

## **Biology 111 Closed Book Take-Home Exam #2 – Evolution & Cells**

There is no time limit on this test, though I have tried to design one that you should be able to complete within 3 hours. There are 7 pages in this test, including this cover sheet. You are not allowed to look at someone else's test, nor use your notes, old tests, the internet, any books, nor are you allowed to discuss the test with anyone until all exams are turned in no later than 9:30am on Monday October. 20. **EXAMS ARE DUE BY 9:30 am ON MONDAY OCTOBER 20.** If you turn in your exam late, then you lose a letter grade for each day you are late. You may use a calculator and/or ruler. The **answers to the questions must be typed under each question** unless you draw the answer. If you do not write your answers in the appropriate location, I may not find them.

I have provided you with a “Data Gallery” in the form of figures and tables. You must move the appropriate image from the last two pages and incorporate them into your answers whenever you see the expression, “Use data to support your answer.” Do not assume how many of the data images you will use, or not use, and you are allowed to use any data image more than once if you need to, and you can use more than one image per question. Simply placing data near your answer is not sufficient support for your answer. You must explain how the significance of the data and how they support your answer. I have given you sentence limits for each question, so be concise.

There are 5 Quick Recall questions that are multiple choice. They are worth 2 points each. Indicate your answers by underlining the letter and the statement of your choice.

**-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):

Read the pledge and sign if you can do so with honor:

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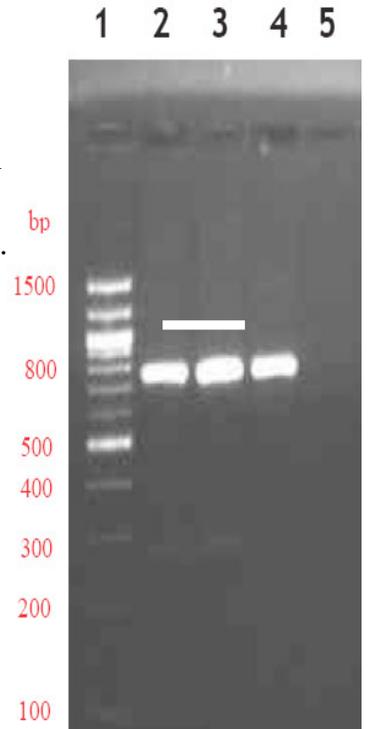
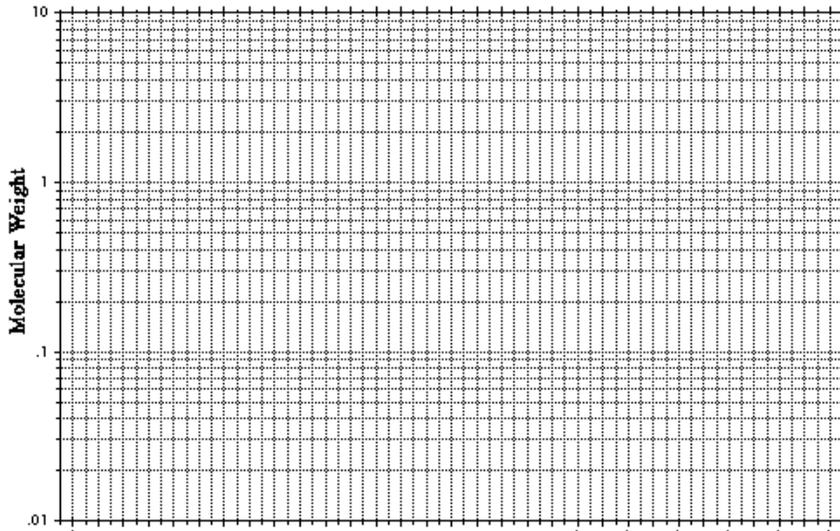
**On my honor I have neither given nor received unauthorized information regarding this work, I have followed and will continue to observe all regulations regarding it, and I am unaware of any violation of the Honor Code by others.**

How long did this exam take you to complete?

Lab Questions: You must show your work to be eligible for partial credit.

**10 pts.**

1) Determine the molecular weight of the large white band that covers lanes 2 and 3. To receive any credit, you must use the graph paper provided here. Tell me your answer in base pairs. I recommend you do this by hand after you have printed out your exam, though you can graph it within Word.



Lecture Questions:

**8 pts.**

2) Limit your answers to a maximum of **3 sentences for each part.**

- a) What was the major outcome from Miller's primitive Earth experiment? Use data to support your answer.
- b) What new question did his research findings stimulate?

