## Agricultural and Environmental Systems Career Field

## Genetics of Plants and Animals

**Subject Code: 012020**

**Outcome & Competency Descriptions**

**Course Description:**

Students gain knowledge and skill in genetic principles and mechanisms of heredity. Students perform applications using knowledge of DNA and chromosome structure, transcription, and gene regulation; replication and cell division; patterns of inheritance; and genetic recombination mutations and their repair. Learners will apply molecular principles to food, plant and animal research and present findings through various forms of communication.

**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: 1.12. 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 design, 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.

**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 regents, 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).

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

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. Safety 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 procedure of different biosafety levels.

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

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**

3.4.3. Differentiate between organic and inorganic compounds.

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

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**

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

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

3.5.15. Describe the purpose of an enzyme-linked immunosorbent assay (ELISA) and interpret the results.

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

3.5.17. Follow complex instructions in performing an assay and explain the role of each step.

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

3.5.20. Apply quality assurance control processes within the lab setting (e.g., pre-analytic, analytic, and post-analytic sources of error).

**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 central dogma of molecular biology (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.

3.6.7. 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.

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

3.6.11. Perform 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, plants, 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.

3.6.15. Describe types and features of passive and active transport systems.

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 is 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 hosts and microorganisms.

3.6.21. Explain gene by environment interactions.

3.6.22. Describe the difference between a quantitative and qualitative gene trait and give examples of each.