



BIOTECHNOLOGY CURRICULUM

CONTENTS

Biotechnology curriculum	1
CTECS - Vision of Graduate	4
CTECS Instructional Model	7
Marzano Compendium	8
Curriculum Introduction	9
Curriculum Components.....	9
Biotechnology Philosophy	11
Biotechnology Program Standards	11
Biotechnology – Course Map	13
Grade 9 – Semester 2	13
Grade 10 – Semester 1	13
Grade 10 – Semester 2	13
Grade 11 – Semester 1	13
Grade 11 – Semester 2	13
Grade 12 – Semester 1	14
Grade 12 – Semester 2	14
Biotechnology 9th Grade Curriculum	15
Priority Standard 9.1 - Basic Laboratory Safety	15
Priority Standard 9.2 - Careers in Biotechnology	17
Priority Standard 9.3 - Foundational Laboratory Skills	18
Priority Standard 9.4 - Chemistry for Biotechnology.....	20
Priority Standard 9.5 - Molecular Biology Concepts	22
Priority Standard 9.6 - Experimental Design and Data.....	24
Priority Standard 9.7 - Microbiology Concepts	25
Priority Standard 9.8 - Biotech Projects	27
Biotechnology 10th Grade Curriculum	28
Priority Standard 10.1 - Chemical Basis of Life	28
Priority Standard 10.2 - Macromolecules	30
Priority Standard 10.3 - Cell Structure and Metabolism	32
Priority Standard 10.4 - Cellular Respiration and Fermentation	34

Priority Standard 10.5 - Genetics and Gene Regulation	36
Priority Standard 10.6 - Biotechnology Techniques and Applications	38
Priority Standard 10.7 - Animal Structure and Physiology.....	40
Priority Standard 10.8 - Basic Scientific Communication	42
Priority Standard 10.9 - Intro to Research.....	44
Priority Standard 10.10 - Production/ Projects	46
Biotechnology 11th Grade Curriculum	47
Priority Standard 11.1 - Research Design, Ethics, and Experimental Planning	47
Priority Standard 11.2 - Experimental Execution, Iteration and Documentation	49
Priority Standard 11.3 - Data Analysis, Interpretation, and Research	50
Priority Standard 11.4 - Public Health Applications of Biotechnology.....	51
Priority Standard 11.5 - Systems Biology.....	53
Priority Standard 11.6 - Plant Biotechnology and Basic Plant Tissue Culture	55
Priority Standard 11.7 - Production / Projects	57
Biotechnology - 12th Grade Curriculum	58
Priority Standard 12.1 - Laboratory Leadership, Safety and Operations	58
Priority Standard 12.2 - Microbial Diversity and Physiology	60
Priority Standard 12.3 - Microbial Cultivation and Isolation.....	62
Priority Standard 12.4 - Microbial Identification and Characterization	63
Priority Standard 12.5 - Molecular Genetics and DNA Analysis.....	65
Priority Standard 12.6 - Molecular Diagnostics	67
Priority Standard 12.7 - Human Genetic Disorders and Genetic Therapies.....	69
Priority Standard 12.8 - Population Genetics and Genetic Variation.....	71
Priority Standard 12.9 - Production/ Projects	72

CTECS - Vision of Graduate
Connecticut Technical Education and Career System
Vision of a Graduate
A CTECS Graduate is...



A Problem Solver

Respectful

A Critical Thinker

Work Ready

Skilled Socially

An Effective Communicator

The Vision of a Graduate (VoG) at the Connecticut Technical Education and Career System (CTECS) embodies our commitment to preparing students for success in Connecticut's workforce.

Developed in collaboration with students, parents, staff, and employers, the VoG ensures that CTECS students are not only job-ready but also equipped to lead, innovate, and adapt in a dynamic world.

As educators, we are dedicated to developing these qualities by providing a comprehensive education that empowers our students to achieve their fullest potential and make meaningful contributions to society.

