RAMA UNIVERSITY

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FACULTY OF AGRICULTURAL SCIENCES

AND ALLIED INDUSTRIES

SEX DETERMINATION

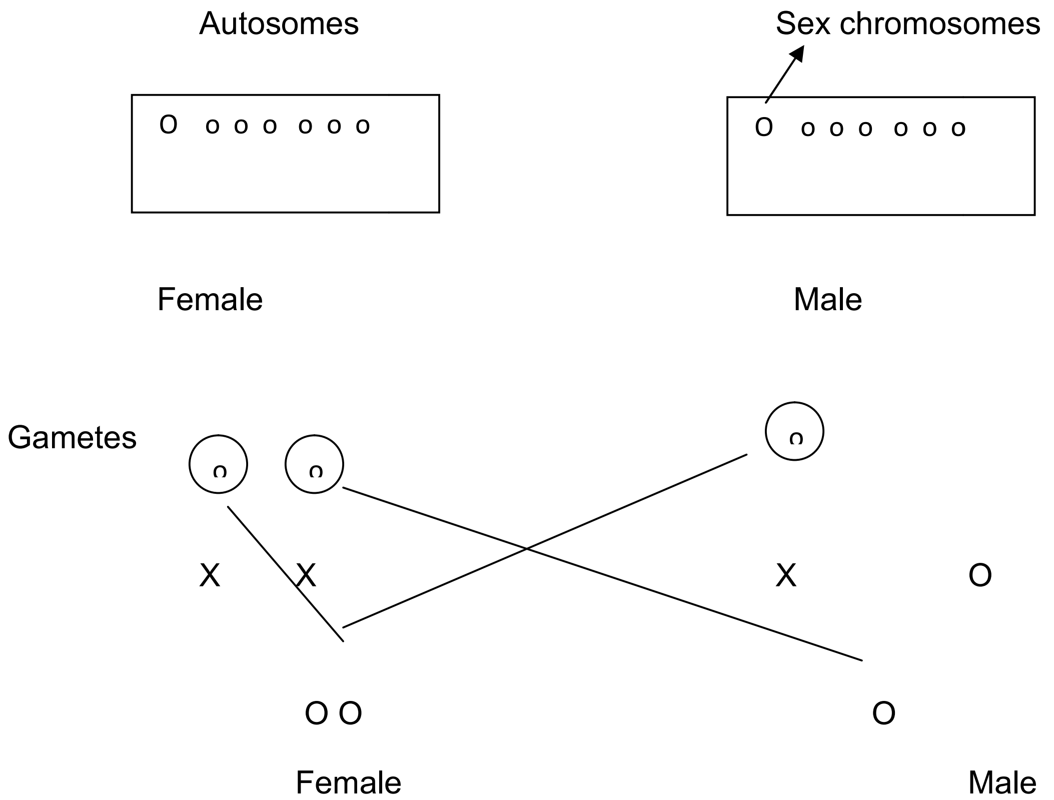
Sex differentiation in living organism into male and female causes morphological, physiological and behavioral differentiation between the two sexes and this pheonomenon is called sexual dimorphism. The precise form of the chromosomal differences between the sexes is not the same in different organism. Four types of sex chromosomes mechanism or heterogamesis have been recognized.

1. Sex chromsomes mechanism

a. Heterogametic male XX - XO type

The chromosome theory of sex determination was put forward by Mc clung (1902) who observed that male grass hopper possessed on odd number of chromosomes in contrast to the female which possessed an even number.

In the squash bug, protenor the femeales have 14 chromosome and the males have only 13 chromosomes in their somatic cells. The odd chromosome of the male thus determines the sex and hence called the sex determiner or Sex chromosme or the 'X' chromosome. The other chromosomes which are alike in females and males are called 'autosomes'. The female is 'XX' and the male is 'XO' (using 'O' to indicate the absence of 'X' chromosome.



