2021 Introduction	2017 Introduction
(1) Students in Biology focus on patterns, processes, and relationships of living organisms through four main concepts: biological structures, functions, and processes; mechanisms of genetics; biological evolution; and interdependence within environmental systems. By the end of Grade 12, students are expected to gain sufficient knowledge of the scientific and engineering practices across the disciplines of science to make informed decisions using critical thinking and scientific problem solving.	***(1)*** *Biology. In Biology, students conduct laboratory and field investigations, use scientific practices during investigations, and make informed decisions using critical thinking and scientific problem solving. Students in Biology study a variety of topics that include: structures and functions of cells and viruses; growth and development of organisms; cells, tissues, and organs; nucleic acids and genetics; biological evolution; taxonomy; metabolism and energy transfers in living organisms; living systems; homeostasis; and ecosystems and the environment.*
(2) Nature of science. Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not currently scientifically testable.	***(2)*** *Nature of science. Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not currently scientifically testable.*
(3) Scientific hypotheses and theories. Students are expected to know that (A) hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions are incorporated into theories; and (B) scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well established and highly reliable explanations, but they may be subject to change as new areas of science and new technologies are developed.	***(3)*** *Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific methods of investigation are experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked.*
(4) Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods of investigation are descriptive, comparative, or experimental. The method chosen should be appropriate to the question being asked. Student learning for different types of investigations include descriptive investigations, which involve collecting data and recording observations without making comparisons; comparative investigations, which involve collecting data with variables that are manipulated to compare results; and experimental investigations, which involve processes similar to	***(4)*** *Science and social ethics. Scientific decision making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods (scientific methods) and ethical and social decisions that involve science (the application of scientific information).*
	(5) *Science, systems, and models. A system is a collection of cycles, structures, and processes that interact. All systems have basic properties that can be described in space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested. Students should analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment.*
	(6) *Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.*

2021 Introduction (continued)	*2017 Introduction (continued)*
comparative investigations but in which a control is identified. (A) Scientific practices. Students should be able to ask questions, plan and conduct investigations to answer questions, and explain phenomena using appropriate tools and models. (B) Engineering practices. Students should be able to identify problems and design solutions using appropriate tools and models. **(5)** Science and social ethics. Scientific decision making is a way of answering questions about the natural world involving its own set of ethical standards about how the process of science should be carried out. Students should be able to distinguish between scientific decision-making methods (scientific methods) and ethical and social decisions that involve science (the application of scientific information). **(6)** Science consists of recurring themes and making connections between overarching concepts. Recurring themes include systems, models, and patterns. All systems have basic properties that can be described in space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested, while models allow for boundary specification and provide a tool for understanding the ideas presented. Students should analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment. **(7)** Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.	

2021	2017
Scientific and Engineering Practices	***Scientific Processes***
(1) Scientific and engineering practices. The student, for at least 40% of instructional time, asks questions, identifies problems, and plans and safely conducts classroom, laboratory, and field investigations to answer questions, explain phenomena, or design solutions using appropriate tools and models. The student is expected to:	***(1)** Scientific processes. The student, for at least 40% of instructional time, conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:*
(A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations;	*NEW*
(B) use scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems;	*(2)(E) plan and implement descriptive, comparative, and experimental investigations, including asking questions, formulating testable hypotheses, and selecting equipment and technology;*
(C) use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency approved safety standards;	*(1)(A) demonstrate safe practices during laboratory and field investigations; and*
(D) use appropriate tools such as microscopes, slides, Petri dishes, laboratory glassware, metric rulers, digital balances, pipets, filter paper, micropipettes, gel electrophoresis and polymerase chain reaction (PCR) apparatuses, microcentrifuges, water baths, incubators, thermometers, hot plates, data collection probes, test tube holders, lab notebooks or journals, hand lenses, and models, diagrams, or samples of biological specimens or structures;	*(2)(F) collect and organize qualitative and quantitative data and make measurements with accuracy and precision using tools such as data-collecting probes, standard laboratory glassware, microscopes, various prepared slides, stereoscopes, metric rulers, balances, gel electrophoresis apparatuses, micropipettes, hand lenses, Celsius thermometers, hot plates, lab notebooks or journals, timing devices, Petri dishes, lab incubators, dissection equipment, meter sticks, and models, diagrams, or samples of biological specimens or structures;*
(E) collect quantitative data using the International System of Units (SI) and qualitative data as evidence;	
(F) organize quantitative and qualitative data using scatter plots, line graphs, bar graphs, charts, data tables, digital tools, diagrams, scientific drawings, and student-prepared models;	
(G) develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and	*NEW*
(H) distinguish among scientific hypotheses, theories, and laws	*(2)(D) distinguish between scientific hypotheses and scientific theories;*
	REMOVED *(1)(B) demonstrate an understanding of the use and conservation of resources and the proper disposal of recycling materials.*

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(2) Scientific and engineering practices. The student analyzes and interprets data to derive meaning, identify features and patterns, and discover relationships or correlations to develop evidence-based arguments or evaluate designs. The student is expected to:	***(2) Scientific processes. The student uses scientific practices and equipment during laboratory and field investigations. The student is expected to:***
(A) identify advantages and limitations of models such as their size, scale, properties, and materials;	*(3)(E) evaluate models according to their limitations in representing biological objects or events; and*
(B) analyze data by identifying significant statistical features, patterns, sources of error, and limitations;	*(2)(G) analyze, evaluate, make inferences, and predict trends from data; and*
(C) use mathematical calculations to assess quantitative relationships in data; and	*NEW*
(D) evaluate experimental and engineering designs.	*NEW*
	REMOVED *(2)(A) know the definition of science and understand that is has limitations, as specified in subsection (b)(2) of this section;* *(2)(B) know that hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions are incorporated into theories.* *(2)(C) know scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well established and highly reliable explanations, but they may be subject to change as new areas of science and new technologies are developed.*
(3) Scientific and engineering practices. The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to:	***(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:***
(A) develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories;	*(2)(G) analyze, evaluate, make inferences, and predict trends from data; and*
(B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and	*(2)(H) communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports.*

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(C) engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.	*NEW*
(4) Scientific and engineering practices. The student knows the contributions of scientists and recognizes the importance of scientific research and innovation on society. The student is expected to:	***NEW***
(A) analyze, evaluate, and critique scientific explanations and solutions by using empirical evidence, logical reasoning, and experimental and observational testing, so as to encourage critical thinking by the student;	*(3)(A) analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, so as to encourage critical thinking by the student;*
(B) relate the impact of past and current research on scientific thought and society, including research methodology, cost-benefit analysis, and contributions of diverse scientists as related to the content; and	*(3)(D) evaluate the impact of scientific research on society and the environment;*
(C) research and explore resources such as museums, libraries, professional organizations, private companies, online platforms, and mentors employed in a science, technology, engineering, and mathematics (STEM) field in order to investigate STEM careers.	*(3)(F) research and describe the history of biology and contributions of scientists.*
	REMOVED *(3)(B) communicate and apply scientific information extracted from various sources such as current events, published journal articles, and marketing materials.* *(3)(C) draw inferences based on data related to promotional materials for products and services.*
Science Concepts	***Science Concepts***
Biological Structures, Functions, and Processes	
(5) The student knows that biological structures at multiple levels of organization perform specific functions and processes that affect life. The student is expected to:	***(4) Science concepts. The student knows that cells are the basic structures of all living things with specialized parts that perform specific functions and that viruses are different from cells. The student is expected to:***
(A) relate the functions of different types of biomolecules, including carbohydrates, lipids, proteins, and nucleic acids, to the structure and function of a cell;	*(9)(A) compare the functions of different types of biomolecules, including carbohydrates, lipids, proteins, and nucleic acids;*
(B) compare and contrast prokaryotic and eukaryotic cells, including their complexity, and compare and contrast scientific explanations for cellular complexity;	*(4)(A) compare and contrast prokaryotic and eukaryotic cells, including their complexity, and compare and contrast scientific explanations for cellular complexity;*

