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GSA 1st Test

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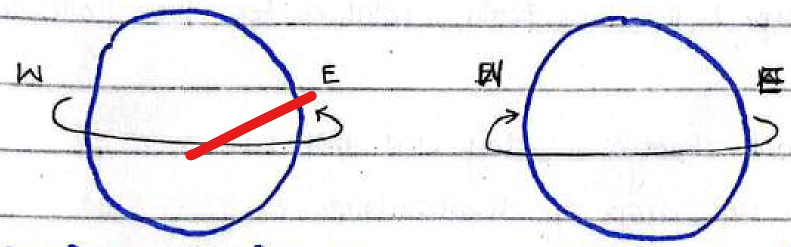
1. Explain the difference between rotation and revolution as they apply to planets.

Rotation and revolution are two phenomena related to planetary motion. They are specific for each each planet but vary from planet to planet.

What is meant by planetary rotation?

Rotation is the spinning motion of a planet as it revolves around its own axis. The duration of rotation varies from planet to planet. All the planets of the solar system move from west to east except Venus which rotates from east to west.



Rotational direction of all planets except Venus

Rotational direction of Venus

Rotational period of different planets of the solar system

Each planet of the solar systems takes different time to complete one full rotation. Following are the rotational period of all the planets of solar system measured in Earth's time:

Mercury → 59 days

Venus → 243 days (slowest)

Earth → 23 hours, 56 minutes and 4 seconds.

Mars → 24 hours, 40 minutes

Jupiter → 9 hours, 55 minutes (fastest)

Saturn → 10 hours, 15 minutes

Uranus → 17 hours

Neptune → 16 hours.

It can be seen that Venus is the slowest rotating planet whereas Jupiter is the fastest one. One theory attributes the speed of rotation to the size of the planet. However, there is no enough evidence to support this theory, as of yet.

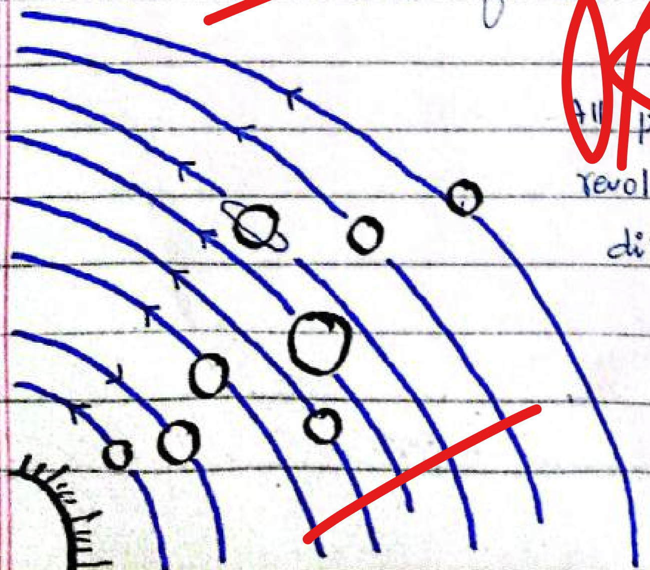
Impact of rotation

With respect to the Earth, rotation has the following impacts:

- Diurnal changes (day and night)
- Rise and drop of temperature.

What is meant by planetary Revolution?

Revolution of a planet refers to its motion around the sun in an axis called the orbit. Just like rotation the revolution period of each planet is different.



All planets, except venus, revolve in counter-clockwise direction.

Kepler's Third Law and the Revolution of planets

It states that:

"The squares of the orbital periods of the planets are directly proportional to the cubes of the semi-major axes of their orbits."

This implies that the period for a planet to orbit the sun increases rapidly with the radius of its orbit.

~~Rotational~~ Revolution periods of the planets of the solar system

Since the periods (in Earth's time) of each planet varies with its distance from the sun, following are the duration of revolution of each planet:

- Mercury → 88 days
- Venus → 225 days
- Earth → 365.25 days
- Mars → 1.88 years
- Jupiter → 11.56 years
- Saturn → 29.46 years
- Uranus → 84 years
- Neptune → 164.79 years.

As evidenced from Kepler's Law, mercury takes least time to complete one revolution while Neptune takes the most time.

Impacts of Planetary Revolution

Taking Earth as reference, revolution affects the Earth ~~as~~ in the form of:

- Changes of seasons.

• Climatic conditions.

Summary of their differences

Rotation	Revolution
→ movement around its own axis	→ Revolves around the Sun
→ Arguably depends on the size of the planets	→ Depends on the distance from the sun.
→ Fastest rotating is Jupiter	→ Fastest revolving is mercury
→ slowest rotating is Venus	→ slowest revolving is Neptune.
→ Brings diurnal changes	→ Brings seasonal changes

Conclusion

Both rotation and revolution are significant features of planetary motion. While both of them relate to planets' movement, they vary in following axes, periods and their effects on planets.

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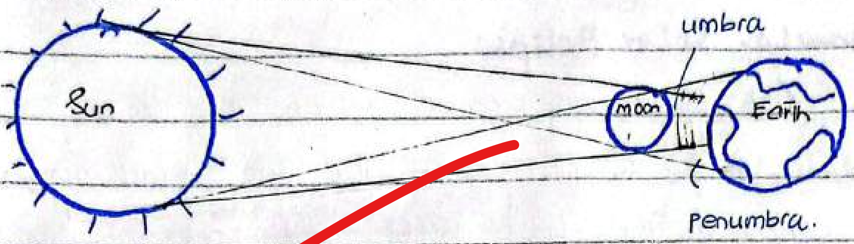
2. Describe the process of how a solar eclipse occurs.

