Science

Science Grade 10

Curriculum Map

Topic C: Cycling of Matter in Living Systems

Resources Included: *Science in Context*

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User Guide

Curricular Topic

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Unit C: Cycling of Matter in Living Systems

Outcomes for Science, Technology & Society (STS) & Knowledge

Students will:

1. **Explain the relationship between developments in imaging technology and the current understanding of the cell**
    - trace the development of the cell theory: all living things are made up of one or more cells and the materials produced by these, cells are functional units of life, and all cells come from pre-existing cells *(e.g., from Aristotle to Hooke, Pasteur, Brown, and Schwann and Schleiden; recognize that there are sub-cellular particles, such as viruses and prions, which have some characteristics of living cells)*
    - describe how advancements in knowledge of cell structure and function have been enhanced and are increasing as a direct result of developments in microscope technology and staining techniques *(e.g., electron microscope, confocal laser scanning microscope [CLSM])*
    - identify areas of cell research at the molecular level *(e.g., DNA and gene mapping, transport across cell membranes)*

2. **Describe the function of cell organelles and structures in a cell, in terms of life processes, and use models to explain these processes and their applications**
    - compare passive transport of matter by diffusion and osmosis with active transport in terms of the particle model of matter, concentration gradients, equilibrium and protein carrier molecules*(e.g., particle model of matter and fluid-mosaic model)*
    - use models to explain and visualize complex processes like diffusion and osmosis, endo- and exocytosis, and the role of cell membrane in these processes
    - describe the cell as a functioning open system that acquires nutrients, excretes waste, and exchanges matter and energy

- identify the structure and describe, in general terms, the function of the cell membrane, nucleus, lysosome, vacuole, mitochondrion, endoplasmic reticulum, Golgi apparatus, ribosomes, chloroplast and cell wall, where present, of plant and animal cells
- compare the structure, chemical composition and function of plant and animal cells, and describe the complementary nature of the structure and function of plant and animal cells
- describe the role of the cell membrane in maintaining equilibrium while exchanging matter
- describe how knowledge about semi-permeable membranes, diffusion and osmosis is applied in various contexts*(e.g., attachment of HIV drugs to cells and liposomes, diffusion of protein hormones into cells, staining of cells, desalination of sea water, peritoneal or mechanical dialysis, separation of bacteria from viruses, purification of water, cheese making, use of honey as an antibacterial agent and berries as a preservative agent by traditional First Nations communities)*
- describe cell size and shape as they relate to surface area to volume ratio, and explain how that ratio limits cell size *(e.g., compare nerve cells and blood cells in animals, or plant root hair cells and chloroplast-containing cells on the surface of leaves)*

3. Analyze plants as an example of a multicellular organism with specialized structures at the cellular, tissue and system levels

- explain why, when a single-celled organism or colony of single-celled organisms reaches a certain size, it requires a multicellular level of organization, and relate this to the specialization of cells, tissues and systems in plants
- describe how the cells of the leaf system have a variety of specialized structures and functions; i.e., epidermis including guard cells, palisade tissue cells, spongy tissue cells, and phloem and xylem vascular tissue cells to support the process of photosynthesis
- explain and investigate the transport system in plants; i.e., xylem and phloem tissues and the processes of transpiration, including the cohesion and adhesion properties of water, turgor pressure and

osmosis; diffusion, active transport and root pressure in root hairs
- explain and investigate the gas exchange system in plants; i.e., lenticels, guard cells, stomata and the process of diffusion
- explain and investigate phototropism and gravitropism as examples of control systems in plants
- trace the development of theories of phototropism and gravitropism *(e.g., from Darwin and Boysen-Jensen to Went)*

Skill Outcomes

Initiating and Planning

Students will:

Ask questions about observed relationships, and plan investigations of questions, ideas, problems and issues

- define and delimit problems to facilitate investigation *(e.g., how do plants adjust to accommodate different environmental conditions such as varying levels of light and fertilizer)*
- design an experiment, identifying and controlling major variables *(e.g., design an investigation to determine the effect of $CO_{2(g)}$ concentration on the number of chloroplasts found in an aquatic plant cell)*
- state a prediction and a hypothesis based on available evidence and background information *(e.g., hypothesize how biochemical interconversions of starch and glucose might regulate the turgor pressure of cells; hypothesize the direction of root and plant growth of a bean plant growing on a rotating turntable, and predict the effects of varying RPMs on the angle of growth)*
- identify the theoretical basis of an investigation, and develop a prediction and a hypothesis that are consistent with the theoretical basis *(e.g., use the particle theory to hypothesize how the rate of diffusion is affected by varying particle size, and then predict the rates of diffusion of a sucrose solution and a starch solution when*

placed into dialysis tubing in a beaker of water)

