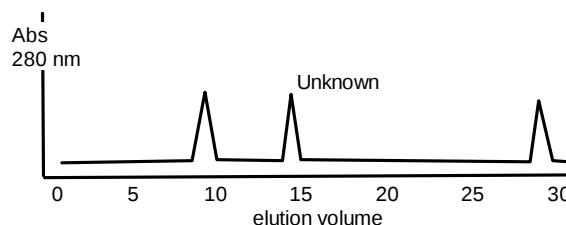


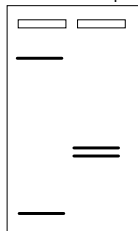
Instructions: This exam consists of 100 points on 6 pages. Please use the space provided to answer the question, or the back of the preceding page. In questions with choices, unless otherwise indicated all your answers will be graded and you will receive the best grade. Allot 1 min/2 points.

1. (5 pts) What fundamental principle allows one to determine the structure of proteins using X-ray diffraction? Name the principle and give a brief description.

2. (6 pts) The elution profile for gel filtration (size exclusion) chromatography is shown to the right. The standard molecular weights are 10,000 and 100,000 Daltons. The unknown peak is the middle peak. A useful plot is shown below the elution profile. ($\log 30,000=4.48$, $\log 60,000=4.78$, $\log 90,000=4.95$)

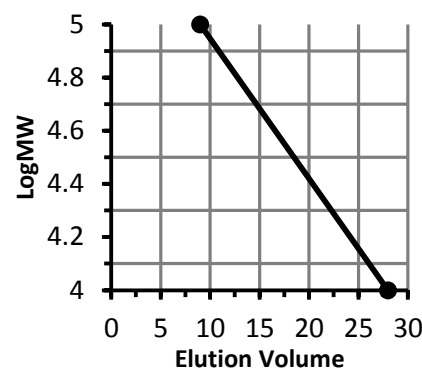


Standard Sample

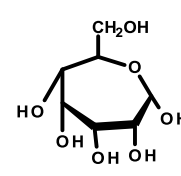
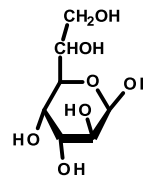
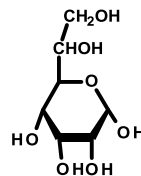
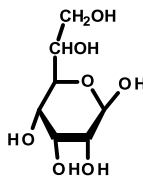
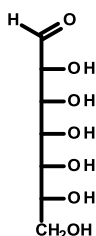


The SDS-PAGE gel (with or without β -mercaptoethanol) shows two bands of equal intensity with molecular weights of 14,500 (α chain) and 15,500 (β chain).

Determine the quaternary structure of this protein. *You must briefly justify your answer for full credit.*



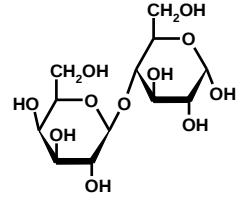
3. (5 pts) The following shows the linear form of a **seven** carbon monosaccharide (left side) and several choices for the ring form. Please answer all of the following parts of the question.



- Is this an aldose or a ketose (circle correct word) (2 pt)
 - Circle the **one** circular form that could **not** be generated from the linear sugar (1 pt)
 - Label the anomeric carbon on the first circular form (2 pts).
4. (4 pts) Fill in the blanks. The _____ carbon is always involved in the formation of the _____ bond that joins two monosaccharides to form a disaccharide. A common disaccharide is _____, and it is composed of monosaccharides _____ and _____.

5. (3 pts) Fill in the six blanks to complete the name of this sugar:

____-galacto____osyl -($\rightarrow$)-____ose
 1 2 3 4 5 6



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

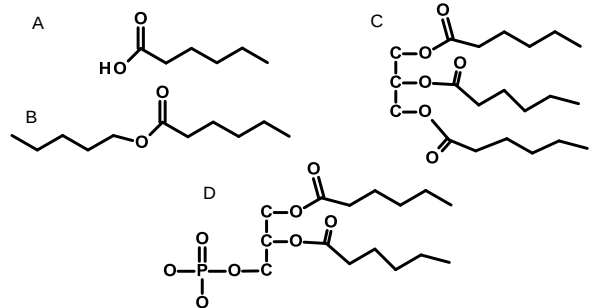
Choice A: Compare and contrast the structure **and** biological function of glycogen and cellulose. In what ways are they similar, and in what ways do they differ?

