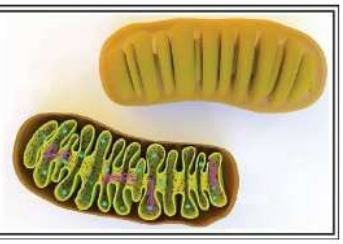
8 CHAPTER

BIOENERGETICS



8.1 ROLE OF ATP – THE ENERGY CURRENCY OF CELL

LONG ANSWER QUESTIONS

Q.1 Define bioenergetics. **(K.B)**

Ans:

BIOENERGETICS

Definition:

Bioenergetics is the study of energy transformations in living organisms.

Source of Energy:

- 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).

Concept of Energy Transformation:

- Oxidation-reduction (redox) reactions are fundamental to the metabolism of organisms.
- In these reactions, electrons are transferred between molecules.

Oxidation:

- In oxidation, molecule loses electrons and in reduction, it gains electrons.
- This electron flow is essential for generating energy in the form of ATP during processes like cellular respiration and photosynthesis.

Q.2 Explain ATP as a molecule that is the chief energy currency of all cells. **(K.B)**

Ans:

ATP AND ADP MOLECULES

Definition:

Cells use a special **energy currency** for their reactions. This currency is a **nucleotide** called adenosine triphosphate (ATP).

Structure of ATP:

ATP molecule has three subunits:

1. **Adenine** - a nitrogen containing base
2. **Ribose** - a five-carbon sugar
3. Three **phosphate** groups

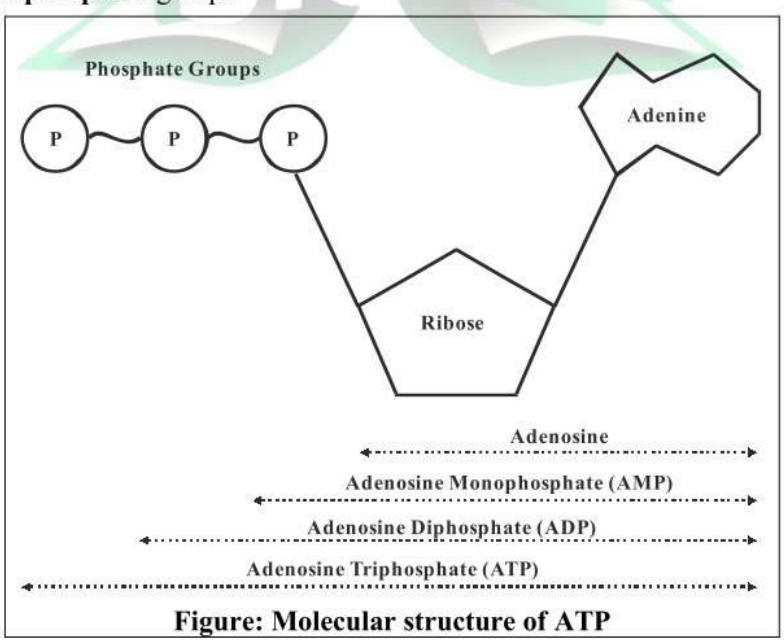


Figure: Molecular structure of ATP

High-Energy Bonds:

- 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.
- The breaking of one phosphate bond releases about **7.3 kcal** (7,300 calories) per mole of ATP.

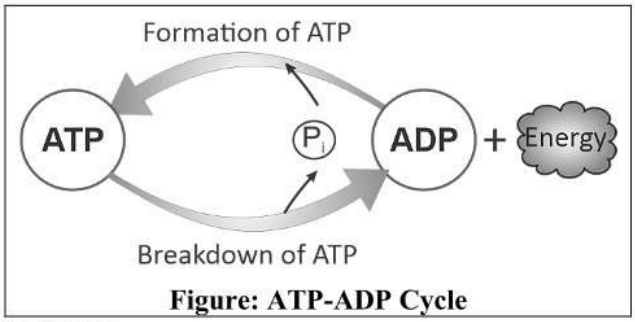


Figure: ATP-ADP Cycle

Energy Releasing Steps:

- 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.

$$ATP + H_2O \longrightarrow ADP + P_i + \text{Energy (7.3 Kcal/mole)}$$

- In some cases, ADP is further broken down to AMP (**adenosine monophosphate**) and Pi.

$$ADP + H_2O \longrightarrow AMP + P_i + \text{Energy (7.3 Kcal/mole)}$$

Energy Storing Steps:

- Cells get energy from the **oxidation of food**.
- They store this energy by combining ADP with Pi to form ATP.
- So, we can summarize that ATP is made during **energy-releasing processes** and is broken down during **energy-consuming processes**.
- In this way ATP transfers energy between metabolic reactions.

$$ADP + P_i + 7.3 \text{ Kcal/mol} \longrightarrow ATP$$

ATP as Cell's Energy Currency:

- When cells store energy, they make ATP.
- When cells need energy, they break ATP.
- In 1941, the Nobel prize winner, **Fritz Lipmann** proposed that ATP is the main energy-transfer molecule in the cell.

SHORT ANSWER QUESTIONS

Q.1 Elaborate bioenergetics. **(K.B)**

Ans:

BIOENERGETICS

Definition:

Bioenergetics is the study of energy transformations in living organisms.

Source of Energy:

- 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).

Q.2 What are high energy bonds? **(K.B)**

Ans:

HIGH ENERGY BONDS

Definition:

In the molecule of ATP, the **covalent bonds** between two **phosphates** are high-energy bonds.

Energy:

- When one of these bonds is broken, **inorganic phosphate** (Pi) separates and energy is released.
- The breaking of one phosphate bond releases about **7.3 kcal** (7,300 calories) per mole of ATP.

Symbol:

They are represented by wavy lines ~

Q.3 What is meant by cell energy currency? (U.B)

Ans:

ENERGY CURRENCY OF CELL

ATP is often referred to as the energy currency of the cell because it is used much like money. When cells breakdown molecules in metabolic reaction, the energy that is released can be captured in molecules of ATP.

Q.4 Describe the structure of ATP. (K.B)

Ans:

STRUCTURE OF ATP

The ability of ATP to store and release energy is due to its molecular structure. Each ATP molecule has three subunits:

- **Adenine** - a nitrogen containing base
- **Ribose** - a five-carbon sugar
- Three **phosphate** groups

Q.5 What is the importance of ATP? (U.B)

Ans:

IMPORTANCE OF ATP MOLECULE

The major energy currency of all cells is a nucleotide called adenosine triphosphate (ATP). It is the main energy source for majority of the functions like

- Growth
- Movement
- Reproduction
- Repair
- Active transport

Q.6 How ATP and ADP molecules are related? (U.B)

Ans:

ADP-ATP CYCLE

ATP to ADP Conversion:

- ATP can be converted to ADP and inorganic phosphate by hydrolysis.
- The third phosphate group separates from ATP and remains in the cell in inorganic form.

Purpose:

When a phosphate group is removed and ATP is converted to ADP, this releases around 7.3kcal of energy. This energy is used by cell for its functions.

ADP to ATP Conversion:

- ADP and phosphate can be converted back to ATP by condensation.
- This process store around 7.3kcal of energy in each phosphate bond formed.

MULTIPLE CHOICE QUESTIONS

1. ATP was discovered by: (K.B)

(A) Fritz Lipmann (B) Karl Lohmann
(C) Malvin Calvin (D) Sir Hans Krebs

2. Who proposed that ATP is the main energy transfer molecule of the cell? (K.B)

(A) Fritz Lipmann (B) Karl Lohmann
(C) Malvin Calvin (D) Sir Hans Krebs

3. ATP is an example of: (K.B)

(A) Amino acid (B) Fatty acid
(C) Nucleic acid (D) Nucleotide

4. Each ATP molecule has subunits: **(K.B)**
(A) Two (B) Three
(C) Four (D) Five

5. Number of phosphate groups in ATP molecule: **(K.B)**
(A) One (B) Two
(C) Three (D) Four

6. From which bond of ATP molecule energy is taken? **(K.B)**
(A) C-N bond (B) C-O bond
(C) C-H bond (D) P-P bond

7. The covalent bond connected to two phosphates is: **(K.B)**
(A) Ratio (B) Proportion
(C) Colon (D) Wavy

8. How much energy is released by breaking of one phosphate bond of ATP? **(U.B)**
(A) 7100 calories (B) 7200 calories
(C) 7300 calories (D) 7400 calories

9. When one inorganic phosphate is detached from ATP, it is converted into: **(K.B)**
(A) ADP (B) AMP
(C) GMP (D) GTP

10. How much energy can be stored in AMP (per mole)? **(A.B)**
(A) 7100 calories (B) 7300 calories
(C) 14600 calories (D) 15000 calories

8.2 PHOTOSYNTHESIS

LONG ANSWER QUESTIONS

Q.1 Outline the processes involved in photosynthesis. **(K.B)**

Ans:

MECHANISM OF PHOTOSYNTHESIS

Definition:

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

Equation:

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

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

Processes involved in Photosynthesis:

Photosynthesis occurs in two phases i.e. **light reactions** and **dark reactions**.

