

BIOLOGY KEYSTONE EXAM

What is it? Comprehensive exam consisting of multiple choice questions and constructed response prompts written and required by the state.

What happens if I don't pass? You will enter a cycle of Biology Remediation (in addition to your other science classes), and retake the test in the fall and spring until you either a) pass the test (YAY!) OR you will do a lengthy project-based assessment to justify your knowledge of eligible content. HOPEFULLY THIS WILL NOT BE AN ISSUE! STUDY HARD AND PASS IT THE FIRST TIME!

What is covered on the test? The Keystone Exam will test you on material from the beginning of the year. It is split into two modules, topics are as follows:

MODULE 1- Biochemistry, Cell structure and functions, Basic Biological principles, Homeostasis, Cell Transport, and Bioenergetics

MODULE 2- Cell Division (Mitosis and Meiosis), DNA/RNA, Genetics, Evolution, and Ecology

How should I study? These review packets are a good place to start. They contain a vocab review, sample multiple choice questions from past keystones, and sample constructed response prompts. Additionally, look over your class notes and any class review sheets from previous tests. There are numerous online review sites, including videos, powerpoints, review games, etc. YOU WILL GET OUT OF THIS WHAT YOU PUT INTO IT! Meaning: if you do nothing to review, do not be surprised if you do not pass.

YOU CAN DO IT! LET'S REVIEW!

BIOCHEMISTRY

A	Adhesion	G	Concentration	M	Monomer
B	Atom	H	Enzyme	N	Nucleic Acid
C	Biological Macromolecules	I	Freezing Point	O	Organic Molecule
D	Carbohydrate	J	Lipids	P	pH
E	Catalyst	K	Macromolecules	Q	Protein
F	Cohesion	L	Molecules	R	Specific Heat

1. _____ A macromolecule that contains atoms of carbon, hydrogen, and oxygen in a 1:2:1 ratio and serves as a major source of energy for living organisms (e.g., sugars, starches, and cellulose).
2. _____ The intermolecular attraction between like molecules. Surface tension results from the cohesive properties of water.
3. _____ A substance that enables a chemical reaction to proceed at a usually faster rate or under different conditions (e.g., lower temperature) than otherwise possible without being changed by the reaction.
4. _____ A molecule containing carbon that is part of or produced by living systems.
5. _____ A group of organic compounds composed mostly of carbon and hydrogen including a proportionately smaller amount of oxygen; are insoluble in water, serve as a source of stored energy, and are a component of cell membranes.
6. _____ A molecule of any compound that can react with other molecules of the same or different compound to form a polymer. Each biological macromolecule has characteristic monomers.
7. _____ A biological macromolecule (DNA or RNA) composed of the elements C, H, N, O, and P that carries genetic information.
8. _____ A macromolecule that contains the principal components of organisms: carbon, hydrogen, oxygen, and nitrogen; performs a variety of structural and regulatory functions for cells.
9. _____ The intermolecular attraction between unlike molecules. Capillary action results from the Adhesive properties of water and the molecules that make up plant cells.
10. _____ A protein that increases the rate of a chemical reaction without being changed by the reaction; an organic catalyst.

STRUCTURE (AND FUNCTION)

A	Analogous Structure	B	Organism	C	Homologous Structure
D	Tissue	E	Organ	F	Vestigial Structure
G	Organ System				

1. _____ A physical characteristic in different organisms that is similar because it was inherited from a common ancestor.
2. _____ An anatomical unit composed of cells organized to perform a similar function.
3. _____ A form of life; an animal, plant, fungus, protist or bacterium.
4. _____ A physical characteristic in organisms that appears to have lost its original function as a species has changed over time.
5. _____ An anatomical system composed of a group of organs that work together to perform a specific function or task.

CELL STRUCTURE

A	Cell	F	Eukaryote	K	Nucleus
B	Chloroplast	G	Extracellular	L	Organelle
C	Endocytosis	H	Golgi Apparatus	M	Plastids
D	Endoplasmic Reticulum	I	Mitochondrion	N	Prokaryotes
E	Endosymbiosis	J	Multicellular	O	Ribosome
				P	Unicellular

1. _____ A cellular structure composed of RNA and proteins that is the site of protein synthesis in eukaryotic and prokaryotic cells.
2. _____ An organelle found in eukaryotic cells responsible for the final stages of processing proteins for release by the cell.
3. _____ A theorized process in which early eukaryotic cells were formed from simpler prokaryotes.
4. _____ A process in which a cell engulfs extracellular material through an inward folding of its plasma membrane.
5. _____ The basic unit of structure and function for all living organisms. Cells have three common components: genetic material, cytoplasm, and a cell membrane. Eukaryotic cells also contain specialized organelles.
6. _____ A group of membrane-bound organelles commonly found in photosynthetic organisms and mainly responsible for the synthesis and storage of food.
7. _____ A single-celled organism that lacks a membrane-bound nucleus and specialized organelles.
8. _____ An organelle found in plant cells and the cells of other eukaryotic photosynthetic organisms where photosynthesis occurs.
9. _____ A membrane-bound organelle in eukaryotic cells functioning to maintain the integrity of the genetic material and, through the expression of that material, controlling and regulating Cellular activities.
10. _____ A subunit within a cell that has a specialized function.

SCIENTIFIC METHOD / NATURE OF SCIENCE

A	Biology	E	Mechanism (Scientific)
B	Forensics	F	Principle (Scientific)
C	Hypothesis	G	Science
D	Law (Scientific)	H	Theory (Scientific)

1. _____ The combination of components and processes that serve a common function.
2. _____ The scientific study of life.
3. _____ An explanation of observable phenomena based on available empirical data and guided by a system of logic that includes scientific laws; provides a system of assumptions, accepted principles, and rules of procedure devised to analyze, predict, or otherwise explain the nature or behavior of a specific set of phenomena.
4. _____ A concept based on scientific laws and axioms (rules assumed to be present, true, and valid) where general agreement is present.
5. _____ A body of evidence-based knowledge gained through observation and experimentation related to the natural world and technology.

- 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 alveoli allows 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 areas of the lungs, allowing efficient gas exchange.

