# 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 **2:20 pm on Monday October 12**. 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.**
Email all your work (including Excel file) 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.

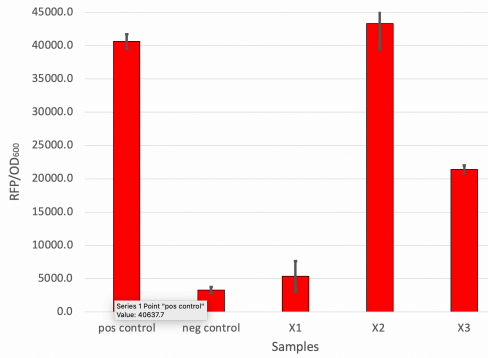
How long did this exam take you to complete?

Lab Questions:

**14 pts.**

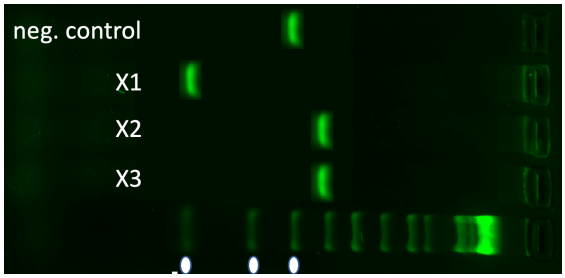
1) 2 pts each answer and graph

a) Because of the bad weather, I decided to do some research instead of yardwork. The attached Excel file contains the data I generated from a positive control, a negative control and 3 clones that I hoped would contain an experimental promoter in pClone Red. The values in the Excel file are RFP/$OD_{600}$ with LB values already subtracted. Interpret the data for all 3 promoters **based solely on the graph you generate within Excel**. You will need to submit your Excel file as part of your answer. **Word limit = 45 maximum for each promoter**




promoter X1: same as negative control (error bars)
promoter X2: same as positive control (error bars)
promoter X3: intermediate (error bars)

b) After seeing the fluorescence data, I decided to run PCR on all 3 experimental clones. **Integrate the PCR results with the graph above** to summarize your conclusions for all 3 promoters. 2 pts each answer **Word limit = 45 maximum for each promoter**




promoter X1: no promoter, explains no RFP
promoter X2: new promoter, better than X3 (mutation?)
promoter X3: new promoter, intermediate (mutation?)

Class Questions:

**26 pts.** 2 pts each answer

2) You know the definition of evolution, the 4 mechanisms of evolution, and the 5 tenets of natural selection. I want you to integrate all of these into one question. Here is a list items, all but one are figures from the data gallery. Explain how each item contributes to a plausible explanation for the origin of life and evolution of eukaryotes. Each explanation should construct a holistic paragraph that gradually builds a cohesive summary. The summation of your answers will be an explanation for life on Earth. **Word limit = 35 maximum for each item**

a. Fig 2: abiotic formation of biological molecules
b. Fig 1: lipids form vesicles with negatively charged clay
c. Fig 29: self-assemble into membranes and vesicles
d. Fig 6: vesicle formation around cargo (RNA)
e. Fig 15: stressed vesicles with RNA steal lipids from non-stressed
f. Fig 22: ribozyme as RNA polymerase

g. Fig 12: vesicles grow and divide
h. Math argument: spill contents when divide
i. Fig 20: vesicles grow when fed
j. Fig 3: store energy when grow
k. Fig 31: origin of eukaryotes from bacteria and archaea
l. Fig 28: origin of chloroplast and mitochondria
m. Fig 13: organelles exhibit remnants of origins

**18 pts.**

3) Life is always adapting to change, including emergence of new pathogens.

a) Explain how figure 17 from the gallery could lead to beneficial or detrimental variation in a population of B cells. **Word limit = 35 maximum** **6 pts**

