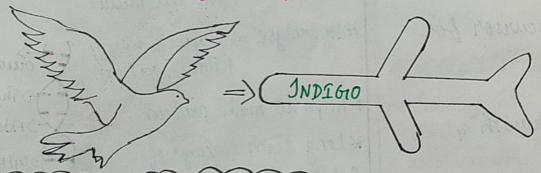
BIOINSPIRATION

Definition :-

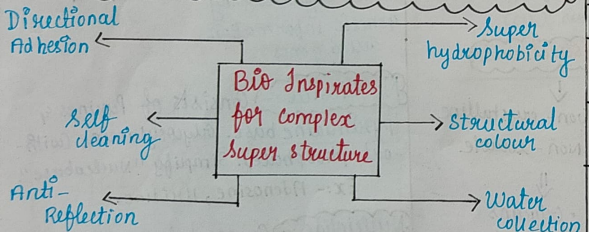
⇒ Bio Inspiration design is studying the structure & function of biological systems

⇒ The model & design the term bio means "life"

⇒ Development of novel material devices & structures in biological systems.



PROPERTIES OF BIOINSPIRATION DESIGN



TYPICAL BIOLOGICAL FUNCTIONS WITH INTEGRATION

* Butterfly Wings :- Superhydrophobicity, structure colour, self cleaning chemical sensing cability
* fish Scale :- Drug reduction, superlicophilicity in air & water.

Lotus Leaf :- Super hydrophobicity, low adhesion.

Rice Leaf :- Super hydrophobicity, anisotrophic wettability

BIOMIMICRY

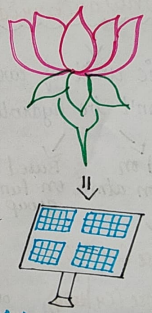
⇒ Biomimicry is a innovation method that seeks suitable solutions by Emulating nature.

⇒ The time-tested patterns and strategies in order to solve human problem

* Eg :- Solar cell is inspired by a leaf

Future Innovations :-

Source (Nature)	Innovations
Ant-colony Network	Repair System
Sharks	Antibiotics, cure to cancer
Bat	Ultra-cane



Advantages :-

⇒ To create products, processes & policies. To create new ways of livings.

⇒ To create suitable products with great performances. To save energy & cut materials cost

⇒ To redefine & diminate waste.

BIOMIMETICS

⇒ Biomimetics is used & deals with the development of innovations on the basis of investigation of chemical.

⇒ Biological structures, functions methods process & systems.

Bios → Life

Mimesis → Imitate

TYPES OF BIOMETIC :-

Natural	Synthetic
Less Availability	More availability
Difficulty Isolation	Relatively Easier
Risk of Pathogen transmission	Reduces risk of Pathogen transmission
Reduced Amenability	Tailorability.

Applications

⇒ Material Science
⇒ Mechanical design
⇒ Electronics & communications
⇒ Infrastructure
⇒ Nanotechnology
⇒ Psychology

BIOMOLECULES

⇒ chemicals (or) molecules present in any living organisms.

⇒ (Compound + Ions) in a cell is called cellular pool.

⇒ Compounds of carbon.

TYPES OF BIOMOLECULES

* **InOrganic Biomolecule**

⇒ which has 'no carbon atom' present

Ex :- Minerals / gases / water

* **Organic Biomolecule**

⇒ which has 'carbon atom' present

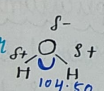
Ex :- Carbohydrate / Lipids / Amino Acid.

* **Based On Size :-**

* **Micromolecule** :- Small size, low molecular weight, size (18 - 800 dalton)

⇒ found in Soluble pool.

Ex :- Sugar, fatty acid, water



* **Macromolecule** :- Large size, high molecular weight, size (above 800 dalton).

⇒ found in Insoluble Pool.

Ex :- Nucleobase, DNA & RNA

CARBOHYDRATES

⇒ Derived from french word

⇒ Hydrate de carbon / hydrate of carbon

⇒ $(n(H_2O)n$ (Polyhydroxy Aldehyde / ketose)

⇒ Most abundant Organic molecule.

functions Of Carbohydrates

* Most abundant source of Energy (~ 4 cal/g). Precursor for many organic compounds.
* Present in glycoprotein & glycolipids for cell growth & fertilization.
* storage form of Energy.

TYPES OF CARBOHYDRATE

Monosaccharide

• Basic unit of carbohydrate
• Cann't be hydrolysed

Based on carbon atm

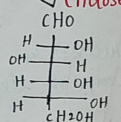
⇓

* Triose ($C_3H_6O_3$)
* Tetrose ($C_4H_8O_4$)
* Pentose ($C_5H_{10}O_5$)
* Hexose ($C_6H_{12}O_6$)
* Heptose ($C_7H_{14}O_7$)

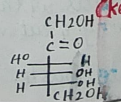
Based on functional group

⇓

(Aldose)



(Ketose)



Oligosaccharide

⇓ further hydrolysed

⇒ 2-9 monosaccharide

* Disaccharide
* Trisaccharide
* Tetrasaccharide

Polysaccharide

• Non-crystalline
• Non-soluble

⇓

• Glycans
• forms by glycosidic bond
• Ideal Compound

Homoglycan
* Made up of 1 type of monosaccharide
Ex :- Starch

Heteroglycan
Made up of 2 more type of saccharides
Ex :- Agar

Nucleic Acids

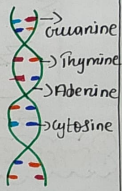
⇒ Largest & most complex Organic molecule.

⇒ Friedrich Mieschen discovered in 1871.

TYPES :- DNA : Deoxy Ribonucleic Acid
RNA : Ribonucleic Acid.

DEOXYRIBOSE NUCLEIC ACID

* found in Yeast cell nuclei
* Hydrolyse ⇒ Sugar & deoxy ribose ribose
* Helps to make protein
* Long term storage of information.
* DNA segment carry genetic information called genes



Nucleoside :- Consists of Purines & Pyrimidine base. Glycosylamine (without phosphate). Simplify "Nucleobase".

Ex :- Adenosine, Uridine.

Nucleotide :- Composed of nucleobase with phosphate group. Ex :- ATP, UTP

Ribo Nucleic Acid :- similar structure of DNA. Sugar + phosphate joined.

⇒ mRNA - Protein Synthesis
tRNA - Transfer AA to RNA
rRNA - Provides structure of ribosome

Lipids - classification & function

Lipids:

Lipids are substances of biological origin that are soluble in organic solvent such as chloroform and methanol.
Eg: fat, oils, vitamins and hormones

Properties: They are,
- → Not polymeric
- → Do aggregate
- → Hydrophobic.

Functions:
- → It aggregate to form structures such as lipid bilayer, Micelles & liposomes.
- → It act as a energy storage.
- → It act as a signalling molecules.

1) Fatty acids:

→ Fatty acids are carboxylic acids with long chain hydrocarbon side group. It occurs in esterified form. The double bonds all have the cis-configurations.

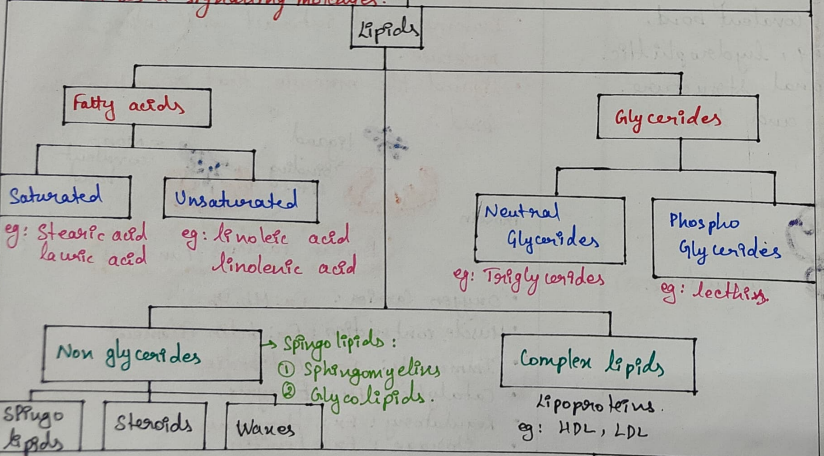
(a) Saturated fatty acids:

→ Having predominantly single bonds. Eg: Palmitic acid and ($CH_3(CH_2)_{14}COOH$)
Stearic acid ($CH_3(CH_2)_{16}COOH$)

(b) Unsaturated fatty acids:

→ Having at least a single - double bond with in the fatty acid chain.

Eg: Palmitoleic acid
$CH_3(CH_2)_5-CH=CH(CH_2)_7COOH$.



Oxydation of Fatty acids:

- $-C-C-C-COOH \xrightarrow{O_2} -C-COH-C-COOH$
  Saturated — difficult
- $-C=C-C-COOH \xrightarrow{O_2} -COH-COH-C-COOH$
  unsaturated — easy

Oxidation → decomposition → Rancidity
→ More saturated → More stable.
eg: Commercial baked goods.
→ More unsaturated → faster deterioration
eg: Antioxidants to protect compounds.

