NCERT/STATE BOARD

CRASH COURSE

NEET/CET 2020-21

UNIT VII

GENETICS & EVOLUTION

Chapter 5 (Part I)

Principles of Inheritance & Variation

MR. PAWAR NAYAN
BIOLOGY EXPERT

Genetics

- Study of Heredity & Variations

***Heredity –** Transfer of characters from parents of offspring.

***Variations –** Difference amongst the offspring.

***Father of Genetic :** G.J. Mendel

***Term of Genetic :** Bateson

***Father of Experimental Genetics :** T.H. Morgan

Mendel works on *Pisum Sativum* (Pea Plant)

1. Flower Bisexual
2. Self pollination, Bud pollination occurs
3. Small & annual plant
4. Duration of life cycle is about 2-3 months.
5. Large number of characters can be analysed with in short duration
6. Having contrasting characteristic – Dominant & Recessive.

Mendel work on ‘7’ pairs of contrasting characteristic

1. Stem height
2. Flower colour
3. Pod shape
4. Pod colour
5. Seed shape
6. Seed colour
7. Flower position

1. In his classical experiment on pea plants, Mendel did not use

a. Seed shape b. Flower position c. Seed colour d. Pod length

Mendel Process

- Monohybrid – Single characters used
- Dihybrid - Double characters used

1. **Number of types of Gametes = 2^n**

   n = Number of Heterozygous (Tt Rr) Homozygous (RR)

Find out Heterozygous gametes

AaBBCC AaBbCC

↑ ↑↑

n=1 2^1=2 n=2 2^2=4

2. How many different types of gametes will produced by plant having the Genotype AABbCC

a. 2 b. 3 c. 4 d. 9

2. Number of types of Phenotype = $(3:1)^n$

- where n=1 for Monohybrid Cross $(3:1)^1$ = (3:1)
- n=2 for Dihybrid Cross $(3:1)^2$ = (3:1) (3:1) = 9:3:3:1

❖**Monohybrid Cross** – Single Character Involved

Tall × Dwarf

TT tt

T T

Filial F1 Gen ⟶ Tt (Tall)

Selfing Tt×Tt

	T	t
T	TT	Tt
t	Tt	tt

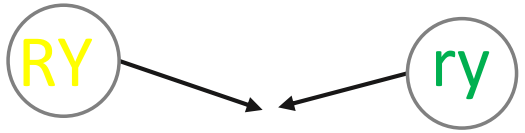
Phenotypic: Tall : Dwarf (3:1)

Genotypic: TT:Tt:tt = 1:2:1

❖**Dihybrid Cross:** Two Characters Involved

Round Yellow × Wrinkle Green

RRYY × rryy



F1 Gen → RrYy (Round Yellow)

Selfing RrYy × RrYy

	RY	Ry	rY	ry
RY	RRYY	RRYy	RrYy	RrYy
Ry	RRYy	Rryy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	rrYy	rryy

Round Yellow 9

Round Green 3

Wrinkle Yellow 3

Wrinkle Green 1

Alternate Method

Homozygous $\frac{1}{4}$

Heterozygous $\frac{2}{4}$

- Round Yellow = 9

$$RRYY = \frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$$

$$RrYY = \frac{2}{4} \times \frac{1}{4} = \frac{2}{16}$$

$$RRYy = \frac{1}{4} \times \frac{2}{4} = \frac{2}{16}$$

$$RrYy = \frac{2}{4} \times \frac{2}{4} = \frac{4}{16}$$

$$\frac{9}{16}$$

Round Green = 3

$$RRyy = \frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$$

$$Rryy = \frac{2}{4} \times \frac{1}{4} = \frac{2}{16}$$

$$\frac{3}{16}$$

3. When cross is made between Tall plant with yellow seed (TtYy) & Tall plant with Green seed (Ttyy), what is phenotype of

a) Tall & Green Plant? b) Dwarf & Green plant?

Tall Green

TT yy $\frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$

Tt yy $\frac{2}{4} \times \frac{1}{4} = \frac{2}{16}$

$\frac{3}{16}$

Dwarf Green =

tt yy $\frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$

3. Number of Barr Bodies = Total Number of X Chromosome – 1

4. Number of Barr Bodies in XX XX Female

a. 1 b. 2 c. 3 d. 4

Genetic Disorders

Mendelian Disorder	Chromosomal Disorder
Haemophilia	Down Syndrome
Sickle Cell Anaemia	Klinefelter Syndrome
Phenyl Ketonuria	Turners Syndromes
Colour Blindness	

1. Haemophilia : Discovered By "John Otto"

- **Sex – linked recessive disorder(XX, XY)** which show its transmission from unaffected carrier female to male progeny.
- CASCADE protein is dysfunctioning so that Blood Clotting Absent.
- Due to simple cut Non Stop Bleeding takes place.
- More common in Male & Rarer in Female

Haemophilia – A	Haemophilia – B
Due to absence of "Antihaemophilic Globulin".	Due to absence of "Plasma Thromboplastin"

Genotype :

✓ XX – Normal Female

✓ X^hX^h - Lethal Female

✓ XY – Normal Male

✓ X^hY – Haemophilic Male

Q: Carrier Haemophilic Female X Normal Male

X^hX XY

	X^h	X
X	X^hX	XX
Y	X^hY	XY

1. Select the incorrect statement with regard to Haemophilia.

   a. It is a Dominant Disorder

   b. A single Protein involved in the clotting of blood is affected

   c. It is Sex – linked Disorder

   d. It is Recessive Disorder

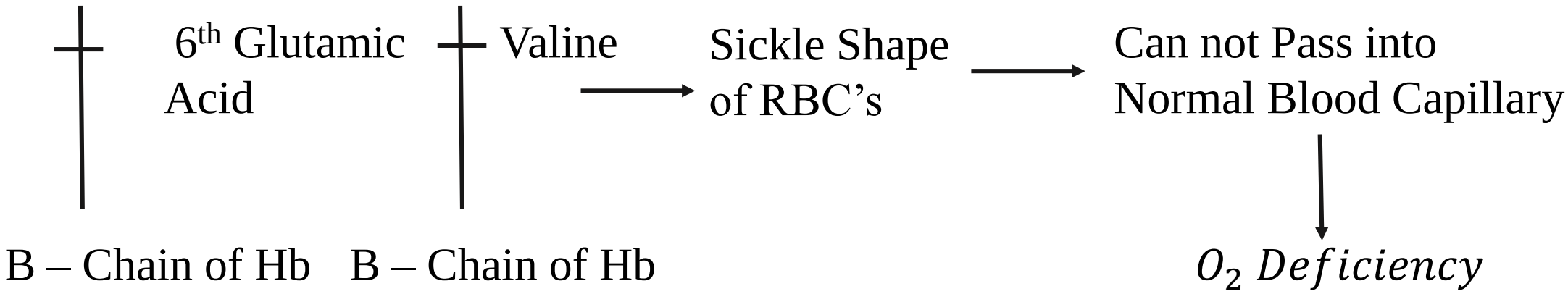
2. Haemophilic Man marries a normal female, their offspring will be

   a. All Haemophilic b. All boys Haemophilic c. All girls Haemophilic d. All Normal

	X^h	Y
X	X^hX	XY
X	X^hX	XY

2. Sickle Cell Anaemia:

- It is Autosomal Linked Recessive Disorder which transmitted from parents to offspring when both partners are carrier for the Gene.



Death of Organism Occur Due to Acute Anaemia – Decrease Hb Count

Genotype :

- ✓ Hb^AHb^A - Normal
- ✓ Hb^SHb^A - Carrier
- ✓ Hb^SHb^S - Sickle Cell Anaemia

Q. Carrier Female X Carrie Male

Hb^AHb^S Hb^AHb^S

	Hb^A	Hb^S
Hb^A	$\frac{Hb^AHb^A}{Normal}$	$\frac{Hb^AHb^S}{Carrier}$
Hb^S	$\frac{Hb^AHb^S}{Carrier}$	$\frac{Hb^SHb^S}{SCA}$

Q. Sickle Cell Anaemia:

a. Causes by Substitution of Valine by Glutamic Acid.
b. Causes by Change in a Single Base pair of DNA.
c. Characterised by elongation of Sickle like RBCs with Nucleus.
d. An autosomal Dominant traits.

