

## Advanced Biochemistry Exam

Q1. Which of the following statements is INCORRECT regarding the phosphorylation step in fructose metabolism and the enzymes involved in this process?

- A. Fructose can be phosphorylated by both hexokinase and fructokinase depending on the tissue type and enzyme availability, where hexokinase has a minor role compared to fructokinase in hepatic metabolism
- B. Fructokinase is mainly localized in metabolically active tissues such as the liver, kidney, and small intestinal mucosa, where it plays a dominant role in fructose metabolism
- C. The phosphorylation of fructose directly produces fructose-6-phosphate as the primary intermediate entering glycolysis without passing through fructose-1-phosphate
- D. ATP serves as the phosphate donor during the phosphorylation process of fructose, providing the necessary energy for the reaction

Q2. Which of the following statements is INCORRECT regarding glycosaminoglycans (GAGs) and their structural composition?

- A. Glycosaminoglycans are long, unbranched heteropolysaccharide chains composed of repeating disaccharide units that include an amino sugar and an acidic sugar component
- B. The amino sugar component of glycosaminoglycans may be acetylated or sulfated, contributing to their chemical diversity and biological function
- C. Glycosaminoglycans are positively charged molecules due to the dominance of amino groups, which determine their interaction with other biomolecules
- D. The acidic sugar component of glycosaminoglycans may include glucuronic acid or iduronic acid, contributing to their negative charge

Q3. Which of the following statements is INCORRECT regarding lipid digestion and emulsification processes in the gastrointestinal tract?

- A. Lipid digestion begins in the stomach through the action of lingual and gastric lipases, although their contribution is relatively limited compared to pancreatic enzymes
- B. Bile salts produced in the liver and stored in the gallbladder play an important role in emulsification in the small intestine, increasing the surface area available for enzymatic digestion
- C. Emulsification decreases the surface area of lipid droplets, thereby reducing enzyme accessibility and slowing the rate of lipid digestion
- D. Pancreatic lipase plays a central role in the digestion of triglycerides into free fatty acids and monoacylglycerol

Q4. Which of the following statements is INCORRECT regarding glycolysis and its cellular localization and function?

- A. Glycolysis occurs in the cytosol of all cells including erythrocytes, which rely entirely on this pathway due to absence of mitochondria
- B. Glycolysis produces pyruvate under aerobic conditions and lactate under anaerobic conditions depending on oxygen availability
- C. Glycolysis requires mitochondria for all of its enzymatic reactions and therefore cannot occur in erythrocytes
- D. Glycolysis provides ATP even in the absence of oxygen through substrate-level phosphorylation

Q5. Which of the following statements is INCORRECT regarding carbohydrate classification and structural diversity?

- A. Monosaccharides can be classified according to the number of carbon atoms they contain, such as trioses, tetroses, pentoses, and hexoses
- B. Disaccharides consist of two monosaccharides linked through glycosidic bonds, which may vary in position and configuration
- C. Polysaccharides are always branched structures and cannot exist in linear forms such as cellulose
- D. Complex carbohydrates may include glycoproteins, glycolipids, and other macromolecules containing carbohydrate components

Q6. Which of the following statements is INCORRECT regarding hereditary fructose intolerance (HFI) and its biochemical consequences?

- A. Hereditary fructose intolerance results from deficiency of aldolase B enzyme, which is responsible for cleavage of fructose-1-phosphate
- B. It leads to accumulation of fructose-1-phosphate within cells, causing depletion of ATP and inorganic phosphate
- C. It increases ATP availability inside the cell and enhances energy production due to accumulation of phosphorylated intermediates
- D. It may cause hypoglycemia, vomiting, jaundice, hemorrhage, and hepatomegaly due to metabolic disruption

Q7. Which of the following statements is INCORRECT regarding glycosaminoglycan function in the extracellular matrix?

- A. Glycosaminoglycans bind large amounts of water contributing to the gel-like consistency and structural integrity of the extracellular matrix
- B. They contribute to lubrication of tissues and increase viscosity of biological fluids such as mucus and synovial fluid
- C. They decrease water retention in tissues and reduce extracellular matrix volume by repelling water molecules
- D. They participate in cell signaling and interactions between cells and their surrounding matrix

Q8. Which of the following statements is INCORRECT regarding the early steps of glycolysis and energy investment phase?

