



This document represents an updating of the 1996 IRP. This updating has been undertaken for the purpose of

- clarifying the Prescribed Learning Outcomes
- introducing Suggested Achievement Indicators
- addressing content overload

Resources previously recommended for the 1996 version of the curriculum, where still valid, continue to support this updated IRP. (See the Learning Resources section in this IRP for additional information.)

# BIOLOGY 11 AND 12

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This document has been updated from the 1996 IRP to include suggested achievement indicators, a more clear and succinct set of prescribed learning outcomes, a snapshot of the course's key elements, and other minor refinements, while maintaining the original intent and essence of the 1996 curricular content.

Many people contributed their expertise to the Biology 11-12 IRP. The Project Manager (2005-2006) was Mr. Wael Afifi of the Ministry of Education, working with other ministry personnel and our partners in education. We would like to thank all who participated in this process, including the teams of educators who developed the 1996 Biology 11-12 IRP, and the following individuals who contributed to the 2005-2006 updating of this document:

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This Integrated Resource Package (IRP) provides basic information teachers will require in order to implement Biology 11 and 12. This document supersedes the *Biology 11 and 12 Integrated Resource Package* (1996).

The information contained in this document is also available on the Internet at [www.bced.gov.bc.ca/irp/irp.htm](http://www.bced.gov.bc.ca/irp/irp.htm)

The following paragraphs provide brief descriptions of the components of the IRP.

### INTRODUCTION

The Introduction provides general information about Biology 11 and 12, including special features and requirements.

Included in this section are

- a rationale for teaching Biology 11 and 12 in BC schools
- information about graduation program requirements and provincial examinations
- listings of each course's curriculum organizers and suborganizers – groupings for prescribed learning outcomes that share a common focus
- suggested time allotments for each course

### CONSIDERATIONS FOR PROGRAM DELIVERY

This section of the IRP contains additional information to help educators develop their school practices and plan their program delivery to meet the needs of all learners.

### PRESCRIBED LEARNING OUTCOMES

This section contains the *prescribed learning outcomes*, the legally required content standards for the provincial education system. The learning outcomes define the required knowledge, skills, and attitudes for each subject. They are statements of what students are expected to know and be able to do by the end of the course.

### STUDENT ACHIEVEMENT

This section of the IRP contains information about classroom assessment and measuring student achievement, including sets of specific achievement indicators for each prescribed learning outcome. Achievement indicators are statements that describe what students should be able to do in order to demonstrate that they fully meet the expectations set out by the prescribed learning outcomes. Achievement indicators are not mandatory; they are provided to assist in the assessment of how well students achieve the prescribed learning outcomes.

Also included in this section are key elements – descriptions of content that help determine the intended depth and breadth of the prescribed learning outcomes.

### LEARNING RESOURCES

This section contains general information on learning resources, and provides a link to titles, descriptions, and ordering information for the recommended learning resources in the Biology 11 and 12 Grade Collections.







# INTRODUCTION

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*Biology 11 and 12*



This Integrated Resource Package (IRP) sets out the provincially prescribed curriculum for Biology 11 and 12. The development of this IRP has been guided by the principles of learning:

- Learning requires the active participation of the student.
- People learn in a variety of ways and at different rates.
- Learning is both an individual and a group process.

In addition to these three principles, this document recognizes that British Columbia's schools include young people of varied backgrounds, interests, abilities, and needs. Wherever appropriate for this curriculum, ways to meet these needs and to ensure equity and access for all learners have been integrated as much as possible into the learning outcomes and achievement indicators.

This document represents an updating of the 1996 IRP. This updating has been undertaken for the purpose of

- clarifying the prescribed learning outcomes
- introducing suggested achievement indicators
- addressing content overload

Resources previously recommended for the 1996 version of the curriculum, where still valid, continue to support this updated IRP. (See the Learning Resources section later in this IRP for additional information.)

Biology 11 and 12, in draft form, was available for public review and response from November to December, 2005. Feedback from educators, students, parents, and other educational partners informed the development of this updated IRP.

## RATIONALE

The science curriculum of British Columbia provides a foundation for the scientific literacy of citizens, for the development of a highly skilled and adaptable work force, and for the development of new technologies. It is a foundation on which teachers can develop a science program that provides a comprehensive set of knowledge, skills, and experiences related to science.

School science programs that are planned to develop scientifically literate students provide experiences that

- help students become flexible and adaptable while acquiring specialized knowledge
- develop the capacity to think critically
- call for a wide range of knowledge, methods, and approaches that enable students to analyse personal and societal issues critically
- encourage students to examine the impact of scientific knowledge on their lives, society, and the environment
- develop a positive attitude toward science
- cultivate students' appreciation of the scientific endeavour and their potential to contribute to it

The science curricula of British Columbia provide a framework of opportunities for students to become scientifically literate by

- examining basic concepts, principles, laws, and theories through scientific inquiry
- actively gaining knowledge, skills, and attitudes that provide the basis for sound and ethical problem solving and decision making
- developing an understanding of the place of science in society and history and its relationships to other disciplines
- making informed and responsible decisions about themselves, their homes, workplaces, and the global community

## REQUIREMENTS AND GRADUATION CREDITS

Biology 11 and 12 are two of the courses available for students to satisfy the Grade 11-12 Graduation Program science requirement.

Biology 11 and 12 are each designated as four-credit courses, and must be reported as such to the Ministry of Education for transcript purposes. Letter grades and percentages must be reported for these courses. It is not possible to obtain partial credit for these courses.

The course codes for Biology 11 and 12 are BI 11 and BI 12. These courses are also available in French (Biologie 11, Biologie 12: course codes BIOSR 11, BIOSR 12).

**GRADUATION PROGRAM EXAMINATION**

Biology 12 has an optional Graduation Program examination, worth 40% of the final course mark for students who choose to write it. Although students are not required to take this exam to receive credit for the course, they should be advised that some post-secondary institutions require Grade 12 exams to meet entrance requirements, and that writing Grade 12 exams also provides opportunities for provincial scholarships.

For more information, refer to the Ministry of Education examinations web site: [www.bced.gov.bc.ca/exams/](http://www.bced.gov.bc.ca/exams/)

**BIOLOGY 11**

Biology is a scientific discipline that studies a great variety of organisms. It is widely accepted that a few major themes exist in biology, and the use of these can provide an organizational framework for studying biology. The three themes for Biology 11 are as follows:

- Unity and Diversity
- Evolutionary Relationships
- Ecological Relationships

Teachers should provide laboratory and field opportunities for students to examine a wide variety of organisms to develop their understanding of the three major themes of Biology 11.

The prescribed learning outcomes for Biology 11 are grouped under the following curriculum organizers and suborganizers:

Biology 11						
Processes of Science	Taxonomy	Evolution	Ecology	Microbiology <ul style="list-style-type: none"> <li>• Viruses</li> <li>• Kingdom Monera</li> </ul>	Plant Biology	Animal Biology

A curriculum organizer consists of a set of prescribed learning outcomes that share a common focus. Note that the ordering of organizers, suborganizers, and outcomes in the Biology 11 curriculum is not intended to imply an order of instruction.

The prescribed learning outcomes related to Processes of Science support the development of knowledge, skills, and attitudes essential for an understanding of science. These learning outcomes should not be taught in isolation, but should be integrated with activities related to the other six curriculum organizers.

**BIOLOGY 12**

Biology 12 focusses on human biology, allowing students to develop an interest in and understanding of science by looking at themselves and seeing how the diverse body systems are integrated to maintain homeostasis.

Laboratory skills are essential to students of Biology 12. These skills are developed in lab activities that focus on the hypothetical as well as the practical. An emphasis on the processes of science is integral to the complete study of

Biology 12 and should be integrated throughout the course.

The order of learning outcomes follows a sequence from cell structure and simple, biochemical processes to the organ systems themselves. However, this order does not imply a required sequence of instruction.

The prescribed learning outcomes for Biology 12 are grouped under the following curriculum organizers and suborganizers:

<b>Biology 12</b>		
<b>Processes of Science</b>	<b>Cell Biology</b>	<b>Human Biology</b>
	<ul style="list-style-type: none"> <li>• Cell Structure</li> <li>• Cell Compounds and Biological Molecules</li> <li>• DNA Replication</li> <li>• Protein Synthesis</li> <li>• Transport across Cell Membrane</li> <li>• Enzymes</li> </ul>	<ul style="list-style-type: none"> <li>• Digestive System</li> <li>• Circulatory System</li> <li>• Respiratory System</li> <li>• Nervous System</li> <li>• Urinary System</li> <li>• Reproductive System</li> </ul>

A curriculum organizer consists of a set of prescribed learning outcomes that share a common focus. Note that the ordering of organizers, suborganizers, and outcomes in the Biology 12 curriculum does not imply an order of instruction.

The prescribed learning outcomes related to Processes of Science support the development of knowledge, skills, and attitudes essential for an understanding of science. These learning outcomes should not be taught in isolation, but should be integrated with activities related to the other two curriculum organizers.

**SUGGESTED TIMEFRAME**

Provincial curricula are developed in accordance with the amount of instructional time recommended by the Ministry of Education for each subject area. Teachers may choose to combine various curricula to enable students to integrate ideas and make meaningful connections.

Biology 11 and 12 each require approximately 90–110 hours of instructional time. Although a four-credit course is typically equivalent to 120 hours, this timeframe allows for flexibility to address local needs. The Student Achievement section of this IRP provides a suggested breakdown of this suggested time allotment by curriculum organizer.





# CONSIDERATIONS FOR PROGRAM DELIVERY

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*Biology 11 and 12*





This section of the IRP contains additional information to help educators develop their school practices and plan their program delivery to meet the needs of all learners. Included in this section is information about

- Alternative Delivery policy
- addressing local contexts
- involving parents and guardians
- course requirements respecting beliefs
- safety considerations
- confidentiality
- inclusion, equity, and accessibility for all learners
- working with the school and community
- working with the Aboriginal community
- information and communications technology
- copyright and responsibility

### ALTERNATIVE DELIVERY POLICY

The Alternative Delivery policy does not apply to Biology 11 and 12.

The Alternative Delivery policy outlines how students, and their parents or guardians, in consultation with their local school authority, may choose means other than instruction by a teacher within the regular classroom setting for addressing prescribed learning outcomes contained in the Health curriculum organizer of the following curriculum documents:

- Health and Career Education K to 7, and Personal Planning K to 7 Personal Development curriculum organizer (until September 2008)
- Health and Career Education 8 and 9
- Planning 10

The policy recognizes the family as the primary educator in the development of children's attitudes, standards, and values, but the policy still requires that all prescribed learning outcomes be addressed and assessed in the agreed-upon alternative manner of delivery.

It is important to note the significance of the term "alternative delivery" as it relates to the Alternative Delivery Policy. The policy does not permit schools to omit addressing or assessing any of the prescribed

learning outcomes within the health and career education curriculum. Neither does it allow students to be excused from meeting any learning outcomes related to health. It is expected that students who arrange for alternative delivery will address the health-related learning outcomes and will be able to demonstrate their understanding of these learning outcomes.

For more information about policy relating to alternative delivery, refer to [www.bced.gov.bc.ca/policy/](http://www.bced.gov.bc.ca/policy/)

### ADDRESSING LOCAL CONTEXTS

There is some flexibility in the Biology 11 and 12 curriculum, providing opportunities for individual teacher and student choice in the selection of topics to meet learning outcomes. This flexibility enables educators to plan their programs by using topics and examples that are relevant to their local context and to the particular interests of their students. When selecting topics it may be appropriate to incorporate student input.

In particular, Biology 11 teachers may wish to customize the curriculum to take advantage of opportunities to study the seasonal flora and fauna of their region. The prescribed learning outcomes offer a variety of organisms to choose from. It is important, however, that teachers recognize the importance of choosing life activities (such as energy acquisition) as a thread that relates each organism studied to those previously studied and those yet to be studied.

### INVOLVING PARENTS AND GUARDIANS

The family is the primary educator in the development of students' attitudes and values. The school plays a supportive role by focussing on the prescribed learning outcomes in the Biology 11 and 12 curriculum. Parents and guardians can support, enrich, and extend the curriculum at home.

It is highly recommended that schools inform parents and guardians about the Biology 11 and 12 curriculum, and teachers (along with school and district administrators) may choose to do so by

- informing parents/guardians and students of the prescribed learning outcomes for the subject by sending home class letters, providing an overview during parent-teacher interviews, etc.
- responding to parent and guardian requests to discuss course unit plans, learning resources, etc.

### COURSE REQUIREMENTS RESPECTING BELIEFS

For many students and teachers, the study of some science concepts may lead to issues and questions that go beyond the immediate scope of curriculum (e.g., science is used to meet many industrial requirements, but industrial decision makers must consider factors other than scientific feasibility before adopting a particular process). The technological application of science in areas such as genetic engineering, human reproduction, and medical technology raises questions of ethics and values. Because these social questions arise, in part, from capabilities that science makes possible, they should be addressed. It must be made clear to students, however, that science only provides the background for what is hoped will be informed personal and social decisions. Teachers must handle these questions objectively and with sensitivity.

Reconciling scientific discoveries (for example, in genetic engineering) and religious faith poses a particular challenge for some students. While respecting the personal beliefs of students, teachers should be careful to distinguish between knowledge based on the application of scientific methods, and religious teachings and associated beliefs such as creationism, theory of divine creation, or intelligent design theory.

### SAFETY CONSIDERATIONS

Science education is an activity-based process that provides an exciting method of teaching and learning. However, experiments and demonstrations may involve inherent risks for both the teacher and the student.

Safety guidelines must be discussed with students. These safety guidelines must support and encourage the investigative approach generally and laboratory instruction specifically, while at the same time promoting safety in the classroom and laboratory.

Encouraging a positive safety attitude is a responsibility shared among the board, school administrators, teachers, and students in every school district. The co-operation of all these groups helps develop a strong safety consciousness both inside and outside our schools.

