Ahmedabad University

School of Arts and Sciences

BIO101 Introductory Biology

Mid Semester Examination 2024 (Bi – Semester)

Total Marks = 60 **Time – 1 hour**

Student Enrollment No: **AU** Student Name:
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1. Which of the following best demonstrates the interplay between inductive and deductive reasoning in scientific inquiry?
A) Developing a theory from observations and testing its predictions experimentally
B) Using a hypothesis to guide observations and identifying anomalies
C) Observing a pattern in nature and applying the findings to unrelated phenomena
D) Testing unrelated hypotheses simultaneously using experimental data

2. Which atomic property most significantly impacts the polarity of covalent bonds in biological molecules?
A) Atomic mass
B) Number of neutrons
C) Electronegativity
D) Valence shell electron pairing

3. Why are essential fatty acids such as omega-3 classified as "essential"?
A) They are synthesized in trace amounts by the human body
B) They form hydrophobic interactions critical for enzyme function
C) They must be acquired through diet as they cannot be synthesized
D) They are a primary energy source in cellular respiration

4. A researcher alters the lipid composition of a plasma membrane by replacing saturated fatty acids with unsaturated ones. What is the most likely outcome?
A) Increased rigidity of the membrane at higher temperatures
B) Reduced fluidity of the membrane in cold conditions
C) Greater flexibility of the membrane at low temperatures
D) Loss of membrane asymmetry

5. Why is facilitated diffusion via carrier proteins slower than diffusion through channel proteins?
A) Carrier proteins require ATP to function, delaying transport
B) Channel proteins allow passive ion flow, while carriers bind and release solutes sequentially

C) Carrier proteins lack specificity, reducing transport efficiency
D) Channel proteins can transport larger molecules than carrier proteins

6. In a biochemical pathway, enzyme A converts substrate S to product P. If the product P acts as a competitive inhibitor for enzyme A, what is the likely consequence when P accumulates?
A) Increased production of P due to enzyme activation
B) Reduced activity of enzyme A, slowing the conversion of S to P
C) Unregulated production of P due to positive feedback
D) Inhibition of all enzymes in the pathway, causing a metabolic block

7. What is the primary role of an enzyme's induced fit mechanism?
A) To allow multiple substrates to bind simultaneously
B) To lower activation energy by optimizing the substrate's transition state
C) To permanently alter the enzyme for continuous substrate binding
D) To stabilize the product immediately after the reaction

8. During oxidative phosphorylation, the proton gradient across the inner mitochondrial membrane is maintained because:
A) ATP synthase actively pumps protons into the matrix
B) Protons are selectively bound to NADH and $FADH_2$
C) The membrane is impermeable to ions except through specific channels
D) The outer mitochondrial membrane generates ATP

9. What is the primary role of the Calvin cycle in photosynthesis?
A) To generate ATP for use in cellular respiration
B) To reduce oxygen into water, generating energy
C) To convert atmospheric CO_2 into organic molecules like glucose
D) To harvest light energy and convert it into ATP

10. Which component of the photosynthetic electron transport chain produces ATP, and how?
A) Photosystem II, via photophosphorylation
B) ATP synthase, via chemiosmosis driven by a proton gradient
C) Ferredoxin-$NADP^+$ reductase, via substrate-level phosphorylation
D) Photosystem I, via oxidation of NADPH

11. Why does a plant appear green despite absorbing other wavelengths of light?
A) Chlorophyll molecules reflect green wavelengths more than others
B) Photosynthetic pigments primarily absorb green light for energy
C) Green light is used by accessory pigments, making it visible
D) Green wavelengths are transmitted to other parts of the plant

12. Which aspect of cell signaling allows for specificity in cellular responses?
A) The universal nature of secondary messengers like cAMP
B) The ability of a single ligand to bind to multiple receptors

C) The receptor's affinity and structural compatibility with specific ligands
D) Rapid ligand degradation after receptor binding

13. Which cellular structure is involved in the detoxification of alcohol in liver cells?
A) Lysosome
B) Peroxisome
C) Endoplasmic reticulum
D) Mitochondria

