

## 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, 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 Feb. 10**. If you *turn in hard copy* of 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. Submit a hard copy to be graded.

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 type):

Read the pledge and sign if you can do so with honor:

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**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:

**6 pts.**

1) Provide the numbers in the boxes to pipet each of the following volumes. Tell me which pipet you'd use (P20, P200 or P1000) and what you would see in the display window:

P20	P200	P1000
X	X	X
X	X	X
X	X	X

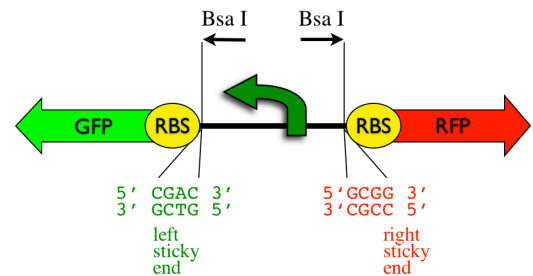
Volume = 125  $\mu$ L    pipet to use: \_\_\_\_\_


Volume = 2.5  $\mu$ L    pipet to use: \_\_\_\_\_


Volume = 854  $\mu$ L    pipet to use: \_\_\_\_\_


**4 pts.**

2) Figure #9 in the data gallery is a position weight matrix (PWM) based on Figure 19. Use the PWM on the *lower case bases* and circle one good promoter to produce RFP when cloned into pClone (see image  $\rightarrow$ ).



The -10 sequence is underlined + italics and the **-35 sequence** is bold letters. Explain how you reached your conclusion. Guessing is insufficient for any credit. **Limit your answer to a maximum of 35 words.**

CGACTAGCATGC tatattgGATAAGAGATGCATT**ACAGTT**GAGCACAGGCGG  
 CGACTGCTATAT**ATGTACC**AGATACAGTAACGATAgacgatgGCATATCGCGG  
 CGACGGCATGACT**TTGACAG**AGATATACAGATACAGttttaaGGCCAATGCGG  
 CGACCACAGTACT**TTGACAG**ATCACATATACAGATCattataGAATTCAGCGG

Textbook Questions:

**15 pts.**

3) It cannot be proteins...

a) When Griffith isolated the S factor, he thought it was part of the cell wall but Avery thought it was in the cytoplasm. Explain these apparent contradictions. Support your answer with data.

**Limit your answer to a maximum of 35 words.**

b) Starting with the 2 base-paired strands of DNA provided here, draw a picture of all the DNA after three rounds of replication in Meselson and Stahl's experiment. Support your answer using data. **Limit your answer to a maximum of 35 words.**



c) Draw a GTP nucleotide that provides energy to ribosomes during translation. Write very neatly and label all the atoms and number the carbons correctly. You may use one letter to represent the entire base.

**15 pts.**

4) Proteins make the world go around...

a) Draw a simple picture that shows how all 3 RNA types interact as they perform their functions. Use experimental data from 2 figures to support your drawing. Label neatly. **Limit your answer to a maximum of 40 words.**

b) Translate this synthetic ORF into protein. Use the single letter code for amino acids and type them below the sequence shown here. The RBS is underlined.

AUGUAGACCACAGGAAAGUAAGCGAUGGCCAAGGAGGCGUGCGCUACUUGACUCGGGGUGUAA 3'

→

c) Write the sequence of the 16S rRNA that binds to the RBS above. Be sure to label the 5' and 3' ends.

Answer here →

**9 pts.**

5) I want to be a promoter when I grow up...

a) What is the function of LacI<sup>+</sup> protein? Support your answer with data. **Limit your answer to a maximum of 35 words.**

b) Draw a new picture of a promoter that incorporates the insight from data gallery figure #5. Label any relevant promoter parts based on a bacterial promoter. Explain how your drawing illustrates the lesson from figure #5. **Limit your answer to a maximum of 35 words.**

**15 pts.**

6) Six months in the lab can save you an afternoon on the computer.