XX-YY type

In many animals and palnts, females and males have the same even numbers of chromosomes, but whereas in the females the members of each pair of chromosomes are alike, in the males the memebrs of one pair of chromosomes are disimilar in size or form.

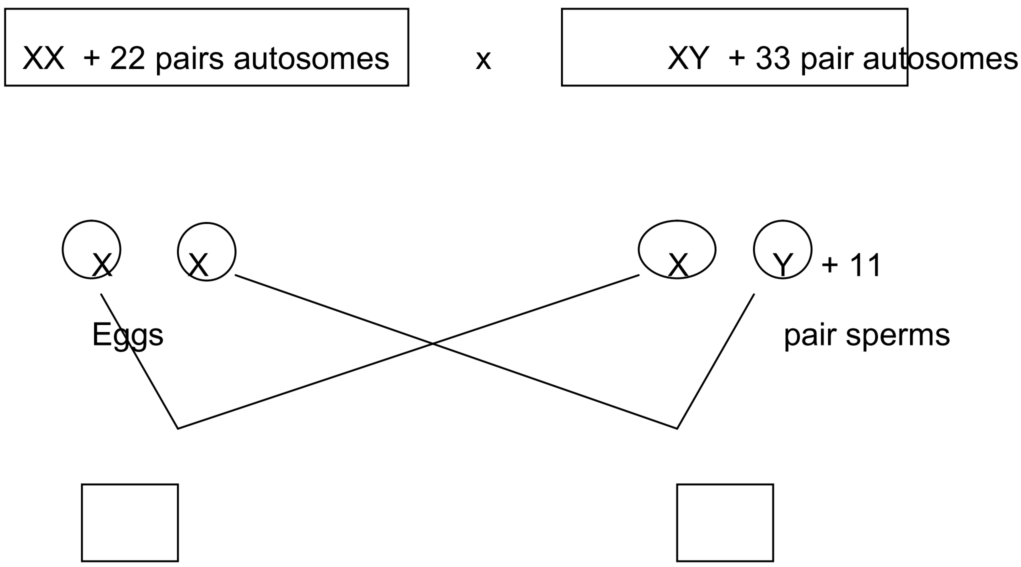
In drosophila, female has four pairs of chromsomes as follows;

1. a pair of rod shaped chromosomes
2. a pair of 'V' shaped chromosomes
3. a pair of slightly longer 'V' shaped chromosomes
4. a pair of very short dot like chromosomes (XX)

In male Drosophila, there is only one rod shaped chromsome (X). the other member of think pair being inverted 'J' shaped (Y) Wilson, who discovered this type of chromosome arrangement in 1905 designated the unlike memebr of their pair in the male as the 'Y' chromosome and the other member which is like the members of onepari in the female as the 'X' chromosome.

Human beings

In human beings 46 chromosome are present in the somatic cells. Females have 22 pair of autosomes and two X chromosomes males have 22 pairs of autosomes and one 'X' and one very short ' Y' chromosomes (considerably smaller than the 'X' chromosome). Each egg carries 22 autosomes and an 'X' chromosome. Sperms, however are of two kinds one kind with 22 autosomes and an 'X' and the other kind 22 autosomes and a 'Y'. The sex of a child in determined at the time of fertilization by the kind of sperm that happens to meet and penetrate, the egg, an X-bearing sperm producing a girl annd a Y- bearing one, a boy.



XX + autosomes 22 pairs XY + Autosomes 22 pair

Girl sBoy

b. Heterogametic female (ZO - ZZ) type)

ZO - ZZ . The female is the heterogametic sex and the male in the homogametic one. e.g. In amoth, Talacoporia, females have 59 chromosomes and male have 60 chromosomes. The eggs are of two kind (29 and 30). All the sperms have 30 chromosomes each on fertilization an egg with 29 chromosomes gives rise to a female and an egg with 30 chromsomes gives rise to male.

