General Science and Ability

PART - II

Section - I

QUES: NO: 3 (a)

Cells Form Organelles:

Cells are the basic structural and functional units of life. To perform various biochemical and physiological processes efficiently, cells develop internal compartments known as organelles. These organelles are membrane-bound structures specialized for distinct functions such as energy production, protein synthesis, and waste disposal.

Why Cells Form Organelles:

1. Division of Labour:-
Each organelle performs a specific task - for instance mitochondria produce energy, the nucleus stores genetic material, and lysosomes digest waste. This specialization increases efficiency.

2 Compartmentalization:
Organelles separate incompatible chemical reactions. For example, hydrolytic enzymes in lysosomes are isolated from the cytoplasm to prevent self-digestion.

3 Increased Surface Area:
Membranes of organelles like mitochondria and endoplasmic reticulum provide large surfaces for enzymatic activities.

4 Regulation and Control:
Organelles allow localized control of metabolism, maintaining cellular homeostasis.

Mitochondria in human cell:

Mitochondria are double-membraned, rod-shaped organelles often called the "Powerhouses of the cell" They convert energy stored in food molecules into ATP (Adenosine triphosphate) the cell's main energy currency..

Structure:

- Outer Membrane:
  Small and permeable to small molecules.

- **Inner Membrane:**
  Folded into cristae, increasing surface area for energy reactions.

- **Matrix:**
  Contains enzymes of the Kreb cycle, mitochondrial DNA, and ribosomes.

Functions:

1 **Energy Production:**
Through aerobic respiration - glucose and oxygen are converted to ATP, CO_2 and H_2O

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{Energy (ATP)}$$

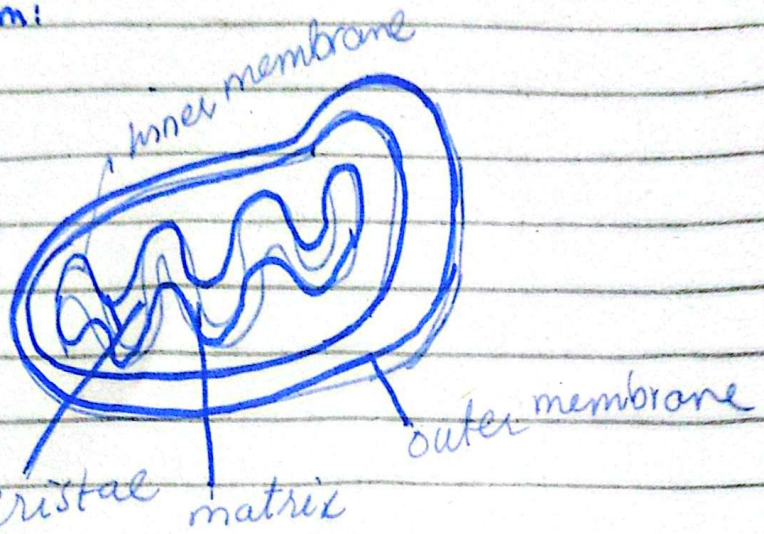
2 **Apoptosis Regulation:**
Releases cytochrome-c to trigger programmed cell death.

3 **Heat Production:**
In brown adipose tissue, mitochondria generate heat (non-shivering thermogenesis)

4 **Calcium storage:**
Helps regulate intracellular calcium levels.

5 **Genetic Autonomy:**
Contain its own circular DNA, suggesting an endosymbiotic origin.

Diagram:



Q3 (b)

Doping:

In a solid-state physics and electronics, doping is the intentional addition of impurity atoms to a pure semiconductor to improve its electrical conductivity. The impurities introduce additional free charge carriers - electrons or holes. The doped semiconductor is called an extrinsic semiconductor.

Types of Doped Semiconductors:

1. n-type Semiconductor.
These semiconductors are doped with pentavalent atoms (five valence electrons) such as phosphorus (P), Arsenic (As)

The one extra electron becomes free increasing electron concentration.
Majority carriers are electrons while minority carriers are holes.
Examples: Silicon doped with Phosphorus.

2 p-type Semiconductor:

These semiconductors are doped with trivalent atoms (3 valence electrons) such as Boron (B), Aluminium (Al)
It creates "holes" or positive charge vacancies in crystal lattice
Majority carriers are 'Holes' while minority carriers are 'Electrons'.
Examples: Silicon doped with Boron

Applications:

1 Diode and Transistors (PN Junctions)
2 Solar Cells and LEDs
3 Integrated circuits (ICs)

Conclusion:

Doping revolutionized electronics by converting poor conductors into tunable materials essential for modern technology.

