

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 1) In microbiology, the term *growth* usually refers to which of the following? 1) _____
 - A) an increase in the number of microbial cells
 - B) an increase in the number and size of microbial cells
 - C) an increase in a microbe's size
 - D) an increase in the amount of ATP produced
 - E) an increase in the number and size of microbial cells and the amount of ATP produced

- 2) A cell that uses an organic carbon source and obtains energy from light would be called a 2) _____
 - A) photoautotroph.
 - B) lithoautotroph.
 - C) chemoautotroph.
 - D) photoheterotroph.
 - E) chemoheterotroph.

- 3) A(n) _____ organism is one that requires oxygen for growth. 3) _____
 - A) anaerobic
 - B) obligate aerobic
 - C) facultative anaerobic
 - D) aerotolerant
 - E) both aerotolerant and anaerobic

- 4) An aquatic microbe that can grow only at the surface of the water is probably which of the following? 4) _____
 - A) an anaerobe
 - B) a heterotroph
 - C) a chemotroph
 - D) a lithotroph
 - E) a phototroph

- 5) Which of the following forms of oxygen is detoxified by the enzyme catalase? 5) _____
 - A) singlet oxygen
 - B) molecular oxygen
 - C) peroxide anion
 - D) superoxide radical
 - E) hydroxyl radical

- 6) All of the following are used to protect organisms from the toxic by-products of oxygen EXCEPT 6) _____
 - A) carotenoids.
 - B) protease.
 - C) superoxide dismutase.
 - D) peroxidase.
 - E) catalase.

- 7) A microbe that grows only at the bottom of a tube of thioglycollate medium is probably a(n) 7) _____
 - A) facultative anaerobe.
 - B) microaerophile.
 - C) aerotolerant anaerobe.
 - D) obligate anaerobe.
 - E) obligate aerobe.

- 8) Nitrogen is a growth limiting nutrient for many organisms because 8) _____
- A) only a small number of bacteria are able to extract it from the atmosphere.
 - B) it is required for lipid synthesis.
 - C) only a few microbes can extract it from the atmosphere, but all organisms require it for amino acid and nucleotide synthesis.
 - D) it is required for synthesis of nucleotides.
 - E) it is necessary for the biosynthesis of amino acids.
- 9) All of the following are examples of growth factors used by microbes EXCEPT 9) _____
- A) heme.
 - B) NADH.
 - C) amino acids.
 - D) selenium.
 - E) vitamins.
- 10) At temperatures higher than the maximum growth temperature for an organism, 10) _____
- A) hydrogen bonds are broken, proteins are denatured, and membranes become too fluid.
 - B) membranes become too fluid for proper function.
 - C) hydrogen bonds within molecules are broken.
 - D) hydrogen bonds are broken, and proteins are permanently denatured.
 - E) proteins are permanently denatured.
- 11) Human pathogens are classified as 11) _____
- A) psychrophiles.
 - B) hyperthermophiles.
 - C) thermophilic.
 - D) mesophiles.
 - E) thermophiles.
- 12) The term *barophile* refers to which of the following growth requirements? 12) _____
- A) pH
 - B) nitrogen source
 - C) osmotic pressure
 - D) temperature
 - E) hydrostatic pressure
- 13) Which of the following organisms would be most likely to contaminate a jar of pickles? 13) _____
- A) an acidophile
 - B) a thermophile
 - C) an obligate anaerobe
 - D) a mesophile
 - E) a neutrophile
- 14) Organisms that can grow with or without oxygen present are 14) _____
- A) aerotolerant anaerobes.
 - B) facultative anaerobes.
 - C) obligate aerobes.
 - D) obligate anaerobes.
 - E) either facultative anaerobes or aerotolerant anaerobes.
- 15) A fastidious organism might be grown on which of the following types of media? 15) _____
- A) enriched media

- B) transport media
- C) differential media
- D) selective media
- E) reducing media

- 16) Obligate anaerobes may be cultured in the laboratory 16) _____
A) on blood agar plates in a candle jar.
B) in a reducing medium.
C) on blood agar plates.
D) in a candle jar.
E) in standard Petri plates.
- 17) Joan wants to discover a microbe capable of degrading an environmental contaminant. Which of the following refers to the process she should use? 17) _____
A) quorum sensing
B) binary fission
C) enrichment culture
D) nitrogen fixation
E) lyophilization
- 18) A microbiologist inoculates a growth medium with 100 bacterial cells/ml. If the generation time of the species is 1 hour, how long will it be before the culture contains more than 10,000 cells/ml? 18) _____
A) 3 hours B) 2 hours C) 10 hours D) 7 hours E) 24 hours
- 19) An epidemiologist is investigating a new disease and observes what appear to be bacteria inside tissue cells in clinical samples from victims. The scientist wants to try to isolate the bacteria in the lab. What culture conditions are most likely to be successful? 19) _____
A) inoculation of EMB plates
B) incubation in a candle jar
C) culturing on blood agar plates
D) inoculation of cell cultures
E) inoculation of a minimal medium broth
- 20) Which of the following measurement techniques would be useful to quantify a species of bacteria that is difficult to culture? 20) _____
A) membrane filtration
B) microscopic counts
C) metabolic activity
D) viable plate counts
E) MPN
- 21) MacConkey agar plates represent _____ medium. 21) _____
A) a differential
B) a selective
C) a minimal
D) both a differential and a selective
E) both a minimal and a selective
- 22) A Petroff-Hauser counting chamber is 22) _____
A) a glass slide containing an etched grid for counting microbes directly using a microscope.
B) a device that counts cells as they interrupt an electrical current.
C) a device used to count numbers of bacterial colonies on a Petri plate.

- D) an apparatus that traps bacterial cells on a membrane filter where they can be counted.
- E) a device that measures the amount of light that passes through a culture.

- 23) Another term for the logarithmic growth of bacterial cells is 23) _____
- A) arithmetic growth.
 - B) generation time.
 - C) absorbance.
 - D) exponential growth.
 - E) binary fission.
- 24) A device that removes wastes and adds fresh medium to bacterial cultures in order to prolong the log phase of a culture is called a(n) 24) _____
- A) cytometer.
 - B) pellicle.
 - C) spectrophotometer.
 - D) chemostat.
 - E) Coulter counter.
- 25) A specimen of urine is determined to contain 30 bacterial cells per microliter. How many cells would be present in a milliliter? 25) _____
- A) 3 B) 30,000 C) 3,000 D) 30 million E) 300
- 26) Which of the following is NOT a direct method for measuring the number of microbes in a sample? 26) _____
- A) membrane filtration
 - B) Coulter counter
 - C) turbidity
 - D) viable plate counts
 - E) MPN
- 27) During which growth phase are bacteria more susceptible to antimicrobial drugs? 27) _____
- A) stationary phase
 - B) log phase
 - C) lag phase
 - D) death phase
 - E) the susceptibility is the same for all phases
- 28) The use of salt and sugar in preserving various types of foods is an application of which of the following concepts? 28) _____
- A) quorum sensing
 - B) nitrogen fixation
 - C) pH
 - D) osmotic pressure
 - E) hydrostatic pressure
- 29) A clinical sample labeled as "sputum" was collected from 29) _____
- A) the skin.
 - B) the blood.
 - C) the lungs.
 - D) a piece of tissue.
 - E) the central nervous system.

- 30) The method of obtaining isolated cultures that utilizes surface area to dilute specimens is called 30) _____
A) transport media.
B) enrichment culturing.
C) the streak-plate technique.
D) serial dilution.
E) the pour-plate technique.
- 31) _____ are complex communities of various types of microbes that adhere to surfaces. 31) _____
A) Isolates
B) Media
C) Colonies
D) Biofilms
E) Aggregates
- 32) A colony-forming unit is the number of cells 32) _____
A) that can be placed on a Petri plate.
B) that produces one colony.
C) in a particular specimen.
D) in a colony.
E) that is in exponential phase in a culture.
- 33) All of the following ingredients might be found in complex media EXCEPT 33) _____
A) blood.
B) soy extract.
C) hydrogen peroxide.
D) yeast extract.
E) milk proteins.
- 34) Sodium thioglycollate is associated with which of the following types of media? 34) _____
A) transport media
B) reducing media
C) complex media
D) differential media
E) selective media
- 35) Which of the following quantification techniques can distinguish living cells from dead cells in a culture? 35) _____
A) a Coulter counter
B) metabolic activity
C) dry weight
D) microscopic counts
E) turbidity

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

Match the statements with the appropriate phase of the bacterial growth curve:

- A) Lag phase
- B) Log phase
- C) Death phase
- D) Stationary phase

- 36) New cells are being produced at the same rate as other cells are dying 36) _____

- | | |
|--|-----------|
| 37) Cells are dying faster than new cells are being produced | 37) _____ |
| 38) Cells are metabolically active but not dividing | 38) _____ |
| 39) The phase normally maintained by means of a chemostat | 39) _____ |
| 40) Cells are rapidly growing and dividing | 40) _____ |

Match each term with the appropriate description:

- A) Hydrostatic pressure
- B) Salt concentration
- C) pH
- D) Carbon dioxide levels
- E) Oxygen levels

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|--------------------|-----------|
| 41) Halophile | 41) _____ |
| 42) Capnophile | 42) _____ |
| 43) Barophile | 43) _____ |
| 44) Microaerophile | 44) _____ |
| 45) Acidophile | 45) _____ |

TRUE/FALSE. Write 'T' if the statement is true and 'F' if the statement is false.

- | | |
|--|-----------|
| 46) Obligate anaerobes have enzymes such as superoxide dismutase to protect them from the damaging effects of oxygen. | 46) _____ |
| 47) Nitrogen fixation is a process that occurs in all bacteria. | 47) _____ |
| 48) Thermotolerant mesophiles are often responsible for spoilage of improperly canned foods. | 48) _____ |
| 49) An obligate halophile will burst if placed in freshwater. | 49) _____ |
| 50) The only effective way to store bacterial cultures for short periods of time is to arrest their metabolism by freezing. | 50) _____ |
| 51) Quorum sensing is a process by which bacteria respond to the density of other bacteria in their environment. | 51) _____ |
| 52) An obligate anaerobe can be cultured in a candle jar. | 52) _____ |
| 53) Agar is a useful compound in the microbiology lab because it is an excellent nutrient for bacteria. | 53) _____ |
| 54) A selective medium can be formulated either by including inhibitory chemical substances or by leaving out a single crucial nutrient. | 54) _____ |
| 55) In spectrophotometry, 40% light transmission is the same thing as 60% absorbance of light. | 55) _____ |

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Correct answers may contain more than one word.