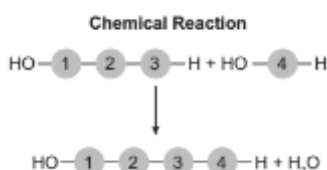
- 4) Which statement BEST describes an effect of the low density of frozen water in a lake?
 - A. When water freezes, it contracts, decreasing the water level in a lake.
 - B. Water in a lake freezes from the bottom up, killing most aquatic organisms.
 - C. When water in a lake freezes, it floats, providing insulation for organisms below.
 - D. Water removes thermal energy from land around the lake, causing the lake to freeze.

- 5) 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
 - D. It forms covalent bonds than can exist in a single plane

- 6) Carbohydrates and proteins are two types of macromolecules. Which functional characteristic of proteins distinguishes them from carbohydrates?
 - A. Large amount of stored information
 - B. Ability to catalyze biochemical reactions
 - C. Efficient storage of usable chemical energy
 - D. Tendency to make cell membranes hydrophobic

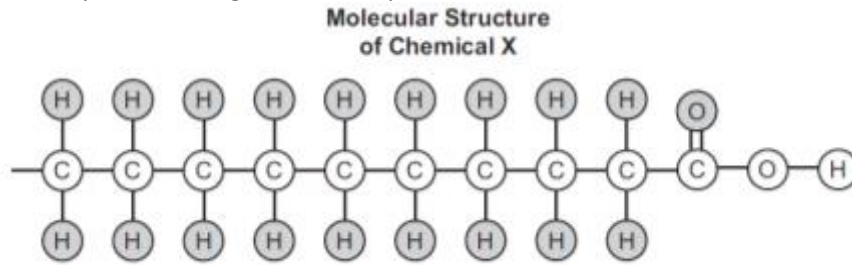
7) The diagram shows a reaction that forms a polymer from two monomers. What is this type of reaction called?

Use the diagram below to answer the question.



- A. glycolysis
- B. hydrolysis
- C. photosynthesis
- D. dehydration synthesis

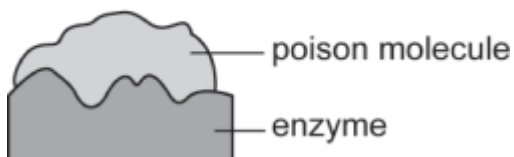
- 7) A scientist formed Chemical X in a laboratory. The material was then analyzed by other scientists. Analysis showed that the chemical was composed of long chains of repeated CH₂ molecules.



A researcher noticed that a similar CH₂ molecular structure was also located in the plasma membrane of an animal cell. The CH₂ molecular structure contained a negatively charged phosphate groups. Which statement BEST describes the primary function of the CH₂ and phosphate molecular structure located in the plasma membrane?

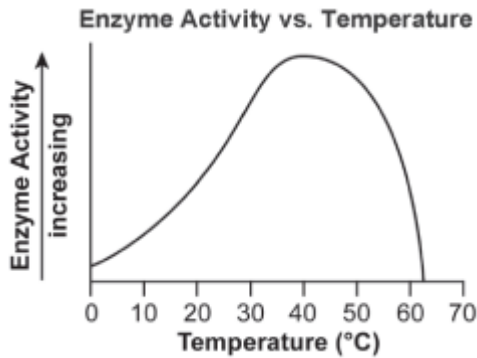
- A. It contains the genetic information needed for protein production.
 B. It allows the energy that a cell needs to perform various life processes.
 C. It allows a cell to regulate the movement of materials into and out of a cell.
 D. It catalyzes specific chemical reactions in the cytoplasm of a cell.
- 8) Which type of organic molecule was MOST LIKELY formed by the scientist in the laboratory?
- A. Lipid
 B. Protein
 C. Carbohydrate
 D. Nucleic acid
- 9) Substance A is converted to substance B in a metabolic reaction. Which statement BEST describes the roles of an enzyme during this reaction?
- A. It adjusts the pH of the reaction medium.
 B. It provides energy to carry out the reaction.
 C. It dissolves substance A in the reaction medium.
 D. It speeds up the reaction without being consumed.
- 10) 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.
- 11) The diagram models how a poison bonds to the active site of an enzyme. Which function is the enzyme MOST LIKELY unable to perform because of the attachment of the poison molecule?

Poison Bonding to an Enzyme



- A. The release of stored chemical energy.
 B. The donation of electrons to the substrate
 C. The supply of activation energy for a reaction.
 D. The catalysis of the reaction with the substrate.

- 12) The graph shows how the activity of an enzyme changes at different temperatures. Which statement BEST describes what happens to the enzyme when the temperature of the reaction increases to 63 degrees?



- A. The enzyme is used up and the reaction stops.
- B. The enzyme begins to decrease the rate of the reaction.
- C. The enzyme continues to increase the rate of the reaction.
- D. The enzyme changes shape and can no longer speed up the reaction.

- 13) The rough endoplasmic reticulum and Golgi apparatus work together in eukaryotic cells. What is one way that the rough endoplasmic reticulum assists the Golgi apparatus?

- A. It assembles nucleic acids from monomers.
- B. It breaks down old, damaged macromolecules.
- C. It packages new protein molecules into vesicles.
- D. It determines which protein molecules to synthesize.

- 14) 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.

- 15) Which of the following is a property of water that allows a water strider to walk on the surface of water?

- A. solubility
- B. cohesion
- C. high specific heat
- D. low freezing point

- 16) 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.

- 17) 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

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

- 18) 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

19) The functions of which cell structure are described in this list?

- A. a lysosome
- B. a mitochondrion
- C. the plasma membrane
- D. the endoplasmic reticulum

Functions of a Cell Structure

- allows waste to exit the cell
- allows chemicals required for cellular respiration to enter the cell
- regulates movement of water into and out of the cell

CONSTRUCTED-RESPONSE QUESTIONS

1. 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.

1A: Describe the general composition of a protein molecule.

1B: Describe how the structures of proteins differ from the structures of carbohydrates.

1C: Describe how the functions of proteins differ from the functions of carbohydrates.

2. Prokaryotic cells are generally much smaller than eukaryotic cells.

2A: Identify a structural difference between prokaryotic cells and eukaryotic cells that is directly related to their difference in size.

