Chapter 26

Early Earth and the Origin of Life

1) What is the evidence that protobionts may have formed spontaneously?
   A) the discovery of ribozymes, showing that prebiotic RNA molecules may have been autocatalytic
   B) the laboratory synthesis of microspheres,liposomes, and coacervates
   C) the fossil record found in the stromatolites
   D) the abiotic synthesis of polymers
   E) the production of organic compounds within a laboratory apparatus simulating conditions on early Earth

2) In what way is the complex process of photosynthesis similar to some of the simple reactions that are
though t to have led to the origin of life on Earth?
   A) Both involve an electron transport chain.
   B) In both, simple molecules are reduced to form complex organic molecules.
   C) Both require light energy in order to proceed.
   D) Oxygen is a by-product of both types ofreactions.
   E) Both must occur within membrane-enclosed structures.

3) In which of the following ways are ALL living things alike?
   A) They are all composed of cells with nuclei.
   B) They all breathe.
   C) They all contain complex, reduced molecules.
   D) They all have circulatory systems.
   E) They all undergo mitosis.

4) In classifying organisms, scientists try to select groups of organisms with common characteristics due
to common ancestry. Of the kingdoms listed below, which one includes organisms with the greatest variety of life styles, structures, and functions? In other words, organisms in which kingdom are LEAST likely to have common ancestry?
   A) Monera
   B) Protista
   C) Fungi
   D) Plantae
   E) Animalia

5) Current theories of prebiotic evolution are based on evidence for all of the following EXCEPT
A) abiotic production of small organic molecules.
B) abiotic polymerization of amino acids.
C) abiotic replication of oligopeptides.
D) abiotic origin of DNA-protein interactions.
E) abiotic production of proteinoid microspheres.

6) The first genetic material was most likely
A) a DNA polymer.
B) a DNA oligonucleotide.
C) an RNA polymer.
D) a protein.
E) a protein enzyme.

Use the following information to answer the questions below. According to the Miller-Urey experimental results, chemical evolution leading up to and including the formation of living matter is believed to have occurred during the early history of Earth. Below are five pairs of events that might have occurred during this period. Judge the relative time of each of these pairs of events according to the key below.

A. Event I occurred before Event II.
B. Event II occurred beofre Event I.
C. Events I and II occurred simultaneously.

7)	Event I nitrogen oxides and carbon dioxide in the atmosphere	Event II free oxygen in the atmosphere
8)	Event I formation of photosynthetic organisms	Event II forma tion of heterotrophic organisms
9)	Event I formation of amino acids	Event II forma tion of enzymes
10)	Event I atmosphere of water, methane, and ammonia	Event II reducing atmosphere

11) Approximately how far does the fossil record extend back in time?
A) 6,000 years
B) 3,500,000 years
C) 6,000,000 years
D) 3,500,000,000 years
E) 5,000,000,000,000 years

12) What are the banded rocks called that are believed to be the fossils of bacterial mat communities?
A) coacervates
B) stalactites
C) stalagmites
D) strata
E) stromatolites

13) Which gas was probably LEAST abundant in Earth's early atmosphere?
A) H_2
B) CO
C) CH_4
D) H_2O
E) NH_3

14) In their laboratory simulation of the early Earth, Miller and Urey observed the abiotic synthesis of
A) amino acids.
B) coacervates.
C) DNA.
D) liposomes.
E) microspheres.

15) Which of the following factors was MOST important in the very early origin of life?
A) natural selection
B) competition for oxygen
C) low levels of solar energy
D) biotic synthesis of organic molecules

16) Which of the following has not yet been synthesized in laboratory experiments studying the origin of life?
A) lipids
B) microspheres with selectively permeable membranes
C) proteins and other polymers
D) protobionts that use DNA to program protein synthesis
E) purines and pyrimidines

17) Why was the primitive atmosphere of Earth more conducive to the origin of life than the modem atmosphere of Earth?
A) The primitive atmosphere had a layer of ozone that shielded the first fragile cells.
B) The primitive atmosphere removed electrons that impeded the formation of protobionts.
C) The primitive atmosphere was a reducing one that facilitated the formation of complex substances
from simple molecules.
D) The primitive atmosphere had more oxygen than the modem atmosphere, and thus it successfully
sustained the first living organisms.
E) The primitive atmosphere had less free energy than the modem atmosphere, and thus newly
formed organisms were less likely to be destroyed.

