પુ•ના International School

Shree Swaminarayan Gurukul, Zundal

Term: 2

Class: 11th **subject:- biology**

Exp. No	Aim
	Major Experiments
1	Separation of plant pigments through paper chromatography
2	Study of distribution of stomata in the upper and lower surfaces of leaves.
3	Study of the rate of respiration in flower buds/leaf tissue and germinating seeds
4	Test for presence of sugar in urine
5	Test for presence of albumin in urine
	Minor Experiments
	B. Study/observation of the following (Spotting)
B 1	Tissues and diversity in shape and size of animal cells (squamous epithelium, smooth, skeletal and cardiac muscle fibers and mammalian blood smear) through temporary/permanent slides
B 2	Mitosis in onion root tip cells and animal cells (grasshopper) from permanent slides

Experiment : 1

Aim

To distinguish and study the various pigments present in plants through the process of paper chromatography.

Theory

Plants carry out the process of photosynthesis, during which light energy from the sun is converted into chemical energy (food). The capturing of light energy is carried out by molecules known as pigments, which are present within the plant cells.

What are Pigments?

Pigments are chemical compounds, which are able to reflect only a particular range of wavelengths of visible light. Leaves of plants primarily contain different types of pigments within their tissues. The four different types of pigments are listed below in a tabular column along with their colours

Pigment	Colour
Chlorophyll A	Dark green
Chlorophyll B	Yellowish-green
Xanthophylls	Yellow

In order to view and distinguish the primary four plant pigments, a simple technique known as chromatography can be used

What is Chromatography?

It is a technique that is used to distinguish between different molecules. This differentiation is based on these attributes-shape, size, charge, mass, adsorption and solubility.

Types of chromatography:

- Column chromatography
- Paperchromatography
- Partitionchromatography
- Thin-layer chromatography

Mechanism of Paper Chromatography

In this technique, the interaction between three components is involved – solid phase, separation of a mixture and a solvent.

1. At first, the mixture is spotted onto the paper and isdried.
2. The solvent is made to flow through the capillaryattraction.
3. While the solvent moves through the paper, the various components of themixture differentiate into varied colouredspots.
4. Later the paper is allowed to dry and the position of various compounds isviewed.
5. The substance, which is the most soluble moves further on the paper as comparedto the other substances that are lesssoluble.

Material Required

- Chromatographychamber
- Spinachleaves
- Mortar andpestle
- Scissors
- Ether acetonesolvent
- Acetone
- Capillarytube
- Pencil
- Spatula
- Scale
- Filter paperstrips
- Stapler
- Thread

- Watchglass

Procedure

- In this experiment, spinach leaves are used to separate differentpigments.
- Pick a few fresh and green leaves of spinach and washit.
- Cut out small pieces of spinach using scissors. Add them to themortar.
- Accurately measure 5ml acetone using a measuring cylinder and add it into themortar.
- With the help of mortar and pestle, grind the spinach leaves into a smoothpaste.
- Shift the prepared paste of spinach into the watch glass with the help of aspatula.
- Place a filter paper strip with a tapering notch towards one ending of thestrip.
- Horizontally trace a line with a scale and a pencil that is 2 to 3 cm apart from the notch'stip.
- Using a capillary tube, add 1 drop of the extract of the pigment in the midsection of theline.
- Let the drop dry. Repeat the same process of adding a drop and allowing it to dry for 4-5 times.
- In the chromatographic chamber, pour the ether acetonesolvent.
- Make sure to folded and stapled an end side of thepaper.
- Suspend the strip in thechamber.

- The loading spot remains about 1 cm above the level of thesolvent.
- Let the chamber remain uninterrupted for awhile.
- We can notice that the solvent passes along the paper scattering various pigments of the blend to differentdistances.
- Once the solvent reaches 3/4th of the strip, carefully take the stripoff.
- Allow the strip todry.

Observation

The dried paper strip displays four different bands. Discrete pigments can be distinguished with the help of colours.

Conclusion

1. The Carotene pigment is observed at the topmost as an orange-yellow band of pigmentsdistinctively.
2. Just below this band, a yellowish band appears which indicatesthe pigmentxanthophyll.
3. The third band appearing dark green indicates chlorophyll-apigment.
4. The yellowish-green band present at the bottom is the chlorophyll b pigment.

Precautions

- The leaves that are selected should be green and fresh spinachleaves

- From the tip of the notch, the loading spot needs to be 2 to 3 cmapart
- While suspending the filter paper strips in the chamber, one need to ensure that the loading spot needs to be set up above 1 cm from the level of solvent.

https://youtu.be/7q5HDMXSdtU

Expt 2

Aim

To study the pattern and distribution of stomata in both the upper and lower leaf surfaces.

Theory

Stomata are tiny openings that are located in the young shoots of plants and epidermis of the leaves. They govern the gas exchange process in plants. The structure of the stomata includes a pair of specialized cells that are found girdling around the opening. These cells are termed as guard cells and are responsible to check and regulate the size of the closing and opening of the stomata.

Through the process of transpiration, water escapes from the stomata into the atmosphere in the form of water vapor. Along with this, carbon dioxide and oxygen too are exchanged in the leaf through these openings.

Stomata are distributed differently between dicots and monocots, between the top side and underside of leaves, between different plant species, etc.

Mostly, stomata are found on surfaces of plants that flourish under greater availability of light, lesser carbon dioxide levels in the atmosphere and also in moist environments.

