Biology 113 Closed Book Take-Home Exam #3 – Chapters 8 - 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 7 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 turned in by 9:30 am on Monday Nov. 17. **EXAMS ARE DUE BY 9:30 AM ON MONDAY NOVEMBER 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 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 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 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.

While you were conducting your research in lab, I was conducting some of my own. Unfortunately, a small meteor landed on my head and I lost the ability to interpret quantitative data. Please help me finish my research and answer these questions. My hypothesis was that the berries would be more toxic than the leaves. Use this web site to analyze the data: http://www.quantitativeskills.com/sisa/statistics/fisher.htm

1) bring shrimp data generated the same way you generate data

Treatment	# Alive	# Dead
Water control	38	2
Methanol control	36	4
Plant A leaves	20	20
Plant A berries	32	8

a) What was my null hypothesis? (maximum of 20 words)

b) Was the methanol toxic? Support your answer with data. (maximum of 20 words)

no

One sided p-values: for p(O>=E):

p(O>=E): 0.3375801 *

c) Was either treatment more toxic than methanol alone? Support your answer with data. (maximum of 20 words)

yes, leaves = 0.62 * 10-5 no, berries = 0.74

d) Was one tissue more toxic than the other? Support your answer with data. (maximum of 20 words)

leaves toxic p = 0.00465

e) Propose an evolutionary explanation for your answer to part d. (maximum of 30 words)

berries need to be dispersed and thus eaten and not toxic

leaves generate energy and cannot be eaten

Lecture Questions:

12 pts.

2) Several questions about cells.

a) Which proteins move faster, large cytoplasmic proteins or integral membrane proteins? Support your answer with data. (maximum of 40 words)

cytoplasmic move faster, #27

b) What are the two main arguments why there are no giant cells. Support your answer with data. maximum of 30 words for each argument)

1. supply vs. demand #30
2. diffusion rates #7 or #27

c) Name one exception to the rule of only small cells and how this species evolved a mechanism to overcome complications of being too big. Support your answer with data. (maximum of 40 words)
giant bacterium with extra genes to produce extra proteins (via extra mRNA) #13

14 pts.

3) some questions about neurons

a) What is the change in cytoplasmic charge when one sodium pump completes one full cycle and consumes one ATP? Support your answer with a figure. (maximum of 40 words)
-1 charge (1 proton loss) difference #28

b) Compare and contrast ligand-gated sodium channels and the calcium channels at the terminus of a neuron. You must list 3 major similarities and 3 major differences. Support your answer with data when possible. (maximum of 30 words for each one)

3 similarities - many acceptable answers, here are 3
1. passive diffusion #44
2. action potential roles
3. cation from outside

3 differences - many acceptable answers, here are 3
1. Ca^{2+} vs Na^{+}
2. gating mechanism #35
3. locations in neuron #34 and #46

c) Describe what a neuron must do before it can send a second action potential. (maximum of 30 words)
refractory period followed by repolarization of Na^{+} and K^{+}

11 pts.

4) some questions about muscles

a) In this movie (http://www.bio.davidson.edu/misc/movies/musclcp.mov), what molecules are in the white band that gets smaller and what molecules are in the dark band that stays about the same? Explain why. Support your answer with visual information. (maximum of 40 words)
actin in light zone, myosin in dark zone #32

b) Muscle cells are giant cells. Describe two adaptations of muscle cells to overcome the limitations of large cell volume. Support your answer with data. (maximum of 30 words for each one)
1. T-tubules increases surface area #48
2. many nuclei #40 make more proteins

c) What role does each ion play in muscle contraction? (maximum of 30 words for each one)
K^{+} : rapid end to depolarization
Na^{+} : depolarization
Ca^{2+} : allows myosin to contact actin

8 pts.

5) some questions about memory formation

a) What is the smallest unit of memory? Support your answer with data. (maximum of 40 words)

synapse #36 or #35C comparing neuron A vs neuron B

b) What separates a long term memory from a short term memory? Support your answer with visual information. (maximum of 40 words)

sufficient activated PKA to activate MAPK #42

10 pts.

