***Brock Biology of Microorganisms, 15e, Global Edition* (Madigan et al.)**
Chapter 1 The Microbial World

1.1 Multiple Choice Questions

1) Which of the following statements is FALSE?
A) Microbial cells can exist as single cells.
B) Microbial cells carry out their life processes of growth independently.
C) Microbial cells include both bacteria and viruses.
D) Microbial cells are surrounded by a plasma membrane.
Answer: C
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.14

2) Which of the following statements is correct?
A) Microorganisms are significant contributors to the total biomass on Earth.
B) Microorganisms represent a much smaller amount of Earth's biomass than plants.
C) Microorganisms represent a much smaller amount of Earth's biomass than animals.
D) Microorganisms are significant in number, but not in overall biomass.
Answer: A
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.1

3) Differential selection and reproduction of phenotypes occurs during a process called
A) cellular differentiation.
B) evolution.
C) growth.
D) transformation.
Answer: B
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.2

4) In what/which domain(s) of life is/are microorganisms represented?
A) Archaea
B) Bacteria
C) Eukarya
D) Archaea, Bacteria, and Eukarya
Answer: D
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.3

5) Biological catalysts involved in the acceleration of the rate of chemical reactions are called
A) catalytic converters.
B) growth agents.
C) evolutionary molecules.
D) enzymes.
Answer: D
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.2

6) Regarding early life on Earth
A) microbial life existed for billions of years before plant and animal life.
B) microbial life existed long before animals but has been around for about the same amount of time as plants.
C) microbial life, plant life, and animal life all appeared at about the same time.
D) it is impossible to determine which type of life first appeared.
Answer: A
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.3

7) The person who described the "wee animalcules" was
A) Robert Hooke.
B) Antoni van Leeuwenhoek.
C) Louis Pasteur.
D) Ferdinand Cohn.
Answer: B
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.5

8) Walther Hesse and _____ pioneered the use of agar as a solidifying agent.
A) Louis Pasteur
B) Ferdinand Cohn
C) Robert Koch
D) Sergei Winogradsky
Answer: C
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.10

9) Which of the following is/are characteristic of all cellular organisms?
A) communication
B) evolution
C) motility
D) communication, evolution, and motility
Answer: B
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.2

10) Deduce why viruses are excluded from the ribosomal RNA—based tree of life.
A) Some viruses contain multiple strands of RNA.
B) Their genetic elements cannot be sequenced.
C) They can infect other organisms, which complicates the genetic comparisons.
D) They lack ribosomal RNA (rRNA).
Answer: D
Bloom's Taxonomy: 5-6: Evaluating/Creating
Chapter Section: 1.13

11) Louis Pasteur developed the vaccine(s) for
A) anthrax only.
B) fowl cholera only.
C) rabies only.
D) anthrax, fowl cholera, and rabies.
Answer: D
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.9

12) The discovery of antibiotics and other important chemicals led to the field of
A) industrial microbiology.
B) agricultural microbiology.
C) marine microbiology.
D) aquatic microbiology.
Answer: A
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.4

13) Microbial sterilization is used to
A) decrease the possibility of contaminants growing in a culture.
B) kill bacteria but not necessarily viruses or other microbes.
C) kill all microbes in or on objects.
D) clean a work area.
Answer: C
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.9

14) Transparent double-sided dishes used for growing microbes are most commonly called
A) Petri dishes.
B) baker dishes.
C) sterilization plates.
D) culture medium plates.
Answer: A
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.10

15) Microbes playing a role in nitrogen fixation in plants live in _____, while those playing a role in the digestive tract of certain herbivores live in _____.
A) rumens / nodules
B) nodules / rumens
C) nodules / fortrans
D) fortrans / rumens
Answer: B
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.4

16) Which of the following is NOT an accomplishment of Louis Pasteur?
A) determined that the alcohol-making process was mediated by microbial fermentation and thus refuted the theory of spontaneous generation
B) developed enrichment culture techniques
C) developed heat sterilization techniques that involved the creation of a specialized swan-necked flask
D) developed the first rabies vaccine and treated thousands of individuals
Answer: B
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.9

