Chapter 9: Heredity And Evolution

Heredity, Mendel's Contribution

- **Inheritance** or **heredity** refers to the passing or transfer of characteristics (from parents to children). The process through which features and characteristics are passed down from generation to generation is referred to as ***heredity***. However, not all of the traits of progeny are identical to their parents.
- The **principles of heredity** dictate how qualities are inherited. They exhibit a range of traits. Thus, **variations** refer to the distinctions between the characteristics (*traits*) of individuals within a species. Character inheritance may occur during **asexual** or **sexual reproduction**.

Accumulation Of Variations During Reproduction

- **Inheritance** from the past gives the following generation both a similar body design and subtle alterations to it. When the new generation reproduces, the second generation will inherit both inherited and newly developed distinctions.
  For instance, if a bacterium splits and produces **two persons**, each of those people will divide again and produce **two further individuals** in the following generation.
- The **four individual bacteria** formed would be remarkably identical but for tiny variances caused by modest errors in **DNA copying**. **However**, sexual reproduction generates considerably more variability.
- Various people would have different benefits depending on the nature of the differences, for example, bacteria that can endure heat would live better during a heat wave.

Inheritance Of Traits

- **Genes** regulate the traits or qualities that are handed down from parents to their children generation after generation. A portion of **DNA** that contains information about a particular protein is referred to as a **gene** for that protein.
- Due to genetic variances, human populations exhibit a considerable lot of variety in the expression of different features, such as **height, skin tone, eye colour, nose, lip, and ear shape, and blood type**.
- Attached and free earlobes have been documented in human cultures. The earlobe is the lowest portion of the ear. The earlobe is not linked to the side of the head in **free earlobes**.

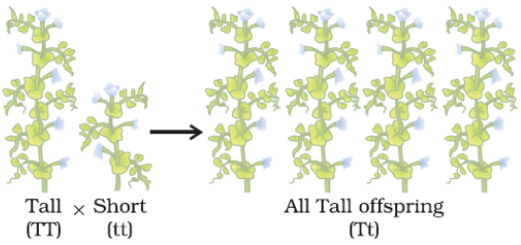
- Whereas with an **attached earlobe**, the earlobe is tightly linked to the head's side. This unique characteristic is inherited.

Mendel's Contribution Towards The Inheritance Of Traits

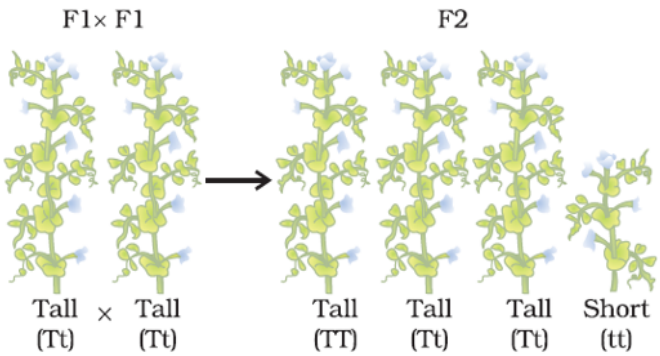
- The laws governing the inheritance of features in humans are based on the fact that both parents contribute an equal quantity of **genetic material** to the kid.
- This indicates that both **father and maternal DNA** may have an effect on each attribute. Thus, each feature will have **two manifestations** in the child. **Mendel** established the fundamental laws governing such inheritances. In the majority of living creatures, heredity is governed by well-defined rules.
- **Mendel** conducted his studies on **garden peas** (*Pisum sativum*). His trials with garden peas, together with the conclusions he drew, laid the groundwork for contemporary genetics.
- **Mendel's** efforts were singular in their application of diverse variables and mathematics to the issue. He maintained a separate record for each generation and focused on the inheritance of a **single pair of characters** at a time.

He performed the following two experiments :

Inheritance Of Traits For One Contrasting Character : Mendel selected pea plants with varying physical features, including height (short and tall plants). All of their descendants (F_1-generation plants) were tall. Mendel then permitted self-pollination of F_1 progeny plants.



