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 9:30 am on Monday Sept. 22. **EXAMS ARE DUE BY 9:30 m ON MONDAY SEPTEMBER 22**. 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 within this test** unless you want to draw on a separate page. 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 blended with lecture Questions:

8 pts.

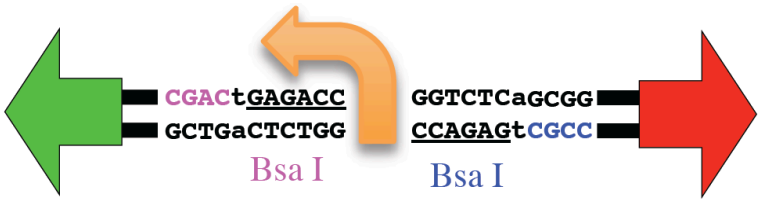
1) To the right is a position weight matrix. Below is a DNA sequence (ACGTATA) that may or may not be part of a promoter. Use the position weight matrix to determine if this is a promoter or not. To receive any credit, you MUST tell me how you reached your conclusion. *Answer Limit: 30 words.*

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

No, if you add up the scores for this sequence, it is about -24 which indicates it is not a promoter.

8 pts.

2) Here is a figure from lab and a potential promoter sequence (GGGAACTGCACGTATAGGCTAGCAT). Use the these data to determine what sequence you would send to the company to have them make the **top oligo** to use with GGA to functionally test if this is a promoter or not.



type your sequence here: 5' cgacGGGAACTGCACGTATAGGCTAGCAT

15 pts.

3) In the attached file Exam1_sequences.docx, I have two sequences for you: DNA derived from mRNA encoding over 100 amino acids, and a gene. These sequences come from the human genome, which means you carry two alleles very similar to what is in the file.

Use BLAST2 and ORF finder to analyze these two sequences and answer these questions:

a) How can you tell which sequence is the mRNA? *Answer Limit: 30 words.*

#1, the shorter one

b) How many amino acids are encoded in the mRNA? *Answer Limit: 20 words.*

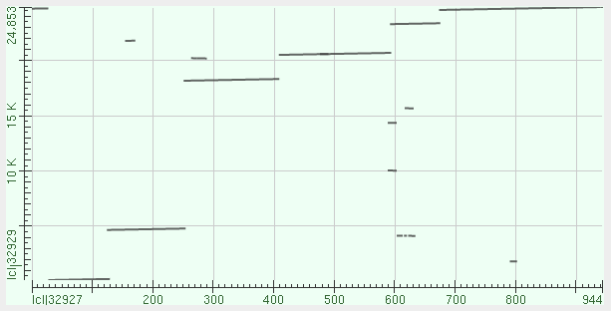
303 as reported on ORF finder

c) How many "start codons" are in this mRNA? Support your answer with data (a screen shot) *Answer Limit: 20 words.*

5 as shown on ORF finder results

d) How many introns are in this gene? Support your answer with data (a screen shot) *Answer Limit: 20 words.*

5 or 6, depending if you count the bit at the beginning of the mRNA.



e) What would you expect to see from this protein's amino acid sequence if the protein were purified from human tissue and you knew the protein were made on the rER? Support your answer by describing the posttranslational modification including. *Answer Limit: 30 words.*
The first 20-25 amino acids would be missing since this is the signal sequence and it is removed when the protein is made in the rER.

Lecture Questions:

9 pts.

5)

a) Draw a simplified diagram to show me what "anti-parallel" means for DNA. In your picture, be sure to label all the ends of your DNA. You do **NOT** need to diagram individual nucleotides.