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

2 C: Describe one similarity between prokaryotic cells and eukaryotic cells that is independent of size.

MAKING ENERGY

- A Adenosine Triphosphate (ATP)
- B Biochemical Conversion
- C Bioenergetics

- D Cellular Respiration
- E Energy Transformation
- F Photosynthesis

1. _____ A process in which energy changes from one form to another form while some of the energy is lost to the environment.
2. _____ The study of energy flow (energy transformations) into and within living systems.
3. _____ A process in which solar radiation is chemically captured by chlorophyll molecules and through a set of controlled chemical reactions resulting in the potential chemical energy in the bonds of carbohydrate molecules.
4. _____ A complex set of chemical reactions involving an energy transformation where potential chemical energy in the bonds of "food" molecules is released and partially captured in the bonds of adenosine triphosphate (ATP) molecules.
5. _____ The changing of organic matter into other chemical forms such as fuels.

MOVING ACROSS THE CELL MEMBRANE

- A Active Transport
- B Carrier (Transport) Protein
- C Concentration Gradient
- D Diffusion
- E Exocytosis

- F Facilitated Diffusion
- G Homeostasis
- H Homeostatic Mechanism
- I Impermeable
- J Intracellular

- K Osmosis
- L Passive Transport
- M Plasma Membrane
- N Pumps (Ion or Molecular)

1. _____ The movement of water or another solvent through permeable membranes from an area of higher water concentration (dilute) to an area of lower water concentration (concentrated).
2. _____ A process in which substances are transported across a plasma membrane with the concentration gradient with the aid of carrier (transport) proteins.
3. _____ Proteins embedded in the plasma membrane involved in the movement of ions, small molecules, and macromolecules into and out of cells; also known as transport proteins.
4. _____ The movement of particles from an area of low concentration to an area of high energy provided by ATP or a difference in electrical charges across a cell membrane.
5. _____ A thin, phospholipid and protein molecule bilayer that encapsulates a cell and controls the movement of materials in an out of the cell through active or passive transport.
6. _____ Any of several molecular mechanisms in which ions or molecules are transported across a cellular membrane requiring the use of an energy source (e.g., glucose, sodium [Na⁺], etc.).
7. _____ The transportation of materials across a plasma membrane without using energy.
8. _____ A regulatory mechanism that contributes to maintaining a state of equilibrium (e.g., thermoregulation, water regulation, and oxygen regulation).
9. _____ The graduated difference in concentration of a solute per unit distance through a solution.
10. _____ Not permitting passage of a substance or substances.

- 1) 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?
- ATP to light
 - Light to chemical
 - Heat to electrical
 - Chemical to chemical

- 2) Photosynthesis and cellular respiration are two major processes of carbon cycling in living organisms. Which statement correctly describes one similarity between photosynthesis and cellular respiration?

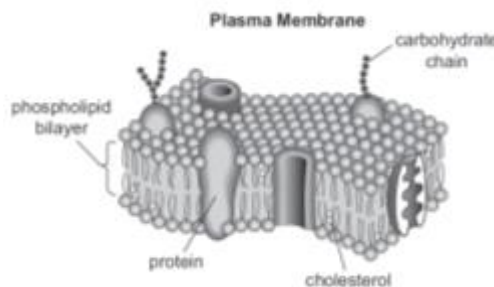
- Both occur in animal and plant cells.
- Both include reactions that transform energy.
- Both convert light energy into chemical energy.
- Both synthesize organic molecules as end products.

- 3) A protein in a cell membrane changed its shape to move sodium and potassium ions against their concentration gradients. Which molecule was **most likely** used by the protein as an energy source?

- ATP
- ADP
- Catalase
- Amylase

- 4) Which component of this membrane contains a hydrophobic region and acts as the primary barrier to MOST foreign substances?

- Protein
- Cholesterol
- Carbohydrate chain
- Phospholipid bilayer



- 5) 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?

- Orientation of cholesterol in the plasma membrane.
- Concentration gradient across the plasma membrane.
- Configuration of phospholipids in the plasma membrane.
- Location of receptors on the surface of the plasma membrane.

- 6) A sodium-potassium pump within a cell membrane requires energy to move a 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?

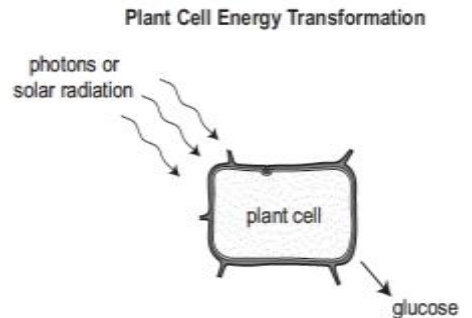
- Sodium and potassium ions move by active transport, and glucose moves by osmosis.
- Sodium and potassium ions move by active transport, and glucose moves by facilitated diffusion.
- Sodium and potassium ions move by facilitated diffusion, and glucose moves by osmosis.
- Sodium and potassium ions move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

7) 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.

8) The diagram 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.



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

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.

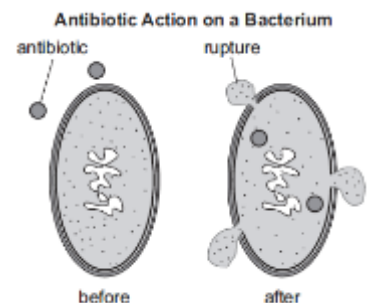
10) A jackrabbit has large ears containing blood vessels that help it maintain a constant body temperature by adjusting heat exchange with the surrounding environment. Which characteristic of life is best described by this example?

- A. growth
- B. energy use
- C. organization
- D. homeostasis

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.

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

- A. skin
- B. liver
- C. heart
- D. pancreas



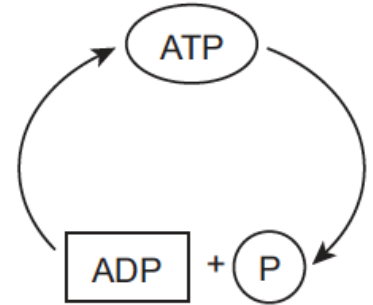
12) Which statement best describes how antibiotics affect cellular homeostasis?

- A. Antibiotics remove chloroplasts from plant cells to cause starvation.
- B. Antibiotics interfere with the transport of intracellular and extracellular materials.
- C. Antibiotics increase the rate of DNA replication in human cells by forming nucleotides.
- D. Antibiotics decrease the rate of cellular respiration in animal cells by producing oxygen.

