

CHAPTER – 9

Heredity and Evolution

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 (1822&1884) : Started his experiments on plant breeding and hybridisation

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.

TABLE OF CONTRASTING CHARACTERS. (SEVEN PARTS)		
CHARACTER	DOMINANT TRAIT	RECESSIVE TRAIT
Flower colour	Purple	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

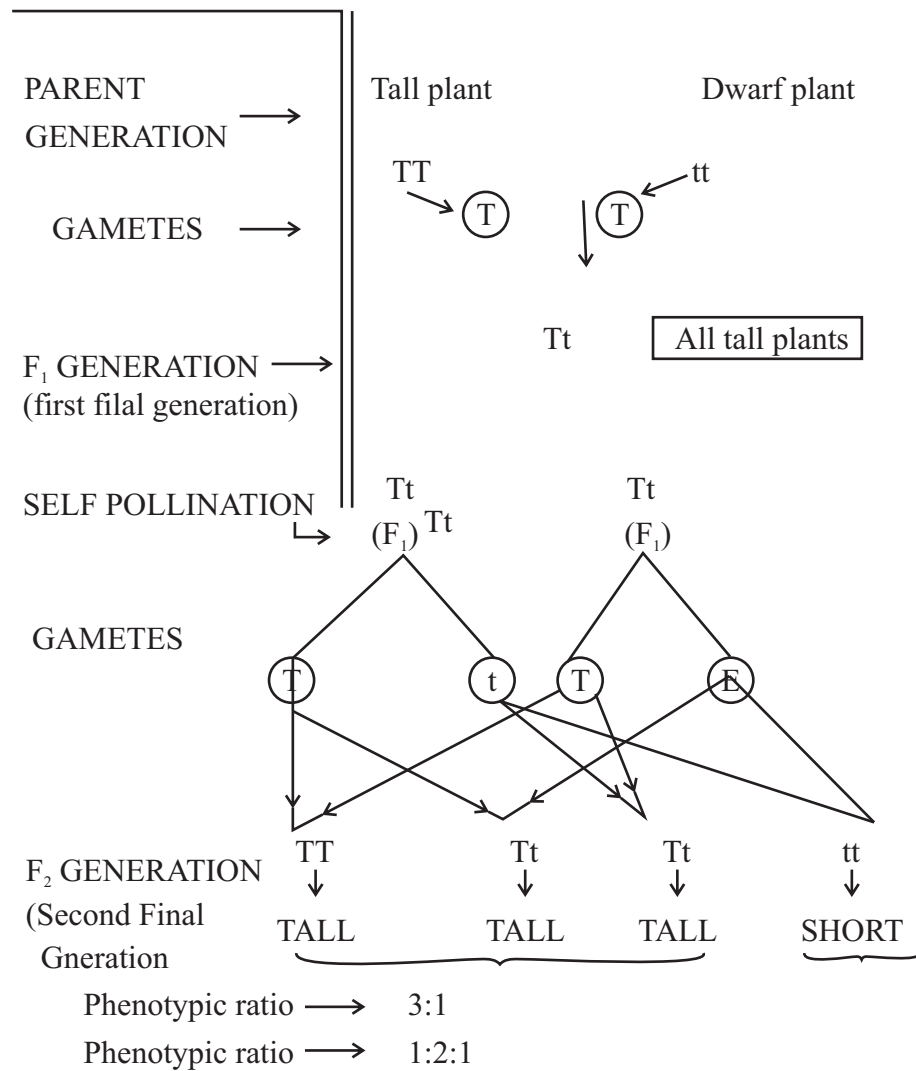
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Seven pairs of contrasting characters in Garden Pea

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 (monohybrid cross) contrasting characters

Example : Tall / Short Plants.

