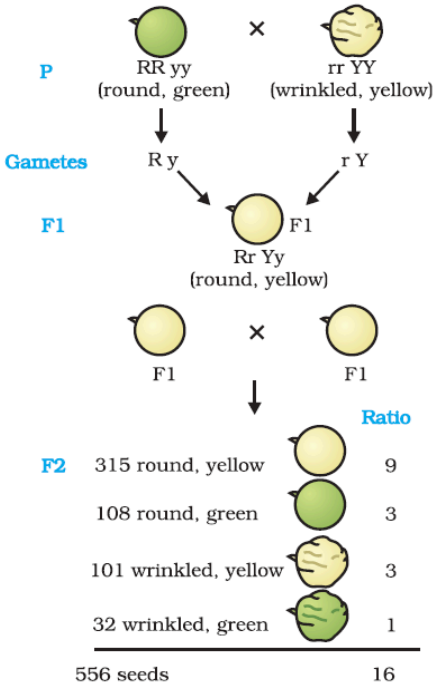
He discovered that none of the plants in the F_2-generation were tall; three-quarters of them were tall, and one-quarter were small. This finding suggested that both low stature and tall stature were inherited in the F_1-generation. However, in the F_1-generation, only the tallness trait was exhibited.



Each sexually reproducing creature inherits two copies of the features.

TT and Tt are tall plants phenotypically, but tt is a

small plant. A single copy of 'T' is sufficient for a plant to grow tall. Thus, in characteristics Tt, 'T' represents a dominant trait, while 't' represents a recessive feature. Both characters are restored in F_2 generation, despite the fact that one of them is absent from the F_1 stage. During gamete production, a pair's factor or alleles segregate.



Inheritance Of Traits For Two Visible Contrasting Characters : Mendel selected two distinct pea plants, one with a **green spherical seed** and the other with a **yellow wrinkled seed**. When the **F1 progeny** were obtained, they had **round and yellow seeds**, demonstrating that **round and yellow** are **dominant features**.

Mendel then permitted self-crossing (self-pollination) of the F_1 offspring in order to create F_2 progeny. He discovered that seeds came in a variety of shapes and colours, including round yellow, round green, wrinkled yellow, and wrinkled green.

The ratio of plants with the aforementioned characteristics was 9: 3: 3: 1. (Mendel observed that two new combinations had appeared in F_2).

During F_2 generation, each of the four characters was randomly assigned. As a result, he asserted that an alternating or contrasting pair of characters acts independently of the other pair. For instance, seed colour is unrelated to seed coat.

Expression Of Traits

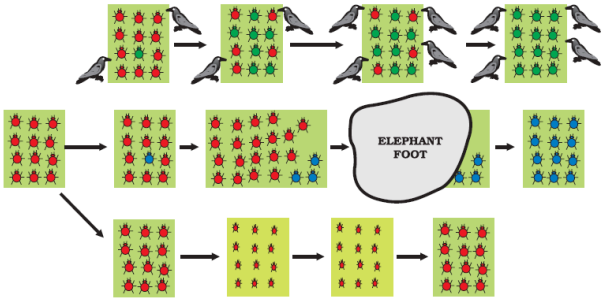
- DNA is the source of information for the cell's protein synthesis. A portion of DNA that contains information about a specific protein is referred to as a gene for that protein.
- As we all are aware, plants contain hormones that stimulate growth. As a result, the quantity of plant hormone produced dictates the plant's height. And the quantity of plant hormone produced is dependent on the efficiency of the manufacturing process.

Evolution

Evolution, or **organic evolution**, is the process through which basic living forms gradually evolve into sophisticated life forms. Because evolution incorporates living beings, it is referred to as **organic evolution**.

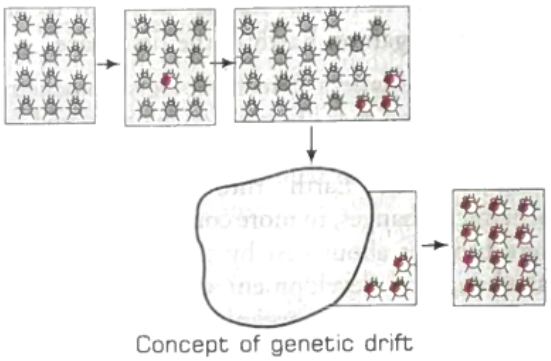
Variations In A Population

Variation is the term used to describe the changes in phenotype and genotype, the individuals within a population, or between parents and their children. Assume twelve red beetles dwell in green-leaved plants. Their population expands by sexual reproduction, resulting in variety. Variation in a population of beetles may arise in the following ways.



