Biology 111 Closed Book Take-Home Exam #2 – Evolution & Cells

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 no later than 9:30am on Monday October. 20. **EXAMS ARE DUE BY 9:30 am ON MONDAY OCTOBER 20**. If you turn in your exam late, then you lose a letter grade for each day you are late. You may use a calculator and/or ruler. The **answers to the questions must be typed under each question** unless you draw the answer. 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. You must move the appropriate image from the last two pages and incorporate them into your answers whenever you see the expression "Use data to support your answer." Do not assume how many of the data images you will use, or not use, and you are allowed to use any data image more than once if you need to. Simply placing data near your answer is not sufficient support for your answer. You must explain how the significance of the data and how they support your answer. I have given you sentence limits so be concise.

There are 5 Quick Recall questions that are multiple choice. They are worth 2 points each. Indicate your answers by underlining the letter and the statement of your choice.

-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.

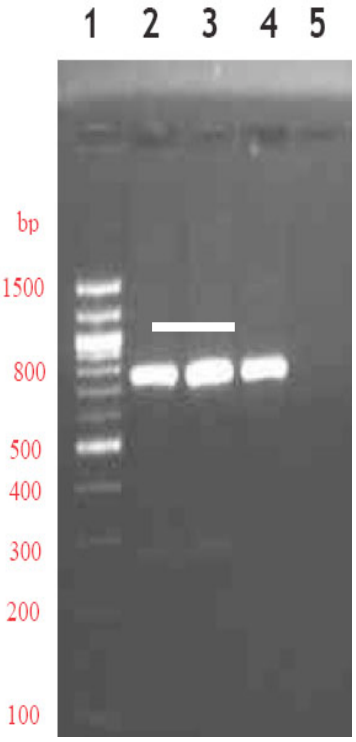
Name (please print):

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.

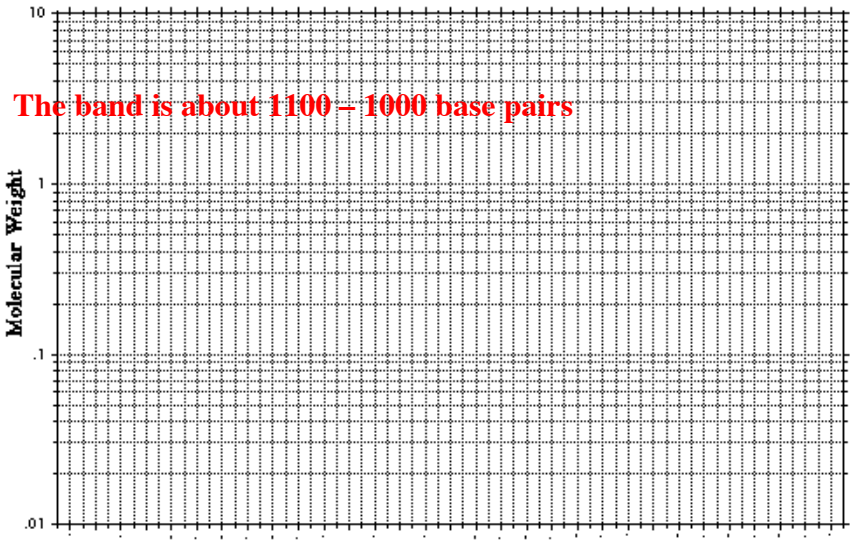
How long did this exam take you to complete?



Lab Questions: You must show your work to be eligible for partial credit.

10 pts.

1) Determine the molecular weight of the large white band that covers lanes 2 and 3. To receive any credit, you must use the graph paper provided here. Tell me your answer in base pairs. I recommend you do this by hand after you have printed out your exam, though you can do it within Word.

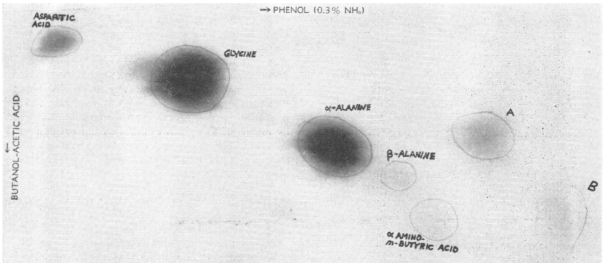


The band is about 1100 – 1000 base pairs

Lecture Questions:

8 pts.

2) Limit your answers to a maximum of **3 sentences for each part**.



a) What was the major outcome from Miller's primitive Earth experiment? Use data to support your answer.

Abiotic forces can produce biologically relevant macromolecules such as the two amino acids shown here.

b) What new question did his research findings stimulate?

Through abiotic means, is it possible to produce biological molecules and structures such as proteins, DNA, RNA and membranes? Could life have evolved on primitive earth in the absences of any living organisms?

18 pts.

3) Limit your answers to a maximum of **6 sentences total**.

Propose a mechanism for the evolution of primitive cells from abiotic components and how this could lead to a population of cells with variation. Support your answer with as many data images as you need to make your case.

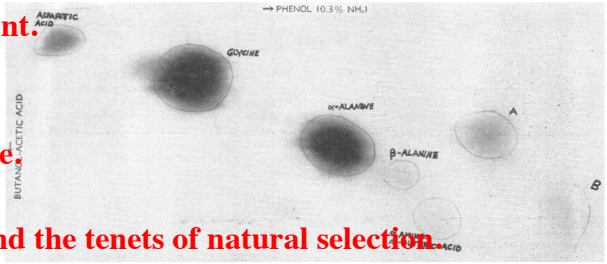
1) Macromolecules via Miller's experiment.

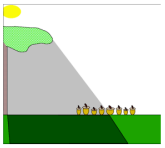
2) Self-replicating RNA ribozyme genome

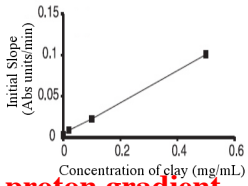
3) Abiotic formation of greedy vesicles and the tenets of natural selection.

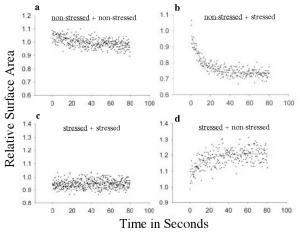
4) Growth and division of vesicles.

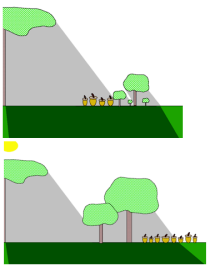
5) Accumulation of energy in the form of proton gradient

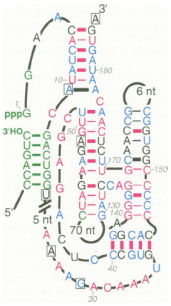


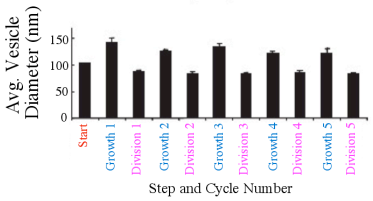


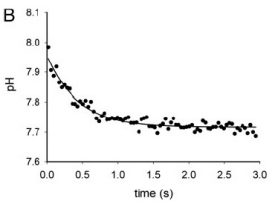


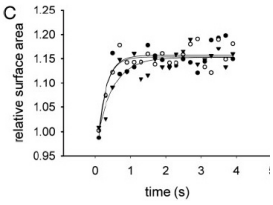










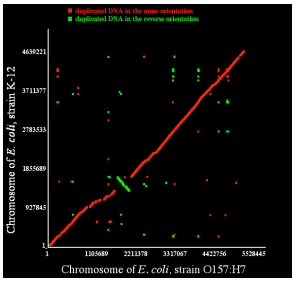


9 pts.

