

Biology 113 Closed Book Take-Home Exam #2 – Chapters 4 - 7

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 6 pages in the exam, including this cover sheet and the data gallery. 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 9:30 am on Monday October 20. **EXAMS ARE DUE BY 9:30 am ON MONDAY OCTOBER 20.** If you turn in your exam late, you will lose a letter grade for each day you are late. The **answers to the questions must be typed within this test** unless you want to draw on a separate page. If you do not write your answers in the appropriate location, I may not find them. Tell me where to look if you put your answer at the back of your test.

I have provided you with a “Data Gallery” in the form of figures and tables. To choose a figure in support of your answer, simply state Figure #x. You do NOT need to move the figure on your test. Do not assume how many of the data images you will use, or not use. **Simply choosing the data is not sufficient support for your answer. You must explain the significance of the data and how they support your answer.** I have given you sentence limits so be concise.

-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:

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:

7 pts.

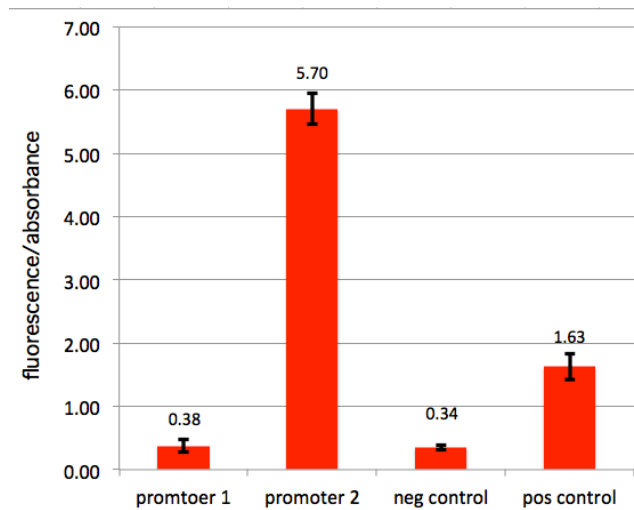
1) Last year, I had a student leave for fall break and never return. Later that year, I saw this student on a reality TV show where a couple tries to survive in the wilderness wearing no clothes, but I digress. The point being, the promoter data never got finished.

a) Generate a graph using data in the attached file (Exam2_data_2014.xlsx) to show the results, including error bars of the standard deviation. Insert your graph into the exam in the space below.

b) Evaluate the strength of the two experimental promoters from the graph you produced.

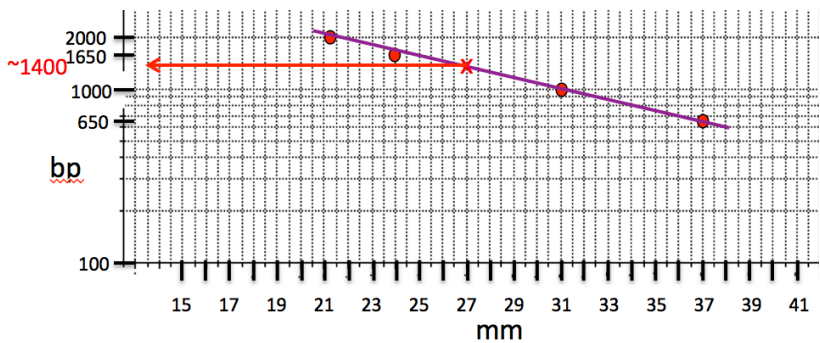
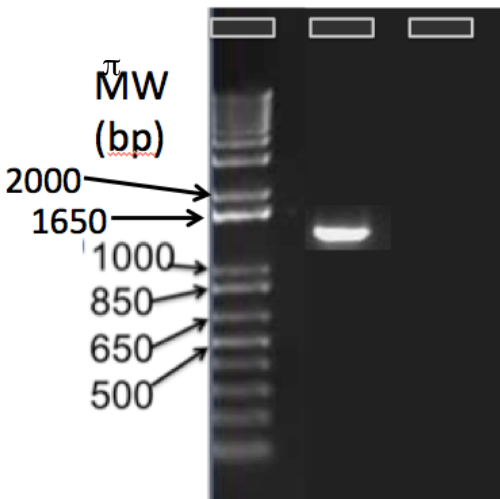
(maximum of 40 words)

- promoter 1 is no better than neg. control
- promoter 2 is 2.7 times stronger than pos. control



3 pts.

2) What is the molecular weight of this unknown band in lane 2? To get credit for this answer, you must show your work drawn by hand on the graph paper provided here.



Answer: ~1400

Lecture Questions:

16 pts.

3) The origin of life is a fundamental concept in biology.

a) Explain the RNA world theory and support it using four experimental results from the data gallery. (maximum of 40 words per experiment)

1. #7 vesicle seed
2. #4 ribozyme OR #5 but not both
3. #2 synthesis of nucleotides
4. #9 growth and division

b) Why is surface area to volume ratio relevant to the origin of cells? (maximum of 30 words)

When vesicle divides, it cannot contain the full volume so it spills some contents (RNA genome) which can seed another vesicle. This is primitive/abiotic reproduction.

14 pts.

4) Evolution is perhaps the main distinction between biology and the other STEM disciplines.

a) What are the five tenets of natural selection? Use data to support each one. (maximum of 40 words per tenet)

Figure #1 is not data and cannot be used to support answers. More than one figure could be used as supporting data. I list only some of them.

1. overproduction #9, #19
2. variation #12 – 15, #19
3. competition #9 & 10
4. selective advantage #9, 10, 19
5. reproduction #19, 26, 27

b) Which mechanism(s) of evolution is/are relevant to the origin of life? Use data to support each one. (maximum of 40 words per mechanism)

primarily mutation (#12) and natural selection (#9 & #10)

14 pts.

5) One form of information is DNA.

a) What do DNA polymerases need to start making a new copy of DNA? Use data to support your answer. (maximum of 40 words)

template and 3' OH group #11

b) Describe five forms of mutation that lead to evolution in cell populations in short periods of time. Use data to support your answer for each one. (maximum of 40 words per form)

1. SNPs #12
2. aneuploidy #14
3. whole genome duplication #15

- 4. somatic hypermutation #18
- 5. horizontal gene transfer #36
- 6. genome fusion #21

12 pts.

6) The evolution of eukaryotes is a major advance in the complexity of life.

a) Compare and contrast the data that supported the “tree of life” vs. the “ring of life” with attention to the origin of eukaryotes. Use one example of data to support each of the two displays of eukaryote evolution. (maximum of 40 words per example)

tree → single gene only #22

circle → whole genomes #21

b) What is the most likely origin of chloroplasts and mitochondria. Use data to support your answer for each one. (maximum of 30 words for each organelle)

mitochondria: *R. prowazekii* MRCA #24

chloroplasts: *Synechocystis* MRCA #24

c) Explain why the outdated “tree of life” display for the evolution of eukaryotes is NOT an example of scientific misconduct.

It is not fabrication, falsification or plagiarism

9 pts.

7) Another major step in evolution was the origin of multicellularity.

a) Using algae as your example, explain why multicellularity evolved rather than the algae remaining unicellular species. Use data to support your answer. (maximum of 40 words)

#26 increased growth rate for colonies over cells of the same size

#27 division of labor is not the best answer because it came after multicellularity

b) Did the evolution of the division of labor in colonies happen at the same time as the evolution of the first colonies? Use data to support your answer. (maximum of 30 words)

No, multicellularity (small colonies) came before DOL #25

c) Calculate the average value (to two decimal places) from the frequency distribution in Figure #28 below. Show your work to get credit.

4.84

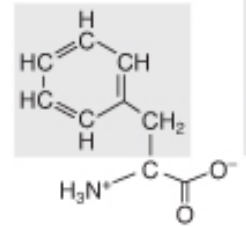
frequency	value	summation	
10	2.5	25	
4	4	16	
6	6	36	
3	8	24	
2	10	20	
		121	total values
		25	total numbers
		4.84	average value

8 pts.

8) Hopefully, when you started this test you were not scared. Remain calm and you will do well.

a) What level(s) of protein structure is/are affected by allosteric modulation? (maximum of 30 words)

tertiary and quaternary



b) Is this amino acid hydrophobic, hydrophilic, or neither? → (maximum of 20 words) To get credit, support your answer using chemical properties of the molecule.

hydrophobic because the side chain has only C-C and C-H nonpolar bonds

c) Explain why the fear response requires signal transduction but steroid modulation of gene activity does not. (maximum of 30 words)

epinephrine is hydrophilic and cannot cross plasma membrane so it needs receptor and signal transduction but steroid is hydrophobic and can diffuse into all cells. Steroid binds to receptors in cytoplasm.

9 pts.

9) By now, you should be very calm because you are nearly done with the exam.

a) How do we know that epinephrine is the cause of glucose release from the liver? Use data to support your answer. (maximum of 30 words)

#30 epi releases glucose but epi + antagonists do not.

b) Can G protein alpha subunits be reactivated or are they permanently inactivated by GDP? Use data to support your answer. (maximum of 30 words)

alpha is reactivated as seen by the increased cAMP production when beta/gamma added to alpha #31

c) When an enzyme is covalently modulated by a kinase, is the modified enzyme's activity enhanced or repressed? Use data to support your answer. (maximum of 30 words)

Phosphorylation can do either as seen when PKA activates an enzyme #33 and inactivates another one #32

8 pts.

10) Many membranes are not planar - they undulate.

a) What is the selective advantage to an undulating membrane? Give one real example where this happens. Use data to support your answer. (maximum of 30 words)

more surface area while maintaining a small volume #34 with ER-like experiment

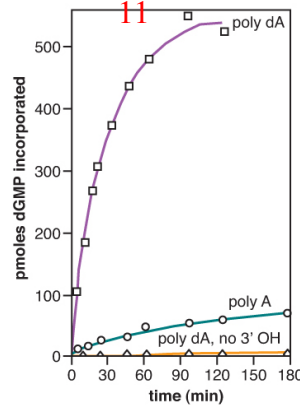
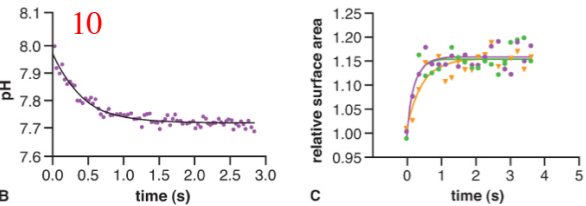
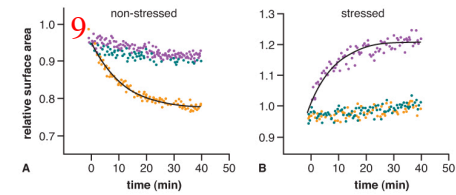
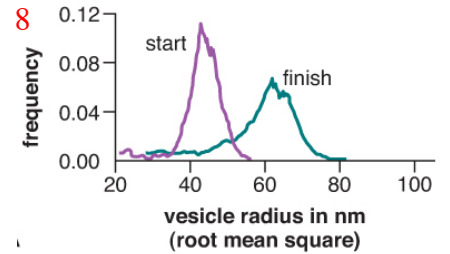
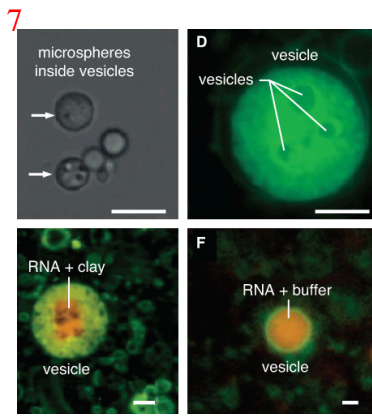
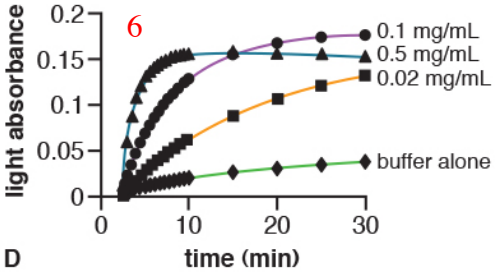
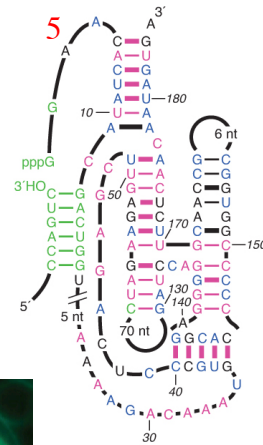
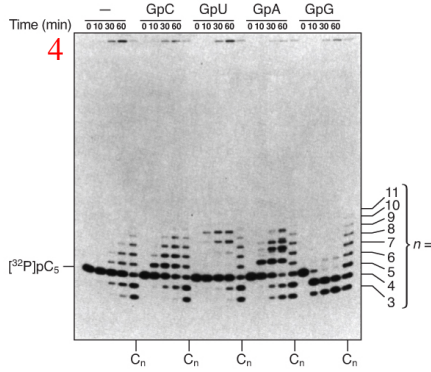
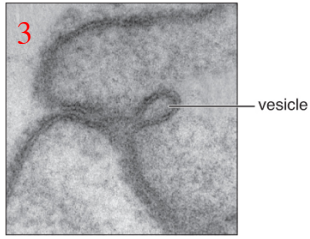
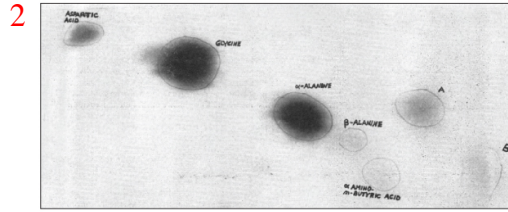
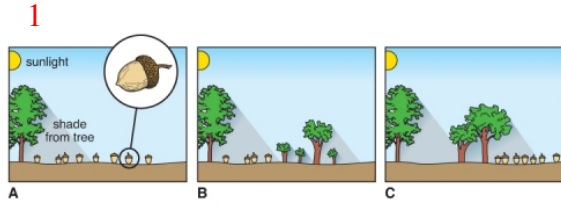
b) What is the selective advantage for different eukaryotic organelles having different lipid compositions? Use data to support your answer. (maximum of 30 words)

They can have different shapes and volumes as shown in #35

c) What role could lipid composition have played in the evolution of very ancient and primitive cells? Use data to support your answer. (maximum of 30 words)

Very early mechanism for cell division instead of just pushing through filter paper #37

Data Gallery



12

ions (concentration in mM)	error rate
Mg ²⁺ (1.0)	1 in 41,000
Ni ²⁺ (1.0)	1 in 5,030
Ni ²⁺ (2.0)	1 in 1,850
Cd ²⁺ (0.1)	1 in 7,810
Cd ²⁺ (0.2)	1 in 5,070
Ca ²⁺ (0.6)	1 in 7,520
Ca ²⁺ (1.0)	1 in 5,500
Ca ²⁺ (2.5)	1 in 3,760

