

## Quiz 4 Review Guide Fall 2018

### Major Topics:

- Enzyme Kinetics:
  - reaction rates and catalysis; transition state binding theory
  - Michaelis-Menten equation and interpretation
  - Inhibitors – types and explanations of mechanism
  - Double-reciprocal (lineweaver-burke) plots
  - Revisiting acetylcholine esterase and irreversible inhibition by VX nerve agent
- Carbohydrates:
  - Definition of carbohydrates
  - Recognize and draw the major carbohydrates: glyceraldehyde, dihydroxyacetone, glucose, and fructose in straight chain and cyclic forms
  - D and L enantiomer definition and identification
  - Ring cyclization and hemiacetal formation
  - Glycosidic bond formation and acetal formation
  - Major polysaccharides: amylose, amylopectin, glycogen, cellulose
- Lipids:
  - Fatty acids- structure and naming
  - Triacylglycerols structures and naming
  - Glycerophospholipids structure and naming
  - Role of membranes and use of cholesterol
- Key Reactions of Biochemistry
- Glycolysis
  - Key mechanisms and steps
  - Highly favorable steps
  - Regulation at PFK (ATP and F26BP)
  - Gluconeogenesis and which steps are bypassed

### Book Sections to pay particular attention to:

- Chapter 8.1 – 8.4 (pg. 266-273), 8.6 (pg. 281-286), and 8.7 (pg. 254-259)
- Chapter 9.1 (pg. 276-283), 9.3-9.4 (pg. 285-293), and 9.5 (pg. 294-296)
- Chapter 10.1-10.2 (pg. 302-309)
- Chapter 11.1 (pg. 336-337), 11.3 (pg. 341-344)
- Chapter 12.2 (pg. 405-411), 12.3 (pg. 412-414), 12.5 (pg. 416-418), and 12.6 (pg. 422)

### Particularly important Sapling Questions:

- HW 8: Enzymes: Questions 1 – 4, 6, 7, 8
- HW 9: Carbohydrates: Questions 1 – 5, 7, 9, 13, 16
- HW 10: Lipids: Questions: 1, 2, 4, 6, 10
- HW 11: Intro to Metabolism: Questions 4 – 6
- HW 12: Carbohydrate Metabolism: Questions 2-4, 7, 8, 12, 13

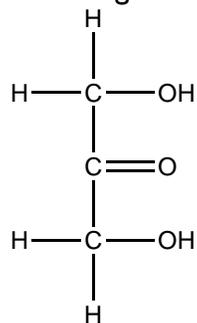
## Practice Problems

- For an enzyme called "Anotherase" that catalyzes the reaction  $A \rightarrow B$ , explain the following:
  - When [Anotherase] is at 0.5  $\mu\text{M}$ , the  $V_{\text{max}}$  is found to be 25  $\mu\text{M}/\text{s}$ . What is the  $k_{\text{cat}}$  for this enzyme?  
  
(II) When [A] is present at 200  $\mu\text{M}$ , the rate of the reaction ( $V_0$ ) is found to be 20  $\mu\text{M}/\text{s}$ . Given that information, what is the  $K_{\text{m}}$  of this enzyme?
- Sketch a Lineweaver-Burke graph of typical enzyme reaction, and illustrate what the presence of a competitive inhibitor would likely do as a dotted line.
- Given available stock solutions of 0.5 M Tris buffer, pH 7.10 ( $\text{pK}_a$  8), 4 M HCl, 4 M NaOH, and water, how would you prepare a 800 mL solution of 0.2 M Tris buffer, pH 7.4?
- From the abbreviated name of the compound Gal( $\beta$ 1,4)Glc, we know that:
  - C-4 of glucose is joined to C-1 of galactose by a glycosidic bond.
  - the compound is a D-enantiomer.
  - the galactose residue is at the reducing end.
  - the glucose is in its pyranose form.
  - the glucose residue is the  $\beta$  anomer.
- Starch and glycogen are both polymers of:
  - fructose.
  - glucose 1-phosphate.
  - sucrose.
  - $\alpha$ -D-glucose.
  - $\beta$ -D-glucose.

