

North Coast Tech Prep Consortium

Biotechnology Technical Competency
Profile

Final



Biotechnology Technician

September 20, 2007
Cleveland, Ohio

NORTH COAST TECH PREP CONSORTIUM
BIOTECHNOLOGY TECHNOLOGIES
BIOTECHNOLOGY TECHNICIAN
TECHNICAL COMPETENCY PROFILE

INTRODUCTION

This document is the result of a local competency profile implementation meeting held September 22, 2005 by the North Coast Tech Prep Consortium. The local panel included business representatives, secondary educators, and post-secondary educators. Please see the following pages for a complete list of panel members.

The local panel reviewed the Ohio Biotechnology Technician Technical Competency Profile and adapted it to meet the needs of local businesses.

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September 20, 2007

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KEY TO PROFILE CODES

IMPORTANCE OF COMPETENCE (Determined by Business and Industry Panel)

Essential Competency: Competency is needed to ensure **minimal** level of employability. Entry level employees should be able to perform this competency without supervision at the end of the associate degree. Competencies required for certification, licensure, and/or national skills standards should be tagged as essential.

Recommended Competency: Competency should be included but is not essential for minimal level of employability.

Delete: Competency should not be included.

DEPTH OF INSTRUCTION (Determined by Educators' Panel)

I = Introduce (applies to 25% of the competency builders. In competencies with 3 or less builders, all builders should be introduced before this code can be used.)

R = Reinforce or add depth (after introducing or proficiency)

P = Proficient (achievement of 80% of the competency builders **without** supervision)

Grade Level: **12** = by the end of grade 12

AD = by the end of the Associate Degree

ACADEMIC CONNECTION (AC)

Section of the Ohio Academic standards to which the competency relates. May include: Math (M), Science (S), Communication (C), or Social Science (H)

Example:

BIL:	Essential		
EDU:	12	AD	AC
	I	P	M,S

Competency 1.1: Analyze

Competency Builders:

Explain

Identify

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				curves	
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**NCTPC BIOTECHNOLOGY
TECHNICAL COMPETENCY PROFILE
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Matrix

BTT = Biotechnology Technician			
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**NOTES TO COLUMBUS FOR BIOTECHNOLOGY TCP FROM NORTH COAST
TECH PREP TCP MEETING - September 20, 2007**

The following reflects changes to the Biotechnology TCP by section:

Unit	Competency	Change	12	AD
1.1			P	R
1.2			P	R
1.3			I	R
1.4			I	R
2.1			I	R
2.2			P	R
2.3			P	R
2.4			P	R
2.6			P	R
3.2	3.2.6	DELETED		
3.2	3.2.8	DELETED		
3.2	3.2.12	DELETED		
3.3	3.3.4	DELETED		
3.3	3.3.6	DELETED		
3.3	3.3.8	DELETED		
3.3	3.3.12	DELETED		
3.3	3.3.13	DELETED		
3.3	3.3.15	DELETED		
3.4	3.4.6	DELETED		
3.4	3.4.12	Use autoclaves		
3.6	3.6.4	Identify proper equipment for monitoring radioactive materials	I	P
3.6	3.6.6	Identify practical applications of radioactive isotopes		
4.8	All	DELETED		
5.3	5.3.3	DELETED	I	P
6.1	6.1.13	DELETED		
6.1	6.1.18	DELETED		
6.2	6.2.4	DELETED		
6.2	6.2.5	DELETED		
8.2			I	P
9.1			P	R
9.2	9.2.19	DELETED		
9.2	9.2.20	DELETED		
10.2			P	R
10.2	10.2.6	Isolate DNA		
10.2	10.2.7	Isolate RNA		
10.3	10.3.5	DELETED		
10.4			I	P
10.6			I	P
10.6	10.6.3	DELETED		
10.6	10.6.4	DELETED		
11.2			I	P

13.2			I	P
13.2	13.2.6	Explain sterilization by micro-filtration		
14.6	14.6.4	Explain how to connect to the internet via current technology		
14.6	14.6.6	Navigate the World Wide Web safely		

Definition of Biotechnology

The knowledge of bioprocesses applied to the engineering and use of cellular and molecular mechanisms to solve problems or make products.

Occupational Definition

Biotechnology Technician

An individual who may prepare materials, conduct experiments, record data, and assist with the development/presentation of reports in the industrial and academic settings. Exit occupations may include, but not be limited to:

Research and Development

- Microbiology Technician
- Cell Culture Technician
- Molecular Biology Technician
- Analytical Technician

Manufacturing

- Quality Technician
- Field Technician
- Bioprocess Technician
- Environmental Technician

Unit 1: Demonstrate Scientific Method

BIL: Essential

EDU:	12	AD	AC
	P	R	S,C

Competency 1.1: Define scientific research methods

Competency Builders:

- 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
- 1.1.5 Conduct literature search

BIL: Essential

EDU:	12	AD	AC
	P	R	C,S

Competency 1.2: Identify components of a research plan

Competency Builders:

- 1.2.1 Define focus of research
- 1.2.2 Identify research plan including significance of problem, purpose, variables, hypothesis, objectives, methods of study, and list of materials
- 1.2.3 Identify deficiencies of plan
- 1.2.4 Suggest alternative solutions

Note:

This would be more appropriate at BD level. Student won't be proficient in this by end of AD. Also, BIL would not have an AD grad perform this skill.

BIL: Essential

EDU:	12	AD	AC
	I	R	S,C,M

Competency 1.3: Apply critical thinking skills

Competency Builders:

- 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 judgement 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 Make decisions based on varying amounts of information
- 1.3.11 Recognize own limitations
- 1.3.12 Recognize and correct discrepancies
- 1.3.13 Analyze data retrieved from instrument output

BIL: Essential

EDU:	12	AD	AC
	I	R	S,M,C

Competency 1.4: Demonstrate problem solving skills

Competency Builders:

- 1.4.1 Recognize existence of problem
- 1.4.2 Identify possible reasons/causes of problem
- 1.4.3 Identify components of action plan to resolve problem
- 1.4.4 Implement plan of action to resolve problem
- 1.4.5 Monitor progress of action plan
- 1.4.6 Evaluate progress of action plan
- 1.4.7 Revise plan as indicated by findings
- 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	R	S,M,C

Competency 2.1: Apply quality control principles to laboratory management

Competency Builders:

- 2.1.1 Describe principles of quality control
- 2.1.2 Describe the role of the laboratory technician implementing quality management
- 2.1.3 Define steps involved in problem-solving procedures
- 2.1.4 Draw a process diagrams to identify input processes and outputs for an experiment conducted in the laboratory
- 2.1.5 Identify ways to ensure that a process is under control
- 2.1.6 Describe the concept of continuous improvement
- 2.1.7 Describe the value of each in planning and designing experiments (as it pertains to conducting experiments)
- 2.1.8 Construct a process flow diagram to describe a project
- 2.1.9 Working with a team construct a process flow diagram to describe a project
- 2.1.10 Describe how teams function, including the roles of different team members, and the value of diversity in teams

