Biology 113 Closed Book Take-Home Exam #1 – Information

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 this test, 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 1**0:30 am on Monday Sept. 21**. 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. 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 word 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):

Answer Key
average = 74.8% after adding 7 pts to all exams

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 blended with lecture Questions:

2 pts.

1) Why do you need to order 2 oligos instead of 1 to build your promoter? *Answer Limit: 30 words.*

Oligos single-stranded, functional DNA is double-stranded, as is pasmid

4 pts.

2) While you were not looking, some jokester took your boiled and cooled oligos and changed the concentration to 3.5 μM. List the steps you would take to prepare your oligos for GGA if the target concentration is to be 70 nM. *Answer Limit: 20 words per number in your list.*

1. 1 μL cooled oligos
2. add 49 μL water

4 pts.

3) The Word file called "genE.pdf" is a fictitious gene and its DNA contains important information. Using only the information provided in genE.pdf:

a) draw a box around the promoter

b) underline the portion that would be turned into mRNA

c) draw a circle around the start codon

d) draw a big arrow showing which way the RNA polymerase will move

Be precise with your drawing as I will take everything exactly as I see it. Print genE.pdf, write on the hard copy, and staple your answer to the back of this exam.

see answer key at back

Lecture Questions:

20 pts.

4) The *lac* operon was chosen as a model system for determining how transcription is regulated. Answer each of these questions and support each of your answers with data – be *very* specific when selecting your data. *Answer Limit: 45 words for each answer.*

a) What is the function of the DNA called *lacI*? Support your answer with specific data.

Figure 11b inhibits transcription at lacO+

Figure 11d inhibition halted when lactose present

b) How did the investigators determine whether the inhibitor of the lac operon was DNA or protein? Support your answer with specific data.

Figure 11e, dominant allele $lacI^D$ repressed distant operator/promoter $lacO^+$

c) What is the function of the DNA called *lacO*? Support your answer with specific data.

promoter; Figure 11f no mRNA, Figure 11g DNA is functional molecule

d) Predict the outcome (in percent) of this diploid *E. coli* in the presence and absence of lactose. Explain the logic behind your answer.
$lacI^{D}$ $lacO^{-}$ $lac\beta^{+}$ $lacP^{+}$ / $lacI^{-}$ $lacO^{+}$ $lac\beta^{+}$ $lacP^{+}$
1% with our without lactose.
left dominant allele will suppress right promoter as in Figure 11d. Left promoter is non-functional and won't produce any.

14 pts.
5) Mendel was a simple man who used math to determine the inheritance pattern in eukaryotes. Answer these questions about the monk and his peas.
a) How did Mendel know that a random process was involved in sexual reproduction? Support your answer with specific data. *Answer Limit: 30 words.*
Figure 9, variation for individual plants but collective averages were consistent, especially with big numbers

b) Of all the random components of matings, what three components did Mendel deduce from his data? List them and then define each one. *Answer Limit: 40 words for each number.*

1. law of independent assortment
2. law of segregation
3. unpredictable which gametes will meet

c) Describe the two experimental procedures that Mendel used to reduce the randomness of mating outcomes that had confounded his peers. *Answer Limit: 30 words.*
3 choices: big numbers, true breeding, enclosed reproductive parts/self fertilization

13 pts.
6) Diversity is the spice of life. I just felt like typing a common saying that is based on biology.
a) List **all** the mechanisms that generate diversity in offspring when two unrelated individuals reproduce. *Answer Limit: 40 words for each item.*

1. law of independent assortment
2. law of segregation
3. unpredictable which gametes will meet
4. recombination
5. mutation
6. epigenetics

b) List **five** aspects of meiosis and mitosis that are very similar. *Answer Limit: 40 words for each aspect.*

1. many acceptable answers, but not cytokinesis unless you said it FOLLOWS meiosis and mitosis.

c) Look at Figure 25 in the data gallery. Shade in the region that contains cells growing at the fastest rate. Explain how this conclusion was reached. *Answer Limit: 30 words for explanation.* The Excel simulation showed that only with faster growth rates of biggest cells could you get the skewed distribution as shown. See figure 25 in gallery.

15 pts.

7) Currently, there is a common misconception that the best way to determine the outcome when a couple has children is to do DNA testing. In the cases below, you do not need to sequence any DNA to determine the probability of each pregnancy.

a) What is the probability of a couple having a girl with cystic fibrosis if the father is a carrier and the mother is heterozygous? Show your work for the chance of partial credit.

½ * ¼ = 1/8

girl * CF (not sex linked)

b) For the same couple in part a above, what is the probability of this couple having a boy who is a carrier for cystic fibrosis given that the parents already had a girl with cystic fibrosis? Show your work for the chance of partial credit.

½ * ½ = 1/4

boy * carrier

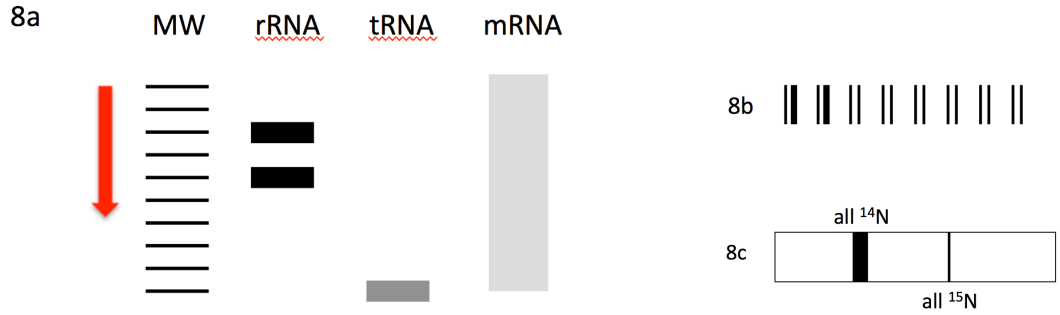
c) Blood types are determined by a single gene with three possible alleles: A, B or O. A and B are both dominant to O, but A and B are co-dominant to each other meaning neither one is recessive. Therefore, a person can be blood type AB. This gene is located on chromosome #9. The mother is blood type A and the father is blood type B. Their first child is blood type O. What is the probability that for their next pregnancy they have a girl who is blood type B or a boy who is blood type A? Show your work for the chance of partial credit.

1/8 + 1/8 = ¼

16 pts.

8) All four parts of question #8 require you to draw your answers. Use a separate piece of paper and attach your answers to the back of this exam.

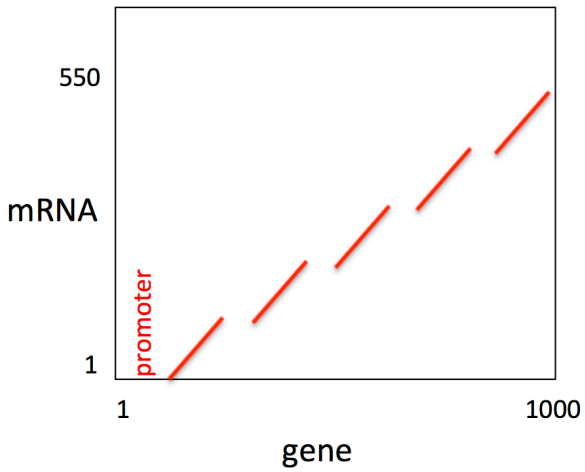
a) Redraw an experimental outcome in separate lanes of one gel showing each type of RNA made by cells. Neatly label each lane in your gel. Include molecular weight markers and show the direction of RNA movement with an arrow pointing the way the RNA moved. (Don't worry about how you are able to get pure samples of each type of RNA.) Label your drawing 8a.



b) Messelson and Stahl performed the most beautiful experiment in biology when they worked with heavy and light nitrogen to determine how DNA is replicated. If you started with one double-stranded piece of DNA at time zero, draw every DNA molecule that would be produced after 3 rounds of replication. Use thick lines to represent DNA containing heavy N and thin lines to represent DNA containing light DNA. Label your drawing 8b.

c) Also draw the banding pattern (after 3 rounds of replication) Messelson and Stahl would have seen if DNA **replicated by the conservative method rather than semi-conservative**. Be sure to label your drawings with neatly printed text so I can read it easily. Label your drawing 8c.

d) Draw a dot plot comparing a gene to its mRNA with the gene on the X-axis. This gene is 1000 base pairs (bp) long, the promoter is 100 bp long, the gene contains 4 introns that are each 50 bp, the 5' untranslated region is 50 bp and the 3' untranslated region is 100 bp long, the entire mRNA is 550 bp, and the protein contains a signal sequence. I recommend you use a ruler so you can draw to scale. Label your drawing 8d.



