

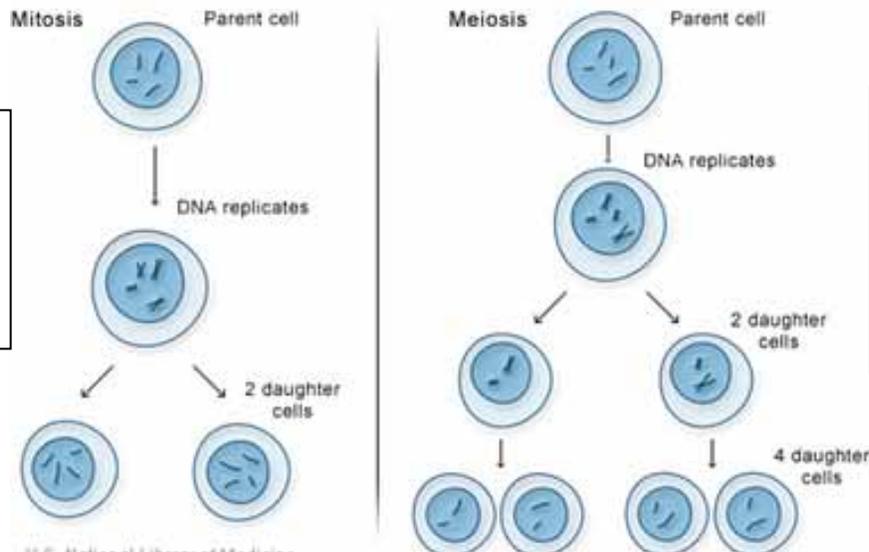
### III. CELLULAR DIVISION / How Cells Reproduce.

All cells come from existing cells. Cells must grow and divide to allow an organism to grow, develop, repair damaged cells.

## Cells divide in two ways.

	<b>MITOSIS – makes body cells</b>	<b>MEIOSIS –makes gametes</b>
<b>TYPE OF CELL PRODUCED after cell division</b>	Mitosis makes somatic cells (body cells) Ex) skin, bone, blood, muscle, etc. <b>2n cell or diploid – whole chromosome #</b>	Meiosis makes reproductive Cells (gametes) Ex) egg, sperm, pollen etc. Cells used for sexual reproduction of a species. <b>1n cells or haploid – ½ total chromosome #</b>
<b>NUMBER OF CHROMOSOMES In cells resulting from division</b>	Same as before division. <b>2n or diploid cells produced.</b>	<b>½ the number of chromosomes as the parent cell</b>
<b>TOTAL NUMBER OF CELLS PRODUCED after division</b>	<b>2 total daughter cells</b>	<b>4 sex cells called gametes</b> Ex) sperm, egg, pollen grains
<b>NUMBER OF CYTOPLASMIC DIVISIONS</b>	<b>1 cytoplasmic division (cytokinesis)</b>	<b>2 cytoplasmic divisions</b>
<b>Crossing Over (exchange of genetic variation)</b>	<b>NO... Does not happen</b>	<b>YES... Happens. Chromosomes exchange information for unique DNA combinations</b>
<b>DNA Comparison of adult cell to daughter cells</b>	<b>Identical DNA to the parent cell</b>	<b>4 unique DNA combination. DNA from both parents exists in the sperm, egg, or pollen produced.</b>

### VISUAL COMPARISON OF MITOSIS and MEIOSIS



#### MITOSIS:

Notice parent and two daughter cells have the same chromosome #

#### MEIOSIS:

Notice the parent cell has twice the number of chromosomes as the 4 different daughter cells.

USE THE INFORMATION ON THE BACKSIDE OF THIS HANDOUT TO  
COMPLETE THE FOLLOWING MULTIPLE CHOICE.

1. Which process is used to replicate genetically identical daughter cells with the same DNA as the original cell?  
a. mitosis            b. meiosis            c. both mitosis and meiosis make identical daughter cells
2. Which process is used to create the sex cells of organisms who reproduce sexually?  
a. mitosis            b. meiosis            c. both mitosis and meiosis make are used in sexual reproduction
3. Which process cuts the number of chromosomes of the parent cell in half?  
a. mitosis            b. meiosis            c. both mitosis and meiosis make are used in sexual reproduction
4. In which process do chromosomes exchange pieces of their DNA, causing maternal and paternal DNA to end up in the same cell?  
a. mitosis            b. meiosis            c. both mitosis and meiosis make are used in sexual reproduction
5. If a healthy female dog has a total of 78 chromosomes in her skin cells, how many chromosomes should she have in her egg cell?  
a. 78                  b. 39                  c. 156                  d. can not be determined
6. Which of the following *best* describes meiosis?  
A It is carried out in all tissues that require cell replacement.  
B It occurs only in cells in the reproductive structures of the organism.  
C It happens in all tissues except the brain and spinal cord.  
D It is the first stage of mitosis.
7. Which of the following sequences represents chromosome number during fertilization when egg and sperm meet?  
a.  $n + n \rightarrow 2n$             b.  $2n \rightarrow n + n$             c.  $n \rightarrow n$             d.  $2n \rightarrow 2n$

8. The table below lists the typical diploid number of chromosomes of several different organisms that sexually reproduce. What is the number of chromosomes that should be in the gametes of each species.

SPECIES	Diploid (2n) Chromosome # (# found in brain, blood, skin, bone cells)	Haploid (n) Chromosome # (# found in egg, sperm or pollen)
Goldfish	94	
Potato	48	
Human	46	
Pea	14	
Fruit fly	8	

9. Which of the following is the *best* explanation for why the diploid chromosome number is always an even number in each of these organisms?  
A. It is only a coincidence; many other organisms have an odd number of chromosomes.  
B. The diploid chromosome number represents pairs of chromosomes, one inherited from each parent of the individual, so it is always an even number. When you multiply any number by 2, (diploid = 2n) the answer can never be odd.  
C. Chromosomes double every time the cell divides, so after the first division, the number is always even.

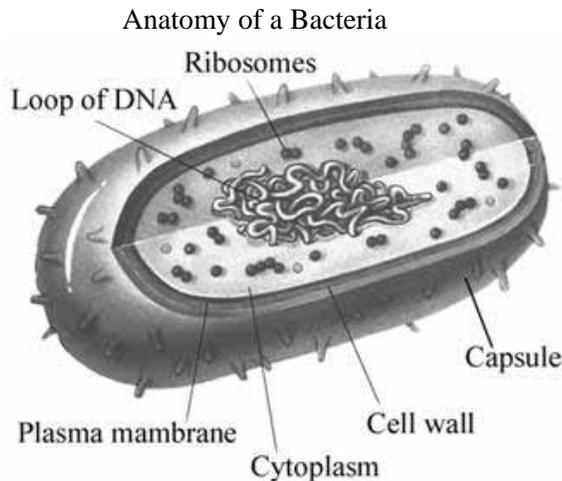
# BIOLOGY REVIEW: BASICS of CELLS

I. Cells are the smallest living structures on earth.

II. There are 2 types of Cells:

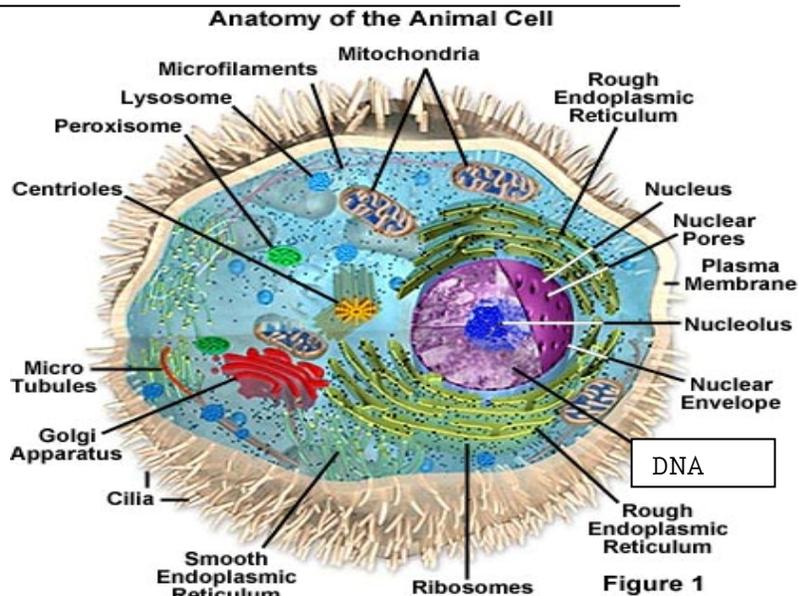
**PROKARYOTE** cells are basic with only a few organelles

Prokaryote cells are bacteria



**EUKARYOTES** cells are more complex with many organelles

Eukaryote cells are in Animals, Plants, Fungi, and Protists



Prokaryotes have no nucleus to house the DNA.

DIFFERENCES BETWEEN PROKARYOTES AND EUKARYOTES: Circle the correct answer choice.

