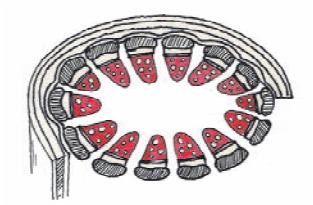
Chapter 7

Multicelluar Structure : Tissue



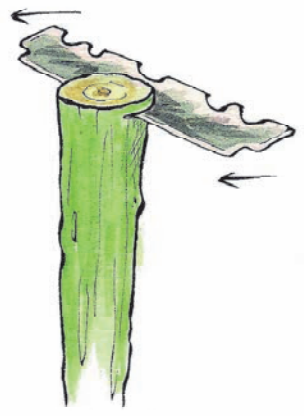
We studied about cells, their structure and function in detail in the previous chapter. We know that all living organisms are composed of cells. The thin layer of cork that Robert Hooke observed under the microscope consisted of a group of several cells. Hooke had named a member of the group, as a cell. We see groups of cells when we try to observe different parts of animals and plants under the microscope, like the leaf peel, internal layer of cheek, muscle of fish/chick etc.

Let us perform some activities to find out some functions that groups of cells are capable of doing.

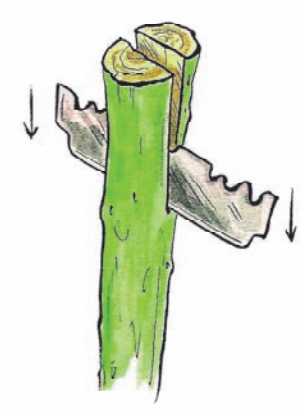
Activity-1

We would need a glass tumbler, red ink, cutter or blade, hand lens and a plant with soft stems or firm leaf stalks (like amorphophallous or jimikand/periwinkle/canna/moneyplant) to perform this activity.

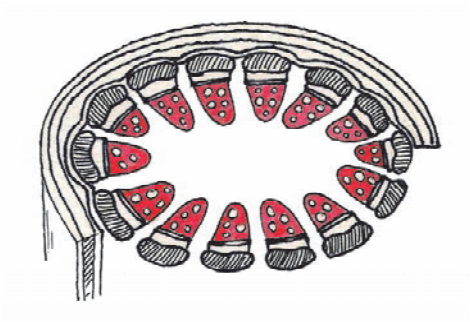
We would need two stalks of the plant. Take one stalk and cut the base uniformly to make it flat. Now observe it with hand lens (for periwinkle and money plant it would be better to cut a transverse section of it and observe it under the microscope). Cut a longitudinal section of the stalk as well. You may take the help of the figure 1 for this. Make a sketch of your observations. Add water to the cut sections so that they don't dry up.



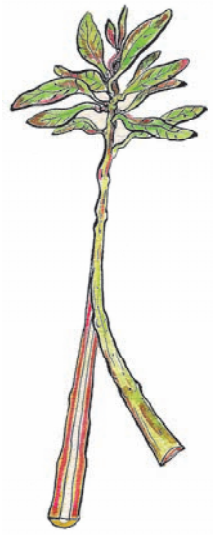
Transverse section



Longitudinal section



(a) Transverse section-
stem of dicotyledonous plant



(b) Longitudinal section-
stem of dicotyledonous plant

Fig. 1

Take an empty glass tumbler and fill 3/4th of it with water. Add enough red ink to get a dark red solution. Place the other stalk of the plant in the tumbler and see to it that the plant stands upright. Leave the set up in sunlight for two hours. Now cut transverse and longitudinal sections of this stalk and observe it carefully. You may take the help of figure 1(a) and (b) for this.

Fig. 2 : stalk of periwinkle immersed in red ink solution

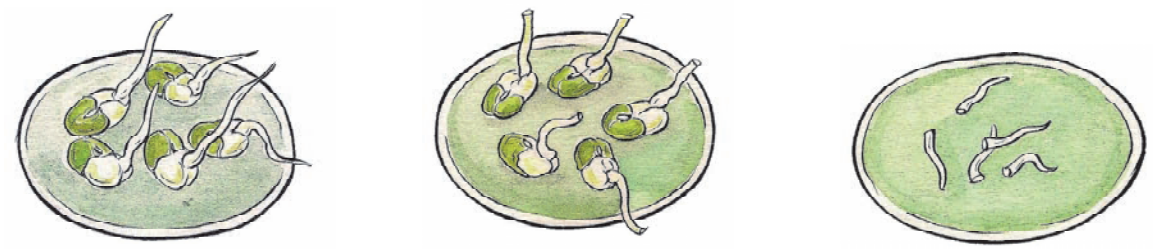
- What major difference do you find while comparing your observation of both the stalks?
- Why do you think only some areas are reddish in the second stalk?
- Can we say that these areas are involved in conduction of water in the stem?

We can clearly see that cells in the colored area are arranged in a manner different from those around them. These areas are involved usually in upward conduction of water in a plant.

Activity-2

For this we would require a clean cotton cloth, gram/moong seeds, blade, 4 bowls, slide, coverslip, red ink, microscope, candle, match box

Soak around 30 seeds either of gram or moong in a bowl for at least 6-7 hours. You may then remove the seeds from the bowl and loosely tie them up in a cotton cloth. Wet the cloth from time to time so that the seeds don't dry up. The seeds would germinate and in 2-3 days they would have quite a long radicle. Choose 10 seeds that have a long clear radicle. Keep 5 of these in bowl A. Put the other 5 in bowl B. Now measure the length of all the radicles of bowl A and B. You may use a thread for the same. This is length for first day. Cut around a millimeter of the tips of the radicle of bowl B and put the cut ends in bowl C. Keep them moistened so that they do not dry. Let them grow for another 3-4 days. On the fifth day measure the radicles once again.



(a) Bowl (a) 5 germinated sead of moong

(b) Bowl (b) 5 germinated seeds with root tip cut

(c) Bowl (c) with 5 root tips

Fig. 3

Table 1

Length of Radicle	Bowl A					Bowl B				
First Day										
Fifth Day										

- Which bowl had longer radicles after the 5th day?
- Did the radicles grow after their tips were cut?

Activity-3

We will use the freshly cut tips of bowl 3. You may do this activity as soon as you cut the tips of the radicles in activity 2. Take a cut tip and place it on a few drops of water on a slide. Heat the slide on a candle flame for some time. Do not let the water dry up completely. Now add a drop of diluted red ink or safranin and cover it with a coverslip. See to it that no bubbles remain under the cover slip. Now gently tap the coverslip with the back of your pen to flatten the tip. Observe the slide under the microscope. Take the help of Figure 4 for your observation. Make a sketch of what you observe.

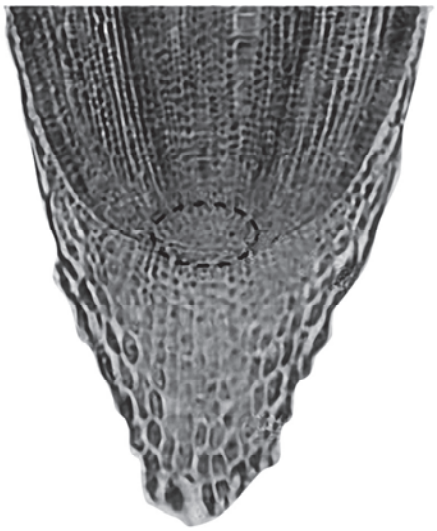


Fig. 4 : Arrangement of cells in the tip of the radicle (circled area shows the fast growing cells)

- In which of the bowls the growth of radicle continued?
- What do you think is the function of the tip of radicles?

You have thus observed that the tip of the radicle had the cells that were responsible for growth. Once these were removed, the tips did not grow in bowl B, while in A growth continued as the cells were present.

We observed so far in activity 1, 2 and 3 that there are some groups of cells that conduct water in plants while there are some others that carry out growth in plants. We also observed that their arrangement differed from those around them. We may thus say that cells are arranged in living organisms in particular patterns to carry out one or more functions. Such arrangements of groups of cells are called as tissue.

7.1 How did we come to know about tissues?

The name 'tissue' was given to interwoven structures by Marie François Xavier Bichat while he was studying diseased parts in the human body. The mention of tissue is found in a book he wrote in the year 1799 giving a detailed description of the composition of tissues of the human body. You may be surprised to learn that, though the microscope was in use in Bichat's time he never used it in his observations. His study was based on his observation of animal tissues which he classified mainly into three categories as-

1. Fibrous or those that were fiber like
2. Serous or those that were watery fluid like
3. Mucous or those that were slimy

He further subdivided these categories into 21 other types which he identified mainly on the basis of their function. Almost all names in classification of animal tissues and most of their description come from Bichat's classification (including nervous, connective, muscle etc.).

Bichat was not the only scientist studying tissues. About a century before Bichat coined the name, scientists had been studying, describing and naming them on the basis of the nature of their surface, composition and function. Nehemiah Grew(1641- 1712) was one of them who, while studying plant matter, inferred that they were composed of 'pithy' or soft and spongy, and 'woody' or hard parts. Nehemiah Grew used the term 'Parenchyma' for the first time for pithy cells having thin walls that appeared to have material poured into their spaces. Schleiden and Schwann also studied such groups of cells and they found that the transverse section of shaft of bird feather and the lining of a lamb's stomach had cells that were similar to parenchyma.

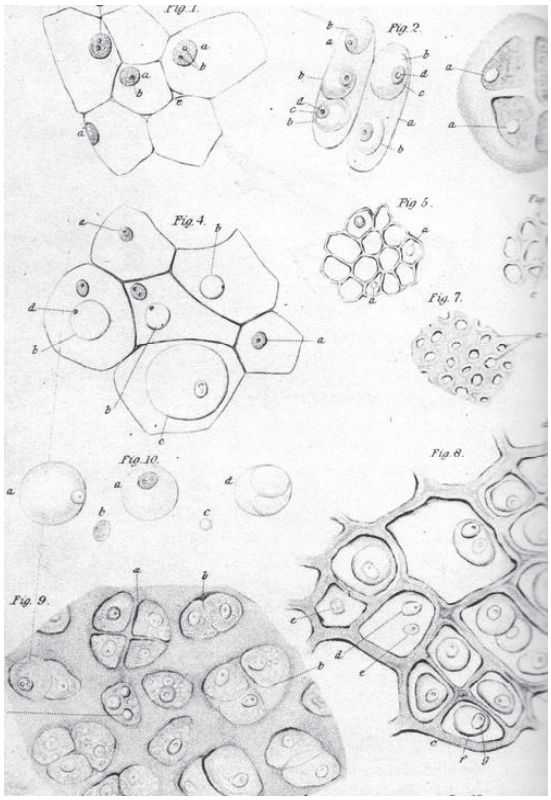


Fig. 5 : Sketches of different types of tissues as observed by Schwann

Another scientist studying tissues was Karl Von Nageli. He was a botanist who introduced the concept of formative and stable tissues. He named formative tissues as "Meristem" or fast growing tissue. He made meticulous observations and found that certain regions like tips of roots and stems in plants, skin and blood in animals were composed mainly of such tissues. He also named the tube like tissues that conducted water, minerals and food material in plants as xylem (meaning wood) and phloem(meaning bark) on the basis of the direction in which they carried water or food materials.

Schleiden and Schwann also observed the fast growing tissues and found that their cells were small with a prominent large nucleus, less cytoplasm and thin cell membrane or cell wall. As the cells matured, their size increased, the size of nucleus decreased, the amount of cytoplasm increased and the walls and membranes became thicker.

Thus we have studied how over time scientists had been studying the arrangement of cells in tissues minutely. The basis of all their detailed study had been the structure and function of the tissues. They studied tissues in both plants and animals to observe the similarities and differences between them. There are some tissues in our body that are very similar to those of plants and it may be very difficult for an experienced scientist as well to make out the differences. Usually mature animal tissues are softer than mature plant tissues. The cell theory was proposed on the basis of the similarities between plant and animal tissues.

- What are the main statements of the cell theory?

While comparing plant and animal tissues we would find that most of the plant tissues involved in conduction of materials across large distances are composed of dead cells while those of animal cells have more of living cells. It is also possible to identify areas of fast growing cells in plants more easily than in animals.

7.2 Grouping of Tissues

Scientists had been studying tissues and trying to name them on the basis of their characters like function, location, organization, arrangement, ability to divide etc. The process of grouping on the basis of these characters helped in the detailed study of tissues. We are now going to group animal and plant tissues separately to facilitate a better study of them. The major characters of each group and subgroups are also included in the flow charts presented here.

7.2.1 Grouping Plant Tissues

An example of grouping of plant tissues can be done in the following manner -

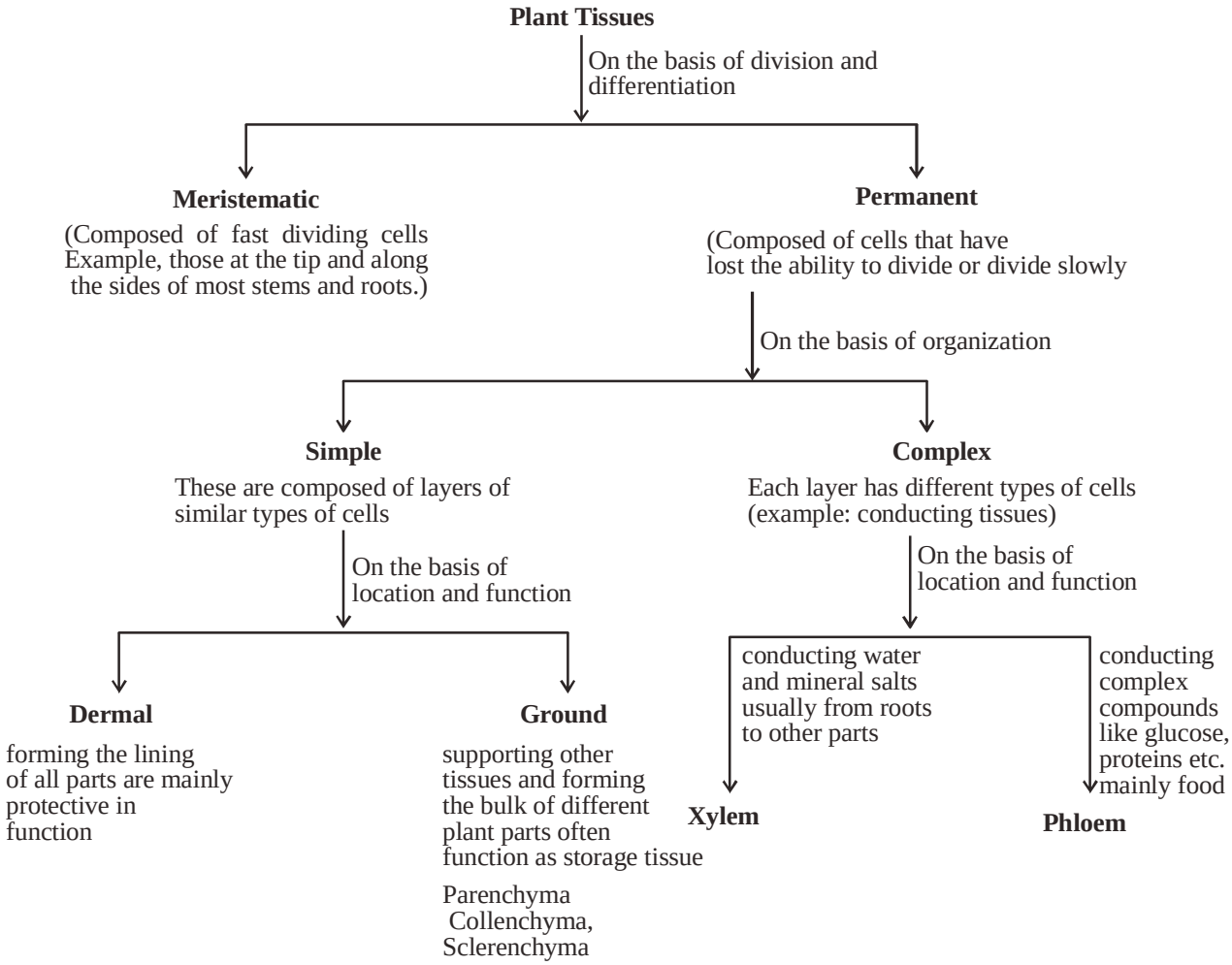


Fig. 6: Grouping of Plant Tissues

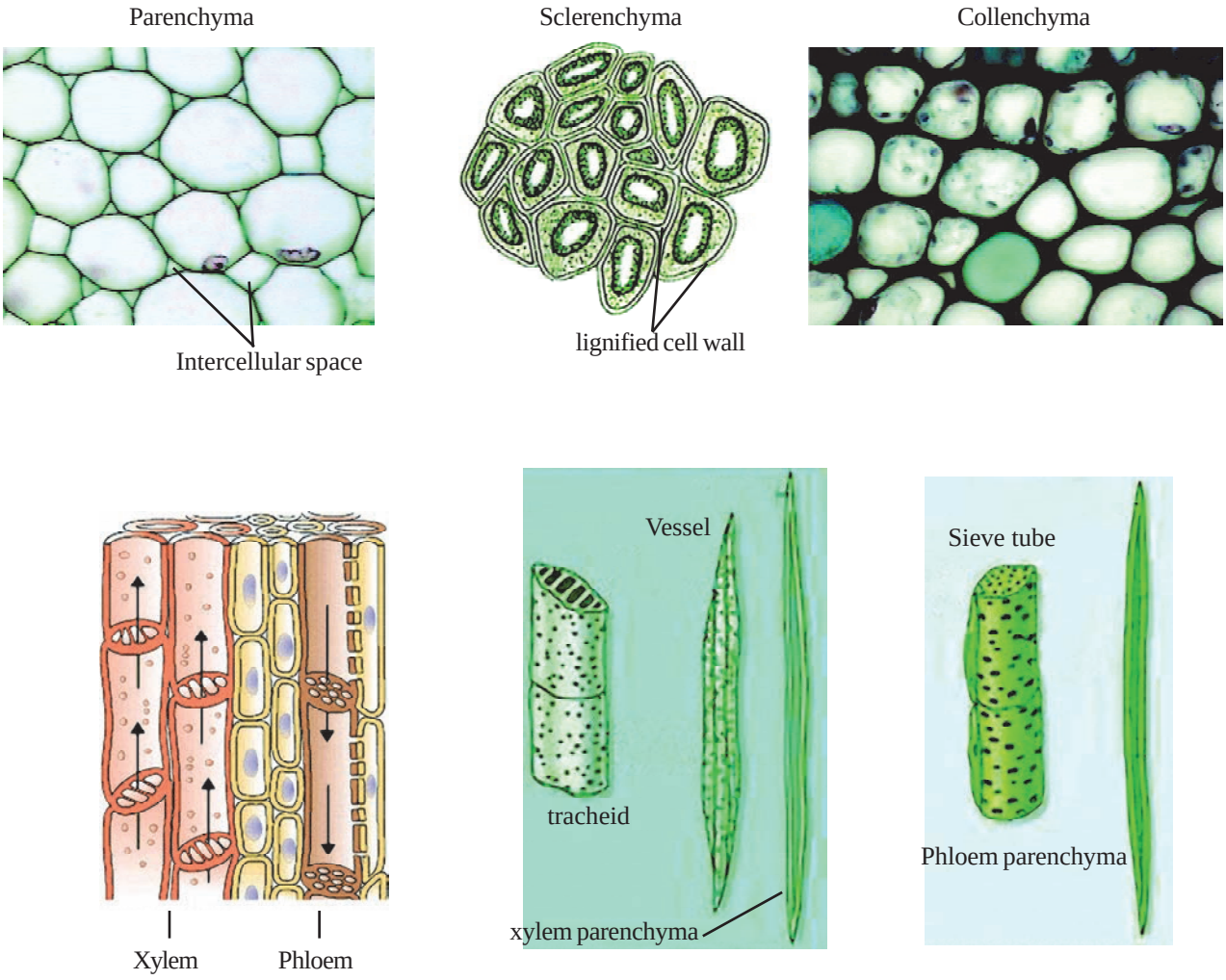


Fig. 7: Different Plant Tissues

There is a limitation of the classification schema of plant tissues as presented in figure 6. Permanent tissues are not just those that have completely lost the ability to divide. Parenchyma and collenchyma included in this category are capable of dividing. Thus we may see that the names of the categories represent stages in the development of tissues. There are intermediary stages as well like permanent tissues that still have the ability to divide.

7.2.2 Grouping of Animal Tissues

Let us now try to study a type of classification of Animal tissues (mainly those in humans).

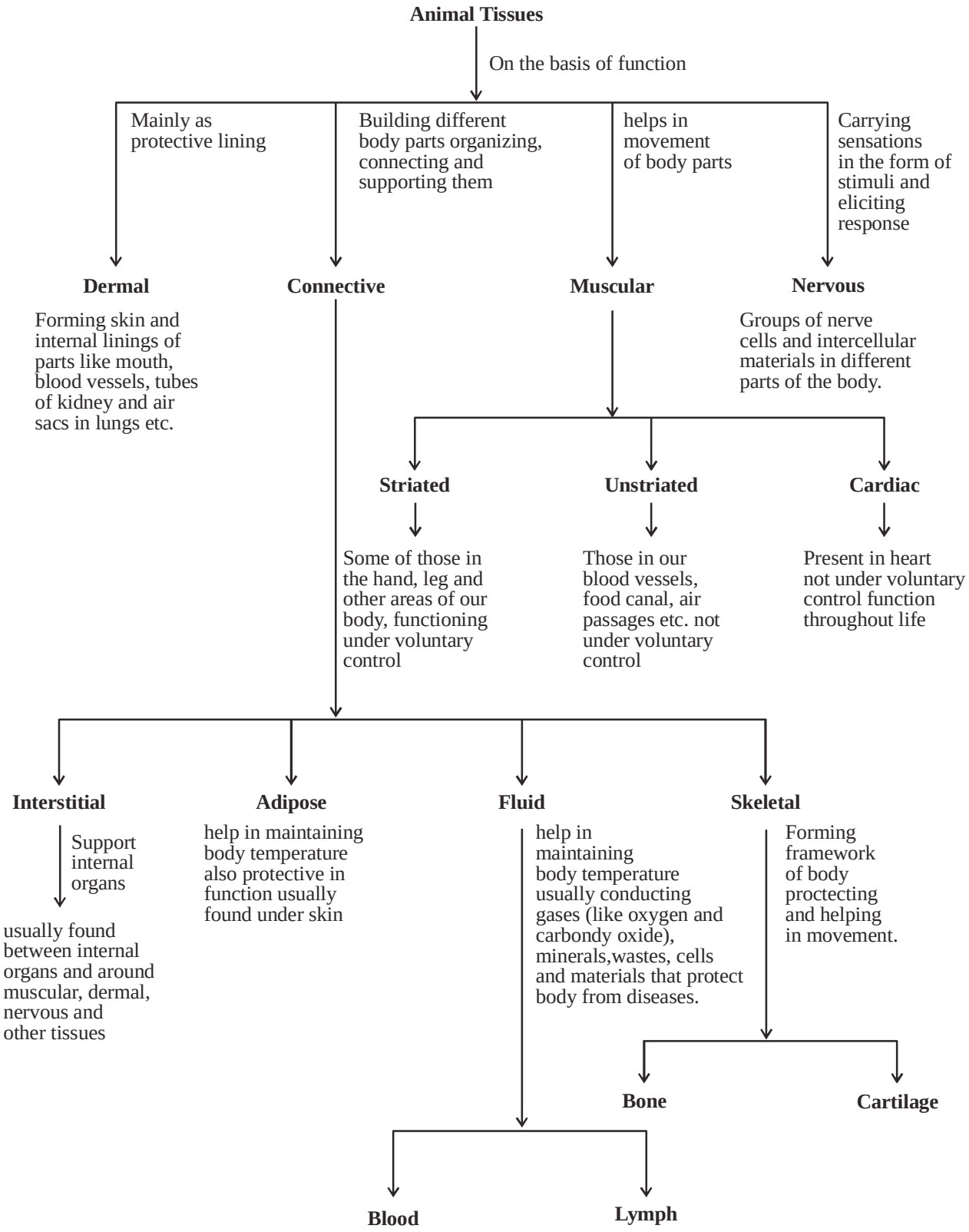
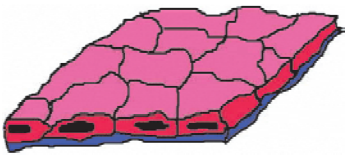
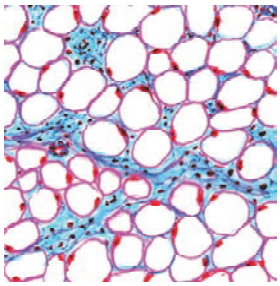


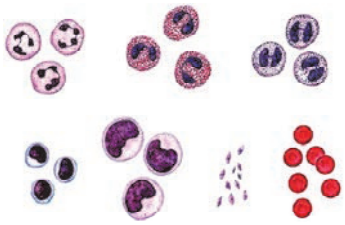
Fig. 8: Grouping some animal tissues



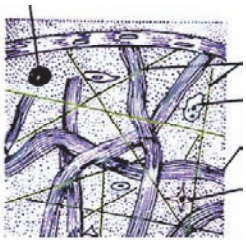
scaly epithelial tissue



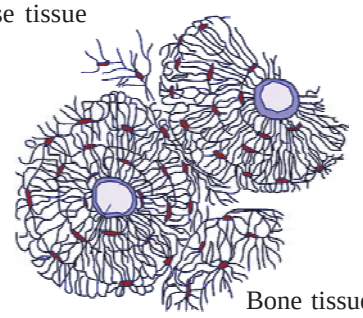
Adipose tissue



Different blood cells



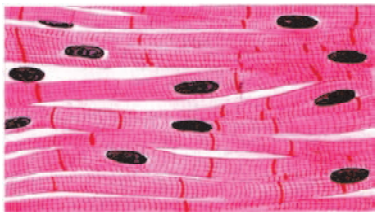
areolar tissue



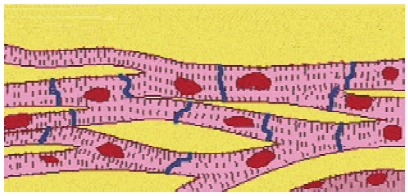
Bone tissue

(A) Dermal Tissue

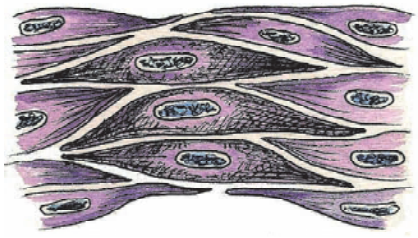
(B) Connective tissue



Striated muscle tissue



Cardiac tissue



Unstriated muscle tissue

(C) Muscular Tissue

(D) Nervous tissue

Fig. 9: Different types of animal tissues

So far we studied about how we came to know about the tissues and some schemas of grouping them. Let us now observe some of them.

7.3 Observing some plant tissues

Take the help of figure 7 to do these activities

7.3.1 Dermal tissue of the leaf

Activity-4

You would need leaves of Rheo or similar plants that have epidermis that strips off easily, microscope, slides and cover slips, blade/sharp scissor

- Tear a piece of leaf lengthwise and check for a thin peel near the edges. This is dermal tissue.
- Take a piece of this and put it on a few drops of water on a slide. Cover with a cover slip.
- Observe this under the microscope and make a sketch of what you see. You may take the help of figure 10 for your observation.
- Write a detailed account on arrangement and structure of cells that you observed.

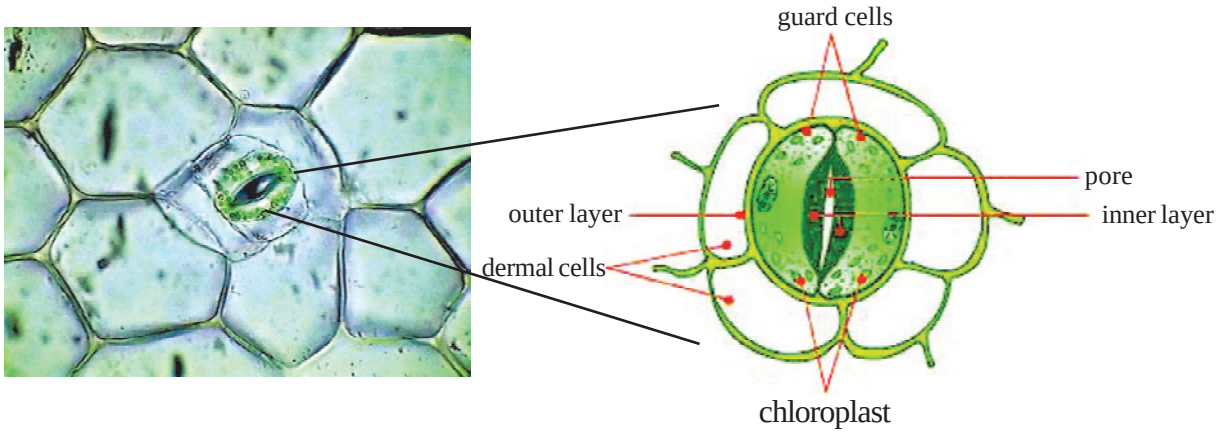


Fig. 10 : Cells in the peel of lower side of leaf and stomatal guard cells

- Could you observe chloroplast containing cells? Take the help of the figure to find out what they are called?

The cells that you observed under the microscope were of the outermost layer of leaf tissue called as dermal or rather epidermal tissue. Just like those of animal dermal tissue its major function is to form a protective layer. The intercellular space is nearly absent between the cells of this tissue. In dry areas, loss of water is prevented due to the presence of a thickened epidermis. The presence of an oily layer over the epidermis protects water plants. Cells that appear kidney shaped in the epidermal layer in most dicotyle-

donous plants are the guard cells. The pore between them is the stomata. These mainly help in exchange of air. Usually large amount of water passes out through them in several plants. This aids the conduction of water in the plant body.

Instruction : You may use other leaves preferably fleshy, to take a leaf peel. You may stain the peel for clearer observation.

7.3.2 Observing Parenchyma

Activity-5

For this we would need banana, petri dishes or watch glasses, dissection needles, iodine solution, microscope, slides and cover slips.

Instructions

1. Take a small piece of the soft banana tissue. You may use the dissecting needle to.
2. Put the sample onto a petri dish or watch glass and mash it slightly using the dissecting needle.
3. Take a small sample of the tissue onto a slide, spread it out with a needle and add a few drops of iodine solution. Place a cover slip on this.
4. Observe the cells under low power and find a section where the cells are lying separate, not over each other.
5. Iodine turns the starch blue black and we see clusters of starch containing plastids in the cells.
6. Observe the arrangement of these cells under higher power of the microscope.
7. Draw a neat and labeled diagram of your observation.

The cell in this tissue have a prominent nucleus, usually have granular cytoplasm, large vacuoles, thin cell walls and membranes, and intercellular space between them.

Parenchyma having chloroplast containing cells are called chlorenchyma. Aquatic plants have large air spaces between the cells of parenchyma, such parenchyma is called as aerenchyma.

7.3.3 Observing Sclerenchyma

Activity-6

We would need soft, ripe guava, microscope, slides and cover slips, iodine solution, dissecting needles or forceps

- Use the forceps or needle to take a small piece of soft guava tissue onto your slide.
- Add two drops of iodine solution.
- Tease the tissue slightly to separate the cells.
- Cover with a cover slip and observe under low power.

- You would find groups of dark cells amongst the rounded parenchyma cells.
- These are parts of sclerenchyma tissue.

Due to sclerenchyma, plant tissues become hard and strong. The cells of this tissue are usually fibrons, thin and dead. A section of these would show thick lignified walls around the cells that lack a nucleus. Lignin is a chemical substance (like cement) that renders strength to the cells. No intercellular space is seen due to deposition of lignin. Coconut fibers, seed coat of mature orange seeds, fibers in a dry bottle gourd etc. are composed of sclerenchyma tissue.

7.4 Observing animal tissues

7.4.1

Activity-7

- You have already observed the cells in the inner lining of your mouth by making slide of them in the previous chapter.
- You may observe dandruff or the layer of cell that peels off from your heels. All these represent the outermost layer of dermal tissue of animals called as epithelium or epidermal layer.
- Write about your observation and also make a sketch of it, keeping in view the arrangement of cells of this tissue and their intercellular space(if any).

We have observed that epithelium forms the outer and inner linings of different parts of the body. They usually form a protective covering. The cells are flat, usually with a prominent nucleus, joined to other cells and usually do not have any intercellular space.

Other functions of this tissue are like conduction of sensation, secretion and repair.

7.4.2 Observing muscular tissue

We shall use permanent slide of cardiac muscle. Take out the slide of cardiac muscle provided in your kit in your lab and observe it under the microscope. Note your observation and make a sketch of it. You may take the help of figure 9 for this.

- What are the different functions that are carried out due to the presence of muscular tissue?

All movements in animal bodies occur with the help of muscular tissue. They may be external movements like movement of hand, leg and trunk or internal like movement in the intestine, lungs and the heart.

7.5 Function of Tissues

We have so far studied that tissue is a community of cells and intercellular substances that are interacting in one or more task.

Do you know?

Tissues and cells are surrounded by fluids that form their environment. A change in its compositions and volume affects the function of the tissue. The type and concentration of minerals and salts must be at levels compatible for their proper functioning. All plant and animal tissues require a suitable fluid environment so that they may function effectively.

Most multicellular plants and animals have cells→tissues→organs→organ systems that distribute the task of survival. One arrangement functions in reproduction while another in excretion. Thus we may say that the plant and animal body shows a division of labour. As for example wood and bone are tissues that function mainly in a structural support in plants and animals respectively. Xylem of wood also conducts minerals and water while bone protects internal organs. An organ has at least two tissues that are organized in certain propositions and patterns performing one or more common tasks. As for example the leaf of plants and the eye of animals are organs. A leaf carries out photosynthesis with the help of light sensitive pigment chlorophyll and gaseous exchange with the help of stomata while the eye helps in seeing with the help of some light sensitive pigment. Thus, leaf or any other photosynthetic part of plants and the eye of animals have certain ability that are light dependent.

Not all tasks are carried out by a particular group of tissues. Some tissues carry out the function of conduction of substances from one part of a multicellular body to another.Some tissues are capable of fast growth and division. These tissues may be present anywhere in the body of a multicellular organism, for example in the skin or in all such tissues that form a lining(be it the lining of digestive system or the skin of the body) or dermal tissue. Those that form the bulk of a body or the ground substance might contain conducting tissues or vascular tissues. These are usually fibre like tissues forming muscles of animals and fibers of the conducting tissues in plants both rendering support, flexibility and connection between certain parts. These would also have fast growing tissue so that the process of growth and repair goes on replacing older layer of tissue with newer ones.

- Write about similar functions of animal and plant tissues

Do you know?

After a certain period of time the growth of certain tissues stops as the cells lose the ability to divide and differentiate(ability to take other forms). But there are some cells called as stem cells that can divide and differentiate constantly. Whenever cells of an organ die and fall off like those of our skin, the stem cells divide forming a new layer. After each division a single stem cell forms two cells, one of these differentiate into a cell of the concerned parts while the other remains as a stem cell.

Scientists have been able to identify not only those stem cells that form a particular organ but even those that may differentiate to form different organs of the body. Such stem cells in humans have been found mainly in the bone marrow and placenta. Damaged organs are being reconstructed or replaced with the help of stem cells.

7.6 Relation of structure and function of tissues

The structural organization cells→tissues→ organs → organ systems happened over a long period of time. There were single cellular forms in the beginning. Multicellular communities formed from these single cellular forms nearly 580 million years ago. The structures and functions of the cells also changed in this process.

If we think how the change of environment from water to land posed challenges to the body structure of plants we would have some idea of how their structure relates to function. Plants that left aquatic habitats found an abundance of sunlight and carbon dioxide for photosynthesis and oxygen for respiration. As they dispersed faster away from their aquatic dwelling, however, they faced a new challenge- how to keep from drying out in air. When we observe the internal structure of root, stem and leaves of land and water plants we see that a network of long tubes from root to leaves are present in land plants, ending in the stomata that open and close in ways that help to conserve water.

Branching in roots helped to draw more and more water and dissolved minerals to send it to large distances. Tube like structures formed carrying substances over large distances. You have seen these in activity 1.

Similarly we may understand the impact of the change of environment from water to land in animal cells and their function. Gases can only move into and out of the animal body by diffusing across a moist surface. This occurs across their body surface in animals living in water. The surfaces started drying out as animals started inhabiting land. Thus these animals were found to have specialized groups of cells organized into tissues, organs and organ systems to carry out gaseons within their body with very little exposure to environment. You may have understood that we are talking about the lungs. The internal lining of lungs are multilayered and highly folded facilitating large amounts of gaseous exchange.

Keywords

Tissue, division of labour, dermal tissue, ground tissue, vascular tissue, xylem, phloem, nervous tissue, connective tissue, muscular tissue

What we have learnt

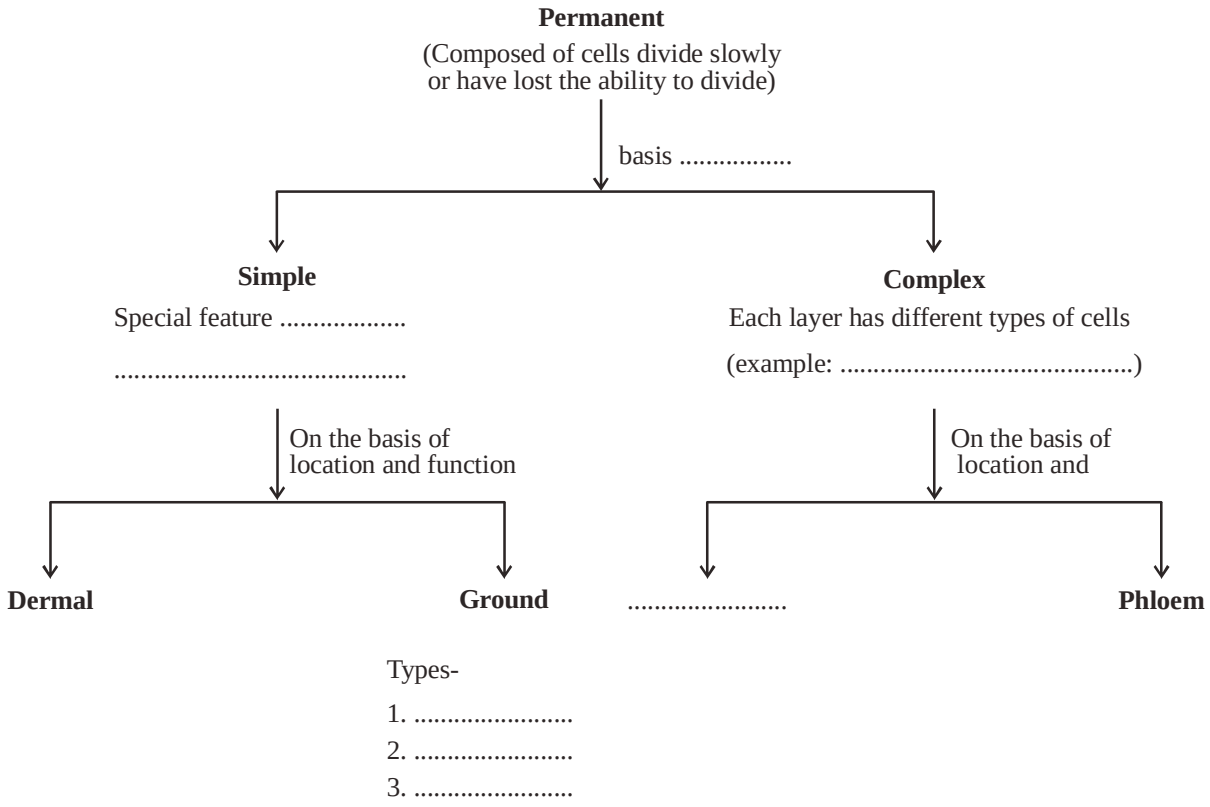
- Tissues are groups of cells along with their environment(fluid) that carry out one or more functions.
- Tissue can have one or more types of cells.
- Similar groups of cells develop into different types of tissues by division and differentiation.
- Distribution of work among different groups of tissues is their division of labour.

- Scientists have been studying the similarities and differences among different types of groups of cells over time and the cell theory had been proposed as the result of a study of similarities.
- Tissues have been grouped as meristematic and permanent on the basis of their ability to divide. Some permanent tissues like parenchyma and collenchyma have the ability to divide though they are grouped as permanent tissue.
- Animal tissues have been grouped into four categories on the basis of their structure and function as dermal, connective, muscular and nervous.
- Structure of tissues affect their function.
- Stem cells can be preserved and used later for replacement or reconstruction of damaged parts.

Exercise

1. Choose the right option
   (i) Grouping of plant tissues on the basis of function of conducting substances through them-
   (a) xylem and parenchyma (b) xylem and phloem
   (c) phloem and dermal tissue (d) parenchyma and aerenchyma
   (ii) Tissues are
   (a) groups of cells (b) cell and cytoplasm
   (c) groups of cells and their surrounding fluid (d) none of these
   (iii) Lignin deposits are seen in one of the following tissues
   (a) parenchyma (b) collenchyma
   (c) chlorenchyma (d) sclerenchyma
2. Fill in the blanks
   (i) ..... tissue carries water and mineral salts in plants.
   (ii) ..... tissue is found in the inner lining of our mouth.
   (iii) ..... and ..... tissues render support and movement to our body parts.
3. What are tissues?
4. Write about the function of any 3 types of tissues.
5. Write about the importance of division of labour among tissues of multicellular organisms.
6. Write some commonly observable examples of sclerenchyma tissue.
7. Why is blood called a connective tissue?
8. Write a note on the historic context of our knowledge of tissues.

9. Complete the flow chart given below-



10. 'There is a deep connection between the structure and function of tissues'. Justify this statement.

11. Group plant tissues on the basis of their characters and function.

12. What are the different groups into which animal tissues have been divided? What is the basis of such a grouping?

13. What are the other groups into which you may organize plant or animal tissues? What would be the basis of your grouping?

Thought provoking

Why do you think human placentas are stored away in laboratories these days?