CONSTRUCTED-RESPONSE QUESTIONS

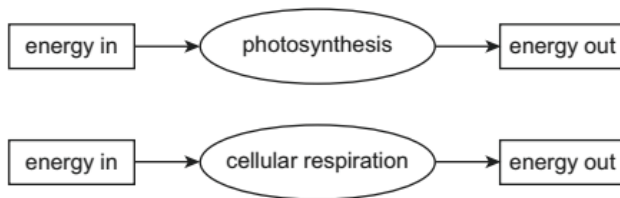
1. USE THE FOLLOWING DIAGRAM TO ANSWER 1A AND 1B...

1A Explain why ATP is important in biochemical reactions.



1B Give two examples of biochemical reactions and explain how an organism uses ATP within the reactions.

2. USE THE FOLLOWING DIAGRAM TO ANSWER 2A AND 2B...



2A: Complete the chart below by describing energy transformations involved in each process.

Process	Energy Transformations
Photosynthesis	
Cellular Respiration	

2 B: Describe how energy transformations involved in photosynthesis are related to energy transformations involved in cellular respiration.

3. 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.

3A: Identify the process in the cell membrane that produces this difference in concentration.

3B: Explain the process that occurs as the cell produces the ion concentration gradient.

3C: Compare the process of potassium ion transport to another mechanism that moves material across the plasma membrane.

4. During physical education class, some students ran one mile. After their run, the students recorded changes they experienced.

Select three changes experienced by the students and explain how each change can represent a homeostatic mechanism.

- | Changes Experienced |
|------------------------------|
| • sweating |
| • muscle cramps |
| • decreased energy |
| • increased heart rate |
| • increased breathing rate |
| • increased thirst |
| • increased body temperature |

CHANGE 1:

CHANGE 2:

CHANGE 3:

CELL DIVISION- MEIOSIS AND MITOSIS

A	Cell Cycle	E	Cytokinesis	I	Interphase
B	Chromosomal Mutation	F	Deoxyribonucleic Acid (DNA)	J	Meiosis
C	Chromosomes	G	DNA Replication	K	Mitosis
D	Crossing-Over	H	Gamete	L	Nondisjunction

1. _____ An exchange of genetic material between homologous chromosomes during anaphase I of meiosis; contributes to the genetic variability in gametes and ultimately in offspring.
2. _____ The process in which DNA makes a duplicate copy of itself.
3. _____ The process in which sister chromatids fail to separate during and after mitosis or meiosis.
4. _____ A change in the structure of a chromosome (e.g., deletion, duplication, inversion and translocation).
5. _____ A single piece of coiled DNA and associated proteins found in linear forms in the nucleus of eukaryotic cells and circular forms in the cytoplasm of prokaryotic cells; contains genes that encode traits.
6. _____ A nuclear division resulting in the production of two somatic cells having the same genetic complement as the original cell.
7. _____ The longest-lasting phase of the cell cycle in which a cell performs the majority of its functions, such as preparing for nuclear division and cytokinesis.
8. _____ The final phase of a cell cycle resulting in the division of the cytoplasm.
9. _____ A two-phase nuclear division that results in the eventual production of gametes with half the normal number of chromosomes.
10. _____ A specialized cell (egg or sperm) used in sexual reproduction containing half the normal number of chromosomes of a somatic cell.

DNA / RNA REPLICATION

A	Frame-shift Mutation	D	Protein Synthesis	G	Translation
B	Mutation	E	Semiconservative Replication	H	Translocation
C	Point Mutation	F	Transcription		

1. _____ The process in which a strand of messenger RNA (mRNA) is synthesized by using the genetic information found on a strand DNA as a template.
2. _____ The process in which amino acids are arranged in a linear sequence through the processes of transcription of DNA and to RNA and the translation of RNA to a polypeptide chain.
3. _____ The process in which a segment of a chromosome breaks off and attaches to another chromosome.
4. _____ The process in which the DNA molecule uncoils and separates into two strands. Each original strand becomes a template on which a new strand is constructed, resulting in two DNA molecules identical to the original DNA molecule.
5. _____ The addition (insertion mutation) or removal (deletion mutation) of one or more nucleotides that is not indivisible by three, therefore resulting in a completely different amino acid sequence than would be normal. The earlier in the sequence nucleotides are added or removed, the more altered the protein will be.

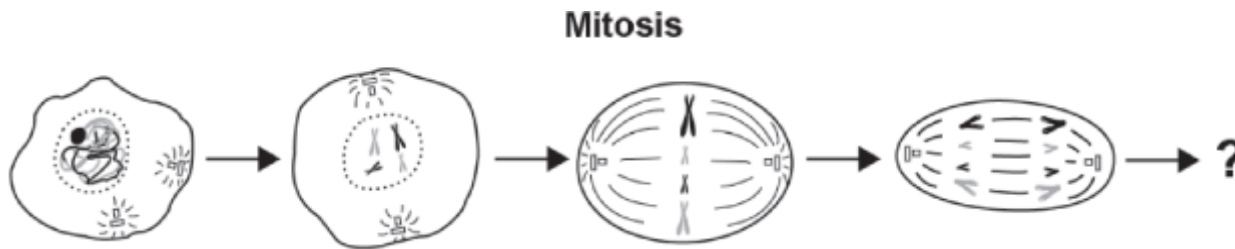
GENETICS

A	Allele	I	Gene Splicing	Q	Inheritance
B	Biotechnology	J	Gene Therapy	R	Migration (Genetics)
C	Cloning	K	Genetic Drift	S	Multiple Alleles
D	Co-dominance	L	Genetic Engineering	T	Phenotype
E	Dominant Inheritance	M	Genetically Modified Organism	U	Polygenic Trait
F	Gene	N	Genetics	V	Recessive Inheritance
G	Gene Expression	O	Genotype	W	Selective Breeding
H	Gene Recombination	P	Incomplete Dominance	X	Sex-linked Trait

1. _____ A pattern of inheritance in which the phenotypic effect of one allele is completely expressed within a homozygous and heterozygous genotype.
2. _____ A natural process in which a nucleic acid molecule (usually DNA but can be RNA) is broken and then joined to a different molecule; a result of crossing-over.
3. _____ A technology that includes the process of manipulating or altering the genetic material of a cell resulting in desirable functions or outcomes that would not occur naturally.
4. _____ The observable expression of a genotype.
5. _____ A variation of a gene's nucleotide sequence (an alternative of a gene).
6. _____ The scientific study of inheritance.
7. _____ A trait, associated with a gene that is carried by either the male or female parent (e.g., color blindness and sickle-cell anemia).
8. _____ Any procedure or methodology that uses biological systems or living organisms to develop or modify either products or processes for specific use. This term is commonly associated with genetic engineering, which is one of many applications.
9. _____ A change in the allele frequency of a population as a result of chance events rather than natural selection.
10. _____ An organism whose genetic material has been altered through some genetic engineering technology or technique.
11. _____ A process in which a cell, cell product, or organism is copied from an original source.
12. _____ The genetic composition of an organism with reference to a single trait, a set of traits, or the entire complement of traits of an organism.
13. _____ A pattern of inheritance in which the phenotypic effect of two alleles in a heterozygous genotype express each phenotype of each allele fully and equally; a phenotype which would not be expressed in any other genotypic combination.
14. _____ A trait in which the phenotype is controlled by two or more genes at different loci on different chromosomes.
15. _____ The intentional insertion, alteration, or deletion of genes within an individual's cell and tissues for the purpose of treating a disease.

16. _____ A pattern of inheritance in which two alleles, inherited from the parents, are neither dominant nor recessive. The resulting offspring have a phenotype that is a blending of the parental traits.
17. _____ A sequence of nucleotides composing a segment of DNA that provides a blueprint for a specific hereditary trait.
18. _____ A pattern of inheritance in which the phenotypic effect of one allele is only expressed within a homozygous genotype. In a heterozygous condition with a dominant allele, it is not expressed in the phenotype.
19. _____ The process of breeding organisms that results in offspring with desired genetic traits.
20. _____ A type of gene recombination in which the DNA is intentionally broken and recombined using laboratory techniques.

Use the diagram below to answer question 1.



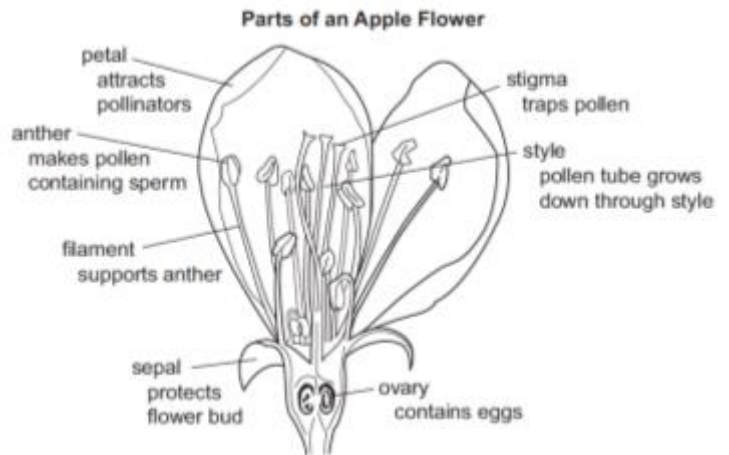
- Which event most likely occurs next in mitosis?
 - The chromatin condenses.
 - The nuclear envelope dissolves.
 - The chromosomes double in number.
 - The cell membrane pinches inward to divide the cytoplasm.
- Mitosis and meiosis are processes by which animal and plant cells divide. Which statement best describes a difference between mitosis and meiosis?
 - Meiosis is a multi-step process.
 - Mitosis occurs only in eukaryotic cells.
 - Meiosis is used in the repair of an organism.
 - Mitosis produces genetically identical daughter cells.
- A scientist observes that a certain trait is determined by a single allele. An organism inherited one version of the trait from one parent and another version from the other parent. Both versions of the trait are expressed in the phenotype of the offspring. Which pattern of inheritance best classifies the observed trait?
 - dominance
 - sex-linkage
 - co-dominance
 - incomplete dominance
- The bacterium *Acetobacter aceti* is found in acidic environments and has an acidic cytoplasm. For this reason, most of its proteins are able to function in acidic conditions. This property distinguishes *Acetobacter aceti* proteins from those of most other organisms. Which characteristic does *Acetobacter aceti* most likely share with other organisms?
 - the method that the organism uses to reproduce itself
 - the physical and chemical responses to environmental changes
 - the type of organelle used to produce energy for cellular functions
 - the process used to form proteins by transcription and translation

5. A mutation occurs at the midpoint of a gene, altering all amino acids encoded after the point of mutation. Which mutation could have produced this change?
- deletion of two nucleotides
 - deletion of three nucleotides
 - insertion of six nucleotides
 - insertion of twelve nucleotides

6. Which statement best describes the relationship between an allele and a gene?
- An allele is a variation of a gene that can be expressed as a phenotype.
 - An allele is the part of a gene that attaches to messenger RNA molecules.
 - An allele is a segment of a DNA molecule that controls replication of a gene.
 - An allele is the primary protein made by a gene found in a developing embryo.

7. Which part of the apple flower produces cells by meiosis?

- style
- anther
- stigma
- filament



8. A trait in cows is determined by two alleles of a single gene: allele R is dominant, and allele r is recessive. What is the probability of the dominant trait being expressed in the offspring of one RR parent and one rr parent?

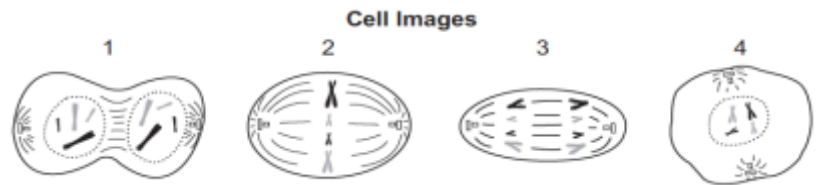
- 25%
- 50%
- 75%
- 100%

9. Which form of genetic engineering was used by humans for many years before the discovery of DNA?

- gene splicing
- gene insertion
- animal cloning
- selective breeding

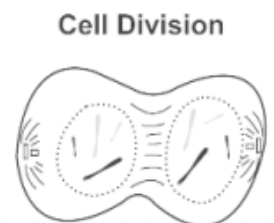
10. Which sequence lists the cell images in chronological order for mitosis?

- 1, 2, 3, 4
- 4, 3, 2, 1
- 1, 4, 3, 2
- 4, 2, 3, 1



11. Which statement best describes the phase of the cell cycle shown?

- The cell is in prophase of mitosis because the number of chromosomes has doubled.
- The cell is in prophase I of meiosis because the number of chromosomes has doubled.
- The cell is in telophase of mitosis because the cell is separating and contains two copies of each chromosome.
- The cell is in telophase of meiosis because the cell is separating and contains two copies of each chromosome.



12. Which process helps to preserve the genetic information stored in DNA during DNA replication?
- the replacement of nitrogen base thymine with uracil
 - enzymes quickly linking nitrogen bases with hydrogen bonds
 - the synthesis of unique sugar and phosphate molecules for each nucleotide
 - nucleotides lining up along the template strand according to base pairing rules

13. 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?

- phenotypes O or A
- phenotypes A or AB
- phenotypes A, B, AB
- phenotypes O, A, B, AB

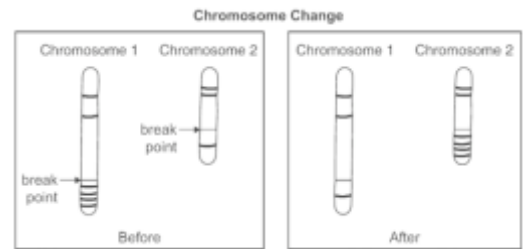
Genotype(s)	Phenotype
ii	O
$I^A I^A, I^A i$	A
$I^B I^B, I^B i$	B
$I^A I^B$	AB

14. 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?

- red and white alleles present on one chromosome
- red and white alleles present on two chromosomes
- a red allele present on both homologous chromosomes
- a red allele present on at least one of two homologous chromosomes

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

- deletion
- insertion
- inversion
- translocation



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

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

17. 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?

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

18. 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?

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

CONSTRUCTED-RESPONSE QUESTIONS

1. A Trichoplax is a simple multicellular animal that lives in water. This animal can reproduce asexually by simply dividing into two organisms.

1A: Describe a cellular division process that could be used by Trichoplax when it reproduces asexually.

1B: Describe one benefit and one limitation of how the Trichoplax can reproduce by simply dividing.

2. Patau syndrome can be a lethal genetic disorder in mammals, resulting from chromosomes failing to separate during meiosis.

2A: Identify the step during the process of meiosis when chromosomes would most likely fail to separate.

2B: Describe how chromosome separation in meiosis is different from chromosome separation in mitosis.

2C: Compare the effects of a disorder caused by chromosomes failing to separate during meiosis, such as Patau syndrome, to the effects of chromosomes failing to separate during mitosis.

3. 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.

3 A: Although a farm has cattle in all three colors, the farmer prefers roan cattle over white or red cattle. Use a Punnett square to show a cross that would produce only roan offspring.

3B. 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.

3C. Predict the possible genotypes and phenotypes of the offspring produced from two roan cattle.

ECOLOGY TERMS

A	Abiotic	K	Decomposer	U	Non-native Species
B	Agriculture	L	Ecology	V	Population
C	Aquatic	M	Ecosystem	W	Population Dynamics
D	Biogeochemical Cycles	N	Endemic Species	X	Producer (ecological)
E	Biome	O	Energy Pyramid	Y	Species
F	Biosphere	P	Environment	Z	Succession
G	Biotic	Q	Food Chain	AA	Symbiotic Relationship
H	Community (Ecological)	R	Food Web	BB	System
I	Competition	S	Habitat	CC	Terrestrial
J	Consumer (Ecological)	T	Limiting Factor	DD	Trophic Level

1. _____ The movement of abiotic factors between the living and nonliving components within ecosystems; also known as nutrient cycles (i.e., water cycle, oxygen cycle, and nitrogen cycle).
2. _____ The zone of life on Earth; sum total of all ecosystems on Earth.
3. _____ A term that describes a nonliving factor in an ecosystem.
4. _____ A species that is found in its originating location and is generally restricted to that geographic area.
5. _____ An organism that obtains nutrients by consuming dead and decaying organic matter which allows nutrients to be accessible to other organisms.
6. _____ Chemical or physical factor that limits the existence, growth, abundance, or distribution of an individual organism or a population.
7. _____ The artificial cultivation of food, fiber, and other goods by the systematic growing and harvesting of various organisms.
8. _____ An area that provides an organism with its basic needs for survival.
9. _____ A complex arrangement of interrelated food chains illustrating the flow of energy between interdependent organisms.
10. _____ An organism that obtains energy by feeding on other organisms or their remains.
11. _____ The position of an organism in relation to the flow of energy and inorganic nutrients through an ecosystem (e.g., producer, consumer, and decomposer).
12. _____ Different populations of organisms interacting in a shared environment.
13. _____ The lowest taxonomic level of biological classification consisting of organisms capable of reproduction that results in fertile offspring.
14. _____ A set of interacting or interdependent components, real or abstract, that form an integrated whole. An open system is able to interact with its environment. A closed system is isolated from its environment.
15. _____ A system composed of organisms and nonliving components of an environment.

16. _____ A relationship between two organisms (i.e., mutualism, in which both organisms benefit; parasitism, in which one organism benefits and the other organism is harmed; and commensalism, in which one organism benefits and the other organism does not benefit or is harmed).
17. _____ An organism that uses a primary energy source to conduct photosynthesis or chemosynthesis.
18. _____ A species normally living outside a distribution range that has been introduced through either deliberate or accidental human activity; also can be known as introduced, invasive, alien, nonindigenous, or exotic.
19. _____ A group of individuals of the same species living in a specific geographical area and reproducing.
20. _____ The total surroundings of an organism or a group of organisms.

