

VU Learning HUB

BIO504T Quiz File

Chapter-wise Solved MCQs

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Lesson 1: Carbohydrates

Q1. What functional group arrangement defines an aldose?

- A) A carbonyl group at any position other than the end of the chain
- B) A carbonyl group located at the end of the carbon chain (an aldehyde group)
- C) Carboxyl groups attached at both extremities of the molecule
- D) An ester linkage located at C-3

Q2. Which of the following trioses is classified as a ketotriose?

- A) Glyceraldehyde
- B) Dihydroxyacetone
- C) Erythrose
- D) Ribulose

Q3. What is the general empirical chemical formula for hexose sugars?

- A) $C_3H_6O_3$
- B) $C_4H_8O_4$
- C) $C_5H_{10}O_5$
- D) $C_6H_{12}O_6$

Q4. How are ketose sugar names generally derived relative to their corresponding aldose names?

- A) By adding the prefix "keto-" to the name
- B) By inserting "ul" into the name of the corresponding aldose
- C) By appending the suffix "-ase"
- D) By substituting the suffix "-ose" with "-ol"

Answer Key

1. B -- An aldose is defined by having its carbonyl group double-bonded to oxygen at the end of the carbon chain as an aldehyde group.
2. B -- Dihydroxyacetone is the simplest three-carbon ketotriose.
3. D -- Hexoses like D-glucose and D-fructose share the general chemical formula $C_6H_{12}O_6$.
4. B -- Ketoses are systematically designated by inserting "ul" into the corresponding aldose name (e.g., ribulose from ribose).

Lesson 2: Disaccharides & Oligosaccharides

Q1. Upon complete hydrolysis, one molecule of lactose yields which monosaccharide units?

- A) Two molecules of D-glucose
- B) One molecule of glucose and one molecule of fructose
- C) One molecule of glucose and one molecule of galactose
- D) Two molecules of D-galactose

Q2. What specific glycosidic bond joins the two glucose residues in maltose?

- A) $\alpha(1 \rightarrow 4)$ glycosidic bond
- B) $\beta(1 \rightarrow 4)$ glycosidic bond
- C) $\alpha(1 \rightarrow 2)$ glycosidic bond
- D) $\beta(1 \rightarrow 6)$ glycosidic bond

Q3. Oligosaccharides consist of short chains containing how many monosaccharide residues?

- A) 1 to 2 units
- B) 3 to 10 units
- C) 11 to 50 units
- D) Over 100 units

Q4. Which disaccharide produces one molecule of glucose and one molecule of fructose upon hydrolysis?

- A) Maltose
- B) Lactose
- C) Sucrose
- D) Cellobiose

Answer Key

1. C -- Lactose yields one molecule of glucose and one molecule of galactose upon hydrolysis.
2. A -- Maltose is formed by an alpha(1->4) glycosidic linkage between carbon 1 and carbon 4 of two glucose units.
3. B -- Oligosaccharides are defined as short chains containing 3 to 10 monosaccharide units linked covalently.
4. C -- Sucrose is a disaccharide that hydrolyses into one glucose unit and one fructose unit.

Lesson 3: Polysaccharides

Q1. Polysaccharides (glycans) yield more than how many monosaccharide units upon hydrolysis?

- A) 2 units
- B) 5 units
- C) 10 units
- D) 50 units

Q2. Which of the following carbohydrates is classified as a homopolysaccharide?

- A) Mucopolysaccharide
- B) Glycosaminoglycan
- C) Glycogen
- D) Heteroglycan

Q3. What serves as the primary storage homopolysaccharide in animal cells?

- A) Starch
- B) Glycogen
- C) Cellulose
- D) Inulin

Q4. What fraction of plant starch typically consists of the unbranched helical polymer amylose?

- A) 5-10%
- B) 13-20%
- C) 40-50%
- D) 80-85%

Answer Key

1. C -- Polysaccharides yield more than 10 monosaccharide molecules when completely hydrolyzed.
2. C -- Glycogen is a homopolysaccharide composed solely of repeating D-glucose monomeric units.
3. B -- Glycogen is the major storage carbohydrate occurring in animal liver and muscle tissues.
4. B -- Amylose makes up approximately 13-20% of starch and features an unbranched helical chain of D-glucose.

