parasympathetics nervous system activate with or with out the endocrine gland system involuntarily. The contrasting actions of both help to maintain the normalcy of physiological activities.

Sympathetic nervous systems	Parasympathetic nervous systems
Pupil dilates	Pupil constricts
Heartbeat increases	Heartbeat becomes normal
Trachea expands	Trachea contracts
Converts glycogen to glucose	Glucose converts to glycogen
Hormone secretion increases	Hormone secretion decreases
Urinary bladder regains normal state	Contracts
Production of saliva decreases	Production of saliva increases
Working of stomach decreases	Increases
Peristalsis slows down	Peristalsis increases

K. Neural disorders, reason and symptoms :

Disorder	Cause	Symptom
Alzheimer's	Degeneration of neurons due to the accumulation of an insoluble protein in the neural tissues of the brain.	Loss of memory, inability to recognize friends or relatives, inability to do routine works.
Parkinsons	Production of dopamine reduces due to degeneration of specific ganglia in the brain.	Loss of body balance, irregular movements in muscles, shivering, profuse salivation ...
Epilepsy	Continuous and irregular discharge of electrical impulses in brain.	Fits (due to uncontrolled muscular contractions), frothy discharge from mouth, clenching of teeth, falls unconscious...

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2. WINDOWS OF KNOWLEDGE

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Feeling of senses are possible only when impulses from sense organs reach at the brain through the sensory nerves.

Eyes, Ears, Nose,Tongue & Skin are our sense organs.

A. Eye : for vision. Our eyes are protected by,
- Bony eye socket (orbit) - External eye muscles
- Eyelids & Eyelashes - Eyebrow - Tears (it clean and lubricate the anterior part, washes away the dust particles and destroys germs by lysozyme)
- Conjunctiva (it secretes mucus to prevent the eye from being dry).

The 3 layers of human eye ?

a. **Sclera** –The outermost layer, that gives firmness to eye. Its transparent anterior portion is the cornea. Conjuctiva covers the front part of sclera, except at cornea.

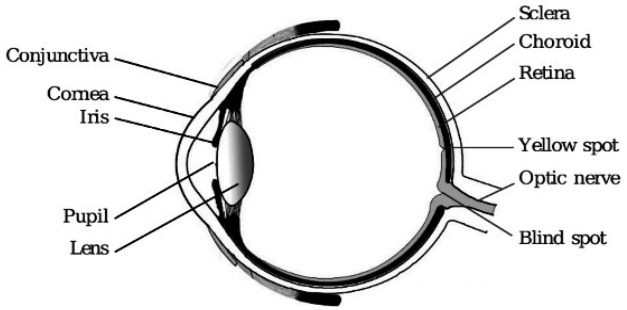
b.**Choroid**- Middle layer of blood capillaries, which supply nutrients and oxygen. Its anterior dark screen with pupil is the iris. The pigment, melanin gives colour to iris.A convex lens, which is connected to ciliary muscles by ligaments, is placed behind the iris.

c. **Retina**- The innermost layer on which, the image forms. Retina contains photoreceptors (cone cells and rod cells). Yellow spot which contains plenty of photoreceptors is the point of maximum visual clarity and the blind spot where no photoreceptors seen due as the begininng of optic nerve is the point of no vision. The optic nerve starts from the retina.

The fluids filled in the chambers of eye ?

* **Aqueous humor** – A watery fluid seen in the aqueous chamber [between cornea and lens] , oozes from the blood. This fluid supplies nutrients and oxygen to cornea and lens.

* **Vitreous humor** - A jelly like fluid filled with in the vitreous chamber [between lens and retina]. It helps to maintain the shape of eyeball.



Radial muscles and circular muscles in the iris regulate the size of pupil according to the intensity of light.

In dim light, radial muscles contract to increase size and in intense light, circular muscles contract to decrease the size of pupil.

Ciliary muscles adjust the curvature of eye lense and there by adjusting focal length.

While viewing near by objects, ciliary muscles contract to increase the curvature of lens to decrease the focal length. While viewing distant object, ligaments stretch to relax the ciliary muscles and curvature of lens decreases to increase the focal length.

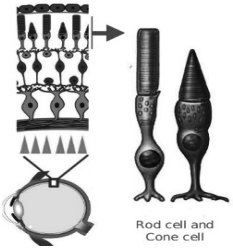
Photoreceptors :

	Pigment	Function	Related disorder
Rod cells	Rhodopsin	Vision under dim light	Night blindness
Cone cells	Photopsin / Iodopsin	Vision under intense light	Colour blindness

Rod cells are more in number than cone cells.

The three types of cone cells (red, green & blue) provide colour vision.

Retinal, the visual pigment found in the photoreceptors, is formed from vitamin A.



Under dim light, rhodopsin dissociates to form retinal and opsin to produce impulses .

Under intense light, photopsin (iodopsin) dissociates to form retinal and opsin to produce impulses.

These impulses are transmitted through the optic nerve to the cerebrum. Thus vision made possible.

Experiencing of vision :

Image on retina – stimulation in the photo receptors – dissociation of rhodopsin / photopsin – impulses form – optic nerve – coordination of images by cerebrum – perfect vision.

Binocular vision is the ability of both the eyes to focus on the same object to get perfect image when brain combines these images. This help us to get a three dimensional image of the object and also to calculate the correct distance, depth, height and width of the object.

