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SOLUTIONS BOOK

CLASS 9

Science · Exploration

CHAPTER 3

Tissues in Action

Complete Questions and Activities Solutions

In-text Questions | Revise, Reflect, Refine | The Journey Beyond

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Every question is followed by its answer. Question numbers above are clickable and the PDF bookmarks panel lets you jump to any exercise set or question. Figures are reproduced from the NCERT textbook (© NCERT) for educational use.

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3.1

CLASS 9 SCIENCE · CHAPTER 3

In-text Questions

Solutions · 20 questions

Directions (Questions 1–20): These are the questions, activities and Pause and Ponder prompts that appear inside the chapter (Think It Over, text questions, Activities 3.1 to 3.5, Pause and Ponder and Think as a Scientist), numbered in the order in which they appear. Activities that depend on your own observations give model answers.

QUESTION 1 *Think It Over · p. 28*

How is the study of cells and tissues significant for understanding the life processes and human welfare?

ANSWER

Every life process, such as growth, movement, nutrition and control, is carried out by cells working together as tissues. Studying them explains how life works and lets us use that knowledge to help people.

a Understanding life processes

- A multicellular body begins as a single cell that divides many times. Tissues, organs and organ systems form in a fixed hierarchy.
- Different tissues perform different tasks: skin protects, muscles move, bones support, nerves control and coordinate, xylem and phloem conduct water and food in plants.
- Knowing how tissues grow and differentiate explains why plants grow from their tips while animals do not.

b Human welfare

Area	How the study helps
Agriculture	Plant tissue culture (Sipra Guha Mukherjee and S. C. Maheshwari) led to crop improvement. Agrobacterium is used to introduce useful genes into plants.
Medicine	Bone marrow stem cells are used to treat blood cancers such as leukaemia and disorders such as thalassaemia.

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Area	How the study helps
Health	Understanding bones, joints and muscles helps us protect them through posture, nutrition, exercise and yoga.
Environment	Counting annual rings of a tree trunk shows its age and the climate in which it grew.

Therefore, studying cells and tissues explains how life processes work and helps in agriculture, medicine and health.

QUESTION 2 *Think It Over · p. 28*

How are tissues in plants and animals different, and why?

ANSWER

Plant and animal tissues differ mainly because plants are fixed in one place and make their own food, whereas animals move and obtain food from outside.

a Differences and their reasons

Feature	Plant tissues	Animal tissues
Support and movement	Plants are fixed and need to stay firm and upright. Cell walls and supporting tissues (collenchyma, sclerenchyma, xylem) give rigidity.	Animals move. Cells without a rigid wall change shape easily. Muscle tissue produces movement and bones support the body.
Nutrition	Tissues such as parenchyma in green parts use solar energy for photosynthesis.	Tissues help to digest food obtained from different sources.
Transport	Xylem carries water and minerals; phloem carries food.	Blood, a connective tissue, carries nutrients, gases and hormones.
Growth	Growth is carried out by meristematic tissues (apical, lateral, intercalary).	Growth tissues differ in structure and function from those in plants.
Control	Conducting and growth tissues are present; there is no nervous tissue.	Nervous tissue controls and coordinates the body.

Therefore, tissues differ because the mode of nutrition, support and movement of plants and animals differ.

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QUESTION 3 *Think It Over · p. 28*

How is the division of labour at various levels of organisation in multicellular organisms correlated with their structure and function?

ANSWER

In a unicellular organism such as Amoeba, one cell performs all functions of life. In a multicellular organism, the work is divided among specialised cells, tissues, organs and organ systems.

a Levels of organisation

Cells of similar type performing a similar function form a **tissue**. More than one type of tissue forms an **organ**. Different organs form an **organ system**, and organ systems together form an **organism**. Division of labour increases the efficiency of the body and enables it to carry out complex life processes.

b Structure suits function

Tissue	Structure	Function
Meristematic tissue	Small cells, thin walls, large nucleus, dense cytoplasm, no vacuoles, tightly packed	Rapid, continuous cell division
Sclerenchyma	Thick lignified walls, mostly dead cells	Hardness and strength
Phloem (sieve tubes)	Long tubular cells joined end to end by perforated walls	Transport food from leaves
Epithelium (exchange)	Single layer of thin, flat cells	Rapid diffusion of liquids and gases
Skeletal muscle	Long, cylindrical, unbranched, multinucleate, striated fibres	Voluntary movement
Neuron	Cell body, dendrites and a long axon	Receive, process and transmit messages

Therefore, each level of organisation has a structure matched to its function, which makes the organism efficient.

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QUESTION 4 *Introduction · p. 28*

What makes cells group together to form tissues? Why do some tissues grow throughout life while others do not?

ANSWER

A multicellular body starts as one cell that divides repeatedly. The resulting cells specialise, and cells of similar type that perform a similar function stay together as a tissue.

a Why cells group into tissues

- Cells of a similar type perform a similar function, so working together as a group makes the function more efficient (division of labour).
- Different tissues together form organs, organ systems and the organism.

b Why some tissues keep growing

- **Meristematic tissues** in plants contain actively dividing cells. They keep adding new cells, so plants grow throughout life.
- Cells that lose the ability to divide undergo differentiation and become **permanent tissues**, which do not grow further.
- Some newly formed cells remain meristematic, while others become permanent. This is why only some tissues keep growing.

Therefore, similar cells group to share work, and only tissues whose cells keep dividing (meristems) grow throughout life.

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QUESTION 5 *Section 3.2 · p. 29*

You must have observed that a small seedling grows into a tall tree, roots grow deep into the soil, stems become thicker with time and grass grows again after being eaten by grazing animals. Which tissues are responsible for these changes?

ANSWER

These changes are caused by meristematic tissues, which are groups of actively dividing cells.

a Tissue responsible for each change

Observation	Meristem responsible	Location
Seedling grows into a tall tree; roots grow deep	**Apical meristem** (growth in length)	Tips of roots and shoots
Stems become thicker with time	**Lateral meristem** (growth in girth)	Ring of dividing cells along the circumference of the stem
Grass grows again after grazing or mowing	**Intercalary meristem** (regrowth)	Base of internode or just above the node

Therefore, apical, lateral and intercalary meristems are responsible for these changes in plants.

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QUESTION 6 *Activity 3.1 · pp. 29–30*

Activity 3.1: Let us design experiments. Take two onion bulbs in jars of water. Cut the root tips of the bulb in Jar B by about 1 cm. Measure the root lengths for seven days and record them in Table 3.1. What trend do you observe in the data? Are your observations similar to the graph in Fig. 3.2? What do you infer?

