Science 100

Questions for Discussion III (be prepared to discuss these Friday, January 28)

Instructions: Same deal as before. Some of you are included in a group and are also turning in your own set of answers; **stop** doing this. If it persists, I will be forced to give you the lower grade of the two. Turn the answers in by midnight of the day of the discussion (it is okay to send them to me by e-mail).

Ward and Brownlee, *The Life and Death of the Planet Earth*

1. (page 102) The authors perpetuate a common oversimplification: "...[the Sun's] light powers photosynthesis, which coverts sunlight into food sugars by plants..." Plants don't make food sugars out of sunlight *only*; what **materials** are necessary for plants to carry out photosynthesis?

2. (page 102) "In fact, our Milky Way galaxy makes dozens of new stars each year." Really? Find a good photo of a so-called "**stellar nursery**" where such stars are born (web page, book or magazine), and give the complete citation.

3. (pages 104 and 105) The authors don't explain this somewhat cryptic statement: "...if all the hydrogen was converted to helium, the Sun would only **one-fourth** the number of atoms it started with..." On page 103, the authors state that the first critical step in nuclear fusion is to fuse two protons (hydrogen nuclei) into a single deuterium nucleus. This cuts the number of atoms in half, from two to one. How do the authors arrive at the "one-fourth" figure?

4. (page 106) The graph shows the "age of animals", a period in Earth's history where mutlicellular life forms flourish. The graph is spoiled a bit by the cryptic y-axis (the vertical axis) with its "1" and "2" and no other labels. Be the editor of this book and supply the correct label for the quantity this axis represents, **including the units**. Hint: note the point representing "now" and the y-value it corresponds to.

5. (page 109) Fill in the reasoning from "the problem of the life span of the biosphere [of Earth]" and "the probability of finding biologically active planets in our galactic neighborhood." In other words, what's the **connection** between how long life exists on this planet with the likelihood of meeting (or even detecting) an ET (extra-terrestrial)?

6. (page 113) What is **reduced carbon**? For that matter, what is **oxidized carbon**? Give an example of a molecule with reduced carbon. Give an example of a molecule with oxidized carbon? Finally, why is reduced carbon necessary for life to exist?

7. (whole chapter) The Gaia hypothesis is an example of a **feedback mechanism**; in other words, when a change in the biosphere occurs, the consequence of that change "feeds back" into the biosphere to either accelerate the change (**positive** feedback) or slow down the change (**negative** feedback). Which type of feedback (**positive** or **negative**) in any system tends to allow the system to continue? Is the **loss of carbon dioxide** from the biosphere an example of positive or negative feedback? In either case, explain your answer.

8. (page 121) The authors suggest that the "**Cambrian Explosion**" was "a huge rising from the monotony and simplicity of the microbial world that had dominated the planet

for more than 3 billion years." But is their view necessarily widely held? My colleague Paul Koch at UC Santa Cruz has a good overview of competing world views of early complex life at http://www.es.ucsc.edu/~pkoch/lectures/lecture8.html. If the authors' view turns out to be incorrect, and that the late pre-Cambrian period (called the **Ediacaran Period**) turns out to be as bio-diverse as the Cambrian, what does this suggest about the tenure of complex life on Earth?

9. (page 127) The authors make the role of the **mitochondrion** in cells too modest; what is the true role of mitochondria in cells? How is this related to the second law of thermodynamics?

10. (whole chapter) Is the **loss of oxygen gas** a positive feedback or a negative feedback? In either case, explain the mechanism — start with "As oxygen gas is lost from the atmosphere...", give the consequences of the loss, then end with how these consequences affect the level of oxygen gas in the atmosphere.