Defects and diseases of eyes :

1. Hyper metropia (long sight): Cannot see nearby objects clearly due to shortened eyeball.
2. Myopia (short sight) :Cannot see distant objects clearly due to elongated eyeball.
3. Night blindness : No clear vision in dim light due to deficiency of vitamin A.
4. Colour blindness : Fails to detect red or green colours due to defects in red and green cone cells.
5. Xerophthalmia : Conjunctiva and cornea become

dry and opaque due to prolonged deficiency of vitamin A.

6. Cataract : Lens become opaque resulting blindness
7. Glaucoma : When re-absorption of aqueous humor obstructed pressure inside the eyes increases, resulting damage to retina and photoreceptors. This ultimately leads to blindness.
8. Conjunctivitis : Infection of bacteria or virus causes red eye with pain

Points related with the health of our eyes.

- Avoid falling bright light like sun light to the eyes.
- Avoid the habit of reading under dim light.
- Do not watch TV or other screens continuously.
- Frequently wash our eyes.
- Include vitamin A rich food.

B. Ear : for hearing and body balance.

Main parts:

a. **External ear** : Pinna, auditory canal and tympanum.

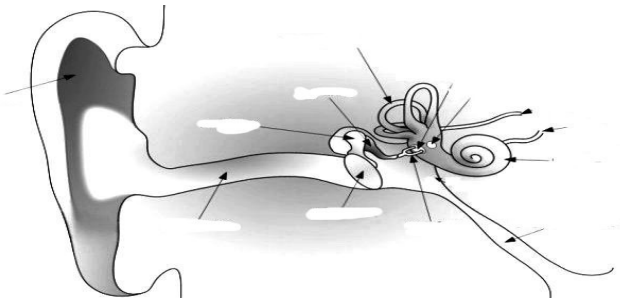
b. **Middle ear** : Ear ossicles (malleus, incus, stapes) and eustachian tube.

c. **Internal ear** : Cochlea, Auditory nerve, Vestibule, 3 semicircular canals and vestibular nerve.

Oval window and round window.

Fluids inside the internal ear :

Endolymph and perilymph.

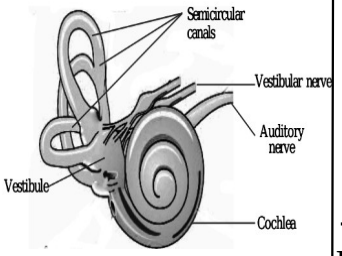


Eustachean tube connects the middle ear to the pharynx. It protects tympanm by balancing the pressure on either sides of it.

Ear ossicles (malleus, incus, stapes) amplify and transmit the vibrations of tympanum to internal ear.

Oval window is attached with stapes, so as to speed the vibrations of ear ossicles to internal ear.

The internal ear, constitutes membraneous labyrinth, seen inside a bony labyrinth. A coiled tube like **cochlea**, auditory nerve,the **vestibular apparatus** (vestibule & 3 semi-circular canals) and vestibular nerve are the parts of internal ear.



The membraneous labyrinth is filled with a fluid, endolymph and the space between the bony labyrinth and membraneous labyrinth is filled with another fluid, named perilymph.

The part, cochlea functions in hearing, while the vestibular apparatus helps to maintain body balance through transmitting impulses to the cerebellum.

Auditory receptors are the hair cells seen in the Organ of Corti of cochlea.

Sensory hair cells are also seen in the vestibule and semicircular canals.

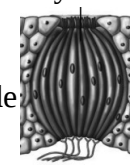
Hearing. (Flowchart).

Sound waves -- ear pinna – auditory canal – tympanum vibrates – ear ossicles amplify it – oval window – cochlear perilymph vibrates -- endolymph vibrates – stimulation in auditory receptors (hair cells) of the basilar membrane of Organ of Corti – impulse form -- auditory nerve – auditory centre of the brain – hearing.

Role of ear in maintaining the equilibrium :

Receptors (hair cells) seen inside the vestibule and semicircular canals,are stimulated according to the movement of head. The impulses formed are transmitted to the cerebellum through the vestibular nerve. Cerebellum functions so as to maintain the equilibrium of body.

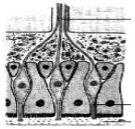
C. Sense of Taste : Chemoreceptors seen inside the mouth and tongue help us to detect taste. They seen inside the papillae of the tongue are the taste buds.



The different taste buds of the tongue include Sweet, salt, sour, bitter, umami etc.

When substances dissolve in saliva, chemo-receptors in the taste buds stimulate and impulses reach the brain through the respective nerves. Then we experience taste.

D. Sense of Smell : by the olfactory receptors in the mucus membrane.



When aromatic particles dissolve in the mucus, the olfactory receptors get stimulate and the impulses reach the brain through the olfactory nerve. Brain helps in feeling smell.

E. Skin : has receptors fto sense Temperature, Cold, Touch, Pressure and Pain.

F. Receptors in a few organisms :

Eye spot in Planaria (to detect light)
Ommatidia (cluster of photoreceptors in housefly)
Jacobson's organ in snake (to detect smell)
Receptors in the Lateral line of shark (to detect changes in the balancing of body)
Olfactory receptors in shark are highly sensitive.

