BIOLOGY 30

Biology 30 consists of four units of study:

A. Nervous and Endocrine Systems
B. Reproduction and Development
C. Cell Division, Genetics and Molecular Biology
D. Population and Community Dynamics

Attitude Outcomes

Students will be encouraged to develop positive attitudes that support the responsible acquisition and application of knowledge related to science and technology. The following attitude outcomes are to be developed throughout Biology 30, in conjunction with the specific outcomes for Knowledge; Science, Technology and Society (STS); and Skills in each unit.

Interest in Science

Students will be encouraged to:
show interest in science-related questions and issues and confidently pursue personal interest and career possibilities within science-related fields; *e.g.,*

- *research the answers to questions they generate*
- *explore and use a variety of methods and resources to increase their knowledge and skills*
- *be critical and constructive when considering new theories and techniques*
- *use scientific vocabulary and principles in everyday discussions*
- *recognize the usefulness of being skilled in mathematics and problem solving*
- *be interested in science and technology topics not directly related to their formal studies*
- *recognize the importance of making connections between various science disciplines*
- *maintain interest in pursuing further studies in science*
- *explore where further science- and technology-related studies and careers can be pursued*
- *recognize that part-time jobs require science- and technology-related knowledge and skills.*

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.,*

- *use a multiperspective approach, considering scientific, technological, economic, cultural, political and environmental factors when formulating conclusions, solving problems or making decisions on an STS issue*
- *research carefully and discuss openly ethical dilemmas associated with the applications of science and technology*
- *explore personal perspectives, attitudes and beliefs toward scientific and technological advancements*
- *recognize the contribution of science and technology to the progress of civilizations*
- *show support for the development of technologies and science as they relate to human needs*
- *recognize that the scientific approach is one of many ways of viewing the universe*
- *recognize the research contributions of both men and women*
- *recognize the research contributions of Canadians*.

Scientific Inquiry

Students will be encouraged to:
seek and apply evidence when evaluating alternative approaches to investigations, problems and issues; *e.g.,*

- *consider the social and cultural contexts in which a theory developed*
- *appreciate how scientific problem solving and the development of new technologies are related*
- *insist on evidence before accepting a new idea or a new explanation*
- *assess, critically, their opinion of the value of science and its applications*
- *question arguments in which evidence, explanations or positions do not reflect the diversity of perspectives that exist*
- *criticize arguments based on faulty, incomplete or misleading use of numbers*
- *recognize the importance of reviewing the basic assumptions from which a line of inquiry has arisen*
- *insist that the critical assumptions behind any line of reasoning be made explicit, so that the validity of the position taken can be judged*
- *evaluate inferences and conclusions, being cognizant of the many variables involved in experimentation*
- *ask questions and conduct research to ensure understanding*
- *expend the effort and time needed to make valid inferences*
- *seek new models, explanations and theories when confronted with discrepant events.*

Collaboration

Students will be encouraged to:
work collaboratively in planning and carrying out investigations and in generating and evaluating ideas; *e.g.,*

- *provide the same attention and energy to the group's product as they would to a personal assignment*
- *be attentive when others speak, seek the point of view of others, and consider a multitude of perspectives*
- *use appropriate communication technology to elicit feedback from others*
- *participate in a variety of electronic group formats.*

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.,*

- *assume part of the collective responsibility for the impact of humans on the environment*
- *participate in civic activities related to the preservation and judicious use of the environment and its resources*
- *encourage their peers or members of their community to participate in a project related to sustainability*
- *consider all perspectives when addressing issues, weighing scientific, technological and ecological factors*
- *discuss both the positive and negative effects of environmental changes caused by nature and by humans on human beings and society*
- *participate in the social and political systems that influence environmental policy in their community*
- *promote actions that are not injurious to the environment*

- *make personal decisions based on a feeling of responsibility toward less privileged parts of the global community and toward future generations*
- *be critical-minded regarding the short- and long-term consequences of sustainability*.

Safety

Students will be encouraged to:
show concern for safety in planning, carrying out and reviewing activities with reference to WHMIS and consumer product labelling information; *e.g.,*

- *consider safety a positive limiting factor in scientific and technological endeavours*
- *read the labels on materials before using them, interpret the WHMIS symbols, and consult a reference document if safety symbols are not understood*
- *manipulate materials carefully, being cognizant of the risks and consequences of their actions*
- *assume responsibility for the safety of all those who share a common working environment by cleaning up after an activity and disposing of materials according to safety guidelines*
- *seek assistance immediately for any first aid concerns, such as cuts, burns or unusual reactions*
- *keep the work station uncluttered, ensuring that only appropriate laboratory materials are present*
- *criticize a procedure, a design or materials that are not safe or that could have a negative impact on the environment*
- *write safety and waste-disposal precautions into a laboratory procedure*
- *use safety and waste disposal as criteria for evaluating an experiment*.

Unit A: Nervous and Endocrine Systems

Themes: Equilibrium and Systems

Overview: This unit examines the biological processes that mediate the interactions between humans and their environment to maintain equilibrium. The nervous system contributes to homeostasis through its response to internal and external stimuli. Endocrine glands help to maintain homeostasis through the hormones they release into the blood. A study of the interactions between the nervous and endocrine systems leads to an examination of the functioning of the central and peripheral nervous systems and their ability to sense the environment and respond to it.

This unit builds on:

- Grade 8 Science, Unit B: Cells and Systems
- Science 10, Unit C: Cycling of Matter in Living Systems
- Biology 20, Unit D: Human Systems

Unit A will require approximately 25% of the time allotted for Biology 30.

Links to Mathematics: Refer to page 56.

Focusing Questions: How does the human body maintain equilibrium between its internal and external environments? What physiological processes and control systems are involved in maintaining homeostasis? What medical technologies are available to alleviate disorders of the nervous and endocrine systems?

General Outcomes: There are two major outcomes in this unit.

Students will:

1. explain how the nervous system controls physiological processes
2. explain how the endocrine system contributes to homeostasis.

Key Concepts: The following concepts are developed in this unit and may also be addressed in other units or in other courses. The intended level and scope of treatment is defined by the outcomes.

- neuron
- nerve impulse transmission
- central and peripheral nervous systems
- reflex arcs
- sensory receptors
- endocrine system and hormones
- homeostasis and feedback systems
- endocrine and nervous system interactions

General Outcome 1
Students will explain how the nervous system controls physiological processes.