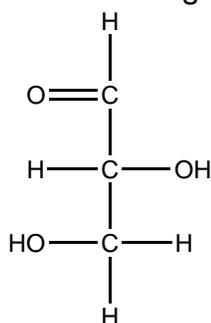
6. Which of the following best describes the cholesterol molecule?
- Amphipathic
  - Nonpolar, charged
  - Nonpolar, uncharged
  - Polar, charged
  - Polar, uncharged
7. The anaerobic conversion of 1 mol of glucose to 2 mol of lactate by fermentation is accompanied by a net gain of:
- 1 mol of ATP.
  - 1 mol of NADH.
  - 2 mol of ATP.
  - 2 mol of NADH.
  - none of the above.
8. In glycolysis, fructose 1,6-bisphosphate is converted to two products with a standard free-energy change ( $\Delta G^\circ$ ) of 23.8 kJ/mol. Under what conditions (encountered in a normal cell) will the free-energy change ( $\Delta G$ ) be negative, enabling the reaction to proceed to the right?
- If the concentrations of the two products are high relative to that of fructose 1,6-bisphosphate.
  - The reaction will not go to the right spontaneously under any conditions because the  $\Delta G^\circ$  is positive.
  - Under standard conditions, enough energy is released to drive the reaction to the right.
  - When there is a high concentration of fructose 1,6-bisphosphate relative to the concentration of products.
  - When there is a high concentration of products relative to the concentration of fructose 1,6-bisphosphate.
9. Which one of the following statements about gluconeogenesis is *false*?
- For starting materials, it can use carbon skeletons derived from certain amino acids.
  - It consists entirely of the reactions of glycolysis, operating in the reverse direction.
  - It employs the enzyme glucose 6-phosphatase.
  - It is one of the ways that mammals maintain normal blood glucose levels between meals.
  - It requires metabolic energy (ATP or GTP).
10. The steps of glycolysis between glyceraldehyde 3-phosphate and 3-phosphoglycerate involve all of the following *except*:
- ATP synthesis.
  - catalysis by phosphoglycerate kinase.
  - oxidation of NADH to  $\text{NAD}^+$ .
  - the formation of 1,3-bisphosphoglycerate.
  - utilization of  $\text{P}_i$ .
11. When the linear form of glucose cyclizes, the product is a(n):
- anhydride.
  - glycoside.
  - hemiacetal.
  - lactone.
  - oligosaccharide.

12. The reaction  $\text{ATP} + \text{H}_2\text{O} \rightarrow \text{ADP} + \text{P}_i$  is an example of a \_\_\_\_\_ reaction.
- homolytic cleavage
  - internal rearrangement
  - free radical
  - acyl substitution
  - oxidation/reduction
13. The conversion of 1 mol of fructose 1,6-bisphosphate to 2 mol of pyruvate by the glycolytic pathway results in a net formation of:
- 1 mol of  $\text{NAD}^+$  and 2 mol of ATP.
  - 1 mol of  $\text{NADH}$  and 1 mol of ATP.
  - 2 mol of  $\text{NAD}^+$  and 4 mol of ATP.
  - 2 mol of  $\text{NADH}$  and 2 mol of ATP.
  - 2 mol of  $\text{NADH}$  and 4 mol of ATP.
14. All of the following enzymes involved in the flow of carbon from glucose to lactate (glycolysis) are also involved in the reversal of this flow (gluconeogenesis) *except*:
- 3-phosphoglycerate kinase.
  - aldolase.
  - enolase.
  - phosphofructokinase-1.
  - phosphoglucoisomerase.
15. Which of the following statements concerning fatty acids is correct?
- One is the precursor of prostaglandins.
  - Phosphatidic acid is a common one.
  - They all contain one or more double bonds.
  - They are a constituent of sterols.
  - They are strongly hydrophilic.
16. When the linear form of glucose cyclizes, the product is a(n):
- anhydride.
  - glycoside.
  - hemiacetal.
  - lactone.
  - oligosaccharide.
17. ATP has a high phosphoryl group transfer potential because:
- it is chemically unstable.
  - it has a high rate of spontaneous hydrolysis at physiological pH and temperature.
  - it exhibits resonance stabilization prior to hydrolysis.
  - it has three phosphate groups.
  - cleavage of either of its two phosphoanhydride bonds proceeds with a large negative  $\Delta G^\circ$  of hydrolysis.
18. Circle the fatty acid in each pair that has the higher melting temperature.
- (a) 18:1 $\Delta$ 9 vs 18:2 $\Delta$ 9,12
- (b) 18:0 vs 18:1 $\Delta$ 9
- (c) 18:0 vs 16:0

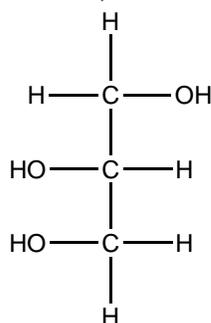
19. Categorize each of the following as an aldose, a ketose, or neither.



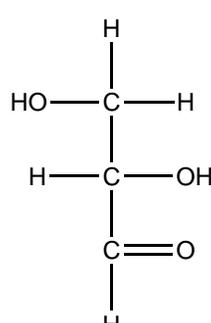
(a)



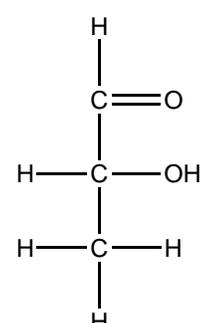
(b)



(c)



(d)



(e)

20. What is the most significant chemical difference between triacylglycerols and glycerophospholipids that leads to their different functions?

