Student-based Performance Standards

Biology 30

Alberta Provincial Diploma Examinations

Alberta

This document was written primarily for:

Students	✓
Teachers	✓ of Biology 30
Administrators	✓
Parents	
General Audience	
Others	

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Contents

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Introduction

The Biology 30 Student-based Performance Standards document is designed to be a tool for the classroom teacher. **This document is not the program of studies**. Rather, it is a document intended to provide teachers with examples of some behaviours exhibited by students at the acceptable standard and at the standard of excellence for this course. These lists of behaviours are neither prescriptive nor exhaustive. This document should be used in conjunction with the program of studies.

The relative number of behaviours described in each unit is not an indication of the time required. Teachers should be guided by the program of studies, which indicates the time for each of the four units. Unit A should be allotted approximately 25% of the time in the course, Unit B 20%, Unit C 40%, and Unit D 15%. In addition, the described behaviours span the range of cognitive levels (Remembering/Understanding, Applying, Higher Mental Activities). Details related to cognitive levels can be found in the *Biology 30 Information Bulletin*.

Some of the described behaviours cannot be adequately assessed in a paper-and-pencil format, especially if the assessment instrument is exclusively machine-scored. However, they are part of the program of studies and should be assessed as part of the school-awarded mark in Biology 30.

The statements in this document reflect specific outcomes for knowledge, skills, and STS in the Biology 30 program of studies. Where possible, skills and STS outcomes have been integrated with related knowledge outcomes rather than being treated separately.

The skills of collaboration, teamwork, and scientific communication are present in every unit of the program of studies (skills outcome 1.4s in each unit). It is assumed that Biology 30 students at both the acceptable standard and the standard of excellence would display the behaviours associated with this skills outcome throughout the course. Therefore, behaviours associated with this skills outcome have not been described repeatedly throughout the document.

Many of the standards in this document are related to laboratory activities that are best experienced directly by the student. Some of these could be replaced by teacher demonstrations, multimedia presentations, or digital simulations, but direct student participation in laboratory activities should be maximized, and other substitutes should be used only when direct experiences are not possible for safety or environmental reasons.

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Biology 30 General Outcome A1 ***Students will*** **explain how the nervous system controls physiological processes.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
A1.1k	• identify the cell body, dendrites, axon, Schwann cell, myelin sheath, node of Ranvier, and synaptic knob (axon terminal) of a neuron on a diagram and describe their functions (A1.2s) • explain the relationship between the myelin sheath and nerve impulse transmission • compare the function of sensory neurons, motor neurons, and interneurons • distinguish between a sensory neuron, a motor neuron, and an interneuron on a diagram (A1.2s) • use a microscope and prepared slides to observe neurons and synapses (A1.2s) • define action potential and refractory period • on an action-potential graph showing depolarization, label the resting potential, depolarization, threshold, and refractory period • describe the movement of sodium and potassium ions during the establishment of a resting membrane potential • describe the formation and transmission of an action potential in terms of the movement of sodium and potassium ions during depolarization, repolarization, and the refractory period • describe the all-or-none response and threshold potential of a nerve impulse • describe a synapse and explain how acetylcholine and/or norepinephrine is used to transmit a signal across the synapse • describe the role of cholinesterase in regulating synaptic transmission • given symptoms of a disorder involving neurons, predict the structures of the neurons that would be affected (A1.1sts)	• interpret a membrane potential vs. time graph to identify resting membrane potential, depolarization, repolarization, hyperpolarization, refractory period, and threshold potential (A1.3s) • draw membrane potential vs. time graphs to depict the transmission of action potentials produced by various types of neurons and/or those that transmit impulses at different intensities; label the resting potential, depolarization, threshold, and refractory period (A1.3s) • explain the role of ion channels and sodium-potassium pumps in the establishment of the resting potential and the generation of an action potential • describe how an external substance, such as a chemical in a prescription drug, alters the flow of sodium and potassium ions, and the ultimate effect of the substance on nerve-impulse transmission (A1.3sts) • relate the flow of sodium, potassium, and other ions to changes in the polarity of a neuron membrane depicted in a membrane-potential vs. time graph • relate types of stimuli and threshold levels to action potentials and to intensity of responses (summation) • explain how intensity of response is altered, taking into consideration the all-or-none response and threshold potential (e.g., the transmission of a touch response vs. a pressure response or a pain response) • explain how other chemicals acting as neurotransmitters, whether inhibitory or excitatory, affect nerve-impulse transmission • explain how and why symptoms of a neuron disorder occur as a result of changes in the structure or functioning of neurons (A1.1sts) • explain the relationship between depolarization and synaptic transmission • infer from data how stimulants, depressants, or other chemicals (e.g., prescription drugs) affect synaptic transmission (A1.2sts) • explain how stimulants, depressants, or other chemicals (e.g. prescription drugs) can help treat a disorder of nerve impulse transmission (A1.3sts) • explain how intensity of response is altered in the context of the all-or-none response and at the synapse to produce inhibitory or excitatory responses in neurons