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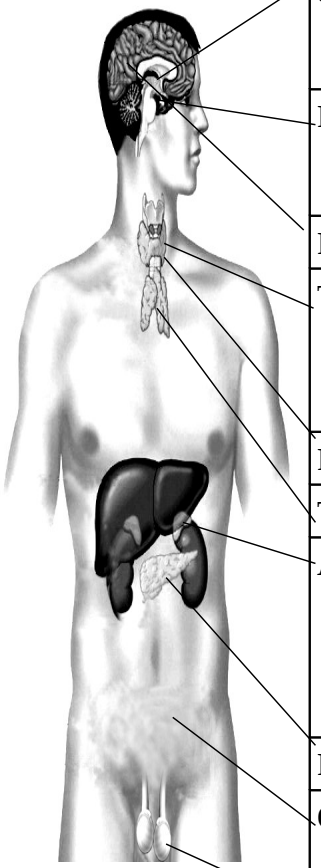
3. CHEMICAL MESSAGES FOR HOMEOSTASIS



Endocrine Glands	Producing hormones	Functions	Related disorder
'Hypo thalamus'	1. Releasing hormones. 2. Inhibitory hormones, 3. Oxytosin, 4. Vasopressin(ADH)	- Stimulates pituitary to secrete hormones - Inhibits the production of hormones from pituitary - Facilitating child birth, ejection of breast milk - Reduces water loss through urine	- - - - Diabetes insipidus
Pituitary	1. Tropic hormones - **TSH, ACTH, GTH** 2. STH (Growth hormone-GH) 3. Prolactin	- Stimulate thyroid, adrenal glands and sex organs. - Promotes the growth of the body. - Production of breast milk.	- -Dwarfism, Gigantism, - Acromegaly
Pineal	Melatonin.	- Maintain rhythm of our daily activities	-
Thyroid	1.Thyroxine 2. Calcitonin.	- Increases the rate of metabolism, energy production, accelerates the development of brain in the foetal stage and infancy and regulates growth in the children. - Maintains the level of calcium in blood (decreases)	- Cretinism, Myxoedema, Grave's disease -
Parathyroid	Parathormone.	- Maintains the level of calcium in blood (increases)	-
Thymus	Thymosine.	- Helps in the maturation and activities of lymphocytes	-
Adrenal	1. Cortisol, 2. Aldosteron, 3. Sex hormones, 4. Epinephrine / Adrenalin 5. Norepinephrine / Noradrenalin	- Glucose production, Prevent inflammation and allergy - Maintains the salt-water balance. - } Act along with the sympathetic nervous system in order to prepare the body to overcome emergency situations.	- - - - -
Pancreas	1. Insulin 2. Glucagon.	- Maintain the normal rate of glucose in our blood	-Diabetes mellitus
Ovaries	1. Oestrogen 2. Progesterone.	- Growth of sex organs, ovum production, ovulation etc. - Ovulation, menstrual cycle, implantation of embryo.	-
Testes	Testosterone.	- Growth of sex organs, sperm production etc. in males.	-

Pheromones
(To facilitate communication among organisms)
* **Musk** in the musk deer,
* **Civeton** in civet cat ,
* **Bombycol** in female silkworm

Plant Hormones	
1. Auxins	- Cell division, cell growth, cell elongation, cell differentiation growth of terminal bud, fruit formation etc. [Inhibits the growth of roots]
2. Cytokinins	- Cell division, cell growth, cell elongation, cell differentiation etc.
3. Gibberellins	- Cell elongation, breakdown of stored food in the seed, flowering, growth of leaves,fruits
4.Ethylene	- Ripening of fruits [Excess amount causes dropping of leaves or fruits]
5. Abscisic acid	- Dormancy of embryo in the seeds, dropping of leaves and fruits, wilting of leaves, flowering.

Synthetic Plant Hormones

- NAA, IBA, 2,4-D
- Gibberellins
- Ethylene
- Ethyphon
- Abscisic acid

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Hormonal disorders

Goitre	Abnormal growth of thyroid lobes [bulged throat] due to iodine deficiency.
Grave's disease	A condition characterized by the bulging of eye balls, due to hyperthyroidism.
Cretinism	Retarded physical – mental growth in children, due to hypothyroidism during early period of growth.
Myxoedema	Inflamed condition of body in adult due to deficiency of thyroxine.
Dwarfism	Stunted growth of bones due to under secretion of somatotropin in children.
Gigantism	Growing tall and heavy due to over secretion of somatotropin in children.
Acromegaly	Excessive growth of the bones on face, jaws and fingers due to the prolonged production of somatotropin even after the growth phase.
Diabetes mellitus	The condition of excessive loss of glucose through urine due to deficiency or inactivity of insulin.
Diabetes insipidus	The condition of excessive loss of water through urine due to deficiency of vasopressin /ADH.

What is the normal level of glucose in blood? How is it maintained ?

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70 – 110 mg /100 ml blood.

This rate is maintained by the antagonistic activities of insulin and glucagone , released from Islets of Langerhans of the pancreas.

When glucose increases in blood, beta cells in the Islets of Langerhans secretes **insulin**. It accelerates the process of glucose intake by the cells and conversion of the excess glucose in to glycogen. When glucose decreases in blood, alpha cells in the Islets of Langerhans secretes **glucagon**, which converts glycogen and amino acids in to glucose.

What is the normal level of calcium in blood? How is it maintained ?

9-11 mg /100 ml blood.

When the level of calcium in blood increases, thyroid gland secretes calcitonin, which lowers the level of calcium in blood, by depositing excess calcium in bones or by preventing the mixing of calcium with blood (from the bones). When the level of calcium decreases in blood, parathyroid gland secretes parathormone, which increases the level of calcium by helping in its re-absorption from kidneys or by preventing the deposition of calcium in bones.

Reason for decreased production of urine during summer season ?

During summer season, the production of vasopressin(ADH) increases and there fore re-absorption of water in the kidneys increases, to lower the quantity of urine.

How can hypothalamus control the entire endocrine system ?

Pituitary controls certain important glands through its various Tropic hormones, which are secreted under the influence of a variety of Releasing and Inhibitory hormones of the hypothalamus. Releasing hormones stimulate the anterior lobe of the pituitary to secrete tropic hormones and other hormones while the Inhibitory hormones inhibits the production of hormones from the pituitary.

How is epinephrine (adrenalin) or norepinephrine (noradrenalin) prepare our body to overcome emergencies ?

When the sympathetic nervous system gets stimulated, the action of epinephrine or norepinephrine prolongs the body activities for more time. Due to these activities we get energy to resist or withdraw ourselves from such situations.

Why does the pineal gland, seen in the centre of our brain, called as a 'biological clock' ?

Melatonin, the hormone of pineal gland, helps to maintain rhythm of our daily activities like awakening, asleep or definite reproductive periods. So the pineal gland is called as a 'biological clock'.

4. KEEPING DISEASES AWAY

A. Communicable [Contagious] Diseases

VIRUS

Structure:- Only a DNA/RNA with in a protein coat . No cell organelles.

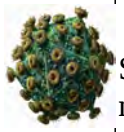
Action:- Multiply by undertaking genetic control of the host cell.

Nipah

Pathogen :- Nipah virus

Spread :- Through fruit eating bats directly or indirectly or through pigs (secondary vector)

AIDS



(Acquired Immuno Deficiency Syndrome)

Pathogen :- HIV (Human Immunodeficiency Virus)

Spread: - Through body fluids.
- By sharing needle and syringe
- Through unprotected sexual contact.
- From HIV infected mother to her foetus.

Does not spread by touch, kiss, saliva, food, coughing, sneezing, insects, sharing toilets etc.

Action :- HIV multiplies using genetic mechanism of lymphocytes and hence the number of lymphocytes decreases considerably. This condition of reduced immunity, any pathogen can easily affect the body

Hepatitis

Pathogen:- Hepatitis virus

Spread:-Through contaminated food and water, blood components and excreta of patient.

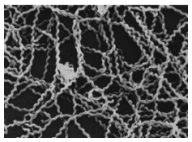
Symptoms:- Liver inflammation, dark yellowish colour to tmucus membrane, eyes or nails due to bilirubin (pigment in the bile).

BACTERIUM

Structure:- Unicellular organisms with out a definite nucleus (prokaryote)

Action:- They multiply and the toxins released by metabolism kill or disrupt the living cells.

Ratfever (Leptospirosis)



Pathogen :- Leptospira

Spread :- Through wounds, from stagnant water and moisture.

Symptoms :- Severe fever, headache, muscle pain, redness in eyes due to internal bleeding.

Diphtheria

Pathogen:- Corynebacterium diphtheriae.

Spread:-Through coughs, sneeze or even directly.

Symptoms:- Fever, throat pain and inflammation in the lymph glands of the throat. Mucus membrane becomes an ash coloured thick coating in the throat.

Tuberculosis

Pathogen :- Mycobacterium tuberculosis.

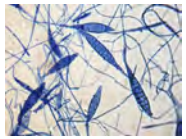
Spread:- Through air.
Mainly affects the lungs.
Also affect the kidneys, bone, joints, brain etc.

Symptoms :- Loss of body weight, fatigue, persistent cough.

Treatment:- Using antibiotics.

Vaccine :- BCG.

FUNGUS



Structure:- Non green plants like

Action:- The toxins produced by them cause diseases.

Fungal diseases and mode of spread :-

* **Ringworm** (Round, red blisters on the skin)
  - spread through contact.
* **Athlets foot** (Reddish scaly rashes that cause itching on the sole of the foot and between the toes)
  - spread through contact with contaminated water and soil.

PROTOZOAN

Structure :- Unicellular eukaryotes.

Action :- Their toxins destroy the cells. Some of them destroy blood cells.

Malaria

Pathogen :- Plasmodium species.

Spread:- Through anopheles mosquitoes.

Symptoms :- High fever with shivering, profuse sweating, headache...

FILARIAL WORM

Filariasis

Spread:- Through culex mosquitoes.

Symptoms:- Swelling in the lymph ducts in legs by the obstruction in the flow of lymph.

B. Non-pathogenic Diseases

Genetic diseases

* **Haemophilia**

Due to defect of genes, defective synthesis of one of the proteins that enables blood coagulation.

Excessive bleeding even from small wounds as blood does not clot

Temporary relief is possible by injecting the deficient protein to patient.

Patients need special care and attention.

* **Sickle cell Anaemia** (അരിവാൾ രോഗം)

Due to the defect of genes, deformities occur in the sequencing of amino acids of haemoglobin, and RBCs become sickle shaped.

Oxygen carrying capacity of red blood cells decreases. Such patients will be anaemic and weaken.

Cancer

The condition by which uncontrolled division of cells and their spread to other tissues occur.

Reasons :- Environmental factors, smoking, radiations, viruses, hereditary factors and alterations in genetic material may lead to the transformation of normal cells in to cancer cells.

Treatment :- Surgery, Chemotherapy, radiation therapy.

Early diagnosis of cancer is important in the treatment

Life style diseases

Caused by our unhealthy living style.

(synthetic food items, fast food etc, lack of physical exercise, mental stress, bad habits like consumption of alcohol, drug abuse or smoking etc.)

Diabetes :- Deficiency or malfunction of insulin.

