

# BIOLOGY

## Standard



## Part - 2



Government of Kerala  
Department of General Education



State Council of Educational Research and Training  
(SCERT), Kerala  
2019



## The National Anthem

Jana-gana-mana adhinayaka, jaya he  
Bharatha-bhagya-vidhata.  
Punjab-Sindh-Gujarat-Maratha  
Dravida-Utkala-Banga  
Vindhya-Himachala-Yamuna-Ganga  
Uchchala-Jaladhi-taranga  
Tava subha name jage,  
Tava subha asisa mage,  
Gahe tava jaya gatha.  
Jana-gana-mangala-dayaka jaya he  
Bharatha-bhagya-vidhata.  
Jaya he, jaya he, jaya he,  
Jaya jaya jaya, jaya he!

## Pledge

India is my country. All Indians are my brothers and sisters.

I love my country, and I am proud of its rich and varied heritage. I shall always strive to be worthy of it.

I shall give respect to my parents, teachers and all elders and treat everyone with courtesy.

I pledge my devotion to my country and my people. In their well-being and prosperity alone lies my happiness.

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Dear Students,

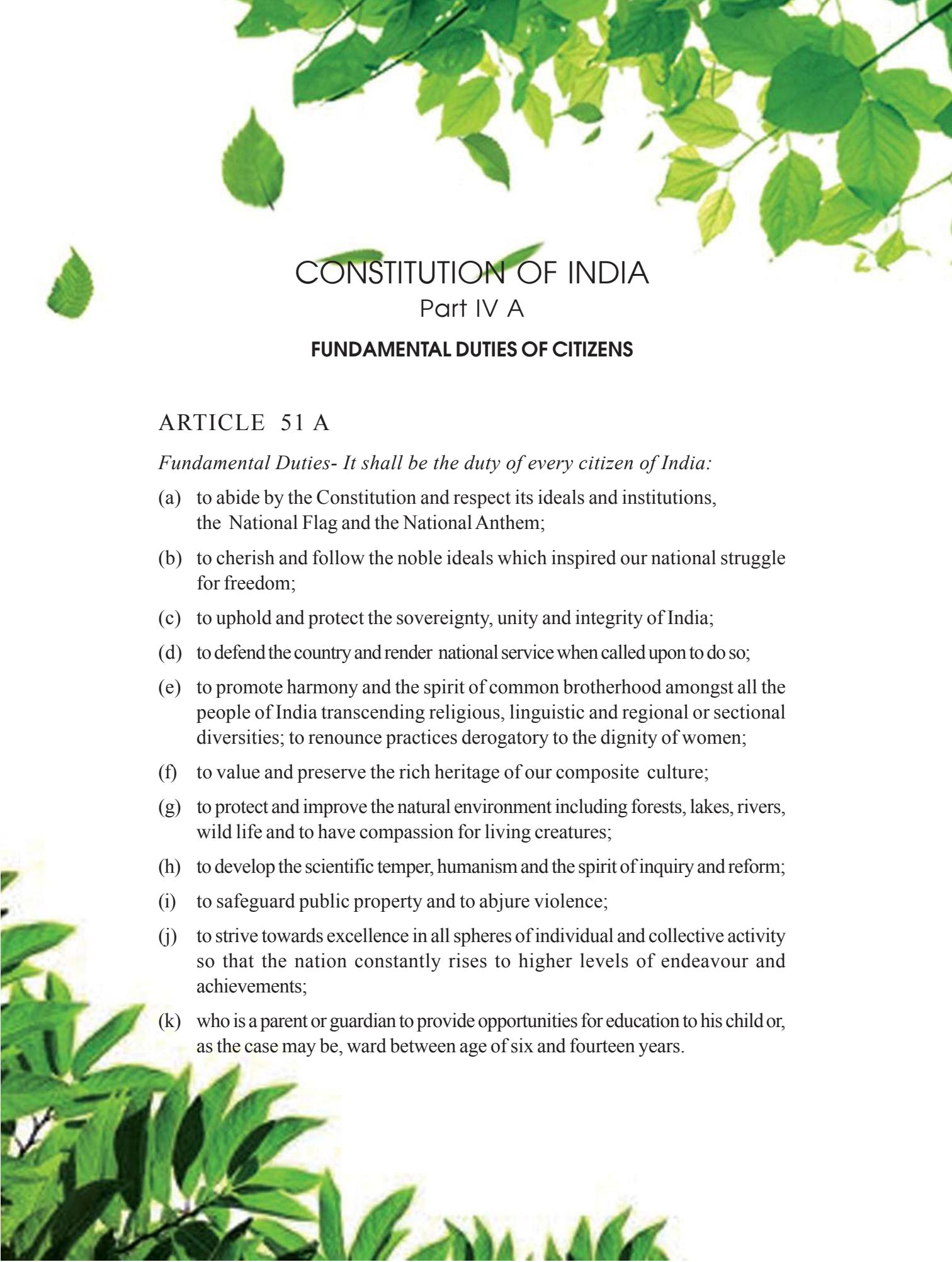
You will be curious to know how we sense and respond to our environment through the windows of knowledge. You will certainly be surprised to learn how the human brain, nerves and hormones act together to co-ordinate the activities of the human body and the genetic secrets behind the uniqueness of living species, the recent developments in the field of Biotechnology which leads to the progress in human life. The path of evolution related to the origin of humans on earth has also been included in the book. How the wonder machine that is, the human body prevents diseases, and the precautionary measures to be followed to keep diseases away are also mentioned here. Reminders on avoiding accidents caused by carelessness, incorporated with learning activities will be beneficial in your daily life.

The student's role is pivotal in the process of construction of knowledge. This Science textbook is only a resource in the learning process. Teachers and supplementary materials will help you in the creation of knowledge. 'Samagra', the education portal and technology enabled Q R Code printed textbooks would definitely make your learning activity in classrooms easy and joyful.

The National Skills Qualifications Framework, the current relevance of Disaster Management and the possibilities of I.C.T. have also been considered while modifying the textbook. Let all this be beneficial for you in the learning of Science by joyfully participating in life related learning experiences that impart knowledge and happiness.

Love and Regards,

**Dr. J.Prasad**  
Director  
SCERT, Kerala



## CONSTITUTION OF INDIA

### Part IV A

#### FUNDAMENTAL DUTIES OF CITIZENS

#### ARTICLE 51 A

*Fundamental Duties- It shall be the duty of every citizen of India:*

- (a) to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;
- (b) to cherish and follow the noble ideals which inspired our national struggle for freedom;
- (c) to uphold and protect the sovereignty, unity and integrity of India;
- (d) to defend the country and render national service when called upon to do so;
- (e) to promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;
- (f) to value and preserve the rich heritage of our composite culture;
- (g) to protect and improve the natural environment including forests, lakes, rivers, wild life and to have compassion for living creatures;
- (h) to develop the scientific temper, humanism and the spirit of inquiry and reform;
- (i) to safeguard public property and to abjure violence;
- (j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievements;
- (k) who is a parent or guardian to provide opportunities for education to his child or, as the case may be, ward between age of six and fourteen years.

# **Content**

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**Certain icons are used in this  
textbook for convenience**



**For further reading  
(Evaluation not required)**



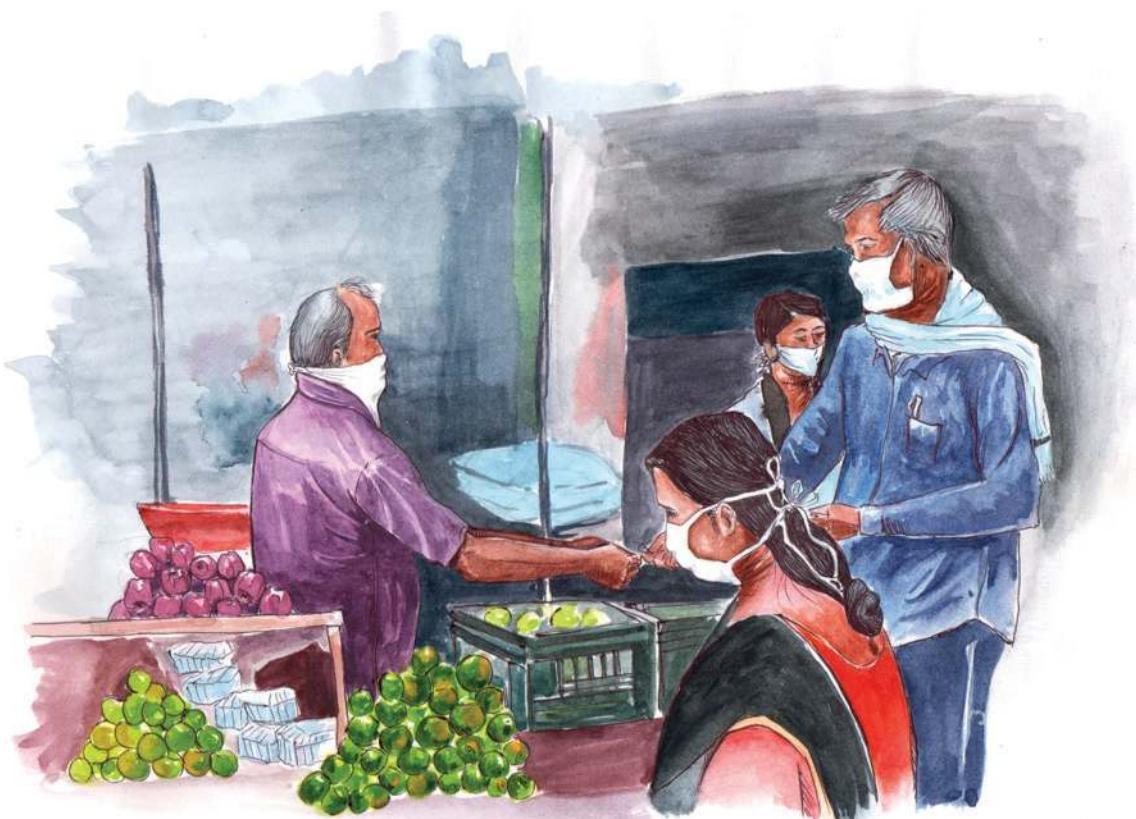
**Let us Assess**



**Extended Activities**

# 5

## Soldiers of Defense



Haven't you observed the picture of people wearing protective masks in places where epidemics spread out? What are the uses of wearing masks in such situations?

- Prevent the entry of germs.
- 

Can such precautions prevent the entry of pathogens into the body to a certain extent?

Doesn't our body have its own natural defense mechanisms to prevent the entry of pathogens? List them.

Defense is the ability of the body to prevent the entry of pathogens and to destroy those that have already entered the body. Our body is well equipped with a variety of defense mechanisms.

Observe illustration (5.1) and prepare a note on the defense mechanisms in our body.

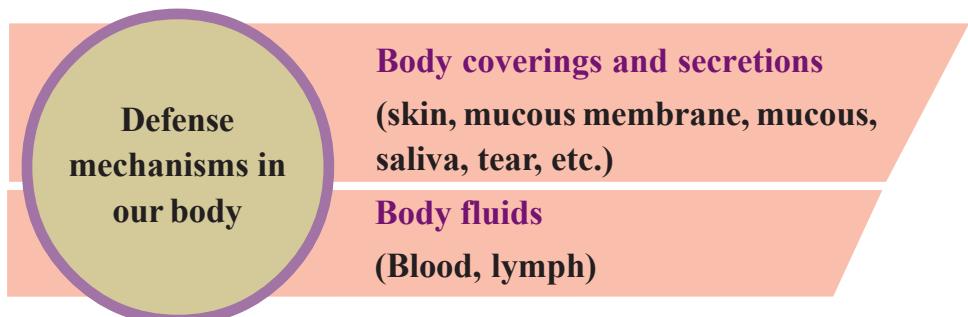


Illustration 5.1 Defense mechanisms

### Body Coverings and Secretions

Skin is the protective covering of the body. It is a safety shield that prevents the entry of germs. Analyse figure (5.1) and the description given below and prepare notes based on the indicators.

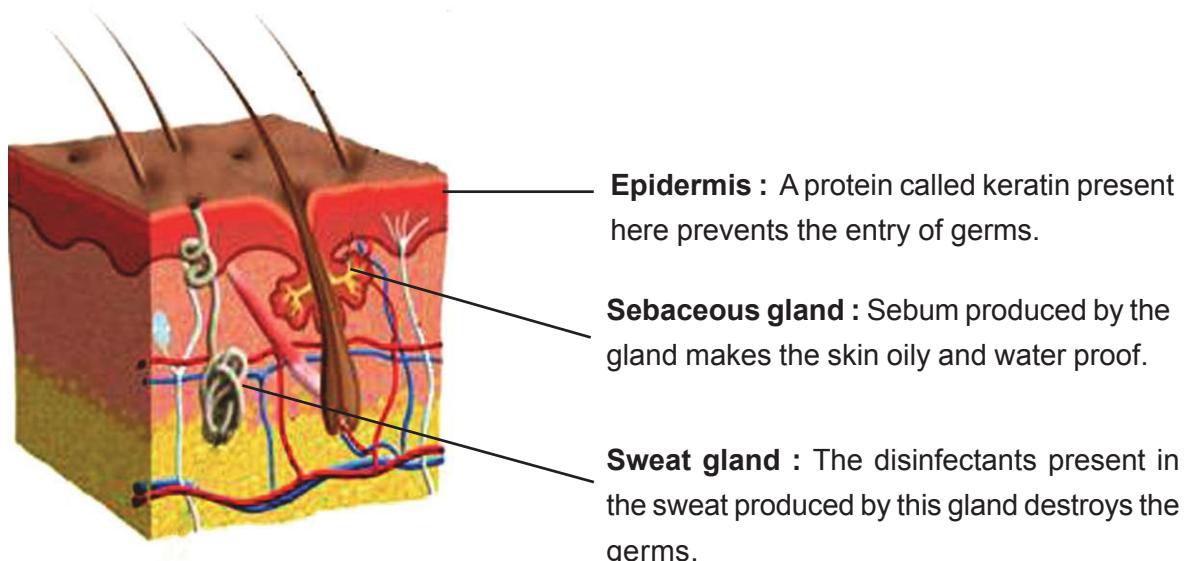
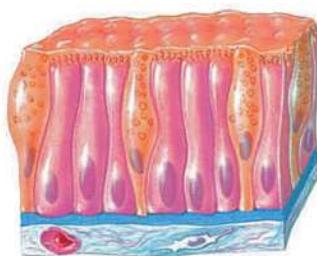


Figure 5.1 The skin and its defense mechanism

The mucous membrane is another protective covering of body parts (figure 5.2). Pathogens trapped in the mucus produced by this membrane, get destroyed. The destroyed germs are expelled out by the cilia cells of the mucous membrane.

Coverings of the body act as a habitat for many useful bacteria. The germs that enter the body need to compete with such useful bacteria for shelter and nutrients. A great number of germs get destroyed in this competition.

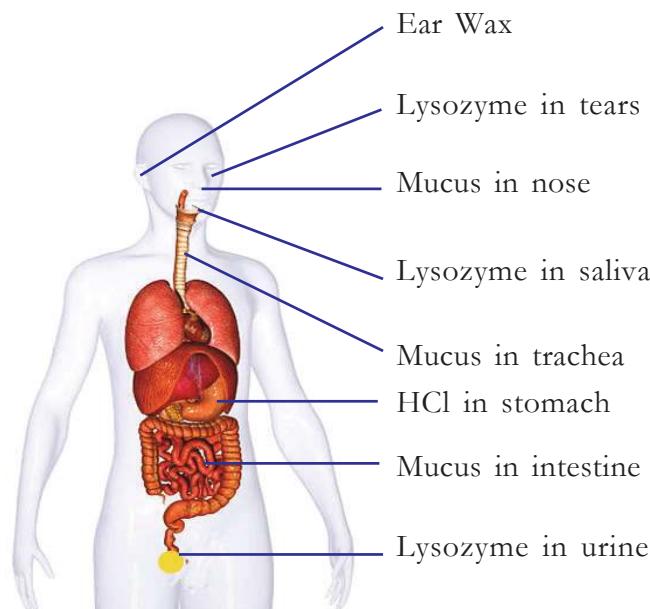


**Figure 5.2**  
**Mucous membrane**

### Indicators

- Skin and defense
- Mucus membrane and defense

You have understood that body secretions like sweat, mucus, etc. destroy germs. Which are the other secretions that help to defend pathogens? Analyse illustration (5.2) and complete table (5.1) given below.



**Illustration 5.2 Body secretions and Defense mechanisms**

Part of the body	Secretion
Ear	.....
.....	Lysozyme in saliva
Eye	.....
.....	HCl



A96IMF

**Table 5.1**

Aren't you convinced of how body coverings and secretions prevent the entry of germs?

## Body Fluids and Defense

Body fluids like blood and lymph play an important role in defense mechanism. These body fluids follow different defense strategies like controlling the entry of germs into the body, neutralising germs and the toxic substances they produce, preventing their multiplication, etc. Let us examine how blood plays its role in the defense system.

### Blood and Defense

White blood cells play a significant role in defense. Analyse illustration 5.3 and prepare notes on the role of white blood cells in defense.

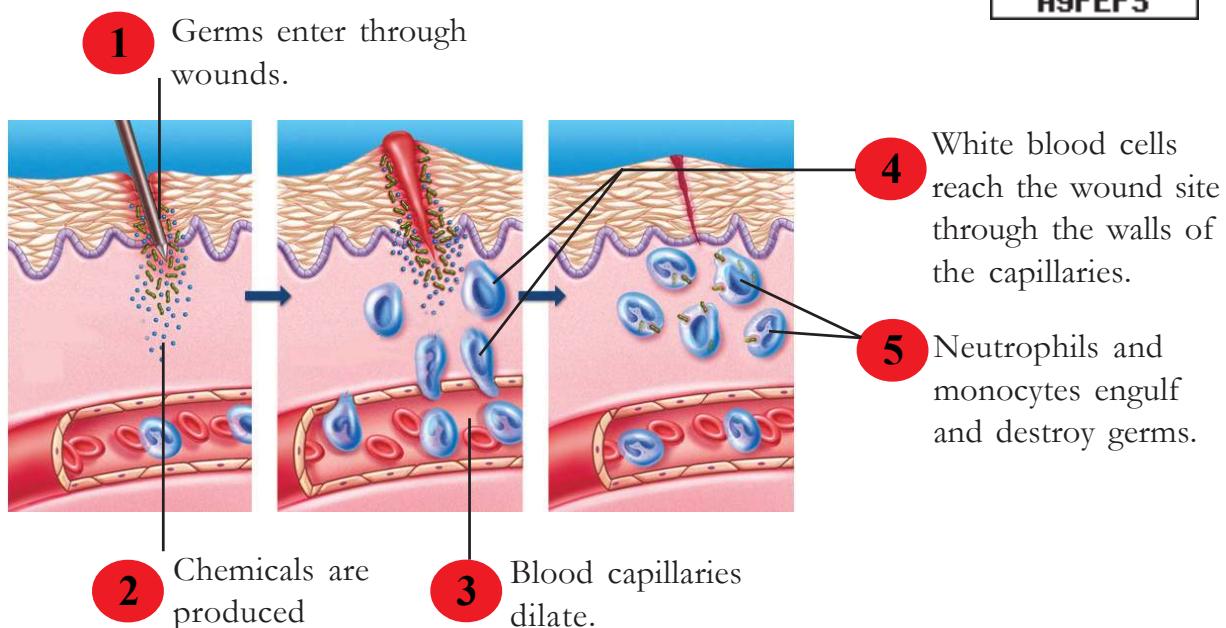
White Blood Cells	Defense Action
	<b>Neutrophil</b> Engulfs bacteria, synthesizes chemicals that destroy bacteria.
	<b>Basophil</b> Stimulates other white blood cells. Dilates the blood vessels.
	<b>Eosinophil</b> Synthesizes chemicals that destroy foreign bodies. Synthesizes chemicals required for the inflammatory responses.
	<b>Monocyte</b> Engulfs and destroys germs.
	<b>Lymphocyte</b> Identifies and destroys germs specifically.