Biology 30 General Outcome A1 ***Students will*** **explain how the nervous system controls physiological processes.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
A1.2k	• outline the basic organization of the nervous system, including the CNS and PNS • relate the location of myelinated and unmyelinated nerve fibres to white and grey matter within the central nervous system • list physiological effects of the sympathetic and parasympathetic pathways of the ANS • describe the function of the somatic nervous system • perform an experimental procedure to investigate different types of receptors in the sensory-somatic nervous system (A1.1s) • explain the homeostatic function of the autonomic nervous system and compare the roles of the sympathetic and parasympathetic systems • identify the cerebrum, lobes of the cerebrum, cerebellum, pons, medulla oblongata, hypothalamus, and spinal cord on a diagram and describe their functions (A1.2s) • observe and identify major structures of the mammalian brain using models, dissections, or computer simulations (A1.2s) • given symptoms of a disorder involving the brain, predict the structures of the brain that would be affected (A1.1sts)	• describe the organization of the peripheral nervous system in terms of motor, sensory-somatic, sympathetic, and parasympathetic pathways • design an experiment to investigate different types of receptors in the sensory-somatic nervous system (A1.1s) • classify elements of the nervous system, based on their functioning, in terms of the divisions of the nervous system • evaluate described symptoms to determine the branch of the ANS stimulated • infer from data or described symptoms the part of the brain that could be affected or damaged (A1.3s) • explain how and why symptoms of a brain disorder occur in terms of changes in the structure or functioning of neurons (A1.1sts)
A1.3k	• describe the elements of a reflex arc, their functions, and how they work together to generate a reflex • on a diagram of a reflex arc, label the components • follow a procedure to investigate a reflex (A1.2s)	• infer from data or described symptoms the part of a reflex arc that could be affected or damaged (A1.2sts) • from a diagram or a description of damage to a component of a reflex arc, predict the physiological effects and justify the prediction • design an experiment to investigate a reflex (A1.2s) • integrate a context, such as a novel sensory pathway, into knowledge of a reflex arc

Biology 30 General Outcome A1 ***Students will*** **explain how the nervous system controls physiological processes.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
A1.4k	• identify the structures of the human eye, including the sclera, cornea, iris, pupil, lens, choroid, retina, rods and cones, fovea centralis, and optic nerve • observe and identify major structures of the mammalian eye using models, dissections, or computer simulations (A1.2s) • describe the functions of the structures of the human eye, including the sclera, cornea, iris, pupil, lens, choroid, retina, rods and cones, fovea centralis, and optic nerve • follow a procedure to investigate the ability to discriminate objects visually (A1.2s) • trace the pathway of light from the eye to the area of the brain where the interpretation of light stimuli occur	• explain how the structures of the eye function together to form an image on the retina • given information about the effects of an eye disorder, predict the expected symptoms and justify the prediction • interpret information to explain how damage to an eye structure ultimately affects vision • design and follow a procedure to investigate the ability to discriminate objects visually (A1.2s); explain how eye structures adjust to increase visual acuity • explain the functioning of a technology that is used to overcome a vision problem (A1.3sts)
A1.5k	• identify the structures of the human ear, including the pinna, auditory canal, tympanum, ossicles, cochlea, organ of Corti, auditory nerve, semicircular canals, and Eustachian tube • observe and identify major structures of the mammalian ear using models, dissections, or computer simulations (A1.2s) • describe the functions of the structures of the human ear, including the pinna, auditory canal, tympanum, ossicles, cochlea, organ of Corti, auditory nerve, semicircular canals, and Eustachian tube • follow a procedure to investigate the ability to hear a range of sounds • trace the pathway of sound from the ear to the area of the brain where the interpretation of sound stimuli occurs	• compare and contrast the structures and functions of parts of the ear that function in hearing with those that function in equilibrium • interpret information to explain how damage to an ear structure ultimately affects hearing or equilibrium • explain how the structures of the ear function together to transmit impulses related to hearing or equilibrium • given information about the effects of an ear disorder, predict the expected symptoms and justify the prediction • design and follow a procedure to investigate the ability to hear a range of sounds (A1.2s); relate hearing a range of sounds to the functioning of the organ of Corti • explain the functioning of a technology that is used to overcome a hearing problem (A1.3sts)
A1.6k	• identify other ways that humans sense their environment	• design an experiment to investigate particular sensory receptors or a chosen sensory pathway (A1.1s)
	• identify the manipulated, responding, and controlled variables in an experimental design (A1.1s)	• construct and evaluate hypotheses (A1.1s) • evaluate the consequences of a technological solution to a problem (A1.3sts)

This list is a description of behaviours that illustrate performance at particular standards based on the Biology 30 Program of Studies. This list is neither prescriptive nor exhaustive. This document is NOT the PROGRAM OF STUDIES.

Biology 30 General Outcome A2 ***Students will*** **explain how the endocrine system contributes to homeostasis.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
A2.1k	• identify in diagrams and on models the principal endocrine structures of humans, including the hypothalamus, pituitary gland, thyroid gland, parathyroid glands, adrenal glands, and the pancreatic islet cells • identify the glands that secrete the following hormones: TSH, thyroxine, calcitonin, PTH, ACTH, cortisol, insulin, glucagon, hGH, ADH, epinephrine, and aldosterone	• explain the relationship between the hypothalamus and pituitary gland, including the general concept of releasing hormones and feedback
A2.2k	• describe the functions of the following hormones: TSH, thyroxine, calcitonin, PTH, ACTH, cortisol, insulin, glucagon, hGH, ADH, epinephrine, and aldosterone • describe how TSH, thyroxine, calcitonin, PTH, ACTH, cortisol, insulin, glucagon, hGH, ADH, epinephrine, and aldosterone maintain homeostasis through negative feedback	• infer, through the analysis and interpretation of data, the role of a hormone in regulating the internal environment (A2.3s) • predict the effects of hypo or hypersecretion of a hormone and evaluate the significance of the effect on human physiology • evaluate how external factors, medical treatments, or features of endocrine disorders alter negative feedback mechanisms (A2.1sts and A2.2sts)
A2.3k	• describe the roles of thyroxine in metabolism; insulin, glucagon, and cortisol in blood glucose metabolism; hGH in growth; ADH in water regulation; aldosterone in sodium ion regulation; and PTH and calcitonin in calcium ion regulation	• analyze and interpret data on blood and urine composition to infer the role of ADH and aldosterone in the maintenance of water and ions in the blood (A2.3s) • design an experiment to determine the relationship between foods consumed (e.g. foods high in sodium) and secretion of some hormones (A2.2s) • compare and contrast the metabolic roles of cortisol and epinephrine; and the metabolic roles of calcitonin and PTH • hypothesize how the secretion of hormones other than insulin and glucagon might affect glucose metabolism (A2.3s)
A2.4k	• using a specific example, explain how the endocrine system allows humans to sense their internal environment and respond appropriately	