- formulate operational definitions of major variables *(e.g., define concentration gradient, equilibrium)*

Performing and Recording

Students will:

Conduct investigations into relationships between and among observable variables, and use a broad range of tools and techniques to gather and record data and information

- carry out procedures, controlling the major variables and adapting or extending procedures *(e.g., perform an experiment to determine the effect of tonicity on plasmolysis and deplasmolysis in plant cells, such as staminal hairs or aquatic leaf cells, identify variables that do affect plasmolysis, such as the amount of light and heat, and control these variables)*
- use instruments effectively and accurately for collecting data *(e.g., use a microscope to observe movement of water in plants; prepare wet mounts of tissue from flowering plants, and observe cellular structures specific to plant and animal cells; stain cells to make them visible)*
- estimate quantities *(e.g., compare sizes of various types of cells under the microscope; calculate magnification, field of view and scale)*
- compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data *(e.g., organize data obtained from measuring daily temperature and bloom dates of plant species, such as aspen, poplar, common purple lilac and crocus to determine a relationship between the two variables)*
- use library and electronic research tools to collect information on a given topic *(e.g., upload and download text, image, audio and video files on emerging technologies for studying cells)*
- select and integrate information from various print and electronic sources or from several parts of the same source *(e.g., create*

electronic documents containing multiple links, or summarize articles based on the scientific principles and/or technological developments)

Analyzing and Interpreting

Students will:

Analyze data and apply mathematical and conceptual models to develop and assess possible solutions

- compile and display, by hand or computer, evidence and information in a variety of formats, including diagrams, flow charts, tables, graphs and scatterplots *(e.g., collect data on the number of stomata per unit area on various plant leaves that grow in areas of differing humidity, and compile this data in a spreadsheet and graph it to determine whether there is a relationship between the variables)*
- interpret patterns and trends in data, and infer or calculate linear and nonlinear relationships among variables *(e.g., compare the surface area to volume ratio of various cells, and relate the findings to the function of each cell; trace ingredients in modern medicines to their traditional counterparts)*
- state a conclusion based on experimental data, and explain how evidence gathered supports or refutes the initial hypothesis *(e.g., observe and record macroscopic and microscopic changes in a growing plant for evidence of differentiation)*
- explain how data support or refute a hypothesis or prediction
- construct and test a prototype of a device or system, and troubleshoot problems as they arise *(e.g., create a model of a cell to illustrate a certain function, for example, use a balloon and tape to represent a guard cell)*
- identify new questions or problems that arise from what was learned *(e.g., determine the purpose of cellular structures from observations of fresh and prepared materials, using dissecting and compound microscopes, or micrographs)*

Communication and Teamwork

Students will:

Work as members of a team in addressing problems, and apply the skills and conventions of science in communicating information and ideas and in assessing results

- communicate questions, ideas and intentions; and receive, interpret, understand, support and respond to the ideas of others *(e.g., describe cytoplasmic streaming in a single-celled organism, and communicate an inference about similar movement in the cells of a multicellular organism)*
- select and use appropriate numeric, symbolic, graphical and linguistic modes of representation to communicate ideas, plans and results *(e.g., draw analogies between division of labour in cells and in communities; record and explain the movement of water in plants)*

Attitude Outcomes

Interest in Science

Students will be encouraged to:

Show interest in science-related questions and issues, and confidently pursue personal interests and career possibilities within science related fields *(e.g., apply concepts learned in the classroom to everyday phenomena related to cells and multicellular organisms; investigate careers in fields, such as botany, forestry, horticulture, cytology, genetics and health care)*

Mutual Respect

Students will be encouraged to:

Appreciate that scientific understanding evolves from the interaction of ideas involving people with different views and backgrounds *(e.g., value the roles and contributions of men and women from many cultures in using science and technology to further our understanding of the cell and of living systems, recognize and appreciate the contributions of the traditional knowledge of Aboriginal peoples to science and technology)*

Scientific Inquiry

Students will be encouraged to:

Seek and apply evidence when evaluating alternative approaches to investigations, problems and issues (e.g., recognize that traditional Aboriginal cultures employed the principles of scientific inquiry through observation and experimentation to solve a variety of unique challenges)

Collaboration

Students will be encouraged to:

Work collaboratively in planning and carrying out investigations, as well as in generating and evaluating ideas (e.g., assume responsibility for their share of the work in preparing for investigations, gathering and recording data; consider alternative approaches suggested by group members)

Stewardship

Students will be encouraged to:

Demonstrate sensitivity and responsibility in pursuing a balance between the needs of humans and a sustainable environment (e.g., show care and respect for all forms of life; evaluate the impact on the environment of personal choices, as well as the choices scientists make when carrying out an investigation)

Safety

Students will be encouraged to:

Show concern for safety in planning, carrying out and reviewing activities (e.g., demonstrate concern for self and others in planning and carrying out experimental activities; select safe methods of collecting evidence and solving problems)

Section 1: General Reference

Aristotle: *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

Cell Division: *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

Cells: *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

Cell Structure and Function: *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

Cellular Respiration: *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

DNA: *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

HIV/AIDS: *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

Louis Pasteur: *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

Microscope: *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

Physiology (Plant): *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

Plants: *Science in Context:* Topic/definition page contains links to featured content, reference, biographies, images, news, videos, academic journals, magazine articles, and websites.

