Sex Linkage

**DIRECTIONS: Watch the following video then read the information below. Finally, look over the same practice problems and complete the additional 4 problems on your own.**

<https://www.youtube.com/watch?v=h2xufrHWG3E>

About 2000 genes are on the X chromosome. Female humans inherit 2 X chromosomes so their genotype is XX for gender. One X chromosome comes from their mother and one comes from the father and so females have **2 alleles** for each X-linked gene. Males inherit only one X chromosome from their mother and a Y from the father so they only have **1 allele** for each X-linked gene.

Since there are many alleles (~2000) on the X chromosome, there are many traits and some genetic disorders that are said to be “linked” to the X chromosome (aka-sex linked genes). These traits and disorders are called “sex linked traits” or “sex linked disorders.” Examples of such traits and disorders include:

1) male-pattern baldness: thinning of hair on your head

2) Duchene muscular dystrophy: unable to produce muscles correctly leading to shorten life

3) Hemophilia: unable to clot blood correctly leading to shorten life

4) Colorblindness: unable to see red and green colors correctly

The use of the X to symbolize X-linked genes is useful when doing genetic crosses or pedigree analysis. All four of these of these traits follows a recessive pattern meaning that you need 1 copy of the recessive allele to get the trait/disorder if you are a male and you need 2 copies of the recessive allele to get the trait/disorder if you are a female.

* IT IS HARDER TO INHERIT 2 MUTATED COPIES OF AN ALLELE SO MALES USUALLY SHOW THE EFFECTS OF SEX-LINKED TRAITS MORE OFTEN THAN FEMALES!

**How do you write alleles that are associated with a gene linked to the X chromosome?**

* XD = normal allele Xd = mutated allele (ex: colorblind allele, hemophilia allele, etc)

**Male genotypes**

* XDY    normal vision
* XdY    colorblind

**Female Genotypes**

* XDXDnormal vision
* XDXd   carries colorblind allele but has normal vision (this type of phenotype is known as being a “carrier” because she carries an allele that she does not show the effect of in her phenotype)
* XdXd    colorblind

**Inheritance**

* Mothers can pass down a mutated X-linked allele to their daughters AND sons
* Fathers can only pass sex linked traits to their daughters (NOT their sons)
	+ For example:
		- A mom with XD**Xd** 🡪 her son MUST get an X from mom and a Y from dad so this

 son could be **Xd** Y so sons can ONLY inherited sex-linked

 traits from their mother because they only get a Y

 chromosome from their dad

 🡪 a daughter MUST get an X from mom and an X from dad so

 a daughter can get the mutated allele from mom OR dad.

**SEX LINKAGE- EXAMPLE PROBLEMS:**

* A colorblind blind male marries a woman, who is not color blind but her father is. What is the chance that they will have a child (boy or girl) that is colorblind?
	+ XD = normal allele
	+ Xd = colorblind allele

XDXd  x XdY

 XD Xd

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Xd | XD Xd | XdXd |  | Genotype Ratio: 25% XD Xd 25% XDY  25% XdXd 25% XDY ***\*\*Note- you need to separate XX & XY’s***Phenotype Ratio: 25% Normal Female 25% Colorblind female 25% Colorblind male 25% Normal Male ***\*\*Note- you need to separate males & females***SO…there is a 50% chance that these parents will have a colorblind child. |
|  Y | XDY | Xd Y |  |
|  |  |

* What is the chance that the same couple (from above) will have a GIRL that is colorblind?

Phenotype Ratio: 25% Normal Female

 25% Colorblind female

 25% Colorblind male

 25% Normal Male ***\*\*Note- you need to separate males & females***

SO…there is a 25% chance that these parents will have a colorblind child that is ALSO a girl.

**PRACTICE PROBLEMS:**

1. A carrier female has children with a male who has normal vision. What is the chance their daughter will be colorblind? Show the cross. Use the allele symbols XB and Xb in the Punnett square.
2. A hemophiliac female has children with a male who has normal. What is the chance their son will be hemophiliac? Show the cross. Use the allele symbols XH and Xh in the Punnett square.

1. A normal female has children with a male who is colorblind. What is the chance they will have a child that is colorblind? Show the cross. Use the allele symbols XB and Xb in the Punnett square.
2. A carrier female has children with a male who has hemophilia. What is the chance their daughter will be hemophiliac? Show the cross. Use the allele symbols XH and Xh in the Punnett square.
3. A carrier female has children with a male who is colorblind. What is the genotype and phenotype probabilities of their future children? Show the cross. Use the allele symbols XB and Xb in the Punnett square.