- 56) The conversion of nitrogen gas to ammonia is called _____. 56) _____
- 57) _____ are organisms that require organic sources of carbon and energy. 57) _____
- 58) The _____ radical is formed during the incomplete reduction of O₂ during electron transport in aerobes. 58) _____
- 59) The _____ growth temperature is the temperature at which an organism exhibits the highest growth rate. 59) _____
- 60) Bacteria that thrive at human body temperatures are classified as _____. 60) _____
- 61) _____ can survive in water up to pH 11.5. 61) _____
- 62) Cells that are exposed to hypertonic environments will exhibit _____. 62) _____
- 63) A(n) _____ is a sample of microorganisms introduced into a growth medium. 63) _____
- 64) A(n) _____ is composed of cells that arise from a single colony. 64) _____
- 65) _____ is a gelling agent derived from algae that is useful for creating solid growth media. 65) _____
- 66) A sample placed into fresh medium is typically initially in the _____ phase of microbial growth. 66) _____
- 67) A(n) _____ plots the number of organisms in a growing population over time. 67) _____
- 68) _____ is a method of counting cells that have been stained or tagged with fluorescent dyes. 68) _____
- 69) A film of cells at the surface of a broth is called a(n) _____. 69) _____
- 70) A(n) _____ can measure changes in the turbidity of a bacterial culture. 70) _____

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

- 71) Explain how aerobic organisms tolerate the presence of oxygen in their metabolic pathways despite its toxic properties.
- 72) Explain how temperature and pH levels can influence microbial infections in the human body.
- 73) Compare and contrast the streak-plate method of isolation with the pour-plate method of isolation.
- 74) Genetic methods of detecting microorganisms reveal that the number of bacterial species in nature exceeds previous estimates by several orders of magnitude. In the human mouth, for example, it is estimated that 500–700 microbial species are normally present. Explain why previous estimates were low.
- 75) Explain the similarities and differences between direct and indirect methods of measuring microbial growth, and give examples of each.

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 76) All of the following are associated with nucleic acid structure EXCEPT 76) _____
- A) phosphate.
 - B) ionic bonds.
 - C) ribose.
 - D) hydrogen bonds.
 - E) uracil.
- 77) Which of the following is found at the 5' end of a DNA strand? 77) _____
- A) a phosphate group
 - B) a hydroxyl group
 - C) a hydrogen bond
 - D) histones
 - E) a methyl group
- 78) The bacterial chromosome is 78) _____
- A) found in a nucleus.
 - B) found in a nucleoid.
 - C) usually circular.
 - D) both circular and found in a nucleoid.
 - E) both circular and found in a nucleus.
- 79) Which of the following types of plasmids allows a bacterial cell to kill its competitors? 79) _____
- A) bacteriocin factors
 - B) virulence factors
 - C) fertility factors
 - D) cryptic plasmids
 - E) resistance factors
- 80) Which of the following is NOT involved in the packaging of eukaryotic chromosomes? 80) _____
- A) heterochromatin
 - B) nucleosomes
 - C) Okazaki fragments
 - D) histones
 - E) euchromatin
- 81) Which of the following statements is true of bacterial plasmids? 81) _____
- A) They are small circular DNA molecules.
 - B) They can replicate autonomously.
 - C) They are found in the nucleoid.
 - D) They carry genes for essential metabolic functions.
 - E) They are small circular DNA molecules that can replicate autonomously.
- 82) DNA helicases 82) _____
- A) synthesize short DNA molecules important for the function of DNA polymerase.
 - B) assist in recognition of promoters during transcription.
 - C) break hydrogen bonds between complementary nucleotides.
 - D) proofread DNA molecules.
 - E) seal gaps between DNA fragments.
- 83) Which of the following statements concerning transcription in bacteria is FALSE? 83) _____
- A) It occurs in the nucleoid region.
 - B) The same RNA polymerase transcribes primer RNA, mRNA, tRNA, and rRNA.

- C) Sigma factors are parts of RNA polymerase that recognize promoter regions.
- D) There are a variety of sigma factors that affect transcription.
- E) Termination is either self-induced or due to the presence of Rho protein.

- 84) Which of the following is involved in translation? 84) _____
- A) both mRNA and tRNA
 - B) mRNA, rRNA and tRNA are all involved.
 - C) tRNA
 - D) rRNA
 - E) mRNA
- 85) Which of the following is a characteristic shared by DNA and RNA polymerases? 85) _____
- A) speed
 - B) dependence on helicase
 - C) type of nucleotides used
 - D) efficiency of proofreading
 - E) direction of polymerization
- 86) Which of the following is the strongest base pair? 86) _____
- A) both adenine-uracil and adenine-thymine
 - B) adenine-uracil
 - C) guanine-cytosine
 - D) guanine-thymine
 - E) adenine-thymine
- 87) A codon is a particular combination of three nucleotides. Therefore, there are _____ possible combinations of the nucleotides A, C, G, and T. 87) _____
- A) 32 B) 16 C) 4 D) 12 E) 64
- 88) The AUG codon functions in coding for the amino acid methionine and as a 88) _____
- A) start signal.
 - B) recognition site for RNA polymerase.
 - C) "wobble" codon.
 - D) termination signal.
 - E) marker for introns.
- 89) Which of the following must be removed from a eukaryotic mRNA molecule before it can be translated? 89) _____
- A) exon B) codon C) intron D) anticodon E) promoter
- 90) A charged tRNA first enters the ribosomal _____ site and then moves into the _____ site. 90) _____
- A) A, P B) P, E C) P, A D) A, E E) E, A
- 91) Which of the following statements regarding eukaryotic transcription is FALSE? 91) _____
- A) Multiple transcription factors are required.
 - B) Transcription occurs in the nucleus, mitochondria, and chloroplasts (if present).
 - C) A guanine is added to the 3' end, and a poly-A tail is added to the 5' end of the mRNA transcript.
 - D) There are four different RNA polymerases.
 - E) Multiple elongation factors are required.
- 92) Semiconservative DNA replication means that 92) _____

- A) the sequence of a DNA molecule is preserved as it is being replicated.
- B) nucleotides are constantly being recycled as cells make DNA.
- C) each daughter DNA molecule is composed of one original strand and one new strand.
- D) each strand of a double-stranded DNA molecule is replicated differently.
- E) the cell can proofread its newly synthesized DNA only part of the time.

- 93) Which of the following is NOT a characteristic of Okazaki fragments? 93) _____
- A) They make up the lagging strand of replicated DNA.
 - B) They begin with an RNA primer.
 - C) They are joined together by DNA ligase.
 - D) They are checked for accuracy by DNA polymerase III.
 - E) They are longer in eukaryotic cells.
- 94) The proofreading function of DNA polymerase III results in an error rate of _____ during DNA replication. 94) _____
- A) 1 error in 1,000 bases
 - B) 1 error in 100,000 bases
 - C) 1 error in 1 million bases
 - D) 1 error in 10 million bases
 - E) 1 error in 10 billion bases
- 95) Which of the following processes is involved in the "central dogma" of genetics? 95) _____
- A) transcription and translation
 - B) transcription
 - C) DNA replication
 - D) DNA replication and translation
 - E) translation
- 96) Inducible operons 96) _____
- A) usually require a repressor to be transcribed.
 - B) are active in the presence of a repressor.
 - C) are normally active.
 - D) are generally anabolic pathways.
 - E) usually require an activator to be transcribed.
- 97) Which of the following are considered to be frameshift mutations? 97) _____
- A) insertions
 - B) deletions
 - C) inversions
 - D) both inversion and insertions
 - E) both deletions and insertions
- 98) If the codon AAA is changed to AAG, it still codes for the amino acid lysine; this is an example of a 98) _____
- A) silent mutation.
 - B) frameshift mutation.
 - C) missense mutation.
 - D) nonsense mutation.
 - E) gross mutation.
- 99) Which of the following causes mutations by creating thymine dimers? 99) _____
- A) nucleotide analogs

- B) ultraviolet light
- C) nitrous acid
- D) benzopyrene
- E) gamma rays

- 100) DNA damage caused by ethidium bromide results in _____ mutations. 100) _____
- A) insertion
 - B) deletion
 - C) substitution
 - D) both inversion and insertion
 - E) both insertion and deletion
- 101) Which of the following is a DNA repair enzyme activated by visible light? 101) _____
- A) DNA ligase
 - B) bacteriocin
 - C) transposase
 - D) DNA photolyase
 - E) primase
- 102) The Ames test proves that a chemical is 102) _____
- A) carcinogenic in *Salmonella*.
 - B) mutagenic in humans.
 - C) carcinogenic.
 - D) carcinogenic in humans.
 - E) mutagenic in *Salmonella*.
- 103) The horizontal transfer process known as transduction 103) _____
- A) requires a cell to be "competent."
 - B) requires a pilus.
 - C) requires a plasmid.
 - D) involves a virus.
 - E) involves a mutagen.
- 104) Frederick Griffith discovered 104) _____
- A) the *lac* operon.
 - B) transposons.
 - C) conjugation.
 - D) DNA.
 - E) transformation.
- 105) In conjugation, F⁺ cells 105) _____
- A) serve as recipient cells.
 - B) do not have conjugation pili.
 - C) can transfer DNA only to other F⁺ cells.
 - D) contain an F plasmid.
 - E) contain "jumping genes."
- 106) Another term for the palindromic sequence found at the ends of transposons is a(n) 106) _____
- A) inverted repeat.
 - B) bacteriophage.
 - C) transposase.
 - D) complex transposon.

E) insertion sequence.

- 107) Which of the following is characteristic of prokaryotic genomes but NOT eukaryotic genomes? 107) ____
A) circular chromosomes
B) typically consist of a few to several chromosomes
C) enclosed in a nuclear membrane
D) linear chromosomes
E) histones
- 108) Genes are active in a region of the eukaryotic chromosome called 108) ____
A) the plasmid.
B) the histone.
C) the nucleoid.
D) heterochromatin.
E) euchromatin.
- 109) The energy required for DNA replication comes from 109) ____
A) DNA ligase.
B) RNA primer.
C) the leading strand.
D) DNA polymerase.
E) triphosphate deoxyribonucleotides.
- 110) Which of the following is NOT involved in the regulation of the *lac* operon? 110) ____
A) a repressor protein
B) an inducer
C) an iRNA
D) cyclic AMP
E) glucose

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

Match the term with the appropriate genetic process:

- A) Transcription
- B) DNA replication
- C) Translation

- 111) Promoter 111) ____
- 112) Codon 112) ____
- 113) Origin 113) ____
- 114) DNA ligase 114) ____
- 115) RNA polymerase 115) ____
- 116) tRNA 116) ____
- 117) fMet 117) ____
- 118) Sigma factor 118) ____

119) Semiconservative 119) _____

120) P site 120) _____

TRUE/FALSE. Write 'T' if the statement is true and 'F' if the statement is false.