- The DNA of a bacteria floats freely within the cell membrane. *The DNA of a eukaryote is kept in the \_\_\_\_\_* (nucleus / ribosome)
- ALL** cells have heritable DNA and genetic information they pass down to their offspring. *DNA is therefore found in \_\_\_\_\_ ?*  
 Animal cells only                      animal and plant cells only                      animal, plant, bacteria, and fungus cell

**Organelles are parts of the cell that have different jobs to do.** Here is a review of the main organelles of Eukaryotic cells are

**Ribosome** – make proteins

**Mitochondria** – burns food energy to make ATP during cellular respiration

**Nucleus** – holds the DNA. Where the genetic information of life is stored.

**Chloroplast** – found in plant cells, perform photosynthesis to make food energy       $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

**Cell membrane** – the phospholipid bilayer that is selectively permeable

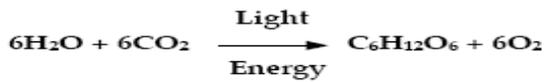
**Lysosome** – breaks down the worn out cell parts, viruses, and recycles re-usable cellular materials using digestive enzymes.

- Cells that perform this cellular       $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$       process need to have many \_\_\_\_\_ (ribosomes / chloroplasts)
- The liver's enzymes are responsible for degrading wastes and toxins from the body. As a result, the liver should have many \_\_\_\_\_ (chloroplasts / lysosomes)
- A cell from heart muscle that must use a lot of energy to beat consistently would *probably* have a high number of \_\_\_\_\_  
 A lysosomes.                      B mitochondria.                      C mRNA.                      D Golgi bodies.
- The cell membrane of the red blood cell will allow water, oxygen, carbon dioxide, and glucose to pass through. Because other substances are blocked from entering, this membrane is called  
 A perforated.                      B semi-permeable.                      C non-conductive.                      D permeable.
- Eukaryotic cells are differentiated from prokaryotic cells because eukaryotic cells  
 A are much smaller.                      B have permeable membranes.                      C have a higher rate of reproduction.                      D have nuclei.
- These proteins speed up chemical reactions. Ex) Catalase breaks down hydrogen peroxide. Lipase, proteinase, and amylase digest food.  
 a. enzymes                      b. Carbohydrates                      c. Fats                      d. Lipids

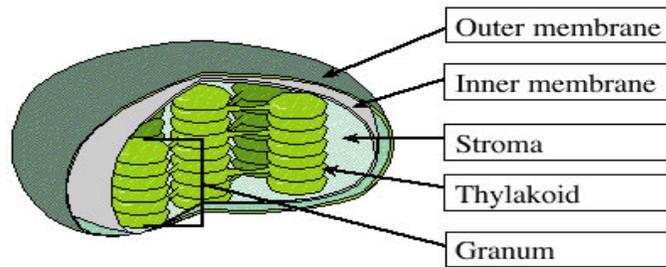
## II. CELLULAR ENERGY: all cells require energy

The sun provides energy needed for life on Earth. Plant cells (and some bacteria) are able to perform PHOTOSYNTHESIS:

PHOTOSYNTHESIS happens inside the CHLOROPLAST:



REACTANTS ----> PRODUCTS

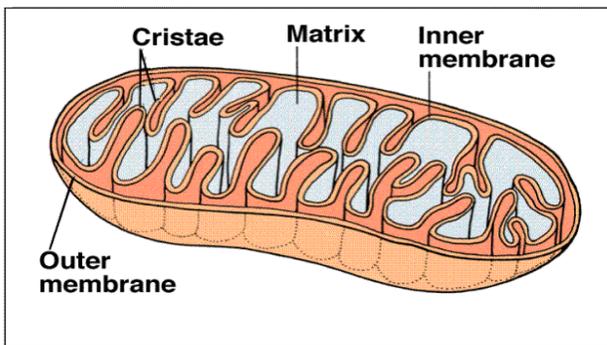


Eukaryotic Cells: (plant, animal, fungus, etc) use MITOCHONDRIA to make ATP Energy during CELLULAR RESPIRATION.

ATP energy is needed for life activities such as growth, repair and maintenance of homeostasis.

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### Mitochondrion



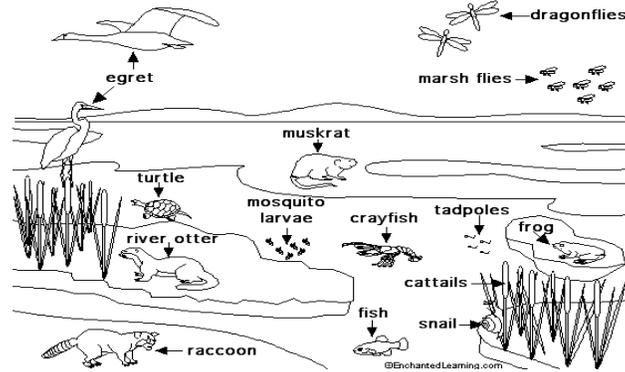
REACTANTS ----> PRODUCTS

1. **Photosynthesis inside plant cells** occurs in which organelle?
  - a. Mitochondria
  - b. ribosome
  - c. cell wall
  - d. chloroplast
2. **Cellular Respiration** inside plants, animals and fungus occurs in which organelle?
  - a. Mitochondria
  - b. ribosome
  - c. cell wall
  - d. chloroplast
3. What are the **reactants** of cellular respiration?
  - a. oxygen and ATP
  - b. oxygen and water
  - c. oxygen and glucose sugar ( $\text{C}_6\text{H}_{12}\text{O}_6$ )
4. What are the **products** of photosynthesis?
  - a. oxygen and ATP
  - b. oxygen and water
  - c. oxygen and glucose sugar ( $\text{C}_6\text{H}_{12}\text{O}_6$ )
5. Which cell(s) make ATP for energy to grow, reproduce, repair damage, and maintain homeostasis using cellular respiration?
  - a. animal cells
  - b. plant cells
  - c. both plant and animal cells make ATP through cellular respiration

## Junior Ecology Review

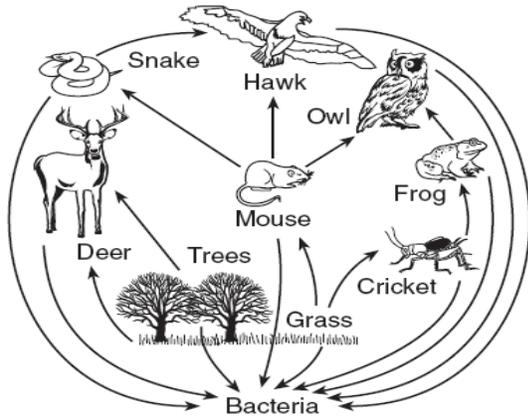
**Directions:** Read the following multiple choice questions and circle the correct answer.

**Figure 1: Wetland Ecosystem**

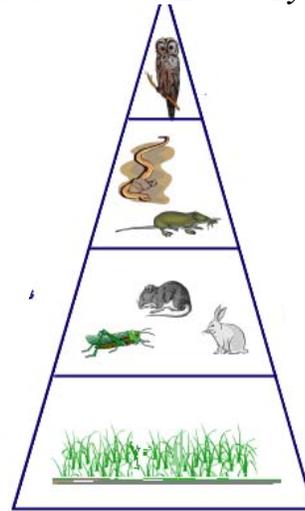


1. In *Figure 1* which of the following interactions describes an ecosystem?
  - a. A river otter hunting for crayfish
  - b. The snail
  - c. The marsh flies mating
  - d. The fish swimming in the water
2. In *Figure 1* which of the following examples describes a community?
  - a. A river otter hunting for crayfish
  - b. The snail
  - c. The marsh flies mating
  - d. The fish swimming in the water
3. Which biome is represented by the New England States?
  - a. Tundra
  - b. Deciduous forest
  - c. Rainforest
  - d. Savannah
4. Select an example of how an abiotic component of an ecosystem can affect a biotic component.
  - a. Long periods of darkness, as found at the North Pole from November to April, decrease the overall temperature of the arctic.
  - b. Abundant plant growth increases animal populations.
  - c. Extended drought decreases plant growth.
  - d. Rainy seasons increase mudslides.
5. Honeybees need the nectar of flowering plants in order to produce honey. How can a honeybee's relationship with flowering plants be considered mutualism?
  - a. The bees eventually kill the plants.
  - b. The bees help pollinate the plants.
  - c. The bees do not help the plants.
  - d. The bees do not harm the plants.
6. Which of the following symbiotic relationships result in one organism being eaten by the other?
  - a. mutualism
  - b. competition
  - c. biodiversity
  - d. predator/prey

**Figure 2: Vermont Food Web**



**Figure 3: Vermont Energy Pyramid**



7. In *Figure 3*, which organism is the producer?
  - a. grass
  - b. mouse
  - c. snake
  - d. owl
  
8. Which of the following represents a correct food chain taken from *Figure 2*?
  - a. bacteria → grass → cricket
  - b. hawk → mouse → grass
  - c. grass → cricket → frog
  - d. mouse → owl → frog
  
9. In *Figure 2* which trophic level is the frog (use *Figure 3* to help)?
  - a. producer
  - b. primary consumer
  - c. secondary consumer
  - d. tertiary consumer
  
