Heredity and Evolution

SYLLABUS

Heredity, Mendel's contribution—Laws of inheritance of traits, Sex determination: brief introduction, Basic concepts of evolution.

Facts that Matter

Heredity is the transmission of characters or traits from the parents to their offspring.

Variation is the difference in the characters or traits among the individuals of a species.

Accumulation of Variations

Sexual reproduction of organisms produces variations. The variations produced in organisms during successive generations get accumulated in the organisms. The significance of a variation shows up only if it continues to be inherited by the offspring for several generations.

In sexually reproducing organisms there is a vast similarity. Variations if any are not genetic but due to environment and are non-inheritable.

Variation increases the chances of survival of a species in a changing environment. Selection of variants by environmental factors forms the basis for evolution process.

Heredity: The rules of heredity determines the process by which traits are inherited.

Inherited traits are those characters which are transferred from one generation to another e.g., height, skin colour, blood group etc.

Rules for Inheritance of traits (Mendel's contributions):

Inheritance is the transmission of genetically controlled characteristics from one generation to the next.

Gregor Mendel choose pea plants for studying inheritance. Pea plants have a number of clear cut differences e.g., some plants were tall, some short, they are easy to tell apart and also they have a short life cycle.

Mendel's Monohybrid Cross

1. Mendel first crossed pure bred tall pea plants with pure bred dwarf pea plant and found that only tall pea plants were produced in the first generation (F_1).
2. Mendel then crossed the tall pea plants of the Ist generation (F_1) and found that both tall plants and dwarf plants were obtained in the second generation (F_2) in the ratio 3:1 i.e., 3/4 tall and 1/4 dwarf plant (monohybrid ratio).

Mendel's Dihybrid Cross

A breeding experiment dealing with two characters at the same time is called a dihybrid cross. Mendel considered shape as well as colour of seeds simultaneously.

Mendel's Conclusion: Based on the findings of monohybrid and dihybrid crosses Mendel concluded—

(*i*) In a monohybrid cross, only one of two contrasting characters (traits) appeared in F_1 generation. However, in F_2 generation, both the parental traits appeared in certain proportion.

(*ii*) In a dihybrid cross, when two contrasting pairs of traits were considered simultaneously, only a parental combination appeared in F_1 generation. However, in F_2 generation, raised by self-pollination, other combinations of traits appeared. These included two parental type traits and two new combinations in approximately same proportion.

Mendel's Interpretation: On the basis of monohybrid and dihybrid crosses, Mendel postulated:

(*i*) There are a pair of unit **factors** controlling each character in pea plant, one inherited from each parent. Mendel considered these factors as the carriers of hereditary information from one generation to another, *i.e.*, from parents to the offsprings. At the time of reproduction, when gametes are formed, these factors segregate so that each gamete receives only one factor of each character. This is called **law of segregation. Fertilisation** brings these two factors again together in the offspring.

(*ii*) In F_1 generation, only one character was expressed. Mendel called it as **dominant** character. The character which was not expressed was termed **recessive** character. **The phenomenon of appearance of only of two contrasting traits in F_1 generation, is termed as dominance.**

(*iii*) The characters are not lost even when they are not expressed.

(*iv*) When F_1 offsprings were allowed to be self pollinated, both the parental traits were expressed in definite proportion in F_2 generation.

(*v*) From the F_1 generation of a dihybrid cross, Mendel postulated that inheritance of factors controlling a particular trait in an organism are independent of the other. **This is called law of independent assortment.** Hence, at the time of reproduction, two pairs of factors of each of the two traits in a dihybrid cross segregated independently during gamete formation and randomly formed combinations.

How do these Traits get expressed?

Traits of parents are transmitted to their offsprings (progeny) through genes present on their chromosomes during the process of sexual reproduction.

In sexually reproducing organisms sex cells are produced by meiosis. Each gamete (sex cell) has a single set of chromosomes. Chromosomes are thread like structure present in the nucleus of a cell which contain hereditary information of the cell. Chromosomes are made up of DNA and proteins. The most important component of chromosome is DNA. Each species has a fixed number of chromosomes in each of its cells. Chromosomes occur in pairs.

One chromosomes comes from the father and the other from the mother. DNA carries the code used by the cell while making proteins. Each chromosome contains one molecule of DNA and genes are the segments of DNA. A section of DNA that provides information for one protein is the gene for that protein e.g., the amount of plant hormone made will depend on the efficiency of the process for making it. If protein works more efficiently, a lot of hormone will be produced, and the plant will be tall.

During fertilisation when the sperm fuses with a female gamete the number of chromosomes of that species is restored. The progeny inherits 2 genes for each trait from its parents but the trait shown by the progeny is the dominant one e.g., in case of traits tallness and dwarfness, tallness is dominant over the gene for dwarfness.

Sex Determination

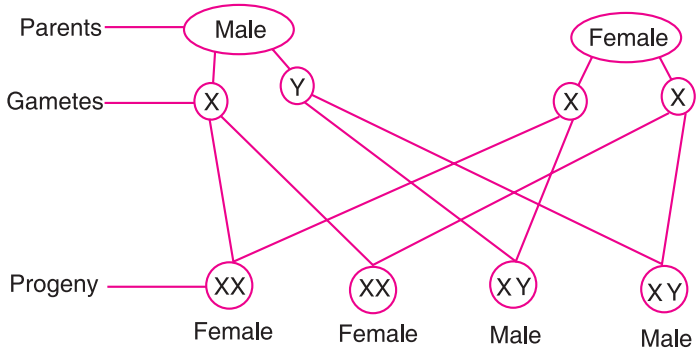
The chromosomes that is associated with sex-determination is known as **sex chromosome.** The other chromosomes are called **Autosomes.**

Sex chromosomes was observed as an unpaired chromosomes in the male grasshoppers during spermatogenesis. This was larger and given the name X-chromosomes. Female carry 2 copies of this chromosome.

In **Drosophila** and humans presence of a specific Y-chromosome was observed among males, in addition to single X-chromosomes. Female have two X-chromosomes.

Females produce gametes both with X-chromosomes. Male have one X and one Y chromosome so half of the sperms carry X-chromosomes and the other half Y-chromosome. All gametes in the females carry one X-chromosome.

When a sperm carrying X-chromosome fertilizes an egg, the zygote develops into a female (XX). When sperm with Y-chromosome fertilizes an egg, the zygote develops into a male (XY).



Evolution

Evolution is a change in the genetic composition of a population. Variations occur due to sexual reproduction or errors in DNA copying.

Illustration

A group of 12 red beetles lives in a bush with green leaves. They are preyed upon by crows. Many situations can develop in this population.

1. Colour variations during reproduction. One beetle develops a green body colour. Crows cannot locate green beetles in the green bush hence the number of green

beetles increases as compared to red beetles. In this case **Natural selection** is exerted by crows and **individuals more suited to the environment survive.**

2. One beetle develops a blue colour. Blue and red both are detected by crows and are eaten. If calamity strikes e.g., an elephant stamps on the bush and **by chance** only blue beetles survive then their number increase. **This random change in the gene frequency occurring by chance irrespective of its being beneficial or harmful is called genetic drift.**
3. In this situation when bushes develops disease, food for beetles reduces. Due to scarcity of food beetles are poorly nourished. The average weight of beetles decreases. Then when scarcity is over the average weight of beetles are again increased.

Acquired and Inherited Traits

There are 2 kinds of traits in every organism.

(*i*) Inherited traits. These traits are controlled by specific genes and are passed on from one generation to another. Any alteration in the DNA will be passed on, through germ cells, to progeny resulting in variations in them.

(*ii*) Acquired traits. Certain traits are acquired by organisms in their life time. For instance, decrease in the body weight of beetles due to starvation is an acquired trait by the beetles during their life time. It involves changes in the non-reproductive tissues caused by environmental factors. It will not bring any change in the DNA. Therefore, even if some of the generations of beetle are low in weight because of starvation, this trait can not be inherited by the progeny over generations.

Speciation

Origin of a new species from the existing one is called speciation.

The important factors which could lead to the rise (or formation) of a new species are the following:

(*i*) Geographical isolation of a population caused by various types of barriers (such as mountain ranges, rivers and sea). The geographical isolation leads to reproductive isolation due to 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 is by chance alone.

(*iii*) Variations caused in individuals due to natural selection.

In most of the cases, new species are formed when the population of some species splits into two separate groups which then get isolated from each other geographically by the barriers such as mountain ranges, rivers or the sea. The geographical isolation of the two groups of population leads to their reproductive isolation due to which no genes are exchanged between them. However, breeding continues within the isolated populations producing more and more generations. Over the generations, the processes of genetic drift (random change in gene frequency), and natural selection operate in different ways in the two isolated groups of population and make them more and more different from each other. After thousand of years, the individuals of these isolated groups of population become so different that they will be incapable of reproducing with each other even if they happen to meet again. We say that new species have been formed.

Evolution and Classification

Characteristics are details of behaviour or appearance. The more characteristics two species will have in common, the more closely they are related. They will also have a common ancestor. Classification of species is a reflection of evolutionary relationship.

Evidences of Evolution

Homologous organs: Organs of different organism that have structural similarity, develop in the same way but perform different functions e.g., forelimb of a frog, a bird, and a human. Similarities indicate that all these vertebrates had a common ancestor.

Analogous organs: Organs of different organisms that are structurally and developmentally different but perform same function. e.g., wings of birds and insects.

Fossils: Remains or impressions of the hard parts of past organisms found in the strata of the earth.

AGE OF FOSSILS

1. **Relative:** Fossils found closer to the surface are more recent than fossils found in the deeper layers.
2. **Radioactive dating:** The age of a fossil can be calculated based on the property of radioactive uranium which changes to lead. The amount of lead in a rock can help to calculate, the age of the fossil.

Evolution by Stages

Evolution by an organism or its organs from simple to complex has taken place in stages:

(*a*) Feathers were first developed in dinosaurs but they could not fly. They protected them from the cold. Later birds used feathers for flight. This indicates that birds are related to dinosaurs also that a character developed for one function is later on used for an entirely different function.

(*b*) Eyes developed first in planaria as photosensitive eye spots. Simple and compound eyes developed in insects and crustaceans. The structure of eye in each is different enough for them to have separate evolutionary origins.

(*c*) Artificial selection is the process by which man selects traits useful to him for improving the qualities of domesticated plants and animals e.g., different vegetables developed from the wild cabbage-cauliflower, broccoli, red cabbage, kale.

Molecular phylogeny is the branch of science which is used to trace the change in DNA (introduced during cell division and accumulated over generations) backwards in time to find out where each change diverged from the other. Thus, closely related organisms accumulated lesser number of differences in their DNA as compared to distantly related organisms which accumulate greater number of differences in their DNA. Such studies help in teaching evolutionary relationships among organisms.

Evolution should not be Equated with Progress

Evolution is the generation of diversity and the shaping of the diversity by environmental selection. The only progressive trend in evolution is that more complex designs have emerged over time. But simple designs are also efficient e.g., bacteria, protozoan have survived. New species evolved from previous one. Natural selection and genetic drift lead to the formation

of a population which cannot reproduce with the original one. New species may have better adaptive advantage to environmental conditions.

Human Evolution

Human evolution has been studied by using various tools for tracing evolutionary relationships like excavating, carbon dating, studying fossils and determining DNA sequences. All human beings are single species called **Homo sapiens.** Earliest members of this species came from Africa.

Human beings and chimpanzees are closely related species. Both these had a common ancestor a long time ago. This ancestor diverged into several forms and each form evolved in its own separate way to give rise to present forms of human beings, chimpanzees and other great apes.

NCERT IN-TEXT ACTIVITIES SOLVED

ACTIVITY 9.1

To study the earlobes of students in the class.

Observation: It is observed that the lowest part of the ear, called the earlobe, is closely attached to the side of the head in some of us, and not in others. Hence, free and attached earlobes are two variants found in human populations.

ACTIVITY 9.2

For Mendel's experiment.

(I) TT tt

Tall short

F_1 Progeny— Tt Tt Tt Tt

All tall plants

(II) Tt Tt

F_2 Progeny— on crossing of traits we get 1 : 2 : 1 ratio as follows:

	T	t
T	TT	Tt
t	Tt	tt

T—is dominant hence

∴ TT — Tall

Tt — Tall

tt — Short

NCERT IN-TEXT QUESTIONS SOLVED

Q1. *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 as it occurs in more number.

Q2. *How does the creation of variations in a species promote survival?*

Ans. Variations increases the adaptability of an organism to its changing environmental conditions.

Q3. *How do Mendel's experiments show that traits may be dominant or recessive?*

Ans. Mendel took pea plants of two different characters *i.e.*, tall plants and short plants. The first generation of F_1 progeny formed were all tall. This shows that traits may be either dominant or recessive, there is no way in between traits obtained.

Q4. *How do Mendel's experiments show that traits are inherited independently?*

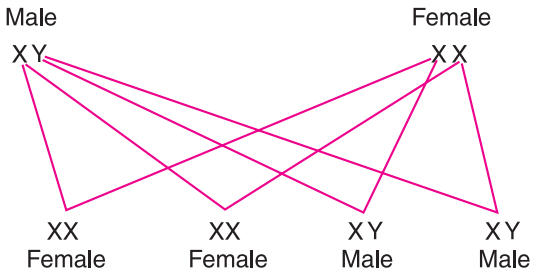
Ans. When Mendel crossed pure bred tall pea plants with pure bred short pea plants, he found that only tall plants were produced in F_1 generation. Mendel, further crossed the tall pea plants obtained in F_1 generation with dwarf plants and obtained the ratio of Tall: Short plant as 3 : 1 in F_2 generation. This experiment proved that traits are inherited independently so other intermediate traits or new traits were formed.

Q5. *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 given information is *not enough* to tell us which of the traits-blood group A or O – is dominant. In blood heredity, bood type A is always dominant and blood type O is always recessive. Here, father's Blood group can be I^AI^A (homozygous) or I^Ai (heterozygous) genotypically, whereas that of mother is *ii*. For daughter to be born with blood group O, she must receive *i* type gene one each from father and mother. For this father must have heterozygous I^Ai blood group and mother must have homozygous blood group *ii*.

Q6. *How is the sex of the child determined in human beings?*

Ans. In case of human beings female sex have a pair of XX chromosomes (sex) and male sex have a pair of XY sex chromosome. When the crossing of male and female gametes takes place then the sex of the child is determined as follows:



This shows that the ratio of male: female sex of the child is same *i.e.*, (1 : 1), 50% possibility of each is seen here.

Q7. *What are the different ways in which individuals with a particular trait may increase in a population?*

Ans. The ways in which individual with a particular trait may be increased in a population are:

(*a*) If it can survive in the adverse condition *i.e.*, naturally selected.

(*b*) It can also be increased by the inheritance.

Q8. *Why are traits acquired during the life-time of an individual not inherited?*

Ans. The traits can be inherited from one generation to the other only if there is a variation/change in DNA. The traits acquired during the life-time of an individual may not bring change in the genes of DNA.

Q9. *Why are the small numbers of surviving tigers a cause of worry from the point of view of genetics?*

Ans. The small number of tigers are causing a worry for the genetics because if they become extinct then the genes of this species will be lost forever. There will be no scope of again getting this species back to life without their genes.

Q10. *What factors could lead to the rise of a new species?*

Ans. The factors which can lead to the rise of a new species are gene flow, genetic drift, reproductive isolation and natural selection.

Q11. *Will geographical isolation be a major factor in the speciation of a self-pollinating plant species. Why or why not?*

Ans. No, geographical isolation cannot be a major factor in the speciation of self-pollinating plant species.

It is because such plants do not depend on other plants for its further reproduction to be carried out.

Q12. *Will geographical isolation be a major factor in the speciation of an organism that reproduces asexually? Why or why not?*

Ans. No, because the asexually reproducing organisms does not depend on other organisms for their reproduction.

Q13. *Give an example of characteristics being used to determine how close two species are in evolutionary terms.*

Ans. Two organisms with similar characteristics have genes with similar DNA codes. Whereas the organisms with different characteristics will have different genes, different DNA structures.

Q14. *Can the wing of a butterfly and the wing of a bat be considered homologous organ? Why or why not?*

Ans. The wing of butterfly and the wing of a bat cannot be considered homologous organs because both have different structures but same function. They have different basic structural design and developmental origin. They are analogous organs.

Q15. *What are fossils? What do they tell us about the process of evolution?*

Ans. Preserved traces of living or dead organisms on solid hard surface is called fossil. Fossils help us to know the evolution. If a fossil is found closer to the surface of earth, then it is more recent in origin than the fossils we find in deeper layers.

Fossils, like Archaeopteryx, help us to find evolutionary relation between organisms.

Q16. *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. Because irrespective differences in characters they have capacity of interbreeding. Interbreeding is an important criteria to categorize them as one species.

Q17. *In evolutionary terms, we can say which among bacteria, spiders, fish and chimpanzees have a better body design? Why or why not?*

Ans. Evolution shows that body design changed from simple to complex. Hence, bacteria has the simplest body design and chimpanzee has the most complex and better body design.

QUESTIONS FROM NCERT TEXTBOOK

Q1. *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 suggests that the genetic make-up of the tall parent can be depicted as*

(*a*) *TTWW* (*b*) *TTww*

(*c*) *TtWW* (*d*) *TtWw*

Ans. (*c*) TtWW

Q2. *An example of homologous organs is*

(*a*) *our arm and a dog's fore-leg.*

(*b*) *our teeth and an elephant's tusks.*

(*c*) *potato and runners of grass.*

(*d*) *all of the above.*

Ans. (*d*) all of the above.

Q3. *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*) a Chinese school-boy

Q4. *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. No, we cannot say that the traits is recessive or dominant unless we know the nature of the two variants of a trait.

Q5. *How are the areas of study—evolution and classification—interlinked?*

Ans. For classification of organisms we generally group the organisms of same characteristics together and those with different characteristics are grouped or classified separately. A set of characteristics tells about the level of evolution of an organism.

Q6. *Explain the terms analogous and homologous organs with examples.*

Ans. Analogous organs—Organs with different structure and same function e.g., wings of bird, insects.

Homologous organs—Organs which have same structure but different functions are called homologous organ e.g., forearm of lizard, bird and human.

Q7. *Outline a project which aims to find the dominant coat colour in dogs.*

Ans. **Dominant → WW (white colour)**

		w	w
White	W	Ww	Ww
colour	W	Ww	Ww

F_1 generation–all white dogs

Ww (Male) Ww (female)

	w	w
W	WW	Ww
w	Ww	ww

F_2 generation

WW, Ww, Ww } White ww black

3 : 1

Q8. *Explain the importance of fossils in deciding evolutionary relationships.*

Ans. Fossils help us to know the following:

(*a*) Fossils help to trace the racial history of organisms.

(*b*) They help to measure the geological time.

(*c*) Older fossils lie at the depth and young fossils are at the upper surface of the earth. Complex organisms are present at top and simple organisms are present at the bottom.

(*d*) Fossil like—Archaeopteryx-show the link between two different types of species.

Q9. *What evidence do we have for the origin of life from inanimate matter?*

Ans. Miller and Urey in 1953 assembled an atmosphere similar to that thought to exist at early period (Gases like ammonia, methane, hydrogen sulphide) over earth. This was maintained at a temperature just below 100°C and sparks were passed through the mixture of gases to simulate lighting. 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. Presence of protein cell membrane correlates with above experiment. This shows that life originated from inanimate matter.

Q10. *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. Variations are seen more in sexual reproduction than asexual reproduction because variations occur due to change in DNA coding and due to sexual reproduction in which two genes from two different sexes *i.e.*, male and female genes crossing over takes place and hence cause the variation.

Q11. *How is the equal genetic contribution of male and female parents ensured in the progeny?*

Ans. By studying the crossing over of genes of male sex and female sex is as follows:

	M ale		**Female**
	XY		**XX**
		X	X
X		XX	XX
Y		XY	XY
	XX		XY
	↓		↓
	Female		Male
F_1	50%		50%
Progeny			

Q12. *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. No, depending on the nature of variations different individuals have different kinds of advantages. However, when a drastic change occurs in environment only those organism in the population will survive which have an advantageous variation in that population to survive in changed environment.

MORE QUESTIONS SOLVED

I. MULTIPLE CHOICE QUESTIONS

1. Which of the following is a totally impossible outcome of Mendel's Experiment (cross breeding pure bred tall and short pea plants)

(*a*) 3 tall 1 short plant (*b*) 24 tall and 8 short plants

(*c*) 8 tall and 0 short plants (*d*) 4 tall plants and 1 medium-height plant.

2. Which one of the following is not one of the direct conclusions that can be drawm from Mendel's experiment?

(*a*) Only one parental trait is expressed

(*b*) Two copies of each trait is inherited in sexually reproducing orgainsm

(*c*) For recessive trait to be expressed, both copies should be identical.

(*d*) Natural selection can alter frequency of an inherited trait.

3. Which one is a possible progeny in F_2 generation of pure bred tall plant with round seed and short plant with wrinkled seeds?

(*a*) Tall plant with round seeds (*b*) Tall plant with wrinkled seeds

(*c*) Short plant with round seed (*d*) All of the above

4. A section of DNA providing information for one protein is called—

(*a*) Nucleus (*b*) Chromosomes

(*c*) Trait (*d*) Gene

5. Which of the following is controlled by genes?

(*i*) Weight of a person

(*ii*) Height of a person

(*a*) only 1 (*i*) (*b*) only (*ii*)

(*c*) both (*i*) and (*ii*) (*d*) Sometimes (*i*) and sometimes (*ii*)

6. Which one of the following is present in the nucleus?

(*a*) Gene (*b*) DNA

(*c*) Chromosomes (*d*) All of these

7. Amongst which of the following animals, sex of the offsprings not genetically determined?

(*a*) Humans (*b*) Snails

(*c*) Birds (*d*) Dogs

8. What is the probability that a human progeny will be a boy?

(*a*) 50% (*b*) 56%

(*c*) 47.34% (*d*) It varies

9. Who have a perfect pair of sex chromosomes?

(*a*) Girls only (*b*) Boys only

(*c*) Both girls and boys (*d*) It depends on many other factors

10. There is an inbuilt tendency of variation during reproduction because of–

(*i*) Errors in DNA copying

(*ii*) Sexual reproduction

(*a*) only (*i*) (*b*) only (*ii*)

(*c*) both (*i*) and (*ii*) (*d*) none of them

11. Which one of the following gives a survival advantage and thus alters frequency of inherited trait.

(*i*) natural selection

(*ii*) genetic drift

(*a*) only (*i*) (*b*) only (*ii*)

(*c*) both (*i*) and (*ii*) (*d*) none of these

12. If we breed a group of squirrels and surgically remove their tails, then amongst the progeny of these tailless squirrels–

(*a*) All have no tail (*b*) All have a tail

(*c*) Some of them have tails (*d*) Cannot be determined.

13. With whom we associate theory of evolution?

(*a*) Charles Darwin (*b*) Mendel

(*c*) Stanley Miller (*d*) Harold Urey

14. Formation of 2 independent species due to genetic drift, geographical isolation, natural selection is specifically referred as–

(*a*) Evolution (*b*) Classification

(*c*) Speciation (*d*) Reproduction

15. Which of the following can be called a characteristic?

(*a*) Plants can photosynthesise (*b*) We have 2 eyes

(*c*) Mango tree is multicellular (*d*) All of these

16. If A and B have n characteristics common while A and C have n/2 characteristics common, then which of the two organisms are more closely related?

(*a*) A and C (*b*) A and B

(*c*) Characteristics need to be known (*d*) None of these

17. Homologous organs have

(*a*) Same structure, same function (*b*) Different structure, different function

(*c*) Same structure, different function (*d*) Same function, different structure

18. Analogous organs have

(*a*) Same structure, same function (*b*) Different structure, different function

(*c*) Same structure, different function (*d*) Same function, different structure

19. Fossils helps

(*a*) To study evolution

(*b*) To understand climatic conditions in past

(*c*) For a hierarchy of organisms (classification)

(*d*) They help in all the above

20. How can we know how old fossils are:

(*a*) Fossils found closer to surface are recent than those found much below

(*b*) Detecting ratios of isotopes

(*c*) Studying its characteristics

(*d*) All of these

21. Which one of the following strongly indicates that bird and dinosaurs are closely related?

(*a*) They both have feathers (*b*) They both respire

(*c*) They both reproduce (*d*) They both have eyes

22. Wild cabbage is being cultivated for thousands of years and humans have generated broccoli, cauliflower, kala etc. from it. This is an example of

(*a*) Natural selection (*b*) Genetic drift

(*c*) Geographic isolation (*d*) Artificial selection

23. Organism A recently came into existence while B was formed millions of years ago. What does this indicate?

(*i*) A is more efficient than B

(*ii*) A is more complex than B

(*a*) Only (*i*) (*b*) Only (*ii*)

(*c*) Both (*i*) and (*ii*) (*d*) Either (*i*) or (*ii*)

Answers

1. (*d*)	**2.** (*d*)	**3.** (*d*)	**4.** (*d*)	**5.** (*b*)	**6.** (*d*)	**7.** (*b*)	**8.** (*a*)
9. (*a*)	**10.** (*b*)	**11.** (*a*)	**12.** (*b*)	**13.** (*a*)	**14.** (*c*)	**15.** (*d*)	**16.** (*c*)
17. (*c*)	**18.** (*d*)	**19.** (*d*)	**20.** (*d*)	**21.** (*a*)	**22.** (*d*)	**23.** (*c*)	

II. VERY SHORT ANSWER TYPE QUESTIONS (*1 Mark*)

Q1. *Define heredity.*

Ans. Heredity deals with the inheritance of characters from one generation to the next.

Q2. *Define variations.*

Ans. Variations are differences that occur between the organisms of the same species in spite of the same basic feature.

Q3. *How does the creation of variations in a species promote survival?*

Ans. Variations increases the adaptability of an organism to its changing environmental conditions.

Q4. *What is a trait?*

Ans. A characteristics feature is called a trait.

Q5. *Name two human traits that show variations.*

Ans. Colours of eyes and shape of external ears.

Q6. *What is adaptation?*

Ans. An adaptation is characteristics feature which helps an organism to survive in its habitat in a better way.

Q7. *Which of the two sperm or egg–decides the sex of the child?*

Ans. The sperm decides the sex of the child.

Q8. *The forelimbs of frog, reptiles, birds and arms of man show the same basic design. What kind of organs are these?*

Ans. Homologous organs.

Q9. *What is microevolutions?*

Ans. Microevolutions is the evolution that takes place on a relatively small scale at the population level and can change the common characteristics of particular species.

Q10. *What is speciation?*

Ans. Speciation is the process of formation of a new species from the already existing species by accumulation of variations, natural selection, gene flow, genetic drift, etc.

Q11. *What is a gene?*

Ans. Gene is the unit of inheritance. It is a part of the chromosome which controls the appearance of a set of hereditary characteristics.

Q12. *Who is known as the "father of Genetics"?*

Ans. G.J. Mendel is called the "father of Genetics".

Q13. *What is evolution?*

Ans. Evolution is the sequence of gradual changes which take place in living organisms over millions of years to give rise to new species.

Q14. *What type of reproduction gives rise to more number of successful variations?*

Ans. Sexual reproduction.

Q15. *What are fossils?*

Ans. Fossils are preserved traces or remains of living organisms of geological past.

Q16. *What are the uses of fossils?*

Ans. 1. Fossils helps to trace the racial history of organisms.

2. They help to analyse the past climatic conditions.

3. They help to measure the geological time.

Q17. *Name the scientist who put forth the theory of natural selection.*

Ans. Charles Darwin.

Q18. *What is artificial selection?*

Ans. It is the process of modification of a species by selective breeding. Animals and plants with desirable characters are selected and propagated. Artificial selection by farmers has resulted in the formation of cauliflowers, cabbage, broccoli and kohlrabi from the wild cabbage.

III. SHORT ANSWER TYPE QUESTIONS (*2 or 3 Marks*)

Q1. *How can we trace evolutionary relationships?*

Ans. Evolutionary relationships can be traced by studying fossils, by studying homologous and analogous organs, by comparing the embryos of different animals and by comparing the DNA's of different species.

Q2. *What is phylogeny and molecular phylogeny?*

Ans. Phylogeny is the evolutionary history of an organism.

Molecular phylogeny traces the evolutionary relationships by comparing the differences in the DNA of different organisms.

Q3. *Why evolution should not be equated with progress?*

Ans. Evolution cannot be equated with progress because it seems to have just given rise to more complex body designs. For example bacteria still flourish in spite of a very simple body design while dinosaurs did not survive in spite of complex design. Thus evolution is simply the generation of diversity and shaping of diversity by environmental selection.

Q4. *What is environmental selection?*

Ans. It is the selection within a population resulting from the influence exerted by the environment. It leads to a change in the composition of genes within a population.

Q5. *What term did Mendel use for genes? Where are the genes located?*

Ans. Mendel used the term 'factors' for genes. Genes are portions of DNA which code for a single protein.

Q6. *How many pairs of chromosomes do human beings have, specify the types of chromosomes also?*

Ans. Human beings have 23 pairs of chromosomes the first 22 pairs are called **autosomes** are similar in males and females. The 23rd pair is called the **sex chromosome.** In males it is XY and in females it is XX.

Q7. *What are homologous organs? Explain with an example.*

Ans. Homologous organs are those organs in different plants or animals which have the same basic structural design and origin but may have different functions.

Example., hand of human and fore-limb of frog.

Q8. *What are analogous organs? Explain with an example.*

Ans. Analogous organs have the same function but have different structural design and origin. For example, wings of birds and insects have the same function but have different structural design and origin.

Q9. *State the importance of variations.*

Ans. Variations are the differences in the characters among the individuals of a species. Variations enable the organisms to adapt themselves in the changing environmental conditions.

Variations form the raw materials for evolution and formation of new species.

Q10. *What is the significance of studying homologous and analogous organs?*

Ans. Organisms that have homologous organs show relatedness and a common ancestory.

Q11. *Which of the following combinations of sex chromosomes produces a male or a female child—XX or XY?*

Ans. XX combination produces a female child while the XY combination produces a male child.

Q12. *Which of the following are homologous and analogous organs?*

(*a*) *Wings of birds and insects.* (*b*) *Flippers of whale and fins of fish.*

(*c*) *Flippers of whale and wings of bat.* (*d*) *Our teeth and elephants tusks.*

(*e*) *Potato and runners of grass.*

Ans. (*a*) — Analogous organs

(*b*) — Analogous organs

(*c*) — Homologous organs

(*d*) — Homologous organs

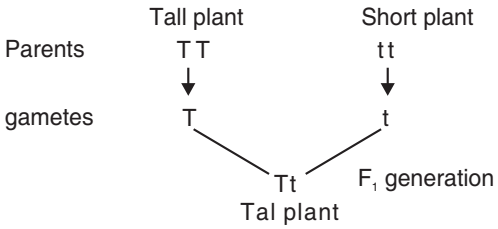
(*e*) — Homologous organs.

Q13. *How do traits or characters get expressed?*

Ans. Genes control the expression of a trait or a character in an organism. Genes produces proteins. The proteins act as enzymes which can directly control a character or help in the formation of a hormone which can control the expression of a particular character.

Q14. *A true breeding tall plant is crossed with a true breeding short plant. All the offsprings of the F_1 generation are tall. Of these two characters which one is dominant and which is recessive.*

Ans.



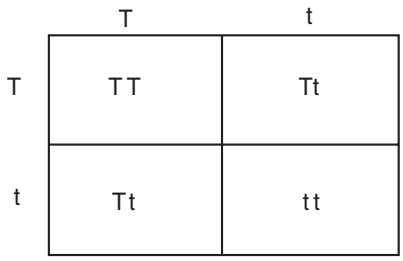
Q15. *In Q14. on previous page the tall plant of the F_1 generation is selfed. What is the outcome or ratio of the F_2 progeny?*

Ans. Parent: Tall Tall (heterozygous)

Tt Tt

/ \ / \

Gametes: T t T t



Progeny: TT Tt Tt tt

(F_2 generation) Tall Tall Tall Short

Ratio Tall : Short

3 : 1

Q16. *How is the sex of the child determined in human beings?*

Ans. Human beings have 23 pairs of chromosomes. 22 pairs are autosomes and the 23rd pair is the sex chromosome. The males have XY and the females have XX. All the gametes formed in the females are of one type i.e., X. In males there are two types of sperms that are formed –X and Y. If the sperms having X fertilizes with the egg the zygote formed is XX. This will form female child. If the sperm having Y fertilizes with the egg then the zygote formed is XY and the offspring will be male child. So basically it's the male gametes that decide the sex of the unborn child.

Q17. *What is genetic drift?*

Ans. Accidents in small populations can change the frequency of some genes in a population even if they give no survival advantage. This is genetic drift, which provides diversity without any adaptations. So, it is the random change in the frequency of alleles in a population over successive generation.

Q18. *Which is gene flow?*

Ans. It is the exchange of genetic material by interbreeding between populations of the same species. Gene flow increases the variations in a population.

Q19. *What is classification?*

Ans. It is the arrangement of organism into series of groups based on the similarity of characters on physiology, anatomy, morphology and other relationships.

Q20. *How do we know how old fossils are?*

Ans. We can find the relative of the fossil by the depth at which the fossil is found. The ones that are found near the surface are more recent than the fossils found in the deeper layer.

The second way of dating fossils in detecting the ratios of different isotopes of the same element in the fossils material.

Q21. *What is speciation? How does it occur?*

Ans. Formation of new species from the existing ones over the period of time is called speciation.

Speciation takes place due to gene flow, genetic drift, reproductive isolation and finally natural selection.

Q22. *What is natural selection?*

Ans. According to Darwin, natural selection is the process which brings about evolution of new species of plants and animals.

It consists of the following processes:

(*i*) He noted that the size of population tends to remain constant despite the fact that more offsprings are produced than needed.

(*ii*) Variations provide adaptations.

(*iii*) The best adopted survive in the changing environment (survival of the fittest).

(*iv*) Nature selects the best organisms with better adaptations and after many generations new species are formed (natural selection).

Q23. *Define Genetics. What did Mendel's contribution to genetics?*

Ans. The science of heredity and variation is called Genetics.

Mendel conducted breeding experiments in a plant called garden pea (pisum sativum) with contrasting pair of characters, found that only one character of the pairs appeared in the first generation but both the characters appeared in the subsequent generation. On the basis of these results of his experiments he put forth the various principals of inheritance. He also suggested that each character is controlled by a pair of factors which are now called as genes.

Q24. *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?* (CBSE 2008)

Ans. Refer to Q5. on page 115.

Q25. *Define variation in relation to a species: Why is variation beneficial is the species.*

Ans. Variations are differences that occur between the organisms of the same species in spite of the same basic features.

Variation in species promotes survival of an organism in changing environment by increasing the adaptability.

Q26. *What is the effect of DNA copying which is not perfectly accurate on the reproduction process?* (AI CBSE)

Ans. If DNA copying is not perfectly accurate then the variations occurs among the species of same organisms.

Q27. *Describe briefly four ways in which individual with a particular trait may increase in population.* (Foreign 2008)

Ans. Four ways in which individual with a particular trait may increase in population are:

(*a*) Variations that occur in species helps in the survival of individuals.

(*b*) Organisms when show genetic drift which cope them to survive in the given environment.

(*c*) Adaptation and natural selection.

(*d*) Sexual reproduction results in variation.

Q28. *"Variations that confer an advantage to an individual organism only will survive in population". Justify.* (Foreign 2008)

Ans. Variation is the difference in the characters or traits among the individuals of a species. Sexual reproduction of organisms produces variation. The variations produced in organisms during successive generations gets accumulated in the organism. The significance of variations shows up only if it continues to be inherited by the offspring for several generation.

Q29. *What are fossils? What do they tell about the process of evolution?* (AI CBSE. 2008)

Ans. Fossils are preserved traces or remains of living organism of geological past. Fossils help to trace the racial history of organisms. Fossils found closer to the surface are more recent than fossils found in the deepest layers.

IV. LONG ANSWER TYPE QUESTIONS (*5 Marks*)

Q1. (*i*) *What is genetics?*

(*ii*) *Give the common name of the plant on which Mendel performed its experiments.*

(*iii*) *What for did Mendel use the term factors and what are these factors called now?*

(*iv*) *What are genes? Where are the genes located?*

Ans. (*i*) Science which deals with the study of heredity and variations is called genetic.

(*ii*) Pea plant.

(*iii*) Mendel used the term factors for 'genes'.

(*iv*) Genes is the unit of inheritance. It is a part of the chromosome which controls the appearance of a set of hereditary character.

Genes are located on the chromosome.

Q2. *Define 'evolution'. State Darwin's theory of evolution.*

Ans. **Evolution** is a change in the genetic composition of a population.

Darwin's theory

1. The size of population remains the same, constant despite the fact that more offsprings are produced than needed.
2. Variations provide adaptations.
3. The best adapted organism survive in the changing environment (survival of the fittest).
4. Nature selects the best organisms with better adaptations and after many generations new species are formed (natural selection).

Q3. *What are various evidences in factors of evolution?*

Ans. Evidences are:

(*a*) *Homologous organs:* Organs which have same structure but different function. E.g., wings of a bat, hands of man and limbs of monkey.

(*b*) *Analogous organ.* Organs which perform similar function but are structurally different are called analogous organ. E.g., wings of bat, insects, birds.

(*c*) *Vestigial organs:* These organs are those which appear in an organism but are functionless e.g., vermiform appendix, nictitating membrane in eye is present in human beings but has no function.

(*d*) *Embryological evidence*: The study of embryos of vertebrates shows that all of them have same origin as their structure at initial stage is same. Embryo of frog, fish, man looks alike.

(*e*) *Fossils as evidence*: Archaeopteryx fossils shows a link between bird and reptiles as this fossil has some feature of bird and some of reptile.

Q4. (*i*) *What are traits?*

(*ii*) *Explain the inherited trait and acquired traits.*

(*iii*) *Define speciation. What are the factors which could lead to the rise of a new species?*

Ans. (*i*) Traits: A characteristic feature is called trait.

(*ii*) Inherited and acquired trait (given in notes on page 112).

(*iii*) Speciation and factors (given in notes on page 112).

Q5. *Explain the analogous organs and homologous organs. Identify the analogous and homologous organ amongst the following:*

Wings of an insect, wings of a bat, forelimbs of frog, forelimbs of human. (CBSE 2007)

Ans. Analogous organs are those organs that have same function but have different structural design and origin. E.g., wings of birds and insects.

Homologous organs are those organs in different plants or animals which have the same basic structural design and organ but have different appearance and functions.

Analogous—Wings of an insect, wings of a bat

Homologous–Forelimbs of frog, forelimbs of human and wings of bat.

V. QUESTIONS ON HIGH ORDER THINKING SKILLS (HOTS)

Q1. *Green and red coloured seeds are recessive and dominant trait respectively. Out of F_1 and F_2, in which generation will the green seed appear, if both parents are not hybrid.*

Ans. F_2 generation.

Q2. *Dead remains of two species A and B were buried. Later only A's body was found to be a fossil but not B's given reason.*

Ans. B's body did not have hard tissues, like bones.

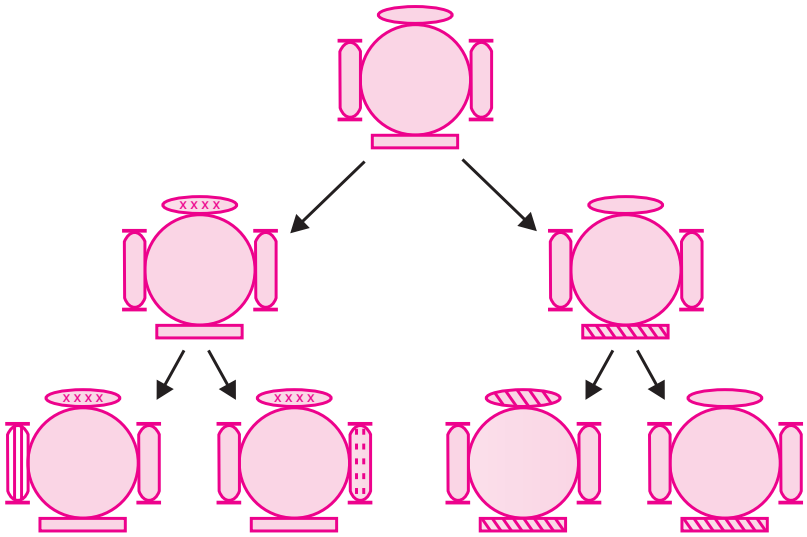
Q3. *Species A shares ten characteristics with species B, species C share fifteen characteristics with D which of the two pairs share closer relation.*

Ans. C and D.

Q4. *After the death of two insects, one of the insect was burried in hot mud and the other in usually found mud. Which of the two is more likely to be preserved better and why?*

Ans. The insect burried in hot mud. The body will not get decomposed in hot mud and the impression of the body will remain.

Q5. *Study the given diagram and answer the questions.*



Creation of diversity over succeeding generations. The original organism at the top will give rise to, say, two individuals, similar in body design, but with subtle differences. Each of them, in turn, will give rise to two individuals in the next generation. Each of the four individuals in the bottom row will be different from each other. While some of these differences will be unique, others will be inherited from their respective parents, who were different from each other.

(*i*) *Why do we find all bottom row individuals different from each other?*

(*ii*) *What is similar in all the individuals?*

Ans. (*i*) The differences can be due to inheritance of acquired traits. When respective parents are different from each other the variation occurs due to inheritance.

(*ii*) Body design.

Q6. *With the help of an example explain how "Genes control characteristics or traits"?*

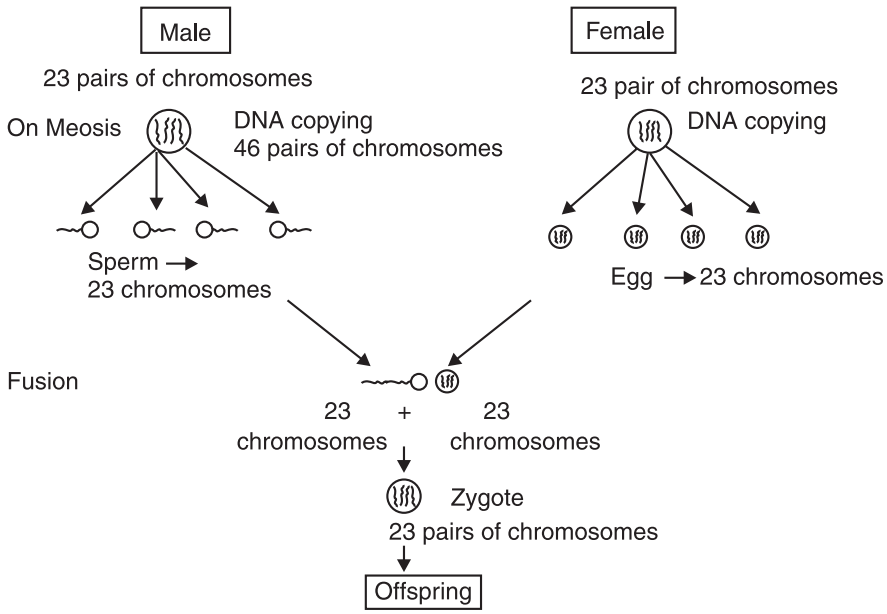
Ans. Tallness of a plant is a characteristic. Height of a plant depend on the amount of hormone secreted by the plant responsible for its tallness. The gene has the coding for the amount of hormone released. If the gene for that hormone has an alteration and makes its efficiency low, then the plant will be short.

Thus, this shows that traits are controlled by gene.

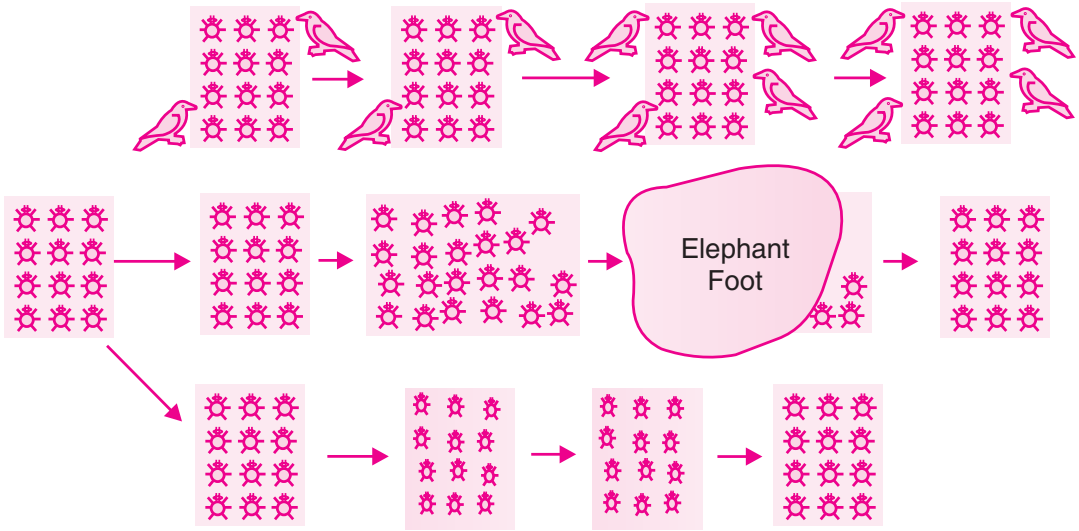
Q7. *Male individual has 23 pairs of chromosomes, female individual has 23 pairs of chromosomes. Then why don't an offspring have 46 pairs of chromosomes which is obtained by the fusion of these two eggs.*

Ans. Male individual has 23 pairs of chromosomes but the gamete that is formed by the meiotic cell division contain only half the number of chromosomes *i.e.*, 23 chromosomes in male sperm and 23 chromosomes in female egg.

It is the fusion of this sperm and egg which leads to an offspring with 23 pairs of chromosomes.



Q8. *Study the given figure and say what information it gives you.*



Variations in a population – inherited and otherwise.

Ans. Do yourself.

VI. VALUE-BASED QUESTION

Q1. *A group of class X students prepared a street play to educate masses on gender disparity to stop sex determination of girl child and abort it.*

(a) In human being, what is the chance of giving birth to a girl child?

(b) Who is responsible for the birth of a female child and why?

(c) What value is depicted among the group members of class X?

Ans. (*a*) The chance of giving birth to a girl child is 50%.

(*b*) Male (father) is responsible for the birth of a female child as only the male individual is a carrier both of X and Y chromosomes which will determine the sex of the foetus.

(*c*) The group members show team work, collaborative leadership, participating citizenship etc.

TEST YOUR SKILLS

Q1. *Name two human traits that show variations.*

Q2. *Who is known as the 'father of genetics'?*

Q3. *What is microevolution?*

Q4. *What is the probability that a human progeny will be a boy?*

Q5. *What is a gene?*

Q6. *What is genetic drift?*

Q7. *State the importance of variations.*

Q8. *What are fossils? Give its two uses.*

Q9. *Give the difference between homologous and analogous organs.*

Q10. *State Darwin's theory of evolution.*

Q11. *What are acquired traits and inherited traits?*