Preface

The Government of Punjab has a strong desire to improve the quality of teaching and learning in the classroom. Various initiatives have been undertaken for provision of quality education to students in the Province. Provision of quality education at secondary level is an important step towards building an education system meant to contribute meaningfully towards development of our society. To achieve the desired goal, activity oriented training for secondary school teachers based on modern teaching methodologies has been considered imperative and crucial.

Directorate of Staff Development (DSD) has been training in-service and pre-service public school teachers and developing educational material since its inception. Considering the quality work produced over the years, the task of development of the Teachers' Guides for secondary school teachers in the subjects of English, Physics, Chemistry, Biology and Mathematics was assigned to the Directorate of Staff Development by the Provincial Government.

DSD worked in collaboration with over three hundred professionals i.e. Teachers, Book Writers and Teacher Trainers from both public and private educational institutions in the subject of English, Physics, Chemistry, Biology and Mathematics who worked in groups to develop these comprehensive Teachers' Guides. These Teachers' Guides with textbooks are aimed to achieve Students' Learning Outcomes (SLOs) through the teaching materials and methodologies which suit varying teaching and learning contexts of Punjab. These Teachers' Guides will help secondary school teachers to deliver and further plan their content lessons, seek basic information on given concepts and topics, and assess students' understanding of the taught concepts.

The DSD team acknowledges the cooperation extended by various public & private, national and international organizations in the preparation of Teachers' Guides. DSD recognizes the contribution made by all developers and reviewers belonging to following organizations including German International Cooperation Agency (GIZ), Institute of Education and Research (IER) Punjab University, Government Science College, International School of Choueifat, Crescent Model Higher Secondary School, Punjab Textbook Board, Lahore Grammar School, Himayat-e-Islam Degree College, SAHE, PEAS, NEEC, HELP Foundation, Ali Institute of Education, Beaconhouse School System, ALBBS, The Educators, Divisional Public School, The City School, AFAQ, Portal, LACAS, Children's Library Complex (CLC) and GICW Lahore, Govt. Higher Secondary Schools and Govt. Colleges for Elementary Teachers in Punjab.

(Nadeem Irshad Kayani)

Programme Director

Directorate of Staff Development, Punjab

UNIT 2

Lesson Plan 1

TOPIC

Solving a Biological Problem

Solving a Biological Problem

Grade IX

Students' Learning Outcomes

- Describe the step involved in biological method of study.
- Describe the use of ratio and proportion in solving biological problem
- Explain the importance of data analysis for confirming, modifying, or rejecting a hypothesis.
- Justify mathematics as an integral part of the scientific process.

Information for Teacher

- Science is systematic knowledge and has its specific method to investigate a problem.
- Being a science, for solving a problem in biology, the same method is used as in other science fields.
- The steps include identification of a biological problem, observation, formulation of hypotheses, deduction, experiment, collection of data, summarization and

reporting of results.

- Observations may be qualitative or quantitative. Quantitative observations are considered more accurate because these are measurable and can be recorded in terms of numbers.
- For making and testing hypotheses and for drawing conclusions, scientists collect and organize information in the form of data.
- Data obtained from, experiments are organized in formats like tables, flow charts, maps and diagrams.
- Data analysis is done through the statistical methods i.e. ratio, proportion, average etc.

Duration/Number of Periods

40 mins / 1 Period

Material/Resources Required

Pictures of man, mosquito and *Plasmodium*, chart, cards of different shapes and colours for developing a flow sheet diagram, textbook

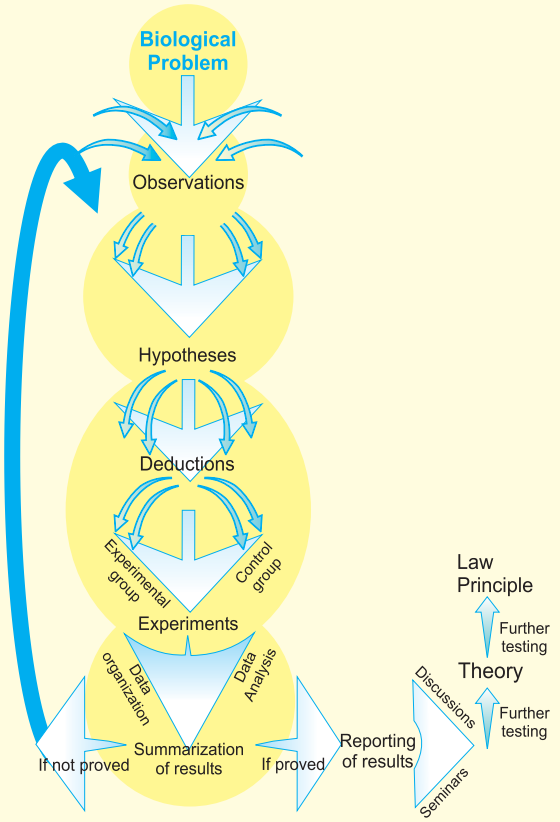
Introduction

- For brainstorming, take the example of 'Malaria' and ask the students: "Why the disease is common in summer and rainy season?"
- Introduce the concept of scientific / biological problem by quoting different examples like "How we can control dengue?", "What is the best way to reduce pollution?" etc.
- Explain to the students that they would take "malaria" as an example of biological problem and would see how this problem was solved by scientists through biological method.

Development

Activity 1

- Introduce the concept of scientific / biological method as steps by which the scientific / biological problem is solved.
- Write the basic steps of biological method on board i.e. identification of a biological problem, observation, formulation of hypotheses, drawing deductions, doing experiments, collection of data, summarization and reporting of results.
- Conduct an interactive session for introducing each step.
- Explain the concept of theory and law / principle in science.



Activity 2

- Ask students what they know about the cause and spread of malaria.
- Explain that it is through biological method that the scientists have solved the problems about the cause and spread of malaria.

Activity 3

- Explain what observations helped scientists to name the disease of chills and fever as "malaria".
- Explain how the famous hypothesis (*Plasmodium* is the cause of malaria) was made and what deductions were drawn from this hypothesis.
- Explain how the deductions were tested through experiments on the blood of malarial patients and normal people.
- Relate each step of the history of malaria with the earlier explained steps of biological method.

Activity 4

- Explain how the next biological problem regarding malaria (how *Plasmodium* gets into the blood of man?) was solved.
- Describe how the observations of A.F.A. King were used to make a hypothesis "mosquitoes transmit *Plasmodium* and are involved in the spread of malaria".
- Explain the experiments of Ross for testing the hypothesis.

Activity 5

- Explain the use of statistical methods (ratio and proportion) for data analysis.
- Let students practice data analysis by using ratio and proportions.
- Brief students about the use of applied mathematics in biological method.

Conclusion/Sum up

Conclude the lesson by highlighting the following points:

- Biological method includes the steps which a biologist adopts for solving a biological problem. The steps include, identification of a biological problem, observation, formulation of hypothesis, deduction, experiment, collection of data, summarization and reporting of result.
- Data organization and analysis are necessary for making and testing hypotheses.

Assessment

Ask following questions to assess the students' learning.

- Why do people slept under fine nets have a less chance to contract malaria?
- Give a logical reason why a person may suffer from malaria after getting a blood transfusion?
- Arrange the steps of biological method in the sequential manner.
- Why did Ronald Ross use sparrows as experimental organism instead of man?

Follow-up

Enrichment activities

- Ask students to draw a flow sheet diagram of biological method of study.
- Guide them to identify some biological problems from surroundings.

Project

- Ask them to measure the heights of class fellows, arrange the data in the form of table and calculate the average height of class.

UNIT 4

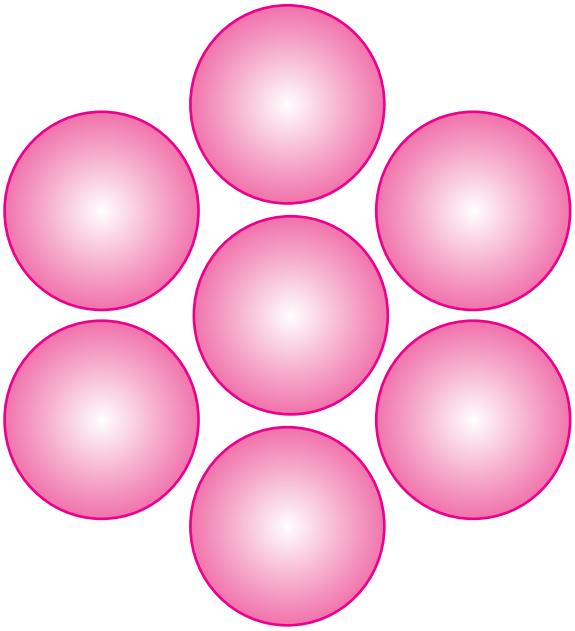
Cells and Tissues

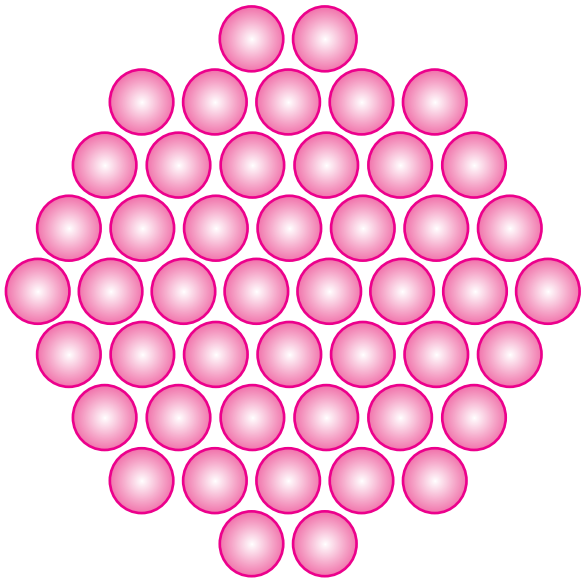
Lesson Plan 2

TOPIC

Relationship between Cell Size and Shape and Surface Area to Volume Ratio

Grade IX





Students' Learning Outcomes

- Describe cell size and shape as they relate to surface area to volume ratio.
- Explain how surface area to volume ratio limits cell size.

Information for Teacher

- Cell size is limited by surface to volume ratio.
- A cell is a metabolic compartment where a multitude of chemical reactions occurs.
- The number of reactions increases as the volume of a cell increases. (The larger the volume the larger the number of reactions).
- All raw materials necessary for metabolism can enter the cell only through its surface (cell membrane/wall).
- The greater the surface area the larger the amount of raw materials that can enter at only one time.
- As a cell grows in size its surface area volume ratio (SA/V) decreases.

Duration/Number of Periods

40 mins / 1 Period

Material/Resources Required

Chart, measuring scale, Tetra pack milk packs (¼ liter, ½ liter and 1 liter), cubes of different sizes, balls of different sizes, textbook

Introduction

- Bring three packs of Tetra pack milk i.e. 250 mililiter, 500 mililiter and 1 liter to the class.
- Ask the students to calculate the surface area of the packs by simple multiplication (6X L^2). The comparison of the three packs shows that the smaller the size, greater is the surface area to volume ratio.

1 liter 500 mililiter 250 mililiter

- Relate the tetra packs to cells and conclude that the small cells in large numbers have large surface area as compared to the large cells in small numbers. The small cells have large surface areas i.e. increased SA/V ratio. It facilitates the entrance of raw materials in these cells through cells membrane/wall .

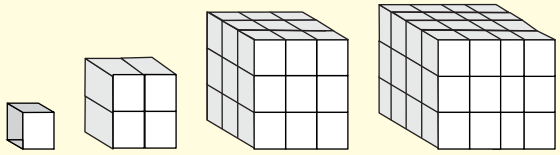
Development

Activity

- Ask students to use mathematics skills. Ask them to imagine that cells were perfect cubes with sides in Angstroms of each of the following sizes.
- Ask them to calculate the surface area and the volume of each cell then find the surface area to volume ratio.

Cell Side (s)	Surface area (6 x s x s)	Volume (s^3)	Surface area to Volume ratio
0.5	1.5	0.125	120
1.0	6	1	6
1.5	13.5	3.375	4.02
2.0	24	8	3

- In order to show how smaller sizes have larger surface area, show the students different cubes made of cartoon or paper. Construct big cubes from the small ones as shown in the figure below.



Case 1 Case 2 Case 3 Case 4

- Make the following table on the board to prove that there is a relation between size and surface area to volume ratio.

Parameter	Case 1	Case 2	Case 3	Case 4
Length (L)	1	2	3	4
Volume (L^3)	1	8	27	64
Surface Area (6 x L^2)	6	24	54	96
Surface Area to Volume ratio	6	3	2	1.5

- Conclude the activity by explaining that smaller the size is, the larger will be surface area to volume ratio. This ratio provides more chances for a cell to interact with the environment.

Conclusion/Sum up

Conclude the lesson by highlighting the following points.

- Increase in volume of a cell provides space for metabolic reactions but it decreases the surface area for a cell to interact with its environment.
- As a cell grows its SA/V decreases.
- Small cells in large numbers facilitate the entrance of raw materials in the cells necessary for metabolism efficiently through cell membranes/walls.

Assessment

- Ask the following questions to assess the students' learning.

1. The surface area of a cube with side length 2.5 cm is:
   a) 15.63 cm^2 b) 37.50 cm^2
   c) 7.50 cm^2 d) 25.00 cm^2
2. The volume of a cube with side length 2.5cm is:
   a) 15.63 cm^2 b) 37.50 cm^2
   c) 7.50 cm^2 d) 25.00 cm^2
3. Which surface area to volume ratio is the largest?
   a) 467/528 b) 382/402
   c) 456/444 d) 105/107

Follow-up

- Ask the students to solve the questions given at the end of unit in textbook.

Homework

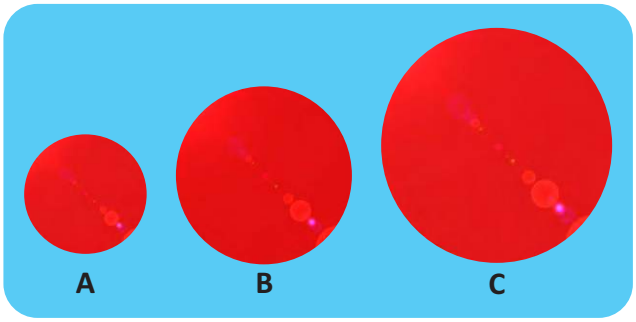
Ask the students to answer the following questions.

- Keeping in mind surface area to volume ratio, why do you think it would take less time to digest food that is well chewed?
- Which organism do you predict will have less volume, one with 4 large cells or one with 10 small cells?
- Which organism do you predict will have more surface area, one with 4 large cells or one with 10 small cells of the same size each?
- Which organism will be able to metabolize more efficiently, the one with 4 large cells or the one with 16 small cells? Why?
- What will be the possible way for a cell to increase it surface area without increasing its size?

Project

Assign the following tasks to students:

- Take balls of different sizes:



- Calculate their surface area volume ratio.
- Calculate how many small balls have the surface area equal to the largest ball.
- Evaluate, which condition is better for organisms either have smaller cells in large numbers or larger cells in lesser number.

UNIT 5

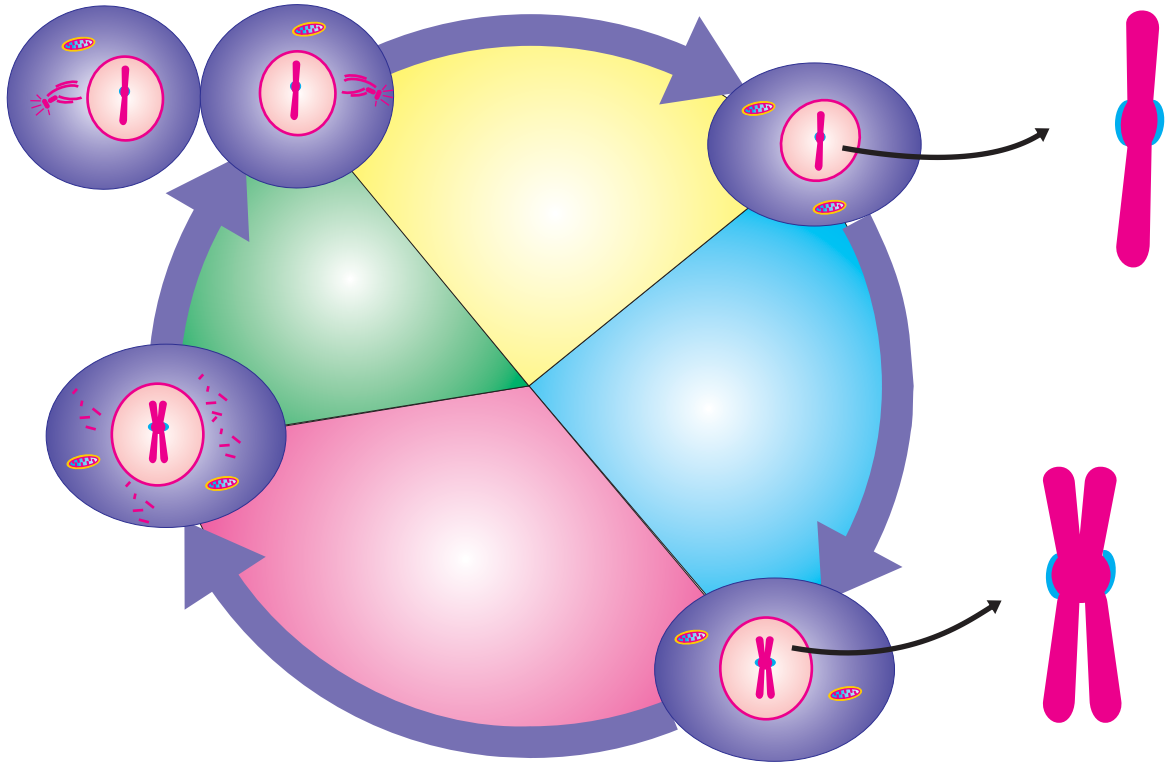
Lesson Plan 3

TOPIC

Cell Cycle

Cell Cycle

Grade IX



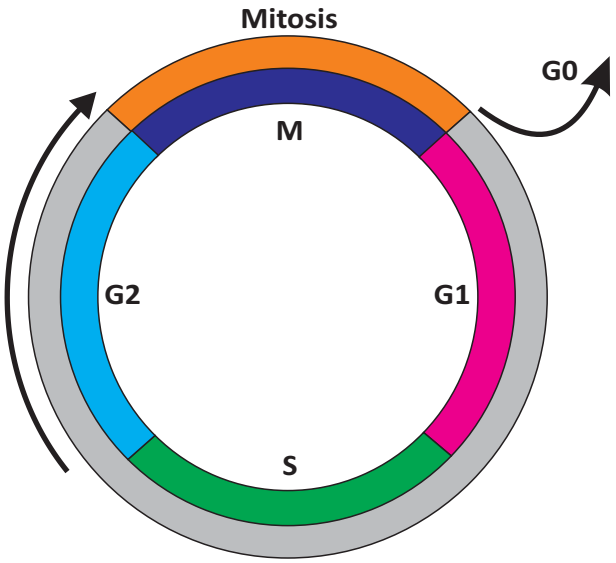
Students' Learning Outcomes

- Define cell cycle and describe its main phases i.e Interphase and division
- Describe the sub phases of the interphase of cell cycle.
- Predict the importance of S-phase of the Interphase.
- Identify from prepared slides or charts, the main phase of cell cycle.

Information for Teachers

- The cell cycle is the series of events from the time a cell is produced until it completes mitosis and produces new cells.
- In cells without a nucleus (prokaryotes), the cell cycle involves binary fission and interphase.
- In cells with a nucleus (eukaryotes), the cell cycle can be divided in two periods i.e. interphase and the mitosis (M phase).

- Interphase consists of three distinct phases: G1 phase, S phase (synthesis) and G2phase.
- In G1 phase, protein and new organelles are synthesized and cell grows in size.
- In S phase, cell duplicates its chromosomes and grows in size.
- In G2 phase cell prepares proteins that are essential for division.
- Cells that have temporarily or permanently stopped dividing are said to have entered a state of quiescence called G0 phase.



Interphase

- After cell division, each of the daughter cells begin the interphase of a new cycle. The relatively brief M phase consists of nuclear i.e division (karyokinesis) and cytoplasmic division (cytokinesis).
- The karyokines is divided into several distinct phases, sequentially known as prophase, metaphase, anaphase, and telophase.

Duration/Number of Periods

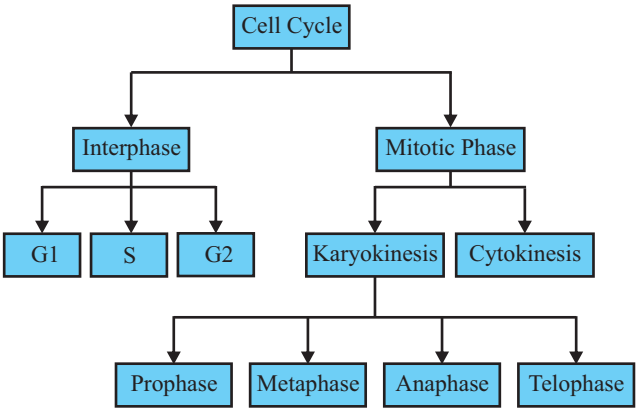
80 mins/2 Periods

Material/Resources Required

Charts showing the main phases of cell cycle / prepared slides of cell division, textbook

Introduction

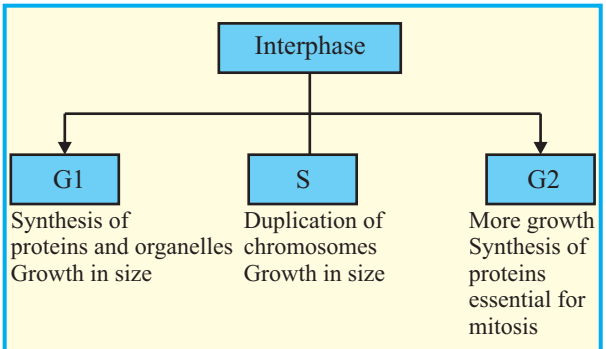
- Recall the previous knowledge giving the reference from chapter 1, about Rudolf Virchow Principle i.e all cells come from cells.
- Inform the students that the continuation of life, including all aspects of reproduction, is based on the reproduction of cells as cell division and it is a part of the whole life of a cell i.e. cell cycle.
- Now introduce the today's topic "cell cycle", correlating with the cell structure and cell division. Make a concept map for further understanding.



Development

Activity 1

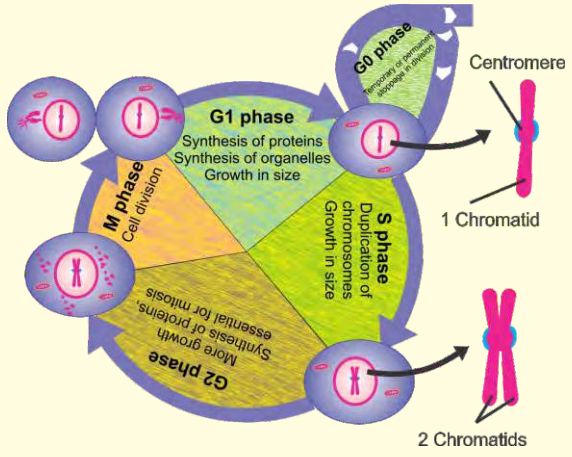
- From the above concept map elaborate the each phase of interphase in cell cycle.



- Inform the students that during interphase, chromosomes replicate, producing two identical sister chromatids attached at the centromere.

Activity 2

- Show chart of cell cycle to students or draw on board and explain them the sequential relationship among each phase of cell cycle.



Activity 3

- Arrange one or two microscopes in the class or take them to the laboratory and show them the prepared slides and then have a healthy discussion on each phase.

Assessment

Ask the questions to students to assess their understanding.

- Can cell cycle be a reversible cycle?
- Can you point out the characteristics of interphase?
- What are the growth phases of the cell cycle?
- The S-phase of interphase is important and a cell can never divide without it. Justify.

Draw a blank cycle on the board and ask the students to come one by one and sketch different phases of cell cycle and properly match the characteristic of that phase.

Follow-up

- Ask the students to consult library or search some information from internet on the topic and make a project.
- Guide the students to solve the problems given at the end of unit in textbook.

UNIT 5

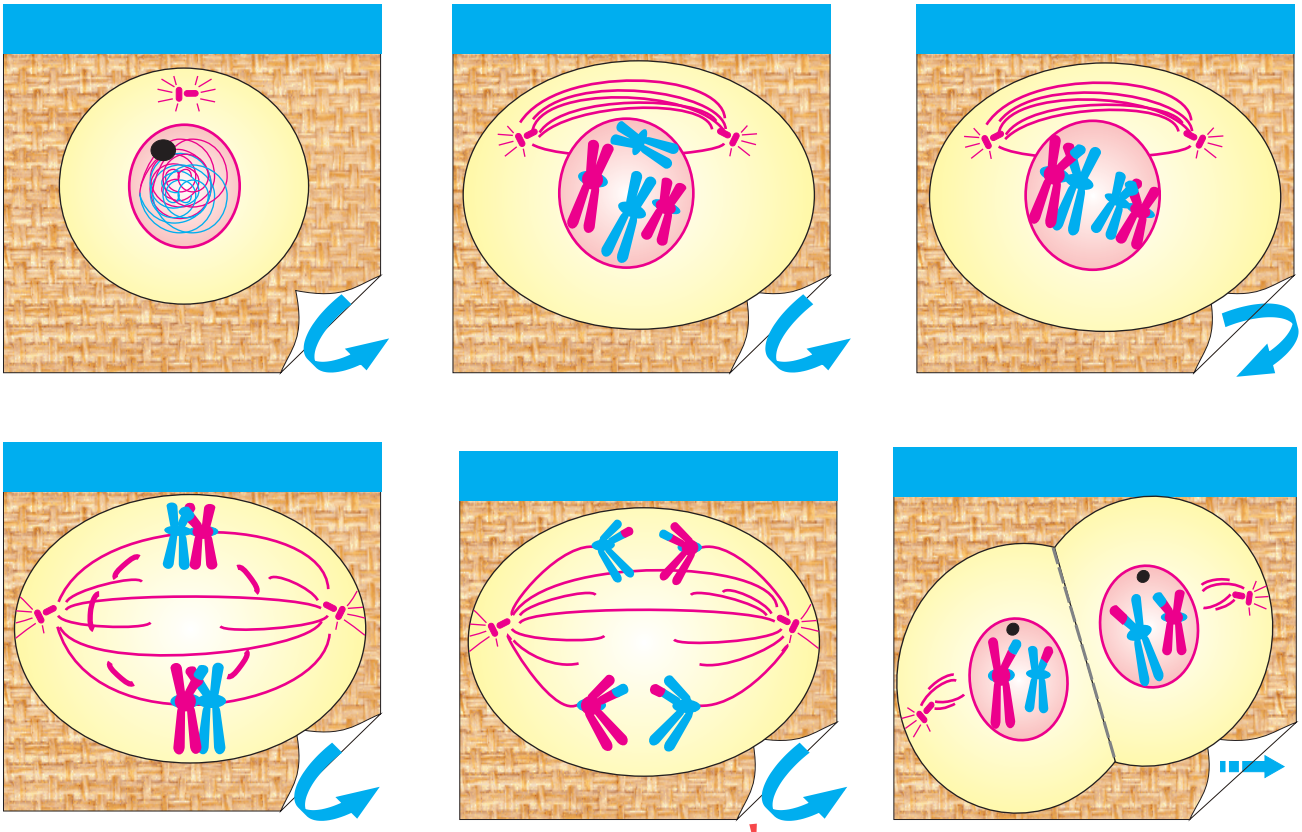
Lesson Plan 4

TOPIC

Meiosis

Cell Cycle

Grade IX



Students' Learning Outcomes

- Describe the events of prophase-i.
- Describe the events taking place in metaphase-I.
- Explain what happens during anaphase-I.
- Describe the events of telophase-I.
- Explain the events occurring during the second meiotic division.
- Compare the second meiotic division with mitosis.

Information for Teachers

- Meiosis is the process by which one diploid cell divides to generate four haploid daughter cells.
- Gametes are haploid reproductive cells produced by meiosis. They contain half the number of chromosomes as compared to the parent (diploid) cell.
- Meiosis occurs in two phases i.e. meiosis I and II.

- Meiosis I and II also consist of prophase, metaphase, anaphase and telophase.
- In prophase I, homologous chromosomes pair up and crossing over occurs.
- During crossing over, the non-sister chromatids of homologous chromosomes exchange their segments.
- The points where homologous chromosomes cross over are called chiasmata.
- Spindles are also formed during prophase I.
- In metaphase I, homologous chromosomes align on spindle fibers along equatorial plan.
- After meiosis I both daughter cells, enter a period of interphase II. There is no S-phase in interphase II.
- Meiosis II is much similar to mitosis and leads to the formation of four haploid daughter cells.

Duration/Number of Periods

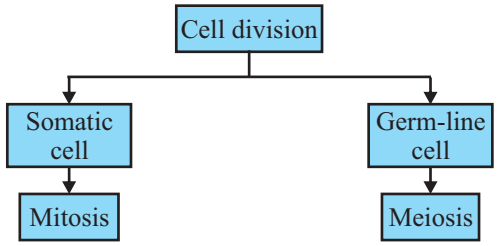
80 mins/ 2 Periods

Material/Resources Required

Charts showing process of meiosis, cut outs of card board paper, coloured markers/ chalk, Prepared slides showing different phases of meioses, textbook

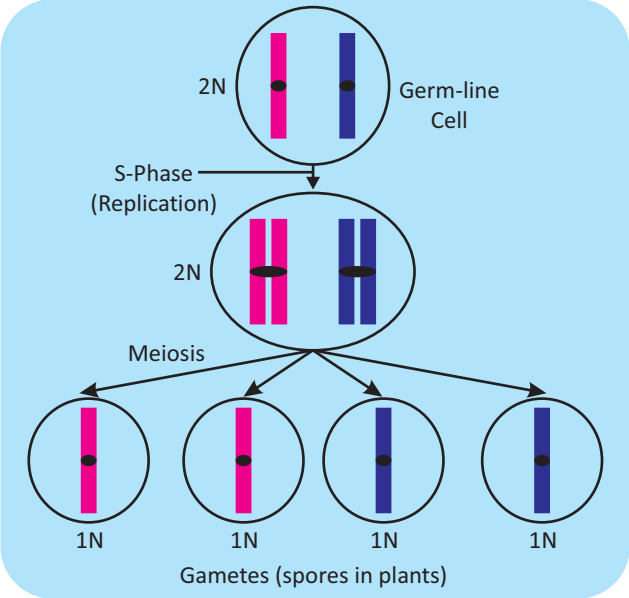
Introduction

- Recall the knowledge about the cell and reproduction.
- Let them think that why there is a need of cell division?
- Recap the terms "cell division", "somatic cells" and "germ-line cells". Introduce the two types of cell division i.e. mitosis and meiosis by concept map.



- Now ask different questions:
  - Why our features resemble with our parents and siblings?
  - Why there are variations in the off-springs from their parents?

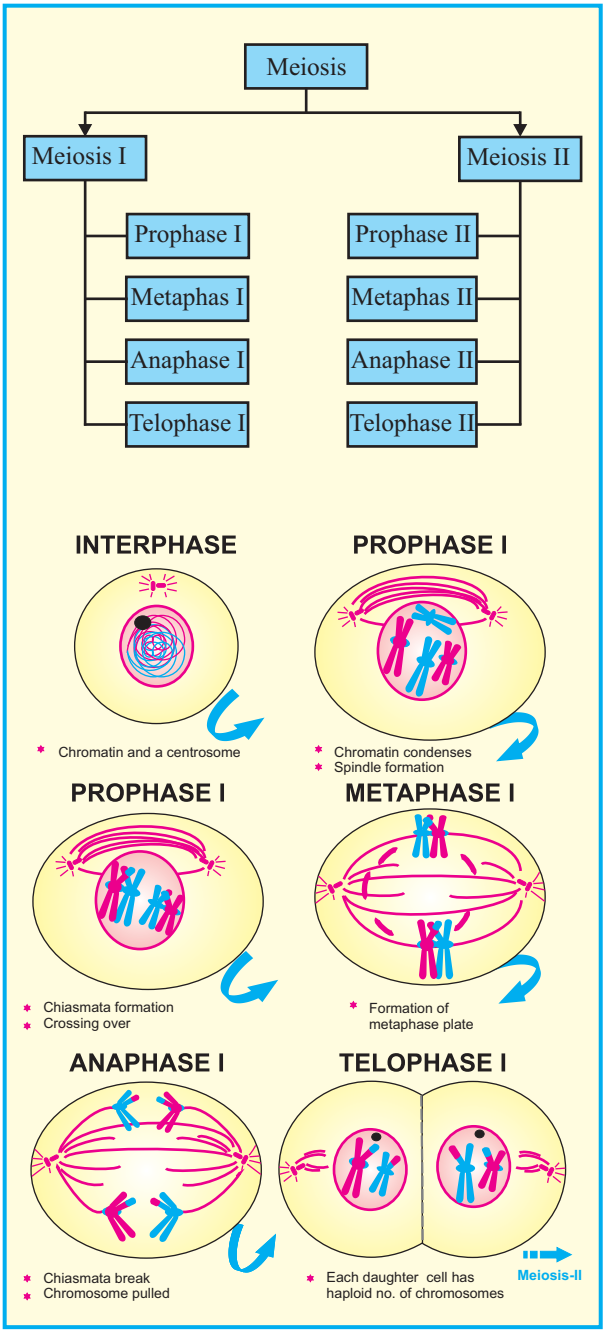
After their responses introduce the topic of meiosis.



