Biology 113 Closed Book Take-Home Exam #3 – Chapters 9 - 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, plus an Excel file. 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 9:30 am on Wednesday April 15. **EXAMS ARE DUE BY 9:30 AM ON WEDNESDAY APRIL 15**. 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.
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 print):

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

_____

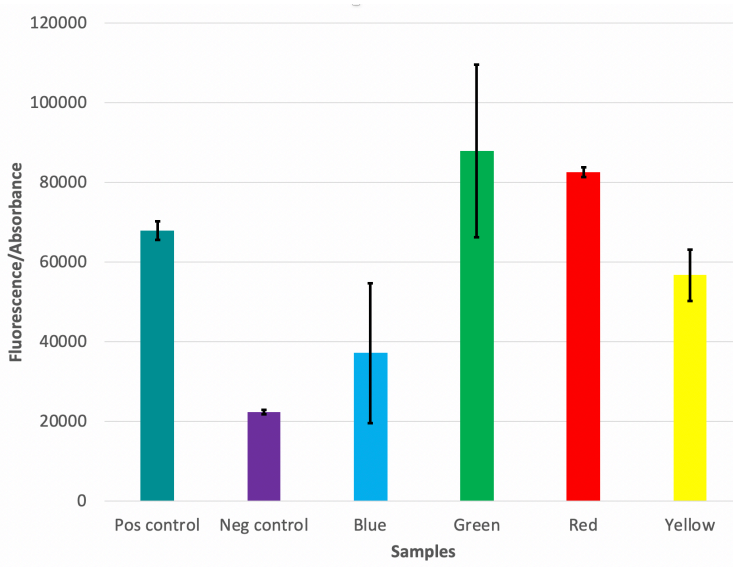
On my honor I have neither given nor received unauthorized information regarding this work, I have followed and will continue to observe all regulations regarding it, and I am unaware of any violation of the Honor Code by others.

How long did this exam take you to complete?

Lab Questions:

10 pts.

1) As you know, I have been working in the lab on your behalf. I came up with 4 new promoters that I named Blue, Green, Red and Yellow. I cloned each of these promoters into pClone Red just as you have done previously. I measured each construct in 5 independent replicates (A – E). The attached Excel file contains the experimental RFP outputs and cell densities (absorbance at 600 nm). I would like you to **a)** generate a graph of the data and submit your Excel file for grading; **b)** interpret the results for each experimental promoter. Be sure to label both axes so I can understand your graph. No need for a graph title. You should use these formulas when analyzing the data: =stdev("Excel cells here"); ="stdev value"/sqrt(n) .



Blue: about equal to negative control, weaker than positive control

Green: about equal to positive control, significantly stronger than negative control

Red: significantly stronger than positive and negative control, about equal to green

Yellow: significantly stronger than negative control, weaker than positive control, about equal to blue.

Lecture Questions:

14 pts.

2) Did someone leave the neuron?

a) Apply figures 10, 13 and 31 to explain how a neurotransmitter is secreted. Focus only on the secretion not how the action potential got there. (maximum of 30 words for each figure)

31: voltage-gated calcium channels flood terminus with calcium

10: calcium binds to proteins on cytoplasmic side of vesicle, allosteric shape change

13: protein from 10 binds to protein on PM and fusion of membranes lets neurotransmitters out of cell

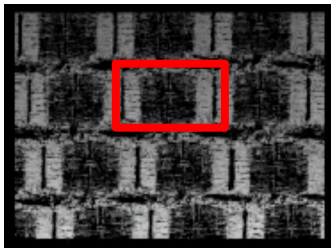
b) To prevent the action potential from moving backwards towards the dendrite, voltage-gated Na^+ channels have refractory periods but voltage-gated K^+ channels do not. Apply what you know about an action potential to explain why the two channels differ. You may use a drawing as part of your answer if you want but this is not required. (maximum of 40 words)

- positive ions moving into neuron depolarize membrane and gate both ion channels open

- K+ leave the neuron and thus repolarize membrane and shut ion channels – no need for refractory period

c) Explain the concept of a threshold potential. Support your answer with data. (maximum of 40 words)
below threshold, voltage-gated ion channels remain closed, at or above threshold and they open to start full action potential; Figure 34 shows one input below (left) and one above (right) threshold

15 pts.
3) Flex your knowledge.
a) The image to the right shows several sarcomeres. Position this red box to outline exactly one sarcomere.



b) Explain why some parts of the sarcomere appear to change in size (name the parts), whereas other parts (name them) do not. (maximum of 40 words)

