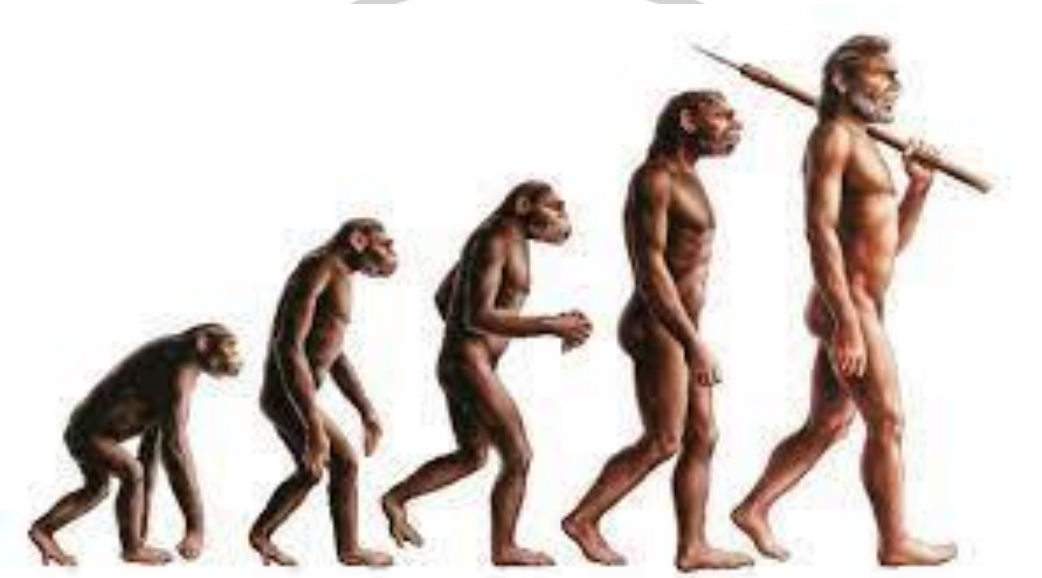
HEREDITY AND EVOLUTION



EDUMAX CLASSES

EDUCATION AT MAXIMUM

The study of heredity and variation is known as genetics. Heredity is defined as transmission of characteristics from parents to offspring's. The differences in characters of parents and offspring's is known as variation.

There are two types of variation- somatic variation and gametic variation.

Somatic variation occurs in the somatic cell of the body. They are not inherited or transmitted in the next generation. So, they are also known as acquired traits.

Gametic variation occurs in the germ cells of the body. They are inherited in the next generation. So, they are known as inherited traits. (NTSE)

Importance of variations

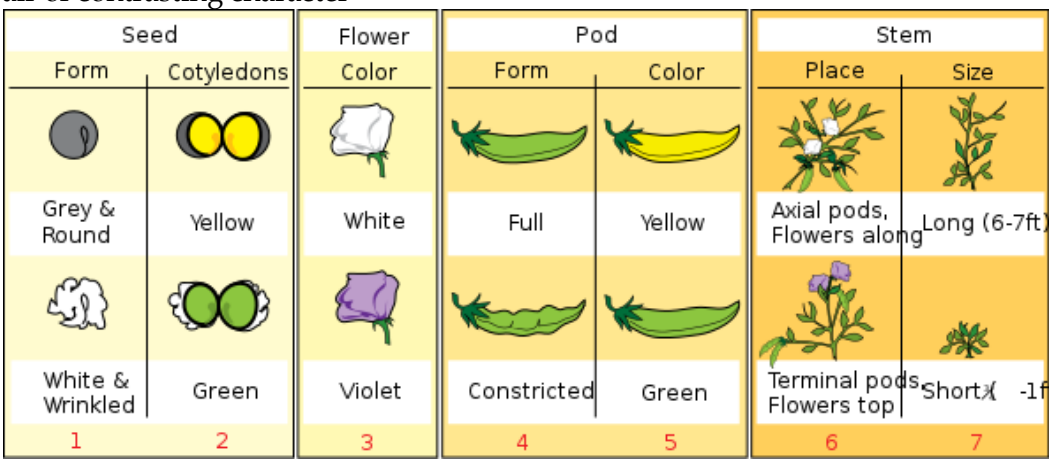
- It is the basis of the heredity.
- It is the basis of the evolution also.
- It increases the chances of the survival of the organism according to the changing environment.

Causes of variation

The most common causes of variations are mutation, recombination and random mating. Recombination or crossing over is one of the important reason for variation. It is a exchange of chromosome segment at the time of gamete formation.

Mendel and his contribution in Genetics

G.J. Mendel started his work on *Pisum sativum* (garden pea). He was known as Father of genetics. He had chosen seven pair of contrasting character-



(NTSE)

The reason of choosing garden pea for experiment was-

- Short life cycle
- Large number of seeds produced
- Self-pollination
- Several contrasting characters can be found (NTSE)

Mendel Laws

Law of Dominance: If the two alleles at a locus differ, then one, the **dominant allele**, determines the organism's appearance; the other, the **recessive allele**, has no noticeable effect on the organism's appearance.

Law of Segregation: The two alleles for a heritable character separate (segregate) during gamete formation and end up in different gametes.

Law of Independent Assortment: Each pair of alleles segregates independently of other pairs of alleles during gamete formation

Monohybrid Cross

When one pair of contrasting characters was taken to cross two pea plants, it is known as monohybrid cross.

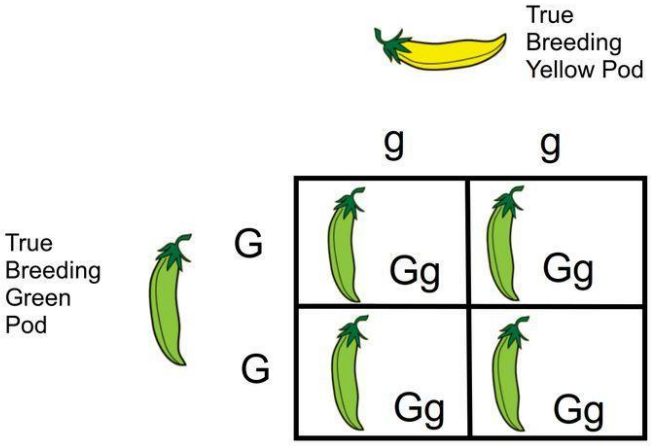


Fig.1. Monohybrid Cross

Fig.1. depicts the monohybrid cross between true breeding yellow pod and true breeding green pod. All the pods obtained was green in colour. The offspring's obtained are known as F1 progeny or First filial generation. In case of heterozygous condition,

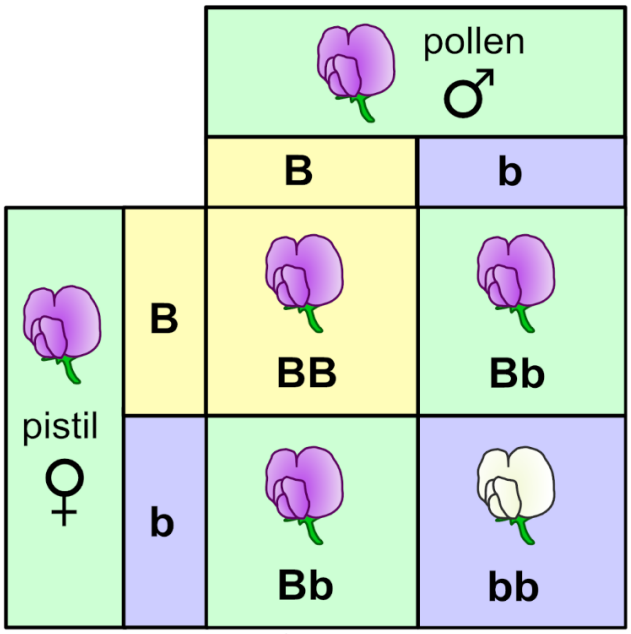


Fig.2. Monohybrid cross with heterozygous parents

In the above figure, the parents are heterozygous, so phenotypically 3 purple flower and 1 white flower was produced. But genotypically, 1 homozygous dominant (BB), 2 heterozygous dominant (Bb) and one homozygous recessive (bb).

