Revision Notes

Class 10 Science

Chapter 9 – Heredity and Evolution

1. Accumulation of variation during Reproduction:

- Reproduction is a process that gives rise to new offspring that are similar to the parents but with some **variations** between them due to the process of **DNA copying**.
- It may be noted that these differences are slightly visible in asexual reproduction as in plants, but they are **greater variations** and diversity in the case of **sexual reproduction** which involves the fusion of **two** different **gametes**.
- This leads to the variations that are seen in each generation.
- These variations may be advantageous or disadvantageous to the individuals and may or may not enable them to cope with the changing environmental conditions. For example, the bacteria that can tolerate higher temperatures would survive the heat waves.
- These **variations accumulate** over generations in the evolutionary process owing to the environmental factors and lead to the formation of **new species** and are equally important for their **survival.**

2. Heredity:

- The biological process that maintains or passes on the characteristics and traits of the parents to their offspring is termed **heredity**. Example, colour of skin or hair, eyes, height etc.
- This is responsible for maintaining the variations in generations and thus the evolution of species over a period of time.

2.1 Inherited traits:

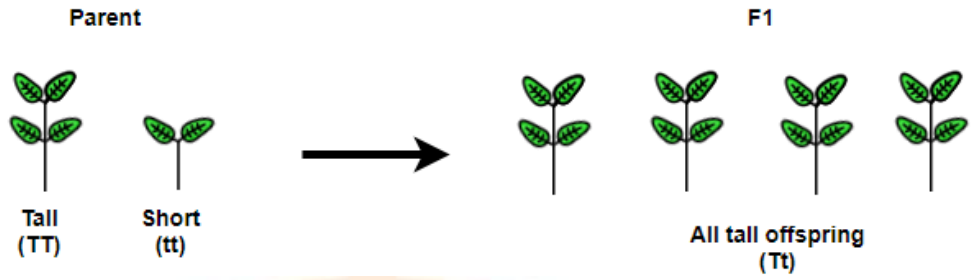
- The characteristics that are inherited from the parents are termed as **traits**, like eye colour or skin colour in humans. If the parent has brown and black eyes, then the offspring may inherit a brown or black or a combination of both.
- This depends on the set of genes responsible for that trait.
- The traits that are inherited in this manner are termed **inherited traits** and these are the cause of the variations in the population, though everyone has a similar basic feature.

2.2 Rules for the Inheritance of traits- Mendel's contributions:

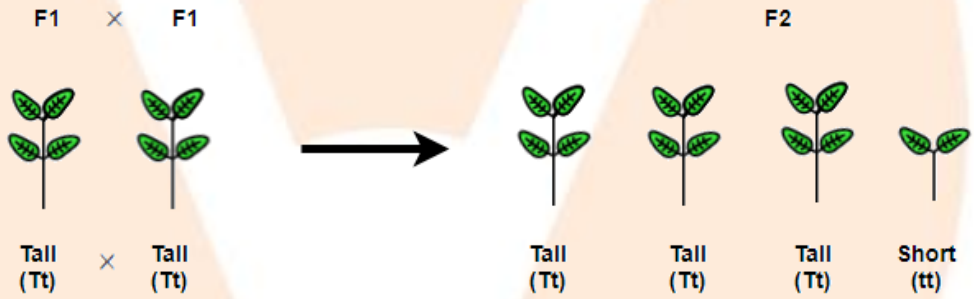
- The rules of inheritance comes from the fact that both the parents contribute equally to the development of the traits in the offspring.
- Gregor Johann **Mendel**, often referred to as the '**Father of genetics'** was a pioneer who used his science and mathematics knowledge to frame these laws of inheritance. He did so using pea plants for his experiments as he found them easy to grow and they had greater number of visible characteristics like tall/short, white/violet flowers, round/wrinkled seeds.
- Mendel found during his experiments that there were some **factors** controlling the traits, which are now known as **genes**.
- The genes are present as a pair for a specific trait and then they are termed as **alleles**.
- Depending on the genes the expression of the traits could be either **dominant or recessive**. If we take the tallness in a plant as dominant trait, then it can be denoted by 'T' and shortness in the plant would be a recessive trait, denoted by 't'. Thus the plant will be tall if it's alleles are 'TT' or 'Tt'.
    - The condition when the alleles of the genes have the same allele for a trait, they are termed as **homozygous**. Example - TT or tt.
    - The condition when the alleles of the genes have the different alleles for a trait, they are termed as **heterozygous**. Example - Tt.
- The morphological expression of a single character is termed as **phenotype**. Example - tallness or shortness, round or wrinkled seeds of the plant.
- The genetic constitution or the allele pair for a specific trait is termed as the **genotype**. Example - Tt or t tot TT.
- Mendel was a mathematician so; he found the statistics of the traits in each generation by using a statistical method known as **Punnett square** for predicting the possible genotypes and phenotypes of the offspring.
- He conducted his experiments to find two types of inheritance namely:

1) Monohybrid inheritance:

- Mendel took a tall (TT) and short (tt) pea plant, crossed it to get the offspring. The first generation or **F1** were all found to **be tall**, showing only one of the traits of the parent.



- Then he self-pollinated the parent and the F1 plants. It was interesting to see that the offspring of the parent plants were all tall, but the offspring of the F1 plants, the **F2** generation did not have all tall plants. **A quarter** of them **were short**, which indicated that both traits of the parent was inherited by F1 generation.
- The traits of tallness was dominant and so it was expressed even with the genotype of TT, Tt but the shortness was a recessive trait that could be expressed only with a genotype of tt.

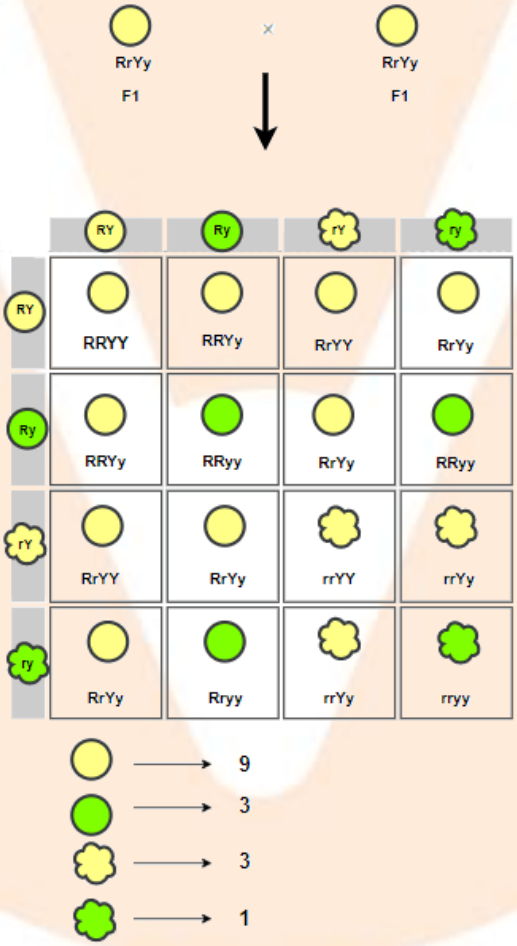


- So, the genotype - 1:2:1 And the phenotype - 3:1
- The inheritance of a trait by a pair of single alleles of a gene is termed as **monohybrid inheritance**.

2) Dihybrid inheritance:

- When a pea plant with two different traits; a plant with round green colour seed (RRyy) is crossed with wrinkled yellow seed (rrYY) plant.
- The F1 generation turned out to have round yellow seeds, RrYy, which showed the dominant traits to be round shape and yellow colour.

- When the F1 generation were self-pollinated, the F2 generation had greater variations than the parent and new combination also came up.



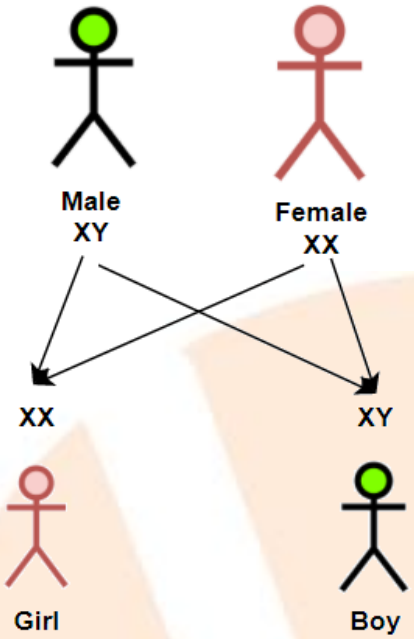
- So, the genotype - 9 different combinations and the phenotype - 9:3:3:1.
- The inheritance of different traits by two pairs of alleles for it is termed as **dihybrid inheritance**. And here the two traits of round/wrinkled seeds and green/yellow colour were inherited independently.

2.3 How do these traits get expressed?

- The DNA present in the cell is responsible for making the proteins. A section of this DNA that provides information for one protein is termed as the **gene** for that specific protein.
- The proteins that are thus synthesized are essential in many of the biochemical reactions that are responsible for the expression of a trait and they are controlled by specific enzymes.
- Any alterations in them will lead to a variation in that trait, and hence genes control the traits in a such a way. If the traits are to be inherited independently from both the parents, then they need to be present separately.
- Therefore each gene set is present as a separate independent pieces that are called as **chromosomes**, with each cell having **two sets**, one each from both the parents.
- When these two germ cells combine, they tend to restore the number of chromosomes and hence the DNA. Hence there are **two genes** for the **expression of every trait**.

2.4 Sex determination:

- There are various mechanism that determine the sex of a new born organism. It may be based on the temperature where the fertilised eggs is kept as in few reptiles, or they may changes ex as in snails. **Humans** on the other hand the sex of a new born child is determined predominantly by the **genes inherited** from the parents.
- All the chromosomes in humans are not paired. There are generally a pair of **22 chromosomes**, with a one of the pair being from each of the parent. These generally determine all the traits.
- There is a pair of chromosomes known as the **sex chromosomes** that differ in males and females. The females have a correct pair and they are termed as X chromosomes, but men have an X chromosome and its pair as Y. So the genotype of **women is XX** and **men is XY**.
- If we look at the inheritance pattern of a male and female, we can see that X is inherited by the child from their mother by default and the **sex of the child** depends **on which pair of the sex chromosome** is being inherited **from the father**.
- If it X, then the pair becomes XX and the child is a girl and if Y is inherited, then it becomes XY and thus the chid is a boy.



3. Evolution:

- The process of a gradual development over millions of years in organisms through generations by inheriting the traits of their previous generations is termed as **evolution**.
- The evolution eventually leads to the evolvement of **new species**. According to J B S Haldane, life on earth may have started as a simple organic molecule and has developed into complex organism with the changing conditions on earth during various periods.
- **Charles Robert Darwin** was an English naturalist who proposed the idea of "**evolution of species by natural selection'** although he was not aware of the mechanisms responsible for the variations.
- **Natural selection** refers to the selection of some traits of a population that favour their survival making them adapt to the environment.
- It was Mendel who proposed the mechanism behind the inheritance of traits. Both these scientist worked on their theories independently.
- These traits that are inherited may be acquired also.

3.1 Acquired and inherited traits:

- Any trait that is acquired by an organism during its lifetime due to any external conditions is not transmitted to its offspring. These traits are termed as **acquired trait**. Example - the way a person speaks or the skills he/she has. These changes do not affect the germ cells and so they cannot be passed on from one generation to the other.

- Any trait that is genetically inherited or passed down from one generation to the next generation is termed as **inherited trait**. Example - the colour of eyes or skin.

4. Speciation:

- A group of organisms that are similar in their traits and are capable of breeding within themselves are termed as **species**.
- The mechanism or process by means of which a new or distant species is formed from the pre-existing species due to various factors is termed as **speciation**.
- This process leads to the formation of different species within a population that is not capable of reproducing among themselves.
- The various **factors** for the same may be seen as:

1) Splitting of population:

- The populations tends to grow rapidly when there is a favourable environment for their survival. As a result the population is very large and spread out.
- This makes it difficult for all the members to interact among themselves due to the **geographical isolation**, so they tend to reproduce with the local near by population. And if they are separated by any barrier like a mountain or a river, then they are isolated further.
- This will cause the **gene flow** or transfer of genes in a population to reduce and they may develop into a new or distant species.

2) Genetic drift:

- The populations undergoes a **change in their genes** for some traits that are specific to that species due to unprecedented reasons. This leads to them being transferred to another existing population.
- Example - If there are a population of red and green beetles and the green are eliminated by being in a forest fire, then the population of only red beetles will remain.

3) Natural selection:

- The process by which certain populations are selected over others due to their variations and ability to adapt is termed as **natural selection**. They lead to the formation of new species over a period of time.
- Example - In case of a storm, the birds with long or short wings died as compared to the ones with average wings. So, they were

naturally selected to adapt to that environment changes and they survive to evolve their species.

- The process of genetic drift and natural selection will eventually lead to two isolated sub species that are entirely different from each other and they form a new species altogether and thus speciation occurs.

5. Evolution and Classification:

- Every species goes through a phase of evolution. The similarities among organisms that allow them to be grouped are based on the **characteristics** or the details of the appearance or behaviour that is seen for a particular form or a function.
- There are some basic characteristics that are shared by most of the organisms like, the cell being the fundamental unit of life. But the next level of grouping or classification may not be common for all the organisms, like the cell may have a nucleus or not. This classification goes further as whether the nucleated cells are single celled or multicellular. This allows a **hierarchy** to be created in the **evolution process** that helps us in the **classification of groups**.
- Thus the more common characteristics are shared by two species, the more closely related they are. The more closely they are related, indicates that they have had common ancestors recently. Example - In a family, a brother and a sister are closely related with common ancestors as parents. Now the girl and her cousin too are related as they common ancestors, grandparents. But they are distant than her brother as they common ancestors in second generation.
- Thus small group of species with recent common ancestors are built, followed by distant common ancestors and this goes on backwards in the evolutionary process.

5.1 Tracing Evolutionary relationships:

- In the evolutionary relationships, the occurrence of common characteristics are the basis of classifying them into groups. These common characteristics can be identified as being of 2 types, namely:
    1) **Homologous characteristics:** These are those characteristics that are present in **different organism** but look similar and they have a have a **common ancestor**. They may have the similar basic organ structures but with a different function in various organisms. Example - Mammals, birds, reptiles and amphibians have four limbs, but each serves a different purpose and are modified to perform that function.

2) **Analogous characteristics:** These are those characteristics that have the **similar function** in different organisms and they have evolved independently for **different ancestors**. Example - the wings of bats and of birds look similar as they serve to perform the same function of flying, but the wings of a bat are actually a fold of skin between the fingers.

- Hence these different types of characteristics help in tracing the evolutionary relationships between species to a great extent.

5.2 Fossils:

- To study the evolutionary relationships, the current species as well as the species that are no longer in existence also needs to be considered.
- The body of an organism usually decomposes when it dies, but due to some environmental conditions like hot mud or lava, their bodies may be buried in them, harden and eventually leave an impression of the body parts. This preserved traces of the living organisms that existed in a past geological period are termed as **fossils.**
- The fossils help in determining the various evolutionary stages of the species. The process of conversion of an organism into a fossil is termed as fossilisation and its study is referred to as palaeontology.
- There are two ways to **determine the age** or dating of the fossils.
    1) **Relative dating:** This method involves the digging of the earth and excavating the fossils from the rocks. The more recent ones are found closer to the earth's surface.
    2) **Radiometric dating:** In this method, the fossils can be dated based on the radioactive elements present in the rocks and detecting the ratios of different isotopes of the same element in the material of the fossil.

5.3 Evolution by Stages:

- It is well established that evolution is a **gradual process** that takes place over thousands of years. The complex organs that have evolved in organisms is not due to a single DNA change but due to thousands of such changes over a large period of time. If the eyes of an octopus and the vertebrates are considered then it is different in both of them suggesting that they have evolved independently. It is also to be noted that a change brought on for a particular feature may have later evolved into a different function altogether. For example, the purpose of feathers initially was considered to provide insulation in cold weather and this is seen in some of the reptiles like the dinosaur, who could not fly. In the evolutionary

process birds adapted these feathers for flight. This leads to the belief that birds were closely related to reptiles.

- Similarly some **structures** that are **dissimilar** have evolved from common ancestors. The best example of it would be wild cabbage that humans have used as food for over two thousand years. They generated different types of vegetables out of the would cabbage by artificial selection and developed the cabbage with short leaves, broccoli which is arrested flowers, cauliflower, the swollen parts as kohlrabi, or leafy kale. If not for artificial selection in this, it would not be known that they originated from a **common ancestor**.
- The change in the DNA is yet another way to understand the evolutionary relationships. The **comparison of the DNAs** of different species would give an insight into the changes that have happened in their evolutionary process.

6. Evolution should not be equated with progress:

- The evolution of a new species does not indicate that the old species has been eliminated or they are inefficient than the new one. It indicates that the new species have evolved as a result of changing environmental conditions.
- It can be said that **evolution** is a process of **creating diversity of species** due to natural selection and genetic drift. This creates a population that is not capable of reproducing with the original species. For example, humans and chimpanzees may have had common ancestors and with time they have evolved in separate directions leading to the present species.
- Hence there is no progress that can be mapped during evolution. Each and every species diversifies in order to reproduce and survive and adapts itself accordingly.
- The only factor is that more and more complex organs have developed in the evolutionary process. That does not indicate the simplest older species like the bacteria are extinct. They can survive in diverse conditions of hot springs, Antarctica etc. Humans are the most evolved, but they are just another species in the evolutionary process.

6.1 Human Evolution:

- The evolutionary relationship in humans has also been traced by the various methods of excavation, time-dating, studying the fossils, and DNA sequences. A great diversity exists among the people of the world in their features, colours, etc. Many times, groups of humans were grouped based on their skin colour. But there is no biological reason for that as all the

humans are part of a single same species. Everyone belongs to the species - ***Homo sapiens***.

- A large number of genes are present in this gene pool which is the source of the vast variations found in humans. This is the reason that no two individuals are alike in looks, abilities, etc, that leads to the diversity in skin colour, height, hair colour, etc.
- Though the humans inhabit different parts of the modern world, all of them **originated from Africa**. The original inhabitants of Africa migrated to across to West Asia, central Asia, Eurasia etc and all this while they were travelling back to Africa too. This lead to a diverse gene pool in a staggered manner as the population across the world increased.