Appendix O

SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH (STEM) YOUTH APPRENTICESHIP

SCIENCE & MATH PATHWAY BIOSCIENCE APPLICATIONS (UNIT 7)

Unit 7: Science & Math Pathway
Bioscience Applications- Required Competencies

Competency

1. Assist to organize & analyze data

Performance Standard Condition

Competence will be demonstrated

- at the worksite
- while assisting a worksite professional

Performance Standard Criteria

Performance will be successful when learners:

- Collect data and results from testing
- Select and use statistical tools to analyze and synthesize data
- Create tables and graphs to organize data
- Query and extract information from data
- Interpret graphs and the trends in data
- Use IT tools to manipulate data creating models, reports, plans, processes, or projects from data provided
  - Access the appropriate database or search engine desired
  - Navigate to the specific source of information needed
  - Discuss information search with worksite professional
  - Perform identification and/or design sequencing from research databases & software
- Document analysis process and tools used
- Draw conclusions based on analysis with worksite professional

Learning Objectives

- Express numbers in scientific notation
- Manipulate numbers expressed in scientific notation back to simple numbers
- Describe standard statistical calculations performed on sets of data
- Explain the difference between data analysis and drawing conclusions
- Explain how statistical tools are used to verify the reliability or validity of the data
- Discuss how error is calculated
- Discuss methods for organizing and representing data
- Discuss how standard curves are developed and evaluated using an equation for a line
- Explain how a standard curve and the equation for a line can be used to predict unknown values or outcomes
- Define bioinformatics
- List common activities or uses of bioinformatics
- Compare basic bioinformatics web services
- Define computational biology

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Required Competencies

Competency

2. Prepare a Bioscience presentation

Performance Standard Condition

Competence will be demonstrated

- at the worksite OR in the classroom in a simulated setting
- NOTE: A simulated setting should ONLY be used IF there is not possibility of skill performance at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Choose a topic based on current research or a project at the worksite
- Outline information to be presented on the topic
- Collect information and data needed for the topic presentation
- Identify and prepare support materials to enhance presentation
- Prepare the presentation in oral, written, and/or visual formats
- Report information with the intent of being informational & instructive
- Explain technical concepts to non-technical audiences
- Use professional terminology
- Identify, select, use appropriate multimedia resources
- Deliver presentation with supporting materials

Learning Objectives

- Explain the various methods for presenting information
- Compare oral, written, visual, and multimedia presentation modes to present scientific, technological, engineering, or mathematical reports
- Discuss how to adjust presentations depending on the intended audience
- List common support materials used to enhance presentations

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency

1. Grow &/or care for plants &/or lab animals

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review protocols for growth and care of plants &/or animal including safety precautions
- Obtain equipment and supplies needed

PLANTS

- Prepare planting spaces
- Prepare soils/media
- Plant seeds, seedlings, or cuttings
- Monitor plants for light, moisture, and temperature requirements
- Mix and apply fertilizers and additives
- Measure growth or other characteristics
- Document planting and feeding

ANIMALS

- Clean and maintain animal quarters
- Safely handle animals
- Mix feed, additives, and/or medicines
- Measure growth or other physical characteristics
- Manage animal waste
- Document care and feeding

Learning Objectives

PLANTS

- Describe the components of a plant and explain their functions
- Explain how soil/media structure, texture, pH, temperatures and salinity affect plant growth
- Explain the growth processes of photosynthesis, respiration & transpiration
- Discuss essential nutrients in plant growth

ANIMALS

- Discuss the Animal Welfare Act
- List proper housing requirements for your lab animals
- Explain how to properly handle your lab animal if required
- List the common nutrients required to maintain animal health
- Define basic terms common in animal anatomy and physiology

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency
2. Collect plant or animal tissues from source

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review protocol for collection of tissue from source including safety precautions
- Obtain equipment and supplies needed to collect tissue
- ***Prepare reagents, solutions, and/or buffers***
- Obtain sample from analyte source
- BLOOD
  - Layer on density gradient
  - Centrifuge
  - Select cells of correct density
- PLANT OR ANIMAL TISSUE
  - Chop up tissue with scissors and/or scalpel
  - Add enzymes
  - Centrifuge on slow speed to separate cells from debris
  - Layer cells on density gradient
  - Centrifuge
  - Select cells of correct density
- Store collected sample as required for further testing
- Document collection as required
- Clean up and shut down equipment

Learning Objectives

- Compare types of tissues and animal products collected for animal examination and testing
- Identify animal tissues that pose health risks
- Compare types of plant tissues
- Explain methods for collecting plant or animal tissues

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency

3. Isolate &/or purify cells, microbes, nucleic acids &/or proteins

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review protocol for isolation &/or purification of desired analyte including safety precautions
- Obtain equipment and supplies needed to isolate &/or purify analyte
- ***Prepare reagents, solutions, and/or buffers***
- Obtain sample from analyte source

CELLS- LABEL BINDING

- Label sample cells with antibodies, fluorescence, etc.
- Separate desired cell set with cell sorter, antibody columns, magnetic beads, chromatography, etc.

CELLS- CENTRIFUGATION

- Layer on density gradient
- Centrifuge at correct speed
- Select cells of correct density

CELL LINES

- ***Culture cells*** from cell lines

MICROBES

- Isolate the microbe in question
  - Streak plate to isolate individual colonies
  - Grow with selective agar media
- ***Culture microbe***

NUCLEIC ACIDS

- Lyse the cell using detergents, enzymatic digestion, or physical methods
- Remove contaminating material from the nucleic acids
- Purify and concentrate the nucleic acids required

PROTEINS

- Prepare cell or tissue sample as required to extract cellular protein from biological sample
- Separate protein from other components
- Isolate specific protein subset

ALL

- Evaluate isolation and/or purification with blotting, ELISA, flow cytometry, spectroscopy, etc.
- Complete any further purification procedures as required by protocol
- Store isolated & purified analyte subset as required for further testing
- Document isolation and/or purification procedures as required
- Clean up and shut down equipment

Learning Objectives

CELLS

- Define eukaryotic
- Compare animal to plant cells
- Discuss common methods to separate and isolate the desired set of cells
- Describe advantages and disadvantages of using cells from blood, tissue or other “live” cultures
- Explain the function of cell surface markers and how they are used in isolating cells
- Describe how antibodies are used to isolate specific cells

NUCLEIC ACIDS

- Compare cell lysis methods and how they work using detergents, enzymes, and physical disruption
- Describe scientific basis behind methods for purifying and concentrating DNA from RNA
- Compare purification using methods such as precipitation, centrifugation, and dialysis membranes

PROTEINS

- Define what is meant by the primary, secondary and tertiary structure of proteins
- Describe categories of characteristics unique to individual proteins such as amino acid sequence, size, shape, solubility, binding, etc.
- Compare methods for separating proteins such as precipitation, chromatography, centrifugation
- Compare advantages and disadvantages of purification procedures

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency

4. Quantify &/or identify cells, microbes, nucleic acids &/or proteins

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review protocol for quantification and/or identification of analyte including safety precautions
- Set up equipment and supplies needed
- ***Prepare reagents, solutions, and/or buffers***
- Sample and transfer the purified analyte in question
- Dilute sample as required

QUANTIFICATION

- Create serial dilutions if required
- Stain and/or label analyte in sample to be counted as required by protocol for microscopy, cytometry, spectrophotometry, etc.
- Obtain readings and/or calculate number of analyte taking into account any dilution factor
- Document counts and calculations as required
- MICROBE CULTURES
  - Culture samples on plates in order to count visible levels of growth
  - Isolate the microbe in question
  - Dilute the sample
  - Streak plate to isolate individual colonies
  - Grow with selective agar media
  - Serially dilute the sample as many times as required
  - Incubate under appropriate conditions
  - Count the CFUs
- NUCLEIC ACIDS
  - Quantify nucleic acid sample by:
  - Abundance in weight: spectroscopy
  - Absolute abundance in number: Q-PCR
  - high-throughput relative abundance: DNA-microarray
  - high-throughput absolute abundance: Serial Analysis of gene expression (SAGE)
  - Size: Gel Electrophoresis
  - Document quantification procedure, calculations and counts as required
  - Clean up equipment and supplies used

IDENTIFICATION

- Follow protocols to perform identification tests such as the following:
- Visually inspect colony morphology
- Obtain images using microscopy
- Stain the sample (Gram stain, Acid Fast, fluorescence, etc.)
- Test agglutination to a specific antibody (Phage Testing)

    - Perform fermentation, hydrolysis, and enzyme tests
    - Complete electrophoresis of the nucleic acids and/or proteins
    - Perform PCR to amplify specific nucleic acid sequences
    - Determine ratio of nucleic acid base pairs to a known
    - Complete nucleic acid sequencing
- Document identification procedure as required
- Clean up and shut down equipment

Learning Objectives

- Describe how to set up serial dilutions and calculate accordingly
- Explain how fluorescent stains, antibodies, & proteins interact in quantification methods
- Compare methods for quantifying analytes such as microscopic counting, colorimetry, flow cytometry, spectrophotometry, etc.

