4

BEHIND MOVEMENTS

DIGITAL TEXT BOOK

- Diversity in movement
- Muscles
- Skeletal system
- Different frameworks
- Muscles and exercise
- Bones, muscles-disorders
- Bones and evolution
- Plant movements

Observe the picture.

" How beautiful is this green earth! "

The Earth is made colourful by plants, animals and countless microorganisms that cannot be seen with our naked eyes. Don't these creatures make our world beautiful and dynamic, with many of their activities like procuring food, etc.?

What all types of movements can be observed in the organisms in the picture?

.....

.....

Don't such movements require energy? Most of the energy produced in the body is utilised by animals for movement. Therefore, animals require more energy compared to plants.

Observe illustration 4.1 and note down the importance of movement in each organism.

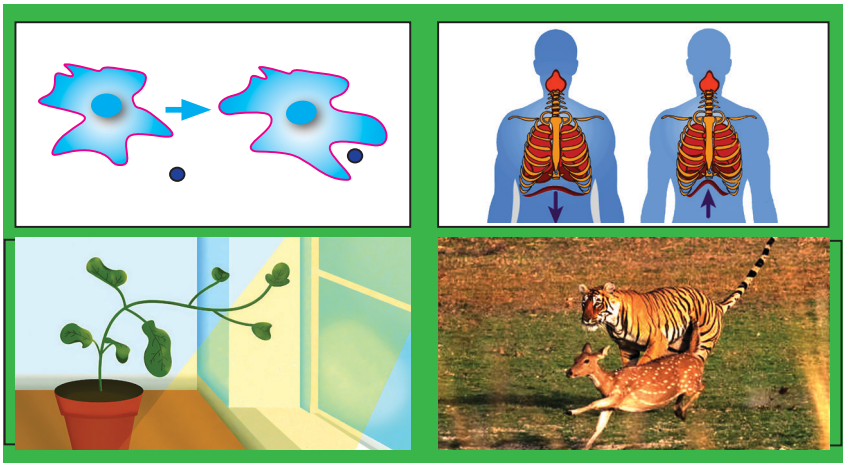


Illustration 4.1 : Different types of movements

- Food acquisition in amoeba
-
-
-

List out other kinds of movements that you are familiar with.

.....

.....

Haven't you understood that different organisms have adapted various types of movements to meet their diverse needs?

Various movements, both visible and invisible to the naked eye, as well as diverse adaptations for movement are seen in the living world. Analyse the illustration 4.2 based on the indicators and note down the inferences regarding the diverse movements in the living world.

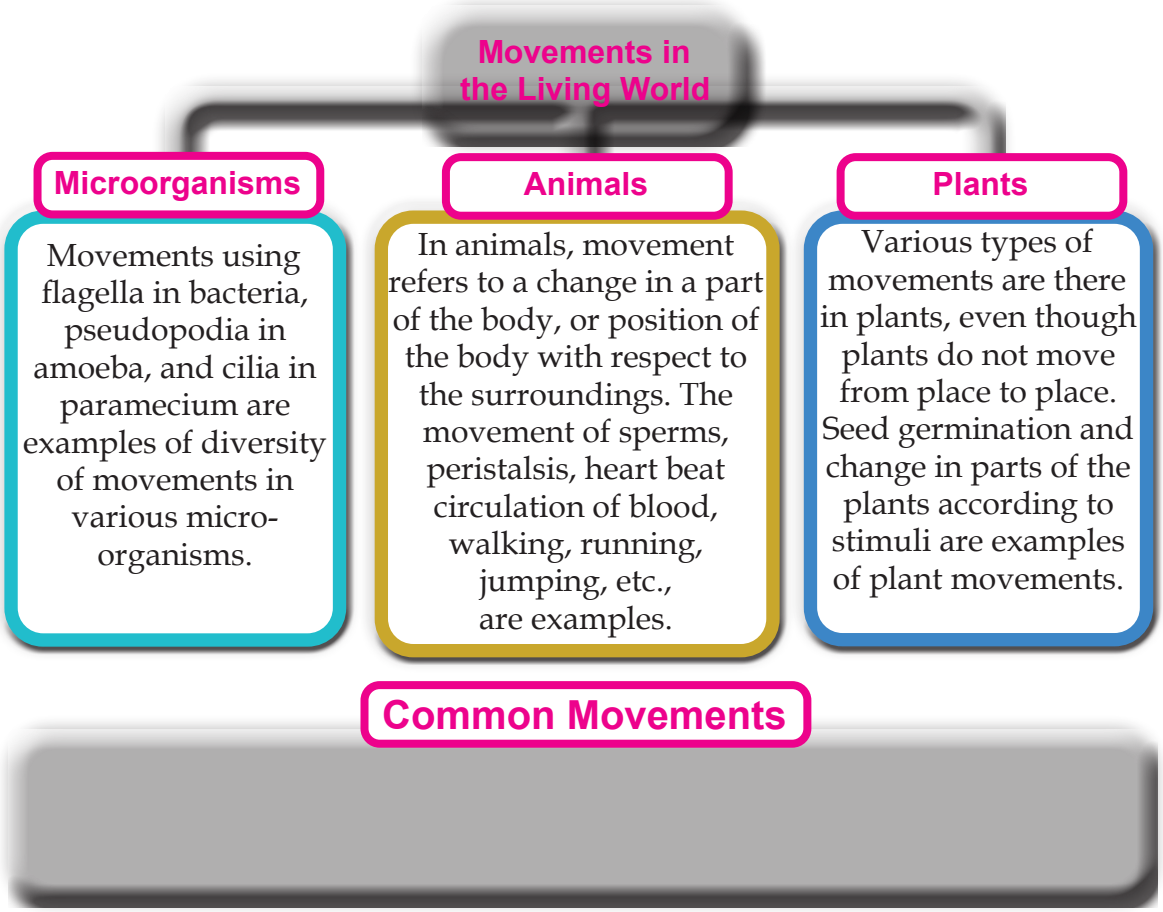


Illustration 4.2 : Movements in the living world

- Movement in plants
- Movement in animals
- Common movements
- Microscopic and macroscopic movements

Haven't you understood that there is great diversity in movements among organisms? There are different means in organisms which support these movements.

Identify the means of movement of the organisms shown in the illustration 4.3 and complete it.

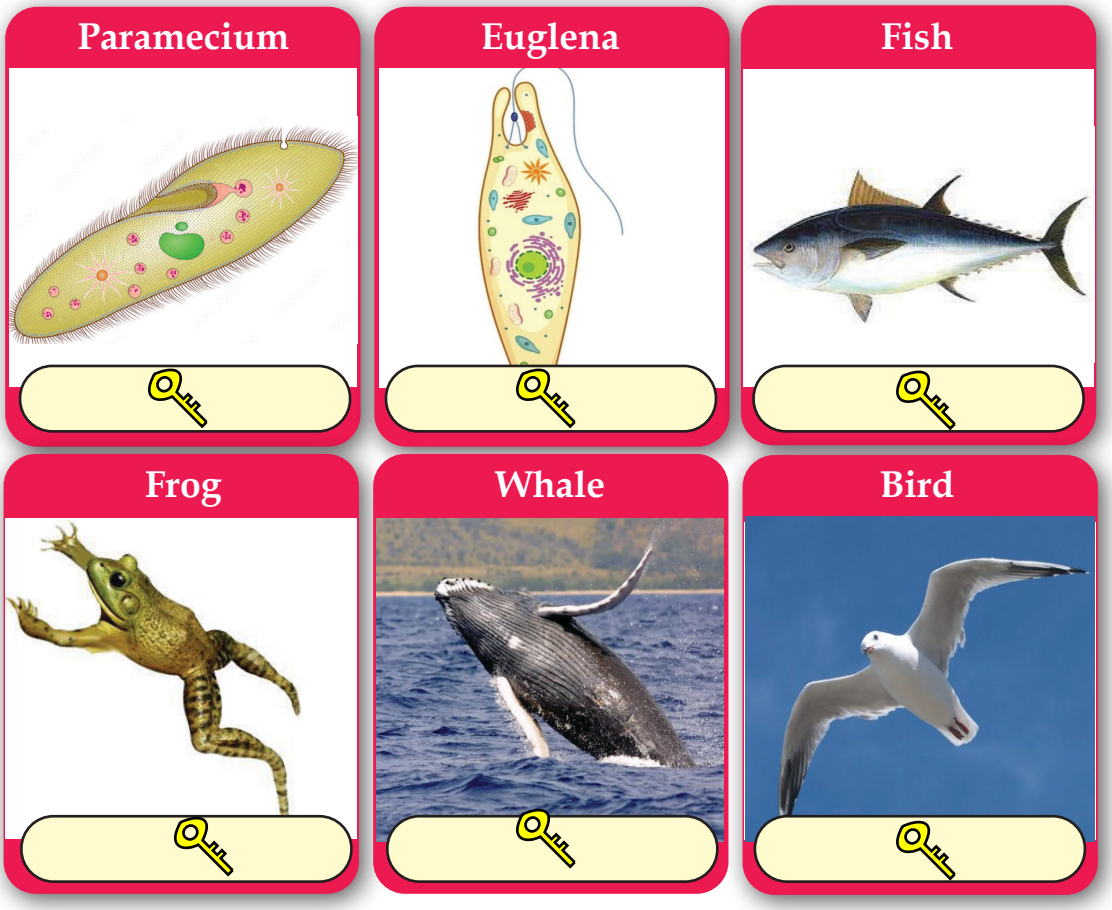


Illustration 4.3 : Means of movement in organisms

Expand Table 4.1 by including more organisms as given above.

