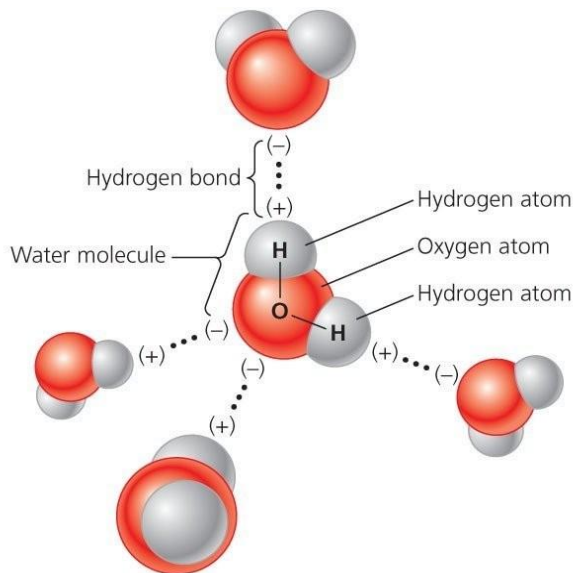


***Environment: Science Behind the Stories, 2e Cdn. Ed. (Withgott)***  
**Chapter 2 Matter, Energy, and the Physical Environment**

**2.1 Graph and Figure Interpretation Questions**



**Figure 2.1**

***Use Figure 2.1 to answer the following questions.***

1) Refer to Figure 2.1. Within the water molecule, \_\_\_\_\_ bonds connect two hydrogens to every oxygen.

- A) polar covalent
- B) nonpolar covalent
- C) hydrogen
- D) ionic
- E) dioric

Answer: A

Diff: 2 Type: MC

Bloom's Taxonomy: 2 - Understanding

Objective: 2.1 Matter

2) Refer to Figure 2.1. Why is one end of each water molecule negative and one end positive?

- A) Oxygen has a greater pull on the electrons than hydrogen.
- B) Oxygen has a greater pull on the protons than hydrogen.
- C) The two hydrogens have a greater pull on the electrons than oxygen.
- D) The two hydrogens have a greater pull on the protons than oxygen.
- E) The hydrogen bonds create a charge difference.

Answer: A

Diff: 3 Type:

Bloom's Taxonomy: 2 - Understanding

Objective: 2.1 Matter

3) Refer to Figure 2.1. What property of water is due to hydrogen bonds?

- A) high pH
- B) low pH
- C) ability to change temperature quickly
- D) ability to dissolve lipids
- E) ability to form droplets

Answer: E

Diff: 3 Type:

Bloom's Taxonomy: 3 - Applying

Objective: 2.1 Matter

4) Refer to Figure 2.1. \_\_\_\_\_ bonds connect adjacent water molecules (hydrogen from one molecule with oxygen of another molecule).

- A) Polar covalent
- B) Nonpolar covalent
- C) Hydrogen
- D) Ionic
- E) Dionic

Answer: C

Diff: 2 Type: MC

Bloom's Taxonomy: 2 - Understanding

Objective: 2.1 Matter

## 2.2 Matching Questions

***Match the following.***

- A) electrons
- B) isotopes
- C) metamorphic
- D) ions
- E) compounds
- F) ionic bond
- G) protons
- H) molecules
- I) atoms
- J) hydrogen bond
- K) sedimentary
- L) covalent bond
- M) neutrons

1) The smallest components of matter that still maintain the chemical properties of the element

Diff: 1 Type: MA

Bloom's Taxonomy: 1 - Remembering

Objective: 2.1 Matter

2) Negatively charged subatomic particles

Diff: 2 Type: MA

Bloom's Taxonomy: 1 - Remembering

Objective: 2.1 Matter

3) Atoms with the same atomic number, but with different atomic masses

Diff: 1 Type: MA

Bloom's Taxonomy: 1 - Remembering

Objective: 2.1 Matter

4) Atoms or molecules with a charge

Diff: 1 Type: MA

Bloom's Taxonomy: 1 - Remembering

Objective: 2.1 Matter

5) Charged subatomic particles located in the nucleus

Diff: 2 Type: MA

Bloom's Taxonomy: 1 - Remembering

Objective: 2.1 Matter

6) Combinations of atoms held together with bonds

Diff: 1 Type: MA

Bloom's Taxonomy: 1 - Remembering

Objective: 2.1 Matter

7) Combinations of atoms of *different* elements held together with bonds

Diff: 3 Type: MA

Bloom's Taxonomy: 1 - Remembering

Objective: 2.1 Matter

8) Bond between atoms sharing electrons equally

Diff: 2 Type: MA

Bloom's Taxonomy: 1 - Remembering

Objective: 2.1 Matter

9) Bond between two atoms of hydrogen that form a molecule of hydrogen gas (H<sub>2</sub>)

