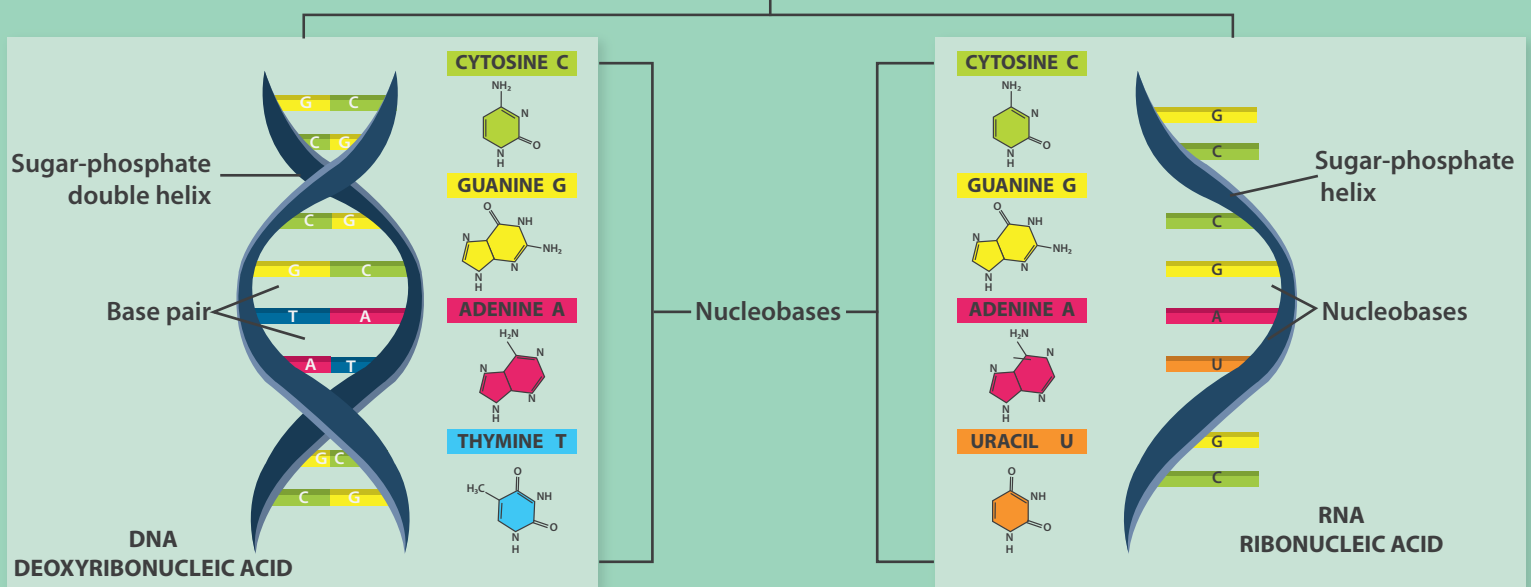


Principles of Inheritance & Variation - Part I

Genetics: Study of genes, genetic code, heredity & variation

Genetic Material

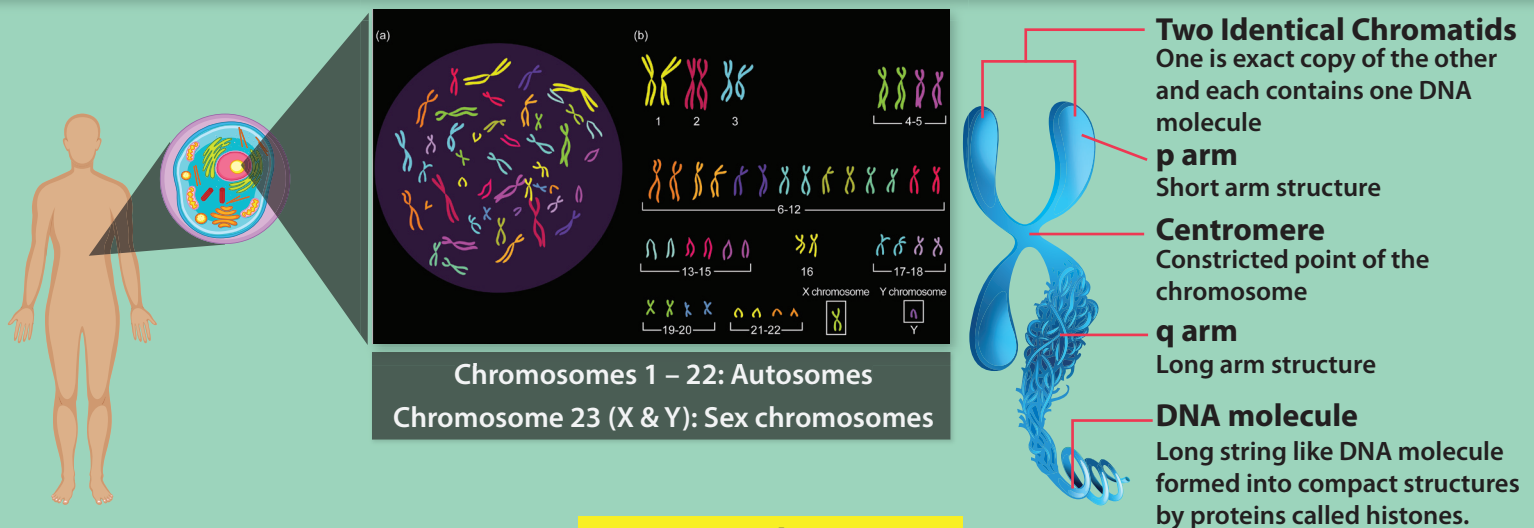


- Most common genetic material, except in some viruses
- Double stranded genetic material
- Nucleotides create chain via phosphodiester bonds & nitrogen bases form hydrogen bonds
- DNA replicates by forming RNA intermediates

- Single-stranded genetic material
- Found in some viruses
- Three types depending on function:
 - mRNA (messenger RNA)
 - tRNA (transfer RNA)
 - rRNA (ribosomal RNA)

Chromosome: Thread-like tightly coiled package of DNA

23 Pairs of Human Chromosomes



Genetic Inheritance



Gregor Johann Mendel

Father of Modern Genetics

Proposed

Laws of Inheritance

1. Law of Dominance

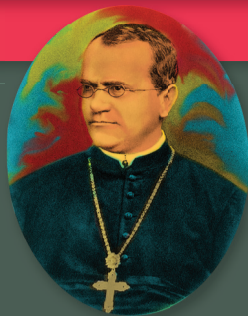
2. Law of Segregation

3. Law of Independent Assortment

Inheritance of Traits

Father Of Modern Genetics

- A monk who went to University of Vienna to study science & Mathematics
- 1856 – 1863: Conducted experiments on pea plant (*Pisum sativum*)
- Studied the pattern of inheritance
- Proposed laws of inheritance



