Biotechnology – Advanced Program Standard

The approved program standard for Biotechnology – Advanced program of instruction leading to an Ontario College Advanced Diploma delivered by Ontario Colleges of Applied Arts and Technology. (MTCU funding code 61304)

Ministry of Training, Colleges and Universities
February 2012

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Inquiries regarding specific Biotechnology – Advanced programs offered by colleges of applied arts and technology in Ontario should be directed to the relevant college.

ISBN 978-1-4435-8322-0 (PDF)

Ce document est disponible en français.

Acknowledgements

The Ministry of Training, Colleges and Universities acknowledges with thanks the significant contribution of the many individuals and organizations who participated in the development of this program standard. In particular, the Ministry of Training, Colleges and Universities would like to acknowledge the important roles of

- all individuals and organizations who participated in the consultations;

- the co-ordinators of Biotechnology - Advanced Programs for their assistance throughout the project and the project officers who led the development of the vocational standard - Paul Johnson, seconded faculty member from Confederation College and Louise Campagna from La Cité collégiale.

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I. Introduction

This document is the Program Standard for the Biotechnology – Advanced program of instruction leading to an Ontario College Advanced Diploma delivered by Ontario colleges of applied arts and technology (MTCU funding code 61304).

Development of System-Wide Program Standards

In 1993, the Government of Ontario initiated program standards development with the objectives of bringing a greater degree of consistency to college programming offered across the province, broadening the focus of college programs to ensure graduates have the skills to be flexible and to continue to learn and adapt, and providing public accountability for the quality and relevance of college programs.

The Program Standards and Evaluation Unit of the Ministry of Training, Colleges and Universities have responsibility for the development, review and approval of system-wide standards for programs of instruction at Ontario colleges of applied arts and technology.

Program Standards

Program standards apply to all similar programs of instruction offered by colleges across the province. Each program standard for a postsecondary program includes the following elements:

- **Vocational standard** (the vocationally specific learning outcomes which apply to the program of instruction in question),
- **Essential employability skills** (the essential employability skills learning outcomes which apply to all programs of instruction); and
- **General education requirement** (the requirement for general education in postsecondary programs of instruction).

Collectively, these elements outline the essential skills and knowledge that a student must reliably demonstrate in order to graduate from the program.

Individual colleges of applied arts and technology offering the program of instruction determine the specific program structure, delivery methods and other curriculum matters to be used in assisting students to achieve the outcomes articulated in the standard. Individual colleges also determine whether additional local learning outcomes will be required to reflect specific local needs and/or interests.

The Expression of Program Standards as Vocational Learning Outcomes

Vocational learning outcomes represent culminating demonstrations of learning and achievement. They are not simply a listing of discrete skills, nor broad statements of knowledge and comprehension. In addition, vocational learning outcomes are interrelated and cannot be viewed in isolation of one another. As such, they should be viewed as a comprehensive whole. They describe performances that demonstrate that significant integrated learning by graduates of the program has been achieved and verified.

Expressing standards as vocational learning outcomes ensures consistency in the outcomes for program graduates, while leaving to the discretion of individual colleges curriculum matters such as the specific program structure and delivery methods.

The Presentation of the Vocational Learning Outcomes

The **vocational learning outcome** statements set out the culminating demonstration of learning and achievement that the student must reliably demonstrate before graduation.

The **elements of the performance** for each outcome define and clarify the level and quality of performance necessary to meet the requirements of the vocational learning outcome. However, it is the performance of the vocational learning outcome itself on which students are evaluated. The elements of performance are indicators of the means by which the student may proceed to satisfactory performance of the vocational learning outcome. The elements of performance do not stand alone but rather in reference to the vocational learning outcome of which they form a part.

The Development of a Program Standard

In establishing the standards development initiative, the Government determined that all postsecondary programs of instruction should include vocational skills coupled with a broader set of essential skills. This combination is considered critical to ensuring that college graduates have the skills required to be successful both upon graduation from the college program and throughout their working and personal lives.

A program standard is developed through a broad consultation process involving a range of stakeholders with a direct interest in the program area, including employers, professional associations, universities, secondary schools and program graduates working in the field, in addition to students, faculty and administrators at the colleges themselves. It represents a consensus of participating stakeholders on the essential learning that all program graduates should have achieved.

Updating the Program Standard

The Ministry of Training, Colleges and Universities will undertake regular reviews of the vocational learning outcomes for this program to ensure that the Biotechnology – Advanced Program Standard remains appropriate and relevant to the needs of students and employers across the Province of Ontario. To confirm that this document is the most up-to-date release, please contact the Ministry of Training, Colleges and Universities at the address or telephone number noted on the inside cover page.

II. Vocational Standard

All graduates of the Biotechnology – Advanced program of instruction must have achieved the eleven vocational learning outcomes listed in the following pages, in addition to achieving the essential employability skills learning outcomes and meeting the general education requirement.

Preamble

Biotechnology encompasses several science disciplines, including cell biology, chemistry, physics, microbiology, molecular biology, genetics, genomics, proteomics, biochemistry and bioinformatics*. The interdisciplinary* nature of biotechnology has contributed to an expanding number of biotechnological applications ranging from, for example, the development and production of safe, commercially viable goods and services; to applications in agriculture and food production; medical healthcare; bioremediation; diagnostics and forensics; and academic and commercial research. To meet the demands of this high-growth career field, graduates of Biotechnology – Advanced programs are prepared to engage in an extensive range of activities related to research, laboratory techniques, quality assurance and quality control, as well as new biotechnology product development and commercialization. Graduates of Biotechnology – Advanced programs have employment opportunities in diverse bio-based sectors, such as medical healthcare and pharmaceutical medicines and vaccines; DNA forensics; agriculture and nutrition; food and beverage bioprocesses; environmental protection and bioremediation; and household and industrial product development and manufacturing.

Because employers are interested in employees with a broad base of skills, graduates of these programs may wish to pursue further education. Through articulation agreements between the colleges, universities and professional organizations, graduates may be granted credits toward relevant degrees or certification. Students should contact their individual colleges for further details on a college's articulation agreements with other institutions or professional associations.

In Canada, the national and provincial associations of professionals working in this field have also created, published and endorsed educational standards that define an entry level requirement for graduates who wish to enter this profession. The program standard that follows is based on those detailed requirements as well as input from appropriate stakeholders in a broad-based consultative process.

** See glossary*

Synopsis of the Vocational Learning Outcomes
Biotechnology – Advanced (Ontario College Advanced Diploma)

The graduate has reliably demonstrated the ability to

1. **perform laboratory duties independently and in compliance with pertinent legislation and regulations, as well as biotechnology standards and guidelines.**

2. **collaborate in implementing and evaluating quality control and quality assurance procedures to meet organizational standards and requirements.**

3. **select and implement best practices for sustainability*.**

4. **complete complex biotechnological applications using advanced principles of chemistry, biology and biostatistics as well as basic principles of physics.**

5. **co-ordinate, implement and validate laboratory procedures to carry out quantitative and qualitative tests and analyses.**

6. **co-ordinate, implement and validate standard cell culture procedures under aseptic conditions.**

7. **co-ordinate, implement and validate molecular biology procedures.**

8. **manage biological data to support biological scientists and researchers in capturing, organizing/summarizing and storing their data.**

9. **prepare, analyze, interpret, maintain and communicate scientific data effectively.**

10. **develop and present a strategic plan for ongoing personal and professional development to enhance work performance.**

11. **apply basic business principles to biotechnology practices.**

Note: The learning outcomes have been numbered as a point of reference; numbering does not imply prioritization, sequencing, nor weighting of significance.

The Vocational Learning Outcomes

1. *The graduate has reliably demonstrated the ability to*

perform laboratory duties independently and in compliance with pertinent legislation and regulations, as well as biotechnology standards and guidelines.

Elements of the Performance

- Monitor ongoing compliance with Good Laboratory Practice (GLP)* in accordance with accepted principles of quality assurance
- Monitor ongoing compliance with Good Manufacturing Practice (GMP)* in accordance with accepted principles of quality management of fabricated/manufactured drug and medicinal products
- Monitor ongoing compliance with Good Clinical Practice (GCP)* to support clinical trials that involve human subjects
- Follow applicable internationally recognized standards, such as ISO regulations systems (e.g., International Organization for Standardization [ISO] series systems—ISO/IEC 17025, ASTM International biotechnology standards or other pertinent biotechnology standards)
- Monitor ongoing adherence to the Ontario *Occupational Health and Safety Act,1990* and its regulations
- Follow the ethical conduct of research involving humans as expressed in the current *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans* (TCPS)
- Follow the biosafety and biocontainment principles and practices outlined in Health Canada's Laboratory Biosafety Guidelines
- Monitor ongoing adherence to pertinent Sections of the *Human Pathogens and Toxins Act, 2009* and its regulations
- Monitor ongoing adherence to pertinent Canadian agricultural biotechnology regulations* including those that are the responsibility of the Canadian Food Inspection Agency, Health Canada and Environment Canada
- Adhere to pertinent Sections of the *Patent Act, 1985* and its regulations
- Protect employee's and employers' intellectual property rights, for example, by following relevant guidelines outlined in the Manual of Patent Office Practice (MOPOP) (i.e., Chapter 17 Biotechnology), Industry Canada's Intellectual Property Policy and current organizational practices, agreements and covenants

2. *The graduate has reliably demonstrated the ability to*

collaborate in implementing and evaluating quality control and quality assurance procedures to meet organizational standards and requirements.

Elements of the Performance

- Promote production efficiency and effectiveness by implementing quality control systems (e.g., Organization for Economic Co-operation and Development [OECD] Quality Assurance and GLP*; International Organization for Standardization [ISO] series systems—ISO 9000 series; Hazard Analysis at Critical Control Points; Lean Six Sigma; and/or continuous improvement [kaizen] efforts)
- Ensure biological materials and products or services match their intended purposes, including workplace and/or customer expectations
- Plan and co-ordinate quality assurance inspections, sampling, testing or audits to verify that biological materials and products are manufactured according to required specifications
- Evaluate the results of quality assurance sampling and testing to make appropriate improvements to biotechnology production processes
- Select, calibrate* and use appropriate measuring instruments to inspect biological materials and products
- Apply approved quality control standards and procedures to uncover and evaluate anomalies, identify root causes of quality problems, as well as recommend and/or carry out the needed corrective measures
- Prepare and analyze reports on quality assurance and quality control data for statistical process control and planning purposes
- Monitor compliance with current quality assurance procedures and required specifications
- Prepare, manage and maintain current, clear and accurate standard operating procedures and other process documents, project-related documents and progress reports in accordance with current organizational practices
- Source equipment, materials, supplies and services related to the production of biotechnology products

3. *The graduate has reliably demonstrated the ability to*

select and implement best practices for sustainability*.

Elements of the Performance

- Act in accordance with bioethical standards
- Promote the responsible and ethical testing of new technologies
- Engage in the socially responsible use of biotechnology in fields such as health care, food and agriculture, industry and the environment
- Comply with environmental management systems (e.g., International Organization for Standardization [ISO] series systems—ISO 14000 series)
- Research, plan and implement best practices in workplaces, such as lean and green sustainability* practices and procedures
- Determine the interrelationships among science, society, the environment, politics, the economy and biotechnology projects
- Comply with and promote policies that foster technical, functional, environmental, ecological, sociocultural and socioeconomic improvements
- Adopt and promote methods for sustainability* when selecting and using materials (e.g., renewable, recyclable or recycled materials)

4. *The graduate has reliably demonstrated the ability to*

complete complex biotechnological applications using advanced principles of chemistry, biology and biostatistics as well as basic principles of physics.

Elements of the Performance

- Analyze and solve complex biotechnical problems applying general and advanced concepts of organic, inorganic, analytical and physical chemistry
- Analyze and solve complex biotechnical problems applying advanced concepts of physiology, cell biology, microbiology, genetics, biochemistry and molecular biology
- Analyze and solve complex biotechnical problems applying basic concepts of physics, in optics, electromagnetic radiation, fluid mechanics and thermodynamics
- Use the scientific method to design, execute and evaluate scientific experiments
- Collect and organize experimental data, summarize and analyze results, and interpret findings to make valid and reliable conclusions and predictions

5. *The graduate has reliably demonstrated the ability to*

co-ordinate, implement and validate laboratory procedures to carry out quantitative and qualitative tests and analyses.

Elements of the Performance

- Monitor maintenance protocols to facilitate proper upkeep and functioning of laboratory instruments and equipment
- Organize and monitor the proper use of laboratory equipment such as pH meters, centrifuges, spectrophotometers, chromatographic systems, electrophoresis apparatus, compound microscope and incubators
- Co-ordinate scheduling and optimal use of laboratory operations
- Prepare chemical solutions, calculate required mass or volume based on the required concentration, using established protocols, and determine a solution' concentration
- Perform bioassay methods in enzymology, immunology, microbiology and molecular biology
- Purify macromolecules using current and established procedures
- Analyze and evaluate samples and test materials using a variety of microscopic methods
- Contribute to the planning, implementation and evaluation of laboratory projects using current and emerging biotechnologies*
- Investigate, assess and acquire and/or update computer skills applicable to current and emerging biotechnologies*

6. *The graduate has reliably demonstrated the ability to*

co-ordinate, implement and validate standard cell culture procedures under aseptic conditions.

Elements of the Performance

- Promote and use standardized aseptic technique practices and procedures to minimize the risk of pathogenic contamination in a laboratory environment
- Collaborate to plan, perform, monitor and evaluate cell manipulations via genetic and epigenetic alterations
- Prepare, monitor, maintain and preserve plant, animal, microbial cultures and/or viral cultures
- Monitor and verify appropriate preparation and disposal of culture media and bioactive materials
- Implement batch fermentations and continuous fermentations using processes such as the preparation of fermentation media, sterilization procedures and inoculum development
- Identify and categorize cell cultures using appropriate microscopic, biochemical, culture, microbial culture, and molecular and immunological techniques

7. *The graduate has reliably demonstrated the ability to*

co-ordinate, implement and validate molecular biology procedures.

Elements of the Performance

- Co-ordinate, perform and monitor DNA/RNA and protein extraction and purification from biological samples
- Isolate, analyze and manipulate DNA using procedures, such as cloning/subcloning, sequencing and amplification by Polymerase Chain Reaction (PCR)
- Separate DNA/RNA and proteins using chromatographic and electrophoretic techniques
- Quantify DNA/RNA and proteins using spectrophotometric techniques
- Co-ordinate and perform routine procedures in accordance with current practices in genomics and proteomics
- Select and use bioinformatics* tools including DNA and protein sequence analysis software

8. *The graduate has reliably demonstrated the ability to*

manage biological data to support biological scientists and researchers in capturing, organizing/summarizing and storing their data.

Elements of the Performance

- Make decisions based on the interdisciplinary* nature of bioinformatics*
- Use effective techniques to manage common biological data types and formats
- Use effective ways to deal with the data management challenges associated with the rapid rate in the growth of biological data
- Access and extract data from private database and public Internet-accessible database sources
- Use standard methods for searching, retrieving and storing biological datasets
- Analyze and integrate data from a variety of biological databases such as DNA, RNA and protein sequence databases, protein structure databases, species-specific databases, biological matter (e.g., bacterial strains, vectors, etc.) and reference gel images
- Control for statistical errors that can confound the interpretation of biological data
- Use effective protocols for archiving biological datasets
- Extract, transform and integrate biological data from multiple data sources using information technologies and methodologies

9. *The graduate has reliably demonstrated the ability to*

prepare, analyze, interpret, maintain and communicate scientific data effectively.

Elements of the Performance

- Conduct comprehensive literature searches and critically evaluate scientific information
- Produce technical and scientific interactive multimodal documents, reports and presentations
- Manage, manipulate and display scientific data using software such as spreadsheet, database or statistical software
- Use biostatistics to analyze, interpret, report and present scientific data
- Collaborate to interpret scientific research results
- Summarize, document and present lab experiments in written reports
- Produce and maintain accurate biostatistical records
- Present scientific research results clearly and concisely using oral, written, graphic and electronic formats
- Promote public awareness of the practical applications of biotechnology

10. *The graduate has reliably demonstrated the ability to*

develop and present a strategic plan for ongoing personal and professional development to enhance work performance.

Elements of the Performance

- Seek out and act upon constructive feedback to enhance work performance
- Develop a plan to keep pace with, and adapt to, changing workforce demands and trends, as well as technological and scientific advances in the biotechnology field
- Apply problem-solving techniques for specific knowledge acquisition and skill development
- Take responsibility for one's job related performance, as an individual and as a member of a team
- Identify training courses, workshops and programs to enhance employment opportunities in the biotechnology field
- Engage in activities that include critical thinking and self-evaluation to promote professionalism
- Develop a plan that includes learning strategies and activities to improve one's skill level and to expand one's skill base
- Develop a plan for developing a professional network and for participating in biotechnology-based professional associations and activities
- Use effective time management and organizational techniques to accomplish personal and professional goals
- Develop and maintain a portfolio of one's accomplishments in the biotechnology field
- Identify the roles and benefits of professional organizations and certification (e.g., the Ontario Association of Certified Engineering Technicians and Technologists (OACETT), Technology Accreditations Canada (TAC) and Technology Professionals Canada (TPC))
- Prepare and present up-to-date employment applications, résumés and portfolios

11. *The graduate has reliably demonstrated the ability to*

apply basic business principles to biotechnology practices.

Elements of the Performance

- Determine the breadth and scope of the commercial, corporate and public applications of biotechnology
- Identify entrepreneurship and intrapreneurship* opportunities within the biotechnology field
- Collaborate in developing new biotechnology product strategies and processes
- Collaborate in developing a basic business plan
- Manage project records and files in an organized and efficient manner
- Apply cost-benefit analysis concepts to ensure an efficient use of resources
- Develop effective leadership and supervision strategies
- Be self-directed and show initiative

Glossary

Bioinformatics – Bioinformatics involves the analysis and interpretation of various types of data, including nucleotide and amino acid sequences, protein domains and protein structures. It integrates knowledge from many different fields to advance the development of innovative solutions to scientific problems. A primary goal of bioinformatics is to increase the understanding of biological processes using computationally intensive techniques, e.g., pattern recognition, data mining, machine learning algorithms and visualization.

Calibrate – To check and adjust the accuracy of the measurement, reading or output of a measuring instrument against an accurate standard.

Canadian Agricultural Biotechnology Regulations – Collectively, Health Canada and the Canadian Food Inspection Agency are responsible for regulating products derived from biotechnology through enforcement of regulations, such as Food and Drug Regulations (Novel Foods Regulation), Medical Devices Regulations, Cosmetics Regulations, Pest Control Products Regulations, Containment Standards for facilities Handling Plant Pests, Fertilizers Regulations, Feeds Regulations, Health of Animals Regulations, Plant Protection Regulations, Seeds Regulations, New Substances Notification Regulations (Organisms), and New Substances Notification Regulations.

Emerging Biotechnologies – Biotechnologies that are not yet standard but which will probably be adopted in the near term. The expectation is that an emerging biotechnology will come into standard usage when the application of the technology matures.

Good Clinical Practice (GCP) – Good Clinical Practice (GCP) is an international ethical and scientific quality standard for designing, conducting, recording and reporting trials that involve the participation of human subjects. Compliance with this standard provides public assurance that the rights, safety and well-being of trial subjects are protected, consistent with the principles that have their origin in the Declaration of Helsinki, and that the clinical trial data are credible. (Health Canada, 2004)

Health Canada has adopted, and endorses, the principles and practice guidelines of the International Conference on Harmonization of Technical Requirements for the Registration of Pharmaceuticals for Human Use-Good Clinical Practice (ICH-GCP).

Good Laboratory Practice (GLP) – Good Laboratory Practice (GLP) is a quality system concerned with the organisational process and the conditions under which non-clinical health and environmental safety studies are planned, performed, monitored, recorded, archived and reported (Organization for Economic Co-operation and Development [OECD], 1998).

In Canada, the Standards Council of Canada (SCC) is responsible for accrediting and recognizing the competence and reliability of laboratory facilities in accordance with the Organization for Economic Co-operation and Development (OECD) Principles of Good Laboratory Practice (GLP).

Good Manufacturing Practices (GMP) – Good Manufacturing Practice (GMP) is a system governing consistency, quality control and risk management over the testing, manufacturing, processing, packaging, labelling, storing and distributing of medicinal products and devices, foods and biologics so that they comply with applicable requirements, specifications and regulations.

For instance, in Canada, Good Manufacturing Practices (GMP) are the part of quality assurance that ensures that drugs are consistently produced and controlled in such a way to meet the quality standards appropriate to their intended use, as required by the marketing authorization...[a] legal document issued by Health Canada, authorizing the sale of a drug or a device based on the health and safety requirements of the Food and Drug Act and its associated Regulations. (Health Canada, 2010, 2009)

Interdisciplinary – Interdisciplinary refers to the interaction among two or more different disciplines and occurs at the interface between disciplines. This may range from the sharing of ideas to the full integration of concepts, methodology, procedures, theory, terminology, data, organization of research and training (Natural Sciences and Engineering Research Council of Canada, 2009).

Intrapreneurship – Intrapreneurship is the process by which an employee, operating in an organizational environment, helps make organizations more profitable by developing innovative marketable products and services.

Sustainability – Sustainability encompasses the ethical ideal that calls for optimizing the long-term carrying capacity and vitality of three interdependent systems—environmental, social and economic. In a biotechnology context, sustainability aims to save and improve the quality of human life, improve the quality and abundance of food while protecting nature, by engaging in biotechnology processes that are safe and humane, conserve biological diversity and protect ecosystems; benefit employees, consumers and communities; and strengthen enterprises that foster economic growth and prosperity.

III. Essential Employability Skills

All graduates of the Biotechnology – Advanced program of instruction must have reliably demonstrated the essential employability skills learning outcomes listed on the following pages, in addition to achieving the vocational learning outcomes and meeting the general education requirement.

Context

Essential Employability Skills (EES) are skills that, regardless of a student's program or discipline, are critical for success in the workplace, in day-to-day living and for lifelong learning.

The teaching and attainment of these EES for students in, and graduates from, Ontario's colleges of applied arts and technology are anchored in a set of three fundamental assumptions:

- these skills are important for every adult to function successfully in society today;
- our colleges are well equipped and well positioned to prepare graduates with these skills;
- these skills are equally valuable for all graduates, regardless of the level of their credential, whether they pursue a career path, or they pursue further education.

Skill Categories

To capture these skills, the following six categories define the essential areas where graduates must demonstrate skills and knowledge.

- Communication
- Numeracy
- Critical Thinking & Problem Solving
- Information Management
- Interpersonal
- Personal

Application and Implementation

In each of the six skill categories, there are a number of defining skills, or sub skills, identified to further articulate the requisite skills identified in the main skill categories. The following chart illustrates the relationship between the skill categories, the defining skills within the categories and learning outcomes to be achieved by graduates from all postsecondary programs of instruction that lead to an Ontario College credential.

EES may be embedded in General Education or vocational courses, or developed through discrete courses. However these skills are developed, all graduates with Ontario College credentials must be able to reliably demonstrate the essential skills required in each of the six categories.

SKILL CATEGORY	**DEFINING SKILLS: Skill areas to be demonstrated by graduates:**	**LEARNING OUTCOMES: The levels of achievement required by graduates. The graduate has reliably demonstrated the ability to:**
COMMUNICATION	• Reading • Writing • Speaking • Listening • Presenting • Visual literacy	1. *communicate clearly, concisely and correctly in the written, spoken and visual form that fulfills the purpose and meets the needs of the audience.* 2. *respond to written, spoken or visual messages in a manner that ensures effective communication.*
NUMERACY	• Understanding and applying mathematical concepts and reasoning • Analyzing and using numerical data • Conceptualizing	3. *execute mathematical operations accurately.*
CRITICAL THINKING & PROBLEM SOLVING	• Analyzing • Synthesizing • Evaluating • Decision making • Creative and innovative thinking	4. *apply a systematic approach to solve problems.* 5. *use a variety of thinking skills to anticipate and solve problems.*

SKILL CATEGORY	DEFINING SKILLS: Skill areas to be demonstrated by graduates:	LEARNING OUTCOMES: The levels of achievement required by graduates. The graduate has reliably demonstrated the ability to:
INFORMATION MANAGEMENT	• Gathering and managing information • Selecting and using appropriate tools and technology for a task or a project • Computer literacy • Internet skills	6. *locate, select, organize and document information using appropriate technology and information systems.* 7. *analyze, evaluate and apply relevant information from a variety of sources.*
INTERPERSONAL	• Teamwork • Relationship management • Conflict resolution • Leadership • Networking	8. *show respect for the diverse opinions, values, belief systems and contributions of others.* 9. *interact with others in groups or teams in ways that contribute to effective working relationships and the achievement of goals.*
PERSONAL	• Managing self • Managing change and being flexible and adaptable • Engaging in reflective practices • Demonstrating personal responsibility	10. *manage the use of time and other resources to complete projects.* 11. *take responsibility for one's own actions, decisions and their consequences.*

IV. General Education Requirement

All graduates of the Biotechnology – Advanced program must have met the general education requirement described on the following pages, in addition to achieving the vocational and essential employability skills learning outcomes.

Requirement

The General Education Requirement for programs of instruction is stipulated in the Credentials Framework (Appendix A in the Minister's Binding Policy Directive *Framework for Programs of Instruction*).

In programs of instruction leading to either an Ontario College Diploma or an Ontario College Advanced Diploma, it is required that graduates have been engaged in learning that exposes them to at least one discipline outside their main field of study and increases their awareness of the society and culture in which they live and work. This will typically be accomplished by students taking 3 to 5 courses (or the equivalent) designed discretely and separately from vocational learning opportunities.

This general education learning would normally be delivered using a combination of required and elective processes.

Purpose

The purpose of General Education in the Ontario college system is to contribute to the development of citizens who are conscious of the diversity, complexity and richness of the human experience; who are able to establish meaning through this consciousness; and who, as a result, are able to contribute thoughtfully, creatively and positively to the society in which they live and work.

General Education strengthens students' essential employability skills, such as critical analysis, problem solving and communication, in the context of an exploration of topics with broad-based personal and/or societal importance.

Themes

The themes listed below will be used to provide direction to colleges in the development and identification of courses that are designed to fulfill the General Education Requirement for programs of instructions.

Each theme provides a statement of Rationale and offers suggestions related to more specific topic areas that could be explored within each area. These suggestions are neither prescriptive nor exhaustive. They are included to provide guidance regarding the nature and scope of content that would be judged as meeting the intent and overall goals of General Education.

1. Arts in Society:

Rationale:
The capacity of a person to recognize and evaluate artistic and creative achievements is useful in many aspects of his/her life. Since artistic expression is a fundamentally human activity, which both reflects and anticipates developments in the larger culture, its study will enhance the student's cultural and self-awareness.

Content:
Courses in this area should provide students with an understanding of the importance of visual and creative arts in human affairs, of the artist's and writer's perceptions of the world and the means by which those perceptions are translated into the language of literature and artistic expression. They will also provide an appreciation of the aesthetic values used in examining works of art and possibly, a direct experience in expressing perceptions in an artistic medium.

2. Civic Life:

Rationale:
In order for individuals to live responsibly and to reach their potential as individuals and as citizens of society, they need to understand the patterns of human relationships that underlie the orderly interactions of a society's various structural units. Informed people will have knowledge of the meaning of civic life in relation to diverse communities at the local, national and global level and an awareness of international issues and the effects of these on Canada, as well as Canada's place in the international community.

Content:
Courses in this area should provide students with an understanding of the meaning of freedoms, rights and participation in community and public life, in addition to a working knowledge of the structure and function of various levels of government (municipal, provincial, national) in a Canadian and/or in an international context. They may also provide an historical understanding of major political issues affecting relations between the various levels of government in Canada and their constituents.

3. Social and Cultural Understanding:

Rationale:
Knowledge of the patterns and precedents of the past provide the means for a person to gain an awareness of his or her place in contemporary culture and society. In addition to this awareness, students will acquire a sense of the main currents of their culture and that of other cultures over an extended period of time in order to link personal history to the broader study of culture.

Content:
Courses in this area are those that deal broadly with major social and cultural themes. These courses may also stress the nature and validity of historical evidence and the variety of historical interpretation of events. Courses will provide the students with a view and understanding of the impact of cultural, social, ethnic or linguistic characteristics.

4. Personal Understanding:

Rationale:
Educated people are equipped for life-long understanding and development of themselves as integrated physiological and psychological entities. They are aware of the ideal need to be fully functioning persons: mentally, physically, emotionally, socially, spiritually and vocationally.

Content:
Courses in this area will focus on understanding the individual: his or her evolution; situation; relationship with others; place in the environment and universe; achievements and problems; and his or her meaning and purpose. They will also allow students the opportunity to study institutionalized human social behaviour in a systematic way. Courses fulfilling this requirement may be oriented to the study of the individual within a variety of contexts.

5. Science and Technology:

Rationale:
Matter and energy are universal concepts in science, forming a basis for understanding the interactions that occur in living and non-living systems in our universe. Study in this area provides an understanding of the behaviour of matter that provides a foundation for further scientific study and the creation of broader understanding about natural phenomena

Similarly, the various applications and developments in the area of technology have an increasing impact on all aspects of human endeavour and have numerous social, economic and philosophical implications. For example, the operation of computers to process data at high speed has invoked an interaction between machines and the human mind that is unique in human history. This and other technological developments have a powerful impact on how we deal with many of the complex questions in our society.

Content:
Courses in this area should stress scientific inquiry and deal with basic or fundamental questions of science rather than applied ones. They may be formulated from traditional basic courses in such areas of study as biology, chemistry, physics, astronomy, geology or agriculture. As well, courses related to understanding the role and functions of computers (e.g., data management and information processing) and assorted computer-related technologies should be offered in a non-applied manner to provide students with an opportunity to explore the impact of these concepts and practices on their lives.