Class X (Biology)
Chapter - 9 (Heredity and Evolution)

Introduction

Reproduction processes give rise to new individuals that are similar, but subtly different.

In this chapter, we shall be studying the mechanism by which variation are created and inherited.

Accumulation of variation during reproduction

Inheritance from the previous generation provides both a common basic body design, and subtle changes in it, for the next generation.

In asexual reproduction, if one bacterium divides, and then the resultant two bacteria divide again, the four individual bacteria generated would be very similar.

However, if sexual reproduction is involved, even greater diversity will be generated.

Q) 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) How does the creation of variation in a species promote survival?

ANS) Variations in a species arise due to errors in DNA copying. Force of nature selection selects individuals with useful variations in the prevailing environment so as to ensure their survival. The individual with useful variation increase (1) in number through differential

Heredity

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

The rules of heredity determine the process by which traits and characteristics are reliably inherited.

Inherited Traits

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

Variations:

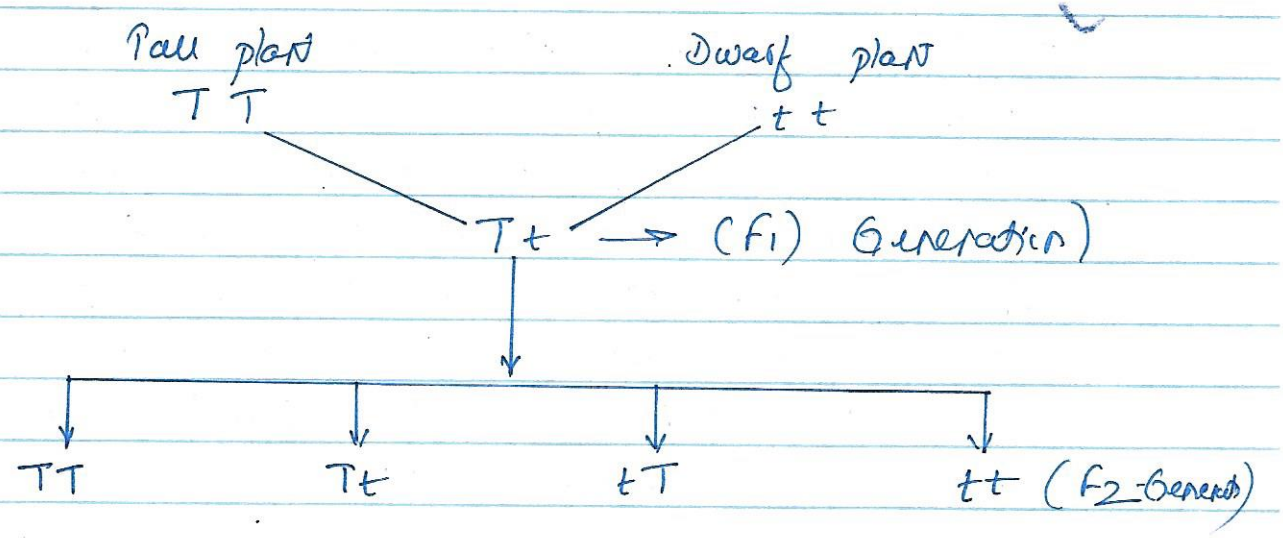
- Differences in the characters (or traits) among the individuals of a species.
- It helps in adaptation of organisms to the changing environment.

Rules for the Inheritance of Traits – Mendel's Contribution

The rules for inheritances of such traits in human beings are related to the fact that both the father and the mother contribute practically equal amounts of genetic material to the child. This means that each trait can be influenced by both paternal and maternal DNA.

(8) How do Mendel's experiments show that traits may be dominant or recessive?

Ans)

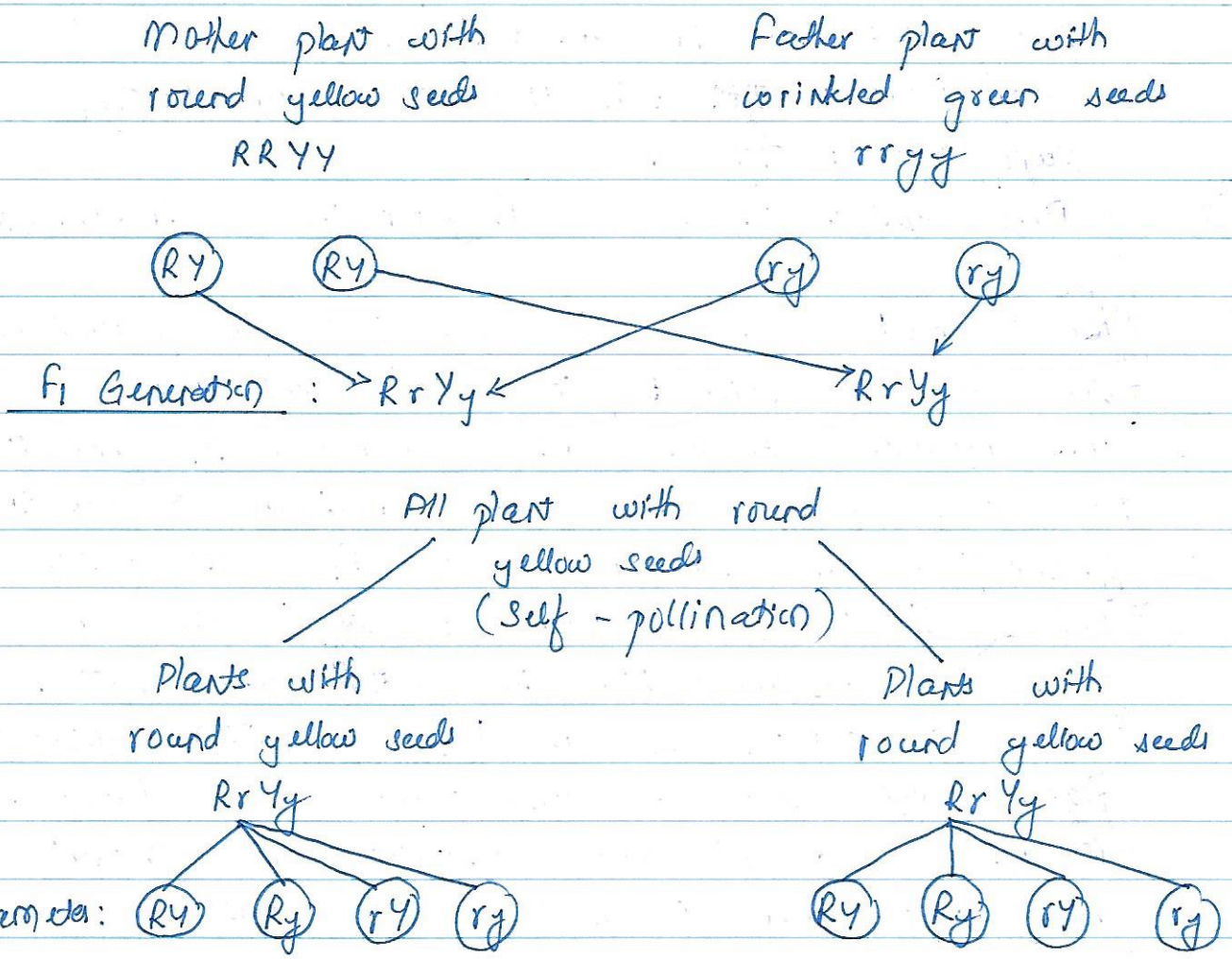


Tall plants : TT, Tt and tT (3)
Dwarf Plants : Tt, tT, tt (3), Hybrid : Tt, tT (2)
Pure Tall : TT (1)
Pure Dwarf : tt (1)

When Mendel's first crossed pure tall tea plants(T) with pure dwarf plants (t), 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 ratio 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.

