Biotechnology for Food, Plant, and Animal Science CTAG Alignments

This document contains information about two (2) proposed Career-Technical Articulation Numbers (CTANs) for the proposed Biotechnology for Food Plant and Animal Science Career-Technical Assurance Guide (CTAG).

The CTANs are:

1. Biotechnology Principles
2. Bioinformatics

ODE Course Alignments:

1. Animal and Plant Biotechnology (012010)
2. Bioresearch (012025)

1. <u>Biotechnology Principles</u>. Potential CTAN alignment with the Biotechnology for Food, Plant and Animal Science Pathway in the Agriculture and Environmental Systems Career Field Technical Content Standards of the Ohio Department of Education

General Course Description: This course covers the foundation of modern biotechnology. It reviews the history and foundational principles of the science. Students will learn the theoretical basis of DNA, RNA, and protein detection, analysis, manipulation, and engineering. Present and future applications of Biotechnology as they relate to areas such as industrial applications, medicine, environment and agriculture will be explored.

Advising Notes:

- Must access credit within 3 years of program completion

Proposed Semester Credit Hours: 3.0

Proposed Alignment:

Proposed Learning Outcomes **The student will be able to:**	**Competencies from the Biotechnology for Food, Plant & Animal Science Pathway of the Agriculture and Environmental Systems Career Field Technical Content Standards**
1. Describe the history of and evaluate the implications of biotechnology in society, e.g., ethics, medicine, agriculture, environment and industry.*	**Outcome 1.3: Business Ethics and Law** 1.3.3. Use ethical character traits consistent with workplace standards (e.g., honesty, personal integrity, compassion, justice). 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. 1.3.6. Identify deceptive practices (e.g., bait and switch,

	identity theft, unlawful door-to-door sales, deceptive service estimates, fraudulent misrepresentations) and their overall impact on organizational performance. 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 1.5: Global Environment** 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. 1.5.8. Identify how multicultural teaming and globalization can foster development of new and improved products and services and recognition of new opportunities. **Outcome 3.4: Molecular-Genetics Technology** 3.4.4. Model the Central Dogma Theory (e.g., replication, transcription, translation). 3.4.22 Explain results from genome sequencing projects and explain how gene sequencing is performed.
2. Demonstrate an understanding of the process of DNA replication, transcription, translation, and gene regulation mechanisms.*	**Outcome 3.3: Microbiology Testing and Technology** 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. **Outcome 3.4: Molecular-Genetics Technology** 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. Explain the theoretical basis of genome analysis, including Sanger sequencing and current sequencing technologies.*	**Outcome 3.4: Molecular-Genetics Technology** 3.4.10 Compare nucleic acids, chromosomal DNA molecules, and proteins using a sequence database (e.g., National Center for Biotechnology Information, European 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. 3.4.19. Evaluate genomes in relation to food, plant, animals and natural resources. 3.4.22 Explain results from genome sequencing projects and explain how gene sequencing is performed.
4. Explain the theoretical basis of recombinant DNA technologies and its application.*	**Outcome 3.4: Molecular-Genetics Technology** 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). 3.4.8. Perform the steps in creating a recombinant DNA molecule. **Outcome 3.6: Culturing** 3.6.10. Describe how vectors (e.g., plasmids, transposons, viruses) are used to transform host and microorganisms.
5. Explain the theoretical basis of gene expression analysis and its application.*	**Outcome 3.4: Molecular-Genetics Technology** 3.4.4. Model the Central Dogma Theory (e.g., replication, transcription, translation). 3.4.6. Identify alternative types of gene expression (e.g., sex-limited, sex-linked, partial dominance, epistatic, pleiotropic). 3.4.10 Compare nucleic acids, chromosomal DNA molecules, and proteins using a sequence database (e.g., National Center for Biotechnology Information, European Bioninformatics Institute). 3.4.12. Apply concepts of screening genetic expression, expression vectors and genetic libraries.

	3.4.21. Identify the role of RNA in gene expression.
6. Explain the theoretical basis of PCR and basic chromatography techniques for separating and identifying nucleic acids, carbohydrates, proteins, and biological metabolites.*	**Outcome 3.3: Microbiology Testing & Technology** 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** 3.4.4. Model the Central Dogma Theory (e.g., replication, transcription, translation). 3.4.9. Isolate and purify nucleic acids, including chromosomal and extra-chromosomal DNA molecules. 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.
7. Explore biotechnology fields and the career opportunities within each	**Outcome 1.1: Employability Skills** 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 3.8: Research and Experiments** 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. 3.8.11. 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.

2. **Bioinformatics.** Potential CTAN alignment with the Biotechnology Pathway in the Agriculture and Environmental Systems Career Field Technical Content Standards of the Ohio Department of Education

General Course Description. The last decade has seen an explosion in the amount of genomic data due to the availability of high-throughput sequencing technologies. This course will provide instruction on the databases commonly used to by scientists to mine these data, the terminology used, and the software used. Students will learn how to generate hypotheses and then use the databases and software to test them

Advising Notes*:*

- Must access credit within 3 years of program completion

Proposed Semester Credit Hours: 3.0

Proposed Alignment:

Proposed Learning Outcomes **The student will be able to:**	**Competencies from the Biotechnology for Food, Plant & Animal Science Pathway of the Agriculture and Environmental Systems Career Field Technical Content Standards**
1. Explain the theoretical basis of Sanger sequencing and current sequencing technologies.*	**Outcome 3.4: Molecular-Genetics Technology** 3.4.4. Model the Central Dogma Theory (e.g., replication, transcription, translation). 3.4.14. Perform and interpret the results of a Polymerase Chain Reaction (PCR). 3.4.22 Explain results from genome sequencing projects and explain how gene sequencing is performed.
2. Locate the primary databases used for genome, transcriptome, and proteome data.*	**Outcome 3.4: Molecular-Genetics Technology** 3.4.10 Compare nucleic acids, chromosomal DNA molecules, and proteins using a sequence database (e.g., National Center for Biotechnology Information, European Bioninformatics Institute).
3. Demonstrate use of commonly used software for gene identification, homology searches, alignments, clustering, and phylogenetics.*	**Outcome 3.4: Molecular-Genetics Technology** 3.4.10 Compare nucleic acids, chromosomal DNA molecules, and proteins using a sequence database (e.g., National Center for Biotechnology Information, European Bioninformatics Institute). 3.4.19 Evaluate genomes in relation to food, plant, animals and natural resources.
4. Generate a hypothesis and test it using available databases and software.*	**Outcome 3.4: Molecular-Genetics Technology** 3.4.10 Compare nucleic acids, chromosomal DNA molecules, and proteins using a sequence database (e.g., National Center for Biotechnology Information, European Bioninformatics Institute).

	Outcome 3.8: Research and Experiments 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. 3.8.4 Establish and implement procedures for systematic collection, organization and use of data. 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. 3.8.10 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.
5. Explore biotechnology fields and the career opportunities within each.	**Outcome 1.0: Employability Skills** 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.