12 pts.

9)

a) Why are epigenetic changes not considered to be mutations? *Answer Limit: 40 words.*
epigenetic changes don't alter DNA sequence and a mutation is a change in DNA sequence

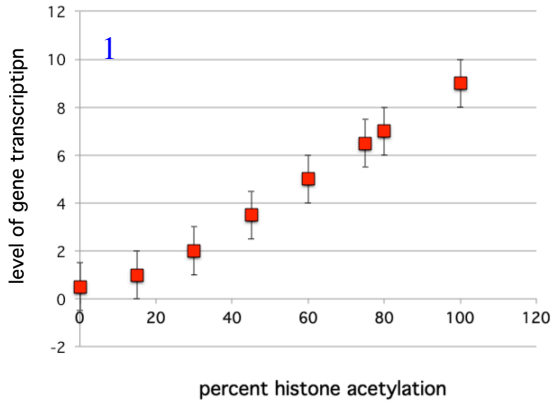
b) Have epigenetic changes been shown to alter gene function? Support your answer with data. *Answer Limit: 30 words.*
Yes, Figure 24 showed that when methylation was blocked by injecting drug into monkeys, the fetal hemoglobin gene was activated.

c) Figure 1 in the data gallery are hypothetical. Acetylation of histones is another form of epigenetic changes and one that was briefly mentioned in the seminar last Friday. Interpret Figure 1 and tell me the effects of histone acetylation on this one particular gene. *Answer Limit:*

40 words for explanation.
Acetylation of histones leads to gene activation in these data.

Data Gallery

1

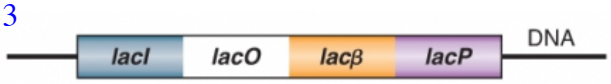


2

sample #	% nitrogen, N	% phosphorus, P	N/P ratio
37	14.21	8.57	1.66
38B	15.93	9.09	1.75
42	15.36	9.04	1.69
44	13.40	8.45	1.58
pure DNA	**15.32**	**9.05**	**1.69**

*from Avery, *et al.*, 1944. Table I.

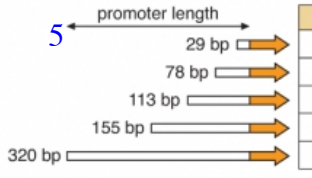
3



4

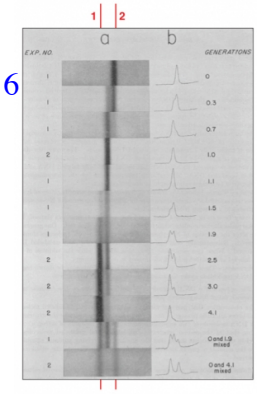
sample source	extracellular	intracellular
^{35}S-Protein Figure 1.8	~80%	~20%
^{32}P-DNA Figure 1.8	~30%	~70%
^{35}S-Protein refined experiment	~99%	~1%
^{32}P-DNA refined experiment	~30%	~70%

5



doubling time	drug resistant
no growth	none
5 hours	none
5 hours	none
3 hours	yes
3 hours	yes

6



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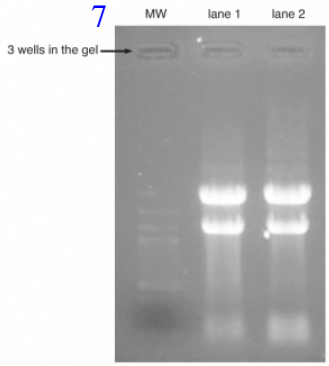

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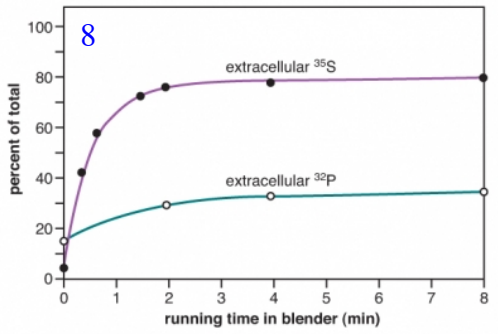
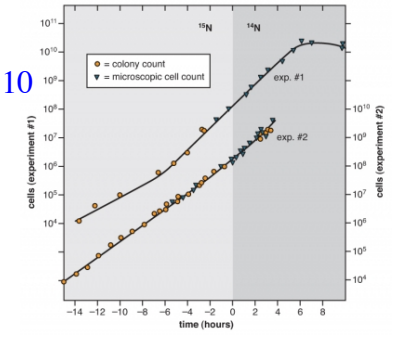