Diff: 3 Type: MA

Bloom's Taxonomy: 4 - Analyzing

Objective: 2.1 Matter

10) Rocks that form as soils, minerals, and weathered rock particles are deposited, weighted down, and compressed over time

Diff: 1 Type: MA

Bloom's Taxonomy: 1 - Remembering

Objective: 2.5 Geological systems

Answers: 1) I 2) A 3) B 4) D 5) G 6) H 7) E 8) L 9) L 10) K

### 2.3 Short Answer Questions

1) Briefly explain the concept of plate tectonics and why it is important for the study of geography.

Answer: Plate tectonics make up the processes that move continental plates, underlie earthquakes and volcanoes, create mountain ranges, and shape shorelines. They determine much of the geography of Earth's surface.

Diff: 3 Type: SA

Bloom's Taxonomy: 6 - Synthesizing

Objective: 2.5 Geological systems

2) Earth's surface consists of a lightweight thin \_\_\_\_\_ of rock floating atop a malleable \_\_\_\_\_.

Answer: crust; mantle

Diff: 1 Type: SA

Bloom's Taxonomy: 1 - Remembering

Objective: 2.5 Geological systems

3) The convergent plate boundaries are created by the processes of \_\_\_\_\_ or \_\_\_\_\_.

Answer: subduction; uplift

Diff: 2 Type: SA

Bloom's Taxonomy: 2 - Understanding

Objective: 2.5 Geological systems

4) Name Earth's three major natural power sources.

Answer: The Sun is Earth's primary power source, providing heat and driving wind, waves, and ocean currents. The gravitational pull of the Moon and Sun, which cause ocean tides, is a second power source. A third source is geothermal energy, resulting from heat emanating from the planet's interior. Geothermal energy can warm groundwater and be harnessed for commercial power.

Diff: 2 Type: SA

Bloom's Taxonomy: 2 - Understanding

Objective: 2.4 Photosynthesis, respiration, and chemosynthesis

5) Why does ice float?

Answer: The unique nature of hydrogen bonds creates the crystalline structure of ice. Within this structure molecules of water are further apart than in liquid water, making the density of ice lower than that of water, which is why ice floats.

Diff: 1 Type: SA

Bloom's Taxonomy: 4 - Analyzing

Objective: 2.1 Matter

6) List four categories of geological hazards.

Answer: Earthquakes, tsunamis, volcanic eruptions, and landslides

Diff: 2 Type: SA

Bloom's Taxonomy: 2 - Understanding

Objective: 2.5 Geological systems

7) What is the first law of thermodynamics, and why is it important?

Answer: This law says that the total energy in the universe is constant and conserved. This law is important because it says that there is a finite amount of energy on Earth. Humans cannot make new energy. We can only change its form.

Diff: 1 Type: SA

Bloom's Taxonomy: 2 - Understanding

Objective: 2.3 Energy

8) \_\_\_\_\_ is that which can change the position, physical composition, or temperature of matter.

Answer: Energy

Diff: 3 Type: SA

Bloom's Taxonomy: 4 - Analyzing

Objective: 2.3 Energy

9) Write the balanced chemical equation for photosynthesis.

Answer:  $\text{Light energy} + 6\text{CO}_2 \text{ (carbon dioxide)} + 12\text{H}_2\text{O (water)} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 \text{ (sugar)} + 6\text{O}_2 \text{ (oxygen)} + 6\text{H}_2\text{O (water)}$ ; simplified version:  $\text{Light energy} + 6\text{CO}_2 \text{ (carbon dioxide)} + 6\text{H}_2\text{O (water)} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 \text{ (sugar)} + 6\text{O}_2 \text{ (oxygen)}$

Diff: 3 Type: SA

Bloom's Taxonomy: 1 - Remembering

Objective: 2.4 Photosynthesis, respiration, and chemosynthesis

10) Write the balanced chemical equation for aerobic cellular respiration.