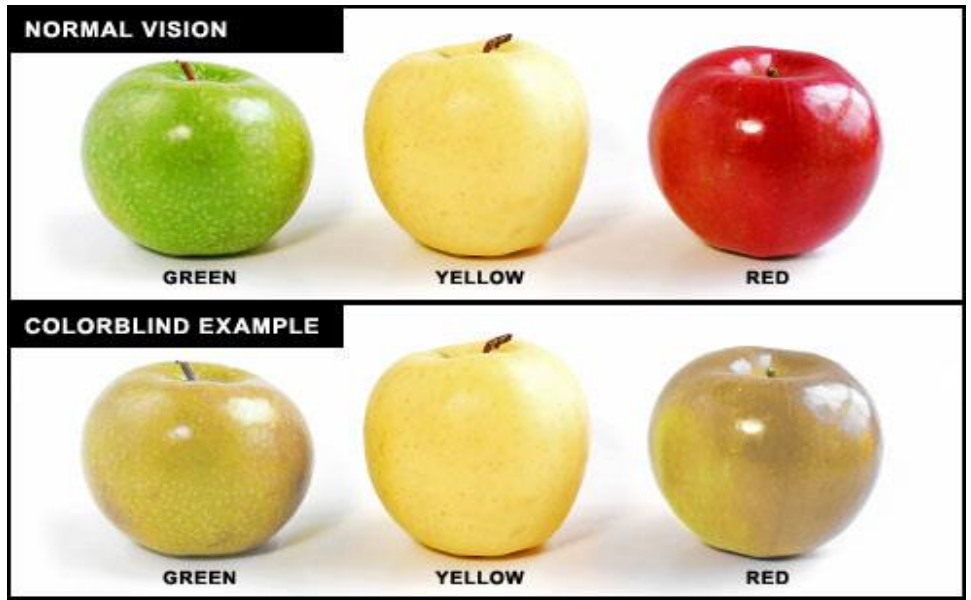
3. Phenyl Ketonuria: In Born Error of Metabolism

- **Homozygous Recessive Autosomal Allele** Present on the Chromosome Number 12 Causes Deficiency of "Phenylalanine Hydrolase" synthesis in Liver.
- Phenylalanine – Tyrosine

(Derivate Accumulate into – Kidney, Liver, Brain).

4. Colour Blindness : Term "Hornes"

- **Sex linked Recessive Disorder** in which Eye Fails to Distinguish Red & Green Colour.
- In Female Colour Blindness appear only when both Sex chromosome carry the Recessive Gene. X^cX^c
- Show criss – cross inheritance



Genotype:

- ✓ XX – Normal Female
- ✓ X^cX - Carrier Female
- ✓ X^cX^c - Colour-blindness Female
- ✓ XY – Normal Male
- ✓ X^cY – Colour Blind Male

Q1. Carrier Female × Normal Male

X^cX × XY

	X^c	X
X	X^cX	XX
Y	X^cY	XY

: X^cX – Carrier Female

: XX – Normal Female

: X^cY – Colour Blind Male

: XY – Normal Male

Q2. A colour blind Man Marries a Female with Normal Sight who has no History of colour-blindness in her family, what is the probability of grandson being colour-blind.

a. Nil b. 0.25 c. 0.5 d. 1

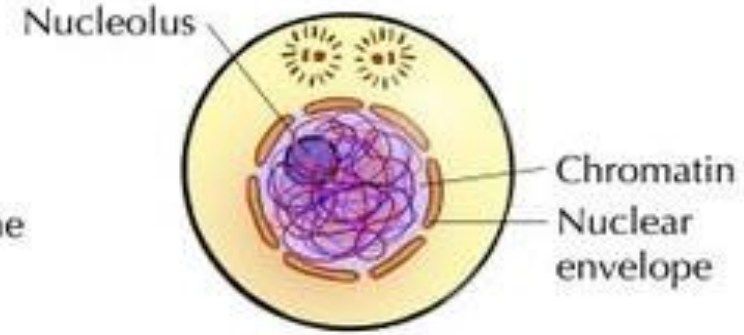
Chromosomal Disorders

- It is due to the Absence or Excess or Abnormal arrangement of one or more chromosome.

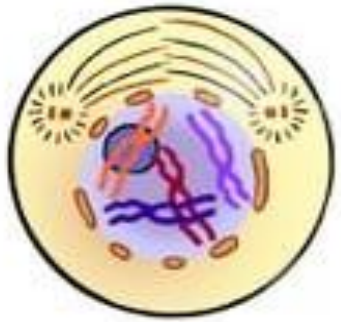
Depending upon change in the number of chromosome.

Aneuploidy	Polyploidy
• Failure of separate chromatids during cell division results in the Loss or Gain of chromosome.	• It occur mainly in the plant at the time of cell division.
e.g. Down Syndrome, Turner Syndrome	• Failure to cytokinesis after telomere stage of cell division results in increase whole set of chromosome.
	e.g. Klinefelter Syndrome

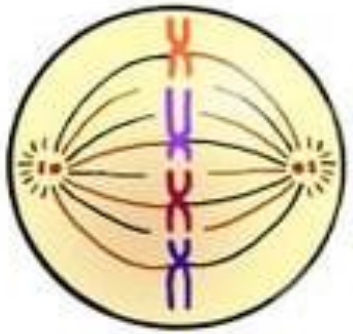
Interphase
The nucleolus and the nuclear envelope are distinct and the chromosomes are in the form of threadlike chromatin.



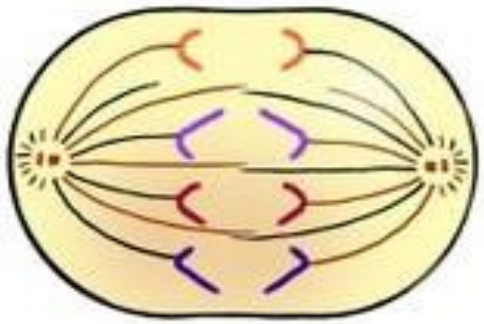
Prophase
The chromosomes appear condensed, and the nuclear envelope in not apparent.



Metaphase
Thick, coiled chromosomes, each with two chromatids, are lined up on the metaphase plate.



Anaphase
The chromatids of each chromosome have separated and are moving toward the poles.

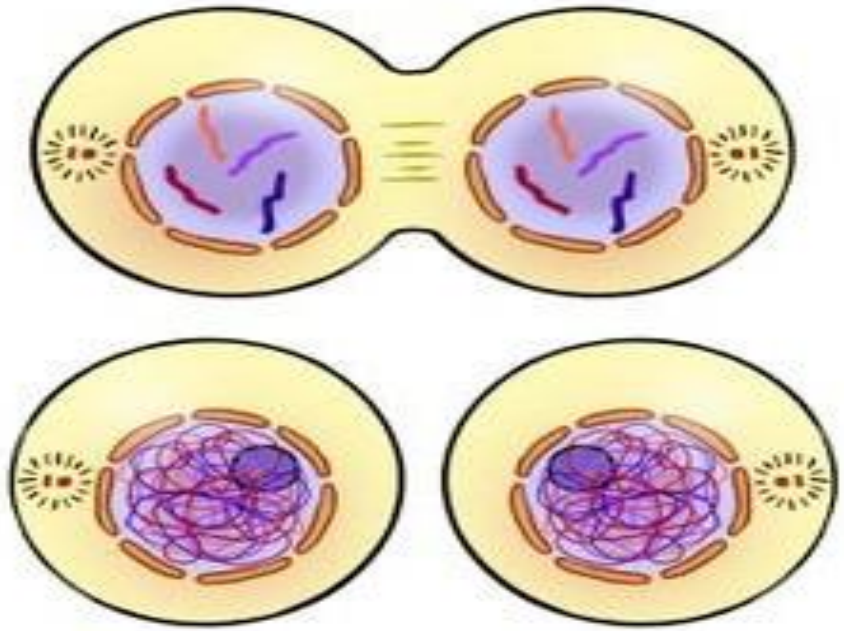


❖Cell Cycle :

I Pass My Algebra Test

Telophase
The chromosomes are at the poles, and are becoming more diffuse. The nuclear envelope is reforming. The cytoplasm may be dividing.

