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ABSTRACT

This document, which lists the biotechnology competencies identified by representatives from biotechnology businesses and industries as well as secondary and post-secondary educators throughout Ohio, is intended to assist individuals and organizations in developing college tech prep programs that will prepare students from secondary through post-secondary associate degree programs for employment as technicians in the biomedical, environmental, pharmaceutical, and other biotechnology related industries, such as bioinformatics. The technical competencies are listed in the following categories: demonstrate scientific method; conducting experiments; laboratory safety and maintenance; instrument analysis; chemical materials handling and sampling; physical properties measurement; biohazard storage, handling, and disposal; basic microbiology; biochemical technology; molecular biology technology; cell culturing; protein bioseparation methods; fermentation technology; microbiology for biotechnology; bioethics; water and wastewater treatment operations; environmental science; environmental assessments; introduction to industry; technical writing and documentation; computer applications for biotechnology; and a bioinformatics strand for database administration, data warehousing, and statistics. The competencies, which are separated into essential competencies needed to ensure a minimal level of employability and recommended competencies, are organized by instructional units and include suggestions as to when students should be introduced to and proficient at them. Appendices include a list of technical competency profile (TCP) panel members and a pathway template. (MO)

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OHIO BIOTECHNOLOGY COMPETENCY PROFILE

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INTRODUCTION

The Ohio Biotechnology Technical Competency Profile was developed under the auspices of the Ohio Board of Regents and the Ohio Department of Education. It provides a framework for a broad-based educational response to Ohio's need for a skilled biotechnology workforce.

The profile includes a comprehensive set of competencies that are grounded in core academic subject areas and focuses on occupations for technicians in the biomedical, environmental, pharmaceutical, and other biotechnology related industries, such as bioinformatics. Generated using the Ohio Tech Prep model for curriculum development, the profile reflects the job opportunities and skills required for Ohio's biotechnology workers. With the future of health care, agriculture and industrial processes gravitating toward biotechnology, industries position biotechnology as the catalyst for their economies.

Four Tech Prep Consortia were selected to pilot the biotechnology curriculum by partnering with secondary, postsecondary and businesses. Pilot sites represented diversity in being urban, rural, and suburban populations. Participating Tech Prep consortia were located at Sinclair Community College in Dayton, Lakeland Community College in Kirtland, Kent State University/Trumbull Campus in Warren, and Cuyahoga Community College in Cleveland. Representatives from biotechnology businesses and industries played a critical role in assisting Ohio Tech Prep define the vision and scope for the curriculum and by identifying the essential and recommended skills for current and future biotechnology professionals. Secondary and post-secondary educators representing schools and colleges in the four consortia identified when in the educational process and to what depth those skills identified by business should be addressed. The curriculum will be updated and/or expanded after the initial year of piloting.

The Biotechnology Technical Competency Profile will be used as the basis for development of an integrated delivery system that provides opportunities for new and challenging programs and courses in Ohio's secondary schools, colleges, and universities. Career-Technical Education, Tech Prep, and adult education will be enhanced and expanded through the use of the biotechnology curriculum.

This profile is available on the Internet at: www.ohtpcs.org. At this location, users can download copies of the entire profile, or by units or conduct searches on a number of key variables. For additional information contact:

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COLLEGE TECH PREP

College Tech Prep is a high school and college career path linked to business, industry, and labor that insures a specified seamless pathway from high school to college to careers, meeting Ohio's technological employment needs.

A College Tech Prep student is enrolled in a state approved Tech Prep education program. A College Tech Prep Program means a program of study that:

- Combines, at a minimum, two years of secondary education (as determined by Ohio definitions) with a minimum of two years of post-secondary education in a non-duplicative, sequential course of study.
- Integrates academic and technical instruction and utilizes work-based and work-site learning, where appropriate and available.
- Provides technical preparation in a career field such as engineering technology; applied science; mechanical, industrial or practical art or trade; agriculture; health occupations; business; or applied economics.
- Builds student competencies in mathematics, science, reading, writing, communications, economics, and workplace skills through applied, contextual academics and integrated instruction, in a coherent sequence of courses.
- Leads to an associate or baccalaureate degree, or a BAT (Bureau of Apprenticeship Training) apprenticeship requiring a minimum of two years in a specific career field.
- Leads to placement in appropriate employment or to further education.

KEY TO PROFILE CODES

IMPORTANCE OF COMPETENCIES

All of the competencies in this document represent the minimum requirements for a College Tech Prep engineering technologies program. It is the responsibility of the local consortia to further define and/or expand the key indicators for each competency, as needed. Each competency will be taught at either the introductory or proficiency level by the completion of the Tech Prep program, which is the minimum of an Associate Degree.

The intent of this document is to integrate high academics with skill acquisition. Technical skills are a required component. However, the degree of skill acquisition may vary based on the educational setting.

I = Introduce (Learner will demonstrate knowledge and comprehension of the competency.)

P = Proficient (Learner will demonstrate ability to apply knowledge of and/or perform the competency.)

R = Recommend (The unit or competency is only recommended at this time.)

Grade Level: 12 = by the end of grade 12
AD = by the end of the Associate Degree

All essential competencies have been assigned a **P (Proficient)** by end of the Associate Degree. [There may be instances where both **Introduce** and **Proficient** are at either the 12th grade or the Associate Degree.]

ACADEMIC CONNECTION (AC)

All Tech Prep programs are responsible for meeting the academic content standards that are referenced in the appendix of this document.

Example:

BIL: Essential

EDU:	12	AD
	I	P

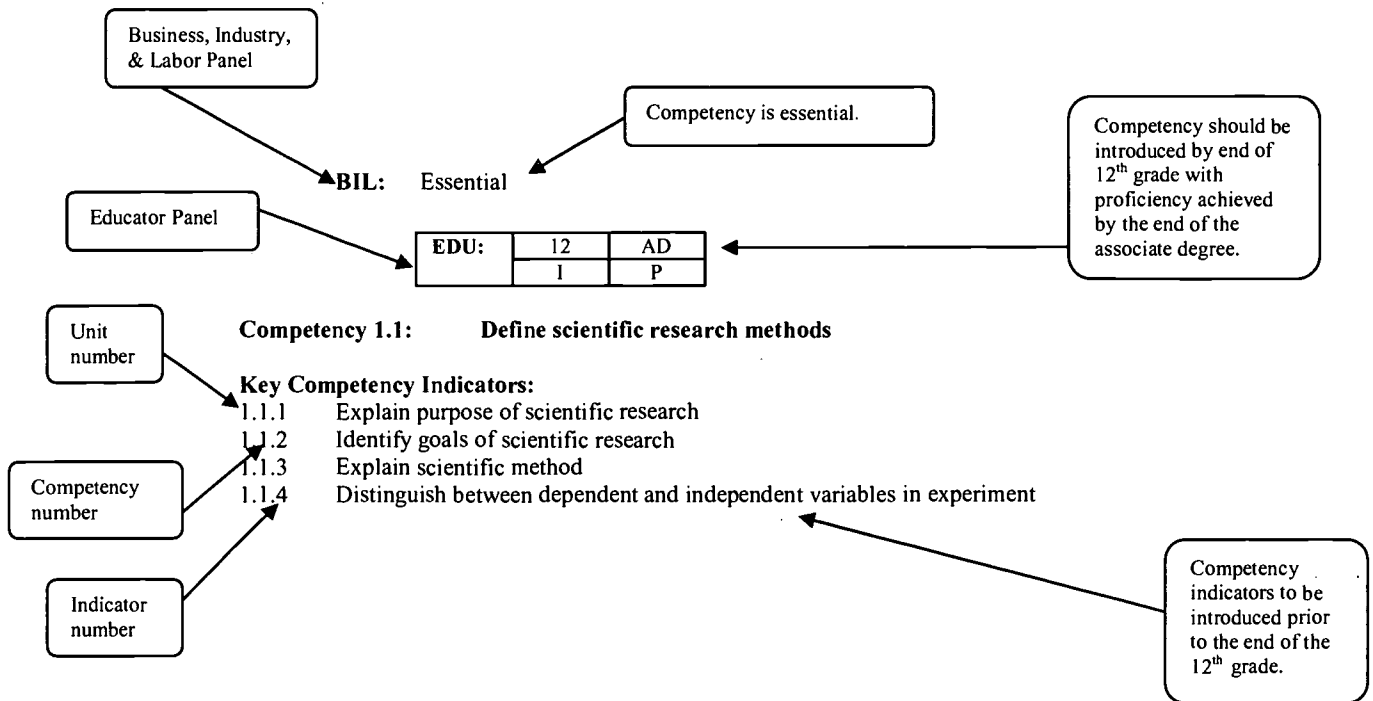
Competency 1.1: Analyze

Key Competency Indicators:

Explain

Identify

EXAMPLE:



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OHIO BIOTECHNOLOGY GENERAL INFORMATION

Biotechnology defined: The knowledge of bioprocesses applied to the engineering and use of organisms, cells or biomolecules to solve problems or make products.

Biotechnology programs prepare people to work in the bioscience industry in the areas of research and development, quality systems, production, clinical testing, and diagnostic work.

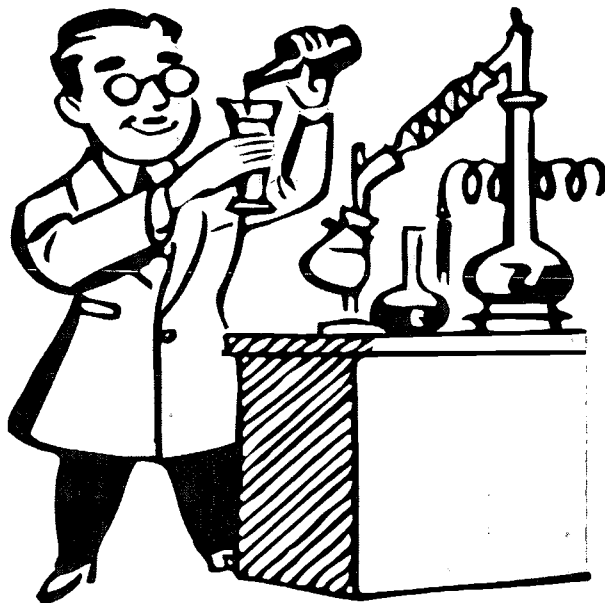
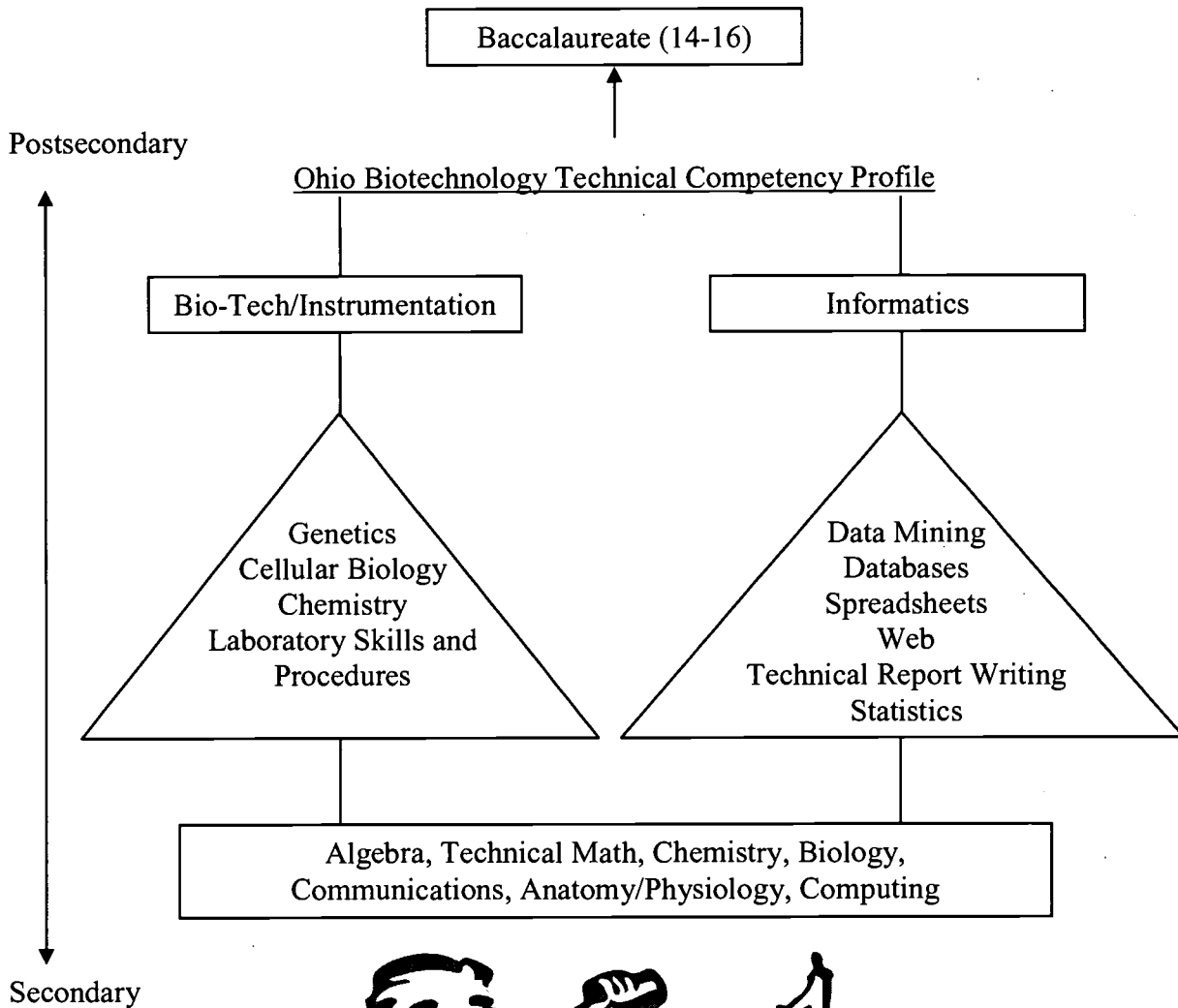
Biotechnology Technician: An individual who may prepare materials, conduct experiments, record data, and assist with the development and presentation of reports. Occupations may include, but **not** limited to:

- ❖ Quality control/assurance technician
- ❖ Fermentation technician
- ❖ Tissue culture technician
- ❖ Laboratory assistant
- ❖ Microbiology technician
- ❖ Molecular biology technician
- ❖ Data analyst
- ❖ Manufacturing technician
- ❖ Development/research technician

Graduates of community college biotechnology programs may obtain entry level work in the bioscience industry and may advance rapidly with on-the-job experience and continued academic work.

