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.

<table>
<thead>
<tr>
<th>Subunit</th>
<th>Macromolecule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatty Acid (1pt)</td>
<td>Lipid</td>
</tr>
<tr>
<td>monosaccharide</td>
<td>Polysaccharide (1pt)</td>
</tr>
<tr>
<td>Nucleotide (1pt)</td>
<td>Nucleic Acids</td>
</tr>
<tr>
<td>Amino Acid (1pt)</td>
<td>Protein (1pt)</td>
</tr>
</tbody>
</table>

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⁺  O₂ (1pt)  CO₂ (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___ H₂CO (formaldehyde) (.5pt)

___4___ HCOOH (formic acid) (.5pt)

___5___ CO₂ (carbon dioxide) (.5pt)

___1___ CH₄ (methane) (.5pt)

___2___ H₃COH (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 -CH₂OH as the side chain on the amino acid at the N terminus, and -CH₃ 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


Hydrophobic region that spans the membrane and Alanine and Isoleucine begin 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)  *(Ipt 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).

   CO2 _____ C _______  .5pt for each correct answer
   O2 _____ 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:

\[ \text{CH}_3\text{-CH}_2\text{-OH} + \text{NAD}^+ \rightarrow \text{CH}_3\text{-CHO} + \text{NADH} + \text{H}^+ \]

(ethanol) (acetaldehyde)

+\(\Delta G= 5.7 \text{ kcal/mol}\)

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

\textit{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. (3 pts) This reaction is catalyzed by the enzyme alcohol dehydrogenase. What effect does this enzyme have on the $\Delta G$?

*No effect*

On the reaction rate?

*Increases*

On the activation energy?

*Decreases*

20. (4 pts) We find a mulberry tree that has wintered at $-40 \, ^\circ C$ 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.*

(2 pt)

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