Field work and field trips require special vigilance with respect to traffic and road safety, safe practices in study areas and when obtaining samples, and an awareness of changes in weather. Teachers are also reminded of the potential risks associated with activities that involve extraction and analysis of human fluids or tissue.

Another important aspect of in-school safety is the Workplace Hazardous Materials Information Systems (WHMIS). Through labelling, material safety data sheets, and education and training, WHMIS is designed to ensure that those using hazardous materials have sufficient information to handle them safely. Each school district should have an individual trained in WHMIS who can work with teachers to establish safe, well-ventilated classroom and laboratory working conditions.

To assist teachers in providing a safe science-learning environment, the Ministry of Education publishes the *Science Safety Resource Manual*, which has been distributed to every school.

The *Science Safety Resource Manual* is available online at [www.bced.gov.bc.ca/irp/resdocs/scisafety.htm](http://www.bced.gov.bc.ca/irp/resdocs/scisafety.htm)

### CONFIDENTIALITY

*The Freedom of Information and Protection of Privacy Act* (FOIPPA) applies to students, to school districts, and to all curricula. Teachers, administrators, and district staff should consider the following:

- Be aware of district and school guidelines regarding the provisions of FOIPPA and how it applies to all subjects, including Biology 11 and 12.
- Do not use students' Personal Education Numbers (PEN) on any assignments that students wish to keep confidential.

- Ensure students are aware that if they disclose personal information that indicates they are at risk for harm, then that information cannot be kept confidential.
- Inform students of their rights under FOIPPA, especially the right to have access to their own personal information in their school records. Inform parents of their rights to access their children’s school records.
- Minimize the type and amount of personal information collected, and ensure that it is used only for purposes that relate directly to the reason for which it is collected.
- Inform students that they will be the only ones recording personal information about themselves unless they, or their parents, have consented to teachers collecting that information from other people (including parents).
- Provide students and their parents with the reason(s) they are being asked to provide personal information in the context of the Biology 11 and 12 curriculum.
- Inform students and their parents that they can ask the school to correct or annotate any of the personal information held by the school, in accordance with Section 29 of FOIPPA.
- Ensure students are aware that their parents may have access to the schoolwork they create only insofar as it pertains to students’ progress.
- Ensure that any information used in assessing students’ progress is up-to-date, accurate, and complete.

For more information about confidentiality, refer to [www.msers.gov.bc.ca/FOI\\_POP/index.htm](http://www.msers.gov.bc.ca/FOI_POP/index.htm)

### **INCLUSION, EQUITY, AND ACCESSIBILITY FOR ALL LEARNERS**

British Columbia’s schools include students of varied backgrounds, interests, and abilities. The Kindergarten to Grade 12 school system focuses on meeting the needs of all students. When selecting specific topics, activities, and resources to support the implementation of Biology 11 and 12, teachers are encouraged to ensure that these choices support inclusion, equity, and accessibility for all students. In particular, teachers should ensure that classroom

instruction, assessment, and resources reflect sensitivity to diversity and incorporate positive role portrayals, relevant issues, and themes such as inclusion, respect, and acceptance.

Government policy supports the principles of integration and inclusion of students for whom English is a second language and of students with special needs. Most of the prescribed learning outcomes and suggested achievement indicators in this IRP can be met by all students, including those with special needs and/or ESL needs. Some strategies may require adaptations to ensure that those with special and/or ESL needs can successfully achieve the learning outcomes. Where necessary, modifications can be made to the prescribed learning outcomes for students with Individual Education Plans.

For more information about resources and support for students with special needs, refer to [www.bced.gov.bc.ca/specialed/](http://www.bced.gov.bc.ca/specialed/)

For more information about resources and support for ESL students, refer to [www.bced.gov.bc.ca/esl/](http://www.bced.gov.bc.ca/esl/)

### **WORKING WITH THE SCHOOL AND COMMUNITY**

This curriculum addresses a wide range of skills and understandings that students are developing in other areas of their lives. It is important to recognize that learning related to this curriculum extends beyond the biology classroom.

School and district-wide programs support and extend learning in Biology 11 and 12. Community organizations may also support the curriculum with locally developed learning resources, guest speakers, workshops, and field studies. Teachers may wish to draw on the expertise of these community organizations and members.

### **WORKING WITH THE ABORIGINAL COMMUNITY**

The Ministry of Education is dedicated to ensuring that the cultures and contributions of Aboriginal peoples in BC are reflected in all provincial curricula. To address these topics in the classroom in a way that is accurate and that respectfully

reflects Aboriginal concepts of teaching and learning, teachers are strongly encouraged to seek the advice and support of local Aboriginal communities. Aboriginal communities are diverse in terms of language, culture, and available resources, and each community will have its own unique protocol to gain support for integration of local knowledge and expertise. To begin discussion of possible instructional and assessment activities, teachers should first contact Aboriginal education co-ordinators, teachers, support workers, and counsellors in their district who will be able to facilitate the identification of local resources and contacts such as elders, chiefs, tribal or band councils, Aboriginal cultural centres, Aboriginal Friendship Centres, and Métis or Inuit organizations.

In addition, teachers may wish to consult the various Ministry of Education publications available, including the “Planning Your Program” section of the resource, *Shared Learnings*. This resource was developed to help all teachers provide students with knowledge of, and opportunities to share experiences with, Aboriginal peoples in BC.

For more information about these documents, consult the Aboriginal Education web site: [www.bced.gov.bc.ca/abed/welcome.htm](http://www.bced.gov.bc.ca/abed/welcome.htm)

### INFORMATION AND COMMUNICATIONS TECHNOLOGY

The study of information and communications technology is increasingly important in our society. Students need to be able to acquire and analyse information, to reason and communicate, to make informed decisions, and to understand and use information and communications technology for a variety of purposes. Development of these skills is important for students in their education, their future careers, and their everyday lives.

Literacy in the area of information and communications technology can be defined as the ability to obtain and share knowledge through investigation, study, instruction, or transmission of information by means of media technology. Becoming literate in this area involves finding,

gathering, assessing, and communicating information using electronic means, as well as developing the knowledge and skills to use and solve problems effectively with the technology. Literacy also involves a critical examination and understanding of the ethical and social issues related to the use of information and communications technology. When planning for instruction and assessment in Biology 11 and 12, teachers should provide opportunities for students to develop literacy in relation to information and communications technology sources, and to reflect critically on the role of these technologies in society.

### COPYRIGHT AND RESPONSIBILITY

Copyright is the legal protection of literary, dramatic, artistic, and musical works; sound recordings; performances; and communications signals. Copyright provides creators with the legal right to be paid for their work and the right to say how their work is to be used. The law permits certain exceptions for schools (i.e., specific things permitted) but these are very limited, such as copying for private study or research. The copyright law determines how resources can be used in the classroom and by students at home.

In order to respect copyright it is necessary to understand the law. It is unlawful to do the following, unless permission has been given by a copyright owner:

- photocopy copyrighted material to avoid purchasing the original resource for any reason
- photocopy or perform copyrighted material beyond a very small part – in some cases the copyright law considers it “fair” to copy whole works, such as an article in a journal or a photograph, for purposes of research and private study, criticism, and review
- show recorded television or radio programs to students in the classroom unless these are cleared for copyright for educational use (there are exceptions such as for news and news commentary taped within one year of broadcast that by law have record-keeping requirements – see the web site at the end of this section for more details)

- photocopy print music, workbooks, instructional materials, instruction manuals, teacher guides, and commercially available tests and examinations
- show videorecordings at schools that are not cleared for public performance
- perform music or do performances of copyrighted material for entertainment (i.e., for purposes other than a specific educational objective)
- copy work from the Internet without an express message that the work can be copied

Permission from or on behalf of the copyright owner must be given in writing. Permission may also be given to copy or use all or some portion of copyrighted work through a licence or agreement. Many creators, publishers, and producers have formed groups or “collectives” to negotiate royalty payments and copying conditions for educational

institutions. It is important to know what licences are in place and how these affect the activities schools are involved in. Some licences may also require royalty payments that are determined by the quantity of photocopying or the length of performances. In these cases, it is important to assess the educational value and merits of copying or performing certain works to protect the school’s financial exposure (i.e., only copy or use that portion that is absolutely necessary to meet an educational objective).

It is important for education professionals, parents, and students to respect the value of original thinking and the importance of not plagiarizing the work of others. The works of others should not be used without their permission.

For more information about copyright, refer to [www.cmec.ca/copyright/indexe.stm](http://www.cmec.ca/copyright/indexe.stm)





# PRESCRIBED LEARNING OUTCOMES

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*Biology 11 and 12*





**P**rescribed learning outcomes are content standards for the provincial education system; they are the prescribed curriculum. Clearly stated and expressed in measurable and observable terms, learning outcomes set out the required knowledge, skills, and attitudes – what students are expected to know and be able to do – by the end of the specified course.

Schools have the responsibility to ensure that all prescribed learning outcomes in this curriculum are met; however, schools have flexibility in determining how delivery of the curriculum can best take place.

It is expected that student achievement will vary in relation to the learning outcomes. Evaluation, reporting, and student placement with respect to these outcomes are dependent on the professional judgment and experience of teachers, guided by provincial policy.

Prescribed learning outcomes for Biology 11 and 12 are presented by grade and by curriculum organizer and suborganizer, and are coded alphanumerically for ease of reference; however, this arrangement is not intended to imply a required instructional sequence.

### WORDING OF PRESCRIBED LEARNING OUTCOMES

All learning outcomes complete the stem, “It is expected that students will....”

When used in a prescribed learning outcome, the word “**including**” indicates that any ensuing item **must be addressed**. Lists of items introduced by the word “including” represent a set of minimum requirements associated with the general requirement set out by the outcome. The lists are not necessarily exhaustive, however, and teachers may choose to address additional items that also fall under the general requirement set out by the outcome.

### DOMAINS OF LEARNING

Prescribed learning outcomes in BC curricula identify required learning in relation to one or more of the three domains of learning: cognitive, psychomotor, and affective. The following definitions of the three domains are based on Bloom’s taxonomy.

The **cognitive domain** deals with the recall or recognition of knowledge and the development of intellectual abilities. The cognitive domain can be further specified as including three cognitive levels: knowledge, understanding and application, and higher mental processes. These levels are determined by the verb used in the learning outcome, and illustrate how student learning develops over time.

- *Knowledge* includes those behaviours that emphasize the recognition or recall of ideas, material, or phenomena.
- *Understanding and application* represents a comprehension of the literal message contained in a communication, and the ability to apply an appropriate theory, principle, idea, or method to a new situation.
- *Higher mental processes* include analysis, synthesis, and evaluation. The higher mental processes level subsumes both the knowledge and the understanding and application levels.

The **affective domain** concerns attitudes, beliefs, and the spectrum of values and value systems.

The **psychomotor domain** includes those aspects of learning associated with movement and skill demonstration, and integrates the cognitive and affective consequences with physical performances.

Domains of learning and, particularly, cognitive levels, inform the design and development of the Graduation Program examination for Biology 12.

**Prescribed Learning Outcomes: Biology 11**

*It is expected that students will:*

**PROCESSES OF SCIENCE**

- A1 demonstrate safe and correct technique for a variety of laboratory procedures
- A2 design an experiment using the scientific method
- A3 interpret data from a variety of text and visual sources

**TAXONOMY**

- B1 apply the Kingdom system of classification to study the diversity of organisms

**EVOLUTION**

- C1 describe the process of evolution

**ECOLOGY**

- D1 analyse the functional inter-relationships of organisms within an ecosystem

**MICROBIOLOGY**

*Viruses*

- E1 evaluate the evidence used to classify viruses as living or non-living
- E2 evaluate the effects of viruses on human health

*Kingdom Monera*

- E3 analyse monerans as a lifeform at the prokaryotic level of organization
- E4 evaluate the effectiveness of various antibiotics, disinfectants, or antiseptics on bacterial cultures

**PLANT BIOLOGY**

- F1 analyse how the increasing complexity of algae, mosses, and ferns represent an evolutionary continuum of adaptation to a land environment
- F2 analyse how the increasing complexity of gymnosperms and angiosperms contribute to survival in a land environment

**ANIMAL BIOLOGY**

- G1 analyse how the increasing complexity of animal phyla represents an evolutionary continuum
- G2 analyse the increasing complexity of the Phylum Porifera and the Phylum Cnidaria
- G3 analyse the increasing complexity of the Phylum Platyhelminthes, the Phylum Nematoda, and the Phylum Annelida
- G4 analyse the increasing complexity of the Phylum Mollusca, the Phylum Echinodermata, and the Phylum Arthropoda
- G5 relate the complexity of the form and function of vertebrates to the evolutionary continuum of animals

**Prescribed Learning Outcomes: Biology 12**

*It is expected that students will:*

**PROCESSES OF SCIENCE**

- A1 demonstrate safe and correct technique for a variety of laboratory procedures
- A2 design an experiment using the scientific method
- A3 interpret data from a variety of text and visual sources

**CELL BIOLOGY**

*Cell Structure*

- B1 analyse the functional inter-relationships of cell structures

*Cell Compounds and Biological Molecules*

- B2 describe the characteristics of water and its role in biological systems
- B3 describe the role of acids, bases, and buffers in biological systems in the human body
- B4 analyse the structure and function of biological molecules in living systems, including
  - carbohydrates
  - lipids
  - proteins
  - nucleic acids

*DNA Replication*

- B5 describe DNA replication
- B6 describe recombinant DNA

*Protein Synthesis*

- B7 demonstrate an understanding of the process of protein synthesis
- B8 explain how mutations in DNA affect protein synthesis

*Transport across Cell Membrane*

- B9 analyse the structure and function of the cell membrane
- B10 explain why cells divide when they reach a particular surface area-to-volume ratio

*Enzymes*

- B11 analyse the roles of enzymes in biochemical reactions

*Biology 12 Prescribed Learning Outcomes continued on page 20*

**Prescribed Learning Outcomes: Biology 12**

*Biology 12 Prescribed Learning Outcomes continued from page 19*

**HUMAN BIOLOGY**

*Digestive System*

- C1 analyse the functional inter-relationships of the structures of the digestive system
- C2 describe the components, pH, and digestive actions of salivary, gastric, pancreatic, and intestinal juices

*Circulatory System*

- C3 describe the inter-relationships of the structures the heart
- C4 analyse the relationship between heart rate and blood pressure
- C5 analyse the functional inter-relationships of the vessels of the circulatory system
- C6 describe the components of blood
- C7 describe the inter-relationships of the structures of the lymphatic system

*Respiratory System*

- C8 analyse the functional inter-relationships of the structures of the respiratory system
- C9 analyse the processes of breathing
- C10 analyse internal and external respiration

*Nervous System*

- C11 analyse the transmission of nerve impulses
- C12 analyse the functional inter-relationships of the divisions of the nervous system

*Urinary System*

- C13 analyse the functional inter-relationships of the structures of the urinary system

*Reproductive System*

- C14 analyse the functional inter-relationships of the structures of the male reproductive system
- C15 analyse the functional inter-relationships of the structures of the female reproductive system



# STUDENT ACHIEVEMENT

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*Biology 11 and 12*



This section of the IRP contains information about classroom assessment and student achievement, including specific achievement indicators to assist in the assessment of student achievement in relation to each prescribed learning outcome. Also included in this section are key elements – descriptions of content that help determine the intended depth and breadth of prescribed learning outcomes.