Gregor Johann Mendel (1822 - 1884)

Reasons For Selecting Pea

- Plants are easy to grow & maintain
- Several visibly distinct & contrasting characters
- Annual plant
- Naturally self-pollinating but can be cross-pollinated

Seven Contrasting Characters of Pea Plant Studied by Mendel

	Flower Colour	Plant Height	Seed Colour	Seed Shape	Pod Colour	Pod Shape	Flower Position
Dominant Traits	Purple	Tall	Yellow	Round	Green	Inflated (full)	Axial
Recessive Traits	White	Short	Green	Wrinkled	Yellow	Constricted (flat)	Terminal



Pea plant (*Pisum sativum*)

Mendel's Experiment

- Cross-pollinated 2 pure lines for contrasting characteristics to obtain F1 generation
- Self-pollinated F1 generation that gave rise to the F2 generation

Results

F ₁ generation	F ₂ generation	
Tall All tall plants	Short 1	Short 3

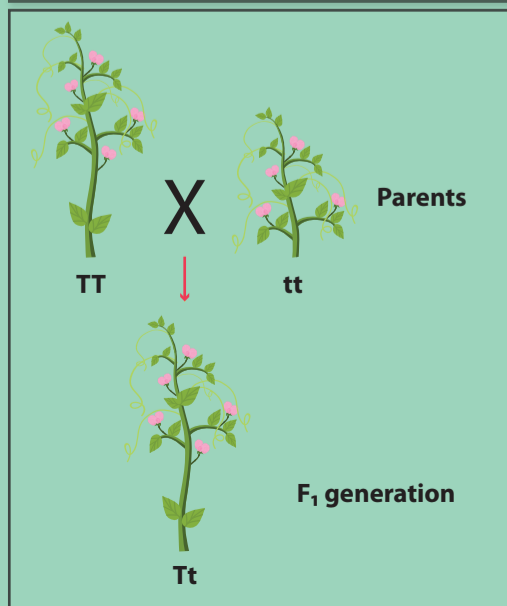
Conclusion

- Genes exist as alleles that pass from parents to offspring
- Homozygous: 2 same alleles
- Heterozygous: Different alleles
- Dominant gene: TT (capital alphabet); Recessive gene: tt (small alphabet)
- Phenotype: Physical appearance
- Genotype: Genetic makeup
- 50% chance of either allele to fuse with other parent to form zygote