Cytokinesis (part of telophase)
Division into two daughter cells is completed.



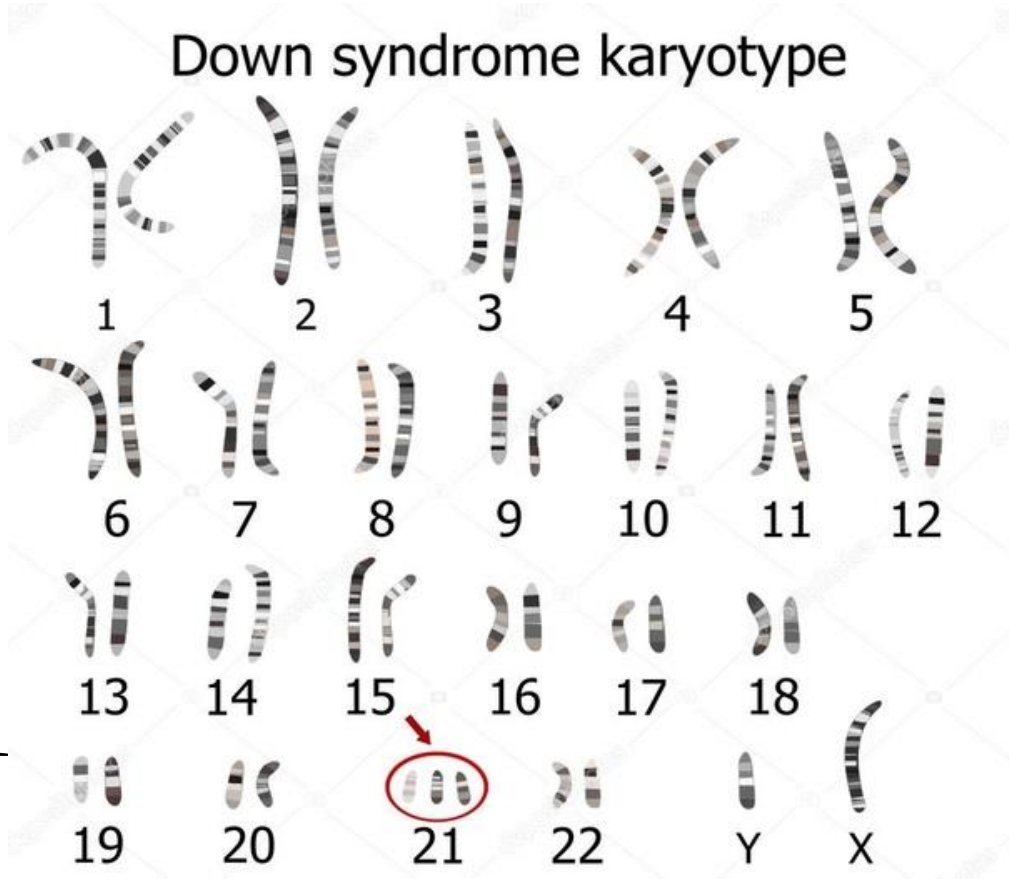
1. Down's Syndrome:

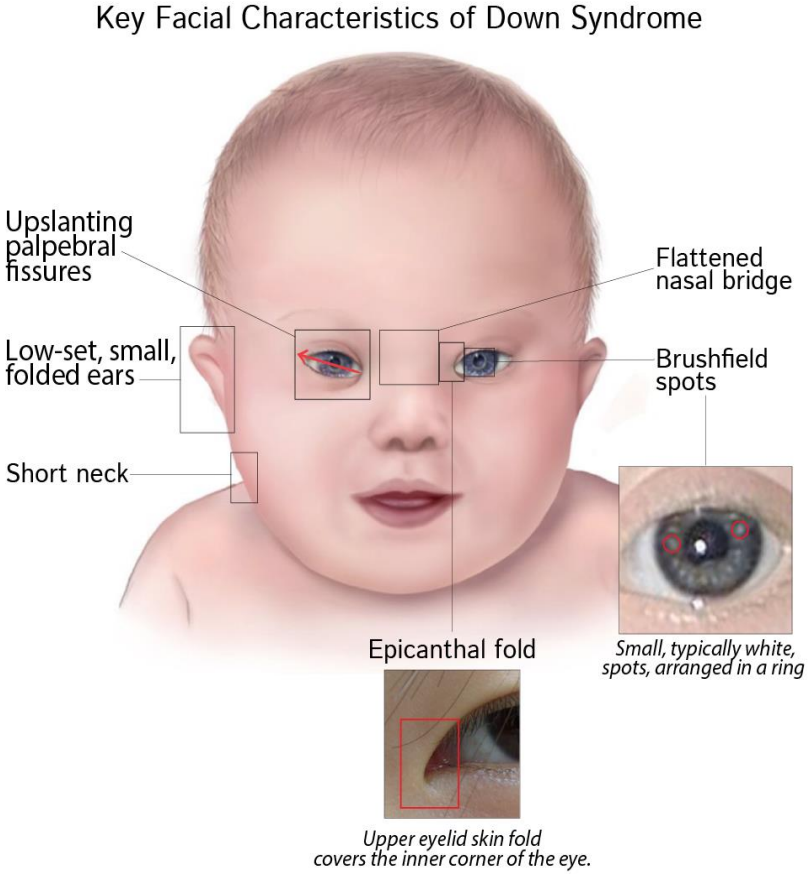
- **1st discovered by "Langdon Down"** (1801)
- Trisomy of 21st Number of Chromosome (2n+1)

$$2n=46$$

$$2n+1= 47$$

- In this syndrome, the presence of an additional copy of chromosomal number 21 i.e. 47





Symptoms:

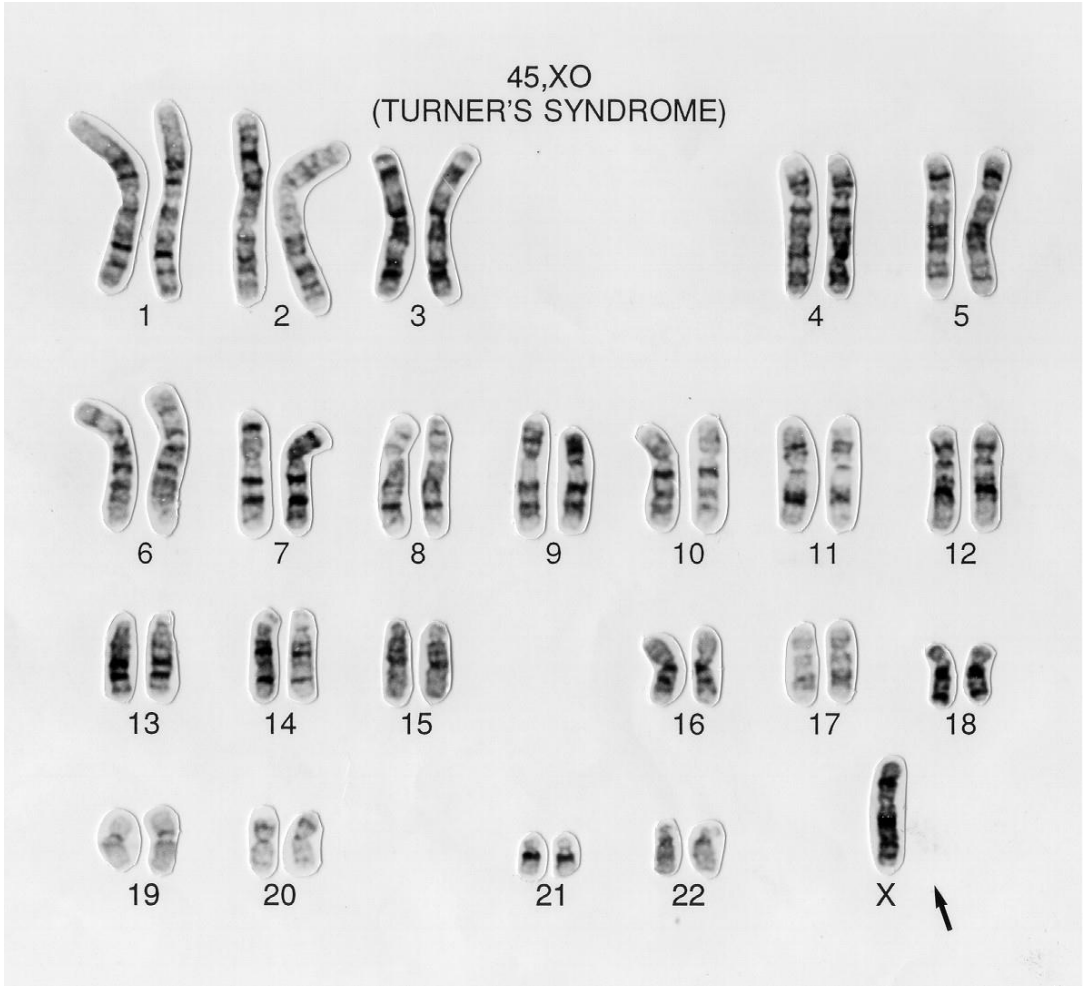
1. Rounded FACE
2. Broad fore HEAD
3. Small EAR
4. Open MOUTH
5. Protruding TONGUE
6. Skin folding at EYE corner
7. Under Development GONADS & Genital Organs
8. Short NECK
9. Congenital HEART disease

2. Turner's Syndrome:

- **Discovered by Turner et. al.**

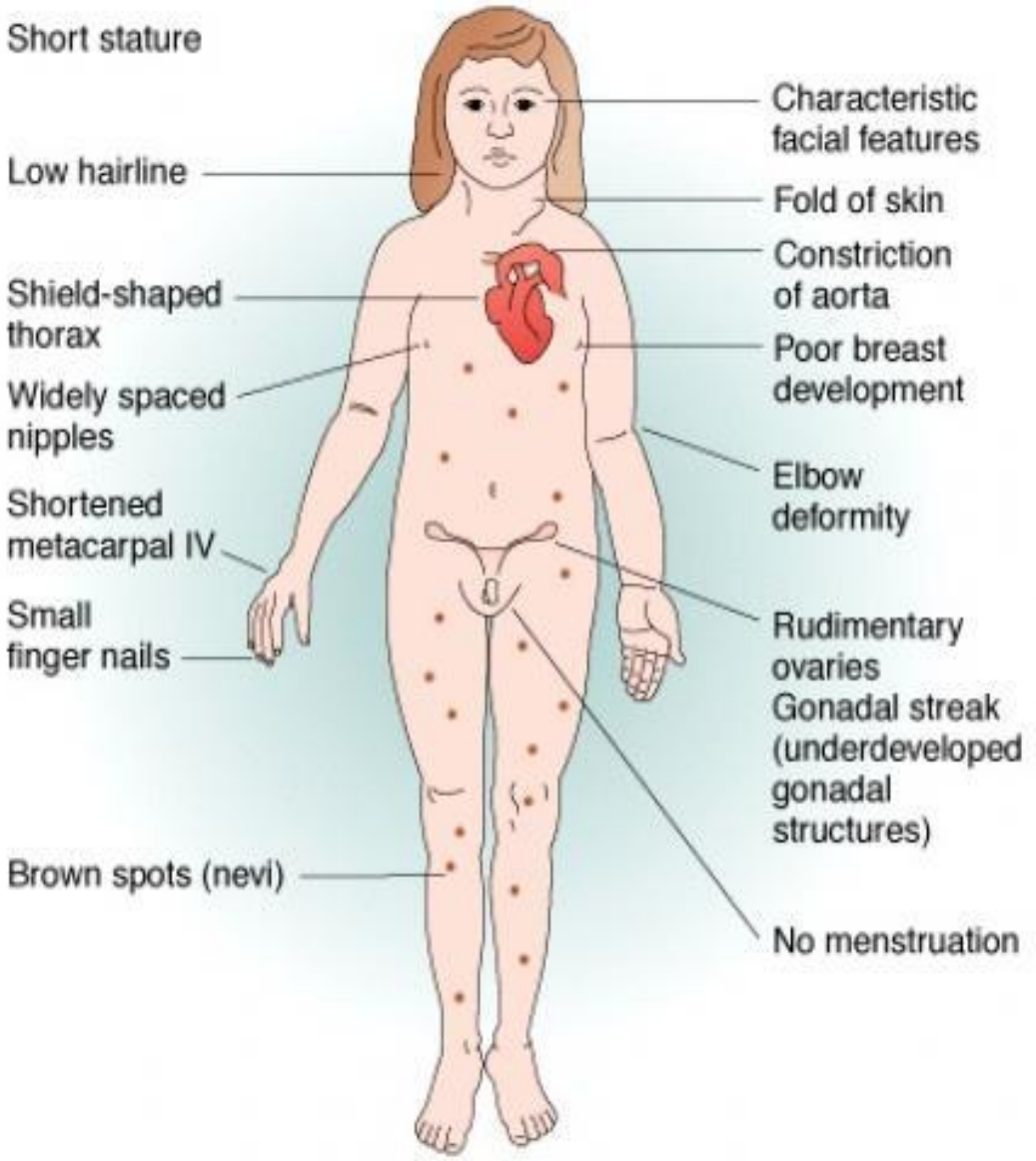
1938

- In this syndrome, absence of one of the X – Chromosome i.e. 45 with chromosome pattern XO (Female XO indicate absence of X Chromosome).



❖Symptoms:

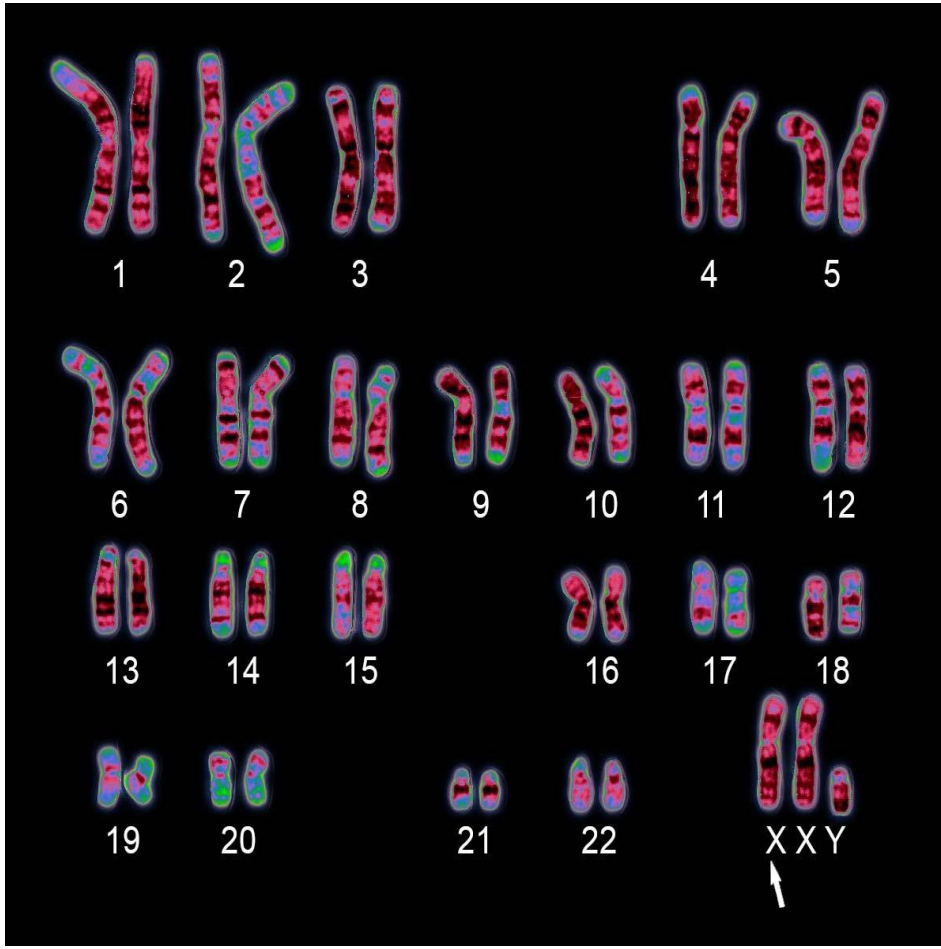
1. **Female STERILE**
2. **Ovary is RUDIMENTARY**
3. **Lack of Secondary SEXUAL CHARACTERS**



