CLASS 9 • BIOLOGY

CHAPTER 7

BIOENERGETICS

60 Solved MCQs • Fully Explained

ATP • Photosynthesis • Cellular Respiration • Fermentation

Reference: scholareye.xyz

Q1 ATP: The Energy Currency

Bioenergetics is best defined as the study of how living organisms:

- A. Reproduce and grow
- **B. Acquire, convert, store, and utilize energy** ✓
- C. Move from one place to another
- D. Repair damaged tissues

💡 **Explanation:** Bioenergetics is the study of how living organisms acquire, convert, store, and utilize energy to fuel life processes.

Q2 ATP: The Energy Currency

ATP is an abbreviation for:

- **A. Adenosine triphosphate** ✓
- B. Adenine triphosphate
- C. Amino triphosphate
- D. Adenosine tetraphosphate

💡 **Explanation:** ATP stands for Adenosine Triphosphate, the nucleotide molecule that acts as the chief energy currency of the cell.

Q3 ATP: The Energy Currency

The Nobel Prize winner who, in 1941, proposed that ATP is the main energy-transfer molecule in the cell was:

A. Sir Hans Krebs

B. Melvin Calvin

C. **Fritz Lipmann** ✓

D. Robert Hill

💡 **Explanation:** In 1941, Fritz Lipmann proposed that ATP is the main energy-transfer molecule in the cell, a concept central to bioenergetics.

Q4 ATP: The Energy Currency

ATP is often referred to as the cell's:

A. Genetic blueprint

B. **Energy currency** ✓

C. Structural framework

D. Waste product

💡 **Explanation:** Cells make ATP when they store energy and break it down when they need energy, which is why ATP is called the cell's energy currency.

Q5 ATP: The Energy Currency

Which of the following is NOT a subunit of the ATP molecule?

- A Adenine
- B Ribose
- C Phosphate groups
- D **Glucose** ✓

💡 **Explanation:** The ATP molecule has three subunits: adenine (a nitrogen-containing base), ribose (a five-carbon sugar), and three phosphate groups. Glucose is not part of ATP's structure.

Q6 ATP: The Energy Currency

Ribose, one of the subunits of ATP, is a sugar containing how many carbon atoms?

- A Three
- B Four
- C **Five** ✓
- D Six

💡 **Explanation:** Ribose is described as a five-carbon sugar that forms part of the ATP molecule along with adenine and three phosphate groups.

Q7 ATP: The Energy Currency

In the ATP molecule, the high-energy bonds are located between:

- A. Adenine and ribose
- B. Ribose and the first phosphate
- C. **Two of the phosphate groups** ✓
- D. Two adenine molecules

💡 **Explanation:** The covalent bonds between two of the phosphate groups in ATP are high-energy bonds. Breaking one of these bonds releases inorganic phosphate (Pi) and energy.

Q8 ATP: The Energy Currency

Breaking one high-energy phosphate bond of ATP releases approximately how much energy per mole?

- A. 3.7 kcal
- B. **7.3 kcal** ✓
- C. 10.3 kcal
- D. 73 kcal

💡 **Explanation:** The breaking of one phosphate bond in ATP releases about 7.3 kcal (7,300 calories) per mole of ATP, as shown by the equation ATP + H2O → ADP + Pi + energy.

Q9 ATP: The Energy Currency

When ATP loses one phosphate group, it is converted into:

- A AMP
- **B ADP ✓**
- C NADP
- D Glucose

💡 **Explanation:** When the outer high-energy phosphate bond of ATP breaks, ATP becomes ADP (adenosine diphosphate) and one inorganic phosphate (Pi) is released.

Q10 ATP: The Energy Currency

Further breakdown of ADP by removing another phosphate group produces:

- A ATP
- **B AMP ✓**
- C NADPH
- D FADH2

💡 **Explanation:** In some cases, ADP is further broken down to AMP (adenosine monophosphate) and Pi, releasing additional energy (ADP + H_2O → AMP + Pi + energy).

