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CELLS AND THE CHEMISTRY OF LIFE

Multiple Choice

- 1) Viruses are made of the same four types of biological molecules as living cells. These include all of the following except
- lipids.
 - capsids.
 - carbohydrates.
 - proteins.
 - nucleic acids.

Text Section: LO5

Key Concept: viruses

Level: Basic fact retention

Answer: B

- 2) The “bead” that allows the HIV particle to attach to and enter cells is
- made of protein.
 - hidden within the virus particle.
 - part of the matrix of the virus.
 - made of RNA.
 - designed to protect the virus’s RNA.

Text Section: LO7

Key Concept: HIV

Level: Basic fact retention

Answer: A

- 3) This element is prominent in both living organisms and in the Earth's surface.
- carbon
 - hydrogen
 - silicon
 - aluminum
 - oxygen

Text Section: LO2

Key Concept: elements

Level: Basic fact retention

Answer: E

- 4) The atomic nucleus consists of
- neutrons and electrons.
 - neutrons only.
 - protons and electrons.
 - neutrons and protons.
 - protons only.

Text Section: LO2

Key Concept: atomic structure

Level: Basic fact retention

Answer: D

- 5) In an atom, the electrons are
- housed within the nucleus.
 - moving through the nucleus.
 - present in various energy shells.
 - usually at rest, but occasionally move.
 - positively charged.

Text Section: LO2

Key Concept: electrons, atomic structure

Level: Basic fact retention

Answer: C

- 6) ^{12}C , ^{13}C , and ^{14}C are all isotopes of carbon. They differ in their
- overall charges.
 - number of electrons.
 - number of protons.
 - number of neutrons.
 - electron energy shells.

Text Section: LO2

Key Concept: isotopes

Level: Basic fact retention

Answer: D

- 7) Because the shared electrons between hydrogen and oxygen spend more time orbiting the oxygen than the hydrogen, water is
- a charged molecule.
 - a neutral molecule.
 - a nonpolar molecule.
 - ionized.
 - a polar molecule.

Text Section: LO3

Key Concept: covalent bond, polar molecules

Level: Basic fact retention

Answer: E

- 8) Rank the following chemical bonds from weakest to strongest:
- hydrogen, ionic, covalent
 - hydrogen, covalent, ionic
 - ionic, hydrogen, covalent
 - ionic, covalent, hydrogen
 - covalent, ionic, hydrogen

Text Section: LO3

Key Concept: chemical bonds

Level: Basic fact retention

Answer: A

- 9) Surface tension of water is due to
- ionic bonding.
 - ionization of water.
 - the ability of water to act as a solvent.
 - hydrogen bonding.
 - water molecules repelling each other.

Text Section: LO4

Key Concept: properties of water, surface tension

Level: Basic fact retention

Answer: D

- 10) The internal pH of most cells is near neutral. This allows
- water to break down into H^+ and OH^- .
 - enzymes within the cells to act at peak efficiency.
 - the buffers produced within the body to affect these cells.
 - enzymes outside of these cells to function.
 - rapid fluctuations between acidic and basic conditions within the cells.

Text Section: LO4

Key Concept: pH of cells

Level: Basic fact retention

Answer: B

- 11) Examples of polysaccharides include all of the following except
- chitin.
 - glycogen.
 - cellulose.
 - sucrose.
 - starch.

Text Section: LO5

Key Concept: polysaccharides

Level: Basic fact retention

Answer: D

- 12) Polypeptides consist of strings of amino acids held together by
- ionic bonds.
 - hydrogen bonds.
 - peptide bonds.
 - double covalent bonds.
 - protein glues.

Text Section: LO5

Key Concept: peptide bonds, polypeptides

Level: Basic fact retention

Answer: C

- 13) Classes of lipids include all of the following except
- phospholipids.
 - fats.
 - waxes.
 - carbohydrates.
 - steroids.

Text Section: LO5

Key Concept: lipids

Level: Basic fact retention

Answer: D

- 14) What method is often used by cells to move large solid material into the cell?
- facilitated diffusion
 - exocytosis
 - simple diffusion
 - active transport
 - phagocytosis

Text Section: LO7

Key Concept: cellular transport, phagocytosis

Level: Basic fact retention

Answer: E

- 15) An atom in which the number of electrons is different from the number of protons is called a(n)
- ion.
 - molecule.
 - compound.
 - isotope.
 - acid.

Text Section: LO2

Key Concept: atomic structure, ions

Level: Basic fact retention

Answer: A

- 16) Kool-Aid readily dissolves in water. This means that Kool-Aid is
- an acid.
 - hydrophilic.
 - hydrophobic.
 - a base.
 - a buffer.

