

Name: \_\_\_\_\_

Date: \_\_\_\_\_

## Station 1- Characteristics of Life

1. What are the 8 characteristics of Life:

- |    |    |
|----|----|
| a. | e. |
| b. | f. |
| c. | g. |
| d. | h. |

2. What does it mean to be a unicellular organism? \_\_\_\_\_

3. What does it mean to be a multicellular organism? \_\_\_\_\_

4. What is a prokaryote? \_\_\_\_\_

5. What is a eukaryote? \_\_\_\_\_

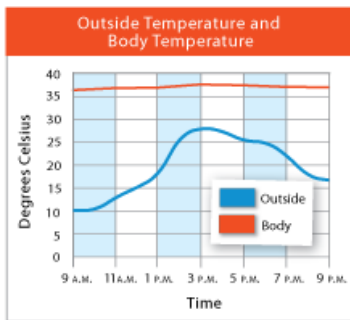
6. What are the 2 types of reproduction? What is the difference between the 2?

7. What is DNA?

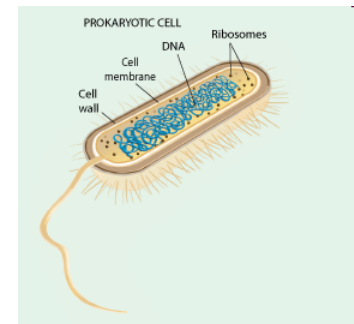
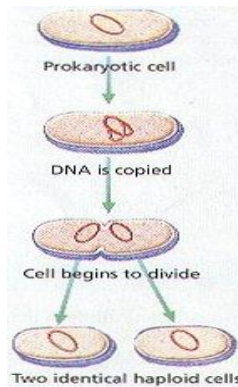
8. What is the difference between growth and development?

9. What is homeostasis? Provide an example of how an organism maintains homeostasis?

10. Look at the images below. Each one is related to a characteristic of life. Some images may be related to more than one characteristic of life. See if you can match at least one characteristic of life to each image:



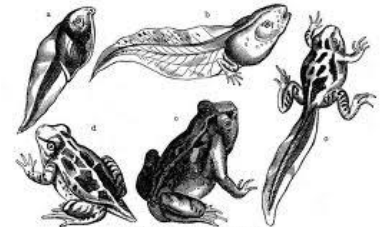
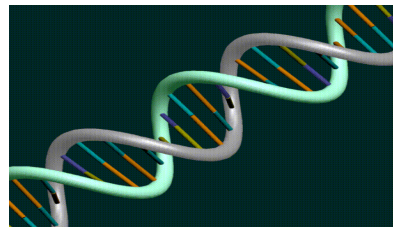
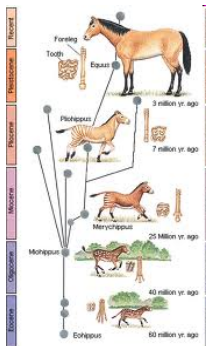
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A. \_\_\_\_\_

B. \_\_\_\_\_

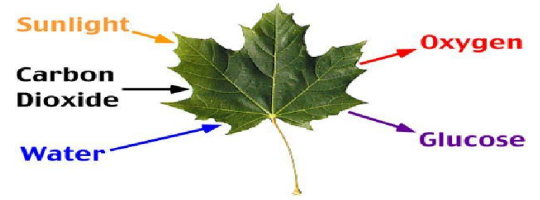
C. \_\_\_\_\_



D. \_\_\_\_\_

E. \_\_\_\_\_

F. \_\_\_\_\_



G. \_\_\_\_\_

H. \_\_\_\_\_

### Open- Ended Questions

Structure and function is a central theme to the study of biology. Each major group of organisms has evolved its own particular body part “tool kit” – a collection of structures that have evolved in ways that make particular functions possible. From capturing food to digesting it, and from reproducing to breathing, organisms use structures that have evolved into different forms as species have adapted to life in different environments. The structure of wings, for example enable birds and insects to fly. The structures of legs enable horses to gallop and kangaroos to hop.

1. Think about your own teeth. What kinds of foods do you think human teeth are suited for?
2. List at least three ways the structure of human teeth serve the function of eating meat and plant material.

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3. Now, last but not least apply the theme of structure and function to something you’re very familiar with - your hands. List out all the ways you can think of that the structure of your hands serve the function of your hands. Hint – you are a primate!

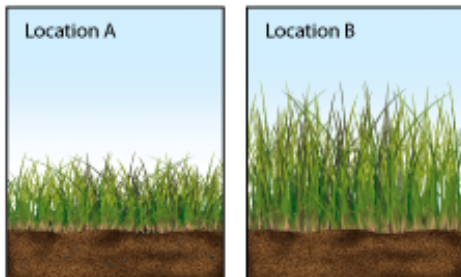
4. **Biological Levels of Organization**→ Rate the following levels from smallest to largest.

Organ Systems      Organs      Cells      Organisms      Tissues

### 5. Scientific Method/Scientific Terms:

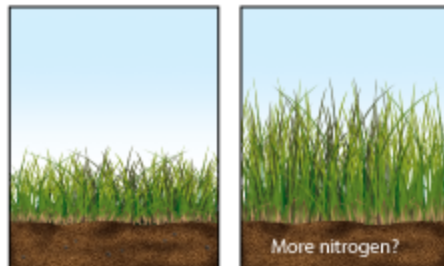
The scenes below show the steps involved in the scientific method read through the experimental scenario and answer the questions below.

#### OBSERVING AND ASKING QUESTIONS



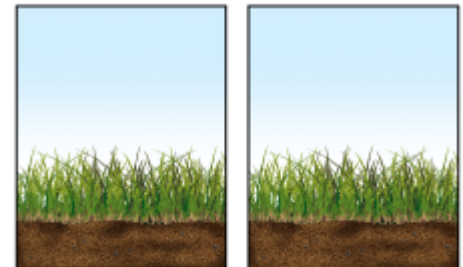
Researchers observed that marsh grass grows taller in some places than others. This observation led to a question: *Why do marsh grasses grow to different heights in different places?*

#### INFERRING AND HYPOTHESIZING



The researchers inferred that something limits grass growth in some places. It could be any environmental factor—temperature, sunlight, water, or nutrients. Based on their knowledge of salt marshes, they proposed a hypothesis: *Marsh grass growth is limited by available nitrogen.*

#### DESIGNING CONTROLLED EXPERIMENTS



The researchers selected similar plots of marsh grass. All plots had similar plant density, soil type, input of freshwater, and height above average tide level. The plots were divided into control and experimental groups.

DESIGNING CONTROLLED EXPERIMENTS cont.

COLLECTING AND ANALYZING DATA

DRAWING CONCLUSIONS

- A. Based on the scenario what is the difference between a hypothesis and an inference?
- B. How did the control group differ from the experimental group?
- C. What were the dependent and independent variables?
- D. What was the observation that started the research?

6. In science the word **theory** applies to a well-tested explanation that unifies a broad range of observations and hypotheses and that enables scientists to make accurate predictions about new situations

A **hypothesis** is a scientific explanation for a set of observations that can be tested in ways that support or reject it.

