

This take-home will be 40 points of your 100 point exam 2. I expect that this test will consist only of your work. Do not discuss this test with anyone else until after the in-class exam. If you have any questions, ask Stuart or Sonya. You may use any outside written material that you wish, but you may not receive/give help to or from anyone else. If you use written material beyond your class notes to answer a question, be certain to cite the source. Any specific information that is not common knowledge should be cited.

Answer each question as concisely as possible. Fully answer the questions, but extra information that does not directly pertain to your answer will not help, and additional incorrect information will cause points to be deducted. The answers must be printed; hand-written papers will **not** be accepted.

1. You have been tasked with helping to develop some drugs to solve some of the more serious problems facing humankind.

A. You are in charge of developing a new chemotherapeutic agent. How will you treat cancer without killing the patients? What will your drug do to treat cancer? How will it eliminate the cancer cells? What are the potential side-effects? (10 pts)

The answer needs detail how the drug will kill cancer cells while not doing undue harm to the patient. Possibilities would be inhibiting telomerase, anti-angiogenesis drugs, adding negative cell cycle regulators like p53, etc.

One example of a good answer: This drug will inhibit the action of telomerase. Since telomeres are shortened during DNA replication, for a cell to divide many times, it needs to express the telomerase protein to add telomeres. This drug will inhibit the telomerase protein thereby limiting how many times the cancer cells can divide. Most adult cells do not express telomerase, so the drug should not kill healthy cells. Some cells, notably gametes, do express telomerase. So side effects may include problems with fertility and inhibition of cell division in skin, stomach lining, etc.

B. You are also trying to develop an anti-viral drug that will be safe for humans. This could be a general anti-viral drug or against a specific virus. Explain how the drug will work to eliminate the virus, while not harming humans. (10 pts)

The answer needs detail how the drug will eliminate the virus while not doing undue harm to the patient. Possibilities would be inhibiting reverse transcriptase for retroviruses, keeping the virus from entering cells by binding a chemical to its surface or the surface of the host cell, inhibiting DNA replication to inhibit viral replication, inducing T-cell activity to recognize and destroy viral infected cells, etc.

One example of a good answer: This drug will be the protein from the surface of HIV that recognizes the human helper T-cells. Infected individuals will be given doses of this protein, which will keep HIV from being able to enter helper T-cells. This binding of the helper T-cell proteins to the viral protein will keep HIV from being able to enter the cells. The patient's own B-cell produced antibodies can then get rid of the HIV trapped outside the cells. Since the drug is simply a protein that binds to the surface of the helper T-cells, there should not be any serious side effects.

2. You are a scientist working for NASA. A life form has been brought back from Mars. Initial experiments have shown that this life form is similar to life on earth, and contains the same biological molecules. Your job is to design a set of experiments that will tell us whether this Martian life form is most similar to animals, plants, fungus, or bacteria (prokaryote). Using Strong Inference (you have been provided the multiple hypotheses), be certain that the experiment(s) that you set up will give a definitive answer to the type of organism that has been discovered on Mars. (10 pts)

Enough experiments need to be done to eliminate all 4 hypotheses. The description of the experiments need enough detail to understand what was done, but not specific techniques. One experiment could

look at the identity of the cell wall/extracellular matrix, which is peptidoglycan in bacteria, cellulose in plants, chitin in fungus, and protein in animals. Looking at the organelles present could differentiate between bacteria- no organelles, plants- chloroplasts, fungi and animals no chloroplasts, but another test would be needed to differentiate between fungus and animals (both also do cellular respiration). Like looking at their motility- fungus cannot move and animals are mobile.

3. Describe a change in the environment that has been predicted to take place over the next 1,000 years. Choose one species, and describe how that species will evolve via natural selection in response to the environmental change you have described. So given this environmental change, how will the species be different 1,000 years from now, and what happened evolutionarily to cause this change? (10 pts)

Answers should start with a predicted and reasonable environmental change- increases temperature, increased rainfall, rising oceans, species translocation, increased pollution, increased CO₂, increased ocean acidification, etc. Then a clear explanation of how the chosen species will have to change in response to the changing environment. Adaptations for cooling the organisms, for surviving weather extremes, to adapt metabolism to function in more and more acidic ocean.

One example of a good answer: Scientists predict more extreme weather events to occur over the next 1,000 years (<http://www.wunderground.com/blog/JeffMasters/entrynum=1732>). In response oak trees will need to change their root structure. To survive flooding, and the lack of oxygen to their roots because of flooding, they will need roots that extend above ground like cypress trees have. And to survive droughts, they will need roots that go deeper underground to get to water.