Chapter 27

Prokaryotes and the Origins of Metabolic Diversity

1) Prokaryotes have ribosomes different from those of eukaryotes. Because of this, which of the following is TRUE?
   A) Some selective antibiotics can block protein synthesis of bacteria without harming the eukaryotic host.
   B) It is believed that eukaryotes did not evolve from prokaryotes.
   C) Protein synthesis can occur at the same time as transcription in prokaryotes.
   D) Some antibiotics can block the formation of cross-links in the peptidoglycan walls of bacteria.
   E) Prokaryotes are able to use a much greater variety of molecules as food sources.

2) The first form of nutrition to evolve was probably that of
   A) photoautotrophs that used light energy to reduce C02 with electrons from H20.
   B) chemoheterotrophs that used abiotically made organic compounds.
   C) anaerobic chemoautotrophs.
   D) photoheterotrophs that used light for energy and abiotically made organic compounds for a carbon source.
   E) photoautotrophs (such as the cyanobacteria) that used water as a source of electrons and protons.

3) Of all the organisms, the prokaryotes have the greatest range of metabolic diversity. Which category of prokaryotes is currently the most important ecologically?
   A) nitrogen fixers
   B) obligate anaerobes
   C) thermoacidophiles
   D) chemoautotrophs
   E) extreme halophiles

4) In the following list of major metabolic pathways, which one must have been the most recent to evolve?
   A) glycolysis
   B) oxidative phosphorylation
   C) fermentation
   D) 02-producing photosynthesis
   E) sulfur-producing photosynthesis

5) Which of the following statements is TRUE for chemoautotrophs?
A) They use hydrogen sulfide as their hydrogen source for the photosynthesis of their organic
compounds.
B) They "feed themselves" by obtaining energy from the chemical bonds of organic molecules.
C) They oxidize inorganic compounds to obtain energy to drive the synthesis of their organic compounds.
D) They live as decomposers of inorganic chemicals in organic litter.
E) They obtain their energy from oxidizing chemical compounds and get their carbon skeletons from
organic compounds.

6) Which of the following is a FALSE statement about the ways that prokaryotic cells differ from
eukaryotic cells?
A) The prokaryotic genome has a unique organiza tion.
B) Prokaryotes have a relatively simple organization of their cytoplasm.
C) Prokaryotes have a cell wall with unique components.
D) Prokaryotes lack specialized membranes.
E) Prokaryotes are typically much smaller than eukaryotes.

7) All of the following are TRUE statements about prokaryotes EXCEPT:
A) Prokaryotes domina te the biosphere.
B) Prokaryotes are the most numerous organisms on Earth.
C) Some prokaryotes can live in extreme habitats.
D) Some prokaryotes are important as decomposers.
E) Prokaryotes are the most important photosynthesizers.

8) 1£ all the bacteria on Earth suddenly disappeared, which of the following would be the most likely
direct result?
A) The number of organisms on Earth would decrease by 10 to 20 percent.
B) Human populations would thrive in the absence of disease.
C) There would be little change in the Earth's ecosystems.
D) Recycling of nutrients would be greatly reduced.
E) The Earth's total photosynthesis would decline markedly.

For the following questions, use the list below of types of bacterial metabolism. Pick the term that best matches eafh of the following statements.

A. photoautotrophs
B. photoheterotrophs
C. chemoautotrophs
D. saprobic chemoheterotrophs
E. parasitic chemoheterotrophs

9) responsible for many human diseases

10) nutritional mode of the earliest prokaryotes

11) use light energy to synthesize organic compounds from C02

12) obtain energy by oxidizing inorganic substances

13) use light energy to generate ATP only

14) responsible for high levels of 02 in Earth's present atmosphere

15) If ancient prokaryotes had not evolved a way to use water as a source of electrons and protons, which of the following processes is LEAST likely to have evolved later?
A) enzyme catabolism
B) the Krebs cycle
C) protein synthesis
D) fermen ta tion
E) glycolysis

16) Which of the following statements best characterizes cell structure and function prior to the evolution of eukaryotic cells?
A) All forms of nutrition and metabolism had evolved in prokaryotes.
B) The basic types oflocomotion by whiplash flagella evolved in prokaryotes.
e) The evolutionary advantages of diploidy were exploited by prokaryotes.
C) Precursors of rough endoplasmic reticula had evolved within prokaryotes.
D) Mitosis developed as a process in more recent prokaryotes.

17) What were the earliest bacteria like?
A) aerobic heterotrophs
B) anaerobic heterotrophs
e) photoautotrophs
C) chemoautotrophs
D) parasites

18) The antibiotics known as penicillins inhibit the ability of bacteria to
A) form spores.
B) perform respiration.
e) replica te DNA.
C) synthesize proteins.
D) synthesize cell walls.