The moon revolves around the Earth, and the Earth ~~also~~ revolves around the Sun. Sometimes, when the Earth, the moon, and the Sun are aligned, with the moon in the middle, the light of the Sun is blocked from coming to the Earth. This phenomenon is called a solar eclipse.

The process of the occurrence of the Solar eclipse

Solar eclipses occurs when the following situation arises:



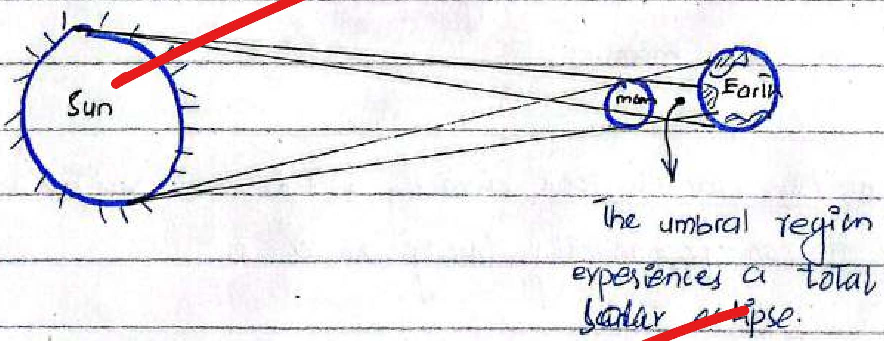
The moon blocks some or all the light at a point on Earth.

Types of solar eclipse

Depending on the extent of blockage of sun's light by the moon, there are three types of solar eclipses.

1. Total solar eclipse

This happens when the moon completely covers the light of the sun when seen from an area. The area covered can vary from 160 – 16,100 km at length.



2. partial Lunar eclipse

A partial lunar eclipse occurs when a part of the sun is covered by the moon in an area at a time.

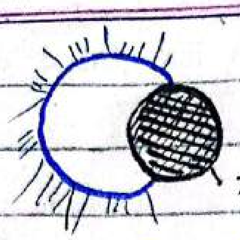


Fig. partial Solar Eclipse

3. Annular Solar Eclipse

Such an eclipse occurs when the moon appears to be smaller than the sun, blocking the centre of the sun's light and leaving an annular ring or annulus behind.

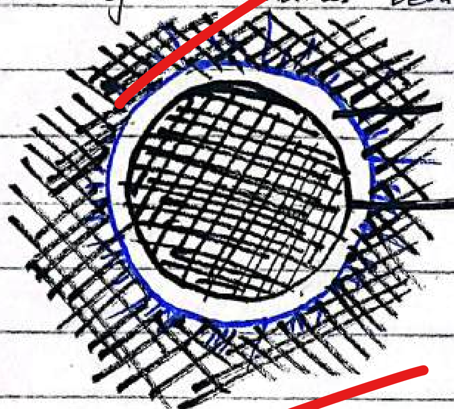


Figure: Annular solar Eclipse when viewed from the Earth.

Example: The annular solar Eclipse in chile this month

Characteristics of a Solar eclipse

- A solar eclipse always happens at the time of a new moon.
- One cannot look directly at the solar eclipse — it can permanently damage the eyes.
- A solar eclipse lasts only for a few minutes.
- Solar eclipses usually occur once every 18 months.

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3. List three renewable energy sources and explain why they are considered 'renewable'.

Renewable energy sources are the ones that can be replenished on human timescale. This means that they can be produced at a scale comparable to its consumption and potentially do not end.

Sources of Renewable Energy

1. Wind power

Wind is one of the most abundantly available natural resources on earth. It has been estimated that the available wind energy potential is 40 times the current electricity demand.

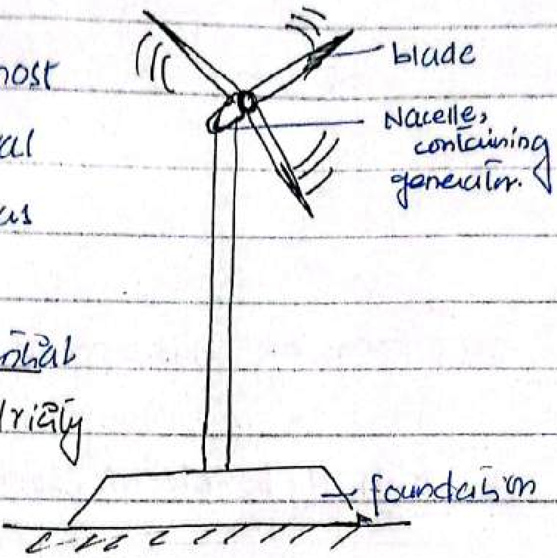

Figure: Wind Mill

The power available from wind is a function of the cube of the wind speed.

According to this equation, there shall be a dramatic increase in the wind power with even a small increase of the wind velocity.

1.1. Output of wind power system

Normally, one setup produces 1.5 - 3 mw of electricity. However, systems producing 5 mw are also available.

1.2. Wind potential of Pakistan

The coastal belt of Pakistan has a 180 km long wind corridor with the potential of producing 50,000 MW of electricity.

The Jhimpir Wind power plant is a prominent example with the capacity of 50 MW.

2. Hydropower

Water, both fresh and saline, is a potential energy source currently used in Pakistan and abroad. The motion of water is used to generate electricity.

2.1. Forms of Hydropower

They can be categorized as:

2.1.1 Hydro-electric sources

They include large scale hydro-electric dams.

Example: Tarbela dam producing 4888 MW.

2.1.2. Micro Hydro systems

They also include dams but at smaller scales, normally up to 100 MW.

2.1.3. Run-of-the river hydel system:

They utilize the kinetic energy of flowing water without the use of dams.

2.1.4. Tidal Energy

The tides of the seas are utilised to generate electricity.

3. Biofuels

Biofuels are those source of renewable energy derived from biomass.

Biofuels

Solid	Liquid	Gas
• Firewood	• Bioethanol	• Biogas
• Wood chips	• Biodiesel	• Syngas.
• Wood pellets	• Bio-oil	
• Charcoal	• Bio butanol	

Biogas production

As a form of biofuel, biogas can be produced both domestically and commercially.

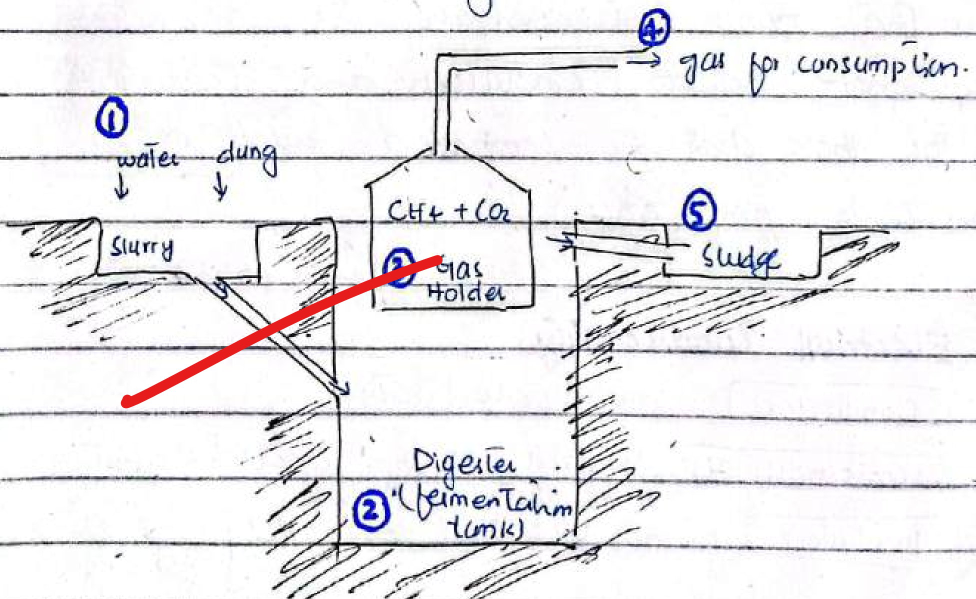

Figure: Biogas production with numbers representing the sequence

Why are these sources considered renewable?

- They can be replinished at human time scale
- Same source can be reused unlimited times. Example water
- The sources can be easily replaced without the fear of repletion.
- They provide the same energy every time they are reused.

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4) Compare and contrast the properties of conductors, insulators and semiconductors.

Insulators and conductors are at two extremes when it comes to conductivity of a property or its insulation. Semiconductors, as the name implies have the properties somewhere between conductors and insulators. The three shall be compared based on multiple properties:

1- **Electrical Conductivity**

Conductors conduct electricity.

Semiconductors conducts less than conductors but more than insulators.

Insulators Do not conduct electricity.

2. Valence Electrons

Conductors — Have only ~~one~~ three or less electrons in their valence shalles

Semiconductors — Normally, four electrons in their valence shell

Insulators — Normally, five or more electrons in their valence shells.

Draw structure of bonds

3. Chemical Bonding

Conductors — The composition of a conductor is for of metallic bonding.

Semiconductors — Semiconductors are formed due to covalent bonding.

Insulators — Insulators have ionic bonding normally.

4. Thermal conductivity

Thermal conductivity is the measure of a material to conduct electricity.

Conductors — Highly conducting

Semiconductors — moderately conducting

Insulators — No conduction

5. Forbidden gap

Forbidden gap refers to the gap between the valence band and conduction band thus implying that a gap means less conductivity.

Conductors — No forbidden gap

Semiconductors — Small forbidden gap

Insulators — Large forbidden gap.

6. Conductivity value

~~Insulator~~ Conductors → $> 10^{-7}$ mho/m

Semi conductors. 10^{-13} - 10^{-7} mho/m

Insulators → $< 10^{-13}$ mho/m.

7. Resistivity value

Conductors $< 10^{-5}$ Ω-m

Semiconductors 10^{-5} - 10^{5} Ω-m

Insulators $> 10^{5}$ Ω-m

8. Current flow

Conductors Due to free electrons

Semiconductors Due to holes and free electrons

Insulators Due to negligible free electrons

9. Zero Kelvin Behavior

Conductors Acts like a super conductor

Semiconductors Acts like an insulator

Insulators Acts like an insulator.

10. Examples

Conductors Iron, Copper, Aluminium.

Semiconductors Germanium, silicon

Insulators Wood, glass, plastic.

