SCIENCE

(Biology)

Chapter 9: Heredity and Evolution

Heredity and Evolution

Heredity and Variation

- Living organisms have certain recognisable heritable features such as height, complexion, colour of hair and eyes, shape of nose and chin etc. These are called **characters**.
- The alternative forms of a character are called **traits**. The inheritable characteristics or traits may be morphological, anatomical, physiological or reproductive.
- The transmission or passing of genetically based characters or traits from the parents to their offspring is called **heredity**.
- The occurrence of small differences or changes among the individuals of a species is called **variation**. Hereditary variations are of great importance in the process of **evolution** of a new species.
- Asexual reproduction results in a small amount of variation as compared to sexual reproduction.
- **Genes** are the specific parts of chromosomes or deoxyribonucleic acid (DNA) segments which determine hereditary characteristics.
- Every gene has two alternative forms for a character, each of which produces different effects in an organism. These alternative forms are called **alleles**. Example: In case of pea plants, the stem height is controlled by two alleles-one for tallness and the other for dwarfness.
- Of the two alleles of a gene, one is dominant, i.e. super ruling and the other is recessive, i.e. subordinate or submissive. A **dominant** allele is the allele which hides or masks the expression of its corresponding allele, which in turn becomes **recessive**.
- A contrasting pair of alleles constitutes an **allelomorph**.
- The genetic constitution of an organism is called its **genotype**. It is the description of genes present in an organism. The genotype of a tall plant could be TT or Tt, while that of a dwarf plant is tt.
- **Phenotype** refers to the observable characteristics or the expressed shown character of an organism. Example: Tall and dwarf are the phenotypes of a plant because these traits are visible to us.
- When two parents are crossed to produce progeny, their progeny is called the **first filial generation**
- or **F_1 generation**.
- When the first generation progeny or F_1 progeny is crossed amongst themselves to produce a second generation progeny, this progeny is called the **second filial generation** or **F_2 generation**.
- A new form of plant resulting from a cross of different varieties of a plant is known as a **hybrid**.

Types of Variations

Somatic Variation

- It takes place in the body cell.

- It is neither inherited nor transmitted.
- It is also known as acquired traits.
- Examples: cutting of tails in dogs, boring of pinna etc.

Gametic Variation

- Takes place in the gametes/Reproductive cells.
- Inherited as well as transmitted.
- Also known as inherited traits.
- Example: human height, skin colour.

Rules for Inheritance of Traits

Mendel's work

Gregor Johann Mendel, known as 'Father of Genetics', was an Austrian Monk who worked on pea plants to understand the concept of heredity.

His work laid the foundation of modern genetics.

He made three basic laws of inheritance - The Law of Dominance, The Law of Segregation and The Law of Independent Assortment.

Traits	Shape of seeds	Colour of seeds	Colour of pods	Shape of pods	Plant height	Position of flowers	Flower colour
Dominant trait	Round 	Yellow 	Green 	Full 	Tall 	At leaf junction 	Purple 
Recessive trait	Wrinkled 	Green 	Yellow 	Flat, constricted 	Short 	At tips of branches 	White 

Seven pairs of contrasting traits in pea plant

Monohybrid Inheritance:

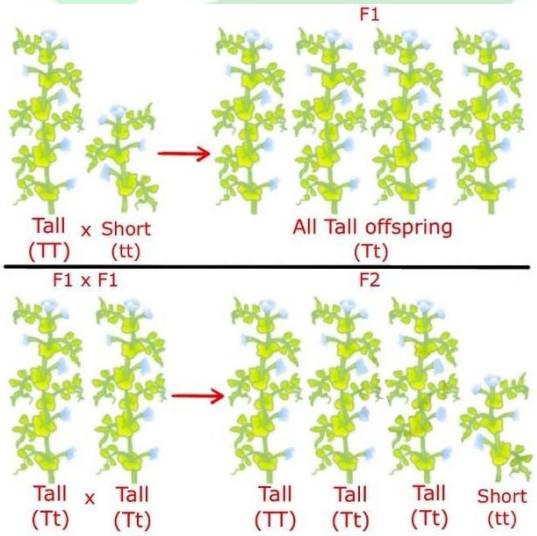
- A cross which involves only a single pair of contrasting characters is called a **monohybrid cross**. Example: A cross between a tall pea plant (TT) and a dwarf pea plant (tt).
- **Observations of Monohybrid Cross**

  (i) All F1 progeny were tall, no medium height plant. (Half way characteristic)

  (ii) F2 progeny ¼ were short, ¾ were tall.

  (iii) Phenotypic ratio F2 – 3 : 1 (3 tall : 1 short)

  Phenotypic ratio: 3 : 1

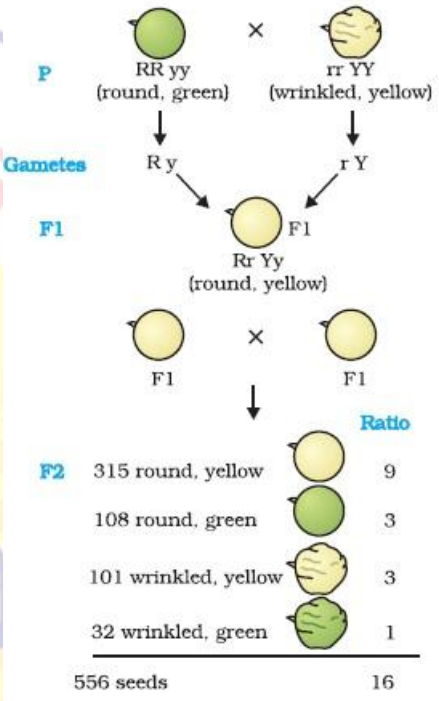


Genotypic ratio: 1 : 2 : 1

- The results of the monohybrid cross enabled Mendel to formulate his first law of inheritance, which is called the **law of segregation**. It states that- 'The characteristics or traits of an organism are determined by internal factors, which occur in pairs. Only one of a pair of such factors can be present in a single gamete'.

Dihybrid Inheritance

- A cross which involves plants with two pairs of contrasting characters is called a **dihybrid cross**. Example: A cross of pea plants having round and yellow seeds (RRYY) and plants with wrinkled and green seeds (rryy).



- **Observations**
  (i) When RRyy was crossed with rrYY in F1 generation all were Rr Yy round and yellow seeds.
  (ii) Self pollination of F1 plants gave parental phenotype and two mixtures (recombinants round yellow and wrinkled green) seeds plants in the ratio of 9 : 3 : 3 : 1.

  Phenotypic ratio: 9 : 3 : 3 : 1
  Genotypic ratio: 1 : 4 : 1 : 1 : 1 :2 : 2 : 2 : 2
- The results of the dihybrid cross enabled Mendel to formulate his second law of inheritance, which is called the **law of independent assortment**. It states that- 'In the inheritance of more than one pair of traits in a cross simultaneously, the factors responsible for each pair of traits are distributed independently to the gametes'.
- **DNA** (Deoxyribonucleic acid) is a highly complex molecule with a spirally coiled, double helical structure which appears like a ladder.

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 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 such a way. If the traits are to be inherited independently from both the parents, then they need to be present separately.

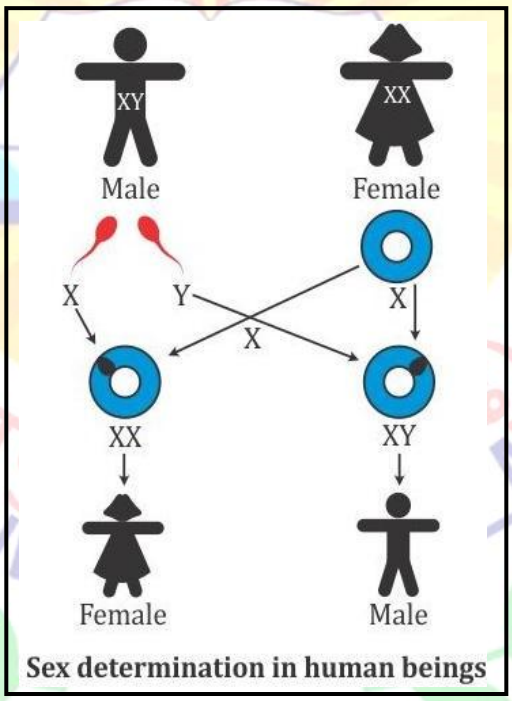
Therefore each gene set is present as separate independent pieces that are called as chromosomes, with each cell having two sets, one each from both the parents.

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.

Sex Determination

- The phenomenon or process which determines whether a developing embryo will be a male or a female is known as **sex determination**.
- In most organisms, **environmental** and **genetic** or **chromosomal** mechanisms are mainly responsible for the determination of sex of an individual.
- Humans have 22 pairs of **autosomes** and 1 pair of **sex chromosome**.
- **Females** have similar sex chromosomes **XX**, whereas **males** have a dissimilar pair, i.e. **XY**. All eggs carry the X chromosome, while sperms may either carry an X or a Y chromosome.
- The sex of a child depends on whether the egg fuses with the sperm carrying an X chromosome (resulting in a **female**) or with the sperm carrying a Y chromosome (resulting in a **male**).



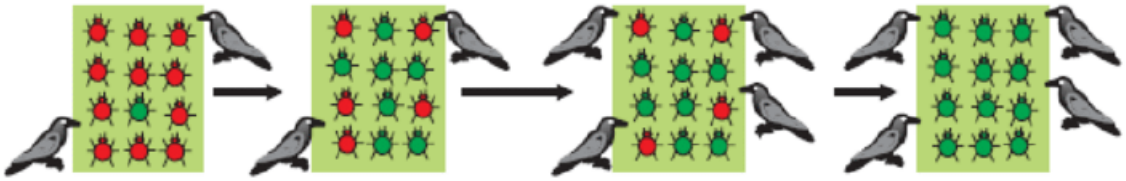
Sex determination in human beings

Evolution

- **Evolution** can be defined as the formation of more complex organisms from pre-existing simpler organisms over a certain period. It is a slow, but progressive, natural, sequential development or transformation of animals and plants from ancestors of different forms and functions.
- Variation and **heredity** are the two basic factors of evolution. The selection of variants by environmental factors forms the basis of evolutionary processes.

An Illustration

Situation I (Group of red and green beetles)(Colour variation arises during reproduction)



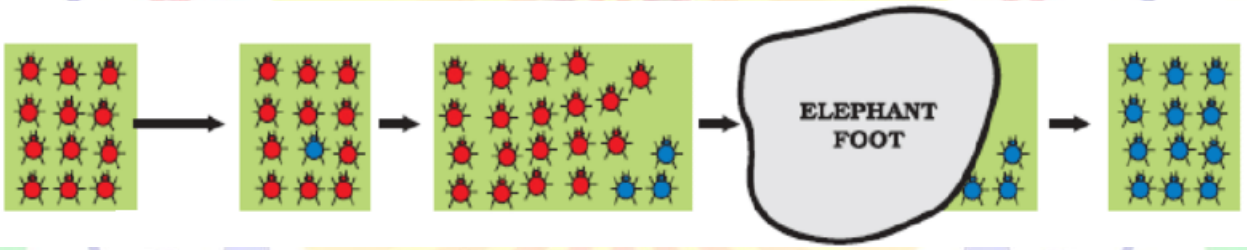
All beetles red except one that is green → Crows feed on red beetle → No. of beetles reduces

One beetle green → Progeny beetles green → Crows could not feed on green beetles as they got camouflaged (hide) in green bushes → Number of green bettles increases

Conclusion

- Green beetles got the survival advantage or they were naturally selected as they were not visible in green bushes.
- This natural selection is exerted by crows resulting in adaptations in the beetles to fit better in their environment.

Situation II (Group of red and blue beetles)

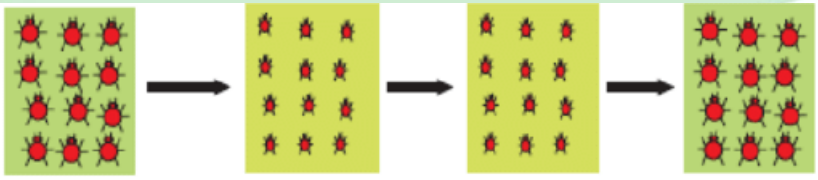


Reproduction in group of red beetles → All beetles are red except one that is blue → Number of red beetles increases as they reproduces → One blue beetle reproduces and no. of blue beetles also increases → Crows can see both blue and red beetles and can eat them → Number reduces but still red beetles are more and blue ones are few → Suddenly elephant comes and stamps on the bushes → Now beetles left are mostly blue

Conclusion

- Blue beetles did not get survivals advantage. Elephant suddenly caused major havoc in beetles population otherwise their number would have been considerably large.
- From this we can conclude that accidents can change the frequency of some genes even if they do not get survival advantage. This is called **genetic drift** and it leads to variation.

Situation III (Group of red beetles and Bushes)



Group of red beetles → Habitat of beetles (bushes) suffer from plant disease → Average weight of beetles decreases due to poor nourishment → Number of beetles kept on reducing → Later plant disease gets eliminated → Number and average weight of beetles increases again

Conclusion

No genetic change has occurred in the population of beetle. The population gets affected for a short duration only due to environmental changes.

Evidence for Evolution

A large amount of information has been collected over the last 200 years to support the theory of organic evolution. Such supporting information which helps us in accepting the theory is called **evidence**.

Morphological Evidence	• Morphological evidence of evolution reflects in the form of external features • or the appearance of an organism.
Anatomical Evidence	• Anatomical evidence of evolution is usually reflected in the form of structures, which appear quite similar in their organisation. • The similarities found in different groups of organisms indicate that these organisms must have had a common ancestor. • Different organisms have organs which perform a similar function. These organs which have a similar function but are different in structure and origin are called analogous organs. For example- tail fin of a lobster and flukes of a whale, wings of a fly and wings of a bird, eyes of arthropods and eyes of vertebrates, are all analogous organs. • There are some organs which are fundamentally similar in structure and origin but are modified to perform different functions in different organisms. They are called homologous organs. For example- forelimbs of man are adapted for handling, while forelimbs of bats and birds are adapted for flying, while those of whales and seals are adapted for swimming.
Vestigial Organs	• Organs which are found in a reduced or rudimentary condition and do not perform any function in the possessor are called vestigial organs or non- functional organs. For example- ear muscles, wisdom tooth, coccyx or reduced tail and plica semilunaris in man.
Study of Fossils	• Fossils are the preserved remains or traces of animals, plants and other organisms from the remote past. • The study of fossils is called palaeontology, which provides direct evidences in favour of organic evolution. • It helps us to compare the past with the present so as to establish the changes which have occurred in the course of evolution.
Embryological Evidence	• The study of development of an organism from the embryonic stage is called embryology. • The comparison of embryos states that in the course of development from the embryo to their adult form, animals go through stages which resemble or represent successive stages in the evolution of

	their remote ancestors.

Differences between Inherited and Acquired Traits

Inherited Traits	Acquired Traits
1. Characteristics inherited from the previous generation.	1. Characteristics which develop in response to the environment and cannot be inherited.
2. Occur due to a change in genes or DNA.	2. No change in genes or DNA is involved.
3. Pass on from one generation to another.	3. Cannot pass on from one generation to another.
4. Examples: Red curly hair, brown eyes	4. Examples: Cycling, swimming

Darwin's Theory of Evolution

- According to **Darwin's Theory of Natural Selection**, organisms produce more offspring than they need for their existence. They compete among themselves and fight with the environmental factors for their various needs in life. In the struggle for existence, those with favourable variations continue to exist and those with unfavourable variations die out. Thus, a new species is formed by natural selection.
- A **species** is a population of organisms consisting of similar individuals which can breed together and produce fertile offspring.
- The process by which a new species develops from the existing species is known as **speciation**.

Important Factors which Contribute to Speciation

Geographical isolation	•Leads to reproductive isolation due to which there is no flow of genes between separated groups of population.
Genetic drift	•Genetic drift with changes in the gene flow imposed by the isolation mechanism acts as an agent of speciation.
Natural selection	•Genetic variation within a population of organisms may cause some individuals to survive and reproduce more successfully than others.

Evolution and Classification

- The principles of classification help us trace the evolutionary relationships of the species

around us.

- In 1859, **Charles Darwin** first described this concept of evolution in his book ***The Origin of Species***.
- Certain groups of organisms have ancient body designs and are referred to as **primitive** or lower organisms. Some organisms have acquired their body designs relatively recently and are called **advanced** or higher organisms.
- There is a strong possibility that complexity within organisms increases with an increase in evolutionary time. Hence, we can say that older organisms are relatively simpler, while younger organisms are more complex.

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:

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.

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.

Fossils:

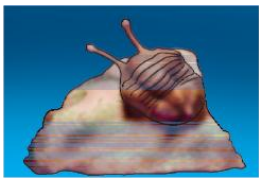
To study the evolutionary relationships, the current species as well as the species that are no longer in existence also needs to be considered.

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.


Fossil – tree trunk


Fossil – invertebrate (Ammonite)


Fossil – invertebrate (Trilobite)


Fossil – fish (Knightia)


Fossil – dinosaur skull (Rajasaurus)

There are two ways to determine the age or dating of the fossils.

- **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.
- **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.

Evolution by Stages

- The great variety of organisms existing on the Earth is due to changes which have occurred gradually in stages and have resulted in the evolution of a new species.
- The occurrence of different stages of evolution in a species is not because of a single DNA change.

Evolution of Eyes	• Primitive organisms which existed on the Earth were slow moving and small in size. They did not require a specialised organ for observing any object. • As evolution progressed, comparatively larger and mobile organisms evolved. Most of them were predators and required better vision for predation. • Hence, from the basic design of eyes, more complex forms evolved.
Evolution of Feathers	• Birds make use of their feathers for flying. • However, feathers did not evolve for flight. They evolved as a means of providing insulation to the body in cold weather.
Evolution by Artificial Selection	• Artificial selection is the process in which human preferences have a significant effect on the evolution of a particular species. • Humans cultivate wild cabbage as a source of food and have produced different varieties of it by artificial selection. Common vegetables such as cabbage, kale, broccoli, cauliflower and kohlrabi are descendents of wild cabbage. • Artificial selection has helped in creating diversity in plants and animals.

Evolution Should Not Be Equated with Progress

- Evolution has resulted in the generation of new varieties of species. It results in the production of diverse life forms subjected to environmental selection. The only progress which has occurred due to evolution is the emergence of more complex body designs of organisms.
- When we consider the evolutionary history of man, we often say that human beings evolved from chimpanzees. However, this is not the case. In fact, both **chimpanzees** and **human beings** had a common ancestor a long time ago. The two offspring of that common ancestor evolved differently to form the modern day chimpanzees and human beings.

Human Evolution

- Human evolution has been studied using various tools of tracing evolutionary relationships such as excavating, carbon-dating, studying fossils and determining DNA sequences.
- Research reveals that the early members of *Homo sapiens* came from Africa. About hundred years ago, some of our ancestors left Africa, while others stayed back. So irrespective of where we live, all human species are natives of Africa. The earliest fossils of human beings include the genus ***Australopithecus***, followed by ***Homo habilis***, ***Homo erectus***, ***Homo heidelbergensis*** and finally modern day man ***Homo sapiens***.

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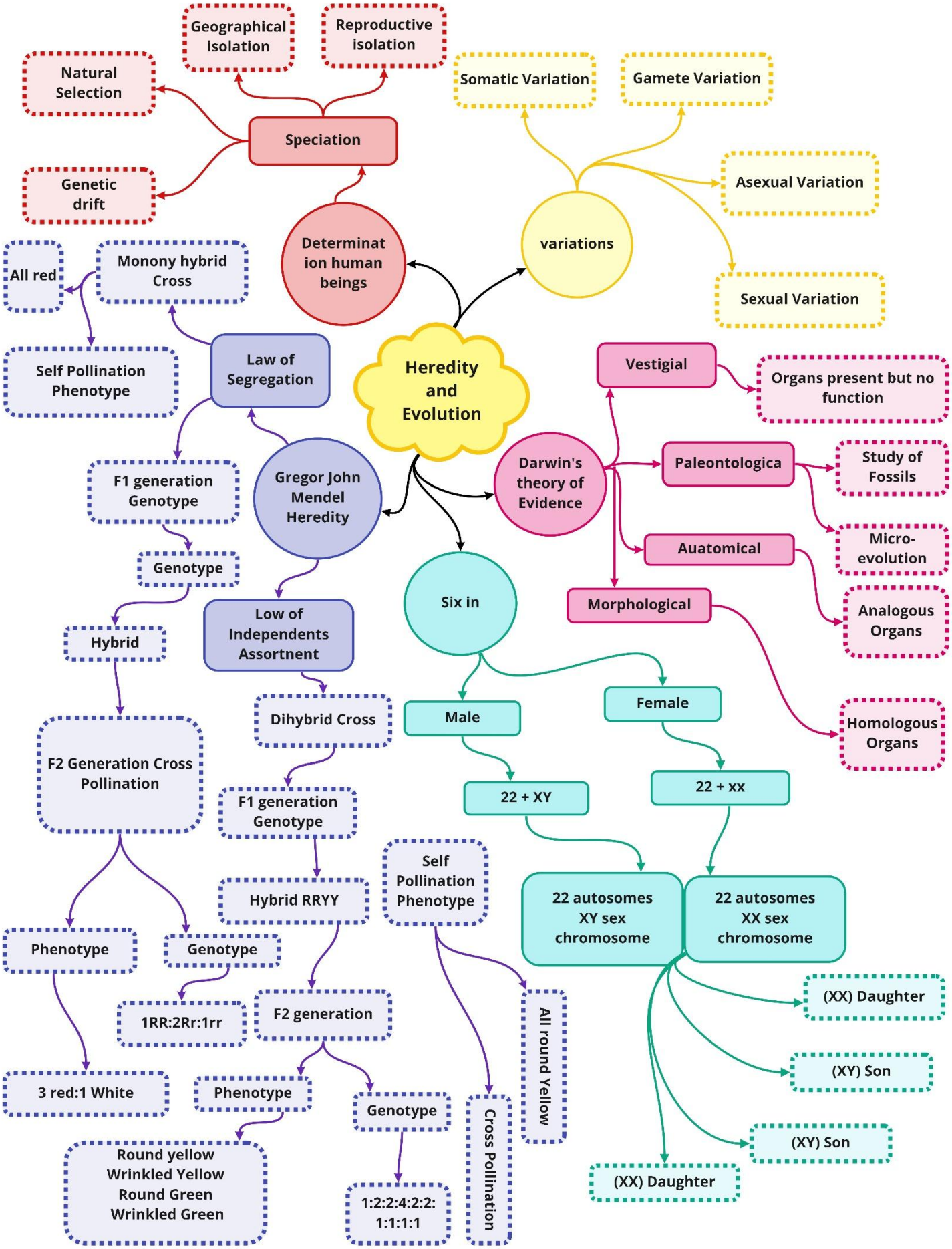
Chapter - 9 Heredity and Evolution



Important Questions

➢ Multiple Choice Questions:

1. Human offspring's sex is determined

(a) through father's sex chromosomes.
(b) through mother's sex chromosomes.
(c) by hormones.
(d) by enzymes.

2. Wing of a bird and wing of an insect are

(a) Homologous organs
(b) analogous organs
(c) vestigial organ
(d) both (a) and (b)

3. Which concept was not included in Charles Darwin's theory of Natural Selection?

(a) Struggle for existence
(b) Punctuated equilibrium
(c) Survival of the fittest
(d) Overproduction of offspring.

4. The remaps (or impressions) of dead animals or plant? that lived in the remote past are known as

(a) extinct species
(b) fossils
(c) naturally selected species
(d) none of the above

5. Natural selection is called 'survival of the fittest'. Which of the following statements best describes an organism?

(a) How strong it is compared to other individuals of the same species.
(b) How much food and resources it is able to gather for its offspring.
(c) The ability to adapt to the environment in the niche it occupies.
(d) The number of fertile offspring it has.

6. The process by which new species develop from the existing species is known as

(a) Evolution
(b) Natural selection
(c) Artificial selection
(d) Speciation

7. The more characteristics two species have in common :

(a) More closely they are related and more recently they had a common ancestors.
(b) More distantly they are related and more recently they have common ancestors.
(c) More closely they are related and more distantly they have common ancestors.

(d) More distantly they are related and more distantly they have common ancestors.

8. A cross between two individuals results in a ratio of 9 : 3 : 3 : 1 for four possible phenotypes of progeny. This is an example of a

(a) Monohybrid cross
(b) Dihybrid cross
(c) Test cross
(d) F1 generation

9. Two pink colored flowers on crossing results in 1 red, 2 pink and 1 white flower progeny. The nature of the cross is:

(a) cross fertilization
(b) self-pollination
(c) double fertilization
(d) no fertilization

10. Differences between organisms in a species are described as variation. Which of the following would you describe as continuous variation?

(a) Hair colour
(b) Eye colour
(c) Weight
(d) Sex

➢ Very Short Question:

1. Who proposed the theory of inheritance of acquired characters?

2. Give an example of a vestigial organ present in human body.

3. Who proposed the theory of natural selection?

4. In terms of evolution, what is the significance of homology between a human hand and a wing of a bird?

5. Name the scientist who established the laws of inheritance.

6. Define inheritance.

7. What is the function of genes in an organism?

8. What is gene?

9. What is speciation?

10. List any two factors that could lead to speciation.

➢ Short Questions:

1. What are fossils? How do they tell us about process of evolution?

2. Describe briefly four ways in which individuals with a particular trait may increase in population.

3. “Variations that confer an advantage to an individual organism only will survive in

a population." Justify.

4. "The sex of the children are determined by what they inherit from their father and not the mother." Justify.

5. Give one example of each of the characters that are inherited and the ones that are acquired in humans.

Mention the difference between the inherited and the acquired characters.

6.

(a) Write foil form of DNA.

(b) Why are variations essential for the species ? (CCE 2011)

7. How do sexual and asexual reproduction lead to speciation? Give one point for each.

8. List four tools used to study evolutionary relationships.

➢ Long Questions:

1.

- What is genetics?
- Give the common name of the plant on which Mendel performed his experiments.
- What for did Mendel use the term factors and what are these factors called now?
- What are genes? Where are the genes located?

2.

- What are chromosomes? Where are they seated?
- What is a sex chromosome?
- Explain the mechanism of sex determination in human beings.

3.

(a) What is geographical isolation?

(b) Illustrate formation of a species with the help of an example where individuals are very different from each other and are capable of reproduction among themselves.

➢ Assertion Reason Questions

1. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
   a. Both A and R are true, and R is correct explanation of the assertion.
   b. Both A and R are true, but R is not the correct explanation of the assertion.

c. A is true but R is false.

d. A is false but R is true.

Assertion: In grasshoppers, females are hetero gametic and males are homo gametic.

Reason: In grasshoppers, male has only one sex chromosome (XO) whereas the female has sex chromosomes (XX).

2. For two statements are given- one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

   a. Both A and R are true, and R is correct explanation of the assertion.

   b. Both A and R are true, but R is not the correct explanation of the assertion.

   c. A is true but R is false.

   d. A is false but R is true.

Assertion: A child which has inherited X chromosome from father will develop into a girl child.

Reason: Girl child inherits X chromosome from father and Y chromosome from mother.

➢ Case Study Questions:

1. Read the following and answer any four questions from (i) to (v).

   Sex determination is the method by which distinction between males and females is established in a species. The sex of an individual is determined by specific chromosomes. These chromosomes are called sex chromosomes or allosomes. X and Y chromosomes are called sex chromosomes. The normal chromosomes other than the sex chromosomes of an individual are known as autosomes.

   i. In XX-XO type of sex determination:

      a. Females produce two different types of gametes.

      b. Males produce two different types of gametes.

      c. Females produce gametes with Y chromosome.

      d. Males produce gametes with Y chromosome.

   ii. A couple has six daughters. What is the possibility of their having a girl next time?

      a. 10%

      b. 50%

      c. 90%

      d. 100%

   iii. Number of autosomes present in liver cells of a human female is:

      a. 22 autosomes.

      b. 22 pairs.

c. 23 autosomes.

d. 23 pairs.

iv. XX-XO type of sex determination and XX-XY type of sex determination are the examples of:

a. Male heterogamety.

b. Female heterogamety.

c. Male homogamety.

d. Both (b) and (c).

v. Select the incorrect statement.

a. In male grasshoppers, 50% of sperms have no sex chromosome.

b. Female fruit fly is heterogametic.

c. Human male produces two types of sperms 50% having X chromosome and 50% having Y chromosomes.

d. In turtle, sex determination is regulated by environmental factors.

2. Read the following and answer any four questions from (i) to (v).

In human, the allele for brown eyes (B) is dominant over that for blue eyes (b). A brown eyed woman marries a blue-eyed man, and they have six children. Four of the children are brown eyed and two of them are blue eyed.

i. What is the genotype of blue-eyed offspring?

a. BB

b. Bb

c. bb

d. Cannot be determined.

ii. What is the woman's genotype?

a. BB

b. Bb

c. bb

d. Cannot be determined.

iii. The ovum, produced by the mother carries the gene regarding eye colour is:

a. BB

b. Bb

c. B or b

d. B only.

iv. The ratio of brown eyed children to blue eyed children in this family is 2 : I, which deviates from typical phenotypic ratios for monohybrid inheritance. What might be the reason?

a. Gametes carrying the brown eyed allele are more viable than those with the blue-eyed allele.

b. A different pattern of inheritance other than monohybrid inheritance is involved.

c. Not all of their babies survived childbirth, thus causing a distortion in the actual ratio.

d. The actual ratio differs from the expected ratio because the sample size is too small.

v. What is the gene carried by of the man's spenn regarding the eye colour?

a. BB

b. Bb

c. b only

d. b or B.

✓ Answer Key-

➢ Multiple Choice Answers:

1. (a) through father's sex chromosomes.
2. (a) Homologous organs
3. (b) Punctuated equilibrium
4. (b) fossils
5. (c) The ability to adapt to the environment in the niche it occupies.
6. (d) Speciation
7. (a) More closely they are related and more recently they had a common ancestor.
8. (b) Dihybrid cross
9. (a) cross fertilization
10. (c) Weight

➢ Very Short Answers:

1. Answer: Jean Baptiste Lamarck (1809).
2. Answer: Vermiform appendix.
3. Answer: Charles Darwin (1859) proposed the theory of natural selection.
4. Answer: Homology indicates that there is common ancestry between a human

hand and a wing of a bird. They have the same fundamental structure but are different in external morphology and functions.

5. Answer: Gregor Johann Mendel.
6. Answer: The transmission of characters from parents to offspring is known as inheritance.
7. Answer: Genes are the carrier of the genetic information for body functions and passage from one generation to another.
8. Answer: Gene is a unit of inheritance which consists of a linear segment of chromosome or DNA that takes part in expressing a particular character.
9. Answer: Speciation: It is the formation of newer species from the pre-existing ones due to accumulation of variations through various processes like isolation, stoppage of gene flow, genetic drift, and natural selection that lead to inability to interbreed.
10. Answer: It is the formation of newer species from the pre-existing ones due to accumulation of variations through various processes like isolation, stoppage of gene flow, genetic drift, and natural selection that lead to inability to interbreed.

➢ Short Answer:

1. Answer: Fossils: They are remains or impressions of past organisms that lie hurried in the rocks and other structures belonging to various ages.

   Fossils Indicate Evolution

   - Different types of organisms appeared in different ages. Many of them have later on disappeared. Some gave rise to other organisms while a few are persisting even now.
   - Early forms were simple. Most of the later forms became more and more complex.
   - Fossils of different ages indicates the path of evolution,

   e.g., fishes → amphibians → reptiles → Birds / Mammals

   - Some fossils have characteristics intermediate between two groups, e.g., Archaeopteryx between reptiles and birds. They indicate the path of evolution.
   - Phylogeny of some organisms has been worked out with the help of fossils e.g., Horse.

2. Answer:

   The individuals with a particular trait will increase in number if the trait provides:

   More Food: The trait helps in obtaining more food that leads to increased growth and reproduction.

Useful Variations: The trait helps the individuals to adapt to environment and achieve greater success in struggle for existence.

Genetic Drift: It causes genetic fixation of a trait which, therefore, occurs, in whole of the progeny.

Differential Reproduction: The trait gives extra benefit to the individuals in survival and reproduction.

3. Answer: Useful variations give advantage to individuals in obtaining more food, adaptation to environmental changes and higher success in the struggle for existence. They give benefit in survival and reproduction. Differential reproduction increases the useful variations in the populations. Other individuals with harmful variations will be eliminated. For example, some bacteria have ability to tolerate high temperature. In warm environment non-tolerant bacteria will be killed. Others with tolerance to high temperature will survive and multiply.

4. Answer: Ovum produced by would-be-mother is always of one type (22 + X). Sperms produced by would-be father are of two types, gynosperms (22 + X) and androsperms (22 + Y). If gynosperm (22 + X) fertilizes the ovum (22 + X), the sex of the child will be female (44 + XX). If androsperms (22 + Y) fuses with the ovum (22 + X), the child born will be boy (44 + XY). Therefore, only father is responsible for the sex of the children.

5. Answer:

   Inherited Trait: Fused and Free ear lobes.

   Acquired Trait: Muscular body of a wrestler.

   Difference: Acquired trait develops during the life time of an individual which affects somatic parts and dies with the death of the individual. Inherited trait is obtained from the parents, influences genes or germ cells and is passed on to the next generation.

6. Answer:

   (a) DNA. Deoxyribose nucleic acid.

   (b) Many of the variations have no immediate benefit to the species. They function as preadaptation's which can be beneficial under certain environmental conditions like heat tolerance variation if the temperature of the area rises.