Fatty liver :- Deposition of excess fat in the liver.

Stroke:- Rupture of blood vessels or block of blood flow in brain.

Hypertension :- Thickening of artery wall by fat deposition.

Heart attack :- Block of blood flow due to fat deposition in the coronary arteries.

Smoking related health problems

- Affect to nervous system to cause stroke, addiction to nicotine etc.
- Affect to respiratory system to cause lung cancer, bronchitis, emphysema etc.
- Affect to circulatory system to cause hypertension, loss of elasticity of arteries and decreased functioning of heart.

Animal diseases

Bacterial diseases : Anthrax, Inflammation of udder.

Viral disease : Foot & mouth disease.

Plant diseases

Bacterial diseases : Blight disease of paddy,
Wilt disease of brinjal.

Viral disease : Mosaic disease in peas and tapioca,
Bunchy top of banana.

Fungal diseases : Quick wilt in pepper,
Bud rot of coconut.

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5 . SOLDIERS OF DEFENSE

A. DEFENSE MECHANISMS IN OUR BODY

Non specific defense

* Body coverings (Skin and mucous membrane)
* Body secretions (Mucus, lysozyme in saliva, tears and urine, sweat, sebum, ear wax, HCl …)
* Body fluids (Blood and lymph)

1. Skin :- The outer most keratin layer (protein) prevents germs from entering it.
   - Sebum makes skin oily and water proof.
   - Sweat have disinfectants to destroy germs.
2. Mucus and cilia in the respiratory tract prevent and wipe out germs and dust.
3. Useful bacteria in skin and mucous membrane.
4. Cough and sneezing to expel foreign bodies.
5. Ear wax and hairs prevent the entry of substances.
6. The enzyme, *lysozyme*, in the tears, saliva and urine destroy germs.
7. HCl in the stomach fight against germs.

Action of WBCs :-

* Neutrophils - Engulfs and destroys bacteria, Produces chemicals against bacteria
* Basophils -Stimulates the other white blood cells, Dilates the blood vessels.
* Eosinophils - Destroys foreign bodies. Produces chemicals for inflammatory response.
* Monocytes - Engulfs and destroys germs.

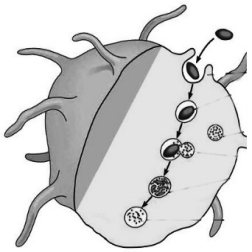
* Lymphocytes (B and T) act specifically against antigens.

1.- **Inflammatory Response**

The dilation of the blood vessels by certain chemicals, when a cut or wound occur, blood flow increases to the wound site and more white blood cells can reach there.

2. **Phagocytosis**

[the process of engulfing and destroying germs by certain white blood cells (phagocytes)]

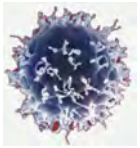


- Phagocyte reach near the pathogen.
- Engulfs the pathogen in the membrane sac.
- Membrane sac combines with lysosome.
- The enzyme in the lysosome destroys the pathogen.
- Phagocyte expels the remnants.

3. **Blood clotting**
   - Tissues of the wounded part degenerate to form an enzyme, thromboplastin.
   - With calcium ions and vitamin K, thromboplastin converts prothrombin to thrombin.
   - Thrombin converts fibrinogen to fibrin.
   - In the fibrin net, RBCs and plateletes entangled to form the blood clot.
4. **Healing of wounds**
   (When connective tissues form to heal the wound, scar remains there)
5. **Fever**
   Toxins of pathogens stimulate WBC to produce chemicals for raising body temperature.
   Fever prevents the rapid multiplication of bacteria and increases the effect of phagocytosis.

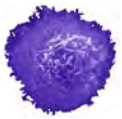
Specific defense

Action of **B Lymphocytes**



B lymphocytes, (which mature in the bone marrow) produce antibodies, which destroy germs by
- disintegrating bacterial cell membrane,
- neutralising their toxins and
- stimulating the other white blood cells.

Action of **T Lymphocytes**



T lymphocytes,(which mature in the thymus gland) stimulate the other white blood cells and destroy cancer cells as well as virus affected cells.

Lymph helps in defense mechanisms:
Lymphocytes in the lymph nodes and spleen destroy bacteria

B. VACCINES for Induced Immunity

Vaccines are substances,given in advance to prevent certain diseases.

Dead, inactive, alive but neutralized germs or toxins are used as vaccines.

By the presence of these antigens, lymphocytes become activated and produce antibodies. These antibodies remain in the body for long time to provide immunity against antigens.

[Smallpox vaccine , the first vaccine, was invented by the scientist Edward Jenner.]

BCG, OPV, Pentavalent, MMR, TT are vaccines.

C. DIAGNOSIS & TREATMENT

Systems of medicine

- Allopathy (Modern Medicine) Hippocrates
- Ayurveda (A life style to maintain the body fit. Majority of medicines are herbal. Indian)
- Homeopathy – Samuel Hanniman.
- Unani etc.

Some specialisation in Modern medicine :
Cardiology – (treatment of heart)
Ophthalmology - (treatment of eye)
Neurology - (treatment of brain or nerves)
Oncology - (treatment of cancer)
E.N.T - (treatment of ear, nose and throat)

Diagnosis

- Equipments (Stethoscope, Sphygmomanometer, Digital manometer, Thermometer, ECG, EEG, Ultra Sound Scanner, CT Scanner, MRI Scanner, ...)
- Lab tests (blood, urine …)

Normal value of blood cells and haemoglobin :-
Haemoglobin – 12-17gm/100ml of blood.
RBCs count - 45-60 lakhs/ml of blood.
WBCs count – 5000-10000/ml of blood.
Platelets count – 2.5-3.5 lakhs/ml of blood.

