"End-of-Course" Biology Exam Must Knows

Useful Review Materials to Help You Study Include…

Biology

1. Bozeman Science, Amoeba Sisters, CrashCourse Biology 2.0 & 1.0 Review Videos
   - http://www.bozemanscience.com/biology-main-page/
   - https://www.youtube.com/@AmoebaSisters/videos
   - https://www.youtube.com/watch?v=PWGBqskV1UQ&list=PL8dPuuaLjXtPW_ofbxdHNciuLoTRLPMgB
   - https://www.youtube.com/watch?v=gMOoMcsGTO4&list=PL3EED4C1D684D3ADF

2. Your AUC Class Lecture Slides

3. Student-Purchased Test Prep Book for A.P. Biology Exam – (what you used to study for your AP exam)

4. Select EOC Prep Handouts posted in Archie

5. Practice Questions with Answers & Review Videos for each Exam Focus Area

   Go to column 2 and click on the links starting with names SC.912 under these four headings:

   1. NATURE OF SCIENCE (throughout test)
   2. MOLECULAR AND CELLULAR BIOLOGY (35% of test)
   3. ORGANISMS, POPULATIONS AND ECOSYSTEMS (40% of test)
   4. CLASSIFICATION, HEREDITY AND EVOLUTION (25% of test)

   Under each link you will find practice questions in column 3 and review videos in column 4.

   - https://www.escambiaschools.org/departments/science/biology-end-of-course-review/biology-eoc-review

EOC Biology Sample Questions

(For Answers: See Bullet #5 above)

Sample Item 1 **SC.912.N.1.1**

An osmosis investigation was conducted using chicken eggs to represent cells with semipermeable membranes. The mass of each egg was measured to determine how much water diffused into or out of the eggs. The eggs were first soaked in vinegar to dissolve the shell. Each egg was then placed in one of three different solutions for 24 hours. The table below shows the results of the investigation.

OSMOSIS IN CELLS

Solution	Average Mass of Eggs Before Soaking (grams)	Average Mass of Eggs After Soaking (grams)	Difference in Average Mass (grams)	Percent Change in Average Mass
Vinegar (95% water)	71.2	98.6	27.4	+38.5
Corn syrup (5% water)	98.6	64.5	34.1	-34.6
Distilled water (100% water)	64.5	105.3	40.8	+63.3

Based on this experiment, which of the following should be inferred about cells with semipermeable membranes?

A. Substances other than water may also cross the cell membrane.
B. Substances other than water may block pores in the cell membrane.
C. Water enters the cell when placed in environments of high water concentration.
D. Water leaves the cell when placed in environments with a low concentration of solutes.

Sample Item 2 **SC.912.L.14.1**

The cell theory was first proposed in 1838. Evidence obtained through additional scientific investigations resulted in the current cell theory. Which statement describes a component of the original cell theory that was removed because of the new scientific knowledge?

A. All living things are made of cells.
B. All cells come from other preexisting cells.
C. Cells form through spontaneous generation.
D. Cells are the basic structural and functional units of life.

Sample Item 3 **SC.912.L.14.3**

There are some similarities between prokaryotic and eukaryotic cells. Which of the following structures is found in both prokaryotic and eukaryotic cells?

A. lysosome
B. mitochondrion
C. nucleus
D. ribosome

Sample Item 4 **SC.912.L.14.7**

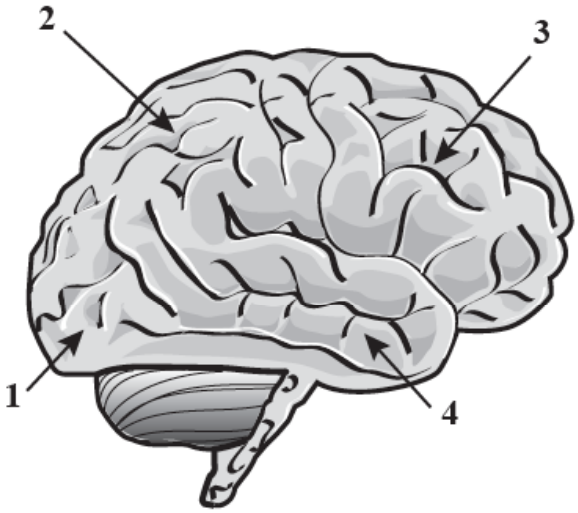
Terrestrial plants have stomata on the surface of their leaves. A single stoma is surrounded by two guard cells that change shape in response to environmental factors and open or close the stoma. Which of the following **best** explains how the structure of the leaf is used in processes that occur in the plant?

A. Water enters the plant through the surface of the leaf for transpiration.
B. Gases for photosynthesis are exchanged through the surface of the leaf.
C. Energy for cellular reproduction is absorbed through the surface of the leaf.
D. Carbon dioxide enters the plant through the surface of the leaf for cellular respiration.

Sample Item 5 **SC.912.L.14.26**

The illustration below shows four lobes of the human brain.

Four Lobes of the Human Brain



What lobe is designated by label 2?

A. temporal
B. parietal
C. occipital
D. frontal

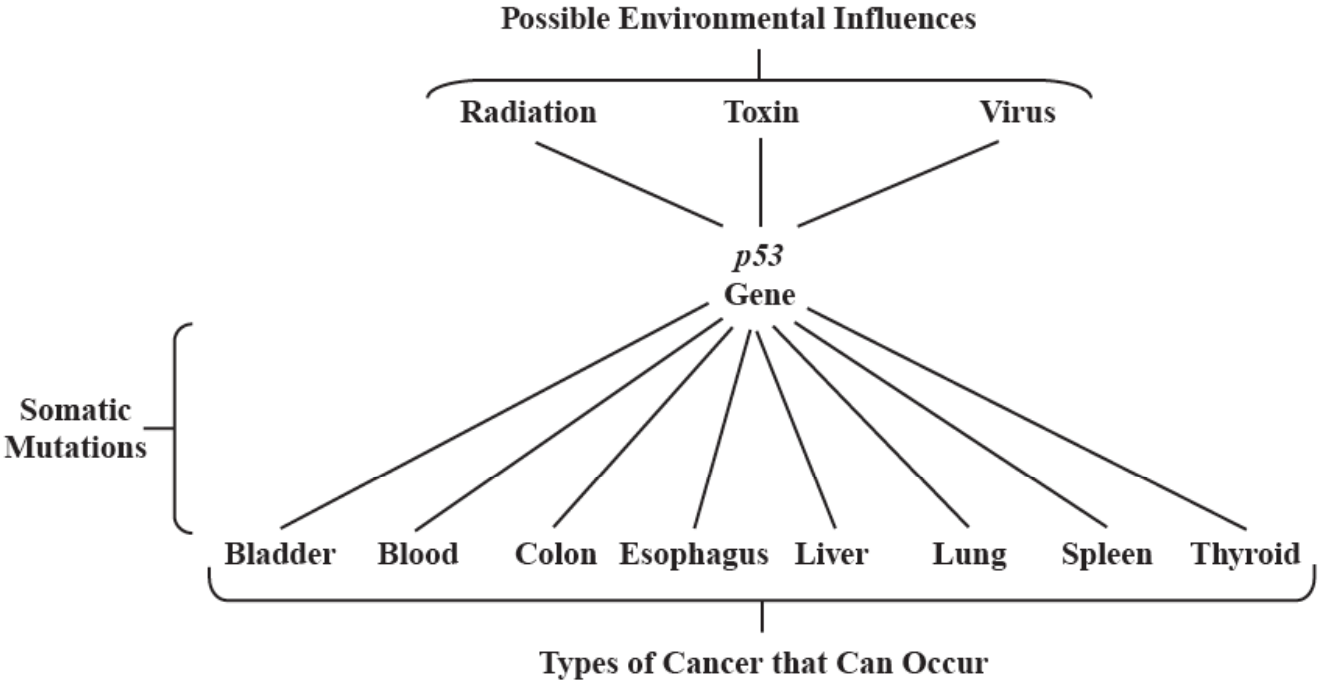
Sample Item 6 **SC.912.L.14.36**

The rate at which blood flows through the human body changes in response to many factors. Which statement describes one of these factors and its effect on blood flow?

A. A high viscosity of blood causes an increased resistance in the blood vessels and leads to slow blood flow.
B. A low blood pH decreases the rate of diffusion through the blood vessels and leads to slow blood flow.
C. The changing of the shape of red blood cells to a crescent shape decreases resistance and leads to a faster blood flow.
D. The narrowing of blood vessels increases pressure and leads to a faster blood flow.

Sample Item 7 **SC.912.L.14.6**

The *p53* gene codes for the p53 protein that locates DNA errors for cellular repair. The diagram below shows the relationships among possible environmental influences, the *p53* gene, and cancer.

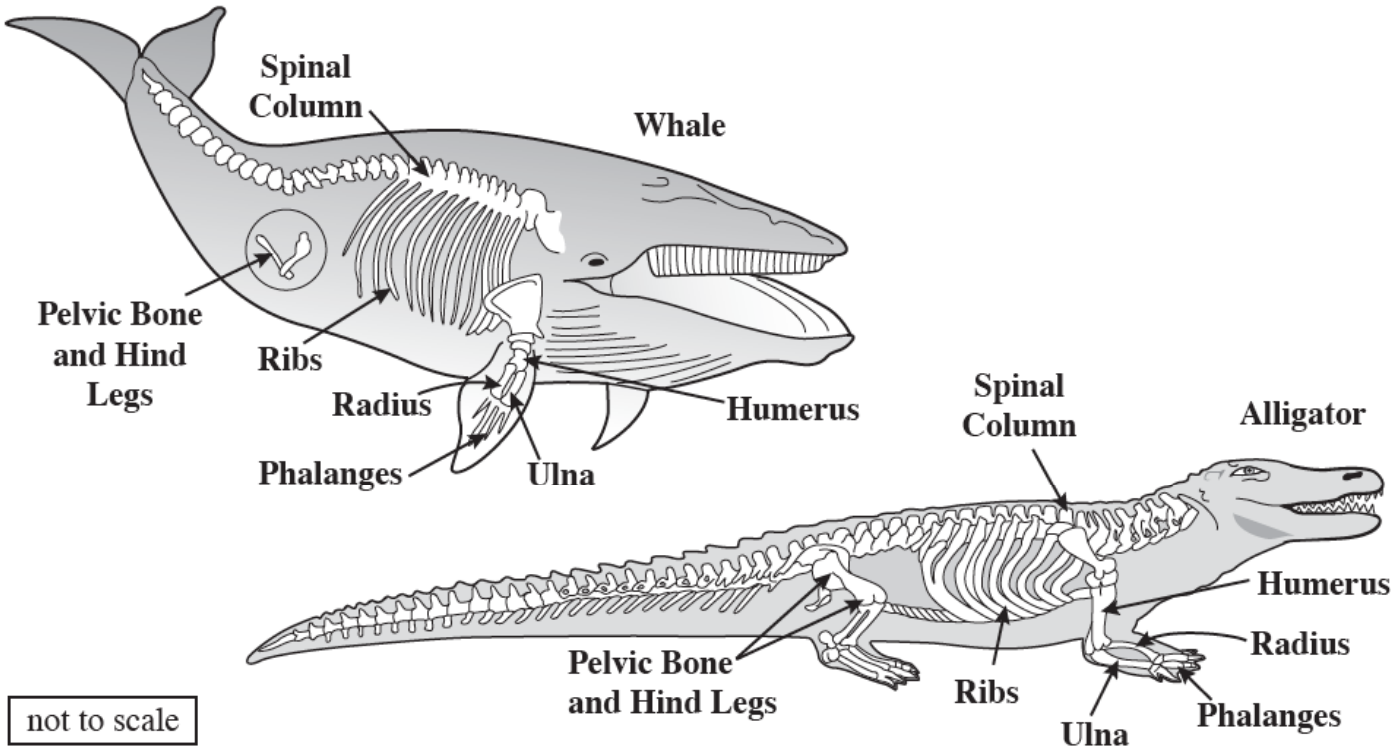


Which of the following statements **best** describes the relationships among possible environmental influences, the *p53* gene, and cancer?

A. Environmental influences can lead to mutations in the *p53* gene, which can cause certain cancers.
B. Increased levels of p53 protein, rather than environmental influences, can cause certain cancers.
C. Mutations in the *p53* gene increase environmental influences that can cause certain cancers.
D. Genes such as *p53* are less causal than environmental influences in stimulating certain cancers.

Sample Item 8 **SC.912.L.15.1**

The scientific theory of evolution is supported by different types of evidence. The diagrams below show the skeletons of two different animal species.



How does comparing the skeletons of these animals provide support for the scientific theory of evolution?

A. It provides information about the organisms' habitats.
B. It shows possible common ancestry between organisms.
C. It provides information to determine the organisms' ages.
D. It shows possible chromosomal similarities between organisms.

Sample Item 9 **SC.912.L.15.6**

Organisms classified as fungi have unique characteristics. Which of the following characteristics is found only in organisms classified in the kingdom Fungi?

A. single cells without a nucleus
B. multicellular with chloroplasts
C. multicellular filaments that absorb nutrients
D. colonies of single, photosynthetic cells that reproduce asexually

Sample Item 10 **SC.912.L.15.8**

One of the accepted scientific theories describing the origin of life on Earth is known as chemical evolution. According to this theory, which of the following events would need to occur **first** for life to evolve?

A. onset of photosynthesis
B. origin of genetic material
C. synthesis of organic molecules
D. formation of the plasma membrane

Sample Item 11 **SC.912.L.15.13**

Over time, the climate of an island became drier, which resulted in changes to the populations of various island finch species. Finch populations with a certain beak shape thrived, while those not having that beak shape decreased. Which of the following describes a necessary condition for these changes in the finch populations to occur?

A. fewer mutations
B. limited food resources
C. limited beak variations
D. overproduction of offspring

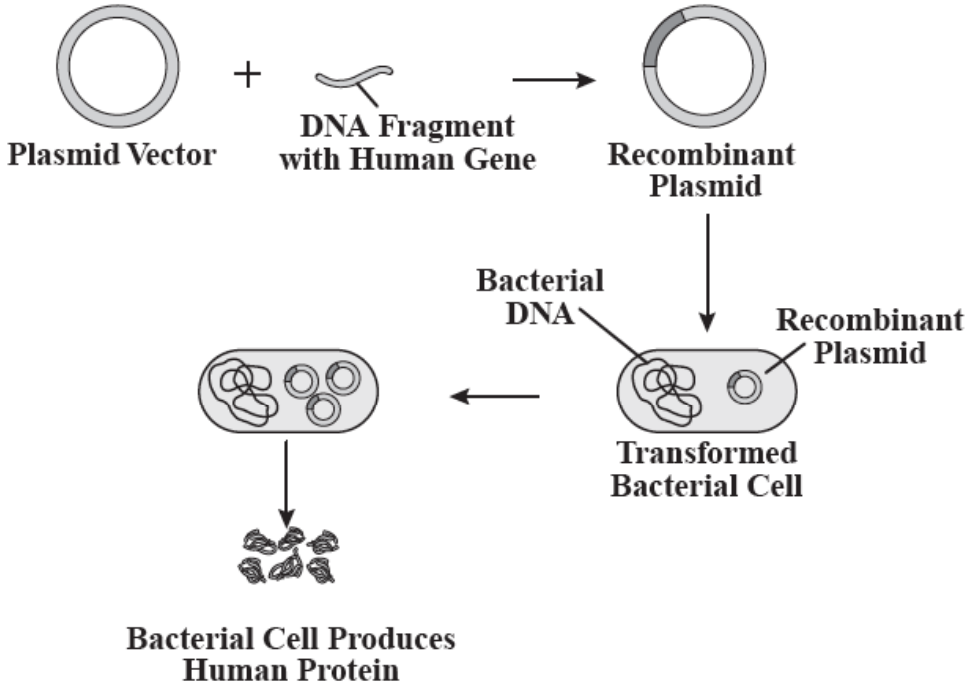
Sample Item 12 **SC.912.L.16.2**

Hemophilia is a sex-linked, recessive trait. Which of the following describes the probability of hemophilia in the offspring of a man who does not have hemophilia and a woman whose father is a hemophiliac?

A. Each of their sons will have hemophilia.
B. None of their daughters will have hemophilia.
C. Their sons have a 25% chance of having hemophilia.
D. There is a 50% chance that their daughters will have hemophilia.

Sample Item 13 **SC.912.L.16.9**

Genes for medically important proteins can be cloned and inserted into bacteria, as shown in the diagram below.



Why can bacteria recognize a human gene and then produce a human protein?

A. DNA replication in bacteria and humans is the same.
B. Bacterial cells contain the same organelles as human cells.
C. The basic components of DNA are the same in humans and bacteria.
D. Bacterial cells and human cells contain the same kind of chromosomes.

Sample Item 14 **SC.912.L.16.10**

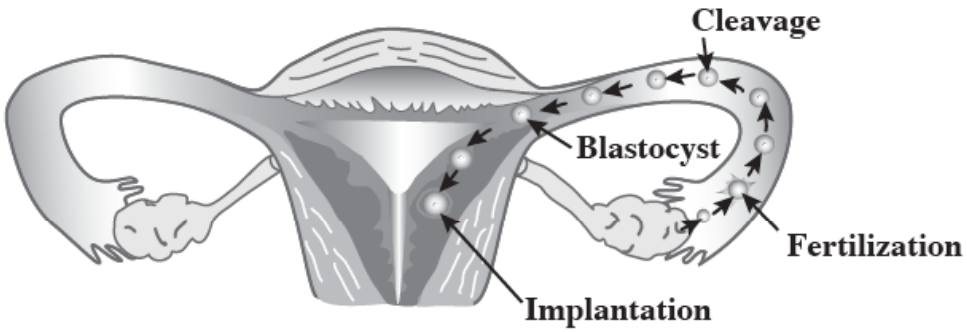
While genetic engineering has positive benefits, there are also concerns associated with widespread use of genetic engineering in agriculture. If many farmers begin to plant more genetically modified crops that have an increased tolerance to insects, which of the following may result?

A. an increase in the use of pesticides
B. a decrease in genetic diversity of the crops
C. an increase in the contamination of the water supply
D. a decrease in crop productivity on these treated fields

Sample Item 15 **SC.912.L.16.13**

A fertilized egg undergoes several stages before it is successfully implanted. The diagram below shows these stages as the fertilized egg travels through the female human reproductive system.

Female Human Reproductive System



In which of the following structures of the female human reproductive system is the blastocyst implanted during normal human development?

A. ovary
B. uterus
C. vagina
D. amniotic sac

Sample Item 16 **SC.912.L.16.17**

Mitosis and meiosis are processes involved in cellular reproduction. Which of the following describes an event that results from mitosis but NOT meiosis?

A. two stages of cell division
B. replication of cellular genetic material
C. daughter cells that are identical to the parent cell
D. four daughter cells that are produced from each parent cell

Sample Item 17 **SC.912.L.17.5**

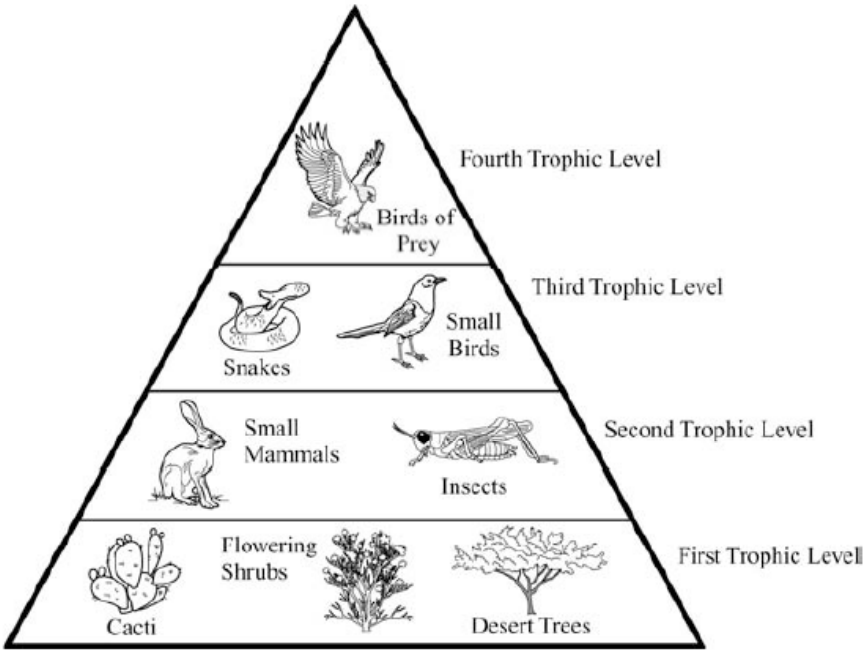
The number of pythons found throughout Everglades National Park has increased in recent years. These huge snakes are not native to Florida and are believed to have been released into the wild by pet owners. Wildlife biologists have initiated attempts to capture and remove these pythons. Which statement **best** explains the biologists' reason for removing these pythons from the Everglades?

A. The pythons could upset the territorial boundaries of native organisms.
B. The pythons could adapt to overcome diseases common to native snakes.
C. The pythons could prey on native organisms and cause native populations to decline.
D. The pythons could begin to interbreed with native snakes and produce a more successful species.

Sample Item 18 **SC.912.L.17.9**

A team of ecologists observed feeding patterns of several populations in the desert. The energy pyramid shown below depicts the feeding patterns the ecologists observed.

DESERT ENERGY PYRAMID



Which of the following **best** explains the difference in the amount of available energy in the trophic levels of the desert ecosystem?

A. There is less energy available in the producers because their tissues are less dense than those at higher trophic levels.
B. There is more energy available in the second trophic level because less energy is needed for hunting compared to the higher trophic levels.
C. There is more available energy in the birds of prey because they have greater muscle mass for storing energy than organisms in lower trophic levels have.
D. There is less available energy in the fourth trophic level because of the loss of energy through metabolism in each of the lower trophic levels.

Sample Item 19 **SC.912.L.17.20**

Salt water is an abundant resource but unusable for irrigation and drinking. As demands on freshwater sources increase, the use of desalination processes to remove salt from ocean water is increasing. A concern of desalinating water is the large amounts of recovered salts that are returned to the ocean. Which of the following describes the most likely impact of desalination on the surrounding ocean environment?

A. Methane gas would pollute the ocean environment as shoreline organisms begin to die and decay.
B. Alteration in ocean salt levels would cause loss of species and unbalanced populations in marine food webs.
C. Nonrenewable resources in the ocean environment would become depleted and upset the ecosystem's balance.
D. Increased levels of salts and minerals in the ocean would result in overpopulation of marine bivalves due to strengthened shells.

Sample Item 20 **SC.912.L.18.11**

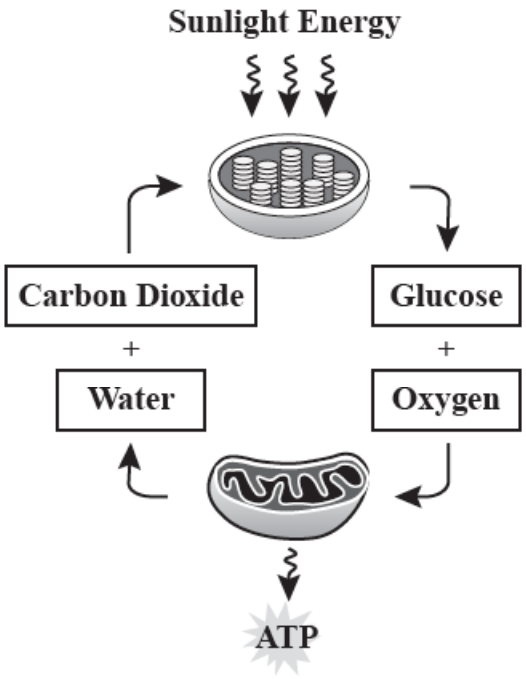
As food travels through the digestive system, it is exposed to a variety of pH levels. The stomach has a pH of 2 due to the presence of hydrochloric acid (HCl), and the small intestine has a pH ranging from 7 to 9. HCl converts pepsinogen into pepsin, an enzyme that digests proteins in the stomach. Which of the following **most likely** happens to pepsin as it enters the small intestine?

A. It becomes inactive.
B. It begins to replicate.
C. Its shape changes to engulf large proteins.
D. Its activity increases to digest more proteins.

Sample Item 21 **SC.912.L.18.9**

The diagram below shows the relationship between photosynthesis and cellular respiration and the organelles in which they occur.

Photosynthesis and Cellular Respiration



Which statement describes how photosynthesis and cellular respiration are interrelated?

A. Oxygen is produced during cellular respiration and stored during photosynthesis.
B. Carbon dioxide and water released by cellular respiration are used in photosynthesis.
C. Photosynthesis releases the energy that is stored during the process of cellular respiration.
D. Glucose is used during cellular respiration to produce food that is broken down during photosynthesis.

Sample Item 22 **SC.912.L.18.12**

Water is essential for life. Its special properties make water the single most important molecule in plant life. Which of the following properties of water enables it to move from the roots to the leaves of plants?

A. Water expands as it freezes.
B. Water is an excellent solvent.
C. Water exhibits cohesive behavior.
D. Water is able to moderate temperatures.

Work through the following bullets to see which items you should re-visit and re-study. **Then, review these items as needed using the videos listed above, your test prep books, and the class slides.**

Water

- Students will understand how the properties make water essential for life on Earth

- Students should know the structure of a water molecules
  - Students should know that the H and O in the molecule do not share electrons equally, making the *H slightly positive in charge permanently and causing the O to have two slightly negative permanently charged areas*.
  - Students should know that this allows water to attract other substances, negative charges in these substances attracting to the H's in the water molecule and positive charges in these substances attracting the negative O in the water molecule. Such substances are considered **hydrophilic.**
  - If a molecule is made of mostly Hs and C's (hydrocarbon-like) then the H's and C's share electrons equally so neither becomes permanently either positively or negatively charged. This type of molecule will not be attracted by water molecules. It will be considered **hydrophobic.**

- Students should understand that a hydrogen bond occurs when a positively charged hydrogen atom inside a molecule *(positive because it is covalently bonded to a highly electronegative atom like oxygen or nitrogen that do not share electrons equally with the hydrogen)* now attracts a negatively charged atom in a neighboring particle/substance. This weak attraction between molecules is a type of intermolecular force of attraction.

- Students will understand the properties of water and be able to explain how these properties lead water to engage in hydrogen bonding, be polar, engage in cohesive behavior (cohesion), engage in adhesion, be able to moderate temperature, expand upon freezing, and act as a versatility as a solvent.
  - Remember if hydrogen bonds form (like what happens when thermal energy is removed and steam can turn into liquid water), energy is released.
  - Remember that energy must be absorbed from the environment instead to break a hydrogen bond between water molecules (like when trying to convert liquid water into gas).
  - Because hydrogen bonding is one of the strongest of the weak intermolecular forces (forces that occur not between atoms within a molecule but between molecules), a lot of energy can be absorbed before they break and a lot of energy is released when they form.

- Students should understand that water can form up to *four* hydrogen bonds with neighboring water molecule. These weak intermolecular bonds keep breaking in liquid water due to the thermal energy present and the fact that water molecules keep moving. These weak intermolecular bonds start to become permanent under 4 degrees Celsius (when liquid water is most dense) and are permanent once water fully freezes at 0 degrees Celsius (when water molecules are held further apart, making frozen water less dense than liquid water).
  - Because of these permanent H-bonds, water molecules when frozen are held further apart than water molecules in liquid water making ice less dense than liquid water 4C or warmer. Liquid water is thus most dense at 4C.

The Nature of Science

- Students will understand the steps of the scientific method (ask questions, do background research, construct a hypothesis, test the hypothesis and resulting prediction, analyze data, support or reject your hypothesis).

- Students will know how to design and/or evaluate a scientific investigation using evidence of scientific thinking and/or problem solving.

- Students will interpret and analyze data to make predications and/or defend conclusions. Scenarios will be placed in the context of experimental design, experiments, scientific investigations, or scientific observations in the field of biology.

- Students will understand how to construct a hypothesis.
  - Remember a hypothesis is **not** a question.
  - Hypothesis should be falsifiable if indeed it is incorrect.
  - A hypothesis is a logical and tentative explanation for an observation. "Petunia plants grow more flowers when given fertilizer." The hypothesis will be tested by an experiment to see if the explanation is valid or not.

- Student will know how to set up a controlled experiment and understand the necessary parts of a controlled experiment.
  - Know that a controlled experiment should keep all variables the same except the **one** you are varying to see if it will have an effect on the one other variable you are measuring in your experiment. The variables you keep the same among all groups of subjects in an experiment are known as **constants (controlled variables).**
  - The variable you are manipulating and changing between groups of subjects is the **independent variable.**
  - The data you collect as a scientist that varies because you are varying the independent variable is the **dependent variable.**
  - **Controlled experiments** need at least two groups: one or more treatment groups (these are the groups of subjects receiving a treatment – the ones where you vary the independent variable with) and one control group (these are the subjects that do not receive the treatment being tested - they either do not get the independent variable at all or get a set amount that we expect them to get naturally).
    - Having a control group allows you to compare results (the changes in the dependent variable in the group that did not have the independent variable manipulated to the groups that did have the independent variable manipulated). This way, you can be more sure that, *IF* the dependent variable did change in the treatment groups, but not the control group, the reason must be because of the changes in the independent variable of the experimental groups.
    - If the dependent variable also changed in the control group, then it must not be as a consequence of changing the independent variable since that wasn't changed or experienced in the control group. There must then be some alternate variable affecting the dependent variable, but not the independent variable you hypothesized affected the dependent variable.

- Students will be able to organize and analyze data, including determining the best format for presenting the data and best way of presenting visual summaries including bar graphs, line graphs, histograms, scatter plots etc…
  - *Remember the independent variable is plotted on the x-axis always and the dependent variable on the y-axis.*

- Students will recognize the differences between theories and laws. Students must also recognize that theories do not become laws nor laws theories. Theories are well-supported explanations of how something happens in the natural world and laws are well-supported descriptions of a phenomenon.

- Students will know what are inferences and generalizations. They will describe how scientific inferences are made from observations and identify examples from biology.

- Students will identify what is science, what is not science, and what resembles, but fails to meet the criteria for science.

- Students will identify ways in which a scientific claim is evaluated (e.g., through scientific argumentation, critical and logical thinking, and consideration of alternative explanations).

Macromolecules

- Students will identify and/or describe the basic molecular structure of carbohydrates, lipids, proteins, and/or nucleic acids including knowing the basic structure/names of monomers and how these are put together into polymers or large molecules and how polymers and large molecules are broken down again *(dehydration synthesis versus hydrolysis reactions)*.

- Students will describe the primary functions of carbohydrates, lipids, proteins, and/or nucleic acids in various organisms of different domains and kingdoms.

- Students should understand the four levels of protein structure.

- Students will know what enzymes are and explain how enzymes speed up the rate of a biochemical reaction by lowering the reaction's activation energy. They should know the difference between endergonic and exergonic reactions and understand how an active site works with substrates.

- Students will identify and/or describe how environmental factors such as changes in the concentration of substrates or enzymes, changes in concentration of salts in solution (positive and negative ions), changes in pH of the environment (changes in the concentration of H+ ions), and changes in temperature effect enzyme activity and why.
    - Any environmental change that may change the shape of a protein (like an enzyme), a change that affects the folding of its polypeptides, can affect the ability of the enzyme to attract and put pressure on the covalent bonds between atoms in the reactants of a chemical reaction (the enzyme's substrates) hindering the enzyme's ability to lower the amount of activation energy needed for chemical reactions to occur as easily.

The Cell

- Students will compare and/or contrast the structure and function of the compound (light) microscope, dissecting microscope, scanning electron microscope, and/or the transmission electron microscope.
    - Students should know what type of image each produces
    - which uses light versus electrons
    - which one can be used to visualize living organisms (LM) vs which can only visualize dead ones (EM)
    - what the magnification power is of each
    - what parts of cells (which organelles and structures) can be viewed using each
        1. **Light Microscopes magnify 1000x, can view life cells, and allow one to see large organelles (spaces inside the cell surrounded by a cell membrane) inside cells.**
        2. **Transmission Electron Microscopes magnify 100,000x to 1000,000x, must kill cells by slicing tissue in thin layers/cross sections, allows one to see organelles, ribosomes (non-organelles involved in protein synthesis), even some large molecules like big proteins.**

3. **Transmission Electron Microscopes magnify 100,000x to 1000,000x, must kill cells by coating specimen in thin layer of gold, allows one to render a 3D surface view of the organism.**

- Student must know all parts of the compound light microscope and their function ***(See PDF about Microscope parts uploaded for you in Archie)***

- Students will describe and/or explain the three tenets of the **modern cell theory:**
  1. **All living organisms are composed of one or more cells**
  2. **The cell is the most basic unit of life.**
  3. **All cells arise from pre-existing, living cells.**

- Students should know how scientists such as Van Leeuwenhoek, Hooke, Schwann, Schleiden, and/or Virchow aided in the development of the cell theory
  - **Antoine Van Leeuwenhoek** (mid to late 1600s to early 1700s) was the first to observe and describe single-celled organisms, which he originally referred to as animalcules, and which are now referred to as microorganisms using a microscope. He was also the first to record microscopic observations of muscle fibers, bacteria, spermatozoa, and blood flow in capillaries (small blood vessels).
  - **Robert Hooke** (mid to late 1600s) designed the first compound microscope and is most famous for observation of dead plant cork tissue through which he discovered for the first time the existence of cells. As a matter of fact, it was Hooke who came up with the term "cell" based on the boxlike nature of these dead cells he saw (he was seeing only the cell walls of the dead plants cells) that reminded him of the cells of a monastery.
  - **Theodor Schwann** (1800s) was a German physiologist who observed numerous animal cells under the microscope, later declaring that "all living things are composed of cells and cell products". This became cell theory or cell doctrine. His many contributions to biology include the development of cell theory then, the discovery of Schwann cells in the peripheral nervous system, the discovery and study of pepsin (a digestive stomach enzyme), the discovery of the organic nature of yeast, and the invention of the term metabolism.
  - **Matthias Jakob Schleiden** (1800s) was a German botanist who studied plants and plant structure under the microscope noting that different plant parts are all composed of cells. He became the co-founder of the cell theory, along with Theodor Schwann and Rudolf Virchow.
  - **Rudolf Ludwig Carl Virchow** (1800s) was a German doctor, anthropologist, pathologist, pre-historian, biologist, writer, editor, and politician, known for his advancement of public health. He is known as "the father of modern pathology" because his work helped to discredit humourism, bringing more science to medicine. His most widely known scientific contribution is his cell theory, which built on the work of Theodor Schwann. He was one of the first to accept the work of Robert Remak, who showed the origins of cells was the division of pre-existing cells. It is a rejection of the concept of spontaneous generation, which held that organisms could arise from nonliving matter. Virchow (and his predecessors) extended this to state that the only source for a living cell was another living cell.