Development

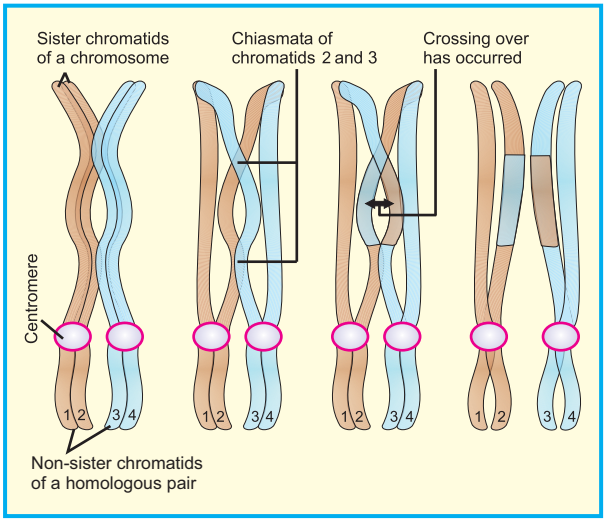
Activity 1

- Elaborate each phase of meiosis I by drawing on the board or by showing charts.
- Let students recap the events of the corresponding phases of mitosis.



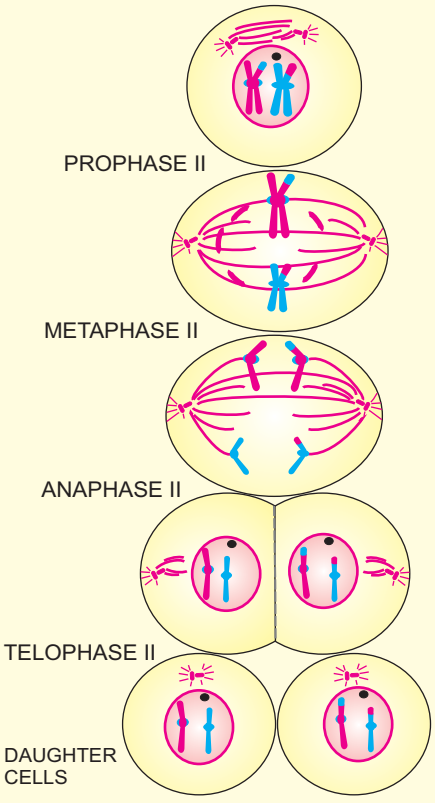
Activity 2

- Draw simple line drawing on board to explain the haploid and diploid number of chromosome.
- By using cut outs of card board paper of different colours and by coloured marker / chalk show the homologous chromosomes and crossing over.



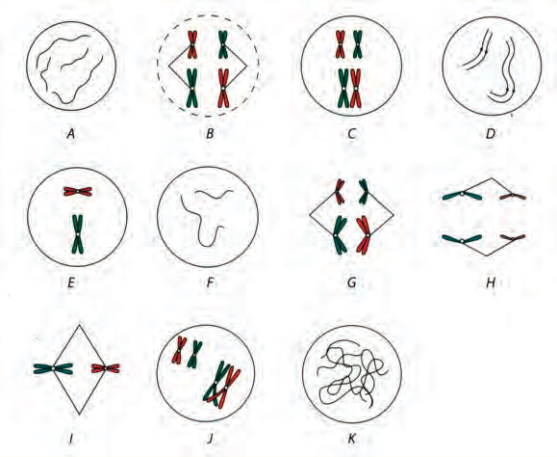
Activity 3

- Draw diagrams on boards to explain the events of the different phases of meiosis II.
- While explaining the events, ask students about the similarities and differences between meiosis II and mitosis.



Activity 4

- Draw the figures on board showing different stages of meiosis in a cell containing two pairs of chromosomes and ask the following questions.



a. Arrange the stages in sequence for meiosis, beginning with the interphase K.

b. What occur in stage G and H?

c. At which stage A-K, does crossing over occur?

d. What types of cells are produced at H?

Assessment

- Draw a table on the board to differentiate between meiosis I and meiosis II.
- Fill it with the help of students and ask the students to copy it on their notebooks.

Phases	Meiosis I	Meiosis II
Prophase		
Metaphase		
Anaphase		
Telophase		

Ask the following questions to assess students' understanding.

- If the parent cell having 24 chromosomes undergoes meiosis, how many chromosomes will be present in daughter cells?
- Meiosis reduces the chromosome number form diploid to haploid. Which particular events, in meiosis ensure that this is so?
- What events in meiosis are similar to those that occur in mitosis?

Follow-up

Homework

- Ask the students to answer the given questions in their notebooks at home.
  - What is the main feature of prophase 1 of meiosis which differentiates it from the prophase of mitosis?
  - Chromosomes are only visible during cell division and not visible during interphase. Why?
  - Make a chart to show the differences between mitosis and meiosis.
- Ask students to solve the questions given at the end of unit in the textbook.

UNIT 5

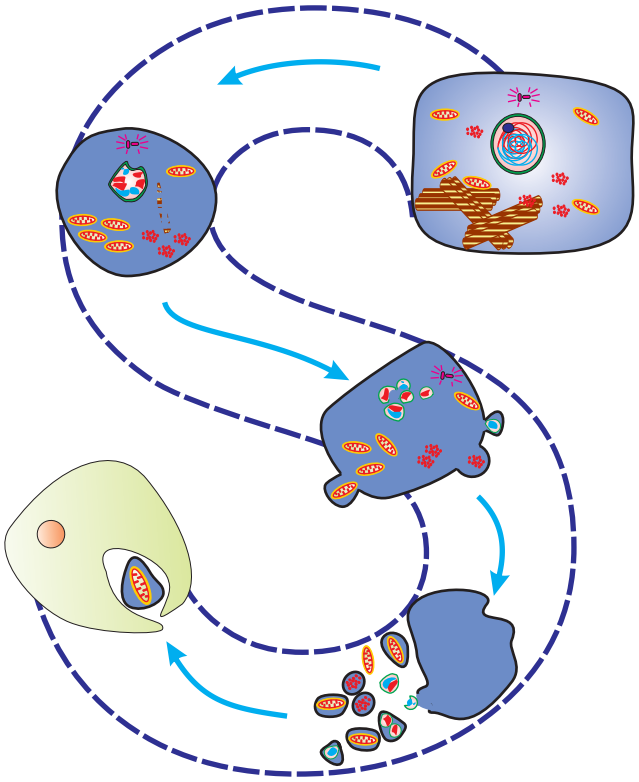
Lesson Plan 5

TOPIC

Necrosis and Apoptosis

Cell Cycle

Grade IX



Students' Learning Outcomes

- Define necrosis and apoptosis.
- Correlate necrosis and apoptosis with cell cycle.

Information for Teachers

- Apoptosis and necrosis are two phenomena of cell death.
- Necrosis is the name given to accidental death of cells and living tissues. Necrosis is less orderly than apoptosis.
- There are many causes of necrosis including injury, infection, cancer, infarction, toxins and inflammation
- Cells that die by necrosis may also release harmful chemicals that damage other cell.
- Apoptosis is programmed cell death and is controlled by extracellular (e.g. hormones) or intracellular signals.

Duration/Number of Periods

40 mins/ 1 Period

Material/Resources Required

Charts showing apoptosis and necrosis, textbook

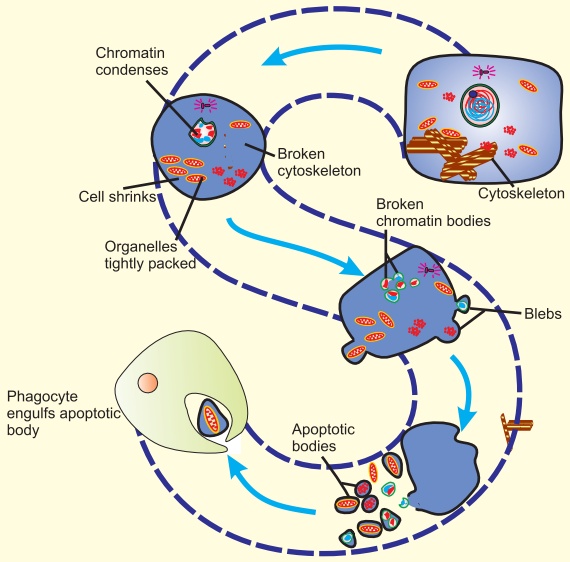
Introduction

- Ask the students what do they know about "cell death".
- After getting responses from students introduce the concept of cell death.
- Now introduce the today's topic i.e. apoptosis and necrosis and tell them that these are two phenomena of cell death.

Development

Activity 1

- Show chart of necrosis to students and explain the accidental death of cells and living tissues.



Activity 2

- Show chart of apoptosis to students and explain the programmed death of cell and living tissues.
- Explain the series of events involved in apoptosis.

Activity 3

Differentiate between necrosis and apoptosis trough a comparison table

Necrosis	Apoptosis

Conclusion/Sum up

Wrap up the lesson by recapping these points.

- Necrosis is the name given to accidental death while apoptosis is programmed cell death.
- Necrosis is less orderly than apoptosis.
- Apoptosis involves a series of biochemical events.

Assessment

Ask the following questions to assess students' learning.

- Make few points about the inability of some mature cells (nerve cells) to divide and the uncontrolled division of certain cells (tumors).

- Arrange the events of apoptosis in sequence:
  - The cell membrane shows irregular buds.
  - Nuclear envelop breaks and DNA is fragmented.
  - Chromatin undergoes condensation.
  - The blebs break off from the cell.
  - Cell shrinks and becomes rounded.

Follow-up

- Ask the students to solve the question at the end of unit in textbook.

Project

- Ask students to make a chart showing apoptosis by using cutouts of cardboard paper of different colours and display the model in class.
- Guide them to surf the internet and collect information about cell death i.e apoptosis and necrosis.

UNIT 7

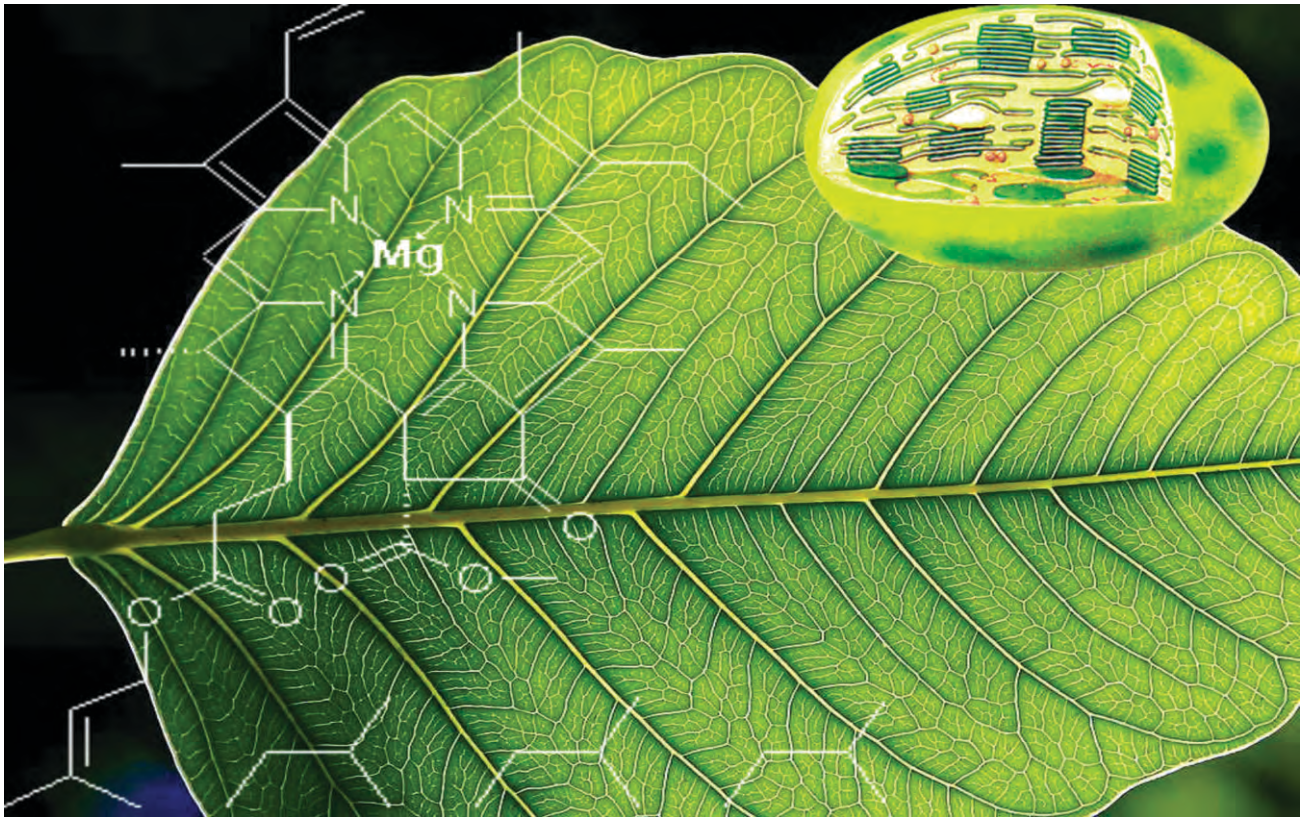
Lesson Plan 6

TOPIC

Photosynthesis

Bioenergetics

Grade IX



Students' Learning Outcomes

- Describe photosynthesis as a fundamental process of life.
- Explain chemical equation for photosynthesis.
- Describe the process of photosynthesis.
- Outline the light and dark reactions involved in the process.
- Explain the concept of limiting factors in photosynthesis.
- Describe the importance of photosynthesis for life on Earth.

Information for Teacher

- All living organisms need energy to sustain life. This energy is obtained from organic molecules such as carbohydrates, fats and proteins.
- The initial formation of such molecules takes place in autotrophs (i.e. some bacteria, algae and green plants), which are able to transfer energy from sunlight into chemical energy in the form of carbohydrates.

- The process by which energy rich compounds such as glucose are synthesized from low energy precursors such as carbon dioxide and water in the presence of light and chlorophyll is known as photosynthesis.

$$6CO_2 + 12H_2O + \text{Light} \xrightarrow{\text{Chlorophyll}} C_6H_{12}O_6 + 6O_2 + 6H_2O$$

- Photosynthesis takes place in two interconnected but separate pathways i.e. the light dependent reactions (light reactions) and light independent reactions (dark reactions).
- In the light dependent stage, light energy is converted into chemical energy and water molecules are split into oxygen and hydrogen atoms.
- In the light independent stage, glucose is formed from carbon dioxide. The reactions are controlled by enzymes and use hydrogen atoms and chemical energy from the light reactions.
- Any environmental factor the absence or deficiency of which can decrease the rate of metabolic reaction is called limiting factor.
- The limiting factor for the photosynthesis are temperature, chlorophyll ,light, carbon dioxide, and water.

Duration/Number of Periods

80 mins / 2 Periods

Material/Resources Required

A potted plant, chart, cards of different shapes and colours for developing a flow sheet diagram, Biology laboratory with basic facilities and chemicals, textbook

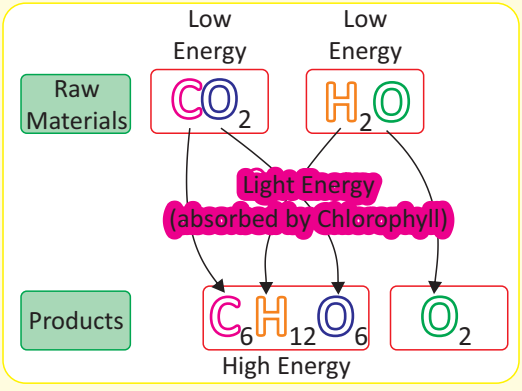
Introduction

- Bring a potted plant in class to show the parts of plants to the students. Introduce that leaves are the major part of plant containing chlorophyll that capture sunlight and prepare food from carbon dioxide and water.
- Tell students that the process in plants by which energy rich compounds such as glucose are synthesized from low energy precursors such as carbon dioxide and water in the presence of light and chlorophyll is known as photosynthesis.
- Relate the introduction with today's topic of the processes involved in photosynthesis.

