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Topic: Sex-linked inheritance

Sex - linked inheritance

In an XY- chromosomal system of sex determination, both X and Y-chromosomes are sex chromosomes. In general, genes on sex chromosomes are described as sex linked genes.

However, the term sex linked usually refers to loci found only on the X-chromosome; the term Y- linked is used to refer to loci found only on the Y-chromosome, which control holandric traits (traits found only in males).

Cytogeneticists have divided the X and Y – chromosomes of some species into homologous and non-homologous regions. The latter is called differential regions. These differential regions contain genes that have no counterparts on the other sex chromosome.

Genes in the differential regions are said to be hemizygous (half zygous). Genes in the differential region of the X show an inheritance pattern called X-

linkage; those in the differential region of the Y show Y- linkage. Genes in the homologous region show what might be called X-and Y linkage.

Another important feature of sex linked genes in XY- chromosomal system of sex determination is that females have two X- chromosomes, they can have normal homozygous and heterozygous allelic combinations.

But males, with only one copy of the X – chromosome can be neither homozygous nor heterozygous.

Hence the term hemizygous is used for X-linked genes in males. Since only one allele is present, a single copy of a recessive allele can determine the phenotype, a phenomenon called pseudodominance.

This is the same way that one copy of a dominant autosomal allele would determine the phenotype of a normal diploid organism; hence the term pseudodominance.

The genes on the differential regions of the sex chromosomes show patterns of inheritance related to sex. The inheritance patterns of genes on the autosomes produce male and female progeny in the same phenotypic proportions, as typified by Mendel's data (for example, both sexes might show a 3:1 ratio).

However, crosses following the inheritance of genes on the sex chromosomes often show male and female progeny with different phenotypic ratios. T.H. Morgan demonstrated the X-linked pattern of inheritance in Drosophila in 1910, when a white eyed male appeared in a culture of wild- type (red-eyed) files.

Example for Drosophila. When white –eyed males are crossed with red – eyed females, all the F_1 progeny have red eyes, showing that the allele for white is recessive. Crossing the red – eyed F_1 males and females produces a 3:1 F_2 ratio of red – eyed to the white- eyed files, but all the white –eyed flies are males.

	Female		**Male**
Parents	Red eye(Wild-type)	×	White eye
F_1 generation	Red eye Crossing the red eyed F1 female and male		Female and male(red eye)
F2 generation	All red eye (Female)		½ Red eye (male) ½ white eye(male)

Fig: Pattern of inheritance of the white eye trait in Drosophila.

This inheritance pattern is explained by the alleles being located on the differential region of the X- chromosome; in other words, by X-linkage.

In X-linked inheritance, the reciprocal cross gives a different result. A reciprocal cross between white-eyed females and red –eyed males gives the F1 in which all the females are red eyed, but all the males are white eyed. The F2 consists of one – half red – eyed and one – half white –eyed files of both sexes.

Hence, in sex linkage, we see examples not only of different ratios in different sexes, but also of differences between reciprocal crosses.

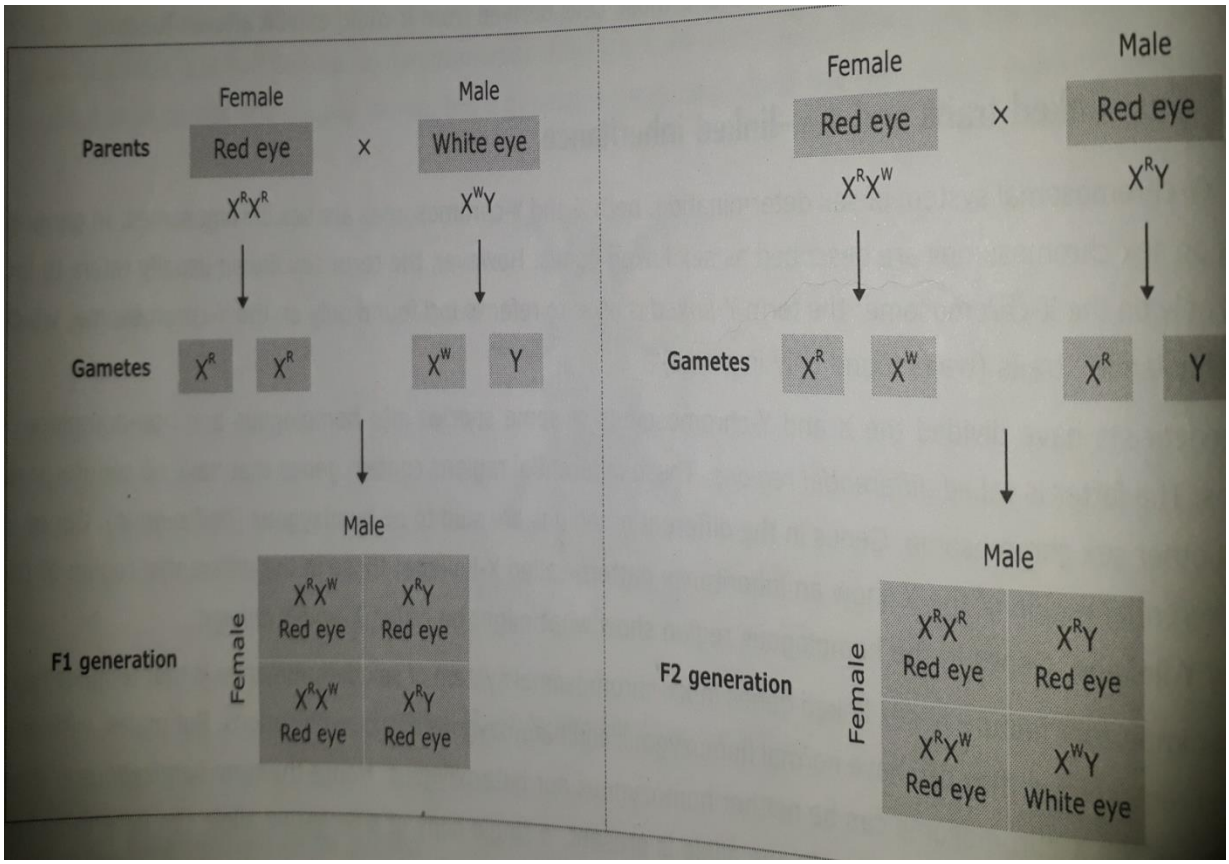

Fig: Crosses by considering eye color locus on X-chromosome.

In X- linked inheritance, the pattern of inheritance for loci on the Heteromorphic sex chromosome differs from the pattern for loci on the Homomorphic autosomal chromosomes, because sex chromosome alleles are inherited in association with the sex of offspring.

Alleles on a male's X-chromosome go to his daughters, but not to his sons, because the presence of his X-chromosome normally determines that his offspring is a daughter.

Since the father passes a trait to his daughters, who passes it to their sons. Hence, this pattern of inheritance is known as criss-cross pattern of inheritance.

In Drosophila, eye color has nothing to do with sex determination, so we see that genes on the sex chromosomes are not necessarily related to sexual function.

The same is true in humans, for whom pedigree analysis has revealed many X- linked genes, of which few could be constructed as being connected to sexual function.