a) Use ORF finder 9 (<https://www.ncbi.nlm.nih.gov/orffinder/>) to identify how many amino acids are encoded in the largest ORF from NM\_002385. Support your answer with a screenshot. **Limit your answer to a maximum of 20 words.**

b) Run a BLAST2

([https://blast.ncbi.nlm.nih.gov/Blast.cgi?PAGE=Proteins&PROGRAM=blastp&BLAST\\_PROGRAMS=blastp&PAGE\\_TYPE=BlastSearch&SHOW\\_DEFAULTS=on&BLAST\\_SPEC=blast2seq&QUERY=&SUBJECTS=](https://blast.ncbi.nlm.nih.gov/Blast.cgi?PAGE=Proteins&PROGRAM=blastp&BLAST_PROGRAMS=blastp&PAGE_TYPE=BlastSearch&SHOW_DEFAULTS=on&BLAST_SPEC=blast2seq&QUERY=&SUBJECTS=)) using the largest ORF from part a) above and this functional protein purified from human tissue:

```
MDHARHGFLPRHRDTGILDKRGSGKVPWLKPGRSPLPSHARSQPGLCNMYKDSHHPARTAHYGSLPQKSHGPRTPPPSQGKGAEGQRPGFGYGGRAS  
DYKSAHKGFKGVDAQGTLISKIFKLGGRDSRSGSPMARR
```

Describe what has happened to the functional protein. Include a screenshot of your BLAST2 results to earn full credit. **Limit your answer to a maximum of 25 words.**

c) Based on your analysis from part b), where was this protein translated? Explain how you reached your conclusion. **Limit your answer to a maximum of 25 words.**

**18 pts.**

7) Mendel and his plants were like two peas in a pod. To get full credit, you must show your work.

One of Mendel's work-brothers found in a cup 37 yellow peas that came from one self-pollinated plant. He planted all of the peas and 36 plants grew. All 36 plants were self-pollinated. Twelve of the plants produced only yellow peas whereas 24 plants produced a mixture of yellow and green peas.

a) What was the genotype of the plant that produced the 37 peas?

b) What was the genotype of the group of 12 plants?

c) The 24 plants produced a total of 912 peas. How many peas would you expect to be yellow?

d) At the 2020 Superbowl, every person in attendance was measured for genetically dry vs wet earwax. They determined 18,854 had dry earwax and 56,246 had wet earwax. Which allele is recessive?

e) Imagine a couple where the man has dry earwax and the woman is heterozygous. What is the probability they would have two children from different pregnancies and both children have dry earwax?

f) What is the probability that this same couple's third child would be a girl with dry earwax or a boy with wet earwax?

**8 pts.**

8) Without reproduction, there can be no evolution.

a) How does a bacterial cell know when it is time to reproduce? Support your answer with two figures from the data gallery. **Limit your answer to a maximum of 35 words.**

b) Distinguish the reproductive consequences if chromatids could recombine vs if they could not recombine. **Limit your answer to a maximum of 40 words.**

**10 pts.**

9) Parenting: the days are long but the years are short.

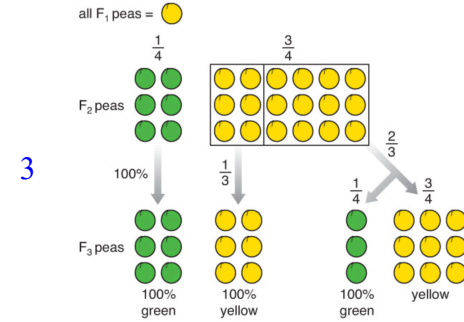
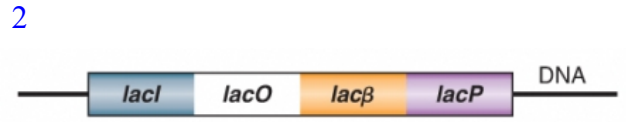
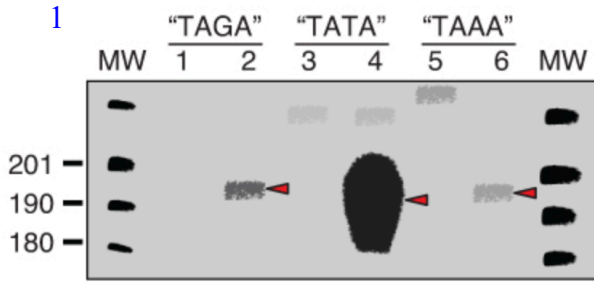
a) Generate a numbered list of experimental evidence that epigenetic changes can regulate transcription. Support each numbered item with data from the gallery. **Limit each numbered item to a maximum of 35 words.**

1.

b) Generate a numbered list of the mechanisms which contribute to genetic diversity in the F<sub>1</sub> generation. Support each numbered item with data from the gallery. **Limit each numbered item to a maximum of 35 words.**

1.