2) Glycerol:

→ It is a simple polyol compound.
→ The glycerol backbone is formed in those lipids known as glycerides.

CH_2-OH
$CH-OH$
CH_2-OH

3) Non- Glycerides:

→ Non-glycerides lipids are not delivered from glycerol but can be visualized as a three-carbon backbone molecules. Lipids contain triglycerides.
→ Non glycerides lipids contain,
(a) Sphingolipids eg: spongosine.
(b) glycolipids eg: cerebroside
(c) Steroids eg: cortisol
(d) Waxes eg: candles.

4) Glycerides:

→ Esters formed from glycerol and fatty acids.

(a) Neutral glyceride
An uncharged fatty acid ester of glycerol.

Saponification:
Formation of soap $3NaOH/H_2O$
Triglyceride $\xrightarrow{heat}$ glycerol + Soap

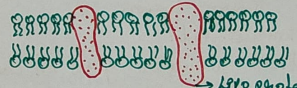
5) Phospho glycerides:

→ Phosphate group is present
eg: Phosphatidic acid.
Phosphatidyl choline.
Phosphatidyl ethanolamines
Phosphatidyl inositol.

Liposomes:

Micesses:

Lipid bilayer:



HDL → High density lipoproteins
LDL → Low Density lipoproteins.

Proteins

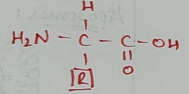
- Macromolecule formed by amino acid.
- Large size molecule.
- Total 20 different AA exist in protein
- Found in all cells.
- Polymers of AA covalently linked by peptide bond.

Protein —hydrolysis→ peptide —Hydrolysis→ Amino acid

Structure of proteins

i) Primary structure :

- It is linear form
- Ordered one
- 1D
- Made sequence of AA of peptide chain
- Amine end to carboxylic end (conversion)



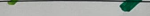
Example :- Insulin.

} Diff types of Amino Acid groups

ii) Secondary structure :

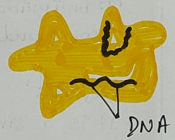
- Non-linear form.
- 3 dimensional.
- Localized to region of an AA chain.
- Stabilized by hydrogen bond, van der waals interaction.

Example : α-helix , β-helix.



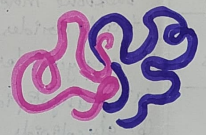
iii) Tertiary Structure :

- Non-linear.
- 3 dimensional
- Global but restricted to the AA polymer.
- Stabilized H-bond, covalent, hydrophobic packing towards core. hydrophillic exposure to solvent
- Globular AA polymer folded and compacted & functional intension



iv) Quaternary Structure :

- Non-linear
- 3 dimensional
- Global, Across distinct AA polymer
- Formed by H-bond, Covalent bond, hydrophobic packing, hydrophillic.
- Favorable, functional structure. occur frequently and have categorized.



Classification of Protein

Based on Structure :

- Fibrous proteins – Long distance in the cell
- Globular proteins – Spherical protein
- Intermediate proteins – Filament of the cytoskeleton

Based on composition : Simple & Conjugated

Simple Proteins :

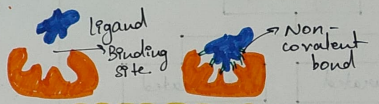
Albumin, Globulins, Histones, Scleroprotein.

Conjugated Proteins :

Phosphoprotein, Glycoprotein, Nucleoprotein, Chromoproteins, lipoprotein, Flavaprotein.

Protein works

- Conformation of a protein → unique function
- Proteins must interact with other molecule.
- Ligand the molecule that a protein can bind.



Protein Factors / Functions

- Oxygen Carrier : Ex: Mb, Hb.
- Muscle contraction : Ex: Actin Filament
- Immunity : Ex: Antibodies
- Catalytic : Ex: Enzyme.
- Regulatory : Ex: Hormones
- Storage : Ex: Ferritin.

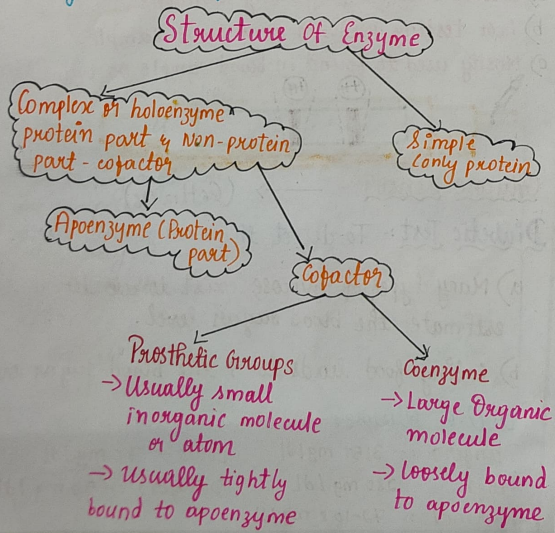
ENZYMES :-

- Enzymes are proteins that increase the rate of reaction by lowering the energy of activators.

Importance :-

* Plays a important role in metabolism, diagnosis & Therapeutics.
* All biochemical reactions are enzyme catalyzed in the living organism.
* Level of Enzyme in blood are of diagnostic importance. Eg :- Good Indicator in disease such as myocardial infraction.

Structure Of Enzyme



Classification Of Enzyme :-

Ec 1. Oxidoreductase

Oxidation → Reduction ⇒ Enzymes Involved in oxidoction - Reduction reactions

$AH_2 + B \longrightarrow A + BH_2$

Ec. 2. Transferase

Group Transfer ⇒ Enzymes that catalyse the transfer of functional group.

$A-X + B \longrightarrow A+B-X$

Ec. 3 Hydrolases

Hydrolysis ⇒ Enzyme that brings about hydrolysis of various component

$A-B + H_2O \longrightarrow AH + BOH$

Ec. 4 Lyases

Addition → Elimination ⇒ Enzymes Specialised in the addition or removal of H_2O, ammonia, CO_2, etc.

$A-B + X-Y \longrightarrow AX-BY$

Ec. 5 Isomerases

Interconversion of Isomerase ⇒ Enzymes involved in all the Isomerisation reacting

$A \rightarrow A'$

Ec. 6 Ligases

Condensation (usually dependent on ATP) ⇒ Enzymes catalysing the synthetic reaction where two molecule are joined.

$A + B \xrightarrow[ATP \; ADP+Pi]{} A-B$

TYPES OF COFACTORS :-

Coenzyme :- The non protein component, lossely bound to apoenzymes by non-covalent bond.
Eg :- Vitamins.

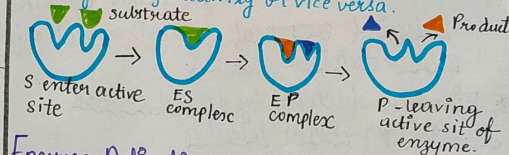
Prosthetic Group :- The non protein component, tightly bound to apoenzyme by covalent bonds.

Activity of Enzyme :-

Active Site :- The area on the enzyme where the substrate or substances attach to is called 'active site'.

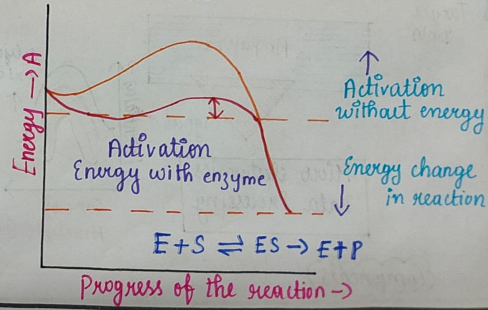
Enzyme Posses 3-characteristic features

* Increases rate of reaction
* One enzyme acts spicifically on one substrate to form product.
* Enzymes can be regulated from a low activity to high activity or vice versa.



Enzyme Activation :-

* Catalysis is the primary function of enzyme
* Enzymes are Powerful catalysts. The nature of catalyses taking place in the biological system is similar to that of non-biological catalysis.
* For any chemical reaction to occur the reactant have to be in an activated state or Transistion state.



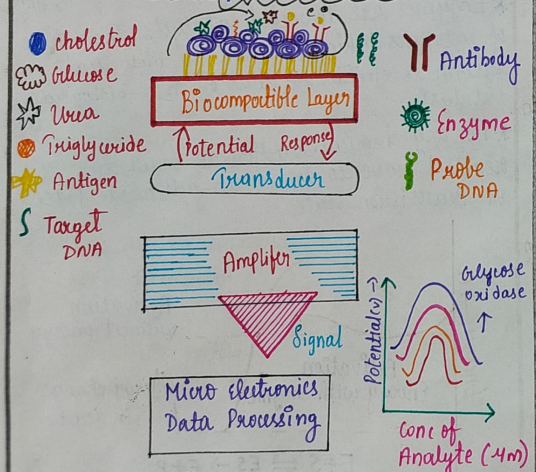
Sensors

⇒ Sensors are devices transforming non-electrical signal from :- Biological radiation, physical & chemical.

