Chapter 3: Tissues in Action

Exercises — Revise, Reflect, Refine

Q1 Meristematic tissues divide repeatedly. Which 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.

SOLUTION

Meristematic tissues are responsible for growth in plants and must divide repeatedly.

Option (i) is incorrect: meristematic cells have thin, not thick, cell walls — thick walls would restrict division.

Option (ii) is incorrect: meristematic cells have very small or absent vacuoles; large vacuoles are a feature of mature parenchyma cells, not actively dividing cells.

Option (iii) is correct: meristematic cells have thin, flexible cell walls that allow the cell to expand and divide. Their dense cytoplasm and large, prominent nucleus reflect active metabolism and the genetic machinery needed for repeated cell division.

Option (iv) is incorrect: meristematic cells are undifferentiated — they have not yet taken on any specialised function. Functionally differentiated cells have lost the ability to divide.

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

Q2 If a plant is unable to transport food from leaves to roots which tissue is malfunctioning?
(i) Xylem
(ii) Phloem
(iii) Epidermis
(iv) Sclerenchyma

SOLUTION

In plants, transport of food (sugars and other organic solutes) manufactured in

leaves by photosynthesis to non-photosynthetic parts such as roots is called translocation.

Option (i) is incorrect: xylem transports water and dissolved minerals from roots upward to leaves and shoots — it does not carry food.

Option (ii) is correct: phloem is the vascular tissue responsible for translocation of food from source (leaves) to sink (roots, stems, fruits, seeds). Sieve tube elements and companion cells are the functional units of this transport. If phloem is malfunctioning, food cannot reach the roots.

Option (iii) is incorrect: epidermis is the outermost protective layer and is not involved in long-distance food transport.

Option (iv) is incorrect: sclerenchyma provides mechanical support through dead, thick-walled cells and plays no role in food transport.

Answer: (ii) Phloem

Q3 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.

SOLUTION

Epithelial tissues lining internal organs (e.g., alveoli in the lungs, walls of the small intestine, kidney tubules) must permit rapid transfer of substances such as oxygen, carbon dioxide, nutrients, and wastes between the organ cavity and the surrounding blood vessels.

Option (i) is incorrect: storage is the function of cells such as parenchyma or adipose tissue, not epithelium.

Option (ii) is incorrect: maximum mechanical strength is provided by stratified (multi-layered) epithelia such as skin, not by single-layered epithelia lining internal organs.

Option (iii) is correct: the rate of diffusion is inversely proportional to the distance travelled. A layer that is only one or a few cells thick minimises the diffusion distance, allowing substances to cross the epithelium rapidly. This is critical for gas exchange in the alveoli and nutrient absorption in the intestinal villi.

Option (iv) is incorrect: friction reduction is a secondary role in certain locations

(e.g., ciliated epithelium moves mucus), but it is not why the epithelium is so thin.

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

Q4 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?

SOLUTION

In a straight-leg jump, the knees and ankles are held stiff and do not flex. All the shock of landing must be absorbed at the hip joint (and partially through the spine), so the hip bends noticeably to compensate. The feet make contact with the ground as a rigid unit, transmitting a large impact force directly up the leg bones.

In a normal jump, the ankles plantarflex on take-off and dorsiflex on landing, the knees flex noticeably on landing, and the hips also flex — but each joint shares the load, so the force at any single joint is much smaller.

Summary of differences:
Ankle: stiff (no flexion) in straight-leg jump; flexes freely (dorsiflexes on landing, plantarflexes on take-off) in normal jump.
Knee: locked straight in straight-leg jump; bends significantly on landing in normal jump, acting as a shock absorber.
Hip: bears the entire impact and bends more in straight-leg jump; bends moderately and shares the load in normal jump.

Cartilage at the knee and ankle joints cushions bones from friction and impact. In a normal jump the combined flexion at multiple hinge joints distributes the landing force across cartilage, tendons, and muscles, preventing injury. The straight-leg jump bypasses this protective mechanism.

Answer: In a straight-leg jump the knees and ankles are rigid so the hip must absorb most of the impact and bends sharply; the ankles and knees show no flexion. In a normal jump the ankles dorsiflex, the knees bend deeply, and the hips flex moderately — the three joints share the landing force, greatly reducing stress on any single joint.