3. Klinefelter Syndrome:

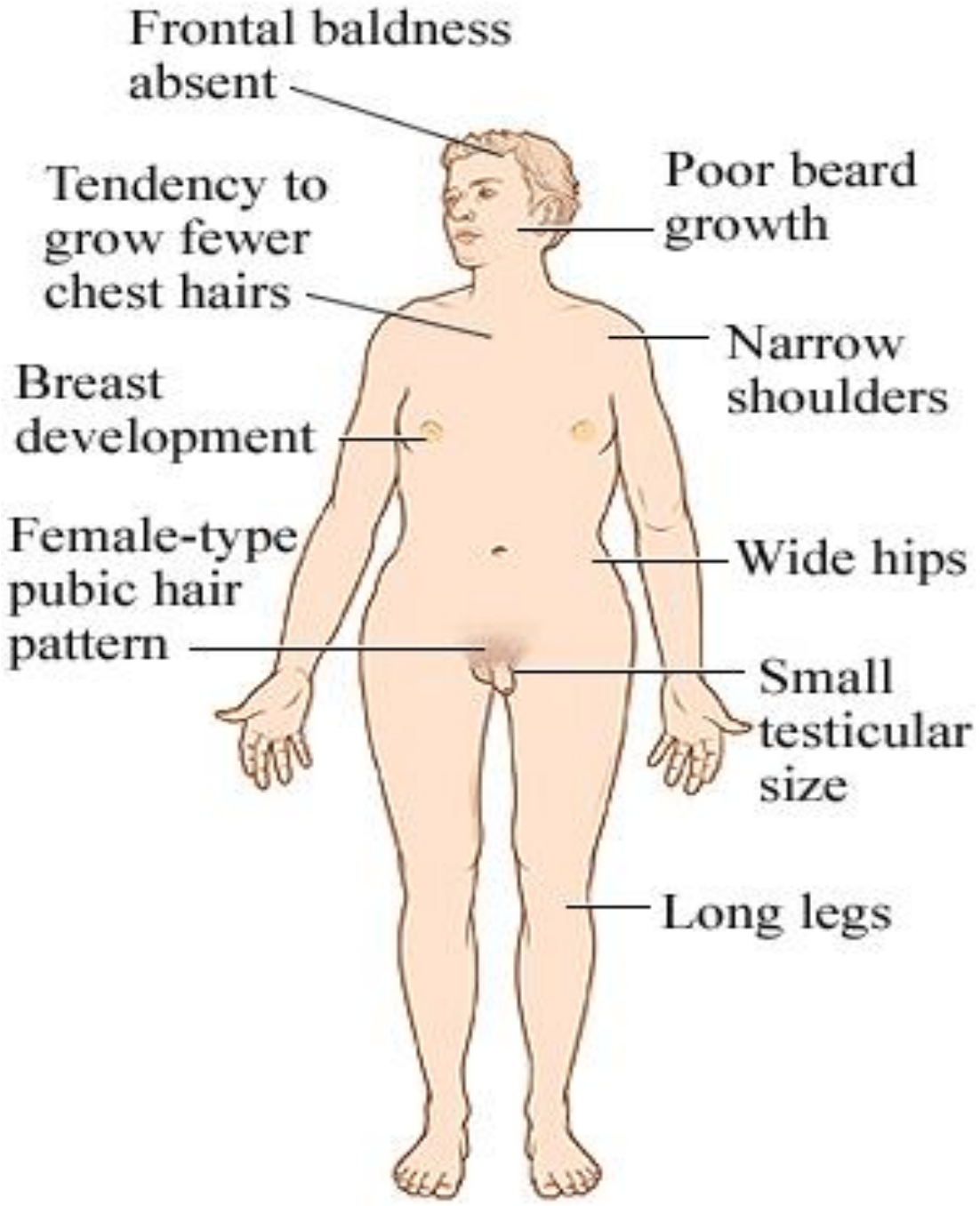
- **Discovered by "Kline Felter" in 1942**

- Sex complement is XXY, XXX, XYY
- Presence of an additional copy of X – Chromosome
- i.e. 47 XXY
- Individuals are MALE with underdeveloped testis.



❖**Symptoms:**

1. **Azospermi (Absence of SPERM Production)**
2. **Occurrence of BARR Body**
3. **Feminine Characters (FEMALE LIKE Characters)**
4. **Gynacomastia (BREAST like appearance in MALE)**



1. Down’s Syndrome in Human is due to

   a. Three X – Chromosome b. Three Copies of Chromosome Number 21

   c. Monosomy d. Two Y – Chromosome

2. A Female with 47 Chromosome due to Three copies of Chromosome 21 is Characterised by

   a. Super Femaleness b. Triploidy c. Turners Syndrome d. Down’s Syndrome

3. A person with the sex chromosome XXY suffers from

   a. Gynandromorphism b. Klinefelter Syndrome

   c. Down’s Syndrome d. Turners Syndrome

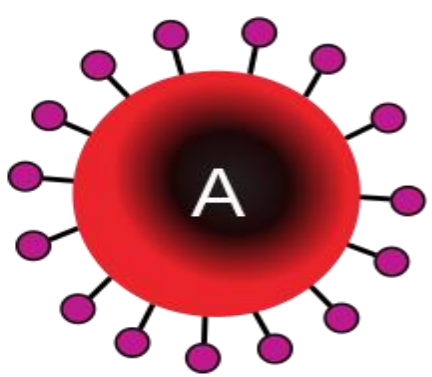
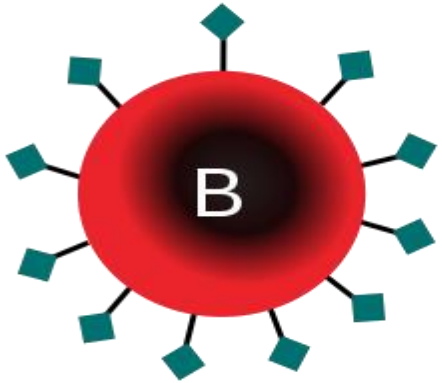
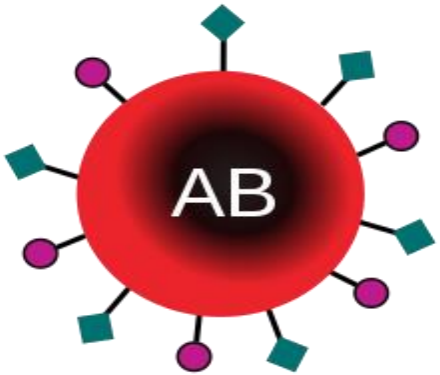
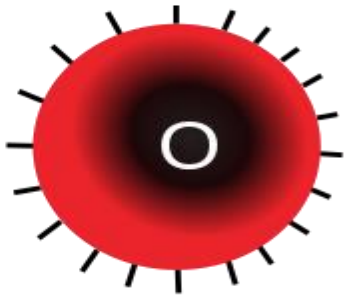
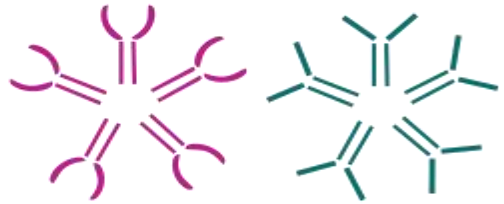
Blood Group & Blood Transfusion Reactions

