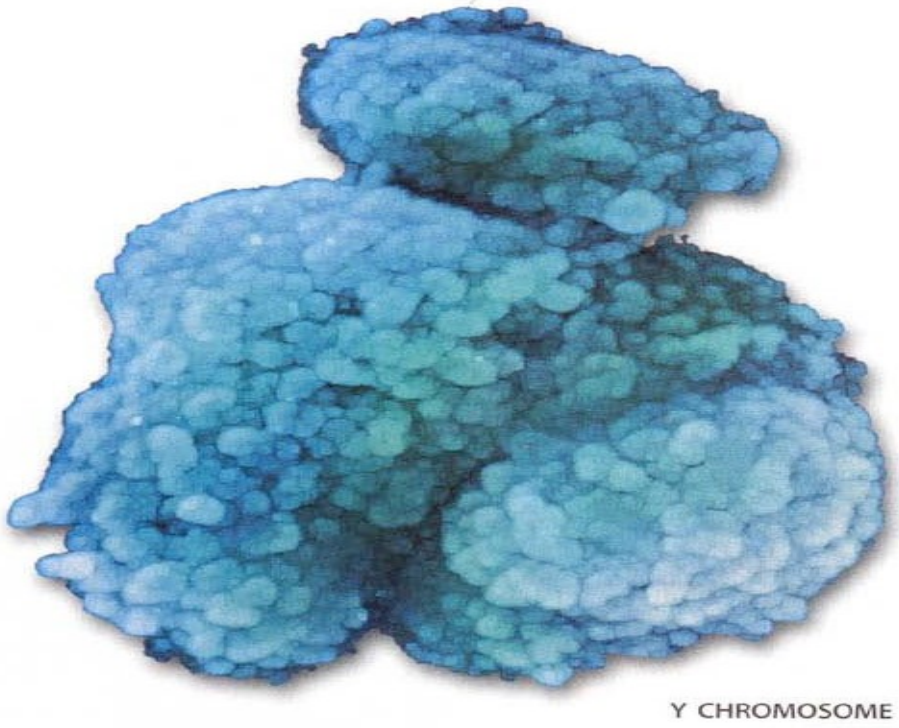
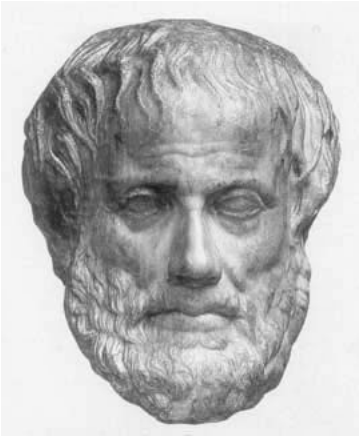


Sex Determination

Sex is determined by the heat of male partner during intercourse…..



Aristotle
(384-322 B.C.)

Sex Differentiation: a favorite topic for philosophers and scientists

8th BC	Homer: Conception is influenced by the wind, north for males and south for females…at least in sheep
130-200 A.D.	Galen: Semen from left testis makes females, right makes males. A mixture produces hermaphrodites.
1677	Anton van Leeuwenhoek: sperm
1827	Carl Ernst von Baer: ovum
1902	Clarence McClung: the "Accessory chromosome"
1947	Alfred Jost: differentiation of the reproductive tract
1949	Barr & Bertram: discovery of the Barr bodies
1959	Welshons & Russell: the role of the Y chromosome
1991	Lovell-Badge et al: discovery of the *SRY* gene

The Jost Paradigm

Genetic Sex Determination

Environmental Sex Determination

Sex Chromosomes

Switches

Gonadal Sex

Phenotypic Sex

Temperature, social cues, etc

Chromosomal sex determination

Genic balance mechanism

Sex determination due to environmental factors

These are two types: a) Heterogametic male and b) Heterogametic female

a) **Heterogametic male:** In this mechanism, the female sex has two 'X' chromosomes, while the male sex has only a single 'X' chromosome. As the male lacks a 'X' chromosome during meiosis, 50% of lthe gametes carry 'X' chromosome, while the rest do not have the 'X' chromosome. Such a mechanism, which produces two different types of gametes in terms of sex chromosome is called heterogametic sex. The female sex here is called homogametic sex because it produces similar type of gametes. The heterogametic male may be of the following two types.

