Biology 113 Closed Book Key Exam #1 – Information Part 1

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 12:30 pm on Monday Sept. 24. **EXAMS ARE DUE BY 12:30 pm ON MONDAY SEPTEMBER 24**. If you turn in your exam late, then you lose a letter grade for each day you are late. The **answers to the questions must be typed below each question unless you are instructed to draw something**. If you do not write your answers in the appropriate location, I may not find them.

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:

_____

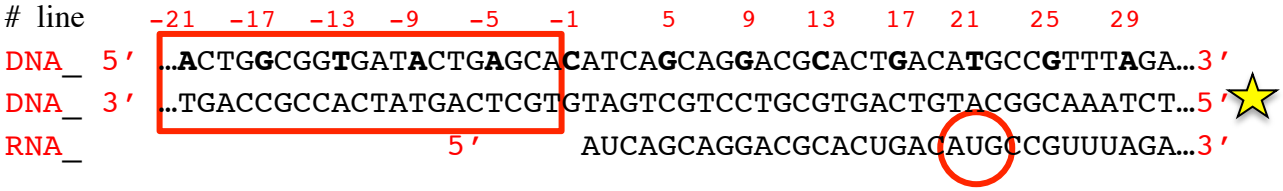
On my honor I have neither given nor received unauthorized information regarding this work, I have followed and will continue to observe all regulations regarding it, and I am unaware of any violation of the Honor Code by others.

How long did this exam take you to complete?

Lab Questions:

6 pts.

1) Below you see three sequences of nucleotides. Label and annotate them as requested.



a) Use the blanks on the left to label each strand as either DNA or RNA.
b) Draw a box around the sequence or sequences that constitute the promoter.
c) Put a star at the far right end of the strand that served as template for the bottom strand.
d) Lab the 5' and 3' ends of all three molecules.
e) Draw a circle (that does not look like a box) around the start codon.
f) Number the nucleotides using the standard numbering scheme (use the area to the right of the "# line"). To conserve space, *label only every other odd number*. To make it clear which nucleotide you are numbering, convert every other odd nucleotide to **bold font**.

4 pts.

2) We are using Golden Gate Assembly to put your new promoters into the receiving plasmid.
a) List two advantages of GGA over traditional cloning methods. Limit each answer to 1 sentence.

1. no gel purification or plasmid preparation
2. all DNA and enzymes in one tube
3. removal of TT and insertion of promoter goes to completion

b) How did you figure out what sticky ends to add onto your promoter? Limit each answer to 1 sentence.
Looked at what was left behind in the receiving plasmid or what was hanging off the removed TT in the PPT presentation.

Lecture Questions:

6 pts.

2)
a) In the space below, draw a picture of one ribonucleotide and add the single letter for the base that would reinforce that you have drawn a ribonucleotide. Your drawing should include every atom and bond except those in the base.
b) Number the carbons in your diagram.
c) Add an arrow to show where the next ribonucleotide would be added to the one you have drawn.
See http://www.bio.davidson.edu/courses/genomics/jmol/ddATP.html Needed U base.
ATP is the far left side. Needed to draw with only one phosphate. Arrow points to 3' OH.

6 pts.

3)

a) List two common misconceptions about DNA evidence. Limit your answer to 1 sentence for each number.

1. People think DNA evidence can be used to convict, but it can only be used to find innocence.
2. People think whole genome is sequenced, but only short fragments are tested.

b) When interpreting experimental data, where should you begin your interpretation, and why? Limit your answer to a maximum of 2 sentences.

Start with controls. If they are not working then none of the data can be trusted.

20 pts.

4)

a) Analyze and interpret figure 10 using mathematics to convince a skeptic that the red line indicates a gene was induced rather than protein accumulated at a constant rate simply because cells were replicating. Limit your answer to a maximum of 2 sentences.

You needed to address the faster increase in enzyme compared to total protein and you needed to use real numbers from the graph.

b) In the space below, draw a genetic circuit diagram to explain what was happening at the molecular level when lactose was added to the system in figure 10.

c) What is the function of LacI and what type of molecule is it? Choose supportive data from the gallery and explain how the data support your answers. Limit your answer to a maximum of 3 sentences.

inhibitor of transcription made of protein

d) Compare and contrast steroid regulation of gene activation with lactose gene activation. Choose supportive data from the gallery and explain how the data support your answer. Limit your answer to a maximum of 4 sentences.

cytoplasm move to nucleus of steroid receptor #12
induction of transcription #6 or #9
increase protein production #10

e) Translate this ORF (type your answer in the space below the sequence I supplied). Use the single letter code in your answer.

