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 **8:30 am on Monday Oct. 16**. 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:

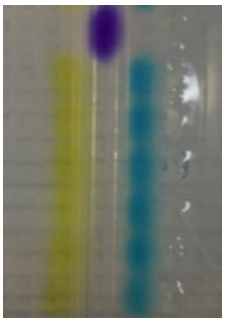
_____

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:

2 pts.



Y B T

1) This photo was taken in lab while your PCR products were being separated by gel electrophoresis. Rank the three dyes based on their molecular weights, starting with the largest dye. If you cannot see three colors, just use the 3 letters below the photo.

largest dye = T

middle dye = B

smallest dye = Y

Y = yellow; B = blue; T = teal

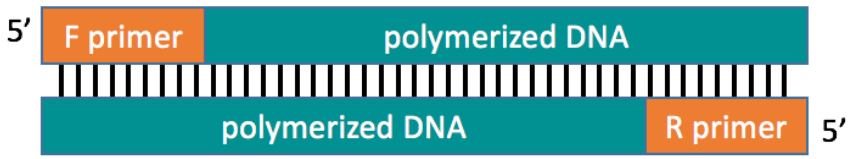
8 pts.

2) Some lab research questions…..

a) Why did you use PCR in your research projects? Maximum of 30 words.

To confirm DNA control element was cloned into plasmid.

b) Illustrate what one PCR product (amplicon) looks like at the molecular level if you could distinguish the 1) primers and 2) the DNA produced by the DNA polymerase. Use two different colors to distinguish the two types of DNA.



Lecture Questions:

18 pts.

3) First a few questions about evolution….

a) What are the four mechanisms of evolution and give a realistic example of each one. Maximum of 30 words for each mechanism.

1. natural selection (many examples possible)
2. mutation (many examples possible)
3. gene flow (many examples possible)
4. genetic drift (many examples possible)

b) In 1953, the equipment in Figure 3 led to a breakthrough in research about the origin of life (figure 2). Give two modern examples of more recent findings that not only supported the 1953 results, but provided even more compelling data. Maximum of 30 words for each example.

1. NASA experiments with UV light or similar compounds found on meteorites
2. modern analysis of Miller's stored samples

18 pts.

4) Discuss how the first abiotic vesicles could have been formed (1), so that they contained a genome (2), they contained an enzyme (3), had the potential to grow (4), could store energy (5), and had the ability to reproduce as a result of natural selection (6). Support your answer with an experimental for each numbered aspect listed above. Maximum of 40 words for each example.
1. 14 or 1
2. 15 or 1
3. 4 or 6
4. 22 or 12 or 9
5. 10
6. 24

24 pts.
5) Now for some applied evolutionary questions.
a) Why did we have to use primers for PCR? Support your answer with two data figures. Maximum of 30 words for each data figure.
1. #7 needed 3' OH end for DNA polymerase
2. #13 primers are incorporated into the grown DNA strand

b) Evolution doubters use the argument that complex organisms cannot evolve from simpler organisms through random DNA changes. Provide **four** data figures that contradict this erroneous belief and support each of your figure choices with a short explanation. Maximum of 35 words for each data figure.
1. 4 increased ribozyme function
2. 23 whole genome duplication
3. 16 inversions, indels, CNV
4. 28 archaea and bacterial genomes fused to make eukaryotes
5. 33 point mutations in somatic hypermutation
6. 19 or 27 organelle formation by engulfing bacteria
7. 5 ploidy changes

c) Study the data in Figure 33. Find one point mutation that produced approximately a ten fold increase in antibody affinity. Support your answer with data from figure 33. Maximum of 40 words
single base change in 4th codon increased affinity about 10 fold
changed amino acid from W to L

6 pts.
6) I don't know what I would do without my nuclei, do you?
a) Go to this web page
< http://www.bio.davidson.edu/people/macampbell/113/MUSCLE_search.html> and answer this question. What organism on this tree is most closely related to the Hemichordate worm Saccoglossus, and explain how you determined the answer. Maximum of 30 words

fruit fly, shortest horizontal distance and numerical difference

b) What is the argument used to claim that eukaryotes evolved equally from Archaea and Eubacteria? Support your answer with data. Maximum of 40 words
28 human orthologs found in different domains, depending on function