Choice B: Bacterial cell walls contain a polysaccharide component that is similar to cellulose.

- In what ways does the polysaccharide component in bacterial cell walls differ from cellulose?
- What additional component is found in bacterial cell walls that are not found in cellulose?

7. (4 pts) Four compounds (A-D) are shown on the right.

- Circle** the triglyceride,
- Put a **box** around the phospholipid,
- Draw an '**X**' through the wax.
- Draw a horizontal line (---) through the fatty acid.



8. (6 pts) Please do **one** of the following choices.

Choice A: What is the critical micelle concentration (CMC)?

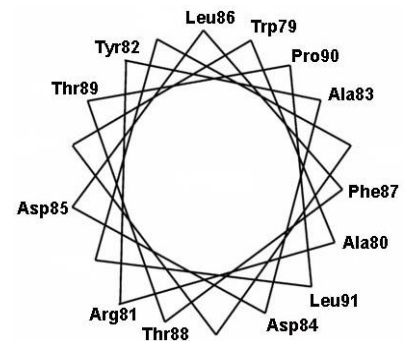
How does it depend on the number of carbons?

Choice B: How does cholesterol affect the properties of membranes and why is this effect important for function?

Choice C: In what way is the function of membrane transport proteins similar to soluble enzymes? In what ways do they differ?

Choice D: The diagram on the right is a helical wheel depiction of an α -helix in a membrane protein. Indicate which part of this helix is exposed to the lipids and what energetic features would stabilize this interaction? Briefly justify your answer.

Choice E: Explain why the potassium channel is selective for K^+ ions.

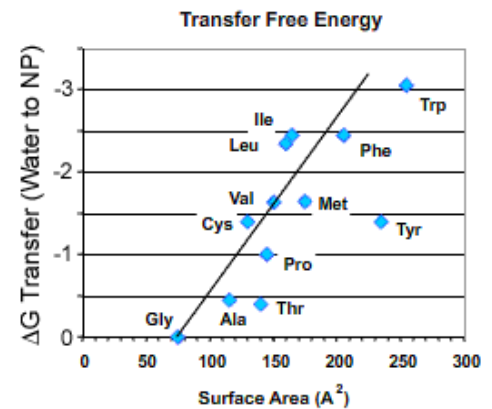


9. (6 pts) What fundamental thermodynamic interaction is responsible for the spontaneous *assembly* of both fatty acid micelles and phospholipid bilayers? [Hint: It is entropic]. In what way does this interaction affect the final structure of the micelle or bilayer?

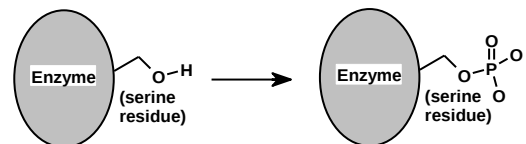
10. (10 pts) Please do one of the following choices.

Choice A: Olive oil is a triglyceride that melts at 10°C and is therefore a liquid at room temperature. Coconut oil is a triglyceride that melts at 25°C and is therefore a solid at room temperature. What is the most likely difference between the fatty acids in these two oils and how does this difference affect their melting temperatures? What fundamental thermodynamic interaction (e.g. H-bonds, electrostatics) is responsible for this difference?

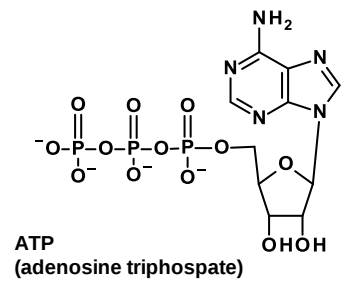
Choice B: The concentration of two short polypeptides in membranes is measured. One polypeptide, consisting entirely of alanine residues, is predominately found in the aqueous solution, while the other peptide, which consists of phenylalanine residues, is predominately found dissolved in the membrane. Explain, in **quantitative** terms, the different behavior of the two peptides. The free energy of transferring a Gly residue from water to a non-polar substance is +1 kcal/mol. The free energy for the transfer of sidechains is given in the diagram on the right.



11. (7 pts) Is the following reaction catalyzed by a kinase or a phosphatase (2 pts)? Briefly justify your answer and list any reactants or products that may be missing from the diagram (2 pts). How does the phosphorylation of enzymes in this manner affect their activity (3 pts)?



12. (3 pts) Why is ATP a “high energy compound”? That is, why does the hydrolysis of ATP to form ADP and P_i release energy (the structure of ATP is shown on the right).