4) Limit your answers to a maximum of **3 sentences for each part**.

a) Categorize the chromosomal differences between two strains of *E. coli*. Use data to support your answer.

inversion, indels, duplications



b) What impact do these data have on evolution of new species?

Evolution does not have to proceed slowly through genetic drift. Rapid changes can occur quickly to produce a new species.

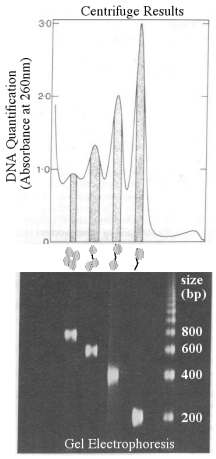
c) How do these data affect the definition of a species?

The definition becomes blurred because these two strains of *E. coli* are considered one species but how many changes in a genome are required before we declare a new species, especially with microbes when traditional mating definitions are hard to measure.

9 pts.

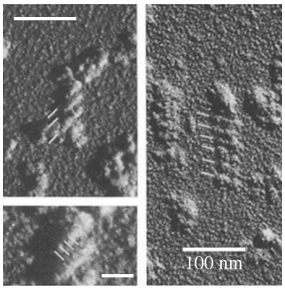
5) Limit your answers to a maximum of **2 sentences for each part**.

a) What happened to the DNA spacer between the beads when the chromatin was in larger pieces? Use data to support your answer.



The DNA between nucleosomes is used to bring two nucleosomes together for higher levels of compaction. If there were no space between them, the beads could not be stackes as in the figures.

b) How does DNA avoid getting tangled? Use data to support your answer.



By coiled, coiled, coiled coils, the think strands of DNA/chromatin are in thick bundles and these are less easily tangled. Furthermore, we have the possibility of glue holding the coils together.

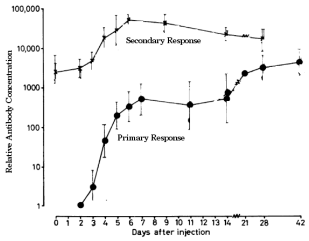
c) DNA bases are 0.34 nm apart and nucleosomes are 10 nm in diameter. Calculate how many bases of DNA are wrapped around the proteins. Use data to validate your calculation.

circumference = d x p: 31.4 nm for a nucleosome and each is wrapped twice: 62.8/0.34 = ~185 bp which is close to the 200 bp seen in the gel above.

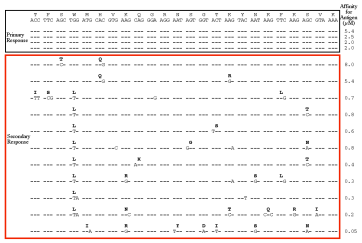
8 pts.

6) Limit your answers to a maximum of **3 sentences for part a** and a maximum of **4 sentence for part b**.

a) Explain how your immune system responds in a secondary response compared to a primary response. Use data to support your answer.



The primary response is slower and produces fewer antibodies. These antibodies have lower affinity too.



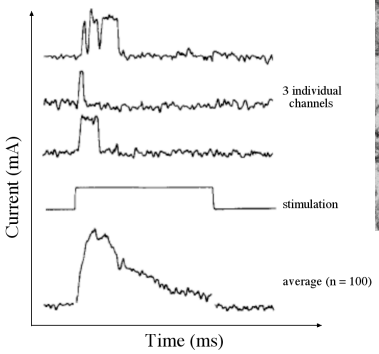
b) Describe the cellular evolution of a secondary immune response. Be sure to utilize the tenets of natural selection in your answer. Use data to support your answer.

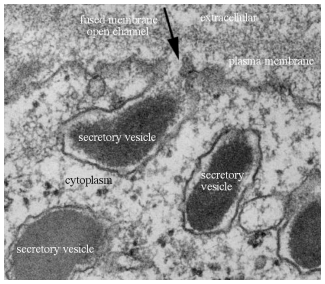
over production, variation in affinities within the population, limited resources for survival, competition, B cells die and some survive.