Illustration 5.3 White Blood Cells and Defense Actions

You have understood the defense actions of white blood cells. Now let us familiarise with the different strategies of defense.

## Inflammatory Response

Haven't you noticed that when a wound occurs, that part swells up? This is called inflammatory response. Illustration (5.4) explains how the inflammatory response takes place. Analyse it with the help of indicators and description, and prepare a note on it.



**Illustration 5.4 Inflammatory Response**

The cells that get damaged by a wound or by an infection produce certain chemical substances. These substances dilate the capillaries thereby increasing the blood flow. Blood plasma and more white blood cells reach the wound site. This is the reason for the swelling of the wound site. This defense mechanism is known as inflammatory response.

### Indicators

- The advantage of dilation of capillaries at the wound site.
- Role of white blood cells in the inflammatory response.
- Inflammatory response and defense.

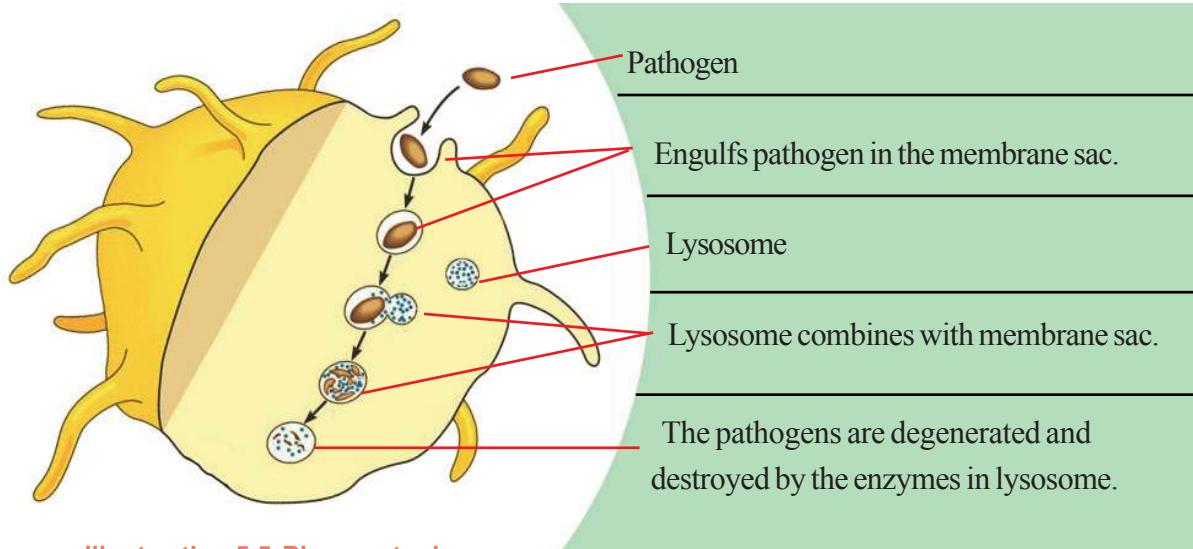
You have understood that the germs at the wound site are engulfed and destroyed by the white blood cells. How does this process take place?

## Phagocytosis



Phagocytosis is the process of engulfing and destroying of germs. The cells that are engaged in this process are called phagocytes. (phago- to engulf, cyte-cell). The white blood cells, namely monocytes and neutrophils are phagocytes.

Analyse illustration (5.5) and write notes on the stages of phagocytosis in the Science diary.



Illustrartion 5.5 Phagocytosis

## Blood Clotting



Blood clotting is also a defense mechanism. The changes that take place during blood clotting is consolidated below. Analyse and understand the different stages in the process of blood clotting and prepare a note on it.

- Tissues and platelets at the site of wound degenerate to form the enzyme called thromboplastin.
- Prothrombin in plasma  $\xrightarrow[\text{Calcium, Vitamin K}]{\text{Thromboplastin}}$  Thrombin
- Fibrinogen  $\xrightarrow{\text{Thrombin}}$  Fibrin fibres
- The red blood cells and platelets get entangled in the network of fibrin fibres to form the blood clot.

Illustration 5.6 Blood clotting

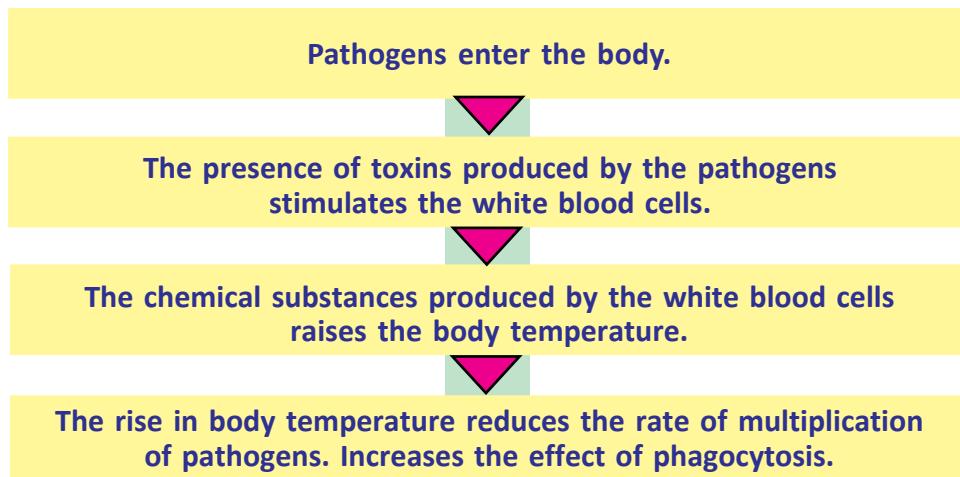
Blood clotting helps to prevent bleeding and checks the entry of pathogens through wounds. As blood clots, the process of healing of wound also begins.

### Healing of Wounds

Healing of wound is a stage after inflammatory response and blood clotting. When a wound occurs new similar tissues are formed in place of the tissues damaged or lost by the wound. In such situations the wound scar does not remain. But, in cases when new similar tissues cannot be formed, the connective tissue heals the wound. In such situations, the wound scar remains. Infections through the wound slow down the healing process. A strong defense system accelerates the process of wound healing and reduces the chance of infection.

### Fever, a Defense Mechanism

The normal body temperature is  $37^{\circ}\text{C}$  ( $98.6^{\circ}\text{F}$ ). Fever is a condition when the body temperature rises above the normal level. Is it a disease or a symptom? Analyse the flow chart given and write your inferences in the Science diary.



### Activated Partial Thromboplastin Time (aPTT)

aPTT is the test to detect the cause of excess bleeding or lack of clotting of blood. Specific reagents are added to the blood sample and the time taken for blood clotting is found out. The normal value of this test is 30 to 40 seconds. The quantity and action of the factors that help in blood clotting can be detected by this test. Usually, when a wound occurs in human beings, bleeding lasts for 2 to 7 minutes and it clots within 8 to 15 minutes.



You have understood that fever is a defense mechanism of the body. Why do we take medicines during fever? Read the note given below and formulate inferences.



When infection becomes uncontrollable, the body temperature may rise tremendously. We take medicines to reduce the body temperature. But it is advisable to treat after diagnosing the exact reason. If the rise in body temperature persists for a long time, it may badly affect the internal organs including the brain. Hence, if fever increases, it is necessary to seek medical assistance immediately.

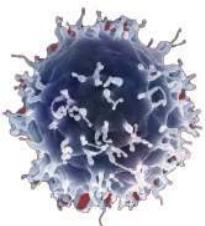
You have understood some mechanisms that help to prevent and destroy the entry of germs.

Non-specific defense mechanism is a mechanism that protects us from all pathogens without considering their characteristic features. Lymphocytes are the blood cells that specifically identify and destroy pathogens that enter the body by overcoming the non-specific defense mechanism of the body.

### **Lymphocytes – The Warrior**

Foreign bodies or pathogens that enter the body and stimulate the defense mechanism are called antigens. The defense mechanism that identifies the structure of each antigen and destroys it specifically is called specific defense.

White blood cells known as lymphocytes are capable of destroying pathogens in this way. Lymphocytes are formed in the bone marrow and are of two types. Those that mature in the bone marrow are called B lymphocytes and those that mature in the thymus gland are called T lymphocytes. Analyse figure 5.3 and description, and prepare a note on the role of lymphocytes in specific defense mechanism.



**B-Lymphocyte**



**T-Lymphocyte**

**Figure 5.3**

### **B - Lymphocytes**

B- Lymphocytes produce certain proteins that act against antigens. These are called antibodies.

Antibodies destroy the pathogens in three different ways.

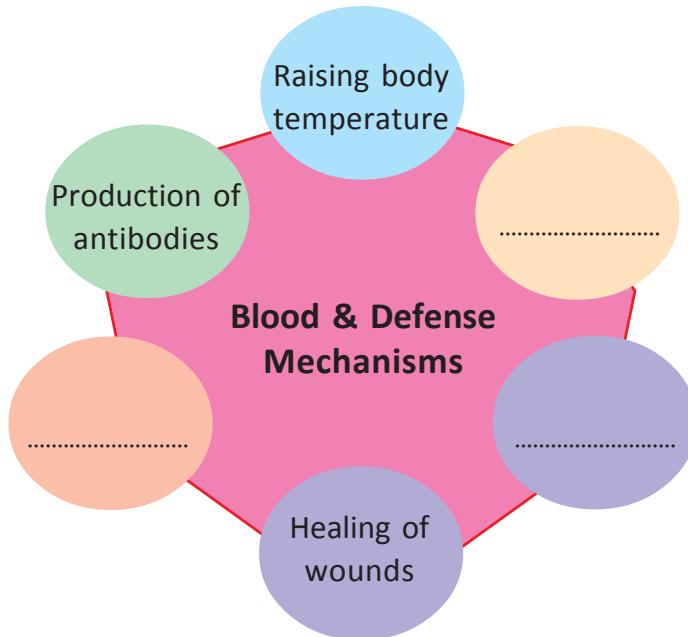
1. Destroy the bacteria by disintegrating their cell membrane.
2. Neutralise the toxin of the antigens.
3. Destroy the pathogens by stimulating other white blood cells.



## T-Lymphocytes

- Stimulate other defense cells of the body.
- Destroy the cells affected by virus.
- Destroy cancer cells.

Complete illustration (5.7) showing the defense mechanisms of blood, on the basis of the facts that you have already understood.



**Illustration 5.7**  
**Blood & Defense Mechanisms**

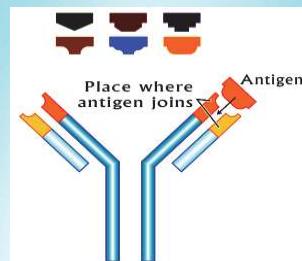
## Lymph and Defense

You have already studied about the lymph. Analyse illustration (5.8) of the lymphatic system and the description given. Discuss how lymph helps in defense mechanisms.

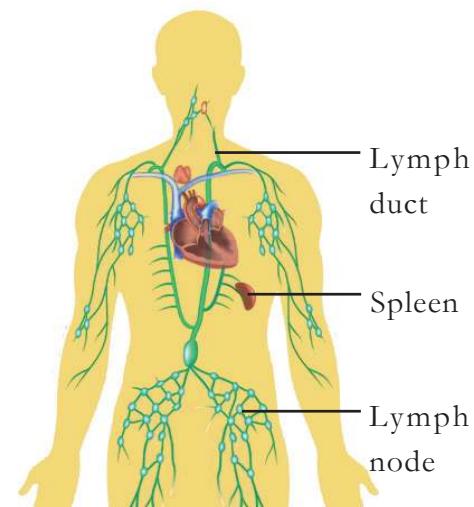
The lymph, formed from the blood and reabsorbed into blood has a prominent role in defense mechanisms, like the blood itself.

Lymph contains plenty of lymphocytes. They destroy the disease causing bacteria in lymph nodes and spleen.

## Immunoglobulin



The defense chemicals produced by B lymphocytes as antibodies are known as immunoglobulins. This is a Y shaped protein. There are specific sites for binding antigens at their ends. These sites help to recognise and destroy antigens specifically. There are five types of immunoglobulins such as IgA, IgD, IgE, IgG and IgM.

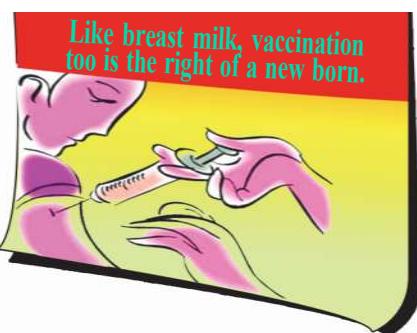


**Illustration 5.8 Lymphatic system**

You have now understood the natural defense mechanisms of the body. Is it possible to acquire immunity artificially? Which are the methods? Discuss.

### Immunization

*When the body itself has defense mechanisms to prevent pathogens, why do we take vaccines?*



**Edward Jenner**

Edward Jenner, an English doctor started immunization in 1798. He observed that people affected by cowpox escaped from the attack of smallpox. He injected the pus taken from a cowpox patient into the body of an 8 year old boy. The boy was affected by cowpox and recovered. After two months the pus taken from a smallpox patient was injected into the boy. He was not affected by smallpox. The immunization programmes got the name vaccination from the Latin word 'vacca' meaning cow, in memory of the cowpox experiments of Jenner.

Note the doubt of the child who observes the poster. What is vaccination? Analyse the description given below and prepare notes in the Science diary.

Defense mechanisms become slow when germs enter the body. This causes the spread and multiplication of germs. Immunization is the artificial method to make the defense cells alert against the attack of pathogens.

Vaccines are the substances used for artificial immunization. Any one of the components from alive or dead or neutralised germs, neutralised toxins or cellular parts of the pathogens will be the component of each vaccine. These act as antigens that stimulate the defense mechanism of the body. Antibodies are formed in the body against them. These antibodies are retained in the body which in future protects the body from the pathogen responsible for the same disease.

## Indicators

- Significance of vaccination
- Components of vaccines
- Antigens and antibodies

Collect the National Immunization Schedule of preventive vaccines to be taken at different stages of childhood from birth. Analyse it, collect more information and complete the table (5.2).



Vaccine	Disease
B.C.G.	
O.P.V.	
Pentavalent	
M.M.R.	
T.T.	

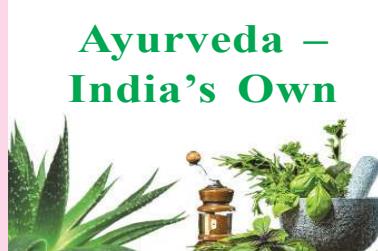
Table 5.2

Prepare posters highlighting the importance of immunization and exhibit them in the classrooms.

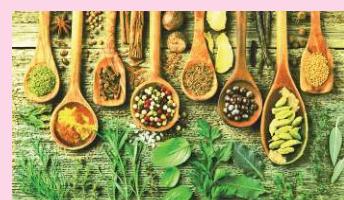
## Treatment – Final Defense

What will happen if no treatment is taken when infected with diseases? Treatment is the final defense, isn't it? Which are the different methods of treatment that we depend on?

- Ayurveda
- Siddha
- Unani
- Naturopathy
- .....
- .....



Ayurveda is a famous method of treatment that has emerged from India. It is inevitable to live in harmony with nature to maintain an efficient and healthy body. In Ayurveda, plant and animal products are used as medicines.



In various parts of the world, methods of treatment have evolved in accordance with the lifestyle of the people, their culture and available natural resources. Siddavaidya, Panchakarma, Unani, Naturopathy, etc. are traditional treatment methods which have evolved like this. Homeopathy is the method of treatment proposed by the German doctor, Samuel Hahnemann. Hippocrates paved the way for modern medicine. He began a treatment system that discarded superstitious beliefs and emphasized only on pathogens, diagnosis and medicines.



A) .....



B) .....



C) .....

**Figure 5.4 Diagnostic equipments**

Prepare a journal by collecting more information related to various systems of medicine.

Modern medicine is far advanced in the field of treatment. Scientific advancements in diagnosis and invention of new medicines became crucial in the development of modern medicine.

Observe figure 5.4 and write the name and use of the diagnostic equipments in your Science diary.

Today, besides these familiar equipments, most modern diagnostic tools are available in the field of medicine. Examine table 5.3 and prepare a note including the pictures and details of the use of modern diagnostic tools in your Science diary.

Equipment	Use
Electro Encephalo Gram (EEG)	to record electric waves in the brain.
Electro Cardio Gram (ECG)	to record electric waves in the heart muscle.
Ultra Sound Scanner	to understand the structure of internal organs using ultrasonic sound waves.
C.T. Scanner (Computed Tomography Scanner)	to get three-dimensional visuals of internal organs with the help of computer, using X-rays.
MRI Scanner (Magnetic Resonance Imaging Scanner)	to get three-dimensional visuals of internal organs.

**Table 5.3**

## Laboratory Tests



You know that laboratory tests help in the diagnosis of diseases. Observe the report of a test showing the quantity of different factors in blood.

Report		
Complete Blood Count (CBC)		
Test details	Test result	Normal Value
Haemoglobin	12.2 gm /100 ml of blood	12-17 gm /100 ml of blood
Number of White Blood Cells	8,200/ml of blood	5000-10000 /ml of blood
Number of Red Blood Cells	47 lakhs /ml of blood	45 lakhs to 60 lakhs/ml of blood
Number of platelets	3.2 lakhs /ml of blood	2.5 lakhs to 3.5 lakhs/ml of blood

Collect information about different types of tests conducted in the laboratory by enquiring about it to a lab technician and record it in the Science diary.

