Biology 113 Closed Book Take-Home Exam #2 – Chapters 4 - 6

You can start anytime you want, but you must finish working on your exam 72 hours after I emailed it to you. There are 5 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 the final deadline on March 4. The **answers to the questions must be typed or inserted in this Word file**. If you do not write your answers in the appropriate location, I may not find them. **Email your file, not a link to your file, to submit your exam within the 72 hour window.**

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.

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:

15 pts.

1)

a) Run this promoter through the oligator:

ATGGCCTTGCTTACAAAACCGACATCAAACT**GGTCTC**CACCTCCCACAACGAAGACTACACCATCGTTGAACAGTACGAACGTGCT GAAGGTCGTCACTCCACCGGTGCTTAATAA (https://gcat.davidson.edu/iGem10/index.html). Paste the DNA sequences and oligo names you would submit to the company so you could clone this promoter using GGA like we did in lab: *(paste on the next line)*

Top1- 5'
CGACATGGCCTTGCTTACAAAACCGACATCAAACT**GGTCTC**CACCTCCCACAACGAAGACTACACCATCGTTGAACA
GTACGAACGTGCTGAAGGTCGTCACTCCACCGGTGCTTAATAA
Bot1- 5'
CCGCTTATTAAGCACCGGTGGAGTGACGACCTTCAGCACGTTCGTACTGTTCAACGATGGTGTAGTCTTCGTTGTGG
GAGGTGGAGACCAGTTTGATGTCGGTTTTGTAAGCAAGGCCAT

b) Describe the first thing you would have to do in order to clone this promoter using GGA. (30 words maximum)

Mutate the BsaI site in bold above.

Class Questions:

20 pts.

2) Evolution in a change in allele frequency in a population over time.

a) Name each mechanism of evolution and provide a real-world example of each. (25 words maximum for each mechanism)

1. Mutation – B cells
2. Gene flow – releasing a pet snake into the wild
3. Genetic drift – loss of an allele through random mating of rare species
4. Natural selection – coral becoming heat resistant

b) List the tenets of natural selection and provide one example for each tenet as part of a cohesive example of natural selection. (20 words maximum for each tenet)

A. Over production (B cells)
B. Limited resources
C. Competition
D. Selective advantage
E. Reproduction

c) What was the first discovered RNA enzyme's primary significance for origin of life research? Support your answer with data. (30 words maximum)

RNA polymerase #23

d) Use figures 4 and 10 to build a plausible scenario for the origin of the first primitive cell. (40 words maximum)

- RNA trapped in vesicle

- Osmotic pressure leads to growth
- Vesicle divides, spills RNA content
- Spilled content catalyzes new vesicle formation

20 pts.

3) New DNA can vary from its template sequence.

a) Describe three important properties of primers used by DNA polymerase. Support your answer with data from one figure. (20 words maximum for each property)

1. 3' OH
2. Consumed in reaction
3. DNA/RNA best

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b) Antibody genes accumulate mutations during an immune response. Explain how mutations can be beneficial, detrimental or neutral. Support your answer with data. (40 words maximum)
mutations can encode new amino acid that improves are reduces binding affinity. Silent mutations can leave amino acid unchanged. #16

c) How is an allergic response an example of evolution? Support your answer with data. (40 words maximum)
natural selection with survival signal and mutation change allele frequency in a population of B cells over time. #16

20 pts.

4) Small cells provided big evolutionary insights.

a) How is the expression "ring of life" connected to the origin of eukaryotic nuclei? (support your answer with data) (30 words maximum)
#25: eukaryotes have nuclei and our cells are the product of a fusion of bacterial and archaeal cells.

b) Generate a numbered list of 3 major characteristics shared by mitochondria, chloroplasts and nuclei. (support your answer with two figures) (20 words maximum for each characteristic)

1. Double outer membrane
2. Genomes
3. Replication / central dogma

25 pts.

5) Humans are products of evolution just like any other organism.

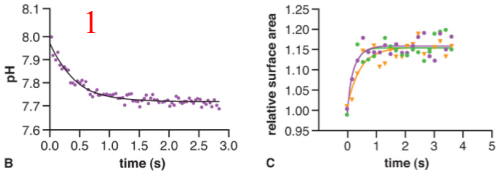
a) Did humans evolve once, or multiple separate times? Use data to answer this question. (30 words maximum)
once #5, MRCA branch point

b) Describe an example of how race incorrectly influences a medical treatment or outcome. (support your answer with data) (30 words maximum)
#14, warfarin not connected to race

c) Give one example of a common, non-medical misconception about biological differences between races that can be refuted with data. (support your answer with two figures) (40 words maximum)
misconception: all Africans have dark skin #15 & 28