12 pts.

7) Limit your answers to a maximum of **3 sentences for each part**.

a) Summarize the two different types of communication systems used by neurons and where each of these takes place in a neuron. Use data to support your answer.





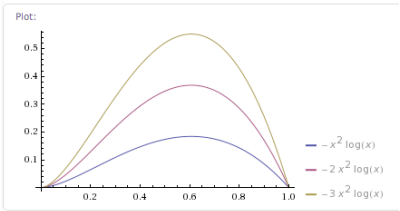
Electrical along the entire length

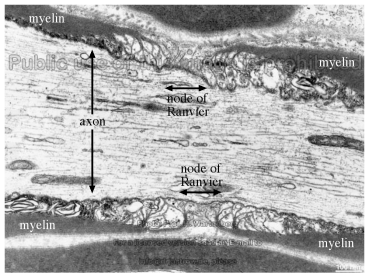
chemical at the input dendrite and at the terminus where exocytosis occurs.

b) Which of these communication systems ultimately triggers muscle contraction? Use data to support your answer.

exocytosis releases neurotransmitter that the muscle converts to contraction.

c) What two things do Schwan cells do to expedite nerve function? Use data to support your answer.



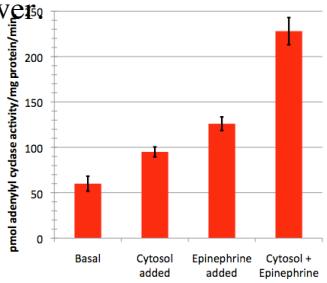


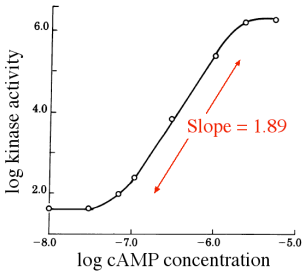
Optimize conductance with the minimal layers and permit faster transmission via nodes of Ranvier

8 pts.

8) Limit your answers to a maximum of **2 sentences for each part**.

a) How did biologists know that an activated epinephrine receptor did not directly stimulate glycogen phosphorylase? Use data to support your answer.





Cytoplasmic factors were required to produce cAMP, cAMP was required to activate PKA, and the time delay between adding epinephrine and the appearance of glucose.

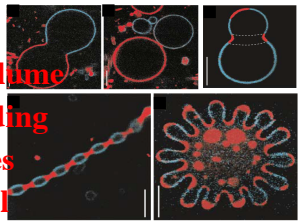
b) How many cAMP molecules it takes to activate PKA. Use data to support your answer.

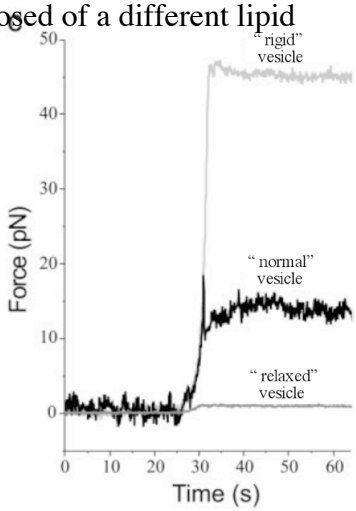
two, see graph above

8 pts.

9) Limit your answers to a maximum of **2 sentences for each part**.

a) Explain why it is adaptive for each eukaryotic organelle to be composed of a different lipid composition. Use data to support your answer.



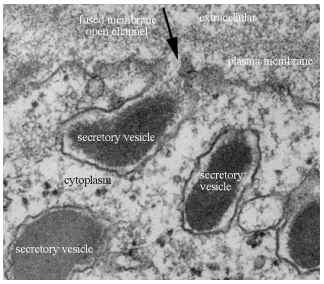


Each one has a particular surface area to volume ratio and different lipids have different bending capacity. Rigid lipids produce larger volumes while relaxed lipids produce bends and small volumes inside membranes.

