AP Biology Summer Assignment 2021

MOUNT NOTRE DAME
Empowering Young Women

I am so glad that you have chosen to take AP Biology! It is an interesting, fun and challenging course. In order to "fit it all in" you must complete a summer assignment prior to our first class meeting. This summer assignment will likely take you between 4-8 hours to complete. You will need to use the internet to help you look up information for this assignment. Copies of your book will be issued at the start of the next school year (access codes reset over the summer for digital so I will get you those in the fall too). All work is due by midnight the first day of school. This course starts out fast, and the frantic pace continues until the AP exam in May. AP Biology is challenging and requires a lot of reading and time but the study of biology is quite exciting and I think you will enjoy the course. I look forward to working with you.

Mrs. Glass
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1. Read the "Biology Review Packet" which highlights concept covered in freshman biology and topics that we will be covering in depth throughout the year. (nothing to turn in for this)

2. Complete the Case Study "A Cool Glass of Water" (last 4 pages of this document) You will be assigned at least one case study per unit that we cover throughout the year. They will vary in length and format but this is a good first practice. Please complete in blue ink its easier for me to read. Look for turn in on Powerschool right before school starts back. (do NOT turn in this entire document, just the case study—last 4 pages)

3. Slideshow of Your Summer Scavenger Hunt: Make a 10 slide powerpoint or prezi with the following.
   a. A slide about you: your name, what you like to be called, a photo of you, a fun fact about you most people don't know. Extracurriculars: hobbies, jobs, sports, interests…
   b. A slide about your learning style: how do you learn best, what causes you to struggle in a course? How do you prepare for tests? Photo of your favorite place to study at home.
   c. A slide about your past schooling: what science classes have you taken (levels), have you ever taken an AP class before? Are you taking other science classes this school year? Do you have any outside of school science experiences? Why are your taking AP biology—what do you hope to gain/ accomplish by it?
   d. Go to a park and take a walk. Tell me a short summary of your experience. Take a photo of you there.
   e. Hold a creature other than your pet cat or dog: a worm, snake, slug, lizard, fish, any insect etc. take a picture of you holding or touching this creature. Briefly describe your experience.
   f. Explain what primary vs. secondary succession is. Find an example of one (or both) near you and include picture with you in it.
   g. You and water: how much water should you consume each day? Why is water so vital for your survival?Discuss 3 properties of water. Include a picture of you drinking water or playing in or near water.
   h. Your body pH varies. Choose 3 different areas of the body with different pHs and explain why that pH is important for that part of the body. Take a picture of you holding a household acid in one hand and a base in the other.
   i. Proteins are important in your diet, why? Give 3 specific reasons. Take a picture of you eating a protein. (Vegetarians—you can do this too!)
   j. Fats(lipids) are important in our diet. Give 3 specific examples of how fats are good for you and help in your body. Include a picture of you eating a "fat

Your slideshow should include only original photos that you took. You may not use photos from the internet. Include a list of web resources used (does not have to be in MLA) **Look for turn-in on PS right before school starts back**.

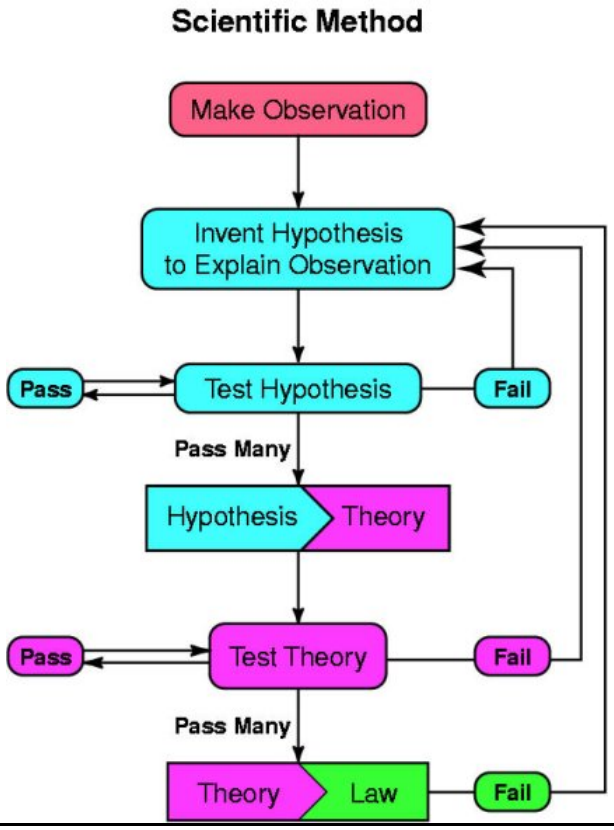
Topic – Scientific Investigation

"What's the opposite of 'Eureka!'?"

Fundamental Concepts and Skills	
1. Correctly use tools and methods of biological research. a) Measurement tools: thermometer, ruler, graduated cylinder, pipette b) Record data: **Qualitative** – using words (Amber's hair is black) **Quantitative** – using numbers (Amber has 5 fingers) c) Data analysis tools: graphs and tables showing relationship between IV and DV d) Research tools include: sources of scientific information (scientific journals), collaboration (working together) e) Laboratory and safety procedures	
2. Explain the Nature of Science: a) **Observations** – using the 5 senses to collect data (Ex. Maria is wearing a blue dress) b) **Inferences** – an explanation or assumption for what you observe. Inferences may be true or false (Ex. Maria likes blue since her dress is blue) c) **Predictions** – what you think might happen; a hypothesis is a type of prediction d) **Theory** – the result of many similar hypotheses that have been tested and supported by data from many experiments and many scientists e) **Validity of Data/Results** – scientists use repeated trials to prove that the data collected has truth (reliable results) and is not a fluke or luck f) **Science knowledge is always changing.** g) **The most reliable scientific information can be found in scientific journals.**	

3. Use the scientific method to investigate biological questions.

a) State the problem.
b) Collect background information about the problem. (Research and observe.)
c) Make a hypothesis (If… then…because…).
d) Design and perform a <u>controlled</u> experiment.
   1. **Independent Variable (IV)** = the one variable changed by the scientist (what is changed among experimental groups)
   2. **Dependent Variable (DV)** = the one variable that is affected by the IV (what is measured or observed)
   3. **Experimental groups** = experimental groups where the IV is applied in various levels (i.e. different amounts, temperatures, conditions)
   4. **Control group** = experimental group where the IV is not applied and is used for comparison (i.e. natural or neutral condition)
   5. **Constants** = all other factors of the experiment that are the same for all experimental groups and control group
e) Collect data and record data precisely.
f) Interpret the data collected through charts, graphs, etc.
g) Write a conclusion that explains whether or not the collected data supports the hypothesis. Why or why not?



4. Identify characteristics of living things.

a) **DOGRACER** is an acronym to remember the 8 characteristics or traits of living things. ALL EIGHT characteristics must be present for something to be classified as living. Living things are also called **organisms**.

D = DNA. All living things contain DNA, this codes for proteins

O = ORGANIZED. Living things are organized
(cells → tissues → organs → organ systems → individual organism → population → community → ecosystem → biosphere).

G = GROWTH and DEVELOPMENT. Living things grow and develop; growth involves gaining mass/getting bigger and development involves changing or gaining skills
Ex. human growth and development (like learning, language) or metamorphosis of a frog or butterfly.

R = REACT or RESPOND. Living things respond to stimuli to maintain homeostasis.

A = ADAPT. Living things adapt to their environment.
Organisms develop behaviors, body structures, and/or internal features that help them survive. This change happens over a long period of time (many generations) – this is called evolution.

C = CELLS. Living things are made of cells.
Organisms can be unicellular or multi-cellular.

E = ENERGY. Living things obtain and use energy.
Autotrophs can make their own food.
Heterotrophs eat other living things.

R = REPRODUCE. Living things reproduce in order to make more of their species. Reproduction occurs either sexually or asexually.

b) **Homeostasis** means keeping internal conditions the constant to maintain life.
Ex. Human body temperature stays at 98.6°F or 37°C. If your body temperature increases, you respond by sweating. The evaporation of sweat from your skin cools your body and brings it back to an acceptable temperature.

Topic – Biochemistry & Cellular Respiration

Fundamental Concepts and Skills

1. Identify the chemical compounds in living things.

a) CHNOPS are the most common elements found in living things.
(Carbon, Hydrogen, Nitrogen, Oxygen, Phosphorous, Sulfur)

b) **Organic compounds = macromolecules that contain carbon**
Examples include:
1. **nucleic acids**
2. **carbohydrates**
3. **lipids**
4. **proteins**

c) **Monomer** is one unit or piece of a polymer, or macromolecule

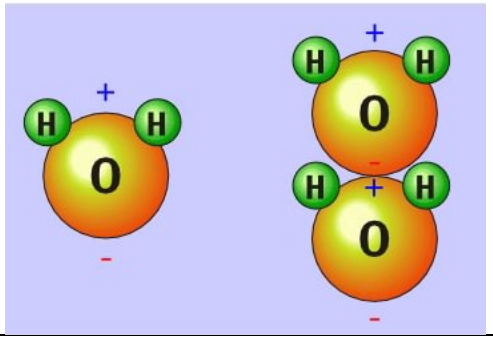
d) **Polymer** is a large molecule, or macromolecule made of many monomers

2. Diagram the structure of water and describe its characteristics.

a) Water is the most abundant compound found in living things

b) A water molecule contains two hydrogen atoms bonded to an oxygen atom forming a molecule that looks like Mickey Mouse ears.

c) Water is a **polar molecule** because it has an uneven distribution of charges. The hydrogen atoms are positively charged and the oxygen atom is negatively charged.



1. A **hydrogen bond** is formed when the partially **positive hydrogen** atoms on one water molecule are attracted to the partially **negative oxygen** atom of *another* water molecule.
2. Hydrogen bonding causes water molecules to be attracted to each other.

d) Characteristics of water include:
1. **Resistance to temperature change** – Water is able to absorb large amounts of heat. This allows lakes and oceans stabilize air and land temperatures. It also allows organisms to get rid of large amounts of heat (such as when humans sweat).
2. **Universal Solvent** – Water is able to dissolve many substance, so the water inside and outside of cells can carry nutrients into and around cells, and wastes away from cells.
3. **Expansion/Density** – In the solid form, water molecules expand causing ice to float, preventing lakes and oceans from freezing solid.
4. **Cohesion** – when water molecules are attracted to each other by hydrogen bonding
    a. **Surface Tension** – because of cohesion, the surface of water is hard to break
5. **Adhesion** – when water molecules are attracted to other surfaces
    a. **Capillary Action** – because of adhesion, water is attracted to the surface of very small tubes found in roots & shoots of plants; this is how plants get water & nutrients through their roots.
6. **Diffusion** – when particles move in water from an area of high concentration to an area of low concentration.
   Example – sugar diffuses from the blood stream into cells of the body
    a. **Osmosis** is the diffusion of water through a membrane
    b. Most of the water in the human body is absorbed in the large intestine
7. Pure water has a neutral pH of 7

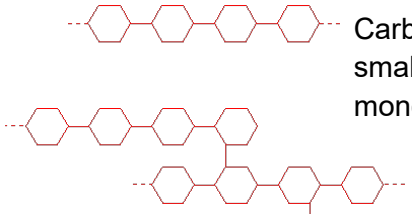
Fundamental Concepts and Skills

3. Explain the importance of pH to organisms.

a) The pH scale goes from 0 to 14.
A pH of 7 is neutral; a pH below 7 is acidic; a pH above 7 is basic.
b) Every cell has a particular pH at which it functions best and maintains homeostasis.
Example: blood cells like 7.4
c) Living organisms can only tolerate small changes of pH in their environment because they must maintain homeostasis.

4. Explain the structure and function of carbohydrates in living things.

a) The function of carbohydrates is to provide cells (and organisms) with **energy**.
b) Carbohydrates are macromolecules formed from monomers called **monosaccharides** or single sugars (*Examples – glucose, fructose*).
   1. Carbohydrates are also known as polysaccharides because they are made of many sugars.
c) The ending "**–ose**" usually means carbohydrate.
d) Glucose is a carbohydrate made by plants in photosynthesis; the carbohydrate cellulose is found in cell walls
e) Dietary sources of carbohydrates include bread, pasta, and fruit.
f) Carbohydrates are made from monosaccharides by the process of dehydration synthesis (putting two molecules together and removing a water molecule). This process requires enzymes to happen.

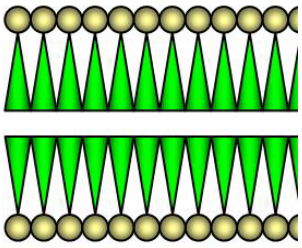


Carbohydrates are made of smaller units called monosaccharides.

Monosaccharides can join

5. Explain the structure and function of lipids in living things.

a) The function of lipids is to **store energy**.
b) Lipids are macromolecules formed from the monomers, **three fatty acid chains** attached to a **glycerol** molecule.
c) Lipids do not dissolve in water.
d) Lipids also **make up cell membranes** (phospholipids).
e) Dietary sources of lipids include butter and oil.
f) Lipids are made from fatty acids and glycerol by the process of dehydration synthesis (putting two molecules together and removing a water molecule. This process requires enzymes to happen.



Lipids are made of 2 parts- glycerol (circle) & fatty acid chains (triangle).

Fundamental Concepts and Skills

6. Explain the structure and function of proteins (including enzymes) in living things.

a) The functions of proteins include:
   1. **structure** (hair, nails, bone)
   2. **transport** (hemoglobin transports oxygen)
   3. **movement** (muscle fibers)
   4. **defense** (antibodies kill germs that invade the body)
   5. **regulating cell functions** (hormones and enzymes are proteins).

b) Proteins are macromolecules formed from monomers called **amino acids**.

c) Dietary sources of proteins include meats and beans.

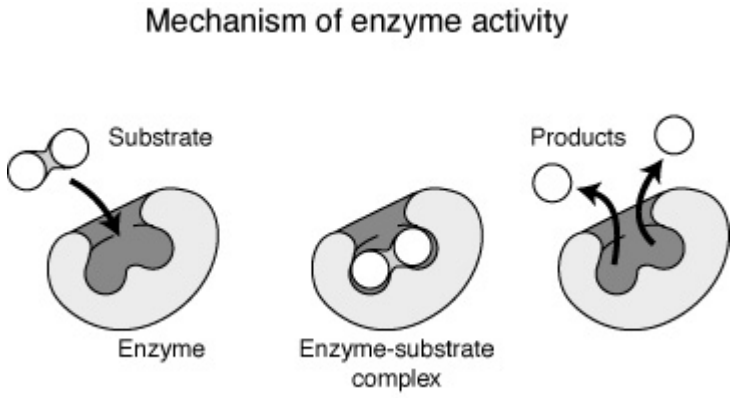
d) **Ribosomes** make proteins by joining amino acids together in a chain.

