‘+9th Biology Unit 8 Long - Corrected Version

Unit 08
Bioenergetics
Descriptive Questions

Q. 1 Describe bioenergetics and the role of ATP.
Ans. Definition
'Bioenergetics is the study of how living organisms acquire, convert, store, and utilize energy to fuel their life processes'. Or 'Bioenergetics is the study of energy transformations in living organisms'.
Explanation
Organisms obtain energy primarily from their surroundings. Plants capture sunlight through photosynthesis, while animals and other organisms consume food. This energy is then converted into usable chemical energy, stored in molecules like ATP (adenosine triphosphate). ATP acts as a ready source of energy that cells can access whenever they need it for processes such as growth, movement, repair, and reproduction.

Q. 2 What are redox reactions? Write their role.
Ans. Introduction
Oxidation-reduction (redox) reactions are fundamental to the metabolism of organisms. In these reactions, electrons are transferred between molecules. In oxidation, a molecule loses electrons and in reduction, it gains electrons.
Role
This electron flow is essential for generating energy in the form of ATP during processes like cellular respiration and photosynthesis.

ATP: The Cell's Energy Currency
Q. 3 Explain ATP as a molecule that is the chief energy currency of all cells.
Ans. ATP
Cells use a special energy currency for their reactions. This currency is a nucleotide called adenosine triphosphate (ATP).
Need of Energy
When cells store energy, they make ATP. When cells need energy, they break ATP.
Structure
ATP molecule has three components i.e. adenine (a nitrogen-containing base); ribose (a five-carbon sugar); and three phosphate groups.
ATP-ADP Cycle
a) ATP into ADP
In the molecule of ATP, the covalent bonds between two phosphates are high-energy bonds. When one of these bonds is broken, inorganic phosphate (Pi) separates and energy is released.
Formation of ATP
The breaking of one phosphate bond releases about 7.3 kcal (7,300 calories) per mole of ATP.
$ATP+H_2O \rightarrow ADP+Pi+energy(7.3kcal/mole)$
In common energy reactions only the outer P-P high-energy bond breaks. When this happens, ATP becomes ADP (adenosine diphosphate) and one Pi is released.
b) ADP into AMP
In some cases, ADP is further broken down to AMP (adenosine monophosphate) and Pi.
$ADP+H_2O \rightarrow AMP+Pi+energy(7.3kcal/mole)$

Cells get energy from the oxidation of food. They store this energy by combining ADP with Pi to form ATP.

Summary

ATP is made during energy-releasing processes and is broken down during energy-consuming processes. In this way, ATP transfers energy between metabolic reactions.

Q. 4 Define photosynthesis. Discuss it with its chemical equation.

Ans. Introduction

Photosynthesis is the synthesis of glucose from carbon dioxide and water in the presence of sunlight (and chlorophyll), with oxygen as a by-product.

Chemical Equation

It is the most important metabolic reaction and all life depends on it. A simple general equation for photosynthesis is as follows:

$6CO_2+12H_2O+\text{light energy} \rightarrow C_6H_{12}O_6+6O_2+6H_2O$

Carbon dioxide + water + light energy → glucose + oxygen + water

Explanation

Autotrophic organisms (plants, algae, some bacteria) use inorganic raw materials to prepare their organic food. The organic food is in the form of carbohydrates. The carbohydrates are used for getting energy and are also converted to other molecules like proteins, lipids etc.

Q. 5 Outlines the processes involved in photosynthesis. / Write a note on mechanism of photosynthesis.

Ans. Introduction

Photosynthesis occurs in two phases i.e. light reactions and dark reactions. Light reactions take place on the thylakoid membranes of chloroplasts. Dark reactions take place in the stroma of the chloroplasts.

1. Light Reactions

Definition

During light reaction, light energy is used to make high-energy molecules (ATP and NADPH).

Key Events of Light Reactions

Following are the key events of light reactions:

a) Emission of Electrons

When chlorophyll absorbs light, reactions start in it. High-energy electrons are released from chlorophyll.

b) Production of ATP

The high-energy electrons are passed to an electron transport chain. In this chain, electrons pass from higher to lower energy level. They release energy which is used to produce ATP.

c) Breakage of Water Molecule (Photolysis)

Light also breaks water molecules. Oxygen is released while hydrogen atoms give electrons to chlorophyll and become hydrogen ions.

d) Reaction of NADP into NADPH

The electrons of chlorophyll, after the production of ATP, and the hydrogen ions of water are used to reduce NADP into NADPH.

e) Nicotinamide Adenine Dinucleotide Phosphate (NADP)

It is a coenzyme. One form of this coenzyme also carries phosphate. It is called NADP.

2. Dark Reactions (Calvin Cycle)

Definition
During this phase, carbon dioxide is reduced to make glucose. The details of dark reactions were discovered by Melvin Calvin.
Summary of Dark Reactions
a) Splitting of 6-Carbon Compounds
CO_2 molecules combine with 5-carbon compounds to form 6-carbon compounds. Each 6-carbon compound splits into two 3-carbon compounds.
b) Reduction of 3-Carbon Compounds
The 3-carbon compounds are reduced to 3-carbon carbohydrates by using ATP and hydrogen from NADPH. The 3-carbon carbohydrates are used to make glucose.
c) Regeneration of Original 5-Carbon Compounds
The 3-carbon carbohydrates are also used to regenerate the original 5-carbon compounds. This step also utilizes ATP.

Q. 6 Explain the role of chlorophyll and light in photosynthesis.
Ans.
The thylakoid membranes of chloroplasts contain pigments. Chlorophyll-a is the main pigment. Others are called accessory pigments and include chlorophyll-b and carotenoids.
Absorption of Light by Pigments
Pigments absorb sunlight and convert it into chemical energy for photosynthesis. Only about 1% of the light falling on the leaf surface is absorbed, the rest is reflected or transmitted. The blue and red lights carry out photosynthesis. Different pigments absorb different wavelengths of light. Chlorophyll-a absorbs light of blue and red wavelengths. The wavelengths which are not absorbed by chlorophyll-a are absorbed by accessory pigments.

Pigments
Pigments are the substances that absorb visible light. Different pigments absorb light of different wavelengths (colours).
Formation of ATP
When a pigment absorbs light, reactions occur in it and its electrons are released. The high-energy electrons pass through electron transport chain and their energy is used for the formation of ATP and for reducing NADP to NADPH.

Q. 7 Define cellular respiration. Explain the types and importance of anaerobic respiration.
Ans.
Organisms get energy by breaking the C-H bonds of food. For this purpose, they carry out the oxidation of food inside cells. This oxidation of food is called cellular respiration. The most common food used by cells to get energy is glucose.
Types of Respiration
The two main types of respiration are:
1. Aerobic Respiration
2. Anaerobic Respiration

1. Aerobic Respiration
Definition: Cellular respiration occurring in the presence of oxygen is called aerobic respiration.
Explanation:
i. It is the complete oxidation of glucose with maximum release of energy.
ii. In its first phase, a molecule of glucose (6-C) is broken down into two molecules of pyruvic acid (3-C).

iii. In the second phase, the molecules of pyruvic acid are completely oxidized (all C-H bonds are broken) and all energy is released.

2. Anaerobic Respiration (Fermentation)

Definition: Cellular respiration that occurs in the absence of oxygen is called anaerobic respiration.

Explanation:

i. In anaerobic respiration, glucose is incompletely oxidized with less amount of energy released.

ii. Its first phase is exactly similar to that of aerobic respiration. A molecule of glucose is broken down into two molecules of pyruvic acid.

iii. In the second phase, pyruvic acid may be treated in two ways:

A. Alcoholic Fermentation

During anaerobic respiration in bacteria and yeast etc., pyruvic acid is further broken down into alcohol (C_2H_5OH) and CO_2. This type of anaerobic respiration is called alcoholic fermentation.

$2(C_3H_4O_3) \rightarrow 2(C_2H_5OH) + 2CO_2$

Pyruvic acid → Ethyl alcohol + Carbon dioxide

Yeast and bacteria can ferment sugars of berries to alcohol. Birds eating these berries can become quite drunk, as is obvious from their flight pattern.

B. Lactic Acid Fermentation

During anaerobic respiration in the skeletal muscles of humans and other animals, pyruvic acid is converted into lactic acid ($C_3H_6O_3$). This type of anaerobic respiration is called lactic acid fermentation.

$2(C_3H_4O_3) \rightarrow 2(C_3H_6O_3)$

Pyruvic acid → Lactic acid

Importance of Fermentation

i. Early Life and Anaerobes

The environment of Earth did not have free oxygen (O_2) in the early phases of life. The early organisms respired anaerobically and got energy for their life. Even today, some organisms including some bacteria and some fungi get energy from anaerobic respiration and are called anaerobes.

ii. Anaerobic Respiration in Skeletal Muscles

When skeletal muscles of humans work hard (during exercise etc.) but oxygen supply is not sufficient to fulfil the demand, the skeletal muscles carry out anaerobic respiration to get energy.

iii. Use of Fermentation

Scientists have used fermentation in fungi and bacteria for making useful products for mankind.

Examples:

a. The fermentation in bacteria is used for making cheese and yogurt.

b. Fermentation in yeasts is used in brewing and baking industries.

c. Similarly, the soy sauce is made through the fermentation by a fungus.

Q. 8 Outline the mechanism of aerobic respiration.

Ans. Introduction

For the study of all the reactions of cellular respiration, mechanism of aerobic respiration is studied. There are three main steps of aerobic respiration.

1. Glycolysis

In the first step, the glucose (6C) molecule is broken. It results in two molecules of pyruvic acid (3C) with 2 ATPs and 2 molecules of NADH. This process is called glycolysis and it occurs in cytoplasm. Oxygen is not required for glycolysis. That is why, it also occurs in anaerobic respiration.

2. Krebs Cycle

When oxygen is available, the molecules of pyruvic acid move from cytoplasm to the matrix of mitochondria. Here, a series of reaction called Krebs cycle (named after British Scientist Sir Hans

Krebs) occurs. Before Krebs cycle, each pyruvic acid is converted into acetyl coenzyme-A, carbon dioxide and NADH.
In Krebs cycle, the acetyl Coenzyme-A is completely oxidized to carbon dioxide. It results in the formation of ATP and energy-rich compounds i.e. NADH and $FADH_2$ (Flavin Adenine Dinucleotide - reduced).

