Department of Education | College, Career and Technical Education

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BioSTEM II

Primary Career Cluster:	Science, Technology, Engineering, and Mathematics (STEM)
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C21H08
Prerequisite(s):	*BioSTEM I* (C21H07)
Credit:	1
Grade Level:	10
Focus Elective Graduation Requirement:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other *BioSTEM* courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition, when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the second course in the *BioSTEM* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.tnskillsusa.com Technology Student Association (TSA): http://www.tntsa.org
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visithttps://www.tn.gov/education/career-and-technical-education/work-based-learning.html.
Promoted Student Industry Credentials	Credentials are aligned with post-secondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	013, 014, 015, 016, 017, 018, 047, 070, 078, 081, 125, 126, 127, 128, 129,157, 210, 211, 212, 213, 214, 230, 232, 233, 413, 414, 415, 416, 417, 418, 449, 470, 477, 519, 531, 595, 596, 700, 740, 760, 982
Required Teacher Certifications/Training:	Teachers who have never taught this course must attend training provided by the Department of Education.
Teacher Resources:	https://www.tn.gov/education/career-and-technical-education/career-clusters/cte-cluster-stem.html Best for All Central: https://bestforall.tnedu.gov/

Approved February 8, 2019

Course-At-A-Glance

There is no one way to create meaningful learning experiences for students. There are best practices available that data and students say impact long-term student learning. One of those best practices is to put student learning in context with their experiences.

Career and Technical Student Organizations (CTSOs) provide an opportunity for students to display their learning in the classroom and through regional, state, and/or national competition. Work-based Learning (WBL) consists of sustained and coordinated work-based activities that relate to the course content. These activities should occur at every level through a program of study. Below is a listing of possible CTSO connections and WBL activities for this course. This listing is intended to be an idea starter and not a comprehensive listing.

Using a Career and Technical Student Organization (CTSO) in Your Classroom

Putting the classroom learning into real life experiences is often what creates a meaningful learning experience for students, one that lasts beyond the exam and course. CTSOs are a great resource to create this type of learning for your students. They are also a great resource to showcase your students learning through regional, state, and national competitions. Possible connections for this course include the following. This is not an exhaustive list.

- Participate in CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry specific skills that involve teamwork and project management
- Participate in contests that highlight job skill demonstration; interviewing skills; community service activities, extemporaneous speaking, and job interview
- Participate in leadership activities such as National Leadership and Skills Conference, National Week of Service, 21st Century Skills

For more ideas and information, visit Tennessee SkillsUSA at http://www.tnskillsusa.com and Technology Student Association (TSA): http://www.tntsa.org

Using Work-based Learning in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standards 1-3**| Invite an industry representative to discuss occupations and safety protocols for the career field.
- **Standards 4-8 |** Invite a geneticist to discuss DNA.
- **Standards 9-11** | Job shadow a geneticist.
- **Standards 12-13** | Work on site with a geneticist on a real project.
- **Standards 14-16** | Invite a data analyst to discuss data interpretation.
- **Standards 17-18** |Do a project that is evaluated by a local laboratory.

For more ideas and information, visit https://www.tn.gov/education/career-and-technical-education/work-based-learning.html.

Course Description

BioSTEM II is a project-based learning experience for students who wish to further explore the dynamic range of BioSTEM fields introduced in BioSTEM I. Building on the content and critical thinking frameworks of BioSTEM I, this course asks students to apply the scientific inquiry and engineering design processes to a course-long project selected by the instructor with the help of student input. Instructors design a project in one of the BioSTEM fields of medical laboratory science, research science, food science, forensic science or environmental science that reflects the interest of the class as a whole; the students then apply the steps of the scientific inquiry process throughout the course to ask questions, test hypotheses, model solutions, and communicate results. In some cases, instructors may be able to design hybrid projects that employ elements of several of the BioSTEM fields. Upon completion of this course, proficient students will have a thorough understanding of how scientists research problems and methodically apply BioSTEM knowledge and skills; and they will be able to present and defend a scientific explanation to comprehensive BioSTEM scenarios.

Note: Standards in this course are presented sequentially according to the traditional steps followed in the scientific inquiry process. While instructors may tailor the order of course standards to their specifications, it is highly recommended that they maintain fidelity to the overall process.

Program of Study Application

This is the second course in the Bio*STEM* program of study. For more information on the benefits and requirements of implementing this program in full, please visit the STEM website at https://www.tn.gov/education/career-and-technical-education/career-clusters/cte-cluster-stem.html.