12 pts.
7) This is the penultimate question….
a) My brother is always trying to lose weight. He found out cellulose is made of glucose and now he won't eat green leafy vegetables. Explain to him in chemical terms why a potato should not be seen as equivalent to salad. Support your answer with data. Maximum of 40 words
specificity of enzyme shape and substrate glucose binding angle as shown for starch and the alpha 1-4 linkage (#30)
b) Distinguish between allosteric and covalent modulation and cite an example from the data gallery for each type of modulation. Maximum of 40 words
allosteric is weak bonds (many examples)
covalent is covalent bond with phosphate (many examples)
c) What do allosteric and covalent modulation have in common? Maximum of 40 words
change of shape, change of function
reversible

12 pts.
8) Now for your final epinephrine rush…
a) Discuss why kinases fall into two categories based on their substrates. Support your answer with data. Maximum of 30 words
#35 serine (S) and threonine (T) is one category, phenylalanine (F) is the other. Size/shape of side chain determines which amino acid will fit into active site
b) What experiment could you perform to determine which cells respond to epinephrine? Maximum of 40 words
label receptor with radioactive/fluorescent ligand, or antibody
examine all tissues
c) Sketch a G protein in the active and inactive stages, and label its parts.
Needed correct quaternary structure and GDP/GTP allosteric interaction

Data Gallery

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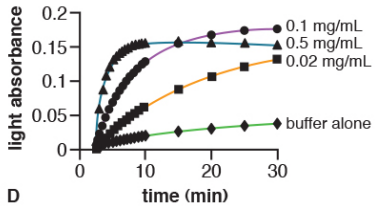

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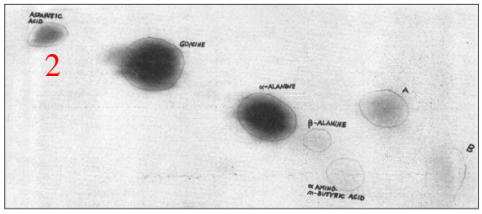

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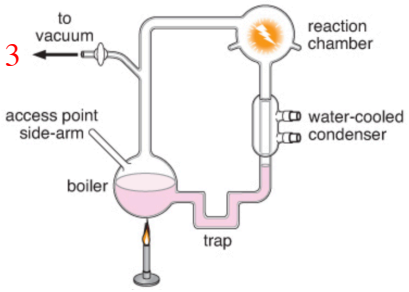

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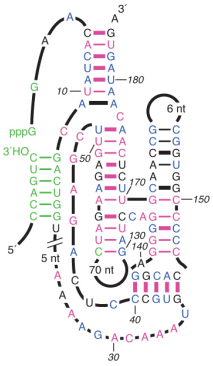

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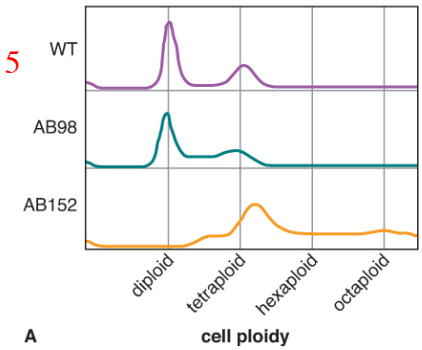

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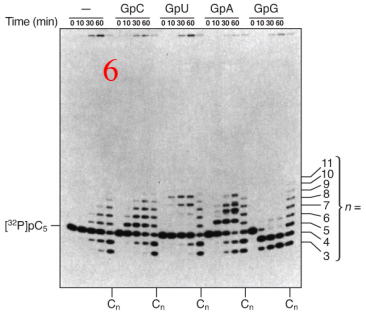

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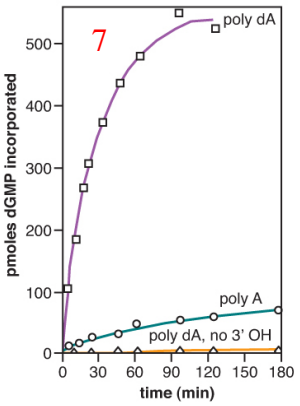

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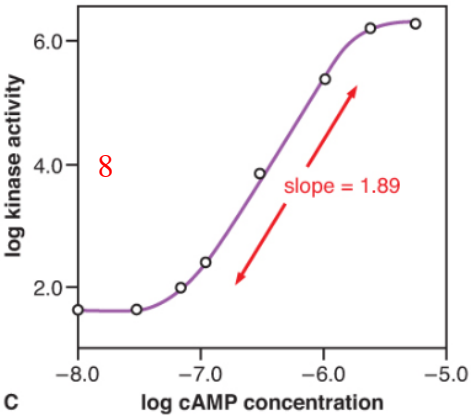