3. Electron Transport Chain

This step occurs on the membranes of mitochondria. During it, NADH and $FADH_2$ change back to NAD and FAD by releasing electrons and hydrogen ions. The released electrons pass through an electron transport chain and release energy. This energy is used to make ATP. At the end of the chain, electrons and hydrogen ions combine with oxygen and form water.

Q. 9 What are the uses of ATP?

Ans.

Respiratory energy produced during cellular respiration is used in various ways:

1. Muscle contractions and movement
2. Active transport of substances
3. Synthesis of biomolecules
4. Replication of DNA and mitosis
5. Transmission of nerve impulse
6. Maintenance of body temperature
7. Breakdown and elimination of toxins from the body

Q. 10 Describe the differences between aerobic and anaerobic respiration.

Ans. Difference between aerobic and anaerobic respiration

Characteristics	Aerobic Respiration	Anaerobic Respiration
Presence of Oxygen	Yes	No
Number of ATP as net profit	36	02
Final products	Carbon dioxide and Water	Lactic acid or Ethanol + CO_2
Site of Occurrence	Cytoplasm and Mitochondria	Cytoplasm
Importance	Major source of energy for most organisms	- Source of energy for anaerobic organisms - Source of energy for aerobic organisms in short supply of O_2 - Source of useful products (ethanol, cheese etc.)

Q. 11 Describe the differences between photosynthesis and respiration.

Ans. Difference between photosynthesis and respiration

Characteristics	Photosynthesis	Respiration
Type of metabolism	Anabolic process	Catabolic process
Energy investment/production	Energy is stored in the form of bond energy	Bond energy of food is transformed into ATP
Organisms capable of performing this process	Some bacteria, all algae and all plants	All organisms
Site of Occurrence	Chloroplasts in green parts only	In cytoplasm and mitochondria in all cells
Time of occurrence	In daytime only in the presence of light	All the time

Q. 12 How does the intake of water and CO_2 take place for photosynthesis? Which phenomenon is involved in the intake of CO_2 and water by plants?

Ans. Intake of water and CO_2 for photosynthesis

Water and CO_2 are the raw materials of photosynthesis. The plants have mechanisms for the intake and transport of these materials.

i. Intake of water

Water present in soil is absorbed by roots and root hairs through osmosis. This water is eventually transported to leaves through xylem vessels. (After the entry of water in the inner cells of the root, it reaches xylem vessels).

ii. Intake of Carbon dioxide (CO_2)

The air that enters the leaf through tiny pores (stomata) reaches into the air spaces present around mesophyll cells. Stomata cover only 1-2% of leaf surface but they allow much air to pass through them.

This air carries CO_2 which gets absorbed in the thin layer of water surrounding the mesophyll cells. From here, the CO_2 diffuses into the mesophyll cells.

9TH Biology Unit 9 Long - Corrected Version

Unit 9
Plant Physiology
Descriptive Questions

Introduction

Q. 1 Differentiate between autotrophic and heterotrophic organisms.

Ans.

a. Autotrophic Organisms

Definition

Autotrophic organisms obtain water, carbon dioxide and minerals from their environment and prepare their food.

Examples
Some bacteria, all algae, and all plants.
b. Heterotrophic Organisms
Definition
Heterotrophic organisms obtain their food from other organisms.
Examples
Most bacteria, and all protozoans, fungi and animals.

Nutrition in Plants
Q. 2 Define nutrition and nutrients.
Ans.
Nutrition
Nutrition means the processes in which food is prepared or obtained and converted into body substances for growth and energy.
Nutrients
Nutrients are the substances required by organisms for energy, growth, repair, and maintenance.

Q. 3 Define macronutrients and micronutrients. Explain role of mineral nutrients in plant life.
Ans.
Mineral Nutrition
These are special chemical elements absorbed from soil that are essential for the plants to grow.
Macronutrients
The minerals which are required in larger quantities are called macronutrients e.g. carbon, hydrogen, oxygen, phosphorus, potassium, nitrogen, sulphur, calcium, and magnesium.

Micronutrients
The minerals which are required in lower quantities are called micronutrients e.g. iron, molybdenum, boron, copper, manganese, zinc, chlorine, and nickel.
Table 9.1: Role of Mineral Nutrients in Plant Life

Macronutrients	Role in Plant Life
Carbon	Major component of all biomolecules
Hydrogen	Major component of all biomolecules
Oxygen	Major component of biomolecules, necessary for cellular respiration
Phosphorus	Component of ATP, nucleic acids, and coenzymes, necessary for seed germination, photosynthesis etc.
Potassium	Regulates the opening and closing of the stoma
Nitrogen	Component of proteins, chlorophyll and enzymes
Sulphur	Component of proteins, vitamins and enzymes
Calcium	Activates enzymes, is a structural component of cell walls, influences water movement in cells

Macronutrients	Role in Plant Life
Magnesium	Component of chlorophyll, activates many enzymes
Micronutrients	**Role in Plant Life**
Iron	Necessary for photosynthesis, activates many enzymes
Molybdenum	Component of the enzyme that converts nitrates to ammonia
Boron	For sugar transport, cell division, and certain enzymes
Copper	Component of several enzymes
Manganese	Involved in the activities of enzymes of photosynthesis and respiration
Zinc	Required in a large number of enzymes
Chlorine	Involved in osmosis of water
Nickel	Required in nitrogen metabolism

Q. 4 What is the role of nitrogen and magnesium in plant growth?
Ans.

a. Role of Nitrogen

i. Nitrogen is a necessary part of all proteins, enzymes and nucleic acids.
ii. It is also a part of chlorophyll.
iii. Nitrogen helps plants for rapid growth, increasing seed and fruit production and improving the quality of leaf.
iv. Plant roots absorb nitrogen in the form of nitrates.
v. Carnivorous plants trap and digest small animals. Such plants fulfil their needs of nitrogen from the prey animals.

