

This lesson will help you practice working with concepts related to the basic principles of genetics. Use it with core lesson 4. 1 Basic Principles of Genetics to reinforce and apply your knowledge.

## Key Concept

Some characteristics of organisms are passed from parents to offspring. How this occurs and characteristics of offspring can be studied on the molecular level.

## Core Skills & Practices

- Describe a Data Set Statistically
- Apply Scientific Processes

## Traits, Heredity, and Genetics

Traits are passed from parents to offspring. This passing of traits from one generation to the next is known as heredity. The field of biology devoted to studying heredity is called genetics.

**Directions:** Use the table below to answer questions 1-3.

Consider a trait in a desert lizard species that is controlled by two alleles, one dominant and one recessive. The table below shows the percentages of lizards that have the dominant trait in three lizard populations.

Lizard Population	Population Size	Percentage of the Population with the Dominant Trait
A	120	30
B	90	20
C	100	40

- What percentage of population B has the recessive trait?  
A. 20                      C. 80  
B. 40                      D. 90
- Population \_\_\_\_\_ has the greatest number of individuals with the dominant trait. In this population, there are \_\_\_\_\_ individuals with the dominant trait.

- Based on the data in this table, what can you infer about dominant traits in a population?  
A. Dominant traits are usually the most common type of trait in a population.  
B. Dominant traits are not always the most common type of trait in a population.  
C. Dominant traits are almost never the most common type of trait in a population.  
D. Dominant traits are almost always the most common type of trait in a population.



## Test-Taking Tip

Before answering a question that asks you to refer to a data, check that you understand what the numbers represent in each cell of the table. When reading the relevant question, be careful to direct your attention to the appropriate spot in the table. If answer choices are provided, check each against the data presented. When you select an answer, read the question and the data table again to check that you have interpreted the question correctly.

## Chromosomes, Genes, and Alleles

Genes, which are found within chromosomes, are segments of DNA that determine traits; different forms of a gene are called alleles.

**Directions:** Use the illustration below to answer questions 4-5.

	Seed Shape	Flower Color	Pod Color	Plant Height
<b>Dominant Trait</b>	round W	purple P	green G	tall T
<b>Recessive Trait</b>	wrinkled w	white p	yellow g	short t

4. Sort the allele combinations to match each set of traits exhibited in Mendel's pea plants. Complete the table by writing the allele combination in the appropriate space.

GGPPTtWw	GgppTTWW	ggPpww
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Traits Exhibited	Allele Combination
tall plant with white flowers, round seeds, and green pods	
tall plant with purple flowers, round seeds, and green pods	
short plant with purple flowers, wrinkled seeds, and yellow pods	

5. Why is it that the expression of most traits that organisms exhibit cannot be accurately represented in this type of illustration?
- Most traits are determined by more than one gene.
  - Most traits are not clearly defined as dominant or recessive.
  - Most traits are determined by single alleles, not a combination.
  - Most traits do not depend on the contribution of particular alleles.

**Directions:** Answer the questions below.

- Which statement accurately describes a component of chromosome replication?
  - Sister chromatids are not identical.
  - Sister chromatids are present only after replication.
  - Homologous chromosomes are identical.
  - Homologous chromosomes do not replicate.
- What are the interacting roles played by DNA, genes, chromosomes, and alleles in determining heredity?

## Inheritance and Meiosis

The patterns of inheritance described by Gregor Mendel can be explained by the cellular process of meiosis, which produces gametes—egg and sperm.

**Directions:** Answer the following questions.

8. A cell cannot function properly if it has too few or too many 1 Select ... ▼. Sexual reproduction, then, must involve a form of cell division in which the nucleus divides in a way that is different from 2 Select ... ▼. Gametes are produced during a type of cell division that involves meiosis. Cell division that involves meiosis occurs only in the production of male gametes (sperm) and female gametes (eggs).

1 Select ... ▼

- A. alleles
- B. nuclei
- C. gametes
- D. chromosomes

2 Select ... ▼

- A. meiosis
- B. mitosis
- C. replication
- D. fertilization

9. Which process would involve the production of gametes?

- A. rapid growth in a bamboo plant
- B. splitting of single-celled amoeba
- C. development of a fetus from a zygote
- D. pollination and fertilization in a pine tree

11. Which allele combination could be found in gametes produced by a parent organism with the allele combination of DdrrAACc?

