Expectations for SBI4U

	A. SCIENTIFIC INVESTIGATION SKILLS AND CAREER EXPLORATION
	OVERALL EXPECTATIONS
	A1. demonstrate scientific investigation skills (related to both inquiry and research) in the four areas of skills (initiating and planning, performing and recording, analysing and interpreting, and communicating);
	A2. identify and describe careers related to the fields of science under study, and describe contributions of scientists, including Canadians, to those fields.
	SPECIFIC EXPECTATIONS
	A1. Scientific Investigation Skills
	Initiating and Planning [IP]*
	A1.1 formulate relevant scientific questions about observed relationships, ideas, problems, or issues, make informed predictions, and/or formulate educated hypotheses to focus inquiries or research
	A1.2 select appropriate instruments (e.g., dialysis tubing, glassware, sphygmomanometer) and materials (e.g., DNA models, plants, plant cuttings, molecular models), and identify appropriate methods, techniques, and procedures, for each inquiry
	A1.3 identify and locate a variety of print and electronic sources that enable them to address research topics fully and appropriately
	A1.4 apply knowledge and understanding of safe laboratory practices and procedures when planning investigations by correctly interpreting Workplace Hazardous Materials Information System (WHMIS) symbols; by using appropriate techniques for handling and storing laboratory equipment and materials and disposing of laboratory and biological materials (e.g., plants and invertebrates); and by using appropriate personal protection
	Performing and Recording [PR]*
	A1.5 conduct inquiries, controlling relevant variables, adapting or extending procedures as required, and using appropriate materials and equipment safely, accurately, and effectively, to collect observations and data
	A1.6 compile accurate data from laboratory and other sources, and organize and record the data, using appropriate formats, including tables, flow charts, graphs, and/or diagrams
	A1.7 select, organize, and record relevant information on research topics from a variety of appropriate sources, including electronic, print, and/or human sources, using suitable formats and an accepted form of academic documentation
	*Analyzing and Interpreting [AI]**
	A1.8 synthesize, analyse, interpret, and evaluate qualitative and/or quantitative data to determine whether the evidence supports or refutes the initial prediction or hypothesis and whether it is consistent with scientific theory; identify sources of bias and/or error; and suggest improvements to the inquiry to reduce the likelihood of error
	A1.9 analyse the information gathered from research sources for logic, accuracy, reliability, adequacy, and bias
	A1.10 draw conclusions based on inquiry results and research findings, and justify their conclusions with reference to scientific knowledge
	Communicating [C]*
	A1.11 communicate ideas, plans, procedures, results, and conclusions orally, in writing, and/or in electronic presentations, using appropriate language and a variety of formats (e.g., data tables, laboratory reports, presentations, debates, simulations, models)
	A1.12 use appropriate numeric, symbolic, and graphic modes of representation (e.g., biological diagrams, three-dimensional molecular models), and appropriate units of measurement (e.g., SI and imperial units)
	A1.13 express the results of any calculations involving data accurately and precisely, to the appropriate number of decimal places or significant figures
	A2. Career Exploration
	A2.1 identify and describe a variety of careers related to the fields of science under study (e.g., scientific journalist, fisheries and wildlife officer, physician, infectious disease researcher, geneticist) and the education and training necessary for these careers
	A2.2 describe the contributions of scientists, including Canadians (e.g., Evelyn Roden Nelson, Maude Menten, Albert Juan Aguayo, Kimberley J. Fernie, Michael Archer), to the fields under study
	B. Biochemistry
	OVERALL EXPECTATIONS
	B1. analyse technological applications of enzymes in some industrial processes, and evaluate technological advances in the field of

	cellular biology;
	B2. investigate the chemical structures, functions, and chemical properties of biological molecules involved in some common cellular processes and biochemical reactions;
	B3. demonstrate an understanding of the structures and functions of biological molecules, and the biochemical reactions required to maintain normal cellular function.
