# Agricultural and Environmental Systems Career Field

## Bioresearch

**Subject Code: 012025**

**Outcome & Competency Descriptions**

**Course Description:**

Learners in this course will apply knowledge of bioinformatics, plant and animal microbiology, and chemistry to data mining and laboratory techniques. Students will perform procedures of developing bio-products to solve issues facing agriculture. In this course, students will also be introduced to bioinformatics related to genome analysis for research and present their overall findings.

**Strand 1.**  **Business Operations/21st Century Skills**

Learners apply principles of economics, business management, marketing and employability in an entrepreneur, manager and employee role to the leadership, planning, developing and analyzing of business enterprises related to the career field.

**Outcome: 1.1. Employability Skills**

Develop career awareness and employability skills (e.g., face-to-face, online) needed for gaining and maintaining employment in diverse business settings.

**Competencies**

1.1.1. Identify the knowledge, skills and abilities necessary to succeed in careers.

1.1.2. Identify the scope of career opportunities and the requirements for education, training, certification, licensure and experience.

1.1.3. Develop a career plan that reflects career interests, pathways and secondary and postsecondary options.

1.1.4. Describe the role and function of professional organizations, industry associations and organized labor and use networking techniques to develop and maintain professional relationships.

1.1.5. Develop strategies for self-promotion in the hiring process (e.g., filling out job applications, resumé writing, interviewing skills, portfolio development).

1.1.6. Explain the importance of work ethic, accountability and responsibility and demonstrate associated behaviors in fulfilling personal, community and workplace roles.

1.1.7. Apply problem-solving and critical-thinking skills to work-related issues when making decisions and formulating solutions.

1.1.8. Identify the correlation between emotions, behavior and appearance and manage those to establish and maintain professionalism.

1.1.9. Give and receive constructive feedback to improve work habits.

1.1.10. Adapt personal coping skills to adjust to taxing workplace demands.

1.1.11. Recognize different cultural beliefs and practices in the workplace and demonstrate respect for them.

**Outcome: 1.2. Leadership and Communications**

Process, maintain, evaluate and disseminate information in a business. Develop leadership and team building to promote collaboration.

**Competencies**

1.2.1. Extract relevant, valid information from materials and cite sources of information.

1.2.12. Use technical writing skills to complete forms and create reports.

**Outcome: 1.4. Knowledge Management and Information Technology**

Demonstrate current and emerging strategies and technologies used to collect, analyze, record and share information in business operations.

**Competencies**

1.4.1. Use office equipment to communicate (e.g., phone, radio equipment, fax machine, scanner, public address systems).

1.4.2. Select and use software applications to locate, record, analyze and present information (e.g., word processing, e-mail, spreadsheet, databases, presentation, Internet search engines).

1.4.3. Verify compliance with security rules, regulations and codes (e.g., property, privacy, access, accuracy issues, client and patient record confidentiality) pertaining to technology specific to the industry pathway.

1.4.4. Use system hardware to support software applications.

1.4.5. Use information technology tools to maintain, secure and monitor business records.

1.4.6. Use an electronic database to access and create business and technical information.

**Strand 3.**  **Biotechnology**

Learners engage in the scientific process, learn fundamental processes using modern tools and laboratory techniques, adhere to safety protocols, and bring a biotechnology product to the market.

**Outcome: 3.1. Research and Experiments**

Use scientific methodology to conduct problem-based studies, develop products, and interpret results.

**Competencies**

3.1.1. Design a research plan, including the significance of the problem, purpose, hypotheses, objectives, appropriate controls, independent variables, dependent variables, methods of study and a list of materials.

3.1.2. Examine sources for credibility.

3.1.3. Apply sampling methods that appropriately represent the population and implement procedures for systematic data collection.

3.1.4. Explain the importance and design of trialing, and the information gained from it.

3.1.5. Document results of the experiment in a laboratory notebook, including a statement of purpose, experimental designs, observations, results, conclusions and next steps.

3.1.6. Create, interpret, and use tabular and graphical displays and describe the data.

3.1.7. Compute measures of central tendency to interpret results and draw conclusions.

3.1.8. Define the concepts of confidence intervals and significant figures.

3.1.9. Use t-test and p-value to determine statistical significance of results.

3.1.10. Describe the relationships among variables using correlations and draw conclusions.

3.1.11. Draw conclusions based on observations and data analyses, recognizing that experimental results must be open to the scrutiny of others.

3.1.12. Prepare and present findings using scientific reports.

3.1.13. Evaluate experimental failure and use integrity to communicate findings.

3.1.14. Describe how the biotechnology products are produced and used in the United States.

3.1.15. Describe how biotechnology products are regulated in the United States.

3.1.16. Describe biotechnology product safety assessment.

**Outcome: 3.2. Laboratory Standard Operational Procedures**

Conduct experiments using proper industry-based protocols, methods and techniques.

**Competencies**

3.2.1. Use aseptic techniques to collect, prepare and test samples.

3.2.3. Test and maintain the integrity of stains, reagents, chemicals and mounts.

3.2.4. Select and apply sterilization methods for reagents, buffers, media, biological samples and solutions.

3.2.5. Perform laboratory measures by calculating and preparing a serial dilution, calculating quantities needed to perform a test analysis and calculating unit conversions and concentrations (graphing results).

3.2.6. Monitor physical properties of reagents, buffers, media and solutions for conductivity and resistivity, pH and turbidity and explain the significance of each.

3.2.7. Perform separation techniques, including chemical separations, chromatography, centrifugation, distillation and filtration and interpret the results.

3.2.8. Titrate liquids.

3.2.9. Create a standard operating procedure and explain its use.

3.2.10. Describe industry-based and required regulatory quality assurance practices for documentation.

**Outcome: 3.3. Specimen, equipment and chemical handling**

Handle, prepare, transport, store and dispose of specimens and chemicals. Monitor, record and maintain the integrity of equipment and instrumentation, environmental conditions of the facility and inventory.

**Competencies**

3.3.1. Prepare and interpret labels for chemicals, supplies and equipment.

3.3.2. Use chemical references to identify hazards associated with handling and storing chemicals.

3.3.3. Safely transfer chemicals from storage containers to equipment used in the laboratory.

3.3.4. Neutralize acids, bases or caustic solutions for handling and disposal.

3.3.5. Sample, monitor and record the environmental conditions of the facility (e.g., air quality, HEPA, temperature, microbial contaminations).

3.3.6. Identify and describe the purpose of common laboratory equipment.

3.3.7. Select personal protective equipment for various laboratory protocols.

3.3.8. Identify required tools and procedures of different biosafety levels.

3.3.9. Adjust, calibrate and perform systems diagnostics on laboratory equipment.

3.3.10. Use and maintain a record keeping system for laboratory equipment, chemicals, or products.

3.3.11. Use and maintain an inventory management system.

3.3.13. Use volumetric glassware to accurately measure liquids.

**Outcome: 3.4. Applying Chemistry to Laboratory Practices**

Using common laboratory equipment, apply general and organic chemistry concepts to examine the structures, functions, binding of molecules, and methodologies for their purity and characterization.

**Competencies**

3.4.1 Illustrate electron configurations of elements, compounds and mixtures.

3.4.2. Use the periodic table to describe atomic structure and to characterize molecules based on functional groups.

3.4.3. Differentiate between organic and inorganic compounds.

3.4.4. Use common and chemical nomenclature for organic and inorganic materials.

3.4.5. Write names and formulas for common compounds.

3.4.6. Prepare solutions based on molarity, percent weight per volume (w/v) and percent volume per volume (v/v),

3.4.7. Describe chemical bonding and bond types and the relationships that they have with the physical state of materials.

3.4.10. Identify materials that can be used as a catalyst and describe their role in reactions.

3.4.13. Calculate errors in various measurements, based on data acquired using common laboratory equipment.

3.4.14. Apply standard rules for determining the number of significant figures in measurements and in the answers to corresponding calculations.

3.4.15. Convert units of measure from English to metric, within the English system, and within the metric system.

**Outcome: 3.5. Microbiology Testing and Technology**

Classify, differentiate between, and test for various kinds of microorganisms and microbial by-products.

**Competencies**

3.5.1. Explain classification, composition and preparation of culture media and prepare media for propagation.

3.5.2. Operate centrifuge, dissecting scope, compound microscope, spectrophotometer, incubator, colony counter, pipettes, and other basic microbiology and analytical equipment to examine biological specimens.

3.5.3. Explain the principles of microscopy and process a specimen for light microscopy.

3.5.4. Perform Gram staining to identify morphology and gram results of bacteria.

3.5.5. Prepare, incubate and identify colonies microscopically and macroscopically (e.g., colonial morphology, staining procedures, biochemical analysis).

3.5.10. Differentiate between types of viruses.

3.5.11. Explain virulence, pathogenicity and the factors that contribute to pathogenicity.

3.5.12. Explain how chemical energy operates major cell processes (e.g., biosynthesis, movement, transport, growth).

3.5.13. Identify bacteriologic methods necessary for the isolation and identification of organisms.

3.5.14. Identify factors that affect and optimize rates of enzyme assay reactions.

3.5.16. Describe types of assays and distinguish uses and limitations.

3.5.18. Perform biochemical assays of proteins, lipids, carbohydrates, nucleic acids and enzymes.

3.5.21. Perform autoclave sterilization.

**Outcome: 3.6. Molecular-Genetics Technology**

Apply knowledge of genetic inheritance and modification to organisms and use genetic information and bioinformatics to analyze specimens

**Competencies**

3.6.4. Model central dogma theory of molecular biology (e.g., replication, transcription, translation).

3.6.6. Explain gene editing including the process, possible benefits and potential risks.

3.6.7. Identify, isolate and manipulate peptides and proteins (i.e., primary, secondary, tertiary, quaternary structures).

3.6.8. Analyze DNA using common laboratory techniques (e.g., DNA isolation, gel electrophoresis, restriction enzyme digest, Southern Blotting, Northern Blotting).

3.6.9. Use bioinformatics to analyze DNA and proteins.

3.6.11. Preform spectroscopy of biological materials explaining the principles behind the procedures, the purpose of a blank and determine the concentration of biomolecular samples.

3.6.12. Evaluate genomes in relation to food, plant, animals and natural resources.

3.6.13. Perform genotyping analysis for genetic diagnostics.

3.6.14. Transform bacteria with exogenous DNA to alter bacterial metabolism, reproduction, cell structures and their functions.

3.6.19. Define genetically modified organisms and explain their impact on society.