ZW-ZZ type: In birds, certain insects, fishes and reptiles, the female has an unlike pair of chromosomes, Z W, and forms eggs of two sorts, one with a 'W; chromosomes and the other with a 'Z' chromosomes. The male has like pairs (ZZ) of chromozomes. On fertilization an egg with a 'W' chromosome and the other with a 'Z' chromosome. The male has like pairs (ZZ) of chromosomes. On fertilization, an egg with a 'W' chromosomes gives rise to a female and an egg with a 'Z' chromosomes gives rise to a male.

Among plants, *Fragaria elatior* is one in which the female is ZW and the male is ZZ.

Balance theory of sex dtermination

All individuals have genes for both sexes. To quote bridges, both sexes are dut to simultaneous action of two opposed sets of genes, one set tending to produce the characters called ' female' and the other to produce the character called 'male'. Which sex actually develops in decided by the balance i.e. by the prepoderance of the female -determining or of the male determining genes. The sex chromosomes are merely vehicles of genes which help in tilting the balance in one direction or another.

Suppot for the balance theory of sex determination comes from the work of Bridges (1921) on Drosophila. Bridges observed some females of Drosophila with ‘X’ chromosomes and 3 sets of autosomes (Triploids). When he crossed them with normal (diploid) males, he found them with normal (diploid) males, he found that same of the progeny had one or more chromosomes less or more thean the normal flies. (i.e. aneuploids).

Bridges found intersexes, super females and super males amogn the progeny. Intersexes are sterile individuals intermediate between females and males super females and super males are sterile individuals which are very weak and very poor in viability.

Bridges interpreted these results as follows:- Sex in Drosophila in determined by the ‘X’ chromosomes as well as by the autosomes, the ratio of the number of ‘X’ chromosomes to the number of sets of autosomes being the deciding factor. In a nroma. (diplid) fmeale, the X/A = 1.00, there being two X chromosomes and two sets of autosomes and in a normal (diploid) male the X/A value in 0.50, there being only one X chromosomes and two sets of autosomes.

Relationship of chromosomes to sex in Drosophila

Chromosome constitution

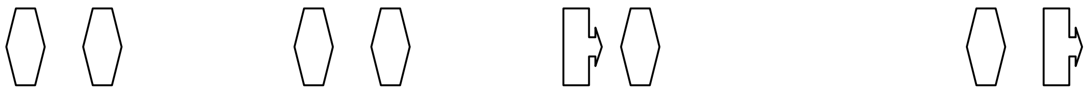
X	Y	A	X/A	Sex
3X	-	2A	1.50	Super female
3X	-	3A	1.00	Female (Triploid)
2X	-	2A	1.00	Female (diploid)
2X	1Y	2A	1.00	Female (diploid)
2X	1Y	3A	0.67	Intersex
2X	-	3A	0.67	Intersex
1X	1Y	2A	0.50	Male
1X	1Y	3A	0.33	Super male

SEX LINKAGE

Mugan crossed a red eyed female with a white eyed male and found that all F1 flies of both sexes were red eyed. In F2, 3 red and 1 white eyed. So, it is due to an allelic pair of genes of which red is dominant.

Red female X White female

Red female Red male

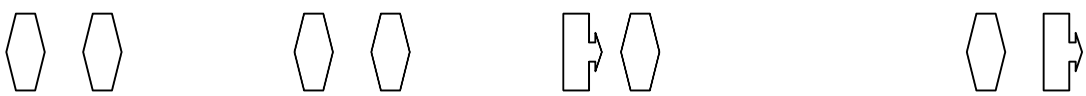


Red female Red female Red male White male

A reciprocal cross was made between white eyed female and red eyed male. It was found that amonf the F1 off spring, alal the females were red eyed and all the males were white eyed. The results wree quite un expected firstly, because the phenotypes of F1 femalen and male wre different.

White female X Red female

Red female White male



White female Red female White male Red male

The different results from the reciprocal crosses could be explained only on the assumption that the gene for eye colour is located on ‘X’ chromosomes and that ‘Y” chromosome has no gene for colour of the eyes.