Data Gallery



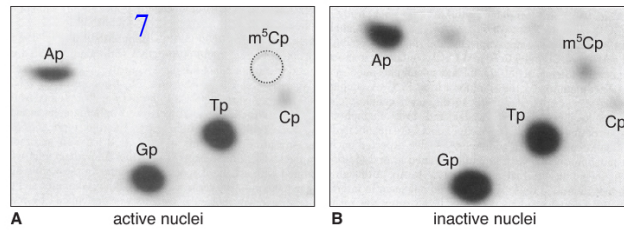
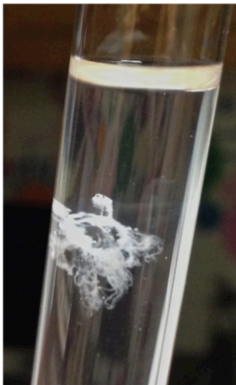
4

generation	wrinkled peas	smooth peas
P	5 true-breeding wrinkled plants	5 true-breeding smooth plants
F <sub>1</sub>	0 wrinkled peas	281 smooth peas
F <sub>1</sub>	0 plants from wrinkled peas	self-cross 253 plants from F <sub>1</sub> smooth peas
F <sub>2</sub>	1,850 wrinkled peas	5,474 smooth peas

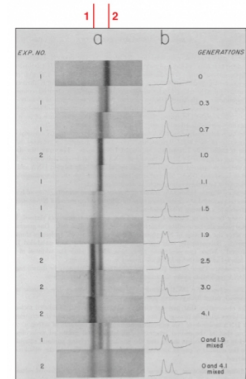
5

promoter length	doubling time	drug resistant
29 bp	no growth	none
78 bp	5 hours	none
113 bp	5 hours	none
155 bp	3 hours	yes
320 bp	3 hours	yes

6



8



9

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

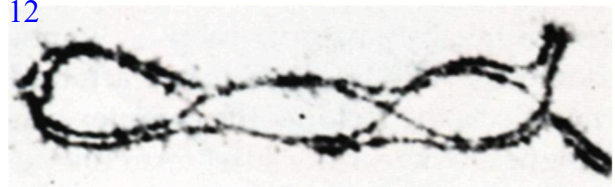
10

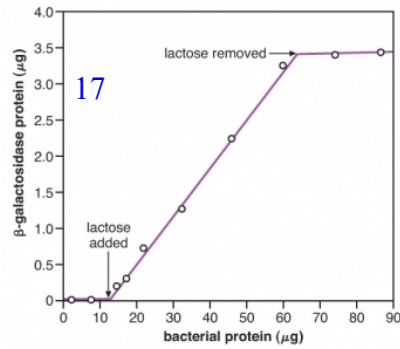
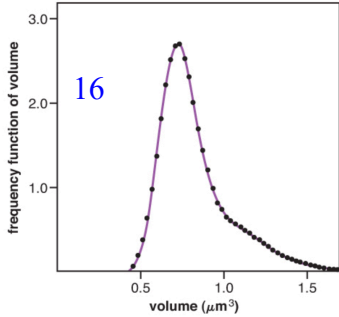
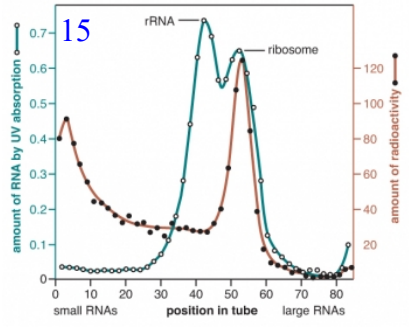
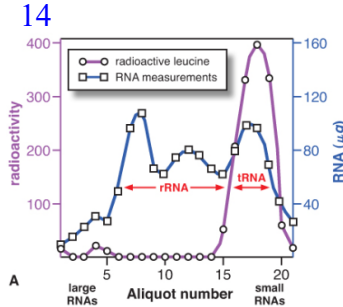
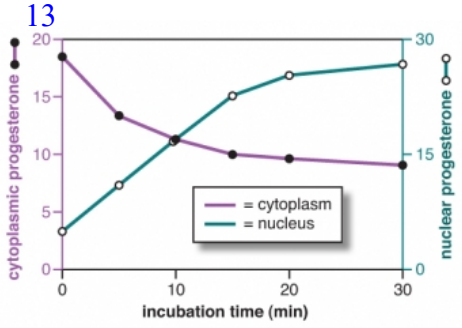
sample source	extracellular	intracellular
<sup>35</sup> S-Protein Figure 1.8	~80%	~20%
<sup>32</sup> P-DNA Figure 1.8	~30%	~70%
<sup>35</sup> S-Protein refined experiment	~99%	~1%
<sup>32</sup> P-DNA refined experiment	~30%	~70%