7. Explain how enzymes are proteins that speed up chemical reactions.

a) Enzymes have a **specific three-dimensional shape** which allows it to recognize and bind with a substrate (like two puzzle pieces).
   1. A **substrate** is the substance that the enzyme works with. Enzymes work exclusively with specific substrates.
   2. The **active site** is the area on the enzyme where the substrate attaches.

b) Enzymes can be used over and over again.
   1. Enzymes in the digestive system break down macromolecules (or polymers) into monomers.
   2. Enzymes in the cells join monomers into polymers to make the macromolecules the body needs.

c) The rate (or speed) of an enzyme reaction is controlled by:
   1. Concentration or amount of enzyme / substrate
   2. Temperature – if too high then enzyme denatures/degrades/falls apart
   3. pH – most enzymes work at a neutral pH



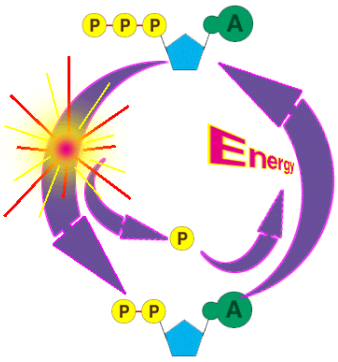
Topic - Photosynthesis & Respiration

Fundamental Concepts and Skills

1. Explain how ATP is a renewable source of energy in the cell.

a) **ATP** stands for adenosine **tri**phosphate.
ATP consists of:
1. Adenine
2. Ribose sugar
3. 3 phosphate groups

b) **ADP** stands for adenosine **di**phosphate.
ADP consists of:
1. Adenine
2. Ribose sugar
3. 2 phosphate groups



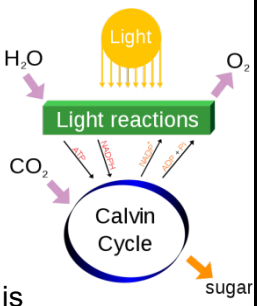
c) The three phosphate groups are essential to ATP's ability to provide the cell energy.
1. When the last phosphate group is separated, energy is released for the cell to use.
2. When the last phosphate group is re-attached, energy is stored.

2. Describe the process of photosynthesis.

a) Photosynthesis is a process that uses sunlight (energy from the sun) to produce glucose (a simple sugar). The chemical equation for photosynthesis is:

$$6\ CO_2 + 6\ H_2O + \text{sunlight} \rightarrow C_6H_{12}O_6\ \text{(glucose)} + 6\ O_2$$

1. **Light-dependent Reactions** – Uses sunlight energy to produce oxygen to produce energy carriers (ATP and NADPH)
2. **Calvin Cycle** – ATP and NADPH produced in the Light-dependent Reactions are used to produce sugars.



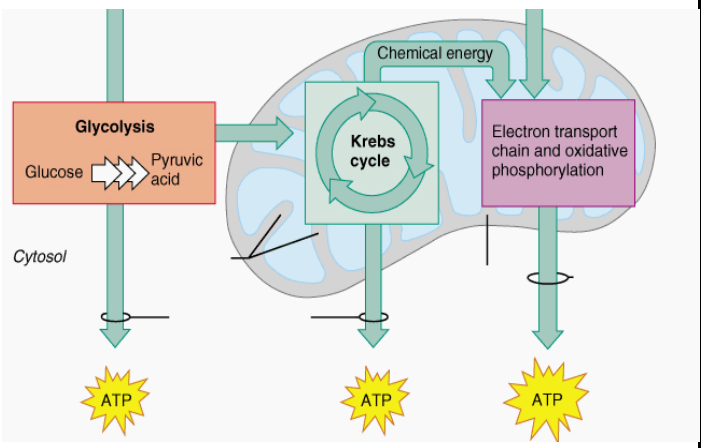
b) Photosynthesis is carried out in the **chloroplasts**.
1. **Chlorophyll** is a green pigment found in chloroplasts that is used to absorb the sunlight.

3. Explain the process cellular respiration.

a) **Aerobic respiration** involves the use of oxygen to produce the maximum amount of ATP (the energy molecule that the cell uses).

$$C_6H_{12}O_6 \text{ (glucose)} + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O + 36\ ATP$$

1. **Glycolysis** – One glucose molecule is broken down into 2 pyruvates.
2. **Krebs Cycle/Citric Acid Cycle** – Pyruvate is broken down through several steps and the cycle releases electron carriers (NADH, FADH).
3. **Electron Transport Chain** – Electron carriers drop off their electrons which are passed through a chain of proteins. The last protein forms ATP and the electrons join with oxygen and hydrogen molecules to make water.
4. **38 ATP** molecules are made from each glucose molecule.

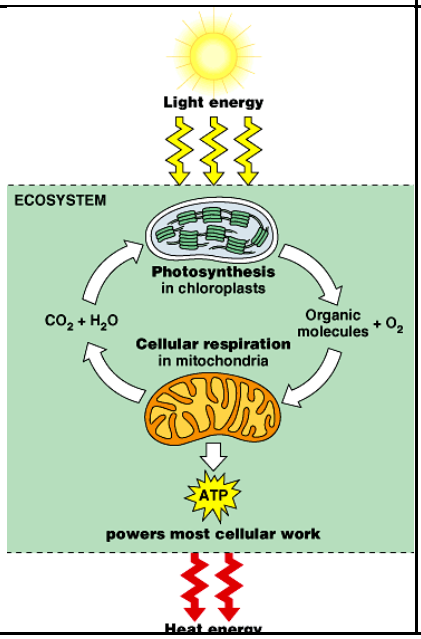


b) **Anaerobic respiration** occurs when no oxygen is present and it produces less ATP.

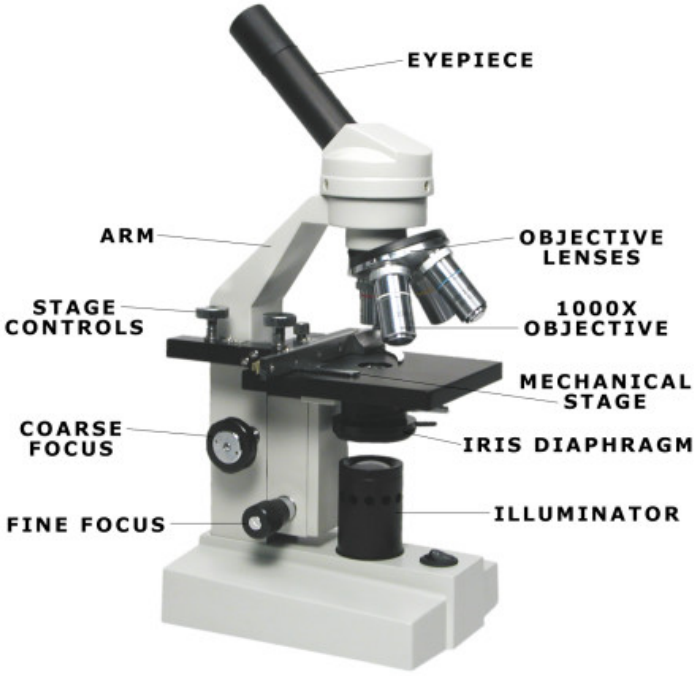
1. In yeast, **alcohol fermentation** occurs. It produces ethyl alcohol and carbon dioxide.
2. In muscles, **lactic acid fermentation** occurs. It produces lactic acid and carbon dioxide.

4. Explain how photosynthesis and respiration are complementary processes for cycling <u>carbon dioxide</u> and <u>oxygen</u> in an ecosystem.

a) Light is the initial source of energy for almost all communities.
b) Photosynthesis converts light energy (sunlight) to chemical energy (glucose).
c) Respiration breaks down organic molecules (like glucose) to release energy stored by photosynthesis.
d) The energy released during respirations (ATP) is transported within the cell.
e) When a cell needs energy for cellular activities, enzymes release the energy stored in ATP.



Topic - Microscopes

Fundamental Concepts and Skills	
1. Identify the parts of the microscope, give the functions of each part and use the microscope to observe, measure and draw cells. a) **Eyepiece**: magnifies the sample 10x b) **Stage**: flat area where slide is placed c) **Diaphragm**: varies the amount of light from the lamp d) **Course adjustment**: focuses the sample at low power objectives by moving the stage a lot e) **Fine adjustment**: focuses the sample at high power objective by moving the stage a little f) **Objective Lenses**: 1. High power: magnifies sample by 40x 2. Medium power: magnifies sample by 10x 3. Low power (scanning): magnifies sample by 4x  g) Determine total magnification of a field of view: **Total magnification = eyepiece magnification x objective magnification**	
2. Explain the difference between a compound light microscope and an electron microscope. a) Electron microscopes use beams of electrons to produce images instead of light. b) Electron microscopes can produce images almost 1000 times more detailed than light microscopes. c) Specimens are preserved and dehydrated before they can be viewed through an electron microscope, so living cells cannot be observed with an electron microscope.	

Topic - Cells

Fundamental Concepts and Skills

1. Explain the Cell Theory and its development

a) The invention of the **light microscope** was necessary to study cells and develop the cell theory.

b) Scientists' discoveries who helped develop the cell theory include:

1. **Robert Hooke** – observed cork under an early microscope and saw small chambers; invented the term "cells"
2. **Anton Van Leeuwenhoek** – first to observe living cells (Protista) in pond water; known as the "Father of Microscopes" because he improved the lenses to magnify specimens
3. **Theodor Schwann** – observed animal tissue under a microscope and concluded that animal are made of cells
4. **Matthias Schleiden** – observed plant tissue under a microscope and concluded that plants are made of cells
5. **Rudolph Virchow** – observed cells dividing under a microscope and concluded cells came from pre-existing cells

c) The **Cell Theory** has three parts:

1. Cells are the basic units of structure and function in living things.
2. All living things are made of one or more cells (unicellular or multicellular)
3. All cells come from pre-existing cells, not through spontaneous generation.

d) Cells are very small so nutrients can easily diffuse in and waste can easily diffuse out of the cell.

2. Identify (in a diagram) and describe the function of cell organelles.

a) **Nucleus** – controls cell's activities and contains DNA

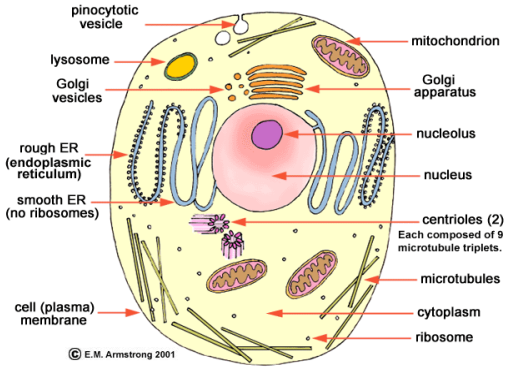
b) **Ribosomes** – make proteins

c) **Mitochondria** – turns food into energy through the process of cellular respiration

d) **Chloroplast** – contains chlorophyll and uses the sun's energy to make sugar (energy) through the process of photosynthesis

e) **Endoplasmic reticulum** – transports substances within the cell

1. Rough endoplasmic reticulum – site of protein production
2. Smooth endoplasmic reticulum – makes lipids



f) **Golgi body (apparatus)** – packages and sends proteins out of the cell

g) **Lysosomes** – contain digestive enzymes

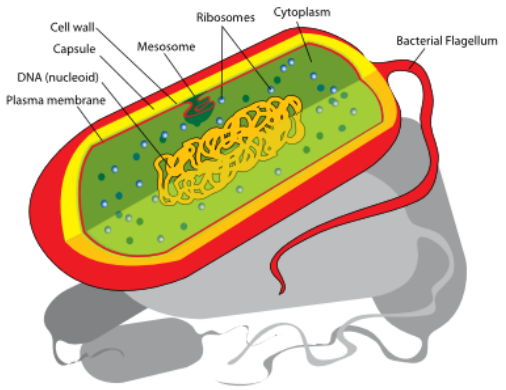
h) **Cell membrane** (or plasma membrane) – controls what materials enter and leave the cell

i) **Cell wall** – gives support to plant cells

j) **Vacuoles** – store waste, water (H_2O), and nutrients.

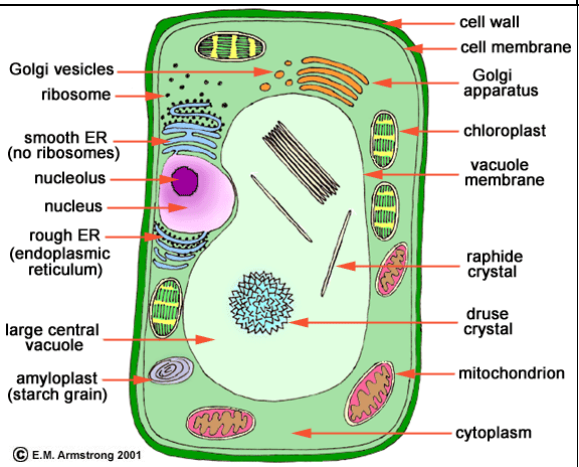
3. Compare and contrast the structure and be able to distinguish between diagrams of prokaryotic and eukaryotic cells

a) Prokaryotes are much simpler and usually smaller cells.
b) Eukaryotes have a **membrane-bound nucleus** and **other membrane-bound organelles** (such as mitochondria, golgi bodies) that prokaryotes do not have.
c) Members of the Kingdom Monera (blue-green algae and bacteria) are prokaryotes. Members of the Protista, Fungi, Plant and Animal kingdoms are eukaryotes.



4. Describe the differences and be able to distinguish between diagrams of plant and animal cells.

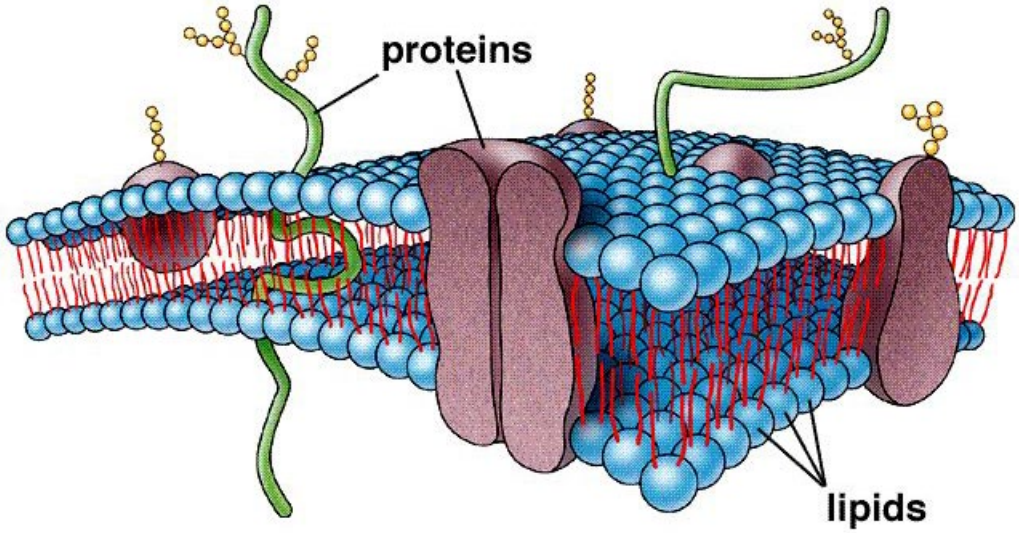
a) Plant cells have chloroplasts for photosynthesis, and a cell wall for support;
both animal and plant cells have cell membranes
b) Plant cells have one or two very large vacuoles;
Animal cells have many small vacuoles
c) Plant cells have a square shape and are green (due to chlorophyll in the chloroplasts)



5. Describe specific examples that illustrate the relationship between cell structure and cell function.

a) The shape of the cell is related to the function (purpose or role) of the cell.
Examples include:
1. Plant cells are like bricks in a wall. Cell walls provide support so the plant can stand up.
2. Muscle cells are long and elastic so they can contract and move an organism. They have more many mitochondria so they can perform a high energy function.
3. Paramecia are covered with cilia and shaped like a torpedo so they can swim. Paramecia are microscopic, unicellular organisms that belong to the Kingdom Protista.
4. Red blood cells are round and flexible so they can move through small blood vessels. They have few organelles to leave room for hemoglobin, a protein that carries oxygen.

Topic - Cell Membrane & Cellular Transport

Fundamental Concepts and Skills	
1. Describe the structure of a cell membrane. a) The structure of the cell membrane is known as the **fluid mosaic model** because it is made of many floating pieces. b) The cell membrane is a **phospholipid bilayer** because it is made up of 2 layers of phospholipids. 1. Each phospholipid is made up of a phosphate head and two lipid tails. 2. The phosphate head is hydrophilic and the lipid tails are hydrophobic. c) **Cholesterol** in the cell membrane untangles the lipid tails. d) There are many different proteins found in the cell membrane: 1. **Transport or Carrier Proteins** move large molecules in or out of the cell. 2. **Marker Proteins** have **Carbohydrate Chains** on the outside surface of the cell membrane that serve as identification markers and also detects if there are any foreign invaders that should not enter the cell.  	
2. Describe the functions of a cell membrane and how they help a cell maintain homeostasis. a) The cell membrane separates the inside of the cell from its outside environment. b) The cell membrane controls what enters & leaves a cell to maintain **HOMEOSTASIS**. 1. Homeostasis is the biological balance which cells must maintain for survival. c) Very small molecules (like oxygen, carbon dioxide, and water) can pass directly through the phospholipids. d) Large molecules (like sugar) must pass through transport proteins ("protein gates").	

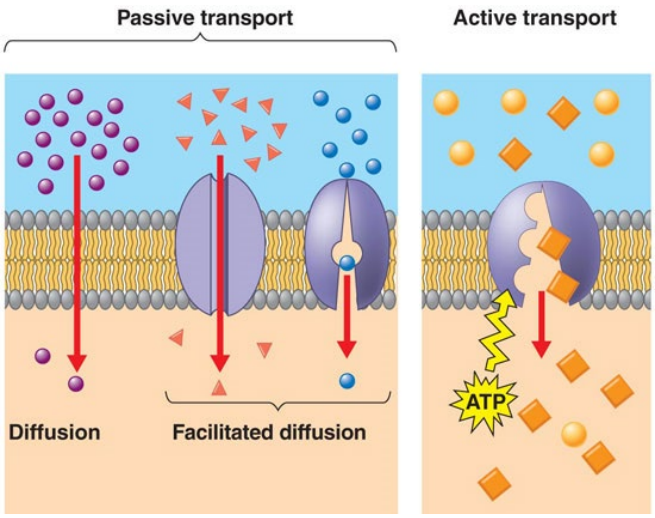
Fundamental Concepts and Skills

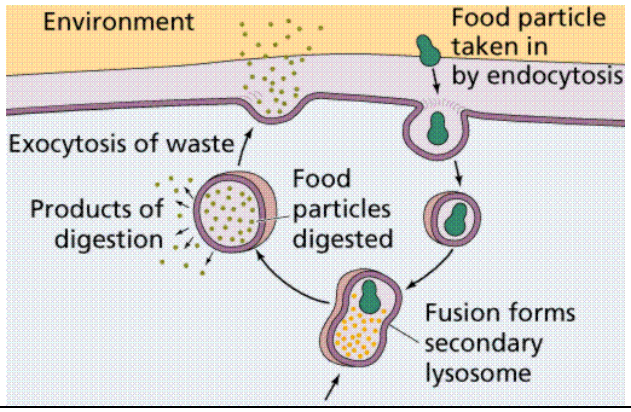
3. Explain the differences between active and passive transport.

a) A **concentration gradient** is formed when there is a difference of concentration in a given area or across a cell membrane

b) **Passive transport** – does not use energy to transport materials
   1. Molecules move from an area of high concentration to low concentration; down or with the concentration gradient
   2. Types of passive transport includes:
      a. **Diffusion**: movement of **molecules** from **high to low** concentration
      b. **Osmosis**: movement of **water** from **high to low** concentration through **cell membrane**
      c. **Facilitated diffusion**: movement of **any large molecule** from **high to low** concentration through the **transport or carrier proteins**

c) **Active transport** – uses energy to transport materials
   1. Molecules move from an area of low to high concentration; up or against the concentration gradient
   2. Types of active transport include:
      a. **Endocytosis**: materials entering the cell by forming a vacuole around the molecule from the cell membrane; Two types of endocytosis are: pinocytosis (cell drinking) and phagocytosis (cell eating)
      b. **Exocytosis**: materials exiting the cell in a vacuole that joins the cell membrane
      c. **Ion Pumps**: movement of charged molecules from **low to high** concentration through the **transport or carrier proteins**



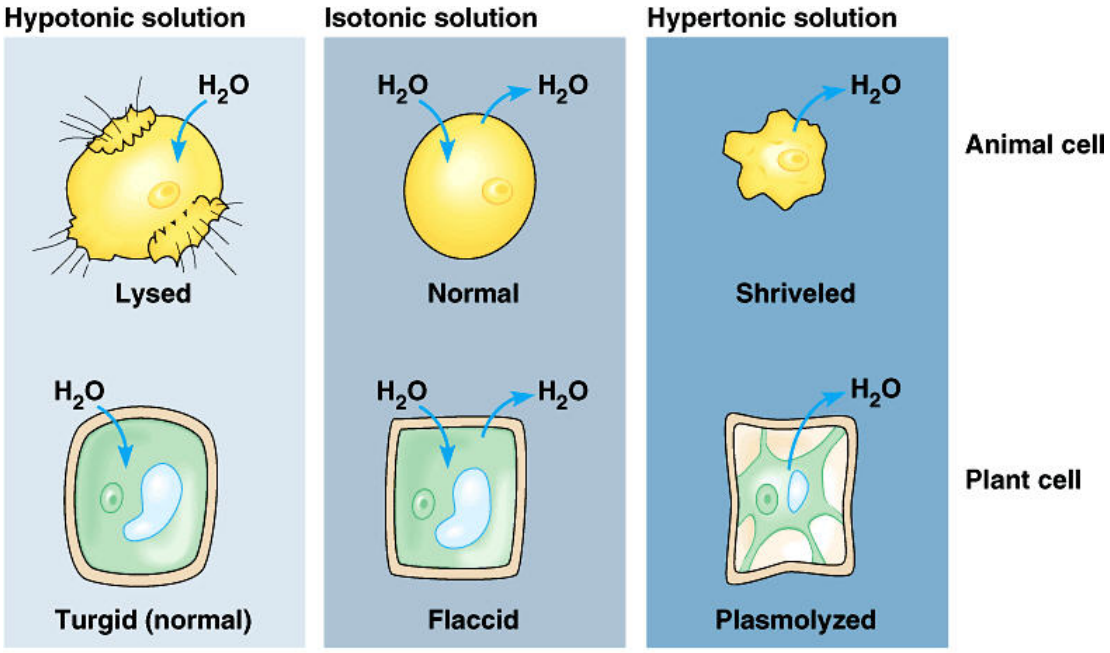


Fundamental Concepts and Skills

4. Explain interactions between cells and their environment in terms of diffusion and osmosis.

a) There are 3 different types of solutions cells can be placed in:

1. **Hypotonic** – cells get bigger because water enters the cell by osmosis; (the solution has a lesser concentration of solute than the interior of the cell)
2. **Hypertonic** – cells get smaller because water leaves the cell by osmosis (the solution has a greater concentration of solute than the interior of the cell)
   a. If humans don't drink enough water, body cells will shrink.
   b. Plants will wilt if they do not have enough water in their cells
3. **Isotonic** – cells stay the same size because water enters and leaves the cell at the same rate
   (the solution has an equal concentration of solute as the interior of the cell)



b) Cells <u>shrink</u> (smaller) in salt / sugar water, and <u>swell</u> (bigger) in pure water

c) Small molecules move into and out of cells by diffusion or osmosis unless the cell uses energy to move molecules against a concentration gradient.

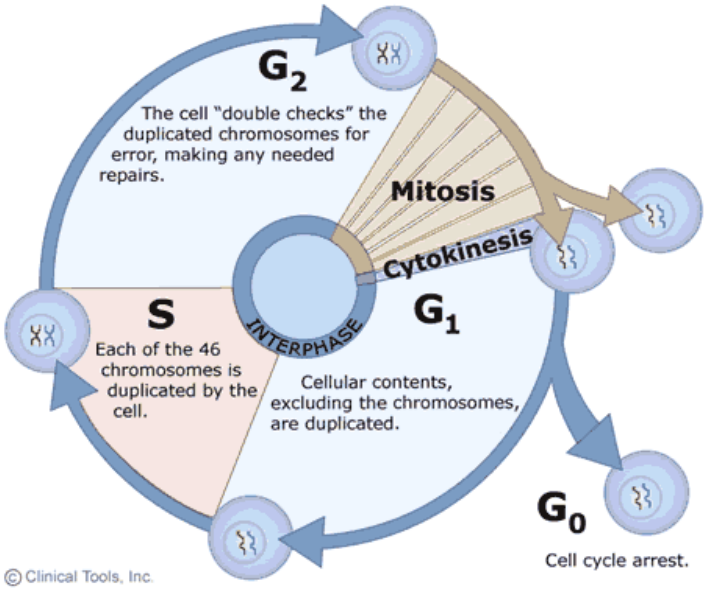
d) In the respiratory and circulatory systems, oxygen diffuses into the blood and carbon dioxide diffuses out of the blood.

1. Prepare a wet mount slide

Topic - Cell Cycle (Mitosis)

1. **Explain the purpose of the Cell Cycle.**
   a) The purposes of the Cell Cycle are:
      1. Growth
         a. As more cells are made, the cells are organized into the following levels: **Cells → Tissues → Organs → Organ systems → Organism**
      2. Development
      3. Healing
      4. Reproduction (only for unicellular organisms)
   b) The Cell Cycle is the process of cellular division and growth.
      1. One cycle is one division and a growth period.
   c) Two identical cells are created from one original cell.
      1. The original cell is called the **parent cell**.
      2. The newly formed cells are called **daughter cells**.
      3. The parent cell divides once.
   d) The Cell Cycle produces **diploid** (2n) cells.
      1. Diploid cells contain two copies of each chromosome.
      2. Body cells are diploid.
         b. Human body cells have 46 chromosomes or 23 pairs.

2. **Describe the parts of the Cell Cycle.**
   a) **Interphase** – the time between cell divisions
      1. Cell grows
      2. Chromosomes must replicate. Each single-stranded chromosome replicates (makes a copy of itself) into a double-stranded chromosome called **sister chromatids**.
         a. Sister chromatids are held together by a **centromere**.
   b) **Mitosis** – nuclear division; there are 4 stages of Mitosis
      1. Prophase
      2. Metaphase
      3. Anaphase
      4. Telophase
   c) **Cytokinesis** – the cell splits in half
      1. The daughter cells are identical to the parent cell (or original cell)



3. Identify, describe and draw the stages of MITOSIS.

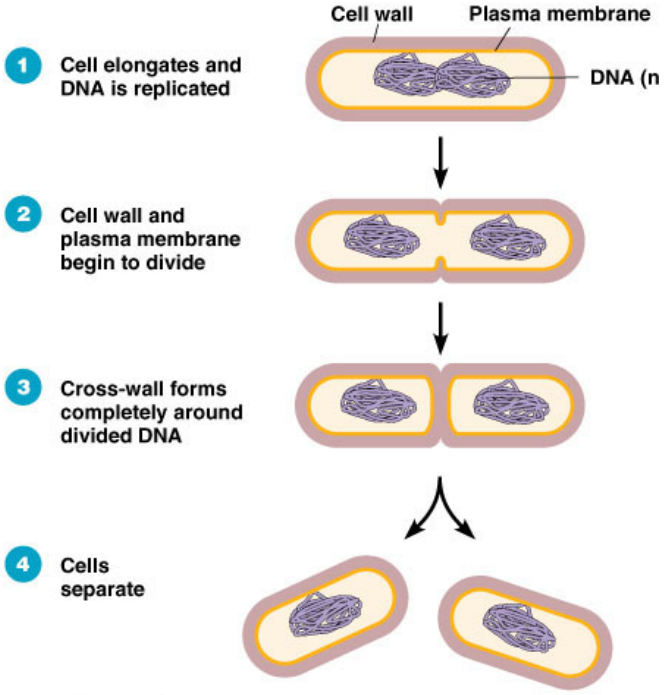
a) Mitosis will not occur unless DNA has been replicated in Interphase.

b) The stages of mitosis are prophase, metaphase, anaphase and telophase.