CHARACTER	DOMINANT TRAIT	RECESSIVE TRAIT
Seed shape	 Round	 Wrinkled
Seed colour	 Yellow	 Green
Flower colour	 Violet	 White
Pod shape	 Full	 Constricted
Pod colour	 Green	 Yellow
Flower position	 Axial	 Terminal
Stem height	 Tall	 Dwarf

Fig. Mendel's seven different unit characters

Tt] → One dominant, one recessive gene] Heterozygous condition.
[Hybrid]

Genotypic ratio : 1:2:1

Genotype Genetic make up [TT, Tt or tt]

Observations :

1. All F_1 progeny were tall
(no medium height plant (half way characteristic))
2. F_2 progeny $\frac{1}{4}$ were short
3. Phenotypic ratio $F_2 - 3:1$
Genotypic ratio $F_2 - 1:2:1$

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) 't' are recessive trait (because it remains suppressed)

PARENT	→	ROUND	WRINKLED
GENERATION		GREEN SEEDS	YELLOW SEEDS

GAMETES \longrightarrow RRYY rryy

F_1 \longrightarrow RY ry

\downarrow

RrYy
[round, yellow]

Selfing F_1	F_1				
	$Rr Yy$	$\left[\begin{array}{l} RY \\ Ry \\ rY \\ ry \end{array} \right.$	$Rr Yy$	$\left[\begin{array}{l} RY \\ Ry \\ rY \\ ry \end{array} \right.$	$\left. \begin{array}{l} G \\ A \\ H \\ E \\ T \\ E \\ S \end{array} \right\}$
F_2	σ^7	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 : Round, yellow : 9
Round, green : 3
Wrinkled, yellow : 3
Wrinkled, green : 1

GENOTYPIC RATIO : RRYY : 1
RRYy : 2
RrYY : 2
RRyy : 1
RrYy : 4
Rryy : 2
rrYY : 1
rrYy : 2
rryy : 1

RATIO : 1 : 2 : 2 : 1 : 4 : 2 : 1 : 2 : 1

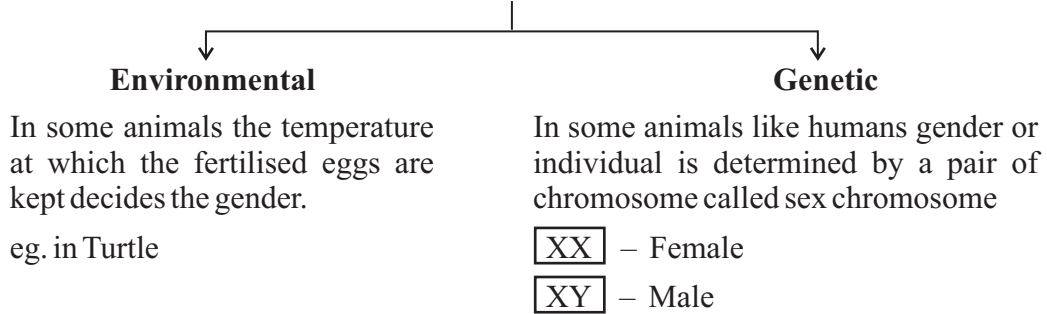
Observations : 1. When **RRYY** was crossed with **rryy** in F_1 generation all were **RrYy** round and yellow seeds.
2. Self pollination of F_1 plants gave parental phenotype + two mixtures (recombinants) Round wrinkled, green yellow : seeds plants appeared in the ratio of 9:3:3:1

