AST 309L--Review for Exam 3

The subject is life in our solar system, chapters 7, 8, and 9. I will not ask you to memorize the names of most of the particular space missions or names of people. I do think you should be familiar with the most prominent of the space missions: these are Viking, Mars Global Surveyor, Mars Odyssey, Mars Express, and Cassini/Huygens.

Chapter 7 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, and I will certainly ask you questions about this (see examples below). But I will NOT be asking you specifically about techniques and missions that are discussed in sec. 7.4. Sections 7.1, 7.2, and 7.3, however, are very important to study. In particular, the discussion of the variety of energy sources that might be available, and the likely necessity of water, are things that I expect everyone to understand by now. Also the arguments for and against life on Moon, Mercury, Venus, Jupiter and other outer planets are not discussed elsewhere, but are important to understand.

You should read all of chapters 8 (Mars) and 9 (moons of giant planets). You are responsible for reading most of Ch. 8 on your own; the lecture on Mars only covered the Martian Meteorites (sec. 8.5). Use good sense and recognize that there is much bewildering detail that I will not question you about concerning Mars; try to just summarize the main idea of each section or even paragraph. I won't ask "The first evidence for subsurface water on Mars was found by" with answers like Viking, Spirit, Opportunity, etc. However I would ask "The Mars rover Opportunity found white patches on its trail that disappeared in a couple of days. This was interpreted as evidence for" a. Life b. Liquid water c. something else d. etc. Also: The Phoenix robotic lander had not been launched at the time of writing of your book, and there will be no questions on it (in case you have come across recent news items in poking around the internet).

I think the presentation in Ch. 9 (Moons of Giant Planets) is excellent, and I have paralleled some of it in class lectures, although my lecture on Titan is mostly supplemental. Notice that the Titan "notes" is actually a document (with many pictures, but also lots of text) to be read, unlike the "slides" that are usually online. Also, there is some more technical material in the notes on Titan that is only for those students who happen to be interested in this subject (including abstracts from some technical papers, reaction paths for some of the chemistry, etc.)

Make sure you understand synchronous rotation due to tides, tidal heating, a rough description of the four Galilean satellites of Jupiter (all in 9.1), but then concentrate on Europa (9.2) and Titan (9.3). Notice there is material on other moons of interest, which you should read—I may ask a question about each of them, but no details; the most important of these is Enceladas. A slide show about this surprising moon of Saturn is at the course web site—look through it for a survey, and a "homework problem" on the last slide. I will ask you something about the answer on the exam.

Most of the "Think about it" questions in the book are useful to make sure you understand the discussion at that point. As far as the "Review Questions" at the end of each chapter, nearly all of them are useful. Again, use common sense: If the question is about something you don't have to know, don't worry about it (e.g. 13 and 14 in Ch.7). I think the most valuable tests of how well you understand the material are afforded by the "Would you believe it?" questions at the end of each chapter. The "Quick Quiz" questions are similar to the levels of questions on the exam, and some of them are very similar to what I will use. For that reason there is no purpose in trying to list specific Quick Quiz questions—they are nearly all useful, or else obviously about material that you don't have to know.

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 may get more questions than any other object or topic, since it has a whole chapter devoted to 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.

Here are some sample questions for you to ponder. They tend to be among the more difficult ones, intentionally; They might seem difficult at first sight, but really, clearly, only have one correct answer. If you have to look up the answers, you need to study more—don't waste time trying to find answers if you realize you do not understand enough to answer most of these questions.

1. Which of the following "environmental requirements for life" is most likely to be available on ANY planet or moon in the solar system?
a. A liquid, not necessarily water and not necessarily on the surface. b. An atmosphere, no matter how thin.
c. A sufficient supply of energy to fuel chemical reactions and metabolism. d. A surface.

2. Which of the following is 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.
[OK, d is too difficult—it is asking if you remember that membranes form because of the hydrophobic effect, but that occurs only because water is such a polar molecule, AND if you remember that candidates for liquids on Titan are *not* polar. But I put it in just for "fun," if this can be considered fun in any sense. Anyway, there is another possible answer…]

3. What is one of the arguments against life on Jupiter or Saturn?
a. There is no liquid water. b. Molecules would be destroyed by vertical mixing with the deep hot layers.
c. It is too cold. d. There is too much methane and ammonia.

4. The Mars Odyssey orbiting gamma ray and neutron detectors indicated that the top meter of Mars' surface is rich in:
a. methane. b. solid carbon dioxide. c. hydrogen, probably water ice. d. various hydrated minerals

5. 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

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. The "Great Red Spot."

7. According to your textbook, what might provide an energy source for present-day Europan organisms?
a. Oxygen cycled from the ice into the ocean below. b. Ultraviolet radiation from the sun.
c. Lightning. d. Impacts of asteroids and comets.

8. The primary reason Europa may be warm enough in its interior for a subsurface ocean has to do with
a. The distance of Jupiter from the Sun. b. The presence of other large satellites of Jupiter.
c. The fact that Europa's orbit is nearly circular. d. Heating by energetic particles in Jupiter's magnetosphere.

9. 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 or ethane ocean that covers its surface.
d. The surface liquid is only in ponds and lakes, and isn't even water.

10. 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.