SECTION 2: The Chemistry of Life (40 Questions)

1. What is the pH of a solution with $[H^+] = 1 \times 10^{-9}$ M?
   A) 5
   B) 7
   C) 9
   D) 11

2. Which type of bond holds the two strands of DNA together?
   A) Covalent bonds
   B) Ionic bonds
   C) Hydrogen bonds
   D) Peptide bonds

3. Which functional group is characteristic of carboxylic acids?
   A) –OH
   B) $–NH_2$
   C) –COOH
   D) –CHO

4. Which of the following is a reducing sugar?
   A) Sucrose
   B) Glucose
   C) Starch
   D) Cellulose

5. The peptide bond forms between:
   A) Two amino groups
   B) An amino group and a carboxyl group
   C) Two carboxyl groups
   D) A hydroxyl group and a carboxyl group

6. Which macromolecule is the primary component of cell membranes?
   A) Proteins
   B) Nucleic acids
   C) Phospholipids
   D) Polysaccharides

7. What is the molar mass of water (H_2O)?
   A) 16 g/mol

B) 18 g/mol
C) 20 g/mol
D) 22 g/mol

8. Which of the following describes an exothermic reaction?
   A) Reactants have less energy than products
   B) Energy is absorbed from the surroundings
   C) ΔH is positive
   D) Heat is released to the surroundings

9. The four levels of protein structure in order are:
   A) Primary, tertiary, secondary, quaternary
   B) Primary, secondary, tertiary, quaternary
   C) Secondary, primary, tertiary, quaternary
   D) Quaternary, tertiary, secondary, primary

10. Which of the following is NOT a nucleotide base found in DNA?
    A) Adenine
    B) Uracil
    C) Cytosine
    D) Guanine

11. A buffer solution resists changes in pH because it:
    A) Neutralizes all acids added to it
    B) Contains both a weak acid and its conjugate base
    C) Has a pH of exactly 7
    D) Absorbs all ions in solution

12. The lock-and-key model of enzyme activity refers to:
    A) The binding of substrates to allosteric sites
    B) The precise fit of a substrate to an enzyme's active site
    C) The denaturation of enzymes at high temperatures
    D) Competitive inhibition

13. Which of the following increases the rate of an enzyme-catalyzed reaction (up to a point)?
    A) Decreasing temperature
    B) Adding a competitive inhibitor
    C) Increasing substrate concentration
    D) Raising pH beyond optimum

14. Fatty acids with no double bonds in their carbon chains are called:
    A) Unsaturated
    B) Polyunsaturated
    C) Saturated
    D) Trans fats

15. Which of the following correctly describes an SN2 reaction?
    A) It proceeds through a carbocation intermediate
    B) It involves inversion of stereochemistry
    C) It is favored by tertiary substrates
    D) It proceeds in two separate steps

16. Hydrolysis of ATP releases energy by breaking which bond?
    A) The glycosidic bond
    B) The peptide bond
    C) The phosphoanhydride bond
    D) The ester bond

17. Which subatomic particle determines the identity of an element?
    A) Neutrons
    B) Electrons
    C) Protons
    D) Quarks

18. Glucose ($C_6H_{12}O_6$) has a molecular weight of approximately:
    A) 120 g/mol
    B) 160 g/mol
    C) 180 g/mol
    D) 200 g/mol

19. Which of the following describes a zwitterion (of an amino acid at physiological pH)?
    A) Only the amino group is protonated
    B) Neither group is charged
    C) Both the amino and carboxyl groups are ionized
    D) Only the carboxyl group is ionized

20. Activation energy of a reaction is lowered by:
    A) Increasing temperature
    B) Adding a catalyst
    C) Increasing pressure
    D) Increasing reactant concentration

21. Which type of isomers are non-superimposable mirror images of each other?
    A) Structural isomers
    B) Geometric isomers
    C) Enantiomers
    D) Conformational isomers

22. Which of the following is an example of a hydrophobic molecule?
    A) Glucose
    B) Sodium chloride
    C) A triglyceride
    D) ATP

23. In the electron transport chain, the final electron acceptor is:
    A) NAD^+
    B) FAD
    C) Oxygen
    D) Carbon dioxide