Text Section: LO4

Key Concept: properties of water

Level: Basic fact retention

Answer: B

- 17) With few exceptions, organic compounds are those that contain
- nitrogen.
 - hydrogen.
 - carbon.
 - oxygen.
 - all of the above.

Text Section: LO5

Key Concept: organic compounds

Level: Basic fact retention

Answer: C

- 18) Viruses are not considered to be living things, although they can evolve, and they do have genetic material. However, they
- cannot reproduce on their own.
 - cannot cause disease.
 - possess a molecular structure entirely different from living cells.
 - do not possess DNA.
 - do not possess enzymes.

Text Section: LO1

Key Concept: viral characteristics

Level: Basic fact retention

Answer: A

- 19) Which of the following elements is not particularly abundant in living cells?
- carbon
 - hydrogen

- c. helium
- d. nitrogen
- e. oxygen

Text Section: LO2

Key Concept: common elements

Level: Basic fact retention

Answer: C

- 20) Water is often known as a universal solvent, it dissolves polar molecules as well as
- a. ionic compounds.
 - b. nonionic compounds.
 - c. hydrophobic compounds.
 - d. covalently bonded compounds.
 - e. lipids.

Text Section: LO4

Key Concept: water as a solvent

Level: Basic fact retention

Answer: A

- 21) Because of the atomic structure of carbon, it tends to form
- a. covalent bonds.
 - b. ionic bonds.
 - c. hydrogen bonds.
 - d. sulfide bonds.
 - e. bonds only with hydrogen.

Text Section: LO5

Key Concept: carbon molecules

Level: Basic fact retention

Answer: A

- 22) Most cells are small. When they reach a certain size, cells typically divide. This has to do with the
- a. amount of genetic material.
 - b. surface-to-volume ratio.
 - c. inability to produce more components of the cell membrane.
 - d. fact that they cannot possess sufficient numbers of organelles for normal cell functioning.
 - e. differences between viral particles and eukaryotic cells.

Text Section: LO6

Key Concept: cell size

Level: Basic fact retention

Answer: B

Matching

1) Match the following components of HIV with the correct descriptive term:

1. ___ Enzyme responsible for copying the HIV RNA into a DNA copy
2. ___ The outer portion of the viral particle
3. ___ Enzyme responsible for the replication of viral nucleic acid in the host chromosomal DNA
4. ___ Type of molecule in which HIV genetic information is required
 - A. integrase
 - B. reverse transcriptase
 - C. matrix
 - D. capsid
 - E. envelope
 - F. RNA

Text Section: LO1 – LO8

Key Concept: HIV

Level: Basic fact retention

Answer: 1. b; 2. e; 3. a; 4. f

2) Match the following examples with the correct cellular organelle.

5. ___ These break down carbon-containing molecules to make ATP.
6. ___ Modification of proteins takes place, often determining the final destination for these proteins.
7. ___ Proteins are made on these.
8. ___ The genetic material is stored here.
9. ___ Lipids and phospholipids for the plasma membrane are produced here.
 - A. nucleus
 - B. ribosomes
 - C. Golgi apparatus
 - D. smooth endoplasmic reticulum
 - E. lysosomes
 - F. mitochondria

Text Section: LO7

Key Concept: organelles

Level: Basic fact retention

Answer: 5. f; 6. c; 7. b; 8. a; 9. d

3) Match the following organic compounds with the appropriate subunit.

- 10. ___ proteins
- 11. ___ carbohydrates
- A. fatty acids
- B. amino acids
- C. nucleotides
- D. phosphates
- E. monosaccharides

Text Section: LO5

Key Concept: biological molecules

Level: Basic fact retention

Answer: 10. b; 11. e

4) Match the following descriptions with the appropriate mechanism of transport across the plasma membrane.

- 12. ___ For moving small, water-soluble, organic compounds down their concentration gradient
- 13. ___ For moving very small, inorganic substances down their concentration gradient
- 14. ___ For pumping substances with the expenditure of energy
- 15. ___ For taking up very large particles
- A. active transport
- B. diffusion
- C. exocytosis
- D. facilitated diffusion
- E. phagocytosis

Text Section: LO7

Key Concept: cellular transport

Level: Basic fact retention

Answer: 12. d; 13. b; 14. a; 15. e

5) Match the following characteristics of atoms and molecules with the proper bond.

