

## Biology 113 Closed Book Take-Home Final Exam

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 final exam, including this cover sheet. There are two supplementary files as well: "FinalExam\_F2022.xlsx" and "Final\_Exam\_Seqs.docx". 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 by noon Friday December 16. **EXAM IS DUE NO LATER THAN NOON FRIDAY DECEMBER 16<sup>th</sup>**. If you turn in your exam late, then you lose a letter grade for each day you are late unless you communicate with me in advance. The **answers to the questions must be typed directly under the questions** unless the question specifically says to write the answer in different place. 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, state Figure #x and do NOT move the image 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, however. 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 together when finished with the exam. Do not print test pages without answers. I only want to see your answers. You can type your answers right under each question.

Name (please type here):

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 Questions

**20 pts.**

1) This lab question is holistic and has 4 parts. You must perform each step to reach the final conclusion and answer all 4 parts of this question. All questions are based on the promoter given in step 1.

**Step 1:** Copy and paste in the space below the oligos (obligator site

<https://gcat.davidson.edu/igem10/>) you would purchase for cloning the promoter below into pClone Red ([http://parts.igem.org/Part:BBa\\_J119137](http://parts.igem.org/Part:BBa_J119137)) to produce RFP.

GAGCTGTTGACAATTAATCATCGGCTCGTATAATGTGTGG

-35

-10

**Step 2:** Graph the data from the attached Excel file. Insert your graph below. Tell me the average and standard error of the mean (SEM) for clone 1. Average = \_\_\_\_\_ SEM = \_\_\_\_\_

**Step 3:** Align the sequences from the four clones in the attached Word file by using Clustal omega (<https://www.ebi.ac.uk/Tools/msa/clustalo/>). Copy and paste the 4 cloned promoter from the aligned sequences. Add underlines for -10 and -35 regions and bold fonts for any mutations you found. To receive full credit, you also must insert a screen shot of only the relevant portion of your sequence alignment, not the entire alignment.

Clone 1:

### Clone 2:

Clone 3:

### Clone 4:

Screenshot here:

**Step 4:** Synthesize all the data. Interpret the structure and function of all 4 cloned promoters.  
(maximum of 30 words for each cloned promoter)

Clone 1:

Clone 2:

Clone 3:

Clone 4:

ICB Book Questions:

**15 pts.**

2) We learned in Chapter 10 why you must breathe oxygen. Now we are going to explore how oxygen is delivered to your cells.

a) The concentration of oxygen in your lungs is about 100 mmHg. If you do aerobic exercises, your muscles can reach a pH of 6.6! If the blood leaving your exercising muscles has an O<sub>2</sub> concentration of about 30 mmHg, estimate the percent oxygen saturation (to the nearest tenth) for hemoglobin and myoglobin. Then fill out the table below based on your answer.

Hemoglobin: \_\_\_\_\_ %

Myoglobin: \_\_\_\_\_ %

	Number of O <sub>2</sub> bound to hemoglobin tetramer				
	0 O <sub>2</sub>	1 O <sub>2</sub>	2 O <sub>2</sub>	3 O <sub>2</sub>	4 O <sub>2</sub>
% tetramers					

b) What emergent property is quantified by hemoglobin's Hill coefficient? Support your answer with data. (maximum of 30 words)

**14 pts.**

3) Humans like to think we are the masters of communication, but bacteria have been communicating for over a billion years.

a) Write a numbered list of 6 steps that constitute the emergent property of quorum sensing in *V. fischeri*. Also, what term is used to describe this type of emergent property (not quorum sensing)? Support your answer with data. (maximum of 20 words for each step)

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.

descriptive term (not a single word) for this emergent property: \_\_\_\_\_

b) Why is quorum sensing evolutionarily favored over constant glowing by the bacterial symbiont? Support your answer with data. (maximum of 30 words)

**12 pts.**

4) Your mother's immune system allowed you to develop in her uterus despite you being non-self.

a) Use 2 figures to disprove 2 hypotheses: i) pregnant women have a weakened immune system; and ii) offspring are protected from their mother's immune system. (maximum of 30 words each)

i:

ii:

b) How does your immune system know when one of your cells has been infected by a virus? Support your answer with 1 figure. (maximum of 35 words)

**14 pts.**

5) Thanks to my inherited DNA, I constantly struggle maintaining a healthy weight and low cholesterol levels....

a) Use figure 23 to distinguish the functions of the *ob* and *db* wildtype genes. Your answer should include the outcomes for the 3 parabiotic mouse pairs.