BIL: Essential

EDU:	12	AD	AC
	P	R	S,M,C

Competency 2.2: Identify components of planning experiments

Competency Builders:

- 2.2.1 Describe the importance of "defining the problem" when conducting experiments
- 2.2.2 Identify goals of an experiment
- 2.2.3 Conduct a literature search
- 2.2.4 Develop a report for an experiment
- 2.2.5 Develop a timetable for an experiment
- 2.2.6 Monitor results of an experiment
- 2.2.7 Identify components of a safety plan
- 2.2.8 Identify components of a quality assurance plan

BIL: Essential

EDU:	12	AD	AC
	P	R	S,M,C

Competency 2.3: Identify components of experimental design**Competency Builders:**

- 2.3.1 Develop plans for conducting an experiment
- 2.3.2 Identify the critical steps in a procedure
- 2.3.3 Determine the number of samples required for a valid experiment and the kind and quantity of data required to validate procedures
- 2.3.4 Estimate the error involved in each of the steps in a procedure
- 2.3.5 Describe the concept of a "control experiment"
- 2.3.6 Specify goals and restraints
- 2.3.7 Generate alternatives
- 2.3.8 Consider health and safety risks
- 2.3.9 Evaluate best alternatives

BIL: Essential

EDU:	12	AD	AC
	P	R	S,M,C

Competency 2.4: Conduct experiments

Competency Builders:

- 2.4.1 Perform procedures based on the experimental design
- 2.4.2 Conduct steps according to standard operating procedures
- 2.4.3 Monitor experiments in progress
- 2.4.4 Construct charts and graphs representing the data obtained
- 2.4.5 Recognize the mechanical limitation of assays being used
- 2.4.6 Make recommendations for future work

BIL: Essential

EDU:	12	AD	AC
	P	R	S,C,M

Competency 2.5: Record experimental results

Competency Builders:

- 2.5.1 Record any observations in a laboratory notebook
- 2.5.2 Record raw data in laboratory notebook following established procedures
- 2.5.3 Identify methods of precision and accuracy of experimental data
- 2.5.4 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
- 2.5.5 Identify types of data

BIL: Essential

EDU:	12	AD	AC
	P	R	C,S,M

Competency 2.6: Report experimental results

Competency Builders:

- 2.6.1 Identify components of scientific paper/report
- 2.6.2 Identify components of oral presentation
- 2.6.3 Prepare scientific report
- 2.6.4 Present scientific report orally
- 2.6.5 Use scientific notation
- 2.6.6 Recognize that experimental results must be open to scrutiny of others
- 2.6.7 Discuss results with team members on a regular basis, making suggestions for modifications
- 2.6.8 Demonstrate various ways to display data

Unit 3: Laboratory Safety and Maintenance

BIL: Essential

EDU:	12	AD	AC
	I	P	S,C,H

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

Competency Builders:

- 3.1.1 Identify the agencies (federal, state, and local) that develop and enforce regulations pertaining to chemical and related industries
- 3.1.2 Explain 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	R	S

Competency 3.2: Demonstrate personal safety procedures

Competency Builders:

- 3.2.1 Describe causes of sight loss in the laboratory environment

- 3.2.2 Use appropriate personal protective equipment (PPE) for a variety of situations involving hazardous chemicals, including but not limited to corrosive, explosive, biological, and volatile materials
- 3.2.3 Use safety equipment, including but not limited to 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 Participate in an evacuation procedure
- 3.2.7 Explain situational awareness

BIL: Essential

EDU:	12	AD	AC
	I	P	S,C

Competency 3.3: Identify general workplace safety hazards

Competency Builders:

- 3.3.1 Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards, non-ionizing radiation, lasers, microwaves, electro magnetic fields)
- 3.3.2 Identify safety materials/equipment and transportation (e.g., absorbent socks, oil dry)
- 3.3.3 Identify purpose of emergency evacuation routes and safety color coding systems
- 3.3.4 Describe methods of evaluating potential hazards (e.g., visual analysis)
- 3.3.5 Interpret material safety data sheets (MSDS)
- 3.3.6 Describe corrective procedures for unsafe conditions
- 3.3.7 Explain precautions required when using hazardous material
- 3.3.8 DELETED
- 3.3.9 Identify correct material handling procedures

BIL: Essential

EDU:	12	AD	AC
	I	P	S,C

Competency 3.4: Handle laboratory equipment safely

Competency Builders:

- 3.4.1 Describe the purpose of common chemical laboratory equipment
- 3.4.2 Handle safely common chemical laboratory equipment
- 3.4.3 Store compressed gases cylinders correctly and safely
- 3.4.4 Transport compressed gases cylinders correctly and safely
- 3.4.5 Change compressed gases cylinders correctly and safely
- 3.4.6 Manipulate glassware and other apparatus safely, including making connections, cleaning, and storing
- 3.4.7 Care for glassware and other apparatus safely including attaching components of a system, cleaning, and storing
- 3.4.8 Describe how maintenance programs for equipment and laboratory facilities relate to safe and efficient laboratory operation
- 3.4.9 Identify common components of electrical and electronic circuits that may frequently be maintained by laboratory technicians
- 3.4.10 Demonstrate a basic awareness of electrical safety and its application to the work environment
- 3.4.11 Use autoclaves
- 3.4.12 Demonstrate use of safety equipment

BIL: Essential

EDU:	12	AD	AC
	I	P	S,C,H

Competency 3.5: Handle chemicals and safety equipment appropriately

Competency Builders:

- 3.5.1 List proper safety equipment (e.g., proper hoods, shields)
- 3.5.2 Identify appropriate protective equipment (e.g., eye wear, special clothing)
- 3.5.3 Identify specific categories of hazardous chemicals
- 3.5.4 Identify hazards associated with collecting samples
- 3.5.5 Label all chemicals, materials, tools, and equipment with appropriate safety, health, and environmental details
- 3.5.6 Explain importance of appropriate display of warning labels
- 3.5.7 Demonstrate safe handling of materials under pressure
- 3.5.8 Explain the hazard symbols and toxicology sections of material safety data sheets (MSDS)
- 3.5.9 Classify chemicals according to reactivity
- 3.5.10 Identify incompatible combinations of chemicals that could result in potentially dangerous situations
- 3.5.11 Use standard operating procedures (SOP) and MSDS
- 3.5.12 Classify chemicals according to safety and health hazards (flammables, corrosives, oxidizers, and carcinogens)
- 3.5.13 Identify the conventions and symbols used for labeling chemical materials; include Hazardous Material Identification System (HMIS) and National Fire Protection Association (NFPA) guidelines
- 3.5.14 Demonstrate the ability to read, interpret, and prepare labels for a variety of chemical materials
- 3.5.15 Interpret hazard data associated with chemicals that are presented in material safety data sheets (MSDS) and other chemical data reference documents

