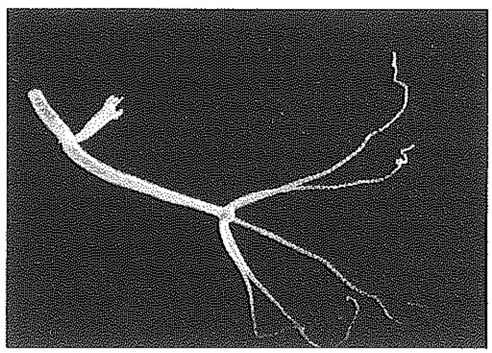
Sunshine State Standards: SC.F.2.3.1

# Review 10

## Reproduction and Heredity

You may have heard of a mythical beast called the hydra. According to Greek myths, the hydra had dozens of heads. If one head were chopped off, two more heads quickly grew in its place, making the beast nearly impossible to kill. There is also a tiny multicellular organism called the hydra. If you cut a hydra in half, the halves will develop into two new hydras; this is why scientists named these organisms hydras.

Hydras have two methods of **reproduction**—that is, of making young versions of themselves. In the first method, a tiny hydra grows out of the side of a parent. The new hydra then breaks off from the parent and lives its own life. A new hydra made by this method is a clone of the parent. In the second method, one hydra makes egg cells and a second hydra makes sperm cells. When an egg and sperm cell join, they produce a new hydra. A hydra produced by this method is not a clone of either parent. Instead, the new hydra is slightly different than both parents.



The hydra is a very simple animal that reproduces both sexually and asexually.

Why does one method of reproduction make a clone while another method makes a different hydra? This review will answer this question and more.

**Words to Know**

- allele
- asexual reproduction
- binary fission
- chromosome
- DNA
- dominant allele
- fertilization
- gamete
- gene
- genotype
- heredity
- heterozygous
- homozygous
- incomplete dominance
- meiosis
- phenotype
- Punnett square
- recessive allele
- reproduction
- sexual reproduction
- spore

## Word Links

Look at the "Words to Know" list on the previous page. Circle three words that you don't know or that you want to learn more about. Then, on a separate piece of paper, write each word and what you think each word means.

## Heredity

Before getting into reproduction, we need to quickly review **heredity**. Heredity refers to the transmission of traits from parents to offspring. For example, bacteria, rabbits, and humans all pass on traits to their offspring. **Genes** control the traits that appear in those offspring. When organisms reproduce, they give genes to their offspring, and those genes cause traits to appear. So, the genes your parents gave you are responsible for your eye color, your natural hair color, the shape of your ears, and so on. Each gene is a small piece of a long molecule called **DNA**. In the reproductive process, DNA arranges itself into structures called **chromosomes**.

Write the term that matches each definition.

A section of a DNA molecule that controls a trait: ______________________________

The passing of traits from parents to offspring: ______________________________

A long molecule that contains genes: ______________________________

A characteristic in a plant or animal: ______________________________

The structure into which DNA arranges itself: ______________________________

Now that we've covered this vocabulary, we can look at the two major reproductive strategies.

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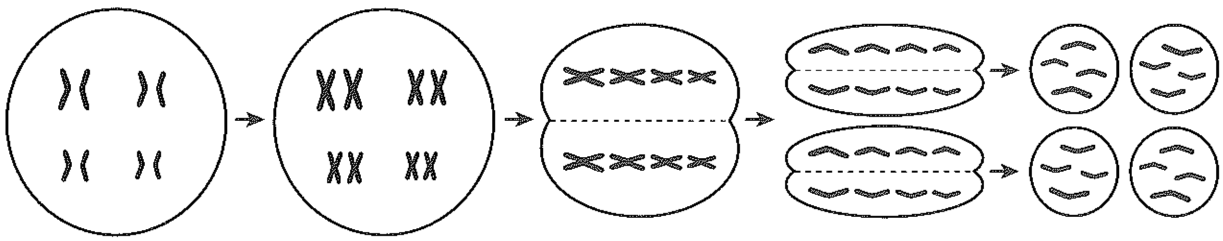
## Sexual Reproduction