**18 pts.**

3) Limit your answers to a maximum of **6 sentences total.**

Propose a mechanism for the origin of primitive cells from abiotic components and how this could lead to a population of cells with variation. Support your answer with as many data images as you need to make your case.

**9 pts.**

4) Limit your answers to a maximum of **3 sentences for each part.**

- a) Categorize the chromosomal differences between two strains of *E. coli*. Use data to support your answer.
- b) What impact do these data have on the evolution of new species?
- c) How do these data affect the definition of a species?

**9 pts.**

5) Limit your answers to a maximum of **2 sentences for each part.**

- a) What happened to the DNA spacer between the “beads” when the chromatin was in multi-bead pieces? Use data to support your answer.
- b) How does DNA avoid getting tangled? Use data to support your answer.
- c) DNA bases are 0.34 nm apart and nucleosomes are 10 nm in diameter. Calculate how many bases of DNA are wrapped around the proteins. Use data to validate your calculation.  
Circumference =  $\pi d$  and area =  $\pi r^2$ .

**8 pts.**

6) Limit your answers to a maximum of **3 sentences for part a** and a maximum of **4 sentence for part b.**

- a) Describe how your immune system responds in a secondary response compared to a primary response. Use data to support your answer.
- b) Describe the cellular evolution of a secondary immune response. Be sure to utilize the tenets of natural selection in your answer. Use data to support your answer.

**12 pts.**

7) Limit your answers to a maximum of **3 sentences for each part.**

- a) Summarize the two different types of communication systems used by neurons and where each of these takes place in a neuron. Use data to support your answer.
- b) Which of these communication systems ultimately triggers muscle contraction? Use data to support your answer.
- c) What two things do Schwann cells do to expedite nerve function? Use data to support your answer.

**8 pts.**

8) Limit your answers to a maximum of **2 sentences for each part.**

- a) How did biologists know that an activated epinephrine receptor did not directly stimulate glycogen phosphorylase? Use data to support your answer.
- b) How many cAMP molecules it takes to activate PKA. Use data to support your answer.

**8 pts.**

9) Limit your answers to a maximum of **2 sentences for each part.**

- a) Explain why it is adaptive for each eukaryotic organelle to be composed of a different lipid mixture. Use data to support your answer.
- b) Would you predict that the secretory vesicles containing epinephrine would contain more rigid lipids, or flexible lipids? Use data to support your answer.

**“Quick Recall” Questions for 2 points each**

**Electronically underline the entire statement of the correct answer.**

**QR1** Some newly made proteins are transported to the surface of cells. Which statement is true?

- a) Viral and host proteins are transported to the cell surface by different mechanisms.
- b) Cell surface proteins are produced in the cytoplasm on ribosomes near the plasma membrane.
- c) Cell surface proteins are produced by a unique type of ribosome that specializes in this class of proteins.
- d) Secreted proteins and cell surface proteins are produced at two different subcellular locations.
- e) All of the statements above are true.
- f) None of the statements above are true.

**QR2** Which of the following statements about protein structure is NOT true?

- a) Quaternary protein structure forms when two or more separate proteins interact and form a larger protein structure.
- b) Primary protein structure is shaped like cork screws and zigzag bands of amino acids that form as soon as the protein is made.
- c) Tertiary protein structure is formed when a single protein folds into its final shape.
- d) Secondary structure forms due to hydrogen bonds and the amino acid side chains determine the shapes formed.
- e) All of these statements are true and none of them are false.

**QR3** A good example of allosteric modulation of protein shape and function is

- a) when a ligand binds to its receptor
- b) when a kinase phosphorylates a protein.
- c) when a phosphatase removes a phosphate from a protein.
- d) when two proteins bind to each other.
- e) only (a) and (d).
- f) all of the above.

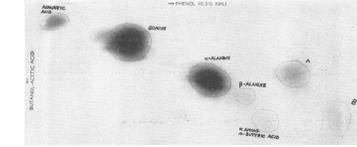
**QR4** Which of these statements does NOT describe common traits of signal transduction?

- a) The original signal is amplified at every step in the multi-step pathway.
- b) Signal transduction pathways always need mechanisms to activate and inactivate rapidly.
- c) Signal transduction pathways can utilize covalent modulation, allosteric modulation or ion gradients.
- d) Signal transduction moves information from the outside to the inside of a cell.
- e) All of the statements above DO describe common traits of signal transduction.