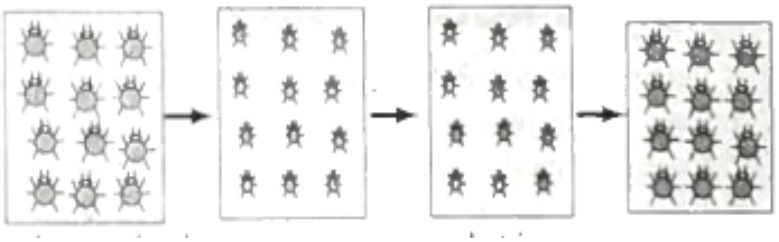
Situation I - A colour difference may occur during reproduction, resulting in the generation of a green beetle. It imparts the colour green to its offspring. Crows are unable to consume green-coloured bugs on green foliage because they cannot see them.
As a result, the grey beetles continue to be consumed, while the population of green beetles expands. Variation confers a survival benefit in this example. Crows' natural selection will ensure the survival of green beetles.

Situation II -In another scenario, a **colour change** occurring during reproduction may result in a blue beetle rather than a grey beetle, and all of its descendants will be blue.
Crows are capable of seeing both blue and grey-coloured insects and hence may consume chem. At first glance, there are a few blue beetles and a greater number of grey beetles.
Suddenly, an elephant scurries through the bushes, annihilating the majority of the bugs. By accident, the few beetles that survived were mostly blue, and their numbers eventually increased. Genetic drift is the gradual increase in the frequency of certain genes in a population that results in variety without a survival penalty.


Concept of genetic drift

Situation III - Here, the bushes get a **plant disease**, and the quantity of leaf material available to the beetles has decreased as a result of the bugs' population increase. As a consequence, the beetles are malnourished, and their **average weight has plummeted**.

After a few years, the plant disease should be eradicated, leaving plenty of food for the beatles. They will then revert to their regular weight. There is no genetic change happening in this instance. Thus, only phenotypic variation between identical genotyped organisms is possible.



Acquired And Inherited Traits

- The features gained by a person throughout his or her lifetime that cannot be passed on to his or her descendants are referred to as **acquired traits (characters)**.
- Individuals' lifetime experiences cannot be passed on to their descendants and cannot be used to drive development.
- **For instance**, if we breed a colony of mice and surgically remove their tails, the descendants will not be tailless. This is because removing the tail has no effect on the genes of the mice's germ cells and so has no effect on evolution. Thus, it demonstrates that changes in non-reproductive organs cannot be transferred to the germ cell DNA.
- **Inherited qualities** are those features that kids inherit from their parents (i.e., from one generation to the next, such as hair and eye color, nose and earlobe form, etc.).

Origin Of Life On Earth

- **Darwin's evolutionary theory** explains how life developed from simpler to more complex forms. **Mendel's experiments** establish the process through which characteristics are passed down from generation to generation. However, none of these explains how life arose on Earth in the first place.
- In 1929, British scientist, biochemist, and geneticist **JBS Haldane** suggested that life must have evolved from basic inorganic components. These molecules may have evolved on the Earth via a lengthy succession

of physiochemical changes that resulted in increasingly complex organic compounds.

- **Organic evolution** is the progressive change or development of complex forms from simpler ones.
- In **1953**, **Stanley L. Miller** and **Harold C. Urey** provided experimental evidence for **Haldane's** idea of life's beginning.
  They constructed an atmosphere over water in an airtight device comparable to that which existed on early Earth (containing **ammonia, hydrogen, methane, water vapour, and hydrogen sulphide, but no oxygen**).
- This was kept at a temperature of about **100°C**. To trigger lighting, continuous sparks were sent through the combination of gases.
  After a week, **15%** of the carbon in **CH4** had been transformed to simple carbon molecules such as **amino acids** (making up the protein molecule).

Speciation

It is the process through which one or more species evolve from another. It happens when two populations are physically and reproductively separated, resulting in essentially little gene flow between them.
However, interbreeding continues within isolated groups, resulting in an increasing number of generations. Eventually, even if they have a chance to meet, the members of these two groupings will be *incapable of reproducing* with one another.
Genetic drift accumulates a variety of alterations in a subpopulation across generations. Additionally, *natural selection* may function differently in these various geographic regions.
For example, crows may be *wiped out by eagles* within the region of one subpopulation. However, this may not be the case in the other subpopulations, where crow populations will likely *increase significantly*.
As a result, the green version will not be chosen at the first location. While the second will be quite selective. When **genetic drift** and **natural selection** act in concert, two isolated subpopulations may become more distinct from one another. This will result in the emergence of new species. These novel species might have evolved.

- If the **DNA modifications** are significant enough, such as a change in the number of chromosomes, the two groups' **germ cells** will ultimately be unable to unite.

- If a new variant occurs in which females may mate with a limited number of men owing to their unique characteristics, this enables a high degree of **natural selection** for that attribute.

Evolution And Classification

- **Evolution** is the process through which newer forms of organisms evolve from pre-existing ones as a result of alteration caused by external influences such as environmental change.
- **Characteristics** are the specific aspects of an object's appearance or behaviour, in other words, a particular shape or function. For example, human beings' forelimbs are a trait, as is the ability of plants to accomplish photosynthesis.
- **Classification** is the process of grouping organisms according to their physiological, biochemical, anatomical, or other characteristics. All categorization systems are hierarchical.
- **Hierarchy** is a social organisation style in which people are ranked according to their position or dominance in comparison to other group members.

Basic Characteristics Of An Organism

- In all living species, the **cell** is the fundamental unit of life.
- Certain species' cells lack an organised **nucleus**, for example, the bacterial cell. Whereas some other creatures' cells include a well-organised nucleus.
- Some creatures with a fully formed nucleus are **unicellular**, whereas others are **multicellular**.
- Similarly, certain multicellular creatures can synthesise their own food (*photosynthesis*), whereas others cannot.
- Another distinction between **unicellular** and **multicellular** creatures is that certain multicellular organisms have a **skeleton** embedded inside their bodies, whilst others have a skeleton wrapped around their bodies.

Evolutionary Relationships With Classification

- **The more closely related two species are**, the more features they will share. And the closer they are linked, the more recent their shared ancestors were.

Illustrate this principle using the following example:

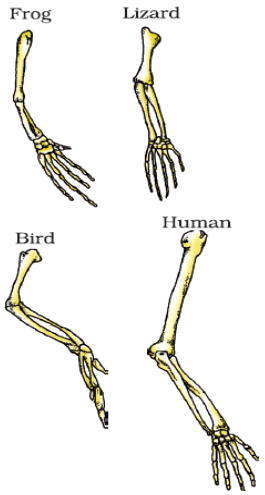
- **A sister and a brother** are inextricably linked since they share an ancestor in the preceding generation, namely their parents.
- A first cousin and a girl are distant cousins, but not as distant as her brother. The cousins have a common ancestry, namely their second generation grandparents. Thus, the taxonomy of organisms reveals evolutionary links.

Tracing Evolutionary Relationships

To ascertain the **evolutionary links** of species, it is necessary to examine their shared characteristics. These shared characteristics across creatures indicate a **common ancestor**. Numerous disciplines have supplied evidence, as listed below:

Homologous Organs : Darwin hypothesised that more closely related species originated from a **common ancestor**. The shared traits and essentially comparable anatomy, such as the **forelimbs of vertebrates**, support the likelihood of a common ancestor.
The phenomenon of structural resemblance owing to shared ancestry is referred to as **homology**. The characteristics of the **homologous organ** are as follows:

- Have the same fundamental structure and developmental origin.
- Perform distinct roles in various species.
- Their resemblance is attributable to shared ancestors. For example, the **forelimbs of vertebrates** (lizard, man, frog, and bird) are structurally identical yet have distinct purposes.



Analogous Organs :

Organs that have a distinct origin and fundamental structure (plan), but have a similar appearance and function, for example, the wings of birds and bats.