

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 **7** 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 **10:30 am on Monday Oct. 19**. 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 in this Word file** unless you are asked to draw on a separate page, or you want to use scratch paper. 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:

6 pts.

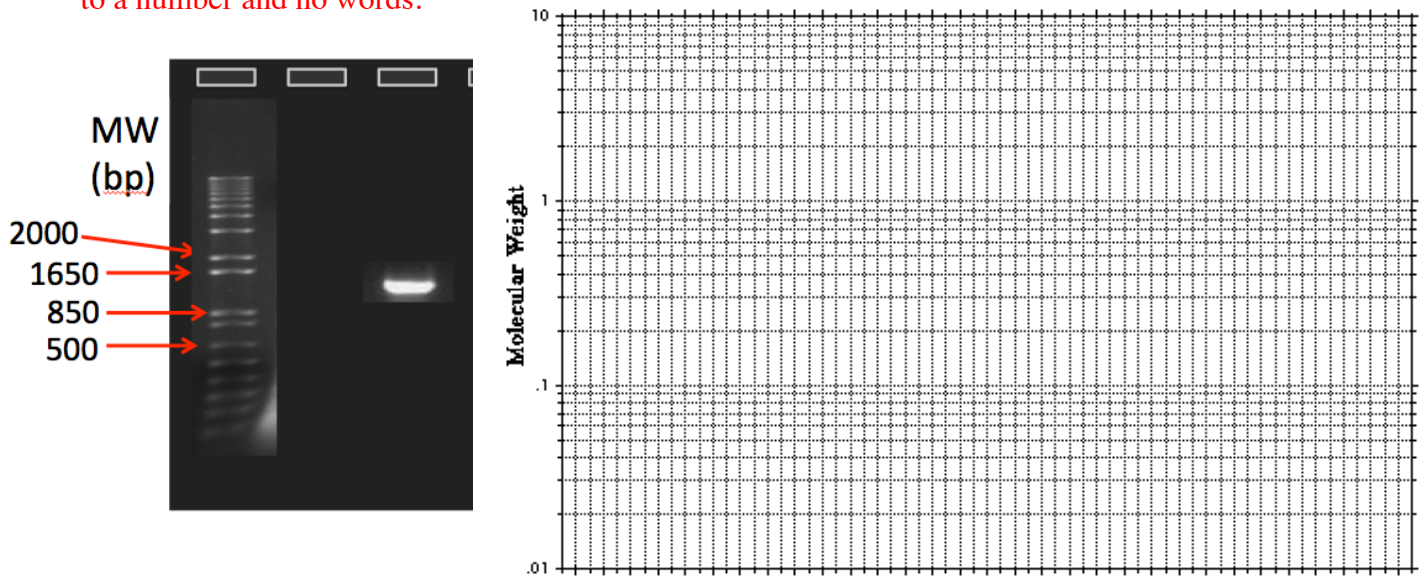
1) While you were on fall break, five other people and I were abducted by aliens. As we were flying through the universe, they sequenced some DNA from all six of us. Just before they beamed me back to Earth, I managed to grab the sequence files (see attached 6 sequence files).

a) Use ApE to find out how many SNPs are in this population. Answer = 6 **Limit your answer to a number and no words. To get full credit, you must include in your exam a screen shot of at least one SNP.**

b) Use BLAST to determine which gene the aliens sequenced. It is a gene we have studied. **Limit your answer to the name of the gene.** Answer = **adenylyl cyclase, human**

4 pts.

2) What is the molecular weight of this unknown band in lane 3? To get credit for this answer, you must show your work drawn by hand on the graph paper provided here. **Limit your answer to a number and no words.**



Answer: answers varied by graph

Lecture Questions:

16 pts.

3) Evolution is a unifying concept in biology. Answer these questions about evolution.

a) What problem does the phrase “theory of evolution” cause? Explain how this specific problem can be avoided. **Answer Limit: 25 words.**

Theory has a common meaning (guess) and a scientific meaning (well documented).

Nonscientists don't realize evolution is not a guess.

b) Which one mechanism of evolution is displayed in question 1a above? Explain your answer.

Answer Limit: 25 words.

Mutations in the DNA in the form of SNPs.

c) Which one mechanism of evolution might have happened in Columbia SC last week given they had 18 inches of rain in 1 day? Explain your answer. *Answer Limit: 25 words.*

Genetic drift happens when natural disasters randomly kill large numbers of individuals regardless of their genotype.

d) What question were investigators trying to answer when they generated faster ribozymes using directed evolution? Support your answer using data. *Answer Limit: 30 words.*

Could ribozymes exist that polymerize RNA fast enough to be biologically functional?

16 pts.

