Biology 150: 3rd in-class examination **Name** Answers

~~February~~ March 27, 2019

Indicate the lab you are registered in:

Tuesday, 9:00-10:50 _____; Tuesday, 11:00-12:50 _____; Tuesday, 1:00-2:50 _____

Answer the questions in the space provided and you may also use the back of the page to complete your response. There are 24 questions worth a total of 50 points. There are also plus two bonus questions worth a total of 5 points. The point value of individual questions appears in parentheses.

1. For a certain reaction the K_{eq} equal 2. If, at chemical equilibrium the concentration of the reactants is 1 M, what is the concentration of the products? (1)

$K_{eq} = 2 = \frac{[pdt]}{[reactants]} = \frac{2M}{1M}$

1. Comparing an enzyme catalyzed reaction to the same reaction uncatalyzed: (1)
   a) ΔG is more negative
   b) ΔG is more positive
   c) E_A is smaller ✓
   d) both a and c
   e) none of the above

3 — unchanged

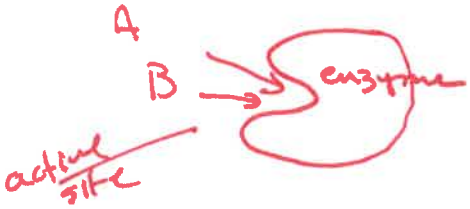
2. The location on an enzyme where the catalyzed reaction takes place is called active site ~~(1)~~.

3. Enzymes are said to be highly specific. What does this mean? (1)

generally, each different type of enzyme catalyzes only one type of reaction.

one enzyme → one reaction.

4. Describe and/or diagram the catalytic cycle of an enzyme. What happens in what order? Roughly how fast can the cycle occur with a typical enzyme? (3)



① reactants (substrates) lodge in the ~~FES~~ active site
② bonds may be strained or atoms pushed together to lower E_A
③ following a reaction the products no longer fit in the active site and leave allowing the active site to catalyze another reaction

- individual enzymes may catalyze hundreds of reactions/second

5. Enzymes are often regulated by chemical modification. What functional group is most often attached to or removed from one or more amino acid increasing or decreasing enzyme activity. (1)

phosphate

6. Contrast competitive enzyme inhibition and non-competitive inhibition. How do they differ? Which of these is a form of allosteric regulation? (3)

— in competative inhibition the inhibitor binds to/in the active site — blocking binding of the substrate(s)
— in non-competative inhibition the inhibitor binds other than at the active site — changing the shape of the protein and of the active site reducing binding efficiency of the substrates)
— non-competative inhibition is a form of allosteric regulation

7. ATP hydrolysis is frequently used to provide the energy to drive otherwise energetically unfavorable reactions in so called "coupled reactions". Explain, and/or diagram, how this actually occurs. (3)

A+B→C — phosphorylation of a substrate molecule (by ATP) renders a more energetic substrate molecule that can now react more exergonically

8. Cooperativity is another form of enzyme regulation. Explain and give an example of a protein subject to this type of regulation. (3)

— binding of substrate to the active site of one subunit of a multisubunit enzyme causes the subunit to change shape
— this causes the other subunits to change shape improving the substrate binding (allosteric activation)
— hemoglobin O_2 binding exhibits cooperativity

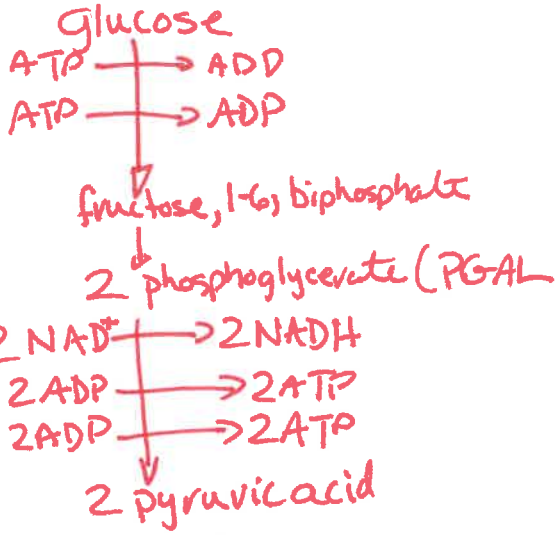
9. Pound for pound which is more energy rich (contains more chemical potential energy) fats or sugars? Explain why this is true. (2)

fats — because most carbons are bonded to only C + H (C–C(H)–C) while sugars are already partly oxidized (C–C(OH)–C)

