CBSE Class 10 Science Chapter 9 Heredity and Evolution Notes

Heredity is used to refer to the passing of characters from one generation to another including facial features, body characteristics, genes for congenital disorders while evolution refers to the process that occurs over generations and helps in shaping up our ancestors. Explore in detail about the same right here under Chapter 9 Heredity and Evolution.

Topics Covered In Chapter 9 Heredity And Evolution:

Accumulation Of Variation During Reproduction

Heredity

- Inherited Traits
- Rules For The Inheritance Of Traits - Mendel's Contributions
- How Do These Traits Get Expressed?
- Sex Determination

Evolution

- An Illustration
- Acquired And Inherited Traits

Speciation

Evolution And Classification

- Tracing Evolutionary Relationships
- Fossils
- Evolution And Stages

Evolution Should Not Be Equated With 'progress'

- Human Evolution

Introduction To The Chapter:

What is Heredity?

Heredity is defined as the sum of all biological processes through which particular genetic characteristics are transmitted from the parents to their offspring. This process is observed in

all sexual reproduction and happens during meiosis and fertilization. In this process, an offspring get their genetic information from both the parents- mother and father.

Genetics is a branch of science which mainly deals with the study of the genes, heredity, and other genetic variation, in living organisms.

Gregor Mendel, a German scientist is known as the Father of Genetics. He conducted immense research and several experiments on pea plants and discovered the fundamental laws of inheritance. As per Mendel's experiments, Laws of Inheritance can be summarized under the following categories:

- Law of Dominance
- Law of Segregation
- Principle of Independent Assortment

Variations And Its Types

Variation is the difference in the characteristics/traits between the parents and offsprings is called variation. Variations are of two types, they are:

- Somatic variation

  - takes place in the body cell

  - it is neither inherited nor transmitted

  - it is also known as acquired traits

  - Example - cutting of tails in dogs, boring of pinna etc

- Gametic Variation

  - Takes place in the gametes/reproductive cells

  - Inherited as well as transmitted

  - Also known as inherited traits

  - Example - human height, skin colour

Accumulation Of Variation During Reproduction

Variation occurs during reproduction whether organisms multiply sexually or asexually

Variations in Asexual Reproduction

- Variations are fewer
- Occurs due to small inaccuracies in DNA copying(mutation)

Variation in Sexual Reproduction

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

Importance Of Variation

- Depending upon the nature of variations different individuals would have different kinds of advantages. Example - Bacteria that can withstand heat will survive better in a heat wave.
- The main advantage of variation to species is that it increases the chances of its survival in a changing environment
- Free ear lobes and attached ear lobes are two variants found in human populations

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 the Father of Genetics
- Plant selected by Mendel Pisum sativum (garden pea). He used a number of contrasting characters for garden pea

Seven pairs of contrasting characters for Garden pea

Character trait	Dominant type	Recessive type
Flower colour	Violet	White
Flower position	Axial	Terminal
Seed color	Yellow	Green
Seed shape	Round	Wrinkled
Pod shape	Inflated	Constricted
Pod color	Green	Yellow
Height of plant	Tall	Dwarf/short

Mendel's Experimental Material

He chose Garden pea (Pisum sativum) as his experiment material because of:

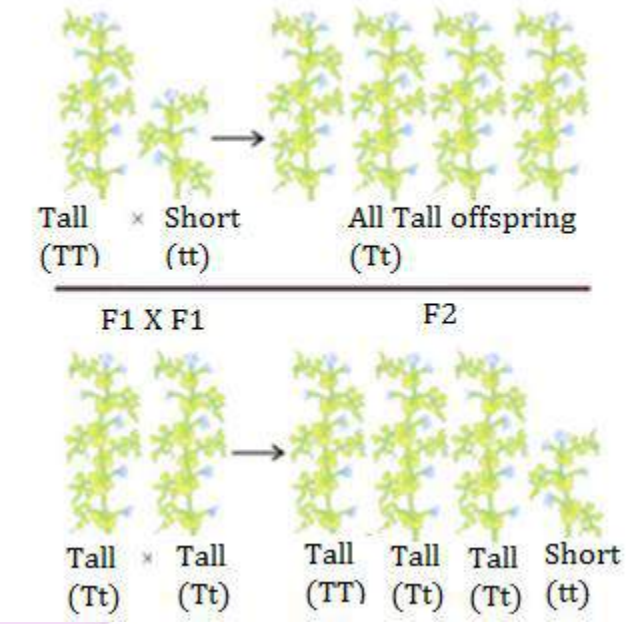
- Availability of detectable contrasting traits of several characters
- Short life span of the plant
- Normally allows self-fertilization but cross-fertilization can also be carried out
- Large number of seeds produced

