# MASTERING BIOCHEMISTRY

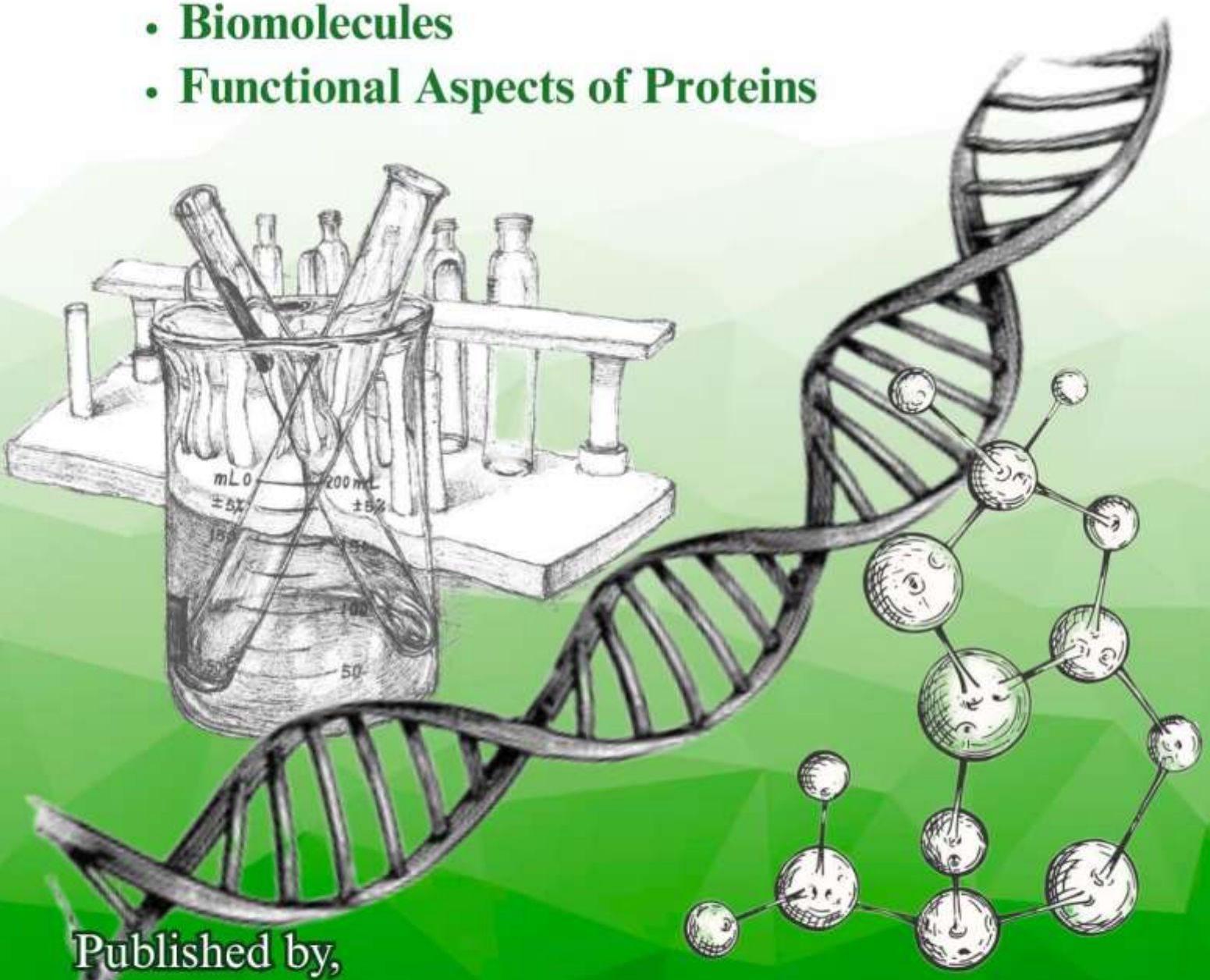
## A Comprehensive Guide to MCQs, Essays, and OSPEs

## Book – II

Uva Wellassa University

**Batch 2 and 3 Semester 1**

- **Cell Biochemistry**
- **Biomolecules**
- **Functional Aspects of Proteins**



Published by,
Department of Biochemistry
Faculty of Medicine
Uva Wellassa University of Sri Lanka

2026

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**Authored by:**

Department of Biochemistry

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## Batch 2 and 3 - Semester 1 (2026)

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**Mastering Biochemistry - A Comprehensive Guide to MCQs, Essays & OSPEs – Book II –** Semester 1 (2026)

**ISBN: 978-624-6685-52-2**
Compiled by:
Department of Medical Education, Faculty of Medicine,
Uva Wellassa University of Sri Lanka,
Passara road, Badulla, Sri Lanka
90 000

Printed and published by:
Book – II: 26.01.2026. Rs. 1500/=

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# Message from the Vice Chancellor

Dear students,

It gives me great pleasure to extend my heartfelt congratulations and sincere appreciation to the Faculty of Medicine, Uva Wellassa University of Sri Lanka, and particularly to Senior Professor Muditha Vidanapathirana, Dean of the Faculty of Medicine, for their remarkable achievement in successfully publishing "Mastering Biochemistry – Part I: A Comprehensive Guide to MCQs, Essays & OSPEs".
This publication serves as an exceptional academic resource, offering considerable value not only to the MBBS undergraduates of Uva Wellassa University of Sri Lanka but also to medical students throughout the country. I strongly encourage students to make the best use of the high-quality learning materials developed by the Faculty of Medicine. Resources such as this guide can greatly enhance the learning process, making studies more organized, productive, and rewarding.

I wish you every success in your future academic pursuits and professional careers.

Senior Professor Kolitha B. Wijesekara
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Vice Chancellor
Uva Wellassa University of Sri Lanka



# Message from the Head of the Department

Dear Students,

As the Head of the Department of Biochemistry, it is both an honour and a privilege to be part of the team behind the publication of "Mastering Biochemistry: A Comprehensive Guide to MCQs, Essays, and OSPEs." This publication has been meticulously designed to align with the Biochemistry curriculum for Year 1, Semester 1, as offered by the Department of Biochemistry, Faculty of Medicine, Uva Wellassa University of Sri Lanka.

As aspiring medical professionals dedicated to excellence, this guide aims to support your academic journey by serving as a resource to prepare effectively for your examinations. It provides detailed insights into the components of MCQs, essays, and OSPEs, helping you navigate these formats with confidence. Furthermore, the publication is structured to assist in testing your comprehension and reinforcing the knowledge acquired through the curriculum.

I extend my heartfelt gratitude to Snr. Prof. Muditha Vidanapathirana, Founder Dean of the Faculty of Medicine, Uva Wellassa University, for conceptualizing this initiative and offering steadfast guidance throughout its development. My sincere appreciation also goes to all contributors who played a role in creating this valuable resource.

I hope this publication serves as a reliable guide and inspires you to excel in your academic endeavours.

Warm regards

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# BIOCHEMISTRY PRACTICE MCQs (T/F & SBR)

- **Cell Biochemistry**
- **Biomolecules**
- **Functional Aspects of Proteins**

# BIOCHEMISTRY PRACTICE MCQs (T/F & SBR)
# T/F QUESTIONS

**(1) True or False regarding the functions of the Smooth Endoplasmic Reticulum (SER)?**

(A) Smooth endoplasmic reticulum is the primary site of protein synthesis.
(B) Smooth endoplasmic reticulum is involved in glycosylation of proteins.
(C) Smooth endoplasmic reticulum plays a major role in lipid metabolism and detoxification.
(D) Smooth endoplasmic reticulum is responsible for ribosome assembly.
(E) Smooth endoplasmic reticulum is the site of DNA replication.

**(2) True or False regarding lysosomes?**

(A) Lysosomes are sites of ATP synthesis.
(B) Lysosomes are organelles lacking membranes.
(C) Lysosomes contain enzymes active at neutral pH.
(D) Lysosomes are the digestive system of the cell.
(E) Lysosomes store calcium ions.

**(3) True or False regarding the inner mitochondrial membrane?**

(A) It allows diffusion of ATP.
(B) It maintains the proton gradient.
(C) It facilitates fatty acid transport.
(D) It enables ribosome binding.
(E) It prevents protein synthesis.

**(4) True or False regarding carbohydrates?**

(A) They are fatty acids and glycerol.
(B) They are polyhydroxy aldehydes or ketones.
(C) They are amino acid polymers.
(D) They are nitrogen-containing bases.
(E) They are steroid derivatives.

**(5) True or False regarding facilitated diffusion?**

(A) It requires ATP.
(B) It moves solutes against their concentration gradient.
(C) It shows saturation at high solute concentrations.
(D) It is not specific for the transported molecule.
(E) It occurs only in living cells.

# SBR QUESTIONS

**(6) Which of the following is the principal feature that distinguishes eukaryotic cells from prokaryotic cells?**

(A) Presence of ribosomes
(B) Presence of plasma membrane
(C) Presence of nucleus
(D) Presence of cytoplasm
(E) Presence of cell wall

**(7) Which organelle is responsible for generating most of the ATP in eukaryotic cells?**

(A) Lysosome
(B) Peroxisome
(C) Golgi apparatus
(D) Mitochondrion
(E) Endoplasmic reticulum

**(8) Which of the following type of transport mechanism is the sodium–glucose cotransporter (SGLT1)?**

(A) Uniporter
(B) Antiporter
(C) Channel protein
(D) Primary active transporter
(E) Secondary active transporter

**(9) Actin filaments are mainly responsible for which of the following functions?**

(A) DNA replication
(B) Protein synthesis
(C) Cell shape and movement
(D) Lipid synthesis
(E) Oxidative phosphorylation

**(10) Which of the following correctly describes ion channel?**

(A) It binds specifically to solutes and undergoes conformational change.
(B) It requires ATP for opening and closing.
(C) It transports molecules more slowly than carrier proteins.
(D) It forms hydrophilic pores across the membrane.
(E) It is non-selective to ions.

**(11) Which of the following factors will most increase the rate of simple diffusion across a membrane?**

(A) Increased molecular size
(B) Decreased concentration gradient
(C) Increased diffusion distance
(D) Increased membrane permeability
(E) Presence of ATP

**(12) The therapeutic effect of cardiac glycosides (e.g., digoxin) is mainly due to which of the following?**

(A) Activation of calcium channels
(B) Complete inhibition of $Na^+/K^+$-ATPase
(C) Partial inhibition of $Na^+/K^+$-ATPase
(D) Stimulation of glucose transporters
(E) Increased potassium efflux

**(13) The pH of a solution is defined as which of the following?**

(A) Logarithm of hydroxide ion concentration
(B) Negative logarithm of hydrogen ion concentration
(C) Logarithm of hydrogen ion concentration
(D) Negative logarithm of hydroxide ion concentration
(E) Reciprocal of hydrogen ion concentration

**(14) Which of the following represents a neutral solution at 25°C?**

(A) pH 5
(B) pH 6
(C) pH 7
(D) pH 8
(E) pH 9

**(15) Which of the following is TRUE regarding weak acids?**

(A) Completely dissociate in water
(B) Do not dissociate in water
(C) Partially dissociate in water
(D) Cannot act as buffers
(E) Have Ka greater than strong acids

**(16) Maximum buffering capacity occurs when which of the following conditions is met?**

(A) pH = 0
(B) pH = 14
(C) Weak acid concentration is zero
(D) Weak acid = conjugate base
(E) Strong acid added

**(17) Which of the following is the main extracellular buffer system?**

(A) Phosphate buffer
(B) Protein buffer
(C) Hemoglobin buffer
(D) Bicarbonate buffer
(E) Ammonia buffer

**(18) Which buffer system is most important in erythrocytes?**

(A) Bicarbonate buffer
(B) Phosphate buffer
(C) Protein buffer
(D) Hemoglobin buffer
(E) Ammonia buffer

**(19) Respiratory acidosis occurs due to which of the following?**

(A) Excessive vomiting
(B) Hyperventilation
(C) Increased $CO_2$ retention
(D) Increased bicarbonate loss
(E) Increased oxygen

**(20) Which of the following buffer systems is important in urine?**

(A) Bicarbonate buffer
(B) Protein buffer
(C) Hemoglobin buffer
(D) Phosphate buffer
(E) Albumin buffer

**(21) Which of the following monosaccharides is classified as a ketohexose?**

(A) Glucose
(B) Galactose
(C) Mannose
(D) Fructose
(E) Ribose

**(22) Optical activity in monosaccharides is due to the presence of which of the following?**

(A) Carbonyl group
(B) Glycosidic bond
(C) Chiral carbon
(D) Peptide bond
(E) Phosphate group

**(23) Which of the following disaccharides is a non-reducing sugar?**

(A) Maltose
(B) Lactose
(C) Glucose
(D) Fructose
(E) Sucrose

**(24) Lactose intolerance is caused by deficiency of which enzyme?**

(A) Sucrase
(B) Maltase
(C) Amylase
(D) Lactase
(E) Cellulase

**(25) Glycogen differs from amylopectin because glycogen is which of the following?**

(A) Composed of fructose units
(B) Linked by β(1→4) bonds only
(C) Highly branched
(D) A heteropolysaccharide
(E) A non-reducing monosaccharide

**(26) Cellulose is indigestible in humans because of which of the following reasons?**

(A) It contains α(1→4) bonds
(B) It is a heteropolysaccharide
(C) Humans lack cellulase enzyme
(D) It is water soluble
(E) It is a reducing sugar

**(27) Which amino acid is unique because it contains a secondary amino group and is often referred to as an "imino acid"?**

(A) Glycine
(B) Alanine
(C) Proline
(D) Histidine
(E) Valine

**(28) At physiologic pH (7.4), what is the typical charge state of the carboxyl and amino groups of a free amino acid?**

(A) Carboxyl is protonated, Amino is dissociated.
(B) Carboxyl is dissociated (negative), Amino is protonated (positive).
(C) Both groups are uncharged.
(D) Both groups are negatively charged.
(E) Carboxyl is positively charged, Amino is negatively charged.

**(29) Which of the following amino acids has a nonpolar side chain that is aromatic?**

(A) Glycine
(B) Valine
(C) Phenylalanine
(D) Serine
(E) Lysine

**(30) Sickle cell anaemia results from the replacement of polar glutamate with which nonpolar amino acid at the sixth position of the subunit of haemoglobin?**

(A) Leucine
(B) Isoleucine
(C) Valine
(D) Alanine
(E) Proline

**(31) Which amino acid is the only one whose side chain can ionize within the physiologic pH range, allowing it to serve as a buffer?**

(A) Arginine
(B) Lysine
(C) Histidine
(D) Glutamate
(E) Aspartate

**(32) Which of the following describes a characteristic of the peptide bond?**

(A) It allows for free rotation between the carbonyl carbon and nitrogen
(B) It is typically found in the cis-configuration
(C) It has a partial double bond character and is rigid/planar
(D) It is easily broken by heating or urea
(E) It is a non-covalent interaction

**(33) Which reagent is used to quantitate separated amino acids by forming a purple compound that can be measured spectrophotometrically?**

(A) Urea
(B) Acetic acid
(C) Ninhydrin
(D) Hydrochloric acid
(E) Insulin

**(34) Which of the following is TRUE regarding DNA structure?**

(A) DNA contains ribose sugar
(B) DNA strands run parallel
(C) DNA is a left-handed helix
(D) DNA contains uracil
(E) DNA strands are antiparallel

**(35) Which base pairing is CORRECT?**

(A) A – C
(B) G – T
(C) A – T
(D) A – G
(E) C – A

**(36) Which of the following is a purine base?**

(A) Cytosine
(B) Uracil
(C) Thymine
(D) Adenine
(E) All are pyrimidines

**(37) Which bond links nucleotides in a polynucleotide chain?**

(A) Hydrogen bond
(B) Peptide bond
(C) Phosphodiester bond
(D) Ionic bond
(E) Glycosidic bond

**(38) Which factor increases DNA melting temperature (Tm)?**

(A) Low GC content
(B) Short DNA length
(C) Low salt concentration
(D) High GC content
(E) Presence of denaturants

**(39) DNA denaturation involves which of the following?**

(A) Breaking phosphodiester bonds.
(B) Breaking hydrogen bonds.
(C) Irreversible process.
(D) Occurs only in vivo.
(E) Formation of nucleosomes.

**(40) Which of the following statements about enzymes is CORRECT?**

(A) Enzymes are consumed during reactions.
(B) Enzymes increase activation energy.
(C) Enzymes alter the equilibrium constant.
(D) Enzymes increase the rate of reaction without being consumed.
(E) Enzymes are not specific to substrates.

**(41) Which of the following best describes the active site of an enzyme?**

(A) A rigid structure that does not change shape.
(B) A region composed only of hydrophobic amino acids.
(C) A site where substrate binding and catalysis occur.
(D) A region unrelated to enzyme function.
(E) A structure present only in multimeric enzymes.

**(42) Which model suggests that the enzyme's active site changes shape to accommodate the substrate?**

(A) Lock and key model
(B) Rigid template model
(C) Induced fit model
(D) Transition state model
(E) Competitive inhibition model

**(43) Which class of enzymes catalyzes oxidation-reduction reactions?**

(A) Transferases
(B) Hydrolases
(C) Lyases
(D) Oxidoreductases
(E) Ligases

**(44) Which of the following statements about enzyme specificity is TRUE?**

(A) One enzyme can catalyze multiple unrelated reactions.
(B) Enzymes are not stereospecific.
(C) Enzymes can act on both D- and L-isomers equally.
(D) Enzymes show substrate and reaction specificity.
(E) Enzymes are non-specific catalysts.

**(45) Which of the following best describes the primary structure of a protein?**

(A) Arrangement of α-helices and β-sheets.
(B) Sequence of amino acids linked by peptide bonds.
(C) Folding of polypeptide chains into 3D structure.
(D) Association of multiple subunits.
(E) Interaction with prosthetic groups.

**(46) Which of the following protein functions is correctly matched?**

(A) Haemoglobin – Enzyme activity
(B) Insulin – Structural protein
(C) Collagen – Hormone
(D) Enzymes – Biocatalysts
(E) Actin – Transport protein

**(47) Why is DNA replication described as semiconservative?**

(A) Both strands are newly synthesized
(B) One strand is parental and one is newly synthesized
(C) DNA is replicated only during mitosis
(D) Only one strand is copied
(E) RNA primers are used

**(48) Which enzyme is responsible for unwinding the DNA double helix during replication?**

(A) DNA ligase
(B) DNA polymerase
(C) Helicase
(D) Topoisomerase
(E) Primase

**(49) During which process are Okazaki fragments formed?**

(A) Leading strand synthesis
(B) Lagging strand synthesis
(C) Transcription
(D) Translation
(E) DNA repair

**(50) Which of the following is a key feature of RNA polymerase?**

(A) Requires a primer
(B) Has proofreading ability
(C) Synthesizes RNA in 5’ → 3’ direction
(D) Uses deoxyribonucleotides
(E) Cannot unwind DNA

**(51) Which post-transcriptional modification increases mRNA stability and helps in translation initiation?**

(A) Splicing
(B) Poly-A tail removal
(C) 5' capping
(D) Intronic insertion
(E) DNA methylation

**(52) Which of the following best describes the main function of hemoglobin?**

(A) Transport carbon dioxide only
(B) Buffer blood pH only
(C) Transport oxygen from lungs to tissues
(D) Transport glucose
(E) Synthesize ATP

**(53) Which globin chains are present in normal adult hemoglobin (HbA)?**

(A) $\alpha_2\gamma_2$
(B) $\alpha_2\beta_2$
(C) $\alpha_2\delta_2$
(D) $\beta_4$
(E) $\alpha_4$

**(54) Which globin chains are present in fetal hemoglobin (HbF)?**

(A) $\alpha_2\beta_2$
(B) $\alpha_2\delta_2$
(C) $\alpha_2\gamma_2$
(D) $\beta_4$
(E) $\gamma_4$

**(55) Which oxidation state of iron is present in functional hemoglobin?**

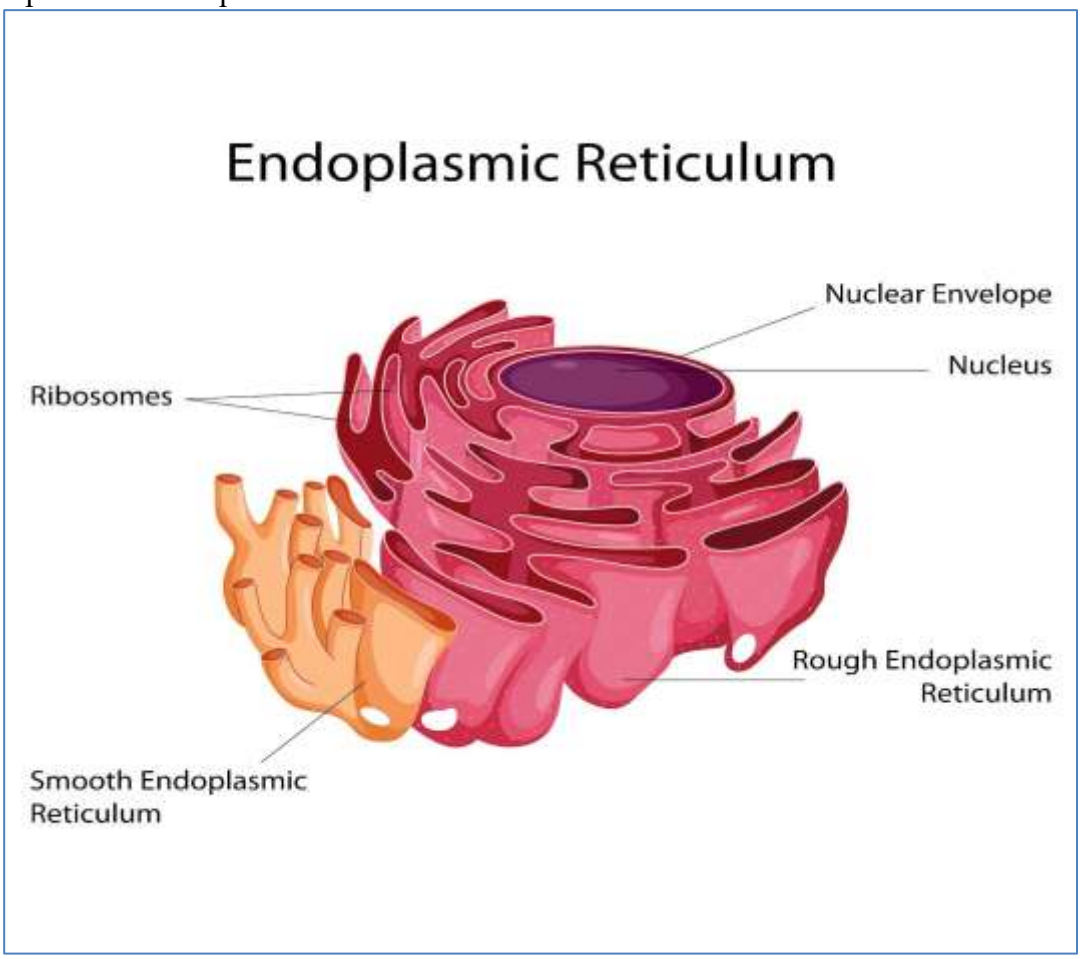
(A) Ferric ($Fe^{3+}$) state
(B) Ferrous ($Fe^{2+}$) state
(C) Metallic state
(D) Reduced sulfur state
(E) Oxidized copper state

**(56) Which substance decreases hemoglobin's affinity for oxygen?**

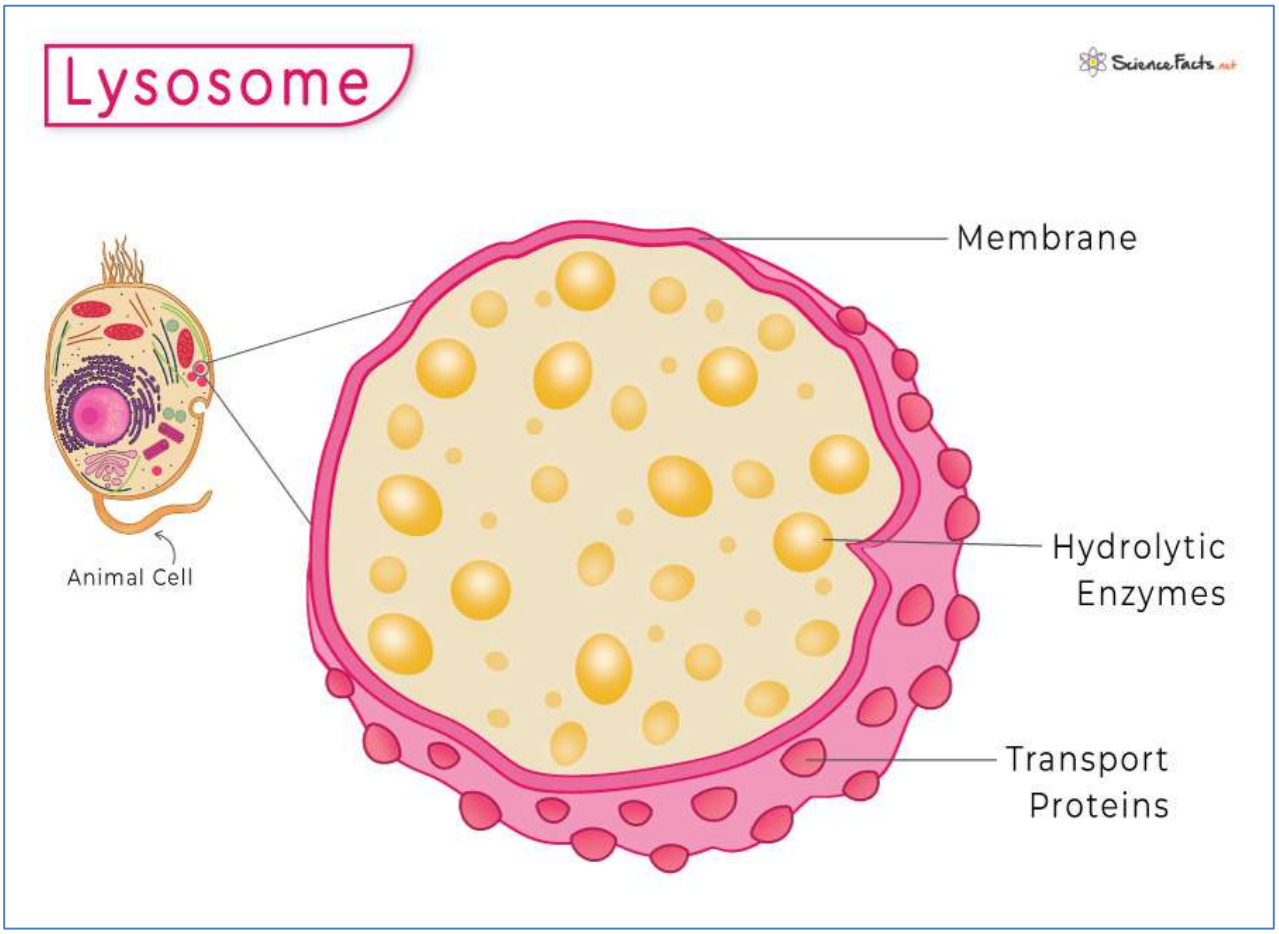
(A) Carbon monoxide
(B) 2,3-Bisphosphoglycerate
(C) Nitric oxide
(D) Carbonic acid
(E) Albumin

# BIOCHEMISTRY PRACTICE MCQ (T/F & SBR) ANSWERS

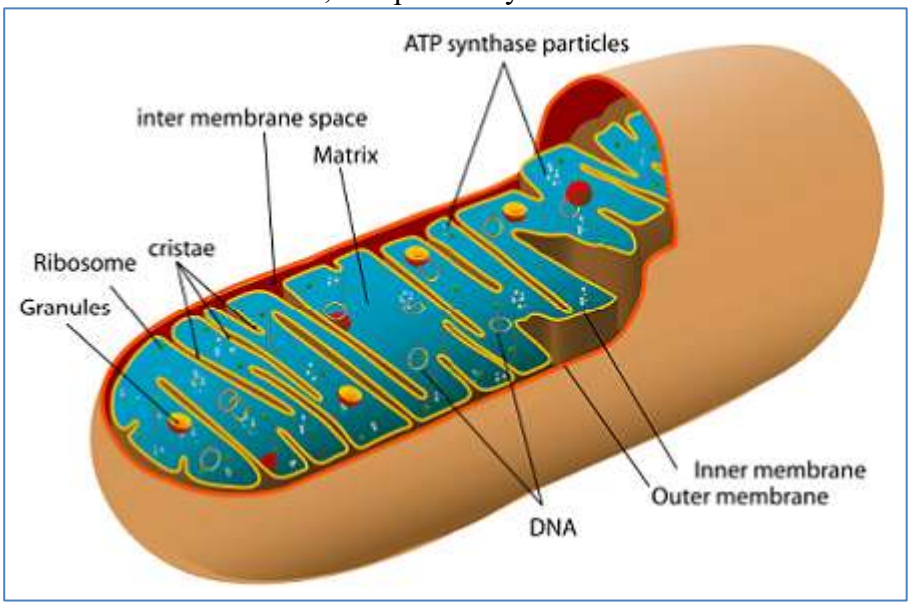
(1) Answer: FFFTF
Explanation:
The smooth endoplasmic reticulum (SER) is not the primary site of protein synthesis because it lacks ribosomes. Protein synthesis occurs on ribosomes attached to the rough endoplasmic reticulum. Glycosylation mainly occurs in the rough ER and Golgi apparatus. SER plays an important role in lipid synthesis, steroid hormone production, detoxification of drugs and toxins, and calcium storage. Ribosome assembly occurs in the nucleolus, while DNA replication takes place in the nucleus.




(2) Answer: FFFTF
Explanation:
Lysosomes are membrane-bound organelles containing hydrolytic enzymes that digest cellular waste, damaged organelles, and foreign materials. They do not synthesize ATP, which is a function of mitochondria. Lysosomes are surrounded by a membrane and contain enzymes that function optimally at an acidic pH rather than a neutral pH. Although lysosomes contribute to cellular digestion, they do not serve as calcium storage organelles.

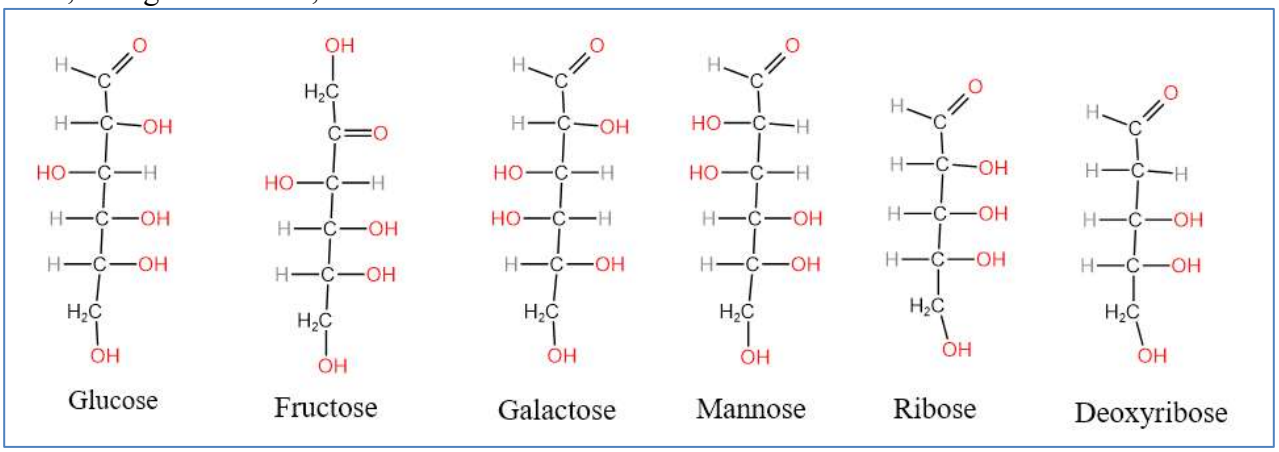



(3) Answer: FTFFF
Explanation:
The inner mitochondrial membrane is highly impermeable and maintains the proton gradient required for ATP synthesis. ATP cannot freely diffuse across this membrane and requires specific transport proteins. Fatty acid transport is facilitated by the carnitine shuttle system rather than the membrane itself. Ribosome binding is not a function of the inner mitochondrial membrane, and protein synthesis does occur within mitochondria.

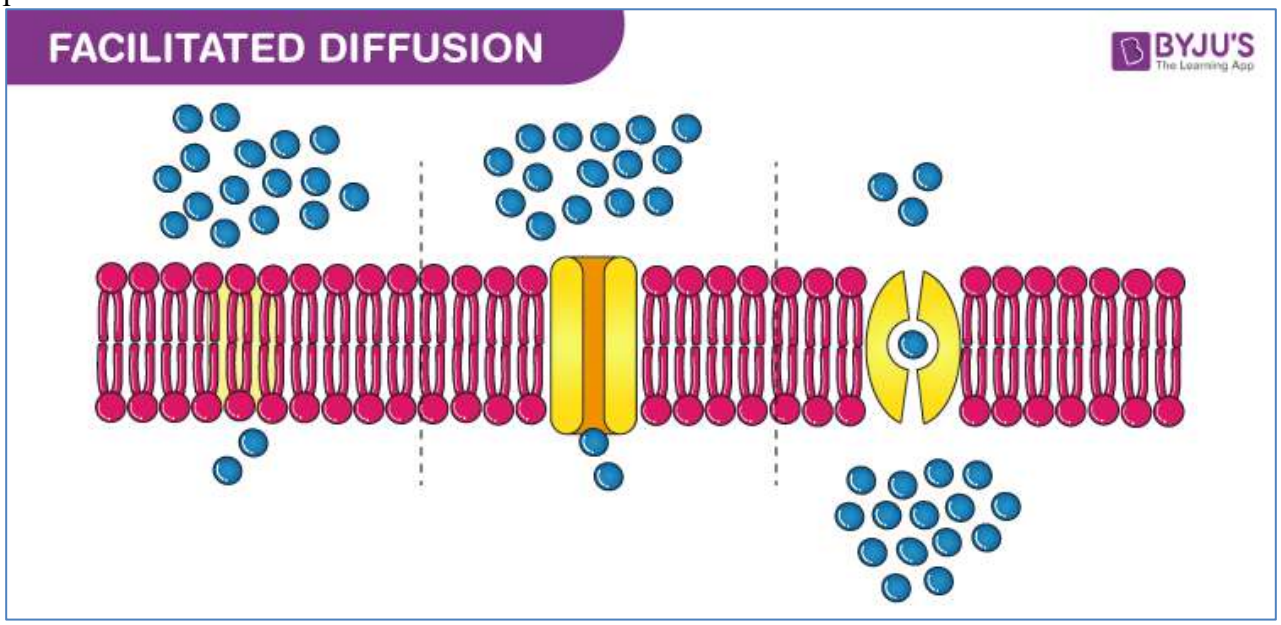



(4) Answer: FTFFF
Explanation:

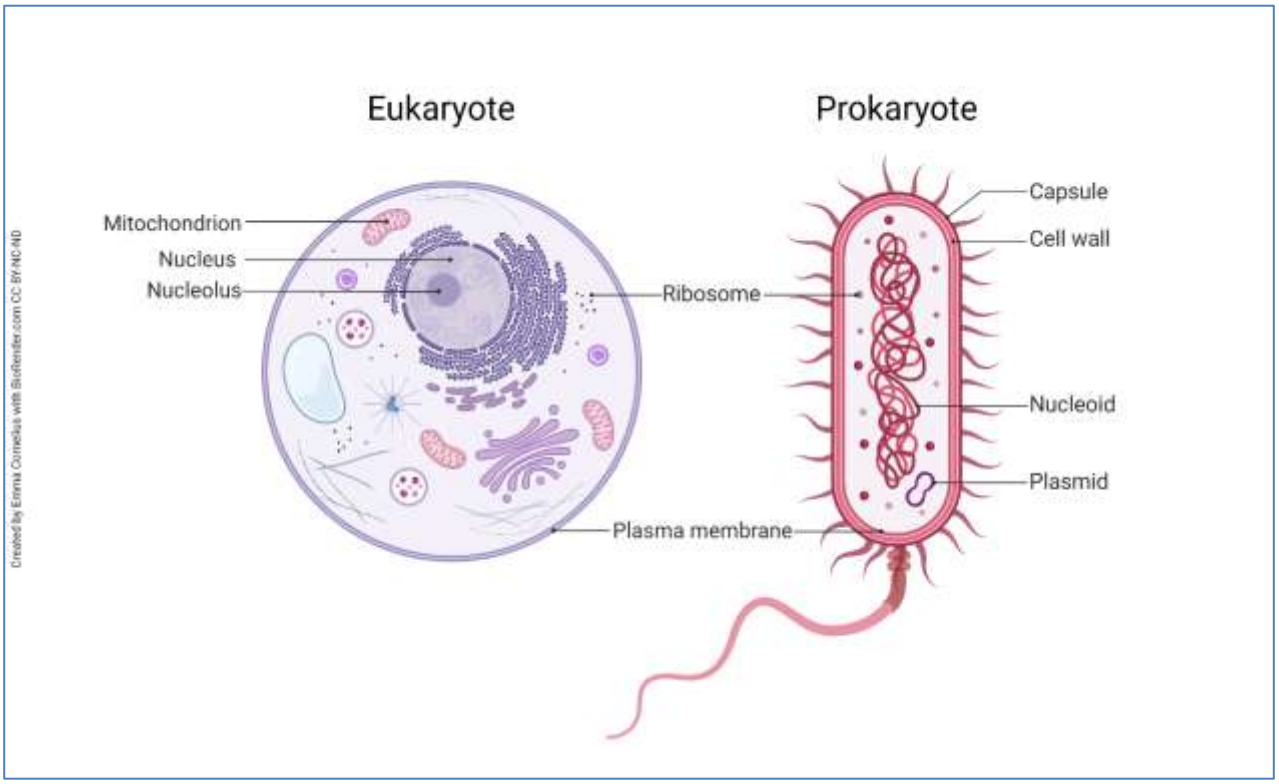
Carbohydrates are organic compounds that are chemically classified as polyhydroxy aldehydes or ketones, or substances that yield such compounds upon hydrolysis. They are not composed of fatty acids and glycerol, which form lipids. They are not polymers of amino acids, nitrogenous bases, or steroid derivatives.



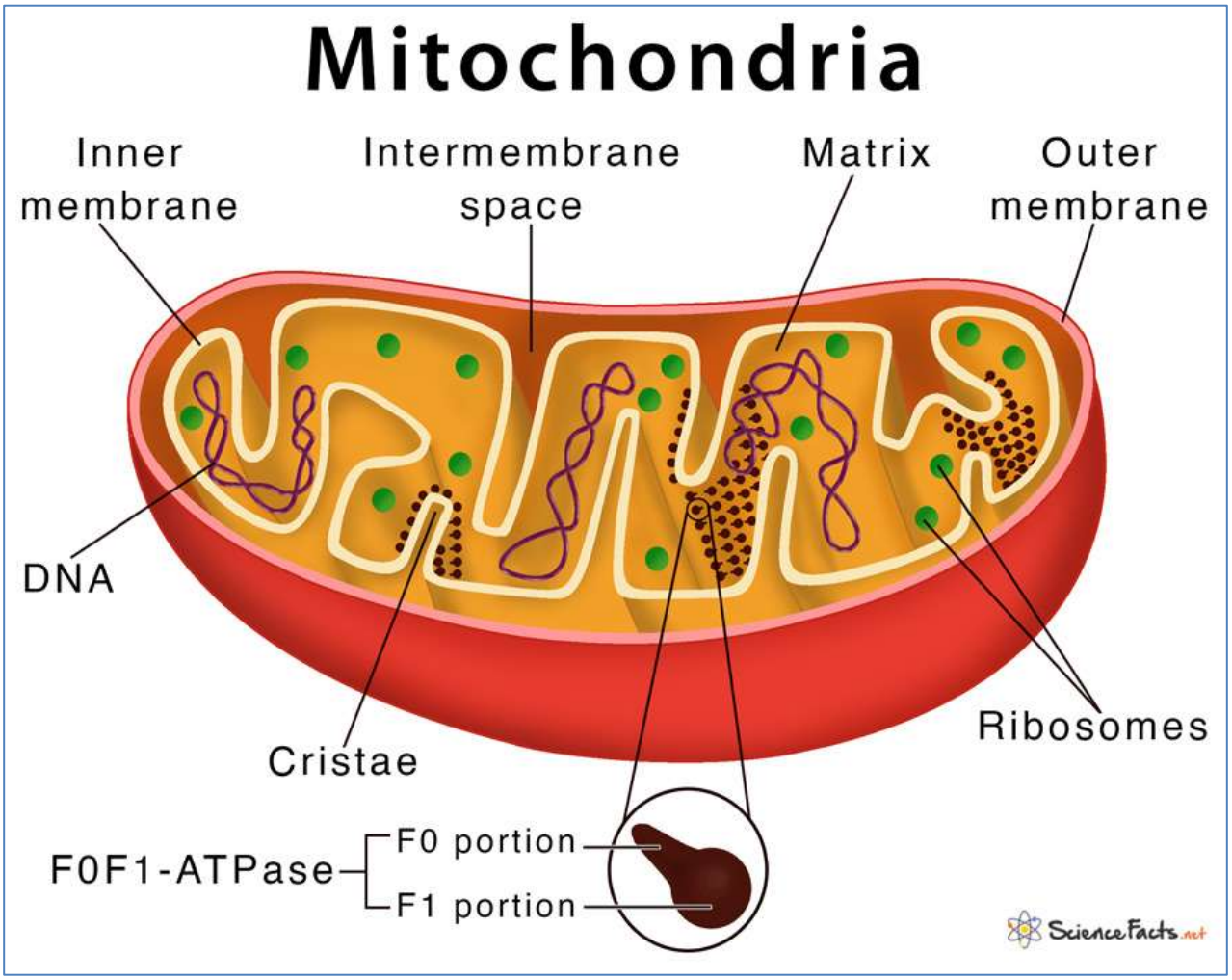

(5) Answer: FFTFT
Explanation:
Facilitated diffusion is a passive transport process that does not require ATP and always occurs down a concentration gradient. It utilizes specific carrier proteins or channels and therefore exhibits saturation when all transporters become occupied. Because transport proteins are highly specific, facilitated diffusion is selective for particular molecules. This process occurs only in living cells where intact membranes and transport proteins are present.




(6) Answer: C. Presence of nucleus
Explanation:
The defining feature of eukaryotic cells is the presence of a membrane-bound nucleus that contains genetic material. Ribosomes, plasma membranes, and cytoplasm are present in both prokaryotic and eukaryotic cells. Although some prokaryotes possess cell walls, the nucleus is unique to eukaryotes.



