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SKU: 9780323354820-TEST-BANK

MULTIPLE CHOICE

1. Pieces of deoxyribonucleic acid (DNA) that move from one genetic element to another and contain genes for movement and genes for other features are called:
   a. transposons.
   b. insertion sequences.
   c. plasmids.
   d. chromatoids.

   ANS: A
   Insertion sequences only code for movement.

   REF: 8

2. Miniature chromosomes composed of several genes in double-stranded, closed, circular structures are called:
   a. transposons.
   b. insertion sequences.
   c. plasmids.
   d. chromatoids.

   ANS: C
   Plasmids can be separate entities, but transposable elements (transposons and insertion sequences) cannot.

   REF: 8

3. A DNA sequence that encodes for a specific product (ribonucleic acid [RNA] or protein) is defined as a:
   a. gene.
   b. genome.
   c. nucleotide.
   d. deoxyribonucleic acid.

   ANS: A
   The genome is the collection of all the genes of an organism. Nucleotides and DNA are building blocks of genes.

   REF: 6

4. The enzyme that adds nucleotide bases to each growing daughter strand in the replication process is called:
   a. replication enzymes.
   b. DNA polymerase.
   c. insertion sequence enzymes.
   d. transcriptase.

   ANS: B

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DNA polymerase is a specific type of replication enzyme.

REF: 9

5. If a bacterial cell encounters unfavorable environmental conditions, then its metabolism will begin to slow until it eventually transforms into an inactive, dormant state. This survival mechanism is known as:
   a. polymerization.
   b. oxidation.
   c. respiration.
   d. sporulation.

   ANS: D
   Organisms sporulate when unfavorable conditions are encountered and remain in this state until favorable conditions return.

   REF: 23

6. Teichoic acids, mycolic acids, peptidoglycan, and disaccharide-pentapeptide subunits are all building blocks of which bacterial structure?
   a. Outer cell membrane
   b. Flagella
   c. Inner cell membrane
   d. Cell wall

   ANS: D
   These elements are all part of the cell walls of some types of bacteria.

   REF: 21 | 22

7. The major difference between gram-positive and gram-negative bacteria is that:
   a. the peptidoglycan layer in gram-positive bacteria is substantially thinner than in gram-negative bacteria.
   b. gram-positive bacteria contain a periplasmic space, whereas gram-negative bacteria do not.
   c. flagella are only present in gram-positive bacteria.
   d. gram-negative bacteria contain an outer membrane that functions as the cell's initial barrier to the environment.

   ANS: D
   Gram-negative bacteria contain an outer membrane, but gram-positive bacteria do not.

   REF: 21

8. In gene regulation and control, *repression* is defined as the:
   a. internal change in the original nucleotide sequence of a gene or genes within an organism's genome.
   b. mechanism of genetic control in which genes are induced only when the substrate to be degraded by enzymatic action is present.
   c. change of the bacterial genotypes through the exchange of DNA from one cell to another.
   d. mechanism of genetic control in which genes are not transcribed and therefore are

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not expressed in the presence of those target products in sufficient supply.

ANS: D
To avoid waste and overproduction of enzymes in the cell, some genes are *turned off* by the presence of the product of that gene expression.

REF: 12

9. In gene regulation and control, *induction* can be defined as the:
   a. mechanism of genetic control in which genes are induced only when the substrate to be degraded by enzymatic action is present.
   b. uptake of free DNA from the environment and recombination with the recipient's homologous DNA.
   c. mechanism of genetic control in which genes are not transcribed and therefore are not expressed in the presence of those target products in sufficient supply.
   d. change of the bacterial genotypes through the exchange of DNA from one cell to another.

   ANS: A
   To avoid waste and overproduction of enzymes in the cell, some genes are *turned on* only by the presence of the substrate of that gene expression.

   REF: 13

10. *Mutation* is defined as the:
   a. change of the bacterial genotypes through the exchange of DNA from one cell to another.
   b. internal change in the original nucleotide sequence of a gene or genes within an organism's genome.
   c. process by which genetic elements such as plasmids and transposons excise from one genomic location and insert into another.
   d. uptake of free DNA from the environment and recombination with the recipient's homologous DNA.

   ANS: B
   Mutation occurs as an internal change in the original nucleotide sequence of a gene or genes within an organism's genome.

   REF: 14

11. *Recombination* is defined as the:
   a. change of the bacterial genotypes through the exchange of DNA from one cell to another.
   b. internal change in the original nucleotide sequence of a gene or genes within an organism's genome.
   c. process by which genetic elements such as plasmids and transposons excise from one genomic location and insert into another.
   d. uptake of free DNA from the environment and recombination with the recipient's homologous DNA.

   ANS: A

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Recombination is an event that frequently occurs in many varieties of bacteria and is a major means by which bacteria may achieve genetic diversity.