13. (2 pts) The maximum yield of ethanol from glucose will be obtained under conditions of high or low oxygen content? (circle correct answer).
14. (2 pts) True or false (circle correct answer)? When glucose is converted to ethanol most of the energy is lost in the process.
15. (12 pts) Assume that you had a cream cheese bagel for breakfast.
- Briefly discuss how the carbon atoms in the food are ultimately converted to CO_2 for either fats or carbohydrates or amino acids that were contained in the bagel. You only need to:
 - state the major pathways that would be involved in the production of CO_2 ,
 - input and output compounds of that pathway,
 - the cellular location of each pathway.
 - Briefly describe the flow of energy as the carbohydrate, fat, or protein is metabolized, i.e. how is the energy that is released by oxidative steps in each pathway is ultimately converted to ATP (i.e. briefly discuss electron transport and ATP synthesis). *Your description of electron transport should list each stage of electron transfer. There is no need to discuss the mechanism of ATP synthesis in detail (6 pts).*

16. (9 pts) All metabolic pathways, when operating, show a negative Gibbs free energy (ΔG) for each step.

i) What does the sign of the Gibbs energy indicate about each step in the pathway (3 pts)?

ii) Many steps in pathways have an unfavorable standard energy change (ΔG°), for example: a) the conversion of fructose-6-P + $P_i \rightarrow$ fructose-1,6-P in glycolysis, b) aldolase in glycolysis, c) the formation of citrate in the citric acid cycle. Briefly describe one general mechanism for converting the positive standard energy change to a negative Gibbs free energy (6 pts). The use of the following formula may be useful in illustrating your answer: $\Delta G = \Delta G^\circ + RT \ln [B]/[A]$.

17. (4 pts) Please do **one** of the following **two** choices

Choice A: Complete **one** (only one will be graded) of the following fill in the blanks.

i) Prior to entering the _____ pathway, pyruvate is converted to _____, using _____ as the electron acceptor. This reaction is catalyzed by a _____ (general name).

ii) In the _____ pathway, an alkane is converted to a _____, using _____ as the electron acceptor. This reaction is catalyzed by a _____ (general name).

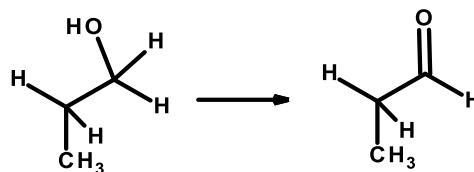
iii) In the _____ pathway, an alcohol is converted to a _____, using _____ as the electron acceptor. This reaction is catalyzed by a _____ (general name).

iv) In the _____ pathway, an aldehyde is converted to a _____, using _____ as the electron acceptor. This reaction is catalyzed by a _____ (general name).

Choice B:

i) Balance the redox reaction on the right, is it an oxidation or a reduction?

ii) What is the general name of the enzyme that catalyzes this type of reaction?



18. (6 pts) Please do **one** of the following choices.

Choice A: Glycolysis, gluconeogenesis, and the TCA cycle are all regulated by “energy sensing”. Select **one** of the three pathways and describe:

- i) the step that is regulated (1 pt).
- ii) the compounds that regulate that step, and whether they activate or inhibit the step (4 pts).
- iii) why this regulation is useful to the cell (1 pts).

Choice B: The liver cell responds to a number of different hormones, including insulin, glucagon, and epinephrine. Select any **one** of these hormones and:

- i) State under what conditions the hormone would be released (e.g. low blood glucose levels) (1 pt).
- ii) Whether proteins become phosphorylated, or not (1 pt).
- iii) How the response to the hormone affects the synthesis and degradation of glycogen and why this response is appropriate for the needs of the organism (4 pts).

Choice C: Discuss how glycolysis and gluconeogenesis are subject to regulation by hormones. Your answer should indicate why this form of regulation is useful to the cell. [Hint: how are levels of F26P affected?]

Bonus Questions (1 ½ pts each)

1. We possess an enzyme (lysozyme) that can digest bacterial cell walls, why is it not possible for us to digest cellulose (you need to briefly explain why lysozyme cannot digest cellulose).
2. Briefly explain why a “high carb diet” is not necessarily the best for marathon runners.
3. What enzyme do lactose intolerant individuals lack? What does this enzyme do?
4. Why does the consumption of high fructose corn syrup potentially lead to an increase in body fat? Why type of syrup would be less likely to cause this problem (Oh Canada!)?