Dihybrid Cross

When two pairs of contrasting characters are taken to cross two plants, it is known as dihybrid cross.

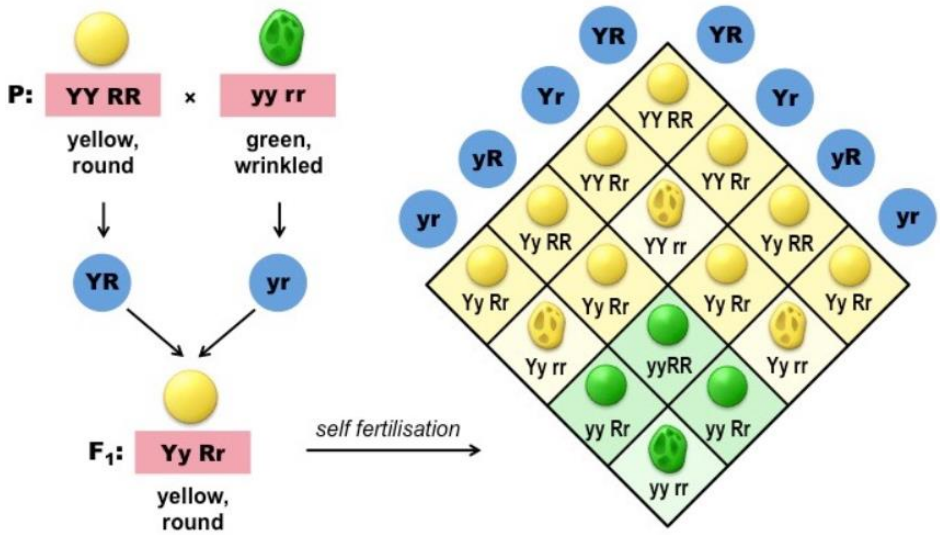


Fig.3. Dihybrid Cross

The phenotypic ratio was found to be 9:3:3:1

9 are round yellow

3 are round green

3 are wrinkled yellow

1 is wrinkled green

But the genotypic ratio was found to be 1:2:1: 2:4:2: 1:2:1.

Sex Determination

Sex determination is used to defined the sex of the offspring's. Environment and genetic factors determine the sex of the offspring's. Environment factor includes temperature such as gender in turtles are determined according to the temperature.

Types of Sex Determination

Different types of sex determination are- XX-XY type (humans), XX-XO type (insects), ZW-ZZ type (chicken) and ZO-ZZ type (moths and butterflies).

Genetic factors include the presence of sex chromosomes. For example, in humans, presence of two X chromosomes leads to female offspring whereas presence of one X and one Y chromosome forms male offspring's.

In human beings there are 23 pairs of chromosomes. Out of these 22 pair of chromosomes are known as autosomes whereas 23rd pair of chromosomes are known as sex chromosomes or allosomes. Sex of the offspring's is determined by the chromosome inherited from the father. (NTSE)

Evolution

The sequence of gradual changes that takes place in an organism over a million of years and leads to the formation of new species is known as evolution.

J.B. Lamarck was the first scientist who gave the theory on evolution. He gave the theory of inheritance of acquired characters. Later on, Charles Darwin came and gave the theory of natural selection or Darwinism. According to his theory, evolution occurs through natural selection.

1. Theory of Lamarckism

This theory is also known as "Theory of inheritance of acquired characters". Lamarckism is based on the following postulates-

1. Living organism tends to increase in size.
2. New needs lead to the formation of new organs.

3. Continued use of a particular organ makes it more developed and disuse of an organ leads to its degeneration.
4. New characters are acquired by individuals during their lifetime

2. Theory of Darwin

Darwin theory was also known as "Theory of Natural selection".

