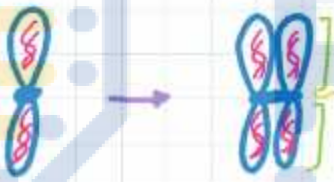
Basic Terms of Inheritance

INHERITANCE → Transmission of traits from parents to offsprings.

GENETICS → Study of genes, and their roles in inheritance.

GENE →
- Basic unit of inheritance
- Sequence of Nucleotides → Determines sequence of A.Acid
- Part of DNA → Determines a specific protein



→ Chromatids (Euchromatin)
Centromere (Pº constriction)
↳ (Heterochromatin)

(Homologous Chromosomes)
Same Position

LOCUS: (Location / Position)
↳ Position of a gene on a chromosome.

ALLELE: → Alternative forms of a gene.

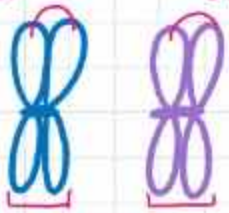
Dominant Allele

Recessive Allele

HOMOZYGOUS
Both alleles are same.
AA , aa , BB , bb

HETEROZYGOUS
Both alleles are different
Aa , Bb , Cc , Dd

Sister Sister



(n) → Set of Chromosome
↳ Haploid

(2n) → Two Set of chromosome
↳ Diploid

Non-Sister chromatid

(2n) → Two set of chromosome
↳ Diploid

(N) → No. of DNA molecule

(2N) → 2 DNA molecule

Chromo-meres

Secondary constriction (NOR), Nucleoli Organizing Region.

Centromere (Primary constriction)

1N

GENE POOL : All genes of a population

GENOME : All the genetic material of an individual

GENOTYPE
Genetic combination of a gene.
→ Homozygous
AA, aa, BB
→ Heterozygous
Aa, Bb, Cc

PHENOTYPE (Expression)
Expression of a gene.

(AA) → Black*

(BB) → Blue*

KARYO-TYPE
Particular array of chromosomes

Mendelian Inheritance

Gregor Johan mendel → Inheritance laws

Experimental Organism → Pisum Sativum (Pea)

- Easy to cultivate
- Fertilization (Self, Cross)
- Artificial Breeding
- Hybrids are fertile
- Generation time short

CHARACTERS OF PEA

CHARACTER	DOMINANT	RECESSIVE
• Stem length	Tall	Dwarf
• Pod shape	Inflated	Constricted
• Seed shape	Round	Wrinkled
• Seed Colour	Yellow	Green
• Flower Colour	Purple	White
• Flower Position	Axial	Terminal
• Pod Colour	Green	Yellow

- Each trait of Pea is distinguished, No intermediate form.
- No. of Chromosomes in Pea is (7)
- But traits gene present on (4) Chromosome.
  - → Chromosome # 1 → Seed colour, Flower Colour
  - → Chromosome # 4 → Stem length, Pod shape, Position of flower
  - → Chromosome # 5 → Pod colour
  - → Chromosome # 7 → Seed shape

Single Trait Inheritance ← **Law of Segregation** → Separation
↳ Law of Purity of gametes

STATEMENT:

"The two co-existing alleles for each trait in an individual segregate (separate) from each other at meiosis, so that each gamete receives only one of the two alleles. Alleles unite again at random fertilization of gametes when zygote is formed."

SINGLE TRAIT INHERITANCE (Mono-Hybrid Cross)

TRUE BREEDING ↷ Self fertilization results in Homozygous

P1 (True Breeding Round) RR × rr (True Breeding wrinkled)

R r

F1 Rr → Phenotypically Round

Rr Rr

R r R r

F2 RR Rr Rr rr Wrinkled

Round Round

	R	r
R	RR	Rr
r	Rr	rr

GENOTYPIC RATIO

RR : Rr : rr

1 : 2 : 1

Homozygous dominant : Heterozygous : Homozygous Recessive

PHENOTYPIC RATIO

Round : Wrinkled

3 : 1

TEST CROSS: To check genotype

Always crossed with Homozygous Recessive.

Round

Rr × rr

R r r

Rr yr

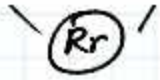
Round

RR × rr

R r

Rr

- 50% Round , 50% wrinkled
- Heterozygous



- 100% population is Round
- Homozygous

- Elementens (Genes)

Dihybrid Cross → **Law of Independent Assortment** → Separation

STATEMENT:

"When two contrasting pair of traits are followed in the same cross, their alleles assort independently into gametes".

TRAITS:

SEED COLOUR + SEED SHAPE

Yellow (Dominant) | Green (Recessive) | Round (Dominant) | Wrinkled (Recessive)

DOMINANT PHENOTYPE TRUE BREEDING:

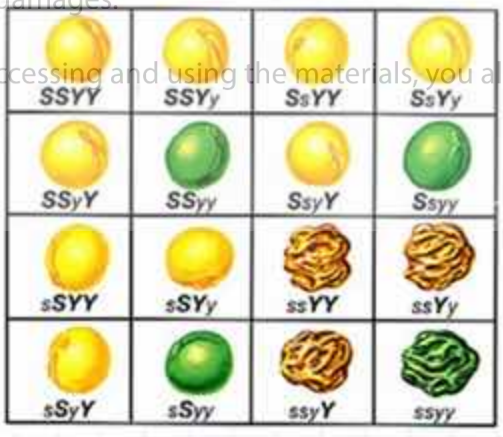
P_1: RRYY (Round, Yellow) × yyyy (Wrinkled, Green)

RY | ry

F_1: RrYy (Round, Yellow)

RrYy × RrYy

RY, Ry, rY, ry | RY, Ry, rY, ry



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

PHENOTYPIC RATIO:

PHENOTYPIC RATIO :

? 9 : ? 3 : 3 ? : 1 ?