Lipid Name	Rat Liver ER[a]	Rat Liver Plasma Membrane[a]	Rat Liver Golgi[a]	Mouse Skin plasma membane[b]	Yeast Inner Mitochondria[b]	Yeast Outer Mitochondria[b]	Yeast Inner Nuclear[b]
phosphatidylcholine	58	39	50	43.0	38.4	45.6	44.6
phosphatidylethanolamine	22	23	20	16.1	24.0	32.6	26.9
sphyngomyelin	3	16	8	12.2	0	0	0
phosphatidylinositol	10	8	12	7.6	16.2	10.2	15.1
phosphatidylserine	3	9	6	6.4	3.8	1.2	5.9
phosphatidic acid	0	0	0	0.0	1.5	4.4	2.2
cholesterol	n.d.	n.d.	n.d.	13	--	--	--
cholesterol or diphosphatidylglycerol	n.d.	n.d.	n.d.	--	16.1	5.9	1.0

a: from Gerrit van Meer, 1998, Table 1.
b: from Orientations of Proteins in Membranes, 2010, http://opm.phar.umich.edu/atlas.php.
n.d. not determined

b) Would you predict that the secretory vesicles containing epinephrine would contain more rigid lipids, or flexible lipids? Use data to support your answer.



relaxed due to large surface area to volume ratio

"Quick Recall" Questions for 2 points each

Electronically underline the entire statement of the correct answer.

QR1 Some newly made proteins are transported to the surface of cells. Which statement is true?

a) Viral and host proteins are transported to the cell surface by different mechanisms.
b) Cell surface proteins are produced in the cytoplasm on ribosomes near the plasma membrane.
c) Cell surface proteins are produced by a unique type of ribosome that specializes in this class of proteins.
d) Secreted proteins and cell surface proteins are produced at two different subcellular locations.
e) All of the statements above are true.
f) None of the statements above are true.

QR2 Which of the following statements about protein structure is NOT true?

a) Quaternary protein structure forms when two or more separate proteins interact and form a larger protein structure.
b) Primary protein structure is shaped like cork screws and zigzag bands of amino acids that form as soon as the protein is made.
c) Tertiary protein structure is formed when a single protein folds into its final shape.
d) Secondary structure forms due to hydrogen bonds and the amino acid side chains determine the shapes formed.
e) All of these statements are true and none of them are false.

QR3 A good example of allosteric modulation of protein shape and function is

a) when a ligand binds to its receptor
b) when a kinase phosphorylates a protein.
c) when a phosphatase removes a phosphate from a protein.
d) when two proteins bind to each other.
e) only (a) and (d).
f) all of the above.

QR4 Which of these statements does NOT describe common traits of signal transduction?

a) The original signal is amplified at every step in the multi-step pathway.
b) Signal transduction pathways always need mechanisms to activate and inactivate rapidly.
c) Signal transduction pathways can utilize covalent modulation, allosteric modulation or ion gradients.
d) Signal transduction moves information from the outside to the inside of a cell.
e) All of the statements above DO describe common traits of signal transduction.

QR5 During a normal neuronal action potential, the depolarization phase occurs when

a) sodium and potassium ions move into the cell.

b) potassium ions move into the cell.

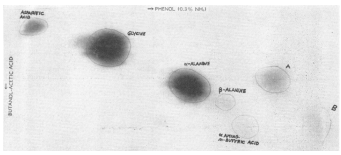
c) sodium ions move into the cell.

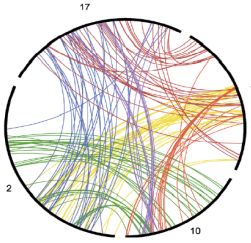
d) the sodium/potassium pump moves ions up their concentration gradients.