Q3 (c)

Volcanic Eruption:-

Volcanoes are natural vents releasing molten rock (magma) gases, and ash from beneath Earth's crust. Though destructive, they play a vital role in shaping Earth's surface and ecosystems

Merits of Eruption:

1 Soil Fertility:
Volcanic ash is rich in minerals. (potassium, phosphorus, and trace elements), creating fertile agricultural land (e.g Java)

2 Geothermal Energy:
Heat from volcanic eruption regions is harnessed for clean, renewable electricity (Iceland, Philipines)

3 Newland Formation:
Lava solidifies to form new Islands (e.g Hawaii) and enriches the lithosphere.

4 Minerals Deposits:
Volcanoes bring valuable minerals (gold, copper) closer to the surface for mining.

Demerits:

1 Loss of Life and Property:
Explosive eruption can destroy entire cities.

2 Air pollution:
Ash and gases (SO_2, CO_2) cause acid rain and respiratory illnesses.

3 Climate Change:
Sulphur aerosols can temporarily cool global temperatures by reflecting sunlight.

4 Destruction of Habitats:
Lava flows and pyroclastic materials destroy forests, and biodiversity.

Conclusion:

Volcanic eruptions are both creators and destroyers. They renew Earth's surface and provide resources but demand disaster management and early warning systems.

Q3 (d)

Dengue:

Dengue is a mosquito-borne viral infection that has become a major global health challenge, especially in tropical and subtropical regions. Pakistan experiences frequent dengue outbreaks during monsoon seasons.

Causative Agent:-

- **Virus:** Dengue virus (DENV), a Flavivirus, with four serotypes DENV-1, DENV-2, DENV-3, DENV-4
- **Vector** - Female Aedes mosquito transmit the virus
- **Transmission** - Bite of an infected mosquito, not spread directly between humans.

Symptomology:

(1) Mild Dengue
- High Fever (up to 104°F)
- Severe headache, retro orbital pain
- Muscle and joint pain ("breakbone fever")
- Rash, nausea, vomiting, mild bleeding (gums/nose)

(2) Severe Dengue:

- Plasma leakage
- Severe abdominal pain
- Persistant vomiting
- Bleeding under the skin, gums or internal organs.
- Organ impairment (liver, heart)

Remedies:

1) No specific antiviral drug exists. treatment is supportive
2) **Hydration**: Maintain fluid and electrolyte balance to prevent shock
3) **Fever control**: Paracetamol, avoid aspirin / NSAIDs (increase bleeding risk)
4) **Monitoring**: Platelet count and hematocrit monitored in hospitals
5) **Preventive Measures**:
   - Remove stagnant water
   - Use mosquitto repellents
   - Community spraying and awareness campaigns

Conclusion:

Dengue reflects the link between environment vector ecology, and human behaviour. Effective prevention is through community

awareness and vector control remains the most powerful remedy.

QUES: NO: 4(a)

Plant Kingdom "Chlorophyll"

The plant kingdom is characterized by its ability to perform photosynthesis a proces driven by the green pigment known as chlorophyll. It is one of the most vital biomolecules on Earth, enabling plants to convert solar energy into chemical energy.

Structure of chlorophyll:

Chlorophyll is a magnesium - porphyrin compound. The central metal ion magnesium (Mg^{2+}) is surrounded by a porphyrin ring. Its chemical formula is $C_{55}H_{72}MgN_4O_5$

There are mainly two types of chlorophyll in plants.

- **chlorophyll a** Primary pigment, blue-green in color, absorbs red and violet light.
- **Chlorophyll b:** Accessory pigment, yellow-green in color, expands the absorption range.

Function:

1 **Photosynthesis:**
Captures light energy to synthesize glucose from CO_2 and H_2O.

$$6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{light}} C_6H_{12}O_6 + 6O_2$$

2 **Energy Conversion:**
Converts light energy into ATP and NADPH during the light reaction.

3 **Ecological Role:**
Maintains atmospheric balance by releasing oxygen and reducing carbondioxide.

Conclusion:

Chlorophyll is the foundation of life on Earth. Without it there would be no photosynthetic activity, no food chains and no oxygen for survival.

Q4 (b)

Ribosomes:

Ribosomes are small, dense organelles present in both prokaryotic and eukaryotic cells. They are known as the "protein factories of the cell" because they are the site of translation - the synthesis of proteins from messenger RNA (mRNA)

Role in Protein Synthesis.