- Students should know how Louis Pasteur and Francisco Redi disproved the idea of spontaneous generation.
  - **Louis Pasteur** was a French chemist and microbiologist who was responsible for crushing the doctrine of spontaneous generation. He performed experiments that showed that without contamination, microorganisms could not develop. Under the auspices of the French Academy of Sciences, he demonstrated that in sterilized and sealed flasks nothing ever developed, and in sterilized but open flasks microorganisms could grow. This experiment won him the Alhumbert Prize of the academy. The process of pasteurization is named after him since Pasteur discovered that heating the beer and wine was enough to kill most of the bacteria that caused spoilage and hence, prevented these beverages from turning sour. Today we use this process readily with dairy products and throughout the food industry. He also discovered the principle of vaccination.
  - **Francisco Redi** was an Italian physician, naturalist, and poet. He was the first scientist to challenge the theory of spontaneous generation by demonstrating that maggots come from eggs of flies. He took six jars and divided in two groups of three: In one experiment, in the first jar of each group, he put an unknown object; in the second, a dead fish; in the last, a raw chunk of veal. Redi covered the tops of the first group jars with fine gauze so that only air could get into it. He left the other group open. After several days, he saw maggots appear on the objects

in the open jars, on which flies had been able to land, but not in the gauze-covered jars. In the second experiment, meat was kept in three jars. One of the jars was uncovered, and two of the jars were covered, one with cork and the other one with gauze. Flies could only enter the uncovered jar, and in this, maggots appeared. In the jar that was covered with gauze, maggots appeared on the gauze but did not survive. He continued his experiments by capturing the maggots and waiting for them to metamorphose, which they did, becoming flies. Also, when dead flies or maggots were put in sealed jars with dead animals or veal, no maggots appeared, but when the same thing was done with living flies, maggots did. was an Italian physician, naturalist, and poet. He was the first scientist to challenge the theory of spontaneous generation by demonstrating that maggots come from eggs of flies.

- Students will compare and/or contrast the structures found in plant cells and in animal cells, including knowing what each structure & organelle does in the cell – its function.
  - Students must also know which structures are unique to each type of cell.
    - Know how to identify and know the function of the cytoplasm, nucleus, DNA, nucleolus, chromatin, rough endoplasmic reticulum – RER, smooth endoplasmic reticulum – SER, mitochondria, chloroplast, central vacuole, centrosome, ribosomes, vesicles, cell walls (when present), vacuoles, Golgi apparatus, peroxisomes, lysosomes, plasma membrane, organelle membranes, nuclear envelope, flagella, cilia, microtubules, microfilaments.
    - Students should know the difference in the final destination of the proteins built by free vs bound ribosomes
      1. All ribosomes start off as **Free Ribosome**s in the cytoplasm. When mRNA is produced by transcribing DNA, the large and small subunits sandwich the mRNA, which carries the instructions from the DNA gene regarding which amino acids connect in which order in the polypeptide the ribosome will construct. Ribosomes that build the entire peptide while floating the cytoplasm are called Free Ribosomes. The polypeptides (which fold up into proteins) they produce remain in the cytoplasm or can be transported into organelles like the mitochondria or the interior of the nucleus by passing through the nuclear pores.
      2. If the growing polypeptide being produced by a Free Ribosome starts off with a certain amino acid sequence, the signal recognition sequence, proteins carry the growing polypeptide attached to the Ribosome, which itself is attached to the mRNA, to the pores of the Rough Endoplasmic Reticulum. Now the ribosome is temporarily referred to as a **Bound Ribosome**. Here, the growing polypeptide is fed into the lumen of the Rough ER or becomes part of the membrane of the Rough ER. The protein that are made remain in the lumen of the endomembrane organelles *(Rough and Smooth ER, Golgi apparatus, transport vesicles, Golgi apparatus, plasma membrane, vacuoles, lysosomes)* , become part of the membrane of the endomembrane organelles (including the nuclear envelope which is contiguous to the membrane of the ER and the cell's plasma membrane), or are **secreted** from the entire cell when the transport vesicle buds of the Golgi and fuses with the plasma membrane of the cell.

- Students will compare and/or contrast the structures in prokaryotic cells and in eukaryotic cells.
  - Understand the role of prokaryotic structures including the cell wall, cell membrane (plasma membrane), nucleoid region (where the single, circular DNA prokaryotic chromosome is found), cytoplasm, plasmids (extra-chromosomal circular peaces of DNA that may contain additional genes), ribosomes, and flagella.
  - Know the difference in the DNA shape, size, naked vs. associated with histone proteins.
    1. Prokaryotic cells are haploid, have one main DNA molecule (chromosome), which is circular and not permanently associated with histone proteins
    2. Eukaryotic cells are often (not always) diploid, have multiple copies of linear DNA molecules wrapped around histone proteins which help package the DNA molecules (chromosomes) inside the nucleus and help control gene expression.
  - Know the difference in the presence and composition of the cell walls of bacteria (lipopolysaccharide- and peptidoglycan-based) versus eukaryotic cells like fungi (chitin-based) and plants (cellulose-based).
  - Know the composition and use of prokaryotic flagella and pili (a.k.a. fimbrea) and eukaryotic flagella and cilia (parallel microtubule fibers - 9 paris and 2 in the center - surrounded by plasma membrane))
  - Know what the capsule does/is in bacteria and that only some bacteria may have one

- Students will describe how structures in cells are directly related to their function in the cell.

- Students must know the definition of diffusion and what direction particles diffuse in based concentration gradients.
    - Remember, particles move **down** their OWN concentration gradients from an area where they are highly concentrated to an area where they are low in concentration (due to the random collision of particles in the environment due to the kinetic motion caused by the presence of thermal energy) without regard for the concentrations of any other types of particles in the same solution!!!

- Students will explain the role of the cell membrane during diffusion, active transport, and passive transport, knowing when the cell may utilize each type depending on the properties of the substance to be moved and the concentration gradient of the substance to be moved.
    - Students must know which of the three types of transport across the membrane requires protein assistance and which does not as well as the general type of protein that can be used to help the substance cross.
    - Students must know which of the three types of transport requires energy to move particles across the membrane and which does not and WHY in relation to concentration gradients this is so.
        - **simple diffusion** = particles moves through membrane by passing in between phospholipids. non-polar particles can do so as they randomly move and collide with other molecules due to thermal energy but are not experiencing many intermolecular forces of attraction with other particles in their environments that would make it hard for them to get bumped in between the hydrophobic phospholipid tail regions on the interior of the phospholipid bilayer of membranes. Particle moves down its concentration gradient. No addition of energy needed.
        - **passive transport** = particles need the help of a channel or carrier protein to cross the phospholipid bilayer of a membrane since these particles are partially or fully charges like polar molecules versus ions. Particle moves down its concentration gradient. No addition of energy needed.
        - **active transport (pumping)** = particles need the help of a carrier protein to cross the phospholipid bilayer of a membrane since these particles are partially or fully charges like polar molecules versus ions. Particle moves against its concentration gradient from area of low concentration to an area where it is already in higher concentration. Addition of energy needed *(often provided by the hydrolysis of ATP into ADP and inorganic phosphate)*.

- Students should know the definition of osmosis *(the diffusion of free water molecules from an area of high free water molecule concentration to low free water molecule concentration)* and know in which direction water will diffuse across a membrane
    - Know that water moves in the direction of the greatest overall concentration of all solute particles combined in a solution. *Water in a solution (where solutes are dissolved in the solvent water) thus moves from an area of low concentration (of solutes) to high concentration (of solutes).*
    - Know that free water moves from an area of high free water concentration to low free water concentration, there being less free water in areas with higher particle concentrations since water will be interacting and hydrogen bonding with the particles and not be free to move in these areas.
    - Know that even when the overall concentration of particles is equal across a membrane, water does keep moving back and forth but no osmosis (diffusion - net movement in one direction or the other) occurs since the rate of movement is equal in both directions preventing any overall movement of water in any one direction more than the other. We have reached a state of **dynamic equilibrium.**

- Students will understand the role of the cell membrane and be able to address the effects of hypotonic, hypertonic, and/or isotonic solutions on the movement of water from one area across a membrane to another area.

Photosynthesis & Cellular Respiration

- Students will explain how the products of photosynthesis are used as reactants for cellular respiration and vice versa.
- Students will explain the **processes by which photosynthesis stores energy and cellular respiration releases energy.**
- Students will identify the **reactants, products and/or the basic function and location of photosynthesis.**
- Students will identify the **reactants, products and/or the basic functions and locations of aerobic and anaerobic cellular respiration (fermentation).**
- Students will connect the role of adenosine triphosphate (ATP) to energy transfers within the cell and understand the ATP cycle.

Cell Cycle & Cell Division

- Students will describe specific events occurring in each of the stages of the cell cycle – G_1, S, G_2, M
  - G_1 – Cell grows in size and performs its normal biological/metabolic functions
  - S – DNA is duplicated once cell receives external and internal chemical signals to divide
  - G_2 – Duplicated DNA is checked for errors, errors corrected, organelles duplicated, proteins needed specifically for mitosis or meiosis synthesized
  - M – involves mitosis and cytokinesis or meiosis and cytokinesis during which the cell physically divides.
- Students will understand and be able to differentiate between the processes of <u>mitosis and meiosis</u> and know what occurs in all the stages of each process.
  - For mitosis this includes knowing what happens in: prophase, metaphase, anaphase *(sister chromatids separate)*, and telophase followed by cytokinesis
  - For meiosis this includes knowing what happens in: prophase I *(homologous chromosomes form tetrads and crossing over occurs)*, metaphase I *(homologous chromosomes separate)*, anaphase I, and telophase I, followed by cytokinesis, and prophase II, metaphase II, anaphase II *(sister chromatids separate)*, and telophase II, followed by cytokinesis.
  - Mitosis starts with a diploid 2n cell and results in two diploid 2n daughter cells genetically identical to the parent cell.
  - Meiosis starts with a diploid 2n cell (in the gonads) and results in four haploid n daughter cells genetically different from the parent cell and each other.
- Students will describe the <u>role of mitosis in asexual reproduction in eukaryotes</u>.
  - Recall that mitosis is performed only in eukaryotes.
- Students should understand the difference between diploid and haploid cells as well as homologous and non-homologous chromosomes, and sister chromatids.
- Students will describe the <u>process of meiosis, including independent assortment and crossing over,</u> including when they occur and what the consequences are for the cell and its DNA/chromosomes.
- Students will describe the <u>role of meiosis in sexual reproduction</u>, including how these processes may contribute to genetic variation.
  - They should understand how crossing over and independent assortment of tetrads lead to gamete formation in which no two gametes are alike genetically and some chromosomes are recombinant.

- Students will explain how meiosis and the reduction division result in the formation of haploid gametes or spores.

- Students will describe specific events occurring in each of the stages of mitosis and meiosis.

- Students will explain how mitosis forms new cells and its role in the growth and repair of multi-cellular organisms and in maintaining chromosome number during asexual reproduction.

- Students will understand what is cancer (uncontrolled mitotic division of eukaryotic cells) and be able to explain how cancer (uncontrolled cell growth) may result from mutations that affect the proteins that regulate the cell cycle.

Heredity

- Students should understand the terms phenotype and genotype and understand how the genotype determines phenotype.
    - Remember, **genotype** refers to which types of alleles of a gene a cell contains (homozygous dominant TT, heterozygous Tt, or homozygous recessive tt in a plant that is a diploid, meaning it has two copies of the gene for determining its height/tallness, for example).
    - **Phenotype** is what the organism looks like, acts like, or what its cells can perform once these genes are expressed and an RNA or protein product forms that then allows the organisms to engage in certain behaviors or structures (a TT and Tt plant may be taller than a tt plant, which may remain short, for example, if the dominant T allele is completely dominant to the t recessive allele).

- Students must understand the difference between **homozygous recessive, heterozygous, and homozygous dominant genotypes.**

- Students must understand when an allele that is recessive versus dominant affects the phenotype of an organism.
    - Remember an allele is considered dominant when it determines the phenotype or outward appearance, behavior, chemistry of an organism that is heterozygous and so has two different versions (alleles) of a gene. The other version of the gene is considered the recessive allele since when in the presence of the dominant allele is does not contribute to the phenotype of the organism.

- Students will understand and use Mendel's laws of segregation and independent assortment to analyze patterns of inheritance.

- Students should know what the genotypes of gametes (haploid sex cells - that contain only **ONE** copy of a gene - not two) would be in a given scenario and which gametes an organism with a specific genotype can produce.
    - The gametes genotypes are what you put on the top and side of the Punnett Square as these are the possible sperm and eggs a parent can make. Then, you show the genotypes that can result in the diploid offspring when the various sperm and eggs unite into the possible zygotes two parents can produce.

