

Instructions. This exam consists of 100 points on 6 pages. Allot 1 min/2 points. On questions with choices, all of your answers will be graded and you will be given the best grade for that question.

1. (4 pts) You are interested in thymidylate kinase from E.coli. You know the amino acid sequence of the protein, from which you predict an isoelectric pH (pI , $<q>=0$) of 7.0. Please answer one of the following choices.

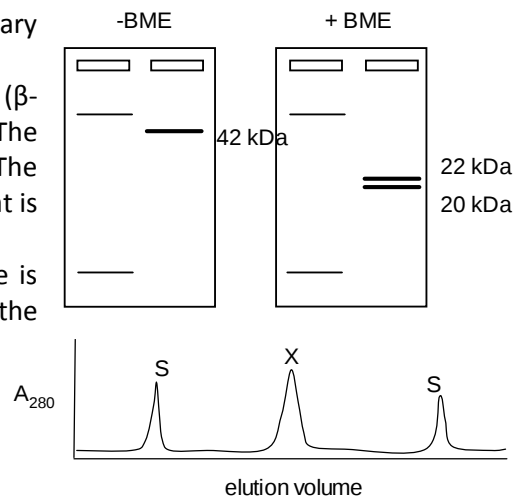
Choice A: Briefly describe how you would use this information to design one of the steps in the purification of the protein.

Choice B: Outline how you could determine the structure of thymidylate kinase using X-ray diffraction methods.

2. (6 pts) After purifying the protein you wish to determine its quaternary structure. Please answer one of the following choices.

Choice A: You run SDS-PAGE gels without and with BME (β -mercaptoethanol). Images of the two gels are shown on the right. The left lane contains the standards and the right lane is the sample. The molecular weights of the proteins are indicated on the gel images. What is the minimum quaternary structure of the protein based on these data?

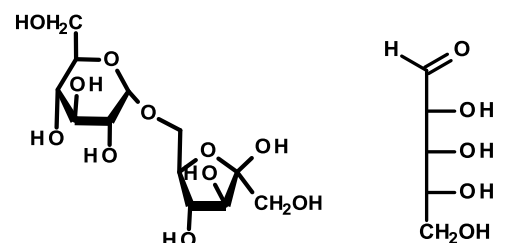
Choice B: You run a gel filtration (size exclusion) and the elution profile is shown on the right. Peaks labeled with S are standards. The size of the protein (marked X) is 85 kDa. How would you have determined this from the data shown on the right?



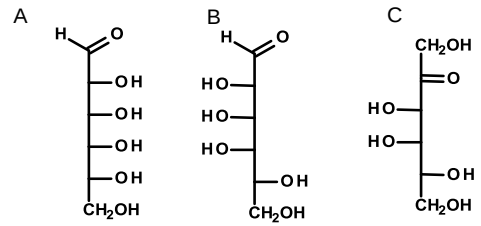
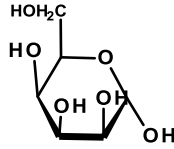
3. (6 pts) Please do one of the following choices.

Choice A: The following is a disaccharide of glucose (top) and fructose (bottom). Please name this sugar using standard nomenclature.

Choice B: Draw the following disaccharide: α -glucopyranosyl – (1-5) β -ribofuranose. Ribose is a C5 aldose and its linear structure is shown on the right.



4. (2 pts) Circle the correct linear form of the cyclic sugar and indicate the anomeric carbon.



5. (6 pts) Please do one of the following choices:

Choice A: Compare cellulose versus glycogen (answer all parts).

- i) How does the structure of cellulose differ from glycogen?
- ii) In what way are these polysaccharides similar?
- iii) Which is used for energy storage in mammals?

Choice B: Compare and contrast bacterial cell walls and cellulose.

6. (6 pts) Draw and name any phospholipid that you like. The following information may be useful: lauric C_{12} , myristic C_{14} , palmitic C_{16} .

7. (6 pts) Please do one of the following choices.

Choice A: What is the critical micelle concentration and what is its relationship to detergents?

Choice B: What is the principal structural difference between a phospholipid and a fatty acid and how does this difference affect the structures these compounds form in water?