6) some questions about cellular respiration

a) Give three examples of homeostasis of cellular respiration. Support each answer with data. (maximum of 30 words) - many acceptable answers, here are 3

1. deamination inhibited by GTP >> ATP #5
2. PFK in glycolysis inhibited by citrate #1
3. deamination inhibited by NADH #5

b) Name three metabolic molecules that are major repositories of energy prior ATP synthesis. Support your answer with visual information in a figure. (maximum of 30 words)

NADH, $FADH_2$, acetyl-CoA (pyruvate) #22

12 pts.

7) more questions about cellular respiration

a) What evidence did Krebs use to deduce the cyclic nature of the citric acid cycle? Cite specific examples. Support your answer with data. (maximum of 30 words)

give animals 8^{th} or 9^{th} acid and first and 4^{th} acids accumulated #12

b) Why do we need to breath in oxygen? Support your answer with a figure. (maximum of 30 words)

final e- acceptor in electron transport pathway #24

c) Which one molecule is the most important one for negative feedback of cellular respiration? Support your answer citing specific examples. (maximum of 20 words)

ATP #24 inhibits nearly every step

12 pts.

8) some questions about photosynthesis

a) Photosynthesis has traditionally been divided into two parts, light reactions and dark reactions. Biochemically, how many distinct parts exist within photosynthesis? Name the parts. Support your answer with data. Please use a numbered list for the parts. (maximum of 20 words for each part)

#21 for all three: water splitting, ATP production, carbon fixation

b) What two molecules are produced as a consequence of cyclic and non-cyclic electron flow? (maximum of 10 words)

NAD**P**H and ATP

c) When photosynthesis generates the two molecules you listed in part b above, do the molecules have a positive or negative ΔG? Explain your answer. (maximum of 30 words)

+ delta G since energy invested

11 pts.

9) some questions about carbon fixation

a) What is required to produce a new ~~PGA~~ G3P which contains three "new" carbons? Support your answer by citing a figure. (maximum of 40 words)

I meant to ask for G3P in which case the answers would have been 3CO2, 9ATP, 6NADPH from figure #18

b) Give three examples of photosynthetic homeostatic regulation. (maximum of 20 words for each example)

1. red v blue light and thylakoid stacking and cyclic v. non-cyclic pathways #14
2. rubisco regulated by Mg^{2+} concentration #24
3. rubisco regulated by pH change #24

c) How is photosynthesis connected to global climate change? Support your answer with data. (maximum of 30 words)

climate change is driven by high CO_2 levels and plants consume CO_2 during photosynthesis but cannot keep up with increased amounts of CO_2 due to human activity #3

Data Gallery

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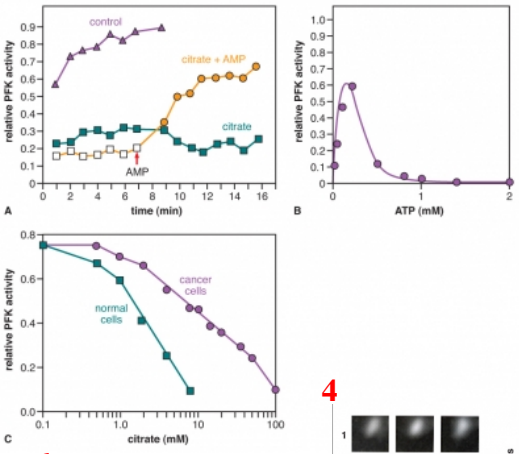
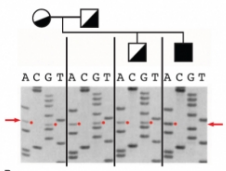


2

lipids tested	16 carbons	14 carbons	8 carbons	4 carbons
family 1	high activity	high activity	low activity	high activity
family 2	low activity	high activity	high activity	high activity
family 3	high activity	high activity	high activity	low activity
family 4	high activity	low activity	high activity	high activity



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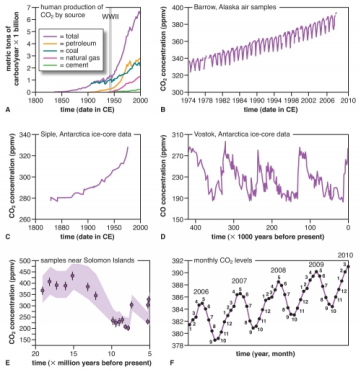