- Students will identify, analyze, and/or predict inheritance patterns caused by various modes of inheritance, including completely dominant alleles, sex-linkage alleles (when gene is located on the X

chromosome as opposed to one of the other autosomes that both males and females inherit in equal quantities-specifically written as X^A or X^a, for example), co-dominance, incomplete dominance, and polygenic inheritance.

- Students should not assume that a gene is on the X chromosome just because the problem talks about males and females unless told the gene is sex linked or you know the disorder is caused by a gene on the X chromosome. If not sex linked the alleles are written as A vs. a, for example, for males and for females with no mention of the X or Y chromosomes since getting the trait is not dependent on whether you are XX or XY in genotype.
- Diseases known to be caused by genes found on the X chromosome that you must know are: hemophilia (recessive), color-blindness (recessive), Duchenne muscular dystrophy (recessive)

- Students will understand dihybrid crosses or patterns that include **co-dominance, incomplete or intermediate dominance, multiple alleles, sex-linkage, or polygenic inheritance** and assess the P and F1 generations.

- Students will know how to express inheritance outcomes in percent, ratios, or fractions.

- Student will know how to use or interpret **Punnet squares** to predict outcomes of a cross for monohybrid and dihybrid crosses.

- Students will know how to analyze the phenotypes and genotypes of individuals in a **pedigree**

- Students will know the following disease inheritance patterns:
  - Tay Sachs = autosomal recessive
  - Cystic Fibrosis = autosomal recessive
  - Sickle Cell Anemia = autosomal recessive
  - Huntington's Chorea = autosomal dominant
  - Color Blindness = sex-linked (X-linked) recessive

DNA Processes

- Students will describe the process of DNA replication and/or its role in the transmission and conservation of genetic information.
  - Students should understand what the components are of nucleotides of DNA and RNA, that DNA is anti-parallel, that DNA is double stranded compared to most RNA's, that nucleotides are covalently bonded together to form the two sugar phosphate backbones of the DNA double helix with the nitrogenous bases facing each other and hydrogen bonding together on the inside of the molecule, that G's hydrogen bond with C's and A's with T's.

- Students will describe types of gene (small scale) and chromosomal (large scale) mutations in the DNA sequence.
  - Large-scale mutations include inversions, duplications, deletions, translocations as well as trisomies, monosomies caused by non-disjunction during meiosis (failure of sister chromatids or of homologous chromosomes to separate).
  - Small-scale mutations include base-pair substitutions, insertions, deletions, duplications that can cause frame-shift mutations, silent mutations, nonsense mutations, and missense mutations.

- Students will explain how mutations in the DNA sequence may or may not result in phenotypic change and explain how mutations in gametes may result in phenotypic changes in offspring, changes in the DNA changing potentially the primary structure of the protein's polypeptide, any change in primary structure of a protein possibly affecting its secondary, tertiary, and quaternary folding. *A proteins function changing if its shape changes!*

- Students will explain the basic processes of **transcription and/or translation**, and their roles in the expression of genes.
  - Students should know the role of the promoter at the start of a genes DNA, how the ribosome works, the role of mRNA and tRNA, codons and anticodons, and RNA Polymerase

- Students will know how to use the codon table (this table will be provided) to determine what polypeptide is constructed from a given messenger RNA sequence.

- Students will explain how and that the basic components of DNA are universal in all organisms.

- Students will explain how similarities in the genetic codes of organisms are due to common ancestry and the process of inheritance.

Biotechnology

- Students will understand what bacterial plasmids are and how their use in biotechnology to clone genes or make a desired protein product using transformed bacteria.
  - Students should understand how restriction enzymes are used to cut DNA at specific restriction sites and that the fragments produced have sticky ends that are useful when creating recombinant DNA.

- Students will know how PCR works to make many copies of specific sections of DNA as needed.

- Students will know how electrophoresis can be used to separate fragments of DNA of different lengths *(separate DNA pieces by size/length)* and understand why these fragments' lengths may differ between people or species.

- Students will evaluate examples and/or explain the possible impact of biotechnology on the individual, society, and/or the environment.
  - Examples include inserting human genes in bacteria to allow bacteria to produce mass quantities of human proteins used to treat disease like human growth hormone or insulin, inserting genes in bacteria that change their phenotype so that they can be used in bioremediation to break down toxic material in the environment like oil spills.

Classification of Organisms

- Students will be able to distinguish characteristics of living organisms including what distinguishes the domains of Archea (prokaryotic), Bacteria (prokaryotic), and Eukarya and the eukaryotic kingdoms of Protista, Fungi (cannot perform photosynthesis), Plantae, and Animalia from each other.

- Students will identify and/or describe how and/or why organisms are hierarchically classified based on evolutionary relationships.

- Students will understand the **Linnean** Classification System (domain, kingdom, phylum, class, order, family, genus, species), which organizes organisms from domain and kingdom down to species and

understand what an organism's scientific name represents.

- Students will identify and/or explain the reasons for changes in how organisms are classified.
- Students need to understand the differences between prokaryotic, eukaryotic, unicellular and/or multicellular organisms, autotrophs, and heterotrophs.
- Students will have to understand and interpret evolutionary classification, phylogeny, and the use of cladograms.

Plants

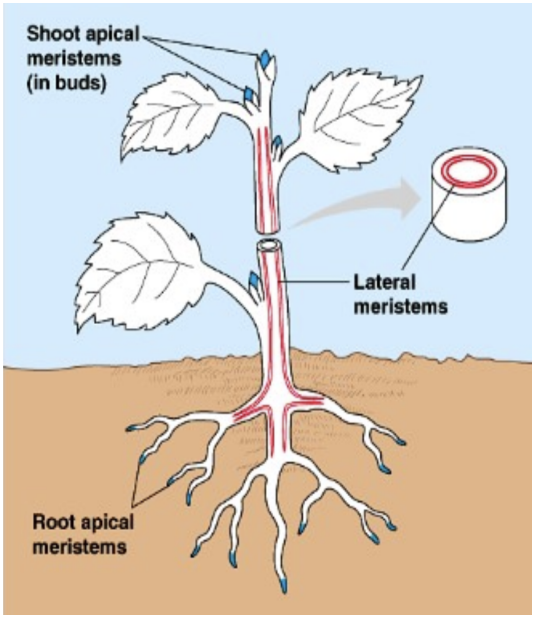
- Students will assess the function of plant tissues and organs in the context of physiological processes.
- Students will be able to identify and understand the roles of plant organs including roots, stems, leaves, flowers (including knowing the parts of the flower and their functions), fruits, seeds, and cones. ***(Study Ch.29&30 slides on plant reproduction posted for you in Archie)***
- Students must, by understanding the above, understand stomata (stoma), root hairs, apical/terminal and lateral buds, petals, carpel/pistil, stigma, ovules, ovary, stamen, anther, pollen.
    - In **conifers, non-flowering plants** like pine trees (gymnosperms). The pollen is made in the male cones of the tree. Inside the pollen, meiosis makes sperm. The pollen is moved mostly by wind to a female cone, which contains many ovules. Inside the ovule an egg is made through meiosis. The sperm then exist the pollen and fertilizes the egg inside the ovule to produce the new zygote, which divides by mitosis into a new plant embryo. **The ovule walls harden into the seed coat. The seed is considered naked because the female cone opens up and releases the seed, which is not protected inside other tissue when released.** When the conditions are right, the embryo inside the seed grows out of the seed coat (germinates) and a new plant starts to grow. *Gymnosperms like conifers (non-flowering plants) do not have ovary structures or flowers and therefore do NOT make fruit.*
    - In **flowering plants** (angiosperms) pollen made by meiosis in the anther of the stamen. Sperm forms in pollen grain. The carpel/pistil contains the ovary at its base. The ovary contain one or more ovules. **Inside the ovule meiosis will produce the egg.** Pollen is brought to the carpel/pistil by wind, insects, or animals (the latter two being called **pollinators** in this case). The pollen sticks to the carpel/pistil at the site called the stigma. The pollen grows a pollen tube from the top of the carpel/pistil, the stigma, down into the ovary and to the ovary inside. The sperm is then transported from the pollen down the tube and to the ovule in which the egg is located. **Once fertilized the zygote divides into a new embryo and the ovule walls harden into a seed. The ovary containing the ovule turns into the fruit. Fruits help protect seeds or help spread seeds in the environment.**
- Students will be able to describe and understand physiological processes including photosynthesis, cellular respiration, transpiration, and reproduction and where and how they happen in a generic plant. ***(The handout PDF showcasing the plant life cycle known as Alteration of Generation is posted for you in Archie)***
- Students will identify and understand the purpose of plant tissues including meristematic, ground, dermal, and vascular tissues and there locations in a generic plant. ***(See Ch.35-36 Slides in Archie showing you the three type of tissues in plants - dermal, vascular, ground)***
- Students need to understand the purpose of plant structures including the cambium, guard cells, phloem, stomata, and xylem, seed.

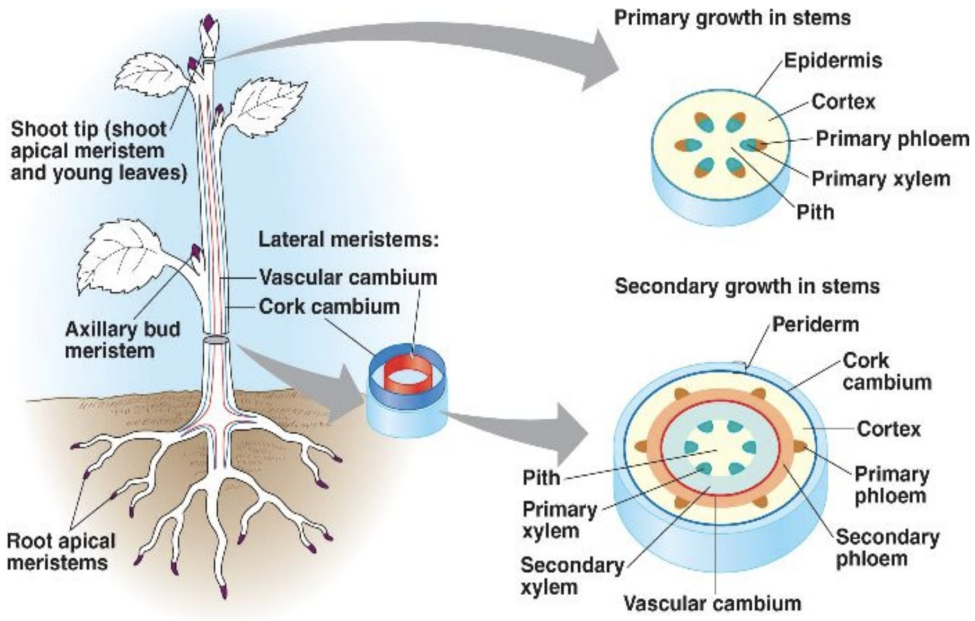
- Plant **meristems** are specialized tissues composed of undifferentiated, unspecialized (emryonic-like) cells that **can divide by mitosis** throughout the plants life without reaching a stage in which they must permanently stop (plants thus exhibiting indeterminate growth).
    - These cells, called meristematic cells, are responsible for producing all new plant cells that then specialize to form new plant tissues and organs. Meristems are essentially the "stem cells" of plants, enabling them to grow and regenerate.

- Meristems are crucial for both primary growth **(lengthwise growth)** and secondary growth **(widthwise growth)** in plants. They also play a role in wound healing and regeneration.

