

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 6 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 Sept. 17**. 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. 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:

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:

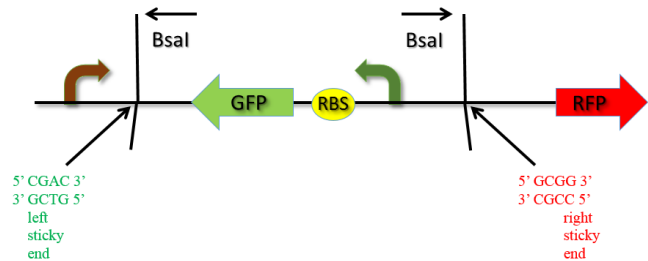
4 pts.

1) While you were sleeping, the oligo fairy snuck into the lab and change the concentrations of your oligos and the annealing buffer. The new concentrations are 40X annealing buffer and 150 μM oligos. You want the final volume to be 20 μL and the final concentrations to be 1X buffer and 5 μM oligos. Fill in the table below to produce the protocol you would need to follow prior to boiling your oligos.

reagent	Volume (give units)
40X buffer	0.5 μL
top oligo	0.67 μL
bottom oligo	0.67 μL
water	18.16 μL

4 pts.

2) Take the sequence below and submit it to the [Oligator web site](#) to produce the DNA you would need to use GGA for cloning the DNA control element into the plasmid shown to the right:



ATGGCCTTGCTTACAAAACCGAGGTCTCACTGGACATCACCTCCCACAACGAAG

Past your DNA below this line and label the 5' end

58-mer Top1 5' -CGACATGGCCTTGCTTACAAAACCGAGGTCTCACTGGACATCACCTCCCACAACGAAG
 58-mer Bottom1 5' -CCGCCTTCGTTGTGGGAGGTGATGTCCAGTGAGACCTCGGTTTTGTAAAGCAAGGCCAT

2 pts.

3) Did you find any surprises in the DNA for question #2? Support your answer with data. **Limit your answer to a maximum of 25 words.**

There was an internal BsaI site that should be removed.

Textbook Questions:

11 pts.

4) DNA is the heritable material, or is it???

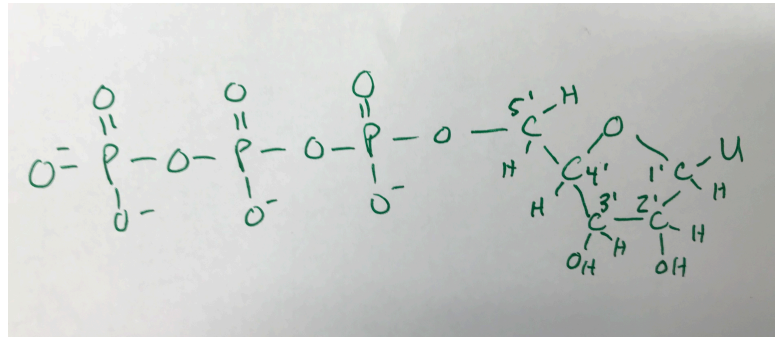
a) Look at figure 24 in the data gallery. How did Griffith know that the mice in the fourth column of data died due to the S-factor rather than directly from S cells that were injected into the mice? Support your answer with data. **Limit your answer to a maximum of 35 words.**

The mice in the second column (heat-treated S cells) did not die because the S cells were killed. Therefore, it is unlikely any S cells survived in the 4th column.

b) Look at the data in figures 7 and 21 in the data gallery. Which one supports the role of epigenetics by correlation and which one by causation? Support your answer using the data in these two figures. **Limit your answer to a maximum of 40 words.**

Figure 7 correlates inactive genes with methylation and active genes with hypomethylation. Figure 21 causes fetal hemoglobin to be induced by injecting monkeys with methylation inhibitor. The more inhibitor, the longer the fetal hemoglobin was induced.

c) In the space provided here, draw the only nucleotide triphosphate that is unique to RNA. You may use a single letter to represent the base. Write very neatly and label all the atoms and number the carbons correctly.



12 pts.

5) Building proteins from genetic information.

a) Compile experimental results from two figures in the data gallery to make the argument that mRNA are the molecules that determine which proteins will be made. **Limit your answer to a maximum of 35 words.**

#14 viral proteins from new mRNA bound to ribosome

#8 size variation of mRNA (smear) matches protein size variation

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

UUUAACCCGGGAUGGCUUUAUGUCAGCUGAUGUAAAGGCAGGGCG 3'

Answer here →

M A L C Q L M

18 pts.

6) Cells are control freaks!

a) What is the function of *lacO*⁺? Support your answer with data. **Limit your answer to a maximum of 25 words.**

#20 lacO⁺ is a promoter, DNA that regulates transcription of adjacent downstream DNA, last row shows not protein

b) How are some cells able to respond to steroids whereas others are not? Support your answer with data. **Limit your answer to a maximum of 35 words.**

#18 only some cells contain steroid receptors, others do not. Steroid binds to receptor in cytoplasm and they move together to nucleus.

c) How do proteins know where to bind within a promoter? Support your answer with data.

Limit your answer to a maximum of 30 words.

#5 or #1 or #19 show proteins bind to particular DNA sequences (position weight matrix OK, but not my first choice)

12 pts.

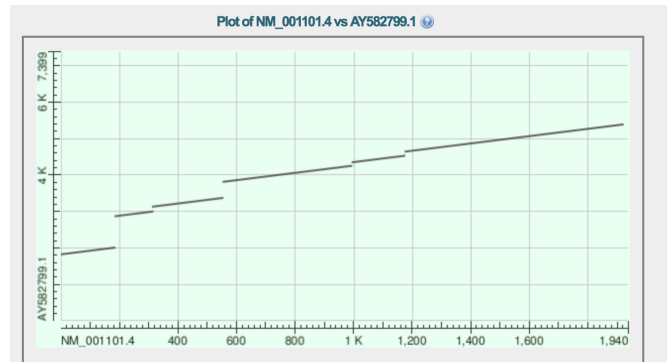
7) Biological information is not always as simple as we first think it will be.

a) **Use only BLAST2** to align these two sequences: **NM_001101.4** and **AY582799.1**

Which sequence is the mRNA and which one is the gene? How do you know? **Limit your answer to a maximum of 20 words.**

NM (x-axis) is mRNA, shorter, ~1.9 kb

AY (y-axis) is gene, much longer, >7kb



b) How many introns and how many exons are in this gene? Support your answer with a screenshot of your data. **Limit your answer to a maximum of 25 words.**

6 exons (line segments) and 5 introns (gaps)

12 pts.

8) Dogs produce puppies, cats produce kittens.... There is a rare and recessive trait that instead of having hairs in their nostrils, some people have small feathers. This gene is located on chromosome 13. Answer the following questions. Show your work for a chance at partial credit.

a) What is the probability of a couple having a daughter who is a carrier or a son with the feathery nostrils if the mother has feathery nostrils and the father's father had feathery nostrils but the father does not? **ff = feathers**

mother = ff, father = Ff

½ (girl) * ½ (carrier) + (or) ½ (boy) * ½ (feathers) = 1/2

b) As it turns out, another very rare trait exists, but it is caused by a dominant allele. Some folks are born with a tiny unicorn that is often removed at birth so you may not have ever seen one. Consider this couple: father had his unicorn removed at birth and his father had feathery nostrils; the mother has feathery nostrils and she did not have a unicorn but her mother did. What is the

probability of this couple having a son with a unicorn from one pregnancy and a daughter with feathery nostrils one year later? **H = unicorn horn, ff = feathers**

mother = hhff, father = FfHh

$\frac{1}{2}$ (boy) * $\frac{1}{2}$ (unicorn) * (and) $\frac{1}{2}$ (girl) * $\frac{1}{2}$ (feathers) = 1/16

12 pts.

