9 HEREDITY AND EVOLUTION

BASIC CONCEPTS – A FLOW CHART

HEREDITY

Transmission of characters (or traits) from the parents to their offsprings.

Variations

- Differences in the characters (or traits) among the individuals of a species.
- It helps in adaptation of organisms to the changing environment.

Inherited Traits

Traits and characteristics are reliably inherited to next generation to provide a common basic body design.

Rules for Inheritance of Traits

- Gregor Johann Mendel first studied inheritance of characters.
- He did his study on pea plant.

Monohybrid Cross

- He concluded:
  - —Characters were controlled by factors or genes which occur in pairs (alleles)
  - —When two different alleles are present together, the dominant one is expressed.
  - —Alleles segregated so that each gamete gets only one of the alleles.

Dihybrid Cross

- He concluded:
  - —Pairs of contrasting characters behave independently of the other pairs.
  - —At the time of gamete formation all genes assort independently of each other.

How are Traits Expressed

- Cellular DNA is the information source for making proteins in the cell.
- A section of DNA that provides information for one protein is called the gene for that protein.
- Each gene set is present as separate independent pieces called chromosomes.
- Each cell has two copies of each chromosome, one each from male and female parents.
- Every germ cell takes one pair from each pair.
- When two germ cells combine, the normal number of chromosomes is restored.

Sex Determination

- Process by which the sex of a person is determined.
- The female has two X-chromosomes (XX) in the germ cell or egg and the male has one X-chromosome and one Y-chromosome (XY) in the germ cell or sperm.
- When a sperm bearing X-chromosome unites with egg or ovum, female (XX) child is born.
- When a sperm bearing Y-chromosome unites with ovum, male (XY) child is born.

Evolution

- A gradual genetic change in a group of living being to produce new forms (organic evolution).
- Reasons:

  (i) Natural Selection: A group of living beings adopts to fit their environment better.

  (ii) Genetic Drift: Provides diversity without any adaptations. There is a random change in gene frequency.

Development of new species

Factors Resulting in Evolution

Acquired Traits

- Characteristics of an organism that are not inherited but develop in response to the environment.

Inherited Traits

- Characteristics of an organism that are caused by a change in the DNA and are inherited.

Speciation

- Origin of new species from the existing one
- Mechanisms of speciation:
  - —Accumulation of variation
  - —Physical barriers
  - —Genetic drift
  - —Natural selection
  - —Migration

Evidences for Evolution

1. *Homologous organs:* Organs having same basic structure but different functions.
2. *Analogous organs:* Organs having different basic structure but similar appearance and functions
3. *Fossils:* Remains or impressions of dead animals or plants that lived in the remote past are known as fossils. The age of fossils can be estimated by two ways:
   (i) If we dig into the earth and start finding fossils, it can be assumed that the fossils closer to the surface are more recent to those found in deeper layers.
   (ii)By detecting the ratios of different isotopes of the same element in the fossil material.

MORE POINTS TO REMEMBER

- **Sexually reproducing** individuals have two copies of genes for the same trait. If the copies are not identical, the trait that gets expressed is called the dominant trait and the other is called the recessive trait.
- **Variations** in the species may confer survival advantages or merely contribute to the genetic drift.
- **Allele:** Alleles are alternate forms of a gene. Different alleles of a gene give rise to different expressions of a character. Hence, alleles for 'green' and 'yellow' are alternative expressions of a gene governing the characteristics for seed colour.
- **Organic evolution:** All the existing complex plants and animals are developed from simple ancient plants and animals.
  - According to **Lamarck,** new organ develops in an organism due to its special needs. Its continuous use develop the organ and its disuse makes it extinct. This acquired character is inherited to its offsprings, *e.g.,* neck of a giraffe. Thus, new race or species were developed. Present horses also developed similarly.
  - **Darwin's** evolution theory is based on natural selection.
  - Mutation refers to the sudden change in the genetic material (chromosomes) of an organism/ individual and their inheritance to the next generation, resulting in a new species.
  - **Isolation** of groups of same animals by physical barriers or reproductive barrier developed new species.
- **Evolution** cannot be said to 'progress' from 'lower' forms to 'higher' forms. Rather, evolution seems to have given rise to more complex body designs even while the simpler body designs continue to flourish.
- **Human evolution:** The study of human evolution indicates that all of us belong to a single species that evolved in Africa. The earliest members of the human species, *Homo sapiens* can be traced there.
  - (*i*) Determining DNA sequences that have been used for studying human evolution.
  - (*ii*) Due to the diversified human forms and features, skin colour is the most common way for identifying the races.
  - (*iii*) All human beings (white, black, yellow or brown) are a single species called *Homo sapiens*.
  - (*iv*) In other words, our genetic footprints can be traced that indicate we have African roots.
  - (*v*) A couple of hundred thousand years ago, some of our ancestors left Africa while others stayed on.
  - (*vi*) The residents spread across Africa and the migrants spread across the planet from Africa to West Asia, Central Asia, Eurasia, South Asia, East Asia, Indonesia, Philippines, Australia and America.
  - (*vii*) They went forward and backward with groups sometimes separating from each other or sometimes coming together.
  - (*viii*) Like all other species on the planet, they had come into being as an accident of evolution, and were trying to live their lives the best way they could.

NCERT Intext Questions

Q. 1. If a trait A exists in 10% of a population of an asexually reproducing species and a trait B exists in 60% of the same population, which trait is likely to have arisen earlier?

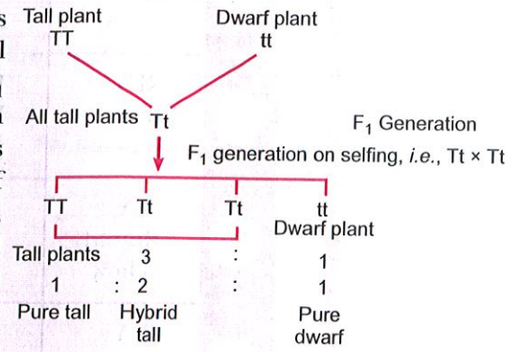
Ans. Trait B is likely to have arisen earlier in a population of an asexually reproducing species.

Q. 2. How does the creation of variations in a species promote survival?

Ans. Variations in a species arise due to errors in DNA copying. Force of natural selection selects individuals with useful variations in the prevailing environment so as to ensure their survival. The individuals with useful variations increase in numbers through differential reproduction in the population.

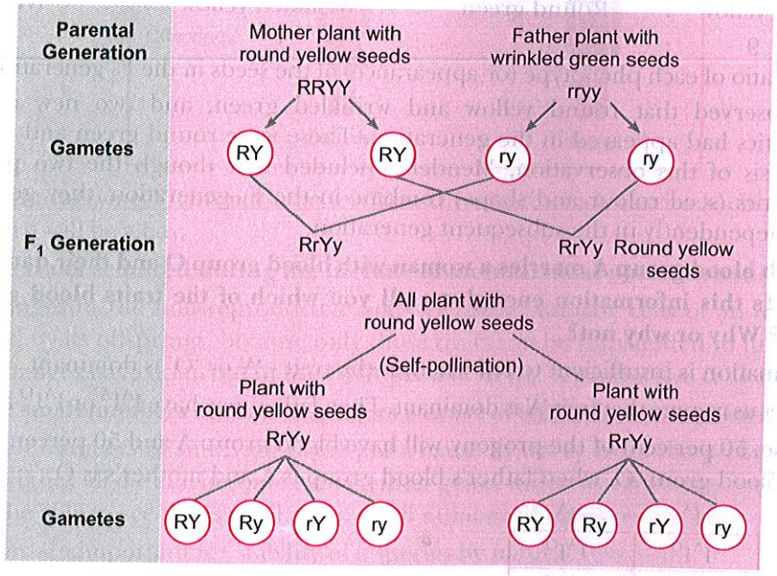
Q. 3. How do Mendel's experiments show that traits may be dominant or recessive?

Ans. When Mendel first crossed pure tall pea plants with pure dwarf pea plants, he found that only tall plants were produced in the first generation(F_1 generation). No dwarf pea plants were obtained in the first-generation of progeny. When F_1 tall plants were self-pollinated, Mendel got both tall and dwarf plants in F_2 generation in 3 : 1 ratio. In other words, in the F_2 generation three-fourth plants were tall and one-fourth were dwarf. Mendel called this tall character as dominant trait and dwarf character as recessive trait.