- A. DdAC
- B. DrAc
- C. DrrAC
- D. DdrrAACc

10. Why doesn't a zygote formed through fertilization have twice as many chromosomes as its contributing parents?

- A. Gametes divide during meiosis.
- B. Each chromosome replicates after meiosis.
- C. The number of parent chromosomes is halved during meiosis.
- D. Homologous chromosome pairs separate, joining sister chromatids.

## Lesson 4.2 Probability of Traits

This lesson will help you practice working with concepts related to determining the probability of inherited traits in organisms. Use it with core lesson 4. 2 Probability of Traits to reinforce and apply your knowledge.

### Key Concept

Some traits are inherited. The probability of inheriting a trait can be calculated.

### Core Skills & Practices

- Use Percents
- Determine the Probability of Events

## Inheriting Traits

The traits of an organism are determined by the alleles, or forms of a gene, that it inherits from its parents.

**Directions:** Answer the questions below.

1. In pea plants, yellow seeds (**Y**) are dominant and green seeds (**y**) are recessive. If a pea plant has green seeds, what combination of alleles make up its genotype?  
A. **YY** only  
B. **yy** only  
C. **Yy** only  
D. **YY** or **yy**
2. Which alleles could be used to represent an organism that is heterozygous for a trait?  
A. **p**  
B. **PP**  
C. **Pp**  
D. **pp**

3. The phenotype of an organism describes its \_\_\_\_\_. How does phenotype differ from the genotype of the organism? Give an example to support your answer.

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### Test-Taking Tip

A short-answer test question may have two or more parts. When answering a short-answer question that has more than one part, separate the parts of the question. As you write your answer, mentally check off each part to ensure that you provide a complete answer.



## Punnett Squares

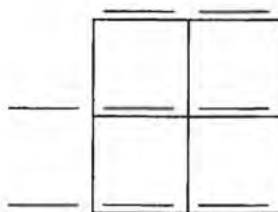
A Punnett square shows how alleles for traits can combine during a cross of two parents to produce specific genotypes and phenotypes in the offspring.

**Directions:** Answer the question below.

4. In cats, the curled ear allele (C) is a dominant trait expressed by ears that are curled backwards. Cats that express this gene appear to have normal ears for the first three or four months of life, then their ears begin to curl backwards. The allele for standard ears in cats (c) is recessive. Suppose a cross between two curled-ear cats, each with the genotype Cc, produces four kittens. What will a Punnett square reveal about the potential phenotype for each kitten?

- A. All kittens will have curled ears.
- B. Each kitten has a 25% chance of having curled ears.
- C. Each kitten has a 50% chance of having curled ears.
- D. Each kitten has a 75% chance of having curled ears.

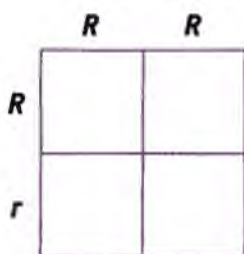
5. In pea plants, yellow seeds (Y) are dominant over green seeds (y). Complete the Punnett square shown to show the possible genotype outcomes of a cross between a pea plant that is heterozygous for yellow seeds and homozygous for green seeds.



## Predicting Traits

Punnett squares help you use traits of the parents to predict the combinations of alleles that produce traits in offspring.

Use the diagram below to answer questions 6-8.



8. In the diagram shown, **R** represents round seeds and **r** represents wrinkled seeds. Based on this information, the probability that an offspring from this cross will have wrinkled seeds is \_\_\_\_\_.

6. The Punnett square shows a cross between two organisms. Complete the Punnett square to show the possible genotype outcomes. Write your answers in the appropriate box.
7. Based upon the information provided in the Punnett square above, what percentage of offspring do you predict will have round seeds? Of these, what percentage do you predict will be homozygous for this trait? Explain your answer.

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## Multiple Traits and Other Patterns of Heredity

Punnett squares can be used to find the probability of multiple traits, traits that are determined by genes carried by sex chromosomes, and traits that have multiple alleles.

**Directions:** Answer the questions below.

9. Which of the following is an example of a trait that is determined by multiple alleles?
  - A. height in pea plants
  - B. gender determination
  - C. blood groups in humans
  - D. flower color in pea plants
10. In humans, what combination of chromosomes results in a male child?
  - A. XY
  - B. XX
  - C. YY
  - D. XXX
11. What is the probability of a trait that is predicted for 2 out of 16 offspring?

