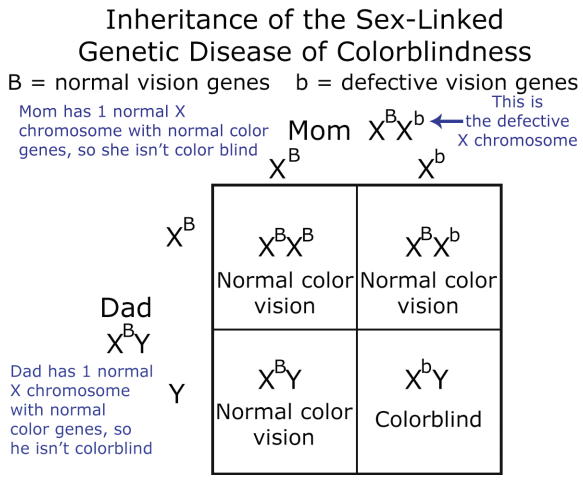
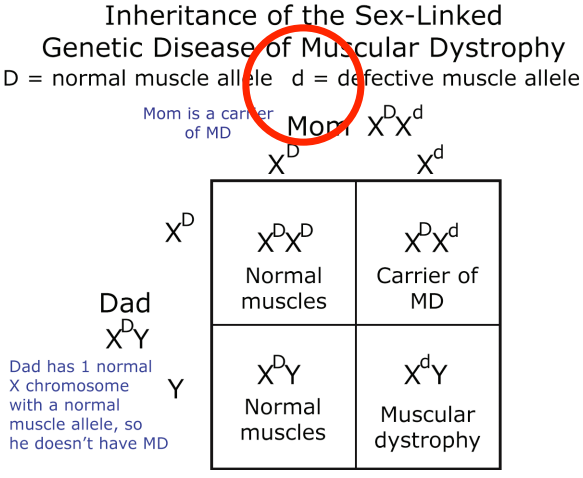
This fact—that the X chromosome carries genes for some non-sex-linked characteristics that the Y chromosome does not—sets the stage for understanding sex-linked genetic diseases. If the X chromosome carries genes for some characteristics that the Y chromosome does not have, there is no other chromosome that carries the genes for those characteristics. They are either on the sex chromosomes, or they aren't. This means boys have some characteristics that only have one chromosome—rather than the usual two—with genes coding for those conditions. Therefore, all that needs to happen for a boy to have a sex-linked genetic disease is to inherit one defective X chromosome from his mom. Since the Y chromosome is smaller and does not carry the same non-sex characteristics the X chromosome does, if the boy inherits a mutated gene on the X chromosome from his mom, there is no corresponding normal gene on the Y chromosome to counteract the defective one on the X chromosome. This is the basis of a sex-linked disease.

8.15 SEX-LINKED DISEASES

Since sex-linked genetic diseases are almost always carried on the X chromosome, geneticists commonly refer to them as "X-linked diseases." Almost all the known defective non-sex coding genes on the X chromosome lead to some type of disease if a boy inherits such a defective X chromosome from his mom. Now, some of you may have noticed that I have mentioned a couple times "if a boy inherits a defective X chromosome from his mom." Why "mom" and not "dad"? Because a boy can only inherit an X-linked disease if he inherits the defective X chromosome from his mom. All boys inherit their Y chromosome from their dads. A boy's X chromosome always comes from his mom, and since the Y chromosome doesn't have the same non-sex alleles on it the X chromosome does, there is no "normal allele" on the y to counteract an abnormal one on the X.

Let's look at a couple of real examples of sex-linked genetic disorders. The genes that code for the information to see in color are sex-linked genes. These genes code for a non-sex trait—the ability to see in color—but are carried on the X chromosome. There are no corresponding "see in color" genes on the Y; therefore, if a boy inherits a defective allele for color vision on his X chromosome, then he will be color blind. The Punnett square outlines how this happens. Dad has a normal X chromosome, so he is not color blind. Mom has one normal X chromosome and one abnormal one. Since she has a normal X chromosome, she is not color blind, but she carries the color blind-causing X chromosome, which means she is a **carrier** of the condition. The bottom right square shows how their sons could be color blind. Each son has a 50-50 chance of receiving the abnormal allele from mom, resulting in color blindness.





Muscular dystrophy (MD) is another sex-linked disease. MD causes all muscles to become small and weak, making the person with it weaker and weaker throughout life until it causes the person's death. Most people with MD die at a very young age, 20 or