18) A key role that day may have played in the origin of life is the tendency for day to
A) form microspheres.
B) assemble into liposome membranes.
C) generate life through spontaneous processes.
D) provide a catalytic surface for the polymerization of organic monomers.

19) How many kingdoms were recognized by Linnaeus?
A) one
B) two
C) three
D) four
E) five

20) In what way were conditions on early Earth different from those on modem Earth?
A) The early Earth had no water.
B) The early Earth was much cooler.
C) The early Earth had an oxidizing atmosphere.
D) Less ultraviolet radiation penetrated the early atmosphere.
E) The early atmosphere had significant quantities of CH4 and NH3.

21) Which of the following is the *CORRECT* sequence of events in the originof life?
1. Formation of protobionts
II. Synthesis of organic monomers
III. Synthesis of organic polymers

A) I, II, III
B) I, III, II
C) II, III, I
D) III, I, II
E) III, II, I

22) Which of the following statements about the origin of genetic material is most probably *CORRECT?*
A) The first genes were DNA produced by reverse transcriptase from abiotically produced RNA.
B) The first genes were DNA whose information was transcribed to RNA and later translated in polypeptides.
C) The first genes were autocatalytic RNA molecules bound to clay surfaces.
D) The first genes were RNA produced by autocatalytic, proteinaceous enzymes called ribozymes.
E) The first genes were protobionts produced by dehydration syntheses of nucleic acids.

The questions below refer to the following scientists.

A. Fox
B. Cech
C. Oparin
S. *Miller and Urey*
E. Whittaker and Margulis

23) discovered ribozymes

24) synthesized proteinoids

25) synthesized coacervates

26) supported the five-kingdom scheme for classification

27) postulated that the spontaneous synthesis of complex molecules could not occur today because oxygen attacks chemical bonds,

extracting electrons

The questions below refer to the following terms. Each term may be used once, more than once, or not at all.

A. coacervates
B. liposomes
C. microspheres
D. proteinoids

28) have been shown to absorb substrates from their surroundings

29) droplets that self-assemble from only polypeptides in cool water

30) formation catalyzed by hot lava or metal atoms such as iron and zinc

31) droplets that self-assemble from organic ingredients that include lipids

32) colloidal droplets that form when polypeptides, nucleic acids, and polysaccharides are shaken together

33) form an electrical potential across their boundary membrane

34) droplets that self-assemble and form a bilayer membrane

The questions below refer to the following list, which uses the five-kingdom classification system.

1. *Plantae*
2. *Fungi*
3. *Animalia*
4. *Protista*
5. *Monera*

35) Which kingdom includes prokaryotic organisms?
A) 1
B) 2
C) 3
D)4
E) 5

36) Which kingdom includes mosses and ferns?
A) 1
B) 2
C) 3
D)4
E) 5

37) Which kingdom would be split apart the most if using an eight-kingdom classification system?
A) 1
B) 2
C) 3
D)4
E) 5

38) Which kingdoms include photosynthetic organisms?
A) 1 and 5 only
B) 2 and 4 only
C) 1,2, and 5 only
D) 1,4, and 5 only
E) 1,2,3,4, and 5

39) If the first genes were made of RNA, why do most organisms today have genes made of DNA?
A) DNA is chemically more stable and replicates with fewer errors (mutations) than RNA.
B) Only DNA can replicate during cell division.
C) RNA is too involved with translation of proteins and cannot provide multiple functions.
D) DNA forms the rod-shaped chromosomes necessary for cell division.
E) Replication of RNA occurs too quickly.

40) In an experiment, zinc and RNA nucleotides are placed in a test tube. IT a short RNA molecule is added
to the test tube, what happens?
A) RNA becomes autocatalytic and replicates portions ofitself.
B) RNA degrades into nucleotides.
C) An autocatalytic protein, amino adenosine triacid ester (AATE), is produced.
D) A protein enzyme is formed that assists RNA in replication.
E) DNA is formed.

41) Why do some scientists think that the kingdom Monera should be subdivided into two kingdoms,
Eubacteria and Archaebacteria?
A) Eubacteria contain organisms that are mostly pa thogenic to humans.
B) Archaebacteria contain colonial forms and should not be classified with Eubacteria.
C) The five- kingdom system was proposed in 1969 and is old.
D) Molecular evidence suggests that the two groups diverged very early in evolutionary history.
E) Only Eubacteria have rigid cell walls.