- 3.5.16 Use a chemical reference handbook to identify hazards associated with handling and storing chemical materials
- 3.5.17 Handle corrosive materials properly
- 3.5.18 Use appropriate techniques to transfer gases, liquids, and solids from storage containers to equipment used in the laboratory
- 3.5.19 On the basis of vapor pressure, assess safe handling procedures for a variety of volatile chemicals
- 3.5.20 Use mixing techniques appropriate for the materials, specifically when handling acids, bases, oxidizers, and strong reducing agents
- 3.5.21 Store chemicals appropriately, recognizing the compatibility of the materials being stored and the containers in which they are being stored
- 3.5.22 Clean laboratory glassware and laboratory equipment made of other materials, using appropriate solvents, detergents, and brushes or cleaning devices
- 3.5.23 Dispose of hazardous materials safely and according to regulatory guidelines
- 3.5.24 Develop a chemical inventory system for a stockroom that includes all pertinent information regarding stability, hazards, and sensitivity; create a database for this information
- 3.5.25 Identify heating and ventilation systems used in chemical storage areas and compare their appropriateness for the groups of chemicals being stored

BIL: Essential

EDU:	12	AD	AC
	I	P	S,C,M

Competency 3.6: Describe safe work practices compliant with radioactive materials

Competency Builders:

- 3.6.1 Compare hazards associated with various modes of radioactive decay
- 3.6.2 Apply the concept of half-life to predict potential hazards of radioactive materials
- 3.6.3 Apply the special requirements for handling and disposal of radioactive materials
- 3.6.4 Identify proper equipment for monitoring radioactive materials
- 3.6.5 Calculate half-life of radioactive material using the first-order decay equation
- 3.6.6 Identify practical applications of radioactive isotopes

BIL: Essential

EDU:	12	AD	AC
		P	S,C

Competency 3.7: Describe laboratory safety and biohazard issues

Competency Builders:

- 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

Unit 4: Instrument Analysis

BIL: Essential

EDU:	12	AD	AC
	P	R	S,M

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

Competency Builders:

- 4.1.1 Demonstrate proper use of pipets
- 4.1.2 Demonstrate proper use of pH meter
- 4.1.3 Demonstrate proper use of centrifuge
- 4.1.4 Demonstrate proper use of balances
- 4.1.5 Demonstrate proper use of electrophoresis apparatus
- 4.1.6 Read measurement devices

BIL: Essential

EDU:	12	AD	AC
		P	S,C

Competency 4.2: Apply principles of filtration

Competency Builders:

- 4.2.1 Define macrofiltration, microfiltration, ultrafiltration, depth filter, membrane filter, and tangential filtration
- 4.2.2 Filter sterilize a solution
- 4.2.3 Filter solutions using depth and membrane filters
- 4.2.4 Choose proper filter for an application
- 4.2.5 Describe ultrafiltration

BIL: Essential

EDU:	12	AD	AC
	I	P	S,M,C

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

Competency Builders:

- 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
- 4.3.6 Explain how to balance a loader

BIL: Essential

EDU:	12	AD	AC
	I	P	S,M,C

Competency 4.4: Demonstrate proficiency in use of the ultraviolet-visible (UV/visible) spectrophotometer, and construct standard curves

Competency Builders:

- 4.4.1 Obtain absorption/transmission data for biological samples
- 4.4.2 Read absorption or percent transmission from a set of test tubes
- 4.4.3 Relate absorption to transmission
- 4.4.4 Construct a standard curve
- 4.4.5 Calculate quantities of a substance

BIL: Essential

EDU:	12	AD	AC
		P	S,M,C

Competency 4.5: Demonstrate proficiency in use of thin-layer chromatography (TLC) and high-performance liquid chromatography (HPLC)

Competency Builders:

- 4.5.1 Write a description of the principles of thin-layer chromatography (TLC) as a separation tool
- 4.5.2 Describe uses of TLC as an analytical tool
- 4.5.3 Describe components of the apparatus used to conduct TLC
- 4.5.4 Identify effects of temperature, solvents, and plate types on conducting TLC separations
- 4.5.5 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
- 4.5.6 Identify components in an unknown material using TLC
- 4.5.7 Identify parameters of a high-performance liquid chromatograph that influence the chromatogram
- 4.5.8 Install chromatographic columns in high-performance liquid chromatography (HPLC) instruments
- 4.5.9 Calibrate HPLC instruments for optimal performance
- 4.5.10 Use HPLC to separate mixtures of substances; install columns, choose appropriate HPLC-grade solvents, and perform separation

BIL: Essential

EDU:	12	AD	AC
	I	P	S,M

Competency 4.6: Apply basic concepts of spectroscopic analytical methods

Competency Builders:

- 4.6.1 Define "spectroscopy" in terms of the interaction of radiant energy and matter
- 4.6.2 Identify wavelength and frequency ranges of ultraviolet (UV), visible, and infrared (IR) regions
- 4.6.3 Show the relationship among wavelength, frequency, and energy and the inverse proportionality between frequency and wavelength
- 4.6.4 Describe differences between the way energy is absorbed in the IR region and the ultraviolet-visible (UV-vis) region of the spectrum
- 4.6.5 Show the relationship between concentration of an absorbing species and the transmittance or absorbance of energy
- 4.6.6 Use Beers' Law

BIL: Essential

EDU:	12	AD	AC
		P	S,M

Competency 4.7: Apply principles and techniques of ultraviolet-visible (UV-vis) spectroscopy

Competency Builders:

- 4.7.1 Identify the radiation sources and the detectors used
- 4.7.2 Describe the kinds of compounds that absorb in the UV region of the spectra
- 4.7.3 List major analytical applications of UV spectroscopy
- 4.7.4 Demonstrate proper care of cells used for analysis

- 4.7.5 Perform several analyses using UV absorption
- 4.7.6 Follow through from calibration to final analysis on known materials
- 4.7.7 Provide examples of ultraviolet-visible (UV-vis) spectroscopy use in local industry

BIL: Essential

EDU:	12	AD	AC
		P	S,C

Competency 4.8: Explain laboratory automation

Competency Builders:

- 4.8.1 Explain why and when to use robotics
- 4.8.2 Define the benefits of automation to high throughput screening, drug discovery and manufacturing

Unit 5: Chemical Materials Handling and Sampling

BIL: Essential

EDU:	12	AD	AC
	P	R	S,M,C

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
- 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	S,M

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)

BIL: Essential

EDU:	12	AD	AC
	I	P	S,M

Competency 5.3: Obtain samples

Competency Builders:

- 5.3.1 Describe the importance of obtaining a representative sample
- 5.3.2 Give examples of some characteristics of solid, liquid, and gas samples that could result in nonhomogeneity
- 5.3.3 Design a sampling scheme to ensure adequate representation from bulk material
- 5.3.4 Use a variety of grinding, blending, and mixing techniques to prepare homogeneous samples on which to conduct measurements
- 5.3.5 Demonstrate good laboratory practices with respect to standard and sample handling
- 5.3.6 Identify errors in a measurement that can be attributed to failure to obtain a representative sample
- 5.3.7 Identify a variety of sample containers and their primary uses
- 5.3.8 Use sieves to separate a sample according to particle size
- 5.3.9 Obtain representative samples of gases, liquids, and solids including: solid materials in bulk storage; material in process streams; high-vapor-pressure materials; corrosive liquids; nonhomogeneous solids; air- and moisture-sensitive materials in environmental (open) systems; gases under pressure; corrosive liquids; micro quantities of liquids and solids; and biological specimens
- 5.3.10 Describe potential interactions between the construction materials of a sample container and the contents being stored
- 5.3.11 Identify compatible container materials for common chemicals, solutions, and mixtures
- 5.3.12 Describe how to store samples to avoid changing their characteristics (i.e., should include holding times and preservatives as required)
- 5.3.13 Prepare a chain of custody document for a sample taken for analysis
- 5.3.14 Conduct a statistical analysis to evaluate how well a sample represents bulk material

Unit 6: Physical Properties Measurement

BIL: Essential

EDU:	12	AD	AC
	I	P	S,M

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 Develop a frequency distribution chart for a data set
- 6.1.5 Describe a control chart and construct such a chart using a data set
- 6.1.6 Define what is meant by an "out-of-control" measurement
- 6.1.7 Define "confidence limit" in terms of standard deviation
- 6.1.8 Describe what is meant by significant figures; give examples
- 6.1.9 Compare systematic and random errors
- 6.1.10 Calibrate analytical balances
- 6.1.11 Use analytical balances for weighing quantities ranging from 0.001 grams to 100 grams to a specified accuracy and precision
- 6.1.12 Identify, select, and demonstrate proper use of volumetric glassware (burets, graduated cylinders, flasks, and pipets)
- 6.1.13 Make quantitative transfers using volumetric glassware
- 6.1.14 Calculate errors in various measurements based on data acquired using common laboratory equipment
- 6.1.15 Apply standard rules for determining the number of significant figures in measurements and in the answers to corresponding calculations
- 6.1.16 Convert units of measure from English to metric and vice versa
- 6.1.17 Evaluate propagation of error in calculation involving one or more steps
- 6.1.18 Define detection limitations
- 6.1.19 Calculate linear regressions

BIL: Essential

EDU:	12	AD	AC
	I	P	S,M

Competency 6.2 Characterize physical properties of alternative states of matter

Competency Builders:

- 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 Identify types of materials, apparatus, and procedures used to make the following measurements (i.e., formula weight, cloud point, odor, color-optical rotation, density, refractive index, dew point, particle size, flash point, taste, freezing point, tensile strength, hardness, viscosity, melting point, thermal conductivity, heat capacity, heats of fusion and vaporization, and colligative properties)
- 6.2.5 For several of the properties, demonstrate use of appropriate apparatus for making the measurement
- 6.2.6 Specify the accuracy and precision of analytical equipment used in the measurement of several physical properties
- 6.2.7 Calculate volume, temperature, and pressure for gases, using the ideal gas law, Charles's law, and Boyle's law
- 6.2.8 Describe the effect of changes in temperature and pressure on the physical properties
- 6.2.9 Correlate physical properties of common materials with necessary conditions for storing and handling of these materials

BIL: Essential

EDU:	12	AD	AC
		P	S,M

Competency 6.3: Follow standard methods

Competency Builders:

- 6.3.1 Compare results of analytical tests to product specifications
- 6.3.2 Describe components of a published method and the information contained in each of the components as it applies to safety considerations, equipment, procedural steps, accuracy, and precision
- 6.3.3 Carry out accepted stepwise procedures to measure physical properties of various materials
- 6.3.4 Choose the most appropriate analytical procedure for required analysis

Unit 7: Biohazard Storage, Handling, and Disposal

BIL: Essential

EDU:	12	AD	AC
	I	P	C,H

Competency 7.1: Handle infectious agents safely

Competency Builders:

- 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 HEPA filter, laminar flow, and 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	P	S, H

Competency 7.2: Explain safe disposal of infectious waste

Competency Builders:

- 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
- 7.2.10 Compare viability of E. coli after various decontamination treatments

Unit 8: Basic Microbiology

BIL: Essential

EDU:	12	AD	AC
	P	R	S,M,H

Competency 8.1: Apply microbiological principles and procedures

Competency Builders:

- 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 specimens
- 8.1.13 Examine specimens
- 8.1.14 Identify difference between autotrophic and heterotrophic microbes

BIL: Essential

EDU:	12	AD	AC
	I	P	S,C

Competency 8.2: Explain immunological procedures

Competency Builders:

- 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 Explain principles of complement fixation, immunoelectrophoresis and enzyme immunoassay
- 8.2.5 Explain clinical significance of commonly performed serological tests

BIL: Essential

EDU:	12	AD	AC
	I	P	S

Competency 8.3: Perform common microbiology procedures

Competency Builders:

- 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	S,M

Competency 8.4: Describe influence of environmental factors on microbes

Competency Builders:

- 8.4.1 Explain various temperature requirements
- 8.4.2 Describe various gas requirements
- 8.4.3 Describe major types of microbial interaction
- 8.4.4 Remove samples and records growth parameters
- 8.4.5 Explain results obtained in growth experiment
- 8.4.6 Correlate bacterial binary fission with generation time
- 8.4.7 Describe normal bacteria population growth curve
- 8.4.8 Indicate methods of enumerating bacteria and measuring bacterial growth
- 8.4.9 Explain closed bacterial culture
- 8.4.10 Identify phases of bacterial growth curve

BIL: Essential

EDU:	12	AD	AC
	P	R	S,C

Competency 8.5: Describe the general structure of viruses

Competency Builders:

- 8.5.1 Describe various coverings, central core structures
- 8.5.2 Describe viral capsid
- 8.5.3 Distinguish between helical and icosahedral viruses
- 8.5.4 Explain origin of viral envelope

Unit 9: Biochemical Technology

BIL: Essential

EDU:	12	AD	AC
	P	R	S,M

Competency 9.1: Prepare common laboratory reagents

Competency Builders:

- 9.1.1 Define mole, molarity, normality, percent w/v and percent v/v
- 9.1.2 Perform serial dilution
- 9.1.3 Describe 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	S,M

Competency 9.2: Demonstrate chemical laboratory skills

Competency Builders:

- 9.2.1 Store prepared solutions and stains to maintain optimal condition
- 9.2.2 Measure pH electronically and manually
- 9.2.3 Perform extraction procedures on organic analyses
- 9.2.4 Filter substances to obtain residues
- 9.2.5 Clean and decontaminate work areas
- 9.2.6 Respond to laboratory spills
- 9.2.7 Measure using MKS system (metric)
- 9.2.8 Identify storage containers that are compatible with the materials to be stored

- 9.2.9 Use safety hoods
- 9.2.10 Utilize solvents, acids, and detergents for cleaning
- 9.2.11 Change pressurized cylinders
- 9.2.12 Demonstrate the proper use of pressurized cylinders
- 9.2.13 Measure volume of a solution to perform a laboratory test
- 9.2.14 Measure temperatures accurately
- 9.2.15 Wash laboratory equipment appropriately
- 9.2.16 Inventory supplies and equipment
- 9.2.17 Prepare equipment for tests
- 9.2.18 Describe typical laboratory procedures (e.g., heating, cooling, filtration, glassware set-up, distillation, weighing, measuring, pipetting, volumetrics)
- 9.2.19 Use proper techniques for mixing acids and bases them with other materials
- 9.2.20 Demonstrate proper titration techniques
- 9.2.21 Use and care for desiccators and centrifuges
- 9.2.22 Describe the physical and chemical properties of common materials and implications for storage
- 9.2.23 Set up vacuum and pressure transfer system
- 9.2.24 Transfer liquids, solids, and gases properly
- 9.2.25 Obtain representative samples
- 9.2.26 Maintain electrodes
- 9.2.27 Use all common types of volumetric equipment and apparatus
- 9.2.28 Follow lab and manufacturing procedures for safe operation of instruments

BIL: Essential

EDU:	12	AD	AC
	P	R	S,M

Competency 9.3: Perform laboratory calculations and measurements

Competency Builders:

- 9.3.1 Calculate quantities needed to perform a test analysis
- 9.3.2 Calculate unit conversions
- 9.3.3 Calculate statistics

- 9.3.4 Calculate logs
- 9.3.5 Calculate scientific notation
- 9.3.6 Generate graphs

BIL: Essential

EDU:	12	AD	AC
	I	P	M,S,C

Competency 9.4: Describe molecular structural characteristics of protein

Competency Builders:

- 9.4.1 Draw structure of an amino acid
- 9.4.2 Build model of an amino acid
- 9.4.3 Identify chemical properties of peptide bond
- 9.4.4 Identify four factors that determine isoelectric point of an amino acid and a protein
- 9.4.5 Determine polarity of functional groups on individual amino acids
- 9.4.6 Explain the solubility of an amino acid and a protein in terms of isoelectric point
- 9.4.7 Determine the isoelectric point of amino acids and proteins
- 9.4.8 Predict the effect of the isoelectric point on molecular behavior of amino acid and protein
- 9.4.9 Differentiate levels of protein structure
- 9.4.10 Describe characteristics of each level
- 9.4.11 Describe methods of denaturing proteins
- 9.4.12 Describe ways proteins can be renatured
- 9.4.13 Identify four methods of renaturation
- 9.4.14 Explain properties that allow for molecular renaturation

BIL: Essential

EDU:	12	AD	AC
	I	P	S,M,C

Competency 9.5: Perform enzyme assays

Competency Builders:

- 9.5.1 Generalize factors affecting rates of reaction
- 9.5.2 Explain factors optimizing rates of reaction
- 9.5.3 Distinguish substrate and product from catalyst in function and role
- 9.5.4 Explain parameters of reaction
- 9.5.5 Assemble correct supplies needed for assay
- 9.5.6 Distinguish various methods to graph data
- 9.5.7 Perform enzyme-linked immunosorbent assay (ELISA)

BIL: Essential

EDU:	12	AD	AC
	I	P	S,C,M

Competency 9.6: Perform biochemical assays of nucleotides and nucleic acids

Competency Builders:

- 9.6.1 Identify three components of a nucleotide
- 9.6.2 Differentiate nucleotides and nucleosides
- 9.6.3 Explain chemical reactivity of each component
- 9.6.4 Isolate nucleic acids
- 9.6.5 Identify functional group reactive in assay process
- 9.6.6 Perform UV spectra of nucleic acids
- 9.6.7 Explain limitation of techniques
- 9.6.8 Standardize spectrophotometer for assay

BIL: Essential

EDU:	12	AD	AC
	P	R	S,C,H

Competency 9.7: Explain the relationship between deoxyribonucleic acid (DNA), ribonucleic acid (RNA), and protein

Competency Builders:

- 9.7.1 Explain how DNA is the genetic material
- 9.7.2 Discuss transcription of genes
- 9.7.3 Explain translation of a messenger RNA into protein
- 9.7.4 Identify the key elements of the transcription and translational machinery

BIL: Essential

EDU:	12	AD	AC
	P	R	S,C,H

Competency 9.8: Describe deoxyribonucleic acid (DNA) replication

Competency Builders:

- 9.8.1 Outline DNA replication cycle
- 9.8.2 Identify conditions under which replication occurs
- 9.8.3 Differentiate the replication cycles of procaryotes and eucaryotes
- 9.8.4 Identify mutagenic and repair mechanisms of DNA
- 9.8.5 Identify mutagenic processes and repair mechanisms
- 9.8.6 Explain how mutagenic mechanisms modify organisms

BIL: Essential

EDU:	12	AD	AC
	P	R	S,C

Competency 9.9: Describe biochemistry of carbohydrates

Competency Builders:

- 9.9.1 Identify components of monosaccharides
- 9.9.2 Draw structural formula for a disaccharide
- 9.9.3 Differentiate function of and structure of deoxyribo, ribo sugars

BIL: Essential

EDU:	12	AD	AC
	P	R	S,C

Competency 9.10: Describe biochemistry of lipids

Competency Builders:

- 9.10.1 Compare and contrast major classes of lipids
- 9.10.2 Identify functional groups and chemical reactivity of classes

Unit 10: Molecular Biology Technology

BIL: Essential

EDU:	12	AD	AC
	P	R	S,M,C

Competency 10.1: Explain genetics and heredity

Competency Builders:

- 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: Essential

EDU:	12	AD	AC
	P	R	S,M,H

Competency 10.2: Apply basic concept of recombinant deoxyribonucleic acid (DNA) technology

Competency Builders:

- 10.2.1 Diagram the relationships among deoxyribonucleic acid (DNA), ribonucleic acid (RNA), and protein
- 10.2.2 Define basic components of cloning
- 10.2.3 Identify specific terms: vectors, restriction enzymes, host transformation, and electrophoresis

- 10.2.4 Apply these concepts to simulated applications
- 10.2.5 Identify unique restriction enzyme sites
- 10.2.6 Isolate DNA
- 10.2.7 Isolate RNA

BIL: Essential

EDU:	12	AD	AC
	I	P	S,M,H

Competency 10.3: Characterize and clone deoxyribonucleic acid (DNA)

Competency Builders:

- 10.3.1 Perform restriction digest
- 10.3.2 Perform electrophoresis
- 10.3.3 Prepare graph and assess results
- 10.3.4 Determine molecular weight of fragments correctly
- 10.3.5 Ensure transformed E. coli acquire antibiotic resistance
- 10.3.6 Prepare report on cloning exercise
- 10.3.7 Describe terminology and processes in deoxyribonucleic acid (DNA) technology
- 10.3.8 Prepare reagents and materials