Q. 4. How do Mendel's experiments show that traits are inherited independently?

Ans. When Mendel first crossed pure-bred pea plants having round-yellow seeds with pure-bred pea plants having wrinkled–green seeds, he found that only round-yellow seeds were produced in the first generation. No wrinkled–green seeds were obtained in the F_1 generation. From this, it was concluded that round shape and yellow colour of the seeds were dominant traits over the wrinkled shape and green colour of the seeds.



When the F_1 generation pea plants having round yellow seeds were cross-bred by self-pollination, then four types of seeds having different combinations of shape and colour were obtained in second generation (F_2). These were round yellow, round green, wrinkled yellow and wrinkled green seeds.

Such a cross is known as dihybrid cross as two sets of corresponding characters are considered.

Gametes ♂	RY	Ry	rY	ry
RY	RRYY Round yellow	RRYy Round yellow	RrYY Round yellow	RrYy Round yellow
Ry	RRYy Round yellow	RRyy Round green	RrYy Round yellow	Rryy Round green
rY	RrYY Round yellow	RrYy Round yellow	rrYY Wrinkled yellow	rrYy Wrinkled yellow
ry	RrYy Round yellow	Rryy Round green	rrYy Wrinkled yellow	rryy Wrinkled green

Gametes ♀ (RY, Ry, rY, ry) — F_2 generation

Independent inheritance of two contrasting traits: Shape and colour of the seeds

Thus, ratio of F_2 generation is

Round yellow	:	Round green	:	Wrinkled yellow	:	Wrinkled green
9	:	3	:	3	:	1

Thus, the ratio of each phenotype (or appearance) of the seeds in the F_2 generation is 9 : 3 : 3 : 1.

Mendel observed that round yellow and wrinkled green, and two new combinations of characteristics had appeared in the generation. These were round green and wrinkled yellow. On the basis of this observation, Mendel concluded that though the two pairs of original characteristics (seed colour and shape) combine in the F_1 generation, they get separated and behave independently in the subsequent generation.

Q. 5. A man with blood group A marries a woman with blood group O and their daughter has blood group O. Is this information enough to tell you which of the traits blood group A or O is dominant? Why or why not?

Ans. The information is insufficient to tell whether the trait - 'A' or 'O' is dominant.

In **case I** let us assume that trait 'A' is dominant. Then father may have I^AI^A or I^AI^O and mother I^OI^O.

In this case, 50 per cent of the progeny will have blood group A and 50 percent of the progeny will have blood group O, when father's blood group is A and mother's is O.

	I^A	I^A
I^O	I^AI^O	I^AI^O
I^O	I^AI^O	I^AI^O

In case II, let us assume that trait 'O' is dominant. In this case also, we see that child may have blood group O.

	I^A	I^O
I^O	I^AI^O	I^OI^O
I^O	I^AI^O	I^OI^O

Since, in both the assumptions the child can have blood group O, so we cannot establish which trait is dominant.

Q. 6. What are the different ways in which individuals with a particular trait may increase in a population?

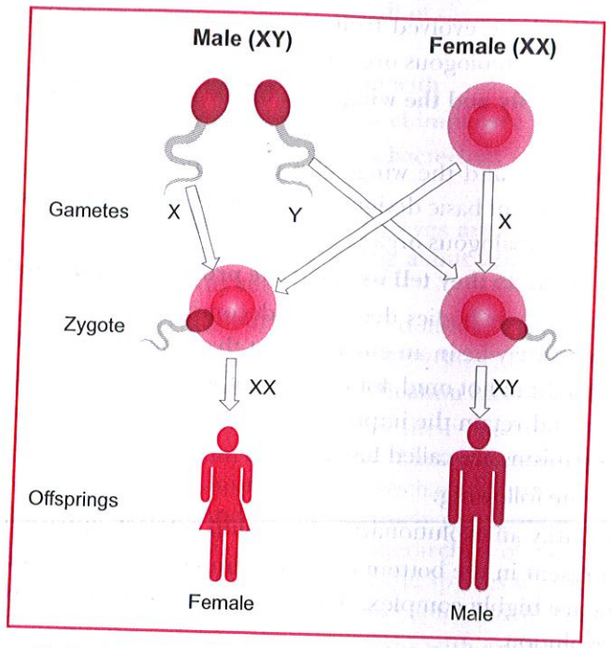
Ans. Individuals with particular trait may increase in a population in the following ways:

(*i*) By natural selection

(*ii*) By genetic drift

Q. 7. How is the sex of the child determined in human beings? *[NCERT Exemplar]*

Ans. In human beings, sex of the child depends upon which kind of male gamete fertilises the female gamete. If sperm carrying X chromosome fertilises the ovum carrying X chromosome, then the child born will be a girl.



If a sperm carrying Y chromosome fertilises the ovum which carries X chromosome, then the child born will be a boy.

Q. 8. Why are traits acquired during the lifetime of an individual not inherited?

Ans. The changes in the non-reproductive body cells, *i.e.*, somatic cells of an organism cannot be inherited by its offsprings, because only those traits can be transmitted to future generations in which changes have occurred in the DNA present in the reproductive cells of parent organism.

Q. 9. Why are small numbers of surviving tigers a cause of worry from the point of view of genetics?

Ans. The small numbers of surviving tigers are a cause of worry from the point of view of genetics because if they all die and become extinct, their genes will be lost forever and coming generations will not be able to see tigers at all. Also, small number of tigers means less chances of variations. Variations are important for stability of a species by natural selection.

Q. 10. What factors could lead to the rise of a new species?

Ans. Genetic variation, natural selection and reproductive isolation are factors that could lead to the rise of a new species.

Q. 11. Will geographical isolation be a major factor in the speciation of a self-pollinating plant species? Why or why not?

Ans. Geographical isolation will not be a major factor for the speciation of a self-pollinating plant species because it does not have to look for other plants for its process of reproduction to be carried out.

Q. 12. Will geographical isolation be a major factor in the speciation of an organism that reproduces asexually? Why or why not?

Ans. Geographical isolation will not be a major factor in the speciation of an organism that reproduces asexually, because it does not require any other organism to carry out reproduction.

Q. 13. Give an example of characteristics being used to determine how close two species are in evolutionary terms.

Ans. Forelimbs of humans and wings of birds show the closeness between these two species. Since, the forelimbs of a human and wings of birds have similar structure but perform different functions. Thus, the presence of homologous organs in different animals provides evidence for evolution by telling us that they have evolved from the same ancestor who had the basic design of the organ on which all the homologous organs are based.

Q. 14. Can the wings of butterfly and the wings of a bat be considered homologous organs? Why or why not?

Ans. The wings of a butterfly and the wings of a bat cannot be considered as homologous organs because they have different basic designs even though they perform similar functions. They are therefore regarded as analogous organs.

Q. 15. What are fossils? What do they tell us about the process of evolution?

Ans. When organisms die, their bodies decay and decompose. But every once in a while, the body or at least some parts may be in an environment that does not let it decompose completely. If a dead insect gets caught in hot mud, for example, it will not decompose quickly, and the mud will eventually harden and retain the impression of the body parts of the insect. All such preserved traces of living organisms are called fossils.

The fossils tell us the following:

(*i*) It helps to identify an evolutionary relationship between apparently different species.

(*ii*) The fossils present in the bottom rocks are simple while the most recent fossil found in the upper strata are highly complex. This geographical succession completely agrees with the concept of evolution.

Q. 16. Why are human beings who look so different from each other in terms of size, colour and looks said to belong to the same species?

Ans. The human beings are different from each other in terms of size, colour and looks but are said to be of the same species (*Homo sapiens*) because they can interbreed to produce fertile offsprings (son and daughter). The earliest members of *Homo sapiens* have been traced back to Africa. Some of our ancestors stayed back in Africa and spread across these continents; other left Africa and slowly spread across the whole earth. They moved forward and backward in groups, separately or in mixed groups at times. These groups of ancestors, like other species, lived their lives in then prevailing environment and developed genetic variation to become differently coloured with specific features of different geographical regions in modern times.

Q. 17. In evolutionary terms, can we say which among bacteria, spiders, fish and chimpanzees have a 'better' body design? Why or why not?

Ans. There is no real 'progress' in the idea of evolution. Evolution is simply the generation of diversity by environmental selection. The only progressive trend in evolution seems to be that more and more complex body designs have emerged over time. However, again, it is not as if the older designs are inefficient. So many of the older and simpler designs still survive. In fact, one of the simplest life forms, *i.e.*, bacteria inhabit the most inhospitable habitats like hot springs, deep-sea thermal vents and ice in Antarctica. In other words, human beings are not the pinnacle of evolution, but simply yet another species in the teeming spectrum of evolving life.

