**Short answer and essay.** Please answer each of the questions below. Partial credit may be given.

1. How do cells and organisms prevent proton donors and acceptors from drastically affecting the overall pH of the cell cytoplasm?
2. How does the positive charge of a hydrogen ion contribute to the overall chemistry of the cell?
3. The electron-transport chain is composed of many different components and present in multiple copies in the inner mitochondrial membrane. List the components of the electron-transport chain in their order of operation, including mobile electron carriers, and describe the functions of each.
4. Answer the questions below. Please show your work when needed.
   1. A carbon atom contains six protons and six neutrons. What is its atomic number?
   2. What is the atomic weight of a carbon atom (whole number, no decimals)?
   3. How many total electrons does a carbon atom possess?
   4. How many additional electrons must be added to a carbon atom to fill its outermost shell?
5. The atomic number of nitrogen is 7. How many neutrons does an atom of radioactive nitrogen-15 possess?
6. Answer the questions below.
   1. Which products of glycolysis would accumulate in the cytosol in the absence of oxygen in cells that cannot do fermentation? Why?
   2. Which steps of glycolysis would be halted? Why?
   3. What would happen if these cells could perform anaerobic respiration? Would the results be the same? Why? What is the difference between fermentation and anaerobic respiration?
7. Explain the following in your own words:
   1. Competitive inhibition
   2. Noncompetitive inhibition
   3. Feedback inhibition
8. Arrange the following terms into two lists where each column is either associated with cutting bonds or making bonds: anabolic, catabolic, exergonic, endergonic, energetically favorable, energetically unfavorable, +ΔG, −ΔG, spontaneous and non-spontaneous.

Table

Description automatically generated

b. If a reaction has a +ΔG, can it be encouraged to go or not? If so, then how?

**Fill in the table below using the word bank provided. Each word may be used more than once.**

1. Where do the high-energy electrons that drive oxidative phosphorylation come from?

**Word bank**

|  |  |
| --- | --- |
| glucose | FAD |
| acetyl CoA | NAD+ |
| pyruvate | FADH2 |
| ADP | H2O |
| CO2 | NADH |
| ADP/ATP |  |

Table

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**Multiple Choice.** Provide the correct answer in the space provided.

1. Which of the following is not required for cell motility?
   1. nucleation of new actin filaments
   2. integrin association with the extracellular matrix or the surface of a neighboring cell
   3. myosin-mediated contraction at the rear of the moving cell
   4. release of Ca2+ from the sarcoplasmic reticulum
   5. gel-sol phase changes
2. What is true about molecular motors?
   1. They stop if ATP is not available.
   2. Minus-end MT motors carry cargo to the periphery of the cell.
   3. Kinesins and dyneins move along both microtubules and actin filaments.
   4. Myosin is only for muscle contraction.
   5. Myosin, kinesin, and dynein can all move vesicles around the cytoplasm.
3. The cytoskeleton of plant cells is different from animal cells because
   1. plant cells cannot change shape.
   2. plant cells cannot phagocytose particles.
   3. plant cells mostly contain intermediate filaments.
   4. plant cells do not have motors on intermediate filaments.
4. Enzymes work by\_\_\_\_\_\_\_.
   1. Decreasing the potential energy difference between reactant and product
   2. Reducing EA
   3. Increasing the potential energy difference between reactant and product
   4. Adding a phosphate group to a reactant
   5. Adding energy to a reaction
5. A sodium-potassium pump \_\_\_\_\_\_\_.
   1. Moves three potassium ions out of a cell and two sodium ions into a cell while producing ATP for each cycle
   2. Moves three sodium ions out of a cell and two potassium ions into a cell using energy from ATP hydrolysis
   3. Moves three potassium ions out of a cell and two sodium ions into a cell using energy from ATP hydrolysis
   4. Moves three sodium ions out of a cell and two potassium ions into a cell and generates an ATP in each cycle
6. Which of the following membrane activities requires energy from ATP hydrolysis?
   1. Facilitated diffusion of chloride ions across the membrane through a chloride channel
   2. Movement of Na+ ions from a lower concentration in a mammalian cell to a higher concentration in the extracellular fluid
   3. Movement of glucose molecules into a bacterial cell from a medium containing a higher concentration of glucose than inside the cell
   4. Movement of carbon dioxide out of a paramecium
7. A student is conducting an experiment in which he adds an inhibitor to an enzyme-catalyzed reaction. When the student first adds the inhibitor, the reaction rate decreases; however, he can return the reaction rate to normal by adding a large quantity of substrate. What type of inhibitor is the student using?
   1. Uncompetitive inhibitor
   2. Competitive inhibitor
   3. Noncompetitive inhibitor
   4. Substrate-sensitive inhibitor
   5. The student made a mistake- this result could not occur regardless of the type of inhibition
8. Tay-Sachs disease is a human genetic abnormality that results in cells accumulating and becoming clogged with very large, complex, undigested lipids. Which cellular organelle is most likely defective in this?
   1. The lysosome
   2. The Golgi apparatus
   3. The smooth endoplasmic reticulum
   4. The rough endoplasmic reticulum
9. Which of the following is true for catabolic pathways?
   1. They consume energy as they degrade polymers to monomers
   2. They are usually non-spontaneous chemical reactions
   3. They consume energy to decrease the entropy of the organism and its environment
   4. They do not depend on enzymes
   5. They release energy to build up polymers from monomers
   6. The products have less free energy than the reactants
10. When the peptide bonds of a protein are broken to separate amino acids, the changes in free energy, total energy and entropy are as follows:
    1. +ΔG, +ΔH, -ΔS
    2. -ΔG, -ΔH, +ΔS
    3. +ΔG, +ΔH, +S
    4. -ΔG, +ΔH, +ΔS
    5. +ΔG, -ΔH, -ΔS
11. For a protein to be an integral membrane protein, it would have to be \_\_\_\_\_\_\_\_\_\_.
    1. Hydrophilic
    2. Hydrophobic
    3. Amphipathic, with at least one hydrophobic region
    4. Exposed on only one surface of the membrane
12. Which of the following statements is correct in comparing sexual and sexual reproduction?
    1. Asexual reproduction, but not sexual reproduction, is characteristic of only plants and fungi.
    2. In asexual reproduction, offspring are produced by fertilization without meiosis
    3. In sexual reproduction, individuals transmit half of their nuclear genes to each of their offspring
    4. Asexual reproduction produces only haploid offspring
13. A carbon atom with an atomic weight of 14 is radioactive. Which of the following subatomic particles establishes the difference in structure between a carbon-14 atom and a nonradioactive carbon12 atom?
    1. proton
    2. electron
    3. neutron
    4. quark
14. Which of the following inheritance patterns describes the ability of a single allele to have multiple phenotypic effects?
    1. Pleiotropy
    2. Incomplete dominance
    3. Multiple alleles
    4. Epistasis
15. Which of the following calculations require the use of the addition rule of probability?
    1. Calculate the probability of black offspring from the cross AaBb x AaBb, where B is the symbol for black
    2. Calculate the probability of children with both cystic fibrosis and polydactyly when parents are each heterozygous for both genes
    3. Calculate the probability of each of four children having cystic fibrosis if the parents are both heterozygous
    4. Calculate the probability of a child having either sickle-cell anemia or cystic fibrosis if parents are each heterozygous for both

**Fill in the blank**

1. Name the type of chemical bond described by each of the statements below.
   1. Connects the two strands of the DNA double helix \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. Strong chemical bond that is formed when a pair of electrons is shared unequally between two atoms \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   3. Chemical bond that connects the atoms of a salt molecule \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   4. Chemical bond that connects water molecules to form the water lattice \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What type of reaction is required to form a peptide bond?