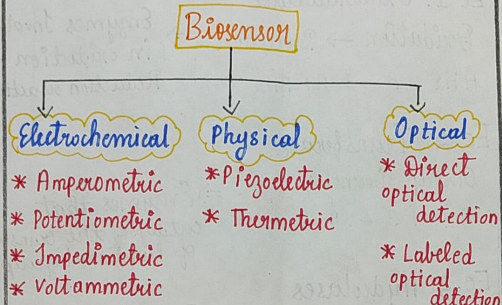
Biosensors

* A biosensors is an analyte device used for detection of an analyte, that combine a biological component of environment with a physico chemical defector.
* Biosensor developed by Leland C. Clark Jr. (1956) for oxygen detection.

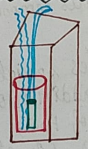
Principle of Biosensor



Types Of Biosensors

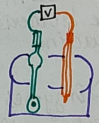


Colorometric : change in Δ used to determine concentration



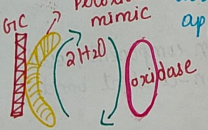
Piezoelectric :- Measure quartz vibration under the influence of electric field.

Potentiometric :- pH meter used to measure rxn (or) absorb $H^{\oplus}$ ion.



Immunosensor :- To detect & amplify an antigen-antibody rxn.

Ampexometric :- Function by production of current when potential is applied.



Optical : To determine the change in light absorption b/w reactor & product.

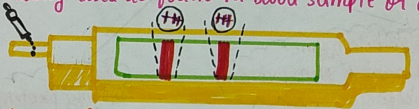
Applications Of Biosensor

* Food Analysis
* Study of Biomolecules
* Drug development
* Crime detection
* Medical Diagnosis (Clinical / Lab)
* Environmental field Monitoring
* Quality Control
* Industrial Process Control.

Protein Biosensor :

Pregnancy Test :- To detect hcg protein in urine

a) Detect human pregnancy hormone
b) hcg testing perform on a blood sample.
c) Mostly used to found in blood sample or urine.



Glucose Sensor :- ⟶ $(C_6H_{12}O_6)$

Diabetic Test :- To detect the blood glucose level.

a) Many types of glucose exist to use to estimate the blood sugar level.

b) Eating food leads to ↑ the blood sugar level.

Level of Glucose :

Danger ↑ :- 315+ mg/dl
High :- 280 mg/dL
Normal :- 72-108 mg/dl
Low :- 70 mg/dl
Danger ↓ :- 50 mg/dl

Cells

→ Smaller living unit
→ Most are Microscopic.

Discovery of cells

* In 1665, Robert Hooke coined the term cell.
* Observed slices of cork.
* Saw "row of empty boxes".

Cell Theory

(a) Theodor Schwann (1810-1822) all living things are made of cells.

(b) Rudolph Virchow. (1821-1902) All cells come from cells.

Principle of cell theory:

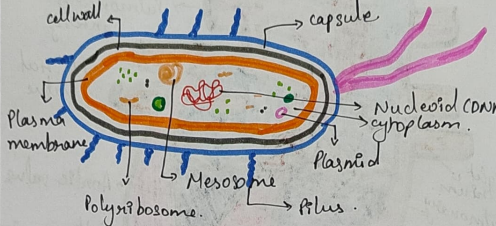
(a) Classical cell Theory:
=> All living organisms are composed of cells
=> They may be unicellular or multicellular
=> The cell is the basic unit of life.

(b) Modern version of cell theory:
=> Energy flow occurs within cells
=> Heredity information. (DNA) is passed on from cell to cell.

Cell structure & functions:

cell size: cell have large surface area to volume ratio.

Types: Prokaryotic cell:



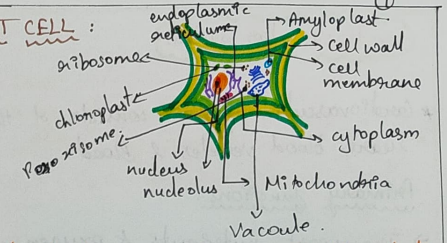
=> First cell type on earth.
=> No membrane bound nucleus.
=> Nucleoid = Region of DNA concentration.
eg: Bacteria & Archea.
=> Prokaryotes are primarily unicellular organisms, though some can form colonies or biofilms.
=> Size: 0.1 - 5.0 micrometers (μm) in diameter.

Eukaryotic cell:
=> Nucleus bound by membrane.
=> Posses may organells. like "bacteria like organells" & organelles derived from membrane.

(a) Bacteria-like Organelles:
→ Derived from symbiotic bacteria.
→ Ancient Association
→ Endosymbiotic Theory.

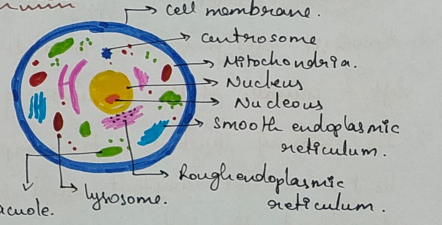
(b) Organelles derived from membrane:
Plasma membrane: Contains cell contents double layer of phospholipids.
Phospholipids: hydrophobic head & hydrophobic acid.

PLANT CELL:



→ Plant cell have rigid cell wall for protection. and structural support.
→ Chloroplasts are for photosynthesis. converting light energy into chemical energy.
→ A large central vacuole maintains cell turgor, stores nutrients, and waste products.
→ Plasmodesmata allow communication and transport between plant cells.

ANIMAL'S CELL:



→ Animal cells lack a rigid cell wall but have a flexible plasma membrane.
→ Lysosomes are present for digestion and waste removal.
→ Centrioles involves in cell division by helping organize the mitotic spindle.
→ Mitochondria → energy production.
→ Endoplasmic reticulum → Protein and lipid synthesis.
→ Golgi complex → protein modification & storage.

Cardiovascular system

* Cardiovascular system consists of the heart, blood veseles & Blood.

Primary functions:

→ Transport nutrients & oxygen rich blood to all parts of the body

→ To carry deoxygenated blood back to the lungs.

Heart

=> Heart is one of the most essential & functional part of the human body. It lies in between the lungs in the thoracic cavity, slightly towards the left & beneath of the sternum.

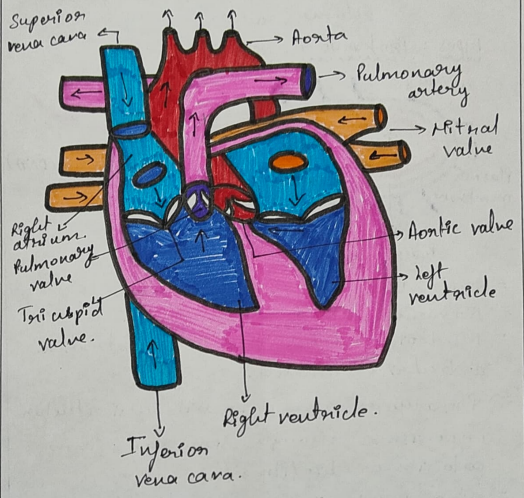
=> It's Primary function is to pumps the blood & maintain constant blood flow throughout the body.

Structure of the human heart:

The human heart is about the size of the human fist & is divided into four chambers namely => Two ventricles → Left & Right
Two Atrium → Left & Right

- Ventricles are the chamber that pumps blood.
- Atrium are the chambers that recieves the blood.

Cardiovascular System



Right atrium: Recieves the deoxygenated blood from the superior vena cava & inferior vena cava & pumps blood to right ventricle through 'Tricuspid valve'.

Right ventricle: Pumps blood to the lungs through the pulmonary valve.

Left Atrium: Recieves the oxygenated blood from the lungs & pumps to the left ventricle through the 'mitral valve'.

Left ventricle: Pumps oxygenated blood to the all body parts through aortic valve.

External structure of heart:

Pericardium: The human heart is enclosed within a fluid cavity called as pericardial cavity. The walls & linings of the pericardial cavity are made up of membrane known as the pericardium.

Heart wall is made up of:

1) **Epicardium:** Outermost layer of the heart. It is composed of a thin layered membrane that to lubricate & protect the outermost section.

2) **Myocardium:** This is a layer of muscle tissue and it constitutes middle layer wall of the heart. Mainly responsible for pumping action.

3) **Endocardium:** Inner most layer that lines the inner chamber & covers the heart valves.

Valves

Atrioventricular valves

- The valve present between right ventricle & right atrium is known as 'Tricuspid valve'.
- The valve present b/w left ventricle & left atrium is known as "Mitral valve".

Semilunal valves.

- These valves are present between left atrium & aorta.
- It is also present between the pulmonary artery & right ventricle.

Blood circulation

Pulmonary circulation:
Right Atrium → Right ventricle → Pulmonary track → Pulmonary artery → lungs → Pulmonary veins → left atrium.