17) The theory of spontaneous generation was refuted by the work of
A) Louis Pasteur.
B) Robert Koch.
C) Robert Hooke.
D) Antoni van Leeuwenhoek.
Answer: A
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.9

18) A Pasteur flask has a(n)
A) swan neck to prevent particulate matter from getting into the main body of the flask.
B) double neck so two substances may be added at the same time.
C) secondary opening at the base to allow for drainage.
D) inverted upper edge to prevent spillage while swirling.
Answer: A
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.9

19) Predict how Pasteur's conclusions on spontaneous generation with swan flasks would have changed if he worked with and maintained the flasks in a sterile laminar flow hood.
A) Sterilization of the swan flask solutions would not have been necessary to reject spontaneous generation. If he did sterilize the flasks, the spontaneous generation hypothesis would have been supported.
B) His incubation times would not have been sufficient to refute spontaneous generation.
C) Pasteur's flasks never would have putrefied, and the experiment would not have refuted spontaneous generation.
D) Viruses would have still been present, and his conclusion would have been unchanged.
Answer: C
Bloom's Taxonomy: 5-6: Evaluating/Creating
Chapter Section: 1.9

20) A pure culture
A) is sterile.
B) is a population of identical cells.
C) is made of a clearly defined chemical medium.
D) contains one microbial cell.
Answer: B
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.9

21) Martinus Beijerinck was the first to isolate
A) green algae.
B) certain nitrogen-fixing root nodule bacteria.
C) certain sulfate-reducing bacteria.
D) green algae, certain nitrogen-fixing root nodule bacteria, and certain sulfate-reducing bacteria.
Answer: D
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.11

22) Chemolithotrophy involves
A) oxidation of organic compounds.
B) oxidation of inorganic compounds.
C) reduction of organic compounds.
D) metabolic autotrophy.
Answer: B
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.11

23) Developments in the fields of immunology and medical microbiology were practical extensions of the work of
A) Sergei Winogradsky.
B) Antoni van Leeuwenhoek.
C) Joseph Lister.
D) Robert Koch.
Answer: D
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.10

24) Microbial control in wastewaters would most logically be a part of
A) microbial genetics.
B) aquatic microbiology.
C) medical microbiology.
D) bacterial energetics.
Answer: B
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.4

25) Robert Koch contributed to the field of microbiology by being the first person to
A) develop the tuberculin test only.
B) formulate four postulates for definitively linking a specific microorganism to a specific disease only.
C) use agar as a solidifying agent in growth media only.
D) develop the tuberculin test, formulate four postulates for definitively linking a specific microorganism to a specific disease, and use agar as a solidifying agent in growth media.
Answer: D
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.9

26) *Mycobacterium tuberculosis* is very difficult to stain because of the
A) presence of ribosomes in the cytoplasm.
B) location of the DNA within the cell.
C) large amounts of a waxlike lipids present in its cell wall.
D) lack of a cell wall.
Answer: C
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.10

27) Louis Pasteur's most famous success was his work on
A) *Mycobacterium tuberculosis*.
B) the rabies vaccine.
C) optical isomers.
D) cultivation of *E. coli.*
Answer: B
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.9

28) Microorganisms play key roles in the cycling of important nutrients in plant nutrition, particularly those of
A) carbon only.
B) nitrogen only.
C) sulfur only.
D) carbon, nitrogen, and sulfur.
Answer: D
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.4

29) Microbial ecology is the study of
A) microbial processes in the rhizosphere that benefit plant growth.
B) the diversity and activities of microorganisms.
C) the grouping and classifying of microorganisms.
D) microorganisms in their natural environments.
Answer: D
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.3

30) The structure that confers structural strength on the cell is known as the
A) cytoplasmic membrane.
B) cell wall.
C) ribosome.
D) cytoplasm.
Answer: B
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.2

31) A microbial cell's membrane is considered _____, because its internal constituents are maintained within the cell. However, it also imports and exports other molecules in response to its environment.
A) differential
B) microselective
C) rigid
D) semipermeable
Answer: D
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.2