14. In the hydrolysis of a disaccharide, which of the following acts as a reactant?
A) Oxygen gas
B) A water molecule
C) An enzyme inhibitor
D) Lipids

15. Which macromolecule is primarily broken down by amylase?
A) Lipids
B) Proteins
C) Nucleic acids
D) Carbohydrates

16. What type of bond links amino acids in a protein?
A) Hydrogen bond
B) Ionic bond
C) Peptide bond
D) Disulfide bond

17. Which subatomic particle determines the chemical properties of an element?
A) Proton
B) Neutron
C) Electron
D) Atomic nucleus

18. What distinguishes isotopes of the same element?
A) Number of protons
B) Number of electrons
C) Number of neutrons
D) Atomic number

19. In water (H_2O), what type of bonds exist between hydrogen and oxygen atoms within a molecule?
A) Ionic bonds
B) Non-polar covalent bonds
C) Polar covalent bonds
D) Hydrogen bonds

20. In cell signaling, what distinguishes autocrine signaling from paracrine signaling?
A) Autocrine signaling occurs over longer distances than paracrine signaling.
B) Autocrine signaling involves a feedback loop where the cell is both the signal sender and receiver.
C) Paracrine signaling requires direct contact between cells, whereas autocrine does not.
D) Paracrine signaling involves hydrophobic ligands, while autocrine signaling uses hydrophilic ligands.

21. Which of the following is the primary role of GTP in G-protein-coupled receptor (GPCR) pathways?
A) To activate secondary messengers like cAMP
B) To phosphorylate target proteins directly
C) To activate the G-protein by binding to its α subunit
D) To inhibit downstream signaling cascades

22. Why does a ligand that binds an intracellular receptor typically need to be hydrophobic?
A) Hydrophobic ligands are more stable in the extracellular environment.
B) They must cross the lipid bilayer of the plasma membrane to reach their receptor.
C) Hydrophobic ligands form stronger bonds with DNA than hydrophilic ligands.
D) Intracellular receptors only exist in hydrophobic cellular environments.

23. How do ion channel-linked receptors contribute to cell communication?
A) They activate protein kinases to phosphorylate target molecules.
B) They form pores that open in response to ligand binding, allowing ion flow across the membrane.
C) They directly transcribe genes upon ligand binding.
D) They mediate vesicle fusion during synaptic transmission.

24. Which of the following is a key difference between enzyme-linked receptors and G-protein-coupled receptors?
A) Enzyme-linked receptors undergo autophosphorylation, while GPCRs do not.
B) GPCRs activate ion channels, whereas enzyme-linked receptors do not.
C) Enzyme-linked receptors directly interact with second messengers like cAMP.
D) GPCRs can bind hydrophobic ligands, whereas enzyme-linked receptors cannot.

25. Why does the splitting of water (photolysis) in Photosystem II play a crucial role in the light reactions?
A) It provides electrons to replace those lost by chlorophyll in the reaction center.
B) It directly generates ATP for the Calvin cycle.
C) It ensures that NADPH is oxidized back to $NADP^+$.
D) It creates a proton gradient that is used by ferredoxin-$NADP^+$ reductase.

26. What distinguishes Photosystem I (PSI) from Photosystem II (PSII) in terms of function?
A) PSI oxidizes water to oxygen, while PSII reduces $NADP^+$ to NADPH.
B) PSI generates ATP, while PSII generates a proton gradient.
C) PSI receives electrons from the electron transport chain, while PSII donates electrons to it.
D) PSI functions in the Calvin cycle, while PSII functions in photorespiration.

27. Why is the formation of a proton gradient across the thylakoid membrane essential for ATP synthesis during photosynthesis?
A) It directly transports ATP from the stroma to the thylakoid lumen.
B) It powers ATP synthase by allowing protons to flow back into the stroma.
C) It activates rubisco for carbon fixation in the Calvin cycle.
D) It increases the solubility of oxygen in the thylakoid lumen.

28. How does the absorption spectrum of chlorophyll explain its role in photosynthesis?
A) It reflects blue and red light, which powers the light reactions.
B) It absorbs green light, making plants appear green.
C) It absorbs light most efficiently in the blue and red regions, providing energy for electron excitation.
D) It reflects red light while transmitting blue light to accessory pigments.

29. Which of the following best represents deductive reasoning in the scientific method?
A) Formulating a general theory based on patterns observed in experiments
B) Testing the prediction that a bird species migrates due to temperature changes based on a broader hypothesis
C) Proposing a hypothesis based on anomalous data points from a controlled study
D) Deriving unrelated conclusions from a set of experimental findings

30. What property of life is illustrated by the behavior of a unicellular organism moving toward a source of nutrients?
A) Adaptation
B) Regulation
C) Response to stimuli
D) Energy processing

31. In biological research, what is the primary difference between basic and applied science?
A) Basic science involves solving real-world problems, while applied science seeks to expand knowledge.
B) Basic science generates foundational knowledge without immediate practical application, while applied science focuses on addressing specific issues.
C) Basic science requires experimental validation, whereas applied science relies solely on observation.
D) Basic science is restricted to theoretical frameworks, while applied science uses natural explanations exclusively.

32.Why do ionic bonds tend to dissociate in water?
A) Water molecules are non-polar, preventing the formation of ionic lattices.
B) Water's partial charges interact with ions, reducing their electrostatic attractions.
C) Ionic compounds are less stable than covalent compounds in general.
D) Water stabilizes the ions by removing their electrons.

33. Which statement correctly describes dehydration synthesis?
A) It involves the breakdown of polymers into monomers by adding water.
B) It results in the formation of a covalent bond by removing a water molecule.
C) It only occurs in the synthesis of lipids.
D) It leads to the creation of isotopes for macromolecules.

34. What is the primary structural difference between saturated and unsaturated fatty acids?
A) Saturated fatty acids have only single bonds, while unsaturated fatty acids contain one or more double bonds.
B) Saturated fatty acids contain double bonds, while unsaturated fatty acids do not.
C) Saturated fatty acids are hydrophilic, while unsaturated fatty acids are hydrophobic.
D) Saturated fatty acids have more carbon atoms than unsaturated fatty acids.

35. Which type of glycosidic linkage is found in cellulose, and what does it result in?
A) α-1,4 linkage; it results in a branched structure.
B) β-1,4 linkage; it forms a linear and fibrous structure.
C) α-1,6 linkage; it produces a compact and branched structure.
D) β-1,6 linkage; it creates a water-soluble structure.

36. What role do phospholipids play in biological membranes?
A) They act as enzymes to catalyze lipid synthesis.
B) They provide energy through their fatty acid tails.
C) They form bilayers with hydrophilic heads and hydrophobic tails, creating a semi-permeable barrier.
D) They store genetic information within their hydrophobic regions.

37. Why do water molecules exhibit cohesion?
A) Water molecules have ionic bonds that attract them to each other.
B) Hydrogen bonds form between the partial charges on adjacent water molecules.
C) Covalent bonds allow water molecules to stick together.
D) Water molecules are hydrophobic, making them attract other water molecules.

38. What is the primary structural difference between DNA and RNA molecules?
A) DNA is single-stranded, while RNA is double-stranded.
B) DNA contains uracil, while RNA contains thymine.
C) DNA contains deoxyribose, while RNA contains ribose.
D) DNA is composed of lipids, while RNA is composed of carbohydrates.

39. What distinguishes a peptide bond from other covalent bonds in macromolecules?
A) It is a hydrogen bond between amino acids.
B) It is a covalent bond formed between the amino group of one amino acid and the carboxyl group of another.
C) It is a bond that forms during the hydrolysis of proteins.
D) It is the weakest covalent bond in biological systems.

40. Why are lipids considered hydrophobic?
A) Their polar groups interact with water.
B) They contain long hydrocarbon chains that do not interact well with water.
C) They have high molecular weight, making them insoluble.
D) Their charged regions repel water molecules.

41. What happens to an atom that becomes an anion?
A) It gains protons and becomes positively charged.
B) It loses protons and becomes negatively charged.
C) It gains electrons and becomes negatively charged.
D) It loses electrons and becomes positively charged.

42. In metabolic pathways, anabolic reactions _____ molecules and require energy, while catabolic reactions _____ molecules and release energy.

43. The plasma membrane is described by the _____ model, which depicts it as a fluid combination of phospholipids, cholesterol, proteins, and carbohydrates.

44. State True or False (3)

- The cell theory states that all living organisms are composed of cells, and all cells arise from preexisting cells. ☐
- Prokaryotic cells lack ribosomes, making them unable to synthesize proteins. ☐
- The nucleolus is the site of ribosomal RNA (rRNA) synthesis and ribosome assembly within the nucleus. ☐
- Chloroplasts and mitochondria are part of the endomembrane system in eukaryotic cells. ☐
- Lysosomes are membrane-bound organelles that contain enzymes responsible for breaking down cellular waste and macromolecules. ☐
- Plant cells lack centrosomes and centrioles, which are responsible for organizing microtubules in animal cells. ☐

45. Which of the following best describes the role of NADH and FADH2 in cellular respiration?
A) They provide oxygen to the electron transport chain.
B) They act as final electron acceptors in the electron transport chain.

C) They donate electrons to the electron transport chain, facilitating ATP production.
D) They catalyze the breakdown of glucose during glycolysis.

46. Which statement about the chemiosmotic theory is correct?
A) It explains ATP synthesis by substrate-level phosphorylation in the cytoplasm.
B) It involves the movement of protons across the mitochondrial inner membrane, creating a proton gradient used to drive ATP synthesis.
C) It describes the direct transfer of electrons to oxygen to generate water.
D) It involves the reduction of NADH and FADH2 to produce ATP.

47. What is the primary role of oxygen in cellular respiration?
A) To donate electrons to the electron transport chain
B) To act as the final electron acceptor in the electron transport chain
C) To phosphorylate ADP to ATP
D) To oxidize glucose to pyruvate

48. What happens to pyruvate in the absence of oxygen?
A) It enters the Krebs cycle
B) It is converted to glucose
C) It undergoes fermentation
D) It is directly used in the electron transport chain

49. What is the main role of the Krebs cycle in cellular respiration?
A) To produce glucose
B) To generate NADH and FADH2 for the electron transport chain
C) To split glucose into pyruvate
D) To store energy as fat

50. What is the primary purpose of cellular respiration?
A) To produce oxygen
B) To generate ATP
C) To break down complex sugars
D) To synthesize CO_2

51. The energy released from electron flow is used to pump protons (H+) from
A) Intermembrane space to cytoplasm
B) Outer mitochondrial membrane to inner mitochondrial membrane
C) Mitochondrial matrix to intermembrane space
D) Inner mitochondrial membrane to outer mitochondrial membrane

52. What is the main function of cell division in multicellular organisms?
A) To produce genetically identical offspring
B) To allow for growth, repair, and maintenance of tissues
C) To create genetic diversity in somatic cells
D) To regulate the movement of organelles within the cell

53. What is the primary purpose of the S phase of interphase?
A) To prepare for cytokinesis
B) To replicate the cell's DNA
C) To divide the cell's cytoplasm
D) To repair damaged organelles

54. Which of the following best describes interphase in the cell cycle?
A) The phase where mitosis and cytokinesis occur
B) The resting phase between cell divisions
C) The phase of active cell growth and DNA replication
D) The phase where the nuclear envelope dissolves

55. Which of the following is an example of a chemical signal that acts locally in paracrine signaling?
A) Neurotransmitters at a synapse
B) Hormones like insulin
C) Gas ligands such as nitric oxide
D) Cytokines in the immune system

56. Which stage marks the start of the cell division process in eukaryotic cells?
A) Interphase
B) G1 phase
C) M phase
D) Cytokinesis

57. What happens to the chromosome number during prokaryotic cell division?
A) It doubles permanently.
B) It is halved.
C) It remains the same, ensuring identical daughter cells.
D) It becomes variable depending on environmental conditions.

58. Which of these structures does NOT have a double membrane (i.e., two lipid bilayers)
A) Endoplasmic reticulum
B) Nucleus
C) Mitochondira
D) Vesicle