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# SBI 3U BIOLOGY WORKSHEETS

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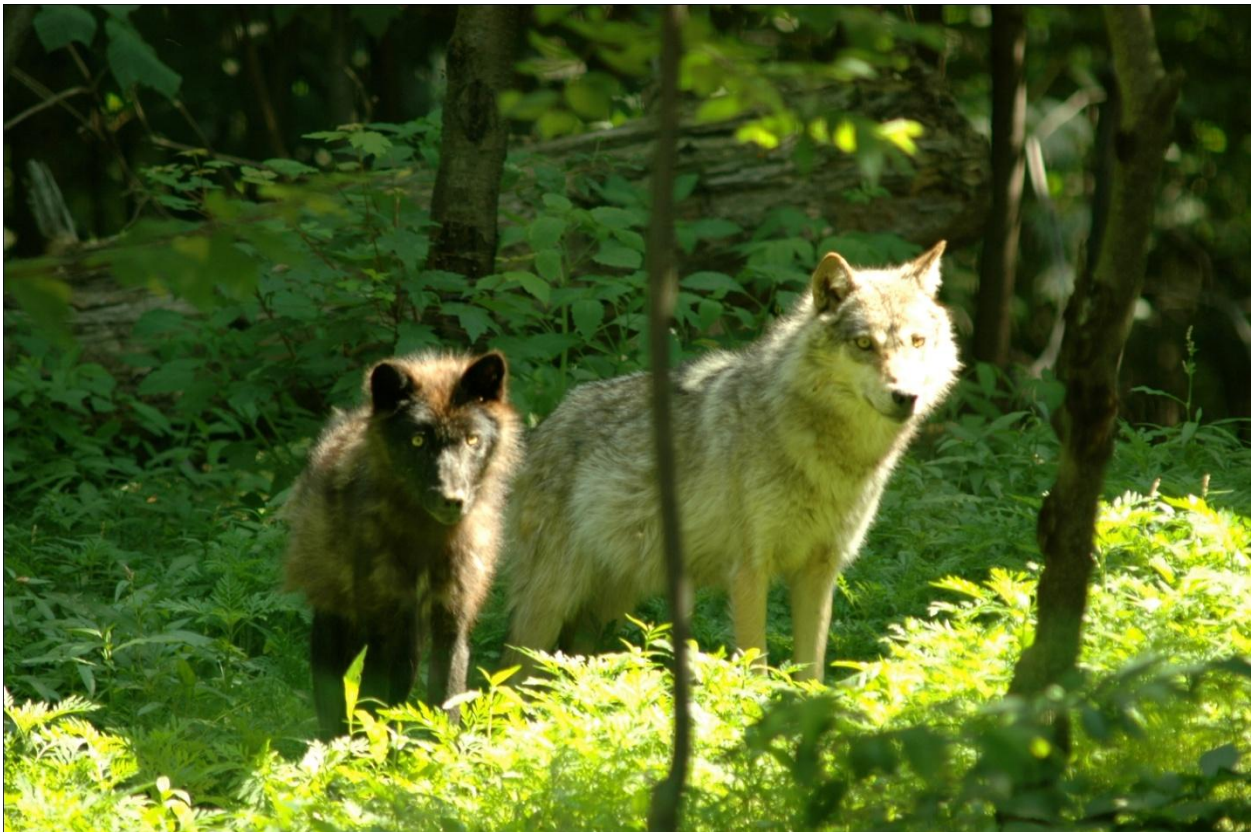


PHOTO BY P. MCBURNEY-  
HALIBURTON WOLF CENTRE

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## 1 : Cell Division and Reproduction Worksheets

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

### 1.1 : Chromosomes and the Cell Cycle

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

#### True or False

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Before most cell divisions, most cells do not increase in size.
- \_\_\_\_\_ 2. During cell division, one of the daughter cells gets all of the larger chromosomes, and the other daughter cell gets all of the smaller chromosomes.
- \_\_\_\_\_ 3. The number of chromosomes in a cell is duplicated before the beginning of mitosis.
- \_\_\_\_\_ 4. Many species of bacteria have a single circular chromosome that consists of double stranded DNA.
- \_\_\_\_\_ 5. Under ideal conditions, some bacteria can reproduce every 20 seconds.
- \_\_\_\_\_ 6. Each human chromosomes contains a maximum of one gene.
- \_\_\_\_\_ 7. The information needed to make a particular cellular protein is contained within a gene.
- \_\_\_\_\_ 8. A chromosome is composed of DNA, RNA, protein, phospholipids, carbohydrates, and cell walls.
- \_\_\_\_\_ 9. A human gamete contains 46 chromosomes.
- \_\_\_\_\_ 10. Two sister chromatids are attached to each other until the beginning of anaphase.
- \_\_\_\_\_ 11. Most cells spend the majority of their lives in interphase.
- \_\_\_\_\_ 12. DNA is duplicated during S phase of the cell cycle.
- \_\_\_\_\_ 13. During mitosis, the duplicated chromosomes move to opposite poles with the aid of microtubules.
- \_\_\_\_\_ 14. Cells have cell cycle checkpoints that regulate progression from one phase of the cell cycle to the next.
- \_\_\_\_\_ 15. Compared to normal cells, cancer cells have exceptionally slow cell division rates.

## 1.1 : Critical Reading

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

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

*Read this passage from the lesson and answer the questions that follow.*

### Control of the Cell Cycle

How does the cell know when to divide? How does the cell know when to replicate the DNA? The answers to these questions have to do with the control of the cell cycle. But how is the cell cycle controlled?

The cell cycle is controlled by a number of protein-controlled feedback processes. Two types of proteins involved in the control of the cell cycle are kinases and cyclins. Cyclins activate kinases. Cyclins are a group of proteins that is rapidly produced at key stages in the cell cycle. Kinases activate other target molecules. It is this precise regulation of proteins that triggers advancement through the cell cycle.

The cell cycle has key checkpoints. When the cell receives key signals or information (feedback regulation), the cell can begin the next phase of the cell cycle. The cell can also receive signals that delay passage to the next phase of the cell cycle. These signals allow the cell to complete the previous phase before moving forward. Three key checkpoints are the cell growth (G1) checkpoint, the DNA synthesis (G2) checkpoint, and the mitosis checkpoint.

The cell growth (G1) checkpoint allows the cell to proceed into the S phase of the cell cycle and continue on to divide. The cell spends most of the cycle in the G1 phase. G1 is where the cell carries out its main functions. If the cell has performed its functions and has grown to significant size to be divided in half, key proteins will stimulate DNA replication to begin. If the cells are not to divide, such as some muscle and nerve cells, the cell will stop at this checkpoint and move into a resting phase. Some cells may stay in this resting period permanently, never dividing.

The DNA synthesis (G2) checkpoint determines if the cell is ready for mitosis. DNA repair enzymes check the replicated DNA at this point. If the checkpoint is passed, the many molecular mechanisms and processes needed for mitosis will begin.

The mitosis checkpoint determines the end of one cycle and the beginning of the next. This checkpoint signals the end of mitosis, allowing the cell to prepare for the beginning of G1 of the next cell cycle.

### Questions

1. Does the cell have any control over its progression through the cell cycle? If so, how is it regulated?
2. What happens at a cell cycle checkpoint?
3. What are the five main phases of the cell cycle? What are the main events in each?
4. List and briefly describe the three main cell cycle checkpoints.
5. What do you think happens when a cell loses control of the cell cycle?

## 1.1 : Multiple Choice

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

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

*Circle the letter of the correct choice.*

1. The process in prokaryotes by which a cell divides to form two identical cells by cytokinesis is called
  - a. binary fission.
  - b. cyclin.
  - c. multi-fission.
  - d. S phase.
2. During which phase of the cell cycle does the cytoplasm split such that two daughter cells are formed?
  - a. G1 phase
  - b. G2 phase
  - c. S phase
  - d. C phase
3. Human liver cells and kidney cells each contain
  - a. different genes from one another, because some of the proteins made differ between the two cell types.
  - b. the same genes, because in a single multicellular organism, all somatic cells (non-germ cells) contain the same genes.
  - c. a set of proteins, all of which are produced in both cell types.
  - d. a single, circular chromosome.
4. Human chromosomes
  - a. are present in cells as a set of 23 chromosomes total.
  - b. come in pairs, both pairs inherited from the mother.
  - c. come in pairs, one of which is inherited from the mother, and the other, from the father.
  - d. come in pairs, both pairs inherited from father.
5. Chromosomes that are the same size and shape and that contain the same genes
  - a. are duplicated during G2 phase.
  - b. are homologous chromosomes.
  - c. are present in prokaryotes, but not eukaryotes.
  - d. all of the above
6. Unfertilized human eggs contain what complement of sex chromosomes?
  - a. one Y chromosome
  - b. one X chromosome
  - c. two X chromosomes
  - d. one X and one Y chromosome
7. Some cancers are triggered by
  - a. ultraviolet radiation.
  - b. tobacco smoking.
  - c. asbestos.
  - d. all of the above

## 1.1 : Vocabulary

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

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

*Match the vocabulary term with the correct definition.*

### Term

- \_\_\_ 1. spindle
- \_\_\_ 2. zygote
- \_\_\_ 3. oncogene
- \_\_\_ 4. gene
- \_\_\_ 5. haploid
- \_\_\_ 6. mitosis
- \_\_\_ 7. cell plate
- \_\_\_ 8. S phase
- \_\_\_ 9. sister chromatid
- \_\_\_ 10. autosomes

### Definition

- a. The cell cycle phase during which the DNA is replicated, and correspondingly, the chromosomes are duplicated.
- b. Microtubule-based fibers used to move chromosomes and separate the sister chromatids during mitosis.
- c. The phase of the cell cycle during which the duplication of the nucleus occurs.
- d. Forms during cytokinesis in plant cells; a new plasma membrane grows along each side of the cell plate, with a new cell wall forming on the outside of each new membrane.
- e. Identical copies of a DNA molecule that are attached at their centromeres.
- f. Chromosomes that are not directly involved in determining the sex of an individual.
- g. The first cell of a new individual.
- h. A segment of DNA that contains the information necessary to encode an RNA molecule or a protein.
- i. A cell that contains one set of chromosomes, such as a human sperm cell or egg.
- j. A gene, which when it is mutated and/or when it produces too much protein product, can cause cancer and speed up the cell cycle.

## 1.2 : Meiosis

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

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

### True or False

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. In some species, an organism can have just one parent.
- \_\_\_\_\_ 2. Asexual reproduction produces an individual that is genetically different from the parent.
- \_\_\_\_\_ 3. All bacteria are either distinctly male or female.
- \_\_\_\_\_ 4. Fragmentation is actually a kind of asexual reproduction.
- \_\_\_\_\_ 5. Human gametes are haploid.
- \_\_\_\_\_ 6. Meiosis is required to form human gametes.
- \_\_\_\_\_ 7. Both prophase I and metaphase II are stages of meiosis.
- \_\_\_\_\_ 8. At the beginning of meiosis in humans, during prophase I, there are 92 chromatids in the cell.
- \_\_\_\_\_ 9. At the end of oogenesis in human females, 4 haploid mature ova are produced from a single primary oocyte.
- \_\_\_\_\_ 10. At the end of spermatogenesis, 4 spermatids are produced from a single primary spermatocyte.
- \_\_\_\_\_ 11. In meiosis, the sister chromatids separate from each other at anaphase I.
- \_\_\_\_\_ 12. Crossing-over during meiosis produces unique combinations of alleles (alternative forms of the same gene) in the recombinant chromosomes.
- \_\_\_\_\_ 13. Sexual reproduction results in less genetically diverse offspring when compared to asexual reproduction.
- \_\_\_\_\_ 14. Organisms with a haploid life cycle never undergo mitosis.
- \_\_\_\_\_ 15. Organisms with a diploid life cycle produce diploid gametes.

## 1.2 : Critical Reading

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

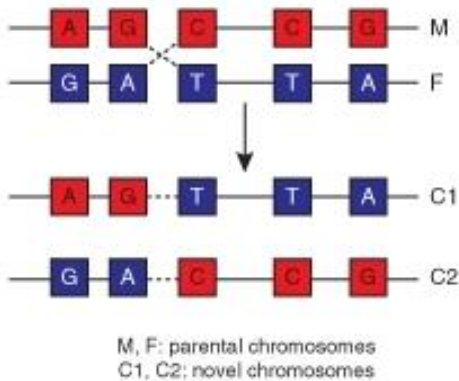
Date: \_\_\_\_\_

Read this passage from the lesson and answer the questions that follow.

### Meiosis and Genetic Variation

Sexual reproduction results in infinite possibilities of genetic variation. This occurs through a number of mechanisms, including crossing-over, the independent assortment of chromosomes during anaphase I, and random fertilization.

Crossing-over occurs during prophase I. Crossing-over is the exchange of genetic material between non-sister chromatids of homologous chromosomes. Recall during prophase I, homologous chromosomes line up in pairs, gene-for-gene down their entire length, forming a configuration with four chromatids, known as a tetrad. At this point, the chromatids are very close to each other and some material from two chromatids switch chromosomes, that is, the material breaks off and reattaches at the same position on the homologous chromosome (Figure below). This exchange of genetic material can happen many times within the same pair of homologous chromosomes, creating unique combinations of genes. This process is also known as recombination.



As mentioned above, in humans there are over 8 million configurations in which the chromosomes can line up during metaphase I. It is the specific processes of meiosis, resulting in four unique haploid cells, that results in these many combinations. Figure below compares mitosis and meiosis. This independent assortment, in which the chromosome inherited from either the father or mother can sort into any gamete, produces the potential for tremendous genetic variation. Together with random fertilization, more possibilities for genetic variation exist between any two people than individuals alive today. Sexual reproduction is the random fertilization of a gamete from the female using a gamete from the male. In humans, over 8 million (223) chromosome combinations exist in the production of gametes in both the male and female. A sperm cell, with over 8 million chromosome combinations, fertilizes an egg cell, which also has over 8 million chromosome combinations. That is over 64 trillion unique combinations, not counting the unique combinations produced by crossing-over. In other words, each human couple could produce a child with over 64 trillion unique chromosome combinations.

### Questions

1. The genetic variation of offspring produced by sexual reproduction is almost limitless. List and describe the mechanisms responsible for this variation.
2. What is crossing over? When does it occur?
3. How do the products of crossing-over (the recombinant chromatids) differ from the parental chromosomes?
4. What is a tetrad? During what phase of the cell cycle are tetrads found?
5. In humans, there are over 8 million possible ways that chromosomes can line up during metaphase I of meiosis. The common dog (*Canis lupus familiaris*) has 78 chromosomes (Lindblad-Toh K et al. 2005. Genome sequence, comparative analysis and haplotype structure of the domestic dog., *Nature*, 438:803-819). Is the number of possible ways that chromosomes can line up during metaphase I greater or less in dogs compared to humans? Why?