- dark band is double-ended myosin that pulls actin into the dark band
- light band is actin which is pulled towards center and appears to get shorter but is hidden in dark band

c) What allosteric modulation is terminated when my thesis protein (SR calcium pump) influences a muscle contraction? Focus only on the allosteric modulation caused directly by calcium. (maximum of 30 words)

- calcium pump in the SR retrieves Ca^{2+} to the SR
- troponin is no longer modulated
- tropomyosin slides back to block myosin binding site and muscle relaxes/stops contracting

10 pts.
4) Recall what you have learned.
a) Draw the positive feedback loop that is responsible for long term memory.
Variant that includes PKA to CREB1 to protease to destroying inhibitory subunit of PKA, repeat
Use data gallery figure 36 for details.

b) Synthesize the data from figure 28 to explain to your family why they should let you study each day rather than cramming right before a test. (maximum of 40 words)
memories are stronger and retained longer if training persists over multiple days (purple line)

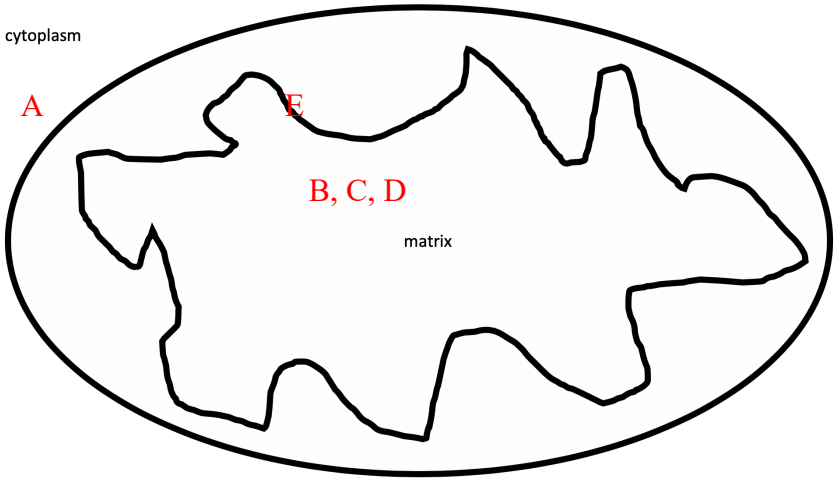
15 pts.
5) Food for thought.

a) List 5 high-energy molecules produced by catabolic reactions prior to the citric acid cycle and state which processes generate them. Support your answer with data. (maximum of 10 words each)

1. ATP: glycolysis 22
2. NADH: glycolysis 22, beta oxidation 11, deamination 7
3. acetyl-CoA: beta oxidation 11, deamination OK 7, post glycolysis 22
4. $FADH_2$: beta oxidation 11
5. pyruvate: glycolysis 22

b) Type the letter (A-E) in the locations each of these processes take place:

A. glycolysis
B. beta oxidation
C. deamination
D. citric acid cycle
E. oxidative phosphorylation



14 pts.

6) You are what you eat.

a) Use figure 22 and explain how the pathway is regulated by a negative feedback loop. (maximum of 40 words)

glycolysis produces ATP which inhibits phosphofructokinase as shown in Figure 1

b) Draw **one** picture that connects the reducing agents NADH and $FADH_2$ to the production of ATP. Incorporate CO into your diagram as well. Neatly label all the key parts of your diagram.

Need to show electronic transport chain (ETC) in membrane, NADH starts at complex I, $FADH_2$ starts at complex II, movement of H+ across mitochondrial membrane, H+ gradient drives ATP synthase to make ATP, CO binds to complex IV in ETC

22 pts.

7) You light up my world.

a) Connect the homeostasis of water consumption during the light reaction with the regulation of cyclic vs non-cyclic electron flow. Support your answer with two figures. (maximum of 40 words)

Figure 3 shows how an electron hole is produced by photooxidation in PSII

Figure 21 shows how blue/red light regulates antenna complex phosphorylation and non-cyclic (red) and cyclic (blue); water provides electrons to fill holes in PSII

b) Explain where the wood in trees comes from. In other words, what is the raw material for cellulose polymers? Support your answer with two figures. (maximum of 40 words)

- Wood is cellulose polymer of glucose and the carbons come from CO_2 that is fixed by rubisco Figure 18 or 15).
- When multiples of 3 carbons are fixed, the G3P 3-carbon sugar can be the raw material to make glucose (Figure 29)

c) A common misconception propagated by traditional textbooks is that plants have light and dark reactions of photosynthesis. The mistake comes from the inference that the "dark reaction" happens at night. Use both halves of figure 16 to refute this misconception. (maximum of 40 words)

