

BIG IDEAS

Homeostasis

The body strives to maintain homeostasis.

DNA and Cells

All living things are made of cells, which contain DNA and cell structures that allow cells to survive and reproduce.

Organization

Organ systems have complex interrelationships to maintain homeostasis.

Learning Standards

Curricular Competencies	Content
<p><i>Students are expected to be able to do the following:</i></p> <p>Questioning and predicting</p> <ul style="list-style-type: none"> • Demonstrate a sustained intellectual curiosity about a scientific topic or problem of personal, local, or global interest • Make observations aimed at identifying their own questions, including increasingly abstract ones, about the natural world • Formulate multiple hypotheses and predict multiple outcomes <p>Planning and conducting</p> <ul style="list-style-type: none"> • Collaboratively and individually plan, select, and use appropriate investigation methods, including fieldwork and lab experiments, to collect reliable data (qualitative and quantitative) • Assess risks and address ethical, cultural, and/or environmental issues associated with their proposed methods • Use appropriate SI units and appropriate equipment, including digital technologies, to systematically and accurately collect and record data • Apply the concepts of accuracy and precision to experimental procedures and data: <ul style="list-style-type: none"> – significant figures – uncertainty – scientific notation 	<p><i>Students are expected to know the following:</i></p> <p>Homeostasis</p> <ul style="list-style-type: none"> • cellular compounds and biological molecules: <ul style="list-style-type: none"> – water – acids, bases, buffers – organic molecules: carbohydrates, lipids, proteins, nucleic acid, ATP • dehydration and synthesis reactions • enzymes and metabolic pathways: <ul style="list-style-type: none"> – models of enzymatic reactions – role of vitamins and coenzymes – effects on enzyme activity – metabolism • feedback loops regulate the body's internal environment: <ul style="list-style-type: none"> – positive feedback – negative feedback • structure of plasma membrane: <ul style="list-style-type: none"> – phospholipid bilayer – hydrophobic and hydrophilic regions – proteins • transport across a cell membrane: <ul style="list-style-type: none"> – selective permeability – factors that affect the rate of diffusion – tonicity • surface-area-to-volume ratio

Learning Standards (continued)

Curricular Competencies	Content
<p>Processing and analyzing data and information</p> <ul style="list-style-type: none"> • Experience and interpret the local environment • Apply First Peoples perspectives and knowledge, other ways of knowing, and local knowledge as sources of information • Seek and analyze patterns, trends, and connections in data, including describing relationships between variables, performing calculations, and identifying inconsistencies • Construct, analyze, and interpret graphs, models, and/or diagrams • Use knowledge of scientific concepts to draw conclusions that are consistent with evidence • Analyze cause-and-effect relationships <p>Evaluating</p> <ul style="list-style-type: none"> • Evaluate their methods and experimental conditions, including identifying sources of error or uncertainty, confounding variables, and possible alternative explanations and conclusions • Describe specific ways to improve their investigation methods and the quality of the data • Evaluate the validity and limitations of a model or analogy in relation to the phenomenon modelled • Demonstrate an awareness of assumptions, question information given, and identify bias in their own work and in primary and secondary sources • Consider the changes in knowledge over time as tools and technologies have developed • Connect scientific explorations to careers in science • Exercise a healthy, informed skepticism and use scientific knowledge and findings to form their own investigations to evaluate claims in primary and secondary sources • Consider social, ethical, and environmental implications of the findings from their own and others' investigations • Critically analyze the validity of information in primary and secondary sources and evaluate the approaches used to solve problems • Assess risks in the context of personal safety and social responsibility 	<p>DNA and Cells</p> <ul style="list-style-type: none"> • cell structures and functions • interrelationship of cell structures • DNA carries the cell's genetic information: <ul style="list-style-type: none"> – process of DNA replication – process of protein synthesis – effects of DNA mutations – genomics – biotechnology, cloning, and recombinant DNA <p>Organization</p> <ul style="list-style-type: none"> • levels of organization • tissues are organized into four groups • organs within each of the systems are interconnected to maintain homeostasis: <ul style="list-style-type: none"> – digestive system – cardiovascular and lymphatic system – respiratory system – urinary system – reproductive system – nervous system • functional interrelationships exist among body systems • nutrition and lifestyle differences affect human health • First Peoples holistic approach to health • medical conditions may affect body systems

Learning Standards (continued)

Curricular Competencies	Content
<p>Applying and innovating</p> <ul style="list-style-type: none"> • Contribute to care for self, others, community, and world through individual or collaborative approaches • Co-operatively design projects with local and/or global connections and applications • Contribute to finding solutions to problems at a local and/or global level through inquiry • Implement multiple strategies to solve problems in real-life, applied, and conceptual situations • Consider the role of scientists in innovation <p>Communicating</p> <ul style="list-style-type: none"> • Formulate physical or mental theoretical models to describe a phenomenon • Communicate scientific ideas, information, and perhaps a suggested course of action, for a specific purpose and audience, constructing evidence-based arguments and using appropriate scientific language, conventions, and representations • Express and reflect on a variety of experiences, perspectives, and worldviews through place 	

Big Ideas – Elaborations

Homeostasis

Sample opportunities to support student inquiry:

- How does the body maintain homeostasis in extreme environments?
- What processes allow the body to maintain constant body temperature?
- How does the body maintain internal balance during exercise?
- How has First Peoples' understanding of the body helped to inform us on how we can lead healthy lives?

DNA and Cells

Sample opportunities to support student inquiry:

- How do cells differentiate to create unique and interconnected body systems?
- How do mutations benefit or disadvantage individuals?

Organization

Sample opportunities to support student inquiry:

- What is the advantage of having specialized tissues?
- How does the body work to prevent new emergent diseases, such as the Zika virus or avian flu?
- What diet/nutrition plan(s) should be considered for lifelong health?

Curricular Competencies – Elaborations

Questioning and predicting:

- **intellectual curiosity:**
 - How can the study of genomics help improve/extend quality of life?
 - Why are some people unable to digest certain foods (e.g., lactose intolerance, gluten intolerance, etc.)?
 - How does caffeine affect the brain?
- **Make observations:**
 - Strip the shell off of an egg (using acetic acid) and observe the effects of different liquids on the diffusion rate.
 - Examine healthy lung tissue and smoker's lung tissue under the microscope to observe differences.
- **Identifying their own questions:** How are local plants used to help maintain a healthy lifestyle?
- **multiple hypotheses:** Based on your understanding of cells and the plasma membrane, hypothesize how salmon can live in both freshwater and saltwater environments during their lifecycle.

Curricular Competencies – Elaborations

Planning and conducting:

- **Collaboratively and individually plan, select, and use appropriate investigation methods:**
 - Design an experiment to test how catalase (from liver) activity changes in the presence of different amounts of catalase or hydrogen peroxide.
 - Plan an experiment to safely determine a person’s reaction time in a reflex response.
- **lab experiments:** Design an experiment to safely test the effects of varying amounts of exercise on the respiratory and circulatory systems.
- **Assess risks and address ethical:**
 - Assess advantages and disadvantages of cloning or growing body parts for transplant.
 - What are some risks and ethical issues associated with making a diet plan for yourself or someone else?

Processing and analyzing data and information:

- **Apply First Peoples perspectives:** For example:
 - Bears and salmon have special significance in many BC First Peoples cultures. Both have specialized homeostatic mechanisms. What happens to the body system of bears when they hibernate? How can salmon survive in both fresh and salt water at different points in their life cycle?
 - What are some possible health conditions that may be treated with traditional First Peoples medicinal teas? Which body systems might be affected?
- **Seek and analyze patterns:** How do EKG readings from healthy individuals look compared with those from individuals who have arrhythmia or other cardiac conditions?
- **connections in data:** Compare and contrast cells from different body systems using microscopy. How is structure related to function?
- **Construct, analyze, and interpret graphs:**
 - Construct graphs to show how different amounts of hydrogen peroxide affect catalase (from liver activity).
 - Collect and graphically display information about the amount of antioxidants found in local plants that are used for medicinal purposes.
- **cause-and-effect relationships:** Describe how the inclusion or exclusion of certain foods can have a direct impact on the health of the digestive and/or excretory systems (e.g., lack of dietary fibre and its link to the incidence of type 2 diabetes and colon cancer; hypertension and its link to kidney function).

Evaluating:

- **ways to improve their investigation:** After completing the liver catalase lab, examine how the method could be changed to increase accuracy about catalase activity.
- **validity and limitations:** Identify the limitations of the induced-fit and lock-and-key models of enzymatic activity.
- **changes in knowledge over time:** How can knowledge of your own genome affect your potential future application for life insurance?
- **tools and technologies:** How has DNA sequencing changed our understanding of DNA?
- **scientific explorations to careers in science:** How can biotechnology and genomics be used to help with exploration in extreme environments (e.g., Mars, ISS, the moon)?
- **healthy, informed skepticism:**
 - Evaluate the effects of nutritional diets and fads.
 - Evaluate the risks and benefits of vaccination or safe-injection sites.
- **Assess risks:**
 - Evaluate the individual and societal risks of cloning body parts for organ transplants.
 - What are some risks involved in making and using medicinal teas without guidance?

Curricular Competencies – Elaborations

Applying and innovating:

• **Contribute to care for self, others, community:**

- Design a project that can reduce pathogens in your community, such as fundraising for providing hand sanitizers in playgrounds or sharps disposal containers in all public washrooms.
- Help promote brain function by developing puzzle games such as word puzzles, sudoku, or KenKen grids that can be shared with a local elder care or other facility in your community.

• **design projects:** Develop a safe dietary plan for a high-performance athlete. How does it compare to a safe dietary plan for an average high school student?

• **local and/or global connections:** How might biotechnology be used to help maximize crop yields in the local and/or global community?

• **finding solutions:**

- How might medicinal teas be blended to aid in improving overall health?
- Who might you approach for help or advice on making medicinal teas?

Communicating:

• **Communicate scientific ideas, information, and perhaps a suggested course of action:** For example:

- How could you market a dietary plan to an appropriate audience?
- Using evidence, develop a public service announcement that highlights the importance of healthy, safe options for teenagers.
- What would be some appropriate ways to share your findings with elementary and middle school students about the importance of wearing a helmet when skateboarding (or engaging in other sports)?

• **perspectives:** There are many alternative medicine approaches. Research an approach that is not commonly found in “mainstream” medicine. How is this approach effective?

Content – Elaborations

Homeostasis

- **water:** solvent, temperature regulator, and lubricant; polarity and hydrogen bonding
- **dehydration and synthesis reactions:** maltase, lactase, carbonic anhydrase
- **enzymes:** metabolism, enzyme, substrate, coenzyme, activation energy
- **metabolic pathways:** cellular respiration, glycolysis, fermentation, photosynthesis
- **models:** induced fit, lock and key
- **effects on enzyme activity:** pH, temperature, substrate concentration, enzyme concentration, competitive inhibitors, non-competitive inhibitors, heavy metal poisoning, lactose intolerance
- **feedback loops:** temperature regulation, CO₂ levels in blood, sweating, oxytocin in childbirth, acidosis, lactic acid

Content – Elaborations

- **transport:** diffusion, osmosis, facilitated transport, active transport, endocytosis, exocytosis
- **rate of diffusion:** temperature, size of molecule, charge of molecule, concentration gradient, pressure gradient
- **tonicity:** hypertonic, hypotonic, isotonic

DNA and Cells

- **effects:** sickle cell disease, hemophilia, cancers
- **mutations:** insertion, deletion, substitution, frameshift, missense, duplication
- **genomics:** human genome project, 1000 Genomes Project, 1000 Plant Genomes Project, personal genomics
- **biotechnology:** GMOs, transgenic organisms
- **recombinant DNA:** genetic modification, gene therapy

Organization

- **levels of organization:** cells, tissues, organs, organ systems
- **tissues:** epithelial, connective, muscular, nervous
- **organs:** basic structure, function, identity, and location in the body
- **digestive system:**
 - mechanical and physical digestion
 - function of insulin in maintaining blood sugar levels
 - bicarbonate as a buffer
 - digestive enzymes break down the components of food, including carbohydrates, proteins, nucleic acids, and fats
 - role of E. coli in the stomach
 - production of hormones such as gastrin, secretin, and CCK
- **cardiovascular and lymphatic:**
 - regulation of blood pH
 - selective uptake and release of O₂ and CO₂ related to pH and temperature
 - components of blood
 - interrelationships between vessels of the circulatory system
 - heart rate and blood pressure
 - fetal and adult circulatory systems
 - relationship between the lymphatic and cardiovascular systems
 - body's defence against pathogens
 - antigens and antibodies
 - inflammatory response
 - adaptive immunity
- **respiratory:**
 - mechanism of respiration

Content – Elaborations

- external and internal respiration
- carbon monoxide versus carbon dioxide
- arterial blood versus venous blood
- **urinary:**
 - anatomy of the kidney and urine formation
 - components of the nephron
 - urine production
 - kidneys and blood pH
 - homeostasis of water and sodium levels in blood (role of ADH, ANH, and aldosterone)
 - regulation of blood pressure and volume
- **reproductive:**
 - components of seminal fluid
 - hormonal regulation of GnRH, FSH, ICSH, and testosterone
 - ovarian and uterine cycles
 - menstruation, fertilization, and pregnancy
 - lactation
 - menopause
- **nervous:**
 - transmission of nerve impulses
 - impulse transmission across a synapse
 - neurotransmitters
 - CNS and PNS
 - somatic and autonomic nervous systems
 - parts of the brain
 - sympathetic and parasympathetic divisions
- **interrelationships:** Compare at least four body systems in depth:
 - nutrients are absorbed in the small intestine and carried through the blood capillaries
 - the lymphatic system helps to return excess tissue fluid to the bloodstream, absorb fats from the digestive tract and return them to the bloodstream, and defend against diseases
 - role of ADH, ANH, and aldosterone in the homeostasis of water and sodium levels in blood
- **lifestyle differences:** diet plans, exercise, sleep, smoking, salt intake, alcohol consumption, drugs, vaccinations, contraception, fertility drugs
- **holistic:** health care that integrates mind, body, and spirit with community
- **medical conditions:** Diseases occur when one or more body systems fail to maintain homeostasis (e.g., ulcers, gallstones, lactose intolerance, Crohn's disease, diabetes, stroke, heart attack, hypertension, emphysema, cystic fibrosis, pneumonia, kidney failure, kidney stones, prostate cancer, erectile dysfunction, testicular cancer, endometriosis, infertility, Lyme disease, Alzheimer's disease, Parkinson's disease, multiple sclerosis, meningitis, amyotrophic lateral sclerosis, myasthenia gravis).