### CLASSROOM ASSESSMENT AND EVALUATION

Assessment is the systematic gathering of information about what students know, are able to do, and are working toward. Assessment evidence can be collected using a wide variety of methods, such as

- observation
- student self-assessments and peer assessments
- quizzes and tests (written, oral, practical)
- samples of student work
- projects and presentations
- oral and written reports
- journals and learning logs
- performance reviews
- portfolio assessments

Assessment of student performance is based on the information collected through assessment activities. Teachers use their insight, knowledge about learning, and experience with students, along with the specific criteria they establish, to make judgments about student performance in relation to prescribed learning outcomes.

Three major types of assessment can be used in conjunction to support student achievement.

- **Assessment for learning** is assessment for purposes of greater learning achievement.
- **Assessment as learning** is assessment as a process of developing and supporting students' active participation in their own learning.
- **Assessment of learning** is assessment for purposes of providing evidence of achievement for reporting.

### *Assessment for Learning*

Classroom assessment for learning provides ways to engage and encourage students to become involved in their own day-to-day assessment – to acquire the skills of thoughtful self-assessment and to promote their own achievement.

This type of assessment serves to answer the following questions:

- What do students need to learn to be successful?
- What does the evidence of this learning look like?

Assessment for learning is criterion-referenced, in which a student's achievement is compared to established criteria rather than to the performance of other students. Criteria are based on prescribed learning outcomes, as well as on suggested achievement indicators or other learning expectations.

Students benefit most when assessment feedback is provided on a regular, ongoing basis. When assessment is seen as an opportunity to promote learning rather than as a final judgment, it shows students their strengths and suggests how they can develop further. Students can use this information to redirect their efforts, make plans, communicate with others (e.g., peers, teachers, parents) about their growth, and set future learning goals.

Assessment for learning also provides an opportunity for teachers to review what their students are learning and what areas need further attention. This information can be used to inform teaching and create a direct link between assessment and instruction. Using assessment as a way of obtaining feedback on instruction supports student achievement by informing teacher planning and classroom practice.

## *Assessment as Learning*

Assessment as learning actively involves students in their own learning processes. With support and guidance from their teacher, students take responsibility for their own learning, constructing meaning for themselves. Through a process of continuous self-assessment, students develop the ability to take stock of what they have already learned, determine what they have not yet learned, and decide how they can best improve their own achievement.

Although assessment as learning is student-driven, teachers can play a key role in facilitating how this assessment takes place. By providing regular opportunities for reflection and self-assessment, teachers can help students develop, practise, and become comfortable with critical analysis of their own learning.

## *Assessment of Learning*

Assessment of learning can be addressed through summative assessment, including large-scale

assessments and teacher assessments. These summative assessments can occur at the end of the year or at periodic stages in the instructional process.

Large-scale assessments, such as Foundation Skills Assessment (FSA) and Graduation Program exams, gather information on student performance throughout the province and provide information for the development and revision of curriculum. These assessments are used to make judgments about students' achievement in relation to provincial and national standards. There is no large-scale provincial assessment for Biology 11. The large-scale provincial assessment for Biology 12 is the optional graduation program examination, worth 40% of the final course mark for students who choose to write it.

Assessment of learning is also used to inform formal reporting of student achievement.

For Ministry of Education reporting policy, refer to [www.bced.gov.bc.ca/policy/policies/student\\_reporting.htm](http://www.bced.gov.bc.ca/policy/policies/student_reporting.htm)

<b>Assessment for Learning</b>	<b>Assessment as Learning</b>	<b>Assessment of Learning</b>
<p><b>Formative assessment is ongoing in the classroom</b></p> <ul style="list-style-type: none"> <li>• teacher assessment, student self-assessment, and/or student peer assessment</li> <li>• criterion-referenced – criteria based on prescribed learning outcomes identified in the provincial curriculum, reflecting performance in relation to a specific learning task</li> <li>• involves both teacher and student in a process of continual reflection and review about progress</li> <li>• teachers adjust their plans and engage in corrective teaching in response to formative assessment</li> </ul>	<p><b>Formative assessment is ongoing in the classroom</b></p> <ul style="list-style-type: none"> <li>• self-assessment</li> <li>• provides students with information on their own achievement and prompts them to consider how they can continue to improve their learning</li> <li>• student-determined criteria based on previous learning and personal learning goals</li> <li>• students use assessment information to make adaptations to their learning process and to develop new understandings</li> </ul>	<p><b>Summative assessment occurs at end of year or at key stages</b></p> <ul style="list-style-type: none"> <li>• teacher assessment</li> <li>• may be either criterion-referenced (based on prescribed learning outcomes) or norm-referenced (comparing student achievement to that of others)</li> <li>• information on student performance can be shared with parents/guardians, school and district staff, and other education professionals (e.g., for the purposes of curriculum development)</li> <li>• used to make judgments about students' performance in relation to provincial standards</li> </ul>



For more information about assessment for, as, and of learning, refer to the following resource developed by the Western and Northern Canadian Protocol (WNCP): *Rethinking Assessment with Purpose in Mind*.

This resource is available online at [www.wncp.ca/](http://www.wncp.ca/)

### ***Criterion-Referenced Assessment and Evaluation***

In criterion-referenced evaluation, a student's performance is compared to established criteria rather than to the performance of other students. Evaluation in relation to prescribed curriculum requires that criteria be established based on the learning outcomes.

Criteria are the basis for evaluating student progress. They identify, in specific terms, the critical aspects of a performance or a product that indicate how well the student is meeting the prescribed learning outcomes. For example, weighted criteria, rating scales, or scoring guides (reference sets) are ways that student performance can be evaluated using criteria.

Wherever possible, students should be involved in setting the assessment criteria. This helps students develop an understanding of what high-quality work or performance looks like.

### **Criterion-referenced assessment and evaluation may involve these steps:**

- |                |  |
|----------------|--|
| <b>Step 1</b>  | Identify the prescribed learning outcomes and suggested achievement indicators (as articulated in this IRP) that will be used as the basis for assessment.   |
| <b>Step 2</b>  | Establish criteria. When appropriate, involve students in establishing criteria.   |
| <b>Step 3</b>  | Plan learning activities that will help students gain the knowledge, skills, and attitudes outlined in the criteria.   |
| <b>Step 4</b>  | Prior to the learning activity, inform students of the criteria against which their work will be evaluated.  |
| <b>Step 5</b>  | Provide examples of the desired levels of performance.   |
| <b>Step 6</b>  | Conduct the learning activities.   |
| <b>Step 7</b>  | Use appropriate assessment instruments (e.g., rating scale, checklist, scoring guide) and methods (e.g., observation, collection, self-assessment) based on the particular assignment and student. |
| <b>Step 8</b>  | Review the assessment data and evaluate each student's level of performance or quality of work in relation to criteria.  |
| <b>Step 9</b>  | Where appropriate, provide feedback and/or a letter grade to indicate how well the criteria are met.   |
| <b>Step 10</b> | Communicate the results of the assessment and evaluation to students and parents/guardians.  |

## KEY ELEMENTS

Key elements provide an overview of content in each curriculum organizer and suborganizer. They can be used to determine the expected depth and breadth of the prescribed learning outcomes.

## ACHIEVEMENT INDICATORS

To support the assessment of provincially prescribed curricula, this IRP includes sets of achievement indicators in relation to each learning outcome.

Achievement indicators, taken together as a set, define the specific level of knowledge acquired, skills applied, or attitudes demonstrated by the student in relation to a corresponding prescribed learning outcome. They describe what evidence to look for to determine whether or not the student has fully met the intent of the learning outcome. Since each achievement indicator defines only one aspect of the corresponding learning outcome, the entire set of achievement indicators should be considered when determining whether students have fully met the learning outcome.

In some cases, achievement indicators may also include suggestions as to the type of task that would provide evidence of having met the learning outcome (e.g., a constructed response such as a list, comparison, analysis, or chart; a product created and presented such as a report, drama presentation, poster, letter, or model; a particular skill demonstrated such as microscope use).

Achievement indicators support the principles of assessment *for* learning, assessment *as* learning, and assessment *of* learning. They provide teachers and parents with tools that can be used to reflect on what students are learning, as well as provide students with a means of self-assessment and ways of defining how they can improve their own achievement.

Achievement indicators are not mandatory; they are suggestions only, provided to assist in the assessment of how well students achieve the prescribed learning outcomes.

Achievement indicators may be useful to provincial examination development teams and inform the development of exam items. However, examination questions, item formats, exemplars, rubrics, or scoring guides will not necessarily be limited to the achievement indicators as outlined in the Integrated Resource Packages.

Specifications for provincial examinations are available online at [www.bced.gov.bc.ca/exams/specs/](http://www.bced.gov.bc.ca/exams/specs/)

The following pages contain the suggested achievement indicators corresponding to each prescribed learning outcome for the Biology 11 and 12 curriculum. The achievement indicators are arranged by curriculum organizer and suborganizer for each grade; however, this order is not intended to imply a required sequence of instruction and assessment.



STUDENT ACHIEVEMENT

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*Biology 11*

**Key Elements: Processes of Science****Estimated Time: integrated throughout**

The prescribed learning outcomes related to Processes of Science support the development of knowledge, skills, and attitudes essential for an understanding of science. These learning outcomes should not be taught in isolation, but should be integrated with activities related to the other curriculum organizers.

***Vocabulary***

conclusion, control, control group, controlled variable, dependent variable, experimental group, experimental variable, independent variable, repeatable procedure, sample size, scientific method, testable hypothesis

***Knowledge***

- independent and dependent variables
- controlled and experimental variables
- control group, experimental group

***Skills and Attitudes***

- demonstrate safe and correct lab technique (e.g., use of dissection and compound microscopes, preparation of wet-mount slides, sterile technique, safe dissection technique)
- apply the scientific method to design and carry out experiments
- make inferences and generalizations
- interpret data from a variety of types of sources
- draw conclusions
- communicate information and results (e.g., graphs, diagrams, models, formulae)

## PROCESSES OF SCIENCE

Prescribed Learning Outcomes	Suggested Achievement Indicators
<i>It is expected that students will:</i>	<p><i>The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
A1 demonstrate safe and correct technique for a variety of laboratory procedures	<ul style="list-style-type: none"> <li><input type="checkbox"/> demonstrate the correct use of a dissection microscope</li> <li><input type="checkbox"/> prepare wet-mount slides</li> <li><input type="checkbox"/> demonstrate safe and correct dissection technique</li> <li><input type="checkbox"/> demonstrate the correct use of a compound microscope</li> <li><input type="checkbox"/> demonstrate sterile technique while preparing a streak plate</li> </ul>
A2 design an experiment using the scientific method	<ul style="list-style-type: none"> <li><input type="checkbox"/> formulate a testable hypothesis to investigate a scientific problem (e.g., determining the effectiveness of antibacterial agents on bacteria, determining the rate of fermentation in yeast)</li> <li><input type="checkbox"/> formulate and carry out a repeatable, controlled procedure to test the hypothesis:               <ul style="list-style-type: none"> <li>– identify controlled versus experimental variables</li> <li>– identify the independent and dependent variables</li> <li>– use control and experimental groups, as appropriate</li> <li>– use a control as appropriate</li> <li>– use appropriate sample size</li> </ul> </li> <li><input type="checkbox"/> observe, measure, and record data</li> <li><input type="checkbox"/> interpret results to draw conclusions</li> <li><input type="checkbox"/> determine whether the conclusions support or reject the hypothesis</li> <li><input type="checkbox"/> determine whether the experiment is reliable</li> <li><input type="checkbox"/> use results and conclusions as a basis for further comparisons, investigations, or analyses</li> </ul>
A3 interpret data from a variety of text and visual sources	<ul style="list-style-type: none"> <li><input type="checkbox"/> use data from a variety of representations (e.g., diagrams, electron micrographs, graphs, photographs) to make inferences and generalizations</li> <li><input type="checkbox"/> draw and present conclusions, applying the most appropriate means to communicate (e.g., graph, diagram, model, formula, map, visual)</li> </ul>

### Key Elements: Taxonomy

**Estimated Time: 3–5 hours**

By the end of this course, students will have an understanding of the applications of taxonomy.

