Chapter 02
The Origin and Chemistry of Life

Multiple Choice Questions

1. Spontaneous generation was first proposed as
A. a concept to explain the formation of the first living cells on earth.
B. a concept to explain the evolution of simple chemicals into complex macromolecules.
C. an explanation for the appearance of maggots and mice from rotting material, fish from leaves that fall into water, etc.
D. an explanation by Pasteur accounting for the germination of spores in broth.

Bloom's Level: 1. Remember
Gradable: automatic
Topic: Spontaneous Generation of Life?

2. Pasteur's work with spontaneous generation showed that
A. life could not have evolved from non-living chemistry on the early earth.
B. mice came from mother mice and maggots from mother flies.
C. simple chemicals could become complex organic macromolecules without any living cell involved.
D. broth did not ferment spontaneously but required contamination with organisms.

Bloom's Level: 1. Remember
Gradable: automatic
Topic: Spontaneous Generation of Life?

3. The hypothesis that simple chemicals may have naturally become complex macromolecules by natural physical forces was first proposed by
A. Stanley Miller.
B. Graham Cairns Smith.
C. Alexander Oparin and J. B. S. Haldane.
D. Sidney Fox.

Bloom's Level: 1. Remember
Gradable: automatic
Topic: Spontaneous Generation of Life?

4. A solution that has a pH of 5 has
A. a concentration of H^+ 20 times higher than water.
B. a concentration of H^+ 100 times higher than water.
C. a concentration of H^+ the same as water.
D. a concentration of H^+ 20 times lower than water.
E. a concentration of H^+ 100 times lower than water.

Bloom's Level: 3. Apply
Gradable: automatic
Section: 02.01
Topic: Water and Life

5. A dissolved substance that has the ability to either remove or add H^+ and OH^- ions to resist pH changes is
A. a solution.
B. pure water.
C. a buffer.
D. a solvent.

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.01
Topic: Water and Life

6. Most organic molecules are associated with living organisms. Which of the following statements is NOT related to the general distinctions between these types of molecules?
A. Carbon dioxide (CO_2) lacks hydrogen atoms found in most organic molecules and therefore is usually not considered to be "organic."
B. Formaldehyde (CH_2O) is a small molecule compared to most organic molecules but does have carbon and hydrogen covalently bonded together and therefore is considered to be "organic."
C. Salt (Na^+Cl) is not an organic molecule but is important to the life of many organisms.
D. Organic carbon atoms are more diverse than inorganic carbon molecules that form the molecular structure of soot or a diamond from pure carbon.
E. All of the choices are correct.

Bloom's Level: 4. Analyze
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

7. Perhaps a better description of an organic compound is that an organic compound is any substance
A. derived from living matter.
B. containing carbon.
C. found within a cell.
D. consumed by animals.

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

8. Carbohydrates are categorized into
A. organic and inorganic carbohydrates.
B. saturated and unsaturated carbohydrates.
C. monosaccharides, disaccharides and polysaccharides.
D. primary, secondary, tertiary and quaternary carbohydrates.
E. monomer and polymer carbohydrates.

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

9. Which of the following is a "structural" carbohydrate molecule?
A. Sucrose
B. Glycogen
C. Cellulose
D. Glucose

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

10. Which of the carbohydrates given below is a major component of the cuticle of arthropods (e.g., insects, crayfish, etc.)?
A. Starch
B. Chitin
C. Cellulose
D. Glycogen

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

11. Which of the following carbohydrates is used in animal muscle and liver cells for energy storage?
A. Starch
B. Chitin
C. Cellulose
D. Glycogen

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

12. Which of the following is the most abundant carbohydrate in the world?
A. Cellulose
B. Glycogen
C. Fructose
D. Glucose

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

13.

Polysaccharides are polymers made up of which kind of monomers?

A. Simple sugars
B. Amino acids
C. Nucleotides
D. Alternating sugar and phosphate groups
E. Fatty acids and glycerol

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

14. The three principal groups of lipids are neutral fats, phospholipids, and
A. glycogen.
B. steroids.
C. amino acids.
D. fatty acids.

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

15. Neutral fats are
A. stored as glycogen.
B. not stored.
C. made of fatty acids and glycerol.
D. made of chains of fatty acids linked together by water molecules.

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

16. Lipids are polymers made of which monomers?
A. Glucose or modified glucose molecules
B. Amino acids
C. Alternating sugar and phosphate groups
D. Fatty acids and glycerol

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

17. A dehydration synthesis reaction is also
A. a condensation reaction.
B. a hydrolysis reaction.
C. an isomeric reaction.
D. a reaction that does not require enzymes.

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Section: 02.03
Topic: Chemical Evolution
Topic: Organic Molecular Structure of Living Systems

18. Which of the lipid groups below is structurally unlike the others?
A. Steroids
B. Neutral fats
C. Triglycerides
D. Phospholipids

Bloom's Level: 2. Understand
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

19. Which of the following lipids forms a bilayer between two fluid regions, such as in the plasma membrane of a cell?
A. Steroids
B. Waxes
C. Phospholipids
D. Lipoproteins

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

20. Which of the following is NOT a steroid?
A. Vitamin D
B. Adrenocortical hormones
C. Sex hormones
D. Cholesterol
E. All of the choices are steroids

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

21. Cholesterol belongs to which of the following groups?
A. Steroids
B. Neutral fats
C. Carbohydrates
D. Phospholipids

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

22. If an animal needs to store high-energy compounds for long-term use with the least amount of extra body weight, which would be the best molecule for storage?
A. Fructose and glucose in the form of honey
B. High-calorie fat molecules
C. Starch
D. Glycogen with extensive side branches of glucose

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

23. A protein is a polymer made up of which kind of monomers?
A. Glucose or modified glucose molecules
B. Amino acids
C. Nucleotides
D. Fatty acids and glycerol

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

24. A peptide bond is found in which type of biological molecule?
A. Carbohydrate
B. Lipid
C. Protein
D. Simple sugar

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

25. A chain consisting of a number of amino acids is a
A. quaternary structure.
B. dipeptide.
C. polypeptide.
D. None of the choices is correct.

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

26. In a protein, the folding of a polypeptide into a three-dimensional structure, usually stabilized by covalent bonds between the side groups of the amino acids, is the
A. primary structure.
B. secondary structure.
C. tertiary structure.
D. quaternary structure.

Bloom's Level: 2. Understand
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

27. The alpha helix is found at which level of protein organization?
A. Primary structure
B. Secondary structure
C. Tertiary structure
D. Quaternary structure

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

28. The splitting of one compound into two by the addition of water is called
A. covalent.
B. ionic formation.
C. hydrolysis.
D. condensation.

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

29. You eat eggs for breakfast and return in the evening to dirty dishes with "dried on" yellow streaks. After soaking awhile, the egg yolk protein molecules easily "wash off." What happened?
A. Heating denatured the egg protein molecules, hydrolysis reactions then formed bonds in the dried egg yolk, and soaking in water eventually resulted in condensation reactions where water broke these bonds
B. Heating denatured the egg protein molecules, unorganized condensation reactions formed bonds in the drying egg, and soaking in water resulted in hydrolysis reactions where water broke these bonds
C. Egg monomers were fused to become one polymer, which was easily dissolved by water back into monomers
D. Addition of water converted organic molecules into inorganic molecules

Bloom's Level: 3. Apply
Gradable: automatic
Section: 02.03
Topic: Chemical Evolution

30. At the molecular level, a cell's ability to vary in its operational tolerance to temperature, etc., is most closely related to
A. enzyme activity and protein denaturation.
B. ATP efficiency.
C. replication of nucleic acids.
D. extent of saturation of fatty acids.

Bloom's Level: 2. Understand
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

31. DNA and RNA are polymers composed of repeated units called
A. nucleotides.
B. bases.
C. sugars.
D. None of the choices is correct.

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

32. A nucleic acid is a polymer made up of which kind of monomers?
A. Amino acids
B. Nucleotides
C. Glucose or modified glucose molecules
D. Alternating sugar and phosphate groups

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

33. Nucleic acids are important because they
A. act as buffers.
B. are the basic units of neutral fats.
C. direct the synthesis of proteins.
D. None of the choices is correct.

Bloom's Level: 2. Understand
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

34. Which of these statements is true about DNA?
A. It is the genetic material of the cell
B. It forms a protein
C. It is pure amino acid
D. It contains no sugar

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

35. Fish sperm is mostly made of male DNA. A chemical test would find high amounts of
A. nitrogenous bases, sugar, and phosphate groups.
B. phospholipids and steroids.
C. amino acids and unsaturated fats.
D. triglycerides and ATP.
E. globular proteins and stored fats.

Bloom's Level: 3. Apply
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

36. Prions are infectious
A. carbohydrates.
B. proteins.
C. lipids.
D. Prions are not actually infectious.

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

37. Which of the following forms of energy is NOT one of those thought to have been involved in the production of large organic molecules in the primitive reducing atmosphere?
A. Radioactivity
B. Electrical energy
C. Radiation from the sun
D. Sound

Bloom's Level: 2. Understand
Gradable: automatic
Section: 02.03
Topic: Chemical Evolution

38. The term "reducing atmosphere" for the early earth means that the atmosphere
A. was much thinner around the surface of the earth than now.
B. contained only two or three kinds of gases.
C. contained little or no free oxygen.
D. contained little or no free nitrogen.

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.03
Topic: Chemical Evolution

39. Who first performed an experiment that proved that amino acids could be produced in the laboratory from a reducing atmosphere and electrical sparks?
A. Stanley Miller and Harold Urey
B. Graham Cairns Smith
C. Thomas Cech
D. Alexander Oparin and J. B. S. Haldane

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.03
Topic: Chemical Evolution

40. Which of the following kinds of molecules is thought to have been absent from the primitive reducing atmosphere?
A. Water vapor (H_2O)
B. Carbon dioxide (CO_2)
C. Oxygen (O_2)
D. Nitrogen (N_2)

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.03
Topic: Chemical Evolution

41.

An alternative environment to the "hot dilute soup" that offers a possible source of energy and molecules for the origin of life is/are the

A. frozen Antarctic ice sheets.
B. surface of Mars.
C. hydrothermal vents in ocean bottoms.
D. Earth mantle and core.

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.03
Topic: Chemical Evolution

42. Water has which of the following important characteristics that explain its key role in living systems?
A. High specific heat capacity
B. High surface tension
C. Is an excellent solvent
D. All of the choices are correct

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.01
Topic: Water and Life

43. A molecule of RNA that has enzymatic or catalytic properties is called a _____.
A. deoxyribose
B. nucleotide
C. ribonucleic acid
D. ribozyme

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.04
Topic: Origin of Living Systems

44. The fact that nucleic acids are very complicated molecules suggests that
A. the RNA-first hypothesis is impossible.
B. the protein-first hypothesis is therefore the only plausible hypothesis.
C. no natural system could ever generate them.
D. None of the choices is correct.

Bloom's Level: 4. Analyze
Gradable: automatic
Section: 02.04
Topic: Origin of Living Systems

45. The ancestral protocells
A. may have contained RNA or DNA as their genetic material.
B. may have evolved before the development of a true cell.
C. may have had a lipid and protein membrane surrounding them, forming a proteinoid microsphere.
D. may have contained a biochemical pathway for energy metabolism.
E. All of the choices are correct.

Bloom's Level: 4. Analyze
Gradable: automatic
Section: 02.04
Topic: Origin of Living Systems

46. Biological evolution differs from chemical evolution in that biological evolution would have been possible only after the development of
A. true cells capable of replication.
B. nucleic acids.
C. enzymes.
D. a metabolic pathway.

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.03
Section: 02.04
Section: 02.05
Topic: Chemical Evolution
Topic: Origin of Living Systems
Topic: Precambrian Life

47. Heating dry mixtures of amino acids and then mixing them with water forms small
A. strands of DNA.
B. living cells.
C. proteinoid microspheres.
D. plasma membranes.

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.03
Topic: Chemical Evolution

48. If the hypothesis that protocells were based on an "RNA world" is correct, what would be necessary to shift to a "DNA world"?
A. An enzyme or reaction capable of removing one oxygen from ribose in nucleotides
B. Enzymes for reverse transcription of RNA into DNA
C. New enzymes to replicate the DNA
D. New enzymes for transcribing DNA back to RNA
E. All are necessary to switch to a "DNA world."

Bloom's Level: 4. Analyze
Gradable: automatic
Section: 02.04
Topic: Origin of Living Systems

49. Scientists once assumed that the earliest protocells would have been autotrophs. This concept appears to be
A. correct, since heterotrophs would depend upon eating autotrophs.
B. correct, since glycolysis and fermentation only occur after oxygen is present from photosynthesis.
C. incorrect, since the primordial soup likely contained many preformed food molecules suitable for heterotrophic metabolism.
D. incorrect, since glycolysis and fermentation require complex enzymes for catalytic reactions.

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.04
Topic: Origin of Living Systems

50. Prokaryotic cells are represented by fossils that are dated back as far as _____ billion years ago.
A. 1.5
B. 2.8
C. 3.8
D. 4.8

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.04
Topic: Origin of Living Systems

51. The Precambrian-Cambrian boundary is
A. a point that separates reduction environments from oxidation environments.
B. the separation point between prokaryotes and eukaryotes.
C. a point of dramatically increased fossilization, although it is likely that many animal groups existed before this time.
D.

the shift-over from plant to animal life.

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.05
Topic: Precambrian Life

52. The first eukaryotic cells probably arose about _____ billion years ago.
A. 1.5
B. 2.5
C. 3.5
D. 4.5

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.05
Topic: Precambrian Life

53. Which pairing of occurrence and date is correct?
A. Beginning of Cambrian — 600 million years ago
B. Origin of life — 3.8 billion years ago
C. Origin of eukaryotic cells — 1.5 billion years ago
D. All of the choices are correct

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.05
Topic: Precambrian Life

54. Our current understanding of the origin of eukaryotic organelles such as mitochondria is that they
A. were copies of a cell nucleus that failed to be separated by cytokinesis.
B.

were prokaryotes that were taken into a cell and now live there symbiotically.

C.

were variations of the plasma membrane.

D.

were new forms of life that arose inside other cells.

Bloom's Level: 1. Remember
Gradable: automatic
Section: 02.05
Topic: Precambrian Life

Fill in the Blank Questions

55. The term _____ refers broadly to compounds that contain carbon.
organic

Bloom's Level: 1. Remember
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

56. The most important of the energy-storing carbohydrate monomers is the molecule _____.
glucose

Bloom's Level: 1. Remember
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

57. The molecule _____ is an important form for storing sugar in animals and is found mainly in the liver and muscle cells of animals.
glycogen

Bloom's Level: 1. Remember
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

58. A(n) _____ fatty acid has two or more carbon atoms joined by double bonds.
unsaturated

Bloom's Level: 1. Remember
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

59. Amino acids are linked together to form proteins by _____ bonds.
peptide

Bloom's Level: 1. Remember
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

60. The alpha-helix is an example of the _____ structure of a protein.
secondary

Bloom's Level: 1. Remember
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

61. When hemoglobin takes up or releases oxygen, it undergoes a change in its _____ structure.
quaternary

Bloom's Level: 1. Remember
Section: 02.02
Topic: Organic Molecular Structure of Living Systems

62. Submarine hot springs where seawater seeps through cracks in the bottom and comes close to the hot magma are called _____ _____.
hydrothermal vents

Bloom's Level: 1. Remember
Section: 02.03
Topic: Chemical Evolution

63. Most biological polymerizations are _____ dehydration reactions in which monomers are linked together by removal of water.
condensation

Bloom's Level: 1. Remember
Section: 02.03
Topic: Chemical Evolution

64. Sidney Fox studied the synthesis of polypeptides into polymers which in water formed small spherical bodies called _____ _____.
proteinoid microspheres

Bloom's Level: 1. Remember
Section: 02.03
Topic: Chemical Evolution

65.

A critical answer to the chicken-or-the-egg problem formed by the nucleic-acid-or-enzyme-first dilemma is potentially solved by the discovery of catalytic RNAs called _____.

ribozymes

Bloom's Level: 1. Remember
Section: 02.04
Topic: Origin of Living Systems

66. The earliest source of reduced compounds for oxidative metabolism was probably _____ _____.
hydrogen sulfide

Bloom's Level: 1. Remember
Section: 02.04
Topic: Origin of Living Systems

67. Bacteria contain a single, large molecule of DNA in the _____ region.
nucleoid

Bloom's Level: 1. Remember
Section: 02.04
Topic: Origin of Living Systems

68. The _____ theory proposes that pre-eukaryotes are the result of anaerobic bacteria ingesting aerobic bacteria and subsequently a symbiotic relationship was formed.
endosymbiotic

Bloom's Level: 1. Remember
Section: 02.05
Topic: Precambrian Life

Essay Questions

69. Describe the first evidence for chemical evolution that came from Stanley Miller's experiment.

Answers will vary.

Bloom's Level: 2. Understand
Section: 02.03
Topic: Chemical Evolution

70.

This chapter began with Pasteur disproving spontaneous generation, the theory that life could arise from non-living material. Then Miller and Urey test the Oparin-Haldane hypothesis and suggest that the organic compounds required for life could be formed from the simpler molecules present in the prebiotic environment. Are these experiments contradictory? Explain how the science community recognize both as valid.

Answers will vary.

Bloom's Level: 4. Analyze
Section: 02.03
Topic: Chemical Evolution
Topic: Spontaneous Generation of Life?

71. The Miller-Urey experiments demonstrated the formation of larger molecules from simple molecules. Why is there still a need for concentration in order to make formation of a protocell more likely?

Answers will vary.

Bloom's Level: 2. Understand
Section: 02.03
Topic: Chemical Evolution

72. Assumptions that the earliest life forms had to make their own food have been replaced with the belief that the earliest microorganisms were definitely primary heterotrophs. How could these earliest cells have lived if they did not make their own food, and why do we feel certain that they were not photosynthetic?

Answers will vary.

Bloom's Level: 4. Analyze
Section: 02.03
Topic: Chemical Evolution

73. What evidence do scientists have that the earth's primeval atmosphere was a reducing atmosphere?

Answers will vary.

Bloom's Level: 4. Analyze
Section: 02.03
Topic: Chemical Evolution

74. Why can't we set up an experiment that would again duplicate the conditions that were present at the early origin of protocells?

Answers will vary.

Bloom's Level: 4. Analyze
Section: 02.04
Topic: Origin of Living Systems

75. Describe the chicken-or-the-egg dilemma with enzymes and hereditary molecules, and detail how the "RNA world" proposal offers a solution.

Answers will vary.

Bloom's Level: 4. Analyze
Section: 02.04
Topic: Origin of Living Systems

76. What are the essential properties of a "protocell"?

Answers will vary.

Bloom's Level: 2. Understand
Section: 02.04
Topic: Origin of Living Systems

77.

Describe the endosymbiotic theory for the origin of eukaryotes.

Answers will vary.

Bloom's Level: 2. Understand
Section: 02.05
Topic: Precambrian Life

78. What may have been the "reason" for the "Cambrian explosion"?

Answers will vary.

Bloom's Level: 2. Understand
Section: 02.05
Topic: Precambrian Life

79. What evidence leads researchers to believe that there was a diversity of animal life before the Cambrian if we cannot find extensive fossils of earlier animals?

Answers will vary.

Bloom's Level: 1. Remember
Section: 02.05
Topic: Precambrian Life

80. Compare and contrast the prokaryotic and eukaryotic cellular structures.

Answers will vary.

Bloom's Level: 2. Understand
Section: 02.05
Topic: Origin of Living Systems
Topic: Precambrian Life

81. If eukaryotes are more complex than prokaryotes, then why are there prokaryotes living today?

Answers will vary.

Bloom's Level: 3. Apply
Section: 02.04
Topic: Origin of Living Systems

82.

Does the recognition of prokaryotes as two major lineages, Archaebacteria and Eubacteria, result in any major changes to the internal taxonomic arrangement of the fungi, protozoan, plant, or animal groups?

Answers will vary.

Bloom's Level: 4. Analyze
Section: 02.04
Topic: Origin of Living Systems