

HEREDITY & EVOLUTION

7 CHAPTER

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➤ INTRODUCTION

- Variation is the degree of difference found in morphological, physiological & other traits found among individuals belonging to the same family race & species.
- Most of the variation are due to mutations caused by error in DNA replication.

➤ ACCUMULATION OF VARIATIONS DURING REPRODUCTION

- Variation appear during reproduction whether organisms are multiplying asexually or sexually. Each generation provides the next generation with a common basic body design and some subtle changes or variations
- The variations accumulate and pass on to more and more individuals with each generation.
- The diversity is small in case of asexually reproducing organism as it is caused by only errors of DNA copying mechanism.

➤ SIGNIFICANCE OF VARIATIONS

Preadaptations :

- Some of the neutral variations function as preadaptation to changing environment. For example, heat wave may kill most bacteria except a few which have a pre-adaptation or variation to tolerate high temperature.

Evolution :

- Variations are raw materials for evolutionary processes. Picking up suitable variants by nature or environment forms the basis of evolution.

Struggle for Existence :

- Useful variation provide advantage to the individuals in the struggle for existence and hence survival in nature.

Individuality :

- Variations provide a distinct identity to each and every individual.

Artificial Selection :

- Picking up of certain variations by breeders have resulted in development of a number of breeds and varieties of domesticated plants and animals

➤ HEREDITY

Heredity (L. hereditas – heirship or inheritance) is the transmission of genetic characters from parents to offspring or one generation to the next

◆ **Inherited Traits :**

They are those traits which are controlled by genetic material of the individuals and are obtained from the parents in inheritance.

➤ MENDELISM

Mendel was a monk in Austria.

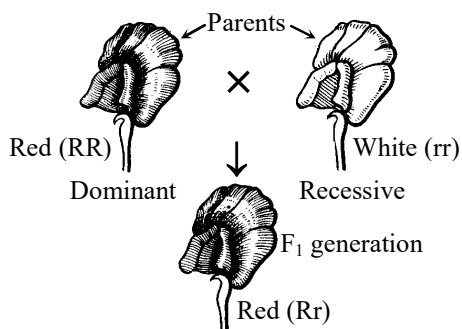
Mendel performed a number of experiments on the garden pea plants (***Pisum sativum***).

◆ **Mendel's Law :**

- The theoretical explanation of Mendel's results are now firmly established as Mendel's laws of inheritance. These are as follows :

◆ Mendel's law of Dominance :

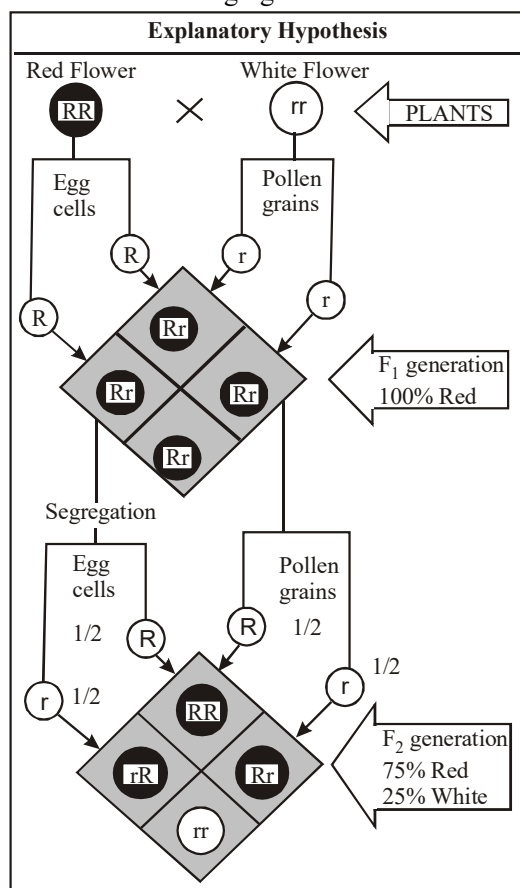
- According to this law, if a cross is made between plants with contrasting pair of characters, the character that appears in the first generation is dominant and the other is recessive.