Lesson 4: Isomerism

Q1. What term describes stereoisomers that are nonsuperposable mirror images of each other?

- A) Diastereomers
- B) Anomers
- C) Enantiomers
- D) Epimers

Q2. What structural change is required to interconvert stereoisomers?

- A) Rotation around a single carbon-carbon bond
- B) Dissolving the molecule in an aqueous solvent
- C) Temporarily breaking one or more covalent bonds
- D) Changing ambient temperature

Q3. Pairs of stereoisomers that are NOT mirror images of each other are designated as:

- A) Enantiomers
- B) Diastereomers
- C) Constitutional isomers
- D) Tautomers

Q4. Whether a sugar belongs to the D or L series is determined by the spatial orientation of groups around which carbon?

- A) C-1 (carbonyl carbon)
- B) C-2
- C) The penultimate carbon (carbon adjacent to the terminal primary alcohol)
- D) The terminal primary alcohol carbon itself

Answer Key

1. C -- Stereoisomers that exist as nonsuperposable mirror images are called enantiomers.
2. C -- Stereoisomers cannot be interconverted without temporarily breaking one or more covalent bonds.
3. B -- Diastereomers are stereoisomers that are not mirror images of one another.
4. C -- The orientation of -H and -OH around the penultimate carbon (C-5 in glucose) determines D or L configuration.

Lesson 10: Ring Structure of Carbohydrates

Q1. During the intramolecular cyclization of D-glucose, the hydroxyl group on which carbon atom attacks C-1?

- A) C-2
- B) C-3
- C) C-4
- D) C-5

Q2. Carbohydrate isomers that differ only in configuration at the hemiacetal or hemiketal carbon are called:

- A) Epimers
- B) Anomers
- C) Enantiomers
- D) Structural isomers

Q3. What chemical functional group is formed when an aldehyde reacts intramolecularly with an alcohol group?

- A) Hemiketal
- B) Hemiacetal
- C) Peptide bond
- D) Ester bond

Q4. Cyclization of an open-chain monosaccharide creates an anomeric center producing which two stereoisomeric forms?

- A) D and L forms
- B) cis and trans forms
- C) alpha and beta forms
- D) R and S forms

Answer Key

1. D -- In D-glucose, the free hydroxyl group at carbon 5 reacts with the aldehydic carbon 1 to form a ring.
2. B -- Anomers are isomeric forms differing exclusively in configuration about the anomeric (hemiacetal/hemiketal) carbon.
3. B -- The reaction between an aldehyde group and an alcohol group yields a hemiacetal derivative.
4. C -- Ring formation renders C-1 asymmetric, generating two distinct stereoisomers designated alpha and beta.

Lesson 27: Proteins

Q1. Which functional class of proteins acts as the primary defense against invading bacteria and viruses?

- A) Enzymes
- B) Immunoglobulins
- C) Structural proteins
- D) Hormones

Q2. Collagen is categorized under which functional group of proteins?

- A) Transport proteins
- B) Contractile proteins
- C) Structural proteins
- D) Storage proteins

Q3. How do proteins assist in maintaining water and electrolyte balance across fluid compartments?

- A) By driving muscle contractions
- B) By exerting osmotic pressure
- C) By catalyzing fatty acid oxidation

D) By binding oxygen in plasma

Q4. Which proteins are directly responsible for muscle fiber contraction and intracellular movement?

- A) Collagen and elastin
- B) Hemoglobin and transferrin
- C) Contractile proteins (myosin and actin)
- D) Ferritin and ceruloplasmin

Answer Key

1. B -- Immunoglobulins (antibodies) serve as the first line of defense against foreign pathogens.
2. C -- Collagen provides essential mechanical support as a major structural protein.
3. B -- Proteins exert osmotic pressure to maintain proper fluid and electrolyte balance in the body.
4. C -- Contractile proteins such as myosin and actin generate movement in muscle fibers and cellular microvilli.

Lesson 29: Amino Acids & Functional Diversity

Q1. All cellular proteins across all species are constructed from what standard set of amino acids?