MICROBES

- Define Colony Forming Unit (CFU)
- Explain how phage quantification of plaque forming units (PFU) is performed
- Describe direct and indirect methods for counting viruses
- Compare microscopic, stain, plate, and DNA methods for microbe identification
- Discuss difference in identification techniques for the different types of microbes

NUCLEIC ACIDS

- Compare methods of nucleic acid quantification and when each is indicated
- Describe how to obtain quantification measures and calculate nucleic acid amounts from spectroscopy, electrophoresis and PCR

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency
5. Culture cells &/or microbes

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review protocol for analyte to be prepared including safety precautions
- ***Isolate and/or purify analyte*** to be cultured
- Prepare culture growth media with appropriate growth factors, pH, etc.
- Calculate the concentration required of cells to media
- ***Use aseptic technique*** to sample and transfer analyte to suspension media or to adherent surface media components
  - Remove a sample of suspension OR
  - Dislodge cells from adherent surfaces
- Store culture in area of appropriate temperature, humidity, light, and gas mixture as required by protocol
- Visually inspect culture frequently as required for color, pH, cloudiness, etc.
- Examine analyte cells as required for viability, morphology, density, etc.
- Feed culture as required by protocol
  - Dilute suspensions with fresh media
  - Divide and ***harvest*** adherent cultures or replace old medium with fresh medium
- Document culture and feeding as required
- Clean up and shut down equipment

Learning Objectives

- Define prokaryote and eukaryote
- Explain the cell process of division- mitosis
- Compare bacteria, virus, fungi, and protist structure
- Compare how bacteria, virus, fungi, and protists replicate
- Define bacteriophage
- Compare common sources of cells for cell culture
- List common ingredients in culture media
- Compare suspension (broth or phage) and adherent culture methods
- Explain how to maintain a cell culture in suspension cultures
- Explain how to maintain a cell culture in adherent cultures
- Describe common culture storage conditions
- Explain the issues that arise as cells grow in culture
- Explain special considerations for virus cultures
- Compare characteristics of mortal versus immortalized cell lines

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency
6. Harvest cells &/or microbes

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review protocol for harvesting analyte from culture including safety precautions
- ***Prepare reagents, solutions, and/or buffers***
- Remove analyte cells from suspension culture as required for further processing
- Remove analyte cells from adherent cultures mechanically, chemically and/or with enzymes as required
- Wash cells or colony as required
- Transfer harvested cells to fresh medium
- Examine harvest for viability, if required
- ***Quantify*** analyte cells
- Document harvesting as required
- Clean up and shut down equipment

Learning Objectives

- Describe the typical growth pattern of cells in organisms (in vivo)
- Describe the growth patterns of cells in culture (in vitro)
- Explain how to harvest cells mechanically, chemically and with enzymes that reduce loss of viability
- Discuss the advantages and disadvantages of cell harvesting techniques
- Explain how analyte viability is determined after harvesting

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency
7. Perform spectroscopy

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review protocol for spectroscopic testing including safety precautions
- Set up equipment and supplies
- ***Prepare reagents, solutions, and/or buffers***
- Prepare sample as required for spectroscopic analysis
- Blank, Zero or run control on the spectrophotometer
- Run sample as required
- Note the reading(s)
- Calculate and analyze the results
- Document testing as required
- Clean up and shut down equipment

Learning Objectives

- Explain the purpose of spectroscopy
- Discuss the fundamental science behind spectroscopy
- Distinguish between the common types of spectroscopy and their uses
- Describe common complications and troubleshooting in spectroscopy

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency

8. Perform chromatography (gas, TLC, HPLC)

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review protocol for chromatography including safety precautions
- Set up equipment and supplies
- ***Prepare reagents, solutions, and/or buffers***
- Prepare sample as required for chromatographic analysis
- Run control(s) along with sample as required
- Note the reading(s)
- Calculate and analyze the results
- Document testing as required
- Clean up and shut down equipment

Learning Objectives

- Explain the purpose of chromatography
- Discuss the fundamental science behind chromatography
- Distinguish between the common types of chromatography and their uses
- Describe common complications and troubleshooting in chromatography

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency
9. Perform flow cytometry