GCUAGUCAAUGGCUCUUUGCCUGAUGUGGUAGCAGACG

M A L C L M W (stop)

9 pts.

5) We have focused on molecular and cellular information. Provide three examples of information that we have studied that are non-linear cell or molecular information. For each example, describe how it illustrates non-linear molecular information. Use this numbered list for your three part answer and limit each number to a maximum of 2 sentences.

1. intron/mRNA splicin
2. protein splicing (figure #5 bonus point for citing data when not asked for)
3. epigenetics

10 pts.

6) Describe central dogma. Your answer should be in the format of a **numbered list**. Each line in your outline should be accompanied by supporting data with an explanation of how the data supports your statement. Limit each number to a maximum of 2 sentences.

1. DNA replication (#3, 2, 22)
2. transcription (#6, 23)
3. translation (#4, 10, 13)

10 pts.

7) Using a numbered list, compare and contrast three forms of reproduction: bacterial, non-sexual eukaryotic and gamete formation. Provide data for as many of the numbered descriptions as you can. Limit each number to a maximum of 2 sentences.

1. cell division of prokaryotes #7
2. mitosis #3
3. meiosis → conception # 8, 15, 11

20 pts.

8)

a) Explain why it is evolutionarily advantageous for DNA polymerase to make errors. Limit your answer to a maximum of 2 sentences.

provides variation in the population which can lead to new phenotypes and selective advantage.

b) Describe two other sources of variation in sexual reproduction. Support your answer with data and limit each example to 2 sentences.

recombination #15

random gametes fusing #8

c) Use experimental data from the data gallery to explain what happens during the S phase of the cell cycle. Explain how the data support your answer. Limit your answer to a maximum of 3 sentences.

DNA replicates by semiconservative mechanism (#2) and DNA polymerase adds to 3' OH ends (#22)

d) Copy and paste the sequence in question #1 above and indicate three bases that could be modified epigenetically if the DNA came from a human genome. Use an arrow for your visual indication.

…**A**CTG**G**CGG**T**GAT**A**CTG**A**GCA**C**ATCA**G**CAG**G**ACG**C**ACT**G**ACA**T**GCC**G**TTT**A**GA…3′

…TGACCGCCACTATGACTCGTGTAGTCGTCCTGCGTGACTGTACGGCAAATCT…5′

e) Describe the chemical modification would you make to the bases in part d) above?

methylated C bases (cytosine)

9 pts.

9) Bio113 is a magical place and it is not uncommon for students in this class to fall in love and marry after college (love at first sight). Let me share with you some genetic counseling information so you can advise a couple of biology alumni who are planning on having children in the near future. You may use fractions for your answer, and you must show your work to eligible for partial credit.

Male Student: Bob Female Student: Sue

Bob's father has the recessive disease abbreviated "XP-F" but he does not. Sue is heterozygous for XP-F.

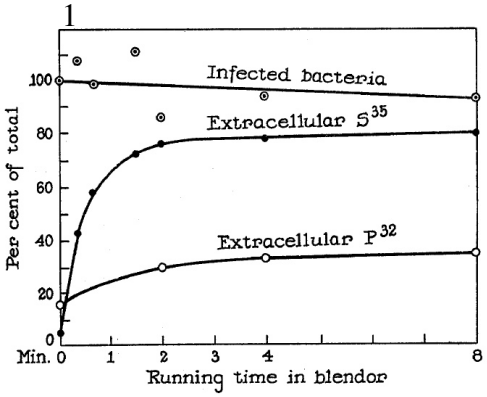
a) What is the probability of them having a child with XP-F? ½ * ½ = 1/4

b) What is the probability of them having a son with XP-F? ¼ * ½ = 1/8

c) What is the probability of them having a son with XP-F or a daughter who is homozygous and disease free? 1/8 + 1/8 = 1/4

Data Gallery

1



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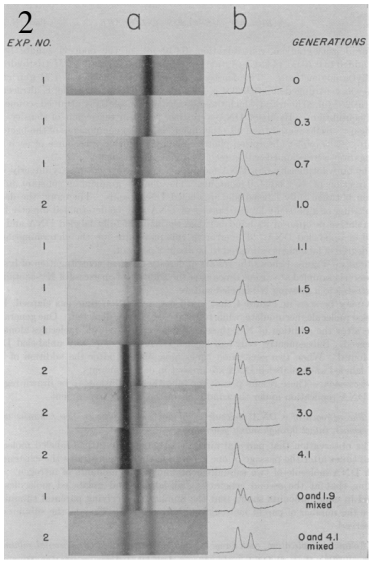

