Spring 2007 Biology 111 Take Home Exam #3 – BioEnergetics

There is no time limit on this test, though I have tried to design one that you should be able to complete within 2 hours, except for typing. There are 5 pages for this test, including this cover sheet. You are not allowed to use your notes, old tests, the internet, or any books, nor are you allowed to discuss the test with anyone until all exams are turned in at 10:30 am on Wednesday April 18. **EXAMS ARE DUE AT CLASS TIME ON WEDNESDAY APRIL 18**. You may use a calculator and/or ruler. The **answers to the questions must be typed on a separate sheet of paper** unless the question specifically says to write the answer in the space provided. If you do not write your answers in the appropriate location, I may not find them.

-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):

Write out the full pledge and sign:

The following statement is the official Honor Pledge of Davidson College: "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 (excluding typing)?

Lab Question:

6 pts.

1) Interpret these data for the 3 cell populations shown in the graph. This was a normal flagella regeneration experiment except one population (Drug1+2) was given drug 1 at 20 minutes and drug 2 at 40 minutes. Conversely, a third population of cells (Drug2+1) was given drug 2 at 20 minutes and drug 1 at 40 minutes. Interpret these data as fully as you can.

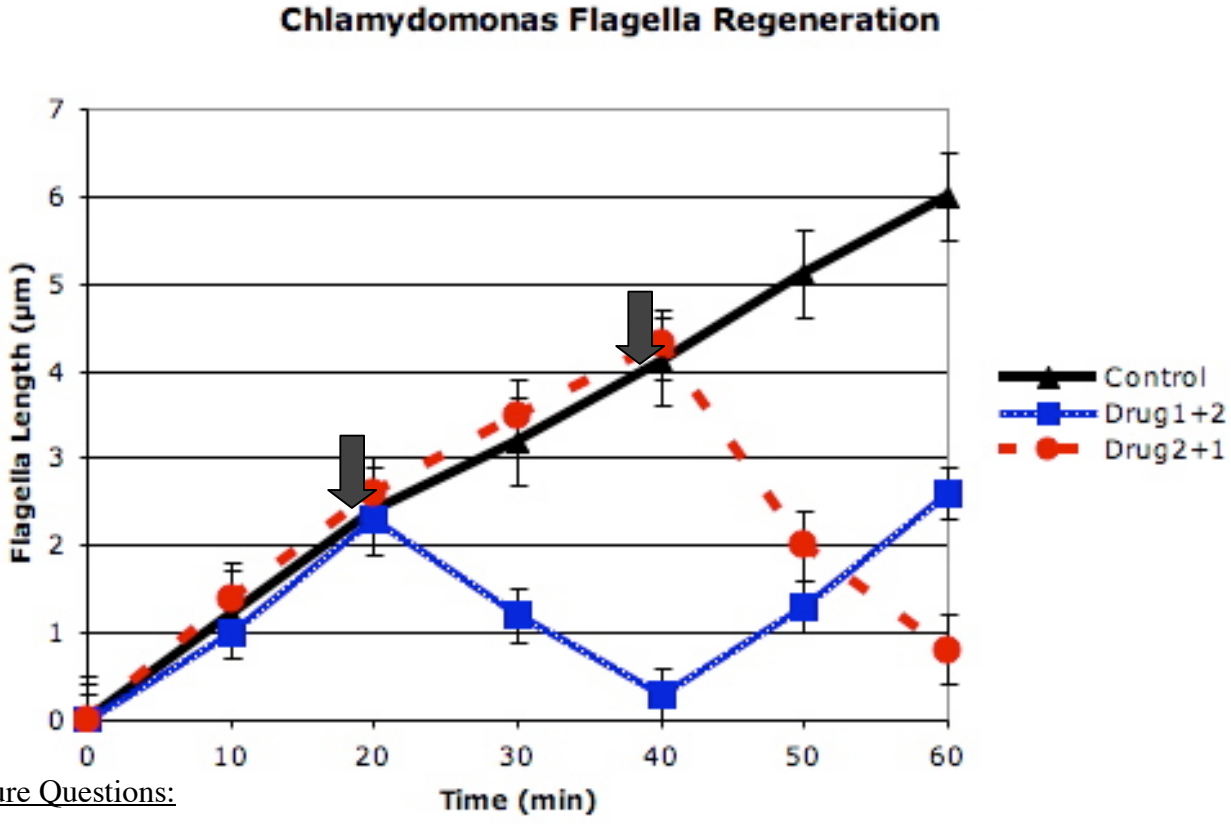
Key points:

drug 1 causes the flagella to shrink, not pop off. You can tell because the error bars are so small.

drug 2 seems to counter/neutralize drug 1

control cells grow fairly constantly over the hour.

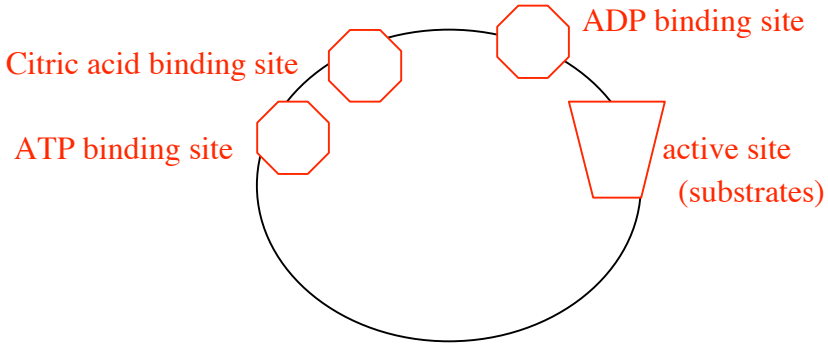
The experimental cells grow at the same rate as the controls when not exposed to drug 1 alone.



Lecture Questions:

5 pts.

2) Draw a picture of phosphofructokinase and label all the key features that are important to its overall function in glycolysis.



10 pts.

3) Consider the evolution of chloroplasts and mitochondria. List 5 characteristics/traits they have in common, explain them in one sentence per characteristic, and state how this shared characteristic underscores their evolution.

Some possible answers include:

Electron transport chain – conserved in both and probably evolved in a common prokaryote ancestor.

NADP+ or NAD+ as electron acceptor– conserved in both and probably evolved in a common prokaryote ancestor.

ATP synthase – conserved in both and probably evolved in a common prokaryote ancestor.

Each has its own genome – remnant of independent life prior to becoming internal symbiont.

Each uses pH gradient – conserved in both and probably evolved in a common prokaryote ancestor.

Each has double outer membranes – remnant of independent life prior to becoming internal symbiont.

4 pts.

4) Explain why anaerobic metabolism is considered advantageous under certain conditions, but inefficient in other conditions. To receive full credit, your answer must include real-world examples of particular conditions not used in the study guide.

If you have no oxygen but need energy (e.g. swimming away from a school of piranha), then 2 ATP per glucose is better than zero. But when you get to the river bank and a swarm of army ants begins to chase you, you can jog away with the comfort of aerobic metabolism and about 34 more ATP per glucose.

6 pts.

5) Explain how we acquire the nitrogen we use to make nucleotides and amino acids. Start your explanation with air and include only the major steps.

N_2 in the air is reduced by soil bacteria to NH_3 which is converted to NH_4^+ by the soil's pH. This can be internalized by plants and incorporated into proteins and nucleic acids. We consume the plants, or animals that eat the plants, and we use the nitrogen for amino acids or nucleotides.

15 pts.

6) Diagram the flow of energy and carbon starting with CO_2 and finishing with 3 fixed carbons in one molecule ("3 all new carbons") of G3P. Use red ink for the energy and **black ink for the carbons and all other atoms**. You must identify one protein by name in this pathway.

Looking for diagram similar to what we did in class.

8 pts.

7) If plants can perform cyclic electron flow for the light reaction of photosynthesis, why do they need water?

Non-cyclic electron flow requires the water as a source of electrons to fill the holes left in photooxidized chlorophyll a. These electrons eventually wind up in NADPH as a reducing power for the dark reaction of photosynthesis.

6 pts.

8) Create an outline of the major steps of chemiosmosis.

I was willing to accept either photosynthesis or cellular respiration examples:

I. Reducing power brought to electron transport chain (primary electron acceptor or NADH and $FADH_2$).

II. High energy electrons enter electron transport chain.

III. H^+ ions pumped across membrane as electrons passed down the chain.

IV. H^+ gradient established in small, membrane-bound space

V. ATP synthase used as conduit for H+ ions to escape small space.

VI. Movement of ATP synthase converts ADP + Pi to ATP.

6 pts.

9) Define ΔG and oxidation and describe the relationship between them.

ΔG is a measure of the change in free energy which is the energy of a reaction that can do work (subtracting out heat and entropy energy).

Oxidation is the removal of electrons from a molecule and this extracts potential energy from the molecule.

ΔG is negative when a molecule is oxidized because the electrons are removed and the products have less potential to do work (free energy) than did the reactants.