**1.2 : Multiple Choice**

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

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

*Circle the letter of the correct choice.*

1. Cytokinesis occurs \_\_\_\_ from the start to finish of meiosis.
  - a. once
  - b. twice
  - c. four times
  - d. not at all
2. In meiosis, the sister chromatids separate from one another during
  - a. metaphase I.
  - b. metaphase II.
  - c. anaphase I.
  - d. anaphase II.
3. In preparation for meiosis, the DNA replicates \_\_\_\_.
  - a. once
  - b. twice
  - c. four times
  - d. not at all
4. Gametogenesis in males produces \_\_\_\_ gametes, and in females \_\_\_\_ gametes.
  - a. two, two
  - b. four, four
  - c. one, four
  - d. four, one
5. In a newly formed zygote, most of the organelles and cytoplasm originated from the
  - a. somatic cells of the father.
  - b. somatic cells of the mother.
  - c. egg.
  - d. sperm.
6. A life cycle in which the zygote is the only diploid cell is called a
  - a. diploid life cycle.
  - b. haploid life cycle.
  - c. alternation of generations life cycle.
  - d. monotypic life cycle.
7. Organisms that have an alternation of generations life cycle
  - a. have all females in one generation, and all males in the next.
  - b. have all males in one generation, and all females in the next.
  - c. alternate between mitosis and cytokinesis.
  - d. alternate between diploid and haploid phases.

## 1.2 : Vocabulary

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

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

*Match the vocabulary term with the correct definition.*

### Term

- \_\_\_ 1. Tetrads
- \_\_\_ 2. Gametes
- \_\_\_ 3. Spore
- \_\_\_ 4. budding
- \_\_\_ 5. gametophyte
- \_\_\_ 6. fertilization
- \_\_\_ 7. meiosis
- \_\_\_ 8. Fission
- \_\_\_ 9. polar body
- \_\_\_ 10. haploid

### Definition

- a. A type of cell division in diploid organisms that results in the production of four haploid cells.
- b. Results from the alignment of a pair of duplicated homologous chromosomes during prophase I.
- c. A cell that is produced during oogenesis and does not develop into a viable gamete, but degrades.
- d. A cell containing one set of chromosomes.
- e. An organism's reproductive cells.
- f. A form of asexual reproduction in which new cells are formed by cleavage of the parental cell in half.
- g. A haploid reproductive cell that can develop into an adult without fusing with another haploid cell.
- h. A type of asexual reproduction in which daughter cell buds off from a parent cell.
- i. The fusion of two gametes to form a zygote.
- j. An organism that produces gametes by mitosis.

## 2 : Medelian Genetics Worksheets

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

### 2.1 : Mendel's Investigations

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

#### True or False

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. The "father of modern genetics" is Gregor Mendel.
- \_\_\_\_\_ 2. The passing of characteristics from parent to offspring is called heredity.
- \_\_\_\_\_ 3. A dihybrid cross tracks the inheritance of one characteristic from parent to offspring.
- \_\_\_\_\_ 4. Fertilization in which pollen from one flower pollinates a flower on a different plant is called self-pollination.
- \_\_\_\_\_ 5. Offspring of the P generation are referred to as F2 offspring.
- \_\_\_\_\_ 6. In Mendel's experiments, a true-breeding purple plant and a true-breeding white plant always produced purple offspring.
- \_\_\_\_\_ 7. A variation of a gene is called an allele.
- \_\_\_\_\_ 8. The allele that is expressed is called the recessive allele.
- \_\_\_\_\_ 9. Genes that are likely to be inherited together because they are located close together on the same chromosome are called linked genes.
- \_\_\_\_\_ 10. Albinism is a recessively inherited disorder in which the body does not produce enough of the pigment melanin.
- \_\_\_\_\_ 11. In genetics problems, capital letters refer to recessive alleles, while lowercase letters refer to dominant alleles.
- \_\_\_\_\_ 12. An organism that has an identical pair of alleles for a trait is called heterozygous.
- \_\_\_\_\_ 13. The genotype of an organism determines its phenotype.
- \_\_\_\_\_ 14. The Law of Independent Assortment states that a pair of alleles is separated, or segregated, during the formation of gametes.
- \_\_\_\_\_ 15. Genetics is the branch of biology that focuses on heredity in organisms.

## 2.1 : Critical Reading

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

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

*Read this passage from the lesson and answer the questions that follow.*

### **Dominant and Recessive Alleles**

Mendel used letters to represent dominant and recessive factors. Likewise, geneticists now use letters to represent alleles. Capital letters refer to dominant alleles, and lowercase letters refer to recessive alleles. For example, the dominant allele for the trait of green pod color is indicated by G. The recessive trait of yellow pod color is indicated by g. A true-breeding plant for green pod color would have identical alleles GG in all its somatic cells. Likewise, a true-breeding plant for yellow pod color would have identical alleles gg in all of its somatic cells. During gamet formation, each gamete receives one copy of an allele. When fertilization occurs between these plants, the offspring receives two copies of the allele, one from each parent. In this case, all of the offspring would have two different alleles, Gg, one from each of its parents.

An organism that has an identical pair of alleles for a trait is called homozygous. The true-breeding parents GG and gg are homozygous for the pod color gene. Organisms that have two different alleles for a gene are called heterozygous. The offspring of the cross between the GG and gg plants are all heterozygous for the pod color gene. Due to dominance and recessiveness of alleles, an organism's traits do not always reveal its genetics. Therefore, geneticists distinguish between an organism's genetic makeup, called its genotype, and its physical traits, called its phenotype. For example, the GG parent and the Gg offspring have the same phenotype (green pods) but different genotypes.

### **Questions**

1. Capital letters and lowercase letters are used to identify what particular alleles?
2. What defines a true-breeding plant?
3. Contrast the terms homozygous and heterozygous.
4. Why does an organism's genotype determine its phenotype?
5. What would be the phenotype for pod color of a pea plant with the genotype GG? Gg? gg? Why?-

## 2.1 : Multiple Choice

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

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

*Circle the letter of the correct choice.*

1. Who is known as the "father of modern genetics"?
  - a. Charles Darwin
  - b. Gregor Mendel
  - c. Robert Hooke
  - d. Carolus Linnaeus
2. The process of transferring pollen from the male part of the flower to the female part of another flower is called
  - a. artificial fertilization.
  - b. artificial selection.
  - c. artificial mating.
  - d. artificial mechanism.
3. According to the blending inheritance hypothesis that was popular in the 19th century, what would happen if a tall plant was mixed with a short plant?
  - a. All the offspring would be tall.
  - b. All the offspring would be short.
  - c. All the offspring would be medium height.
  - d. The offspring would be 50% tall and 50% short.
4. Due to the Law of Segregation, how many alleles are inherited from each parent?
  - a. 1
  - b. 2
  - c. 4
  - d. 5
5. An organism that has an identical pair of alleles for a trait is called
  - a. homozygous.
  - b. heterozygous.
  - c. monozygous.
  - d. dizygous.
6. The allele that is expressed when two separate alleles are inherited is referred to as
  - a. recessive.
  - b. dominant.
  - c. homozygous.
  - d. heterozygous.
7. Linked genes are genes that are located close together on a chromosome and
  - a. are unlikely to be inherited together.
  - b. are likely to be inherited together.
  - c. are never inherited together.
  - d. are always inherited together.

## 2.1 : Vocabulary

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

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

*Match the vocabulary term with the correct definition.*

### Term

- \_\_\_ 1. allele
- \_\_\_ 2. genotype
- \_\_\_ 3. phenotype
- \_\_\_ 4. hybridization
- \_\_\_ 5. linked genes
- \_\_\_ 6. heterozygous
- \_\_\_ 7. homozygous
- \_\_\_ 8. heredity
- \_\_\_ 9. dominant allele
- \_\_\_ 10. recessive allele

### Definition

- a. A cross between two individuals that have different traits.
- b. Organisms that have two different alleles for a gene.
- c. Different versions of a gene.
- d. Genes that are close together on a chromosome and are packaged into the gametes together.
- e. The passing of characteristics from parent to offspring.
- f. The allele that is expressed only in the absence of a dominant allele.
- g. An organism's genetic makeup.
- h. An organism that has an identical pair of alleles for a trait.
- i. The allele that is expressed when two separate alleles are inherited.
- j. An organism's physical traits.

## 2.2 : Mendelian Inheritance

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

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

### True or False

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Probability is the likelihood that a certain event will occur.
- \_\_\_\_\_ 2. Results predicted by probability are most accurate when few trials are performed.
- \_\_\_\_\_ 3. A heterozygote (Bb) has a 50% chance of donating the recessive allele (b) into its gametes.
- \_\_\_\_\_ 4. A test cross is a chart which shows the inheritance of a trait over several generations.
- \_\_\_\_\_ 5. A dihybrid cross tracks the inheritance of two characteristics at the same time.
- \_\_\_\_\_ 6. The genotypic ratio of offspring resulting from a dihybrid cross of two heterozygous individuals is 9:3:3:1.
- \_\_\_\_\_ 7. Pedigrees are useful in tracking the inheritance patterns of genetic disorders.
- \_\_\_\_\_ 8. A human male's sex chromosomes are XX.
- \_\_\_\_\_ 9. Traits that are located on a sex chromosome are called sex-linked traits.
- \_\_\_\_\_ 10. Most sex-linked disorders are dominant and found on the Y chromosome.
- \_\_\_\_\_ 11. It is possible for males to be heterozygous for a sex-linked disorder.
- \_\_\_\_\_ 12. A female who possesses one copy of a sex-linked disorder, but does not express that disorder is referred to as a carrier of that disorder.
- \_\_\_\_\_ 13. If a trait is recessive, a person with the trait may have one, both, or neither parent with the trait.
- \_\_\_\_\_ 14. Environmental factors never influence an organism's phenotype.
- \_\_\_\_\_ 15. Human height can be influenced by environmental factors in addition to genes.

## 2.2 : Critical Reading

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

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

Read this passage from the lesson and answer the questions that follow.

### Complex Forms of Heredity

When three or more alleles determine a trait, the trait is said to have **multiple alleles**. The human ABO blood group is controlled by a single gene with three alleles:  $i$ ,  $I^A$ ,  $I^B$ , and the recessive  $i$  allele. The gene encodes an enzyme that affects carbohydrates that are found on the surface of the red blood cell. A and B refer to two carbohydrates found on the surface of red blood cells. There is not an O carbohydrate. Type O red blood cells do not have either type A or B carbohydrates on their surface.

The alleles  $I^A$  and  $I^B$  are dominant over  $i$ . A person who is homozygous recessive  $ii$  has type O blood. Homozygous dominant  $I^A I^A$  or heterozygous dominant  $I^A i$  have type A blood, and homozygous dominant  $I^B I^B$  or heterozygous dominant  $I^B i$  have type B blood.  $I^A I^B$  people have type AB blood, because the A and B alleles are codominant. Type A and type B parents can have a type AB child. Type A and a type B parent can also have a child with Type O blood, if they are both heterozygous ( $I^B i$ ,  $I^A i$ ).

### Questions

1. How does increasing the number of alleles for a particular trait affect the amount of phenotypic variation possible?
2. What are the three alleles found in the gene that codes for human blood type?
3. What are the relationships found between the three alleles? Which ones are dominant? Which ones are recessive?
4. Use the information found in the passage to complete the following table:

| Genotype  | Phenotype |
|-----------|-----------|
| $I^A I^A$ | ?         |
| ?         | Type A    |
| ?         | Type B    |
| $I^B i$   | ?         |
| $I^A I^B$ | ?         |
| ?         | Type O    |

5. Would it be possible for a man with type A blood and a woman with type B blood to produce a child with type O blood? Explain.



## 2.2 : Multiple Choice

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

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

*Circle the letter of the correct choice.*

1. If you toss a coin 10 times and get 7 heads and 3 tails, what is the probability that the next toss will result in a heads?
  - a. 50%
  - b. 30%
  - c. 70%
  - d. 100%
2. What are the possible parental genotypes of an individual who is homozygous recessive?
  - a. homozygous dominant
  - b. homozygous recessive
  - c. heterozygous
  - d. both b and c
3. In pea plants, the dominant allele (P) codes for purple flowers and the recessive allele (p) codes for white flowers. What is the probability that a cross between a homozygous dominant (PP) plant and a heterozygous plant (Pp) will result in offspring that have purple flowers?
  - a. 100%
  - b. 75%
  - c. 25%
  - d. 0%
4. What is the probability that a cross between a homozygous dominant (PP) plant and a homozygous recessive (pp) plant will result in offspring that have white flowers?
  - a. 100%
  - b. 0%
  - c. 75%
  - d. 25%
5. A pedigree can be used to determine whether
  - a. a trait is sex-linked or autosomal.
  - b. a trait is caused by a dominant or recessive allele.
  - c. a person is heterozygous or homozygous for a particular trait.
  - d. All of the above.
6. In certain plants called snapdragons, the heterozygous phenotype is a blend of the two homozygous phenotypes. Homozygous dominant plants are red, heterozygous plants are pink, and homozygous recessive plants are white. What type of inheritance pattern is this?
  - a. complete dominance
  - b. codominance
  - c. incomplete dominance
  - d. none of the above
7. The A and B alleles in human blood type follow what type of inheritance pattern?
  - a. complete dominance
  - b. codominance
  - c. incomplete dominance
  - d. none of the above

## 2.2 : Vocabulary

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

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

*Match the vocabulary term with the correct definition.*

### Term

- \_\_\_\_ 1. autosome
- \_\_\_\_ 2. pedigree
- \_\_\_\_ 3. polygenic traits
- \_\_\_\_ 4. carrier
- \_\_\_\_ 5. sex-linked trait
- \_\_\_\_ 6. sex chromosome
- \_\_\_\_ 7. testcross
- \_\_\_\_ 8. codominance
- \_\_\_\_ 9. Punnett square
- \_\_\_\_ 10. incomplete dominance

### Definition

- a. Traits that are affected by more than one gene.
- b. A chromosome that determines the sex of an organism.
- c. A cross used to determine an unknown genotype.
- d. A person who is heterozygous for a recessive allele of a trait.
- e. Any chromosome other than a sex chromosome.
- f. Occurs when the phenotype of the offspring is somewhere in between the phenotypes of both parents.
- g. A diagram that helps predict the probable inheritance of alleles in different crosses.
- h. A chart which shows the inheritance of a trait over several generations.
- i. Occurs when both traits appear in a heterozygous individual.
- j. A trait whose allele is found on a sex chromosome.

### 3 : Human Genetics Worksheets

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

#### 3.1 : Human Genes and Chromosomes

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

##### True or False

*Write true if the statement is true and false if the statement is false.*

- \_\_\_\_\_ 1. A genetic disease is caused by a mutation in a gene or chromosome.
- \_\_\_\_\_ 2. The human genome consists only of genes that code for proteins.
- \_\_\_\_\_ 3. All organisms have the same number of chromosomes.
- \_\_\_\_\_ 4. A normal human gamete has 23 pairs of chromosomes.
- \_\_\_\_\_ 5. Chromosomes are composed of both nucleic acids and proteins.
- \_\_\_\_\_ 6. Gene expression is controlled by regulatory sequences on chromosomes.
- \_\_\_\_\_ 7. Linkage refers to whether a gene is dominant or recessive.
- \_\_\_\_\_ 8. Loci on the same chromosome always assort independently during meiosis.
- \_\_\_\_\_ 9. The DNA base sequence CACACACA is a dinucleotide repeat sequence.
- \_\_\_\_\_ 10. Females are heterozygous for the X chromosome.
- \_\_\_\_\_ 11. All sex-linked genes control traits that determine an individual's sex.
- \_\_\_\_\_ 12. The process of X-inactivation results in the formation of male gametes.