10. What do the sizes of the levels in the energy pyramid in *Figure 3* represent?
  - a. The amount of energy available in the organisms at each level
  - b. The amount of energy used daily by the organisms at each level
  - c. The amount of heat given off daily by the organisms at each level
  - d. The amount of energy recycled by the organisms at each level
  
11. Plants use a special gas from the atmosphere to make food for the planet (i.e. glucose). Animals eat plants for food and exhale this special gas as a waste product. Which nutrient cycle best fits this example?
  - a. water
  - b. carbon
  - c. phosphorus
  - d. nitrogen
  
12. This nutrient cycle is also a great example of mutualism. Plants receive this nutrient from special soil bacteria that take it out of the air and plants provide a home for these bacteria.
  - a. water
  - b. carbon
  - c. phosphorus
  - d. nitrogen
  
13. All of the following are examples of human impacts on ecosystems EXCEPT
  - a. overfishing
  - b. climate change
  - c. hurricanes
  - d. deforestation

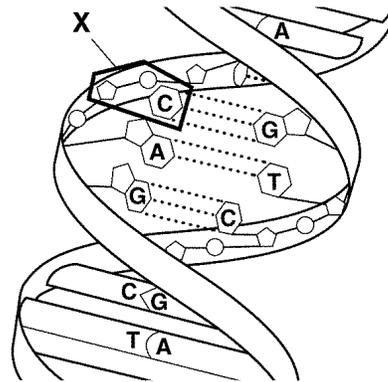


Figure 12-1

- \_\_\_\_\_ 1. Figure 12-1 shows the structure of a(an)
- |                  |                  |
|------------------|------------------|
| a. DNA molecule. | c. RNA molecule. |
| b. amino acid.   | d. protein.      |
- \_\_\_\_\_ 2. Which of the following is a **nucleotide** found in DNA?
- |   |
|---|
| a. ribose + phosphate group + thymine       |
| b. ribose + phosphate group + uracil        |
| c. deoxyribose + phosphate group + uracil   |
| d. deoxyribose + phosphate group + cytosine |
- \_\_\_\_\_ 3. DNA replication results in two DNA molecules,
- |  |
|--|
| a. each with two new strands.  |
| b. one with two new strands and the other with two original strands. |
| c. each with one new strand and one original strand.                 |
| d. each with two original strands.                                   |
- \_\_\_\_\_ 4. During DNA replication, a DNA strand that has the bases **CTAGGT** produces a strand with the bases
- |            |            |
|------------|------------|
| a. TCGAAC. | c. AGCTTG. |
| b. GATCCA. | d. GAUCCA. |
- \_\_\_\_\_ 5. RNA contains the sugar
- |                 |             |
|-----------------|-------------|
| a. ribose.      | c. glucose. |
| b. deoxyribose. | d. lactose. |
- \_\_\_\_\_ 6. Unlike DNA, RNA contains the base
- |             |                      |
|-------------|----------------------|
| a. adenine. | c. phosphate groups. |
| b. uracil.  | d. thymine.          |

- \_\_\_ 7. Which of the following are found in BOTH DNA and RNA?
- ribose, phosphate groups, and adenine
  - deoxyribose, phosphate groups, and guanine
  - phosphate groups, guanine, and cytosine
  - phosphate groups, guanine, and thymine
- \_\_\_ 8. What is produced during transcription?
- RNA molecules
  - DNA molecules
  - RNA polymerase
  - proteins
- \_\_\_ 9. How many bases are needed to specify **one** amino acid?
- 3
  - 6
  - 9
  - 12
- \_\_\_ 10. What happens during the process of translation?
- Messenger RNA is made from DNA.
  - The cell uses information from messenger RNA to produce proteins.
  - Transfer RNA is made from messenger RNA.
  - Copies of DNA molecules are made.
- \_\_\_ 11. Genes contain instructions for assembling
- purines.
  - nucleosomes.
  - proteins.
  - pyrimidines.
- \_\_\_ 12. A pedigree can be used to
- determine whether a trait is inherited.
  - show how a trait is passed from one generation to the next.
  - determine whether an allele is dominant or recessive.
  - all of the above
- \_\_\_ 13. A change in a sequence of DNA is called a
- recombination.
  - polygenic trait.
  - single-gene trait.
  - mutation.

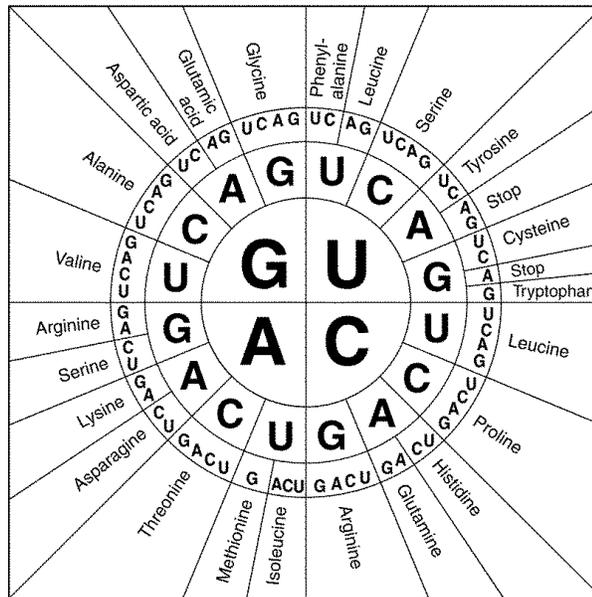


Figure 12–2

14. According to Figure 12–2, what codons specify the amino acid **glycine**?

The pedigree shows the inheritance of free earlobes and attached earlobes in five generations of a family. Attached earlobes are caused by a recessive allele (*f*).

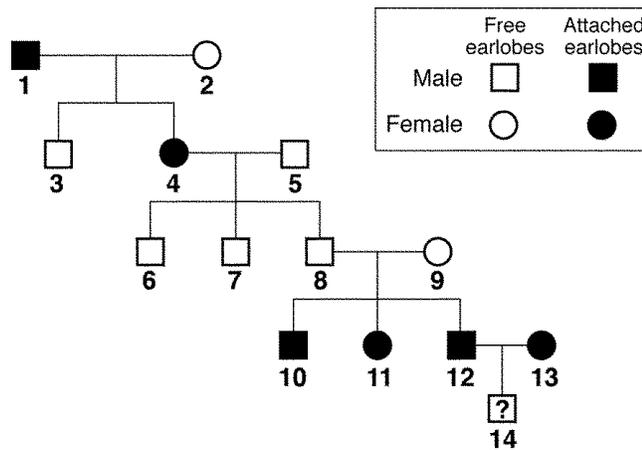


Figure 14–2

15. Does **individual 2** in Figure 14–2 have free or attached earlobes? \_\_\_\_\_
16. In Figure 14–2, how many children of individuals 4 and 5 have attached earlobes? \_\_\_\_\_
17. How many males have attached earlobes? \_\_\_\_\_
18. Predict the phenotype (physical characteristic) of **individual 14** in Figure 14–2. \_\_\_\_\_

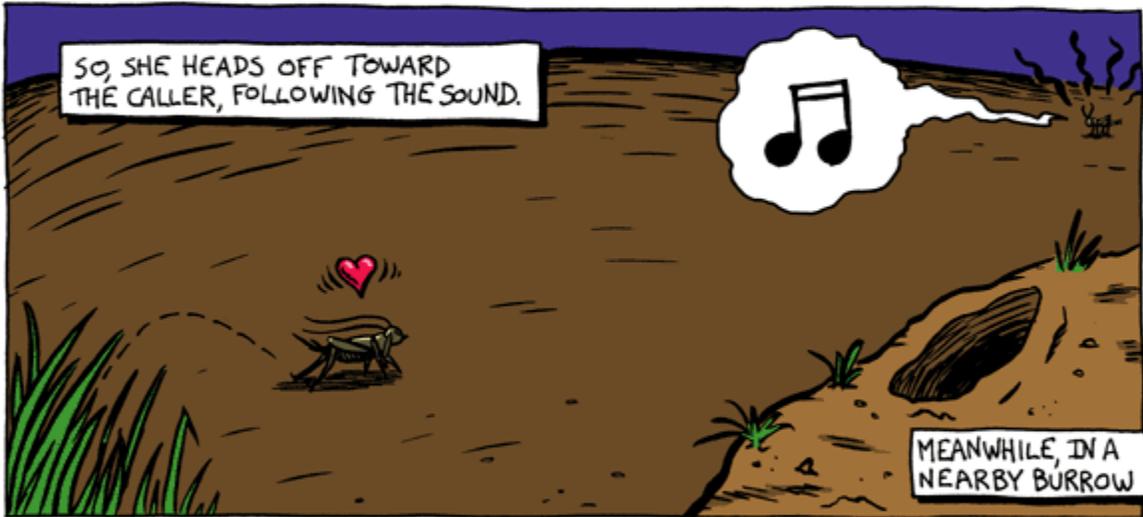
In nature, it's all survival of the fittest, right? The strong survive, and the weak die out. Well, that's often how it is portrayed, but is it really the whole story? Let's check it out...