19) What are bacteria that are poisoned by oxygen called?
A) aerobes
B) aestivating bacteria
e) cyanobacteria
C) facultative anaerobes
D) obligate anaerobes

20) Which of the following would most likely occur if all prokaryotes were suddenly to perish?
A) All life would eventually perish due to disease.
B) All life would eventually perish because chemical cycling would stop.
e) All life would eventually perish because of increased global warming due to the greenhouse effect.
D) Only the organisms that feed directly on prokaryotes would suffer any deleterious effects.
E) Very little change would occur because prokaryotes are not of significant ecological importance.

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21) Which of the following types of bacteria have chlorophyll *a?*
A) cyanobacteria
B) archaebacteria
C) pathogenic bacteria
D) bacteria that decompose organic matter
E) bacteria that oxidize H2S during photosynthesis

22) Heterocysts are structures characteristic of some
A) fungi.
B) cyanobacteria.
C) spore-forming bacteria.
D) heterotrophic cyst-forming archaebacteria.
E) nitrogen-fixing bacteria in root nodules of legumes.

23) In an aerobic prokaryotic cell, the molecules of the respiratory chain are located in the
A) cytosol.
B) cristae.
C) cell wall.
D) plasma membrane.
E) mitochondrial matrix.

24) Which of the following is the antibiotic mechanism of tetracycline?
A) It oxidizes the chemical bonds of organic macromolecules.
B) It uncouples the rotary motor of prokaryotic flagella.
C) It plasmolyzes the plasma membrane.
D) It binds to prokaryotic ribosomes.
E) It disrupts the cell wall.

25) All of the following statements about prokaryotes are correct EXCEPT:
A) The gradual accumulation of oxygen caused the extinction of many prokaryotes.
B) Glycolysis probably evolved in prokaryotes to regenerate ATP in anaerobic environments.
C) Early photosynthetic prokaryotes probably used pigments and light-powered photosystems to fix carbon dioxide.
D) The first prokaryotes were likely photoautotrophs that could utilize the abundant light energy and inorganic minerals of early Earth.
E) The gradual accumulation of oxygen led to the evolution of respiratory mechanisms to either
tolerate or capitalize on rising oxygen levels.

26) Proton pumps of bacteria probably functioned first for
A) pH regulation.
B) ATP synthesis.
C) photosynthesis.
D) reduction of 02.
E) oxidation of food.

27) Coordination of two photosystems occurs during photosynthesis in
A) chemoautotrophic bacteria.
B) purple sulfur bacteria.
C) green sulfur bacteria.
D) anaerobic bacteria.
E) cyanobacteria.

28) Which of the following statements is *CORRECT* about gram-negative bacteria?
A) Penicillins are effective antibiotics to use against them.
B) They often possess an outer cell membrane containing toxic lipopolysaccharides.
C) On a cell-to-cell basis, they possess more DNA than do the cells of any taxonomically higher organism.
D) Their chromosomes are composed of DNA tightly wrapped around histone proteins.
E) Their cell walls are primarily composed of peptidoglycan.

29) The oxygen revolution probably began with the origin of
A) plants.
B) eukaryotes.
C) prokaryotes.
D) cyanobacteria.
E) cellular respiration.

30) The botulism toxin is an example of
A) an antibiotic.
B) an exotoxin.
C) an endotoxin.
D) a nitrogenase.
E) a bacteriorhodopsin.

31) Flagellated bacteria will move away from toxic substances. This phenomenon is termed .:
A) chemotaxis.
B) chemotropism.
C) gliding.
D) magnetotaxis.
E) toxoplasmosis.

32) Which of the following statements about prokaryotes is CORRECT?
A) Bacterial cells conjugate to mutually exchange genetic material.
B) Their genetic material is confined within a nuclear envelope.
C) They divide by binary fission without mitosis or meiosis.
D) The persistence of bacteria through time is due to metabolic similarity.
E) Genetic variation in bacteria arises from their geometric growth rates.

33) If present in a solution, members of which group could not be filtered out ofthe solution by a filter with pores 250 nm in diameter?
A) archaebacteria
B) mycoplasmas
C) myxobacteria
D) pseudomonads
E) spirochetes

For the following questions, refer to the following categories of nutrition. Each answer may be used once, more than once, or not at all.

A. saprobes
B. chemoheterotrophs
C. chemoautotrophs
D. photoautotrophs
E. photoheterotrophs

34) bacteria that oxidize NH3 to *NDI*

35) bacteria that oxidize sulfur to sulfate

36) bacteria that use light for energy and organic matter for a carbon source

37) green sulfur bacteria

38) methanogens

39) The questions below refer to the following prokaryotic groups. Each answer may be used once, more than once, or not at all.