### 3.1 : Critical Reading

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

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

*Read this passage from the lesson and answer the questions that follow.*

#### The Human Genome

What makes each one of us unique? You could argue that the environment plays a role, and it does to some extent. But most would agree that your parents have something to do with your uniqueness. In fact, it is our genes that make each one of us unique—or at least genetically unique. We all have the genes that make us human: the genes for skin and bones, eyes and ears, fingers and toes, and so on. However, we all have different skin colors, different bone sizes, different eye colors, and different ear shapes. In fact, even though we have the same genes, the products of these genes work a little differently in most of us. And that is what makes us unique. The human **genome** consists of all the DNA of *Homo sapiens*. Humans have about 3 billion bases of information, divided into roughly 20,000 genes, which are spread among non-coding sequences. Our genes are distributed on 24 distinct chromosomes. The human genome includes all of the hereditary information encoded in the DNA, not just genes but non-coding sequences as well. It consists of protein-coding exons, noncoding introns, and regulatory sequences. It also contains genes that code for RNA molecules, as well as “junk” DNA, which are regions of DNA for which no function has yet been identified. Our knowledge of the human genome has been advanced greatly by the Human Genome Project. This project is a huge collaborative effort that has sequenced all human genes and produced a reference sequence of the entire human genome.

#### Chromosomes and Genes

The human genome consists of 24 distinct chromosomes: 22 autosomes plus the sex chromosomes, X and Y. A **chromosome** is a threadlike molecule of genes, other DNA, and proteins. Chromosomes are located in the nucleus of cells. Different organisms have different numbers of chromosomes. Human somatic cells have 23 chromosome pairs for a total of 46 chromosomes: two copies of the 22 autosomes (one from each parent), plus an X chromosome from the mother and either an X or a Y chromosome from the father. There are an estimated 20,000 human protein-coding genes, but humans are known to have many more than 20,000 proteins. Most human genes have multiple exons separated by much larger introns. Regulatory sequences controlling gene expression are associated with exons. The introns are usually excised (removed) during post-transcriptional modification of the mRNA. Human cells make significant use of alternative splicing to produce a number of different proteins from a single gene. So even though the human genome is surprisingly similar in size to the genomes of simpler organisms, the human proteome is thought to be much larger. A **proteome** is the complete set of proteins expressed by a genome.

#### Questions

1. How do our genes makes us unique?
2. Describe the human genome.
3. How has the Human Genome Project contributed to knowledge of the human genome?
4. Compare and contrast exons, introns, and regulatory sequences of chromosomes.
5. How is the human proteome related to the human genome?

### 3.1 : Multiple Choice

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

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

*Circle the letter of the correct choice.*

1. What is the function of exons?

- A. They regulate genes.
- B. They replicate genes.
- C. They code for proteins.
- D. Their function is not yet known.

2. How many pairs of autosomes are found in a normal human somatic cell?

- A. 22
- B. 23
- C. 24
- D. 46

3. Which sentence is true about introns in human genes?

- A. They code for RNA molecules.
- B. They are generally much smaller than exons.
- C. They are usually removed from mRNA after transcription.
- D. They splice together different proteins from a single gene.

4. Which two alleles are most likely to appear in the same human gamete?

- A. an allele on the X chromosome and an allele on the Y chromosome
- B. an allele for a gene on one chromosomes of a pair and the allele for the same gene on the other chromosome of the pair
- C. an allele on the X chromosome and an allele on chromosome 23
- D. two alleles on the same X chromosome

5. Which of the following is an example of an SNP?

- A. GGATAA to CCTATT
- B. GGATAA to GGATAG
- C. GGATAA to GGCTCC
- D. GGATAA to AATAGG

6. Repetitive DNA sequences

- A. are highly variable from person to person.
- B. are identical in all human beings.
- C. always code for the most important proteins.
- D. cannot be used for DNA testing.

7. A Barr body is a(n)

- A. type of repeat polymorphism.
- B. inactivated X chromosome.
- C. X-linked or Y-linked gene.
- D. gene that causes a genetic disorder.

### 3.1 : Vocabulary

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

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

*Match the vocabulary term with the correct definition.*

#### Term

- \_\_\_\_ 1. autosome
- \_\_\_\_ 2. chromosome
- \_\_\_\_ 3. genome
- \_\_\_\_ 4. karyotype
- \_\_\_\_ 5. linkage
- \_\_\_\_ 6. sex chromosome
- \_\_\_\_ 7. repetitive sequence
- \_\_\_\_ 8. SNP
- \_\_\_\_ 9. SRY
- \_\_\_\_ 10. X-inactivation

#### Definition

- a. X or Y chromosome in humans
- b. all the hereditary information encoded in DNA
- c. DNA sequence that repeats a number of times
- d. any chromosome that is not a sex chromosome
- e. variation in an individual nucleotide base
- f. sex-determining region of the Y chromosome
- g. relationship between genes located close together on the same chromosome
- h. random inactivation of one X chromosome in each cell of a female
- i. photograph of the chromosomal complement of an individual
- j. threadlike molecule that contains DNA wound around proteins

### 3.2 : Human Inheritance

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

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

#### True or False

*Write true if the statement is true and false if the statement is false.*

- \_\_\_\_\_ 1. All sex-linked traits are controlled by genes on the X chromosome.
- \_\_\_\_\_ 2. Only dominant traits are passed from parents to their children.
- \_\_\_\_\_ 3. A healthy heterozygote for a defective recessive allele is called a carrier.
- \_\_\_\_\_ 4. You need only one dominant allele for a dominant trait to be expressed.
- \_\_\_\_\_ 5. A man passes all of his X-linked genes to all of his daughters.
- \_\_\_\_\_ 6. Only one mutation for Tay-Sachs disease has ever been identified.
- \_\_\_\_\_ 7. People with achondroplasia have severely shortened bones.
- \_\_\_\_\_ 8. Carriers of X-linked recessive disorders are always male.
- \_\_\_\_\_ 9. A person with the ABO genotype AB has type A blood.
- \_\_\_\_\_ 10. The allele that causes sickle-cell disease is pleiotropic.
- \_\_\_\_\_ 11. The most common trisomy in humans is trisomy X.
- \_\_\_\_\_ 12. Gene therapy techniques include selective reverse mutation.

## 3.2 : Critical Reading

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

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

*Read this passage from the lesson and answer the questions that follow.*

### Complex Traits

So far we have discussed traits inherited in a simple Mendelian pattern. Either the trait is dominant or recessive. The trait is affected by only one gene. But this is not the case for many genes; rarely is inheritance that simple. More complex patterns of inheritance are common. Mendel's pea plants showed complete dominance of one allele over the other. The offspring always looked like one of the parents—there was never any phenotype "in between" the two parents. The heterozygous individuals were indistinguishable from the homozygous dominant individuals. Is it possible for both alleles to be dominant, or neither to be completely dominant? The answer to both of these questions is yes.

### Codominance

**Codominance** occurs when two alleles are both expressed in the heterozygous individual; that is, both alleles affect the phenotype in separate and distinguishable ways. The A and B alleles of the ABO blood group system are a classic example. The A and B alleles are codominant with each other. When a person has both an A allele and a B allele, the person has type AB blood. When two people with type AB blood have children, the children can be type A, type AB, or type B. There is a 1A:2AB:1B expected phenotype ratio instead of the 3:1 phenotype ratio expected when one allele is dominant and the other is recessive.

### Incomplete Dominance

**Incomplete dominance** is seen in heterozygous individuals with an intermediate phenotype. For example, if Mendel had ever observed a medium stem length plant when a tall and short plant were crossed, that would have suggested incomplete dominance. In incomplete dominant situations, the phenotype expression is dependent on the dosage of the genes. Two copies of the gene result in full expression, while only one copy produces partial expression and an intermediate phenotype.

### Questions

1. What does codominance refer to?
2. Describe an example of codominance in humans.
3. For a gene with two codominant alleles, how many possible phenotypes are there? Explain your answer.
4. What is incomplete dominance?
5. When an allele has incomplete dominance, how does the heterozygous phenotype compare to the dominant and recessive homozygous phenotypes?



### 3.2 : Multiple Choice

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

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

*Circle the letter of the correct choice.*

- Two normal parents could have a child with an inherited disease if the disease is
  - fatal.
  - recessive.
  - uncommon.
  - dominant.
- Which of the following is an autosomal dominant genetic disorder?
  - Huntington's disease
  - cystic fibrosis
  - Tay-Sachs disease
  - hemophilia A
- A man with a certain genetic trait has several sons and daughters, but none of them has the trait. However, some of the daughters' sons have the trait. This trait is most likely to be a(n)
  - autosomal dominant trait.
  - Y-linked recessive trait.
  - X-linked dominant trait.
  - X-linked recessive trait.
- Duchenne muscular dystrophy is a genetic disease controlled by a gene on
  - the X chromosome.
  - the Y chromosome.
  - an autosome.
  - chromosome 21.
- A human gene that produces a collagen protein is known to affect not only the skeletal system but also the eyes and ears. This is an example of
  - epistasis.
  - hypostasis.
  - pleiotropy.
  - codominance.
- Which genetic disorder is a sex chromosome trisomy?
  - trisomy 21
  - Klinefelter's syndrome
  - Down syndrome
  - Turner syndrome
- What is the most common method of gene therapy?
  - replacing a mutant allele with a normal allele
  - creating a vaccine against a viral vector
  - using ultrasonography to correct abnormalities
  - injecting patients with normal placental tissue

### 3.2 : Vocabulary

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

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

*Match the vocabulary term with the correct definition.*

#### **Term**

- \_\_\_\_ 1. pedigree
- \_\_\_\_ 2. mutation
- \_\_\_\_ 3. achondroplasia
- \_\_\_\_ 4. multiple allele trait
- \_\_\_\_ 5. pleiotropy
- \_\_\_\_ 6. epistasis
- \_\_\_\_ 7. polygenic trait
- \_\_\_\_ 8. nondisjunction
- \_\_\_\_ 9. trisomy
- \_\_\_\_ 10. amniocentesis

#### **Definition**

- a. procedure to test fetal DNA for genetic abnormalities
- b. change in the nucleotide sequence of DNA or RNA
- c. situation in which a gene at one locus alters the phenotypic expression of a gene at another locus
- d. autosomal dominant disorder characterized by dwarfism
- e. trait for which there are more than two possible alleles
- f. chart that represents genetic inheritance in a family
- g. situation in which a gene has multiple phenotypic effects
- h. trait that is controlled by more than one gene and usually influenced by the environment
- i. situation in which an extra chromosome is present in a person's cells
- j. failure of replicated chromosomes to separate properly during meiosis

#### 4 : Evolutionary Theory Worksheets

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

#### 4.1 : Darwin and The Theory of Evolution

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

##### True or False

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Darwin is the only scientist responsible for our understanding of how evolution works.
- \_\_\_\_\_ 2. Traits that an individual acquires during their lifetime can be passed on to their offspring.
- \_\_\_\_\_ 3. Darwin studied to become a doctor and then a clergyman before becoming a "gentleman scientist."
- \_\_\_\_\_ 4. Natural selection selects favorable characteristics that best suit the future environment.
- \_\_\_\_\_ 5. Natural selection that is guided by humans is called artificial selection.
- \_\_\_\_\_ 6. Variation must be heritable for natural selection to operate.
- \_\_\_\_\_ 7. Prior to Darwin and the development of evolutionary theory, most people believed the earth to be very old.
- \_\_\_\_\_ 8. *All life is related through a common ancestor* is one of Darwin's two major evolutionary ideas.
- \_\_\_\_\_ 9. An adaptation is a characteristic that helps an organism survive in its environment.
- \_\_\_\_\_ 10. Cloning is a good way to guarantee the survival of a species.
- \_\_\_\_\_ 11. John Baptiste Lamarck provided nothing useful to our understanding of evolution.
- \_\_\_\_\_ 12. Darwin's idea that individuals in a population compete for resources came from reading a book by Thomas Malthus.
- \_\_\_\_\_ 13. Darwin regretted using the term natural selection to describe his theory and wished he had called it "natural preservation" instead.
- \_\_\_\_\_ 14. Mutations occur when an organism needs change in order to survive.
- \_\_\_\_\_ 15. Species produce more offspring than can survive in the environment.

## 4.1 : Critical Reading

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

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

*Read this passage from the lesson and answer the questions that follow.*

### **Darwin's Theory of Evolution**

Darwin delighted in the great diversity of life, but also saw unity within that diversity. He saw striking patterns in the similarities and differences. Seeking an explanation for those patterns, he developed the concept of natural selection. Natural selection explains how today's organisms could be related – through "descent with modification" from common ancestors. Natural selection explains the story told by the fossil record – the long history of life on Earth. Natural selection is a scientific answer (if only partial) to the old questions: Who are we? How did we come to be?

In the light of natural selection, it is easy to see that variation – differences among individuals within a population – increases the chance that at least some individuals will survive if the environment changes. Here is a strong argument against cloning humans: if we were all genetically identical – if variation (or genetic variation) did not exist – a virus which previously could kill just some of us would either kill all of us, or none of us. Throughout the long history of life, variation has provided insurance that inevitable changes in the environment will not mean the extinction of a species. Similarly, the diversity of species ensures that environmental change will not mean the extinction of life. Life has evolved (or, the Earth's changing environment has selected) variation and diversity because they ensure survival.

### **Questions**

1. "Darwin delighted in the great diversity of life, but also saw unity within that diversity." Using any two organisms of your choosing, identify how they are unified and how they are diverse. What similarities do they have in common? Differences? How can these similarities and differences be explained by the theory of evolution?
2. In your own words, explain the meaning of the phrase, "descent with modification."
3. Why is variation so important to the continuation of life on earth?
4. Explain in your own words why a virus could cause the extinction of a population if that population's members were all identical to each other?
5. Why can natural selection only be a "partial" answer to the questions: Who are we? How did we come to be? What questions can science not answer about life?

#### 4.1 : Multiple Choice

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

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

*Circle the letter of the correct choice.*

1. A scientist who studies fossils to explore the history of life is called a
  - a. geologist.
  - b. botanist.
  - c. archeologist.
  - d. paleontologist.
2. Charles Darwin lived during the
  - a. 20<sup>th</sup> century.
  - b. 19<sup>th</sup> century.
  - c. 18<sup>th</sup> century.
  - d. 17<sup>th</sup> century.
3. What type of fossil remains did Darwin discover in Argentina that turned out to be one of the largest land mammals that have ever lived?
  - a. Galapagos tortoise
  - b. Ground sloth
  - c. Giraffe
  - d. Elephant
4. What is the process by which a certain trait becomes more common within a population?
  - a. Inheritance of Acquired Characteristics
  - b. Natural selection
  - c. Struggle for existence
  - d. Overproducing of offspring
5. Who developed a theory of evolution similar to Darwin's?
  - a. Alfred Russel Wallace
  - b. Charles Lyell
  - c. John Baptiste Lamarck
  - d. Thomas Malthus
6. An explanation which ties together or unifies a large group of observations is called a
  - a. hypothesis.
  - b. law.
  - c. theory.
  - d. trait.
7. A population of worms comes in two varieties: black worms and pink worms. A predator moves into the area that likes to eat only pink worms. What will happen to the worm population over time?
  - a. The population will eventually consist of more black worms than pink worms.
  - b. The population will eventually consist of more pink worms than black worms.
  - c. The predator will eat all the worms causing the worm population to go extinct.
  - d. The population will not change.