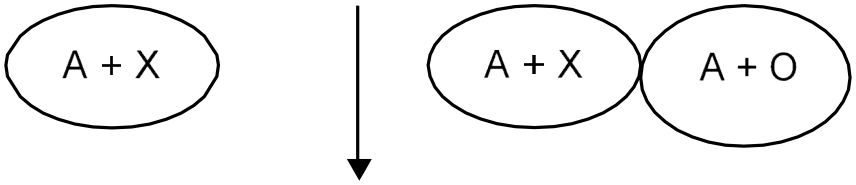
i) XX – XO ii) XX – XY

i) XX - XO: In certain insects belonging to orders Hemiptera (true bugs), Orthoptera (grass hoppers) and Dictyoptera (cockroaches), female has two 'X' chromosomes (XX) and are, thus homogametic, while male has only single 'X' chromosome (XO). This mechanism was found by C.E. McClung in 1902. The presence of an unpaired X chromosome determines the masculine sex. Parents

Parents Female X Male 2A +

XX X 2A + XO

Gametes



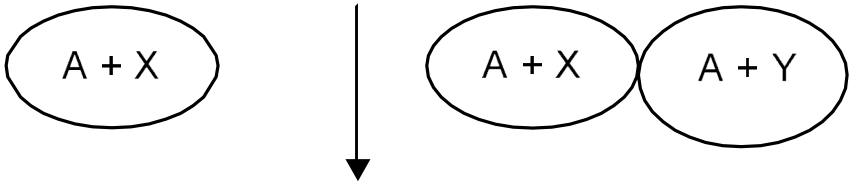
	A + X	**A + O**
A + X	2A + XX Female	2A + XO Male

i) **XX – XY:** In man, other mammals, certain insects including *Drosophila*, certain angiospermic plants including *Melandrium*, the females possess two X chromosomes (XX) and are thus homogametic and homomorphic, while the m ales possess one X and one Y chromosome (XY) and are hence heterogametic and heteromorphic. When an egg is fertilized by 'Y' bearing sperm, a male is produced.

Parents Female X Male 2A + XX

X 2A + XY

Gametes



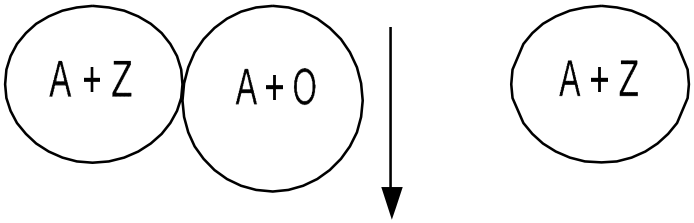
	A + X	**A + Y**
A + X	2A + XX Female	2A + XY Male

a) **Heterogametic female:** In this mechanism the male possess two homomorphic sex chromosomes and are thus homogametic, while the female possesses either a single 'X' chromosome or one 'X' and one 'Y' chromosome and are hence heterogametic. To avoid confusion with earlier types, instead of X and Y, the alphabets Z and W are used. This mechanism of sex determination is also known as "Abraxas mechanism of sex determination" (Kuspira and Walker, 1973) The heterogametic females may be of following two types. i) ZO – ZZ ii) ZW – ZZ

i) ZO – ZZ: This mechanism is found in certain moths and butterflies. In this case, female possess one single 'Z' chromosome and hence is heterogametic. Male possesses two Z chromosomes and thus homogametic.

Parents	Female	X	Male
	2A + ZO	X	2A + ZZ

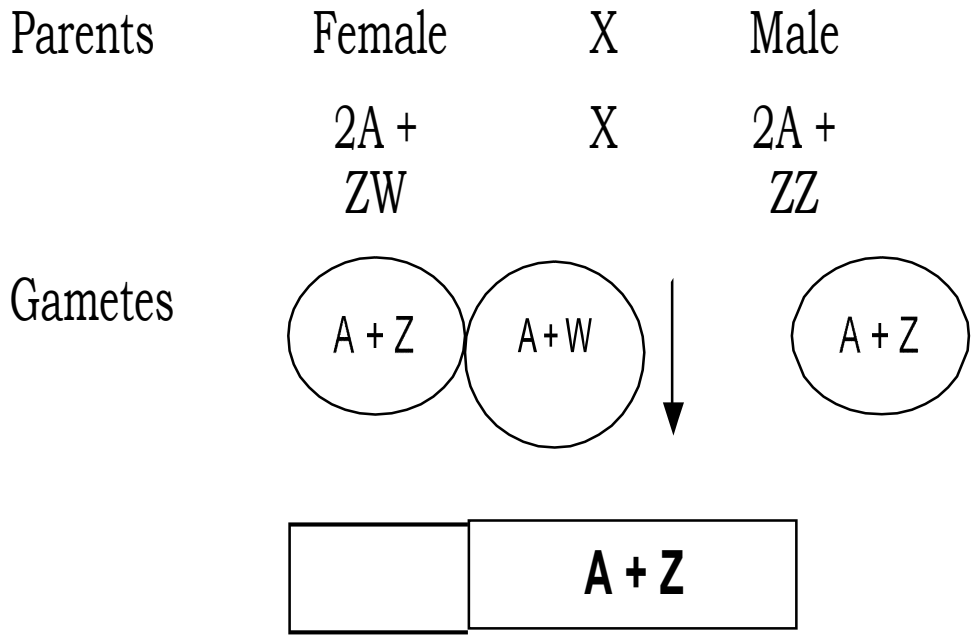
Gametes



	A + Z
A + Z	2A + ZZ Male
A + O	2A + ZO Female

The sex of the offspring depends on the kind of egg.