121) Prokaryotic cells are diploid. 121) _____

122) Prokaryotes have one type of DNA polymerase, which is different from that of eukaryotes. 122) _____

123) The most common type of mutation is a point mutation. 123) _____

124) Most bacteria have a natural ability to take up DNA from their environment. 124) _____

125) The structure of DNA explains both its ability to encode genetic information and the way in which it is copied during cell reproduction. 125) _____

126) DNA, which is negatively charged, wraps around positively charged histones as part of the packaging of eukaryotic chromosomes. 126) _____

127) Bidirectional replication means that each strand of a DNA molecule is replicated in the opposite direction from the other. 127) _____

128) The phenotype of an organism reflects only part of its genotype. 128) _____

129) In generalized transduction, viruses carry random DNA sequences from one cell to another. 129) _____

130) DNA polymerase III participates in the dark repair mechanism of DNA mutation repair. 130) _____

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Correct answers may contain more than one word.

131) A(n) _____ is a specific sequence of nucleotides that codes for a protein or an RNA molecule. 131) _____

132) Loosely packed regions of a eukaryotic chromosome are called _____. 132) _____

133) Transfer of DNA between cells by viruses is called _____. 133) _____

134) A(n) _____ is a mutant organism that has different nutritional requirements from the original wild-type organism. 134) _____

135) The enzyme that removes supercoils generated during DNA replication is _____. 135) _____

136) 5-bromouracil mimics the chemical structure of thymine, making it a(n) _____. 136) _____

137) A mutation that changes the reading frame of a gene is called a _____ mutation. 137) _____

138) The _____ of a transfer RNA molecule is complementary to a codon in a messenger RNA molecule. 138) _____

139) Transfer RNA molecules carrying amino acids initially bind to the ribosome at the _____. 139) _____

- 140) dATP and dCTP are examples of _____, the building blocks of DNA molecules. 140) _____
- 141) A(n) _____ is a set of prokaryotic genes that are regulated and transcribed as a unit. 141) _____
- 142) The _____ is the DNA strand that is synthesized continuously during DNA replication. 142) _____
- 143) The _____ is the set of genes in the genome of an organism. 143) _____
- 144) RNA polymerase initiates transcription by recognizing specific nucleotide sequences called _____. 144) _____
- 145) _____ RNA molecules contain both introns and exons. 145) _____

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

- 146) Describe the basic similarities and differences between DNA replication and transcription.
- 147) Describe the various types of nucleic acids that are typically found in cells.
- 148) Discuss some of the consequences of the significant differences in transcription between prokaryotes and eukaryotes.
- 149) Compare and contrast the lactose operon with the tryptophan operon.
- 150) A point mutation can be completely harmless, or it can result in the death of a cell or organism. Explain why these types of mutations can have such varying effects.

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- 151) Which of the following processes did NOT contribute to the development of genetic engineering? 151) _____
A) chemiosmosis
B) transformation
C) conjugation
D) transcription
E) transduction
- 152) In the 20th century, scientists harnessed the natural metabolic reactions of bacteria to make _____ for the first time in an industrial setting. 152) _____
A) bread B) alcohol C) cheese D) soy sauce E) acetone
- 153) Which of the following items is NOT a part of the name of a restriction enzyme? 153) _____
A) the Gram reaction of the source bacterium
B) the strain of the source bacterium
C) the genus of the source bacterium
D) the specific epithet of the source bacterium
E) Roman numerals to indicate its order of discovery
- 154) The natural role of restriction enzymes in bacteria is 154) _____
A) to make conjugation more efficient.
B) to allow transposons to move to another place in the chromosome.
C) to protect the cell from invading phages.

- D) to provide the cell with new phenotypes, such as antibiotic resistance.
- E) to allow cells to accept foreign DNA.

- 155) A library of cloned sequences representing the expressed genes of an organism is known as a(n) 155) ____
A) microarray.
B) gene library.
C) cDNA library.
D) DNA fingerprint.
E) *FISH* library.
- 156) Which of the following restriction enzyme sites would produce blunt-ended fragments (the arrow represents the cutting site of the enzyme)? 156) ____
A) C↓CGG
B) CCC↓GGG
C) G↓AATTC
D) G↓GATCC
E) A↓AGCTT
- 157) Put the following steps in the correct order needed to produce a recombinant vector containing a human gene insert. 157) ____
I. Introduce the recombinant plasmid into a bacterial cell.
II. Isolate the human gene and the vector DNA using restriction enzymes.
III. Ligate the DNA fragments to produce a recombinant plasmid.
IV. Grow bacterial cells on a medium containing a selective agent (such as an antibiotic).
A) I, III, IV, II B) II, I, III, IV C) II, III, I, IV D) III, I, IV, II E) III, I, II, IV
- 158) Which of the following statements regarding vectors is FALSE? 158) ____
A) Cloning vectors frequently contain sequences necessary for expression of inserted sequences.
B) Vectors are generally over 100,000 base pairs in size.
C) A useful vector contains multiple restriction sites for insertion of DNA.
D) Cloning vectors include a "marker" to facilitate identification of cells containing them.
E) Vectors are usually autonomously replicating DNA molecules.
- 159) Synthetic nucleic acids are useful 159) ____
A) as DNA probes, primers, and antisense RNAs.
B) as DNA probes.
C) as antisense RNAs.
D) as primers for PCR.
E) as DNA probes and antisense RNAs.
- 160) Which of the following would be an appropriate temperature for the first step of PCR? 160) ____
A) 72°C B) 65°C C) 94°C D) 37°C E) 55°C
- 161) Which of the following is essential in PCR? 161) ____
A) DNA polymerase
B) DNA primers
C) antisense RNAs
D) reverse transcriptase
E) both DNA primers and DNA polymerase
- 162) If a researcher used *Escherichia coli* DNA polymerase instead of *Thermus aquaticus* DNA 162) ____
poly meras

e in the 162)
PCR
procedur
e, what
would be
the
result?

- A) PCR would not occur at all.
- B) PCR would occur twice as fast as normal.
- C) PCR would stop after one cycle.
- D) PCR would occur more slowly than normal.
- E) Many mistakes would occur.

163) Which of the following would be an appropriate sequence of temperatures for PCR?

163) _____

- A) 94°C, 65°C, 72°C
- B) 94°C, 55°C, 37°C
- C) 72°C, 65°C, 94°C
- D) 65°C, 72°C, 94°C
- E) 94°C, 37°C, 55°C

164) If you started with a single DNA molecule, how many would you have at the end of six PCR cycles?

164) _____

- A) 4
- B) 64
- C) 32
- D) 16
- E) 100

165) In gel electrophoresis, DNA molecules move toward the _____ electrode because they have an overall _____ charge.

165) _____

- A) negative, negative
- B) negative, positive
- C) negative and positive, neutral
- D) positive, negative
- E) positive, positive

166) Which of the following procedures might be used to detect the presence of genetic sequences of a virus in a patient's blood?

166) _____

- A) Southern blotting
- B) xenotransplantation
- C) genome mapping
- D) electroporation
- E) creation of a gene library

167) A northern blot differs from a Southern blot in

167) _____

- A) the size of the genetic sequences involved.
- B) the presence or absence of a nitrocellulose membrane.
- C) the type of nucleic acid being isolated.
- D) the number of genetic sequences detected.
- E) the type of probe used.

168) Which of the following methods of inserting DNA into cells might be used on plant seeds?

168) _____

- A) protoplast fusion, injection, and electroporation
- B) protoplast fusion
- C) electroporation
- D) both injection and electroporation

E) injection

- 169) The DNA double helix can be separated into single strands using 169) ____
A) both heat and NaOH.
B) heat.
C) heat, NaOH, and reverse transcriptase.
D) NaOH.
E) reverse transcriptase.
- 170) The sequencing and analysis of an organism's genetic information is called 170) ____
A) genomics.
B) protein synthesis.
C) PCR.
D) northern blotting.
E) gene therapy.
- 171) Which of the following devices is used for PCR? 171) ____
A) a DNA sequencer
B) a thermocycler
C) a gene gun
D) an electrophoresis chamber
E) a nucleic acid synthesis machine
- 172) DNA fingerprinting can be used 172) ____
A) to detect unculturable organisms.
B) in forensic investigations.
C) to generate cDNA clones.
D) for forensics and detection of unculturable organisms.
E) to generate cDNA clones and libraries.
- 173) The process of introducing animal organs into the human body is 173) ____
A) electrophoresis.
B) protoplast fusion.
C) recombinant DNA technology.
D) xenotransplantation.
E) biotechnology.
- 174) Subunit vaccines are safer than traditional vaccines because 174) ____
A) they are acellular and can be administered in food.
B) they are acellular and do not pose a risk for causing the disease.
C) they are acellular.
D) they do not pose a risk for causing the disease.
E) they are administered in food.
- 175) Which of the following recombinant tools is NOT used in DNA fingerprinting? 175) ____
A) reverse transcription
B) restriction enzyme digestion
C) gel electrophoresis
D) Neither PCR nor gel electrophoresis is used.
E) PCR
- 176) Transgenic organisms 176) ____

- A) contain cells from other organisms.
- B) have genomes that have been sequenced completely.
- C) contain genetically engineered microbes.
- D) are the same thing as clones.
- E) contain genes from other organisms.

177) Which of the following microbes produces a protein that kills a variety of insect pests? 177) _____

- A) *Pseudomonas*
- B) *Thermus aquaticus*
- C) *Haemophilus influenzae*
- D) *Plasmodium falciparum*
- E) *Bacillus thuringiensis*

178) *In vitro* means 178) _____

- A) "in life."
- B) "within glassware."
- C) "from a stranger."
- D) "in the cell."
- E) "within an organism."

179) If all the following DNA fragments were analyzed on an electrophoresis gel, which one would migrate farthest from the negative electrode? 179) _____

- A) 250 base pairs
- B) 5000 base pairs
- C) 750 base pairs
- D) 1000 base pairs
- E) 2500 base pairs

180) Protoplasts are associated with which of the following? 180) _____

- A) Southern blotting
- B) electroporation
- C) xenotransplants
- D) gene therapy
- E) PCR

181) An antigen is 181) _____

- A) a foreign substance that stimulates immunity.
- B) a genetic marker found in most plasmids.
- C) a naturally occurring insecticide.
- D) a substance used to make gels for DNA electrophoresis.
- E) a molecule necessary for PCR.

182) An effective tool for screening a large number of genetic sequences at once is known as 182) _____

- A) cDNA synthesis.
- B) gel electrophoresis.
- C) microarray.
- D) restriction analysis.
- E) *FISH*.

183) Which of the following is generally NOT considered an ethical issue regarding recombinant DNA technology? 183) _____

- A) answering basic research questions

- B) unforeseen impact on the environment
- C) screening of humans for genes that predispose them to disease
- D) the modification of crop plants
- E) the modification of animals to produce pharmaceuticals for humans

184) The first complete gene map was that of 184) _____

- A) *Escherichia coli*.
- B) *Staphylococcus aureus*.
- C) *Plasmodium falciparum*.
- D) *Pseudomonas*.
- E) *Haemophilus influenzae*.