## 4.1 : Vocabulary

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

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

*Match the vocabulary term with the correct definition.*

### Term

- \_\_\_\_ 1. Natural Selection
- \_\_\_\_ 2. Charles Darwin
- \_\_\_\_ 3. John Steven Henslow
- \_\_\_\_ 4. John Baptiste Lamarck
- \_\_\_\_ 5. Theory
- \_\_\_\_ 6. Law
- \_\_\_\_ 7. Charles Lyell
- \_\_\_\_ 8. Artificial Selection
- \_\_\_\_ 9. Thomas Malthus
- \_\_\_\_ 10. Alfred Russell Wallace

### Definition

- a. The process by which a certain trait becomes more common within a population, including heritable variation, overproduction of offspring, and differential survival and reproduction.
- b. Concluded that the earth was very old and that many small changes over long periods of time led to present-day landscapes.
- c. A statement which reliably describes a certain set of observations in nature; usually testable.
- d. An explanation which ties together or unifies a large group of observations.
- e. Described competition among humans as a result of overpopulation and too little food which lead to the realization that all animals must compete to survive.
- f. Origin of Species author
- g. Darwin's mentor
- h. Animal or plant breeding where humans determine which individuals will reproduce.
- i. Developed independently the same theory of evolution as Darwin
- j. Although incorrect, his concept of inheritance of acquired characteristics provided more interest to the idea that life had evolved

## 4.2 : Evidence for Evolution

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

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

### True or False

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Goosebumps are a type of vestigial structure found in humans.
- \_\_\_\_\_ 2. Analogous structures are structures which evolved from the same structure within a common ancestor.
- \_\_\_\_\_ 3. Plate tectonics explains the distant locations of closely related species as the result of continental drifting.
- \_\_\_\_\_ 4. The fossil record for horses shows gradual changes which correspond to changes in the environment.
- \_\_\_\_\_ 5. Evolution is like a progressing ladder, where species become more and more perfect as time goes on.
- \_\_\_\_\_ 6. Species that are related to each other by a recent common ancestor are located near each other on a cladogram.
- \_\_\_\_\_ 7. The number of differences in DNA bases between any two species measures the time elapsed since two organisms shared a common ancestor.
- \_\_\_\_\_ 8. Human DNA sequences are 50-55% the same as those of chimpanzees.
- \_\_\_\_\_ 9. Comparative embryology reveals homologies which form during adulthood.
- \_\_\_\_\_ 10. The wing of a bat and the wing of a bird are considered to be analogous structures.
- \_\_\_\_\_ 11. The fossil record for horse evolution has large gaps where huge amounts of information are missing.
- \_\_\_\_\_ 12. Fossils are easily formed and maintained over time.
- \_\_\_\_\_ 13. A fossil can be dated by looking at the relative position of the fossil in the rock layer in which it was found.
- \_\_\_\_\_ 14. The study of fossils to explore the history of life is called paleontology.
- \_\_\_\_\_ 15. A theory is a proposed, testable answer to a question or explanation of an observation.

## 4.2 : Critical Reading

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

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

*Read this passage from the lesson and answer the questions that follow.*

### **Molecular Biology**

Did you know that your genes are 50% the same as those of a banana? Unknown in Darwin's time, the "comparative anatomy" of the molecules which make up life has added an even more convincing set of homologies to the evidence for evolution. All living organisms have genes made of DNA. The order of nucleotides –As, Ts, Cs, and Gs - in each gene codes for a protein, which does the work or builds the structures of life. Proteins govern the traits chosen (or not) in natural selection. For all organisms, a single Genetic Code translates the sequence of nucleotides in a gene into a corresponding chain of 20 amino acids. By itself, the universality of DNA genes and their code for proteins is strong evidence for common ancestry. Yet there is more.

If we compare the sequence of nucleotides in the DNA of one organism to the sequence in another, we see remarkable similarities. For example, human DNA sequences are 98-99% the same as those of chimpanzees, and 50% the same as a banana's! These similarities reflect similar metabolism. All organisms have genes for DNA replication, protein synthesis, and processes such as cellular respiration. Although metabolic processes do not leave fossils, similar DNA sequences among existing organisms provides excellent evidence for common ancestry.

### **Questions**

1. What things are made up of DNA?
2. What four substances make up DNA and what do these substances do?
3. What do you think is meant by the phrase, "the universality of DNA genes and their code for proteins is strong evidence for common ancestry"?
4. What does the amount of similarity in two species' DNA indicate?
5. What type of genes make up the 50% that you share with bananas?



## 4.2 : Multiple Choice

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

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

*Circle the letter of the correct choice.*

1. Structures that evolved independently in two different species are referred to as
  - a. homologous.
  - b. vestigial.
  - c. analogous.
  - d. comparative.
2. The study of the development of vertebrate animals before birth or hatching is called
  - a. anatomy.
  - b. embryology.
  - c. homology.
  - d. biogeography.
3. What two structures appear in the early development of all vertebrate embryos?
  - a. fur and nails
  - b. feathers and lungs
  - c. fingers and toes
  - d. gill slits and a tail
4. Which of the following types of evidence for evolution did Darwin not know about?
  - a. Molecular data
  - b. Biogeography
  - c. Comparative anatomy
  - d. Fossils
5. A cladogram is a tree-like diagram used to show
  - a. the position of fossils found in different rock layers.
  - b. analogous structures found in different organisms.
  - c. how life may evolve in the future.
  - d. evolutionary relationships among organisms.
6. The process where a single ancestor rapidly evolves into a large number of different species is known as
  - a. homology.
  - b. adaptive radiation.
  - c. island biogeography.
  - d. adaptation.
7. The study of the distribution of plants and animals and the processes that influence their distribution is called
  - a. biogeography.
  - b. comparative anatomy.
  - c. comparative embryology.
  - d. molecular data.

## 4.2 : Vocabulary

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

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

*Match the vocabulary term with the correct definition.*

### Term

- \_\_\_\_ 1. cladogram
- \_\_\_\_ 2. homologous structures
- \_\_\_\_ 3. embryology
- \_\_\_\_ 4. biogeography
- \_\_\_\_ 5. vestigial structures
- \_\_\_\_ 6. analogous structures
- \_\_\_\_ 7. fossils
- \_\_\_\_ 8. comparative anatomy
- \_\_\_\_ 9. relative dating
- \_\_\_\_ 10. paleontology

### Definition

- a. The study of patterns of distribution of species on continents and islands.
- b. Similar structures with identical functions shared by distantly related species that are a result from natural selection in similar environments, but that evolved independently.
- c. The study of the similarities and differences in organisms' structures.
- d. Structures which evolved from the same structure within a common ancestor; may or may not serve the same function.
- e. The study of fossils to explore the history of life.
- f. A tree-like diagram showing evolutionary relationships according to a given set of data, such as molecular data.
- g. Structures which are reduced and perhaps even nonfunctional in one species but homologous to functional structures in a closely related species.
- h. A technique for aging fossils based on comparing their positions within rock layers; fossils in lower layers are usually older than fossils in upper layers.
- i. A branch of comparative anatomy which studies the development of vertebrate animals before birth or hatching.
- j. The mineralized remains of an animal, plant, or other organism.

### 4.3 : Evolution Continues Today

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

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

#### True or False

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Darwin used his observations of artificial selection, as he called it, to derive and promote his theory of evolution by natural selection.
- \_\_\_\_\_ 2. Transgenic animals are produced by interbreeding two different species.
- \_\_\_\_\_ 3. The first mammal to be cloned was a type of dog named Dolly.
- \_\_\_\_\_ 4. Cloning eliminates variation in a population.
- \_\_\_\_\_ 5. Most pest population evolve resistance to pesticides after a few short generations of exposure.
- \_\_\_\_\_ 6. XDR-Tuberculosis has not evolved resistance to antibiotics.
- \_\_\_\_\_ 7. Antibiotics should be taken to treat the common cold.
- \_\_\_\_\_ 8. You should always finish your bottle of antibiotics even after you begin to feel better.
- \_\_\_\_\_ 9. Sharing antibiotics is a good idea.
- \_\_\_\_\_ 10. A worldwide epidemic is called a pandemic.
- \_\_\_\_\_ 11. Peppered moth populations adapted to changes in their environment by migrating to a new location.
- \_\_\_\_\_ 12. Changes in beak size and body size in Darwin's Finches were determined by changes in weather.
- \_\_\_\_\_ 13. Avian flu is a type of influenza in which the main host is a type of bird.
- \_\_\_\_\_ 14. The biggest concern regarding the spread of viruses among the human population is that the virus will mutate and become more easily transmissible from human to human.
- \_\_\_\_\_ 15. Transgenic animals have provided no benefits to humans.

### 4.3 : Critical Reading

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

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

*Read this passage from the lesson and answer the questions that follow.*

#### **Evolution of Resistance**

The evolution of resistance is a growing problem for many disease-causing bacteria and also for parasites, viruses, fungi, and cancer cells. The “miracle” of drug treatment which appeared to protect humans from disease may be short-lived. How does resistance happen? How can we prevent it?

First, recognize that resistance describes the bacterium (or other microorganism) – not the human. Bacteria multiply much more rapidly than humans, and therefore can evolve much more rapidly. Consider a population of bacteria infecting an individual with tuberculosis. Like all populations, individuals within that population show variation. Mutations add more variation. By chance, mutation may change the chemistry of one or a few bacteria so that they are not affected by a particular antibiotic. If the infected human begins to take antibiotics, they change the environment for the bacteria, killing most of them. However, the few bacteria which by chance have genes for resistance will survive this change in environment - and reproduce offspring which also carry the genes. More and more of the bacterial population will be resistant to antibiotics, because the antibiotics select for resistance. The bacteria are merely evolving in response to changes in their habitats! If the resistant bacteria are transmitted to another human “habitat”, their population continues to expand, and if the new “habitat” takes different drugs, natural selection may result in multi-drug resistance.

#### **Questions**

1. Compare the rate of reproduction in humans to the rate of reproduction in bacteria.
2. How does the difference in rates of reproduction between humans and bacteria relate to the amount of time it takes each organism to evolve?
3. Are all individual bacterium in a population of bacteria the same?
4. What role does chance play in the development of antibiotic resistance?
5. Explain in your own words how a population of bacteria evolves resistance to an antibiotic over time.

### 4.3 : Multiple Choice

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

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

*Circle the letter of the correct choice.*

1. The mating of two different species to produce offspring is called
  - a. cloning.
  - b. hybridization.
  - c. artificial selection.
  - d. coevolution.
2. Which of the following outcome of genetic engineering provides NO direct benefits to humans?
  - a. invention of new medicines
  - b. transgenic animals
  - c. genetic pollution
  - d. improved agriculture
3. The development of resistance to antibiotics is a classic example of
  - a. genetic engineering.
  - b. natural selection.
  - c. cloning.
  - d. transgenic animals.
4. Why does cloning contradict the principles of natural selection?
  - a. It produces no variation.
  - b. It is too slow.
  - c. It is too fast.
  - d. It is another mechanism by which evolution can occur.
5. Epidemics that become wide-spread and impact large numbers of people world-wide are referred to as
  - a. pandemics.
  - b. genetic pollution.
  - c. global epidemics.
  - d. superbugs.
6. What is the virus which causes AIDS that is quickly becoming resistant to anti-viral medications?
  - a. Tuberculosis
  - b. Swine flu
  - c. Avian flu
  - d. HIV
7. The name of a virus that is transmissible from birds to humans is called
  - a. Tuberculosis.
  - b. Swine flu.
  - c. Avian flu.
  - d. HIV.

### 4.3 : Vocabulary

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

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

*Match the vocabulary term with the correct definition.*

#### Term

- \_\_\_ 1. cloning
- \_\_\_ 2. genetic engineering
- \_\_\_ 3. transgenic animal
- \_\_\_ 4. coevolution
- \_\_\_ 5. mutation
- \_\_\_ 6. geologic time
- \_\_\_ 7. genetic pollution
- \_\_\_ 8. genetically modified organism
- \_\_\_ 9. natural selection
- \_\_\_ 10. artificial selection

#### Definition

- a. An animal which possesses genes of another species.
- b. A change in the nucleotide sequence of DNA or RNA.
- c. The process of creating an identical copy of an organism
- d. The process by which a certain trait becomes more common within a population, including heritable variation, overproduction of offspring, and differential survival and reproduction.
- e. An organism whose genes have been altered by genetic engineering.
- f. The manipulation of an organism's genes, usually involving the insertion of a gene or genes from one organism into another.
- g. Time on the scale of the history of Earth, which spans 4.6 billion years.
- h. Animal or plant breeding that involves humans choosing which individuals will reproduce according to desirable traits.
- i. The natural hybridization or mixing of genes of a wild population with a domestic or feral population.
- j. A pattern in which species influence each other's evolution and therefore evolve in tandem.

## 5 : Evolution in Populations Worksheets

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

### 5.1 : Genetics of Populations

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

#### True or False

*Write true if the statement is true and false if the statement is false.*

- \_\_\_\_\_ 1. Darwin didn't know how traits are passed from parent to offspring.
- \_\_\_\_\_ 2. Albinism is caused by having two copies of a recessive gene.
- \_\_\_\_\_ 3. An individual who has identical copies of the same gene is referred to as heterozygous for that gene.
- \_\_\_\_\_ 4. Mutations in body cells do not affect the DNA in eggs and sperm.
- \_\_\_\_\_ 5. Sexual reproduction can create new alleles for a population.
- \_\_\_\_\_ 6. Individuals do not evolve.
- \_\_\_\_\_ 7. Genes code for proteins.
- \_\_\_\_\_ 8. Mutations never improve an organism's fitness.
- \_\_\_\_\_ 9. It is possible to determine an organism's genotype by its phenotype.
- \_\_\_\_\_ 10. The ability of an organism with a certain genotype to survive and reproduce is known as fitness.

## 5.1 : Critical Reading

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

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

*Read this passage from the lesson and answer the questions that follow.*

### Populations and Gene Pools

Individuals do not evolve. Natural selection may affect an individual's chance to survive and reproduce, but it cannot change the individual's genes. However, a **population** – a group of organisms of a single species in a certain area – evolves when natural selection imposes differential survival on individuals within it. **Population genetics** studies populations at the level of genes and alleles in order to discover how evolution works.

