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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1. Membrane lipid bilayers consist primarily of \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​phospholipids | |  | b. | ​cholesterol | |  | c. | ​proteins | |  | d. | ​saturated fatty acids |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2. Membrane proteins do *not* serve as \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​pumps | |  | b. | ​detoxifiers | |  | c. | ​receptors | |  | d. | ​enzymes |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 3. What is the role of cholesterol in plasma membrane structure?   |  |  |  | | --- | --- | --- | |  | a. | ​to produce bile | |  | b. | ​to regulate fluidity and permeability | |  | c. | ​to reduce stability | |  | d. | ​to produce hormones |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 4. Signals generated at one part of a cell are transmitted quickly to other parts of the cell due to the interconnection of the cytosol and \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​glycoproteins | |  | b. | ​filaments | |  | c. | ​glycolipids | |  | d. | ​integral proteins |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 5. The carbohydrate moieties of the plasma membrane glycoproteins and glycolipids are oriented \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​outwardly, away from the cytoplasmic matrix | |  | b. | ​inwardly, toward the lumen | |  | c. | ​equally inwardly and outwardly to maintain symmetry | |  | d. | ​between the bilayers of the membranes |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 6. Proteins attached to the membrane through hydrophobic interactions and embedded in the membrane are called \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​peripheral proteins | |  | b. | ​rough endoplasmic reticula | |  | c. | ​integral proteins | |  | d. | ​Golgi apparatuses |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 7. In the cell structure, the \_\_\_\_ provides support and controls the movement of cell organelles.   |  |  |  | | --- | --- | --- | |  | a. | ​endoplasmic reticulum | |  | b. | ​mitochondrion | |  | c. | ​cytoskeleton | |  | d. | ​matrix space |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 8. The fluid portion of the cytoplasmic matrix does *not* contain \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | amino acids​ | |  | b. | ​glucose | |  | c. | ​carbon dioxide | |  | d. | ​urea |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 9. Enzymes of metabolic pathways within the cytoplasmic matrix are often oriented so that the product of one enzyme is released in close proximity to the next enzyme for which it is a substrate, to facilitate the velocity of the overall pathway. This arrangement includes enzymes of \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​beta-oxidation | |  | b. | ​glycolysis | |  | c. | ​ketone production | |  | d. | ​the Krebs cycle |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 10. ​The organelle responsible for production of most of the metabolic energy (ATP) is the \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​Golgi apparatus | |  | b. | ​endoplasmic reticulum | |  | c. | ​nucleus | |  | d. | ​mitochondrion |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 11. ​All components of the electron transport chain are embedded in the \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | mitochondrial inner membrane | |  | b. | ​mitochondrial outer membrane | |  | c. | mitochondrial matrix | |  | d. | ​cytoplasmic matrix |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 12. ​In which organelle do the TCA cycle and fatty acid oxidation occur?   |  |  |  | | --- | --- | --- | |  | a. | Golgi apparatus​ | |  | b. | ​nucleus | |  | c. | ​microsomes | |  | d. | ​mitochondrion |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 13. ​What is the major route for ATP production?   |  |  |  | | --- | --- | --- | |  | a. | ​oxidative phosphorylation | |  | b. | ​hydrolysis | |  | c. | ​peroxidation | |  | d. | ​transformation |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 14. Which organelle is capable of performing both fission and fusion?   |  |  |  | | --- | --- | --- | |  | a. | ​Golgi apparatus | |  | b. | ​mitochondria | |  | c. | ​rough endoplasmic reticulum | |  | d. | ​nucleus |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 15. Genes contained in mitochondrial DNA are inherited only from the mother and code for \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​all proteins functioning within the mitochondrial matrix | |  | b. | ​nonfunctional ancient proteins considered remnants of evolution | |  | c. | ​proteins vital to the production of ATP | |  | d. | ​antioxidant proteins |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 16. The cell organelle responsible for the initiation and regulation of most cellular activity is the \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​cytoplast | |  | b. | ​nucleus | |  | c. | ​mitochondrion | |  | d. | ​nucleolus |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 17. In addition to the mitochondria, which organelle possesses an inner and outer membrane?   |  |  |  | | --- | --- | --- | |  | a. | ​lysosome | |  | b. | ​lysosome | |  | c. | ​Golgi apparatus | |  | d. | ​nucleus |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 18. Microtubule organization centers (MTOCs) on the outer nuclear membrane are associated with which cellular process?   |  |  |  | | --- | --- | --- | |  | a. | ​oxidative phosphorylation | |  | b. | ​electron transport | |  | c. | ​mitosis | |  | d. | ​protein synthesis |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 19. Encoded within the nuclear DNA of each cell is \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​the entire genome for that organism | |  | b. | ​the genes coding for proteins needed by that particular cell in the organism | |  | c. | ​chromatin | |  | d. | ​a cell-specific histone |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 20. DNA in the nucleus is wrapped around \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​proteins called histones | |  | b. | ​the nucleolus | |  | c. | ​the nuclear envelope | |  | d. | ​ribosomal RNA |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 21. Which nitrogenous base is unique to RNA?   |  |  |  | | --- | --- | --- | |  | a. | ​guanine | |  | b. | ​uracil | |  | c. | ​thymine | |  | d. | ​cytosine |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 22. Which enzyme is responsible for linking together the incoming nucleotides during DNA replication?   |  |  |  | | --- | --- | --- | |  | a. | ​DNA ligase | |  | b. | ​helicase | |  | c. | ​DNA polymerase | |  | d. | ​reverse transcriptase |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 23. Transcription is the process by which \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​the genetic information in a single strand of DNA makes a specific sequence of bases in a messenger RNA (mRNA) chain | |  | b. | ​genetic information in an mRNA molecule specifies the sequence of amino acids in the protein product | |  | c. | ​amino acids are linked together to form the primary structure of a protein | |  | d. | ​the primary structure of a protein is folded several times to become the quaternary structure |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 24. Translation is the process by which \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​the genetic information (base sequence) in a single strand of DNA is used to specify a complementary sequence of bases in an mRNA chain | |  | b. | ​a daughter duplex DNA molecule that is identical to the parental duplex DNA is synthesized | |  | c. | ​the polypeptide chain of the protein product is extended | |  | d. | ​genetic information in an mRNA molecule specifies the sequence of amino acids in the protein product |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 25. Elongation is the process by which \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​the mRNA strand is formed | |  | b. | ​peptide bonds are formed between aligned amino acids after the amino acids are positioned | |  | c. | ​amino acids are activated by ATP at their carboxyl end | |  | d. | ​activated amino acids are transferred to their specific tRNAs that contain the anticodon complementary to each amino acid’s codon |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 26. Transcription-level control mechanisms \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​determine the path by which mRNA can be translated into a   polypeptide | |  | b. | ​determine whether a particular mRNA is actually translated | |  | c. | ​determine if a particular gene can be transcribed | |  | d. | ​are driven by the interaction of tRNA and mRNA |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 27. MicroRNAs are small noncoding RNAs that \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​enhance gene expression by activating mRNA expression | |  | b. | ​silence gene expression by binding to mRNA to inhibit translation | |  | c. | ​modify gene expression by replacing specific nucleotides in mRNA | |  | d. | ​mediate DNA production in a reverse direction |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 28. Which organelle is composed of an extensive network of membranous channels that connects the nuclear membrane, the Golgi apparatus, and the plasma membrane?   |  |  |  | | --- | --- | --- | |  | a. | ​the lysosome | |  | b. | ​the nucleolus | |  | c. | ​the centrioles | |  | d. | ​the endoplasmic reticulum |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 29. The smooth endoplasmic reticulum (SER) is associated with \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​lipid synthesis | |  | b. | ​protein synthesis | |  | c. | ​the calcium ion pump necessary for the contractile process | |  | d. | ​ribosomes and cytochrome P450 enzymes |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 30. Which enzyme complex, used in metabolizing many drugs, is located on the rough endoplasmic reticulum in liver cells?   |  |  |  | | --- | --- | --- | |  | a. | ​chromatins | |  | b. | ​lysozymes | |  | c. | ​cytochromes | |  | d. | ​polymerases |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 31. ​What structural body is made up of flattened cisternae flanked by tubular networks and thought to be an extension of the endoplasmic reticulum?   |  |  |  | | --- | --- | --- | |  | a. | ​nucleus | |  | b. | ​cytoplasm | |  | c. | ​lysosome | |  | d. | ​Golgi apparatus |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 32. ​The Golgi apparatus is prominent in neurons and secretory cells and functions \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​to stop the synthesis of proteins that may need carbohydrate additions | |  | b. | ​to add polysaccharide or lipid moieties to polypeptides | |  | c. | ​only for constitutive secretion of proteins | |  | d. | ​only for regulated secretion of proteins |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 33. Which organelle prevents proteins that have not reached their normal tertiary or quaternary structure from reaching the cell surface?   |  |  |  | | --- | --- | --- | |  | a. | ​the endoplasmic reticulum | |  | b. | ​the Golgi apparatus | |  | c. | ​the nucleus | |  | d. | ​the mitochondrion |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 34. The organelle that serves as the digestive system for the cell is the \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​polysome | |  | b. | ​endosome | |  | c. | ​lysosome | |  | d. | ​ribosome |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 35. The organelle that detoxifies by oxidizing molecules such as hydrogen peroxide and ethanol is the \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​peroxisome | |  | b. | ​endosome | |  | c. | ​lysosome | |  | d. | ​ribosome |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 36. Destruction of which organelle(s) would cause the cell to cease to function due to a total loss of energy?   |  |  |  | | --- | --- | --- | |  | a. | ​the nucleus | |  | b. | ​the Golgi apparatus | |  | c. | ​the ribosomes | |  | d. | ​the mitochondria |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 37. Digestive enzymes delivered to the small intestine from cells in the pancreas are able to leave those cells because of the functioning of the \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​endoplasmic reticulum | |  | b. | ​ribosomes | |  | c. | ​Golgi apparatus | |  | d. | ​lysosomes |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 38. Damage to MTOCs will interfere with which cellular process?   |  |  |  | | --- | --- | --- | |  | a. | ​oxidative phosphorylation | |  | b. | ​mitosis | |  | c. | ​electron transport | |  | d. | ​creation of an mRNA molecule |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 39. Molecular stimuli that bind specifically to receptors are known as \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​ligands | |  | b. | ​enzymes | |  | c. | ​allosteric enzymes | |  | d. | ​hydrolases |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 40. Which are highly specialized membrane proteins that modify the cell's response to its environment?   |  |  |  | | --- | --- | --- | |  | a. | ​transport proteins | |  | b. | ​enzymes | |  | c. | ​receptors | |  | d. | ​peroxisomes |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 41. Most receptor proteins are most likely which type?   |  |  |  | | --- | --- | --- | |  | a. | ​peripheral proteins | |  | b. | ​internal proteins | |  | c. | ​integral proteins | |  | d. | ​glycoproteins |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 42. Cyclic AMP activates which enzymes?   |  |  |  | | --- | --- | --- | |  | a. | ​protein kinases | |  | b. | ​restriction endonucleases | |  | c. | ​allosteric enzymes | |  | d. | ​adenyl (adenylyl) cyclases |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 43. Constitutive enzymes are \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​uninfluenced by external stimuli | |  | b. | ​influenced by external stimuli | |  | c. | ​synthesized at variable rates | |  | d. | ​unaffected by induction |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 44. Substances that bind with allosteric sites and alter the activity of regulatory enzymes are called \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​transport proteins | |  | b. | ​modulators | |  | c. | ​Na pumps | |  | d. | ​sarcoplasmic reticula |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 45. ​Diagnostic enzymology focuses on \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​enzymes that are widely distributed among many tissues | |  | b. | ​intracellular enzymes that express their activity in the blood abnormally due to a disease process | |  | c. | ​secreted enzymes such as clotting proteins in blood | |  | d. | ​nuclear enzymes |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 46. One trigger of apoptosis is \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​overexpression of Bcl-2 | |  | b. | ​inactivation of *Casp-9* | |  | c. | ​swelling of the cell | |  | d. | ​release of mitochondrial cytochrome c |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 47. Malformed Apaf-1 molecules in a cell might \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​cause rapid apoptosis of the cell | |  | b. | ​inactivate cytochrome c | |  | c. | ​lead to the development of a tumor | |  | d. | ​have no effect on apoptosis |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 48. What is released when nutrient molecules are oxidized?   |  |  |  | | --- | --- | --- | |  | a. | ​oxygen | |  | b. | ​potential (or free) energy | |  | c. | ​kinetic energy | |  | d. | ​hydrogen |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 49. In muscle cells, creatine phosphate is used to replenish which substance?   |  |  |  | | --- | --- | --- | |  | a. | ​glucose | |  | b. | ​pyruvic acid | |  | c. | ATP | |  | d. | ​calcium |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 50. Phosphorylation of a molecule is generally accomplished by transferring the terminal phosphate group from which substance?   |  |  |  | | --- | --- | --- | |  | a. | ​GTP | |  | b. | ​pyruvic acid | |  | c. | G6PD | |  | d. | ​ATP |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 51. ​The plasma membrane is a sheet-like structure composed solely of lipids.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