Bioinformatics defined: Bioinformatics is an area of science that incorporates computation approaches to solving biological problems. Bioinformatics is the application of mathematics (e.g., probability and statistics), science (e.g., biochemistry), and a set of problem solving methods (e.g., computer use and programming) to design and implement solutions to critical problems. The field is rapidly evolving and growing. New methods of storing and accessing data are needed for scientists to make efficient use of data. Bioinformaticists must organize a phenomenal amount of biological sequence information and make available to other scientists around the world. Jobs are available in Biotechnology laboratory settings.

OHIO BIOTECHNOLOGY PROGRAM PROFILE



OHIO BIOTECHNOLOGY CURRICULUM MATRIX

BTT = Biotechnology Technician with Laboratory Research and Environmental focus and introduction to occupation for Bioinformaticists			
Page #	Unit #	Unit	BTT
1	1	Demonstrate Scientific Method	E
5	2	Conducting Experiments	E
7	3	Laboratory Safety and Maintenance	E
13	4	Instrument Analysis	E
19	5	Chemical Materials Handling and Sampling	E
21	6	Physical Properties Measurement	E
23	7	Biohazard Storage, Handling, and Disposal	E
27	8	Basic Microbiology	E
31	9	Biochemical Technology	E
41	10	Molecular Biology Technology	E
47	11	Cell Culturing	E
53	12	Protein Bioseparation Methods	E
59	13	Fermentation Technology	E
61	14	Microbiology for Biotechnology	E
63	15	Bioethics	E
65	16	Water and Wastewater Treatment Operations	R
73	17	Environmental Science	R
81	18	Environmental Assessments	R
87	19	Introduction to Industry	E
91	20	Technical Writing and Documentation	E
93	21	Computer Applications for Biotechnology	E
101	22	Database Administration - (Bioinformatics strand)	E
109	23	Data Warehousing - (Bioinformatics strand)	E
113	24	Statistics - (Bioinformatics strand)	E

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Unit 1: Demonstrate Scientific Method

BIL: Essential

EDU:	12	AD	AC
	P	P	

Competency 1.1: Define scientific research methods

Key Indicators:

- 1.1.1 Explain purpose of scientific research
- 1.1.2 Identify goals of scientific research
- 1.1.3 Explain scientific method
- 1.1.4 Distinguish between dependent and independent variables in experiment

BIL: Essential

EDU:	12	AD	AC
	P	P	

Competency 1.2: Develop research plan

Key Indicators:

- 1.2.1 Select research question
- 1.2.2 Design research plan including significance of problem, purpose, variables, hypothesis, objectives, methods of study, and list of materials
- 1.2.3 Identify deficiencies of plan

BIL: Essential

EDU:	12	AD	AC
	I/R	P	

Competency 1.3: Apply critical thinking skills

Key Indicators:

- 1.3.1 Draw conclusions from a set of facts/data
- 1.3.2 Correlate results and plan needed action
- 1.3.3 Make comparative judgment from data
- 1.3.4 Diagnose problems from a set of data and observations
- 1.3.5 Identify solutions
- 1.3.6 Interpret data generated for records, files, and reports
- 1.3.7 Analyze data for accuracy
- 1.3.8 Decipher ambiguous information or instructions
- 1.3.9 Integrate information from diverse sources
- 1.3.10 Recognize own limitations
- 1.3.11 Recognize and correct discrepancies
- 1.3.12 Anticipate and assess emergencies
- 1.3.13 Analyze data retrieved from instrument output
- 1.3.14 Identify models to interpret scientific phenomena

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 1.4: Demonstrate problem solving skills

Key Indicators:

- 1.4.1 Recognize existence of problem
- 1.4.2 Identify possible reasons/causes of problem
- 1.4.3 Implement plan of action to resolve problem

- 1.4.4 Evaluate progress of action plan
- 1.4.5 Revise plan as indicated by findings
- 1.4.6 Identify components of action plan to resolve problem
- 1.4.7 Monitor progress of action plan
- 1.4.8 Apply methods for qualitative and quantitative analysis, data gathering, direct and indirect observations, predictions
- 1.4.9 Identify ethical dilemmas involved in scientific experimentation

Unit 2: Conducting Experiments

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 2.1: Perform routine laboratory support work

Key Indicators:

- 2.1.1 Maintain laboratory and equipment
- 2.1.2 Order and stock supplies
- 2.1.3 Operate equipment
- 2.1.4 Maintain biological stock cultures
- 2.1.5 Clean and prepare items for lab
- 2.1.6 Prepare biological and/or chemical materials
- 2.1.7 Send, receive, and distribute biological and chemical materials
- 2.1.8 Perform routine animal care duties
- 2.1.9 Communicate with co-workers to ensure quality laboratory work

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 2.2: Conduct experiments

Key Indicators:

- 2.2.1 Set up equipment for the production process
- 2.2.2 Perform and monitor the process to make the product or provide the service
- 2.2.3 Inspect materials at all stages of process to determine quality or condition
- 2.2.4 Participate in the installation, modification, and upgrade of equipment
- 2.2.5 Prepare final product for shipping or distribution

Unit 2: Conducting Experiments

- 2.2.6 Monitor, maintain, and troubleshoot equipment, tools, and workstation
- 2.2.7 Communicate with co-workers and/or customers to ensure production of service meets requirements
- 2.2.8 Coordinate inventory

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 2.3: Record and report experimental results

Key Indicators:

- 2.3.1 Maintain lab notebook
- 2.3.2 Identify methods of precision and accuracy of experimental data
- 2.3.3 Document results of the experiment in a written report using good laboratory practices or other procedures, which include statement of purpose, experimental design, results, conclusions, and next steps
- 2.3.4 Monitor results of an experiment
- 2.3.5 Maintain log book
- 2.3.6 Identify components of scientific paper/report
- 2.3.7 Identify components of oral presentation
- 2.3.8 Prepare scientific report
- 2.3.9 Present scientific report orally
- 2.3.10 Use scientific notation
- 2.3.11 Recognize that experimental results must be open to scrutiny of others
- 2.3.12 Demonstrate various ways to display data

Unit 3: Laboratory Safety and Maintenance

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 3.1: Explain the impact of federal, state, local, and company regulations and policies on safety, health, and environmental concerns of the community, worker, and consumer

Key Indicators:

- 3.1.1 Identify the agencies (federal, state, and local) that develop and enforce regulations pertaining to chemical and related industries
- 3.1.2 State the basic philosophy of "Right to Know" legislation
- 3.1.3 Use computers and other reference sources to access information about procedures for chemical safety, environmental protection, and health preservation
- 3.1.4 Describe basic emergency procedures used to respond to a spill or release
- 3.1.5 Explain material safety data sheets (MSDS)

BIL: Essential

EDU:	12	AD	AC
	P	P	

Competency 3.2: Demonstrate personal safety procedures

Key Indicators:

- 3.2.1 Protect against sight loss in the laboratory environment
- 3.2.2 Use appropriate personal protective equipment (PPE) for a variety of situations involving hazardous chemicals, such as corrosive, explosive, biological, and volatile materials

Unit 3: Laboratory Safety and Maintenance

- 3.2.3 Use safety equipment, such as safety glasses, showers, respirators, eye washes, blankets, and portable fire extinguisher
- 3.2.4 Identify protection from blood-borne pathogens
- 3.2.5 Maintain a clean and safe workplace
- 3.2.6 Perform basic first aid skills
- 3.2.7 Participate in employee safety training
- 3.2.8 Monitor air quality in a workplace using a variety of types of air monitoring equipment
- 3.2.9 Identify unsafe conditions and take corrective action

BIL: Essential

EDU:	12	AD	AC
	P	P	

Competency 3.3: Identify general workplace safety hazards

Key Indicators:

- 3.3.1 Identify first aid supplies, personnel, co-worker contact, medical information, emergency protection and evacuation plan
- 3.3.2 Follow appropriate safety procedures, guidelines, and chemical hygiene plan
- 3.3.3 Maintain required safety training to include location and understanding of MSDS
- 3.3.4 Observe rules of equipment safety
- 3.3.5 Comprehend and obey safety symbols/signs
- 3.3.6 Keep work areas free from clutter, food, and drinks
- 3.3.7 Recognize common lab hazards and observe procedures for the safe use of instruments, gas cylinders, and chemicals
- 3.3.8 Utilize safety equipment and personal protection equipment
- 3.3.9 Handle common chemical lab equipment safely
- 3.3.10 Describe the purpose of common chemical laboratory equipment
- 3.3.11 Manipulate glassware and other apparatus safely, including making connections, cleaning, and storing
- 3.3.12 Demonstrate a basic awareness of electrical safety and its application to the work environment

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 3.4: Handle laboratory equipment safely**Key Indicators:**

- 3.4.1 Store compressed gases cylinders correctly and safely
- 3.4.2 Change compressed gas cylinders correctly and safely
- 3.4.3 Choose the proper regulations for gases and other materials under pressure or under vacuum
- 3.4.4 Use equipment such as autoclaves, pressurized reactors, thermal ovens, vacuum reactors/separators, closed systems, and a variety of valves safely
- 3.4.5 Demonstrate use of safety equipment
- 3.4.6 Maintain safety equipment

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 3.5: Handle chemicals and safety equipment appropriately**Key Indicators:**

- 3.5.1 Use appropriate safety equipment (e.g., proper hoods, shields)
- 3.5.2 Identify hazards associated with collecting samples
- 3.5.3 Label and store all chemicals, materials, tools, and equipment with appropriate safety, health, and environmental details
- 3.5.4 Follow the hazard symbols and toxicology sections of material safety data sheets (MSDS)
- 3.5.5 Demonstrate the ability to read, interpret, and prepare labels for a variety of chemical materials

Unit 3: Laboratory Safety and Maintenance

- 3.5.6 Use a chemical reference handbook to identify hazards associated with handling and storing chemical materials
- 3.5.7 Handle corrosive materials properly
- 3.5.8 Use appropriate techniques to transfer gases, liquids, and solids from storage containers to equipment used in laboratory
- 3.5.9 Use mixing techniques appropriate for the materials, specifically when handling acids, bases, oxidizers, and strong reducing agents
- 3.5.10 Dispose of hazardous materials safely and according to regulatory guidelines
- 3.5.11 Order and stock supplies
- 3.5.12 Implement a chemical inventory system for a stockroom that includes all pertinent information regarding stability, hazards, and sensitivity
- 3.5.13 Use (enter into and query out of) a database for chemical information

BIL: Essential

EDU:	12	AD	AC
	I	R	

Competency 3.6: Respond to medical emergencies

Key Indicators:

- 3.6.1 Perform head to toe assessment
- 3.6.2 Describe signs and symptoms of emergency situations
- 3.6.3 Identify basic emergency procedures and equipment
- 3.6.4 Contact local emergency assistance
- 3.6.5 Demonstrate first responder procedures
- 3.6.6 Identify évacuation techniques

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 3.7: Describe laboratory safety and biohazard issues**Key Indicators:**

- 3.7.1 Outline elements of risk assessment
- 3.7.2 Name the typical general safety hazards in tissue culture laboratory
- 3.7.3 Explain proper level of protection for various biohazard procedures
- 3.7.4 Describe proper disposal procedures for tissue culture materials
- 3.7.5 Monitor usage and exposure of radioisotopes and biohazards

Unit 4: Instrument Analysis

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 4.1: Demonstrate proficiency in the use of pipeting devices, microwave, scales, and pH meters

Key Indicators:

- 4.1.1 Perform measurements using the metric system
- 4.1.2 Describe the use of pipeting devices for accurate volume measurements
- 4.1.3 Explain the pH scale
- 4.1.4 Check calibration of pipeting devices, scales, and pH meters

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 4.2: Apply principles of filtration

Competency Builders:

- 4.2.1 Filter sterilize a solution
- 4.2.2 Filter solutions using depth and membrane filters
- 4.2.3 Choose proper filter for an application
- 4.2.4 Describe ultrafiltration

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 4.3: Perform sedimentation and separation of biological materials using centrifuges

Key Indicators:

- 4.3.1 Explain revolutions per minute (RPM), centrifugal force, differential centrifugation, and density gradient centrifugation
- 4.3.2 Run high speed centrifuge
- 4.3.3 Run ultracentrifuge
- 4.3.4 Separate materials by gradient centrifugation
- 4.3.5 Separate cell components by centrifugation

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 4.4: Demonstrate proficiency in use of the common types of microscopes (e.g., light microscope, phase contrast microscope)

Key Indicators:

- 4.4.1 Examine biological specimens using microscopes
- 4.4.2 Demonstrate understanding of the principles of microscopy
- 4.4.3 Process specimen for light microscopy