Q11 Photosynthesis

Photosynthesis is defined as the synthesis of glucose from carbon dioxide and water in the presence of:

- A Oxygen and heat
- **B Sunlight and chlorophyll** ✓
- C ATP only
- D Enzymes only

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

Q12 Photosynthesis

What is released as a by-product of photosynthesis?

- A Carbon dioxide
- B Nitrogen
- **C Oxygen** ✓
- D Ozone

💡 **Explanation:** The general equation of photosynthesis ($6CO_2$ + $12H_2O$ + photons → $C_6H_{12}O_6$ + $6O_2$ + $6H_2O$) shows that oxygen is released as a by-product.

Q13 Photosynthesis

In the general equation of photosynthesis, light energy is represented as:

- A Electrons
- B **Photons** ✓
- C Protons
- D Ions

💡 **Explanation:** The general equation for photosynthesis is written as $6CO_2 + 12H_2O +$ photons → $C_6H_{12}O_6 + 6O_2 + 6H_2O$, where photons represent light energy.

Q14 Photosynthesis

How many molecules of carbon dioxide are required to synthesize one molecule of glucose during photosynthesis?

- A Three
- B **Six** ✓
- C Twelve
- D Two

💡 **Explanation:** According to the general equation of photosynthesis, 6 molecules of CO_2 combine with 12 molecules of water to form one molecule of glucose ($C_6H_{12}O_6$).

Q15 Photosynthesis

Photosynthesis occurs in which two main phases?

- A. Glycolysis and Krebs cycle
- B. **Light reactions and dark reactions** ✓
- C. Aerobic and anaerobic phases
- D. Fermentation and respiration

💡 **Explanation:** Photosynthesis occurs in two phases: light reactions, which take place on the thylakoid membranes, and dark reactions, which occur in the stroma of chloroplasts.

Q16 Photosynthesis

Light reactions of photosynthesis take place on the:

- A. Stroma of chloroplasts
- B. **Thylakoid membranes** ✓
- C. Inner membrane of mitochondria
- D. Cytoplasm

💡 **Explanation:** Light reactions take place on the thylakoid membranes of chloroplasts, whereas dark reactions occur in the stroma.

Q17 Photosynthesis

Dark reactions of photosynthesis occur in the:

- A Thylakoid membranes
- B Cytoplasm
- **C Stroma of chloroplasts ✓**
- D Mitochondrial matrix

💡 **Explanation:** Dark reactions (the Calvin cycle) take place in the stroma of the chloroplasts, unlike light reactions which occur on the thylakoid membranes.

Q18 Photosynthesis

During light reactions, chlorophyll absorbs light and releases high-energy:

- A Protons
- **B Electrons ✓**
- C Neutrons
- D Phosphates

💡 **Explanation:** When chlorophyll absorbs light, two of its electrons become high-energy electrons that are released from chlorophyll and passed to an electron transport chain.

Q19 Photosynthesis

In light reactions, oxygen is released when:

A. ATP is broken down

B. **Water molecules are broken (photolysis)** ✓

C. Glucose is oxidized

D. CO_2 combines with 5-C compounds

💡 **Explanation:** Light also breaks the water molecule; oxygen is released while hydrogen atoms give electrons to chlorophyll and become hydrogen ions.

Q20 Photosynthesis

As high-energy electrons pass through the electron transport chain during light reactions, they release energy used to produce:

A. Glucose

B. **ATP** ✓

C. CO_2

D. Pyruvic acid

💡 **Explanation:** The high-energy electrons released from chlorophyll pass to an electron transport chain, and as electrons move from higher to lower energy levels, they release energy used to produce ATP.

Q21 Photosynthesis

NADP stands for:

- **A. Nicotinamide adenine dinucleotide phosphate ✓**
- B. Nitrogen adenine dinucleotide phosphate
- C. Nicotinamide adenosine diphosphate
- D. Nucleotide adenine diphosphate

💡 **Explanation:** NAD (Nicotinamide Adenine Dinucleotide) is a coenzyme; the form that also carries phosphate is called NADP (Nicotinamide Adenine Dinucleotide Phosphate).

Q22 Photosynthesis

NADPH is formed when NADP is reduced using electrons from chlorophyll and:

- **A. Hydrogen ions from water ✓**
- B. Carbon dioxide molecules
- C. Phosphate groups from ATP
- D. Oxygen molecules

💡 **Explanation:** After ATP production, the electrons of chlorophyll and the hydrogen ions released from water are used to reduce NADP into NADPH (Nicotinamide Adenine Dinucleotide Phosphate – reduced).

Q23 Dark Reactions (Calvin Cycle)

The dark reactions of photosynthesis are also known as the:

- A Krebs cycle
- B **Calvin cycle ✓**
- C Electron transport chain
- D Glycolytic pathway

💡 **Explanation:** During the dark reactions, carbon dioxide is reduced to make glucose; the details of these reactions were discovered by Melvin Calvin, so they are called the Calvin cycle.

Q24 Dark Reactions (Calvin Cycle)

The scientist who discovered the details of the dark reactions of photosynthesis was:

- A Fritz Lipmann
- B Sir Hans Krebs
- C **Melvin Calvin ✓**
- D Robert Mayer

💡 **Explanation:** The details of the dark reactions (Calvin cycle) were discovered by Melvin Calvin, after whom the cycle is named.

Q25 Dark Reactions (Calvin Cycle)

In the Calvin cycle, carbon dioxide molecules combine with compounds having how many carbon atoms?

A Three

B Five ✓

C Six

D Two

💡 **Explanation:** CO_2 molecules combine with 5-carbon compounds in the Calvin cycle to form an unstable 6-carbon compound.

Q26 Dark Reactions (Calvin Cycle)

When CO_2 combines with a 5-carbon compound in the Calvin cycle, it forms an unstable compound with how many carbons?

A 4-carbon

B 5-carbon

C 6-carbon ✓

D 3-carbon

💡 **Explanation:** CO_2 combines with 5-carbon compounds to form a 6-carbon compound, which is unstable and immediately splits into two 3-carbon compounds.

Q27 Dark Reactions (Calvin Cycle)

The unstable 6-carbon compound formed in the Calvin cycle splits into two compounds each containing:

- **A 3 carbons ✓**
- B 5 carbons
- C 6 carbons
- D 2 carbons

💡 **Explanation:** The unstable 6-carbon compound splits into two 3-carbon compounds, which are then reduced to 3-carbon carbohydrates.

Q28 Dark Reactions (Calvin Cycle)

The 3-carbon compounds in the Calvin cycle are reduced to 3-carbon carbohydrates using ATP and:

- A FADH2
- **B NADPH ✓**
- C Oxygen
- D Acetyl-CoA

💡 **Explanation:** The 3-carbon compounds are reduced to 3-carbon carbohydrates by using ATP and hydrogen from NADPH, both of which were produced during the light reactions.

Q29 Dark Reactions (Calvin Cycle)

The 3-carbon carbohydrates produced in the Calvin cycle are ultimately used to make:

- A Pyruvic acid
- **B Glucose ✓**
- C Lactic acid
- D Ethyl alcohol

💡 **Explanation:** The 3-carbon carbohydrates formed in the dark reactions are used to make glucose, the end-product of photosynthesis.

Q30 Dark Reactions (Calvin Cycle)

Besides making glucose, the 3-carbon carbohydrates of the Calvin cycle are also used to:

- **A Regenerate the original 5-carbon compounds ✓**
- B Form Acetyl-CoA
- C Produce lactic acid
- D Form FADH2

💡 **Explanation:** The 3-carbon carbohydrates are also used to regenerate the original 5-carbon compounds, a step that also utilizes ATP, allowing the cycle to continue.