-.-

5. What are the three main types of chemical bonds and what are the key differences between them?

Chemical bond refers to the strong force of attraction between the atoms or ions in a material. There are three main types of chemical bonds, namely:

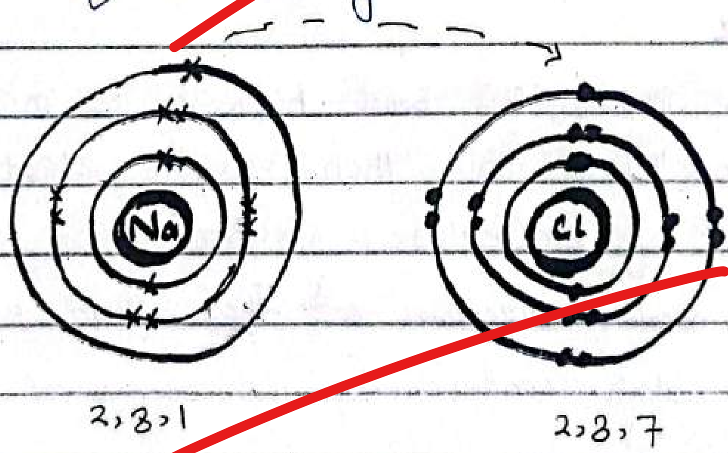
1) Ionic Bond
2) Covalent Bond
3) Metallic Bond

Ionic Bond

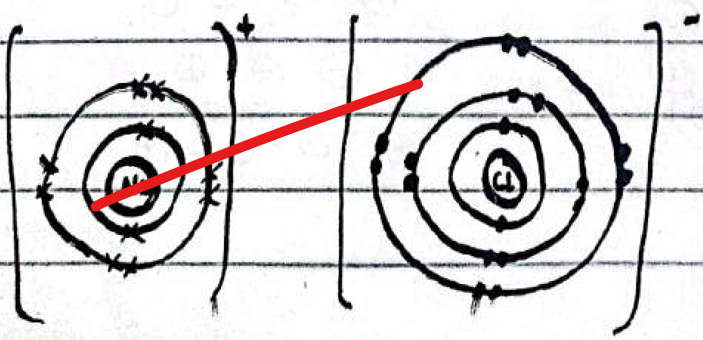
An ionic bond is the one in which the complete transfer of electrons take place. This bond is also known as electrovalent bond.

Example: Sodium Chloride.

The sodium chloride compound is formed as a result of ionic bonding.



After the transfer:

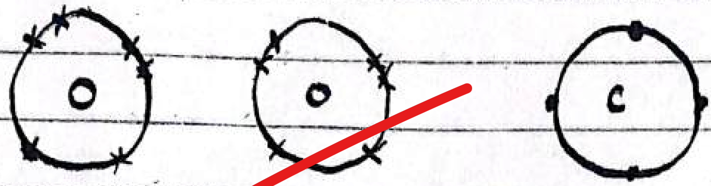


Covalent Bond

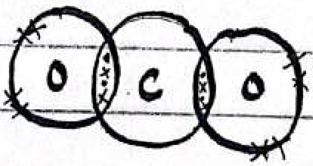
This bond is normally found in non-metallic compounds and is the type of bonding in a compound in which atoms share electrons.

Example Carbon dioxide.

Carbon has four electrons in its valence shell and each oxygen of the pair has 6. In order to complete the octet, they all share bonds to be stable.



After bonding :

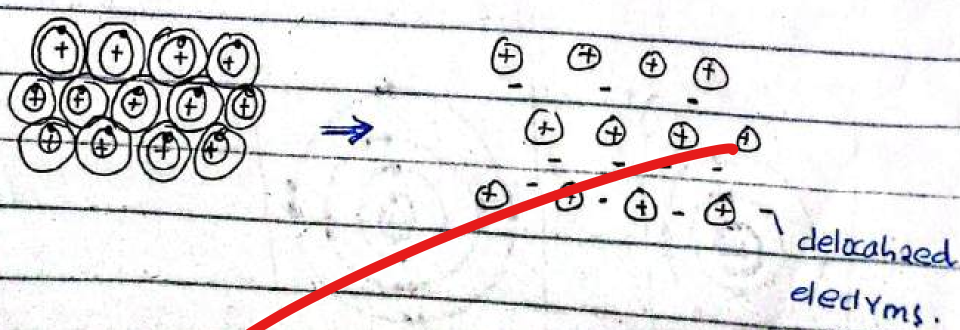


– O = C = O

Metallic Bond

As the name implies this bond happens in metals. The atoms tend to ~~lose~~ lose their valence electrons creating a pool of delocalized electrons.

The freely moving electrons ~~are~~ is the reason why they have such high conductivity.



Key differences between the electrons

Ionic Bond	Covalent Bond	Metallic Bond
• Complete transfer of electrons between atoms having different electronegativities.	The bond is formed by mutual sharing of valence electrons.	• Formed by the attraction between positive ions and mobile electrons.
• Strongest of all bonds	• Moderate bond strength	• Relatively weaker bond.
• Can be found between metals and non-metals	• Formed between non-metals.	• Exclusively metals.
• make the compound brittle.	• makes the compound incompressible	• Makes the compound ductile and malleable.

The three kinds of bonds are the intramolecular binding since the atoms are bound by one of the three bonds.