NCERT Exercises

Q. 1. A Mendelian experiment consisted of breeding tall pea plants bearing violet flowers with short pea plants bearing white flowers. The progeny all bore violet flowers, but almost half of them were short. This suggest that the genetic make-up of the tall parent can be depicted as

(*a*) TTWW (*b*) Ttww (*c*) TtWW (*d*) TtWw

Ans. (*c*)

Q. 2. An example of homologous organs is

(*a*) our arm and dog's foreleg (*b*) our teeth and an elephant's tusks

(*c*) potato and runners of grass (*d*) all of the above

Ans. (*d*)

Q. 3. In evolutionary terms, we have more in common with

(*a*) a Chinese school-boy (*b*) a chimpanzee

(*c*) a spider (*d*) a bacterium

Ans. (*a*)

Q. 4. A study found that children with light-coloured eyes are likely to have parents with light-coloured eyes. On this basis, can we say anything about whether the light eye colour trait is dominant or recessive? Why or why not?

Ans. From this study we can say light-coloured eye is a dominant trait because children born from parents having light-coloured eyes also had light-coloured eyes.

Q. 5. How are the areas of study—evolution and classification interlinked?

Ans. Characteristics of organisms refer to the details of their external and internal appearance or behaviour that distinguish them from one another. These characteristics of organisms also form the basis for the classification of organisms. The more characteristics two species have in common, the more closely they are related. And the more closely they are related the more recently they will have had a common ancestor. By identifying hierarchies of characteristics between species, we can work out the evolutionary relationships of the species we see around us. Thus, we can appreciate that classification of species is in fact reflection of their evolutionary relationship.

Q. 6. Explain the terms analogous and homologous organs with examples.

Ans. Homologous organs: Those organs which have the same basic structural design and developmental origin but may have different functions.

Example: The forelimb of a frog, a lizard, a bird and a man have been built from the same basic design of bones, but they perform different functions.

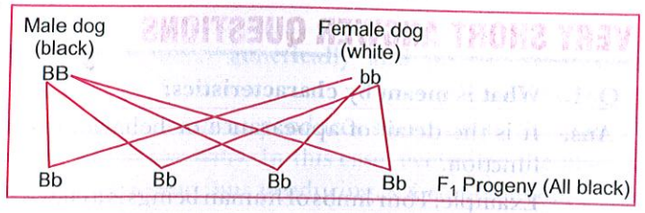
Analogous organs: Those organs which have different basic structural design and developmental origin but have similar functions.

Example: The wings of birds and insects.

Q. 7. Outline a project which aims to find the dominant coat colour in dogs.

Ans. Select a homozygous black (BB) male dog and a homozygous white (bb) female dog. Cross breed them to produce offsprings (F_1 generation).

If all the offsprings are black, we can conclude that black coat colour is dominant over white coat in dogs.



Q. 8. Explain the importance of fossils in deciding evolutionary relationship.

Ans. Fossils are the remains or impressions of dead plants or animals which died millions of years ago. The study of fossils helps us to know about the evolution or links between two species. Fossils tell us how new species are developed from the old ones. So, fossils have an importance in deciding evolutionary relationships.

Q. 9. What evidence do we have for the origin of life from inanimate matter?

Ans. An experiment conducted by Stanley L. Miller and Harold C. Urey in 1953 proved that origin of life takes place from inanimate matter. They assembled an apparatus to create an early earth atmosphere which consisted of gases like methane, ammonia and hydrogen sulphide but no oxygen, over water. This was maintained at a temperature just below 100°C and electric sparks were passed through the mixture of gases to stimulate lightning. At the end of a week, 15% of the carbon (from methane) had been converted to simple compounds of carbon including amino acids which make up protein molecules.

Q. 10. Explain how sexual reproduction gives rise to more viable variations than asexual reproduction. How does this affect the evolution of those organisms that reproduce sexually?

Ans. Sexual reproduction gives rise to more viable variations than asexual reproduction. In asexual reproduction, the offsprings are almost identical to their parents because they have the same genes as of their single parent. Thus, much genetic variation is not possible in asexual reproduction. Asexual reproduction inhibits the further evolution of the organism.

In sexual reproduction, the offsprings although similar to their parents, are not identical to them or to one another. This is because the offsprings receive some genes from the mother and some from the father. Because of the mixing of genes of mother and father in different combinations, all the offspring will exhibit genetic variations. In this way, sexual reproduction leads to a greater variations in the population.

Thus, genetic variation leads to the continuous evolution of various species to form better and still better organisms.

Q. 11. How is the equal genetic contribution of male and female parents ensured in the progeny?

Ans. In case of human beings, 23 pairs of chromosomes have a maternal and a paternal copy. Out of 23 pairs, 22 pairs are said to be autosomes and one pair is called sex chromosome. At the time of fertilisation, the egg cell fuses with the sperm cell which is haploid (n) to form zygote. Zygote is diploid (2n) which contains 23 pairs of chromosomes from mother and 23 from father. In this way, an equal genetic contribution of male and female parents is ensured in the progeny.

Q. 12. Only variations that confer an advantage to an individual organism will survive in a population. Do you agree with this statement? Why or why not?

Ans. We agree with this statement that only variations that confer an advantage will survive in a population.

All the variations do not have an equal chance of surviving in the environment in which they find themselves. The chances of survival depends on the nature of variations. Different individuals would have different kinds of advantages. A bacteria that can withstand heat will survive better in a heat wave. Selection of variants by environmental factors forms the basis for evolutionary processes.

VERY SHORT ANSWER QUESTIONS [1 mark]

Q. 1. What is meant by characteristics?

Ans. It is the detail of appearance or behaviour; in other words, a particular form or a particular function.

Example: Four limbs of human beings is a characteristic and that plant can perform photosynthesis is also a characteristic.

Q. 2. Who is known as the father of genetics?

Ans. Gregor Johann Mendel is known as the father of genetics.

Q. 3. Define chromosome.

Ans. Chromosome is a thread-like structure that bears genes and are enclosed within a nucleus. It is composed of DNA and protein.

Q. 4. Define variation.

Ans. The occurrence of differences among the individuals of a species is called variation.

Q. 5. Define a gene.

Ans. Gene is a segment of a DNA molecule which carries the code for the synthesis of a specific protein.

Q. 6. Define alleles.

Ans. Genes which code for a pair of contrasting traits are known as alleles, *i.e.,* they are the different forms of the same gene.

Q. 7. Write the expanded form of DNA.

Ans. Deoxyribonucleic acid

Q. 8. Where is DNA found in a cell? *[CBSE (AI) 2015]*

Ans. DNA is found in genes or chromosomes.

Q. 9. What is the function of a gene?

Ans. Gene is the carrier of the genetic information from one generation to the next.

Q. 10. Who proposed the theory of natural selection?

Ans. Charles Darwin proposed the theory of natural selection.

Q. 11. Which of the following traits are recessive in pea plant?
Dwarfness, violet flower, wrinkled seed.

Ans. Dwarfness and wrinkled seeds are the recessive characters.

Q. 12. How many pairs of chromosomes are found in human beings?

Ans. 23 pairs of chromosomes are found in human beings.

Q. 13. In humans, the gene for black hair colour is B and gene for brown hair colour is b. What will be the hair colour of person having the genetic constitution?

(*a*) BB **(*b*) bb** **(*c*) Bb**

Ans. (*a*) Black hair, (*b*) Brown hair, (*c*) Black hair (Heterozygous)

Q. 14. Write the names of two types of chromosomes found in an organism.

Ans. Autosomes and sex chromosomes

Q. 15. How many chromosomes are present in a sperm and an ovum?

Ans. Sperm and ovum have 23 chromosomes each.

Q. 16. What is a sex chromosome?

Ans. The chromosomes which are associated with sex determination of an organism are called sex chromosomes.

Q. 17. A woman has only daughters, analyse the situation genetically and provide a suitable explanation. *[NCERT Exemplar]*

Ans. The woman produces ova with 'X' chromosome. The man produces sperms with 'X' and 'Y' chromosome which actually determines the sex of the baby. In this case, everytime the male X chromosome only fuses with the female X chromosome thus producing XX combination.

Q. 18. Which sex chromosomes are found in male and female human beings?

Ans. Males have one X and one Y-chromosomes, whereas females have two X-chromosomes.

Q. 19. Who gave the theory of inheritance of acquired characters?

Ans. Lamarck

Q. 20. Define mutation.

Ans. Sudden changes in the genetic form of an organism which are passed on to the next generation are called mutations. Mutations lead to variations in an organism.

Q. 21. What are fossils?

Ans. Fossils are the remains or impressions of the dead animals and plants that lived in the past.