Q31 Cellular Respiration

Cellular respiration is essentially the process of:

A. Reduction of glucose
B. **Oxidation of food to release energy** ✓
C. Synthesis of glucose from CO2
D. Formation of chlorophyll

💡 **Explanation:** Organisms get energy by breaking the C-H bonds of food through oxidation; this oxidation of food inside cells is called cellular respiration.

Q32 Cellular Respiration

The most common food molecule used by cells to obtain energy through respiration is:

A. **Glucose** ✓
B. Cellulose
C. Chlorophyll
D. ATP

💡 **Explanation:** The most common food used by cells to get energy during cellular respiration is glucose.

Q33 Cellular Respiration

Respiration that occurs in the presence of oxygen is called:

- A. Anaerobic respiration
- B. Fermentation
- C. **Aerobic respiration** ✓
- D. Photosynthesis

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

Q34 Cellular Respiration

Aerobic respiration results in the complete oxidation of glucose with:

- A. Minimum release of energy
- B. **Maximum release of energy** ✓
- C. No release of energy
- D. Release of only heat

💡 **Explanation:** Aerobic respiration is the complete oxidation of glucose with maximum release of energy, unlike anaerobic respiration.

Q35 Cellular Respiration

In the first phase of aerobic respiration, a molecule of glucose (6-C) is broken down into two molecules of:

- A) Lactic acid (3-C)
- B) **Pyruvic acid (3-C)** ✓
- C) Ethyl alcohol (2-C)
- D) Acetyl-CoA (2-C)

💡 **Explanation:** In the first phase of aerobic respiration, a molecule of glucose (6-C) is broken down into two molecules of pyruvic acid (3-C); in the second phase, pyruvic acid is completely oxidized.

Q36 Cellular Respiration

In anaerobic respiration, glucose is:

- A) Completely oxidized with maximum energy
- B) **Incompletely oxidized with less energy released** ✓
- C) Not oxidized at all
- D) Converted directly into ATP

💡 **Explanation:** Anaerobic respiration is respiration without oxygen; glucose is incompletely oxidized, releasing less energy.

Q37 Cellular Respiration

Anaerobic respiration is also commonly known as:

- A Glycolysis
- B **Fermentation ✓**
- C Krebs cycle
- D Photosynthesis

💡 **Explanation:** Anaerobic respiration is also called fermentation, and its first phase is exactly similar to that of aerobic respiration.

Q38 Cellular Respiration

During anaerobic respiration, many C-H bonds of food are:

- A Completely broken
- B **Left unbroken ✓**
- C Converted to CO2 directly
- D Used to form chlorophyll

💡 **Explanation:** In the anaerobic process, many C-H bonds of food are left unbroken, which is why less energy is released compared to aerobic respiration.

Q39 Fermentation & Its Importance

During alcoholic fermentation, pyruvic acid is broken down into ethyl alcohol and:

- A Oxygen
- **B Carbon dioxide ✓**
- C Water
- D Lactic acid

💡 **Explanation:** In alcoholic fermentation, pyruvic acid ($C_3H_4O_3$) is broken down into alcohol (C_2H_5OH) and CO_2: $2(C_3H_4O_3) \rightarrow 2(C_2H_5OH) + 2CO_2$.

Q40 Fermentation & Its Importance

Alcoholic fermentation typically occurs in bacteria and:

- **A Yeast ✓**
- B Skeletal muscle cells
- C Chloroplasts
- D Mitochondria only

💡 **Explanation:** During anaerobic respiration in bacteria and yeast, pyruvic acid is broken down into alcohol and CO_2, a process called alcoholic fermentation.

Q41 Fermentation & Its Importance

Birds that eat berries fermented by yeast can become drunk because the berries contain:

- A. Lactic acid
- **B. Alcohol produced by alcoholic fermentation ✓**
- C. Excess glucose
- D. Excess oxygen

💡 **Explanation:** Yeast and bacteria can ferment sugars of berries to alcohol; birds eating these fermented berries can become quite drunk, as shown by their flight pattern.

