

Class 10 Heredity and Evolution – Gist of lesson

Genetics : Branch of science that deals with Heredity and variation.

Heredity : It means the transmission of features / characters/ traits from one generation to the next generation.

Variation : The differences among the individuals of a species/population are called variations.

Mendel and His Work on Inheritance

Gregor Johann Mendel started his experiments on plant breeding and hybridization. He proposed the laws of inheritance in living organisms. Mendel was known as Father of Genetics

Plant selected by Mendel : *Pisum sativum* (garden pea). Mendel used a number of contrasting characters for garden pea.

Following are the seven pairs of contrasting characters in Garden Pea

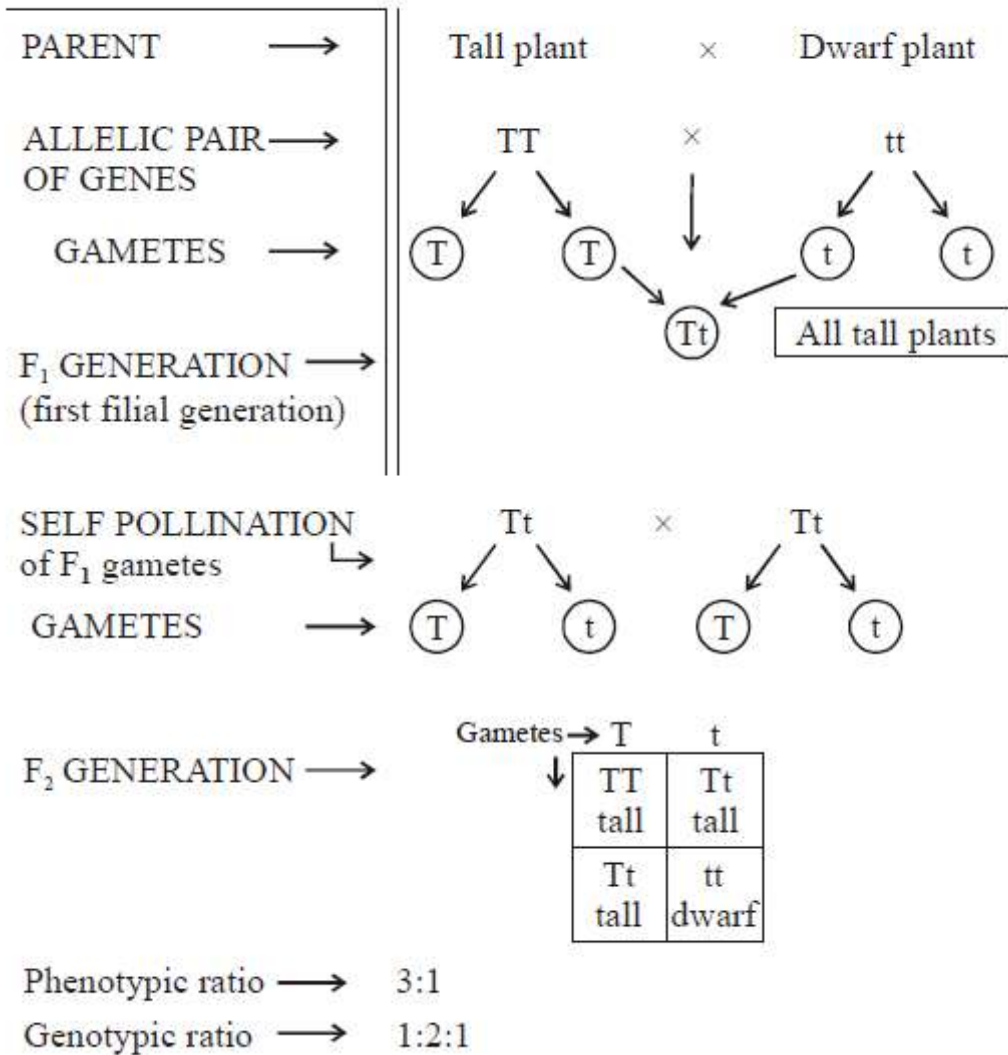
(TABLE OF CONTRASTING CHARACTERS. SEVEN PARTS)

CHARACTER	DOMINANT TRAIT	RECESSIVE TRAIT
Flower colour	Violet	White
Flower position	Axial	Terminal
Seed colour	Yellow	Green
Seed shape	Round	Wrinkled
Pod shape	Inflated	Constricted
Pod colour	Green	Yellow
Height of plant	Tall	Dwarf/Short

Mendels Experiments : Mendel conducted a series of experiments in which he crossed the pollinated plants to study one character (at a time)

Monohybrid Cross : Cross between two pea plants with one pair of contrasting characters is called a monohybrid cross. Example : Cross between a tall and a dwarf plant (short).