- 16. ___ Characteristic of sodium and chloride
- 17. ___ Characteristic of a single water molecule
- 18. ___ Characteristic of carbon atoms
- 19. ___ Characteristic of adjacent water molecules
- A. ionic bonds
- B. ribosomes
- C. covalent bonds
- D. hydrogen bonds

Text Section: LO3, LO 5

Key Concept: molecules and bonds

Level: Application of concepts

Answer: 1. d; 2. b; 3. a; 4. c

6) Match the following characteristics or examples of organic molecules with the molecular classification.

- 20. ___ amino acids
- 21. ___ alpha helix
- 22. ___ DNA
 - A. proteins
 - B. nucleic acids
 - C. carbohydrates
 - D. lipids

Text Section: LO5

Key Concept: organic molecules

Level: Basic fact retention

Answer: 20. a; 21. a; 22. b

Integrate and Apply What You've Learned (Short Answer)

1) Although viruses exhibit some of the characteristics that define living organisms, they are considered nonliving. Explain why.

Text Section: LO1

Key Concept: viruses

Level: Application of concepts

Answer: Viruses have a basic internal structure and order based on biological molecules. They have genetic material that can change over time, so they show evolution. Parts of the virus particle can move, showing motility. However, viruses cannot carry out their own metabolism, cannot respond to their environment, and do not exhibit true growth and development.

2) Describe the different distinct forms that regions of proteins can have. Why are these forms so important?

Text Section: LO5

Key Concept: protein structure

Level: Application of concepts

Answer: Alpha-helical protein regions are shaped like a spiral staircase and provide rigidity to the protein. Pleated sheet regions give the protein flat, box-like sides. Connecting these two types of regions are disordered loops. The relative positions of these protein regions determine the protein's unique shape, essential for the function of the protein.

3) Most of a living organism (approximately 98%) is made up of what three elements?

Text Section: LO2

Key Concept: biological molecules

Level: Basic fact retention

Answer: carbon, hydrogen, and oxygen

- 4) Diagram an atom of nitrogen (which consists of 7 protons, 7 neutrons, and 7 electrons). Be sure to indicate in your illustration the relative size, position, and charge of the subatomic particles.

Text Section: LO2

Key Concept: atomic structure

Level: Application of concepts

Answer: The diagram should be circular in nature with a centrally located circular nucleus. The larger, positively charged protons and neutral neutrons should be located inside the nucleus. The very tiny, negatively charged electrons should be located in shells around the nucleus in the following manner: two in the innermost shell, and five in the second shell.

- 5) What causes water molecules to form hydrogen bonds with each other?

Text Section: LO3, LO4

Key Concept: hydrogen bonds, properties of water

Level: Application of concepts

Answer: The covalent bond between the H and the O of the water molecule is polar because the electrons spend more time around the O. Thus the H is left with a slight positive charge. The slightly positive H is attracted to the slight negative charges created by the polar covalent bonds of other molecules. This attraction, by definition, is a hydrogen bond.

- 6) How are the four major types of biological molecules similar in structure?

Text Section: LO5

Key Concept: biological molecules

Level: Application of concepts

Answer: The most obvious answer is that they all have carbon backbones, but it is also important to recognize that they all are made up of repeating subunits linked together by dehydration synthesis.

- 7) The cells that line your small intestine absorb nutrients. Their cell membranes consist of many extensions and folds that project into the open space of the intestine. Why is this cell structure advantageous in the small intestine?

Text Section: LO6

Key Concept: cell surface area

Level: Advanced critical thinking

Answer: The main function of these cells is absorption of nutrients, and the only way to improve the efficiency of this activity is to increase surface area without too much increase in volume. This leads to the evolution of a multitude of thin, narrow folds in the cell membrane.

- 8) Describe the primary components of an atom.

Text Section: LO2

Key Concept: atoms

Level: Basic fact retention

Answer: Atoms are composed of electrons, which are negatively charged and orbit the nucleus of the cell. The nucleus is composed of protons, which are positively charged, and neutrons, which have no charge.

9) What differentiates various atoms?

Text Section: LO 2

Key Concept: atoms

Level: Basic fact retention

Answer: Different atoms have differing numbers of subatomic particles. An oxygen atom, for example has 8 electrons and 8 protons, while a sodium atom has 11 electrons and 11 protons.

10) Name a place in the human body that is particularly acidic. Where are fluids close to neutrality?
Where are fluids in the human body particularly basic?

Text Section: LO4

Key Concept: atoms

Level: Application of concepts

Answer: The stomach produces hydrochloric acid, so the contents of your stomach are quite acidic. However, the pH of your blood and the cytoplasm of your cells are close to neutrality. There is no place in the human body in which the fluids are overly basic (alkaline).