5'----------3'
3'----------5'

b) Summarize the mathematical argument that protein was a better heritable material than DNA. *Answer Limit: 40 words.*
amino acids: 20^n >> nucleotides 4^n

c) Choose 4 examples from the data gallery to disprove proteins are the heritable material. You must explain why each figure you chose contributes to the evidence. *Answer Limit: 30 words for each example.*

1. #1 heat denatures proteins so it must have been DNA
2. #2 N/P ratio of S factor was very similar to DNA, not proteins which lack phosphorous
3. #3 where only 1% of the protein stayed with the cells compared to 70% DNA (refined experiment)
4. #5 graphical first result, similar to #3, but 30% protein stayed with cell

24 pts.

6)

a) Give two main reasons why Mendel was able to see inheritance patterns that his contemporaries were not. *Answer Limit: 40 words.*

1. true breeding traits
2. large numbers of peas

partial credit for multi-generations

There is a rare recessive trait called upside down nose (n) that can lead to drowning if a *nn* person goes out into the rain without a hat. There is very rare dominant trait that allows affected individuals to breath through their ears (E). Calculate the following scenarios.
N = regular nose
n = upside down
E = ear breather
e = normal ears

b) What is the probability of a couple having a boy who can breath through his ears given none of his grandparents could and only his father can? Show your work to get full credit. *Answer Limit: 10 words.*
man has a new mutation. His phenotype is know so he must be Ee. This is not impossible.
Ee x ee → ½ Ee x ½ boy = ¼

c) If the country's only ear breathing boy were part of a group of 10 men and 10 women (all unrelated) who colonized Mars, how many generations would it take before the ear breathers with at least one dominant allele were the majority of the total population? For this question, assume every couple reproduces and every couple has exactly 2 children per generation. Incest is forbidden on Mars. Support your answer using the rules of probability. Show your work to get full credit. *Answer Limit: 30 words.*
Given the rules of probability, the population will NEVER be dominated by ear breathers. They will remain in the minority forever since the other 9 couples are producing more children than this one couple who on average produces only 1 child who can ear breath.

d) If a woman who could drown in the rain had children with a man whose father could drown in the rain but his mother was homozygous wild-type, what is the probability that one of their three children would be susceptible to drowning in the rain, but the other two would not be susceptible? Show your work to get full credit. *Answer Limit: 10 words.*
nn x nN → ½ x ½ x ½ = 1/8 1/8 + 1/8 + 1/8 = 3/8

e) What is the probability of the following couple having a child with one mutant phenotype? Show your work to get full credit. *Answer Limit: 10 words.*

> ***father**: upside down nose, non-ear breather x **mother**: heterozygous wild-type nose, heterozygous ear breather*
> nnee x NnEe → ¼ one mutant phenotype OR (+) ¼ the other mutant phenotype = ½

f) The colors used in our book were chosen so that color blind people can distinguish the different colors. Red/green color blindness is a sex-linked trait that affects about 8% of men in the general population. How many students in Bio113 are likely to be red/green color blind (33

people: 13 male students, 1 male teacher, 19 female students)? Show your work to get full credit. *Answer Limit: 10 words.*
0.8 x 13 = 1.04 or 1 male student; 0.08 x 0.08 = 0.0064 x 19 << 1 female student

g) What is the probability of the following couple having a color blind son? Show your work to get full credit. *Answer Limit: 10 words.*

father: color blind x mother: her father was color blind but she is not

X^bY x X^bX^B → ½ boy x ½ color blind = ¼

h) What is the probability of this same couple having a color blind daughter? Show your work to get full credit. *Answer Limit: 10 words.*
X^bY x X^bX^B → ½ girl x ½ color blind = ¼

14 pts.
7)
a) If a population of worms doubles every 24 hours, how could you determine whether a muscle protein was induced or not after exposure to heat? Support your answer with data. *Answer Limit: 30 words.*
+/- heat, measure ratio of muscle protein to total protein as in figure #13

b) Do *E. coli* cells in a growing population grow at a constant rate if the temperature is held steady? Support your answer with data. *Answer Limit: 30 words.*
No, as show in Figure 21, bigger cells grow faster which explain the tail on the right side of this graph. This was not a question about population growth rates.