Answer:  $\text{C}_6\text{H}_{12}\text{O}_6$  (sugar) +  $6\text{O}_2$  (oxygen)  $\rightarrow$   $6\text{CO}_2$  (carbon dioxide) +  $6\text{H}_2\text{O}$  (water) + energy (to perform cellular work)

Diff: 3 Type: SA

Bloom's Taxonomy: 1 - Remembering

Objective: 2.4 Photosynthesis, respiration, and chemosynthesis

11) The degree of disorder in a substance, system, or process is called \_\_\_\_\_.

Answer: entropy

Diff: 2 Type: SA

Bloom's Taxonomy: 1 - Remembering

Objective: 2.3 Energy

12) Chemoautotrophs in the deep ocean use the energy contained in \_\_\_\_\_ as their energy source.

Answer: chemical bonds of  $\text{H}_2\text{S}$  (hydrogen sulphide)

Diff: 2 Type: SA

Bloom's Taxonomy: 3 - Applying

Objective: 2.4 Photosynthesis, respiration, and chemosynthesis

## 2.4 Multiple-Choice Questions

1)  $^{12}\text{C}$  and  $^{13}\text{C}$  differ in \_\_\_\_\_.

A) atomic mass

B) ionic number

C) atomic number

D) number of protons

E) number of electrons

Answer: A

Diff: 2 Type: MC

Bloom's Taxonomy: 3 - Applying

Objective: 2.1 Matter

2) \_\_\_\_\_ are composed of amino acids.

A) Proteins

B) Nucleic acids

C) Carbohydrates

D) Lipids

E) Bases

Answer: A

Diff: 2 Type: MC

Bloom's Taxonomy: 1 - Remembering

Objective: 2.2 Macromolecules

3) \_\_\_\_\_ are the primary water-insoluble components of cell membranes.

- A) Proteins
- B) Nucleic acids
- C) Carbohydrates
- D) Acids
- E) Lipids

Answer: E

Diff: 1 Type: MC

Bloom's Taxonomy: 1 - Remembering

Objective: 2.2 Macromolecules

4) Finger nails, hair, and enzymes are classified as \_\_\_\_\_.

- A) proteins
- B) nucleic acids
- C) carbohydrates
- D) lipids
- E) organelles

Answer: A

Diff: 3 Type: MC

Bloom's Taxonomy: 1 - Remembering

Objective: 2.2 Macromolecules

5) A denser oceanic plate subducts underneath another less dense oceanic plate. This \_\_\_\_\_.

- A) creates strike-slip plate boundaries
- B) creates ocean trenches
- C) is caused by volcanoes
- D) occurs when plates pull apart
- E) results in an uplift

Answer: B

Diff: 3 Type: MC

Bloom's Taxonomy: 3 - Applying

Objective: 2.5 Geological systems

6) A sedimentary rock has been subject to extensive compression and increased temperature. The rock is now best described as \_\_\_\_\_.

- A) heat-resistant
- B) igneous
- C) decompressive
- D) metamorphic
- E) deformative

Answer: D

Diff: 1 Type: MC

Bloom's Taxonomy: 3 - Applying

Objective: 2.5 Geological systems

7) Which of the following represents the reaction that provides energy to a human cell?

- A) water + carbon dioxide + energy  $\rightarrow$  glucose + oxygen + water
- B) glucose + oxygen  $\rightarrow$  water + carbon dioxide + energy
- C) water + carbon dioxide  $\rightarrow$  glucose + oxygen + water + energy
- D) nitrogen + carbon dioxide + energy  $\rightarrow$  methane + oxygen
- E) nitrogen + oxygen + glucose  $\rightarrow$  methane + carbon dioxide

Answer: B

Diff: 2 Type: MC

Bloom's Taxonomy: 3 - Applying

Objective: 2.4 Photosynthesis, respiration, and chemosynthesis

8) Which of the following represents the autotrophic processes occurring in the deep ocean vents?

- A) water + carbon dioxide + energy  $\rightarrow$  glucose + oxygen + water
- B) glucose + oxygen  $\rightarrow$  water + carbon dioxide + energy
- C) nitrogen + carbon dioxide + energy  $\rightarrow$  methane + oxygen
- D) glucose + water  $\rightarrow$  methane + carbon dioxide
- E) carbon dioxide + water + hydrogen sulphide  $\rightarrow$  sugar + sulphuric acid

Answer: E

Diff: 2 Type: MC

Bloom's Taxonomy: 3 - Applying

Objective: 2.4 Photosynthesis, respiration, and chemosynthesis

9) The force causing water molecules to adhere to one another in interactions called \_\_\_\_\_.