If we consider all the alleles of all the genes of all the individuals within a population, we have defined the **gene pool** for that population. Gene pools contain all the genetic variation – that raw material for natural selection – within a population. The gene pool for a rabbit population, for example, includes alleles which determine coat color, ear size, whisker length, tail shape, and more. If a population geneticist wants to focus on the variation in an individual gene, s/he may look at the gene pool of all the alleles for that gene alone.

### Questions

1. Why can't an individual evolve?
2. Name some populations of organisms that live in your neighborhood.
3. What does population genetics study?
4. What are some alleles present in the gene pool of a rabbit population?
5. What are some alleles present in the gene pool of a human population?



## 5.1 : Multiple Choice

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

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

*Circle the letter of the correct choice.*

1. Segments of DNA located on a particular place on a chromosome are called
  - a. proteins
  - b. alleles
  - c. genes
  - d. nitrogenous bases
2. How many copies of an individual gene do humans receive?
  - a. 1
  - b. 2
  - c. 4
  - d. It varies from person to person.
3. The mutation that causes sickle cell anemia is what type of mutation?
  - a. single-base substitution
  - b. neutral
  - c. chromosomal
  - d. non-heritable
4. Mutations can be
  - a. neutral
  - b. harmful
  - c. helpful
  - d. all of the above
5. If you saw a rabbit with brown fur color, what would you be able to determine about the rabbit?
  - a. Its phenotype for fur color.
  - b. Its genotype for fur color.
  - c. The number of offspring it will be able to produce.
  - d. The age of the rabbit.
6. The amount of a particular allele in a population is referred to as allele
  - a. abundance
  - b. frequency
  - c. popularity
  - d. potential
7. What is it called when a particular gene is transcribed and translated?
  - a. replication
  - b. coding
  - c. expression
  - d. sequencing

## 5.1 : Vocabulary

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

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

*Match the vocabulary term with the correct definition.*

### Term

- \_\_\_ 1. gene
- \_\_\_ 2. allele
- \_\_\_ 3. genotype
- \_\_\_ 4. phenotype
- \_\_\_ 5. heterozygous
- \_\_\_ 6. homozygous
- \_\_\_ 7. population
- \_\_\_ 8. gene pool
- \_\_\_ 9. allele frequency
- \_\_\_ 10. mutation

### Definition

- a. Describes a genotype or individual having two copies of the same allele for a gene.
- b. Within a population, the sum of all the alleles of all the genes of all the individuals.
- c. A group of organisms of a single species living within a certain area.
- d. The physical appearance of an organism determined by a particular genotype (and sometimes also by the environment).
- e. The genetic makeup of an organism; specifically, the two alleles present.
- f. A change in the nucleotide sequence of DNA or RNA.
- g. A segment of DNA which codes for a protein or RNA molecule; a unit of inheritance.
- h. An alternative form or different version of a gene.
- i. The fraction (usually expressed as a decimal) of a population's gene pool made up of a particular allele.
- j. Describes a genotype or individual having two different alleles for a gene.

## 5.2 : Genetic Change in Populations

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

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

### True or False

*Write true if the statement is true and false if the statement is false.*

- \_\_\_\_\_ 1. A population that is evolving is said to be in Hardy-Weinberg equilibrium.
- \_\_\_\_\_ 2. Large populations are more vulnerable to genetic drift than small populations.
- \_\_\_\_\_ 3. Genetic drift is a random process.
- \_\_\_\_\_ 4. Macroevolution can be measured as a generation-to-generation change in allele frequencies.
- \_\_\_\_\_ 5. Mutations must occur in all body cells in order for them to be passed on from parent to offspring.
- \_\_\_\_\_ 6. Skin color is a polygenic trait in humans.
- \_\_\_\_\_ 7. Natural selection acts on phenotypes, rather than genotypes.
- \_\_\_\_\_ 8. Neutral mutations hold potential for future selection if the environment changes.
- \_\_\_\_\_ 9. Stabilizing selection shifts the frequency curve away from the average by favoring individuals with an extreme form of the variation.
- \_\_\_\_\_ 10. Kin selection involves the sacrifice by an individual of his/her reproductive potential in order to help a close relative reproduce successfully.

## 5.2 : Critical Reading

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

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

*Read this passage from the lesson and answer the questions that follow.*

### Natural Selection

Another way to look at natural selection is in terms of fitness - the ability of an organism with a certain genotype to reproduce. Fitness can be measured as the proportion of that organism's genes in all of the next generation's genes. When differences in individual genotypes affect fitness; the genotypes with higher fitness become more common. This change in genotype frequencies is natural selection.

An intriguing corollary of genotype selection is kin selection. Behaviours which sacrifice reproductive success or even survival can actually increase fitness if they promote the survival and reproduction of close relatives who share a significant proportion of the same genes. Examples include subordinate male turkeys, who help their dominant brothers display to potential mates and honeybee workers, who spend their lives collecting pollen and raising young to ensure that their mother, the queen, reproduces successfully.

### Questions

1. What is fitness?
2. Organism A lives a long life and produces no offspring. Organism B lives a short life, but produces offspring. Which organism has the higher fitness?
3. How is fitness measured?
4. What do subordinate male turkeys do in order to increase their fitness?
5. Why does an organism benefit from helping its kin survive and reproduce?

## 5.2 : Multiple Choice

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

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

*Circle the letter of the correct choice.*

1. Large changes in a species (speciation) over geologic time would be considered
  - a. microevolution
  - b. macroevolution
  - c. Hardy-Weinberg model
  - d. genetic equilibrium
2. In the Hardy-Weinberg equation, what part of the equation refers to heterozygotes?
  - a.  $p^2$
  - b.  $2pq$
  - c.  $q^2$
  - d.  $p^2 + 2pq + q^2$
3. Which of the following conditions of the Hardy-Weinberg model were not met in the cystic fibrosis example given in the text?
  - a. no migration
  - b. random mating
  - c. no natural selection
  - d. all of the above
4. In order for a mutation to be passed from parent to offspring it must appear in
  - a. gametes
  - b. any of the parents' cells
  - c. all of the body cells
  - d. none of the above
5. All of the following are examples of events that could cause genetic drift EXCEPT:
  - a. earthquake
  - b. flood
  - c. fire
  - d. migration
6. What type of natural selection results in a shift of allele frequencies toward one extreme?
  - a. stabilizing selection
  - b. disruptive selection
  - c. directional selection
  - d. extreme selection
7. Why did early humans living in Africa have dark skin?
  - a. It protected them from the harmful effects of UV radiation.
  - b. It was caused by the type of food that was in their diet.
  - c. It was the result of genetic drift.
  - d. It was the result of gene flow.

## 5.2 : Vocabulary

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

*Match the vocabulary term with the correct definition.*

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

### Term

- \_\_\_ 1. Hardy-Weinberg model
- \_\_\_ 2. gene flow
- \_\_\_ 3. genetic drift
- \_\_\_ 4. fitness
- \_\_\_ 5. bottleneck effect
- \_\_\_ 6. founder effect
- \_\_\_ 7. adaptive radiation
- \_\_\_ 8. kin selection
- \_\_\_ 9. stabilizing selection
- \_\_\_ 10. disruptive selection

### Definition

- a. Behaviors which sacrifice reproductive success or even survival to promote the survival and reproduction of close relatives who share a significant proportion of the same genes.
- b. Describes a population at genetic equilibrium, meeting five conditions: no mutation, no migration, very large population size, random mating, and no natural selection.
- c. The loss of diversity resulting from a drastic reduction in population size and subsequent genetic drift.
- d. The ability of an organism with a certain genotype to survive and reproduce, often measured as the proportion of that organism's genes in all of the next generation's genes.
- e. The net movement of genes into or out of a population through immigration or emigration.
- f. Random changes in allele frequencies in small populations.
- g. Selection which favors the two extremes of a phenotypic distribution – the ends of a bell curve, or the homozygous phenotypes, as opposed to the average, or heterozygous phenotype.
- h. Relatively rapid evolution of several species from a single founder population to several to fill a diversity of available ecological niches.
- i. Selection which favors the average or heterozygous phenotype, resulting in no change or in a narrowing of the distribution of phenotypes.
- j. The loss of genetic diversity resulting from colonization of a new area by a small group of individuals which have broken off from a larger population.

### 5.3 : The Origin of Species

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

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

#### True or False

*Write true if the statement is true and false if the statement is false.*

- \_\_\_\_\_ 1. The Morphological Species Concept groups organisms based on their structural and biochemical similarities.
- \_\_\_\_\_ 2. Any two individuals that can mate and produce offspring are always considered to be the same species.
- \_\_\_\_\_ 3. The Biological Species Concept does not adequately define asexually reproducing organisms.
- \_\_\_\_\_ 4. All humans are members of the same species.
- \_\_\_\_\_ 5. Geographic isolation is required for reproductive isolation to occur.
- \_\_\_\_\_ 6. Long periods of environmental stability may slow the rate of speciation.
- \_\_\_\_\_ 7. Gradualism describes the rate of evolution as relatively stable with brief periods of rapid speciation.
- \_\_\_\_\_ 8. While tetraploid plants may self-pollinate or interbreed with other tetraploids, they cannot successfully reproduce with their parents
- \_\_\_\_\_ 9. Rivers, mountains, and glaciers are examples of geographic barriers that result in Sympatric speciation.
- \_\_\_\_\_ 10. Differences in mating seasons is an example of reproductive isolation that may lead to Sympatric speciation.

### 5.3 : Critical Reading

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

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

*Read this passage from the lesson and answer the questions that follow.*

#### **The Tempo of Speciation**

Speciation and extinction characterize all life on earth; the fossil record clearly documents both. Two startling facts emerge from careful study of the fossil record: First, the average successful species lives for “just” a few million years. Second, over 99.9% of all species that have ever lived have become extinct. The last aspects of speciation that we will consider are the tempo and pattern of species formation.

Over time, geographic changes isolate populations. Small populations experience genetic drift. Mutations alter individual genotypes and gene pools. New habitats form, and small groups colonize them. It is clear that evolution continues to change life. However, there is considerable debate about the rate at which speciation occurs over geologic time. Most biologists agree that single mutations seldom if ever cause new species in single evolutionary “leaps.” Mutations in regulatory genes, which have major effects during development, may be an exception, but in general, mutations are more likely to be harmful, and selected against. Except for the special case of polyploidy, discussed above, speciation cannot occur within a single generation. So, what do we know about the rate and pattern of speciation?

Some evolutionary biologists consider the rate of evolution to be slow and constant, with small changes accumulating to form big changes – the idea of gradualism. Others (Niles Eldridge and Stephen Jay Gould), in response to the apparently “sudden” appearance of new forms in the fossil record, suggest that species diverge in bursts of relatively rapid change, and then remain stable for relatively long periods – a model known as punctuated equilibrium. Gould maintains that speciation and evolution occur rapidly in small, peripheral populations, whereas large, central populations remain stabilized for long periods of time. It is the large, central, stable populations which are represented in our fossil record, he argues – not the small, peripheral, evolving ones.

#### **Questions**

1. What two startling facts does the fossil record document?
2. Why do you think 99.9% of all species that have ever lived have gone extinct?
3. While there is no debate that evolution occurs, what do scientists debate about with regards to evolution?
4. In what type of genes should a mutation occur in that might quickly lead to speciation?
5. Describe the two hypotheses given that explain the tempo of speciation.



### 5.3 : Multiple Choice

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

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

*Circle the letter of the correct choice.*

1. According to the Biological Species Concept, a horse and a donkey are not members of the same species because a horse and a donkey are
  - a. unable to mate.
  - b. unable to produce offspring.
  - c. unable to produce offspring that are fertile.
  - d. not found in the same habitat.
2. In the Allopatric speciation experiment with fruit flies, flies that were fed on maltose preferred to mate with what type of fly?
  - a. Only maltose-fed flies
  - b. Only starch-fed flies
  - c. Both maltose-fed flies and starch-fed flies
  - d. Neither maltose-fed flies ore starch-fed flies
3. The duplication of chromosome sets, often resulting in instant speciation is called
  - a. diploidy
  - b. polyploidy
  - c. haploidy
  - d. tetraploidy
4. Sympatric speciation occurs
  - a. with no geographic barriers.
  - b. with geographic barriers.
  - c. only in certain types of organisms.
  - d. none of the above
5. Reproductive isolation
  - a. increases gene flow
  - b. decreases gene flow
  - c. stabilizes gene flow
  - d. has no effect on gene flow
6. What percentage of species that have ever lived are now extinct?
  - a. 20.9%
  - b. 60.9%
  - c. 75.9%
  - d. 99.9%
7. The idea that the rate of evolution is slow and constant, with small changes accumulating to form big changes, is called
  - a. punctuated equilibrium
  - b. Biological species concept
  - c. ecological niche
  - d. gradualism

### 5.3 : Vocabulary

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

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

*Match the vocabulary term with the correct definition.*

#### **Term**

- \_\_\_\_ 1. Biological species concept
- \_\_\_\_ 2. reproductive isolation
- \_\_\_\_ 3. gradualism
- \_\_\_\_ 4. ecological niche
- \_\_\_\_ 5. sympatric speciation
- \_\_\_\_ 6. Morphological species concept
- \_\_\_\_ 7. punctuated equilibrium
- \_\_\_\_ 8. Genealogical (evolutionary) species concept
- \_\_\_\_ 9. allopatric speciation
- \_\_\_\_ 10. speciation

#### **Definition**

- a. The idea that species diverge in bursts of relatively rapid change and then remain stable for relatively long periods.
- b. The process which results in new, separate and genetically distinct groups of organisms (species).
- c. A group of organisms similar enough that they could interbreed and produce fertile offspring under natural conditions.
- d. The set of environmental conditions and resources used or required by a species; the role a species plays in its ecosystem.
- e. The idea that the tempo of evolution is slow and constant, with small changes accumulating to form big changes.
- f. A group of organisms which share a recent, unique common ancestor – common ancestry without divergence.
- g. The evolution of new species from closely related populations located in the same area.
- h. The separation of closely related populations by barriers to producing viable offspring.
- i. A group of organisms which share extensive structural and biochemical similarities.
- j. The evolution of a new species from a closely related population isolated by geographic barriers.

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

## 6.1 : Digestive System Worksheets

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

### True or False

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Food moves through the digestive system because of gravity.
- \_\_\_\_\_ 2. Accessory organs of the GI tract are not needed for digestion.
- \_\_\_\_\_ 3. Chemical digestion begins in the mouth.
- \_\_\_\_\_ 4. The esophagus produces enzymes that help digest sugar.
- \_\_\_\_\_ 5. Digestive enzymes in the stomach require an acidic environment to work.
- \_\_\_\_\_ 6. The main digestive enzyme in the stomach is amylase.
- \_\_\_\_\_ 7. The small intestine is much shorter than the large intestine.
- \_\_\_\_\_ 8. Villi in the jejunum produce the digestive enzyme trypsin.
- \_\_\_\_\_ 9. The enzyme maltase helps digest carbohydrates in the small intestine.
- \_\_\_\_\_ 10. Wastes are stored in the colon until they pass from the body as feces.
- \_\_\_\_\_ 11. Ulcerative colitis is a form of inflammatory bowel disease.
- \_\_\_\_\_ 12. Cystic fibrosis is a disease that affects the pancreas.