Postulates of Darwin theory

1. Speciation (formation of species) - Useful variations from generation to generation gives rise to the formation of new species.
2. Struggle of the existence Due to multiplication of organisms and limited food and space, there exists competition among the organisms.
3. Survival of the fittest or Natural selection Nature selects those characteristics or organisms that are useful and are best adapted to the prevailing conditions. "**For example**: Industrial melanism observed in peppered moth in Britain"

Speciation

Origin of new species from already existing species is known as speciation. Speciation can take place through-

a. **Gene flow** can lead to speciation. It is a transfer of genetic variation from one population to another
b. Random change in allele frequency known as **genetic drift** can also leads to speciation.
c. **Natural selection** is another reason through which speciation can take place
d. Geographical barriers such as mountains, rivers can also lead to speciation. This is known as **geographical isolation**.

Evolution and Classification

Evolution and classification are linked to each other. There are different evidences of evolution was given-

- **Homologous organs** are the organs evolved from the same ancestors but they have different functions. For example, forelimb of horse and wings of bat. Flipper of whale, human hand are other examples of homologous organs.

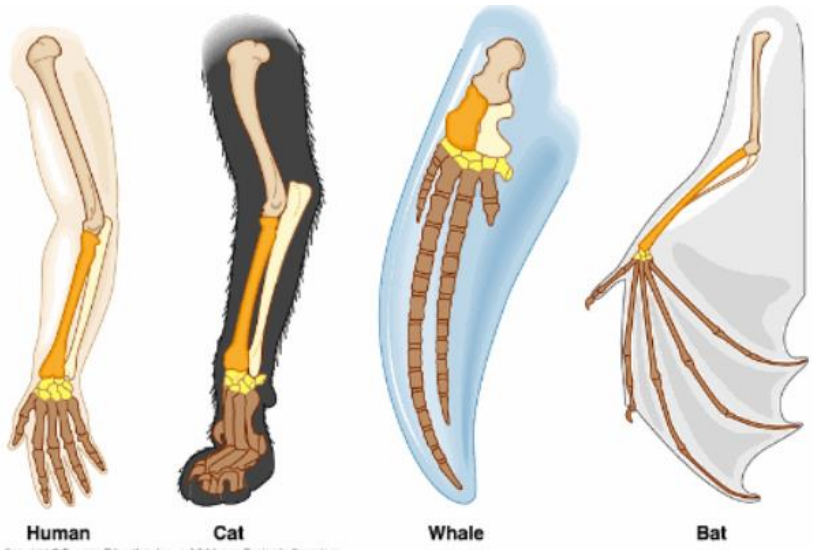


Fig.4. Examples of homologous organs

- **Analogous organs** are the organs arises from different ancestors but have same function. For example, wings of bats, wings of birds, wings of insects etc.

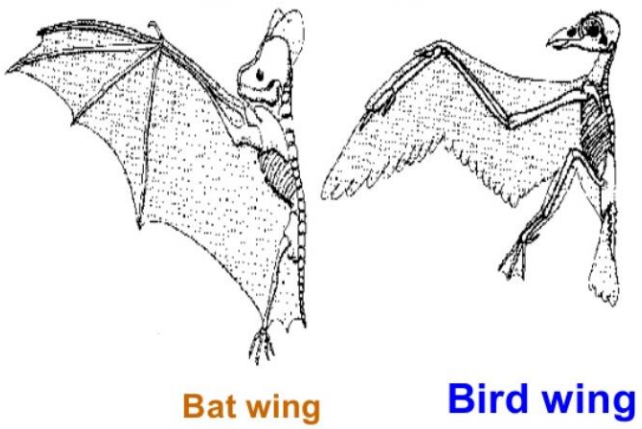


Fig.5. Examples of analogous organs

- **Paleontological (fossil) evidence** was also given for evolution. The dead remains of the organisms are known as fossils. For example, Archaeopteryx possess features of both reptiles and birds. This concludes birds evolved from reptiles. There are two methods for finding the age of the fossils- one is carbon dating and other is by digging. In digging method, the deeper the fossil is, the older it is. **Biogenetic law** states that stages of development of an animal embryo are same as adult animal stages.
- **Vestigial organs** are rudimentary in nature. They have lost their function through evolution. For example, appendix in humans, muscles of ears, wisdom tooth etc.