21. What is the effect of a double bond on fatty acid structure?

22. (a) When relatively high concentrations of fatty acids are suspended in water, they form structures known as \_\_\_\_\_. (b) When relatively high concentrations of membrane phospholipids are dissolved in water, they form structures known as \_\_\_\_\_. (c) Why are the structures listed in your answers to (a) and (b) above energetically favored?

23. What is the role of cholesterol in terms of membrane fluidity?

24. There are two reactions in glycolysis which involve the isomerization of an aldose to a ketose or vice-versa. What enzymes catalyze those two reactions?

25. The simple sugar that is used as the reference for naming D and L states of sugars is:

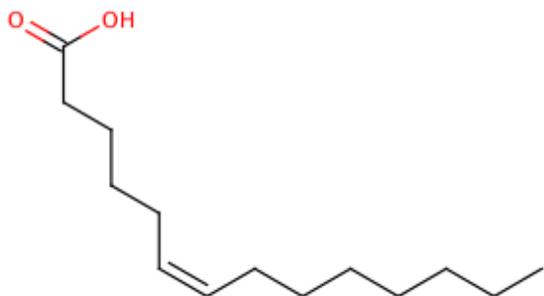
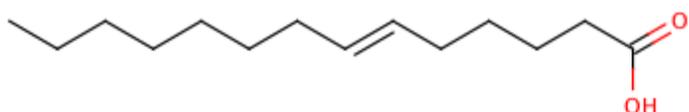
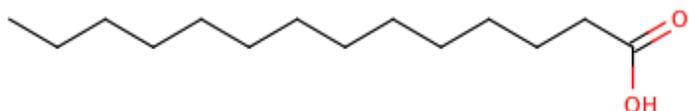
26. Draw D-glucose and a C-3 epimer of D-glucose.

27. Draw the cyclic forms of D-glucose and indicate the anomeric carbon with a \*. Name the forms.

28. Describe the structure of starch. Include the identity of its subunits, and the details of the bonds between them.

29. Why can humans not use cellulose as a nutrient?

30. Circle the following fatty acid that would have the lowest melting point. Put a square box around the fatty acid that is unlikely to be a natural product. Lastly, Name the fatty acid that you have not Circled or Boxed.



31. In cells, fatty acids are stored as triacylglycerols for energy reserves. Draw the molecule that fatty acids react with to form these energy storage molecules.

32. How does the structure of a triacylglycerol and a phospholipid differ? What difference in properties does this create?

33. Describe the part of the glycolytic pathway from fructose 6-phosphate to glyceraldehyde 3-phosphate. Show structures of intermediates, enzyme names, and indicate where any cofactors participate.

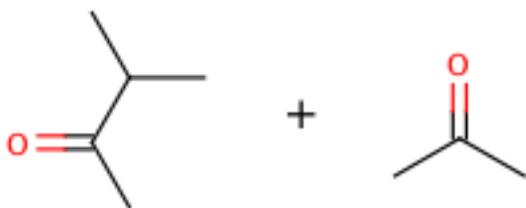
34. When a mixture of 1,3-bisphosphoglycerate and 3-phosphoglycerate is incubated with the enzyme phosphoglycerate kinase in the presence of an excess of ADP and ATP, the final mixture contains approximately 1750 molecules of 3-phosphoglycerate for every 1 molecule of 1,3-bisphosphoglycerate. Estimate the  $\Delta G'^0$  of the reaction below ( $R = 8.315 \text{ J/mol} \cdot \text{K}$  and  $T = 298 \text{ K}$ ).



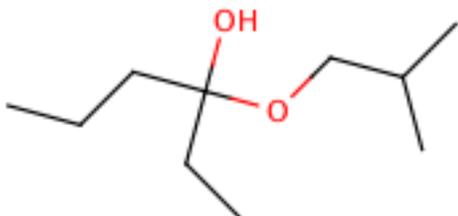
35. Illustrate the arrow-pushing mechanism and intermediate state for the reaction of butanone with 3-hexanol.

36. In the first reaction of glycolysis, when glucose + ATP is transformed into glucose-6-phosphate + ADP by Hexokinase, name the reaction mechanism.

37. Draw the likely product of the enzyme catalyzed reaction of the following reactants:



38. Draw the likely reactants that produced the following product:



39. In the enzymatic conversion of 2-butanol to 2-butene, what type of reaction mechanism would you propose?

40. Draw the likely intermediate of the following enzyme catalyzed reaction, and any missing products:

