AST 309L--Review for Exam 3

The subject is life in our solar system, chapters 6, 7, and 8. I will not ask you to memorize the names of particular space missions or names of people, although I may mention a few of the more prominent of these (e.g. you should be familiar with what Viking and Mars Global Surveyor and Mars Odyssey did, and there is a "homework" on Mars Express below).

Chapter 6 is important to read because it gives an excellent overview of considerations about why or why not various planets in our solar system might be interesting for astrobiology, but I will not be asking you specifically about techniques and missions that are discussed in sec. 6.2. Sections 6.1 and 6.3 however are important to study. In particular, the discussion of the variety of energy sources that might be available, and the likely necessity of water

You are supposed to do your own web-based reading about the very recent results concerning the evidence for water on Mars as explained in the "homework assignment" at the class web site. I will ask you about three questions on this topic.

I'm mostly interested in whether you understand the lines of reasoning that lead scientists to think of various objects in our solar system as having different probabilities for life, i.e. good targets for space missions trying to search for extraterrestrial life. These objects include:

The Moon, Mercury, Venus, Mars, the giant planets, their moons Io, Europa, Ganymede, Callisto, Titan, Neptune's moon Triton, and comets. Of course the major emphasis will be on Mars, Europa, and Titan, since those are the objects we discussed most in class and which are covered in detail in the text. And Mars gets more questions than any other object or topic, since we will have spent two lectures on it and there is so much material in the text. You should also be able to explain the history of the controversial Martian Meteorite (including how long ago various things occurred) and the arguments for and against it containing signs of life.

There is one "homework" assignment that I am asking you to research on the internet:
The European Space Agency's "Mars Express" orbiter has made at least two very interesting and (in one case) controversial discoveries. One of them has to do with the detection of a certain gas in the atmosphere that we have discussed as a "biomarker" earlier in this course. What is the gas and what is the dispute in the interpretation? The other discoveries have to do with an instrument called OMEGA. Find out what OMEGA has found and why it might be significant for astrobiology: does its findings suggest that Mars has been wet in the recent past?

Here are some sample questions for you to ponder. They tend to be among the more difficult ones, purposefully; I hope they will give you an idea of how these questions might seem difficult at first sight, but really, clearly, only have one correct answer. Also, most of the "Think about it" questions in the book are useful to make sure you understand the discussion at that point.

1. What is one of the arguments against life on Jupiter or any of the giant planets?
a. There is no liquid water.
b. There is no solid surface at temperatures where life could survive.
c. It is too cold.
d. There is too much methane and ammonia.

2. The Mars Odyssey gamma ray and neutron detectors indicated that just below the surface is:
a. methane and ammonia. b. solid carbon dioxide. c. solid water ice. d. liquid water.

3. It is plausible that Mars had a thick carbon dioxide (CO_2) atmosphere when it was young. The problem with using the greenhouse effect from this atmosphere to explain large quantities of liquid water on early Mars is:
a. With this amount of carbon dioxide, the greenhouse effect would be too large, resulting in water vapor in the atmosphere, not liquid water on the surface.
b. The carbon dioxide should have been quickly lost by impacts and the effects of solar wind particles.
c. The Sun was dimmer when Mars was young, so even a thick carbon dioxide atmosphere wouldn't have provided enough of a greenhouse to allow stable liquid water.
d. The water is mostly in the form of subsurface ice, which would not be much affected by an atmospheric greenhouse.

4. It has been argued that the Martian Meteorite ALH 84001 discovered in Antarctica does NOT show signs of former Martian life, based on:
a. the carbonates found in the rock may have formed at extremely low temperatures.
b. most of the amino acids were right-handed, unlike Earth-based life
c. the abundance of carbon matched that of Jupiter rather than that of Mars.
d. the purported fossils seem too small to contain genetic material

5. If it had been humid on Mars in the recent past, you'd expect
a. Lots of whitish carbonate minerals.
b. No "desert varnish" on rocks.
c. Lots of the greenish mineral olivine.
d. Only very small quantities of clay minerals.

6. What would be a possible location for the origin of life on Jupiter?
a. The layer of the atmosphere composed of methane and ammonia.
b. The layer of the atmosphere containing liquid water droplets.
c. The surface of the core if the pressure is not too large.
d. It is likely that none of these would work because of vertical mixing with the deep hot layers.

7. What might provide an energy source for present-day Europan organisms?
a. Oxygen churned from the ice into the ocean below.
b. Ultraviolet radiation from the sun.
c. Lightning.
d. Impacts of asteroids and comets.

8. Which of the following is true of Titan, a large satellite of Saturn?
a. Because of tidal heating, it is warm enough to sustain some liquid water.
b. Its atmosphere is rich in methane and ethane, important organic compounds.
c. It probably has a methane ocean that covers its entire surface.
d. There are probably liquid oceans, but only below the icy crust.

9. What is a possible explanation why Titan has an atmosphere while Jupiter's moon Ganymede is larger yet has no atmosphere?
a. Ganymede has strong volcanic activity due to tidal heating by Jupiter.
b. Ganymede is warmer because it is closer to the sun, so its atmosphere could have escaped.
c. Ganymede formed at a distance from the sun where water ice, not methane and ammonia ices, could have formed.
d. Titan is not in synchronous rotation with Saturn, as Ganymede is with Jupiter.

10. Which of the following "environmental requirements for life" is most likely to be available on ANY body in the solar system?
a. A liquid, not necessarily water and not necessarily on the surface.
b. An "organic soup" of complex molecules.
c. A sufficient supply of energy to fuel chemical reactions and metabolism.
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11. Which of the following is NOT an advantage of water over other candidate liquids that might be used for life?
a. It will evaorate (become a gas) less easily than the other candidate liquids if the planet's atmosphere is thin.
b. Chemical reactions proceed too rapidly in other candidate liquids.
c. The temperature at which water is liquid is large enough that there is no danger of having a planet's internal radioactivity-produced heat lead to its evaporation.
d. Cell membrances would be difficult to form in other candidate liquids.