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"HIV infection of cell." *World of Anatomy and Physiology*. Gale, 2009. *Science in Context*. Web. 6 Nov. 2015.

"Leaf." *UXL Encyclopedia of Science*. Ed. Amy Hackney Blackwell and Elizabeth Manar. 3rd ed. Farmington Hills, MI: UXL, 2015. *Science in Context*. Web. 6 Nov. 2015.

Brief Description: A scanning electron micrograph of open stomata on the underside of a rose leaf. Stomata are breathing pores scattered over the leaf surface that regulate the exchange of gases between the leaf's interior and the atmosphere.

"Leaf chloroplasts." *Plant Sciences*. Ed. Richard Robinson. New York: Macmillan Reference USA, 2001. *Science in Context*. Web. 6 Nov. 2015.

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"Photosynthesis." *UXL Encyclopedia of Science*. Ed. Amy Hackney Blackwell and Elizabeth Manar. 3rd ed. Farmington Hills, MI: UXL, 2015. *Science in Context*. Web. 6 Nov. 2015.

Brief Description: A colorized scanning electron micrograph (SEM) image of a plant cell section shows a chloroplast (dark green), where photosynthesis takes place.

"Respiration, Cellular." *UXL Encyclopedia of Science*. Ed. Amy Hackney Blackwell and Elizabeth Manar. 3rd ed. Farmington Hills, MI: UXL, 2015.

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Section 7: Websites

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Brief Description: An interactive online experience that allows visitors to magnify organisms and cells and compare their size to the 2mm head of a pin.

"Illuminating Photosynthesis." *Nova Online.* Nov. 2001. *Gale Science in Context*. Detroit: Gale, 2010. Web. 6 Nov. 2015.

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"Online Digital Microscope." *Gale Science in Context*. Detroit: Gale, 2010. *Science in Context*. Web. 6 Nov. 2015.

"Planting Science." *Planting Science. American Science Foundation and Monsanto Fund. Gale Science in Context*. Detroit: Gale, 2010. *Science in Context*. Web. 6 Nov. 2015.

*Brief Description: **PlantingScience** is an online learning community where scientists provide online mentorship to student teams as they design and think through their own inquiry projects.*

"Water Movement Through a Plant." *Microscopy-UK*. *Gale Science in Context*. Detroit: Gale, 2010. *Science in Context*. Web. 6 Nov. 2015.

Section 8: Videos

"DNA." *BBC News* 7 June 2004. *Science in Context*. Web. 6 Nov. 2015.

"How DNA shapes evolution." *NOVA* 2013. *Science in Context*. Web. 6 Nov. 2015. A look at DNA and how heredity and mutations lead to change over time.

"Organelle overview." *Khan Academy* 24 Jan. 2014. *Science in Context*. Web. 31 July 2015.
Brief Description: Parts of a cell: nucleus, Golgi body, mitochondria, endoplasmic reticulum, vesicle, and vacuole.

"Oxidation and Reduction in Cellular Respiration." *Khan Academy* 1 Nov. 2011. *Science in Context*. Web. 6 Nov. 2015.

"Photosynthesis." *Khan Academy* 1 Nov. 2011. *Science in Context*. Web. 6 Nov. 2015.
Brief Description: Overview of photosynthesis.

"Photosynthesis: Calvin Cycle." *Khan Academy* 1 Nov. 2011. *Science in Context*. Web. 6 Nov. 2015.
Brief Description: The Calvin Cycle or the light-independent (dark) reactions of photosynthesis.

"Photosynthesis: Light Reactions 1." *Khan Academy* 1 Nov. 2011. *Science in Context*. Web. 29 July 2015.

Section 9: Case Study

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Section 10: Primary Source Material

Illustrations by Robert Hooke. Micrographia: Some physiological descriptions of minute bodies made by magnifying glasses. With observations and inquiries thereupon. London. 1665.

- Microscope and other scientific apparatus
- Microscopic View of an Ant
- Microscopic View of Blue Fly and Fly Wing
- Cellular structure of cork plant and cells of a honeycomb, with cork plant branch below
- Magnified View of Spores