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**Directions:** Use the diagram below to answer questions 12-14.

		female carrier	
		$X^C$	$X^c$
male with normal vision	$X^C$	$X^C X^C$	$X^C X^c$
	$Y$	$X^C Y$	$X^c Y$

12. The Punnett square above shows the outcomes of a genetic cross between a male with normal color vision and a female carrier for red-green color blindness. What is the probability of the couple producing a daughter who is a carrier for color blindness?
  - A. 0%
  - B. 25%
  - C. 50%
  - D. 100%
13. The designation \_\_\_\_\_ in the Punnett square indicates that color blindness is a sex-linked trait carried on the X chromosome.
14. Hairly ears are inherited as a Y-linked trait. Suppose a man with hairy ears ( $XY^A$ ) marries a woman without hairy ears ( $XX$ ). Which statement correctly describes how the resulting genotype pattern for hairy ears will compare to the genotype pattern for color blindness illustrated in the Punnett square above?
  - A. One of four children could inherit the gene for hairy ears, but only the male child would be affected. Two of four children could inherit the gene for color blindness, but the affected child could only be female.
  - B. Two of four children could inherit the gene for hairy ears, but only the female children would be affected. Two of four children could inherit the gene for color blindness, but the affected child could only be male.
  - C. One of four children could inherit the gene for hairy ears, but the only a female child would be affected. Two of four children could inherit the gene for color blindness, and the affected children could be male or female.
  - D. Two of four children could inherit the gene for hairy ears, but only the male children would be affected. Two of four children could inherit the gene for color blindness, and the affected children could be male or female.

This lesson will help you practice working with concepts related to evolution, including theories and methods of study that support and explain common ancestry and biological evolution. Use it with core lesson 4. 3 Common Ancestry to reinforce and apply your knowledge.

### Key Concept

The Theory of Universal Common Ancestry suggests that all organisms on Earth evolved from a single common ancestor. Scientists construct diagrams and charts to show how seemingly diverse species share common traits.

### Core Skills & Practices

- Make inferences
- Evaluate Whether a Conclusion or Theory is Supported or Challenged by Particular Data or Evidence

## Darwin and Evolution

English naturalist Charles Darwin proposed a theory of evolution which holds that all forms of life developed over time from different and often much simpler ancestral organisms.

**Directions:** Use the passage to answer questions 1-2.

To understand the significance of a fossil and to recognize the conditions in which the organism lived, a scientist needs to know the age of the fossil. Scientists can use the order of the layers of sedimentary rock to estimate the age of any fossils in the rock. Because lower layers of rock are older than upper layers, a fossil in a lower layer must be older than a fossil in an upper layer.

Three of the four eras of geological time are documented in the walls of North America's Grand Canyon. There are nearly 40 identified rock layers forming the canyon walls. Coral fossils have been found in the limestone caprock, on the rim of the Grand Canyon. Fossils of trilobites, extinct marine animals with hard outer skeletons, have been found deep in the canyon in slopes cut by erosion.

1. Which statement is likely true?
  - A. Trilobites are older than corals.
  - B. Corals and trilobites share a common ancestry.
  - C. Corals and trilobites are the same age.
  - D. Trilobites are more advanced than corals.
2. What aspect of Darwin's theory of evolution does the absence of trilobite fossils in higher rock layers support?
  - A. Life on Earth has changed over time, and some organisms have died out.
  - B. Organisms with soft bodies or thin shells will rarely form fossils.
  - C. Living things will adapt over time to better survive their environment.
  - D. Isolated organisms may develop traits not apparent in the original population.

## Lesson 4.3 Common Ancestry

### The Theory of Universal Common Ancestry

In addition to the theory of evolution, Darwin proposed that all organisms that have ever lived on Earth descended from a single primitive ancestor. This is known as the theory of Universal Common Ancestry (UCA).

**Directions:** Answer the following questions.

3. A great white shark and a mako shark share a common ancestor. Because they are different **1**  , however, they cannot **2**  and produce fertile

**3**

**1**

- A. species
- B. animals
- C. individuals

**2**

- A. species
- B. gametes
- C. offspring

**3**

- A. compete
- B. interbreed
- C. live in freshwater

4. Biologists have discovered that the DNA of human beings is very similar to the DNA of many other animals, such as mice and chimpanzees. How does this information relate to the theory of UCA?

