

## Biology 113 Closed Book Take-Home Exam #3 – Chapters 7 - 11

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. 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 submitted. **HARD COPY EXAMS ARE DUE BY 10:30 AM ON WEDNESDAY 10 APRIL.** If you turn in your exam late, you will lose a letter grade which accumulates 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 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.**

Email all your work when finished with the exam.

Name (please print):

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:

**10 pts.**

1) You have the tools to evaluate DNA that you cloned.

a) Here are two miniprep DNA values from the Nanodrop. Tell me how you would set up a sequencing reaction using water and each of these 3 samples (ignoring the primer for now).

Remember you need 320 ng in a final volume of 8  $\mu$ L. (20 word maximum)

Sample 1: 769 ng/ $\mu$ L 260/280 ratio 1.79  $\rightarrow$  0.416  $\mu$ L (or larger volume of a dilution) + 7.584

Sample 2: 18.2 ng/ $\mu$ L 260/280 ratio 1.85  $\rightarrow$  8  $\mu$ L DNA no water

Sample 3: 174 ng/ $\mu$ L 260/280 ratio 1.93  $\rightarrow$  1.84  $\mu$ L DNA + 6.16  $\mu$ L water

b) Use the Word file called 2024\_XAM\_Seqs.docx and Kalign to analyze the cloned promoters X1, X2 and X3 compared to the intended promoter. Which cloned promoter, if any, has the wildtype sequence? Support your answer with a screenshot of your alignment. (20 word maximum) <https://www.ebi.ac.uk/jdispatcher/msa/kalign>

Only X3 matches 100%

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CLUSTAL multiple sequence alignment by Kalign (3.3.1)

Intended      aaggttcggttaacgggtcacg-agt-tcgaccggggcgctatcatgccataccgcgaaagg
X1_cloned     aaggttcggttaacgggtcacg-gtgtcgaccggggcgctatcatgccataccgcgaaagg
X2_cloned     aaggttcggttaacgggtcacg-agt-tcgaccggggcgctatcatgccataccgcgaaagg
X3_cloned     aaggttcggttaacgggtcacg-agt-tcgaccggggcgctatcatgccataccgcgaaagg

Intended      tttgcaccattcgatgggtgtcaacgtaaatgcatgccgcttctttaatactagagggtct
X1_cloned     tttgcaccattcgatgggtgtcaacgtaaatgcatgccgcttctttaatactagagggtct
X2_cloned     tttgcaccattcgatgggtgtcaacgtaaatgcatgccgcttctttaatactagagggtct
X3_cloned     tttgcaccattcgatgggtgtcaacgtaaatgcatgccgcttctttaatactagagggtct

Intended      tccgacga--g
X1_cloned     tccgac----g
X2_cloned     tccgacgagga
X3_cloned     tccgacga--g
    
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ICB Questions:

**15 pts.**

2) Neurons have feelings too.

a) Once an action potential has moved down the length of a neuron, describe the 3 major ways a neuron resets so that it can fire again later. Support your answer with one figure.

1.  $Ca^{2+}$  pumps move ions from cytoplasm to extracellular (#31)
2.  $Na^+/K^+$  pump puts  $3Na^+$  ions out and  $2K^+$  ions in (#3)
3. Ligand wiggles off receptor and  $Na^+$  channel closes (#5)

b) Calcium ions play a critical role in neurons. From where do these  $Ca^{2+}$  ions come and what action do they regulate? Support your answer with one figure for each part of your answer (2 total figures).

Where: extracellular #31

Action: bind to secretory vesicles and facilitate exocytosis #13

**15 pts.**

3) I find muscles to be the most moving organs in our bodies.

a) Calcium ions play a critical role in muscles. From where do these  $\text{Ca}^{2+}$  ions come and what action do they regulate? Support your answer with one figure for each part of your answer (2 total figures).

Where: in lumen of sarcoplasmic reticulum #23

Action: binds to troponin which pulls tropomyosin away from myosin binding sites on actin #33

b) Neurons and muscle cells share many plasma membrane proteins in common. Make list of 4 similar proteins in both cell types and briefly summarize their contribution to action potentials. Support your answer for each protein with a figure.

1. Ligand-gated  $\text{Na}^+$  channels #5
2. Voltage-gated  $\text{Na}^+$  channels #28 or #34 (threshold)
3. Voltage-gated  $\text{K}^+$  channels #34 (trace goes down)
4. Voltage-gated  $\text{Ca}^{2+}$  channels #23
5.  $\text{Na}^+/\text{K}^+$  pump puts  $3\text{Na}^+$  ions out and  $2\text{K}^+$  ions in (#3)

### 15 pts

4) Sometimes I forget about my memories.

a) A person with photographic memory establishes a long term memory with only one “lesson”. Imagine 4 mutations, each of which could cause a person to be born with a photographic memory, and explain how each mutation by itself would result in a photographic memory.

1. Many acceptable options
- 2.
- 3.
- 4.

b) Why is it easier to form a second long term memory within the same neuron compared to the formation of a first long term memory? Support your answer with data.

mRNA for secretory proteins produced and moved to all synapsis. One puff serotonin sufficient to initiate translation at that synapse. #36

### 15 pts

5) Cells are 50% respiration and half inspiration.

a) Generate a numbered list of carbon sources from food that enter the citric acid cycle. For each source, describe the form in which carbon enters the cycle. Support your answer with a different figure for each source.

1. Lipids/fatty acids → acetyl-CoA #11
2. proteins → acetyl-CoA #7
3. carbohydrates/sugars → acetyl-CoA #22

b) How is the energy in NADH and  $\text{FADH}_2$  harvested to produce ATP? Support your answer with a figure. (40 word maximum)

Bring high energy electrons to transport chain, generates  $\text{H}^+$  gradient in cytoplasm which drives ATP synthase to make ATP from  $\text{ADP} + \text{P}_i$ . #27

### 15 pts

6) It's springtime. Botany plants lately?

a) Start with figure 24 and use a bulleted list to describe how the three parts of photosynthesis are interconnected. Support your answer with multiple figures (at least one for each part). (20 word maximum for each bullet)

- water splitting → replaces PS II electrons that reduce NADP<sup>+</sup> into NADPH #21
- ATP → generated indirectly by electrons in cyclic and non-cyclic flow via cytochromes #16
- C fixation → rubisco uses ATP and NADPH to convert 5C + 1CO<sub>2</sub> into 1 6C sugar #29/26

b) Summarize how the two halves of photosynthesis are each regulated by homeostatic mechanisms? Support your answer with a different figure for each half. (30 word maximum for each half)

1. light reaction: blue (mid-day) light promotes cyclic electron flow which conserves water, red light (early and late day) promotes non-cyclic flow and water consumption #21
2. carbon fixation: rubisco works best when pH is high and Mg<sup>2+</sup> high in stroma when lights are on #17

15 pts

7) Ligands don't take no for an answer.

a) Draw a G protein in the active (left side) and inactive (right side) states. Label all the major components clearly.



b) Use Figure 18 to compile a four step summary of phosphorylase kinase activation.

1. Gamma subunit inactive when both alpha and beta subunits dephosphorylated
2. Beta gets one phosphate which activates gamma about half way
3. Alpha gets one phosphate slower and contributes to half activation
4. Alpha gets second phosphate slowly and contributes activates gamma completely

Data Gallery



