Homework set #2 (assigned 9 February, due 18 February)

Instructions. As before, these questions have many parts to them. Please make sure you read all of each of these questions, and answer all the questions I ask you. Please remember that, while I do not officially "count off" for grammar, spelling, and overall writing style, I do care about such things deeply. You should *definitely* proofread your homeworks not only to see if your answers make sense and have the correct units labeled, but also to see if your wording and spelling are correct.

Some of the math questions here are pretty straightforward and some require more creative thinking. I want to see how well you can do at each of those things. It will definitely help me to see what you have done if you write, in words, what it is that you are doing and trying to do (in addition to writing mathematical formulae).

There is lots of other useful advice in the solution set to homework 1. I suggest you read it and take it to heart – especially the part about starting this homework *early*.

1) This question will help you think about information and biomolecules. How many different nucleic acid bases are used in RNA? How many different combinations of these bases could you create if you had an RNA strand that was four bases long? How about if your strand was 8 bases long? or 80? You can see that the complexities of life can be stored in genes — you just need to make genes big enough and you can store arbitrarily large amounts of information in them. Information here simply means what kind of base you have in a given order, position, or sequence. How many pieces of information can be carried on a single human gene? Compare this to how many physical "characteristics" a human being has.

Now think about proteins. Proteins are made of amino acids, and life on this planet uses 20 different amino acids. How many different proteins could you make if you had a polymer that was 4 amino acids long? How about 8, and 80? So — you can see that, although protein polymer strands are made up of many fewer monomers than RNA polymers are (that is, protein chains have fewer units in them than RNA chains), there is still an enormous amount of complexity available for proteins. That explains (in part) why proteins are so flexible and valuable and have such a wide range of tasks in living systems.

2) Most telecommunications satellites are in geostationary orbits, that is, they are always above the same place on the Earth. That is why satellite dishes don't have to track back and forth across the sky to find their satellites. How far above the Earth's surface do geostationary satellites orbit? Another kind of satellite orbit is called LEO (low Earth orbit). Some weather satellites and the space station occupy these orbits. Their orbital periods are around 90 minutes. How far above the Earth's surface are these satellites? For problems like this (actually, for every problem), a great way to start is to write down what you know, and what you are trying to find out. You might also want to draw a picture. Oftentimes, these simple steps can take you a long way toward figuring out how to do a problem. You must show your work for this problem; it is not acceptable to just look up the answer.

3) Domain Archaea is vastly underknown: there are many organisms that belong in Domain Archaea that have not yet been identified. Why is this? Where and how would you look for Archaea organisms, and why? I am looking for a fairly complete discussion here – more like a paragraph than a sentences.

4) You are sitting at a traffic light. It is a very, very long traffic light. While you are waiting, you start to think about the traffic signal: red, yellow, green. Light from which of these has the shortest wavelength? the longest wavelength? Light from which of these has the largest energy? the smallest energy? Light from which of these has the highest frequency? the smallest frequency? Light from which of these has the smallest wavelength of peak emission? The longest wavelength of peak emission? You might want to just make a table to write down your answers.