Board –CBSE	Class –10th	Topic – Heredity and Evolution

Introduction

- **Genetics** deals with the study of Heredity and Variation.
- The transmission of characters/traits from one generation to the next generation is called **Heredity.**
- The differences in the characters between the parent and offspring are called **Variation.**

Types of Variations

• Somatic Variation

- It is neither inherited nor transmitted also known as acquired traits.
- Examples: cutting of tails in dogs, boring of the pinna, etc.

• Gametic Variation

- Takes place in the gametes/Reproductive cells.
- Also known as inherited traits. Eg: human height, skin colour.

Accumulation of Variation during Reproduction

Variations in Asexual Reproduction

Variations are fewer, due to Mutation.

Variations in Sexual Reproduction

Variations are large, due to crossing over, separation of chromosomes, mutation.

Importance of Variation

Give better survival advantage in changing environment. Eg, Bacteria that can withstand heat will survive better in a heatwave.

Mendel and His Work on Inheritance

- Gregor Johann Mendel (1822 & 1884) **father of Genetics** started his experiments on plant breeding and hybridization.
- He proposed the laws of inheritance by experimenting with **Pisum sativum** (garden pea).

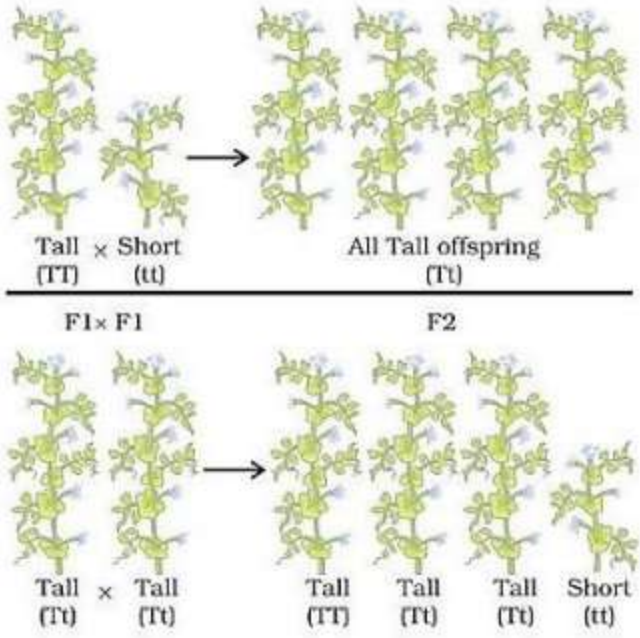
Seven pairs of contrasting characters in Garden Pea

Character Trait	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

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).



- First-generation or F1 progeny are no 'medium-height plants. All plants were tall.
- Second-generation or F2 are progeny (descendant) of the F1 tall plants are not all tall.
- Both the tallness and shortness traits were inherited in the F1 plants, but only the tallness trait was expressed. Thus, two copies of the trait are inherited in each sexually reproducing organism.

Pure or homozygous condition: (TT, tt): Both are dominant traits, both are recessive alleles

Heterozygous condition (Hybrid): Tt: One is dominant, one recessive trait

- Phenotypic ratio (Physical appearance) → 3: 1 (Three tall and one short)
- Genotypic ratio (Genetic makeup) → 1: 2: 1 (TT-one, Tt-two, tt-one)

Observations of Monohybrid Cross

(i) All F1 progeny were tall, no medium height plant. (Halfway characteristic)

(ii) F2 progeny ¼ were short, ¾ were tall.

(iii) Phenotypic ratio F2 – 3: 1 (3 tall: 1 short)

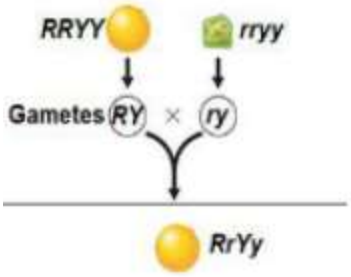
Conclusions

Characters/traits like 'T' are called dominant trait (because it expresses itself) and 't' is a recessive trait (because it remains suppressed).

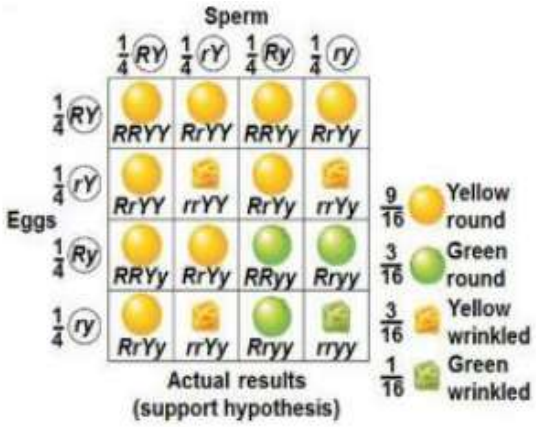
Dihybrid Cross: A cross between plants having two pairs of contrasting characters.