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

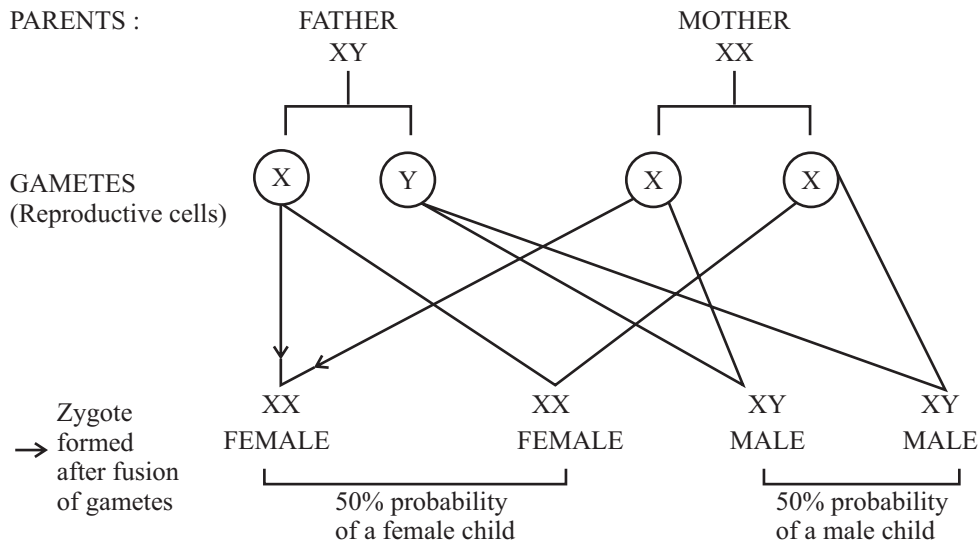
FACTORS Responsible for Sex Determination



Sex Chromosomes : In human beings there are 23 pairs of chromosome. Out of these 22 chromosomes pairs are called autosomes and the last pair of chromosomes that help in deciding gender of that individual are called sex chromosome.