Round, Yellow	:	Round, Green	Wrinkled, Yellow	Wrinkled, Green
$\frac{3}{4} \times \frac{3}{4}$		$\frac{3}{4} \times \frac{1}{4}$	$\frac{1}{4} \times \frac{3}{4}$	$\frac{1}{4} \times \frac{1}{4}$
$\frac{9}{16}$	:	$\frac{3}{16}$	: $\frac{3}{16}$	: $\frac{1}{16}$

LIMITATIONS :

- Chromosome's independent Assortment

Gene linkage

- Alleles riding on Non-Homologous chromosome.

Dominance Relations

Dominance

Physiological effect of an allele to other one is called Dominance. (Same locus)

- Always seen in Heterozygous form.

Complete Dominance → Mendel's all seven traits.

When one allele suppresses the effect of other allele by 100% is called Complete Dominance.

Round × Wrinkled

RR → R

rr → r

Rr → Phenotypically Round

100% suppression of r by R.

F_2 Cross

Genotypic Ration

1 : 2 : 1

Homozygous Dominant | Hetero | Homozygous Recessive

Phenotypic Ratio 3 : 1

In-Complete Dominance → Partial Dominance

Both alleles are unable tp suppresses the effect of other allele by 100% is called incomplete dominance.

→ 4 O clock Plant

Phenotypic & Genotypic ratios are same.

	R	r
R	RR (Red)	Rr (Pink)
r	Rr (Pink)	rr (White)

F_1 Cross

F_1 = Rr

Pink Colour → Different Phenotype.

Co- Dominance

When both alleles are able to express their effect by 100% is called co-dominance.

MN BLOOD GROUP

M	N

Phenotypic Ratio

MN BLOOD GROUP

	M	N
M	MM	MN
N	MN	NN

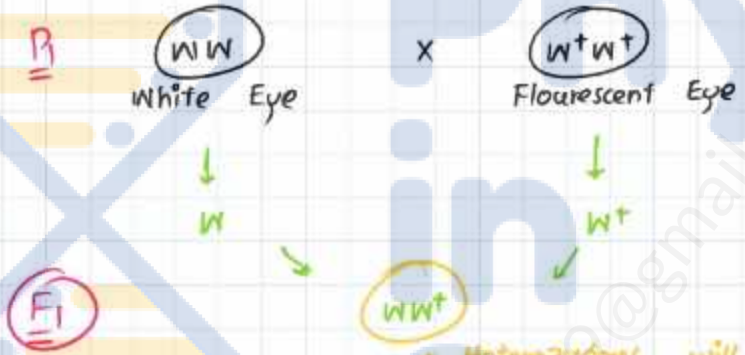
Phenotypic Ratio
1 : 2 : 1

Genotypic Ratio
1 : 2 : 1

NOTE : No test cross Needed.

Over Dominance

When one allele show its effect more than 100% in heterozygous form is called Over-Dominance.



	W	W+
W	WW	WW+
W+	WW+	W+W+

Ratio = 1 : 2 : 1

* Heterozygous will be more brighter

Multiple Alleles and ABO Blood Group System

MULTIPLE ALLELES → More than (2) Population level

Product of mutation (3 min. → 300 max.)

Gamete → (n) Only 1 copy of gene.

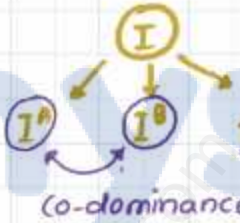
Individual → (2n) 2 alleles

Population → More than (2)

ABO BLOOD GROUP SYSTEM (3 alleles)

→ Karl Landsteiner (1901)

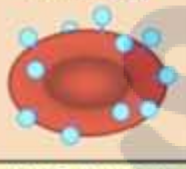
→ Bernstein (1925)
↳ Genetic basis of ABO blood group system



Isohaemoagglutinogen
Chromosome # 9

Recessive for both I^A & I^B.

ABO Blood Groups

	Antigen (A)	Antigen (B)	Antigens (A) & (B)	Neither A or B
Antigen (on RBC)				
Antibody (in plasma)	Anti-B Antibody 	Anti-A Antibody 	Neither Antibody	Both Antibodies 
Blood Type	**Type A** Cannot have B or AB blood Can have A or O blood	**Type B** Cannot have A or AB blood Can have B or O blood	**Type AB** Can have any type of blood Is the universal recipient	**Type O** Can only have O blood Is the universal donor

GENOTYPE → (6)

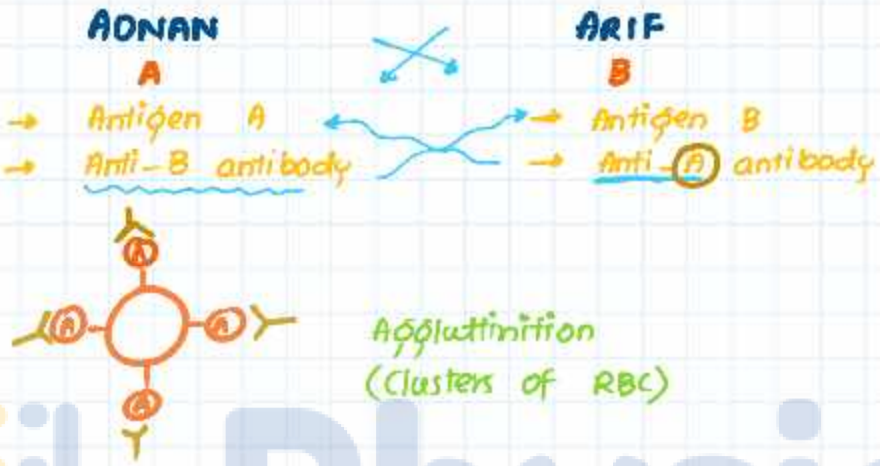
- I^AI^A ✓
- I^Ai ✓
- I^BI^B ✓
- I^Bi ✓
- I^AI^B → Always Heterozygous
- ii → Always Homozygous

PHENOTYPE → (4) A, B, AB, O

UNIVERSAL DONOR → Blood Group (O) (Always in Small Amount)

UNIVERSAL RECEPIENT → Blood Group (AB)

UNIVERSAL RECEPIENT → Blood Group (AB)



Agglutinition
(Clusters of RBC)

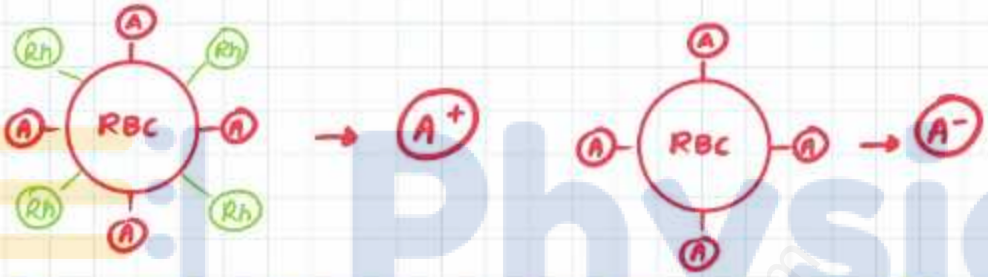
BLOOD GROUP	DONATED TO	RECEIVED FROM
A	A, AB	A, O
B	B, AB	B, O
AB	AB	A, B, AB, O
O	A, B, AB, O	O

Rh Blood Group System

Sign to Blood → ⊕ ⊖ — A^+, A^-, B^+, B^-, AB^+, AB^-, O^+, O^-

Rh → Rhesus Monkey
(Karl Landsteiner → 1930's)

Rh → Present ⊕
Rh → Absent ⊖



Rh Factor Regulating Genes → C, D, E

D d

DD, Dd → Rh^+
dd → Rh^-

PHENOTYPE	FACTOR	GENOTYPE	ANTI-BODIES	DONATE	RECEIVE
Rh^{+ive}	✓	DD, Dd	×	Rh^+	Rh^+, Rh^-
Rh^{-ive}	×	dd	✓	Rh^-, Rh^+	Rh^-

ERYTRO- BLAST- OSIS FOETALIS → Foetus

Erythrocyte (RBC) | Formation | Increased in number

Because of Rh factor incompatibility

Stem Cell → Erythroblast → ⋮ → Reticulocyte → Erythrocyte (RBC)

Immature Erythroblasts (↑↑) ⊖

FATHER Rh^+ — DD ✓ / Dd

100% child will be Rh^+

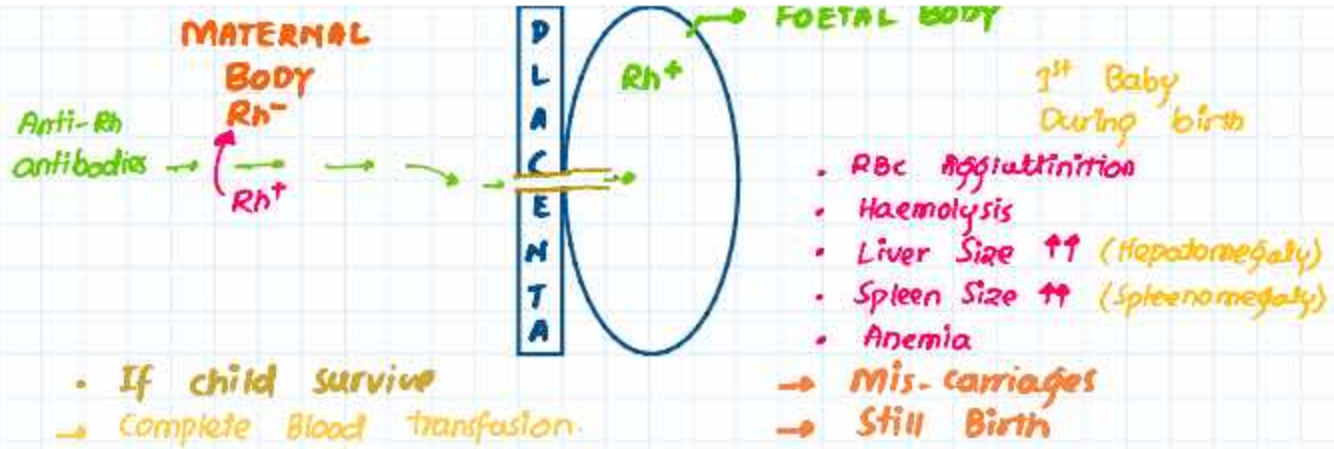
50% Rh^+
50% Rh^-

MOTHER Rh^-

MATERNAL BODY

P L — Rh^+ → FOETAL BODY

1st Baby



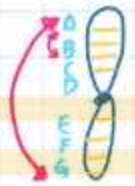
Gene Linkage and Crossing Over

Gene Linkage

- Staying together of genes on a chromosome.
- Physical relationships of genes.

Chromosome → 46 → Thousands of genes

Homologous chromosomes



→ linked genes

(22) ← Autosomal Chromosome

(1) ← Sex chromosome

(23) → linkage group

XX (Female)

XY (Male)

- Greater the distance b/w genes greater will be the chances of separation.

Detection of Gene Linkage → Test Cross

Dihybrid Cross

A, B

(F1) Heterozygous

↓

Back Cross

(Recessive Parent)

Phenotypic Ratios

- 1 : 1 : 1 : 1 (No linkage)
- Parental Types, Recombinant
  ↑↑ ↓↓ (Partial linkage)
- Only Parental Types
  (Tight linkage / Complete linkage)

Autosomal Linkage

Chromosome # 1 → 22

→ Chromosome # 11

- Sickle cell Anemia
- Usher's syndrome (Partial deafness)
- Albinism
  (No pigment at all)

Sex Linkage

Homologous Chromosome # 23

X- Chromosome

- Colour Blindness
- Haemophilia
- Gout

Crossing Over → Exchange of genetic material b/w Non-Sister Chromatid.

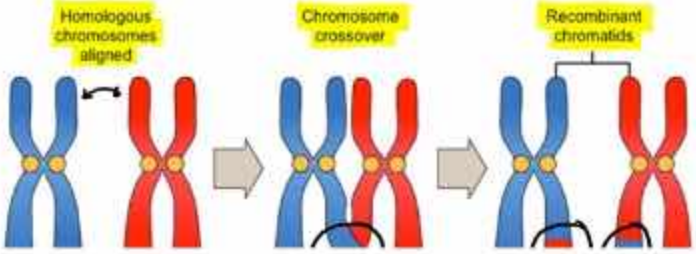
↓

MEIOSIS

(Gametogenesis)

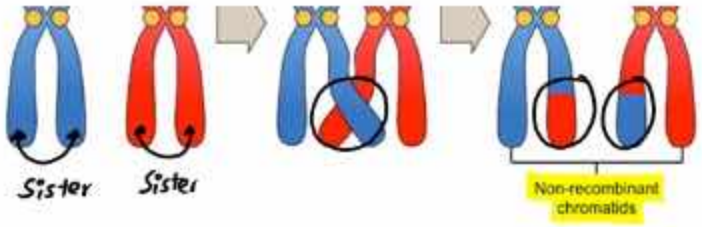
Spermato-genesis

Oogenesis



- Closer the genes lesser will be the crossing over

genesis



over

Recombinant Frequency → Population level

- Population (100)
- Recombinant individuals (20)

$$RF = \frac{\text{Recombinants}}{\text{Total Population}} \times 100$$

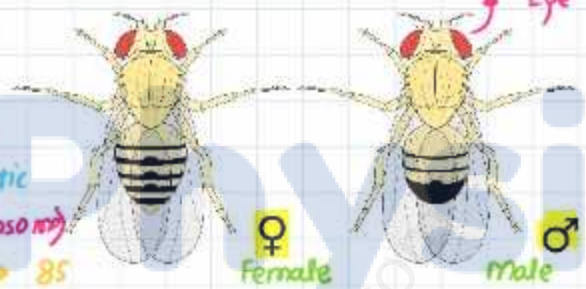
Cross over = RF = $\frac{20}{100} \times 100 = 20\%$

Sex Linkage in Drosophila

T. H. Morgan → 1910
Experimental Organism → Drosophila melanogaster

Advantages of Drosophila

- Easy to Capture
- Sexual Dimorphism
- Generation time (14 days / 2 weeks)
- Excellent for genetic studies (Giant chromosome)
- Contrasting traits → 85
- Human Genome Project



Eye Colour
→ Wild Type (Bright Red Eye)
→ White Eye (Male)
Calvin Bridges

STEP-I Normal Cross

RED EYE (Female) × WHITE EYE (Male) — P_1

1237 Red Eyed → Red Eye is dominant — F_1

STEP-II Normal Cross

RED EYE (Female) × RED EYE (Male) — F_1

RED EYE (Females) : RED EYE (Male) : WHITE EYE (Male) — F_2

2459 : 1011 : 782

Observations

Red Eye (3) : (1) White Eye ×
→ Ratio is not fit to Mendelian Ratio (3:1)
- Recessive trait individuals were quite small.
- All white eyed were male.
- No White Eyed Female were observed.

Conclusion

→ Eye colour inheritance is associated with sex.
→ Gene for Eye colour is on X- chromosome.
→ No allele on Y- chromosome.

CROSSES OF DROSPHILA

STEP-I

Red Eye Female × **White Eye Male** → P_1

$X^{w^+}X^{w^+}$ × $X^{w}Y$

w → White Eye

w^+ → Red Eye

	X^w	Y
X^{w^+}	$X^{w^+}X^{w}$ (Red)	$X^{w^+}Y$ (Red)
X^{w^+}	$X^{w^+}X^{w}$ (Red)	$X^{w^+}Y$ (Red)

Population 1237 → Red Eye → F_1

STEP-II

$F_1 \times F_1$

Red Eye Female × **Red Eye Male** → F_1

$X^{w^+}X^{w}$ × $X^{w^+}Y$

	X^{w^+}	Y
X^{w^+}	$X^{w^+}X^{w^+}$ (Red)	$X^{w^+}Y$ (Red)
X^{w}	$X^{w^+}X^{w}$ (Red)	$X^{w}Y$ (White)

No 3:1

- Result of F_2 cross is in Non-mendelian Ratio.

Red Eyed ♀ → 2459

Red Eyed ♂ → 1011

White Eyed ♂ → 782

STEP-III

(Test Cross)

Red Eye Female × **White Eye Male**

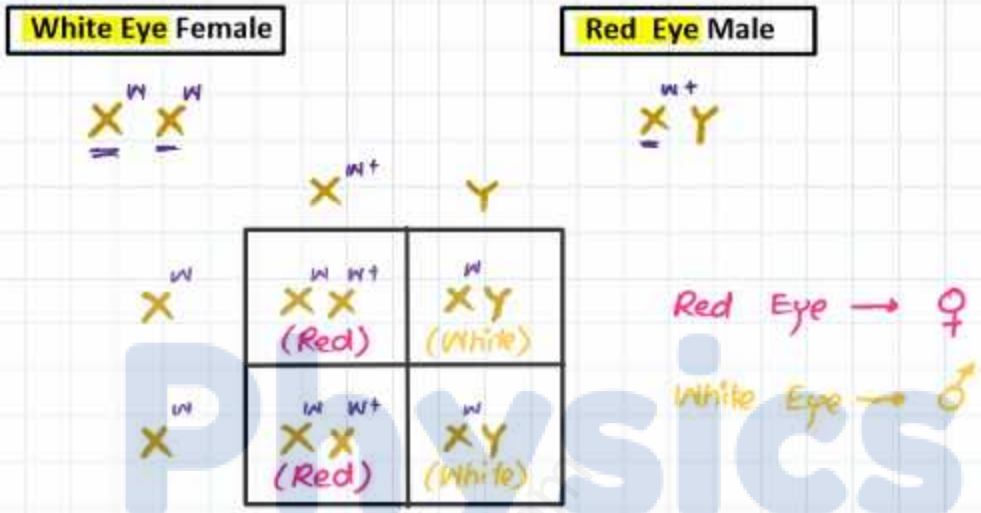
$X^{w^+}X^{w}$ × $X^{w}Y$

	X^w	Y
X^{w^+}	$X^{w^+}X^{w}$ (Red)	$X^{w^+}Y$ (Red)
X^{w}	$X^{w}X^{w}$ (White)	$X^{w}Y$ (White)

Red Eye → ♂, ♀

White Eye → ♂, ♀

STEP-IV → Reciprocal Cross



Sex Linkage in Humans

TRAITS

X- CHROMOSOME → X- Linked Traits

- X- linked Dominant (mother → Daughter/Son)
- X- linked Recessive (Follow Zigzag)
  (Mother → Son → Daughter)

Y- CHROMOSOME → Y- Linked Traits
(Holandric Traits)
(Father → Son)

- Hypertrichosis
- Webbing of toes

PSEUDO-AUTOSOMAL TRAITS :

. Traits which have their genes on X and Y chromosomes, they will be refferred as Pseudo-autosomal Traits.

X- LINKED RECESSIVE TRAITS

HAEMO-PHILIA → BLEEDER'S DISEASE
→ Ability of blood clot is reduced. Clotting Factors

HAEMOPHILIA A → X- linked Recessive (Non-allelic Sex- linked Recessive)
More in Males
Factor VIII (More than 80%.)

HAEMOPHILIA B
Factor IX (20%.)

HAEMOPHILIA C → Autosomal trait (Female/Male)
Chromosome #(4)
Factor XI less than 1 %

. COLOUR BLINDNESS

→ Eye Ratina
- Rhodopsin (dim light)
- Opsin (Intense light)

Normal Vision → Trichromatic

MALOUS

- Protano (Red colour Weakness)
- Deutrano (Green Colour Weakness)
- Triptano (Blue colour Weakness)

NOPIA

- Prota (Red Opsins absent)
- Dutera (Green Opsins absent)
- Tripta (Blue Opsin absent)

DICHROMACY → Dichromant (Two colour), One colour absent

- Protanopia → Red Blindness (Green, Blue Perception)
- Deuteranopia → Green Blindness (Red, Blue Perception)
- Tritanopia → Blue Blindness (Red, Green Perception)

MONOCHROMACY → Monochromant (True colour Blindness)

- Red Colour monochromacy (Red colour Perception)
- Green Colour Monochromacy (Green colour Perception)
- Blue Colour monochromacy (Blue colour Perception)

TESTICULAR FEMINIZATION SYNDROME (Rare X-linked Recessive)

- Apparently female (Breast, Female Genitalia, Blind Vagina)
- Degenerated testes in abdomen

EVOLUTION

"IInd year last topic"

- Concept of Evolution
- Origin of life according to concept of Evolution
- Lamarckism
- Darwinism
- Evidences of Evolution

Concept of Evolution

Definition

Change with respect to time is called Evolution.

Evolution can be said to be the development of an entity in the course of time, through gradual sequence of changes from simple to complex state.

Narrow Definition → Change in genetic composition of a population m generation to generation.

Descent with modification. (Darwin)

Zimmermann (1953) Evolution is the transformation of the form and mode of existence of an organism such a manner that the descendants differ from ancestors.

ORGANIC EVOLUTION → Plants and Animals.

According to this Earth is Evolved not Created.

- Phenomenon of Continental Drift.

DIFFERENT THOUGHTS

- Special Creation
- Spontaneous Generation
- Cosmozoans
- Biochemical Evolution

Role of Scientists

Aristotle
- → First to give "CONCEPT OF EVOLUTION"
- Scala Naturae (Ladder of Nature)
- → Every step of ladder is specific for specific specie

Cuvier (1769 – 1832)
- → Theory of Catastrophism (Destruction at large scale)
  Dinosaurs → Dead
- → Earth's History by Catastrophism
- → Science of Palaeontology

Louis Agassiz (1807 – 1873)
- → New Creation after Each Catastrophism.

Suarez (1548 – 1613) → Special Creation

Carlos Linnaeus (1707 – 1778) → Special Creation + Taxonomy (Classification of organisms)
- Binomial Nomenclature

James Hutton (1726 – 1797) → Uniformitarianism (Time of Evolution)

Charles Lyell (1797 – 1875) → Uniformitarianism + Principles of Geology
- Contemplated forces of wind, water, Earthquake, and volcanism as agents of layered patterned.

Malthus (1766 – 1834) → Essay on "Principles of Population"

Lamarck (1744 – 1829) → Evolution via inheritance of acquired characters.

Charles Darwin (1809 – 1882) → Descent with modification + Origin of species
- Voyage of Beagle

Natural Selection

A.R. Wallace (1823 – 1913) → Sent his theory to Darwin

Theories of Evolution

"EVOLUTION"

EVOLUTIONIST

↓

Natural Selection

(Fittest Organism)

- Earth/universe → Big Bang Theory (3.5 Billion)
- Earth Age → 5 Billion years
- Prokaryotes → Eukaryotes (1.9 – 2.1 Billion years)

"SPECIAL CREATION"

Saurez, C. Linneaus

CREATIONIST

↓

Devine Creations

- Supernatural Events
- Everything in universe is created in 6 days.
- Man 6th day.

Origin of life according to concept of Evolution

Origin of Life

HYDROTHERMAL VENTS → 1st vent in 1977 (Pacific Ocean)

↓

(Extremophiles) ARCHAEO BACTERIAS → Can bear upto 120°C

↓ Thermus Aquaticus

(Absorptive) HETEROTROPHS

↓

* CHEMOSYNTHETIC-AUTO-TROPHS → PHOTOSYNTHETIC *

Environmental changes

REDUCING ENVIRONMENT → NO O_2, H from H_2S, UV radiations

Support → Abiogenesis

Refute

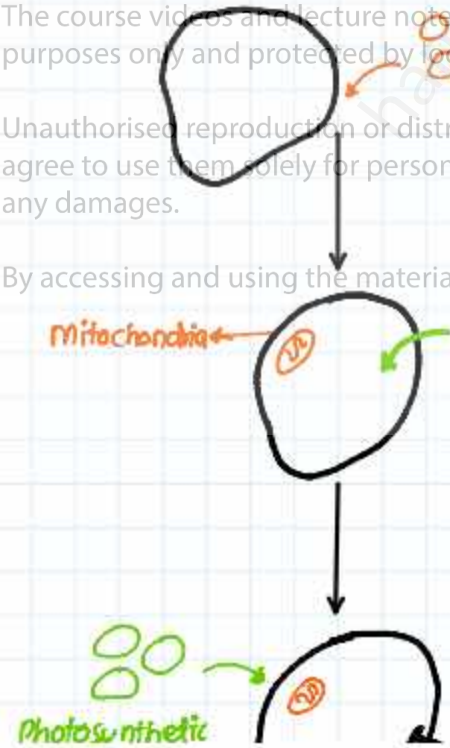
Chemosynthetic Autotrophs

Photosynthetic Autotrophs (3.2 Billion)

OXIDIZING ENVIRONMENT → O_2 liberation; H_2S → H_2O; O_2 → O_3

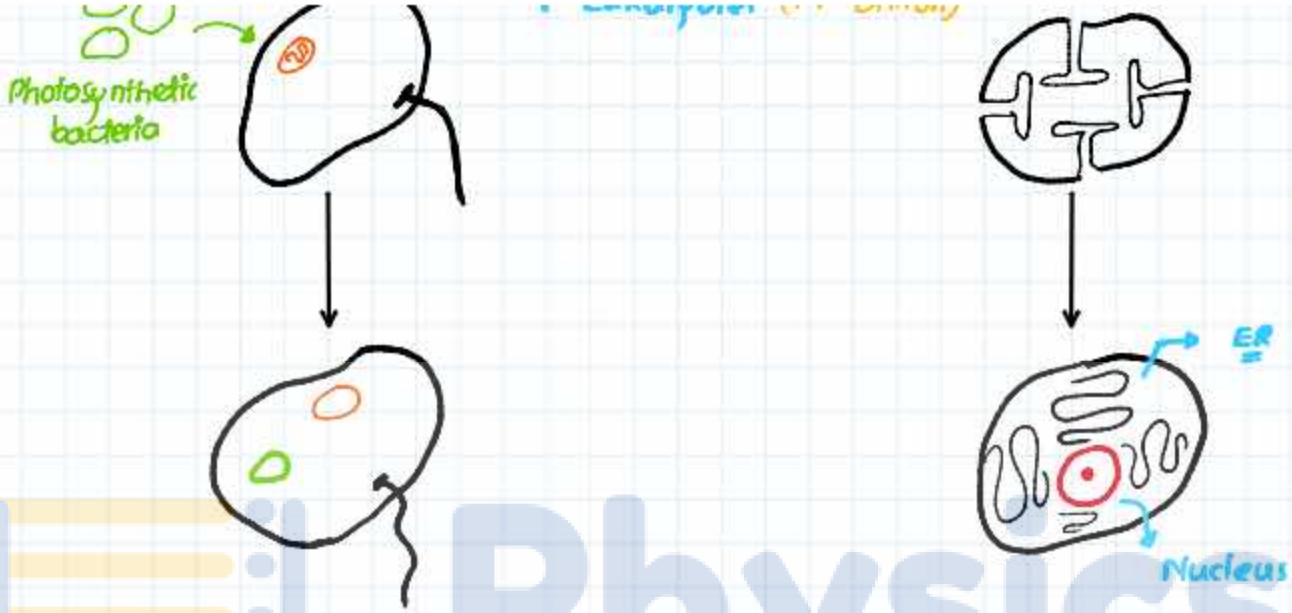
EVOLUTION OF EUKARY. FROM PRO.

Endosymbiotic Hypothesis → L. Margulis



Endo-membrane Hypothesis

- Prokaryotes (3.5 Billion)
  - (About 2 million years)
- Eukaryotes (1.5 Billion)



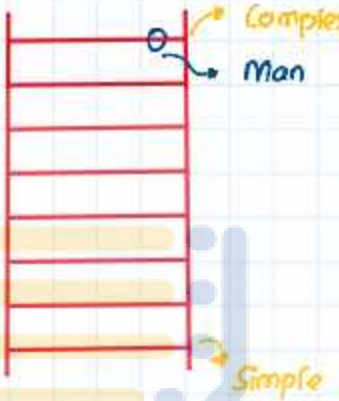
- Chloroplast & Mitochondria both have their own DNA & RNA & ribosome.
- Divide via binary fission

LAMARCKISM

J. B. de Lamarck (1744 – 1829)

Book "Philosphie Zoologique"

"LADDER OF LIFE"



ASSUMPTIONS OF LAMARCKISM

→ USE and DISUSE OF ORGANS

→ INHERITANCE OF ACQUIRED CHARACTERS.

1. USE & DIS-USE OF ORGANS.

- BOBBY BHAI → Accident (limb Amputation) → "SON" (limb Amputation) ×
- BLACK SMITH → Biceps strong → "SON" ×

GIRAFFE NECK:

Grass → Over Grazing → No Grass → "LEAVES" → Neck Size (↑↑)

Loss of Limbs:

→ Snake (limb present) → limb disuse → limb degenerate.

- Loss of Teeth in Whale
- Flightless Birds: → Kiwi, Ostrich
- Foot of modern horse
- WEBBED FEET OF DUCK.

OBJECTIONS:

- No experimental Proof of Lamarck.
- Changes which obtained via accident or disease are not inherited.
- Ear lobe holes are not inheritable.
- Foreskin removal of Penis is not inheritable.

DARWINISM

DARWIN (1809 – 1882) → Origin of Specie 1859
↓
"THEORY OF ORGANIC EVOLUTION BASED ON NATURAL SELECTION"

VOYAGE OF BEAGLE → SOUTH AMERICA → GALAPAGOS ISLANDS
• 965 Km West to Equator

GIANT TORTOISE → SHELL
Saddle shaped
Dome shaped

FINCHES → Types
14 FTB*
13 BTB*, KPK*

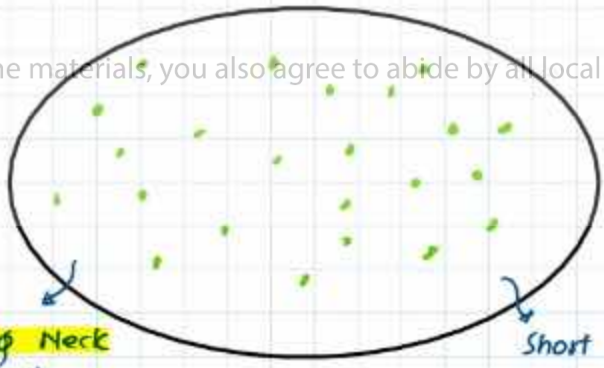
DARWIN'S CONCEPT OF NATURAL SELECTION
• Descent with modification
• Natural Selection

DESCENT WITH MODIFICATION → Backbone of Evolution theory
Parents → Passing on Traits → Off-springs
↓ modified
Crossing over → Genetic Recombination

NATURAL SELECTION
↓
Survival of fittest → Pass on

ARTIFICIAL SELECTION
↳ Desired characters from Plants and Animal.

DESERTIFICATION.



OVER-PRODUCTION

Species have capacity to reproduce.

OVER-PRODUCTION

Species have capacity to reproduce.

- Housefly → 120 eggs
- Rabbit → 4 times / year
- Elephant → 6 offsprings → 19 million population (750 years)

Population Rate ↑↑ Resources ↓↓

STRUGGLE FOR EXISTENCE

Population ↑↑, Individuals ↑↑ → Competition ↑↑

INTRA-SPECIFIC
- Among individuals of same specie.

INTER-SPECIFIC (Prey – Predator)
- Among individuals of different species.

- ENVIRONMENTAL STRUGGLE (EXTRA-SPECIFIC)
  Against Natural forces.

VARIATION → Genetics

+ive → Supportive to survival and successful reproduction in individual.
- No. of individual ↑↑

-ive → Do not support reproduction in individual

Human → Black / Brown / White → Skin colour

SURVIVAL OF FITTEST

+ive (useful variations) → Survival

FLOOD → "NATURAL PHENOMENON"
(Natural selection of Alleles)

- Can breath in water → Survival chances ↑↑ (Favourable)
- Can not breath in water → Dead (Unfavourable) → Eradicated

Survival of fittest → Herbet Spencer
Natural selection → Darwin

ORIGIN OF SPECIE / SPECIATION

Selected Alleles → Transmission of allele

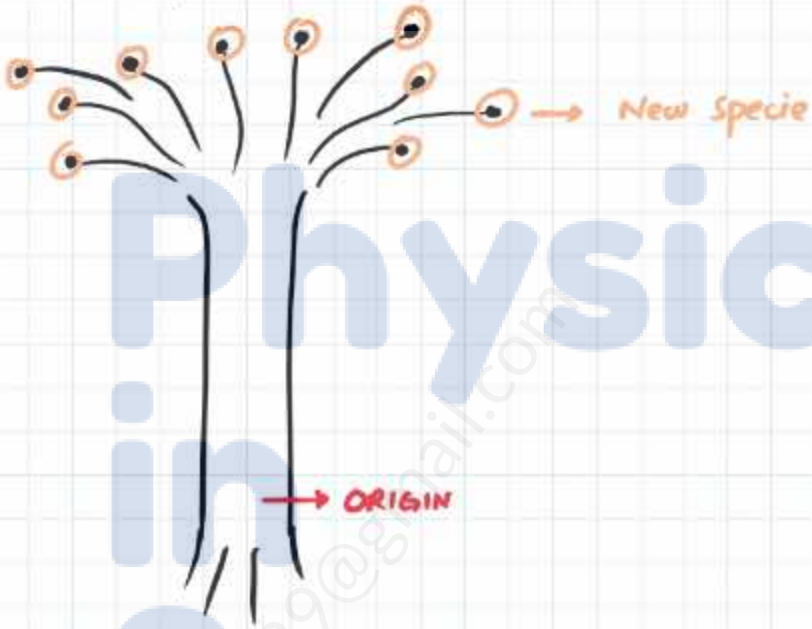
ORIGIN OF SPECIE / SPECIATION

Selected Alleles (Surviving individuals) → Transmission of allele in offspring

↓

Prevalence of Allele (New Individual)

TREE EVOLUTION



CONTRIBUTIONS OF SCIENTISTS

CHARLES LYELL → English Geologist

Book → "Principles of Geology"

Gradual Geological Processes → Gradually shaped Earths Surface.

JAMES HUTTON → Scottish Geologist, Chemist, Naturalist

"Concept of Evolution" By ancestral animals

Natural selection was the base of time

THOMAS MALTHUS → English Economist

"Essay on Population"

Human Population Growth Rate ↑↑ as that of Resources they depend upon.

Population ↑↑ ⤳ Calamity ⤳ Deaths

↳ Immuned / strong / Fit

ALFRED WALLACE → Same time Era

DARWIN'S SUPPORTING EVIDENCES

- Palaeontology
- Geology
- Vistigial Organs
- Biogeography

- Geology
- Vistigial Organs
- Biogeography
- Comparitive studies

NEO-DARWINISM

Natural Selection + Genetics + Biochemistry + Ecology + Palaeontology

Darwinism + Mendel's laws ⟶ Neo-Darwinism

6.5 Evidences of Evolution