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| 52. ​The lipid bilayer determines the function of the plasma membrane, while the proteins are primarily responsible for the structure of the membrane.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

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| 53. The various components within a cell (e.g., mitochondria) are not “free-floating” in the cytosol, but rather, are held in place by the cytoskeleton.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | True | |

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| 54. ​Peripheral proteins are involved in cell-cell recognition, whereas integral proteins function primarily as receptors/transporters.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | True | |

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| 55. ​Different cells express different proteins because they contain different sequences of DNA in the nucleus.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

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| 56. ​Polysomes function to transcribe mRNA into proteins.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

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| 57. ​When discussing enzyme kinetics, Km refers to the substrate concentration at which the enzyme is saturated and functioning at maximal velocity.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

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| 58. ​If two enzymes (e.g., pyruvate dehydrogenase and pyruvate carboxylase) compete for the same substrate (pyruvate), the one with the higher Km has less affinity and will be more active when pyruvate concentrations are high.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | True | |

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| 59. ​Most cellular reactions are irreversible because the same enzyme that catalyzes the conversion cannot catalyze the reverse reaction.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

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| 60. ​Allosteric regulation of enzymes is carried out by modulators, other proteins that bind to the enzyme to inhibit its activity.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

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| 61. ​Most of the metabolic energy produced in cells is made in the mitochondria.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | True | |

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| 62. ​The nuclear envelope is a single membrane structure that helps to isolate the nucleus from the rest of the cell.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

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| 63. ​Transcription of DNA cannot be altered.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | False | |

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| 64. ​An increase in the concentration of a substrate will increase the rate of the enzyme-catalyzed reaction.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | True | |

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| 65. ​Oncosis results from cell injury and is associated with cellular swelling and swelling of the mitochondrial nucleus.   |  |  |  | | --- | --- | --- | |  | a. | True | |  | b. | False |  |  |  | | --- | --- | | *ANSWER:* | True | |

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| ​***Enzyme Classification:*** Match the correct enzyme classification with the examples provided.   |  |  | | --- | --- | | a. | ​enzymes that catalyze cleavage of C-C, C-S, and certain C-N bonds (excluding peptide bonds) without hydrolysis or oxidation-reduction | | b. | ​enzymes forming bonds between carbon and other atoms, such as acetyl-CoA carboxylase, which adds bicarbonate to acetyl-CoA to initiate fatty acid synthesis in the cytoplast | | c. | ​enzymes in the electron transport chain in the mitochondria | | d. | ​enzymes that catalyze cleavage of bonds by addition of water, such as digestive enzymes | | e. | ​enzymes that catalyze reactions, not oxidation or reduction, in which a functional group is moved from one substrate to another, such as transaminases | |

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| 66. ​oxidoreductases   |  |  | | --- | --- | | *ANSWER:* | c | |

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| 67. ​hydrolases   |  |  | | --- | --- | | *ANSWER:* | d | |

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| 68. ​transferases   |  |  | | --- | --- | | *ANSWER:* | e | |

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| 69. ​lyases   |  |  | | --- | --- | | *ANSWER:* | a | |

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| 70. ​ligases   |  |  | | --- | --- | | *ANSWER:* | b | |

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| ​*Match each description to one of the following terms.*   |  |  | | --- | --- | | a. | ​free energy | | b. | ​activation energy | | c. | ​cellular energy | | d. | ​transition state | | e. | ​standard reduction potential | |

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| 71. ​energy derived from a series of chemical reactions, each of which exhibits a free energy change   |  |  | | --- | --- | | *ANSWER:* | c | |

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| 72. ​a higher energy level or barrier at which the exothermic conversion to products takes place   |  |  | | --- | --- | | *ANSWER:* | d | |

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| 73. ​potential energy released from chemical bonds upon oxidation   |  |  | | --- | --- | | *ANSWER:* | a | |

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| 74. ​the tendency of a compound to donate and receive electrons   |  |  | | --- | --- | | *ANSWER:* | e | |

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| 75. ​the energy required to raise the reactants to their transition state   |  |  | | --- | --- | | *ANSWER:* | b | |

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| 76. ​List the three mechanisms that can be used to regulate the function of a protein (e.g., an enzyme) and briefly (in one to two sentences) describe their key features.   |  |  | | --- | --- | | *ANSWER:* | ​  Mechanism 1: Covalent modification—no change in the abundance of a protein. Here, preexisting protein is made active or inactive by covalently modifying it (involves making or breaking covalent bonds). Examples include phosphorylation, carboxylation, glycosylation, or proenzyme activation by breaking a peptide bond.  ​  Mechanism 2: Allosteric regulation—here we also are not changing the abundance of the protein (in this case an enzyme), but we are inhibiting or stimulating its activity—not by covalently modifying the protein, but by having something bind to it, resulting in a change in its conformation that affects its enzymatic activity. What are these things that bind to enzymes to affect their activity? NOT other proteins or enzymes—they are typically substrates, intermediates, or products along the pathway in which the enzyme participates. The book calls them modulators. A good example is ATP—ATP is the end point of a lot of pathways (glycolysis, TCA cycle) and as such, when it is abundant, that is a good sign that we have enough ATP/energy. Once the concentration of ATP reaches a certain level, it begins to bind some of the key enzymes in glycolysis and the TCA cycle and inhibits them. Why continue to make ATP if we have enough? Conversely, when ADP levels are higher than ATP (a sign we need energy), ADP binds to these same enzymes, but the result is not inhibition of their activity, but rather ADP stimulates them to be more active (and thus make more energy). Then, when ATP levels begin to rise again... we’re back where this paragraph started.  Mechanism 3: Induction—inducing a gene to be expressed, thereby ultimately resulting in an increase in the abundance of a protein. This is accomplished by increasing transcription and/or translation of the corresponding gene/mRNA. [By definition, induction means to increase abundance; writing “increase and/or decrease” would be incorrect.]  ​  [Note: For mechanism 1 or 3, the proteins we are talking about can be enzymes, transporters, and so forth. For 2, we are only talking about enzymes. Don’t let the term active confuse you—we use it mostly when we talk about enzymes, but an “active protein” means it is carrying out its function, be it catalytic or transport or anything else. Also note that mechanisms 1 and 2 are fast, whereas mechanism 3 is slower.] | |

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| 77. Briefly describe the role of DNA in cell replication and transcription.​   |  |  | | --- | --- | | *ANSWER:* | ​**Cell Replication**:During cell division, DNA must be replicated into two daughter DNA molecules that are identical to the parental DNA molecule.  The DNA molecule unzips and each strand of the double helix becomes a template used to synthesize a new complementary strand.  The new strand is produced by the process of complementary base pairing.  Nucleotide bases connect to the template at their complementary bases and become connected by phosphate diester bonds through the action of the enzyme DNA polymerase.  In the end, two new DNA chains have joined with the two original DNA templates to form two new DNA molecules.  **Transcription**: This process uses the gene sequence in a DNA strand to direct for the production of specific proteins.  The base sequence of one strand of DNA acts as a template for the production of a single strand of mRNA.  The same single strand of DNA may direct for the creation of many different strands of mRNA which will leave the nucleus and bring the genetic code to the ribosomes for protein production.  Specific DNA codons (three bases in a row) act as either initiators of the production of mRNA or as terminators to specify the length of the mRNA strand. | |

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| 78. ​Choose three of the following terms and in one sentence per term, provide a concise definition of that term: nucleus, mitochondria, RER, transcription, translation, apoptosis, and cell replication.   |  |  | | --- | --- | | *ANSWER:* | ​The **nucleus** is the largest organelle in the cell and, because it contains almost all of the cell’s DNA, it regulates most cellular activities.  **Mitochondria** are the organelles in virtually all cells that are responsible for the major portion of energy (ATP) production, utilizing metabolic processes including the TCA cycle, β-oxidation, parts of gluconeogenesis, and the electron transport chain.  The **rough endoplasmic reticulum** (**RER**) is studded with ribosomes and is intimately involved in protein synthesis.  **Transcription** is the nuclear process of copying one strand of DNA into a single-stranded mRNA and substituting the base uracil in place of thymine.  **Translation** is the process by which the genetic information carried by a molecule of mRNA becomes the sequence of amino acids in a protein.  **Apoptosis** is programmed cell death brought about by several different mechanisms designed to regulate the number of cells in a tissue.  **Cell replication** is the production of two daughter cells from a mother cell that includes the replication of a single DNA strand into two identical daughter DNA strands (one in each new cell). | |

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| 79. Why is cholesterol important in plasma membrane function?​   |  |  | | --- | --- | | *ANSWER:* | The answer should include the following items:   * The steroid rings containing the hydroxyl groups of cholesterol align near the polar head groups of the membrane phospholipids and the hydrocarbon tail aligns with the hydrophobic fatty acids on the phospholipid. * This alignment allows cholesterol to stabilize the membrane and regulate fluidity. * Changes in membrane fluidity alter the permeability of the membrane and control entrance and exit of molecules into and out of the cell. * Membrane fluidity also affects the location and function of membrane proteins. | |

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| 80. ​Describe the cytoskeleton (microtrabecular lattice) and its role as an intercommunication system of proteins and other macromolecules.   |  |  | | --- | --- | | *ANSWER:* | ​The answer should include the following items:   * The cytoskeleton (microtrabecular lattice) consists of microtubules (hollow structures), microfilaments (made of actin), and intermediate filaments (found in cells like neurons and in muscle and epithelial cells that are subjected to physical stress). * It provides a structure for organization of organelles and proteins such as enzymes to facilitate interactions with substrates such as glucose and oxygen, thus facilitating metabolic pathways in all cells. * The cytoskeleton provides mechanism for cell locomotion in certain cells such as phagocytes. * The microtrabecular lattice is vital for cell activation and survival. | |

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| 81. ​Define and describe diagnostic enzymology.   |  |  | | --- | --- | | *ANSWER:* | ​  Diagnostic enzymology studies intracellular enzymes that, due to a problem within the cell, escape and act within the serum where they do not normally exist. The serum activity of these now displaced enzymes is measured, which allows for a determination of the site and extent of the cellular damage. An accurate determination of the site of the damage requires that the enzyme being measured must exhibit a high degree of organ or tissue specificity. | |

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| 82. ​Describe the important implications of the high Km for glucokinase in terms of maintaining normal blood glucose after a meal and during fasting.   |  |  | | --- | --- | | *ANSWER:* | ​The answer should include the following items:   * The high Km for glucokinase means that it requires a high concentration of glucose in the blood to be active. * Thus, it is not very active during fasting and so the glucose that comes into the liver during fasting can easily return to the blood for use by the brain and red blood cells. * After a meal, when a lot of glucose enters the liver, the glucose concentration is high enough that glucokinase phosphorylates glucose, trapping it inside the liver. * This action is important for lowering blood glucose quickly after a meal. | |

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| 83. ​Describe the process of apoptosis in relation to the life span of the cell.   |  |  | | --- | --- | | *ANSWER:* | ​The answer should include the following items:   * Apoptosis refers to programmed cell death as distinguished from pathological cell death, which causes inflammation and possibly autoimmune reactions. * Apoptosis can be beneficial during development of an organism when cells are no longer needed as development progresses. * Apoptosis is thought to be detrimental when it leads to degenerative diseases such as Alzheimer’s. Thus, active research seeks to understand triggers and methods by which it might be controlled. * DNA damage, hypoxia, or other intracellular insults can cause release of mitochondrial factors, especially cytochrome c, which activates caspases and results in the beneficial apoptosis (death) of that damaged cell. * The mitochondrial membrane protein Bcl-2 can prevent apoptosis by blocking the release of cytochrome c. If Bcl-2 is upregulated, it can cause cell survival. Survival of a damaged cell can allow it to continue to grow and cause cancer. * Both the retinoic acid form of vitamin A and the active form of vitamin D are involved in these cell death and survival pathways. Research is needed to completely understand the beneficial control of cell death and survival. | |

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| 84. ​Describe the uphill-downhill concept.   |  |  | | --- | --- | | *ANSWER:* | ​The answer should include the following items:   * Pushing a boulder uphill represents endothermic reactions, which require input of energy to occur. The products of such a reaction will contain greater potential energy than the reactants. It will be the sum of the energy in the reactants plus the energy put in to create the products. * The boulder falling downhill represents exothermic reactions, which release energy as they occur. The products of such a reaction will contain less potential energy than the reactants because free energy, which can be used for work, is released. * Whenever carbohydrates or fats are metabolized completely to carbon dioxide and water, free energy is partly released as heat and partly captured in ATP for use in work. * In the case of downhill reactions, although the overall metabolic pathway is exothermic (energy-releasing), it is not spontaneous and some activation energy needs to be added to the potential energy in the reactants to allow the reaction to proceed. In the uphill-downhill concept, the activation energy is represented by adding energy to push the boulder up a short distance so it is in a position to fall and release some of the potential energy in the reactants as they become products. | |

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| 85. ​Discuss the concept of coupled reactions in the transfer of energy.   |  |  | | --- | --- | | *ANSWER:* | ​The answer should include the following items (note that students may provide other examples such as the coupling of phosphocreatine to creatine with the formation of ATP from ADP):   * Coupled reactions allow metabolism to proceed because exothermic reactions that release energy are capable of driving endothermic reactions that require the energy released. * In metabolism, ATP is involved as the ideal intermediate because the breakdown of high-energy phosphate compounds such as creatine phosphate can drive the formation of the intermediate-energy bond that creates ATP from ADP. * In turn ATP can be hydrolyzed to form ADP and release the intermediate amount of energy in the bond in order to provide energy to, for example, add phosphate to glucose to form glucose-6-phosphate, the first step in the glycolytic breakdown of glucose. * So the breakdown of ATP to ADP to release energy is said to be coupled to the input of energy required to add phosphate to glucose to create glucose-6-phosphate. | |

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| 86. ​A researcher in the field of nutritional genomics is *least* likely to study \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​the interactions among genes and bioactive components in food that change gene expression without changing the DNA nucleotide sequence (nutritional epigenetics) | |  | b. | ​inborn changes in DNA nucleotide sequences or gene variants (nutrigenetics) | |  | c. | ​genetic alterations that can be compensated for by increasing or decreasing specific nutrients (nutrigenomics) | |  | d. | ​the interaction between genetically engineered enzymes and their substrates |  |  |  | | --- | --- | | *ANSWER:* | d | |

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| 87. ​A common mutation in the 5,10-methylenetetrahydrofolate reductase enzyme (MTHFR) \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | prevents the individual from activating the B vitamin folate | |  | b. | has no effect on the activity of the enzyme | |  | c. | increases the activity of the enzyme | |  | d. | ​modifies the folate molecule directly |  |  |  | | --- | --- | | *ANSWER:* | a | |

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| 88. ​The primary mechanism by which gene expression is modified by bioactive factors in food appears to be \_\_\_\_.   |  |  |  | | --- | --- | --- | |  | a. | ​mutations causing cancer | |  | b. | ​interactions with transcription factors | |  | c. | ​production of SNPs | |  | d. | ​downregulation of translation |  |  |  | | --- | --- | | *ANSWER:* | b | |

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| 89. ​What lifestyle change would be most important to individuals with a common variant in the *GST* gene that impairs protection against toxins?   |  |  |  | | --- | --- | --- | |  | a. | ​increasing levels of daily exercise | |  | b. | ​eating a low-fat diet | |  | c. | ​increasing ingestion of cruciferous vegetables | |  | d. | ​increasing intake of omega-3 fats |  |  |  | | --- | --- | | *ANSWER:* | c | |

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| 90. ​Which class of bioactive food components has the ability to get into the nucleus of cells and bind to DNA to influence gene expression?   |  |  |  | | --- | --- | --- | |  | a. | ​lipophilic, small-molecular-weight molecules | |  | b. | ​glycoproteins | |  | c. | ​phospholipids | |  | d. | ​water-soluble vitamins |  |  |  | | --- | --- | | *ANSWER:* | a | |