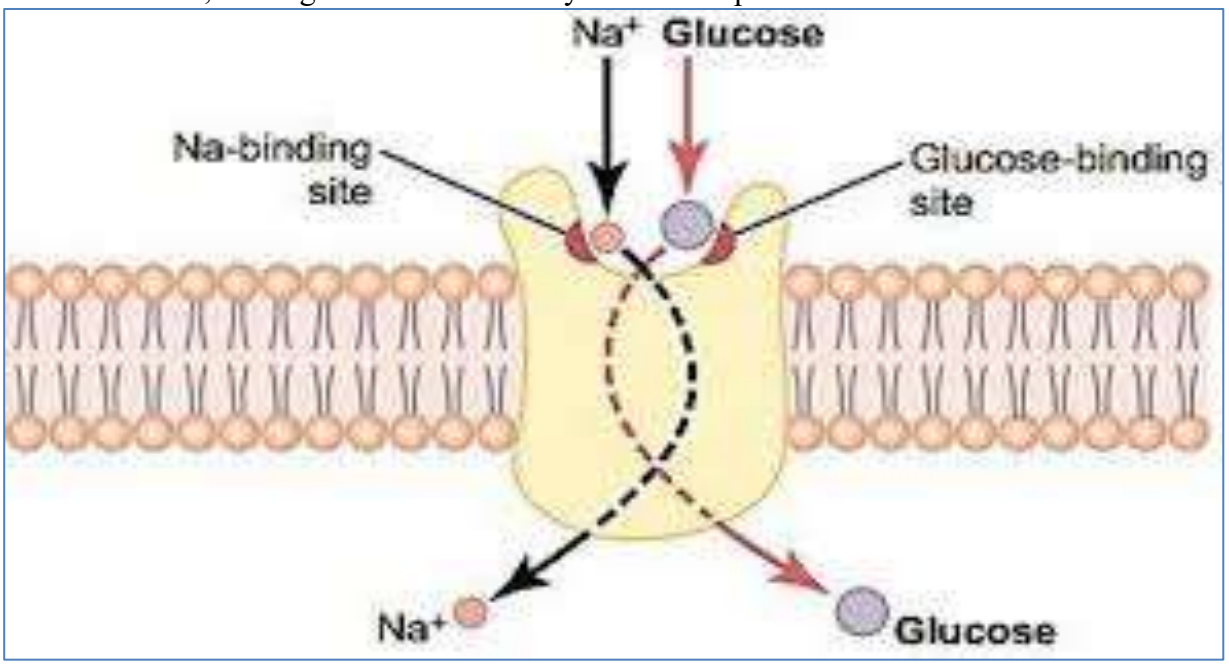

(7) Answer: D. Mitochondrion
Explanation:
Mitochondria generate most of the ATP required by eukaryotic cells through oxidative phosphorylation. For this reason, they are commonly referred to as the powerhouses of the cell.




(8) Answer: E. Secondary active transporter

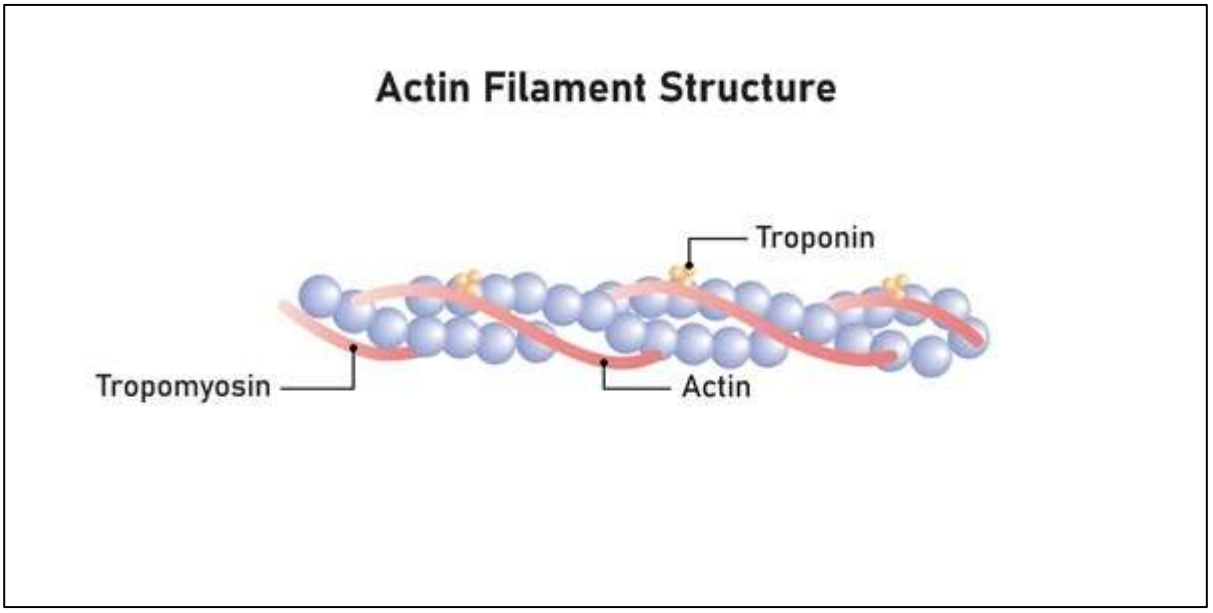
Explanation:

SGLT1 transports glucose into cells by coupling glucose uptake with the movement of sodium ions down their electrochemical gradient. The sodium gradient is established by the $Na^+/K^+$-ATPase, making SGLT1 a secondary active transporter.

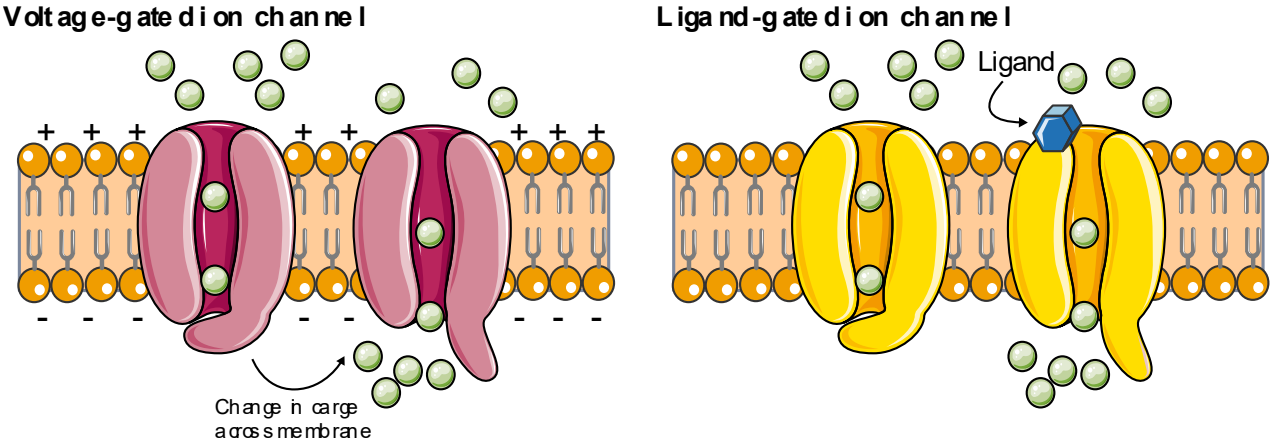



(9) Answer: C. Cell shape and movement

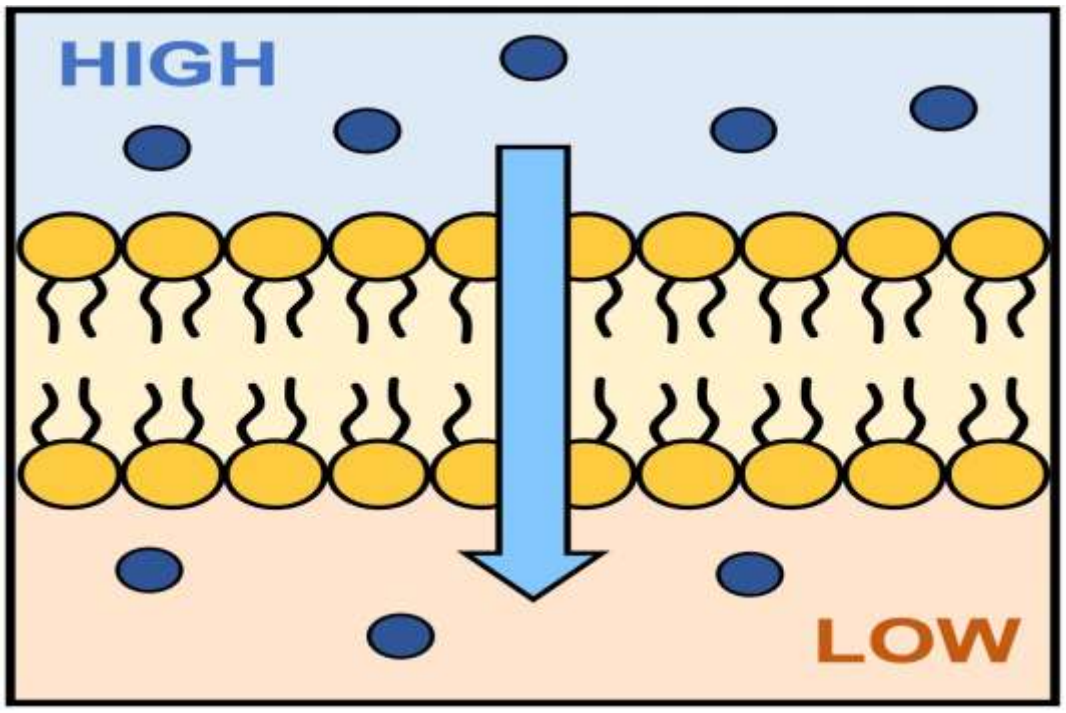
Explanation:
Actin filaments are components of the cytoskeleton that help maintain cell shape, support cell movement, participate in muscle contraction, and facilitate cytokinesis during cell division.



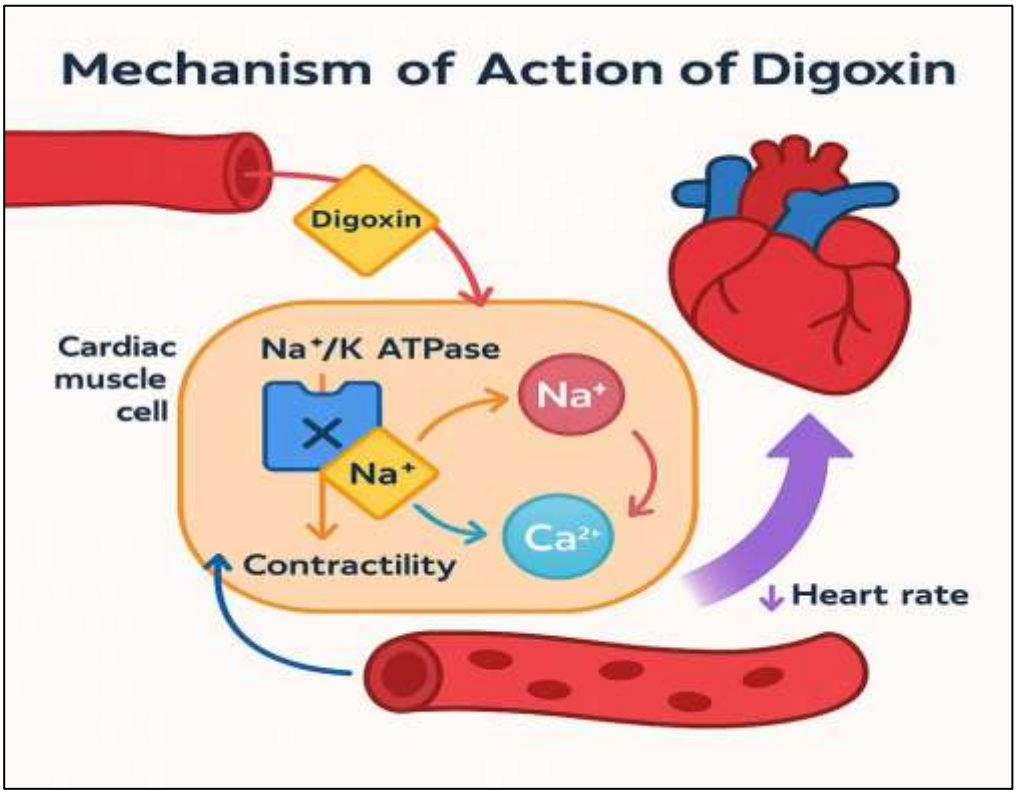

(10) Answer: D. It forms hydrophilic pores across the membrane.
Explanation:
Ion channels are membrane proteins that form aqueous pores through which specific ions move rapidly down their electrochemical gradients. They do not necessarily require ATP and are usually highly selective for particular ions.



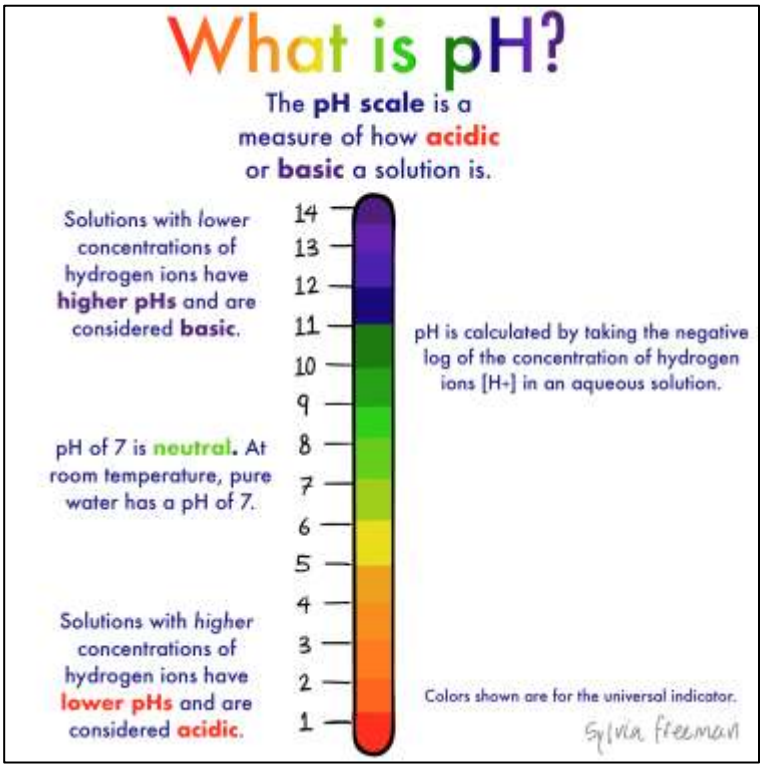

(11) Answer: D. Increased membrane permeability
Explanation:
The rate of simple diffusion increases when membrane permeability increases because molecules can cross the membrane more easily. Increased molecular size and diffusion distance slow diffusion, while a reduced concentration gradient decreases the driving force.




(12) Answer: C. Partial inhibition of $Na^+/K^+$-ATPase
Explanation:
Cardiac glycosides such as digoxin partially inhibit the $Na^+/K^+$-ATPase pump. This increases intracellular sodium concentration, which indirectly increases intracellular calcium levels and enhances the force of cardiac muscle contraction.

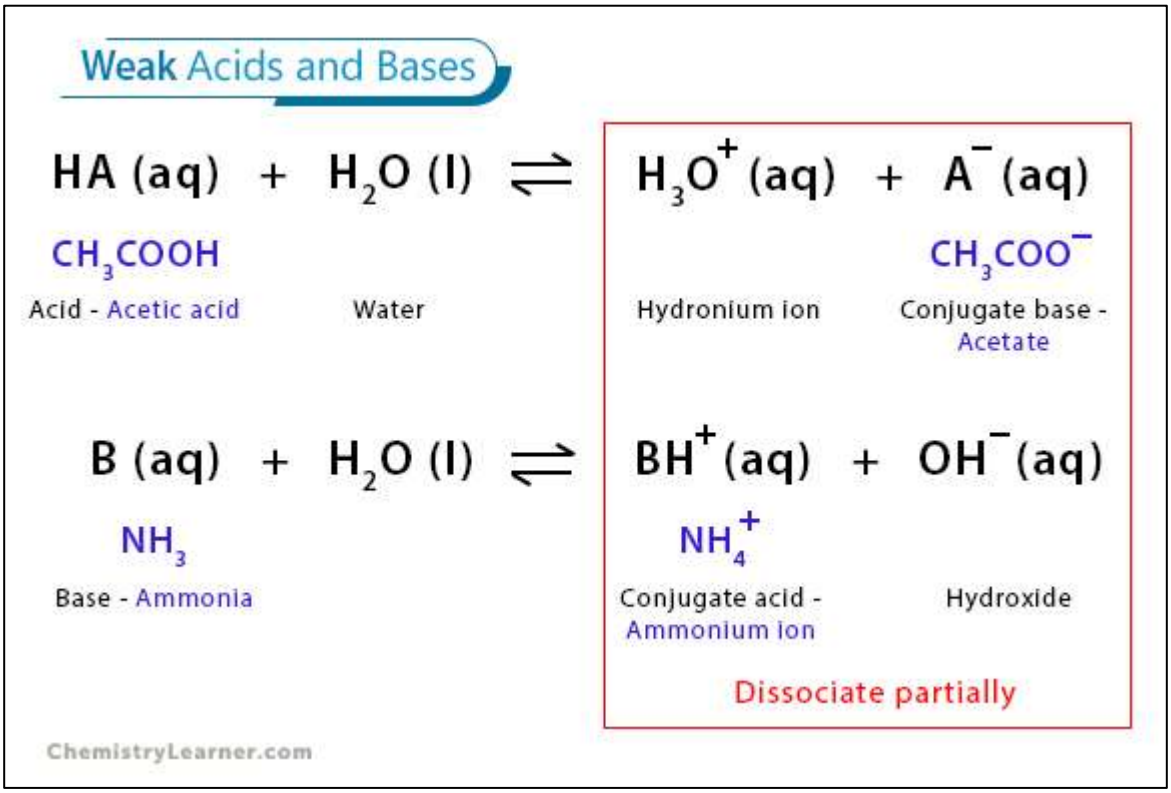



(13) Answer: B. Negative logarithm of hydrogen ion concentration
Explanation:
pH is defined as the negative logarithm of the hydrogen ion concentration of a solution. It provides a convenient measure of acidity or alkalinity.



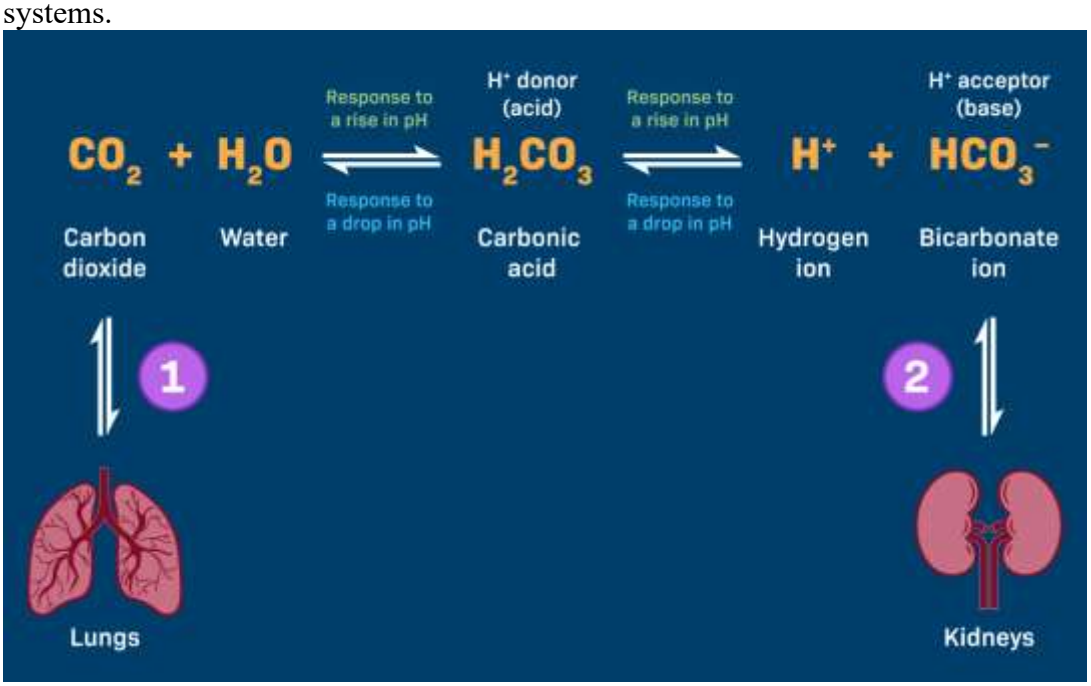

(14) Answer: C. pH 7
Explanation:
At 25°C, a neutral solution has equal concentrations of hydrogen ions and hydroxyl ions, corresponding to a pH of 7.

(15) Answer: C. Partially dissociate in water
Explanation:
Weak acids ionize only partially in aqueous solutions. This partial dissociation allows them to establish an equilibrium between the undissociated acid and its ions, making them useful as buffers.



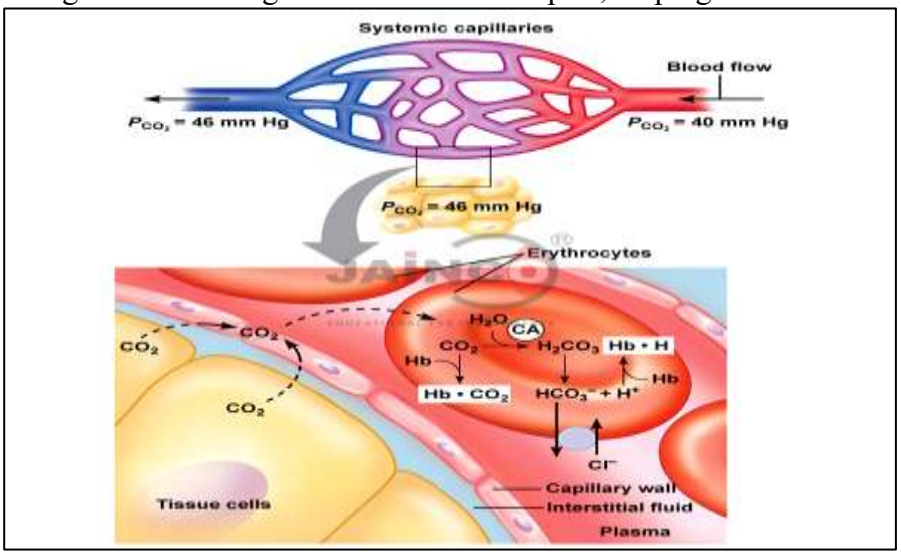

(16) Answer: D. Weak acid = conjugate base
Explanation:
A buffer exhibits maximum buffering capacity when the concentrations of the weak acid and its conjugate base are equal. Under this condition, the pH equals the pKa of the buffer system.

(17) Answer: D. Bicarbonate buffer
Explanation:
The bicarbonate buffer system is the major extracellular buffer in the body and plays a crucial role in maintaining blood pH through interactions with the respiratory and renal systems.

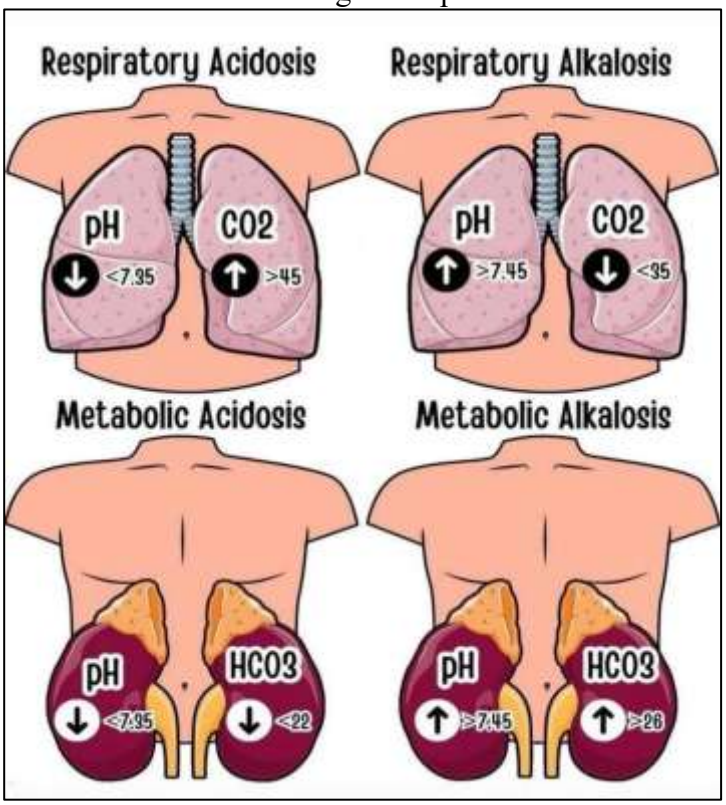



(18) Answer: D. Hemoglobin buffer
Explanation:
Hemoglobin is the most important buffer within erythrocytes because it can bind hydrogen

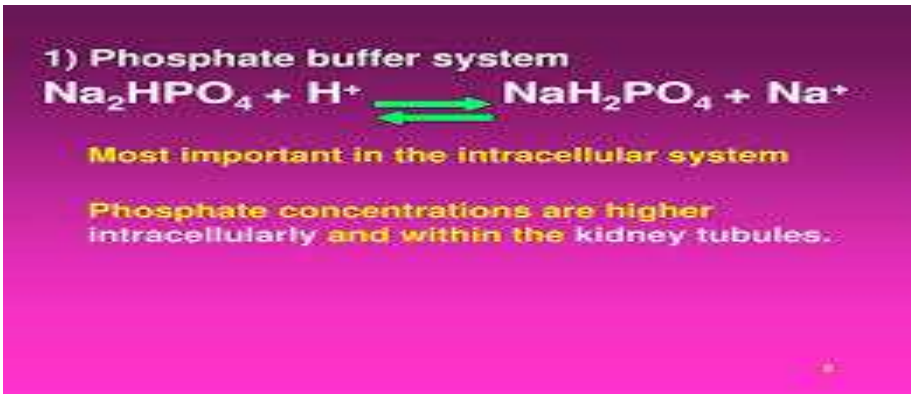
ions generated during carbon dioxide transport, helping to maintain acid-base balance.



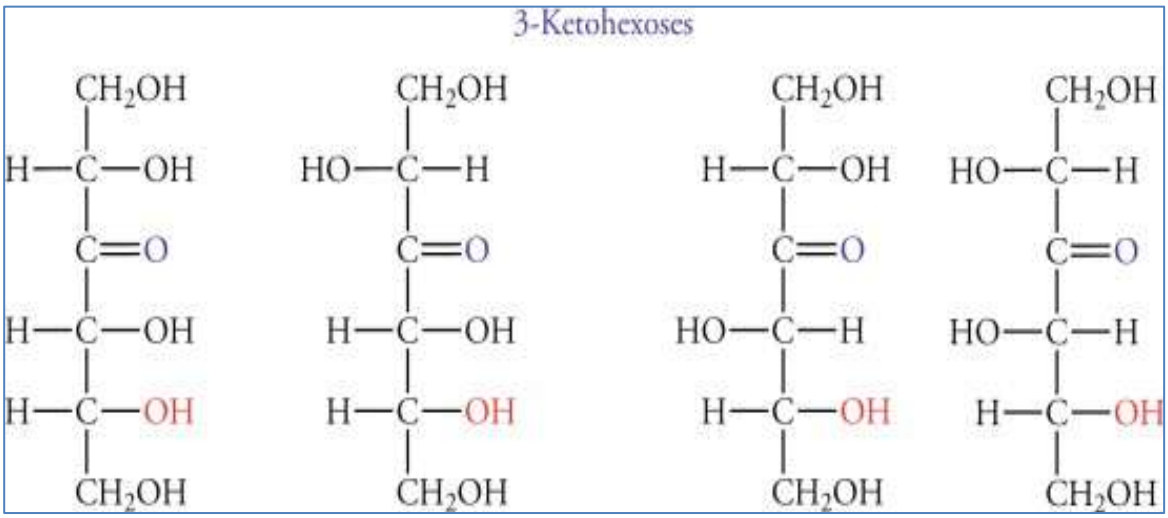

(19) Answer: C. Increased $CO_2$ retention
Explanation:
Respiratory acidosis results from inadequate removal of carbon dioxide by the lungs. Retained $CO_2$ combines with water to form carbonic acid, increasing hydrogen ion concentration and lowering blood pH.



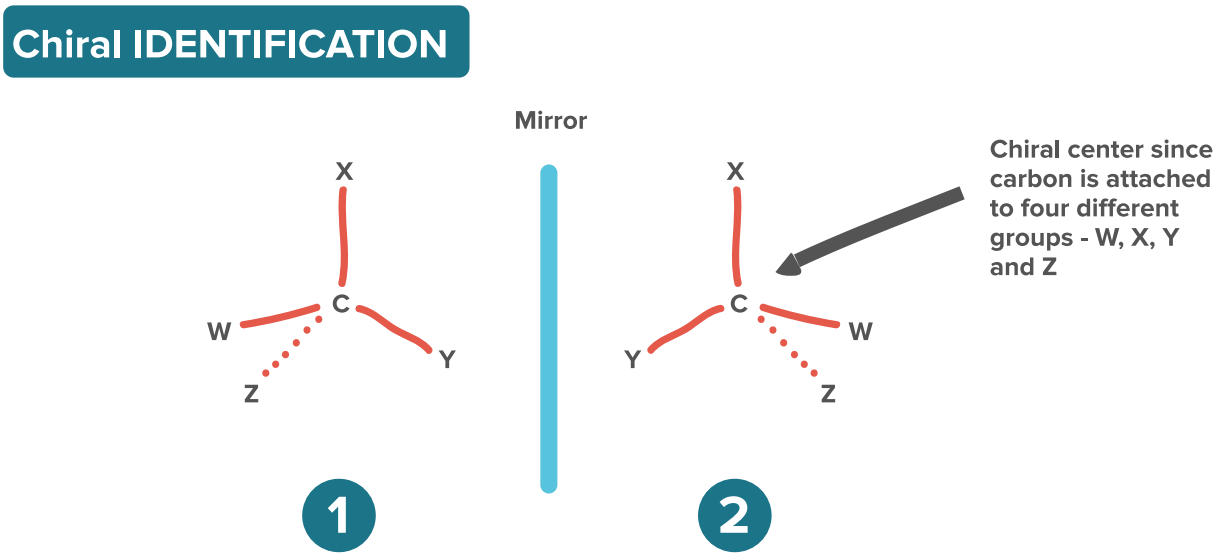

(20) Answer: D. Phosphate buffer
Explanation:
The phosphate buffer system is particularly important in urine, where it helps excrete excess hydrogen ions and contributes to acid-base regulation.



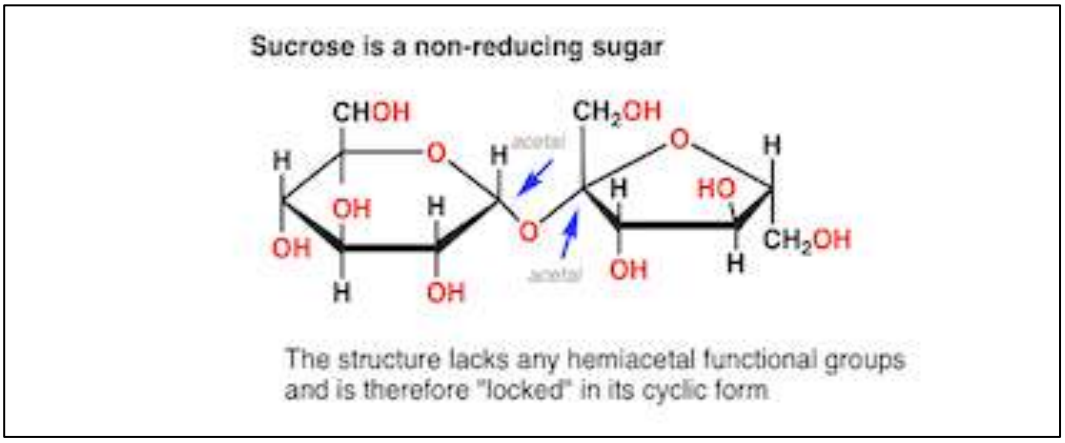

(21) Answer: D. Fructose
Explanation:
Fructose is a ketohexose because it contains a ketone group and six carbon atoms. Glucose, galactose, and mannose are aldohexoses, while ribose is a pentose sugar.



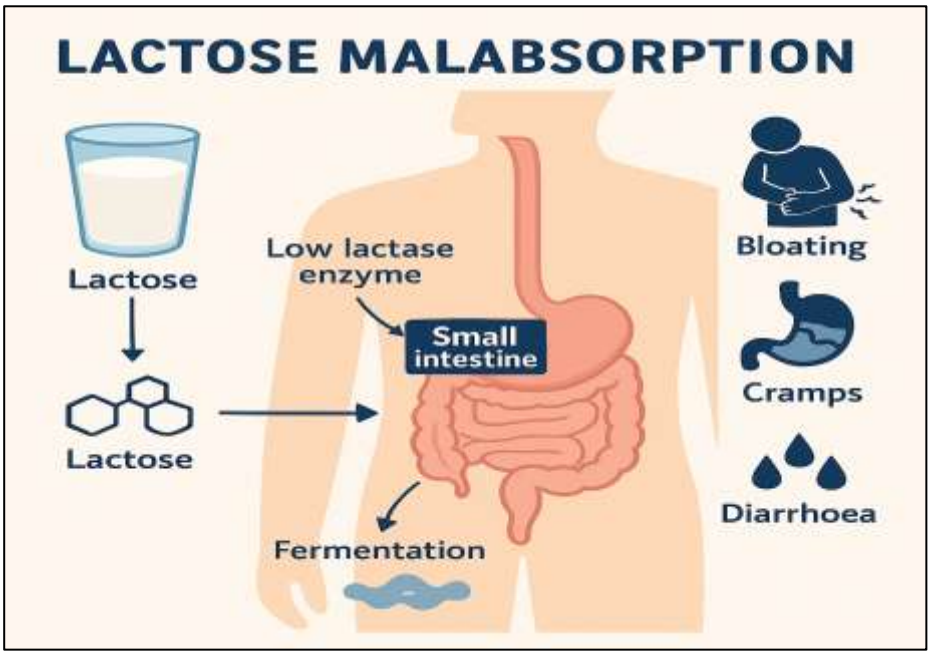

(22) Answer: C. Chiral carbon
Explanation:
Optical activity arises from the presence of chiral carbon atoms that allow molecules to exist as stereoisomers capable of rotating plane-polarized light.



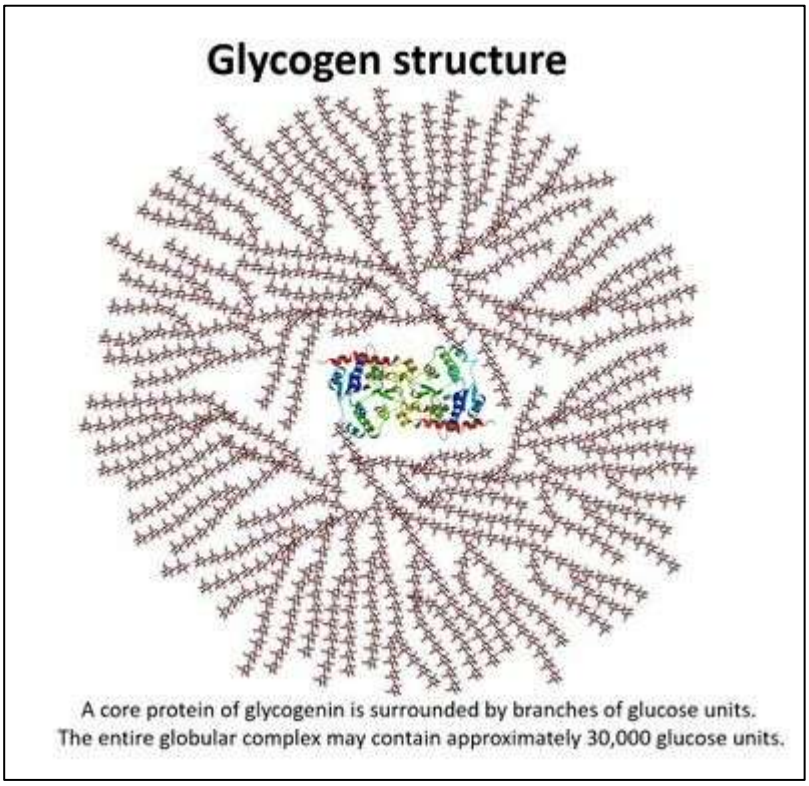
(23) Answer: E. Sucrose
Explanation:
Sucrose is a non-reducing sugar because both anomeric carbons are involved in the glycosidic bond, preventing it from acting as a reducing agent.




(24) Answer: D. Lactase
Explanation:
Lactose intolerance occurs due to deficiency of the enzyme lactase, which is responsible for hydrolyzing lactose into glucose and galactose in the small intestine.

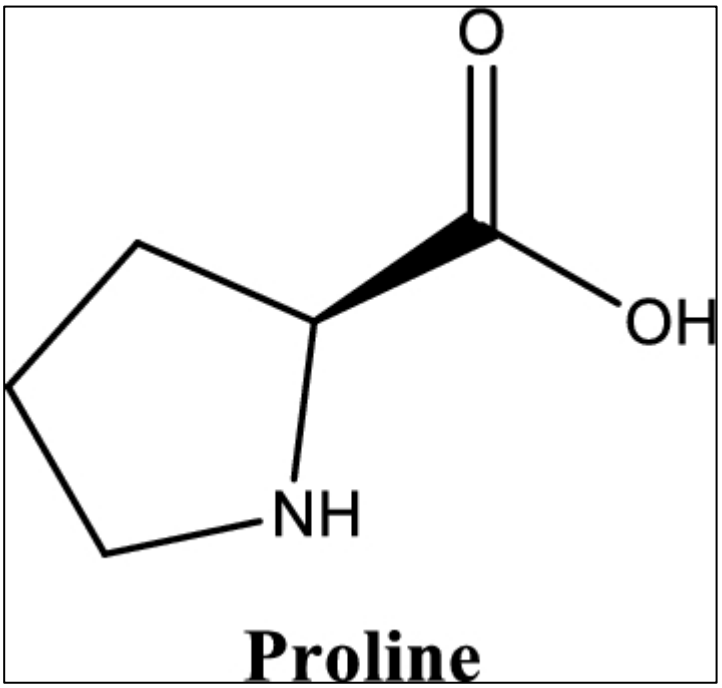



(25) Answer: C. Highly branched
Explanation:
Glycogen is more highly branched than amylopectin. The increased branching allows rapid release and storage of glucose molecules.

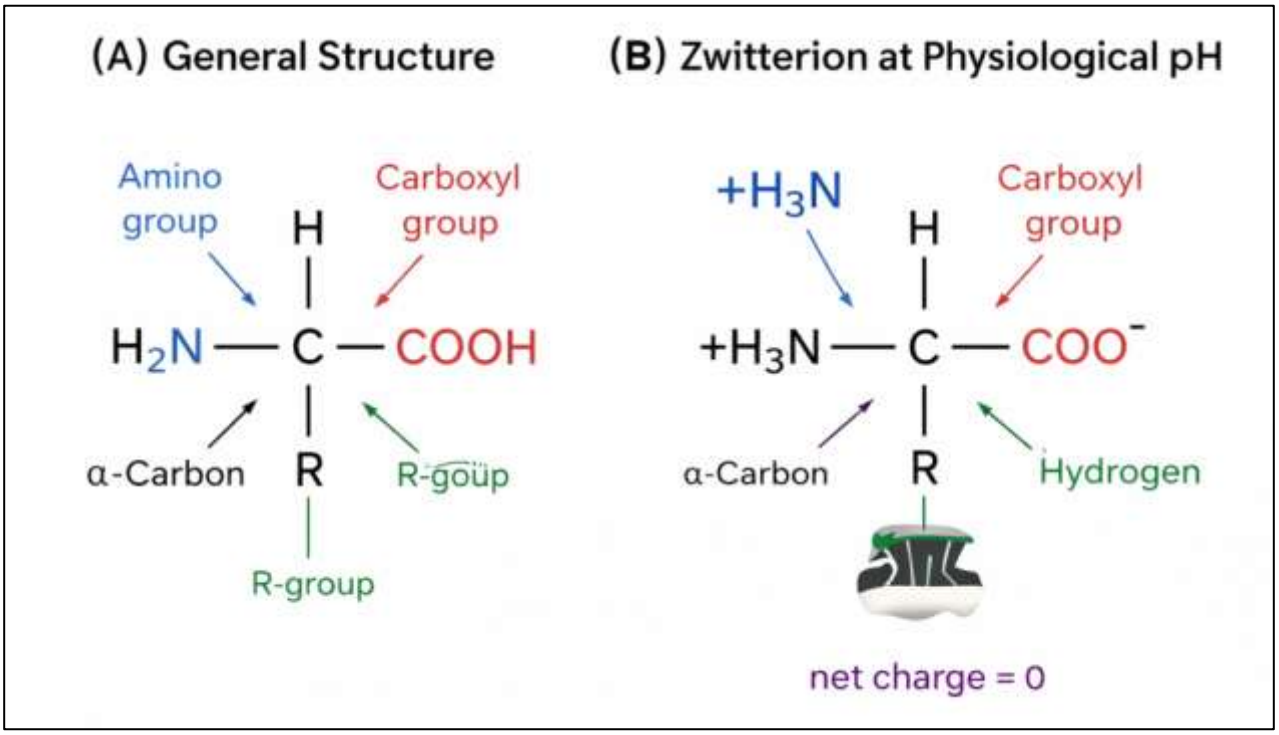



(26) Answer: C. Humans lack cellulase enzyme
Explanation:
Humans cannot digest cellulose because they lack cellulase, the enzyme required to break the β(1→4) glycosidic bonds present in cellulose.

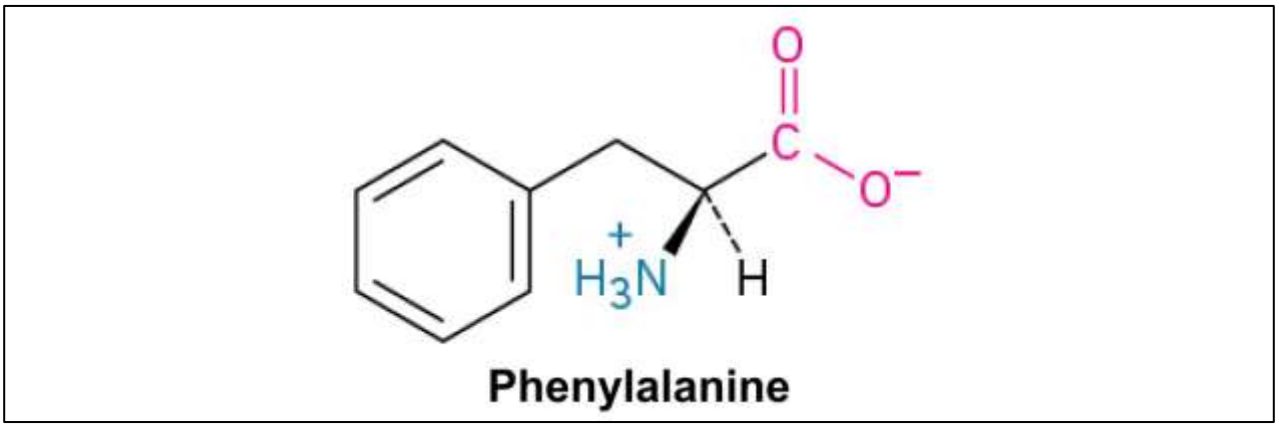
(27) Answer: C. Proline
Explanation:
Proline is unique among amino acids because its amino group is incorporated into a ring structure, making it a secondary amino group and earning the designation "imino acid."