Q. 22. What is the significance of *Archaeopteryx* in evolution?

Ans. *Archaeopteryx* provides evidence of evolution of birds from reptiles and its study shows that:

(*i*) birds and reptiles had a common ancestor.

(*ii*) birds have evolved from reptiles.

Q. 23. Why are acquired characters not inheritable?

Ans. Acquired characters are not inherited because they affect the somatic cells and these changes are not incorporated in the chromosomes of cells that will form germ cells.

Q. 24. What is genetic drift?

Ans. The elimination of the genes of certain traits when a section of a species population migrates or dies due to natural calamity. It alters the gene frequency of the remaining population.

Q. 25. How do we know how old a fossil is?

Ans. Age of fossils can be estimated by the depth of the layer of rocks in which they are found. Age of fossils can also be detected from the ratio of isotopes in the fossils containing rocks.

Q. 26. What is organic evolution?

Ans. Evolution is the sequence of gradual changes of the living organisms, which takes place in the primitive organisms over millions of years resulting in the formation of new species.

Q. 27. What are the basic events in evolution?

Ans. A gradual genetic change in a group of living beings to produce new forms brought about by changes in DNA during reproduction are the basic events in evolution.

Q. 28. When a cell reproduces, what happens to its DNA? *[CBSE (AI) 2017]*

Ans. When a cell reproduces, copy of DNA is created.

Q. 29. Newly formed DNA copies may not be identical at times. Give one reason. *[CBSE (AI) 2017]*

Ans. Newly formed DNA copies may not be identical at times if there is error or inaccuracies in DNA copying.

Q. 30. Why is variation important for a species? *[CBSE (AI) 2017]*

Ans. Variation is important for species to survive.

SHORT ANSWER QUESTIONS–I [2 marks]

Q. 1. Why offsprings differ from parents in certain characters?

Ans. It is due to biparental percentage. The genes on chromosomes which pass over to the next generation is partly derived from both the parents (mother and father). During fertilisation of egg by the sperm, new combination of chromosomes enter the zygote, due to which certain variations occur in the offsprings. Thus, brothers and sisters show variations in their complexion, habits and behaviour.

Q. 2. What are the causes of variations?

Ans. Following are the causes of variations:

(*i*) **Dual percentage:** Offsprings inherit some features from mother and some from father, hence no offspring will exactly resemble to either of the parent or each other.

(*ii*) Mutation in gene or chromosomal pattern also causes variations.

Q. 3. Give the pair of contrasting traits of the following characters in pea plant and mention which is dominant and recessive

(*i*) yellow seed

(*ii*) round seed *[NCERT Exemplar]*

Ans.

(*i*)	yellow	—	dominant
	green	—	recessive
(*ii*)	round	—	dominant
	wrinkled	—	recessive

Q. 4. What is the contribution of Mendel to genetics?

Ans. Mendel observed the occurrence of contrasting characters of garden pea in various generations. On this basis, he interpreted that these contrasting characters are controlled by factors. He considered each and every character as a unit, which is controlled by a 'factor'. Factors are carriers of hereditary information. Now, factors are known as genes.

Q. 5. Do genetic combination of mothers play a significant role in determining the sex of a new born? *[NCERT Exemplar]*

Ans. No, because mothers have a pair of X-chromosomes. All children will inherit an 'X' chromosome from their mother regardless of whether they are boys or girls.

Q. 6. How does use and disuse of an organ help in evolution of a new species?

Ans. According to Lamarck, those organs which are used regularly become strong and more developed. On the other hand, those organs which are not used regularly become weak and degenerate. Such characters are inherited to the offsprings and so on. In the due course of time, such characters become permanent in later generations and become quite different from their ancestors, resulting in the formation of a new species.

Q. 7. A very small population of a species faces a greater threat of extinction than a larger population. Provide a suitable genetic explanation. *[NCERT Exemplar]*

Ans. Fewer individuals in a species impose extensive inbreeding among them. This limits the appearance of variations and puts the species at a disadvantage if there are changes in the environment. Since the individuals fail to cope up with the environmental changes, they may become extinct.

Q. 8. Does the occurrence of diversity of animals on earth suggest their diverse ancestry also? Discuss this point in the light of evolution. *[NCERT Exemplar]*

Ans. Though animals have a vast diversity in structures they probably do not have a common ancestry, because common ancestry may greatly limit the extent of diversity. As many of these diverse animals are inhabiting the same habitat, their evolution by geographical isolation and speciation is also not likely. Thus, a common ancestry for all the animals is not the likely theory.

Q. 9. All the human races like Africans, Asians, Europeans, Americans and others might have evolved from a common ancestor. Provide a few evidences in support of this view. *[NCERT Exemplar]*

Ans. All human races have evolved from a common ancestor because everybody has:

(*i*) Common body design, structure, physiology and metabolism

(*ii*) Constant chromosome number

(*iii*) Common genetic blue print

(*iv*) Freely inter-breeding species.

Q. 10. A change in DNA that is useful for one property to start with, can become useful later for a different function. Explain.

Ans. A change/feature/property of an organism that may have helped it to adopt to an environmental condition can also become useful for a completely different function in the future. For example, feathers in birds, a character developed and selected during natural selection for providing insulation in cold weather, became useful in later stages for flight.

Some dinosaurs had feathers, but they could not fly. Birds later adapted the feathers to fly.

Q. 11. List two differences in tabular form between dominant trait and recessive trait. What percentage/proportion of the plants in the F_2 generation/progeny were round, in Mendel's cross between round and wrinkled pea plants? *[CBSE (F) 2015]*

Ans.

Dominant trait	Recessive trait
1. The trait which appears in the F1 progeny is dominant.	1. The trait which remains hidden or which does not appear in the F1 progeny is the recessive trait.
2. It appears in more numbers.	2. It appears in less number.

75% of the plants were with round seeds.

Q. 12. How many pairs of chromosomes are present in human beings? Out of these how many are sex chromosomes? How many types of sex chromosomes are found in human beings?

Ans. 23 pairs of chromosomes are present in human beings. One pair of these are sex chromosomes. Two types of sex chromosomes are there: XX and XY.

SHORT ANSWER QUESTIONS–II [3 marks]

Q. 1. What is DNA copying? State its importance. *[CBSE Delhi 2015]*

Ans. A process where a DNA molecule produces two similar copies of itself in a reproducing cell is called DNA copying.

Its importance are:

(*i*) It makes the transmission of characters from parents to the next generation possible.

(*ii*) It causes variation in the population.

Q. 2. "We cannot pass on to our progeny the experiences and qualifications earned during our life time". Justify the statement giving reason and examples. *[CBSE Delhi 2015]*

OR

With the help of two suitable examples, explain why certain experiences and traits earned by people during their lifetime are not passed on to their next generations. When can such traits be passed on? *[CBSE (AI) 2017]*

Ans. We acquire knowledge and skills in our lifetime such as learning dance, music, physical fitness, etc. But these skills cannot be passed to our progenies because:

(*i*) Such characters or experiences acquired during one's lifetime do not bring any change in the DNA of the germ cell.

(*ii*) Only germ cells are responsible for passing on the characters from the parents to the progeny. These traits can be passed to the next generation when the changes are in the DNA of the germ cell.

Q. 3. 'Different species use different strategies to determine sex of a newborn individual. It can be environmental cues or genetically determined'. Explain the statement by giving example for each strategy. *[CBSE Sample Paper 2016]*

Ans. Environmental cue:

In some animals, the temperature at which fertilised eggs are kept determines whether the developing animal in egg is male or female.

In some animals like snail, individual can change sex.

Genetical cue:

A child who inherits an X chromosome from the father will be a girl and one who inherits a Y chromosome from the father will be a boy.

Q. 4. List the two types of reproduction. Which one of the two is responsible for bringing in more variations in its progeny and how? *[CBSE (AI) 2017]*

Ans. The two types of reproduction are sexual reproduction and asexual reproduction. Sexual reproduction is responsible for bringing in more variations because of the process of DNA copying which may result in some error in it. Also, it involves fusion of male and female gametes from two different parents.

Q. 5. How do variations occur in an offspring?

Ans. Dissimilarities between members of the same species is called variations. Two offsprings of the same parents show certain variations. Variations occur due to sex chromosomes. Variations arising in germplasm (genes) of the organism are heritable. Mother and father contribute to the gene pattern of the offsprings through their chromosomes, in which recombination occurs at the time of gametogenesis. In zygote formation, gene pattern of both parents come together, that causes some variations between parents and offsprings and amongst offsprings also.