A. Actinomycetes
B. Chlamydias
C. Enteric bacteria
D. Pseudomonads
E. Spirochetes

39) E. *coli* and *Salmonella*

40) *Treponema pallidum* and *Borrelia burgdorferi*

nongonococcal urethritis (NGU)

41) tuberculosis and leprosy

42) most versatile chemoheterotrophs

43) Why do systematic biologists now reject the use of a single kingdom Monera for all prokaryotic organisms?

A) Only eukaryotic organisms have membrane-enclosed organelles.
B) Genetic data show that archaebacteria and eukaryotes share a more recent common

ancestor.

C) Structural data show that eubacteria are more closely related to eukaryotes and that
archaebacteria differ in a greater number of characteristics.

D) Only prokaryotic organisms show growth inhibition in the presence of antibiotics.

E) Only species of eubacteria lack the noncoding parts of genes.

45) A new pa tho genic bacterium has been obtained from a number of individuals exhibiting the-same
symptoms, and it has been isolated and grown in pure culture. What additional steps, if any, are necessary to establish that this bacterium is the cause of the disease?
A) Sufficient data have been accumulated and no further research need be done.
B) Gram stains must be applied, and the appropriate exotoxins or endotoxins must be isolated and
their chemical structures analyzed.
C) The method of transfer of the infection must be identified and the bacteria must be shown to infect
a variety of different species.
D) Cultured bacteria must be introduced to uninfected organisms, cause the same symptoms, and
then be isolated from these test organisms.
E) An antibody must be located, isolated, and shown to provide immunization against further infection by the bacteria.

Skill: Application

46) A particular virus acts to transfer genes during bacterial transduction but does not harm the bacteria in any way. If the virus also benefits from the bacteria, the term that best describes the relationship between virus and bacteria is
A) mutualism.
B) parasitism.
C) commensalism.
D) symbiosis.
E) preda tion.
Skill: Conceptual Understanding

47) All of the following statements about bacterial cell walls are true EXCEPT:
A) They differ in molecular composition from plant cell walls.
B) They prevent cells from bursting in hypoosmotic environments.
C) They prevent cells from dying in hyperosmotic conditions.
D) They are analogous to cell walls of protists, fungi, and plants.
E) They provide the cell with physical protection from the environment.

48) Many physicians administer antibiotics to patients at the first sign of any disease symptoms. Why can this practice cause more problems for these patients and for others not yet infected?
A) The antibiotic administered may not be effective for the particular type of bacterium.
B) Antibiotics may cause other side effects in patients.
C) Overuse of antibiotics can select for antibiotic-resistant strains of bacteria.
D) Particular patients may be allergic to the antibiotic.
E) Antibiotics may interfere with the ability to identify the bacteria present.

49) Which would be the LEAST accurate statement about the evolution of prokaryotes and th~ changing
environment of Earth?
A) Prokaryotes have interacted with the environment for more than 3.5 billion years.
B) While prokaryotes have a diverse morphology, they basically have the same metabolic pathways
and products.
C) Oxygen-producing photosynthesis made life on land possible.
D) An oxidizing environment allowed prokaryotes to evolve new metabolic pathways.
E) Prokaryotes are among several kinds of organisms that recycle chemical elements in ecosystems.

50) In which of the following ways are prokaryotes more successful on Earth than humans?
A) Prokaryotes are much more numerous than humans.
B) Prokaryotes occupy more diverse habitats than humans.
C) Prokaryotes often parasitize humans in many ways.
D) Prokaryotes have survived on Earth for billions of years longer than humans have.
E) All of the above are true.

51) If prokaryotes are more successful on Earth than humans, why is this so? Prokaryotes
A) can evolve more rapidly.
B) have more metabolic diversity.
C) can tolerate extreme habitats.
D) have quickly adapted to the changes in the Earth's environment they have created.
E) The statements above are all true.

52) been divided into two main groups, bacteria and archaea. This
distinction is based primarily on
A) survival in extreme habitats.
B) differences in structure.
C) difference in DNA sequences.
D) physiological differences.
E) All of the above represent differences between bacteria and archaea.

53) The primary ecological role of prokaryotes is
A) parasitizing eukaryotes, thus causing diseases.
B) the decomposition of organic matter.
C) metabolizing materials in extreme environments.
D) to show that cells can exist without cell walls.
E) to show that a diverse group of organisms can be remarkably similar in many ways.

54) Bacteria and archaea differ in all the ways below EXCEPT that
A) most archaea inhabit extreme habitats.
B) bacteria are more likely to be pathogenic (disease causing).
C) only bacteria are organized at a prokaryotic level.
D) archaea are classified at the eukaryotic level.
E) only archaea have nuclei.

55) Since plants, fungi, and prokaryotes have cell walls, why do we classify them in different taxonomic units?
A) Some closely resemble animals which lack cell walls.
B) Their cell walls are constructed from very different biochemicals.
C) Some have cell walls only for support.
D) Some have cell walls only for protection from herbivores.
E) Some have cell walls only to control osmotic balance.

56) Which of the following compounds is the MOST common compound in the cell wells of bacteria?
A) cellulose
B) lipopolysaccharides
C) lignin
D) peptidoglycan
E) capsules

57) About half of all prokaryotes are capable of directional movement. All of the following responses are
ways that bacteria move through their environment EXCEPT
A) flagellar action.
B) responses to the Earth's magnetic field.
C) helical filaments with basal motors.
D) negative phototaxis in photosynthetic forms.
E) positive chemotaxis.

58) Eukaryotic and prokaryotic cells are different in many ways. Which of the following is a significant difference between the genomes of prokaryotes and eukaryotes?
A) Prokaryotic cells are diploid.
B) Prokaryotic chromosomes are sometimes called "genochromes."
C) Prokaryotic cells have chromosomes packaged with a relatively large amount of protein.
D) Instead of a nucleus, prokaryotic cells have a "nucleoid" region.

59) In regard to prokaryotic sexual life cycles, which of the following is TRUE? "
A) Prokaryotes don't do meiosis.
B) Prokaryotes lack syngamy as done by eukaryotes.
C) Prokaryotes have ways of exchanging some of their genes by conjugation, syngamy, and
transduction.
D) Because of limited genetic exchange, mutation is a primary source of variation in prokaryote
popula tions.
E) Prokaryotes skip sexual life cycles because their life cycle is too short.

60) Which of the following is part of the sexual processes of bacteria?
A) meiosis
B) transformation
C) syngamy
D) fertiliza tion
E) mitosis

61) Foods can be preserved in many ways by slowing down or preventing bacterial growth. Which of the following methods and materials would NOT prevent bacterial growth?
A) Refrigeration; slows bacterial metabolism and growth.
B) Closed containers; prevent bacteria from entering.
C) Pickling; creates a pH at which bacterial enzymes will not function.
D) Canning in heavy sugar syrup; creates osmotic conditions that remove water from bacterial cells.
E) Irradiation; kills bacteria by altering their DNA.

62) Bacterial modes of obtaining nutrition used by at least some bacteria include all of the following
EXCEPT
A) chemoautotrophy.
B) photoautotrophy.
C) heteroautotrophy.
D) chemoheterotrophy.
E) photoheterotrophy.

63) "By studying modern prokaryotic organisms, we can be certain of how metabolic pathways involved." This statement is
A) true, because all the fossil evidence indicates that ancient prokaryotes were much like modern prokaryotes.
B) false, because we have no evidence of ancient metabolic pathways.
C) impossible to evaluate, because ancient prokaryotes are all dead.
D) false, because our understanding of early metabolic pathways is hypothetical.
E) true, because both ancient and modern prokaryotes have few enzymes.

64) Which of the following best describes the nutrition of the earliest prokaryotes?
A) chemoheterotrophic
B) opportunistic
C) chemoautotrophic
D) extreme halophilic

65) Which of the following is evidence that Earth's environment switched from a reducing one to an oxidizing one around 2.5 billion years ago?
A) iron oxide precipitates
B) extinction of many anaerobic prokaryotes
C) the evolution of antioxidant mechanisms
D) the evolution of aerobic respiration
E) All of the above provide evidence of the environmental changes.

66) Which of the following is NOT a characteristic of the domain Archaea?
A) Based on DNA analysis, archaea are probably more closely related to eukaryotes than they are to
bacteria.
B) Some archaeans can reduce C02 to methane.
C) Archaean diversity evolved when the Earth was much younger.
D) Some archaeans can inhabit nearly saturated salt solutions.
E) Some archaeans can live in water above the boiling point.

67) All of the following statements are true of the domain Bacteria EXCEPT:
A) They are important decomposers in ecosystems.
B) Bacteria have every mode of nutrition and metabolism.
C) Bacteria can most easily be classified using molecular techniques.
D) Bacteria exist that can use crude oil as a nutrition source.
E) All of the above are true.

68) Symbiosis is common among prokaryotes and probably has been for billions of years. Which of the
following is NOT a typical prokaryote symbiosis?
A) Some prokaryotes are pathogenic (cause illness).
B) Bacterial diseases are a continuing problem in many nations.
C) Bacteria are required for the pollination of some plants.
D) Bacteria in the human intestine produce essential vitamins.
E) Nitrogen-fixing bacteria inhabit nodules of some plants.

69) Which would be the unlikeliest kind of prokaryote?
A) **one that could travel through space by itself**
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B) one that could live in extremely hot conditions
C) one that could live inside rocks in Antarctica
D) one that could live in concentrated salt solutions
E) one that could live without 02