For the first portion of this exam, select the best answer choice for the questions below and mark the answers on your scantron. Then answer the free response questions that follow (100 pts. total; multiple choice 2 pts. each).

For Questions 1 – 5, refer to the following answer choices for the listed descriptions:

A. Primary protein structure
B. Secondary protein structure
C. Tertiary protein structure
D. Quaternary protein structure
E. All of the above

1. Three-dimensional arrangement of every atom in a protein C
2. Sequence of amino acids A
3. Interaction of protein subunits D
4. Arrangement of protein chains into patterns B
5. Is not affected by denaturation A

6. Which of the following contains β(1→4) glycosidic bonds?
   A. amylose
   B. amyllopectin
   C. glycogen
   D. cellulose
   E. maltose

7. Determine which of the following triglycerides is most likely to be an OIL:
   A. one which contains relatively short chain saturated fatty acids
   B. one which contains relatively short chain unsaturated fatty acids
   C. one which contains linear D-glucose units
   D. one which contains long chain saturated fatty acids
   E. one which contains long chain unsaturated fatty acids
8. How many carbon atoms are associated with the generic steroid structure?
   A. 15
   B. 16
   C. 17
   D. 18
   E. 19

9. Of the 21 common and naturally occurring amino acids mentioned in lecture, which is the least likely to be encountered or most rare?
   A. Selenocysteine
   B. Cysteine
   C. Glycine
   D. Proline
   E. Glutamate

10. Glycogen is most structurally similar to which of the following?
    A. Amylose
    B. Amylopectin
    C. Cellulose
    D. Sucrose
    E. Lactose

11. Hemoglobin is made up of how many different types of protein chains?
    A. 1
    B. 2
    C. 3
    D. 4
    E. 5

12. Which of the following amino acids is NOT optically active?
    A. Valine
    B. Tryptophan
    C. Glycine
    D. Proline
    E. Phenylalanine
13. Sucrose undergoes hydrolysis to yield which of the following monosaccharides?

A. two glucose monosaccharides
B. one galactose and one glucose
C. two galactose monosaccharides
D. one glucose and one fructose
E. two fructose monosaccharides

14. When the α and β anomers of glucose reach equilibrium, …

A. there is more β anomer present than the α anomer.
B. the solution does not exhibit optical activity.
C. there are equal amounts of both anomers.
D. the solution does not undergo mutarotation between anomers.
E. they are both equally stable.

15. How many different tripeptides can be made from glycine, alanine, and aspartate if the tripeptide contains each amino acid only once?

A. 3
B. 6
C. 8
D. 9
E. 12

16. The insolubility of lipids in water is best explained by which of the following?

A. Lipids are polar molecules.
B. The polar portion of lipids is much larger than the nonpolar portion.
C. The polar portion of lipids is much smaller than the nonpolar portion.
D. The polar and nonpolar portions of lipids are of comparable size.
E. Lipids deliver chemical signals from one part of the body to another.

17. Determine the relationship between the dipeptides ala-gly and gly-ala:

A. None; they are identical.
B. They are resonance structures.
C. They are allotropes.
D. They are isomers.
E. They are mirror images.
18. Which of the following inorganic reagents is involved in saponification?

A. a strong acid
B. a weak acid
C. a strong base
D. a weak base
E. a salt

For Questions 19 – 21, refer to the following sets of amino acids for the listed descriptions:

A. Alanine and Glutamine
B. Aspartate and Lysine
C. Leucine and Phenyalanine
D. Serine and Tyrosine
E. Proline and Glycine

19. Capable of forming a salt bridge **B**

20. Characterized by predominantly hydrophobic interactions **C**

21. Can form hydrogen bonds **D**

22. When a monosaccharide is converted to an amino sugar, which of the following is true?

A. An amino group replaces an aldehyde carbonyl.
B. An amino group replaces a ketone carbonyl.
C. **An amino group replaces a hydroxyl group.**
D. A phosphate group replaces a hydroxyl group.
E. A hydrogen atom replaces a hydroxyl group.

23. “Bad cholesterol” is denoted by which of the following?

A. HDL
B. **LDL**
C. VLDL
D. Chylomicrons
E. Testosterone
24. “Good cholesterol” is denoted by which of the following?

A. HDL
B. LDL
C. VLDL
D. Chylomicrons
E. Testosterone

25. Which of the following is TRUE of the spacial distribution of the hydroxyl groups in β-D-glucopyranose?

A. They are all in axial positions.
B. They are all in equatorial positions.
C. The hydroxyl on carbon-1 is axial; those remaining are equatorial.
D. The hydroxyl on carbon-1 is equatorial; those remaining are axial.
E. They have equal but opposite optical rotations.

26. (14 pts. total) Consider the Fischer projection of N-acetyl-D-glucosamine shown below:

A. (8 pts.) Draw a Haworth projection (cyclic) AND a chair conformation for the β-pyranose form of this monosaccharide.
B. (4 pts.) Now draw a Haworth projection for the disaccharide formed by joining two units of the pyranose form of \(N\)-acetyl-D-glucosamine by an \(\alpha-1,4\)-glycosidic bond.

C. (2 pts.) Is this a reducing sugar? Briefly explain why or why not.

Yes, see above. The end that has the hemiacetal can open up to give the aldehyde that can be oxidized, thus reducing the reagent that oxidizes it.

27. A. (6 pts.) Draw the structural formula of the tripeptide met-ser-cys.

B. (2 pts.) Which amino acid is the C-terminal end and which is the N-terminal end?

N-terminal: Met
C-terminal: Cys
C. (4 pts.) Based on your knowledge of the chemical properties of amino acid side chains, suggest a substitution for serine in the primary structure of a protein that would probably not change the character of the protein very much.

**Threonine**

D. (6 pts.) If there were two molecules of the tripeptide met-ser-cys, show the type of interaction that would form between the amino acids that comprise the tripeptide.
28. (10 pts. total) Based on the steroid structures shown below, answer the next set of questions:

A. (3 pt.) Which of the structures shown above give a positive test for Lieberman-Burchard reaction?

Structure C

B. (2 pts.) A positive test for the above reaction is indicated by what change?

Greenish color

C. (2 pts.) Using your knowledge of various types of organic reactions studied in this course, what type of reaction is the Lieberman-Burchard test?

Dehydration

D. (3 pts.) Draw the structure of the final product that is produced as a result of a positive Liberman-Burchard reaction.
29. (8 pts. total) Three fatty acids—palmitoleic acid, oleic acid, and linolenic acid—are structurally represented below.

- Palmitoleic acid (16:1)
- Oleic acid (18:1)
- Linolenic acid (18:3)

A. (4 pts.) When 1 mole of each fatty acid reacts with glycerol, predict the final product of this reaction.

\[
\text{Glycerol} + \text{Fatty Acids} \rightarrow \text{Triglyceride}
\]

B. (4 pts.) When the product formed in part A is saponified, predict the outcome of this reaction. Write a balanced chemical equation for this process.