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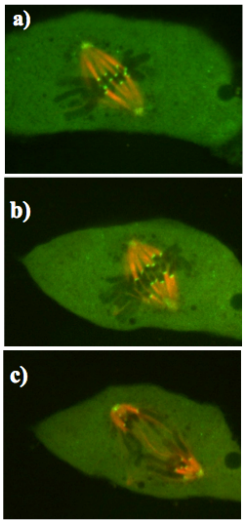

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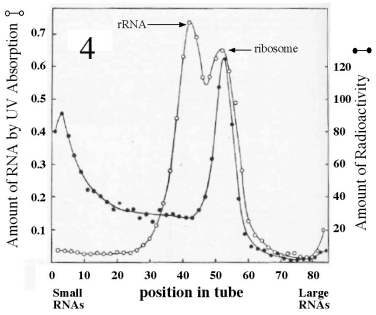

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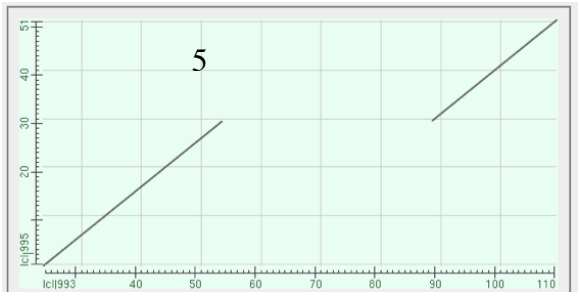

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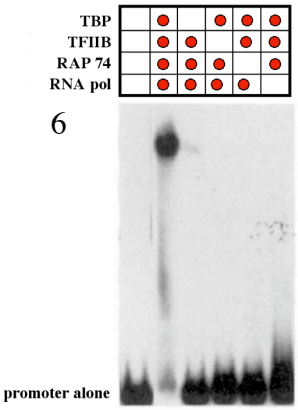

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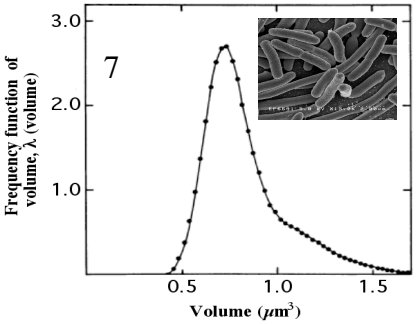

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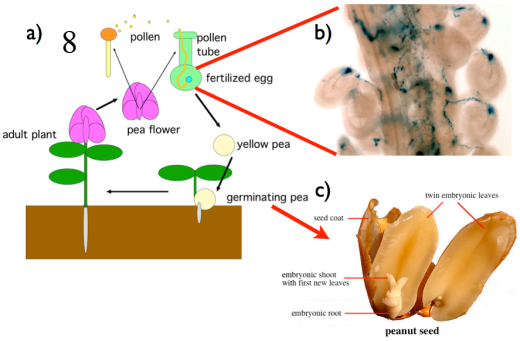

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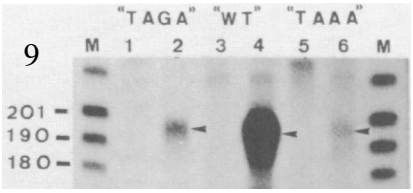

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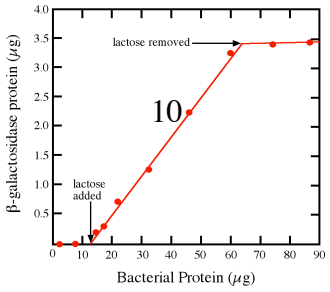

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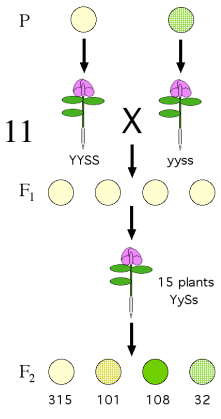