c) Describe one form of information that bacteria use to determine when it is time to divide or not. Support your answer with data. *Answer Limit: 30 words.*
DNA replication is required for cell division as shown in figure #18. Cells unable to replicate DNA grew bigger but never divided.

d) If you sampled 100 skin cells, how many would be going through mitosis and how many would have replicated their DNA but had not started mitosis yet? Support your answer with data. *Answer Limit: 20 words.*
mitosis = 8 and G_2 = 17 (rounding) as calculated using figure #20

12 pts.
8)
a) Explain how steroids can cause muscles to produce more protein. Support your answer with data. *Answer Limit: 30 words.*

Figure #15: bind to receptor in cytoplasm and move to nucleus and function as transcription factor to initiate transcription.

b) Explain how steroids can cause negative side effects. Support your answer with data that you learned in class. *Answer Limit: 30 words*.
steroids enter all cells and any cell with a receptor will be affected, such as neurons and immune cells.

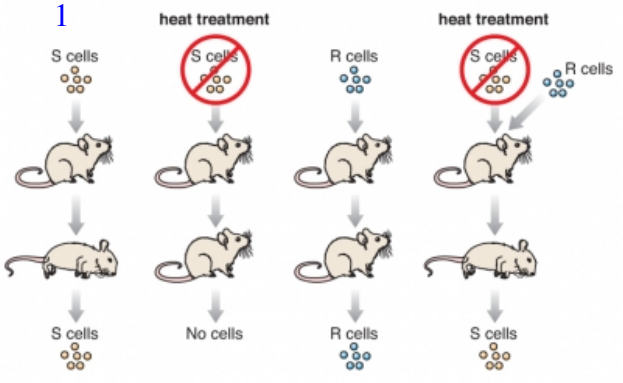
c) What type of molecule determines which cells are affected by steroids and which cells are not? Support your answer with data. *Answer Limit: 30 words*.
Figure #25: pronase destroyed ability of steroids to bind to receptor, which shows the receptor is a protein.

10 pts.
9)
a) Describe how repressors work. Support your answer with data. *Answer Limit: 30 words*.
Figure #12: LacI protein binds to the DNA promoter (lacO) and blocks RNA polymerase from binding and initiating transcription. When lactose is present, LacI releases the DNA.

b) List 3 mechanisms that contribute to the types of unexpected results Mendel found in data gallery figure 12.5. Don't limit your answer to monohybrid crosses. *Answer Limit: 30 words for each mechanism*.
This question was skipped because the vagueness of its wording. I got wildly different answers depending on how it was interpreted. I had intended to ask about the non-ideal 3:1 ratios but failed to focus my question enough. Everyone got these 6 pts.

Data Gallery

1



2

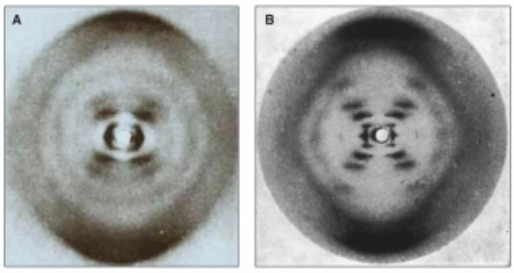
sample #	% nitrogen, N	% phosphorus, P	N/P ratio
37	14.21	8.57	1.66
38B	15.93	9.09	1.75
42	15.36	9.04	1.69
44	13.40	8.45	1.58
pure DNA	**15.32**	**9.05**	**1.69**

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

3

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%

4



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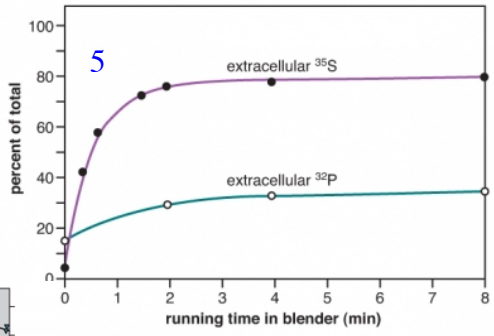

