# Agricultural and Environmental Systems Career Field

## Animal and Plant Biotechnology

**Subject Code: 012010**

**Outcome & Competency Descriptions**

**Course Description:**

Learners will apply principles of chemistry, microbiology and genetics to plant and animal research and product development. Students will apply genetic principles to determine genotypes and phenotypes. Students will describe the parts and functions of animal and plant cells and their importance in biochemistry. They will perform restrictive enzyme digests, Polymerase Chain Reactions and apply principles of nucleic acid blotting. This course will examine applications of Central Dogma Theory and other Molecular-Genetics Technologies.

**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.

1.1.12. Identify healthy lifestyles that reduce the risk of chronic disease, unsafe habits and abusive behavior.

**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.

1.2.2. Deliver formal and informal presentations.

1.2.3. Identify and use verbal, nonverbal and active listening skills to communicate effectively.

1.2.4. Use negotiation and conflict-resolution skills to reach solutions.

1.2.5. Communicate information (e.g., directions, ideas, vision, workplace expectations) for an intended audience and purpose.

1.2.6. Use proper grammar and expression in all aspects of communication.

1.2.7. Use problem-solving and consensus-building techniques to draw conclusions and determine next steps.

1.2.9. Identify advantages and disadvantages involving digital and/or electronic communications (e.g., common content for large audience, control of tone, speed, cost, lack of non-verbal cues, potential for forwarding information, longevity).

1.2.11. Write professional correspondence, documents, job applications and resumés.

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

1.2.13. Identify stakeholders and solicit their opinions.

**Outcome: 1.3. Business Ethics and Law**

Analyze how professional, ethical and legal behavior contributes to continuous improvement in organizational performance and regulatory compliance.

**Competencies**

1.3.1. Analyze how regulatory compliance (e.g., United States Department of Agriculture [USDA], Food and Drug Administration [FDA], United States Department of Interior [USDI], Ohio Livestock Care Standards, water quality standards, local water regulations, building codes) affects business operations and organizational performance.

1.3.2. Follow protocols and practices necessary to maintain a clean, safe and healthy work environment.

1.3.3 Use ethical character traits consistent with workplace standards (e.g., honesty, personal integrity, compassion, justice).

1.3.4. Identify how federal and state consumer protection laws affect products and services.

1.3.5. Access and implement safety compliance measures (e.g., quality assurance information, safety data sheets [SDSs], product safety data sheets [PSDSs], United States Environmental Protection Agency [EPA], United States Occupational Safety and Health Administration [OSHA]) that contribute to the continuous improvement of the organization.

1.3.7. Identify the labor laws that affect employment and the consequences of noncompliance for both employee and employer (e.g., harassment, labor, employment, employment interview, testing, minor labor laws, Americans with Disabilities Act, Fair Labor Standards Acts, Equal Employment Opportunity Commission [EEOC]).

1.3.8. Verify compliance with computer and intellectual property laws and regulations.

1.3.9. Identify potential conflicts of interest (e.g., personal gain, project bidding) between personal, organizational and professional ethical standards.

**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**

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

1.4.8. Use electronic media to communicate and follow network etiquette guidelines.

**Outcome: 1.5. Global Environment**

Evaluate how beliefs, values, attitudes and behaviors influence organizational strategies and goals.

**Competencies**

1.5.1. Describe how cultural understanding, cultural intelligence skills and continual awareness are interdependent.

1.5.2. Describe how cultural intelligence skills influence the overall success and survival of an organization.

1.5.3. Use cultural intelligence to interact with individuals from diverse cultural settings.

1.5.4. Recognize barriers in cross-cultural relationships and implement behavioral adjustments.

1.5.5. Recognize the ways in which bias and discrimination may influence productivity and profitability.

1.5.8. Identify how multicultural teaming and globalization can foster development of new and improved products and services and recognition of new opportunities.

**Outcome: 1.10. Sales and Marketing**

Manage pricing, place, promotion, packaging, positioning and public relations to improve quality customer service.

**Competencies**

1.10.2. Determine the customer's needs and identify solutions.

1.10.3. Communicate features, benefits and warranties of a product or service to the customer.

1.10.5. Monitor customer expectations and determine product/service satisfaction by using measurement tools.

1.10.8. Use promotional techniques to maximize sales revenues (e.g., advertising, sales promotions, publicity, public relations).

1.10.10. Demonstrate sales techniques.

**Outcome: 1.12. Site and Personal Safety Procedures**

Follow site and personal safety procedures in specific situations with specialized tools and equipment, evaluate the situation and take corrective action.

**Competencies**

1.12.2. Interpret safety signs and symbols.

1.12.7. Select, use, store, maintain and dispose of personal protective equipment (PPE), appropriate to job tasks, conditions and materials.

1.12.8. Identify safety hazards and take corrective measures.

1.12.9. Identify, inspect and use safety equipment appropriate for the task.

1.12.10. Follow established procedures for the administration of first aid and contact emergency medical personnel when necessary.

**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 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.

3.1.17. Identify the purpose of a bioreactor and its use in the agricultural industry.

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

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

**Competencies**

3.2.1. Use an aseptic technique to collect, prepare and test samples.

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).

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

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.

3.3.6. 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.

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

3.3.12. Use and calibrate precision weighing and measuring techniques (e.g. analytical balance, micropipette), based on the metric 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**

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

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.

3.5.3. 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.

3.5.6. Use microbial taxonomy and classification systems to identify microbial organisms.

3.5.7. Compare and contrast cellular structure and functions of prokaryotic and eukaryotic cells.

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).

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

**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**

3.6.1. Use a Punnett Square to predict and explain Mendel’s Laws, genotype and phenotype.

3.6.2. Explain epigenetics and provide examples of its effects.

3.6.3. Model, predict and diagram the three-dimensional shape, types of bonds (covalent and hydrogen bonds) and antiparallel nature of DNA.

3.6.4. Model the Central Dogma Theory (e.g., replication, transcription, translation).

3.6.5. Describe post-transcriptional and post-translational modification of RNA and describe its function.

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

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.

3.6.10. Explain cloning techniques including vector preparation, transformation and selection.

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

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

3.6.16. Describe molecular behavior and structure of large molecules, including carbohydrates, lipids, proteins and nucleic acids.

3.6.17. Describe genome sequencing and the information gained from it.

3.6.18. Describe artificial selection and how it used in plant and animal breeding.

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

3.6.20. Describe how vectors (e.g., plasmids, transposons, viruses) are used to transform host and microorganisms.

3.6.21. Explain gene by environment interactions.

**Strand 5. Elements of Production**

Learners apply principles of practice related to the management and maintenance of food, agriculture and natural resources systems.

**Outcome: 5.16. Biosecurity**

Connect the sources and causes of contamination and develop the protocols to implement biosecurity procedures.

**Competencies**

5.16.5. Implement biosecurity procedures to prevent cross-site contamination (e.g., proper use and disposal of personal protective equipment [PPE] from site to site, vehicle cleaning between farm and processing site).