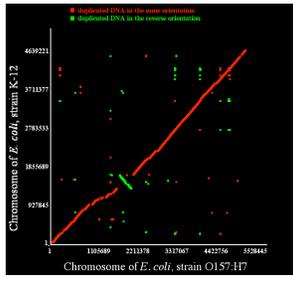
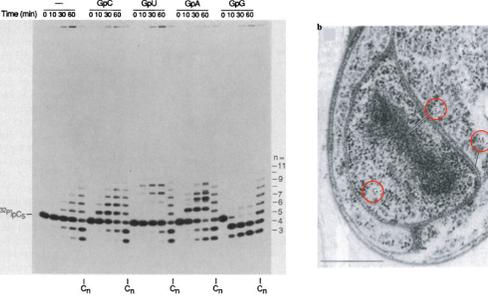
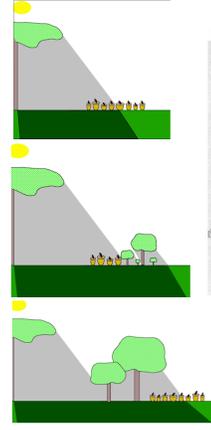
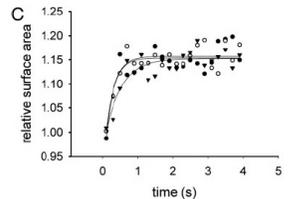
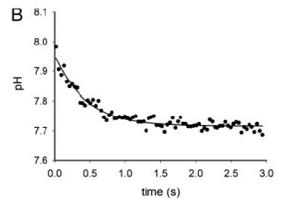
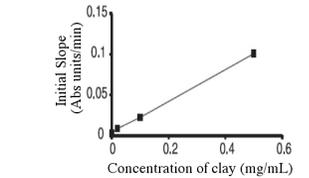
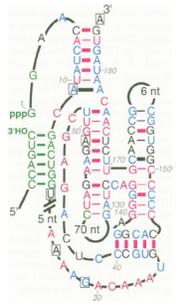
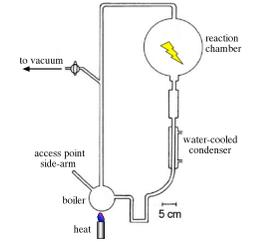
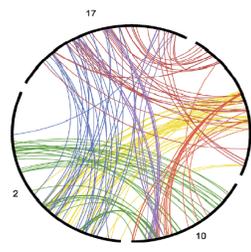
- QR5** During a normal neuronal action potential, the depolarization phase occurs when
- a) sodium and potassium ions move into the cell.
  - b) potassium ions move into the cell.
  - c) sodium ions move into the cell.
  - d) the sodium/potassium pump moves ions up their concentration gradients.
  - e) sodium ions diffuse down the axon to reach the secretory vesicles.
  - f) none of the above.

