BIOLOGY

Grade IX-X

Teachers' Guide

Directorate of Staff Development, Wahdat Colony, Lahore.

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.

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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.
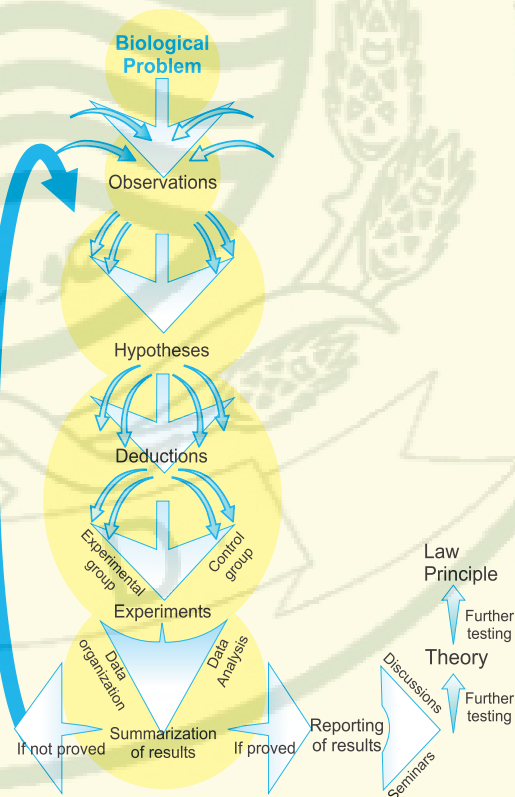
Activity 2

- 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.
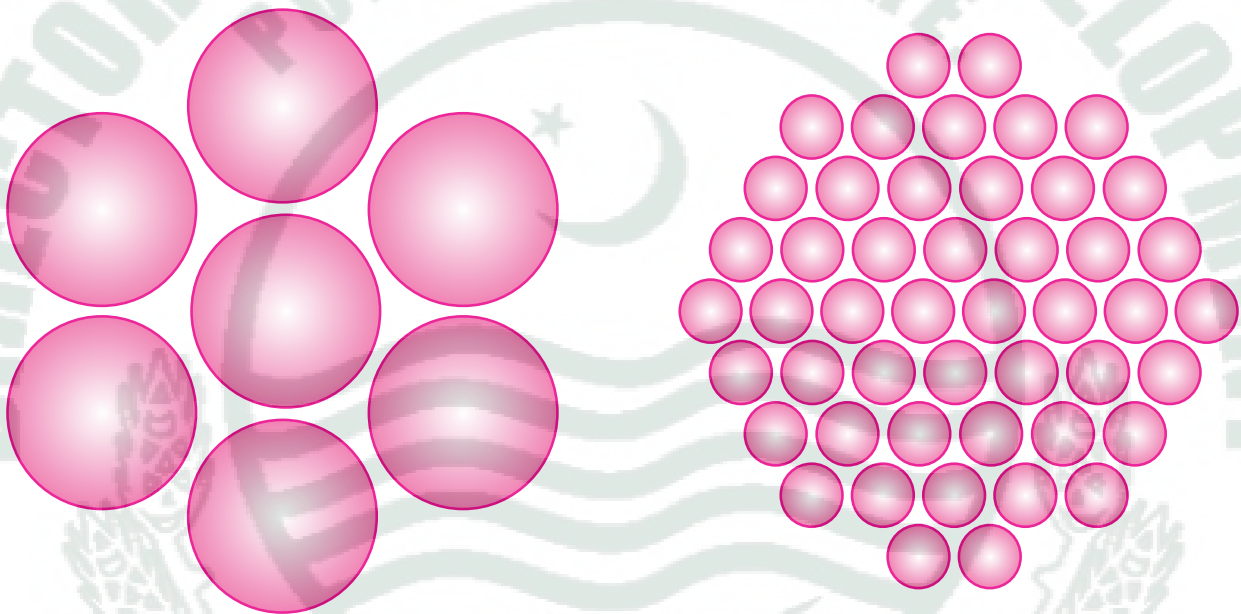
UNIT