6. **Describe the function of nucleus in a eukaryotic cell.**

The distinguishing feature of a eukaryotic cell from a prokaryotic cell is the presence of a nucleus. The nucleus serves as the repository of genetic information as well as acts as the cell's control center.

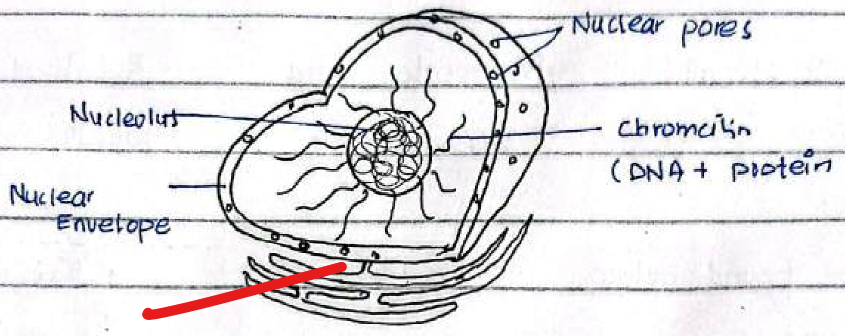


Figure : Nucleus of a prokaryotic cell

The Nucleus is generally in the center of animal cells and pushed to the side in plant cells due to vacuole.

Different parts of the nucleus have different functions.

Nuclear Envelope

- Separates the nuclear material from the cyto-plasm.
- The envelope is a twofold membrane — The outer membrane connects to the endoplasmic reticulum whereas the inner membrane encloses the nuclear content
- The pores on the envelope allow the exchange of materials between the nucleus and cytoplasm.

Nucleoplasm

The nucleoplasm forms a soluble nuclear sap within the nucleus. It is in the nucleoplasm that the internal parts of the nucleus stay.

Chromatin

The deeply stained with color chromatin is changed into chromosome during cell division. This contains DNA and proteins which make every specie unique and distinct. The DNA make up the chromosomes. Every eukaryotic species has a specific number of chromosomes in the nuclei of its body's cells.

Example:

Humans → 46 chromosomes

Frog → 26 chromosomes.

Onion → 16 chromosomes

Chimpanzees → 48 chromosomes.

Nucleolus

Nucleolus is the non-membranous part of the cell's nucleus. Their basic function is to synthesize and store RNA. The RNA is then exported to (cytoplasm) cell through the nuclear pores.

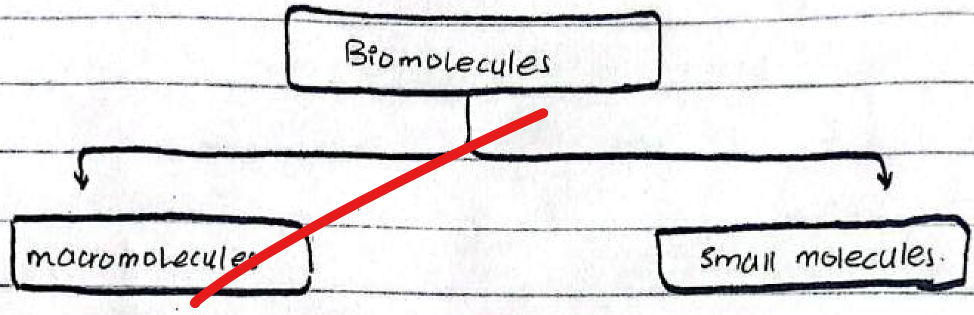
All in all, the nucleus performs the following functions:

1) It controls the activities of the cell.
2) It controls hereditary characters through DNA.
3) It synthesizes, stores and exports RNA to cytoplasm.

7. What are the four major types of biomolecules in living organisms? Briefly describe the general structure and function of each molecule.

Biomolecules are molecules that occur naturally in living organisms. They are essential for the biological processes in living organisms.

Broadly the biomolecules can be divided into:



- Carbohydrates
- proteins
- Lipids
- Nucleic Acids

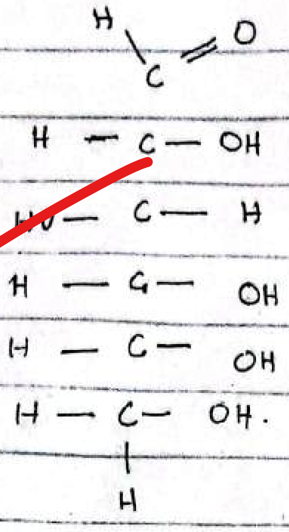
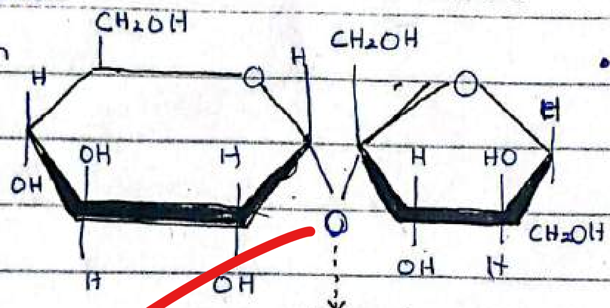
- vitamins
- Hormones

The structure and functions of the four major biomolecules shall be discussed.

Carbohydrates

Carbohydrates are large macromolecules consisting of Carbon (C), Hydrogen (H) and Oxygen (O) with the general formula of $C_x(H_2O)_y$.

The structure and function of carbohydrates vary with the type of carbohydrate.