Advancements in technology have developed various areas of specialization in modern medicine. Identify the specializations in medicine and the related areas and complete table 5.4. Identify more areas and prepare a note on it.

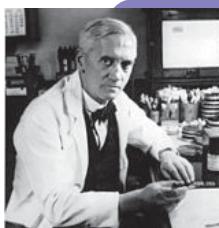
Specialization	Related Area
Cardiology	Treatment of heart
.....	Treatment of eye
Neurology	.....
.....	Cancer treatment
E.N.T	.....

Table 5.4 Specializations and areas

In treatment, along with diagnosis medicines also have great significance. Medicines are either substances extracted from plants, animals or microorganisms or chemical substances synthesised in laboratories.

### Antibiotics

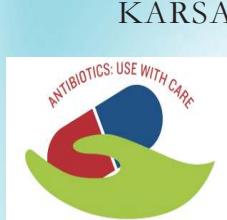
Medicines that are extracted from microorganisms like bacteria, fungi, etc. and used to destroy bacteria are called antibiotics. They can be used externally and internally.



It was Alexander Fleming who first discovered antibiotics in 1928. He accidentally discovered that the fungus *Penicillium notatum* has the ability to destroy bacteria. But it took several years to extract medicine from it.



### Kerala becomes a model again



KARSAP (Kerala Antimicrobial Resistance Strategic Action Plan) submitted on October 2018, is another example for the Kerala model. This action plan aims to fight against the resistance of microbes towards medicines. Kerala is the first in the South East nations to launch this plan. In 2016, a form of tuberculosis, resistant to medicines affected five lakh people all over the world. WHO has already declared the resistive power of microorganisms as a global health crisis. When Kerala strikes a model for such a programme initiated by WHO, it is undoubtedly a mark of pride for the people of the State. We should also be sensible to abstain from unhealthy habits like self treatment.

Though antibiotics are effective medicines, their regular use creates many side effects. Some important side effects are listed below:

- regular use develops immunity in pathogens against antibiotics.
- destroys useful bacteria in the body.
- reduces the quantity of some vitamins in the body.

Antifungal medicines, are used to destroy fungi and antiviral medicines are used to control viruses.

Is it advisable to use antibiotics without the recommendation by a doctor? Discuss and write inferences in the Science diary.

Like diseases, accidents are also challenges to health. What can we do to overcome critical conditions during accidents till we get expert treatment?

### First Aid

Can't we save the life of victims of accidents if we give them timely first aid? Discuss. Observe figures A, B and C and identify the instances in which the following type of first aid is given.

**A**

Giving artificial respiration

**B**

Arm supported by sling

**C**

Removing objects stuck in trachea.

Organise an awareness class regarding first aid by utilizing the facts you have studied and after collecting more information.

During accidents heavy loss of blood occurs. How can this blood loss resolved?

### Blood Transfusion



The transfer of blood from one person to another is called blood transfusion. What all things should be taken care of while transfusing blood?

The instructions shown in a blood bank are given below. Analyse each point and formulate inferences regarding precautions.

#### Notice Board

- People in the age group 18-60 can donate blood.
- Blood donation can be done once in three months.
- Blood donation causes no problem to the donor's health.
- Pregnant women and breast feeding mothers should not donate blood.
- Persons with communicable diseases (transmitted through blood) should not donate blood.

Can a patient receive blood from any person? Why is blood group testing done prior to blood transfusion?

Let us examine different types of blood groups in human beings and the basic concepts behind blood group determination. Analyse table (5.5) and the description based on the indicators and prepare notes in your Science diary.

Blood group	Antigens	Antibodies
A	A	b
B	B	a
AB	A and B	Nil
O	Nil	a and b

Table 5.5 Different types of blood groups



The basis of blood grouping is the presence of antigen A and antigen B in red blood cells. The blood group of a person is named according to the antigen present in that person's blood. In blood transfusion, certain antibodies present in the blood plasma are of special importance. In blood group A, antibody **b** and in group B, antibody **a** are present. In addition to antigens A and B, another antigen called D or Rh factor is present in the cell membrane of red blood cells of certain persons. The blood groups in which Rh factor is present are known as positive blood groups and those without Rh factor are called negative blood groups.

When a foreign antigen reaches one's blood, it stimulates the defense mechanism. On receiving unmatching blood, the antigen present in the donor's blood and the antibody present in the recipient's blood will react with each other and form a blood clot. Hence, everyone cannot receive blood from all blood groups.

Prepare posters on the greatness of donating blood and exhibit them in your classroom.

### Indicators

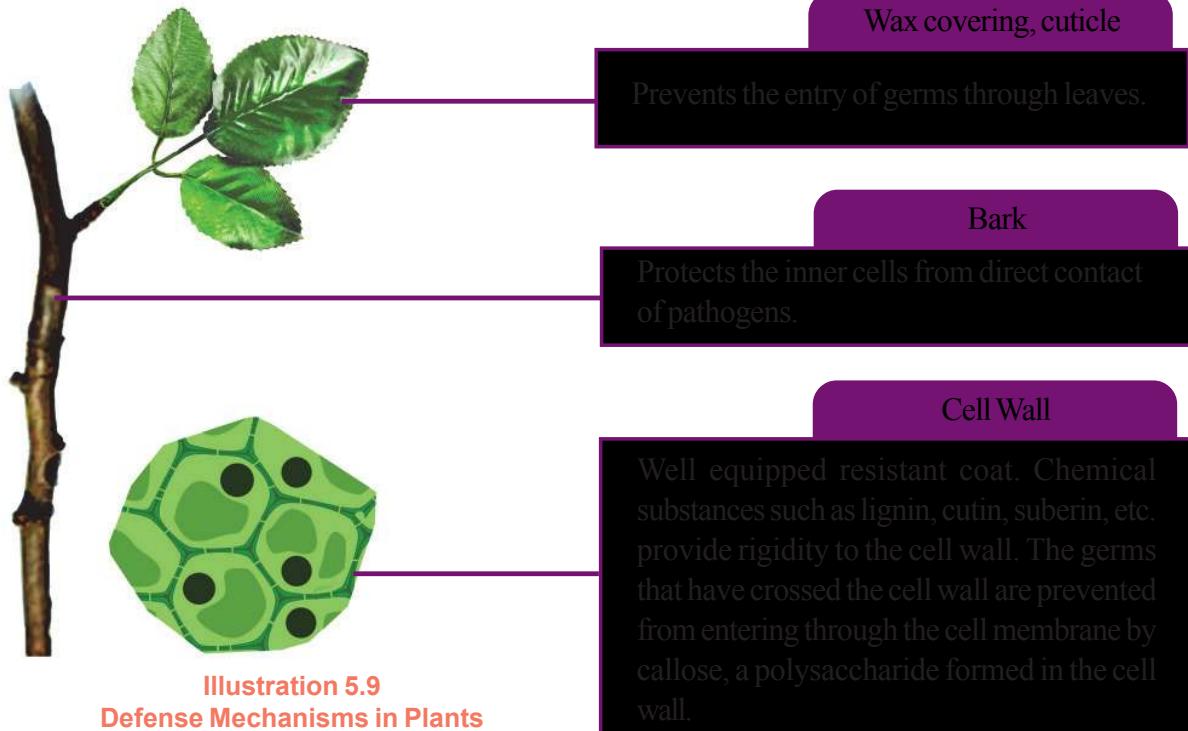
- Antigens and blood groups
- Antibodies and blood groups
- Rh factor

## Defense Mechanisms in Plants

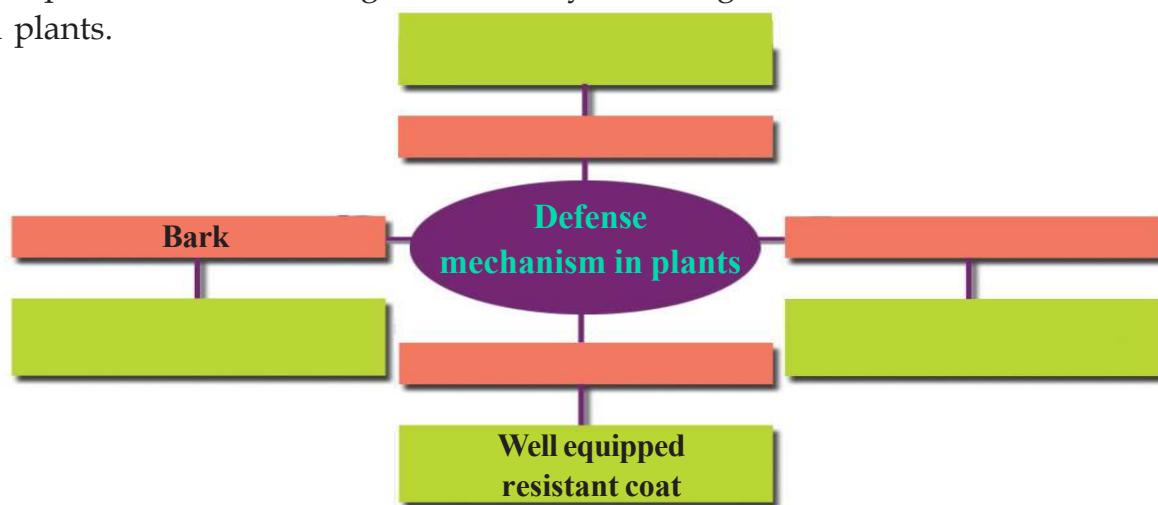
As in animals, plants also have mechanisms to prevent the entry of germs and to fight against those that have already entered. In plants, defense is made possible through structural and biochemical methods.



Analyse illustration (5.9) and prepare notes on defense mechanisms in plants.



Complete illustration 5.10 given below by including different defense mechanisms in plants.



The healthy constitution of the body depends on the healthy state of the external environment. Our body is well equipped with various defense mechanisms. Similarly, it is our responsibility to evolve defense mechanisms to protect our environment from factors causing diseases.



### Let us assess

1. Which among the following is not included in non-specific body defense?
  - a. production of sebum
  - b. action of hydrochloric acid in the stomach.
  - c. action of B lymphocytes.
  - d. action of lysozyme in saliva.
2. Write the functions of blood cells in the defense mechanism of the body.
3. What is the basis of grouping blood into different types? Everybody cannot receive blood of all blood groups. Why?

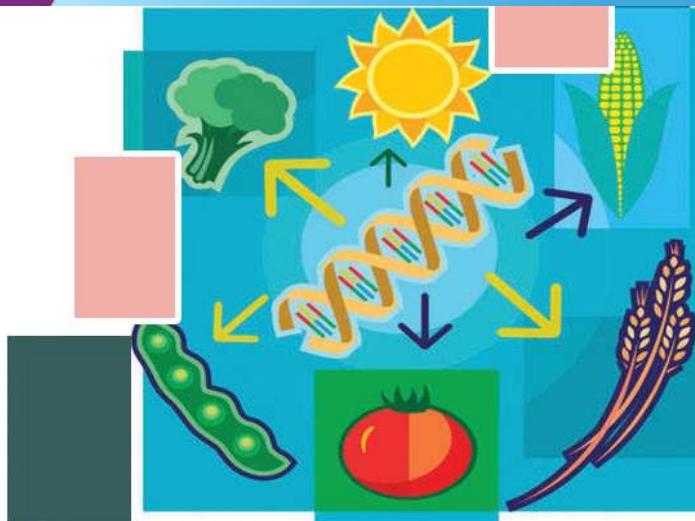


### Extended activities

- Conduct an interview with a doctor and collect information regarding the working of modern equipments used for diagnosing diseases and the significance of laboratory tests. Prepare a wall poster and exhibit it in the classroom.
- Conduct a debate in the class on 'Are antibiotics useful or harmful?'
- Organise an awareness class regarding the significance of immunization.

# 6

## Unravelling Genetic Mysteries

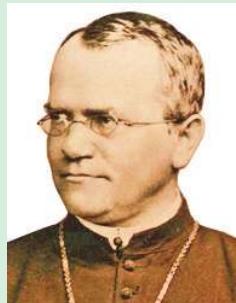


Observe the picture.

You have understood that children acquire certain features from their parents. Besides, don't the children show certain features different from their parents?

Find out such differences from the picture.

Children may inherit certain features either from their mother or father. Features that are not seen in parents may also be found in children.



## Gregor Johann Mendel

Born in 1822 at Brunn, Austria (modern Czech Republic). He studied the inheritance of 7 pairs of contrasting traits in pea plants, scientifically known as *Pisum sativum*. He formulated the laws of inheritance by analysing the inheritance of characters like height of plants, position of flower, shape of seed, colour of seed coat, colour of cotyledon, colour of fruit and shape of fruit. Through his studies on inheritance, he explained that each character is controlled by a pair of factors, which he illustrated using symbols. In 1866 his findings were published, but they failed to get due recognition. In 1884 he died. The significance of his findings was identified by research works conducted later.

The transmission of features of parents to offsprings is termed as heredity. The features seen in offsprings that are different from their parents are called variations. The branch of science that deals with heredity and variations is called Genetics.

## Emergence of Genetics

The inferences formulated by a scientist named Gregor Johann Mendel, on the basis of hybridization experiments carried out in pea plants, led to the foundation of Genetics. Mendel is considered as the Father of Genetics.

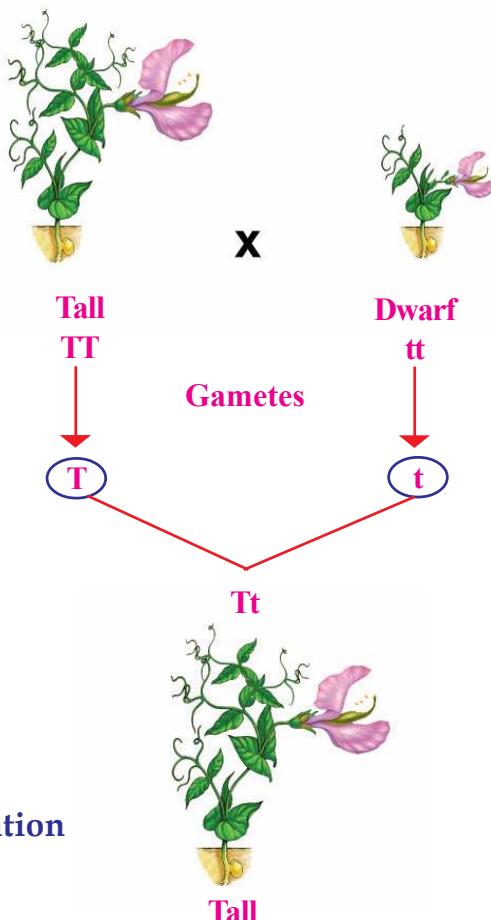


**Figure 6.1 Garden pea (*Pisum sativum*)**

## Experiments of Mendel

Observe illustration 6.1 of the hybridization experiment conducted on the basis of two contrasting traits of the character height in pea plant. Here the factors are illustrated using symbols.

## Parental plants



### First generation (F1)

**Illustration 6.1 Hybridization**

### Indicators

- The character of pea plants considered in this experiment.
- The contrasting traits of this character.
- The traits those were apparent and not apparent in the first generation.
- Difference in the factors of tall parent plant and the first generation plant.

*When plants that differ in a pair of contrasting traits are hybridized, only one trait is expressed while the other remains hidden in the offsprings of the first generation. The expressed trait is called dominant trait and the hidden trait is called recessive trait.*

### Genes and Alleles

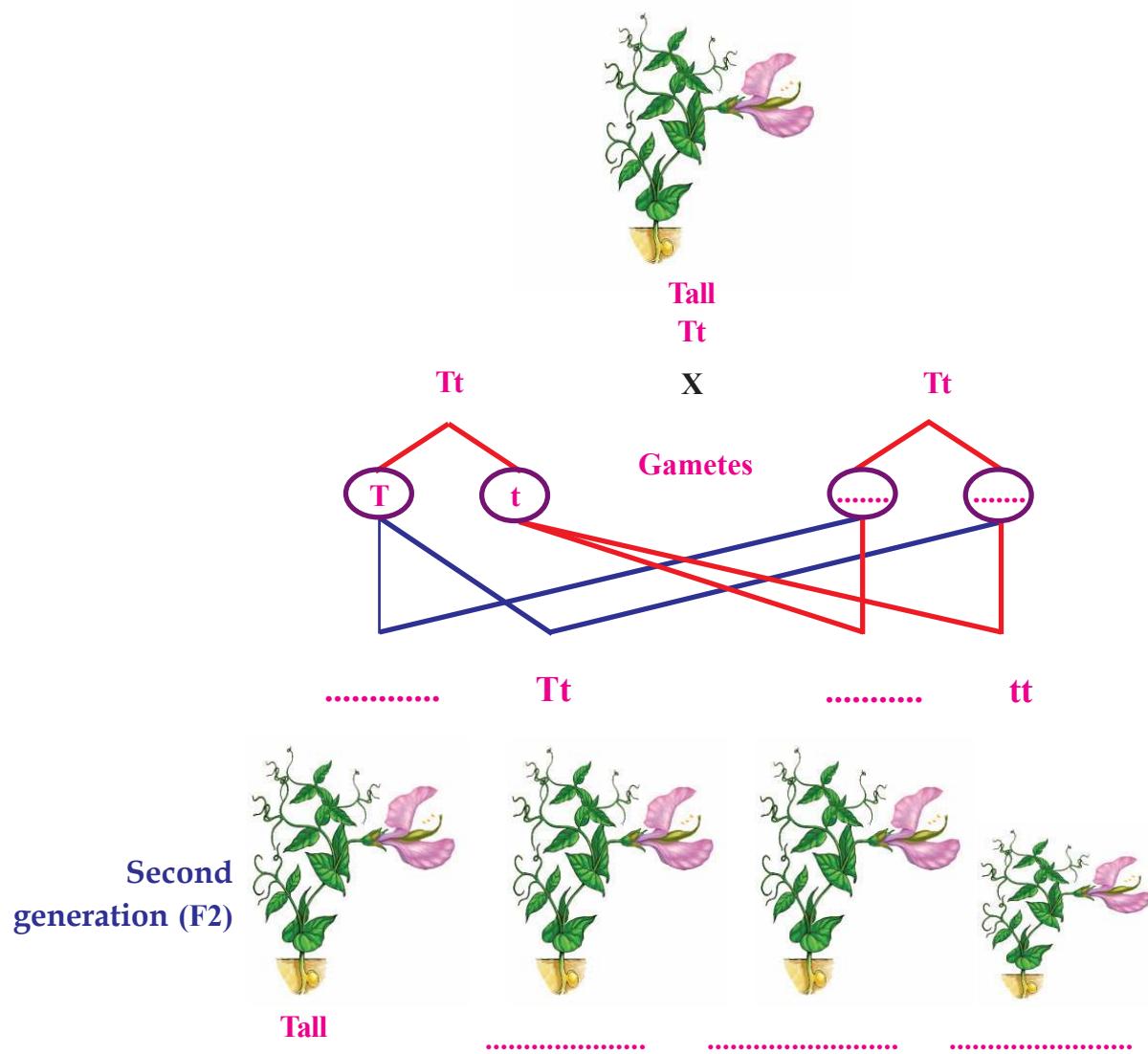
Gregor Mendel assumed that the inheritance of characteristics from parents to offsprings is by certain factors transferred through gametes. It was discovered on the basis of later studies that the factors are the genes present in the chromosomes of the nucleus. A gene that controls a character has different forms. They are called alleles. Generally, a gene has two alleles. For example, **T** and **t** are the different alleles of the gene that controls the character, height. The allele **T** determines the trait tallness and the allele **t** determines the trait dwarfness. The allele that determines the dominant trait in the first generation is generally indicated by a capital letter and the allele that determines the recessive trait is indicated by a small letter.