Q. 6. Why is variation beneficial to the species but not necessary for the individual?

Ans. The importance of variation in organism introduced during reproduction is that it helps the species of various organisms to survive and flourish even in adverse environment. If all the organisms of a population living in that habitat are exactly identical, then there is a danger that all of them may die and no one would survive under those conditions. This will eliminate the species from the habitat completely. However, if some variations are present in some individual organism to tolerate excessive heat or cold, then there is a chance for them to survive and flourish even in adverse excessive heat or cold. Thus, variation is useful for the survival of a species over time.

Q. 7. What is speciation? List four factors responsible for speciation. *[CBSE Delhi 2015]*

Ans. Speciation is the formation of new species from the pre-existing population.

Factors responsible for speciation:

(*i*) Genetic drift **(*ii*) Natural selection**

(*iii*) Geographical isolation **(*iv*) Mutation**

Q. 8. List in tabular form, two distinguishing features between the acquired traits and the inherited traits with one example of each. *[CBSE Delhi 2015]*

OR

List three distinguishing features, in tabular form, between acquired traits and the inherited traits. *[CBSE Delhi 2015]*

OR

Distinguish between the acquired traits and the inherited traits in tabular form, giving one example for each. *[CBSE Delhi 2017]*

OR

Differentiate between inherited and acquired characters. Give one example for each type. *[NCERT Exemplar]*

Ans.

Acquired Traits	Inherited Traits
1. Does not bring about change in the DNA of the germ cell.	1. Brings about change in the DNA of the germ cell.
2. Cannot be passed on to the progeny.	2. Can be passed on to the progeny.
3. Cannot direct evolution.	3. Can direct evolution.
Examples: Acquiring knowledge, loss of weight, etc.	**Examples:** Skin colour, colour of the eye, etc.

Q. 9. In one of his experiments with pea plants Mendel observed that when a pure tall pea plant is crossed with a pure dwarf pea plant, in the first generation, F_1 only tall plants appear.

(*a*) What happens to the traits of the dwarf plants in this case?

(*b*) When the F_1 generation plants were self-fertilised, he observed that in the plants of second generation, F_2 both tall plants and dwarf plants were present. Why it happened? Explain briefly. *[CBSE Delhi 2016]*

Ans. (*a*) The dwarf traits of the plants is not expressed in the presence of the dominant tall trait.

(*b*) In the F_2 generation, both the tall and dwarf traits are present in the ratio of 3 : 1. This showed that the traits for tallness and dwarfness are present in the F_1 generation, but the dwarfness, being the recessive trait does not express itself in the presence of tallness, the dominant trait.

Q. 10. What are chromosomes? Explain how in sexually reproducing organisms the number of chromosomes in the progeny is maintained. *[CBSE (AI) 2015, Delhi (C) 2017]*

Ans. Chromosomes are thread-like structures, made of proteins and DNA, found in the nucleus at the time of cell division.

In sexually reproducing organisms, the gametes undergo meiosis, and hence, each gamete contains only half a set of chromosomes. When two gametes fuse, the zygote formed contains the full set of chromosomes. Hence, the formation of gametes by meiosis helps to maintain the number of chromosomes in the progeny.

Q. 11. Mention the total number of chromosomes along with the sex chromosomes that are present in a human female and a human male. Explain how in sexually producing organisms the number of chromosomes in the progeny remains the same as that of the parents. *[CBSE Delhi 2017]*

Ans. Human male has 22 pairs of chromosomes along with XY sex chromosome.

Human female has 22 pairs of chromosomes along with XX sex chromosomes.

The original number of chromosomes (the amount of DNA) becomes half during gamete formation. When the gametes fuse, the original number of chromosomes (the amount of DNA) is restored in the progeny.

Q. 12. "Two areas of study namely 'evolution' and 'classification' are interlinked". Justify this statement. *[CBSE (AI) 2015]*

OR

"Evolution and classification of organisms are interlinked." Give reasons to justify this statement. *[CBSE (AI) 2017]*

Ans. Different forms of organisms have evolved during the course of evolution. Classification deals with grouping of these organisms into groups and subgroups based on their similarities and differences. The more characteristics any two species have in common more closely they are related. In other words, they will have a more recent ancestor.

Thus, classification helps is tracing the evolutionary relationships between the two organisms. Hence classification and evolution are interlinked.

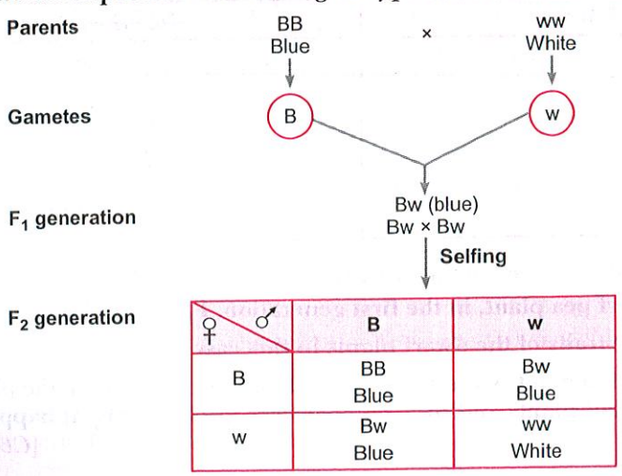
Q. 13. A pea plant with blue colour flower denoted by BB is cross-bred with a pea plant with white flower denoted by ww.

(*a*) What is the expected colour of the flowers in their F_1 progeny?

(*b*) What will be the percentage of plants bearing white flower in F_2 generation, when the flowers F_1 plants were selfed?

(*c*) State the expected ratio of the genotype BB and Bw in the F_2 progeny. *[CBSE (AI) 2015]*

Ans.



♀ \ ♂	B	w
B	BB Blue	Bw Blue
w	Bw Blue	ww White

(*a*) Blue

(*b*) 25%

(*c*) BB : Bw = 1 : 2

Q. 14. Explain the following:

(*a*) Speciation

(*b*) Natural Selection *[CBSE (AI) 2015]*

Ans. (*a*) The process by which new species develop from the existing species is known as speciation. The factors which could lead to speciation are

(*i*) Geographical isolation of population caused by various types of barriers such as mountain ranges, rivers and seas. This leads to reproductive isolation because of which there is no flow of genes between separated groups of population.

(*ii*) Genetic drift caused by drastic changes in the frequencies of particular genes by chance alone.

(*iii*) Variations caused in individuals because of natural selection.

(*b*) According to Darwin's theory of natural selection, the individuals who are most suitable and fit are successful in struggle for existence for food, space, mate, etc. Their offsprings are also better developed and adapted to the environment. Whereas one who are less adapted to the environment may die. Thus, nature selects better adapted organisms. This is called **natural selection** of the well adapted, better developed individuals of species.

Q. 15. "Natural selection and speciation leads to evolution." Justify this statement. *[CBSE Delhi 2017]*

Ans. Natural selection is defined as the change in frequency of some genes in a population, which gives survival advantage to a species. Whereas speciation is the development of a new species from pre-existing ones.

This leads to a sequence of gradual change in the primitive organisms over millions of years, to form newer species which are very different from older ones. This is called evolution.

Q. 16. "Fossils are related to evolution", justify this statement. Give the two ways by which age of the fossils can be estimated?

Ans. Fossils are the remains of the organisms that once existed on earth, *i.e.*, they are the preserved traces of living organisms. They provide evidence of evolution by revealing the characteristics of the past organisms and the changes that have occurred in these organisms to give rise to the present organisms.

Two ways of determining age of fossils are:

(*i*) Relative method—fossils closer to the surface are more recent.

(*ii*) Dating—finding the ratio of different isotopes of the same element.

Q. 17. (*i*) *Planaria*, insects, octopus and vertebrates all have eyes. Can we group eyes of these animals together to establish a common evolutionary origin? Justify your answer.

(*ii*) "Birds have evolved from reptiles". State evidence to prove the statement.

[CBSE Delhi 2015; (F) 2015]

Ans. (*i*) No we can not group them together because the structure of the eye in each of the organisms is different.

(*ii*) Fossils of certain dinosaurs and reptiles show imprints of feathers along with their bones but they could not fly presumably, using the feathers for insulation only. Later they evolved and adapted feathers for flight, thus becoming the ancestors of present day birds.

Q. 18. Mention three important features of fossils which help in the study of evolution. *[NCERT Exemplar]*

Ans. (*a*) Fossils represent modes of preservation of ancient species.

(*b*) Fossils help in establishing evolutionary traits among organisms and their ancestors.

(*c*) Fossils help in establishing the time period in which organisms lived.