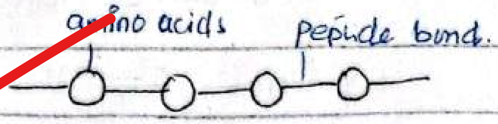
Type of Carbohydrate	Structure	Function
Monosaccharides Simplest, cannot be hydrolyzed. **Examples** Glucose, galactose, fructose.	Glucose ($C_6H_{12}O_6$) 	• Glucose → source of energy • Galactose in milk and fructose in fruits make them sweet. • Ribose is a structural element of nucleic acids.
Disaccharides Two sugar units, produce two mono-saccharides upon hydrolysis. **Examples** Lactose, maltose, sucrose → sucrose < glucose, fructose		• Sucrose is utilised for photosynthesis in plants • maltose is used in immediate starch and glycogen digestion • Lactose is a major source of energy in animals.
Oligosaccharides Yield 3 to 10 monosaccharides upon hydrolysis. → Trisaccharides, tetrasaccharides. **Examples** Glycolipids, Glycoproteins	Complex structure. Trisaccharides with formula $C_n(H_2O)_{n-2}$ and tetrasaccharide's is $C_n(H_2O)_{n-3}$	• Glycoproteins, as attached with proteins help in solubility and antigenicity • Glycolipids are important for cell recognition.
Polysaccharides (Glycans) more than 10 sugar units **Examples** Starch, glycogen, chitin, cellulose	Homopolysaccharides and heteropolysaccharides differ with one and different type of monomer involved.	• provide mechanical stability to cells.

Proteins

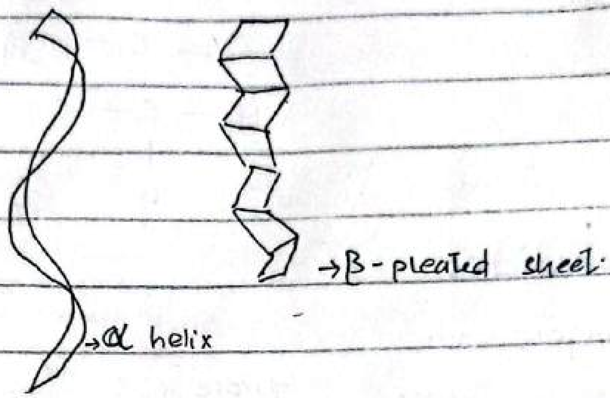
proteins are very large molecules composed of basic units called: amino acids.

protein structure

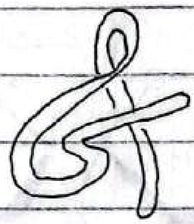
Primary Structure



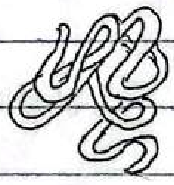
Secondary Structure



Tertiary structure



Qualernary structure



Functions of proteins

Digestion → By digestive enzymes which are proteinaceous in nature.

Movement → of muscles including a protein called myosin

Structure and support : Keratin → hair and nails, collagen → skin and bones, elastin → Lungs.

Cellular communication → Through receptors which are made of proteins.

Acting as a Messenger → between cells, tissues, and organs.

Lipids

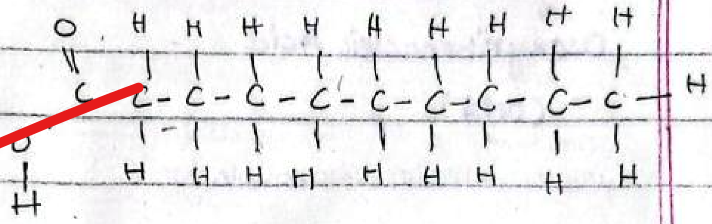
Lipids are organic compounds which form the framework for the structure and functions of living cells.

Lipids are polymers of fatty acids that contain a long, non-polar hydrocarbon chain with a small polar region containing oxygen.

Lipid Structure

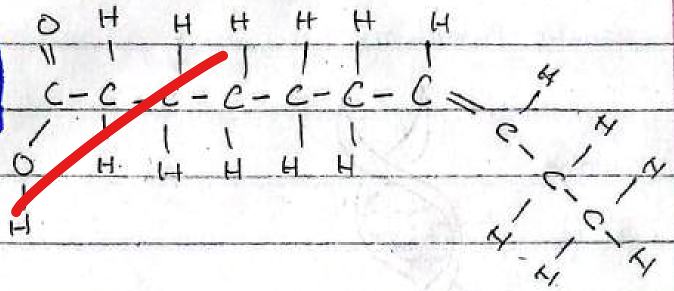
Saturated Fatty Acid

Eg: Stearic Acid



Unsaturated Fatty Acid

Eg: Oleic Acid



Functions of Lipids

- **Energy Reserves** – for later use
- **Membrane permeability** → Regulates membrane permeability
- **Solubility of Fat-soluble vitamins** → Vitamins A, D, E, K
- **Insulation** – from cold and cushion to internal organs.
- **Role in fever and blood-clotting** → the lipid prostanoid

Nucleic Acids

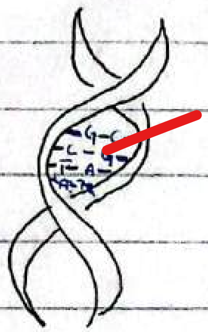
Nucleic acids serve as the primary information-carrying molecules in cells. They are of two major types: DNA and RNA.