9) Tiny cells are important too.

a) What two physical components contribute to the timing of bacterial cell division by binary fission? Support your answer with two figures from the data gallery. **Limit your answer to a maximum of 35 words.**

#17 cell size, cells have to get a certain size before they can divide

#23 cells must replicate their DNA before they can divide

(#22 only says that things happen faster when warmer, but not what physical components determine the timing of cell division)

b) The cells in figure 22 of the gallery appear to have regulated population growth rates. Use a different figure to describe the growth rate of individual *E. coli* cells. **Limit your answer to a maximum of 30 words.**

#17 individual cell growth rate increases once cells get to be about 0.9 μm and then it slows down by 1.4 μm .

13 pts.

10) Why don't we call these processes your-tosis and our-tosis?

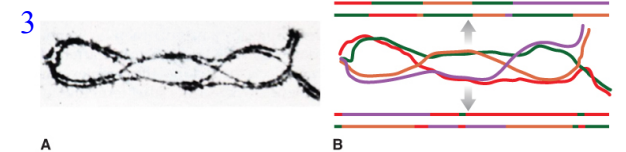
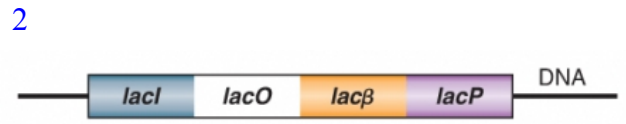
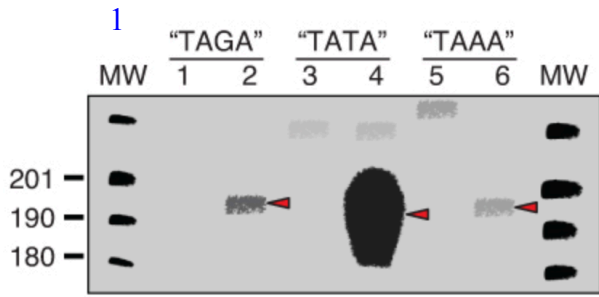
a) On a separate piece of paper, draw a picture of a diploid cell that has two different chromosomes (A is big and B small) during each of the phases of mitosis. Label neatly.

Most common mistake was not drawing a diploid cell to start with. Had to have two chromatids with shared centromere prior to anaphase and two centromeres post anaphase.

b) Synthesize meiotic recombination and the laws of independent assortment and segregation to explain the randomness that Mendel first noticed in figure 11 in the data gallery. **Limit your answer to a maximum of 35 words.**

I messed up here. I never want to write a trick question but this inadvertently turned into one. Recombination was not an issue for Mendel because he chose traits (unknowingly) encoded on separate chromosomes. As I started grading, the hidden trick occurred to me. I had been taking off 2 points for some answers, so I did so for everyone, but gave back 2 points to everyone. I had been taking off points for not describing the random pairing of gametes and recombination did not happen for Mendel. My apologies for this accidental trick question.

Data Gallery

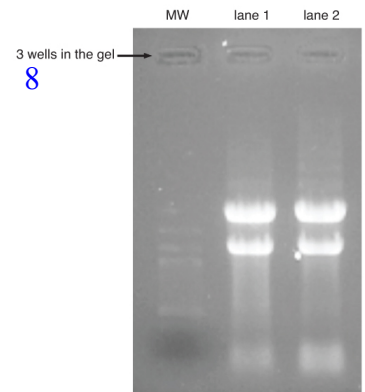
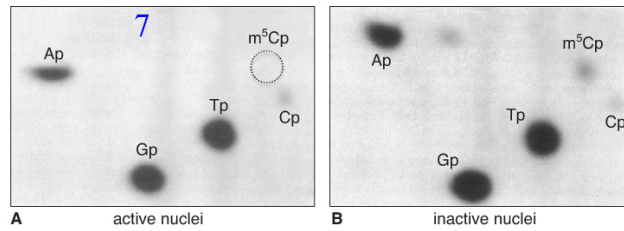
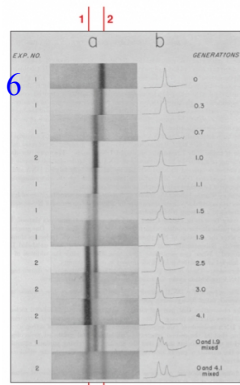


