Fall 2002 Biology 111 Exam #1 - Cellular Communications

There is no time limit on this test, though I have tried to design one that you should be able to complete within 2.5 hours, except for typing. There are three pages for this test, including this cover sheet. You are not allowed to use your notes, old tests, the internet, or any books, nor are you allowed to discuss the test with anyone until all exams are turned in at 8:30 am on Monday September 23. **EXAMS ARE DUE AT CLASS TIME ON MONDAY SEPTEMBER 23**. You may use a calculator and/or ruler. The **answers to the questions must be typed on separate sheets of paper** unless the question specifically says to write the answer in the space provided. If you do not write your answers in the appropriate location, I may not find them.

-3 pts if you do not follow this direction.
Please do not write or type your name on any page other than this cover page.
Staple all your pages (INCLUDING THE TEST PAGES) together when finished with the exam.

Name (please print):

Write out the full pledge and sign:

On my honor I have neither given nor received unauthorized information regarding this work, I have followed and will continue to observe all regulations regarding it, and I am unaware of any violation of the Honor Code by others.

How long did this exam take you to complete (excluding typing)?

Lab Questions:

3 pts.

1) Fill in the table used to set up a reaction (unrelated to question number 2 below).

Stock Solutions	Volumes (in μL)	Final Concentrations
100 mM isocitrate	13	4.33 mM
57 mM enzyme	20	3.8 mM
1.5 M buffer	10	50 mM or 0.05 M
water	257	

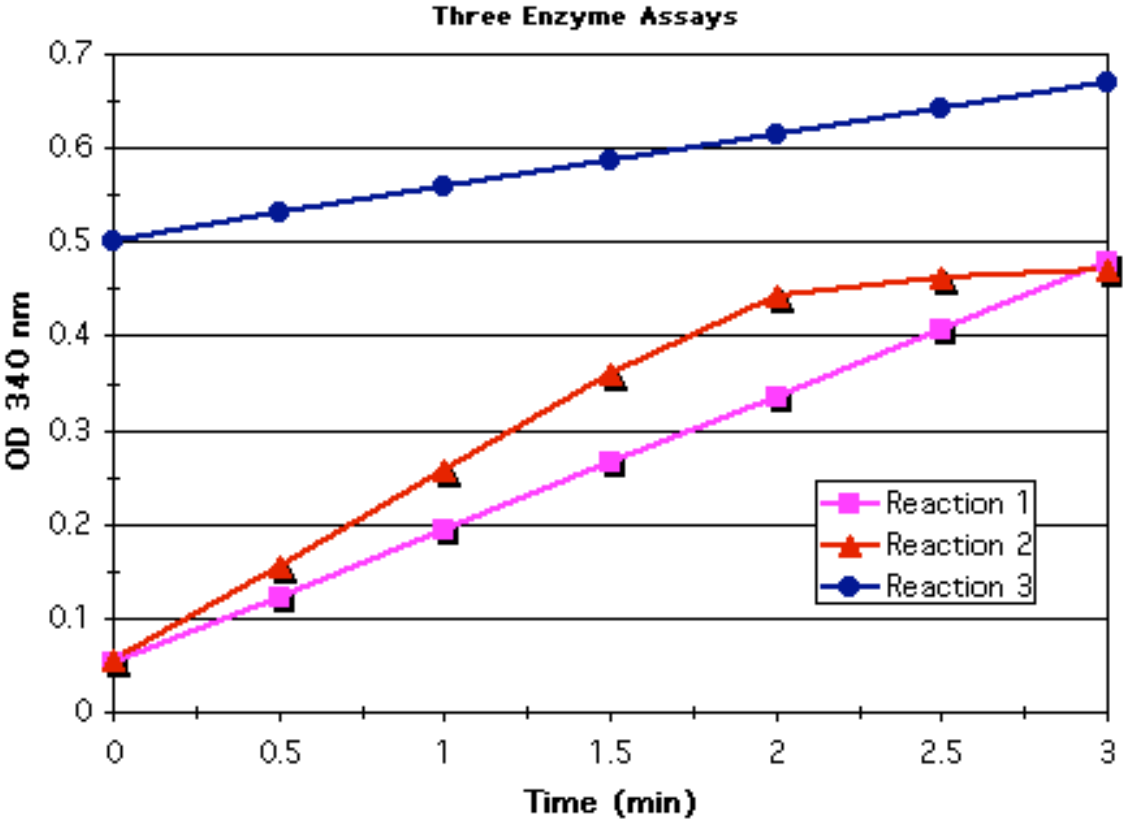
7 pts.

