

Fall 2003 Biology 111 Exam #1 Answer Key - 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 four 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 22. **EXAMS ARE DUE AT CLASS TIME ON MONDAY SEPTEMBER 22.** 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:

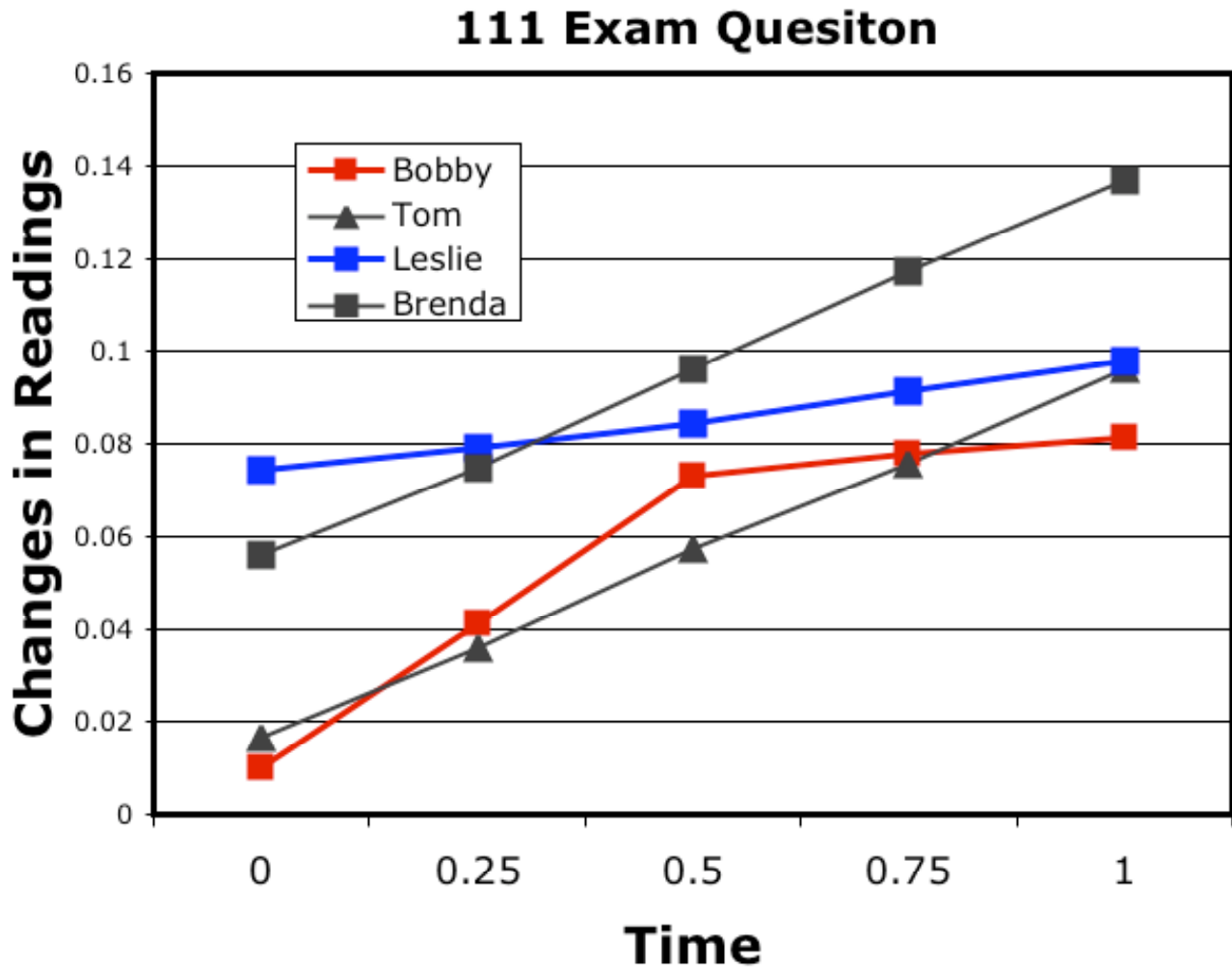
3 pts.

1) Provide the volumes to complete the table below used to set up an enzyme reaction.

Stock Solutions	Volumes (in μL)	Final Concentrations
250 mM isocitrate	12	10 mM isocitrate
enzyme solution	15	5% (v/v) enzyme
1.5 M buffer	20	0.1 M buffer
water	253	
Final Volume	300	

7 pts.

2) Graph the data from the table on page 3. Use red ink for the reaction with the fastest initial rate, blue ink for the slowest initial reaction rate, and pencil for the other two.



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Time	Bobby	Tom	Leslie	Brenda
0.00	0.0100	0.0167	0.0741	0.0559
0.25	0.0412	0.0359	0.0793	0.0749
0.50	0.0729	0.0571	0.0845	0.0962
0.75	0.0779	0.0758	0.0914	0.1171
1.00	0.0812	0.0961	0.0978	0.1370

Lecture Questions:

4 pts.

3) Explain in 4 sentences or less with teleological language why you jumped in your chair on the first day when I scared you.