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 4.5: Demonstrate proficiency in use of the ultraviolet-visible (UV/visible) spectrophotometer, and construct standard curves

Key Indicators:

- 4.5.1 Obtain a and interpret absorption/transmission data for biological samples
- 4.5.2 Construct a standard curve using a known standard
- 4.5.3 Describe one use of a blank in obtaining spectrophotometric measurements
- 4.5.4 Determine the concentration of an unknown sample from the standard curve
- 4.5.5 Identify wavelength and frequency ranges of ultraviolet (UV), visible, and infrared (IR) regions
- 4.5.6 Show the relationship between concentration of an absorbing species and the transmittance or absorbance of energy

BIL: Essential

EDU:	12	AD	AC
	I	I/P	

Competency 4.6: Demonstrate proficiency in use of thin-layer chromatography (TLC) and high-performance liquid chromatography (HPLC)

Key Indicators:

- 4.6.1 Write a description of the principles of thin-layer chromatography (TLC) as a separation tool

Unit 4: Instrument Analysis

- 4.6.2 Describe uses of TLC as an analytical tool
- 4.6.3 Describe components of the apparatus used to conduct TLC
- 4.6.4 Identify effects of temperature, solvents, and plate types on conducting TLC separations
- 4.6.5 Perform a TLC separation of a given mixture of substances, including preparing and conditioning the plates, spotting the samples, scanning the plates, and analyzing the data
- 4.6.6 Identify components in an unknown material using TLC

BIL: Essential

EDU:	12	AD	AC
	I	I/P	

Competency 4.7: Apply basic concepts of spectroscopic analytical methods

Competency Builders:

- 4.7.1 Draw a diagram of the electromagnetic spectrum indicating wavelength regions from gamma rays to radio waves
- 4.7.2 Define "spectroscopy" in terms of the interaction of radiant energy and matter
- 4.7.3 Show the relationship between concentration of an absorbing species and the transmittance or absorbance of energy
- 4.7.4 Use Beers's Law

BIL: Essential

EDU:	12	AD	AC
		P	

Competency 4.8: Apply principles of and typical instrumentation in high-performance liquid chromatography (HPLC)

Key Indicators:

- 4.8.1 Write a description of the principles of high-performance liquid chromatography (HPLC) as a separation technique
- 4.8.2 Describe the principles of HPLC that apply to its use as an analytical tool
- 4.8.3 Identify components of a high-performance liquid chromatography
- 4.8.4 Identify various column phases (normal, reverse, etc.) and describe the appropriate use of each
- 4.8.5 Identify various detectors (e.g., diode array, ultraviolet [UV], mass spectrometry [MS] used in HPLC instruments and choose the most appropriate for a variety of situations
- 4.8.6 Identify parameters of a high-performance liquid chromatograph that influence the chromatogram
- 4.8.7 Install columns into HPLC instruments
- 4.8.8 Calibrate one or more HPLC instruments
- 4.8.9 Use HPLC to separate a known mixture; install columns, choose solvents, choose detectors, and perform calibrations; calculate the percentage of components in mixture
- 4.8.10 Maximize the performance of an HPLC instrument by adjusting parameters to optimize peak width and resolution and minimize tailing
- 4.8.11 Operate a computer-controlled HPLC instrument
- 4.8.12 Perform separations of unknown mixtures using HPLC
- 4.8.13 Troubleshoot common HPLC problems

Unit 4: Instrument Analysis

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 4.9: Calibrate equipment properly and accurately

Key Indicators:

- 4.9.1 Describe the use of calibration techniques when performing instrumental analysis
- 4.9.2 Perform calibrations using available instruments
- 4.9.3 Plot appropriate graphs
- 4.9.4 Identify the linear portion of a calibration curve
- 4.9.5 Describe the causes of nonlinearity in calibration

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 4.10: Maintain laboratory instrumentation

Key Indicators:

- 4.10.1 Use instrument manuals and follow manual directions appropriately
- 4.10.2 Identify warnings and cautions
- 4.10.3 Identify warnings and cautions
- 4.10.4 Maintain equipment log for instruments in laboratory
- 4.10.5 Track periodic maintenance schedules
- 4.10.6 Perform periodic calibration checks on instruments
- 4.10.7 Ensure that service contracts for key instruments are current

Unit 5: Chemical Materials Handling and Sampling

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 5.1: Describe principles and characteristics of chemical materials

Competency Builders:

- 5.1.1 Define "chemistry"
- 5.1.2 Define examples of elements, compounds, and mixtures
- 5.1.3 Differentiate elements, compounds, and mixtures
- 5.1.4 Give examples of elements, compounds, and mixtures
- 5.1.5 Define "atoms" and "molecules"
- 5.1.6 Draw simple atomic structures for several elements including protons, neutrons, and electrons
- 5.1.7 Explain electronic configuration
- 5.1.8 Write simple electronic configurations for several elements
- 5.1.9 Explain how to use periodic table
- 5.1.10 Use the periodic table to identify elements and to describe atomic structure
- 5.1.11 Use the periodic table to characterize elements based on the group
- 5.1.12 Demonstrate how atoms combine to form molecules
- 5.1.13 Calculate formula weight
- 5.1.14 Write balanced chemical reactions
- 5.1.15 Balance chemical reactions
- 5.1.16 Demonstrate how compounds react with other compounds to form new compounds as well as relating this to chemical reactions with several examples
- 5.1.17 Describe the concept of stoichiometry as applied to chemical reactions
- 5.1.18 Describe chemical bonding and bond types including ionic and covalent
- 5.1.19 Write the molecular structure of several organic and inorganic compounds using common bond designations
- 5.1.20 Describe chemical bonding and the relationship of chemical bonding to the physical state of material based on intermolecular bonding; include the concept of hydrogen bonding

Unit 5: Chemical Materials Handling and Sampling

- 5.1.21 Differentiate between organic and inorganic substances
- 5.1.22 Describe characteristics of organic and inorganic substances
- 5.1.23 Define "catalyst"
- 5.1.24 Give examples of materials used as catalysts
- 5.1.25 Give examples of chemical reactions important to local industries that involve catalysts
- 5.1.26 Predict endo/exothermic characteristics of a chemical reaction
- 5.1.27 Calculate heat of reaction for several common reactions

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 5.2: Use both common and chemical nomenclature for inorganic and organic materials

Competency Builders:

- 5.2.1 Use the periodic table to identify and name the elements, according to symbol and group
- 5.2.2 Name common anions and cations and their charges
- 5.2.3 Write names and formulas for common inorganic compounds
- 5.2.4 Write names and chemical structures of common hydrocarbons (aliphatic and aromatic, saturated and unsaturated)
- 5.2.5 Name organic compounds according to functional groups including ketones, aldehydes, alcohols, ethers, carboxylic acids, esters, amines
- 5.2.6 Use naming systems, including common and international union of pure and applied chemistry (IUPAC) conventions
- 5.2.7 Apply various coding systems used for describing the properties of compounds that may be important in hazardous conditions (i.e., Diamond)

Unit 6: Physical Properties Measurement

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 6.1: Apply basic concepts of measurement

Competency Builders:

- 6.1.1 Describe the importance of measurement in chemistry
- 6.1.2 Define "precision" and "accuracy"; provide examples of each
- 6.1.3 Calculate mean, median, mode, and standard deviation for several data sets
- 6.1.4 Define "confidence limit" in terms of standard deviation
- 6.1.5 Describe what is meant by significant figures; give examples
- 6.1.6 Calibrate analytical balances
- 6.1.7 Use analytical balances for weighing quantities ranging from 0.001 grams to 100 grams to a specified accuracy and precision
- 6.1.8 Identify, select, and demonstrate proper use of volumetric glassware (burets, graduated cylinders, flasks, and pipets)
- 6.1.9 Calibrate volumetric glassware
- 6.1.10 Make quantitative transfers using volumetric glassware
- 6.1.11 Calculate errors in various measurements based on data acquired using common laboratory equipment
- 6.1.12 Apply standard rules for determining the number of significant figures in measurements and in the answers to corresponding calculations
- 6.1.13 Convert units of measure from English to metric and vice versa

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 6.2: Characterize physical properties of gases, liquids, and solids

Key Indicators:

- 6.2.1 Describe gases, liquids, and solids in terms of their physical properties
- 6.2.2 Show the relationship to changes in temperature and pressure
- 6.2.3 Describe how physical properties of materials are related to product specifications
- 6.2.4 Demonstrate use of appropriate apparatus for making the measurement
- 6.2.5 Assess the accuracy and precision of analytical equipment used in the measurement of several physical properties
- 6.2.6 Calculate volume, temperature, and pressure for gases, using the ideal gas law, Charles's law and Boyle's law
- 6.2.7 Describe the effect of changes in temperature and pressure on the physical properties

Unit 7: Biohazard Storage, Handling, and Disposal

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 7.1: Handle infectious agents safely

Key Indicators:

- 7.1.1 Explain prevention of exposure to infectious agents
- 7.1.2 Describe basic strategies in safe handling of agents
- 7.1.3 Explain importance of labeling
- 7.1.4 Follow Standard Operating Procedures (SOP)
- 7.1.5 Describe requirements for packaging, shipping and handling of biological specimens
- 7.1.6 Describe safe package inspection protocol and emergency plans
- 7.1.7 Explain prevention of aerosol and droplet generation
- 7.1.8 Demonstrate and analyze production of aerosol
- 7.1.9 Explain design and use of containment equipment in labs
- 7.1.10 Define high-efficiency particulate air (HEPA) filter, biological safety cabinet
- 7.1.11 List personal protection attire
- 7.1.12 Differentiate primary and secondary barriers
- 7.1.13 Discuss laboratory biosafety level criteria
- 7.1.14 List basic characteristics of each of four biosafety levels for infectious agents
- 7.1.15 Identify potential sources of infectious agents

BIL: Essential

EDU:	12	AD	AC
	I - R	P	

Competency 7.2: Explain safe disposal of infectious waste

Key Indicators:

- 7.2.1 Explain infectious potential of laboratory waste
- 7.2.2 Explain occupational and public health risks of infectious lab waste
- 7.2.3 Demonstrate responsibility for safe handling and disposal
- 7.2.4 Explain waste handling methods
- 7.2.5 Describe containment and personal protection
- 7.2.6 Explain sterilization and containment methods
- 7.2.7 Describe decontamination, autoclaving, and incineration
- 7.2.8 Demonstrate effectiveness of various decontamination methods
- 7.2.9 Sterilize test strip using autoclave

BIL: Essential

EDU:	12	AD	AC
		I	

Competency 7.3: Describe methods used to measure and detect radiation

Competency Builders:

- 7.3.1 Describe survey meters used for radiation detection
- 7.3.2 Describe Liquid Scintillation Counting (LSC)
- 7.3.3 Explain radiation dosimeters and their proper usage
- 7.3.4 Explain exposure limits
- 7.3.5 Explain good housekeeping practices to keep radionucleotides outside body
- 7.3.6 Describe methods for radioisotopes disposal

- 7.3.7 Explain emergency procedures and decontamination
- 7.3.8 Explain uses of radioisotopes in biotechnology
- 7.3.9 Describe use of radioactivity in medicine and consumer products
- 7.3.10 Explain NRC guidelines for radiation exposure

Unit 8: Basic Microbiology

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 8.1: Apply microbiological principles and procedures

Key Indicators:

- 8.1.1 Define microbiology
- 8.1.2 Explain microbial taxonomy and classification
- 8.1.3 Explain bacterial metabolism, reproduction, cell structures, and their functions
- 8.1.4 Disinfect and sterilize
- 8.1.5 Explain classification, composition, and preparation of culture media
- 8.1.6 Collect, handle and culture specimen
- 8.1.7 Identify bacteriologic culture techniques necessary for isolation and identification of organisms
- 8.1.8 Test for antibiotic susceptibility
- 8.1.9 Identify commonly encountered aerobic bacteria through morphological, physical, and biochemical properties
- 8.1.10 Prepare Gram stains
- 8.1.11 Explain collection and handling of specimens for fungal, mycobacterial, and viral specimens
- 8.1.12 Prepare and examine specimens
- 8.1.13 Identify difference between autotrophic and heterotrophic microbes

BIL: Essential

EDU:	12	AD	AC
		I	

Competency 8.2: Explain immunological procedures

Key Indicators:

- 8.2.1 Explain immune system and normal immune response
- 8.2.2 Explain physical and chemical properties of immunoglobulins and complement and their reaction in vitro
- 8.2.3 Explain principles of basic agglutination, flocculation, and precipitation procedures
- 8.2.4 Perform basic agglutination, flocculation, and precipitation procedures
- 8.2.5 Explain principles of complement fixation, immunoelectrophoresis and enzyme immunoassay
- 8.2.6 Explain clinical significance of commonly performed serological tests

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 8.3: Perform common microbiology procedures

Key Indicators:

- 8.3.1 Operate microscope, compound microscope, incubator, colony counter, and other basic microbiology and analytical equipment
- 8.3.2 Identify microorganisms and cells
- 8.3.3 Quantify microorganisms and cells
- 8.3.4 Isolate pure cultures
- 8.3.5 Maintain pure cultures
- 8.3.6 Analyze fermentation materials
- 8.3.7 Harvest cells

- 8.3.8 Transform hosts
- 8.3.9 Stain cells and/or bacteria
- 8.3.10 Prepare media
- 8.3.11 Identify sterile techniques used during handling, sampling, and analytical procedures
- 8.3.12 Explain Koch's Postulates and their use in determining primary and secondary pathogens
- 8.3.13 Aseptically transfer microorganisms
- 8.3.14 Sterilize all materials and equipment to be used in fermentation process

BIL: Essential

EDU:	12	AD	AC
	I/P	P	

Competency 8.4: Contrast prokaryotic and eukaryotic cells

Key Indicators:

- 8.4.1 Define prokaryotic and eukaryotic
- 8.4.2 List parts of prokaryotic and eukaryotic cells
- 8.4.3 State function of each cell structure
- 8.4.4 Distinguish between those parts that are common to both and those that are not always present
- 8.4.5 Describe the cell wall/cell membrane
- 8.4.6 Explain endospore
- 8.4.7 Identify conditions that favor the formation of endospores
- 8.4.8 Explain plasmid
- 8.4.9 Identify groups of microorganisms such as bacteria, algae, fungi, etc.

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 8.5: Explain microbial growth

Key Indicators:

- 8.5.1 Correlate bacterial binary fission with generation time
- 8.5.2 Describe normal bacteria population growth curve
- 8.5.3 Indicate methods of enumerating bacteria and measuring bacterial growth
- 8.5.4 Explain closed bacterial culture
- 8.5.5 Describe physical factors that affect microbial growth

Unit 9: Biochemical Technology

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 9.1: Prepare common laboratory reagents

Key Indicators:

- 9.1.1 Define mole, molarity, normality, percent w/v and percent v/v
- 9.1.2 Perform serial dilution
- 9.1.3 Describe and prepare buffers
- 9.1.4 List useful buffers for biological systems
- 9.1.5 Adjust the pH of stock reagents
- 9.1.6 Describe ionic and non-ionic detergents
- 9.1.7 Dilute stock solutions to working solutions
- 9.1.8 Prepare sterile solutions

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 9.2: Demonstrate basic, one-step chemical laboratory skills

Key Indicators:

- 9.2.1 Identify appropriate glassware for task
- 9.2.2 Store prepared solutions and stains to maintain optimal condition
- 9.2.3 Operate laboratory instruments
- 9.2.4 Measure using MKS system (metric)

Unit 9: Biochemical Technology

- 9.2.5 Identify storage containers that are compatible with the materials to be stored
- 9.2.6 Use safety hoods
- 9.2.7 Utilize solvents, acids, and detergents for cleaning
- 9.2.8 Prepare solutions
- 9.2.9 Demonstrate the proper use of pressurized cylinders
- 9.2.10 Measure volume of a solution to perform a laboratory test
- 9.2.11 Measure temperatures accurately
- 9.2.12 Wash laboratory equipment appropriately
- 9.2.13 Sterilize equipment to decontaminate soiled materials

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 9.3: Demonstrate combinations of chemical laboratory skills

Key Indicators:

- 9.3.1 Describe typical laboratory procedures (e.g., heating, cooling, filtration, glassware, setup, distillation, weighing, measuring, pipetting, volumetrics)
- 9.3.2 Carry out laboratory procedures from a written procedure
- 9.3.3 Respond to a laboratory spill
- 9.3.4 Practice safe and proper use of hand tools
- 9.3.5 Use proper techniques for mixing acids and bases with other materials
- 9.3.6 Demonstrate proper titration techniques
- 9.3.7 Describe the physical and chemical properties of common materials and implications for storage
- 9.3.8 Transfer liquids, solids, and gases properly
- 9.3.9 Maintain electrodes
- 9.3.10 Use all common types of volumetric equipment and apparatus

BIL: Essential

EDU:	12	AD	AC
	I	R/P	

Competency 9.4: Identify/describe the following chemical lab equipment and instruments

Key Indicators:

- 9.4.1 Use titrator
- 9.4.2 Use Geiger Mueller counter
- 9.4.3 Use alpha/beta counter
- 9.4.4 Use oil immersion lens
- 9.4.5 Use Bunsen/Fisher burner safely
- 9.4.6 Use autoclaves, hot air oven, and disinfectants

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 9.5: Perform critical laboratory calculations and measurements

Key Indicators:

- 9.5.1 Calculate quantities needed to perform a test analysis
- 9.5.2 Calculate unit conversions
- 9.5.3 Calculate concentrations
- 9.5.4 Construct graphs

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 9.6: Perform sample analysis

Key Indicators:

- 9.6.1 Obtain representative samples
- 9.6.2 Make observations regarding condition of sample and record any notable characteristics
- 9.6.3 Identify the appropriate equipment for the analysis to be conducted
- 9.6.4 Gather and clean the necessary glassware, reagents, and chemicals
- 9.6.5 Calibrate equipment
- 9.6.6 Prepare and standardize reagents
- 9.6.7 Prepare samples for analysis (e.g., dissolve, digest, combust, ash)
- 9.6.8 Prepare standards and control samples
- 9.6.9 Analyze sample
- 9.6.10 Calculate results to appropriate significant figures
- 9.6.11 Evaluate analytical results and respond appropriately
- 9.6.12 Identify conditions that indicate need for an analysis to be repeated
- 9.6.13 Record and report data
- 9.6.14 Return all equipment and material to original storage locations

BIL: Essential

EDU:	12	AD	AC
	I	R/P	

Competency 9.7: Describe molecular behavior of amino acids and peptides

Key Indicators:

- 9.7.1 Draw a structure of an amino acid
- 9.7.2 Build model of an amino acid
- 9.7.3 Identify chemical properties of peptide bond
- 9.7.4 Identify four factors that determine isoelectric point of an amino acid and a protein
- 9.7.5 Determine polarity of functional groups on individual amino acids
- 9.7.6 Explain the solubility of an amino acid and a protein in terms of isoelectric point
- 9.7.7 Determine the isoelectric point of amino acids and proteins
- 9.7.8 Predict the effect of the isoelectric point on molecular behavior of amino acid and protein

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 9.8: Explain protein properties

Key Indicators:

- 9.8.1 Differentiate levels of protein structure
- 9.8.2 Describe characteristics of each level
- 9.8.3 Describe methods of denaturing proteins
- 9.8.4 Describe ways proteins can be renatured

- 9.8.5 Identify four methods of renaturation
- 9.8.6 Explain properties that allow for molecular renaturation

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 9.9: Perform enzyme assays

Key Indicators:

- 9.9.1 Generalize factors affecting rates of reaction
- 9.9.2 Explain factors optimizing rates of reaction
- 9.9.3 Distinguish substrate and product from catalyst in function and role
- 9.9.4 Explain parameters of reaction
- 9.9.5 Assemble correct supplies needed for assay
- 9.9.6 Determine kinetics of an enzyme catalyzed reaction
- 9.9.7 Distinguish various methods to graph data
- 9.9.8 Perform enzyme-linked immunosorbent assay (ELISA)

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 9.10: Perform biochemical assays of nucleotides and nucleic acids

Key Indicators:

- 9.10.1 Identify three components of a nucleotide
- 9.10.2 Differentiate nucleotides and nucleosides
- 9.10.3 Isolate nucleic acids

- 9.10.4 Perform UV spectra of proteins and nucleic acids
 9.10.5 Explain limitation of techniques

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 9.11: Explain the relationship between deoxyribonucleic acid (DNA), ribonucleic acid (RNA), and protein

Key Indicators:

- 9.11.1 Explain how DNA is the genetic material
 9.11.2 Discuss transcription of genes
 9.11.3 Explain translation of a messenger RNA into protein
 9.11.4 Identify the key elements of the transcription and translational machinery

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 9.12: Describe deoxyribonucleic acid (DNA) replication

Key Indicators:

- 9.12.1 Outline DNA replication cycle
 9.12.2 Identify conditions under which replication occurs
 9.12.3 Differentiate the replication cycles of procaryotes and eukaryotes
 9.12.4 Identify mutagenic and repair mechanisms of DNA
 9.12.5 Identify mutagenic processes and repair mechanisms
 9.12.6 Explain how mutagenic mechanisms modify organisms

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 9.13: Describe biochemical assays of carbohydrates

Key Indicators:

- 9.13.1 Identify components of monosaccharides
- 9.13.2 Draw structural formula for a disaccharide
- 9.13.3 Distinguish uses and limitations of various assays

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 9.14: Describe biochemical assays of lipids

Key Indicators:

- 9.14.1 Compare and contrast major classes of lipids
- 9.14.2 Identify functional groups and chemical reactivity of classes
- 9.14.3 Identify basis of chemical reactions of assay

BIL: Essential

EDU:	12	AD	AC
	I	R	

Competency 9.15: Describe membrane fractionation**Key Indicators:**

- 9.15.1 Diagram cell membrane
- 9.15.2 Outline function of molecules within membrane structure
- 9.15.3 Relate diagram to explanation of fluid mosaic model
- 9.15.4 Identify membrane purification/separation techniques

Unit 10: Molecular Biology Technology

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 10.1: Explain genetics and heredity

Key Indicators:

- 10.1.1 Define and discuss Mendel’s work and research
- 10.1.2 Describe basic genetic crosses
- 10.1.3 Describe meiosis and genetic recombination
- 10.1.4 Diagram linkage mapping and solve linkage problems
- 10.1.5 Determine whether a trait is dominant or recessive
- 10.1.6 Determine whether a trait is sex-linked or autosomal
- 10.1.7 Analyze and solve sex-linkage problems
- 10.1.8 Apply Mendelian patterns to family trees with medical problems

BIL: Recommend

EDU:	12	AD	AC
	I	R/P	

Competency 10.2: Describe historical developments leading to modern recombinant deoxyribonucleic acid (DNA) technology

Key Indicators:

- 10.2.1 Describe work of early and recent scientists
- 10.2.2 Trace developments and discoveries in genetics
- 10.2.3 Outline and highlight major events in deoxyribonucleic acid (DNA) technology history

Unit 10: Molecular Biology Technology

- 10.2.4 Analyze trends, controversies, breakthroughs
- 10.2.5 Explain in writing how early scientists' work led to gene cloning techniques

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 10.3: Apply basic concept of recombinant deoxyribonucleic acid (DNA) technology

Key Indicators:

- 10.3.1 Diagram the relationships among deoxyribonucleic acid (DNA), ribonucleic acid (RNA), and protein
- 10.3.2 Define basic components of cloning
- 10.3.3 Identify specific terms: vectors, restriction enzymes, host transformation, and electrophoresis
- 10.3.4 Apply these concepts to simulated applications
- 10.3.5 Identify unique restriction enzyme sites
- 10.3.6 Purify DNA
- 10.3.7 Purify RNA

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 10.4: Isolate and characterize deoxyribonucleic acid (DNA)

Competency Builders:

- 10.4.1 Explain large scale double-stranded deoxyribonucleic acid (DNA) isolation methods
- 10.4.2 Explain mini-prep double-stranded DNA isolation of plasmid DNA
- 10.4.3 Explain genomic DNA isolation from blood samples according to Federal Bureau of Investigation (FBI) protocol
- 10.4.4 Perform restriction digest
- 10.4.5 Perform electrophoresis
- 10.4.6 Prepare graph and assess results
- 10.4.7 Determine molecular weight of fragments correctly

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 10.5: Clone deoxyribonucleic acid (DNA)

Key Indicators:

- 10.5.1 Clone a gene for antibiotic resistance into a vector
- 10.5.2 Ensure transformed E. coli acquire antibiotic resistance
- 10.5.3 Prepare a report on cloning exercise
- 10.5.4 Describe terminology and processes in deoxyribonucleic acid (DNA) technology
- 10.5.5 Prepare reagents and materials

Unit 10: Molecular Biology Technology

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 10.6: Perform advanced techniques in recombinant deoxyribonucleic acid (DNA) technology

Key Indicators:

- 10.6.1 Perform Southern Blot or colony transfer
- 10.6.2 Perform Probe Preparation
- 10.6.3 Perform Hybridization
- 10.6.4 Identify and organize protocols
- 10.6.5 Prepare flowchart of overall procedure
- 10.6.6 Follow tasks in each protocol
- 10.6.7 Summarize in writing procedures and results
- 10.6.8 Explain techniques
- 10.6.9 Apply concepts of screening, genetic expression, expression vectors, and genetic libraries
- 10.6.10 Perform polymerase chain reaction (PCR) technique

BIL: Recommend

EDU:	12	AD	AC
	I	R/P	

Competency 10.7: Relate molecular biology technology to our lives

Key Indicators:

- 10.7.1 Explain results from the Human Genome project and other sequencing projects
- 10.7.2 Explain human genome map data
- 10.7.3 Explain how gene sequencing is performed
- 10.7.4 Give sequencing examples of medical or agricultural advances

- 10.7.5 Give examples of how this information is used in today's applications
- 10.7.6 Relate molecular biology to recent advances in local medicine, food science, or agriculture industries
- 10.7.7 Explain field applications of genetherapy, forensics, and animal husbandry

Unit 11: Cell Culturing

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 11.1: Describe the history of cell culture

Key Indicators:

- 11.1.1 Identify major historic advances in cell culture
- 11.1.2 Describe advantages and disadvantages of cell culture
- 11.1.3 Define different types of cultures

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 11.2: Describe equipment needs of a tissue culture lab

Key Indicators:

- 11.2.1 Describe essential and beneficial equipment for tissue culture facility
- 11.2.2 Describe other types of equipment found in tissue culture facilities
- 11.2.3 Describe necessary consumable items used in tissue culture facilities

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 11.3: Describe aseptic technique

Competency Builders:

- 11.3.1 Describe objectives of aseptic technique
- 11.3.2 Describe good technique for work surface, personal hygiene, pipetting and sterile handling
- 11.3.3 Explain mechanism for laminar flow hoods

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 11.4: Explain factors that influence cell growth during incubation

Key Indicators:

- 11.4.1 Compare surfaces and dishes, plates, and vessels that cells will grow on
- 11.4.2 Explain relationship between carbon dioxide, temperature, buffering, and pH
- 11.4.3 Describe basic constituents of media
- 11.4.4 Contrast advantages and disadvantages of serum-free media

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 11.5: Prepare media for culturing cells**Key Indicators:**

- 11.5.1 Clean and sterilize equipment
- 11.5.2 Prepare media and sterilize by filtration
- 11.5.3 Test media for sterility
- 11.5.4 Describe components needed for media
- 11.5.5 Explain function of each media component
- 11.5.6 List hormones to stimulate growth
- 11.5.7 Use serum-free media

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 11.6: Maintain and passage aseptically cultured cells**Key Indicators:**

- 11.6.1 Culture common cell lines without contamination
- 11.6.2 Establish primary cell culture
- 11.6.3 Count cells using a hemocytometer
- 11.6.4 Demonstrate cryopreservation techniques by freezing and thawing cells

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 11.7: Explain methods for analysis of cultured cells

Key Indicators:

- 11.7.1 Describe methods for deoxyribonucleic acid (DNA), ribonucleic acid (RNA), and protein analysis of harvested cells
- 11.7.2 Explain how cell cultures can be used to assay viability and cytotoxicity
- 11.7.3 Transfect cells with plasmid deoxyribonucleic acid (DNA)
- 11.7.4 Select transfected cells
- 11.7.5 Clone transfected cells
- 11.7.6 Describe the fusion process to create hybridoma cells
- 11.7.7 Describe the use of enzyme-linked immunosorbent assay (ELISA) to screen hybridoma cells for antibody production

BIL: Essential

EDU:	12	AD	AC
	R	P	

Competency 11.8: Describe basic antibody-mediated immunity

Key Indicators:

- 11.8.1 Describe the basic biology of B cells and T cells
- 11.8.2 Diagram an antibody molecule
- 11.8.3 Define and compare polyclonal and monoclonal antibodies
- 11.8.4 Describe methods and uses for antibodies, enzyme-linked immunosorbent assay (ELISA), Western Blot, and hybridoma production

BIL: Essential

EDU:	12	AD	AC
	I	R	

Competency 11.9: Describe the use of animals in research

Competency Builders:

- 11.9.1 Describe ethical considerations of animal use
- 11.9.2 Describe regulations regarding animal care and use
- 11.9.3 Apply knowledge of federal, state, and local animal welfare regulations
- 11.9.4 Describe proper injection technique for immunization of mice

Unit 12: Protein Bioseparation Methods

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 12.1: Explain basic chromatographic theory

Key Indicators:

- 12.1.1 Define the relationship between chromatography and biphasic separation
- 12.1.2 Classify chromatographic methods by type
- 12.1.3 Select appropriate chromatographic method for circumstance/situation
- 12.1.4 Show diagrammatically a stationary and mobile phase, column and fraction

BIL: Recommend

EDU:	12	AD	AC
	I	P	

Competency 12.2: Interpret chromatographic results

Key Indicators:

- 12.2.1 Perform qualitative and quantitative analysis to determine amount and type of unknown sample
- 12.2.2 Detect uncertainties in analysis
- 12.2.3 Point out ways to confirm analysis

BIL: Recommend

EDU:	12	AD	AC
		P	

Competency 12.3: Prepare and run various types of chromatography separation

Key Indicators:

- 12.3.1 Pour, pack, and run gel permeation chromatography column
- 12.3.2 Successfully separate test mixture into its components
- 12.3.3 Collect fractions
- 12.3.4 Evaluate fractions using spectrophotometer and an electrophoresis

BIL: Recommend

EDU:	12	AD	AC
		P	

Competency 12.4: Interpret results of various types of chromatography separation

Key Indicators:

- 12.4.1 Explain results in terms of molecular weight of sample components
- 12.4.2 Identify unknown correctly
- 12.4.3 Evaluate chromatograms using measurement skills
- 12.4.4 Summarize procedures
- 12.4.5 Document results
- 12.4.6 Prepare formal report that summarizes interpretation of results in tabular and text form

BIL: Essential

EDU:	12	AD	AC
		I	

Competency 12.5: Perform proper maintenance and operation techniques to high-performance liquid chromatography (HPLC) system

Key Indicators:

- 12.5.1 Attach proper column to system
- 12.5.2 Check for leaks
- 12.5.3 Check pressure
- 12.5.4 Prime pump and run test sample
- 12.5.5 Store column in correct storage solution
- 12.5.6 Identify components of high-performance liquid chromatography (HPLC) system and trace flow of liquid

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 12.6: Run sample on high-performance liquid chromatography (HPLC) system and interpret results

Key Indicators:

- 12.6.1 Obtain correct separation of sample components
- 12.6.2 Explain results in terms of reverse phase column and sample interactions
- 12.6.3 Identify unknown correctly
- 12.6.4 Evaluate chromatograms using measurement skills
- 12.6.5 Summarize procedures

Unit 12: Protein Bioseparation Methods

- 12.6.6 Document results
- 12.6.7 Prepare formal report that includes interpretation of results in tabular and text form

BIL: Recommend

EDU:	12	AD	AC
	I	P	

Competency 12.7: Identify and explain physical and chemical properties of proteins

Key Indicators:

- 12.7.1 Relate physical properties of a protein to separation methods
- 12.7.2 Relate chemical properties of a protein to separation methods
- 12.7.3 Design a separation strategy based on this information

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 12.8: Desalt protein and change buffer

Key Indicators:

- 12.8.1 Describe how to desalt a sample and change buffer
- 12.8.2 Identify all steps in desalting process
- 12.8.3 Perform dialysis
- 12.8.4 Dialysate with pH of proper buffer, proper conductivity, and activity

BIL: Recommend

EDU:	12	AD	AC
		I/R	

Competency 12.9: Perform ion exchange chromatography**Key Indicators:**

- 12.9.1 Explain principles of chromatographic separation
- 12.9.2 Explain and distinguish between cationic and anionic exchangers
- 12.9.3 Set up chromatography column with DEAE
- 12.9.4 Inspect for correct orientation and no bubbles in connecting tube
- 12.9.5 Run sample on chromatography column
- 12.9.6 Collect fractions
- 12.9.7 Graph data from column fractions
- 12.9.8 Use assays from extraction in supernatant
- 12.9.9 Produce concentrated samples
- 12.9.10 Document and explain procedure

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 12.10: Perform electrophoresis of protein samples**Key Indicators:**

- 12.10.1 Write an explanation of theory of SDS polyacrylamide gel electrophoresis SDS (PAGE) and isoelectric focusing (IEF)
- 12.10.2 Cast a PAGE gel
- 12.10.3 Run samples on PAGE
- 12.10.4 Perform Western Blot
- 12.10.5 Cast an Isoelectric Focusing (IEF) gel

Unit 12: Protein Bioseparation Methods

12.10.6 Transfer IEF gel to Sodium Dodecyl Sulfate (SDS PAGE) gel

12.10.7 Run samples

BIL: Recommend

EDU:	12	AD	AC
	I	P	

Competency 12.11: Perform affinity purification

Key Indicators:

12.11.1 Describe immuno-affinity chromatography techniques

12.11.2 Demonstrate protein A/G purification of antibodies

12.11.3 Describe hydrophobic chromatography methods

12.11.4 Describe ligand-receptor for enzyme purification

Unit 13: Fermentation Technology

BIL: Recommend

EDU:	12	AD	AC
	I	P	

Competency 13.1: Explain various fermentation and bioprocessing applications and the effects of fermentation operations on cell growth kinetics

Key Indicators:

- 13.1.1 Explain various product types and classes of fermentation or bioprocessing
- 13.1.2 Describe advantages and disadvantages of various fermentation processes
- 13.1.3 Outline function of parts of bench-top fermenter
- 13.1.4 Describe function of parts of bench-top fermenter
- 13.1.5 Write material balance for substrates and products
- 13.1.6 Identify factors determining efficiency of process
- 13.1.7 Apply appropriate mathematical functions to calculations
- 13.1.3 Describe relationship of oxygen transfer rates to mass transfer
- 13.1.4 Monitor microorganism growth in appropriate media
- 13.1.5 Determine viability of stored cells

BIL: Essential

EDU:	12	AD	AC
		I	

Competency 13.2: Validate principles and importance of sterility in industrial fermentations

Key Indicators:

- 13.2.1 Explain important features of aseptic technique in terms of absolute sterility
- 13.2.2 Write explanation of sterility
- 13.2.2 Explain the temperature/pressure relationship of saturated steam to sterilization
- 13.2.3 Explain the effect of entrapped air on sterilization effectiveness
- 13.2.4 Compare sterilization methods using dry heat versus moist heat
- 13.2.5 Demonstrate sterilization by micro-filtration
- 13.2.6 Explain the effect of suspended solids in fermentation media on sterilization effectiveness
- 13.2.7 Prepare an uncontaminated sample for analysis

Unit 14: Microbiology for Biotechnology

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 14.1: Describe the general structure of viruses

Key Indicators:

- 14.1.1 Describe various coverings, central core structures
- 14.1.2 Describe viral capsid
- 14.1.3 Distinguish between helical and icosahedral viruses
- 14.1.4 Explain origin of viral envelope

BIL: Recommend

EDU:	12	AD	AC
		I	

Competency 14.2: Explain how chemical energy operates major cell processes (i.e., biosynthesis, movement, transport, and growth)

Key Indicators:

- 14.2.1 Describe biological oxidation and reduction
- 14.2.2 Describe structure of ATP
- 14.2.3 Illustrate general processes of endergonic and exergonic reactions
- 14.2.4 Explain concept of reduction and oxidation (REDOX)
- 14.2.5 Relate ATP synthesis to catabolism and anabolism

BIL: Recommend

EDU:	12	AD	AC
	I/R	P	

Competency 14.3: Describe active and passive transport

Key Indicators:

- 14.3.1 Identify three types of passive transport
- 14.3.2 Identify features in active transport systems
- 14.3.3 Describe two forms of endocytosis

Unit 15: Bioethics

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 15.1: Identify basic principles of ethics

Key Indicators:

- 15.1.1 Define bioethics
- 15.1.2 Identify importance of replication of experiments
- 15.1.3 Identify ethical uses of animals in research (purpose, safety mechanisms, avoidance of unnecessary duplication)
- 15.1.4 Identify ethical and unethical behavior in lab setting
- 15.1.5 Identify ethical and unethical behavior in personal life
- 15.1.6 Explain methods for protecting the integrity of data
- 15.1.7 Explain importance of protecting the integrity of data

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 15.2: Apply principles of ethics to scientific problems

Key Indicators:

- 15.2.1 Identify rules for discussion of ethical issues in a public forum
- 15.2.2 Apply science ethically to a variety of situations
- 15.2.3 Identify ethical issues specific to a particular company or position

Unit 16: Water and Wastewater Treatment Operations

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 16.1: Identify characteristics and principles of water and wastewater treatment

Key Indicators:

- 16.1.1 Describe the hydrologic cycle
- 16.1.2 Identify constituents inherent to groundwater and/or surface water
- 16.1.3 Describe the pH scale and its importance in the water-treatment process
- 16.1.4 Correlate treatment processes to types of facility influent and solids
- 16.1.5 Identify biological organisms used in treatment processes
- 16.1.6 Identify commonly measured wastewater items
- 16.1.7 Identify factors affecting raw wastewater
- 16.1.8 Identify water and wastewater borne diseases
- 16.1.9 Identify gases found in wastewater
- 16.1.10 Define pathogenic organisms, include bacteria, protozoa, and virus
- 16.1.11 Describe the disease associations of pathogenic organisms

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 16.2: Identify wastewater sampling techniques

Key Indicators:

- 16.2.1 Identify reasons for sampling and the types of samples (e.g., simple, representative, grab, composite)
- 16.2.2 Describe methods of sample collection and handling

Unit 16: Water and Wastewater Treatment Operations

- 16.2.3 Identify biological or chemical specific samples required for process control and compliance with standards
- 16.2.4 Identify representative sampling points
- 16.2.5 Identify the basic procedure for quality control/quality assurance in sampling
- 16.2.6 Describe the correct procedure for obtaining a bacteriological sample
- 16.2.7 Describe the correct procedure for sample identification
- 16.2.8 Define the chain of custody for a sample
- 16.2.9 Describe correct sample-collection procedures for inorganic and organic analyses
- 16.2.10 Describe the need for chemical analyses in water treatment
- 16.2.11 Determine whether the finished water is acceptable or unacceptable, according to laboratory results

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 16.3: Describe wastewater collection systems

Key Indicators:

- 16.3.1 Identify types of wastewater collection systems
- 16.3.2 Identify flow variations and conditions that affect plant treatment including infiltration, inflow, and lift stations
- 16.3.3 Describe methods to detect and correct infiltration and inflow
- 16.3.4 Identify dissolved gases in wastewater and the effect of their presence/absence on treatment
- 16.3.5 Explain the effect of lift station performance on the overall treatment process
- 16.3.6 Describe solutions for lift station problems such as surging flows, septic conditions, and power outages

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 16.4: Identify constituents of water entering water-treatment facility

Key Indicators:

- 16.4.1 Differentiate between turbidity and the microbiological quality of water
- 16.4.2 Describe the uses of chemical analysis in water-treatment operations
- 16.4.3 Identify symbols and common names for elements and chemical compounds
- 16.4.4 Identify the primary constituents to be measured
- 16.4.5 Explain the importance of water treatment for the control of coliform bacteria and algae

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 16.5: Analyze the constituents of wastewater

Key Indicators:

- 16.5.1 Describe the need for chemical analysis in waste water treatment
- 16.5.2 Identify laboratory tests required by the NPDES Permit
- 16.5.3 Analyze the specific physical, chemical, and biological characteristics of wastewater
- 16.5.4 Analyze attached and suspended growth, respiration, gas production, aerobic and anaerobic conditions, differences in effluent disposal, and solids management
- 16.5.5 Identify ranges in wastewater treatment and limits on facility discharges

Unit 16: Water and Wastewater Treatment Operations

- 16.5.6 Determine the significance of biological or chemical sample results for process control and reporting
- 16.5.7 Describe the laboratory test performed for the presence of bacteria
- 16.5.8 Determine whether the finished water is acceptable or unacceptable, according to laboratory results

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 16.6: Contrast the aeration and stripping process

Key Indicators:

- 16.6.1 Identify types of aeration systems
- 16.6.2 Explain the benefits of aeration
- 16.6.3 Describe the components of an air-stripping system
- 16.6.4 Describe process control methods for aeration systems

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 16.7: Describe the mixing, coagulation, and flocculation Processes

Key Indicators:

- 16.7.1 Define turbidity, color, coagulation, and flocculation
- 16.7.2 Identify the kinds of equipment used in the coagulation process
- 16.7.3 Identify coagulant chemicals used in water-treatment facilities
- 16.7.4 Identify the steps of coagulation

- 16.7.5 Identify specific sampling locations for control in a coagulation process
- 16.7.6 Identify factors that would contribute to poor flocculation
- 16.7.7 Compute the feed rate in pounds per day when the chemical coagulant and flowrate are known
- 16.7.8 Compute the dosage of coagulant when the rate of flow and the feed rate of the chemical coagulant are known

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 16.8: Describe the filtration and sedimentation process

Key Indicators:

- 16.8.1 Explain concepts related to filtration including types of filters, filter-system components, and the steps for normal filtration operations
- 16.8.2 Explain common problems of filtering systems including head loss, mudballs, filter media loss, and blinding
- 16.8.3 Describe when to backwash a filter
- 16.8.4 Identify the steps for backwashing a filter
- 16.8.5 Explain filter backwash rates
- 16.8.6 Explain concepts of sedimentation, including types of classifiers, sedimentation system components and steps for normal operation
- 16.8.7 Measure sedimentation rates

Unit 16: Water and Wastewater Treatment Operations

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 16.9: Describe the water-softening process

Key Indicators:

- 16.9.1 Identify treatment processes used for water softening
- 16.9.2 Describe types of hardness
- 16.9.3 Describe alkalinity and its components
- 16.9.4 Calculate the distribution of bicarbonate, carbonate, and/or hydroxide ions when given the total alkalinity and phenolphthalein alkalinity
- 16.9.5 Describe carbonate removal
- 16.9.6 Identify the important zones of an upflow clarifier unit
- 16.9.7 Identify the appropriate chemical(s) to use in chemical-precipitation softening process
- 16.9.8 Compute lime demand from raw-water analyses
- 16.9.9 Describe the reasons for recarbonization
- 16.9.10 Compute hardness removal when the ion-exchange capacity is known

BIL: Recommended

EDU:	12	AD	AC
	I	P	

Competency 16.10: Describe the stabilization process

Key Indicators:

- 16.10.1 Identify the chemicals used in stabilization
- 16.10.2 Identify two stabilization indices
- 16.10.3 Determine water stability using the Langelier index and the marble test

BIL: Recommended

EDU:	12	AD	AC
	I	P	

Competency 16.11: Describe the corrosion-control process

Key Indicators:

- 16.11.1 Describe problems that can be created by corrosive waters
- 16.11.2 Define electrochemical reaction
- 16.11.3 Identify the factors that influence corrosion
- 16.11.4 Define cathode film formation
- 16.11.5 Describe the conditions for calcium carbonate film formation
- 16.11.6 Identify the chemicals used in corrosion control
- 16.11.7 Define cathodic protection and its application in water-treatment

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 16.12: Describe the disinfection process

Key Indicators:

- 16.12.1 Identify chemicals used in primary disinfection
- 16.12.2 Identify commonly used chlorinators and hypochlorinators
- 16.12.3 Determine the maximum amount of chlorine gas (in pounds) that may be taken from a cylinder in a 24-hour period
- 16.12.4 Identify proper maintenance procedures for equipment chlorination
- 16.12.5 Identify terminology related to chlorination and disinfection
- 16.12.6 Identify common safety problems or emergency situations that might occur during chlorination
- 16.12.7 Identify the properties of chlorine and its use in water treatment

Unit 16: Water and Wastewater Treatment Operations

- 16.12.8 Explain the points at which chlorine is applied most effectively in water treatment
- 16.12.9 Compute the feed rate needed to treat a given amount of water when given a chlorine demand and the desired chlorine residual

BIL: Recommended

EDU:	12	AD	AC
	I	P	

Competency 16.13: Describe the control and treatment of trihalomethanes

Key Indicators:

- 16.13.1 Describe the formation of total trihalomethanes (TTHM)
- 16.13.2 Describe the specific procedure for collecting samples to determine trihalomethane levels
- 16.13.3 Compute the quarterly average and the annual TTHM measurements when sample results are given
- 16.13.4 Identify processes that remove trihalomethane precursors
- 16.13.5 Identify processes that remove trihalomethanes after they are formed
- 16.13.6 Identify the benefits of alternate disinfectants
- 16.13.7 Describe chloramination as a control of TTHM

Unit 17: Environmental Science

BIL: Recommended

EDU:	12	AD	AC
	P	R	

Competency 17.1: Explain the relationships between plants and animals within ecosystems

Key Indicators:

- 17.1.1 Classify the major categories of organisms
- 17.1.2 Differentiate among biomes
- 17.1.3 Differentiate among types of ecosystems
- 17.1.4 Identify the functions of producers and consumers
- 17.1.5 Compare the growth and development of various types of plant forms
- 17.1.6 Describe the interactions between producers, consumers, and decomposers and antagonists
- 17.1.7 Illustrate a food chain and food web
- 17.1.8 Trace the effects of pollution through a food chain
- 17.1.9 Differentiate between biodegradable and non-biodegradable products
- 17.1.10 Differentiate between organic farming and farming practices that incorporate the use of biocides and inorganic fertilizers and their effects on the environment
- 17.1.11 Differentiate among the various types of habitat and their importance to natural systems
- 17.1.12 Identify several causes for the habitat reduction
- 17.1.13 Explain why preservation of habitat is essential
- 17.1.14 Cite examples of threatened, endangered, and extinct plant and animal species
- 17.1.15 Explain the processes governing an organism's ability to respond to and survive environmental changes
- 17.1.16 List the steps of ecological succession
- 17.1.17 Give examples of how human activity impact succession
- 17.1.18 Provide examples of types of adaption
- 17.1.19 Describe microorganisms used to improve ecology

BIL: Essential

EDU:	12	AD	AC
	P	R	

Competency 17.2: Describe the character and value of natural resources

Key Indicators:

- 17.2.1 Describe the value of natural resources
- 17.2.2 Describe the types and distributions of natural resources
- 17.2.3 Differentiate between renewable and non-renewable natural resources

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 17.3: Evaluate the inappropriate use of natural resources

Key Indicators:

- 17.3.1 Describe natural events which alter the environment
- 17.3.2 Describe various methods used to obtain natural resources
- 17.3.3 Identify the primary factor for the exploitation of natural resources
- 17.3.4 Identify the technological advances contributing to the exploitation of natural resources by industry, agriculture, and transportation
- 17.3.5 Cite examples of the results of overuse that occur from exploitation of natural resources
- 17.3.6 Explain the circumstances contributing to accidental, incidental and deliberate resource abuse

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 17.4: Describe the impact of an increasing human population

Key Indicators:

- 17.4.1 Define doubling time, natural increase, natural decrease, rate of population change, and zero population growth
- 17.4.2 Interpret a population profile
- 17.4.3 Explain the relationship between a country's economic status and its population
- 17.4.4 Identify the results of increases in the population on the environment

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 17.5: Identify the impact of organizations/individuals on the development of environmental policies and issues

Key Indicators:

- 17.5.1 Recognize organizations involved with environmental issues
- 17.5.2 Identify the major issues addressed by environmental organizations
- 17.5.3 Match major events in restoration and/or conservation activities to the organizations responsible
- 17.5.4 List methods governmental agencies used to arrive at decisions affecting the environment
- 17.5.5 Identify recent environmental legislation
- 17.5.6 Describe advantages industry has over individuals on shaping environmental policy

Unit 17: Environmental Science

- 17.5.7 Evaluate results of environmental restoration and conservation efforts
- 17.5.8 Explain the role of the public in fostering environmental protection
- 17.5.9 Explain the role of the public in creating environmental harm
- 17.5.10 Compare and contrast competing interests between environmentalists and economists

BIL: Essential

EDU:	12	AD	AC
	P	R	

Competency 17.6: Describe the impact and implications of resource conservation and pollution abatement

Key Indicators:

- 17.6.1 Explain the importance of resource conservation
- 17.6.2 Cite examples of various levels of resource conservation
- 17.6.3 Identify the results of conservation efforts
- 17.6.4 Describe economic issues of conservation efforts
- 17.6.5 Identify non-economic benefits of conservation activities
- 17.6.6 Describe pollution prevention principles

BIL: Essential

EDU:	12	AD	AC
	P	R	

Competency 17.7: Describe the impact and implications of environment preservation

Key Indicators:

- 17.7.1 Explain the importance of environmental preservation
- 17.7.2 Cite examples of environmental preservation
- 17.7.3 Identify the results of preservation efforts
- 17.7.4 Describe economic issues of preservation efforts
- 17.7.5 Identify non-economic benefits of preservation activities

BIL: Essential

EDU:	12	AD	AC
	P	R	

Competency 17.8: Identify the role of responsible stewardship in maintaining a healthy environment

Key Indicators:

- 17.8.1 Define responsible stewardship
- 17.8.2 Explain the need for responsible stewardship and environmental accountability
- 17.8.3 Identify types of environmental accountability
- 17.8.4 Compare results stemming from responsible and irresponsible stewardships

Unit 18: Environmental Assessments

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 18.1: Describe Phase 1 assessment

Key Indicators:

- 18.1.1 Identify key elements in Phase 1, II, and III assessments
- 18.1.2 Describe the importance of a title search
- 18.1.3 Gather drainage area data
- 18.1.4 Complete field data sheet
- 18.1.5 Record physical and topographical data
- 18.1.6 Interpret basic soil differences
- 18.1.7 Measure ground water level
- 18.1.8 Identify flood plain areas
- 18.1.9 Measure stream flow
- 18.1.10 Complete a title search

BIL: Essential

EDU:	12	AD	AC
		I	

Competency 18.2: Identify past practices

Key Indicators:

- 18.2.1 Locate regulatory reference materials
- 18.2.2 Collect background information
- 18.2.3 Verify accuracy of information
- 18.2.4 Investigate background of complaint

- 18.2.5 Interact with various regulatory agencies
- 18.2.6 Use regulatory reference materials

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 18.3: Conduct lab/field analysis (Phase 2)

Key Indicators:

- 18.3.1 Perform Biochemical Oxygen Demand analysis
- 18.3.2 Perform Chemical Oxygen Demand analysis
- 18.3.3 Perform pH analysis
- 18.3.4 Perform specific conductivity analysis
- 18.3.5 Perform dissolved oxygen analysis
- 18.3.6 Perform suspended solids analysis
- 18.3.7 Measure water temperature, water hardness, water level and flow
- 18.3.8 Perform nitrates and nitrites analysis
- 18.3.9 Measure turbidity
- 18.3.10 Measure oxygen level
- 18.3.11 Analyze water using portable test kit
- 18.3.12 Measure Lower Explosive Levels
- 18.3.13 Measure air flow rate and temperature
- 18.3.14 Perform air particulate analysis
- 18.3.15 Describe procedures for measuring toxic gasses, organic vapors, and radiation
- 18.3.16 Measure basic field levels of contamination
- 18.3.17 Perform percolation test
- 18.3.18 Determine moisture content/dry content
- 18.3.19 Measure density
- 18.3.20 Measure chlorinated compounds
- 18.3.21 Identify background analytical data to establish norm for site

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 18.4: Collect physical data (Phase 2)

Key Indicators:

- 18.4.1 Identify safety hazards of materials
- 18.4.2 Develop “Chain of Custody” procedures
- 18.4.3 Identify physical condition of materials
- 18.4.4 Identify marking procedures
- 18.4.5 Select sampling tools
- 18.4.6 Identify preparation and preservation procedures of samples
- 18.4.7 Collect and label samples
- 18.4.8 Document samples using Chain of Custody forms
- 18.4.9 Sign over Chain of Custody form

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 18.5: Remediate site (Phase 3)

Key Indicators:

- 18.5.1 Identify options
- 18.5.2 Resolve issue with concerned party(ies)
- 18.5.3 Assess options for corrective action
- 18.5.4 Implement selected option for correction
- 18.5.5 Document investigation with summary reports

Unit 19: Introduction to Industry

BIL: Essential

EDU:	12	AD	AC
	I	R	

Competency 19.1: Describe the impact of the biotechnology industry

Key Indicators:

- 19.1.1 Identify industries that use biotechnology
- 19.1.2 Describe and assess the impact of biotechnology on contemporary society
- 19.1.3 Differentiate new areas of biotechnology from earlier uses
- 19.1.4 Identify types of products or processes used by biotechnology companies
- 19.1.5 Contrast differences between laboratories using biotechnology for research and development versus production facilities
- 19.1.6 Explain differences between commercial laboratory endeavors as opposed to academic research

BIL: Essential

EDU:	12	AD	AC
	I	R	

Competency 19.2: Classify applications of biotechnology by major industry uses

Key Indicators:

- 19.2.1 Discuss areas of human health treatment and diagnosis modified or affected by biotechnology products and processes
- 19.2.2 Compare current methods of breeding with methods of molecular genetic engineering

- 19.2.3 Discuss how biotechnologies impact crop and plant agriculture and forestry
- 19.2.4 Describe how biotechnological processes impact food production
- 19.2.5 Describe pharmaceutical company use of monoclonal antibodies
- 19.2.6 Discuss applications of biotechnologies in waste removal and cleanup, bioremediation, decontaminating soils, removing organic pollutants from industrial effluents, treating petroleum sludge and oil spills
- 19.2.7 Project applications of biotechnology to solve health problems

Unit 20: Technical Writing and Documentation

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 20.1: Evaluate technical writing requirements

Key Indicators:

- 20.1.1 Define/prioritize communication needs
- 20.1.2 Resolve conflicting requirements
- 20.1.3 Specify project objectives
- 20.1.4 Determine the size and specifics of the work to be completed
- 20.1.5 Estimate time, materials, and capabilities needed to complete assignment
- 20.1.6 Identify criteria for successful completion of project
- 20.1.7 Evaluate strengths and weaknesses of completed project

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 20.2: Write technical reports

Key Indicators:

- 20.2.1 Determine audience
- 20.2.2 Access needed information using standard references and sources
- 20.2.3 Identify type of report needed
- 20.2.4 Compile relevant data
- 20.2.5 Organize data into charts and graphs
- 20.2.6 Analyze data
- 20.2.7 Draw conclusions from data analysis
- 20.2.8 Outline report

Unit 20: Technical Writing and Documentation

- 20.2.9 Draft report
- 20.2.10 Edit report (e.g., check spelling, grammar, punctuation, sentence structure, accuracy of content)
- 20.2.11 Review report with peers
- 20.2.12 Revise report as needed based on peer feedback
- 20.2.13 Proofread revised report
- 20.2.14 Present reports

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 20.3: Conduct technical research

Key Indicators:

- 20.3.1 Identify target audience
- 20.3.2 Define research questions
- 20.3.3 Determine priorities for the information that should be gathered
- 20.3.4 Identify potential sources of information
- 20.3.5 Target audience/user group as a key information source
- 20.3.6 Identify subject-matter experts
- 20.3.7 Evaluate potential sources of information based on established criteria (e.g., affordability, relevance)
- 20.3.8 Conduct interviews with selection human information sources
- 20.3.9 Gather information from selected print and electronic sources
- 20.3.10 Determine the accuracy and completeness of the information gathered

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 20.4: Design technical documentation

Key Indicators:

- 20.4.1 Define purpose of documentation
- 20.4.2 Specify standards for documentation, including critical success criteria
- 20.4.3 Identify delivery options
- 20.4.4 Evaluate cost-effectiveness of each delivery option
- 20.4.5 Select tools appropriate for task purpose
- 20.4.6 Plan information flow
- 20.4.7 Select writing style and tone appropriate for given documentation
- 20.4.8 Determine level of detail needed
- 20.4.9 Identify visuals appropriate for given documentation
- 20.4.10 Provide feedback on design to development team/individual

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 20.5: Develop technical documentation

Key Indicators:

- 20.5.1 Determine audience
- 20.5.2 Identify parameters
- 20.5.3 Monitor development progress
- 20.5.4 Ask questions
- 20.5.5 Interpret specifications or drawings for target audience
- 20.5.6 Record process (e.g., flowchart, step-by-step narrative)
- 20.5.7 Record data

Unit 20: Technical Writing and Documentation

- 20.5.8 Maintain test logs
- 20.5.9 Compile cumulative reference/record
- 20.5.10 Measure compliance with established parameters
- 20.5.11 Verify the accuracy and validity of the information
- 20.5.12 Select information relevant to and appropriate for the given documentation
- 20.5.13 Organize/synthesize information
- 20.5.14 Present content in clear and concise way
- 20.5.15 Translate technical terminology into understandable terms (for audience)
- 20.5.16 Employ presentation tools and techniques appropriate for the given documentation
- 20.5.17 Obtain feedback on the information provided and its technical accuracy
- 20.5.18 Draft procedures
- 20.5.19 Test documentation for usability
- 20.5.20 Edit documentation for readability, grammar, and usage
- 20.5.21 Publish documentation
- 20.5.22 Maintain required logs
- 20.5.23 Track expenses

Unit 21: Computer Applications for Biotechnology

BIL: Essential

EDU:	12	AD	AC
	P		

Competency 21.1: Demonstrate basic computer literacy

Key Indicators:

- 21.1.1 Identify hardware and its use
- 21.1.2 Use hardware (e.g., printers, modems, touch screen, digitizers, plotters, graphic tablets, scanners, film recorders, video, laser image setters)
- 21.1.3 Demonstrate basic care of hardware
- 21.1.4 Explain need for and application of security levels/procedures
- 21.1.5 Perform basic hardware troubleshooting
- 21.1.6 Explain hardware addressing techniques
- 21.1.7 Create directories/folders and sub-directories
- 21.1.8 Format disks
- 21.1.9 Manipulate files (copy, rename, delete)
- 21.1.10 Demonstrate proficiency in keyboarding skills

BIL: Essential

EDU:	12	AD	AC
	P		

Competency 21.2: Create documents using word processing software

Key Indicators:

- 21.2.1 Retrieve existing documents
- 21.2.2 Create documents using existing forms and templates
- 21.2.3 Safeguard documents using name and save functions
- 21.2.4 Format text using basic formatting functions

Unit 21: Computer Applications for Biotechnology

- 21.2.5 Check documents using print preview functions
- 21.2.6 Locate/replace text using search and replace functions
- 21.2.7 Create new word processing forms, style sheets, and templates
- 21.2.8 Employ word processing utility tools
- 21.2.9 Create tables using table functions
- 21.2.10 Create columns using column functions
- 21.2.11 Create outlines
- 21.2.12 Create footnotes and endnotes
- 21.2.13 Create and run macros
- 21.2.14 Assemble documents using merge functions
- 21.2.15 Format text using advanced formatting features
- 21.2.16 Print materials using print functions
- 21.2.17 Verify accuracy of output
- 21.2.18 Edit documents
- 21.2.19 Assess needed information using help screens
- 21.2.20 Create and incorporate graphs into documents
- 21.2.21 Create and incorporate chromatograms/spectral data into documents
- 21.2.22 Create and incorporate formulas and equations into documents

BIL: Essential

EDU:	12	AD	AC
	P		

Competency 21.3: Create spreadsheets

Key Indicators:

- 21.3.1 Design a spreadsheet in accordance with specifications to aid in the collection, tabulation, synthesis and evaluation of the identified data
- 21.3.2 Create spreadsheets
- 21.3.3 Retrieve existing spreadsheets
- 21.3.4 Check spreadsheets using print preview function
- 21.3.5 Format spreadsheets
- 21.3.6 Perform calculations using formulas
- 21.3.7 Edit spreadsheets
- 21.3.8 Create charts and graphs from spreadsheets
- 21.3.9 Group worksheets

- 21.3.10 Delete within spreadsheets
- 21.3.11 Move/copy within spreadsheets
- 21.3.12 Input/process data using spreadsheet functions
- 21.3.13 Improve spreadsheet display using enhancement features
- 21.3.14 Protect data using spreadsheet protection features
- 21.3.15 Record and run macros
- 21.3.16 Troubleshoot spreadsheet problems
- 21.3.17 Resolve function errors as needed
- 21.3.18 Apply advanced spreadsheet formulas
- 21.3.19 Calculate linear regression and incorporate into spreadsheet
- 21.3.20 Plot linearity data and incorporate into spreadsheet
- 21.3.21 Plot calibration curves and incorporate into spreadsheet
- 21.3.22 Perform statistical analysis such as T-tests and RSD's
- 21.3.23 Create spreadsheet solutions to business problems
- 21.3.24 Use spreadsheets to track, summarize, and monitor trends and analytical data
- 21.3.25 Make “what if—” business decisions using spreadsheets as a tool
- 21.3.26 Save spreadsheets
- 21.3.27 Access needed information using online help features
- 21.3.28 Print spreadsheets

BIL: Essential

EDU:	12	AD	AC
	P		

Competency 21.4: Create databases

Key Indicators:

- 21.4.1 Explain terms used in database systems
- 21.4.2 Describe common functions of database systems
- 21.4.3 Design database in accordance with given specifications
- 21.4.4 Create a database table
- 21.4.5 Edit the design of a database table
- 21.4.6 Edit the content of a database table
- 21.4.7 Search a table to locate records
- 21.4.8 Sort data in a single field

Unit 21: Computer Applications for Biotechnology

- 21.4.9 Enter data using a form
- 21.4.10 Create/modify a form
- 21.4.11 Perform single- and multiple-table queries
- 21.4.12 Create calculated fields
- 21.4.13 Generate customized reports for database files
- 21.4.14 Process data using database functions (e.g., structure, format, attributes, relationships, and keys)
- 21.4.15 Locate/replace data using search and replace functions
- 21.4.16 Print forms, reports, and results of queries
- 21.4.17 Verify accuracy of output
- 21.4.18 Sort data using multiple-field sorts
- 21.4.19 Add/remove filters
- 21.4.20 Create multiple criteria expressions
- 21.4.21 Create adjoined files
- 21.4.22 Index files
- 21.4.23 Create subforms
- 21.4.24 Group data in reports
- 21.4.25 Create graphs
- 21.4.26 Alter the appearance of a form by adding objects or properties
- 21.4.27 Identify the relationship between database components
- 21.4.28 Design a database to meet the needs of an actual situation or business problem
- 21.4.29 Evaluate database design and functionality
- 21.4.30 Use bio-informatics tools and access biological databases
- 21.4.31 Use databases to track and manage data such as quality measures, analytical results, chemical inventory, consumer comments

BIL: Essential

EDU:	12	AD	AC
	P	R	

Competency 21.5: Demonstrate knowledge of the Internet

Key Indicators:

- 21.5.1 Identify the key characteristics of the Internet
- 21.5.2 Demonstrate knowledge of the ownership/administration of the Internet

- 21.5.3 Identify current issues related to the Internet
- 21.5.4 Identify services and tools offered on the Internet
- 21.5.5 Identify the specific strengths, weaknesses, and special features of available search engines
- 21.5.6 Demonstrate knowledge of bookmarks and their functions
- 21.5.7 Demonstrate knowledge of accepted Internet etiquette (netiquette)
- 21.5.8 Identify current uses and applications of the Internet
- 21.5.9 Demonstrate knowledge of the Transmission Control Protocol/Internet Protocol suite
- 21.5.10 Demonstrate knowledge of the Domain Name Server
- 21.5.11 Demonstrate knowledge of Simple Network Management Protocol
- 21.5.12 Demonstrate knowledge of Bootstrap and Dynamic Host Configuration Protocol
- 21.5.13 Demonstrate knowledge of the Address Resolution Protocol
- 21.5.14 Demonstrate knowledge of IP forwarding, encapsulation, and fragmentation
- 21.5.15 Demonstrate knowledge of Internet security issues
- 21.5.16 Identify available Internet security systems

BIL: Essential

EDU:	12	AD	AC
	P		

Competency 21.6: Access the Internet

Key Indicators:

- 21.6.1 Connect to the Internet
- 21.6.2 Test Internet connection
- 21.6.3 Demonstrate knowledge of the components of Internet software
- 21.6.4 Install Internet software
- 21.6.5 Explore browser features
- 21.6.6 Download free software upgrades and shareware from the Internet
- 21.6.7 Unpack files using compression software
- 21.6.8 Demonstrate acute awareness of virus protection techniques

BIL: Essential

EDU:	12	AD	AC
	P	R	

Competency 21.7: Utilize Internet services

Key Indicators:

- 21.7.1 Access business and technical information using the Internet
- 21.7.2 Select search engines to use
- 21.7.3 Select appropriate search procedures and approaches
- 21.7.4 Locate information using search engines and Boolean logic
- 21.7.5 Navigate web sites using software functions (e.g., Forward, Back, Go To, Bookmarks)
- 21.7.6 Evaluate Internet resources
- 21.7.7 Access library catalogs on the Internet
- 21.7.8 Access commercial, government, and education resources
- 21.7.9 Bookmark web addresses (URLs)
- 21.7.10 Download files from FTP archives
- 21.7.11 Communicate via e-mail using the Internet
- 21.7.12 Subscribe to mailing lists
- 21.7.13 Participate in newsgroups
- 21.7.14 Retrieve online tools
- 21.7.15 Download/convert Internet programming files
- 21.7.16 Install/configure web browser
- 21.7.17 Explore the multimedia capabilities of the World Wide Web
- 21.7.18 Add plug-ins and helpers to the web browser
- 21.7.19 Explore collaboration tools
- 21.7.20 Archive files
- 21.7.21 Compile a collection of biotechnology business sites

BIL: Essential

EDU:	12	AD	AC
	P	R	

Competency 21.8: Use a shared environment**Competency Builders:**

- 21.8.1 List purposes of a network environment
- 21.8.2 Define electronic mail
- 21.8.3 Identify advantages and disadvantages of electronic mail
- 21.8.4 Describe impact of local & wide area networks on mail delivery
- 21.8.5 Compose electronic messages
- 21.8.6 Send electronic messages using appropriate format
- 21.8.7 List categories of electronic mail service
- 21.8.8 Transmit document using electronic mail system
- 21.8.9 Monitor electronic mail
- 21.8.10 Use networked environments
- 21.8.11 Search database for properties of materials
- 21.8.12 Conduct literature searches using a variety of on-line tools
- 21.8.13 Explain access, security, transmission and retrieval
- 21.8.14 Participate in electronic discussion groups
- 21.8.15 Use bio-informatics tools and access biological databases (e.g., BLAST, C-DART)