Q. 19. Explain analogous organs and homologous organs. Identify the analogous and homologous organs amongst the following:

Wings of an insect, wings of a bat, forelimbs of frog, forelimbs of a human.

Ans. Analogous organs are those organs which have different structural designs and origin but perform similar functions.

Homologous organs are those which have the same basic structural design and origin but perform different functions.

Analogous organs: Wings of an insect, wings of a bat.

Homologous organs: Forelimbs of a frog, forelimbs of a human.

Q. 20. Explain with the help of an example each, how the following provide evidences in favour of evolution: *[CBSE Delhi 2017]*

(*a*) Homologous organs (*b*) Analogous organs (*c*) Fossils

Ans. (*a*) Homologous organs: The study of these organs suggests that these organisms with organs having same structure but performing different functions have evolved from a common ancestor, *e.g.*, forelimbs of different vertebrates.

(*b*) Analogous organs: The study of these apparently similar organs suggests that the organisms with apparently similar organs do not share common ancestory. Similarity in these organs is superficial or design and the structure of these organs are very different, *e.g.*, wings of bird and wings of butterfly.

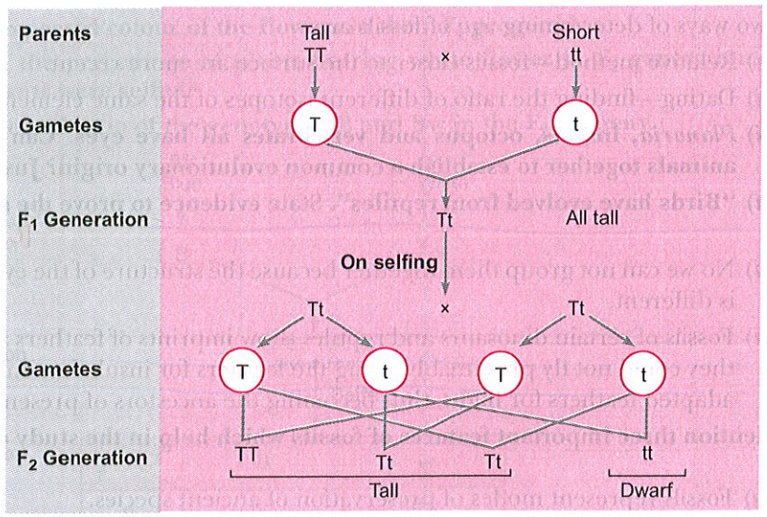
(*c*) Fossils: They provide the missing link between the species, *e.g.*, Fossils of dinosaurs with feathers or fossils of prehistoric horse, etc.

Q. 21. Describe the contribution of Lamarck.

Ans. The gradual unfolding of organisms from pre-existing organisms through changes since the beginning of life is called evolution. The theory proposed by J.B. Lamarck is known as the theory of inheritance of acquired characters. According to this theory, the use and disuse of an organ leads to acquiring of change in that organ. These changes or variations can be passed on from one generation to the next but this idea of inheritance of acquired characters was soon discarded.

Q. 22. Name the organism Mendel used for his experiments. Explain about F_1 and F_2 progeny obtained by Mendel when he bred the tall and the short varieties of the organism he experimented with.

Ans. Mendel used garden pea (*Pisum Sativum*) for his experiment. When Mendel crossed a pure tall plant (TT) with a dwarf plant (tt), the progeny thus obtained was called F_1 progeny/generation.



Then he self-pollinated the F_1 progeny. The progeny now obtained is F_2. In F_2 progeny, he found that 75% plants were tall and 25% were dwarf.

Q. 23. "It is possible that a trait is inherited but may not be expressed." Give a suitable example to justify this statement. *[CBSE (F) 2015]*

OR

With the help of an example justify the following statement: "A trait may be inherited, but may not be expressed". *[CBSE (AI) 2016]*

OR

How did Mendel explain that it is possible that a trait is inherited but not expressed in an organism? *[CBSE (AI) 2017]*

Ans. Yes, it is possible that a trait is inherited but may not be expressed.

For example, when pure tall pea plants are crossed with pure dwarf pea plants, only tall pea plants are obtained in F_1 generation.

On selfing tall plants of F_1, both tall and dwarf plants are obtained in F_2 generation in the ratio 3 : 1.

Reappearance of the dwarf character, a recessive trait in F_2 generation shows that the dwarf trait was present in individuals of F_1 but it did not express.

Q. 24. How did Mendel's experiments show that different traits are inherited independently? Explain. *[CBSE Delhi 2017]*

Ans. Mendel conducted a dihybrid cross; and observed that though he started with two types of parents, he obtained four types of individuals in F_2. The appearance of new recombination in F_2 generations along with parental type characters show that traits are inherited independently of each other.

Q. 25. Name two homologous structures in vertebrates. Why are they so called? How do such organs help in understanding an evolutionary relationship?

Ans. Two homologous structures in vertebrates are:

(*i*) limbs of birds and reptiles.

(*ii*) limbs of reptiles and amphibians.

These are called so because the organs have similar structure to perform different functions in various vertebrates.

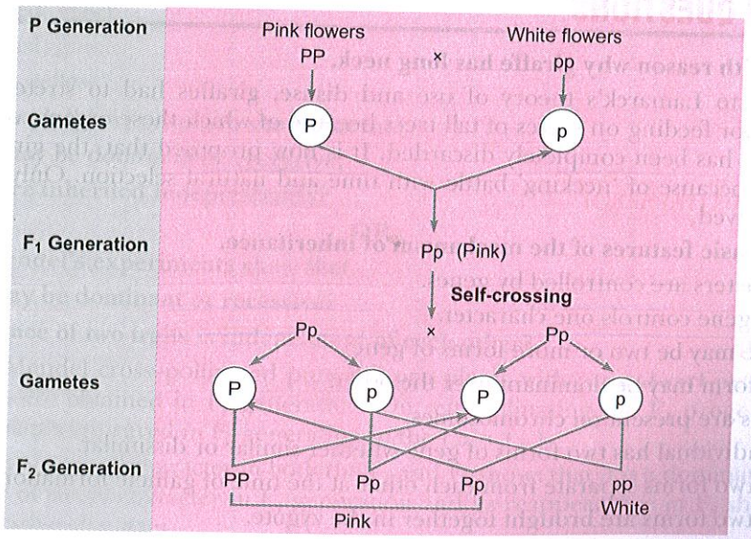
The homologous characteristics of such organs indicate common ancestory. Thus these exist an evolutionary relationship.

Q. 26. In a cross between plants with pink flowers and plants with white flowers the offsprings of F_1 generation all had pink flowers. When the F_1 generation was self-crossed, it was observed in the F_2 generation that out of 100, 75 flowers were pink. Make a cross and answer the following:

(*a*) What are the genotypes of the F_1 progeny?

(*b*) What is the ratio of Pink: White flowers in the F_2 generation?

Ans.



(*a*) Genotype of F_1 progeny is Pp (Pink)

(*b*) **Phenotypic ratio in F_2 generation** Pink : White

3 : 1

Q. 27. List three factors that provide evidences in favour of evolution in organisms and state the role of each in brief. *[CBSE (F) 2016]*

Ans. Three factors that provide evidences are:

(*i*) Analogous organs—organisms with similar looking organs may have different origin.

(*ii*) Homologous organs—organisms with apparently different looking organs may have similar origin.

(*iii*) Fossils—allow us to make estimates of how far back evolutionary relationships go. Fossils when chronologically arranged help in tracing the evolutionary history of an organism.

Q. 28. Does geographical isolation of individuals of a species lead to formation of a new species? Provide a suitable explanation. *[NCERT Exemplar]*

Ans. Yes, geographical isolation gradually leads to genetic drift. This may impose limitations to sexual reproduction of the separated population. Slowly the separated individuals will reproduce among themselves and generate new variations. Continuous accumulation of those new variations through a few generations may ultimately lead to the formation of a new species.

Q. 29. What is an organic evolution? It cannot be equated with progress. Explain with the help of a suitable example. *[CBSE (AI) 2017]*

Ans. Organic evolution is a sequence of gradual changes which take place in the organism over millions of years resulting in the formation of new organisms or species.

Evolution is not the progress from lower form of life to higher. It has given rise to more complex body design even while simpler body designs continue to flourish.

For example, human beings who have not evolved from chimpanzees, but both have common ancestors.

Q. 30. Give an example of the characteristics being used to determine how close two species are in evolutionary terms. *[CBSE (F) 2017]*

Ans. Study of homologous organs such as forelimbs of mammals, birds, reptiles and amphibian shows that though they perform different functions but they have similar basic or internal structure. This is because they have evolved from common ancestor and help us in determining the closeness between two species in evolutionary terms.