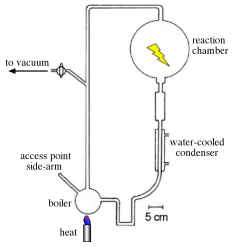
e) sodium ions diffuse down the axon to reach the secretory vesicles.

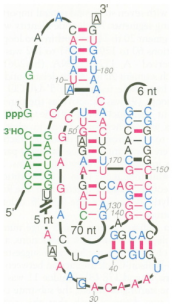
f) none of the above.

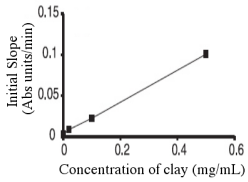
Data Gallery



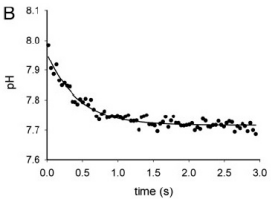


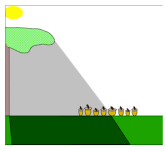


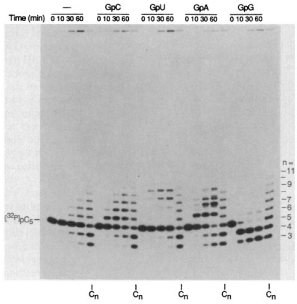


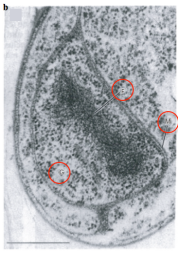


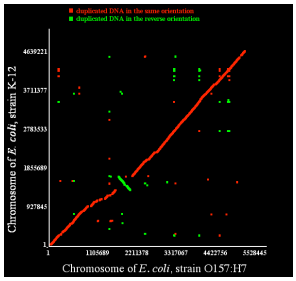
Human Protein #	Protein Function	Protein Location	Best Match Domain
NP_001009	Translation	Cytoplasm/ rER	Archaea
NP_003185.1	Transcription Factor	Nucleus	Archaea
NP_001001937	ATP synthase	Mitochondria	Bacteria
NP_005521	Energy Harvesting	Mitochondria	Bacteria
NP_000393	Energy Harvesting	Cytoplasm	Bacteria
NP_004138	Cell Signaling	Cytoplasm	Archaea
NP_061816	Cytoskeleton	Cytoplasm	Bacteria