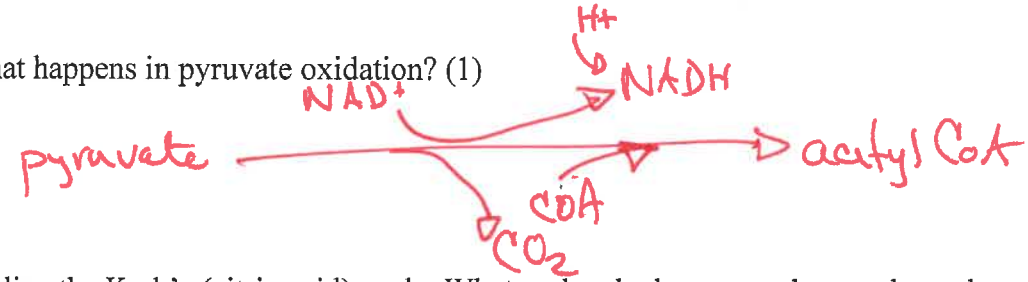
10. Define respiration. (1)

→ oxidation of fuel molecules by cells.

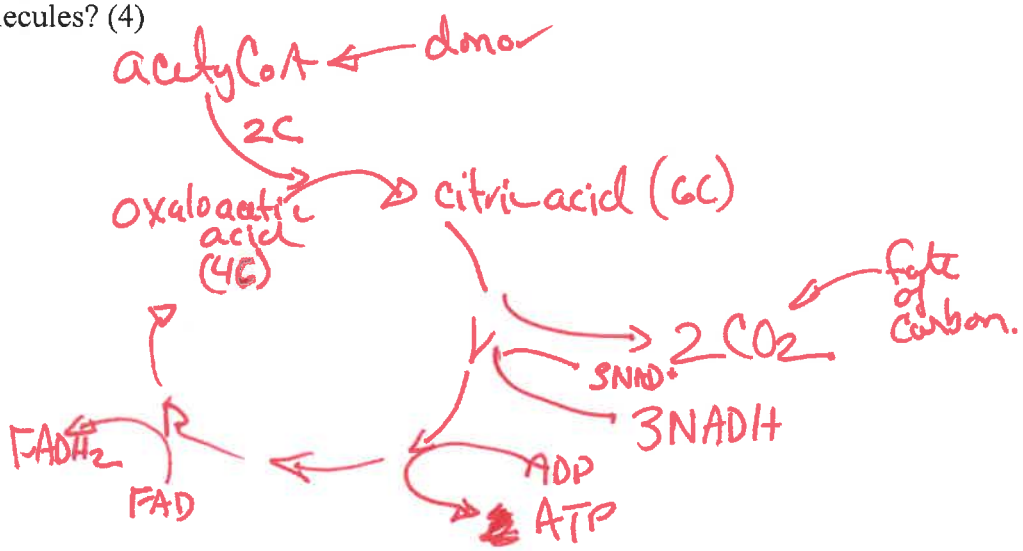
11. Outline glycolysis. Indicate the starting molecule, the use and production (and how many) of energy and electron carrier molecules. Name at least one intermediate molecule and the resulting partially oxidized product molecule(s). (4)



12. What happens in pyruvate oxidation? (1)



13. Outline the Kreb's (citric acid) cycle. What molecule donates carbon to the pathway combining with what four carbon molecule? What six carbon molecule is produced? In a single turn of the cycle indicate the important redox reactions and any ATP produced. What is the fate of the donated carbon molecules? (4)



14. What is chemiosmosis? (1)

– a hydrogen ion gradient across a membrane (established by electron transport) available to do work.

15. Complete respiration of a glucose molecule is currently thought to yield 30 – 32 molecules of ATP. Explain exactly where those numbers come from. (4)

From one glucose

Substrate level phosphorylation:

glycolysis → 2 ATP
Krebs cycle → 2 ATP

NADH synthesis.

glycolysis → 2 (except Heart → 2 $FADH_2$)
2x Pyravate oxidation → 2
2x Krebs → 6
10 → X 2.5 ATP = 25 ATP

oxidative phosphorylation.

2x Krebs 2 $FADH_2$ → 2 → X 1.5 → 3 ATP

25 + 4 = 32

→ 8 NADH
4 $FADH_2$
26 ATP
+ 4
30 ATP

16. In fermentation by yeast, what becomes of the end product of glycolysis? What is the function of fermentation? (3)

pyruvate → (2e) → ethanol + CO_2

NADH → NAD+ (+ H^+)

– the function of fermentation is to oxidize NADH to NAD+ and thus allow glycolysis to continue

17. How does respiration consume fats? (2)

Fats → glycerol → glycolysis
Fats → (hydrolysis) Fatty acids → Boxidation → 2C → CoA → acetyl CoA → Krebs

18. During active exercise is the pH of the matrix higher, the same, or lower than that of the intermembrane space? (1)

higher pH ($[H^+]$ would be lower)

19. Why can't distance runners (i.e. marathoners) run as fast milers? (1)

they can only maintain aerobic capacity running (like milers) using glycogen – but as the supply is limited must rely ~ partly on fat burning but Boxidation is slower than aerobic capacity.