185) Which of the following microbes has been genetically engineered to contain a protein that helps protect crops from freezing? 185) _____

- A) *Salmonella*
- B) *Bacillus thuringiensis*
- C) *Escherichia coli*
- D) *Pseudomonas*
- E) *Deinococcus radiodurans*

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

Match the procedure with the appropriate tool or technique:

- A) Nitrocellulose membranes
- B) Reverse transcriptase
- C) Synthetic nucleic acids and radioactive chemicals
- D) DNA polymerase
- E) Agarose
- F) Single-stranded DNA and silicon chips
- G) DNA ligase
- H) Restriction enzymes
- I) Compressed air and gold beads
- J) Synthetic DNAs and fluorescent tags

186) Synthesis of cDNA 186) _____

187) Probes 187) _____

188) Cutting DNA molecules into fragments 188) _____

189) Microarray 189) _____

190) PCR 190) _____

191) Southern blotting 191) _____

192) *FISH* 192) _____

193) Injecting DNA into cells 193) _____

194) DNA electrophoresis 194) _____

195) Connecting DNA fragments 195) _____

TRUE/FALSE. Write 'T' if the statement is true and 'F' if the statement is false.

- 196) Gene therapy for human genetic diseases has not been successful yet. 196) ____
- 197) Reverse transcriptase synthesizes a DNA molecule from an RNA template. 197) ____
- 198) Large DNA molecules such as chromosomes are easier to work with than small molecules. 198) ____
- 199) Circular DNA molecules are generally more stable inside cells than linear molecules. 199) ____
- 200) The number of DNA molecules produced during PCR increases exponentially. 200) ____
- 201) Sticky-end fragments generated by *EcoRI* will hydrogen bond to any other sticky-end sequence. 201) ____
- 202) Nitrocellulose membranes used in Southern blotting are more delicate than agarose gels. 202) ____
- 203) Southern blotting is a technique that can be used to identify microbes that cannot be cultured. 203) ____
- 204) DNA fingerprinting produces a unique banding pattern of DNA fragments for comparison with other DNA samples. 204) ____
- 205) A subunit vaccine is prepared by extensive manipulation of the genome of the pathogen. 205) ____

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

Correct answers may contain more than one word.

- 206) _____ is the use of microbes to make practical products such as vaccines or hormones. 206) _____
- 207) _____ is used to detect the presence of a particular DNA sequence. 207) _____
- 208) Nucleic acid molecules used to deliver new genes to cells are called _____. 208) _____
- 209) _____, first isolated from bacterial cells, cut DNA molecules at specific sites. 209) _____
- 210) Short nucleic acid molecules used to locate complementary sequences in a larger population of molecules are called _____. 210) _____
- 211) A set of clones representing the entire genome of an organism is known as a(n) _____. 211) _____
- 212) The _____ is a technique used to detect specific RNA molecules in a larger population of molecules that has been separated by gel electrophoresis. 212) _____
- 213) _____ are sequences that bind to mRNA and genes to effect their function. 213) _____
- 214) The process of locating genes within the nucleic acid of an organism is called _____. 214) _____
- 215) _____ involves the insertion of foreign DNA directly into a cell's nucleus using a glass micropipet. 215) _____
- 216) _____ can be used to detect mutant genes associated with genetic diseases in individuals before

any 216)
clinical
symptoms are
noted.

217) A _____ may be used to study the complex, changing patterns of mRNA production in an organism. 217) _____

218) _____, the biochemical precursor to vitamin A, can be added to rice by using recombinant DNA technology, thereby increasing its nutritional value. 218) _____

219) Study of the genome of _____ may provide insight into preventing or correcting genetic damage resulting from radiation. 219) _____

220) Vectors usually contain _____ such as antibiotic resistance genes or fluorescent tags. 220) _____

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

221) Discuss some of the impacts that tools and techniques of recombinant DNA technology have had on medicine.

222) What is reverse transcriptase, and why is it an important tool of recombinant DNA technology?

223) Compare and contrast the two major types of restriction enzymes.

224) Compare and contrast the types of vectors used in recombinant DNA technology.

225) Explain what a transgenic organism is, and give two examples.

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

226) Standard methods of sterilization are not effective in inactivating _____
A) viruses.
B) prions.
C) bacterial cells.
D) fungi.
E) bacterial endospores.

227) Which of the following statements is true of disinfectants? _____
A) Disinfectants are effective in destroying endospores.
B) Disinfectants are used for sterilization.
C) Disinfectants are used on inanimate surfaces.
D) Disinfectants are used on living tissue.
E) Disinfectants are only effective for short periods of time (seconds to minutes).

228) Which of the following statements concerning microbial death is FALSE? _____
A) It is the permanent loss of a microbe's ability to reproduce and can be used to evaluate antimicrobial agents.
B) It can be used to evaluate the efficacy of antimicrobial agents.
C) It is constant over time of exposure to an antimicrobial agent.
D) It is not an effective means of evaluating the efficacy of antimicrobial agents.
E) It is the permanent loss of a microbe's reproductive ability.

- 229) Which of the following is an example of sanitization? 229) ____
- A) A surgeon washes her hands before surgery.
 - B) An autoclave is used to prepare nutrient agar.
 - C) Heat is used to kill potential pathogens in apple juice.
 - D) A public toilet is treated with disinfectants.
 - E) A nurse prepares an injection site with an alcohol swab.
- 230) *Aseptic* means 230) ____
- A) sanitized.
 - B) sterile.
 - C) clean.
 - D) free of all microbes.
 - E) free of all pathogens.
- 231) Which of the following would NOT be bacteriostatic? 231) ____
- A) autoclaving
 - B) freezing below 0°C
 - C) desiccation
 - D) refrigeration of mesophiles
 - E) lyophilization
- 232) Antimicrobial agents that damage nucleic acids also affect 232) ____
- A) the viral envelope.
 - B) the cell membrane.
 - C) endospores.
 - D) protein synthesis.
 - E) the cell wall.
- 233) Seventy percent alcohol is effective against 233) ____
- A) enveloped viruses.
 - B) prions.
 - C) bacterial endospores.
 - D) protozoan cysts.
 - E) nonenveloped viruses.
- 234) An instrument that will come into contact with only the skin of a patient should be disinfected with a(n) 234) ____
- A) low-level germicide.
 - B) germistatic agent only.
 - C) degerming agent only.
 - D) high-level germicide.
 - E) intermediate-level germicide.
- 235) Which of the following is NOT an effective means of sterilization? 235) ____
- A) autoclaving
 - B) incineration
 - C) lyophilization
 - D) ionizing radiation
 - E) dry heat
- 236) Which of the following describes flash pasteurization? 236) ____
- A) heating at 72°C for 15 seconds

- B) heating at 63°C for 30 minutes
- C) passing liquid through steam at 140°C
- D) heating at 72°C for 15 minutes
- E) heating at 134°C for one second

- 237) The dairy creamer used in restaurants is usually sterilized by _____
A) UHT sterilization.
B) ionizing radiation.
C) lyophilization.
D) filtration.
E) autoclaving.
- 238) Boiling water for 10 minutes is effective in ridding it of _____
A) both growing bacteria and enveloped viruses.
B) protozoan cysts.
C) bacterial endospores.
D) actively growing bacteria.
E) enveloped viruses.
- 239) Which of the following is NOT a feature associated with filtration? _____
A) ability of some filters to trap viruses and proteins
B) varying thicknesses of membrane filters used
C) use of HEPA filters to filter air
D) sterilization of heat-sensitive materials
E) nitrocellulose or plastic membrane filters
- 240) Which of the following is a target of pasteurization? _____
A) *Neisseria gonorrhoeae*
B) *Brucella melitensis*
C) *Bacillus stearothermophilus*
D) *Chlamydia trachomatis*
E) *Clostridium botulinum*
- 241) Which of the following types of radiation is nonionizing and has the shortest wavelength? _____
A) X rays
B) ultraviolet light
C) infrared radiation
D) gamma rays
E) microwaves
- 242) Which of the following is used for microbial control in fresh fruits and vegetables? _____
A) X rays
B) microwaves
C) gamma rays
D) ultraviolet light
E) electron beams
- 243) Which of the following can be used to disinfect air? _____
A) ethylene oxide
B) HEPA filters
C) ultraviolet light
D) both HEPA filters and ultraviolet light

E) both ethylene oxide and ultraviolet light

- 244) Lysol is an example of which of the following groups of chemical antimicrobial agents? 244) ____
A) phenolics
B) aldehydes
C) halogens
D) surfactants
E) alcohols
- 245) Which of the following is the most appropriate pairing of microbe and biosafety level? 245) ____
A) Ebola, BSL-2
B) methicillin-resistant *Staphylococcus aureus* (MRSA), BSL-2
C) *E. coli*, BSL-3
D) anthrax, BSL-1
E) tuberculosis, BSL-1
- 246) Betadine is an example of which of the following groups of antimicrobial agents? 246) ____
A) halogens
B) surfactants
C) alcohols
D) phenolics
E) heavy metals
- 247) Which of the following statements about quaternary ammonium compounds is FALSE? 247) ____
A) They function by cross-linking proteins.
B) They are harmless to humans except at high concentrations.
C) They are a type of detergent.
D) Zephiran is an example of a quat.
E) They are not effective against *Pseudomonas aeruginosa*.
- 248) Which of the following is a sterilizing agent? 248) ____
A) peracetic acid
B) ozone
C) hydrogen peroxide
D) ozone and hydrogen peroxide
E) dish soap
- 249) Which of the following was used in the past to prevent the transmission of gonorrhea from an infected mother to her newborn? 249) ____
A) silver nitrate
B) thimerosal
C) hexachlorophene
D) beta-propiolactone
E) hydrogen peroxide
- 250) Which of the following is used to sterilize items that should not, or cannot, be exposed to heat or water? 250) ____
A) triclosan
B) formaldehyde
C) hydrogen peroxide
D) calcium hypochlorite
E) ethylene oxide

- 251) Which of the following statements about aldehydes is FALSE? 251) ____
- A) They are usually hazardous to humans.
 - B) Some aldehydes can sterilize after long periods of exposure.
 - C) They denature proteins.
 - D) They are used in aqueous solutions.
 - E) They are used only to preserve dead tissues.
- 252) Disinfecting agents naturally produced by microorganisms are 252) ____
- A) quats.
 - B) triclosans.
 - C) antimicrobials.
 - D) halogens.
 - E) aldehydes.
- 253) A chemical agent that kills pathogenic microbes in general is a(n) 253) ____
- A) sanitizer.
 - B) germicide.
 - C) fungicide.
 - D) antiseptic.
 - E) disinfectant.
- 254) Which of the following is NOT a desirable characteristic of an ideal antimicrobial agent? 254) ____
- A) It is inexpensive.
 - B) It is harmless to humans.
 - C) It only arrests growth of vegetative cells.
 - D) It is stable during storage.
 - E) It acts quickly.
- 255) The endospores of which of the following microbes are used to measure the effectiveness of autoclave sterilization? 255) ____
- A) *Mycobacterium bovis*
 - B) *Pseudomonas aeruginosa*
 - C) *Bacillus stearothermophilus*
 - D) *Clostridium botulinum*
 - E) *Neisseria gonorrhoeae*
- 256) A scientist develops a new medication that is a protein compound and that must be administered by injection. Which of the following would be the most effective and safest means of preparing a sterile solution of the new medication? 256) ____
- A) dilution with alcohol
 - B) lyophilization
 - C) filtration
 - D) ultraviolet irradiation
 - E) autoclaving
- 257) Which of the following procedures is currently the standard test used in the United States for evaluating the efficiency of antiseptics and disinfectants? 257) ____
- A) thermal death point
 - B) microbial death rate
 - C) use-dilution test
 - D) in-use test

E) phenol coefficient

258) Which of the following would be used to sterilize a mattress? 258) _____

- A) autoclaving
- B) ethylene oxide
- C) heavy metals
- D) formaldehyde
- E) radiation

259) Disinfectants that damage membranes include 259) _____

- A) iodine.
- B) hydrogen peroxide.
- C) phenolics.
- D) alcohol.
- E) both alcohol and phenolics.