- Left: rubisco works best at pH ~8.5 when light strikes chloroplasts (figure 8)
- Right: rubisco works best when Mg^{2+} ions move to the stroma [~5 mM] to counterbalance H+ in thylakoid space)

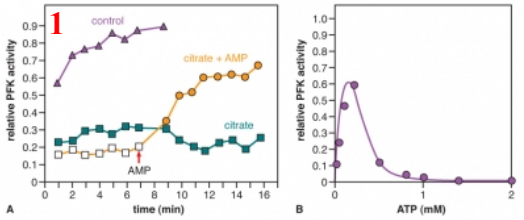
+2 pts

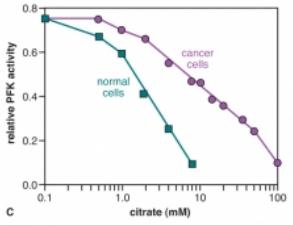
Bonus Question: Integrate what you know about genetics, deamination and memory formation to speculate why a homozygous person with dominant glutamate dehydrogenase (GDH) proteins that cannot be repressed by GTP might not be able to form long-term memories. (maximum of 30 words)

- Long-term memory requires protein production
- GTP required for translation
- GTP represses deamination which means more amino acids for translation
- If GDH never repressed, all amino acids deaminated and no amino acids for memory proteins

Data Gallery

1





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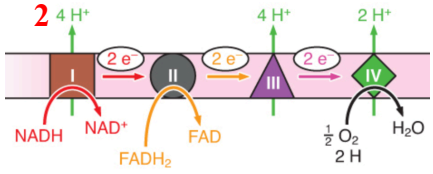

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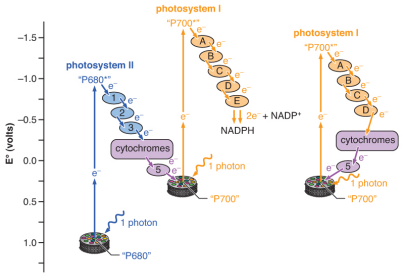

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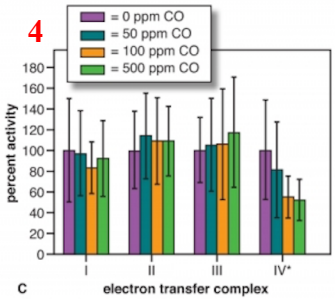

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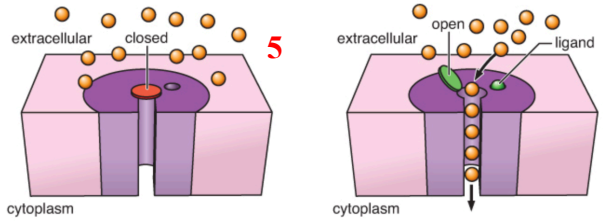

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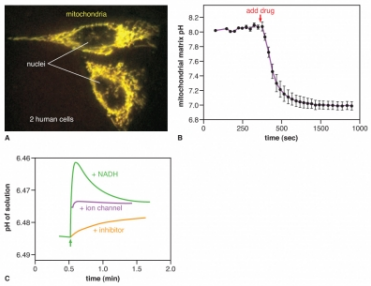

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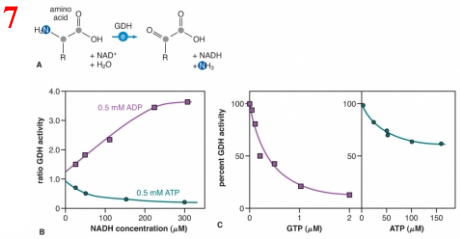

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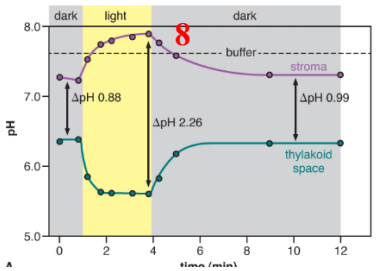

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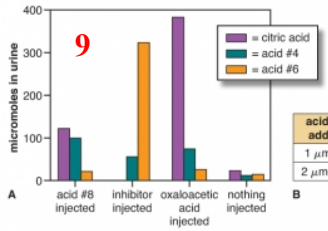

acid #8 added	oxygen uptake (calculated)	oxygen uptake (measured)
1 μmole	6 μmoles	47.2 μmoles
2 μmoles	12 μmoles	69.4 μmoles