	SPECIFIC EXPECTATIONS
	B1. Relating Science to Technology, Society, and the Environment
	B1.1 analyse technological applications related to enzyme activity in the food and pharmaceutical industries (e.g., the production of dairy products; breadmaking; the use of enzymes to control reaction rates in pharmaceuticals) [AI, C]
	B1.2 evaluate, on the basis of research, some advances in cellular biology and related technological applications (e.g., new treatments for cancer, HIV/AIDS, and hepatitis C; radioisotopic labelling to study the function of internal organs; fluorescence to study genetic material within cells; forensic biological techniques to aid in crime resolution)
	B2. Developing Skills of Investigation and Communication
	B2.1 use appropriate terminology related to biochemistry, including, but not limited to: *active and passive transport, covalent and ionic bond, allosteric site, substrate, substrate-enzyme complex,* and *inhibition* [C]
	B2.2 plan and conduct an investigation to demonstrate the movement of substances across a membrane (e.g., the effects of salt water and distilled water on a potato) [IP, PR]
	B2.3 construct and draw three-dimensional molecular models of important biochemical compounds, including carbohydrates, proteins, lipids, and nucleic acids [PR, C]
	B2.4 conduct biological tests to identify biochemical compounds found in various food samples (e.g., use Benedict's solution to test for carbohydrates in food samples), and compare the biochemical compounds found in each food to those found in the others [PR, AI, C]
	B2.5 plan and conduct an investigation related to a cellular process (e.g., factors that affect enzyme activity; factors that affect transport of substances across cell membranes), using appropriate laboratory equipment and techniques, and report the results in an appropriate format [IP, PR, C]
	B3. Understanding Basic Concepts
	B3.1 explain the roles of various organelles, such as lysosomes, vacuoles, mitochondria, internal cell membranes, ribosomes, smooth and rough endoplasmic reticulum, and Golgi bodies, in cellular processes
	B3.2 describe the structure of important biochemical compounds, including carbohydrates, proteins, lipids, and nucleic acids, and explain their function within cells
	B3.3 identify common functional groups within biological molecules (e.g., hydroxyl, carbonyl, carboxyl, amino, phosphate), and explain how they contribute to the function of each molecule
	B3.4 describe the chemical structures and mechanisms of various enzymes
	B3.5 identify and describe the four main types of biochemical reactions (oxidation-reduction [redox], hydrolysis, condensation, and neutralization)
	B3.6 describe the structure of cell membranes according to the fluid mosaic model, and explain the dynamics of passive transport, facilitated diffusion, and the movement of large particles across the cell membrane by the processes of endocytosis and exocytosis
	C. **Metabolic Processes**
	OVERALL EXPECTATIONS
	C1. analyse the role of metabolic processes in the functioning of biotic and abiotic systems, and evaluate the importance of an understanding of these processes and related technologies to personal choices made in everyday life;
	C2. investigate the products of metabolic processes such as cellular respiration and photosynthesis;
	C3. demonstrate an understanding of the chemical changes and energy conversions that occur in metabolic processes.
	SPECIFIC EXPECTATIONS
	C1. Relating Science to Technology, Society, and the Environment
	C1.1 analyse the role of metabolic processes in the functioning of and interactions between biotic and abiotic systems (e.g., specialized microbes and enzymes in biotechnological applications to treat wastewater in the pulp and paper industry; microbes and enzymes in bioremediation, such as in the cleanup of oil spills; energy transfer from producers to consumers) [AI, C]
	C1.2 assess the relevance, to their personal lives and to the community, of an understanding of cell biology and related technologies (e.g., knowledge of metabolic processes is relevant to personal choices about exercise, diet, and the use of pharmacological substances; knowledge of cellular processes aids in our understanding and treatment of mitochondrial diseases [a group of neuromuscular diseases]) [AI, C]
	C2. Developing Skills of Investigation and Communication
	C2.1 use appropriate terminology related to metabolism, including, but not limited to: *energy carriers, glycolysis, Krebs cycle, electron*

	transport chain, ATP synthase, oxidative phosphorylation, chemiosmosis, proton pump, photolysis, Calvin cycle, light and dark reactions, and *cyclic and noncyclic phosphorylation* [C]
	C2.2 conduct a laboratory investigation into the process of cellular respiration to identify the products of the process, interpret the qualitative observations, and display them in an appropriate format [PR, AI, C]
	C2.3 conduct a laboratory investigation of the process of photosynthesis to identify the products of the process, interpret the qualitative observations, and display them in an appropriate format [PR, AI, C]
	C3. Understanding Basic Concepts
	C3.1 explain the chemical changes and energy conversions associated with the processes of aerobic and anaerobic cellular respiration (e.g., in aerobic cellular respiration, glucose and oxygen react to produce carbon dioxide, water, and energy in the form of heat and ATP; in anaerobic cellular respiration, yeast reacts with glucose in the absence of oxygen to produce carbon dioxide and ethanol)
	C3.2 explain the chemical changes and energy conversions associated with the process of photosynthesis (e.g., carbon dioxide and water react with sunlight to produce oxygen and glucose)
	C3.3 use the laws of thermodynamics to explain energy transfer in the cell during the processes of cellular respiration and photosynthesis
	C3.4 describe, compare, and illustrate (e.g., using flow charts) the matter and energy transformations that occur during the processes of cellular respiration (aerobic and anaerobic) and photosynthesis, including the roles of oxygen and organelles such as mitochondria and chloroplasts
	D. Molecular Genetics
	OVERALL EXPECTATIONS
	D1. analyse some of the social, ethical, and legal issues associated with genetic research and biotechnology;
	D2. investigate, through laboratory activities, the structures of cell components and their roles in processes that occur within the cell;
	D3. demonstrate an understanding of concepts related to molecular genetics, and how genetic modification is applied in industry and agriculture.