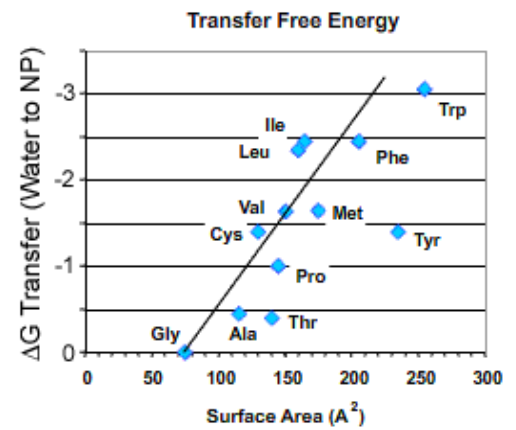
Choice C: Corn oil is a triglyceride that has unsaturated double bonds as part of its fatty acid component. Why is it a liquid at room temperature?

8. (6 pts) A 20 residue protein consists entirely of alanine residues.

Please do one of the following choices.

Choice A. When this protein is added to a solution of phospholipid vesicles very little of the protein enters the bilayer. Why?

Choice B. What is the most likely secondary structure(s) of any proteins that are inserted into the membrane? Why?



9. (5 pts) Please do one of the following choices.

Choice A. Briefly describe why the potassium channel is selective for K^+ ions.

Choice B. Why can the potassium channel be considered an enzyme?

Choice C: Why do cells or membrane vesicles swell when placed in hypotonic (lower salt concentration outside) solutions?

10. (6 pts) Glycolysis converts glucose to pyruvate. Why is it necessary to perform some steps by a different mechanism in gluconeogenesis, where pyruvate is converted to glucose? (5 pts) Give an example of one of those steps (1 pt)

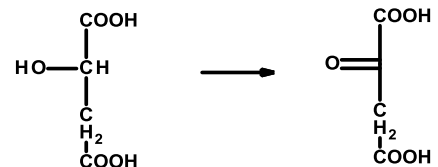
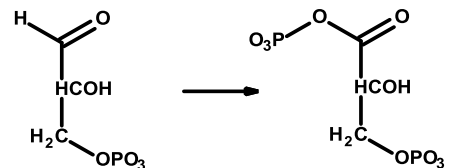
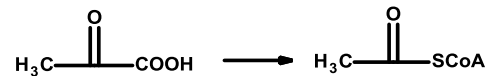
11. (2 pts) What is the difference between a feedback inhibitor and a product inhibitor?

12. (8 pts) Briefly describe the difference between direct coupling and indirect coupling and why coupling of one type or another is usually required in biochemical pathways. Provide one example of either type of coupling.

13. (7 pts) For any one of the following reactions shown on the right:

- Pyruvate to Acetyl-CoA (the thiol ester has the same oxidation state as a carboxylic acid).
- Glyceraldehyde-3-Phosphate to 1,3-phosphoglycerate (the phosphate ester has the same oxidation state as a carboxylic acid).
- Malate to oxaloacetate

- Show, by balancing, that the reaction is a redox reaction (2 pts).
- What is the general name of the type of enzymes that catalyze this type of reaction (1 pt).
- These reactions release energy, how is it captured for use by the cell and not lost as heat (2 pts)?



14. (9 pts) Please do one of the following choices:

Choice A: Briefly describe how either NADH or FADH₂ are processed by electron transport. Be sure to discuss the following: i) the final electron acceptor, ii) how is the energy released by oxidations stored for ATP synthesis, iii) How would you calculate the energy available for ATP synthesis.

Choice B: Briefly explain how ATP is synthesized in the mitochondria. What is the energy source and briefly describe the mechanism by which ATP is formed from ADP and P_i. How would you calculate the energy available for ATP synthesis?

15. (6 pts) Please do one of the following choices.

Choice A: Describe how fatty acids are prepared (activated) for oxidation. Include a description of the chemical changes and the cellular location.

Choice B: Describe the process of fatty acid oxidation, including a statement of cellular location.

Choice C: The TCA cycle is typically thought of as a degradative pathway. Provide **one** example of how intermediates in the TCA cycle can be used in a biosynthetic pathway.

Choice D: Briefly explain why a person on a high fat diet will have low levels of stored glycogen, especially after strenuous exercise.

16. (10 pts) Please do **one** of the following choices. *Regardless of your choice, be sure to mention the key enzymes and how they are regulated.*

Choice A: Briefly explain how glycogen metabolism **or** glycolysis/gluconeogenesis are controlled by hormones under conditions of **high** blood glucose.

Choice B: Briefly explain how glycogen metabolism **or** glycolysis/gluconeogenesis are controlled by hormones under conditions of **low** blood glucose.

Choice C: Briefly explain how glycolysis/gluconeogenesis **are** controlled by energy sensing in the cell, under conditions of **both** high and low energy reserves.

17. (5 pts) The country of Brazil does not import any petroleum products. What fuel is used to power automobiles in that country and how is that fuel made?