Mendel's monohybrid cross between a homozygous red flowered (RR) and a homozygous white flowered (rr) plant to show that red colour is dominant over white (recessive)

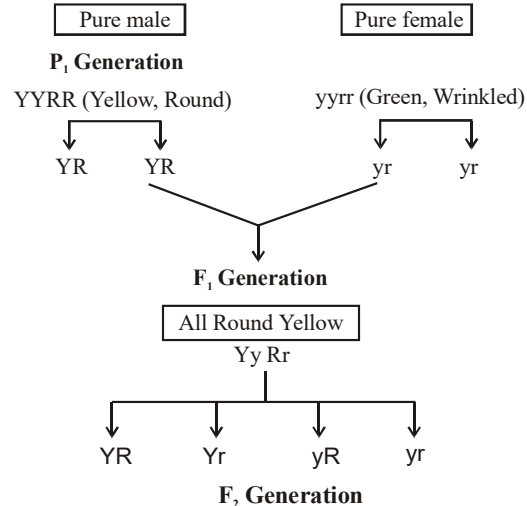
◆ Mendel's law of segregation (or law of purity of gametes) :

- Both parental alleles (i.e. dominant as well as recessive) segregate or separate and are expressed phenotypically in F₂ generation, and this is called Mendel's Law of segregation.



◆ Mendel's Law of Independent Assortment :

- Which states that most of the characters of parents can appear in any combination in their offsprings



♀ \ ♂	YR	Yr	yR	yr
YR	YYRR Round yellow	YYRr Round yellow	YyRR Round yellow	YyRr Round yellow
Yr	YYRr Round yellow	YYrr wrinkled yellow	YyRr Round yellow	Yyrr wrinkled yellow
yR	YyRR Round yellow	YyRr Round yellow	yyRR Round green	yyRr Round green
yr	YyRr Round yellow	Yyrr wrinkled yellow	yyRr Round green	yyrr wrinkled green

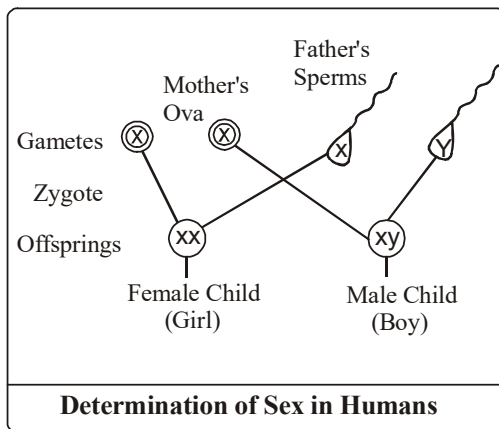
Fig: Result of Dihybrid cross between pea plants having round yellow seeds and wrinkled green seeds.

➤ SEX DETERMINATION

It is a process by which the sex of a person is determined. Genetics is involved in the determination of the sex of a person, which is explained as follows :

- A male has one X chromosome and one Y chromosome, i.e., half of the male gamete or sperms will have X chromosome and the other half will have Y chromosome.
- A female has two X chromosomes, i.e., all the female gametes or ova will have only X chromosomes.

- Sex of a child depends on what happens at fertilisation.
- If a sperm carrying **X** chromosome fertilises an ovum which carries **X** chromosome, then the **child born** will be a **girl**.
- If a sperm carrying **Y** chromosome fertilises an ovum which carries **X** chromosome, then the **child born** will be a **boy**.
- Thus, the sperm determines the sex of the child.
- Sex determination is also controlled by the environmental factors in some animals.
- For example, in some reptiles like **turtle**, high incubation temperature leads to the development of female offsprings, while in case of **lizard**, high incubation temperature results in male offsprings.



➤ EVOLUTION

Evolution (L.evolvere – to unfold) or organic evolution (Spencer, 1852) is the unfolding of nature wherein newer types of organisms develop from the pre-existing ones through modification.

◆ Acquired Traits :

Acquired traits are those variations which an individual develops during its life time due to effect of environmental factors, use and disuse of organs and conscious efforts.

Theory of Inheritance of Acquired Characters (Lamarckism). It is the first theory of evolution that was proposed by French biologist Jean Baptiste de Lamarck. It is based on the following

- **Internal Vital Force** : There is a vital force in organisms which tends to change them, generally making them larger and more complex.

- **Environment** : A change in environment brings about direct changes in plants. It produces new needs in animals.
- New needs (Doctrine of Desires), New need being about new desires that result in changes of older and formation of new organs.
- Use and Disuse of Organs, Repeated use of an organ makes it more complex and efficient. Non-use of an organ brings about its degeneration.
- Inheritance of Acquired Characters. The traits acquired by an individual during its life time are passed on to the next generation. After several generations the accumulation of changes results in the formation of new species.

◆ Inherited traits :

- Inherited traits are those characteristics which are passed from parents to their offspring, generation after generation because they are controlled by genes.
- There is also reshuffling of inherited variations during gametogenesis and fertilization.

➤ SPECIATION

It is the formation of new species from an existing one due to reproductive isolation of a section of its population.

Development of reproductive isolation is basic to formation of new species. This can occur by the following methods

◆ Physical Barrier :

- A physical barrier like valley, mountain, water body, etc. develop between two populations of a species.

◆ Two Ends of Long Range :

- Subpopulations at the two ends of a long range seldom interbreed.

◆ Mutations :

- A large mutation can make some members reproductively isolated from the rest.

◆ Genetic Drift (Wright Effect) :

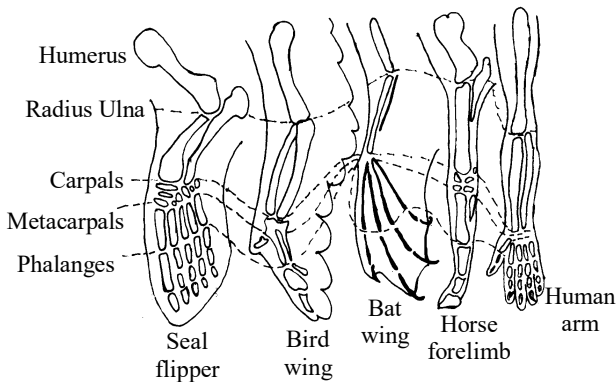
- It is random change in gene frequency that occurs in a small population due to fixation of certain alleles and elimination of others.



EVIDENCE OF EVOLUTION

Homologous Organs :

- These organs are similar in structure but dissimilar in functions.
- Homologous organs are found in forms showing adaptive radiation from a common ancestor so these give evidence of '**divergent evolution**'.
- Ex. forelimbs of mammals, bat's wing, a cat's paw.
- In plants homologous organs may be a thorn or a tendril as they arise in the axillary position. If homology is seen at the molecular level. This is called **molecular homology**.



Homology in Endoskeleton of Forelimbs of Some Vertebrates

Analogous Organs :

- These organs perform similar function but quite different in origin and development.
- Analogous organs are also called **homoplastic organs**.
- Analogous organs like wings of insects, birds and bats illustrate '**convergent evolution**'.
- Ex. - Wings of birds, wings of insects show the same function but their origin and development is different.

Vestigial Organs :

- Vestigial organs are useless organs found in the body. These are present in reduced form.
- Ex. wings of kiwi, limbs of snakes, the nictitating membrane of the eye, body hair and the muscles that move the ears.
- During the period of evolution vestigial organs have become functionless.

Fossil Evidences :

- Fossils are the remains of the organisms that found in the ancient period. We can determine fossil's age through the period of rock by radioactive material. Geological time scale is a chronological order of evolution history based upon the study of fossils.

- Study of fossils known as **palaeontology**.

Petrification :

- Hard parts are preserved in this type of fossil.

Archaeopteryx :

- A fossil bird shows both reptilian and avian features - It had wing like birds, thecodont dentition and tail like reptiles. Hence, Archaeopteryx is a connecting link between birds and reptiles.

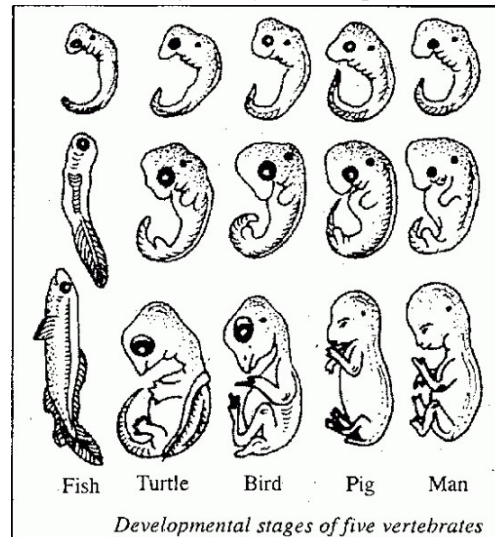
Connecting links :

Peripatus	Arthropods and annelids
Neopilina	Annelids and molluscs
Protopterus	Amphibians and fishes
Viruses	Living and nonliving
Euglena	Plants and animals
Platypus	Reptiles and Mammals

Embryological Evidences:

The study of embryo from various organisms reveals similarity in the early stages of embryo development & this theory suggests that these organisms have evolved from common ancestors.

Eg. Embryos of fish, turtle, bird, pig & man shows the similarity during embryo development.



EXERCISE # 1

A. Multiple Choice Type Questions

- Q.1** Mendel worked on -
(A) *Pisum* (B) *Solanum*
(C) *Lathyrus* (D) *Dolichos*
- Q.2** Father of genetics is -
(A) Morgan (B) Mendel
(C) Darwin (D) Hutchinson
- Q.3** A gamete contains -
(A) Two alleles of a gene
(B) One allele of a gene
(C) All alleles of a gene
(D) None of the above
- Q.4** A breeding experiment dealing with a single trait is called -
(A) Dihybrid (B) Monohybrid
(C) Monozygous (D) Heterozygous
- Q.5** Mendel noted as many pairs of contrasting traits in pea plants -
(A) 2 (B) 5 (C) 7 (D) 9
- Q.6** Which one is not a vestigial organ in man ?
(A) Vermiform appendix
(B) Epiglottis
(C) Muscles of ear pinna
(D) Nictitating membrane
- Q.7** The wings of bat, locust and pigeon are the example of -
(A) Homologous organs
(B) Analogous organs
(C) Vestigial organs
(D) Exoskeleton
- Q.8** Homologous structure are -
(A) Dissimilar in origin, similar in function
(B) Dissimilar in origin and function both
(C) Similar in origin and similar in function
(D) Similar in origin and dissimilar in function
- Q.9** Palaeontology is study of -
(A) Fossils (B) Bones
(C) Birds (D) Embryo
- Q.10** 'Descent with modification' is the central theme of -
(A) Recapitulation (B) Genetics
(C) Evolution (D) Biogenesis
- Q.11** The book "Origin of Species by Natural Selection" was written by -
(A) Oparin
(B) Wallace
(C) Darwin
(D) Darwin and Wallace
- Q.12** Sudden inheritable change is called -
(A) Recombination (B) Mutation
(C) Natural selection (D) Segregation
- Q.13** The ultimate source of variation is -
(A) Natural selection
(B) Mutation
(C) Sexual reproduction
(D) None of these
- Q.14** Inheritance of acquired characters was proposed by -
(A) Darwin (B) Lamarck
(C) Wallace (D) Oparin
- Q.15** Vestigial organs are -
(A) Primitive organs
(B) Preimordial organs
(C) Organs reduced due to disuse
(D) Organs marked only in embryonic stage

EXERCISE # 2

A. Very Short Answer Type Questions

- Q.1 Define inherited traits.
- Q.2 Give two examples of inherited traits.
- Q.3 Who is known as father of genetics ?
- Q.4 Name the plant on which Mendel performed his experiments.
- Q.5 How many characters did Mendel study ?
- Q.6 Which is dominant-Round or wrinkled seed shape ?
- Q.7 Define monohybrid cross.
- Q.8 Define dihybrid cross.
- Q.9 What is the literal meaning of the word 'evolution.'
- Q.10 What is organic evolution?
- Q.11 Mention two main causes of variation during reproduction.
- Q.12 Define genetic drift..
- Q.13 What are acquired characters ?

B. Short Answer Type Questions

- Q.14 Distinguish between homologous and analogous organs.
- Q.15 Explain the process of fossil formation.
- Q.16 What are inherited traits ? Give three examples.
- Q.17 Mention any three pairs of contrasting characters on which Mendel performed his experiments.
- Q.18 Explain in brief the procedure adopted by Mendel during his experimentation.
- Q.19 How is sex of the child determined in human beings ?
- Q.20 Explain how do the traits get expressed ?

- Q.21 Give two examples to explain that inheritance of acquired characters does not take place.

C. Long Answer Type Questions

- Q.22 Explain the role of natural selection and genetic drift in speciation.
- Q.23 Write a short note on fossils—an evidence for tracing evolutionary relationships.
- Q.24 Explain the dihybrid cross as performed by Mendel.
- Q.25 Explain the interpretations drawn by Mendel after his experiments on pea plant.
- Q.26 What are sex chromosomes ? Explain the process of sex determination in human beings.