Blood Group

In Human Being, **A B O** Blood group System Present Like

- Blood Group A
- Blood Group B
- Blood Group AB &
- Blood Group O

Concept of BLOOD GROUP is Given By "Landsteiner & Weiner".

	Group A	Group B	Group AB	Group O
Red blood cell type				
Antibodies in plasma	 Anti-B	 Anti-A	None	 Anti-A and Anti-B
Antigens in red blood cell	 A antigen	 B antigen	 A and B antigens	None

BLOOD GROUP	ANTIGEN	ANTIBODY	GENOTYPES
A	A	b	$I^A I^A / I^A i$
B	B	a	$I^B I^B / I^B i$
AB	AB	-	$I^A I^B$
O	-	ab	ii

- **Blood Group Consists of 4 Phenotype (A, B, AB, O) & 6 Genotype $I^A I^A / I^A i$, $I^B I^B / I^B i$, $I^A I^B$, ii.**

- **<u>Transfusion of BLOOD:</u>**

The concept of Blood Transfusion was given by "Weiner".

RULE

- Antigen of Donor Blood React with Antibody of Recipient Blood Group.

- ‘AB’ blood Group is Consider Universal Recipient Because Antibodies absent inside the Plasma of RBC’s.

- Universal Donor – ‘O’ Blood Group is called Universal Donor Because Antigen Absent On the Surface of RBC’s.

1. Person with Blood group AB considered as universal Recipient because of

    a. Both A & B antigen on RBC’s but no antibodies in the plasma

    b. Both A & B antibodies in plasma

    c. No antigen on RBC & No antibody in Plasma

    d. Both A & B antigen in the plasma but no antibodies.

2. In the ABO system of blood group if both antigens are present but no antibody, the blood group of individual will be

    a. B b. O c. AB d. A

SEROLOGY

- The study of Antigen & antibody reaction of Blood is called Serology.

Q. Husband Blood Group ‘A’ & Wife Blood Group ‘B’ , so what is probability of Blood Group of their Children's.

Ans: Husband ‘A’ Wife ‘B’

$I^A I^A / I^A \mathbf{i}$ $I^B I^B / I^B \mathbf{i}$

	I^A	i
I^B	$I^A I^B$	$I^B \mathbf{i}$
i	$I^A \mathbf{i}$	ii

AB	B
A	O

Q. A child Blood Group ‘O’, the parent blood group can not be

a. A & B b. A & A c. AB & O d. B & O

$I^A I^A / I^A \mathrm{i}$ $I^B I^B / I^B \mathrm{i}$

	I^A	I^B
i	$I^A i$	$I^B i$
i	$I^A i$	$I^B \mathrm{i}$

Q. Wife blood group ‘O’ & her Husband of blood Group ‘B’ & their child have Blood Group ‘O’, could be there.

a. 50% Chance b. 75% Chance c. 25% Chance d. 100% Chance

Mother Blood Group ‘O” × Father Blood Group ‘B’

$$ii \quad \times \quad I^B I^B / I^B i$$

1st Cross	I^B	i
i	$I^B i$	ii
i	$I^B i$	ii

2nd Cross	I^B	I^B
i	$I^B i$	$I^B i$
i	$I^B i$	$I^B i$

Total Progeny = 8

Total Blood Group ‘O’ = 2

$$\frac{2}{8} \times 100 = 25\%$$

BACK CROSS

- F1 hybrid × Dominant Parents

Tt × TT

TT TT Tt Tt

Tall

- All are dominant : Back cross is perform so that Dominant characters of the parents pass into progeny.

TEST CROSS

- It is a type of Back Cross
- F1 Hybrid × Recessive Parents

Tt × tt

Tt Tt tt tt

Tall **Dwarf**

❖It is important for Determine Genotype of the Plant F2 Generation

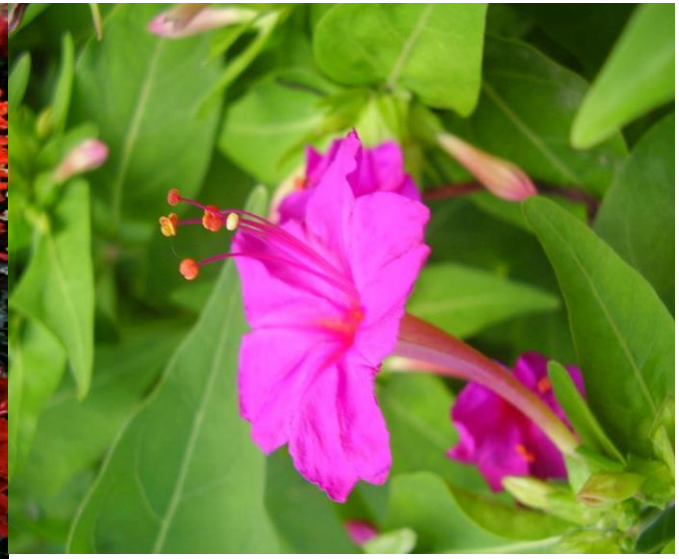
❖50% Tall & 50% Dwarf (1:1)

Post Mendelian Principle / Gene Interaction

A. Incomplete Dominance:

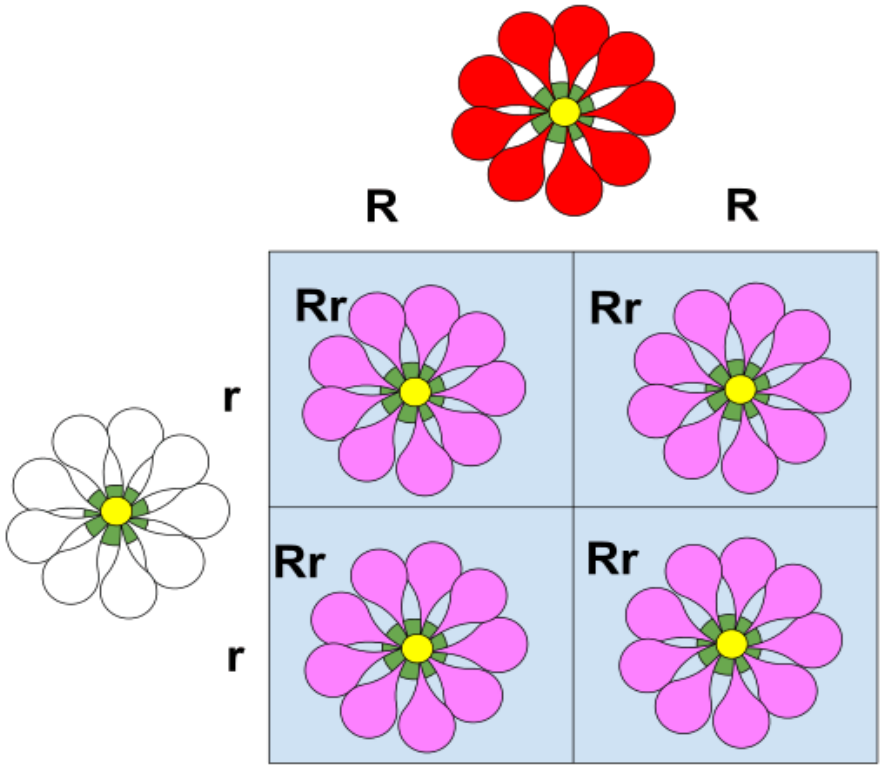
✓It was 1st studied by “Carl Correns” in Mirabilis jalapa (4 O Clock Plant).