- A. It supports the theory that genetics play a key role in evolution and that a single organism can produce species that do not look alike.
- B. It suggests that the organisms share a genetic link to a common biological ancestor, which may support the theory of UCA.
- C. It implies that humans are not related to other organisms such as plants and bacteria and thus contradicts the theory of UCA
- D. It confirms that seemingly unrelated species can develop from one species that lived in the past, which supports the theory of UCA.

5. Based on the ideas proposed by UCA, what is the connection between adaptation and biodiversity?

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## Cladograms

Scientists can study the relationship of organisms using cladistics, a method of describing evolutionary relationships between species using diagrams called cladograms, which are similar to a family tree

**Directions:** Answer the following questions.

6. Scientists have used cladograms to explore the theory of universal common ancestry. What has been the result?
- A. By diagramming the evolutionary relationships between species, scientists have traced the origins of each species back to a single common ancestor.
  - B. By examining the evolutionary development of each species, scientists have learned there is no link between the three domains of life.
  - C. By diagramming the adaptive traits of living organisms, scientists have deduced that each species has evolved over time.
  - D. By examining the physical traits of living organisms, scientists have discovered organisms that do not share a common ancestor.
7. On a cladogram, a cow has more structural traits in common with a whale than a frog. What can be inferred from this information?
- A. The cow and the whale have the same common ancestors as the frog.
  - B. The cow and the whale are more closely related than the cow and the frog.
  - C. The cow and the whale have evolved over time, while the frog has not.
  - D. The cow and the whale are closer to the universal common ancestor than the frog.

8. The steps for constructing a cladogram are described in the boxes below. Put the steps for constructing a cladogram in their correct sequence. Write each step in the appropriate box.

A. List or draw each organism.

B. Choose structural traits to compare.

C. Draw circles around the species that share a trait.

D. Choose the species you would like to compare.

E. Make a table matching organisms and traits.

F. Use this information to construct a cladogram.

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6



### Test-Taking Tip

In a computer-based test, sequencing questions such as the one above may require that you drag and drop answers into the correct box. Decide how to sequence your answers before you begin. If possible, decide on the first and last items in the sequence. This will make the remaining items easier to arrange.

## Lesson 4.4 Heredity: Genetic Variations and Expression

This lesson will help you practice working with concepts related to heredity, sources of heritable genetic variation, and environmental influences on genetic expression. Use it with core lesson 4. 4 Heredity: Genetic Variations and Expression to reinforce and apply your knowledge.

### Key Concept

Offspring from sexual reproduction have a unique set of traits. There are various causes of changes in traits from one generation to the next.

### Core Skills & Practices

- Make Predictions Based upon Data or Evidence
- Cite Textual Evidence

## Genetic Variation

The variation in human and animal species can be traced back to genes, the expressions of genes, and the interaction of genes and the environment.

**Directions:** Use the illustration below to answer questions 1-2.



1. Which process does the illustration best demonstrate?
  - A. It demonstrates how strands of a DNA molecule separate during replication.
  - B. It demonstrates why mutations can be passed from parent to child.
  - C. It demonstrates why a child can show a mixture of family characteristics.
  - D. It demonstrates how an error may occur in the genetic material of a cell.
2. Which statement about the illustrated process is true?
  - A. It occurs only in male gametes.
  - B. It occurs during an early phase of mitosis.
  - C. It allows the redistribution of linked genes.
  - D. It results in reduced genetic variation among gametes.



### Test-Taking Tip

When answering a multiple choice question, cover the answer options and read the question stem. Try to answer the question on your own. Next, read the stem with each option and eliminate the options you know are incorrect. Finally, select the answer that seems to most closely answer the question.

