Cell Biology (2020), First Midterm, Spring 2004

1. (5 pts)_____

2. (4 pts)_____

3. (2 pts) _____

4. (6 pts)_____

5. (6 pts)_____

6. (2.5pts) _____

7. (8 pts) _____

8. (5 pts) _____

9. (4 pts) _____

10. (2pts) _____

11. (4pts) _____

12. (3 pts)_____

13. (8 pts) _____

14. (4 pts) _____

15. (3pts) _____

16. (4 pts) _____

17. (8pts) _____

18. (7.5 pts) _____

19. (7 pts) _____

20. (4 pts)_____

21. (3 pts)_____

1. (5 pts) Below is a table comparing the 4 major cellular macromolecules and the subunits of which they are composed. Complete the table by filling in the blank spaces.

Subunit	Macromolecule
Fatty Acid (1pt)	Lipid
monosaccharide	***Polysaccharide (1pt)***
Nucleotide (1pt)	Nucleic Acids
Amino Acid (1pt)	***Protein (1pt)***

2. (4 pts) Fossil records indicate that life on Earth has been evolving for at least 3.5 billion years, and we constructed a scenario in class for the likely order of major events in cell evolution. For each pair of structures or processes below, **circle** the one that is thought to have evolved **first**.

DNA or **RNA** ***(1pt)***

Chloroplast or **mitochondrion** ***(1pt)***

photosynthesis or respiration ***(1pt)***

Nucleus or mitochondrion ***(1pt)***

3. (2 pts) **Circle** the molecule(s) that can freely diffuse through the phospholipid bilayer

H^+ **O_2** ***(1pt)*** **CO_2** ***(1pt)*** Cl^- Glycine

4. (6 pts) Fill in the appropriate letter. Use each letter exactly once.

Hydrophobic_____***D___(1pt)***_____

Hydrophilic_____***C E___(1pt)***_____

Amphipathic_____***A B F___(1pt)***_____

A. Fatty acid
B. Phosphatidyl choline (whole molecule)
C. Glucose
D. Interior of plasma membrane
E. Water
F. Cholesterol

5. (6pts) While on a safari in Tasmania, you come across a tribe that has become deathly ill. The illness shows symptoms not seen with any other disease, and appears to be spreading rampantly. Being the bright cell biologist that you are, you decide to investigate.

A. (2 pts) You are able to isolate, what appears to be a single-celled organism, that you believe is the cause of the disease. List two things that this organism must be capable of in order to be classified as living.

1. ***Reproduce Autonomously (1pt)***
2. ***Extensive Metabolism (1pt)***

B. (1 pts) Using microscopy, you have determined the overall size of the cell to be 50um in diameter. Is the organism likely to be a prokaryote or a eukaryote?

Eukaryote (1pt)

C. (3 pts) You think the organism may disrupt protein synthesis in the human cells. What organelle will you examine in the human cells to test your theory? What technique will you use to image this organelle? Briefly explain this technique.

1. ***Ribosome or RER (1pt)***
2. ***TEM or Immunofluorescence (1pt)***
3. ***Explain (1pt)***

6. (2.5pts) Put the following in order from most to least reduced. Use 1 for most reduced and 5 for most oxidized.

____***3***____ H_2CO (formaldehyde) ***(.5pt)***

____***4***____ HCOOH (formic acid) ***(.5pt)***

_____***5***___ CO_2 (carbon dioxide) ***(.5pt)***

____***1***____ CH_4 (methane) ***(.5pt)***

_____***2***___ H_3COH (methanol) ***(.5pt)***

7. (8 pts) Match the following- note that some letters are used more than once. (Points will be deducted for putting down an incorrect letter.)

A.	Mitochondria	____***CAJ***_____	***-.5pt for each wrong answer***
B.	Chloroplast	__***CAJD***_____	
C.	Golgi Apparatus	_____***E***_____	
D.	Smooth ER	_____***B***_____	
E.	Vacuole	_____***I***_____	
F.	Lysosome	_____***H***_____	
G.	Nucleus	_____***CA***_____	
H.	Nucleoid	_____***C***_____	
I.	Cytoskeleton	_____***F***_____	
J.	Cell Wall	_____***G***_____	

Peptides

8. (5 pts) Draw a dipeptide using $-CH_2OH$ as the side chain on the amino acid at the N terminus, and $-CH_3$ as the side chain on the amino acid at the carboxy terminus. Circle the peptide bond.

9. (4 pts) The following is a hypothetical oligopeptide that spans the plasma membrane. From N to C terminus, it has a region in the external aqueous environment, a region in the membrane and finally the C terminal region is in the cytosol. Circle the 2 amino acids that you predict are the first and the last amino acids **in the membrane**. Explain your answer.
See key posted in biology building
1pt. for each amino acid structure
2pt. for drawing and circling the peptide bond
1pt. for overall amino acid structure

N – Glutamic acid - Lysine – **Alanine** – Tryptophan - Isoleucine – Proline – Glycine – Leucine – **Isoleucine** - Serine - Aspartic acid – Histidine – Tyrosine – Asparagine - Lysine - C

Hydrophobic region that spans the membrane and Alanine and Isoleucine bein and end the hydrophobic series.

10. (2 pts) Proteins span a phospholipid bilayer in one of two forms, an __***alpa helix*** or a _***beta _sheet/barrel*** . Each of these is an example of the _____***2***_____(1_,2_, 3_or 4) structure of proteins which is formed by ___***H***_____ bonds between members of the peptide bond. ***(.5pt each)***

11. Fill in the blanks. (4 pts) ***(1pt each)***

The ATP synthase is a rotary motor made up of many polypeptides, thus exhibiting _____***4***_____(1_,2_, 3_or 4_) structure. It uses the energy of H+ flowing down their electrochemical gradient to turn a rotor made of c subunits. The rotor is attached to the ***gamma***__ subunit that also rotates and changes the _***conformation***_____ of __***beta***_____ subunits that make ATP.

12. (3 pts) Briefly explain why the number of H^+ that must flow through the synthase to make one ATP is variable. Include a statement of the minimum amount of free energy (at 100% efficiency) that is needed to make an ATP.

Amount of free energy needed to make ATP 7.3 kcal (1pt.)

Energy in gradient fluctuates and explain (2pt)

Variable ATPsynthase parts (1pt)

13. (8 pts) The figure above shows a hypothetical membrane transporter.

a. (2 pts) What type of membrane protein is this? **Circle one**;

Transmembrane OR membrane associated OR lipid-linked OR protein attached.

b. (1 pt) Is this a channel or **carrier** protein?

c. (1 pts)Is this **active** or passive transport?

d. (2 pts) If active, what form of energy is being captured and utilized? If passive explain why.

EC gradient or chemiosmotic
Going down its gradient

e. (2 pts) Is this coupled transport? If yes, is it symport or antiport? If no, explain why.

Yes, coupled antiport

14. (4pts) The cardiac glycoside **oubain** binds to the K+ binding site on the external domain of the Na+/K+ ATPase, completely blocking its activity.

A. (2 pts) What effect would this have of the membrane potential (normally –70 mV, interior negative) of the treated cell? Why?

(1pt) Sodium ions cannot move out so inside cell will become more positive
(1pt) Membrane potential decreases

B. (2 pts) Most animal cells swell and burst when treated with oubain. Why?

(1pt) The increase in ion concentration
(1pt) Causes water to rush in and cells burst

15. (3pts) Indicate whether the following molecules are **NET** consumed (write C), produced (write P) or neither consumed nor produced (write N) during the Calvin-Benson cycle (dark reactions of photosynthesis).

CO_2 _____***C***_____ ***.5pt for each correct answer***

O_2 _____***N***_____

ATP_____***C***_____

Ribulose bisphosphate (5C intermediate)_____***N***_____

NADP+_____***P***_____

NAD+_____***N***_____

16. (4 pts) Briefly explain why a lipid bilayer does not naturally exist as a planar sheet. What structure will it spontaneously form instead? What type of **bond/interaction** is most responsible for this phenomenon?

(1pt) becomes a sphere, circle

(1pt) H bond or hydrophobic interaction
(2pt) Explain: Hydrophobic tails are exposed to minimize contact with water and will form a sphere, leaving hydrophillic heads near water.

17. (8 pts) Using the figure above, answer the following questions.

A. (2 pts) Name the type of reaction shown.
Condensaton or anaerobic

B. (2 pts) Name the polysaccharide shown above?
Cellulose

C. (1pt) Where is this polymer likely to be found in a cell?
Cell wall

D. (1pt) In animal cells, is this polymer used to store glucose to be catabolized when energy demands are high?
No

E. (2 pts) Being as specific as possible, name the linkage?
Beta (1,4)

18. (7.5pts) Circle correct choice or fill in the blank. (15 total responses)

The ***__light_____*** reactions of photosynthesis begin with the absorption of a photon of (***blue*** **or green**) light by chlorophyll molecules in the ***__thylakoid___*** membrane. These chlorophylls transfer their (***energy*** **or electron**) to a ***_rxn center_*** where charge separation occurs. The special chlorophyll at the reaction center ultimately regains a low energy electron from water liberating H^+, e- and ***oxygen____***. An electron leaves the reaction center and move down an electron transport chain by a series of redox reactions; at each transfer the energy in the electron (**increases or** ***decreases***) and is used to

move a ***_proton__*** across the membrane into the (***thylakoid space*** **or stroma**) forming an electrochemical gradient. This electrochemical gradient is used to make ***_ATP_____*** in the (**thylakoid space or *stroma***). The electron then enters photosystem ***_I_____***(I or II) where another photon excites it to a very high energy and it eventually reduces NADP+. The splitting of one water molecule provides ***_____2_____***(how many?) electrons that are excited by ***___4____***(how many?) photons as they move down the electron transport chain. These electrons eventually reduce ***____1_____***(how many?) NADP+.

19. (7 pts) Consider the following reaction:

$$\underset{\text{(ethanol)}}{CH_3\text{-}CH_2\text{-}OH} + NAD^+ \Rightarrow \underset{\text{(acetaldehyde)}}{CH_3\text{-}CHO} + NADH + H^+$$

$+\Delta G = 5.7$ kcal/mol

A. (2 pts) Draw the reaction pathway vs. energy for the above reaction. Label the reactants, products, and ΔG.

See key posted in biology building.

B. (2 pts) Will this reaction occur spontaneously in your cells after a night of binge drinking? If yes, why? If no, what could drive this detoxification reaction?

No, coupling it to a favorable rxn.

C. (3pts) This reaction is catalyzed by the enzyme alcohol dehydrogenase. What effect does this enzyme have on the ΔG?

No effect

On the reaction rate?

Increases

On the activation energy?

Decreases

20. (4 pts) We find a mulberry tree that has wintered at –40_C and we warm it slowly. What two major changes do you expect to find in the fatty acid side chains following warming to summer temperatures?

Longer tails (1pt)
Increased saturation (1pt)

What effect will these changes have on membrane fluidity?

The changes in tail length and saturation favor the Gel state, but when combined with the temperature change membrane fluidity shouldn't change too much.
(2pt)

21. (3 pts) What are the three general classes of **immediate** energy currency: hint - these

are converted from one to another during photosynthesis, glycolysis and respiration.

1. ***Electrochemical gradients***
2. ***Reducing power***
3. ***Covalent Bonds***

.5pt for giving an example