Nucleic Acids

Deoxyribonucleic Acid (DNA)

Group of molecules responsible for carrying and transmitting genetic instructions

Nitrogenous Bases:
- Guanine
- Cytosine
- Tymine
- Adenine

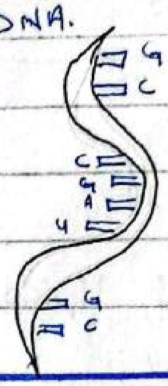


Functions of DNA.

- Does the replication process — transfer genetic information during cell division.
- Helps in cellular metabolism
- protein synthesis
- Responsible for transferring hereditary information from parents to offsprings

Ribonucleic Acid (RNA)

RNA helps in the synthesis of proteins and is single-stranded unlike DNA.



C. Cytosin
G: Guanine
A: Adenine
U: racil.

Functions of RNA

- facilitate the translation of DNA into protein (rRNA)
- Serves as messenger between DNA and ribosomes (mRNA)
- Carrier of genetic information (tRNA).

8. Explain the importance of enzymes in biological processes.

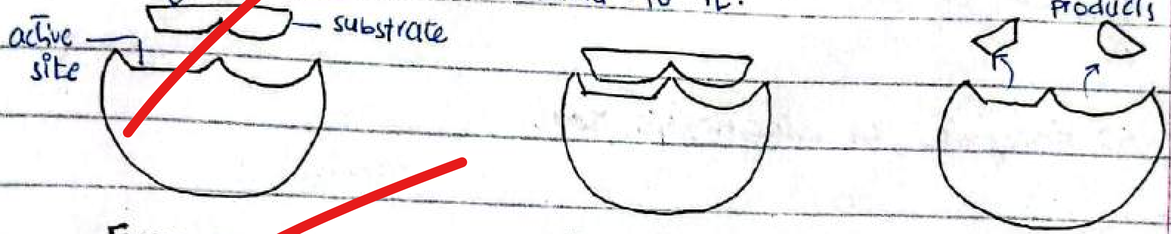
Enzymes are proteinaceous enzymes that that catalyze biochemical reactions. For this purpose they are also called biocatalysts.

Enzyme structure

Enzymes are three-dimensional chains of amino acids.

The Key and lock model

Enzymes have an active site where only a certain kinds of substrate can bind to it.



Enzyme | Enzyme-substrate complex | Enzyme

Significance of enzymes in biological process

Enzymes play a pivotal role in biological processes and subsequently in sustaining life.

1) Enzymes in metabolism

metabolism is the sum of all chemical reaction in an organism. Enzymes act as catalysts, facilitating the conversion of molecules into different forms to produce energy or build complex biomolecules.

Example → Lipases break down fats

→ Amylases break down carbohydrates into simpler sugars

2) Enzymes in digestion

Enzymes enable the breakdown and assimilation of nutrients for the body. They are involved at multiple stages.

mouth → amylases initiate the breakdown of starch into smaller sugars

stomach → pepsin (pepsidase) breakdown of proteins

gastro-intestinal tract → trypsin, amylase and lipase do the further breakdown

3) Enzymes and DNA replication

polymerase ensures that the genetic code is accurately preserved during cell division.

helicase unwinds and stabilizes DNA.

4) Enzymes as diagnostic tools

many diseases and disorders are associated with the specific changes in enzyme activity. For example, elevated levels of certain enzymes in blood can indicate liver damage, heart attacks or muscle disorders.

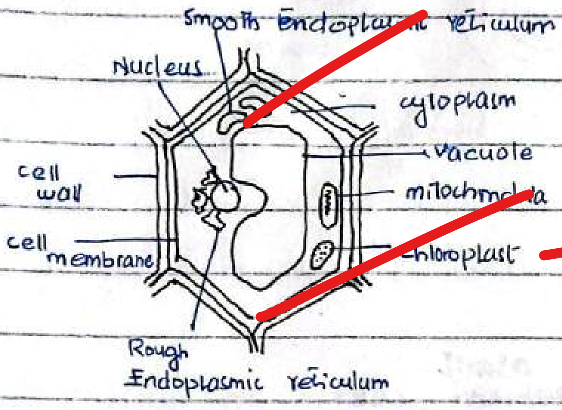
Conclusion

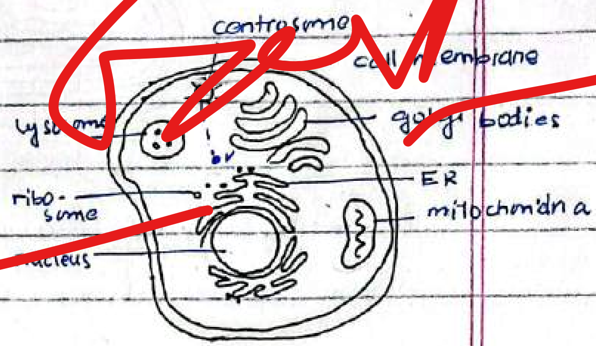
As biocatalysts, enzymes are extremely essential for the biological processes in an organism. They participate in metabolic processes, help in digestion, speed up DNA replication and can be used as diagnostic tools to find about medical conditions. Although enzymes do not participate in reactions, they their catalytic significance is unquestionable for sustaining life.

9

Q. What are the differences between plant cells and animal cells?

Plants and animal cells have fundamental similarities, however there are differences between them as well that significantly distinguish the two from each other.