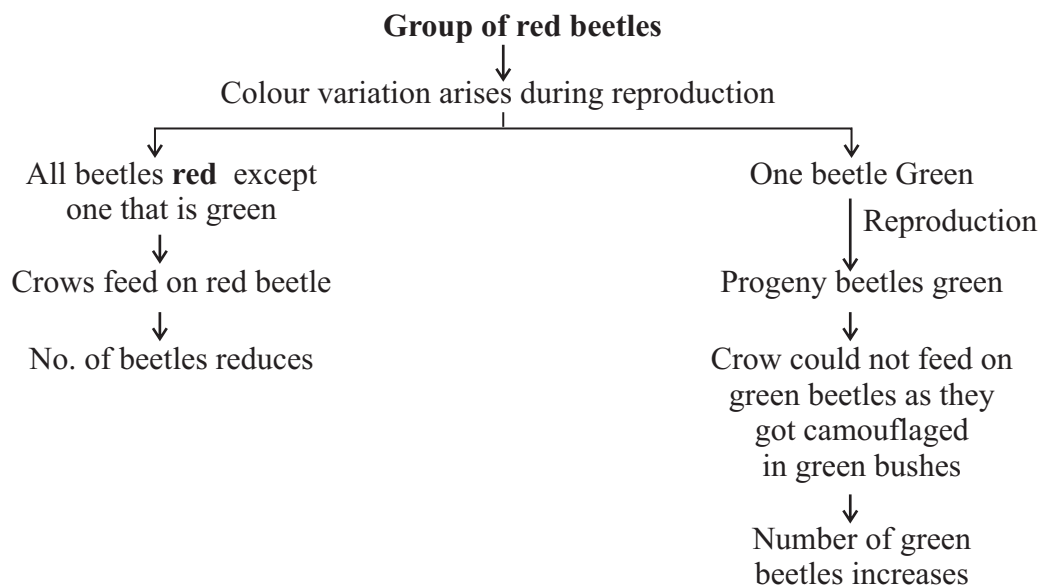
XX – female
XY – male

Sex determination in Human beings



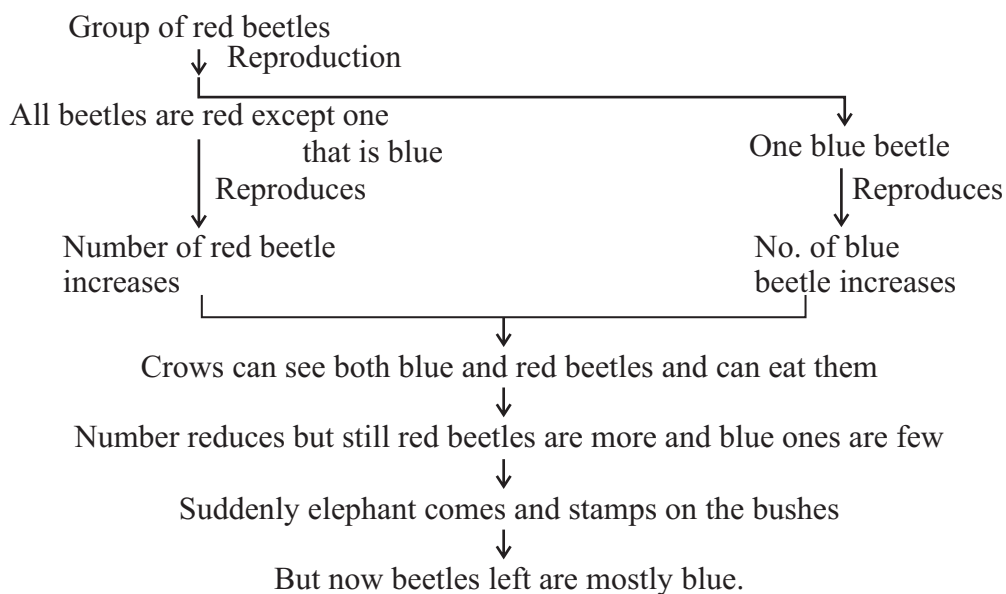
This shows that half the children will be boys and half will be girls. All children will inherit an X chromosome from their mother regardless whether they are boys or girls. Thus sex of children will be determined by what they inherit from their father, and not from their mother.

Evolution SITUATION-I



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

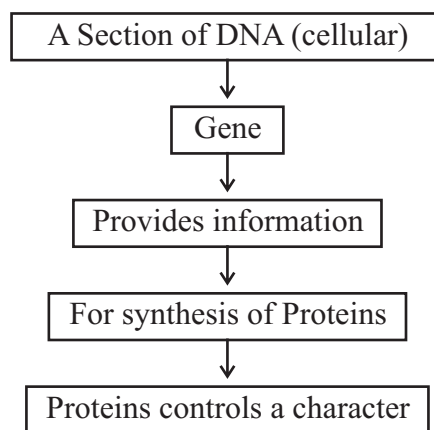


Situation 2 : Blue beetles did not get survival advantage. Elephant suddenly caused major havoc in beetle population otherwise their number would have been considerably large.

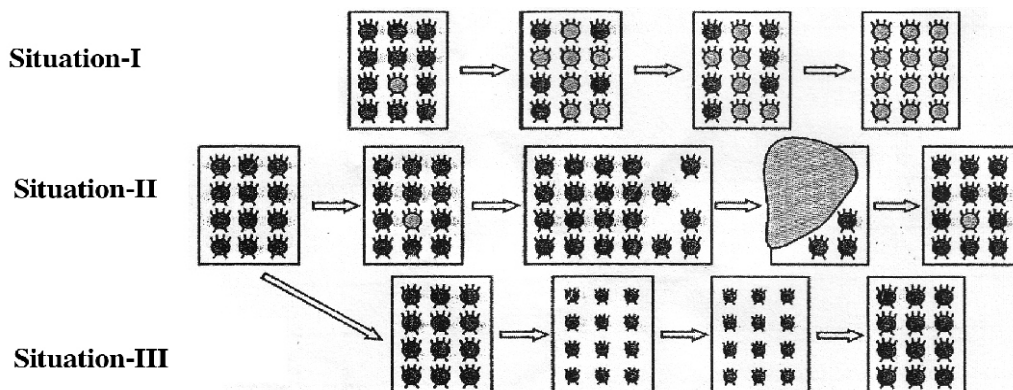
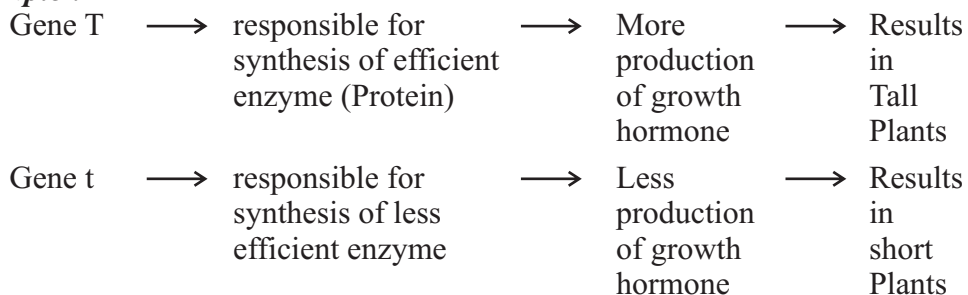
From this we can conclude that accidents can change the frequency of some genes even if they do not get survival advantage: This is called genetic drift and it leads to variation.

