Historical Geology
Learning Objectives and Study Questions, Chapter 11

1. Describe how the inner (terrestrial) planets differ in mass and composition from the outer (Jovian) ones, and relate these differences to the original composition and early history of the solar nebula.

2. Outline the roles that gravity played in Earth's accretion and subsequent differentiation, and describe how gravity interacted with other processes (e.g., impact heating, radioactive decay, and liquid immiscibility) to give rise to the planet’s internal structure.

3. Referring to a map of the Canadian Shield, identify granite-gneiss complexes and greenstone belts and describe how each is thought to have been formed.

4. Describe one rock type that a geologist could use to distinguish an Archean greenstone belt from a younger sequence of folded volcanic and deep-water sedimentary rocks. Briefly explain what this rock type implies was different about Earth during the Archean compared to later Eons.

5. Specify which of the three major components in Earth's modern oceans and atmosphere — water, oxygen, and nitrogen — were probably formed primarily by outgassing and describe how the third was formed.

6. Describe one feature that a geologist studying a sequence of Archean rocks in the field (without a microscope) might cite to indicate the presence of life on Earth when the rocks were deposited.

7. Briefly explain the significance of the Miller-Urey experiment to our understanding of the origin of life on Earth. The experiment did not yield living matter, so why was it important?

8. Given the ability to study a single-celled organism, distinguish an autotroph from a heterotroph, and a prokaryote from a eukaryote.

1. The Archean Eon represents approximately the first _____ million years of Earth’s history.
   A. 2500
   B. 250
   C. 2000
   D. 200
   E. 500

2. Studies of the rates at which distant galaxies are moving away from Earth indicate the Universe is approximately _____ years old.
   A. 45 billion
   B. 13.7 billion
   C. 4.56 billion
   D. 2.5 billion
   E. 6,000

3. The nebular hypothesis for the origin of the solar system accounts for the ______.
   A. counterclockwise revolution of all planets
   B. orbit of all planets in the same plane
   C. inner planets being small and refractory-rich
   D. outer planets being large and volatile-rich
4. Earth’s moon is thought to have been formed by _____.
   A. splitting out of material from Earth
   B. capture of a nearby planetesimal
   C. loss of volatiles from a Jupiter-like body
   D. a “glancing blow” from a planetesimal
   E. an excess of California cheese

5. Early Earth was heated internally by all of the following except _____.
   A. radioactive decay
   B. impacts
   C. intense solar radiation
   D. gravitational compression
   E. potential energy released during differentiation

6. Most of Earth’s oceans and early atmosphere are thought to have formed by _____.
   A. chemical reactions within the crust
   B. gases emitted by radioactive decay
   C. capture from the solar nebula
   D. outgassing
   E. a non-union workforce

7. Exposed regions of Archean rocks are known as _____.
   A. cratons
   B. shields
   C. platforms
   D. terranes
   E. orogenic belts

8. The earliest continental crust is thought to have formed by re-melting of older crust at _____.
   A. subduction zones
   B. divergent boundaries
   C. hotspots
   D. asteroid impact sites
   E. early burger joints

9. Studies of cratons suggest Archean crust consisted of felsic plutons and gneisses separated by synclinal bodies of altered mafic lavas and marine sediments called _____.
   A. forearc basins
   B. accretionary wedges
   C. banded iron formations
   D. greenstone belts
   E. continental platforms
10. Between about 3.1 and 2.7 Ga, we see evidence in shallow water sediments of the formation of the first _____.
   A. life on Earth
   B. large craton
   C. greenstone belt
   D. modern orogenic belt
   E. multicellular plants

11. The Miller-Urey experiment showed that using chemical compounds and energy sources likely to be present on the early Earth __________ would form rapidly.
   A. DNA
   B. RNA
   C. complex proteins
   D. amino acids
   E. living tissues

12. Life on Earth apparently arose during an 1 Ga window between end of heavy asteroid bombardment and the discovery of the oldest stromatolites, a window from about _____.
   A. 4.5-3.5 Ga
   B. 4.3-3.3 Ga
   C. 3.2-2.2 Ga
   D. 2.5-1.5 Ga
   E. 2.0-1.0 Ga

13. As far as we can tell, life on Earth during the Archean consisted of _____.
    A. prokaryotes
    B. prokaryotes and eukaryotes
    C. simple multicellular plants
    D. all of the above
    E. There was no life on Earth during the Archean

14. In order to replicate the proteins necessary for their reproduction and self-regulation, we think the early prokaryotes used ___ rather than the more complex DNA.
    A. carbohydrates
    B. lipids
    C. RNA
    D. ATP
    E. STP

15. For a number of reasons related to the absence of oxygen and availability of dissolved nutrient compounds, we now think early life on Earth—probably chemosynthetic bacteria—originated in _____.
    A. mid-ocean ridge thermal springs
    B. tide pools and estuaries
    C. terrestrial lakes and streams
    D. the ancient atmosphere
    E. New York's sewers