	SPECIFIC EXPECTATIONS
	D1. Relating Science to Technology, Society, and the Environment
	D1.1 analyse, on the basis of research, some of the social, ethical, and legal implications of biotechnology (e.g., the bioengineering of animal species, especially those intended for human consumption; the cultivation of transgenic crops; the patenting of life forms; cloning) [IP, PR, AI, C]
	D1.2 analyse, on the basis of research, some key aspects of Canadian regulations pertaining to biotechnology (e.g., current or potential legislation for mandatory DNA fingerprinting, human cloning, ownership of a genome, patenting of genetically modified organisms), and compare them to regulations from another jurisdiction [IP, PR, AI, C]
	D2. Developing Skills of Investigation and Communication
	D2.1 use appropriate terminology related to molecular genetics, including, but not limited to: *polymerase I, II, and III, DNA ligase, helicase, Okazaki fragment, mRNA, rRNA, tRNA, codon, anticodon, translation, transcription,* and *ribosome subunits* [C]
	D2.2 analyse a simulated strand of DNA to determine the genetic code and base pairing of DNA (e.g., determine base sequences of DNA for a protein; analyse base sequences in DNA to recognize an anomaly) [AI]
	D2.3 conduct an investigation to extract DNA from a specimen of plant or animal protein [PR]
	D2.4 investigate and analyse the cell components involved in the process of protein synthesis, using appropriate laboratory equipment and techniques, or a computer simulation [PR, AI]
	D3. Understanding Basic Concepts
	D3.1 explain the current model of DNA replication, and describe the different repair mechanisms that can correct mistakes in DNA sequencing
	D3.2 compare the structures and functions of RNA and DNA, and explain their roles in the process of protein synthesis
	D3.3 explain the steps involved in the process of protein synthesis and how genetic expression is controlled in prokaryotes and eukaryotes by regulatory proteins (e.g., the role of operons in prokaryotic cells; the mechanism of gene expression in eukaryotic cells)
	D3.4 explain how mutagens, such as radiation and chemicals, can cause mutations by changing the genetic material in cells (e.g., the mechanisms and effects of point mutations and frameshift mutations)
	D3.5 describe some examples of genetic modification, and explain how it is applied in industry and agriculture (e.g., the processes involved in cloning, or in the sequencing of DNA bases; the processes involved in the manipulation of genetic material and protein synthesis; the development and mechanisms of the polymerization chain reaction)
	D3.6 describe the functions of some of the cell components used in biotechnology (e.g., the roles of plasmids, restriction enzymes, recombinant DNA, and vectors in genetic engineering)
	D3.7 describe, on the basis of research, some of the historical scientific contributions that have advanced our understanding of

	molecular genetics (e.g., discoveries made by Frederick Griffith, Watson and Crick, Hershey and Chase)
	E. Homeostasis
	OVERALL EXPECTATIONS
	E1. evaluate the impact on the human body of selected chemical substances and of environmental factors related to human activity;
	E2. investigate the feedback mechanisms that maintain homeostasis in living organisms;
	E3. demonstrate an understanding of the anatomy and physiology of human body systems, and explain the mechanisms that enable the body to maintain homeostasis.
	SPECIFIC EXPECTATIONS
	E1. Relating Science to Technology, Society, and the Environment
	E1.1 assess, on the basis of findings from a case study, the effects on the human body of taking chemical substances to enhance performance or improve health (e.g., the risks and benefits of taking large quantities of vitamins or amino acids; the effects on the human body of substances that people use to cope with stress) [PR, AI, C]
	E1.2 evaluate, on the basis of research, some of the human health issues that arise from the impact of human activities on the environment (e.g., the effects of synthetic estrogen compounds released into our water systems; the effects of leaching of compounds from plastic products into soil and water) [IP, PR, AI, C]
	E2. Developing Skills of Investigation and Communication
	E2.1 use appropriate terminology related to homeostasis, including, but not limited to: *insulin, testosterone, estrogen, nephron, dialysis, pituitary, synapse,* and *acetylcholine* [C]
	E2.2 plan and construct a model to illustrate the essential components of the homeostatic process (e.g., create a flow chart that illustrates representative feedback mechanisms in living things) [IP, AI, C]
	E2.3 plan and conduct an investigation to study a feedback system (e.g., stimulus response loop) [IP, PR, AI]
	E2.4 plan and conduct an investigation to study the response mechanism of an invertebrate to external stimuli (e.g., the instinctive behaviour of an invertebrate in response to a stimulus such as light), using appropriate laboratory equipment and techniques [IP, PR, AI]
	E3. Understanding Basic Concepts
	E3.1 describe the anatomy and physiology of the endocrine, excretory, and nervous systems, and explain how these systems interact to maintain homeostasis
	E3.2 explain how reproductive hormones act in human feedback mechanisms to maintain homeostasis (e.g., the actions of male and female reproductive hormones on their respective body systems)
	E3.3 describe the homeostatic processes involved in maintaining water, ionic, thermal, and acid–base equilibrium, and explain how these processes help body systems respond to both a change in environment and the effects of medical treatments (e.g., the role of feedback mechanisms in water balance or thermoregulation; how the buffering system of blood maintains the body's pH balance; the effect of medical treatments on the endocrine system; the effects of chemotherapy on homeostasis)
	F. Population Dynamics
	OVERALL EXPECTATIONS
	F1. analyse the relationships between population growth, personal consumption, technological development, and our ecological footprint, and assess the effectiveness of some Canadian initiatives intended to assist expanding populations;
	F2. investigate the characteristics of population growth, and use models to calculate the growth of populations within an ecosystem;
	F3. demonstrate an understanding of concepts related to population growth, and explain the factors that affect the growth of various populations of species.
	F1 Relating Science to Technology, Society, and the Environment
	F1.1 analyse the effects of human population growth, personal consumption, and technological development on our ecological footprint (e.g., the deforestation resulting from expanding development and demand for wood products causes the destruction of habitats that support biological diversity; the acidification of lakes associated with some industrial processes causes a decrease in fish populations) [AI, C]
	F1.2 assess, on the basis of research, the effectiveness of some Canadian technologies and projects intended to nourish expanding populations (e.g., the risks and benefits of growing genetically modified canola; some of the sustainable development projects funded by the Canadian International Development Agency [CIDA]) [IP, PR, AI, C]
	F2 Developing Skills of Investigation and Communication

	F2.1 use appropriate terminology related to population dynamics, including, but not limited to: *carrying capacity*, *population growth*, *population cycle*, *fecundity*, and *mortality* [C]
	F2.2 use conceptual and mathematical population growth models to calculate the growth of populations of various species in an ecosystem (e.g., use the concepts of exponential, sigmoid, and sinusoidal growth to estimate the sizes of various populations) [PR, AI, C]
	F2.3 determine, through laboratory inquiry or using computer simulations, the characteristics of population growth of two different populations (e.g., the different population cycles of a predator and its prey; the population cycles of two populations that compete for food; the increase of Aboriginal compared to non-Aboriginal populations and the significant difference in average age between the two groups) [PR, AI, C]
	F3 Understanding Basic Concepts
	F3.1 explain the concepts of interaction (e.g., competition, predation, defence mechanism, symbiotic relationship, parasitic relationship) between different species
	F3.2 describe the characteristics of a given population, such as its growth, density (e.g., fecundity, mortality), distribution, and minimum viable size
	F3.3 explain factors such as carrying capacity, fecundity, density, and predation that cause fluctuation in populations, and analyse the fluctuation in the population of a species of plant, wild animal, or microorganism
	F3.4 explain the concept of energy transfer in a human population in terms of the flow of food energy in the production, distribution, and use of food resources
	F3.5 explain how a change in one population in an aquatic or terrestrial ecosystem can affect the entire hierarchy of living things in that system (e.g., how the disappearance of crayfish from a lake causes a decrease in the bass population of the lake; how the disappearance of beaver from an ecosystem causes a decrease in the wolf population in that ecosystem)