The offspring of **sexual reproduction** have two parents. The male contributes a sperm cell; the female contributes an egg cell. The sperm and egg cells are called **gametes**. Organisms that reproduce sexually make gametes through a two-step process known as **meiosis**. The end result of meiosis is four sex cells, each with half the chromosomes of the original cell. In males, this produces four sperm cells. In females, only one of the four gametes becomes an egg; the other three do not.



| | | | | |
|---|---|---|---|---|
| chromosomes paired but not yet duplicated | each chromosome in a pair duplicates; duplicates attach at middle | pairs of duplicated chromosomes separate; duplicates move to either side of dividing cell | first cell division complete; then, duplicates separate and move to either side of dividing cell | second cell division complete; each gamete ends up with four unpaired chromosomes |

The illustration above shows meiosis in an organism that has cells containing four pairs of chromosomes. Write a sentence stating how many chromosomes are in each sex cell that the organism produces.

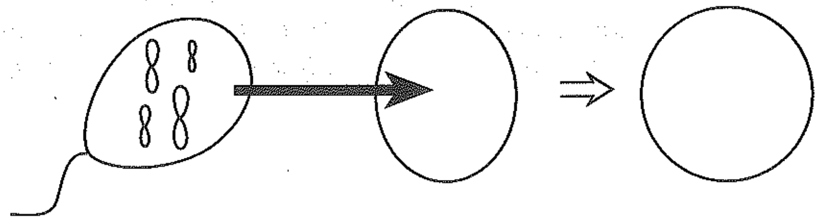
______________________________________________

Most human cells have 46 chromosomes. How many chromosomes are in a human sex cell?

______________________________________________

Why do sex cells have only half as many chromosomes as other cells? This ensures that offspring receive genes from both parents. The process by which a sperm and an egg cell join is called **fertilization**. In fertilization, half of the male's chromosomes join with half of the female's chromosomes to make one complete set of chromosomes. The new organism now has a complete set of genes. Because half of the genes came from one parent and half from the other, the offspring's set of genes is different from either of the parent's set of genes.

A certain organism with eight chromosomes reproduces sexually. The diagram below shows a sperm cell joining with an egg cell. Complete the diagram to show the process of fertilization.



## Asexual Reproduction

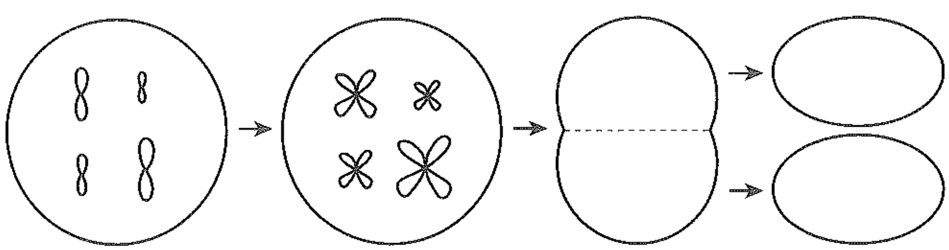
In **asexual reproduction**, the offspring has one parent that multiplies without using sex cells (egg and sperm) or fertilization. The offspring of asexual reproduction are almost always exact genetic copies of the single adult parent.

Name one organism (plant or animal) that reproduces asexually.

______________________________________________

Asexual reproduction comes in different types. Some simple animals, such as corals, reproduce by budding. A group of cells (called a bud) develops on part of the organism and eventually grows into a new individual. Fungi (such as mushrooms) and mosses can reproduce asexually by making **spores**. Wind and water carry away the spores, which grow into new organisms. Bacteria usually only have one chromosome and reproduce by **binary fission.** A cell duplicates its chromosome(s) and then divides into two cells. Each new cell is an exact copy of the parent. The offspring of asexual reproduction are almost always exact copies of the parent.

A certain organism with four chromosomes reproduces asexually. Complete the following diagram to show how the chromosomes are distributed.



| parent cell has four chromosomes that are not yet duplicated | chromosomes duplicate, attach at middle | duplicates separate, move to either side of dividing cell | cell division complete: each daughter cell has four chromosomes |
|---|---|---|---|

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# Phenotype and Genotype

Scientists can study traits by examining how organisms look on the outside. The outside expression of a gene is called the **phenotype**. For example, suppose Chris has dimples on his cheeks. A scientist will say that Chris is expressing the dimple phenotype. Scientists are also able to study traits by examining the genes that code for them. Humans have two copies of each gene, called **alleles**, one from the biological mother and one from the biological father. When scientists determine which two alleles a person has, they are determining the person's **genotype**.

Just because we can see that Chris has the dimple phenotype, it does not mean we know his genotype. A **dominant allele** causes dimples in humans. Dominant alleles hide the expression of **recessive alleles**. Scientists use an uppercase letter (*D*) to indicate a dominant allele and a lowercase letter (*d*) to indicate a recessive allele. The dimple gene has three possible genotypes: *DD*, *Dd*, or *dd*. Chris has dimples. Therefore, we know that Chris has at least one dominant allele. His genotype is either *DD* or *Dd*. If a person has two identical alleles, that person is **homozygous** for a trait. If a person has two different alleles, that person is **heterozygous** for a trait. If Chris's genotype is *DD*, then he is homozygous dominant. If his genotype is *Dd*, then he is heterozygous.

Lupe doesn't have any dimples. Write the letters for her genotype. ____________________

What is Lupe's genotype: homozygous dominant or homozygous recessive?

______________________________________________________________________

Sometimes, one allele is not completely dominant over another allele. This condition is called **incomplete dominance**.

A good example can be found in the snapdragon flower. In snapdragons, if a plant has the genotype *RR*, the blooms of the flower are red. If a plant has the genotype *rr*, the blooms of the flower are white. If a plant has the genotype *Rr*, however, the blooms are pink, not red. When there is incomplete dominance, a third phenotype appears when both alleles are present. (Red flowers are the first phenotype, white flowers are the second phenotype, pink flowers are the third phenotype.)

The two alleles that show incomplete dominance do not become "mixed." If two *Rr* snapdragons are crossed, some of the plants will have red flowers (*RR*), some will have white flowers (*rr*), and some will have pink flowers (*Rr*).

# Punnett Squares

If you know the genotypes of people who are about to have a baby, you can use a **Punnett square** to predict the probability that their child will inherit a particular genotype and phenotype. Let's use the example of tongue rolling to look at how a Punnett square works. The ability to roll one's tongue is caused by a dominant allele. People who are homozygous dominant (*TT*) or heterozygous (*Tt*) are able to roll the sides of their tongues up. People who can't roll their tongues are homozygous recessive (*tt*).

A Punnett square shows all of the possible combinations of alleles that children can inherit when two people produce offspring. Let's look at a Punnett square that shows the pairing of two people who are heterozygous for tongue rolling.

| Heterozygous for Tongue Rolling (*Tt*) | | Heterozygous for Tongue Rolling (*Tt*) | |
|---|---|---|---|
| | | ***T*** | ***t*** |
| | ***T*** | *TT* | *Tt* |
| | ***t*** | *Tt* | *tt* |

A Punnett square shows the probability (the chances) of an offspring inheriting a particular genotype or phenotype. You can express probability as a ratio, a fraction, or a percentage. Look at the Punnett square above. Two of the four possible combinations are *Tt*. You can write the probability of an offspring getting the *Tt* genotype as 1:2, $\frac{1}{2}$, or 50%.

State the probability of an offspring having the *tt* genotype.

Ratio: __________ Fraction: __________ Percentage: __________

State the probability of an offspring having the tongue-rolling phenotype.

Ratio: __________ Fraction: __________ Percentage: __________

State the probability of an offspring not having the recessive allele (*t*).

Ratio: __________ Fraction: __________ Percentage: __________

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## Word Links

Now that you've read through this review, go back to the words you circled in the "Words to Know" list. Write each word in the "Word Links" table your teacher has provided you. Fill out one row for each word.

## *Keys to Keep*

- **Organisms inherit traits from their parents.**
- **The genes that code for traits are found on DNA chromosomes.**
- **Sexually reproducing organisms receive half of their chromosomes from a female and half from a male.**
- **Meiosis produces sex cells with half the chromosomes of the parent.**
- **Asexually reproducing organisms receive all of their chromosomes from one parent.**
- **Phenotype refers to how an organism looks.**
- **Genotype refers to which alleles are in an organism's DNA.**
- **Alleles can be dominant, recessive, or show incomplete dominance to each other.**
- **Punnett squares help find the probability of a trait being passed on.**

# Explore It Yourself

The camellia flower provides another example of incomplete dominance. Like the snapdragon, two alleles for red color (*RR*) produce red blooms, two alleles for white color (*rr*) produce white blooms, and one allele for red color and one allele for white color (*Rr*) produce pink blooms.