A Problem Solver	Work Ready
<p><i>Problem solvers tackle challenges by identifying root causes of issues, brainstorming solutions, implementing effective strategies, and demonstrating adaptability.</i></p> <ul style="list-style-type: none"> → Engage students with open-ended, creative thinking tasks that require both conventional and innovative solutions. → Facilitate group discussions and collaborative projects. → Use real-world scenarios and hands-on activities. → Highlight the importance of effort, persistence, and continuous learning. → Provide regular feedback and encourage reflection. 	<p><i>To be work-ready includes a combination of technical expertise, soft skills, and personal qualities that ensure a graduate can effectively contribute to the workplace from day one.</i></p> <ul style="list-style-type: none"> → Set high standards for punctuality, responsibility, professionalism, and task completion. → Use project-based learning and collaborative assignments. → Emphasize clear written and verbal communication. → Offer practical exercises like mock interviews and resume workshops. → Integrate technology and teach digital literacy.
Respectful	Skilled Socially
<p><i>Graduates who embody respectfulness emphasize the importance of treating others with dignity, valuing diversity, and fostering an inclusive and positive environment, both personally and professionally.</i></p> <ul style="list-style-type: none"> → Demonstrate personal, interpersonal, and professional skills. → Show respect for diversity. → Model respect through active listening and empathy. → Set clear expectations for respectful interactions. → Promote collaboration and group discussions. → Celebrate respectful behavior. → Address disrespect promptly and constructively. 	<p><i>Graduates who are skilled socially are equipped to navigate social environments, build relationships, and contribute positively to their communities and workplaces.</i></p> <ul style="list-style-type: none"> → Show awareness of global responsibility to others and the environment. → Participate in community involvement. → Design cooperative group projects and team activities → Set expectations for respect and give regular feedback. → Facilitate discussions on inclusivity, kindness, and respect. → Model positive interactions and recognize strong social skills.
A Critical Thinker	An Effective Communicator
<p><i>Critical thinkers approach problems systematically by analyzing, evaluating, and synthesizing information to make well-informed decisions and contribute to innovative solutions.</i></p> <ul style="list-style-type: none"> → Encourage critical thinking individually and collaboratively. → Design lessons that challenge assumptions and explore diverse viewpoints. → Use open-ended questions, rigorous activities, and cross-curricular projects. → Integrate project-based learning and real-world problem-solving. → Offer reflective opportunities like journaling and discussions. → Cultivate an environment that values curiosity and inquiry. 	<p><i>Effective communicators convey ideas, information, and emotions accurately and persuasively, fostering understanding and collaboration.</i></p> <ul style="list-style-type: none"> → Communicate effectively using oral, written, visual, artistic, and technical modes. → Include group discussions, presentations, and peer reviews. → Promote active listening and thoughtful responses. → Offer clear guidelines and constructive feedback. → Stress clear, respectful, and purposeful communication.

CTECS Instructional Model

CTECS uses the Marzano Compendium to guide research-based instructional strategies that differentiate learning and promote access, engagement, and success for all students. Teachers apply these strategies to support diverse learners (including multilingual learners, students with disabilities, and students with varied academic or technical backgrounds) through scaffolds, modeling, guided practice, and multiple ways to participate and show understanding. This approach ensures every student can work toward proficiency in the Priority Standards and the competencies outlined in the CTECS Vision of a Graduate.

Marzano Compendium

Feedback

Providing and Communicating Clear Learning Goals

1. Providing scales and rubrics
2. Tracking student progress
3. Celebrating success

Using Assessments

4. Using informal assessments of the whole class
5. Using formal assessments of individual students

Content

Conducting Direct Instruction Lessons

6. Chunking content
7. Processing content
8. Recording and representing content

Conducting Practicing and Deepening Lessons

9. Using structured practice sessions
10. Examining similarities and differences
11. Examining errors in reasoning

Conducting Knowledge Application Lessons

12. Engaging students in cognitively complex tasks
13. Providing resources and guidance
14. Generating and defending claims

Using Strategies That Appear in All Types of Lessons

15. Previewing strategies
16. Highlighting critical information
17. Reviewing content
18. Revising knowledge
19. Reflecting on learning
20. Assigning purposeful homework
21. Elaborating on information
22. Organizing students to interact

Context

Using Engagement Strategies

23. Noticing and reacting when students are not engaged
24. Increasing response rates
25. Using physical movement
26. Maintaining a lively pace
27. Demonstrating intensity and enthusiasm
28. Presenting unusual information
29. Using friendly controversy
30. Using academic games
31. Providing opportunities for students to talk about themselves
32. Motivating and inspiring students

Implementing Rules and Procedures

33. Establishing rules and procedures
34. Organizing the physical layout of the classroom
35. Demonstrating withitness
36. Acknowledging adherence to rules and procedures
37. Acknowledging lack of adherence to rules and procedures

Building Relationships

38. Using verbal and nonverbal behaviors that indicate affection for students
39. Understanding students' backgrounds and interests
40. Displaying objectivity and control

Communicating High Expectations

41. Demonstrating value and respect for reluctant learners
42. Asking in-depth questions of reluctant learners
43. Probing incorrect answers with reluctant learner

Curriculum Introduction

This curriculum document outlines the essential learning for this trade program and provides a clear structure for planning, instruction, and assessment. It includes the components required by NEASC Standard 2.2a, along with elements that reflect the unique nature of CTECS technical programs. The curriculum is organized to show what students learn in each course, how learning progresses across grade levels, and how instruction supports both technical skill development and the CTECS Vision of a Graduate.

Teachers should use this document to:

- Understand the overall structure and expectations of the course sequence
- Reference the Course Map to see the scope and sequence of Priority Standards and the alignment to District Summative Assessments (DSAs)
- Use the Priority Standards and Units of Study to guide daily, weekly, and cycle-based planning
- Integrate Big Ideas, Essential Questions, Skills/Learning Outcomes, vocabulary, and resources during lesson design
- Identify required safety, industry, and technical content expectations
- Plan and implement formative assessments to monitor progress and guide instruction
- Prepare students for the District Summative Assessments, ensuring alignment with the Course Map
- Maintain consistency of technical and professional practice instruction across campuses while adapting to student needs and industry-based opportunities

Curriculum Components

Course Map

A Course Map serves as the scope and sequence for this course by outlining the progression of instructional units and the standards that guide teaching and assessment. While each campus will have individual student needs, cycle schedules, and industry-based opportunities, all instructors are expected to teach the standards outlined in the Course Map. Using the Course Map below, teachers will intentionally plan learning experiences that prepare students to meet the identified standards within the designated assessment windows.

Priority Standards (Units of Study)

Priority Standards identify the most essential learning in the trade program. They reflect the core technical competencies, safety practices, and industry-aligned skills that require the greatest instructional focus and appear on program assessments. In CTE programs, each Priority Standard also functions as a Unit of Study, because it includes the required components such as big ideas, essential questions, content topics, and skills/learning outcomes aligned to assessments.

Vertical Alignment

Vertical alignment shows how Priority Standards and instructional expectations progress from grade to grade within the trade program. It provides a clear pathway of skill development, increasing complexity, and technical proficiency across the four-year sequence.

Learning Outcomes

Learning outcomes are what students will know (Concepts) and be able to do (Skills). Concepts identify the major content topics within the Priority Standard (Unit of Study). They appear in the left column of the Learning Outcomes table and follow a similar coding structure as the Priority Standard.

Skills are learning objectives that describe the measurable actions students must be able to perform to demonstrate proficiency. They appear in the right column of the Learning Outcomes table and show the progression of learning evidence in the Priority Standard.

Vocabulary

Essential vocabulary includes the technical and academic terms students must understand and use accurately to engage in trade-specific learning and demonstrate proficiency on assessments. Vocabulary is foundational to safety, technical precision, and industry communication, and should be a primary initial focus within each unit and taught explicitly through modeling, demonstration, and repeated application.

Resources

Resources include the tools, equipment, texts, materials, and digital tools that support learning within each unit and reflect industry standards.

Assessment Practices

Teachers use ongoing formative assessments—such as questioning, checks for understanding, performance demonstrations, reflections, and teacher observation—to monitor progress, guide instruction, and support all learners in mastering the Priority Standards.

Each program also includes District Summative Assessments (DSAs), which measure proficiency on the Priority Standards identified in the Course Map. DSAs provide consistent evidence of student learning across campuses and ensure

alignment to industry expectations, safety requirements, and program outcomes. Teachers should reference the Course Map and Units of Study when planning instruction to ensure students have opportunities to practice and demonstrate the skills and knowledge assessed on the DSA.

Biotechnology Philosophy

The Biotechnology course of studies exposes students to a wide variety of careers in the field while developing entry-level skills necessary for future employment. Students will have opportunities to gain real-world research experiences to support a successful transition to the workplace or post-secondary education.

The Biotechnology course is designed to provide students with a broad range of skills and content knowledge within the trade. Practical experience will be gained within the school, through participation in collaborative research projects with outside institutions, and through optional Work Based Learning (employment by a biotechnology-related company).

Biotechnology Program Standards

The Biotechnology program will create an awareness of the opportunities within the dynamic field of biotechnology. The program incorporates modern developments, laboratory practices, and real-world applications in medical, agricultural and industrial biotechnology.

As a result of education in the Biotechnology Program (Grades 9-12), students will:

- Demonstrate safe work habits when handling chemicals, biological materials, and laboratory equipment, including interpreting and using Safety Data Sheets (SDS) and using appropriate protective gear.
- Develop and follow experimental protocols while maintaining accurate and complete laboratory records
- Read, interpret, and communicate scientific findings across multiple formats - including written, visual, and oral modes - using appropriate scientific conventions
- Design and implement scientific investigations using appropriate controls and variables, and revise based on data
- Analyze, interpret, and present experimental data using basic statistical and computational tools
- Perform laboratory calculations, measurements, and conversions with accuracy and precision

- Demonstrate proper techniques for preparing and using solutions, reagents, and buffers including performing dilution calculations and adjusting solution concentrations
- Operate and maintain common laboratory equipment
- Perform molecular biology techniques involving DNA, RNA, and protein analysis and manipulation
- Perform microbiological techniques to culture, isolate, identify and characterize microorganisms
- Perform and maintain plant tissue cultures using aseptic techniques to prevent contamination and ensure successful propagation
- Use bioinformatic tools to access, analyze, and interpret biological data