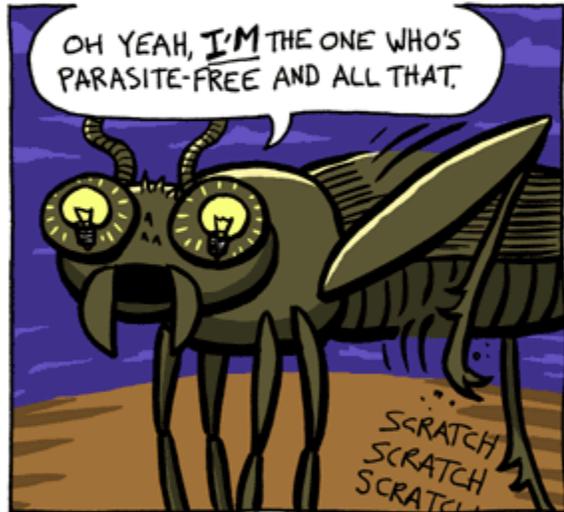
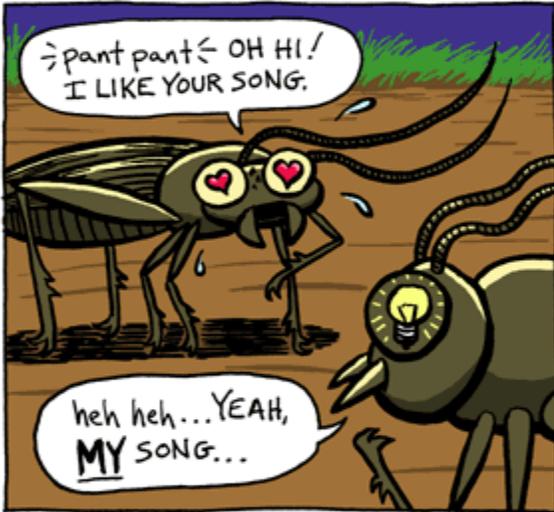
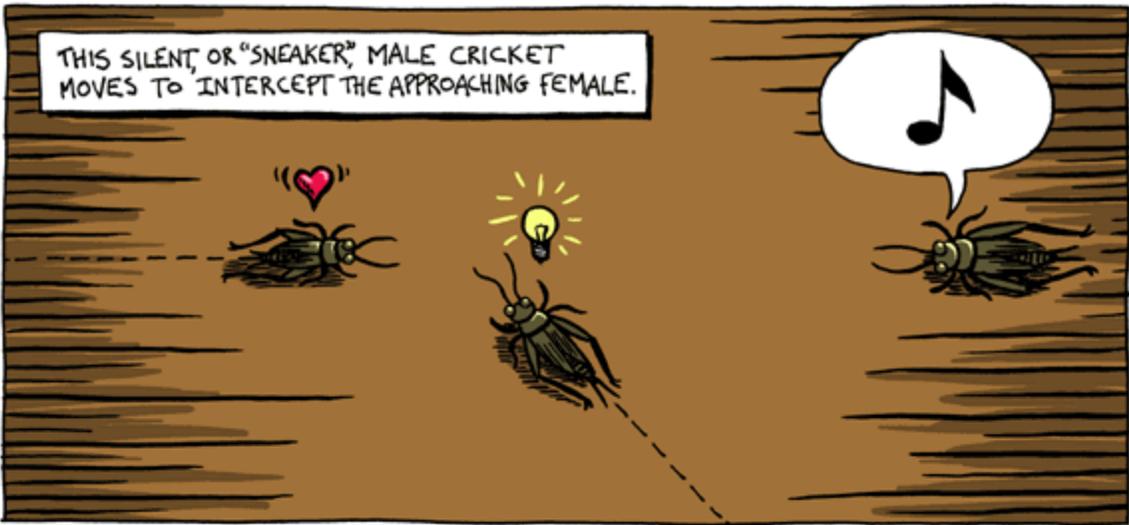


NOT FAR AWAY A FEMALE CRICKET LIKES WHAT SHE HEARS...



OH YEAH!  
MY EXOSKELETON  
IS SOOO GLOSSY!  
I'M PARASITE FREE!





AND OUR ORIGINAL, STRONG, LOUD, CALLING MALE IS OUT OF LUCK.



IN FACT, HIS SONG HAS ATTRACTED SOME UNWANTED ATTENTION.



MAYBE OUR SNEAKER MALE'S KIDS WILL INHERIT THE "SNEAKY" GENES, AND IN TURN USE SNEAKY BEHAVIOR LIKE THEIR FATHER.



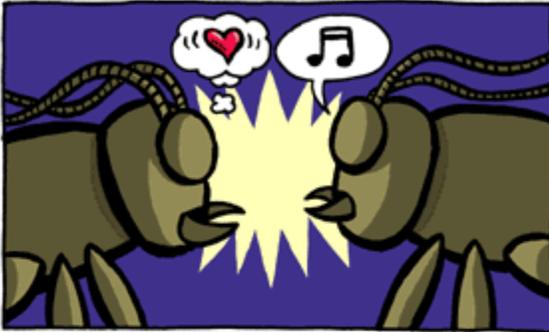
OF COURSE, TOUGHNESS CAN HELP TO INCREASE AN ORGANISM'S CHANCE OF LIVING LONG ENOUGH TO REPRODUCE...



...BUT REPRODUCTION AND THE PASSING ON OF GENES ARE MOST IMPORTANT IN TERMS OF EVOLUTION. AND THERE ARE MANY WAYS THAT AN INDIVIDUAL CAN GET THEIR GENES INTO THE NEXT GENERATION.

CALLING IS STILL A GOOD STRATEGY FOR MALE CRICKETS TO INCREASE THEIR CHANCE OF MATING. FEMALES ARE ATTRACTED TO CALLING MALES, AND THERE WON'T ALWAYS BE SNEAKERS OR PREDATORS AROUND TO DERAILED THE CALLERS.

AND IF THEY ALL USED THE SILENT, SNEAKER STRATEGY, THEN **NO** FEMALES WOULD BE ATTRACTED AT ALL, AND THE MALES WOULD HAVE SOME LONG, LONELY NIGHTS.



SO, WE END UP WITH A VARIETY OF SUCCESSFUL MATING STRATEGIES. THAT'S HOW NATURAL SELECTION WORKS. THERE IS NO ONE, TRUE, ULTIMATE SURVIVAL STRATEGY. A SUCCESSFUL STRATEGY IS WHATEVER GETS THE JOB DONE.



## EXTRA CRICKET!

CRICKETS DON'T ACTUALLY SING WITH VOICES, LIKE BIRDS OR PEOPLE. THE MALE CRICKET'S SONG IS MADE BY SCRAPING ONE WING ACROSS ANOTHER, SORT OF LIKE A VIOLIN BOW SCRAPING ACROSS A STRING.



CRICKETS CHIRP MORE OFTEN IF IT'S HOTTER. IN FACT, IT'S POSSIBLE TO ESTIMATE THE TEMPERATURE BASED ON THE FREQUENCY OF CRICKET CHIRPS.



## Questions

1. When it comes to crickets, what does fitness mean?
2. Is calling good or bad for a cricket's fitness?
3. Give some examples of selection at work in this cricket story.
4. How does selection favor calling? How does selection favor not calling?

**Explanations:**

1. Fitness refers to an individual's ability to survive and reproduce in a specific environment.
2. Calling is both good and bad for fitness. Calling is necessary to attract a mate, but can also attract predators.
3. In natural selection, organisms with traits well-suited to their environment survive and reproduce, passing those trait to the next generation; those unsuited die before reproducing, meaning their traits aren't passed on. Over time, the unfavorable traits are less common in the population. In this story, the chirping cricket is eaten before he reproduces, meaning his traits aren't passed on to the next generation. The more clever (or "sneaker") cricket's mating strategy allows him to avoid being eaten and to mate, potentially passing similar traits on to his offspring.
4. See #2.

## Day 1 – Atomic Structure

1. The sum of the protons and neutrons in an atom is its

- A. mass number.
- B. atomic energy.
- C. charge.
- D. atomic number.

2. A neutral atom could become a positively-charged particle through the loss of...

- A. neutrons.
- B. ions.
- C. electrons.
- D. protons.

3. What is the smallest particle of an element?

- A. molecule
- B. compound
- C. mixture
- D. atom

4. In the electron cloud model, if you begin at the electron shell closest to the nucleus of an atom and move out, what is the number of electrons that each energy level or electron shell needs to fill the first four electron shells?

- A. 8, 8, 8, 8
- B. 2, 8, 6, 2
- C. 2, 8, 18, 32
- D. 2, 6, 10, 14

5. The nucleus of an atom consists of:

- A. neutrons alone
- B. protons and neutrons
- C. neutrons and electrons
- D. protons and electrons

6. Which of the following subatomic particles is neutral (i.e., has no charge)?

- A. electron
- B. neutron
- C. nucleus
- D. proton

7. Can the number of protons in an element ever change?

- A. No, if the number of protons changes, the element changes.
- B. No, protons and neutrons are bound together in atomic nuclei, and neither can change.
- C. Yes, when different elements bond, they can share or transfer protons.
- D. Yes, isotopes of the same element have different numbers of protons.

