

Instructions. This exam contains 17 questions and 100 points on 6 pages. Allot 1 min/2 points. On questions with choices, all of your answers will be graded and you will receive the grade for the best attempt.

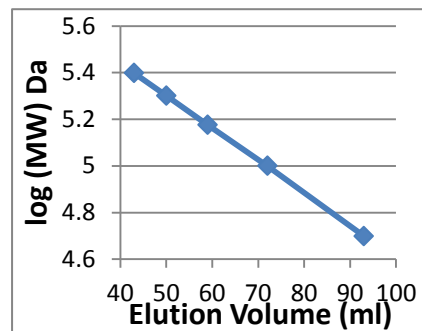
1. (2 pts, Fill in the blanks). In structure determination by X-ray diffraction, the _____ in the atoms scatter the X-rays and the _____ between the scattered X-rays allows the determination of the structure.

2. (6 pts) Determine the quaternary structure of a protein based on the data below. *Briefly justify your answer.*

a) Gel filtration chromatography. Elution volume=50 ml. The calibration curve for the column is given on the right. Some useful log values:

$\log 50,000=4.69$, $\log 100,000=5$, $\log 150,000=5.17$, $\log 200,000=5.3$

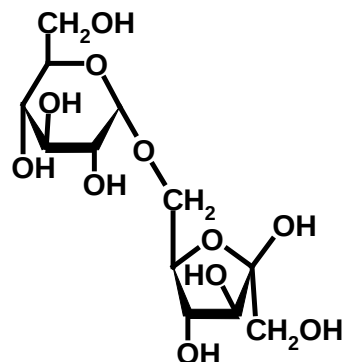
b) SDS-PAGE, two bands of equal intensity, one at 40,000 Da and the other at 60,000 Da.



3. (3 pts) A disaccharide is shown on the right. Label the i) anomeric carbons, ii) glycosidic bond, iii) the aldose.

4. (3 pts) Select the correct name for the disaccharide shown on the right. *Briefly justify your answer in case you need partial credit.*

- a) α -glucopyranosyl (1-6) β -frucofuranose
- b) β -frucofuranose (6-1) α -glucopyranosyl
- c) α -glucopyranosyl (1-6) β -ribofuranose
- d) α -glucofuranosyl (1-6) β -frucopyranose



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

Choice A: Compare and contrast the structure of glycogen to cellulose.

Choice B: Describe the major features of a bacterial cell wall

Choice C: Why can lysozyme digest bacterial cell walls, but not cellulose?

6. (3 pt) Which is the storage form of glucose in animals (circle answer). *Glycogen* *Starch* *Triglycerides*
7. (8 pts) Margarine is made by catalytic hydrogenation of vegetable oils, (e.g. corn oil), i.e. hydrogens are added to double bonds. Explain how this process converts the liquid oil to solid margarine. Be sure to mention any important molecular interactions and thermodynamic forces that are related to this process.
8. (6 pts) What energetic/thermodynamics features or forces are common to both protein folding and the spontaneous assembly of lipid bilayers? Your answer should refer to the general structure of phospholipids.
9. (5 pts) Please answer **one** of the following choices.
- Choice A:** Why do fatty acids form micelles, while phospholipids form bilayers.
- Choice B:** Define the critical micelle concentration and briefly discuss how it would be affected by the length of the fatty acid.
- Choice C:** What will happen to the size of a phospholipid vesicle, whose interior is 0.1M NaCl, when placed in a solution of 0.5 M NaCl? Be sure to discuss the molecular bases for the permeability of water and ions in your answer.
- Choice D:** What is the role of cholesterol in membranes?

10. (6 pts) Please answer **one** of the following choices.

Choice A: Membrane proteins are typically all α -helical or β -sheet. What is the thermodynamic basis for this property?

Choice B: A short peptide composed entirely of alanine residues (sidechain $-\text{CH}_3$) will not readily insert into a bilayer, even though the sidechain of alanine is clearly non-polar. Why?

Choice C: Briefly describe the molecular basis for the ion selectivity of the potassium channel, i.e. why is only potassium allowed through the channel, while other ions, like Na^+ , cannot.

11. (6 pts) Please answer **TWO** of the following choices. For each choice state the name and location of all metabolic pathways the carbons flow through, and provide the names of key molecules, such as the input to the pathway, output from the pathway, and any intermediate molecules between the pathways. Feel free to draw a well labeled diagram for your answer.

Choice A: Outline the flow of carbon atoms from carbohydrates (.e.g. glucose) in metabolism.

Choice B: Outline the flow of carbon atoms from triglycerides in metabolism.

Choice C: Outline the flow of carbon atoms from amino acids, such as alanine, glutamic acid, aspartic acid, in metabolism.

12. (8 pts) Overview of energy production and flow (please read Q13 before proceeding).

- i) What is the general nature of reactions in metabolism that release energy? Give one example from **any** pathway [Hint: structures on the formula page may be useful.] (4 pts)
- ii) How is this energy captured in biological systems and not released as heat? (1 pt)
- iii) What is the next step in the energy flow? (1pt, no need to give details, just state how the energy is stored, you can provide the details in Q13)
- iv) What is the final step in the energy flow? (1pt, again, no need to give details, just state what the step is. You can provide more details in Q13).

13. (6 pts) Please do one of the following two choices.

Choice A: What is the role of complex II (succinate dehydrogenase) in the electron transport process? What is the path of electrons from complex II to the final electron acceptor?

Choice B: How does ATP synthase generate ATP from ADP and P_i ?

14. (6 pts) Please do one of the following choices:

Choice A: Compare and contrast a product inhibitor to a feedback inhibitor (5 pts). Provide **one** example of **either** (1 pt).

Choice B: What are the covalent changes catalyzed by kinases and phosphatases? You may answer this question by giving the reaction scheme of one phosphatase and one kinase.

15. (10 pts) A reaction in a pathway converts A to B. The standard energy difference, ΔG° , between A and B is large and positive, e.g. +15 kJ/mol.

i) Is this step likely to be spontaneous, based on the ΔG° ? Briefly justify your answer (4 pts)

ii) How could you make this step spontaneous? Support your answer with an example from a metabolic pathway discussed in class (6 pts).

16. (6 pts) Please do one of the following choices:

Choice A: How are metabolic pathways sensitive (i.e. regulated by) the energy levels in the cell? Give one example, including the regulated step and how it is regulated.

Choice B: Under what conditions is ethanol produced from glucose? Approximately what percentage of the original energy in glucose is still contained in ethanol? 80% or 20%

Choice C: Why should athletes minimize their intake of fats as their primary energy source?

17. (10 pts) Select **one** of the following four choices and briefly describe how the pathway you picked (glycogen or glucose synthesis/degradation) is regulated by the blood glucose level (low or high) you picked. Be sure to mention any hormones that may be involved and the role of the hormone in the process. Also be sure to state the names of the enzymes that are regulated and how they are regulated. Finally, indicate that the regulation you described makes sense with respect to the needs of the cell or organism.

Choice A: Low blood glucose & glycogen syn/deg

Choice B: Low blood glucose & glucose syn/deg

Choice C: High blood glucose & glycogen syn/deg

Choice D: High blood glucose & glucose syn/deg

Bonus (2 pts each):

A. Why is it better to put maple syrup on your pancakes instead of high fructose corn syrup?

B. What is the purpose of generating thioesters in oxidations?