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(C) investigate homeostasis through the cellular transport of molecules; and	*(4)(B) investigate and explain cellular processes, including homeostasis and transport of molecules; and*
(D) compare the structures of viruses to cells and explain how viruses spread and cause disease.	*(4)(C) compare the structures of viruses to cells, describe viral reproduction, and describe the role of viruses in causing diseases such as human immunodeficiency virus (HIV) and influenza.*
(6) The student knows how an organism grows and the importance of cell differentiation. The student is expected to:	***(5) Science concepts. The student knows how an organism grows and the importance of cell differentiation. The student is expected to:***
(A) explain the importance of the cell cycle to the growth of organisms, including an overview of the stages of the cell cycle and deoxyribonucleic acid (DNA) replication models;	*(5)(A) describe the stages of the cell cycle, including deoxyribonucleic acid (DNA) replication and mitosis, and the importance of the cell cycle to the growth of organisms;*
(B) explain the process of cell specialization through cell differentiation, including the role of environmental factors; and	*(5)(B) describe the roles of DNA, ribonucleic acid (RNA), and environmental factors in cell differentiation; and*
(C) relate disruptions of the cell cycle to how they lead to the development of diseases such as cancer.	*(5)(C) recognize that disruptions of the cell cycle lead to diseases such as cancer.*
Mechanisms of Genetics	
(7) **The student knows the role of nucleic acids in gene expression. The student is expected to:**	***(6) Science concepts. The student knows the mechanisms of genetics such as the role of nucleic acids and the principles of Mendelian and non-Mendelian genetics. The student is expected to:***
(A) identify components of DNA, explain how the nucleotide sequence specifies some traits of an organism, and examine scientific explanations for the origin of DNA;	*(6)(A) identify components of DNA, identify how information for specifying the traits of an organism is carried in the DNA, and examine scientific explanations for the origin of DNA;*
(B) describe the significance of gene expression and explain the process of protein synthesis using models of DNA and ribonucleic acid (RNA);	*(6)(D) recognize that gene expression is a regulated process;*
(C) identify and illustrate changes in DNA and evaluate the significance of these changes; and	*(6)(E) identify and illustrate changes in DNA and evaluate the significance of these changes;*
(D) discuss the importance of molecular technologies such as polymerase chain reaction (PCR), gel electrophoresis, and genetic engineering that are applicable in current research and engineering practices.	***formerly (6)(H) from the 2010 Science TEKS*
	REMOVED *(6)(B) recognize that components that make up the genetic code are common to all organisms* *** concept reflected in (7)(A)*

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	REMOVED *(6)(C) explain the purpose and process of transcription and translation using models of DNA and RNA.* ***concepts reflected in (7)(B)*
(8) The student knows the role of nucleic acids and the principles of inheritance and variation of traits in Mendelian and non-Mendelian genetics. The student is expected to:	***NEW***
(A) analyze the significance of chromosome reduction, independent assortment, and crossing over during meiosis in increasing diversity in populations of organisms that reproduce sexually; and	*(6)(G) recognize the significance of meiosis to sexual reproduction*
(B) predict possible outcomes of various genetic combinations using monohybrid and dihybrid crosses, including non-Mendelian traits of incomplete dominance, codominance, sex-linked traits, and multiple alleles.	*(6)(F) predict possible outcomes of various genetic combinations such as monohybrid crosses, dihybrid crosses, and non-Mendelian inheritance; and*
Biological Evolution	
(9) The student knows evolutionary theory is a scientific explanation for the unity and diversity of life that has multiple lines of evidence. The student is expected to:	***(7) Science concepts. The student knows evolutionary theory is a scientific explanation for the unity and diversity of life. The student is expected to:***
(A) analyze and evaluate how evidence of common ancestry among groups is provided by the fossil record, biogeography, and homologies, including anatomical, molecular, and developmental; and	*(7)(A) analyze and evaluate how evidence of common ancestry among groups is provided by the fossil record, biogeography, and homologies, including anatomical, molecular, and developmental;*
(B) examine scientific explanations for varying rates of change such as gradualism, abrupt appearance, and stasis in the fossil record.	*(7)(B) examine scientific explanations of abrupt appearance and stasis in the fossil record;*
(10)The student knows evolutionary theory is a scientific explanation for the unity and diversity of life that has multiple mechanisms. The student is expected to:	***NEW***
(A) analyze and evaluate how natural selection produces change in populations and not in individuals;	*(7)(C) analyze and evaluate how natural selection produces change in populations, not individuals;*
(B) analyze and evaluate how the elements of natural selection, including inherited variation, the potential of a population to produce more offspring than can survive, and a finite supply of environmental resources, result in differential reproductive success;	*(7)(D) analyze and evaluate how the elements of natural selection, including inherited variation, the potential of a population to produce more offspring than can survive, and a finite supply of environmental resources, result in differential reproductive success;*
(C) analyze and evaluate how natural selection may lead to speciation; and	*(7)(E) analyze and evaluate the relationship of natural selection to adaptation and to the development of diversity in and among species; and*