Organisms	Means of movement
Bacteria	Flagellum
Amoeba	Pseudopodia
Hydra	Tentacles
Cockroach	Legs and wings
Earthworm	Setae
House lizard	Legs
Eagle	Legs and wings

Table 4.1 : Means of movement in different organisms

Haven't you understood the means of movement in different organisms? How does movement occur in humans? What are the means involved? Discuss, collect more information and complete the illustration 4.4.

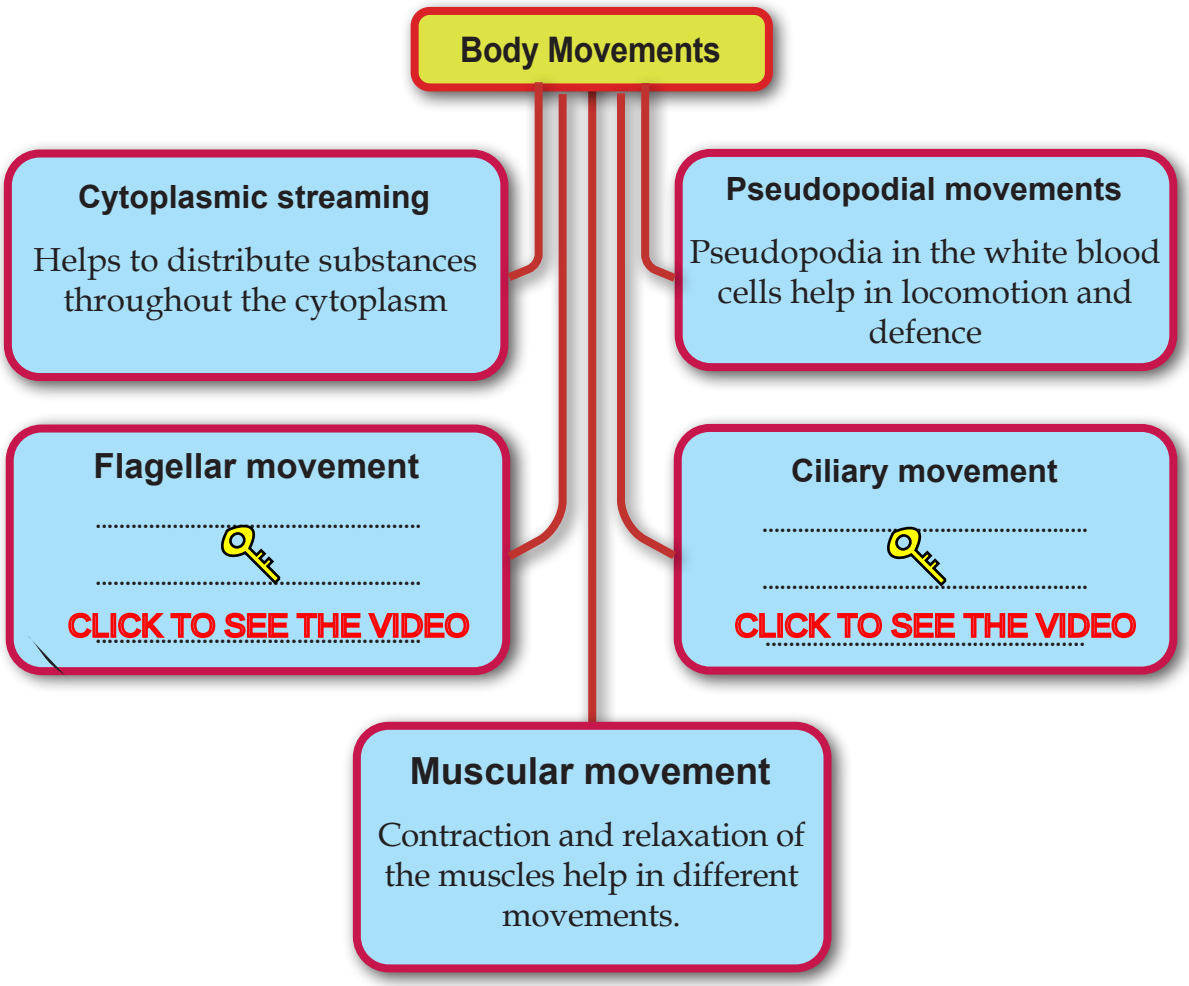


Illustration 4.4 : Movement and means of movement in human beings

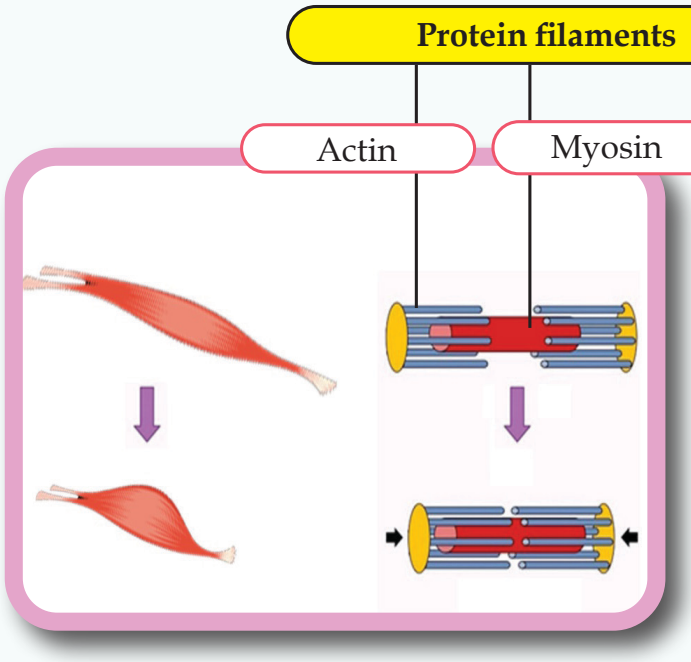
The diversity of movements and locomotion in humans is caused by the functioning of muscles. Which characteristic of muscles helps in movement? Analyse the description provided and form inferences.

CLICK TO SEE THE 3D VIEW OF HUMAN MUSCULAR SYSTEM

Muscle tissue

Muscles are specialised tissues which are responsible for the movements of the body. There are various types of muscles in the body. These are formed of muscle cells. Muscle cells contain nucleus and almost all cell organelles. However, unlike other cells, they contain more micro filaments made of proteins such as **Actin** and **Myosin**. By the action of these filaments, muscles contract and relax. This enables the body movements.

CLICK TO SEE THE VIDEO



- Characteristics of muscle tissues
- Proteins in muscle cells and their importance

You have understood the various types of muscles in the human body.

Analyse the illustration 4.5, do the given activity and complete table 4.2.

How does Actin and Myosin help in the contraction of muscles? Find out.

