# Sex-Linked Inheritance

So far we have considered inheritance of such characters as were assumed to be controlled by one or more genes located on the chromosomes other than sex chromosomes. The chromosomes other than sex chromosomes are called *autosome*. In humans, there are 46 chromosomes and of these, 44 are autosomes and 2 sex or (X) and (Y) chromosomes. Similarly, in other living organisms there are generally 2 sex chromosomes and the rest, the autosomes. In some insects, you might come across more or less than 2 sex chromosomes.

In human beings, there are two sex chromosomes and they are called X and Y chromosomes. Any variation in their number produces an abnormal individual. A human embryo having XY chromosomes will develop into a boy and the one with XX chromosomes will develop into a girl. It will be seen that the woman will produce only one type of eggs, i.e. (X) (X), whereas the man will form two types of sperms, one carrying X and the other Y. The Y sperm will produce a boy when it fertilises an egg, i.e., the genotype will be XY and the X sperm will produce a girl when it fertilises the egg, i.e., the genotype will be XX.

In drosophila, as well as in some other insects, the same mechanism for sex determination operates as in humans, i.e., XY will be male and XX female. But in birds, the situation is just the reverse, i.e., the male birds, for instance, a cock, will be XX. To keep this mechanism distinct from that found in man and other animals, use of different letters is preferred. One can use Z and W to show the sex constitution of birds. A male bird will then be designated as ZZ and the female bird as ZW.

In man, the male sex develops when the two sex chromosomes are dissimilar, i.e., XY, while in birds, the female sex develops when the sex chromosomes are different i.e., ZW. The sex which depends upon the presence of two different sex chromosomes is called "*heterozygous or*

*heterogametic sex*" while the other type will be "*hemazygous or homogametic*". In man, the male sex is heterogametic, whereas in birds the female sex is heterogametic.

We encounter still a different mechanism in some insects. For example, the bug will have all the 14 chromosomes, while the male will have only 13 chromosomes. The male will, therefore, produce two types of sperms, one with 6 chromosomes and the other with 7 chromosomes. The 6 chromosome sperm will produce a male and the 7 chromosome sperm will produce a female bug on uniting with a 7 chromosome egg.

**Sex-Linked Characters in Man**

*Colour blindness* in man is an instance of sex-linked characters, i.e., the gene or genes developing colour blindness are on the sex chromosomes. Of the two sex chromosomes in man (XY), Y is, by and large, empty of genes. Only the X chromosome contains the genes which are called sex-linked genes. The character, *colour blindness* is recessive; it will develop in a female only when there are two recessive alleles, one on each X chromosome. So, for the colour blindness to develop in male only one allele, on the X chromosome, will be needed because the other is Y, which is empty. A female of $X^b X^b$ constitution will be colour blind. A male of $X^b$ Y constitution will be colour-blind. The gene B is dominant and will not produce colour blindness, as is shown below:

(i)

| | ♀ | | ♂ |
|---|---|---|---|
| Parents | Normal vision | | Colour blind |
| | female $X^B X^B$ | × | $X^{*b}$ y male |
| Gametes | $X^B$ | | $X^b$, y |
| $F_1$ | $X^B X^{*b}$ | | $X^B$ y |

*Neither sex will show colour blindness.

(ii)

Parents Female normal vision $X^B X^b$ * × $X^B$ y male normal vision

Female gametes

| Male gametes | $X^B$ | $X^b$ |
|---|---|---|
| $X^B$ | $X^B X^B$ Female | $X^B X^b$ Female |
| Y | $X^B$ y Male | $X^b$ *y Male |

*shows the pathway of criss-cross inheritance; male transmits its sex-linked character (colour blindness) through his daughter to the grandson.

Similarly, hemophilia is a sex-linked disease in man and it behaves as a recessive character. The same explanation as for colour blindness holds good for this character.

**Sex-Linked Genes in poultry**

As we have said before, in poultry (birds) the female is the heterogametic sex contrary to man where male is the heterogametic sex. Barred plumage in poultry is a sex linked character and is dominant over black plumage. The allele for barred may be designated as B and its recessive allele as b for black.

B-will be female and barred
Bb will be male and barred
bb will be male and black

Parents Female barred $Z^B W$ × $Z^b Z^b$ Male non-barred
Gametes $Z^B$ W $Z^b$
$F_1$'s $Z^B Z^b$, $Z^b$ W
(Male barred) (Female non-barred)
Cross the above parents.

| Male gametes \ Female gametes | $Z^b$ | W |
|---|---|---|
| $Z^B$ | $Z^B Z^b$ Male | $Z^B$ W Female |
| $Z^b$ | $Z^b Z^b$ Male | $Z^b$ W Female |

1/2 male: 1/2 female. Both males and females half barred and half non-barred.

**Non-Disjunction of X Chromosome in Drosophila**