- A) Van der Waals attractions
- B) polar covalent bonds
- C) nonpolar covalent bonds
- D) acid–base attractions
- E) hydrogen bonds

Answer: E

Diff: 3 Type: MC

Bloom's Taxonomy: 1 - Remembering

Objective: 2.1 Matter

10) Which of the following describes a property of water necessary for life?

- A) changes temperature rapidly
- B) is noncohesive
- C) is more dense as a solid
- D) has high pH
- E) dissolves many chemicals

Answer: E

Diff: 2 Type: MC

Bloom's Taxonomy: 3 - Applying

Objective: 2.1 Matter



11) Precipitation \_\_\_\_\_.

- A) that is acidic has a low concentration of hydrogen ions
- B) that is acidic would have a pH higher than 7
- C) that is acidic would have a pH lower than pure water
- D) that measures pH = 4 is twice as acidic as precipitation that measures pH = 5
- E) has become increasingly more basic in the last 100 years, because of industrial air pollution

Answer: C

Diff: 2 Type: MC

Bloom's Taxonomy: 1 - Remembering

Objective: 2.1 Matter

12) Phytoremediation \_\_\_\_\_.

- A) remediates phytoplankton
- B) uses polycyclic aromatic hydrocarbons found in lemon scented-geranium
- C) increases light penetration in water
- D) uses plants to detoxify soils
- E) increases food supply by making crop photosynthesis more effective

Answer: D

Diff: 3 Type: MC

Bloom's Taxonomy: 1 - Remembering

Objective: 2.1 Fundamentals of environmental chemistry

13) Which of the following is *not* a macromolecule?

- A) DNA
- B) cellulose
- C) glucose
- D) starch
- E) chitin

Answer: C

Diff: 2 Type: MC

Bloom's Taxonomy: 3 - Applying

Objective: 2.2 Macromolecules

14) Which of the following describes lipids?

- A) dissolve in water
- B) include components of the body's immune system
- C) include DNA
- D) are absent from most animal cells
- E) store energy and are in cell membranes

Answer: E

Diff: 2 Type: MC

Bloom's Taxonomy: 2 - Understanding

Objective: 2.2 Macromolecules

15) River water held behind a dam is best described as a form of \_\_\_\_\_.

- A) kinetic energy
- B) potential energy
- C) chemical energy
- D) entropy
- E) thermodynamics

Answer: B

Diff: 1 Type: MC

Bloom's Taxonomy: 1 - Remembering

Objective: 2.3 Energy

16) The sun rises in the morning and shines on your garden. Inside the cells of the vegetables growing in your garden \_\_\_\_\_.

- A) there is not net consumption or production of water
- B) entropy increases
- C) entropy stays the same
- D) oxygen is consumed
- E) water and carbon dioxide are consumed

Answer: E

Diff: 3 Type: MC

Bloom's Taxonomy: 3 - Applying

Objective: 2.4 Photosynthesis, respiration, and chemosynthesis

17) Which of the following is NOT associated with convergent plate boundaries?

- A) Hawaiian volcanic islands
- B) trenches
- C) coastal mountain ranges parallel to the coastline
- D) "ring of fire"
- E) Japanese volcanic islands

Answer: A

Diff: 3 Type: MC

Bloom's Taxonomy: 4 - Analyzing

Objective: 2.5 Geological systems

18) Early Earth (4.5 billion years ago) \_\_\_\_\_.

- A) had more abundant and complex life forms compared to today's Earth
- B) was stagnant and lifeless
- C) was virtually void of oxygen
- D) had a very similar atmosphere to today's Earth but lacked water
- E) had very high levels of oxygen

Answer: C

Diff: 2 Type: MC

Bloom's Taxonomy: 2 - Understanding

Objective: 2.6 Early Earth and the origin of life

19) The \_\_\_\_\_ hypothesis, proposed in the 1930s, says that carbon dioxide, oxygen, and nitrogen dissolved in Earth's water formed simple amino acids and eventually complex organic compounds that self-replicated.

- A) heterotrophic
- B) extraterrestrial
- C) ultraterrestrial
- D) homotrophic
- E) chemoautotrophic

Answer: A

Diff: 2 Type: MC

Bloom's Taxonomy: 2 - Understanding

Objective: 2.6 Early Earth and the origin of life

20) Stanley Miller and Harold Urey did experiments in the early 1950s to prove the \_\_\_\_\_ hypothesis that life evolved from a "primordial soup" of simple inorganic chemicals.