i) **ZW – ZZ:** This system is found in certain insects (gypsy moth) and vertebrates such as fishes, reptiles and birds. In this system, the female is heterogametic and produces two types of gametes, one with 'Z' chromosome and the other with 'W' chromosome. On the other hand, male is homogametic and produces all sperms of same type carrying one 'Z' chromosome. The sex of the offspring depends on the kind of egg being fertilized. The 'Z' chromosome bearing eggs produce males, but the 'W' chromosome bearing eggs produce females.



Genic balance mechanism:

Genic balance mechanism of determination of sex was first observed and studied by C.B. Bridges in 1921 while working with *Drosophila* for the inheritance of vermillion eye colour.

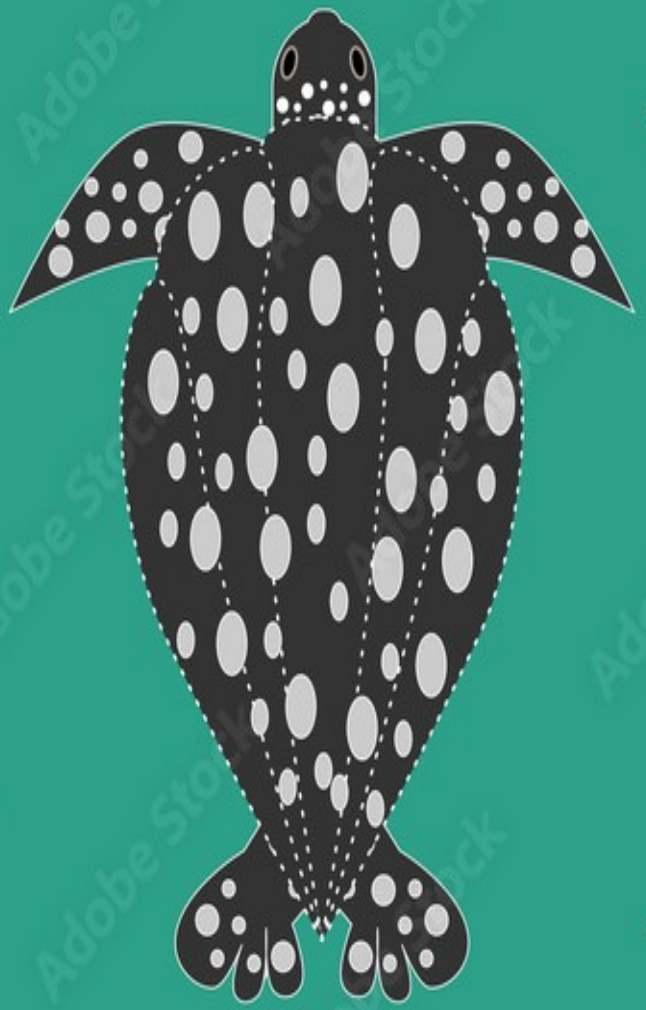
According to this mechanism, the sex of an individual in *Drosophila melanogaster* is determined by a balance between the genes for femaleness located in the X-chromosome and those for maleness located in autosomes. Hence, the sex of an individual is determined by the ratio of number of its X chromosomes and that of its autosomal sets, the 'Y' chromosome being unimportant. The ratio is termed as sex index and is expressed as follows.

$$\text{Sex index} = \frac{\text{No. of X chromosomes}}{\text{No. of autosomal sets}} = X/A$$

Different doses of X – Chromosomes and autosome sets and their effect on sex determination

S.No.	Ploidy level	X-Chromo-somes	Sets of autosomes	Sex index (X/A ratio)	Sex Expression
1.	Diploid	3(xxx)	2(AA)	1.50	}Super female
2.	Triploid	4(xxxx)	3(AAA)	1.33	} or meta female }
3.	Haploid	1(x)	1(A)	}	
4.	Diploid	2(xx)	2(AA)	} }1.00	Female
5.	Triploid	3(xxx)	3(AAA)	}	
6.	Tetraploid	4(xxxx)	4(AAAA)	}	
7.	Triploid	2(xxy)	3(AAA)	0.67	}

TSD Temperature Dependent Sex Determination



Top > 32°C FEMALE

Middle > 28–32°C MALE : FEMALE 50 : 50

Bottom < 28°C MALE

Nesting Beach