- A) 10
- B) 12
- C) 20
- D) 64

Q2. Light emission in fireflies is catalyzed by luciferase using ATP and which substrate protein?

- A) Hemoglobin
- B) Keratin
- C) Luciferin
- D) Myosin

Q3. What structural protein constitutes the primary component of vertebrate hair, scales, horn, and nails?

- A) Collagen
- B) Keratin
- C) Dystrophin
- D) Fibrinogen

Q4. Mature human red blood cells are packed with large amounts of which oxygen-transporting protein?

- A) Myoglobin
- B) Hemoglobin
- C) Transferrin
- D) Ferritin

Answer Key

1. C -- Proteins across all complex and simple forms of life are constructed from a universal alphabet of 20 precursor amino acids.

2. C -- Bioluminescence in fireflies results from ATP-dependent oxidation of luciferin catalyzed by luciferase.
3. B -- Keratin forms the principal structural component of outer protective structures in vertebrates.
4. B -- Red blood cells contain high concentrations of hemoglobin to transport oxygen to tissues.

Lesson 30: Standard Amino Acids & Peptide Bond

Q1. In all 20 common standard amino acids, the carboxyl group and amino group are bonded to which carbon?

- A) Beta carbon
- B) Gamma carbon
- C) Alpha carbon
- D) Terminal carbon

Q2. The universal genetic code explicitly specifies which stereoisomeric form of amino acids?

- A) D-alpha-amino acids
- B) L-alpha-amino acids
- C) D-beta-amino acids
- D) L-beta-amino acids

Q3. The term "residue" used when describing amino acids in a polypeptide chain reflects:

- A) The addition of a phosphate molecule
- B) The loss of the elements of water during peptide bond formation
- C) The cleavage of the variable side chain
- D) The presence of a free terminal amino group

Q4. What part of the molecule differentiates the 20 standard amino acids from one another?

- A) The carboxyl backbone group
- B) The amino backbone group
- C) The distinctive side chain (R group)
- D) The type of peptide bond formed

Answer Key

1. C -- All 20 common amino acids are alpha-amino acids with amino and carboxyl groups attached to the alpha-carbon.
2. B -- The genetic code specifies exclusively the 20 L-alpha-amino acid monomer units.
3. B -- "Residue" highlights the loss of H₂O elements when amino acids condense into a chain.
4. C -- Amino acids differ from each other in the structure, size, electric charge, and solubility of their R side chains.

Lesson 53: Peptide Bond

Q1. A peptide bond is formed by condensation between which two functional groups of amino acids?

- A) alpha-carboxyl group of one amino acid and alpha-amino group of another
- B) Side chain hydroxyl group and carboxyl group
- C) Two amino groups
- D) Side chain thiol group and carboxyl group

Q2. Virtually all peptide bonds in natural proteins occur in which geometric configuration?

- A) Cis configuration
- B) Trans configuration
- C) Gauche configuration
- D) Cyclic configuration

Q3. Why is the trans peptide bond configuration strongly favored over the cis form?

- A) Trans configuration forms stronger hydrogen bonds with solvent
- B) Steric clashes between groups attached to adjacent alpha-carbon atoms hinder cis formation
- C) Ribosomes cannot physically synthesize cis peptide bonds
- D) Trans configuration contains no partial double bond character

Q4. Chemically, the covalent bond linking adjacent amino acids in a protein backbone is what type of linkage?

- A) Ester linkage
- B) Ether linkage
- C) Amide linkage
- D) Glycosidic linkage

Answer Key

1. A -- Peptide bond formation occurs via removal of water between the alpha-carboxyl carbon of one residue and the alpha-amino nitrogen of another.
2. B -- Steric factors heavily favor the trans configuration in protein peptide bonds.
3. B -- Steric hindrance between side chains attached to neighboring alpha-carbons destabilizes the cis configuration.
4. C -- The peptide bond is covalently classified as a substituted amide linkage.

Lesson 54: Structure of Proteins

Q1. Which level of protein structure refers strictly to the linear covalent sequence of amino acid residues?