- A) heterotrophic
- B) extraterrestrial
- C) ultraterrestrial
- D) homotrophic
- E) chemoautotrophic

Answer: A

Diff: 2 Type: MC

Bloom's Taxonomy: 2 - Understanding

Objective: 2.6 Early Earth and the origin of life

21) The \_\_\_\_\_ hypothesis, proposed by Svante Arrhenius in the early 1900s, suggests that meteorites delivered life and organic material to Earth.

- A) heterotrophic
- B) extraterrestrial
- C) ultraterrestrial
- D) homotrophic
- E) chemoautotrophic

Answer: B

Diff: 2 Type: MC

Bloom's Taxonomy: 2 - Understanding

Objective: 2.6 Early Earth and the origin of life

22) The \_\_\_\_\_ hypothesis, proposed in the 1970s and 1980s by Jack Corliss and others, suggests that life on Earth originated in the deep sea where sulphur was abundant.

- A) heterotrophic
- B) extraterrestrial
- C) ultraterrestrial
- D) homotrophic
- E) chemoautotrophic

Answer: E

Diff: 2 Type: MC

Bloom's Taxonomy: 2 - Understanding

Objective: 2.6 Early Earth and the origin of life

23) During the night, a plant cell burns sugar to obtain energy. This process \_\_\_\_\_.

- A) releases carbon dioxide and water
- B) releases oxygen and water
- C) represents a decrease in entropy
- D) requires the green pigment chlorophyll
- E) involves a net consumption of water

Answer: A

Diff: 3 Type: MC

Bloom's Taxonomy: 4 - Analyzing

Objective: 2.4 Photosynthesis, respiration, and chemosynthesis

24) Coal, oil, and natural gas are \_\_\_\_\_.

- A) renewable
- B) fossil fuels
- C) part of a sustainable energy future
- D) inorganic
- E) synthetic

Answer: B

Diff: 1 Type: MC

Bloom's Taxonomy: 1 - Remembering

Objective: 2.3 Energy

25) Consider the following processes: respiration, chemosynthesis, combustion, and photosynthesis. How many of these result in the release of oxygen into the atmosphere?

- A) none
- B) 1
- C) 2
- D) 3
- E) 4

Answer: B

Diff: 2 Type: MC

Bloom's Taxonomy: 4 - Analyzing

Objective: 2.4 Photosynthesis, respiration, and chemosynthesis

26) When you burn a log in your fireplace you are converting \_\_\_\_\_.

- A) chemical to thermal (heat) energy
- B) thermal to electromagnetic energy
- C) electromagnetic to chemical energy
- D) chemical to nuclear energy
- E) proteins to amino acids

Answer: A

Diff: 2 Type: MC

Bloom's Taxonomy: 2 - Understanding

Objective: 2.3 Energy

27) Which of the following is NOT associated with divergent plate boundaries?

- A) Hawaiian volcanic islands
- B) rising magma
- C) mid-ocean ridges
- D) new crust
- E) Iceland

Answer: A

Diff: 3 Type: MC

Bloom's Taxonomy: 4 - Analyzing

Objective: 2.5 Geological systems

28) Which is NOT true about basalt?

- A) It is an intrusive rock.
- B) It is the principal rock of the Hawaiian volcanic islands.
- C) It has small crystals.
- D) It cooled rapidly during its formation.
- E) It is the main rock of oceanic crust.

Answer: A

Diff: 3 Type: MC

Bloom's Taxonomy: 4 - Analyzing

Objective: 2.5 Geological systems

29) Which is NOT true about granite?

- A) It is extrusive rock.
- B) It is plutonic rock.
- C) It has a coarse-grained appearance.
- D) It cooled slowly during its formation.
- E) It solidified below Earth's surface.

Answer: A

Diff: 2 Type: MC

Bloom's Taxonomy: 4 - Analyzing

Objective: 2.5 Geological systems

30)  $^{14}\text{C}$  has 6 protons and \_\_\_\_\_.

- A) 8 neutrons
- B) 8 electrons
- C) 6 neutrons
- D) 14 neutrons
- E) 14 electrons

Answer: A

Diff: 2 Type: MC

Bloom's Taxonomy: 3 - Applying

Objective: 2.1 Matter

31) List four samples of freshwater of different temperatures in order of increasing density (with the least dense first and the densest last). All temperatures are in  $^{\circ}\text{C}$ :

- A) -5, 20, 4, 1
- B) 20, 4, 1, -5
- C) 20, 1, 4, -5
- D) -5, 1, 4, 20
- E) -5, 20, 1, 4

Answer: E

Diff: 3 Type: MC

Bloom's Taxonomy: 3 - Applying

Objective: 2.1 Matter

## 2.5 True/False Questions

1) The heterotrophic hypothesis for the origin of life on Earth argues that the first life forms to evolve were heterotrophs living in deep-ocean vents.

Answer: FALSE

Diff: 2 Type: TF

Bloom's Taxonomy: 4 - Analyzing

Objective: 2.6 Early Earth and the origin of life

2) The chemoautotrophic hypothesis is also known as the panspermia hypothesis.

Answer: FALSE

Diff: 2 Type: TF

Bloom's Taxonomy: 1 - Remembering

Objective: 2.6 Early Earth and the origin of life

3) All landmasses were once joined together in a supercontinent called Pangaea.

Answer: TRUE

Diff: 1 Type: TF

Bloom's Taxonomy: 1 - Remembering

Objective: 2.5 Geological systems

4) Japan is a product of a continental collision.

Answer: FALSE

Diff: 1 Type: TF

Bloom's Taxonomy: 3 - Applying

Objective: 2.5 Geological systems

5) Bacteria in deep-sea vents use the chemical bond energy in water molecules to transform inorganic compounds into organic compounds in a process called chemosynthesis.

Answer: FALSE

Diff: 3 Type: TF

Bloom's Taxonomy: 3 - Applying

Objective: 2.4 Photosynthesis, respiration, and chemosynthesis

6) The Murchison meteorite, which fell in Australia in 1969, was found to contain bacteria.

Answer: FALSE

Diff: 3 Type: TF

Bloom's Taxonomy: 1 - Remembering

Objective: 2.6 Early Earth and the origin of life

7) Mariana Trench, Earth's deepest abyss, was created at a transform plate boundary.

Answer: FALSE

Diff: 3 Type: TF

Bloom's Taxonomy: 3 - Applying

Objective: 2.5 Geological systems

## 2.6 Essay Questions

1) Describe the rock cycle, explaining how the three major types of rock form and break down.

Answer: All rocks can melt. At sufficiently high temperatures, liquid rock occurs, called magma. Magma may cool back into rock underground or may be released above ground through a volcano or vent in the form of ash or lava, which may then cool into rock on Earth's surface. Rock formed from the various types of magma is called igneous rock. Igneous rock can also be altered by heat and pressure into a metamorphic rock. Alternatively, over time, wind, weather, and physical damage can erode rock into gravel, sand, silt, and clay particles.

The material from igneous or metamorphic rocks that have been broken into small components, can be transported and deposited, often in or along water features, in layers. Over time, these are compressed into layered rock, called sedimentary rock. These, too, can erode back into smaller fragments.

Igneous or sedimentary rock buried underground and exposed to extreme forces of heat or pressure can change form into metamorphic rock, which may be quite different from its original form. It, in turn, may be subject to erosion or melting.

Diff: 3 Type: ES

Bloom's Taxonomy: 2 - Understanding

Objective: 2.5 Geological systems

2) List the four types of macromolecules essential to life. Describe the structures of each, and describe their major role(s) in organisms.

Answer: Carbohydrates are made of carbon, hydrogen, and oxygen and have the general formula  $\text{CH}_2\text{O}$ . Carbon and water exist in a 1:1 ratio. They are the primary components of cell walls and are the preferred energy source for many organisms.

Proteins are chains of amino acids (amine group + carboxyl group + central carbon). They are primarily structural molecules. They are blood transporters, aid in the function of the immune system, and promote metabolic reactions. All enzymes are proteins.

Nucleic acids are made of chains of nucleotides (phosphate + sugar + nitrogenous bases). They carry genetic information needed to synthesize proteins. They also pass genetic traits from generation to generation.

Lipids are long chains or rings of hydrogen and carbon. They can store high amounts of energy, and are the primary components of cell membranes. Lipids also include the steroid hormones, which regulate sexual function in animals.

Diff: 3 Type: ES

Bloom's Taxonomy: 6 - Synthesizing

Objective: 2.2 Macromolecules

3) Describe the first and second laws of thermodynamics. Illustrate both laws by using an example of a burning log of firewood.

Answer: The first law states that energy can change from one form to another, but it cannot be created or destroyed. Therefore, total energy in the universe remains constant. The second law states that the form of energy in the universe will change from a more ordered to a less ordered one. In every transfer of energy some of the energy is converted into a more disorganized, and, therefore, less usable form. Entropy, a measure of disorder, is increasing at the scale of the universe, as energy is converted from high to low quality. When a firewood log is burned, the complex biological polymers that make up the wood are converted, with the help of oxygen, into simpler molecules of carbon dioxide and water, and into carbon ash and smoke. The sum of the energy contained in the chemical bonds of wood polymers making up the log before burning is equal to the sum of the energy contained in the products of the burning, and in the heat and light of the fire (the first law). However, the energy contained in the log was much more organized, and more usable, than the heat, light, and chemical energy of the molecules created by the burning (the second law).

Diff: 3 Type: ES

Bloom's Taxonomy: 3 - Applying

Objective: 2.3 Energy



4) Explain why chemistry is important in examining environmental issues and solving environmental problems. Illustrate with examples of such issues/problems.

Answer: Chemistry shows us how various components of our environment combine, separate, and recombine in different forms, as well as what drives these transformations. Given this, chemistry is crucial to an understanding of how gases such as carbon dioxide and methane contribute to global climate change, how pollutants such as sulphur dioxide and nitric oxides cause acid rain, and how pesticides and other artificial compounds we release into the environment affect the health of wildlife and people. Chemistry is central in understanding water pollution and sewage treatment, atmospheric ozone depletion, hazardous waste and its disposal, and energy issues.

Diff: 2 Type: ES

Bloom's Taxonomy: 6 - Synthesizing

Objective: 2.1 Matter

5) Summarize the heterotrophic hypothesis, the extraterrestrial hypothesis, and the chemoautotrophic hypothesis for the development of life on Earth.

Answer: The heterotrophic or "primordial soup" hypothesis states that life evolved from simple inorganic chemicals—carbon dioxide, oxygen, and nitrogen—dissolved in the surface waters of the oceans or tidal shallows around oceanic margins. Simple amino acids may have formed under these conditions, and more complex organic compounds may have followed, including nucleic acids that could replicate and give rise to basic forms of life. It is called the heterotrophic hypothesis because it argues that heterotrophs evolved first. The extraterrestrial hypothesis is similar, but suggests that early chemical reactions on Earth may have received help from outer space. Bacteria from space may have been deposited on meteorites that crashed to Earth, seeding our planet. The chemoautotrophic hypothesis suggests that early life was formed by chemoautotrophs that derived their energy from the chemical energy contained in the sulphur compounds abundant in the hot deep-sea vents.

Diff: 3 Type: ES

Bloom's Taxonomy: 2 - Understanding

Objective: 2.6 Early Earth and the origin of life

6) Compare the processes of photosynthesis and cellular respiration. Include a brief explanation of autotrophs and heterotrophs in your answer.

Answer: Photosynthesis is performed by photoautotrophs. In photosynthesis, light energy is converted into chemical energy of high-energy molecules (ATP and NADPH), and this chemical energy can be then stored within the bonds of glucose (the Calvin cycle). In photosynthesis, water and carbon dioxide are consumed, and oxygen is released as a by-product. Cellular respiration is the reverse of the photosynthesis: oxygen is consumed, and the bonds of glucose are broken to release energy (which is then used for work within the cell). The by-products of respiration are carbon dioxide and water. Cellular respiration is performed by both autotrophs (primary producers) and heterotrophs (consumers) to meet their energy needs.

Diff: 3 Type: ES

Bloom's Taxonomy: 5 - Evaluating

Objective: 2.4 Photosynthesis, respiration, and chemosynthesis

7) Explain how isotopes are used in environmental science and provide an example from your text.

Answer: Isotopes are powerful instruments for environmental scientists. There are two groups of isotopes: radioactive and stable. The radioactivity of the former allows them to be quantified and traced. They emit energy that can be traced inside organisms (to follow metabolic pathways, such as photosynthesis). Because radioactive isotopes emit a measurable quantity of radiation and decay over time (according to their half-life), they can be also used to date organic materials such as human remains, grain, shells, tissues of ancient animals, and fossils. We can learn about ancient cultures and Earth's history from them. The text gives an example of the radioactive isotope  $^{14}\text{C}$ . Scientists date fossils, human remains, foodstuffs, and other carbon-containing items by measuring the percentage of  $^{14}\text{C}$ . Stable isotopes do not emit radiation but are useful because their relative abundance can be enriched or depleted by various biological and physical processes, so by measuring the ratios of the stable isotopes in organisms and environment we can learn about these processes. The text examples are the ratios of stable isotopes of  $^{12}\text{C}$  and  $^{13}\text{C}$ , which are used to study ecological pathways (food chains), and, together with  $^2\text{H}$  and  $^1\text{H}$ , are used to study past climates and geographic origin and migrations of animals.