Q5 Which type of joint is involved when you bend your knees and ankles?
(i) Ball and socket
(ii) Hinge
(iii) Pivot

SOLUTION

Option (i) is incorrect: a ball-and-socket joint (e.g., shoulder, hip) allows movement in multiple planes — rotation, abduction, adduction, flexion, and extension. The knee and ankle do not rotate freely; they move primarily in one plane.

Option (ii) is correct: both the knee joint and the ankle joint are hinge joints. A hinge joint allows flexion and extension in a single plane, like the hinge of a door. The shaped bone surfaces of the knee (femur–tibia) and ankle (tibia/fibula–talus) permit bending and straightening but restrict lateral rotation. This single-plane movement is exactly what occurs when you bend your knees and ankles during a jump.

Option (iii) is incorrect: a pivot joint (e.g., the atlas–axis joint in the neck) allows rotational movement around a single axis. The knee and ankle do not function as pivot joints.

Answer: (ii) Hinge

Q6 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.

SOLUTION

Case A:
Assertion: Alveolar epithelium is well-suited for gas exchange in the lungs. — TRUE: simple squamous epithelium of the alveoli provides a very short diffusion distance for O_2 and CO_2.
Reason: It consists of multiple layers of tall cells that slow down diffusion. — FALSE: the alveolar epithelium is a single layer of extremely thin, flat (squamous) cells, not multiple layers of tall cells. Multiple layers of tall cells would increase the diffusion distance and impede, not aid, gas exchange.
Answer for A: (iii) — Assertion is true, Reason is false.

Case B:
Assertion: Cardiac muscle can contract continuously without fatigue. — TRUE: the heart beats non-stop throughout life.
Reason: Cardiac muscle cells have a high number of mitochondria and an abundant blood supply. — TRUE: the high density of mitochondria provides a continuous supply of ATP via aerobic respiration, and the rich coronary circulation delivers oxygen and nutrients while removing waste, preventing fatigue.

The Reason correctly and directly explains the Assertion.
Answer for B: (i) — Both are true, and (R) is the correct explanation of (A).

Case C:
Assertion: Tendons connect bone to bone and allow joint movement. — FALSE: tendons connect muscle to bone. It is ligaments that connect bone to bone.
Reason: Tendons are made of tough connective tissue that transmits force from muscle to bone. — TRUE: tendons are composed of dense, regular connective tissue (collagen fibres) that efficiently transmit the contractile force of muscles to bones.
Answer for C: (iv) — Assertion is false, Reason is true.

Case D:
Assertion: In a hinge joint, movement occurs primarily in one plane. — TRUE: hinge joints (knee, elbow, ankle) permit flexion and extension in a single sagittal plane.
Reason: The bone ends are shaped to allow sliding in all directions. — FALSE: in a hinge joint the opposing bone surfaces are shaped (convex–concave fitting) to constrain movement to one plane, not to allow sliding in all directions. Allowing sliding in all directions is characteristic of a ball-and-socket joint.
Answer for D: (iii) — Assertion is true, Reason is false.

Answer: A — (iii): Assertion true, Reason false (alveolar epithelium is a single layer of flat cells, not multiple layers of tall cells). B — (i): Both true, Reason correctly explains Assertion (high mitochondria + rich blood supply sustain continuous contraction). C — (iv): Assertion false, Reason true (tendons connect muscle to bone, not bone to bone). D — (iii): Assertion true, Reason false (hinge joint bone surfaces are shaped to restrict, not allow, sliding in all directions).

Q7 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.

Table 3.7:

S.No.	Age (Years)	DBH (cm)	Annual rings
1	5	4	5
2	10	8	10
3	20	24	20
4	25	28	25
5	30	32	30
6	40	40	40

(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?

SOLUTION

(i) Analysis of diameter over time:
From the data, the DBH increases from 4 cm at age 5 to 40 cm at age 40. The growth is relatively rapid between ages 10 and 20 (an increase of 16 cm over 10 years, i.e. ~1.6 cm/year) compared to ages 20–40 (an increase of 16 cm over 20 years, i.e. ~0.8 cm/year). Overall the graph shows a steadily increasing curve that becomes less steep with age — the tree grows faster in diameter during its younger years (rapid growth phase) and the rate of diameter increase slows as the tree matures. This pattern is typical for trees: vigorous secondary growth early in life, gradually decelerating as the tree ages.

(ii) Relation between diameter and annual rings:
From the data, the number of annual rings formed equals the age of the tree in years (e.g., 5 rings at 5 years, 40 rings at 40 years). Both the diameter and the number of annual rings increase together as the tree ages. Therefore, a greater diameter corresponds to a greater number of annual rings — the number of annual rings is directly proportional to the age of the tree, and diameter also increases (though not linearly) with age. In other words, a tree with a larger

diameter has more annual rings.

(iii) Tissue responsible for increase in girth:
The vascular cambium (a type of lateral meristematic tissue) is responsible for the increase in girth (secondary growth) of the stem.
Location: the vascular cambium is located between the xylem (wood) and the phloem (bark) in the stem, forming a cylindrical layer. It produces secondary xylem (wood) towards the inside and secondary phloem towards the outside each growing season, thereby increasing the diameter of the stem. Each year's ring of secondary xylem forms one annual ring.

Answer: (i) The graph shows DBH increasing with age; growth rate is faster in younger years (~1.6 cm/year between ages 10–20) and slows with age. (ii) The number of annual rings equals the age of the tree; both annual rings and diameter increase together, so a larger diameter means more annual rings. (iii) The vascular cambium (lateral meristem), located between xylem and phloem in the stem, is responsible for the increase in girth.

Q8 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?

SOLUTION

(i) Functions hampered by debarking:
The bark consists of the outer bark (dead cork cells) and the inner bark (phloem). Removing the bark disrupts:
a) Protection: the outer bark (cork/periderm) protects the tree from mechanical injury, pathogens, water loss, and temperature extremes. Debarking removes this protective layer.
b) Food transport: the inner bark contains phloem, which translocates sugars and organic nutrients from leaves to roots and other growing parts. Debarking girdles

the phloem, cutting off the food supply to the roots.

(ii) Plant tissue affected by further damage after debarking:
Immediately beneath the bark lies the vascular cambium (a thin layer of actively dividing meristematic cells). Further damage to the trunk after debarking would injure or destroy the vascular cambium.
Loss of the vascular cambium means the tree can no longer produce secondary xylem or secondary phloem, permanently halting secondary growth and the tree's ability to heal or grow in girth.

(iii) Function hampered if tissues beneath bark are severely damaged:
If the vascular cambium and the secondary xylem (wood) are damaged, the upward transport of water and minerals from roots to leaves — conducted by the xylem — would be severely impaired. The tree would wilt and eventually die from inability to supply water and nutrients to its leaves for photosynthesis.

(iv) Assumptions and how the answer would change:
Assumption 1: the debarking is complete (all around the trunk, i.e., ring-barking), not partial. If only one side is debarked, some phloem may remain intact and the tree might survive, as food can still flow down through the remaining phloem.
Assumption 2: the damage is limited to the bark layer and does not reach the vascular cambium or xylem. If the assumption is changed and the vascular cambium is also damaged, the tree loses the ability to regenerate new tissues and will die even faster.
Assumption 3: the environment remains normal (adequate water supply through roots). If the roots are also stressed (e.g., drought), the tree's condition worsens more rapidly.

Answer: (i) Debarking hampers the protective function (outer bark/cork is removed) and food transport (phloem in inner bark is severed, starving the roots). (ii) The vascular cambium immediately beneath the bark would be affected by further damage. (iii) If vascular cambium and secondary xylem are damaged, water and mineral transport (xylem function) is hampered, leading to wilting and death. (iv) Key assumptions: complete ring-barking; damage limited to bark only; normal root water supply — if any of these change (partial debarking, cambium spared, or drought), the tree's fate differs accordingly.

Q9 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.

SOLUTION

Tissue responsible for flexibility:

Collenchyma is the tissue responsible for the flexibility of young plant stems. Collenchyma cells have unevenly thickened primary cell walls (thickened at corners) but remain living and pliable. The walls contain cellulose and pectin, which confer mechanical support while still allowing the tissue to stretch and bend without breaking. Young mango saplings have collenchyma in their stems, allowing them to flex in the wind.

Impact if replaced by sclerenchyma:

Sclerenchyma cells have uniformly thick, lignified secondary cell walls and are dead at functional maturity. Lignin makes the walls extremely rigid and non-extensible.

If the collenchyma in the young sapling's stem were replaced by sclerenchyma:

1. The stem would become very rigid and unable to bend or flex when wind exerts force on it.
2. Instead of bending elastically and springing back, the rigid stem would snap or fracture under the mechanical stress of strong monsoon winds.
3. The sapling would be far more vulnerable to breakage and windthrow, reducing its survival rate.

In summary, sclerenchyma provides strength for mature, non-growing tissues (e.g., seed coats, nut shells) where flexibility is not required, but it is unsuitable for young, growing stems that need to withstand dynamic mechanical forces.

Answer: Collenchyma is responsible for the flexibility of the young mango stem; its unevenly thickened but pliable cell walls allow bending without breaking. If replaced by sclerenchyma, the stem would become rigid and brittle due to lignified cell walls, causing it to snap rather than flex in monsoon winds.

Q10 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?

SOLUTION

(i) Why type 'B' sprouted but type 'A' did not:
Sugarcane is propagated vegetatively using stem cuttings. For a cutting to sprout and develop into a new plant, it must contain nodes — the regions of the stem where meristematic tissue (intercalary and axillary meristems) and buds are present.
Type 'B' cuttings (Fig. 3.23) include at least one node with an axillary bud, which contains the meristematic cells capable of cell division and growth.
Type 'A' cuttings appear to be internodal — taken from the segment of stem between two nodes — and therefore lack buds and the meristematic tissue needed for regeneration. Without meristematic cells, the cutting cannot divide and form new shoots or roots.

(ii) Difference between type 'B' and type 'A':
Type 'B' cuttings have at least one node (with an axillary bud and associated meristematic tissue), whereas type 'A' cuttings are internodal segments that lack nodes and buds. The presence of a node — and the meristematic cells within it — is the critical structural difference.

(iii) Observation/measurement made to determine the effect:
The presence or absence of sprouting (new shoot growth emerging from the cutting) was the key observation. Sohan likely recorded: whether shoots appeared from the cuttings after a set number of weeks, the number of cuttings that sprouted out of the total (germination/sprouting percentage), and possibly the length of new shoots as a measure of growth. Type 'B' developed into new plants; type 'A' showed no sprouting.

(iv) Parameters to keep the same for a fair comparison:

1. Length and thickness of the cuttings — so the amount of stored nutrients is similar.
2. Soil type and composition — same growing medium for both.
3. Watering schedule and amount — equal water supply.
4. Light conditions — same intensity, duration, and quality of light.
5. Temperature — both sets kept under the same temperature conditions.
6. Time of observation — both assessed after the same number of days.
7. Position in the soil — cuttings planted to the same depth at the same orientation.
8. Age and variety of sugarcane — cuttings taken from the same plant or batch to avoid genetic differences.

Answer: (i) Type 'B' cuttings contain a node with axillary buds and meristematic cells, enabling sprouting; type 'A' are internodal and lack meristematic tissue, so they cannot regenerate. (ii) The node (with bud and meristematic tissue) is present in type 'B' but absent in type 'A'. (iii) Presence or absence of sprouting (new shoot emergence) after a set number of weeks was observed. (iv) Length, soil type, watering, light, temperature, observation time, planting depth, and sugarcane variety must all be kept identical.

Q11 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.

SOLUTION

Rohan's definition is accurate for simple tissues:

Simple tissues are composed of only one type of cell, all performing the same function. For example:

Parenchyma — loosely packed, thin-walled living cells that perform storage, photosynthesis, and secretion.

Collenchyma — living cells with unevenly thickened walls that provide flexible mechanical support.

Sclerenchyma — dead cells with thick, lignified walls that provide rigid mechanical strength.

In each case, all cells in the tissue are morphologically similar and carry out the same function, so Rohan's definition holds perfectly.

Rajiv is correct for complex tissues:
Complex tissues are made up of more than one type of cell, which together perform a common overall function — but each cell type within the tissue has a distinct structure and a specific role. The classic examples are:
Xylem: composed of tracheids, vessel elements (both dead, for water transport), xylem parenchyma (living, for storage and lateral transport), and xylem fibres (dead, for mechanical support). The cells are structurally diverse, yet collectively they conduct water and minerals.
Phloem: composed of sieve tube elements (living but lacking a nucleus, for sugar transport), companion cells (living, with dense cytoplasm, supporting sieve tubes), phloem parenchyma (storage and lateral transport), and phloem fibres (support). Again, the cell types differ structurally but work together for translocation of food.

Conclusion:
Both students are correct — in complementary ways. Rohan's definition applies to simple tissues where all cells are identical. Rajiv correctly extends the concept: in complex tissues, the group is made of different cell types that are structurally dissimilar but functionally interdependent, working together as a unit to carry out one integrated function (water transport or food transport). A complete definition of tissue must therefore include both scenarios.

Answer: Rohan's definition — 'similar cells, similar functions' — correctly describes simple tissues (parenchyma, collenchyma, sclerenchyma) where all cells are morphologically alike and perform the same role. Rajiv is right that complex tissues (xylem, phloem) comprise structurally different cell types (e.g., vessels, parenchyma, fibres in xylem), each with a distinct job, yet all working together for one overall function (water or food transport). Both views together give the complete picture of what a tissue is.

Q12 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.

SOLUTION

Tissue providing strength — sclerenchyma:
Coconut husk fibres are composed of sclerenchyma (specifically, sclerenchyma fibres). Sclerenchyma cells have the following structural features that make them suitable for tough, fibrous products such as mats:

1. Thick, uniformly lignified secondary cell walls: lignin is a hard, waterproof polymer that makes the walls extremely rigid, strong, and resistant to stretching or compression.
2. Dead at maturity: the cell contents (cytoplasm, organelles) degenerate as the wall thickens, leaving only the strong wall. Dead cells do not need maintenance and remain structurally intact indefinitely.
3. Long, narrow, tapering fibres: the elongated shape of sclerenchyma fibres gives them high tensile strength along their length, ideal for making tough, fibrous materials.

Why living parenchyma cannot serve the same purpose:
Parenchyma cells are living, thin-walled cells with only a primary cell wall made of cellulose and pectin. They lack lignin entirely, making their walls soft and flexible rather than rigid and strong. Because they are living, they require water and nutrients to survive; once removed from the plant or dried, they collapse and lose structural integrity. Their isodiametric (roughly spherical) shape also provides no directional tensile strength. Therefore, parenchyma fibres would be weak, soft, easily compressed, and unable to produce the tough, durable mat fibres that sclerenchyma provides.

Answer: Sclerenchyma fibres provide the strength; their thick, lignified, dead cell walls make them rigid, tough, and durable. Living parenchyma cannot serve the same purpose because its thin, non-lignified walls are soft and collapse when dried, providing no tensile strength.

Q13 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?

SOLUTION

Evaluation of Vibha's statement:
Vibha's statement is incorrect. While apical meristems are indeed located at the root tip and shoot tip (apices), meristematic tissue is not restricted to these positions only. There are three types of meristems based on position:
1. Apical meristem — at root and shoot tips; responsible for primary growth (increase in length). This is the meristem Vibha correctly identifies.
2. Lateral meristem (vascular cambium and cork cambium) — located along the sides of the stem and root in woody plants; responsible for secondary growth

(increase in girth/diameter).

3. Intercalary meristem — located at the base of internodes (e.g., in grass stems and leaves); responsible for the regrowth of grass after it is grazed or mown.

Questions Neha can ask Vibha:

1. "Have you ever noticed that a grass lawn or field grows back quickly after being mown? If meristematic cells were only at the shoot apex (which gets cut off when grass is mown), how would the grass regrow?" — This guides Vibha towards intercalary meristems.
2. "How does the trunk of a tree increase in thickness (girth) over the years if meristematic cells are only at the tips?" — This leads to lateral meristems (vascular cambium) responsible for secondary growth.
3. "Are there any meristematic tissues between the root and shoot apices that could allow growth in width?" — An open question prompting Vibha to research lateral meristems.

Answer: Vibha's statement is incomplete/incorrect. Meristematic tissue also occurs as lateral meristems (vascular cambium and cork cambium) that increase stem girth, and intercalary meristems at the base of internodes in grasses. Neha could ask: "How does a tree trunk grow thicker over time if meristematic cells are only at the tips?" or "Why does mown grass regrow even though its shoot apex has been removed?"

Q14 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?

SOLUTION

(i) The plant cell will have a larger vacuole.

Mature plant cells typically possess one large central vacuole that can occupy 70–90% of the cell's volume. This central vacuole:

a) Maintains cell turgidity (turgor pressure) by storing water, contributing to the structural rigidity of non-woody plant tissues.

b) Stores nutrients, waste products, pigments, and secondary metabolites.

c) Plays a role in cell growth — as the vacuole fills with water, it pushes the cytoplasm and organelles to the cell periphery and drives cell expansion without proportionally increasing cytoplasmic content.

Animal cells, by contrast, either have no permanent vacuole or possess only

small, temporary vesicles/vacuoles (e.g., food vacuoles in phagocytosis, contractile vacuoles in some protists). Animal cells do not require large vacuoles for turgor since they are supported by a rigid skeleton and their shape is maintained by the cytoskeleton rather than osmotic pressure.

Therefore, given cells of the same overall size, the plant cell will have a far larger vacuole, and the animal cell will have proportionally more cytoplasm and organelles occupying the same total volume.

(ii) Assumptions:
1. The plant cell is a mature, differentiated cell (e.g., a parenchyma cell) — young, meristematic plant cells have small vacuoles similar in size to animal cell vacuoles.
2. The animal cell is a typical somatic cell (e.g., a liver or muscle cell) — specialised animal cells such as macrophages engaged in phagocytosis may have large temporary food vacuoles, but these are transient.
3. 'Same size' refers to the total cell volume, not just cell wall dimensions; if only the plasma membrane volume is compared, the comparison remains valid.
If assumptions change (e.g., comparing a young plant meristematic cell with an animal cell actively performing phagocytosis), the animal cell's vacuoles could be transiently comparable in size or number.

Answer: (i) The plant cell will have a larger vacuole; its large central vacuole occupies up to 70–90% of the cell volume to maintain turgor pressure and store substances, whereas animal cells have only small, transient vacuoles or none at all. (ii) Assumptions: the plant cell is a mature differentiated cell (not a meristematic cell), and the animal cell is a typical somatic cell not currently engaged in phagocytosis.

Q15 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?

SOLUTION

Critical questions to examine the statement:
1. Are there any plant tissues whose cells perform more than one distinct function simultaneously?
2. Does parenchyma perform only one function, or does it perform storage,

photosynthesis (as chlorenchyma), gas exchange, and secretion — all in different contexts?
3. Can the same tissue type serve different functions in different parts of the plant — for example, does epidermis only protect, or does it also regulate gas exchange (stomata) and absorb water (root hair cells)?
4. Does xylem solely transport water, or do xylem parenchyma cells also store starch and assist in lateral transport — multiple functions from cells within the same tissue?
5. In complex tissues such as phloem, do the constituent cell types (sieve tubes, companion cells, phloem parenchyma, fibres) each perform only one function, or do they collectively fulfil multiple roles within the tissue?
6. Can a tissue change its function under different conditions or stages of plant development?

Examples of tissues to investigate:
Parenchyma: examine whether it is limited to one function — in leaves it forms mesophyll (photosynthesis + gas exchange), in roots/stems it stores starch and water, and in some plants it stores secretory products (latex, resins). This tissue clearly performs multiple functions depending on location and specialisation.

Epidermis: test whether it only protects — it also forms root hair cells (absorption), guard cells (stomata, gas exchange and transpiration regulation), trichomes (secretion and protection from herbivores). Multiple distinct functions arise from the same tissue.

Xylem: investigate whether it only conducts water — xylem parenchyma stores food, and xylem fibres provide mechanical support. The tissue as a whole performs conduction, support, and storage.

Conclusion: these examples collectively challenge the textbook statement. While each tissue may have one primary function, many plant tissues perform more than one function — the statement is an oversimplification. A more accurate statement would be: 'Each plant tissue has one primary function, but may also carry out secondary or supporting functions'.

Answer: Critical questions include: Does parenchyma perform only one function, or does it also photosynthesise, store, and secrete? Does epidermis only protect, or does it also absorb (root hairs) and regulate gas exchange (stomata)? Does xylem solely transport water, or do xylem parenchyma cells also store starch? Examples — parenchyma (storage + photosynthesis + secretion), epidermis (protection + absorption + gas exchange), and xylem (conduction + support + storage) — all demonstrate multiple functions, showing the textbook statement is an oversimplification.