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review protocol for flow cytometry including safety precautions
- Set up equipment and supplies
- ***Prepare reagents, solutions, and/or buffers***
- Prepare sample as required for flow cytometry analysis
  - Stain or label the marker in question with tagged conjugates
- Run control(s) along with sample as required
- Visualize sample in flow cytometer
- Note the reading(s)
- Calculate and analyze the results
- Document testing as required
- Clean up and shut down equipment

Learning Objectives

- Explain the purpose of flow cytometry
- Discuss the fundamental science behind flow cytometry
- Discuss how flow cytometry selects for cells desired
- Describe common complications and troubleshooting in flow cytometry

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency

10. Perform microscopy

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review protocol for the microscopy required including safety precautions
- Power on the microscope
- Set control and magnification settings to scan first
- Adjust light aperture, power, stage, etc. according to protocol
- For Scanning Electron Microscopes (SEMs) or Transmission Electron Microscopes (TEMs)- Use the computer to set & adjust appropriate mode, vacuum settings, & image resolution

BASIC

- Place slide/sample on stage
- Find item in scan setting
- Switch to low power and use course knob to refocus
- Switch to high power and use fine adjustment to refocus only if slide has cover slip or is thin enough
- For Scanning Electron Microscopes (SEMs) or Transmission Electron Microscopes (TEMs)- set sample height, evacuate chamber, obtain, capture & store images as required

MOUNT

- Place drop of sample on slide
- Cover sample with cover slip by placing slip at liquid edge at an angle and lower over drop
- For Scanning Electron Microscopes (SEMs) or Transmission Electron Microscopes (TEMs)- prepare samples as required per protocol

STAIN

- Stain samples according to protocol prior to slide mount or on slide as required
- Place one drop of stain at edge of cover slip
- Draw to stain other side

CLEAN UP

- Remove slide from stage
- Return all settings to lowest magnification
- Power off microscope
- Wipe excess material as required
- Cover and store microscope as required
- Wash and dry slides as required
- Discard covers lips as required
- Document testing as required

Learning Objectives

- Compare types of microscopes and how they function to magnify samples
- List basic components of a microscope and their functions
- Demonstrate proper use and care of a microscope

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency
11. Perform restriction digests

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review protocol for restriction digests including safety precautions
- Set up equipment and supplies
- ***Prepare reagents, solutions, and/or buffers***
- Prepare sample as required for restriction digestion
- Combine buffer(s), nucleic acid sample and restriction enzymes
- Digest control(s) along with sample as required
- Centrifuge, incubate, and wash/cut/dye as required
- Document digestion procedure as required
- Clean up and shut down equipment

Learning Objectives

- Explain the common purposes of nucleic acid restriction digestion
- Define restriction enzyme & restriction site
- Explain the source of restriction enzymes
- Describe the action of restriction enzymes
- Compare restriction enzyme types
- Describe common complications and troubleshooting in the restriction digestion procedure
- Discuss the importance of proper reaction and storage conditions for enzymes

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency

12. Hybridize nucleic acids

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review the protocol for hybridization including safety precautions
- Set up equipment and supplies
- ***Prepare reagents, solutions, and/or buffers***
- ***Isolate*** the nucleic acids
- Heat the nucleic acids to melting temperature
- Label strands of one type of nucleic acid
- Mix the labeled strands with unlabeled strands from another source of nucleic acid
- Incubate
- Asses the hybridized nucleic acid binding visually
- Analyze the results
- Document hybridization procedure as required
- Clean up and shut down equipment

Learning Objectives

- Explain the purpose of hybridization
- Discuss common applications of hybridization
- Describe the scientific principle behind hybridization
- Explain how hybridization is analyzed

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency
13. Perform gel electrophoresis

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review the protocol for electrophoresis including safety precautions
- Set up equipment and supplies
- ***Prepare reagents, solutions, and/or buffers***
  - Prepare the gel for the size of the bio-molecule to be assessed
- Prepare the sample as required
- Pour the gel
- Set up the gel rack and cool
- Submerge rack into buffer
- Inject stained markers, control(s) and sample into gel wells
- Apply current as required
- Stop current when control marker approaches end of gel
- Remove gel
- Stain gel as required
- Visualize gel as required
- Note the reading(s)
- Calculate and analyze the results
  - Calculate molecular weight based in standards and distance traveled
- Document testing as required
- Clean up and shut down equipment