24. Which of the following best describes a polar covalent bond?
    A) Electrons are shared equally between two atoms
    B) One atom completely gains electrons from another
    C) Electrons are shared unequally due to electronegativity differences
    D) Electrons are transferred between ions

25. At standard conditions, which of the following has the highest electronegativity?
    A) Carbon
    B) Nitrogen
    C) Oxygen
    D) Fluorine

26. The process of converting glucose into pyruvate is called:
    A) Gluconeogenesis
    B) Glycolysis
    C) The citric acid cycle
    D) Beta-oxidation

27. Cellulose differs from starch in that cellulose:
    A) Is composed of glucose monomers linked by alpha glycosidic bonds
    B) Can be digested by human amylase
    C) Has beta-1,4-glycosidic bonds making it structurally rigid
    D) Stores energy in animals

28. Which of the following describes Km in enzyme kinetics?
    A) The maximum rate of an enzyme-catalyzed reaction
    B) The substrate concentration at which reaction rate is half of Vmax
    C) The amount of enzyme present in solution
    D) The activation energy required for the reaction

29. Which of the following is a characteristic of aromatic compounds?
    A) They contain only single bonds
    B) They are highly reactive with water
    C) They are cyclic, planar, and follow Hückel's rule
    D) They always contain nitrogen atoms

30. Denaturation of a protein refers to:
    A) Breaking of peptide bonds in the primary structure
    B) Loss of three-dimensional shape without breaking peptide bonds
    C) Hydrolysis of the protein into amino acids
    D) Phosphorylation of the protein

31. Which of the following is the product of beta-oxidation of fatty acids?
    A) Pyruvate
    B) Glucose
    C) Acetyl-CoA
    D) Glycerol

32. A solution is considered acidic if its pH is:
    A) Greater than 7
    B) Equal to 7
    C) Less than 7
    D) Equal to 14

33. Which of the following best describes competitive inhibition of an enzyme?
    A) The inhibitor binds irreversibly to the enzyme's active site
    B) The inhibitor binds to the active site and can be displaced by excess substrate
    C) The inhibitor changes the shape of the enzyme's active site
    D) The inhibitor blocks transcription of the enzyme gene

34. Which type of reaction joins two monosaccharides with the loss of water?
    A) Hydrolysis
    B) Oxidation
    C) Dehydration (condensation) synthesis
    D) Reduction

35. The R group of an amino acid determines its:
    A) Peptide bond formation
    B) Unique chemical properties and identity
    C) Position in a polypeptide chain
    D) Ability to undergo hydrolysis

36. Which of the following represents the correct Henderson-Hasselbalch equation?
    A) pH = pKa + log([acid]/[base])
    B) pH = pKa log([base]/[acid])
    C) pH = pKa + log([base]/[acid])
    D) pH = Ka + log([base]/[acid])

37. Which of the following correctly describes an aldose?
    A) A ketone-containing monosaccharide
    B) An aldehyde-containing monosaccharide
    C) A disaccharide with reducing properties
    D) A sugar with more than 8 carbons

38. Allosteric regulation of an enzyme involves:
    A) Substrate binding to the active site
    B) A molecule binding to a site other than the active site to change enzyme activity
    C) Irreversible binding of an inhibitor
    D) Chemical modification of the substrate

39. The melting point of saturated fats is generally higher than unsaturated fats because:
    A) Saturated fats have more double bonds allowing tight packing
    B) Saturated fats have no double bonds, allowing tighter molecular packing
    C) Unsaturated fats contain more carbon atoms
    D) Saturated fats have polar heads that interact with water

40. Which of the following is a coenzyme derived from niacin (vitamin B3)?
    A) FAD
    B) CoA
    C) NAD^+
    D) ATP

Answer Key

1. C
2. C
3. C
4. B
5. B
6. C
7. B
8. D
9. B
10. B
11. B
12. B
13. C
14. C
15. B
16. C
17. C
18. C
19. C
20. B
21. C
22. C
23. C
24. C
25. D
26. B

27. C
28. B
29. C
30. B
31. C
32. C
33. B
34. C
35. B
36. C
37. B
38. B
39. B
40. C