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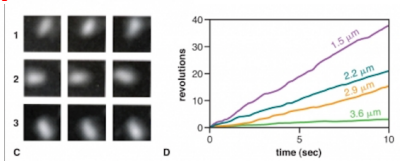

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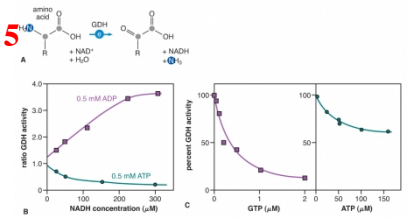

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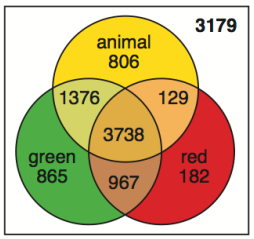

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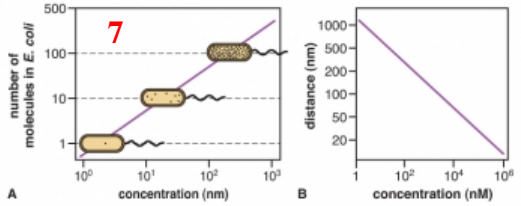

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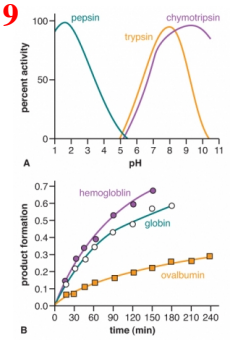
source of protein	protein added	substrate added	oxygen consumed	substrate consumed	product formed
mitochondria	2.7 mg	no	6.1 μmoles	n.d.	0.9 μmoles
mitochondria	2.7 mg	yes	23.2 μmoles	8.0 μmoles	8.5 μmoles
nucleus	3.5 mg	no	1.5 μmoles	n.d.	0.3 μmoles
nucleus	3.5 mg	yes	2.3 μmoles	0.9 μmoles	1.1 μmoles
cytoplasm	4.5 mg	no	1.3 μmoles	n.d.	0.2 μmoles
cytoplasm	4.5 mg	yes	1.0 μmoles	n.d.	0.2 μmoles

9



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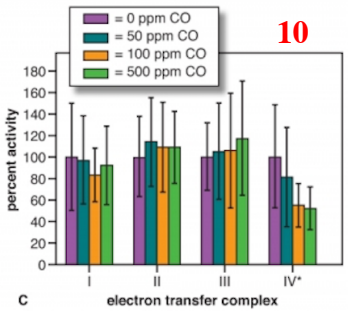

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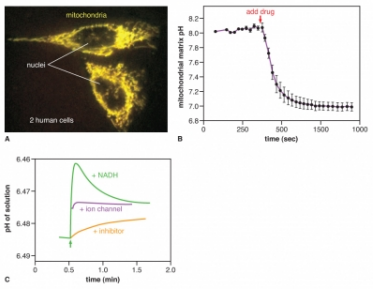

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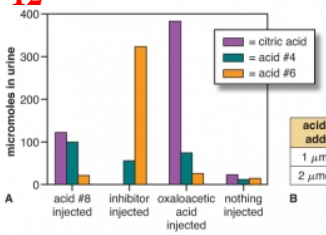

acid #8 added	oxygen uptake (calculated)	oxygen uptake (measured)
1 μmole	6 μmoles	47.2 μmoles
2 μmoles	12 μmoles	69.4 μmoles

13

gene name	average copy number	copy number range
ftsZ	80,600	35,800–198,800
dnaA	48,700	29,800–153,000
recA	120,000	60,300–205,000
16S rRNA	368,000	241,000–737,000