DNA mutations can produce higher, lower or equal affinities (-1 for affinity; -0.5 for older)

b) Connect your answer above to 2 mechanisms of evolution that are seen in allergic responses. **Word limit = 35 maximum** **6 pts**

mutation = new alleles in population
natural selection of B cells with high affinity B cells

c) Explain to a high school student why their allergic response gets stronger with each exposure. Support your answer with 3 figures. **Word limit = 35 maximum for each figure** **6 pts**

Fig 19: faster secondary response
Fig 14: more antibodies
Fig 33: higher affinity antibodies

**24 pts.**

4) Unfortunately, America perpetuates systemic racism in many aspects of daily life.

a) Explain to an older relative that systemic racism in America has real biological consequences but racial categories cannot be defined biologically. Choose 2 figures to show biological consequences and 2 figures to show biological similarities among races. **Word limit = 35 maximum for each figure** **3 pts each**

consequence 1: #24 – multiple health disparities by race
consequence 2: #26 – race-based medicine is not good science/medicine or #10 and birthweights
similarity 1: #27, 11, 9 – shared ancestry, 99.9% identical DNA
similarity 2: #32 – promoter SNP, not race, for effective drug dosage

b) Race-based medicine is widespread and recalcitrant in America. Use 3 figures to explain to a younger relative why race-based medicine is a mistake based on historic bias and incomplete information. **Word limit = 45 maximum for each figure** **4 pts each**

Fig 1: #26 correlation based on allele frequencies
Fig 2: #8 biochemical origin for different effective doses
Fig3: #32 promoter SNP determines effective dose, not race

**18 pts.**

5) In proteins, structure determines function. Please answer these questions based on what we have learned so far in Bio113.

a) What makes an amino acid hydrophilic or hydrophobic? To answer this question correctly, you must describe the chemical basis for this physical property of amino acids. **Word limit = 35 maximum 4 pts**

hydrophilic have polar bonds in side chains; NOPS atoms present

hydrophobic have non-polar bonds in side chains; C-C an C-H bonds dominate

b) Does warfarin affect blood clot formation by allosteric or covalent modulation? Explain how you reached your conclusion. **Word limit = 30 maximum 2 pts**

allosteric, no covalent bond formed

c) Use figure 18 to define signal transduction. **Word limit = 40 maximum 3 pts**

external hydrophilic signal (epinephrine) generates amplified intracellular response (glucose release)

d) Use steps within figure 4 to supports these hallmarks of signal transduction. Explain why you chose each step. **Word limit = 35 maximum for each selected step 3 pts each**

multiple correct answers

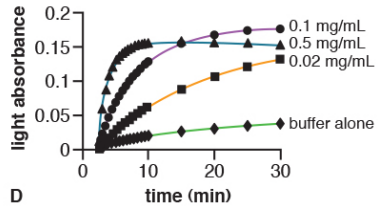
amplification step:

specificity of shape step:

reset one particular step:

# Data Gallery

1

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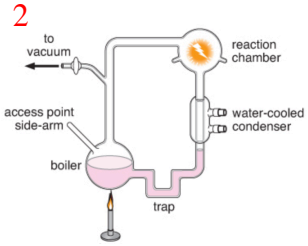


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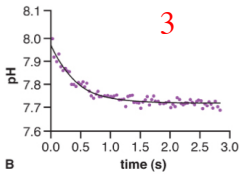


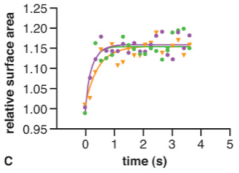


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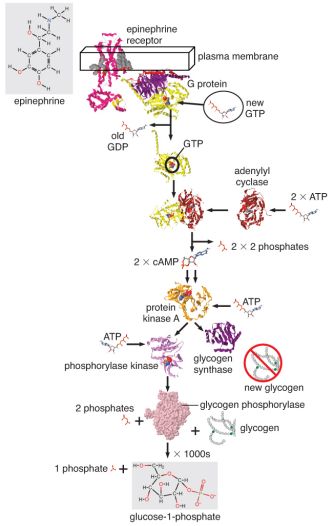