The fact that no intermediate plants were formed by the hybridization of tall and dwarf plants, and the factor responsible for dwarfness remaining hidden persuaded Mendel to continue with his experiments.

He self pollinated the first generation plant to understand what happened to the factor responsible for dwarfness in the first generation. Complete illustration (6.2) of this experiment, analyse it on the basis of indicators and write your inferences in the Science diary.

### Self pollination of first generation plant



**Illustration 6.2 Self pollination of first generation plant**

## Indicators

- Characters of plants in the second generation.
- Plants in the second generation and their factors.
- Recessive trait in the first generation and the second generation.

## Statistics in Mendel's Experiment

Among the 1064 plants obtained in the second generation, 787 plants were tall and 277 plants were dwarf. The ratio of the result obtained is approximately 3 : 1. He continued his experiments based on contrasting traits of the other six different characters in pea plant. Complete table 6.1 given below and compare the ratios.

Parental plants	First generation	Second generation (self pollination)	Approximate ratio
<b>Position of flowers</b> Axial × Terminal	.....	651 (Axial), 207 (Terminal)	.....
<b>Shape of seeds</b> Round × Wrinkled	.....	882 (Round), 299 (Wrinkled)	.....

Table 6.1 Hybridization experiment and ratio

Why does the recessive trait in the first generation appear in the second generation?

Mendel came up with the assumption that during gamete formation the factors that determine a particular character segregate without getting mixed; ie., half of the gametes formed from first generation plant  $Tt$ , contain  $T$  and the other half contain  $t$ .

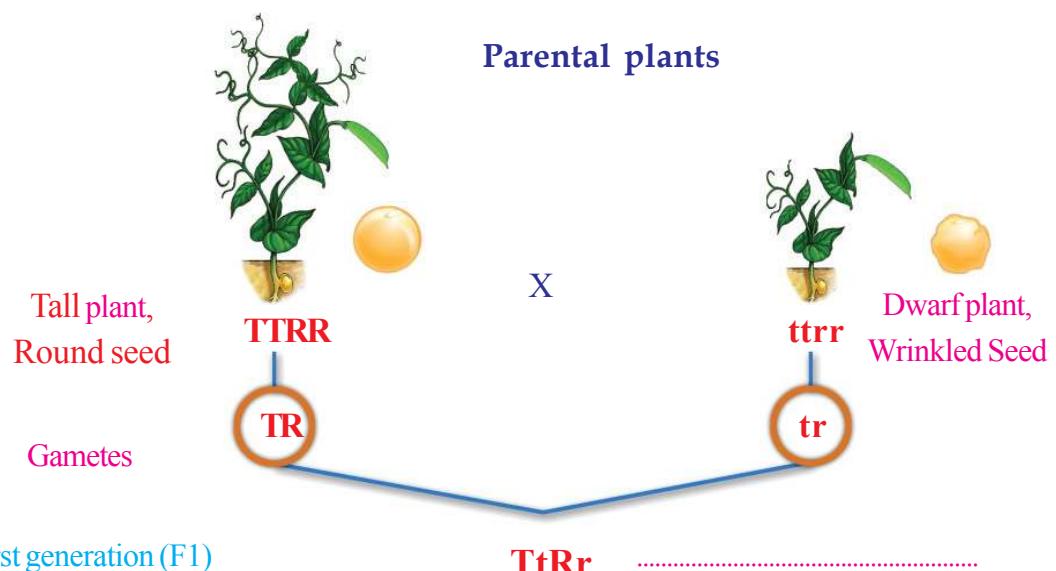
The inferences formulated by Mendel from such experiments are given below.

- A character is controlled by the combination of two factors.
- One trait is expressed (dominant trait) and the other trait remains hidden (recessive trait) in the offsprings of the first generation.
- The traits that remain hidden in the first generation appear in the second generation.
- The ratio of the dominant and the recessive traits in the second generation is 3 : 1.

In his first experiment, Mendel observed the inheritance of a single pair of contrasting traits. He observed the inheritance of two pairs of contrasting traits of the same plant in the next stage. Observe the illustration showing the hybridization experiment conducted by Mendel on two characters namely, height of the plant and shape of the seed.

Complete the illustration suitably.

Based on the indicators, analyse illustration 6.3 and write down the inferences in the Science diary.



**Self pollination in first generation -**  $TtRr \times TtRr$

Gametes	TR	Tr	tR	tr
TR	TTRR Tall plant, Round Seed			
Tr				
tR				
tr				

Illustration 6.3 Hybridization of two characters

## Indicators

- Factors present in the gametes produced by first generation.
- Characters in the plants of second generation.
- Characters different from parents that appeared in the second generation.

Through this experiment Mendel could find the reason for the appearance of new combination of characters in offsprings that were not expressed in parents.

Mendel explained that the appearance of variations in offsprings (characters not present in previous generation) is due to the independent assortment of each character.

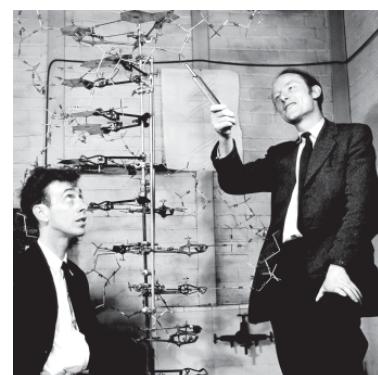
Gregor Mendel described those which are responsible for the inheritance of characters as factors. The real structure and peculiarities of these factors were not identified till the early 20th century. It was through further studies that the significance of DNA (Deoxyribo Nucleic Acid) molecule in the inheritance of characters was made clear. It was also found that the carriers of heredity which Mendel described as 'factors' were the genes present in DNA. Findings about the structure of DNA in chromosomes became a great achievement in later genetic researches. Molecular genetics is a fast developing area in the field of scientific research.

## DNA (Deoxyribonucleic Acid)

Two scientists, James Watson and Francis Crick, presented the double helical model of DNA in 1953. This model fetched wide acceptance in the scientific world, and they were awarded the Nobel Prize in 1962.

### Mendel gains recognition

Mendel presented the most scientific inferences about the inheritance of characters. But, at that time the scientific world discarded his inferences. Scientists named Carl Correns, Erich von Tschermak and Hugo de Vries conducted similar experiments and observations independently. Before publishing the results of their studies, they noticed the experiments and inferences of Gregor Mendel. Then, they published their study results to substantiate scientifically the inferences of Gregor Mendel. Thus in 1990, the inferences of Mendel were established as Mendel's Laws of Inheritance.

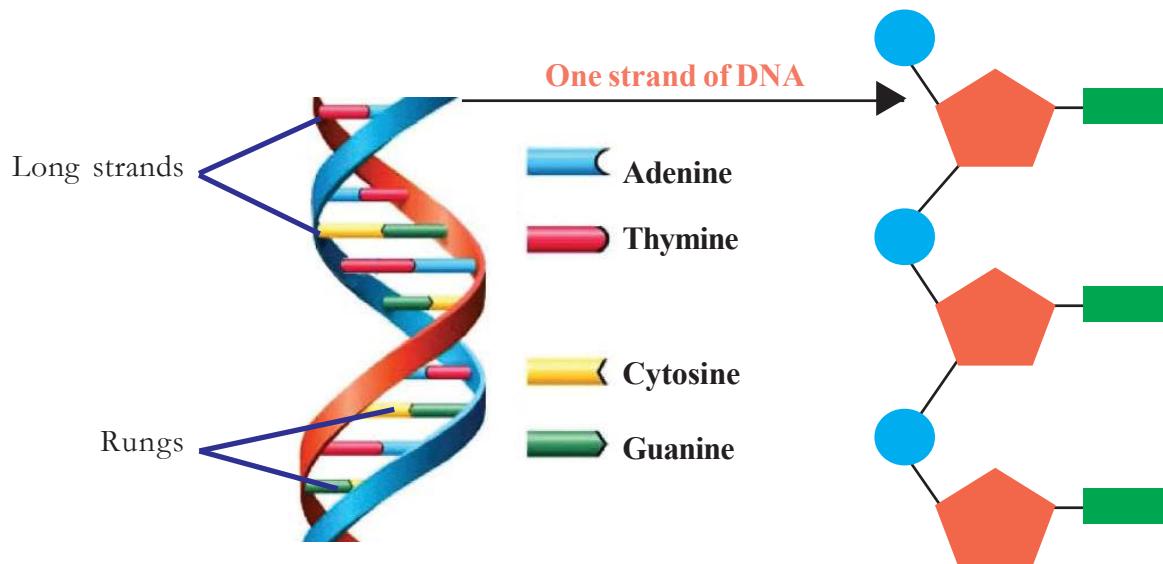


**Figure 6.2**  
**Watson and Crick**

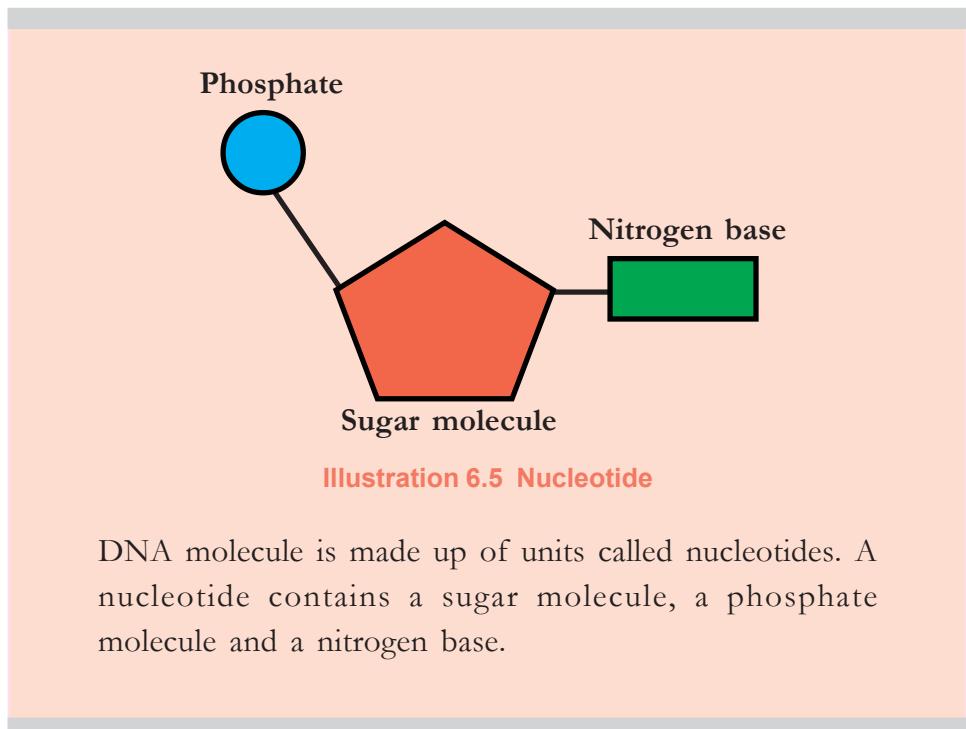


As per the double helical model, DNA molecule contains two strands. A structure with two long strands made up of sugar and phosphate, and rungs with nitrogen bases, was suggested.

Based on the indicators, analyse illustration 6.4 and 6.5 and the description given below. Prepare a note on the structure of DNA.



**Illustration 6.4 Structure of DNA**



**Illustration 6.5 Nucleotide**

DNA molecule is made up of units called nucleotides. A nucleotide contains a sugar molecule, a phosphate molecule and a nitrogen base.

DNA contains deoxyribose sugar. Nitrogen bases are molecules that contain nitrogen and are alkaline in nature. Since DNA has four kinds of nitrogen bases, namely adenine, thymine, guanine and cytosine, DNA has four kinds of nucleotides too. Nitrogen bases, the building components of DNA, are molecules with great specificity. In DNA, the base adenine pairs only with thymine and guanine pairs only with cytosine.

### Indicators

- Components of nucleotide.
- Nitrogen bases.
- Specificity maintained by nitrogen bases in pairing.

The arrangement of nucleotides in a DNA molecule is illustrated below. Redraw this illustration (6.6) in the Science diary and complete its second strand.

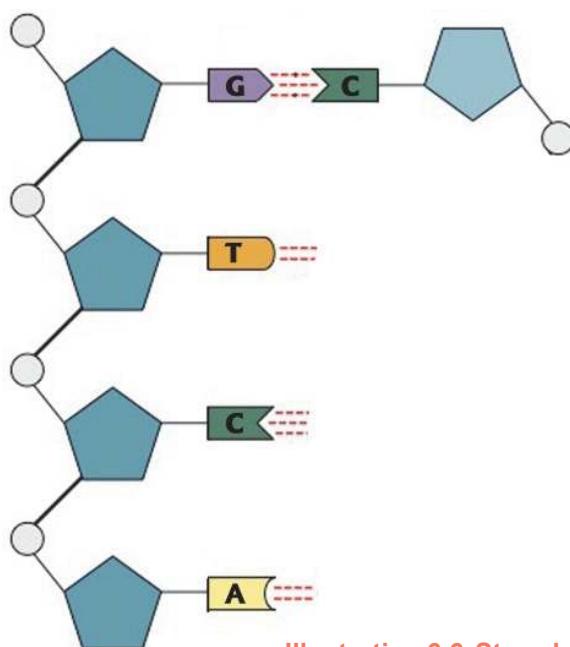


Illustration 6.6 Strands of DNA

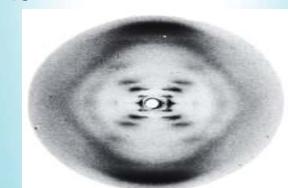


### A humble attempt, yet a great achievement!



Rosalind Franklin

Watson and Crick happened to see the X-ray diffraction picture of DNA, captured using X-rays by Rosalind Franklin, a researcher who was conducting research to identify the structure of DNA. From this, they were able to disclose the molecular structure of DNA, the molecule of life.



Based on this picture, Watson and Crick produced models using various things in their hostel room and ensured the possibility of double helical model of DNA.

## RNA (Ribonucleic acid)



RNA is another nucleic acid like DNA. RNA is also formed of nucleotides. Ribose sugar is present in RNA. In RNA, the nitrogen base uracil is seen instead of thymine. Majority of RNAs have only a single strand.

Compare the structure of DNA and RNA and complete table (6.2) suitably.

	Number of strands	Type of sugar	Nitrogen bases
DNA			
RNA			

Table 6.2

### How do genes act?

The activity of particular proteins (enzymes) controls metabolic activities and is responsible for specific characteristics. Genes contain information for protein synthesis. Genes are particular segments of DNA. Observe illustration 6.7 and get an understanding about the location of genes.

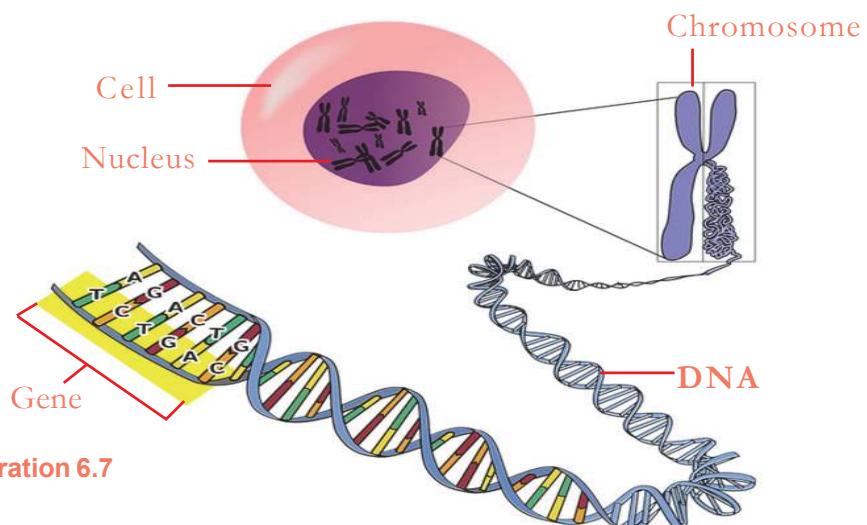
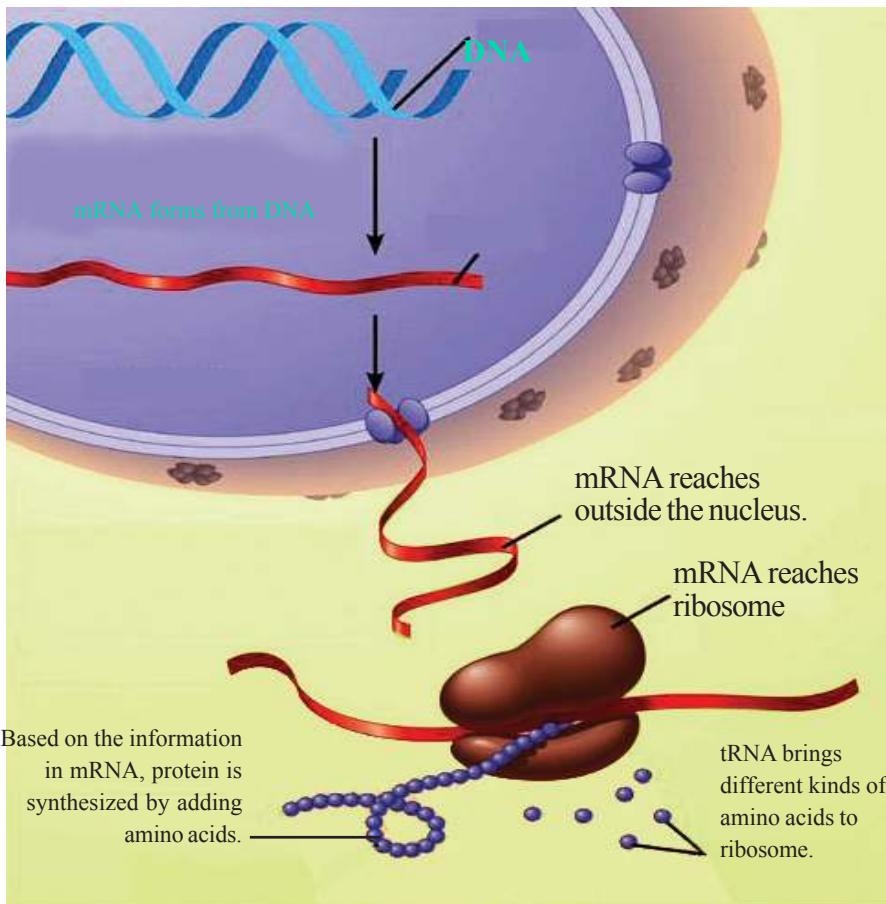


Illustration 6.7

How do genes act? Based on the indicators, analyse illustration 6.8 and the description. Write inferences in your Science diary.