BIL: Essential

EDU:	12	AD	AC
	I	P	S,M,C

Competency 10.4: Perform advanced techniques in recombinant deoxyribonucleic acid (DNA) technology

Competency Builders:

- 10.4.1 Perform Southern Blot or colony transfer
- 10.4.2 Perform Probe Preparation
- 10.4.3 Perform Hybridization

- 10.4.4 Identify and organize protocols
- 10.4.5 Prepare flowchart of overall procedure
- 10.4.6 Follow tasks in each protocol
- 10.4.7 Summarize in writing procedures and results
- 10.4.8 Explain techniques
- 10.4.9 Apply concepts of screening, genetic expression, expression vectors, and genetic libraries
- 10.4.10 Perform polymerase chain reaction (PCR) technique

BIL: Essential

EDU:	12	AD	AC
	I	P	S,C

Competency 10.5: Interpret other molecular biology technologies

Competency Builders:

- 10.5.1 Interpret results from ribonucleic acid (RNA) experiments
- 10.5.2 Interpret Northern Blot taken from literature
- 10.5.3 Explain concept of expression
- 10.5.4 Design simulated experiment
- 10.5.5 Relate techniques to protein separation
- 10.5.6 Relate techniques to cell culture
- 10.5.7 Explain concept of transgenics

BIL: Essential

EDU:	12	AD	AC
	I	P	S,C

Competency 10.6: Explain deoxyribonucleic acid (DNA) isolation protocols/methods

Competency Builders:

- 10.6.1 Explain large scale double-stranded deoxyribonucleic acid (DNA) isolation methods
- 10.6.2 Explain mini-prep double-stranded DNA isolation of plasmid DNA
- 10.6.3 Explain simultaneous isolation of 96 “well” double-stranded DNAs using Biomek-automated workstation

Unit 11: Cell Culturing

BIL: Essential

EDU:	12	AD	AC
	I	P	S,C

Competency 11.1: Describe aseptic technique

Competency Builders:

- 11.1.1 Describe objectives of aseptic technique
- 11.1.2 Describe good technique for work surface, personal hygiene, pipetting and sterile handling
- 11.1.3 Explain mechanism for laminar flow hoods

BIL: Essential

EDU:	12	AD	AC
	I	P	S,C

Competency 11.2: Explain factors that influence cell growth during incubation

Competency Builders:

- 11.2.1 Compare surfaces and dishes, plates, and vessels that cells will grow on
- 11.2.2 Explain relationship between carbon dioxide, temperature, buffering, and pH
- 11.2.3 Describe basic constituents of media
- 11.2.4 Contrast advantages and disadvantages of serum-free media

BIL: Essential

EDU:	12	AD	AC
		P	S

Competency 11.3: Prepare media for culturing cells

Competency Builders:

- 11.3.1 Clean and sterilize equipment
- 11.3.2 Prepare media and sterilize by filtration
- 11.3.3 Test media for sterility
- 11.3.4 Describe components needed for media
- 11.3.5 Explain function of each media component
- 11.3.6 List hormones to stimulate growth
- 11.3.7 Use serum-free media

BIL: Essential

EDU:	12	AD	AC
		P	S

Competency 11.4: Maintain and passage aseptically cultured cells

Competency Builders:

- 11.4.1 Culture CHO-KI, NIH3T3, and NS-1 cell lines without contamination
- 11.4.2 Establish primary cell culture
- 11.4.3 Count cells using a hemocytometer
- 11.4.4 Demonstrate cryopreservation techniques by freezing and thawing CHO-KI cells

BIL: Essential

EDU:	12	AD	AC
		P	S,C

Competency 11.5: Explain methods for analysis of cultured cells

Competency Builders:

- 11.5.1 Describe methods for deoxyribonucleic acid (DNA), ribonucleic acid (RNA), and protein analysis of harvested cells
- 11.5.2 Explain how cell cultures can be used to assay viability and cytotoxicity
- 11.5.3 Transfect CHO-KI cells with plasmid deoxyribonucleic acid (DNA)
- 11.5.4 Select transfected cells
- 11.5.5 Clone transfected cells
- 11.5.6 Transform NIH3T3 cells and stain foci with Giemsa stain
- 11.5.7 Describe the fusion process to create hybridoma cells
- 11.5.8 Describe the use of enzyme-linked immunosorbent assay (ELISA) to screen hybridoma cells for antibody production

BIL: Essential

EDU:	12	AD	AC
		P	S,C,H

Competency 11.6: Describe the use of animals in research

Competency Builders:

- 11.6.1 Describe ethical considerations of animal use
- 11.6.2 Describe regulations regarding animal care and use
- 11.6.3 Apply knowledge of federal, state, and local animal welfare regulations
- 11.6.4 Describe proper injection technique for immunization of mice

Unit 12: Protein Bioseparation Methods

BIL: Essential

EDU:	12	AD	AC
		P	S,C

Competency 12.1: Prepare and run gel permeation separation

Competency Builders:

- 12.1.1 Pour, pack, and run gel permeation chromatography column
- 12.1.2 Successfully separate test mixture into its components
- 12.1.3 Collect fractions
- 12.1.4 Evaluate fractions using spectrophotometer
- 12.1.5 Explain results in terms of molecular weight of sample components
- 12.1.6 Identify unknown correctly
- 12.1.7 Evaluate chromatograms using measurement skills
- 12.1.8 Summarize procedures
- 12.1.9 Document results
- 12.1.10 Prepare formal report that summarizes interpretation of results in tabular and text form

BIL: Essential

EDU:	12	AD	AC
		P	S

Competency 12.2: Perform proper maintenance and operation techniques to high-performance liquid chromatography (HPLC) system

Competency Builders:

- 12.2.1 Attach proper column to system
- 12.2.2 Check for leaks
- 12.2.3 Check pressure
- 12.2.4 Prime pump and run test sample
- 12.2.5 Store column in correct storage solution
- 12.2.6 Identify components of high-performance liquid chromatography (HPLC) system and trace flow of liquid

BIL: Essential

EDU:	12	AD	AC
		P	S

Competency 12.3: Run sample on high-performance liquid chromatography (HPLC) system and interpret results

Competency Builders:

- 12.3.1 Obtain correct separation of sample components
- 12.3.2 Explain results in terms of reverse phase column and sample interactions
- 12.3.3 Identify unknown correctly
- 12.3.4 Evaluate chromatograms using measurement skills
- 12.3.5 Summarize procedures
- 12.3.6 Document results
- 12.3.7 Prepare formal report that includes interpretation of results in tabular and text form

BIL: Essential

EDU:	12	AD	AC
		P	S

Competency 12.4: Perform protein extraction from animal and bacterial cell

Competency Builders:

- 12.4.1 Write flowchart outlining a generic protein isolation
- 12.4.2 Describe methods used to clear a cell extract
- 12.4.3 Identify protein assays
- 12.4.4 Prepare a standard protein concentration using a serial dilution
- 12.4.5 Maintain accurate records in a laboratory notebook
- 12.4.6 Perform protein precipitations

