ASTR/GEOL-2040-001: Search for Life in the Universe
Homework #1 (Wednesday Sep 6, 2017) model solutions

1. Can computers be alive?

(i) No, because they would not interact in new/adaptive ways with the environment.
No, because their technology needs fixing and becomes outdated.
No, because there is no natural selection.

(ii) This would not change if computers could reprogram themselves, because they would still suffer from outdated technology and the lack of selection.

(iii) If they were to write programs that could operate machinery to build other computers, they might resemble *some* aspects of life, but to invent new pathways and to adapt to a changing environment there must be natural selection.

(iv) It would never be possible to create true life with computers, because computer technology would be inferior to biology, which in turn is much more diverse. Given the right conditions, life could self-start based just on chemistry, but computers cannot.

The purpose of this exercise was to make you think about the definition of life and that any definition might easily run into difficulties.

2. Darwinian evolution assumes that during replication, life forms can undergo *small variations*. It also assumes that these life forms have to *struggle for survival*, so not all of them will survive. Introducing new medicines reduces the survival of the bacteria and thus increases their struggle for survival. However, the occurrence of small variations during replication continues, which means that those variations that tend to be immune to the new medicine continue to survive and replicate. Thus, these bacteria *have evolved*, just as predicted by Darwin.

The purpose of this exercise was to make you aware of the fact that Darwinian evolution is a *testable theory* and that it passes some simple tests. It is not a matter of belief.

3. Ammonia is not a good alternative solvent for biomolecules, because,

(i) since ammonia is only weakly polar, lipids, and therefore cells, tend to dissolve in it. This would destroy cells that are made out of lipids.

(ii) since ammonia occurs in liquid form only at rather low temperatures, chemical reactions would operate sluggishly. This would slow down chemical and biological evolution and life may not have started.

The purpose of this exercise was to remind you of an important disadvantage of apolar (or weakly polar) solvents for biomolecules and of the fact that at low temperatures, chemical reactions happen slowly.