Biology 30 General Outcome A2 ***Students will*** **explain how the endocrine system contributes to homeostasis.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
A2.5k	• differentiate between the short-term stress response and the long-term stress response	• compare the endocrine and nervous control systems and explain how they act together • relate the short-term stress response and the roles of norepinephrine and the adrenal glands to the sympathetic nervous system
A2.6k	• describe the physiological consequences of hormone imbalance in a person with diabetes mellitus • describe the physiological consequences of imbalances of TSH, thyroxine, calcitonin, PTH, ACTH, cortisol, insulin, glucagon, hGH, ADH, epinephrine, and aldosterone	• differentiate between type I and type II diabetes mellitus • compare and contrast the treatments of type I and type II diabetes mellitus (A2.1sts) • analyze and interpret data on blood and urine composition to infer the role of insulin in the maintenance of glucose in the blood (A2.3s) • compare urinalysis data from a person with diabetes to data from a person without diabetes (A2.3s, A2.2s) • describe the physiological consequences of a hormone imbalance when given information on a particular disorder (A2.2s)
	• identify the manipulated, responding, and controlled variables in an experimental design (A2.1s)	• evaluate the use of technologies designed to treat endocrine disorders (A2.1sts) • evaluate the intended and unintended consequences of technologies such as the use of hormone therapy (A2.2sts) • formulate a hypothesis from published data on the influence of environmental factors on the endocrine system (A2.1s)

Biology 30 General Outcome B1 ***Students will*** **explain how survival of the human species is ensured through reproduction.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
B1.1k	• describe the structures and functions of the female reproductive system, including the ovaries, Fallopian tubes, uterus, endometrium, cervix, and vagina • identify in diagrams and on models the structures of the female reproductive system (B1.2s)	• explain how an external factor (e.g., genetic condition, infectious illness, or environmental agent) affects structures of the female reproductive system and predict the ultimate effect on fertility
B1.2k	• describe the structures and functions of the male reproductive system, including the testes, seminiferous tubules, interstitial cells, Sertoli cells, epididymides, vasa deferentia, Cowper's glands, seminal vesicles, prostate gland, ejaculatory duct, urethra, and penis • identify in diagrams and on models the structures of the male reproductive system (B1.2s) • describe the composition of semen and the importance of each component • describe the pathway of sperm through the male reproductive tract	• explain how an external factor (e.g., genetic condition, infectious illness, or environmental agent) affects structures of the male reproductive system and predict the ultimate effect on fertility
B1.3k		• distinguish ova from their related structures (i.e., follicle and corpus luteum) on a diagram, prepared slide, or photomicrograph of ovaries (B1.2s) • distinguish sperm from their related structures (i.e., Sertoli cells, seminiferous tubules, interstitial cells) on a diagram, prepared slide, or photomicrograph of testes (B1.2s) • evaluate solutions to decreased fertility, including technologies and medical treatments that might be employed (B1.3s, B1.1sts)
B1.4k	• identify the Y chromosome as a factor that determines development of reproductive organs in an embryo and fetus • identify testosterone as a factor that influences the development of reproductive organs in an embryo and fetus	• explain how the Y chromosome and testosterone determine primary sex characteristics and the development of reproductive organs in an embryo and fetus

Biology 30 General Outcome B1 ***Students will*** **explain how survival of the human species is ensured through reproduction.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
B1.5k	• describe generally how sexually transmitted infections (STIs) interfere with fertility and reproduction	• explain specifically how a particular STI can interfere with reproductive physiology based on its anatomical consequences (B1.1sts) • given a description of symptoms of a particular STI, predict the specific effect on reproduction and justify the prediction (B1.1s)
	• explain that technologies and interventions relating to human reproduction are associated with a number of perspectives (B1.1sts)	• evaluate a technology, procedure, or intervention from a number of different perspectives (B1.1sts)
	• identify the manipulated, responding, and controlled variables in an experimental design (B1.1s)	