*Identify whether each statement is a hypothesis or a theory. For a hypothesis, write an "H" on the line. For a theory, write a "T."*

- \_\_\_\_\_ A. The rate that grass grows is related to the amount of light it receives. \_\_\_\_\_
- \_\_\_\_\_ B. All life is related and descended from a common ancestor. \_\_\_\_\_
- \_\_\_\_\_ C. The universe began about 15 billion years ago. \_\_\_\_\_
- \_\_\_\_\_ D. New tennis balls bounce higher than old tennis balls. \_\_\_\_\_
- \_\_\_\_\_ E. Caffeine raises blood pressure. \_\_\_\_\_

### Keystone Assessed Questions

1. **Which characteristic is shared by all prokaryotes and eukaryotes?**
  - a. ability to store hereditary information
  - b. use of organelles to control cell processes
  - c. use of cellular respiration for energy release
  - d. ability to move in response to environmental stimuli
2. **Living organisms can be classified as prokaryotes or eukaryotes. Which two structures are common to both prokaryotic and eukaryotic cells?**
  - a. cell wall and nucleus
  - b. cell wall and chloroplast
  - c. plasma membrane and nucleus
  - d. plasma membrane and cytoplasm
3. **Alveoli are microscopic air sacs in the lungs of mammals. Which statement best describes how the structure of the alveoli allows the lungs to function properly?**
  - a. They increase the amount of energy transferred from the lungs to the blood.
  - b. They increase the flexibility of the lungs as they expand during inhalation.
  - c. They increase the volume of the lungs, allowing more oxygen to be inhaled.
  - d. They increase the surface area of the lungs, allowing efficient gas exchange.
4. **Which example is an activity that a fish most likely uses to maintain homeostasis within its body?**

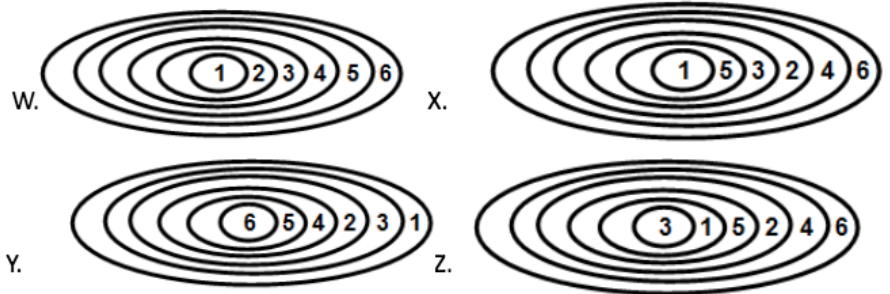
- a. using camouflage to avoid predators
- b. feeding at night to regulate body temperature
- c. moving to deeper water to regulate metabolic wastes
- d. exchanging gases through its gills to regulate oxygen levels

5. Which statement best describes an effect of the low density of frozen water in a lake?

- a. When water freezes, it contracts, decreasing the water level in a lake.
- b. Water in a lake freezes from the bottom up, killing most aquatic organisms.
- c. When water in a lake freezes, it floats, providing insulation for organisms below.
- d. Water removes thermal energy from the land around a lake, causing the lake to freeze

6. Which diagram best represents the relationship of the items in the list below?

- 1. Cell
- 2. Organ
- 3. Organelle
- 4. Organ system
- 5. Tissue
- 6. Whole organism



- A. X
- B. Y
- C. Z
- D. W

## Station 2- Cells and Cellular Organization

Complete the following table by writing the name of the cell part or organelle in the right hand column that matches the structure/function in the left hand column. A cell part may be used more than once.

Structure/Function	Cell Part
Membrane bound structures found in eukaryotic cells which have a specific function	
Stacked, flattened sacs – modifies and packages proteins for exit out of the cell	
The sites of protein synthesis	
Transports proteins within the cell	
The region inside the cell except for the nucleus	
Organelle that manages or controls all the cell functions in a eukaryotic cell. Houses the cells DNA	
Contains chlorophyll, a green pigment that traps energy from sunlight and gives plants their green color	
Digests excess or worn-out cell parts, food particles and invading viruses or bacteria	
Organelle that produces lipids and detoxifies cell	
Rigid, protective structure that gives the cell its shape in plants, fungi, most bacteria and some protists	
Powerhouse of the cell -Produces a usable form of energy for the cell- ATP	

Stores water, large, found in plant cells	
Site where ribosomes are made	
The membrane surrounding the cell, composed of phospholipid bilayer with proteins embedded in it	
Provides support for the cell,	
DNA in the nucleus of eukaryotic cells, thin and threadlike, seen in a <b>non-dividing cell</b>	
Small hair-like structures used for movement or sensing things	
Condensed and coiled DNA in a dividing cell	
Longer whip-like structures used for movement	

Put a check in the appropriate column(s) to indicate whether the following organelles are found in plant cells, animal cells or both

Organelle	Plant Cells	Animal Cells
Cell Wall		
Vesicle		
Chloroplast		
Chromatin		
Cytoplasm		
Cytoskeleton		
Endoplasmic reticulum		
Golgi apparatus		

Organelle	Plant cells	Animal Cells
Lysosome		
Mitochondria		
Nucleolus		
Nucleus		
Plasma membrane		
Central vacuole		
Ribosome		
Vacuole		

### Keystone Released Questions

1. Which characteristic is shared by **all** prokaryotes and eukaryotes?

- a. Ability to store hereditary information
- b. Use of organelles to control cell processes
- c. Use of cellular respiration for energy release
- d. Ability to move in response to environmental stimuli

2. Living organisms can be classified as prokaryotes or eukaryotes. Which two structures are common to both prokaryotic and eukaryotic cells?

- a. Cell wall and nucleus
- b. Cell wall and chloroplast
- c. plasma membrane and nucleus
- d. plasma membrane and cytoplasm

**3. Prokaryotic cells are generally much smaller than eukaryotic cells.**

**Part A:** Identify a structural difference between prokaryotic cells and eukaryotic cells that is directly related to their difference in size.

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**Part B:** Based on structural difference, explain why prokaryotic cells can be much smaller than eukaryotic cells.

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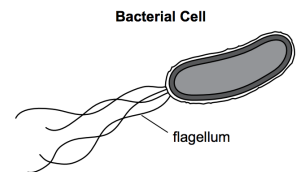
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**Part C:** Describe one Similarity between prokaryotic cells and eukaryotic cells that is independent of size.

4. Alveoli are microscopic air sacs in the lungs of mammals. Which statement **best** describes how the structure of the alveoli allows the lungs to function properly?

- A. They increase the amount of energy transferred from the lungs to the blood
- B. They increase the flexibility of the lungs as they expand during inhalation.
- C. They increase the volume of the lungs, allowing more oxygen to be inhaled.
- D. They increase the surface area of the lungs, allowing efficient gas exchange.

5. Use the diagram at the right to answer the question. A scientist observes a single-celled organism with several long, whip-like tails. Which function do the whip-like tails **most likely** perform for the organism?

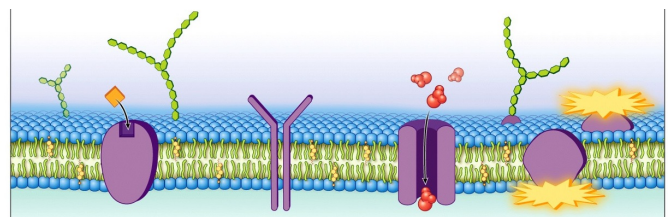


- a. Defense against predators
- b. Movement through an environment
- c. Detection of the location of a light source
- d. Measurement of atmospheric temperature changes

6. Living organisms can be classified as prokaryotes or eukaryotes. Which two structures are common to both prokaryotic and eukaryotic cells?

- a. Cell wall and nucleus
- b. Cell wall and chloroplast
- c. Plasma membrane and nucleus
- d. Plasma membrane and cytoplasm

Look at the image above: Identify its structure and function.



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**A new  
type of**

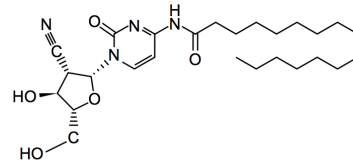
**12.** In order for medicine X to produce the effects that the researchers observed, it must have entered into which part of the targeted cells?

- A. nucleus
- B. ribosomes
- C. Golgi apparatus
- D. rough endoplasmic reticulum

**treatment:** Some human diseases involve the unregulated growth of cells. Although some patients are not affected by these growths, many are harmed. Cells in harmful growths divide uncontrollably and can eventually invade other cells, tissues and organs of the body. Some patients carry a mutation on one or more growth suppressor genes (GSGs). GSGs help to repair damage to DNA. This mutation decreases an individual's ability to fight these harmful growths. Recently researchers reported on the results of using a combination of two types of medicine to treat patients with unregulated growths caused by a lack of functioning GSGs. When medicine "X" and "Y" are used together they cause the cell processes in the targeted cell to fail. In order for medicine X to produce the effects that the researchers observed, it must have entered into which part of the targeted cells?

