6. Sex chromosomes and sex-linked inheritance

Sex chromosomes are those that determine an individual's sex. In humans and many organisms, they are distinguished from non-sex chromosomes or autosomes. In humans, there are 23 pairs of chromosomes:

Autosomes = 22 pairs of chromosomes that are identical in both sexes.

Gonosomes = sex chromosomes (X chromosome and Y chromosome).

- **Differences between X and Y chromosomes**

- **X chromosome** : This is a relatively large chromosome containing about 1,100 genes. These genes play a role in various aspects of human biology, in addition to sex determination.
- **Y chromosome** : It is much smaller than the X chromosome and contains around 50 to 200 genes. Its main role is to determine male sex, in particular through the SRY gene (Sex-determining Region Y), which initiates the development of male characteristics in embryos.

Sex-linked inheritance involves genes carried on the sex chromosomes, primarily the X chromosome in males. Traits or diseases linked to these genes follow a specific inheritance pattern called " **X-linked inheritance** " or " **X-linked recessive inheritance** ."

- **Inheritance of X-linked traits**

- **Females (XX)** : They can be homozygous (two normal alleles or two disease-carrying alleles) or heterozygous (one normal allele and one disease-carrying allele). Females often carries an X-linked disease without expressing symptoms if the defective gene is recessive.
- **Males (XY)** : They only have one X chromosome. Therefore, if this chromosome contains a defective gene, they will express the associated characteristics, because they do not have a second X chromosome to compensate.

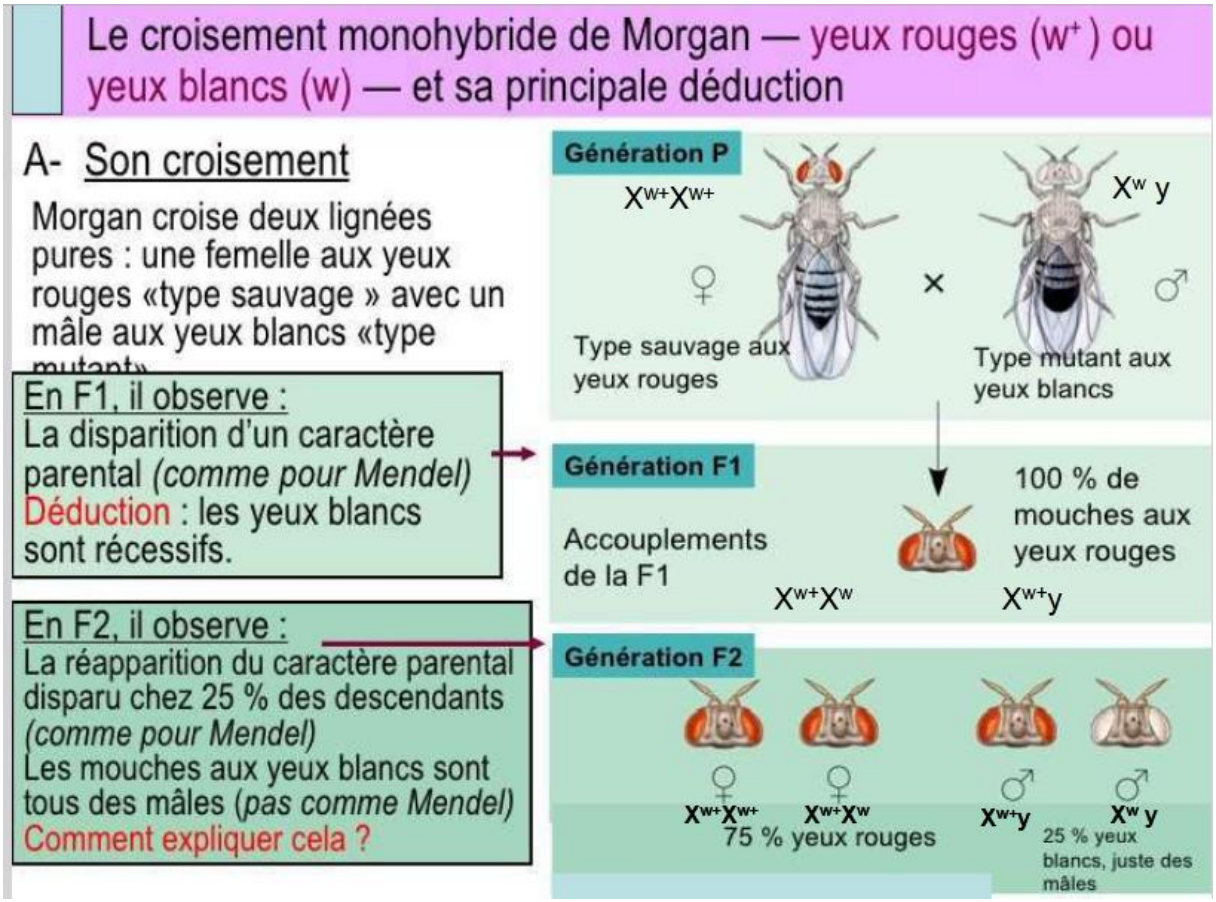
Examples of sex-related diseases

1. **Hemophilia** : A disease in which the blood does not clot properly. It is linked to a defective gene on the X chromosome.

2. **Color blindness** : Inability to distinguish certain colors (most commonly red and green) due to mutations on the X chromosome.
3. **Duchenne muscular dystrophy** : A serious muscle disease caused by a mutation in the dystrophin gene on the X chromosome.