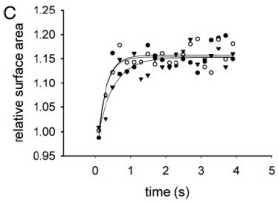


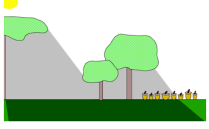


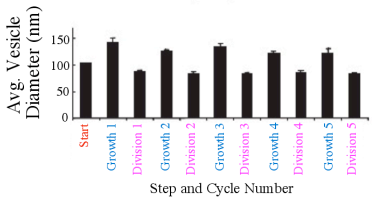


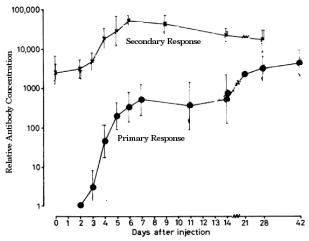


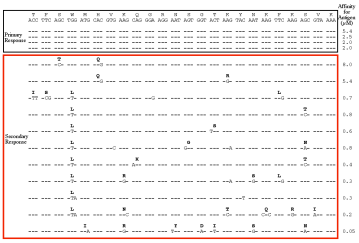


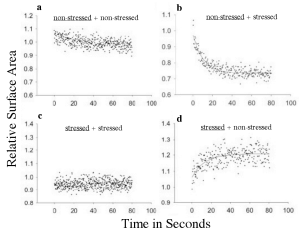


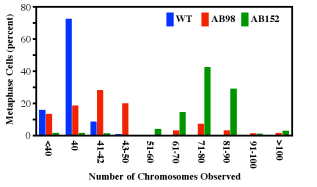


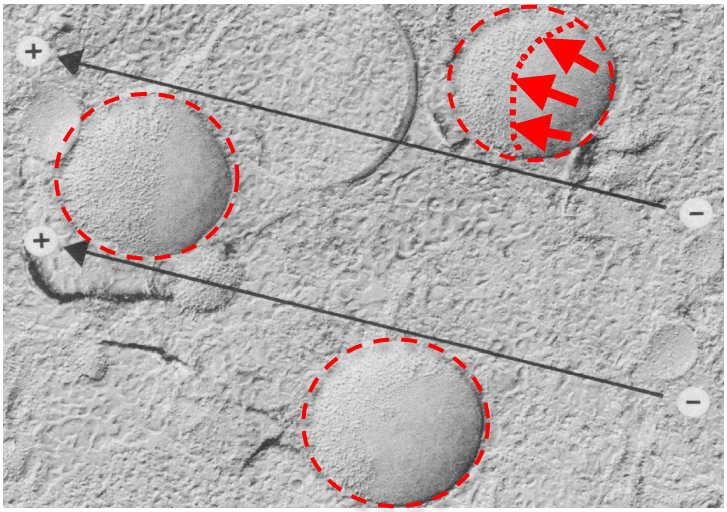


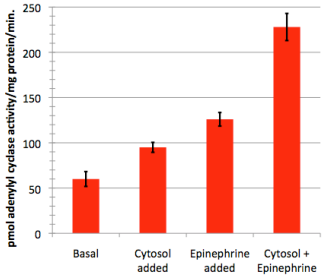


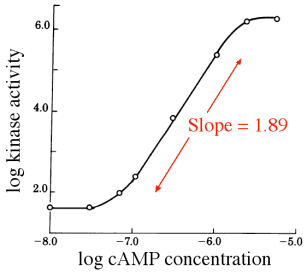


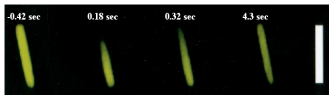


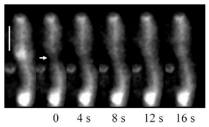


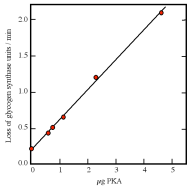


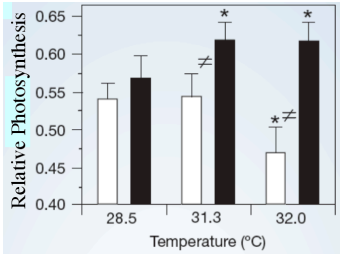


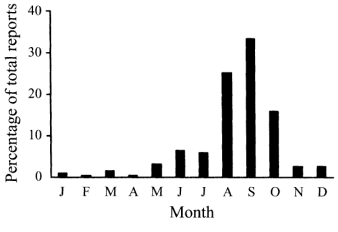


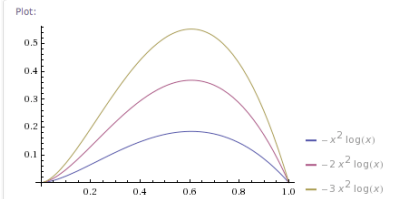




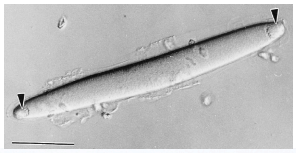


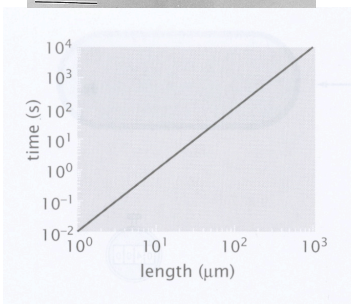


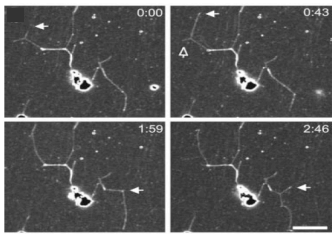


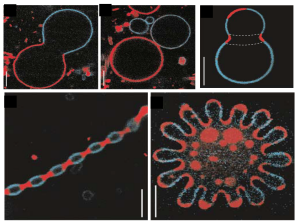


Dr. Campbell's Bio111 Exam #2 – Fall 2010

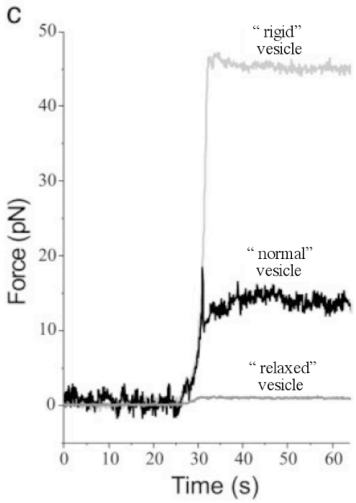








Species	Domain	Description	Genome Mbps	Proteins
Candidatus Carsonella ruddii	Bacteria	Plant eating insect endosymbiont	0.16	182
Candidatus Sulcia muelleri	Bacteria	A leafhopper symbiont	0.25	227
Buchnera aphidicola	Bacteria	Endosymbiont of the aphid	0.42	362
Nanoarchaeum equitans	**Archaea**	Hot vent tube worms symbiont	0.49	536
Mycoplasma genitalium	Bacteria	Urinary tract pathogen	0.58	477