Effects of Nitrogen Deficiency

i. Nitrogen deficiency slows down the growth of plant.
ii. It also results in insufficient production of chlorophyll and so leaves begin to turn yellow.

b. Role of Magnesium

i. Magnesium is part of the chlorophyll.
ii. It also activates many plant enzymes needed for growth.
iii. It also helps in fruit formation and germination of seeds.
iv. Plant roots absorb magnesium in ionic form (Mg^{2+}).

Effects of Magnesium Deficiency

i. If sufficient amounts of magnesium are not available, plants begin to break the chlorophyll in leaves.
ii. This causes the yellowing of leaves. After prolonged magnesium deficiency leaves may also drop.
iii. When a plant faces N or Mg deficiency, it transports these elements from older to younger leaves. So, the yellowing of leaves is seen in old leaves first. If deficiency continues, this symptom progresses to the young leaves.

Figure 9.1: (a) Chlorosis due to Nitrogen deficiency, (b) Chlorosis due to magnesium deficiency

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Transport in Plants

Q. 5 (a) What is transport in plants? How does it take place?

Ans.

Definition

Transport means the movement of substances, such as water, nutrients, hormones, and waste products within an organism.

Need of Transport

This movement is essential for cellular functions, growth, and responses to environmental changes.

Explanation

i. Plants get water and mineral nutrients (salts) from the soil. These materials are transported to the aerial parts of the body.

ii. Similarly, the food prepared by leaves is transported to other parts of the body.

iii. In all land plants (except mosses and liverworts), the transport of water, salts and food is carried out by xylem and phloem tissues.

a. Xylem is responsible for the transport of water and salts.

b. Phloem is responsible for the transport of food.

Q. 5 (b) Define the following terms:

i. Diffusion

ii. Passive Transport and Active Transport

iii. Osmosis

Ans.

Diffusion: It is the movement of molecules from an area of higher concentration to an area of lower concentration, until they are evenly spread out.

Passive Transport: It is the movement of molecules across a cell membrane from a high to a low concentration, without using energy.

Active Transport: It is the movement of molecules across a cell membrane from a low concentration to a high concentration, using energy.

Osmosis: It is the movement of water molecules through a semi-permeable membrane from a region of lower solute concentration to a region of higher solute concentration.

Q. 6 Explain the internal structure of root and describe the uptake of water and salts by roots.

Ans.

Introduction

Roots are the organs which absorb water and salts from the soil. The internal structure of a root shows the following features that help the roots to perform this function.

Internal Structure of Root

Epidermis

The outermost covering of the root i.e. epidermis is a single layer of cells.

Root Hairs

Many cells of epidermis have tiny hair-like extensions into the spaces among soil particles. These extensions called root hairs are in direct contact with soil water. Root hairs have large surface area.

Absorption and Transport of Water

The soil water has a lower concentration of salts as compared to root hairs. Root hairs take in more salts by active transport. Due to the difference in the concentration of salts in soil and root hair, water

moves by osmosis (passive transport) from soil to the root hairs. From root hairs, the water with dissolved salts moves to the other cells of epidermis.
Cortex: It is broad zone of cells just inside the epidermis. Water moves from epidermis to cortex.
Endodermis: It is the innermost boundary of cortex that receives water from cortex.
Pericycle: It is a narrow layer of cells present on the inner side of endodermis.
Vascular Tissues
i. Xylem and phloem (collectively called vascular bundle) are present in the innermost region of the root.
ii. They are in the form of a rod which is connected to the similar rod in the stem.
iii. Water from pericycle moves into the xylem of root from where it will be transported to the xylem of the stem.
iv. Inside the root, water and salts take two pathways to reach the core of the root: through the cells and through cell walls and intercellular spaces.

Transpiration
Q. 7 Define transpiration. Where does it take place?
Ans.
Definition
The loss of water in the form of vapours from plant surface is called transpiration.
Occurrence
This loss may occur through stomata in leaves, through the cuticle present on leaf epidermis, or through special openings called lenticels present in the stems of some plants.
Stomatal Transpiration
Most of the transpiration occurs through stomata and is called stomatal transpiration. In leaves, water moves from the xylem into the cell walls of mesophyll cells. From the moist walls of mesophyll cells, water evaporates into the air spaces of the leaf. These water vapours then move towards the stomata and then pass to the outside air.