8. If an atom has 15 protons, 11 neutrons, and 19 electrons what is the atoms charge?

- A. -8
- B. +8
- C. -4
- D. +4

1. An element's **mass number** is the sum of the protons and neutrons in the nucleus of one atom of the element.
2. Electrons are negatively-charged subatomic particles that are found outside of an atom's nucleus. If a neutral atom loses an electron, then the atom will have more protons than electrons. Thus, the atom will have a positive charge.
3. An **atom** is the smallest part of an element that still has all the properties of the element.
4. In the electron cloud model of an atom, electrons found within electron shells travel around the nucleus in unpredictable patterns. Although every atom basically has an infinite number of shells for the electrons to move around in, the electrons tend to stay in the electron shell that has the lowest energy and is closer to the nucleus.

Electron shells are named K, L, M, N, O, P (from the shell closest to the nucleus moving outward). To fill the electron shells: K needs 2 electrons, L needs 8 electrons, M needs 18 electrons, N needs 32 electrons, O needs 18 electrons, and P needs 4 electrons. The last electron shell of an atom usually will contain no more than eight electrons.

5. The nucleus of an atom contains protons and neutrons. Electrons are found outside of an atom's nucleus.
6. Protons have a positive charge. Electrons have a negative charge. **Neutrons** are neutral; they have no charge.
7. The number of electrons in an element can change when it forms an ion or chemical bond. The number of neutrons in an element can change when it forms an isotope or goes through radioactive decay. However, the number of protons in an element **never** changes.

This is demonstrated by the fact that the periodic table is arranged in order of the elements' number of protons, otherwise known as the elements' atomic numbers. If the number of protons changes, the element changes.

8. Each proton has a charge of (+1), each electron has a charge of (-1), each neutron has a neutral charge(0). Add up the charges in the atom:

$$(+15) + (-19) + 11(0) = -4$$

## NECAP Chemistry Review – Chemical and Physical Changes

1. Almost all chemical reactions absorb or release heat. This is because...
  - A. chemical changes only occur when heat is added.
  - B. matter is gained and lost during chemical reactions.
  - C. energy is gained and lost as chemical bonds are broken and formed.
  - D. phase changes always occur during chemical reactions.
2. Physical Changes also involve the absorption and the release of heat. This is because...
  - A. Physical changes only occur when heat is added.
  - B. matter is gained and lost during physical reactions.
  - C. energy is gained and lost as chemical bonds are broken and formed.
  - D. phase changes involve increasing or decreasing the movement of particles.
3. A physical property may be investigated by
  - A. Melting ice.
  - B. Allowing milk to sour.
  - C. Burning wood.
  - D. Allowing iron to rust.
4. The particles in a solid are
  - A. Packed closely together.
  - B. Far apart.
  - C. Constantly in motion.
  - D. Able to slide past each other.
5. The state of matter in which a material has neither a definite shape nor a definite volume is the
  - A. Solid state.
  - B. Liquid state.
  - C. Gaseous state.
  - D. Elemental state.
6. The mass of a 6.0 mL sample of kerosene is 4.92 g. The density of kerosene is
  - A. 0.82 g/mL.
  - B. 0.92 g/cm<sup>3</sup>.
  - C. 1.2 g/mL.
  - D. 1.5 g/cm<sup>3</sup>.

7. The density of aluminum is  $2.70 \text{ g/cm}^3$ . The volume of a solid piece of aluminum is  $1.50 \text{ cm}^3$ . Find its mass.

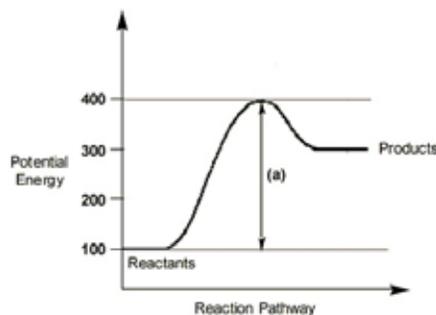
- A. 1.50 g
- B. 1.80 g.
- C. 2.70 g.
- D. 4.05 g.

8. The density of pure diamond is  $3.5 \text{ g/cm}^3$ . The mass of a diamond is 0.25 g. Find its volume.

- A.  $0.071 \text{ cm}^3$ .
- B.  $0.875 \text{ cm}^3$ .
- C.  $3.5 \text{ cm}^3$ .
- D.  $14 \text{ cm}^3$ .

9. Which of the following is true of exothermic reactions?

- A. They release heat and feel cold to the touch.
- B. They release heat and feel warm to touch.
- C. They absorb heat and feel warm to the touch.
- D. They absorb heat and feel cold to the touch.



10. Examine the graph above. Which of the following would be correct conclusions? (You may mark one or more answers.)

- A. The reaction will feel cold to the touch.
- B. This is an endothermic reaction.
- C. The reaction will feel warm to the touch.
- D. This is an exothermic reaction.

## Explanations:

1. answer: C

During chemical reactions, chemical bonds are broken or formed. During these processes, energy is either absorbed or released. Since the total amount of energy that is absorbed is rarely equal to the total amount of energy that is released, chemical reactions display an overall gain or loss of energy. Reactions that gain heat energy are called *endothermic reactions*, and reactions that lose heat energy are called *exothermic reactions*.

2. answer: D

During physical reactions the particles involved absorb or release energy increasing or decreasing their movement. When a substance in its solid state and absorbs energy the particle will begin to move more rapidly until they overcome the attraction between particles and melt. When a substance in its liquid state absorbs energy they overcome all remaining attraction between particles and boil. When the two physical changes above are reversed and energy is released a substance will condense or freeze. The process where a substance goes directly from solid to gas is called sublimation.

3. answer: A

In observing physical properties the matter involved doesn't change in chemical composition (ie melting, boiling, dissolving, and separating). Chemical properties when observed the matter changes in composition (ie burning, reacting, cooking) and will result in new substances being formed.

4. answer: A

Solids have particles that are highly organized and tightly packed. Liquids have particles that are less organized, farther apart, and able to move past each other. Gases have particles that are very disorganized and move freely about.

5. answer: C

See above

6. answer: A

Density is a physical property that describes the mass per unit of volume of a substance.

$$D = \frac{m}{V} \quad D = \frac{4.92g}{6.0mL}$$

7. answer: D (see explanation in #6)  $2.70 = \frac{m}{1.5mL}$ ;  $2.7 \times 1.5 = m$

8. answer: A (see explanation in #6)  $3.5 = \frac{0.25g}{V}$ ;  $3.5V = 0.25$ ;  $V = \frac{0.25g}{3.5g/mL}$

9. answer: B

In exothermic reactions, the reactants have a higher potential energy than the products, so energy is released as heat. Heat energy flowing away from an object toward your hand will make it feel warm to the touch.

10. answer: A and B

In endothermic reactions, the products have a higher energy than the reactants. Heat energy is absorbed and used to power the reaction. Heat being absorbed from your hand by the reaction makes it feel cold to the touch.

## Chemistry Lesson – Periodic Table and Bonding

1. Atoms of different elements can combine chemically to form compounds. Which of the following elements would be most likely to form a compound bound tightly together with a covalent bond?

- A. one sodium atom and one chlorine atom to form sodium chloride (NaCl)
- B. one magnesium atom and two bromine atoms to form magnesium bromide (MgBr<sub>2</sub>)
- C. four hydrogen atoms and one carbon atom to form methane (CH<sub>4</sub>)
- D. two aluminum atoms with three oxygen atoms to form aluminum oxide (AlO<sub>3</sub>)

2. Sodium and chlorine react and an ionic bond forms. Which statement is true about the bonding that has occurred?

- A. The sodium and the chlorine atoms have both lost an electron.
- B. The sodium atom has lost an electron and the chlorine atom has gained one.
- C. The sodium and the chlorine atoms have both gained an electron.
- D. The chlorine atom has lost an electron and the sodium atom has gained one.

3. Which compound has ionic bonding?

- A. Cl<sub>2</sub>
- B. HF
- C. CaO
- D. NO<sub>2</sub>

4. Which of the following lists the beryllium, radium, barium, and magnesium ions in order from smallest to largest ionic radius?

- A. Be<sup>2+</sup>, Mg<sup>2+</sup>, Ra<sup>2+</sup>, Ba<sup>2+</sup>
- B. Be<sup>2+</sup>, Mg<sup>2+</sup>, Ba<sup>2+</sup>, Ra<sup>2+</sup>
- C. Ra<sup>2+</sup>, Ba<sup>2+</sup>, Be<sup>2+</sup>, Mg<sup>2+</sup>
- D. Ra<sup>2+</sup>, Ba<sup>2+</sup>, Mg<sup>2+</sup>, Be<sup>2+</sup>

5. An unknown element is a soft metallic solid. It is highly reactive and has a low melting point. In which group of the periodic table is it most likely to be found?

- A. 2
- B. 17
- C. 1
- D. 18

6. Potassium Bromide (KBr) is a hard and brittle substance that conducts electricity in the aqueous and molten state, and with a very high melting point. What type of solid is potassium bromide?

