Fall 2003 Biology 111 Exam #3 – BioEnergetics ANSWER KEY

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, except for typing. There are three 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 11:30 am on Monday November 24. **EXAMS ARE DUE AT CLASS TIME ON MONDAY NOVEMBER 24**. 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:

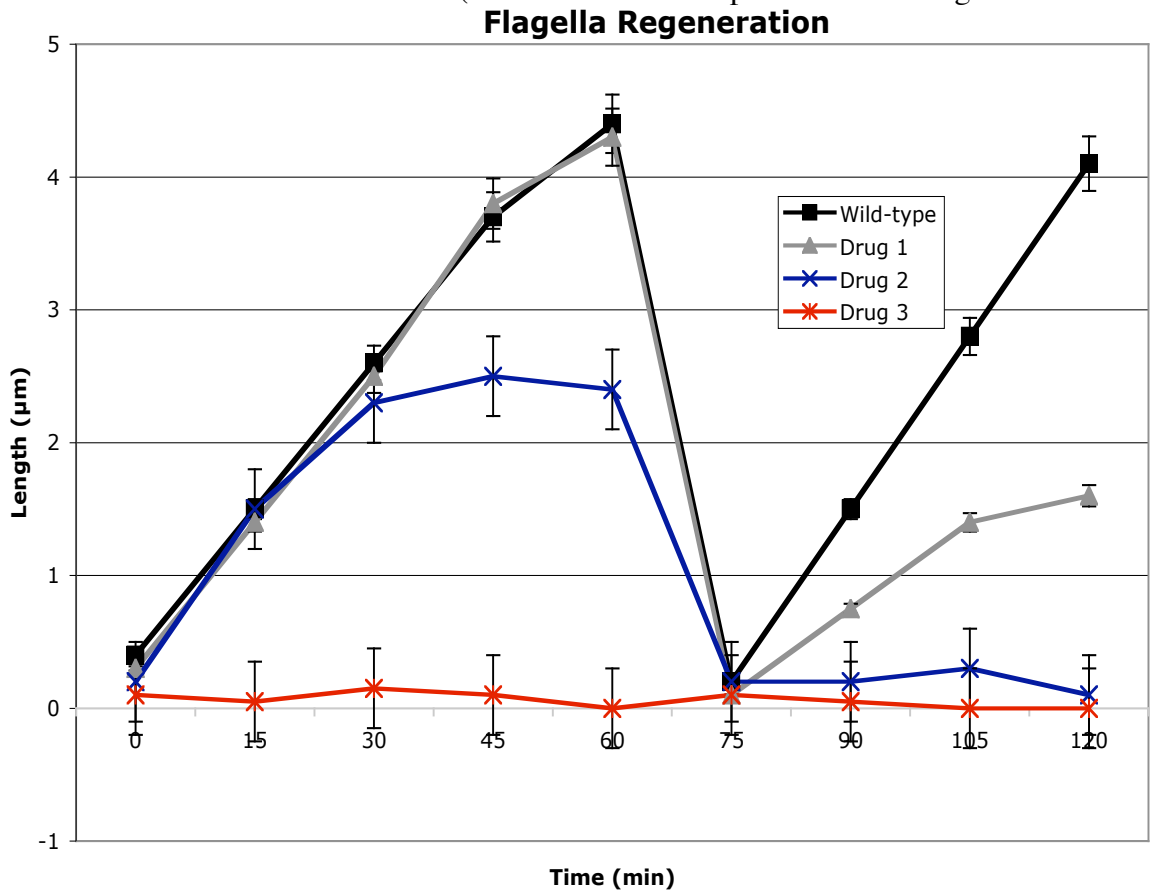
On my honor I have neither given nor received unauthorized information regarding this work, I have followed and will continue to observe all regulations regarding it, and I am unaware of any violation of the Honor Code by others.

How long did this exam take you to complete (excluding typing)?

Lab Question:

10 pts.

1) Interpret these data for the four cell populations as shown in the graph. This was a normal flagella regeneration experiment except at 60 minutes, all cells were deflagellated a second time and their treatments were continuous (i.e. the cells were exposed to their drugs the whole time).



wt – Cells regenerate flagella at equal rates both times.

Drug 1 – appears to be transcriptional inhibitor such as actinomycin D. mRNA plus new and old proteins were sufficient to produce full flagella the first time but the second time the translation of new protein stopped as mRNA was depleated.

Drug 2 – appears to block translation similar to cycloheximide. Pre-made tubulins were sufficient to grow half flagella the first time and no more protein was made so second regeneration was nearly zero.

Drug 3 – appears to block tubulin polymerization the way some chemotherapy drugs do. The cells do not appear to be dead since error bars indicate some growth over time for some cells.

Lecture Questions:

4 pts.

2) Using your own body as an example, provide distinctions between potential and kinetic energies.
Many answers possible here. Either chemical energy or physical energy was acceptable.

10 pts.
3) Diagram the flow of energy in the light reactions of photosynthesis.
Diagrams varied in detail, but certain features necessary for full credit:
Photosystem 1 and cyclic electron flow to produce proton motive force and ATP production via ATP synthase.
Photosystem 1 and 2 for non-cyclic electron flow as above but also NADPH production for the second half (without proton motive force). Water split to replenish electron supply for PSII.

6 pts.
4) a) Why does the absorption spectrum for chlorophyll a differ from the absorption spectrum of a chloroplast?
Chloroplasts contain more pigments than just chlorophyll a (also chlorophyll b and carotenoids). These other pigments absorb different wavelengths of light and thus produce a wider spectrum for the full chloroplast compare to just chlorophyll a.
b) Do chlorophyll a and chloroplast absorption spectra have any features in common? Explain your answer.
Yes, because chlorophyll a is a major pigment in the chloroplast, the pigment contributes to a part of the organelle's overall spectrum.

12 pts.
5) Explain how the products of the light reaction are consumed in the dark reaction. Keep track of the proportions of energy sources. To receive full credit, you must diagram the dark reaction and keep track of the carbons. Simple figures are sufficient (i.e. you do not need chemical structures).
Diagrams varied in detail, but certain features necessary for full credit:
Ribulose bisphosphate plus CO_2 combined to produce a 6 carbon 2 phosphate molecule, and the rest of the dark reaction with the consumption of ATP and NADPH.
You also needed to include the recycling of the carbons to reproduce ribulose bisphosphate with the requisite consumption of ATP. This allowed you to account for the two sources of ATP production and one source of NADPH production. (see #3).
You could do this by a 3 or 6 cycles of the reaction to produce either G3P or glucose.

6 pts.
6) a) What are the two raw material components legumes use to produce amino acids?
Various acceptable answers, but you needed to include a carbon source and a nitrogen source.
b) How do the plants obtain these two components?

Legumes fix the carbon like all photosynthetic plants. Their symbiotic microbes Rhizobium fix the nitrogen to provide the amino group on the amino acid. Discussions of amino acid formation from □-ketoglutarate were especially good topics.

4 pts.

7) Describe how muscle cells acquire the glucose they need for energy.

The main point was to address how glucose is transported passively via a transporter. The glucose concentration is higher outside a muscle cell because it very quickly metabolizes glucose to glucose-6-phosphate in glycolysis.

15 pts.

8) Cellular respiration has three main parts. Make a three column table with each catabolic part heading a different column. In your table, list the products for each of these three parts of cellular respiration.

glycolysis	citric acid cycle (post pyruvate)	oxidative phosphorylation
2 ATP 2 pyruvate 2 NADH	6 CO_2 8 NADH 2 $FADH_2$ 2 ATP	≈ 32 ATP 12 H_2O (same number as NADH + $FADH_2$)

5 pts.

9) a) Why do humans need oxygen to produce ATP?

We need oxygen as the final electron acceptor in the electron transport system. Without oxygen, we would not produce enough ATP since we only get 4 after glycolysis and citric acid cycle.

b) Are there any exceptions to this requirement of oxygen for ATP production? Explain your answer.

As noted above, we can produce 2 ATP from glycolysis which does not require oxygen. However, this requires fermentation which we cannot sustain. 2 ATP/glucose is not enough to survive, however.

8 pts.

10) a) How does cyanide kill?

Cyanide binds to the penultimate cytochrome in our mitochondrial electron transport chains. This blocks the movement of electrons, which inhibits the production of the proton motive force and thus ATP production (except by glycolsyis; see number 12). Too little energy to survive.

b) Why was there concern for pot smokers whose marijuana was contaminated with paraquat?

Two acceptable answers: 1) membrane damage due to oxygen radicals and 2) possibility that paraquat would bind up all the electrons in mitochondrial membranes the same way it does in plants and this might inhibit production of proton motive force.

6 pts.

11) a) Draw the chemical structure of pyruvate.

As per our multiple examples in class, including the optional review session Friday.

b) List and briefly describe as many ways to metabolize pyruvate as you can.

1) citric acid cycle

2) fermentation to lactic acid

3) fermentation to ethanol via acetaldehyde

6 pts.

12) NADH is an essential metabolite that can kill you. Explain this statement.

NADH is a necessary metabolite to bring high energy electrons to the electron transport chain in mitochondia. This leads to the production of ATP.

If you have too much NADH (i.e. too little NAD+) and you cannot produce any more NAD+ by conveying the electrons to the oxidative phosphorylation pathway, then you would die due to a complete reliance on glycolysis as the only source of ATP.

8 pts.

13) Explain how can *Chlostridium tetanii* can kill a human?

Main points:

1) bacteria produce exotoxin

2) exotoxin binds to and is internalized by "relaxing neurons" of the CNS

3) toxin is a metaloprotease that cleaves VAMP and blocks exocytosis

4) neurotransmitter that signals skeletal muscle relaxation is not secreted and thus you die by rigid paralysis.

5) Diaphragm is a skeletal muscle and you suffocate.

PS. For a species name, you should always use italics and capitalize the genus.