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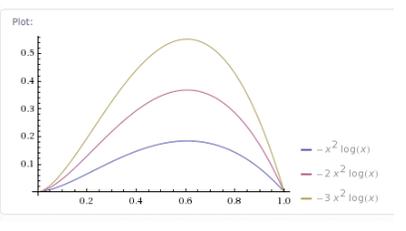
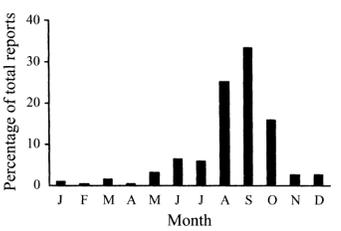
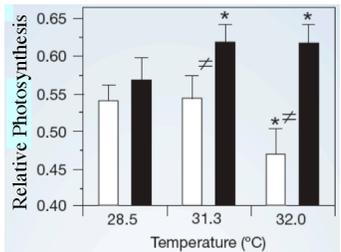
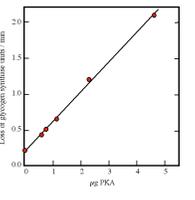
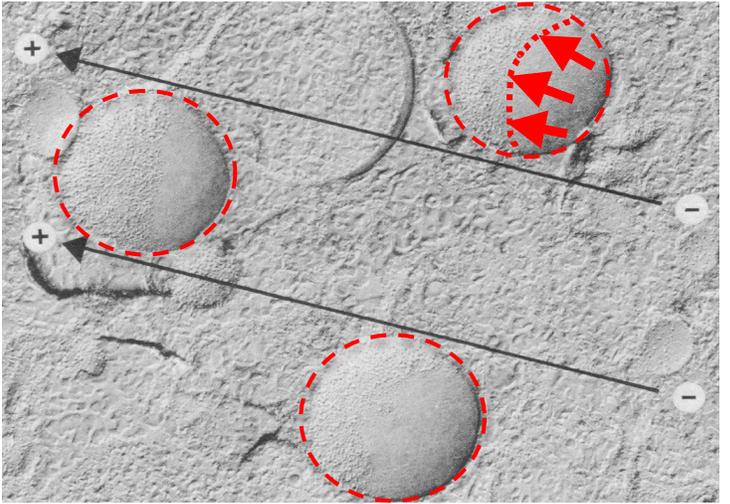
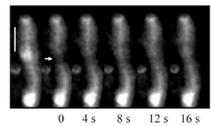
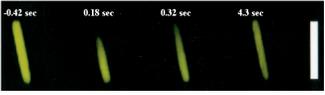
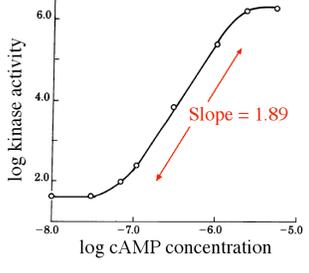
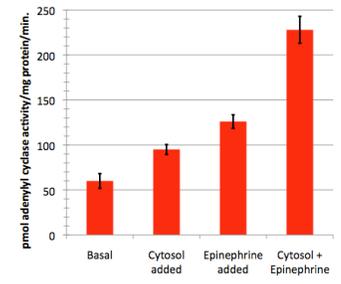
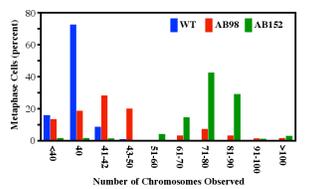
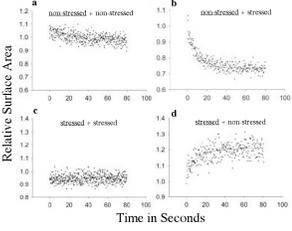
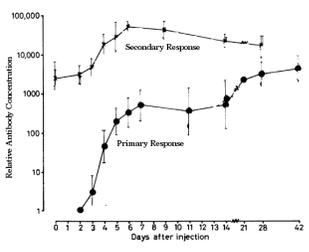
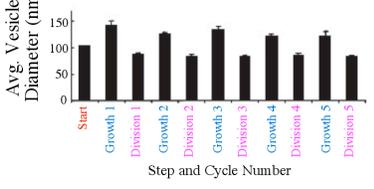
## Data Gallery



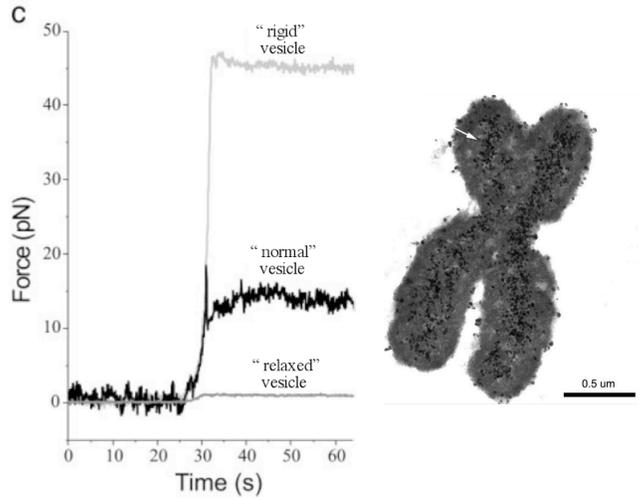
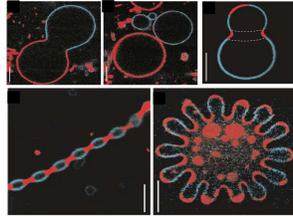
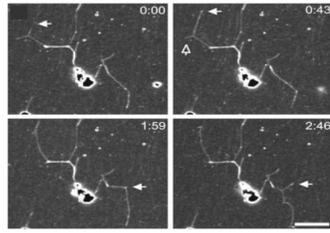
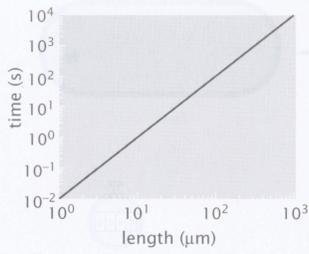
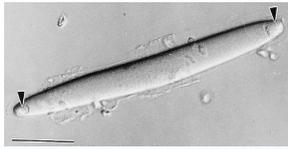
Human Protein #	Protein Function	Protein Location	Best Match Domain
NP_001009	Translation	Cytoplasm/ER	Archaea
NP_003185.1	Transcription factor	Nucleus	Archaea
NP_00101937	ATP synthase	Mitochondria	Bacteria
NP_005521	Energy Harvesting	Mitochondria	Bacteria
NP_000393	Energy Harvesting	Cytoplasm	Bacteria
NP_004138	Cytoskeleton	Cytoplasm	Archaea
NP_061816	Cytoskeleton	Cytoplasm	Bacteria



Days	Response	Relative Antibody Concentration
0	Primary Response	1
1	Primary Response	10
2	Primary Response	100
3	Primary Response	1000
4	Primary Response	10000
5	Primary Response	100000
6	Primary Response	1000000
7	Primary Response	10000000
8	Primary Response	100000000
9	Primary Response	1000000000
10	Primary Response	10000000000
11	Primary Response	100000000000
12	Primary Response	1000000000000
13	Primary Response	10000000000000
14	Primary Response	100000000000000
15	Primary Response	1000000000000000
16	Primary Response	10000000000000000
17	Primary Response	100000000000000000
18	Primary Response	1000000000000000000
19	Primary Response	10000000000000000000
20	Primary Response	100000000000000000000
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36	Primary Response	1000000000000000000000000000000000000
37	Primary Response	10000000000000000000000000000000000000
38	Primary Response	100000000000000000000000000000000000000
39	Primary Response	1000000000000000000000000000000000000000
40	Primary Response	100
41	Primary Response	1000
42	Primary Response	100
43	Secondary Response	1000
44	Secondary Response	100
45	Secondary Response	1000
46	Secondary Response	100
47	Secondary Response	1000
48	Secondary Response	100
49	Secondary Response	1000
50	Secondary Response	100



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Species	Domain	Description	Genome Mbps	Proteins
<i>Candidatus Carsonella ruddii</i>	Bacteria	Plant eating insect endosymbiont	0.16	182
<i>Candidatus Sulcia muellerii</i>	Bacteria	A wolfspurger symbiont	0.25	227
<i>Buchnera aphidicola</i>	Bacteria	Endosymbiont of the aphid	0.42	362
<i>Nanoarchaeum equitans</i>	Archaea	Hot vent tube worms symbiont	0.49	336
<i>Mycoplasma genitalium</i>	Bacteria	Urinary tract pathogen	0.58	477
<i>Candidatus Phytoplasma mali</i>	Bacteria	Apple proliferation disease	0.60	479
<i>Ureaplasma parvum</i>	Bacteria	Urinary tract pathogen	0.75	614
<i>Mycoplasma pneumoniae</i>	Bacteria	Bronchitis and pneumonia	0.82	689
<i>Borrelia burgdorferi</i>	Bacteria	Lyme disease	0.92	818
<i>Chlamydia trachomatis</i>	Bacteria	Leads to blindness and STIs	1.00	874
<i>Escherichia coli</i>	Bacteria	Diarrhea (from undercooked meat)	5.50	5423

Lipid Name	Rat Liver ER	Rat Liver Plasma Membrane	Rat Liver Golgi	Mouse Skin plasma membrane	Yeast Inner Mitochondria <sup>a</sup>	Yeast Outer Mitochondria <sup>a</sup>	Yeast Inner Nucleus <sup>a</sup>
phosphatidylcholine	58	39	50	43.0	38.4	45.6	44.6
phosphatidylethanolamine	22	23	20	16.1	24.0	32.6	26.9
sphingomyelin	3	16	8	12.2	0	0	0
phosphatidylinositol	10	8	12	7.6	16.2	10.2	15.1
phosphatidylserine	3	9	6	6.4	3.8	1.2	5.9
phosphatidic acid	0	0	0	0.0	1.5	4.4	2.2
cholesterol	n.d.	n.d.	n.d.	13	--	--	--
cholesterol or diphenylpicrylhydrazyl	n.d.	n.d.	n.d.	--	16.1	5.9	1.0

<sup>a</sup>: from Gerini van Meer, 1998, Table 1.  
<sup>b</sup>: from Orientations of Proteins in Membranes, 2010, <http://opm.phar.umich.edu/ops.php>.  
 n.d. not determined

Table 11.2 Mobility of proteins in and on *E. coli*.

Protein	Location	Diffusion Rate (μm <sup>2</sup> / sec)	Fold Slower
GFP	Water	87.0 ± 2.0	n.a.
GFP	Cytoplasm <i>E. coli</i>	8.0 ± 2.3	~10 X
GFP over produced	Cytoplasm <i>E. coli</i>	3.6 ± 0.7	~24 X
GFP + sugar-binding protein	Cytoplasm <i>E. coli</i>	2.5 ± 0.6	~35 X
GFP	Periplasm <i>E. coli</i>	2.6 ± 1.2	~33 X
GFP + TatA protein	Outer Membrane <i>E. coli</i>	0.13 ± 0.03	~669 X