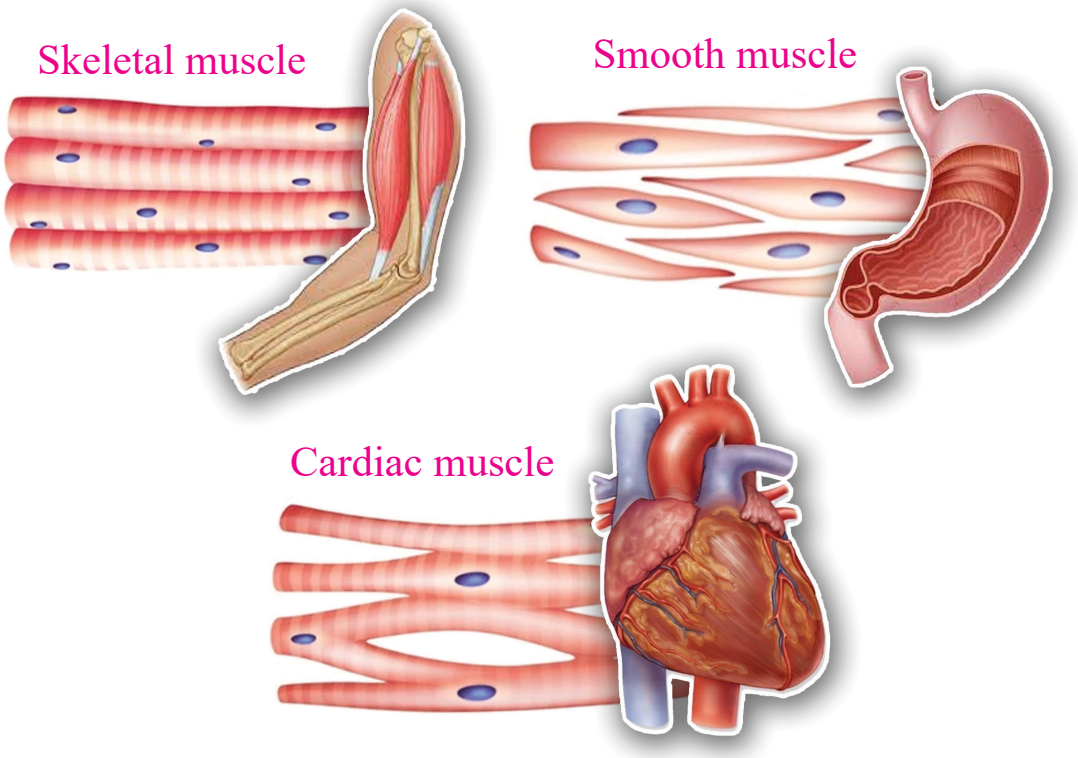
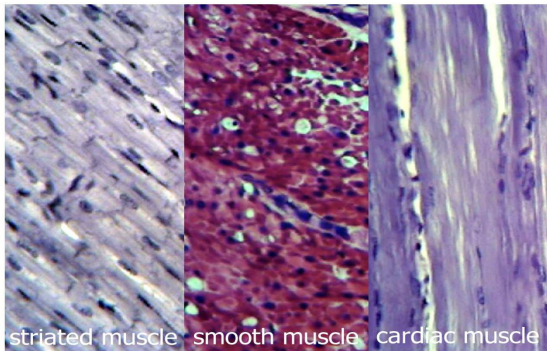


Illustration 4.5 : Different types of muscles

CLICK TO SEE THE VIDEO

You have observed the illustration.

Observe the permanent slide of the muscles through a microscope in the laboratory.



Permanent slide of Muscles

Let's observe the muscles

To identify the minute characteristics of various muscles, observe the permanent slides of muscle tissues at different magnifications through a microscope. Illustrate your observations. Compare this with the illustration 4.5 and form inferences.

	Muscles attached to the bones	Muscles in the hollow internal organs	Muscles in the walls of the heart
Name of the muscle			
Shape of the cells			
Presence of striations			
Branches			
Control of the muscles according to one's will.			

Table 4.2 : Different types of muscles

Some muscles in our body that can be controlled (voluntary muscles) and some others cannot be controlled (involuntary) according to our will. In which all parts of the body are each one of these found? Find out examples through discussion and note them down in the table provided.

How is the action of involuntary muscles controlled? Find out.

Voluntary muscles	Involuntary muscles
• Muscles in the hands • •	• Muscles in the oesophagus • •

Table 4.3 : Voluntary and Involuntary Muscles

You know that folding and stretching of hands is a voluntary action. How does this movement take place?

Two muscles are mainly involved in this process.

By folding and stretching your hands and analysing the illustration 4.6, understand the contraction and relaxation of muscles. Discuss on the basis of indicators and prepare notes.

CLICK TO SEE THE VIDEO

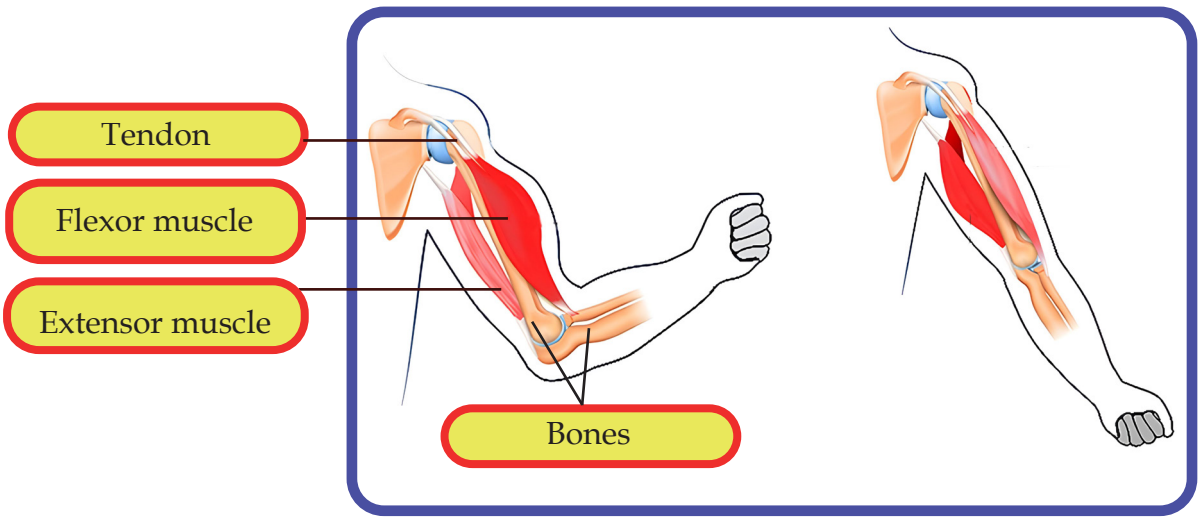


Illustration 4.6 : Movement of hands

- The part that connects muscles to bones.
- Muscles involved in the movement of hands.
- The importance of connecting the two tips of the muscles to two bones.
- The change that should occur to the two muscles in order to fold the hands.
- The changes that should occur to the two muscles in order to stretch the hands.

The antagonistic actions of the two muscles make the folding and stretching of hands possible. Most of the movements in the body are made possible with such actions of the muscles.

Muscle fatigue

While engaging in physical activities, muscles need to function continuously. This requires a lot of energy. You have understood that ATP is formed in muscles in the presence of oxygen due to cellular respiration. Muscles function, receiving energy from ATP molecules. When skeletal muscles have to function continuously (e.g. during exercise), if required oxygen is not available, muscles become weak and they may temporarily lose the capacity to contract. This condition is called **Muscle Fatigue**. What would be the reasons for this? Find out.

CLICK TO SEE THE VIDEO

Is movement possible solely by the action of muscles?

Note down your assumption.

.....

In human beings, muscles are connected to either bones or to cartilages. Diversity of movements are made possible due to the combined action of muscles and bones. Observing the skeleton in your school lab, and analysing the illustration 4.7 develop an understanding of the two divisions in the human skeletal system. Label the parts and complete the illustration. Prepare notes based on the indicators.