MONOHYBRID CROSS



TT	→	Both dominant traits]	Pure or homozygous	condition
tt	→	Both recessive alleles]		
Tt	→	One dominant, one recessive trait]	Heterozygous condition - Hybrid	

Phenotypic ratio : 3:1















Genotypic ratio : 1:2:1

Phenotype → Physical appearance [Tall or Short]

Genotype → Genetic make up [TT, Tt or tt]

Mendel's Seven Traits

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	Flower Color	Flower Position	Pea Color	Pea Shape	Pod Color	Pod Shape	Height
Dominant	 purple	 axial	 yellow	 round	 green	 inflated	 tall
Recessive	 white	 terminal	 green	 wrinkled	 yellow	 constricted	 short

Observations of Monohybrid Cross

1. All F₁ progeny were tall (no medium height plant (half way characteristic))
2. F₂ progeny $\frac{1}{4}$ were short, $\frac{3}{4}$ were tall
3. Phenotypic ratio F₂ – 3:1 (3 tall : 1 short)

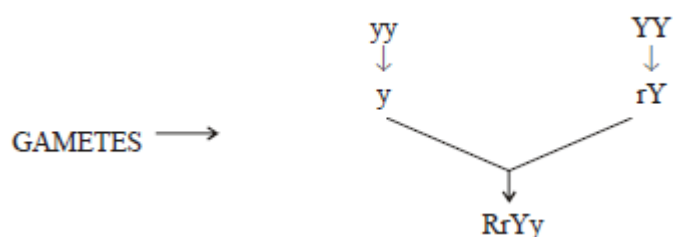
Genotypic ratio F₂ – 1 : 2 : 1 = TT : Tt : tt

Conclusions

1. TT and Tt both are tall plants while tt is a short plant.
2. A single copy of T is enough to make the plant tall, while both copies have to be 't' for the plant to be short.
3. Characters/Traits like 'T' are called dominant trait (because it express itself) and 't' are recessive trait (because it remains suppressed)

Dihybrid Cross : A cross made between two plants having two pairs of contrasting characters is called dihybrid cross.

PARENT GENERATION ---> ROUND GREEN SEEDS x WRINKLED YELLOW SEEDS



F₁ → [round, yellow]

F₁ × F₁

Selfing F₁ → gametes Rr Yy

[RY	×	Rr Yy	[RY	}	G
-	Ry	×	Rr Yy	-	Ry	}	A
-	rY	×	Rr Yy	-	rY	}	M
-	ry	×	Rr Yy	-	ry	}	E
]]			T
							E
							S

♂ →	RY	Ry	rY	ry
♀ ↓	RY	RRYY	RRYy	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	rrYy	rryy

Phenotypic Ratio

9
3
3
1
 Round Yellow Round green Wrinkled Yellow Wrinkled green

Observations

1. When **RRyy** was crossed with **rrYY** in F₁ generation all were **Rr Yy** round and yellow seeds.
2. Self pollination of F₁ plants gave parental phenotype and two mixtures (recombinants round yellow & wrinkled green) seeds plants in the ratio of 9:3:3:1

9
3
3
1
 Round Yellow Round green Wrinkled Yellow Wrinkled green

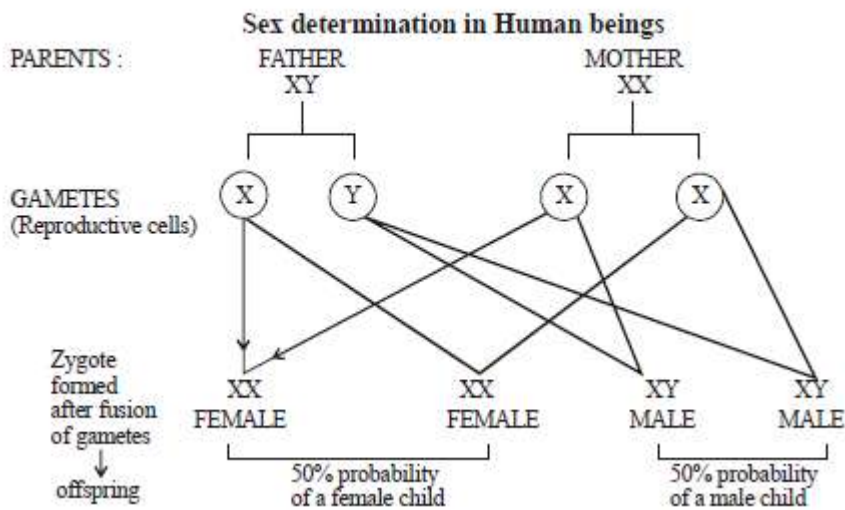
Conclusions

1. Round and yellow seeds are **DOMINANT** characters
2. Occurrence of new phenotypic combinations show that genes for round and yellow seeds are **inherited independently** of each other

SEX DETERMINATION : Phenomenon of decision or determination of sex of an offspring

FACTORS Responsible for Sex Determination

1. Environmental : In some animals the temperature at which the fertilised eggs are kept decides the gender. eg. in Turtle
2. Genetic : In some animals like humans gender or individual is determined by a pair of chromosome called sex chromosome XX – Female and XY – Male



This shows that half the children will be boys and half will be girls. All children will inherit an X chromosome from their mother regardless whether they are boys or girls. Thus sex of children will be determined by what they inherit from their father, and not from their mother.