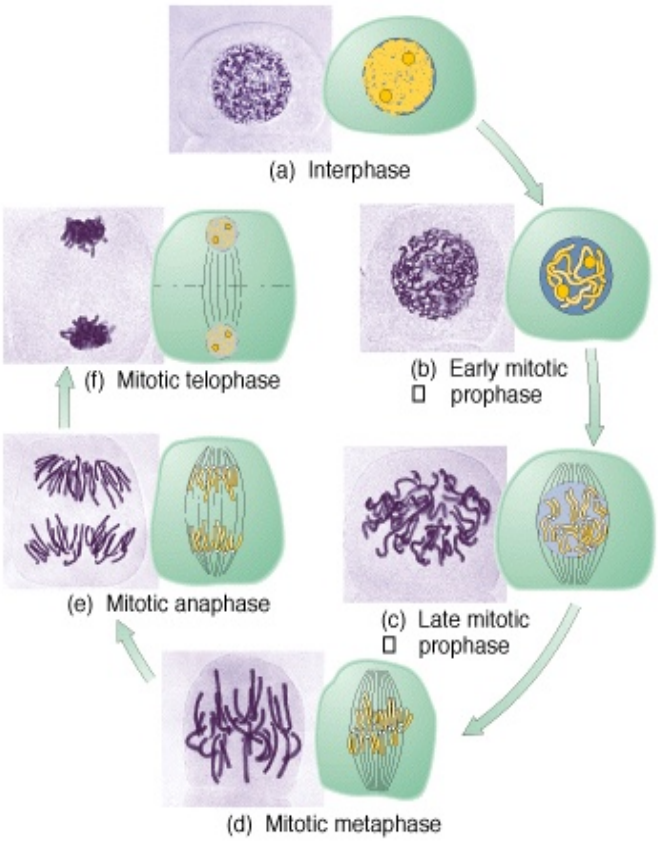
1. **Prophase** – the cell prepares to divide; sister chromatids become visible, centrioles replicate and travel to opposite ends of the cell
2. **Metaphase** – sister chromatids line up at the cell equator or middle of the cell
3. **Anaphase** – sister chromatids are pulled apart to opposite ends of the cell
4. **Telophase** – the cell begins to form two nuclei (for two cells)

c) For unicellular organisms (*i.e. bacteria and paramecium*), mitosis is part of a form of asexual reproduction called **binary fission**.

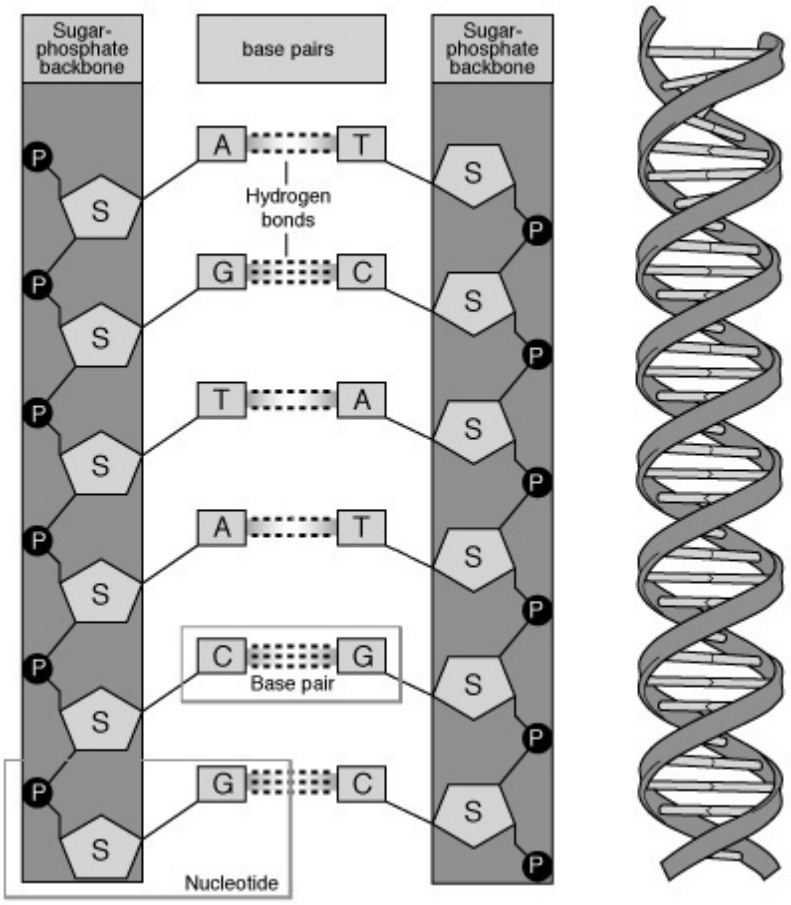
1. Asexual reproduction produces offspring that are identical to their parent.



(a) A diagram of the sequence of cell division.



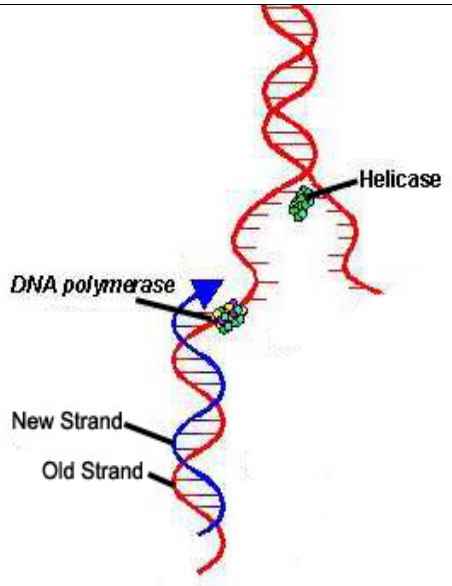
Topic - DNA

Fundamental Concepts and Skills	
1. Explain how the genetic code is contained in DNA. a) The genetic code is the sequence of DNA nucleotides. b) DNA is a **nucleic acid**. Nucleic acids are macromolecules (or polymers) made up of monomers called **nucleotides**. 1. A **DNA nucleotide** is made up of 3 parts: a. phosphate group b. deoxyribose sugar c. nitrogen base i. there are 4 nitrogen bases in DNA *adenine (A), guanine (G), thymine (T), cytosine (C)* ii. Nitrogen bases pair up according to Chargaff's rule or the base-pair rule: **A pairs with T, C pairs with G** c) The structure of DNA is called a **double helix**. 1. DNA is made of 2 strands or it is double-stranded. 2. The two strands twist to form a helix. 3. A double helix is shaped like a twisted ladder. The rungs or steps of the ladder are the base pairs; the sides of the ladder are alternating phosphate groups and deoxyribose sugars.  	

Fundamental Concepts and Skills

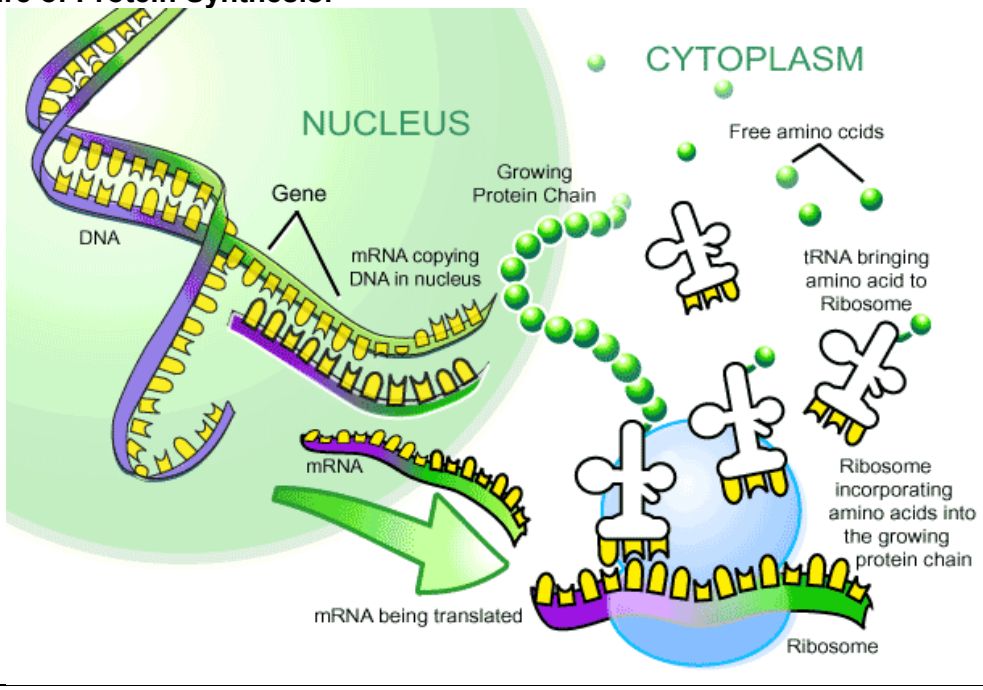
2. Describe how cells pass on the genetic code by replicating (or copying) their DNA. (DNA replication)

a) DNA replication is the process where 2 identical copies of DNA are made.
b) The steps to replicating DNA are:
   1. An enzyme named helicase unwinds and unzips the double helix.
   2. Each unzipped strand serves as a template for building a new DNA molecule.
   3. Free nucleotides bond to the template strands by base-pair rule to form a complementary strand.
   4. DNA polymerase connects the nucleotides and zips and winds the new DNA molecules.



3. Explain how genetic information inherited by an organism controls the activities of each cell. (Protein Synthesis)

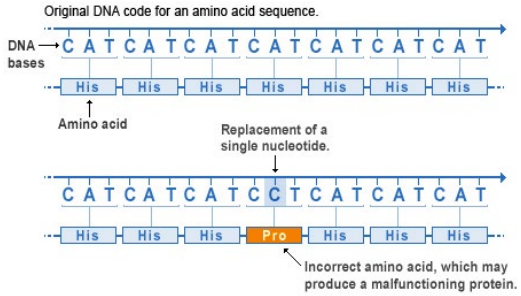
a) Protein synthesis is the process of constructing proteins from the genetic code.
   1. The genetic or DNA code controls cell activities by telling the cell which proteins to make.
   2. A gene is a portion of the DNA sequence that codes for a protein.
b) There are 2 parts to protein synthesis: Transcription and Translation.
   1. **Transcription**
      a. Occurs in the nucleus
      b. The DNA sequence is transcribed or copied into an mRNA sequence
   2. **Translation**
      a. Occurs at the ribosome in the cytoplasm
      b. The mRNA sequence (a complementary copy of the DNA sequence) is translated into an amino acid chain (a protein).
c) **RNA** is a type of nucleic acid that assists DNA during protein synthesis.
   1. RNA is also made of monomers called nucleotides.
      A **RNA nucleotide** is made up of 3 parts:
      a. phosphate group
      b. ribose sugar
      c. nitrogen base
         i. there are 4 nitrogen bases in DNA
            adenine (A), guanine (G), cytosine (C), ***uracil (U)***
         ii. Nitrogen bases pair up according to the base-pair rule:
            A pairs with U, C pairs with G
   2. There are 3 different types of RNA:
      a. **Messenger RNA (mRNA)** – a copy of the DNA sequence that travels to the ribosome
         i. **Codon** – a set of 3 nucleotides in an mRNA sequence
      b. **Transfer RNA (tRNA)** – translates the mRNA sequence into a protein by bringing amino acids to the ribosome
         i. **Anticodon** – a set of 3 nucleotides on tRNA
         ii. tRNA brings amino acids to the ribosome by matching its anticodon to the codons on mRNA
         iii. **Ribosomal RNA (rRNA)** – the ribosome is made up of rRNA

Fundamental Concepts and Skills	
Picture of Protein Synthesis: 	

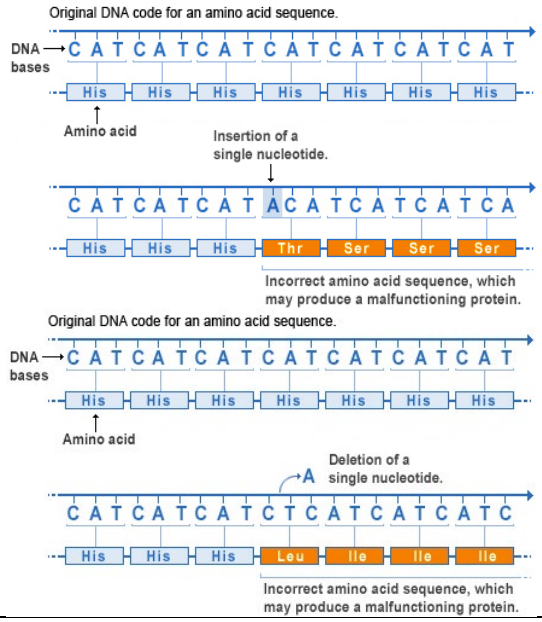
4. Describe gene mutations and their effects.

a) A mutation is a change in the nitrogen base sequence of a gene.
b) When the DNA base sequence of the gene is changed, the amino acid sequence and the protein is changed.
c) An amino acid change in a protein could affect its structure, resulting in a change in the protein's function.
d) Changes in the DNA sequence create differences between individual organisms. This is called variation.