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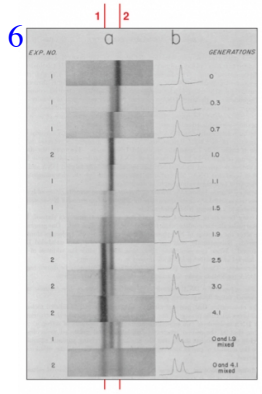

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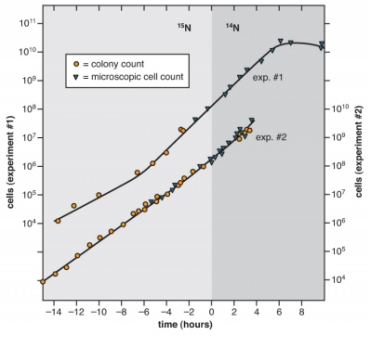

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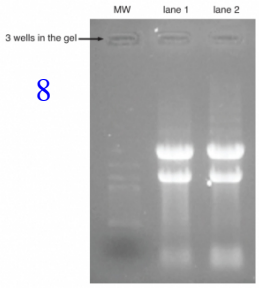

10

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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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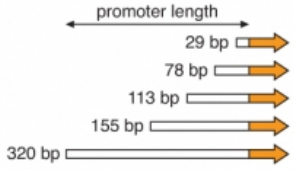
11



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

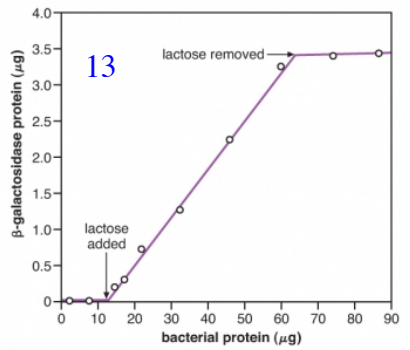
12

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

12.5

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**

13



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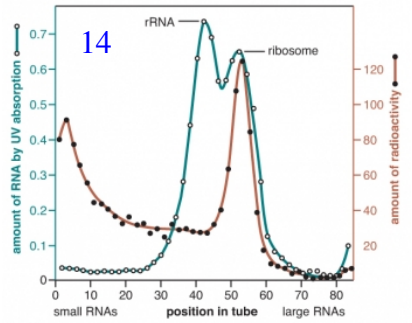

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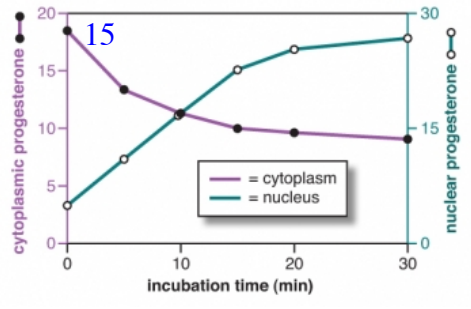

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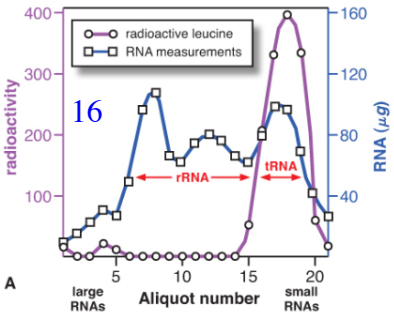

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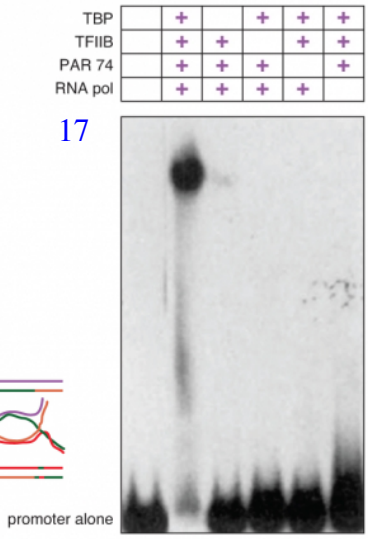