BIL: Essential

EDU:	12	AD	AC
		P	S

Competency 12.5: Desalt protein and change buffer**Competency Builders:**

- 12.5.1 Describe how to desalt a sample and change buffer
- 12.5.2 Identify all steps in desalting process
- 12.5.3 Perform dialysis
- 12.5.4 Dialysate with pH of proper buffer, proper conductivity, and activity

BIL: Essential

EDU:	12	AD	AC
		P	S

Competency 12.6: Perform electrophoresis of protein samples**Competency Builders:**

- 12.6.1 Write an explanation of theory of polyacrylamide gel electrophoresis (PAGE) and isoelectric focusing (IEF)
- 12.6.2 Cast a PAGE gel
- 12.6.3 Run samples on PAGE
- 12.6.4 Perform Western Blot

- 12.6.5 Determine if B galactosidase band is present
- 12.6.6 Cast an Isoelectric Focusing (IEF) gel
- 12.6.7 Transfer IEF gel to Sodium Dodecyl Sulfate (SDS PAGE) gel
- 12.6.8 Run samples

Unit 13: Fermentation Technology

BIL: Essential

EDU:	12	AD	AC
		P	S,C

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

Competency Builders:

- 13.1.1 Explain various product types and classes of fermentation or bioprocessing
- 13.1.2 Match various product types to class of fermentation or bioprocessing
- 13.1.3 Write analysis of types and classifications
- 13.1.4 Describe advantages and disadvantages of each fermentation process

BIL: Essential

EDU:	12	AD	AC
	I	P	S,C

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

Competency Builders:

- 13.2.1 Explain important features of aseptic technique in terms of absolute sterility
- 13.2.2 Write explanation of sterility
- 13.2.3 Explain the temperature/pressure relationship of saturated steam to sterilization
- 13.2.4 Explain the effect of entrapped air on sterilization effectiveness

- 13.2.5 Compare sterilization methods using dry heat versus moist heat
- 13.2.6 Explain sterilization by micro-filtration
- 13.2.7 Explain the effect of suspended solids in fermentation media on sterilization effectiveness
- 13.2.8 Apply standard aseptic techniques
- 13.2.9 Ensure sample is not contaminated

Unit 14: Basic Computer Concepts and Applications for Biotechnology

BIL: Essential

EDU:	12	AD	AC
	P	R	

Competency 14.1: Demonstrate basic computer literacy

Competency Builders:

- 14.1.1 Create directories/folders and sub-directories
- 14.1.2 Format disks
- 14.1.3 Manipulate files (copy, rename, delete)
- 14.1.4 Keyboard proficiently by touch

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 14.2: Operate computer hardware

Competency Builders:

- 14.2.1 Practice proper media handling techniques (e.g., magnetic fields, dust, liquids)
- 14.2.2 Identify hardware and its use
- 14.2.3 Use hardware (e.g., printers, modems, touch screen, digitizers, plotters, graphic tablets, scanners, film recorders, video, laser image setters)
- 14.2.4 Demonstrate basic care of hardware
- 14.2.5 Explain need for and application of security levels/procedures
- 14.2.6 Perform basic hardware troubleshooting
- 14.2.7 Explain hardware addressing techniques

14.2.8 Maintain usage and maintenance logs

BIL: Essential

EDU:	12	AD	AC
	P	R	

Competency 14.3: Use word processing packages

Competency Builders:

- 14.3.1 Define word processing terminology
- 14.3.2 Explain functions of word processing software
- 14.3.3 Explain word processing applications
- 14.3.4 Use appropriate reference materials
- 14.3.5 Keyboard efficiently by touch
- 14.3.6 Use mouse
- 14.3.7 Prepare backup file
- 14.3.8 Maintain backup file
- 14.3.9 Update spelling dictionary and spell check
- 14.3.10 Perform document functions (e.g., locate, rename, delete, save, retrieve, copy)
- 14.3.11 Perform formatting functions (e.g., center, underline, bold, cut and paste)
- 14.3.12 Use edit features
- 14.3.13 Use sort features
- 14.3.14 Add page numbers to document
- 14.3.15 Add headers and footers
- 14.3.16 Print files, pages, screens and blocks of text
- 14.3.17 Verify accuracy of output
- 14.3.18 Create a document
- 14.3.19 Save a document to disk
- 14.3.20 Retrieve a document from disk
- 14.3.21 Edit an existing document
- 14.3.22 Describe word-wrap
- 14.3.23 Print a document
- 14.3.24 Store boilerplate material (e.g., templates, stationary files)
- 14.3.25 Compose documents at keyboard

- 14.3.26 Tabulate multiple columns
- 14.3.27 Prepare new documents from existing ones
- 14.3.28 Prepare various types of table options
- 14.3.29 Format text
- 14.3.30 Integrate database, spreadsheet and graphic files
- 14.3.31 Convert documents from one system to another
- 14.3.32 Demonstrate use of computer thesaurus
- 14.3.33 Use multimedia techniques/resources
- 14.3.34 Perform merge functions
- 14.3.35 Use word processing to create technical documents (i.e., Standard Operating Procedures (SOPs), methods, training manuals, and reports)
- 14.3.36 Demonstrate ability to incorporate the following into these documents:
 - Graphs
 - Chromatograms/spectral data
 - Macros
 - Formulas
 - Equations

BIL: Essential

EDU:	12	AD	AC
	P	R	M

Competency 14.4: Use spreadsheet packages

Competency Builders:

- 14.4.1 Define spreadsheet
- 14.4.2 Demonstrate knowledge of basic spreadsheet terminology
- 14.4.3 Define components of spreadsheets
- 14.4.4 Describe implementation of spreadsheet operations in business scope
- 14.4.5 Identify the type of data needed
- 14.4.6 Determine the best spreadsheet to aid in the collection, tabulation, synthesis and evaluation of the identified data
- 14.4.7 Use spell check
- 14.4.8 Execute an electronic spreadsheet

- 14.4.9 Enter data, formulas, and functions
- 14.4.10 Differentiate between labels and numbers
- 14.4.11 Speculate using "what if..." questions
- 14.4.12 Sequence keystrokes in the creation of a macro
- 14.4.13 Create database within spreadsheet and perform data query functions
- 14.4.14 Move around in spreadsheet and correct errors
- 14.4.15 Format spreadsheet
- 14.4.16 Create graphs
- 14.4.17 Print graphs
- 14.4.18 Save previously saved files
- 14.4.19 Load previously saved files
- 14.4.20 Replicate cells using copy commands
- 14.4.21 Use electronic spreadsheet to complete business application
- 14.4.22 Use spreadsheet to plan financial strategies
- 14.4.23 Prepare spreadsheet
- 14.4.24 Use multimedia techniques/resources
- 14.4.25 Analyze data
- 14.4.26 Interpret results
- 14.4.27 Use spreadsheets to track, summarize, and monitor trends and analytical data
- 14.4.28 Demonstrate the ability to perform the following functions with spreadsheet applications:
 - Calculate linear regression
 - Plot linearity data
 - Plot calibration curves
 - Perform statistical analysis such as T-tests and _____ (RSD's)
- 14.4.29 Create macros to perform routine calculations
- 14.4.30 Validate macros