ANSWER

Roots in Jar A keep growing, but roots in Jar B stop growing after the tips are cut. The values below are read from the graph in Fig. 3.2; your own readings may differ slightly.

a Table 3.1: Experimental data (values read from Fig. 3.2)

Experimental jars	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
A (uncut)	0.2	0.8	1.8	2.9	3.8	4.9	5.8
B (tips cut)	0.2	0.7	1.6	2.6, then 1.6 after cutting	1.6	1.6	1.6

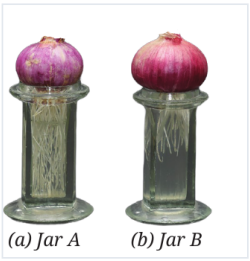


Fig. 3.1: Experimental set-up (Jar A and Jar B)



Fig. 3.2: Growth of onion roots

b Trend and inference

- **Jar A:** the root length increases steadily every day (about 0.2 cm to about 5.8 cm), so roots continue to grow in length.
- **Jar B:** the length drops by about 1 cm when the tip is cut (2.6 cm to 1.6 cm) and then stays constant, so the roots stop growing.
- **Similarity:** the observations match the graph in Fig. 3.2.

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- **Inference:** roots grow only from their tips, where cells divide continuously (apical meristem). Shoot tips also contain actively dividing cells.

Therefore, plants have growth zones (apical meristems) at the tips of roots and shoots, which help them grow in length.

QUESTION 7 *Section 3.2.3 · p. 31*

Why do you think that the cells of meristematic tissues lack vacuoles?

ANSWER

Meristematic cells divide rapidly and continuously. Everything about their structure is arranged to support this, and a large vacuole would get in the way.

a Reasons

- The cells have dense cytoplasm with many organelles and a large, prominent nucleus. These are needed to make new cell material and to control division.
- A large vacuole would take up space inside the small cell and push the dense cytoplasm and nucleus aside.
- Vacuoles store substances and keep mature cells firm. Dividing cells do not need to store much; they need to make new cells quickly.
- The cells are small, thin-walled and tightly packed. A small, compact cell can divide quickly.

Therefore, meristematic cells lack vacuoles so that their cytoplasm and nucleus can support continuous and rapid cell division.

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QUESTION 8 *Section 3.2.4 · pp. 31–32*

Observe the T.S. of a sunflower stem (Fig. 3.7). What do you observe? Are all the cells similar in shape and size? How many different types of tissues can you identify? What differences do you notice among them? What might be the reason for the presence of different types of cells and tissues?

ANSWER

The cells are not all similar. The stem has several groups of cells, and each group looks different because it performs a different function.

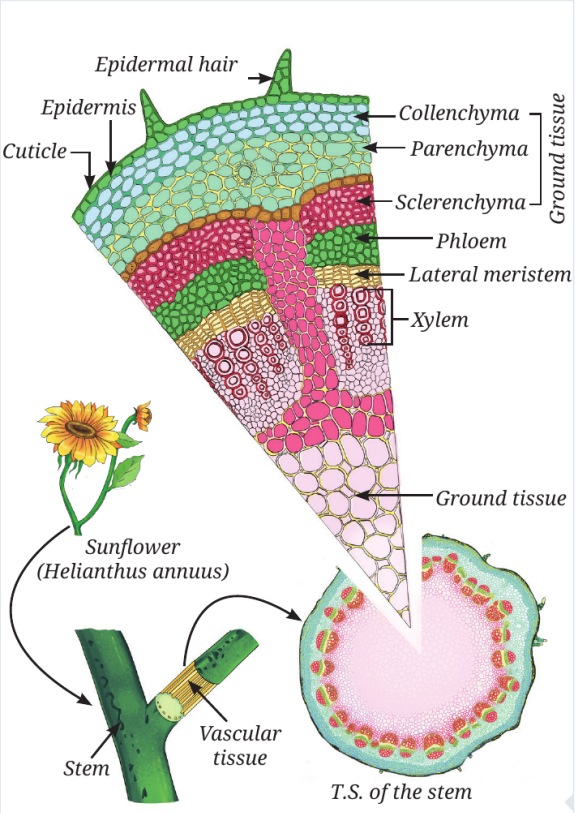


Fig. 3.7: Internal structure of a sunflower stem

a Tissues that can be identified in Fig. 3.7

Tissue	What it looks like	Function
Epidermis (with cuticle, epidermal hair)	Outermost single layer of tightly packed flat cells	Protection
Collenchyma	Living cells with unevenly thickened corners	Support with flexibility

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Tissue	What it looks like	Function
Parenchyma	Thin-walled, loosely packed living cells	Storage, photosynthesis
Sclerenchyma	Thick lignified walls, mostly dead cells	Strength and hardness
Xylem	Large tubes (vessels) with thick walls	Conducts water and minerals
Phloem	Living cells including sieve tubes	Conducts food
Lateral meristem	Ring of dividing cells between xylem and phloem	Growth in girth

b Reason for different tissues

Each tissue is specialised to perform a specific function, so different groups of cells have different shapes, sizes and wall thickness. These are permanent tissues (plus the lateral meristem), which can be simple (one type of cell) or complex (more than one type of cell).

Therefore, six types of permanent tissue and a lateral meristem are seen, and they differ because each performs a specific function.

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QUESTION 9 *Section 3.2.4 · pp. 32–33*

What protects plants from mechanical injury, water loss, harmful microorganisms and extreme environmental conditions? What keeps a plant upright? Why does a fresh twig bend but a dry twig break? Why are seed coats hard and how do aquatic plants float? How does water reach the leaves of tall trees? How does food prepared in leaves reach other parts of the plant?

ANSWER

These questions are answered by the three kinds of plant tissue: protective, supporting and conducting.

a Answers

Question	Answer
What protects plants from injury, water loss, microorganisms and extreme conditions?	**Epidermis**: a tightly packed single layer covered with a waxy cuticle of cutin.

Question	Answer
What keeps a plant upright?	**Supporting tissues** (parenchyma, collenchyma, sclerenchyma) and xylem, which also gives strength.
Why does a fresh twig bend but a dry twig break?	A fresh twig has living cells such as collenchyma, which give flexibility. In a dry twig the flexible living cells have dried and the hard, lignified tissue makes it brittle.
Why are seed coats hard?	They have **sclerenchyma**, whose cells have thick lignified walls.
How do aquatic plants float?	**Parenchyma** forms air spaces in aquatic plants, which help them float.
How does water reach the leaves of tall trees?	Through **xylem**, which transports water and minerals from roots; transpiration creates a pull.
How does food made in leaves reach other parts?	Through **phloem** (sieve tubes), regulated by companion cells.

Therefore, epidermis protects, supporting tissues give strength and flexibility, and xylem and phloem conduct water and food.

QUESTION 10 *Pause and Ponder 1 · p. 33*

You may have noticed that fibres of coconut husk are hard and brittle, whereas the leaf stalks of coriander are soft and flexible. Find out the reason.

ANSWER

The difference is due to the type of supporting tissue present in each plant part.

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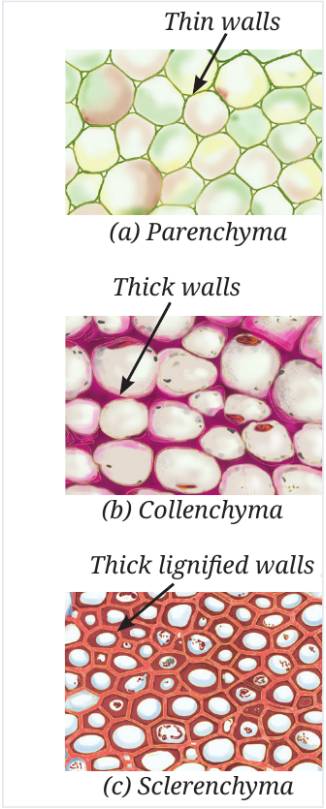


Fig. 3.8: Types of simple permanent tissues, (a) parenchyma, (b) collenchyma, (c) sclerenchyma

a Comparison

Point	Coconut husk fibres	Coriander leaf stalk
Tissue	Sclerenchyma	Collenchyma and parenchyma
Cell walls	Thick, deposited with lignin	Thin walls, or corners thickened with pectin
Cells	Most are dead	Living cells
Property	Hard, strong and brittle	Soft and flexible; bends without breaking

Therefore, coconut husk has sclerenchyma (hard, lignified, dead cells), while coriander stalks have flexible living cells.

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QUESTION 11 *Pause and Ponder 2 · p. 34*

Why do you think that a thick cuticle on the outer wall of epidermis is advantageous for a plant living in the desert but disadvantageous for a plant living underwater?

ANSWER

The cuticle is a waxy layer of cutin that reduces loss of water from the plant surface. Whether it helps depends on the habitat.

a Desert plant

Water is very scarce and the plant loses water by transpiration. A thick cuticle reduces water loss, so it helps the plant survive.

b Underwater plant

Water is always available all around the plant, so there is no need to prevent water loss. A thick waxy cuticle would instead make it harder for the plant to absorb water, minerals and dissolved gases directly through its surface.

Therefore, a thick cuticle saves water in a desert but is of no use, and a hindrance, for a plant living in water.

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QUESTION 12 *Pause and Ponder 3 · p. 34*

Once water is absorbed by plant roots, it has to travel against gravity through xylem. How do the 'dead' cells of the xylem work together with the living cells of leaves at the top to keep the water moving?

ANSWER

Xylem cells that conduct water are dead, hollow tubes. The force that moves water comes from the living cells of the leaves.

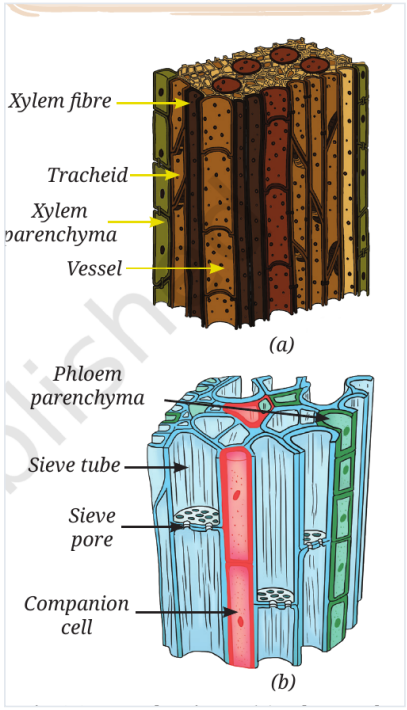


Fig. 3.9: Vascular tissue, (a) xylem and (b) phloem

a How the two work together

- Tracheids and vessels are tubular, thick-walled and dead, so they form continuous open pipes from roots to leaves.
- In the leaves, water evaporates from living cells through the stomata. This is **transpiration**.
- Transpiration creates a **transpiration pull** in the xylem, which draws water up through the continuous tubes.
- The thick walls give the xylem strength so that the tubes remain open while water is pulled up.

Therefore, dead xylem tubes provide the pathway and the living leaf cells provide the pull by transpiration.

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QUESTION 13 *Pause and Ponder 4 · p. 34*

What do you think will happen if there were no stomata in the epidermis of the stem or leaves?

ANSWER

Stomata are pores in the epidermis that help in gaseous exchange and in transpiration. Without them these functions would stop.

a **Consequences**

- **Gaseous exchange** would be hindered, so carbon dioxide could not enter easily for photosynthesis and oxygen could not move in and out.
- **Transpiration** would stop, so there would be no transpiration pull in the xylem and water transport upward would be affected.
- Elimination of waste through transpiration would also be affected.
- The plant would therefore grow poorly and could not survive for long.

Therefore, without stomata a plant could not exchange gases or transport water properly.

QUESTION 14 *Section 3.3 · p. 34*

Blink your eyes, clench and open your fist, take a deep breath and touch something warm or cold. Now think, which tissue helps you move? Which tissue enables you to sense heat or cold? Which tissue allows oxygen to enter the blood? Which tissue holds the body together so that the skin does not fall off?

ANSWER

The four main animal tissues are epithelial, connective, muscular and nervous tissue. Each answer below follows from the function of one of them.

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a Answers

Question	Tissue	Reason
Which tissue helps you move?	Muscular tissue	Muscles contract to produce voluntary and involuntary movements.
Which tissue enables you to sense heat or cold?	Nervous tissue	Neurons receive messages and transmit them to the brain, which responds.
Which tissue allows oxygen to enter the blood?	Epithelial tissue	A single layer of thin, flat cells lining the lungs and blood vessels allows rapid diffusion of gases.
Which tissue holds the body together so that the skin does not fall off?	Connective tissue	It connects and supports other tissues and organs.

Therefore, muscular, nervous, epithelial and connective tissues are responsible for movement, sensing, gas exchange and holding the body together.

QUESTION 15 *Activity 3.2 · p. 36*

Activity 3.2: Let us understand further. Recall the everyday experiences given in the first column of Table 3.3. Write your observations and questions in your notebook and compare your observations with those given in Table 3.3.

ANSWER

Each everyday experience is explained by the components of blood. The questions column is completed below.

a Table 3.3: Experiences, observations and questions

Experience	Observation	Question and explanation
A small cut on the skin	Red blood oozes out. A clot forms after some time.	**What causes blood to clot?** Platelets help in clotting at the site of injury.
A skin infection	The area turns red and slightly swollen; there may be fever.	**Why does the area turn red and swell?** White blood cells collect at the infected area, causing inflammation (redness, swelling) and possible pus formation.

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Experience	Observation	Question and explanation
Exercise or running	You breathe faster. Your face may turn red.	**Why do we breathe faster and why does the face turn red?** Muscles need more oxygen, so breathing becomes faster and blood flow increases.

b Facts about blood

- The red colour is due to haemoglobin, an iron-rich protein in red blood cells (RBCs). RBCs live for about 4 months and are replaced regularly.
- Blood is a fluid connective tissue with a watery, soft matrix: plasma (55% of total volume) and formed elements (45%).

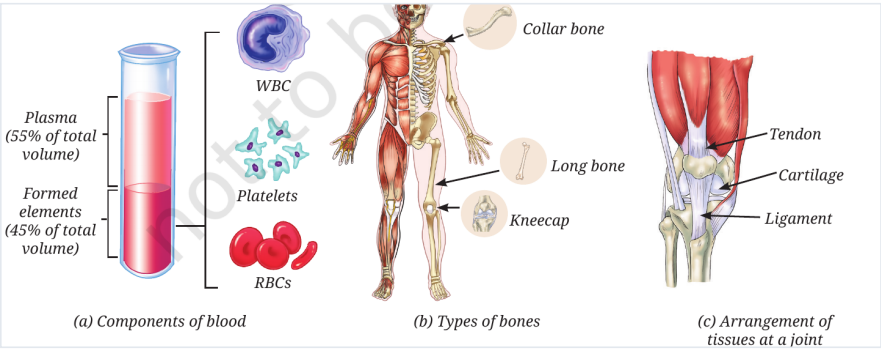


Fig. 3.12: Types of connective tissues

Therefore, platelets help in clotting, WBCs fight infection and RBCs carry oxygen with haemoglobin.

QUESTION 16 *Activity 3.3 · p. 37*

Activity 3.3: Let us perform. Perform the actions given in Table 3.4, record your experiences and compare them with the experiences given in the table. Study their functions and identify the connective tissues (Fig. 3.12).

ANSWER

Each action points to a different connective tissue. They differ in matrix and in what they connect.

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a Identification of connective tissues

Action	Experience	Function	Tissue
Touch your elbow gently	Hard and rigid structure	Strength, support and protection	**Bone** (Fig. 3.12b)
Press and fold your ear or press your nose	Soft, flexible; regains its shape	Flexibility; cushions ends of bones	**Cartilage** (Fig. 3.12c)
Touch forearm muscles and wiggle your fingers	Movement felt in forearm although fingers are far away	Connects muscle to bone and brings about movement	**Tendon** (Fig. 3.12c)
Sit and move your leg upwards till the knee allows	The joint does not go beyond a limit	Connects bone to bone; limits movement and helps prevent dislocation	**Ligament** (Fig. 3.12c)

b Why they differ

Bones have a rigid matrix containing calcium and phosphorus compounds. Cartilage has a soft, jelly-like matrix. Tendons connect muscles to bones, while ligaments connect bones to bones and prevent excessive movement.

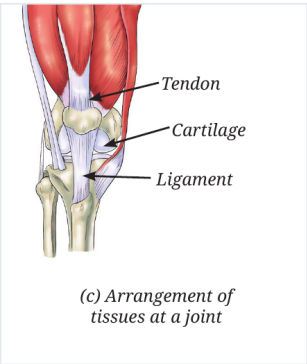


Fig. 3.12(c): Arrangement of tissues at a joint

Therefore, bone, cartilage, tendon and ligament are connective tissues with different structures and functions.

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QUESTION 17 *Activity 3.4 · p. 39*

Activity 3.4: Let us investigate. What percentage of total body weight comes from bones and muscles? Find your body weight, find the average bone and muscle mass percentage, multiply to estimate their weights, compare with your total body weight and with your classmates, and discuss why bone and muscle mass differ between individuals and how they contribute to the overall body weight.

ANSWER

This is an activity based on your own weight. A worked model is given for a person of 50 kg; replace 50 kg by your own weight.

a Steps with a model calculation (body weight = 50 kg)

Quantity	Percentage	Calculation	Estimated weight
Bone (all adults)	12 to 15%	50 × 12/100 to 50 × 15/100	6 kg to 7.5 kg
Muscle (adult male)	40 to 50%	50 × 40/100 to 50 × 50/100	20 kg to 25 kg
Muscle (adult female)	30 to 40%	50 × 30/100 to 50 × 40/100	15 kg to 20 kg

Comparison with total weight: bone and muscle together are about 52% to 65% of body weight in an adult male (12 + 40 to 15 + 50) and about 42% to 55% in an adult female (12 + 30 to 15 + 40). For the class average, add the estimated values of all students and divide by the number of students.

b Discussion

- Bone and muscle mass differ between individuals because of age, gender and body composition, as the percentages above show.
- Together, bones and muscles make up a large part of the body weight, since muscles pull on bones to produce movement and bones support the body and protect organs.

Therefore, bones are about 12 to 15% of body weight and muscles about 30 to 50%, depending on gender and body composition.

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QUESTION 18 *Activity 3.5 · p. 39*

Activity 3.5: Let us observe. Move different parts of your body and observe what movement(s) each can make (Table 3.5). Why can some parts move in many directions while others move in only one direction? What actually causes the bones to move?

ANSWER

Observations may vary slightly from person to person. The elbow row is as given in the textbook; the joint type is stated where it is discussed in the chapter.

a **Table 3.5: Movements our body can make**

Body part	Complete rotation	Partial rotation	Bending	Other movement
Elbow (hinge joint)	No	No	Yes	Straightens and bends in one direction only, like a door hinge
Shoulder (ball and socket)	Yes (circular movement)	Yes	Yes	Forward, backward and sideways raising of the arm
Knee (hinge joint)	No	No	Yes	Bends and straightens in one direction
Neck (pivot joint)	No	Yes	Yes	Turns side to side like shaking the head ‘no’; also nods up and down
Fingers	No	No	Yes	Straighten after bending; can spread apart
Toes	No	No	Yes	Curl and straighten; limited sideways movement
Wrist	No	Yes	Yes	Up-down, side-to-side and circular movement of the hand

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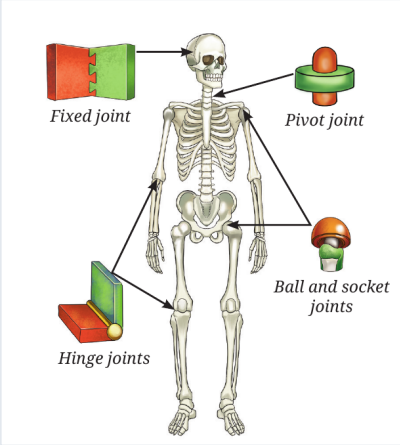


Fig. 3.16: Types of joints

b Why the movements differ

The difference is due to the type of joint. A joint is a junction between two or more bones. Ball and socket joints allow movement in many directions, hinge joints in one direction, pivot joints allow turning from side to side, and fixed joints (skull) do not allow movement.

c What causes the bones to move?

Joints allow movement but cannot move the bones on their own. **Muscles** pull on bones to produce movement. They are attached to bones by tendons, and when a muscle contracts, the tendon transmits the force to the bone. The musculoskeletal system works under the control of the nervous system.

Therefore, the type of joint decides the direction of movement, and muscles acting through tendons make the bones move.

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QUESTION 19 *Pause and Ponder 5 · p. 40*

Look at the picture given below (Fig. 3.17). Carefully observe the various poses of classical and folk dances of India. Can you identify which joints are involved? Also, what type of movement does each joint allow?

ANSWER

Dance poses use many joints. The joints below are involved in almost every pose, along with the type of movement each allows.



Fig. 3.17: Poses of classical and folk dances of India

a Joints and the movements they allow

Joint	Type	Movement allowed	Seen in dance as
Shoulder and hip	Ball and socket	Forward, backward, sideways and circular	Arms stretched or raised in different directions; legs lifted or turned
Elbow and knee	Hinge	Bending and straightening in one direction	Bent arms; bent knees in low squatting poses
Neck (skull and backbone)	Pivot	Head turns from side to side	Side-to-side head movements
Skull bones	Fixed	No movement	Head stays protected while the body moves

Therefore, dance poses use ball and socket, hinge and pivot joints, each allowing its own kind of movement.

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QUESTION 20 *Think as a Scientist · p. 42*

Based upon Table 3.6, think about these questions: (a) What do you conclude about the characteristics of phloem cells of carrot? (b) In which of the three combinations would you obtain the highest and lowest biomass? What could be the possible reason(s) for this observation? (c) Will you get the same results if you culture animal cells instead of carrot cells? (d) Think and mention any two commercial applications of the study above.

ANSWER

F. C. Steward grew single phloem cells of carrot in a nutrient medium and obtained whole plants (Fig. 3.19). Table 3.6 shows how light, air and the medium affected their growth.

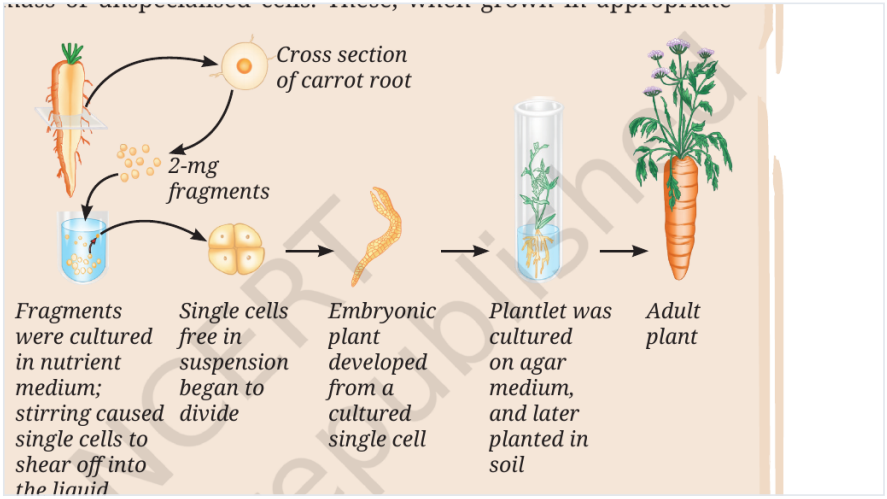


Fig. 3.19: Regeneration of a carrot plant

Light	Air	Medium	Change in fresh weight
Present	Absent	Solid medium + nutrients	Reduced
Present	Present	Liquid medium + nutrients	20% increase
Absent	Present	Liquid medium + nutrients	Reduced

a (a) Characteristics of phloem cells

Even mature, specialised phloem cells can lose their specialisation (dedifferentiate), divide, and then redifferentiate into roots, shoots and a whole plant under suitable conditions. This property is **totipotency**, and such cells are totipotent, like a zygote.

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b (b) Highest and lowest biomass

The **highest** biomass is obtained with light, air and a liquid medium with nutrients (20% increase). In a liquid medium the cells are in contact with nutrients, air supplies oxygen for respiration and light is available. In the other two combinations the fresh weight is reduced. The table does not give separate values for these two, so the **lowest** cannot be decided from the table alone. It is most likely the one with no air, since without oxygen the cells cannot respire properly and a solid medium also limits nutrient contact.

c (c) Animal cells

No. Specialised animal cells are generally not totipotent, so they cannot regrow a whole animal in the same way, and they need different growth conditions. Only cells such as the zygote have this ability.

d (d) Two commercial applications

- Plant tissue culture to produce large numbers of identical plants quickly.
- Crop improvement and production of disease-resistant varieties, and of valuable phytochemicals, using plant cell culture and genetic engineering.

Therefore, plant cells are totipotent, growth is best in a liquid medium with light and air, and this has uses in agriculture.

NCERT ARCHIVE

3.2

CLASS 9 SCIENCE · CHAPTER 3

Revise, Reflect, Refine

Solutions · 15 questions

Directions (Questions 1–15): These are the exercise questions at the end of the chapter (page 44 onwards). For multiple-choice questions the correct option is given first, followed by the reason.

QUESTION 1 *Revise, Reflect, Refine*

Meristematic tissues divide repeatedly. What property of their cells allows them to do this?
(i) They have thick walls for protection.
(ii) They contain large vacuoles that store nutrients.
(iii) They have thin walls, dense cytoplasm and large prominent nucleus.
(iv) They are functionally differentiated cells.

ANSWER

Correct option: (iii) They have thin walls, dense cytoplasm and large prominent nucleus.

a **Explanation**

Option	Verdict	Reason
(i) Thick walls	Incorrect	Meristematic cells have thin walls.
(ii) Large vacuoles	Incorrect	Vacuoles are generally absent.
(iii) Thin walls, dense cytoplasm, large nucleus	**Correct**	These features, with tight packing, allow continuous and rapid cell division.
(iv) Differentiated cells	Incorrect	Differentiated cells have lost the ability to divide and form permanent tissue.

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Therefore, the answer is (iii).

QUESTION 2 *Revise, Reflect, Refine*

If a plant is unable to transport food from leaves to roots which tissue is malfunctioning?
(i) Xylem
(ii) Phloem
(iii) Epidermis
(iv) Sclerenchyma

ANSWER

Correct option: (ii) Phloem.

a **Explanation**

- Phloem (sieve tubes) transports food prepared in the leaves to other parts of the plant, including the roots.
- Xylem transports water and minerals from the roots upwards; epidermis protects; sclerenchyma gives strength.

Therefore, the answer is (ii) Phloem.

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QUESTION 3 *Revise, Reflect, Refine*

Why are the epithelial tissues that line an animal's internal organs usually only one or a few cells thick?
(i) To store food efficiently.
(ii) To provide maximum strength.
(iii) To allow quick exchange of materials across them.
(iv) To reduce friction.

ANSWER

Correct option: (iii) To allow quick exchange of materials across them.

a **Explanation**

- A thin layer, such as the single layer of thin, flat cells lining blood vessels and lungs, helps in rapid diffusion of liquids and gases.
- Epithelium lining the small intestine is a single layer for efficient absorption of nutrients and water.

Therefore, the answer is (iii).

QUESTION 4 *Revise, Reflect, Refine*

You can perform these two jumps (Fig. 3.21):
Straight-leg jump: keep knees and ankles stiff.
Normal jump: bend knees and ankles naturally.
How did your ankle, knee and hip positions differ between the two jumps?

ANSWER

The two jumps differ in how much the ankle, knee and hip joints bend. Fig. 3.21 shows the bent position (normal jump) and the straight position.

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Fig. 3.21

a Comparison of joint positions

Joint	Straight-leg jump	Normal jump
Ankle	Stiff and almost straight	Bends before take-off and on landing
Knee	Stiff and straight	Bends (hinge joint) into a crouch, then straightens to push the body up
Hip	Body stays upright with the hip nearly straight	Hip bends as the body lowers, then straightens

b Observation

In a normal jump the bent joints let muscles pull on the bones through tendons to push the body up smoothly. In the straight-leg jump the joints are locked, so only a small movement is possible and the landing is felt as a jolt.

Therefore, ankle, knee and hip bend freely in a normal jump but stay stiff in a straight-leg jump.

QUESTION 5 *Revise, Reflect, Refine*

Which type of joint is involved when you bend your knees and ankles?
(i) Ball and socket
(ii) Hinge
(iii) Pivot

ANSWER

Correct option: (ii) Hinge.

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a Explanation

- A hinge joint bends and straightens in one direction only, like a door hinge. The knee is a hinge joint.
- Ball and socket joints (shoulder) move in many directions, and pivot joints (neck) allow turning from side to side.

Therefore, the answer is (ii) Hinge.

QUESTION 6 *Revise, Reflect, Refine*

In each of the following cases (A, B, C and D), choose the correct option:
(i) Both (A) and (R) are true, and (R) is the correct explanation of (A).
(ii) Both (A) and (R) are true, but (R) is not the correct explanation of (A).
(iii) (A) is true, but (R) is false.
(iv) (A) is false, but (R) is true.
A. Assertion: Epithelium is well-suited for gas exchange in the lungs.
Reason: It consists of multiple layers of tall cells that slow down diffusion.
B. Assertion: Cardiac muscle can contract continuously without fatigue.
Reason: Cardiac muscle cells have a high number of mitochondria and an abundant blood supply.
C. Assertion: Tendons connect bone to bone and allow joint movement.
Reason: Tendons are made of tough connective tissue that transmits force from muscle to bone.
D. Assertion: In a hinge joint, movement occurs primarily in one plane.
Reason: The bone ends are shaped to allow sliding in all directions.

ANSWER

Each Assertion and Reason is checked against the facts in the chapter.

a Answers

Case	Assertion (A)	Reason (R)	Option
A	True. Epithelium of the lungs is suited for exchange of gases.	False. The lining is a single layer of thin, flat cells, which speeds up rapid diffusion.	**(iii)**

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Case	Assertion (A)	Reason (R)	Option
B	True. Cardiac muscle works tirelessly without fatigue.	True. Mitochondria and rich blood supply provide the energy and oxygen needed, so R explains A.	**(i)**
C	False. Tendons connect muscle to bone; ligaments connect bone to bone.	True. Tendons transmit force from muscle to bone.	**(iv)**
D	True. A hinge joint moves in one direction (plane) only.	False. The bone ends allow movement in one direction, not sliding in all directions.	**(iii)**

Therefore, the answers are A: (iii), B: (i), C: (iv) and D: (iii).

QUESTION 7 *Revise, Reflect, Refine*

Plot a graph between the age of a tree (in years) on the x-axis and the diameter of the tree (in cm) along with the number of annual rings formed over time on the y-axis, using the data given in Table 3.7.
(i) Analyse the graph in terms of the diameter of the stem over time and share the interpretation.
(ii) What is the relation between the diameter of the teak tree to the annual rings formed?
(iii) Which specialised tissue is responsible for the girth of the stem and where is it located?

ANSWER

The data of Table 3.7 are plotted below. Age is on the x-axis; diameter (DBH) and number of annual rings are on the y-axis.

a **Table 3.7 and rate of growth in diameter**

Age (years)	DBH (cm)	Annual rings	Increase in diameter since previous reading
5	4	5	4 cm in 5 years (0.8 cm/year)
10	8	10	4 cm in 5 years (0.8 cm/year)
20	24	20	16 cm in 10 years (1.6 cm/year)
25	28	25	4 cm in 5 years (0.8 cm/year)
30	32	30	4 cm in 5 years (0.8 cm/year)

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Age (years)	DBH (cm)	Annual rings	Increase in diameter since previous reading
40	40	40	8 cm in 10 years (0.8 cm/year)



Graph of Table 3.7: Age of teak tree against diameter and number of annual rings

b (i) Interpretation of the graph

- The diameter increases as the tree grows older, from 4 cm at 5 years to 40 cm at 40 years.
- The growth is about 0.8 cm per year, except between 10 and 20 years when it is faster (1.6 cm per year). This was a period of favourable growing conditions.

c (ii) Relation between diameter and annual rings

One annual ring forms each year, so the number of rings equals the age of the tree (5, 10, 20, 25, 30, 40). The diameter increases as more rings are added. Wide rings show favourable years and narrow rings show unfavourable years, which is why the diameter does not rise equally in all periods.

d (iii) Tissue responsible for girth

The **lateral meristem** is responsible for increase in girth. It is a ring of actively dividing cells along the circumference of the stem, between the xylem and phloem, that adds new cells inside and outside.

Therefore, diameter and rings increase with age, and the lateral meristem along the stem's circumference increases the girth.

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QUESTION 8 *Revise, Reflect, Refine*

In a forest, it was observed that one of the trees was severely debarked by an elephant to meet its food requirements, as the bark is a rich source of nutrients (Fig. 3.22). Based on your learning, answer the following:
(i) Which function(s) of the tree is/are hampered by debarking?
(ii) Which plant tissue would be affected by further damage to the tree trunk even after debarking?
(iii) Which function of the tree would be hampered if the tissues beneath the bark were severely damaged?
(iv) What assumptions are you making to answer the questions above? How would the answer change if your assumptions are also changed?

ANSWER

The bark is the outer protective covering of the trunk. The tissues beneath it are the conducting tissues and the growth tissue.



Fig. 3.22

a **(i) Function hampered by debarking**

Protection. The bark protects the trunk from mechanical injury, water loss and entry of microorganisms. After debarking the trunk is exposed to all of these.

b **(ii) Tissue affected by further damage**

The tissues just beneath the bark are the **phloem** (and the lateral meristem that lies between phloem and xylem). Damage here affects them first.

c **(iii) Function hampered if the tissues beneath are severely damaged**

Conduction. Damaged phloem cannot carry food to the roots and other parts; if xylem is damaged, water and minerals cannot reach the leaves. Increase in girth would also stop if the lateral meristem is damaged.

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d (iv) Assumptions

- We assume that only the outer bark was removed and that the tissues beneath were not cut. If only a small patch is removed, the tree can survive.
- We assume the tree is a dicot tree with phloem beneath the bark and xylem inside it. If a full ring around the trunk is removed down to the phloem, food cannot pass to the roots and the tree may die.
- If the damage reaches the xylem, the water supply to the leaves is cut and the tree would die sooner.

Therefore, debarking removes protection, and damage to the tissues beneath would stop food and water conduction.

QUESTION 9 *Revise, Reflect, Refine*

Aamrapali observed that a young mango sapling's stem bends flexibly during monsoon winds and does not break. Which tissue is responsible for this flexibility? Predict and provide your explanation of the impact if the existing tissue was replaced by sclerenchyma.

ANSWER

The flexible tissue that supports young stems is **collenchyma**.

a Tissue responsible

Collenchyma consists of living cells with unevenly thickened corners due to pectin, a chemical that gives flexibility like rubber. It provides support and flexibility, allowing parts like stems and tendrils to bend without breaking.

b If it were replaced by sclerenchyma

- Sclerenchyma has thick lignified walls and most cells are dead, so it is hard and strong but not flexible.
- The sapling's stem would become rigid and brittle, so strong monsoon winds would break it instead of bending it.
- Because the cells are dead, they cannot divide or grow, so the young stem could not easily grow in length.

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Therefore, collenchyma gives flexibility; replacing it with sclerenchyma would make the stem stiff and easy to break.

QUESTION 10 *Revise, Reflect, Refine*

Sohan designed an experiment for the regeneration of sugarcane, where he used cuttings to grow sugarcane. He used two types of cuttings, type 'A' and type 'B' (Fig. 3.23). After a few weeks, type 'B' cuttings sprouted and developed into sugarcane plants, whereas the type 'A' cuttings did not sprout.
(i) Why were the type 'B' cuttings able to grow as sugarcane but type 'A' could not?
(ii) What difference was present in type 'B' compared to type 'A'?
(iii) What observation or measurement was made to determine whether this change had an effect?
(iv) What parameters should be kept the same for both types of cuttings to ensure a fair comparison?

ANSWER

Sugarcane regenerates from its stem cuttings. Type 'B' has a node, which is the point where new branches arise.

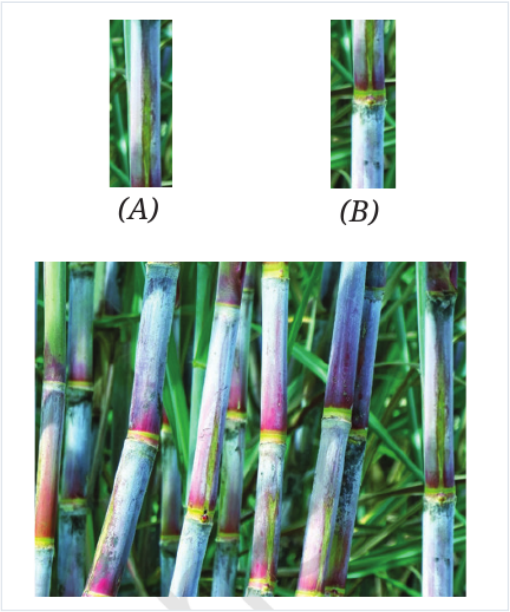


Fig. 3.23

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a (i) and (ii) Why type ‘B’ grew

Type ‘B’ cutting includes a **node** (the joint of the stem), while type ‘A’ is only a piece of internode. The intercalary meristem is located at the base of the internode or just above the node, and new branches arise from nodes. Type ‘A’ has no node, so it has no meristem to regrow and does not sprout.

b (iii) Observation or measurement

After a few weeks, observe and count how many cuttings of each type sprouted, and measure the length of the new shoots and roots.

c (iv) Parameters kept the same

Same variety and age of sugarcane, same length and thickness of cuttings, same type of soil, same amount of water, same light and temperature, same depth of planting and the same number of cuttings of each type.

Therefore, only the cutting with a node (type B) sprouted because the intercalary meristem is present at the node.

QUESTION 11 *Revise, Reflect, Refine*

During the discussion in class, Rohan gives a statement that, “A tissue is a group of similar cells performing similar functions”. But Rajiv counter argues that, “this is true in case of simple tissues but little different in case of complex tissues”. Provide your explanation in view of the discussion in class.

ANSWER

Rajiv is right. The statement fits simple tissues fully but complex tissues are made of different types of cells.

a Simple permanent tissues

These are composed of only one type of cell (parenchyma, collenchyma, sclerenchyma). All cells are similar and perform similar functions, so Rohan’s statement is correct for them.

b Complex permanent tissues

Tissue	Different cell types present	Common function
Xylem	Tracheids, vessels, xylem parenchyma, xylem fibres	Transport water and minerals; give strength

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Tissue	Different cell types present	Common function
Phloem	Sieve tubes, companion cells, phloem parenchyma, phloem fibres	Transport food

In complex tissues the cells are of different types, but they work together to perform a common function.

Therefore, a tissue is a group of cells working together for a function; the cells are alike in simple tissues but of more than one type in complex tissues.

QUESTION 12 *Revise, Reflect, Refine*

Coconut husk fibres are used for mats which are tough and fibrous. Which tissue has structural features suitable for providing this strength? Explain why living parenchyma couldn't serve the same purpose.

ANSWER

The tissue is **sclerenchyma**.

a **Comparison**

Feature	Sclerenchyma (husk fibres)	Parenchyma
Cell walls	Thick, lignified	Thin
Cells	Mostly dead	Living
Packing	Compact	Loosely packed with intercellular spaces
Main role	Hardness and strength	Storage of food, photosynthesis, air spaces

Thin-walled, loosely packed living parenchyma has no lignin. It would be soft, weak and would tear easily, so it could not make tough mats.

Therefore, sclerenchyma with thick lignified walls gives strength to coconut husk, which parenchyma cannot.

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QUESTION 13 *Revise, Reflect, Refine*

Vibha claims to her friend Neha that, “Meristematic cells are located only at the root and shoot apices”. What do you think about this statement? What question can Neha ask Vibha to help her understand further if the statement is incorrect?

ANSWER

The statement is **incorrect**. Meristems are also present at other places.

a Why it is incorrect

Meristem	Location	Function
Apical	Tips of roots and shoots	Growth in length
Lateral	Along the circumference of stems	Growth in girth
Intercalary	Base of internode or just above the node	Regrowth after cutting or grazing

b Questions Neha can ask

- How does the stem of a tree become thicker if cells divide only at the tips?
- Why does grass grow again after being mowed or eaten by grazing animals?
- Where do new branches come from if the tip of a young stem is cut?

Therefore, meristematic cells are also found along the stem (lateral) and at nodes (intercalary), not only at the apices.

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QUESTION 14 *Revise, Reflect, Refine*

A plant cell and an animal cell are of the same size.
(i) Which cell will have a larger vacuole? Give reasons.
(ii) What assumptions are you making to answer the question above?

ANSWER

The plant cell will usually have the larger vacuole.

a **(i) Reasons**

- Mature plant cells have a large vacuole that stores substances and keeps the cell firm. Plants are fixed, so they need support to stay upright.
- Animal cells have no vacuoles or only small ones, since animals are supported by their skeletal system and need cells that can change shape easily.

b **(ii) Assumptions**

- The plant cell is a mature, differentiated cell. A meristematic plant cell generally lacks vacuoles, so then the answer would change.
- The animal cell is a typical animal cell and not a specialised cell with a large storage space.

Therefore, a mature plant cell has a larger vacuole than an animal cell of the same size.

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QUESTION 15 *Revise, Reflect, Refine*

A textbook states, “Each plant tissue performs only one specific function”. What questions would you ask to critically examine the correctness of this statement? What examples of tissues would you take to find out the answers to these questions?

ANSWER

The statement can be tested by asking whether a tissue does more than one job. The chapter shows several tissues that do.

a Questions and example tissues

Question to ask	Tissue taken	Finding
Does the epidermis only protect?	Epidermis	It also carries stomata for gas exchange and transpiration, and root hair for absorption.
Does parenchyma only store food?	Parenchyma	It also performs photosynthesis in green parts and forms air spaces for floating.
Does xylem only transport?	Xylem	It transports water and minerals and also gives strength.
Does phloem only transport food?	Phloem	Phloem parenchyma stores food, resin, tannins and latex; phloem fibres give strength.

Therefore, the statement is incorrect, since many plant tissues perform more than one function.

NCERT ARCHIVE

3.3

CLASS 9 SCIENCE · CHAPTER 3

The Journey Beyond

Solutions · 7 activities

Directions (Questions 1–7): These are the activities of “The Journey Beyond” and the question of “The Quest Continues…” at the end of the chapter (page 47). Model answers are given; add your own observations.

QUESTION 1 *The Journey Beyond · p. 47*

Visit a doctor and find out what happens in ligament rupture, cartilage rupture and fracture of bones. How can we reduce the risk by changing our lifestyle and nutritional balance?

ANSWER

This is an activity to be done with a doctor. The model answer below gives general points; always follow your doctor’s advice.

a What happens in each injury

Injury	What happens
Ligament rupture	The ligament that joins bone to bone tears, so the joint becomes unstable; pain, swelling and limited movement follow.
Cartilage rupture	The soft cushioning tissue at the joint tears, causing pain and stiffness, and the joint cannot absorb shock well.
Fracture of bone	The hard, rigid bone breaks; it needs to be held in place until it heals.

b Reducing the risk

- Eat a balanced diet with enough calcium and phosphorus, since bones have a rigid matrix containing these.
- Do regular exercise, yoga and stretching to keep bones strong, muscles fit and joints flexible.
- Maintain correct posture and warm up before games and exercise.

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Therefore, a balanced diet, regular exercise and proper posture reduce the risk of ligament, cartilage and bone injuries.

QUESTION 2 *The Journey Beyond · p. 47*

Perform the following activity. (i) Sit with your feet flat on the floor. (ii) Place your fingers on the back of your ankle just above the heel (Fig. 3.24). (iii) Point your toes down and up, and you will feel the tendon moving. Try exploring other tendons in your body around the different joints.

ANSWER

The structure felt behind the ankle is a tendon (the Achilles tendon), which connects the calf muscle to the heel bone.



Fig. 3.24

a Observation

When the toes are pointed down and up, the tendon moves under the fingers. The muscle pulls on the tendon and the tendon transmits the force to the bone, so the foot moves. Tendons connect muscles to bones and withstand huge pulling forces.

b Other tendons to explore

- The back of the hand and wrist while wiggling the fingers.
- The front of the knee below the kneecap while straightening the leg.
- The inner side of the elbow while bending the arm.

Therefore, tendons transmit the force of contracting muscles to bones and make movement at a joint possible.

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QUESTION 3 *The Journey Beyond · p. 47*

Reflect on any of the physical practices you are familiar with, such as yoga, kabaddi, etc. How would it support bone and muscle health?

ANSWER

Physical practices keep the musculoskeletal system healthy.

Practice	How it supports bone and muscle health
Yoga	Postures and stretching improve flexibility, posture and breathing; they keep bones strong, muscles fit and joints flexible.
Kabaddi	Running, jumping and tackling use many muscles and put load on bones, making muscles stronger and bones sturdy; it also needs quick responses controlled by the nervous system.

Therefore, regular physical practices keep bones strong, muscles fit and joints flexible.

QUESTION 4 *The Journey Beyond · p. 47*

Reflect on any gardening methods you know, such as pruning, grafting, irrigation or crop rotation. How does each practice support the healthy functioning of plant tissues like meristems, conducting tissues or supporting tissues?

ANSWER

Each gardening practice works with one of the plant tissues.

Practice	How it supports plant tissues
Pruning	Cutting the tip stops growth in length, and new branches arise from the nodes by the intercalary meristem; this gives a bushy plant, as in a hedge.
Grafting	The cut ends of two plants join when their dividing cells (meristem) grow together; the xylem and phloem then connect to conduct water and food.
Irrigation	Water is carried up by xylem and keeps living cells firm, which helps supporting tissues and growth.

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Practice	How it supports plant tissues
Crop rotation	It keeps the soil fertile so that roots can absorb minerals, which supports healthy growth of meristems and conducting tissues.

Therefore, gardening practices help meristems to grow and keep conducting and supporting tissues healthy.

QUESTION 5 *The Journey Beyond · p. 47*

Turn a nature walk into a research project. (i) Observe different leaves and study their adaptations for various environments, such as desert, very moist or aquatic habitats. (ii) Consult an elder community resource person about their knowledge on different plant leaves, such as leaves that remain fresh for a long time, repel water or deter insects. Find out their traditional uses, such as making plates, preparing cooling wraps or functioning as insect repellents.

ANSWER

This is a project; the answers depend on what you observe. Model points from the chapter are given.

a (i) Leaf adaptations

Habitat	Adaptation linked to tissues
Desert	A thick cuticle on the epidermis reduces water loss in transpiration through stomata.
Aquatic	Parenchyma forms air spaces which help the plant to float; a thick cuticle is not needed.
Very moist	Water is plentiful, so loss of water is not a problem; note the shape and surface of leaves you see.

b (ii) Elders' knowledge

Write down for each leaf its name, the property (stays fresh, repels water or deters insects), the traditional use (plates, wraps, repellent) and who told you. Compare your list in class.

Therefore, leaves are adapted to their habitat, and traditional knowledge shows many uses of plant leaves.

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QUESTION 6 *The Journey Beyond · p. 47*

Study various dance forms of different tribal communities across the country. Each student learns and experiences at least five steps. Observe the joint movements involved in performing these steps and then develop a dance or drama on the concept of joint movements. Perform this at the school's annual function so that students from different grades can learn from it.

ANSWER

This is a group activity. A plan is given below.



Fig. 3.25

a Plan

- Each student learns at least five steps of a tribal dance form.
- For every step, note the joints used: shoulder and hip (ball and socket), elbow and knee (hinge), neck (pivot).
- Prepare a dance or drama in which each type of joint, and the muscles and tendons that move it, is shown through movement.
- Perform it at the annual function with a short explanation of each joint.

Therefore, dance steps help students learn how different joints allow different movements.

NCERT ARCHIVE

QUESTION 7 *The Quest Continues... · p. 47*

Will it be possible to obtain a complete animal from an animal cell like plants? If yes, what would be the advantages and challenges of this development?

ANSWER

In plants, some cells are totipotent and can grow into a whole plant. Most specialised animal cells are not totipotent, so it is far more difficult in animals.

a Is it possible?

In principle it may be possible with special techniques, as cells like the zygote can divide and differentiate into an entire organism. Scientists are still exploring how far this can be done for other animal cells.

b Advantages and challenges

Advantages (possible)	Challenges
Production of animals with desirable traits; saving endangered species; help in medical research and treatment of diseases	Animal cells are not freely totipotent; the process is difficult and costly; ethical and animal welfare concerns arise

Therefore, obtaining a whole animal from an animal cell is possible only in limited ways and raises scientific and ethical challenges.

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