(maximum of 40 words total)

functions:

top pair:

middle pair:

bottom pair:

b) Explain why i) fad diets are doomed to fail and ii) caloric restriction alone is insufficient to minimize body fat. Support your two part answer with a different figure for each part. (maximum of 30 words per figure)

- i)
- ii)

**25 pts.**

6) We were each born this way. (If you want a retro break, you can watch Lady Gaga's video from 2011. <https://youtu.be/wV1FrqwZyKw> )

a) Choose 2 figures to explain how the cells of an embryo "know" which genes to turn on and make the correct body part. (maximum of 30 words per figure)

Fig \_\_\_\_

Fig \_\_\_\_

b) Individuals with more than 1 X chromosome must silence all but one X chromosome. Explain what we know about the mechanism for silencing all the genes on one X chromosome but don't address how a particular X chromosome is chosen. Support your answer with 3 figures.

(maximum of 30 words per figure)

Fig \_\_\_\_

Fig \_\_\_\_

Fig \_\_\_\_

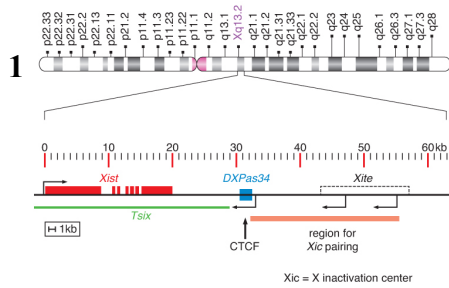
c) Explain to a politician three different examples of sex reversal and why there is no such thing as a genetic test to determine someone's biological sex. Support each example and the genetic test problem with a different figure. (maximum of 30 words per figure)

example 1:

example 2:

example 3:

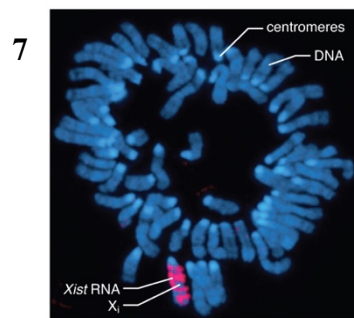
genetic test:



**5**

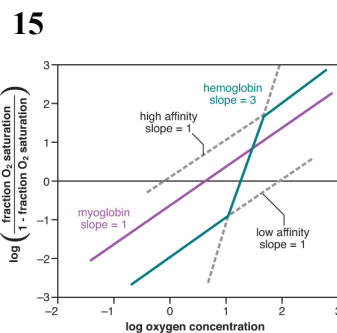
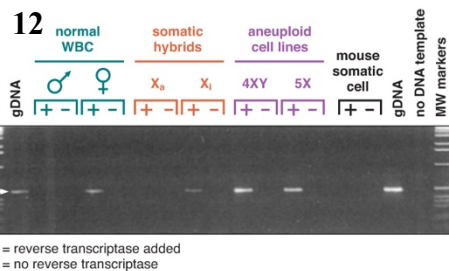
genotype	age (days)	free-feeding mice			pair-fed mice		
		body weight (g)	weight change (g)	percent fat	body weight (g)	weight change (g)	percent fat
wt	20	14.6 ± 0.5*	—	9.5 ± 0.4	15.1 ± 0.6	—	n.d.
wt	48	26.1 ± 0.9	+ 11.5	9.1 ± 0.8	21.4 ± 0.8	+ 6.3	14.9 ± 0.8
ob/ob	20	17.0 ± 0.5	—	23.9 ± 1.1	17.1 ± 0.4	—	n.d.
ob/ob	48	38.8 ± 0.4	+ 21.6	42.9 ± 1.4	25.6 ± 1.0	+ 8.5	43.7 ± 1.0
db/db	20	16.8 ± 0.4	—	24.3 ± 0.9	16.6 ± 0.5	—	n.d.
db/db	48	38.2 ± 0.5	+ 21.4	36.8 ± 0.8	24.3 ± 1.2	+ 7.7	41.7 ± 0.7

\*mean values ± standard error of the mean with 4 mice in each group.