Laws of Inheritance

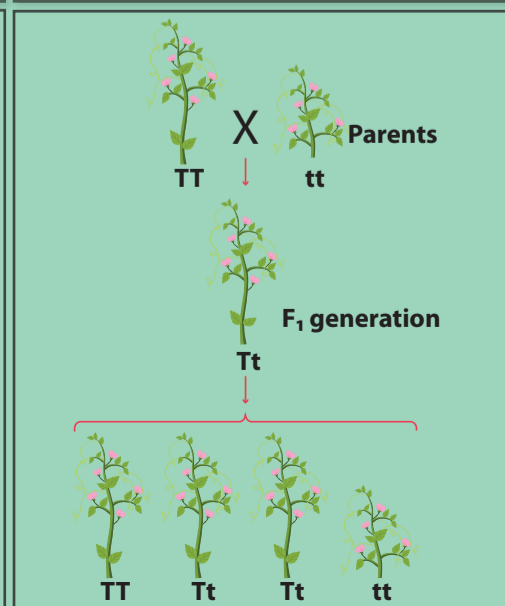
Law of Dominance

In heterozygous condition, the dominant allele gets expressed. F₁ generation express dominant alleles.



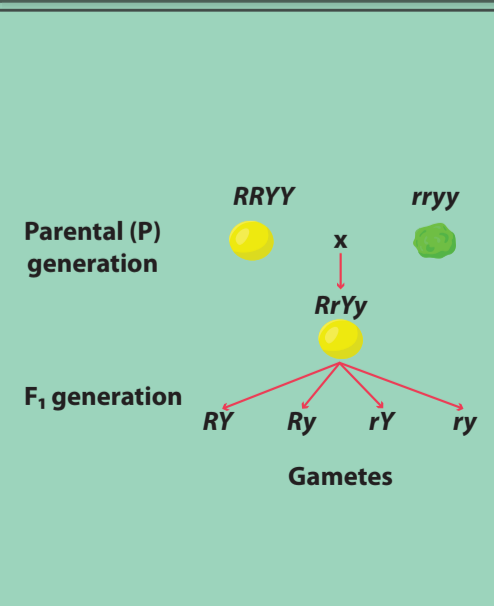
Law of Segregation

Two alleles do not mix when they come together in hybrid pair & are independent of each other.



Law of Independent Assortment

During gamete formation, two genes segregate independently of each other as well as of the other trait



Linkage, Sex Determination & Mutation

Linkage & recombination are the phenomena which describe the inheritance of genes

Linkage

• Two or more linked genes are always inherited together in the same combination for over two generations

Recombination frequency

- Test cross < 50%
- Two completely linked genes ~ 0%

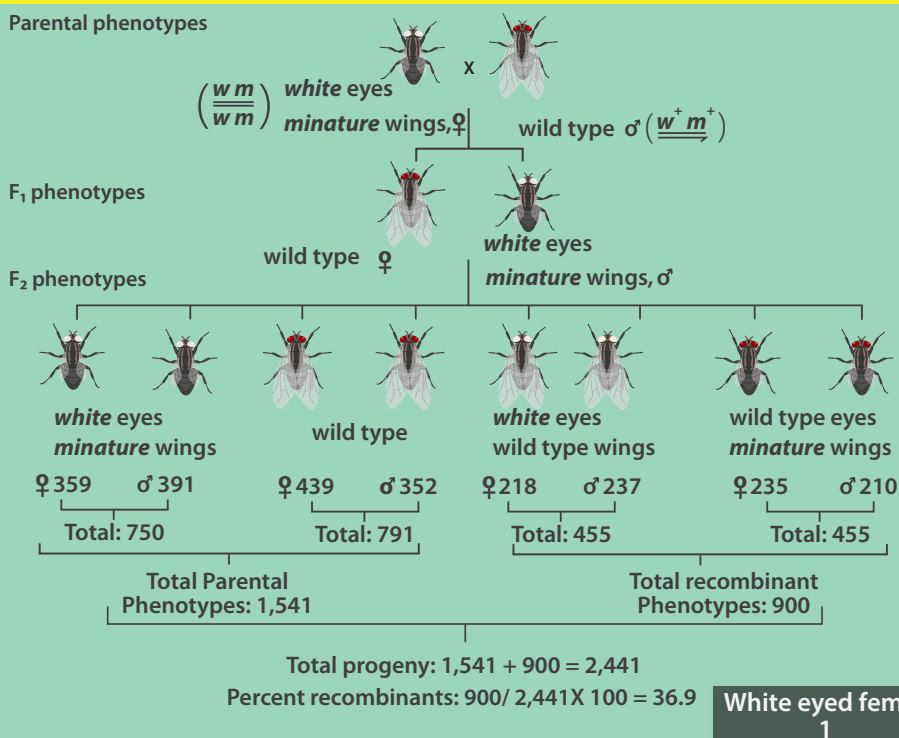
Types of linkage

- Complete linkage
- Incomplete linkage

Significance:

- Desired traits can't be brought together by breeders
- No recombination possible

Morgan's Experiment



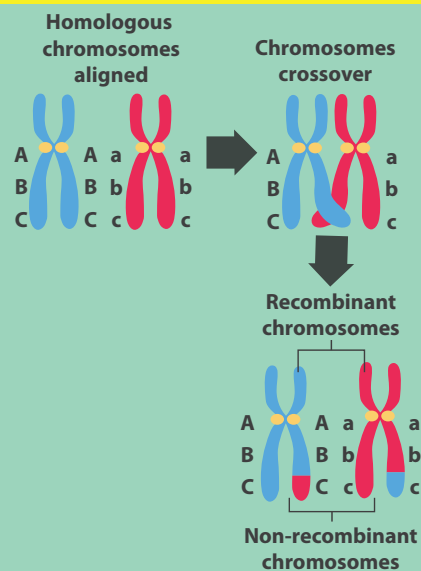
Reasons for choosing *Drosophila melanogaster*:

- Noticed a white-eyed male instead of the regular red eyes
- Small size
- Short life enables studying many generations
- High reproductive rate

- Phenotypic ratio of F₁ generation – 3:1
- Phenotypic ratio of F₂ generation – 1:1:1:1

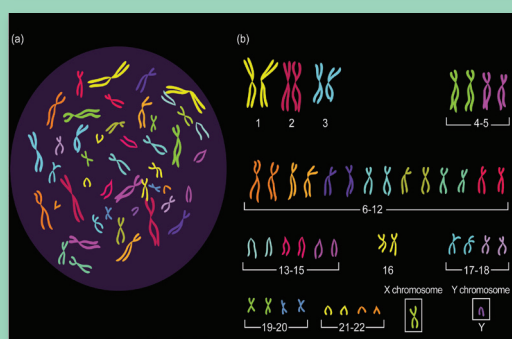
Crossing over

- Exchange of genetic material between sister chromatids
- Steps:
 - Synapsis
 - Chromosome duplication
 - Crossing over
 - Chiasmata formation
 - Terminalization



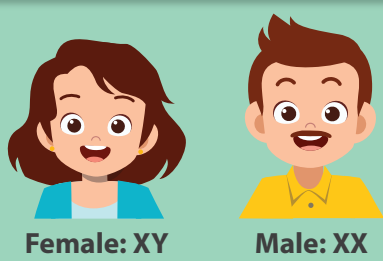
Sex Determination: System that decides the sexual characteristics of an organism

Human Chromosomes

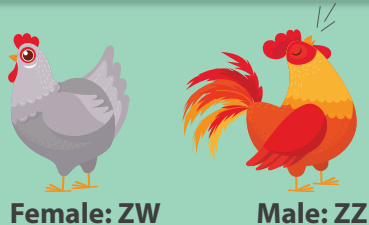


- Chromosomes 1 – 22: Autosomes
- Chromosome 23 (X & Y): Sex chromosome

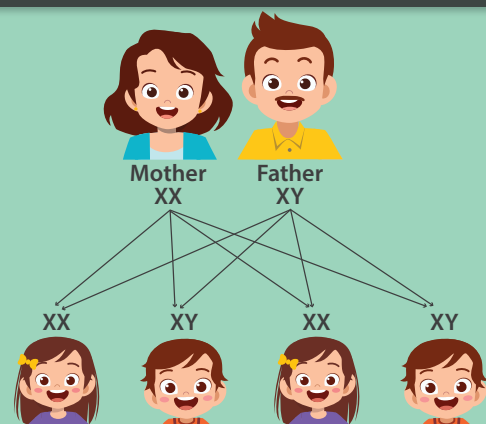
Humans



Birds



Human Sex Determination



Pre-natal sex determination (done by Amniocentesis) is an offense in many countries in the world, including India.

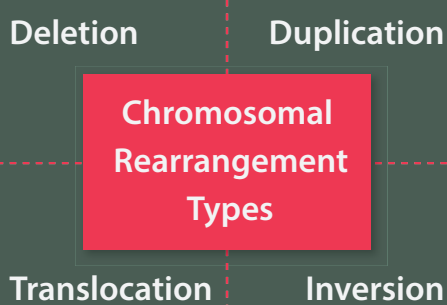
Mutation & Chromosomal Disorders: Major drawbacks of genetic inheritance

Mutation

- Minor change in the genetic material of an individual
- Leads to diversity in species

Types

- Somatic/Acquired
- Hereditary



Disorders

- Down's syndrome (Trisomy of 21st chromosome)
- Turner's syndrome (XO)
- Klinefelter's syndrome (XXY)
- Edward's syndrome (Trisomy of 18th chromosome)
- Sex-linked diseases