- A. Glucose is phosphorylated to glucose-6-phosphate in an irreversible step catalyzed by hexokinase or glucokinase
- B. Glucose-6-phosphate is converted to fructose-6-phosphate by phosphoglucose isomerase
- C. Fructose-6-phosphate is phosphorylated to fructose-1,6-bisphosphate by phosphofructokinase, which is a key regulatory step
- D. ATP is produced in the initial steps of glycolysis before any phosphorylation reactions take place

Q9. Which of the following statements is INCORRECT regarding sodium-dependent glucose transport mechanisms?

- A. Sodium-dependent cotransport allows glucose movement against its concentration gradient by coupling it with sodium influx
- B. This transport depends on the sodium gradient established by Na<sup>+</sup>/K<sup>+</sup>-ATPase activity in the cell membrane
- C. This transport mechanism is independent of sodium ions and functions similarly to facilitated diffusion
- D. It occurs in intestinal epithelial cells and renal tubular cells where active absorption of glucose is required

Q10. Which of the following statements is INCORRECT regarding the sorbitol pathway and its physiological and pathological roles?

- A. Glucose is converted to sorbitol by aldose reductase in certain tissues
- B. Sorbitol is converted to fructose by sorbitol dehydrogenase
- C. Sorbitol accumulation is harmless because it freely diffuses across cell membranes and does not affect osmotic balance
- D. Sorbitol accumulates in diabetic tissues such as retina, lens, kidney, and nerves leading to complications

Q11. Which of the following statements is INCORRECT regarding glycolysis energy production and its biochemical outcomes?

- A. NADH is produced during glycolysis at the step catalyzed by glyceraldehyde-3-phosphate dehydrogenase and may contribute to ATP production under aerobic conditions
- B. ATP is produced in glycolysis through substrate-level phosphorylation at specific steps such as phosphoglycerate kinase and pyruvate kinase reactions

- C. Glycolysis does not produce any ATP molecules directly and relies entirely on mitochondrial oxidative phosphorylation for ATP generation
- D. The amount of ATP produced in glycolysis differs depending on whether the pathway proceeds under aerobic or anaerobic conditions

Q12. Which of the following statements is INCORRECT regarding cell membrane structural organization and functional properties?

- A. The plasma membrane consists primarily of a phospholipid bilayer that provides a structural barrier between the intracellular and extracellular environments
- B. Membrane proteins are embedded within or associated with the lipid bilayer and contribute to transport, signaling, and structural integrity
- C. The cell membrane is completely rigid and static, preventing movement of lipids and proteins within the bilayer
- D. The membrane exhibits selective permeability, allowing certain molecules to pass while restricting others

Q13. Which of the following statements is INCORRECT regarding the cleavage of fructose-1-phosphate during fructose metabolism?

- A. Aldolase B catalyzes the cleavage of fructose-1-phosphate into dihydroxyacetone phosphate and glyceraldehyde
- B. The products of this cleavage can enter glycolytic pathways after appropriate enzymatic modifications
- C. Both dihydroxyacetone phosphate and glyceraldehyde directly enter glycolysis without any further metabolic conversion
- D. Dihydroxyacetone phosphate can be readily utilized in central metabolic pathways such as glycolysis or gluconeogenesis

Q14. Which of the following statements is INCORRECT regarding lipid absorption mechanisms in the small intestine?

- A. Lipid digestion products such as fatty acids and monoacylglycerols are incorporated into micelles for transport to intestinal epithelial cells
- B. Short-chain fatty acids require incorporation into micelles for efficient absorption into enterocytes
- C. Long-chain fatty acids are transported within micelles formed by bile salts to facilitate their absorption
- D. Lipid absorption primarily occurs in the small intestine following digestion

Q15. Which of the following statements is INCORRECT regarding the functional differences between hexokinase and glucokinase enzymes?