4) The origin of life is a difficult area of research. Answer these questions that are based on some of the best research in the world on this challenging topic.

a) List five life-like traits that have been observed in abiotic vesicles. Support each trait with data from the gallery. *Answer Limit: 25 words for each of the 5 traits.*

Many, including growth (10), competition (9), carry cargo (1 or 6), genome surrounded by membrane (11), store energy (18 or 15).

b) What evidence is used to support the claim that stressed vesicles take lipids directly from non-stressed vesicles? Support your answer with data. *Answer Limit: 30 words.*

The rates of change in figure 9 are the same.

c) What mathematical argument is made to address the first form of reproduction in the earliest cells to evolve? Support your answer using quantitative reasoning. *Answer Limit: 30 words.*

Surface area doubles, volume triples, and division means content (genome) spills and can catalyze new vesicle.

d) Look at Figure 1 and predict what you see if you added more lipid to the tube containing 0.5 mg/mL concentration of clay? *Answer Limit: 25 words.*

More vesicles would form/absorbance goes higher on y-axis.

14 pts.

5) DNA is not only an information molecule, it is also an important factor in evolution.

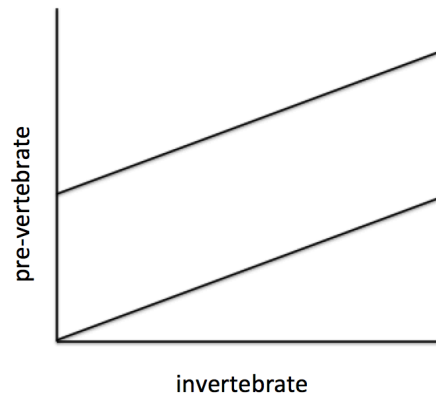
a) When you sent your DNA to be sequenced, you pipetted two solutions. One was your PCR amplified DNA and the other was a sequencing primer. Your DNA sequence was generated by a modified form of replication. Describe two important features of the sequencing primer and support your answer using data from the gallery. *Answer Limit: 35 words.*

Primer was DNA and had 3' OH group (7)

b) List three forms of rapid changes in DNA that have contributed to the evolution of new species. Support your answer with data from the gallery. *Answer Limit: 25 words for each form.*

- 1. aneuploidy #8*
- 2. whole genome duplication #13*
- 3. indels #16*

c) On a separate piece of paper, sketch of a dot blot that illustrates the major DNA change that happen in order for vertebrates to evolve. You must label the X-axis and Y-axis but do not show individual bases. *Write neatly for your labels.*



14 pts.

6) None of us would have survived long without our immune system. Answer these questions about your adaptive immunity.

a) Adaptive immunity has two characteristics: specificity and memory. Choose one figure that best illustrates both of these characteristics. Explain how each characteristic is revealed in the figure you chose. *Answer Limit: 30 words.*

#22 – specific (first and second antigens different responses) and memory (second response stronger)

b) Using B cells as your example, explain all the tenets of natural selection. Used a numbered list for the tenets. Choose one figure from the gallery that best illustrates your each tenet. *Answer Limit: 25 words for each tenet.*

Figure 34

1. overproduction – lots of B cells
2. variation – somatic hypermutation
3. competition – limited survival signal antigen
4. selective advantage – higher affinity for antigen
5. reproduction – memory B cells

8 pts.

7) Once life began, cell theory makes it easier to understand how all other species evolved.

a) What is the best explanation available today that explains how eukaryotes evolved from prokaryotes. Use *data* to support your answer. *Answer Limit: 30 words.*

#21 fused bacteria and archaea genomes/cells and formation of nucleus (old cell?)

b) A very common argument used to refute evolution is that complexity cannot evolve by chance into more complex systems. Use the case of multicellular Volvox to explain how complex colonies evolved through natural selection. Support your answer with data. *Answer Limit: 40 words.*

#26: rich environment, large cells grow slower than colonies of the same size

10 pts.

8) Provide your best answers to these questions about evolution at the organismal level.

a) Look at Figure 25 in the Data Gallery. Explain why the investigators used a log scale on the X-axis. *Answer Limit: 20 words.*

size range is too big for linear scale

b) Use Figure 25 to explain one benefit and one down side to frequency distribution plots.

Answer Limit: 30 words.

benefit is easier to see pattern of distribution; down side is hard to estimate average

c) On a separate piece of paper, draw an evolutionary tree that illustrates the origins of mitochondria and chloroplasts. The goal is not for you to remember exactly the one in the book but to draw something similar that makes the same point. You do NOT have to remember exact species names. You can simply just provide descriptive names. Your tree must have 8 different sources of information that are being evaluated on your tree. *Write neatly for any labels.*

various answers but similar to figure 6.18B

12 pts.