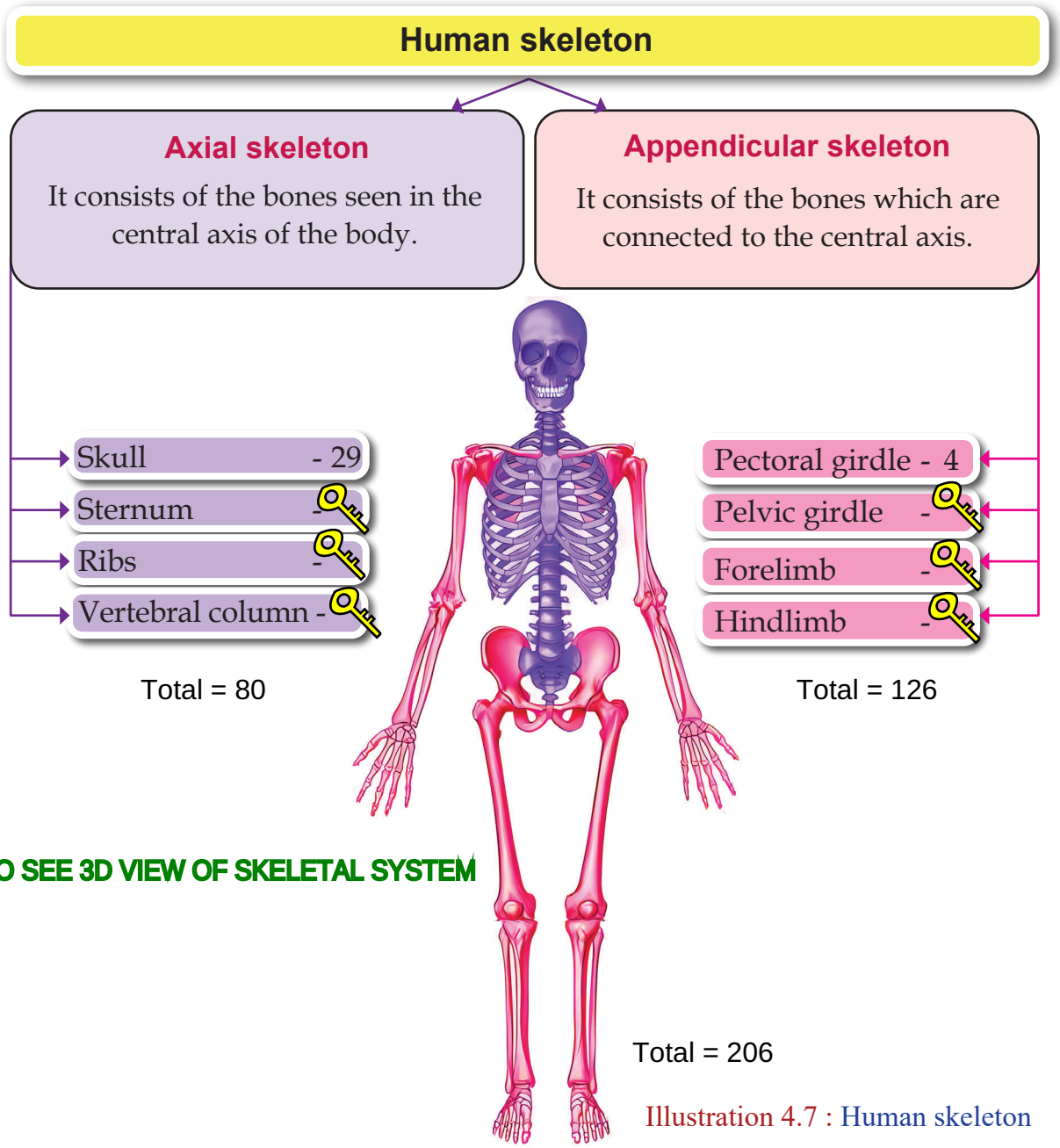


Illustration 4.7 : Human skeleton

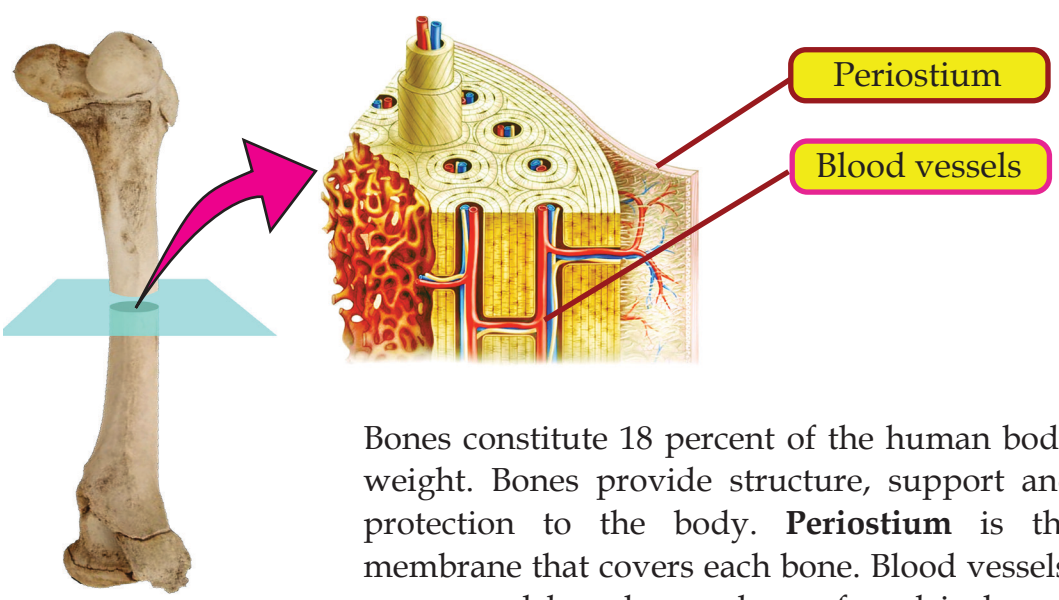
Is the number of bones same in children and adults?

What is the reason? Find out.

- Two divisions of human skeleton
- Total number of bones
- Number of bones in the axial skeleton and appendicular skeleton

You have understood the position and the number of bones in each part of the skeleton. What are the structural peculiarities of bones? Analyse the description given below based on the indicators and prepare a note.

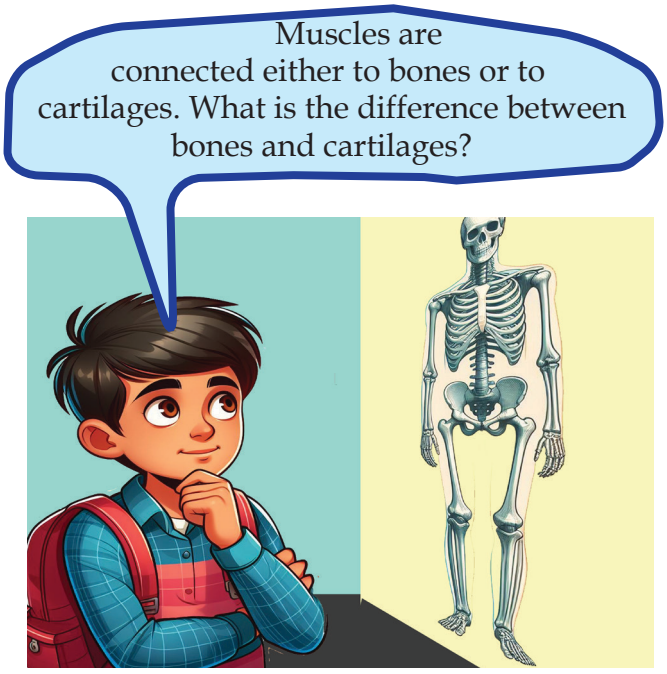
Structure of bone



Bones constitute 18 percent of the human body weight. Bones provide structure, support and protection to the body. **Periostium** is the membrane that covers each bone. Blood vessels, nerves and lymph vessels are found in bones. Calcium, phosphate, collagen proteins and salts provide hardness and strength to bones. **Osteoblast cells** of bones deposit minerals in the bones, make them strong and firm and also help in growth and repair.

CLICK TO SEE THE VIDEO

- Hardness of bones
- Function of osteoblast cells



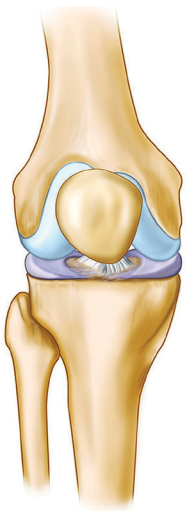
Analyse the information provided and find out the answer to the child's doubt.

Do all living organisms have a skeletal framework like that of humans?

Observe the figure 4.1 and based on the discussion, form inferences.

CLICK TO SEE 3D VIEW OF CARTILAGE

Cartilage



Cartilage is the connective tissue which is softer and more flexible than bones. These are present in elbows, knees, ankles, at the tip of ribs, between the vertebrae of the vertebral column, pinna, at the tip of the nose and in the trachea. Cartilages present at the tip of the bones reduce friction in the joints. Blood vessels and nerves are absent in them. Due to the absence of blood vessels their growth is slower than the rest of the cells.

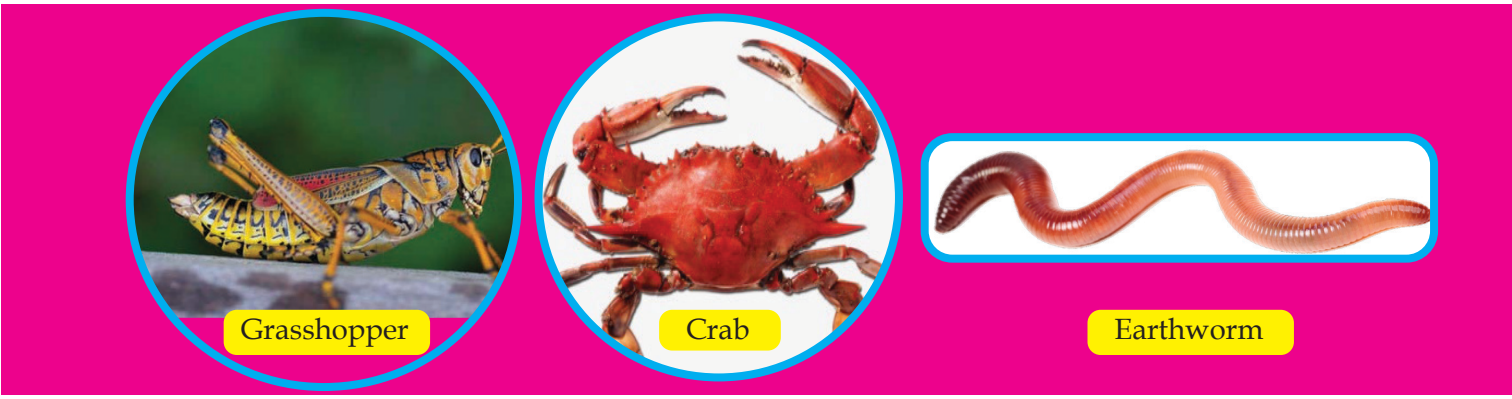


Figure 4.1 : Structural frameworks of various organisms

You have understood that all organisms do not have skeletal framework (Endoskeleton) like humans beings.