In a dicot leaf, in comparison with the upper surface, the lower surface has a higher distribution of stomata whereas in a monocot leaf, usually, the upper and the lower surfaces usually see an equal distribution of stomata.

Material Required

- Blade
- Forceps
- Dropper

- Glycerine
- Cover slip
- Watchglass
- GlassSlide
- Distilled water
- Needle andbrush
- Safraninsolution
- Four O'clockplant
- Compoundmicroscope

Procedure

- One fresh leaf from a four-o'clock plant is used in thisexperiment
- On two watch glasses, add some distilled water
- Slit the leaf in an obliquemanner
- With the help of forceps, peel a section from the upper surface of theleaf
- Set this section into one of the watch glass holdingwater
- With the help of forceps, peel another section from the lower surface of theleaf
- Set this section on another watch glass which is also holdingwater
- With the help of a dropper, add few drops of safranin solution into both the watchglasses
- Now place cleared glass slides on each of the peels one at a time with the help of abrush
- From each of the peels, cut a square or a rectangular piece with the help of ablade
- With the help of a dropper, add one drop of glycerine on each of theslides
- With the help of a needle, gently place a cover slip on thepeel
- Examine each of the glass slides under themicroscope
- Notice and count the occurrence of stomata in each of the peels of both the lower and upper epidermis of the four-o'clockleaf.

Observation And Conclusion

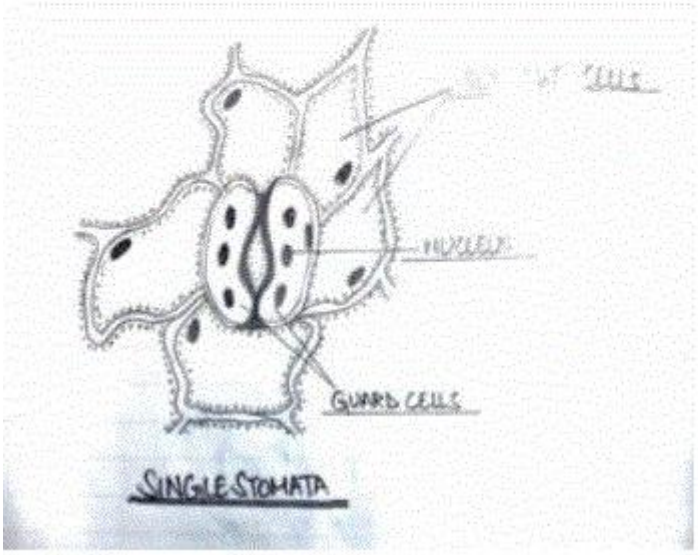
The section of leaf plucked from the four-o'clock plant shows that the number of stomata is much more in the lower epidermis while a few are found in the upper epidermis of the leaf.

Precautions

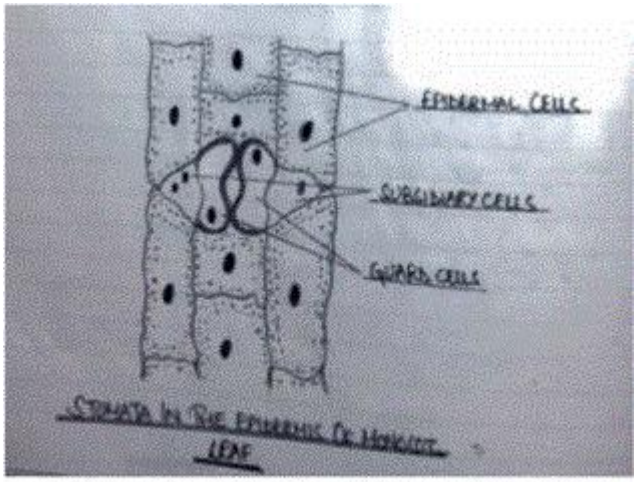
- Avoid leafcurling
- Gently place the cover slip on the slide to avoid airbubbles
- Transferring peel to the slide from the watch glass should always be done using abrush

PRECAUTIONS:

- The cutting of peel should be avoided.
- Always use filter paper to remove the excess of methylene blue.
- Use the brush to transfer the pills from water glass to the slide.
- Air bubbles must be avoided.



Single Stomata



Stomata in the epidermis of monocot leaf.

https://youtu.be/v53Zf2MhrwE

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EXPERIMENT 3

Aim

To study and demonstrate the rate at which respiration takes place in flowering buds or in leaf tissue or in germinating seeds.

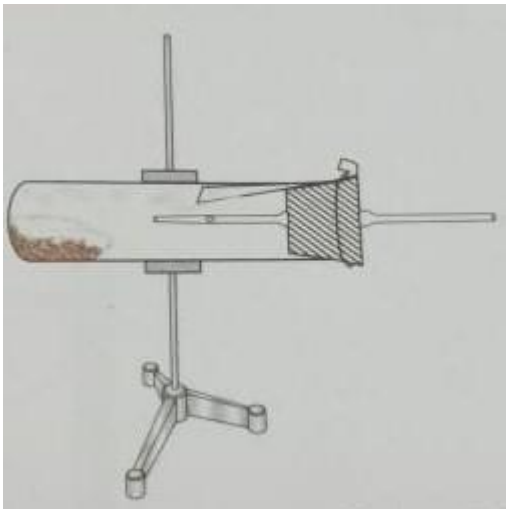
Theory

Respiration is a vital process in living organisms and generates energy through break down

Of food materials in presence / absence of O_2 .The released energy is used for all life processes of .Rate of respiration depends internal and external factors (age , physiological status and type of cell, temperature and availability of O_2)

Materials Required

- 10% KOHsolution.
- Flower buds/ germinating seeds, boiling tube, single bore rubber cork fitted with a pipette, cotton , stand with burrette clamp ,black paper and filterpaper
- Germinating seeds or Flower petals or a LeafTissue.



