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Sex Determination

Sex determination system is a biological system that determines the development of sexual characteristics in an organism.

Sex is a character. It has two alternatives namely maleness and femaleness. The male produces the sperm and female produces ovules. The female has two X chromosomes and the has one X chromosome and one Y chromosome. The female is a homogametic and produces one type of gamete carrying X chromosome. Male is heterogametic and it produces two kinds gametes. One type of gamete carries X chromosome and one gamete carries Y chromosome.

Types of sex determination

1. XX - XY type :- There are two different patterns of sex determination in XX-XY type.

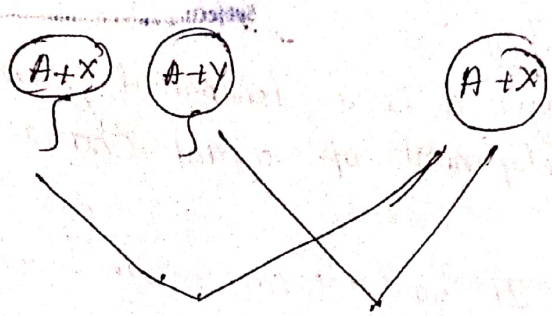
(i) Female homogametic and male heterogametic type :-

In this type of sex determination, the female is sexually homozygous or homogametic, having two X- chromosomes. The male is sexually heterozygous or heterogametic, having X and Y chromosomes. The female produce only one type of gamete, each carrying an X- chromosome in addition to the autosomes (A+X). The male produces two types of gametes (pollen grains), one type carrying the autosomes with X chromosome (A+X) and the other type carrying the autosome with one Y chromosome (A+Y) Fertilization with male X chromosome with female X- chromosome results in female offspring. and If male Y- chromosome with fertilized with female X chromosome the offspring will be male.

Ex:- Angiosperms.

parents: Male × Female
(AA - Autosome) ← AA + XY AA + XX

Gametes



AA+XX AA+XY
Female male

(ii) Female heterogametic and male homogametic - (ZW and ZZ)

In this mode of sex determination, the female is heterozygous or heterogametic, having X and Y chromosomes, while the male is sexually homozygous or homogametic having two X chromosomes. Thus male plant produces similar type of pollens, each with an X chromosome, while the female produces two types of eggs; ~~the X type~~ One egg with X-chromosome and another one with Y-chromosome. On fertilization, if male X chromosome fuses with female X-chromosome, the offspring will be female, if male X-chromosome fuses with female Y-chromosome, the offspring will be female. In this type of sex-determination the X and Y chromosomes are also designated as Z and W chromosomes respectively. Eg:- Flagellaria

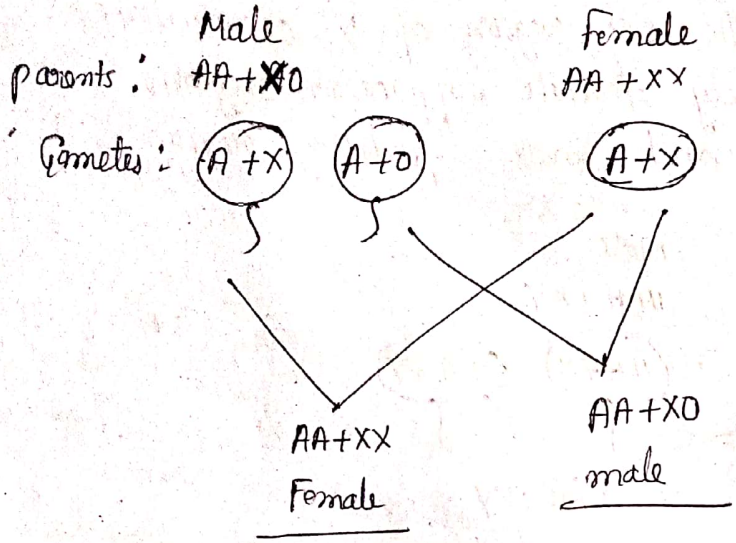
XX-XO type:-

Female homogametic and male heterogametic type:

Some plants have been discovered with XO type of sex determination. In this case, the females produce only one type of egg which carries autosomes + X chromosome. But the males produce two types of pollens. One type carries autosomes and one X chromosome. (A+X). and the other type carries only type the autosomes (A+0). Fertilization by a pollen of the first type

(A+X) fuses with female (A+X) results in a female offspring. If female (A+X) fuses with male (A+O) results in a male offspring

Eg: Discoria simulata



Sex determination in Melandrium

Melandrium is a dioecious plant having separate male and female plants. In Melandrium chromosome determines the sex of the plant. The diploid chromosome number of this plant is 12 pairs. Out of these, 11 pairs are autosomes and one pair is allosomes or sex chromosomes.

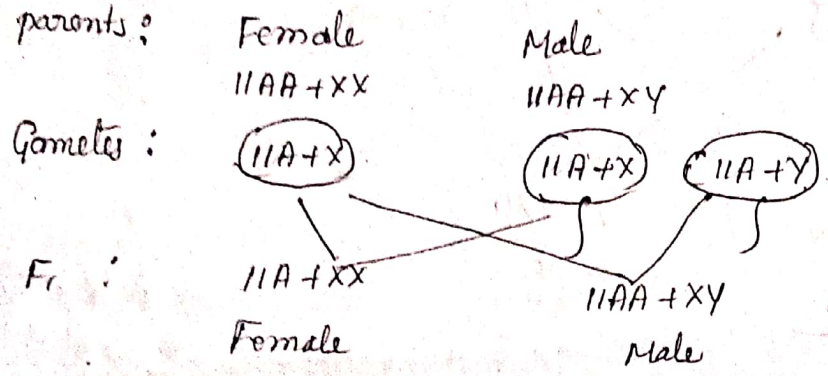
The female plant has two X chromosomes and the male plant has one X chromosome and one Y chromosome. The female plant is homogametic (XX) and male plant is heterogametic (XY). The female produces only one type of gamete carrying one X chromosome. The male plant produces two kinds of gametes, one type of gamete carries X chromosome and other gamete carries one Y chromosome. The male gametes determine the sex of the plant.