- A) Primary structure
- B) Secondary structure
- C) Tertiary structure
- D) Quaternary structure

Q2. Which covalent linkages primarily maintain the primary structure of a polypeptide chain?

- A) Hydrogen bonds and hydrophobic forces
- B) Peptide bonds and disulfide bonds
- C) Ionic bonds and van der Waals forces
- D) Phosphodiester bonds

Q3. How many hierarchical levels of structural organization are defined for complex proteins?

- A) Two
- B) Three
- C) Four
- D) Five

Q4. What determines the specific primary sequence of amino acids in a protein?

- A) Cytosolic pH

- B) Genes (nucleotide sequences in DNA)
- C) Chaperonin helper complexes
- D) Body temperature

Answer Key

1. A — Primary structure describes the linear sequence of amino acid residues linked by covalent bonds.
2. B — Peptide bonds along the backbone and occasional disulfide cross-links hold the primary structure together.
3. C — Four structural levels are defined: primary, secondary, tertiary, and quaternary.
4. B — The unique primary amino acid sequence of a protein is encoded by gene sequences.

Lesson 101: Lipid Chemistry

Q1. Lipids are grouped together as a class of biomolecules primarily on the basis of:

- A) A shared functional group
- B) Physical property of insolubility in water
- C) Formation of polymeric chains
- D) High molecular weight above 50 kDa

Q2. What insulating structure formed by lipids allows rapid transmission of nerve impulses?

- A) Synaptic vesicle
- B) Myelin sheath
- C) Axonal cytoplasm
- D) Cytoskeletal actin network

Q3. Which amphipathic lipid classes form the fundamental hydrophobic barrier of biological membranes?

- A) Triacylglycerols and waxes
- B) Phospholipids and sterols
- C) Glycogen and starch
- D) Free fatty acids and glycerol

Q4. How are insoluble lipids transported through blood plasma?

- A) As free lipid droplets
- B) In combination with proteins as lipoproteins
- C) Bound to hemoglobin
- D) Attached to ribosomal RNA

Answer Key

1. B — Lipids are a heterogeneous group defined more by physical solubility (insoluble in water) than chemical structure.
2. B — Lipids form the myelin sheath around nerve fibers, enabling high-speed impulse transmission.
3. B — Phospholipids and sterols are major structural elements creating membrane bilayers.
4. B — Lipids circulate in aqueous blood plasma encapsulated in protein-lipid complexes called lipoproteins.

Lesson 102: Classification of Lipids

Q1. Neutral fats and oils are chemically defined as esters of fatty acids with which alcohol?

- A) Sphingosine
- B) Glycerol
- C) Cholesterol
- D) Ethanolamine

Q2. How do true waxes differ chemically from neutral triacylglycerols?

- A) Waxes contain no fatty acids
- B) Waxes are esters of fatty acids with higher molecular weight monohydric alcohols
- C) Waxes contain glycerol and phosphate
- D) Waxes are water-soluble polymers

Q3. Glycolipids are categorized as complex lipids because they contain which non-lipid moiety?

- A) Phosphoric acid
- B) Carbohydrate
- C) Sulfate ester
- D) Nucleotide

Q4. Fatty acids, glycerol, steroids, and ketone bodies belong to which broad lipid classification?

- A) Simple lipids
- B) Complex lipids
- C) Precursor and derived lipids
- D) Phospholipids

Answer Key

1. B — Fats are esters formed between long-chain fatty acids and glycerol.
2. B — Waxes consist of fatty acids esterified to high molecular weight monohydric alcohols rather than glycerol.
3. B — Glycolipids contain a fatty acid, sphingosine, and a carbohydrate group.
4. C — Free fatty acids, alcohols, steroids, ketone bodies, and fat-soluble vitamins represent precursor and derived lipids.

Lesson 158: Biomedical Importance of Nucleotides

Q1. Which nucleotide acts as the universal cellular energy currency and principal donor of phosphoryl groups?

- A) CTP
- B) ATP
- C) UTP
- D) GTP

Q2. Which key metabolic coenzyme contains an adenine nucleotide unit in its structure?

- A) Ascorbic acid
- B) Flavin Adenine Dinucleotide (FAD)
- C) Pyridoxal phosphate
- D) Thiamine pyrophosphate

Q3. How do nucleotides participate directly in regulating metabolic pathways?

