**Part One: Multiple choice & matching questions**  

(2 pt each)

1. Which of the following does not describe a type of redox reaction?
   a) Burning wood
   b) Putting a chunk of pure lithium metal (Li) into hydrochloric acid (HCl)
   c) Making margarine (saturated fat) from corn oil (unsaturated fat) by industrial hydrogenation
   d) Mixing sodium hydroxide (NaOH) with hydrobromic acid (HBr) to produce salt and water

2. Oxidation of a secondary alcohol produces what kind of functional group?
   a) Carboxylic acid  
   b) Ketone  
   c) Aldehyde  
   d) Primary alcohol

3. The reaction shown below would require which of the following co-factors?
   a) FAD  
   b) NAD+  
   c) Coenzyme A  
   d) Mg²⁺

4. Hydrolysis and hydration reactions both utilize water as a reactant, but can be distinguished because hydrolysis reactions start with ______ molecule and produce _______, whereas hydration reactions start with ______ and produce _______.
   a) 1 → 2; 2 → 1  
   b) 2 → 2; 1 → 1  
   c) 1 → 2; 1 → 1  
   d) 2 → 1; 1 → 2

5. Which of the following terms does not describe a set of distinct, chiral molecules?
   a) Stereoisomers  
   b) Diastereomers  
   c) Enantiomers  
   d) Geometric isomers

6. Nucleotides in complementary DNA strands base-pair with each other by:
   a) Dispersion forces  
   b) Ionic interactions  
   c) Hydrogen bonds  
   d) Covalent bonds

7. For the following four problems, match each amino acid shown to one of the following classes:
   (4 pts)
   
   a) Non-polar  
   b) Polar/neutral  
   c) Polar/acidic  
   d) Polar/basic

   aspartate: ______  
   arginine: ______  
   threonine: ______  
   valine: ______
8. Which of the following properties is different in a pair of enantiomers?
   a) Chemical reactivity  
   b) Solubility in water  
   c) Molecular mass  
   d) Melting point  
   e) all of these are different  
   f) none of these are different

9. If the amino acid glycine—shown below—were placed into an aqueous solution at pH 12, what would you expect the overall charge on the molecule to be?
   a) +2  
   b) +1  
   c) 0  
   d) -1  
   e) -2

10. Which level(s) of folding would you expect to be altered by placing a protein into a highly acidic solution? (circle all that apply)
    a) Primary  
    b) Secondary  
    c) Tertiary  
    d) Quaternary

11. In the structure shown below, identify what type of tertiary interaction is being represented for each of the four letters on the diagram. (4 pts)

   A. ___________________________  
   B. ___________________________  
   C. ___________________________  
   D. ___________________________

12. Match the following protein types with the class you would expect them to be classified within:
    a) Globular  
    b) Fibrous  
    c) Membrane  
    (4 pts)

    - Cytosolic enzymes (eg. hexokinase): ______
    - Ion transporters (eg. Na+ channel): ______
    - Extracellular structural proteins (eg. collagen): ______
    - Water-soluble secreted proteins (eg. insulin): ______

13. What type of intermolecular force is responsible for secondary folding of proteins into alpha-helices and beta-pleated sheets?
    a. Hydrogen bonds between R-groups  
    b. Salt bridges between R-groups  
    c. Hydrogen bonds in the peptide backbone  
    d. Dispersion forces in the peptide backbone
14. The diagram shown to the right provides a cartoon example of what class of inhibitor?
   a) Non-specific
   b) Specific, competitive
   c) Specific, non-competitive (allosteric)
   d) cannot be determined

15. Which of the following molecular formulas represents a simple carbohydrate?
   a) C₃H₆O₆  
   b) C₄H₁₂O₄  
   c) C₅H₁₀O₅  
   d) C₆H₁₂O₆

16. What two categories correctly describe the sugar D-xylose, shown to the right?
   a) Pentose; aldose
   b) Pentose; ketose
   c) Hexose; aldose
   d) Hexose; ketose

17. Naturally occurring amino acids are found exclusively in the _____ stereoisomer configuration, while monosaccharides are found exclusively in the _____ configuration.
   a) L; L  
   b) L; D  
   c) D; L  
   d) D; D

18. In the Hayworth projection shown to the right, what is the correct nomenclature associated with this form of D-ribose?
   a) Alpha (α), furanose
   b) Alpha (α), pyranose
   c) Beta (β), furanose
   d) Beta (β), pyranose

19. What specific type of glycosidic bond is shown in the disaccharide to the right?
   a) α(1→4)  
   b) α(1→6)  
   c) β(1→4)  
   d) β(1→6)

20. The type of enzyme that would be required to break the bond shown in the disaccharide to the right is called a ________________.
   a) Hydrolase
   b) Isomerase
   c) Kinase
   d) Dehydrogenase