Systematic circulation:
Left atrium → Left ventricle → Aortic valve → All body parts → superior & inferior vena cava → Right atrium.

RESPIRATORY SYSTEM

1) Introduction :

→ Inhale O_2

→ Exhale CO_2

→ Exchange of $O_2 + CO_2$ is called respiration.

2) Function :

→ Allows you to talk and smell.

→ Delivers O_2 to the cells in your body.

→ Removes waste gases

→ Protect → harmful substances & irritations.

3) Anatomy :

Respiratory System

- Upper Respiratory Track: Nose, Mouth, Pharynx, Larynx, Trachea.
- Lower respiratory Track: Lungs, Bronchides, Alveoli.

Air Entrance :

→ Air enters via mouth / nostrils
- ↳ Passage → warm → Blood capillaries
- ↳ Moist → Mucous.
- ↳ filter → hairs (cilia).

The Pharynx :

→ The common passage for food & air.

Pharynx.

- Esophagus (leads to stomach)
- Trachea (part of the respiratory system)

The Larynx :

The Larynx - voice box

* Vibrate - make sound

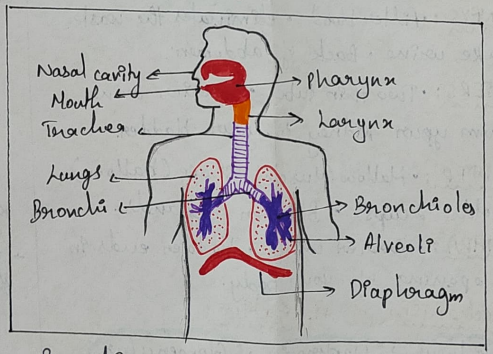
The Trachea :

→ air → trachea → larynx

→ Cartilage of rings

→ inner - cilia - removes / filters dust particles.

→ trachea < left Bronchi, Right Bronchi



Bronchi :

→ Divides into smaller branchioles.

→ At the end - Alveoli (air sacs)

Alveoli :

→ Air Sacs

→ Exchange of gas takes place.

→ 100 millions of alveoli.

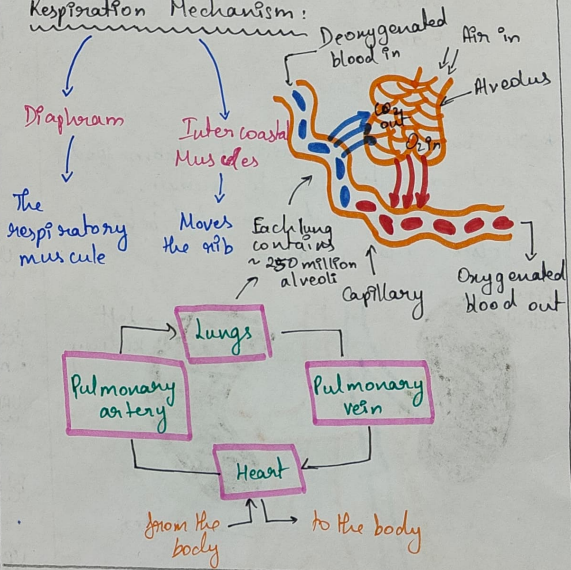
→ Blood ← O_2 ← Alveolar air

↓

rest of the body

→ Alveoli → CO_2 → exchange.

Respiration Mechanism :



During Inhalation	During Exhalation
→ External muscles between the ribs contract & moves up	→ The rib muscles - relax.
→ Chest cavity - increases	→ Chest cavity - reduced.
→ Diaphram - contract.	→ Diaphram - releases.
→ Air → nose → lungs ← Trachea	→ Int. pressure → increases Air → lungs.

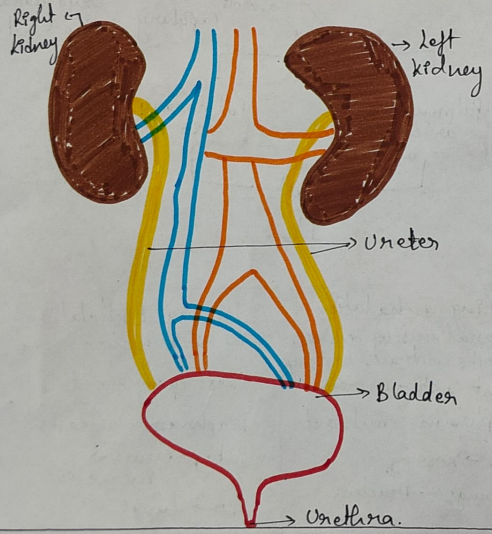
Function of urinary system:

* To filter blood and create urine as a waste by product.

Organs of urinary system:

- → kidneys
- → Renal Pelvis
- → Ureters
- → Bladder
- → Urethra

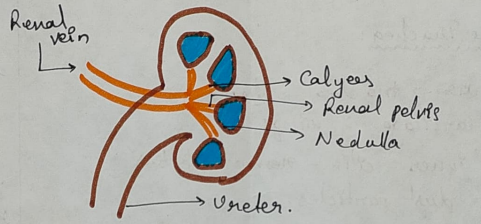
* The body takes nutrients from food and converts them to energy.
* The waste products are left behind bowel and in blood.



RENAL SYSTEM

The kidney & urinary system help the body to eliminate the liquid waste called UREA. Urea is carried in the blood stream to the kidneys, where it is removed along with water and other wastes in the form of urine.

ANATOMY OF THE KIDNEY:



Urinary System: The kidney, ureters, Bladder, urethra.

KIDNEYS: • filter blood • eliminates the waste • make urine • Back of abdomen.

URETERS: • Two thin tubes • Carries urine from your kidney to your bladder.

BLADDER: • Hallow (Muscle) • Shape (balloon) • holds (2 cups) • Bladder expands.

URETHRA: • Carries urine • bladder ends in an opening of your body.

Mechanism of filtration:

Kidney → Nephron → Glomerular capsules

Kidney	Nephron	Glomerular capsules
* Filtration	* Bunch of capillaries	* process
* Renal corpscle	* process	* Re-absorbs water + solute.
* Renal lobule	* Re-absorbs water + solute.	* Collective duct.
* Medulla	* Collective duct.	
* Cortex		

Urine Production:

1) Filtration:

* Blood forced through a membrane
* Only tiny particles pass through

2) Reabsorption:

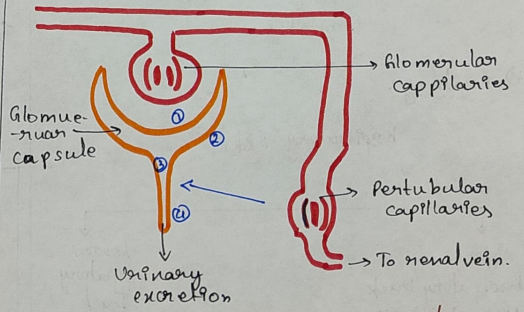
* Water & glucose go back to blood.
* All the waste will become urine.

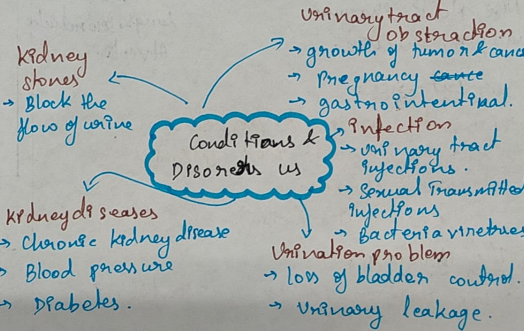
3) Secretion:

* Components of blood join filtrate.
* Drugs / Metabolites / potassium etc.

4) Excretion:

* Water + urea / nitrogenous waste.
* Also includes ionic solutes.