Mechanism of Heredity

Characters or traits of an organism are controlled by the genes

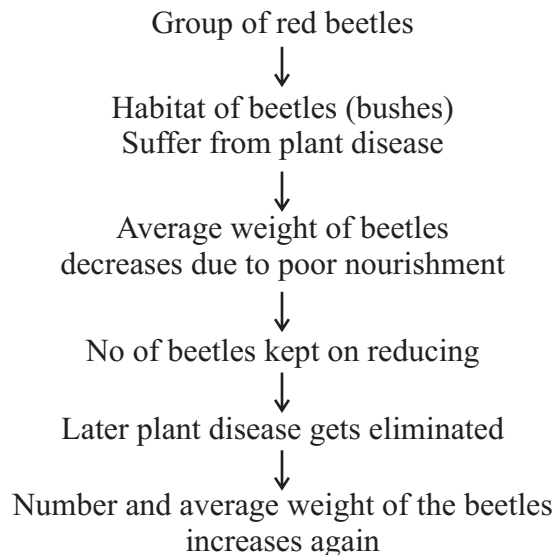


Example :



Genetic drift. It leads to diversity without any adaptation

SITUATION-III



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	Inherited Traits
<ol style="list-style-type: none">1. These are the traits which are developed in an individual due to special conditions2. They cannot be transferred to the progeny3. They cannot direct evolution eg. Low weight of starving beetles.	<ol style="list-style-type: none">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.

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

Species : A group of similar individuals that along to a population that can interbreed and produce fertile off spring.

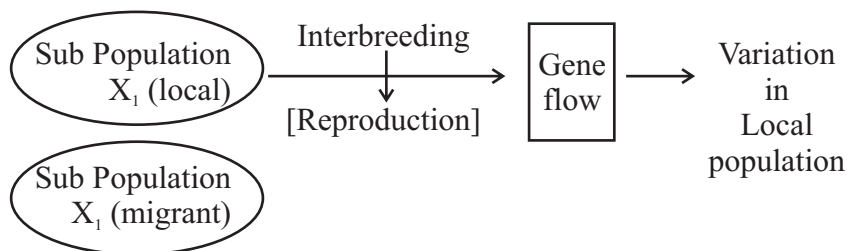
Geneflow : It is exchange of genetic material by interbreeding between populations of same species or individuals

WAYS BY WHICH SPECIATION TAKES PLACE



Speciation takes place when variation is combined with geographical isolation.

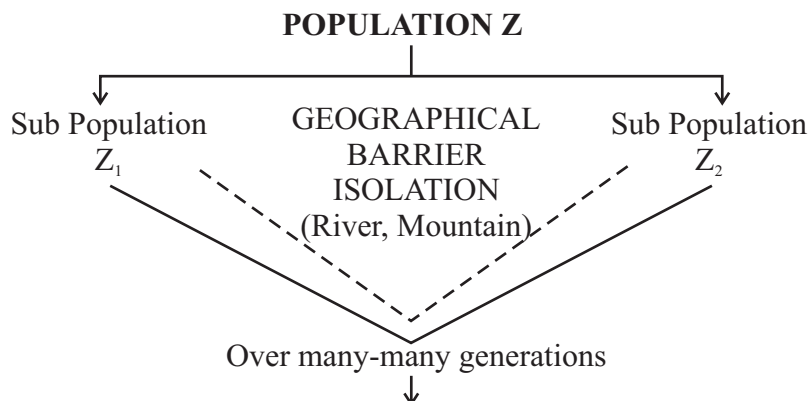
Gene flow : occurs between population that are partly but not completely seperated