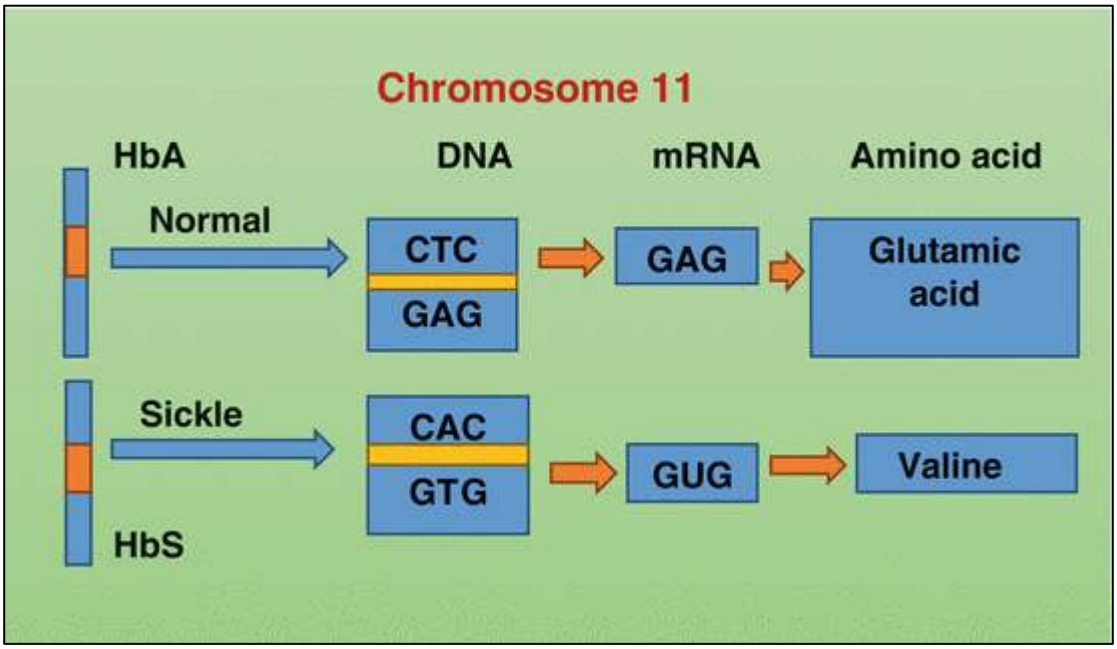
(28) Answer: B. Carboxyl is dissociated (negative), Amino is protonated (positive).
Explanation:
At physiological pH, amino acids predominantly exist as zwitterions. The carboxyl group carries a negative charge while the amino group carries a positive charge.



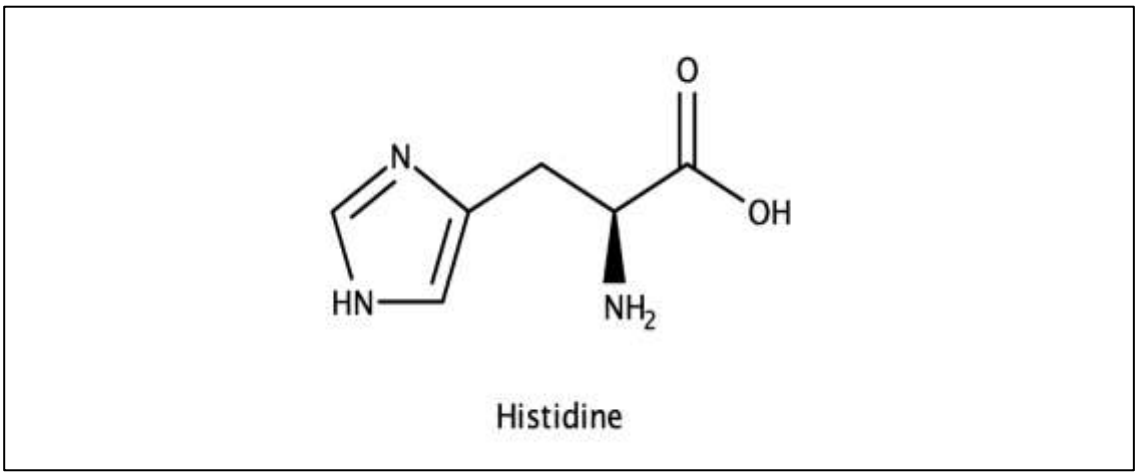

(29) Answer: C. Phenylalanine
Explanation:
Phenylalanine contains a hydrophobic benzyl side chain and is classified as a nonpolar aromatic amino acid.




(30) Answer: C. Valine
Explanation:
Sickle cell anemia results from a mutation in the β-globin chain where glutamate is replaced by valine at position six. This substitution promotes abnormal hemoglobin aggregation under low oxygen conditions.

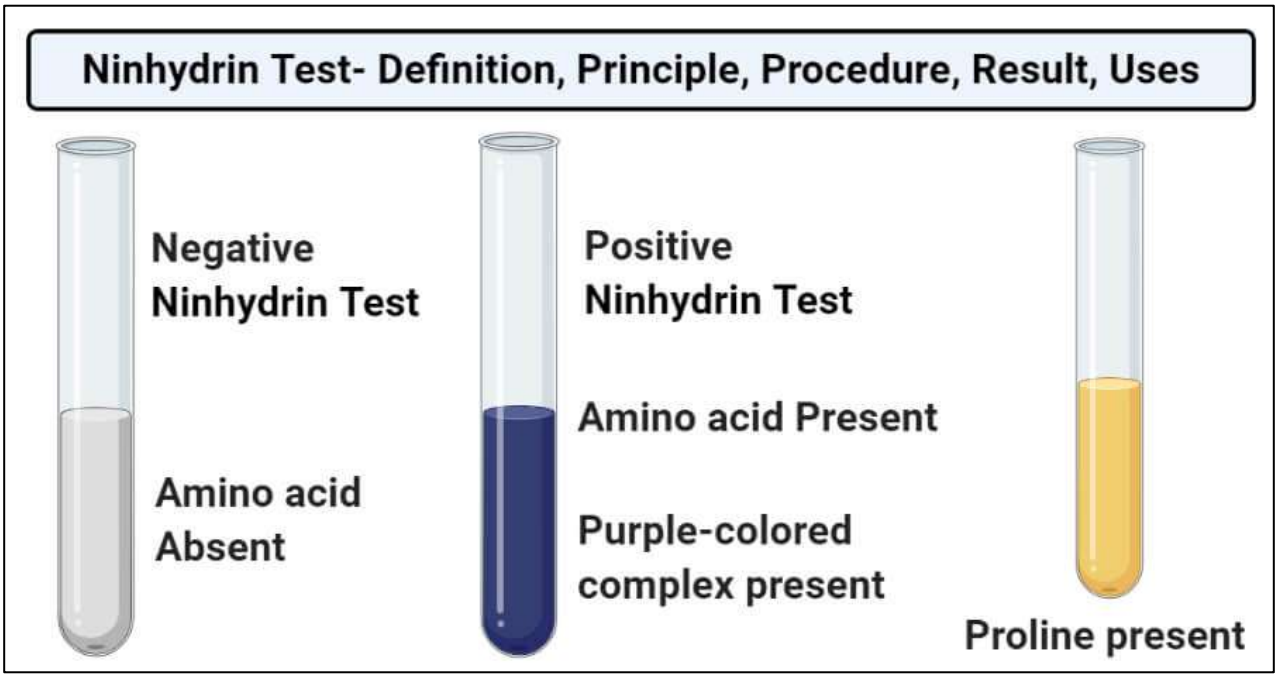



(31) Answer: C. Histidine
Explanation:
Histidine contains an imidazole side chain with a pKa close to physiological pH, allowing it to accept or donate protons and function effectively as a biological buffer.

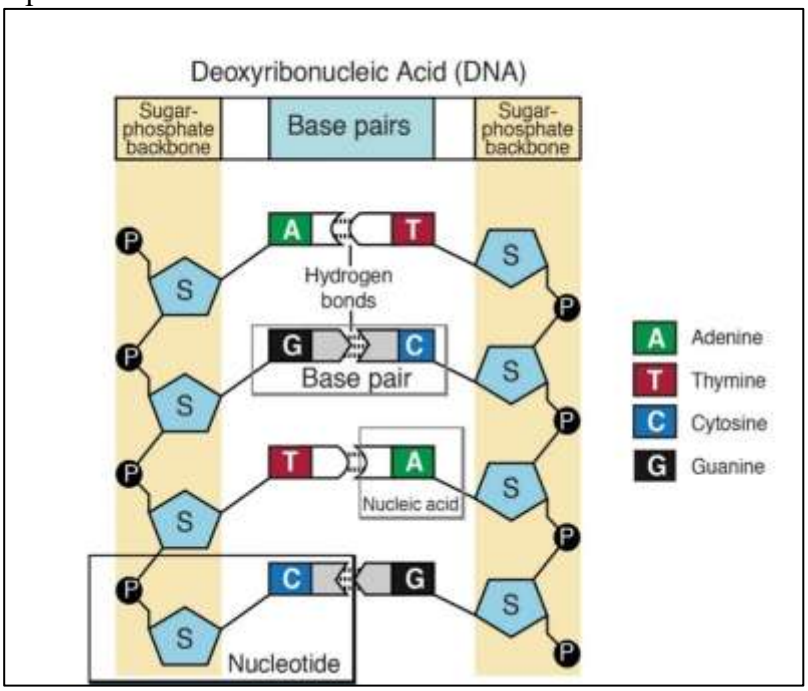



(32) Answer: C. It has a partial double bond character and is rigid/planar
Explanation:
The peptide bond exhibits resonance, giving it partial double bond character. This restricts rotation and results in a rigid, planar structure that is important for protein conformation.

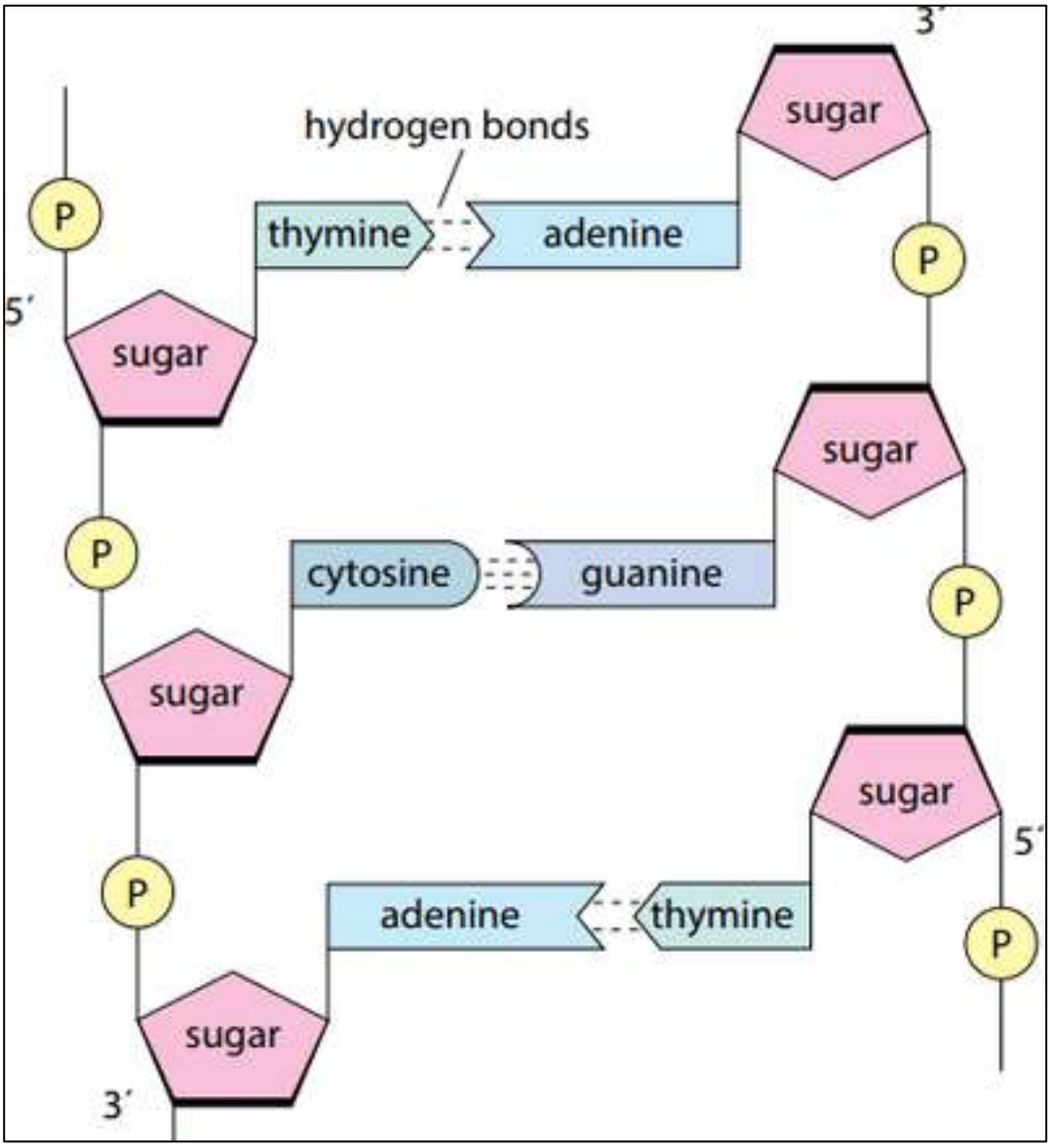
(33) Answer: C. Ninhydrin
Explanation:
Ninhydrin reacts with free amino groups of amino acids to produce a purple-colored compound known as Ruhemann's purple. The intensity of the color is proportional to the amino acid concentration and can be measured spectrophotometrically.




(34) Answer: E. DNA strands are antiparallel
Explanation:
DNA consists of two polynucleotide strands running in opposite directions, one in the 5′→3′ direction and the other in the 3′→5′ direction. This antiparallel arrangement is essential for replication and other DNA functions.




(35) Answer: C. A – T
Explanation:
In DNA, adenine pairs specifically with thymine through two hydrogen bonds, while guanine pairs with cytosine through three hydrogen bonds. This complementary base pairing maintains DNA stability.



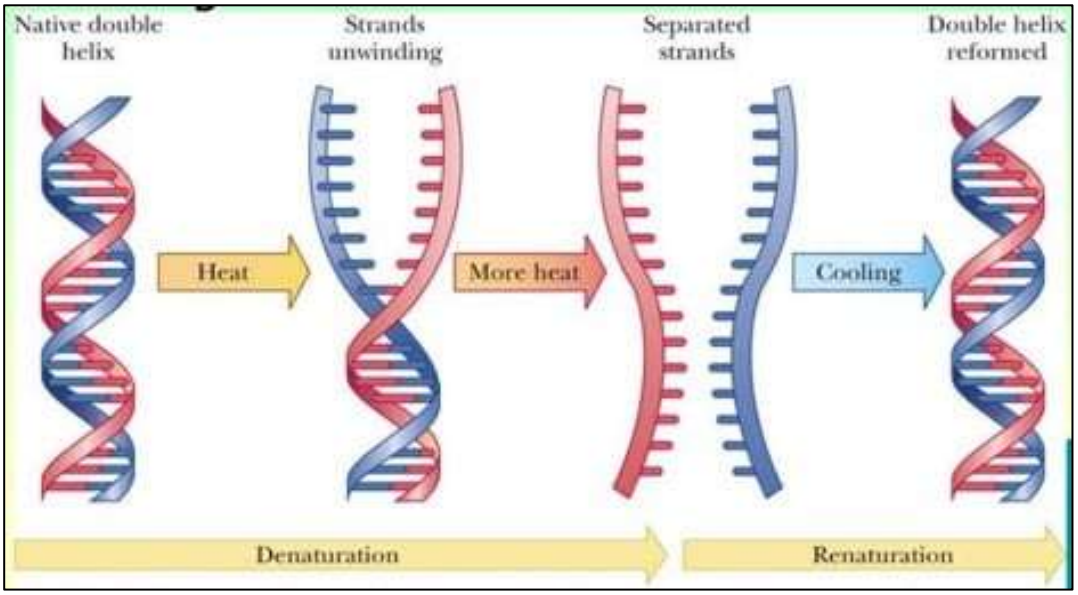

(36) Answer: D. Adenine
Explanation:
Adenine and guanine are purine bases, characterized by a double-ring structure. Cytosine, thymine, and uracil are pyrimidines with a single-ring structure.

(37) Answer: C. Phosphodiester bond
Explanation:
Adjacent nucleotides in a nucleic acid chain are linked by phosphodiester bonds formed between the phosphate group and the sugar molecules of neighboring nucleotides.

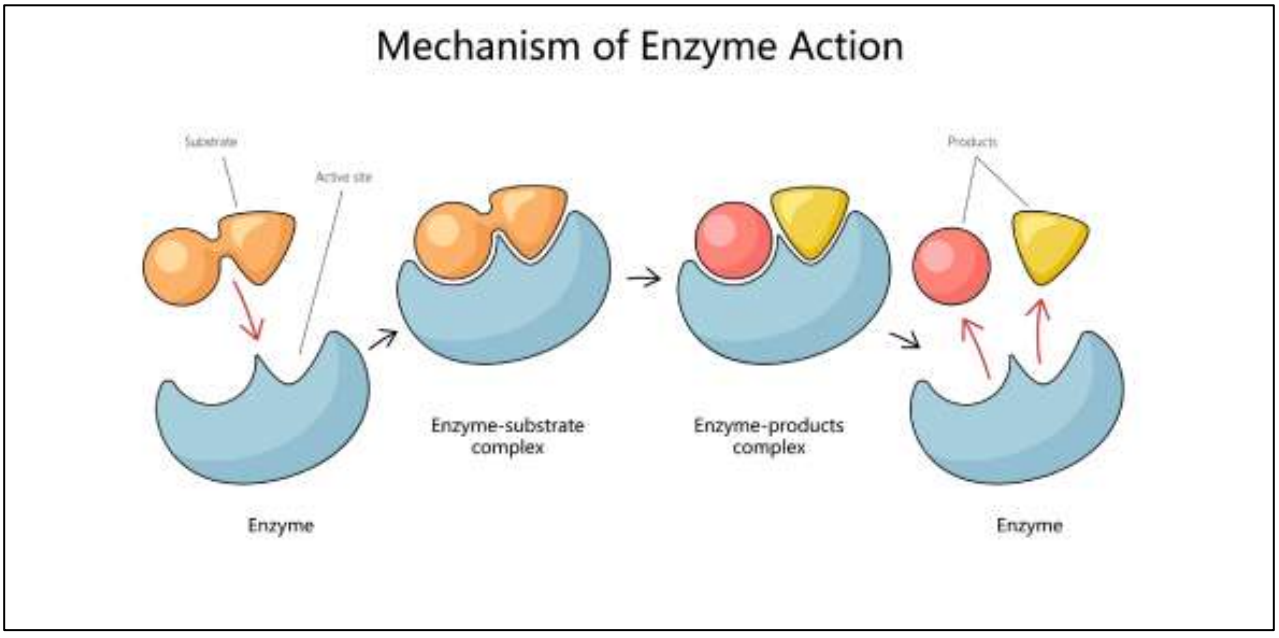
(38) Answer: D. High GC content
Explanation:
DNA regions with high guanine-cytosine content have more hydrogen bonds and stronger base stacking interactions, making them more resistant to denaturation and increasing the melting temperature.

(39) Answer: B. Breaking hydrogen bonds.
Explanation:
DNA denaturation involves disruption of the hydrogen bonds that hold complementary

strands together. The phosphodiester backbone remains intact during this process.

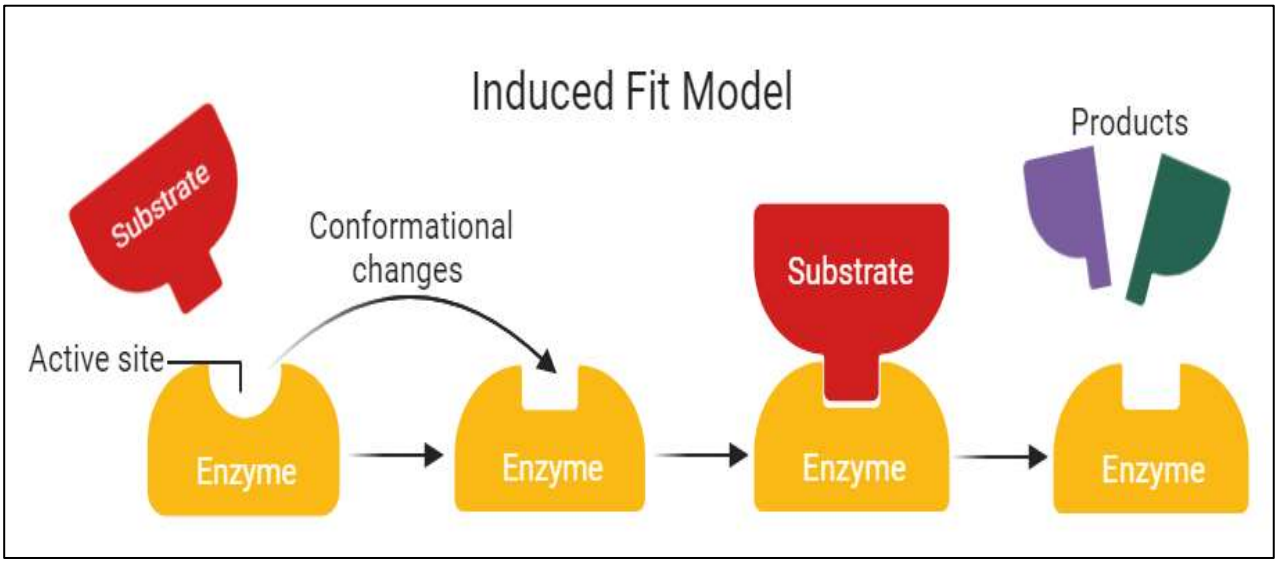



(40) Answer: D. Enzymes increase the rate of reaction without being consumed.
Explanation:
Enzymes are biological catalysts that accelerate chemical reactions by lowering activation energy. They are not consumed during the reaction and can be reused repeatedly.

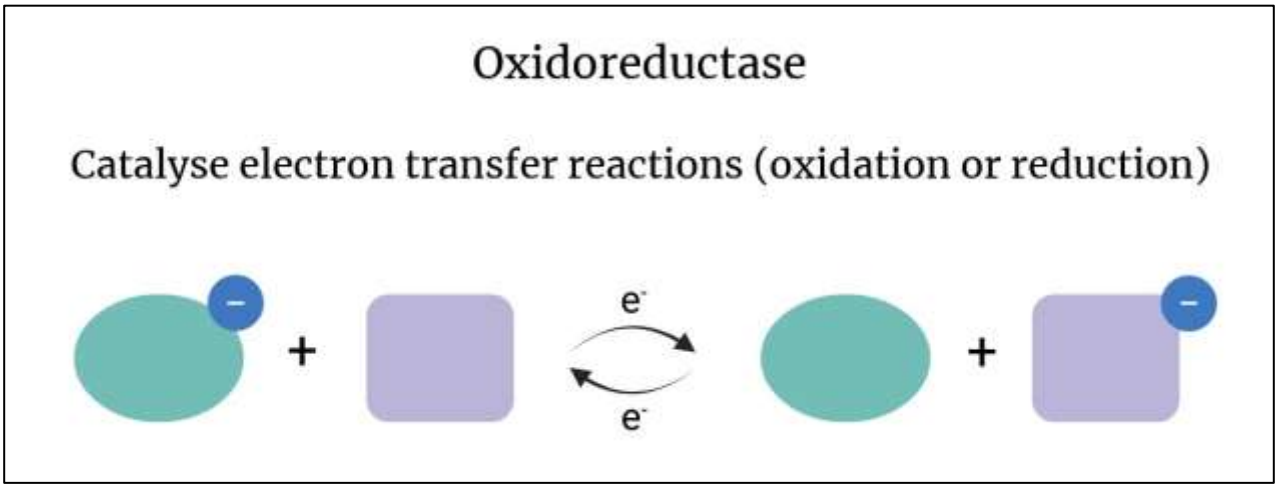



(41) Answer: C. A site where substrate binding and catalysis occur.
Explanation:
The active site is a specialized region of an enzyme where substrate molecules bind and undergo chemical transformation. Its specific structure determines enzyme specificity.

(42) Answer: C. Induced fit model
Explanation:
According to the induced fit model, substrate binding causes a conformational change in the enzyme that improves the fit between the enzyme and substrate, enhancing catalysis.

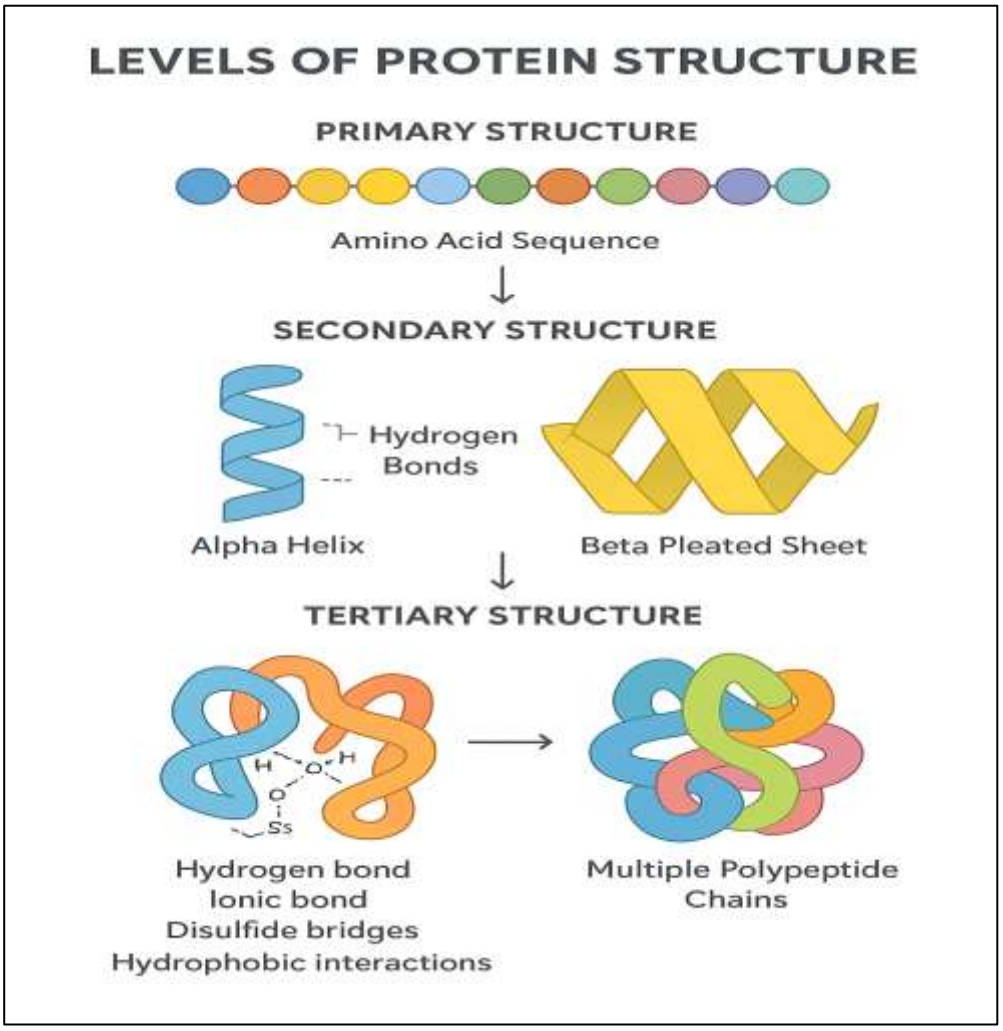



(43) Answer: D. Oxidoreductases
Explanation:
Oxidoreductases catalyze oxidation-reduction reactions involving the transfer of electrons or hydrogen atoms between molecules.



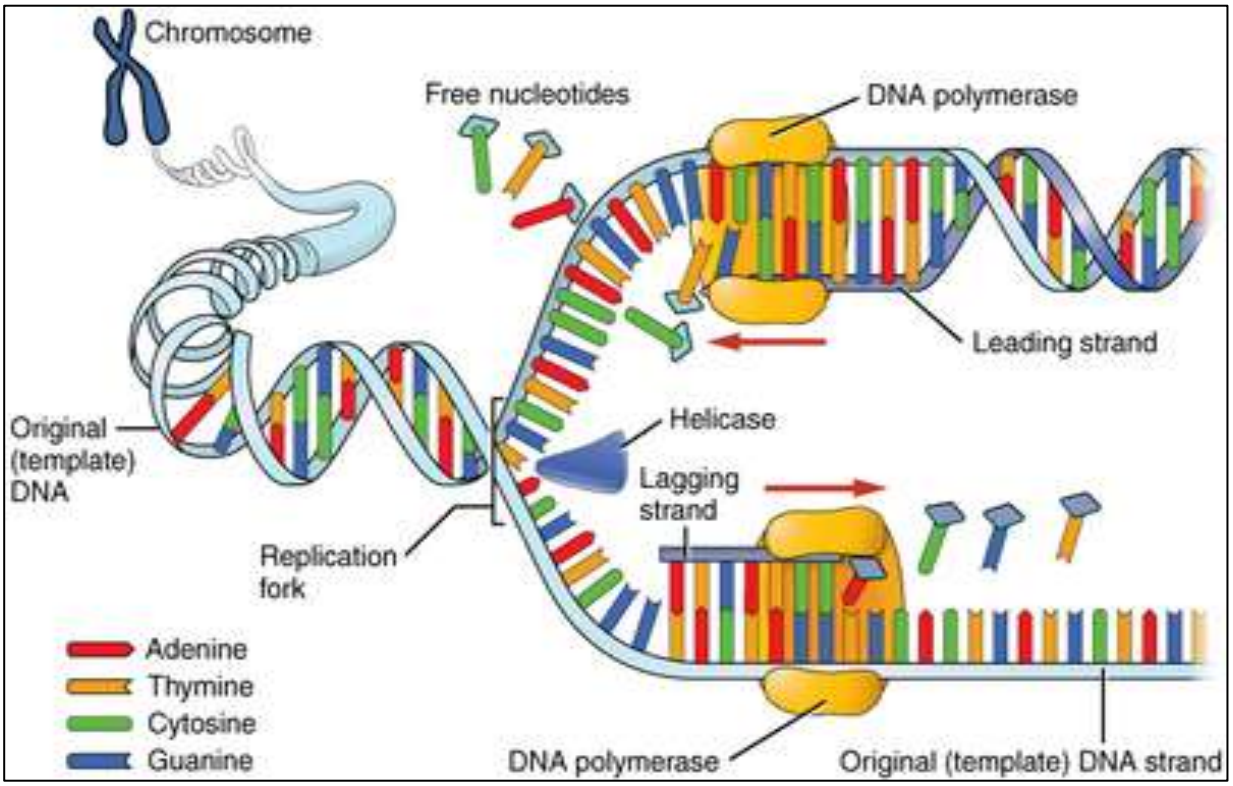

(44) Answer: D. Enzymes show substrate and reaction specificity.
Explanation:
Enzymes are highly specific catalysts. They typically act on particular substrates and catalyze specific types of chemical reactions due to the unique structure of their active sites.

(45) Answer: B. Sequence of amino acids linked by peptide bonds.
Explanation:
The primary structure of a protein refers to the linear sequence of amino acids connected by peptide bonds. This sequence determines higher levels of protein structure and function.




(46) Answer: D. Enzymes – Biocatalysts
Explanation:
Enzymes function as biological catalysts that accelerate biochemical reactions. Hemoglobin transports oxygen, insulin is a hormone, collagen is a structural protein, and actin contributes to cell movement and structure.

(47) Answer: B. One strand is parental and one is newly synthesized
Explanation:
DNA replication is described as semiconservative because each daughter DNA molecule contains one original parental strand and one newly synthesized strand.



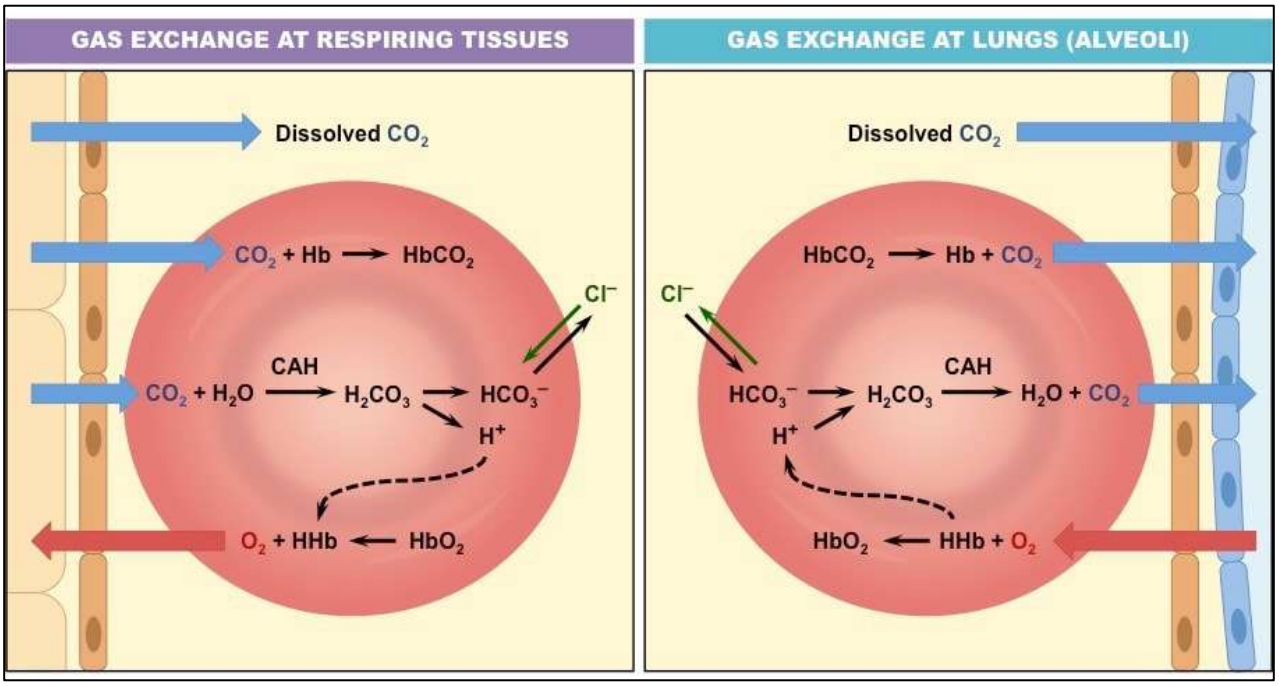

(48) Answer: C. Helicase
Explanation:
Helicase unwinds the DNA double helix by breaking the hydrogen bonds between complementary base pairs, creating replication forks for DNA synthesis.

(49) Answer: B. Lagging strand synthesis
Explanation:
Okazaki fragments are short DNA segments synthesized discontinuously on the lagging strand because DNA polymerase can synthesize DNA only in the 5′→3′ direction.

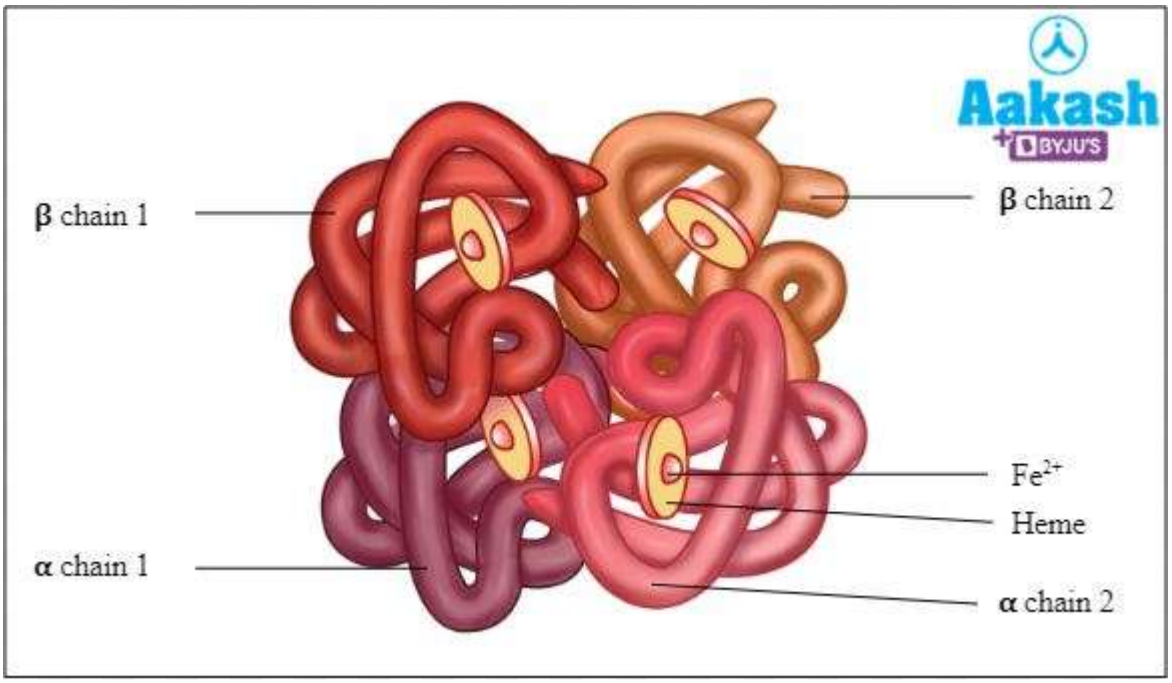
(50) Answer: C. Synthesizes RNA in 5’ → 3’ direction
Explanation:
RNA polymerase synthesizes RNA molecules by adding ribonucleotides in the 5′→3′ direction using a DNA template. Unlike DNA polymerase, it does not require a primer.

(51) Answer: C. 5’ capping
Explanation:
The addition of a 7-methylguanosine cap to the 5′ end of mRNA protects the molecule from degradation and facilitates ribosome recognition during translation initiation.

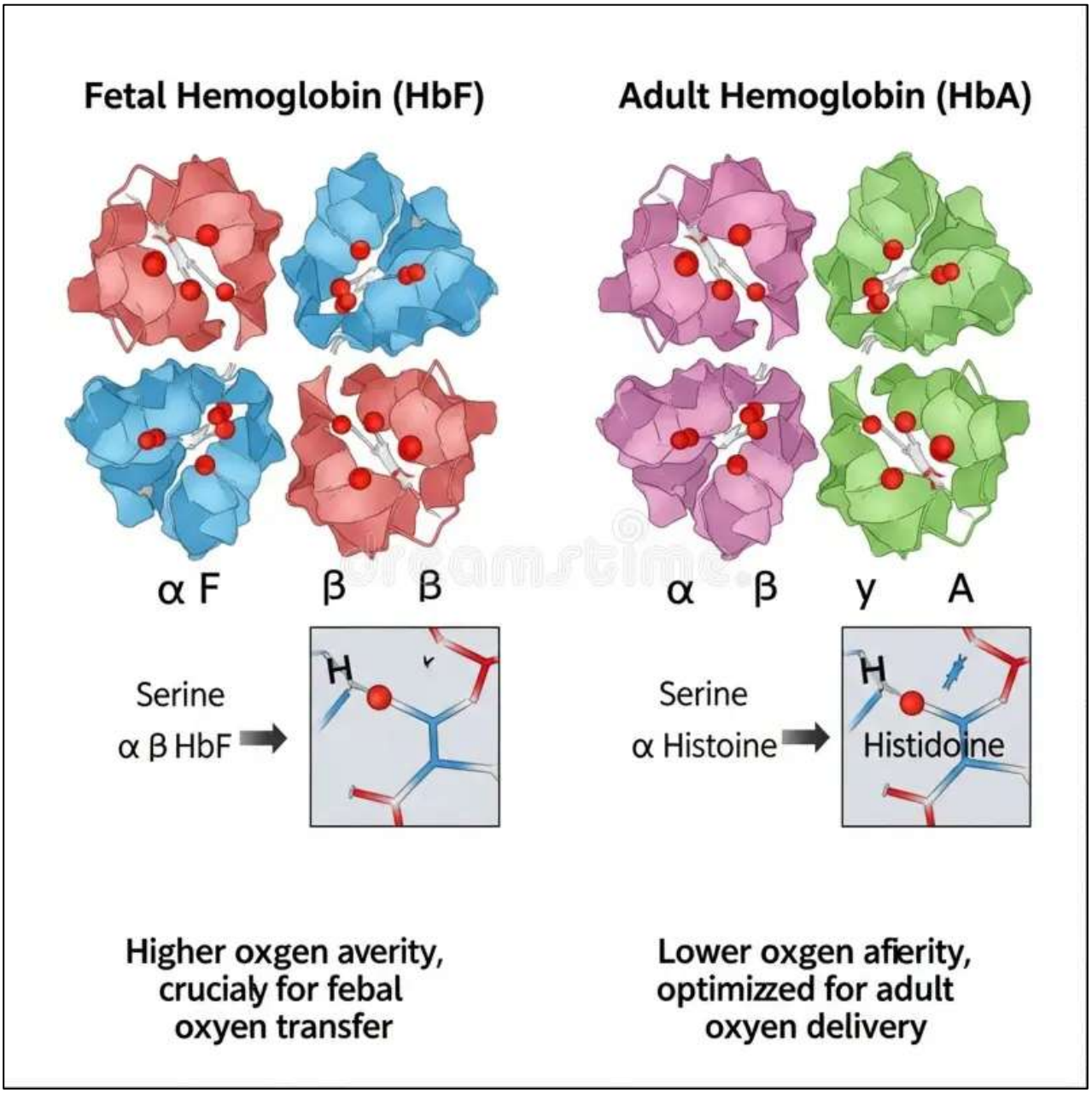
(52) Answer: C. Transport oxygen from lungs to tissues
Explanation:
The primary function of hemoglobin is to transport oxygen from the lungs to body tissues. It also contributes to carbon dioxide transport and buffering of blood pH.



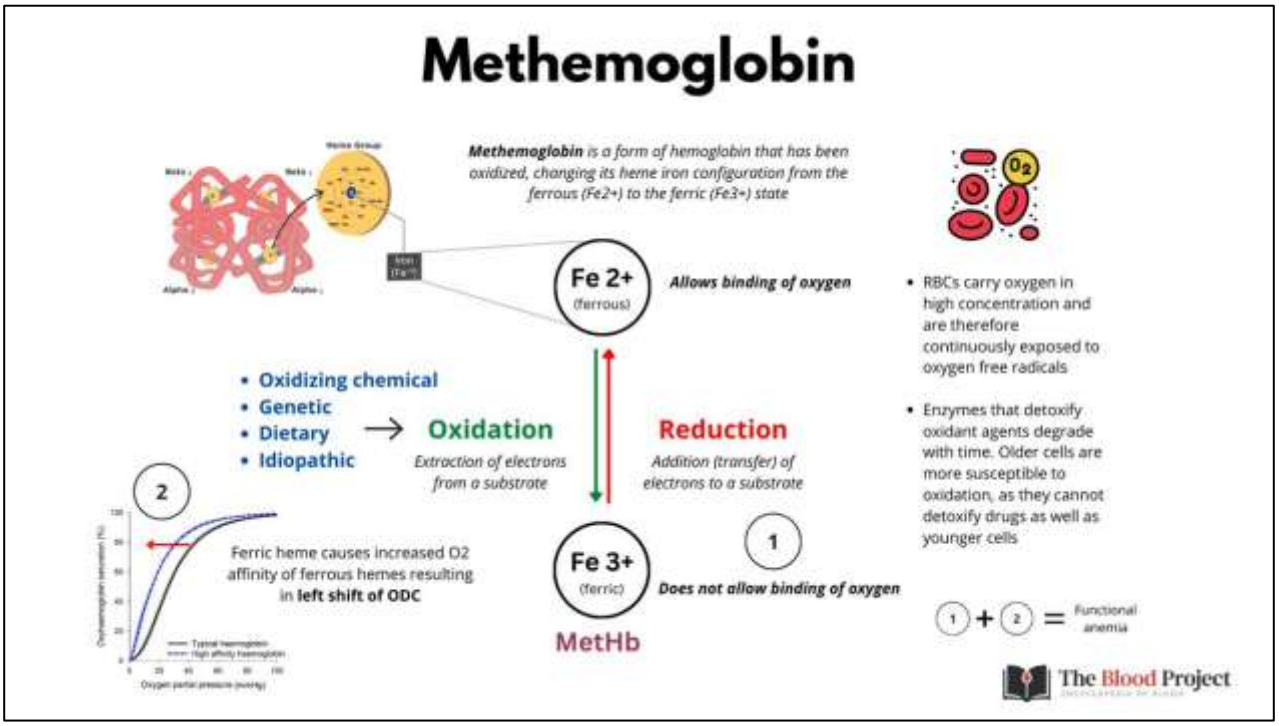

(53) Answer: B. $\alpha_2\beta_2$
Explanation:
Normal adult hemoglobin (HbA) consists of two alpha (α) chains and two beta (β) chains. This is the predominant hemoglobin form in healthy adults.