32) Some microorganisms can undergo _____ in which various cell types can become specialized and arise from one parent cell type.
A) differentiation
B) genetic exchange
C) maturation
D) mutagensis
Answer: A
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.2

33) Cyanobacteria and purple sulfur bacteria both obtain energy from light. However, only the _____ are capable of releasing _____.
A) cyanobacteria / organic compounds
B) cyanobacteria / oxygen
C) purple bacteria / organic compounds
D) purple bacteria / oxygen
Answer: B
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.3

34) The process whereby microorganisms are used to help clean up pollution created by human activities is known as
A) bioaugmentation.
B) biodegradation.
C) bioengineering.
D) bioremediation.
Answer: D
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.4

35) Robert Koch received the 1905 Nobel Prize in Physiology or Medicine for
A) developing a smallpox vaccination.
B) identifying *Mycobacterium tuberculosis* as the causative agent of tuberculosis.
C) making an effective rabies vaccine.
D) developing a smallpox vaccination, identifying *Mycobacterium tuberculosis* as the causative agent of tuberculosis, and making an effective rabies vaccine.
Answer: B
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.10

36) *Bacillus anthracis* deficient in its ability to differentiate would not be able to
A) chemotax towards growth substrates.
B) create vesicles.
C) form endospores.
D) grow without additional supplemented nutrients.
Answer: C
Bloom's Taxonomy: 5-6: Evaluating/Creating
Chapter Section: 1.10

37) Microbial biochemistry most specifically involves the discovery of microbial _____ and the _____ they perform.
A) organelles / diffusion
B) enzymes / organelles
C) reactions / enzymes
D) biomolecules / functions
Answer: D
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.2

38) Microbial cells first evolved on Earth approximately _____ billion years ago.
A) 1.6 to 1.8
B) 3.8 to 4.3
C) 5.4 to 5.6
D) 7.0 to 7.2
Answer: B
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.3

39) The disease anthrax is caused by the pathogenic bacterium _____, which produces heat-resistant structures known as _____.
A) *Azotobacter chroococcum* / endospores
B) *Azotobacter chroococcum* / plasmids
C) *Bacillus anthracis* / endospores
D) *Bacillus anthracis* / plasmids
Answer: C
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.2

40) The first documented description of a microorganism was of a _____ by _____.
A) bacterium / Ferdinand Cohn
B) fungus / Robert Koch
C) mold / Robert Hooke
D) yeast / Martinus Beijerinck
Answer: C
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.5

41) _____ produced by microbial fermentation of glucose from cellulose or cornstarch is becoming a more important component of biofuels in the United States, and specialized _____ are needed to make this a commercially available product.
A) Biodiesel / biotechnologists
B) Biodiesel / industrial microbiologists
C) Ethanol / biotechnologists
D) Ethanol / industrial microbiologists
Answer: D
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.4

42) _____ was the first to describe microorganisms, while _____ was the first person to see bacteria.
A) Antoni van Leeuwenhoek / Robert Hook
B) Antoni van Leeuwenhoek / Robert Koch
C) Robert Hooke / Antoni van Leeuwenhoek
D) Robert Koch / Antoni van Leeuwenhoek
Answer: C
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.5

43) The production of human proteins (e.g., insulin) by genetically engineered microorganisms is an example of _____, a subdiscipline of microbiology.
A) applied microbiology
B) biotechnology
C) industrial microbiology
D) molecular microbiology
Answer: B
Bloom's Taxonomy: 3-4: Applying/Analyzing
Chapter Section: 1.4

44) Approximately two billion years ago, _____ were primarily responsible for initially oxygenating Earth.
A) algae
B) *Archaea*
C) cyanobacteria
D) purple sulfur bacteria
Answer: C
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.3

45) *Archaea* and *Bacteria* are unified as prokaryotes in lacking _____ which *Eukarya* contain, such as mitochondria.
A) membranes
B) nuclei
C) membrane-enclosed organelles
D) nuclei and membrane-enclosed organelles
Answer: D
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.2