**Illustration 6.8 Action of genes**

DNA does not participate directly in protein synthesis. DNA performs its activities with the help of RNA. RNA that carries information from DNA reaches ribosome and controls protein synthesis. Since this RNA is the messenger of DNA, it is called messenger RNA or mRNA. Besides mRNA, there are tRNA (Transfer RNA) that carry amino acids to the ribosomes and rRNA (Ribosomal RNA) that are seen associated with ribosomes. Protein molecule is synthesized by the combined activities of all these molecules.

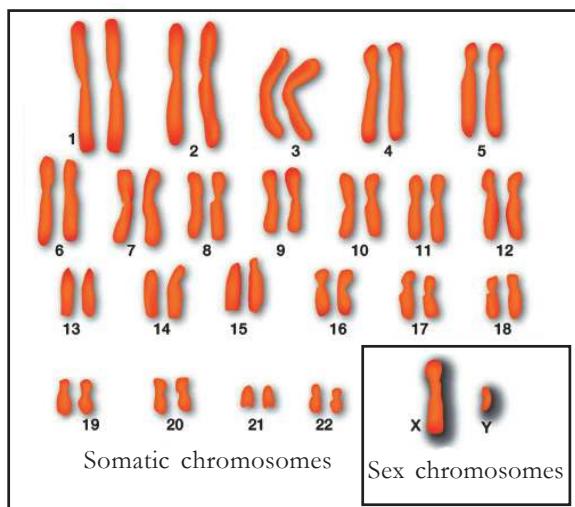
### Indicators

- Different kinds of RNAs.
- Role of mRNA in protein synthesis.
- Activities that take place in the nucleus.
- Activities that take place in the cytoplasm.

Prepare a flow chart including the processes involved in protein synthesis in the Science diary.

## Chromosomes in Humans

Each species has a definite number of chromosomes. Analyse figure 6.3 on the basis of indicators and the description. Prepare a note on chromosomes in humans in your Science diary.



**Figure 6.3**

There are 46 chromosomes in human beings. Of these, 44 are somatic chromosomes and two are sex chromosomes. A somatic chromosome pair contains two identical chromosomes. Thus in human beings there are 22 pairs of somatic chromosomes.

Sex chromosomes are of two types. They are called X chromosome and Y chromosome. Females have two X chromosomes and males have one X chromosome and one Y chromosome. i.e., the genetic makeup of female is  $44 + XX$  and that of male is  $44 + XY$ .

### Indicators

- Chromosome number
- Somatic chromosomes
- Sex chromosomes

### Genetics of Variation

Analyse the description given below and illustration (6.9). Based on the indicators, write your inferences about the processes that cause variations in organisms.

## Crossing over in Chromosomes – A Source of Variation

During the initial phase of meiosis, chromosomes pair and exchange their parts. This process is called crossing over of chromosomes. As a result of this, part of a DNA crosses over to become the part of another DNA. This causes a difference in the distribution of genes. When these chromosomes are transferred to the next generation, it causes the expression of new characters in offsprings.

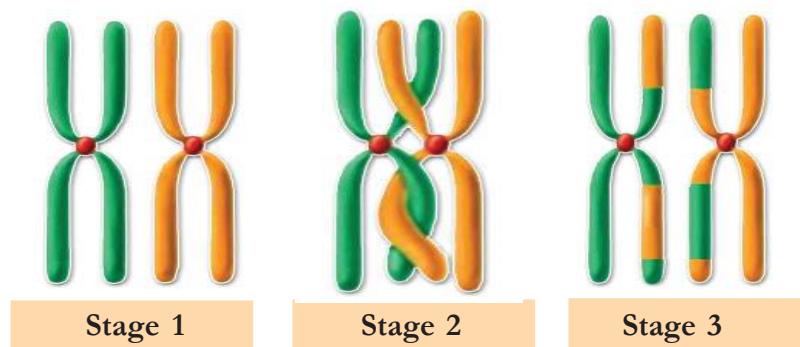


Illustration 6.9 Crossing over of chromosomes

## Chromosomes and Diseases

Certain diseases have genetic causes. For example, it has been discovered that in humans, the disorder of gene in chromosome number 11 and the disorder of gene in chromosome number 14 is responsible for sickle cell anemia and Alzheimer's disease respectively. Melanoma, the skin cancer, is caused by the disorder of gene in chromosome number 9.



## Indicators

- Crossing over of chromosomes.
- Role of crossing over in causing variations.

## Combination of Allele during fertilization

The chromosomes of parents reach the offsprings through gametes. When gametes undergo fusion, the combination of allele changes. This causes the expression of characteristics in offsprings that are different from parents. Thus, fertilization causes variations in the next generation.



Figure 6.4

## Mutation

A sudden heritable change in the genetic constitution of an organism is called mutation. This may occur due to defects in the duplication of DNA, certain chemicals, radiations, etc. Mutations bring about changes in genes which can be transmitted over generations and thus leading to variations in characters. Mutations have great relevance in evolution.

### Is the child male or female?

What is the genetic mechanism that determines whether a child is male or female?

Observe illustration 6.10. Discuss with the help of indicators and write down inferences in the Science diary.

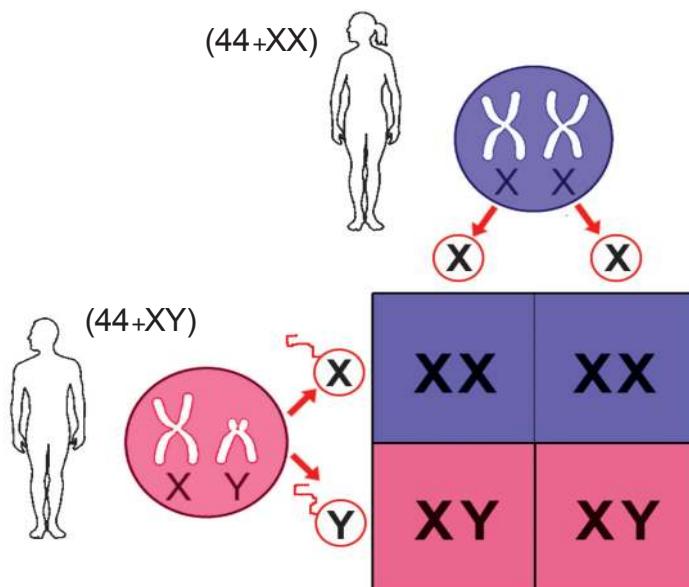


Illustration 6.10 Determination of sex

## Indicators

- Number of chromosomes in male and female.
- Chromosome difference in male and female.

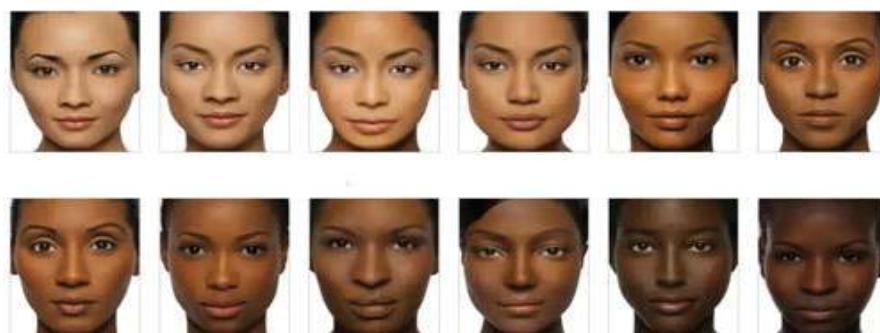
What is the possibility for the birth of a male or a female child? Discuss.

The XY chromosomes of the father determine whether the child is male or female. Child with XX sex chromosomes is female and one with XY sex chromosomes is male.

### Difference in Skin colour

What may be the reason for the difference in the colour of skin in people living in various parts of the world?

Melanin, a pigment protein imparts colour to the skin. The rise or fall in the production of melanin is due to difference in the function of alleles of genes responsible for skin colour. This is the reason for the colour difference of human skin.



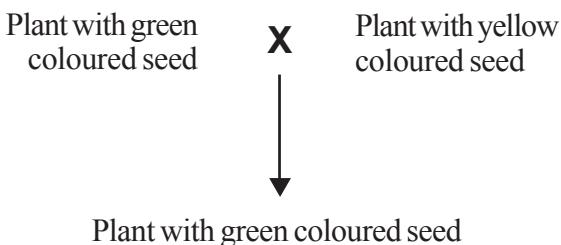
**Illustration 6.11 Different colour of human skin**

It is not racial difference which makes the skin colour dark or light. This is simply an adaptation to live under the sun. Races among mankind are only cultural. Biologically, all men are of the same race. Studies in genetics become meaningful only when one attains an awareness to consider all men equal without any racial discrimination.



## Let us assess

1. The nitrogen base absent in RNA.
    - a. Adenine
    - b. Thymine
    - c. Uracil
    - d. Cytosine
  2. Arrange the stages of protein synthesis in the form of a flow chart.
    - protein synthesized by adding amino acids.
    - mRNA reaches ribosomes.
    - mRNA is formed.
    - amino acids are carried to the ribosomes.
  3. Observe the hybridization experiment given below.



- a. Illustrate this hybridization experiment using symbols.
  - b. Illustrate the second generation formed by the self pollination of first generation plant.

4. Three processes that cause variations in new generations are given. Prepare a short note on each of the processes.

  - Crossing over of chromosome
  - Fertilization
  - Mutation

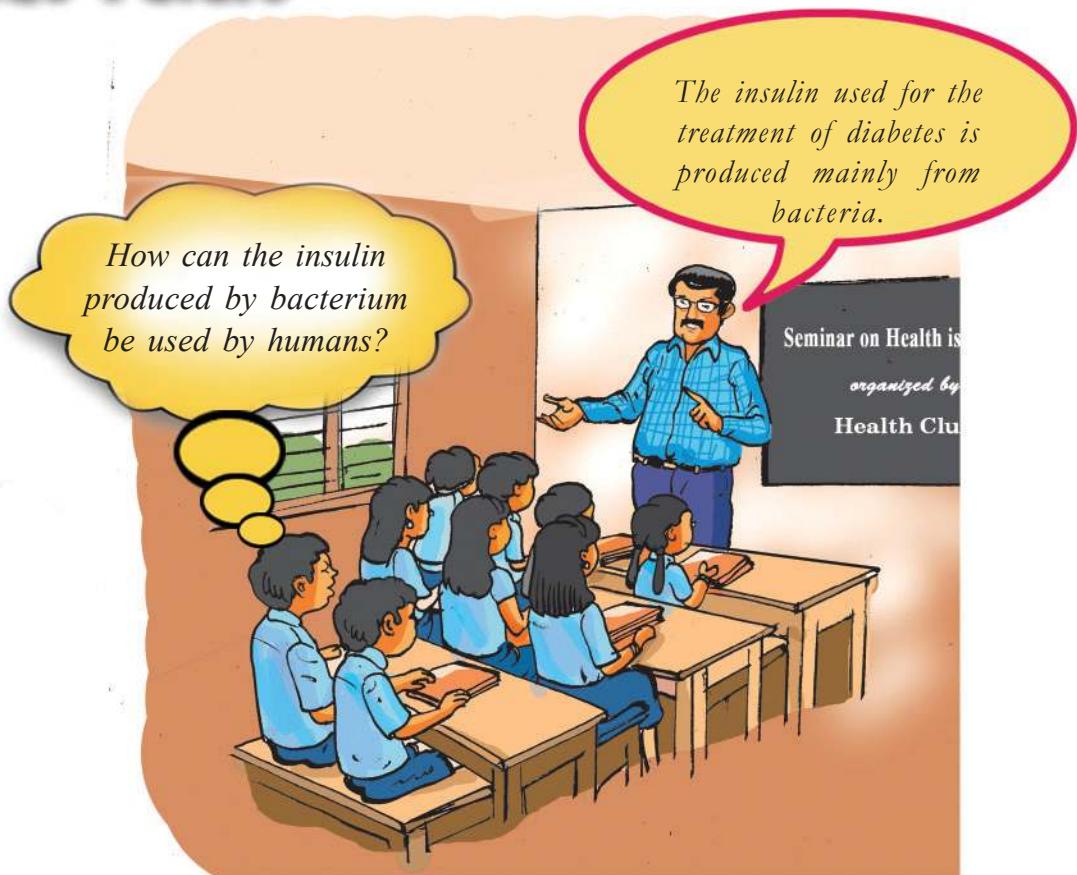
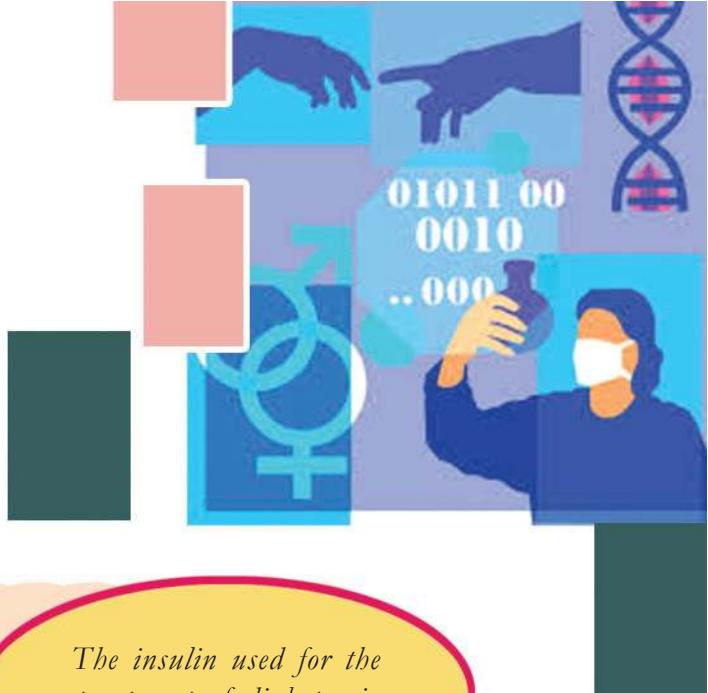


## Extended activities

- Prepare an edition including information on scientists who have made contributions in the progress of genetics.
  - Prepare models of DNA and RNA using locally available materials and present them in Science exhibition.

# 7

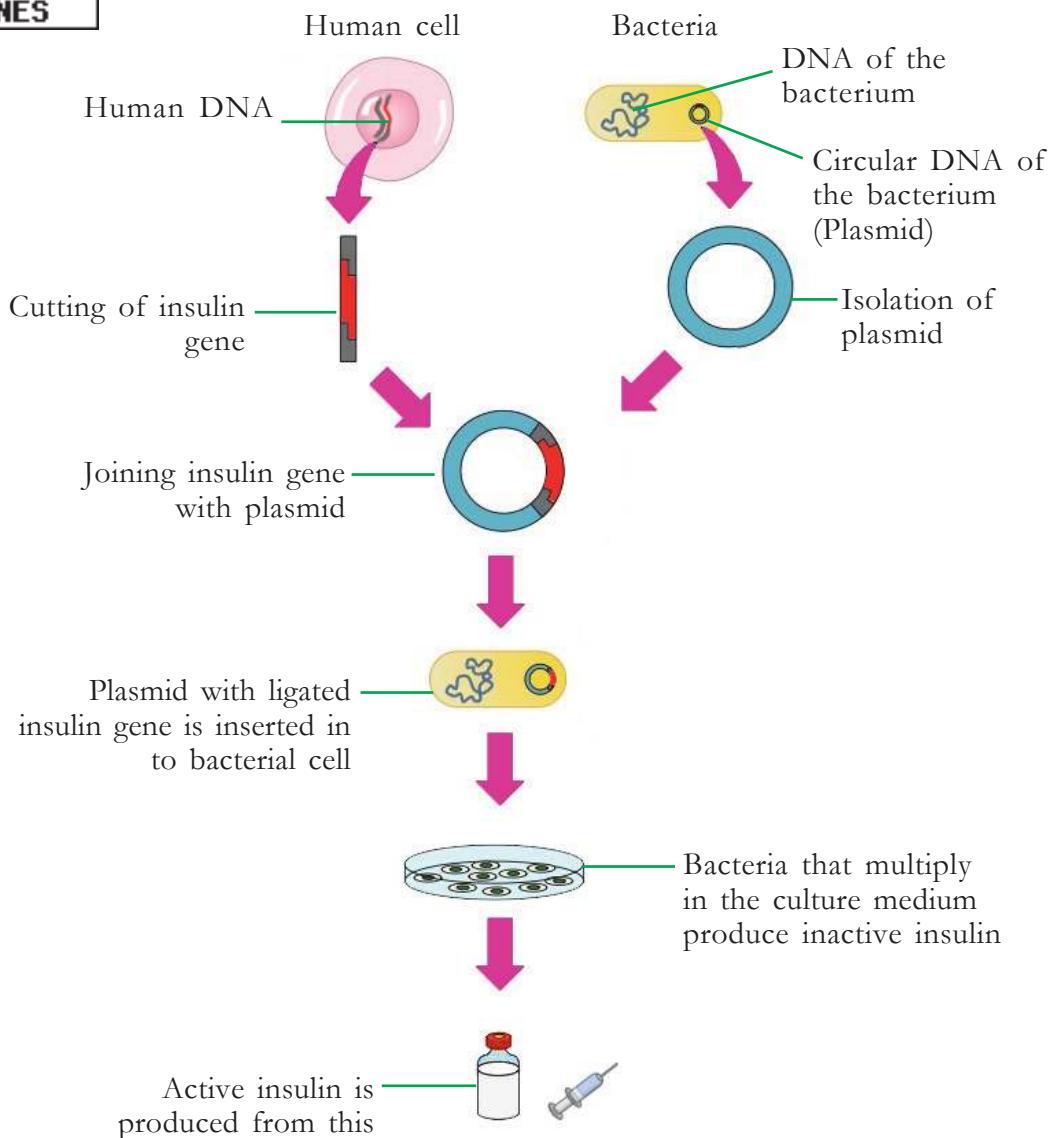
## Genetics of the Future



Did you notice Saju's doubt when he heard the doctor's talk in the seminar conducted by the Health Club?

How can bacteria produce insulin that can be used by humans?  
Note down your assumption.

Observe illustration 7.1 on the various stages in the production of bacteria that are capable of producing insulin. Based on the indicators, analyse the illustration, validate your assumption and write down the inferences in the Science diary.



**Illustration 7.1 Production of insulin through genetic engineering**

## Indicators

- Change brought about in the genetic constitution of bacteria.
- New trait formed in this bacterium.
- Ability of production of insulin by succeeding generations of this bacterium.

## Genetic engineering

Science has progressed in such a way that it can produce organisms with desirable qualities, by bringing about changes in the genetic material. The use of microorganisms and biological processes for various human requisites is called Biotechnology.

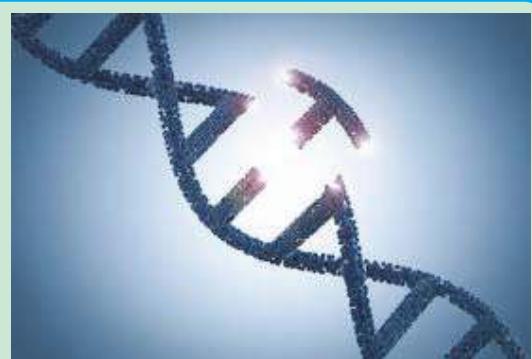
From BC 4000 onwards organisms like yeast, a kind of fungus, were used to prepare food items like bread. The ability of fungi and bacteria to convert sugar into alcohol was utilised to make wine, appam and cake. These can be considered as traditional methods of biotechnology. Genetic engineering is the modern form of biotechnology.

Today, we can produce things essential for humans by bringing about changes in the genetic material of organisms. You have already been familiarised with this idea when you analysed the method of production of insulin. Genetic engineering is the technology of controlling traits of organisms by bringing about desirable changes in the genetic constitution of organisms. The basis of this is the discovery of the fact that genes can be cut and joined.

How are the very minute genes cut and joined?

Analyse the description given below on the basis of the indicators and prepare notes.

Enzymes are used to cut and join genes. The enzyme restriction endonuclease is used to cut genes. This enzyme is known as 'genetic scissors'. The enzyme ligase is used for joining. This enzyme is called 'genetic glue'.



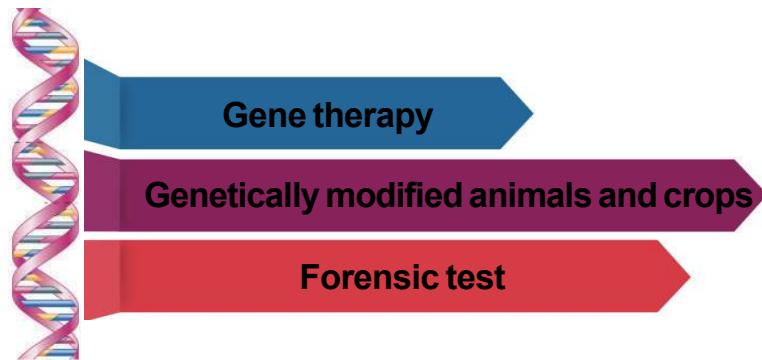
How was the insulin producing gene of humans transferred into bacteria? A gene from one cell is transferred to another cell by using suitable vectors. Vectors which contain ligated genes enter target cells. Plasmids in bacteria are generally used as vectors. In this way, the new genes become a part of the genetic constitution of target cells.

### Indicators

- Cutting of gene
- Ligation (insertion) of gene
- Vectors

The progress in genetic engineering has influenced various sectors of life.

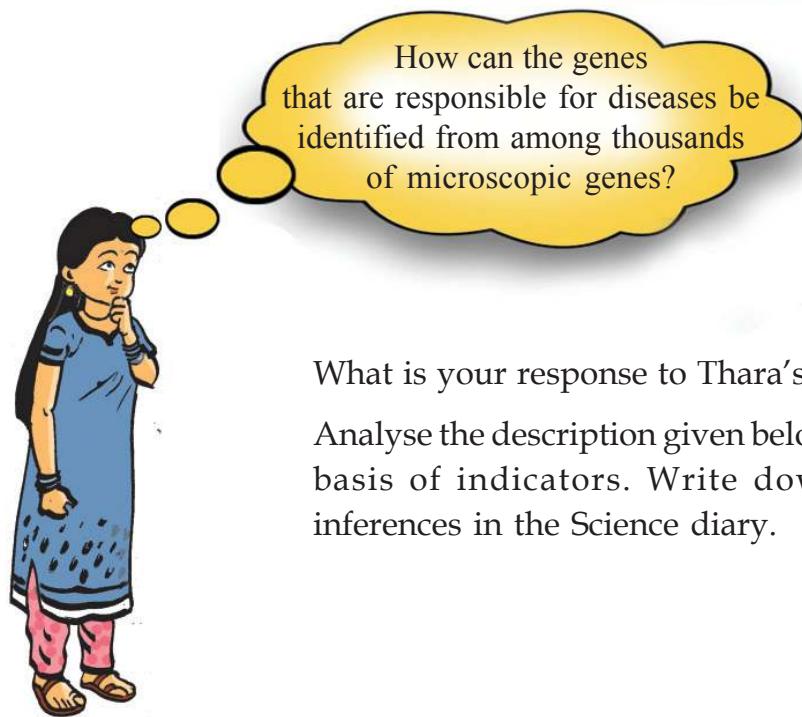
Identify this by observing illustration 7.2 indicating some of the scope of genetic engineering.



**Illustration 7.2 Scope of genetic engineering**

### Gene therapy

Genetic engineering has made a great leap in the treatment of genetic diseases. Gene therapy is a method of treatment in which the genes that are responsible for diseases are removed and normal functional genes are inserted in their place. This has triggered great hope in the control of genetic diseases.

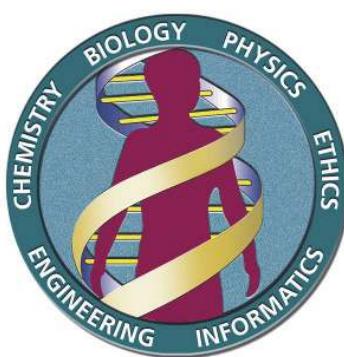


What is your response to Thara's doubt?

Analyse the description given below on the basis of indicators. Write down your inferences in the Science diary.



## Human Genome Project



**Figure 7.1**  
**The logo of Human Genome Project**

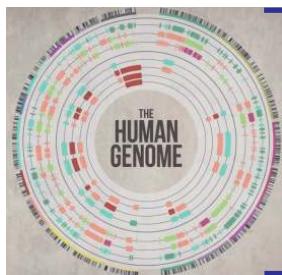
Even though science has progressed a lot, we couldn't control genetic diseases. The reason for this is that we could not identify the exact gene responsible for a specific trait and its location. In 1990, the Human Genome Project was started as an attempt to solve this issue. As a result of experiments conducted in various laboratories around the world till 2003, the secrets of human genome were revealed. The technology known as

gene mapping helped to identify the location of a gene in the DNA responsible for a particular trait. The complete genetic material present in an organism is called its genome. In human DNA, majority of genes, except the genes that code for protein are non-functional. They are called junk genes.

### Indicators

- Relevance of Human Genome Project
- Benefit of gene mapping

Did you understand the relevance of the Human Genome Project? Prepare a wall magazine using the information given below and collecting more data. Exhibit the magazine in the classroom.



Human genome has about 24000 functional genes.

Major share of human DNA includes junk genes.

There is only 0.2 percent difference in DNA among humans.

About 200 genes in human genome are identical to those in bacteria.

### Genetically modified animals and crops

Many proteins that can be used for the treatment of diseases in humans are produced through genetic engineering.

Examine table 7.1 given below and prepare notes on these proteins.



Protein required for treatment	Disease/Symptom
Interferons	Viral diseases
Insulin	Diabetes
Endorphin	Pain
Somatotropin	Growth disorders

Table 7.1

Genetic engineering has progressed a lot more from biotechnology. Today, genetic modification in organisms can be implemented more effectively. This is made possible through the insertion of gene that code for desirable characters into the genetic constitution of an organism.

One of the future promises of genetic engineering is pharm animals.

Genes responsible for the production of insulin and growth hormones required for humans are inserted into animals like cow, pig etc, transforming them into pharm animals.

There are certain limitations in producing insulin using bacteria. The most important hurdle in this field is the culturing of bacteria. Researches in this field show that instead of this, medicines can be extracted from the blood or milk of genetically modified animals.

Genetic modification is implemented not only in animals but in plants also. Today, insect resistant plants like Bt brinjal, soyabean, cotton, maize etc are common. When genetic modification is carried out in organisms, it should be ensured that there are no harmful consequences to humans or nature. Prepare a Science edition on the new inventions in this field by collecting more information.

## Editing of genetic constitution

Today, genetic engineering can edit the genes in the genetic constitution of organisms just as editing an essay. This most modern aspect of genetic engineering is called gene editing. CRISPR - Cas 9 is the most effective genetic scissors used for this. This contains 'Cas 9', an enzyme and a guide RNA (gRNA). Active researches on gene editing are being conducted worldwide. Recently, China released the news on the birth of twins whose genes were edited. It is declared that these children have acquired resistance to HIV through gene editing. This technology has created an avenue to the endless scope of gene therapy. But it has also initiated many criticisms. Worldwide protests are going on against researches which do not consider the possibilities of exploitations, dangerous effects and deterioration of values due to these experiments.



**Lost child found after years :  
Identified through DNA testing**



Did you notice the headline of the newspaper report?

How are persons identified through DNA testing?

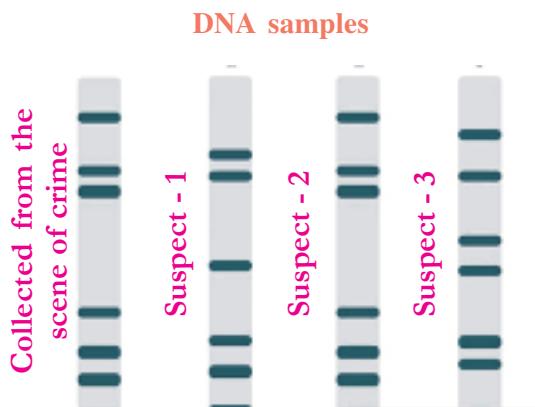
Read the description given below. Discuss it on the basis of the indicators and formulate inferences. Write them down in the Science diary.

### DNA Finger printing



**Alec Jeffreys**

The technology of testing the arrangement of nucleotides is DNA profiling. Certain experiments conducted by a scientist named Alec Jeffreys in 1984 paved the way for DNA testing. Just like the difference in the fingerprint of each person, the arrangement of nucleotides in each person also differs. This discovery became the basis of DNA testing. Hence this technology is also called DNA finger printing.

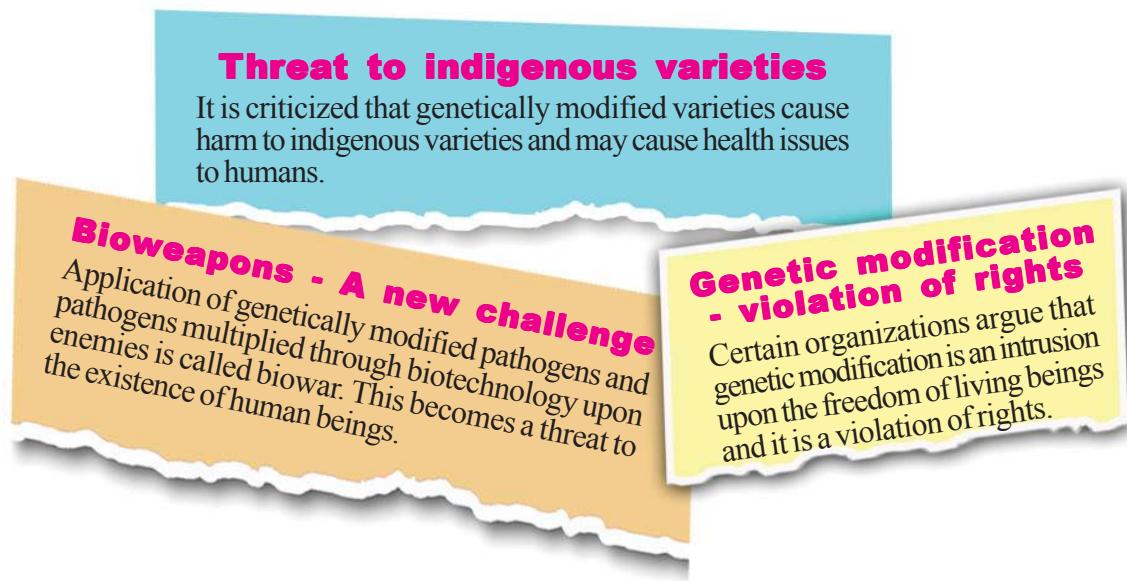


The arrangement of nucleotides among close relatives has many similarities. Hence, DNA finger printing is helpful to find out hereditary characteristics, to identify real parents in cases of parental dispute and to identify persons found after long periods of missing due to natural calamities or wars. DNA of the skin, hair, nail, blood and other body fluids obtained from the place of murder, robbery etc., is compared with the DNA of suspected persons. Thus, the real culprit can be identified from among the suspected persons through this method.

## Indicators

- Basis of the technology of DNA finger printing.
- Scope of DNA finger printing.

We have familiarized ourselves with the endless scope of genetic engineering. Collect more information regarding the scope of genetic engineering and exhibit in the Science corner. Through active researches and new discoveries, this branch is advancing day by day. But, like any other technology, genetic engineering has also been misused. Observe the collage given below.



Is it right to misuse technologies that can pave the way to human progress?

As such possibilities prevail, must we promote genetic engineering?

Organize a debate in the class on this topic.

Science and technology are the products of man's reasoning ability. We can justify this only if they are utilized for human benefit. We must use science and technology as means to overcome the challenges faced by human beings.





### Let us assess

1. Which of the following is not a part of modern genetic engineering?
  - a) DNA profiling
  - b) Gene mapping
  - c) DNA finger printing
  - d) X-ray diffraction
2. Gene therapy is an example of the boons of science for human existence.
  - a) What is gene therapy?
  - b) What was the discovery that led to gene therapy?
  - c) How does gene therapy become useful to human beings?
3. 'Since genetic engineering has many harmful effects, it shouldn't be promoted'. Do you agree with this statement? Why?

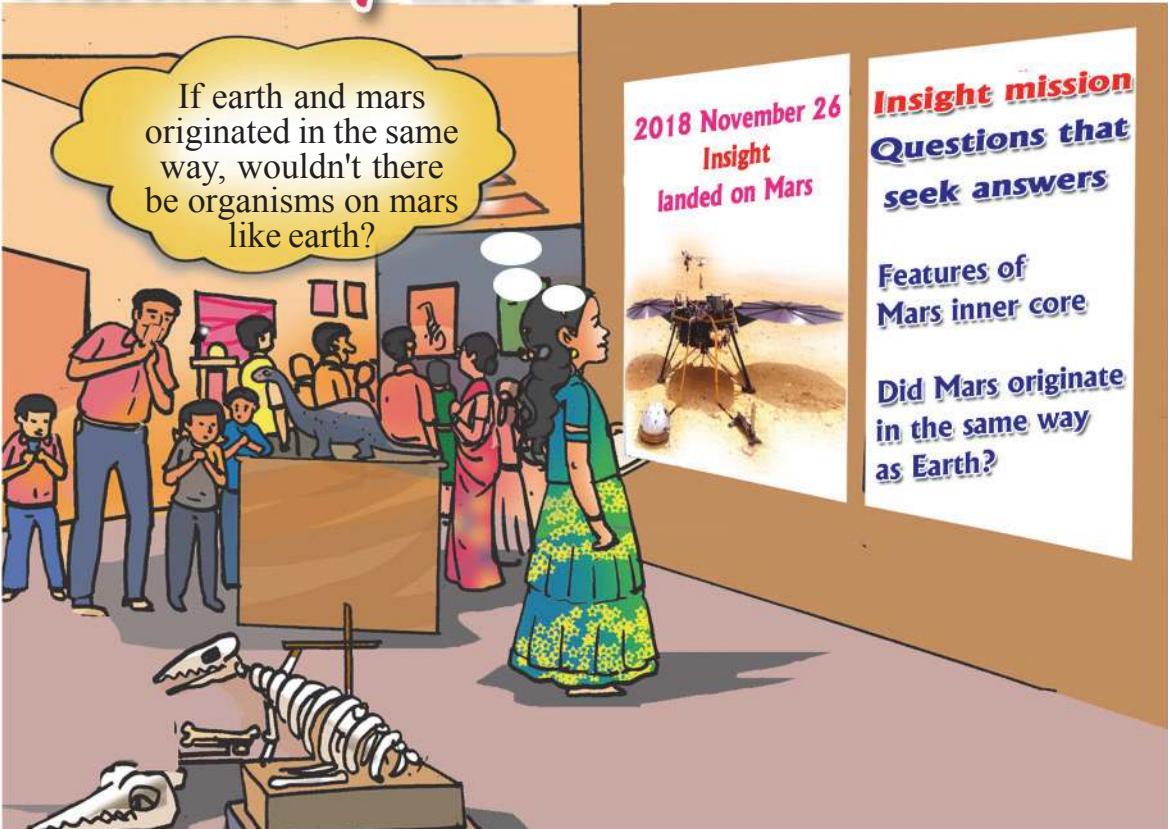


### Extended activities

- Prepare a slide presentation on the stages of insulin production through genetic engineering.
- Prepare a science edition by collecting pictures and news related to genetic engineering.

# 8

## The Paths Traversed by Life



Did you notice the child's doubt?

How did the planets, including earth originate? How might have life originated? Is there life on other planets? All such questions have always come under the purview of scientific enquiry. Science has been able to put forth certain hypotheses on how earth and life on earth originated. The more predominant theory, on the origin of life on earth that was formed about 4500 million years ago, is the Chemical evolution theory. The Panspermia hypothesis is also a widely discussed one.





A.I.Oparin



J.B.S.Haldane

The Panspermia argues that life originated in some other planet in the universe and accidentally reached the earth. The organic substances obtained from the meteors that fell on earth support this.

The hypothesis that evolved into the theory of chemical evolution is that life originated as a result of the changes that occurred in the chemical substances in seawater, under specific conditions in primitive earth. This theory is generally accepted by the scientific world due to its experimental evidences. The Russian scientist A.I. Oparin (1924) and the British scientist J.B.S. Haldane (1929) are the proponents of this theory.

Analyse illustration 8.1 and prepare a note on the theory of Chemical evolution in your Science diary.

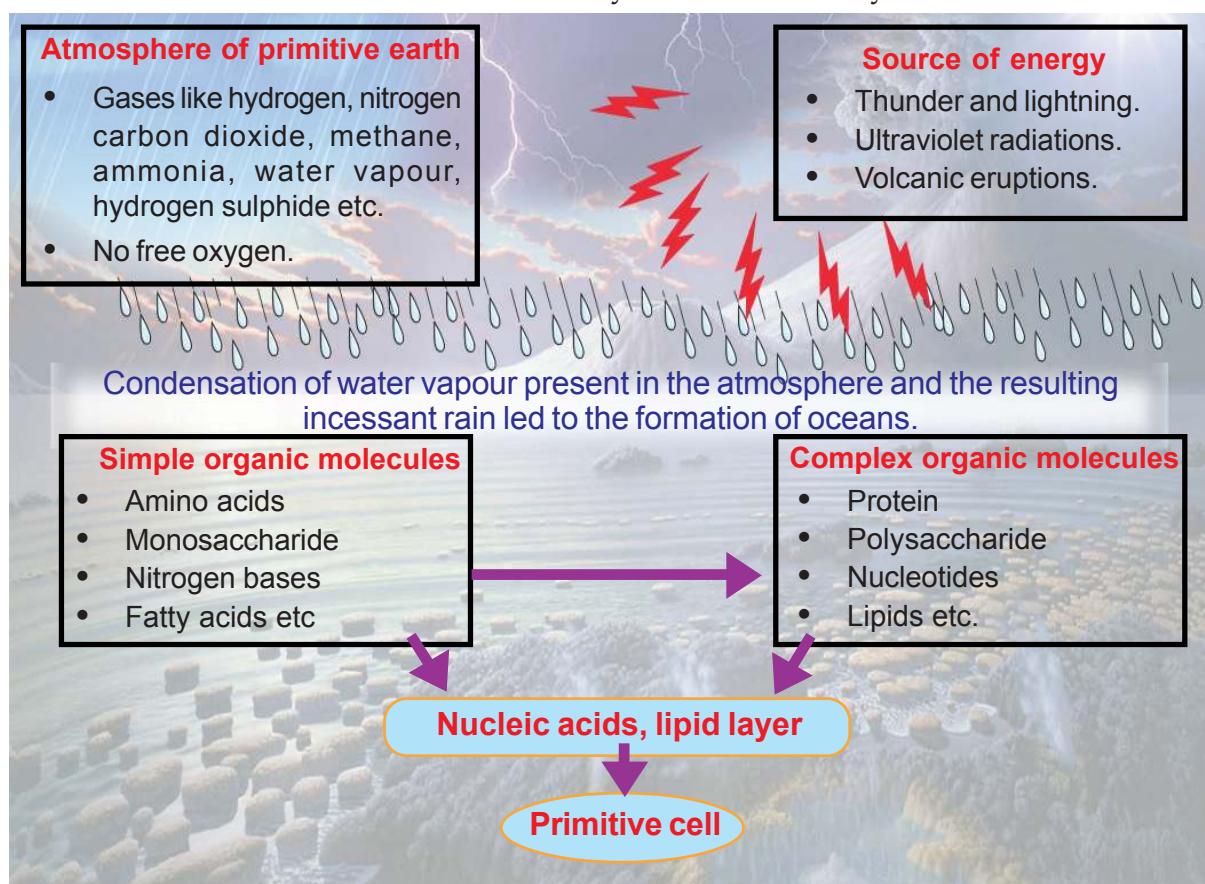


Illustration 8.1. Chemical evolution

### Indicators

- Atmosphere of primitive earth – peculiarities.
- Sources of energy.
- Formation of ocean.
- Chemical reactions that led to the formation of cell.

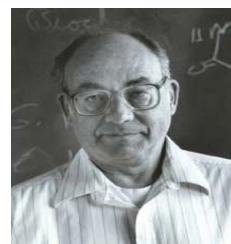


The scientific basis of this hypothesis regarding the origin of life was later proved through various experiments.

### Urey – Miller Experiment

Urey and Miller conducted their experiment by artificially recreating the atmosphere of primitive earth that contained methane, ammonia, hydrogen and water vapour.

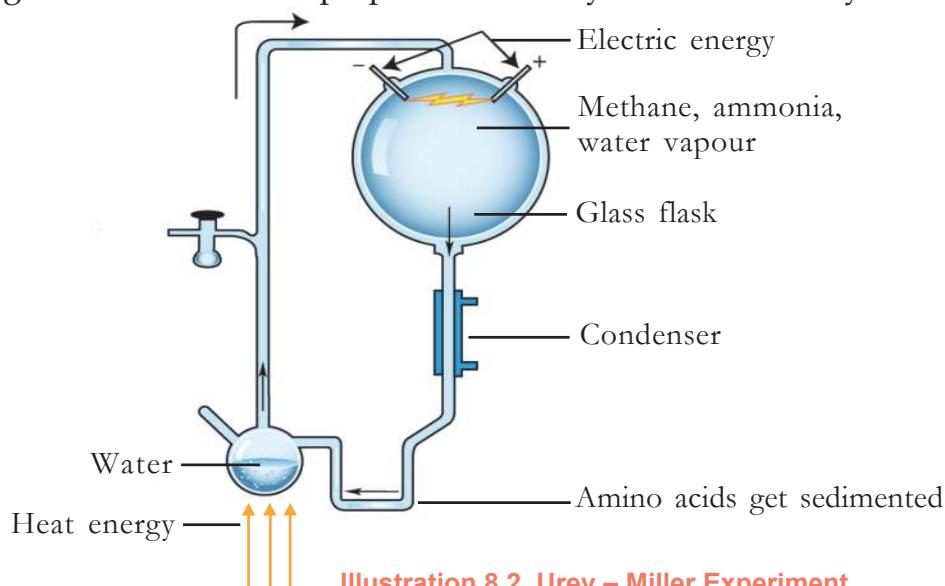
Analyse illustration 8.2 and the description, on the basis of the given indicators and prepare a note in your Science diary.



**Stanley Miller**



**Harold Urey**



**Illustration 8.2 Urey – Miller Experiment**

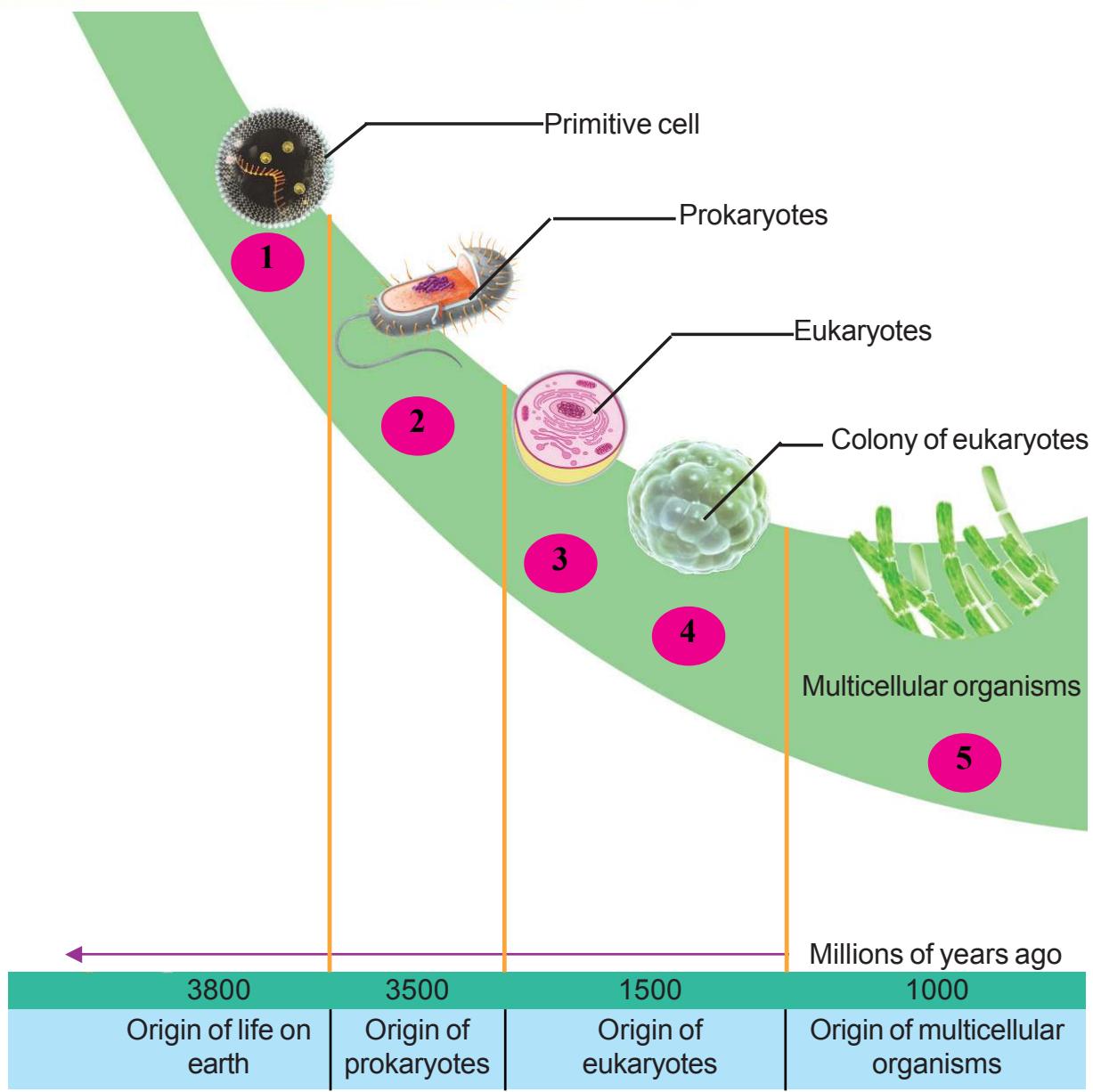
In the place of natural energy sources like thunder and lightning in the atmosphere of primitive earth, high voltage electricity was passed through the gaseous mixture in the glass flask. Then, this gaseous mixture was cooled with the help of a condenser. The sediment substances were separated and when observed, organic molecules such as amino acids, were found. Later many scientists designed similar experiments and more organic compounds were synthesized. This finally gave more acceptance to the Oparin – Haldane Hypothesis.

### Indicators

- Atmosphere of primitive earth and chemical components in the glass flask.
- Organic molecules formed after the chemical reaction.

In the oceans of primitive earth, organic compounds were formed due to chemical evolution that continued for millions of years. On the basis of the given indicators analyse the major events related to the origin of life as illustrated in the geological time scale 8.3. Prepare a note in the Science diary.





### Indicators

- Primitive cell
- Origin of prokaryotes
- Origin of eukaryotes
- Appearance of multicellular organisms

Researches all over the world are still striving to unravel the mysteries related to the origin of life on earth. Presence of life on other planets is also a main area of research. Life emerged as a result of the accidental combining of inorganic molecules.

Many space explorations still undertake the quest to find out whether similar phenomena occur anywhere else among the millions of celestial orbs.

The method of science is formulation of inferences on the basis of evidences obtained through experiments and observations. Science emerged along with the origin of human beings. So direct evidences are not available for explaining the origin of life and the process of evolution that began a long time before the origin of man. Hence, scientific concepts in these two areas undergo continuous changes. This is not a limitation of science. Science is unprejudiced and accepts all new knowledge formulated on the basis of derived evidences and rejects or revises the existing ones. This aspect of Science makes it credible.

## **Evolution - through theories**

Many scientists have attempted to explain the history of evolution from primitive cells to the biodiversity that exists today. The first attempt among them was by Jean Baptist Lamarck, a French biologist.

### **Lamarckism**



**Lamarck**

The characters developed during the life time of organisms are called acquired characters. Lamarck explained that these characters accumulate through generations and lead to the formation of new species. According to Lamarck giraffes had short necks in the beginning. When they faced food scarcity, they stretched their necks to reach out to tall trees. Thus giraffes with long necks emerged through generations (figure 8.1). But this argument was not accepted by the scientific world as these acquired characters are not inheritable.

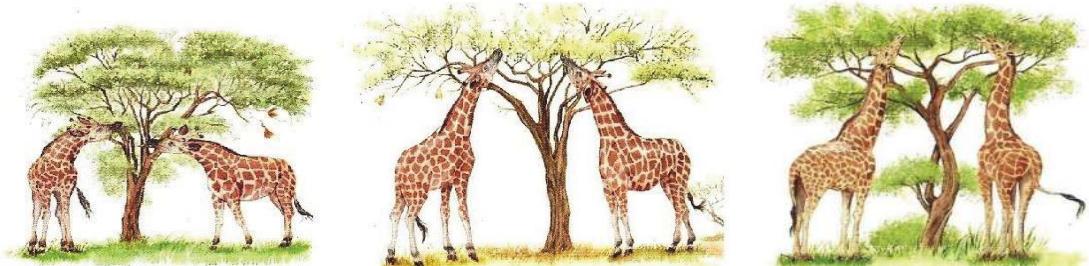
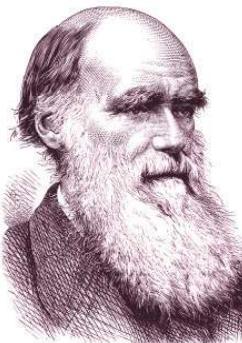


Figure 8.1

## Darwinism

A logical scientific theory on evolution was first put forward by Charles Robert Darwin, an English naturalist. Darwin adopted a scientific method for formulating inferences through observation and data analysis. This scientific credibility paved way for the larger acceptance of Darwin's theory of evolution.



Charles Darwin

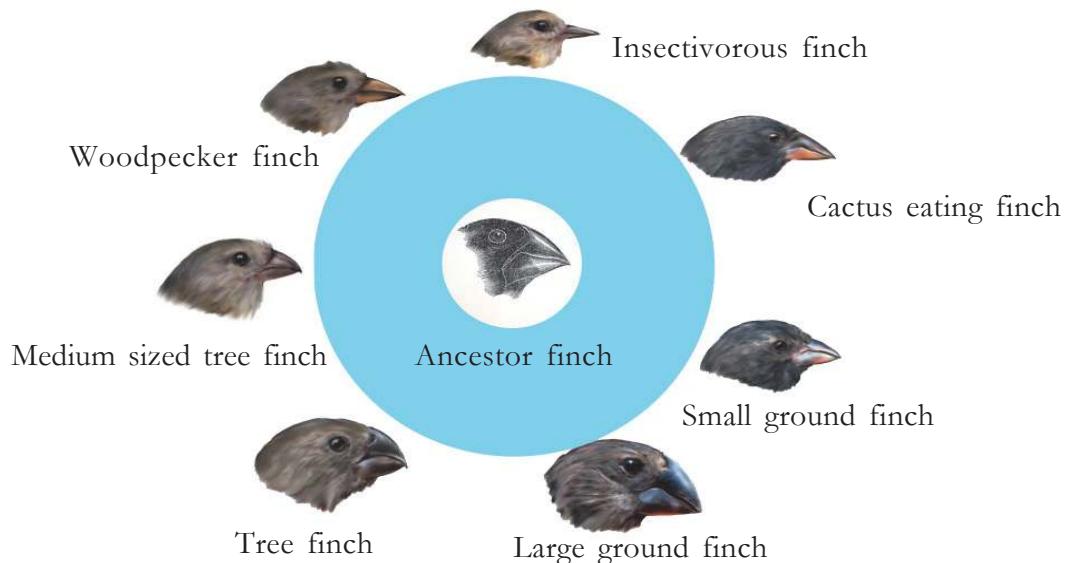
### Darwin's Voyage

Darwin's voyage to the Galapagos Islands in the ship HMS Beagle was a turning point both in his life and in the history of the theory of evolution. Charles Darwin formulated his theory of evolution on the basis of the studies conducted on organisms in Galapagos Islands.

Darwin was only 22 years old when he joined a group appointed by the British government to construct maps of coastal areas. By the time he returned to Britain after 7 years, he had collected necessary evidences for his theory of evolution. After further follow up enquiries, observations and studies, he presented his theory in the renowned text *Origin of Species by Means of Natural Selection*, at the age of fifty. This theory that broke off many existing beliefs got great acceptance in the scientific world.

Finches were one among the organisms observed and closely studied by Darwin in the Galapagos Islands. The differences in the beaks of these finches attracted Darwin.

On the basis of indicators, analyse illustration 8.4 and the description given below. Write down your inferences in the Science diary.



**Illustration 8.4 Galapagos finches**

Insectivorous finches have small beaks and those that feed on cactus plants have long and sharp beaks. There were also woodpecker finches that used sharp beaks to pick small twigs for feeding on worms from the holes in tree trunks. The ground finches that feed on seeds with large beaks were also present.



### Indicators

- Which peculiarity of the finches attracted Darwin?
- How do these peculiarities help finches in their survival?

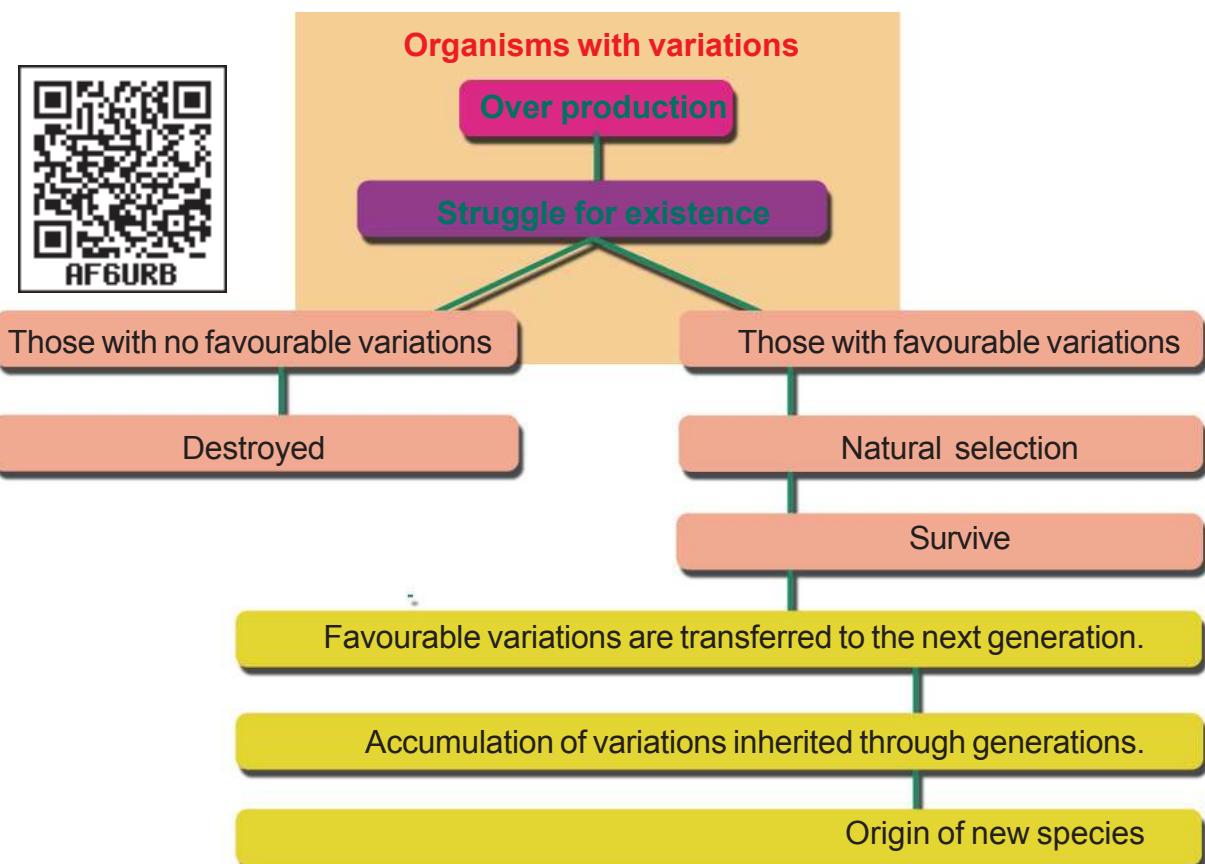
It is clear that the finches Darwin observed had beaks adapted to their feeding habits. Another idea that influenced Darwin's speculations about the diversity of the beaks of finches was that of Thomas Robert Malthus, an economist.

Rate of food production is not proportionate to the growth of human population. Thomas Robert Malthus pointed out that scarcity of food led to diseases, starvation and struggle for existence.



**Robert Malthus**

Analyse illustration 8.5 and the description given below. Identify the main concepts of the 'Theory of Natural Selection' put forward by Darwin by incorporating Malthusian ideas. Based on the indicators, prepare a note in your Science diary.



**Illustration 8.5 Theory of Natural Selection**

### The Theory of Natural Selection

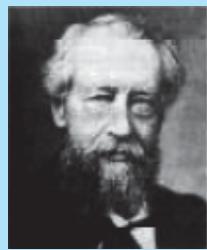
Every species produces more number of offsprings than that can survive on earth. They compete with one another for food, space and mates. The competition becomes hard when the number of organisms is more and the availability of resources is less. Many variations are visible in organisms. These variations may be favourable or unfavourable. Those with favourable variations survive in the struggle for existence. Others are eliminated. Variations that are inherited through generations and repeated differently help to form species that are different from their ancestors. This type of selection, done by nature, leads to the diversity of species that we see around us. This is the explanation of Darwin's theory which is known as the Theory of Natural Selection.

#### Indicators

- Circumstance that leads to severe competition among organisms.
- Variations and natural selection.
- Origin of new species.

Though Darwin identified that continuous variations occurred in organisms, he could not explain the reasons for these variations. During his period there was no idea regarding genes, chromosomes etc. Darwinism was revised in the light of new information from the fields of genetics, cytology, geology and paleontology. This modified version of Darwinism is known as Neo Darwinism.

### Mutation Theory



Hugo deVries

You know that changes in genes are one of the reasons for variations in organisms. Sudden changes that occur in genes are called mutations. Mutation theory explains that new species are formed by the inheritance of such changes. This theory was formulated by a Dutch scientist, Hugo deVries. Later it was explained that mutations that cause variations lead to the evolution of species.

### Evidences of Evolution

There are many evidences to support the evolution of new species. Paleontology, comparative morphology, physiology and modern molecular biology provide evidences to validate evolution.

### Fossils – Evidence of evolution

Fossils are the remnants of primitive organisms. They are evidences that explain the history of life on earth.

Fossils may be the body, body parts or imprints of organisms. The age of fossils can be calculated scientifically. They are categorised on the basis of geological time scale and their peculiarities are studied. The oldest known fossils dating from about 3.5 billion years ago are of prokaryotes. Fossils from different layers of rocks indicate the evolution of eukaryotes from prokaryotes. Cell Biology and Molecular Biology make fossil evidences more scientific. What are the inferences you can arrive at from such studies?

Analyse illustration 8.6 and prepare notes.



Primitive fossils have simple structure.

Recently formed fossils have complex structure.

Certain fossils are connecting links between different species.

**Illustration 8.6 Evidences provided by fossils**

### Comparative Morphological Studies

Observe illustration 8.7 and compare the structure of forelimbs in lizard, bat, whale etc.



**Illustration 8.7 Comparative morphological studies**



The forelimbs of these organisms differ in their external appearance. Are they different in their anatomy too?

These forelimbs are made up of blood vessels, nerves, muscles and bones. Differences in their external appearances are their adaptations to live in their own habitats. Organs that are similar in structure and perform different functions are called homologous organs.

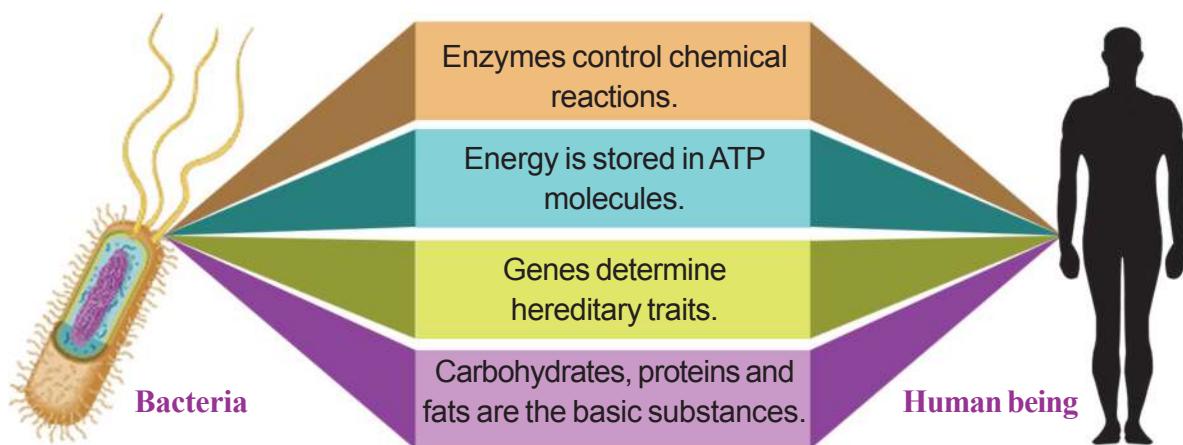
Do such anatomical resemblances justify the inference that all organisms evolved from a common ancestor?

Discuss and write down your inferences in the Science diary.

## Biochemistry and Physiology

How different are microbes, plants and animals in their external appearance! But there are close resemblances in their cell structure and physiology.

Observe illustration 8.8.



**Illustration 8.8 Biochemistry and Physiology**

What proof of evolution do you get from these facts?

Isn't it clear from these facts that different species that exist today have a common ancestor? Discuss.

## Molecular Biology

Through a comparative study of protein molecules in different species, the evolutionary relationship among organisms can be identified. Mutations may occur in the genes that determine the amino acid sequence in protein molecules. This causes changes in amino acids. The amino acids in the  $\beta$  chain of haemoglobin in man has been compared to the amino acids in the  $\beta$  chain of other organisms. Available data are listed below. Based on the indicators, analyse table 8.1 and write your inferences in the Science diary.

Organism	Difference from the amino acids in the $\beta$ chain of haemoglobin in man
Chimpanzee	no change
Gorilla	difference of one amino acid
Rat	difference of 31 amino acids.

Table 8.1

This is an effective method to illustrate the branching pattern of evolution from a common ancestor.

These kinds of molecular studies help to find out the evolutionary relationship of different species of organisms.

### Indicators

- Which organism is the farthest from humans from the evolutionary point of view? Why?
- Which organism is the closest to man from the evolutionary point of view? What is the reason for this?

### Evolution of Human beings

An evolutionary tree relating to certain organisms including humans is given below. Organisms show many similarities as they have evolved from a common ancestor. Analyse illustrations 8.9 and description on the main branches in the evolution of human beings. Prepare a note in your science diary.

Humans, chimpanzee, gorilla, orangutan, gibbon and monkeys are included in the category Anthropoidea. This is further classified into Cercopithecoidea and Hominoidea.



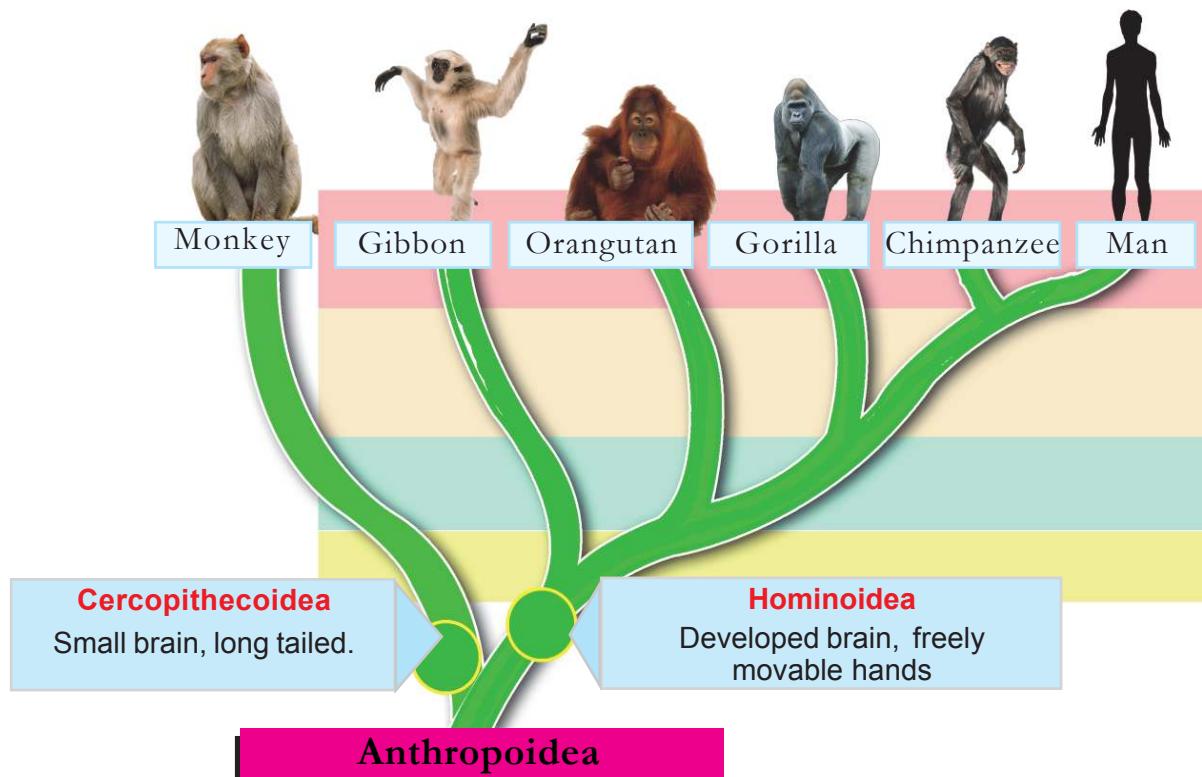


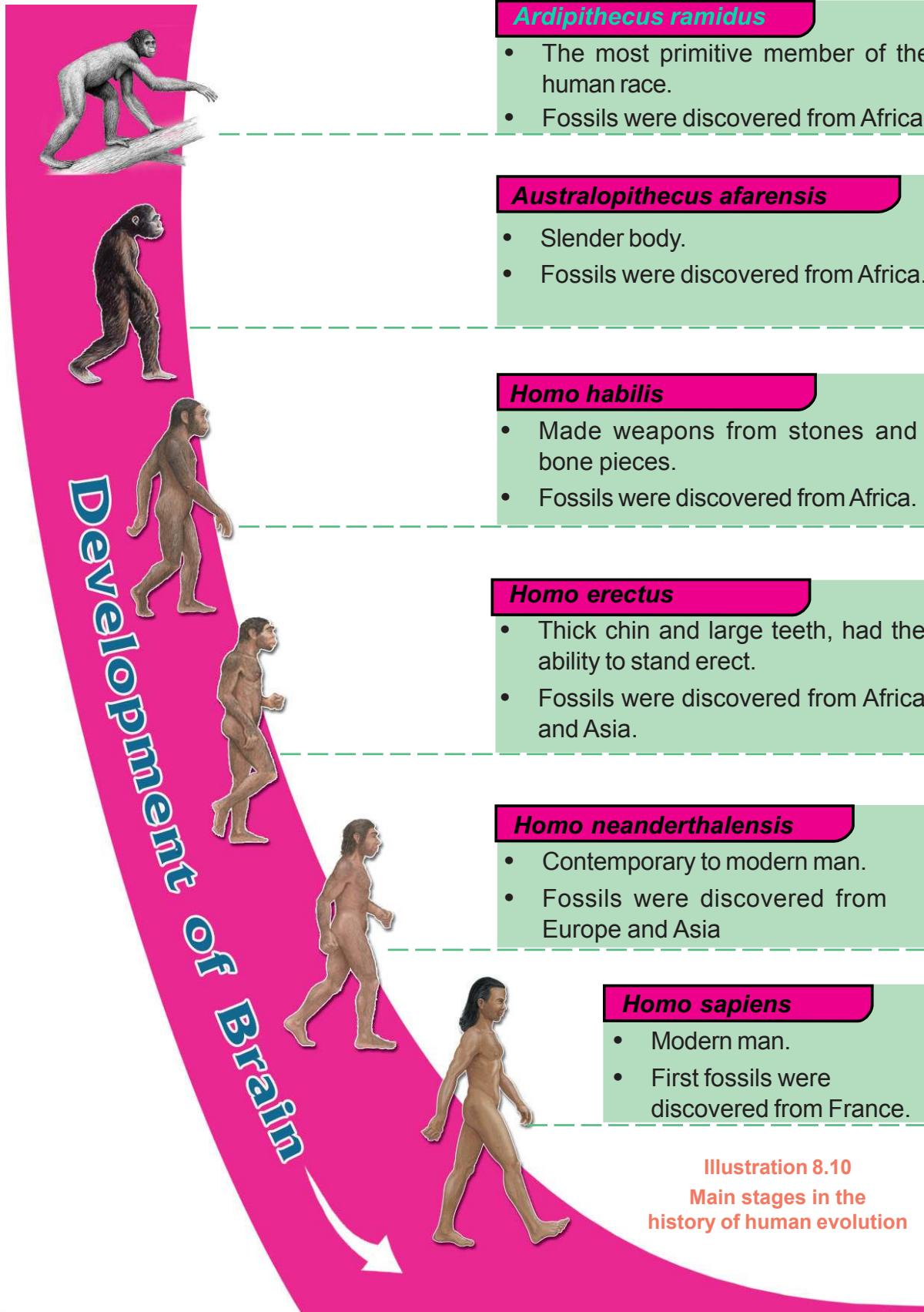
Illustration 8.9 Evolution of human beings

## Indicators

- Which organism is the closest to humans in specific characters?
- How Anthropoidea, Cercopithecoidea and Hominoidea are related to each other?
- What are the characteristics of the organisms which belong to the group hominoidea?
- “Man evolved from monkeys”. How would you respond to this statement?



Illustration 8.10 depicts the evolutionary history of modern man. Formulate inference on how biological changes helped human being to emerge in the present form, by analysing the illustration.



What are the features of modern man that differentiate him from other organisms included in the historical path of human evolution?

- 
- 
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Does the interference of human beings have a negative impact on the existence of organisms and nature itself?

Biodiversity at global level has increased much recently than ever before. But this biodiversity is on a dangerous decline due to the interference of human beings. It is recorded in the evolutionary history that there occurred five mass extinctions till now and biodiversity got reestablished rapidly afterwards.

Would the reckless interference of intelligent human beings destroy the continuity of life on earth?

Discuss.

Today we are aware of the challenges raised by climatic changes brought about by human interventions and the extinction of organisms. Individuals and organizations are actively participating in programmes for the conservation of nature. This reinforces the fact that human life is possible on earth only with the preservation of other diverse ecosystems. Human beings are capable of foreseeing far-reaching consequences and taking necessary precautions in this regard. This leaves us with hopes for future life on earth.



## Let us assess

1. Which concept is put forward by the Theory of Natural Selection?
  - a. Origin of life
  - b. Origin of species
  - c. Origin of eukaryotes
  - d. Chemical evolution of life
2. List the main concepts that indicate how the biodiversity seen today has developed from prokaryotes.
3. How does the interference of human beings with nature influence the process of evolution? How does this affect the existence of other organisms?
4. What are the evidences that substantiate the theories of evolution? Identify and explain them.



## Extended activities

- Prepare and exhibit a model of the experimental set up constructed by Urey – Miller to scientifically prove the theory of chemical evolution.
- Prepare a chart illustrating the evolutionary tree of man.
- Collect data on scientists who contributed scientific evidences for chemical evolution and prepare an edition.

## Notes

## Notes

## Notes

## Notes

## Notes

## **Its high time we protected nature and natural resources....!**

Forests have a great role in conserving the health of the environment in which we live. Forests are decisive in many respects. Source of the water we drink and the air we breathe, balancing atmospheric temperature, determining weather, managing agriculture, source of our food etc., are some of those areas.

Wild animals inhabit forests. Each animal has a function to perform in the environment in which it lives. Thus wild animals have a vital role in aspects like pollination of plants, dispersal of seeds, sustenance of forests etc.

It is our duty to protect and preserve forests, lakes, rivers, wild animals etc,which are all part of our nature. Also, Article 51(g) of our constitution reminds every citizen of India to have a compassion for living creatures.

Activities taken up for the conservation of forests and wild life by the Forest Department:

- Establishing Forestry clubs in schools, for spreading knowledge about forests.
- Establishing Eco-tourism centres as a part of encouraging eco-friendly tourism.
- Conducting Nature study camps as a part of forest and wild life education.
- Making public places green.
- Providing financial aid to conserve '*kaavu*'.
- Turtle conservation project.
- Instituting 'Vanamitra award' for promoting creative contributions in the field of green projects.
- Instituting 'Prakritimitra award' for conserving habitats outside forests and biodiversity.
- Conducting the 'Citizen Conservator Programme' for ensuring the role of public in forest conservation.

**Toll free number of Forest department: 18004254733**