21. Which of the following is not an energy storage carbohydrate?
   a) Starch  
   b) Cellulose
   c) Glycogen
   d) Amylopectin
   e) Amylose

22. The overall purpose of lactic acid or ethanol fermentation is to:
   a) Produce more oxygen  
   b) Generate more pyruvate
   c) Convert glucose to CO₂
   d) Regenerate NAD⁺ by oxidizing NADH

23. Genomic DNA found in the nucleus of a cell is packaged into chromosomes after winding it around a cluster of positively charged proteins, which are called:
   a) Chromatin  
   b) Nucleosomes
   c) DNA polymerase
   d) Histones
Part Two: Chemical Reaction Types

1. For each of the following condensation reactions: (a) **Circle** the two functional groups involved in the reaction, and (b) **fill in** the type of chemical bond formed by each reaction. (9 pts)

A. Two monosaccharides: (b) Bond type? __________________________

\[ \text{β-D-glucose} + \text{α-D-mannose} \]

B. Two amino acids: (b) Bond type? __________________________

\[ \text{L-alanine} + \text{L-tyrosine} \]

C. Two nucleotides: (b) Bond type? __________________________

\[ \text{cytosine monophosphate} + \text{adenosine triphosphate} \]
2. Sketch out the product that you would expect to find in the following reactions (Please use skeletal line structures): (3 pts each)

a. **Dehydration reaction**

\[\text{HO-COOH} \rightarrow \text{Product}\]

b. **Redox reaction** (note: reactant is being reduced here)

\[\text{NADH} \rightarrow \text{NAD}^+ \rightarrow \text{Product}\]

c. **Condensation reaction**

\[\text{Ph-COOH} + \text{NH}_2 \rightarrow \text{Ph-C(OH)}_2\text{NH}

d. **Hydrolysis reaction**

\[\text{Ph-S-Ph} + \text{H}_2\text{O} \rightarrow \text{Product}\]
3. Indicate (a) the kind of reaction and (b) the type of enzyme for each of the following glycolytic reactions shown below: (2 pts each)

1,3-biphosphoglycerate + ADP $\rightarrow$ 3-phosphoglycerate

(a)

(b)

dihydroxyacetone phosphate $\rightarrow$ Glyceraldehyde-3-phosphate

(a)

(b)

2- phosphoglycerate + $\text{H}_2\text{O}$ $\rightarrow$ Phosphoenolpyruvate

(a)

(b)

Glyceraldehyde-3-phosphate + NAD$^+$ + $\text{P}_i$ $\rightarrow$ 1,3-biphosphoglycerate

(a)

(b)
4. Isopropanol—also known as “rubbing alcohol”—is a toxic alcohol that severely damages the liver when consumed. It can be metabolized in very small amounts, however, by the pathway shown below.

![Metabolic pathway diagram]

Answer the following questions about this metabolic process. (9 pts)

a. Indicate the type of reaction that is occurring to the molecules that are shown at all four steps of the metabolic pathway. (hint: it is the same for all four steps)

b. What functional groups are changing at each step of the pathway?

1) _______________________ → _______________________
2) _______________________ → _______________________
3) _______________________ → _______________________
4) _______________________ → _______________________

(c) What cofactor is required for steps 1, 3 and 4?

d. What type of reaction is this cofactor undergoing at each of these steps?

e. How would you characterize this metabolic pathway? (circle one)

   Aerobic or Anaerobic

f. This process occurs in the liver, which is also where the process of gluconeogenesis (aka. ‘glucose re-synthesis’) occurs. Based on the information above, how many molecules of isopropanol would be required to synthesize 1 molecule of glucose by the process of gluconeogenesis?
Part Three: Molecular & Chemical Structure Relationships

1. The tripeptide **Met-Ala-Ser** is shown below. Identify the following components of this molecule:

   a) Put a **box** around all of the peptide bonds

   b) **Circle** each of the R-groups (side chains) for each amino acid

   c) **Label** the N-terminus and the C-terminus

   ![Peptide Structure](image)

2. For a given DNA sequence, answer the following questions. Use the codon chart shown to the left to help you identify the genetic code.

   a) **Fill in the complementary mRNA sequence to the DNA strand below**, assuming that the **bottom strand** is the template strand for transcription:

   
   
   mRNA 5' ______________________ 3'
   
   
   b) **Indicate the peptide sequence** encoded by this mRNA strand. You should identify the **‘reading frame’** by identifying a **start codon**.

   
   

3. For the nucleotide diagram shown to the right (cytosine), **(a) draw circles** around, and **(b) label** the following elements:

   (4 pts)

   ![Nucleotide Structure](image)

   I. 3' functional group

   II. 5' functional group

   III. The specific part of the molecule that will be involved in base-pairing to guanosine

   IV. The functional group that identifies this as a **ribonucleotide**, rather than a deoxyribonucleotide.