Point Mutation:

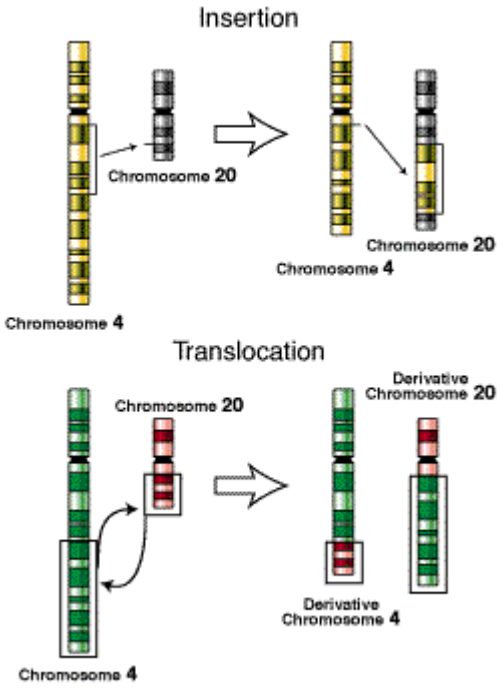


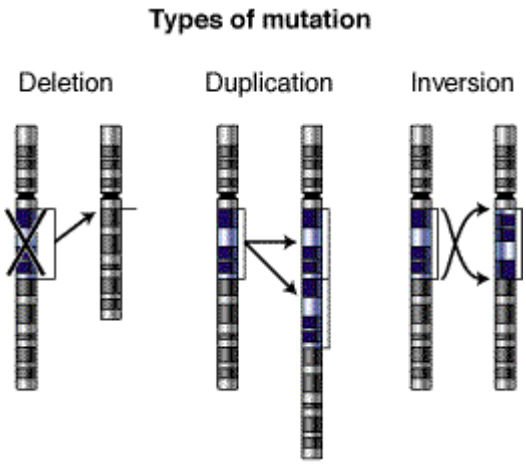
Frameshift Mutations:



5. Describe chromosomal mutations and their effects.

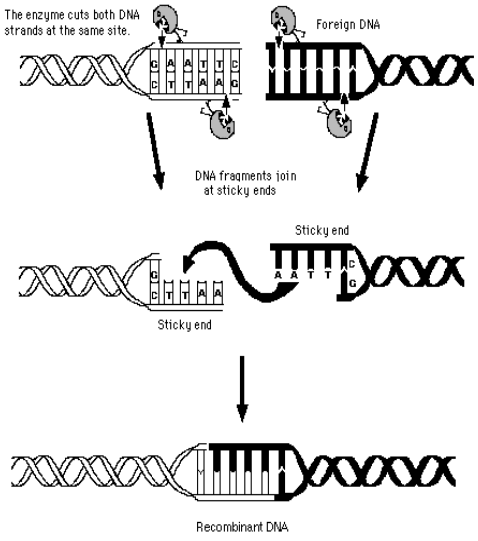
a) Chromosomal mutations are changes in the chromosome segments.
b) There are different types of chromosomal mutations:
   1. **Deletion**: when a segment of a chromosome is lost
   2. **Duplication**: when a segment of a chromosome is copied and inserted into the same chromosome
   3. **Inversion**: when a segment of a chromosome is inserted in the reverse order
   4. **Insertion**: when a segment of a chromosome is inserted into another chromosome
   5. **Translocation**: when a segment of a chromosome exchanges places with a segment from another chromosome





6. Describe the uses of various types of DNA technology.

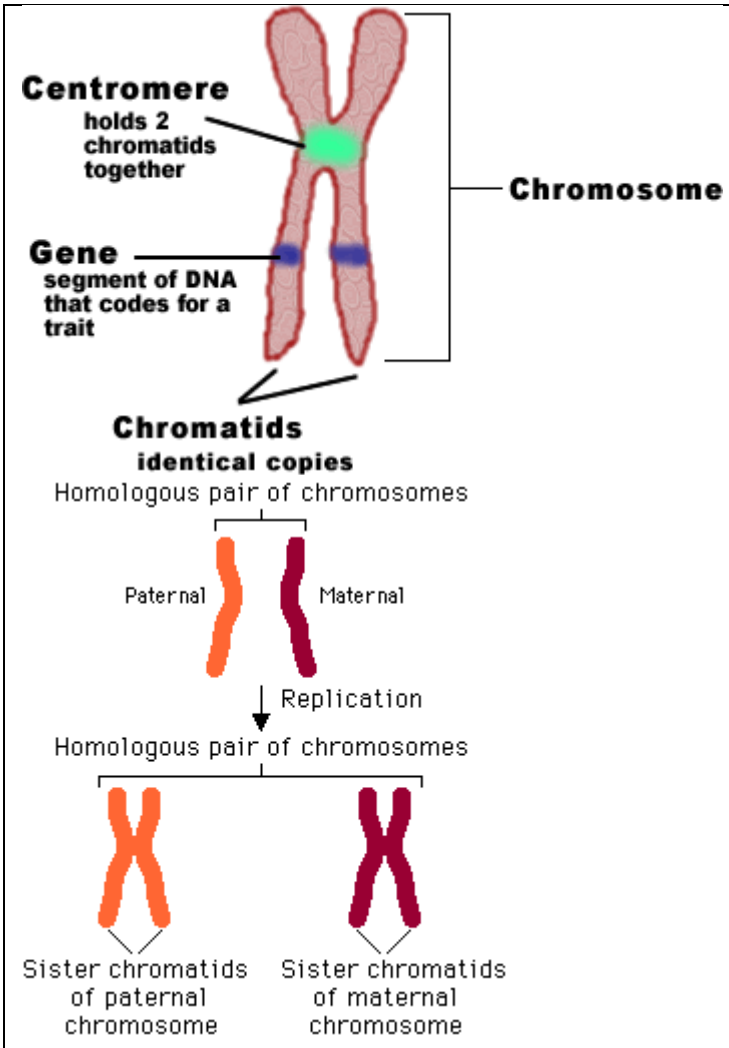
a) **Restrictions enzymes** cut DNA into smaller fragments or pieces.
b) DNA fingerprinting compares the DNA fragments from a known sample to those from suspects.
c) Genetic engineering involves inserting DNA fragments from one organism into another organism
   1. **Recombinant DNA** is DNA formed from two or more organisms.
d) Gene therapy is the insertion of normal genes into human cells to correct genetic disorders.
e) Cloning is the creation of genetically identical DNA, cells or organisms.



Dragonfly Book 322-326, 331-333, 355-360

Topic - Meiosis

Fundamental Concepts and Skills	
1. Explain the purpose of meiosis. a) Meiosis produces gametes which are necessary for sexual reproduction. 1. **Gametes** are sex cells *Example – Human gametes are eggs in females and sperm in males.* 2. Gametes are **haploid** (n) cells. a. Haploid cells contain one copy of each chromosome. b. Human gametes have 23 chromosomes (while body cells have 46 chromosomes) b) Four different gametes are created from one original cell. 1. The parent cell divides twice, producing 4 gametes. c) Meiosis is important for sexual reproduction so that organisms can maintain their chromosome number from generation to generation.	
2. Identify and explain the different forms of chromosomes. a) Chromosome – one DNA molecule b) Chromatin – uncoiled DNA molecule c) Chromatid – a coiled DNA molecule 1. Sister chromatids – a coiled DNA molecule and its duplicate 2. Centromere – area where sister chromatids are attached d) Homologous pair – chromosomes that are the same size and shape 1. One chromosome in the pair is inherited from the mother, the other chromosome is inherited from the father 2. Tetrad – 4 chromosomes; a homologous pair with their duplicates	

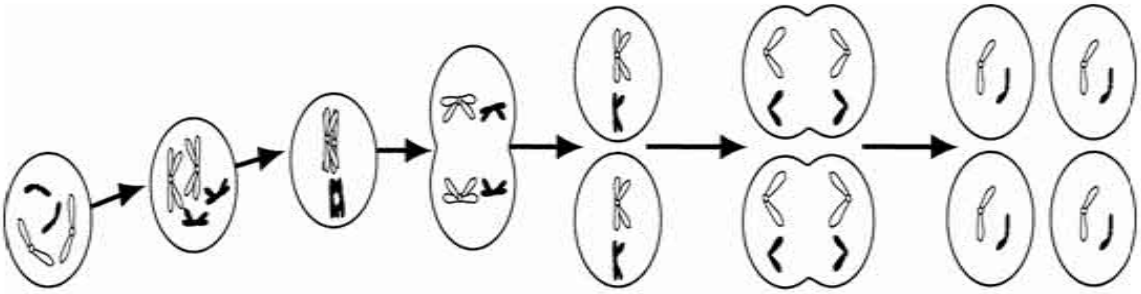

Centromere
holds 2 chromatids together
Chromosome
Gene
segment of DNA that codes for a trait
Chromatids
identical copies
Homologous pair of chromosomes
Paternal
Maternal
Replication
Homologous pair of chromosomes
Sister chromatids of paternal chromosome
Sister chromatids of maternal chromosome

Fundamental Concepts and Skills

3. Identify and describe the phases of MEIOSIS.

a) Meiosis has 2 parts because the parent cell divides twice.

1. ***Meiosis 1*** – Homologous pairs are separated
   a. Interphase, Prophase 1, Metaphase 1, Anaphase 1, Telophase 1, Cytokinesis
2. ***Meiosis 2*** – Sister chromatids are separated
   b. Prophase 2, Metaphase 2, Anaphase 2, Telophase 2, Cytokinesis



3. Explain how variation results from meiosis and sexual reproduction.

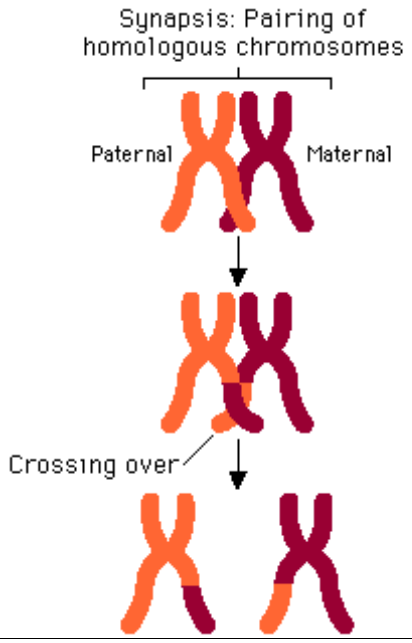
a) Meiosis increases variation.

1. Variation means increased differences between individuals.
2. Sexual reproduction produces offspring that are a combination of their parents' DNA, increasing variation.

b) Synapsis or **crossing over** occurs in Prophase 1 when the chromosomes are in tetrads.

1. Crossing over results in new combinations of genes (diversity or variation).

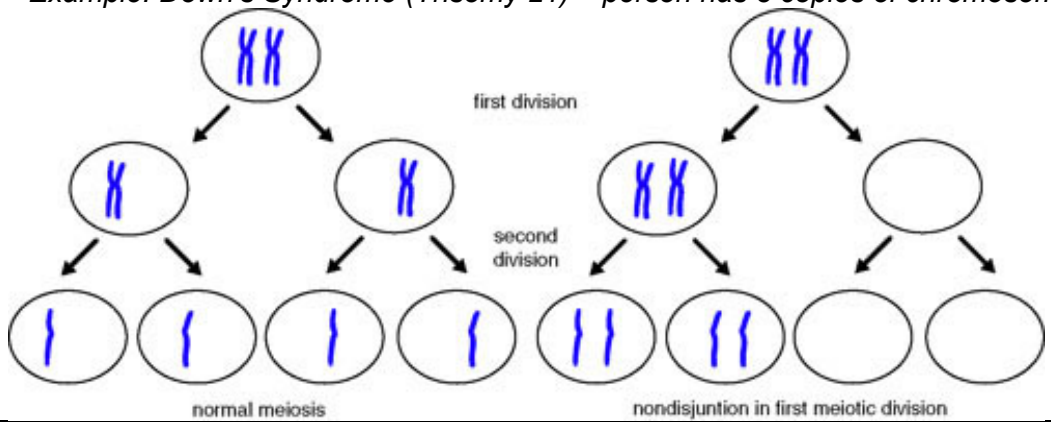
c) Mutations can also result in variation.



Fundamental Concepts and Skills

4. Describe what disjunction is and its effects.

c) **Nondisjunction** is when chromosomes do not separate properly in meiosis, resulting in an extra chromosome or a missing chromosome
Example: Down's Syndrome (Trisomy 21) – person has 3 copies of chromosome 21

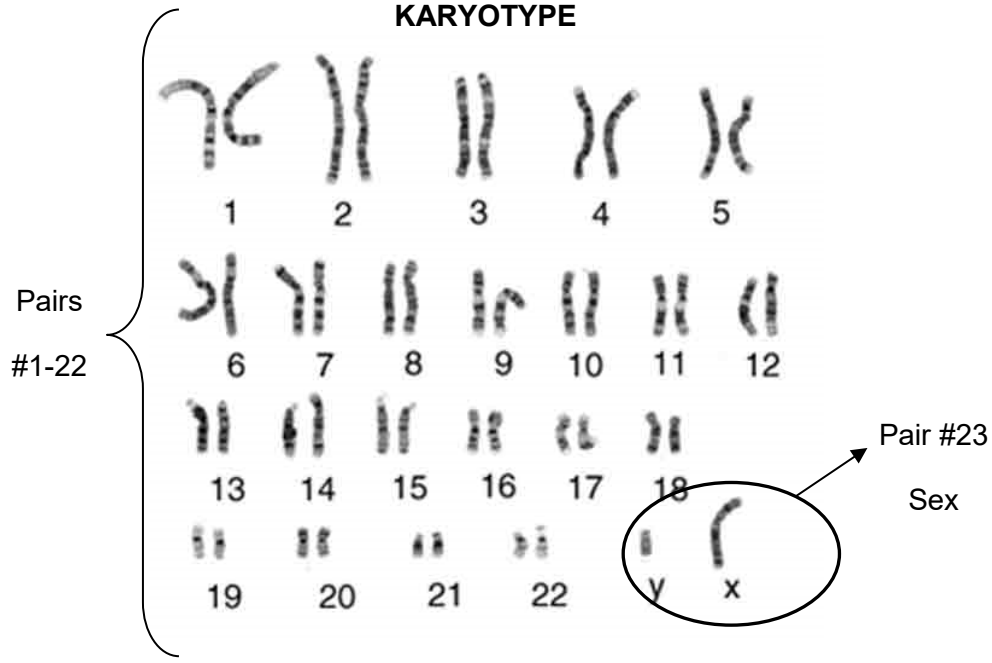


5. Interpret a karyotype.

a) A Karyotype is a technique where homologous pairs are arranged based on their shape and size.

b) Information that can be determined by a karyotype are:

1. Gender
   a. Pair #23 in humans determine gender and are called the sex chromosomes.
   b. Females are XX; Males are XY
2. Normal or abnormal number of chromosomes.
   a. Pair #1-22 are called autosomes
   b. Additional or missing chromosomes in any autosome pair can cause different genetic disorders.
   Example: Down's Syndrome (Trisomy 21) – person has 3 copies of chromosome 21



Topic - Genetics

Fundamental Concepts and Skills

1. Describe how Mendel studied inheritance in peas.

a) **Inheritance** is the passing of traits from one generation to the next.
   1. **Genetics** is the study of inheritance.

b) **Alleles** are different forms of a gene
   Example – the alleles for plant height are tall or short

c) Gregor Mendel used pea plants to study inheritance patterns.
   1. Some alleles are dominant and other alleles are recessive.
      a. **Dominant** genes overpower other genes from showing their traits.
         Dominant genes are represented by CAPITAL letters.
      b. **Recessive** genes only show their traits when two recessive genes are present.
         Recessive genes are represented by lowercase letters.