Procedure

- Take about 10-15 buds or 10-15 g germinating seeds in a boiling tube or wide mouth test tube. Introduce a swab of cotton. Dip a 2× 1 cm strip of filter paperin

KOH solution and place it in the tube ensuring that it does not touch the cotton swab or seeds

- Dip the pipette in water and slowly suck in water in such a manner that a small air bubble is trapped in it. Now insert the attached rubber cork into the tube. The test tube should be fixed in horizontal position with buretteclamp.

- Note the position of air bubble in the pipette.

- Record the distance travelled by the bubble at 2 minute intervals for a period of time.

- Now shift the set up to bright sunlight outside the laboratory . After a few minutes note the distance travelled by the bubble at 2 minutes intervals for the sameperiod

Observation

Compare the two sets of values obtained in the experiments. It is likely that in the experiment conducted in bright sunlight the bubble moves much faster indicating higher rate of respiration. One of the factors that is responsible for increase in rate of respiration is temperature. Can you think of a reason

Inference:

- Notice the rates of respiration are not the same in different materials and undrdifferent condition.
- Respiration is an enzymatic processes where food materials are broken downto releaseenergy
- Light and temperature affect the process.Young meristematic cells show high rate of respiration

- https://youtu.be/xtZhgu2EDGA
- https://youtu.be/k1CTrQy8fEU

Experiment 4

Aim

Sugar presence in a sample of urine can be detected by performing the following two tests:

1. Benedict'stest
2. Fehling'stest

What is Benedict's Test?

A Benedict's solution serves as a reagent in this test. The reagent is a blend of copper, sodium citrate and sodiumcarbonateandcopperIIsulphatepenthydrate($CuSO_4.5H_2O$)

What is Fehling's test?

In this test, the two different types of Fehling's solution are used:

1. Fehling's solution – A: Aqueous solution of copper II sulphate – Blue coloursolution.
2. Fehling's solution – B: Aqueous solution of sodium potassium tartrate – Clear and Colourlesssolution.

Whentheurinesampleisboiledwiththetwodifferentreagents,the$CuSO_4$foundinBenedict'sandFehling's solution is reduced by the reducing agent, glucose for the formation of a coloured cuprous oxide precipitate. Depending on the glucose concentration, a yellow, green and brick-red formation of precipitates of oxides take place.

The table below depicts the colour sequence on the basis of glucose level concentration.

Precipitate colour	Sugar level (Percentage)
Blue	Absence of sugar
Green	0.5%-1%
Yellow	1%-2%
Brick red	2% or higher

1. Benedict’s Test

MaterialRequired

- Burner.
- Testtube.
- Urinesample.
- Test tubeholder.
- Benedict’ssolution.
- Measuringcylinders.

Procedure

- Take a clean and dried testtube.
- Using the measuring cylinder, accurately measure 2ml of the given urinesample.
- Pour the measured urine sample into the testtube.
- Add accurately 5ml of Benedict’s reagent into the test tube containing the urinesample.
- Now fix the test tube holder, bring the test tube near the bunsen burner and allow it to heat for 2minutes.
- While it is heating, keep stirring the tubecontinuously.
- Observe thechanges.

Observation And Conclusion

Upon heating the sample, gradually, a yellow precipitate is formed in the test tube, which indicates the presence of sugar in the given urine sample. Different precipitates are formed depending upon the sugar concentration in urine, which can be yellow, green, or brick red.

2. Fehling’s Test

MaterialRequired

- Burner.
- Testtube.
- Urinesample.
- Test tubeholder.
- Measuringcylinder.
- Fehling’s solutionA.
- Fehling’s solutionB.

Procedure

- Take a clean and dried testtube.
- Using the measuring cylinder, accurately measure 2ml of the given urinesample.
- Pour the measured urine sample into the testtube.
- Add accurately 2ml of Fehling’s solution A into the tube containing urine sample and shakewell.
- Add accurately 2ml of Fehling’s solution B into the same test tube and mix all the solutionslowly.
- Now fix the test tube holder, bring the test tube near the bunsen burner and allow it to heat for 2minutes.
- While it is heating, keep stirring the tubecontinuously
- Notice thechanges

Observation And Conclusion

Upon heating the sample, gradually, a green precipitate is formed in the test tube, which indicates the presence of sugar in the given urine sample. Different precipitates are formed depending upon the sugar concentration in urine which can be yellow, green, brick red.

https://youtu.be/-eg-MHdoJ_Q

Experiment 5

Aim

To perform a test detecting the presence of albumin in the given sample of urine.

Theory

What is albumin?

Albumin is a protein that is produced by the liver. It is a typical constituent of bloodthat is filtered by the kidney.

What is the significance of albumin?

- It maintains the intravascular oncotic pressure thereby checking the stability of the fluid pressure inside the bloodvessels.
- It acts as a carrier proteins for fatty acids, thyroid hormones, steroids in theblood

About Albuminuria

A normally functioning kidney has very less to no traces of albumin in the urine, about 250mg in normal urine in a day. Any damage to the kidney causes an unusual range of albumin, way above the normal level to enter into the urine. This condition is known as albuminuria. If the albumin level is very little and persists to stay abnormal, then the condition is referred to as microalbuminuria.