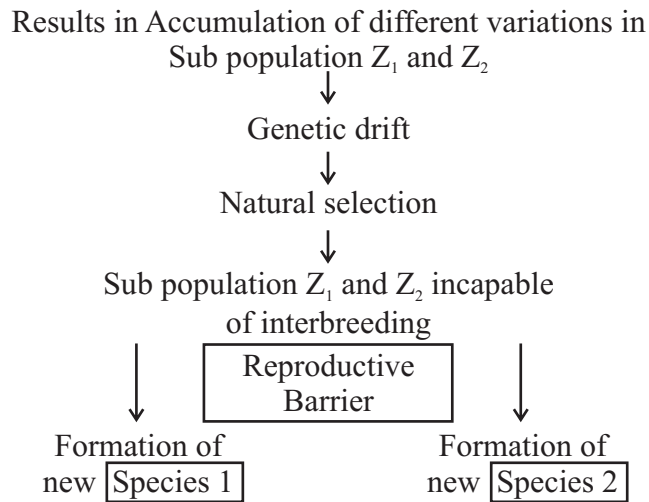


Genetic Drift

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 posseses favorable variations





Genetic drift takes place due to

- Severe changes in the DNA
- Change in number of chromosomes

Evolution and classification

Both evolution and classification are interlinked.

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

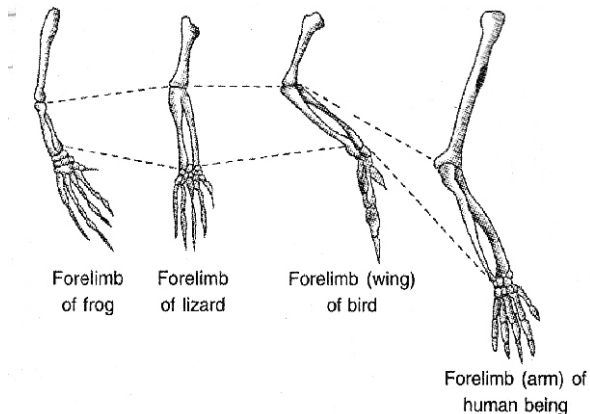


Fig. 5.9 Homologous organs of some vertebrates

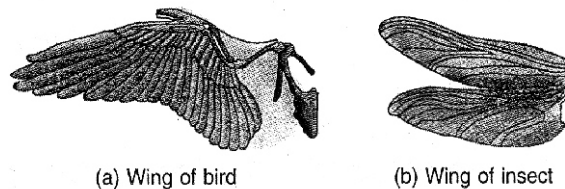


Fig. Analogous organ of flying birds

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.

Example :

Forelimb of Horse	(Running)] Same basic plan, different functions
Wings of bat	(flying)	
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 :

Wings of bat	elongated fingers with skin folds] Design different same function ie. flight
Wings of bird	Feathery covering along the arm	

- III. **Fossils :** (Palaeontological evidences)

The remains and relics of dead organisms of the past.

Example :

- i) Fossil of woolly mammoth
- ii) Archeopteryx (fossil bird)
- iii) Dead insect caught in hot mud.

FOSSILS ARE PRESERVED TRACES OF LIVING ORGANISMS

Eg. AMMONITE	-	Fossil invertebrate
TRILOBITE	-	Fossil in vertebrate
KNIGHTIA	-	Fossil fish
RAJASAUROS	-	Fossil dinosaur skull

AGE OF THE FOSSILS

- | | |
|--|---|
| <p>i. Deeper the fossil, older it is.</p> <p>II. Detecting the ratios of different of the same element in the fossil material ie Radio-carbon dating.
[C-(14) dating]</p> | <div style="display: flex; justify-content: space-between;"> Recent → ● </div> <div style="display: flex; justify-content: space-between;"> 1. 2. </div> <div style="display: flex; justify-content: space-between;"> 3. 4. </div> <div style="display: flex; justify-content: space-between;"> 5. 6. </div> <div style="display: flex; justify-content: space-between;"> ← ● Older </div> |
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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** enough to
give fitness
advantage
- Insects have **compound eyes**
- Humans have **binocular eyes**

