

X-Linked Traits

by Sophia



WHAT'S COVERED

In this lesson, you will learn about traits and disorders associated with the sex chromosomes.

Specifically, this lesson will cover:

1. X-Linked Traits and Disorders

1a. X-Linked Recessive Disorders

1b. X-Linked Dominant Disorders

2. Inheritance

1. X-Linked Traits and Disorders

Sex chromosomes, also known as the X and Y chromosomes, determine an individual's biological sex. Human females inherit an X chromosome from their father for a composed XX genotype. Human males inherit a Y chromosome from their father for a composed XY genotype. X-linked traits are disorders related to a person's X chromosomes. Both males and females can be affected by X-linked traits; however, males are generally more at risk of being afflicted by an X-linked trait because they only have one X chromosome. If only one X chromosome is affected in a female, the other X chromosome will generally mask the effect.



TERM TO KNOW

Sex Chromosome

The chromosomes that, when paired, determine the biological sex of the organism, in humans XX = female while XY = male.

1a. X-Linked Recessive Disorders

X-linked traits or disorders can be caused by recessive alleles or a dominant mutant allele on an X chromosome. The following are examples of X-linked recessive disorders:

- **Hemophilia:** A bleeding disorder in which blood doesn't properly clot.
- **Red-green color blindness:** A disorder where a person can't distinguish between the colors red and green.
- **Duchenne's muscular dystrophy:** A disorder in which muscles begin to degenerate over time.



TERMS TO KNOW

Hemophilia

An X-linked recessive disorder that affects the blood's ability to clot.

Red-Green Color Blindness

An X-linked recessive disorder in which a person cannot distinguish between the colors red and green.

Duchenne Muscular Dystrophy

An X-linked recessive disorder in which the muscles deteriorate over time.

1b. X-Linked Dominant Disorders

Disorders caused by a dominant mutant allele on the X chromosome are much less common. **Faulty enamel trait** is an example of an X-linked dominant disorder. The enamel that protects your teeth doesn't properly develop in people with this disorder. Their teeth will rot easily because they don't have protective enamel on their teeth.



TERM TO KNOW

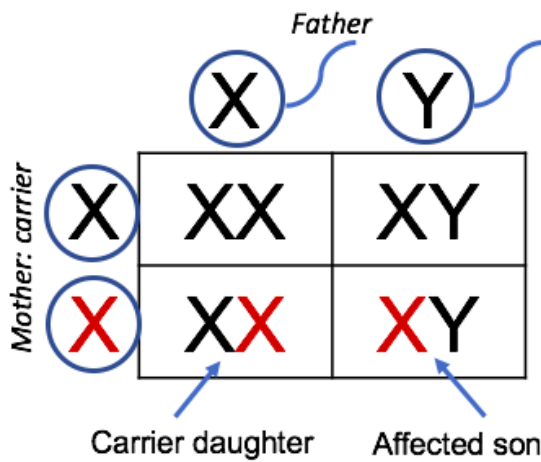
Faulty Enamel Trait

A disorder caused by a dominant mutant allele on the X chromosome in which enamel that protects teeth does not properly develop.

2. Inheritance

Using hemophilia as an example, it is possible to look at how these types of disorders can be passed on. We know that a mother can pass on one of two X chromosomes. Remember that a father can pass on an X and a Y chromosome. If he passes on an X chromosome, the child will be female. If he passes on a Y chromosome, the child will be male. A father with an X-linked disorder like hemophilia will therefore only pass this trait on to a daughter and never to a son. Let's look at more potential combinations.

On the Punnett square below, the 4 boxes are potential combinations, each with a 25% probability of occurrence. The alleles listed on the top are the sperm a father can supply, and the alleles listed on the left side are the possible eggs a mother could supply. This example shows the mother as a carrier for hemophilia. The X shown in red is the recessive allele that is affected.



Because the mother has a normal X chromosome, any effect the recessive X would have is probably masked. She is only a carrier. She has a 50% chance of passing this chromosome on to any of her children, creating either a daughter who is a carrier like her or a son who has hemophilia. She also has a 50% chance of passing on an X chromosome that is not affected, creating a daughter or a son that is not affected. Since she also has a 50% chance of having either a daughter or a son, the likelihood that she will have a son with hemophilia is therefore 25%.

This illustrates how X-linked traits can be passed on from parents to offspring and why males are generally more susceptible to inheriting these disorders. If they inherit the X chromosome from their mother that is affected, they will automatically get that disease.

Many X-linked disorders follow common patterns of inheritance. There are lots of different patterns of inheritance like this that geneticists can study to understand these diseases and the patterns in which these diseases are passed through generations. Pedigrees are another useful tool in tracking these disorders as well because you can follow the family history of a disease.

⇒ **EXAMPLE** One type of inheritance pattern is that only daughters can inherit recessive alleles from their affected father because the sons will get the Y chromosome. In other words, if a father is affected, he can only give an affected X chromosome. His daughters, therefore, will either be affected or be carriers.



MAKE THE CONNECTION

If you're taking the Human Biology Lab course simultaneously with this lecture, it's a good time to try the Mendelian Inheritance Activity in Unit 7 of the Lab course. Good luck!



SUMMARY

X-linked traits or disorders are those located on the X sex chromosome. They can be caused by a recessive allele or a dominant mutant allele on the X chromosome. Hemophilia, red-green color blindness, and Duchenne muscular dystrophy are examples of **X-linked recessive disorders**, and faulty enamel trait is a disorder caused by a dominant mutant allele. These disorders can be **inherited**. Women are generally only carriers of X-linked recessive traits because the second X they have can

mask the affected X. Men are most susceptible to X-linked recessive disorders because they only have one X. Geneticists can study patterns of inheritance to understand these diseases, and pedigrees can be a helpful tool for them.

Keep up the learning and have a great day!

Source: THIS WORK IS ADAPTED FROM SOPHIA AUTHOR AMANDA SODERLIND



TERMS TO KNOW

Duchenne Muscular Dystrophy

An X-linked recessive disorder in which the muscles deteriorate over time.

Faulty Enamel Trait

A disorder caused by a dominant mutant allele on the X chromosome, in which enamel that protects teeth does not properly develop.

Hemophilia

An X-linked recessive disorder that affects the blood's ability to clot.

Red-Green Color Blindness

An X-linked recessive disorder in which a person cannot distinguish between the colors red and green.

Sex Chromosome

The chromosomes that, when paired, determine the biological sex of the organism, in humans XX = female while XY = male.