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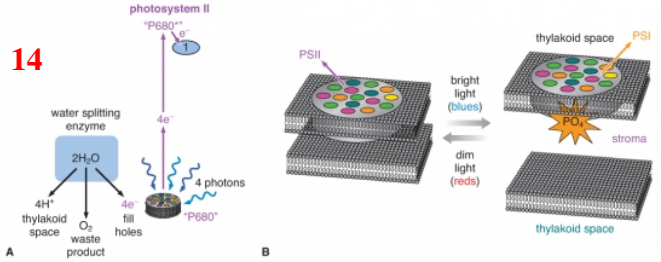

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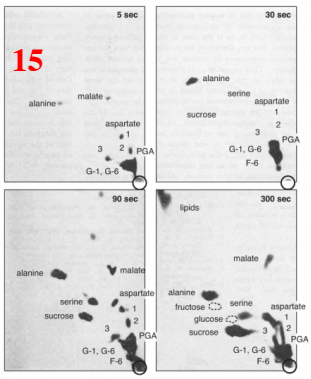

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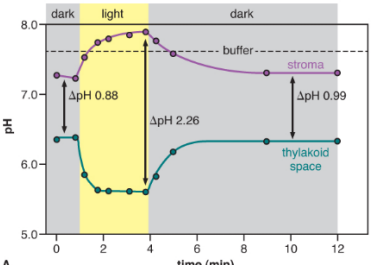

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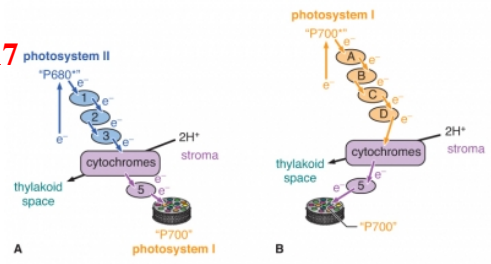

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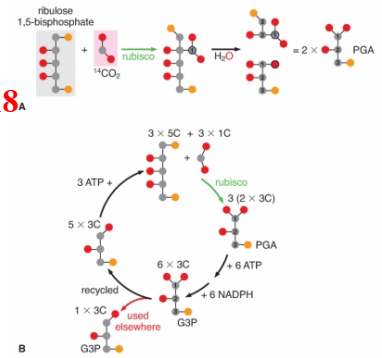

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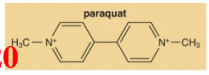

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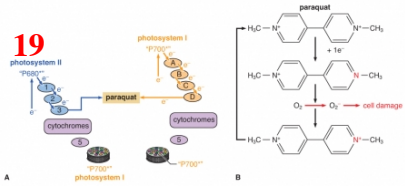

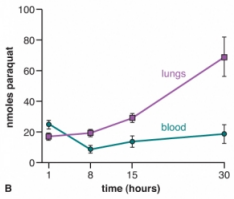

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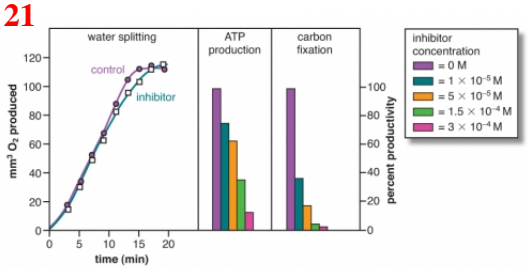

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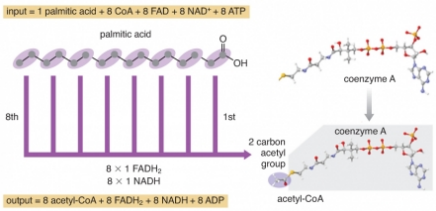

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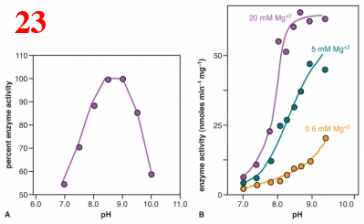

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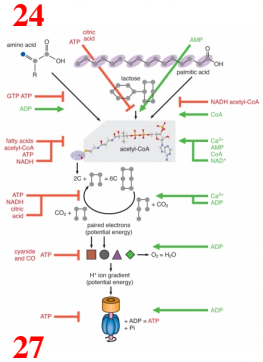