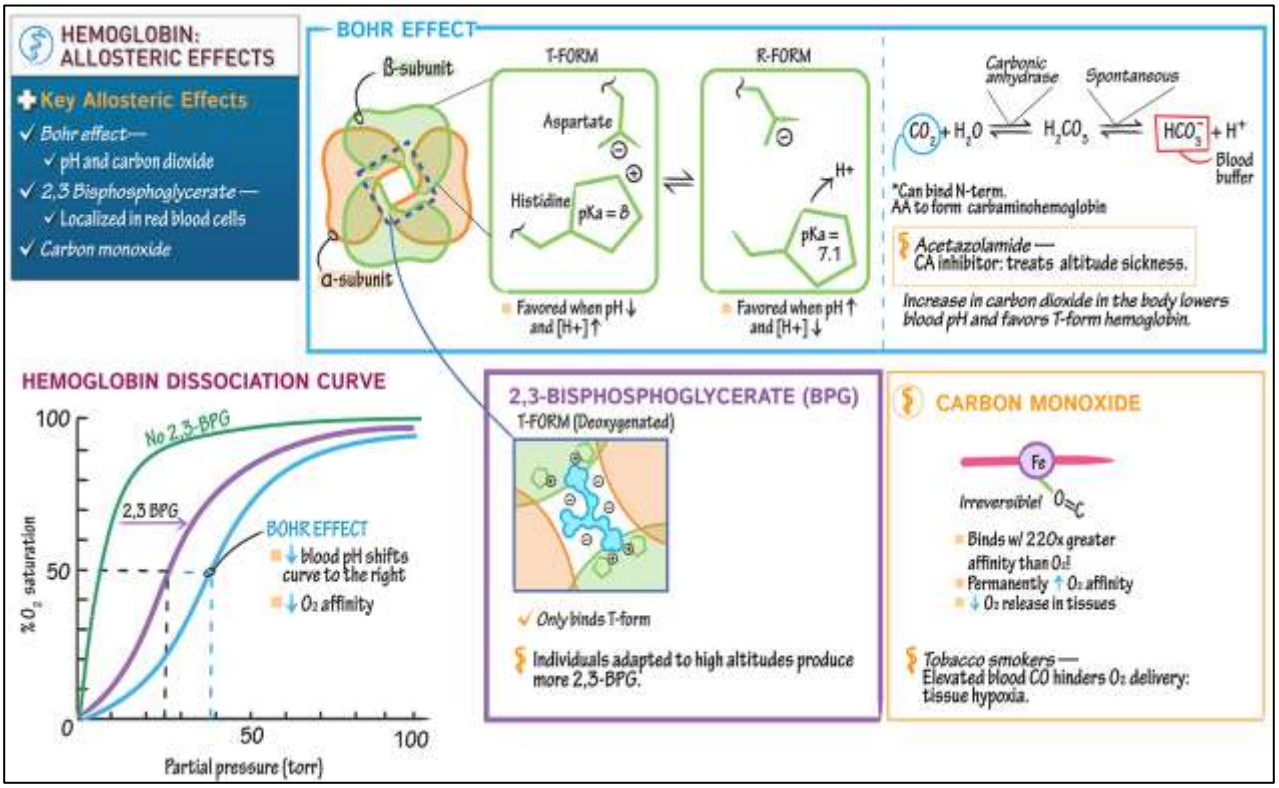

(54) Answer: C. $\alpha_2\gamma_2$
Explanation:
Fetal hemoglobin (HbF) contains two alpha (α) chains and two gamma (γ) chains. HbF has a higher affinity for oxygen than adult hemoglobin, facilitating oxygen transfer from mother to fetus.




(55) Answer: B. Ferrous ($Fe^{2+}$) state
Explanation:
Functional hemoglobin contains iron in the ferrous ($Fe^{2+}$) state, which can reversibly bind oxygen. Oxidation to the ferric ($Fe^{3+}$) state forms methemoglobin, which cannot effectively bind oxygen.




(56) Answer: B. 2,3-Bisphosphoglycerate
Explanation:
2,3-Bisphosphoglycerate (2,3-BPG) binds to deoxygenated hemoglobin and decreases its affinity for oxygen. This promotes oxygen release from hemoglobin to peripheral tissues, enhancing oxygen delivery.



# COURSE 1- CELL BIOCHEMISTRY

# TUTORIALS & ANSWERS

# Tutorial 1 – Cell Structure and Function Questions

**(1) True or False Regarding Nuclear Envelope and Nuclear Components?**

(A) The nuclear envelope is composed of a single membrane.
(B) The nuclear pore complex is the only regulated gateway between the nucleus and cytoplasm.
(C) The outer nuclear membrane is continuous with the endoplasmic reticulum.
(D) The nuclear lamina is mainly composed of actin filaments.
(E) The nuclear envelope shows selective permeability.

**(2) True or False Regarding Prokaryotic Cell Structure and Function?**

(A) Prokaryotic DNA is linear and associated with histone proteins.
(B) Prokaryotic ribosomes are 80S in size.
(C) The prokaryotic plasma membrane is a phospholipid bilayer.
(D) Prokaryotic cells do not possess a rigid cell wall.
(E) Translation in prokaryotes occurs within a membrane-bound nucleus.

**(3) True or False Regarding Mitochondria?**

(A) Glycolysis occurs inside mitochondria.
(B) Mitochondria contain circular DNA but do not encode all their proteins.
(C) The inner mitochondrial membrane is freely permeable to ions.
(D) Oxidative phosphorylation occurs on the inner mitochondrial membrane.
(E) An intermembrane space is present between the outer and inner mitochondrial membranes.

**(4) True or False Regarding Lysosomes?**

(A) Lysosomal enzymes function optimally at an acidic pH.
(B) Lysosomal storage diseases result from defective degradation of macromolecules.
(C) Lysosomes are the main site of protein synthesis.
(D) The lysosomal membrane protects the cytosol from acid hydrolases.
(E) Lysosomal enzymes are most active at neutral pH.

**(5) True or False Regarding the Golgi Apparatus?**

(A) The Golgi modifies proteins and lipids before secretion.
(B) The trans-Golgi network is the main receiving face of the Golgi.
(C) The Golgi apparatus is directly involved in glycolysis.
(D) The cis-Golgi network functions as the entry face of the Golgi.
(E) The Golgi synthesizes ribosomal RNA.

**(6) True or False Regarding Ribosomes?**

(A) Free ribosomes synthesize proteins destined for the nucleus, cytosol, and mitochondria.
(B) Ribosomes are composed of ribosomal RNA and proteins.
(C) Eukaryotic ribosomes consist of 60S and 40S subunits.
(D) Ribosomes are involved in lipid synthesis.
(E) Ribosomes bound to the rough ER synthesize cytoskeletal proteins.

**(7) True or False Regarding the Cytoskeleton?**

(A) Actin filaments are composed of tubulin subunits.
(B) Microtubules participate in vesicle transport and mitotic spindle formation.
(C) Intermediate filaments are highly dynamic structures.
(D) Actin filaments are found only in the nucleus.
(E) Cytoskeletal elements interact with organelles.

**(8) True or False Regarding the Plasma Membrane?**

(A) The plasma membrane consists of a phospholipid bilayer with embedded proteins.
(B) Large polar molecules diffuse freely across the membrane.
(C) Integral membrane proteins facilitate transport.
(D) Cholesterol reduces membrane fluidity at high temperatures.
(E) Membrane proteins can function as receptors.

**(9) True or False Regarding Peroxisomes?**

(A) Peroxisomes contain their own DNA.
(B) Peroxisomes are the main site of protein synthesis.
(C) Peroxisomes participate in fatty acid β-oxidation.
(D) Peroxisomes generate ATP by oxidative phosphorylation.
(E) Peroxisomal proteins are synthesized on free ribosomes and imported post-translationally.

**(10) True or False Regarding the Endoplasmic Reticulum?**

(A) The rough endoplasmic reticulum synthesizes steroid hormones.
(B) The smooth endoplasmic reticulum is involved in lipid metabolism and calcium storage.
(C) The smooth endoplasmic reticulum is studded with ribosomes.
(D) The rough endoplasmic reticulum synthesizes secretory and membrane proteins.
(E) The endoplasmic reticulum contributes to cellular detoxificatio

# Tutorial 1- Cell Structure and Function Answers

(1) Answer – FTTFT

Explanation - The nuclear envelope is a double membrane structure that separates the nucleus from the cytoplasm. Nuclear pore complexes regulate molecular transport between the nucleus and cytoplasm. The outer nuclear membrane is continuous with the endoplasmic reticulum, while the nuclear lamina is composed of lamins (intermediate filament proteins), not actin. The nuclear envelope exhibits selective permeability through nuclear pores.

(2) Answer – FFTFF

Explanation - Prokaryotes possess circular DNA and 70S ribosomes. Their plasma membrane is a phospholipid bilayer, and most have a rigid cell wall composed of peptidoglycan. Since prokaryotes lack a membrane-bound nucleus, transcription and translation occur in the cytoplasm.

(3) Answer – FTFTT

Explanation - Mitochondria are double-membraned organelles responsible for ATP production. They contain circular DNA but rely on nuclear genes for most of their proteins. Glycolysis occurs in the cytosol, whereas oxidative phosphorylation takes place on the inner mitochondrial membrane. The inner membrane is highly impermeable to ions and encloses an intermembrane space.

(4) Answer – TTFTF

Explanation - Lysosomes contain acid hydrolases that function optimally at an acidic pH. They degrade intracellular macromolecules, and defects in lysosomal enzymes cause storage diseases. Protein synthesis occurs on ribosomes, not lysosomes. The lysosomal membrane protects the cytoplasm from digestive enzymes.

(5) Answer – TFFTF

Explanation - The Golgi apparatus modifies, sorts, and packages proteins and lipids. Proteins enter through the cis-Golgi network and leave through the trans-Golgi network. Glycolysis occurs in the cytosol, while ribosomal RNA synthesis occurs in the nucleolus rather than the Golgi apparatus.

(6) Answer – TTTFF

Explanation - Ribosomes are composed of ribosomal RNA and proteins and are responsible for protein synthesis. Eukaryotic ribosomes consist of 60S and 40S subunits. Free ribosomes synthesize proteins destined for the cytosol, nucleus, and mitochondria, whereas rough ER-bound ribosomes synthesize secretory, lysosomal, and membrane proteins. Lipid synthesis mainly occurs in the smooth ER.

(7) Answer – FTFFT

Explanation - The cytoskeleton consists of actin filaments, microtubules, and intermediate filaments. Actin filaments are made of actin, whereas microtubules are composed of tubulin and function in intracellular transport and mitosis. Intermediate filaments provide structural support and are relatively stable. Cytoskeletal elements interact with and help position cellular organelles.

(8) Answer – TFTTT

Explanation - The plasma membrane is a phospholipid bilayer containing proteins and cholesterol. Large polar molecules cannot diffuse freely across the membrane and require transport proteins. Integral membrane proteins function as channels, carriers, pumps, and receptors. Cholesterol helps regulate membrane fluidity, particularly at high temperatures.

(9) Answer – FFTFT

Explanation - Peroxisomes are involved in fatty acid oxidation and detoxification reactions. They do not contain their own DNA and do not synthesize proteins. Peroxisomal proteins are synthesized on free ribosomes in the cytosol and imported into the organelle after translation. ATP generation by oxidative phosphorylation occurs in mitochondria.

(10) Answer – FTFTT

Explanation - The rough endoplasmic reticulum contains ribosomes and synthesizes secretory and membrane proteins. The smooth endoplasmic reticulum is involved in lipid synthesis, steroid hormone production, calcium storage, and detoxification of drugs and toxins. Ribosomes are absent from the smooth ER, giving it a smooth appearance.

# Tutorial 2 -Transport Across Membranes Questions

**(1) Explain the physiological basis of Oral Rehydration Therapy (ORT)?**
**(2) Describe the composition of Oral Rehydration Solution (ORS) and explain the role of sodium–glucose co-transport in rehydration?**
**(3) Why is Oral Rehydration Therapy (ORT) preferred over intravenous (IV) fluid therapy in patients with mild to moderate dehydration?**
**(4) Discuss the importance of Oral Rehydration Therapy (ORT) in low-resource settings?**
**(5) What modifications may be required in Oral Rehydration Therapy (ORT) in patients with severe electrolyte disturbances?**

# Tutorial 2 - Transport Across Membranes Answers

**(1) Explain the physiological basis of Oral Rehydration Therapy (ORT)?**

Oral rehydration therapy works by utilizing the intact sodium–glucose co-transport mechanism in the small intestine, which remains functional even during severe diarrhea. When glucose is absorbed by intestinal epithelial cells, sodium is absorbed simultaneously through co-transporters in the intestinal brush border membrane. This sodium movement creates an osmotic gradient that pulls water from the intestinal lumen into the bloodstream. Thus, ORT promotes efficient water reabsorption, correcting dehydration despite ongoing fluid loss.

**(2) Describe the composition of Oral Rehydration Solution (ORS) and explain the role of sodium–glucose co-transport in rehydration?**

A standard oral rehydration solution contains sodium chloride ($Na^+$ source), glucose, potassium chloride, citrate or bicarbonate (to correct acidosis), and clean water. Glucose and sodium enter intestinal cells together via specific transport proteins (SGLT-1). As sodium is actively absorbed, water follows passively by osmosis, leading to rapid rehydration.

**(3) Why is Oral Rehydration Therapy (ORT) preferred over intravenous (IV) fluid therapy in patients with mild to moderate dehydration?**

ORT is preferred because it is equally effective for mild to moderate dehydration, inexpensive, and easy to administer. It avoids complications associated with intravenous therapy, such as infection and electrolyte imbalance, and does not require hospital admission or trained personnel. Therefore, ORT is safer and more practical in most diarrheal cases.

**(4) Discuss the importance of Oral Rehydration Therapy (ORT) in low-resource settings?**

ORT has dramatically reduced childhood mortality from diarrhea because it can be administered at home, requires minimal equipment, prevents progression to severe dehydration, and is highly cost-effective. It is considered one of the most successful public health interventions worldwide.

**(5) What modifications may be required in Oral Rehydration Therapy (ORT) in patients with severe electrolyte disturbances?**

In patients with severe hyponatremia or hypernatremia, severe dehydration, or persistent vomiting, modified ORS formulations or intravenous fluids may be required. Sodium and potassium concentrations may need adjustment under medical supervision to safely correct fluid and electrolyte imbalances.

# Tutorial 3 – pH and Buffers Questions

**(1)**

**(1.1) Define pH. (20 Marks)**

**(1.2) Briefly describe how pH value is calculated using the Sorensen equation. (30 Marks)**

**(1.3) Discuss the impact of ionization of water on pH measurement. (20 Marks)**

**(1.4) Briefly describe how a weak and strong acids can be differentiated.(30 Marks)**

**(2)**

**(2.1) Provide five (05) examples of biological fluids with their respective pH ranges. (20 Marks)**

| Fluid | pH range |
|---|---|
| | |
| | |
| | |
| | |
| | |

**(2.1) Explain why maintaining pH balance is crucial for cellular functions.(30 Marks)**

**(2.1) Explain the importance of physiological pH and pH homeostasis in biological systems. (50 Marks)**

# Tutorial 3 – pH and Buffers Answers

**(1.1) Define pH. (20 Marks)**

- pH is the negative logarithm of hydrogen ion concentration. (5 Marks)
- It indicates the acidity or alkalinity of a solution. (5 Marks)
- The Sorensen equation is $pH = -\log_{10}[H^+]$. (5 Marks)
- Lower pH values indicate acidic solutions, while higher pH values indicate alkaline solutions. (5 Marks)

**(1.2) Briefly describe how pH value is calculated using the Sorensen equation. (30 Marks)**

- Sorensen introduced the concept of pH in 1909. (5 Marks)
- The equation used is $pH = -\log_{10}[H^+]$. (5 Marks)
- Determine the hydrogen ion concentration of the solution. (5 Marks)
- Calculate the logarithm (base 10) of the hydrogen ion concentration. (5 Marks)
- Change the sign of the logarithmic value to obtain the pH. (5 Marks)
- Example: If $[H^+] = 1 \times 10^{-7}$ mol/L, pH = 7. (5 Marks)

**(1.3) Discuss the impact of ionization of water on pH measurement. (20 Marks)**

- Water undergoes self-ionization to produce $H^+$ and $OH^-$ ions. (5 Marks)
- In pure water, $[H^+]$ equals $[OH^-]$. (5 Marks)
- The ionic product of water (Kw) is $1 \times 10^{-14}$ at 25°C. (5 Marks)
- The concentration of $H^+$ ions generated from water determines the pH and influences pH measurements. (5 Marks)

**(1.4) Briefly describe how weak and strong acids can be differentiated. (30 Marks)**

- Strong acids completely dissociate in water, whereas weak acids dissociate partially. (6 Marks)
- Strong acids produce a higher concentration of hydrogen ions than weak acids. (6 Marks)
- Strong acids have lower pH values than weak acids of the same concentration. (6 Marks)
- Strong acids have larger dissociation constants (Ka) than weak acids. (6 Marks)
- Examples: HCl and $H_2SO_4$ are strong acids; acetic acid and carbonic acid are weak acids. (6 Marks)

**(2.1) Provide five (05) examples of biological fluids with their respective pH ranges. (20** Marks)

- Blood: pH 7.35–7.45 (4 Marks)
- Saliva: pH 6.2–7.6 (4 Marks)
- Gastric juice: pH 1.0–3.0 (4 Marks)
- Urine: pH 4.5–8.0 (4 Marks)
- Pancreatic juice: pH 7.8–8.5 (4 Marks)

**(2.2) Explain why maintaining pH balance is crucial for cellular functions. (30 Marks)**

- Enzymes function optimally within a narrow pH range. (6 Marks)
- pH affects protein structure and biological activity. (6 Marks)
- Membrane transport processes depend on proper pH levels. (6 Marks)
- Cellular metabolism and ATP production require stable pH conditions. (6 Marks)
- Extreme pH changes can result in cellular dysfunction or death. (6 Marks)

**(2.3) Explain the importance of physiological pH and pH homeostasis in biological systems. (50 Marks)**

- Physiological pH provides optimal conditions for enzyme activity. (5 Marks)
- It maintains the normal structure and function of proteins. (5 Marks)
- It regulates metabolic and biochemical reactions. (5 Marks)
- It supports oxygen transport by hemoglobin. (5 Marks)
- It helps maintain electrolyte balance. (5 Marks)
- It is necessary for normal membrane function. (5 Marks)
- It supports nerve impulse transmission. (5 Marks)
- It is essential for muscle contraction. (5 Marks)
- It prevents acidosis and alkalosis. (5 Marks)
- Buffer systems, lungs, and kidneys help maintain pH homeostasis. (5 Marks)

# Tutorial 4 – Bioenergetics Questions

(1) Define what is the “Electron Transport Chain”. (10 Marks)
(2) What are the main components of the Electron Transport Chain, and where is it located within the cell? (30 Marks)
(3) Explain the role of electron carriers (NADH and FADH2) in the ETC. (10 Marks)
(4) How is the proton gradient established across the mitochondrial membrane, and why is it important for ATP synthesis? (20 Marks)

# Tutorial 4 – Bioenergetics Answers

**(1) Define what is the Electron Transport Chain (ETC). (10 Marks)**

- The Electron Transport Chain (ETC) is a series of electron carrier complexes that transfer electrons from NADH and $FADH_2$ to oxygen. (2 Marks)
- It is the final stage of aerobic cellular respiration. (2 Marks)
- The ETC generates a proton gradient across the inner mitochondrial membrane. (2 Marks)
- The energy released during electron transfer is used for ATP production. (2 Marks)
- Oxygen acts as the final electron acceptor, forming water. (2 Marks)

**(2) What are the main components of the Electron Transport Chain, and where is it located within the cell? (30 Marks)**

- The ETC is located in the inner mitochondrial membrane of eukaryotic cells. (5 Marks)
- Complex I (NADH dehydrogenase) receives electrons from NADH. (5 Marks)
- Complex II (Succinate dehydrogenase) receives electrons from $FADH_2$. (5 Marks)
- Coenzyme Q (Ubiquinone) transfers electrons between Complexes I/II and III. (5 Marks)
- Complex III (Cytochrome $bc_1$ complex) transfers electrons to cytochrome c. (5 Marks)
- Complex IV (Cytochrome c oxidase) transfers electrons to oxygen, producing water.(5 Marks)

**(3) Explain the role of electron carriers (NADH and $FADH_2$) in the ETC. (10 Marks)**

- NADH and $FADH_2$ carry high-energy electrons generated during glycolysis, the citric acid cycle, and β-oxidation. (3 Marks)
- NADH donates electrons to Complex I, while $FADH_2$ donates electrons to Complex II. (3 Marks)
- Electron transfer through the ETC releases energy used to pump protons across the inner mitochondrial membrane. (2 Marks)
- This process ultimately contributes to ATP synthesis. (2 Marks)

**(4) How is the proton gradient established across the mitochondrial membrane, and why is it important for ATP synthesis? (20 Marks)**

- As electrons pass through Complexes I, III, and IV, energy is released. (5 Marks)
- This energy is used to pump protons ($H^+$) from the mitochondrial matrix into the intermembrane space. (5 Marks)
- The accumulation of protons creates an electrochemical gradient known as the proton motive force. (5 Marks)
- Protons flow back into the matrix through ATP synthase, driving the synthesis of ATP from ADP and inorganic phosphate. (5 Marks)

# Tutorial 5 – Defects in Cellular Organelles and Cell Membranes That Led to Diseases Questions

**(1) True or False Regarding Membrane Structure and Function?**
(A) The cell membrane is composed of a lipid bilayer with hydrophilic heads facing outward and hydrophobic tails facing inward.
(B) Membrane proteins include receptors, transporters, enzymes, and structural components.
(C) Excess cholesterol in membranes may alter membrane function.
(D) All membrane proteins are located only on the outer surface of the membrane.
(E) Ligand binding to a membrane receptor may initiate intracellular signaling without the ligand entering the cell.

**(2) True or False Regarding Receptor Defects?**
(A) Autoantibodies against acetylcholine receptors are seen in Myasthenia gravis.
(B) In Myasthenia gravis, acetylcholine receptors are destroyed by complement-mediated mechanisms.
(C) Myasthenia gravis results in increased muscle strength.
(D) Receptor internalization can play a role in causing disease.
(E) Myasthenia gravis is caused by a defect in mitochondrial DNA.

**(3) True or False Regarding Familial Hypercholesterolemia (FH)?**
(A) FH is usually inherited as an autosomal dominant disorder.
(B) It is caused by mutations affecting LDL receptors.
(C) Defective LDL receptors reduce LDL uptake by hepatocytes.
(D) LDL cholesterol levels may exceed 190 mg/dL in affected adults.
(E) FH results in decreased plasma LDL levels.

**(4) True or False Regarding Cystic Fibrosis?**
(A) Cystic fibrosis is caused by mutation of the CFTR chloride channel.
(B) It is inherited in an autosomal recessive pattern.
(C) Decreased chloride secretion leads to thick, sticky mucus.
(D) Water movement into the airway lumen increases in cystic fibrosis.
(E) Male infertility may occur due to abnormal development of the vas deferens.

**(5) True or False Regarding Copper Transport Disorders?**
(A) Wilson disease is caused by mutation in the ATP7B gene.
(B) Wilson disease leads to copper accumulation in the liver and brain.
(C) Kayser–Fleischer rings are due to iron deposition in the cornea.
(D) Menkes syndrome is an X-linked disorder.
(E) Menkes syndrome results in systemic copper deficiency.

**(6) True or False Regarding Mitochondrial Defects?**
(A) Mutations affecting oxidative phosphorylation can cause neurological disorders.
(B) Leigh syndrome is associated with defects in the electron transport chain.
(C) Leber Hereditary Optic Neuropathy is inherited through mitochondrial DNA.
(D) Mitochondrial disorders affect only muscle tissue.
(E) Lactic acidosis may occur in mitochondrial diseases.

**(7) True or False Regarding Lysosomal Storage Diseases?**
(A) They are caused by deficiencies of lysosomal enzymes.
(B) Substrate accumulation occurs inside cells.
(C) They commonly result in organ enlargement such as hepatosplenomegaly.
(D) All lysosomal storage diseases are inherited in an autosomal dominant manner.
(E) Neurological manifestations may occur in some lysosomal disorders.

**(8) True or False Regarding I-cell Disease?**

(A) It is caused by deficiency of N-acetylglucosamine-1-phosphotransferase.
(B) Mannose-6-phosphate tagging of lysosomal enzymes is defective.
(C) Lysosomal enzymes are secreted outside the cell instead of entering lysosomes.
(D) It is inherited as an autosomal recessive disorder.
(E) Enzyme levels are decreased in urine.

**(9) True or False Regarding Pompe Disease?**

(A) Pompe disease is also known as glycogen storage disease type II.
(B) It is caused by deficiency of acid alpha-glucosidase.
(C) Glycogen accumulates in lysosomes.
(D) It primarily affects cardiac and skeletal muscle.
(E) It is caused by excessive mitochondrial ATP production.

**(10) True or False Regarding Organelle Coordination and Cellular Balance?**

(A) Mitochondria and lysosomes help maintain the balance between anabolic and catabolic activities.
(B) Mutations affecting membrane transporters can disrupt cellular homeostasis.
(C) The Golgi apparatus plays a role in targeting lysosomal enzymes.
(D) Membrane defects cannot cause systemic disease.
(E) Organelle dysfunction may affect multiple organs.

# Tutorial 5 – Defects in Cellular Organelles and Cell Membranes That Led to Diseases Answers

(1) Answer – TFTFT

Explanation - The cell membrane is a phospholipid bilayer with embedded proteins, and cholesterol modulates membrane fluidity. Membrane proteins function as receptors, transporters, enzymes, and structural components. Ligand binding to receptors can initiate intracellular signaling without ligand entry into the cell. However, not all membrane proteins are located only on the outer surface.

(2) Answer – TTTFF

Explanation - Myasthenia gravis is an autoimmune disease involving autoantibodies against acetylcholine receptors. These antibodies activate complement and promote receptor destruction. It causes muscle weakness rather than increased strength. It is not caused by mitochondrial DNA defects.

(3) Answer – TTTFT

Explanation - Familial hypercholesterolemia is an autosomal dominant disorder caused by LDL receptor mutations. Defective receptors reduce LDL uptake by hepatocytes, leading to elevated LDL levels, often exceeding 190 mg/dL. Therefore, LDL is increased, not decreased.

(4) Answer – TTTFT

Explanation - Cystic fibrosis is caused by CFTR gene mutations and is inherited in an autosomal recessive pattern. Defective chloride transport leads to thick mucus and reduced water movement into airway lumen. It may also cause male infertility due to abnormal vas deferens development.

(5) Answer – TTFFT

Explanation - Wilson disease is caused by ATP7B mutation leading to copper accumulation in liver and brain. Kayser–Fleischer rings are due to copper deposition, not iron. Menkes syndrome is X-linked and causes systemic copper deficiency.

(6) Answer – TTTFT

Explanation - Mitochondrial defects affect oxidative phosphorylation and can cause neurological disease. Leigh syndrome involves electron transport chain defects, and LHON is maternally inherited. However, mitochondrial disorders affect multiple organs, not only muscle.

(7) Answer – TTTTT

Explanation - Lysosomal storage diseases result from enzyme deficiencies causing intracellular substrate accumulation. They often cause hepatosplenomegaly and may have neurological involvement. Most are autosomal recessive or X-linked, not autosomal dominant.

(8) Answer – TTTFT

Explanation - I-cell disease is caused by deficiency of N-acetylglucosamine-1-phosphotransferase, leading to defective mannose-6-phosphate tagging. Lysosomal enzymes are secreted outside the cell instead of being targeted to lysosomes. It is autosomal recessive, and enzyme levels are not decreased in urine but increased extracellularly.

(9) Answer – TTTFT

Explanation - Pompe disease is glycogen storage disease type II caused by acid alpha-glucosidase deficiency. Glycogen accumulates in lysosomes, mainly affecting cardiac and skeletal muscles. It is not caused by excessive ATP production.

(10) Answer – TTTTT

Explanation - Mitochondria and lysosomes regulate metabolic balance. Transporter mutations disrupt homeostasis. The Golgi helps target lysosomal enzymes. Membrane defects can cause systemic disease, and organelle dysfunction often affects multiple organs.

# SGDs & ANSWERS

# SGD 1 - Cell Structure and Function Questions

The nucleus is a membrane-bound organelle that serves as the control center of the cell, housing the genetic material and regulating gene expression. It is surrounded by the nuclear envelope, which consists of an outer and inner membrane, nuclear pores, and a nuclear lamina that provides structural support. The integrity and function of the nucleus are crucial for cell survival, differentiation, and homeostasis.

(1) Explain the importance of nuclear-cytoplasmic transport through nuclear pore complexes?
(2) Discuss the composition and role of nuclear lamins in maintaining nuclear architecture?
(3) Describe how A-type lamins (lamin A, lamin C, and lamin C2) are encoded by a single gene (LMNA) but undergo differential mRNA splicing and processing to produce distinct proteins?

# SGD 1 - Cell Structure and Function Answers

**(1) Explain the importance of nuclear-cytoplasmic transport through nuclear pore complexes.**

- Nuclear pore complexes (NPCs) regulate selective exchange of molecules between nucleus and cytoplasm.
- They allow passive diffusion of small molecules and ions.
- They actively transport large proteins, RNA, and ribonucleoprotein complexes using energy-dependent mechanisms.
- They maintain cellular function by controlling import of transcription factors into the nucleus and export of mRNA to the cytoplasm.
- They ensure proper gene expression, protein synthesis, and cellular regulation.
- They prevent uncontrolled movement of macromolecules, preserving nuclear integrity and function.

**(2) Discuss the composition and role of nuclear lamins in maintaining nuclear architecture.**

- Nuclear lamins are fibrous proteins forming the nuclear lamina beneath the inner nuclear membrane.
- They are intermediate filament proteins providing mechanical strength to the nucleus.
- They maintain nuclear shape and structural stability.
- They anchor nuclear pores and chromatin to the nuclear envelope.
- They regulate DNA replication, transcription, and chromatin organization.
- They play a role in nuclear assembly and disassembly during cell division.
- Mutations in lamins can lead to nuclear fragility and disease.

(3) **Describe how A-type lamins (lamin A, lamin C, and lamin C2) are encoded by a single gene (LMNA) but undergo differential mRNA splicing and processing to produce distinct proteins.**

- A-type lamins are encoded by the LMNA gene.
- Alternative mRNA splicing of LMNA produces different transcripts.
- Lamin A and lamin C are produced by alternative splicing of the same pre-mRNA.
- Lamin C2 is a germ cell-specific isoform generated through differential splicing and promoter usage.
- Lamin A is initially synthesized as prelamin A and undergoes post-translational processing (farnesylation, cleavage, and maturation).
- Lamin C is produced directly without extensive post-translational processing.
- This differential processing allows tissue-specific expression and functional diversity of nuclear lamins.

# SGD 2 – Transport Across Membranes Questions

(1) Explain the physiological principles underlying oral rehydration therapy and how it promotes rehydration in diarrheal illness?

(2) Describe the standard composition of an oral rehydration solution (ORS) and explain the role of sodium–glucose co-transport in facilitating water absorption from the intestine?

(3) Explain why ORT is considered the treatment of choice over intravenous fluid therapy in cases of mild to moderate dehydration?

(4) Discuss the importance of ORT in the management of diarrheal diseases, particularly in low-resource and community healthcare settings?

(5) Describe any necessary modifications to standard ORS formulations when managing patients with severe electrolyte disturbances?

# SGD 2 – Transport Across Membranes Answers

**(1) Explain the physiological principles underlying oral rehydration therapy and how it promotes rehydration in diarrheal illness?**

- ORT works by utilizing the intact sodium–glucose co-transport mechanism in the small intestine.
- This transport system remains functional even during most diarrheal diseases.
- Sodium and glucose are absorbed together via SGLT-1 in the intestinal brush border.
- Sodium absorption creates an osmotic gradient.
- Water follows passively from the intestinal lumen into the bloodstream.
- This mechanism restores fluid and electrolyte balance despite ongoing diarrhea.

**(2) Describe the standard composition of an oral rehydration solution (ORS) and explain the role of sodium–glucose co-transport in facilitating water absorption from the intestine?**

- Standard ORS contains sodium chloride, glucose, potassium chloride, and citrate or bicarbonate in clean water.
- Sodium provides essential electrolytes lost in diarrhea.
- Glucose facilitates sodium absorption via sodium–glucose co-transport (SGLT-1).
- Potassium helps replace intracellular electrolyte losses.
- Citrate or bicarbonate helps correct metabolic acidosis.
- Co-transport of sodium and glucose enhances water absorption by osmosis.

**(3) Explain why ORT is considered the treatment of choice over intravenous fluid therapy in cases of mild to moderate dehydration?**

- ORT is equally effective for mild to moderate dehydration.
- It is simple, inexpensive, and can be administered at home.
- It avoids complications of IV therapy such as infection and fluid overload.
- It does not require hospital admission or specialized staff.
- It is safer and more practical in most diarrheal illnesses.

**(4) Discuss the importance of ORT in the management of diarrheal diseases, particularly in low-resource and community healthcare settings?**

- ORT significantly reduces mortality from diarrheal diseases, especially in children.
- It is cost-effective and widely accessible.
- It can be administered at home or community level without medical equipment.
- It prevents progression to severe dehydration and shock.
- It reduces hospital admissions and healthcare burden.
- It is one of the most successful public health interventions globally.

**(5) Describe any necessary modifications to standard ORS formulations when managing patients with severe electrolyte disturbances?**

- In severe hyponatremia or hypernatremia, electrolyte composition must be adjusted.
- Potassium levels may need correction based on serum potassium status.
- Severely dehydrated patients may require intravenous fluids instead of ORS.
- Persistent vomiting may limit ORS effectiveness and require IV therapy.
- All modifications should be done under medical supervision with electrolyte monitoring.

# SGD 3 - Bioenergetics Questions

**The role of oxidative phosphorylation in energy production.**

(1.1) What is oxidative phosphorylation, and how does it differ from substrate-level phosphorylation? (20 Marks)

(1.2) Describe the role of ATP synthase in the ETC. (20 Marks)

(1.3) How does the coupling of the electron transport chain and ATP synthesis occur? (30 Marks)

(1.4) Discuss the impact of oxygen availability on the efficiency of the electron transport chain and ATP production. (30 Marks)

# SGD 3 - Bioenergetics Answers

**(1) What is oxidative phosphorylation, and how does it differ from substrate-level phosphorylation? (20 Marks)**

- Oxidative phosphorylation is the process of ATP production driven by the electron transport chain and proton gradient formation in mitochondria. (5 Marks)
- It occurs in the inner mitochondrial membrane and is linked to oxygen-dependent respiration. (5 Marks)
- Substrate-level phosphorylation is the direct formation of ATP by transfer of a phosphate group from a high-energy substrate to ADP. (5 Marks)
- Oxidative phosphorylation depends on oxygen as the final electron acceptor, while substrate-level phosphorylation does not require oxygen. (5 Marks)

**(2) Describe the role of ATP synthase in the ETC. (20 Marks)**

- ATP synthase is an enzyme located in the inner mitochondrial membrane. (5 Marks)
- It catalyzes the conversion of ADP and inorganic phosphate into ATP. (5 Marks)
- It is powered by the flow of protons down their electrochemical gradient. (5 Marks)
- This proton movement provides the energy required for ATP synthesis. (5 Marks)

**(3) How does the coupling of the electron transport chain and ATP synthesis occur? (30 Marks)**

- Electron transport through Complex I, III, and IV releases energy. (6 Marks)
- This energy is used to pump protons from the mitochondrial matrix into the intermembrane space.(6 Marks)
- This establishes an electrochemical proton gradient known as the proton motive force. (6 Marks)
- Protons flow back into the matrix through ATP synthase. (6 Marks)
- The energy from this flow drives ATP synthesis from ADP and inorganic phosphate. (6 Marks)

**(4) Discuss the impact of oxygen availability on the efficiency of the electron transport chain and ATP production. (30 Marks)**

- Oxygen acts as the final electron acceptor in the electron transport chain. (6 Marks)
- It accepts electrons at Complex IV and forms water. (6 Marks)
- Without oxygen, electron transport stops and the chain becomes blocked. (6 Marks)
- Proton pumping ceases and ATP synthesis through oxidative phosphorylation stops. (6 Marks)
- Cells then rely on anaerobic glycolysis producing less ATP and lactic acid accumulation. (6 Marks)

# SGD 4 - Defects in Cellular Organelles and Cell Membranes That Led to Diseases Questions

(1) Describe the basic structure and main functions of the cell membrane? (30 marks)
(2) Explain how a defect in the CFTR membrane protein leads to the development of cystic fibrosis? (40 marks)
(3) Explain the role of lysosomes in the cell with reference to Pompe disease? (30 marks)

# SGD 4 - Defects in Cellular Organelles and Cell Membranes That Led to Diseases Answers

(1) **Describe the basic structure and main functions of the cell membrane. (30 marks)**

- The cell membrane is a phospholipid bilayer with hydrophilic heads facing outward and hydrophobic tails facing inward. (6 marks)
- It contains embedded proteins such as channels, carriers, receptors, and enzymes. (6 marks)
- Cholesterol is present and regulates membrane fluidity and stability. (6 marks)
- The membrane is selectively permeable, controlling movement of substances in and out of the cell. (6 marks)
- It facilitates transport, cell signaling, and cell recognition. (6 marks)

(2) **Explain how a defect in the CFTR membrane protein leads to the development of cystic fibrosis. (40 marks)**

- CFTR is a chloride ion channel present in epithelial cell membranes. (8 marks)
- Mutations in the CFTR gene lead to defective chloride transport. (8 marks)
- Reduced chloride secretion causes decreased water movement into epithelial surfaces. (8 marks)
- This results in thick, sticky mucus in airways, pancreas, and other organs. (8 marks)
- The mucus obstructs ducts and promotes recurrent infections and inflammation. (8 marks)

(3) **Explain the role of lysosomes in the cell with reference to Pompe disease. (30 marks)**

- Lysosomes are membrane-bound organelles containing hydrolytic enzymes for intracellular digestion. (6 marks)
- They degrade macromolecules such as proteins, lipids, and glycogen. (6 marks)
- In Pompe disease, there is deficiency of acid alpha-glucosidase. (6 marks)
- This leads to accumulation of glycogen inside lysosomes, especially in muscle cells. (6 marks)
- The accumulation causes muscle weakness and cardiomyopathy. (6 marks)

# COURSE 2 - BIOMOLECULES

# TUTORIALS & ANSWERS

# Tutorial 1-Carbohydrates Questions

(1) **Which of the following carbohydrates are ketose sugars?**
- (A) Galactose
- (B) Fructose
- (C) Glucose
- (D) Mannose
- (E) Glyceraldehyde

(2) **True or False Regarding Glucose as a Structural Unit?**
- (A) Maltose
- (B) Glycogen
- (C) Mannose
- (D) Lactose
- (E) Sucrose

**(3) True or False Regarding Carbohydrate Storage Forms?**
- (A) Carbohydrates are stored as Glycoprotein:
- (B) Polyglucans in most living cells
- (C) Cellulose in most plants
- (D) Lactose in the mammary gland
- (E) Glycogen in mammalian muscle as a source of blood glucose

**(4) True or False Regarding Different Carbohydrates?**
- (A) Maltotriose is an oligosaccharide
- (B) Ketone derivative of hexose is fructose
- (C) Glucose usually exists in the furanose form
- (D) Galactose is a reducing sugar
- (E) Starch is a heteroglycan

**(5) True or False Regarding Glycosaminoglycans?**
- (A) Collagen
- (B) Hyaluronic acid
- (C) Chondroitin sulphate
- (D) Heparin
- (E) Keratan sulphate

**(6) True or False Regarding Glycosaminoglycans Structure and Function?**
- (A) Heparin contains repeating units of D-glucuronic acid and D-glucosamine
- (B) Heparin is a strongly acidic substance due to sulphate groups
- (C) N-acetyl D-glucosamine is found in both heparin and hyaluronic acid
- (D) Proteoglycans contain keratan sulphate and chondroitin sulphate arranged in a branched Structure
- (E) Blood group antigen is an example of glycosaminoglycan occurring in the body

**(7) True or False Regarding Glycoproteins?**

(A) Glycoproteins determine blood type
(B) Glycoproteins act as templates for synthesis of glycosaminoglycans
(C) Glycoproteins contribute to cell surface receptor specificity
(D) Glycoproteins influence the rate of clearance of certain molecules from circulation
(E) Glycoproteins are involved in targeting cells to specific tissues

**(8) True or False Regarding Glucose Chemistry?**

(A) Alpha and beta forms of glucose are epimers
(B) Pyranose and furanose forms are anomers
(C) L and D forms are enantiomers
(D) Dextro and levo forms are based on direction of optical rotation
(E) Straight-chain structure cannot explain mutarotation

**(9) True or False Regarding Fructose?**

(A) Fructose is a ketose sugar
(B) Fructose is the sweetest of all sugars
(C) The pyranose form is more stable than the furanose form
(D) Fructose is a D isomer of glucose
(E) Fructose resembles glucose in many reactions

**(10) True or False Regarding Carbohydrates in General?**

(A) Fructose is an aldohexose
(B) Starch is a glucose polysaccharide
(C) Sucrose is a disaccharide of glucose and fructose
(D) Cellulose is a fructose polysaccharide
(E) Maltose is a disaccharide of glucose and fructose

**SEQ**

**(1) Discuss how the ability of glycosaminoglycans (GAGs) to recover their shape after deformation is essential for their biological functions.** ***(20 marks)***

# Tutorial 1-Carbohydrates Answers

(1) Answer – FTFFF

Explanation - Ketose sugars contain a ketone group, while aldoses contain an aldehyde group. Among the listed carbohydrates, only fructose is a ketose, while galactose, glucose, mannose, and glyceraldehyde are aldoses or aldotrioses.

(2) Answer - TTFFF

Explanation - Maltose and glycogen contain glucose as their structural unit. Mannose and lactose do not contain glucose as their primary structural unit, and sucrose is composed of glucose and fructose.