• Parent → Round yellow × Wrinkled green

F1cross



F2 cross



Phenotypic Ratio (9:3:3:1)

Round, yellow: 9

Round, green: 3

Wrinkled, yellow: 3

Wrinkled, green: 1

Observations

(i) When RRyy was crossed with rrYY in the F1 generation all were Rr Yy round and yellow seeds.

(ii) Self-pollination of F1 plants gave parental phenotype and two mixtures (recombinants round yellow and wrinkled green) seeds plants in the ratio of 9 : 3 : 3 : 1.

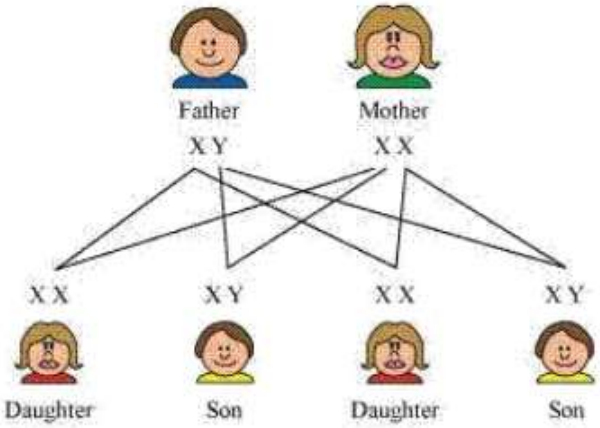
Conclusions

- Round and yellow seeds are Dominant characters.

- Genes for round and yellow seeds are inherited independently of each other.

How do these traits get expressed?

Cellular DNA (Information source) → For the synthesis of Proteins (Enzyme) → Works efficiently → More Hormone → produced Tallness of plant



Therefore, **genes control characteristics/traits.**

Sex Determination

Sex Chromosomes

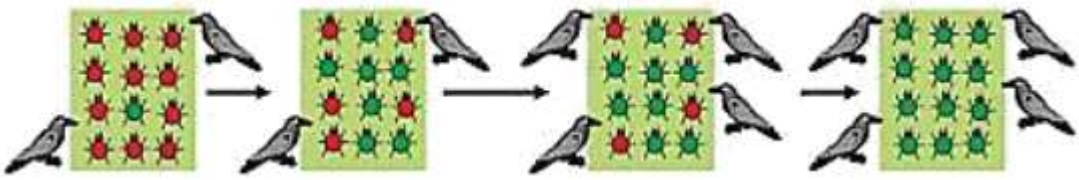
- In human beings, there are 23 pairs of chromosomes.
- Out of these 22 chromosomes, pairs are called **autosomes,** and the last pair of chromosomes that help in sex determination is called **sex chromosomes.**

  XX – Female

  XY – Male
- Thus, the sex of children will be determined by what they inherit from their father, and not from their mother.

Evolution

"Evolution is the sequence of gradual changes which takes place in the primitive organisms, over



millions of years, in which new species are produced".

The situation I (Group of red and green beetles)

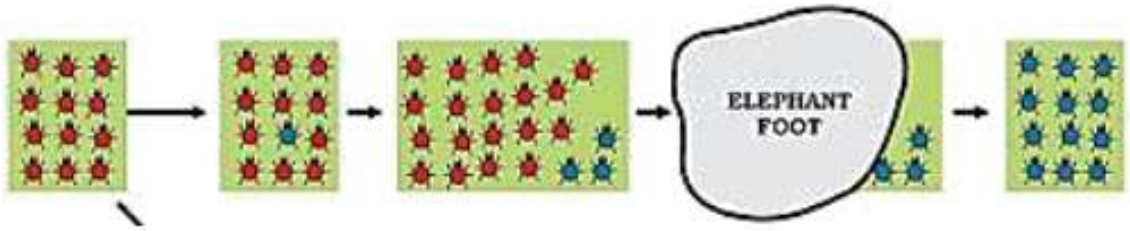
- All beetles red except one that is green → Crows feed on red beetle → No. of beetles reduce

- One beetle green → Progeny beetles green → Crows could not feed on green beetles as they got camouflaged (hide) in green bushes → Number of green bettles increases.