260) Which of the following antimicrobial agents is the most toxic to humans? 260) _____

- A) ethylene oxide
- B) 70% alcohol
- C) quats
- D) iodophors
- E) chloramines

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

Match the antimicrobial agent or method with the appropriate description:

- A) Disinfectant
- B) Sterilizing agent
- C) Both disinfectant and sterilizing agent

261) Filtration 261) _____

262) Hydrogen peroxide 262) _____

263) Incineration 263) _____

264) Alcohols 264) _____

265) Quats 265) _____

266) Ethylene oxide 266) _____

267) Glutaraldehyde 267) _____

268) Chlorine dioxide 268) _____

269) Gamma irradiation 269) _____

270) Boiling water 270) _____

TRUE/FALSE. Write 'T' if the statement is true and 'F' if the statement is false.

271) An environment may contain some microbes and still be considered sterile. 271) _____

- 272) Some viruses are inactivated by the same chemical or physical agents that damage cytoplasmic membranes. 272) _____
- 273) UV light has the most effect on protein structure. 273) _____
- 274) Antimicrobial agents usually work best at high temperatures and pH levels. 274) _____
- 275) The phenol coefficient is one of the most widely used measurements of an antimicrobial agent's effectiveness. 275) _____
- 276) No chemical or antimicrobial agents inactivate prions. 276) _____
- 277) The decimal reduction time is the time required to kill all the microbes in a given sample. 277) _____
- 278) Slow freezing is more damaging to microbial cells than quick freezing. 278) _____
- 279) Hydrogen peroxide is an effective antiseptic. 279) _____
- 280) By themselves, soaps have only degerming activity, not antimicrobial activity. 280) _____

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

Correct answers may contain more than one word.

- 281) _____ is the process of freeze-drying microbes to preserve them. 281) _____
- 282) Natural antiseptics such as pine or clove oil are examples of antimicrobial compounds called _____. 282) _____
- 283) A(n) _____ is an iodine-containing organic compound found in such antiseptics as Betadine. 283) _____
- 284) Disinfectants known as _____ have the chemical group 醛CHO, which reacts with and damages both proteins and nucleic acids. 284) _____
- 285) The lowest temperature that kills all cells in a broth in 10 minutes is known as the _____. 285) _____
- 286) The amount of time needed to sterilize materials using moist heat is _____ (greater than/less than) the time needed to sterilize using dry heat. 286) _____
- 287) A(n) _____ is an instrument that sterilizes by exposing materials to steam under pressure. 287) _____
- 288) The containment level _____ is appropriate when handling highly contagious deadly microbes. 288) _____
- 289) Ultraviolet light penetrates materials _____ (more effectively/less effectively) than gamma rays. 289) _____
- 290) _____ is a phenolic antimicrobial compound that has been incorporated into consumer items such as garbage bags and diapers. 290) _____

- 291) Elements such as iodine, chlorine, and bromine are examples of _____, which are the basis for many effective antimicrobial agents. 291) _____
- 292) Heavy metal and oxidizing agent disinfectants damage _____, interfering with microbial metabolism. 292) _____
- 293) The use of high levels of salt or sugar in the preservation of foods relies on the phenomenon of _____. 293) _____
- 294) The process of heating milk or fruit juice to levels that kill any pathogenic microbes present is known as _____. 294) _____
- 295) Sterilization procedures generally focus on inactivating or eliminating bacterial _____. 295) _____

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

- 296) Some sterilization procedures do not kill all the microbes that may be present. Explain how these procedures can still be considered sterilization.
- 297) Describe the cellular structures or processes that can be targets of antimicrobial agents.
- 298) What is the in-use test, and why is it more useful than other methods of evaluating disinfectants?
- 299) Some physical methods of microbial control that work by removing microbes are just as effective as agents that kill or inhibit these microbes. Explain why this is so, and give some examples of these types of agents.
- 300) A student is shopping for antibacterial hand cleansers and is trying to decide which one to buy. One is a "waterless" hand gel containing 70% isopropanol, the second is an "antibacterial" hand soap containing triclosan (a phenolic), and the third is a wipe that lists benzethonium chloride (a synthetic quaternary ammonium salt) as the active ingredient. Compare and contrast these cleansers in terms of the action of the antimicrobial ingredient and the level of disinfection (degerming, germistatic, germicidal).

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 301) A large percentage of antibiotics and semisynthetic drugs are produced by members of the _____ genus 301) _____
A) *Mycobacterium*.
B) *Streptomyces*.
C) *Cephalosporium*.
D) *Penicillium*.
E) *Bacillus*.
- 302) An antimicrobial that inhibits cell wall synthesis will result in which of the following? 302) _____
A) Cells cannot attach to their hosts.
B) Ribosomes lose their function.
C) Cells become more susceptible to osmotic pressure.
D) The sterols in the cell wall become nonfunctional.
E) The replication of cells, including cancer cells, slows down.
- 303) Beta-lactam antibiotics have an effect on which of the following types of cells? 303) _____
A) fungal cells
B) virus-infected cells
C) bacterial cells

- D) animal cells
- E) both animal and fungal cells

- 304) Which of the following is a primary advantage of semisynthetic drugs? 304) ____
- A) They are less stable and consequently have fewer side effects.
 - B) They are not readily absorbed, so they persist longer.
 - C) They have a broader spectrum of action.
 - D) They work faster.
 - E) They must be administered intravenously.
- 305) Which of the following drugs specifically targets cell walls that contain arabinogalactan-mycolic acid? 305) ____
- A) isoniazid
 - B) bacitracin
 - C) penicillin
 - D) vancomycin
 - E) methicillin
- 306) Which of the following antibiotics disrupts cytoplasmic membrane function? 306) ____
- A) streptomycin
 - B) amphotericin B
 - C) tetracycline
 - D) erythromycin
 - E) penicillin
- 307) Which of the following is NOT a target of drugs that inhibit protein synthesis? 307) ____
- A) movement of the ribosome from one codon to the next
 - B) interference with alanine-alanine bridges
 - C) the enzymatic site of the 50S ribosomal subunit
 - D) the shape of the 30S ribosomal subunit
 - E) the tRNA docking site
- 308) Which scientist coined the term *antibiotic*? 308) ____
- A) Domagk B) Kirby C) Ehrlich D) Fleming E) Waksman
- 309) The most limited group of antimicrobial agents is the _____ drugs. 309) ____
- A) anthelmintic
 - B) antifungal
 - C) antiviral
 - D) antibacterial
 - E) antiprotozoan
- 310) Another term for the Kirby-Bauer test is the 310) ____
- A) E test.
 - B) diffusion susceptibility test.
 - C) broth dilution test.
 - D) minimum inhibitory concentration test.
 - E) minimum bactericidal concentration test.
- 311) Which of the following statements about the zone of inhibition is FALSE? 311) ____
- A) It is measured as a diameter.
 - B) It is measured after incubation.

- C) The larger the zone, the more resistant the organism is.
- D) It is a clearing zone with no growth.
- E) It is a result of diffusion of the drug out of the paper disk.

- 312) Which of the following groups of drugs can become incorporated into the bones and teeth of a fetus? 312) ____
- A) aminoglycosides
 - B) sulfonamides
 - C) beta-lactams
 - D) tetracyclines
 - E) quinolones
- 313) Which of the following can result when antibiotic therapy disrupts the normal microbiota? 313) ____
- A) thrush
 - B) anaphylactic shock
 - C) black hairy tongue
 - D) pseudomembranous colitis
 - E) both pseudomembranous colitis and thrush
- 314) Which of the following statements concerning development of antibiotic resistance is FALSE? 314) ____
- A) Resistant cells are normally in the minority in a bacterial population.
 - B) Resistant cells grow more efficiently and quickly than susceptible cells.
 - C) Resistance can occur through mutation of existing bacterial genes.
 - D) It is often mediated by R-plasmids.
 - E) New resistance genes can be gained through transformation, transduction, or conjugation.
- 315) β -lactamase production is an example of which of the following types of resistance? 315) ____
- A) removal of the drug via a pump
 - B) change in the permeability of the drug
 - C) overproduction of an enzyme in a key metabolic pathway
 - D) inactivation of the drug
 - E) alteration of the target of the drug
- 316) Probiotics 316) ____
- A) is a term for resistance to antibiotics.
 - B) involve microbial antagonism.
 - C) are an alternative to the use of chemotherapy involving microbial antagonism.
 - D) are an alternative to the use of chemotherapy.
 - E) involve the use of extracts from microorganisms.
- 317) Most drugs that inhibit the synthesis of the cell wall act by 317) ____
- A) preventing the formation of alanine-alanine bridges.
 - B) blocking the secretion of cell wall molecules from the cytoplasm.
 - C) disrupting the formation of the mycolic acid layer of the cell wall.
 - D) preventing the formation of β -lactamases.
 - E) preventing the cross-linkage of NAM subunits.
- 318) Most broad-spectrum antibiotics act by 318) ____
- A) inhibiting protein synthesis.
 - B) inhibiting metabolic pathways.
 - C) inhibiting nucleic acid synthesis.
 - D) disrupting the cytoplasmic membrane.

E) inhibiting the synthesis of the cell wall.