4

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

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



9

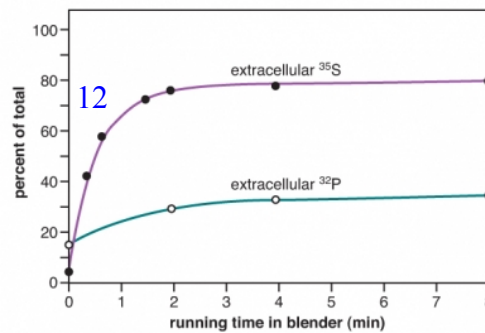
position #	1	2	3	4	5	6	7
A	-6.64	1.84	-6.64	0.84	1.26	-6.64	-0.72
C	-6.64	-6.64	-0.37	-6.64	-6.64	-6.64	-6.64
G	-0.37	-6.64	-6.64	1.18	-0.37	-6.64	1.92
T	1.57	-6.64	1.57	-6.64	-0.72	1.84	-6.64

10

sample source	extracellular	intracellular
³⁵ S-Protein Figure 1.8	~80%	~20%
³² P-DNA Figure 1.8	~30%	~70%
³⁵ S-Protein refined experiment	~99%	~1%
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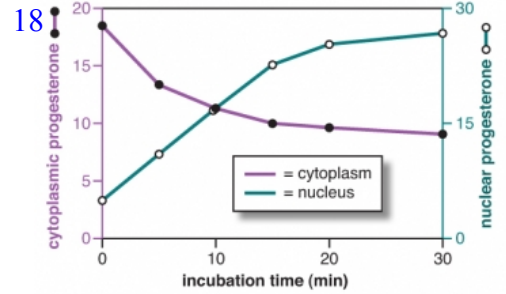
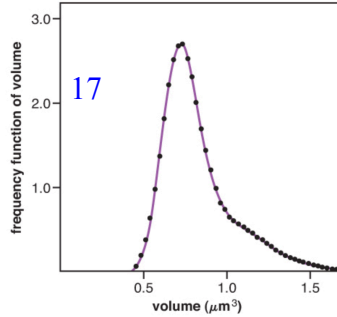
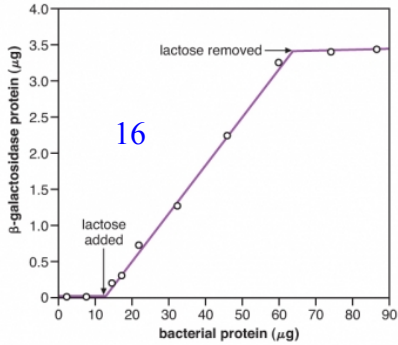
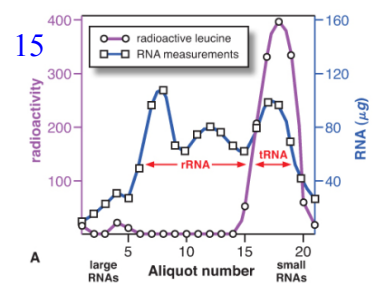
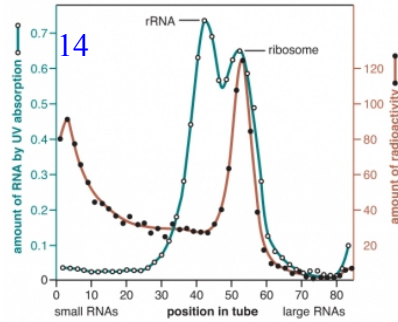
11

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
totals	336	101	totals	355	123