1 Initiation: Ribosome binds to mRNA at the start codon (AUG)

2 Elongation: Transfer RNA (tRNA) brings amino acids to the ribosome. Peptide bonds form between amino acids.

3 Termination: The process stops when a stop codon (UAA, UAG, UGA) is reached

4 Product Formation: The newly formed polypeptide chain folds into a functional protein.

Conclusion:-

Ribosomes play an indispensable role in the expression of genetic information, ensuring that cellular functions are maintained through continuous protein production.

Q NO: 4 (C)

Solid Waste Management:

Solid waste management refers to the collection, treatment, and disposal of solid materials that are discarded by human activities. Effective management is vital for environmental protection and public health.

1 Segregation and Collection

Waste is categorized as biodegradable, non-biodegradable hazardous, or recyclable. Proper collection systems reduce contamination.

2 Recycling and Reuse:

Materials such as paper, glass, metals and plastics are reprocessed and reused, conserving resources and reducing landfill waste.

3 Composting:

Organic waste (kitchen and garden waste) is biologically decomposed to produce compost, used as a soil fertilizer.

4 Incineration:
Wastes is burned at high temperatures to reduce volume. Energy can be recovered in Waste-to-Energy plants

5 Landfilling:
Non-recyclable and non-hazardous waste is buried in engineered landfills with liners and drainage systems to prevent pollution.

6 Vermicomposting:
Uses earthworms to decompose organic waste into nutrient-rich compost.

Conclusion:

A combination of scientific techniques, public participation, and government regulation is essential for sustainable solid waste management.

Q4 (d)

Define Following Terms:

(i) Biofuel.

Biofuel is a renewable energy source derived from biological materials such as plants or animals waste.

Examples include

ethanol - from sugarcane

biodiesel - from vegetable oil

(ii) Adulteration

The process of adding inferior or harmful substances to food, fuel, or medicine to increase profit

Examples:

- mixing water in milk or sand in sugar.
-

(iii) Hydrosphere:

The hydrosphere comprises all the water on earth - oceans, lakes, glaciers, groundwater and vapours It covers about 71% of earth's surface. It is crucial for planet's climate and life.

(iv) Troposphere:

The lower layer of Earth's atmosphere, extending up to about 12 km above sea level

It contains 78% nitrogen, 21% oxygen and most of the weather phenomenon like rain and storms occur here.

(v) Isotopes:

Atoms of the same element having the same number of protons but different numbers of neutrons

Example:

Hydrogen isotopes

Protium (^1H), Deutrium (^2H), Tritium (^3H)

Section II

Q.NO: 7

(a) Diameter = D = 14cm

Radius = r = 7cm

Volume = $\frac{4}{3}\pi r^3$

using $\pi = \frac{22}{7}$

$V = \frac{4}{3} \times \frac{22}{7} \times 7^3$

$= \frac{4}{3} \times \frac{22}{1} \times 343$

$= \frac{4}{3} \times 1078$

49 × 7 = 343

49 × 22 = 1078

$V = 1437\ cm^3$

(b) let shares $= k(1+2+3+4+5)$

$= k15 = 25000$

$k = \frac{25000}{15} = \boxed{1666.666}$

(c)

(i) All of the numbers fit

(ii) 3, 5, 7, 11, 13, 17 (prime numbers).

(d) Pythagoras theorem

$5^2 + 12^2 = 13^2$

$25 + 144 = 169$

$\sin\theta = 5/13 = 22.62$

$\sin\theta = 12/13 = 67.38$

~~$\sin\theta\ 13/13 =$~~

right angle $= 90°$.

Q6(d)

(i) STSTAICITS → STATISTICS
(ii) LGEMABR → ALGEBRA

Q6(c)

distance cover = 36km
Speed = 18 km/h
T = 1:00pm

$T = d/s = 36/18 = 2$ hours

Arrival Time = 1:00 + 2:00
= 3 hours.

Q6(b)

camera price = $200
Discount = 25% = 0.25

Discount = $0.25 \times 200 = 50$
Discounted price = 200 − 50
$150

Tax = ~~66~~ 6% of 150.
$= 0.06 \times 150 = 9$
$= 150 + 9 = \$159$

Q6(a)

Let common factor = k

Apple = 3k Cherry = 2k

Berry 6k Date = 5k

Given $5k - 3k = 35$

$2k = 35$

$k = \frac{35}{2} = 17.5$

Berry = $6k = 6 \times 17.5 = 105$.