46) Bioremediation _____ by introducing pollutant-consuming microorganisms or specific nutrients that help microorganisms degrade pollutants.
A) accelerates the natural cleanup process
B) exploits genetic exchange mechanisms
C) invokes microbial evolution
D) uses chemotaxis of biodegrading microorganisms
Answer: A
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.4

47) _____ was the first to identify a new form of autotrophy in which energy is obtained from oxidizing inorganic compounds called _____.
A) Martinus Beijerinck / heteroautotrophy
B) Martinus Beijerinck / chemolithotrophy
C) Sergei Winogradsky / heteroautotrophy
D) Sergei Winogradsky / chemolithotrophy
Answer: D
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.11

48) Electron microscopy has greater _____ than light microscopy, because the wavelength of visible light is much larger than the wavelength of electrons.
A) contrast
B) magnification
C) resolution
D) penetration
Answer: C
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.8

49) Which of the following types of microscopy is especially effective for viewing details of internal structures within live cells?
A) phase-contrast microscopy
B) transmission electron microscopy
C) bright-field microscopy
D) scanning electron microscopy
Answer: A
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.6

50) Which of the following types of microscopy could be used to visualize the layers of the cell membrane and the cell wall?
A) phase-contrast microscopy
B) transmission electron microscopy
C) bright-field microscopy
D) confocal microscopy
Answer: B
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.8

51) Who was the first researcher to provide direct experimental data that supported the germ theory to explain infectious disease?
A) Pasteur
B) Winogradsky
C) Lister
D) Koch
Answer: D
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.10

52) When medical devices are left in the body, bacteria may grow on them as _____, which makes them especially resistant to treatment.
A) biofilms
B) liquids
C) populations
D) communities
Answer: D
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.4

53) Microbes that live at high temperatures in hot springs are _____.
A) always Archaea.
B) also able to thrive at low temperatures.
C) called extremophiles.
D) rarely found.
Answer: C
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.3

54) What field focuses specifically on the use of microbes to make products, such as antibiotics, on a large scale?
A) microbial ecology
B) biotechnology
C) industrial ecology
D) medical microbiology
Answer: C
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.3

55) Which statement about the relationship between microbes and humans is FALSE?
A) Most microbes are pathogenic.
B) Infectious disease is an important public health concern.
C) Bacteria in the digestive tract are important for digestion.
D) Microbes in root nodules fix nitrogen and allow plants to make nitrogen-rich products.
Answer: A
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.4

56) Why is ribosomal RNA especially useful for the study of phylogenetic relationships?
A) It is only found in some species, helping to distinguish them from others.
B) It is highly conserved.
C) It is highly variable.
D) It is extremely short.
Answer: B
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.13

57) Why is it important to use cultivation-independent methods to help understand microbial diversity?
A) It allows researchers to identify species that cannot be grown in culture.
B) It is the only way that phylogenetic trees can be constructed.
C) It must be used after bacteria are cultured to more fully sequence their DNA.
D) It is necessary to be able to examine ribosomal RNA.
Answer: A
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.13

1.2 True/False Questions

1) Most microorganisms are pathogenic.
Answer: FALSE
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.4

2) All microorganisms require molecular oxygen to carry on life functions.
Answer: FALSE
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.3

3) Metabolism is a unifying characteristic of all cellular organisms.
Answer: TRUE
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.2

4) According to our present understanding, each of the three major domains has what is known as its own universal ancestor.
Answer: FALSE
Bloom's Taxonomy: 3-4: Applying/Analyzing
Chapter Section: 1.3

5) Both environmental conditions and nutrient resources strongly influence the composition of a microbial community.
Answer: TRUE
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.3

6) The environment in which a microbial population lives is called its habitat.
Answer: TRUE
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.3

7) Differentiation occurs only in multicellular organisms.
Answer: FALSE
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.2

8) The discipline of microbiology is intimately associated with biochemistry and genetics, because cells are both biochemical catalysts and genetic coding devices.
Answer: TRUE
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.1

9) Today, the enrichment culture technique developed over a century ago by Martinus Beijerinck remains a feasible approach to discovering bacteria capable of degrading pollutants.
Answer: TRUE
Bloom's Taxonomy: 3-4: Applying/Analyzing
Chapter Section: 1.11