Causes:

- Can be caused due to the kidney damage from the condition ofdiabetes
- Albuminuria can also be caused by kidney damage caused by heart failure, high blood pressure, lupus and cirrhosis

Tests that can be carried out to detect the presence of albumin in urine are:

- Heller's Test – A white ring is caused due to albuminprecipitation
- Sulphosalicylic acid Test – Coagulation resulting in white cloudiness in thesolution

1. Heller's Test

MaterialRequired

- Concentrated nitricacid
- Urinesample
- Testtube
- Measuringcylinder
- Dropper
- Test tubeholder

Procedure

- From the reagent bottle, add 5ml concentrated nitric acid accurately using a measuring cylinder, pour it into a testtube
- From the sample urine bottle, add some drops of the urine sample with the help of adropper

- Pour some sample of urine along the inner side of the test tube with the help of a dropper and by inclining thetube.
- The above step is performed so as to form a covering on the nitricacid
- Notice the changes taking place in the testtube.

Observation And Conclusion

The changes taking place in the test tube is observed. At the intersection of the two layers, a white ring appears which indicates that albumin is present in the given sample of urine.

2. Sulphosalicylic Acid Test

Material Required

- 30% Sulphosalicylicacid
- Urinesample
- Measuringcylinder
- Burner
- Testtube
- Test tubeholder
- Dropper

Procedure

- From the sample urine bottle, add 2ml sample of the urine accurately using a measuring cylinder, pour it into a testtube
- Add some drops of the sulphosalicylic acid with the help of a dropper into the tube holding the urine sample
- The solution in the tube turns into a whitecolor
- Securely hold the tube with the help of a holder to heat upon the burnergently.
- Make note of the changesobserved

Observation And Conclusion

The given sample of urine appears as a cloudy turbid solution or whitish which indicates that albumin is present in the sample.

https://youtu.be/i7dZBzhQCaI

B :1

Tissues and diversity in shape and size of animal cells (squamous epithelium, smooth, skeletal and cardiac muscle fibers and mammalian blood smear) through temporary/permanent slides

This topic gives an overview of;

- AnimalTissues
- EpithelialTissue
- ConnectiveTissue
- MuscularTissue
- NervousTissue

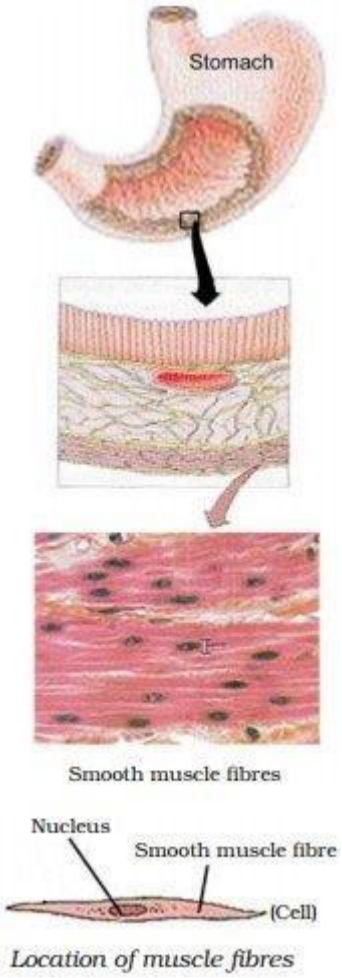
Animal Tissues

When we breathe we can actually feel the movement of our chest. How do these body parts move? For this we have specialised cells called **muscle cells** . The **contraction and relaxation** of these cells result in movement.

During breathing we inhale **oxygen**. Where does this oxygen go? It is absorbed in the lungs and then is transported to all the body cells through blood. The functions of mitochondria we studied earlier provide a clue to this question. Blood flows and carries various substances from one part of the body to the other. For example, it **carries oxygen and food** to all cells. It also collects wastes from all parts of the body and carries them to the liver and kidney fordisposal.

Blood and muscles are both examples of **tissues** found in our body. On the basis of the functions they perform we can think of different types of animal tissues, such

as **epithelial tissue, connective tissue, muscular tissue and nervous tissue**. Blood is a type of **connective tissue**, and muscle forms musculartissue.