- A. covalent-network
- B. molecular
- C. ionic
- D. metallic

7. The reactivity of elements can be predicted based on the position of an element in the periodic table. Based on the periodic table, which of the following elements would be expected to be the least reactive?

- A. iodine (I)
- B. fluorine (F)
- C. chlorine (Cl)
- D. bromine (Br)

8. Which of the following generally has the lowest boiling points?

- A. small covalent molecule
- B. large covalent molecule
- C. large ionic molecule
- D. all of these generally have the same boiling points

9. Which of following elements is most likely to undergo radioactive decay?

- A. Ag
- B. Br
- C. Am
- D. C

10. Fluorine easily gains an electron to form a negative one anion. Which best describes this process?

- A.  $F + e^- + \text{energy} \longrightarrow F^-$  ; a large amount of energy is absorbed due to Fluorine's high electronegativity.
- B.  $F + \text{energy} \longrightarrow F^- + e^-$  ; a large amount of energy is absorbed due to Fluorine's high electronegativity.
- C.  $F \longrightarrow F^- + e^- + \text{energy}$  ; a large amount of energy is released due to Fluorine's high electronegativity.
- D.  $F + e^- \longrightarrow F^- + \text{energy}$  ; a large amount of energy is released due to Fluorine's high electronegativity.

## Answers and explanations:

1. Covalent bonds are formed when two or more atoms of an element share electrons. Carbon and hydrogen are both non-metal elements that have similar electronegativities, which increase the chance of covalent bonding. The other answers are examples of ionic bonding.
2. In ionic bonding, an atom donates one or more electrons to another atom, which gives both atoms a full outer shell of electrons. An electron has a negative charge. So, the atom that loses the electron(s) becomes a positive ion and the atom that gains the electron(s) becomes a negative ion.

In this case, sodium donates one electron to chlorine to satisfy the outer shells of both atoms. So, the sodium atom has lost one electron and the chlorine atom has gained one.

3. Ionic bonding occurs between a positively charged ion and a negatively charged ion, with electrons transferred between atoms. In this case,  $\text{Ca}^{2+}$  is a positive ion and donates two electrons to the negative  $\text{O}^{2-}$  ion. This creates an ionic bond. The other three compounds have covalent bonds, with electrons shared between negative ions.
4. These elements are all Alkaline Earth Metals. As atoms, the atomic radii (sizes) of the atoms increases down the group due to the addition of another principle energy level of electrons. Since all these elements lose two electrons when forming compounds the trend is retained as positive ions. ( $\text{Be} > \text{Mg} > \text{Ba} > \text{Ra}$ )
5. All of the elements in group 1 of the periodic table are alkali metals. These elements share similar properties such as being highly reactive, being soft metallic solids, and having low melting points.

The elements in group 2 are alkaline earth metals. These elements are harder and denser, have higher melting and boiling points, and are not as reactive as alkali metals.

6. Potassium Bromide is an ionic solid. This means that the solid is held together by a crystal lattice of ionic bonds. The lattice structure causes the very high melting point and makes it a hard solid. The charged ions will not conduct in the lattice, but will conduct when the lattice is broken down as in an aqueous solution or liquid state.
7. Chemical properties describe a substance's potential to change into new substances. These properties depend on the elements that the substance contains, the arrangement of atoms within the substance, as well as the type of bonding that is present within the substance. Flammability, combustibility, and reactivity are all examples of chemical properties.

Reactivity of nonmetals generally decreases as you move down the periodic table. This occurs because the bonding electrons are further from the nucleus and so are not held as strongly. This trend means that iodine would be expected to be the least reactive of the four elements listed. Reactivity of representative metals is is opposite due to the electrons being farther and less tightly held to the atom.

8. In ionic bonding, one or more electrons are passed from one atom to another, forming a positive charged ion and a negatively charged ion. The electrostatic attraction between such ions results in large crystalline structure with relatively strong bonds, resulting in high boiling points. Covalent bonding relies on the sharing of electrons between atoms and intermolecular forces between molecules. Covalent molecules generally boil more easily (low boiling point) due to weak intermolecular forces that hold them together. These forces are weaker than ionic bonds. Larger covalent molecules has stronger intermolecular forces than smaller ones. Therefore, small covalent molecules have the lowest boiling points.

9. Americium is most likely to undergo radioactive decay. Americium is an actinide. Lanthanides and actinides are all radioactive metals. Most actinide don't exist naturally and are synthesized in a laboratory. Most atoms with atomic numbers greater than 84 will decay through and alpha, beta, or, gamma process.

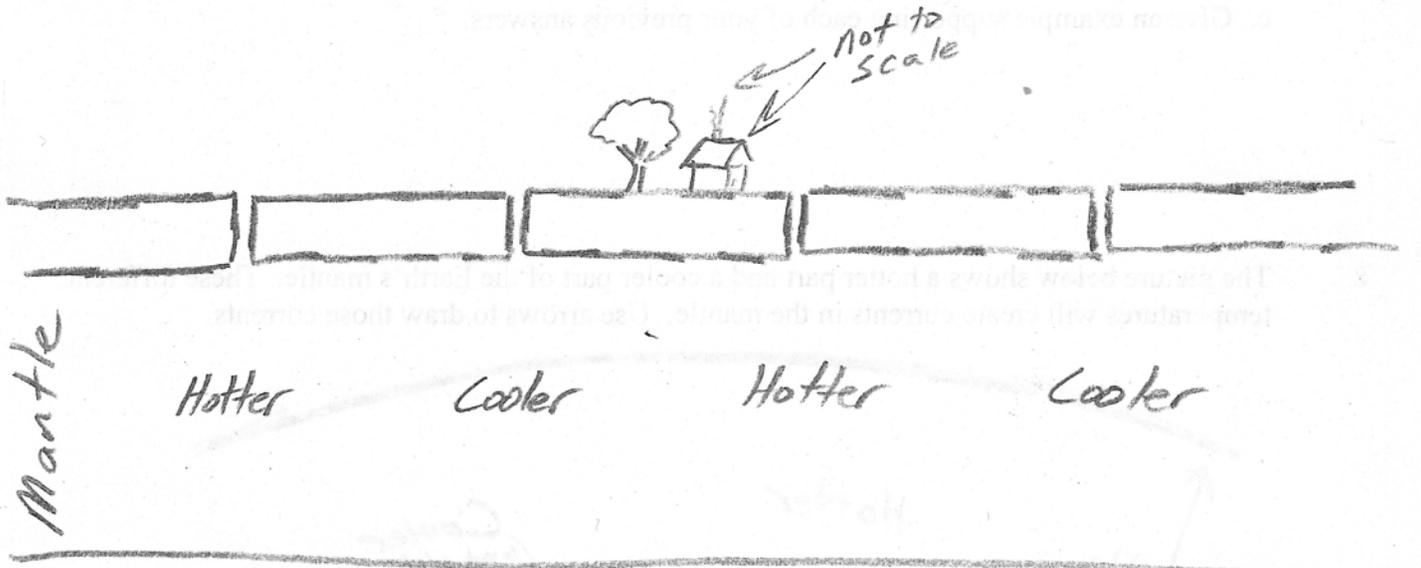
10.

$F + e^{-} \longrightarrow F^{-} + \text{energy}$ ; a large amount of energy is released due to Fluorine's high electronegativity.

The electron affinity is a measure of how much energy is absorbed or released when an electron is gained. Fluorine has a high electron affinity and therefore will release energy when an electron is added making the ion more stable than the atom. This energy would appear as a negative number indicating that energy is released during the process. This is called an exothermic process.

**NECAP Question:**

1. The diagram below shows several of earth's tectonic plates. The cracks between the plates are "plate boundaries." Label each plate boundary to indicate whether it is convergent (plates moving together) or divergent (plates moving apart).

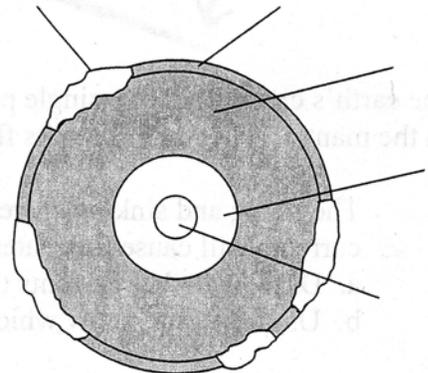


**Supporting Questions**

**Layers of The Earth:**

2. Use these words to label the layers of the Earth on the diagram to the right:

Mantle, Ocean Crust, Continental Crust, Inner core, Outer core

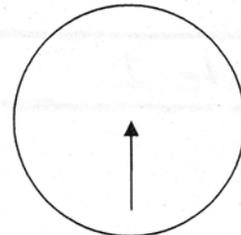


3. What type of crust is most dense?

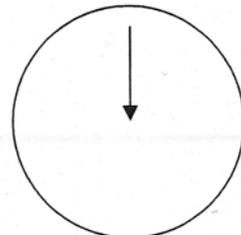
4. What type of crust is least dense?