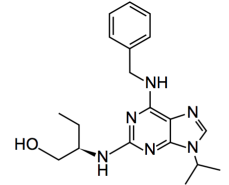
Characteristics of Medicine X

- large molecule
- damages DNA



Characteristics of Medicine Y

- large molecule
- decreases enzyme activity



- a. Nucleus      b. Endoplasmic reticulum      c. golgi apparatus      d. Ribosomes

Use the list below to answer the question.

**Cell Structures**

- plasma membrane
- endoplasmic reticulum
- Golgi apparatus
- mitochondria
- nucleus
- ribosomes

A scientist identifies several structures in a cell and organizes them in a list.

**Part A:** Describe how the cell structures in this list can be used to classify the cell as either **prokaryotic or eukaryotic**. Use examples of the structures that would help identify the cell in your answer.

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**Part B:** Compare how **both** prokaryotes and eukaryotes use two of the cell structures listed and describe the common functions of these structures.

**Structure 1:** \_\_\_\_\_

**Common Function:** \_\_\_\_\_

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**Structure 2:** \_\_\_\_\_

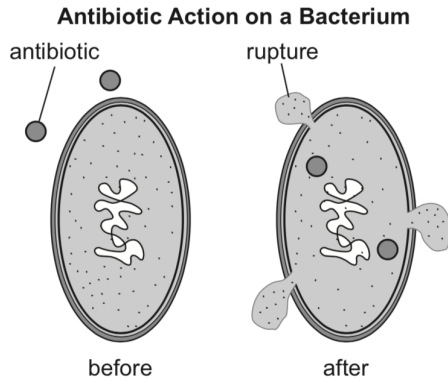
**Common Function:** \_\_\_\_\_

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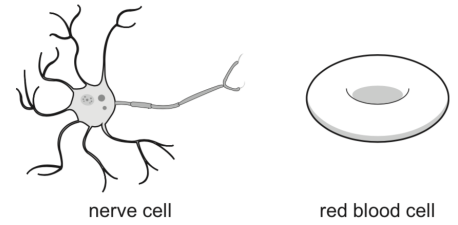
## Bacteria and Antibiotics

Bacteria are single-celled microorganisms. The cell walls of these microorganisms serve as barriers to chemicals that might affect the processes that occur within a bacterial cell. Antibiotics are a type of substance used to stop bacterial growth. Some antibiotics cause the bacterial cell wall to rupture.



How to answer question 2.

## Body Cells



What explains why these cells have structural differences?  
different functions.  
found in different organisms.  
one develops into the other type of cell.  
one is more primitive than the other cell.

The function of which human organ is **most like** the cell walls of bacteria?

- a. Skin
- b. Liver
- c. Heart
- d. Pancreas

A group of students is given a sample of an unknown substance. The students are asked to gather evidence to determine whether the substance is living or nonliving. The students take a small sample of the substance and observe it using a microscope.

**Part A:** Describe two characteristics of the substance that could be observed to indicate whether it is living or nonliving.  
**Characteristic 1:**

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**Characteristic 2:**

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**Part B:** Describe an investigation that could be performed to classify the substance as living or nonliving

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### Station 3- Macromolecules

1. Define and illustrate an ionic and covalent bond:
  
2. What does it mean for a compound to be organic?
  
3. Water is (circle one) **polar** / **nonpolar** because the electrons are not evenly shared. Draw 2 water molecules and label a covalent and hydrogen bond.
  
4. Explain the following properties of water and how they are important to living things:  
 Universal solvent: \_\_\_\_\_  
 Specific Heat: \_\_\_\_\_  
 Cohesion: \_\_\_\_\_  
 Adhesion: \_\_\_\_\_  
 Capillary action: \_\_\_\_\_  
 Polarity: \_\_\_\_\_
5. What is the difference between a monomer and polymer?
  
6. Dehydration synthesis \_\_\_\_\_ water to \_\_\_\_\_ a bond, while hydrolysis \_\_\_\_\_ water to \_\_\_\_\_ a bond.  
 Draw 2 amino acids and illustrate dehydration synthesis.
  
7. Carbohydrates have a \_\_\_\_: \_\_\_\_: \_\_\_\_ ratio of C:H:O. Carbohydrates are the main \_\_\_\_\_ source for a cell.
8. What are the two monomers of lipids? \_\_\_\_\_
9. Lipids make up the majority of the cell \_\_\_\_\_
10. What are the monomers of a protein? \_\_\_\_\_.
11. Compared to most other substances, a great deal of heat is needed to raise the temperature of water by a given amount. This is because water:
  - A. is an acid
  - B. readily forms solutions
  - C. has a high heat capacity
  - D. acts as a buffer
12. Frozen water is less dense than liquid water. Explain why this is important for aquatic organisms.
  
13. Define Macromolecules:

Macromolecule	Elements	monomer (building block)	Draw the monomer	Function/s List All!	Examples
Carbohydrates Frequently ends in - _____					

Lipids					
Proteins Enzymes end in _____					
Nucleic Acids					

18. What occurs during a chemical reaction?
19. What is the difference between a product and a reactant?
20. Energy is used differently in different types of chemical reactions. Explain how energy use differs in energy-releasing and energy-absorbing reactions.
21. How is energy related to the products and reactants of a chemical reaction?
22. What is the role of an enzyme in living organisms? Explain enzyme specificity. Give example.
23. . In what way do enzymes/catalysts increase the rate of reactions? How do enzymes accomplish this task?
23. Describe the relationship between enzymes and substrate.
24. How/Why is the structure of an enzyme so important to its function in living things? Why does the structure of an enzyme determine the type of reaction it will catalyze?
25. What happens to enzyme function when the temperature or pH conditions change? Why?
26. The energy needed to get a reaction started is the:  
A. adhesion energy   B. cohesion energy   C. activation energy   D. chemical energy

**Keystone released questions**

1. Which statement correctly describes how carbon's ability to form four bonds makes it uniquely suited to form macromolecules?
  - a. It forms short, simple carbon chains.
  - b. It forms large, complex, diverse molecules.
  - c. It forms covalent bonds with other carbon atoms.
  - c. It forms covalent bonds that can exist in a single plane.
2. The diagram shows a reaction that forms a polymer from two monomers. What is this type of reaction called?
 

*Use the diagram below to answer the question.*

**Chemical Reaction**

$\text{HO}-\textcircled{1}-\textcircled{2}-\textcircled{3}-\text{H} + \text{HO}-\textcircled{4}-\text{H}$

$\text{HO}-\textcircled{1}-\textcircled{2}-\textcircled{3}-\textcircled{4}-\text{H} + \text{H}_2\text{O}$

  - A. glycolysis                      B. hydrolysis
  - C. photosynthesis                D. dehydration synthesis
3. Carbohydrates and proteins are two types of macromolecules. Which functional characteristic of proteins distinguishes them from carbohydrates?

- A. large amount of stored information
- B. efficient storage of usable chemical energy

- C. ability to catalyze biochemical reactions
- D. tendency to make cell membranes hydrophobic

4. Substance A is converted to substance B in a metabolic reaction. Which statement **best** describes the role of an enzyme during this reaction?

- A. It adjusts the pH of the reaction medium.
- B. It dissolves substance A in the reaction medium.
- C. It provides energy to carry out the reaction.
- D. It speeds up the reaction without being consumed.

5. A scientist observes that, when the pH of the environment surrounding an enzyme is changed, the rate the enzyme catalyzes a reaction greatly decreases. Which statement **best** describes how a change in pH can affect an enzyme?

- A. A pH change can cause the enzyme to change its shape.
- B. A pH change can remove energy necessary to activate an enzyme.
- C. A pH change can add new molecules to the structure of the enzyme.
- D. A pH change can cause an enzyme to react with a different substrate.

6. Whenever biological organic compounds, such as proteins and carbohydrates, are broken down or synthesized...

- b. a phase change of matter results.
- c. thermal expansion occurs.
- d. sunlight is required.
- e. energy is absorbed or released.

7. Why does an enzyme function as a catalyst in a reaction?

- f. It creates the right pH needed for the reaction.
- g. It decreases the amount of energy needed for the reaction.
- h. It provides the extra energy needed for the reaction.
- i. It maintains the proper temperature needed for the reaction.