9) Fear is a natural and healthy response that has evolved through natural selection.

a) Give one example of allosteric modulation and one for covalent modulation. You must use data to support the specific example you chose. *Answer Limit: 30 words for each type of modulation.*

allosteric: GTP binding to G protein to change shape and function (#1) – many alternative correct answers

covalent: kinase phosphorylating regulatory subunits in Figure 32 to activate gamma subunit

b) Which amino acids can be covalently modulated by a kinase? Support your answer with data.

Answer Limit: 25 words.

serine, threonine and tyrosine (#17) with OH available

c) Which two amino acids can function as substrates for the same kinase? Support your answer with data. *Answer Limit: 25 words.*

serine and threonine (#17) with similar side chains

14 pts.

10) This is the last question for the exam. Hopefully you are no longer tense and can relax.

a) Look at Figure 12 from the Gallery. What molecule is this? *Answer Limit: 15 words.*

G protein

b) Describe the different levels of protein structure shown in Figure 12. *Answer Limit: 40 words.*

primary = amino acids

secondary = beta strands and alpha helices

tertiary = folded 3D shape of each subunit

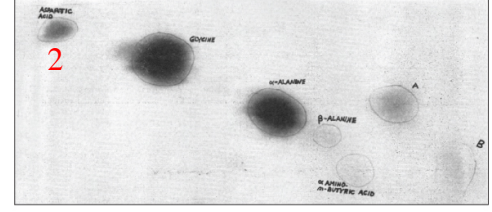
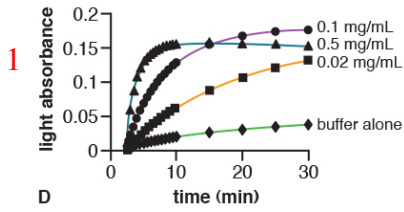
quaternary = 3 subunits interacting

c) Choose one figure to explain the four hallmarks of signal transduction. *Answer Limit: 25 words for each hallmark.*

#12 (many alternative correct answers)

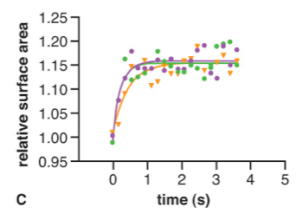
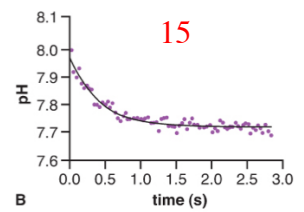
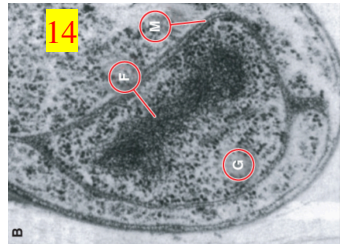
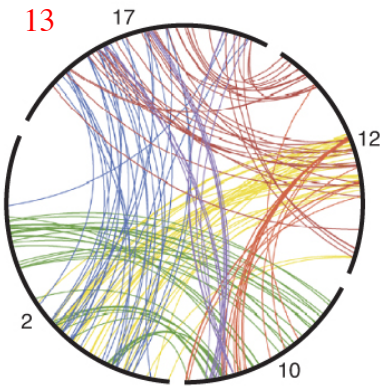
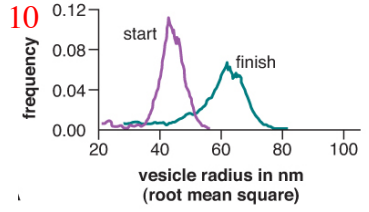
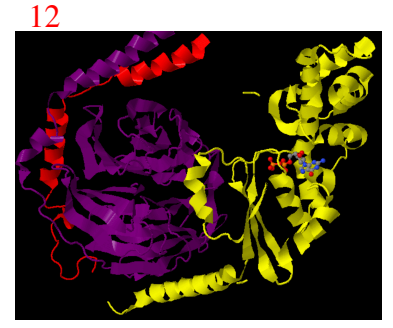
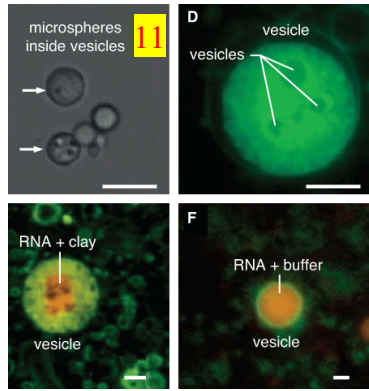
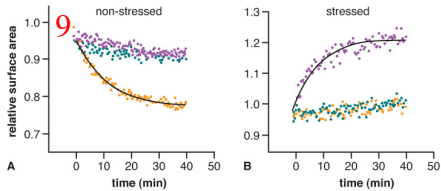
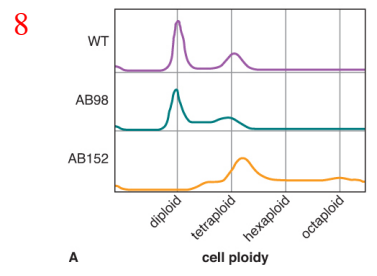
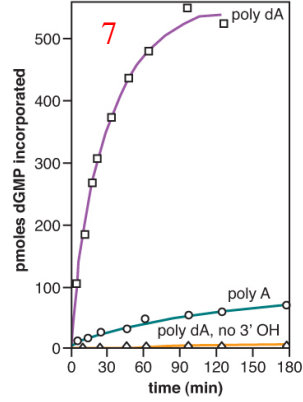
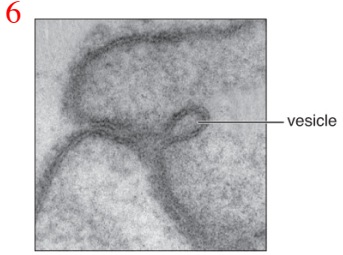
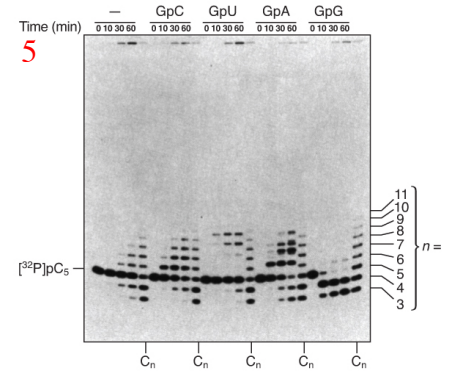
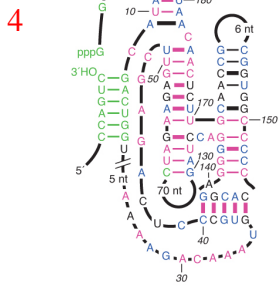
1. amplify (activated adenylyl cyclase makes many cAMPs)
2. specificity (G protein only activates adenylyl cyclase and no other enzyme in pathway)
3. change of shape, change of function (G protein has differences with GTP vs GDP)
4. reset process to turn off (GTP converts to GDP after time)