## 6.1 : Critical Reading

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

Read this passage from the lesson and answer the questions that follow.

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

### Digestion and Absorption: The Small Intestine

The small intestine is narrow tube about seven meters long in adults. It is the site of most chemical digestion and virtually all absorption. As you can see from Figure 1, the small intestine is much longer than the large intestine. It is called "small" because it is smaller in diameter than the large intestine. Like the rest of the GI tract, the small intestine pushes food along with peristalsis. The small intestine is made up of three parts: the duodenum, jejunum, and ileum. Each part has a different function.

### Digestion in the Small Intestine

The **duodenum** is the first part of the small intestine. It is only about 25 cm long, but most chemical digestion occurs here. Many enzymes are active in the duodenum, and several are listed in **Table below**. Some of the enzymes are produced by the duodenum. The rest are produced by the pancreas and secreted into the duodenum.

| Digestive Enzymes Active in the Duodenum |                     |                    |
|--|---------------------|--------------------|
| Name of Enzyme                           | Nutrient It Digests | Site of Production |
| Amylase                                  | carbohydrates       | pancreas           |
| Trypsin                                  | proteins            | pancreas           |
| Lipase                                   | lipids              | pancreas           |
| Maltase                                  | carbohydrates       | small intestine    |
| Peptidase                                | proteins            | small intestine    |
| Lipase                                   | lipids              | small intestine    |

How does the pancreas "know" when to secrete enzymes into the small intestine? The pancreas is controlled by compounds called hormones. Hormones are chemical messengers in the body. They regulate many body functions, including secretion of digestive enzymes. When food enters the stomach, a hormone called gastrin is secreted by the stomach. Gastrin, in turn, stimulates the pancreas to secrete its digestive enzymes.

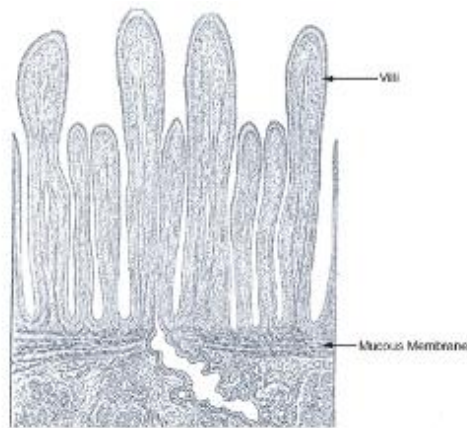
The liver produces fluid called bile, which is secreted into the duodenum. Some bile goes to the gall bladder, where it is stored and becomes more concentrated. In the duodenum, bile breaks up large globules of lipids into smaller globules that are easier for lipase enzymes to break down chemically.

Bile also reduces the acidity of the chyme entering from the highly acidic stomach. This is important for digestion, because digestive enzymes in the duodenum require a neutral environment in order to work. The pancreas also contributes to the neutral environment of the duodenum by secreting bicarbonate, a basic substance that neutralizes acid.

## Absorption in the Small Intestine

The **jejunum** is the second part of the small intestine. It is about 2.5 meters long. This is where most nutrients are absorbed into the blood.

As shown in **Figure below**, the mucous membrane lining the jejunum is covered with microscopic, fingerlike projections called **villi** (singular: villus). Each villus, in turn, has thousands of even smaller projections called microvilli (singular: microvillus). The villi contain capillaries, which are tiny blood vessels. Nutrients are absorbed into these capillaries across the surface of the villi and microvilli. Because there are millions of these tiny projections, they greatly increase the surface area for absorption. In fact, villi and microvilli increase the absorptive surface of the small intestine to the size of a tennis court! This allows far greater absorption of nutrients.



*Magnified image of villi lining the jejunum (small intestine).*

The **ileum** is the third part of the small intestine. It is about 3.5 meters long. A few remaining nutrients are absorbed in the ileum. Salts that form from liver bile are also absorbed there. Like the jejunum, the ileum is covered with villi and microvilli that increase the area for absorption.

## Questions

1. Where is the duodenum located, and what happens here?
2. Name two functions in digestion that are served by liver bile.
3. How does the pancreas contribute to digestion in the duodenum?
4. Describe intestinal villi, and explain their significance in the absorption of nutrients in the jejunum.
5. Describe the ileum and its role in digestion.

## 6.1 : Multiple Choice

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

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

*Circle the letter of the correct choice.*

1. The lower GI tract includes the
  - a. large intestine.
  - b. esophagus.
  - c. stomach.
  - d. mouth.
2. Mechanical digestion takes place mainly in the
  - a. liver and pancreas.
  - b. mouth and stomach.
  - c. small and large intestines.
  - d. gall bladder and small intestine.
3. Teeth that grind food into smaller pieces as you chew include
  - a. molars.
  - b. canines.
  - c. ncisors.
  - d. all of the above.
4. Maltase is a digestive enzyme produced by the
  - a. mouth.
  - b. stomach.
  - c. pancreas.
  - d. small intestine.
5. Parts of the large intestine include the
  - a. duodenum.
  - b. jejunum.
  - c. cecum.
  - d. ileum.
6. Crohn's disease is a type of
  - a. inflammatory bowel disease.
  - b. bacterial infection.
  - c. stomach ulcer.
  - d. food allergy.
7. Inflammation of the colon is called
  - a. appendicitis.
  - b. hepatitis.
  - c. gastritis.
  - d. colitis.

## 6.1 : Vocabulary

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

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

*Match the vocabulary term with the correct definition.*

### Term

- \_\_\_\_ 1. cecum
- \_\_\_\_ 2. colon
- \_\_\_\_ 3. duodenum
- \_\_\_\_ 4. esophagus
- \_\_\_\_ 5. ileum
- \_\_\_\_ 6. jejunum
- \_\_\_\_ 7. liver
- \_\_\_\_ 8. pharynx
- \_\_\_\_ 9. rectum
- \_\_\_\_ 10. stomach

### Definition

- a. first part of the small intestine, where most chemical digestion occurs
- b. third part of the large intestine, where feces accumulates
- c. third part of the small intestine, where a few remaining nutrients and salts are absorbed
- d. tube connecting the mouth to the rest of the digestive tract
- e. saclike organ between the esophagus and small intestine, where mechanical and chemical digestion take place
- f. second part of the large intestine, where excess water is absorbed from food wastes
- g. second part of the small intestine, where most nutrients are absorbed
- h. narrow tube that passes food from the mouth to the stomach
- i. first part of the large intestine, where waste enters from the small intestine
- j. large organ next to the stomach that produces bile needed for digestion

## 7 : Circulatory and Respiratory Systems Worksheets

### 7.1 : Circulatory System

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

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

#### True or False

*Write true if the statement is true or false if the statement is false.'*

- \_\_\_\_\_ 1. In adults, the normal mass of the heart is 100-200 grams.
- \_\_\_\_\_ 2. The right side of the heart collects oxygenated blood from the body.
- \_\_\_\_\_ 3. Valves in the heart maintain the flow of blood.
- \_\_\_\_\_ 4. Cardiac muscle is self-exciting.
- \_\_\_\_\_ 5. The heartbeat is made up of three parts.
- \_\_\_\_\_ 6. Arteries carry blood away from the heart.
- \_\_\_\_\_ 7. The aorta is the largest artery in the body.
- \_\_\_\_\_ 8. Capillaries are the smallest of the body's blood vessels.
- \_\_\_\_\_ 9. The lymphatic system is often called the primary circulatory system.
- \_\_\_\_\_ 10. Atherosclerosis normally begins in adulthood.



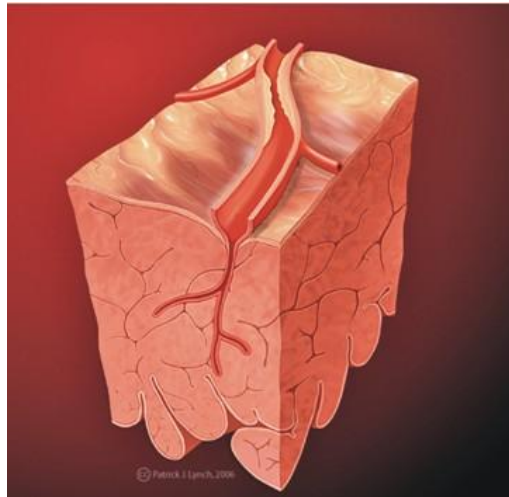
## 7.1 : Critical Reading

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

*Read this passage from the lesson and answer the questions that follow.*

### Homeostatic Imbalances of the Cardiovascular System

**Cardiovascular disease (CVD)** refers to any disease that affects the cardiovascular system, but it is usually used to refer to diseases related to **atherosclerosis**, which is a chronic inflammatory response in the walls of arteries that causes a swelling and buildup of materials called **plaque**. Plaque is made of cell debris, cholesterol, fatty acids, calcium, and fibrous connective tissue that build up around an area of inflammation. As a plaque grows it stiffens and narrows the artery, which reduces the flow of blood through the artery, shown in **Figure below**.



*Atherosclerosis is sometimes referred to as hardening of the arteries.*

### Atherosclerosis

Atherosclerosis normally begins in later childhood, and is usually found in most major arteries. It does not usually have any early symptoms. Causes of atherosclerosis include a high-fat diet, high cholesterol, smoking, obesity, and diabetes. Atherosclerosis becomes a threat to health when the plaque buildup interferes with the blood circulation in the heart (coronary circulation) or the brain (cerebral circulation). A blockage in the coronary circulation, can lead to a heart attack, and blockage of the cerebral circulation (leading to, or within the brain) can lead to a stroke. According to the American Heart Association, atherosclerosis is a leading cause of CVD.

### Questions

1. Cardiovascular disease (CVD) is usually referred to diseases related to what?
2. What is plaque made up of?
3. Atherosclerosis is sometimes referred to as what?
4. What are the causes of atherosclerosis?
5. In what two organs can plaque buildup interfere with blood circulation?

## 7.1 : Multiple Choice

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

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

*Circle the letter of the correct choice.*

1. What does the cardiovascular system move to and from body cells?
  - a. nutrients
  - b. hormones
  - c. gases and wastes
  - d. all of the above
2. In adults, the normal mass of the heart is \_\_\_\_\_.
  - a. 50-100 grams (g)
  - b. 100-150 g
  - c. 200-250 g
  - d. 250-350 g
3. One of the semilunar valves is the \_\_\_\_\_.
  - a. pulmonary
  - b. tricuspid
  - c. bicuspid
  - d. mitral
4. Which of the following is the most critical nutrient carried by the blood?
  - a. calcium
  - b. oxygen
  - c. iron
  - d. none of the above
5. In Canada the healthy systolic pressure is \_\_\_\_\_.
  - a. less than 80 mm Hg
  - b. less than 100 mm Hg
  - c. less than 120 mm Hg
  - d. less than 140 mm Hg
6. An example of a portal venous system is the blood vessel network between the digestive tract and the
  - a. heart.
  - b. liver.
  - c. brain.
  - d. none of the above
7. The lymphatic system
  - a. removes excess fluids from body tissues.
  - b. absorbs fats and transports them to the cardiovascular system.
  - c. produces certain types of white blood cells.
  - d. all of the above

## 7.1 : Vocabulary

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

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

*Match the vocabulary term with the correct definition.*

### Term

- \_\_\_ 1. vein
- \_\_\_ 2. systole
- \_\_\_ 3. artery
- \_\_\_ 4. ventricles
- \_\_\_ 5. hypertension
- \_\_\_ 6. diastole
- \_\_\_ 7. coronary circulation
- \_\_\_ 8. blood pressure
- \_\_\_ 9. sphygmomanometer
- \_\_\_ 10. atrioventricular valves

### Definition

- a. Large, muscular vessels that carry blood away from the heart
- b. Contraction of the heart chambers, which drives blood out of the chambers
- c. Supplies the heart tissue with blood
- d. Heart chambers which collect blood from the atria and pump it out of the heart
- e. Vessel that carries blood toward the heart
- f. The force exerted by circulating blood on the walls of blood vessels
- g. Ensure blood flows from the atria to the ventricles
- h. Measures arterial pressure
- i. Period of time when the heart relaxes after contraction
- j. Condition in which a person's blood pressure is chronically high

## 7.2 : Blood

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

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

### True or False

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. Arterial blood carries oxygen and nutrients to all the body's cells.
- \_\_\_\_\_ 2. Plasma acts as a buffer, maintaining pH near 7.4.
- \_\_\_\_\_ 3. Mature red blood cells have a nucleus.
- \_\_\_\_\_ 4. Platelets make up 50 percent of blood volume.
- \_\_\_\_\_ 5. The hemoglobin molecule is the major transporter of oxygen in mammals.
- \_\_\_\_\_ 6. Increasing blood flow to the surface causes cooler skin.
- \_\_\_\_\_ 7. Type O blood does not have an antigen.
- \_\_\_\_\_ 8. The Rhesus system is named after the Rhesus monkey.
- \_\_\_\_\_ 9. Those with type AB positive blood are called universal donors.
- \_\_\_\_\_ 10. Those with sickle cell disease are resistant to malaria.

## 7.2 : Critical Reading

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

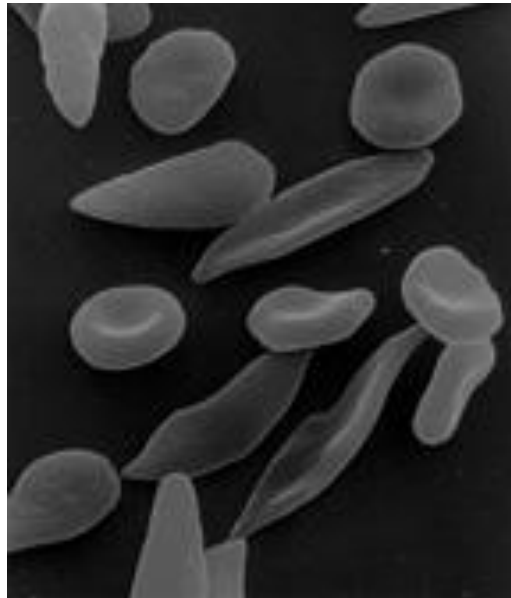
Date: \_\_\_\_\_

*Read this passage from the lesson and answer the questions that follow.*

### Homeostatic Imbalances of the Blood

Problems can occur with red blood cells, white blood cells, platelets, and other components of the blood. Many blood disorders are genetic, they are inherited from a parent, some are a result of nutrient deficiency, while others are cancers of the blood.

**Sickle-cell disease** is a group of genetic disorders caused by abnormally shaped hemoglobin, called sickle hemoglobin. In many forms of the disease, the red blood cells change shape because the abnormal hemoglobin proteins stick to each other, causing the cell to get a rigid surface and sickle shape, shown in **Figure below**. This process damages the membrane of the red blood cell, and can cause the cells to get stuck in blood vessels. This clotting causes oxygen starvation in tissues, which may cause organ damage such as stroke or heart attack. The disease is chronic and lifelong. Individuals are most often well, but their lives are punctuated by periodic painful attacks. Sickle-cell disease occurs more commonly in people (or their descendants) from parts of the world such as sub-Saharan Africa, where malaria is or was common. It also occurs in people of other ethnicities. As a result, those with sickle cell disease are resistant to malaria since the red blood cells are not favored by the malaria parasites. The mutated hemoglobin allele is recessive, meaning it must be inherited from each parent for the individual to have the disease.