- **Apical Meristems:** Located at the **tips of roots and shoots**, and are responsible for primary growth.
    - Apical Meristem tissues are found in **apical (terminal) buds** and **lateral (axillary)** buds of **stems.**
        - **Apical buds** are located at the tip of a stem/branch as well as near the tip of a root.
            - Apical buds are primarily responsible for elongation of branches so they can access sunlight.
        - **Lateral buds** are found at the sides of the stem/branch, typically at the base of a leaf.
            - Lateral buds can develop into new branches or flowers.
    - Apical Meristems produce new cells that elongate and differentiate into mature tissues, increasing plant (shoot and root) **length** from the **tips** of branches and roots outward.
        - **The Shoot Apical Meristem** (SAM) provide a constant supply of new cells allowing plants to keep growing taller and branches to spread wider, the cells forming by mitosis of these meristematic cells giving rise to organs like longer branches, leaves, flowers etc
        - **The Root Apical Meristem** (RAM) provide a constant supply of new cells allowing roots to grow longer at their tips so plants can push through soil to obtain nutrients/minerals and water.

- **Lateral Meristems:** Found in the **vascular cambium** (responsible for creating secondary - additional - xylem and phloem) in branches and roots and found in the **cork cambium** (responsible for creating bark in woody plant trunks and branches), and are responsible for secondary growth.
    - **Vascular Cambium:** Produces **secondary** (additional) **xylem** (cells which secrete hardening agents like lignan into their cell walls and are functionally dead at maturity - the source of **wood**) and **secondary** (additional) **phloem**, increasing stem and root thickness, allowing larger plants to transport larger volumes of xylem and phloem sap.
        - Meristems between the xylem and phloem increase the **width** of the trunk/branches & roots of a plant.
        - New layers of xylem form the **annual growth rings** in woody tree trunks.
    - **Cork Cambium:** Produces the inner portion of the protective outer layer of of a trunk/branch called **bark** in woody plants. Cork cells secrete a wax (suberin) into their cell walls, helping prevent water loss from thick trunk/branches in large woody plants **(FYI: small non-woody plants rely instead on the waxy cuticle secreted on the outside of the dermal tissue since they do not form bark)**





The Brain

- Students should understand the difference between the central and peripheral nervous system.
- Students will be able to identify on diagrams the parts of the human brain including the cerebrum, cerebellum, pons, medulla oblongata, brain stem, frontal lobe, parietal lobe, occipital lobe, and temporal lobe. ***(Slides as a PDF with the various brain part locations you need to know is uploaded for you in Archie)***

The Immune System

- Students should understand the difference between the first, second, and third line of defense ***(Slides as a PDF with the various immune system information you need to know is uploaded for you in Archie)***
  - **First Line:** Barriers to infection like skin, cilia on tracheal cells in respiratory track that wash away mucous secreted by the cells, epithelial cells that keep environment at a low pH like in the stomach or vagina, and mucous membranes like saliva and tears that contain lysozyme enzyme to break down bacterial cell walls.
  - **Second Line:** Non-specific responses (generalized responses to pathogen infection, not targeting a specific cell type nor able to make a memory of the encounter)
  - **Third Line:** Specific responses (specific invader is recognized and memory cells are made that will recognize this one specific invader in the future).
- Students will identify and/or explain the basic functions of the human immune system, including specific and nonspecific immune responses.
  - They should understand the steps in the inflammation response.
  - They should understand the relationship between antigens and antibodies, the function of antibody, that B cells produce antibodies, the role of macrophages, the role of T helper cells in activating B and T killer (cytotoxic) cells, the role of T killer (cytotoxic) cells, and the creation of B, T helper, and T killer (cytotoxic) memory cells.
- Students will describe how the human immune system responds to vaccines and/or antibiotics initially and how long term memory to the substances in vaccines is made.
  - Students should know that many vaccination involve introducing killed or weakened viruses, bacterial cells, or fungal cells into the body or proteins from the surfaces of viruses, bacterial cells, or fungal cells. The vertebrate immune system then recognizes and destroys these foreign invaders or body cells that are infected with foreign invaders (even if they are not able to make you ill).
  - **B cells** recognize proteins or the proteins on the surfaces of intact foreign cells when those proteins interact with B cell receptors. B cells thus get activated by directly binding to proteins, intact viruses, and intact foreign cells on the outside of our body cells. B cells once activated secrete antibody proteins that stick to foreign proteins and foreign proteins on the surface of pathogens, tagging the foreign entities for destruction - they will get phagocytosed by phagocytotic white blood cells like macrophages.
  - **T killer/cytotoxic T cells** get activated when they notice a foreign protein being displayed on the surface of our own body cells. This happens when our own body cells have been infected by something like a virus, the viral DNA or RNA now using the cell's machinery to make viral proteins and nucleic acid copies to make for viruses with inside the host cell.
  - **T helper cells** get activated when antigen presenting (phagocytotic white blood) cells like macrophages display pieces of foreign proteins from the material they have phagocytosed on their plasma membrane surfaces. The T helper cells when activated secrete signal molecules that stimulate other T helper, B, and T killer cells that have recognized a foreign protein to multiple by mitosis to create an "army" of T and B cells helping combat the intruder.
  - Some of the B and T cells made after "cloning" (mitosis is activated) work (as described above) to neutralize and help destroy foreign cells or body cells that have become infected by foreign pathogens. But, some of these B and T cells also become memory cells and, thus, remain in the body as memory B and memory T cells that will be able to recognize this same foreign protein or cell with these surface proteins if it enters the body again in the future. By keeping many copies of those B and T cells around long term that can recognize a foreign entity, if that foreign entity

should ever enter your body, you will have many copies of B an T cells that can recognize those foreign proteins faster and so start the process of destroying the foreign entity faster.
    - With the **vaccines** we "tricked" the body, though, into believing it fought the real pathogen when it didn't - it fount only one of the surface proteins we injected or a weakened or damaged or dead version of the virus or foreign cell. The second time you are exposed to that protein it may be on the surface of the real bacteria, fungi, or virus, one that can cause damage and reproduce inside the body. Now, when infected with the real pathogen, however, you will be able to recognize it and destroy it faster (because of all the extra B and T cells) before it has a chance to multiple inside your body effectively and make you very sick.

- Students will explain the significance of genetic factors, environmental factors, and pathogenic agents to health from the perspective of both individual and public health.
    - Know different types of **pathogens** from multicellular animal parasites to protists (like the *plasmodium* protist that causes malaria) to bacteria to viruses (being sure to understand the structures and viral reproductive stages of both **eukaryotic viruses** (including **retroviruses** like h.i.v.) and **prokaryotic viruses** that engage in the **lytic cycle** and the **lysogenic cycles**.
        - **Pasteur** (1800s), together with **Redi**, was responsible for crushing the doctrine of spontaneous generation. He performed experiments that showed that without contamination, microorganisms could not develop. Under the auspices of the French Academy of Sciences, he demonstrated that in sterilized and sealed flasks nothing ever developed, and in sterilized but open flasks microorganisms could grow.

- Students understand strategies to prevent, detect, and treat communicable and chronic diseases, such as **covering** up mouth and nose when sneezing or coughing, **washing** hands before touching food or the openings of the face - eyes, mouth, nose, **social distancing** if something is transmitted via water droplets in exhaled air, taking **antibiotics** to kill bacteria or **fungicides** to kill fungi etc.

The Vertebrate Reproductive System

- Students will identify and/or describe the anatomy and physiology of the human reproductive system.

- Students will identify on diagrams and know the function of male human reproductive system organs including the seminal vesicle, prostate gland, vas deferens, urethra, epididymis, scrotum, penis, and testes.

- Students will identify on diagrams and know the function of female human reproductive system organs including the ovaries, oviduct (fallopian tube), uterus, cervix, and vagina.

- Students will describe the process of human development from the zygotic stage to the end of the third trimester and birth.

- Students need to identify changes in each trimester of normal human development/pregnancy. ***(Slides with information posted for you in Archie)***

- Students need to be familiar with the early stages of development including implantation, morula, blastocyst, gastrulation, and neurulation all taking place at the early start of the first trimester.

- Students will understand how the placenta, umbilical cord, amniotic sac, and amniotic fluid relate to the development of the fetus.

- Students will understand the production of hormones in the physiology of the human reproductive system.

Evolution

- Students need to know how the overall contributions of scientists such as **Darwin, Lamarck, Lyell, Malthus, Mendel,** and **Wallace** aided in the development of the scientific theory of evolution.

- Student will know that an **adaptation** is the term for *any behavior, structure, or physiological/ chemical process that increases the organisms ability to survive and reproduce*. Adaptations evolve in populations because of natural selection.

- Students will explain and/or describe the conditions required for **natural selection** that result in differential survival (which then naturally will result in differential reproductive success of different organisms in relation to each other).
    1. **Inherited variation** in characteristics exists within a population (due to DNA mutations and variations in gene expression)
    2. There exists a **struggle for survival** (organisms are under attack by other organisms or are in competition for resources like water, sunlight - for photosynthesizing organisms -, and nutrients)
    3. As a result **some organisms survive better than others leading to differential reproductive success** (some versions of characteristics - traits - are passed down better than others in an environment). Organisms of a species do not all exhibit the same biological fitness.

- Students will explain and/or describe the four other scientific mechanisms that cause **evolution** **(changes in the frequency of the alleles for a gene in the gene pool)**, in addition to natural selection, such as mutations, genetic drift, gene flow, and nonrandom mating that result in evolutionary change (allele = version of a gene - a gene with a different nucleotide sequence from a another version of that same gene for that same protein construction or RNA molecule construction)

- Students will identify evidence and/or explain how the scientific theory of evolution is supported by the fossil record, comparative anatomy (the existence of homologous and analogous structures), comparative embryology, biogeography, molecular biology (DNA and protein comparisons), and observable evolutionary change.

- Students will be able to describe and identify homologous structures and vestigial structures or organs. They should know the difference between these and analogous structures and should understand how both are evidence for evolution.

- Students will explain and/or describe how mutation and genetic recombination increase genetic variation, including an understanding at the DNA level of what mutations are and how they affect the proteins produced in the cell and how genetic variation is produced through sex by meiosis (with its crossing over and independent assortment) and fertilization. They will understand too how this genetic variation among organisms within a population together with differential reproductive success and the environmental conditions affects the evolution of populations.

- Students should understand the concepts of adaptive radiation, convergent evolution, coevolution, and punctuated equilibrium.

- Student should understand that asexual reproduction has its benefits but that it produces clones instead of generating genetic variation. Students should, however, understand how asexual species like bacteria may develop some genetic variation through mutation, conjugation, transformation, and transduction.

Human Evolution

- Students will identify examples of and basic trends in hominid evolution from early ancestors six million years ago to modern humans. Items referring to the development of language or the manufacturing of tools will relate this development to changes in the skull or brain size.

- Students will understand the basic trends in human evolution as related to brain size, jaw size, language, and manufacturing of tools.
    - **Brain Size Trend:** Modern humans have **brains that are more than three times larger** than our closest living relatives, chimpanzees and bonobos. An analysis of 94 hominid fossils published this week shows that average brain size of human ancestors increased gradually and consistently over the past 3 million years.
    - **Jaw Size Trend:** Over the last 100,000 years there has been a continuation of the trend towards **smaller molar teeth and a smaller, more delicate jaw** (and protruding chin) compared to ancestors with larger, more protruding jaws. Upper Palaeolithic humans of 30,000 years are described as being 20-30% more robust than present-day people. This demonstrable trend in tooth size is probably linked to the use of food-processing techniques that reduce the need for prolonged chewing, and thus provides a good example of the results of natural selection in human populations.

Biogenesis – The Origins of Life on Earth

- Students will identify situations or conditions contributing to the origin of life on Earth.

- Student will describe the scientific explanation of the origin of life on Earth.

- Students will understand how contributions of scientists such as **Pasteur** *(showed that modern cells come from existing cells disproving the theory of spontaneous generation)*, **Oparin and Haldane** *(hypothesized that early Earth's atmosphere was reducing – containing H_2, H_2O, NH_3, CH_4, CO_2, but no O_2)*, **Miller and Urey** *(showed that under the early conditions of earth, organic molecules like amino acids, urea, hydrocarbons, and nucleotides could form)*, **Margulis** *(theory of endosymbiosis)*, or Fox *(demonstrated that protobionts (pre-cells) can be created spontaneously from basic lipids and proteins)* aided in the development of the scientific explanation of the origin of life.