Specific Outcomes for Knowledge

Students will:

30–A1.1k describe the general structure and function of a neuron and myelin sheath, explaining the formation and transmission of an action potential, including all-or-none response and intensity of response; the transmission of a signal across a synapse; and the main chemicals and transmitters involved, i.e., norepinephrine, acetylcholine and cholinesterase

30–A1.2k identify the principal structures of the central and peripheral nervous systems and explain their functions in regulating the voluntary (somatic) and involuntary (autonomic) systems of the human organism; i.e., cerebral hemispheres and lobes, cerebellum, pons, medulla oblongata, hypothalamus, spinal cord, sympathetic and parasympathetic nervous systems, and the sensory-somatic nervous system

30–A1.3k describe, using an example, the organization of neurons into nerves and the composition and function of reflex arcs; *e.g., the patellar reflex, the pupillary reflex*

30–A1.4k describe the structure and function of the parts of the human eye; i.e., the cornea, lens, sclera, choroid, retina, rods and cones, fovea centralis, pupil, iris and optic nerve

30–A1.5k describe the structure and function of the parts of the human ear, including the pinna, auditory canal, tympanum, ossicles, cochlea, organ of Corti, auditory nerve, semicircular canals and Eustachian tube

30–A1.6k explain other ways that humans sense their environment and their spatial orientation in it; *e.g., olfactory receptors, proprioceptors, taste receptors, receptors in the skin.*

Specific Outcomes for Science, Technology and Society (STS) (Nature of Science Emphasis)

Students will:

30–A1.1sts explain that scientific knowledge and theories develop through hypotheses, the collection of evidence, investigation and the ability to provide explanations **(NS2)**

- *discuss the biological basis of neurological diseases such as Alzheimer's or Parkinson's disease and how this relates to treatment*
- *evaluate the impact of photoperiod (light wavelength and duration) on humans and identify adaptations to light deprivation in northern communities*

30–A1.2sts explain that scientific investigation includes the process of analyzing evidence and providing explanations based upon scientific theories and concepts **(NS5f) [ICT C7–4.2]**

- *analyze experimental evidence regarding the influence of anesthetics, drugs and chemicals, natural and synthetic, on the functioning of the nervous system and relate this to addiction theories*
- *analyze the contribution of technological developments and physiological knowledge to longevity and quality of life*

30–A1.3sts explain that the goal of technology is to provide solutions to practical problems **(ST1) [ICT F2–4.4]**

- *investigate technologies available to correct eye defects such as myopia, hyperopia and astigmatism and ear defects such as hearing loss and tinnitus*
- *investigate the biological basis of neurotoxin action and their antidotes (snake venom, box jellyfish, botulin, reserpine [Rauwolfia serpentina])*
- *investigate the use of neurotoxins by Indigenous peoples*
- *discuss how advances in science have contributed to technologies that increase access to the world beyond normal sensory limits.*

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 1
Students will explain how the nervous system controls physiological processes.

Specific Outcomes for Skills (Nature of Science Emphasis)

Initiating and Planning

Students will:

30–A1.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues
- design an experiment to investigate heat, cold, pressure and touch receptors **(IP–NS1, IP–NS2, IP–NS3)**.

Performing and Recording

Students will:

30–A1.2s 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
- design and perform an experiment to investigate the physiology of reflex arcs **(IP–NS2, PR–NS2, PR–NS3, PR–NS4) [ICT F1–4.2]**
- perform experiments to measure the ability to discriminate objects visually and to hear a range of sounds **(PR–NS2, PR–NS3, PR–NS4)**
- use a microscope and prepared slides to observe neurons and synapses **(PR–NS2, PR–NS3, PR–NS4)**
- observe the principal features of a mammalian brain, eye and ear, using models, computer simulations or dissections, and identify the major structures of those organs **(PR–NS3, PR–NS4) [ICT C6–4.4]**
- *investigate and integrate, from library and electronic sources, information on the impact of photoperiod and wavelength on humans* **(PR–NS1, PR–NS4) [ICT C1–4.1]**
- *compile and display, in appropriate format, data collected from investigations on reflex arcs, stimulus strength versus force of muscle contraction, and/or auditory range* **(PR–NS4) [ICT P2–4.1]**.

Analyzing and Interpreting

Students will:

30–A1.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions
- *interpret patterns and trends in data on strength of stimuli versus force of muscle contraction* **(AI–NS2) [ICT C7–4.2]**
- *analyze and interpret aspects of vision, such as blind spot, acuity, accommodation, adaptation, binocular vision and peripheral vision* **(AI–NS2) [ICT C7–4.2]**
- *analyze a hearing aid as a device that simulates a sensory function* **(AI–ST1)**
- *pose new questions, such as: "Why are some people more tolerant to pain than others?"* **(AI–NS5)**
- *collect and analyze class data on colour charts* **(PR–NS4, AI–NS2) [ICT C7–4.2]**
- *analyze data that shows the interrelationship between taste and smell receptors* **(AI–NS2) [ICT C7–4.2]**.

Communication and Teamwork

Students will:

30–A1.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results
- use appropriate Système international (SI) units, fundamental and derived units and significant digits **(CT–NS2)**¬
- use appropriate numeric, symbolic, graphical and linguistic modes of representation to communicate ideas, plans and results **(CT–NS2)**¬
- *work cooperatively with group members to investigate neurological disorders such as Alzheimer's or Parkinson's disease* **(CT–NS1)**.

¬To be developed throughout the course.

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 2
Students will explain how the endocrine system contributes to homeostasis.

Specific Outcomes for Knowledge

Students will:

30–A2.1k identify the principal endocrine glands of humans; i.e., the hypothalamus/pituitary complex, thyroid, parathyroid, adrenal glands and islet cells of the pancreas

30–A2.2k describe the function of the hormones of the principal endocrine glands, i.e., thyroid-stimulating hormone (TSH)/thyroxine, calcitonin/parathyroid hormone (PTH), adrenocorticotropic hormone (ACTH)/cortisol, glucagon/insulin, human growth hormone (hGH), antidiuretic hormone (ADH), epinephrine, aldosterone, and describe how they maintain homeostasis through feedback

30–A2.3k explain the metabolic roles hormones may play in homeostasis; i.e., thyroxine in metabolism; insulin, glucagon and cortisol in blood sugar regulation; hGH in growth; ADH in water regulation; aldosterone in sodium ion regulation

30–A2.4k explain how the endocrine system allows humans to sense their internal environment and respond appropriately; *e.g., calcium balance, osmotic pressure of blood*

30–A2.5k compare the endocrine and nervous control systems and explain how they act together; *e.g., stress and the adrenal gland*

30–A2.6k describe, using an example, the physiological consequences of hormone imbalances; i.e., diabetes mellitus *(e.g., diabetes insipidus, gigantism, goitre, cretinism, Graves' disease).*

Specific Outcomes for Science, Technology and Society (STS) (Social and Environmental Contexts Emphasis)

Students will:

30–A2.1sts explain that science and technology are developed to meet societal needs and expand human capability **(SEC1) [ICT F2–4.8]**

- *compare the function of technological control systems, such as computer control systems for car emissions, with electrochemical control systems in organisms*
- *assess the impact of research into biochemical control systems on human performance*
- *describe the current treatments for type 1 and type 2 diabetes*

30–A2.2sts explain that science and technology have both intended and unintended consequences for humans and the environment **(SEC3) [ICT F2–4.8, F3–4.1]**

- *evaluate the use of biotechnology to solve practical problems (hormone synthesis for diabetes mellitus, dwarfism, milk yield in cows)*
- *evaluate the use of hormone therapy in the treatment of humans (growth hormone and aging, anabolic steroids and human performance)*
- *explain the relationship between pigment deposition within skin cells and ultraviolet light as influenced by stratospheric ozone.*

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 2
Students will explain how the endocrine system contributes to homeostasis.