9

plant number	smooth pea	wrinkled pea	plant number	yellow pea	green pea
1	45	12	1	25	11
2	27	8	2	32	7
3	24	7	3	14	5
4	19	10	4	70	27
5	32	11	5	24	13
6	26	6	6	20	6
7	88	24	7	32	13
8	22	10	8	44	9
9	28	6	9	50	14
10	25	7	10	44	18
totals	**336**	**101**	**totals**	**355**	**123**

10



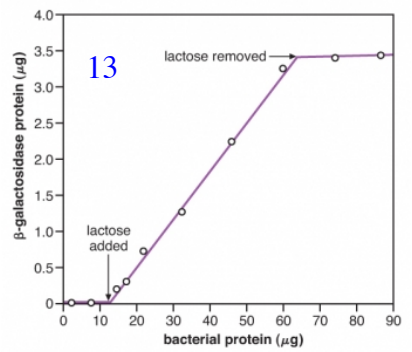
11

genotype	– lactose	+ lactose
I^+ O^+ β^+ P^+	1	100
I^- O^+ β^+ P^+	100	100
I^+ O^+ β^+ P^+ / I^+ O^+ β^+ P^+	1	240
I^D O^+ β^+ P^+	1	1
I^D O^+ β^+ P^+ / I^+ O^+ β^+ P^+	1	2
I^+ O^- β^+ P^+	<1	<1
I^+ O^- β^+ P^+ / I^+ O^+ β^+ P^+	1	100

12

position #	1	2	3	4	5	6	7
A	–6.64	1.84	–6.64	0.84	1.26	–6.64	–0.72
C	–6.64	–6.64	–0.37	–6.64	–6.64	–6.64	–6.64
G	–0.37	–6.64	–6.64	1.18	–0.37	–6.64	1.92
T	1.57	–6.64	1.57	–6.64	–0.72	1.84	–6.64

13



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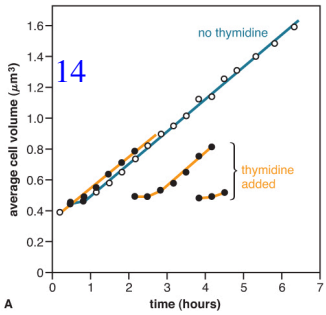

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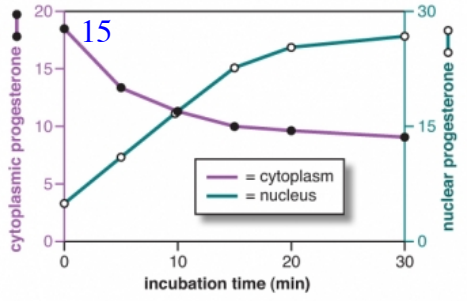

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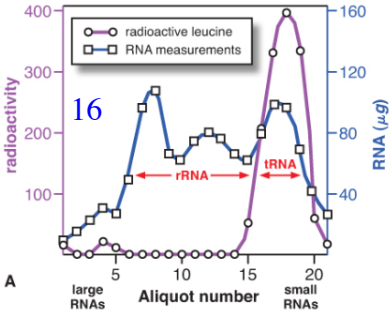

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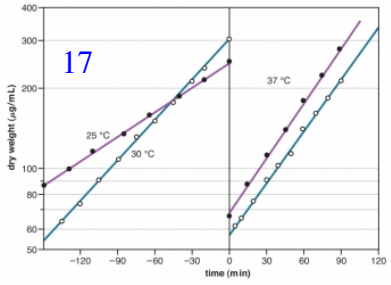

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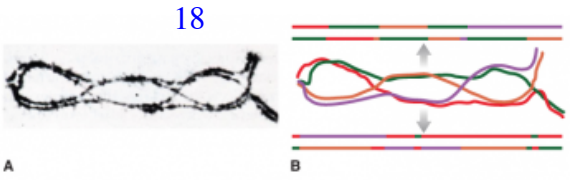