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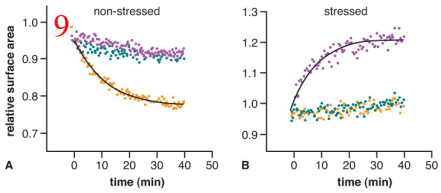

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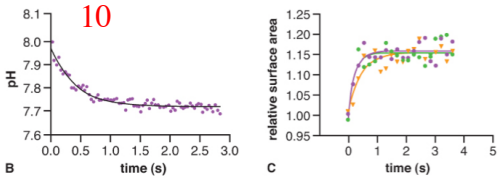

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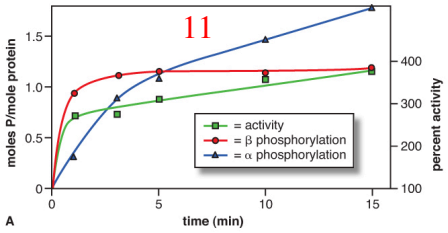

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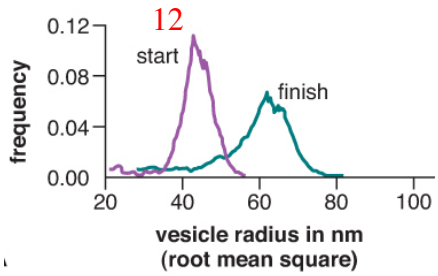

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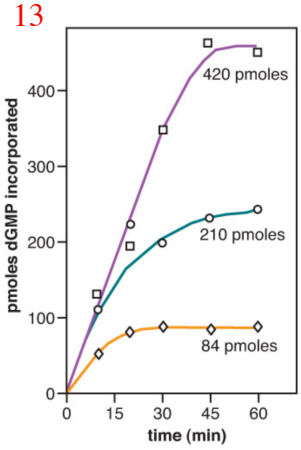

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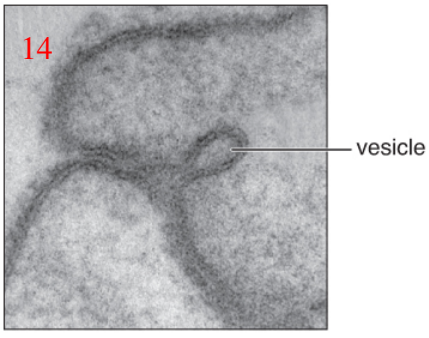

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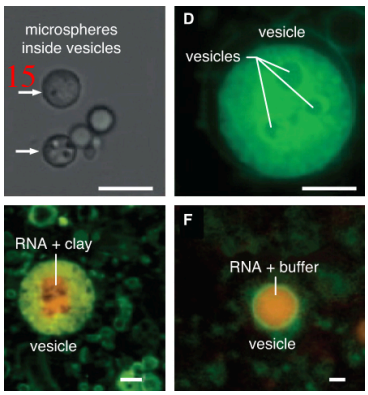

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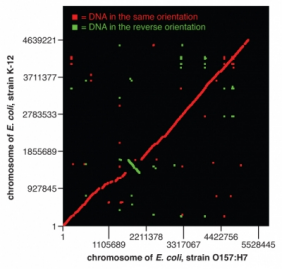

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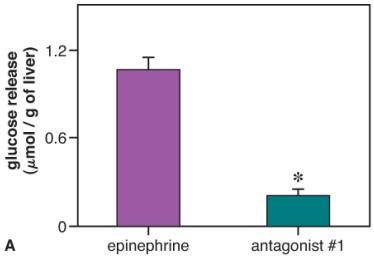

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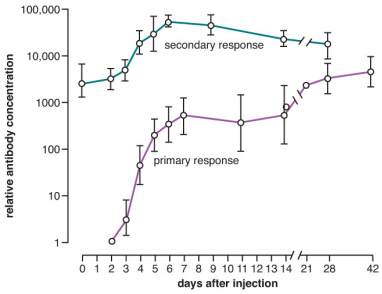

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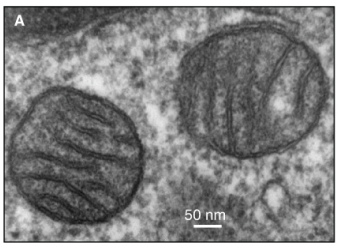