(3) Answer - TFFTF

Explanation - Carbohydrates are stored mainly as glycogen in animals and starch in plants. Cellulose is a structural polysaccharide, lactose is a milk sugar, and glycoproteins are functional molecules rather than storage forms.

(4) Answer - TTFTF

Explanation - Maltotriose is an oligosaccharide and fructose is a ketose hexose. Glucose mainly exists in the pyranose form, galactose is a reducing sugar, and starch is a homopolysaccharide of glucose, not a heteroglycan.

(5) Answer - FTTTT

Explanation - Glycosaminoglycans include hyaluronic acid, chondroitin sulfate, heparin, and keratan sulfate. Collagen is a structural protein, not a glycosaminoglycan.

(6) Answer – TTFTF

Explanation - Heparin contains glucuronic acid and glucosamine and is highly acidic due to sulfate groups. N-acetyl glucosamine is not present in heparin, and blood group antigens are glycoproteins/glycolipids, not glycosaminoglycans.

(7) Answer – TFTTT

Explanation - Glycoproteins are involved in blood group determination, receptor specificity, clearance of molecules, and tissue targeting. They are not templates for glycosaminoglycan synthesis.

(8) Answer – FFTTT

Explanation - Alpha and beta glucose are anomers, not epimers. L and D forms are enantiomers, and optical rotation defines dextro and levo forms. Mutarotation cannot be explained by a straight-chain structure.

(9) Answer – TTFTT

Explanation - Fructose is a ketose sugar and is the sweetest natural sugar. It mainly exists in a stable furanose form and is not a D isomer of glucose, but it shows similar chemical behavior to glucose.

(10) Answer – FTTFF

Explanation - Fructose is a ketose, starch is a glucose polymer, and sucrose is made of glucose and fructose. Cellulose is a glucose polymer, and maltose is composed of glucose and glucose.

**(1) Discuss how the ability of glycosaminoglycans (GAGs) to recover their shape after deformation is essential for their biological functions. (20 marks)**

- Glycosaminoglycans are highly negatively charged, long unbranched polysaccharides present in the extracellular matrix, especially in cartilage, tendons, and connective tissues. (4 marks)
- Their negative charges attract water and cations, forming a highly hydrated gel-like structure. (4 marks)
- When mechanical pressure is applied, water is temporarily displaced and the GAG network becomes compressed. (4 marks)
- After removal of the force, the hydrated structure rapidly re-expands due to osmotic pressure and electrostatic repulsion between negatively charged groups. (4 marks)
- This reversible deformation allows tissues such as cartilage to resist compression and act as shock absorbers in joints. (2 marks)
- It also maintains tissue elasticity, flexibility, and structural integrity during movement. (2 marks)
- This property is essential for normal joint function, preventing wear and tear of bones and connective tissues. (2 marks)

# Tutorial 2 - Proteins Questions

**Case Scenario**

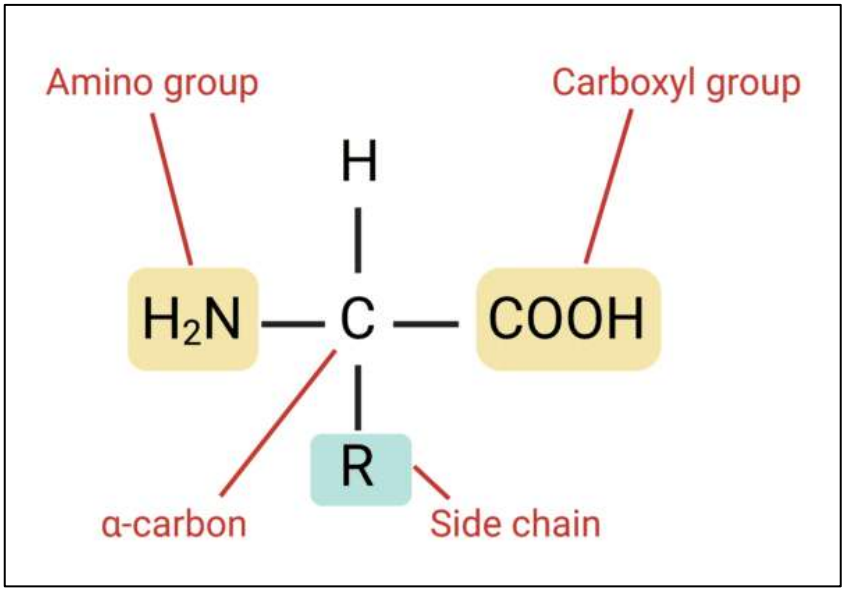
A 35-year-old man with type 1 diabetes mellitus attends the clinic for routine follow-up. The physician explains that insulin therapy must be given by injection rather than orally because insulin is a protein hormone. During a discussion with medical students, the doctor further explains that proteins are composed of amino acids joined by peptide bonds and that certain amino acids must be obtained from the diet.

(1) Describe the general structure of an amino acid and illustrate it with a labeled diagram showing its components?
(2) Classify the 20 amino acids found in proteins into hydrophobic and hydrophilic amino acids?
(3) Explain the concept of essential amino acids and list the essential amino acids?
(4) Identify the essential amino acid that is required in infants but not in adults and explain the reason for this difference?
(5) Explain the term “zwitterion” in relation to amino acids?
(6) Illustrate, with a diagram, the process of peptide bond formation between amino acids?
(7) List out the biological importance of Glutathione?
(8) Explain why insulin cannot be consumed orally?

# Tutorial 2 - Proteins Answers

**(1) Describe the general structure of an amino acid and illustrate it with a labeled diagram showing its components.**

- An amino acid consists of a central α-carbon atom bonded to four different groups.
- These include an amino group (–$NH_2$), a carboxyl group (–COOH), a hydrogen atom, and a variable side chain (R group).
- The R group determines the identity and properties of the amino acid.




**(2) Classify the 20 amino acids found in proteins into hydrophobic and hydrophilic amino acids.**

Hydrophobic amino acids:
Alanine, Valine, Leucine, Isoleucine, Methionine, Phenylalanine, Tryptophan, Proline, Glycine
Hydrophilic amino acids:
Serine, Threonine, Cysteine, Tyrosine, Asparagine, Glutamine, Aspartate, Glutamate, Lysine, Arginine, Histidine

**(3) Explain the concept of essential amino acids and list the essential amino acids.**

- Essential amino acids are those that cannot be synthesized in sufficient amounts by the human body and must be obtained from the diet.
- They are required for protein synthesis, growth, and tissue repair.
  Essential amino acids:
  Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Threonine, Tryptophan, Valine

**(4) Identify the essential amino acid that is required in infants but not in adults and explain the reason for this difference.**

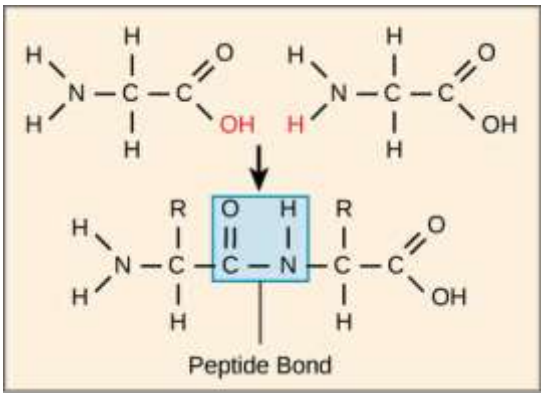
- Histidine is considered essential in infants but not strictly essential in adults.
- Infants have rapid growth and higher protein synthesis demands.
- Their biosynthetic pathways are not fully mature, so dietary intake is required.
- In adults, histidine can be synthesized in small amounts sufficient for maintenance needs.

**(5) Explain the term "zwitterion" in relation to amino acids.**

- A zwitterion is a molecule that carries both positive and negative charges but is electrically neutral overall.
- In amino acids, the amino group is protonated ($–NH_3^+$) and the carboxyl group is deprotonated ($–COO^–$) at physiological pH.
- This ionic form increases solubility in water and affects buffering properties.

**(6) Illustrate, with a diagram, the process of peptide bond formation between amino acids.**

A peptide bond forms when the carboxyl group of one amino acid reacts with the amino group of another amino acid, releasing a molecule of water (condensation reaction).
Diagram:




**(7) List out the biological importance of Glutathione.**

- Acts as a major intracellular antioxidant
- Protects cells from oxidative stress by reducing reactive oxygen species
- Maintains protein –SH groups in reduced form
- Participates in detoxification of xenobiotics in the liver
- Helps maintain red blood cell integrity
- Regenerates other antioxidants such as vitamins C and E

**(8) Explain why insulin cannot be consumed orally.**

- Insulin is a peptide/protein hormone.
- In the gastrointestinal tract, it is digested by proteolytic enzymes such as pepsin, trypsin, and chymotrypsin.
- It is broken down into amino acids before absorption.
- It is also too large and hydrophilic to cross intestinal epithelial membranes intact.
- Therefore, it must be administered by injection to reach the bloodstream in active form.

# Tutorial 3 – Lipids Questions

**(1) True or False Regarding Lipids?**
(A) Usually associated with covalent interactions
(B) Are structural components of membranes
(C) May contain nitrogen and phosphate
(D) Are an intracellular energy source
(E) Are poorly soluble in water

**(2) True or False Regarding Lipids?**
(A) Among foods of animal origin, milk has the minimum cholesterol content
(B) Lecithin is a phospholipid
(C) Iodine number is an indication of molecular weight
(D) Omega-3 fatty acids are important for brain health
(E) Prostaglandins are formed from arachidonic acid

**(3) True or False Regarding Lipids as a Group of Compounds?**
(A) Lipids are homogeneous in nature
(B) They have a significant role in absorption and metabolism of vitamins
(C) They are highly concentrated in nerve tissue
(D) Linoleic acid is the only essential fatty acid
(E) Beta oxidation of fatty acids only takes place in the mitochondria

**(4) True or False Regarding Lipids Present in Plasma?**
(A) Most fatty acids are branched chain compounds
(B) Free fatty acids are immediately available energy sources
(C) Short-chain fatty acids are carried mainly bound to albumin
(D) Chylomicrons are the primary lipoproteins responsible for transporting cholesterol in blood
(E) Plasma phospholipids are primarily structural components rather than direct energy sources

**(5) True or False Regarding Rancidity of Lipids?**
(A) Unsaturated fatty acids are more readily spoiled by rancidity than saturated fatty acids
(B) Rancid fats are unsuitable for human consumption
(C) Rancidity is prevented by light
(D) Lipids undergo rancidity producing offensive odour and taste
(E) Bacterial action is a cause of rancidity

**(6) True or False Regarding Triglycerides?**
(A) Triglycerides are the major component of dietary fat
(B) They consist of three fatty acids connected to glucose
(C) Triglycerides cross the placenta freely
(D) Triglycerides are carried in plasma by lipoproteins
(E) Triglycerides have increased plasma concentration during pregnancy

**(7) True or False Regarding Fatty Acids?**
(A) Fatty acids can be synthesized from excess carbohydrates and proteins
(B) Fatty acids must be entirely supplied by diet
(C) In delta nomenclature carbon atoms are numbered from the carboxyl carbon
(D) Delta 10 indicates a double bond between carbon 10 and carbon 11
(E) Carbonyl carbon is also known as alpha carbon

**(8) True or False Regarding Natural Fatty Acids?**
(A) Most fatty acids occurring in nature are aliphatic compounds
(B) They have two carboxyl groups
(C) They have an even number of carbon atoms
(D) They have no double bonds
(E) They are soluble in water

**(9) True or False Regarding Short-Chain Fatty Acids?**
(A) Short-chain fatty acids are typically found in dairy products
(B) Short-chain fatty acids have fewer than six carbon atoms
(C) Short-chain fatty acids are beneficial for gut health
(D) Short-chain fatty acids are harmful to the intestinal lining
(E) Short-chain fatty acids are used by colon cells as an energy source

**(10) True or False Regarding Omega-3 Fatty Acids?**
(A) Omega-3 fatty acids are small fatty acids composed of three 2-carbon groups
(B) They have their first double bond at the omega carbon position
(C) Linoleic acid is rapidly converted to EPA and DHA in the body
(D) Linoleic acid is found in abundance in fish oils
(E) Omega-3 fatty acids cause hypolipidemia

# Tutorial 3 - Lipids Answers

(1) Answer – TTFTT

Explanation - Lipids are major structural components of membranes and are poorly soluble in water. They may contain nitrogen and phosphate (e.g., phospholipids). They are mainly associated with non-covalent interactions in membranes and are not primarily defined as intracellular energy sources compared to carbohydrates.

(2) Answer - FFTTF

Explanation - Milk does not have the minimum cholesterol among animal foods. Lectin is not a phospholipid. Iodine number reflects degree of unsaturation, not molecular weight. Omega-3 fatty acids are important for brain health, and prostaglandins are derived from arachidonic acidLipids as a group of compounds

(3) Answer - FTTFT

Explanation - Lipids are heterogeneous compounds. They play an important role in vitamin absorption and metabolism and are abundant in nervous tissue. Linoleic acid is not the only essential fatty acid, and beta-oxidation occurs mainly in mitochondria.Lipids in plasma

(4) Answer – FFTFF

Explanation - Most fatty acids are not branched chain. Free fatty acids are immediate energy sources. Short-chain fatty acids are not mainly albumin-bound (long-chain FFA are). Chylomicrons transport dietary triglycerides, not cholesterol primarily. Plasma phospholipids are mainly structural components.Rancidity of lipids

(5) Answer - TTTTT

Explanation - Unsaturated fats are more prone to rancidity. Rancid fats are unsuitable for consumption. Light accelerates rancidity. Lipids develop offensive odour and taste due to oxidation. Bacterial action can also cause rancidity.
Triglycerides

(6) Answer - TFTTF

Explanation - Triglycerides are major dietary fat components. They are formed from glycerol, not glucose. They do not freely cross the placenta. They are transported by lipoproteins, and levels increase during pregnancy.
Fatty acids

(7) Answer - TFFTF

Explanation - Fatty acids can be synthesized from excess carbohydrates and proteins. They are not entirely dietary. Delta numbering starts from the carboxyl carbon, but the alpha carbon is adjacent to the carboxyl carbon, not the carbonyl carbon.
Natural fatty acids

(8) Answer - TFFTF

Explanation - Most natural fatty acids are aliphatic and have even numbers of carbon atoms. They have one carboxyl group, often contain double bonds, and are not water soluble.
Short-chain fatty acids (SCFAs)

(9) Answer - TTTFT

Explanation - SCFAs are produced by gut fermentation and found in fermented foods. They have fewer than six carbons, support gut health, and serve as energy sources for colon cells. They are not harmful. Omega-3 fatty acids

(10) Answer - FTFFT

Explanation - Omega-3 fatty acids are long-chain polyunsaturated fatty acids. They have a double bond at the omega-3 position. Linoleic acid is not efficiently converted to EPA/DHA and is mainly plant-derived. Omega-3 fatty acids help reduce blood lipid levels.

# Tutorial 4 – Nucleic Acid Questions

**(1) Which of the following nitrogenous bases is classified as a pyrimidine?**
(A) Adenine
(B) Guanine
(C) Cytosine
(D) Hypoxanthine
(E) None of the above

**(2) Which nitrogenous base is present exclusively in DNA and absent in RNA?**
(A) Uracil
(B) Cytosine
(C) Thymine
(D) Adenine
(E) Guanine

**(3) Which type of RNA is the most abundant within the cell?**
(A) Messenger RNA (mRNA)
(B) Transfer RNA (tRNA)
(C) Ribosomal RNA (rRNA)
(D) Heterogeneous nuclear RNA (hnRNA)
(E) Small nuclear RNA (snRNA)

**(4) Which of the following bases is unique to RNA?**
(A) Cytosine
(B) Thymine
(C) Uracil
(D) Adenine
(E) Guanine

**(5) A nucleoside is composed of which of the following components?**
(A) Sugar and phosphate group
(B) Nitrogenous base and phosphate group
(C) Sugar and nitrogenous base
(D) Nitrogenous base and amino acid
(E) Nitrogenous base and lipid

(6) **What is the primary functional significance of the major and minor grooves in the DNA double helix?**
(A) Sites for RNA polymerase binding during transcription
(B) Regions that allow binding of regulatory proteins
(C) Initiation points for DNA replication
(D) Indicators of strand polarity
(E) Locations of covalent linkage between DNA strands

(7) **Which type of bond links a nitrogenous base to the pentose sugar in a nucleotide?**
(A) Ester bond
(B) Peptide bond
(C) Glycosidic bond
(D) Hydrogen bond
(E) Phosphodiester bond

**(8) Which of the following statements regarding DNA is correct?**
(A) It contains ribose sugar
(B) It contains uracil
(C) It is typically single-stranded
(D) It is relatively stable under alkaline conditions
(E) It is found exclusively in mitochondria

**(9) What is the primary function of transfer RNA (tRNA)?**
(A) Storage of genetic information
(B) Structural component of ribosomes
(C) Transport of amino acids during protein synthesis
(D) Inhibition of protein synthesis
(E) Formation of double-stranded RNA

**(10) Which enzyme is responsible for synthesizing RNA using a DNA template?**
(A) DNA polymerase
(B) RNA polymerase
(C) DNA ligase
(D) Nuclease
(E) Helicase

**(11) Which of the following is NOT a function of nucleic acids?**
(A) Protein synthesis
(B) Storage of genetic information
(C) Catalysis of biochemical reactions
(D) Transport of oxygen
(E) Regulation of gene expression

**(12) Why is RNA more susceptible to alkaline hydrolysis compared to DNA?**
(A) It is single-stranded and lacks protective proteins
(B) It contains uracil instead of thymine
(C) It possesses a 2′-hydroxyl group in its ribose sugar
(D) It has a higher phosphate content
(E) Its bases are inherently more reactive

**(13) A mutation changes an mRNA codon from UAU to UAA. What is the most likely outcome?**
(A) Amino acid substitution
(B) No change in protein structure
(C) Elongation of the polypeptide chain
(D) Premature termination of translation
(E) Frameshift mutation

**(14) Which of the following pairings is incorrect in terms of nucleic acid structure or function?**

(A) Adenine – Thymine (DNA)
(B) Guanine – Cytosine
(C) Ribose – DNA
(D) Uracil – RNA
(E) Phosphodiester bond – Nucleotide linkage

**(15) Which feature specifically distinguishes a DNA double helix from an RNA hairpin structure?**

(A) Presence of phosphodiester bonds
(B) Hydrogen bonding between bases
(C) Antiparallel arrangement of strands
(D) Use of purine and pyrimidine bases
(E) Presence of nitrogenous bases

# Tutorial 4 – Nucleic acid Answers

(1) Cytosine

Explanation – Pyrimidines include cytosine, thymine, and uracil, which are single-ring nitrogenous bases. Adenine and guanine are purines.

(2) Thymine

Explanation – DNA contains thymine, while RNA contains uracil instead. Both nucleic acids share adenine, guanine, and cytosine.

(3) Ribosomal RNA (rRNA)

Explanation – rRNA forms the structural and catalytic core of ribosomes and is the most abundant type of RNA in cells.

(4) Uracil

Explanation – Uracil is unique to RNA, replacing thymine which is found in DNA.

(5) Sugar and nitrogenous base

Explanation – A nucleoside consists of a pentose sugar attached to a nitrogenous base; addition of phosphate forms a nucleotide.

(6) Regions that allow binding of regulatory proteins

Explanation – Major and minor grooves provide access for transcription factors and regulatory proteins involved in gene expression.

(7) Glycosidic bond

Explanation – A β-N-glycosidic bond links the nitrogenous base to the 1′ carbon of the pentose sugar.

(8) It is relatively stable under alkaline conditions

Explanation – DNA lacks a 2′-OH group, making it more stable in alkaline conditions compared to RNA.

(9) Transport of amino acids during protein synthesis

Explanation – tRNA carries specific amino acids to the ribosome according to codon–anticodon pairing.

(10) RNA polymerase

Explanation – RNA polymerase synthesizes RNA using a DNA template during transcription.

(11) Transport of oxygen

Explanation – Oxygen transport is performed by hemoglobin protein, not nucleic acids.

(12) It possesses a 2′-hydroxyl group in its ribose sugar

Explanation – The 2′-OH group in RNA makes it susceptible to alkaline hydrolysis.

(13) Premature termination of translation

Explanation – UAU codes for tyrosine, while UAA is a stop codon, causing early termination of protein synthesis.

(14) Ribose – DNA

Explanation – DNA contains deoxyribose, not ribose; ribose is found in RNA.

(15) Antiparallel arrangement of strands

Explanation – DNA has two antiparallel strands, whereas RNA hairpins are single-stranded secondary structures.

# SGDs & ANSWERS

# SGD 01 - Carbohydrates Questions

(1) Define Diabetes Mellitus and explain how it is characterized by abnormal blood glucose regulation. Describe the three primary types—Type 1, Type 2, and Gestational Diabetes—including their pathophysiology, risk factors, and how each type affects insulin production or action.

(2) What is the Glycemic Index (GI)? Describe in detail how the GI of a food is measured, including test food preparation, reference food comparison, blood glucose monitoring, and interpretation of results.

(3) Explain the clinical relevance of the Glycemic Index (GI) in managing carbohydrate intake. Discuss how knowledge of GI can help control blood glucose levels, assist in diabetes management, and support weight management and overall health.

(4) Define Glycemic Load (GL) and explain how it integrates both the quality and quantity of carbohydrates in a food. Compare GL with Glycemic Index (GI), and discuss why considering GL is clinically important for managing blood sugar in diabetes, including examples such as watermelon.

(5) What are soluble fibers? Describe their sources, mechanisms of action in the digestive system, and health benefits, including effects on blood glucose control, cholesterol reduction, gut microbiota, cardiovascular health, and weight management.

(6) Differentiate between diverticulosis and diverticulitis in terms of definition, symptoms, and pathophysiology. Recommend appropriate dietary fiber intake for each condition, explaining why high-fiber or low-fiber diets are advised at different stages.

(7) Differentiate between Glycosaminoglycans (GAGs) and Proteoglycans.

# SGD 01 - Carbohydrates Answers

**(1) Define Diabetes Mellitus and explain abnormal blood glucose regulation. Describe Type 1, Type 2, and Gestational Diabetes.**

Diabetes Mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia due to defects in insulin secretion, insulin action, or both.

It results from:
Insufficient insulin production
Ineffective action of insulin at target tissues

The main types are Type 1 DM, Type 2 DM, and Gestational Diabetes Mellitus.

Type 1 Diabetes Mellitus
Also called insulin-dependent diabetes mellitus
Autoimmune destruction of pancreatic β-cells
Absolute insulin deficiency
Often autoimmune in origin
Requires lifelong insulin therapy

Type 2 Diabetes Mellitus
Most common type of diabetes
Characterized by insulin resistance with relative insulin deficiency
Initially normal or increased insulin, later β-cell dysfunction

Risk factors:
Obesity
Physical inactivity
Unhealthy diet
Hypertension and dyslipidemia
Smoking
Poor sleep
Age >45 years
Family history
Ethnic predisposition
Previous gestational diabetes
Low socioeconomic status

Mechanism:
Insulin resistance leads to impaired glucose uptake and hyperglycemia
Gestational Diabetes Mellitus
Glucose intolerance occurring during pregnancy
Usually develops between 24–28 weeks
Caused by placental hormones causing insulin resistance
Usually resolves after delivery
Increases future risk of Type 2 DM

Risk factors:
Obesity
Advanced maternal age
Family history of Type 2 DM
PCOS
Previous gestational diabetes

**(2) What is the Glycemic Index (GI) and how is it measured?**

Glycemic Index (GI) is a ranking of carbohydrate-containing foods based on their effect on postprandial blood glucose compared with a reference food.

It is based on the incremental area under the blood glucose response curve after consuming 50 g of available carbohydrates.

Measurement process:
A test food containing 50 g available carbohydrates is consumed by fasting individuals
Blood glucose is measured over 2 hours at regular intervals
On another day, the same subjects consume a reference food (glucose or white bread)
The incremental area under the curve is calculated
Formula:

$$\mathrm{GL} = \left( \frac{\mathrm{GI} \times \mathrm{Carbohydrate\ Content\ (g)}}{100} \right)$$

Interpretation:
Low GI ≤55
Medium GI 56–69
High GI ≥70
High GI foods cause rapid glucose rise, while low GI foods produce gradual glucose release

**(3) Clinical relevance of Glycemic Index**

GI is used in dietary management of carbohydrate intake.

It helps in:
Improving glycemic control in diabetes
Reducing postprandial glucose spikes
Lowering insulin demand
Improving insulin sensitivity
Supporting weight management through satiety
Reducing cardiovascular disease risk
Providing sustained energy release

**(4) Define Glycemic Load (GL) and compare with GI**

Glycemic Load (GL) measures both quality and quantity of carbohydrates in a serving.

Formula:
GL = (GI × carbohydrate grams per serving) / 100

Interpretation:
Low GL ≤10
Medium GL 11–19
High GL ≥20

Difference:

GI reflects carbohydrate quality
GL reflects real-life glycemic impact of portion size

Clinical importance:
More accurate prediction of blood glucose response
Useful for dietary planning in diabetes

Example:
Watermelon has high GI but low carbohydrate content per serving, so GL is low and has minimal impact on blood glucose

**(5) What are soluble fibers? Describe their sources, mechanisms of action in the digestive system, and health benefits, including effects on blood glucose control, cholesterol reduction, gut microbiota, cardiovascular health, and weight management.**

Soluble fibers

Soluble fibers dissolve in water to form a gel-like substance in the intestine and are partially fermented in the colon.

Sources:
Oats, barley
Legumes
Fruits such as apple, citrus, berries, banana
Vegetables such as carrot and broccoli
Seeds such as flax and psyllium

Mechanisms:
Delay gastric emptying
Form viscous gel reducing glucose absorption
Bind bile acids
Fermentation by gut microbiota produces short-chain fatty acids

Health benefits:
Improve blood glucose control
Lower LDL cholesterol
Support gut microbiota
Produce anti-inflammatory SCFAs like butyrate
Reduce cardiovascular risk
Increase satiety and aid weight control

**(6) Differentiate between diverticulosis and diverticulitis in terms of definition, symptoms, and pathophysiology. Recommend appropriate dietary fiber intake for each condition, explaining why high-fiber or low-fiber diets are advised at different stages.**

Diverticulosis vs Diverticulitis

Diverticulosis is the presence of diverticula in the colon wall and is usually asymptomatic.
It is caused by increased intraluminal pressure and weak colonic wall areas.
Diverticulitis is inflammation or infection of diverticula.
It presents with abdominal pain, fever, nausea, and bowel changes.

Diverticulosis dietary advice:
High-fiber diet (25–35 g/day)
Prevents constipation and reduces colonic pressure

Diverticulitis dietary advice:
Low-fiber or liquid diet during acute phase to rest the bowel
Gradual return to high-fiber diet after recovery

**(7) Differentiate between Glycosaminoglycans (GAGs) and Proteoglycans**

Glycosaminoglycans vs Proteoglycans

Glycosaminoglycans (GAGs) are long unbranched polysaccharides made of repeating disaccharide units.
They are highly negatively charged and contribute to hydration, lubrication, and elasticity of tissues.

Examples include hyaluronic acid, chondroitin sulfate, heparan sulfate, and keratan sulfate.

Proteoglycans consist of a core protein with one or more GAG chains attached.

They are major components of the extracellular matrix and are important in structural support and cell signaling.

Example: aggrecan in cartilage.

Key difference:
GAGs are carbohydrate chains alone
Proteoglycans are protein–carbohydrate complexes

# SGD 02 - Proteins Questions

(1) **True or False regarding amino acids?**
(A) Amino acids not found in proteins exist in free form in cells
(B) In solid state, amino acids exist as zwitterions
(C) Amino acids may be structurally modified after incorporation into proteins
(D) Amino acids can be separated by paper chromatography
(E) All properties of amino acids are conferred by the carboxyl group

(2) **True or False regarding amino acids?**
(A) In aqueous solution, amino acids predominantly exist as $H_3N^+–CH–COO^-$
(B) Glycine is optically active because it has two R groups
(C) Aliphatic amino groups do not ionize
(D) Amino acids in proteins are always of D-configuration
(E) The 20 canonical amino acids are the fundamental building blocks of life

(3) **True or False regarding isoelectric pH of amino acids?**
(A) It depends on optical rotation
(B) It depends on molecular weight
(C) It depends on number of ionizable acidic and basic groups
(D) It depends on number of carboxyl groups
(E) It depends on chain length

(4) **True or False regarding individual amino acids?**
(A) Glycine is an essential amino acid
(B) Histidine gives a yellow colour in ninhydrin reaction
(C) Proline is an aromatic amino acid
(D) Leucine has a sparing effect on isoleucine requirement
(E) Serine and threonine are hydroxyl amino acids

(5) **True or False regarding amino acid properties?**
(A) Methionine forms disulphide linkages
(B) Phenylalanine has a polar R group
(C) Glycine shows optical isomerism
(D) Lysine has three ionizable groups
(E) Glutamic acid has three carboxyl groups

(6) **True or False regarding amino acids containing nitrogen other than α-amino group?**
(A) Serine
(B) Arginine
(C) Lysine
(D) Cysteine
(E) Phenylalanine

(7) **True or False regarding amino acids containing hydroxyl groups?**
(A) Tyrosine
(B) Lysine
(C) Serine
(D) Threonine
(E) Methionine

(8) **True or False regarding amino acids that are both glucogenic and ketogenic?**
(A) Leucine
(B) Phenylalanine
(C) Tryptophan
(D) Serine
(E) Tyrosine

(9) **True or False regarding essential amino acids?**
(A) Required in diet for protein synthesis
(B) Cannot be synthesized in adequate amounts by the body
(C) Cannot be metabolized in the body
(D) Glycine is an essential amino acid
(E) There are 20 essential amino acids

(10) **True or False regarding glutathione?**
(A) It is a tripeptide
(B) It has three peptide bonds
(C) It contains a thiol group
(D) It has two carboxyl and one amino group
(E) It is readily oxidized

(11) **True or False regarding proteins**
(A) Contain C, H, O, S and N
(B) Can be hydrolyzed into ammonia and amino acids
(C) Are composed primarily of amino acids
(D) All proteins are water soluble
(E) Contain approximately 16% nitrogen

(12) **True or False regarding protein structure stability?**
(A) Peptide bonds
(B) Hydrogen bonds
(C) Hydrophobic interactions
(D) Van der Waals forces
(E) Ionic bonds

# SGD 02 – Proteins Answers

(1) Answer: FFTTF

Explanation: Amino acids not found in proteins exist in free form in cells. In aqueous solution they exist mainly as zwitterions, and they also exist as zwitterions in solid state. They may be structurally modified after incorporation into proteins and can be separated by paper chromatography. However, amino acid properties are not determined only by the carboxyl group; both amino and carboxyl groups contribute.

(2) Answer: TFTFT

Explanation: Amino acids in aqueous solution exist as zwitterions. Glycine is not optically active. Aliphatic amino groups can ionize depending on pH. Protein amino acids are L-configuration, not D. The 20 canonical amino acids are the building blocks of proteins.

(3) Answer: FFTFF

Explanation: Isoelectric pH depends on ionizable acidic and basic groups in the amino acid structure. It is not influenced by optical rotation, molecular weight, or chain length.

(4) Answer: FFFTT

Explanation: Glycine is non-essential. Histidine does not produce a yellow color in ninhydrin reaction. Proline is not aromatic. Leucine influences branched-chain amino acid balance. Serine and threonine are hydroxyl amino acids.

(5) Answer: FFFTF

Explanation: Methionine does not form disulphide bonds. Phenylalanine is non-polar. Glycine is achiral. Lysine has three ionizable groups. Glutamic acid has two carboxyl groups.

(6) Answer: FTTFF

Explanation: Arginine, lysine, and cysteine contain nitrogen in side chains beyond the α-amino group, while serine and phenylalanine do not.

(7) Answer: TFTTF

Explanation: Tyrosine, serine, and threonine contain hydroxyl groups. Lysine and methionine do not contain hydroxyl groups.

(8) Answer: FTTFT

Explanation: Leucine, phenylalanine, tryptophan, and tyrosine are ketogenic or both glucogenic and ketogenic. Serine is glucogenic only.

(9) Answer: TTTFF

Explanation: Essential amino acids are required in the diet and cannot be synthesized in sufficient amounts. Glycine is non-essential. There are fewer than 20 essential amino acids in humans.

(10) Answer: TTFTT

Explanation: Glutathione is a tripeptide with peptide bonds and contains a thiol group. It has specific amino

and carboxyl group arrangement and can be oxidized.

(11) Answer: TFTFF

Explanation: Proteins contain C, H, O, N, and sometimes S. They are hydrolyzed into amino acids, not ammonia directly. Not all proteins are water soluble, and nitrogen content is about 16%.

(12) Answer: TTTTT

Explanation: Protein structure is stabilized by peptide bonds, hydrogen bonds, hydrophobic interactions, van der Waals forces, and ionic bonds.

# SGD 03 - Lipids Questions

(1) Describe the general structure of a phospholipid molecule.
(2) Briefly describe why phospholipids are classified under complex lipids.
(3) Outline the significance of sphingomyelin.
(4) Outline the significance of choline.
(5) Outline the significance of dipalmitoyl lecithin.
(6) Outline the significance of phosphatidylserine.
(7) Discuss the structure and biological properties of cholesterol.
(8) Illustrate the typical structure of a lipoprotein molecule.
(9) List the types of lipoprotein molecules.

# SGD 03 – Lipids Answers

(1) **Describe the general structure of a phospholipid molecule.**

Phospholipids are amphipathic molecules composed of a glycerol or sphingosine backbone, two hydrophobic fatty acid chains, a phosphate group, and a polar head group such as choline, ethanolamine, serine, or inositol. They have a hydrophilic head and hydrophobic tails, allowing formation of biological membranes.

(2) **Briefly describe why phospholipids are classified under complex lipids.**

Phospholipids are complex lipids because, in addition to fatty acids and alcohol, they contain a phosphate group and often a nitrogenous or other substituent. On hydrolysis, they yield fatty acids, alcohol, phosphoric acid, and additional components such as choline or serine.

(3) **Outline the significance of sphingomyelin.**

Sphingomyelin is a major phospholipid in the myelin sheath of nerves, important for insulation and nerve conduction. It contains sphingosine instead of glycerol. Deficiency of sphingomyelinase leads to Niemann–Pick disease.

(4) **Outline the significance of choline.**

Choline is a component of phosphatidylcholine (lecithin) and sphingomyelin. It is required for acetylcholine synthesis, acts as a lipotropic factor preventing fatty liver, and is important in membrane structure and lipid transport.

(5) **Outline the significance of dipalmitoyl lecithin.**

Dipalmitoyl lecithin is a major component of pulmonary surfactant. It reduces surface tension in alveoli, preventing lung collapse. Deficiency in premature infants leads to neonatal respiratory distress syndrome.

(6) **Outline the significance of phosphatidylserine.**

Phosphatidylserine is an important membrane phospholipid involved in cell signaling, apoptosis, membrane fluidity, and coagulation processes.

(7) **Discuss the structure and biological properties of cholesterol.**

Cholesterol is a sterol with a four-ring steroid nucleus, a hydroxyl group at C3, a hydrocarbon side chain at C17, and a double bond between C5 and C6. It is amphipathic.
It is an essential component of cell membranes, maintaining fluidity and stability. It is a precursor for bile acids, steroid hormones, and vitamin D. It is transported in blood via lipoproteins. Excess cholesterol contributes to atherosclerosis and cardiovascular disease.

(8) **Illustrate the typical structure of a lipoprotein molecule.**

Lipoproteins are spherical particles with a hydrophobic core containing triglycerides and cholesteryl esters, and a surface layer composed of phospholipids, free cholesterol, and apolipoproteins. This structure allows transport of lipids in plasma.

(9) **List the types of lipoprotein molecules.**
Chylomicrons
Very low-density lipoproteins (VLDL)
Intermediate-density lipoproteins (IDL)
Low-density lipoproteins (LDL)
High-density lipoproteins (HDL)

# SGD 04 – Nucleic Acid Questions

(1) Compare and contrast the structural features of DNA and RNA, and discuss how these differences relate to their respective biological functions.
(2) Describe the principle of complementary base pairing in DNA and explain how it contributes to both the structure and function of the molecule.
(3) Outline the hierarchical organization of DNA packaging in eukaryotic cells, from the double helix to fully condensed chromosomes.
(4) Describe the structure of nucleosomes and explain their role in chromatin organization and DNA compaction.
(5) Discuss the diverse roles of nucleotides beyond nucleic acid synthesis, providing relevant examples from cellular metabolism and signaling.

# SGD 04 - Nucleic acid Answers

**(1) Compare and contrast the structural features of DNA and RNA, and discuss how these differences relate to their biological functions.**

DNA is composed of deoxyribose sugar (lacking a 2′-OH group), while RNA contains ribose sugar with a reactive 2′-OH group. DNA contains the bases adenine, guanine, cytosine, and thymine, whereas RNA contains adenine, guanine, cytosine, and uracil instead of thymine. DNA is usually double-stranded, while RNA is mostly single-stranded. DNA is highly stable, long, and found mainly in the nucleus (and mitochondria), whereas RNA is less stable, shorter, and present in both nucleus and cytoplasm.

Functionally, DNA serves as a long-term storage molecule for genetic information due to its stability and double-stranded structure, which allows repair and protection of genetic code. RNA is more reactive due to the 2′-OH group, making it less stable but capable of catalytic activity (ribozymes). The use of uracil instead of thymine allows faster synthesis and turnover, supporting short-term genetic functions. RNA's single-stranded nature allows folding into diverse shapes, enabling roles in protein synthesis (mRNA, tRNA, rRNA) and regulation.

**(2) Describe the principle of complementary base pairing in DNA and explain how it contributes to both structure and function.**

In DNA, adenine pairs with thymine via two hydrogen bonds, and guanine pairs with cytosine via three hydrogen bonds. This specific pairing is based on the complementarity of purine and pyrimidine bases.

Structurally, complementary base pairing maintains a uniform width of the DNA double helix and stabilizes the molecule through hydrogen bonding and base stacking interactions. It also ensures the antiparallel orientation of the two strands.

Functionally, complementary base pairing enables accurate DNA replication, where each strand serves as a template for synthesis of a new strand. It also ensures faithful transcription of RNA from DNA, maintaining genetic continuity and minimizing errors in genetic information transfer.

**(3) Outline the hierarchical organization of DNA packaging in eukaryotic cells, from the double helix to fully condensed chromosomes.**

DNA is first organized as a double helix, which wraps around histone proteins to form nucleosomes. These nucleosomes coil to form a 30 nm chromatin fiber. Further folding creates looped domains attached to scaffold proteins, which condense into chromatin. During cell division, chromatin becomes highly condensed to form metaphase chromosomes.

This hierarchical packaging allows a large amount of DNA to fit within the nucleus, protects DNA from damage, and regulates gene expression by differentiating between active euchromatin and inactive heterochromatin.

**(4) Describe the structure of nucleosomes and explain their role in chromatin organization and DNA compaction.**

A nucleosome consists of a histone octamer made of two molecules each of H2A, H2B, H3, and H4. About 146 base pairs of DNA wrap around this histone core. Linker DNA connects adjacent nucleosomes, and histone H1 stabilizes the structure.

Nucleosomes are the basic unit of chromatin and play a central role in DNA compaction. They help organize DNA within the nucleus and regulate gene expression through histone modifications such as acetylation and methylation. They also protect DNA from damage.

**(5) Discuss the diverse roles of nucleotides beyond their role in nucleic acid synthesis, providing relevant examples.**

Nucleotides function as energy carriers, with ATP serving as the main energy currency of the cell and GTP involved in protein synthesis and signaling. They also act as second messengers, such as cAMP in hormonal signaling and cGMP in vasodilation.

They form components of coenzymes like $NAD^+$/NADH and $FAD/FADH_2$, which participate in redox reactions and the electron transport chain. Activated nucleotide intermediates such as UDP-glucose are essential in glycogen synthesis. Nucleotides also act as regulatory molecules by modulating enzyme activity through allosteric effects.

# COURSE 3 -FUCTIONAL ASPECTS OF PROTEINS

# TUTORIALS & ANSWERS

# Tutorial 01 – Functions of Protein and Protein Synthesis Questions

**This quiz consists of 40 Fill in the blanks questions. Answer all the questions with in one hour.**

**Section A: DNA Structure & Function**

1. DNA is made up of a sugar called _____, are made of a phosphate group, and nitrogenous bases.
2. The nitrogenous base Thymine (T) pairs with _____.
3. DNA strands are held together by _____ bonds between complementary bases.
4. The DNA double helix is arranged in an _____ manner.
5. The process of separating DNA strands is called _____.
6. The temperature at which half of the DNA double helix is lost is called _____.
7. DNA strands can re-form the double helix through a process known as _____.
8. DNA has a directionality from _____ to _____.
9. The loss of helical structure in DNA is referred to as _____.
10. The reformation of the double helix under proper conditions is termed _____.

**Section B: Components and Organization**

(1) DNA in the nucleus is associated with proteins called _____.

(2) The basic structural unit of chromatin is the _____.

(3) During replication, new histones are synthesized and associate with _____ DNA strands.

(4) In prokaryotes, DNA is located in the _____ region.

(5) The backbone of DNA is formed by _____ bonds between nucleotides.

(6) Each nucleotide consists of a nitrogenous base, a sugar, and a _____ group.

(7) The 5'-end of DNA has a free _____ group.

(8) The 3'-end of DNA has a free _____ group.

(9) The sequence of DNA bases is always read from _____ to _____ direction.

(10) The double-stranded nature of DNA allows it to serve as a _____ during replication.

**Section C: DNA Replication**

(1) DNA replication is described as _____ because each new DNA molecule contains one old and one new strand.

(2) In prokaryotes, replication begins at a single site called the _____.

(3) In eukaryotes, replication begins at multiple sites called _____ sequences.

(4) The site where DNA strands unwind to begin replication is called the _____.

(5) DNA unwinding is facilitated by an enzyme called _____.

(6) _____ prevents reformation (Reannealing) of the double helix .

(7) _____ helps relieve supercoiling during DNA replication.

(8) Short stretches of RNA required to initiate DNA synthesis are called _____.

(9) DNA polymerase adds nucleotides to the _____ end of the new strand.

(10) On the leading strand, DNA synthesis is _____.

(11) On the lagging strand, DNA synthesis occurs in short fragments called _____ fragments.

(12) RNA primers on the lagging strand are removed by the _____ activity of DNA polymerase I.

(13) DNA fragments are joined by the enzyme _____.

(14) The enzyme that proofreads and corrects replication errors is _____.

(15) Errors not corrected by proofreading are repaired by the _____ repair system.

(16) In the lagging strand, DNA synthesis proceeds _____ from the replication fork.

(17) Each Okazaki fragment requires a separate _____ to initiate synthesis.

(18) The enzyme _____ synthesizes short RNA primers needed to start DNA synthesis.

(19) DNA Polymerase I in prokaryotes also has _____ activity to remove RNA primers.

(20) The enzyme responsible for sealing nicks between fragments during DNA replication is _____.