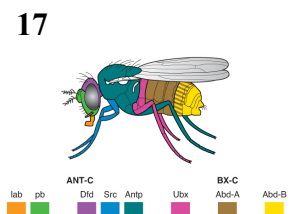
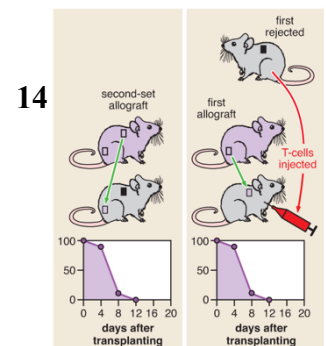
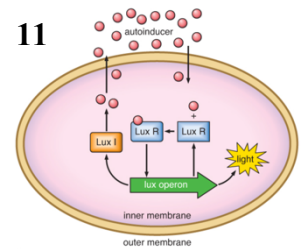
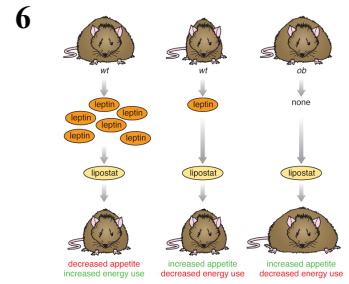
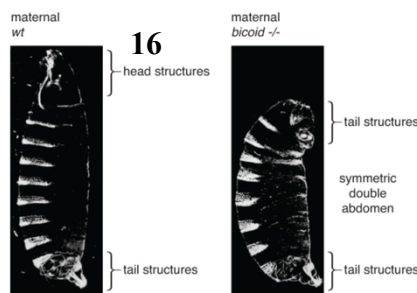
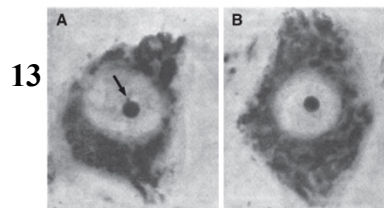
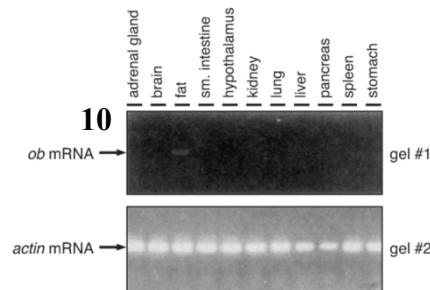
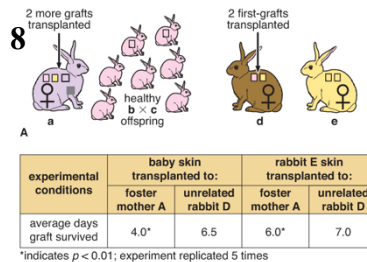
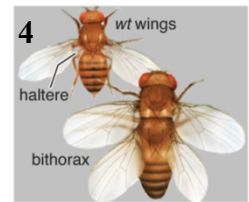
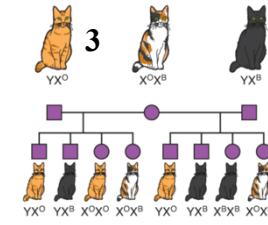
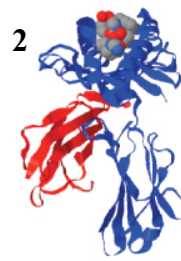


**9**

treatment	strain 1 cells	strain 2 cells
negative control media	delayed	delayed
strain 1 media	immediate	delayed
strain 1 media, filtered	immediate	nt
strain 1 media, boiled	delayed	nt
strain 2 media	delayed	immediate
strain 2 media, filtered	nt	immediate
strain 2 media, boiled	nt	immediate

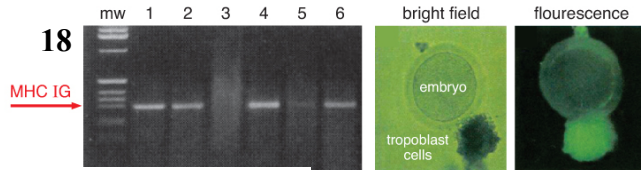


## Data Gallery





Dr. Campbell's Bio113 Exam #4 – Fall 2022



**19**

<i>Xist</i> RNA	DNA methylation	histone hypoacetylation	relative $X^{UP}$	relative $X^{UP}$
wt	wt	wt	1X	1X
deleted	wt	wt	2.5X	100X
wt	blocked	wt	19X	12X
wt	wt	blocked	1X	ND
deleted	blocked	wt	30X	4,800X
wt	blocked	blocked	29X	ND
deleted	blocked	blocked	60X	ND
wt	<i>Dnmt1</i> deleted	wt	1,500X	ND
deleted	<i>Dnmt1</i> deleted	wt	2,500X	ND