I jumped because my muscles wanted to be prepared for any possible danger. The sound lead me to believe there might be danger and I might need to flee or fight so my nerves and muscles did a twitch in order to have me ready to move quickly. This anticipation by my muscles provides me with a little head start.

8 pts.

4) In the space provided, use chemical structure diagrams to illustrate why we can digest glycogen and starch but not cellulose. Be sure to label neatly any parts you want to highlight.

I was looking for diagrams illustrating α 1-4 linkages between two glucose molecules v. β 1-4 linkages for cellulose. These would have to be labeled. Furthermore, I was looking for a diagram of an enzyme that had a shape complementary to the alpha linkage but not the beta linkage. I accepted short text with similar information.

11 pts.

5) a. Define activation energy. **Energy needed to initiate a chemical reaction.**

b. List three different non-protein allosteric modulators, which proteins they modulate, and whether each activates or inactivates the protein.

There are many correct answers, but some include:

Ca²⁺ - changes the shape of troponin and reveals the actin binding sites (indirectly)

cAMP – activates protein kinase A (PKA)

IP₃ – activates the IP₃ receptor which opens and allows Ca²⁺ to leave the ER

6 pts.

6) Explain why caffeine gives you a buzz. In your answer, choose one of the four systems we covered as a specific example.

In the heart, you produce cAMP when stimulated by epinephrine. Caffeine works by inhibiting the phosphodiesterase that normally destroys cAMP. This results in a protracted excited state in your cells and thus you feel a buzz due to the reduced capacity to reset your excited cytoplasm. In the heart, PKA phosphorylates your calcium channels in the plasma membrane (PM) so they stay open longer and more calcium enters the cells which leads to a harder contraction and thus more blood flowing in your body per unit time.

10 pts.

7) ATP is a common source of energy. List 5 ways it is used in the 4 systems we have covered so far. For each way, be sure to use one sentence to describe what happens when the ATP is consumed (i.e. what task is accomplished immediately when ATP is consumed).

There are many correct answers; here are some.

ATP is converted to cAMP by adenyl cyclase.

ATP is used to pump Ca^{2+} ions into the SER.

ATP is used to antiport Na^{+} and K^{+} across the PM.

ATP is consumed by myosin to make it let go of actin before becoming phosphorylated and starting the process over again.

ATP is consumed by PKA when glycogen phosphorylase is phosphorylated.

6 pts.

8) Explain the concepts of voltage and current using an analogy.

Voltage is the separation of charges, similar to having flowers on one side of screen window and bees on the other.

Current is the movement of charged particles, similar to the bees moving towards the flowers if a hole is cut in the screen.

9 pts.

9) What ions contribute to muscle contraction? List the ions and then describe what role each ion plays. In your answer, only consider the muscle cell, not the neuron.

Na^{+} is used to depolarize you muscle cell.

K^{+} is used to repolarize your muscle cell.

Ca^{2+} is used to reveal the myosin binding sites on actin.

8 pts.

10) Draw a picture of a cortical granule. In your diagram, label all the parts, including the molecules that we did not discuss in this system, but must be present for exocytosis to occur in response to increased cytoplasmic calcium concentration.

I was looking for an image that showed:

mucopolysaccharides

proteases

a molecule that functioned like synaptotagmin

a molecule that functioned like VAMP.

These last two had to be in the membrane of the cortical granule while the first two needed to be inside the vesicle.

8 pts.

11) Explain in molecular terms how myasthenia gravis causes flaccid paralysis when a person produces antibodies against his or her own acetylcholine receptors.

Flaccid paralysis means a lack of movement due to an inability to contract. Myasthenia gravis is caused by antibodies blocking the acetylcholine receptors and thus blocking the ligand gated Na^{+} channels. If these ligand-gated Na^{+} channels do not open, you cannot contract your muscles.

8 pts.

12) Outline an experiment to obtain purified IDH from human red blood cells so that the IDH is still functional. You do not want a general mixture of many protein, but one that is close to 100% IDH.

There are several but I was looking for column chromatography and not gel electrophoresis. You would need to start with RBCs and lyse them open before beginning your experiment. Ideally, you would mention that more than one column would need to be run in order to purify IDH from the other proteins.

12 pts.

13) Use the skeletal muscle contraction system as a model for cellular communication. Describe 6 common themes of cellular communication.

cascade – cellular communications usually involve an ordered series of many steps (from PM to SER to actin to myosin)

amplify – each step in the cascade results in a larger output than input (a few acetylcholine molecules results in a billion Ca^{2+} ions flooding the cytoplasm)

ion gradients – ion gradients are used as potential energy sources (e.g. Ca^{2+} , Na^{+} and K^{+} gradients in contraction and depolarization)

second messenger – after the ligand, often a second soluble molecule diffuses to a wide area in the cytoplasm (Ca^{2+} from the SER)

deactivation – every system can reset to resting (e.g. when calcium is pumped into the SER, the muscles relax; Na/K pump returns PM to resting as well)

ligands and receptors for signal transduction – often the first event is a ligand binding to a receptor which signals a change inside the cell from the outside (acetylcholine)

change of shape / change of function – When allosteric or covalent modulation occurs, the proteins change their shapes and this causes a change in function (troponin binding to Ca^{2+})