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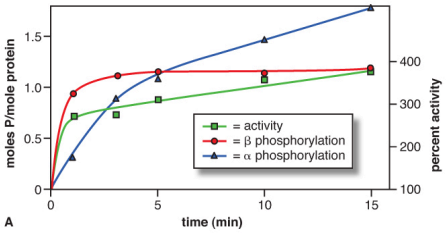


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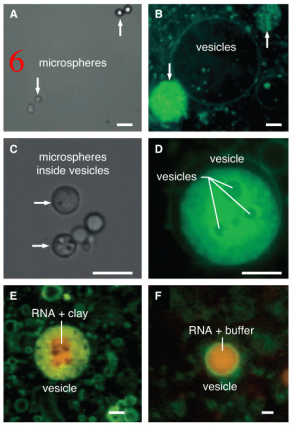


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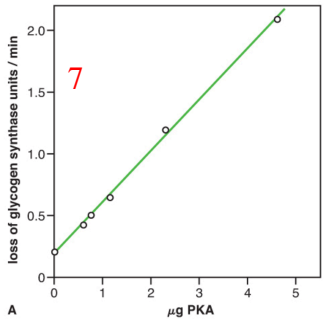


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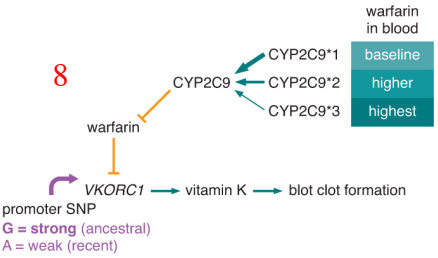
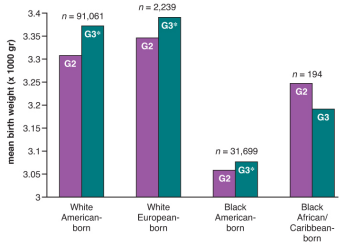



9

| gene name | human variant | age of human variant |
|---|---|---|
| *MFSD12* | darker skin color | ~996,000 years |
| *OCA2#* | lighter skin color | ~629,000 years |
| *DDB1* | lighter skin color | ~250,000 years |
| *HERC2* | lighter skin color | ~247,000 years |
| *SLC24A5* | lighter skin color | ~30,000 years* |

*introduced to East Africa ~5,000 years ago
# null allele causes albinism

10

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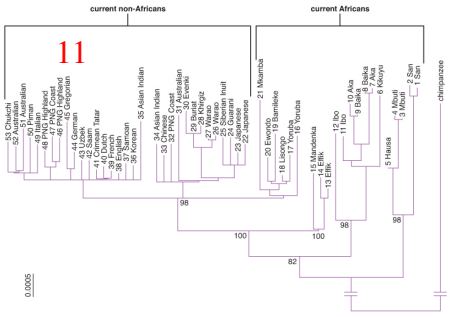


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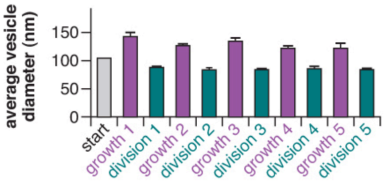


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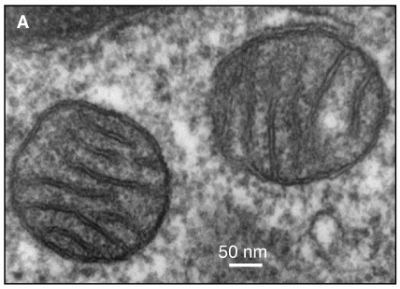