Biology 30 General Outcome B2 ***Students will*** **explain how human reproduction is regulated by chemical control systems.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:
B2.1k	• define and describe primary and secondary sex characteristics • identify the hormones that stimulate the development of secondary sex characteristics in females and males • describe the functions of GnRH, FSH, LH, testosterone, estrogen, and progesterone in the regulation of primary and secondary sex characteristics • identify the structures that secrete GnRH, FSH, LH, testosterone, estrogen, and progesterone	
B2.2k	• describe the general functions of FSH, LH, estrogen, and progesterone in females • describe the negative feedback mechanisms that control the secretion of FSH and LH in females • identify the follicle and corpus luteum within the ovary using models, diagrams, or computer simulations (B2.2s) • describe the changes that occur in the ovary and uterus during a single menstrual cycle • describe how hormones secreted by the follicle and corpus luteum regulate development of the endometrium • describe in general terms the events that take place in each phase of the menstrual cycle (e.g., flow phase, follicular phase, ovulation, luteal phase)	• explain how FSH, LH, estrogen, and progesterone interact in the maintenance and functioning of the female reproductive system • analyze blood hormone data and physiological events of a single menstrual cycle to infer the roles of female sex hormones (B2.3s) • relate changing blood hormone levels to physiological events that occur in the ovary and uterus (B2.3s) • explain the changing hormone levels and the events that occur during the four phases of the menstrual cycle, the interactions of hormones that regulate the four phases, and the regulation of the hormones through feedback mechanisms (B2.3s) • graph the changes in FSH, LH, estrogen, and progesterone levels in the blood through a single menstrual cycle (B2.2s) • analyze graphs of changing levels of hormones through a single menstrual cycle and relate information to ovarian and endometrial events (B2.3s) • analyze data related to varying hormone levels through an atypical menstrual cycle; hypothesize the effects on reproduction and justify the hypothesis (B2.3s) • evaluate the administration of hormones as therapy on the functioning of the female reproductive system (B2.1sts, B2.2sts) • predict the effects of the administration of hormone therapy on the regulation of the menstrual cycle and associated hormones; justify the prediction (B2.1s) • evaluate how external factors or medical treatments alter feedback mechanisms and functioning of the female reproductive system

This list is a description of behaviours that illustrate performance at particular standards based on the Biology 30 Program of Studies. This list is neither prescriptive nor exhaustive. This document is NOT the PROGRAM OF STUDIES.

Biology 30 General Outcome B2 ***Students will*** **explain how human reproduction is regulated by chemical control systems.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:
B2.3k	• describe the general functions of FSH, LH, and testosterone in males • describe the negative feedback mechanisms that control the secretion of FSH, LH, and testosterone in males	• explain how FSH, LH, and testosterone interact in the maintenance and functioning of the male reproductive system • analyze blood hormone data and physiological events to infer the roles of male sex hormones (B2.3s) • evaluate the administration of hormones as therapy on the functioning of the male reproductive system (B2.1sts, B2.2sts) • predict the effects of the administration of hormone therapy on the male reproductive system and hormones; justify the prediction (B2.1s) • evaluate how external factors or medical treatments alter feedback mechanisms and functioning of the male reproductive system
	• explain that technologies and interventions relating to human reproduction are associated with a number of perspectives (B2.2sts)	• evaluate a technology, procedure, or intervention from a number of different perspectives (B2.2sts)
	• identify the manipulated, responding, and controlled variables in an experimental design (B2.1s)	• communicate blood hormone data using appropriate numerical and graphical representation (B2.4s)

Biology 30 General Outcome B3 ***Students will*** **explain how cell differentiation and development in the human organism are regulated by a combination of genetic, endocrine, and environmental factors.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
B3.1k	• describe the locations of fertilization and implantation • describe the sequence of events that leads to fertilization and implantation • identify the tissues that form the placenta • describe the functions of the placenta, amnion, chorion, and allantois • identify the structure that secretes hCG • describe the roles of LH and hCG in maintaining pregnancy during the first trimester • describe the role of progesterone in early pregnancy • describe the change in progesterone secretion that occurs in preparation for parturition • identify the gland that secretes prolactin and oxytocin and identify their target tissues • describe the role of oxytocin in parturition and lactation • describe the role of prolactin in lactation • describe the role of prostaglandins in parturition • describe the events in parturition	• compare the ovarian and endometrial events that take place when fertilization occurs with the events that take place when fertilization does not occur, including associated hormones • integrate knowledge of cell division (both meiosis and mitosis) with early events in development (fertilization, development of the embryo) • describe the development of the amnion, chorion, and allantois • explain how the chorion and the endometrium form the placenta • explain how hormones secreted by the pituitary gland, ovary, and chorion regulate the development of the placenta • interpret graphs of maternal levels of hCG, estrogen, and progesterone during pregnancy (B3.3s) • describe how parturition is initiated by changes in levels of hormones such as progesterone, prostaglandins, and oxytocin • explain how oxytocin and prolactin interact to initiate and maintain lactation, including the feedback mechanisms that regulate both hormones
B3.2k	• describe how the zygote and blastocyst form • define gastrulation and morphogenesis • identify some events of embryonic and fetal development and their relative chronology (B3.3s) • describe the main physiological events of embryonic and fetal development during each trimester, including major body systems • observe changes during embryonic development using preserved materials, models, or computer simulations (B3.3s)	• describe the time of fertilization, blastocyst formation, and implantation relative to the time of ovulation • describe gastrulation • integrate knowledge of the formation of the zygote and blastocyst, the processes of gastrulation and implantation, and embryonic and fetal development by trimester • observe changes during embryonic development using preserved materials, models, or computer simulations; compare and contrast these events to the development of a human embryo (B3.3s)

Biology 30 General Outcome B3 ***Students will*** **explain how cell differentiation and development in the human organism are regulated by a combination of genetic, endocrine, and environmental factors.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:
B3.3k	• define differentiation • identify major tissues and organs that arise from the ectoderm, the mesoderm, and the endoderm in an embryo	• evaluate the ultimate effect of factors that interfere with a specific germ layer on the embryo, fetus, or child (B3.2s) • justify the ultimate effect of damage to a specific germ layer in terms of progress of development and major events in development (B3.2s)
B3.4k	• identify environmental factors that could affect embryonic and fetal development (B3.2s) • investigate specific environmental factors that could affect embryonic and fetal development (B3.2s)	• explain how environmental factors, such as teratogens, could specifically affect the development of the embryo and fetus and whether the effects will be long-lasting depending on the time of exposure (B3.2s)
B3.5k	• identify different reproductive technologies related to conception control, in vitro fertilization, and infertility reversal	• describe different reproductive technologies, such as conception control, in vitro fertilization, and infertility reversal, in physiological terms, explaining how they work and why they are effective
	• explain how science and technology relating to human reproduction provide solutions to challenges (B3.1sts) • explain that technologies and interventions relating to human reproduction are associated with a number of perspectives (B3.2sts) • describe the perspectives associated with a particular technology (B3.2sts)	• explain in physiological terms how a particular technology relating to human reproduction provides solutions to challenges (B3.1sts) • evaluate a technology, procedure, or intervention from a number of different perspectives (B3.2sts) • evaluate advantages and disadvantages of the use of reproductive technologies and compare their relative effectiveness (B3.1sts)
	• identify the manipulated, responding, and controlled variables in an experimental design (B3.1s)	

Biology 30 General Outcome C1 ***Students will*** **describe the processes of mitosis and meiosis.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
C1.1k	• define haploidy, diploidy, and polyploidy • compare the number and type of chromosomes in haploid and diploid cells	• explain the significance of chromosome number in somatic and sex cells • determine the ploidies of cells from a description of typical or atypical events occurring in a cell cycle • explain how a particular external event or substance could alter ploidy and the ultimate effect on the organism • explain, using a specific example, how ploidy relates to possibilities for reproduction • explain the relationship between ploidy and genetic diversity
C1.2k	• describe the events of the cell cycle, including interphase, mitosis, and cytokinesis • explain the purpose and result of mitosis • describe the major events that occur in each phase of mitosis • identify each phase of mitosis on diagrams or models • arrange diagrams or models of the phases of mitosis in the order in which the phases take place • perform a simulation of mitosis to demonstrate the behaviour of chromosomes (C1.2s) • interpret human karyotypes in terms of the number and arrangement of chromosomes (C1.3s) • prepare karyotypes using models or computer simulations (C1.3s)	• interpret various diagrams of the cell cycle showing interphase, phases of mitosis, and cytokinesis to determine the major events occurring in specific parts of the diagram • interpret microscope slides or photomicrographs of phases of the cell cycle and describe the major events occurring in each phase (C1.2s) • explain the significance of events occurring in each phase of the cell cycle • calculate the relative duration of each stage of mitosis using microscope slides (C1.2s) • explain how interference with mitotic structures or disruption of mitotic processes affects cell reproduction and ultimately the organism • analyze karyotypes of a variety of organisms, including the number and arrangement of chromosomes; integrate information in the karyotype with knowledge of cell reproduction (C1.3s)

Biology 30 General Outcome C1 ***Students will*** **describe the processes of mitosis and meiosis.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
C1.3k	• explain the purpose and result of meiosis • describe the necessity of the reduction of the chromosome number and how it is achieved in meiosis • identify the changes in chromosome number (ploidy) that occur during the first and second meiotic divisions • identify the major events that occur in each phase of meiosis • identify each phase of meiosis on diagrams or models • arrange diagrams or models of the phases of meiosis in the order in which the phases take place • perform a simulation of meiosis to demonstrate the behaviour of chromosomes • describe the events in meiosis that are involved in maintaining a consistent chromosome number in a species • compare spermatogenesis and oogenesis in terms of the number and size of gametes produced	• interpret diagrams of phases of meiosis and describe the major events occurring in each phase • compare and contrast on diagrams or models phases of meiosis I with phases of meiosis II • compare and contrast phases of meiosis I with phases of meiosis II in terms of the events taking place and the behaviour of chromosomes • explain the significance of events occurring in each phase of meiosis • explain how interference with various phases of meiosis affects cell reproduction and, ultimately, the organism • compare and contrast the processes of spermatogenesis and oogenesis
C1.4k	• compare the processes of mitosis and meiosis, including purpose of the process, number of divisions, chromosome content (ploidy) of the cells produced, number of cells produced, and type of cells produced • distinguish between sexual and asexual reproduction	• compare and contrast the appearance of chromosomes at analogous phases of mitosis and meiosis (e.g., metaphase of mitosis, metaphase I, metaphase II) • compare and contrast the behaviour of chromosomes at analogous phases of mitosis and meiosis (e.g., metaphase of mitosis, metaphase I, metaphase II) • explain how the consequences of a disruption in the process of mitosis differ from the consequences of a disruption in the process of meiosis, both short-term and long-term (C1.1s)
C1.5k	• identify the phase of meiosis when crossing over occurs • describe the process of crossing over • define nondisjunction and explain how it results in an atypical number of chromosomes	• evaluate the effect of crossing over on the genetic composition of an organism • explain the effect crossing over on genetic diversity in a population • evaluate the significance of nondisjunction on inheritance and development

Biology 30 General Outcome C1 ***Students will*** **describe the processes of mitosis and meiosis.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
C1.6k	• explain how fraternal twins and identical twins are formed • compare and contrast the genetic composition of fraternal and identical twins	• integrate concepts related to the formation of fraternal and identical twins with concepts in early embryonic development • apply knowledge of the formation of fraternal and identical twins to a unique scenario
C1.7k	• interpret a diagram of a life cycle to determine when the processes of mitosis, meiosis, and fertilization would take place • interpret a diagram of a life cycle to determine ploidy of cells or organisms (C1.2s)	• describe the diversity of reproductive strategies by comparing the life cycles of a range of organisms • interpret diagrams of life cycles of various organisms to infer their reproductive strategies (C1.2s) • analyze diagrams of life cycles of various organisms with alternation of generations, including ploidies of structures, while considering the effects of aspects of the life cycle on genetic diversity (C1.2s)
	• identify the manipulated, responding, and controlled variables in an experimental design (C1.1s) • describe examples of medical advancements and other technologies related to cell division that improve the human condition (C1.1sts)	