Q. 8 Describe the events involved in the opening and closing of stomata. / Describe the mechanism of opening and closing of stomata.
Ans.
Introduction
Stomata open and close because of changes in the turgor pressure of their guard cells. The sausage-shaped guard cells are the only epidermal cells which contain chloroplasts. Their cell wall is thicker on the inside and thinner elsewhere. When guard cells become turgid, they become bean-shaped. In this condition, their inner walls of two guard cells move away from each other and the stoma between them opens.
Transport of Water and Salts and Transpiration Pull
Transpiration is a necessary evil. Although transpiration is the loss of water from plant but, yet it creates a pull on the water columns in the xylem tissue of leaves, stem and root. This pull is responsible for the transport of water and salts from root to leaves.
Movement of Water from Epidermal Cells to Guard Cells
a. Events during Daytime: The guard cells take in potassium ions from the surrounding cells by active transport. As a result, the solute concentration of guard cells increases as compared to the other cells of epidermis. So, water moves from epidermal cells to guard cells by osmosis.
b. Opening of Stomata
The guard cells become turgid and their inner sides move away from each other. In this way, the

stoma between them opens. The solute concentration remains high in guard cells because they do photosynthesis and prepare glucose in them. So, water stays in them and they remain turgid.
c. Events during Evening: At evening, the glucose concentration falls in guard cells and potassium ions also move back to epidermal cells. As a result, water moves out from guard cells and they lose turgor. Their inner sides touch each other and the stoma closes.

Q. 9 Describe the factors affecting the rate of transpiration. / Describe temperature, wind and humidity as the factors affecting the rate of transpiration.
Ans. Transpiration is affected by several factors. For example:

- **Temperature:** Increase in temperature results in an increase in the rate of transpiration. It is due to the fact that at higher temperature, water evaporates more quickly.
- **Wind:** Wind speeds up transpiration by carrying away humid air surrounding the leaves, allowing for more water to evaporate.
- **Humidity:** The higher is humidity (the percentage of water vapour in the atmosphere), the lower is the rate of transpiration.
- **Surface Area and Distribution of Stomata:** Leaves with more surface area transpire more than the leaves with narrow blades. In most plants the number of stomata on the lower leaf surface is greater than on the upper surface. Therefore, the rate of transpiration from the lower surface is greater than from the upper surface.

Transport of Water and Salts in Plants
Q. 10 Describe the mechanism of transport of water and salts in plant.
Ans.
Introduction

Roots cannot push the absorbed water and salts to the leaves of the plant. Instead, the leaves apply a pulling force on water present in roots. The pulling force in leaves is created by the transpiration of water from their surfaces. Therefore, it is called transpirational pull.
Explanation
When mesophyll cells of leaf lose water, more water enters in them from xylem vessels. Inside xylem vessels, there is a continuous water column. This water column extends from leaves to stem and to the roots. The continuous water column is created due to three reasons:
(i) The forces of attraction among water molecules (cohesion).
(ii) The narrow diameter of xylem vessels.
(iii) The force by which water molecules are adhered to the walls of xylem vessels (adhesion).
When one water molecule moves up by the xylem of the leaf, it produces a tension on the entire water column in the xylem of leaves, stem and root. As a result, the entire water column is pulled upwards.

Q. 11 Describe the mechanism of transport of food in plants. / Describe pressure flow mechanism.
Ans.
Introduction
Inside the plant body, food is transported from one part to the other through phloem tissue. For transportation in most plants, sucrose is converted into other sugars. The mechanism of the transport of food in plants is called pressure flow mechanism.
Explanation
i. According to pressure flow mechanism, dissolved food flows from a source to a sink. The sources include photosynthetic tissues (e.g. mesophyll of leaves) and storage tissues (e.g. roots). Sinks

include the sites of food utilization (e.g. growing tips of roots and stems) and the storage tissues.
ii. Xylem is a one-way passage for water and salts (from roots to leaves). Phloem is a two-way passage for food. The direction of food movement is decided by supply and demand in the sources and sinks.
iii. At the source site, food (sucrose) enters the sieve tubes of phloem by active transport. Companion cells of phloem provide energy for this transport. Due to higher solute concentration in sieve tubes than the nearby xylem tissue, water flows into sieve tubes by osmosis. In this way, the osmotic pressure in sieve tubes increases and the solution of food flows towards the sink.
iv. At the sink, sucrose is actively unloaded from the phloem cells into sink tissues. It reduces osmotic pressure in the phloem cells. So, water also flows out and moves to xylem tissue.

Q. 12 Describe the process of gaseous exchange in plants.
Ans.
During Daytime
During the day time, all plant cells are carrying out cellular respiration while their green parts are carrying out photosynthesis.

- In photosynthesis, they use carbon dioxide and release oxygen. They take carbon dioxide which they produce in respiration. They also take carbon dioxide from the environment.
- In respiration, they use oxygen produced during photosynthesis. They release carbon dioxide to the environment.

So, during daytime leaves are releasing oxygen and taking carbon dioxide from the environment.
During Night Time
During night, all cells are carrying out respiration while there is no photosynthesis. So, the plant is taking in oxygen from environment and releasing carbon dioxide.

Process of Gaseous Exchange
i. Gaseous Exchange through Epidermis and Cuticle
In plants, the gaseous exchange between body and the environment occurs through the surface. The epidermis of root, stem and leaves allows the exchange of gases between the inner cells and environment. At some parts a thick cuticle is present over epidermis. It also allows the exchange of gases.
ii. Gaseous Exchange through the Leaves and Stems
In leaves and young stems, the air moves in and out through the stomata present in epidermis. Inside body, gaseous exchange occurs between cells and air.
iii. Gaseous Exchange in Woody Stems
In woody stems, the outer surface is covered by bark. Gaseous exchange cannot occur through bark. The bark contains special pores called lenticels, which allow the gaseous exchange with the environment.
Figure 9.8: Lenticels in a bark

Mechanism for Excretion
Q. 13 How do plants exchange extra water and salts from their bodies? / Describe the mechanism / adaptations in plants for excretion.
Ans.
a. Excretion of Extra Carbon dioxide and Oxygen
During the day, plants use the carbon dioxide produced in cellular respiration for photosynthesis. However, at night, when photosynthesis is not occurring, carbon dioxide becomes a waste product. Plants release this excess carbon dioxide through their general surfaces and stomata.

Similarly, the oxygen produced during photosynthesis is used for cellular respiration during the day. Excess of oxygen is released into the atmosphere through the stomata.

b. Excretion of Extra Water

Plants store large amounts of water in the vacuoles of their cells. It results in turgor, which provides support to the soft parts of plant body. If plants have extra water, they remove it in two ways.

1. Transpiration

a. **At Day:** During the day, plants remove their extra water by transpiration. There are three types of transpiration: stomatal transpiration, cuticular transpiration, and lenticular transpiration.

b. **At Night:** At night, transpiration usually does not occur because most plants have their stomata closed. If there is high water content in soil, water enters the roots and is accumulated in xylem vessels.

2. Guttation at Night

At night, when stomata are closed, many plants store excess water in their xylem tissue. This water is removed during the day. Some plants, such as grasses, have a specialized mechanism called guttation to remove excess water at night. Guttation involves the release of water droplets through small pores located at the tips or edges of leaves. This process helps to regulate the plant's water content.

Dew Formation

Guttation is different from dew formation. Dew means the water drops on the surface of leaves formed by the condensation of water vapours present in the air.

c. Excretion of other Metabolic Wastes

Plants adopt different methods to remove other metabolic wastes from their bodies.

i. Some plants can store wastes in the form of harmless crystals.

ii. Some plants keep their wastes in their leaves. When their leaves fall, the plant body also gets rid of these wastes.

iii. Some plants excrete their wastes through special pores by applying force. For example, rubber plant produces latex, keekar tree excretes gums, coniferous trees excrete resins, and ladyfinger/okra excretes mucilage.

Q. 14 Explain osmotic adjustments in mesophytes, hydrophytes, xerophytes and halophytes.

Ans. On the basis of habitats, there are four types of plants:

1. Mesophytes

Introduction

Mesophytes are the terrestrial plants which live in lands where medium quantity of water is available. They absorb water through roots.

Osmotic Adjustments

i. Most of their body surface is covered with waxy cuticle, which prevents water loss.

ii. They also control excess transpiration of water by closing their stomata.

Examples

Maize (corn), clover and rose etc. are examples of mesophytes.

2. Hydrophytes

Introduction

Hydrophytes live in freshwater (ponds, and lakes etc.) or in wet soil. In these plants, the absorption of water occurs through the whole surface.

Osmotic Adjustments

They use different ways to remove extra water from their bodies:

- Broad Leaves and large number of Stomata
  i. For example, many hydrophytes have broad leaves which float on the surface of water.

ii. These leaves have large number of stomata on their upper surfaces. Water moves out through these stomata.

Example

The most common example of such plants is water lily.

3. Xerophytes

Introduction

Xerophytes live in extremely dry environments (deserts).

Osmotic Adjustments

i. They have deep roots to absorb water from almost dry soil.

ii. Few Stomata and Waxy Cuticle: Their body surface has very few stomata. It is also covered with thick waxy cuticle to reduce the loss of water.

iii. Succulent Organs: Some xerophytes e.g. Cacti (singular, Cactus) store water in their specialized stems or roots. Such stems or roots are soft and juicy and are called succulent organs.

Example

Examples of xerophytes include Cacti (singular Cactus).

4. Halophytes

Introduction

Halophytes live in habitats with salty waters (e.g. sea or salty marshes).

Osmotic Adjustments

i. Water tries to move out from their hypotonic bodies into the hypertonic environment. Such plants absorb salts from outside and make their bodies hypertonic. In this way, water does not move out of cells. The excess salt can be stored in cells or excreted out from salt glands on leaves.

Example

Many sea grasses are included in this group.

9th Biology Unit 9 Short - Corrected Version

Short Answer Questions (Exercise)

Q.1. Define mineral nutrition in plants.

Ans. Plants get their food from a process called photosynthesis. But for the synthesis of other biomolecules, they need other materials from soil. Such materials are called mineral nutrients and the process through which these special chemicals are absorbed from soil that are essential for the plants to grow is called mineral nutrition.

Q.2. Define macronutrients and micronutrients and give examples.

Ans. The minerals which are required in larger quantities are called macronutrients e.g. carbon, hydrogen, oxygen, phosphorus, potassium, nitrogen, sulphur, calcium, and magnesium. While, the minerals which are required in lower quantities are called micronutrients e.g. iron, molybdenum, boron, copper, manganese, zinc, chlorine, and nickel.

Q.3. State the roles of nitrogen and magnesium in plants.

Nitrogen	Magnesium
i. Nitrogen is a necessary part of all proteins, enzymes, nucleic acids and chlorophyll.	i. Magnesium is part of the chlorophyll.

Nitrogen	Magnesium
ii. Nitrogen helps plants for rapid growth, increasing seed and fruit production and improving the quality of leaf.	ii. It also activates many plant enzymes needed for growth.
iii. Plant roots absorb nitrogen in the form of nitrates.	iii. It also helps in fruit formation and germination of seeds.
iv. Carnivorous plants fulfil their needs of nitrogen from the prey animals.	iv. Plant roots absorb magnesium in ionic form (Mg^{2+}).

Q.4. Define transpiration and its types.
Ans.
Definition
The loss of water in the form of vapours from plant surface is called transpiration.
Types:

1. Stomatal transpiration
2. Cuticular transpiration
3. Lenticular transpiration

Q.5. How is the transpirational pull important in plants?
Ans. Transpiration creates a pull called transpiration pull which is principally responsible for the conduction of water and salts from roots to the aerial parts of the plant body.

Q.6. Transpiration is the loss of water from plants. Is it a harmful phenomenon? If no, what is its importance?
Ans. Transpiration is a necessary evil. It is harmful during the condition of drought as water loss causes wilting of the plant.
But at the same time it is important for plant as it causes cooling effect, generates transpirational pull and helps in gaseous exchange.

Q.7. Differentiate between:
i. Xylem and phloem

Xylem	Phloem
1. Xylem conducts water and mineral salts, and provides support and strength.	1. Phloem conducts prepared food from leaves to stem and roots etc.
2. Xylem consists of two main types of cells namely tracheids and vessel elements.	2. Two main types of cells in the phloem namely sieve tube elements and companion cells.

ii. Transpiration and guttation

Transpiration	Guttation
i. Plants absorb water from the soil by the roots. This absorbed water moves in the aerial parts of the plant from where most of this water (approx. 99%) has been lost in the form of vapours into the atmosphere. This loss is called transpiration.	i. The appearance of drops of water on the tips or edges of leaves is called guttation.
ii. Transpiration always occurs against the gravity.	ii. Guttation is not to be confused with dew, which condenses from the atmosphere on to the plant surface.
iii. Transpiration involves mainly the xylem cells.	iii. Some plants such as sea grasses and strawberry force this water through special pores present at leaf tips or edges and form drops.

iii. Hydrophytes and Halophytes

Hydrophytes	Halophytes
i. These plants live in water-rich environments.	i. These plants are adapted to salty environments.
ii. Rate of transpiration is highest.	ii. Salts enter in such plants due to their higher concentration in sea water.
iii. Stomata are present on the upper surface of leaf.	iii. Water tends to move out of their cells into the hypertonic sea water.
iv. These plants have thin cuticle.	

iv. Hydrophytes and xerophytes

Hydrophytes	Xerophytes
i. They live in water-rich environments.	i. These plants are adapted to extreme dry conditions.
ii. Rate of transpiration is highest.	ii. They exhibit lowest rate of transpiration.
iii. Stomata are present on the upper surface of leaf.	iii. Xerophytes possess sunken stomata.
iv. These plants have thin cuticle.	iv. Thick cuticle is present in them.
v. The most common example of such plants is water lily.	v. Cacti etc.

v. Lenticular transpiration and stomatal transpiration

Stomatal Transpiration	Lenticular Transpiration
Most of the transpiration occurs through stomata and is called stomatal transpiration. In leaves, water moves from the xylem into the cell walls of mesophyll cells.	This is the water loss of plant in form of vapours by the lenticels.

Q.8. How do the plants of rubber and keekar excrete their wastes?
Ans. Plants deposit many metabolic wastes in their bodies as harmless insoluble materials:
i. Latex is removed by rubber plants.
ii. Gums are removed by keekar.

Short Answer Questions (Additional)

Transport in Plants
Q.9. Define following terms:
(i) Osmotic adjustment
Osmotic adjustment, also known as osmoregulation, is the plant's way of maintaining the right balance of water and solutes in its body.
(ii) Transpiration
Plants absorb water from the soil by the roots. This absorbed water moves in the aerial parts of the plant from where most of this water (approx. 99%) has been lost in the form of vapours into the atmosphere. This loss is called transpiration.

(iii) Translocation
The transport of prepared food (organic solutes) to different parts of the plant through the phloem tissue is translocation.
(iv) Micronutrients
The seven elements are needed in traces or small amounts (less than 0.05% dry weight) for normal plant growth and development that are known as micronutrients. These include iron, boron, manganese, copper, molybdenum, chlorine, and zinc.
(v) Excretophores
Plant cells have large vacuoles that can store useful stuff or waste. Sometimes, these stored substances can build up and form crystals in the vacuoles. Leaves are key players in this process. When the leaves are loaded with large amount of pigmented compounds, they turn yellow. Remember, this yellowing is not due to lack of chlorophyll as happens in chlorosis.
Such leaves are generally fallen from plants in autumn season. In this way leaves act as organs of excretion, therefore, such leaves are also called excretophores. This is why gardeners like using decomposed autumn leaves as a mineral-rich source for plants.
(vi) Vascular Bundle
There are two types of compound tissues in plants: (a) xylem (b) phloem. Together they form the vascular bundles. Both xylem and phloem are composed of more than one type of cells. Xylem tissue is responsible for the transport of water and dissolved substances from roots to aerial parts. Phloem is responsible for the conduction of dissolved organic matter (food) between different parts of plant body.
(vii) Xylem

1. Xylem tissue is responsible for the transport of water and dissolved substances from roots to aerial parts.
2. They provide support to plant body because of presence of lignin in its secondary cell walls. Lignin makes these walls thick and rigid.

(viii) Adhesion

Adhesion is the attraction between water molecules and other substances. Water is strongly attracted to the walls of the xylem cells because both water and cellulose (in cell walls) are polar molecules. This adhesion helps water move upward in the plant against gravity. It also keeps water in the xylem when transpiration is not happening.

(ix) Cohesion

Cohesion is the attraction between nearby water molecules, which is possible because water is a polar molecule.

Q.10. What is the effect of temperature on the rate of transpiration?

Ans. (i) On a sunny day with strong sunlight, the air temperature rises, and this increase in temperature lowers the humidity in the air. As a result, more water evaporates from the surfaces of plant mesophyll cells which leads to a higher rate of transpiration.

(ii) For every 10°C increase in temperature, the rate of transpiration roughly doubles.

(iii) However, when the environmental temperature becomes very high, around 40-45°C, it causes the stomata on plant leaves to close. This closure helps the plant conserve its much-needed water because excessive loss can be detrimental.

(iv) If these higher temperatures persist for an extended period and the soil doesn't have enough water, the plants may start to wilt and could eventually die.

Q.11. How is homeostasis maintained in plants?

Ans. Transpiration provides evaporative cooling. As water leaves the plant tissues it takes energy with it in the form of heat. Much like when we sweat, this allows the plants to cool and maintain homeostasis.

Transport of Water and Salts in Plants

Q.12. Differentiate between pith and cortex.

Pith	Cortex
Pith is a small area in the center of vascular bundles of plants.	Cortex consists of many layers of parenchyma cells, inner to epidermis.

Q.13. Difference between guard cells and epidermal cells.

Guard Cells	Epidermal Cells
A pair of guard cells form a stoma, which is involved in the gas exchange of plants.	Epidermal cells provide protection to the plant from the external environment.

Translocation of Food in Plants

Q.14. Differentiate between sink and source.

Ans. A location in a plant where sugar is being produced either by photosynthesis or by the breakdown of stored starch is called a sugar source; green leaves and stem.

A location in a plant where sugar is consumed or stored is called a sugar sink e.g. young leaves, fruits etc.

Q.15. Define endodermis and pericycle.
Ans. Endodermis refers to the inner layer of cortex that surrounds the vascular bundle. Pericycle is a single ring-like layer internal to the endodermis.

Gaseous Exchange
Q.16. What is the pattern of gas exchange between plant and environment at the time of dawn and dusk?
Ans. During dawn and dusk, when light intensity is low, the rates of photosynthesis and respiration become equal. This means the carbon dioxide produced by respiration is enough for photosynthesis and the oxygen released by photosynthesis is used in respiration. At this point, there's no net exchange of gases with the environment, and we call it the "compensation point of photosynthesis."

Q.17. Why do plants absorb carbon dioxide and release oxygen during daytime?
Ans. During the day, plants are busy with both photosynthesis (making food) and respiration. The rate of photosynthesis varies throughout the day as it mainly depends upon light intensity. Generally, the rate of photosynthesis is greater than rate of respiration, therefore, the photosynthesis needs more carbon dioxide than what respiration produces, so plants bring in extra carbon dioxide from the environment. On the other hand, photosynthesis produces more oxygen than respiration needs, so plants release excess oxygen.

Q.18. How are carbon dioxide and oxygen removed from plants?

Ans. As the process of respiration takes place continuously, so carbon dioxide is also produced continuously. Photosynthesis takes place at daytime in the plants, during which oxygen is released. CO_2 produced during respiration at daytime is used in photosynthesis. Only a small quantity of oxygen produced during photosynthesis is used by plants for respiration. The rest of the oxygen is released through stomata and lenticels. At night no photosynthesis takes place. So, CO_2 is released as by-product and atmospheric oxygen is used for respiration in plants.

Mechanism for Excretion
Q.19. Name some waste products of plants.
Ans.
(i) CO_2
(ii) Extra Oxygen
(iii) Excess Water
(iv) Calcium oxalate

Q.20. Define excretion.
Ans. The process by which metabolic wastes are eliminated from body to maintain the internal conditions at equilibrium is called excretion e.g. urea, salts of uric acid and water are eliminated out of body through excretion.

Osmotic Adjustment in Plants
Q.21. Write any three osmotic adjustments in hydrophytes.

Ans. They have developed mechanisms for the removal of extra water from their cells. Hydrophytes have broad leaves with large number of stomata on their upper surfaces. This characteristic helps them to remove the extra amount of water.

Q.22. Define osmoregulation.
Ans. It is defined as the maintenance of the amounts of water and salts in body fluids i.e. blood and tissue fluids, e.g., blood glucose level remains about 1 g/L despite eating a meal rich in carbohydrates.