EVOLUTION

Evaluation is the sequence of gradual changes which takes place in the primitive organisms, over millions of years, in which new species are produced.

Situation-I

Group of red beetles

Colour variation arises during reproduction

All beetles red except one that is green

One beetle Green Reproduction

Crows feed on red beetle

Progeny beetles green

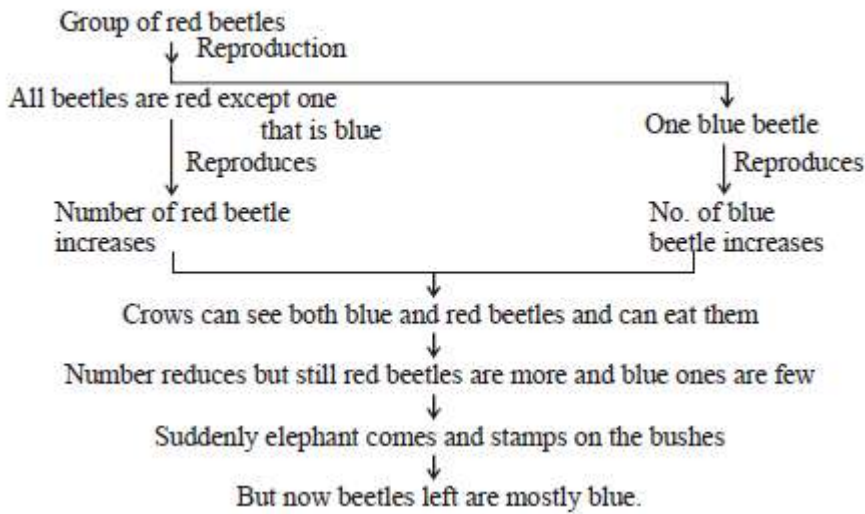
No. of beetles reduces

Crow could not feed on green beetles as they got camouflaged in green bushes

Number of green beetles increases

Situation 1 : Green beetles got the survival advantage or they were naturally selected as they were not visible in green bushes. This natural selection is exerted by crows resulting in adaptations in the beetles to fit better in their environment

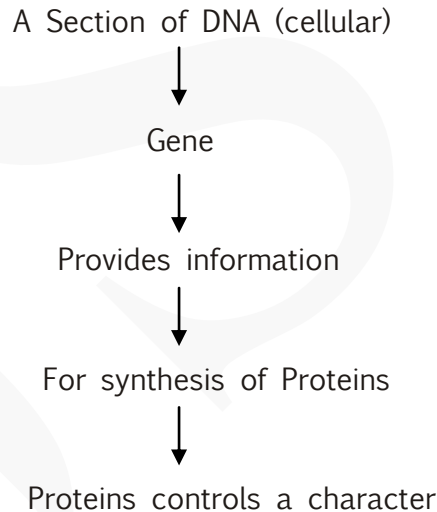
Situation-II



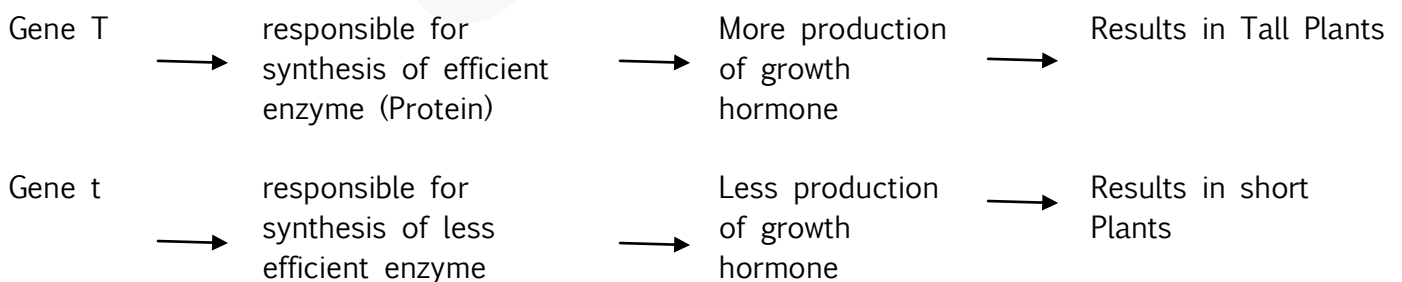
Situation 2 : Blue beetles did not get survival advantage. Elephant suddenly caused major havoc in beetle population otherwise their number would have been considerably large.