**Directions:** Answer the questions below.

3. A cut on your hand heals as the result of \_\_\_\_\_.
- A. DNA replication
  - B. genetic recombination
  - C. electromagnetic radiation
  - D. mutation of a single allele
4. Which is not a characteristic of a mutation?
- A. creates a permanent change in DNA
  - B. is a failure of the replication process
  - C. may compromise an organism's fitness
  - D. allows healthy diversity among organisms
5. Genetic errors can occur during replication or other normal processes related to genetic material. Categorize these results of genetic error by writing them in the correct column of the table below. One item will be used twice.

cancer	Down Syndrome	cystic fibrosis
May be passed on, parent to child		Cannot be passed on, parent to child

Genetic Information Lost (switched or added at the chromosome level)	Error in DNA Coding within Egg or Sperm Cells	Errors During Replication that affect Body Cells

**Directions:** Choose the correct terms to complete the sentences below.

6. When an organism reproduces, new traits may occur that benefit the offspring. These traits are the result of the process called 1 Select... ▼, as shown in the illustration. During this process, genes are exchanged between male and female 2 Select... ▼. In this way, both the sperm cell and the egg cell receive a new combination of genes, and the offspring will have new traits that are not identical to those of either parent.

1 Select... ▼

- A. crossing over
- B. mitotic division
- C. DNA replication
- D. genetic variation

1 Select... ▼

- A. sperm cells
- B. alternative genes
- C. complex molecules
- D. matching chromosomes



## Lesson 4.4 Heredity: Genetic Variations and Expression

### Genetic Expression and the Environment

The chemical environment of a cell can have an effect on the cellular processes that regulate gene expression. These environmentally induced changes can affect physical characteristics.

**Directions:** Use the passage below to answer questions 7-9.

### Genetic Engineering

Detailed knowledge of DNA, genes, and chromosomes is relatively new because of the complex technology scientists needed to study such small structures. However, that does not mean that the study of genetics is new. For thousands of years, people have been using their observations to breed plants and animals with specific traits. This technique is called selective breeding. Nevertheless, the process takes time, and changes occur slowly over several generations. A faster and more complex method of controlling the genetic makeup of an organism is genetic engineering. This is the deliberate alteration of the structure of genetic material in a living organism.

One method of genetic engineering involves cutting a portion of the DNA from one organism and inserting it into another organism. DNA formed by combining pieces from different sources is described as recombinant (ree KAHM buhnunt) DNA. Scientists generally transfer DNA from a more complex organism to a simpler one. For example, they might transfer DNA from a human to a bacterial cell.

The organism into which the recombinant DNA is inserted is known as the host organism. The host organism uses the foreign DNA as if it were its own. When the bacteria reproduce, a copy of the DNA in a cell is made. The cell then divides into two cells that are identical to the original cell. When a bacterial cell containing human DNA reproduces, the cells produced also contain human DNA.

Why would scientists want to insert human DNA into bacteria? One reason is to produce substances that humans need. Insulin is a protein humans need to control the level of sugar in the blood. People with a condition known as diabetes must take injections of insulin every day. Genetically engineering bacterial cells that produce human insulin creates a plentiful supply of needed insulin.

7. By which process would the bacterial cell reproduce?
  - A. meiosis
  - B. mutation
  - C. replication
  - D. epigenetics
8. As used in the passage above, the word trait means\_\_\_\_\_.
9. The cell containing the foreign DNA reproduces once, twice, and a third time. How many of the eight resulting cells will contain the foreign DNA?
  - A. all of them
  - B. six of them
  - C. two of them
  - D. half of them



## Selection and Adaptation Lesson 4.5

This lesson will help you practice working with concepts related to natural selection and adaptation. Use it with core lesson 4. 5 Selection and Adaptation to reinforce and apply your knowledge.

### Key Concept

Through natural selection, adaptations evolve. Natural selection explains how species change over time and how new species arise.

### Core Skills & Practices

- Reconcile Multiple Findings, Conclusions, or Theories
- Draw Conclusions

## Natural Selection

Natural selection is a process by which organisms that are best adapted to their environment tend to survive and pass on genetic characteristics to their offspring.

