D II (Hons) Zoology Paper – III Grp B Topic – Sex Determination

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Sex Determination

Most living organisms usually have two sexes. A Sex determination system is a biological system that determines the development of sexual characteristics in an organism. Most organisms that create their offspring using sexual reproduction have two sexes. The organisms producing eggs are known as females and those producing sperms are males. Occasionally, there are hermaphrodites in place of one or both sexes.

The various genetically controlled Sex determination mechanisms have been classified into following categories.

1. Chromosome Theory of Sex determination
2. Male haploidy or Haplo-diploidy mechanism.
3. Genic balance Theory
4. Singh gene effect.
5. Cytoplasmic Sex determination.

Chromosome Theory of Sex determination.

Sex expression is governed by chromosomes & genes. In unisexual animals chromosomes are of 2 types i.e autosomes or Allosomes or Sex chromosomes. In majority of diploid sexual animals are found a pair of sex chromosomes which are specialized for Sex determination. These are represented by X and Y.

Autosomes — chromosomes which donot differ in morphology and number in male and female.

Allosomes — chromosomes which differ in morphology and number in male and female and contain genes that determine sex.

The X-chromosomes was first observed by German biologiest, Henking in 1891 during the spermatogenesis in male bug and was discribed as x-body. The chromosome theory of sex determination was worked out by E.B. Wilson & Stevens (1902-1905). They named the x and y chromosomes as sex chromosomes or allosomes and other as autosomes.

2. Types of chromosomal mechanism of sex determination

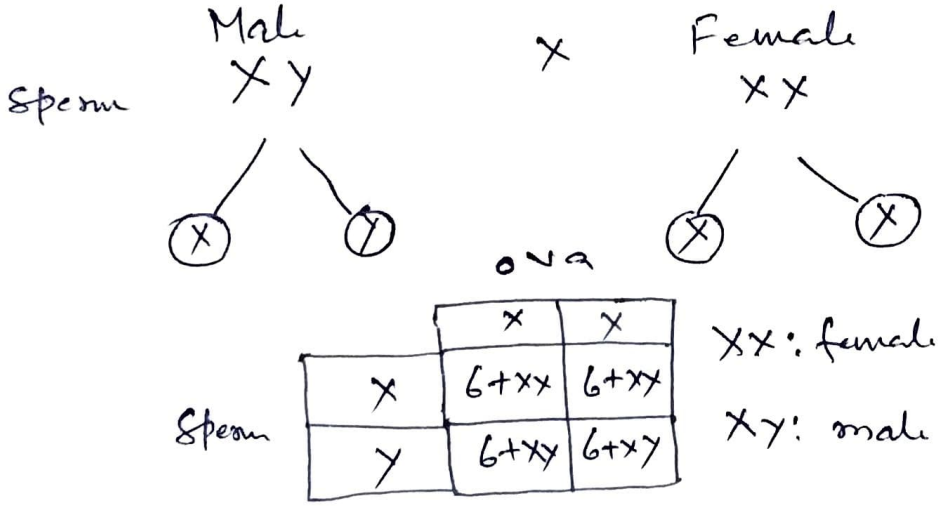
(a) Sex-chromosome undifferentiated:—
In primitive forms sex chromosomes or x and y chromosomes are not identified. The genes determining the sex seem to be located on certain autosomes. This is regarded as the most primitive type of sex determination.

(b) XX-XY or Lygaeus Type (Female-male system).
It was first studied in milk weed bug Lygaeus turicus by Wilson and stevens. So it called Lygaeus Type. There are 2 different patterns of sex determination in Lygaeus Type.

1. Female Homogametic XX and Male Heterogametic XY
In this system female has 2 x chromosomes (XX) is homogametic and produce only one type of gamete i.e. (X).
The male is heterogametic & has one x and one y chromosome and produces two types of gametes viz X & Y.

This is simple XX–XY type & is found in man & Drosophila and certain insects. Union of X ovum with X sperm leads to development of female (XX) sex. If X ovum unites with Y sperm, it produces male (XY) sex.

Example 1. Drosophila: In Drosophila total No. of chromosomes is eight of which 6 are autosomes, common to both male and female. The fourth pair is of sex chrom. In male this is represented by XY i.e. Karyotype of male Drosophila is 6+XY and in female XX i.e. 6+XX. Ova produced by female are all similar possessing 3+X chromosomes but the sperm produced by male are 3+X and 3+Y in equal numbers.