II. Functional Advantage

Evolutions of feathers

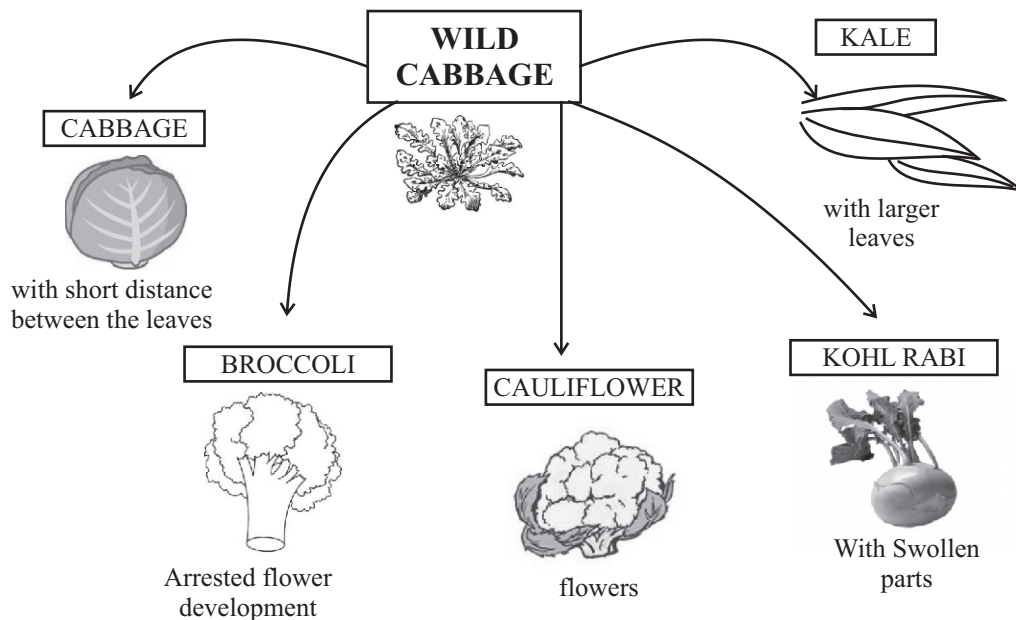
Feathers provide insulation in cold weather
but later they might become useful for flight.

Example :

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

Artificial Selection :

Humans have been a powerful agent in modifying wild species to suit their own requirement through out ages by using artificial selection. eg (i) Wild cabbage the dissimilar looking structures have evolved from a common ancestral design. (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

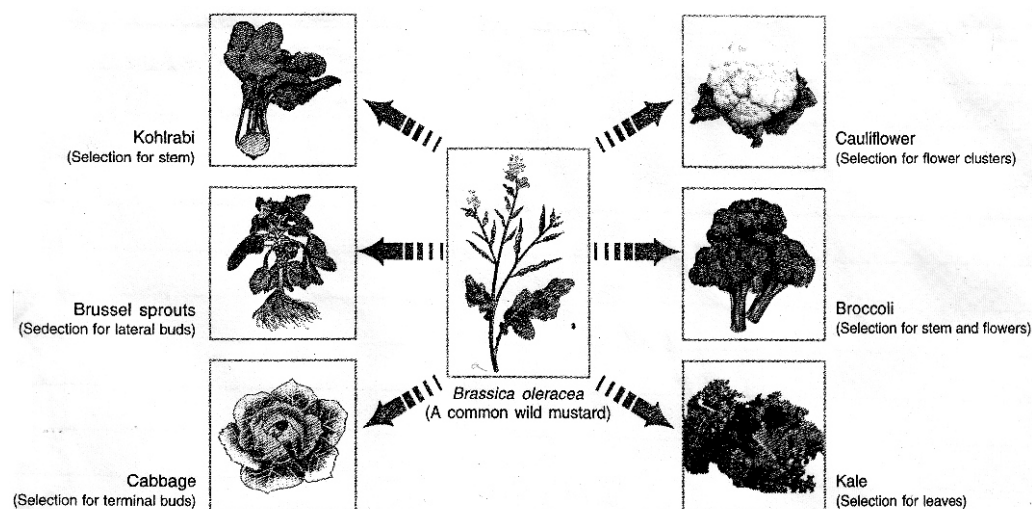
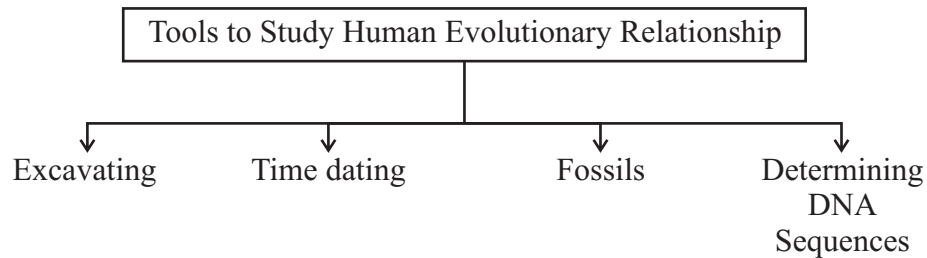