- 319) Which of the following works by inhibiting ergosterol synthesis? 319) ____
- A) amphotericin B
 - B) terbinafine
 - C) nystatin
 - D) fluconazole
 - E) both fluconazole and terbinafine
- 320) Sulfonamides 320) ____
- A) are antimetabolic drugs.
 - B) are no longer widely used.
 - C) were the first widely used antimetabolic antimicrobial and indirectly inhibit nucleic acid synthesis.
 - D) indirectly inhibit the synthesis of nucleic acids.
 - E) were the first widely used antimicrobial drugs.
- 321) Which of the following pathways is specifically inhibited by sulfonamides? 321) ____
- A) the conversion of tetrahydrofolic acid to PABA
 - B) the conversion of PABA to dihydrofolic acid
 - C) the conversion of dihydrofolic acid to PABA
 - D) the conversion of dihydrofolic acid to tetrahydrofolic acid
 - E) the conversion of PABA to tetrahydrofolic acid
- 322) Which of the following drugs inhibits nucleic acid synthesis specifically in prokaryotes? 322) ____
- A) actinomycin
 - B) quinolones
 - C) tetracycline
 - D) rifampin
 - E) 5-fluorocytosine
- 323) The cooperative activity of drugs such as beta-lactam antibiotics and clavulanic acid, a β -lactamase inhibitor, is known as 323) ____
- A) synergism.
 - B) cross resistance.
 - C) antimetabolism.
 - D) chemotherapy.
 - E) selective toxicity.
- 324) Alterations in the structure of which of the following are an important aspect of Gram-negative bacterial resistance to antimicrobial drugs? 324) ____
- A) plasmids
 - B) cytoplasmic membrane
 - C) porins
 - D) ribosomes
 - E) mitochondria
- 325) It is inappropriate to prescribe antibacterial agents to treat colds or flu because 325) ____
- A) these diseases are transmitted by endospores, which are hard to kill.
 - B) these diseases are caused by viruses.
 - C) these diseases exhibit cross resistance.
 - D) the microbes involved can develop resistance rapidly.

E) these diseases can act synergistically with each other.

- 326) Who discovered the first widely available antibiotic? 326) ____
A) Fleming
B) Ehrlich
C) Waksman
D) Domagk
E) Ehrlich and Waksman
- 327) Which of the following statements is true of selective toxicity? 327) ____
A) Selective toxicity takes advantage of structural differences between host and pathogen.
B) Antimicrobial agents must target structural differences between host and pathogen and be more toxic to the patient than the pathogen.
C) Selective toxicity takes advantage of metabolic differences between host and pathogen.
D) To be effective, an antimicrobial agent must be more toxic to the patient than the pathogen.
E) Selective toxicity takes advantage of structural and/or metabolic differences between host and pathogen.
- 328) Antimicrobials that block protein synthesis by binding to the mRNA are 328) ____
A) antisense nucleic acids.
B) beta-lactams.
C) aminoglycosides.
D) macrolides.
E) nucleic acid analogs.
- 329) The Etest determines which of the following? 329) ____
A) MBC
B) MIC
C) susceptibility
D) both susceptibility and MIC
E) both MBC and MIC
- 330) Which of the following is NOT a criterion by which all antimicrobial agents can be evaluated? 330) ____
A) their spectrum of action
B) their activity against cell walls
C) their efficacy
D) their safety
E) their route of administration
- 331) Which of the following interferes with cell wall synthesis by blocking alanine bridge formation? 331) ____
A) beta-lactams
B) bacitracin
C) vancomycin
D) cycloserine
E) both cycloserine and vancomycin
- 332) Antimicrobial sugar analogs are effective for 332) ____
A) blocking a metabolic pathway.
B) preventing virus attachment.
C) preventing cell membrane synthesis.
D) preventing bacterial protein synthesis.
E) preventing nucleic acid synthesis.

- 333) Which of the following is a measurement associated with the broth dilution test? 333) ____
A) lack of turbidity and zone of inhibition
B) cell lysis
C) the zone of inhibition
D) presence of turbidity and cell lysis
E) lack of turbidity
- 334) Infection of the _____ would be the hardest to treat with antimicrobial drugs. 334) ____
A) kidneys B) colon C) liver D) heart E) brain
- 335) Disruption of the normal microbiota can result in infections caused by which of the following microbes? 335) ____
A) *Clostridium difficile*
B) *Mycobacterium*
C) both *Mycobacterium* and *Clostridium difficile*
D) *Candida albicans*
E) *Candida albicans*, *Mycobacterium*, and *Clostridium difficile*

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

Match the drug with its mode of action:

- A) Disruption of cytoplasmic membranes
- B) Inhibition of cell wall synthesis
- C) Inhibition of nucleic acid synthesis
- D) Inhibition of metabolic pathways
- E) Inhibition of protein synthesis

- 336) Quinolones 336) _____
- 337) Amphotericin B 337) _____
- 338) Vancomycin 338) _____
- 339) Tetracyclines 339) _____
- 340) Trimethoprim 340) _____
- 341) Erythromycin 341) _____
- 342) Methicillin 342) _____
- 343) Ribavirin 343) _____
- 344) Polymyxin 344) _____
- 345) Sulfonamides 345) _____

TRUE/FALSE. Write 'T' if the statement is true and 'F' if the statement is false.

- 346) Paul Ehrlich coined the term *antibiotics* for the "magic bullet" antimicrobials he pursued. 346) ____
- 347) Antisense nucleic acids are designed to have no side effects against humans. 347) ____

- 348) Beta-lactam drugs act by inhibiting formation of the cytoplasmic membrane. 348) ____
- 349) Because all cells engage in protein synthesis, there are few antimicrobial drugs that selectively inhibit this process. 349) ____
- 350) Many antimicrobial drugs that affect the cytoplasmic membrane are used only externally because they can be toxic to humans. 350) ____
- 351) Some bacterial cells are resistant to a variety of antimicrobials because they actively pump the drugs out of the cell. 351) ____
- 352) The outer membrane of Gram-negative bacteria enables many antimicrobial drugs to enter the cell more easily. 352) ____
- 353) If a subculture of an MIC test grows in an MBC test, the concentration of the drug was bactericidal. 353) ____
- 354) Brain and spinal cord infections are difficult to treat because most antimicrobial drugs cannot diffuse out of the blood into these organs. 354) ____
- 355) Organs that are commonly affected by drug toxicity include the kidneys and the liver. 355) ____

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

Correct answers may contain more than one word.

- 356) Any drug that acts against a disease is called a(n) _____ agent. 356) _____
- 357) _____ means that a given antimicrobial agent is more toxic to a pathogen than to the host being treated. 357) _____
- 358) Antimicrobial agents that mimic the chemical structure of DNA building blocks are called _____. 358) _____
- 359) A(n) _____ drug is effective against a wide variety of pathogens. 359) _____
- 360) _____ are serious secondary infections that result from the killing of the normal microbiota. 360) _____
- 361) Competition between beneficial microbes and potential pathogens is called _____. 361) _____
- 362) A(n) _____ concentration of a drug is one at which microbes survive but are not able to grow and reproduce. 362) _____
- 363) Extrachromosomal pieces of DNA called _____ promote horizontal transfer of genes among bacteria and contribute to the spread of antimicrobial resistance. 363) _____
- 364) Some bacteria develop resistance to groups of drugs because the drugs are all structurally similar to each other; this is a phenomenon known as _____. 364) _____
- 365) _____ drugs are semisynthetic drugs developed to combat resistance against an existing drug. 365) _____

- 366) Drugs that slow down bacterial growth would be _____ to penicillin. 366) _____
- 367) External infections can be treated by _____ administration, in which a drug is applied directly to the site of infection. 367) _____
- 368) The abbreviation _____ stands for the smallest amount of a drug that will inhibit the growth and reproduction of a pathogen. 368) _____
- 369) Antiviral medications frequently block unique _____ to prevent production of new virus. 369) _____
- 370) Praziquantel alters the cytoplasmic membrane permeability of _____. 370) _____

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

- 371) Why can microbial resistance to antibiotics and other drugs be considered a primarily genetic phenomenon?
- 372) Discuss the cellular factors that might make a drug's spectrum of action narrow rather than broad.
- 373) Explain the concept of selective toxicity.
- 374) Examine the diffusion susceptibility plate results shown in Figure 10.9. Propose an explanation for the appearance of the zone around the AM/10 disk, and discuss the implications for therapeutic use of this antibiotic for the pathogen tested.
- 375) Explain why many antibiotics are effective only against cells that are actively growing and reproducing.

- 1) A
- 2) D
- 3) B
- 4) E
- 5) C
- 6) B
- 7) D
- 8) C
- 9) D
- 10) A
- 11) D
- 12) E
- 13) A
- 14) E
- 15) A
- 16) B
- 17) C
- 18) D
- 19) D
- 20) B
- 21) D
- 22) A
- 23) D
- 24) D
- 25) B
- 26) C
- 27) B
- 28) D
- 29) C
- 30) C
- 31) D
- 32) B
- 33) C
- 34) B
- 35) B
- 36) D
- 37) C
- 38) A
- 39) B
- 40) B
- 41) B
- 42) D
- 43) A
- 44) E
- 45) C
- 46) FALSE
- 47) FALSE
- 48) TRUE
- 49) TRUE
- 50) FALSE
- 51) TRUE

- 52) FALSE
- 53) FALSE
- 54) TRUE
- 55) TRUE
- 56) nitrogen fixation
- 57) Chemoheterotrophs
- 58) superoxide
- 59) optimum
- 60) mesophiles
- 61) Alkaliphiles
- 62) crenation
- 63) inoculum
- 64) pure culture
- 65) Agar
- 66) lag
- 67) growth curve
- 68) Flow cytometry
- 69) pellicle
- 70) spectrophotometer
- 71) Oxygen is toxic to organisms only because of the highly reactive alternative forms of the molecule. These forms of oxygen can accumulate in cells and damage them by oxidizing key cellular molecules and structures. To tolerate the presence of oxygen (to allow aerobic cellular respiration to take place), cells must have ways of converting these toxic forms of oxygen to less harmful molecules. Cells use a variety of enzymes to accomplish this. These enzymes are superoxide dismutase (for elimination of the superoxide radical) and catalase and peroxidase (for the removal of hydrogen peroxide from cells). By continuous use of these enzymes, aerobic cells can use oxygen in their metabolism without suffering too many of the adverse effects of oxygen. Likewise, one major reason obligate anaerobes cannot tolerate any oxygen in their environment is the absence or reduced activity of such enzymes in those cells.
- 72) All microbes have particular ranges of temperature and pH within which they exist. When the temperature or pH of their environment falls outside this range, their growth is inhibited, and they may even die as a result of the adverse conditions. Therefore, only those microbes whose pH and temperature requirements match those conditions found in the human body will be able to grow and reproduce there. For example, because the temperature of the human body is 37°C, only mesophiles can reproduce there. In addition, the pH of most tissues and fluids in the body is 6.5–7.5, which matches the pH requirements of neutrophiles. Therefore, it is not surprising that most human pathogens are mesophiles and neutrophiles. However, this is not always the case. Some microbes have adapted to environments that would otherwise be extremely hostile to most microbes. A good example is the bacterium *Helicobacter pylori*, which is able to live in the extremely acidic conditions of the stomach by secreting substances that help to neutralize the acid. The result is an infection that can lead to stomach ulcers.
- 73) The streak-plate and the pour-plate methods of bacterial isolation are both used to produce pure cultures of bacteria from specimens. Both techniques involve the use of agar-based growth media contained in Petri plates. Additionally, both techniques involve the use of dilutions as a means of isolating single cells or groups of cells that then grow into isolated colonies. However, there are several significant differences between the two techniques. The main difference is the way in which the specimen is diluted. In the streak-plate method, the specimen is diluted by use of an inoculating loop that spreads organisms over the surface of the agar. Thus, colonies appear only on the agar surface. In the pour-plate method, however, dilutions of the specimen are made in tubes of broth and then each dilution is added to melted agar, which is then poured into Petri dishes. Thus, microbes are mixed throughout the agar, and colonies will appear both in and on the medium.
- 74) Previous estimates of microbial diversity were largely based on the ability to detect microbes in samples handled in a typical laboratory setting. In most cases, laboratory conditions represent a narrow range of growth parameters, including temperature range, oxygen and other gas levels, and spectrum of nutrients. Even in cases where attempts are made to simulate the normal conditions for microbes (e.g., providing a high-pressure environment for organisms collected from hyperbaric environment), microorganisms must frequently tolerate fluctuations in the

grow or even exposure to extremely adverse conditions for short periods of time. Organisms that are intolerant of the significant fluctuation in their environmental requirements do not survive transport to the lab to be measured or cultured. As a consequence, only the relatively few microbes that are versatile in their nutrient requirements and can tolerate fluctuations in their growth environment have been observed or isolated in the laboratory. This, in turn, resulted in misleadingly low estimates of microbial diversity.