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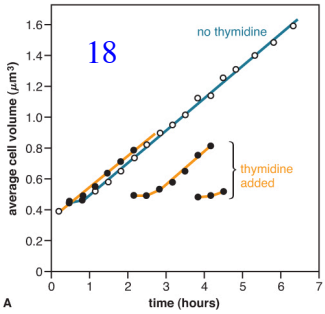

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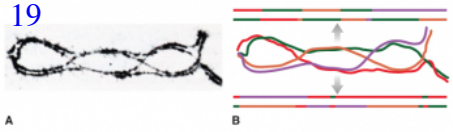
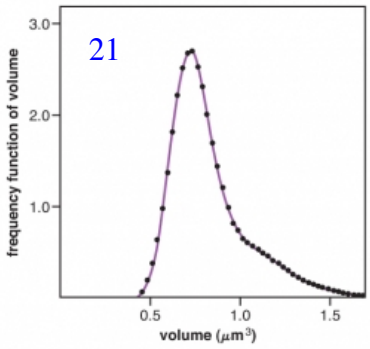


20

name	description	duration (hours)
G_1	growth and normal cellular functions	10
S	synthesis of DNA	8
G_2	growth and normal cellular functions	4
mitosis	separation of chromosomes	2

21



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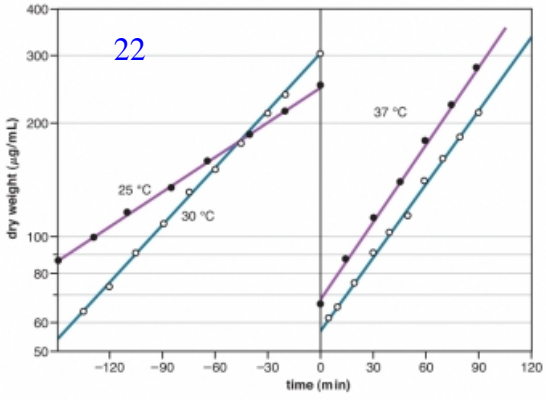

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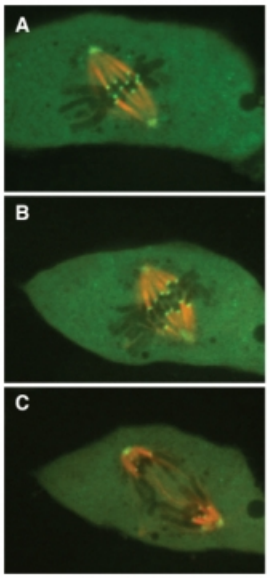

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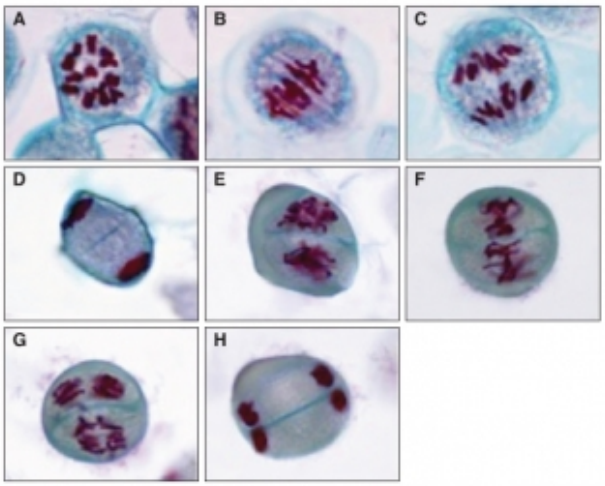

25