Therapy

* Using **Antibiotics**

Antibiotics are effective medicines used to resist bacterial diseases.

The first antibiotics -penicillin – was synthesized by Alexander Fleming (in 1928).

Side effects:

- Regular use develops immunity in pathogens against antibiotics.
- Destroy useful bacteria in the body.
- Reduces the quantity of certain vitamins in the body.

* **Radiation Therapy** (for cancer and eye disease)
* **Surgery**
* **Transplantation of organs**

* **Blood Transfusion**

Carl Landsteiner proposed A,B,AB, O blood grouping on the basis of A, B antigens seen on the surface of the RBC.

Those blood with Rh factor (antigen D) on the surface of RBC are termed as positive group blood and those with out Rh are termed as negative group blood.

If blood is not compatible, the antigen in the received blood will react with the antibody in the recipient's blood of so as to clot RBC (agglutination).

Blood group	Antigen present	Antibody possible	Whom can receive
A+	A, Rh	b	A+, A-, O+, O-
A-	A	b	A-, O-
B+	B, Rh	a	B+, B-, O+, O-
B-	B	a	B-, O-
AB+	A, B, Rh	nil	All groups
AB-	A, B	nil	All, except O+
O+	Rh	a, b	O+, O-
O-	ഇല്ല	a, b	O-

Donating blood is not harmful to our health, instead it is a noble deed.

D. Defense Mechanisms in Plants

- **Bark** protects the inner cells.
- **Cuticle** and **wax** on leaves, defends the attack of microorganisms.
- **Cell wall**, made up of cellulose, is rigid coat by the deposition of lignin, cutin or suberin.
- **Callose**, a poly saccharide, prevents the germs which have crossed the cell wall.

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6. UNRAVELLING GENETIC MYSTERIES

Genetics is the branch of science which deals with heredity and variations.

Cregor Johann Mendel is the 'Father of Genetics'.
He conducted hybridization experiments in pea plants considering up to 7 different traits and arrived at certain inferences, which paved way to Genetics.

Mendel's experiment on pea plants (One trait)

Parents- **TT** x **tt**
(Tall) (Dwarf)
Gametes- (T) (t)

F1 Generation- **Tt**
(Tall)
Gametes- (T) (t) (T) (t)

F2 Generation- **TT, Tt, Tt, tt**
Ratio - 3 : 1

Mendel's experiment on pea plants (Two traits)

Parents- **TTRR** x **ttrr**
(Tall Round) (Dwarf Wrinkled)
Gametes- (TR) (tr)

F1 Generation- **TtRr**
(Tall Round)
Gametes- (TR) (tR) (TR) (tR)
(Tr) (tr) (Tr) (tr)

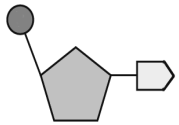
F2 Generation- Tall Round- 9, Tall Wrinkled- 3
Dwarf Round- 3, Dwarf Wrinkled - 1
Ratio - 9:3:3:1

Mendel's inferences:
* A trait is controlled by two factors (eg:- Tt)
* One trait is expressed (dominant trait) eg: Tall T
The other remains hidden (recessive trait) eg: t
* The hidden trait appears in the second generation.
* The ratio of the dominant and recessive in the second generation is 3:1 .
* Factors of each pair segragate and assort independently to each offspring.

Gene : Specific parts of DNA that control metabolic activities and specific characteristic features.

Alleles : The different forms of a gene that controls a trait. (eg:- T is the allele of t, t is allele of T)

Nucleic Acids (**DNA & RNA**) are made of units called nucleotides.

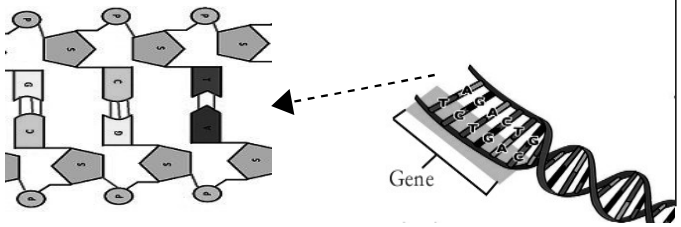


A nucleotide consist of a sugar molecule, a phosphate and a nitrogen base.

RNA – Single stranded elongated molecule with ribose sugar, phosphate and nitrogen bases adenine, uracil, cytosine and guanine.

DNA – Double stranded double helical structured molecule with deoxyribose, phosphate and nitrogen bases adenine, thymine, cytosine and guanine. (pairing A-T and G-C)

James Watson and Francis Crick proposed the double helical model of DNA in 1953.



Action of Gene : (through synthesizing proteins)
- DNA unwinds and mRNA forms.
- mRNA reaches outside the nucleus and reaches ribosomes.
- tRNA transfers amino acids to ribosomes
- Ribosomes bind amino acids to form protein.

Melanin is a protein which gives colour to skin.

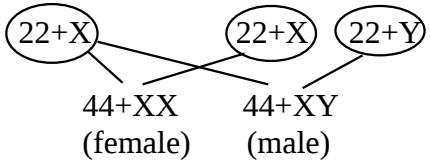
Chromosomes

Each chromosome contains a single DNA.
46 chromosomes (23 pairs) are seen in a human cell.
44 = somatic chromosomes 2= sex chromosomes.