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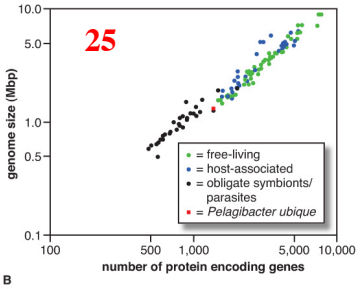

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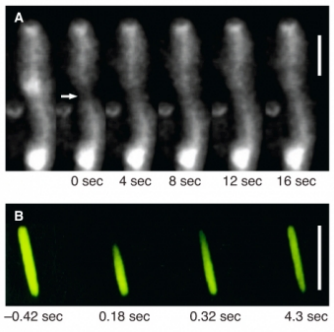

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protein	location	diffusion rate	fold slower
GFP	water	87.0 ± 2.0	n.a.
GFP	cytoplasm *E. coli*	8.0 ± 2.3	~10 X
GFP over produced	cytoplasm *E. coli*	3.6 ± 0.7	~24 X
GFP + sugar-binded protein	cytoplasm *E. coli*	2.5 ± 0.6	~35 X
GFP	periplasm *E. coli*	2.6 ± 1.2	~33 X
GFP + membrane protein	membrane *E. coli*	0.13 ± 0.03	~669 X

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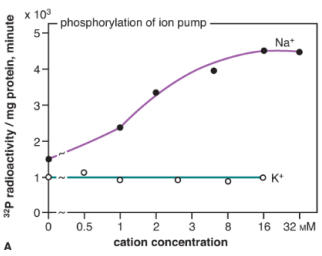

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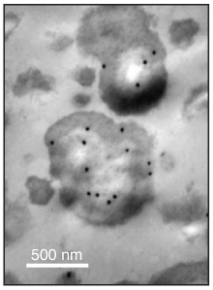

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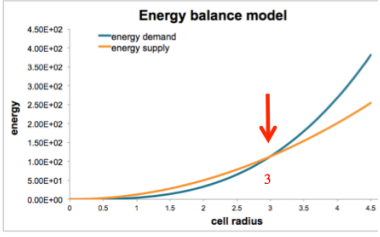

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ion	intracellular concentration	extracellular concentration
K^+	155 mM	4 mM
Na^+	12 mM	145 mM
Ca^{2+}	0.0001 mM	1.5 mM
Cl^-	4 mM	120 mM

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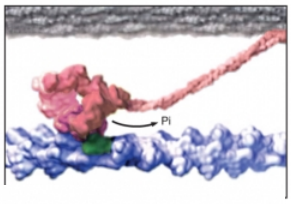

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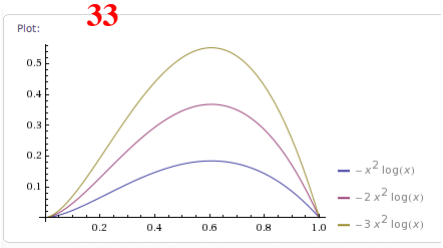

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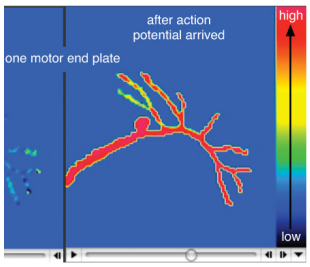

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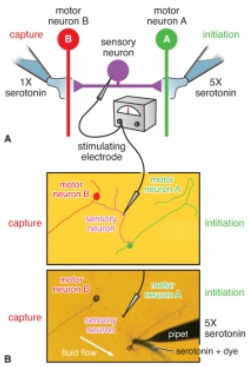

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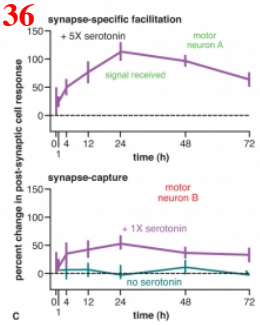

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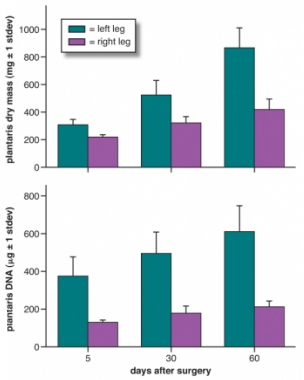

