**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.

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

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]).

1.3.9. 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.

1.5.4. 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.

**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.

*An “X” indicates that the pathway applies to the outcome.*

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| **Pathways** |  | Agribusiness and Production Systems |  | Animal Science and Management | X | Bioscience | | |  | Horticulture |
|  | Natural Resource Management |  | Power Technology | | |  |  | | |
| **Green Practices** |  | Green-specific |  | Context-dependent | | |  | Does not apply | | |

**Strand 3. Biotechnology**

Learners apply the skills and knowledge of interpreting laboratory requests, using protective clothing and hazardous material containment, specimen collection procedures, a variety of laboratory testing and techniques, and maintenance of laboratory equipment and supplies.

**Outcome: 3.2. Foundations of Chemistry**

Perform a systematic and methodical application of general and organic chemistry principles to examine structures, their functions, their binding to other molecules and the methodologies for their purity and characterization.

**Competencies**

3.2.1. Illustrate electron configurations of elements, compounds and mixtures.

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

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

3.2.8. Apply the concepts of stoichiometry and the laws of thermodynamics to chemical reactions.

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

**Outcome: 3.3. Microbiology Testing and Technology**

Describe the morphologies and processes of the reproduction of microorganisms.

**Competencies**

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

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

3.3.3. Transform deoxyribonucleic acid (DNA) to alter bacterial metabolism, reproduction, cell structures and their functions.

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

**Outcome: 3.4. Molecular-Genetics Technology**

Apply knowledge of nucleic acid structure and function, deoxyribonucleic acid (DNA) replication, transcription, translation, chromosome structure and remodeling and regulation of gene expression in prokaryotes and eukaryotes.

**Competencies**

3.4.1. Use a Punnet square to predict and explain Mendel’s Laws, genotype and phenotype.

3.4.2. Explain alternative forms of transmission (e.g., non-Mendelian inheritance).

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

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

3.4.5. Follow regulations for genetic modification (e.g., histone acetylation, ribonucleic acid [RNA] stability, co- and post-translational modifications).

3.4.6. Identify alternative types of gene expression (e.g., sex-limited, sex-linked, partial dominance, epistatic, pleiotropic).

3.4.8. Perform the steps in creating a recombinant DNA molecule.

3.4.9. Isolate and purify nucleic acids, including chromosomal and extra-chromosomal DNA molecules.

3.4.10. Compare nucleic acids, chromosomal DNA molecules and proteins using a sequence database (e.g., National Center for Biotechnology Information, Europeon Bioninformatics Institute).

3.4.11. Perform a restrictive enzyme digest and analyze the results.

3.4.12. Apply concepts of screening genetic expression, expression vectors and genetic libraries.

3.4.13. Apply the principles of nucleic acid blotting (e.g., colony transfer, Southern and Northern Blot Analysis).

3.4.14. Perform and interpret the results of a polymerase chain reaction (PCR).

3.4.15. Explain applications of Southern and Northern Blot Analysis.

3.4.16. Isolate, quantitate (e.g., Bradford assay) and characterize (e.g., Western Blot analysis) proteins.

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

3.4.21. Identify the role of RNA in gene expression.

3.4.22. Explain results from genome sequencing projects and explain how gene sequencing is performed.

**Outcome: 3.5. Laboratory Standard Operational Procedures**

Perform methods and techniques using protocols to conduct an experiment.

**Competencies**

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

3.5.2. Prepare and dispense stock reagents, buffers, media and solutions by calculating concentrations, adjusting factors such as pH and selecting purification techniques and containers.

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

3.5.4. Select and apply sterilization methods for reagents, buffers, media and solutions.

3.5.5. 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).

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

**Outcome: 3.6. Culturing**

Perform experimental techniques used in microbial biology to study cell growth, manipulation and evaluation.

**Competencies**

3.6.1. Identify the structure of cells and the functions of their components.

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

**Outcome: 3.8. Research and Experiments**

Conduct a problem-based study, applying scientific methodology and using descriptive statistics to communicate and support predictions and conclusions.

**Competencies**

3.8.1. Identify research problems and structure a statistical experiment, simulation or study related to the problem.

3.8.2. Design a research plan, including the significance of the problem, purpose, variables, hypotheses, objectives, methods of study and a list of materials.

3.8.3. Distinguish between dependent, independent and control variables in an experiment.

3.8.4. Establish and implement procedures for systematic collection, organization and use of data.

3.8.5. Select and apply sampling methods that appropriately represent the population to be studied.

3.8.6. Define the concepts of confidence limit and significant figures.

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

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

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

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

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

3.8.12. Prepare and present findings using scientific reports.

*An “X” indicates that the pathway applies to the outcome.*

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| **Pathways** |  | Agribusiness and Production Systems |  | Animal Science and Management | X | Bioscience | | |  | Horticulture |
|  | Natural Resource Management |  | Power Technology | | |  |  | | |
| **Green Practices** |  | Green-specific |  | Context-dependent | | |  | Does not apply | | |

**Strand 4. Power Systems**

Learners apply principles of tool use, power transmission, hydraulics, two- and four-stroke cycle combustion, heating and cooling, exhaust, ignition, starting and charging, steering and lubrication systems to operate, to maintain or repair equipment.

**Outcome: 4.1. Tool, Stationary and Mobile Equipment Maintenance**

Inspect, clean, maintain and perform planned preventative maintenance on tools, machinery, implements and equipment.

**Competencies**

4.1.1. Identify the types of hand tools, power tools and stationary equipment and describe their functions.

4.1.2. Ensure the presence and functionality of safety systems and hardware.

4.1.3. Identify potential hazards and limitations related to the use of hand tools, power tools and stationary equipment.

4.1.4. Maintain machinery, equipment, instrument and facility cleanliness, appearance and safety.

4.1.11. Calibrate metering, monitoring and sensing equipment.

**Outcome: 4.2. Equipment Operations**

Operate and maintain mechanical equipment and power systems.

**Competencies**

4.2.1. Follow manufacturer’s recommended operating procedures and adjustment specifications.

4.2.2. Differentiate among the functions, limitations and proper use of equipment, equipment controls and instrumentation.

4.2.3. Perform pre- and post-operation inspections and adjustments and report malfunctions.

4.2.4. Perform appropriate start-up, operating and shut-down procedures.

4.2.5. Select and operate the equipment and attachments needed to complete the task including levers, pedals or valves.

*An “X” indicates that the pathway applies to the outcome.*

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| **Pathways** |  | Agribusiness and Production Systems |  | Animal Science and Management | X | Bioscience | | |  | Horticulture |
|  | Natural Resource Management |  | Power Technology | | |  |  | | |
| **Green Practices** |  | Green-specific |  | Context-dependent | | |  | Does not apply | | |

**Strand 7. Food Science**

Learners apply principles of biology, chemistry and physics to the research, development, production, processing and distribution of food products meeting quality assurance standards in a system that is safe and secure.

**Outcome: 7.7. Biosecurity**

Connect the sources and causes of contamination and develop the protocols to implement bio-security procedures.

**Competencies**

7.7.5. 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).

*An “X” indicates that the pathway applies to the outcome.*

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| **Pathways** |  | Agribusiness and Production Systems |  | Animal Science and Management | X | Bioscience | | |  | Horticulture |
|  | Natural Resource Management |  | Power Technology | | |  |  | | |
| **Green Practices** |  | Green-specific |  | Context-dependent | | |  | Does not apply | | |