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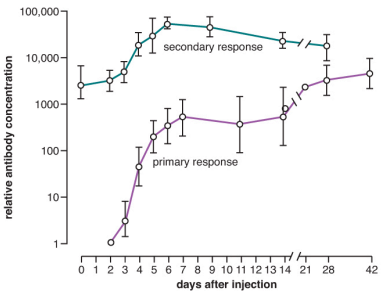


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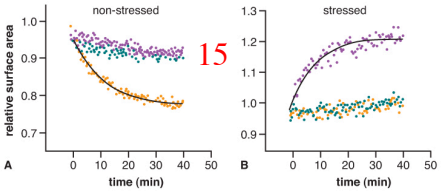

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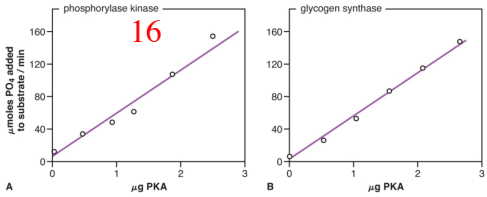
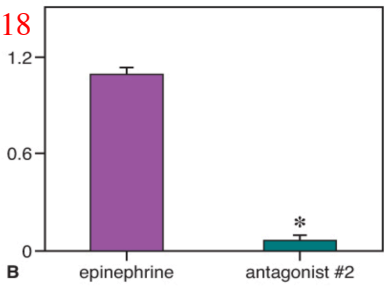



17

| DNA polymerase | ion | bases polymerized | error rate |
|---|---|---|---|
| young | $Mg^{2+}$ | 17,300 | 1 in 1821 bases |
| old | $Mg^{2+}$ | 5,400 | 1 in 474 bases |
| young | $Mn^{2+}$ | 26,800 | 1 in 1848 bases |
| old | $Mn^{2+}$ | 18,800 | 1 in 556 bases |

18

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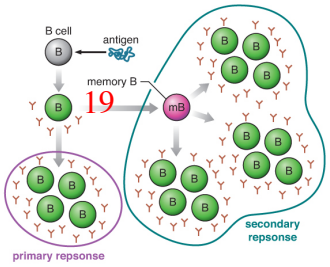


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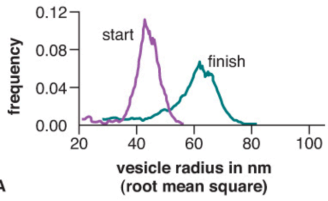
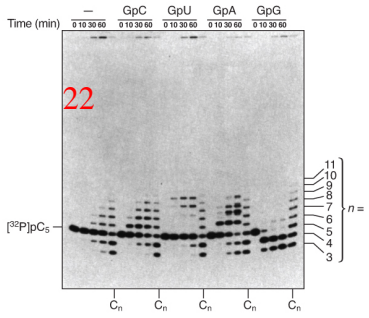



21

| CSHL HapMap populations | % homozygous A | % heterozygous | % homozygous G |
|---|---|---|---|
| **CEU** = Utah, Northern & Western European ancestry | 98.2 | 1.8 | 0.0 |
| **HCB** = Han Chinese in Bejing | 2.4 | 14.3 | 83.3 |
| **JPT** = Japanese in Tokyo | 0.0 | 8.2 | 91.8 |
| **YRI** = Yoruba in Ibadan, Nigeria | 0.0 | 2.7 | 97.3 |
| **ASW** = African ancerstry, Southwest USA | 0.0 | 32.7 | 67.3 |
| **CHB** = Han Chinese in Bejing | 2.4 | 19.5 | 78.1 |
| **CHD** = Chinese in Metropolitan Denver | 0.0 | 22.4 | 77.6 |
| **GIH** = Gujarati Indians in Houston | 89.7 | 10.3 | 0.0 |
| **LWK** = Luhya in Webuye, Kenya | 1.1 | 8.9 | 90.0 |
| **MEX** = Mexican ancerstry in Los Angeles | 46.0 | 46.0 | 8.0 |
| **MKK** = Maasai in Kinyawa, Kenya | 9.8 | 46.9 | 43.3 |