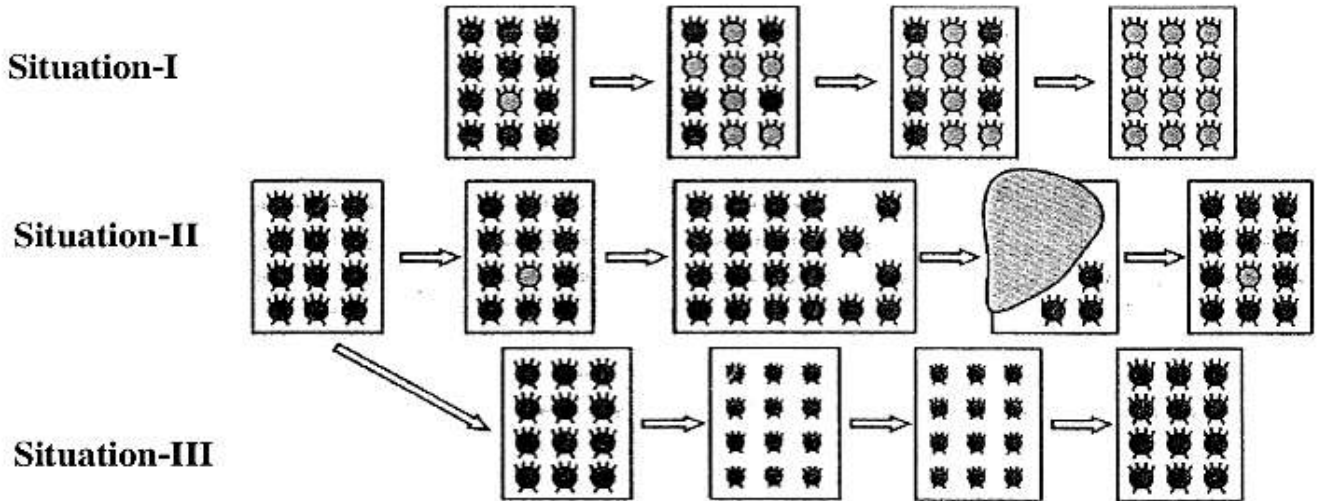
From this we can conclude that accidents can change the frequency of some genes even if they do not get survival advantage: This is called genetic drift and it leads to variation.

Characters or traits of an organism are controlled by the genes

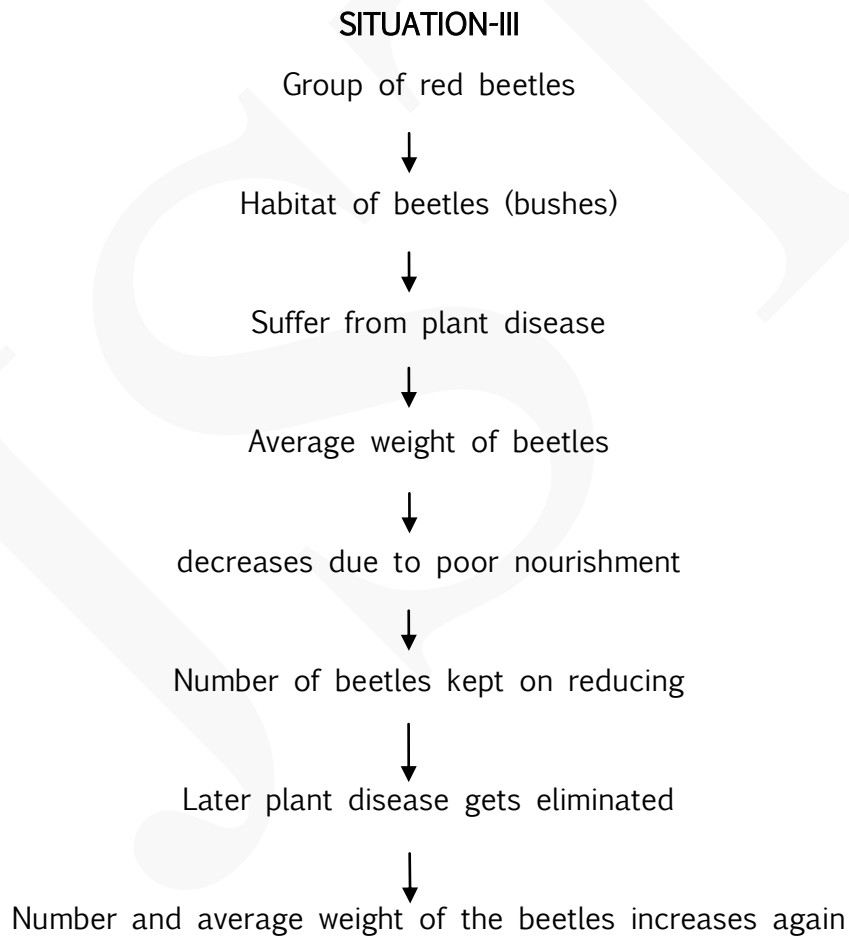


Example :





Genetic drift. It leads to diversity without any adaptation



Situation 3 : No genetic change has occurred in the population of beetle. The population gets affected for a short duration only due to environmental changes.