- A) By saponifying plasma membranes
- B) Via allosteric regulation of key enzymes and ATP-dependent phosphorylation
- C) By forming peptide bonds between enzymes
- D) By cleaving lipid esters

Q4. What role do nucleotides play in genetic expression?

- A) Serving as primary structural lipids
- B) Storing and transmitting genetic information as monomer units of DNA and RNA
- C) Acting as digestive enzymes in stomach acid
- D) Exerting osmotic pressure in plasma

Answer Key

1. B — Nucleoside triphosphates like ATP act as the primary donors of phosphoryl groups for energy transduction.
2. B — Coenzymes like FAD, NAD⁺, and Coenzyme A incorporate adenine nucleotides in their chemical structures.
3. B — Nucleotides modulate intermediary pathways allosterically (e.g., AMP, ATP, CTP) and through phosphorylation.
4. B — Nucleotides store and transfer genetic information, enabling protein synthesis and cell inheritance.

Lesson 161: Composition of Nucleotides

Q1. Every standard nucleotide is composed of which three structural components?

- A) Fatty acid, glycerol, and phosphate
- B) Nitrogenous base, pentose monosaccharide, and phosphate group(s)
- C) Amino acid, hexose sugar, and nitrate
- D) Purine base, lipid, and sulfate

Q2. Which of the following bases belongs to the double-ring purine family?

- A) Cytosine
- B) Thymine
- C) Uracil
- D) Guanine

Q3. Which pyrimidine base is present in DNA but absent in standard RNA?

- A) Uracil
- B) Thymine
- C) Cytosine
- D) Adenine

Q4. How do the pyrimidine bases thymine and uracil differ structurally?

- A) Thymine contains a methyl group at position 5 that is absent in uracil
- B) Uracil contains an additional exocyclic amino group
- C) Thymine contains a fused imidazole ring
- D) Uracil contains a deoxyribose sugar

Answer Key

1. B — A nucleotide consists of a nitrogenous base, a pentose monosaccharide, and 1 to 3 phosphate groups.
2. D — Guanine and adenine belong to the double-ring purine family.

3. B — Thymine is found in DNA, whereas uracil replaces thymine in RNA.
4. A — Thymine is 2,4-dioxy-5-methyl-pyrimidine, differing from uracil (2,4-dioxy-pyrimidine) by one methyl group.

Lesson 171: DNA

Q1. Deoxyribonucleotides in a single strand of DNA are covalently linked together by:

- A) 2'->3' glycosidic bonds
- B) 3'->5' phosphodiester bonds
- C) Peptide linkages
- D) Disulfide bridges

Q2. In eukaryotic nuclei, chromosomal DNA is organized around basic proteins called:

- A) Globulins
- B) Histones
- C) Albumins
- D) Cytochromes

Q3. In prokaryotic cells, DNA is located in a specialized, non-membrane-bound region termed the:

- A) Nucleolus
- B) Nucleoid
- C) Plasmid
- D) Centrosome

Q4. What is the fundamental biological role of nuclear DNA?

- A) Acting as a structural cell wall component
- B) Functioning as the repository of genetic information
- C) Catalyzing cytosolic carbohydrate breakdown
- D) Storing fatty acids for fasting states

Answer Key

- 1. B — DNA is a polymer of deoxyribonucleoside monophosphates joined covalently by 3'->5' phosphodiester bonds.
- 2. B — Eukaryotic nuclear DNA complexes with basic histone proteins to form chromatin.
- 3. B — Prokaryotic DNA resides in a dedicated non-membrane-enclosed cytosolic area called the nucleoid.
- 4. B — DNA serves as the central cellular repository for storing and transmitting genetic master plans.

Lesson 191: Enzymes

Q1. With the exception of catalytic RNA molecules (ribozymes), all enzymes are chemically:

- A) Carbohydrates
- B) Lipids
- C) Proteins
- D) Steroids

Q2. What is the mandatory initial step in any enzyme-catalyzed reaction?