22

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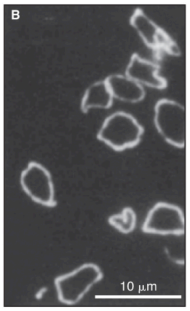
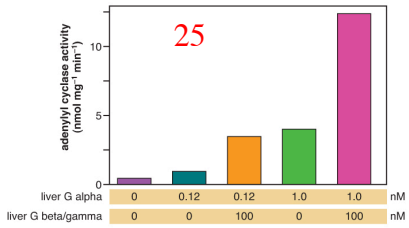



24

| | White Americans | Black Americans |
|---|---|---|
| age-adjusted death rate (2015)[1] | 753.2/100,000 | 876.1/100,000 |
| prevalence of coronary heart disease (2010)[2] | 5.8% (± 0.1%) | 6.5% (± 0.4%) |
| age-adjusted cancer deaths (2010-14)[3] | 166.2/100,000 | 194.2/100,000 |
| infant mortality (2011-13)[4] | 5.1/1,000 | 11.3/1,000 |
| pregnancy-related maternal deaths (2011-13)[5] | 12.7/100,000 | 43.5/100,000 |
| diagnosed diabetes (2015)[6] | 7.4% | 12.7% |
| obesity (≥ 20 yrs, 2011-12)[7] | 32.6% (± 4%) | 47.8% (± 3.5%) |
| unemployment (≥ 20 years, 1st Q, 2018)[8] | 3.6% | 6.6% |

25

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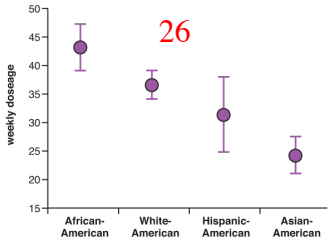
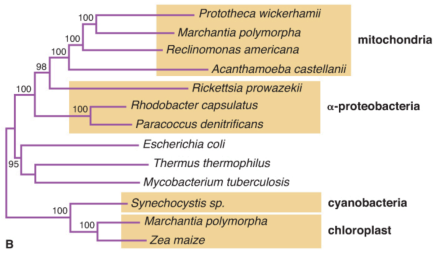



27

| human genome | |
|---|---|
| 3,200,000,000 genome total | total, rounded |
| 3,196,800,000 identical DNA | 99.9% |
| 3,200,000 DNA differences | 0.1% |
| 2,720,000 differences within populations | 85% of 0.1% |
| 480,000 differences between populations | 15% of 0.1% |

| chimp genome | |
|---|---|
| 2,700,000,000 genome total | total, rounded |
| 2,667,600,000 identical DNA | 98.8% |
| 3,240,000 DNA differences | 1.2% |

28

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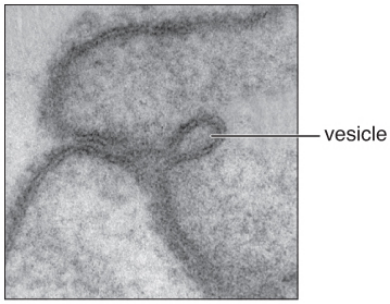


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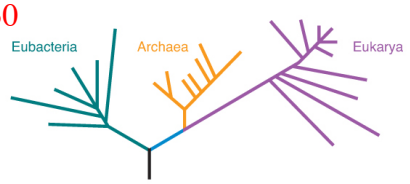


31

| 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 |

32

| Effective Weekly Doses | | | | |
|---|---|---|---|---|
| **SNP genotypes** | **Blacks** | **Whites** | **Hispanics** | **Asians** |
| GG | 39.9 mg | 42.7 mg | 43.1 mg | 42.7 mg |
| GA | 31.5 mg | 31.5 mg | 32.0 mg | 31.7 mg |
| AA | 21.7 mg | 21.0 mg | 20.8 mg | 19.6 mg |

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