75) Direct methods of measuring microbial growth involve quantifying the number of microbes in a specimen through actual counting of cells in a microscope or cytometer or counting the numbers of colonies produced from the plating of a specimen. The advantage of these techniques lies in their usefulness for counting very large and very small populations of bacteria. Indirect methods, by contrast, seek to quantify cells by measuring some characteristic related to the number of cells present. For example, spectrophotometry measures the amount of light transmitted through a culture; the less light that is transmitted, the more cells are present. The amount of light transmitted gives an approximation of the number of cells present. Indirect methods are useful for quantifying microbes, such as filamentous microbes, that are hard to count directly. Both direct and indirect methods seek to arrive at an approximation of the actual number of cells present. Because that number is changing even during the measurement process, neither technique can give an exact number of cells.

76) B

77) A

78) D

79) A

80) C

81) E

82) C

83) B

84) B

85) E

86) C

87) E

88) A

89) C

90) A

91) C

92) C

93) E

94) E

95) A

96) D

97) E

98) A

99) B

100) E

101) D

102) E

103) D

104) E

105) D

106) A

107) A

108) E

109) E

110) C

111) A

112) C

- 113) B
- 114) B
- 115) A
- 116) C
- 117) C
- 118) A
- 119) B
- 120) C
- 121) FALSE
- 122) FALSE
- 123) TRUE
- 124) FALSE
- 125) TRUE
- 126) TRUE
- 127) FALSE
- 128) TRUE
- 129) TRUE
- 130) FALSE
- 131) gene
- 132) euchromatin
- 133) transduction
- 134) auxotroph
- 135) topoisomerase
- 136) nucleotide analog
- 137) frameshift
- 138) anticodon
- 139) A site
- 140) triphosphate deoxyribonucleotides
- 141) operon
- 142) leading strand
- 143) genotype
- 144) promoters
- 145) Pre-messenger

- 146) DNA replication and transcription are similar processes in that they both involve the production of molecules of nucleic acids using a preexisting template. Therefore, they both involve the polymerization of nucleotides to create long chains, as well as the utilization of complementary base-pairing rules to create the nucleotide sequence of the new molecule based on the sequence of the template. Additionally, these chains of nucleotides are synthesized in the same direction, 5' to 3', regardless of the type of nucleic acid being produced.
However, there are a number of differences between these two processes as well. The product of DNA replication is an exact, complete DNA copy of an entire DNA molecule that will be passed on to the offspring of the cell producing it. The product of transcription is an RNA copy of a limited region (a gene) of a DNA molecule. Furthermore, this RNA molecule may not be an exact copy of the gene, because transcription is more prone to errors than DNA replication. The RNA molecules produced during transcription are used within the cell that produces them to provide information for the synthesis of proteins during translation.
- 147) All cells possess one or more DNA molecules that serve as the genetic blueprint of the cell; these molecules are generally referred to as chromosomes. Prokaryotic chromosomes differ from eukaryotic chromosomes in their number and physical shape. Eukaryotic chromosomes tend to be more complex in their organization, involving specialized packaging proteins called histones. Eukaryotic cells also tend to contain more chromosomes than prokaryotes, which have no more than two chromosomes. In addition, all cells contain additional nucleic acid in the form of various types of RNA (mRNA, tRNA, primer RNA, siRNA, RNAi, and rRNA), which are used to assist in the cell's genetic processes.
Most cells contain other types of nucleic acid, such as plasmids or the DNA found in organelles such as

mitochondria and chloroplasts. Plasmids are a common form of prokaryotic DNA and confer a variety of special abilities to the cell, depending on the specific genes carried by the plasmid. Some eukaryotic cells may also contain plasmids. The DNA of eukaryotic mitochondria and chloroplasts is used to partially control the activities of these organelles in conjunction with genes found in the cell's nucleus.

- 148) The eukaryotic transcript is extensively modified after transcription and must be transported out of the nucleus before it is translated. Prokaryotic transcripts are not extensively modified before translation, and translation can be initiated before transcription is completed. One result of these differences is that regulated protein products are produced more promptly in prokaryotes than in eukaryotes, allowing prokaryotes to respond to environmental change much more quickly. Eukaryotes have multiple RNA polymerases for transcription and a larger variety of transcription initiation factors. As a consequence, gene regulation is potentially more complex in eukaryotes than in prokaryotes.
- 149) Both the lactose and the tryptophan operons have certain features in common. They both contain a set of genes dedicated to a common purpose (such as the catabolism of lactose by the genes of the lactose operon) and regulatory elements such as a promoter and an operator. Each of these operons makes use of a repressor protein, which binds to the operator region and alters the activity of the operon. However, the lactose operon is classified as an inducible operon, which means it requires an inducer (lactose itself) in order to be activated. In the absence of the inducer, the repressor protein shuts down the operon. In contrast, the tryptophan operon is a repressible operon, which requires a corepressor (tryptophan itself) in order to activate the repressor and shut down the operon. In the absence of the corepressor and repressor, the operon is fully functional. In both types of operons, the molecule either catabolized (in the case of lactose) or synthesized (in the case of tryptophan) is an important component of the regulation of the operon. In this way, the cell maintains precise control over these genetic pathways and does not spend time and energy making enzymes that are not needed. For example, making enzymes to catabolize lactose when no lactose is present would waste energy and metabolites.
- 150) A point mutation is a single base change in the nucleotide sequence of a cell's genome. The effects of a point mutation can depend on its location. Point mutations in noncoding regions of the genome are usually harmless. Even in coding regions, point mutations can be harmless if they result in silent mutations. Silent mutations preserve the sense of the amino acid code because of the concept of "wobble," in which two codons can code for the same amino acid by varying only at the third base of the codon. If the point mutation has occurred at this third base, then the amino acid sequence of the protein will remain unchanged. Point mutations occurring at the first or second base of the codon are almost always much more serious because they change the codon to a completely different amino acid. This type of point mutation is known as a missense mutation. (The only exception to this occurs when the new amino acid is chemically similar to the previous amino acid, in which case the missense mutation usually causes little or no change in the overall structure or function of the protein.) Finally, one of the most serious types of point mutations is a nonsense mutation in which the codon has been changed to a stop codon. These types of mutations result in the abnormal termination of a protein sequence. In all such cases, if the protein affected by the mutation is an enzyme or some other vital protein required for proper cellular function, then the cell and/or organism may die as a result of these relatively simple mutations.
- 151) A
152) E
153) A
154) C
155) C
156) B
157) C
158) B
159) A
160) C
161) E
162) C
163) A
164) B
165) D

166) A
167) C
168) E
169) A
170) A
171) B
172) D
173) D
174) B
175) A
176) E
177) E
178) B
179) A
180) B
181) A
182) C
183) A
184) E
185) D
186) B
187) C
188) H
189) F
190) D
191) A
192) J
193) I
194) E
195) G
196) FALSE
197) TRUE
198) FALSE
199) TRUE
200) TRUE
201) FALSE
202) FALSE
203) TRUE
204) TRUE
205) FALSE
206) Biotechnology
207) Southern blot
208) vectors
209) Restriction enzymes
210) probes
211) gene library
212) northern blot
213) Antisense RNA
214) genetic mapping
215) Microinjection
216) Genetic screening
217) DNA microarray

- 218) Beta-carotene
- 219) *Deinococcus radiodurans*
- 220) genetic markers
- 221) Human gene libraries and DNA sequencing have greatly facilitated detecting genes and gene complexes that contribute to disease, both the genetic mutations that cause disease and genetic predispositions to a wide range of diseases. PCR, *FISH*, and microarrays are all tools that can be used to determine whether a person carries a specific genetic variation linked to disease or to detect the presence of a pathogen causing disease. Recombinant technology has provided tools to prevent or cure disease. Some examples include the ability to produce therapeutic agents such as humulin for diabetes, clotting factors for people with blood-clotting disorders, and vaccines to prevent infection. The use of gene therapy to correct disorders of abnormal or nonfunctional genes is in its infancy but holds great promise.
- 222) Reverse transcriptase is an enzyme produced by retroviruses. This enzyme allows these viruses to carry out their unique life cycle, which involves the production of double-stranded DNA molecules from an RNA template. This activity is exploited in the lab to produce cDNA molecules from mRNA isolated from a cell. cDNA is a useful molecule because it does not contain any intron sequences normally present in eukaryotic genes; it essentially represents the genetic information in its "final form" from the viewpoint of the cell. Thus, cDNA is ideal for expressing human (or eukaryotic) genes in bacteria because all of the RNA processing (which is unique to eukaryotes) has already been done.
- 223) All restriction enzymes recognize specific sequences in DNA molecules and cut at those sequences, making them powerful tools for generating and manipulating DNA fragments. However, these enzymes differ in the type of cut they make. One type of cut is a staggered cut, which produces complementary overhangs known as "sticky ends." These ends can base pair with each other (if they have the same sequence), and they allow DNA fragments to be joined relatively easily. The other type of cut occurs at the same place on each strand of DNA and produces "blunt ends." Fragments with this type of end do not base pair with each other at all, making the joining of these fragments more difficult than sticky-ended fragments. However, blunt ends are more "generic" than sticky ends; they allow two fragments to be joined no matter which restriction enzyme generated them (as long as they were generated by blunt-end cutters).
- 224) All vectors have certain things in common. They are small enough to be easily manipulated, and they are able to survive for long periods of time inside cells. Also, they usually contain genetic markers that help identify the cells that receive the vector. However, there are different types of vectors available. Bacterial plasmids are commonly used, but they are limited in the size of the genes they can carry. Transposons and viruses can also be used as vectors. They have the advantages of being able to carry large amounts of DNA and to integrate themselves into the chromosome of the cell, making them some of the most stable types of vectors.
- 225) A transgenic organism is one that contains genes from other organisms. These genes usually add some special ability or function to the organism. Agriculture offers many examples of transgenic organisms. Soybeans have been engineered to contain glyphosate-resistance genes, and other crops have been engineered to grow well in soil with high salt concentrations. Still other plants have been engineered to contain the gene for Bt toxin, a bacterial toxin that kills insect pests that would otherwise feed on and destroy the crop. Not all transgenic organisms represent such extreme genetic modifications, however. Some genetically modified organisms simply represent efforts to improve nutritional content (in the case of plant crops) or to increase food yield (in the case of bovine growth hormone, which is produced by transgenic bacteria and then given to cattle to increase their meat and milk yield).
- 226) B
- 227) C
- 228) D
- 229) D
- 230) E
- 231) A
- 232) D
- 233) A
- 234) A
- 235) C
- 236) A