- A) Conversion of bound substrate to product
- B) Reversible binding of substrate to form an enzyme-substrate complex (ES)

- C) Irreversible cleavage of the enzyme backbone
- D) Product release into solvent

Q3. Why are higher-order protein structures (tertiary/quaternary) critical in enzymes?

- A) They prevent the enzyme from dissolving in water
- B) They maintain the precise three-dimensional active site required for catalytic activity
- C) They convert proteins into nucleic acids
- D) They eliminate substrate specificity

Q4. Which statement accurately describes the catalytic performance of enzymes?

- A) Enzymes display low specificity and act randomly on surrounding molecules
- B) Enzymes function only in nonpolar organic solvents
- C) Enzymes possess extraordinary catalytic power and high substrate specificity
- D) Enzymes are permanently consumed during single catalytic cycles

Answer Key

1. C — Except for catalytic RNA ribozymes, all biological enzymes are highly specialized proteins.
2. B — The first step in enzymatic catalysis is substrate binding: $E + S \rightleftharpoons ES$.
3. B — Primary, secondary, tertiary, and quaternary folding patterns create the specific active site necessary for catalysis.
4. C — Enzymes exhibit immense catalytic acceleration and exquisite substrate specificity in aqueous cellular environments.

Lesson 219: Water

Q1. Water constitutes approximately what proportion of the total weight of most living organisms?

- A) 20%
- B) 40%
- C) 70% or more
- D) 95%

Q2. What intermolecular attraction accounts for water's unusually high melting point, boiling point, and heat of vaporization?

- A) Covalent bonding
- B) Hydrogen bonding
- C) Ionic attraction
- D) Disulfide cross-linking

Q3. In liquid water and ice, each water molecule forms hydrogen bonds tetrahedrally with up to how many neighbors?

- A) 2
- B) 3
- C) 4
- D) 6

Q4. Pure water undergoes slight reversible ionization to yield which pair of ions?

- A) Na^+ and Cl^-
- B) Hydrogen ions (H^+) and Hydroxide ions (OH^-)

- C) H_3O^+ and CO_3^{2-}
- D) NH_4^+ and NO_3^-

Answer Key

1. C — Water is the most abundant biological constituent, making up 70% or more of cellular mass.
2. B — Hydrogen bonding between water molecules imparts unusually high thermal transition temperatures.
3. C — Water molecules arrange four hydrogen bonds tetrahedrally around each central oxygen atom.
4. B — Water undergoes weak ionization yielding equal concentrations of H^+ and OH^- ions at neutrality.

Lesson 225: Buffer Solutions

Q1. What is the fundamental biological function of a buffer solution?

- A) To accelerate chemical reaction rates
- B) To resist changes in pH when small amounts of acid (H^+) or base (OH^-) are added
- C) To hydrolyze disaccharides into monosaccharides
- D) To emulsify lipids in blood plasma

Q2. A biological buffer system typically consists of a mixture of:

- A) A strong acid and a strong base
- B) A weak acid (proton donor) and its conjugate base (proton acceptor)
- C) A neutral salt and pure water
- D) A nonpolar lipid and a protein

Q3. A buffer system exhibits its maximum buffering capacity under which chemical condition?

- A) When pH is much lower than pKa
- B) When $\text{pH} = \text{pKa}$ (i.e., when $[\text{HA}] = [\text{A}^-]$)
- C) When the solution is fully boiled
- D) When $[\text{HA}] = 0$

Q4. When the concentration of un-ionized acid $[\text{HA}]$ exceeds the conjugate base $[\text{A}^-]$, the solution pH will be:

- A) Greater than pKa
- B) Less than pKa
- C) Equal to 14
- D) Equal to 0

Answer Key

1. B — Buffers resist pH shifts upon addition of H^+ or OH^- ions.
2. B — Buffers comprise a weak acid (proton donor) in equilibrium with its conjugate base (proton acceptor).
3. B — Maximum buffering capacity occurs at $\text{pH} = \text{pKa}$, where equal amounts of proton donor and acceptor are present.
4. B — When $[\text{HA}] > [\text{A}^-]$, the Henderson-Hasselbalch relationship dictates that $\text{pH} < \text{pKa}$.

End of Quiz

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