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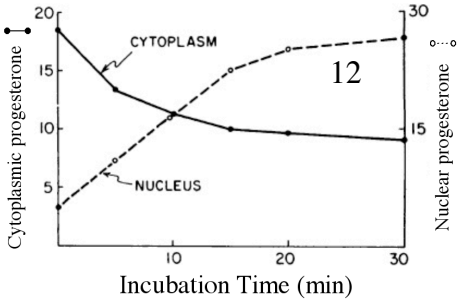

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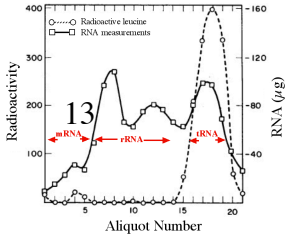

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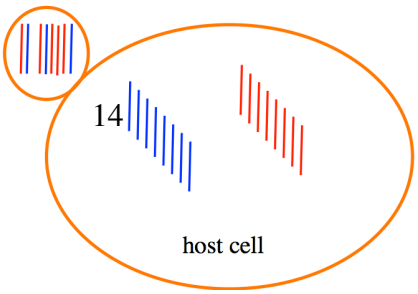

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16

Cell volume 0.70 – 0.75		
Current # of cells in this volume category		100
Minus cells grown to larger volume category	100*0.08	- 8
Plus cells grown from smaller volume category	50*0.08	+ 4
Plus twice # cells that were 1.4 – 1.5 µm³ and divided in half	2*0.1*50	+10
Equals new # of cells after 10 seconds		106

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Table 1.1 Comparison of four independent preparations of the transforming factor and purified DNA.

Sample #	% carbon, C	% hydrogen, H	% nitrogen, N	% phosphorus, P	N/P ratio
37	34.27	3.89	14.21	8.57	1.66
38B	no data	no data	15.93	9.09	1.75
42	35.50	3.76	15.36	9.04	1.69
44	no data	no data	13.40	8.45	1.58
Pure DNA	**34.20**	**3.21**	**15.32**	**9.05**	**1.69**

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Table 2.2 Amount of radioactive RNAs per milligram of total RNA.

Type of RNA	Radioactivity after 7 minutes	Radioactivity after 30 minutes
tRNA	8,620	12,400
rRNA (small)	1,260	2,660
rRNA (large)	714	2,160

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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

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	% β-galactosidase induction		% Permease induction	
Genotype	**- lactose**	**+ lactose**	**- lactose**	**+ lactose**
$I^+ O^+ \beta^+ P^+$	1	100	1	100
$I^- O^+ \beta^+ P^+$	100	100	90	90
$I^+ O^+ \beta^+ P^+ / I^+ O^+ \beta^+ P^+$	1	240	1	270
$I^D O^+ \beta^+ P^+$	1	1	1	1
$I^D O^+ \beta^+ P^+ / I^+ O^+ \beta^+ P^+$	1	2	1	3
$I^+ O^- \beta^+ P^+$	<1	<1	<1	<1
$I^+ O^- \beta^+ P^+ / I^+ O^+ \beta^+ P^+$	1	100	1	100

21

Second Base in Codon

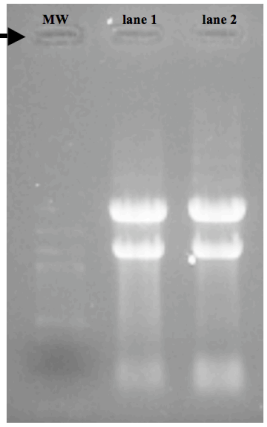
First Base in Codon	U	C	A	G
U	UUU phe F UUC phe F UUA leu L UUG leu L	UCU ser S UCC ser S UCA ser S UCG ser S	UAU tyr Y UAC tyr Y UAA stop UAG stop	UGU cys C UGC cys C UGA stop UGG trp W
C	CUU leu L CUC leu L CUA leu L CUG leu L	CCU pro P CCC pro P CCA pro P CCG pro P	CAU his H CAC his H CAA gln Q CAG gln 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	AGU ser S AGC 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

22

Time	Incorporation into long DNA polymers	
	pmoles ^{32}P primers	pmoles ^{3}H dNTPs
0 minutes	14.4	4.5
20 minutes	74.4	480.0
40 minutes	78.6	765.0
80 minutes	82.2	1062.0

3 wells in the gel

23



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Generation	Green Peas	Yellow Peas
P	5 true-breeding green plants	5 true-breeding yellow plants
F_1	0 green peas	273 yellow peas
F_1	0 plants from green peas	258 plants mature from F_1 yellow peas
F_2	2,001 green peas	6,022 yellow peas

25