Q42 Fermentation & Its Importance

During lactic acid fermentation, pyruvic acid is converted into:

- A. Ethyl alcohol
- **B. Lactic acid ($C_3H_6O_3$) ✓**
- C. Acetyl-CoA
- D. Glucose

💡 **Explanation:** During anaerobic respiration in the skeletal muscles of humans and other animals, pyruvic acid is converted into lactic acid ($C_3H_4O_3 + 4H \rightarrow C_3H_6O_3$).

Q43 Fermentation & Its Importance

Lactic acid fermentation occurs in skeletal muscles mainly when:

- A. Oxygen supply is more than enough
- **B. Oxygen supply is insufficient for demand** ✓
- C. Glucose is completely unavailable
- D. The body is completely at rest

💡 **Explanation:** During hard exercise, when oxygen supply cannot meet the muscles' demand, skeletal muscles carry out lactic acid fermentation for energy.

Q44 Fermentation & Its Importance

Early organisms on Earth respired anaerobically mainly because:

- A. They lacked mitochondria completely
- **B. The early environment did not have free oxygen** ✓
- C. Glucose was unavailable
- D. Sunlight was unavailable

💡 **Explanation:** The environment of Earth did not have free oxygen (O2) in the early phases of life, so early organisms respired anaerobically and got energy for their life.

Q45 Fermentation & Its Importance

Organisms that get energy from anaerobic respiration, even today, are called:

A Autotrophs

B Anaerobes ✓

C Aerobes

D Heterotrophs

💡 **Explanation:** Even today, some organisms including certain bacteria and fungi get energy from anaerobic respiration and are called anaerobes.

Q46 Fermentation & Its Importance

Soy sauce is produced through fermentation carried out by a:

A Bacterium

B Fungus ✓

C Virus

D Yeast only

💡 **Explanation:** Scientists have used fermentation in fungi and bacteria for making useful products; for example, soy sauce is made through fermentation by a fungus.

Q47 Glycolysis

Glycolysis, the first step of aerobic respiration, takes place in the:

- A Mitochondrial matrix
- B **Cytoplasm** ✓
- C Nucleus
- D Chloroplast

💡 **Explanation:** Glycolysis occurs in the cytoplasm, and since oxygen is not required for this process, it also occurs during anaerobic respiration.

Q48 Glycolysis

During glycolysis, a glucose (6-C) molecule is broken down into two molecules of:

- A **Pyruvic acid (3-C)** ✓
- B Acetyl-CoA (2-C)
- C Lactic acid (3-C)
- D Ethyl alcohol (2-C)

💡 **Explanation:** In glycolysis, the glucose (6-C) molecule is broken down, resulting in two molecules of pyruvic acid (3-C), along with two ATPs and two NADH.

Q49 Glycolysis

What is the net gain of ATP molecules from glycolysis per glucose molecule?

- **A 2 ATP ✓**
- B 4 ATP
- C 0 ATP
- D 6 ATP

💡 **Explanation:** Glycolysis uses 2 ATP but produces 4 ATP, giving a net gain of 2 ATP molecules per glucose, along with 2 NADH and 2 pyruvic acid molecules.

Q50 Glycolysis

Does glycolysis require the presence of oxygen?

- A Yes, it strictly requires oxygen
- **B No, oxygen is not required for glycolysis ✓**
- C Only in plant cells
- D Only during the Krebs cycle

💡 **Explanation:** Oxygen is not required for glycolysis; that is why glycolysis also occurs during anaerobic respiration (fermentation).

Q51 Glycolysis

How many molecules of NADH are produced during glycolysis?

