

Review 5

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.

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

Heredity

Before getting into reproduction, we need to quickly review heredity. **Heredity** refers to the passing 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: _____

Scientists make a distinction between inherited traits and learned traits. An inherited trait is a quality that is controlled by specific genes, and is passed on from parents to offspring by reproduction. Learned traits are qualities or abilities that an organism gains through experience. For example, a child is not born knowing how to speak a particular language, such as English or Spanish. Instead, the child learns how to speak a given language over time.

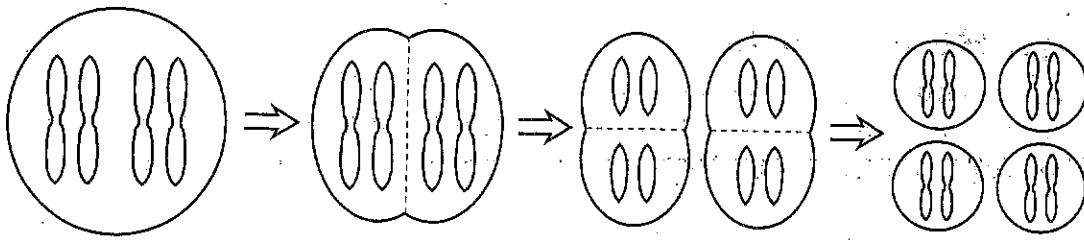
The language that a person speaks is a learned trait. Is the ability to speak at all a learned or an inherited trait?

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

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.

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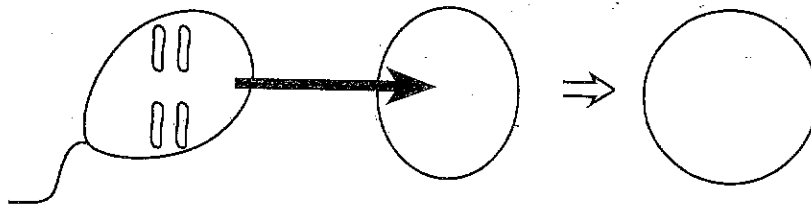


The illustration above shows meiosis in an organism that has cells containing four chromosomes. Write a sentence stating how many chromosomes are in each sex cell that the organism produces.

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.



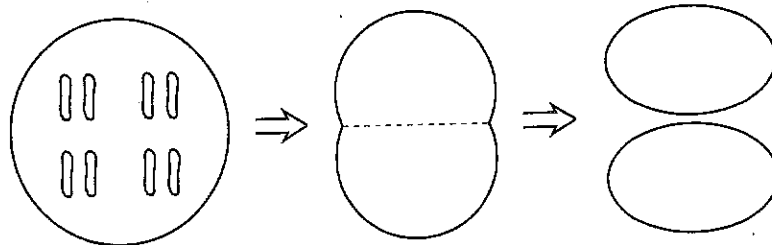
Asexual Reproduction

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. Finally, many single-celled organisms (such as bacteria, protists such as amoebas and paramecia) reproduce by **binary fission**. A cell duplicates its chromosomes 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 eight chromosomes reproduces by binary fission. Complete the following diagram to show how the chromosomes are distributed.



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 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?

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 children will inherit their alleles. 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 that are homozygous dominant (TT) or heterozygous (Tt) are able to roll their tongues into a "tongue taco." People that 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 mating between two people that are heterozygous for tongue rolling.

		Heterozygous for Tongue Rolling (Tt)	
		T	t
Heterozygous for Tongue Rolling (Tt)	T	TT	Tt
	t	Tt	tt

The genotypes written inside the Punnett square are all of the genotypes possible in the offspring of these two people. Notice that their children have a 75% chance of being tongue rollers and a 25% chance of not being tongue rollers.

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, eggs and sperm, 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 and recessive to each other.
- You can use Punnett squares to determine the probability of an offspring having a trait.

Explore It Yourself



Sometimes alleles are neither dominant nor recessive to each other. Take, for example, the flower called the camellia. The camellia has one allele for red flower color and one allele for white flower color. A camellia with two red alleles makes red flowers. A camellia with two white alleles makes white flowers. A camellia with one red allele and one white allele makes pink flowers. When both alleles affect an organism's phenotype, biologists say the alleles are in a relationship of **incomplete dominance**. 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	
		r	r
Camellia with Red Flowers	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.

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?

NJ ASK Practice

		Mother's Genes	
		W	?
Father's Genes	?	Ww	
	w		ww

- The diagram above is a partial Punnett square for the widow's peak trait. What can be concluded about the genotype of each parent?
 - One parent is heterozygous; the other parent is homozygous recessive.
 - Both parents are homozygous dominant.
 - One parent is homozygous dominant; the other parent is heterozygous.
 - Both parents are homozygous recessive.
- Which of the following is an example of an inherited trait?
 - Donald plays the banjo.
 - Lucas rolls his tongue.
 - Mikayla speaks French.
 - Wanda enjoys swimming.
- Genes code for inherited traits. Which of the following **best** describes a gene?
 - a carbohydrate molecule
 - a small protein molecule
 - a section of a DNA molecule
 - a chromosome
- What is the name for the process in which gametes merge to produce a complete set of chromosomes?
 - binary fission
 - fertilization
 - meiosis
 - zygosis
- A certain mammal has 12 chromosomes in a gamete cell. How many chromosomes are in a body cell of this mammal?
 - 6
 - 12
 - 24
 - 48

6. 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

7. Which of the following is an example of asexual reproduction?

- A. Mrs. Floyd gives her neighbor a leaf from one of her African violets so the neighbor can start a new plant with it.
- B. Mrs. Floyd gives her neighbor some seeds that grew in her garden so the neighbor can plant a garden next year.
- C. Mrs. Floyd takes pollen from one plant and uses it to fertilize another plant.
- D. Mrs. Floyd prevents one type of sweet corn in her garden from pollinating another type of sweet corn in her garden.



8. The diagram shows the results of sexual reproduction. In this species of mouse, white color (W) is dominant over black color (w). Describe the genotypes of the two parents.
