









Generate variation, new combinations of alleles.



A, B, C represent favorable mutations.

Figure a) Mutations occur regularly, but the only way all three can get into a single individual creating the most fit individual is for the new mutation to occur in an individual that already carried the preexisting good mutation.

Figure b) Mutations occur in separate individuals, but through sexual reproduction and recombination, can quickly become established in a single individual.

During the linkage and mapping discoveries of the early 1900s, there was a major transformation in the understanding of the "genetic" bases of sex determination.

Early thoughts on sex determination:

- "The determination of sex is not by inheritance, but by the combined effect of external circumstances."
 - Edmund Wilson 1894, The Cell in Development and Inheritance, McMillan Press
- "The force of experimental evidence has now become irresistible that sex determination must now be treated as a form of heredity..."
 - Edmund Wilson 1911





Soon after, Morgan and students using Drosophila:

Identified sex linked genes, Saw sex chromosomes in Drosophila, Began to unravel the mechanisms of sex determination.









They concluded that	Chromosome	Chromosome	Ratio of X chromosomes to autosome sets	Sexual morphology
1) Y is irrelevant for sex determination (but not fertility)	Ȓc	3X/2A	1.5	Metafemale
2) Ratio of X chromosomes and sets of autosomes (ploidy level) seems to be critical	»r	3X/3A	1.0	Female
	2°C	2X/2A	1.0	Female
	Mig	3X/4A	0.75	Intersex
Z sets of autosomes	Mr	2X/3A	0.67	Intersex
For typical males with <u>one</u> X in a diploid (<u>2</u> N) individual,	Dir	X/2A	0.50	Male
the X/A ratio = 0.5.	DE	XY/2A	0.50	Male
For typical females with <u>two</u> Xs in a diploid (<u>2</u> N) individual, the X/A ratio = 1.0	»ic	XY/3A	0.33	Metamale



So how do the number of X chromosomes make an individual either male or female?

Several steps in the process:

1) Need to count the number of X chromosomes and sets of autosomes.

2) Once the count has been made, a specific gene (*Sex-lethal Sxl*) needs to be turned "on" in females and "off" in males.

3) This gene is responsible for beginning a cascade of other steps needed for the development of male or female morphology.





















Identi	nes the	sex in b	oth Dro	sopnia	(D) and Human (H)?
	Α	в	с	D	E
	DН	DН	DН	DН	DH
хх	FF	FF	FF	FF	MF
Ху	мм	мм	мм	мм	FM
X0	FΜ	мм	ΜF	ΜF	FM
ххх	FF	FF	FF	FF	MF
ХХу	ΜF	FΜ	FΜ	мм	FM
Хуу	мм	мм	мм	мм	FM









Sabo, Kesseli et al. 1995; Szczys, Hughes & Kesseli 2003, 2005







Classes		GSD*	
Suborders	XX/XY ^e	ZZ/ZW ^d	TSD*
Mammals	+		
Birds		+	
Reptiles			
Crocodilians			+
Turtles	+	+	+
Squamates			
Lizards	+	+	+
Snakes		+	
Amphiblans			
Anurans	+	+	+
Urodeles	+	+	+
Fish			
Teleosts	+	+	+
Table taken, with permi	ission from Ref. 1		
CSD denotion cox dot	assignation		







Sex Determination in Drosophila Sisterless genes (*sisA, sisB, sisC*) products A) "count" the number of X chromosomes B) "count" the number of autosome sets C) When expressed (0n) initiates female development D) Act as enhancers of *Sxl* expression E) Both A and D