A white eyed female crossed with a red-eyed male produces red eyed females and whtie eyed males, this method of inheritance, is often referred to as ‘criss-cross inheritance’. The F2 consisted of red eyed and white eyed individuals in equal numbers in both sexes.

Criss cross:- A sex linked gene passes from male to female then back to male.

The gene for eye colour is located on ‘X’ chromosome, it is called ‘X’ linked gene. This apttern of inheritance is called ‘Sex linkage’.

There are genes locate on ‘Y’ chromosomes and its allels absent in X chromosome. Such gene are called ‘Y linked’ or Holandric genes. The gene responsible for hypertrichosis causing hairy prina (ear lobes) in human beings is a Y linked gene.

There are certain homologons regions on x and Y chromosomes in which both the allels of a gene may be present as in the case of bobbed bristles (b) and its allele (b+) for normal bristle. Such genes are present both in X and Y chromosomes are called XY linked genes. Eg. Colour blindness.

Sex influenced character

These characters may be expressed differently in the two sexes even when their genotypes are identical. The more influence of the sex of the individual may be sufficient to alter the phenotypic expression of a gene. The most common expression of sex influence in that dominance is reversed between the sexes. Genes determining sex influenced characters are borne on autosomes. E.g. i. Presence of horns in sheep is said to be recessive character in females but a dominant character in males.

Horned female x Hornless male

HH ↓ hh

F1 Hh

In female → Hornless

In male → Horned.

↓

F2	1 hh	: 2 Hh	: 1 hh
Female :	Horned	Hornless	Hornless
Male :	Horned	Horned	Hornless

Reciprocal crosses show no differences because the gene is carried by autosomes.

e.g. (2) Boldness in human being.

Bb X BB

Non-Bold ness ↓ Boldness male

Bb

F1 Male ⟶ Bold

Female ⟶ Non bold

F2	BB	Bb	bb
Male	Bold	Bold	Non bold
Female	Bold	Non bold	Non bold

Boldness is recessive is female and dominant in male.

SEX LINKED CHARACTER

Sex limited inheritance is an extreme type of sex influence in which a particular phenotype can be expressed only in one sex. As genes for sex limited characters are borne on autosomes, all genotypes should occur with identical frequencies in both sexes, but the physiological frequences between the sexes are such that certain genotypes can be expressed only in one sex.

e.g. (1) In domestic poultry, cock feathering is a character limited to the male sex.

'H' ⟶ Hen feathering is due the dominant gene.

‘h’ ⟶ Cock feathering is due to recessive gene.

But females with genotypes ‘hh’ are hen feathered. (because cock feathering is limited the male only).

Genotypes	Phenotype	
	Female	Male
HH	Hen feathered	Hen feathered
Hh	,,	Hen feathered
Hh	,,	Cock feathered

Removal of the ovaries in hens with genotypes ‘hh’ results in cock feathering. This indicates that female. Sex hormone inhibits the production of cock-feathering in hens with genotype ‘hh’.

e.g. (2) Yellow clover butterfly

‘White” is a character limited to female limited character found only in female.

Genotype	Phenotype	
	Female	Male
WW	White	Yellow
Ww	White	Yellow
ww	Yellow	Yellow

SEX REVERSAL

In several species of plants that are normally bisexual, suppression of male or female strucutres has been observed in nature. The androecium getting converted into petals in ornamental plants or carpels as in carrot and cabbage or pistils as in maize, papaya and primros ehas been observed. When the stamens get converted into rudimentary organ is called the ‘Staminode’ and a similar conversion of the pistil into non-functional redimentary organ is called the ‘pistillode’. The phenomenon in which there is suprression of one sex at the expense of the other is called ‘sex reversal’. The sex reversals are mostly due to physiological and biochemical allterations involving sex hormones.

In maize, rarely it is observed that the male influence, Tassel beans seeds due to sex reversal. The recessive gene ‘ba’ is responsible for barren plants and another recessive gene ‘ts’ is responsible for tassel seed. Sex reversal in maize is due to the genetic constitution of the plants.