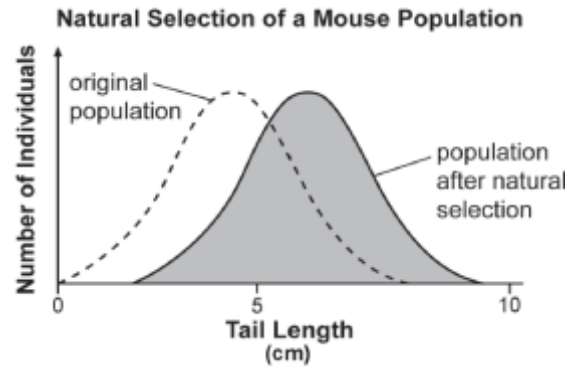
EVOLUTION

A Allele Frequency	E Fossils	I Natural Selection
B Embryology	F Founder Effect	J Punctuated Equilibrium
C Evolution	G Gradualism	K Speciation
D Extinction	H Isolating Mechanisms	

1. _____ A process in nature in which organisms possessing certain inherited traits are better able to survive and reproduce compared to others of their species.
2. _____ The measure of the frequency of an allele at a genetic locus in a population; expressed as a proportion of percentage.
3. _____ A process typically caused by the genetic isolation from a main population resulting in a new genetically distinct species.
4. _____ A proposed explanation in evolutionary biology stating that new species arise from the result of slight modifications (mutations and resulting phenotypic changes) over many generations.
5. _____ The branch of zoology studying the early development of living things.
6. _____ The preserved remains or traces of organisms that once lived on Earth.
7. _____ A proposed explanation in evolutionary biology stating that species are generally stable over long periods of time. Occasionally there are rapid changes that affect some species which can quickly result in a new species.
8. _____ A process in which new species develop from preexisting species (biological evolution or macroevolution); a change in the allele frequencies of a population of organisms from generation to generation (genetic evolution or microevolution).
9. _____ A decrease in genetic variation caused by the formation of a new population by a small number of individuals from a larger population.
10. _____ A term that typically describes a species that no longer has any known living individuals.

- The frequency of an allele in a fly population changes from 89% to 20% after three generations. Which other events most likely occurred during the same time period?
 - an environmental change and a fly population increase
 - an environmental change and a fly population decrease
 - interbreeding of flies with an invasive species and fly population speciation
 - interbreeding of flies with an established local species and fly population speciation

- Tail length in mice varies within a population. Scientists observed change in the distribution of tail lengths in a mouse population over time. At the genetic level, what has most likely happened to the allele for the shortest tail lengths?
 - The allele changed from being dominant to being recessive.
 - The allele changed from being autosomal to being sex-linked.
 - The allele became less frequent than the alleles for longer tail lengths.
 - The allele began to code for long tail lengths instead of the shortest ones.



Students' Observations of a Pond Ecosystem

Quantitative	Qualitative
37 fish and 3 frogs	Leaves lie on the bottom of the pond.
2 types of aquatic grass	Water insects move along the water's surface.
12 small rocks and 1 medium rock	All 3 frogs are sitting on a pond bank.
sand	

- A group of students measured a ten-square-meter section of a pond ecosystem and recorded observations. Which statement is a testable hypothesis?
 - The frogs living in the pond represent a population.
 - Water is an abiotic component in the pond ecosystem.
 - If the fish are given more food, then they will be happier.
 - If the frogs are startled, then they will jump into the water.
- A researcher observing an ecosystem describes the amount of sunlight, precipitation, and type of soil present. Which factors is the researcher most likely describing?
 - biotic factors in a forest
 - biotic factors in a tundra
 - abiotic factors in a prairie
 - abiotic factors in an ocean
- Scientists observed that the populations of top-level consumers in a particular ecosystem were rapidly decreasing. Further studies revealed that there was also a decline in producer productivity. Which other changes did the scientists most likely observe in the ecosystem?
 - increased producer diversity
 - decreased population size at all levels
 - decreased primary consumer populations only
 - increased primary and secondary consumer diversity

6. Overuse of antibiotics has caused antibiotic resistance in some bacteria in a population. Which statement describes the most likely impact of natural selection on the bacterial population?

- A. Beneficial mutations have decreased, resulting in a larger population than normal.
- B. Only the genes for antibiotic resistance are now expressed, eliminating other genes.
- C. More antibiotic-resistant bacteria have survived, resulting in more offspring with this trait.
- D. The bacteria have become genetically isolated, resulting in decreased reproductive rates.

7. A student studying the biosphere makes a list of biotic and abiotic characteristics of various biomes. Which characteristic is considered a biotic factor?

- A. dry, sandy, nutrient-poor soil in a desert
- B. less than 25 cm of precipitation in a desert
- C. evergreen trees present in a coniferous forest
- D. temperature range of -40 to 40°C in a grassland

8. Which example describes a mutualistic relationship between organisms?

- A. Young wasps prey on caterpillars.
- B. Crabs eat the remains of dead fish.
- C. Ants protect a tree on which they feed.
- D. Tapeworms feed on food in the intestines of cats.

9. Most of the water on Earth is located in the oceans and has a salinity of about 3.5%. Which statement best explains why rain is fresh water and has a very low salinity?

- A. When water precipitates from oceans, most of the salt remains in the oceans.
- B. When water evaporates from oceans, most of the salt remains in the oceans.
- C. When water precipitates from clouds, most of the salt remains in the clouds.
- D. When water evaporates from clouds, most of the salt remains in the clouds.

10. Why are nonnative species often considered a disturbance in an ecosystem?

- A. They increase mutations.
- B. They compete for resources.
- C. They have special growth needs.
- D. They cause increased biodiversity.

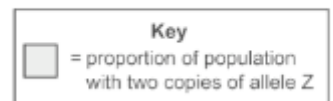
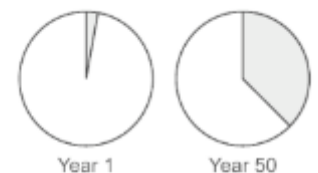
11. In North America, the eastern spotted skunk mates in late winter, and the western spotted skunk mates in late summer. Even though their geographic ranges overlap, the species do not mate with each other. What most likely prevents these two species from interbreeding?

- A. habitat isolation
- B. gametic isolation
- C. geographic isolation
- D. reproductive isolation

13. The graphs illustrate change in a lizard population over time. Which process most likely led to the change in the lizard population?

- A. natural selection acting on a harmful trait
- B. natural selection acting on a beneficial trait
- C. natural selection acting on a dominant trait
- D. natural selection acting on a recessive trait

Changes in Allele Frequency Over Time

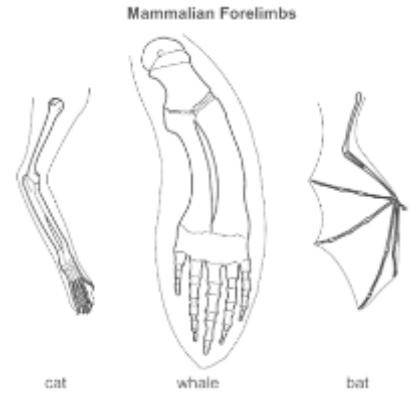


12. A mutation occurs in the genes that code for coat color in deer. Which change will most likely result from this mutation?