Data Gallery

1



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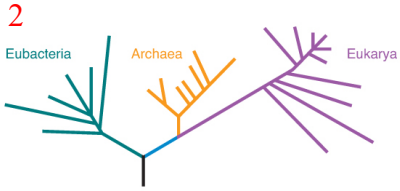

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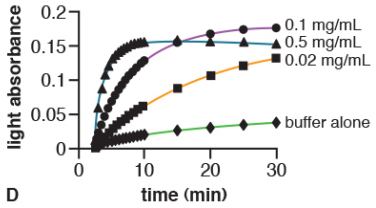

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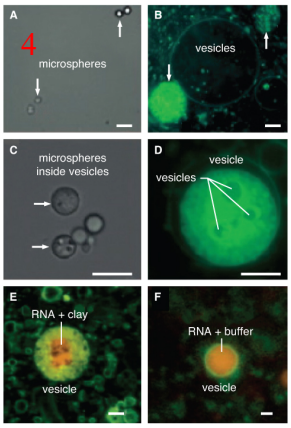

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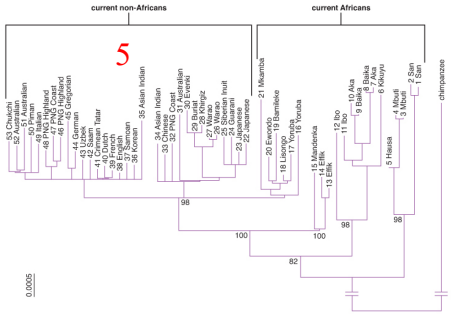

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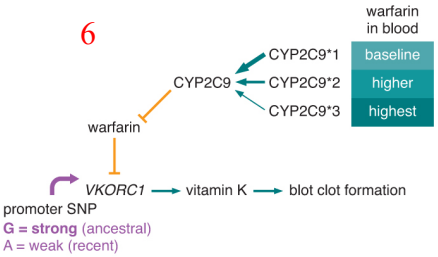

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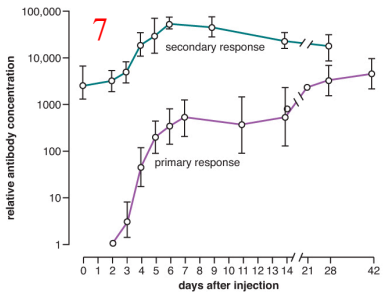

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gene name	human variant	age of human variant
MFSD12	darker skin color	~996,000 years
OCA2#	lighter skin color	~629,000 years
DDB1	lighter skin color	~250,000 years
HERC2	lighter skin color	~247,000 years
SLC24A5	lighter skin color	~30,000 years*

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

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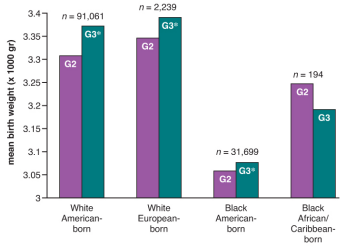

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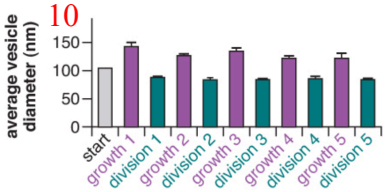

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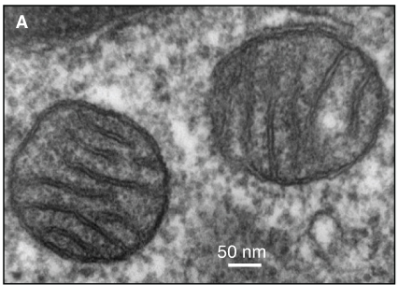

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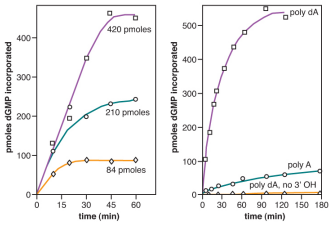

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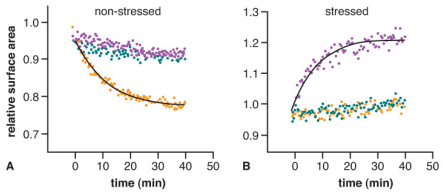

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Effective Weekly Doses				
SNP genotypes	Blacks	Whites	Hispanics	Asians
GG	39.9 mg	42.7 mg	43.1 mg	42.7 mg
GA	31.5 mg	31.5 mg	32.0 mg	31.7 mg
AA	21.7 mg	21.0 mg	20.8 mg	19.6 mg