2) List the three reactions in order from fastest to slowest reaction rates. Explain why you placed each reaction where you did.

Reaction 2 is the fastest because its INITIAL slope is the steepest. Slope is a measure of enzyme activity.

Reaction 1 is the middle one due to its intermediate slope.

Reaction 3 is the slowest with its shallow slope.



Lecture Questions:

4 pts.

3) Explain the basic elements of evolution in four sentences.

There is genetic variation in any population.
Species over produce so there is competition for limited resources.
Individuals with adaptive capacity will out compete less fit individuals.
Those that survive will reproduce and propagate their adaptive genes.

4 pts.

4) Using a specific example we studied, explain the phrase "form follows function".

An ion channel is built with hydrophobic outer layers so it stays embedded within the plasma membrane. The central pore of the channel is lined with hydrophilic amino acids so charged ions can pass through. The construction of the channel is well suited for its capacity to perform a cellular task.

6 pts.

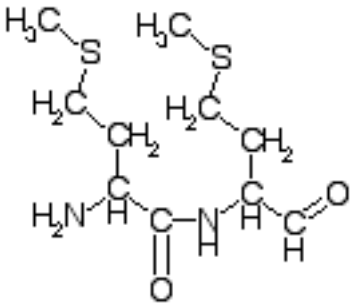
5) a) What kind of molecule is shown in this picture?

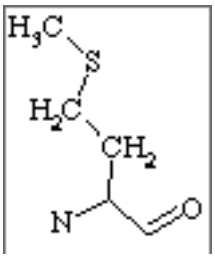
an amino acid

b) Is it hydrophobic or hydrophilic?

Hydrophilic due to the S in its R group

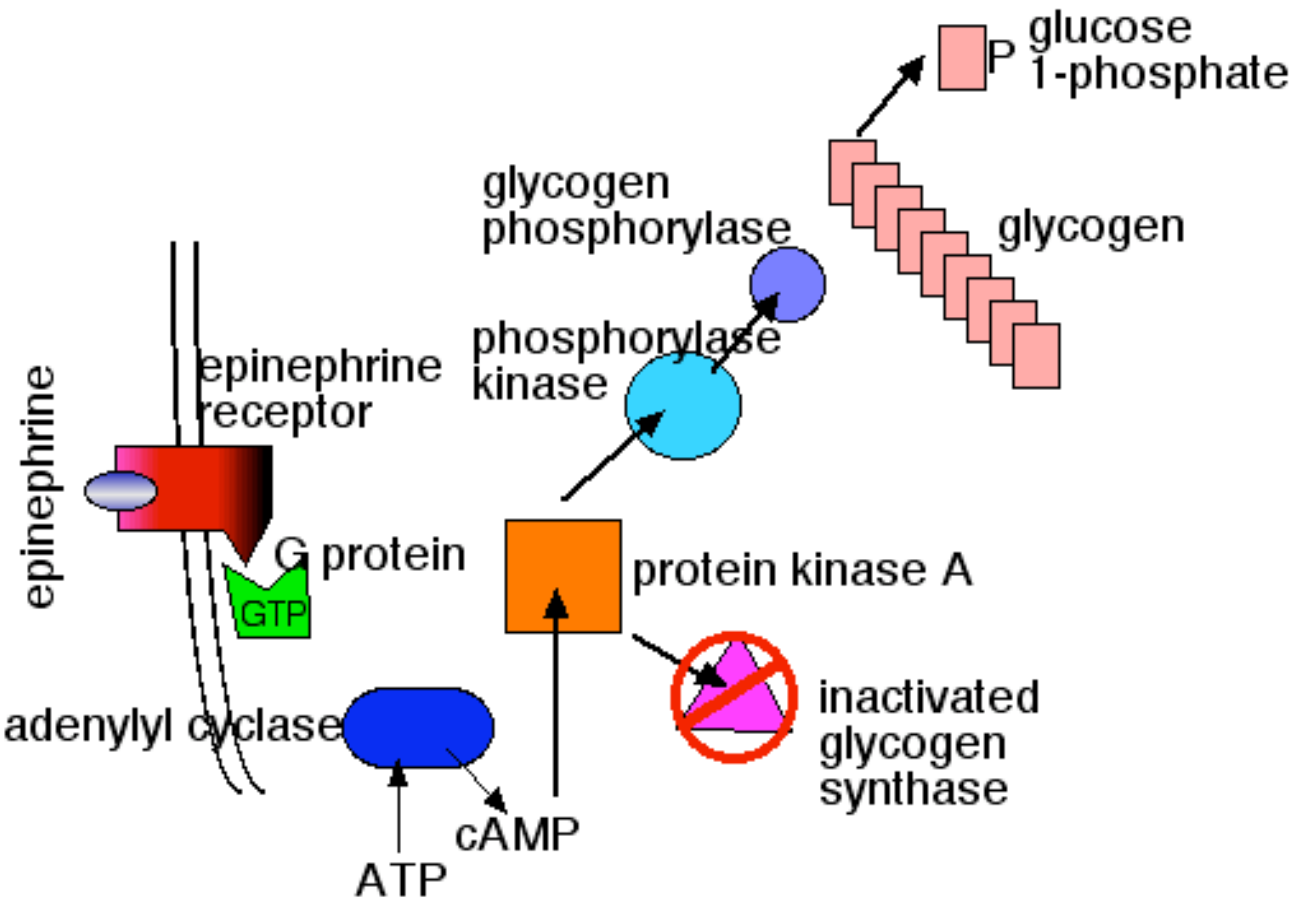
c) In the space below, diagram how two copies of this molecule would be connected together in one of your cells.





