Sex-linked Traits

**Sex-linked traits** (genes) are located on the sex chromosomes (X or Y chromosomes).

Traits that were investigated up until now were carried on **autosomal chromosomes** (not gender determining chromosomes).

When we work out sex-linked trait genetics, we must take into consideration the gender of the parents and offspring in our analysis.
Sex-linked Traits

If a gene is located on a Y chromosome it is a Y-linked trait, and can only be inherited in males.

There are a number of genes carried on the X chromosome in a number of different organisms. These are X-linked traits and can be inherited in both males and females.

For example, in fruit flies, the gene for eye colour is carried on the X chromosome.
Sex-linked Traits

Sex Chromosomes

XX chromosome - female
Xy chromosome - male

fruit fly eye color
Sex-linked Traits

Remember:
The Y chromosome in males does not carry the same traits as the X chromosome. The male only inherits one X chromosome so they either have a sex linked trait, or don’t have the trait.

Red-eyed male: \( X^R Y \)
White-eyed male: \( X^r Y \)
Sex-linked Traits

Females, because they carry 2 X chromosomes, can sometimes be heterozygous for a trait.

Red-eyed female: $X^R X^R$

Red-eyed female (known as a carrier): $X^R X^r$

White-eyed female: $X^r X^r$
Problem: In fruit flies, red eyes are dominant to white eyes. Cross a white-eyed female fruit fly with a red-eyed male fruit fly, and determine gender and eye colour of the offspring.

white-eyed female  x  red-eyed male

\[ X^rX^r \quad \times \quad X^R Y \]

Diagram:

- Top left: \( X^rX^r \)
- Top right: \( X^R Y \)
- Bottom left: \( X^r \)
- Bottom right: \( X^r \)

Output:
Sex-linked Traits

$\frac{1}{2}$ red eyed and female ($X^R X^r$)

$\frac{1}{2}$ white eyed and male ($X^r Y$)
X-linked Recessive Traits

In X-linked recessive traits, the phenotype is expressed in males because they only contain one X chromosome. The phenotype may be masked in females if the second X chromosome contains a normal gene for that same trait. An example of this can be seen in hemophilia.

Male hemophiliac: $X^hY$
Female carrier: $X^HX^h$
Female hemophiliac: $X^hX^h$
X-linked Dominant Traits

- In X-linked dominant traits, the phenotype is expressed in both males and females who have an X chromosome that contains the abnormal gene. If the mother has one mutated X gene (she has the disease) and the father does not have the disease, then the sons and daughters have a 50/50 chance of inheriting the disease. If the father has the disease and the mother does not, all of the daughters will inherit the disease and none of the sons will inherit the disease.
- Example: Fragile X syndrome- causes a range of developmental problems.
- Draw the punnett squares