Diff: 3 Type: ES

Bloom's Taxonomy: 6 - Synthesizing

Objective: 2.1 Matter

8) Describe several properties of water that explain why the lakes in Canada typically do not freeze all the way to the bottom even during extremely long and cold winters.

Answer: Water has high heat capacity, which means that it takes a lot of winter cooling to lower water temperature.

Density of liquid (fresh) water reaches its maximum at  $4^\circ\text{C}$ , which means that as the water cools below  $4^\circ\text{C}$ , the coldest water stays close to the surface, preventing the cold from penetrating into deep layers of the lake, and promoting formation of ice on the surface, which insulates the water from frigid air.

Ice is less dense than liquid water, so when it forms, it floats, creating an insulating layer.

Diff: 3 Type: ES

Bloom's Taxonomy: 5 - Evaluating

Objective: 2.1 Matter

## 2.7 Scenario-Based Questions

***Read the following scenario and answer the questions below.***

Almost all environmental scientists agree that gases contribute to global climate change. Carbon dioxide, methane, nitrous oxide, ozone, halocarbons (CFCs and HFCs), and water vapour are the main culprits. These "greenhouse gases" have increased dramatically in our atmosphere in the last 300 years, because of rapid industrialization. Human activities significantly increase greenhouse gases in our atmosphere. Chief among these is the burning of fossil fuels for energy. When we burn fossil fuels, we combine the carbon in fossil remnants of an organic matter with oxygen and release the resulting gasses into the atmosphere. With rising standards of living in developing countries, emissions of carbon dioxide and other greenhouse gases are expected to continue to rise. If unchecked, it is predicted that carbon dioxide levels will reach twice preindustrial levels by mid-century and double again by the end of the century. Computer models have shown that this increase alone could raise Earth's temperatures by 1 to 3°C by 2100.

1) The burning of fossil fuels is chemically most similar to which of the following biological processes?

- A) phytoremediation
- B) autotrophy
- C) chemosynthesis
- D) cellular respiration
- E) photosynthesis

Answer: D

Diff: 1 Type: MC

Bloom's Taxonomy: 3 - Applying

Objective: 2.4 Photosynthesis, respiration, and chemosynthesis

2) Nitrous oxide from burning fossil fuels, in addition to being a greenhouse gas, contributes to acid precipitation. This can be explained by \_\_\_\_\_.

- A) its ability to form compounds that raise pH
- B) its ability to form compounds that lower pH
- C) the ability of acids to raise the temperature of the substances which dissolve them
- D) the airborne nature of all compounds containing nitrogen
- E) the hydrogen bonds connecting the nitrogen and oxygen atoms in the molecule

Answer: B

Diff: 1 Type: MC

Bloom's Taxonomy: 3 - Applying

Objective: 2.1 Matter

3) Overpopulation contributes to global warming when \_\_\_\_\_.

- A) most of the population is vegetarian
- B) there is also greater consumption of natural resources
- C) we compromise our living standards
- D) most people use public transportation
- E) solar energy is used as the primary source of energy

Answer: B

Diff: 1 Type: MC

Bloom's Taxonomy: 2 - Understanding

Objective: 2.4 Photosynthesis, respiration, and chemosynthesis

4) The primary source of increased levels of greenhouse gases on Earth is \_\_\_\_\_.

- A) increased photosynthetic activity
- B) loss of heterotrophs
- C) modern human lifestyles
- D) aerosol spray cans
- E) asteroids falling to Earth

Answer: C

Diff: 2 Type: MC

Bloom's Taxonomy: 3 - Applying

Objective: 2.4 Photosynthesis, respiration, and chemosynthesis

5) Why does burning fossil fuels increase global warming?

- A) Fossils, if left untouched, cool Earth.
- B) New energy is created on Earth when fossil fuels are burned.
- C) Burning fossil fuels destroys the ozone layer.
- D) Carbon present in coal, oil, and natural gas becomes carbon dioxide when these fuels burn.
- E) Burning fossil fuels removes water vapour from the atmosphere.

Answer: D

Diff: 1 Type: MC

Bloom's Taxonomy: 3 - Applying

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