7. Answer:

   Sexual reproduction produces a lot of variations due to reshuffling of chromosomes and crossing over.

   Variations help in natural selection and speciation.

   Asexual reproduction also develops variations occasionally due to errors in DNA replication. These variations help in natural selection and speciation.

8. Answer:

Study of fundamental and correlated characters.

Study of homologous organs.

Study of fossil ancestors.

Molecular phylogeny.

➢ Long Answer:

1. Answer:

- Genetics: It is the branch of biology that deals with the study of heredity and variations.
- Garden or Edible Pea.
- Factors: They are particulate inheritable entities which control the expression of traits of a character, e.g, T for tallness, t for dwarfness. The factors are now called genes.
- Genes: They are units of inheritance that take part in expression of particular characters. Genes are located over the chromosomes as linear segments.

2. Answer:

- In case of asexually reproducing organisms, there is no gametogenesis and fertilization. Chance separation and chance pairing of genes and their chromosomes are absent. Therefore, asexually developed individual carries the same genes and their chromosomes as are present in its parent.
- Allosomes (Gk. alios— other, soma—boay) or sex chromosomes are those chromosomes which determine the sex of the individual in unisexual organisms. Human beings have 23 pairs of chromosomes.
- Establishment of male and female individuals through differential development of their sex organs is called sex determination. In some organisms sex is determined by environmental conditions. In others including human beings, it is determined genetically.

Environmental Determination of Sex:

- Crepidula (marine mollusc) and Bonellia (marine worm) develop into females if growing alone. In the company of a female, they develop into males.
- In turtle, Chrysema picta an incubation temperature above 33°C produces females while a temperature below 28°C produces only males.
- In lizard, Agama agama, high incubation temperature produces male offspring.
- Annelid Ophryotrocha is male in young state and female later on. Snails are also known to change sex.

3. Answer:

(a) Geographical Isolation. Prevention of mating between breeding groups due to geographical or physical barriers (e.g., Valley, Mountain, Water body) is called geographical isolation. The isolated populations develop different variations and changes in physiology and behaviour to form new species.

(b) Over 160 breeds of dogs have come up due to selective breeding and artificial selection. Similarly, there are about 800 breeds of cattle. They differ in size, height, features, behaviour, colour and other traits. However, all dogs belong to one species of Canis familiaris while all cattle belong to one species of Bos indiens. Despite their structural and behaviour differences all the breeds belonging to the same species can interbreed and produce fertile offspring. However, if interbreeding is prevented by spatial isolation these different breeds can develop reproductive isolation and form new species, e.g., Porto Santo rabbits, Galapogos finches.

➢ Assertion Reason Answer:

1. (d) A is false but R is true.

Explanation:

In grasshoppers, the male has only one sex chromosome (XO) whereas the female has two sex chromosomes i.e., homo gametic. This type of sex determination mechanism is called XX-XO mechanism.

2. (c) A is true but R is false.

Explanation:

Father produces two types of sperms, one with X and one with Y chromosome, whereas mother produces all egg with X chromosome. Zygote that inherits X chromosome from father has XX chromosomes and develops into baby girl, whereas zygote which inherits Y chromosome from father has XY chromosomes and develops into baby boy.

➢ Case Study Answer:

1. i (b) Males produce two different types of gametes.

Explanation:

In XX-XO type and XX-XY type of sex determining mechanisms, males produce two different types of gametes, either with or without X-chromosome (XO type), or some gametes with X-chromosome and some with Y-chromosome (XY type). Such type of sex determination mechanism is designated to be the example of male heterogamety. In both, females are homogametic and produce X type of gametes in both the cases and have XX genotype.

ii. (b) 50%

Explanation:

The possibility of having a girl or boy child is equal i.e., 50%, as 50% male gametes are Y type and 50% are X type. Fusion of egg with X type sperm will produce a girl child.

iii. (b) 22 pairs.

Explanation:

In humans, number of autosomes are 2n = 44 or 22 pairs regardless of the sex.

iv. (a) Male heterogamety.

v. (b) Female fruitfly is heterogametic.

Explanation:

Male fruitflyis heterogametic whereas female fruitfly is homogametic.

2. i (c) bb

ii. (b) Bb

Explanation:

According to the given passage some children show recessive trait, i.e., homozygous. So, the woman must be heterozygous.

iii. (c) B or b

Explanation:

Human ova are haploid; hence they only contain one copy of each gene. Since the woman has a Bb genotype her ova would contain either B orb allele.

iv. (d) The actual ratio differs from the expected ratio because the sample size is too small.

Explanation:

According to the given passage, within a single family, the sample size of offspring in each generation is very small. Hence, the actual phenotypic and genotypic ratios often deviate from expected ratios. It is only when sample sizes of offspring is large that actual ratios approach theoretical or expected ratios more closely.

v. (c) b only

Explanation:

Human sperm is haploid; hence they only contain one copy of each gene. Since the man has a bb genotype, his sperm would contain allele b only.