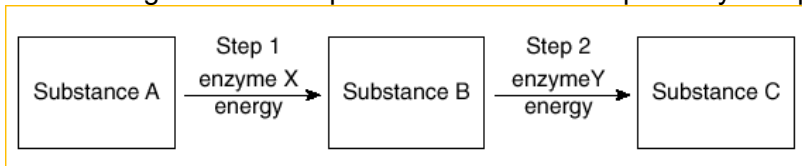
8. Proteins are a major part of every living cell and have many different functions within each cell. Carbohydrates also perform numerous roles in living things.

Part A: Describe the general composition of a protein molecule.

Part B Describe how the structures of proteins differ from the structures of carbohydrates.

Part C: Describe how the functions of proteins differ from the functions of carbohydrates

9.. The diagram below represents the chemical pathway of a process in a human liver cell.

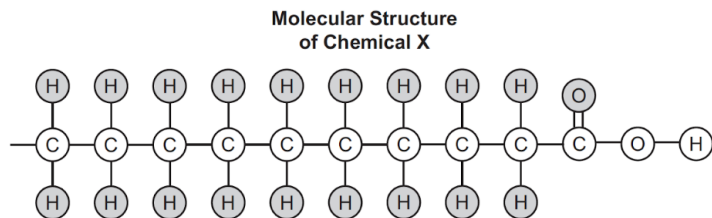


A particular liver cell is unable to make substance C. One possible explanation for the inability of this cell to make substance C is that

1. Excess energy for step 2 prevented the conversion of substance B to substance C
2. An excess of enzyme X was present, resulting in a decrease in the production of substance B
3. Nuclear DNA was altered resulting in the cell being unable to make enzyme Y

4. A mutation occurred causing a change in the ability of the cell to use substance

A scientist formed Chemical X in a laboratory. The material was then analyzed by other scientists.



Analysis showed that the chemical was composed of long chains of repeated copies of  $\text{CH}_2$  molecules.

A researcher noticed that a similar  $\text{CH}_2$  molecular structure was also located in the plasma membrane of an animal cell. This  $\text{CH}_2$  molecular structure contained a negatively charged phosphate group. Which statement best describes the primary function of the  $\text{CH}_2$  and phosphate molecular structure located in the plasma membrane?

- A. It contains the genetic information needed for protein production.
- B. It catalyzes specific chemical reactions in the cytoplasm of a cell.
- C. It stores the energy that a cell needs to perform various life processes.
- D. It allows a cell to regulate the movement of materials into and out of a cell.

Trees are typically able to transport water from their roots to their stems and leaves. Which statement describes the property of water that most supports the transportation of water to all parts of a tree?

- a. Water forms a crystalline structure when it freezes.
- b. Water dissolves fewer substances than any other liquid.
- c. Water has strong attractions to itself and many other molecules.
- d. Water can absorb large amounts of energy with minimal temperature changes.

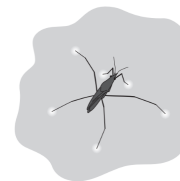
Which statement best describes a relationship between enzymes and a simple biological reaction?

- a. Enzymes will increase the amount of substrate formed during a biological reaction
- b. Enzymes will decrease the amount of substrate formed during a biological reaction
- c. A reaction rate can be increased when the specific enzyme for a biological reaction is present
- d. A reaction rate can be decreased when multiple enzymes for a biological reaction are present

Look at the image to the right:

Which of the following is a property of water that allows a water strider to walk on the

Water Strider



surface of water?

Use the table below to answer question 5.

Students' Descriptions of Four Organic Compounds

Student	Organic Compounds	Description
1	carbohydrates	complex compounds made of purines and pyrimidines that function as data-storage molecules
2	lipids	use the relatively high energy contained in carbon-hydrogen bonds to perform their primary function
3	proteins	chains of amino acids that can function as enzymes, hormones, or antibodies
4	nucleic acids	compounds, produced by photosynthetic plants, that contain only carbon, hydrogen, and oxygen

5. Which two students correctly described organic compounds?
- A. students 1 and 2
  - B. students 2 and 3
  - C. students 3 and 4
  - D. students 2 and 4

a. Solubility

- b. Cohesion
- c. high specific heat
- d. Low freezing point

Carbonic anhydrase is an enzyme involved in the reaction of carbon dioxide with water to form a molecule that dissolves well in the liquid part of blood. How does carbonic anhydrase affect this reaction?

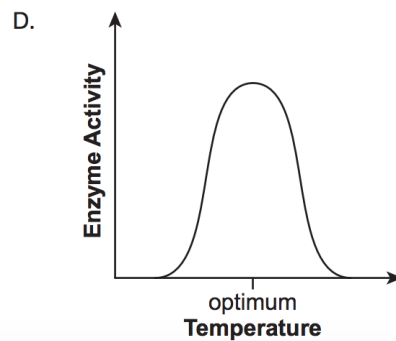
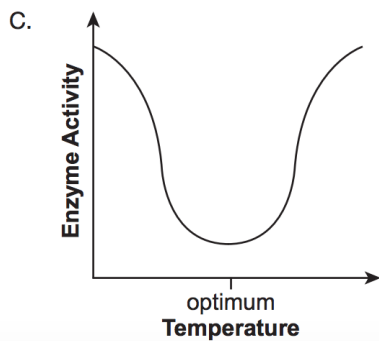
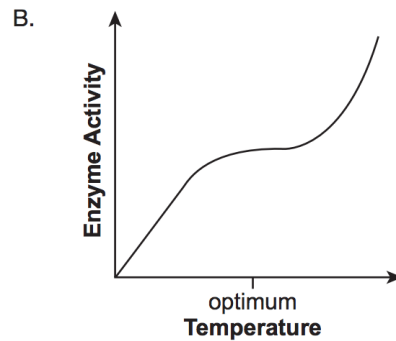
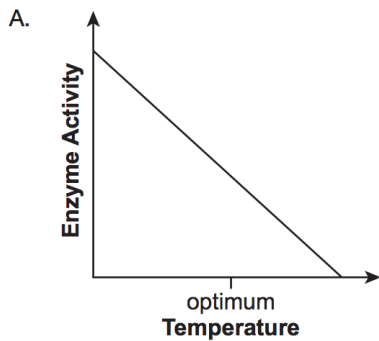
- a. By making the reaction reversible
- b. By changing chemical products

of the reaction

- C. by increasing the time needed for the reaction to occur

D. by decreasing the amount of energy needed to complete the reaction

Which graph **best** shows how enzyme activity changes as the temperature is adjusted above and below the enzyme's optimum temperature?



Use the Biological molecule information chart below.

Molecule	Structure	Cellular Use
1	A molecule made mostly of carbon with two nonpolar chains and a polar head	Is a component of plasma membranes
2	A polar molecule made of repeating units of sugar bonded to a phosphate and a nitrogenous base	Stores genetic information

Which biological molecules are most likely represented by molecules 1 and 2?

- a. Molecule 1: lipid  
Molecule 2: nucleic acid
- b. Molecule 1: lipid  
molecule 2: protein
- c. molecule 1: carbohydrates  
Molecule 2: nucleic acid
- d. Molecule 1: carbohydrates  
molecule 2: protein

Which statement describes the formation of a protein molecule?

- a. Amino acids combine to form a protein chain
- b. Fatty acid monomers dissolve to form a protein chain
- c. Fatty acid monomers combine to form a protein chain
- d. Amino acids dissolve monomers to form a protein chain

Lipase is an enzyme that breaks down lipids in the digestive system of humans. It functions best at a pH range of 4.0-5.0. When a person takes an antacid tablet to relieve heartburn, the antacid increase the pH to around 7 in certain areas of the digestive system. Which initial effect would most likely be caused by a change in pH?

- a. More lipids would be digested
- b. The production of lipase would decrease
- c. The production of lipase molecules would increase
- d. Fewer lipids would be digested

### Station 4- Cell Transport

1. What is passive transport?

2. **Paramecium are freshwater protozoan. The salt content of its cytoplasm is greater than that of the surrounding medium.**

A. Does water tend to enter or leave the paramecium? Is this process of passive or active transport?

B. How does the paramecium expel water? Is this a process of passive or active transport? Explain.

C. Where does the energy for active transport come from?

#### Practice Questions:

3. Using a microscope, a student observes a small, green organelle in a plant cell. Which energy transformation most likely occurs first within the observed organelle?

- a. ATP to light
- b. light to chemical
- c. heat to electrical
- d. chemical to chemical

4. Carbon dioxide and oxygen are molecules that can move freely across a plasma membrane. What determines the direction that carbon dioxide and oxygen molecules move?

- a. orientation of cholesterol in the plasma membrane
- b. concentration gradient across the plasma membrane
- c. configuration of phospholipids in the plasma membrane
- d. location of receptors on the surface of the plasma membrane

5. A sodium-potassium pump within a cell membrane requires energy to move sodium and potassium ions into or out of a cell. The movement of glucose into or out of a cell does not require energy. Which statement best describes the movement of these materials across a cell membrane?

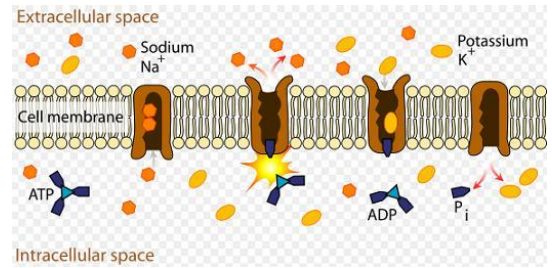
- a. Sodium and potassium ions move by active transport, and glucose moves by osmosis
- b. Sodium and potassium ions move by active transport, and glucose moves by facilitated diffusion.
- c. Sodium and potassium ions move by facilitated diffusion, and glucose moves by osmosis
- d. Sodium and potassium ions move by facilitated diffusion, and glucose moves by active transport.

6. The cell membrane serves many functions. One of the cell membrane's functions is to help the cell maintain homeostasis. Which of the following statements best supports this claim?

- a. The cell membrane contains a polar region and a nonpolar region.
- b. The cell membrane contains proteins.
- c. The cell membrane contains phospholipids.
- d. The cell membrane regulates what goes in and out of the cell.

7. In order for nerve cells and muscle cells to function properly, they require a high concentration of potassium ions inside the cells and a high concentration of sodium ions outside the cells. To maintain this condition, cells utilize sodium-potassium pumps embedded within their cellular membranes to move the ions against their concentration gradients. Since sodium-potassium pumps require an input of energy to operate, they are an example of...

- a. passive transport.
- b. facilitated diffusion.
- c. Filtration.
- d. active transport.



When a person inhales, oxygen fills tiny air sacs in the person's lungs. Next, the oxygen moves from these air sacs into small blood vessels that line the lungs, and then it moves into the bloodstream so that it can be transported around the body. Oxygen moves by random molecular motion from the air sacs of the lungs to the blood vessels because the concentration of oxygen in the air sacs is higher than the concentration of oxygen in the blood vessels.

8. This movement of oxygen molecules from an area of higher concentration to an area of lower concentration is known as ...
- a. Diffusion
  - b. Osmosis
  - c. Respiration
  - d. photosynthesis

**Open-ended Question:**

**Some animals can produce a potassium ion concentration inside their cells that is twenty times greater than that of their environment. This ion concentration gradient is maintained by the plasma membrane.**

**Part A:** Identify the process in the cell membrane that produces this difference in concentration.

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**Part B:** Explain the process that occurs as the cell produces the ion concentration gradient.

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**Part C:** Compare the process of potassium ion transport to another mechanism that moves material across the plasma membrane.

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**Station 5- Bioenergetics (Photosynthesis & Cellular Respiration)**

1. What are the different energy molecules in the cell? Describe the energy storage capacity of each and relate this to their function in living organisms.

2. What are the three parts of an ATP molecule?

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3. Energy is released from an ATP molecule when:

- A. a phosphate group is added
- B. a phosphate group is removed
- C. adenine bonds to ribose
- D. the molecule is exposed to sunlight.

4. How do heterotrophs and autotrophs differ in the way they obtain energy?

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### Photosynthesis:

1. Which organelle is involved in photosynthesis? List and describe the parts of this organelle.
2. Explain what happens to energy during photosynthesis. In what form does it enter photosynthesis? In what form does it exist during photosynthesis? In what form does it leave photosynthesis? How is this related to the overall goal of photosynthesis?
3. Plants absorb energy with **light-absorbing** molecules called:
4. What is the primary pigment involved in photosynthesis? Why do plants also contain accessory pigments?
5. A student exposed one plant to only red light and another to only green light. Which should grow better and why?
6. Write the basic equation for photosynthesis using the names of the molecules involved. Identify the products and reactants. Is light a product or reactant? If not, what does it supply to the equation?
7. A student is collecting gas being given off by a plant in direct sunlight. The gas is most likely:

### Cellular Respiration and Fermentation

1. What are the products and reactants of cellular respiration? Where does the reaction take place in cells?
2. How is energy transformed during cellular respiration? In what form does it enter cellular respiration? In what form does it leave cellular respiration? How is this related to the overall goal of cellular respiration?
3. What is a calorie? Briefly explain how cells use a high-calorie molecule such as glucose.
4. Compare and contrast photosynthesis and cellular respiration in terms of product, reactant, and energy transformations in each.
5. Why are photosynthesis and cellular respiration considered opposite reactions?
7. Compare and contrast fermentation and cellular respiration in terms of product, reactant, and energy

transformations involved.

8. Because fermentation takes place in the absence of oxygen, it is said to be

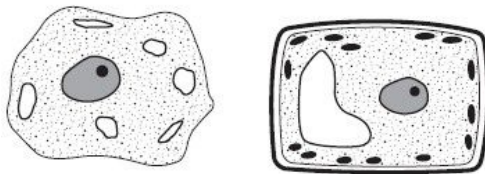
- A. aerobic    B. anaerobic    C. cyclic    D. oxygen-rich

9. In what circumstances is fermentation a better option than cellular respiration and vice versa?

10. Certain bacteria thrive in conditions that lack oxygen. What does that fact indicate about the way they obtain energy?

11. In certain cases, regular exercise causes an increase in the number of mitochondria in muscle cells. How might that situation improve an individual's ability to perform energy-requiring activities?

12. Why must plants contain mitochondria, despite the fact that they can turn light energy into chemical energy?



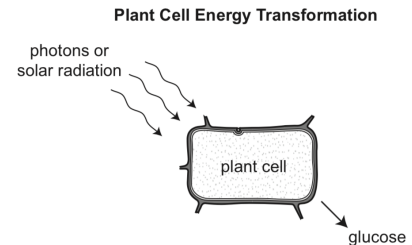
Cell A

Cell B

13. How do cells A and B obtain energy? Explain energy transformation in both cell types.

14. The diagram to the right shows an energy transformation that typically occurs in plant cell plastids. Which statement **best** describes this role of plastids in the plant cell?

- a. Chloroplasts transform light energy into chemical energy
- b. Mitochondria transform light energy into chemical energy
- c. Chloroplasts transform chemical energy into electromagnetic energy
- d. Mitochondria transform chemical energy into electromagnetic energy



Use the list below to answer question 9.

- 1. Cellular respiration and photosynthesis both involve water.
- 2. Cellular respiration uses sugar, and photosynthesis produces sugar.
- 3. Cellular respiration and photosynthesis both use light to produce energy.
- 4. Cellular respiration requires light energy, and photosynthesis requires chemical energy.

9. Which two statements correctly describe one similarity and one difference between cellular respiration and photosynthesis?

- A. statements 1 and 2
- B. statements 1 and 4
- C. statements 2 and 3
- D. statements 3 and 4

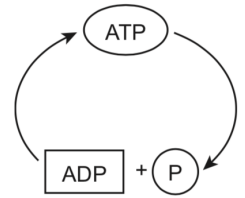
A scientist observed that during the course of a chemical reaction the number of ATP molecules was reduced. What did the scientist **most likely** learn from the observation?

