

# Biology 30

## Curriculum Package

### February 2012



2012

**Unit A: Nervous and Endocrine Systems**

Specific Outcomes	Achievement Indicators – Measurable outcomes
<i>It is expected that students will:</i>	<i>The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:</i>
<p><b>Focusing Questions:</b>            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?</p>	
<p><b>1 GENERAL OUTCOME: STUDENTS WILL EXPLAIN HOW THE NERVOUS SYSTEM CONTROLS PHYSIOLOGICAL PROCESSES.</b></p>	
<p><b>Knowledge:</b> students will explain how the nervous system controls physiological processes.</p>	<ul style="list-style-type: none"> <li>• 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</li> <li>• 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</li> <li>• 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</li> <li>• 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</li> <li>• 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</li> <li>• 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.</li> </ul>
<p>Explain that scientific knowledge and theories develop through hypotheses, the collection of evidence, investigation and the ability to provide explanations discuss the biological basis of neurological diseases  <b>Science, Technology and Society (STS)</b>            Nature of Science Emphasis:</p>	<ul style="list-style-type: none"> <li>• Discuss the biological basis of neurological diseases such as Alzheimer’s or Parkinson’s disease and how this relates to treatment</li> <li>• Evaluate the impact of photoperiod (light wavelength and duration) on humans and identify adaptations to light deprivation in northern communities</li> </ul>
<p>Explain that scientific investigation includes the process of analyzing evidence and providing explanations based upon scientific theories and concepts</p>	<ul style="list-style-type: none"> <li>• 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</li> <li>• Analyze the contribution of technological developments and physiological knowledge to longevity and quality of life</li> </ul>
<p>Explain that the goal of technology is to provide solutions to practical problems</p>	<ul style="list-style-type: none"> <li>• Investigate technologies available to correct eye defects such as myopia, hyperopia and astigmatism and ear defects such as hearing loss and tinnitus</li> <li>• Investigate the biological basis of neurotoxin action and their antidotes (snake venom, box jellyfish, botulin, reserpine [Rauwolfia serpentina])</li> <li>• Investigate the use of neurotoxins by Indigenous peoples</li> <li>• Discuss how advances in science have contributed to technologies that increase access to the world beyond normal sensory limits.</li> </ul>

**Unit A: Nervous and Endocrine Systems**

Specific Outcomes	Achievement Indicators – Measurable outcomes
<i>It is expected that students will:</i>	<i>The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:</i>
<b>SKILLS OUTCOMES:</b> (embed throughout the unit)	
<b>Initiating and Planning:</b> Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	<ul style="list-style-type: none"> <li>• Design an experiment to investigate heat, cold, pressure and touch receptors</li> </ul>
<b>Performing and Recording:</b> 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	<ul style="list-style-type: none"> <li>• Design and perform an experiment to investigate the physiology of reflex arcs</li> <li>• Perform experiments to measure the ability to discriminate objects visually and to hear a range of sounds</li> <li>• Use a microscope and prepared slides to observe neurons and synapses</li> <li>• 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</li> <li>• Investigate and integrate, from library and electronic sources, information on the impact of photoperiod and wavelength on humans</li> <li>• Compile and display, in appropriate format, data collected from investigations on reflex arcs, stimulus strength versus force of muscle contraction, and/or auditory range</li> </ul>
<b>Analyzing and Interpreting:</b> Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	<ul style="list-style-type: none"> <li>• Interpret patterns and trends in data on strength of stimuli versus force of muscle contraction</li> <li>• Analyze and interpret aspects of vision, such as blind spot, acuity, accommodation, adaptation, binocular vision and peripheral vision</li> <li>• Analyze a hearing aid as a device that simulates a sensory function</li> <li>• Pose new questions, such as: “Why are some people more tolerant to pain than others?”</li> <li>• Collect and analyze class data on colour charts</li> <li>• Analyze data that shows the interrelationship between taste and smell receptors</li> </ul>
<b>Communication and Teamwork:</b> Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	<ul style="list-style-type: none"> <li>• Use appropriate International System of Units (SI) notation, fundamental and derived units and significant digits</li> <li>• Use appropriate numeric, symbolic, graphical and linguistic modes of representation to communicate ideas, plans and results</li> <li>• Work cooperatively with group members to investigate neurological disorders such as Alzheimer’s or Parkinson’s disease</li> </ul>
<b>2 GENERAL OUTCOME:</b> STUDENTS WILL EXPLAIN HOW THE ENDOCRINE SYSTEM CONTRIBUTES TO HOMEOSTASIS.	
<b>KNOWLEDGE:</b> Students will explain how the endocrine system contributes to homeostasis.	<ul style="list-style-type: none"> <li>• Identify the principal endocrine glands of humans; i.e., the hypothalamus/pituitary complex, thyroid, parathyroid, adrenal glands and islet cells of the pancreas</li> <li>• Describe the function of the hormones of the principal endocrine glands, i.e., thyroid-stimulating hormone (TSH)/thyroxine, calcitonin/parathyroid hormone (PTH), adrenocorticotrophic hormone (ACTH)/cortisol, glucagon/insulin, human growth hormone (hGH), antidiuretic hormone (ADH), epinephrine, aldosterone, and describe how they maintain homeostasis through feedback</li> <li>• 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</li> <li>• Explain how the endocrine system allows humans to sense their internal environment and respond appropriately</li> </ul>

**Unit A: Nervous and Endocrine Systems**

Specific Outcomes	Achievement Indicators – Measurable outcomes
<i>It is expected that students will:</i>	<i>The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:</i>
<b>KNOWLEDGE:</b> Students will explain how the endocrine system contributes to homeostasis. (continued)	<ul style="list-style-type: none"> <li>• Compare the endocrine and nervous control systems and explain how they act together</li> <li>• Describe, using an example, the physiological consequences of hormone imbalances</li> </ul>
Explain that science and technology are developed to meet societal needs and expand human capability <b>Science, Technology and Society (STS)</b> (Social and Environmental Contexts Emphasis)	<ul style="list-style-type: none"> <li>• Compare the function of technological control systems, such as computer control systems for car emissions, with electrochemical control systems in organisms</li> <li>• Assess the impact of research into biochemical control systems on human performance</li> <li>• Describe the current treatments for type 1 and type 2 diabetes</li> </ul>
Explain that science and technology have both intended and unintended consequences for humans and the environment	<ul style="list-style-type: none"> <li>• Evaluate the use of biotechnology to solve practical problems (hormone synthesis for diabetes mellitus, dwarfism, milk yield in cows)</li> <li>• Evaluate the use of hormone therapy in the treatment of humans (growth hormone and aging, anabolic steroids and human performance)</li> <li>• Explain the relationship between pigment deposition within skin cells and ultraviolet light as influenced by stratospheric ozone.</li> </ul>
<b>SKILLS OUTCOMES:</b> (embed throughout the unit)	
<b>Initiating and Planning:</b> Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	<ul style="list-style-type: none"> <li>• 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</li> </ul>
<b>Performing and Recording:</b> 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	<ul style="list-style-type: none"> <li>• Research seasonal affective disorder (SAD) or general adaptation syndrome and identify the main hormonal and nervous components</li> </ul>
<b>Analyzing and Interpreting:</b> Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	<ul style="list-style-type: none"> <li>• 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</li> <li>• 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</li> </ul>
<b>Communication and Teamwork:</b> Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	<ul style="list-style-type: none"> <li>• 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</li> </ul>

## Unit B: Reproduction and Development

Specific Outcomes	Achievement Indicators – Measurable outcomes
<i>It is expected that students will:</i>	<i>The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:</i>
<b>Focusing Questions:</b> 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?	
<b>1 GENERAL OUTCOME: STUDENTS WILL EXPLAIN HOW SURVIVAL OF THE HUMAN SPECIES IS ENSURED THROUGH REPRODUCTION</b>	
<b>Knowledge:</b> Students will explain how survival of the human species is ensured through reproduction.	<ul style="list-style-type: none"> <li>• Identify the structures in the human female reproductive system and describe their functions</li> <li>• Identify the structures in the human male reproductive system and describe their functions</li> <li>• Distinguish sperm and egg from their supporting structures</li> <li>• Describe the chromosomal factors and hormonal influence on the formation of the gonads and reproductive organs in the female and male embryo and fetus</li> <li>• Explain how sexually transmitted infections (STIs) can interfere with fertility and reproduction</li> </ul>
Explain that decisions regarding the application of scientific and technological development involve a variety of perspectives, including social, cultural, environmental, ethical and economic considerations <b>Science, Technology and Society (STS)</b> (Social and Environmental Contexts Emphasis)	<ul style="list-style-type: none"> <li>• Evaluate the implications of a reproductive technology for human biology</li> <li>• Consider the application of long-term scientific and technological solutions to population control, using the Aboriginal concept of seven generations</li> <li>• Discuss society’s expectations of the scientific community with respect to reproductive technologies</li> <li>• Discuss the impact of STIs on individuals, considering the physiological damage they cause.</li> </ul>
<b>SKILLS OUTCOMES:</b> (embed throughout the unit)	
<b>Initiating and Planning:</b> Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	<ul style="list-style-type: none"> <li>• Identify ethical concerns about reproductive technologies, infertility and the transmission of STIs</li> </ul>
<b>Performing and Recording:</b> 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	<ul style="list-style-type: none"> <li>• Observe the principal features of the human reproductive system, using models or computer simulations, and identify the major structures from drawings</li> <li>• 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</li> </ul>
<b>Analyzing and Interpreting:</b> Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	<ul style="list-style-type: none"> <li>• Evaluate practical solutions to decreased fertility; i.e., low sperm count, difficulty in egg production, hormonal imbalance</li> <li>• Evaluate information collected from library and electronic sources on the implications of reproductive technologies such as surrogacy, sperm banks and cloning</li> </ul>
<b>Communication and Teamwork:</b> Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	<ul style="list-style-type: none"> <li>• 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</li> </ul>

**Unit B: Reproduction and Development**

Specific Outcomes	Achievement Indicators – Measurable outcomes
<i>It is expected that students will:</i>	<i>The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:</i>
<b>GENERAL OUTCOMES: STUDENTS WILL EXPLAIN HOW HUMAN REPRODUCTION IS REGULATED BY CHEMICAL CONTROL SYSTEMS</b>	
<b>Knowledge:</b> Students will explain how human reproduction is regulated by chemical control systems	<ul style="list-style-type: none"> <li>• Describe the role of hormones</li> <li>• Identify the principal reproductive hormones in the female and explain their interactions in the maintenance of the menstrual cycle</li> <li>• Identify the principal reproductive hormones in the male and explain their interactions in the maintenance and functioning of the male reproductive system</li> </ul>
Explain how science and technology have influenced, and been influenced by, historical development and societal needs <b>Science, Technology and Society (STS)</b> (Social and Environmental Contexts Emphasis)	<ul style="list-style-type: none"> <li>• Research and assess the effects of the medical use of reproductive hormones on humans</li> <li>• Research and assess the implications for humans of producing and using reproductive hormones in domestic animals, such as cattle and horses</li> </ul>
Explain why decisions regarding the application of scientific and technological development involve a variety of perspectives, including social, cultural, environmental, ethical and economic considerations	<ul style="list-style-type: none"> <li>• 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.</li> </ul>
<b>SKILLS OUTCOMES:</b> (embed throughout the unit)	
<b>Initiating and Planning:</b> Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	<ul style="list-style-type: none"> <li>• Design an investigation to determine at which point during the menstrual cycle a female is most fertile</li> </ul>
<b>Performing and Recording:</b> 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	<ul style="list-style-type: none"> <li>• Graph the changes in estrogen, progesterone, FSH and LH levels in the blood of a female through a single menstrual cycle</li> <li>• Identify the follicle and corpus luteum within the ovary, using models, diagrams or computer simulations</li> </ul>
<b>Analyzing and Interpreting:</b> Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	<ul style="list-style-type: none"> <li>• Analyze blood hormone data and physiological events for a single menstrual cycle, inferring the roles of female sex hormones</li> <li>• Analyze blood hormone data and physiological events, inferring the roles of male sex hormones</li> </ul>
<b>Communication and Teamwork:</b> Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	<ul style="list-style-type: none"> <li>• Select and use appropriate numerical and graphical modes of representation to communicate information on changing reproductive hormone levels in the blood</li> <li>• 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</li> </ul>
<b>3 GENERAL OUTCOMES: STUDENTS WILL EXPLAIN HOW CELL DIFFERENTIATION AND DEVELOPMENT IN THE HUMAN ORGANISM ARE REGULATED BY A COMBINATION OF GENETIC, ENDOCRINE AND ENVIRONMENTAL FACTORS</b>	
<b>Knowledge:</b> Students will explain how cell differentiation and development in the human organism are regulated by a combination of genetic, endocrine and environmental factors.	<ul style="list-style-type: none"> <li>• 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</li> </ul>

**Unit B: Reproduction and Development**

Specific Outcomes	Achievement Indicators – Measurable outcomes
<i>It is expected that students will:</i>	<i>The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:</i>
<p><b>Knowledge:</b> Students will explain how cell differentiation and development in the human organism are regulated by a combination of genetic, endocrine and environmental factors. (Continued)</p>	<ul style="list-style-type: none"> <li>• 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</li> <li>• Identify major tissues and organs that arise from differentiation and morphological development of the ectoderm, mesoderm and endoderm in the embryo;               <ul style="list-style-type: none"> <li>○ Ectoderm: nervous system, epidermis</li> <li>○ Mesoderm: skeleton, muscles, reproductive structures</li> <li>○ Endoderm: lining of the digestive and respiratory systems, endocrine glands</li> </ul> </li> <li>• Describe the influence of environmental factors on embryonic and fetal development</li> <li>• Describe the physiological or mechanical basis of different reproductive technologies</li> </ul>
<p>Explain that science and technology are developed to meet societal needs and expand human capability  <b>Science, Technology and Society (STS)</b>            (Social and Environmental Contexts Emphasis)</p>	<ul style="list-style-type: none"> <li>• Analyze the use of technology to solve problems of immunological incompatibility between fetus and mother</li> </ul>
<p>Explain why decisions regarding the application of scientific and technological development involve a variety of perspectives, including social, cultural, environmental, ethical and economic considerations</p>	<ul style="list-style-type: none"> <li>• Assess the use of technologies such as ultrasound, chorionic villus sampling (CVS), amniocentesis and a fetal heart rate monitor in monitoring fetal development</li> <li>• Assess the effects of a conception control technology on population demographics in developed and developing countries</li> <li>• Discuss how knowledge of embryonic/fetal development has influenced the value that society places on human life</li> <li>• Discuss the societal impact of environmental contaminants (such as polychlorinated biphenyls [PCBs], heavy metals, dioxins and furans) and teratogens.</li> </ul>
<p><b>SKILLS OUTCOMES:</b> (embed throughout the unit)</p>	
<p><b>Initiating and Planning:</b> Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues</p>	<ul style="list-style-type: none"> <li>• Design an experiment to investigate hormonal changes during pregnancy</li> </ul>
<p><b>Performing and Recording:</b> 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</p>	<ul style="list-style-type: none"> <li>• 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</li> <li>• Research the societal impact of technology such as ultrasound, amniocentesis, in vitro fertilization and CVS</li> <li>• Investigate, using library and electronic sources, how embryonic cells communicate during development</li> </ul>

## Unit B: Reproduction and Development

Specific Outcomes	Achievement Indicators – Measurable outcomes
<i>It is expected that students will:</i>	<i>The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:</i>
<b>Analyzing and Interpreting:</b> Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	<ul style="list-style-type: none"> <li>• 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</li> <li>• Interpret hormonal data from published investigations; e.g., pregnancy testing</li> <li>• Evaluate, from published data, the effectiveness and safety of various reproductive technologies</li> <li>• Analyze the stages of embryonic and fetal development</li> </ul>
<b>Communication and Teamwork:</b> Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	<ul style="list-style-type: none"> <li>• Develop clear and logical arguments, based on published data, to defend a given decision on the effectiveness and safety of available reproductive technologies</li> </ul>

## Unit C: Cell Division, Genetics and Molecular Biology

### 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?

### 1 GENERAL OUTCOMES: STUDENTS WILL DESCRIBE THE PROCESSES OF MITOSIS AND MEIOSIS

<b>Knowledge:</b> Students will describe the processes of mitosis and meiosis.	<ul style="list-style-type: none"> <li>• Define and explain the significance of chromosome number in somatic and sex cells; i.e., haploidy, diploidy and polyploidy</li> <li>• Explain, in general terms, the events of the cell cycle; i.e., interphase, mitosis and cytokinesis</li> <li>• Describe the process of meiosis (spermatogenesis and oogenesis) and the necessity for the reduction of chromosome number</li> <li>• Compare the processes of mitosis and meiosis</li> <li>• Describe the processes of crossing over and nondisjunction and evaluate their significance to organism inheritance and development</li> <li>• Compare the formation of fraternal and identical offspring in a single birthing event</li> <li>• Describe the diversity of reproductive strategies by comparing the alternation of generations in a range of organisms</li> </ul>
Explain that science and technology are developed to meet societal needs and expand human capability <b>Science, Technology and Society (STS)</b> (Social and Environmental Contexts Emphasis)	<ul style="list-style-type: none"> <li>• Discuss the role of mitosis and biotechnology in regenerating whole, damaged or missing parts of organisms (stem cells, skin tissue)</li> <li>• Evaluate how knowledge of cell division or development of nanotechnology might be applied to the regulation of cancerous growth in plants or animals</li> <li>• Discuss and assess the impact of research in plant and animal reproduction on our understanding of mitosis and meiosis in humans (cloning, chromosome shortening)</li> <li>• 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.</li> </ul>

### SKILLS OUTCOMES: (embed throughout the unit)

<b>Initiating and Planning:</b> Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	<ul style="list-style-type: none"> <li>• Define questions related to mitosis and meiosis, such as chromosome shortening, conditions/stimuli for meiosis, aging and mitosis, cytokinesis</li> </ul>
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**Unit C: Cell Division, Genetics and Molecular Biology**

Specific Outcomes	Achievement Indicators – Measurable outcomes
<i>It is expected that students will:</i>	<i>The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:</i>
<b>Performing and Recording:</b> 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	<ul style="list-style-type: none"> <li>• Perform a simulation to demonstrate the behaviour of chromosomes during mitosis</li> <li>• 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</li> <li>• 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</li> <li>• Prepare microscope slides to demonstrate some stages of mitosis and meiosis</li> </ul>
<b>Analyzing and Interpreting:</b> Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	<ul style="list-style-type: none"> <li>• Prepare and interpret models of human karyotypes by using hard-copy or online resources</li> <li>• Analyze the similarities and differences of cell division in plants and animals</li> </ul>
<b>Communication and Teamwork:</b> Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	<ul style="list-style-type: none"> <li>• Work collaboratively in the preparation of mitosis slides</li> <li>• Present two contrasting reproductive strategies, emphasizing the differences</li> </ul>
<b>2 GENERAL OUTCOME: STUDENTS WILL EXPLAIN THE BASIC RULES AND PROCESSES ASSOCIATED WITH THE TRANSMISSION OF GENETIC CHARACTERISTICS</b>	
<b>Knowledge:</b> Students will explain the basic rules and processes associated with the transmission of genetic characteristics.	<ul style="list-style-type: none"> <li>• Describe the evidence for dominance, segregation and the independent assortment of genes on different chromosomes, as investigated by Mendel</li> <li>• Compare ratios and probabilities of genotypes and phenotypes for dominant and recessive, multiple, incompletely dominant, and codominant alleles</li> <li>• Explain the influence of gene linkage and crossing over on variability</li> <li>• 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</li> <li>• 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.</li> </ul>
Explain that decisions regarding the application of scientific and technological development involve a variety of perspectives, including social, cultural, environmental, ethical and economic considerations <b>Science, Technology and Society (STS)</b> (Social and Environmental Contexts Emphasis)	<ul style="list-style-type: none"> <li>• 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)</li> <li>• Discuss the contributions of Aboriginal peoples in the development of early plant hybrids</li> <li>• Discuss the application of genetic crosses in the development of specific breeds or hybrids (wheat and corn).</li> </ul>
<b>SKILLS OUTCOMES:</b> (embed throughout the unit)	
<b>Initiating and Planning:</b> Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	<ul style="list-style-type: none"> <li>• Design a plan for collecting data to demonstrate human inheritance</li> </ul>

**Unit C: Cell Division, Genetics and Molecular Biology**

Specific Outcomes	Achievement Indicators – Measurable outcomes
<i>It is expected that students will:</i>	<i>The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:</i>
<b>Performing and Recording:</b> 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	<ul style="list-style-type: none"> <li>• Perform an experiment to demonstrate inheritance of a trait controlled by a single pair of genes; e.g., albino corn, Drosophila or Arabidopsis</li> <li>• Design and perform an experiment to demonstrate that an environmental factor can cause a change in the expression of genetic information in an organism</li> </ul>
<b>Analyzing and Interpreting:</b> Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	<ul style="list-style-type: none"> <li>• 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</li> <li>• Perform experiments to record and explain predicted phenotypic ratios versus actual counts in genetic crosses to show a relationship between chance and genetic results</li> <li>• Draw and interpret pedigree charts from data on human single-allele and multiple-allele inheritance patterns</li> <li>• Analyze crossover data for a single pair of chromosomes to create a chromosome map showing gene arrangement and relative distance</li> </ul>
<b>Communication and Teamwork:</b> Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	<ul style="list-style-type: none"> <li>• Work cooperatively with team members to investigate a monohybrid cross (tongue rolling, attached earlobes) and solve problems as they arise</li> </ul>
<b>3 GENERAL OUTCOMES: STUDENTS WILL EXPLAIN CLASSICAL GENETICS AT THE MOLECULAR LEVEL.</b>	
<b>Knowledge:</b> Students will explain classical genetics at the molecular level.	<ul style="list-style-type: none"> <li>• 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</li> <li>• 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</li> <li>• 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</li> <li>• Explain, in general, how restriction enzymes cut DNA molecules into smaller fragments and how ligases reassemble them</li> <li>• Explain, in general, how cells may be transformed by inserting new DNA sequences into their genomes</li> <li>• Explain how a random change (mutation) in the sequence of bases results in abnormalities or provides a source of genetic variability</li> <li>• Explain how base sequences in nucleic acids contained in the nucleus, mitochondrion and chloroplast give evidence for the relationships among organisms of different species.</li> </ul>
Explain that science and technology have both intended and unintended consequences for humans and the environment <b>Science, Technology and Society (STS)</b> (Social and Environmental Contexts Emphasis)	<ul style="list-style-type: none"> <li>• Discuss the implications for society of corporations being able to patent genes, such as the gene for herbicide resistance in canola</li> <li>• Assess the concerns and benefits of genetically modified organisms, such as transgenic food organisms or tree cloning for reforestation</li> </ul>

**Unit C: Cell Division, Genetics and Molecular Biology**

Specific Outcomes	Achievement Indicators – Measurable outcomes
<i>It is expected that students will:</i>	<i>The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:</i>
Explain that scientific research and technological development help achieve a sustainable society, economy and environment	<ul style="list-style-type: none"> <li>• Discuss the Human Genome Project and the potential of proteomic technologies, in terms of the needs, interests and financial support of society</li> <li>• Discuss biotechnology and gene replacement therapy in the treatment of human genetic disorders</li> <li>• Assess the impact and value of DNA sequencing on the study of genetic relationships and variations in population ecology</li> <li>• Explore the application of nanotechnology and its implications for clinical diagnostics, pharmacology, biological research or proteomic programs.</li> </ul>
<b>SKILLS OUTCOMES:</b> (embed throughout the unit)	
<b>Initiating and Planning:</b> Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	<ul style="list-style-type: none"> <li>• Design an experiment to identify the proteins produced in a cell at a particular point in time or development</li> </ul>
<b>Performing and Recording:</b> 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	<ul style="list-style-type: none"> <li>• Construct models of DNA to demonstrate the general structure and base arrangement</li> <li>• Perform simulations to demonstrate the replication of DNA and the transcription and translation of its information</li> <li>• Perform simulations to demonstrate the use of restriction enzymes and ligases</li> <li>• Perform an investigation to extract DNA from cells in green peas, beans, bananas or onions</li> <li>• Research gel electrophoresis techniques and their applications in medical diagnostics and forensics</li> </ul>
<b>Analyzing and Interpreting:</b> Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	<ul style="list-style-type: none"> <li>• Analyze, from published data, relationships between human activities and changes in genetic information that lead to heritable mutations and cancer</li> <li>• Analyze DNA fingerprints</li> <li>• Compare and contrast homologous DNA sequences to infer ancestry of various species</li> </ul>
<b>Communication and Teamwork:</b> Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	<ul style="list-style-type: none"> <li>• 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</li> <li>• Debate the advantages and disadvantages of corporate funding and patenting of genetic research results, including Aboriginal and other perspectives of ownership</li> </ul>
<b>Unit D: Population and Community Dynamics</b>	
<p><b>Focusing Questions:</b></p> <p>How does one determine if populations are changing over time?</p> <p>In what ways may individual members of a population interact with one another or with members of a different population?</p> <p>What quantitative measures indicate that populations change over time?</p> <p>What role does society play in managing wildlife populations?</p>	
<b>1 GENERAL OUTCOMES:</b> STUDENTS WILL DESCRIBE A COMMUNITY AS A COMPOSITE OF POPULATIONS IN WHICH INDIVIDUALS CONTRIBUTE TO A GENE POOL THAT CAN CHANGE OVER TIME.	
<b>Knowledge:</b> Students will describe a community as a composite of populations in which individuals contribute to a gene pool that can change over time.	<ul style="list-style-type: none"> <li>• Describe the Hardy-Weinberg principle and explain its significance in population gene-pool stability and nonequilibrium values</li> <li>• 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</li> <li>•</li> </ul>

**Unit D: Population and Community Dynamics**

Specific Outcomes	Achievement Indicators – Measurable outcomes
<i>It is expected that students will:</i>	<i>The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:</i>
<b>Knowledge:</b> Students will describe a community as a composite of populations in which individuals contribute to a gene pool that can change over time. (Continued)	<ul style="list-style-type: none"> <li>• Apply, quantitatively, the Hardy-Weinberg principle to observed and published data to determine allele and genotype frequencies, using the equations <math>p + q = 1</math> and <math>p^2 + 2pq + q^2 = 1</math></li> <li>• 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).</li> </ul>
Explain that science and technology have both intended and unintended consequences for humans and the environment <b>Science, Technology and Society (STS)</b> (Social and Environmental Contexts Emphasis)	<ul style="list-style-type: none"> <li>• Discuss the introduction of exotic species into new ecosystems</li> <li>• Discuss the development of ecological reserves to preserve gene-pool diversity</li> <li>• Assess the bottleneck effect characteristic of small populations, such as in whooping crane and swift fox populations, and suggest strategies to counteract it</li> <li>• Investigate the role of gene banks in the preservation of endangered species and genotypes, particularly of plants and animals used in agriculture</li> <li>• Assess habitat loss and the responsibility of society to protect the environment for future generations</li> </ul>
Explain how concepts, models and theories are often used in interpreting and explaining observations and in predicting future observations	<ul style="list-style-type: none"> <li>• 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.</li> </ul>
<b>SKILLS OUTCOMES:</b> (embed throughout the unit)	
<b>Initiating and Planning:</b> Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	<ul style="list-style-type: none"> <li>• Identify a question about the resistance of bacteria to specific antibiotics or about the resistance of plants to specific herbicides</li> </ul>
<b>Performing and Recording:</b> 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	<ul style="list-style-type: none"> <li>• Design and perform an investigation and/or a computer simulation to demonstrate population growth and gene-pool change</li> <li>• Research, integrate and synthesize information on a related topic, such as:               <ul style="list-style-type: none"> <li>○ The development and persistence of deleterious genes in gene pools</li> <li>○ The development of bacterial resistance to antibiotics</li> </ul> </li> </ul>
<b>Analyzing and Interpreting:</b> Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	<ul style="list-style-type: none"> <li>• Calculate and interpret results based on the Hardy-Weinberg principle in problem-solving exercises</li> </ul>
<b>Communication and Teamwork:</b> Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	<ul style="list-style-type: none"> <li>• Use appropriate notation and significant digits to show gene frequency and changes in gene frequency over time</li> </ul>

**Unit D: Population and Community Dynamics**

Specific Outcomes	Achievement Indicators – Measurable outcomes
<i>It is expected that students will:</i>	<i>The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:</i>
<b>2 GENERAL OUTCOMES: STUDENTS WILL EXPLAIN THE INTERACTION OF INDIVIDUALS IN A POPULATION WITH ONE ANOTHER AND WITH MEMBERS OF OTHER POPULATIONS</b>	
<b>Knowledge:</b> Students will explain the interaction of individuals in a population with one another and with members of other populations.	<ul style="list-style-type: none"> <li>• 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</li> <li>• Explain the role of defence mechanisms in predation and competition; e.g., mimicry, protective coloration, toxins, behaviour</li> <li>• Explain how mixtures of populations that define communities may change over time or remain as a climax community; i.e., primary succession, secondary succession.</li> </ul>
Explain why Canadian society supports scientific research and technological development to facilitate a sustainable society, economy and environment <b>Science, Technology and Society (STS)</b> (Social and Environmental Contexts Emphasis)	<ul style="list-style-type: none"> <li>• 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</li> <li>• Identify examples of wildlife management techniques used by Aboriginal peoples</li> <li>• Assess the long-term implications of fire control and prevention on population and ecosystem stability, diversity and productivity</li> <li>• 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.</li> </ul>
<b>SKILLS OUTCOMES:</b> (embed throughout the unit)	
<b>Initiating and Planning:</b> Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	<ul style="list-style-type: none"> <li>• Plan an investigation of species interaction in a national park or wilderness area</li> </ul>
<b>Performing and Recording:</b> 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	<ul style="list-style-type: none"> <li>• Design and perform an experiment or a simulation to demonstrate interspecific and intraspecific competition</li> <li>• Design and perform an experiment to demonstrate succession in a micro-environment and record the pattern of succession over time; e.g., hay infusion</li> <li>• Perform simulations to investigate relationships between predators and their prey; e.g., computer simulation, role-playing</li> </ul>
<b>Analyzing and Interpreting:</b> Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	<ul style="list-style-type: none"> <li>• Summarize and evaluate a symbiotic relationship</li> <li>• Research and analyze the effects of clearcutting versus selective logging practices on ecosystems</li> </ul>
<b>Communication and Teamwork:</b> Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	<ul style="list-style-type: none"> <li>• Research and present practical solutions for reducing the impact of highway fencing on animals in Banff and Jasper National Parks</li> <li>• Develop, present and defend a position on whether organisms should be deliberately introduced into new environments</li> <li>• Research and present characteristics of interrelationships between organisms for analysis by classmates</li> </ul>

**Unit D: Population and Community Dynamics**

Specific Outcomes	Achievement Indicators – Measurable outcomes
<i>It is expected that students will:</i>	<i>The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:</i>
<b>3 GENERAL OUTCOMES: STUDENTS WILL EXPLAIN, IN QUANTITATIVE TERMS, THE CHANGE IN POPULATIONS OVER TIME.</b>	
<b>Knowledge:</b> Students will explain, in quantitative terms, the change in populations over time.	<ul style="list-style-type: none"> <li>• Describe and explain, quantitatively, factors that influence population growth; i.e., mortality, natality, immigration, emigration change in population size, <math>\Delta N = [\text{natality} + \text{immigration}] - [\text{mortality} + \text{emigration}]</math></li> <li>• 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.               <ul style="list-style-type: none"> <li>○ Growth rate, <math>gr = \frac{\Delta N}{\Delta t}</math>, where <math>\Delta N</math> is the change in number of individuals in a population and <math>\Delta t</math> is change in time</li> <li>○ Per capita growth rate, <math>cgr = \frac{\Delta N}{N}</math>, where <math>\Delta N</math> is the change in number of individuals in a population relative to <math>N</math>, the original number of individuals</li> <li>○ Population density, <math>D_p = \frac{N}{A}</math>, or <math>D_p = \frac{N}{V}</math>, where <math>N</math> is the number of individuals in a given space, <math>A</math> is the area, and <math>V</math> is the volume</li> </ul> </li> <li>• Explain the different population growth patterns; i.e.,               <ul style="list-style-type: none"> <li>○ Logistic growth pattern (S-shaped curve) and exponential growth pattern (J-shaped curve)</li> <li>○ Open and closed populations</li> </ul> </li> <li>• Describe characteristics and reproductive strategies of <i>r</i>-selected and <i>K</i>-selected organisms.</li> </ul>
Explain how concepts, models and theories are often used in interpreting and explaining observations and in predicting future observations <b>Science, Technology and Society (STS)</b> (Nature of Science Emphasis)	<ul style="list-style-type: none"> <li>• Develop appropriate investigative strategies, such as a risk-benefit analysis or cost-benefit analysis, for analyzing biological issues</li> <li>• Compare the growth of the human population with that of populations of other species.</li> </ul>
<b>SKILLS OUTCOMES:</b> (embed throughout the unit)	
<b>Initiating and Planning:</b> Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	<ul style="list-style-type: none"> <li>• Identify questions about factors that affect population growth rates</li> </ul>
<b>Performing and Recording:</b> 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	<ul style="list-style-type: none"> <li>• Design and perform an experiment or a computer simulation to demonstrate the effect of environmental factors on population growth rate</li> <li>• Monitor a paramecium population over time, using a microscope and a grid slide</li> <li>• Research zebra mussel population growth in the Great Lakes (PR–NS1, PR–NS4)</li> <li>• Research the impact of introduced trout species on populations of native bull trout (<i>Salvelinus confluentus</i>) in Alberta’s lakes and streams</li> </ul>
<b>Analyzing and Interpreting:</b> Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	<ul style="list-style-type: none"> <li>• Graph and interpret population growth of <i>r</i>-selected and <i>K</i>-selected organisms</li> <li>• Calculate and interpret change in population size, growth rate, per capita growth rate and population density</li> <li>• Compare and evaluate human population growth rates in various countries</li> <li>• Demonstrate and assess the effect of environmental factors (biotic potential and environmental resistance) on population growth curves</li> <li>• Calculate population growth rate under ideal conditions, given specific parameters</li> <li>• State a generalization based on data for the growth of a closed population</li> <li>• Explain limitations in identifying changes in populations and explain how traditional knowledge can contribute to knowledge about changes</li> </ul>

**Unit D: Population and Community Dynamics**

Specific Outcomes	Achievement Indicators – Measurable outcomes
<p><i>It is expected that students will:</i></p>	<p><i>The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:</i></p>
<p><b>Communication and Teamwork:</b> Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results</p>	<ul style="list-style-type: none"> <li>• Develop, present and defend a position on Earth’s carrying capacity of Homo sapiens</li> </ul>