- A. Hexokinase has a high affinity for glucose and is inhibited by its product glucose-6-phosphate
- B. Glucokinase acts as a glucose sensor in pancreatic  $\beta$ -cells and contributes to regulation of insulin secretion
- C. Glucokinase functions optimally at low glucose concentrations and is most active during fasting states
- D. Hexokinase is widely distributed in tissues and plays a role in basal glucose metabolism

Q16. Which of the following statements is INCORRECT regarding glycosaminoglycan degradation and associated metabolic disorders?

- A. Glycosaminoglycans are degraded in lysosomes by specific hydrolase enzymes that sequentially remove sugar residues
- B. Deficiency of these lysosomal enzymes results in accumulation of partially degraded glycosaminoglycans in tissues
- C. These accumulation disorders are collectively known as mucopolysaccharidoses and can affect multiple organ systems
- D. Glycosaminoglycan degradation occurs exclusively in the cytosol without involvement of lysosomal pathways

Q17. Which of the following statements is INCORRECT regarding membrane fluidity and lipid movement within the bilayer?

- A. Membrane fluidity is influenced by temperature and lipid composition including fatty acid saturation
- B. Unsaturated fatty acids increase membrane fluidity by introducing kinks that prevent tight packing
- C. Lipid molecules and some proteins cannot move laterally within the membrane and are fixed in position
- D. Cholesterol plays a role in modulating membrane fluidity under different temperature conditions

Q18. Which of the following statements is INCORRECT regarding the final steps of glycolysis and pyruvate formation?

- A. Phosphoenolpyruvate is converted to pyruvate by pyruvate kinase in an irreversible reaction
- B. This step results in the generation of ATP through substrate-level phosphorylation
- C. The reaction catalyzed by pyruvate kinase is reversible under physiological conditions
- D. Pyruvate formed can enter various metabolic pathways depending on cellular conditions

Q19. Which of the following statements is INCORRECT regarding fructose metabolism kinetics and regulation?

- A. Fructose metabolism is generally faster than glucose metabolism due to bypass of key regulatory steps
- B. Fructose-derived intermediates enter glycolysis downstream of phosphofructokinase
- C. Fructose metabolism is regulated at the phosphofructokinase step in the same manner as glucose metabolism
- D. Fructose metabolism may contribute to increased lipogenesis through production of acetyl-CoA

Q20. Which of the following statements is INCORRECT regarding glycosidic bonds in carbohydrate structures?

- A. Glycosidic bonds can be classified as O-glycosidic or N-glycosidic depending on the atoms involved
- B. These bonds are responsible for linking monosaccharide units in disaccharides and polysaccharides
- C. Glycosidic bonds exist only in proteins and are not found in carbohydrate structures
- D. The configuration and position of glycosidic bonds determine the properties of the carbohydrate

Q21. Which of the following statements is INCORRECT regarding lactate formation during anaerobic glycolysis?

- A. Lactate is formed from pyruvate under anaerobic conditions through reduction reactions
- B. This process regenerates NAD<sup>+</sup> required for continuation of glycolysis
- C. Lactate formation occurs in erythrocytes due to absence of mitochondria
- D. Lactate formation increases ATP yield beyond that produced in aerobic glycolysis

Q22. Which of the following statements is INCORRECT regarding UDP-galactose metabolism and function?

- A. UDP-galactose participates in biosynthetic pathways such as formation of glycoproteins and glycolipids
- B. It can be converted into UDP-glucose through epimerase reactions
- C. UDP-galactose is metabolically inactive and does not participate in any cellular pathways
- D. It serves as an activated form of galactose for biosynthetic reactions

Q23. Which of the following statements is INCORRECT regarding the pyruvate dehydrogenase complex (PDH)?

- A. The PDH complex is located in the mitochondria and links glycolysis to the TCA cycle
- B. The reaction catalyzed by PDH is irreversible under physiological conditions
- C. The complex requires multiple coenzymes such as thiamine pyrophosphate and lipoic acid
- D. The PDH complex functions without requiring any coenzymes or cofactors

Q24. Which of the following statements is INCORRECT regarding membrane proteins and their classification?

- A. Integral membrane proteins span the lipid bilayer and often function as transporters or receptors
- B. Peripheral proteins are loosely attached to the membrane surface and can be easily removed
- C. All membrane proteins function exclusively in transport and have no other roles
- D. Membrane proteins contribute to signaling, structure, and enzymatic activity

Q25. Which of the following statements is INCORRECT regarding the tricarboxylic acid (TCA) cycle?

- A. The TCA cycle occurs in the mitochondria of cells that contain this organelle
- B. It generates reducing equivalents such as NADH and FADH<sub>2</sub> for ATP production
- C. The TCA cycle occurs efficiently in red blood cells despite absence of mitochondria
- D. It serves as a final common pathway for oxidation of carbohydrates, fats, and proteins

Q26. Which of the following statements is INCORRECT regarding gluconeogenesis?

- A. Gluconeogenesis occurs primarily in the liver and to a lesser extent in the kidney
- B. It uses substrates such as lactate, glycerol, and glucogenic amino acids
- C. Gluconeogenesis is most active immediately after carbohydrate-rich meals when insulin levels are high
- D. It plays a role in maintaining blood glucose levels during fasting

Q27. Which of the following statements is INCORRECT regarding glycosaminoglycan classes?

- A. Glycosaminoglycans include chondroitin sulfate and dermatan sulfate
- B. Heparin and heparan sulfate are classified within glycosaminoglycans
- C. Hyaluronic acid is a non-sulfated glycosaminoglycan that is not covalently bound to proteins
- D. All glycosaminoglycans are covalently attached to proteins forming proteoglycans

Q28. Which of the following statements is INCORRECT regarding fructokinase deficiency?

- A. It is generally considered a benign metabolic condition
- B. It does not lead to significant ATP depletion
- C. It produces severe metabolic disturbances similar to hereditary fructose intolerance
- D. It may result in fructose excretion in urine

Q29. Which of the following statements is INCORRECT regarding glycolysis regulation?

- A. Insulin stimulates glycolysis by enhancing enzyme synthesis
- B. Glucagon inhibits glycolysis during fasting
- C. Glycolysis operates independently of hormonal regulation
- D. Blood glucose levels influence glycolytic activity

Q30. Which of the following statements is INCORRECT regarding membrane transport mechanisms?

- A. Passive transport occurs along concentration gradients without energy input
- B. Active transport requires ATP to move substances against gradients
- C. Facilitated diffusion requires ATP for transport across membranes
- D. Cotransport mechanisms use ion gradients such as sodium to drive transport

Q31. Which of the following statements is INCORRECT regarding mannose metabolism?

- A. Mannose can be phosphorylated to mannose-6-phosphate
- B. Mannose-6-phosphate can be converted to fructose-6-phosphate
- C. This conversion is irreversible and tightly regulated
- D. Mannose-derived intermediates can enter glycolysis

Q32. Which of the following statements is INCORRECT regarding carbohydrate digestion?

- A. Carbohydrate digestion begins in the mouth with salivary amylase
- B. Digestion temporarily stops in the stomach due to acidic pH

- C. Digestion continues in the small intestine through pancreatic enzymes
- D. Carbohydrate digestion requires insulin for breakdown of polysaccharides

Q33. Which of the following statements is INCORRECT regarding glycerol metabolism?

- A. Glycerol is transported to the liver after release from triglycerides
- B. It can be converted to glycerol-3-phosphate and then to dihydroxyacetone phosphate
- C. It can enter glycolysis or gluconeogenesis pathways
- D. Glycerol is used exclusively in muscle tissue and cannot be metabolized in the liver

Q34. Which of the following statements is INCORRECT regarding phospholipid structure?

- A. Phospholipids form the structural basis of biological membranes
- B. They contain a hydrophilic head group and hydrophobic fatty acid tails
- C. Their amphipathic nature allows formation of lipid bilayers
- D. Phospholipids are completely water soluble molecules

Q35. Which of the following statements is INCORRECT regarding glycoproteins?

- A. Glycoproteins contain carbohydrate chains covalently attached to proteins
- B. Their carbohydrate chains are typically short and branched compared to glycosaminoglycans
- C. Glycoproteins are structurally identical to glycosaminoglycans in terms of repeating disaccharide units
- D. They play roles in cell recognition and membrane structure

Answer Key:

C, C, C, C, C, C, C, C, D, C, C, C, C, C, B, C, D, C, C, C, C, D, C, D, C, C, C, D, C, C, C, C, D, D, D, C