BIOENERGETICS

Chapter 7 — Complete Solved Exercise

✔ MCQs Solved & Explained

✔ Short Answers Included

✔ Detailed Answers Included

Every multiple-choice question below is ticked with the correct option and backed by a clear explanation. Short and detailed questions are answered fully so you can revise the whole chapter with confidence.

Reference: www.scholareye.xyz

✔ SECTION A: MULTIPLE CHOICE QUESTIONS

1. 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

EXPLANATION

ATP (adenosine triphosphate) stores usable energy in the high-energy phosphoanhydride bonds that link its three phosphate groups. When ATP is converted to ADP, the terminal **P–P bond** is hydrolysed and the energy released from breaking this bond is used to power cellular activities.

2. Light reactions of photosynthesis occur in;

a) Plasma membrane of cell

b) Cytoplasm of cell

c) Stroma of chloroplasts

✔ d) Thylakoids of chloroplasts

EXPLANATION

The light-dependent reactions require chlorophyll and other pigments that are embedded in the membranes of the **thylakoids** inside the chloroplast. Here, light energy is trapped and used to produce ATP and NADPH, and to split water, releasing oxygen.

3. Which wavelengths of light are absorbed to maximum by chlorophylls?

a) Green and blue

b) Green and red

✔ **c) Red and blue**

d) Only green

EXPLANATION

Chlorophyll pigments absorb light most strongly in the **red and blue** regions of the visible spectrum. Green light is largely reflected rather than absorbed, which is why leaves appear green to our eyes.

4. Where do the dark reactions of photosynthesis occur?

✔ **a) Stroma of chloroplast**	b) Thylakoids of chloroplast
c) Outer membrane	d) Cytoplasm

EXPLANATION

The dark reactions (Calvin cycle) do not directly need light. They take place in the fluid-filled **stroma** of the chloroplast, where the ATP and NADPH produced during the light reactions are used to fix carbon dioxide into sugars.

5. Which process in aerobic respiration produces the most ATP?

a) Glycolysis

b) Krebs cycle

✔ **c) Electron transport chain**

d) Fermentation

EXPLANATION

Although glycolysis and the Krebs cycle each generate a small amount of ATP directly, the **electron transport chain** uses the NADH and FADH2 produced earlier to build a proton gradient that drives ATP synthase, generating by far the largest share of ATP — about 32–34 molecules per glucose.

✔ SECTION B: SHORT ANSWERS

1. Write the importance of oxidation-reduction reactions.

ANSWER

Oxidation-reduction (redox) reactions are the basis of energy transfer in living cells. In these reactions, electrons (often along with hydrogen atoms) are transferred from one substance (which is oxidised) to another (which is reduced). This electron flow is exactly how cells capture, store and release chemical energy — for example, in respiration, food molecules are oxidised and the released energy is trapped as ATP, while in photosynthesis, carbon dioxide is reduced to glucose using energy from light.

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

ANSWER

ATP stands for **Adenosine Triphosphate** and ADP stands for **Adenosine Diphosphate**.

ATP is the immediate energy currency of the cell: it stores energy in its high-energy phosphate bonds and releases this energy when it loses a phosphate group and is converted to ADP. ADP, in turn, is recharged back into ATP during respiration (and photosynthesis in plants) by adding a phosphate group. This continuous ATP ↔ ADP cycle allows energy to be captured from food or light and supplied instantly wherever the cell needs it — for muscle contraction, active transport, biosynthesis, and nerve impulses.

3. Write down the word equation for photosynthesis.

ANSWER

Carbon dioxide + Water $\rightarrow$(sunlight, chlorophyll)$\rightarrow$ Glucose + Oxygen

In symbols: $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ (in the presence of sunlight and chlorophyll).

4. How is oxygen produced during photosynthesis?

ANSWER

Oxygen is produced during the light reactions of photosynthesis through the **photolysis (splitting) of water** molecules. When light strikes the photosystems in the thylakoid membrane, water molecules are split into hydrogen ions, electrons and oxygen. The electrons replace those lost by chlorophyll, the hydrogen ions contribute to the proton gradient used to make ATP, and the oxygen is released as a by-product into the atmosphere.

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

ANSWER

Photosynthesis is carried out by green plants, algae, and certain bacteria (such as cyanobacteria) that contain chlorophyll or similar light-absorbing pigments.

The **chloroplast** is the cell organelle responsible for absorbing light energy, since it contains the chlorophyll pigments packed into its thylakoid membranes.

6. State the main purpose of cellular respiration.

ANSWER

The main purpose of cellular respiration is to break down food molecules, mainly glucose, in a controlled, step-wise manner so that the chemical energy stored in them is released and captured in a usable form — ATP — which the cell can then use to carry out its life processes.

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

ANSWER

In words: Glucose + Oxygen → Carbon dioxide + Water + Energy (ATP)

In symbols: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + Energy (about 36–38 ATP).

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

ANSWER

Oxygen acts as the **final electron acceptor** at the end of the electron transport chain in the mitochondria. As electrons pass along the chain, oxygen combines with them and with hydrogen ions to form water. By continuously removing electrons from the end of the chain, oxygen keeps the electron transport chain running, which allows the proton gradient to keep building and ATP synthesis to continue efficiently. Without oxygen, the chain would back up and ATP production through this pathway would stop.