Analyze and Evaluate the Concepts (Essay)

1) The HIV virus can take over much of the cell's machinery to produce many copies of the virus. Two classes of drugs that have been effective against HIV are base analogs (e.g., AZT) and protease inhibitors. How do these work to slow or stop HIV replication? What other steps in the HIV life cycle might be targets for drug development? What else can be done to try to stop the spread of HIV?

Text Section: LO1 – LO8

Key Concept: HIV infection

Level: Advanced critical thinking

Answer: The best responses will include discussions of the following ideas: HIV attachment and movement into the cell; reverse transcription (AZT) and integration of the HIV nucleic acids; production and maturation (protease inhibitors) of viral proteins; assembly of complete viral particles; and continued infection of the population. Possible drugs could target attachment, integration, assembly, and continued infection. The student response to the last question is open but should include discussion of the following topics: education; and means to prevent transmission. Thoughtful answers will discuss the ramifications these changes will have on society and why they have not been implemented or have been ineffective.

2) How are viruses such as HIV similar to living things? How are they different?

Text Section: LO1

Key Concept: viruses

Level: Application of concepts

Answer: The best answers classify viruses according to the major characteristics of life discussed in Chapter 1. Viruses are organized entities made up of the same molecules that make up living things. Viruses contain DNA or RNA that can evolve. Parts of a virus exhibit motility. However, viruses do not carry on metabolism on their own, are unresponsive to environmental stimuli, and lack the ability to reproduce, grow, and develop without the help of a living cell.

- 3) Discuss three physical or chemical properties of water and explain how each of these properties contributes to the importance of water for life on Earth to survive.

Text Section: LO4

Key Concept: properties of water

Level: Advanced critical thinking

Answer: A good answer will include any three of the following five properties and explanations:

- a. Water molecules tend to stick together (hydrogen bonding), which contributes to the flowing nature of water. Most fluids in living things are mainly water, so this flow helps to deliver nutrients (blood), sperm (semen), etc., to the proper location.*
- b. Ice floats. This made it possible for many life-forms to survive the ice ages. As a layer of ice formed on the surfaces of deep bodies of water, the organisms in the water below were protected from the extreme temperatures.*
- c. Water resists changes in temperature. Thus the first organisms that evolved in the Earth's oceans were protected from temperature extremes and rapid temperature fluctuations.*
- d. Water is a universal solvent. This makes it an excellent medium for transporting nutrients.*
- e. Water exhibits a slight tendency to dissociate into hydrogen and hydroxide ions. These ions are very important to many of the reactions involved in metabolism.*

- 4) Think about your favorite kind of pizza. How is your body provided with each of the four major biological molecules when you eat this pizza? Why is it important that your food contains these biological molecules?

Text Section: LO5

Key Concept: biological molecules

Level: Advanced critical thinking

Answer: This is an open-ended question, but the best responses would look something like this:

carbohydrates - from crust

proteins - from meat and cheese

lipids - from fats in the meat and cheese

nucleic acids - from the nuclei of all cells that were once living (meat, vegetables, etc.)

It is important to take in these biological molecules in your diet because they provide energy (especially carbohydrates) and they provide the raw materials necessary for your body to build new tissues for growth, maintenance, and repair.

- 5) Given the half-life of radioactive carbon of 5730 years, if a sample from an archaeological site is analyzed, and it is determined to have 1/4 of the amount of ^{14}C that a living organism would have, describe how you would go about aging this fossil.

Text Section: LO2

Key Concept: radioactive dating

Level: Application of concepts

Answer: If the fossil had 50% of the amount that a living organism would have, it would be 5730 years old. Since this fossil has 25% of the amount that a living organism would have, it would be 11,460 years old (5730 x 2).

- 6) Describe the unique nature of hydrogen bonds, and how this makes water such a unique, and biologically important molecule.

Text Section: LO3

Key Concept: ions

Level: Application of concepts

Answer: Water, with two hydrogen atoms and one oxygen atom, tends to form hydrogen bonds with adjacent water molecules. The slightly electronegative oxygen atom attracts the slightly electropositive hydrogen atom of an adjacent water molecule. These are very important, but very transient bonds. Hydrogen bonding results in many of the unique characteristics of water, such as ice floating and water forming "beads," and is an important component of the structure of DNA. Further, water dissolves polar compounds and most ionic compounds.

- 7) Describe the theme you have learned in this chapter relating to monosaccharides, disaccharides, and polysaccharides. Relate this to what you have learned about lipids and proteins as well.

Text Section: LO5

Key Concept: biological molecules

Level: Application of concepts

Answer: Two monosaccharides may be hooked together to form a disaccharide; a chain of monosaccharides is a polysaccharide. Likewise, the building blocks that form lipids and proteins may exist as a simple molecule, or be hooked together to form long chains.