BIL: Essential

EDU:	12	AD	AC
	I	P	

Competency 14.5: Use databases

Competency Builders:

- 14.5.1 Define database
- 14.5.2 Explain terms used in database systems
- 14.5.3 Describe common functions of database systems
- 14.5.4 Use database to create, input, edit, and display fields and records
- 14.5.5 Analyze structure of database files
- 14.5.6 Perform calculations with a database file
- 14.5.7 Alter structure of database file
- 14.5.8 Construct database for the specified purpose
- 14.5.9 Sort records based on multiple fields
- 14.5.10 Identify advanced database technology
- 14.5.11 Use appropriate reference materials
- 14.5.12 Utilize relational database
- 14.5.13 Enter elements into database
- 14.5.14 Proofread database
- 14.5.15 Explain database
- 14.5.16 Design report formats
- 14.5.17 Transfer data to and from remote database
- 14.5.18 Print reports using data from multiple databases
- 14.5.19 Use database files with other application software
- 14.5.20 Verify accuracy of output (e.g., edit reports)
- 14.5.21 Determine the best database to aid in the collection, tabulation, synthesis and evaluation of the particular data identified
- 14.5.22 Identify the type of data needed
- 14.5.23 Use bio-informatics tools and access biological databases
- 14.5.24 Use databases to track and manage data; this data includes but not limited to the following:
 - Quality measures
 - Analytical results via LIMS
 - Chemical inventory
 - Consumer comments
- 14.5.25 Use database forms to generate reports
- 14.5.26 Perform search using Blast

BIL: Essential

EDU:	12	AD	AC
	P	R	

Competency 14.6 Demonstrate knowledge of the Internet

Competency Builders:

- 14.6.1 Define the Internet
- 14.6.2 Explain how the Internet works
- 14.6.3 Explain Internet capabilities and limitations
- 14.6.4 Explain how to connect to the Internet via current technology
- 14.6.5 Install Internet software
- 14.6.6 Navigate the World Wide Web safely
- 14.6.7 Identify services and tools offered on the Internet
- 14.6.8 Use services and tools offered on the Internet
- 14.6.9 Explain bookmarks

BIL: Essential

EDU:	12	AD	AC
	P	R	

Competency 14.7: Use the Internet for research

Competency Builders:

- 14.7.1 Define how the Internet can be used for research
- 14.7.2 Use services and tools offered on the Internet for research
- 14.7.3 Identify search engines
- 14.7.4 Use search engines
- 14.7.5 Evaluate Internet resources and accuracy of information
- 14.7.6 Access library catalogs on the Internet
- 14.7.7 Access commercial and government resources
- 14.7.8 Download files

Appendix A

Acronyms for Biotechnology

AA	atomic absorption
ACP	
ACS	American Chemical Society
AL	action limit
AOAC	Association of Official Analytical Chemists
ASTM	American Standard of Testing Materials
ATP	adenosine tri-phosphate
ATR	ambient temperature range
B cells	Lymphocytes (B-lymphocytes antibody producing cells)
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, & Liability Act
CFR	Code of Federal Regulations
CHO-KI	Chinese Hausta Ovary Cell Line
CPR	Cardiopulmonary Resuscitation
CTD	cumulative trauma disorder
CWA	Clear Water Act
DEAE gel	Diethylaminoethanol OR Diethylaminoethyl
DNA	Deoxyribonucleic acid
cDNA	Complementary DNA
DO	dissolved oxygen
DOE	Department of Education
DOT	Department of Transportation
E. coli	Escherichia coli (intestinal bacteria)
ELISA	enzyme-linked immunosorbent assay
EM	Electron microscopy
EPA	Environmental Protection Agency
FBI	Federal Bureau of Investigation
FDA	Food & Drug Administration
F-test	Statistical analysis test
GC	gas chromatography
GLI	Great Lakes Initiative
GLP	Good Laboratory Practices
HAPs	hazardous air pollutants
HEPA	high-efficiency particulate air
HMIS	Hazardous Material Identification System
HPLC	high-performance liquid chromatography
IAW	In accordance with
IC	Ion Chromatography
IEF gel	isoelectric focusing
IR	infrared

FTIR	Fourier transform infrared
NIR	Near infrared
ISO	International Standards Organization
IUPAC	international union of pure and applied chemistry
JSA	job safety analysis
JUMP	
LC	liquid chromatography
LIMS	Laboratory Information Management Systems
LSC	liquid scintillation counting
MACTs	Master of Arts in College Teaching
MAKs	
MKS system	metric
MPL	maximum permissible limit
MS	mass spectrometry
MSDS	material safety data sheets
NFPA	National Fire Protection Association
NIH3T3	A fibroblast Cell Line "3T3" Cells
NIOSH	National Institute for Occupational Safety & Health
NIR	Non-Inculin-requiring??
NMR	nuclear magnetic resonance
NPDES	National Pollutant Discharge Elimination System
NS-1 OR NS-I	
NWPA	Nuclear Waste Policy Act
ODH	Ocatanol Dehydrogenase OR Octopine Dehydrogenase
ODNR	Ohio Department of Natural Resources
OSHA	Occupational Safety & Health Administration
PAGE gel	Polyacrylamide Gel Electrophoresis
PCR	polymerase chain reaction
PELs	Permissible exposure limits
percent v/v	value per volume (20% ethanol v/v)
percent w/v	weight per volume (10%
PH	power of hydrogen
PPA	Measure of the H ⁺ ion concentration = (-log [H ⁺])
PPE	Personal Protective Equipment
RCRA	Resource Conservation & Recovery Act
REDOX	reduction and oxidation
RELs	
RNA	ribonucleic acid
RPM	Revolutions per minute
RSD's	
SARA	Superfund Amendment Reauthorization Act
SDS PAGE gel	Sodium Dodecyl Sulfate ??
SDWA	Safe Drinking Water Act
SEM	Scanning election microscopy
S/H/E	safety/health and environmental
SOP	Standard Operating Procedures
SPC	
STEM	scanning transmission electron microscopy

T7	T & DNA promoter (promoter region for T & RNA polymerase)
TCA	Tetracycnonthracene
T cells	immune cell that develops in the thymus gland (cell-mediated response)
TEM	transmission electron microscopy
TLC	thin-layer chromatography
TLVs	Total Lung Volume ??
TIE	Toxicity Identification Evaluations
TM	
TRE	Toxicity Reduction Evaluations
TRI	toxic release inventory
TSCA	Toxic Substance Control Act
T-tests	Statistical tests
USP	United States Pharmacopeia
UV-vis	ultraviolet-visible