- A. The reaction produced water.
- B. The reaction consumed water.
- C. The reaction caused an output of energy.
- D. The reaction required an input of energy.

7. Use the lists below to answer the question.

**Cell Structures Observed in Two Organisms**

Cell Structures in Organism 1		Cell Structures in Organism 2	
<ul style="list-style-type: none"> <li>• cell wall</li> <li>• endoplasmic reticulum</li> <li>• Golgi body</li> <li>• chloroplasts</li> </ul>	<ul style="list-style-type: none"> <li>• mitochondria</li> <li>• nucleus</li> <li>• ribosomes</li> <li>• vacuole</li> </ul>	<ul style="list-style-type: none"> <li>• cell membrane</li> <li>• endoplasmic reticulum</li> <li>• Golgi body</li> </ul>	<ul style="list-style-type: none"> <li>• mitochondria</li> <li>• nucleus</li> <li>• ribosomes</li> </ul>



A student made lists of structures observed in cells from two different organisms. Which statement describes the **most likely** difference in the way that organism 1 and organism 2 obtain energy?

- A. Only organism 1 uses solar energy to make energy-rich compounds.
- B. Only organism 1 stores solar energy until it is needed for its life processes.
- C. Only organism 2 produces molecules for long-term energy storage.
- D. Only organism 2 transforms food energy into ATP during cellular respiration.

15. Use the diagram to the right to answer the following questions

**Part A: Explain why ATP is important in biochemical reactions**

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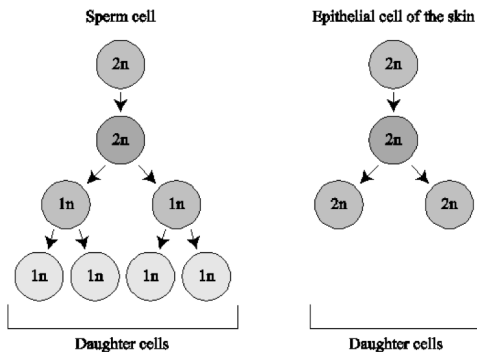
**Part B: Give 2 examples of biochemical reactions and explain how an organism uses ATP within the reactions**

Example	Explanation

## Station 6- Cell Cycle and Cell Division

*In the table provided, place a check mark in the columns that apply to the particular event. If appropriate indicate whether it happens in prophase (P), metaphase (M), anaphase (A), or telophase (T)*

Description / Event	Interphase	Mitosis	Meiosis I	Meiosis II	Neither
Nuclear membrane starts to break down					
Sex cells result					
Daughter cells are identical to parent					
Body cells result					
Homologous chromosomes line up in middle of cell					
Final chromosome # is the same as the parent cell					
Diploid cells result at end					
Homologous chromosomes assort independently					
Tetrads form					
DNA is replicated					
Chromosomes migrate to opposite poles					
Cytokinesis begins					
Cells are genetically different					
Spindle fibers form					
Haploid Cells Result					
Sister chromatids separate					
Crossing over happens					
Each cell contains only one copy of each gene					



4. Cell division can occur either through meiosis or mitosis. The figure shown compares meiosis in a sperm cell with mitosis in a skin cell. Which key difference is observed in the daughter cells after both the cells complete cell division?

- Sperm cells produce two daughter cells for each original cell.
- The meiotic cell division of the sperm produces haploid daughter cells.
- Daughter cells produced through mitosis in the skin cells have two nuclei.

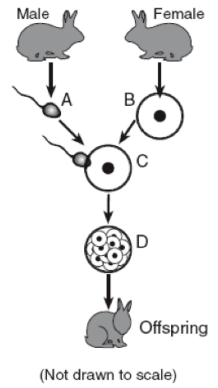
d. Mitotic cell division of the skin cells causes a reduction in the chromosome number.

14. The diagram to the right shows information about the reproduction and development of a rabbit. Which letter in the diagram represents fertilization

- a. A                      b. B                      c. C                      d. D

In sexually reproducing species, the number of chromosomes in each body cell remains the same from one generation to the next as a direct result of

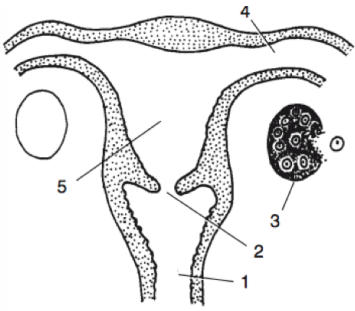
- a. meiosis and fertilization                                      b. mitosis and mutation  
c. differentiation and aging                                      d. homeostasis and dynamic equilibrium



The diagram below represents part of the human female reproductive system.

Fertilization and development normally occur in structures

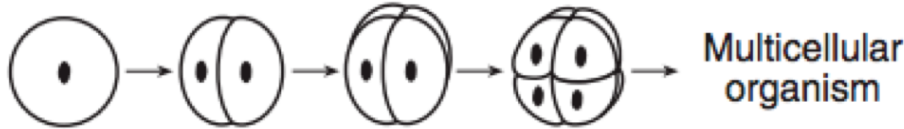
- a. 1 and 5              b. 2 and 4              c. 3 and 1              d. 4 and 5



In animals, the normal development of an embryo is dependent on

- a. fertilization of a mature egg by many sperm cells  
b. production of new cells having twice the number of chromosomes as the zygote  
c. production of body cells having half the number of chromosomes as the zygote  
d. mitosis and the differentiation of cells after fertilization has occurred

Which phrase best describes a process represented in the diagram below?



zygote

- a. a zygote dividing by mitosis                                      b. a zygote dividing by meiosis  
c. a gamete dividing by mitosis                                      d. a gamete dividing by meiosis

Student Comparisons of Meiosis and Mitosis

Student	Outcome of Meiosis	Outcome of Mitosis
1	two haploid cells	two diploid cells
2	two diploid cells	four haploid cells
3	four haploid cells	two diploid cells
4	four diploid cells	four haploid cells

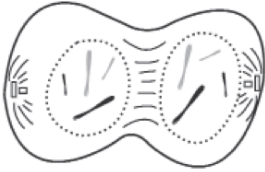
Which student correctly compared the outcomes of meiosis and mitosis?

- a. student 1    b. student 2    c. student 3    d. student 4

Which statement **best** describes the outcomes of both meiosis and mitosis?

- a. Cell division results in daughter cells that contain DNA.  
b. Each daughter cell has two complete sets of chromosomes.  
c. Within a cell, two chromosomes pair up and exchange segments of genetic material.  
d. Genetically identical daughter cells are produced that can function as body cells or sex cells.

## Cell Division



Which statement **best** describes the phase of the cell cycle shown?

- A. The cell is in prophase of mitosis because the number of chromosomes has doubled.
  - B. The cell is in prophase I of meiosis because the number of chromosomes has doubled.
  - C. The cell is in telophase of mitosis because the cell is separating and contains two copies of each chromosome.
  - D. The cell is in telophase of meiosis because the cell is separating and contains two copies of each chromosome.
3. Which process occurs during meiosis but **not** during mitosis?
- a. crossing over
  - b. gene mutation
  - c. nuclear division
  - d. replication of DNA
9. The reproductive system of the human male produces gametes and
- a. transfers gametes to the female for internal fertilization
  - b. produces enzymes that prevent fertilization
  - c. releases hormones involved in external fertilization
  - d. provides an area for fertilization

Define fertilization and describe the resulting development of a human embryo. In your answer, be sure to include a definition of fertilization and the functions of the ovary, uterus, and placenta. Circle the terms *fertilization*, *ovary*, *uterus*, and *placenta* in your description. \_\_\_\_\_

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## Station 7- Genetics

1. Two fish meet at the coral reef, fall in love, and get married that same night. They decide to make babies right away. The mom fish has a big fluffy tail (TT) while the dad has a very boring flat tail (tt). The dad is worried that he will pass his ugly tail down to his kids. What is the chance that the first child will have a flat tail?