- 237) A
- 238) A
- 239) B
- 240) B
- 241) B
- 242) C
- 243) D
- 244) A
- 245) B
- 246) A
- 247) A
- 248) A
- 249) A
- 250) E
- 251) E
- 252) C
- 253) B
- 254) C
- 255) C
- 256) C
- 257) C
- 258) B
- 259) E
- 260) A
- 261) B
- 262) C
- 263) B
- 264) A
- 265) A
- 266) B
- 267) C
- 268) A
- 269) B
- 270) A
- 271) TRUE
- 272) TRUE
- 273) FALSE
- 274) FALSE
- 275) FALSE
- 276) FALSE
- 277) FALSE
- 278) TRUE
- 279) FALSE
- 280) TRUE
- 281) Lyophilization
- 282) phenolics
- 283) iodophor
- 284) aldehydes
- 285) thermal death point
- 286) less than
- 287) autoclave
- 288) BSL-4

- 289) less effectively
- 290) Triclosan
- 291) halogens
- 292) proteins
- 293) osmotic pressure
- 294) pasteurization

295) endospores

296) Theoretically, sterilization is the complete removal or destruction of all microbes in a particular environment. These include dormant forms of microbes, such as bacterial endospores. However, from a practical standpoint, one must take other factors into account when deciding what is or is not sterile. For example, the particular application of the sterilized material must be considered. Although there may be hyperthermophilic microbes present in canned foods after sterilization, they cannot grow and divide at normal shelf temperatures; thus, their presence does not cause problems. In practice, only those microbes that would cause problems either by their presence or by their continued growth and reproduction are generally the targets of sterilization methods. When these microbes have been eliminated, the goal of sterilization can be said to have been reached.

297) In general, there are two types of cellular targets for antimicrobial agents. One type of target is the variety of cellular molecules and structures that make up the cell. These include such structures as the cytoplasmic membrane and the cell wall, either of which can be damaged by various types of antimicrobial agents. When these structures are damaged, the cell loses control over the entry and exit of molecules, or it succumbs to the forces of osmotic pressure on its overall structure. The disruption of the cell's osmotic balance due to problems with the cell wall or cell membrane can disable virtually all cellular chemical reactions, because most of them depend on water. Proteins and nucleic acids can also be a target of antimicrobial agents, which directly alter these molecules either by denaturation, in the case of proteins, or by mutation, in the case of DNA molecules. Damage to these types of targets impairs the ability of the cell to function. Denaturation of enzymes can disrupt a variety of metabolic pathways, which, in turn, can inhibit the growth of the cell or even kill it. Mutations in DNA molecules can influence metabolic pathways and other cellular functions and may be extensive enough that the microbe ceases to function (dies).

298) The in-use test is a method of evaluating antimicrobial agents such as disinfectants or antiseptics. It involves collecting specimens from objects that need to be disinfected, both before and after the disinfecting agent is applied. Then the specimens are inoculated into growth media, and the presence or absence of growth is an indicator of the effectiveness of the agent. The in-use test is regarded as an informative and useful test because it makes use of microbes that are actually found in the area of concern, and it gives a "real-life" picture of how the antimicrobial agent will work in that situation. Conversely, other tests, such as the disk-diffusion test or the use-dilution test, are not as useful because they rely on standardized conditions in a laboratory environment, using test microbes that may or may not have any relation to the actual microbes that need to be targeted by the antimicrobial agent. Additionally, in some environments, many microbes form biofilms that can affect the activity of an antimicrobial agent, and these biofilms are not normally present in standardized testing procedures. Therefore, although the in-use test is not as convenient or quick as the other types of tests, it is regarded as more useful.

299) In some antimicrobial applications, the ability to remove microbes is just as good as, if not better than, killing or inhibiting their growth. The reason is that microbes such as bacteria can cause problems by their mere presence in a particular environment because of their ability to grow and divide rapidly. The removal of a microbe automatically eliminates its growth. Microbes can be mechanically removed from a particular environment in two ways: by filtration or by the use of chemical compounds such as soaps. Filtration involves the use of membranes with small pores that trap relatively small bacterial cells and, in some cases, even viruses. The liquid that passes through the filter is then free of these microbes and can be considered sterile. Soaps are examples of surfactants, molecules that have hydrophobic and hydrophilic regions. Soaps are thus able to interact with both water molecules and oily material, which usually contains the target microbial cells. The result is that soaps can disinfect by a process of degreasing, which is the physical removal of microbes from an environment, such as the hands.

300) All three are germicidal, although not all to the same degree.

The alcohol of the waterless hand cleaner is a germicide that disrupts cytoplasmic membranes and denatures proteins. It is not effective against bacterial endospores or fungal spores, and it has limited effect on nonenveloped viruses. The alcohol evaporates quickly, so the germicidal effect is short term. The waterless hand cleaner is an

inter not an effective degermer.

medi The hand soap contains a phenolic, which also damages cytoplasmic membranes and denatures proteins, and is
ate-l effective on the same range of microbes as the alcohol. Phenolics are intermediate-level disinfectants that persist on
evel surfaces for long periods of time, providing extended disinfection. If used with running water and the hands are
disin vigorously rubbed, the hand soap can be an effective degermer.

fecta Synthetic "quats" (quaternary ammonium compounds) disrupt cell membranes. They are effective against fungi,
nt enveloped viruses, and most bacteria, but not against nonenveloped viruses, nor on endospores. Quats are
and low-level disinfectants that are germicidal for some microbes. The action of using and discarding the wipe provides
is some degerming effect.

301) B

302) C

303) C

304) C

305) A

306) B

307) B

308) E

309) C

310) B

311) C

312) D

313) E

314) B

315) D

316) C

317) E

318) A

319) E

320) C

321) B

322) B

323) A

324) C

325) B

326) D

327) E

328) A

329) D

330) B

331) E

332) B

333) E

334) E

335) E

336) C

337) A

338) B

339) E

340) D

341) E

342) B

343) C

- 344) A
- 345) D
- 346) FALSE
- 347) TRUE
- 348) FALSE
- 349) FALSE
- 350) TRUE
- 351) TRUE
- 352) FALSE
- 353) FALSE
- 354) TRUE
- 355) TRUE
- 356) chemotherapeutic
- 357) Selective toxicity
- 358) nucleotide analogs
- 359) broad-spectrum
- 360) Superinfections
- 361) microbial antagonism
- 362) bacteriostatic
- 363) R-plasmids
- 364) cross resistance
- 365) Second-generation
- 366) antagonistic
- 367) topical
- 368) MIC
- 369) enzymes
- 370) parasitic worms
- 371) Microbial resistance is considered a genetic phenomenon because there are two major ways that bacteria acquire resistance: through mutations of chromosomal genes or through acquisition of new genes carried on R-plasmids. In both cases, the cell gains the ability to resist the activity of a particular drug through the modified structure or activity of proteins that are coded for by the genes in question. For example, some of these altered proteins can be cytoplasmic membrane proteins or porin proteins that no longer allow a drug such as penicillin to enter the cell. Also, some of the proteins coded for by these genes may be enzymes of various sorts that serve to inactivate a particular drug, such as the inactivation of beta-lactam antibiotics by β -lactamases. Furthermore, these altered genes and proteins are then heritable by the offspring of the cell that acquired the resistance, leading quickly to entire populations of bacteria or other microbes that are resistant to a drug. When selective pressure is then brought to bear (through the administration of a particular drug) on a population that contains both susceptible and resistant cells, the result is that the susceptible cells die off, leaving the resistant cells to grow and flourish.
- 372) When a drug is labeled "narrow-spectrum," meaning that it has activity against only a limited number of microbes, generally the reason is that many microbes possess some form of natural resistance against the drug. For example, many drugs work better against Gram-positive organisms than Gram-negative ones because Gram-negative cells possess an outer membrane that does not allow these drugs to enter the cell as readily as they enter Gram-positive cells. Other cellular factors that can have an effect on the spectrum of action of a particular drug include the presence of R-plasmids in the cell that carries resistance genes, the presence of altered cytoplasmic membrane or cell wall proteins that prevent the passage of some types of drugs, and alterations in a cell's metabolic pathways, which can make the cell more resistant to certain types of drugs. Other antimicrobials have a narrow spectrum of action because they target a metabolic or structural feature unique to a single pathogen or small group of pathogens. One example of this type of narrow-spectrum antimicrobial is antisense RNA, which complements a specific nucleotide sequence that may be present in only one pathogen.
- 373) Selective toxicity is the underlying principle supporting Ehrlich's idea of the "magic bullet." This simply means that the most effective antimicrobial drugs are those that target some difference in a cellular structure or metabolic

proc patient cell and the target microbe. Conversely, the more similar the host cell and the microbe are, the harder it is to
ess selectively attack just the microbe. Drugs that do not differentiate very well between types of cells are generally
betw more toxic to the host than those that are more selective. This is most striking in the case of antiviral drugs, which
een are generally poor magic bullets because the virus is dependent on the host cell for all aspects of its growth. Those
the drugs that successfully inactivate the virus sometimes also end up damaging or even killing the cell.
host/

- 374) The ring of colonies within the outermost limit of the zone of inhibition indicates that there are some cells in the population that are less susceptible to the antibiotic than the rest. If this antibiotic were used to treat an infection with this population, the growth of bacteria with some resistance would be promoted at the expense of the more susceptible cells, potentially giving rise to a new variant that is fully resistant. If this were to occur in a patient being treated, the antibiotic therapy would fail, putting the patient's health at risk. Therefore drug AM would be a poor choice, perhaps the poorest choice, for chemotherapy against this bacterial species.
- 375) When cells are not actively growing and reproducing, they are not synthesizing many of their component molecules or structures. Because many antimicrobial drugs inhibit the synthesis of structures such as the cell wall or interfere with various metabolic pathways, cells that are not actively doing one or both of these activities will be naturally more resistant to these drugs. For example, as bacterial cells age or become dormant, they cease to synthesize molecules such as peptidoglycan; therefore, drugs such as penicillin, which act by inhibiting peptidoglycan synthesis, have no effect on these cells. Additionally, as cells age, they may modify or cease certain metabolic pathways. Drugs that target these pathways will thus lose their effect.