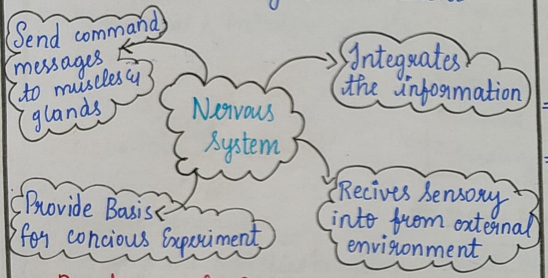




NERVOUS SYSTEM

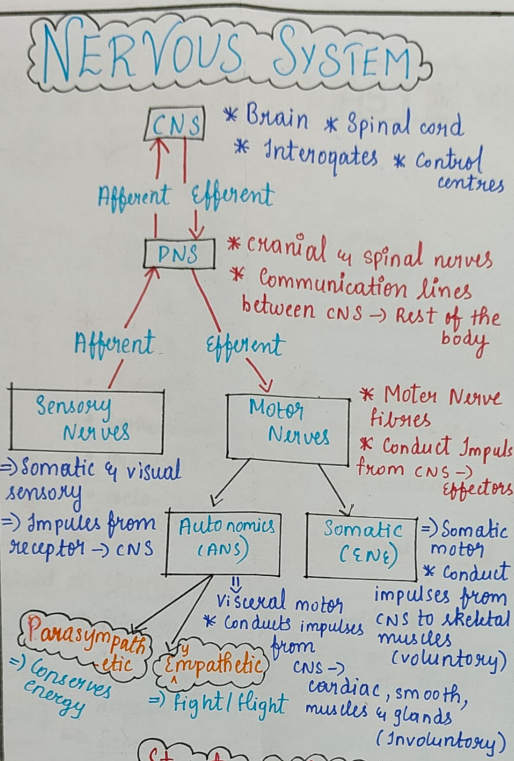
1. INTRODUCTION :-

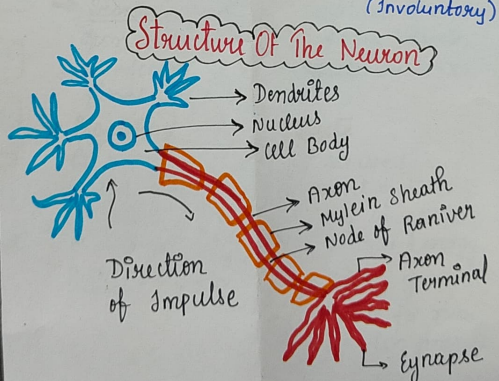
→ Controls various complex functions
→ Co-ordinates
→ Composed of brain, sensing devices & high speed communication.
→ Responsible - Learning, Memory, acquiring, interaction with Society & Environment.



2. Anatomy Of The Nervous System :

* Neuron - Basic unit
* Single cell - Cell Body - Somatic cells
* Dendrites Axon - Long transmitting fibre
* Sensory - Neuron → Info → SD → Nerve → CNS
* Motor - Neuron → Info → CNS → Nerve → Muscles & glands
* Inter neuron - CNS → carry message from one set of neuron to other.





Dendrities :- * Receive Message
* Allow transmission of messages to the cell body.

Cell Body :- * Each neuron has => cell body with nucleus, golgi body, endoplasmic veticlum, mitochondria.

Axon :- * Tube-like structure, carriers electrical impulse → Cell body - Axon - other neuron.
* surrounded by mylein sheath.

Synapse :- Chemical Impulse. One neuron → terminal → Dendrite of other.

How Do Neurons Work :-

* Sending chemicals - Neurotransmitters
* from one neuron → Dendrite of other
* Exchange of information => synapse
* Neurons => CNS & PNS to report Information
* Information enables us to think, talk, move etc.

Neuron functions :-

chemical Synapse :-
Action potential → Axon → post synapse response → releases chemical messengers & neurotransmetters.

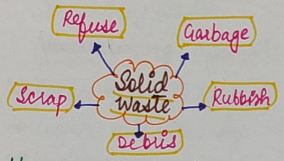
Electrical Synapse :-
Neurons are connected by a gap functions → result in an electrical synapse → faster than chemical synapse.

INTEGRATED SOLID WASTE MANAGEMENT

Solid Waste

→ It comprises of all the wastes arising from human and animal activities that are typically solid & are useless.

→ It is all-inclusive of the heterogeneous mass from the urban community as well as more homogeneous accumulation of agricultural & industrial wastes.



Waste Generation

→ Encompasses activities in which materials are identified as no longer being of value.

→ Generated from households, commercial areas, industries, other municipal services.

Collection of solid waste

→ Process of collection of solid waste from point of production to the point of treatment.

→ It also considers all activities related to loading of waste into collection vehicles, unloading waste from vehicles at collection points, processing places, transfer stations & final disposal sites.

PILLARS OF ISWM

- Waste system elements
  - Generation
  - Segregation
  - Collection
  - Transportation
  - Disposal
  - Recycling
- \+ Key Performance Indicators
  - Technical
  - Economic
  - Environmental
  - Institutional
  - Socio-cultural
- \+ State holders
  - Community members
  - ULB officials,
  - Sanitation officials, engineers
  - Waste collectors
  - NGOs
  - Ragpickers

Phases Involved

House to dustbin
↓
Dustbin to truck
↓
Truck from house to house
↓
Truck to transfer station
↓
Truck to disposal

Classification

→ Primary collection - Collection of solid waste from the source of generation & transportation of waste to the final disposal site.

→ Secondary collection - Collection of waste from communal bins, storage points, transfer station & transportation to the final disposal site.

Classification (B/o mode of operation)

→ Hauled container System (HCS) - Commercial & C K D waste

→ Stationary container system (SCS)

Processing of solid waste

Processing techniques are used in solid waste management systems to improve the efficiency of operations & to recover conservation products & energy.

PURPOSE:-
- Improving efficiency of SWMS.
- Recovering material for reuse
- Recovering conversion products and energy.

Processing → Onsite / Offsite

I. Onsite Processing

- Low rise dwelling: Grinding, sorting, Compaction, Composting, Incineration.
- Medium & High rise: Compaction, Incineration - Flue fed, chute fed
- Shredding and pulping

II. Offsite processing

- Mechanical volume reduction: Compaction equipment, pulverizer.
- Mechanical size reduction: Hammer mills, hydropulpel
- Chemical volume reduction: Incineration, pyrolysis
- Component seperation: a) Manually - Hand sorting
  b) Mechanically - Air seperation, screening, Magnetic seperator
- Drying and dewatering

Recovery of solid waste

→ Recycling is a resource recovery practice that refers to the collection and reuse of disposed materials such as empty beverage containers.

→ The materials from which the items are made can be reprocessed into new products.

→ The most common consumer products recycled include aluminium, polyethylene, PET bottles, glass bottles & jars.

→ PVC, LDPE, PP and PS are also recyclable. These items are usually composed of a single type of material, making them relatively easy to recycle to new products.

TREATMENT METHODS

I. NEUTRALIZATION :-

- The volumes of landfilled waste are significantly decreased through waste neutralization.
- Hazardous waste is neutralised by the controlled chemical reaction of an acid or base, which results in non hazardous substances like water or salts.
- Once the pH has been adjusted b/w 2 & 12.5, it is no longer a "hazardous waste".

Neutralizing agents

→ Copper sulphate / Nitric acid
→ Copper nitrate, copper sulfate
→ Hydrochloric acid / Pyridine
→ Copper nitrate / Sodium nitrate
→ Ammonium hydroxide.

II. OXIDATION & REDUCTION :-

* Reduction / oxidation (Redox) reactions chemically convert hazardous contaminants to less toxic compounds.
* Redox reactions involve the transfer of electrons from one compound to another.
* One reactant is oxidized & one is reduced.
* The oxidizing agents most commonly used for treatment of hazardous contaminants like ozone, hydrogen peroxide.

III. SOLIDIFICATION :-

- Solidification refers to a process in which waste materials are bound in a solid mass, often a monolithic block.
- The waste may or may not react chemically with the agents used to create the solid.
- Solidification is generally discussed in conjugation with stabilisation.

Solidification process is applicable in the following :-

→ waste does not meet the leachability classification requirements for the disposal.
→ waste is liquid or releases liquid phase by sedimentation.
→ chemical composition of the waste has possible negative effects on the quality of leachate.
→ Waste is dusty or reacting and may exceed defined emission.
→ Disposal of unmodified waste may be result in an adverse reaction with the waste disposed in active layer.
→ Contaminants are fixed using binding & filling agents like
- cement
- fly ash
- hydraulic lime
- hydratic lime

IV. INCINERATION :-

- Incineration is the process of control and complete combustion for burning solid wastes.
- It leads to energy recovery & destruction of solid wastes.
- In these plants recyclable material is segregated & rest material is burnt.

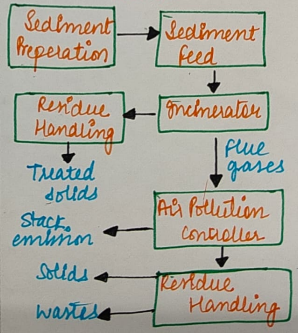
Advantages

→ The amount & volume of the MSW can be reduced.
→ Waste to energy.

Disadvantages

→ Not all waste can be burned.
→ Disposal of the ash
→ Release hundreds of toxic chemicals into atmosphere.
→ Highly related to economic condition.

Process



V. DISPOSAL :- (Methods)

Dumping : Refuse is dumped in low lying areas. As a result of bacterial action, refuse decreases considerably in volume and is converted into humus.

Composting : It is a method of combined disposal of refuse & night soil. The heat produced during is more ≯60°C. The end product is a good soil builder.

Manure pits : the garbage, cattle dung, straw, & leaves should be dumped and covered with earth. this is effective in rural communities.

Burial : For small camps. the contents are used after four to six months.

VI. LANDFILLS :-

* A landfill is an engineered method for land disposal of solid waste.
* The purpose of landfilling is to bury the chemical composition of the waste so that they do not pose any threat to environment / public health.

Landfill settling process :-

→ Primary consolidation
→ Secondary compression
→ Decomposition

VII. LANDFILL LEACHATE :-

- During landfill site operation, a liquid known as leachate is formed.
- It is a mixture of organic degradation products & rain water.
- It has high organic carbon content, high concentrations of nitrogen and is usually slightly acidic.