✓i.e. Antirrhinum Species (Snapdragon or Dog Flower)



Definition:

- The allele of the locus controlling a characters are such that Neither of then Dominant over each other & F1 Generation is the intermediate NOT resembling with any of the parents.



➢Examples: Flower Colour of Mirabilis Jalapa

Red × White

RR × rr

R × r

F1 Generation ⟶ Rr (Pink)

Self Crossing

Rr × Rr

	R	r
R	RR/ Red	Rr/ Pink
r	Rr/ Pink	Rr/ White

***Phenotype Ratio:**

RED : PINK : White

1 : 2 : 1

***Genotypic Ratio:**

RR : Rr : rr

1 : 2 : 1

Phenotypic Ratio : Genotypic Ratio

B. Co – Dominance :

✓The allele of locus controlling a character are such that both the parents are Completely Dominant & they Expressed in the progeny such that F1 Generation Has Characters of both the parents.

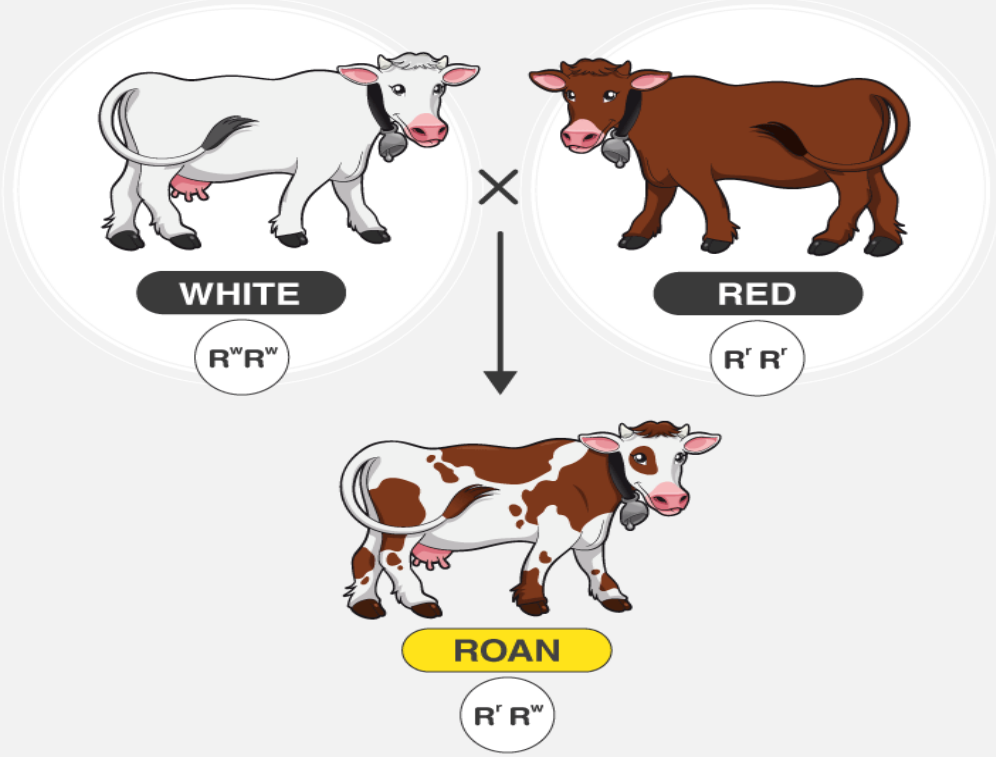
Example : A) Black × White B) Blood Group AB

BB × bb

B b

Bb (Roan)