Biology 30 General Outcome C2 ***Students will*** **explain the basic rules and processes associated with the transmission of genetic characteristics.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
C2.1k	• describe the principles of dominance, segregation, and independent assortment • provide illustrative examples of the principles of dominance and segregation • distinguish among chromosomes, genes, and alleles	• explain the principle of independent assortment • provide an illustrative example for the independent assortment of genes on different chromosomes, as investigated by Mendel • illustrate dominance, segregation, and independent assortment using Punnett squares (C2.3s) • evaluate research data to determine which of Mendel's principles (dominance, segregation, or independent assortment) is best exemplified, and classify them
C2.2k	• distinguish between genotype and phenotype • explain how genotype determines phenotype • analyze genotype symbols to determine phenotype • determine and use symbols to represent possible genotypes from a given phenotype • explain the difference between homozygous and heterozygous genotypes • illustrate and interpret the results of monohybrid and dihybrid crosses using Punnett squares (C2.3s) • determine ratios and probabilities of genotypes and phenotypes for dominant and recessive alleles, autosomal alleles, multiple alleles, incompletely dominant alleles, and co-dominant alleles (C2.3s) • predict the results of crosses between parents of known genotypes and provide genotypic and phenotypic ratios of offspring (C2.3s) • analyze genotypic or phenotypic ratios to determine the pattern of inheritance of the alleles involved (dominant/recessive, incompletely dominant, co-dominant, or multiple alleles) (C2.3s) • express probabilities as decimals, fractions, and percentages (C2.3s) • construct pedigree charts using provided data (C2.3s) • analyze pedigree charts to determine the phenotypes and genotypes of individuals when the inheritance pattern of the trait is known (C2.3s)	• explain why predicted phenotypic ratios differ from actual counts in genetic crosses (C2.3s) • compare patterns of inheritance (dominant and recessive alleles, autosomal alleles, multiple alleles, incompletely dominant alleles, and co-dominant alleles) • analyze genotypic or phenotypic ratios to determine the genotypes and phenotypes of the parents for one or more patterns of inheritance (C2.3s) • illustrate and interpret results of crosses using Punnett squares when two different patterns of inheritance are combined (C2.3s) • determine probabilities and ratios when two different patterns of inheritance are combined (C2.3s) • use the product rule to determine genotypic and phenotypic ratios when appropriate (C2.3s) • infer the pattern of inheritance of a trait and the genotypes of individuals from a pedigree chart when the pattern is not provided (C2.3s) • analyze pedigree charts to determine genotypic and/or phenotypic ratios or probabilities expected in the offspring of two parents when the pattern of inheritance is not provided and must first be determined (C2.3s) • use relevant evidence from a pedigree chart to justify the inheritance pattern (C2.3s) • apply acquired knowledge of various concepts in genetics to new situations and combinations

Biology 30 General Outcome C2 ***Students will*** **explain the basic rules and processes associated with the transmission of genetic characteristics.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
C2.3k	• describe the significance of linked genes • analyze crossover data for a single pair of chromosomes to produce a chromosome map (C2.3s) • construct a chromosome map from crossover data to show gene arrangement and relative distances between them (C2.3s)	• explain the influence of gene linkage on phenotypic ratios in a population • explain the influence of crossing over on phenotypic ratios in a population • explain the influence of crossing over on genetic diversity in a population • evaluate a chromosome map to determine the likelihood of genes being exchanged during a crossover
C2.4k	• explain the relationship between variability and the number of genes controlling a trait	
C2.5k	• compare the pattern of inheritance produced by genes on sex chromosomes, as investigated by Morgan and others, to other patterns of inheritance • use symbols to represent genotypes of an X-linked trait (C2.3s) • illustrate and interpret the results of crosses of X-linked traits using Punnett squares (C2.3s) • determine ratios and probabilities of genotypes and phenotypes for dominant and recessive X-linked alleles (C2.3s) • predict the results of crosses of an X-linked trait between parents of known genotypes and provide genotypic and phenotypic ratios of offspring (C2.3s) • express probabilities as decimals, fractions, or percentages (C2.3s) • analyze genotypic or phenotypic ratios to determine that alleles are inherited in an X-linked pattern (C2.3s) • describe patterns of inheritance of X-linked traits • distinguish an X chromosome from an autosome • construct pedigree charts using provided data (C2.3s) • analyze pedigree charts to determine the phenotypes and genotypes of individuals when the inheritance pattern of the trait is known (C2.3s)	• determine the pattern of inheritance of a trait by interpreting data illustrating autosomal and X-linked inheritance (C2.3s) • interpret data to determine if an allele is X-linked • analyze genotypic or phenotypic ratios to determine the genotypes and phenotypes of the parents for an X-linked trait and one additional pattern of inheritance (C2.3s) • illustrate and interpret results of crosses using Punnett squares when an X-linked trait is combined with another pattern of inheritance (C2.3s) • determine probabilities and ratios when an X-linked trait is combined with another pattern of inheritance (C2.3s) • infer the pattern of inheritance of an X-linked trait and the genotypes of individuals from a pedigree chart when the pattern is not provided (C2.3s) • analyze pedigree charts to determine genotypic and/or phenotypic ratios or probabilities expected in the offspring of two parents when an X-linked pattern of inheritance is not provided and must first be determined (C2.3s) • use relevant evidence from a pedigree chart to justify the inheritance pattern of an X-linked trait (C2.3s) • apply acquired knowledge of various concepts in genetics to new situations and combinations involving sex chromosomes (e.g., solving problems with two traits, one autosomal and one X-linked) (C2.3s)