LIGHT REACTIONS

Explanation:

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

Site:

Light reactions take place on the **thylakoid membranes** of chloroplasts.

Events of Light Reaction:

Following are the key events of light reactions:

1. **Absorption of Light**
   - When chlorophyll absorbs light, reactions start in it.
   - High energy **electrons** are released from chlorophyll.
2. **Emission of Electrons**
   - 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.
3. **Photolysis**
   - Light also **breaks** water molecule.

- Oxygen is released while hydrogen atoms give electrons to chlorophyll and become hydrogen ions.

4. Reduction of NADP

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

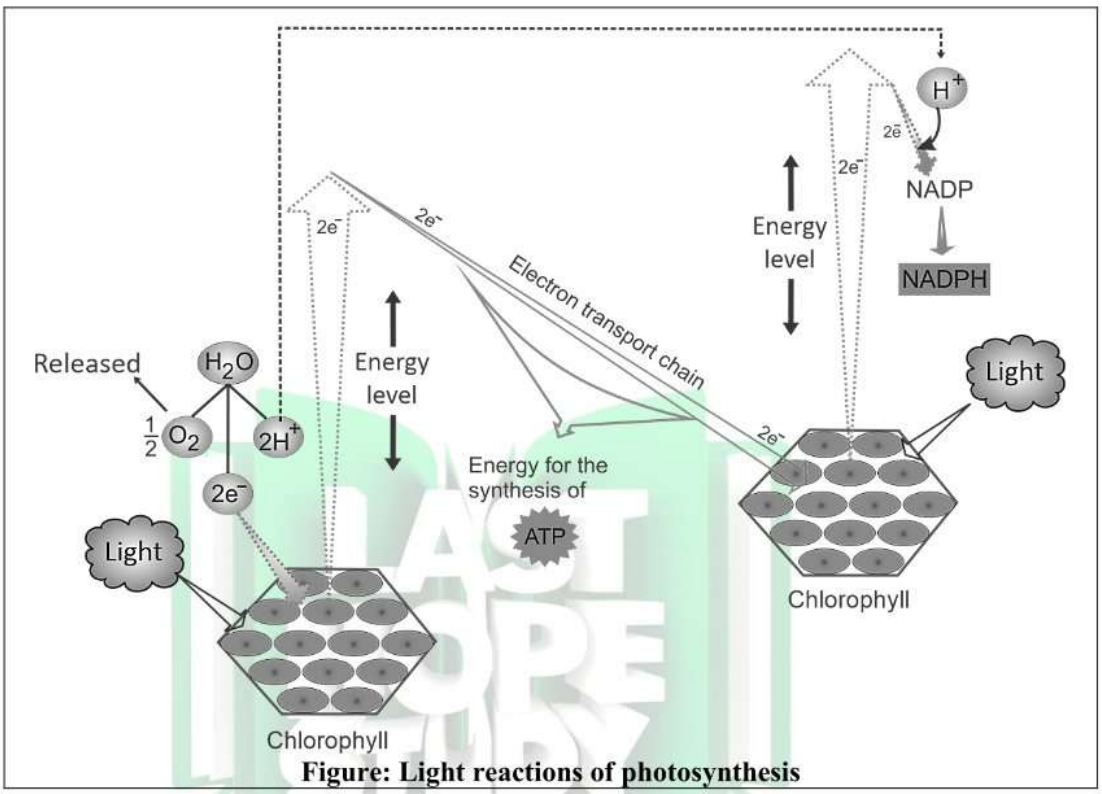


Figure: Light reactions of photosynthesis

DARK REACTIONS

Explanation:

During this phase, carbon dioxide is reduced to make glucose.

Discovery:

The details of dark reactions were discovered by **Melvin Calvin**.

Site:

Dark reactions take place in the **stroma** of the **chloroplasts**.

Events of Dark Reaction:

Following is the summary of dark reactions:

1. CO_2 Fixation

- CO_2 molecules combine with **5-carbon compounds** to form 6-carbon compounds.
- Each 6-carbon compound **splits** into two 3-carbon compounds.

2. Synthesis of Glucose

- 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**.

3. Regeneration of 5-Carbon Molecules

- The 3-carbon carbohydrates are also used to **regenerate** the original 5-carbon compounds.
- This step also utilizes ATP.

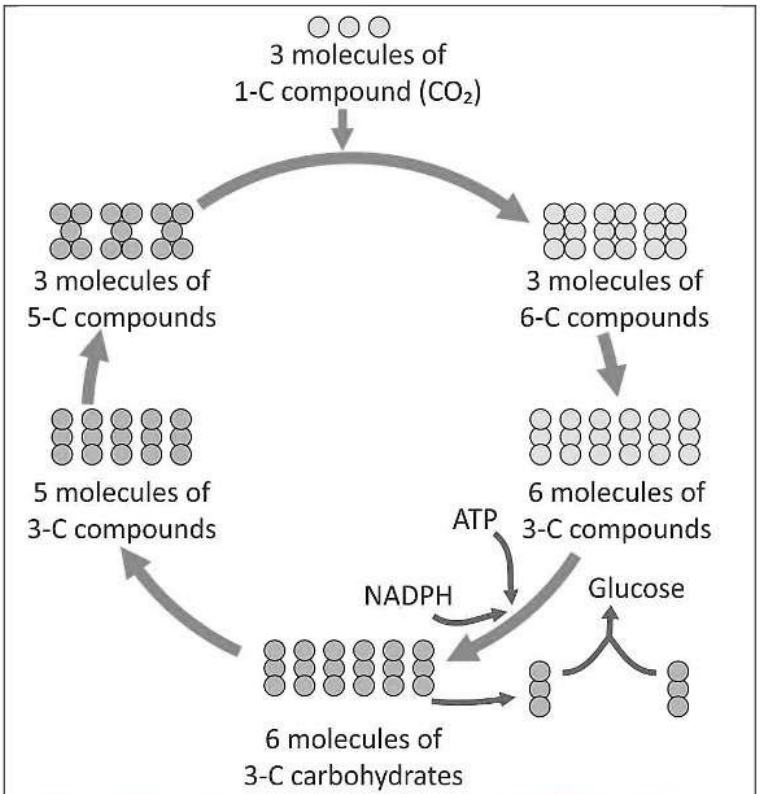


Figure: Dark reactions of photosynthesis

Q.2 Explain the role of chlorophyll in photosynthesis. (K.B)

Ans:

ROLE OF CHLOROPHYLL

Pigments:

Pigments are the substances that absorb **visible light**. Different pigments absorb light of different **wavelengths** (colours).

Pigments in Chloroplast:

- The thylakoid membranes of chloroplasts contain pigments.
- **Chlorophyll-a** is the main pigment.
- Others are called **accessory pigments** and include **chlorophyll-b** and **carotenoids**.

Role of Pigments:

- Pigments absorb **sunlight** and convert it into **chemical energy** for photosynthesis.
- Only about 01% of the light falling on the leaf surface is absorbed, the rest is **reflected** or **transmitted**.
- The **blue** and **red lights** carry out more 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.

Role of Light:

- 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**.

SHORT ANSWER QUESTIONS

Q.1 Define photosynthesis. (K.B)

Ans:

PHOTOSYNTHESIS

Definition:

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

Importance:

- It is an important biochemical process performed by **plants**, **algae** and **cyanobacteria**.
- Nearly all life forms depend on photosynthesis for food directly or indirectly.