**Directions:** Answer the following questions.

1. What observation did Darwin most likely make about tortoises living on the Galápagos Islands that caused him to question how species evolve?
  - A. They all lived only on land.
  - B. They were not highly vulnerable to predators.
  - C. Their necks were different lengths and their shells were different shapes.
  - D. The offspring had a high mortality rate.
2. What relationship did Charles Darwin recognize regarding the 13 different species of finches he observed?
  - A. Beak shape was related to food type.
  - B. Bone density was related to migration patterns.
  - C. Leg length was related to ability to escape predators.
  - D. Feather color was related to flora found in the environment.
3. A genetic mutation in a moth results in the moth emitting a new scent. Write A, B, C, and D in the appropriate box below to identify the correct sequence in the process of natural selection.
  - A. Two distinct species of moths with specific scents develop.
  - B. Many male moths are very attracted to the female moth emitting the new scent.
  - C. Offspring of the moth with the new scent produce a growing population of moths with the scent, while the population of moths with the original scent gets smaller.
  - D. The moth populations interbreed in captivity but in the wild breed only with their kind.

1.	
2.	
3.	
4.	

## Lesson 4.5 Selection and Adaptation

### Adaptations

An adaptation is any trait that helps an organism survive and reproduce in its environment.

**Directions:** Answer the following questions.

4. Which is an example of mimicry?
- A. a stick insect that looks like the twigs found on the tree where it lives
  - B. a hare whose fur changes from brown to white in the winter
  - C. a nonpoisonous pine snake vibrating its tail like a poisonous rattle snake
  - D. a rose plant that produces brightly colored flowers to which bees are attracted
5. On the Galapagos Islands, Darwin observed that finches that ate large seeds had a thick beak, while those that ate small seeds had a much thinner beak. What would happen to the finch population on an island where all the birds had thick beaks if the seeds they eat suddenly became much smaller?
- A. The birds would feed on other types of seeds because their beaks are thicker.
  - B. The birds would reproduce with smaller beaked bird species to pass on the small beak trait
  - C. The birds would need to evolve to have smaller beaks to feed on the smaller seeds.
  - D. The birds would find it difficult to survive because their beaks are not suited for smaller seeds.

**Directions:** Read the passage below. Then choose the option that correctly completes each sentence.

6. Many adaptations help to protect organisms from predators. An important adaptation is 1 **Select ... ▼**, which helps an organism blend into the surrounding environment. Another important adaptation is 2 **Select ... ▼**, the ability of a harmless organism to look like a different, more dangerous organism.

1 **Select ... ▼**

- A. mimicry
- B. camouflage
- C. bright coloration
- D. protective covering

2 **Select ... ▼**

- A. mimicry
- B. camouflage
- C. bright coloration
- D. protective covering



### Test-Taking Tip

The more you practice reading different types of texts of different lengths, the better prepared you will be to read and understand passages presented in reading tests. A good way to practice is to read as much as you can about subjects that interest you. Not only will you become a better reader when taking a test, you will also increase your enjoyment of reading.

## Speciation

Speciation is a process that results in a new species of organism arising from a parent organism.

**Directions:** Answer the following question.



7. A scientist studying the birds shown in the image notes that both ducks and herons spend a great deal of time in the water. The scientist also observes that the foot structures of the two birds are very different. Which explanation can be used to reconcile these findings?
- A. The webbed feet of the duck are suited to swimming. A heron walks through water instead of swimming, so it needs a foot structure better suited for wading.
  - B. Ducks need to swim to obtain their food from the water, but herons feed on small animals that live at the shoreline, so they do not need to have a foot structure that allows them to move easily in shallow water.
  - C. A heron spends its time in the water only at the shoreline, so it does not need a foot structure that helps to move it through the water. The webbed feet of ducks allow the birds to live for long periods of time in the water.
  - D. The structure of the heron's feet is well suited for wading, but the webbing of the duck's feet increase the surface area of the foot making it very well suited for walking on rocky shorelines with ease.

**Directions:** Use the passage below to answer questions 8-9.

Marsupials in Australia evolved from the same ancestor. Kangaroos and koalas are both marsupials, but they are very different animals. Kangaroos are large animals that move on two powerful hind legs that help them travel long distances to find food. As they move, kangaroos also make use of large, powerful tails, which they use for balance and for defense. Koalas are far smaller marsupials that climb trees in order to find eucalyptus leaves to eat.

8. How are kangaroos and koalas examples of adaptive radiation? Explain your response.
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
9. Kangaroos and koalas are separate species. What trait needs to occur in order for two species that evolved from a common ancestor to be considered separate species?
- A. The two species have to have different feeding habits.
  - B. The two species must look different from each other.
  - C. The two species are not able to reproduce viable offspring with each other.
  - D. The two species cannot survive in the same habitat anymore.