2. Predict the inheritance of simple traits based on the laws of probability.

a) **Genotype** is the allele combination an organism has for a particular gene.
   Example: In pea plants, the H gene controls height.
   The possible genotypes an organism can be are HH, Hh, hh

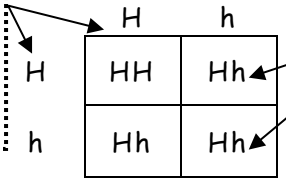
b) **Phenotype** is the appearance of an organism based on its genotype.
   Example: In pea plants, the H gene controls height.
   The possible phenotypes for the H gene (pea plant height) are tall and short.
   HH and Hh represent a tall plant and hh represents a short plant

c) **Homozygous** describes a genotype having two of the same alleles.
   Example: HH or hh

d) **Heterozygous** describes a genotype having two different alleles.
   Example: Hh

e) A **monohybrid Punnett square** is used to predict the genotype and phenotype ratios of offspring for a given cross.
   1. *Example: In pea plants the H gene controls height.*
      H is the dominant, tall allele and h is the recessive, short allele.
      Two pea plants, which are heterozygous for the H gene, are crossed.
      What are the expected genotype & phenotype ratios for the offspring?
   2. The resulting Punnett square to solve this genetics problem is:

Each letter outside the square represents an allele the parent can pass on to the offspring.



Genotypes in each quadrant represent the genotype of a possible offspring

   3. **Genotype ratio** is determined by
      # homozygous dominant **:** # heterozygous **:** # homozygous recessive
      1HH **:** 2Hh **:** 1hh
   4. **Phenotype ratio** is determined by
      # dominant showing offspring **:** # recessive showing offspring
      3 tall **:** 1 short

f) A dihybrid Punnett square is used to predict the genotype and phenotype ratios of offspring for a given cross involving two traits.

Fundamental Concepts and Skills

3. Explain and identify the patterns of inheritance of different traits and give examples.

a) **Recessive traits** – Both recessive genes are required to express/show or have the trait or disease

Example – blue eyes, straight hair

1. An individual can be a **carrier** – someone who does not show the trait or have the disease, but has the potential to pass the trait/disease on to their offspring
2. A carrier is heterozygous

b) **Dominant traits** – Only one gene is required to express/show or have the trait or disease

Example – Huntington's disease.

c) **Incomplete dominance** – Blending of alleles for a heterozygous genotype

Example – Red Carnation = RR, White = WW and Pink = RW

d) **Co-dominance** – Alleles are expressed equally for a heterozygous genotypes

Example – Checkered chickens (have black & white feathers)

Example – Sickle-cell anemia (all round blood cells = RR; all sickled blood cells = SS or R'R'; Sickle cell trait = RS or R'R)

e) **Multiple Alleles** – there are more than 2 alleles for a trait

Example – Human Blood Types (There are 3 alleles – A, B and O, where A and B are codominant to each other, and O is recessive to A and B)

Human Blood Genotypes	Human Blood Phenotypes
AA (homozygous), AO (heterozygous)	A blood type
BB (homozygous), BO (heterozygous)	B blood type
AB	AB blood type
OO	O blood type

f) **Sex-linked traits** – the gene is carried only on the X chromosome.

Example – Hemophilia, color blindness, baldness

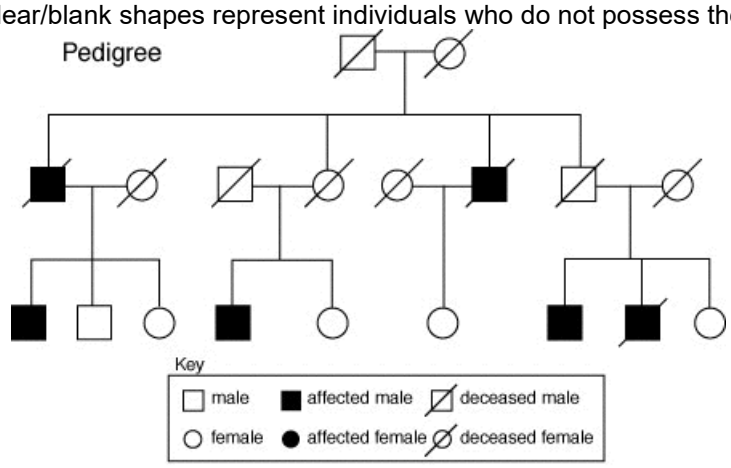
1. Sex-linked traits occur more often in males than females
2. Typically the trait is passed from mother to sons.
   a. Females are XX and therefore have 2 copies of the gene
   b. Males are XY and therefore have only 1 copy of the gene

4. Interpret a pedigree.

a) **Pedigrees** are family trees that allow geneticists to predict how genes/traits are inherited from generation to generation.

b) Symbols in a pedigree include:

1. Circles represent females; squares represent males
2. Filled-in shapes represent individuals who express or show the trait, half-filled shapes represent carriers, people who carry the trait but do not express it, and clear/blank shapes represent individuals who do not possess the trait/gene.



Topic – Evolution

Fundamental Concepts and Skills	
1. Describe Early Earth and the first forms of life. a) Earth's early atmosphere was toxic! It is believed that simple compounds combined together to form the organic compounds that are needed for life. b) Photosynthetic organisms evolved and released oxygen into the atmosphere. c) According to the endosymbiotic theory, eukaryotic cells evolved from symbiotic relationships between prokaryotic cells. d) After eukaryotic cells appeared, these cells began to reproduce sexually, which sped up the evolutionary process. e) Cells began to form organized communities. These cells began to collaborate and function as one unit. This was the beginning of multicellular life. f) Most early organisms lived in the sea, but as time went on, they later evolved (and adapted) to life on land. The organisms became more complex because they had to adapt to changes like predation	
1. Describe how changes in the environment and natural selection result in changes in populations. a) **Jean-Baptiste Lamarck – Use and Disuse Theory** 1. Hypothesized that acquired traits could be passed on to offspring. a. Traits that organisms used will become stronger during their lifetime and will be passed on to their offspring. b. Traits that are not used will become weaker and will not be passed on to their offspring. b) **Charles Darwin – Natural Selection.** 2. **Overproduction** – All populations produce more offspring than the environment can support. This leads to a struggle for survival with only a fraction of the offspring surviving. 3. There is great variety or variation among individuals in a population. The **Gene pool** is the available alleles in a specific population. 4. Those individuals best fit or adapted to the environment survive and produce more offspring. (**Survival of the Fittest**) 5. The unequal ability of individuals to survive and reproduce leads to gradual change in a population, generation after generation. 6. **Evolution** is a gradual change in a species over a long period of time. **a.** Types of evolution include: **i.** **Divergent evolution** is when two closely related species develop different traits to survive in different environments. **ii.** **Convergent evolution** is when two unrelated species develop similar traits to survive in similar environments. **b.** Rates of evolution include: **i.** <u>Punctuated Equilibrium</u> — no change (equilibrium) and then sudden change (looks like <u>stairs</u>) **ii.** <u>Gradualism</u> — slow change	

2. Describe the evidence for evolution from the fossil record and molecular biology.

a) A **fossil** is any evidence of an organism that lived long ago, usually an impression left in rock layers.
   1. The approximate ages of fossils can be determined by how deeply they are buried by sediments and by **radiometric/carbon dating**.
   2. A history of life on earth can be reconstructed by dating fossils and examining layers of sediments on the earth's crust.
   3. This history shows that the millions of species of organisms that are alive today are only a fraction of the species that ever lived.

b) **Homologous structures** are similar structures found in different species, believed to evolve from a common ancestor
   Example: flippers of a whale, arms of humans, and wings of birds

c) **Analogous structures** are used for similar purposes but they are very different in structure
   Example: bird wing vs. butterfly wing.

d) **Vestigial structures** are structures that organisms have, but are no longer used
   Example: human appendix

e) **Molecular biology** shows that closely related organisms have very similar DNA and amino acid sequences.
   1. Fewer differences in DNA are seen between closely related species.
   2. More differences in DNA are seen between more distantly related species.

3. Give examples of evolution.

a) The evolution of antibiotic resistant strains of bacteria.
   7. Antibiotics are capable of destroying bacteria.
   8. When bacteria are first exposed to antibiotics, some of the bacteria are killed. However, some of the bacteria survive.
   9. Because the surviving bacteria are able to reproduce, the surviving bacteria evolve. The survivors are said to be members of a resistant strain, able to withstand the ability of antibiotics to destroy bacteria cells.

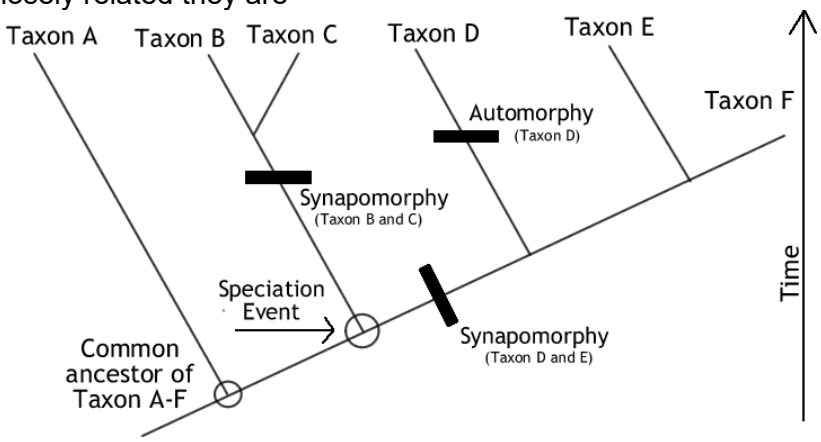
b) The evolution of DDT resistance insects.
   1. DDT is a pesticide that kills mosquitoes and other insects.
   2. When they are first exposed to DDT some of the mosquitoes are killed. However, some survive and reproduce.
   3. The survivors pass on their "DDT-resisting" genes, changing future populations.

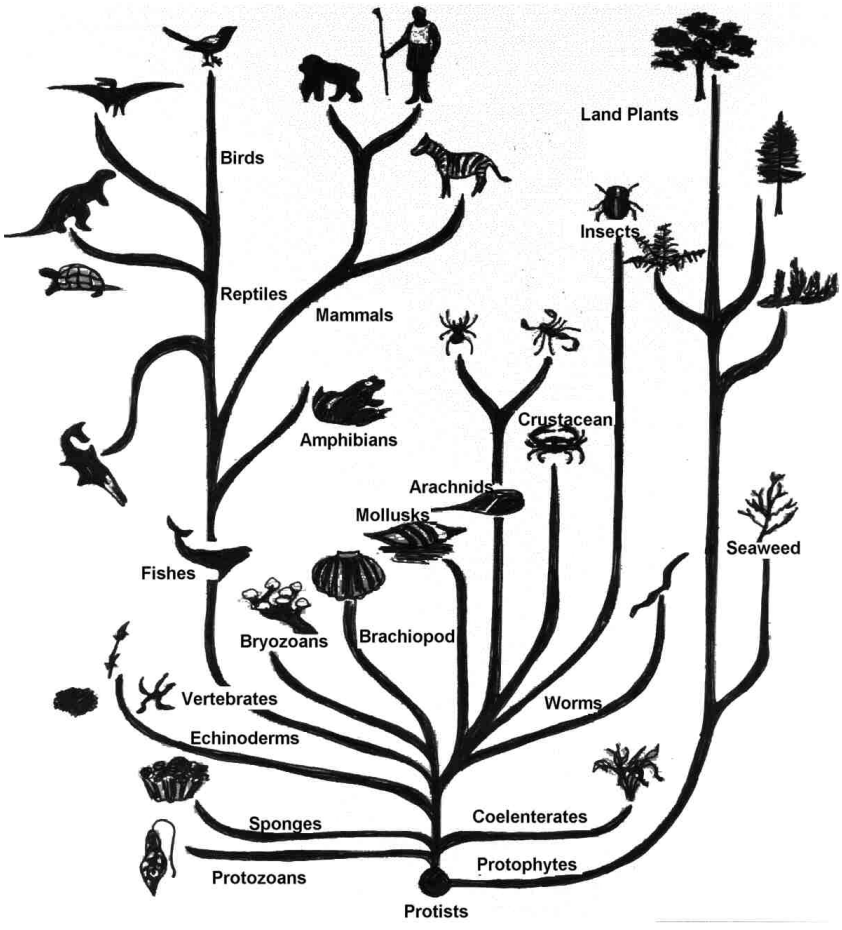
c) The evolution of the peppered moth.
   1. Peppered moths in England can be light colored or dark colored. Originally most were light colored.
   2. During the industrial revolution many buildings were covered in soot so that the light colored moths stood out against the buildings. Dark colored moths were better camouflaged.
   3. The light colored moths were more often eaten by predators and dark colored moths reproduced, changing the population of moths.

4. What are phylogenetic trees or cladograms?

a) A **Phylogenetic tree or Cladogram** shows the relationship between organisms

1. The closer organisms are on the tree branches to each other, the more closely related they are





Topic -Taxonomy and Classification

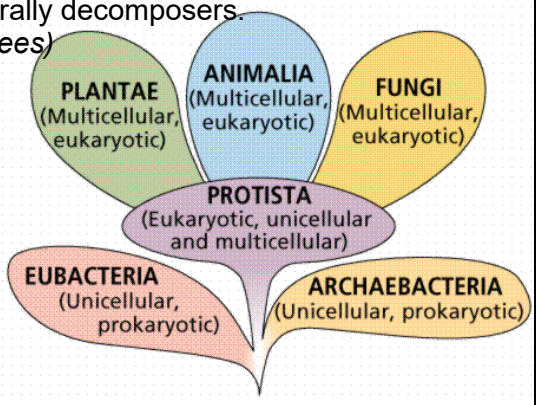
Fundamental Concepts and Skills

1. Describe the basis for the current system of classification

a) **Taxonomy** is the system used by scientists to classify or group organisms
b) Organisms are grouped based on:
   a. Structural similarities
   b. Fossil evidence of common ancestors
   c. Similarities in developmental stages
   d. Similarities of DNA.
c) Carl Linneus came up with the classification system used today:
   Kingdom, Phylum, Class, Order, Family, Genus, and Species
d) **Binomial Nomenclature** – A scientific system for naming organisms using the organism's genus and species. The 1st letter of the genus is capitalized followed by the species name. Both are underlined or italicized.
   Example: *Gulo gulo* = wolverine; Homo sapiens = Humans
e) A **dichotomous key** is a tool used by scientists to identify organisms that uses a series of paired statements.