10) Sergei Winogradsky worked with bacteria involved in cycling nitrogen and sulfur.
Answer: TRUE
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.11

11) *Treponema pallidum,* a bacterium associated with syphilis, is not considered a pathogen because to date it remains unculturable in the lab, and, therefore, Koch's postulates are unable to be fulfilled.
Answer: FALSE
Bloom's Taxonomy: 3-4: Applying/Analyzing
Chapter Section: 1.10

12) Not only do some microorganisms tolerate extremely hot temperatures, some actually require high temperatures for optimal growth.
Answer: TRUE
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.3

13) Electron microscopes have less resolving power (resolution) than light microscopes.
Answer: FALSE
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.8

1.3 Essay Questions

1) Explain the nature and function of an enrichment culture.
Answer: Answers will vary, but an enrichment culture uses media, chemicals, or culture conditions to select for or encourage the growth of organisms with specific characteristics. An answer could describe providing only carbon dioxide as a source of carbon to select for autotrophs, for example.
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.11

2) Why is it incorrect to say that an object is partially sterile?
Answer: Sterile means the absence of all living organisms. Something is either sterile or it is not.
Other terms are used to describe objects that have been cleaned but are not sterile, such as disinfected.
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.9

3) Microbes were first formally observed during the mid-1600s, but the cell theory was not enunciated until 1839. Write a brief essay explaining why microbiology did not become a formally recognized science until Louis Pasteur's and Robert Koch's time.
Answer: Answers will vary, but a theme should be the lack of powerful microscopy tools. Without sufficient microscopes individual cells could not be seen, but the activities of microorganisms could be observed, such as the production of ethanol in Louis Pasteur's experiments on fermentation.
Bloom's Taxonomy: 5-6: Evaluating/Creating
Chapter Section: 1.5

4) List three contributions of Ferdinand Cohn to the development of microbiology.
Answer: Answers could possibly include: founding bacteriology as a separate science, studying *Beggiatoa*, discovering the genus *Bacillus* (along with its endospore formation and its life cycle), and devising methods to prevent contamination.
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.6

5) Compare and contrast the works of Louis Pasteur and Robert Koch in terms of both applied techniques and basic science.
Answer: Answers will vary, but should highlight the differences between basic scientific research in which fundamental ideas are discovered opposed to the usage of microbiological principles to solve larger questions. Examples of Pasteur's basic science contributions are his work showing that fermentation was mediated by microorganisms and the preferential metabolism of particular optical isomers by microbes. Pasteur also applied his ideas to develop sterilization techniques. Robert Koch focused more on the application of microbiology to identify the cause of tuberculosis by developing pure culturing techniques and the four postulates to link microbes to a disease.
Bloom's Taxonomy: 5-6: Evaluating/Creating
Chapter Section: 1.9, 1.10

6) Explain why microbial cells are excellent models for understanding cell function in higher organisms.
Answer: Answers will vary but should include commonality of function, biochemical and genetic similarities, and ease and speed with which they can be grown in large quantities.
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.1

7) Compare and contrast the leading causes of death in 1900 with the leading causes of death today. What roles have microbiologists played in the dramatic changes that are evident?
Answer: Answers will vary, but a focus should be that pathogens that killed people in the early 1900s are now treatable due to knowledge learned from microbiologists.
Bloom's Taxonomy: 3-4: Applying/Analyzing
Chapter Section: 1.4

8) Explain how you would use Robert Koch's postulates to determine that *Streptococcus pyogenes* is the causative agent of streptococcal pharyngitis ("strep throat").
Answer: Answers will vary but will need to detail how *S. pyogenes* will be subjected to all four postulates.
Bloom's Taxonomy: 3-4: Applying/Analyzing
Chapter Section: 1.10

9) The text states that antibiotics are derived from microorganisms. What is the benefit to an antibiotic-producing microorganism of producing an antibiotic in its natural habitat?
Answer: Answers will vary, but it must first be stated the antibiotic-producing microbe would need to be resistant to the antibiotic. This should then follow into a discussion on how antibiotic production could be viewed as a way to persist in the environment, such as maintaining dominance in a community over others.
Bloom's Taxonomy: 5-6: Evaluating/Creating
Chapter Section: 1.2