#### *Vocabulary*

binomial nomenclature, biochemical relationship, class, embryological relationship, eukaryotic cell, evolutionary relationship, family, genus, homologous structure, kingdom, order, phylum, prokaryotic cell, species, sub-phylum, taxonomy/taxon

#### *Knowledge*

- principles of taxonomy
- Kingdom system of classification, taxons, binomial nomenclature
- characteristics of the kingdoms Monera, Protista, Fungi, Plantae, and Animalia

#### *Skills and Attitudes*

- use classification keys
- demonstrate correct use of a compound microscope
- observe organisms to recognize common characteristics
- demonstrate ethical, responsible, co-operative behaviour
- show respect for living things

## TAXONOMY

Prescribed Learning Outcomes	Suggested Achievement Indicators
<i>It is expected that students will:</i>	<p><i>The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
B1 apply the Kingdom system of classification to study the diversity of organisms	<ul style="list-style-type: none"> <li><input type="checkbox"/> explain how the following principles are used in taxonomy to classify organisms:               <ul style="list-style-type: none"> <li>- evolutionary relationships</li> <li>- biochemical relationships</li> <li>- homologous structures</li> <li>- embryological relationships</li> </ul> </li> <li><input type="checkbox"/> compare characteristics of a prokaryotic cell with those of a eukaryotic cell</li> <li><input type="checkbox"/> describe the unifying characteristics of organisms in each of the following kingdoms:               <ul style="list-style-type: none"> <li>- Monera</li> <li>- Protista</li> <li>- Fungi</li> <li>- Plantae</li> <li>- Animalia</li> </ul> </li> <li><input type="checkbox"/> classify selected organisms using the following taxons: kingdom, phylum (and sub-phylum), class, order, family, genus, species</li> <li><input type="checkbox"/> apply binomial nomenclature to name selected organisms</li> </ul>

### Key Elements: Evolution

**Estimated Time: 5–10 hours**

By the end of this course, students will have an understanding of the mechanics of evolution.

#### *Vocabulary*

complementary base pairing, convergent evolution, divergent evolution, deoxyribonucleic acid (DNA), double helix, evolutionary change, gene flow, genetic drift, gradual change model, mutation, natural selection, nitrogenous base, non-random mating, punctuated equilibrium model, speciation, sugar-phosphate backbone

#### *Knowledge*

- basic structure of DNA
- role of DNA in evolution
- agents of evolutionary change
- patterns of evolution
- tempo of evolutionary change

#### *Skills and Attitudes*

- create models (e.g., agents of evolutionary change, DNA)
- gather data to study variation within a population
- communicate results (e.g., using graphs, tables, diagrams, lab reports)
- demonstrate ethical, responsible, co-operative behaviour



## EVOLUTION

Prescribed Learning Outcomes	Suggested Achievement Indicators
<i>It is expected that students will:</i>	<p><i>The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
C1 describe the process of evolution	<ul style="list-style-type: none"> <li><input type="checkbox"/> describe the basic structure of deoxyribonucleic acid (DNA) with reference to the following terms:               <ul style="list-style-type: none"> <li>– double helix</li> <li>– sugar-phosphate backbone</li> <li>– nitrogenous bases (A, T, C, G)</li> <li>– complementary base pairing (A-T, C-G)</li> </ul> </li> <li><input type="checkbox"/> explain the role of DNA in evolution</li> <li><input type="checkbox"/> describe the five agents of evolutionary change: mutation, genetic drift, gene flow, non-random mating, and natural selection</li> <li><input type="checkbox"/> differentiate among and give examples of convergent evolution, divergent evolution, and speciation</li> <li><input type="checkbox"/> compare the gradual change model with the punctuated equilibrium model of evolution</li> </ul>

**Key Elements: Ecology****Estimated Time: 10–12 hours**

By the end of this course, students will have an understanding of the role various organisms play in an ecosystem.

***Vocabulary***

carrying capacity, cellular respiration, chemical equations, climax community, commensalism, consumer, cyclic growth, decomposer, density-dependent factors, density-independent factors, ecological succession, energy flow, exponential growth, logistic growth, mutualism, parasitism, photosynthesis, pioneer species, population, producer, products, pyramid of energy, reactants, steady state, symbiosis

***Knowledge***

- interdependent roles of organisms in ecosystems
- energy flow and energy pyramids
- photosynthesis and cellular respiration
- factors affecting population growth

***Skills and Attitudes***

- create bar graphs, line graphs, pie charts, tables, and diagrams to extract and convey information
- create models to represent a given type of data (e.g., populations)
- conduct experiments (e.g., quadrat study)
- relate cause to effect
- assess human impacts on an ecosystem
- demonstrate ethical, responsible, co-operative behaviour
- show respect and sensitivity for the environment

## ECOLOGY

Prescribed Learning Outcomes	Suggested Achievement Indicators
<i>It is expected that students will:</i>	<p><i>The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
D1 analyse the functional inter-relationships of organisms within an ecosystem	<ul style="list-style-type: none"> <li><input type="checkbox"/> describe the process of ecological succession, with reference to terms such as pioneer species and climax community</li> <li><input type="checkbox"/> explain the roles of producers, consumers, and decomposers in ecosystems</li> <li><input type="checkbox"/> describe a pyramid of energy in terms of energy flow through an ecosystem</li> <li><input type="checkbox"/> describe the roles of photosynthesis and cellular respiration within a pyramid of energy</li> <li><input type="checkbox"/> compare photosynthesis and cellular respiration in terms of the reactants, products, and chemical equations</li> <li><input type="checkbox"/> describe the stages a population goes through as it increases in size, with reference to terms such as exponential growth, logistic growth, cyclic growth, carrying capacity, steady state</li> <li><input type="checkbox"/> describe density-dependent and density-independent factors that limit and control population growth</li> <li><input type="checkbox"/> define <i>symbiosis</i> and types of symbiosis: <i>parasitism</i>, <i>commensalism</i>, and <i>mutualism</i></li> </ul>

**Key Elements: Microbiology****Estimated Time: 20–25 hours**

By the end of this course, students will have an understanding of characteristics and functions of viruses and bacteria.

*Vocabulary*

Viruses: antibody, antigen, DNA, host cell, lymphocyte, lysogenic cycle, lytic cycle, membranous envelope, mucous membrane, nucleic acid core, phagocytic white blood cell, primary line of defence, protein capsid, RNA, secondary line of defence, tertiary line of defence, viral specificity, white blood cell

Monera: aerobic respiration, antibiotic, antiseptic, bacteria, binary fission, classification, conjugation, disinfectant, ecological role, fermentation, motility, mutate/mutation, photosynthesis, prokaryote, resistant/resistance

*Knowledge*

## Viruses

- definitions of living vs. non-living
- structure of viruses
- viral reproduction
- effects of viruses on humans

## Monera

- characteristics of prokaryotic cells
- structure and function of bacteria
- moneran diversity
- roles and effects of bacteria
- effects of antibacterial agents

*Skills and Attitudes*

- demonstrate proper techniques for handling and disposing of laboratory materials involving bacteria
- use personal protective equipment
- demonstrate emergency response procedures
- demonstrate safe and correct use of a Bunsen burner
- observe organisms to recognize common characteristics
- communicate results (e.g., using graphs, tables, diagrams, lab reports)
- create models (e.g., life cycle of a virus)
- conduct experiments (e.g., antibiotic sensitivity of bacteria)
- demonstrate ethical, responsible, co-operative behaviour
- show respect for living things

## MICROBIOLOGY

Prescribed Learning Outcomes	Suggested Achievement Indicators
<i>It is expected that students will:</i>	<p><i>The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
<p><b>Viruses</b></p> <p>E1 evaluate the evidence used to classify viruses as living or non-living</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> identify criteria for classifying organisms as living</li> <li><input type="checkbox"/> describe the basic structure of a virus, including the antigens, the membranous envelope, the protein capsid, and the nucleic acid core (DNA or RNA)</li> <li><input type="checkbox"/> identify the role of the host cell in viral reproduction</li> <li><input type="checkbox"/> compare the lytic and lysogenic cycles</li> </ul>
<p>E2 evaluate the effects of viruses on human health</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> define and give examples of viral specificity</li> <li><input type="checkbox"/> describe the body's basic lines of defence against a viral attack, including               <ul style="list-style-type: none"> <li>– primary line of defence (e.g., skin, mucous membranes, tears)</li> <li>– secondary line of defence (e.g., phagocytic white blood cells engulf viruses)</li> <li>– tertiary line of defence (e.g., white blood cells called lymphocytes produce antibodies)</li> </ul> </li> <li><input type="checkbox"/> give examples of ways to reduce the spread of viral diseases</li> </ul>
<p><b>Kingdom Monera</b></p> <p>E3 analyse monerans as a lifeform at the prokaryotic level of organization</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> examine monerans and identify the characteristics that unify them</li> <li><input type="checkbox"/> use examples to illustrate moneran diversity with respect to the following:               <ul style="list-style-type: none"> <li>– classification</li> <li>– shape and grouping of cells</li> <li>– motility</li> <li>– ecological role</li> <li>– nutrition (fermentation, aerobic respiration, photosynthesis)</li> <li>– reproduction (binary fission, conjugation)</li> <li>– human diseases</li> </ul> </li> <li><input type="checkbox"/> give examples of the beneficial roles of bacteria</li> </ul>
<p>E4 evaluate the effectiveness of various antibiotics, disinfectants, or antiseptics on bacterial cultures</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> conduct an experiment using sterile technique to test the effects of various antibacterial agents (e.g., antibiotics, disinfectants, and antiseptics) on bacterial cultures</li> <li><input type="checkbox"/> analyse and interpret data from experiments to draw conclusions about the effectiveness of particular agents on specific bacteria</li> <li><input type="checkbox"/> explain how bacteria mutate to become resistant to antibiotics</li> </ul>

### Key Elements: Plant Biology

**Estimated Time: 20–23 hours**

By the end of this course, students will have an understanding of the increasing complexity of phyla within the Kingdom Plantae and the characteristics that place organisms within each phylum.

#### *Vocabulary*

adaptation, alternation of generations, colonial, dicots, enclosed seeds, flowers, fruit, leaves, monocots, multicellular, pollen, roots, seeds, stems, unicellular, vascular tissue

#### *Knowledge*

- trends of increasing complexity in plant lifeforms
- characteristics of algae, mosses, ferns, gymnosperms, and angiosperms
- adaptations of plants to a land environment

#### *Skills and Attitudes*

- observe plants to recognize common characteristics
- communicate results (e.g., using graphs, tables, diagrams, lab reports)
- create models (e.g., vascular tissue of a plant)
- conduct experiments (e.g., plant dissection, water transport in vascular tissue)
- demonstrate ethical, responsible, co-operative behaviour
- show respect and sensitivity for the environment

## PLANT BIOLOGY

Prescribed Learning Outcomes	Suggested Achievement Indicators
<i>It is expected that students will:</i>	<p><i>The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
F1 analyse how the increasing complexity of algae, mosses, and ferns represent an evolutionary continuum of adaptation to a land environment	<ul style="list-style-type: none"> <li><input type="checkbox"/> examine green algae and describe the characteristics that unify them</li> <li><input type="checkbox"/> use examples of unicellular, colonial, and multicellular green algae to illustrate their increasing complexity</li> <li><input type="checkbox"/> examine mosses and describe the characteristics that unify them</li> <li><input type="checkbox"/> examine ferns and describe the characteristics that unify them</li> <li><input type="checkbox"/> describe alternation of generations in algae, mosses, and ferns</li> <li><input type="checkbox"/> describe features of mosses and ferns that have enabled adaptation to a land environment</li> </ul>
F2 analyse how the increasing complexity of gymnosperms and angiosperms contribute to survival in a land environment	<ul style="list-style-type: none"> <li><input type="checkbox"/> examine gymnosperms and describe the characteristics that unify them</li> <li><input type="checkbox"/> explain how gymnosperms are adapted for survival in a land environment with respect to the following: alternation of generations, roots, stems, leaves, seeds, pollen, vascular tissue</li> <li><input type="checkbox"/> examine angiosperms and describe characteristics that unify them</li> <li><input type="checkbox"/> use specimens to differentiate between monocots and dicots</li> <li><input type="checkbox"/> describe how angiosperms are adapted for survival in a land environment, with respect to alternation of generations, flowers, pollen, enclosed seeds, fruit, roots, stems, leaves, vascular tissue</li> <li><input type="checkbox"/> compare the ways in which mosses, ferns, gymnosperms, and angiosperms have adapted to a land environment</li> </ul>

**Key Elements: Animal Biology****Estimated Time: 32–35 hours**

By the end of this course, students will have an understanding of the increasing complexity within the Kingdom Animalia and the characteristics that place organisms within each phylum.