Toxicology:

History:

→ Father of toxicology - philip Von Hohenheim.

Terms:

Toxin: substances produced naturally.

Toxic: This term relates to deadly effects on body / poisonous.

Toxicants: Any chemical that can injure or kill humans, animals, plants

Toxicity: Describes the degree to which a substance is poisonous / causes injury.

The toxicity depends on a variety of factors: dose, duration and route of exposure, shape and structure of chemical itself and individual human factors.

what is Toxicology:

Science of poison → The study of how natural or man made poisons cause undesirable effects in living organisms.

Sub-disciplinary of Toxicology:

Environmental, Occupational (industrial), Regulatory, Food, clinical, Forensic Toxicologies.

TOXICODYNAMICS:

→ The study of toxic actions of xenobiotic substances on living organisms.

→ TD is concerned with what the toxicant do to the body.

How toxicokinetics can influence the toxicity?

Absorption: A toxic xenobiotic which is poorly absorbed may not cause toxicity.

→ It is the first rate limiting step

→ No absorption = No toxicity.

factors affecting absorption:

Factors related with chemicals:

→ Physiochemical properties.

→ Concentration at absorption site.

→ physical form.

Factors related with site of exposure:

→ Blood flow

→ surface area

→ Permeability.

Distribution: The distribution of a toxicant to a tissue other than the target organ decreases it's toxicity.

→ only free fraction xenobiotic is active.

Metabolism

→ Also known as Biotransformation.

→ Two substances with equal absorption rate may differ in toxicity depending on their biotransformation.

→ Generates more water soluble, inactive metabolites.

→ Readily excreted from body.

Elimination / Excretion:

→ The toxicity of xenobiotic depends on its elimination rate from an organism.

→ Xenobiotics are excreted / eliminated from the body in the form of the Parent compounds, their metabolites and their conjugates.

The primary excretion/elimination routes:

→ Urinary - Renal

→ Fecal

→ Respiratory - exhalation

→ other.

Acute & chronic toxicity:

⇒ Acute toxicity occurs from a single dose of toxin. Chronic toxicity occurs from small doses of toxins administrated to an organism over time.

⇒ example of Acute toxicity: Snake bite.

⇒ example of chronic toxicity: cigerretes, etc.

BIO-ASSAY

Bioassay is defined as estimation of potency of an active principle in a unit quantity of Preparation.

Principle of Bioassay:

To compare the test substance with the international standard preparation of the same and to find out how much test substance is required to produce same biological effect as produced by the standard.

Importance: It is the only method of Assay. If

1. Active principle of drug is unknown. or can't be isolated.
2. Chemical method is either not available or if available, it's too complex & intensive, requires high dose.
3. Chemical composition is not known.
4. Chemical composition of drug differs but have the same physiological, Pharmalogical action and vice-versa

ex: cardiac glycosides, catecholamines, etc.

Types of Bioassay:

1. Quantal Assay: either no response / max. response. Drug producing quantal effect can be bioassayed by End-point method.
2. Graded Assay: Response is proportional to the dose and response may lie between No or max. response.

Types: direct matching, Interpolation, Multiple Point assays and cumulative dose response.

BIOREMEDIATION

Bioremediation is the use of microorganisms to destroy or immobilize waste materials.

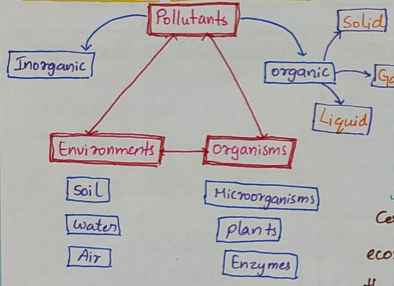
Microorganisms include:

→ Bacteria (aerobic and anaerobic)

→ Fungi

→ Actinomycetes (filamentous bacteria).

A TRIPLE-CORNERS PROCESS:



Bioremediation Mechanism:

Microorganisms destroy organic contaminants in the course of using the chemicals for their own growth and reproduction.

Organic chemicals provide:

Carbon: source of cell building material.

electron: source of energy.

BIOINDICATOR SPECIES:

Bioindicators are the organisms that indicate or Monitor the health of the Environment.

A Good bioindicator will indicate the precence of the pollutant and also attempt to provide additional information about the amount and intensity of the exposure.

Bioluminescent bacteria as Bioindicators:

Bioluminescent bacteria: used to test water for environmental toxins. The toxins present in water affects the quality of light emitted by bacu. Takes 30 mins to complete but could not identify the toxin.

Plant system: The presence or absence of Certain plant or other vegetative life in an ecosystem can provide important clues about the health of environment. They can be from both higher and lower classes of plants.

Animal system: An increase or decrease in an animal population may indicate damage to ecosystem caused by pollution. In addition to monitoring the size & no. of certain species, of animal indication includes monitoring the concentration of toxins in animal tissues/ monitoring the rate at which deformities arise in animal population.

BIOFERTILIZERS:

Biofertilizers are natural fertilizers that are microbial inoculants of bacteria, algae and fungi. which may help in biological Nitrogen fixation and helps build up soil micro-flora & soil health. They include organic fertilizers like manure, etc. Improves organic farming by improving soil fertility.

Types of Biofertilizers:

Bacteria: Symbiotic N_2 fixers:
→ Rhizobium, Azospirillum spp.
Free-living N_2 fixers:
→ Azatobacter, Klebsialla, etc.

Algal biofertilizers:
→ BGA in association with Azolla
→ Anabena, Nostoc, Ocillatoria.

Phosphate solubilizing bacteria:
→ Pseudomonas
→ Bacillus megaterium.

Fungal biofertilizer:
→ VAM

Earthworms

Biofertilizers applications:

Three ways of using N_2-fixers.

→ Seed treatment
→ Root dipping
→ Soil applications.

BIOFUELS:

Biofuel is the fuel which is produced from organic products and wastes.

Classification of Biofuels:

→ 1st Gen biofuels: sugar, starch, ..
→ 2nd Gen biofuels: wood, straw, ..
→ 3rd Gen biofuels: marine algae.

Bio Gas: fuel used as domestic purpose. obtained from vegetable, fruit waste and cow manure.

application of Biogas:

→ cooking → lighting → Fuel for engine.

Advantages of Biofuels:

→ Renewable
→ Reduces Greenhouse Gases
→ Economic security
→ Easy to source
→ lower level pollution.

Disadvantages of Biofuels:

→ High cost of production
→ Industrial pollution
→ Future rise in price
→ Shortage of food
→ Use of Fertilizer.

Common types of biofuels:

→ Bioethanol
→ Biodiesel
→ Biobutanol
→ Biogas

CONTEMPORARY ENVIRONMENT ISSUES

BIODIVERSITY LOSS

Definition :- Biodiversity loss refers to the decline of various forms of life on earth including variety of species, ecosystems, etc.

Components of biodiversity :-
- Genetic diversity
- Species diversity
- Ecosystem diversity

Causes of biodiversity :-
- Pollution
- Over exploitation
- Population growth
- Habitat alteration
- Invasive species
- Degradation of habitats
- Deforestation

CLIMATE CHANGE IN WORLD

Definition :- climate change refers to long term changes in temperature, precipitation, wind patterns, & other aspects of the Earth's climate system.

Factors affecting :-

ABIOTIC	BIOTIC
Latitude	Transpiration
Altitude	Respiration
Ocean currents	Photosynthesis
Topography	Decomposition
Radiation	Digestion
Volcano	

Impacts of climate change :-
- Glaciers melting
- Animal & plant life effects
- Release of CO_2, CH_4, NO_2.
- Earth temperature changing.

OZONE LAYER DEPLETION

Definition :- Ozone layer depletion refers to the thinning and reduction of the ozone concentration in the Earth's atmosphere.

Causes of ozone depletion :-
- Chlorofluocarbons (CFCs)
- Halons
- Methyl chloroform
- Hydrofluocarbons (HCFCs)

Impacts of ozone depletion :-
- Harm to human health
- Adverse impacts on agriculture
- Effects on plants
- Effects on animals
- Effects on materials

Measures to prevent :-
- Limit vehicles
- Avoid pesticides
- Ban plastics
- Use eco friendly products
- Ban CFCs

SEA LEVEL RISE

Definition :- Sea level rise refers to the increase in the average height of the world's oceans.

Causes of sea level rise :-
- Ocean warming
- Melting of Glaciers
- Decline in water storage
- Global warming
- Eustasy
- Isostasy

Impacts of sea level rise :-
- Wet land loss
- Coastal erosion
- Loss of habitats
- Contamination of soil

Adaption strategies :-
- Protection
- Retreat
- Attract
- Accomodation

GLOBAL WARMING

Definition :- Global warming refers to long term increase in Earth's average surface temperature due to human activities particularly emission of greenhouse gases.