Biology 30 General Outcome C2 ***Students will*** **explain the basic rules and processes associated with the transmission of genetic characteristics.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:
	• perform an experiment to demonstrate the inheritance of a trait controlled by a single pair of alleles (C2.2s) • identify the manipulated, responding, and controlled variables in an experimental design (C2.1s)	• design a plan for collecting data to demonstrate inheritance in humans (C2.1s)
	• explain that technologies and interventions relating to human genetics are associated with a number of perspectives (C2.1sts) • describe the perspectives associated with a particular technology (C2.1sts)	• evaluate a technology, procedure, or intervention from a number of different perspectives (C2.1sts)

Biology 30 General Outcome C3 ***Students will*** **explain classical genetics at the molecular level.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
C3.1k	• summarize the historical events that led to the discovery of the structure of the DNA molecule, including the work of Franklin and of Watson and Crick	
C3.2k	• explain that genes are regions of DNA • describe nitrogen-base pairing in DNA • describe the relationship between genes, DNA, and amino acids • describe how genetic information is coded for by the sequences of bases in DNA molecules • describe the molecular structure of DNA, including the complementary nature of the coding and non-coding strands • draw or build a model of a DNA nucleotide (C3.2s) • construct a model of DNA to show the general structure and arrangement of bases (e.g., sugar–phosphate backbone, nitrogen bases, hydrogen bonding, complementary strands) (C3.2s) • explain how DNA molecules replicate themselves • identify the part of the cell where replication takes place • perform simulations to demonstrate replication (C3.2s)	• analyze data to predict the effects of an agent that disrupts replication in a particular way; justify the prediction (C3.3s)

Biology 30 General Outcome C3 ***Students will*** **explain classical genetics at the molecular level.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
C3.3k	• describe the molecular structure of RNA • describe nitrogen-base pairing in mRNA • compare and contrast the structure and function of DNA and RNA • draw or build a model of an mRNA nucleotide (C3.2s) • distinguish between mRNA and tRNA • describe how genetic information is transcribed from the coding strand of a DNA molecule into a sequence of bases in mRNA • describe the translation of mRNA into sequences of amino acids in proteins • perform simulations to demonstrate transcription and translation (C3.2s) • determine the mRNA sequence that is coded for by a given gene sequence • determine the gene sequence that is coded for by a given mRNA sequence • determine the sequence of amino acids that is coded for by a given gene sequence or mRNA sequence	• explain the process of transcription, including the location, processes, and molecules involved • explain the roles of codons, anticodons, initiator codons, and terminator codons • explain the process of translation, including location, processes, and molecules involved • explain how tRNA achieves its role in protein synthesis • determine a gene sequence that codes for a given amino acid sequence • determine the tRNA codons that will be involved in the translation of a particular gene sequence • analyze data to hypothesize the effect of an agent that disrupts transcription or translation; justify the hypothesis (C3.3s)
C3.4k	• describe the function of restriction enzymes and ligase in genetic recombination technology • perform simulations to demonstrate the functioning of restriction enzymes and ligase (C3.2s)	• analyze a procedure to determine in what part of the procedure restriction enzymes and ligase would be used • apply knowledge of restriction enzymes and ligase to the functioning of a novel genetic technology in order to make comparisons
C3.5k		• explain how cells can be transformed by inserting new DNA sequences into their genomes
C3.6k	• describe the effect of mutations on cells and organisms • explain how a mutation provides a source of genetic variability	• explain how the consequences of a mutation can be positive, negative, or neutral for the organism or the population • analyze data or diagrams related to mutations to predict the effect of a particular mutation on the products of transcription or translation; justify the prediction • analyze data to infer the relationship between human activities and changes in genetic information that lead to inheritable mutations and cancer (C3.3s) • relate cancer to the cell cycle (C1.2k)

This list is a description of behaviours that illustrate performance at particular standards based on the Biology 30 Program of Studies. This list is neither prescriptive nor exhaustive. This document is NOT the PROGRAM OF STUDIES.

Biology 30 General Outcome C3 ***Students will*** **explain classical genetics at the molecular level.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
C3.7k	• explain how similarities in genomes indicate that different species have common ancestry • identify the parts of a cell in which genetic material is located, including the nucleus, mitochondrion, and chloroplast • describe the inheritance of genes present in mitochondrial DNA	• explain how mitochondrial DNA and chloroplast DNA provide evidence for relationships between organisms of different species
	• identify the manipulated, responding, and controlled variables in an experimental design (C3.1s) • identify an intended and an unintended consequence of a genetic technology (C3.1sts)	• analyze examples of genetic technologies to determine intended and unintended consequences (C3.1sts, C3.2sts)

Biology 30 General Outcome D1 ***Students will*** **describe a community as a composite of populations in which individuals contribute to a gene pool that can change over time.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
D1.1k	• define gene pool • recognize that genetic variability exists within a population • describe the Hardy–Weinberg principle • list and describe the five conditions of the Hardy–Weinberg principle • recognize when a population is in genetic equilibrium	• illustrate that the Hardy–Weinberg principle is based on probability • explain how a disruption in any of the conditions of the Hardy–Weinberg principle affects gene frequencies
D1.2k	• describe the factors that cause the gene pool to change, including natural selection, genetic drift, gene flow, nonrandom mating, bottleneck effect, founder effect, migration, and mutation • recognize that allele frequencies in a gene pool can change over time	• perform experiments and simulations to illustrate change in the gene pool and apply the Hardy–Weinberg principle to data collected (D1.3s) • design an experiment or simulation to illustrate population growth and change in the gene pool (D1.2s) • evaluate how altering one of the factors that causes the gene pool to change would ultimately affect the diversity and growth of a particular population
D1.3k	• describe the mathematical equation that expresses the Hardy–Weinberg principle • relate each term in the Hardy–Weinberg equation with frequencies of alleles, genotypes, and phenotypes • determine frequencies of the recessive or dominant alleles using the Hardy–Weinberg equation (D1.3s) • report calculated gene frequencies using appropriate notation and significant digits • describe equilibrium values, where the values of p and q do not change over time, and non-equilibrium values, where the values of p and q change over time	• analyze population data using the Hardy–Weinberg equation to determine if gene frequencies are changing over time (D1.3s) • determine frequencies of genotypes or phenotypes using the Hardy–Weinberg equation (D1.3s) • evaluate solutions to Hardy–Weinberg problems for correctness (D1.3s) • determine the Hardy–Weinberg expression that represents a particular group of individuals in a population (D1.3s)