Specific Outcomes for Skills (Social and Environmental Contexts Emphasis)

Initiating and Planning

Students will:

30–A2.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues

- formulate a hypothesis, from published data, on an environmental factor that can be detected and responded to by humans; *e.g., stress and hormonal disruption, ultraviolet light and pigment deposition, diet and thyroid function* **(IP–NS3)**.

Performing and Recording

Students will:

30–A2.2s 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

- *research seasonal affective disorder (SAD) or general adaptation syndrome and identify the main hormonal and nervous components* **(PR–NS4)**.

Analyzing and Interpreting

Students will:

30–A2.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions

- infer the role of ADH and aldosterone in the maintenance of water and ions, using the analysis and interpretation of data on blood and urine composition **(AI–NS6) [ICT C7–4.2]**
- infer the role of insulin in the regulation of blood sugar by performing an experiment to investigate the presence of glucose in simulated urine and comparing the results with normal urinalysis data, and/or investigate the role of insulin in the regulation of blood sugar by using a computer simulation **(AI–NS6) [ICT C7–4.2]**.

Communication and Teamwork

Students will:

30–A2.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results

- *evaluate individual and group processes used in planning and carrying out group investigations of hormone therapy or the use of biotechnology to solve practical problems* **(CT–SEC1, CT–SEC4)**.

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

Links to Mathematics
The following mathematics outcomes are related to the content of Unit A but are not considered prerequisites.

Concept	Mathematics Course, Strand and Specific Outcome
Data Collection and Analysis	Grade 9 Mathematics, Statistics and Probability (Data Analysis), Specific Outcome 3
Measurement and Unit Conversions	Mathematics 10-3, Measurement, Specific Outcome 1
Graph Analysis	Mathematics10C, Relations and Functions, Specific Outcome 1; Mathematics 20-3, Statistics, Specific Outcome 1

Unit B: Reproduction and Development

Themes: Change and Systems

Overview: This unit investigates the human reproductive system as a representative mammalian system responsible for propagating the organism and perpetuating the species. The processes associated with human reproduction and development, as well as the regulation of these processes by hormones, are reviewed. The influence of environmental factors on embryonic and fetal development is examined, as are various reproductive technologies.

This unit builds on:
- Grade 8 Science, Unit B: Cells and Systems
- Grade 9 Science, Unit A: Biological Diversity
- Science 10, Unit C: Cycling of Matter in Living Systems
- Biology 20, Unit D: Human Systems

Unit B will require approximately 20% of the time allotted for Biology 30.

Links to Mathematics: Refer to page 64.

Focusing Questions: How do the reproductive systems function to ensure survival of the species? What mechanisms are responsible for regulating the reproductive systems? What are the major processes and events of human embryonic and fetal development? How do reproductive technologies affect functioning of the reproductive systems, and what impact do these technologies have on society?

General Outcomes: There are three major outcomes in this unit.

Students will:

1. explain how survival of the human species is ensured through reproduction
2. explain how human reproduction is regulated by chemical control systems
3. explain how cell differentiation and development in the human organism are regulated by a combination of genetic, endocrine and environmental factors.

Key Concepts: The following concepts are developed in this unit and may also be addressed in other units or in other courses. The intended level and scope of treatment is defined by the outcomes.
- male and female reproductive systems
- reproductive hormones
- reproductive technologies
- embryonic and fetal development
- parturition
- lactation

General Outcome 1
Students will explain how survival of the human species is ensured through reproduction.

Specific Outcomes for Knowledge

Students will:

30–B1.1k identify the structures in the human female reproductive system and describe their functions; i.e., ovaries, Fallopian tubes, uterus, endometrium, cervix, vagina

30–B1.2k identify the structures in the human male reproductive system and describe their functions; i.e., testes, seminiferous tubules, interstitial cells, Sertoli cells, epididymides, vasa (ductus) deferentia, Cowper's glands, seminal vesicles, prostate gland, ejaculatory duct, urethra, penis

30–B1.3k distinguish sperm and egg from their supporting structures; i.e., seminiferous tubules, interstitial cells, Sertoli cells, follicle, corpus luteum

30–B1.4k describe the chromosomal factors and hormonal influence on the formation of the gonads and reproductive organs in the female and male embryo and fetus; i.e., Y chromosome and role of testosterone

30–B1.5k explain how sexually transmitted infections (STIs) can interfere with fertility and reproduction; *e.g., chlamydia, gonorrhea, human papilloma virus.*

Specific Outcomes for Science, Technology and Society (STS) (Social and Environmental Contexts Emphasis)

Students will:

30–B1.1sts explain that decisions regarding the application of scientific and technological development involve a variety of perspectives, including social, cultural, environmental, ethical and economic considerations **(SEC4b)**

- *evaluate the implications of a reproductive technology for human biology*
- *consider the application of long-term scientific and technological solutions to population control, using the Aboriginal concept of seven generations*
- *discuss society's expectations of the scientific community with respect to reproductive technologies*
- *discuss the impact of STIs on individuals, considering the physiological damage they cause.*

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 1
Students will explain how survival of the human species is ensured through reproduction.

Specific Outcomes for Skills (Social and Environmental Contexts Emphasis)

Initiating and Planning

Students will:

30–B1.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues

- *identify ethical concerns about reproductive technologies, infertility and the transmission of STIs* **(IP–SEC1)**.

Performing and Recording

Students will:

30–B1.2s 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

- observe the principal features of the human reproductive system, using models or computer simulations, and identify the major structures from drawings **(PR–NS4) [ICT C6–4.4]**
- use a microscope to observe prepared slides of ovaries and testes so as to distinguish eggs and sperm from their supporting structures; i.e., follicle, corpus luteum, interstitial cells, Sertoli cells, seminiferous tubules **(PR–NS2, PR–NS4)**.

Analyzing and Interpreting

Students will:

30–B1.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions

- evaluate practical solutions to decreased fertility; i.e., low sperm count, difficulty in egg production, hormonal imbalance **(AI–ST2, AI–SEC2)**
- *evaluate information collected from library and electronic sources on the implications of reproductive technologies such as surrogacy, sperm banks and cloning* **(AI–SEC2, AI–SEC4) [ICT C1–4.1, C3–4.1, C3–4.2]**.