Key differences between animal cells and plant cells

Animal and plant cells differ in the presence of some organelles in one and the absence in another.

1) **Lysosomes in Animals cells**

Animal cells have it and plant cells do not. They are the "garbage disposal" of animal cells. In plants the digestive processes take place in vacuoles.

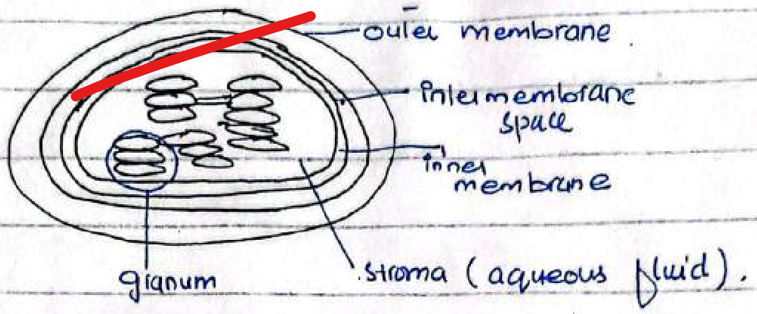
2) **Cell wall in plant cells**

The cell wall is a rigid covering that provides support to cell's structure and protects the cell. The cell wall is found in plant cells and is mostly made up of cellulose.

The crunch in raw vegetables is due to cell walls.

3) Chloroplasts in plant cells

Chloroplasts are plant cell organelle that carry out photosynthesis. Plants (autotrophs) are able to make their own food, like sugars, while animals (heterotrophs) must ingest their food.



The chloroplasts contain a green pigment called chlorophyll which captures light and drives the photosynthesis.

4) The central vacuole in plant cells

The central vacuole plays a key role in regulating the cell's concentration of water in changing environmental conditions. It holds water and when the water concentration in the soil becomes lower than that of the plant, vacuole releases the water and thus the plant appears wilted.

5) Cell shape

Animal cells are usually irregular or round shapes, whereas plant cells are more regular and in a polygonal shape.

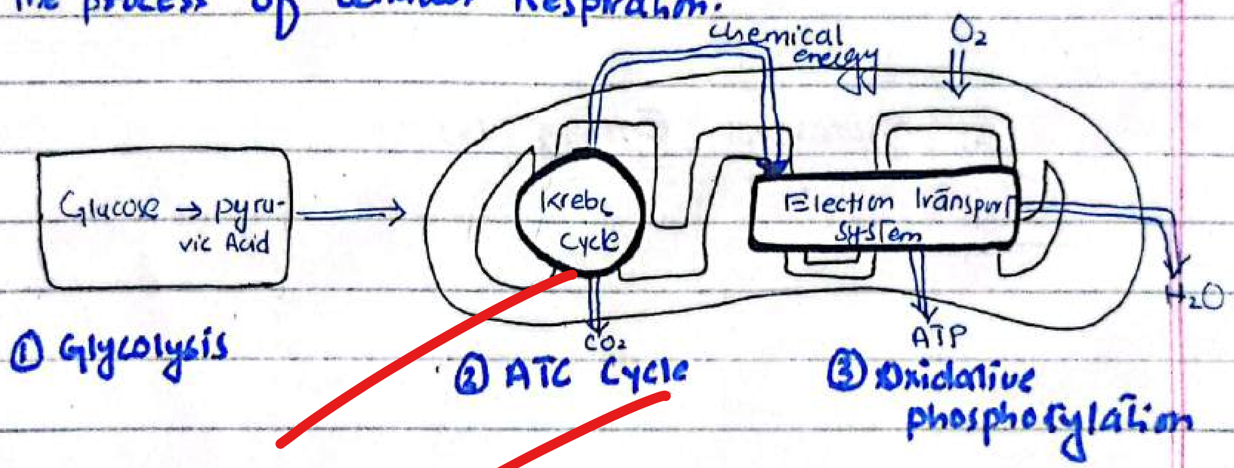
10. Briefly describe the process of cellular respiration. Why is it essential for life?

Cellular respiration is a set of metabolic reactions occuring inside the cells to convert biochemical energy obtained from food into a chemical compound called adenosine triphosphate (ATP).

There are three main steps of cellular respiration:

1) Glycosis } in cytosol
2) Citric Acid Cycle } in mitochondria.
3) Oxidative phosphorylation

The process of cellular Respiration.



Through this process, energy is generated which is essential for life.

The process can thus be summarized as:

Oxygen enters cell ⟹ O_2 breaks down the glucose present in cell
⇓
The process releases energy ⟵ it produces water and CO_2
⇓
The energy is utilized by the body

Why is cellular respiration essential for life?

Respiration releases energy stored in glucose for life process.

These life processes include:

1) **Macrolevel Energy use**

Broadly, energy is required:

i) For movement — to make the muscles contract in animals and to transport substances in phloem in plants.

ii) For keeping warm warm-blooded animals.

iii) To drive chemical reactions to keep organisms alive.

2) **Microlevel Energy use**

Energy is also used:

i) For cell division

ii) To maintain constant conditions in cells and the body — homeostasis.

iii) For the transmission of nerve impulses.

4

Conclusion

Cellular respiration is significant part for the sustenance of life. The process involves in breaking down glucose at cellular level to release energy. This energy is utilized by the body for various life processes.