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(D) analyze evolutionary mechanisms other than natural selection, including genetic drift, gene flow, mutation, and genetic recombination, and their effect on the gene pool of a population.	*(7)(F) analyze other evolutionary mechanisms, including genetic drift, gene flow, mutation, and recombination.*
	REMOVED *Concept addressed in Grade 7* *(8)(A) define taxonomy and recognize the importance of a standard taxonomic system to the scientific community.* *(8)(B) categorize organisms using a hierarchical classification system based on similarities and differences among groups; and* *(8)(C) compare characteristics of taxonomic groups, including archaea, bacteria, Protista, fungi, plants and animals.*
Biological Structures, Functions, and Processes	
(11) Science concepts--biological structures, functions, and processes. The student knows the significance of matter cycling, energy flow, and enzymes in living organisms. The student is expected to:	***(9) Science concepts. The student knows the significance of various molecules involved in metabolic processes and energy conversions that occur in living organisms. The student is expected to:***
(A) explain how matter is conserved and energy is transferred during photosynthesis and cellular respiration using models, including the chemical equations for these processes; and	*(9)(B) compare the reactants and products of photosynthesis and cellular respiration in terms of energy, energy conversions, and matter; and*
(B) investigate and explain the role of enzymes in facilitating cellular processes	*(9)(C) identify and investigate the role of enzymes.*
(12) Science concepts--biological structures, functions, and processes. The student knows that multicellular organisms are composed of multiple systems that interact to perform complex functions. The student is expected to:	***(7) Science concepts. The student knows that biological systems are composed of multiple levels. The student is expected to:***
(A) analyze the interactions that occur among systems that perform the functions of regulation, nutrient absorption, reproduction, and defense from injury or illness in animals; and;	*(10)(A) describe the interactions that occur among systems that perform the functions of regulation, nutrient absorption, reproduction, and defense from injury or illness in animals;*
(B) explain how the interactions that occur among systems that perform functions of transport, reproduction, and response in plants are facilitated by their structures.	*(10)(B) describe the interactions that occur among systems that perform the functions of transport, reproduction, and response in plants; and*
	REMOVED *(10)(C) analyze the levels of organization in biological systems and relate the levels to each other and to the whole system.*

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	REMOVED *11)(A) summarize the role of microorganisms in both maintaining and disrupting the health of both organisms and ecosystems* *(11)(B) describe how events and processes that occur during ecological succession can change populations and species diversity. **concept refelcted in Grade 8*
Interdependence Within Environmental Systems	
(13) The student knows that interactions at various levels of organization occur within an ecosystem to maintain stability. The student is expected to:	***(12)Science concepts. The student knows that interdependence and interactions occur within an environmental system. The student is expected to:***
(A) investigate and evaluate how ecological relationships, including predation, parasitism, commensalism, mutualism, and competition, influence ecosystem stability;	*(12)(A) interpret relationships, including predation, parasitism, commensalism, mutualism, and competition, among organisms;*
(B) analyze how ecosystem stability is affected by disruptions to the cycling of matter and flow of energy through trophic levels using models;	*(12)(C) analyze the flow of matter and energy through trophic levels using various models, including food chains, food webs, and ecological pyramids;*
(C) explain the significance of the carbon and nitrogen cycles to ecosystem stability and analyze the consequences of disrupting these cycles; and	*(12)(D) describe the flow of matter through the carbon and nitrogen cycles and explain the consequences of disrupting these cycles; and*
(D) explain how environmental change, including change due to human activity, affects biodiversity and analyze how changes in biodiversity impact ecosystem stability..	*(12)(E) describe how environmental change can impact ecosystem stability.*
	REMOVED *(12)(B) compare variations and adaptations of organisms in different ecosystems; **reflected in Grade 8*