***Vocabulary***

asexual reproduction, cell, cephalization, closed circulatory system, coelom, colonial, fluid feeding, endoskeleton, excretion, exoskeleton, filter feeding, free-living, internal transport, invertebrates, levels of organization, life functions, medusa, motility, motility/motile, multicellular, niche, open circulatory system, organ, organ system, parasite/parasitic, polyp, reproduction, respiration, response, sessile, sexual reproduction, symmetry, tissue, vertebral column

***Knowledge***

- trends of increasing complexity in animal lifeforms
- characteristics of Phylum Porifera, Phylum Cnidaria, Phylum Platyhelminthes, Phylum Nematoda, Phylum Annelida, Phylum Mollusca, Phylum Echinodermata, Phylum Arthropoda, and Subphylum Vertebrata (Phylum Chordata)
- how animals in each phylum carry out their life functions
- ecological significance of various animal phyla

***Skills and Attitudes***

- demonstrate proper techniques for handling and disposing of laboratory materials involving preserved specimens
- use personal protective equipment
- demonstrate safe and correct dissection technique
- observe organisms to recognize common characteristics
- communicate results (e.g., using graphs, tables, diagrams, lab reports)
- create models (e.g., of a sponge)
- conduct experiments (e.g., light sensitivity in planaria)
- demonstrate ethical, responsible, co-operative behaviour
- show respect for living things



ANIMAL BIOLOGY

Prescribed Learning Outcomes	Suggested Achievement Indicators
<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 corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
<p>G1 analyse how the increasing complexity of animal phyla represents an evolutionary continuum</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> compare phyla in terms of                             <ul style="list-style-type: none"> <li>– levels of organization – cell, tissue, organ, organ system</li> <li>– cephalization</li> <li>– development of a coelom</li> <li>– symmetry</li> <li>– reproduction</li> </ul> </li> <li><input type="checkbox"/> describe the life functions animals need to survive, including                             <ul style="list-style-type: none"> <li>– feeding</li> <li>– respiration</li> <li>– internal transport</li> <li>– excretion</li> <li>– reproduction</li> <li>– response and motility</li> </ul> </li> <li><input type="checkbox"/> compare the advantages and disadvantages of different ways animals carry out their life functions (e.g., filter feeding vs. fluid feeding, parasitic vs. free-living, asexual vs. sexual reproduction, sessile vs. motile)</li> </ul>
<p>G2 analyse the increasing complexity of the Phylum Porifera and the Phylum Cnidaria</p> <p><i>Organizer 'Animal Biology' continued on page 42</i></p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> examine members of the Phylum Porifera and identify their unifying characteristics</li> <li><input type="checkbox"/> describe how poriferans carry out their life functions</li> <li><input type="checkbox"/> examine members of the Phylum Cnidaria and identify their unifying characteristics</li> <li><input type="checkbox"/> describe how cnidarians carry out their life functions</li> <li><input type="checkbox"/> compare polyp and medusa with respect to structure, general function, and motility</li> <li><input type="checkbox"/> suggest the advantages of a motile form in the life cycle of a cnidarian</li> <li><input type="checkbox"/> explain the evolutionary significance of colonial (poriferan) versus multicellular (cnidarian) lifeforms</li> <li><input type="checkbox"/> describe the ecological roles of sponges and cnidarians</li> </ul>

Prescribed Learning Outcomes	Suggested Achievement Indicators
<p><i>Organizer 'Animal Biology' continued from page 41</i></p> <p>G3 analyse the increasing complexity of the Phylum Platyhelminthes, the Phylum Nematoda, and the Phylum Annelida</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> examine members of the Phylum Platyhelminthes and describe their unifying characteristics</li> <li><input type="checkbox"/> describe how platyhelminthes carry out their life functions</li> <li><input type="checkbox"/> examine members of the Phylum Nematoda and describe their unifying characteristics</li> <li><input type="checkbox"/> describe how nematodes carry out their life functions</li> <li><input type="checkbox"/> examine members of the Phylum Annelida and describe their unifying characteristics</li> <li><input type="checkbox"/> describe how annelids carry out their life functions</li> <li><input type="checkbox"/> describe the physical changes that were necessary for flatworms and roundworms to become parasitic</li> <li><input type="checkbox"/> evaluate the characteristics of a successful parasite</li> <li><input type="checkbox"/> describe human disorders that are caused by non-segmented worms</li> <li><input type="checkbox"/> compare platyhelminthes, nematodes, and annelids with respect to evolutionary changes</li> <li><input type="checkbox"/> describe the ecological roles of platyhelminthes, nematodes, and annelids</li> </ul>
<p>G4 analyse the increasing complexity of the Phylum Mollusca, the Phylum Echinodermata, and the Phylum Arthropoda</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> examine members of the Phylum Mollusca and describe their unifying characteristics</li> <li><input type="checkbox"/> describe how molluscs carry out their life functions</li> <li><input type="checkbox"/> examine members of the Phylum Echinodermata and describe their unifying characteristics</li> <li><input type="checkbox"/> describe how echinoderms carry out their life functions</li> <li><input type="checkbox"/> examine members of the Phylum Arthropoda and describe their unifying characteristics</li> <li><input type="checkbox"/> describe how arthropods carry out their life functions</li> <li><input type="checkbox"/> compare how molluscs, echinoderms, and arthropods have evolved to adapt to different niches</li> <li><input type="checkbox"/> demonstrate a knowledge of the diverse ecological roles of molluscs, echinoderms, and arthropods</li> </ul>
<p>G5 relate the complexity of the form and function of vertebrates to the evolutionary continuum of animals</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> examine members of the Subphylum Vertebrata and describe their unifying characteristics</li> <li><input type="checkbox"/> compare members of two or more classes of vertebrates</li> <li><input type="checkbox"/> compare the vertebrates and invertebrates in terms of increasing complexity, with reference to characteristics including                         <ul style="list-style-type: none"> <li>– endoskeleton vs. exoskeleton</li> <li>– presence or absence of vertebral column</li> <li>– closed vs. open circulatory system</li> </ul> </li> <li><input type="checkbox"/> describe the diverse ecological role of vertebrates</li> </ul>



STUDENT ACHIEVEMENT

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*Biology 12*

**Key Elements: Processes of Science****Estimated Time: integrated throughout**

The prescribed learning outcomes related to Processes of Science support the development of knowledge, skills, and attitudes essential for an understanding of science. These learning outcomes should not be taught in isolation, but should be integrated with activities related to the other curriculum organizers.

***Vocabulary***

conclusion, control, control group, controlled variable, dependent variable, electron micrograph, experimental group, experimental variable, independent variable, reliable, repeatable procedure, sample size, scientific method, testable hypothesis

***Knowledge***

- distinguish between independent and dependent variables
- distinguish between controlled and experimental variables
- distinguish between control group and experimental group

***Skills and Attitudes***

- safe and correct lab technique (e.g., use of dissection and compound microscopes, dissection technique)
- applying the scientific method to design and carry out experiments
- making inferences and generalizations
- interpreting data from a variety of types of sources (e.g., electron micrographs)
- drawing conclusions
- communicating information and results (e.g., graphs, diagrams, models, formulae)

## PROCESSES OF SCIENCE

Prescribed Learning Outcomes	Suggested Achievement Indicators
<i>It is expected that students will:</i>	<p><i>The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
A1 demonstrate safe and correct technique for a variety of laboratory procedures	<input type="checkbox"/> demonstrate the correct use of a dissection microscope <input type="checkbox"/> demonstrate safe and correct dissection technique <input type="checkbox"/> demonstrate the correct use of a compound microscope
A2 design an experiment using the scientific method	<input type="checkbox"/> formulate a testable hypothesis to investigate a scientific problem (e.g., factors affecting enzyme activity, tonicity of various cells) <input type="checkbox"/> formulate and carry out a repeatable, controlled procedure to test the hypothesis: <ul style="list-style-type: none"> <li>– identify controlled versus experimental variables</li> <li>– identify the independent and dependent variables</li> <li>– use control and experimental groups, as appropriate</li> <li>– use a control as appropriate</li> <li>– use appropriate sample size</li> </ul> <input type="checkbox"/> observe, measure, and record data <input type="checkbox"/> interpret results to draw conclusions <input type="checkbox"/> determine whether the conclusions support or reject the hypothesis <input type="checkbox"/> determine whether the experiment is reliable <input type="checkbox"/> use information and conclusions as a basis for further comparisons, investigations, or analyses
A3 interpret data from a variety of text and visual sources	<input type="checkbox"/> use data from a variety of representations (e.g., diagrams, electron micrographs, graphs, photographs) to make inferences and generalizations <input type="checkbox"/> draw and present conclusions, applying the most appropriate means to communicate (e.g., graph, diagram, model, formula, map, visual)

**Key Elements: Cell Biology (Cell Structure)**

**Estimated Time: 5–6 hours**

By the end of this course, students will have an understanding of the structure of cells.

*Vocabulary*

cell membrane, cell wall, cellular respiration, chloroplast, chromatin, chromosome, cristae, cytoplasm, cytoskeleton, Golgi bodies, lysosome, matrix, mitochondria, nuclear envelope, nuclear pore, nucleolus, nucleus, organelle, polysome, ribosome, rough endoplasmic reticulum, smooth endoplasmic reticulum, vacuole, vesicle

*Knowledge*

- functional inter-relationships of cell structures
- how cell compartmentalization assists in the production and distribution of molecules

*Skills and Attitudes*

- demonstrate correct use of a compound microscope
- communicate results (e.g., using graphs, tables, diagrams, lab reports)
- create models (e.g., of a cell, or an organelle)
- demonstrate ethical, responsible, co-operative behaviour

## CELL BIOLOGY (CELL STRUCTURE)

Prescribed Learning Outcomes	Suggested Achievement Indicators
<i>It is expected that students will:</i>	<p><i>The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
B1 analyse the functional inter-relationships of cell structures	<ul style="list-style-type: none"> <li><input type="checkbox"/> describe the following cell structures and their functions: <ul style="list-style-type: none"> <li>– cell membrane</li> <li>– cell wall</li> <li>– chloroplast</li> <li>– cytoskeleton</li> <li>– cytoplasm</li> <li>– Golgi bodies</li> <li>– lysosomes</li> <li>– mitochondria – including cristae and matrix</li> <li>– nucleus – including nuclear pore, nucleolus, chromatin, nuclear envelope, and chromosomes</li> <li>– ribosomes (polysomes)</li> <li>– smooth and rough endoplasmic reticulum</li> <li>– vacuoles</li> <li>– vesicles</li> </ul> </li> <li><input type="checkbox"/> state the balanced chemical equation for cellular respiration</li> <li><input type="checkbox"/> describe how the following organelles function to compartmentalize the cell and move materials through it: <ul style="list-style-type: none"> <li>– rough and smooth endoplasmic reticulum</li> <li>– vesicles</li> <li>– Golgi bodies</li> <li>– cell membrane</li> </ul> </li> <li><input type="checkbox"/> identify cell structures depicted in diagrams and electron micrographs</li> </ul>

**Key Elements: Cell Biology (Cell Compounds and Biological Molecules)****Estimated Time: 7–9 hours**

By the end of this course, students will have an understanding of the structures and function of cell compounds and biological molecules.

***Vocabulary***

acid, acid (carboxyl) group, adenine, adenosine triphosphate (ATP), alpha helix, amine group, amino acid, base, beta pleated sheet, bonding, buffer, carbohydrate, cellulose, complementary base pairing, cytosine, dehydration synthesis, deoxyribonucleic acid (DNA), deoxyribose, dipeptide, disaccharide, double helix, glucose, glycerol, guanine, glycogen, hemoglobin, hydrogen bonding, hydrolysis, lipid, lubricant, maltose, monomer, monosaccharide, neutral fat, nitrogenous base, nucleic acids, nucleotide, organic, peptide bond, pH, phosphate, phospholipid, polarity, polymer, polypeptide, polysaccharide, primary structure, protein, quaternary structure, R-group, ribonucleic acid (RNA), ribose, saturated fatty acid, secondary structure, solvent, starch, steroid, sugar-phosphate backbone, temperature regulator, tertiary structure, thymine, unsaturated fatty acid, uracil

***Knowledge***

- characteristics of water and its role in biological systems
- importance of pH and the role of acids, bases, and buffers in biological systems
- structure and function of biological molecules in living systems: carbohydrates, lipids, proteins, and nucleic acids
- dehydration synthesis and hydrolysis
- types of carbohydrates, lipids, proteins, and nucleic acids
- empirical formula of a carbohydrate

***Skills and Attitudes***

- create molecular models
- conduct experiments (e.g., to observe the effects of acids and bases on indicators; to test foods for the presence of carbohydrates, lipids, and proteins)
- communicate results (e.g., using graphs, tables, diagrams, lab reports)
- demonstrate ethical, responsible, co-operative behaviour



## CELL BIOLOGY (CELL COMPOUNDS AND BIOLOGICAL MOLECULES)

Prescribed Learning Outcomes	Suggested Achievement Indicators
<i>It is expected that students will:</i>	<p><i>The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
B2 describe the characteristics of water and its role in biological systems	<input type="checkbox"/> describe the role of water as a solvent, temperature regulator, and lubricant <input type="checkbox"/> describe how the polarity of the water molecule results in hydrogen bonding
B3 describe the role of acids, bases, and buffers in biological systems in the human body	<input type="checkbox"/> differentiate among acids, bases, and buffers <input type="checkbox"/> describe the importance of pH to biological systems in the human body
<i>Suborganizer 'Cell Biology (Cell Compounds and Biological Molecules)' continued on page 50</i>	

Prescribed Learning Outcomes	Suggested Achievement Indicators
<p><i>Suborganizer 'Cell Biology (Cell Compounds and Biological Molecules)' continued from page 49</i></p> <p>B4 analyse the structure and function of biological molecules in living systems, including</p> <ul style="list-style-type: none"> <li>- carbohydrates</li> <li>- lipids</li> <li>- proteins</li> <li>- nucleic acids</li> </ul> <p><i>Suborganizer 'Cell Biology (Cell Compounds and Biological Molecules),' PLO B4 continued on page 51</i></p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> demonstrate a knowledge of dehydration synthesis and hydrolysis as applied to organic monomers and polymers</li> <li><input type="checkbox"/> differentiate among carbohydrates, lipids, proteins, and nucleic acids with respect to chemical structure</li> <li><input type="checkbox"/> recognize the following molecules in structural diagrams: <ul style="list-style-type: none"> <li>- adenosine triphosphate (ATP)</li> <li>- deoxyribonucleic acid (DNA)</li> <li>- disaccharide</li> <li>- glucose</li> <li>- glycerol</li> <li>- hemoglobin</li> <li>- monosaccharide</li> <li>- neutral fat</li> <li>- phospholipid</li> <li>- polysaccharide (starch, glycogen, and cellulose)</li> <li>- ribose</li> <li>- RNA</li> <li>- saturated and unsaturated fatty acids</li> <li>- steroids</li> </ul> </li> <li><input type="checkbox"/> recognize the empirical formula of a monosaccharide as <math>C_nH_{2n}O_n</math></li> <li><input type="checkbox"/> list the main functions of carbohydrates</li> <li><input type="checkbox"/> differentiate among monosaccharides (e.g., glucose), disaccharides (e.g., maltose), and polysaccharides</li> <li><input type="checkbox"/> differentiate among starch, cellulose, and glycogen with respect to <ul style="list-style-type: none"> <li>- function</li> <li>- type of bonding</li> <li>- level of branching</li> </ul> </li> <li><input type="checkbox"/> describe the location, structure, and function of the following in the human body: <ul style="list-style-type: none"> <li>- neutral fats</li> <li>- steroids</li> <li>- phospholipids</li> </ul> </li> </ul>

Prescribed Learning Outcomes	Suggested Achievement Indicators
<p><i>Suborganizer 'Cell Biology (Cell Compounds and Biological Molecules),' PLO B4 continued from page 50</i></p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> compare saturated and unsaturated fatty acids in terms of molecular structure</li> <li><input type="checkbox"/> list the major functions of proteins</li> <li><input type="checkbox"/> draw a generalized amino acid and identify the amine, acid (carboxyl), and R-groups</li> <li><input type="checkbox"/> identify the peptide bonds in dipeptides and polypeptides</li> <li><input type="checkbox"/> differentiate among the following levels of protein organization with respect to structure and types of bonding: <ul style="list-style-type: none"> <li>– primary</li> <li>– secondary (alpha helix, beta pleated sheet)</li> <li>– tertiary</li> <li>– quaternary (e.g., hemoglobin)</li> </ul> </li> <li><input type="checkbox"/> list the major functions of nucleic acids (RNA and DNA)</li> <li><input type="checkbox"/> name the four nitrogenous bases in ribonucleic acid (RNA) and describe the structure of RNA using the following terms: <ul style="list-style-type: none"> <li>– nucleotide (ribose, phosphate, nitrogenous base, adenine, uracil, cytosine, guanine)</li> <li>– linear, single stranded</li> <li>– sugar-phosphate backbone</li> </ul> </li> <li><input type="checkbox"/> name the four nitrogenous bases in DNA and describe the structure of DNA using the following terms: <ul style="list-style-type: none"> <li>– nucleotide (deoxyribose, phosphate, nitrogenous base, adenine, thymine, cytosine, guanine)</li> <li>– complementary base pairing</li> <li>– double helix</li> <li>– hydrogen bonding</li> <li>– sugar-phosphate backbone</li> </ul> </li> <li><input type="checkbox"/> compare the general structural composition of DNA and RNA</li> <li><input type="checkbox"/> relate the general structure of the ATP molecule to its role as the “energy currency” of cells</li> </ul>

**Key Elements: Cell Biology (DNA Replication)**

**Estimated Time: 4–5 hours**

By the end of this course, students will have an understanding of the process of DNA replication.

***Vocabulary***

complementary base pairing, DNA helicase, DNA polymerase, nucleotides, recombinant DNA, replication, semi-conservative replication

***Knowledge***

- purpose of DNA replication
- site of DNA replication in the cell
- semi-conservative DNA replication
- recombinant DNA

***Skills and Attitudes***

- interpret graphs, tables, and diagrams
- create models (e.g., of DNA replication)
- conduct experiments (e.g., to isolate DNA, to produce recombinant DNA)
- demonstrate ethical, responsible, co-operative behaviour

## CELL BIOLOGY (DNA REPLICATION)

Prescribed Learning Outcomes	Suggested Achievement Indicators
<i>It is expected that students will:</i>	<p><i>The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
B5 describe DNA replication	<ul style="list-style-type: none"> <li><input type="checkbox"/> describe the three steps in the semi-conservative replication of DNA:               <ul style="list-style-type: none"> <li>– “unzipping” (DNA helicase)</li> <li>– complementary base pairing (DNA polymerase)</li> <li>– joining of adjacent nucleotides (DNA polymerase)</li> </ul> </li> <li><input type="checkbox"/> describe the purpose of DNA replication</li> <li><input type="checkbox"/> identify the site of DNA replication within the cell</li> </ul>
B6 describe recombinant DNA	<ul style="list-style-type: none"> <li><input type="checkbox"/> define recombinant DNA</li> <li><input type="checkbox"/> describe a minimum of three uses for recombinant DNA</li> </ul>

**Key Elements: Cell Biology (Protein Synthesis)**

**Estimated Time: 4–6 hours**

By the end of this course, students will have an understanding of the process of protein synthesis.

***Vocabulary***

amino acid, anti-codon, codon, DNA sequence (genetic code), elongation, environmental mutagen, genetic disorder, initiation, messenger RNA (mRNA), mutation, polypeptide chain, ribosomes, termination, transcription, transfer RNA (tRNA), translation

***Knowledge***

- process of protein synthesis
- how mutations in DNA affect protein synthesis
- mutations causing genetic disorders

***Skills and Attitudes***

- interpret tables and diagrams
- create models (e.g., protein synthesis or mutation)
- demonstrate ethical, responsible, co-operative behaviour

## CELL BIOLOGY (PROTEIN SYNTHESIS)

Prescribed Learning Outcomes	Suggested Achievement Indicators
<i>It is expected that students will:</i>	<p><i>The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
B7 demonstrate an understanding of the process of protein synthesis	<ul style="list-style-type: none"> <li><input type="checkbox"/> identify the roles of DNA, messenger RNA (mRNA), transfer RNA (tRNA), and ribosomes in the processes of transcription and translation, including initiation, elongation, and termination</li> <li><input type="checkbox"/> determine the sequence of amino acids coded for by a specific DNA sequence (genetic code), given a table of mRNA codons</li> <li><input type="checkbox"/> identify the complementary nature of the mRNA codon and the tRNA anti-codon</li> </ul>
B8 explain how mutations in DNA affect protein synthesis	<ul style="list-style-type: none"> <li><input type="checkbox"/> give examples of two environmental mutagens that can cause mutations in humans</li> <li><input type="checkbox"/> use examples to explain how mutations in DNA change the sequence of amino acids in a polypeptide chain, and as a result may lead to genetic disorders</li> </ul>

**Key Elements: Cell Biology (Transport Across Cell Membrane)****Estimated Time: 6–7 hours**

By the end of this course, students will have an understanding of the structure and function of cell membranes.

***Vocabulary***

active transport, carbohydrates, carrier protein, cell membrane, channel protein, cholesterol, concentration gradient, diffusion, endocytosis, exocytosis, facilitated transport, fluid-mosaic membrane model, glycolipid, glycoprotein, hydrophilic, hydrophobic, hypertonic, hypotonic, isotonic, osmosis, passive transport processes, phagocytosis, phospholipid, phospholipid bilayer, pinocytosis, pressure gradient, protein, selectively permeable, surface area-to-volume ratio, tonicity

***Knowledge***

- structure and function of the cell membrane
- factors affecting rate of diffusion
- transport processes
- why cells divide when they reach a particular surface area-to-volume ratio

***Skills and Attitudes***

- interpret diagrams, tables, and graphs (e.g., of surface area to volume ratio)
- create models (e.g., of cell membrane, compare surface area-to-volume ratio of objects of different sizes)
- conduct experiments (e.g., to determine the tonicity of cells, diffusion)
- demonstrate ethical, responsible, co-operative behaviour



## CELL BIOLOGY (TRANSPORT ACROSS CELL MEMBRANE)

Prescribed Learning Outcomes	Suggested Achievement Indicators
<i>It is expected that students will:</i>	<p><i>The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
B9 analyse the structure and function of the cell membrane	<ul style="list-style-type: none"> <li><input type="checkbox"/> apply knowledge of organic molecules – including phospholipids, proteins, glycoproteins, glycolipids, carbohydrates, and cholesterol – to explain the structure and function of the fluid-mosaic membrane model</li> <li><input type="checkbox"/> identify the hydrophobic and hydrophilic regions of the phospholipid bilayer</li> <li><input type="checkbox"/> explain why the cell membrane is described as “selectively permeable”</li> <li><input type="checkbox"/> describe passive transport processes including diffusion, osmosis, and facilitated transport</li> <li><input type="checkbox"/> explain factors that affect the rate of diffusion across a cell membrane (e.g., temperature, size of molecule, charge of molecule, concentration gradient, pressure gradient)</li> <li><input type="checkbox"/> predict the effects of hypertonic, isotonic, and hypotonic environments on osmosis in animal cells</li> <li><input type="checkbox"/> describe active transport processes including active transport, endocytosis (phagocytosis and pinocytosis), and exocytosis</li> <li><input type="checkbox"/> compare specific transport processes – including diffusion, osmosis, facilitated transport, active transport, endocytosis, and exocytosis – in terms of               <ul style="list-style-type: none"> <li>– concentration gradient</li> <li>– use of channel or carrier protein</li> <li>– use of energy</li> <li>– types/sizes of molecules transported</li> </ul> </li> <li><input type="checkbox"/> devise an experiment using the scientific method (e.g., to investigate the tonicity of cells)</li> </ul>
B10 explain why cells divide when they reach a particular surface area-to-volume ratio	<ul style="list-style-type: none"> <li><input type="checkbox"/> differentiate between cells that have a high or low surface area-to-volume ratio</li> <li><input type="checkbox"/> demonstrate an understanding of the significance of surface area-to-volume ratio in cell size</li> </ul>

**Key Elements: Cell Biology (Enzymes)**

**Estimated Time: 6–7 hours**

By the end of this course, students will have an understanding of the role of enzymes in biochemical reactions.

***Vocabulary***

activation energy, biochemical reaction, coenzyme, competitive inhibitor, enzyme, enzyme activity, enzyme concentration, heavy metal, induced fit model, metabolism, non-competitive inhibitor, pH, proteins, substrate, substrate concentration, thyroid, thyroxin, vitamins

***Knowledge***

- roles of enzymes and coenzymes in biochemical reactions
- balanced chemical equation for cellular respiration
- effects on enzyme activity
- thyroxin and its source gland

***Skills and Attitudes***

- interpret graphs, tables, and diagrams
- create models (e.g., enzyme action – induced fit)
- conduct experiments (e.g., observing enzyme activity at varying pH and temperatures)
- demonstrate ethical, responsible, co-operative behaviour

## CELL BIOLOGY (ENZYMES)

Prescribed Learning Outcomes	Suggested Achievement Indicators
<i>It is expected that students will:</i>	<p><i>The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
B11 analyse the roles of enzymes in biochemical reactions	<ul style="list-style-type: none"> <li><input type="checkbox"/> explain the following terms: metabolism, enzyme, substrate, coenzyme, activation energy</li> <li><input type="checkbox"/> use graphs to identify the role of enzymes in lowering the activation energy of a biochemical reaction</li> <li><input type="checkbox"/> explain models of enzymatic action (e.g., induced fit)</li> <li><input type="checkbox"/> differentiate between the roles of enzymes and coenzymes in biochemical reactions</li> <li><input type="checkbox"/> identify the role of vitamins as coenzymes</li> <li><input type="checkbox"/> apply knowledge of proteins to explain the effects on enzyme activity of pH, temperature, substrate concentration, enzyme concentration, competitive inhibitors, and non-competitive inhibitors including heavy metals</li> <li><input type="checkbox"/> devise an experiment using the scientific method (e.g., to investigate the activity of enzymes)</li> <li><input type="checkbox"/> identify the thyroid as the source gland for thyroxin, and relate the function of thyroxin to metabolism</li> </ul>

**Key Elements: Human Biology (Digestive System)****Estimated Time: 8–10 hours**

By the end of this course, students will have an understanding of the structures and function of the digestive system.

***Vocabulary***

absorption, anaerobic bacteria, anus, appendix, bile, capillary, cardiac sphincter, chemical digestion, digestive enzyme, digestive tract, duodenum, emulsification, epiglottis, esophagus, gall bladder, gastric juice, hydrochloric acid (HCl), insulin, intestinal juice, lacteals, large intestine (colon), lipase, liver, maltase, microvillus, nuclease, pancreas, pancreatic amylase, pancreatic juice, pepsin, pepsinogen, peptidase, peristalsis, pH, pharynx, physical digestion, protease, pyloric sphincter, rectum, salivary amylase, salivary gland, salivary juice/saliva, small intestine, sodium bicarbonate, stomach, swallowing, trypsin, villus

***Knowledge***

- structures of the digestive system and their inter-relationships
- components, pH, and digestive actions of salivary, gastric, pancreatic, and intestinal juices

***Skills and Attitudes***

- interpret graphs, tables, and diagrams
- demonstrate safe and correct dissection technique
- demonstrate correct use of a dissection microscope (e.g., interior surface of stomach and small intestine)
- demonstrate proper technique for handling and disposing of laboratory materials
- create models (e.g., of specific aspects of the digestive system such as peristalsis)
- conduct experiments (e.g., to test the effect of digestive enzymes such as amylase or pepsin)
- communicate results (e.g., using tables, graphs, diagrams, lab reports)
- demonstrate ethical, responsible, co-operative behaviour
- show respect for living things

## HUMAN BIOLOGY (DIGESTIVE SYSTEM)

Prescribed Learning Outcomes	Suggested Achievement Indicators
<i>It is expected that students will:</i>	<p><i>The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
<p>C1 analyse the functional inter-relationships of the structures of the digestive system</p> <p><i>Suborganizer 'Human Biology (Digestive System)' continued on page 62</i></p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> identify and give a function for each of the following: <ul style="list-style-type: none"> <li>– mouth</li> <li>– tongue</li> <li>– teeth</li> <li>– salivary glands</li> <li>– pharynx</li> <li>– epiglottis</li> <li>– esophagus</li> <li>– cardiac sphincter</li> <li>– stomach</li> <li>– pyloric sphincter</li> <li>– duodenum</li> <li>– liver</li> <li>– gall bladder</li> <li>– pancreas</li> <li>– small intestine</li> <li>– appendix</li> <li>– large intestine (colon)</li> <li>– rectum</li> <li>– anus</li> </ul> </li> <li><input type="checkbox"/> describe swallowing and peristalsis</li> <li><input type="checkbox"/> identify the pancreas as the source gland for insulin, and describe the function of insulin in maintaining blood sugar levels</li> <li><input type="checkbox"/> list at least six major functions of the liver</li> <li><input type="checkbox"/> explain the role of bile in the emulsification of fats</li> <li><input type="checkbox"/> describe how the small intestine is specialized for chemical and physical digestion and absorption</li> <li><input type="checkbox"/> describe the structure of the villus, including microvilli, and explain the functions of the capillaries and lacteals within it</li> <li><input type="checkbox"/> describe the functions of anaerobic bacteria in the colon</li> <li><input type="checkbox"/> demonstrate the correct use of the dissection microscope to examine the various structures of the digestive system</li> </ul>

Prescribed Learning Outcomes	Suggested Achievement Indicators
<p><i>Suborganizer 'Human Biology (Digestive System)' continued from page 61</i></p> <p>C2 describe the components, pH, and digestive actions of salivary, gastric, pancreatic, and intestinal juices</p>	<ul style="list-style-type: none"><li><input type="checkbox"/> relate the following digestive enzymes to their glandular sources and describe the digestive reactions they promote:<ul style="list-style-type: none"><li>- salivary amylase</li><li>- pancreatic amylase</li><li>- proteases (pepsinogen, pepsin, trypsin)</li><li>- lipase</li><li>- peptidase</li><li>- maltase</li><li>- nuclease</li></ul></li><li><input type="checkbox"/> describe the role of water as a component of digestive juices</li><li><input type="checkbox"/> describe the role of sodium bicarbonate in pancreatic juice</li><li><input type="checkbox"/> describe the role of hydrochloric acid (HCl) in gastric juice</li><li><input type="checkbox"/> describe the role of mucus in gastric juice</li><li><input type="checkbox"/> describe the importance of the pH level in various regions of the digestive tract</li></ul>

**Key Elements: Human Biology (Circulatory System)****Estimated Time: 14–16 hours**

By the end of this course, students will have an understanding of the structures and function of the circulatory system, including the heart, blood vessels, blood, and the role of lymphatic system.

***Vocabulary***

anterior vena cava, antibody, antigen, aorta, arterial duct atrioventricular valve, autonomic nervous system, atrioventricular (AV) node, blood, blood pressure, blood velocity, blood vessel, capillary-tissue fluid exchange, carotid artery, chordae tendineae, coronary artery, coronary vein, diastolic pressure, fetal circulation, heart rate, hepatic portal vein, hepatic vein, hypertension, hypotension, iliac artery, iliac vein, jugular vein, left atrium, left ventricle, lymph capillaries, lymph node, lymphatic system, lymphatic veins, mesenteric artery, oval opening, plasma, platelets, posterior vena cava, pulmonary arteries, pulmonary circulation, pulmonary trunk, pulmonary veins, Purkinje fibres, red blood cell, renal artery, renal vein, right atrium, right ventricle, sinoatrial (SA) node, semi-lunar valve, septum, subclavian artery, subclavian vein, systemic circulation, systolic pressure, total cross-sectional area, umbilical artery, umbilical vein, valve, veins, venous duct, vessel wall, white blood cell

***Knowledge***

- structures of the circulatory system and their inter-relationships
- structure of the heart
- relationship between heart rate and blood pressure
- structures and functions of blood vessels
- pulmonary and system circulation
- components of blood
- fetal circulation
- roles of antigens and antibodies
- structures and functions of the lymphatic system

***Skills and Attitudes***

- interpret graphs, tables, and diagrams
- demonstrate safe and correct dissection technique
- demonstrate correct use of a compound microscope (e.g., blood slides)
- demonstrate correct use of a dissection microscope (e.g., heart dissection)
- demonstrate proper technique for handling and disposing of laboratory materials
- create models (e.g., antigens and antibodies, specific aspects of the circulatory system such as the heart)
- conduct experiments (e.g., to test the effect of physical activity on heart rate and blood pressure)
- communicate results (e.g., using tables, graphs, diagrams, lab reports)
- demonstrate ethical, responsible, co-operative behaviour
- show respect for living things

HUMAN BIOLOGY (CIRCULATORY SYSTEM)

Prescribed Learning Outcomes	Suggested Achievement Indicators
<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 corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
<p>C3 describe the inter-relationships of the structures the heart</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> identify and give functions (including where blood is coming from and going to, as applicable) for each of the following:                             <ul style="list-style-type: none"> <li>– left and right atria</li> <li>– left and right ventricles</li> <li>– coronary arteries and veins</li> <li>– anterior and posterior vena cava</li> <li>– aorta</li> <li>– pulmonary arteries and veins</li> <li>– pulmonary trunk</li> <li>– atrioventricular valves</li> <li>– chordae tendineae</li> <li>– semi-lunar valves</li> <li>– septum</li> </ul> </li> <li><input type="checkbox"/> recognize heart structures using both internal and external diagram views</li> </ul>
<p>C4 analyse the relationship between heart rate and blood pressure</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> describe the location and functions of the sinoatrial (SA) node, atrioventricular (AV) node, and Purkinje fibres</li> <li><input type="checkbox"/> describe how the autonomic nervous system increases and decreases heart rate and blood pressure</li> <li><input type="checkbox"/> differentiate between systolic and diastolic pressures</li> <li><input type="checkbox"/> describe hypertension and hypotension and their causes</li> <li><input type="checkbox"/> demonstrate the measurement of blood pressure</li> </ul>
<p>C5 analyse the functional inter-relationships of the vessels of the circulatory system</p> <p><i>Suborganizer 'Human Biology (Circulatory System)' PLO C5 continued on page 65</i></p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> identify and give the function (including where the vessel is carrying blood from and where it is carrying blood to) of each of the following:                             <ul style="list-style-type: none"> <li>– subclavian arteries and veins</li> <li>– jugular veins</li> <li>– carotid arteries</li> <li>– mesenteric arteries</li> <li>– anterior and posterior vena cava</li> <li>– pulmonary veins and arteries</li> <li>– hepatic vein</li> <li>– hepatic portal vein</li> <li>– renal arteries and veins</li> <li>– iliac arteries and veins</li> <li>– coronary arteries and veins</li> <li>– aorta</li> </ul> </li> <li><input type="checkbox"/> describe and differentiate among the five types of blood vessels with reference to characteristics such as                             <ul style="list-style-type: none"> <li>– structure and thickness of vessel walls</li> <li>– presence of valves</li> <li>– direction of blood flow (toward or away from the heart)</li> </ul> </li> </ul>



Prescribed Learning Outcomes	Suggested Achievement Indicators
<p><i>Suborganizer 'Human Biology (Circulatory System)' PLO C5 continued from page 64</i></p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> differentiate between pulmonary and systemic circulation with respect to oxygenation or deoxygenation of blood in the vessels involved</li> <li><input type="checkbox"/> demonstrate a knowledge of the path of a blood cell from the aorta through the body and back to the left ventricle</li> <li><input type="checkbox"/> relate blood pressure and blood velocity to the total cross-sectional area of the five types of blood vessels</li> <li><input type="checkbox"/> describe capillary-tissue fluid exchange</li> <li><input type="checkbox"/> identify and describe differences in structure and circulation between fetal and adult systems, with reference to umbilical vein and arteries, oval opening, venous duct, arterial duct</li> </ul>
<p>C6 describe the components of blood</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> describe the shape, function, and origin of red blood cells, white blood cells, and platelets</li> <li><input type="checkbox"/> list the major components of plasma</li> <li><input type="checkbox"/> explain the roles of antigens and antibodies</li> </ul>
<p>C7 describe the inter-relationships of the structures of the lymphatic system</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> describe the functions of the lymphatic system</li> <li><input type="checkbox"/> identify and give functions of lymph capillaries, veins, and nodes</li> </ul>

**Key Elements: Human Biology (Respiratory System)****Estimated Time: 6–8 hours**

By the end of this course, students will have an understanding of the structures and function of the respiratory system.

***Vocabulary***

alveoli, aortic bodies, bicarbonate ions, bronchi, bronchioles, carbaminohemoglobin, carbon dioxide, carbonic anhydrase, carotid bodies, cilia, diaphragm, exhalation, external respiration, hydrogen ions, inhalation, intercostal (rib) muscles, internal respiration, larynx, lungs, mucus, nasal cavity, oxygen, oxyhemoglobin, pH, pharynx, pleural membrane, reduced hemoglobin, respiratory centre in the medulla oblongata, respiratory tract, ribs, stretch receptors, thoracic cavity, trachea

***Knowledge***

- structures of the respiratory system and their inter-relationships
- processes of breathing
- internal and external respiration
- role of various substances in stimulating breathing

***Skills and Attitudes***

- interpret graphs, tables, and diagrams
- demonstrate safe and correct dissection technique
- demonstrate correct use of a compound microscope (e.g., slides showing cilia)
- demonstrate correct use of a dissection microscope (e.g., lung tissue)
- demonstrate proper technique for handling and disposing of laboratory materials
- create models (e.g., inhalation and exhalation, respiratory tract)
- conduct experiments (e.g., to measure vital capacity)
- communicate results (e.g., using tables, graphs, diagrams, lab reports)
- demonstrate ethical, responsible, co-operative behaviour
- show respect for living things

## HUMAN BIOLOGY (RESPIRATORY SYSTEM)

Prescribed Learning Outcomes	Suggested Achievement Indicators
<i>It is expected that students will:</i>	<p><i>The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
C8 analyse the functional inter-relationships of the structures of the respiratory system	<ul style="list-style-type: none"> <li><input type="checkbox"/> identify and give functions for each of the following:               <ul style="list-style-type: none"> <li>– nasal cavity</li> <li>– pharynx</li> <li>– larynx</li> <li>– trachea</li> <li>– bronchi</li> <li>– bronchioles</li> <li>– alveoli</li> <li>– diaphragm and ribs</li> <li>– pleural membranes</li> <li>– thoracic cavity</li> </ul> </li> <li><input type="checkbox"/> explain the roles of cilia and mucus in the respiratory tract</li> <li><input type="checkbox"/> explain the relationship between the structure and function of alveoli</li> </ul>
C9 analyse the processes of breathing	<ul style="list-style-type: none"> <li><input type="checkbox"/> describe the interactions of the following structures in the breathing process:               <ul style="list-style-type: none"> <li>– respiratory centre in the medulla oblongata</li> <li>– lungs</li> <li>– pleural membranes</li> <li>– diaphragm</li> <li>– intercostal (rib) muscles</li> <li>– stretch receptors</li> </ul> </li> <li><input type="checkbox"/> compare the processes of inhalation and exhalation</li> <li><input type="checkbox"/> explain the roles of carbon dioxide and hydrogen ions in stimulating the respiratory centre in the medulla oblongata</li> <li><input type="checkbox"/> explain the roles of oxygen, carbon dioxide, and hydrogen ions in stimulating carotid and aortic bodies</li> </ul>
C10 analyse internal and external respiration	<ul style="list-style-type: none"> <li><input type="checkbox"/> describe the exchange of carbon dioxide and oxygen during internal and external respiration, including               <ul style="list-style-type: none"> <li>– location of exchange</li> <li>– conditions that favour exchange (e.g., pH, temperature)</li> </ul> </li> <li><input type="checkbox"/> explain the roles of oxyhemoglobin, carbaminohemoglobin, reduced hemoglobin, bicarbonate ions, and carbonic anhydrase in the transport of carbon dioxide and oxygen in the blood</li> <li><input type="checkbox"/> write the chemical equations for internal and external respiration</li> </ul>

**Key Elements: Human Biology (Nervous System)****Estimated Time: 12–14 hours**

By the end of this course, students will have an understanding of the structures and function of the nervous system.

***Vocabulary***

acetylcholine (ACh), acetylcholinesterase (AChE), action potential, adrenal medulla, adrenalin, “all-or-none” response, autonomic nervous system, axomembrane, axon, axoplasm, calcium ion, cell body, central nervous system, cerebellum, cerebrum, contractile protein, corpus callosum, dendrite, depolarization, effector, excitatory neurotransmitter, hypothalamus, impulse, inhibitory neurotransmitter, interneuron, medulla oblongata, meninges, motor neuron, myelin sheath, myelinated nerve fibre, neuroendocrine control centre, neuron, neurotransmitters, node of Ranvier, norepinephrine, parasympathetic division, peripheral nervous system, pituitary gland, polarity, postsynaptic membrane, potassium gate, presynaptic membrane, receptor, reflex arc, refractory period, repolarization, resting potential, saltatory transmission, Schwann cell, sensory neuron, sodium gate, sodium-potassium pump, somatic nervous system, sympathetic division, synapse, synaptic cleft, synaptic ending, synaptic vesicle, thalamus, threshold value

***Knowledge***

- transmission of nerve impulses
- components of a synapse
- impulse transmission across synapses
- structure and function of a reflex arc
- divisions of the nervous system and their inter-relationships
- functions of parts of the brain
- autonomic and somatic nervous systems; sympathetic and parasympathetic divisions

***Skills and Attitudes***

- interpret graphs, tables, and diagrams
- demonstrate safe and correct dissection technique
- demonstrate correct use of a compound microscope (e.g., nerve cells)
- demonstrate correct use of a dissection microscope (e.g., brain, spinal cord)
- demonstrate proper technique for handling and disposing of laboratory materials
- create models (e.g., reflex arc, nerve impulse transmission)
- communicate results (e.g., using tables, diagrams, lab reports)
- demonstrate ethical, responsible, co-operative behaviour
- show respect for living things