**Currents:**

5. Suppose you have a dish of water, like the one on the right. If a current of water shoots up from the bottom (see arrow), the water in the tank will begin to swirl. Use more arrows to show how the water will swirl.



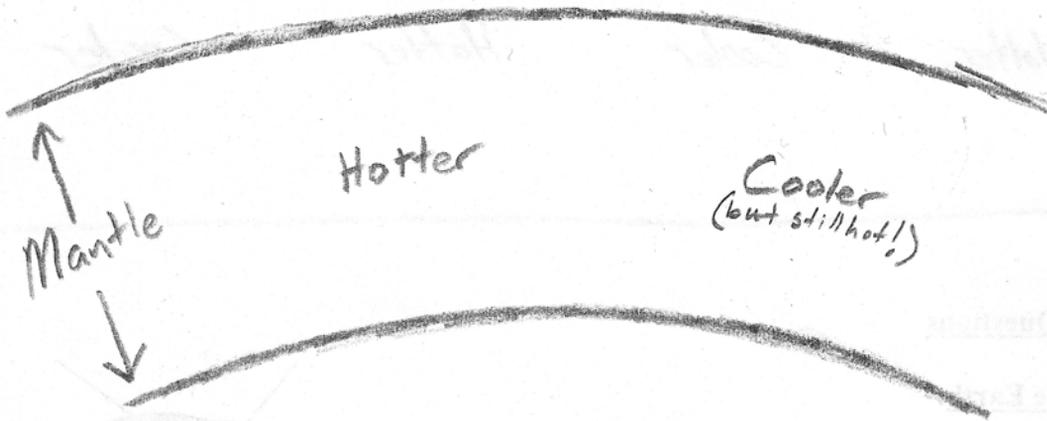
6. Show how a dish of water will swirl if a current shoots down from the top.



## Convection Currents:

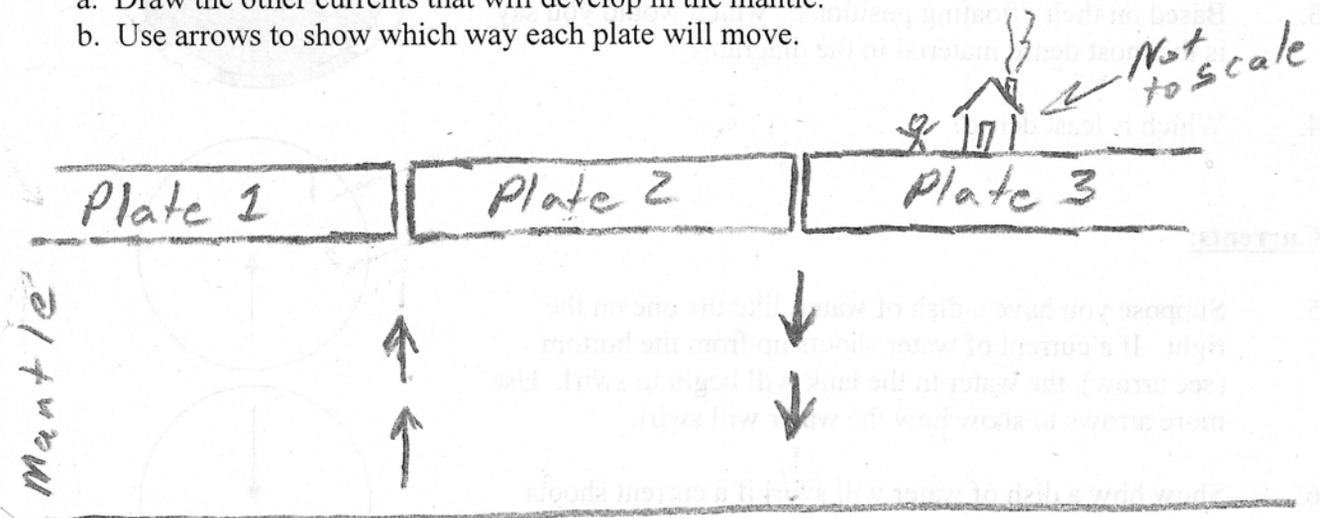
7.
  - a. What kind of air rises, hot air or cold air?
  - b. What kind of air sinks, hot or cold?
  - c. Give an example supporting each of your previous answers.

8. The picture below shows a hotter part and a cooler part of the Earth's mantle. These different temperatures will create currents in the mantle. Use arrows to draw those currents.



The earth's crust is not one single piece of material. It is made up of separate **plates**, which float around on the mantle. They are like rafts floating on a river; they move with the current below them.

9. The rising and sinking currents in the mantle drawing below will form other currents. These currents will cause the plates above them to move.
  - a. Draw the other currents that will develop in the mantle.
  - b. Use arrows to show which way each plate will move.



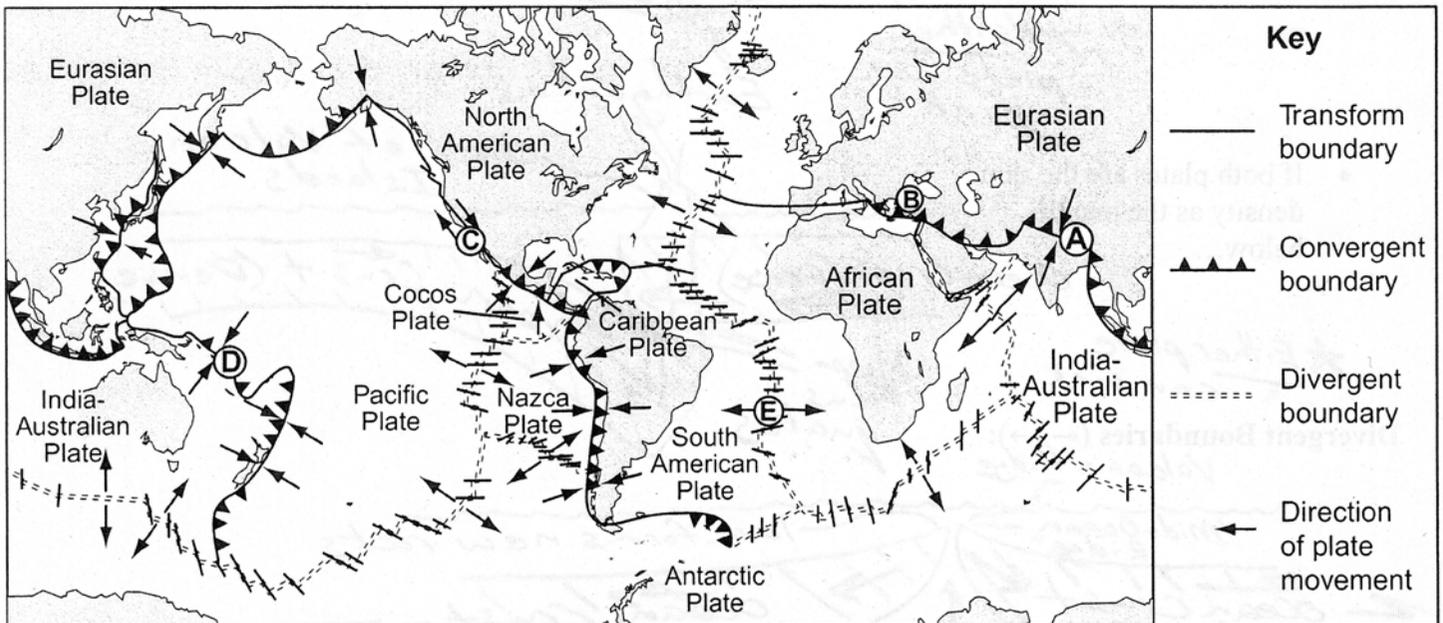
**NECAP Question:**

Many of Earth's surface features and landforms have been created by the movement of the Earth's plates. If you understand the Theory of Plate Tectonics, you can use a plate boundary map, like the one below, to determine where certain types of landforms can be found.

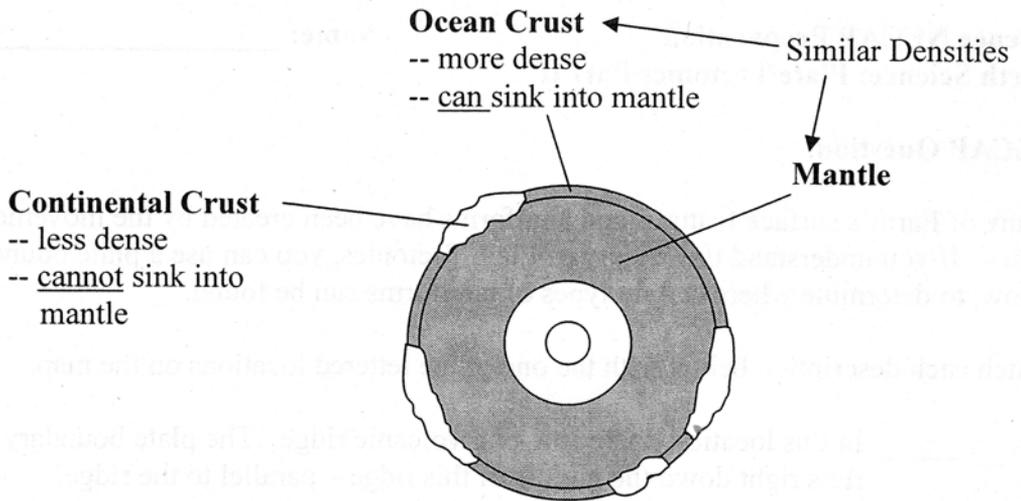
Match each description below with the one of the lettered locations on the map.

