History of the Earth, Life and the Formation of the Oceans

I. The Beginning
   a. Earth began to form about 4.7 billion years ago as a discrete, globular mass within the solar system.
      i. At this time it was mostly a silicon compounds and iron and magnesium oxides
   b. At about 4 billion years ago, the earth began to heat up, which could have happened by three possible mechanisms
      i. Impacting bodies bombard the Earth and their energy of motion is converted to heat
      ii. Gravitational compression of the Earth into a smaller volume causes its interior to heat up.
      iii. Disintegration of radioactive elements and heat flow away from points where particles are absorbed.

II. Planetary Differentiation
   a. Once the planet got hot enough, it began to melt iron, which is about one-third of its material.
   b. The melting iron sank into the center of the planet
   c. This molten iron solidified, forming the solid core.
      i. When the core formed it raised the average temperature by 2000°C, causing a large fraction of the Earth to melt, and formed the liquid core.
   d. The sinking iron left behind lighter compounds, such as silicon and oxygen on the surface, which later became the crust.
      i. The crust is a relatively thin (about 40 km thick) and rigid layer of the earth
   e. Between the core and the crust formed a residual mantle.
      i. The mantle is partially melted and is the reservoir for magnesium-iron silicates.

III. Formation of the Oceans
   a. As the earth warmed and partial melting occurred, water was released and carried to the surface along with lava
   b. As the lava reached the surface, much of the water escaped as hot vapor clouds, which condensed and filled the basins, thus forming oceans.
   c. Volcanoes also released various gasses such as carbon dioxide, hydrogen chloride and nitrogen.
   d. Through weathering, or erosion, of rocks, other elements were released.
   e. These gasses and the products of the weathering react with the water to form ions, which give the ocean its chemical characteristics and make it salty.

IV. Origin of Life-Synthesis of Organic Compounds (The Stuff of Life)
   a. Proteins, Fats, Carbohydrates, Lipids and Nucleic Acids
      i. Simple organic compounds could have formed from methane, hydrogen, ammonia and water with the help of some lightning
         1. Stanley Miller (1950’s) was able to produce amino acids and other small organic compounds by bombarding
methane, ammonia, water and hydrogen with an electric charge.

ii. Two Theories on the Formation of Complex Organic Compounds

1. Clay in Tidal Mudflats and Estuaries
   a. Served as a template for the spontaneous assembly of proteins and other complex organic compounds. Thin stacked layers of aluminosilicates with metal ions at the surface attract amino acids, which are then warmed and dried repeatedly, and it yields proteins and other complex organic compounds.

2. Hydrothermal Vents
   a. Complex organic compounds formed spontaneously near hydrothermal vents on the seafloor. Experimental tests show that when amino acids are heated and then placed in water, they spontaneously order themselves into small protein-like molecules.
   b. Because of their structure, some proteins may have been able to hasten the formation of other proteins, thus becoming enzymes (molecules which catalyze biological reactions), or binding metal ions and other agents of metabolism.

b. 1st cells originated in the Archean eon, 3.9-2.5 billion years ago (bya)
   i. Prokaryotes- lack a nucleus and membrane-bound organelles
   ii. Little more than membrane bound, self-replicating sacs of DNA
   iii. Because there wasn’t any Oxygen, they must have been anaerobic

c. Proterozoic Eon- 2.5 bya-570 mya
   i. Photosynthesis derived oxygen begins to accumulate in the atmosphere.
      1. Oxygen-rich atmosphere stopped further chemical origin of living tissue.
      2. Aerobic respiration became the dominant energy-releasing pathway.
      3. Oxygen in the atmosphere formed an ozone layer, blocking harmful UV radiation and allowing life to inhabit shallow waters and the land.
   ii. First eukaryotes evolved through endosymbiosis some time before 1.2 bya
      1. Endosymbiosis- one species lives permanently inside the other, in an interaction that benefits both