# Tutorial 01 – Functions of Protein and Protein Synthesis Answers

**Answer Key**

1. Deoxyribose
2. Adenine
3. Hydrogen
4. Antiparallel
5. Denaturation
6. Melting temperature (Tm)
7. Renaturation
8. 5'; 3'
9. Denaturation
10. Renaturation
11. Histones
12. Nucleosome
13. Newly synthesized
14. Nucleoid
15. Phosphodiester
16. Phosphate
17. Phosphate
18. Hydroxyl (OH)
19. 5'; 3'
20. Template
21. Semiconservative
22. Origin of replication
23. Consensus
24. Replication fork
25. Helicase
26. SSB proteins
27. Topoisomerase
28. RNA primers
29. 3'
30. Continuous
31. Okazaki
32. Exonuclease
33. DNA ligase
34. DNA polymerase
35. Mismatch
36. Away
37. RNA primer
38. Primase
39. Exonuclease
40. DNA ligase

# Tutorial 02 – Enzymes Questions

(1) Define what an enzyme is?
(2) List four factors that affect enzyme activity?
(3) List the six major classes of enzymes and state the type of chemical reaction catalysed by each class?
(4) Briefly describe catalytic efficiency of enzymes?
(5) Briefly describe enzyme specificity?
(6) Briefly describe holoenzymes?

# Tutorial 02 – Enzymes Answers

**(1) Define what an enzyme is?**

- Enzymes are biological protein catalysts
- that increase the rate of biochemical reactions
- without being consumed or permanently changed in the reaction
- They lower the activation energy required for reactions

**(2) List four factors that affect enzyme activity?**

- Temperature
- pH (hydrogen ion concentration)
- Substrate concentration
- Enzyme concentration

**(3) List the six major classes of enzymes and state the type of chemical reaction catalysed by each class?**

- Oxidoreductases – catalyse oxidation-reduction reactions
- Transferases – transfer functional groups such as C, N, or P
- Hydrolases – catalyse bond cleavage using water
- Lyases – break C-C, C-S, and certain C-N bonds without hydrolysis
- Isomerases – catalyse rearrangement of atoms within a molecule
- Ligases – form bonds between molecules using energy from ATP hydrolysis

**(4) Briefly describe catalytic efficiency of enzymes?**

- Enzymes greatly increase reaction rates compared to uncatalysed reactions (about $10^3$–$10^8$ times faster)
- Each enzyme molecule can convert many substrate molecules per second
- This is expressed as turnover number (kcat), typically $10^2$–$10^4$ $s^{-1}$
- It reflects how efficiently an enzyme converts substrate into product

**(5) Briefly describe enzyme specificity?**

- Enzymes are highly specific for their substrates
- Each enzyme typically catalyses only one type of reaction
- Specificity depends on the active site structure
- Cellular enzyme composition determines metabolic pathways in a cell

**(6) Briefly describe holoenzymes?**

- A holoenzyme is the complete and active form of an enzyme
- It consists of an apoenzyme (protein part) plus a cofactor
- Cofactors may be metal ions (e.g., $Zn^{2+}$, $Fe^{2+}$) or organic coenzymes
- If tightly bound, they are prosthetic groups; if loosely bound, they are co-substrates
- The apoenzyme alone is inactive without its non-protein component

# Tutorial 03 – Plasma Proteins Questions

(1) List four physiological functions of albumin in the body?
(2) List four causes of hypoalbuminemia?
(3) List four clinical features of hypoalbuminemia?
(4) Briefly describe the diagnostic uses of serum albumin levels?
(5) Outline the management strategies for hypoalbuminemia?
(6) Outline the major types of globulins and their functions?
(7) Discuss the role of alpha-1 antitrypsin and the consequences of its deficiency?
(8) Explain the clinical significance of gamma globulins (immunoglobulins), including their role in immunity and disease states?
(9) Describe methods used for the detection of globulin abnormalities and their diagnostic value in conditions like multiple myeloma?

# Tutorial 03 – Plasma Proteins Answers

**(1) List four physiological functions of albumin in the body?**

- Maintenance of plasma oncotic (osmotic) pressure, which helps retain fluid within blood vessels
- Transport of substances such as hormones, fatty acids, bilirubin, and drugs
- Buffering of blood pH by contributing to acid–base balance
- Antioxidant properties by binding and neutralizing reactive molecules

**(2) List four causes of hypoalbuminemia?**

- Decreased synthesis (e.g., chronic liver disease, cirrhosis)
- Increased loss (e.g., nephrotic syndrome, protein-losing enteropathy)
- Increased catabolism due to severe illness, infection, or inflammation
- Hemodilution due to fluid overload or pregnancy

**(3) List four clinical features of hypoalbuminemia?**

- Generalized edema due to reduced oncotic pressure
- Ascites and pleural effusion in severe cases
- Fatigue and generalized weakness
- Poor wound healing and increased susceptibility to infections

**(4) Briefly describe the diagnostic uses of serum albumin levels?**

- Assessment of liver synthetic function, especially in chronic liver disease
- Marker of nutritional status, particularly protein-calorie malnutrition
- Prognostic indicator in critically ill patients, surgery, and chronic disease
- Indicator of kidney disease when associated with proteinuria (e.g., nephrotic syndrome)
- Negative acute-phase reactant, decreases in inflammation, sepsis, and trauma

**(5) Outline the management strategies for hypoalbuminemia?**

- Treat underlying cause such as liver disease, kidney disease, infection, or inflammation
- Improve nutritional intake with high-protein diet and oral or enteral supplements
- Use parenteral nutrition in severe malnutrition when oral intake is inadequate
- Manage fluid imbalance with cautious use of diuretics and fluid restriction if needed
- Albumin infusion in selected severe cases (e.g., cirrhosis with ascites or shock)

**(6) Outline the major types of globulins and their functions?**

- Alpha-1 globulins: include α1-antitrypsin; inhibit proteolytic enzymes and protect tissues
- Alpha-2 globulins: include haptoglobin and ceruloplasmin; transport hemoglobin and copper
- Beta globulins: include transferrin and complement proteins; transport iron and support immunity
- Gamma globulins: immunoglobulins (IgG, IgA, IgM, IgE, IgD); responsible for immune defense

**(7) Discuss the role of alpha-1 antitrypsin and the consequences of its deficiency?**

- Alpha-1 antitrypsin is a serine protease inhibitor produced mainly by the liver
- It inhibits enzymes such as neutrophil elastase, protecting lung tissue from damage

Consequences of deficiency:

- Lung disease (early-onset emphysema) due to unchecked elastase activity destroying alveolar walls
- Liver disease due to accumulation of abnormal protein in hepatocytes causing hepatitis and cirrhosis
- Smoking worsens disease by inactivating the inhibitor and accelerating lung damage

**(8) Explain the clinical significance of gamma globulins (immunoglobulins), including their role in immunity and disease states?**

- Gamma globulins are antibodies that provide humoral immune defense
- They neutralize pathogens, toxins, and promote opsonization and complement activation
- Increased levels occur in chronic infections, autoimmune diseases, and multiple myeloma
- Decreased levels occur in immunodeficiency states leading to recurrent infections
- Monoclonal increase indicates plasma cell disorders such as multiple myeloma or MGUS

**(9) Describe methods used for the detection of globulin abnormalities and their diagnostic value in conditions like multiple myeloma?**

- Serum protein electrophoresis (SPEP): detects monoclonal “M spike” in gamma region in multiple myeloma
- Immunofixation electrophoresis (IFE): identifies type of monoclonal immunoglobulin (IgG, IgA, κ, λ)
- Quantitative immunoglobulin assays: measure levels of IgG, IgA, IgM for diagnosis and monitoring
- Urine protein electrophoresis (UPEP): detects Bence Jones proteins (free light chains) in urine
- These tests help diagnose, classify, and monitor multiple myeloma and related plasma cell disorders

# SGDs & ANSWERS

# SGD 01 – Functions of Protein and Protein Synthesis Questions

(1) Describe the concept of DNA melting temperature (Tm). Include the factors that influence it and the clinical applications of understanding Tm?
(2) Outline the structure and medical significance of plasmids. Include their role in antibiotic resistance and biotechnology?
(3) Define the central dogma of molecular biology. Discuss its steps, associated enzymes, and relate it to a genetic disorder?
(4) Anticancer agents such as etoposide target human topoisomerase II, while bacterial DNA gyrase is targeted by quinolones such as ciprofloxacin. Describe the role of topoisomerases in DNA metabolism and explain how etoposide and ciprofloxacin exert their therapeutic effects?

# SGD 01 – Functions of Protein and Protein Synthesis Answers

**(1) Describe the concept of DNA melting temperature (Tm). Include the factors that influence it and the clinical applications of understanding Tm?**

DNA melting temperature (Tm) is the temperature at which 50% of double-stranded DNA becomes single-stranded due to the breaking of hydrogen bonds between complementary base pairs. It reflects the thermal stability of DNA.

Factors influencing Tm:
• GC content – higher GC content increases Tm due to stronger triple hydrogen bonding
• Length of DNA – longer DNA strands have higher Tm
• Salt concentration – higher ionic strength stabilizes DNA and increases Tm
• Base mismatches – reduce stability and lower Tm
• pH and denaturing agents – extreme conditions decrease Tm

Clinical applications:
• PCR primer design and optimization
• Detection of mutations using melting curve analysis
• Molecular diagnosis of infectious and genetic diseases
• DNA hybridization techniques
• Forensic and paternity testing

**(2) Outline the structure and medical significance of plasmids. Include their role in antibiotic resistance and biotechnology?**

Plasmids are small, circular, double-stranded extrachromosomal DNA molecules found in bacteria that replicate independently of chromosomal DNA.

Structure:
• Circular DNA molecule with an origin of replication (ori)
• May carry antibiotic resistance or virulence genes
• Can be transferred between bacteria via conjugation

Medical significance:
• Spread of antibiotic resistance through R-plasmids among bacteria
• Carry genes for toxins and virulence factors
• Contribute to horizontal gene transfer and bacterial evolution

Biotechnology applications:
• Used as cloning vectors in genetic engineering
• Production of recombinant proteins such as insulin
• Gene cloning and expression systems
• Tools in molecular biology and gene therapy research

**(3) Define the central dogma of molecular biology. Discuss its steps, associated enzymes, and relate it to a genetic disorder?**

The central dogma describes the flow of genetic information in biological systems: DNA → RNA → Protein.

Steps:
• Replication: DNA → DNA (enzyme: DNA polymerase)
• Transcription: DNA → mRNA (enzyme: RNA polymerase)
• Translation: mRNA → protein (ribosomes, tRNA, aminoacyl-tRNA synthetase)

Associated enzymes:
• DNA polymerase for replication
• RNA polymerase for transcription
• Ribosomal machinery and translation factors for protein synthesis

Genetic disorder example:
• Sickle cell anemia
• Caused by point mutation in β-globin gene
• Leads to abnormal hemoglobin (HbS) and altered red blood cell shape
• Demonstrates how DNA mutation leads to defective protein and disease

**(4) Anticancer agents such as etoposide target human topoisomerase II, while bacterial DNA gyrase is targeted by quinolones such as ciprofloxacin. Describe the role of topoisomerases in DNA metabolism and explain how etoposide and ciprofloxacin exert their therapeutic effects?**

Topoisomerases are enzymes that regulate DNA supercoiling and relieve torsional stress during replication, transcription, and repair.

Roles:
• Topoisomerase I cuts one DNA strand to relieve supercoiling
• Topoisomerase II cuts both DNA strands to untangle and separate DNA molecules
• DNA gyrase (bacteria) introduces negative supercoils to facilitate replication

Etoposide:
• Inhibits human topoisomerase II
• Prevents re-ligation of DNA strands after breakage
• Causes accumulation of double-strand breaks
• Leads to apoptosis in rapidly dividing cancer cells

Ciprofloxacin:
• Inhibits bacterial DNA gyrase (topoisomerase II equivalent)
• Prevents DNA replication and transcription
• Causes bacterial DNA damage and cell death
• Selective toxicity due to targeting bacterial-specific enzyme systems

# SGD 02 – Haemoglobin Questions

(1) Describe the role of haemoglobin in carbon dioxide transport?
(2) Explain the buffering action of haemoglobin in blood?
(3) Discuss the causes and biochemical basis of methemoglobinemia?
(4) Summarize the biosynthesis and regulation of heme and globin?

# SGD 02 – Haemoglobin Answers

**(1) Describe the role of haemoglobin in carbon dioxide transport?**

• Most $CO_2$ produced in tissues is transported in blood as bicarbonate ion ($HCO_3^-$).
• A smaller portion is carried bound to haemoglobin as carbaminohemoglobin.
• $CO_2$ binds to the N-terminal amino groups of globin chains.
• Binding of $CO_2$ stabilizes the deoxygenated (T state) form of haemoglobin.
• This decreases haemoglobin's affinity for oxygen and promotes oxygen release in tissues (Bohr effect).
• In the lungs, $CO_2$ dissociates from haemoglobin and is exhaled.

**(2) Explain the buffering action of haemoglobin in blood?**
• $CO_2$ diffuses into red blood cells and is converted to carbonic acid by carbonic anhydrase.
• Carbonic acid dissociates into bicarbonate ($HCO_3^-$) and hydrogen ions ($H^+$).
• Free $H^+$ would lower blood pH, but haemoglobin binds $H^+$ and acts as a buffer.
• Deoxygenated haemoglobin has a high affinity for $H^+$, preventing acidosis in tissues.
• In the lungs, oxygenation of haemoglobin reduces its affinity for $H^+$, releasing hydrogen ions.
• $H^+$ combines with bicarbonate to form $CO_2$ and water, which are exhaled.

**(3) Discuss the causes and biochemical basis of methemoglobinemia?**
• Methemoglobinemia is caused by oxidation of iron in haemoglobin from $Fe^{2+}$ to $Fe^{3+}$.
• $Fe^{3+}$ form (methemoglobin) cannot bind oxygen, reducing oxygen delivery to tissues.
Causes:
• Drug-induced oxidation (e.g., nitrates, local anesthetics, oxidant drugs)
• Endogenous oxidative stress (reactive oxygen species)
• Genetic mutations in globin chains (Hb M variants)
• Deficiency of NADH–cytochrome b5 reductase (enzyme responsible for reducing $Fe^{3+}$ back to $Fe^{2+}$)
Clinical features:
• Chocolate-brown blood and cyanosis ("chocolate cyanosis")
• Headache, dizziness, dyspnea, anxiety
• Severe cases: coma and death due to tissue hypoxia
Treatment:
• Methylene blue, which enhances reduction of methemoglobin to haemoglobin

**(4) Summarize the biosynthesis and regulation of heme and globin?**
Heme biosynthesis:
• Occurs partly in mitochondria and cytosol
• First step: glycine + succinyl-CoA → δ-ALA via ALA synthase (rate-limiting step)
• ALA → porphobilinogen → protoporphyrin IX
• Final step: insertion of $Fe^{2+}$ into protoporphyrin IX by ferrochelatase to form heme
Regulation:
• ALA synthase is the key regulatory enzyme
• Inhibited by feedback inhibition from heme
• Induced by increased demand for cytochrome P450 (e.g., barbiturates)

Globin synthesis:
• Globin chains are produced on ribosomes in cytoplasm
• Different genes are expressed during development:
• Embryonic: ζ, ε
• Fetal: $\alpha_2\gamma_2$ (HbF)
• Adult: $\alpha_2\beta_2$ (HbA), $\alpha_2\delta_2$ ($HbA_2$)
• Gene switching occurs after birth from γ to β chains
• Expression is developmentally regulated and coordinated with heme availability

# SGD 03 – Enzymes Questions

(1) Define $V_0$ in enzyme kinetics?
(2) Define Vmax in enzyme kinetics?
(3) Define Km in enzyme kinetics?
(4) Illustrate the effect of a competitive inhibitor on the reaction velocity ($V_0$) versus substrate concentration plot?
(5) Illustrate the Lineweaver–Burk plot of competitive inhibition of an enzyme?
(6) Briefly describe statin drugs as examples of competitive inhibitors?
(7) Briefly describe how substrate concentration affects enzyme reaction velocity?
(8) Briefly describe how pH affects enzyme reaction velocity?
(9) Illustrate the effect of a non-competitive inhibitor on the reaction velocity ($V_0$) versus substrate concentration plot?
(10) Illustrate the Lineweaver–Burk plot of non-competitive inhibition of an enzyme?
(11) Briefly describe cyanide as an example of a non-competitive inhibitor?

# SGD 03 – Enzymes Answers

**(1) Define $V_0$ in enzyme kinetics?**
$V_0$ (initial velocity) is the rate of an enzyme-catalyzed reaction measured at the very beginning of the reaction, before significant substrate depletion or product accumulation occurs.

**(2) Define Vmax in enzyme kinetics?**
Vmax is the maximum velocity of an enzyme-catalyzed reaction when all enzyme active sites are fully saturated with substrate.

**(3) Define Km in enzyme kinetics?**
Km (Michaelis–Menten constant) is the substrate concentration at which the reaction velocity is half of Vmax. It indicates enzyme affinity for substrate; low Km means high affinity, high Km means low affinity.

(4) **Illustrate the effect of a competitive inhibitor on the reaction velocity ($V_0$) versus substrate concentration plot?**
• In competitive inhibition, Vmax remains unchanged
• Km increases (apparent decrease in affinity)
• Curve shifts to the right on the $V_0$ vs substrate concentration graph
• Higher substrate concentration can overcome inhibition

**(5) Illustrate the Lineweaver–Burk plot of competitive inhibition of an enzyme?**
• y-intercept (1/Vmax) remains unchanged
• x-intercept shifts toward zero (−1/Km becomes less negative)
• slope increases
• lines intersect on the y-axis

**(6) Briefly describe statin drugs as examples of competitive inhibitors?**
• Statins are competitive inhibitors of HMG-CoA reductase
• They resemble the natural substrate of the enzyme
• They block the rate-limiting step in cholesterol synthesis
• This leads to reduced cholesterol production and lower plasma LDL levels

**(7) Briefly describe how substrate concentration affects enzyme reaction velocity?**
• As substrate concentration increases, reaction velocity increases
• At low substrate levels, velocity increases rapidly
• At high substrate levels, enzyme active sites become saturated
• The reaction reaches Vmax where further increases in substrate do not increase velocity

**(8) Briefly describe how pH affects enzyme reaction velocity?**
• Enzymes have an optimum pH at which activity is highest
• Changes in pH alter ionization of amino acids at the active site
• Extreme pH can denature enzymes by disrupting protein structure
• Activity decreases when pH moves away from optimum

**(9) Illustrate the effect of a non-competitive inhibitor on the reaction velocity ($V_0$) versus substrate concentration plot?**
• Vmax decreases
• Km remains unchanged
• Curve shows a lower maximum plateau
• Inhibition cannot be overcome by increasing substrate concentration

**(10) Illustrate the Lineweaver–Burk plot of non-competitive inhibition of an enzyme?**

- y-intercept increases (1/Vmax increases)
- x-intercept remains unchanged (−1/Km constant)
- slope increases
- lines intersect on the x-axis

**(11) Briefly describe cyanide as an example of a non-competitive inhibitor?**

- Cyanide inhibits cytochrome c oxidase (Complex IV) in the electron transport chain
- It binds at a site other than the substrate binding site
- It blocks electron transport and oxidative phosphorylation
- This prevents ATP production and causes cellular hypoxia and rapid tissue death
- It is especially toxic to high oxygen-demand tissues like the brain and heart

# BIOCHEMISTRY MOCK PAPERS AND ANSWERS CAT 1 - 2026

# CAT- 1 (BATCH 3) MOCK MCQ - 2026

# UVA WELLASSA UNIVERSITY
## FACULTY OF MEDICINE
## MBBS Degree Program
## Continuous Assessment 01
## MOCK Paper
## 2024/2025 (03rd) Batch
## BIOCHEMISTRY
## Multiple Choice Question (MCQ) Paper

Please Time 8.30- 9.30a.m. (01 hour) Date of the exam:2026-05-22

do not attempt or promote copying. No textbooks, notes, mobile phones, smart watches, or any other electronic communication devices are allowed.

Please read the following instructions before marking responses on your answer sheets

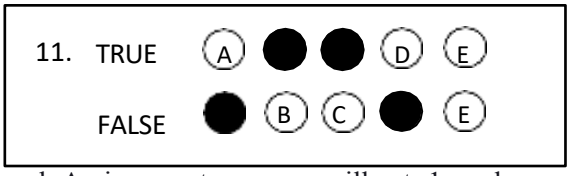
1. Check that your question paper has a total of 5 pages, including the front page.
2. A single answer sheet is provided. Please write your index number in the given space.
3. Read each question carefully before answering.
4. Mark the correct response as a heavy black mark filling the relevant circle completely, using a black lead pencil (6B or above grade).
5. Mark no stray marks on the answer sheet. In case of an error, erase cleanly.
6. Your final answer should be a densely coloured circle through which the underlying letter is not visible.
7. Marking using any other method (e.g., mark the circle with a cross) is not valid.

Ten (10) True/False Type Questions (Questions 1-10/Page 2-3)

1. Mark whether each response is true or false.
2. Given below is an example of how to mark a true/false type question.

Q 11. A woman has

A. one ovary.
B. one nose.
C. two ears.
D. one eye.
E. two hairs.



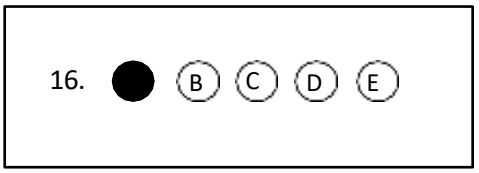

A correct response will get +1 mark An incorrect response will get -1 mark
No response will get 0 (zero) mark
Negative marks will not be carried over to the next question

Ten (10) Single Best Response Type Questions (Questions 11-20/ Page 3-4)

1. Mark the best response. Only one response per question should be marked.
2. If you mark the correct response, you will get the full marks for the question.
3. If you mark an incorrect response, fail to mark any response, select more than one response, or mark your response unclearly, you will not receive any marks for that question.
4. Given below is an example of how to mark a single best response type question.

Q 16. Speaking is a unique ability observed in humans. Which of the following body parts is primarily used for speech production?

A. Tongue
B. Hands
C. Feet
D. Ears
E. Nose



**Question numbers 01 to 10 are True or False type questions. Mark your answer for each of the five responses (A to E).**

(1) True or False regarding primary structure in protein synthesis?

(A) It contains functional domains.
(B) It contains peptide bonds.
(C) It is the final structure of a functional protein.
(D) It is translated and produced by the nucleotide sequence of its gene.
(E) Its structure is lost during denaturing.

(2) True or False regarding fatty acids?

(A) It is a storage form of fat in the human body.
(B) They are hydrophilic.
(C) They comprise double bonds.
(D) They contain phosphate groups.
(E) They can form ester bonds with Glycerol.

(3) Which of the following biomolecules are found in the cell membrane?

(A) Sphingophospholipids
(B) Triacylglycerol
(C) Proteins
(D) Glycolipids
(E) Cholesteryl esters

(4) True or False regarding enzymes?

(A) All enzymes are regulated allosterically.
(B) They decrease the activation energy of reactions.
(C) They show their highest activity at 37 °C.
(D) Their reactions are regulated by increasing the transcription of the enzyme.
(E) They are inhibited competitively by functional analogues of substrates.

(5) True or False regarding tricarboxylic acid cycle (TCA)?

(A) This cycle occurs in red blood cells.
(B) It is a common pathway for all macromolecules.
(C) It produces $CO_2$.
(D) This cycle takes part in gluconeogenesis.
(E) It uses $NAD^+$ and FAD as co-enzymes.

(6) True or False regarding Electron transport chain?

(A) It creates an electrochemical gradient.
(B) During this process, energy is released.
(C) During this process, $FADH_2$ is oxidized.
(D) It happens on mitochondrial cristae.
(E) During this process, NADH regenerates.

(7) True or False regarding the pentose phosphate pathway?

(A) Glucose-6-phosphatase is the key regulatory enzyme.
(B) It is active in the adrenal cortex.
(C) Non-oxidative phase occurs bypassing the oxidative phase
(D) Thymine pyrophosphate is required for the non-oxidative phase.
(E) Uses NADH as a cofactor.

(8) True or False regarding gluconeogenesis?

(A) Occurs in skeletal muscles during exercise.
(B) Produces energy in hepatocytes.
(C) Occurs in red blood cells.
(D) Usually occurs in the fed state.
(E) It is an energy-generating mechanism.

(9) Which of the following inhibit cholesterol synthesis?

(A) Statins
(B) Sterol regulatory element-binding protein
(C) Glucose
(D) Bile acids
(E) Glucagon

(10) True or False regarding glucose in cellular energy metabolism?

(A) Oxidation in inner most renal medulla produce a net yield of 2 ATP.
(B) Energy release during formation of covalent bonds.
(C) Aerobic glycolysis occurs in white blood cells.
(D) Pyruvate dehydrogenase is vital for red blood cells.
(E) ATP is produced in HMP shunt.

**Questions number 11 to 20 are Single Best Response (SBR) type. Select the best response to each question.**

(11) Defects in intracellular organelles can disrupt normal cellular processes.

Which of the following statement best describes such effects?
(A) Golgi apparatus defects impair protein modification and transport.
(B) Lysosomal dysfunction causes accumulation of undegraded materials.
(C) Mitochondrial defects impair ATP production.
(D) Nuclear defects mainly affect genetic regulation.
(E) Rough endoplasmic reticulum defects affect protein synthesis.

(12) A 70-year-old patient with chronic heart failure is treated with digoxin to improve cardiac performance.

Which of the following is the primary cellular mechanism responsible for its therapeutic effect?
(A) Blocking potassium channels in cardiac cells.
(B) Enhancement of myocardial contractility.
(C) Increase in intracellular calcium concentration.
(D) Inhibition of $Na^+/K^+$-ATPase pump.
(E) Reduction of sodium-calcium exchanger activity.

(13) Glycosaminoglycans are important components of connective tissues.

Which of the following feature is most important for their function?
(A) High negative charge due to sulfate groups.
(B) Acting as enzymes in extracellular fluid.
(C) Providing energy storage.
(D) Being linked via peptide bonds.
(E) Synthesized mainly in mitochondria.

(14) During intense exercise, increased $CO_2$ and decreased pH affect oxygen delivery.

What is the effect of this on hemoglobin?
(A) Increased oxygen affinity in acidic tissues.
(B) Decreased oxygen release in high $CO_2$ conditions.
(C) Enhanced oxygen release in tissues with high $CO_2$.
(D) Increased binding of oxygen in muscles.
(E) Reduced hemoglobin saturation in lungs.

(15) The efficiency of enzymes depends on their active sites.

Which of the following characteristic is most important for enzyme function?
(A) Flexibility of the active site structure
(B) Lack of interaction with substrates
(C) Location deep within the enzyme core
(D) Rigid and unchanging structure
(E) Specific arrangement of amino acid side chains

(16) A 30-year-old woman with acute renal failure is evaluated for acid–base balance.

Which buffer system plays the most significant role in maintaining blood pH?
(A) Ammonia buffer system
(B) Bicarbonate buffer system
(C) Hemoglobin buffer system
(D) Phosphate buffer system
(E) Plasma protein buffer system

(17) Which of the following protein is NOT typically detected in serum protein electrophoresis?
(A) Albumin
(B) Ceruloplasmin
(C) Ferritin
(D) Fibrinogen
(E) Haptoglobin

(18) Which of the following factor most strongly stabilizes the DNA double helix?
(A) Base stacking interactions
(B) Ionic bonding
(C) Phosphodiester bonds
(D) Polycation interactions
(E) Hydrogen bonding between purines

(19) Which of the following statement best describes facilitated diffusion?
(A) Movement via specific carrier proteins
(B) Transport via vesicles
(C) Requires ATP
(D) Moves against gradient
(E) Uses ion pumps

(20) DNA template: 5’-GCTTCGA-3’
Which of the following is the mRNA sequence?
(A) 3’-CGAAGCU-5’
(B) 3’-CGAAGCT-5’
(C) 3’-CGAUCGU-5’
(D) 3’-GCUAGCU-5’
(E) 3’-GCTTCGA-5’

# CAT- 1 (BATCH 3) MOCK MCQ ANSWERS - 2026

MOCK MCQ Answer Guide Semester 1

(1) Answer: F T F T T

Explanation:
The primary structure of a protein refers to the linear sequence of amino acids linked by peptide bonds. This sequence is determined by the nucleotide sequence of the gene during translation. Functional proteins usually require higher levels of organization such as secondary, tertiary, or quaternary structures. Denaturation disrupts the native conformation of proteins and results in loss of their functional structure.

(2) Answer: F F T F T

Explanation:
Fatty acids are long-chain carboxylic acids that are largely hydrophobic in nature. They may be saturated or unsaturated, with unsaturated fatty acids containing one or more double bonds. Fatty acids can combine with glycerol through ester bonds to form triacylglycerols, the major storage form of fat in the body.

(3) Answer: T F T T F

Explanation:
Cell membranes are composed mainly of phospholipids, proteins, cholesterol, and glycolipids arranged in a fluid mosaic structure. Membrane lipids provide structural integrity, while proteins mediate transport and signaling. Storage lipids such as triacylglycerols and cholesteryl esters are not normal structural components of biological membranes.

(4) Answer: F T F T T

Explanation:
Enzymes are biological catalysts that accelerate chemical reactions by lowering activation energy. Their activity can be regulated by several mechanisms, including gene expression, allosteric regulation, and inhibition. Competitive inhibitors often resemble the substrate and compete for the enzyme's active site.

(5) Answer: F T T T T

Explanation:
The tricarboxylic acid (TCA) cycle occurs in the mitochondrial matrix and serves as a central metabolic pathway for the oxidation of carbohydrates, fats, and proteins. It generates carbon dioxide and reducing equivalents in the form of NADH and $FAD_2$, while providing intermediates for several biosynthetic pathways including gluconeogenesis.

(6) Answer: T T T T T

Explanation:
The electron transport chain is located in the inner mitochondrial membrane and is responsible for oxidative phosphorylation. Electrons from NADH and $FADH_2$ are transferred through a series of complexes, releasing energy that is used to create a proton gradient. This gradient drives ATP synthesis while regenerating $NAD^+$ and FAD.

(7) Answer: F T T T F

Explanation:
The pentose phosphate pathway is an alternative pathway of glucose metabolism that produces NADPH and ribose-5-phosphate. NADPH is required for reductive biosynthesis and antioxidant defense. The pathway consists of oxidative and non-oxidative phases, and transketolase reactions in the non-oxidative phase require thiamine pyrophosphate (TPP).

(8) Answer: F F F F F

Explanation:
Gluconeogenesis is the synthesis of glucose from non-carbohydrate precursors such as lactate, glycerol, and amino acids. It occurs mainly in the liver and kidneys during fasting or starvation. The pathway requires significant energy input and functions to maintain blood glucose levels rather than generate energy.

(9) Answer: T F F T T

Explanation:
Cholesterol synthesis is regulated primarily through the enzyme HMG-CoA reductase. Statins directly inhibit this enzyme, while bile acids and glucagon suppress cholesterol synthesis through feedback and hormonal regulation. Factors promoting lipogenesis generally stimulate rather than inhibit cholesterol production.

(10) Answer: T F T F F

Explanation:
Glucose is the major energy source for many tissues and can be metabolized through glycolysis, the TCA cycle, and oxidative phosphorylation. Certain cells, such as red blood cells and cells in the renal medulla, rely heavily on glycolysis. While glycolysis generates ATP, the pentose phosphate pathway primarily produces NADPH and ribose sugars rather than ATP.

(11) Answer: C. Mitochondrial defects impair ATP production

Explanation:
Mitochondria are the primary site of ATP production through oxidative phosphorylation. Defects in these organelles directly impair cellular energy generation and can affect the function of multiple organs, particularly those with high energy demands such as the heart, brain, and muscles.

(12) Answer: D. Inhibition of $Na^+/K^+$-ATPase pump

Explanation:
Digoxin exerts its therapeutic effect by inhibiting the $Na^+/K^+$-ATPase pump in cardiac muscle cells. This increases intracellular sodium concentration, which reduces sodium-calcium exchange and leads to an increase in intracellular calcium. The elevated calcium enhances myocardial contractility and improves cardiac output.

(13) Answer: A. High negative charge due to sulfate groups

Explanation:
Glycosaminoglycans (GAGs) contain numerous sulfate and carboxyl groups that impart a strong negative charge. This property attracts water and cations, allowing connective tissues to resist compression, provide lubrication, and maintain structural integrity.

(14) Answer: C. Enhanced oxygen release in tissues with high $CO_2$

Explanation:
Increased carbon dioxide concentration and decreased pH shift the oxygen dissociation curve to the right, a phenomenon known as the Bohr effect. This reduces hemoglobin's affinity for oxygen and promotes oxygen release to metabolically active tissues.

(15) Answer: E. Specific arrangement of amino acid side chains

Explanation:
The catalytic activity and specificity of an enzyme depend on the precise arrangement of amino acid residues within its active site. These residues facilitate substrate binding and catalysis, allowing the enzyme to efficiently carry out its biological function.

(16) Answer: B. Bicarbonate buffer system

Explanation:
The bicarbonate buffer system is the most important extracellular buffer in the body. It works in conjunction with the lungs and kidneys to maintain blood pH within a narrow physiological range and plays a central role in acid-base homeostasis.

(17) Answer: D. Fibrinogen

Explanation:
Fibrinogen is normally absent from serum because it is consumed during the clotting process. Therefore, it is not detected in serum protein electrophoresis, although it can be identified in plasma protein electrophoresis.

(18) Answer: A. Base stacking interactions

Explanation:
The major stabilizing force of the DNA double helix is base stacking between adjacent nitrogenous bases. These hydrophobic and van der Waals interactions contribute more to DNA stability than hydrogen bonding between complementary bases.

(19) Answer: A. Movement via specific carrier proteins

Explanation:
Facilitated diffusion is a passive transport mechanism in which molecules move down their concentration gradient through specific carrier proteins or channels. It does not require ATP and cannot transport substances against a gradient.

(20) Answer: A. 3'-CGAAGCU-5'

Explanation:
During transcription, the mRNA sequence is complementary and antiparallel to the DNA template strand. Uracil (U) replaces thymine (T) in RNA. Therefore, the complementary sequence to 5'-GCTTCGA-3' is 3'-CGAAGCU-5'.

# CAT- 1 (BATCH 3) MOCK SEQ - 2026

**UVA WELLASSA UNIVERSITY FACULTY OF MEDICINE**
**MBBS Degree Program Continuous Assessment MOCK Paper**
**April 2026 2024/2025 (3rd) Batch BIOCHEMISTRY**
**Structured Essay Paper**

Instructions to candidates:

- This paper consists of two Structure Essay Questions
- Answer all questions
- Write the answers on answer sheets provided
- Start each question on a new page

Question 1

A person who claimed to have not eaten for a day had the following urine results:

- Sugar – negative
- Protein – negative
- Ketone bodies – positive

(1.1) Name **one** test that can be used to detect each of the following in urine:

1.1.1 Sugar (10 marks)
1.1.2 Protein (10 marks)

(1.2) Name **two** metabolic pathways that are activated in this person. (20 marks)

(1.3) Explain how ketone bodies appear in his urine. (60 marks)

Question 2

(1.1) List **three** substrates of gluconeogenesis. (30 marks)

(1.2) Name the key regulatory enzyme of each of the following pathways:

2.2.1 Glycolysis (10 marks)
2.2.2 Glycogenolysis (10 marks)

(1.3) List **two** specific features/properties of allosteric enzymes. (20 marks)

(1.4) Describe the importance of allosteric enzymes in regulating metabolic pathways. (30 marks)

# CAT-1 (BATCH 3) MOCK SEQ ANSWERS - 2026

MOCK SEQ Answer Guide Semester 3

**Question 1**

**(1.1) Name one test that can be used to detect each of the following in urine**

**1.1.1 Sugar (10 marks)**
**Answer:** Benedict's test. **(10 marks)**

**1.1.2 Protein (10 marks)**
**Answer:** Heat coagulation test (or Sulfosalicylic acid test). **(10 marks)**

**(1.2) Name two metabolic pathways that are activated in this person. (20 marks)**

**Answer:**
- Gluconeogenesis **(10 marks)**
- Ketogenesis (or Fatty acid oxidation/Lipolysis) **(10 marks)**

**(1.3) Explain how ketone bodies appear in his urine. (60 marks)**

**Answer:**
- After one day of fasting, blood glucose levels begin to fall and insulin secretion decreases. **(10 marks)**
- The low insulin to glucagon ratio stimulates lipolysis in adipose tissue, releasing free fatty acids into the blood. **(10 marks)**
- These fatty acids are transported to the liver and undergo β-oxidation, producing large amounts of acetyl-CoA. **(10 marks)**
- During fasting, oxaloacetate is diverted towards gluconeogenesis, reducing its availability for the TCA cycle. **(10 marks)**
- As a result, excess acetyl-CoA cannot enter the TCA cycle and is converted into ketone bodies (acetoacetate, β-hydroxybutyrate and acetone) in the liver. **(10 marks)**
- When ketone body production exceeds tissue utilization, their concentration in blood rises (ketonemia) and excess ketone bodies are excreted in urine (ketonuria). **(10 marks)**

**Question 2**

**(2.1) List three substrates of gluconeogenesis. (30 marks)**

**Answer:**
- Lactate **(10 marks)**
- Glycerol **(10 marks)**
- Glucogenic amino acids (e.g., alanine) **(10 marks)**

**(2.2) Name the key regulatory enzyme of each of the following pathways**

**2.2.1 Glycolysis (10 marks)**
**Answer:** Phosphofructokinase-1 (PFK-1). **(10 marks)**

**2.2.2 Glycogenolysis (10 marks)**
**Answer:** Glycogen phosphorylase. **(10 marks)**

**(2.3) List two specific features/properties of allosteric enzymes. (20 marks)**

**Answer:**

- They possess specific allosteric (regulatory) sites separate from the active site. **(10 marks)**
- They exhibit sigmoidal (S-shaped) substrate saturation kinetics due to cooperative substrate binding. **(10 marks)**

**(2.4) Describe the importance of allosteric enzymes in regulating metabolic pathways. (30 marks)**

**Answer:**

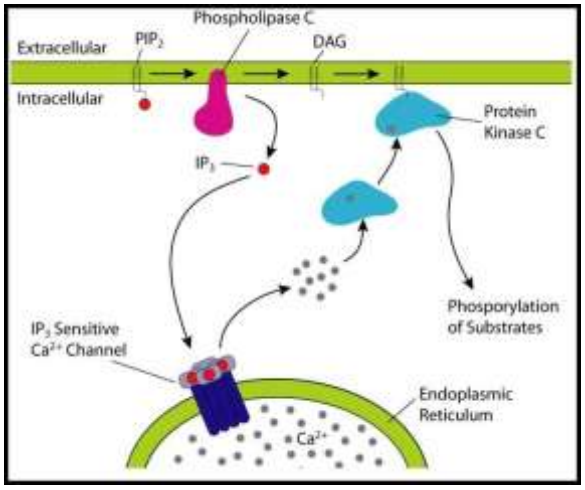
- Allosteric enzymes usually catalyze the rate-limiting or committed step of metabolic pathways. **(6 marks)**
- Their activity is rapidly altered by allosteric activators and inhibitors according to the metabolic needs of the cell. **(6 marks)**
- They allow feedback inhibition, where the end product of a pathway inhibits an earlier regulatory enzyme. **(6 marks)**
- They prevent unnecessary synthesis or degradation of metabolites, conserving energy and resources. **(6 marks)**
- They coordinate and integrate different metabolic pathways to maintain metabolic homeostasis. **(6 marks)**

**Total = 30 marks**.

# CAT- 1 (BATCH 3) MOCK OSPE - 2026

**(Q1)**

**Second Messenger Pathway**




The diagram shows a second messenger pathway involved in producing cellular responses.

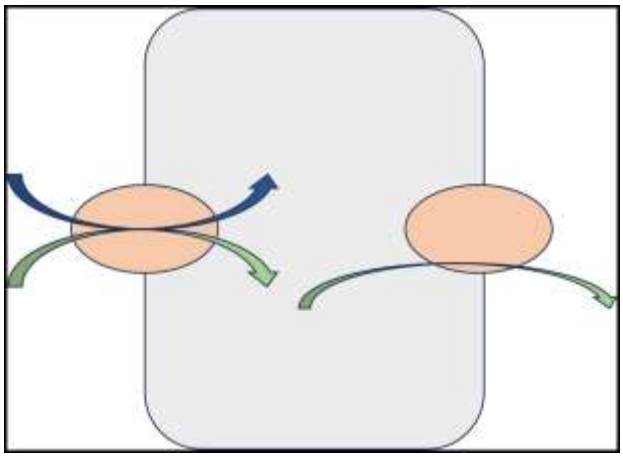
(1.1) Name the second messenger X. (05 Marks)

(1.2) Name a hormone that makes cellular responses through this pathway. (05 Marks)

**(Total: 10 Marks)**

**(Q2)**

**Iodine Transport in Thyroid Follicular Cell**



This diagram illustrates the transport mechanism of iodine across a follicular cell of the thyroid gland.

(2.1) Identify A. (04 Marks)

(2.2) List two plasma proteins that bind thyroid hormones. (03 Marks)

(2.3) Name the precursor for thyroid hormone synthesis. (03 Marks)

**(Total: 10 Marks)**

**(Q3)**

## Familial Hypercholesterolemia





These pictures show a patient with familial hypercholesterolemia.

(3.1) Identify the abnormality shown here. (03 Marks)

(3.2) Which lipoprotein is mainly elevated in the serum in this condition? (03 Marks)

(3.3) List three ways of improving the condition of this patient. (04 Marks)

**(Total: 10 Marks)**

**(Q4)**

**Blood Glucose Values**

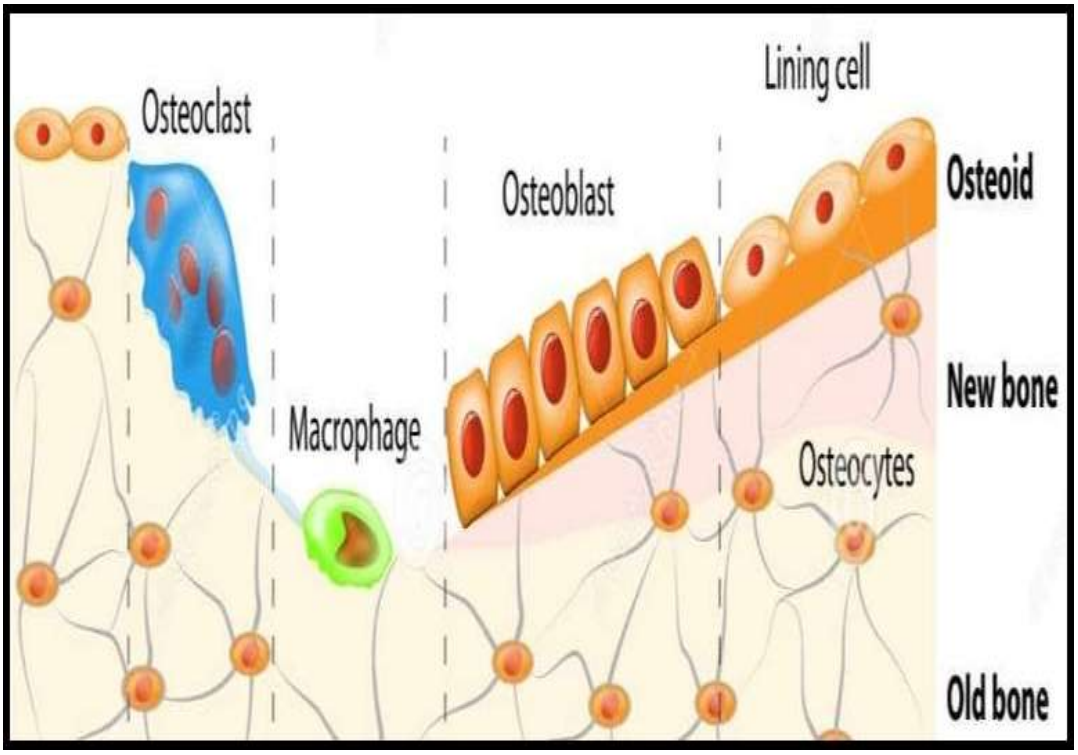
FBS - 97 mg/dL
PPBS in 1 hour - 188 mg/dL
PPBS in 2 hours - 162 mg/dL

(4.1) Comment on the above values of the patient. (05 Marks)
(4.2) State the importance of knowing the above values. (05 Marks)

**(Total: 10 Marks)**

**(Q5)**

**Bone Remodelling Process**




The picture shows a biological process occurring in bone tissue.