1. \_\_\_\_\_ In this location, there is a long volcanic ridge. The plate boundary forms a crack that runs right down the middle of this ridge – parallel to the ridge.
2. \_\_\_\_\_ In this location, there are volcanoes on one side of the plate boundary. The volcanoes are islands. There are also deep-focus earthquakes.
3. \_\_\_\_\_ Here there are tall mountains and earthquakes, but no volcanoes and no lava.
4. \_\_\_\_\_ At this location, shallow-focus earthquakes occur along a crack in the ground. There are no mountains, and there are no significant volcanoes or lava.
5. \_\_\_\_\_ In this location, there are volcanoes on one side of the plate boundary. These volcanoes are tall mountains on a continent. There are also deep-focus earthquakes.

**Plate Movements**



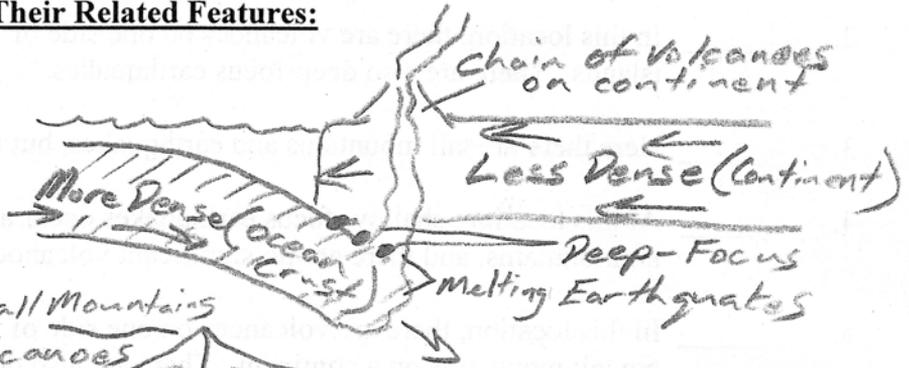
**Helpful Information**



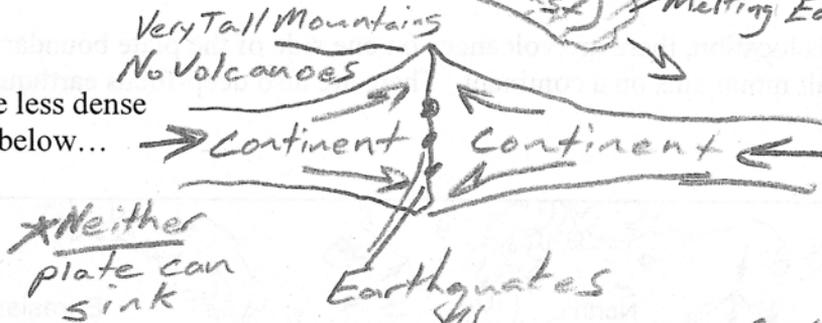
**Understanding Plate Boundaries and Their Related Features:**

**Convergent Boundaries (→←):**

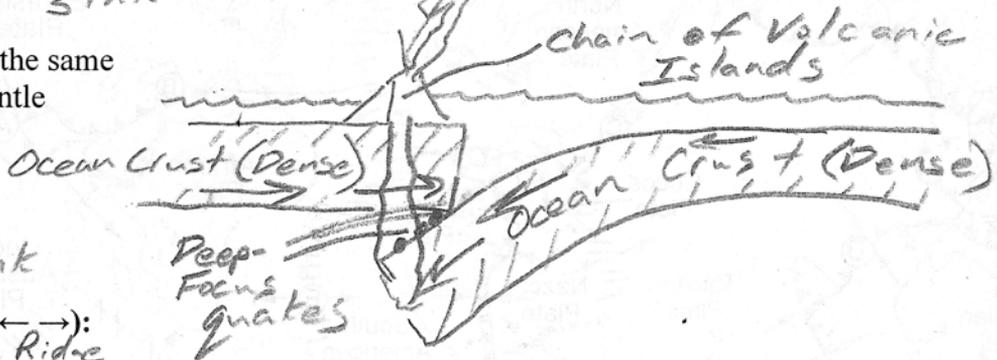
- If one plate is more dense than the other...



- If both plates are less dense than the mantle below...

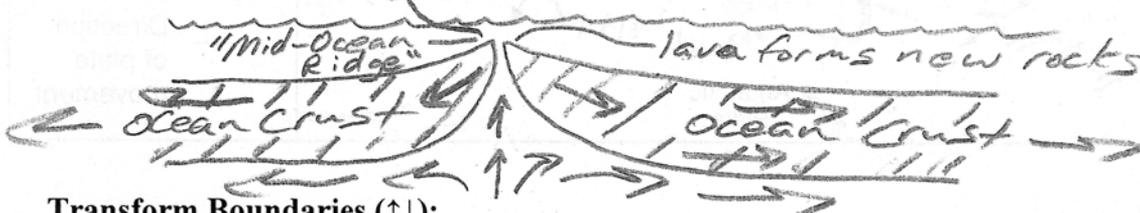


- If both plates are the same density as the mantle below...

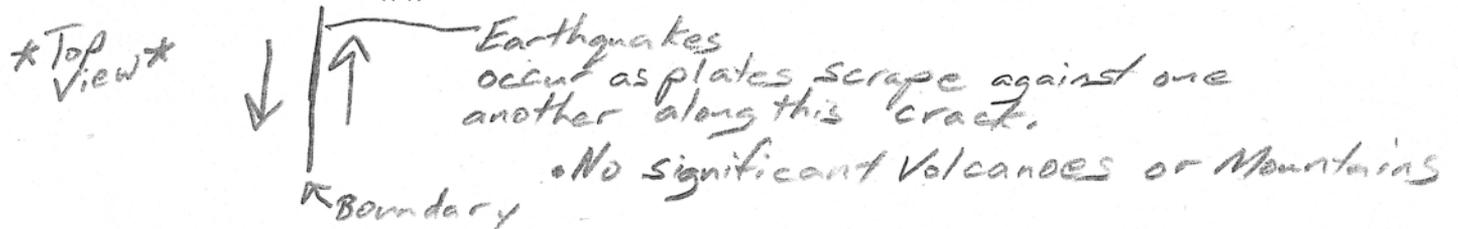


**Divergent Boundaries (←→):**

Volcanic Ridge



**Transform Boundaries (↑↓):**



NECAP Review

Topic: Constant Acceleration of Free-Falling Objects

### Calculating Velocity of Free-Falling Objects on Earth

Calculate the velocity of a rock that is dropped from a cliff and has fallen for 5 seconds.

Calculate the velocity of a rock that is dropped from a cliff and has fallen for 7 seconds.

### Calculating distance traveled of Free-Falling Objects on Earth

Calculate the distance a rock has traveled that is dropped from a cliff and has fallen for 5 seconds.

Calculate the distance a rock has traveled that is dropped from a cliff and has fallen for 10 seconds.

Let's suppose you are on a planet in which objects accelerate at a rate of  $2 \text{ m/s}^2$ . Calculate the velocity and distance traveled for the times given below:

Fall Time	Acceleration	Velocity	Distance Traveled
1 sec	$2 \text{ m/s}^2$		
2 sec	$2 \text{ m/s}^2$		
3 sec	$2 \text{ m/s}^2$		

**Physics NECAP Review Question #2**

**Topics: Universal gravitation, Newton's 1<sup>st</sup> and 3<sup>rd</sup> Laws**

1. The moon rotates around the Earth. What is the force that acts on the moon to keep it moving around the Earth? (do not say "centripetal force"). Does this force also act on the Earth?

2. Look at the reference sheet and identify the equation you would use to calculate the force that keeps the moon moving around the Earth. Write that equation in the space below and then answer the following questions.

Equation:

a. If the mass of the moon were to increase but the mass of the Earth and the distance between the two bodies remained constant, how would the force change? Write out this relationship between force and mass.

b. If the masses of the two bodies remained the same but the distance between them increased, how would the force change? Write out this relationship in a general statement.

c. In general, which variable, mass or distance, has the greater effect on the force? Explain.

3. (a) If the moon's velocity decreased, what would happen to it? (b) If the moon's velocity increased, what would happen to it?

4. Use the following data to **explain** if you would weigh more on Earth or on Mars.

Mass of Earth:  $5.98 \times 10^{24}$  kg  
Radius of Earth:  $6.38 \times 10^6$  m

Mass of Mars:  $6.42 \times 10^{23}$  kg  
Radius of Mars:  $3.38 \times 10^6$  m

5. (a) Using the above data for the Earth, calculate the force of attraction between Bob,  $m=75$  kg, and the Earth. (b) What is another name for this force of attraction between Bob and the Earth? Remember:  $G= 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$