The following paper-and-pencil exercise uses Punnett squares to explore the inheritance of alleles in a relation of incomplete dominance.

Step 1: Suppose that a camellia with red flowers (*RR*) and a camellia with white flowers (*rr*) produce offspring. Fill in the following Punnett square with the correct two-letter codes for the offspring of this cross.

**Camellia with White Flowers**

| Camellia with Red Flowers | | *r* | *r* |
|---|---|---|---|
| | *R* | | |
| | *R* | | |

Step 2: Now suppose that two of the offspring from Step 1 fertilize each other and make more offspring. Use the following blank Punnett square to show the results of this cross. First, fill in the correct two-letter codes for both parents. (Be sure to label which parent is which, as above.) Then, find the offspring of the pairing.

| | | |
|---|---|---|
| | | |
| | | |

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## What Does It Mean?

1. Suppose that the red camellia and the white camellia from Step 1 make 100 offspring. Expressed as a percentage, what is the probability that an offspring will have the following colors of blooms?

   White blooms: ____________ Red blooms: ____________ Pink blooms: ____________

2. Suppose that the two pink camellias from Step 2 make 100 offspring. Expressed as a percentage, what is the probability that an offspring will have the following colors of blooms?

   White blooms: ____________ Red blooms: ____________ Pink blooms: ____________

3. What evidence do you have that the alleles for red and white blooms do not physically merge into a single "pink" allele?

   ______________________________________________________________________

   ______________________________________________________________________

   ______________________________________________________________________

   ______________________________________________________________________

   ______________________________________________________________________



Florida Science Practice begins on the following page.

Mother's Genes

| Father's Genes | W | ? |
|---|---|---|
| ? | Ww | |
| w | | ww |

1. Look at the partial Punnett square pictured above for the widow's peak trait. What can be concluded about the genotype of each parent?

   A. One parent is heterozygous; the other parent is homozygous recessive.

   B. Both parents are homozygous dominant.

   C. One parent is homozygous dominant; the other parent is heterozygous.

   D. Both parents are homozygous recessive.

2. In the four o'clock plant, plants with two dominant alleles (*RR*) have red flowers, plants with one dominant and one recessive allele (*Rr*) have pink flowers, and plants with two recessive alleles (*rr*) have white flowers. If two plants with pink flowers are crossed, what percentage of the offspring can be expected to have **red** flowers?

   F. 25%

   G. 50%

   H. 75%

   I. 100%

3. What is the **advantage** of sexual reproduction in plants and animals?

   A. Mutations never occur in sexual reproduction.

   B. The offspring are not exactly the same as the parents.

   C. Many more offspring can be produced by sexual reproduction.

   D. Not as many cells are needed for sexual reproduction.

4. A certain mammal has 12 chromosomes in a gamete cell. How many chromosomes are in a body cell of this mammal?

   F. 6

   G. 12

   H. 24

   I. 36

5. Amanda is not sick, but she is the carrier of a disease allele. What is another way to describe her condition?

   A. homozygous dominant for the disease gene

   B. heterozygous for the disease gene

   C. recessive for the disease gene

   D. homozygous recessive for the disease gene





Go On

**6** Which of the following is an example of asexual reproduction?

F. Mrs. Kinney prevents one type of sweet corn in her garden from pollinating another type of sweet corn in her garden.

G. Mrs. Kinney gives her neighbor some seeds that grew in her garden so the neighbor can plant a garden next year.

H. Mrs. Kinney takes pollen from one plant and uses it to fertilize another plant.

I. Mrs. Kinney gives her neighbor a leaf from one of her African violets so the neighbor can start a new plant with it.

READ
INQUIRE
EXPLAIN

**7** Michelle's mom is breeding flowers in her garden. She has white petunias and red petunias. Last week a new petunia plant showed up in the garden and it had pink flowers. Michelle's mom was wondering where the pink flowers came from, but Michelle knew. In the space below, write the explanation Michelle should give to her mother.

______________________________________________

______________________________________________

______________________________________________

______________________________________________