- **'s monohybrid cross :**

Crossing for a sex-linked trait Red (w+) or white (w) eye trait



Morgan's hypothesis to explain his results: The Mendelian trait(gene) for eye color is carried on the X chromosome and has no equivalent on the Y chromosome. (Sex-linked gene).

- **Heredity influenced by sex:**

• Sex-influenced inheritance occurs when a trait is controlled by autosomal genes, which behave differently in men and women. The genes are present in both males and females, but they will only be expressed in one sex due to the presence of stimulator or inhibitor genes, which are linked to the sex chromosomes.

Example : Bulls, for example, have many genes that control milk production, they pass these genes on only to their female offspring, but neither they nor their male offspring can express this trait.

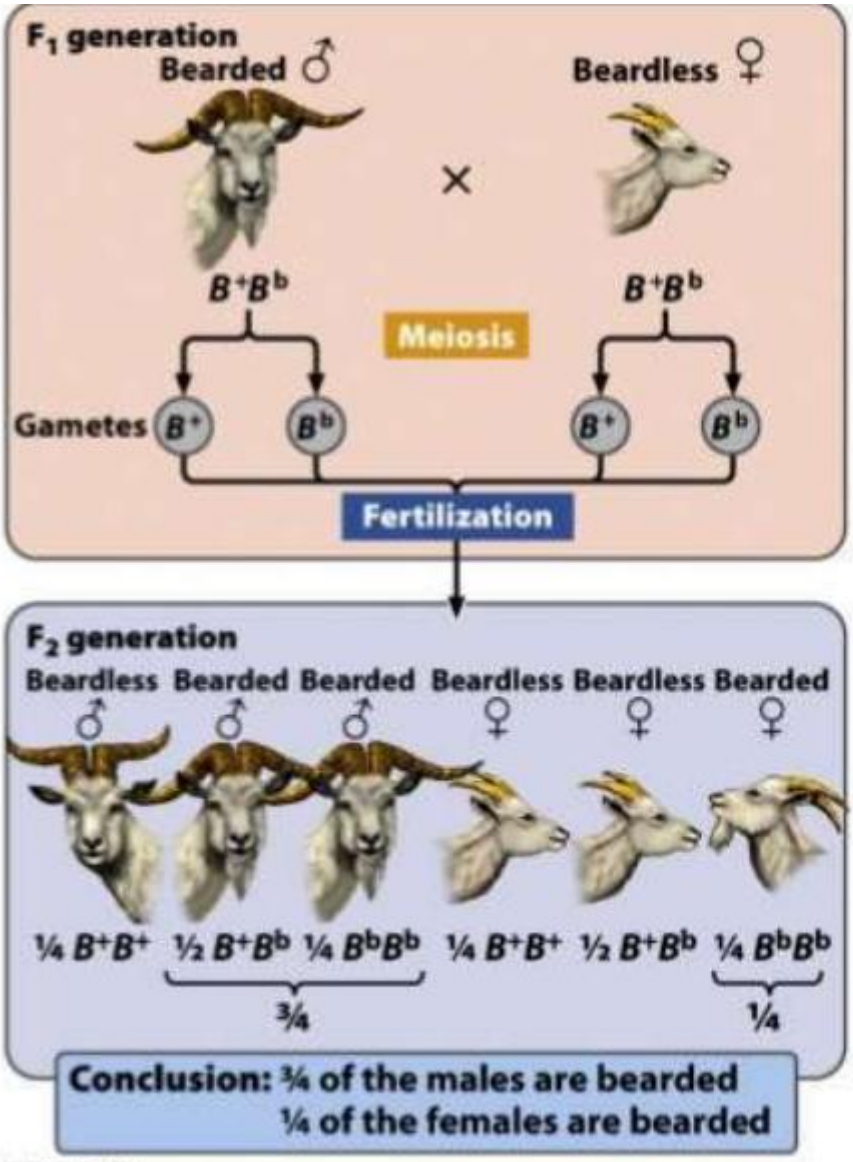


Figure 5-12b
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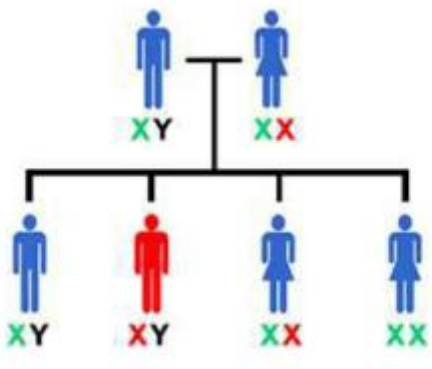
➢ **X-linked hereditary diseases due to a recessive allele**

• In this mode of inheritance, the morbid allele behaves like a recessive trait. Heterozygous women are not affected but can transmit the disease; they are said to be carriers of the disease.

• The disease often occurs in males (XY) who have only one copy of the lethal gene (hemizygous subjects).



- Color Blindness: Color blindness is when someone has the inability to distinguish the differences between certain colors.

Vue normale

Vue par un daltonien

d = color blind D = normal Dd = carrier

XDXD = normal woman XDXd = surrogate woman

XdXd = affected woman XDY = normal man

XdY = affected man

Une mère dont la vision est normale mais conductrice et un père daltonien peuvent avoir :

Père	x	Mère
X^dY		X^DX^d

a) Un garçon daltonien

b) Une fille daltonienne

La dystrophie musculaire de Duchenne: