

Some Notes about Sex-Linked Genes

General Genetic Information

Autosome: all chromosomes (1-22) except the sex chromosomes

Sex chromosome: the Y and X chromosomes

Sex determination:

- autosomes and sex chromosomes segregate during meiosis (review meiosis if necessary)
- sex of offspring is determined by the combination of sex chromosomes in the fertilized egg. The mother can only contribute an X chromosome because her genotype is XX, however the father can contribute either an X or a Y, because his genotype is XY. Therefore, the genotype of the off-spring is either male or female depending on whether the gamete receives an X or Y from the FATHER.
 - o Most organisms: XX=female XY=male
- The sex of some animals is determined in different ways.
 - o Grasshoppers XX=girl XO=male
 - o Ants and bees have NO sex chromosomes—sex determined by total chromosome number.
 - Males-unfertilized egg, haploid Females-fertilized egg, diploid
 - o Fish and reptiles-sex determined by factors in the environment—like the temperature

Sex-Linked Genes

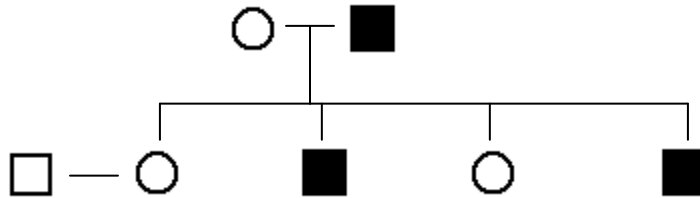
Sex-linked gene:

- a gene that is located on the X or Y chromosomes

Sex-linked gene examples:

- White-eyes in fruit flies: If a fruit fly is white-eyed, then it must be male because the gene that makes the color of the eyes white is located on the Y chromosome. White eyes in fruit flies is a Y-linked trait..
- Muscular dystrophy: Characterized by progressive weakness and degeneration of the skeletal and voluntary muscles with control movement
 - a. Affects people of all ages
 - b. Different forms have different onset ages, ranges from infancy to middle age or later
 - c. No specific treatment for any of the forms
 - d. Life expectancy of individuals varies by form
 - e. Examples of types of muscular dystrophy include:
 - i. Duchenne Muscular Dystrophy, with an onset of 2 to 4 years, (X-linked)
 - ii. Becker Muscular Dystrophy, with an onset in the teen and young adult years, (X-linked)
 - iii. Emery-Dreifuss Muscular Dystrophy, with an onset of childhood or adulthood, (X-linked or autosomal)
 - iv. Note: there are other forms of muscular dystrophy that are autosomal instead of X-linked
- Hairy ears in humans: The gene for hairy ears is found only on the Y chromosome (Y-linked). Therefore, males are the only ones to have this sex-linked gene.

Below is an example of a pedigree for a Y-linked gene.



- Color-blindness in humans: The gene for color blindness is located on the X chromosomes (X-linked) and is recessive. This means that color blindness affects more males than females because males only get one X chromosome while females get two X chromosomes. If a female has the gene for color blindness on one of her X chromosomes, it is likely that she will have the dominant gene on her other X chromosome and therefore will not express the trait. On the other, if a male has the gene for color blindness he does not have a second gene that could be dominant, so he will express the trait.
- Hemophilia in humans: Like color-blindness, the gene for hemophilia is recessive and located on the X chromosome (X-linked). This means that males are more likely to be affected than females as explained above.

Historically, hemophilia has had an interesting effect on Queen Victoria and her family. She possessed the X-linked gene for hemophilia and passed this gene on to her children. This gene was passed down the royal family line, eventually affecting the youngest son of Tsar Nicolas the II, who received the gene from his mother, the granddaughter of Queen Victoria.

Reference: Huskey, Robert J. A Pedigree of Hemophilia in the Royal Families of Europe [online]. 1998. [cited 2004 June 30]. Available from URL:

<http://www.people.virginia.edu/~rjh9u/roylhema.html>.

Adapted from:

http://www.glc.k12.ga.us/builderv03/lptools/lpshared/lpdisplay.asp?Session_Stamp=21133:452036&LPID=96299