Development

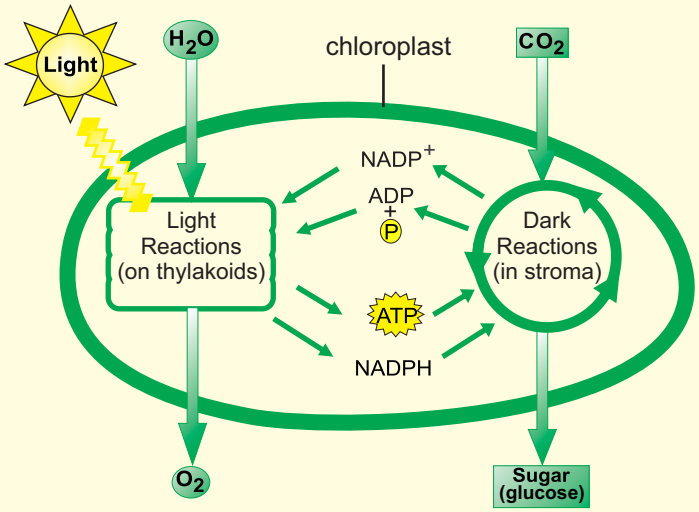
Activity 1

- Explain the phenomenon of photosynthesis in terms of raw materials and the products.
- Draw the equation of photosynthesis on board by using different colours for different elements and conduct interactive session to explain the role of carbon dioxide, water, light and chlorophyll.



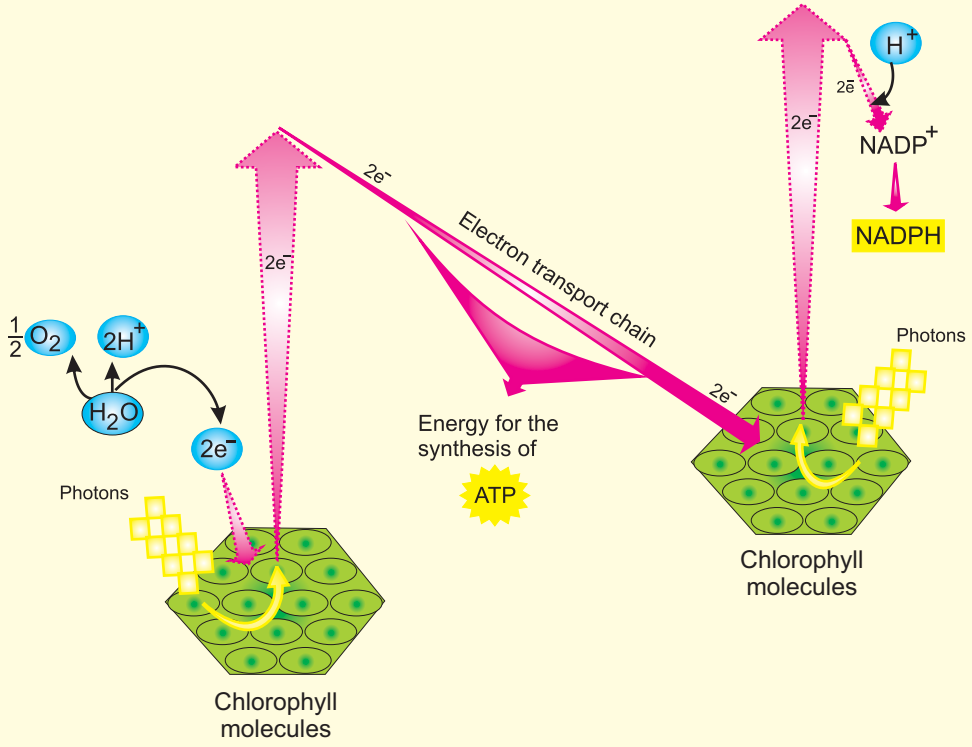
Activity 2

- Outline the Light and Dark reactions of photosynthesis by putting cards of different shapes and colours in sequential manner. Draw the diagram if required.



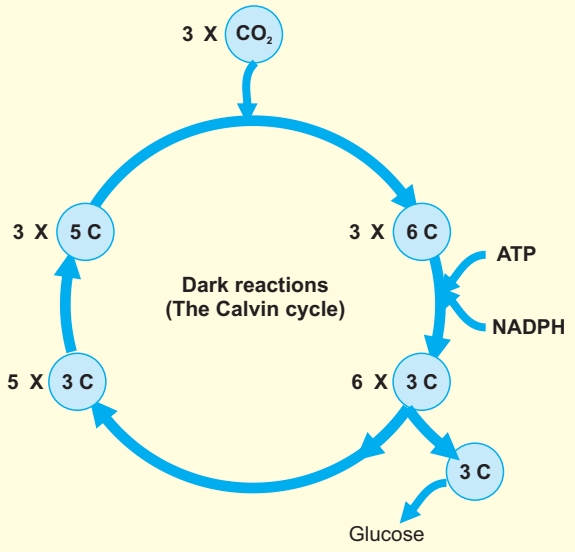
Activity 3

- Brief the students about the main steps of the Light reactions of photosynthesis with the help of a simplified diagram, like the following.
- Explain the concept of NADP (as energy carrier for the dark reactions) and Electron Transport Chain while mentioning the steps of the Light reactions.



Activity 4

- Brief the students about the main steps of the dark reactions of photosynthesis (Calvin cycle).
- Draw a simple cycle (like the following) while describing the Dark reactions.



Activity 5

- Explain the concept of limiting factors and their importance for the process. The importance of limiting factors can be proved by laboratory activities.

Conclusion/Sum up

Conclude the lesson by highlighting the following points.

- Photosynthesis is a multi-step process in which light energy is trapped by chlorophyll and converted into chemical energy. This chemical energy is used to synthesize carbohydrates from water and carbon dioxide.
- Photosynthesis occurs in two stages; the light-dependent stage (light reactions) and light independent (dark reactions).
- The limiting factors of photosynthesis are chlorophyll, temperature, light, carbon dioxide and water.

Assessment

Ask the following questions to assess the students' learning.

- Define photosynthesis?
- What role does chlorophyll play in the process of photosynthesis?
- How are sunlight, carbon dioxide and water used in photosynthesis?
- From where the oxygen produce during photosynthesis come from?
- Enlist the factors affecting the rate of photosynthesis?
- How the intensity of light affects the rate of photosynthesis?

Follow-up

- Guide the students to solve the problems given at the end of unit / chapter of the textbook.

Enrichment activity

- Guide the students to collect variegated leaves from the field and test them for the presence of starch .

Homework

- Direct students to prepare a flow sheet diagram of Light and Dark reactions of photosynthesis.

Project

- Excite the students to do a practical at their home to prove that light is necessary for photosynthesis by putting two similar potted plants, one in light and other in darkness.

UNIT 7

Lesson Plan 7

TOPIC

Respiration

Bioenergetics

Grade IX

Students' Learning Outcomes

- Describe respiration by means of word and symbol equation.
- Describe the anaerobic respiration and importance.
- Describe the aerobic respiration and importance.
- Outline the mechanism of respiration while defining Glycolysis, Krebs cycle and Electron transport chain.
- Compare aerobic and anaerobic respiration.
- List ways in which respiratory energy is used in the body.

Information for Teacher

- Organic molecules contain energy which is released as these molecules combine with oxygen to form carbon dioxide and water.

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy}$

- In living cells the process is controlled by a metabolic path way called respiration.
- In anaerobic reparation, glucose is broken down into pyruvic acid in the absence of oxygen.
- In aerobic respiration, glucose is oxidized completely in the presence of oxygen.
- Firstly, in cytoplasm of the cell, glucose is converted to pyruvates. This stage is called glycolysis.
- Next, inside mitochondria, pyruvate is fed into a cycle of reactions called the Krebs cycle.
- Finally, still inside mitochondria, electrons produced in the Krebs cycle are passed along an electron transport chain producing ATP, the energy rich compound.
- All the life activities e.g. metabolism, growth, movement, cell division, maintenance of body temperature etc. require energy, which is produced through the process of respiration.

Duration/Number of Periods

80 mins / 2 Periods

Material/Resources Required

Chart, cards of different shapes and colours for developing a flow sheet diagram, glucose, spoon, candle or Bunsen burner, biology laboratory with basic facilities and chemicals, textbook

Introduction

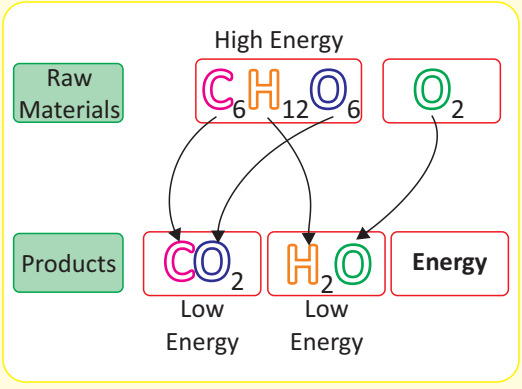
- Put some amount of Glucose in a spoon and let it burn by heating. It burns vigorously and energy stored in it released in the form of heat. (*Ask the students, in this condition what type of energy convert into other type*).
- Tell the students that the C-H bonds of glucose are broken down by oxidation reduction reactions and carbon dioxide and water are produced. In our cells, the breakdown of glucose produces energy which is transformed into ATP.

  $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy (ATP)}$
- Explain that in living organisms the glucose molecules dismantle steadily in a series of reactions catalyzed by enzymes and energy is released step wise.

Development

Activity 1

- Explain the phenomenon of respiration in terms of raw materials and the products.
- Draw the equation of respiration on board by using different colours for different elements and conduct interactive session to explain the breakdown of C-H bonds in respiration.

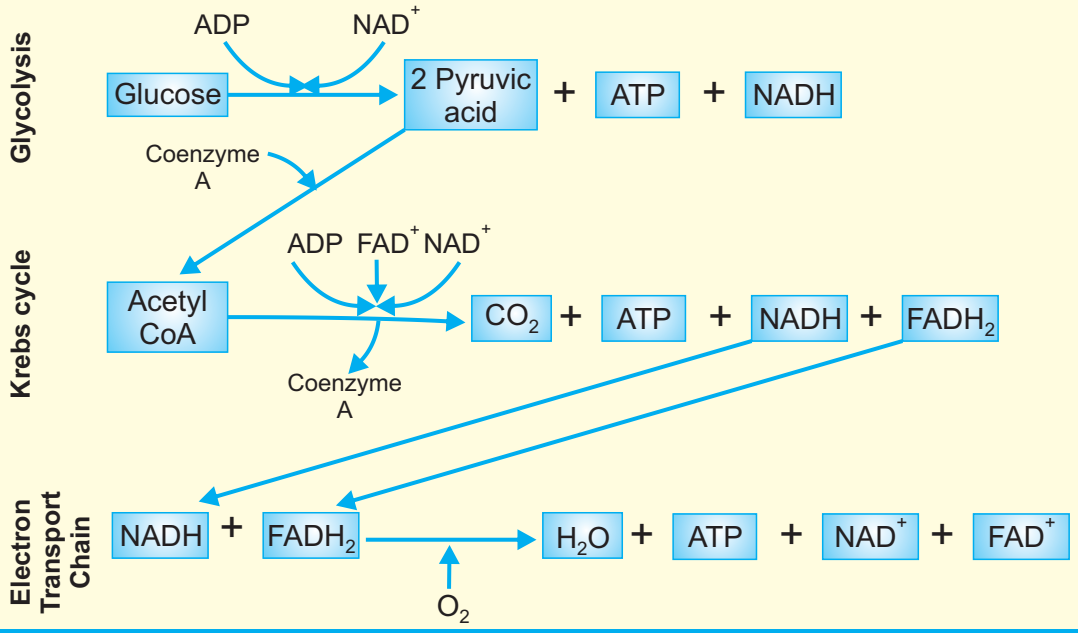


Activity 2

- Explain the process of anaerobic and aerobic respiration by simple equations.

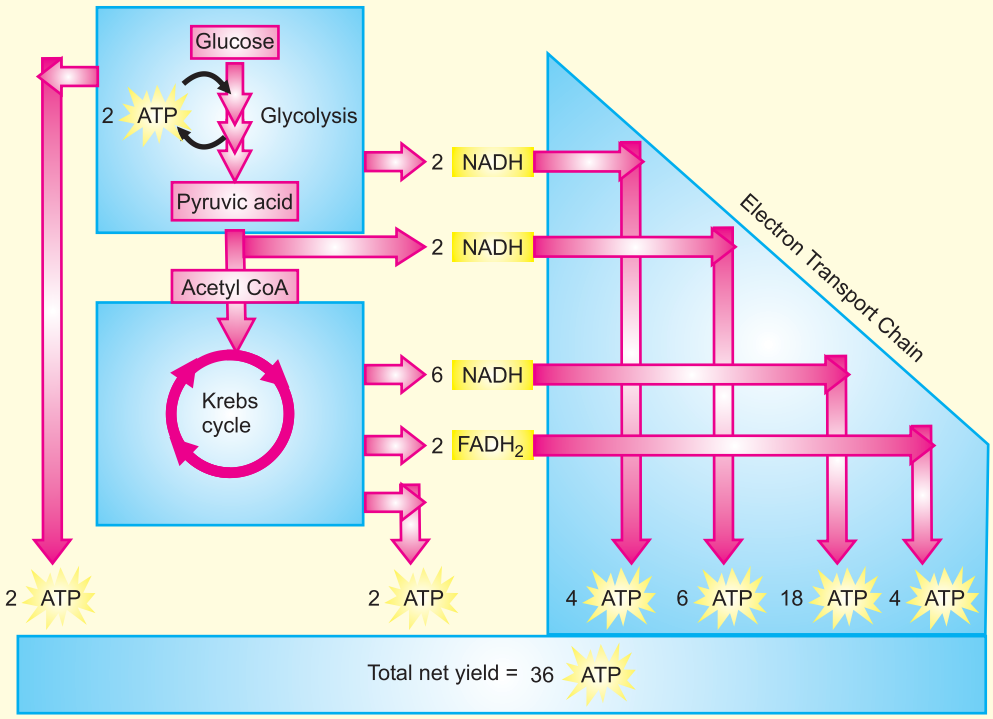
Activity 3

- Illustrate Glycolysis, Krebs Cycle and Electron transport chain by flow sheet method putting cards of different shapes and colours in a sequential manner. Draw the diagram if required.



Activity 4

- Help students to calculate the number of ATP molecules by the help of diagram.



Conclusion/Sum up

Conclude the lesson by highlighting the following points.

- The process in living organisms by which organic molecules (glucose)are broken down to release energy is called respiration.
- It is of two types i.e. anaerobic and aerobic respiration
- In anaerobic reparation glucose in broken down in pyruvic acid in the absence of oxygen.
- In aerobic respiration, glucose is oxidized completely in the presence of oxygen.
- The overall reaction of aerobic respiration is $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{energy}$
- In living cells the process is controlled by a metabolic path way called respiration consisting of three steps i.e. Glycol sis, Krebs cycle and Electron Transport Chain.
- The energy produced during the respiration in the form of ATP is used for performing all the life activities by living organisms.

Assessment

Ask the following questions to assess the students' learning.

- Define respiration.
- Write the chemical equation for respiration.
- Where is the chemical energy stored in a glucose molecule?
- What role do mitochondria play in the process of aerobic respiration?
- How does the temperature affect the process of respiration?
- Which type of respiration, anaerobic and aerobic is more beneficial for living organisms?
- Do you think that photosynthesis and respiration are opposite to each other if yes, how?

Follow-up

- Guide the students to solve the problems given at the end of unit / chapter in textbook.

Enrichment activities

- Ask the students to make a balance sheet of net gain of ATP molecules produced after the complete breakdown of a glucose molecule in aerobic respiration.
- Ask them to compare the process of anaerobic and aerobic respiration through a table.

Homework

- Ask students to compare rate of heart beat of a resting and exhausting individual and give reason of this change in his/her heart beat.

Projects

- Ask students to burn same amounts of wood and oil. Ask them to evaluate which type of fuel gives more heat and why?

