Heredity and Evolution

Heredity

- **Acquired traits-** a trait that an individual experiences during his lifetime

  a) involves changes in non-reproductive tissues
  b) cannot be passed on to the progeny

- **Inherited traits-** distinguishing qualities or characteristics that one acquires from his/her ancestors.

  a) involves changes in DNA or reproductive tissues.
  b) transmitted to progeny

- **Heredity**- transmission of characteristics or traits from parents to offsprings.
- **Variations**- difference among individuals of a species and also among offsprings of same parents.
- Variations are of two types- heritable and non-heritable.
- **Basis of heredity**- each trait is influenced by both maternal and paternal DNA.

Mendel's work

- Proposed- heredity is controlled by factors. Factors are now called genes.
- Performed experiments on garden pea (*Pisum sativum*)
- Used seven contrasting pairs of characters or traits to study heredity.
- **Dominant trait-** able to express itself over another contrasting trait
- **Recessive trait-**unable to express its effect in the presence of a dominant trait
- Mendel represented- dominant trait as upper case (e.g., T for tallness) and recessive trait as lower case (e.g., t for shortness)
- **Homozygous-** when the factors or genes of a trait are similar e.g., TT or tt
- **Heterozygous-** when the factors or genes of a trait are different e.g., Tt
- **Genotype-**genetic constitution of an organism e.g., pure tall- TT
- **Phenotype-**observable traits or characteristics of an organism e.g., tallness, shortness etc.
- **Genotypic ratio-**expected ratio of genotypes produced by a particular cross
- **Phenotypic ratio-**expected ratio of phenotypes produced by a particular cross
- **Monohybrid cross-**involves only one pair of contrasting characters
- **Phenotypic ratio in monohybrid cross is 3:1**
- **Dihybrid cross-**involves two pairs of contrasting characters
- **Phenotypic ratio in dihybrid cross is 9:3:3:1**

Stages of Mendel's experiment

- Selection of parents- true breeding with contrasting pairs of traits e.g., pure tall (TT) and pure dwarf (tt) pea plants were selected

- Obtaining F_1 plants- F_1 generation is the first filial generation, formed after crossing desirable parents e.g., crossing pure tall (TT) and dwarf (tt) plants gives heterozygous tall (Tt) F_1 plants
- Self-pollination of F_1 plants- involves crossing F_1 plants to obtain F_2 plants
- **Dihybrid cross:** It is the cross between two parents that have two pairs of contrasting characters; for example, the cross between round yellow seed and wrinkled green seeds.
- The phenotypic ratio obtained in dihybrid cross is 9:3:3:1.
- On the basis of observation of dihybrid cross, the law of independent assortment was proposed.

Principles of Mendel

- Each characteristic in an organism is represented by two factors
- Two factors are - dominant and recessive
- Two contrasting factors when present in an individual do not blend
- When more than two factors are involved, they are independently inherited
- Heredity occurs at cellular level
- Inside the nucleus of a cell, heredity material is present in the form of DNA
- DNA associates with proteins to form chromosomes
- Every somatic (body) cell of the human body has 23 pairs (46) of chromosomes

- **Monohybrid cross:** It is a cross between two parents that have one pair of contrasting characters; for example, a cross between tall (TT or Tt) and dwarf (tt) plants.
- The phenotypic ratio obtained in monohybrid cross is 3:1 while genotypic ratio is 1:2:1.
- Based on observations on monohybrid crosses, two laws were proposed –

1. **First law or law of dominance:** It states that only one parental trait gets expressed in the F1 generation while both the traits get expressed in the F2 generation.
2. **Law of segregation:** It states that two alleles segregate from each other when characters are transferred from parents to offspring during reproduction.

- **Dihybrid cross:** It is the cross between two parents that have two pairs of contrasting characters; for example, the cross between round yellow seed and wrinkled green seeds.
- The phenotypic ratio obtained in dihybrid cross is 9:3:3:1.
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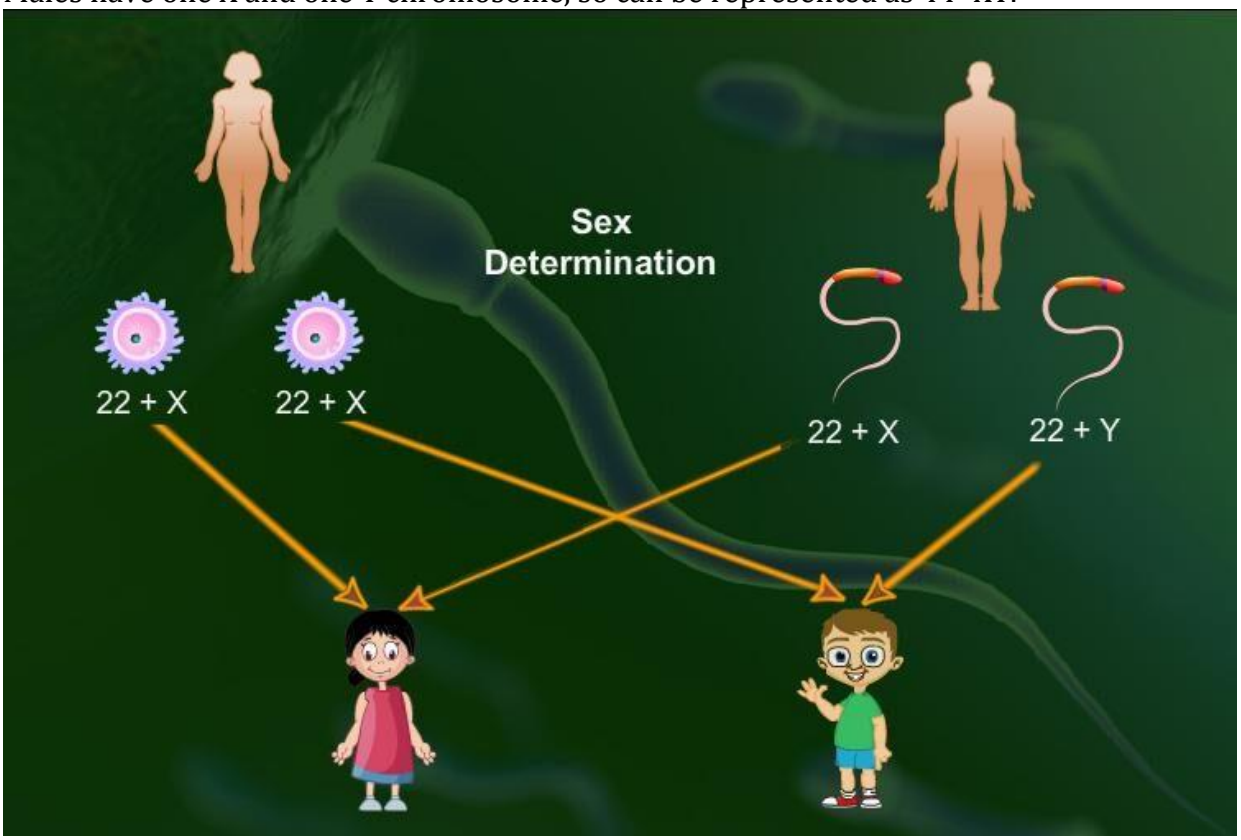
  Law of independent assortment: It states that the members of different pairs of alleles assort independently into gametes.
- **Incomplete dominance**
- It is the phenomenon where one allele is incompletely dominant over the other member of the allelic pair.
- Both phenotypic and genotypic ratios are the same in the case of incomplete dominance, i.e., 1:2:1.
- **Co-dominance**
- It is the phenomenon where both the alleles of a gene are equally dominant and get expressed together in heterozygous condition; for example, ABO blood group in humans.
- Blood group ABO is an example of multiple alleles.

Sex determination in humans

- Autosomes- first 22 pairs of chromosomes that do not determine the sex of an individual.

- Sex chromosomes- last pair of chromosomes, represented as X and Y.
- Females have two X chromosomes,so can be represented as 44+XX.
- Males have one X and one Y chromosome, so can be represented as 44+XY.



- Each gamete receives half of the chromosomes i.e. 22+X or 22+Y.
- Male gametes have 22 autosomes and either X or Y sex chromosome.
- Male gametes can be of two types, 22+X or 22+Y.
- Female gametes can be of only one type, 22+X.
- Sex of a baby is determined by the type of the male gamete (X or Y) that fuses with the female gamete.

Speciation- formation of new species

Causes of Evolution
Natural selection- a process that results in an increased survival and reproductive success of individuals that are well adjusted to the environment
Genetic drift- accidental change in the frequency of genes in a small population
Geographical isolation- Two sub-populations of the same species cannot interbreed because of the appearance of geographical barriers such as rivers, mountains etc.

Relationship between Evolution and Classification

- Evolution and classification is studies on the basis of characteristics.
- Characteristics are details of appearance or behaviour.

- Some basic characteristics will be shared by most organisms like cell is the basic unit of life in all organisms.
- The more characteristics two species will have in common, the more closely they are related.
- We can thus build up small groups of species with recent common ancestors, then super-groups of these groups with more distant common ancestors, and so on.
- Similarities among organisms will allow us to group them and then study the groups.
- Therefore, evolution and classification are interlinked.

Homologous organs:

The homologous organs are similar in form , but perform different functions in different organisms.

Analogous organs:

The organs that perform similar functions in different organisms of different origins are **analogous**.

What are fossils?

Fossils are the remains of organisms that once existed on Earth. They represent the ancestors of plants and animals.

Appearance of fossils

Fossils have the same shape as that of the original animal, but their colour and texture may vary widely. The colour of a fossil depends upon the type of minerals that form it.

The science dealing with the study of fossils is called Palaeontology.

Formation of Fossils

1. Organisms decay after their death, but the hard parts of the organisms are preserved.
2. When organisms die, they get buried under the sediments of sand .
3. Sediment deposition occurs and their hard parts absorb minerals.
4. Many years later, minerals replace their hard parts and convert them into fossils.
5. The sediments which cover the fossils get converted into sedimentary rocks.

Importance of Fossils

(i) They inform us about the types of living things that existed in the past.

(ii) They inform us about the extent to which living things have changed over time.

(iii) They inform us about the time when a particular life form existed.

Evolutionary line

We can organize animals in an evolutionary line on the basis of the following factors:

1. **Increasing complexity of organs:**

- **Evolution of the eye**

- Earlier, eye was present in the form of a simple patch of photosensitive cells called an eyespot.
- This eyespot modified into a structure called pit eyes which have the ability to discriminate between light and darkness.
- Insects have compound eyes, which are made of a thousand units.
- Human eyes are highly complex in structure and function.

- **Decreasing complexity of organs:**
- **Vestigial organs**- Such organs, which are present in a reduced form and do not play any role in the normal body functions, are known as vestigial organs**. For example, the nictitating membrane of the eye, vermiform appendix.**

Evolution and progress

Evolution cannot always be equated with progress.

Evolution simply creates more complex body designs, but the simple body designs are not inefficient. Bacteria, with a simple body design, are still the most widely found organisms on Earth.

Therefore, humans are only a branch of evolution and cannot be considered as the highest evolved species or culminating species.

- There is a great diversity of human forms and features across the planet.
- For a long time,people used to talk about human 'races'. Over recent years, it has been found that there is no
  biological basis to the notion of human races. All humans are a single species.
- We (*Homo sapiens)* all come from Africa
- A couple of hundred thousand years ago, some of our ancestors left Africa while others stayed
- the residents spread across Africa, the migrants slowly spread across the planet
- Like all other species on the planet, they had come into being as an accident of evolution while trying to live their lives the best they could.