4

Cells and Tissues

T O P I C

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 ($6 \times L^2$). 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 ($6 \times s \times s$)	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.
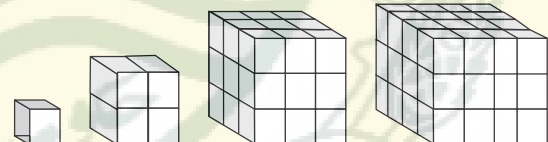
Case 1   Case 2   Case 3   Case 4

- 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 ($6 \times L^2$)	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 2.5 cm 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:

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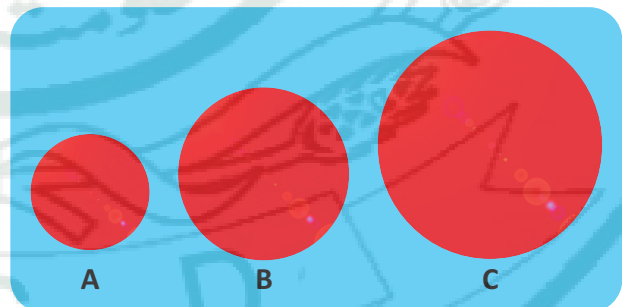
- Calculate their surface area volume ratio.
- Calculate how many small balls have the surface area equal to the largest ball.
- Evaluate, which condition is better for organisms either have smaller cells in large numbers or larger cells in lesser number.