REF: 14

12. *Transformation* is defined as the:
    a. change of the bacterial genotypes through the exchange of DNA from one cell to another.
    b. internal change in the original nucleotide sequence of a gene or genes within an organism's genome.
    c. process by which genetic elements such as plasmids and transposons excise from one genomic location and insert into another.
    d. uptake of free DNA from the environment and recombination with the recipient's homologous DNA.

    ANS: D
    Transformation involves recipient uptake of DNA that is free in the environment when another bacterial cell dies and undergoes lysis.

    REF: 14

13. *Transduction* is defined as the:
    a. change of the bacterial genotypes through the exchange of DNA from one cell to another.
    b. internal change in the original nucleotide sequence of a gene or genes within an organism's genome.
    c. process by which genetic elements such as plasmids and transposons excise from one genomic location and insert into another.
    d. mechanism that is mediated by viruses, by which DNA from two bacteria may come together in one cell, thus allowing for recombination.

    ANS: D
    Bacteriophages, viruses that infect bacteria, integrate their DNA into the bacterial cell's chromosome, in which viral DNA replication and expression is directed; thus, the DNA is dispersed to another bacterium when other cells are infected.

    REF: 14

14. The mechanism for adenosine triphosphate (ATP) production in which high-energy phosphate bonds produced by the central metabolic pathways are donated to adenosine diphosphate (ADP) to form ATP is:
    a. substrate-level phosphorylation.
    b. fermentative metabolism.
    c. oxidative phosphorylation.
    d. aerobic respiration.

    ANS: A
    Fermentative metabolism is one form of substrate-level phosphorylation that does not require oxygen. Oxidative phosphorylation is an electron transport system that can use either oxygen as the terminal electron acceptor (aerobic respiration) or acceptors other than oxygen (anaerobic respiration).

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REF: 17

15. A pathway that generates ATP by substrate-level phosphorylation that does not require oxygen and produces various end products, including alcohols, acids, carbon dioxide, and hydrogen, is:
    a. substrate-level phosphorylation.
    b. fermentative metabolism.
    c. oxidative phosphorylation.
    d. aerobic respiration.

    ANS: B
    Fermentative metabolism is one form of substrate-level phosphorylation that does not require oxygen. Oxidative phosphorylation, including both aerobic and anaerobic respiration, is an electron transport system.

    REF: 17 | 18

16. The pathway of metabolism that involves a series of electron transfers from reduced carrier molecules such as $NADH_2$ and $NADPH_2$ to a terminal electron acceptor is:
    a. substrate-level phosphorylation.
    b. fermentative metabolism.
    c. oxidative phosphorylation.
    d. aerobic respiration.

    ANS: C
    Fermentative metabolism is one form of substrate-level phosphorylation. Oxidative phosphorylation is an electron transport system that can use either oxygen as the terminal electron acceptor (aerobic respiration) or acceptors other than oxygen (anaerobic respiration).

    REF: 19

17. The term used when oxidative phosphorylation uses oxygen as the terminal electron acceptor is:
    a. substrate-level phosphorylation.
    b. fermentative metabolism.
    c. anaerobic respiration.
    d. aerobic respiration.

    ANS: D
    Oxidative phosphorylation is an electron transport system that can use either oxygen as the terminal electron acceptor (aerobic respiration) or acceptors other than oxygen (anaerobic respiration).

    REF: 19

18. Which organelle is found in eukaryotic cells and is responsible for controlled enzymatic degradation of intracellular substances?
    a. Mitochondria
    b. Lysosomes
    c. Endoplasmic reticulum
    d. Golgi body

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ANS: B
Lysosomes in the cell are responsible for controlled degradation of intracellular substances.

REF: 20

19. Teichoic acids are:
    a. waxy substances that are found in some bacterial cell walls that make the cells resistant to toxic substances, including acids.
    b. glycerol- or ribitol-phosphate polymers that are combined with various sugars, amino acids, and amino sugars, which are a part of the cell wall of gram-positive bacteria.
    c. high–molecular-weight polysaccharides that coat some bacterial cells and protect the bacteria from attack by cells of the human defense system.
    d. hairlike, proteinaceous structures that extend from the cell.

    ANS: B
    Teichoic acids, mycolic acids, peptidoglycan, and disaccharide-pentapeptide subunits are all building blocks of the bacterial cell wall.

    REF: 22

20. Pieces of DNA that move from plasmid to chromosome or vice versa but are not found as separate entities are called:
    a. DNA polymerases.
    b. transposable elements.
    c. plasmids.
    d. chromatoids.

    ANS: B
    Plasmids can be separate entities, but transposable elements cannot.

    REF: 8

21. All genes within an organism make up that organism's:
    a. chromosomes.
    b. genome.
    c. nucleotides.
    d. DNA.

    ANS: B
    Chromosomes are elements of the genome. Nucleotides and DNA are building blocks of genes.

    REF: 6

22. A bacterial cell that contains teichoic acid stains which color on the Gram stain?
    a. Pink
    b. Red
    c. Green
    d. Purple

    ANS: D

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Gram-positive organisms contain teichoic acid and therefore stain purple on the Gram stain.