(5.1) Name the process interpreted here. (05 Marks)
(5.2) Name the two types of cells shown as A and B. (05 Marks)

**(Total: 10 Marks)**

**(Q6)**

## Vitamin Deficiency



A 6-year-old child presents with fatigue, bleeding gums and joint pain. On examination, there are petechiae, swollen bleeding gums and poor wound healing. The child has a history of a highly restricted diet lacking fresh fruits and vegetables. A vitamin deficiency is suspected.

(6.1) What is the most likely diagnosis? (04 Marks)
(6.2) State the biochemical role of the deficient vitamin mentioned above. (06 Marks)

**(Total: 10 Marks)**

**(Q7)**

## Copper Metabolism

A patient has kinky hair, growth retardation and neurological symptoms. A copper deficiency is suspected.

(7.1) Name one copper-containing enzyme. (05 Marks)
(7.2) Name the disease caused by copper accumulation. (05 Marks)

**(Total: 10 Marks)**

**(Q8)**

## Cardiac Biomarkers

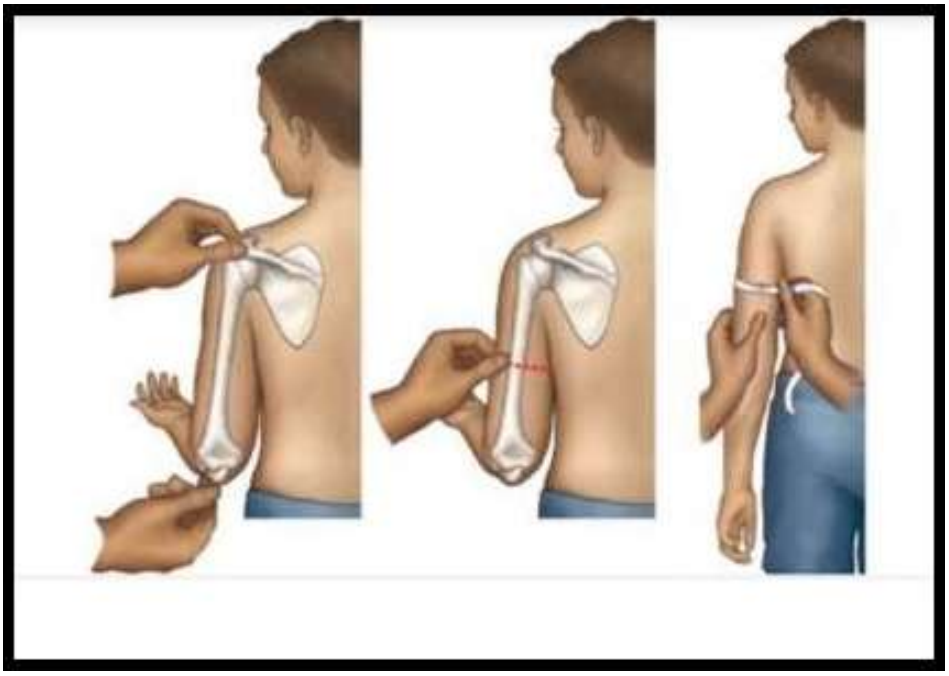
A 55-year-old man presents with chest pain for 4 hours.

(8.1) Which cardiac biomarker is most specific for myocardial infarction? (04 Marks)
(8.2) Which biomarker rises earliest after myocardial infarction? (03 Marks)
(8.3) Name one enzyme previously used in diagnosis of myocardial infarction. (03 Marks)

**(Total: 10 Marks)**

**(Q9)**

**Anthropometry Measurement**



This picture shows one anthropometry measurement taken from the body. The above measurement value is shown as 11 cm.

(9.1) Name the anthropometry shown in the picture. (03 Marks)

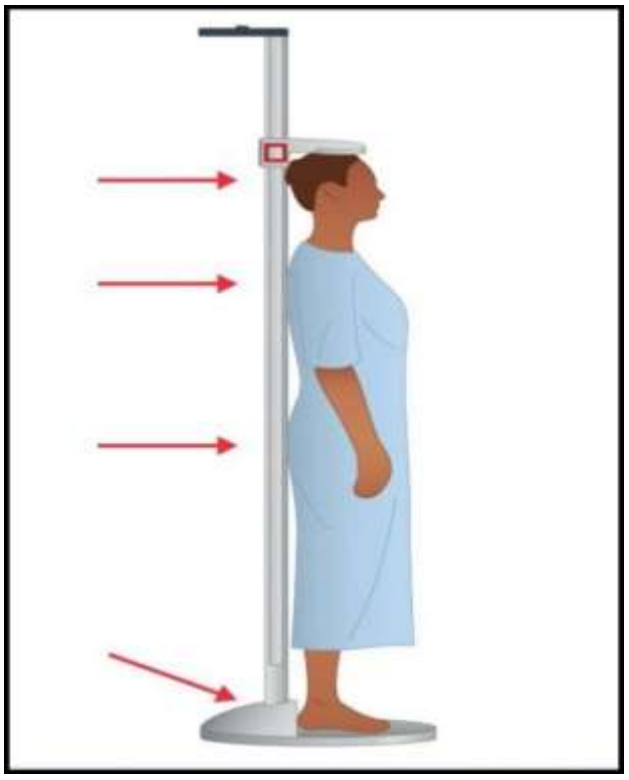
(9.2) What are the advantages of this measurement compared with calculated BMI value in the body? (03 Marks)

(9.3) Conclude your opinion about the person's body status. (04 Marks)

**(Total: 10 Marks)**

**(Q10)**

**Standing Height Measurement**



The picture shows an instrument used to take an anthropometry measurement.

(10.1) What is the instrument shown in the picture? (03 Marks)

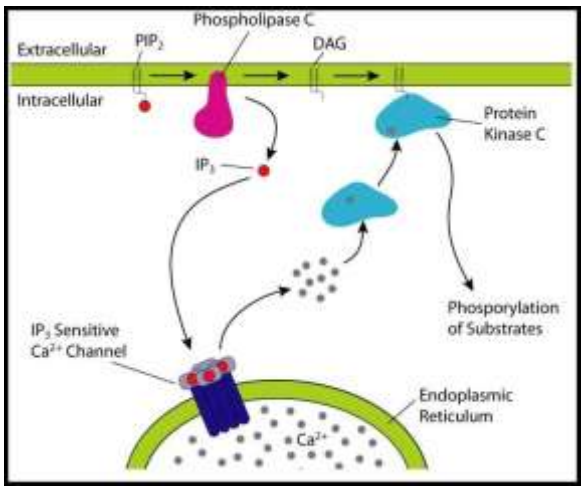
(10.2) What is the anthropometry measurement taken from that instrument? (03 Marks)

(10.3) What are the body places A, B, C, D and E which should touch the instrument while taking the measurement? (04 Marks)

**(Total: 10 Marks)**

# CAT- 1 (BATCH 3) MOCK OSPE ANSWERS - 2026

MOCK OSPE ANSWER GUIDE
Semester 3




(Q1)
(1.1) Cyclic AMP (cAMP)
(1.2) Glucagon (also acceptable: ACTH, TSH, FSH, LH, PTH)

(Q2)
(2.1) Sodium–Iodide Symporter (NIS)
(2.2) Two plasma proteins that bind thyroid hormones:

- Thyroxine-binding globulin (TBG)
- Transthyretin (Thyroxine-binding prealbumin)

(2.3) Thyroglobulin





(Q3)
(3.1) Tendon xanthoma
(3.2) Low-density lipoprotein (LDL)
(3.3) Three ways to improve the condition:

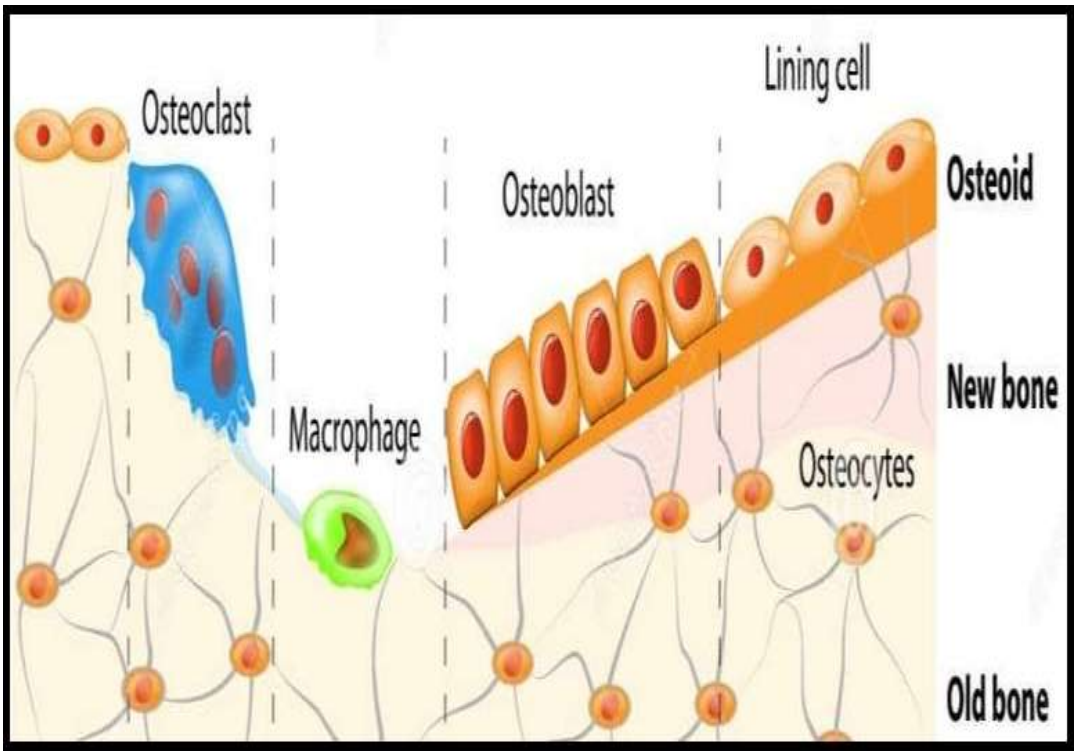
- Low-cholesterol and low-saturated-fat diet
- Regular physical exercise
- Statin therapy

FBS - 97 mg/dL

PPBS in 1 hour - 188 mg/dL
PPBS in 2 hours - 162 mg/dL

(Q4)
(4.1) Impaired glucose tolerance (Prediabetes)
(4.2) Importance:

- Early detection of diabetes mellitus
- Assessment of glucose metabolism
- Identification of individuals at risk of developing diabetes
- Monitoring effectiveness of treatment/lifestyle modification
- Prevention of diabetic complications




(Q5)
(5.1) Bone remodelling
(5.2)
A – Osteoclast
B – Osteoblast

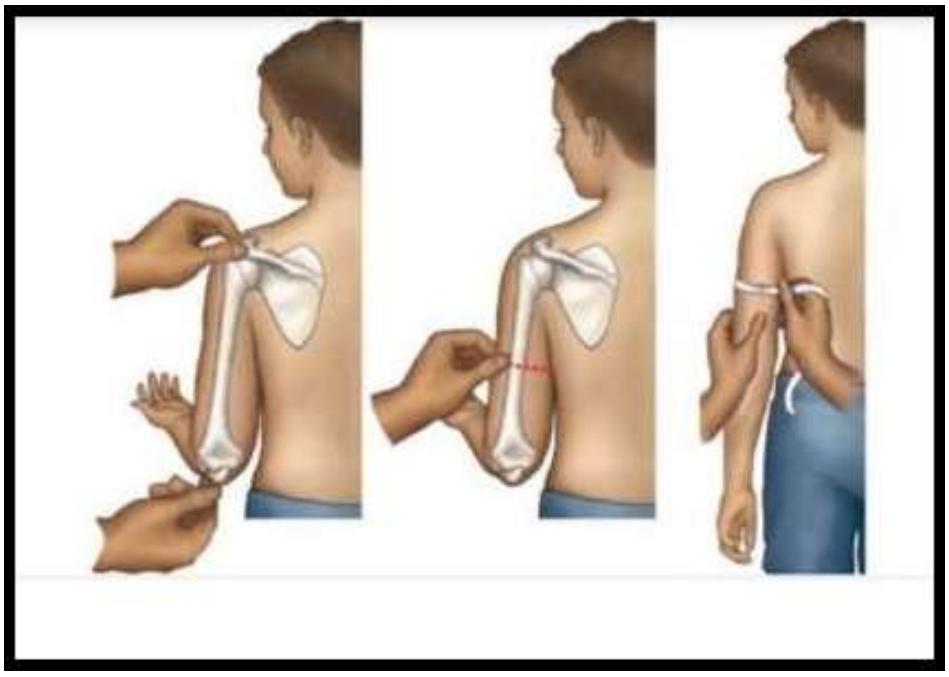


(Q6)
(6.1) Scurvy (Vitamin C deficiency)
(6.2) Biochemical roles of Vitamin C:

- Hydroxylation of proline and lysine during collagen synthesis
- Antioxidant function
- Enhances iron absorption
- Promotes wound healing
- Maintains connective tissue integrity
- Supports immune function

(Q7)
(7.1) Cytochrome c oxidase (also acceptable: Superoxide dismutase, Tyrosinase, Lysyl oxidase)
(7.2) Wilson disease

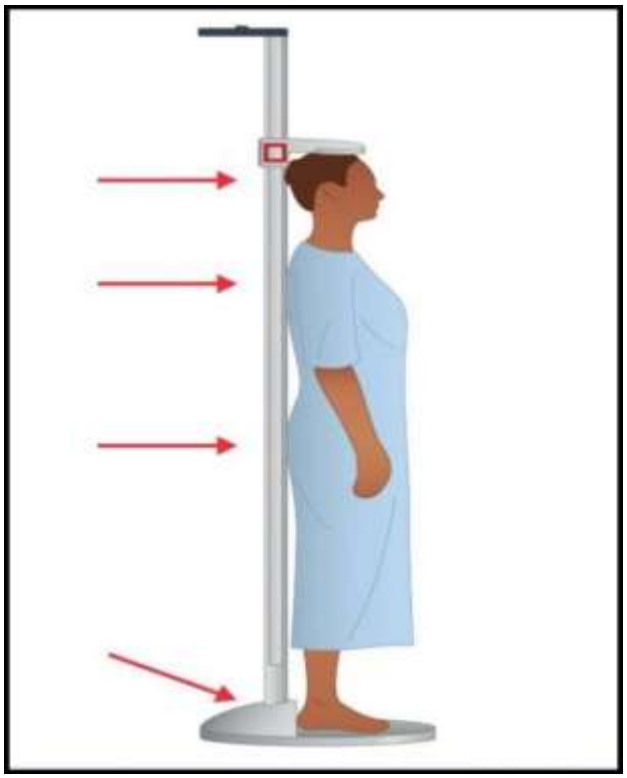
(Q8)
(8.1) Cardiac Troponin I (cTnI) (or Troponin T)
(8.2) Myoglobin
(8.3) Creatine kinase-MB (CK-MB)



(Q9)
(9.1) Waist circumference
(9.2) Advantages compared with BMI:

- Better indicator of central (abdominal) obesity
- Better predictor of cardiovascular and metabolic risk
- Simple and inexpensive measurement

(9.3) The person has abdominal/central obesity (assuming the measurement shown is 110 cm)



(Q10)
(10.1) Stadiometer
(10.2) Standing height
(10.3) Body parts A–E that should touch the instrument:

- Heels
- Calves
- Buttocks
- Shoulders (upper back/scapular region)
- Back of the head (occiput)

# BIOCHEMISTRY CONTINUOUS ASSESSMENT-1

# 2024/2025 (THIRD BATCH)

# CAT- 1 (BATCH 3) MCQ PAPER - 2026

**UVA WELLASSA UNIVERSITY OF SRI LANKA FACULTY OF MEDICINE**
**Continuous Assessment 01**
**June 2026 2024/2025 (03rd) Batch**
**Biochemistry**
**Multiple Choice Questions (MCQ) Paper**

Time 10.00 a.m. – 11.00 a.m. (01 hour) Date of the exam: 2026.06.01 Please do not attempt or promote copying. No textbooks, notes, mobile phones, smart watches, or any other electronic communication devices are allowed.

Please read the following instructions before marking responses on your answer sheets

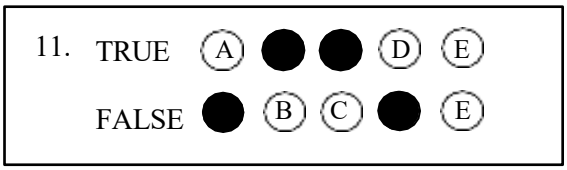
1. Check that your question paper has a total of 06 pages, including the front page.
2. A single answer sheet is provided. Please write your index number in the given space.
3. Read each question carefully before answering.
4. Mark the correct response as a heavy black mark, filling the relevant circle completely, using a black lead pencil (6B or above grade).
5. Do not make stray marks on the answer sheet. In case of an error, erase cleanly.
6. Your final answer should be a densely coloured circle through which the underlying letter is not visible.
7. Marking using any other method (e.g., mark the circle with a cross) is not valid.

Ten (10) True/False Type Questions (Questions 1-10/Page 2-3)

1. Mark whether each response is true or false.
2. Given below is an example of how to mark a true/false type question.

Q 11. A woman has

A. one ovary.
B. one nose.
C. two ears.
D. one eye.
E. two hairs.



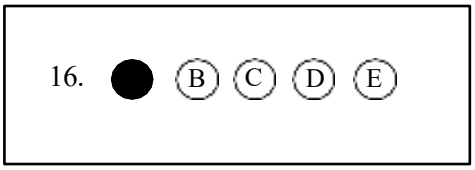

A correct response will get = +1 mark An incorrect response will get = -1 mark
No response will get = 0 (zero) mark
Negative marks will not be carried over to the next question

Ten (10) Single Best Response (SBR) Type Questions (Questions 11-20/ Page 4-6)

1. If you mark the correct response, you will get the full marks for the question.
2. If you mark an incorrect response, fail to mark any response, select more than one response, or mark your response unclearly, you will not receive any marks for that question.
3. Given below is an example of how to mark a single best response type question.

Q 16. Speaking is a unique ability observed in humans. Which of the following body parts is primarily used for speech production?

A. Tongue
B. Hands
C. Feet
D. Ears
E. Nose



**Question numbers 01 to 10 are True or False type questions. Mark your answer for each of the five responses (A to E).**

(1) True or False regarding sites of ATP production?
- (A) Cytoplasm
- (B) Endoplasmic Reticulum
- (C) Golgi apparatus
- (D) Lysosome
- (E) Mitochondrion

(2) True or False regarding the Golgi apparatus?
- (A) It consists of membrane-bound cisternae.
- (B) It is a double-membrane organelle.
- (C) It is the primary site of protein synthesis.
- (D) It is the site of sorting and packaging proteins.
- (E) It tags lysosomal enzymes with mannose-6-phosphate.

(3) True or False regarding functions of the cell membrane?
- (A) Cholesterol affects membrane fluidity.
- (B) Hydrophobic molecules require membrane proteins to cross.
- (C) Ion imbalance disrupts cellular homeostasis.
- (D) Pinocytosis allows entry of large molecules.
- (E) Sphingolipids contribute to signal transduction.

(4) True or False regarding structural proteins?
- (A) Collagen contains hydroxyproline for stability.
- (B) Elastin provides elasticity to tissues.
- (C) Keratin is found in epidermis.
- (D) Laminin facilitates cell apoptosis.
- (E) Myosin forms thin filaments in muscle.

(5) True or False regarding bioenergetics?
- (A) ATP is the main energy currency of the cell.
- (B) $Cu^{2+}$ is a cofactor for enzymes in oxidative phosphorylation.
- (C) Endergonic reactions occur spontaneously.
- (D) NADPH acts as an electron carrier.
- (E) Oxidative phosphorylation occurs in the mitochondrial inner membrane.

(6) True or False regarding the sphingolipids?
- (A) Glycerol acts as the polar head.
- (B) Phosphocholine is an example.
- (C) Some sphingolipids contain nitrogen.
- (D) Sphingosine forms the backbone.
- (E) Two fatty acid chains are attached to sphingosine.

(7) True or False regarding the glycogen molecule?
- (A) It contains $\beta(1\rightarrow4)$ bonds.
- (B) It is a highly branched molecule.
- (C) It is made of glucose units.
- (D) It is present in the kidney.
- (E) It is the main form of energy storage in adipose tissues.

(8) Which of the following are examples of aromatic amino acids?
(A) Arginine
(B) Phenylalanine
(C) Proline
(D) Tryptophan
(E) Valine

(9) Which of the following are examples of metalloproteins containing iron ($Fe^{2+}$ or $Fe^{3+}$)?
(A) Albumin
(B) Ceruloplasmin
(C) Cytochromes
(D) Haemoglobin
(E) Myoglobin

(10) Which of the following factors increases DNA melting temperature (Tm)?
(A) High AT content
(B) High GC content
(C) High salt concentration
(D) Presence of denaturants
(E) Short DNA length

**Question numbers 11 to 20 are Single Best Response (SBR) type. Select the best response for each question.**

(11) A 6-year-old child presents with generalized oedema. Urine examination shows marked proteinuria. Serum protein electrophoresis reveals a reduced albumin band with a relative increase in α2-globulin, while γ-globulins are also reduced.

Which of the following is the most likely diagnosis?
(A) Acute glomerulonephritis
(B) Acute infection
(C) Chronic liver disease
(D) Multiple myeloma
(E) Nephrotic syndrome

(12) A type of haemoglobin is uniquely characterized by the presence of gamma (γ) globin chains, which confer a higher affinity for oxygen compared to adult haemoglobin, facilitating oxygen transfer across the placenta.

Which of the following haemoglobin type best matches this description?
(A) Haemoglobin A (HbA)
(B) Haemoglobin $A_2$ ($HbA_2$)
(C) Haemoglobin C (HbC)
(D) Haemoglobin F (HbF)
(E) Haemoglobin S (HbS)

(13) A nitrogenous base found in nucleic acids is characterized by a single heterocyclic ring and the presence of an amino group ($–NH_2$).

Which of the following nucleic acid best matches this description?
(A) Adenine
(B) Cytosine
(C) Guanine
(D) Thymine
(E) Uracil

(14) A membrane transport mechanism is characterized by its ability to use the energy stored in an electrochemical gradient of one solute to drive the transport of another solute against its concentration gradient.

Which of the following best matches this description?
(A) Antiporter
(B) Channel protein
(C) Primary active transporter
(D) Secondary active transporter
(E) Uniporter

(15) A physiological buffer system is characterized by its ability to bind hydrogen ions through reversible oxygenation changes in red blood cells, thereby playing a major role in buffering during $CO_2$ transport in blood.

Which of the following buffer systems best matches this description?

(A) Albumin
(B) Ammonia
(C) Bicarbonate
(D) Haemoglobin
(E) Phosphate

(16) During serum protein electrophoresis, one plasma protein is absent because it is removed during sample processing.
Which of the following protein is absent?

(A) Albumin
(B) Ceruloplasmin
(C) Fibrinogen
(D) Globulin
(E) Transferrin

(17) A researcher studies DNA stability and notes that disruption of hydrophobic interactions significantly destabilizes the double helix.
Which of the following interactions is primarily affected?

(A) Base stacking
(B) Glycosidic bonds
(C) Hydrogen bonding
(D) Ionic interactions
(E) Phosphodiester bonds

(18) A drug enters cells via a transport mechanism that is saturable and does not require ATP.
Which of the following best describes this mechanism?

(A) Active transport
(B) Endocytosis
(C) Facilitated diffusion
(D) Secondary transport
(E) Simple diffusion

(19) An enzyme exhibits a characteristic property in which its reaction rate increases with substrate concentration only up to a certain point, after which it reaches a maximum velocity (Vmax) due to saturation of active sites.

Which of the following best describes this property of enzymes?

(A) Allosteric inhibition
(B) Competitive inhibition
(C) Feedback inhibition
(D) Irreversible inhibition
(E) Michaelis–Menten kinetics

(20) A mutation in a human cell leads to reduced protein production. Further analysis shows that initiation of transcription is specifically affected, while DNA replication remains normal. Which of the following enzyme is most directly affected in this condition?

(A) DNA ligase
(B) DNA polymerase
(C) Reverse transcriptase
(D) RNA polymerase
(E) Topoisomerase

# CAT- 1 (BATCH 3) MCQ ANSWERS - 2026

(1) TFFFT
(2) TFFTT
(3) TFTTT
(4) TTTFF
(5) TTFTT
(6) FTTTF
(7) FFTTF
(8) FTTFT
(9) FFTTT
(10) FT TFF
(11) E
(12) D
(13) B
(14) D
(15) D
(16) C
(17) A
(18) C
(19) E
(20) D

# CAT- 1 (BATCH 3) SEQ PAPER - 2026

**UVA WELLASSA UNIVERSITY FACULTY OF MEDICINE**
**Continuous Assessment 03**
**June 2026 2024/2025**
**(03rd) Batch**
**Biochemistry**
**Structured Essay Questions (SEQ) Paper**

Time **11.15 am – 12.15 pm** (01 hour) Date of the exam: 2026.06.01

Index (MED) Number ……

Please do not attempt or promote copying. No textbooks, notes, mobile phones, smart watches, or any other electronic communication devices are allowed.

**Instructions to Candidates**

- This paper contains two (02) Structured Essay Questions.
- Answer all questions.
- Write your answers in the spaces provided.
- If additional space is required, you may use extra sheets. Ensure that the relevant question number is clearly indicated on each additional sheet.
- Write your index number in the designated space on each answer sheet, including any extra sheets used.

(Q1). Regarding Cellular Transport Mechanisms and pH

(1.1) Regarding cellular transport mechanisms

(1.1.1) Define endocytosis. (15 Marks)

(1.1.2) Compare facilitated diffusion and active transport under the following headings. (20 Marks)

- Energy requirement
- Direction of transport
- Carrier protein involved
- An example of a molecule/ion that uses this transport mechanism

(1.2) Regarding pH

(1.2.1) Define pH. (15 Marks)

(1.2.2) Name the weak acid and conjugate base of the following buffer systems. (20 Marks)

- Phosphate buffer system
- Ammonia buffer system

(1.2.3) Briefly explain the mechanism of action of the bicarbonate buffer system in maintaining blood pH. (30 Marks)

Total: 100 Marks

(Q2). Regarding Protein and Protein Synthesis

(2.1) List the main steps in protein synthesis. (20 Marks)
(2.2) List three covalent attachment type post-translational modifications of proteins and state one significance of each modification. (30 Marks)
(2.3) Briefly describe the structure of haemoglobin. (30 Marks)
(2.4) List four (04) factors that affect the oxygen dissociation curve. (20 Marks)

Total: 100 Marks

# CAT -1 (BATCH 3) SEQ ANSWERS - 2026

**(Q1)**

**(1.1.1) Define endocytosis (15 Marks)**

- Energy-dependent transport process – 5 marks
- Invagination of the plasma membrane – 5 marks
- Formation of membrane-bound vesicles/internalization of extracellular substances – 5 marks

**Total: 15 marks**

**(1.1.2) Compare facilitated diffusion and active transport (20 Marks)**

- Energy requirement – 5 marks
- Direction of transport – 5 marks
- Carrier protein involved – 5 marks
- Example of a molecule/ion – 5 marks

**Total: 20 marks**

**(1.2.1) Define pH (15 Marks)**

- Correct formula: $pH = -\log_{10}[H^+]$ – 10 marks
- States that pH is a measure of hydrogen ion concentration/acidity and alkalinity – 5 marks

**Total: 15 marks**

**(1.2.2) Name the weak acid and conjugate base of the following buffer systems (20 Marks)**

- $H_2PO_4^-$ (dihydrogen phosphate) – 5 marks
- $HPO_4^{2-}$ (hydrogen phosphate) – 5 marks
- $NH_4^+$ (ammonium ion) – 5 marks
- $NH_3$ (ammonia) – 5 marks

**Total: 20 marks**

**(1.2.3) Briefly explain the mechanism of action of the bicarbonate buffer system in maintaining blood pH (30 Marks)**

- Correct bicarbonate buffer equation – 5 marks
- Formation of carbonic acid from $CO_2$ and $H_2O$ – 5 marks
- Dissociation into $H^+$ and $HCO_3^-$ – 5 marks
- Buffering action when acid is added – 5 marks
- Buffering action when base is added – 5 marks
- Role of lungs and kidneys in regulation – 5 marks

**Total: 30 marks**

**Q2**

**(2.1) List main steps in protein synthesis (20 Marks)**

- Transcription – 3 marks
- RNA processing – 3 marks
- Activation of amino acids – 3 marks
- Initiation – 3 marks
- Elongation – 4 marks
- Termination – 4 marks

**Total: 20 marks**

**(2.2) List three covalent attachment type post-translational modifications of proteins and state one significance of each modification (30 Marks)**

- Phosphorylation – 5 marks
- Significance of phosphorylation – 5 marks
- Glycosylation – 5 marks
- Significance of glycosylation – 5 marks
- Hydroxylation – 5 marks
- Significance of hydroxylation – 5 marks

**Total: 30 marks**

**(2.3) Briefly describe the structure of haemoglobin (30 Marks)**

- Haemoglobin is a tetramer – 5 marks
- Consists of two α and two β globin chains in HbA – 5 marks
- Each chain contains a heme group – 5 marks
- Heme consists of protoporphyrin IX and $Fe^{2+}$ – 5 marks
- One haemoglobin molecule binds four oxygen molecules – 5 marks
- Description of protein structural levels/quaternary structure – 5 marks

**Total: 30 marks**

**(2.4) List four factors that affect the oxygen dissociation curve (20 Marks)**

- pH (Bohr effect) – 5 marks
- Partial pressure of $CO_2$ ($pCO_2$) – 5 marks
- Temperature – 5 marks
- 2,3-Bisphosphoglycerate (2,3-BPG) – 5 marks

**Total: 20 marks**

# CAT -1 (BATCH 3) OSPE PAPER - 2026

## (Q1)

### A Laboratory Instrument




An image of a laboratory instrument is given.

(1.1) Name the instrument. (04 Marks)

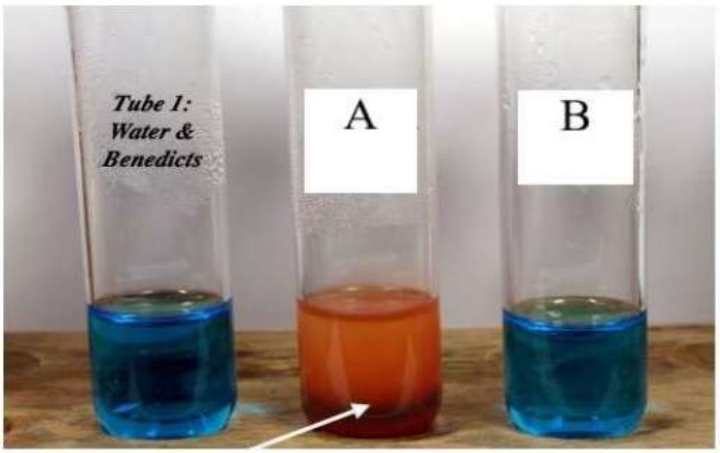
(1.2) Name the part labelled as "A". (03 Marks)

(1.3) What is the function of "A"? (03 Marks)

**(Total: 10 Marks)**

## (Q2)

### Benedict's Test




Two urine samples were received by the laboratory, and Benedict's Test was performed on both samples (Sample A and Sample B). The result is shown above.

(2.1) Interpret the results. (04 Marks)

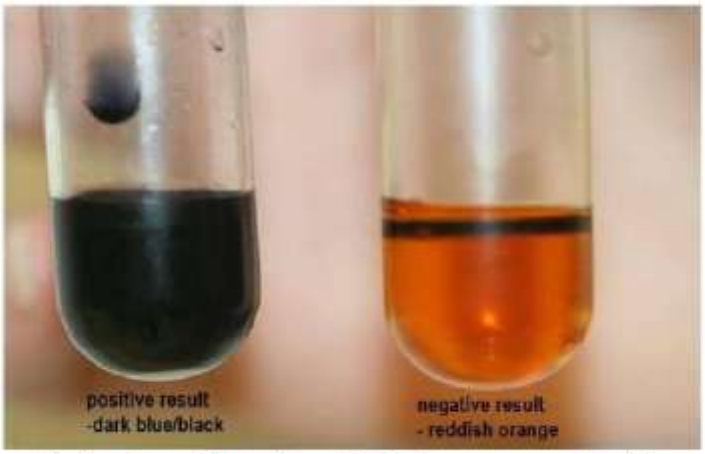
(2.2) State the most likely substance present in sample A. (03 Marks)

(2.3) Name **one** other substance that will give positive results for the above test. (03 Marks)

**(Total: 10 Marks)**

**(Q3)**

## Iodine Test




A solution gives a blue-black color with iodine which disappears on heating and reappears on cooling.

(3.1) Identify the carbohydrate present. (04 Marks)
(3.2) State the structural basis for this color change. (03 Marks)
(3.3) Name **two** types of glycosidic bonds present in this molecule. (03 Marks)

**(Total: 10 Marks)**

**(Q4)**

## Saturated Fats



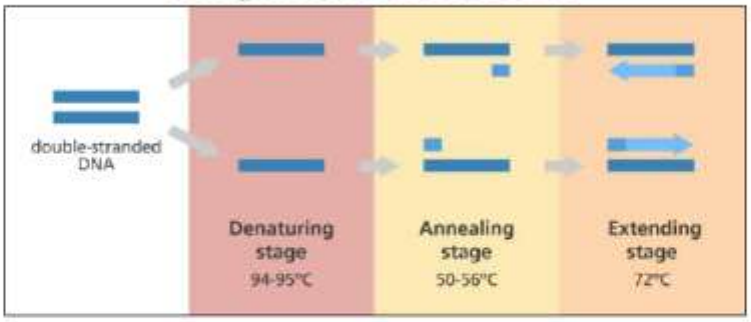

A patient with an abnormal lipid profile is advised to reduce intake of saturated fats.

(4.1) What is the difference between saturated and unsaturated fatty acids? (04 Marks)
(4.2) State the principle of bromine water test in detecting unsaturation. (03 Marks)
(4.3) State **one** health risk associated with trans fats. (03 Marks)

**(Total: 10 Marks)**

## (Q5)

### Amplification of DNA




A laboratory is performing amplification of a specific DNA segment using a thermocycler.

(5.1) Name the molecular technique used. (04 Marks)

(5.2) Name the enzyme responsible for DNA synthesis in this technique. (03 Marks)

(5.3) List **two** additional essential components required for this process. (03 Marks)

**(Total: 10 Marks)**

## (Q6)

### Biuret and Ninhydrin tests

| Solution | Biuret Test (Result observed) | Ninhydrin Test (Result observed) |
|---|---|---|
| A |  |  |
| B |  |  |
| C |  |  |
| D |  |  |

Four solutions (A, B, C, D) were tested using Biuret and Ninhydrin tests. The results are shown above.

(6.1) Identify which solutions contain proteins, based on test results. (04 Marks)

(6.2) State the principle of the Biuret test. (03 Marks)

(6.3) Name one amino acid that gives a yellow color for the Ninhydrin test. (03 Marks)

**(Total: 10 Marks)**

## (Q7)

### Compound Light Microscope

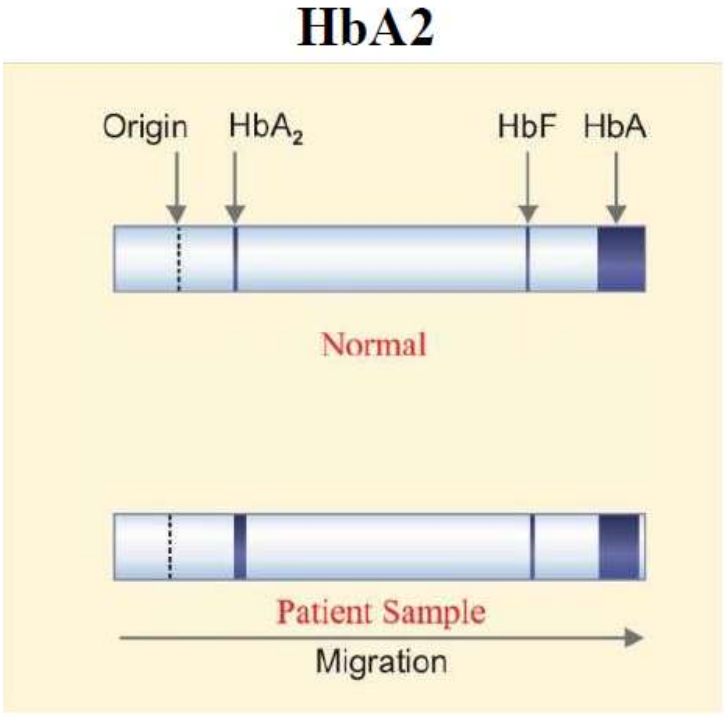
A compound light microscope is provided.

(7.1) Identify the parts labelled as A and B. (06 Marks)

(7.2) Calculate the total magnification when using a 10× eyepiece and a 40× objective. (04 Marks)

**(Total: 10 Marks)**

# (Q8)




A patient presents with anemia. Laboratory results show increased HbA2 levels.

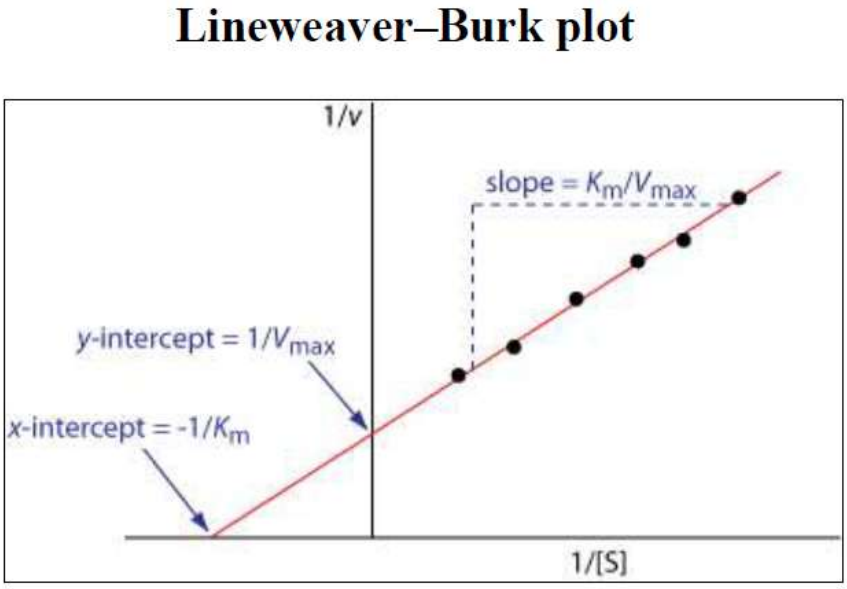
(8.1) Name **one** condition where increased levels of HbA2 is present. (04 Marks)

(8.2) State the biochemical basis of this condition. (03 Marks)

(8.3) Name **one** confirmatory diagnostic test. (03 Marks)

**(Total: 10 Marks)**

# (Q9)

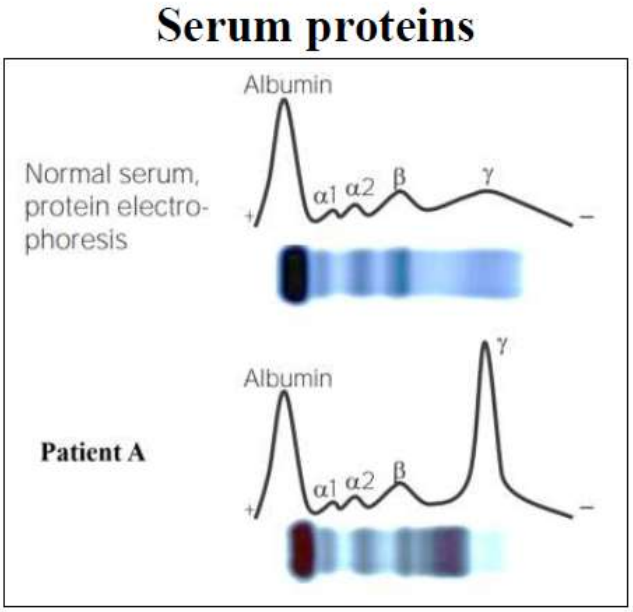



A Lineweaver–Burk plot shows changes in $K_m$ and $V_{max}$ after adding an inhibitor.

(9.1) Identify the type of inhibition. (04 Marks)
(9.2) State the effect of this inhibitor on $K_m$. (03 Marks)
(9.3) Give **one** clinical example of such inhibition. (03 Marks)

**(Total: 10 Marks)**

# (Q10)




An image showing results of a laboratory test for serum proteins is given above.

(10.1) Identify the laboratory test shown in the image. (04 Marks)
(10.2) State the abnormality seen in the results of patient A. (03 Marks)
(10.3) Name **one** disease most likely to be present in patient A. (03 Marks)

**(Total: 10 Marks)**

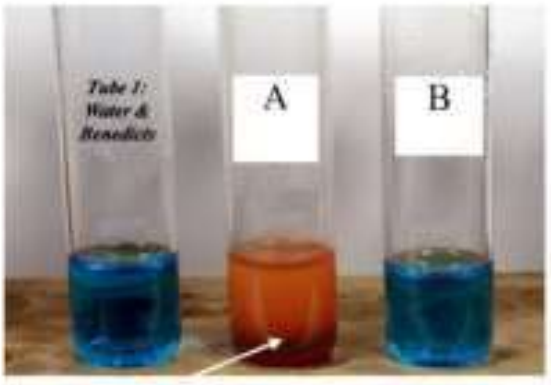
# CAT -1 (BATCH 3) OSPE ANSWERS - 2026

(Q1)



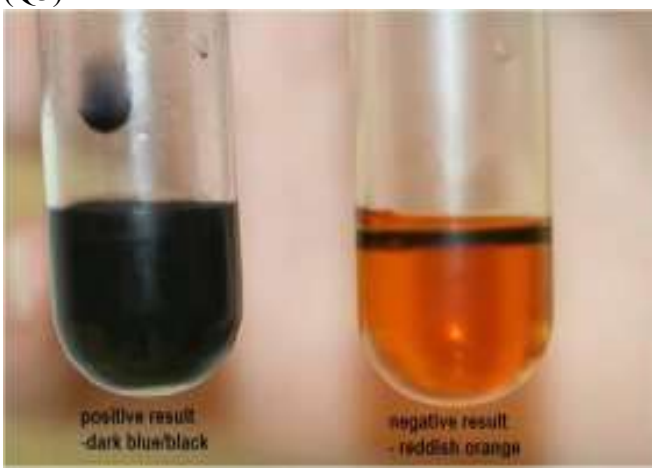

Instrument: pH meter
Part "A": Glass electrode (pH electrode / sensing electrode)
Function of "A": Detects hydrogen ion ($H^+$) activity in the solution / detects pH.