Learning Objectives

- Explain the purpose of gel electrophoresis
- Discuss the fundamental science behind gel electrophoresis
- Compare types of electrophoresis and their uses
- Explain how to interpret electrophoresis fragmentation patterns
- Explain the purpose of the gel
- Discuss factors that affect the migration of bio-molecules
- Explain how to calculate molecular weight
- Describe common complications and troubleshooting in the electrophoresis procedure
- Compare methods for staining and visualizing electrophoresis results

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency

14. Perform amplification

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review the protocol for nucleic acid amplification including safety precautions
- Set up equipment and supplies
- ***Prepare reagents, solutions, and/or buffers***
- Prepare the nucleic acid sample as required
- Pipet amplification reagents into centrifuge tubes
- Pipet nucleic acid samples into tubes and mix
- Amplify the control(s) and nucleic acid through the required thermocycle steps
- Note the reading(s)
- Calculate and analyze the results during or after amplification
  - Calculate the amplification of sample during PCR or RT-PCR
  - Analyze amplification products with gel electrophoresis
- Document amplification as required
- Clean up and shut down equipment

Learning Objectives

- Explain the purpose of nucleic acid amplification
- Define PCR and RT-PCR
- Discuss the fundamental science behind amplification
- Distinguish between PCR & RT-PCR and their uses
- Describe common complications and troubleshooting in amplification
- Define primer and its purpose in PCR
- Define polymerase and its purpose in PCR
- Compare stains used in PCR & RT-PCR
- Describe quantification calculations completed in nucleic acid amplification

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency

15. Perform blot assays (Southern, Western, Northern)

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review the protocol for blotting including safety precautions
- Set up equipment and supplies
- ***Prepare reagents, solutions, and/or buffers***
- Prepare the sample as required
- ***Perform restriction digests***
- ***Perform gel electrophoresis*** to separate and isolate desired bio-molecule
- Transfer separate bio-molecule to membrane
- Hybridize with labeled target probe
- Wash any unbound tags
- Detect and visualize the pattern
- Calculate and analyze the results
- Document testing as required
- Clean up and shut down equipment

Learning Objectives

- Explain the purpose of the blot assay
- Discuss the fundamental science behind blotting
- Distinguish between the types of blots and their uses
- Describe common complications and troubleshooting in blotting
- Compare blot detection methods

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency

16. Perform nucleic acid sequencing

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review the protocol for nucleic acid sequencing including safety precautions
- Set up equipment and supplies
- ***Prepare reagents, solutions, and/or buffers***
- Prepare nucleic acid to be sequenced as a single strand
- Anneal primer
- Supply nucleic acid with a labeled mix of the four nucleotides
- Incubate
- Separate fragments by length
- Visualize fragments
- MICROARRAYS
  - Prepare nucleic acid to arrayed
  - Spot sample cDNA or cRNA onto chip plate of probe DNA
  - Visualize probes
- Calculate and analyze the results
- Document sequencing as required
- Clean up and shut down equipment

Learning Objectives

- Explain the purpose of nucleic acid sequencing
- Discuss the fundamental science behind nucleic acid sequencing
- Distinguish between the types of sequencing techniques and when each is preferred
- Describe common complications and troubleshooting in nucleic acid sequencing
- Define high-throughput sequencing
- Compare standard dye-terminator sequencing to high-throughput sequencing
- Describe DNA microarrays
- Explain how DNA microarrays are used
- Explain how to calculate and analyze sequencing results

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency

17. Perform cellular assays

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review protocol for manipulating cells including safety precautions
- Set up equipment and supplies
- ***Prepare reagents, solutions, and/or buffers***
- ***Harvest cells*** to be manipulated
- ***Conduct the testing according to protocol***
  - Conduct assays to measure for cell proliferation, cell death, cell metabolism, cell protein turnover, receptor binding, receptor activation, cell signaling, reporter gene activity, high throughput screening, etc.
  - Use technologies such as electrophoresis, ELISA, flow cytometry, fluorescence microscopy, phase microscopy, spectroscopy, etc.
- Calculate and analyze the results
- Document assay procedure as required
- Clean up and shut down equipment

Learning Objectives

- List common reasons for testing cells
- Compare common types of cellular assays and when each is used

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency

18. Perform immunoassays (ELISA)

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review protocol for immunoassay including safety precautions
- Set up equipment and supplies
- ***Prepare reagents, solutions, and/or buffers***
- Prepare the sample as required
- Prepare test plate with capture antigen or antibody
- Add sample to each test well
- Wash test plate
- Add labeled antibody-enzyme conjugates
- Wash test plate
- Visualize wells
- Calculate and analyze the results
- Document assay procedure as required
- Clean up and shut down equipment

Learning Objectives

- Define antigens and their function
- Describe how antibodies are formed
- Explain how antibodies can be used to detect and quantify antigens
- Explain how the principle of antigen-antibody binding is used in bioscience lab testing
- Define monoclonal and polyclonal antibodies
- Explain the purpose of the Enzyme-Linked Immunoabsorbent Assay (ELISA)
- Discuss the fundamental science behind the ELISA
- Describe common complications and troubleshooting in ELISA testing

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency

19. Perform protein assays (Bradford, Lowry)

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review protocol for performing assay including safety precautions
- Set up equipment and supplies
- ***Prepare reagents, solutions, and/or buffers***
- ***Separate and isolate protein*** to be tested
- ***Conduct the testing according to protocol***
  - Use technologies such as electrophoresis, ELISA, flow cytometry, spectroscopy, etc.
- Calculate and analyze the results
- Document assay procedure as required
- Clean up and shut down equipment

Learning Objectives

- List common reasons for testing proteins
- Compare common types of protein assays and when each is used
- Discuss common techniques for protein interaction and function testing
- Explain immunostaining for proteins
- Compare types of immunostaining for proteins
- Indicate how enzyme activity assays are used to detect proteins

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency
20. Perform transfection/transformation

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review the protocol for transfection/transformation including safety precautions
- Set up equipment and supplies
- ***Prepare reagents, solutions, and/or buffers***
- ***Isolate & purify the nucleic acid*** material to be transfected
- Incubate the vector DNA, insert DNA, DNA Ligase, and buffers
- Prepare the vector with promoter elements and/or resistance markers
- Isolate competent host cells
- Transfect the host according to protocol
  - Use methods such as calcium phosphate, liposomes, cationic polymers, electroporation, viruses, magnetic nanoparticles, etc.
- Wash, store and/or culture cells as required
- Document procedure as required
- Clean up and shut down equipment

Learning Objectives

- Explain the DNA transformation, translation and replication process in cells
- Define transfection, transformation, and transduction
- Define plasmid and vector
- Explain the common conformations of plasmid DNA
- Discuss common applications of plasmids
- Explain the purpose of transfection/transformation
- Discuss the fundamental science behind transfection/transformation
- Compare transfection/transformation techniques and when each is preferred
- Describe common complications and troubleshooting in transfection/transformation

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency
21. Perform basic cloning

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Review the protocol for cloning including safety precautions
- Set up equipment and supplies
- ***Prepare reagents, solutions, and/or buffers***
- ***Isolate & purify the nucleic acid*** material to be cloned
- Prepare the vector
- Isolate competent host cells
- ***Transfect/transform*** the cells
- Wash and plate cells
- Incubate
- ***Harvest cells***
- Check/select cloned cells with gel electrophoresis
- Document procedure as required
- Clean up and shut down equipment

Learning Objectives

- Explain the DNA transformation, translation and replication process
- Define cloning and sub-cloning
- Explain the purpose of cloning
- Discuss the fundamental science behind cloning
- Describe common complications and troubleshooting in cloning
- Compare molecular cloning to artificial embryo twinning
- Discuss legislation restricting the uses of cloning and recombinant technology
- Define genomics

Comments:

Unit 7: Science & Math Pathway
Bioscience Applications- Competency Choices

Competency

22. Run expression cloning tests

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Choose the appropriate test for cloning genetic analysis
- Review the protocol for expression tests including safety precautions
- Set up equipment and supplies
- ***Prepare reagents, solutions, and/or buffers***
- ***Perform basic cloning***
- Analyze genes and gene expression using technologies such as PCR, RT-PCR, DNA sequencing, Microarrays, hybridization and karyotyping
- Evaluate results according to procedure used
- Document analysis procedure as required
- Clean up and shut down equipment

Learning Objectives

- Explain the importance of genetics
- Explain how to estimate the heritability of certain traits
- Describe a karyotype
- Describe sex determination, linkage, crossover, and mutation
- Explain the reasons for the genetic modification of organisms
- Describe the processes and techniques used to produce transgenic organisms
- Describe how biotechnology can be used to evaluate existing transgenic organisms
- Explain the purpose of the expression testing
- Discuss the fundamental science behind expression testing
- Distinguish between the types of expression testing and when each is preferred
- Describe common complications and troubleshooting in expression testing
- Define single nucleotide polymorphisms (SNPSs)
- Describe how SNPs are identified
- Explain problems associated with expression cloning testing

Comments: