

17. Introduction to Biotechnology



- Tissues: animal tissues and plant tissues
- Tissue culture
- Agritourism
- Agri-business



Can you recall?

1. Which components bring about important processes in the living organisms?
2. Which is the smallest structural and functional unit of the body of living organisms?

Tissue

In the case of amoeba-like unicellular organisms, all functions are performed by organelles of that single cell. However, most of the organisms are multicellular. How are the various processes brought in their body? Groups of cells come together, so as to perform the various functions of the body.

Are you familiar with the sequence- letters → words → sentences → lessons → text book?

Similarly, organization of the body of organisms follows a definite hierarchy. You have already studied cells and cell organelles in that hierarchy.

'A group of cells having the same origin, same structure and same function is called 'tissue'. Millions of cells are present in the body of multicellular organisms. These cells are divided into different groups and each group performs a definite function. For example, we can perform movements due to contraction-relaxation of muscles. Conducting tissues in plants transport water and food to all its parts. All functions of the body occur with full efficiency due to the specific organization of cells and their division of work.

Types of tissue

Simple tissue

Simple Tissues

Made up of only one type of cells

Ex. Epithelial tissue of animals,
Meristematic tissue of plants

Complex tissue

Complex Tissues

Made up of more than one type of cells
Ex. Blood of animals, Xylem
and phloem of plants



Think about it

Are the structure and functions of the bodies of plants and animals the same?

Plants being sedentary, most of their tissues are of the type that give support. There are dead cells in some tissues and these do not need much attention. Growth of the plants occurs in specific parts of their body where the tissues contain dividing cells. As animals have to move from place to place in search of food, shelter and partners, their energy needs are greater. Most of the tissues of animals are made up of living cells. Uniform growth occurs throughout the body of an animal and they do not have different dividing and non-dividing tissue. This means that plants and animals have different types of tissue to performing the necessary functions.

Animal tissue

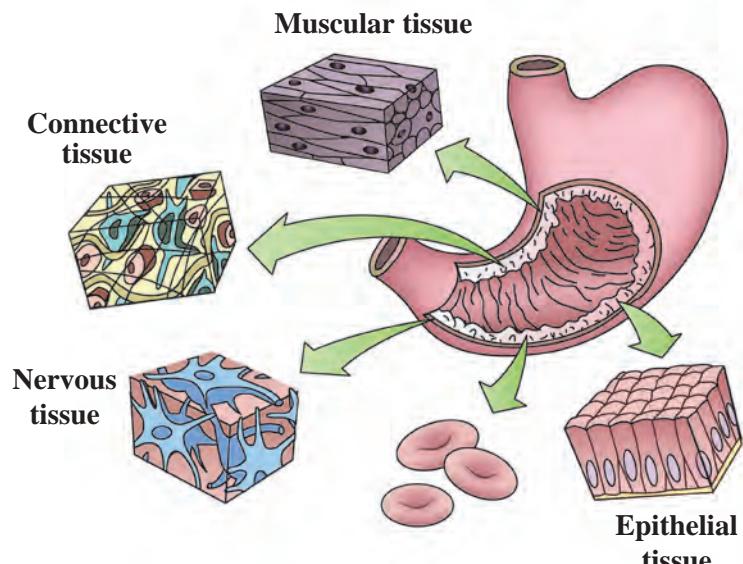


Think about it

Why can we not see our organs like the heart, blood vessels and intestines?

In the body of animal different organs come together to perform a specific function. Organs like the lungs and trachea, with the help of the contraction and relaxation of some muscles bring about the function of respiration. Different tissues perform different functions in the organs. Accordingly, tissues are classified into different types.

There are four main types of animal tissues, namely epithelial tissue, connective tissue, muscular tissue and nervous tissue.



17.1 Types of animal tissues



Do you know?

Blood is also a type of connective tissue. It circulates in our body from one part to another and transports different materials. For example, it transports oxygen and nutrients to all cells in the body. Similarly, it transports waste materials generated all over the body to the kidney for excretion.



Observe

Observe the skin of the back of your hand with the help of a magnifying lens. Do you see the closely attached squarish and pentagonal shapes?

Epithelial tissue

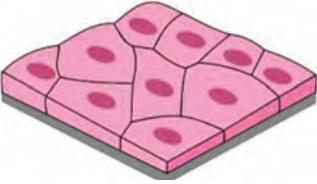
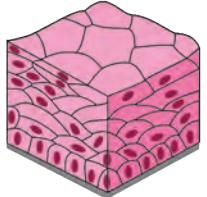
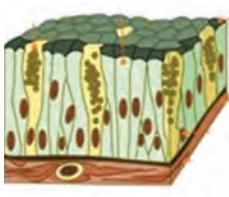
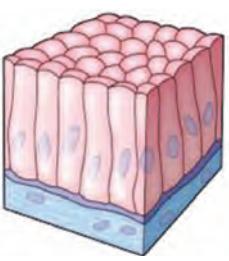
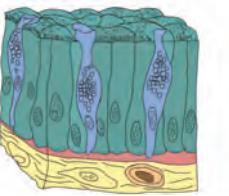
Protective coverings in the animal body are called epithelial tissues. Cells in this tissue are closely packed and form continuous layers. Any material that enters the body first encounters epithelial tissue. Cells of epithelial tissue are separated from the cells of other underlying tissues by a fibrous membrane. The skin, mucous layer of the mouth cavity, inner surface of blood vessels, walls of the alveoli, etc. are made up of epithelial tissues.



Use your brain power !

What keeps the various organs and organ systems separate from each other? How?

Types of epithelial tissues

Name	Appearance (diagrammatic)	Location	Structure	Function
Squamous epithelium		Inner surface of mouth, oesophagus, blood-vessels, alveoli	Thin, small, flat cells form semipermeable membrane.	Selective transport of substances.
Stratified epithelium		Outer layer of skin	Many layers of cells	Prevention of wearing of organs, protection of organs.
Glandular epithelium		Inner layer of skin, etc.	Cells contain vesicles packed with secretory material	Secretion of sweat, oil (sebum), mucus, etc.
Columnar epithelium		Inner surface (mucosa) of intestine, alimentary canal	Column-like tall cells. Upper free surface bears folds made of these cells at places of absorption	Secretion of digestive juice, absorption of nutrients
Ciliated Epithelium		Inner surface of respiratory tract	Upper free surface of cells bears minute hair-like processes	Push mucus and air forward to keep the air passage free
Cuboidal epithelium		Tubules of kidney (nephron), salivary gland	Cells are cuboidal	Reabsorption of useful materials from urine, secretion of saliva



Use your brain power !

Why are epithelial tissues said to be simple tissues?



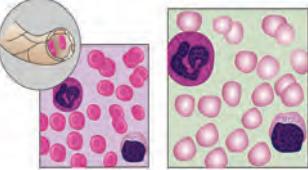
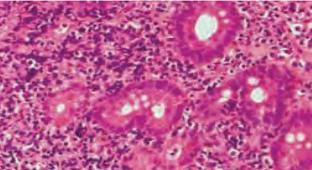
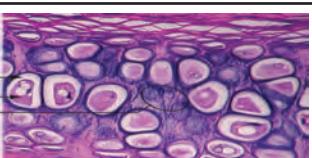
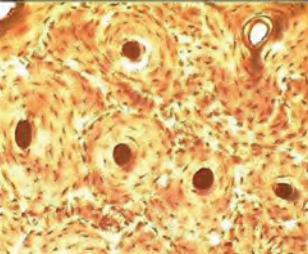
Observe

Observe a permanent slide of a blood smear under a compound microscope. What did you see?

Cells of different types, colour and shape are mixed together. Hence, blood is a type of complex tissue.

Connective tissue : Tissues which join different parts of the body are called connective tissues. Cells in this type of tissue are loosely arranged with a ground substance in the free spaces in between. The ground substance may be solid, liquid like water or jelly-like.

Types of connective tissue

Type	Appearance (diagrammatic)	Location	Structure	Function
Blood		Closed circulatory system	Erythrocytes, leucocytes and platelets in a liquid plasma	Transport of oxygen nutrients, hormones and waste.
Lymph		All around the cells in the body.	Fluid oozed out of blood capillaries, contains leucocytes and liquid ground substance	Protection of body from infections.
Areolar Tissue		Between the skin and muscles, around blood vessels	Different types of cells loosely arranged and supported by a jelly-like ground substance and elastic fibres	Supports internal organs
Adipose Tissue		Below the skin and around internal organs.	Cells filled with fat droplets, jelly-like ground substance	Insulation, supply of energy, storage of fats
Cartilage		Nose, ear, larynx, trachea	Cells supported by fibrous, flexible Jelly-like ground substance	Lubricates the surfaces of bones, gives support and shape to organs
Bones		Skeleton (A specific structure extending throughout the body)	Osteocytes embedded in solid ground substance made up of calcium phosphate	Supports and protects different organs, helps in movement
Tendons and ligaments		At the joints	Tendons: fibrous, strong, less elastic Ligaments: strong and highly flexible	Tendons: join muscles to bones Ligaments: join two bones to each other



Use your brain power !

1. Why do slim persons feel more cold in winter than those who are obese?
2. Why can bones not be folded?

Muscular tissue

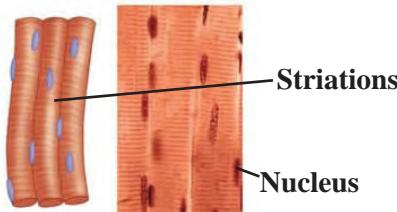
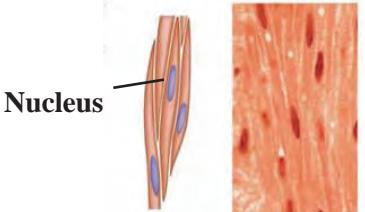
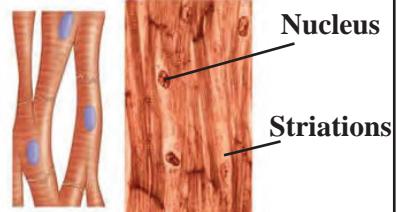


Try this

Bend your arm at elbow. Observe the muscles in the front and the back of the arm. Straighten the arm and observe the same muscles again. Do the same with your leg folding it at the knee joint. Did you experience the contraction and relaxation of muscles at every movement?

Muscle fibres and muscular tissues are formed from special type of contractile proteins due to which this contraction and relaxation is possible. Muscular tissues are made up of the long cells of muscle fibres. Muscular movement occurs due to contraction and relaxation of the contractile proteins in these cells.

Types of muscular tissues

Striated muscles	Non-striated muscles	Cardiac muscles
 Striations Nucleus	 Nucleus	 Nucleus Striations
Muscle cells are long, cylindrical, multinucleate and have no branches.	Muscle cells are short, spindle-shaped, uninucleate and have no branches.	Muscle cells are cylindrical, uninucleate and branched.
Structure: There are alternate dark and light bands on these muscles as they are attached to bones, they are also called skeletal muscles. They move as per our will, hence they are called voluntary muscles.	Structure: Dark and light bands are absent. Not attached to bones. Their movements are not under the control of our will, hence they are called involuntary muscles. They are present in the alimentary canal, blood vessels, etc.	Structure: Dark and light bands are present. The heart is made of these muscles. Their movements are not under the control of our will. They contract and relax rhythmically.
Function: These muscles bring about movements of arms and legs, running, speaking, etc.	Function: Movements of eye lids, passage of food through alimentary canal, contraction and relaxation of blood vessels	Function: Contraction and relaxation of the heart.



Can you recall?

Which type of muscle is the diaphragm of the respiratory system?



Try this

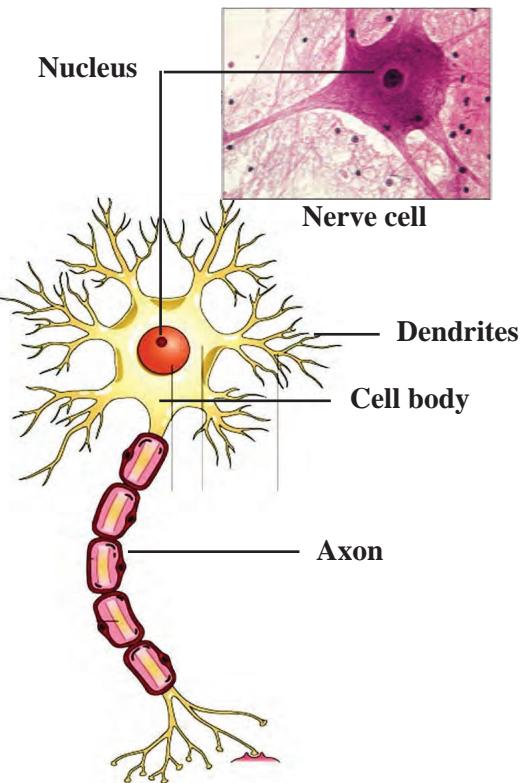
Close your eyes and try to identify different objects by feeling them with your hand. Why is it possible for you to identify things like a notebook, text-book, bench, compass-box, etc, only by touching them?

Nervous tissue

Often you must have identified the singer by merely listening to the song or identified what is being cooked in the kitchen by the mere smell! What helps us do this?

Nervous tissue enables us to respond to stimuli like touch, sound, odour, colour, etc.

Cells of the nervous tissue are specially made to become excited and to conduct that excitation from one part of body to other. The cell body which contains the cytoplasm and the nucleus is the main part of each nerve cell. Numerous, small, branched fibres called dendrites arise from the cell body. One of the fibres, however, is extremely long. It is called as the axon. The length of a nerve cell may even be up to one meter. Many nerve cells are bound together with the help of connective tissue to form a nerve. Nervous tissue is present in the brain, spinal cord and the network of nerves spread all through the body. In most animals, action in response to a stimulus occurs due to the integrated functioning of nervous tissue and muscular tissue.



17.2 Nerve cell : A unit of nervous tissue

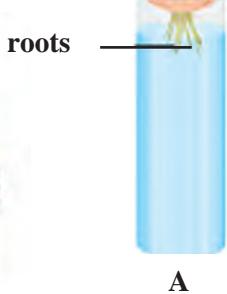
Plant tissue



Can you recall?



Try this



A



B

17.3 Changes in roots of onion

As shown in the figure 17.3, place an onion on each gas jar in such a way that its base (roots) will remain dipped in water. Measure and record the length of the roots of both onions on the first, second and third day. On the fourth day, cut off 1 cm of the roots of the onion in flask B.

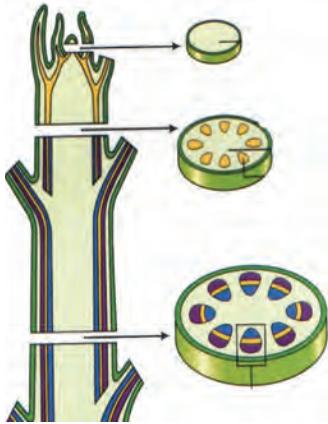
Measure the length of the roots of both onions for the next five days and record your observations in the following table.

Length (cm)	Day 1	Day 2	Day 3	Day 4	Day 5
Flask A					
Flask B					

1. Which onion has longer roots? Why?
2. Why did the roots of the onion in jar B stop growing?

Meristematic tissue

As meristematic tissue is present in specific parts of a plant, growth occurs in those parts only. Cells of meristematic tissue contain thick cytoplasm, a conspicuous nucleus and a thin cell wall and are compactly packed together. Vacuoles are usually absent in these cells. These cells are highly active. To bring about plant growth is the main function of meristematic tissue. According to the location, meristematic tissue is of three types as given below.

Figure	Location	Function
	Apical meristem : At the tip of the root and stem	Increases the length of the root and stem.
	Intercalary meristem : At the base of the petiole of leaves and branches.	Growth of branches, formation of leaves and flowers.
	Lateral meristem : Lateral sides of root and stem	Increases girth (diameter) of the root and stem.

17.4 Location of meristematic tissues in plants

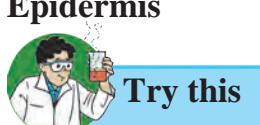
Permanent tissue

After their growth is complete, new cells formed by division of meristematic tissue lose their ability to divide and start to perform a specific function at specific place. Thus, they permanently acquire a specific structure, shape and location and perform a specific function. This is called as differentiation and permanent tissues are formed from these differentiated cells. There are two types of permanent tissues-simple permanent and complex permanent tissue.

Simple permanent tissues

These are made up of only one type of cells. According to function, they are of the following different types.

Epidermis



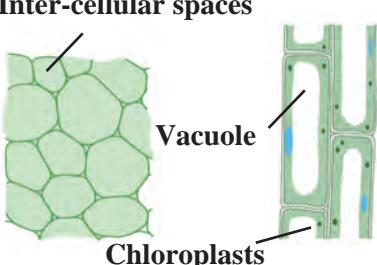
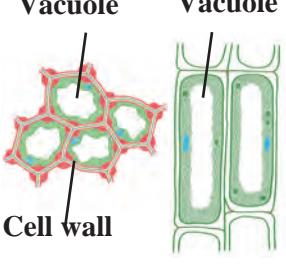
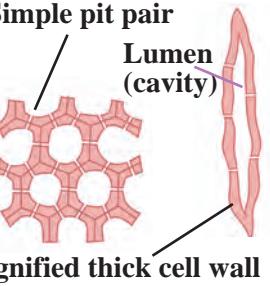
Take a fresh and fleshy leaf of *Rhoeo*, lily or any other plant. Pull and press it, tearing it obliquely in such a way that its transparent epidermis will be visible at the cut margins. Take the transparent epidermis with the forceps and keep it in dilute safranin solution for 1 minute. Spread it on a slide, cover with a cover-slip and observe it under a compound microscope.



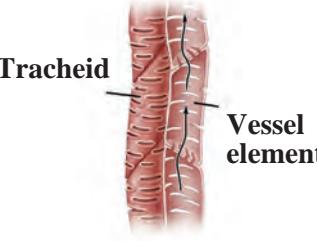
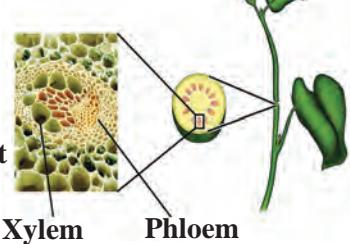
The entire outer surface of a plant is made up of only one layer of cells. That layer is called 'epidermis'. Cells of the epidermis are flat and as there are no intercellular spaces between them, a single continuous layer is formed. The epidermis of the stem and leaves is covered by a waxy layer of 'cuticle' due to which water in the

17.5 Tissue of *Rhoeo* plant

Types of simple permanent tissues

Name of Tissue	Parenchyma	Collenchyma	Sclerenchyma
Figure	Inter-cellular spaces  Vacuole Chloroplasts	Vacuole  Cell wall	Simple pit pair  Lumen (cavity) Lignified thick cell wall
Structure of Cells	Living cells with thin cell wall and intercellular spaces	Elongated living cells with thickened cell wall at corners due to cellulose and pectin	Dead and fibrous cells with tapering ends, cell wall contains lignin
Location	All parts like roots, stem, leaves, flowers and seeds	At the base of leaf petiole, branches and stem	Stem, veins of leaves, hard coats of seeds, outer covering of coconut
Functions	Support, storage of food and filling vacant spaces	Support and flexibility to various parts	Give strength and rigidity to parts of the plants.
Sub-types	Chlorenchyma: Leaves, performs photosynthesis. Aerenchyma : Helps aquatic plants, leaves and stem to float		

Types of complex permanent tissues

Name of tissue	Xylem	Phloem
Figure	Tracheid  Vessel element	 Sieve tube Companion cell
Characteristics	Consists of thick-walled dead cells	Consists of cytoplasm containing living cells
Types of cells	Tracheids, vessels and xylem fibres-dead cells Xylem parenchyma-living cells	Sieve tubes, companion cells, phloem parenchyma- living cells Phloem fibres- dead cells
Function	Structure like interconnected tubes, conduct water and minerals only in upward direction.	Tubes joined to each other, conduct sugar and amino acids from leaves to various parts in upward and downward direction

Some cells in the body of living organisms are ‘**totipotent**’, that is if provided a proper environment, a new organism can grow from these cells. It was realized that with the help of this property of the cells and their genetically controlled biochemical processes, varieties of high yielding crops and new species of animals and various vaccines could be produced. This led to the rise of a new branch in biology, ‘biotechnology’.

Biotechnology

With the help of this technique it has become possible to produce plants and animals bearing some new characteristics in addition to their natural ones. The techniques of bringing about improvements in living organisms by artificial genetic changes and by hybridization for the welfare of human beings, are together called ‘Biotechnology’. It includes the techniques of genetic engineering and tissue culture. Its uses are in the production of cash crops, improvement in varieties of cash crops, increase in abilities of plants to withstand environmental stresses, vaccine production, early diagnosis of congenital diseases, organ transplant, cancer research, production of artificial skin, cartilage, etc. in laboratories.

Tissue culture



Can you tell?

Suppose you want to grow a garden like the one shown in the picture, around your home or school. What would you do to achieve that? By which methods will you cultivate those seedlings?



You must have seen flowers of same variety but of 2 or 3 different colours borne by same plant. How is this possible?

Let us learn about a modern technique related to farming and gardening.

17.6 Tissue culture: Plantlets of banana and farming with their help

‘*Ex vivo* growth of cells or tissues in an aseptic and nutrient-rich medium’ is called tissue culture. Nowadays, a complete organism can be developed from a single cell or from tissue with help of the tissue culture technique.

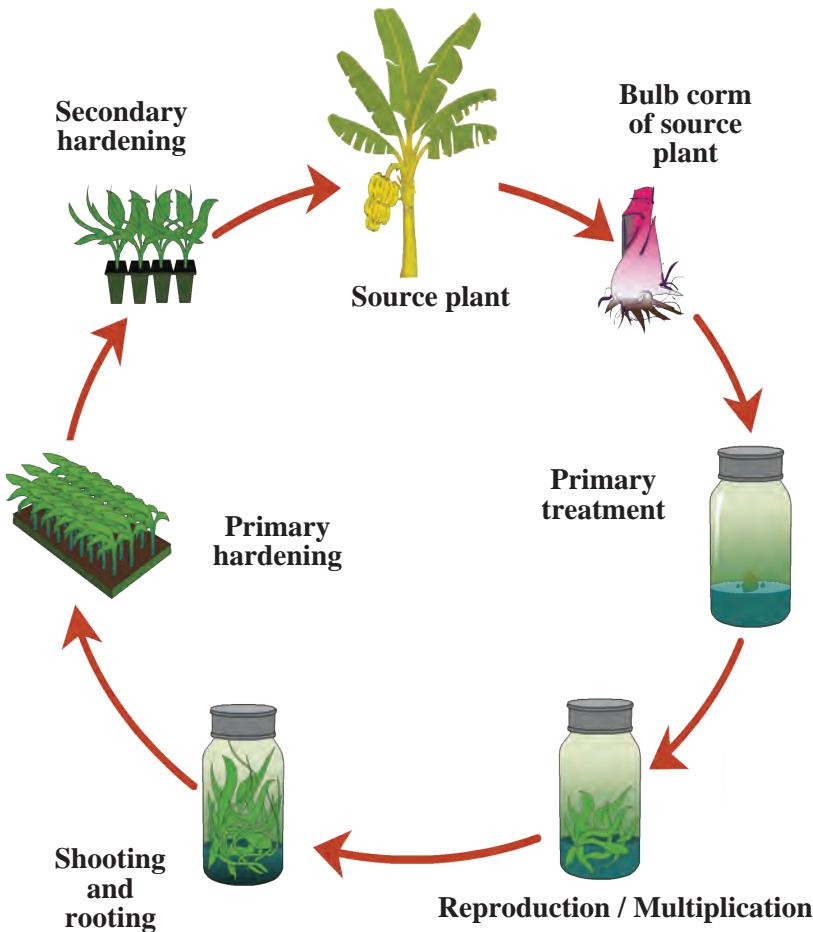
A liquid, solid or gel-like medium prepared from agar, which supplies nutrients and energy necessary for tissue culture is used in this technique.

Using ICT

With the help of the following websites, collect information about tissue culture and make a presentation in the class.

www.britannica.com/science/tissue-culture

[www.encyclopedia.com/plants and animals/agriculture and horticulture](http://www.encyclopedia.com/plants-and-animals/agriculture-and-horticulture)



17.7 Various processes in tissue-culture

An introduction to scientists



Frederick Campion Steward (1904–1993) was a British botanist. He had shown that cells and tissues can be grown *ex vivo*. To prove this, he isolated the cells from carrot root and cultured them in a nutrient medium. He also proved that each cell has the ability to produce a new plant.

Changes in agricultural management due to biotechnology

1. Genetically Modified Crops (GM crops) are being produced by introducing changes in DNA of natural crops. Normally, such varieties are not found in nature. Thus, new varieties are produced artificially. Different useful characters are introduced in such varieties.
2. Ability to withstand environmental stress- Some naturally occurring varieties cannot withstand environmental stresses like frequently changing temperature, wet and dry famines, changing climate, etc. However, GM crops can grow in any of such adverse conditions.
3. As GM crops are resistant to insect pests, pathogens, chemical weedicides, etc, the use of harmful chemicals like pesticides can be avoided.
4. Due to use of seeds of GM crops, there is improvement in nutritive value and decrease in loss of crops.



In this way, as seeds of a better quality of crops are being produced, farmers all over the world are cultivating the GM crops on large scale. The area under its cultivation is increasing day by day. High Yielding Varieties of GM crops like banana, maize, rice, potato, soybean, tomato, cotton, apple, brinjal, papaya, beet, rose, tobacco, wheat, etc. are available. Pest-resistant genes have been introduced in some of these GM crops. For example,

Maize : MON 810, MON 863.

Potato : Amflora

Rice : Golden Rice

Soybean : Vistive Gold

Tomato : Vaishali

Cotton : BT cotton

In this way, a 'green evolution' is being achieved through tissue culture and a country like India with a huge population is meeting with success in producing sufficient food-grains for all.

Establish your own plant nursery near your school or home. Prepare the seedlings of flowering plants, fruit plants, and ornamental plants being grown in your area. Can you start a business in the future with the help of this activity? Think it over.

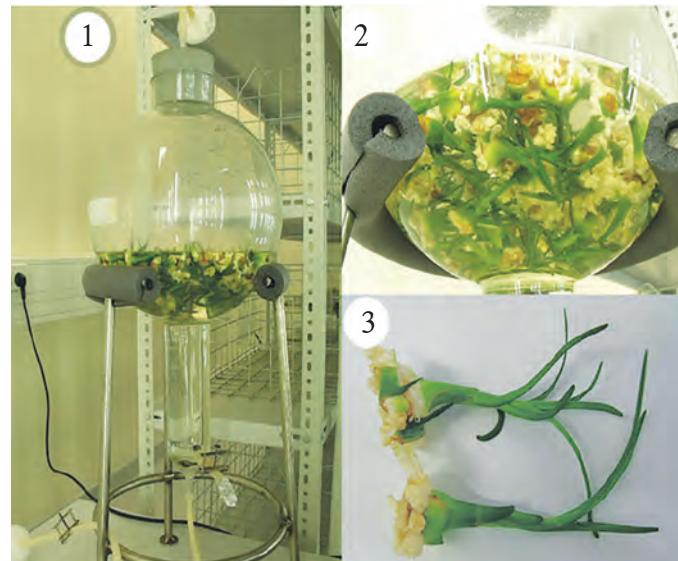


Try this

Application of biotechnology in floriculture, nurseries and forestry

Nurseries are necessary for various purposes like growing gardens on a large scale, afforestation, reforestation, etc. Seedlings have to be supplied in large numbers for all these purposes. It is profitable in such cases to produce plantlets with the help of tissue culture techniques.

1. Tissue culture can be used to grow those plants on a large scale, which bear flowers, fruits of excellent quality.
2. Fully grown plants can be produced in shorter durations.
3. Plants can be grown on a large scale even if means of pollination or germinating seeds are not available. For example, orchids or pitcher plant do not germinate but these plants can easily be produced by means of tissue culture.
4. In a bioreactor, cells can be grown in a more nutritive medium and protected from pathogens. Bioreactors are useful for producing plantlets on a very large scale.



17.8 Bioreactor and production of plantlets



Find out

Collect information about GM varieties of crops in your area and make a note of them. Also find out if there are any adverse effects of GM crops on human beings and the environment.

5. Large numbers of seedlings/plantlets can be produced in a short time using minimum resources and materials.
6. Usually, plants produced by tissue culture and genetic modification techniques are disease-free. Plantlets produced by tissue culture of the meristem are virus-free.
7. Embryos formed by conventional hybridization technique between two or more varieties may not grow fully for some reasons. However, embryos produced by tissue culture technique always complete their growth.
8. Rare and endangered plants can be grown by tissue culture technique and can thus be protected from extinction. Similarly, various parts and seeds of such plants can be preserved by tissue culture and those varieties can be protected.

These are the uses of tissue culture and biotechnology in the case of plants. Next year, we will study the use of this technique in the medical field and for conservation of animals.



Use your brain power !

1. Which other industries can be developed as an extension of the of plant nursery business?
2. To which places do people choose to go on vacation in order to relax when they are tired of crowds and a stressful life?

What is inter-relationship between the two questions above?

Agritourism

If sufficient land is available, the emerging field of 'agri-tourism' would be a good business. Plantlets of flowering, medicinal, ornamental, vegetable plants and fruit trees can be produced on a large scale by the tissue culture technique. And, by growing some of the plants fully a self-sufficient agritourism centre can be developed.



17.9 Some of the fruit trees in the agritourism centre

- Mango, chikoo (sapota), guava, coconut, custard apple and some other regional fruit trees.
- Shade giving local or exotic attractive plants.
- Ornamental and flowering plants.
- Butterfly garden.
- Medicinal plant garden.
- Organic vegetables and fruits.

People visit places with such attractions in large numbers. Selling plantlets / seedlings, fruits, vegetables at such place can be quite profitable.

Using ICT : www.ecotourdirectory.com/agritourism, www.agritourism.in

Agro-complementary occupations :



Observe and discuss.

A. Animal husbandry

Visit a modern cowshed nearby and record the following points -

The number of cattle, their variety, total milk production, cleanliness in cattle-shed, arrangements for health care of cattle.

In India, animal husbandry is practised for milk production and for using the cattle as help in farming operations. Ex. Cows and buffaloes are raised for milk and bulls and male buffaloes for pulling the heavy loads.

Local Indian varieties of cows like sahiwal, sindhi, gir, lal kandhari, devni, khillari, dangi, etc. and exotic varieties like jersey, brown Swiss, Holstein, etc. are kept for their milk. Proper care of cattle is necessary for a clean and high yield of milk.

1. A balanced diet i.e. which includes all constituents of food should be given to cattle. It must include fibre-rich coarse food, fodder, and sufficient water.
2. The cattle-shed should be clean and dry with proper ventilation and a roof.
3. Cattle should be regularly vaccinated.



Find out

1. What is meant by 'white revolution'? Who was its pioneer? What benefits did it bring?
2. Collect more information about animal husbandry.
3. Find out from the internet the average daily milk yield from local and exotic varieties of cows.



17.10 Animal husbandry

B. Poultry farming

Rearing of egg and meat yielding chickens is called poultry farming.

The objectives behind development of new hybrid varieties from a cross between Indian varieties like Aseel and exotic varieties like Leghorn are as follows : to produce good quality chickens in large numbers, to develop the ability to withstand high temperature, to use by-products of agriculture as poultry feed, etc.

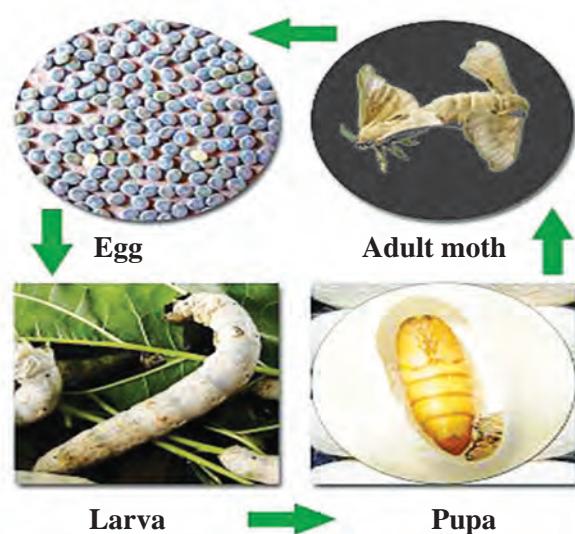
Rhode Island Red, New Hampshire, Plymouth Rock, Black Rock are varieties of chicken reared for eggs as well as meat.

Layers	Broilers
Chickens raised for eggs.	Chickens raised for meat.
Leghorn, Minorca, Ancona, Lehman	Brahma, Long, Cochin, Aseel
 	 

E. Sericulture

Silkworms (moths) are reared for production of silk. *Bombyx mori* is the most commonly used variety for this purpose. The life cycle of the silk moth consists of four stages, namely egg, larva, pupa and adult. Thousands of eggs deposited by female moths are incubated artificially to shorten the incubation period. Larvae hatching out of eggs are released on mulberry plants. Larvae are nourished by feeding on mulberry leaves. After feeding for 3 – 4 days, larvae move to branches of mulberry plant. The silk thread is formed from the secretion of their salivary glands. Larvae spin this thread around themselves to form a cocoon. The cocoon may be spherical in shape.

Ten days before the pupa turns into an adult, all the cocoons are transferred into boiling water. due to the boiling water, the pupa dies in the cocoon and silk fibres become loose. These fibres are unwound, processed and reeled. Various kinds of fabric is woven from silk threads.



17.10 Life cycle of the silk moth





Use your brain power !

Why are the cocoons transferred to boiling water before the pupa develops into an adult?

Exercises



1. **Each of the following statements is wrong. Rewrite them correctly by changing either one or two words.**
 - a. Simple squamous epithelium is present in respiratory tract.
 - b. Glandular epithelium is present in kidneys.
 - c. Chlorenchyma helps the plant to float in water.
 - d. Striated muscles are also called involuntary muscles.
 - e. Chloroplast is present in permanent tissue.
2. **Identify the odd word and explain why it is odd.**
 - a. Xylem, phloem, permanent tissue, meristematic tissue.
 - b. Epithelium, Muscle fibre, nerve fibre, epidermis.
 - c. Cartilage, bone, tendon, cardiac muscle.
3. **Write the names of the following tissues.**
 - a. Tissue lining inner surface of mouth.
 - b. Tissue joining muscles and bones.
 - c. Tissue responsible for increasing height of plants.
 - d. Tissue responsible for increasing girth of stem.
4. **Write the differences.**
Simple tissue and complex tissues in plants.
5. **Write short notes.**
 - a. Meristematic tissue.
 - b. Xylem
 - c. Striated muscles.
 - d. Agro-complementary business.
 - e. Genetic engineering
 - f. Sericulture
6. **Explain the meaning of biotechnology and its impact on agricultural management with suitable examples.**
7. **Which two main techniques are used in biotechnology? Why?**
8. **Discuss 'Agritourism' in the class and write a project on an agro-tourism centre nearby. Present it in the class in groups.**
9. **Define the term tissue and explain the concept of tissue culture.**
10. **'Rearing of sheep is a livestock'. Justify this statement.**

Activity :

1. Obtain information about the diversity of butterflies. Collect detailed information about what would have to be done to establish a butterfly garden in your school.
2. Visit an apiculture centre and gather information about it.