UNIT 9

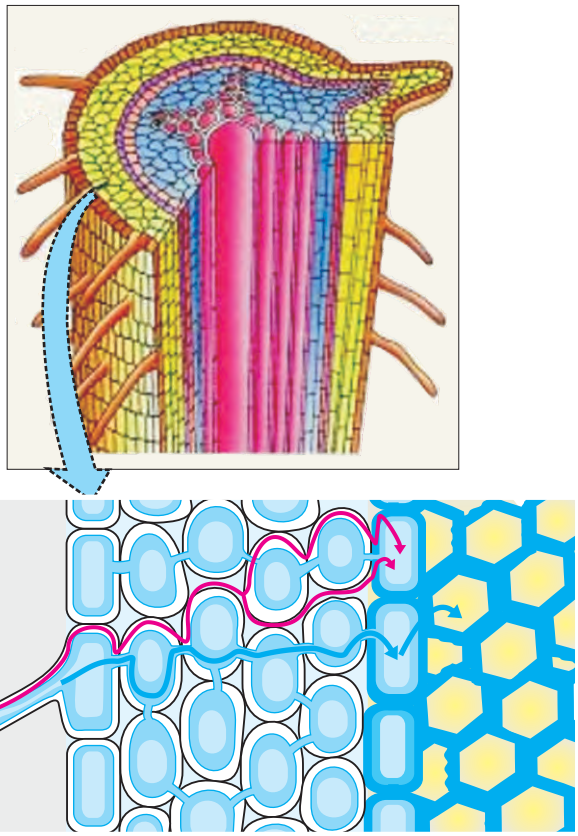
Transport

Lesson Plan 8

TOPIC

Transport in Plants (Transport of Water)

Grade IX

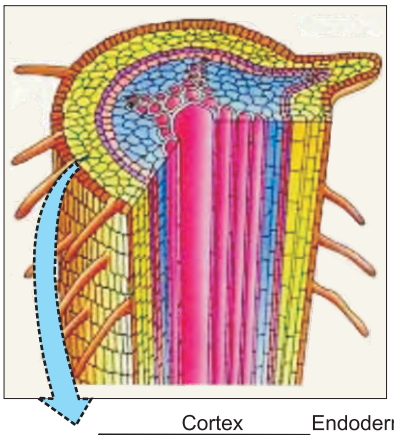


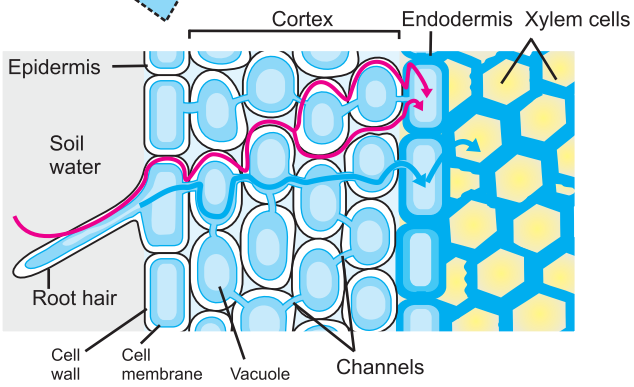
Students' Learning Outcomes

- Describe how roots take up water and mineral salts by active and passive absorption.
- Explain the movement of water in terms of transpirational pull.
- Observe and investigate transpiration in potted plant under a bell jar / polythene bag.
- Investigate to illuminate the pathway of water in a cut stem.

Information for Teachers

- Absorption of water and mineral salts takes place through the root system.
- Water enters in root hairs by osmosis. It moves from one cell to the other down an osmotic gradient that is from a cell having high water potential to a cell having low water potential.
- Salts also enter root hairs by diffusion or active transport.





- Water and minerals travel up the plant through xylem.
- Water rises in the xylem because transpiration from leaves produces a force called "Transpiration pull" which moves water from the root to the leaves of the plant. It happens as follows:
  - When transpiration (evaporation of water from surface) occurs from a leaf, the water concentration of mesophyll cells drops and so water moves by osmosis from xylem of leaf into mesophyll cells.
  - When one water molecule moves up in the xylem of the leaf, it creates a pulling force (transpirational pull) that continues all the way to the root.
- The transpirational pull is created due to:
  - Smaller diameter of xylem tubes,
  - Adhesion between water molecules and xylem tube, and
  - Cohesion between water molecules.

Duration/Number of Periods

80 mins/ 2 Periods

Material/Resources Required

Charts, Balsam plant, methylene blue solution, beaker, microscope, razor, stand, glass slide, 2 jars, 2 pots, textbook

Introduction

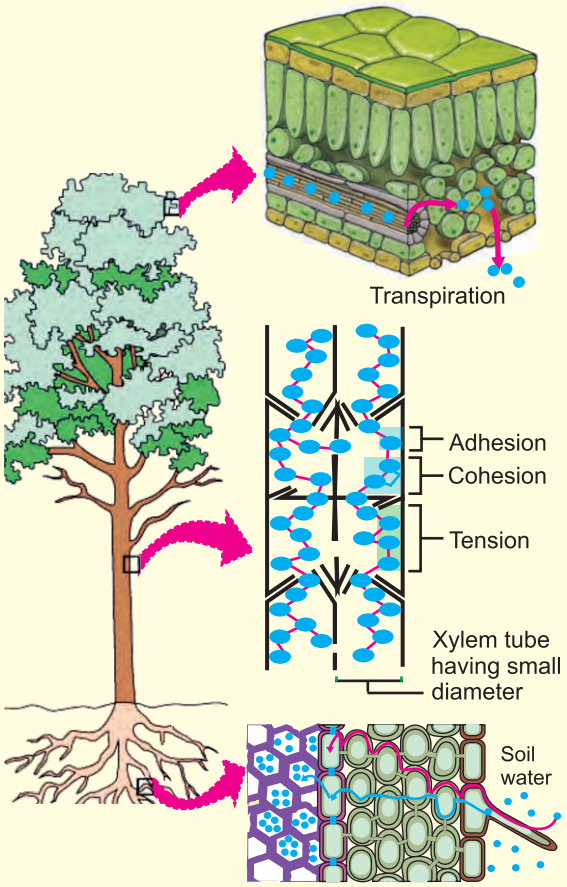
- Explain the concept of movement of water into the xylem vessels by giving an example that a drink moves up a straw when the straw is sucked.
- Ask the students: How does this happen?
- After getting their response conclude that when a straw is sucked, the pressure at the top of the straw reduces. The liquid at the bottom of the straw is at higher pressure so it flows up into the mouth.
- Lead the discussion and explain that the same thing happens with the water in the xylem vessels. Pressure at the top of the vessels is lower while the pressure at the bottom is high. Water therefore, flows up the xylem vessels.
- Ask the student: How the pressure at the top of the xylem vessel is reduced?
- After getting their responses, conclude that it is due to transpiration.

Development

Activity 1

- Draw the sketch on the board as shown in the diagram or show the chart and

explain the concept of transport of water and minerals in plants.

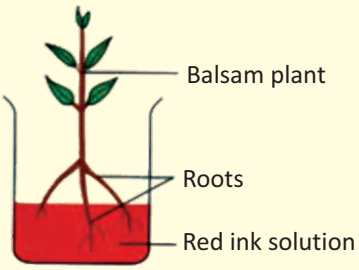


- While explaining the transport of water, ask the student: How does water escape from the leaves and how does the stem get water?
- After getting their responses, conclude that water escapes by transpiration and it is taken in the roots from the soil and moves upward through the stem.
- Ask students how water moves up to the xylem?
- After getting their responses, conclude that it is due to transpirational pull.

Activity 2

- Explain the pathway of water through a plant by performing this experiment:

1. Take a young Balsam plant and wash its roots with water to remove the soil.
2. Allow the plant to stand with its roots immersed in dilute red ink solution.



3. After a few hours, you can see that the red ink has risen up the plant, right up to the veins in the leaves. Cut thin transverse sections of the stem and the portion of the root not immersed in the ink.
4. Place the sections on a glass slide. Examine the sections under a microscope.

- After the activity, ask following questions from the students

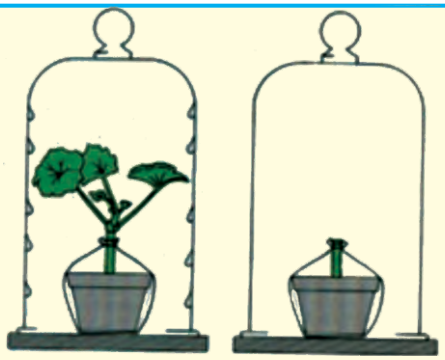
a. Which tissue has been stained red?

b. What conclusion can you draw from your investigations?

- Conclude the activity by explaining that water moves through the xylem of the stem.

Activity 3

- Set the apparatus as shown in the diagram and explain the concept of transpiration. Divide the students into groups and ask them to perform this activity.



- After the activity, ask following questions from the students
  - Why are there no vapors in jar taken as control?
  - Why are there water vapors condensed in the jar in experimental set up?
  - What do you conclude from this experiment?
  - Why is little water taken up by some trees in winter when they drop their leaves?

Conclusion/Sum up

Sum up the lesson by wrapping up the main points.

- Water enters the plant through roots by the process of osmosis.
- Ions/mineral salts are absorbed mainly by active transport and energy for this process comes from cellular respiration.
- Water rises in the xylem because transpiration from leaves produces a force called "Transpiration pull" which moves water from the root to the leaves of the plant.

Assessment

- Assess students learning by ask the following questions:
- Explain why water moves into the root hair cells from the soil.
- How does water travel from root hair to a xylem vessel?
- Why does water move up the xylem vessel?
- The movement of water from a film on mesophyll cells surface into the intercellular air spaces of a leaf is a process called:

  a) Osmosis b) Diffusion

  c) Evaporation d) Pinocytosis
- Water loss in plant is most rapid when conditions are:

  a) Wet, windy and cold

  b) Wet, windy and warm

  c) Dry, windy and warm

  d) Dry, still and warm
- The process by which water enters the root hair is called:

  a) Transpiration b) Active transport

  c) Osmosis d) Phagocytosis
- The concentration of a certain mineral ions in soil water is 50 parts per million (ppm). Inside the root hair cell vacuole, the same nutrient ion concentration is 200ppm. This nutrient enters the root hair from the soil water by:

  a) Diffusion b) Osmosis

  c) Active transport d) Filtration

Follow-up

- Ask students to solve the following questions:
  - How cohesion, adhesion and the diameter of xylem help in the transport of water through the stem?
  - If you add a lot of soluble inorganic fertilizer to a potted plant, the plant will die. Explain why?
- Guide students to solve the questions at the end of unit in textbook.

UNIT 9

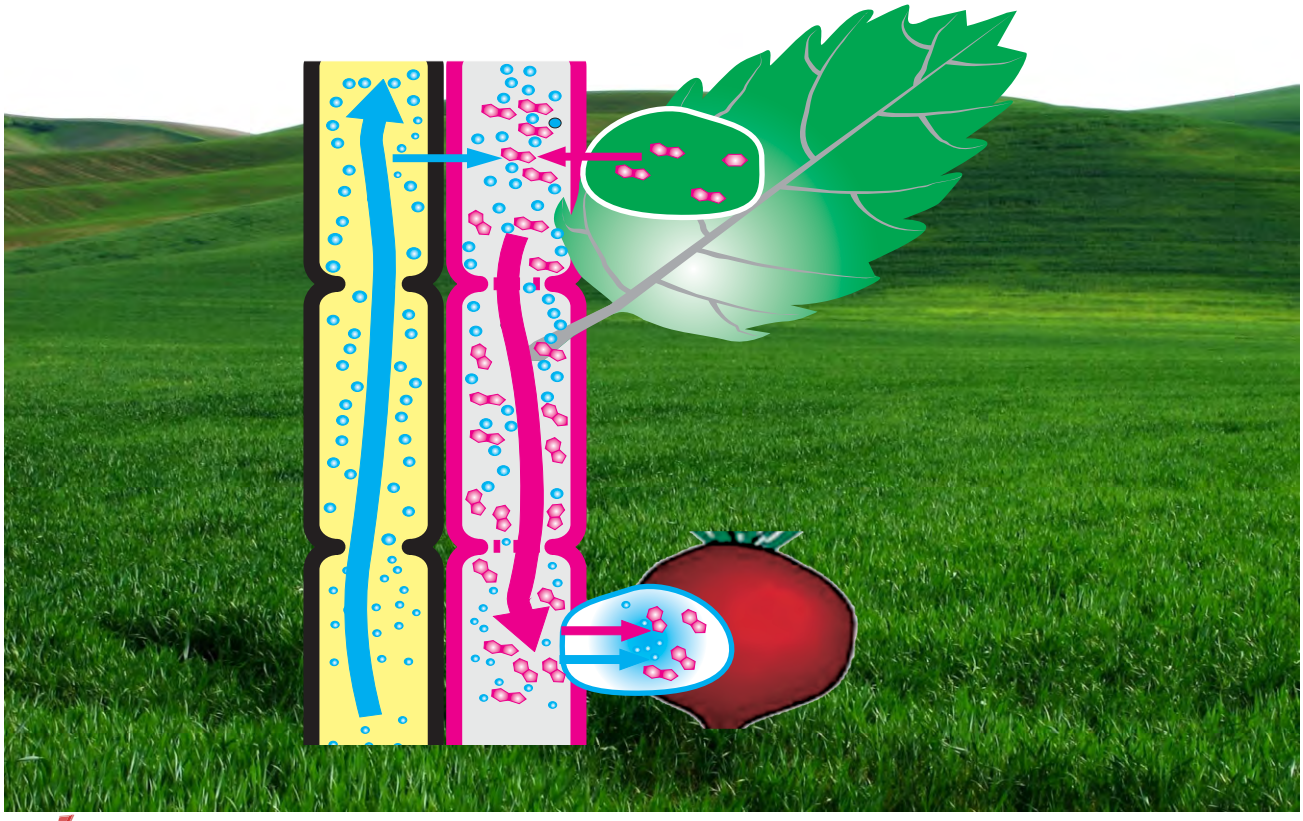
Transport

Lesson Plan 9

TOPIC

Transport in Plants (Food Translocation)

Grade IX



Students' Learning Outcomes

- Explain the mechanism of food translocation by the theory of pressure flow mechanism.

Information for Teachers

- The transport of sugar in phloem is explained by the pressure flow theory.
- This theory relies on differences in hydrostatic pressure to move fluid through the sieve tubes of phloem.
- Leaf manufactures a lot of sugar, which flows to other newly developing leaves, flowers, fruits and roots.
- Much of this sugar is transported into sieve tube members by companion cells.
- Concentration of sugar increases in the phloem which in turn attracts water to enter by osmosis causing high hydrostatic pressure in that part of the phloem.

- Part of the plant that consumes sugar (e.g. fruits/roots) removes sugar from the sieve tube.
- Loss of sugar causes loss of water by osmosis resulting in the low hydrostatic pressure.
- Water and dissolved sugar move by bulk flow in the sieve tube from high to low pressure.

Duration/Number of Periods

80 mins/ 2 Periods

Material/Resources Required

Charts (transport of food), board, chalk/ markers, plastic tubs, rubber tubing, water, textbook

Introduction

- Introduce the pressure flow mechanism with this example:
  - If two membranous bags called A and B filled with concentrated and dilute sugar solutions respectively, are connected by a narrow glass tube and immersed in water, the solvent water enters into bag A. As the water enters into the bag A, a very high hydrostatic pressure develops, with the result, sugar solution starts moving into the glass tube towards bag B. Same process occurs in the transport of sugar in the sieve tube of phloem.
- Ask students questions like; Where food is prepared? Which parts of the plant need food? Do some parts of plant store food?
- After getting their responses, conclude the answers.
- Ask the students to draw the sketch of xylem and phloem cells and discuss their functions.

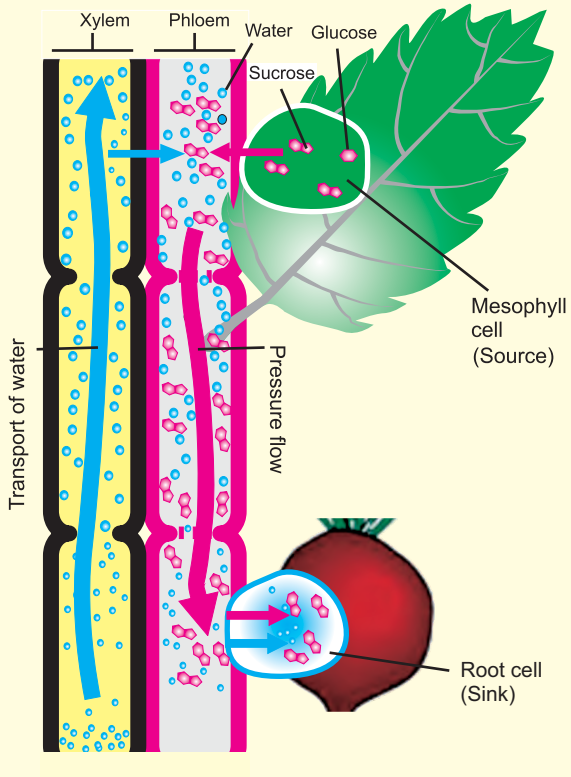
Development

Activity 1

- Bring two plastic tubs A and B in class.
- Fill 75% of tub A and 25% of tub B with water.
- Insert a rubber tube in the tub A and suck water from the other end of tube till water comes out of the tube.
- Leave the end of tube with running water in the water of tub B.
- Ask students to observe the process and start discussion session.