## HUMAN BIOLOGY (NERVOUS SYSTEM)

Prescribed Learning Outcomes	Suggested Achievement Indicators
<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 corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
<p>C11 analyse the transmission of nerve impulses</p> <p><i>Suborganizer 'Human Biology (Nervous System)' continued on page 70</i></p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> identify and give functions for each of the following: dendrite, cell body, axon, axoplasm, and axomembrane</li> <li><input type="checkbox"/> differentiate among sensory, motor, and interneurons with respect to structure and function</li> <li><input type="checkbox"/> explain the transmission of a nerve impulse through a neuron, using the following terms: <ul style="list-style-type: none"> <li>– resting and action potential</li> <li>– depolarization and repolarization</li> <li>– refractory period</li> <li>– sodium and potassium gates</li> <li>– sodium-potassium pump</li> <li>– threshold value</li> <li>– “all-or-none” response</li> <li>– polarity</li> </ul> </li> <li><input type="checkbox"/> relate the structure of a myelinated nerve fibre to the speed of impulse conduction, with reference to myelin sheath, Schwann cell, node of Ranvier, and saltatory transmission</li> <li><input type="checkbox"/> identify the major components of a synapse, including <ul style="list-style-type: none"> <li>– synaptic ending</li> <li>– presynaptic and postsynaptic membranes</li> <li>– synaptic cleft</li> <li>– synaptic vesicle</li> <li>– calcium ions and contractile proteins</li> <li>– excitatory and inhibitory neurotransmitters (e.g., norepinephrine, acetylcholine – ACh)</li> <li>– receptor</li> <li>– acetylcholinesterase (AChE)</li> </ul> </li> <li><input type="checkbox"/> explain the process by which impulses travel across a synapse</li> <li><input type="checkbox"/> describe how neurotransmitters are broken down in the synaptic cleft</li> <li><input type="checkbox"/> describe the structure of a reflex arc (receptor, sensory neuron, interneuron, motor neuron, and effector) and relate its structure to how it functions</li> </ul>

Prescribed Learning Outcomes	Suggested Achievement Indicators
<p><i>Suborganizer 'Human Biology (Nervous System)' continued from page 69</i></p> <p>C12 analyse the functional inter-relationships of the divisions of the nervous system</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> compare the locations and functions of the central and peripheral nervous systems</li> <li><input type="checkbox"/> identify and give functions for each of the following parts of the brain: <ul style="list-style-type: none"> <li>- medulla oblongata</li> <li>- cerebrum</li> <li>- thalamus</li> <li>- cerebellum</li> <li>- hypothalamus</li> <li>- pituitary gland</li> <li>- corpus callosum</li> <li>- meninges</li> </ul> </li> <li><input type="checkbox"/> explain how the hypothalamus and pituitary gland interact as the neuroendocrine control centre</li> <li><input type="checkbox"/> differentiate between the functions of the autonomic and somatic nervous systems</li> <li><input type="checkbox"/> describe the inter-related functions of the sympathetic and parasympathetic divisions of the autonomic nervous system, with reference to <ul style="list-style-type: none"> <li>- effect on body functions including heart rate, breathing rate, pupil size, digestion</li> <li>- neurotransmitters involved</li> <li>- overall response (“fight or flight” or relaxed state)</li> </ul> </li> <li><input type="checkbox"/> identify the source gland for adrenalin (adrenal medulla) and explain its role in the “fight or flight” response</li> </ul>

**Key Elements: Human Biology (Urinary System)****Estimated Time: 9–11 hours**

By the end of this course, students will have an understanding of the structures and function of the urinary system.

***Vocabulary***

antidiuretic hormone (ADH), adrenal cortex, afferent and efferent arterioles, aldosterone, ammonia, Bowman's capsule, collecting duct, glomerulus, glucose, homeostasis, hypothalamus, kidney, loop of Henle, metabolic waste, nephron, nitrogenous waste, osmotic gradient, peritubular capillary network, pH, posterior pituitary, pressure filtration, proximal and distal convoluted tubules, reabsorption of water, renal artery, renal cortex, renal medulla, renal pelvis, renal vein, selective reabsorption, tubular excretion, urea, ureter, urethra, urinary bladder, urine

***Knowledge***

- structures of the urinary system and their inter-relationships
- components of the nephron
- urine production
- kidneys and blood pH
- homeostasis of water and sodium levels in the blood

***Skills and Attitudes***

- interpret graphs, tables, and diagrams
- demonstrate safe and correct dissection technique
- demonstrate correct use of a compound microscope (e.g., nephrons)
- demonstrate correct use of a dissection microscope (e.g., internal structure of the kidney)
- demonstrate proper technique for handling and disposing of laboratory materials
- create models (e.g., nephron)
- communicate results (e.g., using tables, diagrams, lab reports)
- demonstrate ethical, responsible, co-operative behaviour
- show respect for living things

## HUMAN BIOLOGY (URINARY SYSTEM)

Prescribed Learning Outcomes	Suggested Achievement Indicators
<i>It is expected that students will:</i>	<p><i>The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
C13 analyse the functional inter-relationships of the structures of the urinary system	<ul style="list-style-type: none"> <li><input type="checkbox"/> identify and explain the functions of each of the following: <ul style="list-style-type: none"> <li>– kidney</li> <li>– ureter</li> <li>– urethra</li> <li>– urinary bladder</li> <li>– renal cortex</li> <li>– renal medulla</li> <li>– renal pelvis</li> <li>– nephron</li> </ul> </li> <li><input type="checkbox"/> identify and explain the functions of the following components of the nephron: <ul style="list-style-type: none"> <li>– glomerulus</li> <li>– Bowman’s capsule</li> <li>– afferent and efferent arterioles</li> <li>– peritubular capillary network</li> <li>– proximal and distal convoluted tubules</li> <li>– collecting duct</li> <li>– loop of Henle</li> </ul> </li> <li><input type="checkbox"/> describe the production of urine with reference to the following terms: <ul style="list-style-type: none"> <li>– pressure filtration</li> <li>– selective reabsorption</li> <li>– reabsorption of water following an osmotic gradient</li> <li>– tubular excretion</li> <li>– metabolic waste (e.g., nitrogenous waste, urea, ammonia)</li> </ul> </li> <li><input type="checkbox"/> describe how the kidneys maintain blood pH</li> <li><input type="checkbox"/> compare urea and glucose content of blood in the renal artery with that of the renal vein</li> <li><input type="checkbox"/> identify the source glands for antidiuretic hormone (ADH) and aldosterone</li> <li><input type="checkbox"/> describe how the hypothalamus, posterior pituitary, ADH, and the nephron achieve homeostasis of water levels in the blood</li> <li><input type="checkbox"/> describe how the adrenal cortex, aldosterone, and the nephron achieve homeostasis of water and sodium levels in the blood</li> </ul>



**Key Elements: Human Biology (Reproductive System)****Estimated Time: 9–11 hours**

By the end of this course, students will have an understanding of the structures and function of the male and female reproductive systems.

***Vocabulary***

acrosome, anterior pituitary, cervix, clitoris, corpus luteum, Cowper's glands, ductus (vas) deferens, endometrium, epididymis, estrogen, follicles, follicle-stimulating hormone (FSH), follicular phase, gonadotropin-releasing hormone (GnRH), head, homeostatic regulation, human chorionic gonadotropin (HCG), hypothalamus, implantation, interstitial cells, luteal phase, luteinizing hormone (LH), menstruation, midpiece, ovarian cycle, ovaries, oviducts (fallopian tubes), ovulation, oxytocin, penis, positive feedback mechanism, progesterone, proliferative phase, prostate gland, scrotum, secretory phase, seminal fluid, seminal vesicles, seminiferous tubules, sperm, tail (flagellum), testes, testosterone, urethra, urethral opening, uterine cycle, uterus, vagina

***Knowledge***

- functional structures of the male and female reproductive systems
- components of seminal fluid
- ovarian and uterine cycles
- production, regulation, and functions of male and female hormones

***Skills and Attitudes***

- interpret graphs, tables, and diagrams
- demonstrate safe and correct dissection technique
- demonstrate correct use of a compound microscope (e.g., to examine sperm)
- demonstrate proper technique for handling and disposing of laboratory materials
- communicate results (e.g., using tables, diagrams, lab reports)
- demonstrate ethical, responsible, co-operative behaviour
- show respect for living things

## HUMAN BIOLOGY (REPRODUCTIVE SYSTEM)

Prescribed Learning Outcomes	Suggested Achievement Indicators
<i>It is expected that students will:</i>	<p><i>The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.</i></p> <p><i>Students who have fully met the prescribed learning outcome are able to:</i></p>
C14 analyse the functional inter-relationships of the structures of the male reproductive system	<ul style="list-style-type: none"> <li><input type="checkbox"/> identify and give functions for each of the following:               <ul style="list-style-type: none"> <li>– testes (seminiferous tubules and interstitial cells)</li> <li>– scrotum</li> <li>– epididymis</li> <li>– ductus (vas) deferens</li> <li>– prostate gland</li> <li>– Cowper’s glands</li> <li>– seminal vesicles</li> <li>– penis</li> <li>– urethra</li> </ul> </li> <li><input type="checkbox"/> describe the path of sperm from the seminiferous tubules to the urethral opening</li> <li><input type="checkbox"/> list the components seminal fluid (as contributed by the Cowper’s glands, prostate gland, and seminal vesicles), and describe the functions of each component</li> <li><input type="checkbox"/> identify the tail (flagellum), midpiece, head, and acrosome of a mature sperm and state their functions</li> <li><input type="checkbox"/> describe the functions of testosterone</li> <li><input type="checkbox"/> describe the homeostatic regulation of testosterone levels by the hypothalamus, anterior pituitary, and testes</li> </ul>
C15 analyse the functional inter-relationships of the structures of the female reproductive system	<ul style="list-style-type: none"> <li><input type="checkbox"/> identify and give functions for each of the following:               <ul style="list-style-type: none"> <li>– ovaries (follicles and corpus luteum)</li> <li>– oviducts (fallopian tubes)</li> <li>– uterus</li> <li>– endometrium</li> <li>– cervix</li> <li>– vagina</li> <li>– clitoris</li> </ul> </li> <li><input type="checkbox"/> describe the functions of estrogen</li> <li><input type="checkbox"/> describe the sequence of events in the ovarian cycle, with reference the follicular phase, ovulation, and the luteal phase</li> <li><input type="checkbox"/> describe the sequence of events in the uterine cycle, with reference to menstruation, the proliferative phase, and the secretory phase</li> <li><input type="checkbox"/> describe the control of the ovarian and uterine cycles by hormones including gonadotropin-releasing hormone (GnRH), follicle-stimulating hormone (FSH), luteinizing hormone (LH), estrogen, and progesterone</li> <li><input type="checkbox"/> describe the hormonal changes that occur as a result of implantation, including               <ul style="list-style-type: none"> <li>– production of human chorionic gonadotropin (HCG) to maintain the corpus luteum</li> <li>– increased production of progesterone by the corpus luteum</li> </ul> </li> <li><input type="checkbox"/> describe a positive feedback mechanism involving oxytocin</li> </ul>



# LEARNING RESOURCES

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*Biology 11 and 12*



This section contains general information on learning resources, and provides a link to the titles, descriptions, and ordering information for the recommended learning resources in the Biology 11 and 12 Grade Collections.

#### *What Are Recommended Learning Resources?*

Recommended learning resources are resources that have undergone a provincial evaluation process using teacher evaluators and have Minister's Order granting them provincial recommended status. These resources may include print, video, software and CD-ROMs, games and manipulatives, and other multimedia formats. They are generally materials suitable for student use, but may also include information aimed primarily at teachers.

Information about the recommended resources is organized in the format of a Grade Collection. A Grade Collection can be regarded as a "starter set" of basic resources to deliver the curriculum. In many cases, the Grade Collection provides a choice of more than one resource to support curriculum organizers, enabling teachers to select resources that best suit different teaching and learning styles. Teachers may also wish to supplement Grade Collection resources with locally approved materials.

#### *How Can Teachers Choose Learning Resources to Meet Their Classroom Needs?*

Teachers must use either:

- provincially recommended resources OR
- resources that have been evaluated through a local, board-approved process

Prior to selecting and purchasing new learning resources, an inventory of resources that are already available should be established through consultation with the school and district resource centres. The ministry also works with school districts to negotiate cost-effective access to various learning resources.

#### *What Are the Criteria Used to Evaluate Learning Resources?*

The Ministry of Education facilitates the evaluation of learning resources that support BC curricula,

and that will be used by teachers and/or students for instructional and assessment purposes. Evaluation criteria focus on content, instructional design, technical considerations, and social considerations.

Additional information concerning the review and selection of learning resources is available from the ministry publication, *Evaluating, Selecting and Managing Learning Resources: A Guide* (Revised 2002)  
[www.bced.gov.bc.ca/irp/resdocs/esm\\_guide.pdf](http://www.bced.gov.bc.ca/irp/resdocs/esm_guide.pdf)

#### *What Funding is Available for Purchasing Learning Resources?*

As part of the selection process, teachers should be aware of school and district funding policies and procedures to determine how much money is available for their needs. Funding for various purposes, including the purchase of learning resources, is provided to school districts. Learning resource selection should be viewed as an ongoing process that requires a determination of needs, as well as long-term planning to co-ordinate individual goals and local priorities.

#### *What Kinds of Resources Are Found in a Grade Collection?*

The Grade Collection charts list the recommended learning resources by media format, showing links to the curriculum organizers and suborganizers. Each chart is followed by an annotated bibliography. Teachers should check with suppliers for complete and up-to-date ordering information. Most suppliers maintain web sites that are easy to access.

### **BIOLOGY 11 AND 12 GRADE COLLECTIONS**

The Grade Collections for Biology 11 and 12 list the recommended learning resources for these courses. Resources previously recommended for the 1996 version of the curriculum, where still valid, continue to support this updated IRP. The ministry updates the Grade Collections on a regular basis as new resources are developed and evaluated.

Please check the following ministry web site for the most current list of recommended learning resources in the Biology 11 and 12 Grade Collections: [www.bced.gov.bc.ca/irp\\_resources/lr/resource/gradcoll.htm](http://www.bced.gov.bc.ca/irp_resources/lr/resource/gradcoll.htm)