Causes of global warming :-

MAN MADE	NATURAL
Deforestation	Volcanoes
Use of vehicles	water vapour
chlorofluorocarbon	Melting glaciers
Industries	Forest fires
Agriculture	
Overpopulation	

Effects of Global warming :-
- Rise in temperature
- Threats to ecosystem
- climate change
- Spread of diseases
- Loss of habitat

INTERNATIONAL EFFORTS FOR ENVIRONMENTAL PROTECTION

- United Nations framework Convention on climate change (UNFCCC) : 1992
  - Kyoto Protocol : 1997
  - Paris Agreement : 2015
  - Montreal Protocol : 1987
  - Convention on Biological Diversity : 1992
- Intergovernmental Panel on climate change (IPCC) : 1988
  - Sustainable development Goals (SDGs) : 2015
- United Nation Environment Programme (UNEP) : 1972

RESTORATION OF WATER BODIES

WASTE WATER TREATMENT PLANT:

It is a facility designed to treat and process wastewater which includes sewage industrial effluent and stormwater run off to remove contaminants and produce water that is safe to return to the environment or reuse.

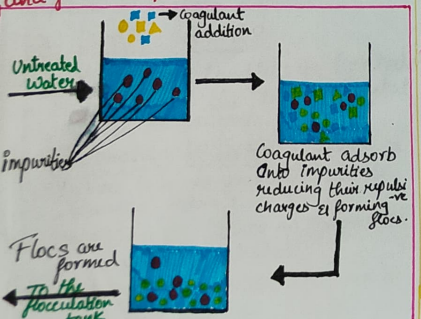
PRELIMINARY TREATMENT:

- Removal of large solids and debris through screening and grit removal.
- Coagulation and flocculation are key steps in the process.

COAGULATION:

- Coagulants destabilize and aggregate suspended particles in the water such as dirt, bacteria & organic matter.
- They neutralize the negative charges on particles, allowing them to come together and form larger aggregates called microflocs.

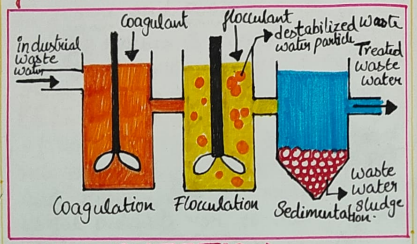
example: Aluminium Sulphate, ferric chloride, and ferric Sulphate.



FLOCCULATION:

- Flocculation helps to further aggregate the microflocs into larger, more easily removable particles called flocs.

example: Polymers such as polyacrylamide [PAM], cationic, anionic or non-ionic flocculants.

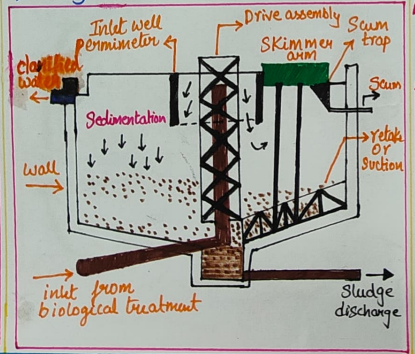


SEDIMENTATION:

- Sedimentation is a key process in water and waste water treatment where gravity is used to remove suspended particles from water.
- It is a primary treatment.

CLARIFIER:

- A clarifier is a vital component in water and wastewater treatment plants designed to remove solid particles from liquids through sedimentation.
- It is the second step involved in primary treatment.

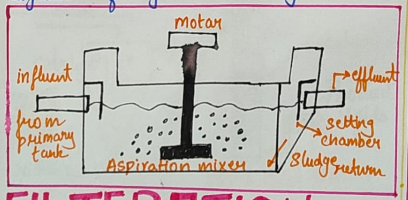


SECONDARY TREATMENT:

- It involves removing dissolved and suspended biological matter from sewage.

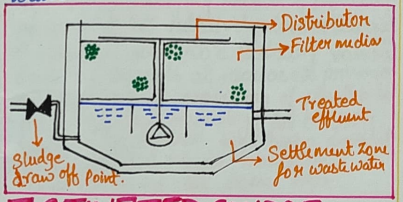
AERATION:

- It is a crucial process in the activated sludge process.
- It involves addition of air [oxygen] to wastewater to promote the aerobic digestion of organic matter by microbes.



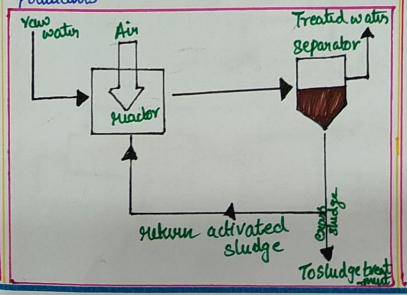
FILTERATION:

- It is used to remove suspended solids bacteria and other contaminants from water.



ACTIVATED SLUDGE PROCESS:

- It is a biological method that uses microbes to decompose organic Pollutants.



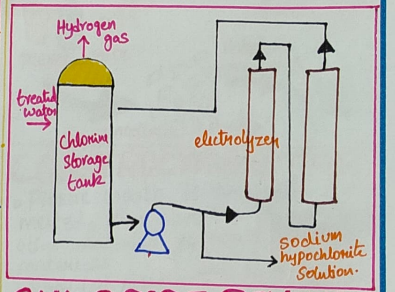
TERTIARY TREATMENT:

- Tertiary waste water treatment is the final stage of waste water treatment.
- It aims to improve the quality of effluent before it is discharged into the environment & reused.

DISINFECTION:

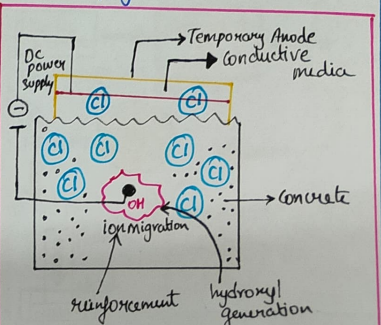
- It aimed at killing or inactivate Pathogenic microorganisms to protect Public health & the environment.

Chlorination: addition of chlorine or chlorine compounds.



CHLORIDE REMOVAL:

- Chloride removal is essential in various applications particularly when the treated effluent is intended for reuse in irrigation, industrial processes or even portable water supply.

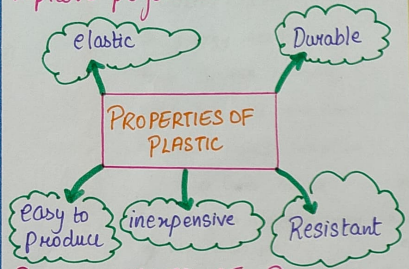


PLASTIC WASTE UPSKILLING

PLASTIC: A wide range of semi synthetic or synthetic organic solid materials suitable for the manufacture of industrial products.

Plastics are polymers with high molecular weight.

They may contain other substances to improve performance or reduce cost.



DISADVANTAGES OF PLASTICS:

- Decomposition
- Non-Renewable
- Hard to reuse
- Difficult to recycle
- Toxic
- Threat to animals.

LANDFILLS:

- Landfills are sites where waste is disposed of by burying it in the ground.
- They are one of the most common methods of waste disposal.

How landfills work?

(a) **Site selection**: Landfills are located in areas where the environmental impact is minimized.

(b) **Preparation**: (i) **lining**: installing a protective liner to prevent leachate [contaminant liquid].

(ii) **Drainage system**: Setting up systems to collect and treat leachate.

(iii) **Gas collection**: Install systems to capture and manage landfill gas.

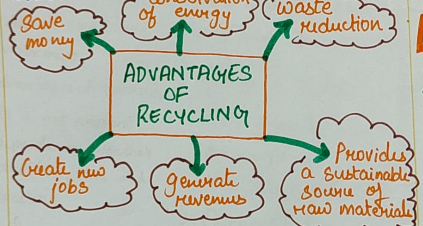
(c) **Waste disposal**: waste is compacted and layered to maximize space and stability.

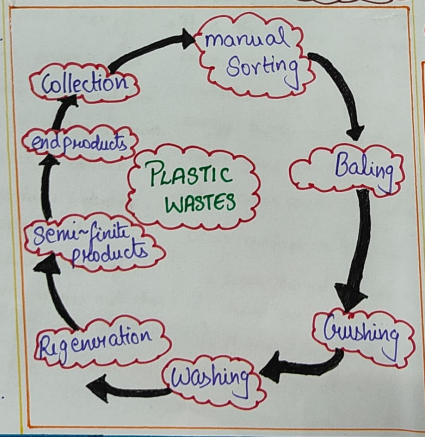
(d) **monitoring and Maintenance**: Landfills are regularly monitored for leachate and environmental controls.

(e) **closure and post closure**: once a landfill reaches its capacity it is closed off and monitored for many years.

RECYCLING:

- Plastic recycling is the process of recovering scrap or waste plastic and reprocessing the material into useful products or to their original state.