*Sickle-cell disease. The abnormal shape of the red blood cells damages the red blood cells which causes them to get stuck in blood vessels. The blocked capillaries reduce the blood flow to an organ, and can result in pain and organ damage.*

**Iron deficiency anemia** is the most common type of anemia. It occurs when the dietary intake or absorption of iron is less than what is needed by the body. As a result, hemoglobin, which contains iron, cannot be made. In the United States, 20 percent of all women of childbearing age have iron deficiency anemia, compared with only 2 percent of adult men. The principal cause of iron deficiency anemia in premenopausal women is blood lost during menstruation.

**Leukemia** is a cancer that originates in the bone marrow and is characterized by an abnormal production of white blood cells (rarely red blood cells) that are released into the bloodstream.

**Lymphoma** is a cancer of the lymphatic system, which helps to filter blood. Lymphoma can be categorized as either Hodgkin's lymphoma or non-Hodgkin's lymphoma.

**Hemophilia** is the name of a group of hereditary genetic diseases that affect the body's ability to control blood clotting. Hemophilia is characterized by a lack of clotting factors in the blood. Clotting factors are needed for a normal clotting process. When a blood vessel is injured, a temporary scab does form, but the missing coagulation factors prevent the formation of fibrin which is needed to maintain the blood clot. Therefore, a person who has hemophilia is initially able to make a clot to stop the bleeding, but because fibrin is not produced, the body is unable to maintain a clot for long. The risks of the re-bleeding of an injury and internal bleeding are increased in hemophilia, especially into muscles, joints, or bleeding into closed spaces.

**Haemochromatosis** is a hereditary disease that is characterized by a buildup of iron in the body. Iron accumulation can eventually cause end organ damage, most importantly in the liver and pancreas, manifesting as liver failure and diabetes mellitus respectively. It is estimated that roughly one in every 300-400 people is affected by the disease, primarily of Northern European and especially people of Irish, Scottish, Welsh and English descent.

## Questions

1. In sickle-cell disease, why do the red blood cells change shape?
2. Why are people with sickle-cell disease resistant to malaria?
3. Why must sickle-cell disease be inherited from each parent in order for the individual to have the disease?
4. Why can't a person who has hemophilia maintain a blood clot?
5. In what part of the world would you most likely find people with the disease of haemochromatosis?

## 7.2 : Multiple Choice

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

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

*Circle the letter of the correct choice.*

1. Blood accounts for what percent of the human body weight?
  - a. 2%
  - b. 7%
  - c. 10%
  - d. 25%
2. Within blood plasma are \_\_\_\_\_.
  - a. erythrocytes
  - b. leukocytes
  - c. thrombocytes
  - d. all of the above
3. Which of the following produce antibodies?
  - a. B-cells
  - b. T-cells
  - c. macrophages
  - d. lymphocytes
4. How long do platelets survive before being removed by the liver and spleen?
  - a. 2 days
  - b. 5 days
  - c. 10 days
  - d. 15 days
5. Blood plasma contains
  - a. serum albumin.
  - b. antibodies.
  - c. hormones.
  - d. all of the above
6. Which of the following is a blood group system?
  - a. MNS
  - b. Kell
  - c. Duffy
  - d. all of the above
7. Leukemia is characterized by an abnormal production of
  - a. red blood cells.
  - b. white blood cells.
  - c. platelets.
  - d. none of the above

## 7.2 : Vocabulary

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

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

*Match the vocabulary term with the correct definition.*

### Term

- \_\_\_\_ 1. thrombocytes
- \_\_\_\_ 2. hemoglobin
- \_\_\_\_ 3. erythrocytes
- \_\_\_\_ 4. lymphoma
- \_\_\_\_ 5. serum albumin
- \_\_\_\_ 6. universal recipients
- \_\_\_\_ 7. hormones
- \_\_\_\_ 8. hematopoiesis
- \_\_\_\_ 9. blood type
- \_\_\_\_ 10. coagulation

### Definition

- a. protein in red blood cells that carries oxygen
- b. a cancer of the lymphatic system, which helps to filter blood
- c. individuals with type AB positive blood
- d. red blood cells
- e. chemical messengers that are produced by one cell and carried to another
- f. platelets
- g. determined by the presence or absence of certain molecules, called antigens, on the surface of red blood cells
- h. the production of blood cells in the red and yellow bone marrow
- i. blood clotting
- j. a plasma protein that acts as a transporter of hormones and other molecules



### 7.3 : Respiratory System

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

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

#### True or False

*Write true if the statement is true or false if the statement is false.*

- \_\_\_\_\_ 1. The exchange of gases between the blood and the cells of the body is called internal respiration.
- \_\_\_\_\_ 2. The trachea pulls air in and pushes it out.
- \_\_\_\_\_ 3. Respiration is the transport of oxygen from the outside air to the cells of the body.
- \_\_\_\_\_ 4. One of the products of cellular respiration is carbon dioxide.
- \_\_\_\_\_ 5. The pharynx closes over the trachea when food is swallowed.
- \_\_\_\_\_ 6. The alveoli are part of the upper respiratory tract.
- \_\_\_\_\_ 7. In air-breathing vertebrates such as humans, respiration of oxygen includes three stages.
- \_\_\_\_\_ 8. The process of gas exchange occurs in the alveoli.
- \_\_\_\_\_ 9. Exhaled air has a relative humidity of 100 percent.
- \_\_\_\_\_ 10. Exhalation is generally an active process.

### 7.3 : Critical Reading

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

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

*Read this passage from the lesson and answer the questions that follow.*

#### **Homeostatic Imbalances of the Respiratory System: Diseases and Disorders**

**Respiratory disease** is the term for diseases of the lung, bronchial tubes, trachea and throat. These diseases range from mild, such as a cold, to being possibly life-threatening, such as bacterial pneumonia.

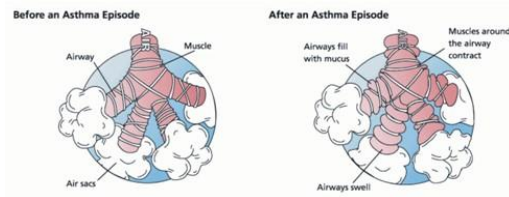
Respiratory diseases can be grouped as either obstructive (conditions which lower the rate of the airflow into and out of the lungs, such as in asthma) or restrictive (conditions that cause a reduction in the functional volume of the lungs, such as emphysema.)

**Emphysema** is a chronic lung disease caused by loss of elasticity of the lung tissue. The destruction of elastic structures that support the alveoli and the capillaries that feed the alveoli cause them to become hard and stiff. Eventually the walls of the alveoli break down and the alveoli become larger. The amount of oxygen that can enter the blood with each breath is reduced because the large alveoli cannot function efficiently; much of the oxygen that gets into the large alveoli cannot be absorbed into the blood so the oxygen is unused. Symptoms include shortness of breath on exertion (usually when climbing stairs or a hill, and later at rest), and an expanded chest. Damage to the alveoli, which can be seen in **Figure below**, is irreversible. Smoking is a leading cause of emphysema.



*The inside of a lung showing the characteristics of emphysema due to smoking. Instead of alveoli, the cut surface shows multiple cavities lined by heavy black carbon deposits.*

**Bronchitis** is an inflammation of the bronchi. Acute bronchitis is usually caused by viruses or bacteria and may last several days or weeks. Acute bronchitis is characterized by cough and phlegm (mucus) production. Symptoms are related to the inflammation of the airways and phlegm production, and include shortness of breath and wheezing. Chronic bronchitis is not necessarily caused by infection and is generally part of a syndrome called chronic obstructive pulmonary disease (COPD). Chronic bronchitis is defined clinically as a persistent cough that produces phlegm and mucus, for at least three months in two consecutive years.



*Asthma narrows the airways by causing allergy-induced spasms of surrounding muscles, narrowing of the airway, and excessive production of phlegm (mucus), which clogs the airways. The airway constriction responds to medicines called bronchodilators which relax the muscles. The feeling of breathlessness is somewhat like being able to breath only through a straw while walking.*

**Asthma** is a chronic illness in which the airways narrow and becomes inflamed, as shown in **Figure above**. Excessive amounts of mucus are also made by the lungs. Asthma often happens in response to one or more triggers. It may be triggered by exposure to an allergen such as mold, dust, or pet hair. It can also be caused by cold air, warm air, moist air, exercise, or emotional stress. In children, the most common triggers are viral illnesses such as those that cause the common cold. This airway narrowing causes symptoms such as wheezing, shortness of breath, chest tightness, and coughing. Some people with asthma, especially children, can become very frightened by the symptoms, which may cause even more breathing distress. Between asthma attacks, most patients feel well but can have mild symptoms and may remain short of breath after exercise for longer periods of time than a person who does not have asthma. The symptoms of asthma, which can range from mild to life threatening, can usually be controlled with a combination of medicines and environmental changes.

Public attention in the developed world has recently focused on asthma because of the increasing numbers of cases, affecting up to one in four children who live in cities.

## Questions

1. What are the two major ways in which respiratory diseases can be grouped?
2. What happens to lung tissue in emphysema?
3. In emphysema, why is the amount of oxygen that can enter the blood with each breath reduced?
4. How is chronic bronchitis defined clinically?
5. How is asthma an example of an obstructive respiratory disease?

### 7.3 : Multiple Choice

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

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

*Circle the letter of the correct choice.*

1. The respiratory system consists of the \_\_\_\_\_.
  - a. pharynx
  - b. trachea
  - c. diaphragm
  - d. all of the above
2. In cellular respiration, which of the following is not produced?
  - a. oxygen
  - b. carbon dioxide
  - c. ATP
  - d. water
3. Which of the following is part of the lower respiratory tract?
  - a. nasal cavity
  - b. pharynx
  - c. trachea
  - d. none of the above
4. Which of the following is one of the stages of the respiration of oxygen?
  - a. ventilation from the atmosphere into the alveoli of the lungs
  - b. pulmonary gas exchange from the alveoli into the pulmonary capillaries
  - c. gas transport from the pulmonary capillaries through the circulation to the peripheral capillaries in the organs
  - d. all of the above
5. Exhaled air has a relative humidity of what percent?
  - a. 25
  - b. 50
  - c. 75
  - d. 100
6. Immediately after the aorta, oxygenated blood travels to the
  - a. peripheral capillaries.
  - b. smaller arteries.
  - c. arterioles.
  - d. none of the above
7. Which of the following is a respiratory disease?
  - a. bronchitis
  - b. pneumonia
  - c. tuberculosis
  - d. all of the above

### 7.3 : Vocabulary

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

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

*Match the vocabulary term with the correct definition.*

#### **Term**

- \_\_\_ 1. obstructive
- \_\_\_ 2. lung volume
- \_\_\_ 3. emphysema
- \_\_\_ 4. respiratory disease
- \_\_\_ 5. internal respiration
- \_\_\_ 6. restrictive
- \_\_\_ 7. bronchitis
- \_\_\_ 8. alveoli
- \_\_\_ 9. diaphragm
- \_\_\_ 10. asthma

#### **Definition**

- a. the exchange of gases between the blood and the cells of the body
- b. a muscle that is found below the lungs
- c. conditions which lower the airflow rate into and out of the lungs
- d. a chronic illness in which the airways narrow and become inflamed
- e. multi-lobed sacs in which most of the gas exchange occurs
- f. the average breath capacity of a person
- g. conditions that cause a reduction in the functional volume of the lungs
- h. a chronic lung disease caused by loss of elasticity of the lung tissue
- i. an inflammation of the bronchi
- j. the term for diseases of the lung, bronchial tubes, trachea and throat

## 8 : Classification Worksheets

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

### 8.1 : Form and Function

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

#### True or False

*Write true if the statement is true and false if the statement is false.*

- \_\_\_\_\_ 1. Scientists have identified millions of different species of organisms.
- \_\_\_\_\_ 2. Classification helps scientists understand the diversity of organisms.
- \_\_\_\_\_ 3. Aristotle considered birds to be the most complex organisms.
- \_\_\_\_\_ 4. Linnaeus tried to classify the entire known natural world.
- \_\_\_\_\_ 5. All organisms capable of moving on their own belong to the same class.
- \_\_\_\_\_ 6. Linnaeus thought of each species as an unchanging "ideal type."
- \_\_\_\_\_ 7. More than one species may have the same genus and species names.
- \_\_\_\_\_ 8. In binomial nomenclature, the species name is always capitalized.
- \_\_\_\_\_ 9. Linnaeus' method for naming species is no longer used.
- \_\_\_\_\_ 10. Linnaean taxonomy has not been revised since it was first introduced.
- \_\_\_\_\_ 11. Modern classification systems are based on evolutionary relationships.
- \_\_\_\_\_ 12. Vertebrates are a subphylum in the phylum called chordates.

## 8.1 : Critical Reading

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

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

*Read this passage from the lesson and answer the questions that follow.*

### Binomial Nomenclature

The single greatest contribution that Linnaeus made to science is his method of naming species. This method, called **binomial nomenclature**, gives each species a unique, two-word name (also called a scientific or Latin name). Just like we have a first and last name, organisms have a distinguishable two word name as well. The two words in the name are the genus name and the species name. For example, the human species is uniquely identified by its genus and species names as *Homo sapiens*. No other species has this name.

Both words in a scientific name are Latin words or words that have been given Latin endings. The genus name is always written first and starts with an upper-case letter. The species name is always written second and starts with a lower-case letter. Both names are written in italics.

As another example, consider the group of organisms called *Panthera*. This is a genus in the cat family. It consists of all large cats that are able to roar. Within the genus *Panthera*, there are four different species that differ from one another in several ways. One obvious way they differ is in the markings on their fur. *Panthera leo* (lion species) has solid-colored fur, *Panthera tigris* (tiger species) has striped fur, and the other two *Panthera* species have fur with different types of spots. As this example shows, the genus name *Panthera* narrows a given cat's classification to big cats that roar. Adding the species name limits it to a single species of cat within this genus.

Why is Linnaeus' method of naming organisms so important? Before Linnaeus introduced his method, naming practices were not standardized. Some names were used to refer to more than one species. Conversely, the same species often had more than one name. In addition, a name could be very long, consisting of a string of descriptive words. For example, at one time, common wild roses were named *Rosa sylvestris alba cum rubore folio glabro*. Names such as this were obviously cumbersome to use and hard to remember.

For all these reasons, there was seldom a simple, fixed name by which a species could always be identified. This led to a great deal of confusion and misunderstanding, especially as more and more species were discovered. Linnaeus changed all that by giving each species a unique and unchanging two-word name. Linnaeus's method of naming organisms was soon widely accepted and is still used today.