Course Standards

Safety

1) Accurately read and interpret safety rules, including but not limited to rules published by the National Science Teachers Association (NSTA), rules pertaining to electrical safety, Occupational Safety and Health Administration (OSHA) guidelines, and state and national code requirements. Be able to distinguish between the rules and explain why certain rules apply.

2) Identify and explain the intended use of safety equipment available in the classroom. For example, demonstrate how to properly inspect, use, and maintain safe operating procedures with tools and equipment. Incorporate safety procedures and complete safety test with 100 percent accuracy.

The Roles of Scientists

3) Determine the scientist's role in explaining why phenomena occur in the natural world, justified by historical and current science knowledge. Research a known scientist and present in an informative paper, oral presentation, or other format his/her contributions to scientific knowledge in the fields of food, environmental, biomedical, research, and forensic science. Include an outline of how the scientific inquiry process was used in his/her work.

DNA Basics

4) Explain how DNA serves as a template for self-replication and encoding of biological information using an original visual DNA model. Define the terms DNA replication, DNA transcription, and translation of mRNA. Recount the processes involved in each and describe the negative outcomes if there is an interference in the process. Using domain-specific terminology, develop a scientific explanation to support the claim that the structures and mechanisms of DNA and RNA are the primary sources of heritable information.

5) Construct a visual artifact, annotated with written explanations, detailing how DNA in chromosomes is transmitted to the next generation via mitosis or meiosis. Note qualitative and quantitative traits, mutations, transposable genetic elements, and regulation of gene expressions.

6) Research and explain Mendel's model of inheritance. Using this model, trace the pattern of appearance within a family for a heritable disease that is on the recessive allele and one that is on the dominant allele. Develop an argumentative essay regarding how a certain biotechnology could genetically modify a gene to prevent this disorder, citing information from textbooks and/or professional journals and websites.

7) In an argumentative essay, state claims and counterclaims about how DNA structure and function may be exploited using modern genetic engineering methods to produce specific genetic constructs, such as selecting, excising, ligating, and cloning of genetic material. Ensure the documentation is written in domain-specific medical terminology.

8) Distinguish between a number of strategies used to isolate or clone a gene, such as activation tagging, map-based gene cloning, plasmid cloning vectors, viral vectors, and shuttle vectors. Present an overview of these strategies in a visual format.

Questioning and Defining Problems

9) Engage in scientific inquiry by brainstorming to create questions to understand how a certain phenomenon in the natural world works, to understand why a phenomenon occurs, or to determine the validity of a theory.

10) Research various sources (e.g., articles, end-uses, textbooks) and identify one or more questions that will guide a scientific investigation of the various functions of DNA in food, environmental, biomedical, research, or forensic science. For example, questions should be relevant, testable, and based on current scientific knowledge.

11) Develop an original proposal as would a food, environmental, biomedical, research, or forensic scientist that will guide the scientific inquiry and follow responsible ethical practices. For example, the proposal should outline the reason for the research interest, hypothesis, methodology, data analysis, importance of study, and deliverables.

Planning and Investigating

12) Make a hypothesis that explains a scientific question about DNA and its relationship to food, environmental, biomedical, research, or forensic science. Plan and conduct a simple investigation and record observations (e.g., data) in a manner easily retrievable by others.

13) Identify the independent variables and dependent variables in an investigation. Demonstrate the effects of a changing independent variable on a dependent variable, and observe and record results.

Data Analysis and Interpretation

14) Use mathematics to represent and solve scientific questions. For example, simple limit cases can be used to determine if a model is realistic.

15) Evaluate data and identify any limitations of data analysis. Using this information, determine whether to make scientific claims from data or revise an investigation and collect more data.

16) Compare and contrast the data results from multiple iterations of a scientific investigation. For example, consider how well each explanation is supported by evidence, prior research, and scientific knowledge.

Problem Solutions and Scientific Explanations

17) Develop an explanation to a scientific question that is logically consistent, peer reviewed, and justified by DNA analysis and scientific knowledge.

Communicating Solutions and Explanations

18) Develop a technical report to communicate and defend a scientific explanation and justify its merit and validity with scientific information. Consider the ethical implications of the findings. The report can include tables, diagrams, graphs, procedures, and methodology. For example, conduct a BioSTEM forum, present scientific research, and provide evidence to support arguments for or against scientific solutions.

Standards Alignment Notes

*References to other standards include:

- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.