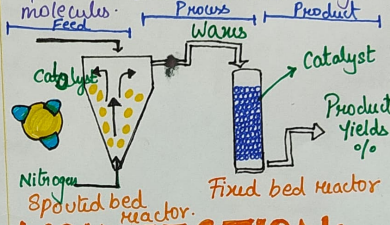




PYROLYSIS:

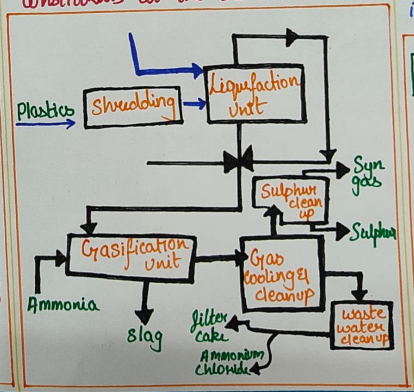
Pyro – Heat lysis – breakdown.

Pyrolysis is a thermal cracking reaction of the large molecular weight polymer carbon chains under an oxygen free environment and produces small molecular weight molecules.



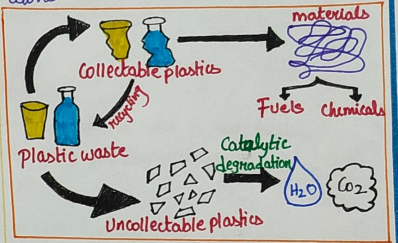
LIQUEFACTION:

- It is also called thermal liquefaction
- It is an emerging method of processing performed at relatively lower temperature of between 300–450°C utilizing various kinds of solvents at increased pressure.
- Hydrothermal processing of plastics is a prospective technology for tertiary recycling to produce high value chemical compounds and recover monomeric constituents at the same time.



CATALYTIC DEGRADATION:

- It is a process in which catalysts are used to breakdown complex materials such as plastics into simpler molecules at lower temperatures and with greater efficiency than thermal degradation alone.

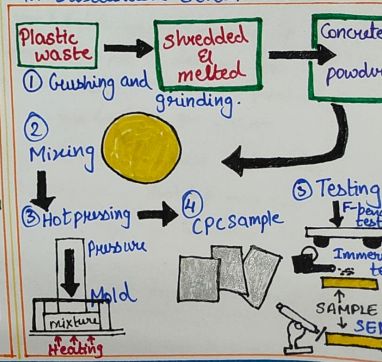


CONSTRUCTION & TAR:

- Plastic waste is shredded and melted, then mixed with sand or other materials to create a composite materials.
- Shedded plastic waste is mixed with bitumen to create a modified asphalt. This mixture is used to pave roads

CONCRETE PRODUCTION:

- Concrete production from waste materials is an innovative approach to address the issue of waste management to contribute in sustainable development.



RENEWABLE ENERGY:

The Energy resources which can be used to produce again and again are known as Renewble Energy resources.

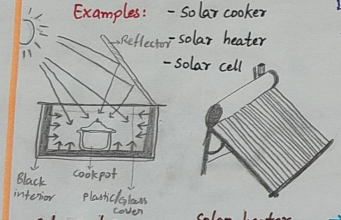
There are different forms of Renewable Energy:

1. Solar Energy:

The energy earth recieves from the sun, primarily as visible light and other forms of Electromagnetic radiation.

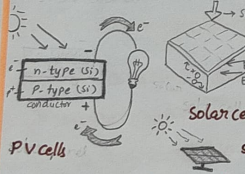
Solar Energy can be converted into Electrical energy by using solar plates.

Examples: - Solar cooker
- Solar heater
- Solar cell



Solar cooker

Solar heater



PV cells — Solar cell — solar panel

- Thermal solar panels are used to generate heat energy.
- 3.4 % of total electricity was generated by solar PV in UK (2017).

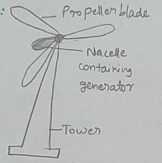
- photovoltaic cells (PV): made from silicon turn light directly into electricity.

Advantages of Solar cells:
→ solar energy doesn't produce carbon dioxide
→ It does n't effect our environment.

Disadvantages of Solar cells:
→ It is not constant, depends on weather condition, time and location.

2. Wind Energy:

→ wind power is good renewable, clean and free source of energy of power.
→ Reduce dependance on flossil fuels including important oils.
→ Reduce emission of greenhouse gas and other Pollutant.



Windturbine

Wind farm:
→ Strong winds
→ Clear hilltop
→ Turbines in Prevailing wind direction.

The Amount of power, and therfore electricity, a wind turbine can Produce is largely based on wind velocity using this equation;

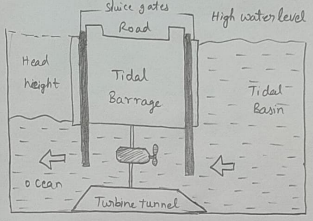
$$\text{Power} = \tfrac{1}{2} \rho A V^3$$

ρ = air density; $\approx 1\ kg\ m^3$
A = swept area (πr^2)
V = velocity ($m\ s^{-1}$)

3. Ocean Thermal Energy:

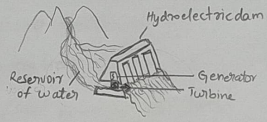
→ It is the largest renewable energy source available to contribute to the security of energy supply reduce green house gases emission.
→ The Oceans cover 75% of world.

Ocean contain 2 types of energy:
→ Ocean thermal energy conversion from sun's heat.
→ Mechanical energy from tides & waves.



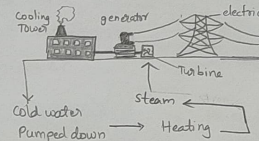
4. Hydroelectric Energy:

→ Hydroelectronic power harnesses the kinetic energy of running waters.
→ Water flow downwards with Gravity to spin a turbine.
→ More reliable than solar and wind Power.
→ Hydroelectric dams are very expensive and can harm wildlife.



5. Geothermal Energy:

⇒ Geothermal energy = heat energy from earth. Decay of radio active elements & residual heat from Planetary formation 4.5 billion ys ago
⇒ water is pumped down into hot rock where it is heated.



→ steam can then be used to heat buildings directly or to generate electricity by spinning a turbine.

6. Biomass Energy:

→ one of primary resources which can used to provide renewable and clean energy.
→ because: waste residues will always exist in terms of scrap, wood, mill & forest residuals. Properly Managed ~~forests~~ will always have more trees and will always have crops and residual biological matter from these crops.

Alternative Energy sources:

Economical reasons:
→ Fossil fuels won't last forever.
→ Renewables provide new jobs.
→ our country will be less dependant on other for fuel.

environmental reasons:
→ Renewable will decrease air pollution & greenhouse gas emissions.

Fossil fuel: Energy resource that is formed from the remains of plant & animals that lived a long time ago. → They consists largely of [H-C], complex chains of H & C atoms.
→ They're extracted from earth's crust.

POLLUTANT MONITORING AND REMOTE SENSING

Remote sensing is an effective tool for monitoring various Pollutants, water quality parameters, including BOD, COD, tubidity, and other. Satellites can provide synoptic, continuous and long term global observation of water bodies.

BOD:- Major interfences of BOD test are substances that inhibit the growth of the micro organism viz. chlorine, mineral acids & heavy metals.

COD:- [chemical oxygen demand] It is useful to assess the stregth of waster, which contain toxins and biologically resistant organic substances.

turbidity:- Turbidity is the amount of cloudiness in the water.
- It is indicator of water quality

TSS & TDS [Dissolved organic compounds] :-
⇒ Used to asses the quality of water including ocean water or wask water post treatment

Phosphorus:-
It is essential nutrient but excess amounts can be leading to eutrophication and water quality problems.

Nitrak:- nitrate is essential for identifying sources, tracking trends, informing managment practices and ultimately preventing water pollution.

CO :-
⇒ primary pollutant
⇒ Toxic air pollutant
⇒ Excellent Tracer for combustion and dynamics

SO_2 :- ⇒ SO_2 monitoring is essential for understanding air quality, identifying pollution sources, health impacts

Particle Matter :- composed of liquid aerosal particles and solid aerosal Particles - suspended in and move with the air
→ Aerosal are droplets of liquids
→ Generally below 10μm size.

NOX :- one of the main ingredients involved in the formation of ground level ozone which can trigger serious respiratory problems

Active remote sensing techniques like LiDAR can measure water depth and map submerged aquatic vegetation. Passive techniques like multispectral and hyperspectral imaging are used to derive water quality parameters from optical properties

GIS :- widely used in water resources managment, agricultur, soil and forestry applications. It anables spatial analysis, modeling and visualization of environmental data

Oil spill Monitoring :- Satellite sensor like SAR can detect oil spills on water surfaces even on cloudy conditions

Alkalinity & pH :- Alkalinity & pH are important indicators of water quality and acidity
- pH can be estimated from alkalinity, temparature and dissolved oxygen.

Remote sensing provides a powerful synoptic and cost-effective way to monitor a wide range of water quality, atmosphere, soil and vegetation parameters. Integrity Satellite data with in-situ measurements and GIS enables comprehensive environment monitoring and management.