LONG ANSWER QUESTIONS [5 marks]

Q. 1. Explain with reason why giraffe has long neck.

Ans. According to Lamarck's theory of use and disuse, giraffes had to stretch their necks and forelimbs for feeding on leaves of tall trees because of which these organs were elongated. But this theory has been completely discarded. It is now proposed that, the giraffe's neck evolved with time because of 'necking' battle with time and natural selection. Only giraffes with long necks survived.

Q. 2. Give the basic features of the mechanism of inheritance. *[NCERT Exemplar]*

Ans. (*i*) Characters are controlled by genes.

(*ii*) Each gene controls one character.

(*iii*) There may be two or more forms of gene.

(*iv*) One form may be dominant over the other.

(*v*) Genes are present on chromosomes.

(*vi*) An individual has two forms of gene whether similar or dissimilar.

(*vii*) The two forms separate from each other at the time of gamete formation.

(*viii*) The two forms are brought together in the zygote.

Q. 3. **(*i*) Mention any two points of difference between acquired and inherited traits.**

(*ii*) If the tail of a mouse is cut for twenty one generations, will the tail occur in the twenty second generation of that mouse? Give reason to support your answer.

(*iii*) Define the term – natural selection. *[CBSE Sample Paper 2016]*

Ans. (*i*)

Acquired Traits	Inherited Traits
1. These are traits acquired during one's lifetime.	1. These are traits inherited from one's predecessors.
2. These are not inheritable.	2. These are inheritable.
3. Not present in the genetic make up.	3. Present in the genetic makeup.
4. Change in DNA will not result in any change in such traits.	4. Change is DNA will bring about change in such traits.

(Any two)

(*ii*) The mouse will continue to have information for presence of tail in its DNA. So, it will continue to have tail because absence of tail is an acquired trait and not an inherited trait.

(*iii*) Natural selection means that nature selects the best trait in a species, leading to survival of fittest and evolution of species.

Q. 4. In the following crosses write the characteristics of the progeny.

Cross **Progeny**

(*i*) RR YY × RR YY _____

Round, yellow and round, yellow

(*ii*) Rr Yy × Rr Yy _____

Round, yellow and round, yellow

(*iii*) rr yy × rr yy _____

Wrinkled, green and wrinkled, green

(*iv*) RR YY × rr yy _____

Round, yellow and wrinkled, green *[NCERT Exemplar]*

Ans. (*i*) Round, yellow

(*ii*) Round, yellow

Round, green

Wrinkled, yellow

Wrinkled, green

(*iii*) Wrinkled, green

(*iv*) Round, yellow

Q. 5. How do Mendel's experiments show that the

(*i*) traits may be dominant or recessive,

(*ii*) traits are inherited independently? *[CBSE (AI) 2015, Delhi (C) 2017]*

OR

How do Mendel's experiments show that

(*a*) traits may be dominant or recessive?

(*b*) inheritance of two traits is independent of each other? *[CBSE Delhi 2017]*

Ans. (*i*) When Mendel cross–pollinated pure tall pea plants with pure dwarf pea plants, only tall plants were obtained in F_1 generation. On self pollinating the F_1 progeny, both tall and dwarf plants appeared in F_2 generation in the ratio 3 : 1.

Appearance of tall character in both the F_1 and F_2 shows that it is a dominant character. The absence of dwarf character in F_1 generation and its reappearance in F_2 shows dwarfness is the recessive character.

(*ii*) When Mendel first crossed pure-breed pea plants having round-yellow seeds with pure-breed pea plants having wrinkled-green seeds, he found that only round-yellow seeds were produced in the first-generation. No wrinkled-green seeds were obtained in the generation. From this, it was concluded that round shape and yellow colour of the seeds were dominant traits over the wrinkled shape and green colour of the seeds.

When the F_1 generation pea plants having round-yellow seeds were cross-bred by self-pollination, then four types of seeds having different combinations of shape and colour were obtained in second generation (F_2). These were round-yellow, round-green, wrinkled-yellow and wrinkled-green seeds.

Such a cross is known as dihybrid cross as two sets of corresponding characters are considered.

Mendel observed that along with round-yellow and wrinkled-green, two new combinations of characteristics, round-green and wrinkled-yellow, had appeared in the F_2 generation. On the basis of this observation, Mendel concluded that though the two pairs of original characteristics (seed colour and shape) combine in the F_1 generation, they get separated and behave independently in the subsequent generation.

Q. 6. What are the various evidences in favour of evolution?

OR

Explain with an example for each, how the following provides evidences in favour of evolution in organisms:

(*i*) Homologous organs **(*ii*) Analogous organs**

(*iii*) Fossils *[CBSE (AI) 2015]*

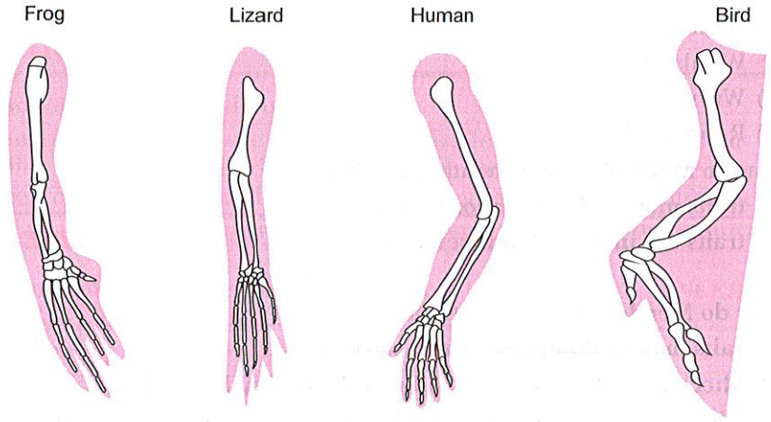
OR

List three factors that provide evidences in favour of evolution in organisms and state the role of each in brief. *[CBSE (F) 2016, 2017]*

Ans. The following are the various evidences in favour of evolution:

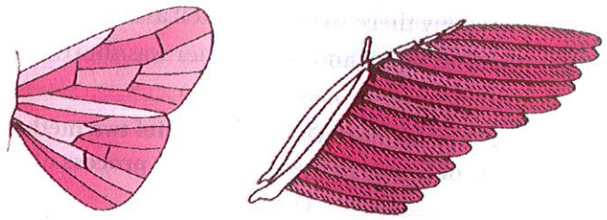
(*i*) **Homologous organs:** Organs with a common basic structural design but with different functions are said to be homologous organ. For example, forelimbs of a frog, lizard, bird and man.

The forelimbs of man are used for grasping, of lizard for running, of frog for propping up and bird for flying. They have different functions but have same structural pattern.



Homologous organs

(*ii*) **Analogous organs:** The analogous organs have different basic structure but perform similar functions. For example, the wing of insects and the wing of birds, have a totally different anatomy and origin but they perform the same function of flying in air.



Analogous organs

(*iii*) **Evidences from fossils:** The fossils also provide evidences for evolution. For example, the fossil *Archaeopteryx* looks like a bird but it bears a number of other features, which are found in reptiles. This observation provides a clue that birds have evolved from reptiles.

Q. 7. Explain the ways in which evolutionary relationships can be traced.

Ans. Evolutionary relationships can be traced in the following ways:

(*i*) **Study of homologous organs:** Some organs in different organisms are similar in structure and design because they are inherited from a common ancestor. For example, forelimbs of horse, wings of bird and arms of man may be functionally different, but because of their similarity in structure, origin and design, they indicate that horse, birds and man are closely linked and had a common ancestor.

(*ii*) **Study of fossils:** Fossils are the remains or impressions of organisms that existed in the past, allow us to study organ structure of organisms that are no longer alive. Comparing their organ structure with organ structure of present day organisms also enable us to trace evolutionary relationships.

(*iii*) **Comparing DNA of different species:** This will give us a direct estimate of how much the DNA has changed during the formation of these species. This, too, can be used as a criterion to trace evolutionary relationships.

Q. 8. Describe Darwin's theory of evolution.

Ans. Following are the points of Darwin's theory of natural selection:

(*i*) **Over-production:** Every organism has enormous potential to reproduce.

(*ii*) **Struggle for existence:** Population size of an organism is limited due to struggle between the members of same species as well as the members of different species. It is due to struggle for food, space and mate.

(*iii*) **Variation:** Due to struggle, the fit organisms possess some variations which are favourable, and they can leave the progeny to continue the favourable variations.

(*iv*) **Survival of the fittest:** The fittest organism survive to continue the favourable variations.