13

		second base in codon			
		U	C	A	G
U	U	UUU phe	UCU ser	UAU tyr	UGU cys
	U	UUC phe	UCC ser	UAC tyr	UGC cys
	U	UUA leu	UCA ser	UAA stop	UGA stop
	U	UUG leu	UCG ser	UAG stop	UGG trp
C	U	CUU leu	CCU pro	CAU his	CGU arg
	U	CUC leu	CCC pro	CAC his	CGC arg
	U	CUA leu	CCA pro	CAA gln	CGA arg
	U	CUG leu	CCG pro	CAG gln	CGG arg
A	U	AUU ile	ACU thr	AAU asn	AGU ser
	U	AUC ile	ACC thr	AAC asn	AGC ser
	U	AUA ile	ACA thr	AAA lys	AGA arg
	U	AUG met	ACG thr	AAG lys	AGG arg
G	U	GUU val	GCU ala	GAU asp	GGU gly
	U	GUC val	GCC ala	GAC asp	GGC gly
	U	GUA val	GCA ala	GAA glu	GGA gly
	U	GUG val	GCG ala	GAG glu	GGG gly

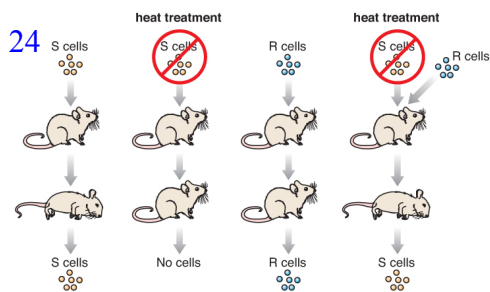
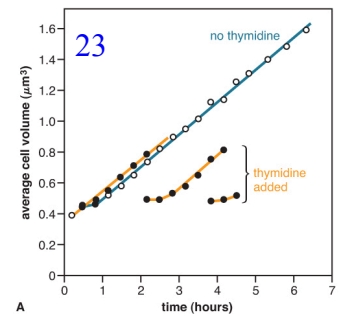
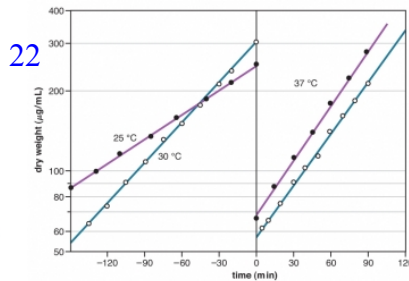
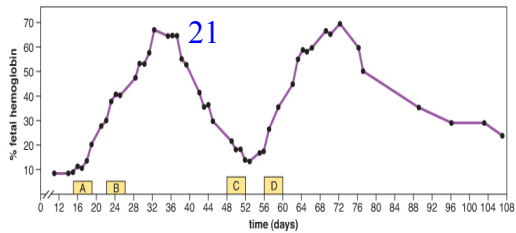


19

V-T7 5'...TAAACACGGTACGATGTACCACATGAAACGACAGTGAGTC...3'
 V-fd 5'...GCTTCTGACTATAATAGACAGGGTAAAGACCTGATTTTG...3'
 V-SV40 5'...ATTGCAAGCTTATAATGGTTACAAATAAAGCAATAGCA...3'
 V-1 5'...ACTGGCGGTGATCTGAGCACATCAGCAGGACGCACCTGAC...3'
 B-rRNA 5'...GTCAATTTGATATGATCGCCCCCTTCCCGATAAGGAGC...3'
 B-Lac 5'...TCCGGCTCGTATGTTGTGTGGATTGTGAGCGGATAACAA...3'

20

genotype	- lactose	+ lactose
$I^+ O^+ \beta^+ P^+$	1	100
$I^- O^+ \beta^+ P^+$	100	100
$I^+ O^+ \beta^+ P^+ / I^+ O^+ \beta^+ P^+$	1	240
$I^0 O^+ \beta^+ P^+$	1	1
$I^0 O^+ \beta^+ P^+ / I^+ O^+ \beta^+ P^+$	1	2
$I^+ O^- \beta^+ P^+$	<1	<1
$I^+ O^- \beta^+ P^+ / I^+ O^+ \beta^+ P^+$	1	100



TBP	+	+	+	+	+
TFIIIB	+	+	+	+	+
PAR 74	+	+	+	+	+
RNA pol	+	+	+	+	+