Conclusion

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

Situation II (Group of red and blue beetles)

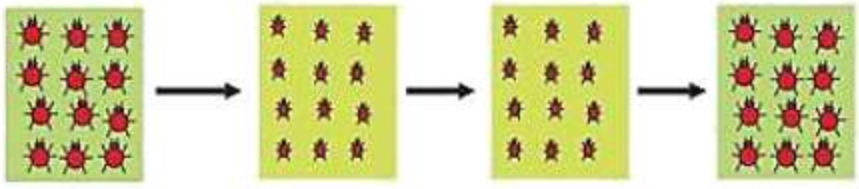


Reproduction in a group of red beetles → All beetles are red except one that is blue → Number of red beetles increases as they reproduce → One blue beetle reproduces and no. of blue beetles also increases → Crows can see both blue and red beetles and can eat them → Number reduces but still red beetles are more and blue ones are few → Suddenly elephant comes and stamps on the bushes → Now beetles left are mostly blue.

Conclusion

- **Blue beetles did not get a survivals advantage.** An elephant suddenly caused major havoc in the beetle's population.
- This is called **genetic drift (accidental changes in genes)** and it leads to variation.

Situation III (Group of red beetles and Bushes)



Group of red beetles → Habitat of beetles (bushes) suffer from plant disease → Average weight of beetles decreases due to poor nourishment → Number of beetles kept on reducing → Later plant disease gets eliminated → Number and average weight of beetles increases again

Conclusion

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
These are the traits that are developed in an individual due to special conditions.	These are the traits that are passed from one generation to the next.
They cannot be transferred to the progeny.	They get transferred to the progeny.
They cannot direct evolution.	They are helpful in evolution.
Example: Low weight of starving beetles.	Example: Colour of eyes and hair.

Ways by which Speciation takes place

Speciation takes place when variation is combined with geographical isolation.

(i) Gene flow: Occurs between populations that are partly but not completely separated.

(ii) Genetic drift: It is the random change in the frequency of alleles (gene pair) in a population.

Genetic drift takes place due to:

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

(iii) Natural selection: The process by which nature selects and consolidates those organisms which are more suitable adapted and possess favorable variations.

(iv) Geographical isolation: It is caused by mountain ranges, rivers, etc. Geographical isolation leads to **reproductive isolation** due to which there is no flow of genes between separated groups of the population.

Evolution and Classification

Classification of species is a reflection of their evolutionary relationship.

The more characteristics two species have in common the more closely they are related.

The more closely they have a common ancestor.

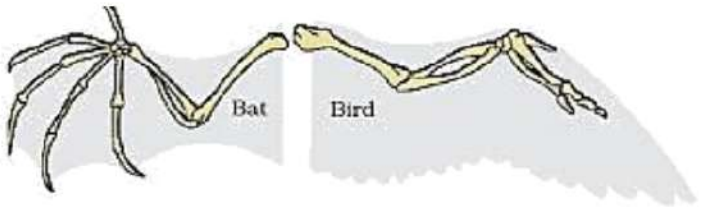
Similarities among organisms allow us to group them together and to study their characteristic.

Evidences of Evolution

(i) Homologous Organs:

These are the organs that have the same basic structural plan and origin but different functions. Homologous organs provide evidence for evolution by telling us that they are derived from the same ancestor.

Example: Forelimb of horse (Running) Winds of bat (Flying) Paw of a cat (Walk/scratch/attack)



(ii) Analogous Organs:

- These are the organs that have different origins and structural plans but the same function.
- Analogous organs provide a mechanism for evolution.

Example:

Wings of bat → Elongated fingers with skin folds

Wings of bird → Feathery covering along the arm

(iii) Fossils: (Paleontological evidences)

- They have preserved traces of living organisms.
- **Fossil Archaeopteryx** possesses features of reptiles as well as birds. This suggests that birds have evolved from reptiles. Eg: Ammonite: Fossil-invertebrate, Trilobite: Fossil-invertebrate, Knightia: Fossil-fish, Rajasaurus: Fossil-dinosaur skull

Age of the fossils: Detecting the ratios of difference of the same element in the fossil material Radio-carbon dating [C-(14) dating]

Evolution by Stages

(i) Fitness Advantage

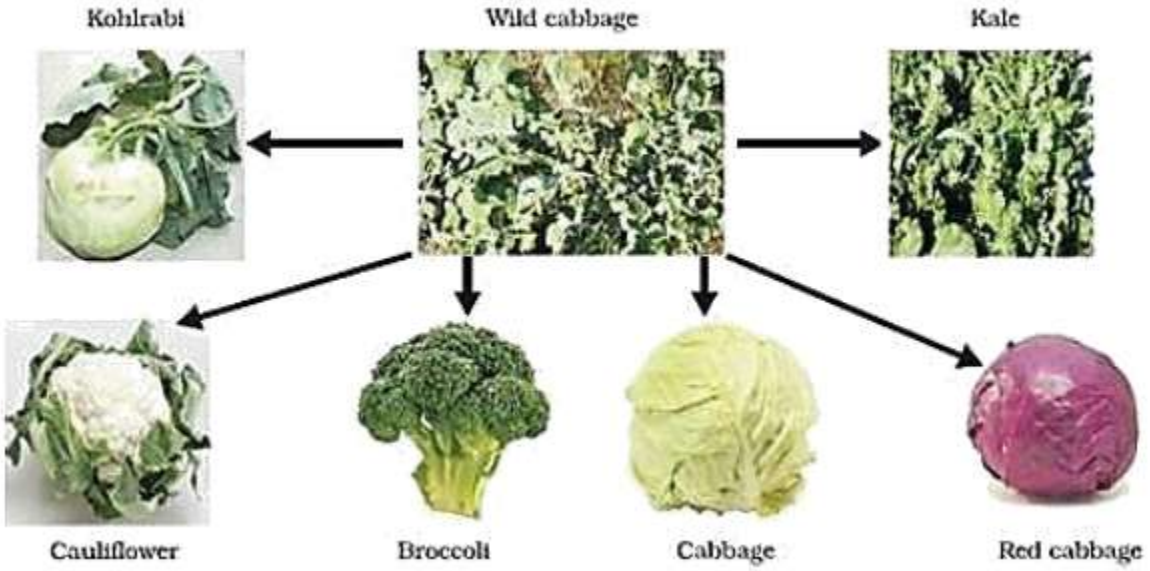
Evolution of Eyes: The evolution of complex organs is not sudden. It occurs due to minor changes in DNA, however takes place bit by bit over generations.

• Flatworm has rudimentary eyes. (Enough to give fitness advantage)

• Insects have compound eyes.

• Humans have binocular eyes.

(ii) Functional Advantage

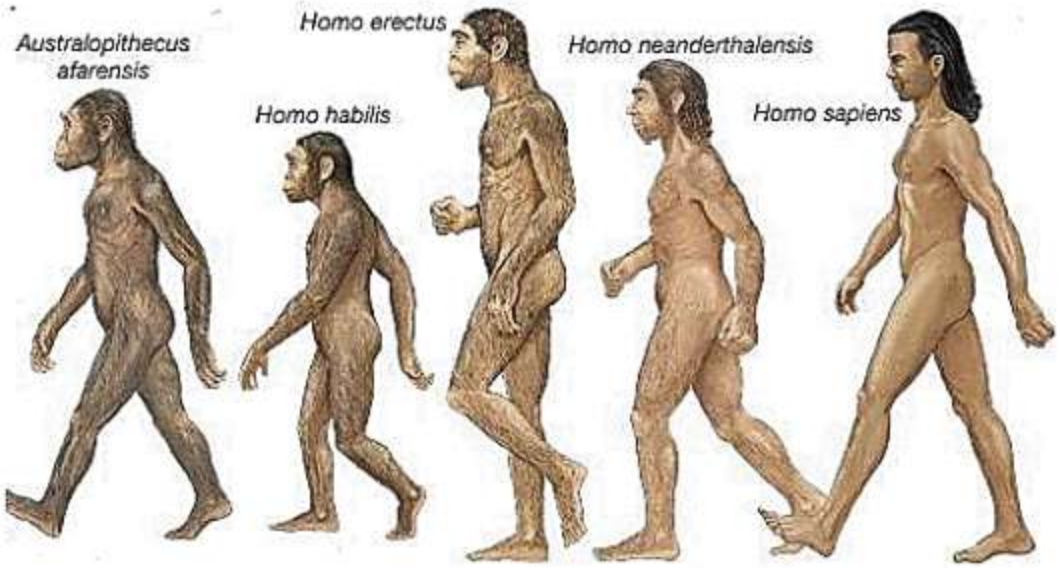


Evolution of Feathers: Feathers provide insulation in cold weather but later they might become useful for flight. Example:

(i) Dinosaurs had feathers, but could not fly using feathers.

(ii) Birds seem to have later adapted the feathers to fly.

Evolution by Artificial Selection: From wild cabbage, many varieties like broccoli, cauliflower, red cabbage, kale, cabbage, and kohlrabi were obtained by artificial selection.



Human Evolution