BIL: Essential

EDU:	12	AD	AC
	P	R	

Competency 21.9: Operate software packages for science technology

Key Indicators:

- 21.9.1 Use PowerPoint or other presentation software
- 21.9.2 Use BLAST and other such programs for biological data analysis
- 21.9.3 Run instrumental data systems

Unit 22: Database Administration – (Bioinformatics strand)

BIL: Essential

EDU:	12	AD	AC
	I/P	P	

Competency 22.1: Apply databases to actual situations and business problems

Key Indicators:

- 22.1.1 Derive database design from a workflow drawing or other requirement documents
- 22.1.2 Design a database to solve a business problem or other real-life problem situation
- 22.1.3 Identify the relationship between database components
- 22.1.4 Sort data on multiple fields
- 22.1.5 Add/remove filters
- 22.1.6 Create queries with multiple criteria
- 22.1.7 Join tables in a query
- 22.1.8 Enhance the design of a form
- 22.1.9 Create needed subforms
- 22.1.10 Group data in reports
- 22.1.11 Make a calculation on a report
- 22.1.12 Imbed data and graphics
- 22.1.13 Import data and graphics
- 22.1.14 Link data and graphics

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 22.2: Apply data modeling techniques

Key Indicators:

- 22.2.1 Interpret terminology associated with data models
- 22.2.2 Compare/contrast various data models
- 22.2.3 Analyze data models
- 22.2.4 Develop a data model to describe an application’s data

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 22.3: Create conceptual data models

Indicators:

- 22.3.1 Analyze model requirements
- 22.3.2 Identify business entities and the relationships between them
- 22.3.3 Define data in an integrated data dictionary
- 22.3.4 Ensure that conceptual model includes tools to facilitate user access

BIL: Essential

EDU:	12	AD	AC
	I	I/P	

Competency 22.4: Validate conceptual data models

Key Indicators:

- 22.4.1 Present conceptual data model to client
- 22.4.2 Resolve issues with client
- 22.4.3 Secure client approval for model
- 22.4.4 Feed recommendations back into the modeling process
- 22.4.5 Document validation process

BIL: Essential

EDU:	12	AD	AC
		I/P	

Competency 22.5: Integrate conceptual data models with enterprise models

Key Indicators:

- 22.5.1 Ensure that conceptual model is consistent with enterprise model (e.g., entity names, relationships, and definitions)
- 22.5.2 Develop conceptual schema
- 22.5.3 Secure client approval for modifications in enterprise models

BIL: Essential

EDU:	12	AD	AC
		I/P	

Competency 22.6: Reconcile conceptual models with appropriate-level process models

Key Indicators:

- 22.6.1 Verify consistencies between models
- 22.6.2 Identify areas of overlap
- 22.6.3 Verify that data entities in process model have a corresponding entity data model
- 22.6.4 Document changes or modifications in either model

BIL: Essential

EDU:	12	AD	AC
		I/P	

Competency 22.7: Create logical data models

Key Indicators:

- 22.7.1 Map data model to a relational model
- 22.7.2 Identify attributes of model entities and relationships between them
- 22.7.3 Verify that logical model is consistent with conceptual model
- 22.7.4 Specify integrity constraints

BIL: Essential

EDU:	12	AD	AC
		I/P	

Competency 22.8: Distinguish unique identifiers

Key Indicators:

- 22.8.1 Document identifiers
- 22.8.2 Identify rationale for selection of identifiers
- 22.8.3 Validate identifiers with client

BIL: Essential

EDU:	12	AD	AC
		I/P	

Competency 22.9: Normalize data models

Key Indicators:

- 22.9.1 Normalize data models
- 22.9.2 Verify that data model matches specifications
- 22.9.3 Validate logical data model with client

BIL: Essential

EDU:	12	AD	AC
		I/P	

Competency 22.10: Reconcile conceptual models with lower process models

Key Indicators:

- 22.10.1 Verify consistencies between models
- 22.10.2 Identify areas of overlap
- 22.10.3 Verify that data entities in process model have a corresponding entity data model
- 22.10.4 Document changes or modifications in either model
- 22.10.5 Integrate logical data model with enterprise model

BIL: Essential

EDU:	12	AD	AC
		I/P	

Competency 22.11 Determine environment/platform for physical data models

Key Indicators:

- 22.11.1 Research potential environments/platforms
- 22.11.2 Identify platform capabilities and limitations
- 22.11.3 Select environment/platform based on technical, business, and skill information gathered
- 22.11.4 Secure approval of target environment/platform

BIL: Essential

EDU:	12	AD	AC
		I/P	

Competency 22.12: Identify backup and recovery requirements for physical models

Indicators:

- 22.12.1 Establish backup requirements consistent with corporate policy and business needs
- 22.12.2 Document established backup procedures
- 22.12.3 Control access to database to maintain security

BIL: Essential

EDU:	12	AD	AC
		I/P	

Competency 22.13: Identify model access requirements

Key Indicators:

- 22.13.1 Identify inputs, output, and volume of every user view
- 22.13.2 Categorize user views by type of transaction
- 22.13.3 Document access to data by type of access
- 22.13.4 Integrate access requirements with backup and recovery plan

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 22.14: Identify physical database characteristics

Key Indicators:

- 22.14.1 Identify name, type, and length of attributes
- 22.14.2 Employ table and file names that conform to naming conventions
- 22.14.3 Group/assign tables to disk files
- 22.14.4 Index files for performance and integrity
- 22.14.5 Verify that data types are consistent between attributes
- 22.14.6 Employ normalization and modeling as cross-checking techniques

BIL: Essential

EDU:	12	AD	AC
		I/P	

Competency 22.15: Reconcile physical design with processing requirements

Key Indicators:

- 22.15.1 Resolve conflicts between physical model and process model
- 22.15.2 Verify that data entities in process model have a corresponding entity data model
- 22.15.3 Document changes made to either model

Unit 23: Data Warehousing – (Bioinformatics strand)

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 23.1: Demonstrate knowledge of basic data warehousing concepts

Key Indicators:

- 23.1.1 Differentiate between traditional databases and data warehouses
- 23.1.2 Recognize importance of data warehouses and integration
- 23.1.3 Recognize that information is a competitive resource
- 23.1.4 Identify components of data warehouses (e.g., subject-oriented, integrated, time-variant, nonvolatile)
- 23.1.5 Identify the characteristics and uses of metadata
- 23.1.6 Define types of information (e.g., associations, sequences, classifications, clusters, and forecasting)
- 23.1.7 Demonstrate knowledge of data conversion techniques and functions
- 23.1.8 Identify types of programs and applications for data warehousing
- 23.1.9 Identify types of data mining tools (i.e., neural networks, decision trees, rule induction, and data visualization)
- 23.1.10 Define public summary data
- 23.1.11 Demonstrate knowledge of ethical issues of data warehousing

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 23.2: Apply ethical behaviors to data warehousing

Key Indicators:

- 23.2.1 Define appropriate security measures
- 23.2.2 Analyze the limitations of external data
- 23.2.3 Identify ethical uses of data
- 23.2.4 Define use of permanent detail data for legal or ethical purposes

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 23.3: Perform data entry and updating

Key Indicators:

- 23.3.1 Develop an entity-relationship diagram
- 23.3.2 Employ appropriate index or indices
- 23.3.3 Define data repositories
- 23.3.4 Design metamodel
- 23.3.5 Apply appropriate security measures
- 23.3.6 Differentiate between permanent detail data and regular data
- 23.3.7 Apply skill in working with data programs
- 23.3.8 Maintain metadata
- 23.3.9 Size data warehouse
- 23.3.10 Load/transfer data (map data)
- 23.3.11 Scrub/filter data

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 23.4: Perform data retrieval

Key Indicators:

- 23.4.1 Locate appropriate data warehouses
- 23.4.2 Perform strategic analyses using a multidimensional database
- 23.4.3 Secure necessary indices
- 23.4.4 Design reasonable query
- 23.4.5 Define nature of application
- 23.4.6 Apply appropriate security measures
- 23.4.7 Obtain necessary responses from data query
- 23.4.8 Calculate derived and aggregate data
- 23.4.9 Validate the processing of data

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 23.5: Apply data

Key Indicators:

- 23.5.1 Optimize query procedures
- 23.5.2 Evaluate information gathered in query
- 23.5.3 Utilize public summary data
- 23.5.4 Design reporting medium
- 23.5.5 Perform online analytical processing
- 23.5.6 Construct report from data gathered

Unit 24: Statistics - (Bioinformatics strand)

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 24.1: Demonstrate knowledge of the role of statistics and probability

Key Indicators:

- 24.1.1 Identify the role of statistical methods in decision-making
- 24.1.2 Recognize the pervasive use of probability in the real world
- 24.1.3 Demonstrate knowledge of how to make predictions based on exponential or theoretical probabilities
- 24.1.4 Establish procedures for the systematic collection, organization, and use of data
- 24.1.5 Recognize the importance of using tables, charts, and graphs to organize and present data

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 24.2: Make frequency distributions

Key Indicators:

- 24.2.1 Demonstrate knowledge of the characteristics and uses of grouped and ungrouped frequency distributions
- 24.2.2 Make ungrouped frequency distributions using raw data
- 24.2.3 Make grouped frequency distributions using raw data
- 24.2.4 Interpret frequency distributions

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 24.3: Present data graphically

Key Indicators:

- 24.3.1 Demonstrate knowledge of the characteristics and uses of various tools for presenting data graphically
- 24.3.2 Prepare line charts/frequency polygons
- 24.3.3 Interpret line charts/frequency polygons
- 24.3.4 Prepare bar charts/histograms
- 24.3.5 Interpret bar charts/histograms

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 24.4: Apply measures of central tendency

Key Indicators:

- 24.4.1 Define mean, median, mode
- 24.4.2 Compute means, medians, and modes
- 24.4.3 Interpret measures of central tendency
- 24.4.4 Determine when and how to use measures of central tendency

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 24.5: Explain measures of dispersion

Key Indicators:

- 24.5.1 Define variance, average deviation, standard deviation, and coefficient of variation
- 24.5.2 Compute variance average deviations, standard deviations, and coefficients of variation
- 24.5.3 Interpret measures of dispersion
- 24.5.4 Determine when and how to use measures of dispersion

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 24.6 Solve probability problems

Key Indicators:

- 24.6.1 Define joint, marginal, and conditional probabilities
- 24.6.2 Solve joint probability problems using additions, multiplication permutation, and combination formulas
- 24.6.3 Solve marginal probability problems using additions, multiplication permutation, and combination formulas
- 24.6.4 Solve conditional probability problems using additions, multiplication permutation, and combination formulas

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 24.7 Apply binomial and normal probability distributions

Key Indicators:

- 24.7.1 Demonstrate knowledge of the characteristics and uses of normal probability distributions
- 24.7.2 Make binomial probability distributions
- 24.7.3 Make normal probability distributions

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 24.8 Demonstrate knowledge of statistical inference

Key Indicators:

- 24.8.1 Demonstrate knowledge of the purposes of sampling
- 24.8.2 Demonstrate knowledge of standard methods for selecting a sample
- 24.8.3 Select a sample using an appropriate method
- 24.8.4 Demonstrate knowledge of the characteristics/uses of hypothesis testing
- 24.8.5 State a hypothesis
- 24.8.6 Test a hypothesis

APPENDICES

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Appendix A

Biotechnology Profile Review Panel Participants

Debra Baker, Associate Director, Gene Screen

Bill Busby, Manager, Human Resources, Athersys, Inc.

Teresa A. Castle, Specialist, Analytical R&D, Mead Central Research Laboratories

Alan Coe, President/CEO, Paraspinal Diagnostic Corp.

Bryan Conn, Manager, Cancer Research Laboratories, The Rogosin Institute

Chris Cordle, Manager, Immunology R&D, Ross Products Division, Abbott Laboratories

Paul DeMasi, Manager, Human Resources, Alkermes, Inc.

Joseph Dietz, Director, QC/QA, ICN Biomedical

Patricia Eisenhardt, Vice President, ChipRx, Inc.

Lynn E. Elfner, CEO, The Ohio Academy of Science

Evan Facher, Manager, Business Development, Athersys, Inc.

Paula Gregory, Assistant Professor/Director, Outreach & Education, Human Cancer Genetics/OSU

Paul J. Grothaus, Director, Client Services & Marketing, Battelle Memorial Institute

Tim J. Huffner, The Proctor & Gamble Co, Miami Valley Labs

Cindy Karger, Tech Prep Director, Cuyahoga Community College

Ron Kindell, Tech Prep Director, Sinclair Community College

Dennis W. King, President, STATKING Consulting Inc.

Dave McDaniel, Biotechnology Pathway Manager, Sinclair Community College

Adel Mikhail, Vice President, Marketing & Development, LabBook.com Inc.

K. Megan O'Neill Miller, Chief Operating Officer, ChanTest, Inc.

Kunthavi Natarajan, Associate Professor, Biotechnology Program, Sinclair Community College

Denise S. Richardson, Technology Liaison, Northern Ohio, Edison Biotechnology Center, Inc.

Jack Steinicke, Tech Prep Director, Lakeland Community College

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C. Ron Wilson, Senior Program Manager, Applied Biotechnology, Cognis Corp.

Business and education partners of:

Lakeland Community College
Sinclair Community College
Kent State University/Trumbull Campus
Cuyahoga Community College

Appendix B
PATHWAY TEMPLATE



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Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)



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