42) What characteristic do all protobionts have in common?
A) the ability to synthesize enzymes
B) a boundary membrane
C) RNAgenes
D) a nucleus
E) the ability to replicate RNA

43) Although absolute distinctions between the "most evolved" protobiont and the first living cell are
fuzzy, all scientists agree that one major difference is that all protobionts
A) do not possess a selectively permeable membrane boundary.
B) are not capable of osmosis.
C) do not grow in size.
D) are not capable of controlled, precise reproduction.
E) do not absorb compounds from the external environment.

44) High temperatures, the presence of metal ions such as zinc, and the presence of a substrate such as
clay all directly facilitate the formation of
A) coacervates.
B) organic polymers.
C) genes.
D) cells.
E) liposomes.

45) Which of the following is the strongest evidence that prokaryotes evolved before eukaryotes?
A) the primitive structure of plants
B) meteorites that have struck the Earth
C) abiotic experiments that constructed microspheres in the laboratory
D) Liposomes and coacervates look like prokaryotic cells.
E) The oldest fossilized cells resemble prokaryotes.

46) How could RNA have become involved in the mechanism for protein transla tion?
A) Only ribozymes were available as catalysts.
B) RNA replication is enhanced if proteins are produced.
C) Natural selection acted against autocatalyic protein formation.
D) DNA was not available for protein translation.
E) Natural selection favored RNA molecules that sequenced proteins that enhanced the replication
of more of the same RNA.

47) Why is the abiotic origin of the organic compounds essential for life considered a testable hypothesis?
A) Scientists can prove how life began.
B) Organic compounds can be tested for life in the laboratory.
C) Simple cells can be constructed.
D) Scientists can prove the importance of these compounds to living organisms.
E) Scientists can simulate the early Earth environment.

48) Which of the following is the MOST compelling reason why fungi and plant roots have formed many different symbiotic relationships?
A) They both require the same nutrients.
B) They have coexisted in the soil for hundreds of millions of years.
C) They can coexist because they require entirely different nutrients.
D) They both have cell walls that prevent interaction with the soil.

49) Life on Earth today comes only from preexisting life. How could life have evolved from "nonlife" 3.8
billion years ago?
A) Environmental conditions were very different when life evolved.
B) The early environment of Earth was an oxidizing one that destroyed organic molecules and prevented evolution.
C) The numerous meteors and volcanoes produced organic molecules in large numbers.
D) Nobody knows. There is no evidence and there are not testable hypotheses.
E) Life was not possible until Darwin invented DNA.

50) When considering the possibility of an extraterrestrial origin of life on Earth, all of the following
provide valid evidence EXCEPT
A) apparent bacterialike structures recovered from a Martian meteorite.
B) evidence of water on Mars.
C) evidence of water on one of Jupiter's moons.
D) organic molecules found in meteorites.
E) the crash of an alien spacecraft in New Mexico.

51) RNA molecules can be both self-replicating and catalytic. This probably means
A) that RNA was the first hereditary information.
B) that protobionts had an RNA membrane.
C) that RNA could make energy.
D) that DNA is unimportant in the origin oflife on Earth.
E) that RNA is a polymer of amino acids.

52) The Miller- Urey experiments
A) proved how cells formed on the early Earth.
B) could not be repeated under present atmospheric conditions.
C) continue to stimulate debate about the origin of life on Earth.
D) were based on our precise knowledge of Earth's early atmosphere.

53) Which of the following is NOT an example of a "protobiont"?
A) a coacervate
B) a proteinoid microsphere
C) a bacterial cell
D) a liposome

54) The members of which of the following pairs of organisms are most closely related to one another?
A) prokaryotes and plants
B) animals and plants
C) fungi and animals
D) fungi and plants

55) The production of oxygen by plant and algal photosynthesis
A) made life on land difficult.
B) is a relatively recent event.
C) made it easier to maintain reduced molecules.
D) made the Earth an oxidizing environment.
E) prevented the formation of an ozone layer.

56) The early atmosphere of the Earth probably contained all of the following molecules in large amounts
EXCEPT
A) H2.
B) C02.
C) Co.
D) N2.
E) H20.

57) In the five-kingdom taxonomic system, each group has a well-defined set of common characteristics
EXCEPT
A) Plantae.
B) Fungi.
C) Animalia.
D) Protista.
E) Monera.

58) The "best" taxonomic system
A) best organizes the available evidence.
B) is used by the most people.
C) is the one most recently proposed.
D) is one that is not a human construct.