Equation:

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

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

Q.2 How CO_2 is taken into plants through leaves. (U.B)

Ans:

INTAKE OF CO_2 BY PLANTS

Atmosphere contains 0.04 percent CO_2. During photosynthesis CO_2 diffuses from the external environment through the stomata into the air spaces of the leaf. A thin layer of water always surrounds the surfaces of mesophyll cells. CO_2 is dissolved in this water and diffuse into mesophyll cells.

Q.3 Differentiate between light and dark reaction. (U.B)

Ans:

DIFFERENTIATION

The difference between light and dark reactions are as follows:

Light Reactions	Dark Reactions
PHASE	
It is the first phase of photosynthesis.	It is the second phase of photosynthesis
ATP AND NADPH	
Light energy is captured to produce ATP and NADPH.	CO_2 is reduced by NADPH to from glucose. This reduction required energy which is ATP.
LIGHT	
These reactions require light.	These reactions do not use light directly.
SITE	
These reactions take place on the thylakoid membrane of chloroplasts.	These reactions take place in the stroma of the chloroplasts.

Q.4 What is meant by Photolysis? (K.B)

Ans:

PHOTOLYSIS

During light reactions, photolysis is a process in which **light splits water molecule** into oxygen atom, two hydrogen ions (H^+) and two electrons. Oxygen is released out while electron pair is provided to chlorophyll to compensate its electron loss.

Equation:

$$H_2O \xrightarrow{\text{Photons}} 2H^+ + \frac{1}{2}O_2 + 2\bar{e}$$

Q.5 Who discovered dark reactions? (K.B)

Ans:

DISCOVERY OF DARK REACTIONS

The sequence of light independent (dark) reactions were discovered by **Melvin Calvin** and his colleagues. Therefore, it is also known as Calvin cycle.

Q.6 Write the requirements and immediate products of dark reactions. (U.B)

Ans:

DARK REACTIONS

Requirements	The immediate products
ATP	ADP
NADPH	NADP

CO_2	3-Carbon carbohydrate (G3P)
5-Carbon Compound (RuBP)	Water
Enzymes in the chloroplast	Inorganic molecules

Q.7 What is meant by pigment? **(K.B)**

Ans:

PIGMENT

Definition:

Pigments are the substances that absorb **visible light**. Different pigments absorb light of different **wavelengths** (colours).

Pigments in Chloroplast:

- The thylakoid membranes of chloroplasts contain pigments.
- **Chlorophyll-a** is the main pigment.
- Others are called **accessory pigments** and include **chlorophyll-b** and **carotenoids**.

Q.8 Write down the steps of light reactions. **(K.B)**

Ans:

LIGHT REACTIONS

Events of Light Reaction:

Following are the key events of light reactions:

1. **Absorption of Light**
   - When chlorophyll absorbs light, reactions start in it.
   - High energy **electrons** are released from chlorophyll.
2. **Emission of Electrons**
   - 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.
3. **Photolysis**
   - Light also **breaks** water molecule.
   - Oxygen is released while hydrogen atoms give electrons to chlorophyll and become hydrogen ions.
4. **Reduction of NADP**

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

MULTIPLE CHOICE QUESTIONS

1. Photosynthesis is: **(K.B)**

(A) Anabolic process (B) Catabolic process
(C) Metabolic process (D) Physical process

2. In which process oxygen is released as a byproduct? **(U.B)**

(A) Photosynthesis (B) Respiration
(C) Fermentation (D) Reproduction

3. Light reactions take place on: **(K.B)**

(A) Thylakoid membranes (B) Stroma of chloroplasts
(C) Mitochondria (D) All of these

4. During light reactions, oxygen is released out the leaves via: **(U.B)**

(A) Stomata (B) Stroma
(C) Mitochondria (D) All of these

5. Dark reactions take place in: **(K.B)**

(A) Stroma of chloroplasts (B) Thylakoid membranes
(C) Mitochondria (D) Cisternae

6. **NADPH is formed during:** **(U.B)**
(A) Light reactions (B) Dark reactions
(C) Krebs cycle (D) Glycolysis

7. **The breakdown of water molecule during light reactions is called:** **(K.B)**
(A) Glycolysis (B) Krebs cycle
(C) ETC (D) Photolysis

8. **The details of dark reactions were discovered by:** **(K.B)**
(A) Karl Lohmann (B) Fritz Lipmann
(C) Melvin Calvin (D) Louis Pasteur

9. **Photosynthetic pigments are arranged in the form of clusters called:** **(K.B)**
(A) Carotenoids (B) Chlorophyll-a
(C) Chlorophyll-b (D) Photosystems

10. **Main photosynthetic pigment:** **(K.B)**
(A) Carotenoids (B) Chlorophyll-a
(C) Chlorophyll-b (D) All of these

11. **Sunlight is absorbed by:** **(U.B)**
(A) Flower (B) Stem
(C) Chlorophyll (D) Roots

12. **Chlorophyll pigment absorbs maximum light in wavelengths of:** **(K.B)**
(A) Green and blue (B) Green and red
(C) Green (D) Red and blue

13. **The output of Calvin cycle is:** **(U.B)**
(A) One G3P molecule (B) One glucose molecule
(C) 6 ATP molecules (D) One glucose and 3 ADP molecules

14. **Maximum rate of photosynthesis in plants is generally at:** **(K.B)**
(A) 20°C (B) 25°C
(C) 25°F (D) 37°C

15. **The 6-carbon molecule of dark reaction splits into two:** **(K.B)**
(A) 3-carbon molecules (B) 6-carbon molecules
(C) RuBP molecule (D) Glucose

16. **How much of light falling on leaves, is absorbed for photosynthesis?** **(K.B)**
(A) 1% (B) 10%
(C) 50% (D) 90%

17. **What happens when a photosynthetic pigment absorbs light?** **(K.B)**
(A) Glucose forms (B) ATP forms
(C) Electrons are emitted (D) Plant grows

8.3 CELLULAR RESPIRATION

LONG ANSWER QUESTIONS

Q.1 **Explain the types and importance of anaerobic respiration.** **(K.B)**

Ans:

ANAEROBIC RESPIRATION

Definition:

Cellular respiration that occurs in the **absence of oxygen** is called anaerobic respiration. It is also known as **fermentation**.

Oxidation of Glucose:

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

Phases of Anaerobic Respiration:

1. **First Phase (Glycolysis)**
   - Its first phase is exactly similar to that of aerobic respiration.
   - A molecule of **glucose** is broken down into two molecules of **pyruvic acid**.
2. **Second Phase**

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

   (A) Alcoholic Fermentation:
   - During anaerobic respiration in **bacteria** and **yeast**, pyruvic acid is further broken down into **alcohol** (C_2H_5OH) and **CO_2**.
   - This type of anaerobic respiration is called **alcoholic fermentation**.

   Equation:

   $$\underset{\text{Pyruvic acid}}{2(C_3H_4O_3)} \rightarrow \underset{\text{Ethyl alcohol}}{2(C_2H_5OH)} + 2CO_2$$

   (B) Lactic Acid Fermentation:
   - During anaerobic respiration in the **skeletal muscles** of humans and other animals, pyruvic acid is converted into **lactic acid** ($C_2H_5O_3$).
   - This type of anaerobic respiration is called **lactic acid fermentation**.

   Equation:

   $$\underset{\text{Pyruvic acid}}{2(C_3H_4O_3)} + 4H \rightarrow \underset{\text{Lactic acid}}{2(C_3H_6O_3)}$$

Importance of Anaerobic Respiration:

1. **Early Life on Earth**
   - 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.
2. **Anaerobes**

   Even today, some organisms including some **bacteria** and some **fungi** get energy from anaerobic respiration and are called **anaerobes**.
3. **Skeletal Muscles during Exercise**
   - When skeletal muscles of humans work hard (during **exercise** etc.) but oxygen supply is not sufficient to fulfil the demand.
   - The skeletal muscles then carry out anaerobic respiration to get energy.
4. **Industrial Products**

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

   Examples:
   - The fermentation in **bacteria** is used for making **cheese** and **yogurt**.
   - Fermentation in **yeasts** is used in **brewing** and **baking** industries.
   - Similarly, the **soy sauce** is made through the fermentation by a **fungus**.

Q.2 Outline the mechanism of aerobic respiration. (K.B)

Ans:

MECHANISM OF AEROBIC RESPIRATION

Definition:

Cellular respiration occurring in the **presence of oxygen** is called aerobic respiration.

Oxidation of Glucose:

It is the **complete oxidation** of glucose with maximum release of energy.

Mechanism of Aerobic Respiration:

There are three main steps of aerobic respiration.

1. **Glycolysis**

Site:

It occurs in **cytoplasm**.

Process:

- 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 NADH.
- This process is called **glycolysis**.
- Oxygen is not required for glycolysis. That is why, it also occurs in anaerobic respiration.

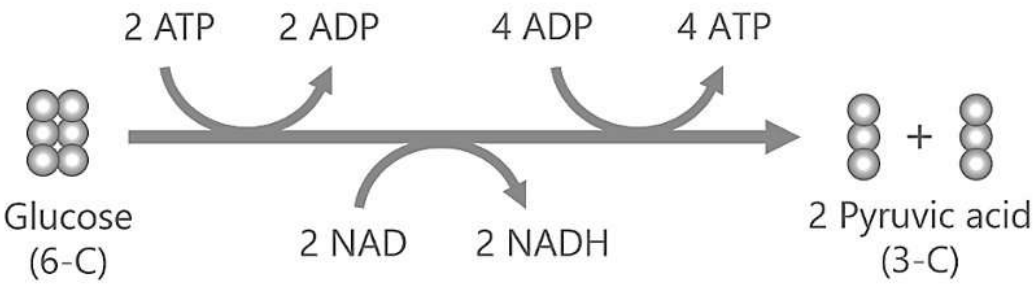


Figure: Summary of glycolysis

2. **Krebs Cycle**

Site:

Krebs cycle occurs in mitochondrial **matrix.**

Acetyl CoA Formation:

Before Krebs cycle, each pyruvic acid is converted into **Acetyl coenzyme-A**, carbon dioxide and NADH.

Kreb's Cycle:

- When oxygen is available, the molecules of acetyl coenzyme-A move from cytoplasm to the matrix of mitochondria.
- Here, a series of reaction called Krebs cycle (discovered by a British scientist **Sir Hans Krebs**) occurs.
- 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**).

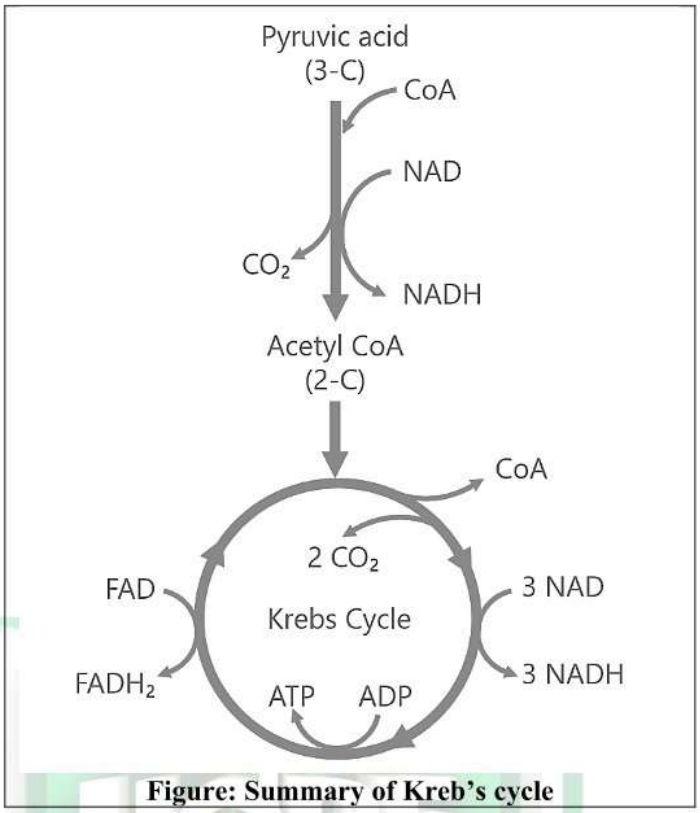


Figure: Summary of Kreb's cycle

3. **Electron Transport Chain**

Site:

This step occurs on the membranes of mitochondria (**Cristae**).

Process:

- 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 chain, electrons and hydrogen ions combine with oxygen and form water.

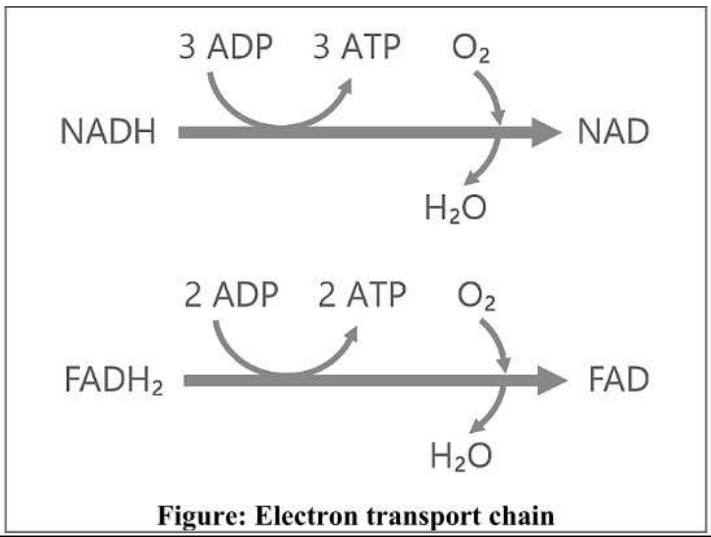


Figure: Electron transport chain

Q.3 What is the difference between aerobic and anaerobic respiration? (U.B)

Ans:

DIFFERENTIATION

	Aerobic Respiration	Anaerobic Respiration
Presence of Oxygen	Yes	No
Number of ATP as net profit	36	02
Final products	CO_2 and H_2O	Lactic acid or Ethanol + CO_2
Site of occurrence	Cytoplasm and Mitochondrion	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.4 Give comparison of respiration and Photosynthesis. (K.B)

Ans:

DIFFERENTIATION

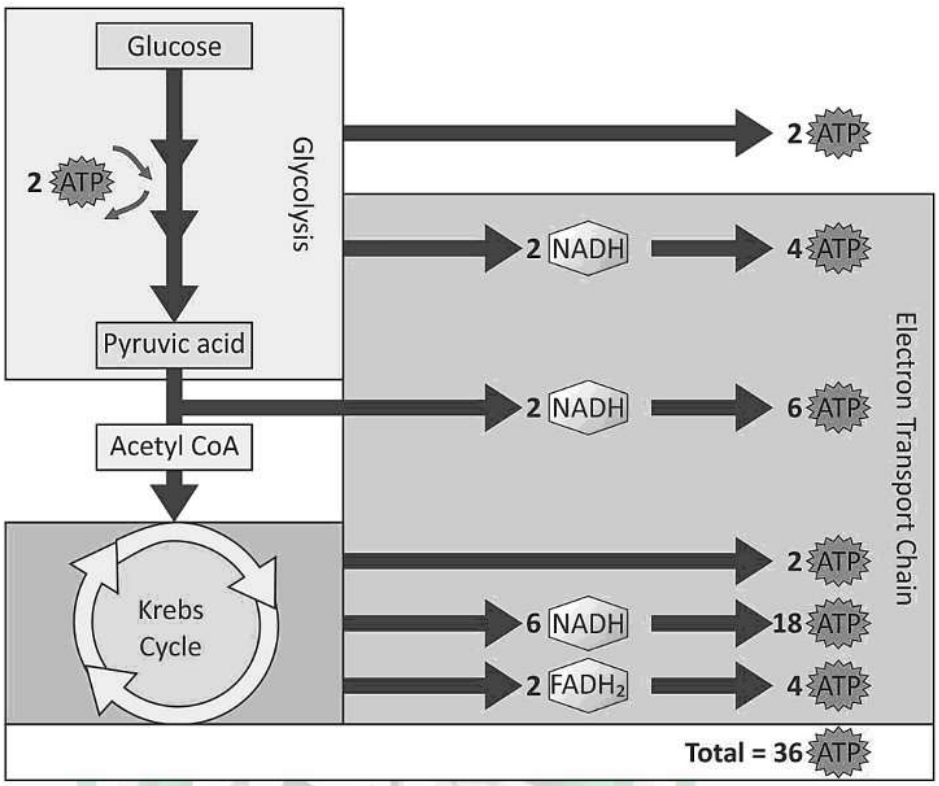
Difference between respiration and photosynthesis is given as follow:

Characteristics	Respiration	Photosynthesis
Type of metabolism	Catabolic process	Anabolic process
Energy investment/ production	Bond energy of food in transformed into ATP.	Energy is stored in the form of bond energy.
Organisms capable of performing this process	All living organisms	Some bacteria, all algae, and all plants
Site of occurrence	In all cells of the organism	In green parts only.
Site of occurrence in cell	In cytoplasm and mitochondria	Chloroplast
Time of occurrence	All the time	In daytime only, in the presence of light.
Reactants	Glucose and oxygen	CO_2 and H_2O
Products	CO_2 and H_2O	Glucose and oxygen

Q.5 Give an overview on ATPs production during aerobic respiration. (K.B)

Ans:

ENERGY BUDGET



SHORT ANSWER QUESTIONS

Q.1 Define cellular respiration. (K.B)

Ans:

CELLULAR RESPIRATION

Definition:

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.

Type of Food:

The most common food used by cells to get energy is **glucose**.

Types of Respiration:

The two main types of respiration are:

- Aerobic respiration
- Anaerobic respiration

Q.2 Define aerobic respiration. Write its equation. (K.B)

Ans:

AEROBIC RESPIRATION

Definition:

Cellular respiration occurring in the **presence of oxygen** is called aerobic respiration.

Oxidation of Glucose:

It is the **complete oxidation** of glucose with maximum release of energy.

Equation:

$$\underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6O_2} \longrightarrow \underset{\text{Cabon dioxide}}{6CO_2} + \underset{\text{Water}}{6H_2O} + \underset{\text{Energy}}{ATP}$$

Q.3 What is anaerobic respiration/ Fermentation? (K.B)

Ans:

FERMENTATION

Definition:

Cellular respiration that occurs in the **absence of oxygen** is called anaerobic respiration. It is also known as **fermentation**.

Oxidation of Glucose:

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

Types of Anaerobic Respiration:

(i) Alcoholic fermentation.

(ii) Lactic Acid Fermentation

Q.4 What is alcoholic fermentation? (K.B)

Ans:

ALCOHOLIC FERMENTATION

Definition:

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

Equation:

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

Pyruvic acid — Ethyl alcohol

Q.5 What is the difference between aerobic and anaerobic respiration? (U.B)

Ans:

DIFFERENTIATION

Aerobic Respiration	Anaerobic Respiration
A process which requires oxygen and involves the complete breakdown of glucose to CO_2 and H_2O.	A process in which glucose is not completely oxidized to CO_2 and H_2O but is converted into CO_2 and alcohol or lactic acid.
Oxidation of Glucose	
Complete oxidation (breakdown) of glucose occurs.	It is incomplete breakdown of glucose molecule.
Occurrence	
Cytoplasm and Mitochondrion	Cytoplasm
Number of ATP	
36 ATP are produced as a result of aerobic respiration.	2 ATP are produced as a result of anaerobic respiration.

Q.6 What is the role of electron transport chain in aerobic respiration? (K.B)

Ans:

ELECTRON TRANSPORT CHAIN

Definition:

Electron transport chain is a series of electron carrier molecules located in the inner membrane of mitochondria.

Importance:

- 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 chain, electrons and hydrogen ions combine with oxygen and form water.

Q.7 Represent the steps of aerobic respiration by equations. (K.B)

Ans:

STEPS OF AEROBIC RESPIRATION

The process of aerobic respiration takes place in following steps:

1. **Glycolysis**

   Glucose → 2 Pyruvic Acid + 2 ATP + 2 NADH

2. **Formation of Acetyl CoA**
   2 Pyruvic Acid + 2 CoA → 2 Acetyl CoA + 2 CO_2 + 2 NADH
3. **Kreb's Cycle**
   2 Acetyl CoA → 4CO_2 + 2 ATP + 6 NADH + 2 $FADH_2$

Q.8 What is glycolysis? Explain. (K.B)

Ans:

GLYCOLYSIS

Site:

It occurs in **cytoplasm**.

Process:

- 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 NADH.
- This process is called **glycolysis**.
- Oxygen is not required for glycolysis. That is why, it also occurs in anaerobic respiration.

Q.9 Discuss some importance of anaerobic respiration. (K.B)

Ans:

IMPORTANCE OF ANAEROBIC RESPIRATION

Anaerobic respiration is important for living organisms in following ways:

1. **Early Life on Earth**
   - 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.
2. **Anaerobes**
   Even today, some organisms including some **bacteria** and some **fungi** get energy from anaerobic respiration and are called **anaerobes**.
3. **Skeletal Muscles during Exercise**
   - When skeletal muscles of humans work hard (during **exercise** etc.) but oxygen supply is not sufficient to fulfil the demand.
   - The skeletal muscles then carry out anaerobic respiration to get energy.
4. **Industrial Products**
   Scientists have used **fermentation** in fungi and bacteria for making useful products for mankind.

   Examples:
   - The fermentation in **bacteria** is used for making **cheese** and **yogurt**.
   - Fermentation in **yeasts** is used in **brewing** and **baking** industries.
   - Similarly, the **soy sauce** is made through the fermentation by a **fungus**.

Q.10 What is the usage of ATP in the body of a living organism? (U.B)

Ans:

USAGE OF ATP

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

- Muscle contractions and movement
- Active transport of substances
- Synthesis of biomolecules
- Replication of DNA and mitosis
- Transmission of nerve impulse
- Maintenance of body temperature
- Break down and elimination of toxins from the body

Q.11 Make a list of conditions for different types of respiration? (U.B)

Ans:

TYPES OF RESPIRATION

The following table shows difference of conditions and products of different types of respiration.

TYPE	CONDITIONS	PRODUCTS
Aerobic respiration	Oxygen	CO_2 +H_2O + ATP
Alcoholic fermentation	Yeast, Bacteria	Ethyl alcohol + CO_2
Lactic acid fermentation	Muscles, Bacteria	Lactic Acid

Q.12 How eating berries can make birds drunk? (U.B)

Ans: **BIRDS**

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.

MULTIPLE CHOICE QUESTIONS

1. From which bond of food energy is taken? (K.B)
(A) P-P bonds (B) C-H bonds
(C) C-N bonds (D) C-O bonds

2. The greatest fuel of energy of cellular respiration is: (U.B)
(A) Glucose (B) Proteins
(C) Amino acid (D) Lipids

3. In cellular respiration, food is oxidized to: (K.B)
(A) Carbon dioxide (B) H_2O
(C) Both A and B (D) Glucose

4. Through which process organism gets energy? (K.B)
(A) Photosynthesis (B) Respiration
(C) Transpiration (D) Evaporation

5. Alcoholic fermentation occurs in: (K.B)
(A) Bacteria (B) Yeasts
(C) Both A & B (D) Humans

6. Whose fermenting powers are used for making cheese and yogurt? (A.B)
(A) Bacteria (B) Viruses
(C) Fungi (D) Algae

7. In which phase of respiration glucose molecule is broken into two molecules of pyruvic acid? (K.B)
(A) Glycolysis (B) Krebs cycle
(C) Electron transport chain (D) Light reaction

8. Soy sauce is made through the fermentation by a fungus: (A.B)
(A) *Rhizopus* (B) *Penicillium*
(C) *Aspergillus* (D) *Puccinia*

9. How many stages are present in aerobic respiration? (K.B)
(A) 1 (B) 2
(C) 3 (D) 4

10. Process of glycolysis is found in: (K.B)
(A) Ribosomes (B) Cytoplasm
(C) Golgi complex (D) Vacuole

11. In electron transport chain each NADH produces: (K.B)
(A) 2 ATP (B) 3 ATP
(C) 4 ATP (D) 5 ATP

12. In which step of respiration CO_2 is produced? (U.B)
(A) Glycolysis (B) Krebs cycle
(C) Electron transport chain (D) All of these

13. How many net ATP molecules are generated in aerobic respiration? (U.B)
(A) 38 (B) 24
(C) 34 (D) 36

14. In cell, aerobic respiration sites are: (K.B)
(A) Golgi bodies (B) Mitochondria
(C) Ribosomes (D) Chloroplast

15. Krebs cycle and electron transport chain occur in: (K.B)
(A) Cytoplasm (B) Nucleus
(C) Mitochondria (D) Ribosomes

16. **In electron transport chain, each $FADH_2$ generates:** **(K.B)**
(A) 2 ATP (B) 3 ATP
(C) 4 ATP (D) 1 ATP

17. **Which is used in wine making process?** **(K.B)**
(A) Yeast (B) Lactobacillus
(C) Bacteria (D) Algae

18. **Bacteria that convert milk to yogurt have ability to produce:** **(K.B)**
(A) Ethyl alcohol (B) Lactic acid
(C) Carbon dioxide (D) Water

19. **An Acetyl-CoA through Krebs cycle produces:** **(K.B)**
(A) 2 NADH (B) 3 NADH
(C) 6 NADH (D) 4 NADH

TEXTBOOK EXERCISE

MULTIPLE CHOICE QUESTIONS

21. **When we get energy from ATP, which bonds are broken?**
(A) P-P bonds (B) C-H bonds
(C) C-N bonds (D) C-O bonds

22. **Light reactions of photosynthesis occur in;**
(A) Plasma membrane of cell (B) Cytoplasm of cell
(C) Stroma of chloroplasts (D) Thylakoids of chloroplasts

23. **Which type of chlorophyll is most common in plants?**
(A) Chlorophyll a (B) Chlorophyll b
(C) Chlorophyll c (D) Chlorophyll d

24. **Where does the reaction of photosynthesis take place?**
(A) Chloroplast (B) Mitochondria
(C) Cytoplasm (D) Ribosomes

25. **When yeast ferments glucose, the products are;**
(A) Alcohol and CO_2 (B) Alcohol and Water
(C) Lactic acid (D) CO_2 and H_2O

26. **In which part of the chloroplast does the light-dependent reactions occur?**
(A) Stroma (B) Thylakoid membrane
(C) Outer membrane (D) Matrix

27. **Which molecule donates electrons in the light-dependent reactions of photosynthesis?**
(A) NADPH (B) Water
(C) Oxygen (D) Carbon dioxide

28. **Which process in aerobic respiration produces the most ATP?**
(A) Glycolysis (B) Krebs cycle
(C) Electron transport chain (D) Fermentation

29. **In yeast cells, anaerobic respiration leads to the production of:**
(A) Lactic acid (B) Ethanol
(C) Acetic acid (D) Glucose

30. **How many ATP molecules are produced from one glucose molecule during anaerobic respiration?**
(A) 2 (B) 4
(C) 12 (D) 36

31. **What is a common byproduct of anaerobic respiration in animal cells?**
(A) Oxygen (B) Water
(C) Lactic acid (D) Carbon dioxide

SHORT ANSWER QUESTIONS

Q.11 Write the importance of oxidation-reduction reactions.

Ans:

OXIDATION-REDUCTION REACTIONS

Importance of Oxidation-Reduction Reactions:

- Oxidation-reduction (redox) reactions are fundamental to the **metabolism** of organisms.
- In these reactions, **electrons** are transferred between molecules.
- In oxidation, molecule loses electrons and in reduction, it gains electrons.
- This **electron flow** is essential for generating energy in the form of ATP during processes like cellular respiration and photosynthesis.

Q.12 What do ATP and ADP mean? What are the roles of these molecules for the cellular metabolism?

Ans:

ENZYMES

1. **ATP**

   ATP stands for **Adenosine triphosphate**.

   Role of ATP:

   - ATP is the main energy storing molecule.
   - It provides energy for processes like active transport, protein synthesis, muscle contraction, etc.
   - So, it is an energy releasing molecule.

2. **ADP**

   ADP stands for **Adenosine diphosphate**.

   Role of ADP:

   - ADP is the precursor of ATP molecule.
   - When energy is available, ADP combines with Pi to form ATP.
   - So, it is an energy storing molecule.

Q.13 Write down the word equation for photosynthesis.

Ans:

PHOTOSYNTHESIS

Equation:

Carbon dioxide + Water (In the presence of sunlight and chlorophyll) → Glucose + Oxygen

Q.14 Why is chlorophyll important for photosynthesis?

Ans:

IMPORTANCE OF CHLOROPHYLL

Capturing Light:

Chlorophyll is crucial for photosynthesis because it **absorbs sunlight**, particularly **blue** and **red** wavelengths, and converts it into chemical energy.

Energy Production:

- This energy drives the reactions of photosynthesis, producing **ATP** and reducing NADP to **NADPH**, which are essential for synthesizing glucose.
- Without chlorophyll, the light-dependent reactions of photosynthesis cannot occur.

Q.15 How is oxygen produced during photosynthesis?

Ans:

OXYGEN PRODUCTION

Oxygen is produced during the **light reactions** of photosynthesis.

Explanation:

- When light is absorbed by chlorophyll, it provides energy to **split water molecules** (H_2O) in a process called **photolysis**.
- This splitting releases oxygen (O_2) as a byproduct, along with H^+ ions and electrons, which are used in further reactions to produce energy molecules like ATP and NADPH.

Q.16 Which organisms carry out photosynthesis? Which cell organelle is responsible for the absorption of light for photosynthesis?

Ans:

PHOTOSYNTHESIS

Photosynthetic Organisms:

Photosynthesis occurs in following organisms:

- All plants
- All algae
- Some bacteria (i.e., Cyanobacteria)

Photosynthetic Organelle:

In cell, **chloroplast** is responsible for photosynthesis. The presence of chlorophyll molecules male thylakoids of chloroplasts to absorb light.

Q.17 State the main purpose of cellular respiration.

Ans:

IMPORTANCE OF CELLULAR RESPIRATION

The main purpose of cellular respiration is to produce energy in the form of ATP (adenosine triphosphate). This energy is essential for carrying out various biological processes, like

- Muscle contractions and movement
- Active transport of substances
- Synthesis of biomolecules
- Replication of DNA and mitosis
- Transmission of nerve impulse
- Maintenance of body temperature
- Break down and elimination of toxins from the body

Q.18 State the equation (in words or symbols) for aerobic respiration.

Ans:

AEROBIC RESPIRATION

Equation:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 36ATP$$

Q.19 Write a brief note on the role of oxygen in aerobic respiration.

Ans:

ROLE OF OXYGEN

Role of Oxygen in Kreb's Cycle:

- In the presence of oxygen, **pyruvic acid** enters the mitochondrial matrix in the form of Acetyl-CoA.
- It participates in Kreb's cycle to produce further energy molecules.

Role of Oxygen in Electron Transport Chain:

- Oxygen plays a critical role in aerobic respiration as the **final electron acceptor** in the electron transport chain.
- It combines with electrons and hydrogen ions to form water, a byproduct of the process.

Q.20 Define anaerobic and aerobic respiration.

Ans:

DEFINITION

1. **Anaerobic Respiration**
   Cellular respiration that occurs in the **absence of oxygen** is called anaerobic respiration. It is also known as **fermentation**.
   Oxidation of Glucose:
   In anaerobic respiration, glucose is **incompletely oxidized** with less amount of energy released.
2. **Aerobic Respiration**
   Cellular respiration occurring in the **presence of oxygen** is called aerobic respiration.
   Oxidation of Glucose:
   It is the **complete oxidation** of glucose with maximum release of energy.

Q.21 What are the end products of anaerobic respiration in animals and yeast?

Ans: **END PRODUCTS OF ANAEROBIC RESPIRATION**

In Animals:

The end product is lactic acid. This occurs in muscle cells during hard work, when glucose is broken down in the absence of oxygen to release energy.

Equation:

Glucose → Lactic Acid + Energy

In Yeast:

The end products are ethanol and carbon dioxide. Yeast performs fermentation under anaerobic conditions.

Equation:

Glucose → Ethanol + Carbon Dioxide + Energy

Q.22 How do muscles respond to oxygen deficiency during intense exercise?

Ans: **MUSCLES DURING INTENSE EXERCISE**

Explanation:

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

Equation:

$$\underset{\text{Pyruvic acid}}{2(C_3H_4O_3)} + 4H \rightarrow \underset{\text{Lactic acid}}{2(C_3H_6O_3)}$$

Q.23 List ways in which respiratory energy is used in the body.

