

Unit B: Cells and Systems (Nature of Science Emphasis)

Overview: Living things take a variety of forms as reflected in their structures, internal processes and ways of responding to their environments. Finding pattern within this diversity has been a major challenge for the biological sciences and has led to the development of ideas, such as *systems*, *cells*, *structures* and *functions*—ideas developed from the study of all living things. Using these ideas, students learn to interpret life at a variety of levels, from individual cells to complex organisms. To develop their understanding, students investigate ways that components of a living system work together and, through these studies, learn that healthy organisms—including healthy humans—function as balanced systems within a life-supporting environment.

Focusing Questions: How can we make sense of the vast diversity of living things? What do living things have in common—from the smallest to the largest—and what variations do we find in the structure and function of living things?

Key Concepts

The following concepts are developed in this unit and may also be addressed in other units at other grade levels. The intended level and scope of treatment is defined by the outcomes below.

- organisms
- cells
- organs
- tissues
- structure and function
- systems
- response to stimuli
- health and environmental factors

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

Students will:

1. Investigate living things; and identify and apply scientific ideas used to interpret their general structure, function and organization
 - investigate and describe example scientific studies of the characteristics of living things (*e.g., investigate and describe an ongoing scientific study of a locally-found organism*)
 - apply the concept of system in describing familiar organisms and analyzing their general structure and function
 - illustrate and explain how different organisms have similar functions that are met in a variety of ways (*e.g., recognize food gathering as a common function of animals, and note a variety of food-gathering structures*)
2. Investigate and describe the role of cells within living things
 - describe the role of cells as a basic unit of life
 - analyze similarities and differences between single-celled and multicelled organisms (*e.g., compare, in general terms, an amoeba and a grizzly bear, a single-celled alga and a poplar tree*)
 - distinguish between plant and animal cells (*e.g., distinguish between cell walls and cell membranes*)
 - describe the movement of gases and liquids into and out of cells during diffusion and osmosis, based on concentration differences [*Note: This outcome requires a general understanding of processes, not a detailed analysis of mechanisms.*]
 - examine plant and animal structures; and identify contributing roles of cells, tissues and organs

3. Interpret the healthy function of human body systems, and illustrate ways the body reacts to internal and external stimuli
 - describe, in general terms, body systems for respiration, circulation, digestion, excretion and sensory awareness (*e.g., describe how blood is circulated throughout the body to carry oxygen and nutrients to the body's various tissues and organs*)
 - describe, in general terms, the role of individual organs and tissues in supporting the healthy functioning of the human body (*e.g., the role of lungs in exchanging oxygen and carbon dioxide, the role of bronchia in providing a passageway for air*)
 - describe ways in which various types of cells contribute to the healthy functioning of the human body (*e.g., describe the roles of individual cells in nerves, muscle, blood, skin and bone*)
 - describe changes in body functions in response to changing conditions (*e.g., changes in heart rate in response to exercise, change in metabolism in response to lower temperature, reflex responses to stimuli*)

4. Describe areas of scientific investigation leading to new knowledge about body systems and to new medical applications
 - identify examples of research into functions and dysfunctions of human cells, organs or body systems
 - describe ways in which research about cells, organs and systems has brought about improvements in human health and nutrition (*e.g., development of medicines; immunization procedures; diets based on the needs of organs, such as the heart*)
 - investigate and describe factors that affect the healthy function of the human respiratory, circulatory and digestive systems (*e.g., investigate the effect of illness, aging or air quality on the function of the respiratory system*)

Skill Outcomes (focus on scientific inquiry)

Initiating and Planning

Students will:

Ask questions about the relationships between and among observable variables, and plan investigations to address those questions

- identify questions to investigate (*e.g., identify questions that arise from their own observations of plant and animal diversity*)
- rephrase questions in a testable form (*e.g., rephrase a question, such as: "Why this structure?" to become questions, such as: "How is this structure used by the organism?", "How would the organism be affected if this structure were absent or did not function?" or "What similar structures do we find in other organisms?"*)
- formulate operational definitions of major variables and other aspects of their investigations (*e.g., define body systems in terms of the functions they perform*)

Performing and Recording

Students will:

Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data

- use instruments—including microscopes—effectively and accurately for collecting data (*e.g., use a microscope to produce a clear image of cells*)
- estimate measurements (*e.g., estimate the size of an object viewed under a microscope*)

- observe and record data, and produce simple line drawings (*e.g., draw cells and organisms*)
- organize data, using a format that is appropriate to the task or experiment (*e.g., compare the structure and function of two or more organisms, using charts and drawings*)

Analyzing and Interpreting

Students will:

Analyze qualitative and quantitative data, and develop and assess possible explanations

- identify strengths and weaknesses of different methods of collecting and displaying data (*e.g., compare methods of measuring heart rate*)
- identify and suggest explanations for discrepancies in data (*e.g., explain variations in the heart rate and blood pressure of the same individual at different times during the day*)
- compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs and line graphs (*e.g., prepare charts that compare structures of different organisms*)
- identify new questions and problems that arise from what was learned

Communication and Teamwork

Students will:

Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results

- receive, understand and act on the ideas of others (*e.g., adopt and use an agreed procedure for preparing diagrams and charts*)
- communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means
- work cooperatively with team members to develop and carry out a plan (*e.g., prepare a class presentation on the digestive system, including a model constructed by the group*)
- evaluate individual and group processes used in planning, problem solving, decision making and completing a task (*e.g., evaluate processes used in completing a cooperative group project*)

Attitude Outcomes

Interest in Science

Students will be encouraged to:

Show interest in science-related questions and issues, and pursue personal interests and career possibilities within science-related fields (*e.g., select and explore media on topics related to the diversity of living things and the maintenance of health; express interest in science-related/technology-related careers that contribute to the welfare of living things*)

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., recognize that a wide range of people working in different fields have contributed to scientific and medical knowledge*)

Scientific Inquiry

Students will be encouraged to:

Seek and apply evidence when evaluating alternative approaches to investigations, problems and issues (*e.g., consider a wide variety of possible interpretations of their observations of animal structures and functions; critically evaluate inferences and conclusions, basing their arguments on fact rather than opinion*)

Collaboration

Students will be encouraged to:

Work collaboratively in carrying out investigations and in generating and evaluating ideas (*e.g., assume responsibility for their share of work in preparing for investigations and in gathering and recording evidence; consider alternative ideas and approaches suggested by members of the group; share the responsibility for difficulties encountered in an activity*)

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 interest in the health of individuals in their family and community; assume personal responsibility for the impact of their actions on the health of others and for the welfare and survival of other living things*)

Safety

Students will be encouraged to:

Show concern for safety in planning, carrying out and reviewing activities (*e.g., wear proper safety attire, without having to be reminded; follow appropriate safety procedures in handling biological material; clean their work area during and after an activity; ensure the proper disposal of materials*)