Biology 30 General Outcome D2 ***Students will*** **explain the interaction of individuals in a population with one another and with members of other populations.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
D1.4k	• describe the molecular basis of changes in the gene pool and the significance of these changes over time, including mutations and natural selection	• explain the significance of stability in a population's gene pool • explain that a change in the gene pool over time can be directed by natural selection • compare the gene pool of a population that is changing with the gene pool of a population that is not changing • predict the consequences to a population if the gene pool changes significantly over time and justify the predictions
	• explain that science and technology have both intended and unintended consequences for populations (D1.1sts)	
	• identify the manipulated, responding, and controlled variables in an experimental design (D1.1s)	• evaluate data related to changing gene frequencies over time to hypothesize how gene frequencies could change in the future (D1.2sts)

Biology 30 General Outcome D2 ***Students will*** **explain the interaction of individuals in a population with one another and with members of other populations.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
D2.1k	• describe predator–prey and producer–consumer relationships, and describe their influence on population changes • perform simulations to investigate the relationships between predators and their prey (D2.2s) • define commensalism, mutualism, and parasitism and give examples of each • describe a symbiotic relationship in terms of the contribution of each species to the relationship • define interspecific competition and intraspecific competition and give examples of each • analyze text or research to classify relationships among organisms	• analyze data to interpret the relationship between predators and their prey (D2.3s) • analyze data to interpret symbiotic relationships among species in a community (D2.3s) • describe the influence of interspecific and intraspecific competition on changes in population size • design an experiment or a simulation to demonstrate interspecific and intraspecific competition (D2.2s) • analyze data to interpret the results of an experiment or simulation illustrating intraspecific or interspecific competition (D2.3s)
D2.2k	• explain the role of defence mechanisms in predation and competition • give examples of defence mechanisms employed by a variety of species	
D2.3k	• define succession, pioneer community, and climax community • describe how a community is characterized by its populations • compare and contrast primary and secondary succession • describe how a community can change over time to become a climax community	• design and perform an experiment to demonstrate succession and record the pattern of succession over time (D2.2s) • explain how a climax community can remain in a certain area • evaluate an ecological disturbance and how it can lead to succession in an area
		• explain the significance of understanding population dynamics in terms of ecosystem management (D2.1sts)
	• identify the manipulated, responding, and controlled variables in an experimental design (D2.1s)	

Biology 30 General Outcome D3 ***Students will*** **explain, in quantitative terms, the change in populations over time.**

	Behaviours of a student functioning at the acceptable standard include, but are not limited to, the following:	**Behaviours of a student functioning at the standard of excellence include, but are not limited to, the following:**
D3.1k	• identify and describe factors that influence population growth • explain how mortality, natality, immigration, and emigration influence population growth • determine change in population size using the formula ΔN = [natality + immigration] – [mortality + emigration] (D3.3s)	• explain factors influencing natality and mortality • compare the effects of density-dependent (biotic) and density-independent (abiotic) limiting factors on natality and mortality
D3.2k	• determine the growth rate of a population using the formula $gr = \Delta N/\Delta t$ (D3.3s) • determine per capita growth rate of populations using the formula $cgr = \Delta N/N$ (D3.3s) • determine the density of a population using the formula $D_p = N/A$ or $D_p = N/V$ (D3.3s) • define carrying capacity, biotic potential, and environmental resistance, and describe their effect on the growth of a population	• design and perform an experiment or simulation to demonstrate the effect of environmental factors on population growth rate (D3.2s) • interpret data on population size, growth rate, per capita growth rate, and population density (D3.3s) • explain how limiting factors lead to logistic growth or exponential growth • evaluate characteristics of a community to hypothesize how carrying capacity, biotic potential, and environmental resistance are affected
D3.3k	• define logistic growth and exponential growth • illustrate theoretical growth curves for logistic (S-shaped) and exponential (J-shaped) growth patterns of populations (D3.3s) • describe characteristics of open and closed populations • explain the difference in growth patterns of open and closed populations • illustrate how changes in factors that influence population growth would affect the population's growth curve	• interpret population growth curves (D3.3s) • compare and contrast logistic (S-shaped) and exponential (J-shaped) growth curves (D3.3s) • evaluate characteristics of open and closed populations to hypothesize their growth patterns (D3.1s) • illustrate how changes in factors that influence population growth would affect the population's growth curve (D3.3s)
D3.4k	• describe characteristics and reproductive strategies of *r*-selected and *K*-selected species • graph population growth of *r*-selected and *K*-selected species (D3.3s)	• relate reproductive strategies to population growth curves (D3.3s) • evaluate characteristics of a species to determine the traits that are *r*-selected and *K*-selected
	• identify the manipulated, responding, and controlled variables in an experimental design (D3.1s)	• evaluate population data to predict future population growth (D3.1sts)