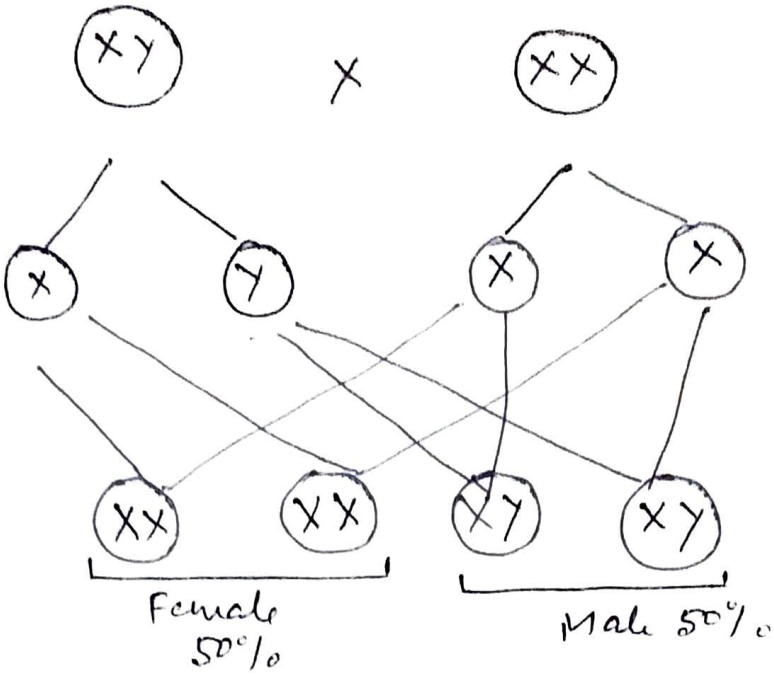
Example – 2 Man.

In case of man total No. of chromosome is 23 pair or 46.

In Male (man) 44+XY

In female (woman) 44+XX

The sperm Produced by male are of two types (a) 22+X & (b) 22+Y whereas ova all have 22+X chromo.



(2) ~~XX—XO~~ Female Heterogametic & Male Homogametic

In this system female has double allele (heterogamete). In fowl, other birds and some fishes, certain moths and butterflies the female sex is heterogamatic with X & Y chromosome often represented by Z & W and laying two types eggs, one half with X or Z chromosome & the other half with Y or W chromosome. The male sex is homogametic and produces sperms of all of one type.

(3) XX ♀ & XO ♂ Type or Protenor type:-

McClung in male Squash bug (Anasa) observed 10 pairs of chromosomes & an Unpaired chromosome. Their females have 11 eleven pairs of chromosomes. Thus all eggs carry a set of 11 chromosomes but Sperms are of 2 types: 50% of eleven chromosomes and other 50% of ten chromosomes. The accessory chromosome was X-chromosomes. Fertilization of an egg by sperm carrying eleven chromosomes results in a female which fertilization by a sperm with 10 chromosomes Produces male. It is said to be evolved by the loss of Y chromosome. Ex - Squash bug (Anasa).

Female : 22 chromosomes : 20+XX < 10+X, 10+X — Male (20+XO)

Male : 21 chromosomes : 20+X < 10+X, 10 — 20+XX Female

This found in orthoptera & Heteroptera.

Female Diploid & Male Haploid or Hymenopteran Type

In honey bees, wasps, ants & certain other hymenopterans Parthenogenesis is widespread. Three types of individuals are there.

1). Diploid queens :— These develop from fertilized eggs & are fully developed functional females.

2). Diploid workers — These also developed from fertilized eggs but are underdeveloped non functional females which are unable to produce ova.

3). Haploid drones or Male :— These develop parthenogenetically from the haploid unfertilized eggs & are functional males.

GENIC BALANCE THEORY

This theory was Postulated by Bridges in (1922) in Drosophila. According to this theory "the sex of an individual is determined by a balance between the genes for maleness and those for femaleness present in the individual.

Genic balance theory states that sex determining genes are present on both X chromosome as well as autosomes. The male sex determining genes are present on autosomes and female sex determining genes on X-chromosomes. The sex expression is determined by the balance of genes on autosomes and X-chromosomes.

In other words, the expression of sex depends on the ratio of X-chromosomes to that of autosomes. This ratio is represented as X/A ratio.

The genic balance is governed by X/A index. Individuals with index 1 develop into female and those with sex ratio index of 0.5 into males.

To be continued in next lecture.