Data Gallery

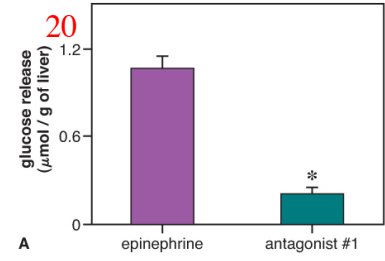
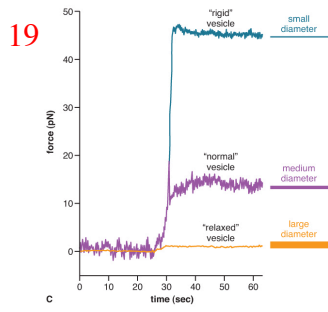
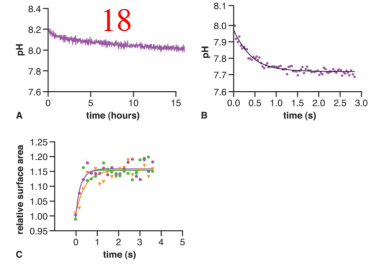
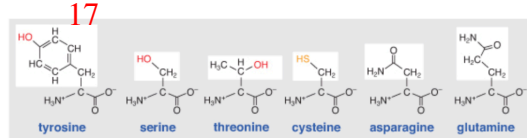
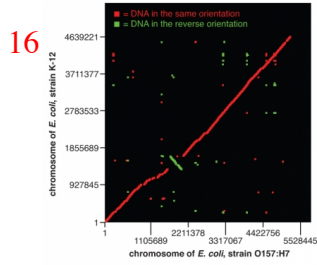


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ions (concentration in mM)	error rate
Mg ²⁺ (1.0)	1 in 41,000
Ni ²⁺ (1.0)	1 in 5,030
Ni ²⁺ (2.0)	1 in 1,850
Cd ²⁺ (0.1)	1 in 7,810
Cd ²⁺ (0.2)	1 in 5,070
Ca ²⁺ (0.6)	1 in 7,520
Ca ²⁺ (1.0)	1 in 5,500
Ca ²⁺ (2.5)	1 in 3,760



Dr. Campbell's Bio113 Exam #2 – Fall 2015



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human protein number	protein function	protein location	best match domain
NP_001009	translation	cytoplasm/ER	archaea
NP_003185.1	transcription factor	nucleus	archaea
NP_001001937	ATP synthase	mitochondria	bacteria
NP_005521	energy harvesting	mitochondria	bacteria
NP_000393	energy harvesting	cytoplasm	bacteria
NP_004138	cell signaling	cytoplasm	archaea
NP_061816	cytoskeleton	cytoplasm	bacteria