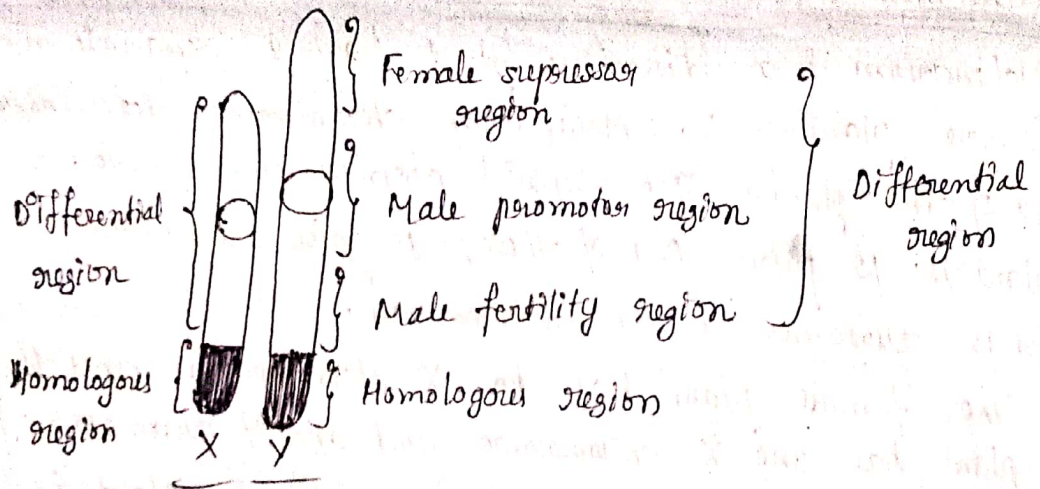
In Melandrium, the sex is determined by the Y chromosomes. When Y chromosome is present, the sex is male, when Y chromosome is absent the sex is female.

The Y chromosome is long and conspicuous and X chromosome is short in Melandrium. The X and Y

chromosome contain two distinct regions, namely homologous region and differential regions. The homologous region are similar in both X and Y chromosomes. The differential regions are different in the different chromosomes.

The differential region of the X chromosome carries genes for femaleness. The differential region of Y chromosome has three regions namely female suppressor region, male promoter region and male fertility region.





Sex determination in Maize

Maize is a monoecious plant with male inflorescence (tassel) and the female inflorescence (silk) located on the same plant. A gene called 'ts' converts the tassel into seed bearing (female) inflorescence, while another gene called 'sk' (silkless) is responsible for the absence of silks. Therefore a plant with genotype 'sk/sk' will be effectively male plant (because it checks the growth of silk-female inflorescence) and a plant with

genotype ts/ts will be effectively a female plant (because ts converts tassel into silk). Thus individual single genes can impose bisexuality in Maize.

Sex determination in Papaya :-

Sex expression in papaya is controlled by a single gene, with three alleles which have a pleiotropic effect. Papaya is a dioecious plant, consist of male, female and hermophrodite (bisexual) plant. Female plant possess homogametic X chromosomes (XX), while male and hermophrodite have heterogametic XY and XY^h chromosomes respectively. The sex inheritance in papaya depends on three alleles including a recessive 'm' allele for female, a dominant 'M' allele for males, and 'M^h' allele for hermophrodite. The three viable genotypes are Female homozygous recessive mm, male heterozygous Mm, hermophrodite $M^h m$. The Mm and $M^h m$ remain viable because an 'm' sex chromosome is present in each genotype.

Sex determination in Viscum

Viscum is a monoecious species. Sometimes become dioecy in flowering plants is due to mutations affecting the hormone systems which control the development of female and male reproductive structures in the flower. In these species, male plant consistently show a multivalent ring of chromosomes during meiosis instead of bivalents. The rings may be 4, 6, 8, 10 or even 12 in numbers. This is due

to existence of permanent translocation heterozygosity. But this is not apparent in female plants, which produce only normal bivalents.

Sex determination in coccinia

Coccinia is a dioecious species, a member of family Cucurbitaceae. The sex determination in Coccinia indica was studied by Prof. R.P. Roy and his co-workers. They studied the sex in diploid, triploid and tetraploid plants with and without Y chromosome and observed that irrespective of the number of X-chromosome and autosomes, presence of a single Y chromosome gave a male individual. Here the sex is determined by XX-XY mechanism. The female plant posses homogametic XX chromosome while male plant posses heterogametic XY chromosome. Y chromosome determine the sex of an individual in Coccinia.

Monogenic or single genic sex determination

Monogenic or single genic sex determination is a system of sex determination, in which a single gene determines the sex of an individual.

Eg:- Maize.

The polygenic sex determination is a system of sex determination, in which multiple or more than 2 genes determine the sex of an individual.