Sex determination in man

In females, 44+ XX chr. In males, 44+ XY chr.

44+XX (female) 44+XY (male)



Reasons for Variations

a. Fertilization:- During fusion of gametes, allele combinations changes. Hence, offsprings shows certain variations.

b. Crossing over :- During the initial phase of meiosis chromosomes may pair and exchange parts. This causes difference in normal distribution of genes. Hence variations in offsprings.

c. Mutation :- Sudden change in the genetic constitution leads to variations.

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7. GENETICS OF THE FUTURE

Biotechnology is the use of microrganisms and biological processes for various human requisites.
Traditionally,
Yeast (a fungus) was used to prepare bread.
Bacteria and fungi were utilized to convert sugar in to alcohol and to make wine, appam or cake.

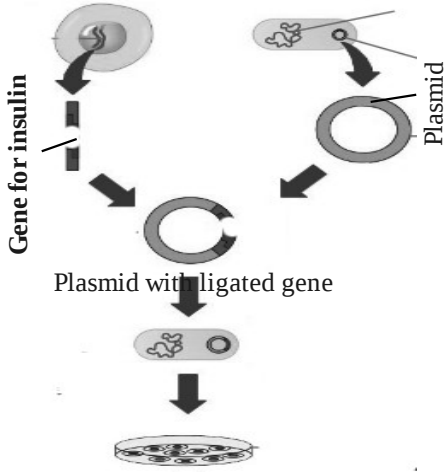
Genetic engineering (modern form of biotechnology) is a technology that controls traits of organisms by bringing about desirable changes in their genetic constitution.

Genetic modification in organism is done by cutting or joining specific genes, using certain enzymes.

The enzymes (eg:- Restriction endonuclease) are generally called as '**genetic scissors**'.
The enzymes (eg:-Ligase) are as '**genetic glue**'.
The DNA used for transfering genes are called **'vectors'** (eg- bacterial DNA / plasmid).

Stages in the production of human insulin bacteria
(Process of genetic engineering)

a- From human DNA, cut the gene responsible for the production of insulin.
b- Plasmid (circular DNA) is isolated from a bacterium.
c- Human insulin gene is ligated with the isolated plasmid, which is used as the 'vector'
d- Insert this ligated plasmid in to another bacterial cell.
e- This bacterium is allowed to multiply in a culture mediumto produce inactive insulin.
f- Active insulin is produced from this.



Bacterial multiplication in culture medium

Scope of genetic engineering :
* Gene therapy, in the control of genetic diseases.
* GMO (genetically modified organisms)
Eg:- -Bacteria which produce insulin, interferon, endorphin, somatotropin etc.
-Pharm animals which produce medicines.
- BT crops (disease resistant crops)
- High yielding varities of crops.
* Forensic test through DNA finger printing (DNA profiling/ DNA test)

Possibilities to misuse genetic engineering :
- Genetically modified varieties are threat to our indigenous varieties.
- Possibilities to misuse the genetically modified organisms as 'bioweapons' for 'bio war'.
- Sometimes, violation of right.

Genome :- The sum total o genes present in the 46 chromosomes.(about 24,000 functional genes)
Junk genes:- Non functional genes in the genome.
Human Genome Project :- Aproject started in 1990s to identify/map the exact location of all genes (that control each trait) in the 46 DNA.
Gene Mapping :- A technology by which we can locate a specific gene in the DNA responsible for a particular trait.

DNA finger printing :- The technology of testing the arrangement of nucleotides in the DNA of persons (or DNA profiling /DNA test).
Proposed by **Alec Jeffrey**.
Principle behind DNA finger printing :- The arrangement of nucleotides in the DNA of each person differs.
Uses :- To find out hereditary characteristics,
To identify real parents in parental dispute.
To identify persons found after a long periods of missing
To prove crimes like murder, robbery etc.

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8. THE PATHS TRAVERSED BY LIFE

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A. Origin of first life on primitive earth.

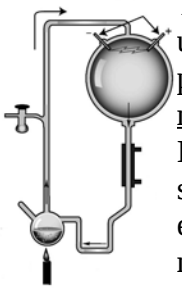
1. **Panspermia theory** : Life has originated in some other planet in the universe and accidentally reached the earth. (Evidence : The organic substances obtained from the meteors)
2. **Theory of chemical evolution** : Life originated as a result of the changes that occurred in the chemical substances in seawater, under specific conditions in primitive earth, where free oxygen was absent. (by A.I. Oparin and J.B.S Haldane). (Support: Urey-Miller experiment)

Major events in the evolving of organic molecules:

- Earth forms - formation of primitive gases in primitive atmosphere
- condensation of water vapour to form rain
- formation of primitive ocean
- formation of simple organic molecules
- formation of complex organic molecules
- formation of primitive cell from nucleic acids and lipids.

Major energy sources for chemical evolution:
Lightning, UVradiations and volcanic eruptions.

Experimental support by by Stanley Miller and Harold Urey :



They re-created an experimental set up, in which the glass flask as the primitive atmosphere that contained methane, ammonia and water vapour. Instead of lightning or other energy sources, they passed high voltage electricity through the gaseous mixture.They condensed this gaseous mixture to water, that was considered as the primitive ocean. Organic molecules like amino acids were found in this.

B. Evolutionary stages after the origin of earth.

4500 m.y back – origin of earth
3800 m.y back – origin of primitive cell (life)
3500 m.y back – origin of prokaryotes
1500 m.y back – origin of eukaryotes
1000 m.y back – origin of multicellular organisms

C. Theories related to organic evolution.

1. Inheritance of Acquired characters. (**Lamarckism**)
The characters developed during the life time of organisms (acquired characters) accumulate through generations and lead to the formation of new species.
According to Lamarck, when giraffes with short neck faced food scarcity, they stretched their necks to reach out to tall trees. Thus giraffes with long necks emerged through generations .
Scientists critisized lamarckism as acquired characters were not inheritable.

2. Theory of **Natural Selection** (by Charles Darwin)
When over production of organisms occur, they compete for food, space, mate, and other limited resources (Struggle for Existence). In this struggle, only organisms with favourable variations survive in that nature. Over a long period,the favourable variations accumulate, resulting the formation of new species. (Natural selection).

Observations in Galapagos Islands and the population theory of Robert Malthus were influenced Darwin.

The finches in Galapagos had beaks adapted to their feeding habits. Only beaks with favourable variations (or adaptations) to that nature might have survived there.

Ship: HMS Beagle
Book published: The Origin of Species by means of Natural Selection.

Limitation in Darwin's theory ?
Darwin could not explain the reasons for variations in organisms. Later, Hugo deVries explained one reason as mutation.

3. Neodarwinism : is the modified version of Darwin's theory in the light of new information from the branches of genetics, cytology, geology and paleontology about the reasons of variations occurred in organisms.
(eg:- Mutation theory of Hugo deVries) which states that sudden and heritable changes (mutation) lead to evolution.

D. Evidences to organic evolution.

- Palaeontology (fossil study),
- Comparative morphology,
- Biochemistry and Physiology,
- Modern molecular biology.

1.Primitive fossils have simple structure.
Recently formed fossils have complex structure.
(Complex structured organisms are evolved from primitive simple organisms.)
Certain linking fossils reveal the evolution of one form of organisms from another form.

2. The evidences from the comparative morphological studies of homologous organs justify that all organisms were evolved from a common ancestor.

[Homologous organs are organs that are similar in structure but perform different functions]

3. Biochemistry and physiology justify that organisms are made up of cells with similar protoplasm, cell organelles and cellular activities. Enzymes control chemical reactions and energy is stored in ATP molecules in all organisms. Hereditary factors are gene , seen in DNA and the structure of DNA is alike in all. Carbohydrates, proteins and fats are the basic substances. There are similarities in growth, excretion etc.
[All organisms are evolved from common ancestor]

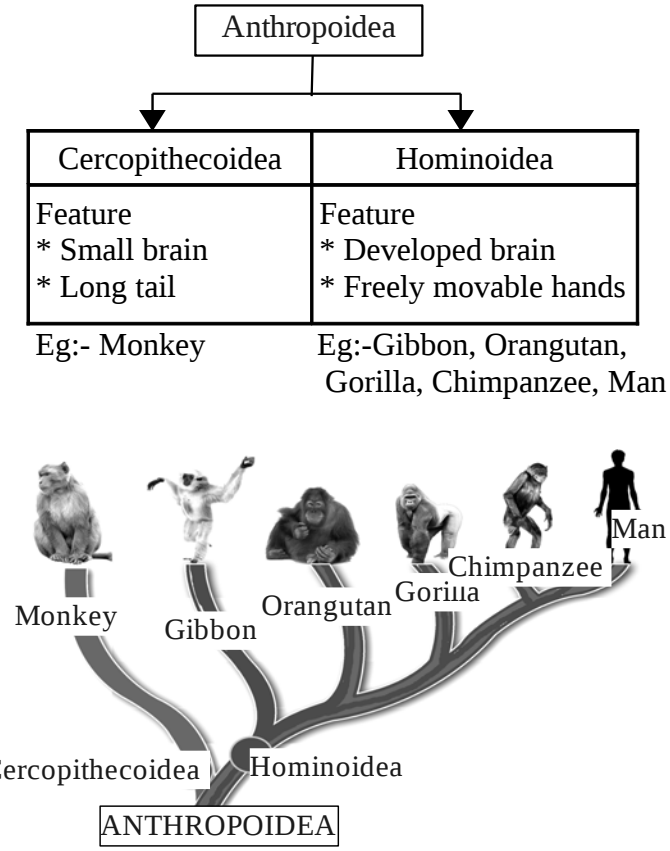
4. Study of modern molecular biology (comparative study of same protein molecules of different organisms) reveals the evolutionary relationship among organisms as well as the period of separation of different group of organisms from their ancestor.

For instance, we can analyse the similarities or differences in the sequence of amino acids in the beta chain of haemoglobin molecules of different mammals and there by we can understand about the evolutionary relationship (how close/how far) among them.

Chimpanzee	No difference
Gorilla	Difference of 1 amino acid
Rat	Difference of 31 amino acids

From this, we can understand that chimpanzee is so close to human being .

E. Human evolution :



Organisms that are included in the evolutionary history of modern man :

A (Human beings)	B (Features)	C. (First fossil from)
a. Ardipithecus ramidus	Most primitive man	Africa
b. Australopithecus afarensis	Slender body.	Africa
c. Homo habilis	Made weapons from stones and bones First 'Homo'	Africa
d. Homo erectus	Thick chin and large teeth, Ability to stand erect	Africa and Asia
e. Homo neanderthalensis	Contemporary to modern man	Europe and Asia
f. Homo sapiens	Modern man	First in France

Interventions of modern man brought climatic change as well as extinction of many organisms.

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