- Students will describe how organic molecules, an oxygen-rich environment (consequences of the evolution of bacterial photosynthesis), and eukaryotic cells (theory of serial endosymbiosis) originated.

- Students will describe the endosymbiotic theory for the origin of eukaryotic cells, both plants and animals.

Ecology

- Students will describe the energy pathways through the different **trophic levels** of a food web or energy pyramid. Energy will be expressed in units of Joules (J).

- Students will understand the roles of organisms in food webs and identify them as **producers, consumers** (primary, secondary, tertiary) and **decomposers** (chemical recyclers who break down the organic material of producers, other decomposers, and all consumers)).

- Students will analyze the movement of matter (cycling of matter) through different biogeochemical cycles (water cycle, nitrogen cycle, and carbon cycle).
  - Students need to remember that matter (atoms) are recycled in the environment compared to energy that flows through the environment captured in the bonds of macromolecules by photosynthetic producers but eventually lost to outer space in the form of heat.
  - Decomposers are essential for returning matter to their abiotic reservoirs and from their organic form back to their inorganic form, when applicable, so they can be accessed and used by producers again, which convert them back into organic form and use the inorganic matter as needed.

- Students will understand that energy flows through food chains eventually leaving as **heat.**
  - Remember that the arrow in a food chain or food web show the direction in which **energy** flows from one organism to the next (energy carried as chemical energy in the carbon-to-carbon bonds in the high energy organic molecules that enter one organism when it consumes another)
  - Remember too that only **10%** of the energy found in one trophic level moves up into the next higher trophic level!

- Students will use data and information about population dynamics, abiotic factors, and/or biotic factors to explain and/or analyze a change in **carrying capacity** and its effect on population size in an ecosystem.

- Students will explain that different types of organisms exist within aquatic systems due to chemistry, geography, light, depth, salinity, and/or temperature.

- Students will describe the potential changes to an ecosystem resulting from seasonal variations, climate changes, and/or **biological succession (primary and secondary)**. caused by disturbances.

- Students will identify positive and/or negative consequences that result from a reduction in biodiversity.

- Students will understand how reduction in biodiversity may result from catastrophic natural events, climate changes, human activities, and the introduction of invasive and nonnative species.

- Students will describe issues related to **climate change** and its effects on population dynamics and biodiversity. They should understand the role of green house gases (CH_4, CO_2, H_2O) in creating the greenhouse effect and how manmade changes in green house gases are causing global warming and its consequences as related to species loss, rising sea levels and more.

- Students will predict how actions of humans may impact environmental systems and/or affect sustainability.

- Students will evaluate possible environmental impacts resulting form the use of renewable and nonrenewable resources and be able to explain how human activities (logging, deforestation, burning fossil fuels) may be altering the concentrations of greenhouse gasses and disrupting the carbon and water cycles.

- **Environmental sustainability** = refers to the responsible management of natural resources to fulfill current needs without compromising the ability of future generations to meet their future needs. Sustainability is the ability to maintain an ecological balance in our planet's natural environment and conserve natural resources to support the wellbeing of current and future generations.
  - Sustainability aims to balance ecological, economic and social goals, such as **reducing carbon emissions**, **promoting renewable energy** and **ensuring equitable resource access.**

- **Human impacts** on environmental systems include, but are not limited to…
  - Altering Air Qualify
    - **Acid Rain** = any form of precipitation with acidic components, such as sulfuric or nitric acid that fall to the ground from the atmosphere in wet or dry forms. This can include rain, snow, fog, hail or even dust that is acidic.
    - **Smog** = air pollution that reduces visibility. Smog was common in industrial areas, and remains a familiar sight in some cities today.
    - **Ozone Depletion** = When chlorine and bromine atoms come into contact with ozone in the stratosphere, they destroy ozone molecules. One chlorine atom can destroy over 100,000 ozone molecules before it is removed from the stratosphere. Ozone can be destroyed more quickly than it is naturally created.
      - Ozone (O_3) protective barrier that prevents ultraviolet sunlight (UV-B) radiation from the sun from reaching the Earth's surface and harming plant and animal life by damaging their DNA and proteins.
    - **Burning Fossil Fuels** *(releasing stored organic carbon in the form of CO_2)*
  - Altering Water Quality
    - **Eutrophication =** occurs when the environment becomes enriched with nutrients *(often those leached out of agricultural fields that are over fertilized after it rains or the land is irrigated and carried away in the ground water to rivers, lakes, seas, and oceans)*.
      - As a result of eutrophication, algae and other protists as well as plant growth may increase in estuaries and coastal waters
        - The overgrowth of certain protists like dinoflagellates are referred to as r**ed tides**, the organisms secreting toxins that kill other animal life in the water
        - When photosynthetic algal populations explode in size, we refer to this enlarged population as an **algal bloom**. When the algae later die in large numbers as the extra nutrients are used up, decomposer populations *(ex: bacteria)* expand as they obtain more nutrients from the large number of dying and dead algae. The enlarged decomposer population consumes higher amounts of oxygen gas for their own cellular respiration, leading to hypoxic situations in the water that results in the death of other aerobically respiring animals *(fish, dolphins, etc…)*
    - **Ocean acidification** = decreasing levels of pH in the ocean, which makes the sea more acidic. It is the long-term change in seawater chemistry due to the absorption of carbon dioxide from the atmosphere. Roughly 30 percent of human-made CO2 is absorbed by the oceans.
  - Direct Harm to Organisms
    - Changes to **Trophic Structures** = the feeding relationships in a biological community characterized by the manner in which food energy is passed from one trophic level to the next along the food chain. The base of the pyramid is composed of species called **autotrophs,** the **primary producers** of the ecosystem that store chemical energy in organic molecules by doing either photosynthesis or chemosynthesis. All other organisms in the ecosystem are consumers called **heterotrophs**, which either get their chemical energy directly from producers (these are the **primary consumers** or **herbivores)** or which get their energy indirectly from producers, the energy first passing through one or more level of consumers (the **secondary consumers, tertiary consumers and on** being the **carnivores**). Remember, **decomposers** get their energy from all trophic levels, producers and consumers
    - **Bioaccumulation** = Bioaccumulation is the buildup of absorbed chemicals in an organism over time.
    - **Biomagnification** = Biomagnification is the increase in concentration of these chemicals in each organism up the food chain.
  - Altering Land Quality
    - **Deforestation** = the purposeful clearing of forested land. Throughout history and into modern times, forests have been razed to make space for agriculture and animal grazing, and to obtain wood for fuel, manufacturing, and construction.

        - **Erosion** = the geological process in which earthen materials *(i.e., soil, rocks, sediments)* are worn away and transported by natural forces such as wind or water.
        - **Desertification** = a type of land degradation in which a land region becomes increasingly arid, typically losing its bodies of water as well as vegetation and, thus, wildlife. It is caused by a variety of factors, such as climate change and human activities *(like deforestation, unsustainable agricultural practices, over-irrigation, salinization of soil etc)*. This leaves their soils less able to support crops and, thus, livestock and wildlife.
    - Climate Change *(a long-term change in the average weather patterns that have come to define Earth's local, regional and global climates)*
    - Introduction of Invasive Species
        - An introduced species is one living outside its native distributional range, but which has arrived there by human activity, either deliberate or accidental.
            - **Introduced species often outcompete native species due to:**
                - a lack of natural predators in the new environment, which then allows for the invasive species' population to increase exponentially in a short period of time.
                - the biotic and abiotic factors being favorable in the new environment
                - the ability to adapt quickly to new environmental condition if they have high biological fitness in the new environment, their adaptations allowing them to obtain nutrients and successfully reproduce.
            - **What effect do non-native species have on the local ecosystem?**
                - Reduce of Biodiversity = wipe out endemic and/or local endangered species populations
                - Loss of Habitats and Resources = they may destroy large numbers of trees or vegetation due to overgrazing or infestation (ex: parasites, fungi). Native organisms who inhabit these areas loose they home, breeding grounds, food sources etc… Competition among native organisms and between the invasive and local organisms for limited resources increases, which can force native organisms to have to emigrate or may increase native organisms' death rates and/or lowering their birth rates.
                - Economic Loss = Native species provides us humans with food, medicine, building materials etc. Their loss can have an impact on our local economy.
                - Harm to Human Health = the use of pesticides to get rid of some of these invasive species can accumulate in the food chains. Runoff and percolation can move these toxic products onto rivers, lakes, canals, oceans, and our groundwater, increasing the level of pollution in water we drink or use for irrigating land. Toxic products can be a part of biomagnification, making our food supply more dangerous to consume. Also, invasive species sometimes harbor parasites or disease, which can infect other organisms we consume or use or can infect us directly.

- Overpopulation and each person's ecological footprint influence sustainability.
    - **Overpopulation** = the state whereby the human population rises to an extent exceeding the carrying capacity of the ecological setting. In an overpopulated environment, the numbers of people might be more than the available essential materials for survival such as transport, water, shelter, food or social amenities.
    - **Carbon Footprint** = the total amount of greenhouse gases (including carbon dioxide and methane) that are generated by our actions.
        - The average carbon footprint for a person in the United States is 16 tons, one of the highest rates in the world. Globally, the average carbon footprint is closer to 4 tons.

- Costs and benefits of renewable and nonrenewable natural resources.
    - **Natural resources** = materials from the Earth that are used to support life and meet people's needs *(shelter, transportation, education, recreation, fashion, cooking, medical care, etc)*. Any natural substance that humans use can be considered a natural resource. Oil, coal, natural gas, metals, stone and sand are natural resources. Other natural resources are air, sunlight, soil and water.
        - Renewable Resources = those that can be replenished fairly easily within a human lifetime.
            - **Renewable Energy** is obtained from resources like the **sun** and **wind.**
        - Nonrenewable Resources = those that cannot be replenished (or at least not in our life time)
            - **Non-renewable Energy** is obtained from energy sources like **fossil fuels** *(natural gas, coal, oil)* and

nuclear reactions, that cannot be replaced over a useful period of time, thus making their use limited. These resources were formed millions of years ago, when existing deposits are depleted, they are gone for good.

- **Nuclear Energy** = energy from atomic nuclei. *(Cons: Although nuclear energy could be a "cleaner" source of energy, the material used in nuclear power plants is not renewable. Uranium, the material used is found in rocks all over the world, but is non-renewable. Nuclear power plants are complicated to build, and the nuclear energy is difficult to harvest. Many countries lack the technologies, engineers or the trained scientists to run these power plants. Power plants produce radioactive waste which is extremely toxic. Pros: Produces lots of energy. It does **not** produce green house gases, so no air pollution or green house gas emission. Power plants can be built in rural and non-rural areas with minimal disruption of the environment around them.)*

- Students should understand that monitoring of environmental parameters is important to maintaining human health, safety, economies ,and more. The health of the environment and our personal health are related. Environmental policy decisions should be made after adequate monitoring of environmental parameters.
  - Collecting an analyzing data about specific environmental parameters *(salinity, depth, pH, light, food resources, etc)* is important to assess the quality of the environment around us, including whether it is improving, worsening, or staying the same. This information can then be used to assist in decision making, both by governments and private sectors.
    - Public health officials and other healthcare providers need information about both short-term and long-term environmental impacts. For example, the short-term environmental issue of poor air quality affects the ability to treat patients with asthma and the need to issue smog advisories. The long-term environmental issue of toxic substances in groundwater may also be relevant to healthcare workers.
    - Municipal engineers must know about potential toxins in water sources so they can treat them, and potential water level maximums so they can design flood control systems. Insurance actuaries also need to understand environmental risk.
    - First responders must understand the nature of toxic events so they know how to respond and treat survivors, and how to use safety equipment effectively.
    - Farmers need to understand nutrient levels in surface water so they can assist with runoff management while keeping their land fertile.
    - Industrial concerns must monitor the environmental effects they have on their surroundings to ensure regulatory compliance and worker safety.
    - Because of ecological and economical concerns, we must determine the presence of invasive species that threaten the local biodiversity. For example, Environmental DNA (eDNA) is DNA collected from bodies of water, soil, even air; rather than directly from the organisms. This is information is used to determine the presence of invasive species, predict impact on ecosystems and economy; and work on solutions to control the problem.