- A One
- **B Two** ✓
- C Three
- D Six

💡 **Explanation:** According to the summary of glycolysis, breaking down one glucose molecule produces two molecules of NADH along with two pyruvic acid molecules and a net gain of 2 ATP.

Q52 Glycolysis

Glycolysis is common to which type(s) of respiration?

- A Aerobic respiration only
- B Anaerobic respiration only
- **C Both aerobic and anaerobic respiration** ✓
- D Neither aerobic nor anaerobic respiration

💡 **Explanation:** The first phase of both aerobic and anaerobic respiration is glycolysis, in which glucose is broken down into pyruvic acid.

Q53 Krebs Cycle

Before entering the Krebs cycle, each pyruvic acid molecule is first converted into:

A. Lactic acid

B. **Acetyl coenzyme-A** ✓

C. Ethyl alcohol

D. Glucose

💡 **Explanation:** Before the Krebs cycle, each pyruvic acid molecule is converted into acetyl coenzyme-A, along with the release of carbon dioxide and NADH.

Q54 Krebs Cycle

The Krebs cycle was discovered by the British scientist:

A. Fritz Lipmann

B. Melvin Calvin

C. **Sir Hans Krebs** ✓

D. Robert Hill

💡 **Explanation:** The Krebs cycle, a series of reactions occurring in the matrix of mitochondria, was discovered by the British scientist Sir Hans Krebs.

Q55 Krebs Cycle

In the Krebs cycle, acetyl coenzyme-A is completely oxidized to form:

- (A) Glucose
- (B) Pyruvic acid
- (C) **Carbon dioxide** ✓
- (D) Lactic acid

💡 **Explanation:** In the Krebs cycle, acetyl coenzyme-A is completely oxidized to carbon dioxide, resulting in the formation of ATP and energy-rich compounds NADH and FADH2.

Q56 Krebs Cycle

Apart from ATP, the two energy-rich compounds produced in the Krebs cycle are NADH and:

- (A) NADPH
- (B) **FADH2** ✓
- (C) AMP
- (D) Acetyl-CoA

💡 **Explanation:** The Krebs cycle results in the formation of ATP and energy-rich compounds, namely NADH and FADH2 (Flavin Adenine Dinucleotide – reduced).

Q57 Electron Transport Chain & ATP Yield

The electron transport chain, the third step of aerobic respiration, occurs on the:

A. Outer membrane of mitochondria

B. **Inner membranes of mitochondria** ✓

C. Thylakoid membranes

D. Cell membrane

💡 **Explanation:** The electron transport chain occurs on the inner mitochondrial membranes, where NADH and FADH2 release electrons and H+ to make ATP.

Q58 Electron Transport Chain & ATP Yield

During the electron transport chain, NADH and FADH2 change back to NAD and FAD by releasing electrons and hydrogen ions, and this energy is used to make:

A. Glucose

B. **ATP** ✓

C. Pyruvic acid

D. Chlorophyll

💡 **Explanation:** During the electron transport chain, NADH and FADH2 release electrons and hydrogen ions, changing back to NAD and FAD; the released energy is used to make ATP.

Q59 Electron Transport Chain & ATP Yield

At the end of the electron transport chain, electrons and hydrogen ions combine with oxygen to form:

- A Carbon dioxide
- **B Water ✓**
- C Glucose
- D Ozone

💡 **Explanation:** At the end of the electron transport chain, the electrons and hydrogen ions combine with oxygen to form water, which is why oxygen is essential for aerobic respiration.

Q60 Electron Transport Chain & ATP Yield

According to the overview of aerobic oxidation of glucose, the total number of ATP molecules produced is:

- A 2
- B 18
- C 24
- **D 36 ✓**

💡 **Explanation:** Summing the ATP from glycolysis (2), the electron transport chain fed by glycolysis NADH (4) and Krebs cycle NADH (18) and $FADH_2$ (4), plus Krebs cycle ATP (2), gives a total of 36 ATP molecules from the complete aerobic oxidation of one glucose molecule.

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