9. Define anaerobic and aerobic respiration.

ANSWER

Aerobic respiration is the breakdown of glucose in the presence of oxygen to release a large amount of energy, producing carbon dioxide and water as end products.

Anaerobic respiration is the breakdown of glucose in the absence (or insufficient supply) of oxygen, releasing a much smaller amount of energy and producing incomplete end products such as lactic acid (in animals) or ethanol and carbon dioxide (in yeast/plants).

✔ SECTION C: DETAILED ANSWERS

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

DETAILED ANSWER

ATP (adenosine triphosphate) is called the “energy currency” of the cell because, just like money is exchanged for goods, ATP is the molecule that is “spent” whenever a cell needs energy for its activities.

Structurally, ATP is made up of the nitrogenous base adenine, the sugar ribose, and a chain of three phosphate groups. The bonds joining the second and third phosphate groups are high-energy bonds. When a cell needs energy, an enzyme hydrolyses the terminal phosphate bond, converting ATP into ADP (adenosine diphosphate) and releasing a usable burst of energy.

This energy is used for muscle contraction, active transport across membranes, nerve impulse conduction, synthesis of large molecules, and countless other cellular processes. ADP is then recharged back into ATP using energy obtained from respiration (in all cells) or photosynthesis (in green plants), making ATP part of a continuous energy cycle that keeps every cell running.

2. Outline the processes involved in photosynthesis?

DETAILED ANSWER

Photosynthesis takes place in the chloroplasts of green plants in two main stages:

1. Light reactions (in the thylakoid membranes): Chlorophyll absorbs light energy, mainly in the red and blue regions of the spectrum. This energy is used to split water molecules (photolysis), releasing oxygen as a by-product. The energy captured is also used to generate ATP and NADPH, which carry chemical energy forward to the next stage.

2. Dark reactions / Calvin cycle (in the stroma): The ATP and NADPH produced in the light reactions are used to fix carbon dioxide from the atmosphere into organic molecules, eventually producing glucose. These reactions do not directly require light, but they depend entirely on the products of the light reactions.

Together, these two stages convert light energy into chemical energy stored in glucose, which the plant can use for growth or store for later use.

3. Write a note on the intake of carbon dioxide and water by plants

DETAILED ANSWER

Plants obtain the two key raw materials for photosynthesis — carbon dioxide and water — from their surroundings.

Carbon dioxide enters the plant mainly through tiny pores on the surface of leaves called **stomata**. These pores open and close (controlled by guard cells) to regulate gas exchange; carbon dioxide diffuses in from the surrounding air and moves through the air spaces inside the leaf to reach the photosynthesising cells.

Water is absorbed from the soil by the root hairs, which greatly increase the surface area for absorption. It then travels upward through the root, stem and into the leaves via the xylem tissue, driven largely by transpiration pull.

Once inside the leaf cells, carbon dioxide and water are brought together in the chloroplasts, where they are used in the light and dark reactions to manufacture glucose, releasing oxygen as a by-product.

4. Explain the types and importance of anaerobic respiration.

DETAILED ANSWER

Anaerobic respiration is the breakdown of glucose without using oxygen, and it releases far less energy than aerobic respiration because glucose is only partially broken down.

Types of anaerobic respiration:

• **Alcoholic fermentation:** occurs in yeast and some plant cells; glucose is converted into ethanol and carbon dioxide, releasing a small amount of energy. This process is used industrially in baking (to make bread rise) and brewing.

• **Lactic acid fermentation:** occurs in animal muscle cells (and some bacteria) when oxygen supply is insufficient, such as during vigorous exercise; glucose is converted into lactic acid, again releasing a small amount of energy.

Importance: Anaerobic respiration allows cells and organisms to keep producing some ATP even when oxygen is limited or unavailable, such as in muscles during intense activity, in waterlogged plant roots, or in oxygen-poor environments inhabited by certain microbes. It is also commercially valuable — fermentation by yeast and bacteria is used to produce bread, yogurt, cheese and alcoholic beverages.

5. Outline the mechanism of aerobic respiration.

DETAILED ANSWER

Aerobic respiration takes place in three main stages, occurring partly in the cytoplasm and partly in the mitochondria:

1. Glycolysis (in the cytoplasm): One molecule of glucose is broken down into two molecules of pyruvate. This stage does not require oxygen and produces a small net gain of ATP and NADH.

2. Krebs cycle / Citric acid cycle (in the mitochondrial matrix): Pyruvate is first converted into acetyl-CoA, which then enters the Krebs cycle. Here it is completely oxidised, releasing carbon dioxide and generating more ATP, along with electron carriers NADH and FADH2.

3. Electron transport chain (on the inner mitochondrial membrane): The NADH and FADH2 from the earlier stages donate their electrons to a series of carrier proteins. As electrons move along the chain, energy is used to pump protons across the membrane, creating a gradient that drives ATP synthase to produce a large amount of ATP. Oxygen acts as the final electron acceptor, combining with electrons and hydrogen ions to form water.

Overall, one molecule of glucose can yield roughly 36–38 molecules of ATP through this complete aerobic pathway.

✔ You have completed Chapter 7: Bioenergetics! ✔

For more solved chapters, notes and quizzes, visit **www.scholareye.xyz**