$I^A I^B$

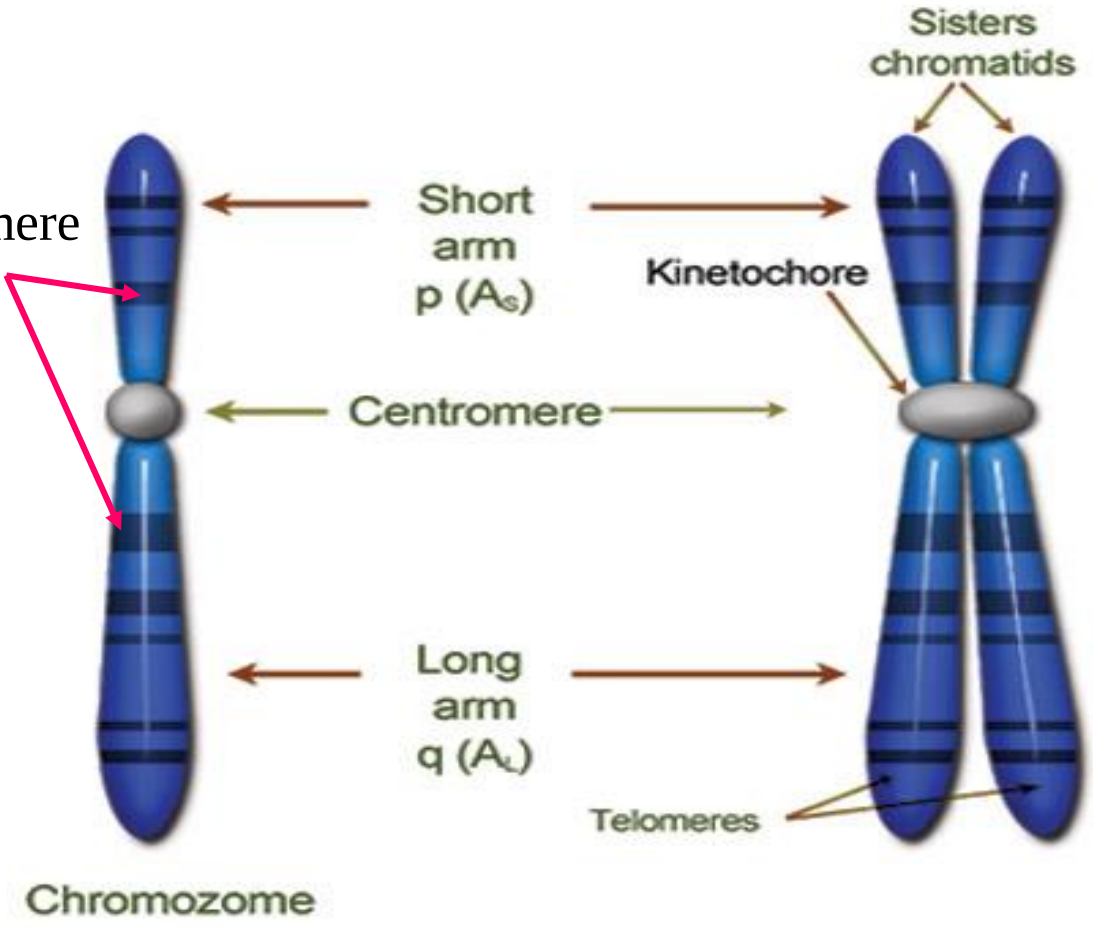


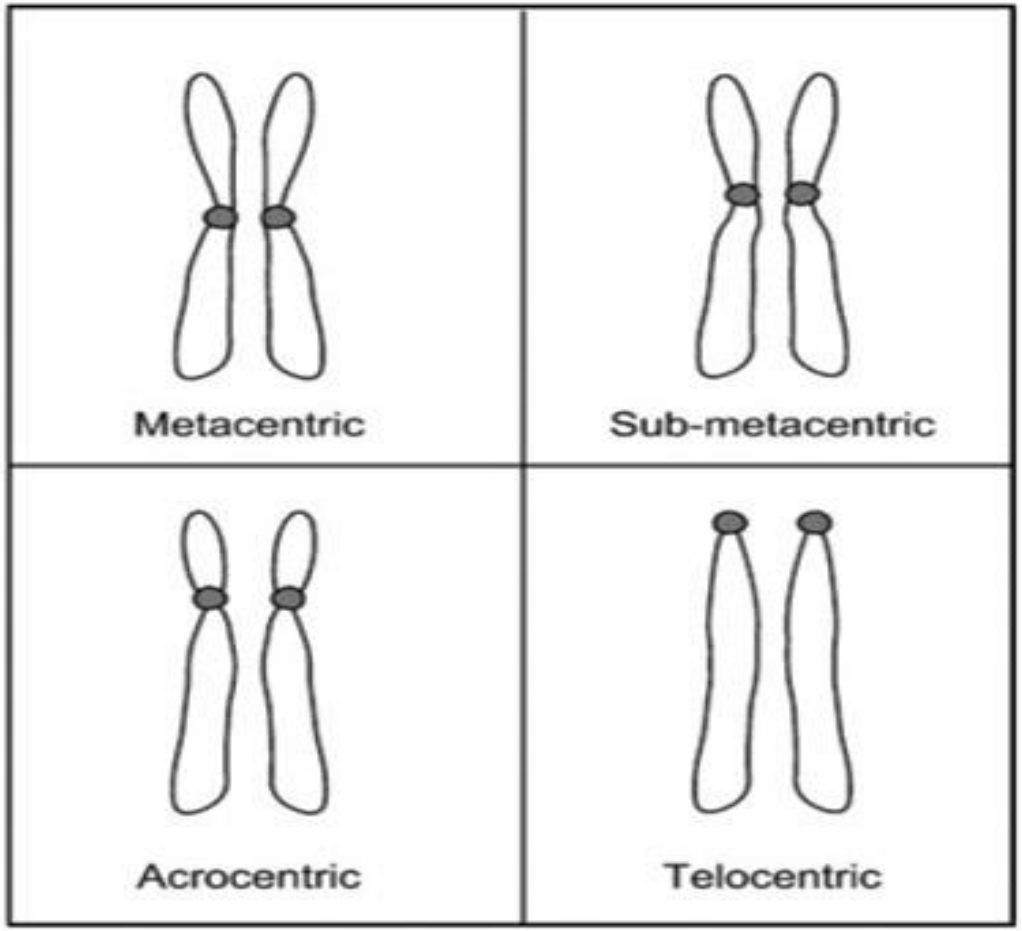
Chromosome:

- **Term chromosome is given by – "von Waldeyer-Hartz"**
- 1st observed by – "Wilhelm Hofmeister" in pollen mother cells of "*Tradescantia pallida*".
- Smallest chromosome – "Fungi"
- Largest chromosome – "Trillium"

Structure of Chromosome

Chromomere (Gene Located)





Chromosomal Theory of Inheritance

- **“Suttan” & “Boveri”** – Proposed the Chromosomal Theory of Inheritance.
- The pairing & separation of a pair of chromosome would leads to the segregation of a pair of Factors.
- **FATHER – “Thomas Hunt Morgan (Father of Experimental Genetics).**

- **He worked on – Drosophila Melanogaster (Fruit Fly),** they Grow on the ripened Banana Fruit.

Chromosomal Basis of Inheritance

Walter Sutton

Theodor Boveri

Thomas Hunt Morgan

LINKAGE

- Discovered by – “Bateson” & “Punnet” in Lathyrus odoratus (Sweet Pea).
- Define & Prove by **“Morgan”**.
- Linkage is also known as – **“Physical Association”**.

- Tendency of Gene Present on the same chromosome to inheritance together for two or more Generation is Known as Linkage.

- i.e. Parental Combination to Remain together which Expressed in Term of low frequency of New Combination.

According to the Chromosomal Theory of Linkage

1. Linked Genes are present on the Chromosome.
2. Linked Genes are present in the Linear sequence on the chromosome.
3. Linked Genes produce parental phenotype more Frequently.

- $\textbf{Linked} \propto \frac{1}{\textit{Distance Between Two Gene}}$

Complete linkage	Incomplete Linkage
Crossing Over is Absent	Crossing Over is Present
Recombinant is Absent	Recombinant are Formed along with Parents
e.g. Male Drosophila	e.g. Female Drosophila

Sex determination

- It depends on – Chromosomal Pattern, Genetics, Environment.
- X – Chromosome was Discovered by – **"Henking"**.
- Y – Chromosome was Discovered by – **"Stevens"**.

Types of Sex Determination

1. **XX – XY Type – Reported in**

Mammals,

Man,

Drosophila

Chromosome – 46 (23pairs)	
Autosomal Chromosome	**Sex Chromosome**
✓ 22 Pairs	✓ 1 pair – XY
✓ They control all the Physiological process	✓ they help in Sex - Determination

	X	YX
X	XX	XX
Y	XY	XY

Chances of Male : Female

50% : 50%

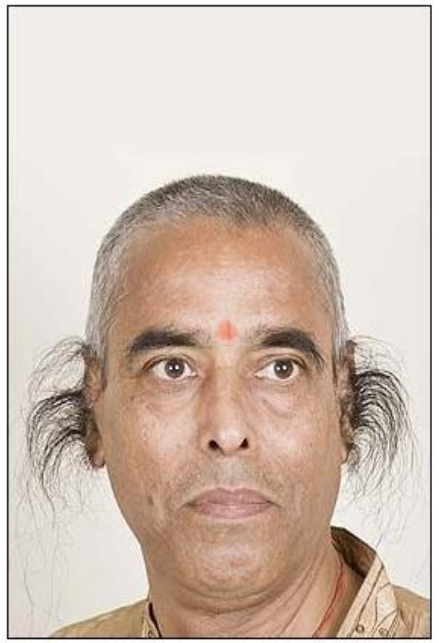
1:1

- **Holandric Gene:**

✓Transfer from FATHER to SON Directly because ‘Y’ Chromosome of father enter into the SON.

Y encodes traits only found in males;
contains very few genes.
Genes on the Y chromosome- holandric genes

Hairy ears in men



TDF (Testis Determination Factor)

- Present on the 14^{th} chromosome number, responsible for Maleness.

2. **XX – XO type – They are Reported in**

Grasshopper

Roundworm

Cockroach

Drosophila

‘O’ Means absence of ‘Y’ chromosome

	X	X
X	XX	XX
O	XO	XO

Male having absence of ‘Y’ chromosome chances of Male:Female 1:1 50%:50%

3. **ZW – ZZ type – Reported in Birds & Hens.**

Heterozygous Female (ZW)

ZZ – Homozygous = Male

	Z	W
Z	ZZ	ZW
Z	ZZ	ZW

Chances of Male : Female

50% : 50%

1:1

Mutation

- Term mutation was given by – **“Hugo de vries” in “*Oenothera lamarckiana*” (Evening primrose).**
- Hugo de vries also propesed – The Theory of Mutation
- Mutation is sudden inheritable Discontinuous variation which appear in the organism which causes change in – Phenotype & Genotype.

Mutation		
Genomic Mutation	**Chromosomal Mutation**	**Gene Mutation**
✓ Change in the number of chromosome. Point Mutation Frame Sift Mutation	✓ Change in the Arrangement of Gene in chromosome.	✓ Change in the Form & Expression of the Gene.

Mutagen

- The Substance/Chemical which causes mutation is called Mutagen.

Physical Mutagen	Chemical Mutagen
• e.g. High Temperature	• e.g. Nitrous Acid
• High Energy Radiation	• Alkylating Agent
• α- Ray	• Acridine
• y- Ray	
• uv- Ray	