UNIT

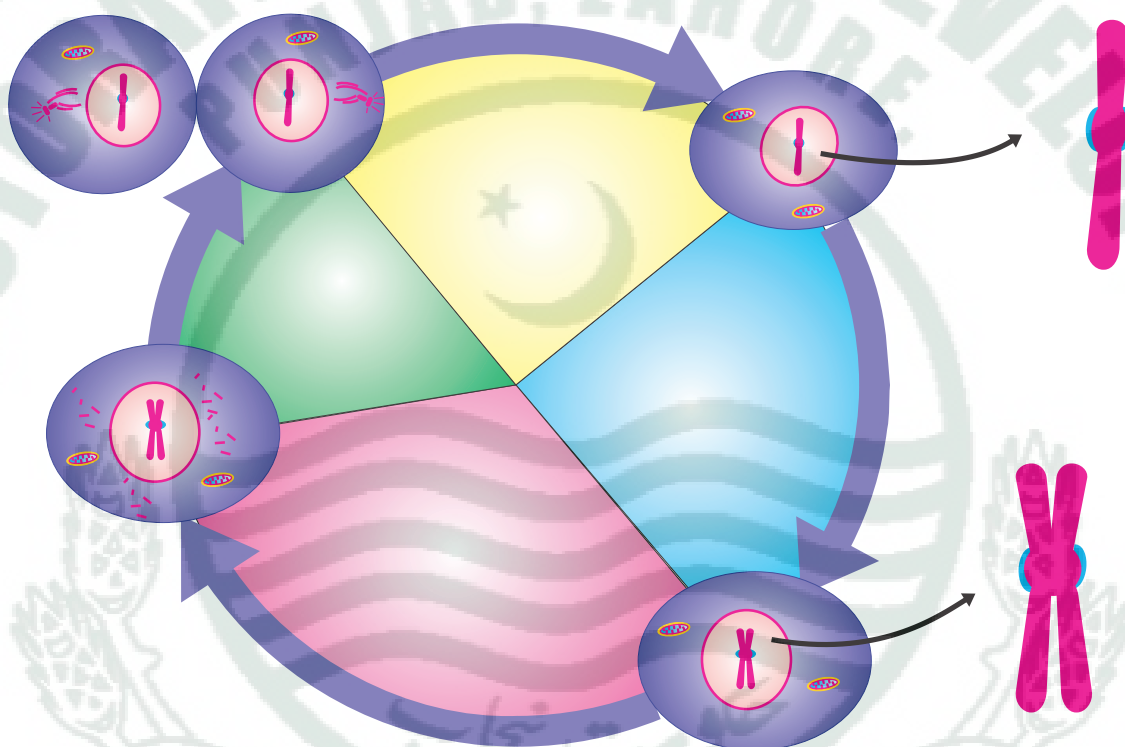**5**

Cell Cycle

T O P I C

# 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 G2 phase.
- 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.
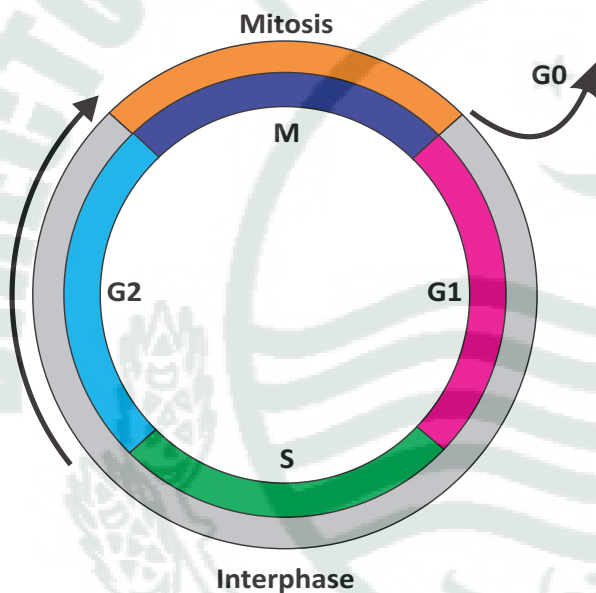
Interphase

- 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
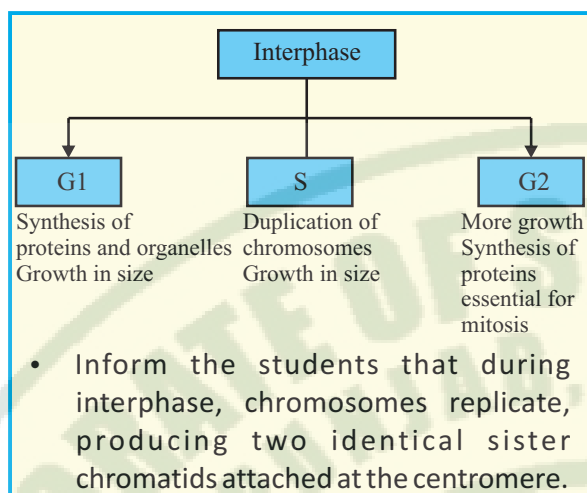
Introduction

- 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.
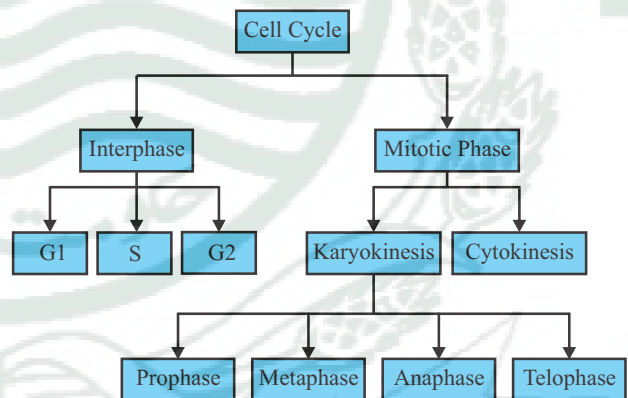

Development

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.
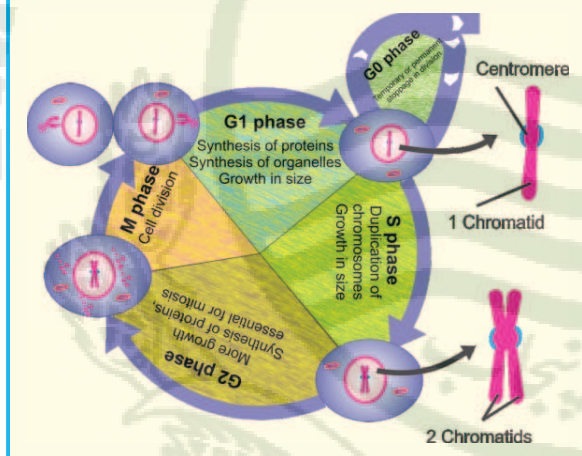
Activity 3

- 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.