(Q2)




Sample A: Positive result — orange/brick-red precipitate indicating the presence of a reducing sugar.
Sample B: Negative result — solution remains blue indicating absence of reducing sugars.
Most likely substance in sample A: Glucose.
One other substance giving a positive result: Fructose / Vitamin C / Lactose / Galactose.

(Q3)



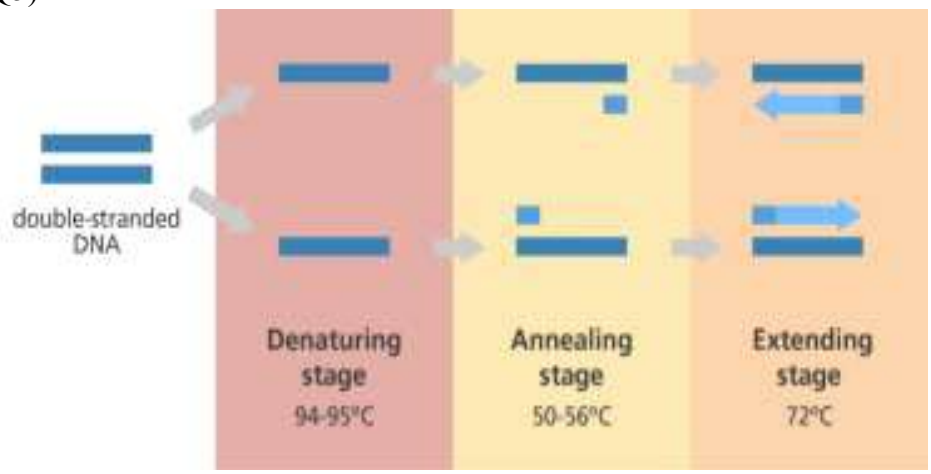
Starch.
Iodine binds to the amylose helix; heating disrupts the helix causing loss of color, and cooling restores the helix causing the color to return.
α-1,4 and α-1,6 glycosidic bonds.

(Q4)




Saturated fatty acids: No double bonds.
Unsaturated fatty acids: One or more double bonds.
Bromine is decolorized due to addition across double bonds.
Atherosclerosis / cardiovascular disease.

(Q5)




PCR.
Taq DNA polymerase.
Primers, dNTPs, Template DNA, $Mg^{2+}$.

(Q6)

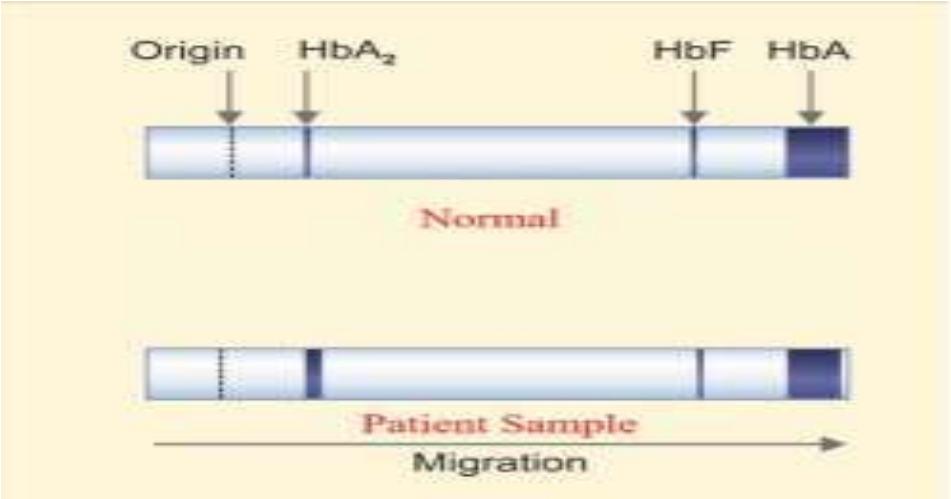
| Solution | Biuret Test (Result observed) | Ninhydrin Test (Result observed) |
|---|---|---|
| A | | |
| B | | |
| C | | |
| D | | |

Solutions A and C contain proteins.
Copper ions react with peptide bonds producing a violet color.
Proline.

(Q7)

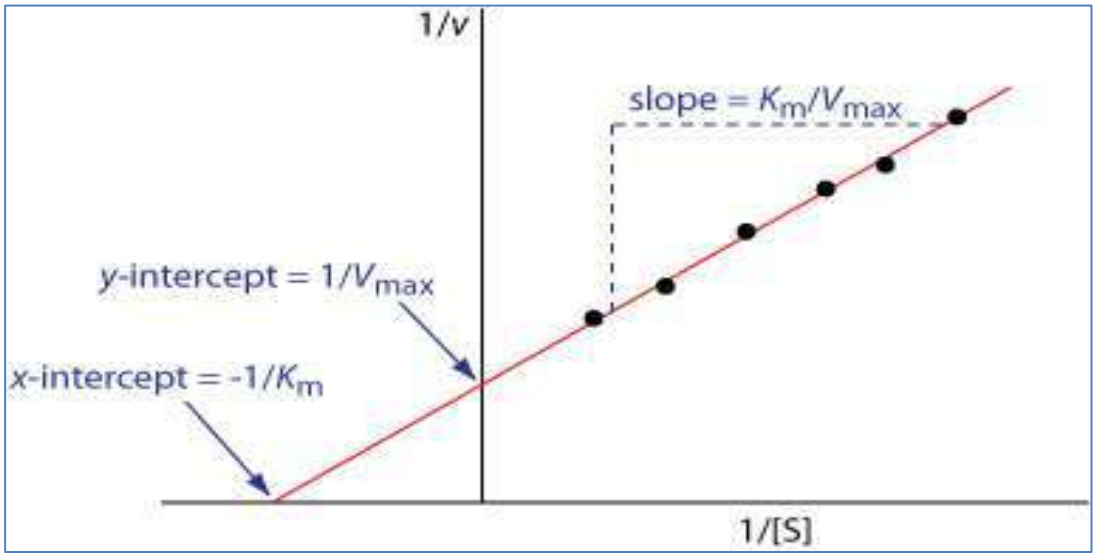
A – Eyepiece
B – Light source
Total magnification = 10 × 40 = 400×.

(Q8)



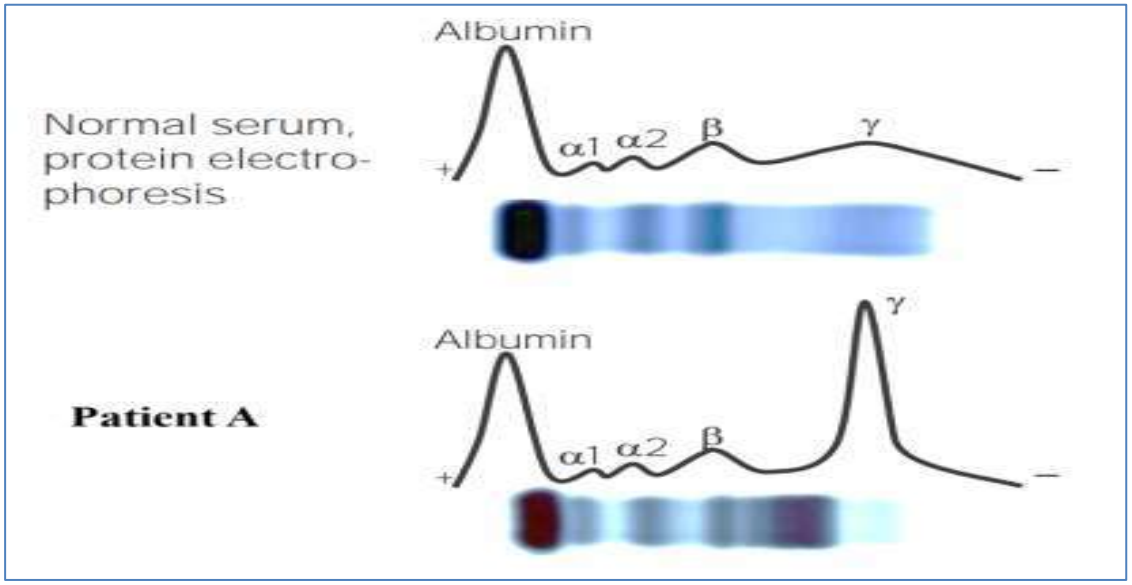

β-thalassemia trait.
Reduced β-globin synthesis leading to increased $HbA_2$ formation.
Hemoglobin electrophoresis / HPLC.

(Q9)




Competitive inhibition.
Km increases.
Methotrexate (DHFR inhibition).

(Q10)




Serum Protein Electrophoresis (SPEP).
Presence of a sharp monoclonal spike (M-spike) in the γ region.
Multiple myeloma.

# 2023/2024 (SECOND BATCH)

# CAT- 1 (BATCH 2) MCQ PAPER - 2025

**UVA WELLASSA UNIVERSITY FACULTY OF MEDICINE**
**Continuous Assessment 01**
**June 2025**
**2023/2024 (02nd) Batch**
**Biochemistry**
**Multiple Choice Questions (MCQ) Paper**

Time 10.00 am – 11.00 am (01 hour) Date of the exam: 2025.06.02

Please do not attempt or promote copying. No textbooks, notes, mobile phones, smart watches, or any other electronic communication devices are allowed.

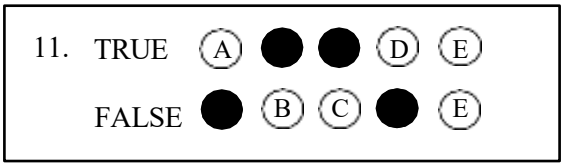
**Please read the following instructions before marking responses on your answer sheets**

1. Check that your question paper has total of **6 pages,** including the front page.
2. **A single answer sheet is provided**. Please write your index number in the given space.
3. Read each question carefully before answering.
4. Mark the correct response as a **heavy black mark filling the relevant circle completely**, using a black lead pencil (6B or above grade).
5. Mark no stray marks on the answer sheet. In case of an error, erase cleanly.
6. Your final answer should be a densely coloured circle through which the underlying letter is not visible.
7. Marking using any other method (e.g., mark the circle with a cross) is not valid.

## TEN (10) TRUE/FALSE TYPE QUESTIONS (Questions 1-10/Page 2-3)

1. Mark whether each response is true or false.
2. Given below is an example of how to mark a true/false type question.

11. A woman has
    A. one ovary.
    B. one nose
    C. two ears
    D. one eye
    E. two hairs

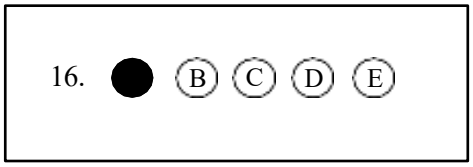



A correct response will get = +1 mark
An incorrect response will get = -1 mark
No response will get = 0 (zero) mark
Negative marks will not be carried over to the next question

## TEN (10) SINGLE BEST RESPONSE TYPE QUESTIONS (Questions 11-20/ Page 4-6)

1. Mark the best response. Only one response per question should be marked.
2. If you mark the correct response, you will get the full marks for the question.
3. If you mark an incorrect response, fail to mark any response, select more than one response, or mark your response unclearly, you will not receive any marks for that question.
4. Given below is an example of how to mark a single best response type question.

16. Speaking is a unique ability observed in humans. Which of the following body parts is primarily used for speech production?
    A. Tongue
    B. Hands
    C. Feet
    D. Ears
    E. Nose



Questions numbers 01 to 10 are True or False type questions. Mark your answer for each of the 5 responses (A to E).

(1) Small RNAs
(A) are important in mRNA processing.
(B) are non-coding RNAs
(C) form hybrids with other RNAs.
(D) have gene-silencing effects.
(E) include tRNA.

(2) True or False regarding lysosomes?
(A) Lysosomal acid hydrolases become inactive if released into the cytosol.
(B) Lysosomal storage diseases are due to mutations in genes encoding lysosomal enzymes.
(C) Lysosomes fail to degrade glycolipids due to I-cell disease.
(D) Lysosomes fail to receive enzymes due to a defect in mannose-6-phosphate tagging.
(E) Lysosomes require ATP-dependent proton pumps to maintain an acidic internal environment.

(3) True or False regarding Oral Rehydration Therapy (ORT) in cholera?
(A) It helps to correct hypokalaemia.
(B) It inhibits cholera toxin-related secretory diarrhoea.
(C) ORT corrects dehydration primarily by promoting glucose-coupled sodium absorption in the small intestine.
(D) ORT is replaced by intravenous fluids in severe cases.
(E) The addition of bicarbonate to ORT is essential for effective sodium absorption.

(4) True or False regarding protein denaturation?
(A) Denatured enzymes retain their enzymatic activity.
(B) It causes a loss of biological activity of proteins.
(C) It disrupts the secondary and tertiary structures of proteins.
(D) It is a hydrolysis of peptide bonds.
(E) It occurs when exposed to high temperatures.

(5) True or False regarding carbohydrates?
(A) Amylose contains an α (1→6) glycosidic bond.
(B) Cellulose is a soluble carbohydrate.
(C) Glycogen is a homopolymer.
(D) Muscle glycogen contributes to regulating blood glucose levels.
(E) Skeletal muscle stores in total more glycogen compared to the liver.

(6) True or False regarding the malate-aspartate shuttle?
(A) Aspartate is transported across the mitochondrial membrane through the α-ketoglutarate transporter.
(B) It contributes to the production of ATP via oxidative phosphorylation.
(C) It converts malate into oxaloacetate.
(D) It is active in the heart.
(E) It transfers hydrogen of NADH from the cytosol to mitochondria.

(7) True or False regarding the isoelectric pH (pI) of proteins?
(A) At pH values below the pI, a protein carries a net negative charge.
(B) At pI, a protein has no net charge.
(C) At pI, a protein will not move towards the anode or the cathode.
(D) At pI, proteins are least soluble in water.
(E) The pI of a protein is calculated using the Henderson-Hasselbalch equation.

(8) True or False regarding fibronectin?
(A) It does not interact with integrins on the cell membrane.
(B) It is a glycoprotein that contributes to cell adhesion.
(C) It is a major structural component of the nuclear envelope.
(D) It plays a role in wound healing and tissue repair.
(E) Soluble forms are present in the body.

(9) True or False regarding Essential Fatty Acids (EFAs)?
(A) EFA deficiency is commonly seen in individuals who consume a high-fat Western diet.
(B) EFA deficiency leads to scaly dermatitis.
(C) EFAs are linoleic acid and alpha-linolenic acid.
(D) In alpha-linolenic acid deficiency, arachidonic acid synthesis is affected.
(E) Prolonged deficiency leads to growth retardation in children.

(10) True or False regarding the buffering action of haemoglobin?
(A) Buffering ability depends on the imidazole group of histidine residues.
(B) Buffering ability is independent of carbon dioxide transport.
(C) Haemoglobin acts as a buffer by binding hydrogen ions.
(D) It maintains blood pH by participating in the chloride shift.
(E) The buffering capacity is higher in its oxygenated form.

Questions numbers 11 to 20 are Single Best Response (SBR) type. Select the best response to each question.

(11) A 30-year-old woman presented with acute renal failure.

What is the buffer that contributes most in maintaining the blood pH in this patient?
(A) Ammonia buffer system
(B) Bicarbonate buffer system
(C) Haemoglobin
(D) Phosphate buffer system
(E) Protein buffer system

(12) Which of the following lipoproteins is primarily responsible for transporting cholesterol from peripheral tissues to the liver?
(A) Chylomicrons
(B) High-density lipoproteins (HDL)
(C) Intermediate-density lipoproteins (IDL)
(D) Low-density lipoproteins (LDL)
(E) Very low-density lipoproteins (VLDL)

(13) A 32-year-old patient presented with cyanosis, a chocolate-brown discoloration of blood, and a history of frequent headaches. Laboratory tests revealed an increased level of methaemoglobin in her blood. Acquired methemoglobinemia was suspected.

Which of the following is the most likely cause of methemoglobinemia in this patient?
(A) Deficiency of cytochrome b5 reductase
(B) Excessive iron supplementation
(C) Exposure to oxidizing drugs like dapsone
(D) Genetic mutation leading to haemoglobin M
(E) High levels of foetal haemoglobin

(14) Haemoglobin plays a role in carbon dioxide transport in the human body. Formation of carbaminohaemoglobin is a step in this process.

Which of the following correctly describes the role of carbaminohaemoglobin in the transport of carbon dioxide?
(A) It facilitates the Bohr effect by enhancing oxygen release in peripheral tissues.
(B) It is formed when $CO_2$ binds to the globin portion of haemoglobin.
(C) It is formed when $CO_2$ is converted to bicarbonate in red blood cells.
(D) It is mainly formed in the lungs, where $CO_2$ is released.
(E) It is the most important carbon dioxide carrier in the blood.

(15) A 3-year-old child presented with developmental delay and recurrent respiratory infections. Urine analysis revealed elevated oligosaccharide fragments. Further investigations indicated a disorder related to defective degradation of glycoproteins.

Which of the following is most likely to cause this condition?
(A) Deficiency of coenzyme, $Zn^{2+}$.
(B) Deficiency of lysosomal enzymes resulting in oligosaccharide accumulation.
(C) Excessive glycoprotein intake.
(D) Inherited defect in glycoprotein catabolism.
(E) Mitochondrial dysfunction causing buildup of short-chain sugars.

(16) Serum protein electrophoresis is a diagnostic approach used for in detection and separation of different classes of plasma proteins, with the exception of one plasma protein.

What is this protein?
(A) Albumin
(B) Ceruloplasmin
(C) Ferritin
(D) Fibrinogen
(E) Haptoglobin

(17) When the molecular architecture of the DNA double helix is considered**,** some features are responsible for maintaining its native conformation under physiological conditions.

Which of the following best describes a key stabilizing feature of the DNA double helix?
(A) Base-stacking interactions
(B) Ionic interactions
(C) Phosphodiester bonds
(D) Polycation interactions
(E) Purine–purine hydrogen bonds

(18) There are various mechanisms by which substances cross the plasma membrane that are vital in maintaining biochemical processes of the human body.

Which of the following statements best describes facilitated diffusion?
(A) It allows hydrophilic molecules to cross the membrane via specific carrier proteins.
(B) It contributes to the movement of large molecules across membranes through vesicle formation.
(C) It is an energy-efficient process.
(D) It moves substances across the membrane against a concentration gradient.
(E) It supports ion movement across membranes via protein pumps.

(19) The DNA template for RNA synthesis has the following order of bases, 5'-GCTTCGA-3'.

What will be the order of bases in mRNA?
(A) 3'-CGAAGCT-5'
(B) 3'-CGAAGCU-5'
(C) 3'-CGAUCGU-5'
(D) 3'-GCUAGCT-5'
(E) 3'-GCTTCGA-5'

(20) A 2-year-old child presented with coarse facial features, developmental delay, and restricted joint movement. Laboratory investigations reveal elevated levels of multiple lysosomal enzymes in the plasma. I-cell disease was suspected.

Which of the following statements best explains the underlying defect in this condition?
(A) It is caused by a defect in peroxisomal protein targeting.
(B) It is inherited in an autosomal dominant pattern.
(C) It results from a deficiency of N-acetylglucosamine-1-phosphotransferase.
(D) Lysosomal enzymes are tagged with mannose-6-phosphate.
(E) Plasma levels of lysosomal enzymes are decreased due to intracellular accumulation.

# CAT- 1 (BATCH 2) MCQ ANSWERS- 2025

True/False

(1) T T T T F
(2) T T F T T
(3) T F T T F
(4) F T T F T
(5) F F T F T
(6) F T T T T
(7) F T T T F
(8) F T F T T
(9) F T T F T
(10) T F T T F

SBR
(11) B
(12) B
(13) C
(14) B
(15) D
(16) D
(17) A
(18) A
(19) B
(20) C

# CAT- 1 (BATCH 2) SEQ PAPER - 2025

**UVA WELLASSA UNIVERSITY FACULTY OF MEDICINE**
**Continuous Assessment 01**
**June 2025**
**2023/2024 (02nd)**
**Batch**
**Biochemistry**
**Structured Essay Questions (SEQ)**
**Paper**

Time **11.15am – 12.15pm** (01 hour) Date of the exam: 2025.06.02

Index (MED) Number ……

Please do not attempt or promote copying. No textbooks, notes, mobile phones, smart watches, or any other electronic communication devices are allowed.

**Instructions to Candidates**

- This paper contains two (02) Structured Essay Questions.
- Answer all questions.
- Write your answers in the spaces provided.
- If additional space is required, you may use extra sheets. Ensure that the relevant question number is clearly indicated on each additional sheet.
- Write your index number in the designated space on each answer sheet, including any extra sheets used.

(Q1)

(1.1.)

(a) Outline the structural organization of Lamins. (10 marks)
(b) Outline the significance of the nuclear pore complex (NPC) in nucleocytoplasmic transport. (20 marks)

(1.2.)
(a)List three (03) examples of ion channel disruptions due to toxins and pharmaceutical drugs. (15 marks)
(b) List five (05) main components of a plasma membrane, mentioning one significant function of each. (25 marks)

(1.3) Briefly explain the contribution of glycosaminoglycans (GAGs) to the functions of synovial fluid. (30 marks)

(Q2)

(2.1) Briefly outline the roles of different types of RNAs during protein synthesis. (30 marks)

(2.2) List three (03) antibiotics with different mechanisms of action that inhibit protein synthesis and state the mechanism of action of each. (15 marks)

(2.3) Three (03) disease conditions associated with defective post-translational modifications of

collagens are given in the following table. Write the cause, affected modification, and the effect on collagen in each of these three conditions:

- Scurvy
- Menkes Disease
- Osteogenesis Imperfecta (15 marks)

(2.4) Describe three (03) mechanisms by which the rate of an enzyme reaction/activity is controlled depending on the metabolic requirements of the human body. (40 marks)

# CAT-1 (BATCH 2) SEQ ANSWERS - 2025

**(1.1.)**

**(a)Outline the structural organization of Lamins. (10 marks)**

- Lamins are intermediate filament proteins of the nuclear lamina. (2 marks)
- Located beneath the inner nuclear membrane. (2 marks)
- Possess a central α-helical rod domain. (2 marks)
- Have N-terminal head and C-terminal tail domains. (2 marks)
- Assemble into dimers and higher-order filamentous networks that support the nucleus. (2 marks)

**(b) Outline the significance of the nuclear pore complex (NPC) in nucleocytoplasmic transport. (20 marks)**

- NPC spans the nuclear envelope. (2 marks)
- Forms channels between nucleus and cytoplasm. (2 marks)
- Allows passive diffusion of small molecules. (3 marks)
- Mediates selective transport of proteins into the nucleus. (3 marks)
- Mediates export of RNA from the nucleus. (3 marks)
- Recognizes nuclear localization signals (NLS). (2 marks)
- Transport requires importins/exportins and Ran-GTP. (3 marks)
- Maintains communication between nucleus and cytoplasm. (2 marks)

**(1.2.)**

**(a) List three examples of ion channel disruptions due to toxins and pharmaceutical drugs. (15 marks)**

- **5 marks each**
- Tetrodotoxin blocks voltage-gated sodium channels. (5 marks)
- Local anesthetics (e.g., lidocaine) block sodium channels. (5 marks)
- Calcium channel blockers (e.g., verapamil) inhibit calcium channels. (5 marks)

**(b) List five main components of a plasma membrane, mentioning one significant function of each. (25 marks)**

**5 marks each**

| **Component** | **Function** |
|---|---|
| Phospholipids | Form lipid bilayer barrier |
| Cholesterol | Regulates membrane fluidity |
| Integral membrane proteins | Transport substances across membrane |
| Peripheral proteins | Cell signalling and structural support |
| Glycolipids/Glycoproteins | Cell recognition and adhesion |

**(1.3) Briefly explain the contribution of glycosaminoglycans (GAGs) to the functions of synovial fluid. (30 marks)**

- Hyaluronic acid is the major GAG in synovial fluid. (5 marks)
- Provides viscosity to synovial fluid. (5 marks)
- Acts as a lubricant reducing friction between articular surfaces. (5 marks)
- Functions as a shock absorber during movement. (5 marks)
- Retains water because of its highly negative charge. (5 marks)
- Facilitates smooth joint movement and protects cartilage. (5 marks)

**(2.1) Briefly outline the roles of different types of RNAs during protein synthesis. (30 marks)**

- mRNA carries genetic information from DNA to ribosomes. (10 marks)
- tRNA transports amino acids and recognizes codons via anticodons. (10 marks)
- rRNA forms the structural and catalytic core of ribosomes and catalyzes peptide bond formation. (10 marks)

**(2.2) List three antibiotics with different mechanisms of action that inhibit protein synthesis and state the mechanism of action of each. (15 marks)**

- **5 marks each**

| **Antibiotic** | **Mechanism** |
|---|---|
| Tetracycline | Blocks aminoacyl-tRNA binding to 30S subunit |
| Streptomycin | Causes misreading of mRNA by 30S subunit |
| Chloramphenicol | Inhibits peptidyl transferase activity of 50S subunit |

**(2.3) Disease conditions associated with defective post-translational modifications of collagen. (15 marks)**

- **5 marks each**

| **Condition** | **Cause** | **Affected Modification** | **Effect on Collagen** |
|---|---|---|---|
| Scurvy | Vitamin C deficiency | Hydroxylation of proline and lysine | Reduced collagen stability |
| Menkes disease | Copper deficiency | Lysyl oxidase-mediated cross-linking | Weak collagen fibers |
| Osteogenesis imperfecta | Mutation in type I collagen genes | Collagen synthesis/assembly | Defective collagen formation |

**(2.4) Describe three mechanisms by which enzyme activity is controlled according to metabolic requirements. (40 marks)**

- **Allosteric regulation (14 marks)**
- Regulatory molecules bind sites other than active site. (4 marks)
- May activate or inhibit enzyme activity. (5 marks)
- Provides rapid metabolic control. (5 marks)
- **Covalent modification (13 marks)**
- Enzyme activity altered by phosphorylation/dephosphorylation. (5 marks)
- Usually hormone-mediated. (4 marks)
- Can activate or inactivate enzymes. (4 marks)
- **Regulation of enzyme amount (13 marks)**
- Control of enzyme synthesis and degradation. (5 marks)

- Changes enzyme concentration within cells. (4 marks)
- Provides long-term metabolic regulation. (4 marks)

# CAT- 1(BATCH 2) OSPE PAPER - 2025

## Question 01

A 45-year-old male with a history of chronic alcohol use presents with jaundice, ascites, and fatigue. His liver function tests (LFTs) show elevated liver enzymes and bilirubin levels, and a decreased albumin level.

1.1 State the reason for the low serum albumin in this patient. (05 Marks)
1.2 State 02 clinical signs that occur due to low serum albumin. (02 Marks)
1.3 State the biochemical basis for the clinical signs stated in 1.2. (03 Marks)

**(Total: 10 Marks)**

## Question 02

Solutions of fructose, galactose, and maltose are placed in test tubes labelled as A, B, and C. Each solution is tested using Benedict's test, Barfoed's test, and Seliwanoff's test. The results are as follows:

- Sample A: Positive only for Benedict's test
- Sample B: Positive for Benedict's test, Barfoed's tests, and negative for Seliwanoff's test
- Sample C: Positive for all three tests

2.1. Based on the test results, identify which sugar corresponds to samples A, B, and C. (06 Marks)
2.2. State the expected final color for Sample C, for each of the three tests. (04 Marks)

**(Total: 10 Marks)**

## Question 03

A solution contains 0.010 M acetic acid ($CH_3COOH$) in water. The acid dissociation constant ($K_a$) of acetic acid is $1.8\times10^{-5}$. What is the pH of the solution?

**(Total: 10 Marks)**

## Question 04

When an iodine solution is added, the color of a solution turns blue-black initially, and the colour disappears upon heating and reappears after cooling.

4.1. What type of carbohydrate is likely to be present in this sample? (04 Marks)
4.2. On hydrolysis, the above-identified carbohydrate produces two distinct glucose polymers.
4.2.1. Name the two polymers found in the sample above (02 Marks)
4.2.2. Specify the types of glycosidic bonds present in each (04 Marks)

**(Total: 10 Marks)**

## Question 05

Proteins are sensitive biomolecules that are denatured by exposure to various physical or chemical conditions.

5.1. List four (04) factors that cause protein denaturation. (04 Marks)
5.2. Name three (03) types of bonds that are disrupted during denaturation. (06 Marks)

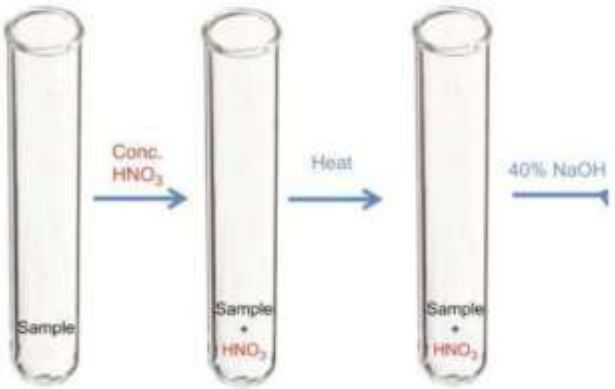
**(Total: 10 Marks)**

## Question 06

Three amino acids—alanine, methionine, and tryptophan were tested using the Xanthoproteic test. (Steps of Xanthoproteic test are given below.)

6.1. Which of these amino acid/s gives a positive result with Xanthoproteic test? (05 Marks)

6.2. What colour changes are observed at each step in a positive xanthoproteic test? (05 Marks)




**(Total: 10 Marks)**

## Question 07

The blood cholesterol level was measured using a spectrophotometer. The absorbance of the standard solution was recorded as 0.400, and the absorbance of the serum sample was 0.300. The concentration of cholesterol in the standard solution is 200 mg/dL.

7.1. Calculate the cholesterol concentration in the serum sample. (06 Marks)
7.2. What is the principle applied in the spectrophotometer? (04 Marks)

**(Total: 10 Marks)**

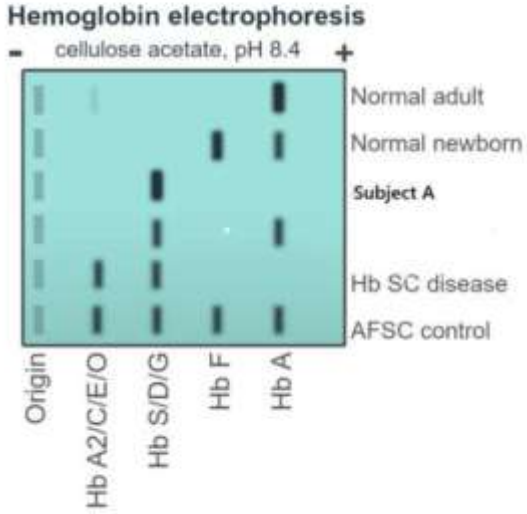
## Question 08

Explain how the iodine absorption test is used to distinguish between saturated and unsaturated fatty acids. (10 Marks)

**(Total: 10 Marks)**

## Question 09

A haemoglobin electrophoresis on a patient's blood sample was performed. The electrophoretogram is given below.




9.1. What haemoglobin variant is likely to be present in patient A? (2.5 Marks)

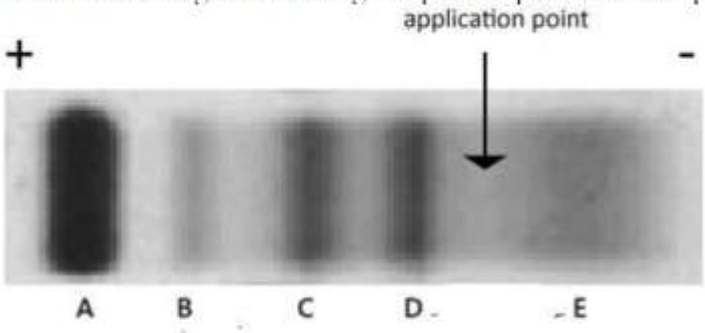
9.2. Based on the electrophoretic pattern, what is the most likely diagnosis? (2.5 Marks)

9.3. With reference to the findings above, describe the molecular defect responsible for this haemoglobin variant. (05 Marks)

**(Total: 10 Marks)**

## Question 10

You have been given an image of plasma protein electrophoresis of a patient.




10.1. Identify A, B, C, D, and E bands (05 Marks)

10.2. What do you observe in band A in a cirrhosis patient (05 Marks)

**(Total: 10 Marks)**

# CAT-1 (BATCH 2) OSPE ANSWERS - 2025

## Question 01

A 45-year-old male with a history of chronic alcohol use presents with jaundice, ascites, and fatigue. His liver function tests (LFTs) show elevated liver enzymes and bilirubin levels, and a decreased albumin level.

1.1 State the reason for the low serum albumin in this patient. (05 Marks)
1.2 State 02 clinical signs that occur due to low serum albumin. (02 Marks)
1.3 State the biochemical basis for the clinical signs stated in 1.2. (03 Marks)

**(Total: 10 Marks)**

**(1.1)**
Low serum albumin occurs due to decreased synthesis of albumin by the damaged liver in chronic liver disease/cirrhosis.

**(1.2)**
• Ascites
• Peripheral edema (ankle or pedal edema)

**(1.3)**
Albumin is the major contributor to plasma colloid osmotic pressure. Low serum albumin decreases plasma oncotic pressure, causing fluid to move from the intravascular space into the interstitial tissues and peritoneal cavity, resulting in edema and ascites.

## Question 02

Solutions of fructose, galactose, and maltose are placed in test tubes labelled as A, B, and C. Each solution is tested using Benedict's test, Barfoed's test, and Seliwanoff's test. The results are as follows:

- Sample A: Positive only for Benedict's test
- Sample B: Positive for Benedict's test, Barfoed's tests, and negative for Seliwanoff's test
- Sample C: Positive for all three tests

2.1. Based on the test results, identify which sugar corresponds to samples A, B, and C. (06 Marks)
2.2. State the expected final color for Sample C, for each of the three tests. (04 Marks)

**(Total: 10 Marks)**

**(2.1)**
• Sample A – Maltose
• Sample B – Galactose
• Sample C – Fructose

**(2.2)**

| Test | Final colour for Sample C (Fructose) |
|---|---|
| Benedict's test | Brick-red precipitate |
| Barfoed's test | Red precipitate |
| Seliwanoff's test | Cherry-red colour |

## Question 03

A solution contains 0.010 M acetic acid ($CH_3COOH$) in water. The acid dissociation constant ($K_a$) of acetic acid is $1.8\times10^{-5}$. What is the pH of the solution?

**(Total: 10 Marks)**

**(3)**
Given:
$Ka = 1.8 \times 10^{-5}$
$C = 0.010$ M
$[H^+] = \sqrt{(Ka \times C)}$
$= \sqrt{(1.8 \times 10^{-5} \times 0.010)}$
$= \sqrt{(1.8 \times 10^{-7})}$
$= 4.24 \times 10^{-4}$ M
$pH = -\log(4.24 \times 10^{-4})$
= **3.37**
**Answer: pH = 3.37**

## Question 04

When an iodine solution is added, the color of a solution turns blue-black initially, and the colour disappears upon heating and reappears after cooling.

4.1. What type of carbohydrate is likely to be present in this sample? (04 Marks)
4.2. On hydrolysis, the above-identified carbohydrate produces two distinct glucose polymers.
4.2.1. Name the two polymers found in the sample above (02 Marks)
4.2.2. Specify the types of glycosidic bonds present in each (04 Marks)

**(Total: 10 Marks)**

**(4.1)**
Starch
**(4.2.1)**
• Amylose
• Amylopectin
**(4.2.2)**
• Amylose – α(1→4) glycosidic bonds
• Amylopectin – α(1→4) glycosidic bonds with α(1→6) branch points

## Question 05

Proteins are sensitive biomolecules that are denatured by exposure to various physical or chemical conditions.

5.1. List four (04) factors that cause protein denaturation. (04 Marks)
5.2. Name three (03) types of bonds that are disrupted during denaturation. (06 Marks)

**(Total: 10 Marks)**

**(5.1)**
Any four:
• Heat
• Strong acids
• Strong alkalis
• Organic solvents
• Heavy metal ions
• Radiation
• Mechanical agitation

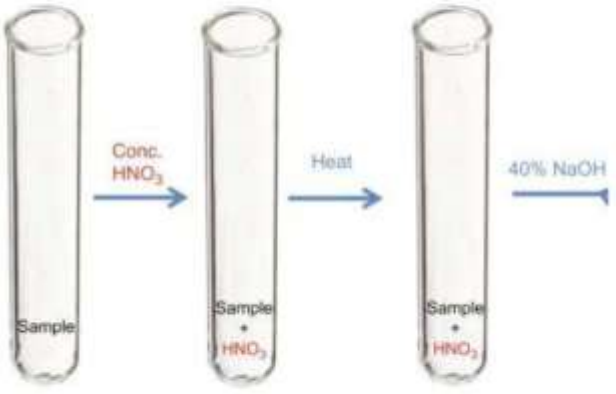
**(5.2)**
Any three:
• Hydrogen bonds
• Ionic bonds (salt bridges)
• Hydrophobic interactions
• Disulfide bonds

## Question 06

Three amino acids—alanine, methionine, and tryptophan were tested using the Xanthoproteic test. (Steps of Xanthoproteic test are given below.)

6.1. Which of these amino acid/s gives a positive result with Xanthoproteic test? (05 Marks)

6.2. What colour changes are observed at each step in a positive xanthoproteic test? (05 Marks)




**(Total: 10 Marks)**

**(6.1)**
Tryptophan gives a positive Xanthoproteic test.
**(6.2)**
• Initially – colourless solution
• After addition of concentrated nitric acid and heating – yellow colour develops
• After addition of alkali – yellow changes to orange/orange-yellow colour

## Question 07

The blood cholesterol level was measured using a spectrophotometer. The absorbance of the standard solution was recorded as 0.400, and the absorbance of the serum sample was 0.300. The concentration of cholesterol in the standard solution is 200 mg/dL.

7.1. Calculate the cholesterol concentration in the serum sample. (06 Marks)
7.2. What is the principle applied in the spectrophotometer? (04 Marks)

**(Total: 10 Marks)**

**(7.1)**
Concentration of sample = (Absorbance of sample ÷ Absorbance of standard) × Concentration of standard
= (0.300 ÷ 0.400) × 200
= 150 mg/dL
**Answer: 150 mg/dL**
**(7.2)**
Beer-Lambert Law: The absorbance of light is directly proportional to the concentration of the absorbing substance and the path length.

## Question 08

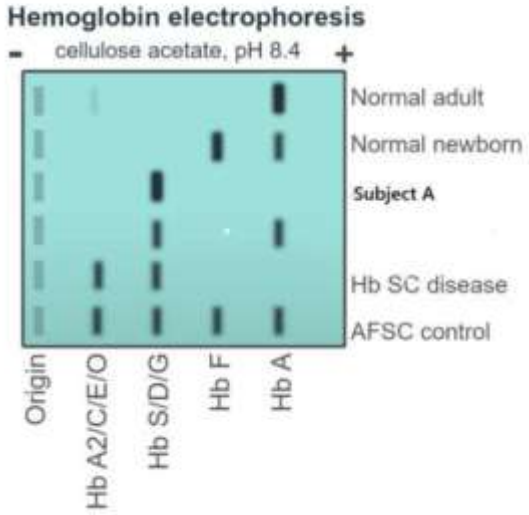
Explain how the iodine absorption test is used to distinguish between saturated and unsaturated fatty acids. (10 Marks)

**(Total: 10 Marks)**

**(8)**
The iodine absorption test is based on the ability of iodine to react with carbon-carbon double bonds present in unsaturated fatty acids.
• Saturated fatty acids contain no double bonds and therefore do not absorb iodine.
• Unsaturated fatty acids contain one or more double bonds and absorb iodine across these double bonds.
• The greater the number of double bonds, the more iodine is absorbed.
• Thus, a higher iodine value indicates a higher degree of unsaturation, while a lower iodine value indicates a more saturated fat.

## Question 09

A haemoglobin electrophoresis on a patient's blood sample was performed. The electrophoretogram is given below.




9.1. What haemoglobin variant is likely to be present in patient A? (2.5 Marks)

9.2. Based on the electrophoretic pattern, what is the most likely diagnosis? (2.5 Marks)

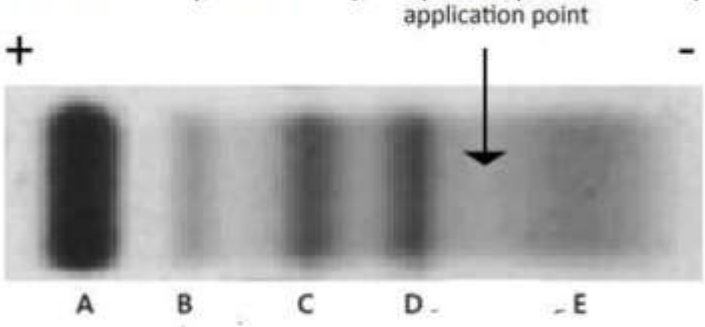
9.3. With reference to the findings above, describe the molecular defect responsible for this haemoglobin variant. (05 Marks)

**(Total: 10 Marks)**

**(9.1)**
Haemoglobin S (HbS)
**(9.2)**
Sickle cell disease (Sickle cell anemia)
**(9.3)**
A point mutation occurs in the β-globin gene, resulting in substitution of valine for glutamic acid at the 6th position of the β-globin chain (Glu6Val). This produces HbS.

## Question 10

You have been given an image of plasma protein electrophoresis of a patient.




10.1. Identify A, B, C, D, and E bands (05 Marks)

10.2. What do you observe in band A in a cirrhosis patient (05 Marks)

**(Total: 10 Marks)**

**(10.1)**
- A – Albumin
- B – $\alpha_1$-globulin
- C – $\alpha_2$-globulin
- D – β-globulin
- E – γ-globulin

**(10.2)**
In cirrhosis, band A (albumin band) is decreased due to reduced hepatic synthesis of albumin.



# MESSAGE OF THE DEAN

**As the Dean of the Uva Wellassa Medical Faculty, I am delighted to present "Mastering Biochemistry – Semester 1 – Book – II (2026): A Comprehensive Guide to MCQs, Essays, and OSPEs." This publication represents a significant achievement in our ongoing commitment to enhancing the quality of medical education and supporting student learning.**

**In the ever-evolving discipline of medicine, a thorough knowledge of Biochemistry continues to be a cornerstone of academic and professional success. This guide has been thoughtfully designed to serve as a comprehensive learning resource, covering a wide range of assessment formats, including MCQs, essays, and OSPEs, while providing detailed explanations and model answers to reinforce understanding.**

**The primary aim of this book is to equip students with the knowledge and skills necessary to excel in examinations and deepen their comprehension of principles in biochemistry. We believe that this guide will become a trusted companion throughout your academic journey, helping to build confidence, improve clarity, and establish a strong foundation for learning.**

**I extend my heartfelt gratitude to the faculty members and contributors whose dedication, expertise, and hard work made this publication possible. It is our sincere hope that you will find this guide both informative and inspiring as you advance through your medical studies.**

**I wish you every success in your academic endeavors and in your future career as a medical professional.**

**Sincerely,**
**Senior Professor Muditha Vidanapathirana,**
**MBBS (Col), DLM, MD, MA (SJP), FFFLM (UK)**
**Dean,**
**Faculty of Medicine,**
**Uva Wellassa University of Sri Lanka**

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