20 pts.

6) On the back of this page, draw a picture of the entire signal transduction pathway in your liver starting with ligand binding to receptor and ending with the production of glucose 1-phosphate. Your diagram must be clear and you must write labels for all parts of your figure. Make sure your writing can be read easily, so print neatly.



10 pts.

7) a) What is a gated ion channel?

An ion channel that has a trigger to open the passage way.

b) List every type of gated ion channel we have studied so far and give one example of each type.

voltage-gated Na+ channel – neuron PM
voltage-gated K+ channel – neuron PM
voltage-gated Ca2+ channel – neuron PM
ligand gated Na+ channel – neuron PM
unknown mechanism gated Ca2+ channel – skeletal muscle SR
ligand-gated Ca2+ channel – egg ER

6 pts.

8) Explain how calcium is used to *open and close* the IP3 receptor.

Once IP3 has caused the release of some calcium, this calcium can bind to and open the same channel at other sites on the egg's ER. This opens the channel.
If a lot of calcium is released, then a second calcium ion binds and this causes the channel to close.

6 pts.

9) List the ways a fertilized egg can reset its cytoplasm to prepare it for a new use of calcium as a second messenger.

sperm stops activating the receptor for X
G protein cleaves GTP to GDP and becomes inactive

IP3 is converted to IP2 and thus cannot open IP3 receptors
CICR causes 2 calciums to bind to IP3 receptor and shut it.
Calcium pumps move calcium from cytoplasm to ER lumen

6 pts.
10) Explain how calcium is used to regulate neurotransmitter release into the neuromuscular junction. You may include a diagram in your answer if it helps you.
On the surface of a secretory vesicle, calcium binds to synaptotagmin which changes it shape. This causes VAMP to reveal a binding site for syntaxin which is located in the inner surface of the PM. The interaction of VAMP and syntaxin leads to exocytosis of the neurotransmitter.

8 pts.
11) Explain the difference/s between a more forceful heart contraction and a faster heart rate.
A more forceful contraction is due to more myosin crossbridges forming per unit time. This causes the actin and myosin to move past each other with greater force and thus the heart contracts very fully. In addition, the myosin heads are cycling faster so there is more force per contraction.
A faster heart rate is controlled by the relaxation rate of the heart. Relaxation is regulated by the pumping of calcium out of the cytoplasm and this is controlled by the calcium pump. The faster the relaxation, the faster the rate, but this does not mean the force will necessarily be harder.

8 pts.
12) List four especially common phenomena in intercellular signaling systems.
signal transduction (crossing the membrane)
amplification of the initial signal
unidirectional pathway
an ability to inactivate or reset the system

6 pts.
13) Explain what would happen to a neuron that contained a defective K+ channel that was non-functional.
This neuron could be depolarized but never repolarized. This would lead to release of neurotransmitter but no relaxation. Therefore it would lead to paralysis through constant contraction.

6 pts.
14) Explain how gels separate molecules based on size.
Gels are filled with small tunnels of different sizes. Molecules of different sizes are driven through the gel by the attraction to the opposite pole (i.e. the positive pole). Big molecules must bounce around until they can find a tunnel through which they can travel while smaller molecules can fit through a larger percentage of the tunnels. Therefore, small molecules travel faster since they can move through a larger number of tunnels and their progress in not impeded by their size.

Bonus Question (+2 points): Hypothesize why benign familial neonatal convulsions disappear a few months after birth.
Probably because the affected neurons are able to make a new form of K+ channel as the child ages and the defective ones are not the only channels available. This may be due to increased activity of the child.