Activity 2

- Draw the sketch on the board as shown in the diagram or show the chart and explain the concept of translocation of food in plants.



Conclusion/Sum up

- The process of mass flow moves sugar from where it is produced in the plant to where it is used.
- During the mass flow, sugar is actively transported into the phloem cell where it is produced and is actively transported out of the phloem cells where it is used.
- These active transport process produce a sugar gradient and water pressure gradient which cause the movement of sugar and water.

Assessment

For assessment following type of questions may be given to students.

- Define the pressure-flow theory.
- How food is transported in plants?
- Sugar is transported in phloem by:

  a) Osmosis b) Active transport

  c) Hydrostatic pressure gradient

  d) Diffusion
- The internal pressure exerted on the cell wall by the water moving into the cell is called:

  a) Root pressure b) Water potential

  c) Turgor pressure d) Osmotic pressure

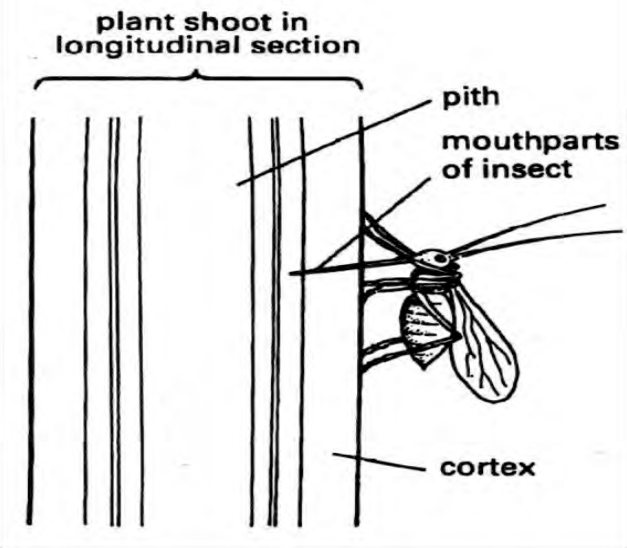
Follow-up

Enrichment Activity

- Show the following figure to students in which an insect is feeding from the shoot of a plant. Ask students to answer the following questions.
  - Which tissue must the insect's mouth-parts enter to obtain food?
  - Name the carbohydrate which the insect will be ingesting.
  - Place an **X** on the diagram to show the position of the tissue which carries mineral salts.
  - It is thought that the insect ingests most of its carbohydrate during daylight hours. Suggest why?
  - One of the following is responsible for transport of sugar from leaves to the roots of a flowering plant:

    a) Xylem b) Cambium

    c) Phloem d) Pith



Homework

- Ask students to make a model of a plant showing translocation by using foam sheet / colored cardboard papers.
- Ask them to display the model in the class and discuss the process of translocation.
- Guide the students to solve the questions at the end of unit in textbook.

UNIT 11

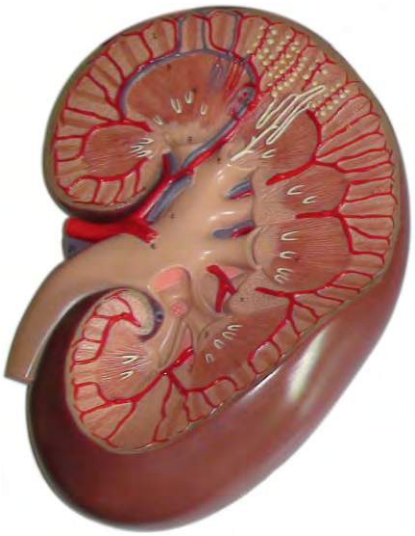
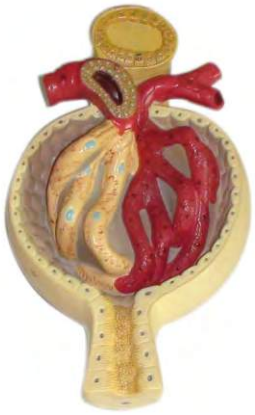
Lesson Plan 10

TOPIC

Urinary System of Man

Homeostasis

Grade X


Students' Learning Outcomes

- Identify the different organs of the urinary system.
- Relate the structure of kidney with its function.
- State that nephron is the excretory unit of the kidney.
- Locate the different parts of the nephron and relate them with their function.
- State the main role of kidney in urine formation.
- Describe that urine formation involves three process i. e. filtration, reabsorption and secretion.

Information for Teachers

- Human urinary system consists of a pair of kidneys, ureter, bladder & urethra. Urea and ammonia are the chief waste products of animal body. Animals get rid of nitrogenous wastes, excess water and salts through

excretion.

- Nephron plays the major role in filtration of the blood containing nitrogenous and other wastes.
- Each nephron consists of glomerulus, Bowman's capsule, proximal tubule, loop of Henle , distal tubule and the collecting duct.
- Nephron performs the functions of filtration, re-absorption and secretion to regulate salt, water content of the body.
- Filtration occurs in the Bowman's capsule in each nephron of a kidney. In this process, blood is pumped in the capillaries of the glomerulus forcing out water, dissolved wastes & nutrients. Reabsorption is a process by which water and nutrients are removed from the filtrate and passed back into the blood. Secretion is the process by which waste and excess substance are removed from the blood for excretion.

Duration/Number of Periods

120 min/ 3 Periods

Material/Resources Required

Charts, model, prepared slides, goat kidney, dissecting box, papers, textbook

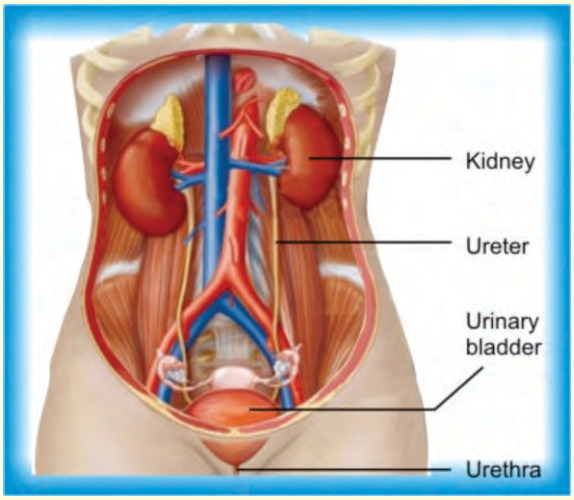
Introduction

- Start the concept of urinary system through an example.
  - Ask questions after explaining a scenario: "You come to know that some poisonous material is hidden somewhere in your house. What will you do then? (Expected responses i. Find the material ii. Remove that material)
- Now lead the discussion by explaining that we will need a system of searching and removing that material, otherwise everyone at home will suffer a lot.
- Our body does the same thing every day. Our body produces dangerous waste materials that must be removed in order to survive.

Development

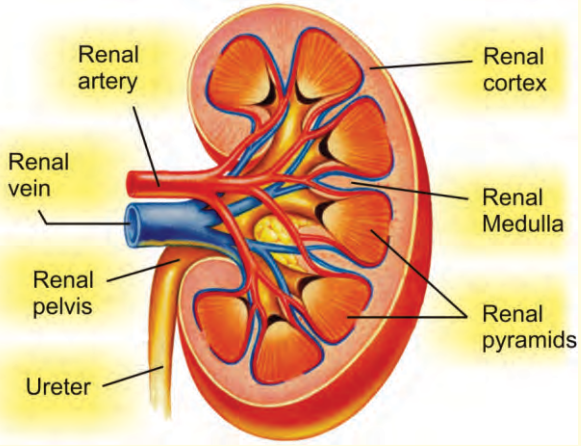
Activity 1

- Ask the students to recall the organs of urinary system. The expected response of the students is: pair of kidneys with attached ureters, urinary bladder and urethra.
- Show the students a chart of the urinary system and explain its different organs. Ask them to draw and label the organs of urinary system on their note books.
- Explain that the kidneys are the main organs associated with the removal of the liquid wastes from the body.



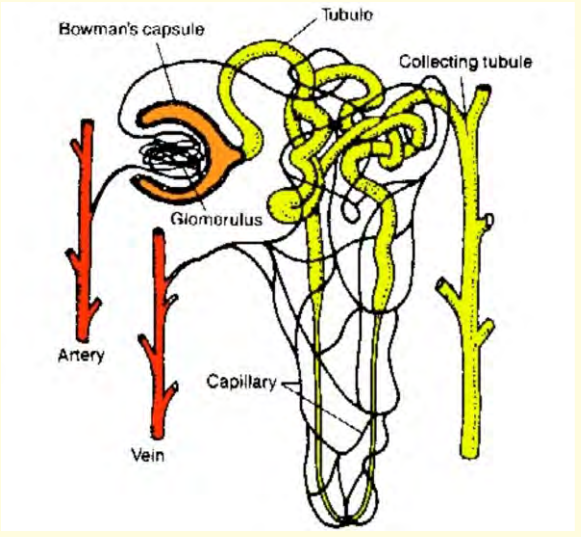
Activity 2

- Explain different parts of the kidney with the help of a chart and the model. Also draw the diagram on board.
- Make groups of the students and provide them with goat kidney and ask to cut it longitudinally and observe its internal structure.
- Ask the students to draw and label internal structure of kidney.



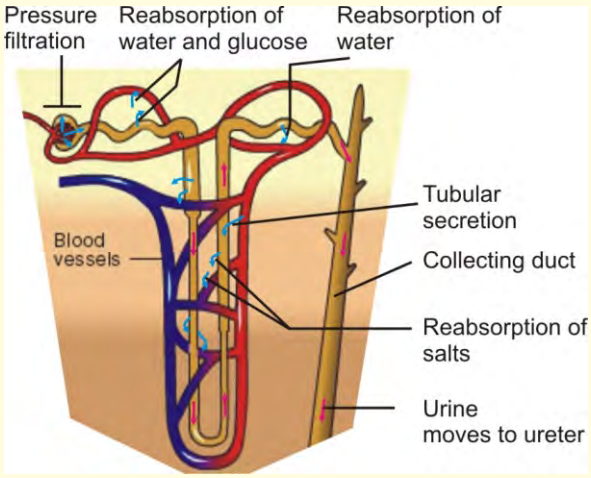
Activity 3

- Explain that the unit of kidney is nephron.
- Explain different parts of the nephron by using black board, chart and drawing.



Activity 4

- Ask the students to draw and label the diagram of nephron.
- Explain the functions of different parts of the nephron through lecture method and class discussion using the chart.



Conclusion/Sum up

Repeat the main points of the lesson:

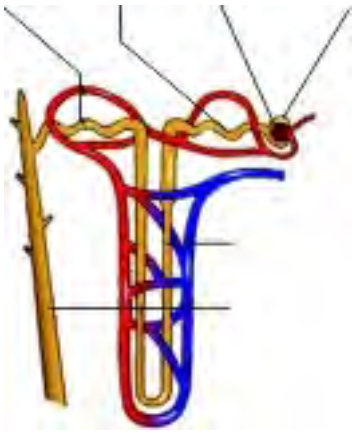
- Kidney contains numerous nephrons.
- A nephron consists of glomerulus, Bowman's capsule, first convoluted tubule, loop of Henle, last convoluted tubule and collecting duct.
- Urine formation involves ultra-filtration, selective re-absorbtion and tubular secretion.
- In a healthy person, urine normally consists of extra water, extra mineral salts, urea and other nitrogenous waste products.

Assessment

Ask the following question to assess students' learning:

- What are the functions of glomerulus and Bowman's capsule?

- Label different parts of the diagram:



- Trace the flow of blood through the nephron.
- Trace the path of filtrate through the nephron (beginning at the glomerulus).
- Which of the following is an example of mammalian excretory product?

  a) Faeces b) Urea

  c) Plasma d) Sebum

- Valuable soluble substances e.g. glucose are retained or recovered by the mammalian kidney by the process of:

  a) Ultrafiltration b) Secretion

  c) Osmosis d) Reabsorption

Follow-up

- Guide the students to solve the questions at the end of unit in textbook.

Enrichment Activity

- Ask students to Collect information about kidney failure and transplant of kidney from available resources.

Homework

- Ask students to draw the labeled diagram of nephron and to explain the process of filtration & absorption.

Project

- Ask the students to prepare a model of the kidneys by using foam sheets/ card board papers of different colors and display the model next day in class.

UNIT 15

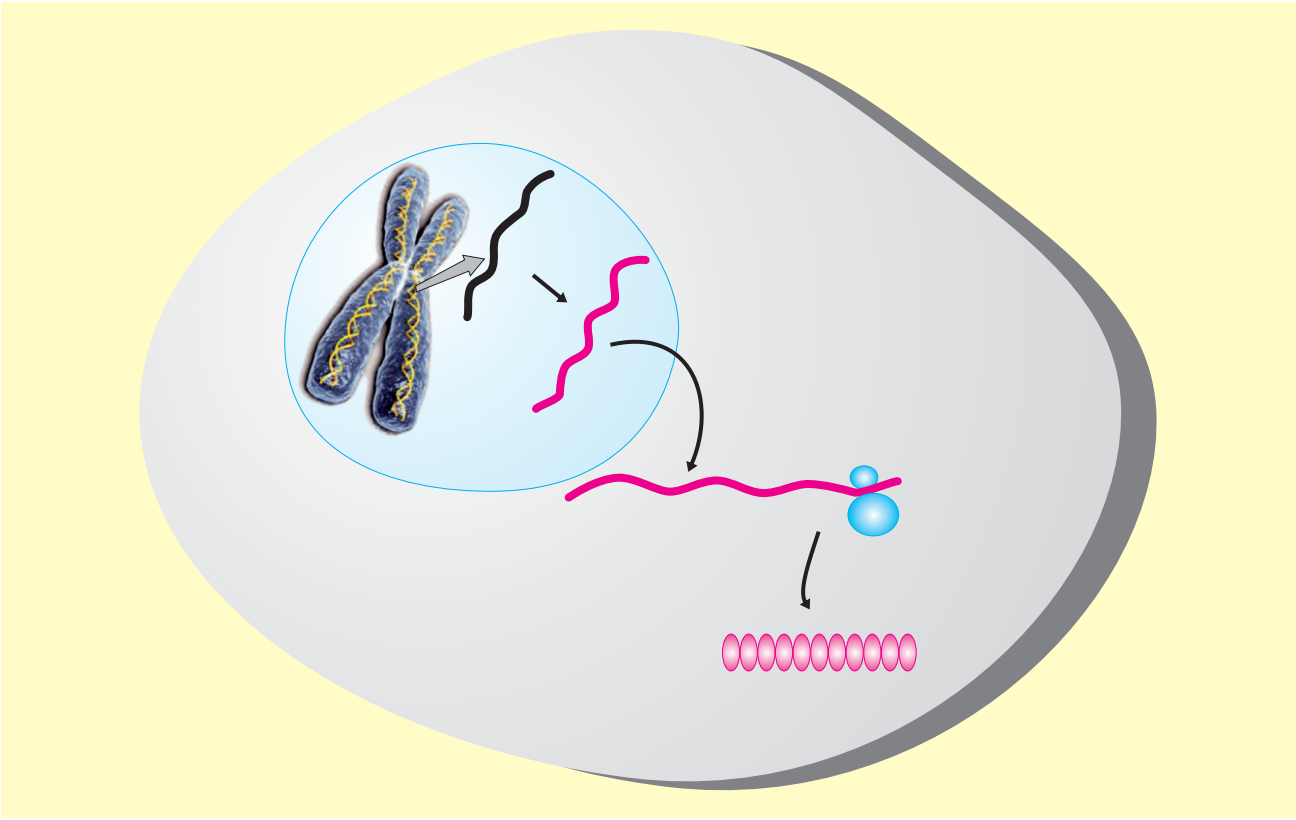
Lesson Plan 11

TOPIC

Chromosomes and Genes

Inheritance

Grade X



Students' Learning Outcomes

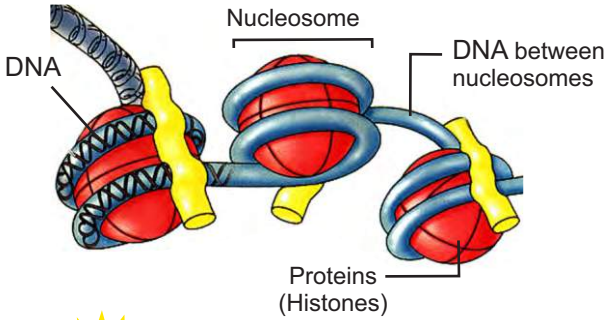
- Describe the composition of chromatin material.
- Define gene (a localized region of dna that codes for a protein).
- Explain that gene is a unit of inheritance and that it can be copied and passed on to the next generation.
- Describe the central dogma stating the role of gene in protein synthesis.

Information for Teachers

- The genes which we have inherited from our parents are found on the chromosomes in the cell nucleus.
- Each somatic cell in our bodies has 23 pairs of chromosomes.
- A chromosome is made up of a molecule of DNA (deoxyribonucleic acid) wrapped around proteins (histones).
- DNA molecule consists of two anti-parallel

strands twisted around each other to form a double helix.

- A gene is a segment of DNA which controls the formation of a single protein.
- Gene stores a message (called the genetic code) which determines how a protein should be made in the cell.



Duration/Number of Periods

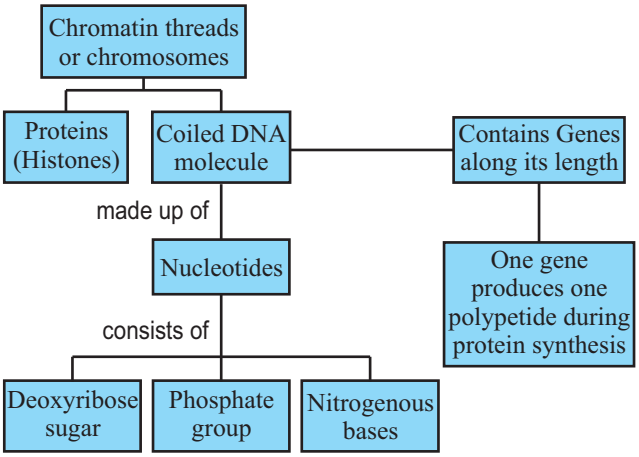
80 mins/ 2 Periods

Material/Resources Required

Match sticks, plasticine of different colour, chart (DNA, gene and chromosomes), textbook

Introduction

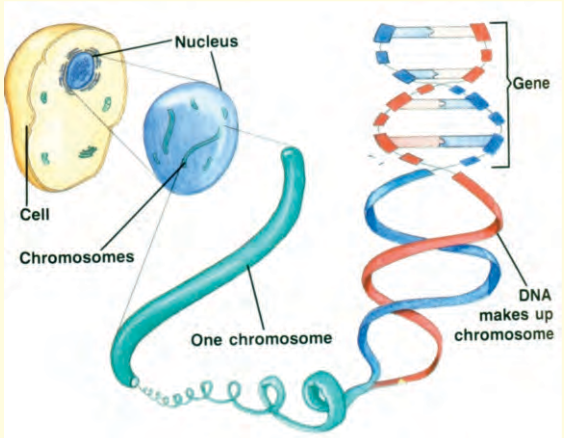
- Brainstorm the students by asking the following questions
  - What is inheritance? (Expected response: Transfer of traits from one generation to the other)
  - What is the genetic material? (Expected response: DNA)
  - What is meant by gene?
  - Where the genes are located? (Expected response: On chromosomes)
- After the students' response introduce the today's topic by drawing the concept map on the board.



Development

Activity 1

- Show chart or model to the students and explain them the relationship among DNA, gene and chromosomes.



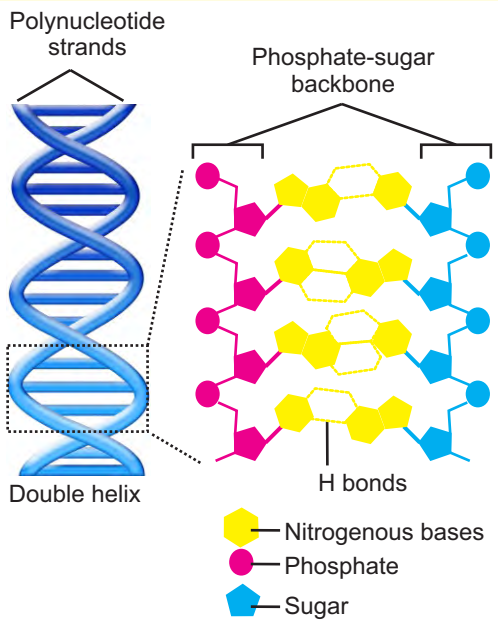
Activity 2

- Using match sticks, plasticine of different colours and any other suitable materials, construct flat models (i.e models which lie flat on a table one by one and explain as following).

1. **The molecular structure of DNA**

- Show the relationship between the sugar, phosphate and nitrogenous

bases (the molecular and the complementary relationship between the bases).



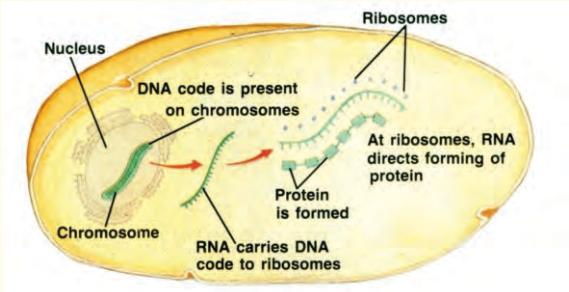
2. The central dogma (principle)

a. Formation of messenger RNA

- Explain how DNA is transcribed into messenger RNA.

b. How messenger RNA controls assembly of a protein

- Make models of amino acids, ribosomes and messenger RNA.
- Show that the sequence of the bases in the messenger RNA in translated into protein.



Activity 3

- Manage the class in groups to watch the animation of protein synthesis (e.g. www.youtube.com/watch?v=Ikq9AcBcohA&Feature=fvst)

Assessment

- Write this passage on board and ask students to copy and complete it with the appropriate word or words.

  Synthesis of mRNA is called _____. The mRNA moves from the nucleus to the _____ where it attaches to a _____ for the process of _____.

- Inform the students that "DNA is a molecule containing a number of genes arranged length wise" then ask the following questions:
  - Where would you find DNA inside a cell?
  - Why is DNA such an important substance?
  - How the genes and DNA are interlinked?
  - Which information is stored in the genes?

Follow-up

- Ask the students to surf the internet to find examples of DNA that has been extracted from fossils and to find out what studies scientists are conducting on this DNA.
- Guide the students to solve the questions at the end of unit / chapter in textbook.

UNIT 17

Biotechnology

Lesson Plan 12

TOPIC

Fermenters

Grade X

Students' Learning Outcomes

- Explain the use of fermenter in large-scale production of microorganisms and their products.
- Describe the procedure of using fermenters.
- Describe the advantages / profitability of using fermenters in preparing medical products.

Information for Teachers

- Fermenter is a device that provides optimum environment in which organisms can grow to produce biomass and can interact with a substrate, forming the product.
- Two types of fermentation occur in fermenters i.e. batch fermentation and continuous fermentation.
- During batch fermentation (i) the tank of fermenter is filled with the raw materials to be

fermented; (ii) nutritive supplements are added; (iii) the materials are steam sterilized, (iv) pure culture of microorganisms is added; and (iv) after the proper time the fermented products are taken out.

- During continuous fermentation, the substrate is added to fermenter continuously at a fixed rate and the products are taken out continuously.
- Fermenters allow the production of medicines (therapeutic proteins) in bulk quantities. Massive amounts of insulin, human growth hormone and other proteins are being produced in fermenters.

Duration/Number of Periods

40 mins/ 1 Period

Material/Resources Required

Board, chart, coloured markers / chalks, textbook

Introduction

Activity 1

- Ask students' previous knowledge of "fermentation in biotechnology". Recall their knowledge that in biotechnology fermentation means the production of any product by the mass culture of micro-organisms.

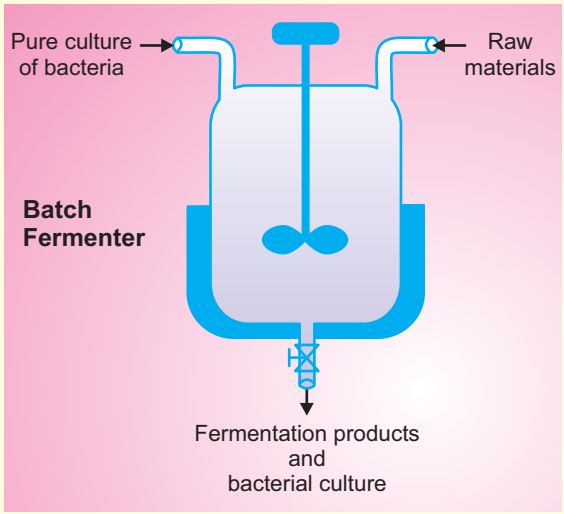
Activity 2

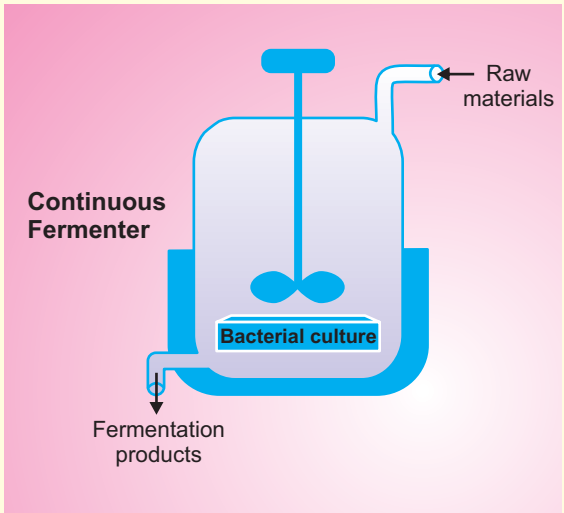
- Take start by asking questions like the following:
  - Where the biotechnologists can carry out fermentation at large scale?
  - Should that apparatus be in the form of beakers and test tubes or should it be like big tanks?
- After getting students' responses, introduce the concept of fermenters.

Development

Activity 1

- Draw the following diagrams on a chart with coloured markers or with coloured chalks on writing board.





- Explain how batch fermentation and continuous fermentation are done in the fermenters by mentioning the steps of process in the diagrams.

Conclusion/Sum up

- Ask a student to teach back the basic steps in batch fermentation.
  - (i) The tank of fermenter is filled with the raw materials to be fermented; (ii) nutritive supplements are added; (iii) the materials are steam sterilized, (iv) pure culture of microorganisms is added; and (iv) after the proper time the fermented products are taken out.
- Revise the other points of the lesson:
- In continuous fermentation, the substrate is added to fermenter continuously at a fixed rate and the products are taken out continuously.
- In fermenters, many medicines are produced in bulk quantities e.g. insulin, human growth hormone etc.

Assessment

- Ask the following questions:
  - Define fermenter.
  - What are the two types of fermenters being used in industry?
  - Which fermenter requires more complex design and why?
  - List the medical products, which are obtained by using fermenters.

Follow-up

Project

- Assign the following projects to the groups of students. Ask them to use internet for getting the latest information about the applications of fermenters.
  - The major medical products produced by using fermenters
  - Local industries where fermenters are being used
- Guide the students to solve the questions at the end of unit in textbook.

UNIT 17

Biotechnology

Lesson Plan 13

TOPIC

Genetic Engineering and its Uses

Grade X

Students' Learning Outcomes

- Define genetic engineering and describe its objectives.
- Describe how a gene is transplanted?
- Describe major achievements of genetic engineering with reference to improvement in agricultural crops (herbicide resistance, virus resistance and insect resistance).
- Describe major achievements of genetic engineering in curing animal diseases (foot and mouth disease, coccidiosis, trypanosomiasis) and in animal propagation (animal cloning).
- Describe the application of genetic engineering in the production of human insulin and growth hormones.

Information for Teachers

- Biotechnology is the use of living organisms in systems or processes for the manufacture of

useful products or for services to mankind.

- Genetic engineering is considered as modern biotechnology. Genetic engineering means the artificial synthesis, modification, removal, addition and repair of the genetic material (DNA).
- The objectives of genetic engineering include;
  1. isolation of a particular gene or part of a gene for various purposes,
  2. production of particular RNA and protein molecules,
  3. improvement in the production of enzymes, drugs and commercially important organic molecules
  4. production of varieties of plants having desirable characteristics, and
  5. treatment of genetic defects in higher organisms.
- The basic steps involved in genetic engineering are;
  1. the isolation of the gene of interest from a donor organism by using cutting enzyme (restriction endonuclease),
  2. insertion of the gene of interest into a vector (a plasmid or a bacteriophage) by using cutting enzymes and joining enzyme (ligase),
  3. transfer of gene of interest+vector (recombinant DNA) into host organism to transform it into a genetically modified organism (GMO),
  4. growth of the GMO, and
  5. the isolation of the desired product from culture medium after the expression of the gene.

Duration/Number of Periods

120 mins/ 3 Periods

Material/Resources Required

Board, coloured chalks/markers, computer with internet connection, textbook

Introduction

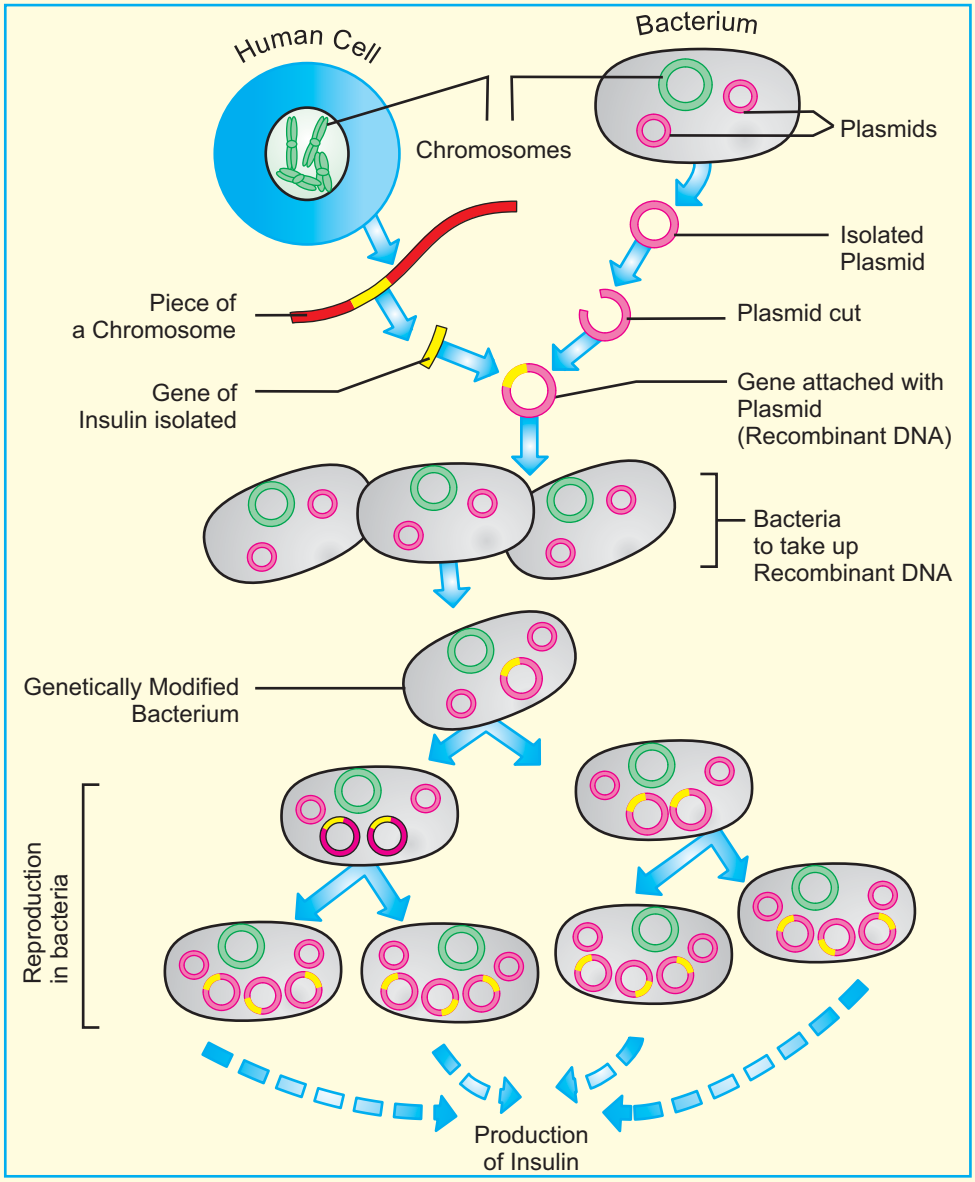
- Begin the lesson by interactive discussion on genes. After getting their ideas on genes, show a cartoon picture as given below.

- Ask questions like the following:
  - Can you imagine?
  - Have you ever heard the word genetic engineering?
  - Explain that it may be possible through genetic engineering.
- Introduce today's topic of genetic engineering and tell students that they will study how genetic engineers modify the genetic material in order to produce genetically modified organisms i.e. GMOs.

Development

Activity 1

- Draw the following pictures on a chart with coloured markers or with coloured chalks on writing board.



- Explain the way by which genetic material is exchanged between organisms. Explain the role of vectors (plasmids) in this technology and the production of human insulin and growth hormones
- Manage the class (in groups) to see the animation of genetic engineering (e.g. http://www.youtube.com/watch?v=AEINuCL-5wc&feature=related).

Conclusion/Sum up

- Repeat the main points of the lessons.
  - During genetic engineering we; (1) use restriction endonuclease to isolate the gene of interest from a donor organism; (2) make a recombinant DNA through the insertion of the gene into a vector by using restriction endonuclease and ligase; (3) transfer recombinant DNA into host organism; (4) give proper medium to the GMO for growth; and the (5) isolate the desired product from culture medium.
  - Genetic engineering is done for (1) isolation of a particular gene or part of a gene; (2) production of RNA and protein molecules; (3) production of enzymes, drugs and commercially important organic material; (4) treatment of genetic defects in higher organisms.

Assessment

- Ask the following question:
  - Define genetic engineering?
  - Why do we use plasmids in the genetic engineering?
  - Crop plants can be given genes which make them resistant to chemicals which kill weeds, or able to make chemicals which kill insects. Describe advantages and disadvantages of doing this?
  - Describe, three applications of genetic engineering in agriculture.
  - How can genetic engineering be used to help people with genetic diseases?

Follow-up

- Guide the students to solve the questions at the end of unit in textbook.

Homework / Project

- Assign the following projects to the groups of students. Ask them to use internet for getting the latest information about the applications of genetic engineering.
  - The major achievements of genetic engineering with reference to improvement in agricultural crops
  - The major achievements of genetic engineering in curing animal diseases (foot and mouth disease, coccidiosis, trypanosomiasis) and in animal propagation (animal cloning)

Enhancement Activity

- Introduce three roles (a student, a genetic engineer, a religious person) to the class. Make three groups in class and assign one role to each group.
- Have each group discuss the ethical issues concerning genetic engineering, in the perspective of assigned role.
- During the next class period, ask the groups to present their position statements.
- After the groups have presented their positions, have a class discussion.

UNIT 17

Biotechnology

Lesson Plan 14

TOPIC

Single-Cell Protein and its Uses

Grade X

Students' Learning Outcomes

- Describe single-cell protein and its importance.
- Describe the significance of single-cell protein in animal feed.
- State the significance of single-cell protein in human food.
- Apply knowledge to identify products of animal and human food having single-cell proteins.

Information for Teachers

- Single-Cell Protein (SCP) means the protein content extracted from pure or mixed cultures of algae, yeasts, fungi or bacteria.
- For the production of single-cell proteins, the micro-organisms are grown in fermenters. These microorganisms utilize a variety of substrates like agricultural, industrial wastes, natural gas like methane etc. Microorganisms grow very vigorously and produce a high yield of protein.

- For a better management of food shortage problems (in humans and domestic animals), the use of microbes as the producers of single-cell proteins has been successful on experimental basis.
- When single-cell proteins are produced by using yeasts, the products also contain high vitamin content.
- In the production of single-cell proteins, agricultural and industrial wastes are used as raw materials. It helps in controlling pollution.
- The production of single-cell proteins is independent of seasonal variations.

Duration/Number of Periods

40 mins/ 1 Period

Material/Resources Required

Board, charts, chalk / marker textbook

Introduction

- Ask students about the central dogma of cell genetics. [Expected response: DNA is transcribed and mRNA is made which directs the synthesis of a specific protein.]
- Have students recall the application of genetic engineering in different fields. Focus on the transformation of microorganisms by the introduction of genes of beneficial proteins e.g. insulin.

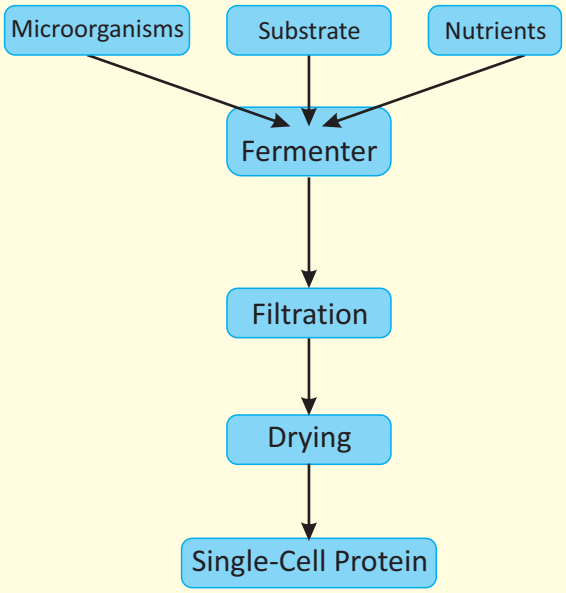
Development

Activity 1

- Get students' ideas about the global food shortage problem. Ask them to use their knowledge of biotechnology for making suggestions to solve this problem.
- Write students' responses on board and conclude the discussion by introducing the concept of single cell protein. Explain its role in the management of food shortage problems (in humans and domestic animals).

Activity 2

- Recall the use of fermenters in biotechnology.
- Draw the following flowchart on board and explain the production of SCP.



- While explaining the flowchart, let students know the benefits of using SCP production method i.e. industrial wastes are used as raw materials and this method is independent of seasonal variations.
- Conduct interactive discussion about why the product of above process is known as single-cell protein. Conclude the discussion by explaining that it is

because the micro-organisms used as producers of proteins are unicellular or filamentous individuals.

- Ask the students to prepare flowcharts which can demonstrate the process of single-cell protein production.

Conclusion/Sum up

- Conclude the lesson by repeating the main points:
  - SCP is the protein content extracted from pure or mixed cultures of algae, yeasts, fungi or bacteria.
  - For the production of SCP, the microorganisms are grown in fermenters with proper substrate e.g. agricultural / industrial wastes, natural gas like methane etc. Microorganisms grow and produce a high yield of protein.
  - SCP production has proved successful for a better management of food shortage problems.

Assessment

Ask the following questions

- What may be the maximum amount of proteins in the cells of microorganism, processed for the production of SCP?

  a) 80% b) 60%

  c) 40% d) 20%

- Make a list of SCPs (using internet) available as animal feed and human food.

Follow-up

- Guide the students to solve the exercise problems given at the end of unit / chapter of the textbook.

Homework / Project

- Assign the following Projects to the groups of students. Ask them to use internet or school library for getting the latest information about the production of SCP.
  - Disadvantages of single-cell protein manufacture
  - List of animal and human food products having single-cell proteins

UNIT 18

Pharmacology

Lesson Plan 15

TOPIC

Introduction of Pharmacology and Medicinal Drugs

Grade X

Students' Learning Outcomes

- Define pharmacology as the detailed study of drugs.
- Define the term 'drug' (the substance or product that is used to modify physiological systems of the body).
- Enlist the various sources of drugs i.e. minerals, animals, plants, synthetics, microorganisms.
- Describe the principle usages of painkillers, antibiotics, vaccines and sedatives.

Information for Teachers

- Pharmacology is the study of drug sources, composition, properties and medical applications.
- Any substance that, when absorbed into the body of a living organism, alters normal body function is known as a drug.
- The drugs which are used in the diagnosis, cure, treatment, or prevention of disease are known as pharmaceutical or medicinal drugs.

Addictive drugs make person dependent on them, or addicted.

- Many drugs are obtained from plants and fungi (e.g. the antibiotic penicillin comes from a fungus, the cardiotonic digitalis - used to stimulate the heart - is made from the leaves of foxglove plant, the pain reliever morphine is made from the juice of the Opium).
- Drugs are also obtained from animals (e.g. fish liver oils, musk, bees' wax, certain hormones and antitoxins are obtained from animal sources).
- Several common drugs are produced from minerals (e.g. the mineral iodine is used in making tincture of iodine; the powder form of silver nitrate is rubbed onto wounds to stop bleeding and prevent infection).
- Many antibiotics e.g. streptomycin are obtained from bacteria, while some drugs are synthesized in the laboratory (e.g. aspirin).
- Drugs are classified on the basis of their chemical properties and modes of action. Analgesics (painkillers) reduce pain e.g. aspirin, paracetamol etc. Antibiotics inhibit or kill bacteria and treat bacterial infections e.g. tetracycline, cephalosporin etc. Sedatives induce sedation by reducing irritability or excitement e.g. diazepam.
- Vaccines are used to develop immunity against viral and bacterial infections e.g. vaccines against small pox, whooping cough, hepatitis B etc.
- Antiseptics reduce the possibility of infections on skin. Antibiotics destroy bacteria within the body. Disinfectants destroy microorganisms found on non-living objects.

Duration/Number of Periods

80 mins/ 2 Periods

Material/Resources Required

Board, chalk / marker, textbook

Introduction

- Conduct an interactive session for getting students' ideas about drugs. Ask them questions like the following:
  - Which drugs are usually present in your homes?
  - If anyone of you has visited a pharmacy, can you count the types of drugs present there?
  - Have you ever used antibiotics? What are the antibiotics used for?
- Write students' responses on board and conclude this discussion by providing them a comprehensive definition of "drug" and "pharmacology".

Development

Activity 1

- Explain the sources of drugs by drawing a table on board. Write the sources in the first column of table and the examples of drugs in the second column.

Sources of Drugs	Examples of Drugs
Plants and fungi	
Animals	
Minerals	
Bacteria	
Synthetic Drugs	

Activity 2

- Explain the classification of drugs on the basis of their chemical properties and modes of action. Conduct this session by drawing a table on board.

Type of Drug	Usage	Examples
Analgesics (painkillers)	Reduce pain	Aspirin, Paracetamol
Antibiotics	Inhibit or kill bacteria	Tetracycline, Cephalosporin
Sedatives	Induce sedation	Diazepam
Vaccines	Develop immunity against viral and becterial infections	Vaccines against small pox, whooping cough, hepatitis B

- Tell the students the usage of antiseptics and disinfectants so that they can differentiate these chemicals from antibiotics.

Conclusion/Sum up

- Ask students to recall the definitions of drug and pharmacology.
- Repeat the concept of pharmaceutical drug and addictive drugs.
- Revise the main sources of drugs i.e. plants, fungi, animals, minerals and bacteria.
- Ask a student to teach back the major classes of drugs i.e. analgesics (painkillers), antibiotics, sedatives and vaccines.

Assessment

- Ask the following questions:
  - Define drug and pharmacology.
  - Differentiate between pharmaceutical drugs and addictive drugs.
  - What are the usages of analgesics (painkillers), antibiotics, sedatives and vaccines?
  - From where is the drug aspirin obtained?

Follow-up

- Guide the students to solve the exercise problems given at the end of unit / chapter of the textbook.

Glossary

Addictive drug	The drug which makes person dependent on it, or addicted
Aerobic respiration	The respiration in which organic material (glucose) is completely oxidized in the presence of oxygen
AIDS	Acquired Immunity Deficiency Syndrome
Anaerobic respiration	The respiration in which organic material (glucose) is incompletely oxidized (in the absence of oxygen)
Analgesic	Painkiller medicine
Antibiotics	Drugs the kill bacteria or inhibit their growth
Apoptosis	Programmed cell death that is controlled by extracellular or intracellular signals
Aspirin	Drugs used as painkiller an anti-clotting
ATP	Adenosine Tri-Phosphate; the energy currency of the cellular metabolism
Bacteriophage	The virus that attacks a bacterium
Batch fermentation	Fermentation carried out in batches (with breaks)
Biotechnology	The use of living organisms in systems or processes for the manufacture of useful products or for services to mankind
Blebs	Broken pieces of cell during necrosis
Cardiotonic	Drug that strengthens heart muscles
Chiasmata	The interlocking of non-sister chromatids of homologous chromosomes
Chlorophyll	The green pigment, responsible for capturing light and its conversion into chemical energy
Chloroplast	The double membrane-bounded organelles responsible for photosynthesis
Chromatin	The chemical material of which the chromosomes are made of
Chromosome	The thread-like structures found in nucleus of the cell; composed of DNA and proteins
Codon	The sequence of nucleotides along the length of DNA; responsible for sequencing the amino acids during protein synthesis
Continuous fermentation	Fermentation that is carried out without any break and substrate are added continuously
Crossing over	The phenomenon in which the non-sister chromatids of homologous chromosomes exchange their segments
Cytokinesis	The division of the cytoplasm
Cytoskeleton	The tubular / filamentous network present in the cytoplasm of cell; responsible for cell support, movement etc.
Deduction	The logical consequences drawn out from hypothesis by taking it true
Diploid cell	The cell with complete set of chromosomes in pairs
Disinfectants	The drugs that destroy microorganisms found on non-living objects

DNA	Deoxyribonucleic Acid
Endonuclease	The enzyme used for cutting DNA at specific points
Fermentation	[illegible]
Fermenter	Device that provides optimum environment in which organisms can grow to produce biomass and can interact with a substrate, forming the product
G0 phase	A state of quiescence in cell cycle; the phase in which cells temporarily or permanently stop dividing
G1 phase	The phase in cell cycle in which protein and new organelles are synthesized and cell grows in size
G2 phase	The phase in cell cycle in which cell prepares proteins that are essential for division
Gene	The part of DNA (consisting of specific sequence of nucleotides) that has message for the synthesis of a protein or polypeptide
Genetic engineering	The artificial synthesis, modification, removal, addition and repair of the genetic material (DNA)
Glomerulus	The mass of blood capillaries in the nephron
Glycolysis	The breakdown of glucose molecule into 2 molecules of pyruvic acid
Haploid cell	The cell with half number of chromosomes (not in pairs)
HIV	Human Immunodeficiency Virus; responsible for AIDS
Homologous chromosomes	Chromosomes with almost the same set of genes and same size
Hypothesis	A tentative explanation for an observation, phenomenon, or scientific problem that can be tested by further tested
Inheritance	Study of the heridity
Interphase	The transmission of characters from one generation to the other
Karyokinesis	Division of the nucleus
Krebs cycle	The set of reactions in which the products of glycolysis are further oxidized (broken) to release energy
Ligase	Enzyme used to join the ends of DNA
Loop of funnel Henle:	U shaped portion of the renal tubule in the medulla
Messenger RNA	The RNA that carries message from DNA to ribosomes for translation (protein synthesis)
Mitosis	Cell division in which the daughter cells receive the same number of chromosomes as are present in parent cell
NADP	Nicotineamide adenine nucleotide phosphate: an electron carrier in photosynthesis
NADPH	The reduced form of NADPH
Necrosis	Accidental death of cells and living tissues
Nephron	The functional unit of nephron
Osmosis	The movement of water from low solute concentration area to high solute concentration, across a semi-permeable membrane
Phagocytes	The white blood cells that engulf the pathogens
Pharmacology	The study of drug sources, composition, properties and medical

Phloem	The plant tissue that transports food from sources to sinks
Plasmid	The extra-chromosomal DNA found in some bacteria
Polypeptide	Chains form of many amino acids
Reabsorption	The step in urine formation in which water, salts and glucose are reabsorbed from nephron to blood
Recombinant DNA	Collective name for plasmid and the gene of interest
Renal corpuscles	Collective name for glomerulus and Bowman's capsule
Respiration	The process in which organic molecule (glucose) is oxidized to release energy
S phase	The phase in cell cycle in which cell duplicates its chromosomes
Secretion	The step in urine formation in which urea are hydrogen ions etc. are secreted from blood into the glomerular fluid in nephron
Sedatives	Drugs that induce sedation by reducing irritability or excitement
Single Cell Protein	The protein content extracted from pure or mixed cultures of algae, yeasts, fungi or bacteria
Stomata	Pores present in the epidermis of leaves; work for the exchange of gases and water vapours
T-Cells	Types of white blood cells that recognize pathogens and kill them by various methods
Transpiration	The evaporation of water from the surface of plants
Transpiration pull	The pulling force created by the transpiration; responsible for the transport of water and salts in plants
Ultrafiltration	The step in urine formation in which urea, water, glucose etc. are filtered from blood (in glomerolus) into the Bowman's capsule of nephron
Vaccines	Medicines used to develop immunity against viral and bacterial infection
Vector	(In genetic engineering) Plasmid or bacteriophage used for carrying the gene of interest into a bacterium
Xylem	The plant tissue that transports water from roots to leaves