11

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
<b>totals</b>	<b>336</b>	<b>101</b>	<b>totals</b>	<b>355</b>	<b>123</b>

12





18

second base in codon

	U	C	A	G
U	UUU phe F UUC phe F UUA leu L UUG leu L	UCU ser S UCC ser S UCA ser S UCG ser S	UAU tyr Y UAC tyr Y UAA stop UAG stop	UGU cys C UGC cys C UGA stop UGG trp W
C	CUU leu L CUC leu L CUA leu L CUG leu L	CCU pro P CCC pro P CCA pro P CCG pro P	CAU his H CAC his H CAA gin Q CAG gin Q	CGU arg R CGC arg R CGA arg R CGG arg R
A	AUU ile I AUC ile I AUA ile I AUG met M	ACU thr T ACC thr T ACA thr T ACG thr T	AAU asn N AAC asn N AAA lys K AAG lys K	AUU ser S AUC ser S AGA arg R AGG arg R
G	GUU val V GUC val V GUA val V GUG val V	GCU ala A GCC ala A GCA ala A GCG ala A	GAU asp D GAC asp D GAA glu E GAG glu E	GGU gly G GGC gly G GGA gly G GGG gly G

19

V-T7 5'...TAAACACGGTACGATGTACCACATGAAACGACAGTGAGTC...3'  
V-fd 5'...GCTTCTGACTATAAATAGACAGGGTAAAGACCTGATTTTG...3'  
V-SV40 5'...ATTGCAGCTTATAATGGTTACAAATAAAGCAATAGCA...3'  
V-1 5'...ACTGGCGGTGATACAGCACATCAGCAGGACGCACTGAC...3'  
B-rRNA 5'...GTCATTTGATATGATCGCCCCCTTCCCGATAAGGAGC...3'  
B-Lac 5'...TCCGGCTCGATGTTGTGTGGATTGTGAGCGGATAACAA...3'

20

genotype	- lactose	+ lactose
<i>I<sup>+</sup> O<sup>+</sup> β<sup>+</sup> P<sup>+</sup></i>	1	100
<i>I<sup>-</sup> O<sup>-</sup> β<sup>+</sup> P<sup>+</sup></i>	100	100
<i>I<sup>+</sup> O<sup>+</sup> β<sup>+</sup> P<sup>+</sup> / I<sup>-</sup> O<sup>-</sup> β<sup>+</sup> P<sup>+</sup></i>	1	240
<i>I<sup>0</sup> O<sup>+</sup> β<sup>+</sup> P<sup>+</sup></i>	1	1
<i>I<sup>0</sup> O<sup>+</sup> β<sup>+</sup> P<sup>+</sup> / I<sup>+</sup> O<sup>+</sup> β<sup>+</sup> P<sup>+</sup></i>	1	2
<i>I<sup>+</sup> O<sup>-</sup> β<sup>+</sup> P<sup>+</sup></i>	<1	<1
<i>I<sup>+</sup> O<sup>-</sup> β<sup>+</sup> P<sup>+</sup> / I<sup>+</sup> O<sup>+</sup> β<sup>+</sup> P<sup>+</sup></i>	1	100