REF: 22

23. A bacterial cell that contains an outer membrane and periplasmic space stains pink to red on Gram stain. Which one of the following statements explains this discrepancy?
    a. The bacteria were subjected to too much alcohol during the decolorization process, causing the organism to absorb the pink-to-red dye.
    b. The bacteria with an outer membrane and periplasmic space should not be Gram stained because of their cell wall content.
    c. Something is wrong with the lot of stains and may be expired. The Gram stain reagents are most likely expired.
    d. No discrepancy is present; organisms that contain an outer membrane and periplasmic space should stain pink because of their cell wall composition.

    ANS: D
    Gram-negative organisms contain an outer membrane and periplasmic space and therefore should stain red to pink to red on Gram stain because of their cell wall composition.

    REF: 20

24. Amino acids, fatty acids, sugars, and nucleotides are produced during which metabolic reaction?
    a. Fueling
    b. Biosynthesis
    c. Polymerization
    d. Assembly

    ANS: B
    During biosynthesis, amino acids, fatty acids, sugars, and nucleotides are produced using precursor products in dozens of pathways to produce nearly 100 different products.

    REF: 20

25. Which of the following processes takes place in the cytoplasm and involves the transfer RNA (tRNA) mediating the sequential addition of amino acids in a specific sequence that is dictated by the codon sequence of the messenger RNA (mRNA) molecule?
    a. Transcription
    b. Initiation
    c. Elongation
    d. Termination

    ANS: C
    Elongation, which is one of the steps of translation, adds amino acids in a specific sequence, which ultimately codes for a specific protein. Translation occurs in the cytoplasm, whereas transcription occurs in the nucleus. Initiation begins with the association of ribosomal subunits, mRNA, and formylmethionine tRNA carrying the initial amino acid of the protein to be synthesized. After the initial complex is formed, addition of individual amino acids begins. Termination is the final step in translation and occurs when the ribosomal A site encounters a stop codon that does not specify an amino acid.

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REF: 11

26. The structure of bacterial chromosomes differs from that of eukaryotic organisms in all of the following except:
    a. bacterial chromosomes are typically circular.
    b. the genes are polycistronic.
    c. the bacteria have two copies of each chromosome.
    d. bacterial mutations are easily transmitted or inherited.

    ANS: C
    Bacterial typically contain a single chromosome that is circular in nature. In order to maximize usage of a small genome, bacteria produce regions that are polycistronic or include multiple genes under the control of one region. Because bacteria typically contain one copy of the chromosome, mutations that are not lethal to the organism are easily transferred to successive generations.

    REF: 6

27. In the following genetic sequence, identify the correct complementary strand of DNA for the sequence 3' CAGTACCGTAAGCT 5'
    a. 3' GTCATGGCATTCGA 5'
    b. 5' GTCATGGCATTCGA 3'
    c. 5' AGCTTACGGTACTG 3'
    d. 5' GTCATGGCTTCGA 3'

    ANS: B
    The antiparallel complementary strand must read in the opposite direction: 5' to 3' and it must adhere to the A-T and G-C base pairing.

    REF: 6 | 9

ADVANCED QUESTIONS

28. A patient is infected with a bacteria that is resistant to erythromycin (the antibiotic is not effective) and sensitive to clindamycin (the antibiotic is effective). However, the patient is not improving and the organism now appears to be resistant to both antibiotics. The reason for this alteration in gene expression in the bacterium is likely due to:
    a. genetic regulation that encodes the resistance mechanism is constitutive.
    b. the genetic regulation encoding the enhanced resistance is inducible.
    c. the genetic regulation for the enhanced resistance is normally suppressed.
    d. the organism was always resistant to both antibiotics and should not have been treated with the combination therapy.

    ANS: B
    The genetic resistance is considered inducible. The clindamycin resistance is turned on only in the presence of the antibiotic erythromycin and is only active when an organism is resistant to that antibiotic. If the organism was susceptible to erythromycin, the organism would be killed and not alive to activate the resistance mechanism for the second antimicrobial agent.

    REF: 13

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29. *Neisseria gonorrhoeae* are present in the vaginal compartment with nonpathogenic commensal *Neisseria* spp. When the patient's system begins to attack the pathogenic species, some of the cells autolyze releasing their genetic material into the environment. Other *Neisseria* species are then capable of taking up the DNA from the organisms that have autolyzed altering their genetic makeup and changing their pili protein structure. This process can be described as:
    a. competent cells being transformed by genetic recombination.
    b. bacteria ingesting DNA and using the information for transcription.
    c. mutation of the pathogenic organisms resulting in enhanced infection.
    d. transformation and genetic recombination resulting in expression of new pili proteins to evade the immune system.

    ANS: D
    Neisseria species are one of the bacterial organisms that are competent and able to take up naked DNA from their environment via the mechanism of transformation. Once transformed with other DNA, the organisms are capable of incorporating that DNA into their chromosomes by genetic recombination resulting in the expression of altered pili proteins that are not recognized by the immune system until a new response is manifested.

    REF: 14

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