T = fluffy tail      t = flat tail      Genotypic Ratio: \_\_\_\_\_      Phenotypic Ratio: \_\_\_\_\_


2. In Japanese four-o'clocks, the gene for red flower color (R) is incompletely dominant over the white flower color (W). Predict the genotypic and phenotypic ratios of a red plant crossed with a white plant.

RR – Red      RW' = pink      WW = white

3. The palomino horse is a hybrid (mix) showing a golden coat with a lighter mane and tail. A pair of codominant alleles, D1 and D2 is known to be involved in this trait. Horses with the D1D1 genotype are chestnut colored, horses with the D1D2 genotype are palomino, and horses with the D2D2 genotype are white in color.

Two palomino horses mate by artificial insemination. What types of offspring could be produced?

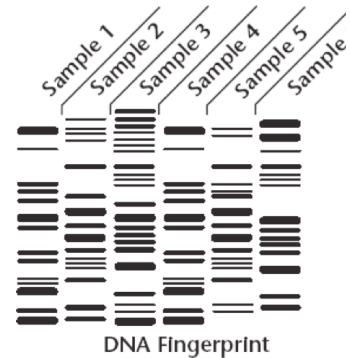
D1D2 = palomino                      D1D1 = Chestnut                      D2D2 = white  
 Phenotypic ratio= \_\_\_\_\_                      genotypic ratio= \_\_\_\_\_

4. White eyed fruit flies are the result of a sex-linked recessive gene. Show the results from a cross between a red-eyed (R) male and white-eyed (r) female fruit fly. Cross = female  $X^rX^r$  x male  $X^RY$

5. How could cloning help humans in need of organs?

6. On the lines below, write T next to an example of a transgenic organism, and C next to an example of a clone.

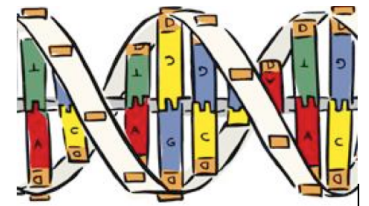
- \_\_\_\_\_ a. A goat that produces spider's silk in its milk
- \_\_\_\_\_ b. A lamb that is born with the same DNA as a donor cell
- \_\_\_\_\_ c. A colony of bacteria that grows from one bacterium
- \_\_\_\_\_ d. A bacterium that can produce human insulin



7. Look at the image to the right. Which two samples might be from a set of identical twins? \_\_\_\_\_

Mitosis and meiosis are processes by which animal and plant cells divide. Which statement **best** describes a difference between mitosis and meiosis?

- A. Meiosis is a multi-step process.                      B. Mitosis occurs only in eukaryotic cells.
- C. Meiosis is used in the repair of an organism.                      D. Mitosis produces genetically identical daughter cells.



8. Suppose that the central C-G base pair in the DNA molecule to the right is substituted by an A-T base pair. What is the most likely result of this mutation?

- a. genetic variation                      b. genetic clones
- c. incomplete translation                      d. identical offspring

9. Hemophilia is an inheritable genetic disorder that prohibits the proper formation of blood clots. The recessive gene that causes hemophilia is located on the X-chromosome. Given this information, which of the following statements is true?

- a. In order for a male offspring to be a hemophiliac, his mother must be a hemophiliac.
- b. In order for a female offspring to be a hemophiliac, her father must be a hemophiliac.
- c. In order for a male offspring to be a hemophiliac, his father must be a hemophiliac.
- d. In order for a female offspring to be a hemophiliac, her mother must be a hemophiliac.

10. Which of the following statements is true?

- a. Mitosis results in the formation of two haploid gametes which can then combine to form a diploid daughter cell.
- b. During the process of meiosis, haploid cells are formed. After fertilization, the diploid number of chromosomes is restored.
- c. The process of meiosis forms daughter cells which are genetically identical to their parent cells.
- d. The daughter cells formed during mitosis are genetically similar to, though not identical to, their parent cell.

11. In a flowering plant species, red flower color is dominant over white flower color. What is the genotype of any red-flowering plant resulting from this species?

- A. red and white alleles present on one chromosome
- B. red and white alleles present on two chromosomes
- C. a red allele present on both homologous chromosomes
- D. a red allele present on at least one of two homologous chromosomes



12. Which of the following best describes the way that genes, chromosomes, and DNA are related?

- a. Chromosomes contain several genes, which are made up of sequences of DNA.
- b. Genes contain several chromosomes, which are made up of sequences of DNA.
- c. Genes contain several sequences of DNA, which are made up of chromosomes.
- d. Sequences of DNA contain several genes, which are made up of chromosomes.

13. If a cat has 38 chromosomes in each of its body cells, how many chromosomes will be in each daughter cell after mitosis?

- a. 19
- b. 11
- c. 76
- d. 38

Use the table below to answer the question.

### Blood Types

Blood Types

Genotypes	Phenotypes
ii	O
$I^A I^A$ , $I^A i$	A
$I^B I^B$ , $I^B i$	B
$I^A I^B$	AB

14. Blood type is inherited through multiple alleles, including  $I^A$ ,  $I^B$ , and i. A child has type A blood. If the father has type AB blood, what are all the possible phenotypes of the mother?

- a. phenotypes O or A
- b. phenotypes A or AB
- c. phenotypes A, B, AB
- d. phenotypes O, A, B, AB

15. Genetic engineering has led to genetically modified plants that resist insect pests and bacterial and fungal infections. Which outcome would **most likely** be a reason why some scientists recommend caution in planting genetically modified plants?

- A. unplanned ecosystem interactions
- B. reduced pesticide and herbicide use
- C. improved agricultural yield and profit
- D. increased genetic variation and diversity

16. A cell in the process of cell division contains the normal chromosome number. Each chromosome consists of two identical sister chromatids. During which stages and processes can such a cell exist?

- A. telophase of mitosis, but no stage of meiosis
- B. metaphase of mitosis, but no stage of meiosis
- C. anaphase I of meiosis and anaphase of mitosis
- D. prophase I of meiosis and prophase of mitosis

17. Which statement correctly describes the alleles for any gene in a female cat's body cell?

- A. they have the same DNA sequence, but are located on separate chromosomes
- B. They have different DNA sequences, but are located on the same chromosome
- C. They may have the same or different DNA sequences, but are located on the same chromosome
- D. They may have the same or different DNA sequences, but are located on separate chromosomes

21. A child has type O blood. If the child's mother has type A blood, what are all the possible genotypes and phenotypes of the father?

- A. ii only
- B. ii and  $I^A i$
- C. ii,  $I^A i$ , and  $I^B i$
- D. ii,  $I^A i$ ,  $I^A I^A$ , and  $I^B i$

21. The gene for seed shape in pea plants has two alleles, resulting in either smooth or wrinkled peas. A pea plant with one smooth allele and one wrinkled allele produces only smooth peas. Based on this information, which conclusion can be drawn?

- A. both alleles are codominant
- B. one allele is incompletely dominant
- C. the allele for smooth seeds is recessive
- D. the allele for wrinkled seeds is recessive

22. Fruit flies normally have red eyes. A recessive allele causes some fruit flies to have purple eyes. Which statement describes the purple-eyed offspring of a red-eyed parent and a purple-eyed parent?

- A. The offspring has two recessive alleles located on the same chromosome
- B. The offspring has two chromosomes with a recessive allele present on each.
- C. The offspring has one dominant and one recessive allele located on the same chromosome
- D. The offspring has one chromosome with a dominant allele and one chromosome with a recessive allele.

23. A scientist uses enzymes to splice genetic DNA into a plasmid, and then inserts the plasmid into a cell. Which of the following is most likely an application of this process?

- a. producing an exact genetic clone of prized racehorse
- b. producing a vaccine against the human papillomavirus
- c. determining which of several rice varieties should be crossed
- d. determining whether a suspect's blood was present at a crime scene

24. Which of the following is not an example of genetic engineering?

- a. An agricultural scientist creates a hybrid strain of rice by crossing two rice varieties.
- b. A biology student inserts plant DNA into bacteria to determine its role in the cell cycle.
- c. A vaccine manufacturer inserts a plasmid containing a gene for a virus into yeast cells.
- d. A medical researcher isolates a functional copy of a muscular dystrophy gene for gene therapy.