Fig. Some crop plants produced by selective breeding

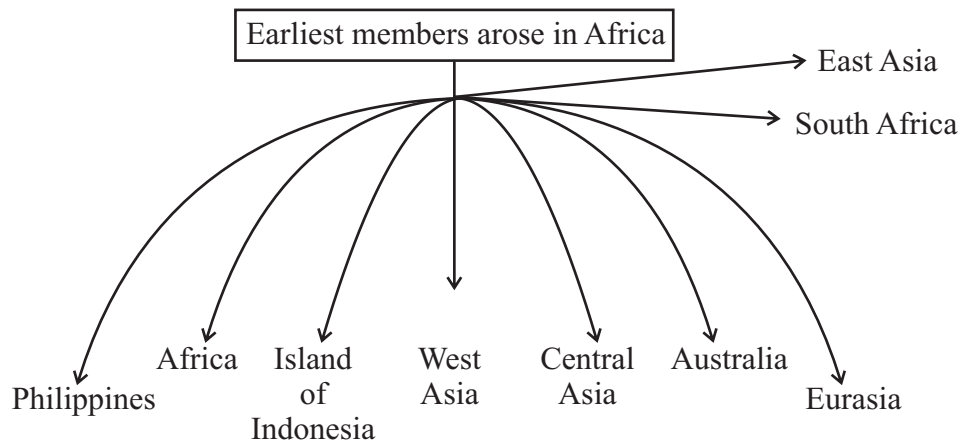
Human Evolution



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

GENETIC FOOTPRINTS OF HUMANS

Hundreds/thousand of years ago



- They didn't go in a single line
- They went forward and backward
- Moved in and out of Africa
- Sometimes came back to mix with each other.

EXERCISE

(Question Bank)

Very Short Answers (1 Mark)

1. Define variation
2. What is monohybrid cross?
3. What is dominant trait.
4. What are genes?
5. Define Homologous organs
6. If an individual has XX chromosome [22+XX] will that individual be male or female.
7. Which plant Mendel had chosen for his experiments.
8. How do Mendel's experiment show that traits may be dominant or recessive?
9. Define analogous organs? Give example.

Short Answers (2 Marks)

1. Differentiate between acquired and Inherited traits? Give example of each.
2. Explain what are fossils? How the age of fossils be determined
3. What is speciation? What factors lead to formation of a new species.
4. Explain the mechanism of sex determination in humans.
5. Differentiate between homologous and analogous organs. by giving examples.
6. Define inheritance. What are the units of inheritance
7. What is genetic drift? How it contributes to the formation of new species
8. Explain monohybrid cross by taking tall and dwarf plants. Mention the phenotypic and genotypic ratio of F_1 and F_2 offsprings.

Long Answer (5 Marks each)

1. Explain the process of artificial selection by taking the example of wild cabbage plant.
2. Explain about the human evolution.