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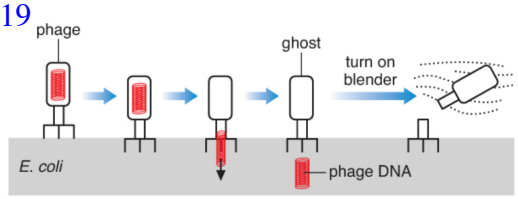

20

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V-T7      5′...TAAACACGGTACGATGTACCACATGAAACGACAGTGAGTC... 3′
V-fd      5′...GCTTCTGACTATAATAGACAGGGTAAAGACCTGATTTTTG... 3′
V-SV40    5′...ATTGCAGCTTATAATGGTTACAAATAAAGCAATAGCA..... 3′
V-1       5′...ACTGGCGGTGATACTGAGCACATCAGCAGGACGCACTGAC... 3′
B-tRNA    5′...GTCATTTGATATGATGCGCCCCGCTTCCCGATAAGGAGC ... 3′
B-Lac     5′...TCCGGCTCGTATGTTGTGTGGAATTGTGAGCGGATAACAA... 3′
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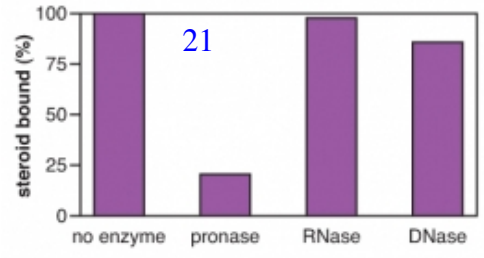
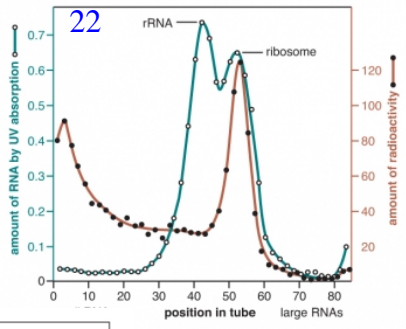
21



22



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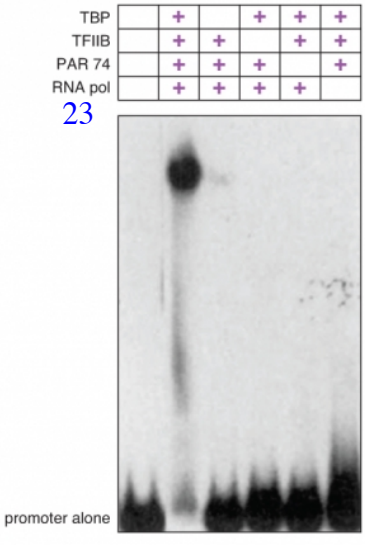

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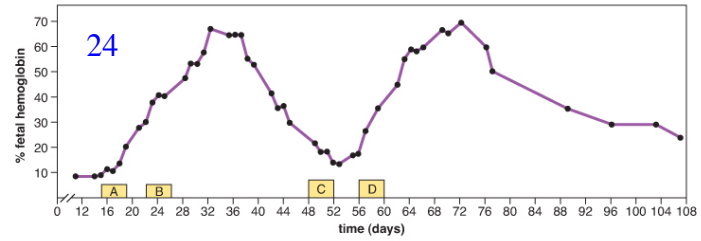

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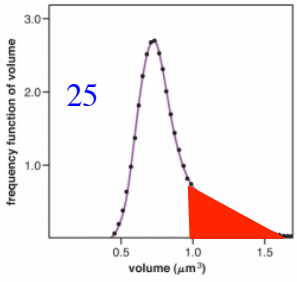

***genE* for use with Bio113 Exam #1, Fall 2015.**
Numbers refer to the bases on the ends of each row
-10 and -35 boxes are colored red and underlined

-172 -71
caatacgcaaaccgcctctccccgcgcgttggccgattcattaatgcagctggcacgacaggtttcccgactggaaagcgggcagtgagcgcaacgcaat

-72 -35 -10 +28
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+29 +128
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+129 +228
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+229 +328
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+429 +528
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