(*v*) **Formation of a new species:** These variations when accumulated for a long time, leads to the origin of a new species.

Q. 9. Explain Mendel's experiment with peas on inheritance of characters considering only one visible contrasting character. *[CBSE (F) 2015]*

Ans. Mendel conducted breeding experiments with garden peas:

(*i*) He studied plants (pure) of a tall/short varieties.

(*ii*) He crossed them and obtained F_1 progeny.

(*iii*) He found that F_1 progeny was all tall plants.

(*iv*) He selfed the (hybrid) plants of F_1 progeny.

(*v*) He found that in F_2 progeny there were tall as well as short plants.

(*vi*) The three quarter plants were tall and one quarter was short .

(or any other contrasting character may be taken.)

Q. 10. What are fossils? How are they formed? Describe in brief two methods of determining the age of fossils. State any one role of fossils in the study of the process of evolution. *[CBSE (AI) 2015]*

OR

What are fossils? How are they formed? List two methods of determining the age of fossils. Explain in brief the importance of fossils in deciding the evolutionary relationships.

[CBSE (F) 2016, 2017]

Ans. Fossils are dead remains of animals and plants from remote past.

Fossils are formed when dead organisms are not completely decomposed. The organisms may get trapped in resins of tree, lava of volcanoes or hot mud, which when hardens retains the animal's parts thus forming fossils.

Two methods of determining the age of fossils are:

(*i*) **Relative method:** By estimating the age of the layer of earth's crust where the fossil is found. Fossils near the surface are recent and those in the deeper layers are more ancient.

(*ii*) **Radio-carbon dating method:** By detecting the ratios of different isotopes of carbon in the fossils.

Fossils play the following roles:

(*i*) By determining the age of fossils we come to know the type of earth strata present at that time.

(*ii*) We can also know the type of animals and plants present on the earth at that time.

(*iii*) They help in establishing evolutionary relationship by providing connecting links. (*Any one*)

Q. 11. What is speciation? List four factors that could lead to speciation. Which of these cannot be a major factor in the speciation of a self-pollinating plant species? Explain. Give reason to justify your answer. *[CBSE Delhi 2016, (F) 2015]*

Ans. Speciation is the formation of new species from the pre-existing population.

Factors responsible for speciation:

(*i*) Genetic drift (*ii*) Natural selection

(*iii*) Geographical isolation (*iv*) Mutation

Geographical isolation cannot be a major factor in the speciation of a self pollinating plant species because physical barrier cannot be created in self-pollinating plants.

Q. 12. A. How does speciation take place?

B. Define the term gene.

C. The gene for red hair is recessive to the gene for black hair. What will be the hair colour of a child if he inherits a gene for red colour from his mother and a gene for black hair from his father? Express with the help of flow chart. *[CBSE Sample Paper 2016]*

Ans. A. Speciation may take place by

(*i*) Migration (*ii*) Natural selection

(*iii*) Mutation (*iv*) Genetic drift (Any two)

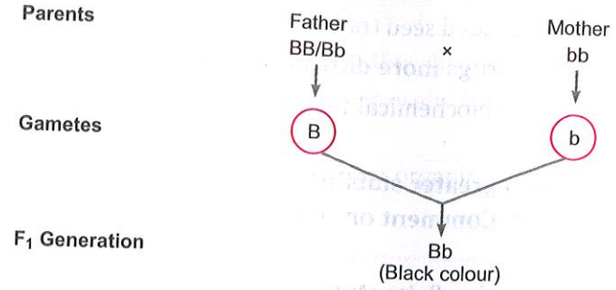
B. The segment of DNA which is functional and is made of nucleic acids and protein is called gene.

C. Given,

Mother has red hair which is recessive, *i.e.*, bb

Father has black hair which is dominant, *i.e.*, BB or Bb.

The inheritance pattern can be shown as follows:



Thus, the child will have black hair.

Q. 13. How has the method of 'artificial selection' by humans helped in the evolution of different vegetables?

Ans. A wild variety of a plant may show different variations. Humans have selected some such variants and grown them for generations and during the course of time, they have become totally different species.

For example, variants in wild cabbage were selected on the basis of certain features to generate different vegetables.

(*i*) Short distances between leaves, led to formation of green leaf buds—the common cabbage.

(*ii*) Arrested flower development has bred broccoli.

(*iii*) The variant with sterile flowers has made the cauliflower.

(*iv*) Variant with swollen leaf parts—kohlrabi.

(*v*) Variant with larger leaves—kale.

HOTS (Higher Order Thinking Skills)

Q. 1. Why do all the gametes formed in human females have X chromosome?

[NCERT Exemplar]

Ans. Human females have two X chromosomes called sex chromosomes. During meiosis at the time of gamete formation, one X chromosome enters each gamete. Hence all the gametes possess an X chromosome.

Q. 2. In human beings, the statistical probability of getting either a male or female child is 50 : 50. Give a suitable explanation. *[NCERT Exemplar]*

Ans. The sex of an infant is determined by the type of sex chromosome contributed by the male gamete. Since the ratio of male gametes containing X chromosome and those containing Y chromosome is 50 : 50, the statistical probability of male or a female infant is also 50 : 50.

Q. 3. Why did Mendel choose pea plant for his experiments? *[NCERT Exemplar]*

Ans. (*a*) Easy to grow

(*b*) Short lifespan

(*c*) Easily distinguishable characters

(*d*) Larger size of flower

(*e*) Self-pollinated

Q. 4. Give reasons for the appearance of new combinations of characters in the F_2 progeny. *[NCERT Exemplar]*

Ans. The tall/short and round/wrinkled seed trait are independently inherited.

Q. 5. Why is making anti-viral drugs more difficult than making anti-bacterial medicines?

Ans. Since viruses have very few biochemical mechanisms of their own, anti-viral drugs can't be made so easily.

Q. 6. Evolution has exhibited a greater stability of molecular structure when compared with morphological structures. Comment on the statement and justify your opinion. *[NCERT Exemplar]*

Ans. We see immense diversity in size, form, structure and morphological features in the living world. But at the molecular level these diverse types of organisms exhibit unbelievable similarity. For instance, the basic biomolecules like DNA, RNA, carbohydrates, proteins, etc., exhibit remarkable similarity in all organisms.

Proficiency Exercise

Very Short Answer Questions [1 mark]

1. A man with blood group B marries a woman with blood group O and their daughter has blood group O. Is this information sufficient to tell you which of the traits, *i.e.*, blood group B or O is dominant? Why or why not?
2. Sexual reproduction brings marked variation in the offsprings while asexual reproduction does not. Why?
3. What is heredity?
4. What do you understand by monohybrid and dihybrid cross performed by Mendel?
5. What is the cause of variation?

Short Answer Questions–I [2 marks]

6. A change in DNA that is useful for one property to start with, can become useful later for a different function. Explain.
7. Name the scientific terms used to represent the following:
   (*i*) The branch of biology dealing with the study of heredity and variation.
   (*ii*) The transmission of traits from parents to offspring.
8. In human beings, the statistical probability of getting either a male or a female child is 50 : 50. Justify this statement with the help of a diagram.
9. What are homologous structures? Give an example. Is it necessary that homologous structures always have a common ancestor? *[NCERT Exemplar]*

Short Answer Questions–II [3 marks]

10. How is the sex of an offspring determined in the zygote in human beings? Explain with suitable diagram showing the cross between male and female gametes.
11. What is natural selection? List the main concepts of Darwin's theory of natural selection.

12. "The sex of a newborn individual in some species is largely determined genetically, while in others it is otherwise". Give three different examples to justify this statement.
13. Give reasons why acquired characters are not inherited. *[NCERT Exemplar]*
14. Name the descendants of wild cabbage. How were they developed?
15. How do variations arise in organisms? "Variation is useful for the survival of species." Justify this statement with the help of an example. *[CBSE (F) 2017]*
16. What are fossils? How do they act as an evidence for organic evolution? *[CBSE (F) 2017]*

Long Answer Questions [5 marks]

17. Bacteria have a simpler body plan when compared with human beings. Does it mean that human beings are more evolved than bacteria? Provide a suitable explanation. *[NCERT Exemplar]*
18. Why are flippers of whales and wings of birds considered as homologous organs.
19. Explain struggle for existence.
20. Study the following cross and showing self pollination in F_1, fill in the blank and answer the question that follows:

Parents	RRYY	X	rryy	
	Round, yellow		Wrinkled, green	
F_1 —	Rr Yy	X	_____	
	Round, yellow			

In the above cross what are the combinations of character in the F_2 Progeny? What are their ratios? *[NCERT Exemplar]*