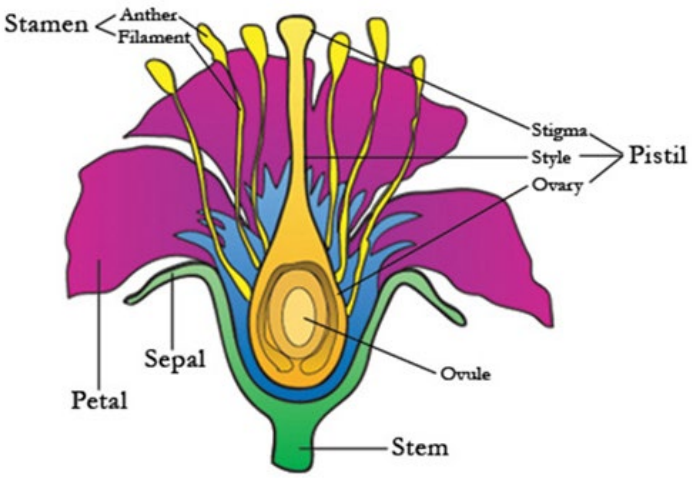
3. Describe metabolic and structural similarities and differences among organisms in the 5 KINGDOMS.

h) **Monera** *(Examples – bacteria and blue-green algae)*
   a. Only prokaryotic kingdom (cells have no defined nucleus)
   b. Usually unicellular
   c. Can be autotrophic (producers) or heterotrophic (consumers)
   d. Microscopic
   e. Kingdom Monera has been divided into Eubacteria (true bacteria) and Archaebacteria (bacteria that live in extreme conditions)
i) **Protista** *(Examples – amoebas, paramecium and euglena)*
   a. Eukaryotic kingdom (cells have a defined nucleus)
   b. Unicellular or multicellular
   c. Can be autotrophic or heterotrophic
   d. Lack complex organ systems
   e. Generally live in moist environments and move with flagella, cilia, or pseudopodia
j) **Fungi** *(Examples – mushrooms and molds)*
   a. Eukaryotic
   b. Unicellular or multicellular.
   c. Heterotrophic
   d. Immobile (does not move) and are generally decomposers.
k) **Plants** *(Examples – grasses, shrubs, and trees)*
   a. Eukaryotic
   b. Multicellular
   c. Autotrophic
   d. Immobile
l) **Animals** *(Examples – sea sponges, sea*
m) *stars, fish, frogs, birds and mammals)*
   a. Eukaryotic
   b. Multicellular
   c. Heterotrophic
   d. Mobile



Fundamental Concepts and Skills	
4. Describe defining characteristics of the phyla (phylum) of invertebrates in the animal kingdom. Invertebrates are organisms that do not have a nerve cord that runs the length of their back. a) Porifera – sponges b) Cnidaria – jellyfish, sea anemones, coral c) Platyhelminthes – flatworms, tapeworms, flukes d) Nematoda – roundworms e) Annelida – earthworms and leeches f) Molluska – snails, clams, octopi, squid g) Arthropoda – lobsters, crabs, spiders, insects h) Echinodermata – sea stars, sea urchins, sea cucumbers	
5. Describe defining characteristics of the classes of vertebrate animals. The Chordate phylum is also known as vertebrates because they have a nerve cord that runs the length of their back. a) Agnatha – jawless fish b) Chondrictheyes – sharks, skates, rays c) Osteichtheyes – boney fish d) Amphibia – frogs, toads, salamanders e) Reptilia – crocodiles, alligators, turtles, snakes f) Aves – birds g) Mammalia – kangaroos, tigers, gorillas, humans, etc	

6. Describe the reproduction in a flowering plant



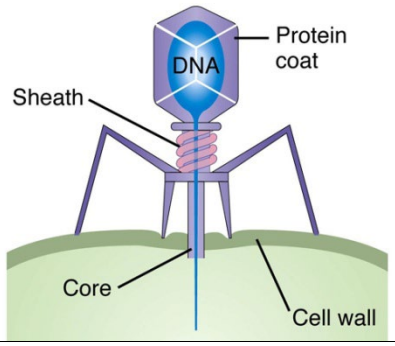
a) Flowers are the organs of reproduction for plants.
   Part of the flower include:
   1. Petal – colorful leaf that protects the flower bud/reproductive organs
   2. Sepal – leaf that protects the flower bud/reproductive organs
   3. **Pistil** – Female reproductive organ where the ovule (eggs) are made
      The pistil has 3 parts:
      a. **Stigma** = sticky top part where the pollen lands
      b. **Style** = tube that connects the stigma to ovary
      c. **Ovary** = where the eggs are made during meiosis (where fertilization takes place)
   4. **Stamen** – Male reproductive organ where pollen are made in meiosis; there are usually many more stamen than pistil in a flower
      The stamen has 2 parts:
      a. **Anther** = where the pollen are made/stored
      b. **Filament** = a stand that holds up the anther

b) **Pollination** is the movement of pollen from anther (stamen) to the stigma (pistil)
   1. Self-pollination – takes place in the same flower
   2. Cross-pollination – takes place in different flowers
c) **Fertilization** is the joining of pollen and ovule to form a zygote
d) Ovules become the seeds; Ovaries become the fruits

Fundamental Concepts and Skills

7. Describe the structure and replication of viruses.

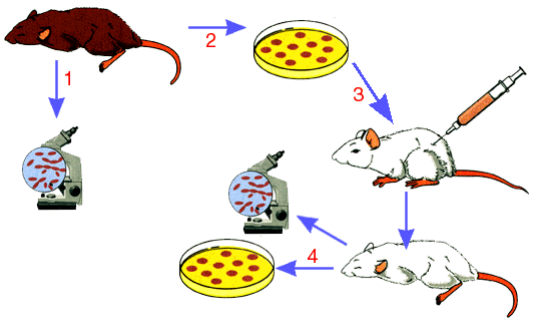
a) Viruses are tiny, non-living particles.
b) Viruses do not fulfill all criteria for life; including metabolism.
c) Viruses only replicate inside a living host.
d) Once inside a host cell, viral DNA takes over, making more viruses and destroying the host cell.
e) Examples of common viruses are: Ebola, Influenza (flu), HIV and the common cold.



8. Explain the evidence that supports the Germ Theory of Disease.

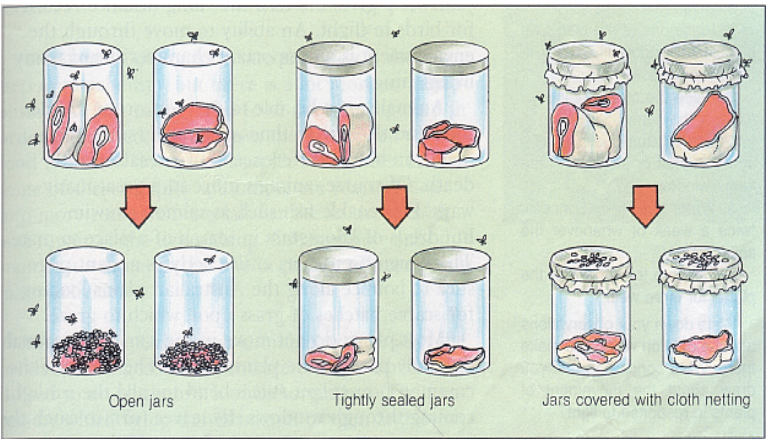
a) **Koch's Postulates** – 4 criteria to determine a relationship between a disease and its causitive microorganism.

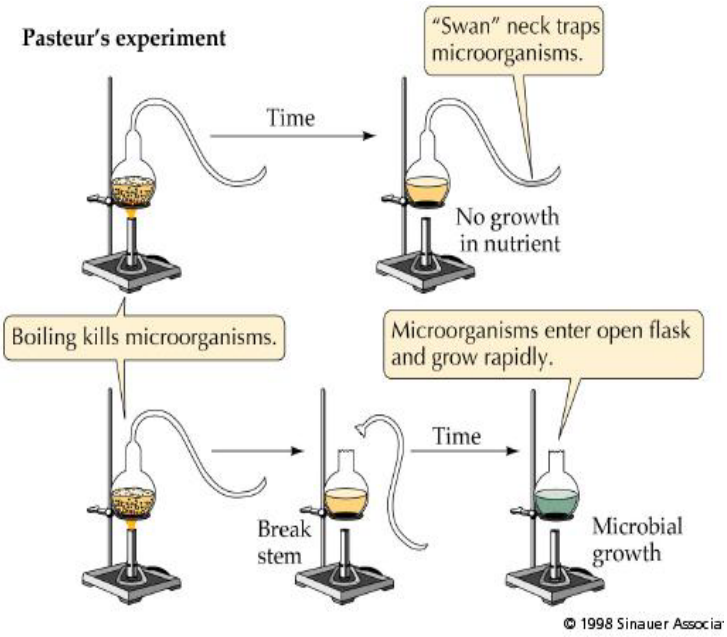
1. The microorganism must be found in the infected organism and not found in healthy organisms.
2. The microorganism must be isolated and grown in a pure culture.
3. The microorganism from the pure culture will be injected into a healthy organism.
4. The microorganism must be isolated from the injected organism and identified as the same microorganism as the original.



b) **Disproving Spontaneous Generation**

1. **Francesco Redi** – Studied decaying meat and maggots
2. **Louis Pasteur** – Studied nutrient broth and microorganisms

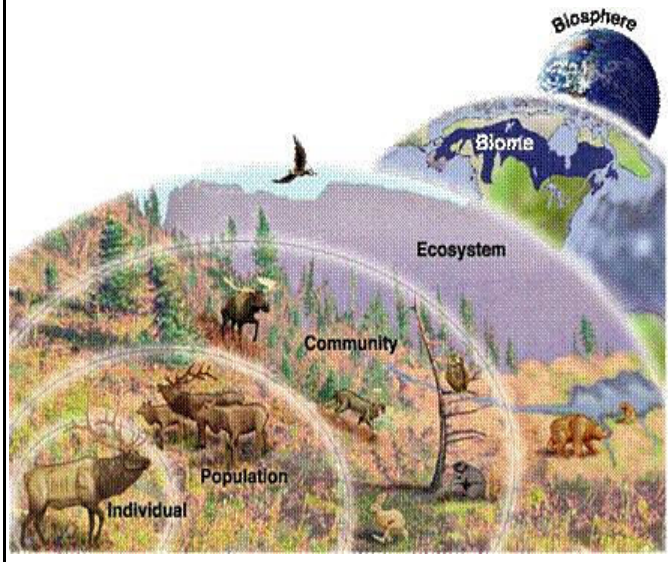




Topic - Ecology

Fundamental Concepts and Skills	

1. Explain how living things are organized into different types of ecosystems.



a. Organisms are in the same **species** if they can interbreed and produce fertile offspring.

b. A **population** is a group of organisms that belong to the same species and live in the same place (and interbreed).

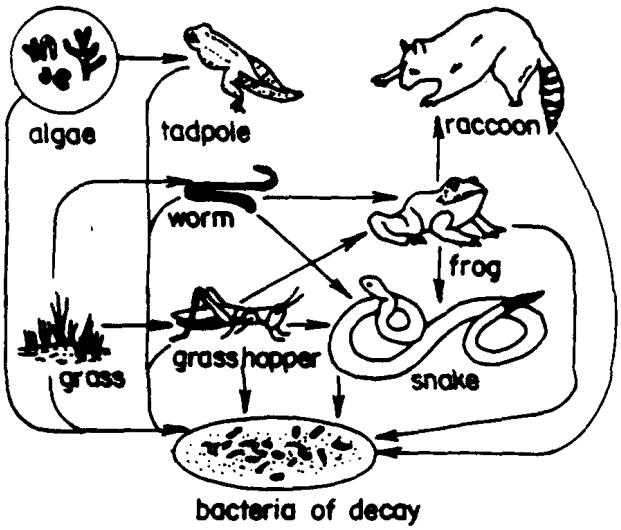
c. A **community** is a group of all of the organisms that live in the same place.

d. An **ecosystem** includes all of the <u>abiotic</u> factors (nonliving things in an ecosystem such as water and soil) plus all of the <u>biotic</u> factors (living organisms in an ecosystem).

e. A **biome** is a large group of ecosystems that share the same type of climax community and climate. *Examples include: ocean/marine, tundra, taiga, desert, grassland, temperate forest, and rain forest.*

2. Illustrate energy flow in a community by correctly drawing a food chain with a producer, primary, secondary and tertiary consumers.

a) Energy enters and leaves an ecosystem
b) Energy from the sun enters an ecosystem through producers (plants).
c) Energy flows from the producers to the primary consumers, to the secondary consumers and to the tertiary consumers.
d) As energy flows from one level to another a large part of energy is lost through heat and work done by organisms.
e) A **food chain** diagram must start with a producer, and the arrows must point in the direction of energy flow. For example, the arrows will point from producers to the primary consumer.
f) An **autotroph** is an organism which can produce its own food.
A **heterotroph** is an organism which must get its energy by consuming organic material.
g) A **food web** is made of several intertwined food chains.



3. Describe how nutrients (matter) cycle in ecosystems, using the example of the carbon cycle.

a) Water Cycle
1. Water falls to the Earth as precipitation. Precipitation can come in many forms- rain, snow, sleet or hail.

2. Water runs along the surface of the ground until it is brought to oceans or lakes.
3. Water is soaked up by soil and is either stored as ground water or absorbed by plants.
4. Water evaporates into the atmosphere.
5. Water condenses into droplets that form clouds.

b) Nitrogen Cycle
   1. Nitrogen is in the Earth's atmosphere in a gaseous form.
   2. Nitrogen-fixing bacteria converts nitrogen gas into ammonium.
      Other types of bacteria in the soil convert ammonium into nitrates and nitrites.
   3. Producers use nitrates and nitrites to make proteins and the consumers reuse the nitrogen to make their own proteins.
   4. Decomposers return nitrogen to the soil as ammonium.
   5. Bacteria that perform denitrification convert nitrates to nitrogen gas.

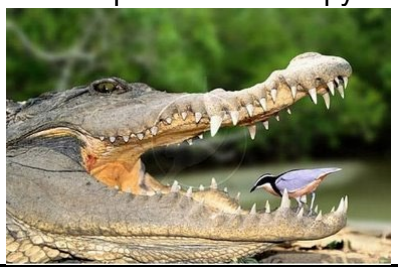
c) Carbon Cycle
   1. Carbon dioxide is fixed/changed into carbohydrates by producers.
   2. The carbon from the producers passes to the consumers.
   3. Through cellular respiration, both producers and consumers make carbon dioxide. When consumers breathe, they release carbon dioxide into the atmosphere.
   4. When consumers are decomposed by decomposers and/or burned, carbon dioxide is released into the atmosphere.

4. Describe ways that organisms in an ecosystem cooperate and compete.

a) **Symbiosis:** close and permanent relationship between organisms of different species.
   1. Parasitism: relationship when one organism benefits and the other is harmed. example: fleas on a dog.
   2. Commensalism: a relationship when one organism is benefited and the other is neither harmed nor benefited. Example: mites that live on human eyelashes.
   3. Mutualism: relationship when both organisms benefit. Example: elephant & bird.

b) Organisms <u>compete</u> for resources such as food, space, sunlight, mates, water, etc.

c) **Niche** is an organism's place in its environment (what it eats, how it lives). No two species can occupy the same niche.



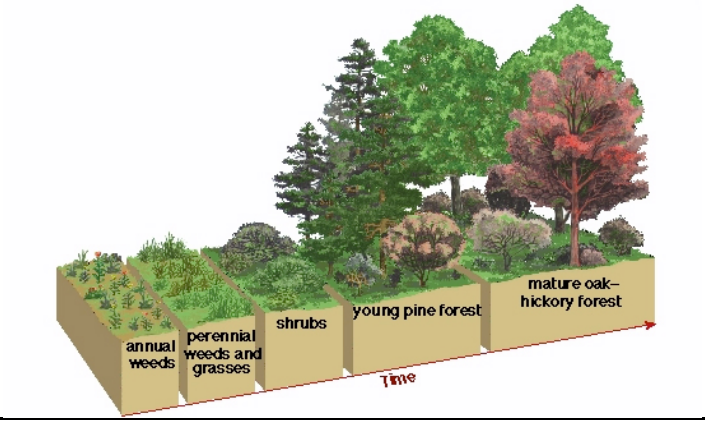

Fundamental Concepts and Skills

5. Describe the pattern of succession in an ecosystem.

a) **Succession** is a process of natural orderly changes that happen in an ecosystem.
   1. A piece of land in Northern Virginia is cleared so that nothing remains but the soil.
      The first organism to live on the land is called a **pioneer species**.
   2. Seeds carried by the wind fall onto the soil.
      The fast growing, shallow rooted, sun-loving plants will grow first (grass).

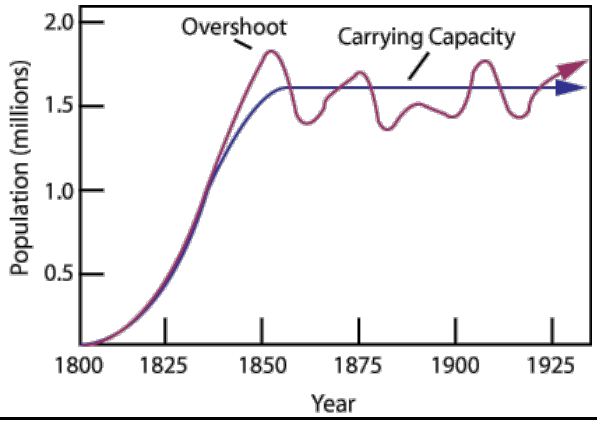
3. Insects carried in by the wind live on the plants.
4. These plants and insects live and die, decompose, and build up the soil, changing the environment and making the environment more hospitable for different species of plants and animals.
5. Process takes time:

grass → bushes/shrubs → small trees → larger trees → climax community



6. Describe how populations grow.

a) A **population** is a group of interbreeding individuals (same species) that live in the same place at the same time, and compete with each other for food, water, shelter and mates.
b) The available **resources** (food, water, shelter and mates) regulate population growth. These are **limiting factors**.
c) Populations grow the fastest when there are excess resources available.
d) Populations stop growing when the resources start to run out.
e) The **carrying capacity** is the maximum number of individuals in a population that can survive on available resources.
It is represented by an S-curve.



A Cool Glass of Water: A Mystery

by

Li-hsuan Yang, Department of Education, University of Michigan—Flint

Part I—A Surprise

In an undergraduate science course, a group of student teachers just finished some experiments using salt and ice. They had observed that salt made ice melt at temperatures below its normal melting point.

"That makes sense—remember how we use salt to melt ice on the sidewalk? Salt helps the ice to melt," said Marian to her group members. They all agreed.

The instructor then introduced them to a teaching project. She announced, "Now I want you to take a look at the state curriculum standards. Try to find a science concept that is interesting to you and your group members. You are asked to put together a lesson to teach that concept to elementary school students. Feel free to use the knowledge you have acquired in this class for your teaching project."

Marian: Why don't we teach children the three states of water? We can do experiments with them, like melting ice cubes.

John: Yeah, we can ask children to predict which ice cube will melt first, the one in salt water or the one in fresh water. That will catch their attention.

Gail: Good idea. Then we can do the experiment with them to check their predictions.

Sally: Let's try the experiment first ourselves.

Gail: I'll make some salt water and measure out 200 milliliters of salt water and fresh water. John, can you measure their temperatures to make sure they are the same?

John: Yes, they are; they're at room temperature, 22 degrees Celsius.

Sally: I'll have to find two ice cubes with the same size and shape. Okay, I have them. Ready? Get set; go!

Sally put one ice cube in each of the two liquids at the same time while Gail started the stop watch to measure the time elapsed. Both ice cubes floated in the liquid. To their surprise, the ice cube in fresh water melted much more quickly than the one in salt water.

"How come?!" said everyone.

Part II—Related Phenomena

That afternoon, the group members went home thinking about this mystery. Marian wanted to bake some cookies for her family. As she poured some water and oil in the measuring cup, she noticed that the oil was sitting on top of the water. She thought about that for a moment. Then suddenly she exclaimed, "I know what happened with the ice cubes! I must tell my group the first thing next Monday."

John went to a hot air balloon show that evening. As he was watching the hot air balloons rising, John said to himself, "I guess I might have an idea to solve the problem involved in our experiment."

Gail's family went on a vacation that weekend. As Gail went swimming in the ocean, she noticed that her body seemed to float higher in ocean water than in fresh water. She thought, "I bet I know why that ice cube in the salt water took so long to melt."

Sally accidentally knocked over a glass of iced tea on the counter of her bathroom. She noticed that the brown iced tea seemed to go to the bottom of the bath tub filled with warm water. "I wonder if that has anything to do with our experiment."

The four of them saw each other on Monday. After exchanging ideas, they thought they now had a perfect explanation for the mystery. They wanted to test their idea. They made colored ice cubes by putting several drops of food coloring in the water before freezing it into ice. Then they repeated the original experiment with the colored ice cubes. They couldn't wait to see if the test would confirm their idea or not.

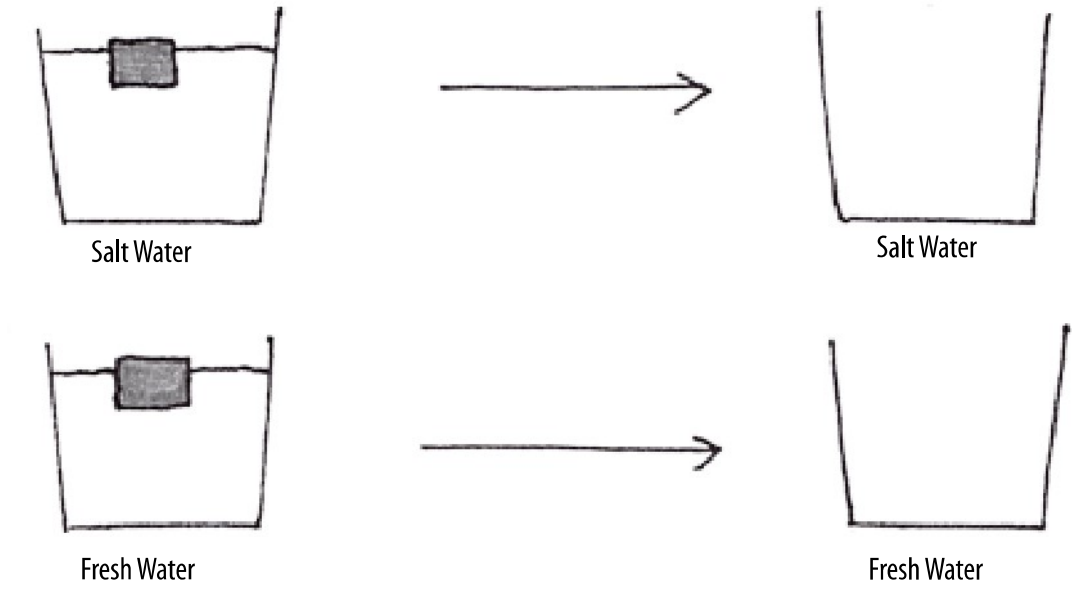
Question

1. What do you think might be the explanation they are trying to test with the colored ice cubes?

Part III— Predictions and Observations

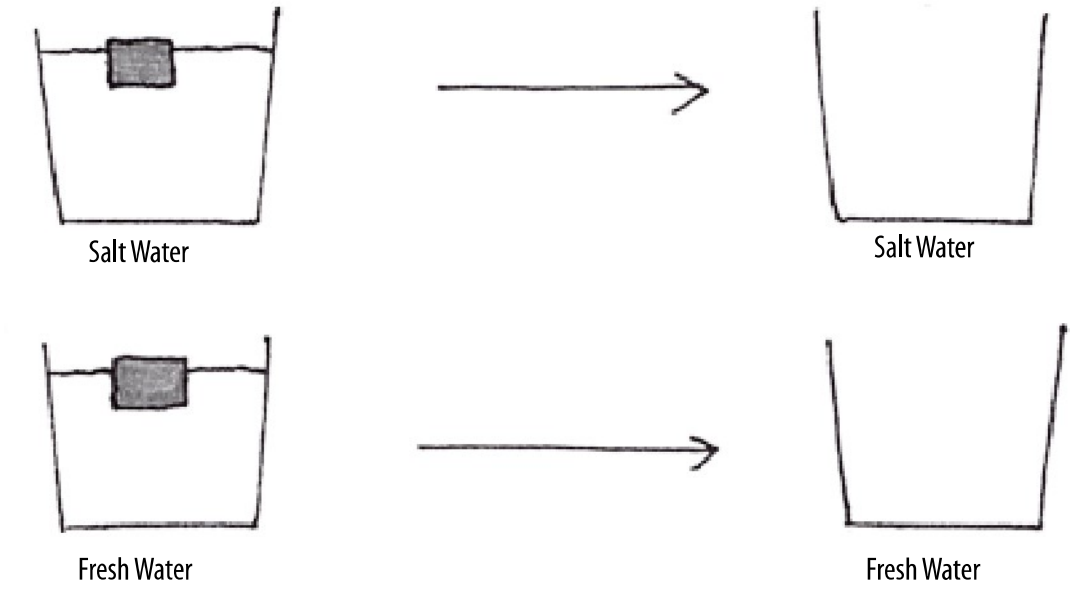
If their explanation were correct, draw what you would expect to see in the experiment with colored ice cubes.

Figure 1—Predicitions for colored ice melting.



After you have drawn your predictions and shared them with your group members, do the experiment and record your observations. Are the observations consistent with your predictions?

Figure 2—Observations of colored ice melting.



Part IV—Experimental Design and Explanation

As Marian, John, Gail, and Sally were doing the experiment, they noticed that the two ice cubes not only melted at different rates, they also melted in different ways.

Sally: Look! This one in fresh water is becoming smaller and smaller all around, but that one in salt water seems to be staying the same size if you look at it from above.

Marian: But actually the one in salt water is also melting, just more slowly. It's becoming thinner and thinner.

John: It looks like it's not melting from the sides. Do you think it's melting from the top down or from the bottom up?

Gail: I'm not sure. What do you think?

Figure 3—Fresh water observations.

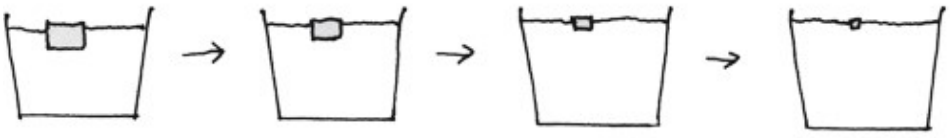
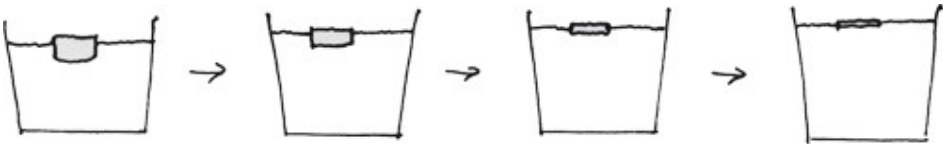


Figure 4—Salt water observations.



Questions

1. Do you think the ice cube in salt water is melting from the top down or from the bottom up?
2. Why do you think so?
3. What test would you do to verify your idea?
4. How would you explain what you see in the test?
5. How does the density of an object or a fluid affect its floating or sinking behavior in another fluid? Can you think of examples of this principle at work in everyday experience?
6. What are the two ways that heat is transferred from a region of higher temperature to a region of lower temperature in this example of an ice cube in a glass of water? Is there yet another way that heat could be transferred between two objects?
7. Can you think of examples of heat transfer in everyday experiences? Which way(s) of heat transfer is (are) involved in each example?