**Open-ended Question:**

25. A cattle farmer genetically crosses a cow (female) with a white coat with a bull (male) with a red coat. The resulting calf (offspring) is roan, which means there are red and white hairs intermixed in the coat of the calf. The genes for coat color in cattle are co-dominant.

**Part A:** Although a farm has cattle in all three colors, the farmer prefers roan cattle over white or red cattle. Use the

Punnett square to show a cross that would produce only roan offspring.


**Part B:** Explain how a roan calf results from one white- and one red-coated parent. In your explanation, use letters to represent genes. Be sure to indicate what colors the letters represent.

**Part C:** Predict the possible genotypes and phenotypes of the offspring produced from two roan cattle.

## Station 8- DNA Replication, Transcription and Translation

**DNA REPLICATION:** Summarize the process of replication. Be sure to include the following terms:

DNA helicase, hydrogen bonds, DNA polymerase, nucleotides, the phase of the cell cycle it occurs in and what is produced as a result of replication

**According to the base pairing rule determine the corresponding sequence:** TAG CCC TTA TGG CAT AGA \_\_\_\_\_

If a mRNA transcript has 300 nucleotides, how many amino acids would that code for? \_\_\_\_\_

Transcription: Explain the process of transcription. Include the following terms: RNA polymerase, hydrogen bonds, mRNA, codon

TRANSLATION- Define and summarize the steps. Include the following terms: ribosomes, tRNA, mRNA, amino acids, polypeptides/proteins, anticodon

What does this message code for? mRNA : AUG CUU CCA GAG UGA

**Define mutations and explain each type of mutation below:** \_\_\_\_\_

**Deletion:** \_\_\_\_\_

**Duplication:** \_\_\_\_\_

**Inversion:** \_\_\_\_\_

**Translocation:** \_\_\_\_\_

**Point mutation:** \_\_\_\_\_

To emphasize the point of mutation, I am using English (an alphabet with 26 letters, not 4!) Imagine you have the following message: **THE CAT ATE THE RAT**

Using the above bolded mutations, label the type of mutation each must be:

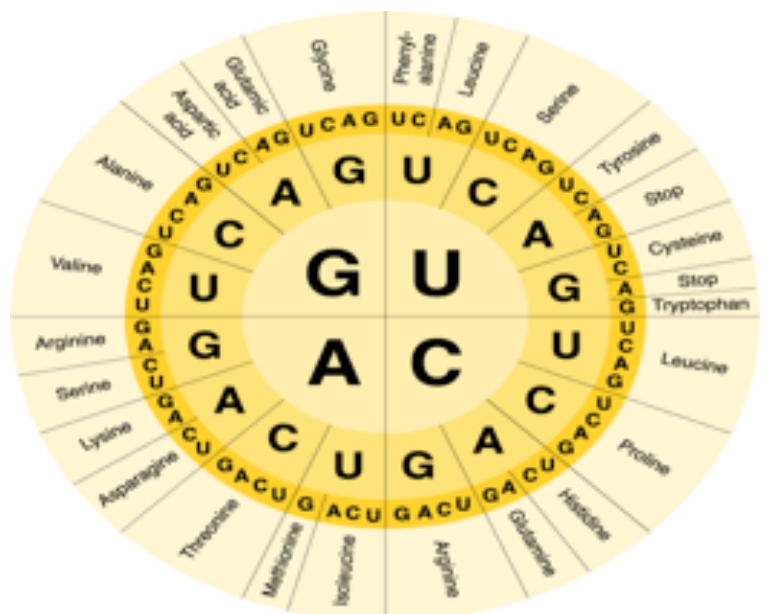
\_\_\_\_\_ THE HAT ATE THE RAT

\_\_\_\_\_ TTH EHA TAT ETH ERA T

\_\_\_\_\_ THE ATA TET HER AT

Fill in the chart:

DNA Triplet	mRNA Codon	tRNA Anticodon	Amino Acid
TAC			
		GGA	
TTC			



		AUC	
--	--	-----	--

Which process helps to preserve the genetic information stored in DNA during DNA replication?

- A. the replacement of nitrogen base thymine with uracil
- B. enzymes quickly linking nitrogen bases with hydrogen bonds
- C. the synthesis of unique sugar and phosphate molecules for each nucleotide
- D. nucleotides lining up along the template strand according to base pairing rule

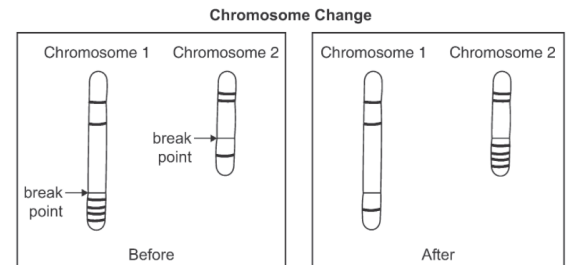
The endoplasmic reticulum is a network of membranes within the cell, and it is often classified as rough or smooth, depending on whether there are ribosomes on its surface. Which statement **best** describes the role of rough endoplasmic reticulum in the cell?

- A. It stores all proteins for later use.
- B. It provides an attachment site for larger organelles.
- C. It aids in the production of membrane and secretory proteins.
- D. It stores amino acids required for the production of all proteins.

*Use the diagram to the right to answer the question*

Which type of change in chromosome composition is illustrated in the diagram?

- A. deletion
- B. insertion
- C. inversion
- D. translocation



Which statement describes a cell process that is common to both eukaryotic and prokaryotic cells?

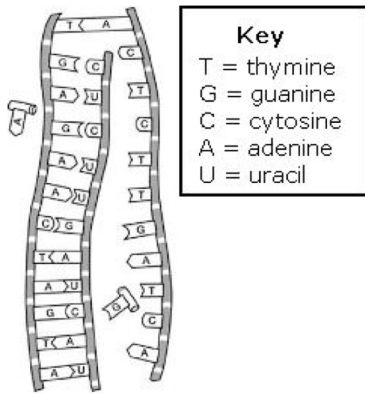
- A. Both cell types carry out transcription in the nucleus.
- B. Both cell types use ribosomes to carry out translation.
- C. Both cell types assemble amino acids to carry out transcription.
- D. Both cell types carry out translation in the endoplasmic reticulum.

A genetic mutation resulted in a change in the sequence of amino acids of a protein, but the function of the protein was not changed. Which statement **best** describes the genetic mutation?

- A. It was a silent mutation that caused a change in the DNA of the organism.
- B. It was a silent mutation that caused a change in the phenotype of the organism.
- C. It was a nonsense mutation that caused a change in the DNA of the organism.
- D. It was a nonsense mutation that caused a change in the phenotype of the organism.

Which of the following is primarily responsible for the coding of the amino acids used in the synthesis of cellular proteins?

- a. DNA
- b. transfer RNA
- c. ribosomes
- d. Golgi apparatus



1. Which statement describes the diagram to the right?
- DNA transcription is producing ribosomal RNA.
  - DNA translation is producing messenger RNA.
  - DNA transcription is producing messenger RNA.
  - DNA translation is producing ribosomal RNA.

Which organelle is not involved in the synthesis and secretion of a protein from the cell?

- ribosome.
- Smooth ER.
- Golgi apparatus.
- Plasma membrane.

Which pair consists of terms that represent equivalent units of information?

- Codon : DNA
- Gene : polypeptide
- Chromosome : protein
- Nucleotide : amino acid

A tRNA molecule with which of the following anticodons would be able to bind to a molecule of lysine (has codons AAA or AAG)?

- TTT
- TTC
- AAA
- UUC

Suppose all of the ribosomes in a cell were destroyed. How would this most likely affect the process of gene expression?

- The DNA double strand would be unable to separate.
- The cell would be unable to form mRNA strands.
- The amino acids could not be joined to form a protein.
- The tRNA molecules would bind to the wrong amino acids.

**Open-ended Question:**

Consider the process of gene expression in a eukaryotic cell.

**Part A:** Describe two similarities between transcription and translation:

Could have any of the following four things:

**Part B:** Describe two differences between transcription and translation