The structural framework is different in each of these organisms.

Analyse the description and complete illustration 4.8.

Diversity in the Structural Framework

Hydroskeleton

CLICK TO SEE THE VIDEO

Fluid filled chambers are present in the body of the earth worm. Here, water is the means to maintain body structure and locomotion. This mechanism is commonly called hydroskeleton. **Hydroskeleton** helps in the movements of hydra and snail.

Exoskeleton

Hard shells present in crabs, mussels and oysters which is made mainly of calcium carbonate, and the outer covering of grasshoppers and cockroaches which is made of chitin, are **exoskeleton**. These connect muscles in respective places and help in movement, locomotion and protection of the body.

CLICK TO SEE THE VIDEO

Endoskeleton

Vertebrates including human beings have a framework made of cartilages and bones. This mechanism which provides shape to the body, protects internal organs and helps in movement and locomotion is called **endoskeleton**.

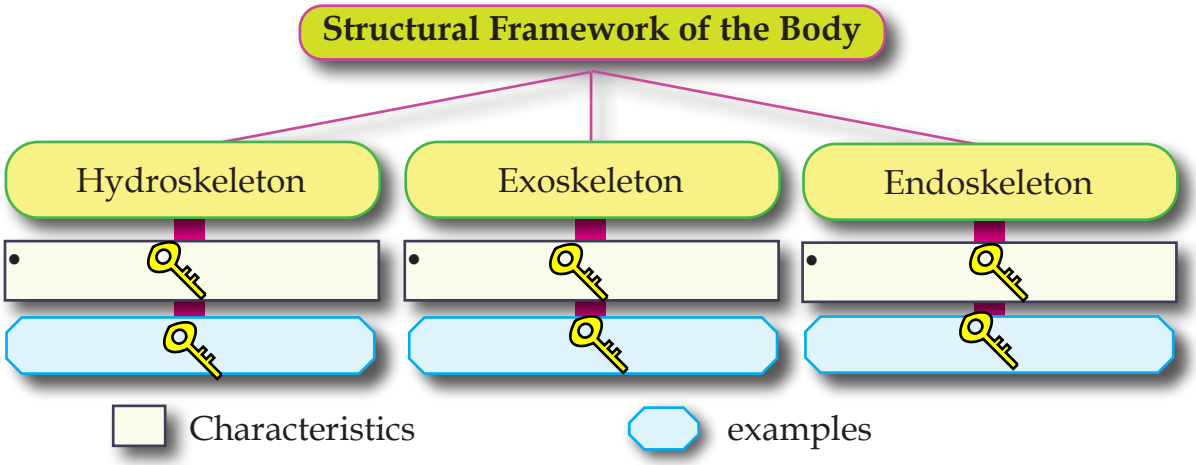


Illustration 4.8 : Diversity in structural framework

Are there parts of exoskeleton in organisms with endoskeleton? Discuss and find out.

Collect the exoskeleton and endoskeleton of various organisms and organise an exhibition in the Science Lab.

Some organisms having exoskeleton shed their outer covering. Why? Find out.

Joints

The bones are connected to each other by joints. Connecting the bones in this way makes movement easier. The skeletal joints have some peculiarities. Analyse the illustration 4.9 and the given hints, prepare a note on the structure of a joint.

CLICK TO SEE 3D VIEW OF A JOINT

CLICK TO SEE THE VIDEO

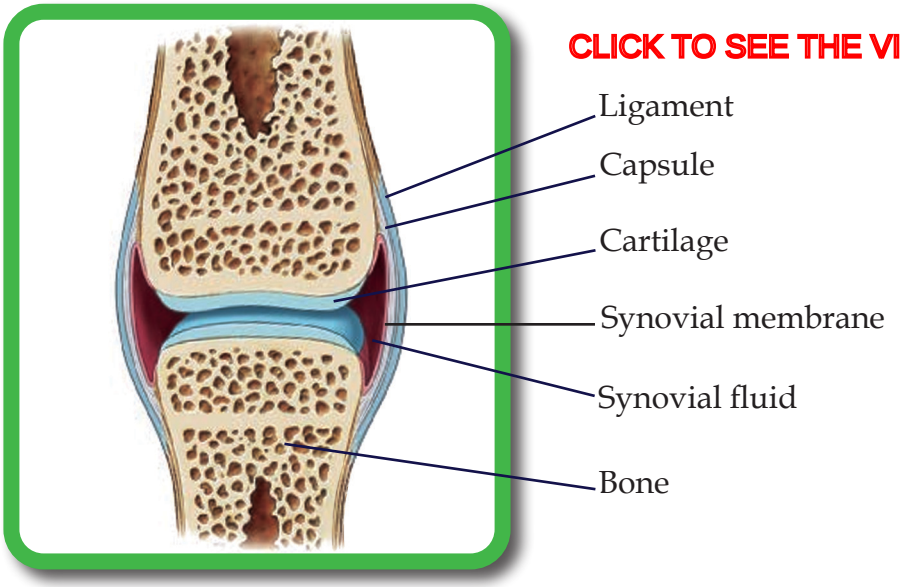


Illustration 4.9 : Structure of a Joint

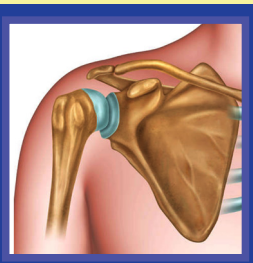
- **Ligaments** are found connecting two bones. The **capsule** seen inside this helps in the smooth movement of bones.
- **Cartilage** is found covering the tip of each bone. This reduces friction between the bones.
- **Synovial flluid** is the fluid present between the two bones of a joint. This also reduces friction between the bones.
- Synovial fluid is produced by the **synovial cells** of the synovial membrane.

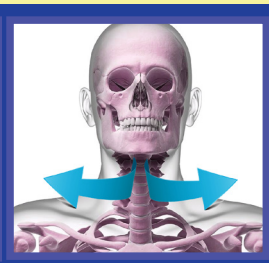
Are all the joints in the body alike? Joints differ according to their function. You have studied different types of joints in the body.

Analyse the figure of the joints and complete the Table 4.4.

Different Types of Joints

CLICK TO SEE THE VIDEO






Name	Ball and Socket joint	Hinge Joint	Pivot Joint	Gliding Joint
Peculiarities	CLICK HERE TO SEE THE COMPLETED TABLE			
Position				

Table 4.4 : Different types of Joints

Collect more information about joints in different parts of the body. Prepare a chart and exhibit it in the class.

Body growth and Bone Development

Growth during childhood and adolescence is associated with the development of the skeletal system. It is essential that calcium should deposit in the bones to ensure their hardness and strength. Food rich in calcium such as dairy products (milk, yogurt, butter), fish and leafy vegetables should be consumed in abundance at this stage. Vitamin D is necessary for the absorption of calcium. For the natural production of vitamin D in the skin, engage in activities that expose us to sunlight. Egg and fishes like sardines, mackerel, etc., are rich sources of Vitamin D. Since protein is essential for bone development, meat, beans, peas etc can be abundantly included in the diet. As age advances, the density of bones decreases, making them weaker and more prone to fracture. Nutritious diet plays a crucial role in preventing the degradation of bones.

How does the deficiency of vitamin D affect the body? Find out.

You have understood that the combined action of muscles and bones enables body movement. What are the other functions of bones? Discuss and expand the list.

- Formation of blood cells
-
-
-
-

Muscles and Exercise

We can ensure the active functioning of muscle cells through movement. Exercise helps to strengthen muscles and increase their efficiency. In what all ways is exercise beneficial for the body? Examine the activity book of health and physical education, discuss and complete the table 4.5.

Part of the body	The Benefits of Exercise
Lungs	Vital capacity increases, gaseous exchange becomes efficient
Hands and legs	
Muscles, bones	
Heart and blood vessels	

Table 4.5 : The benefits of exercise

Vital Capacity

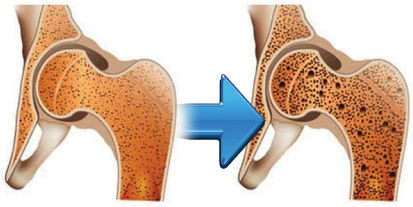
The total volume of air exhaled forcefully after a deep inhalation is called vital capacity. This is the maximum amount of air a person can breathe. This is the measurement of a person's respiratory health. In men, it is approximately 4.5 litres, and in women, it is 3 litres. A decrease in vital capacity may be an indication of pulmonary diseases.

Disorders of Bones and Muscles

Continuous and excessive muscle activity will adversely affect the functioning of muscles. Bones are prone to injuries just like muscles. Analyse the description and complete the table 4.6 on the disorders of bones and muscles.

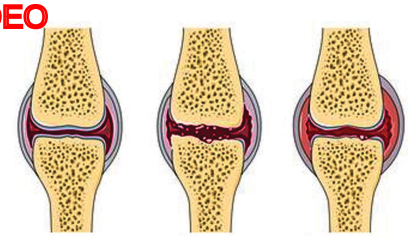
Osteoporosis CLICK TO SEE THE VIDEO

This is a condition in which parts of bones get damaged and the density of bones deteriorates as they become porous. The deficiency of protein, calcium and vitamin D also leads to this disease.



Rheumatoid arthritis CLICK TO SEE THE VIDEO

In some people the immune system may destroy their cartilages and synovial membrane. This causes severe pain and swelling in the joints. This disorder is found more in women than men.



Why is this disorder more in women than men? Find out.

Muscular dystrophy CLICK TO SEE THE VIDEO

This is a condition in which muscles get damaged due to various reasons. Muscles become weak. This is often seen in boys. The change that occurs in the genes is the chief reason for this.

Sprain CLICK TO SEE THE VIDEO

A sprain is an injury which is caused by the stretching or breaking of ligaments which connect the bones in a joint. This usually affects the joints in the ankle, wrist, knees, etc. Pain, swelling, bruises, difficulty in moving the joints, etc., are the symptoms of sprain.

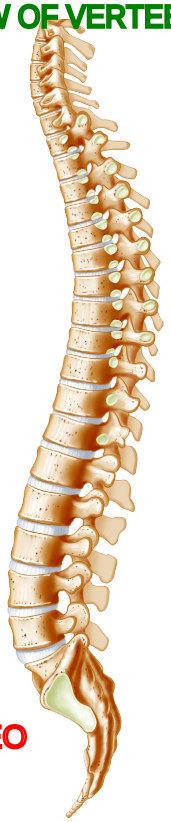
Disease	Causes	Symptoms

CLICK HERE TO SEE THE COMPLETED TABLE

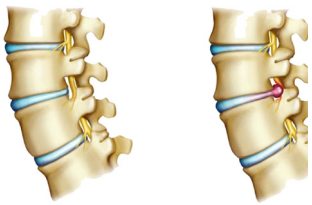
Table 4.6 : Various bone and muscular disorders

Disc Prolapse

CLICK TO SEE 3D VIEW OF VERTEBRAL COLUMN

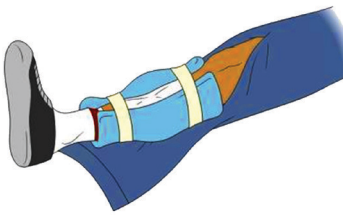
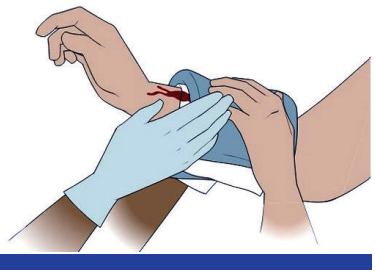


Vertebral column is the part that gives protection to the spinal cord along with support to the body. Each bone in the vertebral column is called vertebra. A peculiar part called intervertebral disc, which is filled with a gel-like substance is found in between two vertebrae. They provide flexibility to the vertebral column and protects it from external shocks. It is the presence of the intervertebral disc that enables us to be involved in such activities like bending and straightening up. These discs also distribute the body weight equally through out the vertebral column. The wearing of the vertebrae, sudden shock and continuous strain on the vertebral column can cause the bulging out of the gel-like part inside the intervertebral disc. This condition is called **disc prolapse**. As this bulging causes pressure in the spinal nerves, it results in numbness and pain in the body parts. If it aggravates, it will cause severe back pain, weakening of the legs and a loss of sensation. This situation requires immediate medical aid.



CLICK TO SEE THE VIDEO

Have you understood the first aid measures to be given when bones and muscles become injured? Identify the situations in which the first aid measures shown in the pictures are used and complete the illustration 4.10.

Sling	Splint	Bandage
.....	.....	.....
.....	.....	.....

Illustration 4.10 : First aid measures

Organise an awarness class by a health expert about the first aid measures in cordination with the Health Club. Get a hands-on training on the first aid measures given.

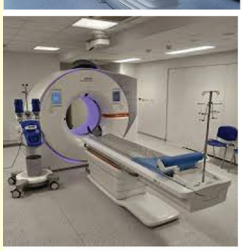
CLICK TO SEE THE VIDEO

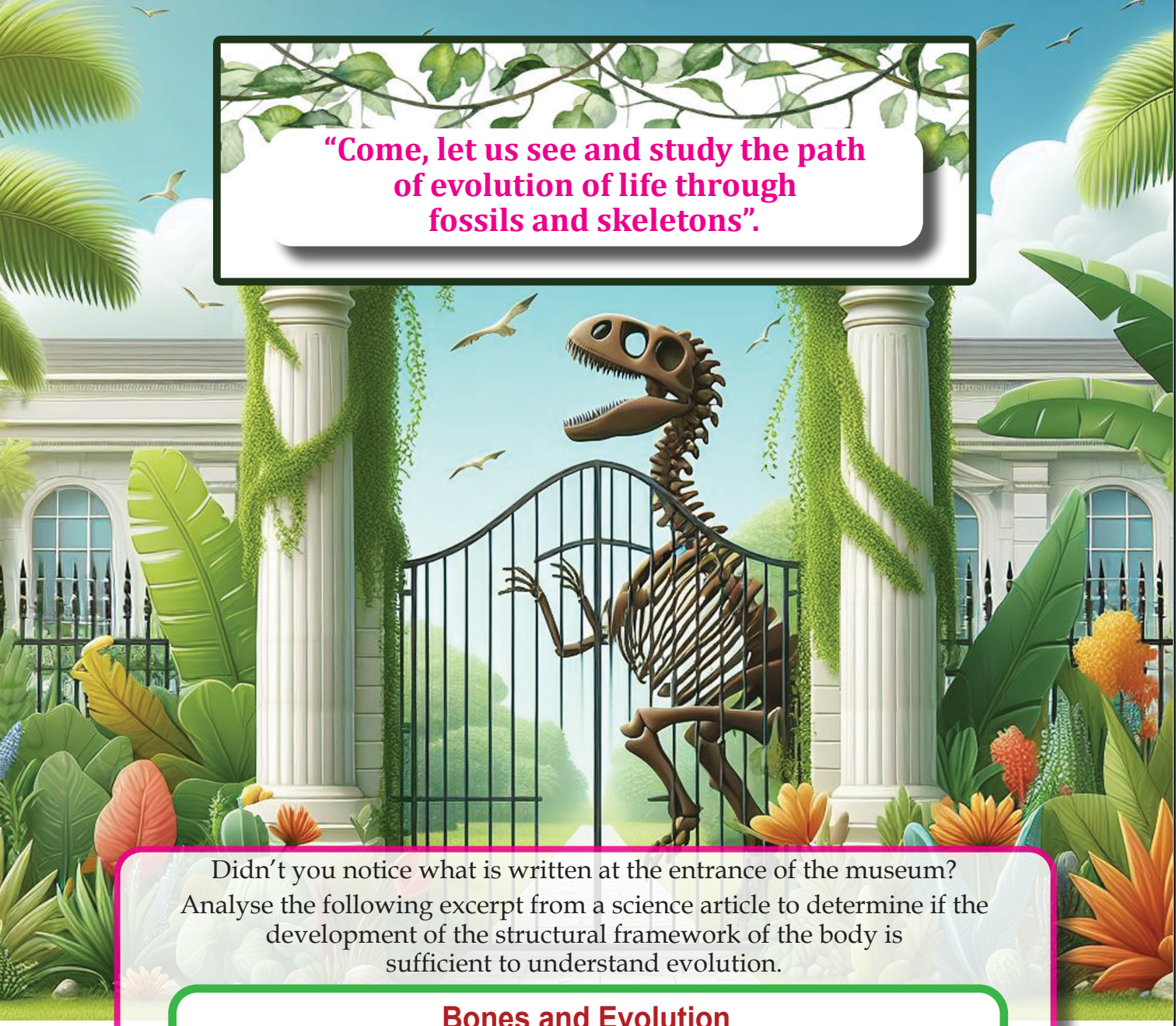
- How to prepare a sling
- How to use a splint
- How to prevent blood loss when a wound occurs
- The use of bandage and band-aid
- First aid to be given when there is a spinal injury

Medical Imaging Technology

CLICK TO SEE THE VIDEO

X ray technology has been widely used for the accurate detection of fracture, dislocations, tumours and other bone damages. Ultrasound scanning, Magnetic Resonance Imaging (MRI) and Computed Tomography (C.T.Scan) are latest techniques for diagnosis. This field of medical science is known as Medical Imaging Technology. Courses on Medical Imaging Technology provide attractive job opportunities to interested students.



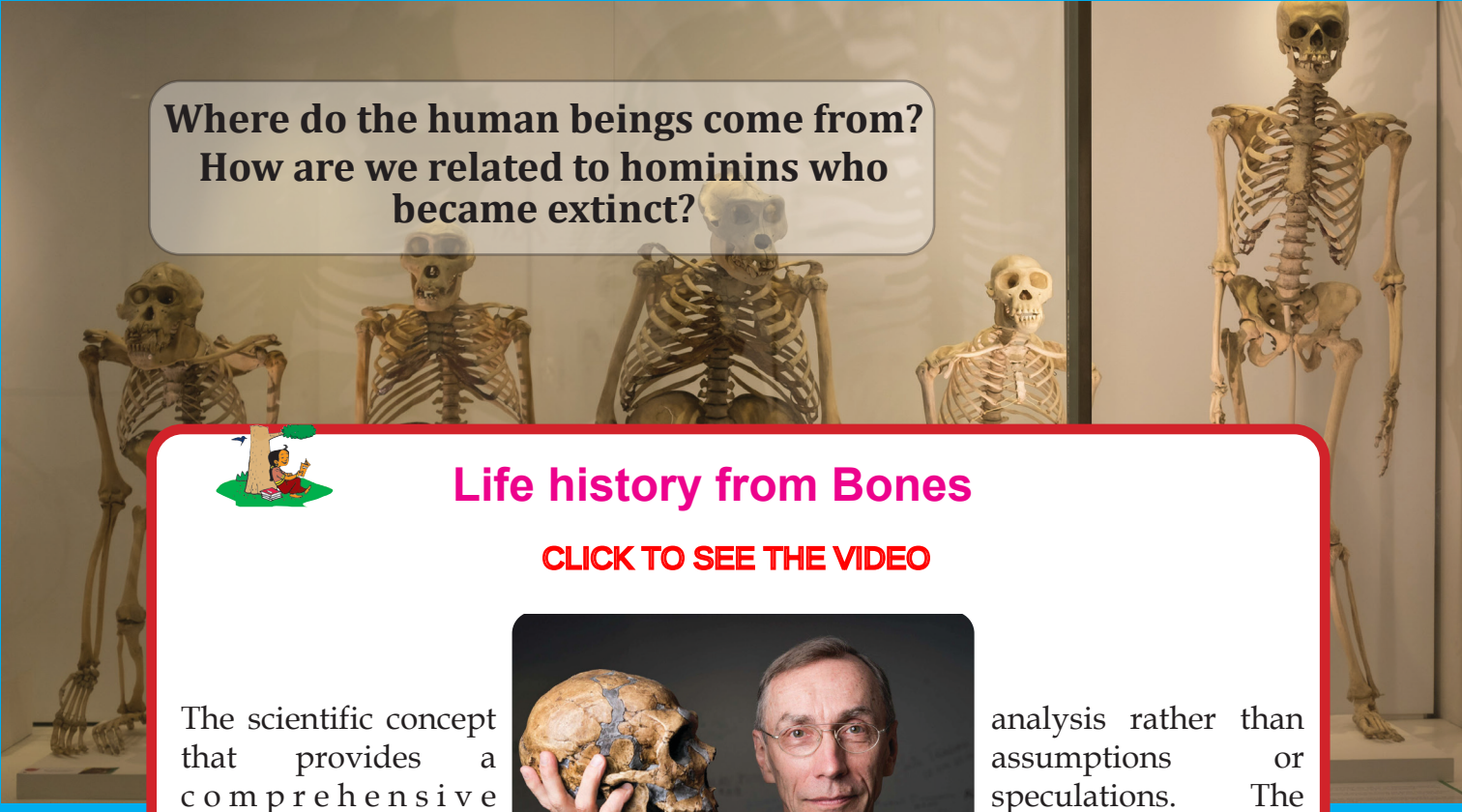
"Come, let us see and study the path of evolution of life through fossils and skeletons".

Didn't you notice what is written at the entrance of the museum?

Analyse the following excerpt from a science article to determine if the development of the structural framework of the body is sufficient to understand evolution.

Bones and Evolution

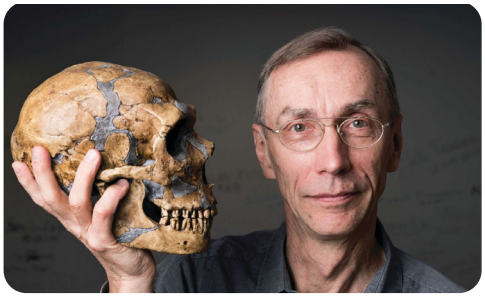
The study on the framework of organisms give, several evidences for the scientific concept that all living beings have involved sequentially. The hydroskeleton helps in the movement of organisms like jellyfish, earthworms, etc. Organisms like crabs and mussels having exoskeleton also appeared gradually along with these organisms. Later, vertebrate organisms with endoskeleton evolved. Endoskeleton provided more flexibility and movement and also supported their large bodies. Bipedal walking is an important phase in human evolution. Such changes in the skeletal system helped human beings to travel long distances and find suitable habitat, thus helping in the expansion of human race.



Where do the human beings come from? How are we related to hominins who became extinct?

Life history from Bones

CLICK TO SEE THE VIDEO



Swante Pabo

The scientific concept that provides a comprehensive explanation about the formation of the diversity of life that evolved on Earth over millions of years is called evolution of life. The picture of evolution of life is made up of many evidences from various spheres such as genetics, embryology and palaeontology or the study of fossils. The study of fossils is an effective means of study that sheds light into the past.

The study of fossils ranging from simple structured bacteria to the complex structured organisms including dinosaurs and mammals tells the story of the dynamic nature of life. The study including fossils helps to explain scientifically the evolutionary interrelationship of all living organisms based on observation, evidence, and scientific analysis rather than assumptions or speculations. The process of evolution of life helps in identifying the importance of scientific inquiry in revealing the mysteries of nature and the role of science in formulating inferences based on evidences.

The Swedish evolutionary geneticist Swante Pabo analysed DNA extracted from the ancient piece of bone and made crucial discoveries about the genetic similarities and differences between human ancestors and modern man. With the help of modern technology which retrieves and analyses DNA from fossils, he laid the foundation for the branch of science called Paleogenomics. He was awarded the Nobel Prize in 2022 for his latest discoveries in the genome of the extinct hominins and about human evolution.

Movements in Plants

You know that there is movement not only in animals but also in plants.

Plant movements occur according to stimuli. The internal or external instigation that evokes a response in living organisms is called a stimulus. Light, water, gravity, touch, chemical substances, etc. are stimuli that cause plant movements.

Analyse figure 4.2, discuss and find out the various plant movements and the stimuli that cause movements in plants.

Figure 4.2 : Plant movements

Are all the plant movements that you have listed related to the direction of stimulus? Discuss.

Analyse illustration 4.11 and examine the validity of your findings.

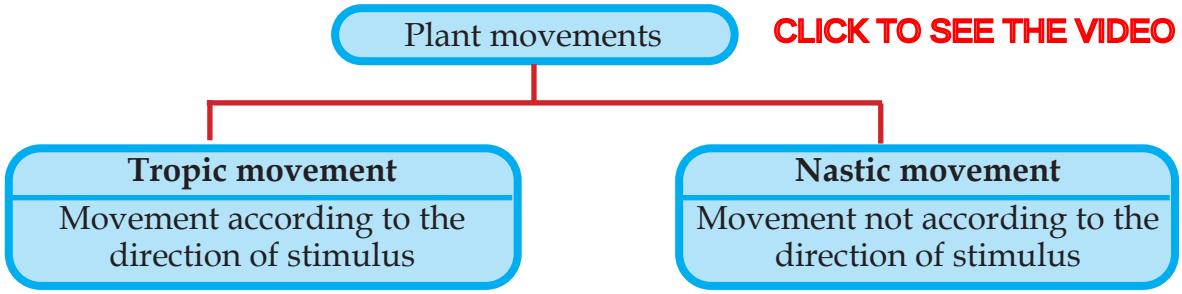
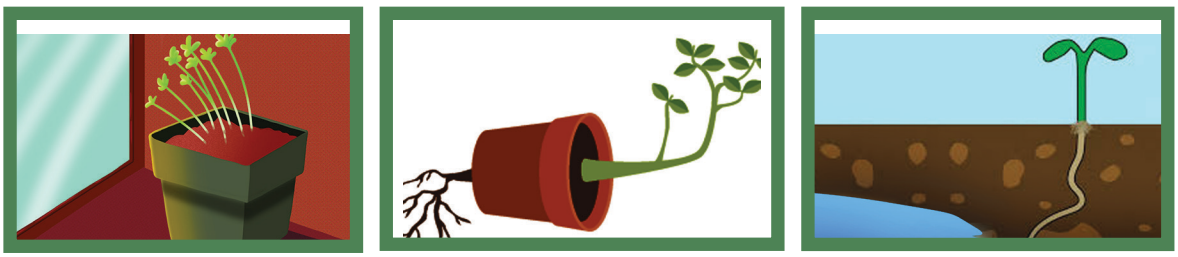


Illustration 4.11 : Plant movements

Analyse illustration 4.12, identify how the movement of the shoot and root are related to the direction of stimulus and complete table 4.7.



Phototropism Geotropism Hydrotropism

Illustration 4.12 : Tropic movements

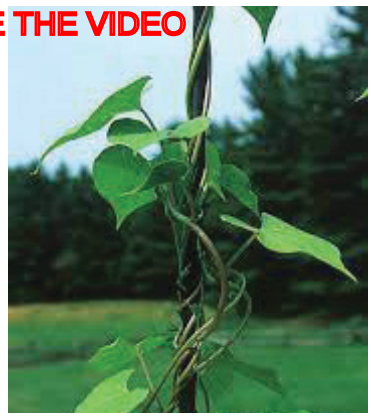
Plant movements	Stimulus	Direction of movement of the shoot	Direction of movement of the root
Phototropism			
Geotropism			
Hydrotropism			

Table 4.7 : Tropic movements

Two other tropic movements found in plants are given in illustration 4.13. Find out the characteristics of these and record them in the science diary.

Haptotropism

CLICK TO SEE THE VIDEO



Chemotropism

CLICK TO SEE THE VIDEO

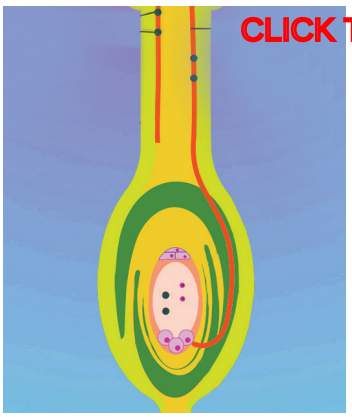
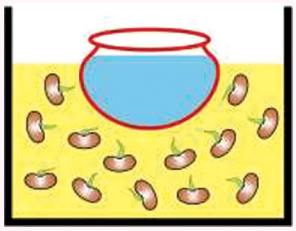


Illustration 4.13 : Other tropic movements



Arrange saw dust and an earthen pot filled with water, in a box as shown in the figure. Place some gram seeds at different parts of the box. Take the pot out carefully after a few days. Observe the direction of growth of the roots.

Observation : .....

Inference : .....

Have you ever touched a Touch-me-not plant? How is the movement of the leaves of a Touch me not plant?

Which type of movement is this? What is the peculiarity of such movements?

Such type of movements are called as nastic movements.

List out more examples for nastic movements.

-
-

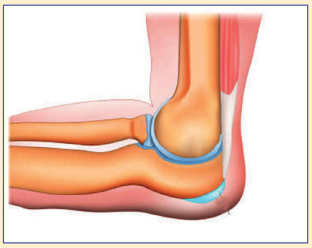
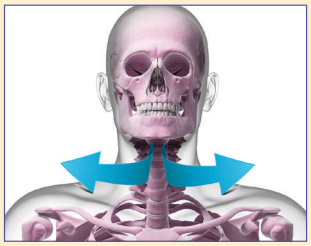
Adaptations of organisms for their existence ranges from the movement of molecules in the cells to the various movements of organisms. Knowledge about these not only reveals the wonders in the diversity of movements of the living world, but also gives insight into the evolution of life. Evolution helps organisms to adapt themselves to the changing environment. Society also should undergo transformative movements in order to face problems which keep arising continuously. These movements help us to survive, progress and to follow a more just world.

Let us Assess

1. Identify the plant movement mentioned in each of those given below.
   (a) The pea plant twines around a support
   (b) The coconut tree near the bank of a river grows leaning towards the river.
   (c) The pollen tube grows towards the ovary.
   (d) The leaf of Touch-me-not plant folds while touching.
2. Identify the disease mentioned in the statement given below.

   In some people certain cells of the immune system may destroy the cartilages and synovial membrane.
3. Identify the muscle from the peculiarities given below.

   - Cells with single nucleus.
   - Spindle shaped cells
4. Observe the joints denoted as X, Y, Z and choose the one which comes in the correct order.

X	Y	Z
		

	X	**Y**	**Z**
a)	Ball and Socket joint	Gliding joint	Pivot joint
b)	Pivot joint	Ball and Socket joint	Hinge joint
c)	Gliding joint	Hinge joint	Pivot joint
d)	Hinge joint	Ball and Socket joint	Gliding joint

5. Disorders of the bones and muscles are given in column 1 and their causes are given in coloums 2. Analyse them and choose the option including the correct pairs.

Column 1	Column 2
P) Sprain	i. Destruction of cartilage by certain defence cells
Q) Osteoporosis	ii. Changes that occur in genes
R) Rheumatoid arthritis	iii. Stretching or breaking of ligaments
S) Muscular dystrophy	iv. Deficiency of protein, calcium and Vitamin D

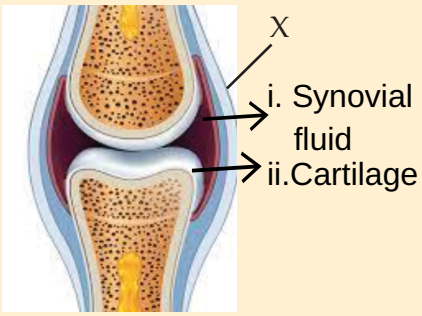
(a) P – ii , Q - iv, R - i, S - iii
(b) P – iv, Q - iii, R - ii, S - i
(c) P – i, Q - ii, R - iii, S - iv
(d) P – iii, Q - iv, R - i, S - ii

6. Re-draw the diagram and answer the following questions.

(a). Identify the parts mentioned below and label them.

i) Fluid present between the bones

ii) The part seen at the tip of bones which reduces friction



(b). Identify the part labelled as 'X' in the diagram and write its function.

Extended activities

1. Collect pictures and information related to the diversity of locomotion in the living world and display them in the class.
2. Prepare posters indicating the importance of exercise using graphics software and display them in the notice board.
3. Observe various organisms in your surroundings and record the diversity in their movements in your Science diary.

TYPES OF JOINTS

Name	Peculiarity	Position
Ball and Socket	Allows for multidirectional movement (rotation, flexion, extension, abduction, adduction)	Shoulder (humeral), Hip (femoral), Eye sockets (orbital)
Hinge	Permits movement in only one plane (flexion and extension)	Elbow, Knee, Ankle, Fingers (interphalangeal), Toes (interphalangeal)
Pivot	Enables rotational movement around a single axis	Atlas-axis joint (C1-C2) in neck, Radioulnar joint (proximal and distal) in forearm
Gliding	Allows for limited sliding or gliding movement between flat bone surfaces	Wrist (carpal), Ankle (tarsal), Vertebrae (intervertebral), Ribs (costovertebral), Pelvis (sacrococcygeal)

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VARIOUS BONE AND MUSCULAR DISORDERS

Disease	Causes	Symptoms
Osteoporosis	Bone damage, protein, calcium, and vitamin D deficiency	Weak and porous bones, fractures, loss of height, back pain
Rheumatoid Arthritis	Autoimmune destruction of cartilage and synovial membrane	Severe joint pain, swelling, stiffness, redness, warmth, limited mobility
Muscular Dystrophy	Genetic mutations, muscle damage	Muscle weakness, wasting, difficulty walking, respiratory issues, deformities
Sprain	Stretching or breaking of ligaments due to injury or trauma	Pain, swelling, bruising, difficulty moving joints, limited mobility, ankle, wrist, or knee instability

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