Communication and Teamwork

Students will:

30–B1.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results

- *work cooperatively as a team to research the damage to reproductive organs caused by STIs and use appropriate multimedia to present the findings to the class* **(CT–SEC1, CT–SEC2) [ICT C1–4.4, P3–4.1]**.

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 2
Students will explain how human reproduction is regulated by chemical control systems.

Specific Outcomes for Knowledge

Students will:

30–B2.1k describe the role of hormones, i.e., gonadotropic-releasing hormone (GnRH), follicle-stimulating hormone (FSH), luteinizing hormone (LH), estrogen, progesterone, testosterone, in the regulation of primary and secondary sex characteristics in females and males

30–B2.2k identify the principal reproductive hormones in the female and explain their interactions in the maintenance of the menstrual cycle; i.e., estrogen, progesterone, FSH, LH

30–B2.3k identify the principal reproductive hormones in the male and explain their interactions in the maintenance and functioning of the male reproductive system; i.e., testosterone, FSH, LH.

Specific Outcomes for Science, Technology and Society (STS) (Social and Environmental Contexts Emphasis)

Students will:

30–B2.1sts explain how science and technology have influenced, and been influenced by, historical development and societal needs **(SEC2)**

- *research and assess the effects of the medical use of reproductive hormones on humans*
- *research and assess the implications for humans of producing and using reproductive hormones in domestic animals, such as cattle and horses*

30–B2.2sts explain why decisions regarding the application of scientific and technological development involve a variety of perspectives, including social, cultural, environmental, ethical and economic considerations **(SEC4b) [ICT F2–4.2, F3–4.1]**

- *explain how reproductive hormone homeostasis is disrupted by the natural aging process and discuss whether available technologies, such as hormone treatment for menopause and andropause, should be used to restore balance.*

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 2
Students will explain how human reproduction is regulated by chemical control systems.

Specific Outcomes for Skills (Social and Environmental Contexts Emphasis)

Initiating and Planning

Students will:

30–B2.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues
- *design an investigation to determine at which point during the menstrual cycle a female is most fertile* **(IP–NS2, IP–NS3, IP–NS4)**.

Performing and Recording

Students will:

30–B2.2s 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
- graph the changes in estrogen, progesterone, FSH and LH levels in the blood of a female through a single menstrual cycle **(PR–NS4) [ICT C6–4.2]**
- identify the follicle and corpus luteum within the ovary, using models, diagrams or computer simulations **(PR–NS4) [ICT C6–4.4]**.

Analyzing and Interpreting

Students will:

30–B2.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions
- analyze blood hormone data and physiological events for a single menstrual cycle, inferring the roles of female sex hormones **(AI–NS2, AI–NS6)**
- analyze blood hormone data and physiological events, inferring the roles of male sex hormones **(AI–NS2, AI–NS6) [ICT C7–4.2]**
- *research and assess the effects of the medical use of reproductive hormones on conditions such as menopause, andropause and infertility* **(PR–SEC1, AI–SEC2, AI–SEC4) [ICT C7–4.2]**.

Communication and Teamwork

Students will:

30–B2.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results
- select and use appropriate numerical and graphical modes of representation to communicate information on changing reproductive hormone levels in the blood **(CT–ST2)**
- *work cooperatively with team members to investigate the impact of the use of reproductive hormones in agriculture on the environment (such as the feminization of fish) and, using appropriate multimedia, present the information to the class* **(CT–SEC1, CT–SEC2, CT–SEC3) [ICT C1–4.4, P3–4.1]**.

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 3
Students will explain how cell differentiation and development in the human organism are regulated by a combination of genetic, endocrine and environmental factors.

Specific Outcomes for Knowledge

Students will:

30–B3.1k trace the processes of fertilization, implantation and extra-embryonic membrane formation, i.e., placenta, amnion, chorion, allantois, followed by embryonic and fetal development, parturition and lactation, and describe the control mechanisms of these events, i.e., progesterone, LH, human chorionic gonadotropin (hCG), prostaglandins, oxytocin, prolactin

30–B3.2k describe development from fertilization to parturition in the context of the main physiological events that occur in the development of organ systems during each major stage (trimester); i.e., zygote, blastocyst, gastrulation, general morphogenesis

30–B3.3k identify major tissues and organs that arise from differentiation and morphological development of the ectoderm, mesoderm and endoderm in the embryo; i.e.,

- ectoderm: nervous system, epidermis
- mesoderm: skeleton, muscles, reproductive structures
- endoderm: lining of the digestive and respiratory systems, endocrine glands

30–B3.4k describe the influence of environmental factors on embryonic and fetal development; *e.g., maternal lifestyle, teratogens such as alcohol, drugs, viral infections and radiation*

30–B3.5k describe the physiological or mechanical basis of different reproductive technologies; i.e., conception control, in vitro fertilization, infertility reversal.

Specific Outcomes for Science, Technology and Society (STS) (Social and Environmental Contexts Emphasis)

Students will:

30–B3.1sts explain that science and technology are developed to meet societal needs and expand human capability **(SEC1)**

- *analyze the use of technology to solve problems of immunological incompatibility between fetus and mother*

30–B3.2sts explain why decisions regarding the application of scientific and technological development involve a variety of perspectives, including social, cultural, environmental, ethical and economic considerations **(SEC4b)**

- *assess the use of technologies such as ultrasound, chorionic villus sampling (CVS), amniocentesis and a fetal heart rate monitor in monitoring fetal development*
- *assess the effects of a conception control technology on population demographics in developed and developing countries*
- *discuss how knowledge of embryonic/fetal development has influenced the value that society places on human life*
- *discuss the societal impact of environmental contaminants (such as polychlorinated biphenyls [PCBs], heavy metals, dioxins and furans) and teratogens.*

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 3
Students will explain how cell differentiation and development in the human organism are regulated by a combination of genetic, endocrine and environmental factors.

Specific Outcomes for Skills (Social and Environmental Contexts Emphasis)

Initiating and Planning

Students will:

30–B3.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues

- *design an experiment to investigate hormonal changes during pregnancy* **(IP–NS2, IP–NS3, IP–NS4)**.

Performing and Recording

Students will:

30–B3.2s 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

- investigate, using library and electronic sources, the effects of environmental factors on human embryonic and fetal development; *e.g., alcohol, cocaine, cigarette smoke, diet, and prescription and nonprescription drugs* **(PR–SEC1) [ICT C1–4.1]**
- *research the societal impact of technology such as ultrasound, amniocentesis, in vitro fertilization and CVS* **(PR–SEC1) [ICT F3–4.1]**
- *investigate, using library and electronic sources*, *how embryonic cells communicate during development* **(PR–NS1) [ICT C1–4.1]**.

Analyzing and Interpreting

Students will:

30–B3.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions

- observe the changes during embryo development, using preserved material such as chicken embryos, models or computer simulations, and extrapolate these events to the development of a human **(PR–NS3, AI–NS2) [ICT C6–4.1, C6–4.4]**
- interpret hormonal data from published investigations; *e.g., pregnancy testing* **(AI–NS2) [ICT C7–4.2]**
- *evaluate, from published data, the effectiveness and safety of various reproductive technologies* **(AI–SEC1, AI–SEC2)**
- *analyze the stages of embryonic and fetal development* **(AI–NS2)**.

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 3
Students will explain how cell differentiation and development in the human organism are regulated by a combination of genetic, endocrine and environmental factors.

Communication and Teamwork

Students will:

30–B3.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results

- *develop clear and logical arguments, based on published data, to defend a given decision on the effectiveness and safety of available reproductive technologies* **(CT–SEC3) [ICT C1–4.4]**.

Links to Mathematics
The following mathematics outcomes are related to the content of Unit B but are not considered prerequisites.

Concept	Mathematics Course, Strand and Specific Outcome
Data Collection and Analysis	Grade 9 Mathematics, Statistics and Probability (Data Analysis), Specific Outcome 3
Measurement and Unit Conversions	Mathematics 10-3, Measurement, Specific Outcome 1
Graph Analysis	Mathematics10C, Relations and Functions, Specific Outcome 1; Mathematics 20-3, Statistics, Specific Outcome 1

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

Unit C: Cell Division, Genetics and Molecular Biology

Themes: Change and Diversity

Overview: This unit examines the two types of cell division, mitosis and meiosis. Students learn about chromosomal behaviour during cell division and expand their knowledge of chromosomes by studying classical genetics. Classical genetics is further extended to a molecular level by exploring the basic structure of deoxyribonucleic acid (DNA), its role in protein synthesis and the impact of mutation.

This unit builds on:
- Grade 9 Science, Unit A: Biological Diversity

Unit C will require approximately 40% of the time allotted for Biology 30.

Links to Mathematics: Refer to page 73.

Focusing Questions: What cellular processes allow for growth and reproduction of an organism? What regulates the transmission of genetic information from one generation to the next? How is DNA responsible for the production of proteins? How has knowledge of the molecular nature of genes and DNA led to new biotechnologies and the treatment of genetic disorders?

General Outcomes: There are three major outcomes in this unit.

Students will:

1. describe the processes of mitosis and meiosis
2. explain the basic rules and processes associated with the transmission of genetic characteristics
3. explain classical genetics at the molecular level.

Key Concepts: The following concepts are developed in this unit and may also be addressed in other units or in other courses. The intended level and scope of treatment is defined by the outcomes.

- cell cycle
- mitosis and meiosis
- chromosome number
- karyotype
- alternation of generations
- Mendel's laws of heredity
- probability
- monohybrid, dihybrid and sex-linked inheritance
- incomplete dominance and codominance
- polygenic and multiple allelic traits
- gene linkage
- model of DNA
- replication
- transcription
- translation
- mutation
- genetic engineering

General Outcome 1
Students will describe the processes of mitosis and meiosis.

Specific Outcomes for Knowledge

Students will:

30–C1.1k define and explain the significance of chromosome number in somatic and sex cells; i.e., haploidy, diploidy and polyploidy

30–C1.2k explain, in general terms, the events of the cell cycle; i.e., interphase, mitosis and cytokinesis

30–C1.3k describe the process of meiosis (spermatogenesis and oogenesis) and the necessity for the reduction of chromosome number

30–C1.4k compare the processes of mitosis and meiosis

30–C1.5k describe the processes of crossing over and nondisjunction and evaluate their significance to organism inheritance and development

30–C1.6k compare the formation of fraternal and identical offspring in a single birthing event

30–C1.7k describe the diversity of reproductive strategies by comparing the alternation of generations in a range of organisms; *e.g., Daphnia, sea anemone, moss, pine.*

Specific Outcomes for Science, Technology and Society (STS) (Social and Environmental Contexts Emphasis)

Students will:

30–C1.1sts explain that science and technology are developed to meet societal needs and expand human capability **(SEC1)**

- *discuss the role of mitosis and biotechnology in regenerating whole, damaged or missing parts of organisms (stem cells, skin tissue)*
- *evaluate how knowledge of cell division or development of nanotechnology might be applied to the regulation of cancerous growth in plants or animals*
- *discuss and assess the impact of research in plant and animal reproduction on our understanding of mitosis and meiosis in humans (cloning, chromosome shortening)*
- *discuss the types and sources of teratogenic compounds found in the environment and the technological means by which they can be removed or controlled to ensure quality of life for future generations.*

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 1
Students will describe the processes of mitosis and meiosis.

Specific Outcomes for Skills (Nature of Science Emphasis)

Initiating and Planning

Students will:

30–C1.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues

- *define questions related to mitosis and meiosis, such as chromosome shortening, conditions/stimuli for meiosis, aging and mitosis, cytokinesis* **(IP–NS1)**.

Performing and Recording

Students will:

30–C1.2s 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

- perform a simulation to demonstrate the behaviour of chromosomes during mitosis **(PR–NS3)**
- use a microscope and prepared slides of onion root tip cells to identify the stages of a cell cycle and calculate the duration of each stage **(PR–NS3, AI–NS2)**
- research and compare a range of reproductive strategies in organisms and present them in the form of charts, tables or diagrams; *e.g., binary fission, budding, the sexual and asexual phases of alternation of generations* **(PR–NS1, PR–NS4) [ICT C6–4.3]**
- *prepare microscope slides to demonstrate some stages of mitosis and meiosis* **(PR–NS2, PR–NS3, PR–NS4)**.

Analyzing and Interpreting

Students will:

30–C1.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions

- prepare and interpret models of human karyotypes by using hard-copy or online resources **(AI–NS2)**
- *analyze the similarities and differences of cell division in plants and animals* **(AI–NS2) [ICT C7–4.2]**.

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 1
Students will describe the processes of mitosis and meiosis.

Communication and Teamwork

Students will:

30–C1.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results

- *work collaboratively in the preparation of mitosis slides* **(CT–NS1)**
- *present two contrasting reproductive strategies, emphasizing the differences* **(CT–ST2) [ICT C1–4.4]**.

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 2
Students will explain the basic rules and processes associated with the transmission of genetic characteristics.

Specific Outcomes for Knowledge

Students will:

30–C2.1k describe the evidence for dominance, segregation and the independent assortment of genes on different chromosomes, as investigated by Mendel

30–C2.2k compare ratios and probabilities of genotypes and phenotypes for dominant and recessive, multiple, incompletely dominant, and codominant alleles

30–C2.3k explain the influence of gene linkage and crossing over on variability

30–C2.4k explain the relationship between variability and the number of genes controlling a trait; *e.g., one pair of genes, as for Rh factor, versus two or more pairs of genes, as for skin colour and height*

30–C2.5k compare the pattern of inheritance produced by genes on the sex chromosomes to that produced by genes on autosomes, as investigated by Morgan and others.

Specific Outcomes for Science, Technology and Society (STS) (Social and Environmental Contexts Emphasis)

Students will:

30–C2.1sts explain that decisions regarding the application of scientific and technological development involve a variety of perspectives, including social, cultural, environmental, ethical and economic considerations **(SEC4b) [ICT F2–4.2, F3–4.1]**

- *evaluate the needs and interests of society and the role of genetic counselling and technology in the identification and treatment of potentially disabling genetic disorders (phenylketonuria, cystic fibrosis, germ-cell modification)*
- *discuss the contributions of Aboriginal peoples in the development of early plant hybrids*
- *discuss the application of genetic crosses in the development of specific breeds or hybrids (wheat and corn).*

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 2
Students will explain the basic rules and processes associated with the transmission of genetic characteristics.

Specific Outcomes for Skills (Nature of Science Emphasis)

Initiating and Planning

Students will:

30–C2.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues
- design a plan for collecting data to demonstrate human inheritance **(IP–NS2)**.

Performing and Recording

Students will:

30–C2.2s 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
- perform an experiment to demonstrate inheritance of a trait controlled by a single pair of genes; *e.g., albino corn*, *Drosophila or Arabidopsis* **(PR–NS2, PR–NS3, PR–NS4)**
- *design and perform an experiment to demonstrate that an environmental factor can cause a change in the expression of genetic information in an organism* **(IP–NS2, IP–NS3, IP–NS4, PR–NS3, PR–NS4, PR–NS5) [ICT F1–4.2]**.

Analyzing and Interpreting

Students will:

30–C2.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions
- interpret patterns and trends of inheritance of traits and predict, quantitatively, the probability of inheritance of traits illustrated in monohybrid, dihybrid and sex-linked inheritance, using pedigrees and Punnett squares **[ICT C7–4.2]**
- perform experiments to record and explain predicted phenotypic ratios versus actual counts in genetic crosses to show a relationship between chance and genetic results **(PR–NS2, PR–NS3, PR–NS4, AI–NS3)**
- draw and interpret pedigree charts from data on human single-allele and multiple-allele inheritance patterns; *e.g., hemophilia, blood types* **(PR–NS4, AI–NS2) [ICT C7–4.2]**
- analyze crossover data for a single pair of chromosomes to create a chromosome map showing gene arrangement and relative distance **(AI–NS2) [ICT C7–4.2]**
- *identify limitations of data associated with phenotypic ratios for small populations in which the ratios may not conform with the theoretical ratios expected* **(AI–NS4)**.

Communication and Teamwork

Students will:

30–C2.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results
- *work cooperatively with team members to investigate a monohybrid cross (tongue rolling, attached earlobes) and solve problems as they arise* **(CT–NS1, CT–NS2)**.

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 3
Students will explain classical genetics at the molecular level.

Specific Outcomes for Knowledge

Students will:

30–C3.1k summarize the historical events that led to the discovery of the structure of the DNA molecule, including the work of Franklin and Watson and Crick

30–C3.2k describe, in general, how genetic information is contained in the sequence of bases in DNA molecules in chromosomes and how the DNA molecules replicate themselves

30–C3.3k describe, in general, how genetic information is transcribed into sequences of bases in RNA molecules and is finally translated into sequences of amino acids in proteins

30–C3.4k explain, in general, how restriction enzymes cut DNA molecules into smaller fragments and how ligases reassemble them

30–C3.5k explain, in general, how cells may be transformed by inserting new DNA sequences into their genomes

30–C3.6k explain how a random change (mutation) in the sequence of bases results in abnormalities or provides a source of genetic variability

30–C3.7k explain how base sequences in nucleic acids contained in the nucleus, mitochondrion and chloroplast give evidence for the relationships among organisms of different species.

Specific Outcomes for Science, Technology and Society (STS) (Social and Environmental Contexts Emphasis)

Students will:

30–C3.1sts explain that science and technology have both intended and unintended consequences for humans and the environment **(SEC3) [ICT F3–4.1]**

- *discuss the implications for society of corporations being able to patent genes, such as the gene for herbicide resistance in canola*
- *assess the concerns and benefits of genetically modified organisms, such as transgenic food organisms or tree cloning for reforestation*

30–C3.2sts explain that scientific research and technological development help achieve a sustainable society, economy and environment **(SEC4a) [ICT F2–4.2, F2–4.8]**

- *discuss the Human Genome Project and the potential of proteomic technologies, in terms of the needs, interests and financial support of society*
- *discuss biotechnology and gene replacement therapy in the treatment of human genetic disorders*
- *assess the impact and value of DNA sequencing on the study of genetic relationships and variations in population ecology*
- *explore the application of nanotechnology and its implications for clinical diagnostics, pharmacology, biological research or proteomic programs.*

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 3
Students will explain classical genetics at the molecular level.

Specific Outcomes for Skills (Nature of Science Emphasis)

Initiating and Planning

Students will:

30–C3.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues
- *design an experiment to identify the proteins produced in a cell at a particular point in time or development* **(IP–NS2, IP–NS3, IP–NS4)**.

Performing and Recording

Students will:

30–C3.2s 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
- construct models of DNA to demonstrate the general structure and base arrangement **(PR–ST2) [ICT C6–4.4]**
- perform simulations to demonstrate the replication of DNA and the transcription and translation of its information **(PR–NS2, PR–NS4)**
- perform simulations to demonstrate the use of restriction enzymes and ligases **(PR–NS3, PR–NS4)**
- *perform an investigation to extract DNA from cells in green peas, beans, bananas or onions* **(PR–NS2, PR–NS3, PR–NS4, PR–NS5)**
- *research gel electrophoresis techniques and their applications in medical diagnostics and forensics* **(PR–ST1)**.

Analyzing and Interpreting

Students will:

30–C3.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions
- analyze, from published data, relationships between human activities and changes in genetic information that lead to heritable mutations and cancer **(AI–NS2) [ICT C7–4.2]**
- *analyze DNA fingerprints* **(AI–NS2)**
- *compare and contrast homologous DNA sequences to infer ancestry of various species* **(AI–NS2)**.

Communication and Teamwork

Students will:

30–C3.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results
- *work cooperatively with team members to investigate the impact of an environmental factor on the expression of a gene and to solve problems as they arise* **(CT–NS1)**
- *debate the advantages and disadvantages of corporate funding and patenting of genetic research results, including Aboriginal and other perspectives of ownership* **(CT–SEC2, CT–SEC3) [ICT C1–4.4]**.

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

Links to Mathematics
The following mathematics outcomes are related to the content of Unit C but are not considered prerequisites.

Concept	Mathematics Course, Strand and Specific Outcome
Data Collection and Analysis	Grade 9 Mathematics, Statistics and Probability (Data Analysis), Specific Outcome 3
Measurement and Unit Conversions	Mathematics 10-3, Measurement, Specific Outcome 1
Graph Analysis	Mathematics10C, Relations and Functions, Specific Outcome 1; Mathematics 20-3, Statistics, Specific Outcome 1
Ratios and Probability	Grade 8 Mathematics, Number, Specific Outcomes 4 and 5; Grade 8 Mathematics, Statistics and Probability (Chance and Uncertainty), Specific Outcome 2; Mathematics 30-2, Probability, Specific Outcomes 1 and 3; Mathematics 30-3, Probability, Specific Outcome 1

Unit D: Population and Community Dynamics

Themes: Systems, Equilibrium and Change

Overview: Population change over time can be examined through a study of population genetics (Hardy-Weinberg principle) and population growth. Both of these can be expressed quantitatively. Individual members of populations interact with each other as well as with members of other populations, which can have an impact on the populations involved. Communities are a sum of all the different populations living together. Communities may change over time as a result of natural or artificial events.

This unit builds on:
- Grade 9 Science, Unit A: Biological Diversity
- Biology 20, Unit A: Energy and Matter Exchange in the Biosphere and Unit B: Ecosystems and Population Change

Unit D will require approximately 15% of the time allotted for Biology 30.

Links to Mathematics: Refer to page 81.

Focusing Questions: How does one determine if populations are changing over time? In what ways may individual members of a population interact with one another or with members of a different population? What quantitative measures indicate that populations change over time? What role does society play in managing wildlife populations?

General Outcomes: There are three major outcomes in this unit.

Students will:

1. describe a community as a composite of populations in which individuals contribute to a gene pool that can change over time
2. explain the interaction of individuals in a population with one another and with members of other populations
3. explain, in quantitative terms, the change in populations over time.

Key Concepts: The following concepts are developed in this unit and may also be addressed in other units or in other courses. The intended level and scope of treatment is defined by the outcomes.

- Hardy-Weinberg principle
- gene pool
- natural selection
- symbiotic relationships and other interactions
- succession
- determiners of population size: natality, mortality, immigration, emigration
- population growth rate and population growth curves
- *r*- and *K*-selected reproductive strategies

General Outcome 1
Students will describe a community as a composite of populations in which individuals contribute to a gene pool that can change over time.

Specific Outcomes for Knowledge

Students will:

30–D1.1k describe the Hardy-Weinberg principle and explain its significance in population gene-pool stability and nonequilibrium values

30–D1.2k describe the factors that cause the diversity in the gene pool to change; i.e., natural selection, genetic drift, gene flow, nonrandom mating, bottleneck effect, founder effect, migration, mutation

30–D1.3k apply, quantitatively, the Hardy-Weinberg principle to observed and published data to determine allele and genotype frequencies, using the equations $p + q = 1$ and $p^2 + 2pq + q^2 = 1$

30–D1.4k describe the molecular basis of gene-pool change and the significance of these changes over time; i.e., mutations and natural selection *(e.g., drug-resistant bacteria, herbicide-resistant plants).*

Specific Outcomes for Science, Technology and Society (STS) (Social and Environmental Contexts Emphasis)

Students will:

30–D1.1sts explain that science and technology have both intended and unintended consequences for humans and the environment **(SEC3) [ICT F3–4.1]**

- *discuss the introduction of exotic species into new ecosystems*
- *discuss the development of ecological reserves to preserve gene-pool diversity*
- *assess the bottleneck effect characteristic of small populations, such as in whooping crane and swift fox populations, and suggest strategies to counteract it*
- *investigate the role of gene banks in the preservation of endangered species and genotypes, particularly of plants and animals used in agriculture*
- *assess habitat loss and the responsibility of society to protect the environment for future generations*

30–D1.2sts explain how concepts, models and theories are often used in interpreting and explaining observations and in predicting future observations **(NS6a)**

- *assess the role and importance of models in ecology, such as the Hardy-Weinberg principle, in explaining scientific phenomena such as changes in gene frequencies.*

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 1
Students will describe a community as a composite of populations in which individuals contribute to a gene pool that can change over time.

Specific Outcomes for Skills (Nature of Science Emphasis)

Initiating and Planning

Students will:

30–D1.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues

- *identify a question about the resistance of bacteria to specific antibiotics or about the resistance of plants to specific herbicides* **(IP–NS1)**.

Performing and Recording

Students will:

30–D1.2s 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

- design and perform an investigation and/or a computer simulation to demonstrate population growth and gene-pool change **(IP–NS2, IP–NS3, IP–NS4, PR–NS3, PR–NS4, PR–NS5) [ICT C6–4.4, F1–4.2]**
- *research, integrate and synthesize information on a related topic, such as:*
  - *the development and persistence of deleterious genes in gene pools*
  - *the development of bacterial resistance to antibiotics* **(PR–NS1) [ICT C7–4.2]**.

Analyzing and Interpreting

Students will:

30–D1.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions

- calculate and interpret results based on the Hardy-Weinberg principle in problem-solving exercises **(AI–NS6) [ICT C6–4.1]**.

Communication and Teamwork

Students will:

30–D1.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results

- use appropriate notation and significant digits to show gene frequency and changes in gene frequency over time **(CT–NS2)**.

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 2
Students will explain the interaction of individuals in a population with one another and with members of other populations.

Specific Outcomes for Knowledge

Students will:

30–D2.1k describe the basis of species interactions and symbiotic relationships and describe the influence of these interactions on population changes; i.e.,
- predator-prey and producer-consumer relationships
- symbiotic relationships: commensalism, mutualism and parasitism
- interspecific and intraspecific competition

30–D2.2k explain the role of defence mechanisms in predation and competition; *e.g., mimicry, protective coloration, toxins, behaviour*

30–D2.3k explain how mixtures of populations that define communities may change over time or remain as a climax community; i.e., primary succession, secondary succession.

Specific Outcomes for Science, Technology and Society (STS) (Social and Environmental Contexts Emphasis)

Students will:

30–D2.1sts explain why Canadian society supports scientific research and technological development to facilitate a sustainable society, economy and environment **(SEC4a) [ICT F2–4.2, F2–4.8]**
- *discuss public support for scientific work done on predator-prey relationships as part of wildlife management in national and provincial parks, such as the introduction of wolves*
- *identify examples of wildlife management techniques used by Aboriginal peoples*
- *assess the long-term implications of fire control and prevention on population and ecosystem stability, diversity and productivity*
- *assess the impact of parasites on populations and how this impact could be reduced, considering examples such as liver flukes in elk and lungworms in bighorn sheep.*

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 2
Students will explain the interaction of individuals in a population with one another and with members of other populations.

Specific Outcomes for Skills (Social and Environmental Contexts Emphasis)

Initiating and Planning

Students will:

30–D2.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues
- *plan an investigation of species interaction in a national park or wilderness area* **(IP–NS2, IP–NS3)**.

Performing and Recording

Students will:

30–D2.2s 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
- design and perform an experiment or a simulation to demonstrate interspecific and intraspecific competition **(IP–NS2, IP–NS3, IP–NS4, PR–NS3, PR–NS4, PR–NS5)**
- design and perform an experiment to demonstrate succession in a micro-environment and record the pattern of succession over time; *e.g., hay infusion* **(IP–NS2, IP–NS3, IP–NS4, PR–NS3, PR–NS4, PR–NS5)**
- perform simulations to investigate relationships between predators and their prey; *e.g., computer simulation, role-playing* **(PR–NS2, PR–NS3, PR–NS4)**.

Analyzing and Interpreting

Students will:

30–D2.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions
- summarize and evaluate a symbiotic relationship **(PR–NS1, AI–NS6)**
- *research and analyze the effects of clearcutting versus selective logging practices on ecosystems* **(PR–SEC1, AI–SEC2)**.

Communication and Teamwork

Students will:

30–D2.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results
- *research and present practical solutions for reducing the impact of highway fencing on animals in Banff and Jasper National Parks* **(CT–SEC1, CT–SEC2) [ICT C1–4.4]**
- *develop, present and defend a position on whether organisms should be deliberately introduced into new environments* **(CT–SEC1, CT–SEC2) [ICT C1–4.4, C7–4.2]**
- *research and present characteristics of interrelationships between organisms for analysis by classmates* **(CT–SEC1, CT–SEC2) [ICT C1–4.4, C7–4.2]**.

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 3
Students will explain, in quantitative terms, the change in populations over time.

Specific Outcomes for Knowledge

Students will:

30–D3.1k describe and explain, quantitatively, factors that influence population growth; i.e.,
- mortality, natality, immigration, emigration
- change in population size, ΔN = [natality + immigration] – [mortality + emigration]

30–D3.2k describe the growth of populations in terms of the mathematical relationship among carrying capacity, biotic potential, environmental resistance and the number of individuals in the population; i.e.,
- growth rate, $gr = \frac{\Delta N}{\Delta t}$, where ΔN is the change in number of individuals in a population and Δt is change in time
- per capita growth rate, $cgr = \frac{\Delta N}{N}$, where ΔN is the change in number of individuals in a population relative to N, the original number of individuals
- population density, $D_p = \frac{N}{A}$, or $D_p = \frac{N}{V}$, where N is the number of individuals in a given space, A is the area, and V is the volume

30–D3.3k explain the different population growth patterns; i.e.,
- logistic growth pattern (S-shaped curve) and exponential growth pattern (J-shaped curve)
- open and closed populations

30–D3.4k describe the characteristics and reproductive strategies of *r*-selected and *K*-selected organisms.

Specific Outcomes for Science, Technology and Society (STS) (Nature of Science Emphasis**)**

Students will:

30–D3.1sts explain how concepts, models and theories are often used in interpreting and explaining observations and in predicting future observations **(NS6a)**
- *develop appropriate investigative strategies, such as a risk-benefit analysis or cost-benefit analysis, for analyzing biological issues*
- *compare the growth of the human population with that of populations of other species.*

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

General Outcome 3
Students will explain, in quantitative terms, the change in populations over time.

Specific Outcomes for Skills (Nature of Science Emphasis)

Initiating and Planning

Students will:

30–D3.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues
- *identify questions about factors that affect population growth rates* **(IP–NS1)**.

Performing and Recording

Students will:

30–D3.2s 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
- design and perform an experiment or a computer simulation to demonstrate the effect of environmental factors on population growth rate **(IP–NS2, IP–NS3, IP–NS4, PR–NS3, PR–NS4) [ICT C6–4.4, F1–4.2]**
- *monitor a paramecium population over time, using a microscope and a grid slide* **(PR–NS2, PR–NS3, PR–NS4, PR–NS5)**
- *research zebra mussel population growth in the Great Lakes* **(PR–NS1, PR–NS4)**
- *research the impact of introduced trout species on populations of native bull trout (Salvelinus confluentus) in Alberta's lakes and streams* **(PR–NS1)**.

Analyzing and Interpreting

Students will:

30–D3.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions
- graph and interpret population growth of *r*-selected and *K*-selected organisms **(AI–NS2) [ICT C7–4.2]**
- calculate and interpret change in population size, growth rate, per capita growth rate and population density **(AI–NS2, AI–NS3, AI–NS4)**
- *compare and evaluate human population growth rates in various countries* **(AI–NS2)** [**ICT C7–4.2]**
- *demonstrate and assess the effect of environmental factors (biotic potential and environmental resistance) on population growth curves* **(AI–NS2, AI–NS6)**
- *calculate population growth rate under ideal conditions, given specific parameters* **(AI–NS3, AI–NS4)**
- *state a generalization based on data for the growth of a closed population* **(AI–NS2, AI–NS6)**
- *explain limitations in identifying changes in populations and explain how traditional knowledge can contribute to knowledge about changes* **(AI–NS4)**.

Communication and Teamwork

Students will:

30–D3.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results
- *develop, present and defend a position on Earth's carrying capacity of Homo sapiens* **(CT–SEC1, CT–SEC2, CT–SEC3) [ICT C1–4.4, C7–4.2]**.

Note: Some of the outcomes are supported by examples. The examples are written in italics and **do not form part of the required program** but are provided as an illustration of how the outcomes might be developed.

Links to Mathematics
The following mathematics outcomes are related to the content of Unit D but are not considered prerequisites.

Concept	Mathematics Course, Strand and Specific Outcome
Data Collection and Analysis	Grade 9 Mathematics, Statistics and Probability (Data Analysis), Specific Outcome 3
Measurement and Unit Conversions	Mathematics 10C, Measurement, Specific Outcome 2; Mathematics 10-3, Measurement, Specific Outcome 1; Mathematics 20-3, Algebra, Specific Outcome 3; Mathematics 30-3, Measurement, Specific Outcome 1
Graph Analysis	Mathematics10C, Relations and Functions, Specific Outcomes 1 and 3; Mathematics 20-3, Statistics, Specific Outcome 1; Mathematics 30-1, Relations and Functions, Specific Outcomes 9 and 10 ; Mathematics 30-2, Relations and Functions, Specific Outcomes 5 and 6
Ratios and Probability	Grade 8 Mathematics, Number, Specific Outcomes 4 and 5; Grade 8 Mathematics, Statistics and Probability, Specific Outcome 2; Mathematics 30-2, Probability, Specific Outcomes 1 and 3; Mathematics 30-3, Probability, Specific Outcome 1
Powers	Mathematics10C, Algebra and Number, Specific Outcome 3
Solving Equations	Mathematics 20-1, Algebra and Number, Specific Outcome 3