(5) 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 type of seeds having different combination 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 ♂

Gametes ♀	RY	Ry	rY	ry
RY	RRYY (Round yello)	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)

Thus, ratio of F_2 generation is :

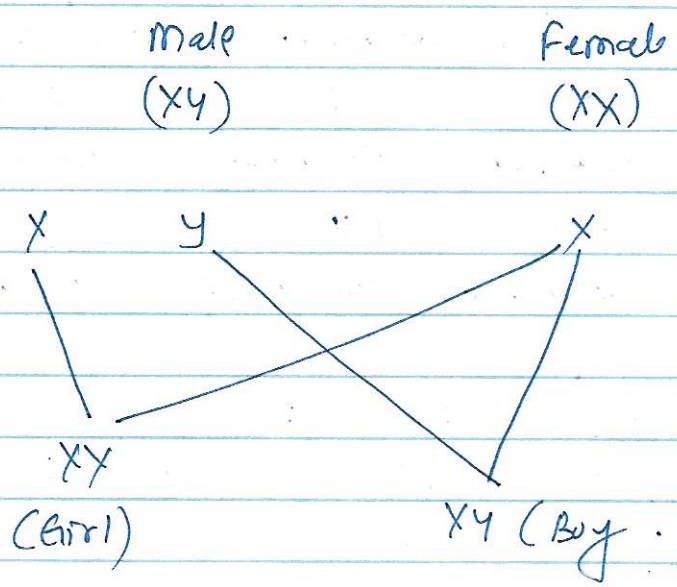
Round yellow	:	Round Green	: Wrinkled yellow	: Wrinkled Green
9		3	3	1

Thus, the ratio of each phenotype (or appearance) of the seeds in the F_2 generation = 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. Mendel concluded that through the two pairs of original characteristics (seed colour and shape) combine in the F_1 generation, (5) they get separated and behave

Sex Determination

Women have a perfect pair of sex chromosomes, both called X. But men have a mismatched pair in which one is a normal-sized X while the other is a short one called Y. So women are XX, while men are XY.

All children will inherit an X chromosome from their mother regardless of whether they are boys or girls. Thus, the sex of the children will be determined by what they inherit from their father. A child who inherits an X chromosome from her father will be a girl, and one who inherit a Y chromose from him will be a boy.



Questions

(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.

(2) Who is known as the father of genetic?

ANS) Gregor Johann Mendel.

(3) Define chromosem.

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

(4) Define variation.

ANS) The occurance of differences among the individuals of a species is called variation.

(5) Define Gene.

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

(6) 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).

(7) What are causes of variation?

Ans) (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..

(8) Do genetic combination of mothers play a significant role in determining the sex of a new born?

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

(9) 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 pair of chromosomes are present in human beings. One pair of these are sex chromosomes. Two Types of sex chromosomes are there : XX and XY.

(10)

Dominant Trait	Recessive Trait
(i) The trait which appears in the F1 progeny is dominant	(i) The trait which remain hidden or which does not appear in the F1 progeny is the recessive trait
(ii) It appear in more number	(ii) It appear in less number.

Evolution

A gradual genetic change in a group of living being to produce new form (organic evolution).

It is the sequence of gradual change which take place in the primitive organism over million of years in which new species are produced.

All the plants and animals (or organisms) which we see today around us have evolved from some or the other ancestors that lived on this earth long, long ago.

Acquired and Inherited Traits

Acquired Traits	Inherited Traits
1) Does not bring about change in the DNA of the germ cell	1) Bring about change in the DNA of the germ cell.
2) Cannot be passed on to the progeny (Progeny means "offspring" or "children".	2) Can be passed on to the progeny.
3) Cannot direct evolution	3) Can direct evolution
Examples: Acquiring knowledge, loss of weight, etc.	Example: Skin colour, colour of the eye, etc.

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

Ans) (i) By natural Section

A group of living beings adapts to fit their environment better.

According to Darwin's theory of natural, the individuals who are most suitable and fits 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 organism. This is called natural selection.

(ii) By genetic drift.

Provides diversity without any adaptation.

There is a random change in gene frequency.

Q) Why traits acquired during the lifetime of an individual not inherited?

Ans) Evolution: formation of new species because of barriers, genetic drift and natural selection takes place which leads to complex structure with better survival advantage. This is known as evolution.

The traits, which are acquired during the life time of an organism affect the structure and functioning of cells, tissues and organ without affecting the genetic material (DNA) and thus are not inherited.

Speciation

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

The important factors which lead to speciation:

(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 change in the frequencies of particular genes by chance alone.

(iii) Variation caused in individual due to natural selection.

(iv) Severe DNA change.

Q) Natural selection and speciation leads to evolution? Justify this statement.

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 organism over millions of years, to form newer species which are very different from older ones. This is called evolution.

G) Explain in brief the role of natural selection and genetic drift in this process of speciation.

Ans) Genetic drift is flow of genes from one population to another by chance factor as randomly. Over generation it will accumulate different changes in different population.

In addition, natural selection operates differently in different population selecting the fittest/favourable feature in both the population. Over a long period of time the differences in the two population may become so drastic that they no longer reproduce with each other and thus give rise to new species.

Q) 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.

G) 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) 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) Write full form of DNA. Where is it located?

ANS) DNA – Deoxyribonucleic Acid.
It is located in the cell nucleus.

Q.) What is function of gene?

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

Evolution and Classification

The more characteristics (or features) two species have in common, the more closely they will be related.

Some of the important sources which provide evidences for evolution are:

(i) Homologous Organ.
(ii) Analogous Organ
(iii) Fossils.

Homologous Organ.

Those organs which have the same basic structure (or same basic design) but different function are called homologous organ.

Example: forelimbs of a frog, lizard, bird and man.

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

Analogous Organ.

Those organ which have different basic structure (or different basic design) but have similar appearance and perform similar functions are called analogous organ.

Example: the wings of insects and wings of birds have a totally different anatomy and origin but they perform the same function of flying in air.

Fossils

The remains (or impressions) of dead animals or plants that lived in the remote past are known as fossils. The fossils also provides 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) 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.

Ans) Fossils are dead remain 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 retain the animal's part thus forming fossils.

Two method of determining the age of fossils are:

(i) Relative method: By estimating the age of the layer of earth's crust where the fossils 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 fossil 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.

Tracing Evolutionary Relationships:

Q) 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, wing 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 remain 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 structure of present day organisms also enable us to trace evolutionary relationships.

(iii) Comparing DNA of different species:

This will give us the 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.

Evolution By Stages:

Evolution of Eyes

The eye is very important organ for animals. The complex body organs of animals such as eyes have been created in 'stages' over many generations.

The eyes of flatworm are very simple that are actually just 'eye-spots' which can detect light. Starting from this basic design, more complex eyes were then evolved in various organisms. Most of the animals have eyes. For example, the insects, octopus and invertebrate, all have eyes. The structure of eyes in each of these organisms is, however, different which suggests their separate evolutionary origins.

Evolution of Feathers :

Sometimes an evolutionary change produced in an organism for one purpose later on becomes more useful for an entirely different function.
For example, birds evolved feathers as a mean for providing insulation to their bodies in cold weather but later on these feathers became more useful for the purpose of flying.
Even some dinosours had feathers though they could not fly by using these feathers. Birds, however, adapted feathers for flying.

Evolution by Artificial Selection :

Dissimilar looking structure can evolve from a common ancestral body design.
The wild cabbage plant is a good example to prove that entirely different looking organisms can evolve from the same organism by the process of evolution.

The farmers have been cultivating wild cabbage as a food plant for over two thousand years and have produced entirely different looking vegetables like cabbage, broccoli, cauliflower, kohlrabi and kale from it by artificial selection.

Human Evolution

It is now known that the so called human races have not evolved differently. In fact, there is no biological basis for dividing human beings into different 'races'. All human beings (whether, white, black, yellow or brown) are a single species (called Homo sapiens).

Human species (Homo sapiens) came from Africa. Those who left Africa slowly spread across the whole earth.

Human evolution has been studied by using the various tools of tracing evolutionary relationships like excavating (digging earth), carbon-dating, studying fossils and determining DNA sequences.

(Changes in DNA during reproduction are the basic events in evolution. Comparing the DNA of different species should give us a direct estimate of how much the DNA has changed during the formation of these species.)

Evolution Should Not be Equated with Progress

There is no real 'progress' in the idea of evolution. Evolution is simply the generation of diversity and the shaping of the diversity by environmental selection. The only progressive trend in evolution seems to be that more and more complex body designs have emerged over time.

Human beings are not the pinnacle of evolution, but simply yet another species in the teeming spectrum of evolving life.