20. Which of the following correctly outlines the path of electrons in non-cyclic photophosphorylation: (1)
a) H_20 → NADPH → electron transport → photosystem I → electron transport → photosystem II
b) H_20 → photosystem II → electron transport → NADPH → electron transport → photosystem I
c) H_20 → photosystem II → electron transport → photosystem I → electron transport → NADPH
d) NADPH → photosystem II → electron transport → photosystem I → electron transport → H_20
e) H_20 → photosystem I → electron transport → photosystem II → electron transport → NADPH

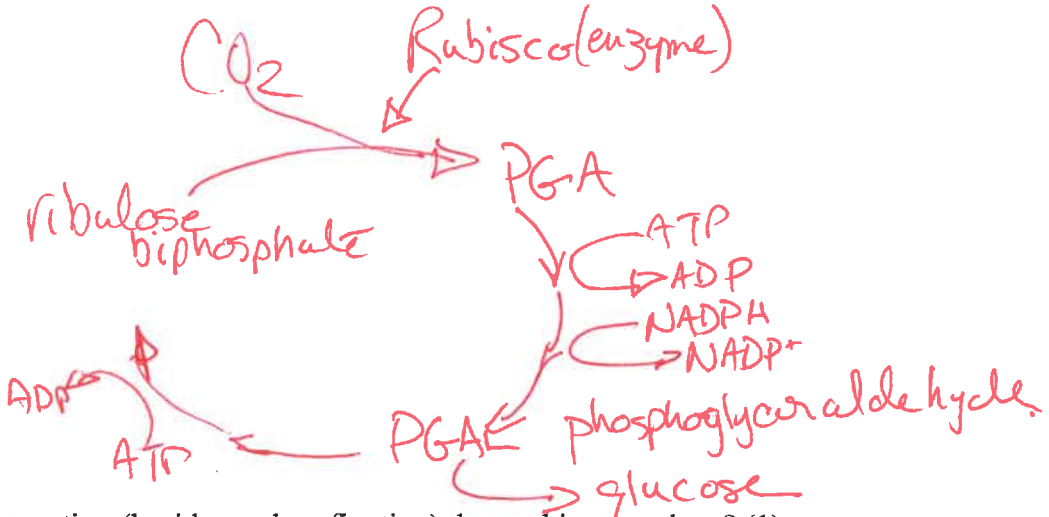
21. During active photosynthesis is the pH of the thylakoid lumen higher, the same, or lower than that of the stroma? (1)

lower ($[H^+]$ will be higher)

22. What photosystem is involved in cyclic photophosphorylation? Describe how useful energy is captured by cyclic photophosphorylation. (3)

- Photosystem I
- an excited electron is passed from PSI to the primary electron acceptor and then to a series of electron transporters, finally back to chlorophyll A of the PSI reaction center. Electron transport drives H+ transport into the thylakoid. Chemiosmosis then drives ATP synthesis

23. Outline the Calvin cycle. Name at least two intermediate molecules. Indicate the function of Rubisco. Show the use of energy carrier molecules. (3)



24. What other reaction (besides carbon fixation) does rubisco catalyze? (1)

Photo respiration

Bonus questions:

1) DNP (2,4-dinitrophenol) is a lipid soluble base. It collapses pH gradients across membranes because it will tend to bind to H^+ on the side of the membrane where it is in higher concentration and dissociate on the other side. What effect would you predict DNP will have on Oxygen consumption. Explain your answer. (2)

DNP will collapse the H^+ gradient (eliminate chemiosmosis). Oxidative phosphorylation (ATP synthesis) will fall. Because the cell continues to use ATP, the ATP concentration will fall as oxidative phosphorylation decreases. ATP blocks the reaction catalysed by phosphofructokinase (feedback inhibition of glycolysis). Glycolysis will therefore increase. Rising levels of pyruvate will increase respiration and therefore O_2 consumption.

2) The therapeutic index for DNP is about 3 and for ethanol it about 20 and for THC (tetrahydrocannabinol; the active ingredient in cannabis) is greater than 10,000. What is the therapeutic index? Which of these drugs is more dangerous and why? (3)

Therapeutic index = $\frac{\text{lethal dose}}{\text{effective dose}}$

The therapeutic index is a measure of how close the lethal dose (i.e. overdose) of a drug is to the effective dose and therefore how dangerous the drug is. (If the lethal dose is close to the effective dose it is easy to "take too much".)

The small the number the more dangerous. DNP is therefore the most dangerous. Alcohol (ethanol) is dangerous as well (but less so) while THC represents no risk at all.