Mendel's experiments

Mendel carried out 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 - a 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 of F2 are progeny (descendants) of the F1 tall plants are not all tall
- Both the tallness and shortness 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
- These two may be identical or may be different depending on the parentage

Pure or Homozygous condition

(TT, tt) - Both are dominant traits. Both are recessive alleles.

Heterozygous condition (Hybrid)

Tt - one is dominant and the other is a recessive trait

-> Phenotypic ratio - 3:1 (Three tall and one short)

-> Genotypic ratio - 1 : 2 : 1 (TT - one, Tt - two, tt - one)

Phenotype means physical appearance either they are tall or short.

Genotype means genetic make up that are TT, tt or Tt

Observations of Monohybrid cross

- All F1 progeny were tall, no medium height plant (halfway characteristics)
- F2 progeny 1/4 were short, 3/4 tall
- Phenotypic ratio F2 - 3 : 1 (3 tall : 1 short)

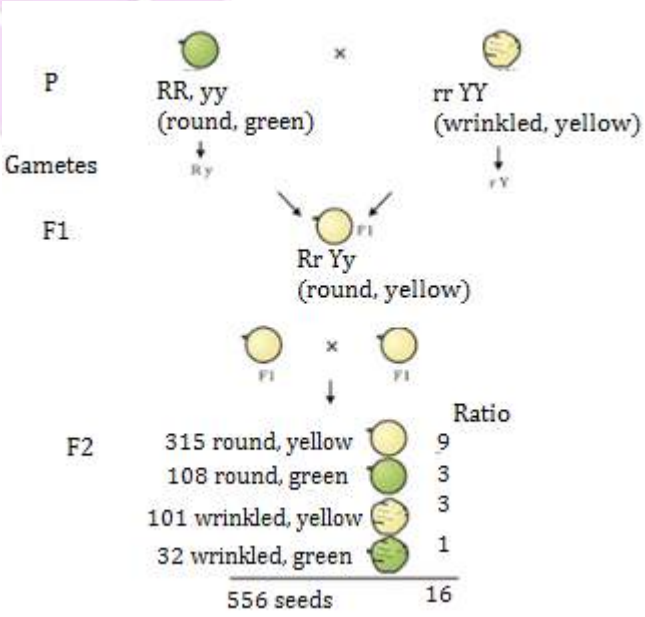
Conclusions

- TT and Tt both are tall plants while tt is a short plant
- 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
- Characters/traits like 'T' are called dominant trait (because it expresses itself) and 't' are a recessive trait (because it remains suppressed)

Dihybrid cross

A cross between two plants having two pairs of contrasting characters is called dihybrid cross

Parent ---> Round green x Wrinkled yellow



	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

Observations

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

Conclusion

- Round and yellow seeds are dominant characters
- The occurrence of new phenotype combinations show that genes for round and yellow seeds are inherited independently of each other

How do these traits get expressed

- Cellular DNA is the information source for making proteins in the cell
- A section of DNA that provides information for one protein is called the gene for that protein
- Plant height can thus depend on the amount of a particular plant hormone. The amount of the plant hormone made will depend on the efficiency of the process for making it
- Cellular DNA (information source) --> For synthesis of proteins (enzyme) --> works efficiently --> more hormone --> produced tallness of plant

  Therefore, genes control characteristics/traits

Sex Determination

Determination of sex of an offspring is known as Sex determination

Factors responsible for Sex determination

Environmental and genetic factors are responsible for sex determination

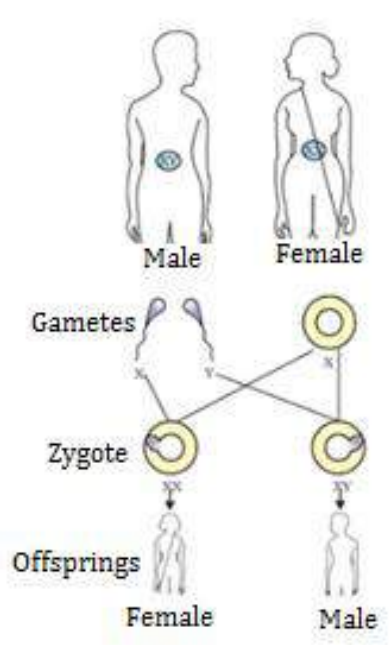
- Environmental - In some animals, the temperature at which the fertilized eggs are kept decides the gender. Example - Turtle
- Genetic - In some animals like humans, genders or individual is determined by a pair of chromosomes called sex chromosome.

  XX - Female, XY - Male

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 the chromosome that help in deciding the gender of that individual is called sex chromosome

  XX - Female, XY - Male



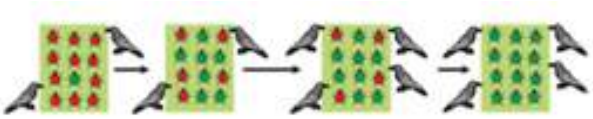
Evolution

Evolution can be defined as the changes in the heritable characteristics of the progeny over successive generations. According to Darwin's theory of Evolution, evolution takes place through the process of natural selection. Charles Robert Darwin, a naturalist, geologist, and

biologist, provided many theories and ideas on Evolution, therefore he is considered as the father of Evolution.

It is a 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 and green beetles)



Color variation arises during reproduction

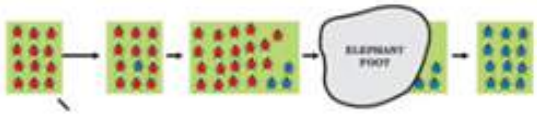
All beetles red except one that is green --> crows feed on red beetle --> Number of beetles reduces

One beetle green --> Progeny beetles green --> crows could not feed on green beetles as they got camouflage (hide) in green bushes --> number of green beetles increases

Conclusion

- Green beetles got the survival advantage or they were naturally selected as they were not visible in green bushes
- The natural selection is exerted by crows resulting in adaptations in the beetles to fir better in the environment

Situation II (Group of red and blue beetles)

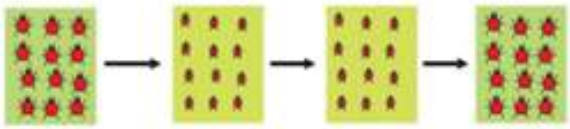


Reproduction in group of red beetles --> All beetles are red except one that is blue --> Number of red beetles increases as they reproduce --> One blue beetle reproduced and no. of blue beetles also increases --> Crows can see both blue and red beetles and can eat them --> Number reduces but still red 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 survival advantage. Elephant suddenly caused major havoc in beetles 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 a survival advantage. This is called genetic drift 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 beetles. 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 which are developed in an individual due to special conditions	These are the traits which 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 Example - Low weight of starving beetles	They are helpful in evolution Example - Colour of eyes and hair

Speciation And The Ways By Which Speciation Takes Place

Speciation takes place when variation is combined with geographical isolation.

(i) Gene flow - occurs between the population 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 over successive generations

Genetic drift takes places due to:

--- severe changes in the DNA

--- Change in number of chromosomes

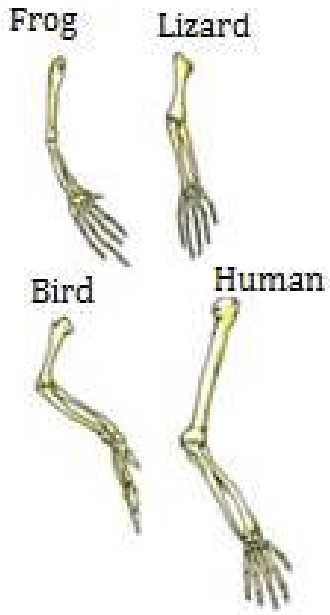
(iii) Natural selection - the process by which nature selects and consolidates those organisms which are more suitable adapted and possesses favourable variations

(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

Both evolution and classification are interlinked

- Classification of species is a 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 characteristics



Evidence of Evolution

(i) Homologous Organs (Morphological and anatomical evidences)

- These are the organs that have the same basic structural plan and organ but different functions
- Homologous organs provides evidences for evolution by telling us that they are derived from the same ancestor

Example - Forelimb of a horse (running), wings of a bat (flying), the paw of a cat (walk/scratch/attack)

Same basic structural plan, but different functions are performed

(ii) Analogous organs

These are the organs that have different origin and structural plan but same function

- Analogous organs provide a mechanism for evolution

Example - Wings of a bat --> Elongated fingers with skin folds, wings of a bird - feathery covering along the arm

Different basic structure but perform similar function i.e., flight

Fossils (Paleontological evidences)

- The remains and relics of dead organisms of the past
- They are preserved traces of living organisms
- Fossil Archaeopteryx possesses features of reptiles as well as birds. This suggests that birds have evolved from reptiles

Example - Ammonite: Fossil-invertebrate, Trilobite: Fossil-invertebrate, Knightia - Fossil-fish, Rajasaurus - Fossil-Dinosaur skull

Age Of The Fossils

- Deeper the fossil, older it is
- Detecting the ratios of the difference of the same element in the fossil material Radio-carbon dating C-(14) dating

Evolution by Stages

Evolution takes place in stages i.e., bit by bit 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

- Flatworms have rudimentary eyes (enough to give fitness advantage)
- Insects have compound eyes
- Humans have binocular eyes

(ii) Functional advantage

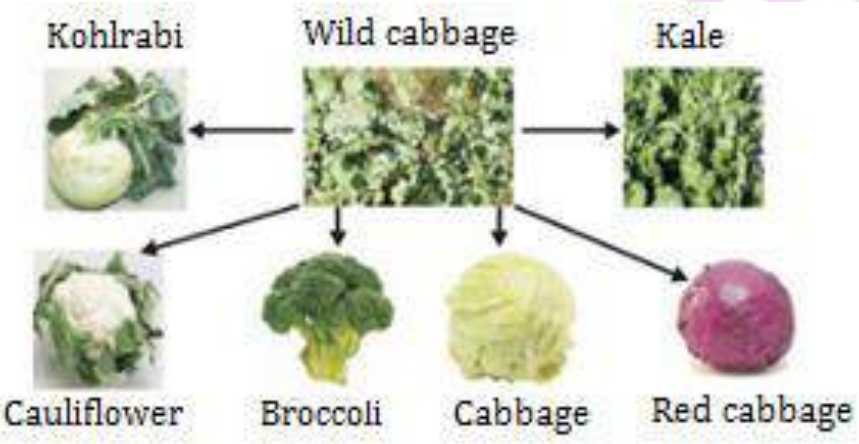
Evolution of feathers - Feathers provide insulation in cold weather but later they might become useful for flight.

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

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.

Example:



(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 the evolution
- Organisms which are most distantly related will accumulate greater differences in their DNA.

Human Evolution

Excavating, Time dating, Fossils and Determination of DNA sequences are the tools to study Human evolutionary relationship

- Although there is a great diversity of human forms all over the world, yet all humans are a single species
- All humans come from Africa. The earliest members of the human species. Homo sapiens, can be traced there. Our genetic footprints can be traced back to our African roots
- The residents spread across Africa, the migrants slowly spread across the planet from Africa to West Asia, then to Central Asia, Eurasia, South Asia, East Asia. they travelled down the islands of Indonesia and the Philippines to Australia, and they crossed the Bering land bridge to the Americas
- They did not go in a single line
- Sometimes came back to mix with each other

Few Important Questions

- What are fossils? Explain its importance.
- What is speciation? Explain with its types and examples.
- List out the factors involved in the formation of new species?
- Explain the following terms with examples.
    - Inherited Traits.
    - Human Evolution.
    - Analogous and Homologous organs.
    - Dominant trait and Recessive traits.