- A. a change in the selection pressures acting on coat color
- B. a change in the coat-color genes of deer predator species
- C. an increase in coat-color diversity in the population
- D. an increase in the number of genes for coat color in the population

14. The skeletons of mammalian forelimbs represent variations of a structure that was present in their common ancestor. What has most likely caused the variation in forelimbs?

- A. changes in muscle structure
- B. changes in the genetic codes
- C. trait formation due to behaviors
- D. development of vestigial structures



15. A researcher observing an ecosystem describes the amount of sunlight, precipitation, and type of soil present. Which factors is the researcher most likely describing?

- A. biotic factors in a forest
- B. biotic factors in a tundra
- C. abiotic factors in a prairie
- D. abiotic factors in an ocean

16. A student wrote several observations in a field notebook. Which term best classifies all of the student's observations?

- A. population
- B. food chain
- C. ecosystem
- D. community

Observations

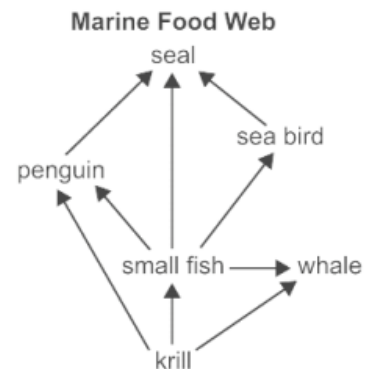
- two grey wolves
- five moose
- several species of conifer trees
- large granite rock
- shallow pond

17. A species of snapping turtles has a tongue that resembles a worm. The tongue is used to attract small fish. Which best describes the interaction between the fish and the snapping turtle?

- A. predation
- B. symbiosis
- C. parasitism
- D. competition

18. Which sequence correctly describes the flow of energy between organisms in the marine food web?

- A. from seals to penguins to krill
- B. from whales to krill to small fish
- C. from sea birds to seals to penguins
- D. from small fish to penguins to seals



19. Which statement correctly describes how nitrogen in the soil returns to the atmosphere?

- A. Soil bacteria convert nitrates into nitrogen gas.
- B. Decomposers directly convert ammonium into nitrogen gas.
- C. Plants assimilate nitrites and convert them into nitrogen gas.
- D. Nitrogen-fixing bacteria in plant roots convert nitrates into nitrogen gas.

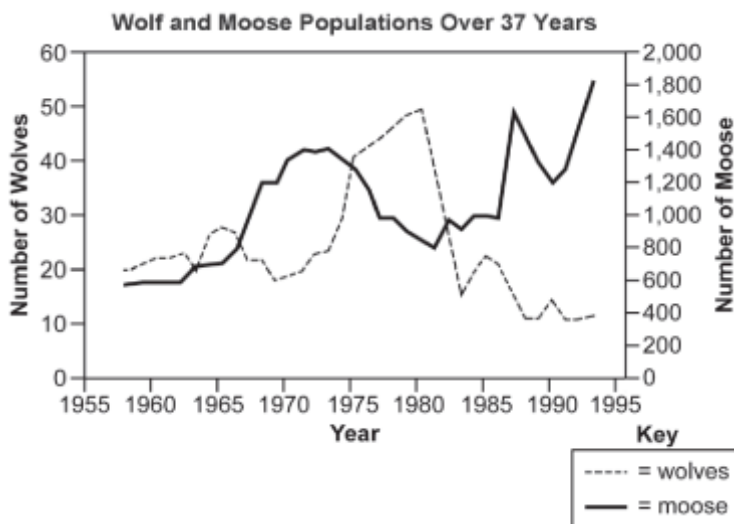
20. Agricultural runoff can carry fertilizers into lakes and streams. This runoff can cause algae populations to greatly increase. Which effect does this change in the algae population sizes most likely have on affected lakes and streams?

- A. an increase in water level
- B. an increase in water clarity
- C. a reduction in dissolved oxygen needed by fish and shellfish
- D. a reduction in temperature variations near the water's surface

21. A farmer observed that an increase in a field's soil nitrogen content was followed by an increase in producer productivity. What does this observation most likely indicate about the relationship between nitrogen and the producers in the field?

- A. Nitrogen was a biotic factor.
- B. Nitrogen was a limiting factor.
- C. Nitrogen became a surplus resource.
- D. Nitrogen became a selection pressure.

CONSTRUCTED-RESPONSE QUESTION



1. Isle Royale is located in Lake Superior. Isle Royale is home to populations of wolves and moose. The interactions between the wolves and moose, as well as the individual population sizes, have been studied since 1958. The graph shows the population sizes over time for both wolves and moose.

1A: Describe one limiting factor for the moose population.

1B: Explain one likely reason why the wolf population rapidly increased between 1975 and 1980.

1C: Predict what will happen to the moose population's size after 1994 by describing the shape of the curve. In your answer, be sure to explain the reasoning behind your prediction.

Organism Relationships in an Ecosystem

Animal	Food Sources	Predators
beaver	tree bark, twigs, leaves, and roots; pond lilies	coyote, wolf, eagle, black bear
warbler birds	insects, earthworms, fruit	eagle, coyote, hawk
black bear	fish, insects, fruit, small mammals, eggs, carrion	brown bear, wolf

2. An ecosystem includes the organisms listed in the table.

2A: Identify the initial source of energy for the ecosystem.

2B: Using the table, complete a food chain that includes a producer, a primary consumer, and a secondary consumer.

2C: The number of beavers in this ecosystem suddenly decreases. Describe the effect this may have on one other organism.

3. The gene COII is in the genome of many organisms. A comparison of the number of base differences between the COII gene in a rat and that of two other animals is shown.

Sequence Differences between COII Genes in Some Animals

Animal	Number of Base Differences from a Rat
mouse	101
cow	136

3A: Based on the data, describe a possible evolutionary relationship between rats, mice, and cows.

3B: Describe how different organisms having a common gene such as COII supports the theory of evolution.

3C: The COII gene of a monkey has 203 base differences from the same gene in a rat and 210 base differences from the same gene in a mouse. Compare the evolutionary relationships between the monkey, the rat, and the mouse.