Cardiovascular System

- Students will identify factors that affect blood flow and/or describe how these factors affect blood flow through the cardiovascular system.
  - Factors that affect **blood flow** through blood vessels include…
    1. **Blood Pressure** = Pressure exerted against the blood vessel walls by moving blood. ls highest as left ventricle squeezes, contracts, and is lowest at right atrium when deoxygenated blood comes from the body.
       - Blood Pressure is affected by several factors including peripheral resistance, vessel elasticity, blood volume, and cardiac output
         - The highest blood pressure occurs where the blood leaves the left ventricle as it squeezes blood against the walls of the **aorta** (the largest artery the body) that carries blood out of the heart into the systemic circuit)
         - The lowest blood pressure occurs where the blood returns to the right atrium of the heart after passing

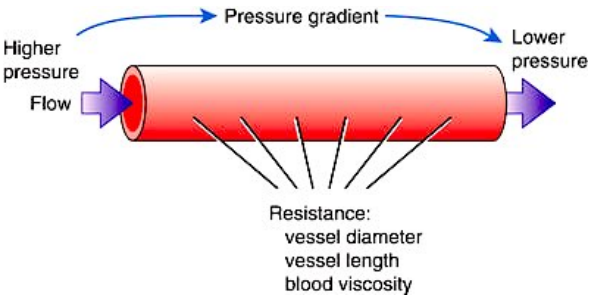
through the systemic circuit.

2. **Blood Volume** = Volume of blood (both red blood cells and plasma) in the circulatory system of any individual. A typical adult has a blood volume of approximately 5 liters, with females generally having less blood volume than males.
    - Reduced blood volume (ex: due to excessive sweating - water loss -, or excessive bleeding) reduces blood pressure.
    - Increased blood volume (ex: due to water retention from excessive salt intake in the diet) increases blood pressure.
        - The **kidneys** help filter the blood from waste products like urea (what harmful ammonia is converted into by the liver) and products like excess water or excess ions and in doing so help maintain the right blood pressure, blood volume, and blood concentration.
            - Long term homeostatic mechanisms compensate the temporal imbalance by bringing blood volume and blood pressure back up to normal levels.
3. **Resistance** = Force that slows down blood flow as it passes through the blood vessels of our vascular system. Ex. The increased resistance the blood experiences as it slides against the walls of the blood vessels (friction) due to the constriction (narrowing in diameter) of peripheral blood vessels, which slows down blood flow in the circulatory system.
    - Vascular resistance then is to the force that must be overcome to push blood through the circulatory system and create flow and is also the force slows down blood flow.
        - **Three factors affect resistance:**

        i) **Blood Viscosity** = Thickness of the blood.
            - The greater the viscosity (the more concentrated the solutes), the less easily molecules in the blood solution slide past one another and the more difficult it is to get the fluid moving and keep it moving. (Ex: Viscosity increases in individuals with diabetes due to increased glucose levels in blood).
            - If the diameter of the blood vessel decreases (vasoconstriction), then resistance increases. (ex: This happens during atherosclerosis)
            - If the diameter of the blood vessel increases (vasodilation), then resistance decreases.
            - **The greater the viscosity, the greater the resistance, the more blood flow decreases and the more blood pressure increases.**

        ii) **Diameter (radius)** of the blood vessel
            - Imagine yourself sipping a smoothie though a thin straw, then through a thicker straw. Which one will offer less resistance, and will allow more flow of the beverage?
            - **Narrow blood vessels offer more resistance => Less blood flow => Increased blood pressure**
            - **Thicker blood vessels offer less resistance => More blood flow => Decreased blood pressure**
            - A diet high in cholesterol and saturated fat causes a disease known as **atherosclerosis**.
            - Blood vessels become less elastic in part due to plaque build up on the inner walls of the arteries. The blood vessel decreases in diameter and so narrows, which increases resistance the blood experiences as it passes through, decreasing blood flow, and, thus, increasing blood pressure.
            - If a coronary artery is blocked by a blood clot or plaque, a **heart attack** results. If blockage is at the brain it causes a **stroke**. Regions of cells in those organs will not get the oxygen and nutrients needed and will not be able to get rid of waste effectively if blood cannot flow.

        iii) **Length** of the blood vessels



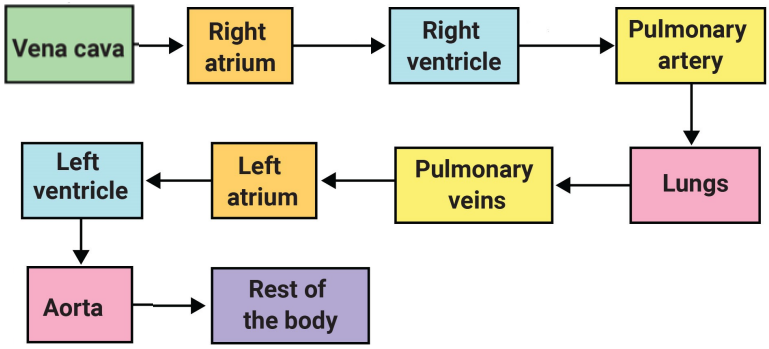
•Blood experiences more friction as it passes through longer blood vessels compared to shorter blood vessels. Therefore, longer blood vessels offer more resistance to the path of the blood and blood flow decreases as it passes through longer blood vessels.

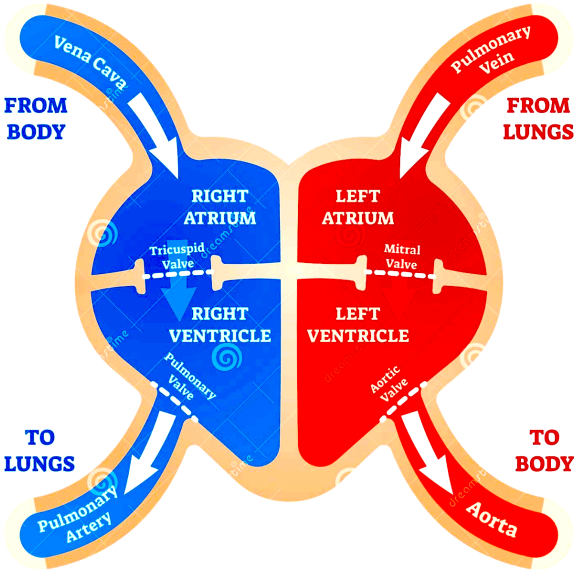
4. **Disease**
   - Diseases that affect blood flow in the human body include:
     - **Atherosclerosis =** Condition in which arteries become narrower due to the deposit of fatty material (cholesterol, lipid like fatty acids), and flow of blood decreases, vessels become less elastic, and lead to high blood pressure. May lead to stroke (in brain) or heart attack.
     - **Hypertension =** Blood pressure in arteries is elevated (140 / 90 or higher), caused by diet high in salts, sustained stress or by atherosclerosis. If arteries lose their elasticity and become more rigid or blood volume increases due to water retention, blood pressure increases. Hypertension causes small tears in blood vessels, setting the stage for atherosclerosis. Uncontrolled hypertension can lead to heart attack, stroke, kidney damage etc.
     - **Smoking** causes fatal damage to multiple human body system due to the mutagens and carcinogens in the smoke. Smoking causes vessels to constrict (narrow) which decreases blood flow through the body.
     - **Diabetes =** condition in which there is an elevated level of sugar (glucose) in the blood. Diabetes results in slower blood flow. The increase in glucose concentration in the blood stream causes the blood to be viscous or thicker causing the flow to decrease.
     - **Sickle Cell Anemia =** Genetic disease caused by a mutation that produces abnormal red blood cells in a "C" shape. This cells clump together often because of their shape, forming clots that block narrow blood vessels. Individuals suffer from pain, tiredness, blood flow blockages in small blood vessels of body organs and tissues, and require blood transfusions.
5. **Stress**
   - Stress can cause hypertension through repeated blood pressure elevations as well as by stimulation of the nervous system to produce large amounts of vasoconstricting hormones that increase blood pressure.
6. **Exercise**
   - During exercise your muscles require higher amounts of energy (ATP). The process of cellular respiration will break down glucose molecules to release their energy, store it on ATP molecules, and deliver that energy where needed to complete work. Cellular respiration requires oxygen. Therefore exercise will:
     - increase the breathing rate to provide muscles with more oxygen,
     - the heart will beat faster and harder to get more oxygen to cells, which increases blood pressure
     - blood vessel carrying blood to muscles will become more dilated (enlarged diameter), which will increases blood flow, which results in more blood volume being taken to muscles and less to stomach (same to brain).

- Students will be able to explain the relationship between pressure, resistance, and blood flow.

- Students will be able to describe various diseases related to the cardiovascular system.

- Students will be able to **diagram** blood flow of oxygenated and deoxygenated blood through the heart, lungs, and body, knowing how blood flows through the heart and body.
  - **Blood Vessels** = allow for the movement of blood to all cells in the body.
    - **Arteries** = Take blood out of the heart (whether they contain oxygenated or deoxygenated blood)
    - **Veins** = Return blood to the heart (whether they contain oxygenated or deoxygenated blood)
    - **Capillaries** = smallest blood vessels in diameter with thin walls of epithelial cells where gas, water, nutrient, and waste exchange occurs between the interstitial fluid surrounding the body's cells and the blood.
      - The pumping action of the heart, however, is needed to provide enough pressure to move blood throughout the body.





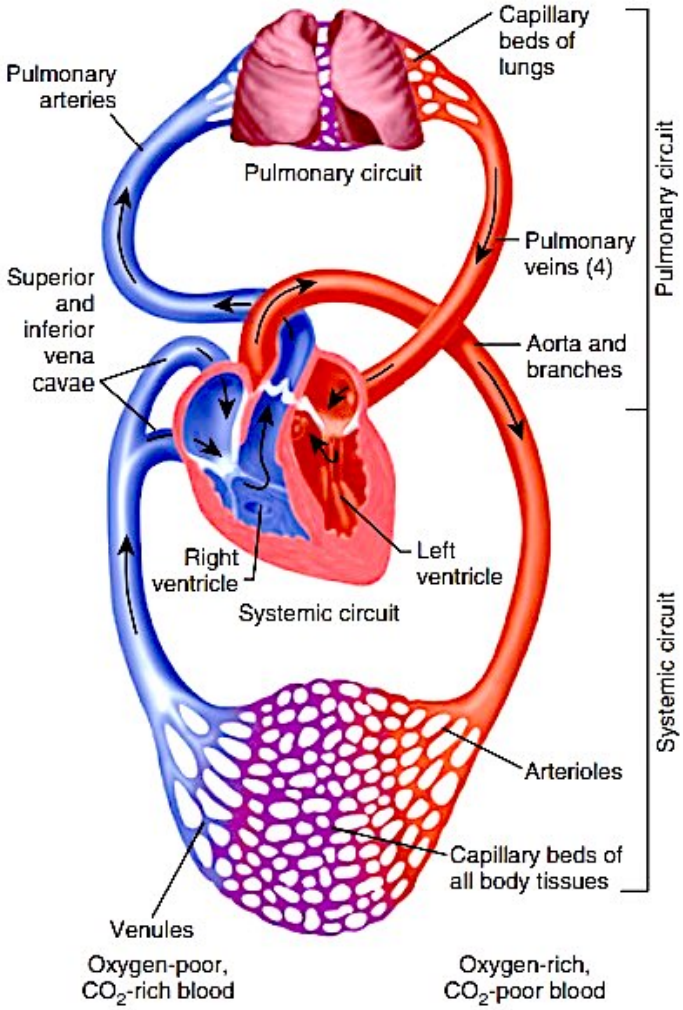


FIGURE 18-1 The blood pathway includes two circuits. The right ventricle supplies the pulmonary circuit, and the left ventricle supplies the systemic circuit.