Candidatus Phytoplasma mali	Bacteria	Apple proliferation disease	0.60	479
Ureaplasma parvum	Bacteria	Urinary tract pathogen	0.75	614
Mycoplasma pneumoniae	Bacteria	Bronchitis and pneumonia	0.82	689
Borrelia turicatae	Bacteria	Tick-borne relapsing fever	0.92	818
Chlamydia trachomatis	Bacteria	Leads to blindness and STDs	1.00	874
Escherichia coli	Bacteria	Diarrhea (from undercooked meat)	5.50	5423



Lipid Name	Rat Liver ER[a]	Rat Liver Plasma Membrane[a]	Rat Liver Golgi[a]	Mouse Skin plasma membrane[a]	Yeast Inner Mitochondria[b]	Yeast Outer Mitochondria[b]	Yeast Inner Nucleus[a]
phosphatidylcholine	58	39	50	43.0	38.4	45.6	44.6
phosphatidylethanolamine	22	23	20	16.1	24.0	32.6	26.9
sphyngomyelin	3	16	8	12.2	0	0	0
phosphatidylinositol	10	8	12	7.6	16.2	10.2	15.1
phosphatidylserine	3	9	6	6.4	3.8	1.2	5.9
phosphatidic acid	0	0	0	0.0	1.5	4.4	2.2
cholesterol	n.d.	n.d.	n.d.	13	--	--	--
cholesterol or diphosphatidylglycerol	n.d.	n.d.	n.d.	--	16.1	5.9	1.0

a: from Gerrit van Meer, 1998, Table 1.
b: from Orientations of Proteins in Membranes, 2010, http://opm.phar.umich.edu/atlas.php.
n.d. not determined

Table 11.2 Mobility of proteins in and on *E. coli*.

Protein	Location	Diffusion Rate (μm^2 / sec)	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-binding protein	Cytoplasm *E. coli*	2.5 ± 0.6	~35 X
GFP	Periplasm *E. coli*	2.6 ± 1.2	~33 X
GFP + TatA protein	Outer Membrane *E. coli*	0.13 ± 0.03	~669 X