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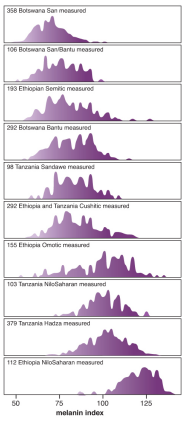

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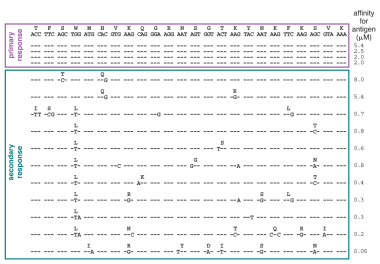

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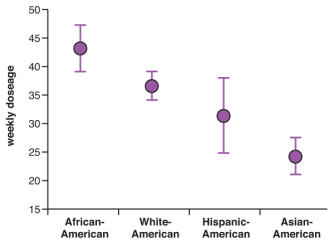

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human genome	
3,200,000,000 genome total	total, rounded
3,196,800,000 identical DNA	99.9%
3,200,000 DNA differences	0.1%
2,720,000 differences within populations	85% of 0.1%
480,000 differences between populations	15% of 0.1%

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%

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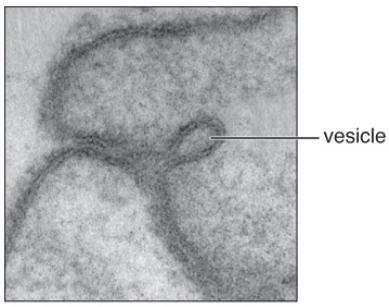

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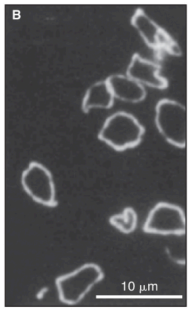

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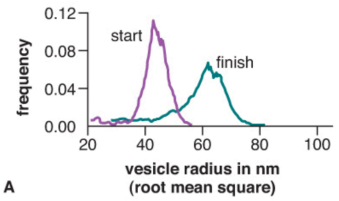
	White Americans	Black Americans
age-adjusted death rate (2015)[1]	753.2/100,000	876.1/100,000
prevalence of coronary heart disease (2010)[2]	5.8% (± 0.1%)	6.5% (± 0.4%)
age-adjusted cancer deaths (2010-14)[3]	166.2/100,000	194.2/100,000
infant mortality (2011-13)[4]	5.1/1,000	11.3/1,000
pregnancy-related 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%

22



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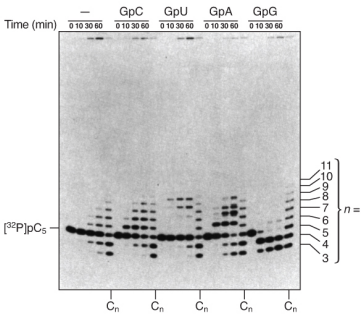

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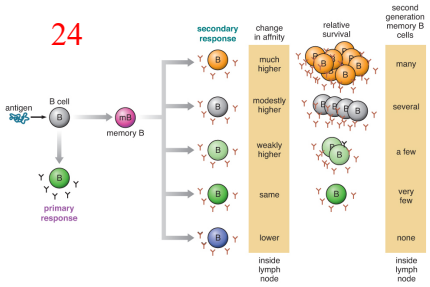

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human protein number	protein function	protein location	best match domain
NP_001009	translation	cytoplasm/rER	archaea
NP_003185.1	transcription factor	nucleus	archaea
NP_001001937	ATP synthase	mitochondria	bacteria
NP_005521	energy harvesting	mitochondria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

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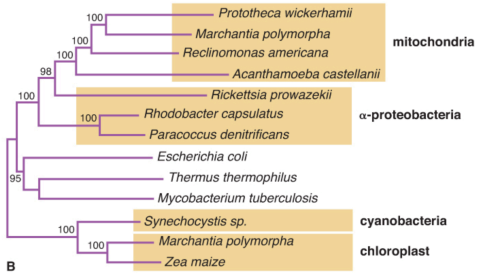

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DNA polymerase	ion	bases polymerized	error rate
young	Mg^{2+}	17,300	1 in 1821 bases
old	Mg^{2+}	5,400	1 in 474 bases
young	Mn^{2+}	26,800	1 in 1848 bases
old	Mn^{2+}	18,800	1 in 556 bases

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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 ancestry, Southwest USA	0.0	32.7	67.3
CHB = Han Chinese in Bejing	2.4	19.5	78.1
CHD = Chinese in Metroplolitan 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 ancestry in Los Angeles	46.0	46.0	8.0
MKK = Maasai in Kinyawa, Kenya	9.8	46.9	43.3