Evolution by Stages

Evolution can take place in stages also. For example, evolution of eyes. Flatworms have rudimentary eyes, whereas insects possess compound eyes. In the last humans have binocular vision.

Evolution of feathers is also an example of evolution by stages. For example, dinosaurs have feathers but unable to fly. But later on birds used feathers for flying.

Molecular Phylogeny

It is also an evidence for evolution. According to this, changes in DNA during reproduction are the basic events of evolution. Organisms which are related to each other most distantly, they will have greater differences in their DNA.

Evolution by artificial selection

Artificial selection selects special phenotypic characters to produce organism with enhanced characteristics. For example, plants which are disease or insect resistance. Artificial selection can be used to produce different cabbage varieties such as broccoli, cauliflower, red cabbage etc.

Human Evolution

Excavating, fossils, time dating and determination of DNA sequences are used to study human evolutionary relationships. Study of human evolution indicates that all of us belong to a single species that evolved in Africa and then spread across the world in stages.

Stages of human development are as follows-

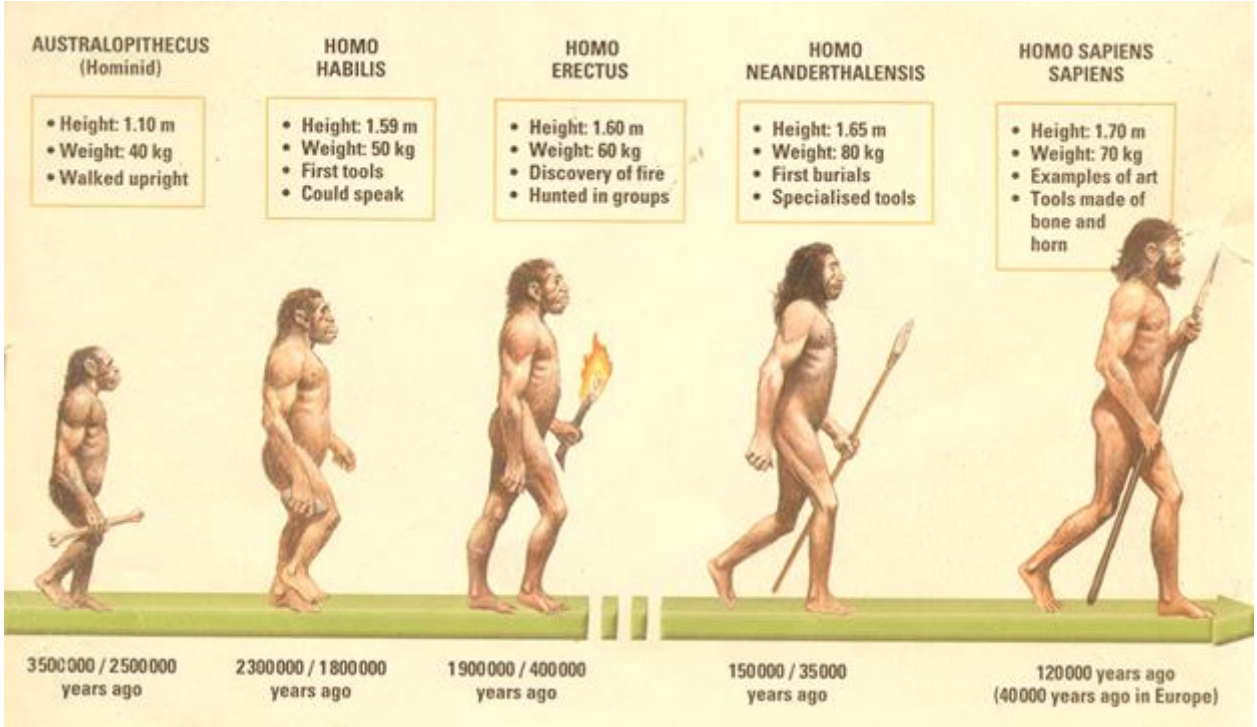


Fig. 6. Stages of human development