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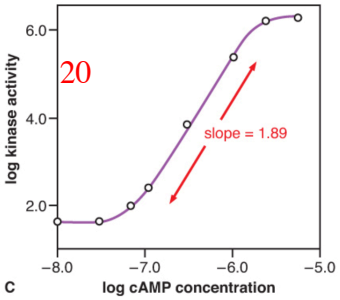
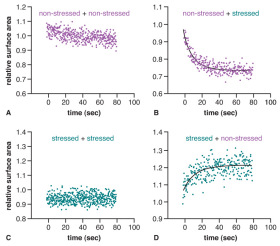


21

enzyme	liver	skeletal muscle
epinephrine receptor	✔	✔
G protein	✔	✔
adenylyl cyclase	✔	✔
protein kinase A	✔	✔
glycogen synthase	✔	✔
phosphorylase kinase	✔	✔
glycogen synthase	✔	✔

22



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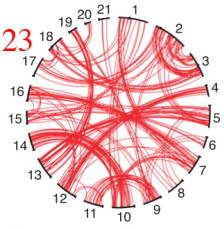

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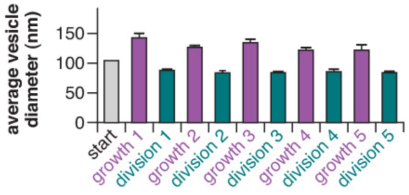

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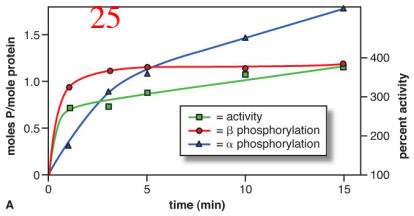

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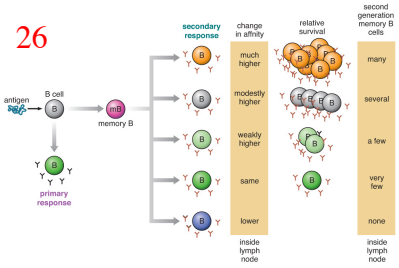

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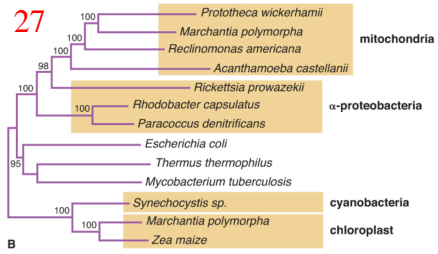

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human protein number	protein function	protein location	best match domain
NP_001009	translation	cytoplasm/rER	archaea
NP_003185.1	transcription factor	nucleus	archaea
NP_001001937	ATP synthase	mitochondria	bacteria
NP_005521	energy harvesting	mitochondria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

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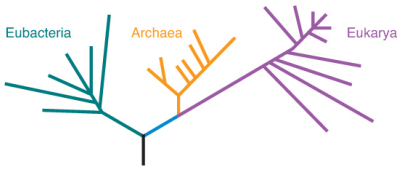

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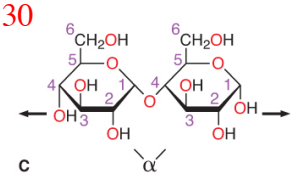

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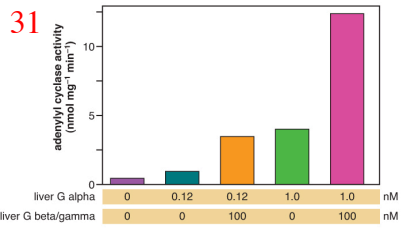

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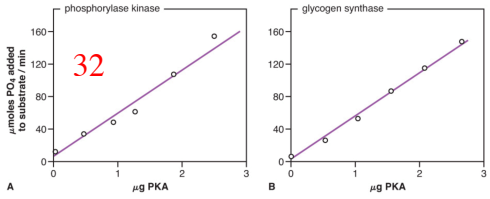

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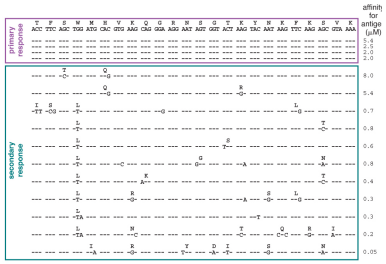

34

phosphorylase kinase P
. . . KRSGSVYEPL . . .

glycogen synthase P
. . . PRRASCTSSS . . .

35