10) Describe beneficial and harmful ways in which microorganisms interact with agricultural crops.
Answer: Certain microbes are beneficial to crops when they produce nutrients (e.g., NH_4^+, SO_4^{2-}) usable by a crop from a substrate that was unusable. Other microbes can cause diseases in plants, much like pathogens cause disease in humans.
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.4

11) Provide evidence supporting the statement that an "ecosystem is controlled by microbial activities."
Answer: Answers will vary, but one example could be oxygen depletion, where a loss of oxygen would then favor anaerobic microorganisms.
Bloom's Taxonomy: 5-6: Evaluating/Creating
Chapter Section: 1.3

12) Explain why only anaerobic bacteria inhabited Earth for the first two billion years of its existence.
Answer: The key idea is an anoxic environment will not allow aerobic organisms to survive.
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.3

13) How would the presence of endospores in Louis Pasteur's nutrient solutions have affected his conclusions about spontaneous generation?
Answer: Answers will vary, but ultimately this could have confounded Pasteur if the endospores sometimes went into a vegetative growth phase and other times no growth was observed.
Bloom's Taxonomy: 3-4: Applying/Analyzing
Chapter Section: 1.9

14) Using specific examples, explain why it is sometimes impossible to satisfy Robert Koch's postulates.
Answer: Answers will vary, but one issue is the consideration for a model animal host that will react to the (human) pathogen in the same manner as in a human host. For example, a chicken would not show flu-like symptoms when infected with the influenza virus. Another issue is the inability to cultivate some microorganisms outside of the host.
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.10

15) Explain why infectious diseases are much less lethal in developed countries than in underdeveloped countries.
Answer: Answers will vary but should emphasize ways in which increased knowledge about microbial pathogenesis has influenced preventative care (e.g., sanitation) and treatment (e.g., antimicrobial drugs).
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.4

16) Describe two capabilities of microbes that exemplify their dynamic nature in interacting with their environment.
Answer: Answers could possibly include cell-cell communication, ability to move (motility), ability to differentiate, and exchange of materials (any two).
Bloom's Taxonomy: 1-2: Remembering/Understanding
Chapter Section: 1.2

17) Compare and contrast the functions microbes serve in the digestive systems of both humans and rumens (e.g., cattle).
Answer: Answers will vary but should focus on humans having a high cell localized density in the colon (large intestine), whereas rumens have higher microbial populations in the rumen. Microbes in both systems aid in digestion and improve nutrition/health of the host.
Bloom's Taxonomy: 3-4: Applying/Analyzing
Chapter Section: 1.4

18) The explosive chemical trinitrotoluene (TNT) can remain in soils after use and is hazardous to humans. Propose an experiment in which TNT-degrading microorganisms could be isolated for purposes of bioremediation. Also indicate what experimental evidence would be useful to isolate TNT-degrading microorganisms.
Answer: Experimental designs will vary, but one example would be to use the enrichment culture technique with soil from an ammunition site. While adding TNT to the enrichment culture, a key piece of experimental evidence could be the loss of TNT in the culture to initiate isolation attempts.
Bloom's Taxonomy: 5-6: Evaluating/Creating
Chapter Section: 1.4

19) What type of microscope would you use to visualize the internal structures of a chloroplast? Support your answer with evidence based on the size of the structures you want to see and the resolution and magnification power of different types of microscopes.
Answer: Transmission electron microscopy would be necessary to visualize the internal structures of a chloroplast. Chloroplasts are less than 5 μm in diameter and the internal membranes are only 10 nm thick. Light microscopes only have a resolution of 200 nm, thus any structure less than 200 nm will not be visible. Individual chloroplasts could be seen with a light microscope, but not the structures inside. Scanning electron microscopy can only see external features because electrons cannot penetrate the cell, thus the cell must be sectioned and prepared for transmission electron microscopy to see the inside of the chloroplasts.
Bloom's Taxonomy: 5-6: Evaluating/Creating
Chapter Section: 1.8