ACQUIRED AND INHERITED TRAITS

Acquired Traits

1. These are the traits which are developed in an individual due to special conditions
2. They cannot be transferred to the progeny
3. They cannot direct evolution eg. Low weight of starving beetles.

Inherited Traits

1. These are the traits which are passed from one generation to the next.
2. They get transferred to the progeny.
3. They are helpful in evolution. eg. Colour of eyes and hair

SPECIATION

Micro evolution : It is the evolution which is on a small scale. eg. change in body colour of beetles.

The process by which new species develop from the existing species is known as speciation.

Speciation : it is the process of formation of new species.

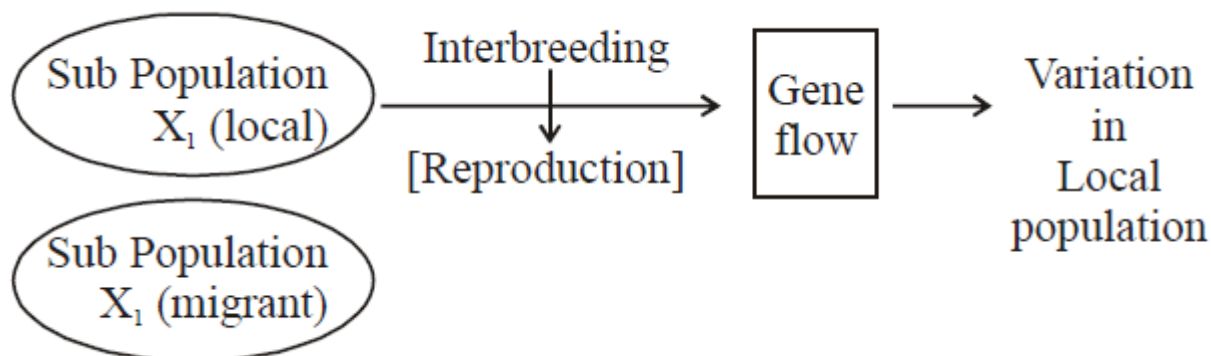
Species : A group of similar individuals within a population that can interbreed and produce fertile offspring.

Geneflow : It is exchange of genetic material by interbreeding between populations of same species or individuals

WAYS BY WHICH SPECIATION TAKES PLACE

Speciation takes place when variation is combined with geographical isolation.

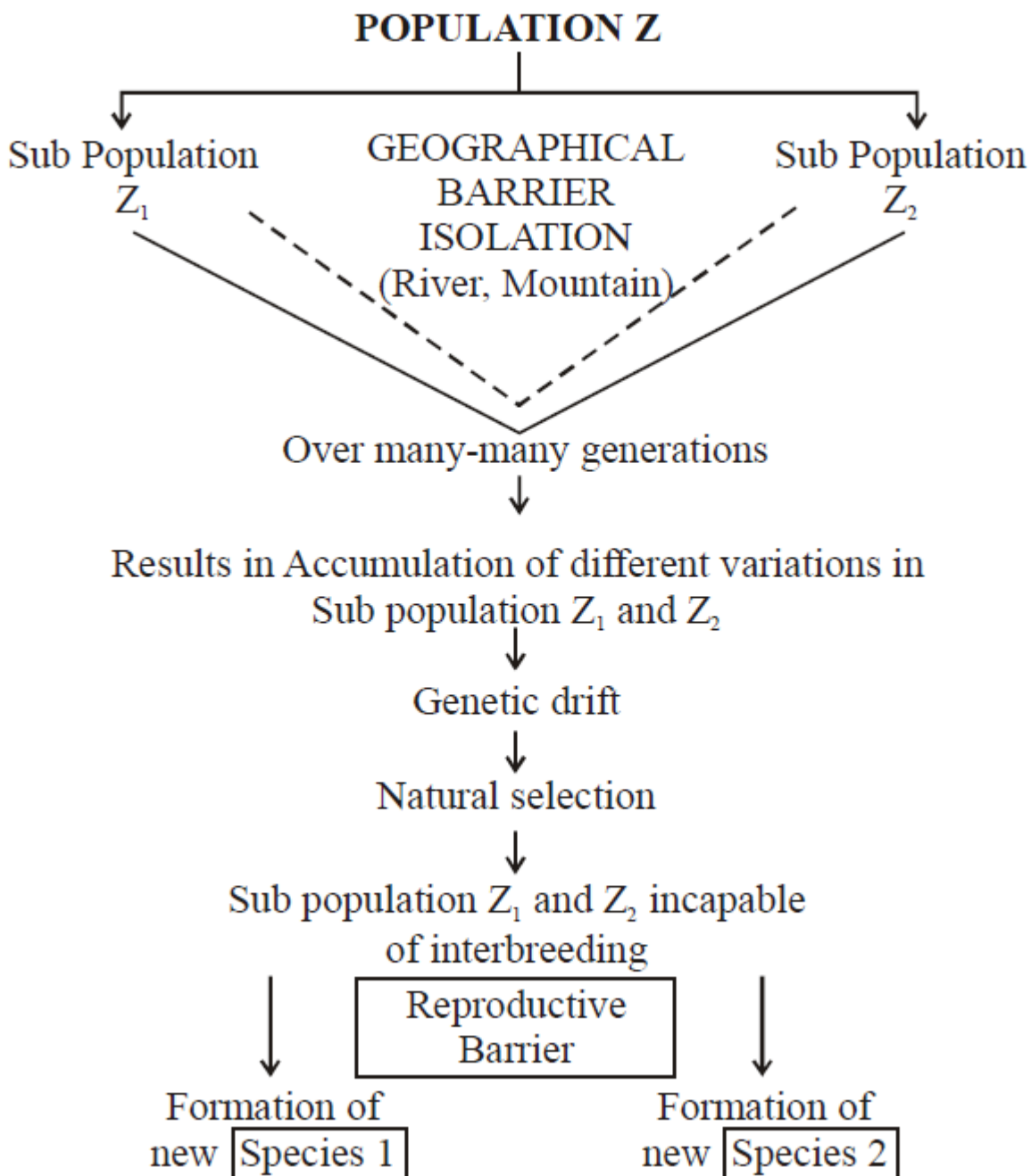
Gene flow : occurs between population that are partly but not completely separated



GENETIC DRIFT

It is the random change in the frequency of alleles (gene pair) in a population over successive generations.

***Natural Selection :** The process by which nature selects and consolidate those organisms which are more suitably adapted and possesses favorable variations



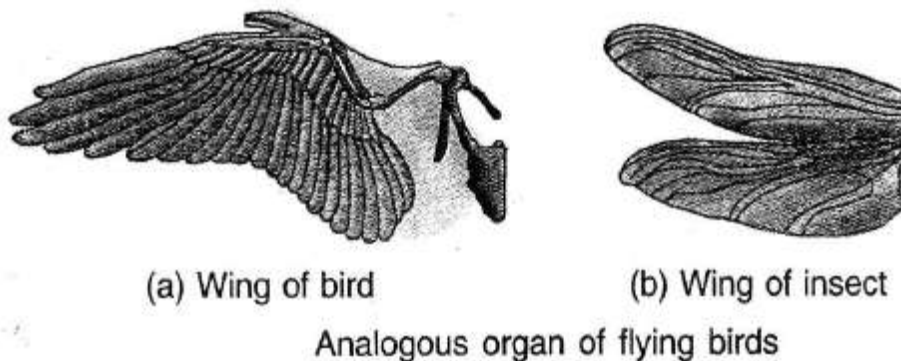
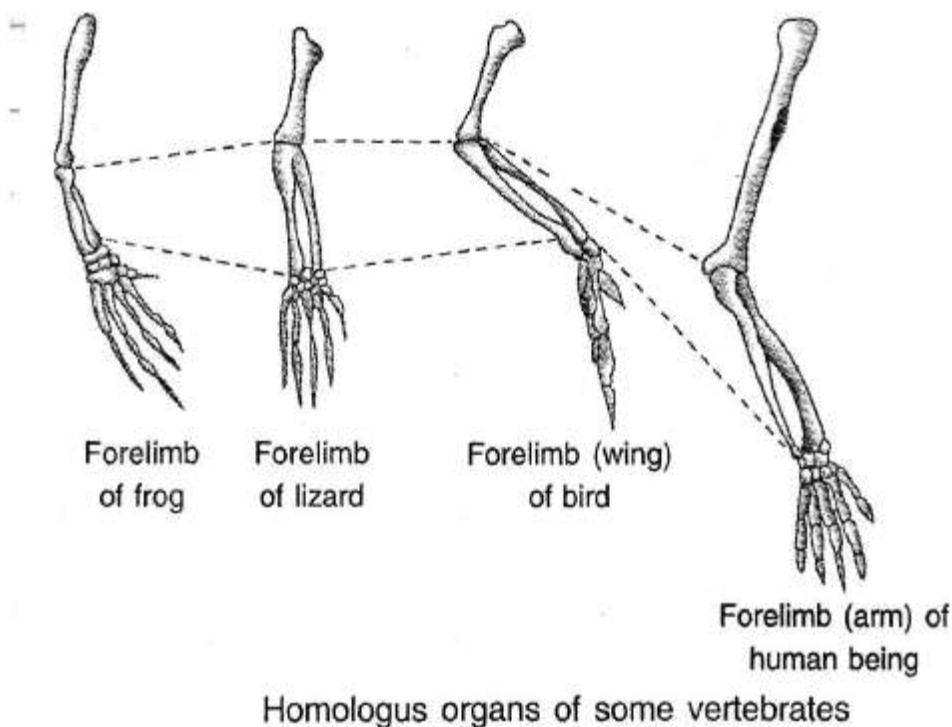
Genetic drift takes place due to

- (a) Severe changes in the DNA (b) Change in number of chromosomes

Evolution and classification

Both evolution and classification are interlinked.

1. Classification of species is reflection of their evolutionary relationship.
2. The more characteristic two species have in common the more closely they are related.
3. The more closely they are related, the more recently they have a common ancestor.
4. Similarities among organisms allow us to group them together and to study their characteristic.



TRACING EVOLUTIONARY RELATIONSHIPS

(Evidences of Evolution)

I. **Homologous Organs** : (Morphological and anatomical evidences. These are the organs that have same basic structural plan and origin but different functions.

Homologous organs provides evidence for evolution by telling us that they are derived from the same ancestor.

Example :

Forelimb of Horse	(Running)	} Same basic structural but different functions perform.
Wings of bat	(flying) plan,	
Paw of a cat	(walk/scratch/attack)	

II. **Analogous Organs** : These are the organs that have different origin and structural plan but same function example :

Example : Analogous organs provide mechanism for evolution.

Wings of bat	elongated fingers with skin folds	} Different basic structure, but perform similar function i.e., flight.
Wings of bird	Feathery covering along the arm	

III. **Fossils** : (Palaeontological evidences) : The remains and relics of dead organisms of the past.

FOSSILS ARE PRESERVED TRACES OF LIVING ORGANISMS

Fossil Archaeopteryx possess features of reptiles as well as birds. This suggests that birds have evolved from reptiles. **Examples of Fossils**

AMMONITE - Fossil-invertebrate

TRILOBITE - Fossil-invertebrate

KNIGHTIA - Fossil-fish

RAJASOURUS - Fossil dinosaur skull

AGE OF THE FOSSILS

I. Deeper the fossil, older it is.

II. Detecting the ratios of difference of the same element in the fossil material i.e. **Radio-carbon dating** [C-(14) dating]

Evolution by stages : Evolution takes place in stages ie bit by bit over generations.

I. Fitness advantage

Evolution of Eyes

Evolution of complex organs is not sudden it occurs due to minor changes in DNA, however takes place bit by bit over generations.

Flat worm has **rudimentary eyes**

Insects have **compound eyes**

Humans have **binocular eyes**

} enough to give fitness advantage

II. Functional Advantage

Evolutions of feathers :

Feathers provide insulation in cold weather but later they might become useful for flight.

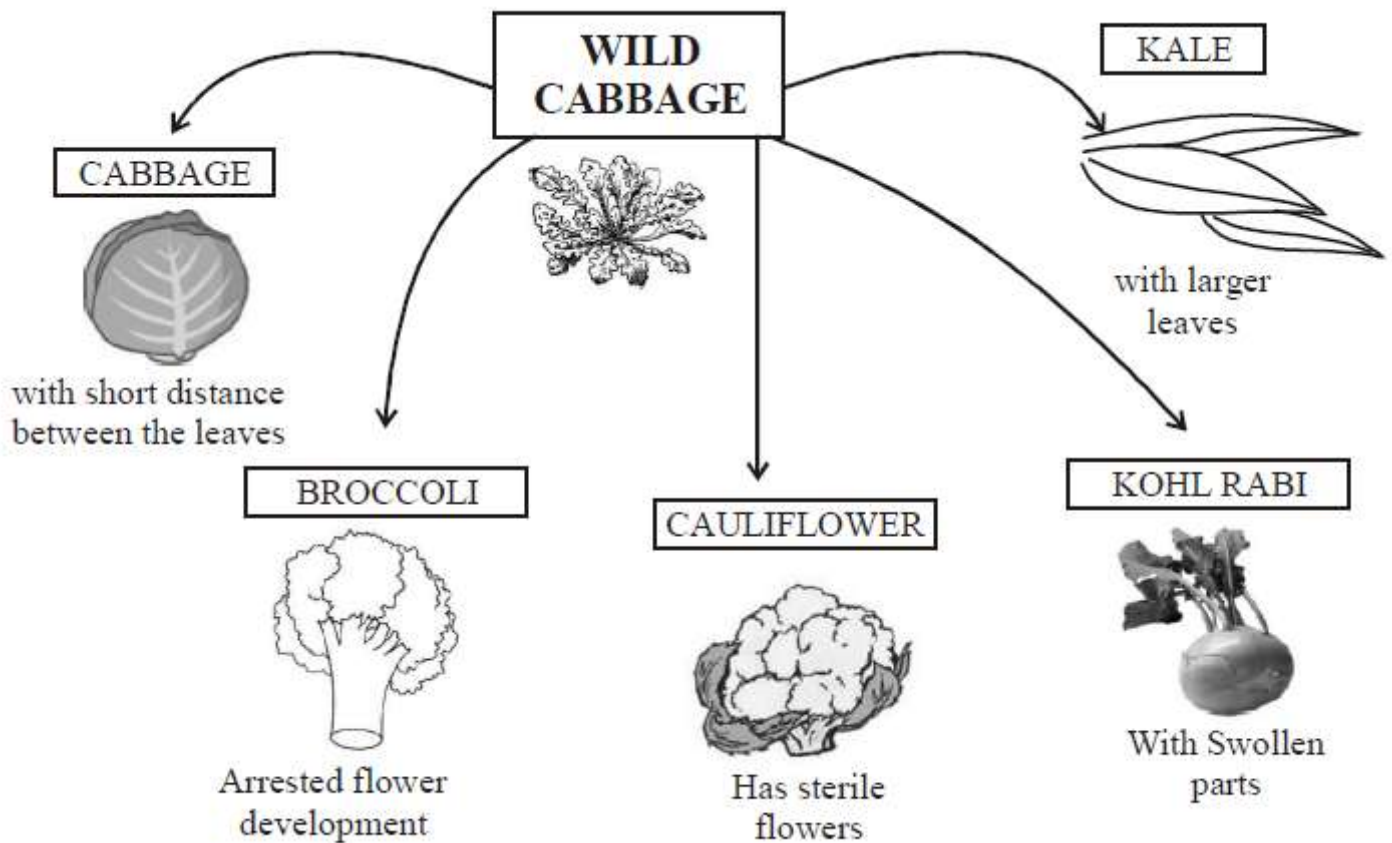
Example : Dinosaurs had feathers, but could not fly using feathers. Birds seem to have later adapted the feathers to flight.

Evolution by Artificial Selection :

Humans have been a powerful agent in modifying wild species to suit their own requirement throughout ages by using artificial selection. eg

(i) From wild cabbage many varieties like broccoli, cauliflower, red cabbage, kale, cabbage and kohlrabi were obtained by artificial selection.

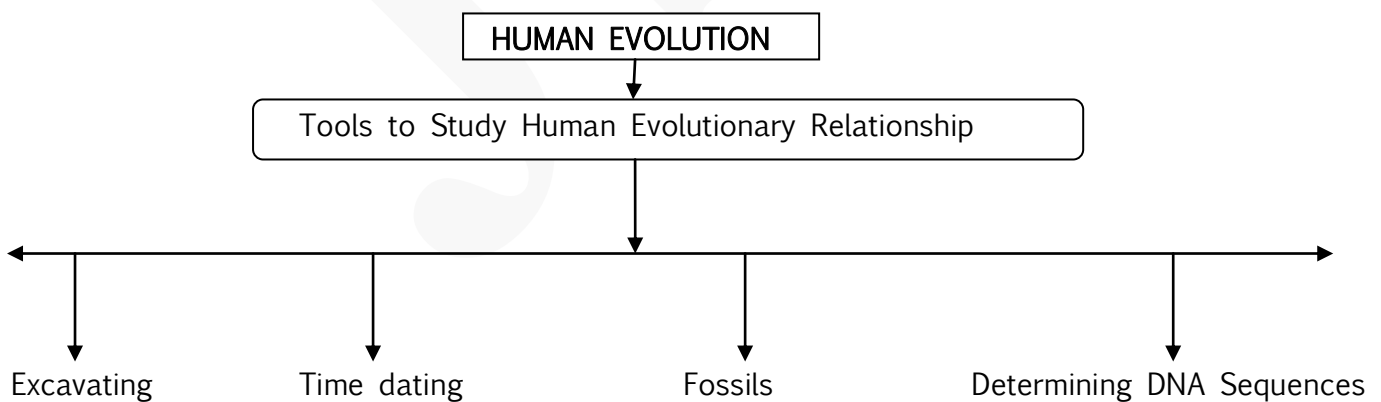
(ii) Wheat (many varieties obtained due to artificial selection).



Molecular Phylogeny

⇒ It is based on the idea that changes in DNA during reproduction are the basic events in evolution

⇒ Organisms which are more distantly related will accumulate greater differences in their DNA



Although there is great diversity of human forms all over the world yet all humans are a single species.