### Questions

1. What is Linnaeus' single greatest contribution to science?
2. What two words make up the name of a species in Linnaeus' naming system?
3. What is the scientific name for the human species? For the tiger species?
4. Describe naming practices that were used before Linnaeus introduced his method.
5. What are the advantages of binomial nomenclature over earlier naming practices?

## 8.1 : Multiple Choice

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

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

Circle the letter of the correct choice.

1. Which grouping of organisms is a kingdom?
  - a. plants
  - b. cats
  - c. mammals
  - d. vertebrates
2. Whales, bats, and humans all belong to the same
  - a. species.
  - b. genus.
  - c. family.
  - d. class.
3. Among animals, the most diverse group of organisms is the
  - a. rodents.
  - b. insects.
  - c. amphibians.
  - d. reptiles.
4. The scientist known as the "father of taxonomy" was
  - a. Linnaeus.
  - b. Aristotle.
  - c. Darwin.
  - d. Taxonomus.
5. A species is a division of a(n)
  - a. genus.
  - b. phylum.
  - c. order.
  - d. species.
6. Which taxon is missing from the sequence below? kingdom - phylum - \_\_\_?\_\_\_ - order - family
  - a. superfamily
  - b. domain
  - c. genus
  - d. class
7. Lions have the scientific name *Panthera leo*. What genus do lions belong to?
  - a. leo
  - b. Panthera
  - c. Catus
  - d. Carnivora



## 8.1 : Vocabulary

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

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

*Match the vocabulary term with the correct definition.*

### **Term**

- \_\_\_ 1. taxonomy
- \_\_\_ 2. taxa
- \_\_\_ 3. kingdom
- \_\_\_ 4. species
- \_\_\_ 5. phylum
- \_\_\_ 6. class
- \_\_\_ 7. order
- \_\_\_ 8. family
- \_\_\_ 9. genus
- \_\_\_ 10. binomial nomenclature

### **Definition**

- a. taxon that is a division of a kingdom
- b. taxon that is a division of an order
- c. major grouping of organisms such as plants or animals
- d. method of organizing living things into groups
- e. taxon that is a division of a phylum
- f. group of organisms that are similar enough to mate and produce offspring together
- g. taxon that is a division of a class
- h. Linnaeus' method of naming species using a unique two-word name
- i. taxon that is a division of a family
- j. categories of organisms in a taxonomy

## 8.2 : Phylogenetic Classification

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

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

### True or False

*Write true if the statement is true and false if the statement is false.*

- \_\_\_\_\_ 1. The tips of the branches of a phylogenetic tree represent common ancestors.
- \_\_\_\_\_ 2. Species that shared a more recent common ancestor are more closely related.
- \_\_\_\_\_ 3. A clade always includes at least five species of related organisms.
- \_\_\_\_\_ 4. An example of a derived trait in humans is the presence of eyes.
- \_\_\_\_\_ 5. Derived traits are always entirely new traits, unlike any traits in ancestors.
- \_\_\_\_\_ 6. The phylogenetic classification of birds groups them with mammals rather than reptiles.
- \_\_\_\_\_ 7. There is no limit on the number of levels in a cladogram.
- \_\_\_\_\_ 8. A phylogenetic classification can include any organisms without regard to ancestry.
- \_\_\_\_\_ 9. Phylogenetic classifications always agree with Linnaean taxonomic classifications.
- \_\_\_\_\_ 10. Phenetic analysis distinguishes between ancestral traits and derived traits.
- \_\_\_\_\_ 11. Similar nucleic acid base sequences are assumed to indicate descent from a common ancestor.
- \_\_\_\_\_ 12. Horizontal gene transfer is a drawback in using nucleic acid base sequences for phylogenetic analysis.

## 8.2 : Critical Reading

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

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

*Read this passage from the lesson and answer the questions that follow.*

### Cladistics

The most popular method of making phylogenetic trees is called cladistics. It depicts hypotheses about how organisms are related, based on traits of ancestor and descendent species. Cladistics was developed in the 1950s by a scientist named Willi Hennig. Over the next several decades, it became very popular. It is still widely used today.

### Clades and Cladograms

The term cladistics comes from the word clade. A clade is a group of organisms that includes an ancestor species and all of its descendants. A diagram showing evolutionary relationships within one or more clades is called a cladogram. Clade is a relative concept. How you define a clade depends on which species you are interested in. For example, all insects can be considered a clade because they have a common ancestor. Within the insect clade, butterflies, moths, and flies can also be considered a clade for the same reason.

### Generating Cladograms

The starting point in constructing a cladogram is a set of data on traits of a group of related species. The traits could be physical traits, genetic traits, or both. The next step is deciding which traits were inherited from the common ancestor and which traits evolved only in a descendant species after splitting off from the common ancestor. Traits inherited from a common ancestor are called ancestral traits. Traits that evolved since two groups shared a common ancestor are called derived traits. In cladistics, the sharing of derived traits is the most important evidence for evolutionary relationships. Organisms with the same derived traits are grouped in the same clade. More than one possible cladogram usually can be created from the same set of data. In fact, the number of possible cladograms increases exponentially with the number of species included in the analysis. Only one cladogram is possible with two species. More than 100 cladograms are possible with five species. With nine species, more than two million cladograms are possible!

### Choosing the Best Cladogram

How do scientists know which of many possible cladograms is the "right" one? There is no right or wrong cladogram. However, some cladograms fit the facts better than others. Statistical methods can be used to determine which cladogram best fits a particular data set. An important deciding factor is parsimony. Parsimony means choosing the simplest explanation from among all possible explanations. In cladistics, parsimony usually means choosing the cladogram with the fewest branching points. A cladogram shows just one of many possible phylogenies for a group of organisms. It can provide insights about how evolution occurred. However, a cladogram should not be considered a model of actual evolutionary events. It does not necessarily show what really happened. It just shows what could have happened.

### Questions

1. What is cladistics?
2. Why is clade a relative concept?
3. What is the difference between ancestral traits and derived traits?
4. What does parsimony usually mean in cladistics?
5. How is a cladogram like a hypothesis?

## 8.2 : Multiple Choice

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

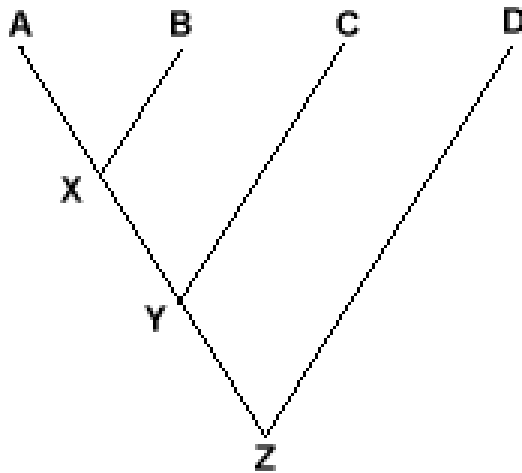
Date: \_\_\_\_\_

*Circle the letter of the correct choice.*

1. What was Charles Darwin trying to show with his "Tree of Life"?

- (a) how life had originated
- (b) how "descent without modification" had occurred
- (c) what factors had led to natural selection
- (d) why some species had gone extinct

2. Which two species in the cladogram below shared the most recent common ancestor?



- (a) species A and B
- (b) species B and C
- (c) species C and D
- (d) species A and D

3. How many clades are represented by the cladogram in question 2?

- (a) one
- (b) two
- (c) three
- (d) four

4. An example of a derived trait in birds is

- (a) eyes.
- (b) lungs.
- (c) feathers.
- (d) legs.

5. A drawback of phylogenetic classification is that it

- (a) has fixed numbers and types of taxa.
- (b) is based only on physical traits of form and function.
- (c) does not include a method for naming species.
- (d) does not represent evolutionary relationships.

6. What is one problem in using DNA data for phylogenetic analysis?

- (a) DNA data are rarely available for extinct species.
- (b) DNA can pass only from parents to offspring.
- (c) DNA is not found in microorganisms.
- (d) DNA is found only in fossils.

## 8.2 : Vocabulary

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

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

*Match the vocabulary term with the correct definition.*

### ***Term***

- \_\_\_\_ 1. phylogeny
- \_\_\_\_ 2. phylogenetic tree
- \_\_\_\_ 3. common ancestor
- \_\_\_\_ 4. cladistics
- \_\_\_\_ 5. clade
- \_\_\_\_ 6. cladogram
- \_\_\_\_ 7. ancestral traits
- \_\_\_\_ 8. derived traits
- \_\_\_\_ 9. parsimony
- \_\_\_\_ 10. phylogenetic classification

### ***Definition***

- a. last ancestral species that two descendant species shared
- b. diagram showing evolutionary relationships within one or more clades
- c. evolutionary history of a group of genetically related organisms
- d. traits inherited from a common ancestor
- e. method of making evolutionary trees based on traits of ancestor and descendant species
- f. diagram representing a phylogeny
- g. choosing the simplest explanation from among all possible explanations
- h. classification of organisms on the basis of evolutionary relationships
- i. traits that evolved since two groups shared a common ancestor
- j. group of organisms that includes an ancestor species and all of its descendants

### 8.3 : Modern Classification Systems

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

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

#### True or False

*Write true if the statement is true and false if the statement is false.*

- \_\_\_\_\_ 1. The Linnaean system of classification was first revised in the late 1900s.
- \_\_\_\_\_ 2. By 1977, a total of six new kingdoms had been added to the Linnaean system.
- \_\_\_\_\_ 3. The protist kingdom originally included both bacteria and protozoa.
- \_\_\_\_\_ 4. Bacteria were placed in their own kingdom when it was discovered that they do not make their own food.
- \_\_\_\_\_ 5. The original Monera kingdom was later renamed the Eukarya domain.
- \_\_\_\_\_ 6. The five-kingdom classification system included the Fungi kingdom.
- \_\_\_\_\_ 7. The last kingdom to be added to Linnaeus' original classification was the Eukarya.
- \_\_\_\_\_ 8. The Eubacteria kingdom was later re-classified as the Archaea domain.
- \_\_\_\_\_ 9. There are more organisms in the Eukarya domain than in both other domains combined.
- \_\_\_\_\_ 10. Archaea were found to differ from the other organisms in the composition of their cell membranes.
- \_\_\_\_\_ 11. Animals and archaea are currently classified in the same domain.
- \_\_\_\_\_ 12. The three-domain system of classification is unlikely to be revised in the future.

### 8.3 : Critical Reading

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

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

*Read this passage from the lesson and answer the questions that follow.*

#### Domains

The six-kingdom system didn't show that all four eukaryote kingdoms are more closely related to each other than to the two bacteria kingdoms. It also didn't show that the two bacteria kingdoms are as different from each other as they are from the eukaryote kingdoms. To show these similarities and differences, a new taxon, called the domain, was introduced. It was defined as a taxon higher than the kingdom.

#### The Three-Domain System

In 1990, a new classification system was introduced that contained three domains: Bacteria, Archaea, and Eukarya. The Bacteria domain was formerly the Eubacteria kingdom, and the Archaea domain was formerly the Archaeobacteria kingdom. The Eukarya domain includes all four eukaryote kingdoms: plants, animals, protists, and fungi. The three-domain system emphasizes the similarities among eukaryotes and the differences among eukaryotes, bacteria, and archaea. By using domains, these relationships could be shown without replacing the popular six-kingdom system. Archaea were first found in extreme environments. For example, they were found in the hot water geysers in Yellowstone National park. Archaea have since been found in all of Earth's habitats. They are now known to be present everywhere in high numbers. They may contribute as much as 20 percent to Earth's total biomass. The three-domain system was quickly adopted by many other biologists. There were some critics, however, who argued that the system put too much emphasis on the uniqueness of Archaea. Later studies confirmed how different Archaea are from other organisms. For example, organisms belonging to Archaea were found to differ from both Eukarya and Bacteria in the composition of their cell membranes and the system they use for DNA replication. These differences convinced most critics that the three-domain system was justified. After its introduction in 1990, the three-domain system became increasingly popular. Within a decade of its introduction, it had largely replaced earlier classifications.

#### How Are the Three Domains Related?

Comparisons of ribosomal RNA base sequences showed that organisms belonging to Eukarya are more similar to Archaea than they are to Bacteria. This suggested the hypothesis that Archaea and Eukarya shared a more recent common ancestor with each other than with Bacteria. However, the results of a study published in 2007 seem to conflict with this hypothesis. Comparing DNA base sequences, the 2007 study suggested that the domain Archaea may be older than either Bacteria or Eukarya. That would make Archaea the most ancient group of organisms on Earth. Which, if either, hypothesis is correct is not yet known. Scientists need to learn more about Archaea and their relationships with other organisms to resolve these questions.

#### Questions

1. Where does the domain fit into Linnaean taxonomy?
2. Why was there a need for the domain?
3. List the domains of the three-domain system.
4. What kingdoms are included in each of the three domains?
5. State two current hypotheses about how the three domains are related.



### 8.3 : Multiple Choice

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

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

*Circle the letter of the correct choice.*

1. Protozoa were originally classified as animals because
  - a. they consist of just one cell.
  - b. they do not have a nucleus.
  - c. they lack a cell membrane.
  - d. they can move on their own.
2. When the protist kingdom was first introduced in 1866, it consisted of all known
  - a. fungi.
  - b. microorganisms.
  - c. plants.
  - d. animals.
3. In a bacterial cell, the cell's organelles may
  - a. be found in the nucleus.
  - b. lack surrounding membranes.
  - c. have nuclear membranes.
  - d. contain DNA.
4. All of the following are eukaryotes except
  - a. frogs.
  - b. halobacteria.
  - c. molds.
  - d. mushrooms.
5. Bacteria that were once classified in the Eubacteria kingdom are now placed in the
  - a. Monera kingdom.
  - b. Bacteria domain.
  - c. Archaea domain.
  - d. Eukarya domain.
6. The human species is placed in the domain called
  - a. Chordata.
  - b. Mammalia.
  - c. Eukarya.
  - d. Animalia.
7. At present, the most widely used classification system is the
  - a. five-kingdom system.
  - b. three-kingdom system.
  - c. three-domain system.
  - d. one-domain system.

### 8.3 : Vocabulary

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

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

*Match the vocabulary term with the correct definition.*

**Term**

- \_\_\_\_ 1. protozoa
- \_\_\_\_ 2. Protista
- \_\_\_\_ 3. prokaryote
- \_\_\_\_ 4. eukaryote
- \_\_\_\_ 5. Monera
- \_\_\_\_ 6. fungi
- \_\_\_\_ 7. domain
- \_\_\_\_ 8. Bacteria
- \_\_\_\_ 9. Archaea
- \_\_\_\_ 10. Eukarya

**Definition**

- a. kingdom of single-celled eukaryote organisms such as protozoa
- b. organism whose cells have nuclei
- c. original name of the kingdom that included all bacteria
- d. kingdom of eukaryote organisms such as mushrooms and molds
- e. domain that was formerly the Archaeobacteria kingdom
- f. single-celled organisms that can move on their own
- g. domain that includes all four eukaryote kingdoms
- h. domain that was formerly the Eubacteria kingdom
- i. organism whose cells lack nuclei
- j. taxon higher than the kingdom