Location of muscle fibres

Epithelial Tissue

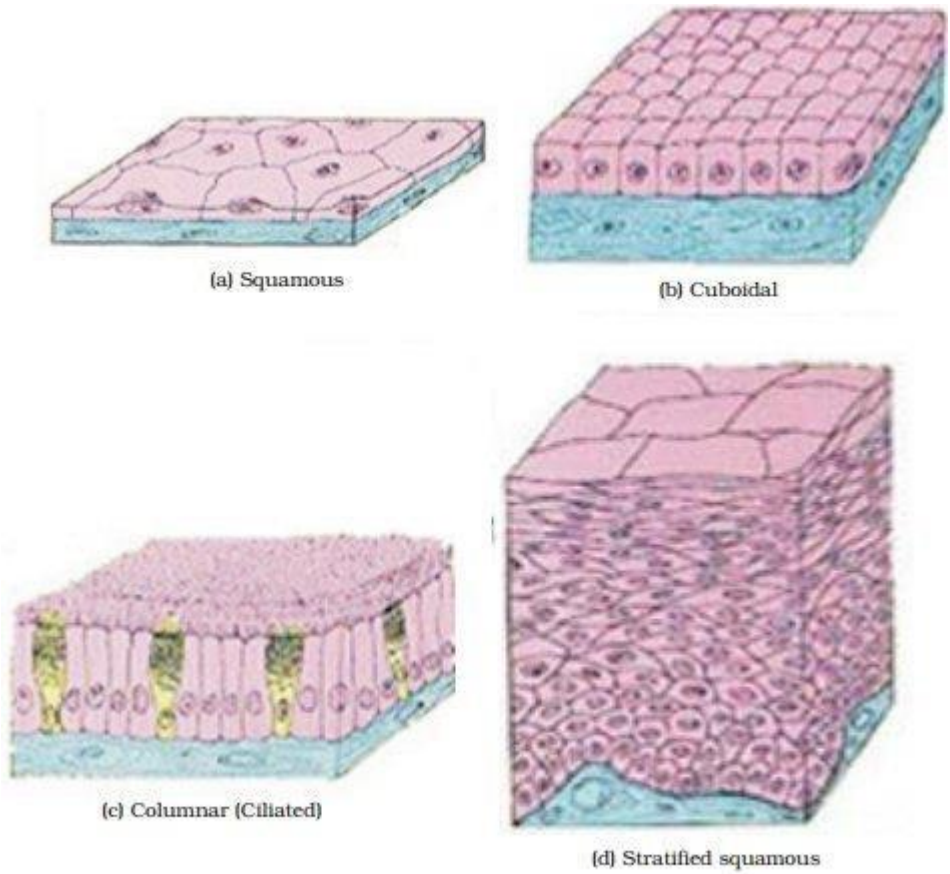
The **covering or protective tissues** in the animal body are epithelial tissues. **Epithelium** covers most organs and cavities within the body. It also forms a barrier to keep different body systems separate. The skin, the lining of the mouth, the lining of blood vessels, lung alveoli and kidney tubules are all made of epithelial tissue.

Epithelial tissue cells are tightly packed and form a continuous sheet. They have only a small amount of cementing material between them and almost no intercellular spaces. Obviously, anything entering or leaving the body must cross at least one layer of epithelium. As a result, the **permeability of the cells** of various epithelia play an important role in regulating the exchange of materials between the body and the external environment and also between different parts of the body. Regardless of the type, all **epithelium** is usually separated from the underlying tissue by an extracellular fibrous basementmembrane.

Different epithelia show differing structures that correlate with their unique functions. For example, in cells **lining blood vessels** or **lung alveoli**, where transportation of substances occurs through a selectively permeable surface, there is a simple flat kind of epithelium. This is called the simple **squamous epithelium**. Simple squamous epithelial cells are extremely thin and flat and form a delicate lining. The oesophagus and the lining of the mouth are also covered with squamous epithelium. The skin, which protects the body, is also made of squamous epithelium. **Skin epithelial cells** are arranged in many layers to prevent wear and tear. Since they are arranged in a pattern of layers, the epithelium is called **stratified squamous epithelium**.

Where absorption and secretion occur, as in the inner lining of the intestine, **tall epithelial cells** are present. This **columnar** (meaning ‘pillar-like’) **epithelium** facilitates movement across the epithelial barrier. In the respiratory tract, the **columnar epithelial tissue** also has **cilia,** which are hair-like projections on the outer surfaces of epithelial cells. These cilia can move, and their movement pushes the mucus forward to clear it. This type of epithelium is thus **ciliated columnar epithelium**.

Cuboidal epithelium (with cube-shaped cells) forms the lining of kidney tubules and ducts of salivary glands, where it provides mechanical support. Epithelial cells often acquire additional specialisation as gland cells, which can secrete substances at the epithelial surface. Sometimes a portion of the epithelial tissue folds inward, and a **multicellular gland** is formed. This is **glandular epithelium**.



Different types of epithelial tissues

ConnectiveTissue

Blood is a type of **connective tissue**. Now, let us look at this type of tissue in some more detail. The cells of connective tissue are **loosely spaced** and embedded in an **intercellular matrix**. The matrix may be jelly like, fluid, dense or rigid. The nature of matrix differs in concordance with the function of the particular connective tissue.

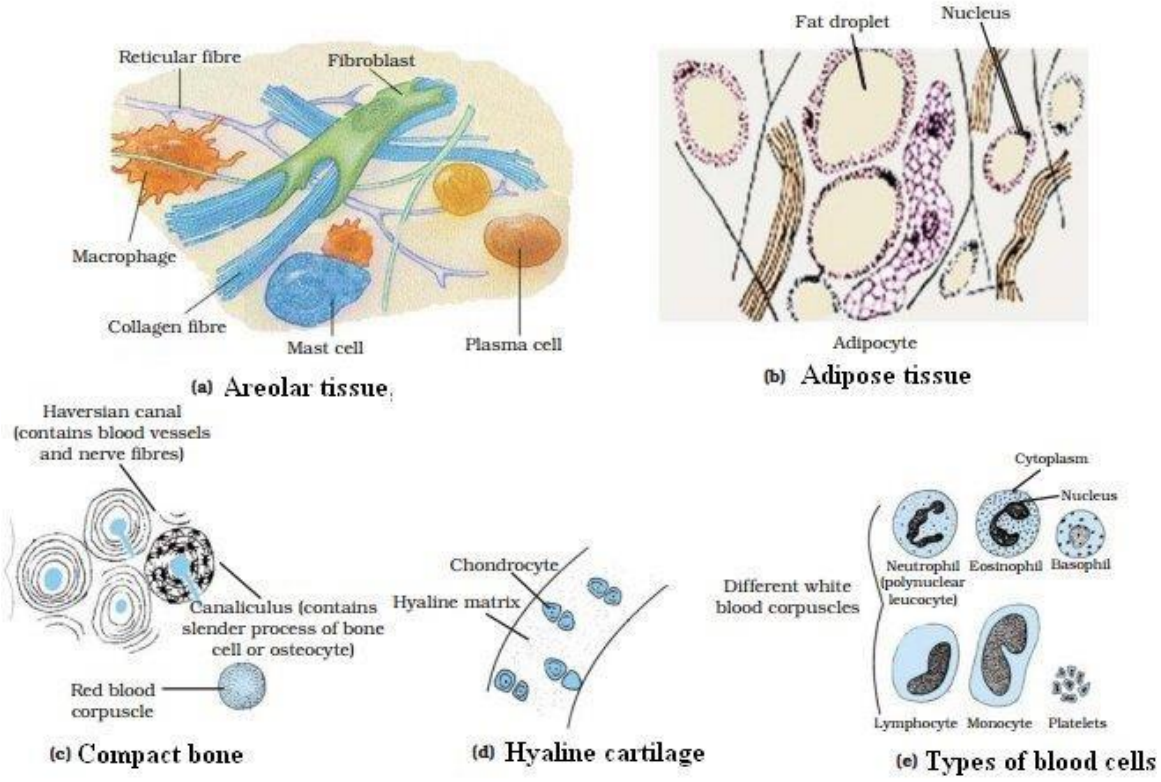
Take a drop of blood on a slide and observe different cells present in it under a microscope Blood has a fluid (liquid) matrix called **plasma**, in which red blood cells (RBCs), white blood cells (WBCs) and platelets are suspended. The plasma contains proteins, salts and hormones. Blood flows and transports gases, digested food, hormones and waste materials to different parts of the body.

Bone is another example of a **connective tissue**. It forms the framework that supports the body. It also anchors the muscles and supports the main organs of the body. It is a strong and nonflexible tissue. Bone cells are embedded in a hard matrix that is composed of **calcium and phosphoruscompounds.**

Two bones can be connected to each other by another type of connective tissue called the **ligament**. This tissue is very elastic. It has considerable strength. Ligaments contain very l**ittle matrix**. **Tendons** connect muscles to bones and are another type of connective tissue. Tendons are **fibrous tissue** with great strength but limitedflexibility.

Another type of connective tissue, **cartilage**, has widely spaced cells. The **solid matrix** is composed of proteins and sugars.Cartilage smoothens bone surfaces at joints and is also present in the nose, ear, trachea and larynx. We can fold the cartilage of the ears, but we cannot bend the bones in our arms. Think of how the two tissues are different !

Areolar connective tissue is found between the skin and muscles, around blood vessels and nerves and in the bone marrow. It fills the space inside the organs, supports internal organs and helps in repair of tissues.



Fat- storing adipose tissue is found below the skin and between internal organs. The cells of this tissue are filled with fat **globules**. Storage of fats also lets it act as an insulator.

Muscular Tissue

Muscular tissue consists of elongated cells, also called muscle fibres. This tissue is responsible for movement in our body.Muscles contain special proteins called **contractile proteins**, which contract and relax to causemovement.

We can move some muscles by conscious will. Muscles present in our limbs move when we want them to, and stop when we so decide. Such muscles are called **voluntary muscles**. These muscles are also called **skeletal muscles** as they are mostly attached to bones and help in body

movement. Under the microscope, these muscles show alternate light and dark bands or striations when stained appropriately. As a result, they are also called **striated muscles**. The cells of this tissue are long, cylindrical, unbranched and multinucleate (having many nuclei).

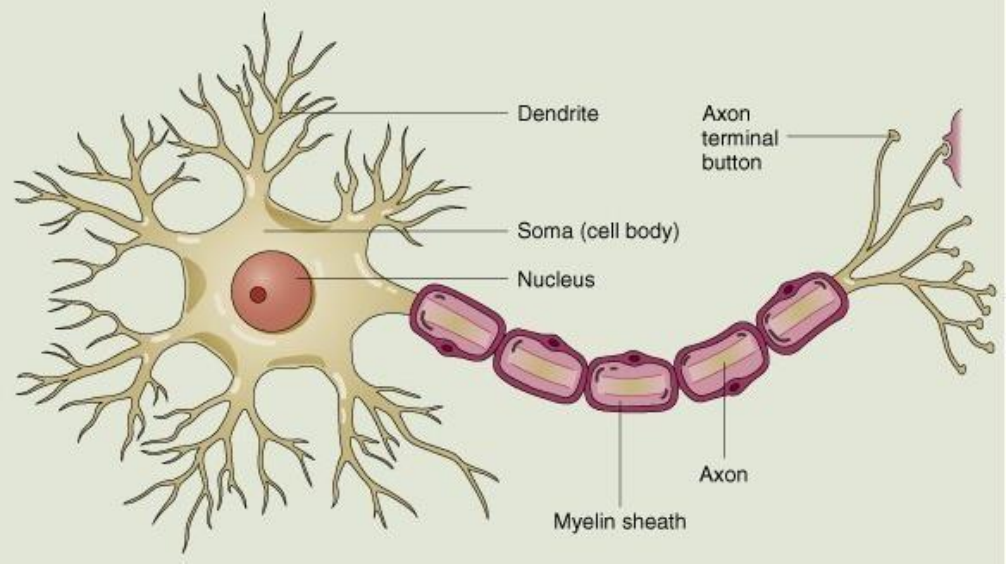
The movement of food in the alimentary canal or the contraction and relaxation of blood vessels are **involuntary movements**. We cannot really start them or stop them simply by wanting to do so! Smooth muscles or involuntary muscles control such movements. They are also found in the iris of the eye, in ureters and in the bronchi of the lungs. The cells are **long with pointed ends** (spindle-shaped) and uninucleate (having a single nucleus). They are also called **unstriated muscles.**

The muscles of the heart show rhythmic contraction and relaxation throughout life. These involuntary muscles are called **cardiac muscles**. Heart muscle cells are cylindrical, branched and uninucleate.

Compare the structures of different types of muscular tissues. Note their shape, number of nuclei and position of nuclei within the cell.

Nervous Tissue

All cells possess the ability to respond to **stimuli**. However, cells of the nervous tissue are highly specialised for being stimulated and then transmitting the stimulus very rapidly from one place to another within the body. The brain, spinal cord and nerves are all composed of the **nervous tissue**. The cells of this tissue are called nerve cells or **neurons**. A neuron consists of a cell body with a nucleus and cytoplasm, from which long thin hair-like parts arise. Usually each neuron has a single long part, called the axon, and many short, branched parts called **dendrites**. An individual nerve cell may be up to a metre long. Many nerve fibres bound together by connective tissue make up anerve.



Nerve impulses allow us to move our muscles when we want to. The functional combination of nerve and muscle tissue is fundamental to most animals. This combination enables animals to move rapidly in response to stimuli.

Summary

- Animal tissues can be epithelial, connective, muscular and nervoustissue.

- Depending on shape and function, epithelial tissue is classified as squamous, cuboidal, columnar, ciliated andglandular.
- The different types of connective tissues in our body include areolar tissue, adipose tissue, bone, tendon, ligament, cartilage andblood.
- Striated, unstriated and cardiac are three types of muscletissues.
- Nervous tissue is made of neurons that receive and conductimpulses.

B 2

Aim: Mitosis in onion root tip cells and animal cells (grasshopper) from permanent slides

Theory

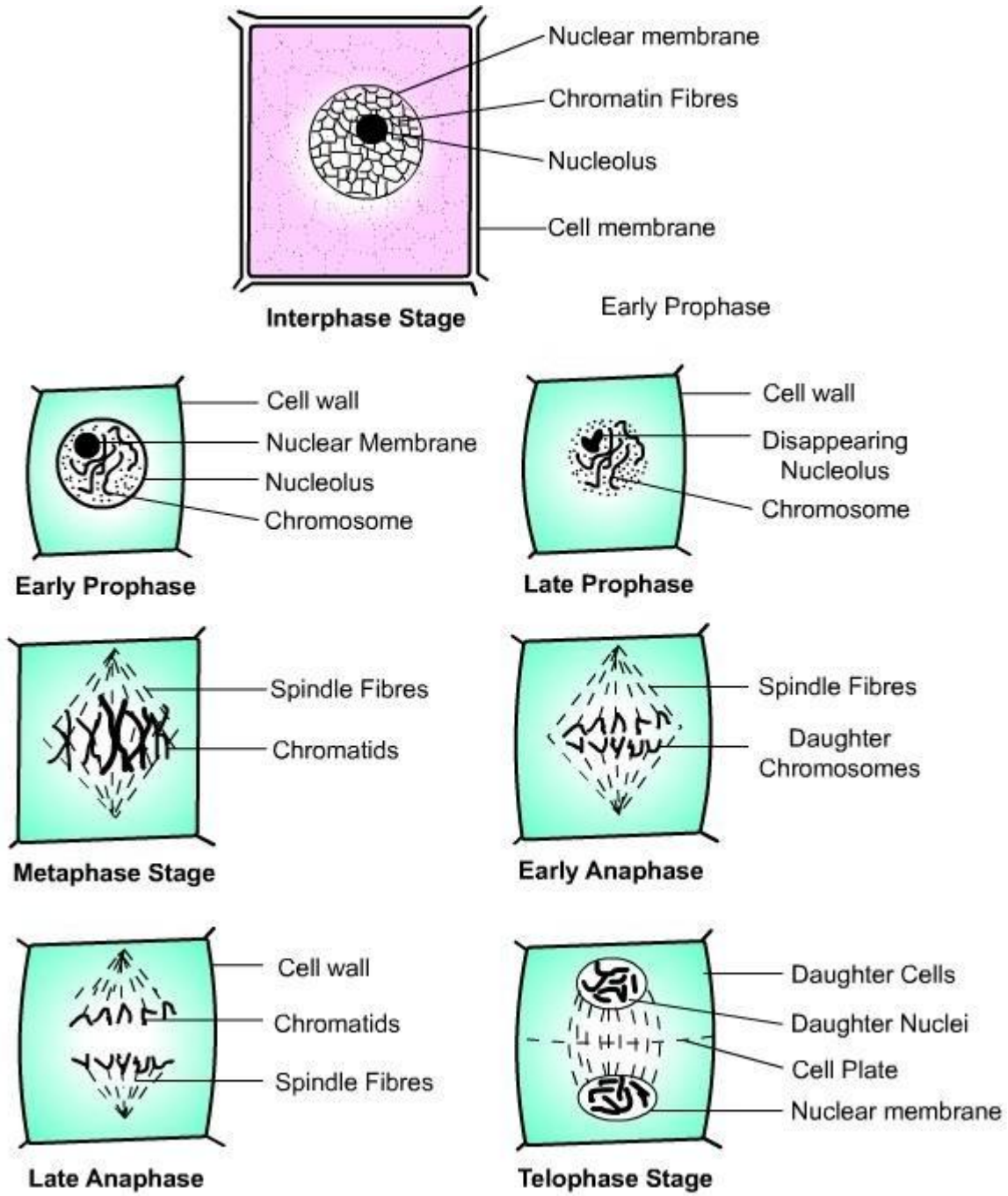
All organisms are made of cells. For an organism to grow, mature and maintain tissue, new cells must be made. All cells are produced by division of pre-existing cells. Continuity of life depends on cell division. There are two main methods of cell division: mitosis and meiosis. In this tutorial we will learn about mitosis.

What is Mitosis?

Mitosis is very important to life because it provides new cells for growth and replaces dead cells. Mitosis is the process in which a eukaryotic cell nucleus splits in two, followed by division of the parent cell into two daughter cells. Each cell division consists of two events: cytokinesis and karyokinesis. Karyokinesis is the process ofdivision of the nucleus and cytokinesis is the process of division of cytoplasm.

Events during Mitosis

1. Prophase:
    1. Mitosis begins at prophase with the thickening and coiling of thechromosomes.
    2. The nuclear membrane and nucleolus shrinks anddisappears.
    3. The end of prophase is marked by the beginning of the organization of a group of fibres to form a spindle.
2. Metaphase
    1. The chromosome become thick and two chromatids of each chromosome becomeclear.
    2. Each chromosome attaches to spindle fibres at itscentromere.
    3. The chromosomes are arranged at the midline of thecell.
3. Anaphase
    1. In anaphase each chromatid pair separates from the centromere and move towards the opposite ends of the cell by the spindlefibres.
    2. The cell membrane begins to pinch at thecentre.
4. Telophase
    1. Chromatids arrive at opposite poles ofcell.
    2. The spindle disappears and the daughter chromosome uncoils to form chromatinfibres.
    3. The nuclear membranes and nucleolus re-form and two daughter nuclei appear at opposite poles.
    4. Cytokinesis or the partitioning of the cell may also begin during thisstage.



The stage, or phase, after the completion of mitosis is called interphase. It is the non dividing phase of the cell cycle between two successive cell divisions. Mitosis is only one part of the cell cycle. Most of the life of a cell is spent in interphase. Interphase consist of three stages call G1, S and G2.

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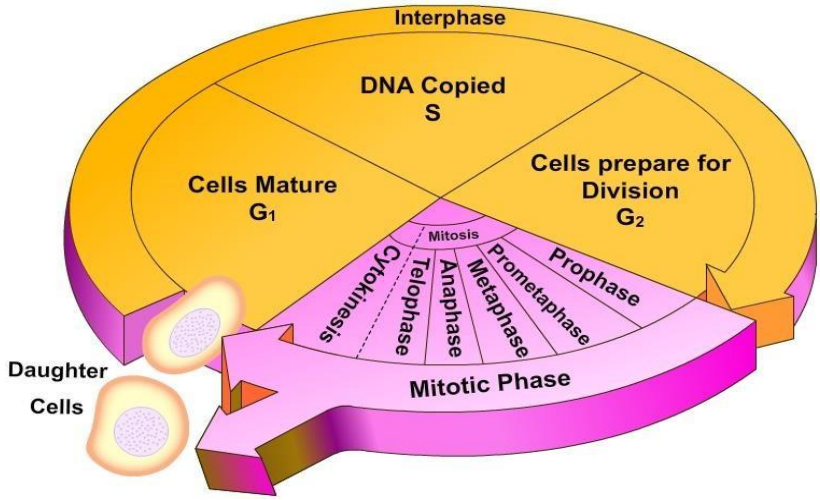
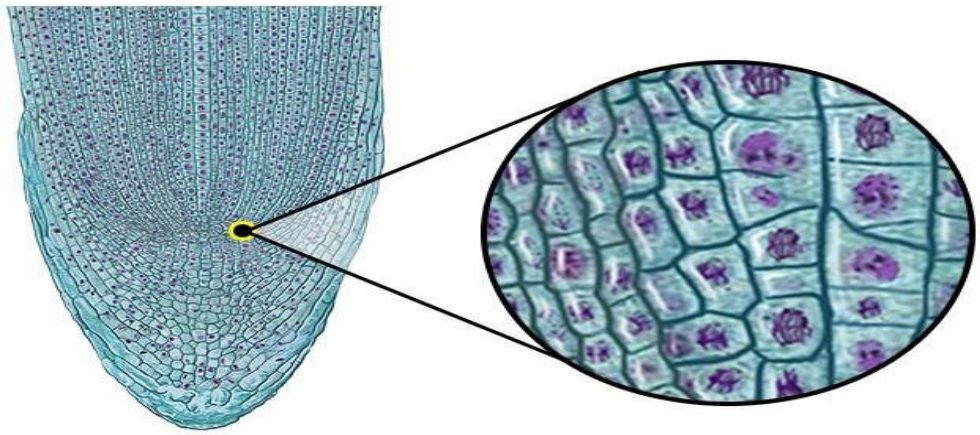


Mitosis in Onion Root Tip

The meristamatic cells located in the root tips provide the most suitable material for the study of mitosis. The chromosome of monocotyledonous plants is large and more visible, therefore, onion root tips are used to study mitosis. Based on the kind of cells and species of organism, the time taken for mitosis may vary. Mitosis is influenced by factors like temperature and time



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Learning Outcomes:

- Students understand the termmitosis.
- Students understand the different events duringmitosis.
- Students do the experiment better in the real lab having gone through the animation andsimulation.