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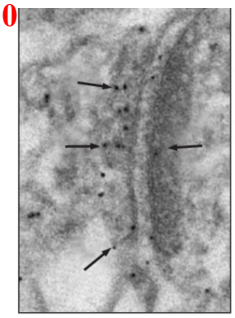

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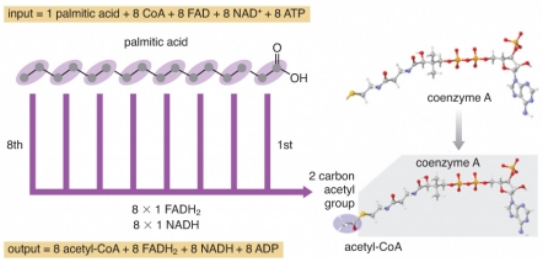

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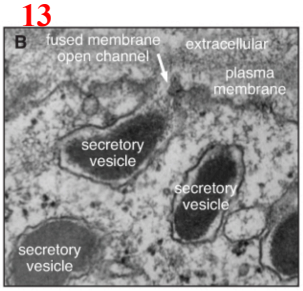
enzyme identification	enzyme (μM)	substrate (μM)	
e1	n.a	s1	near 0
phosphofructokinase	n.a	s2	1,500
e3	810	s3	80
e4	1,400	s4	80
e5	130	s5	50
e6	540	s6	20
pyruvate kinase	170	s6a	65

13



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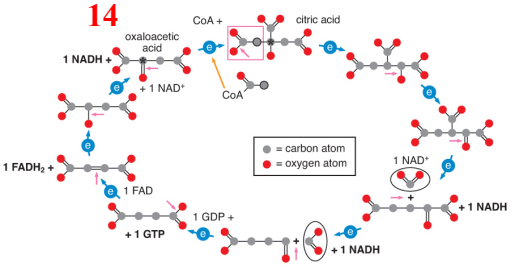

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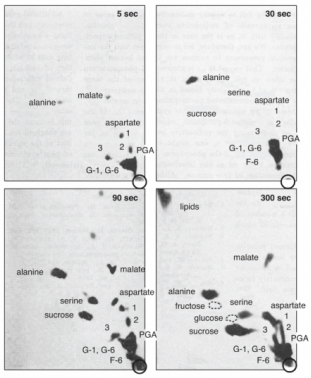

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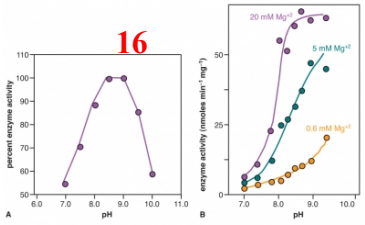

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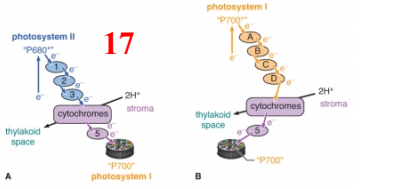

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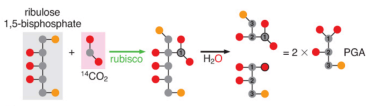

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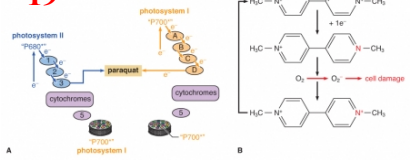

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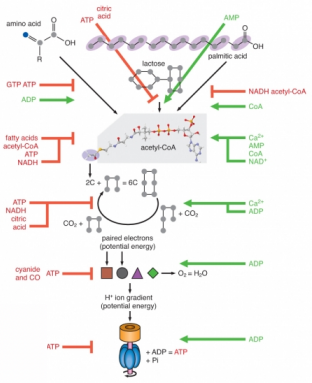

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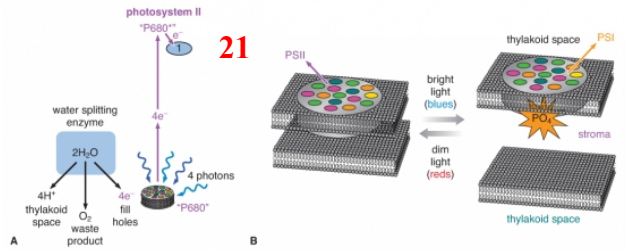

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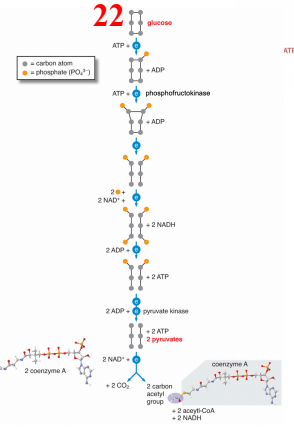

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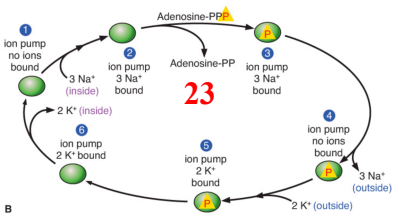

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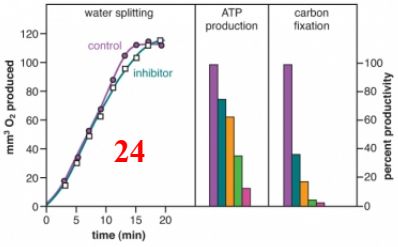

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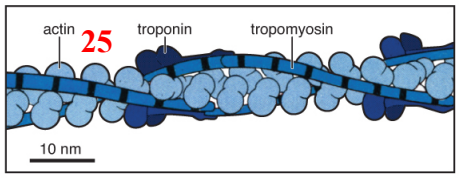
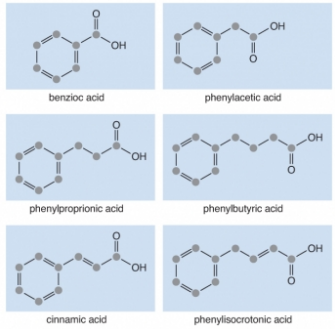


26

ion	intracellular concentration	extracellular concentration
K^+	155 mM	4 mM
Na^+	12 mM	145 mM
Ca^{2+}	0.0001 mM	1.5 mM
Cl^-	4 mM	120 mM

27



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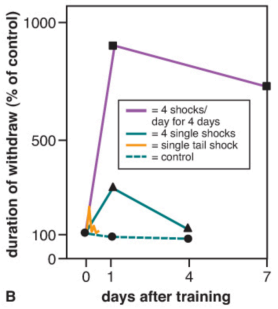

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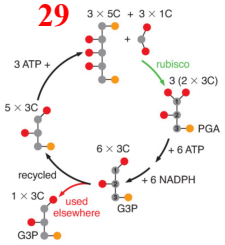

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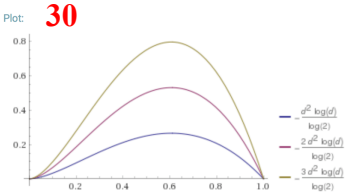

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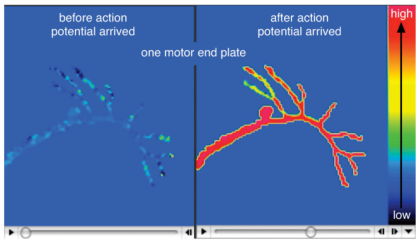

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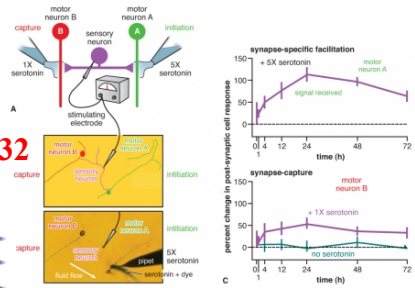

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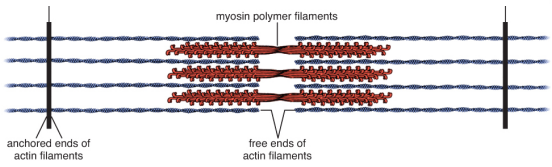

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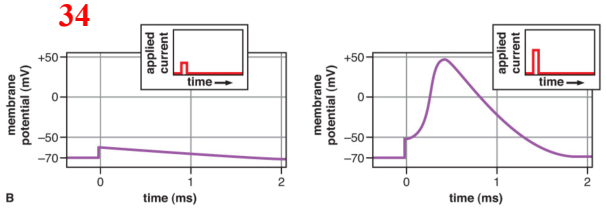

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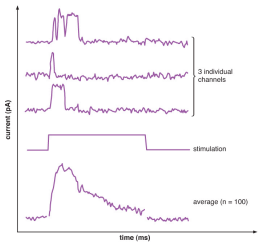

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