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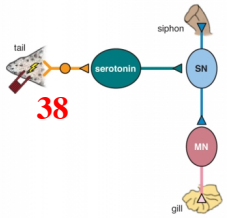

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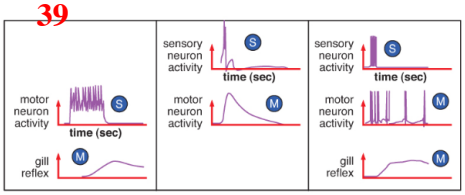

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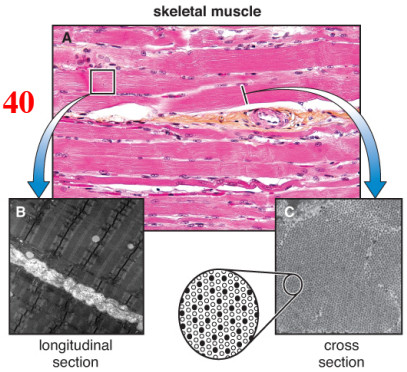

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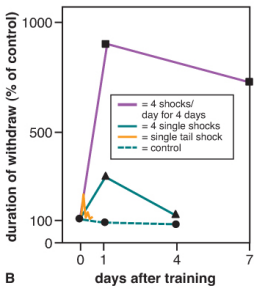

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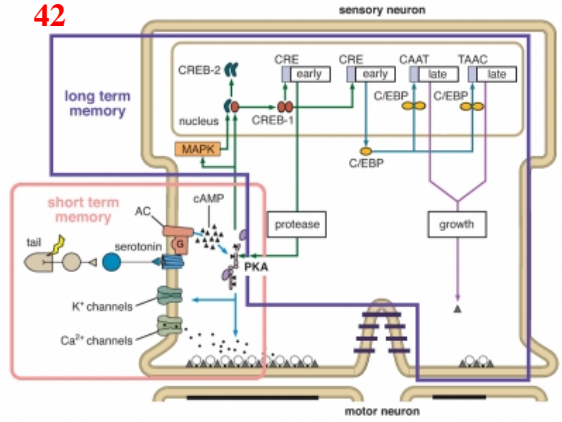

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enzyme identification	enzyme (μM)	substrate (μM)	
e1	n.a	s1	near 0
phosphofructokinase	n.a	s2	1,500
e3	810	s3	80
e4	1,400	s4	80
e5	130	s5	50
e6	540	s6	20
pyruvate kinase	170	s6a	65

B

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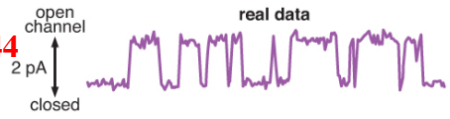

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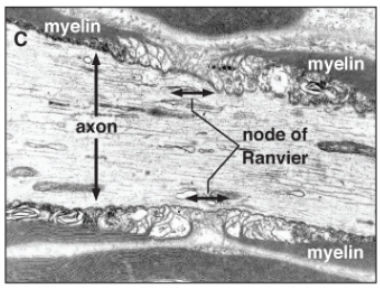

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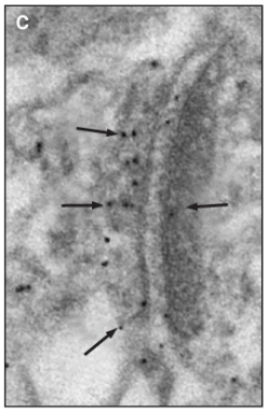

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description	green alga	bacterium	diatom	yeast, fungus	red alga	flowering weed
species	*O. tauri*	*E. coli*	*T. pseudonana*	*S. cerevisiae*	*C. merole*	*A. thaliana*
cell length	1 μm	2 μm	5 μm	5 μm	2 μm	multicellular
genome size	12.5 Mbp	4.6 Mbp	34 Mbp	12 Mbp	16.5 Mbp	140 Mbp
number of chromosomes	20	1	24	16	20	5
number of genes (rounded)	8,200	4,300	11,200	6,600	5,300	27,200

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