Ans: **USE OF RESPIRATORY ENERGY**

The main purpose of respiratory energy is to carry out various biological processes, like

- Muscle contractions and movement
- Active transport of substances
- Synthesis of biomolecules
- Replication of DNA and mitosis
- Transmission of nerve impulse
- Maintenance of body temperature
- Break down and elimination of toxins from the body

EXTENSIVE ANSWER QUESTIONS

Q.6 Explain ATP as a molecule that is the chief energy currency of all cells.

See Q.No.2 of topic 8.1

Q.7 Outline the processes involved in photosynthesis?

See Q.No.1 of topic 8.2

Q.8 Write a role on the intake of carbon dioxide and water by plants?

Ans: **INTAKE OF CO_2 AND WATER**

Photosynthesis in Plants:

In plants, photosynthesis occurs in the **mesophyll cells** of leaves. The raw materials of photosynthesis i.e. water and carbon dioxide are provided to the mesophyll cells.

Intake of Water:

- Plants absorb **water** and **salts** by their roots.
- Root hair provide the larger surface areas for this absorption.
- From root hair, the absorbed water enters the inner cells of root and then reaches xylem vessels.
- The xylem vessels transport water to the leaves.

Intake of Carbon Dioxide:

- Air enters the leaf through tiny pores called stomata.
- This air carries CO_2 which is absorbed by the mesophyll cells.

Q.9 Explain the types and importance of anaerobic respiration.
See Q.No.1 of topic 8.3

Q.10 Outline the mechanism of aerobic respiration.
See Q.No.2 of topic 8.3

Q.11 Compare the processes of respiration and photosynthesis.
See Q.No.4 of topic 8.3

INQUISITIVE ANSWER QUESTIONS

Q.1 How does the structure of ATP enable it to store and release energy efficiently?

Ans: **ATP**

Introduction:
Cells use a special energy currency for their reactions. This currency is a **nucleotide** called **adenosine triphosphate (ATP)**.

High Energy Bonds:
ATP is a high-energy molecule that serves as the primary energy currency of the cell. In the molecule of ATP, the covalent bonds between **two phosphates** are high-energy bonds.

Release of Energy:
The breaking of one phosphate bond releases about **7.3 kcal (7,300 calories)** per mole of ATP. When this happens, ATP becomes ADP (adenosine diphosphate) and one Pi is released.

$$\mathbf{ATP + H_2O \rightarrow ADP + P_i + energy\ (7.3\ kcal/mole)}$$

In some cases, ADP is further broken down to AMP (adenosine monophosphate) and Pi:

$$\mathbf{ADP + H_2O \rightarrow AMP + Pi + energy\ (7.3\ kcal/mole)}$$

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

$$\mathbf{ADP + Pi + energy\ (7.3\ kcal/mole) \rightarrow ATP + H_2O}$$

Conclusion:
So, we can summarize that the P-P bonds of ATP are adapted and involved in the energy storing and releasing ability.

EXTRA CONCEPTUAL MCQs

17. What is the main pigment used in photosynthesis?
(A) Anthocyanin (B) Xanthophyll
(C) Chlorophyll (D) Carotene

18. Where does the Krebs cycle occur in a cell?
(A) Nucleus (B) Mitochondria
(C) Ribosomes (D) Endoplasmic reticulum

19. What is the process of converting glucose into energy in the absence of oxygen?
(A) Photosynthesis (B) Fermentation
(C) Oxidation (D) Hydrolysis

20. During photosynthesis, which gas is taken in by plants?
(A) Oxygen (B) Nitrogen
(C) Argon (D) Carbon dioxide

21. Glycolysis is the breakdown of:
(A) Fructose (B) Glucose
(C) Lactose (D) Maltose

22. The mechanism of ATP synthesis is:
(A) Phosphorylation (B) Photosynthesis
(C) Respiration (D) Glucose

23. In aerobic respiration, pyruvic acid changes to:
(A) Glucose (B) Fructose
(C) Acetyl CoA (D) Citric acid

24. Which of these uses oxygen as the final acceptor?
(A) Glycolysis (B) Electron transport chain
(C) Krebs cycle (D) Photosynthesis

25. Which of these produces carbon dioxide?
(A) Krebs cycle (B) Electron transport chain
(C) Glycolysis (D) Photosynthesis

26. What are the products of light reactions in photosynthesis?
(A) ATP, NADPH and oxygen (B) ATP and NADP
(C) ATP, PGA and oxygen (D) PGA and oxygen

27. Which feature helps plants to make most food by the process of photosynthesis?
(A) Broad and flat leaves (B) Spiny leaves
(C) Yellow leaves (D) Curled leaves

28. The diagram shows a pond weed in the test tube filled with water. Which conditions would cause the plant to produce more bubbles?

	Dissolved CO_2	Light	Temperature
(A)	Present	Bright	Cool
(B)	Present	Bright	Warm
(C)	Present	Dim	Cool
(D)	Absent	Dim	Warm

29. Which of the following process is used by plants to make oxygen during the process of photosynthesis?
(A) Intake of water (B) Intake of CO_2
(C) Photolysis of water (D) Calvin cycle

30. A child left a carton on the lawn for two days. When the carton was picked up, the grass under it had turned yellow. What caused the grass to change colour?
(A) Lack of oxygen (B) Lack of CO_2
(C) Lack of light (D) Lack of water

STUDENT LEARNING OUTCOMES (SLOs)

SHORT ANSWER QUESTIONS

Q.19 Why is ATP sometimes described as the energy currency of cell?

Ans:

ENERGY CURRENCY OF CELL

ATP is sometimes described as energy "**currency**" for cells.

Explanation:

Just like **money** is used to buy things, cells use ATP to do different activities and reactions. When a cell needs energy, it changes **ATP** into **ADP** (Adenosine Diphosphate) by breaking a bond between the second and third phosphate groups. This releases a considerable amount of energy equal to **7.3 kcal/mole**.

Q.20 What is the importance of light in photosynthesis?

Ans:

IMPORTANCE OF LIGHT

Light is a form of energy known as **electromagnetic radiation**. The electromagnetic radiation is a broad term that refers to both visible and invisible radiation. It is the sunlight energy that is absorbed by chlorophyll and then converted into chemical energy to drive the photosynthetic process.

Q.21 Why does increasing light intensity only increase the rate of photosynthesis up to a certain

point?

Ans:

EFFECT OF LIGHT INTENSITY

When light intensity increases, the rate of **photosynthesis initially rises**, as the plant can use more light to convert carbon dioxide and water into glucose and oxygen.

Effect after a Certain Limit:

Beyond a certain point, increasing light intensity does not increase the rate of photosynthesis. This is because

- Other factors, like CO_2 concentration or temperature, become the **limiting factors**.
- Also, too much light can damage the plant's chlorophyll, the pigment responsible for absorbing light.

Q.22 Discuss the process of photosynthesis in Sulphur bacteria?

Ans:

SULPHUR BACTERIA

Definition:

Some bacteria use **hydrogen sulfide** (H_2S) instead of water as a source of electrons in photosynthesis and are typically referred to as Sulphur bacteria.

Explanation:

These bacteria are commonly found in anaerobic environments such as hot springs and oxygen-poor aquatic habitats like deep ocean vents, releasing **Sulphur** as a byproduct of photosynthesis instead of oxygen.

Q.23 How lactic acid fermentation works to provide energy in the muscle tissues?

Ans:

LACTIC ACID FERMENTATION IN MUSCLE CELLS

Lactic Acid Production:

During exercise, anaerobic respiration causes **lactic acid** to accumulate in muscle cells and surrounding tissues. This accumulation can lead to muscle fatigue and discomfort.

Lactic Acid to Glucose:

To ease this condition, the lactic acid from muscle is transported to the **liver** through blood, which converts it into **glucose**.

Glucose as Energy Source:

This glucose can then be released back into the bloodstream to provide energy to muscles and other tissues, effectively recycling lactic acid into usable energy.

Q.6 Write the equation of a) Photosynthesis, b) Fermentation, c) Aerobic respiration.

Ans:

EQUATIONS

Photosynthesis:

The equation for photosynthesis is:

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

OR

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

Fermentation:

There are two types of fermentation. The equation for alcoholic fermentation is:

Pyruvic acid → Ethyl Alcohol + Carbon dioxide

The equation for lactic acid fermentation is:

Glucose → Pyruvic acid → Lactic Acid

Aerobic Respiration:

The equation for aerobic respiration is:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + 36\ ATP$$

Q.7 Why a part of photosynthesis is called dark reactions?

Ans: **DARK REACTIONS**

The part of photosynthesis called "**dark reactions**" or the "**Calvin cycle**" is named so because it does not directly require light energy to occur. This part of photosynthesis uses energy from light dependent reactions to convert CO_2 into glucose.

Q.8 How photosynthesis and aerobic respiration are interlinked with each other?

Ans: **DARK REACTIONS**

Photosynthesis and aerobic respiration are interlinked in the following ways:

Energy Transfer:

Photosynthesis produces glucose and oxygen, which are then used in aerobic respiration to produce ATP (by breaking glucose).

Carbon Cycle:

- Photosynthesis removes carbon dioxide from the atmosphere and converts it into glucose.
- Aerobic respiration then converts glucose back into carbon dioxide, releasing it back into the atmosphere.

This cycle is essential for maintaining the balance of carbon dioxide levels in the atmosphere.

Oxygen Cycle:

- Photosynthesis produces oxygen as a byproduct, which is then used in aerobic respiration.
- Aerobic respiration releases carbon dioxide and water as byproducts, which are then used in photosynthesis.

This cycle is essential for maintaining the balance of oxygen levels in the atmosphere.

Ecological Balance:

- Photosynthesis supports the growth of plants, which are then consumed by animals.
- Aerobic respiration supports the growth of animals, which are then consumed by other animals.

MULTIPLE CHOICE QUESTIONS

19. The energy released (per mole) by the breakdown of one phosphate of ATP is:
(A) 7.3 kcal (B) 14.6 kcal
(C) 730 cal (D) 14.6 cal

20. In 1929, ATP was discovered by:
(A) Fritz Lipmann (B) Karl Lohmann
(C) Louis Pasteur (D) Hardy Weinberg

21. The role of ATP as cell's energy currency was explained by:
(A) Fritz Lipmann (B) Karl Lohmann
(C) Louis Pasteur (D) Hardy Weinberg

22. The byproduct of Sulphur bacteria during photosynthesis is:
(A) Oxygen (B) CO_2
(C) H_2S (D) Sulphur

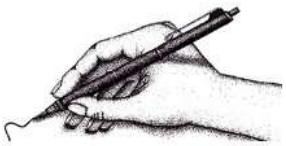
23. Zymology is the study of:
(A) Enzymes (B) Fermentation
(C) Fungi (D) Energy

24. Liver converts lactic acid to:
(A) Glucose (B) Carbon dioxide and water
(C) Pyruvic acid (D) Energy

25. During yogurt formation from milk, which is converted to lactic acid?
(A) Glucose (B) Lactose
(C) Pyruvic acid (D) Sucrose

ASSIGNMENT

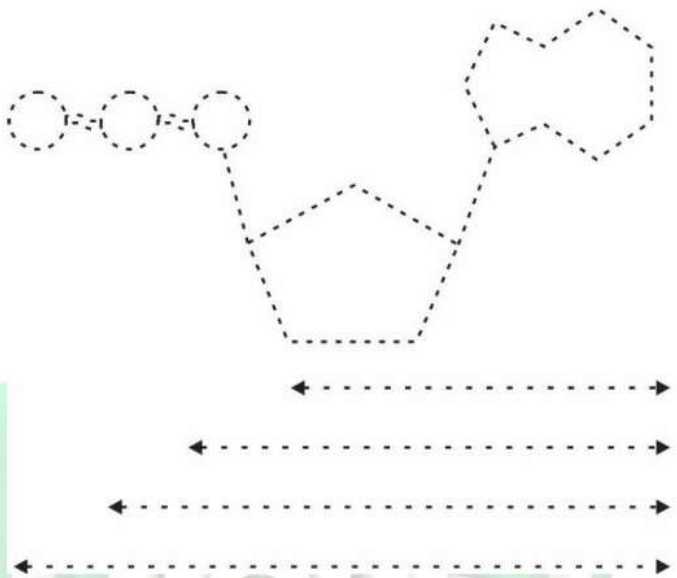
LET'S DRAW AND LABEL



(B) Molecular Structure of ATP

Instructions:

Trace the patterns and marks the labels



(C) Draw and Label the Light Reactions of Photosynthesis

(D) Draw and Label the Dark Reactions of Photosynthesis

Terms to Know	
Anaerobic	A form of respiration which occurs in the absence of oxygen.

Respiration	
ATP	The primary molecule used by cells to capture and supply energy is called ATP.
Autotrophs	Organisms capable of synthesizing their own food using new material.
Bioenergetics	The study of energy relationships in biological system.
Calvin cycle	The sequence of reactions is also called dark reactions occurring in the stroma of the chloroplast produce sugar.
Chlorophyll	A green pigment present in thylakoid membranes responsible for absorption of light for photo synthesis.
Electron Transport Chain	Series of electron carries located in inner membrane of mitochondria.
Glycolysis	A process in which glucose is broken down into two molecules of Pyruvic acid and produce 2 ATP as a net gain.
Kreb's Cycle	Cyclic Process which takes place in mitochondria matrix in which Acetyl CoA is completely oxidized into H_2O and CO_2 to produce high energy compounds such as ATP, NADH and $FADH_2$.
Lactic Acid Fermentation	A type of anaerobic respiration which occurs in muscles during vigorous exercise in the absence of oxygen and bacteria that converts milk into yogurt.
Light Dependent Reaction	The first phase of photosynthesis in which light energy is captured to produce ATP and NADPH.
Chlorophyll	Photosynthetic pigment that captures light and is found in thylakoid membranes of the chloroplast.
NAD^+	Nicotinamide adenine dinucleotide, an enzyme acting as electron carrier in redox reactions.
Oxidation	When an atom or molecule loses an electron.
Photolysis	A process in which light splits water into oxygen atom, two hydrogen ions and two electrons.
Photosynthesis	A process in which plants use carbon dioxide and water to make glucose in presence of light which is absorbed by chlorophyll.
Photosystem	Cluster of photosynthetic pigments in the thylakoid membranes of chloroplast.
Pigments	Light absorbing molecules are called pigments.
Pyruvic Acid	A 3-carbon compound formed when glucose is broken down in cellular respiration.
Reduction	When an atom or molecule gains an electron, it is reduced and the process is called reduction.
Respiration	The process by which energy is produced from food is called respiration.
Stroma	The matrix of chloroplast which is a thick fluid in between grana where various enzymes, molecules and ions are found and where dark reaction of photosynthesis occurs.
Thylakoid	Membranous infoldings of chloroplasts, where photosynthetic pigments are found.
Z-Scheme	Also called as light dependent reaction, the first phase in photosynthesis, occurring in the presence of light used to make high energy compounds.

Answer Key

TOPIC 8.1

1	B	**2**	A	**3**	D	**4**	B	**5**	C
6	D	**7**	D	**8**	C	**9**	A	**10**	C

TOPIC 8.2

1	A	**2**	A	**3**	A	**4**	A	**5**	A
6	A	**7**	D	**8**	C	**9**	D	**10**	B
11	C	**12**	D	**13**	A	**14**	B	**15**	A
16	A	**17**	C						

TOPIC 8.3

1	B	**2**	A	**3**	C	**4**	B	**5**	C
6	A	**7**	A	**8**	C	**9**	C	**10**	B
11	B	**12**	B	**13**	D	**14**	B	**15**	C
16	A	**17**	A	**18**	B	**19**	B		

TEXTBOOK EXERCISE MCQs

1	A	**2**	D	**3**	A	**4**	A	**5**	A
6	B	**7**	B	**8**	C	**9**	B	**10**	A
				11	C				

EXTRA CONCEPTUAL MCQs

1	C	**2**	B	**3**	B	**4**	D	**5**	B
6	C	**7**	C	**8**	B	**9**	A	**10**	A
11	A	**12**	B	**13**	C	**14**	C		

SLOs MCQs

1	A	**2**	B	**3**	A	**4**	D	**5**	B
6	A	**7**	B						