Biotechnology – Course Map

Grade 9 – Semester 2

- 9.1- Basic Lab Safety
- 9.2 - Careers in Biotech
- 9.3 - Lab Foundations
- 9.4 - Chemistry for Biotechnology
- 9.5 - Molecular Biology
- 9.6 - Experimental Design
- 9.7 - Biotech Projects

Grade 10 – Semester 1

- 10.1 - Chemical Basis of Life
- 10.2 - Macromolecules
- 10.3 - Cell Structure and Metabolism
- 10.4 - Cellular Respiration and Fermentation
- 10.5 - Genetics and Gene Regulation

Grade 10 – Semester 2

- 10.6 - Genetics and Biotechnology
- 10.7 - Animal Structure and Physiology
- 10.8 - Basic Scientific Communication
- 10.9 - Intro to Research
- 10.10 - Production/Projects

Grade 11 – Semester 1

- 11.1 - Research Design
- 11.2 - Experimental Execution
- 11.3 - Data Analysis
- 11.4 - Public Health Applications of Biotech

Grade 11 – Semester 2

- 11.5 - Systems Biology
- 11.6 - Plant Biotechnology and Basic Plant Tissue Cult
- 11.7 - Production/ Projects

Grade 12 – Semester 1

- 12.1 - Lab Leadership
- 12.2 - Microbial Diversity and Physiology
- 12.3 - Microbial Cultivation and Isolation
- 12.4 - Microbial Identification and Characterization

Grade 12 – Semester 2

- 12.5 - Molecular Genetics and DNA Analysis
- 12.6 - Molecular Diagnostics
- 12.7 - Human Genetic Disorders
- 12.8 - Population Genetics and Genetic Variation
- 12.9 - Production / Projects

Biotechnology 9th Grade Curriculum

Priority Standard 9.1 - Basic Laboratory Safety

Big Idea(s):

- Safety is the responsibility of everyone in the shop
- Safety needs to be a habit and a consideration throughout daily living as well as in the work environment
- Training and awareness can prevent injuries

Essential Question(s):

- What strategies ensure everyone’s safety when the unexpected happens in the lab?
- What dangers may exist if a biomedical technician does not follow standard operating procedures or protocols?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
9.1.1 Safe Work Habits	<ul style="list-style-type: none"> ● Identify the location of safety equipment in the laboratory ● Describe how to use safety equipment in the laboratory ● Explain when to use safety equipment in the laboratory ● Demonstrate basic steps to respond to minor laboratory incidents ● 100% on written safety test
9.1.2 Personal Protective Equipment (PPE)	<ul style="list-style-type: none"> ● Identify the biosafety levels and the required personal protective equipment needed for each ● Explain why personal protective equipment (PPE) are important in the lab ● Demonstrate correct select and use of PPE during routine laboratory tasks ● 100% on written safety test
9.1.3 Safety Data Sheet (SDS)	<ul style="list-style-type: none"> ● Derive information from SDS ● Identify safety symbols ● Describe procedures for safe handling and storage of chemicals
9.1.4 First Aid	<ul style="list-style-type: none"> ● Describe emergency response procedures ● Discuss reporting safety concerns ● Understand the importance of safety training

Technical Vocab-

Personal protective equipment, safety data sheet, contamination, biohazard, chemical hazard, biosafety level, danger, warning

Resources-

OSHA.gov , district safety curriculum, CDC.org

Priority Standard 9.2 - Careers in Biotechnology

Big Idea(s):

- The development of biotechnology has been driven by groundbreaking discoveries and innovations, each building on previous knowledge to revolutionize science, medicine, and industry
- Biotechnology integrates biology, technology, and engineering to create solutions that address real-world problems
- Professionalism and ethical behavior are key components of a successful biotechnology career

Essential Question(s):

- How does education and training prepare individuals for the diverse career paths in biotechnology?
- What are the characteristics of professionalism in a biotechnology laboratory setting?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
9.2.1 Job Opportunities <ul style="list-style-type: none"> ● Career Paths ● Skills needed ● Major sectors of biotechnology <ul style="list-style-type: none"> ○ Medical ○ Agricultural ○ Environmental ○ Industrial 	<ul style="list-style-type: none"> ● Identify different roles within a biotechnology facility ● Compare the responsibilities and career trajectories of academic vs industry biotech labs ● Research job opportunities in Biotechnology ● Identify the technical and soft skills necessary for success in a career in the biotechnology field ● Describe major areas of biotechnology (medical, agricultural, industrial, environmental etc)
9.2.2 Employability Skills <ul style="list-style-type: none"> ● Readiness ● Organization ● Reliability 	<ul style="list-style-type: none"> ● Describe appropriate workplace behaviors ● Discuss importance of proactive safety communication ● Follow practices associated with regulatory compliance

Technical Vocab-

Professionalism, Organization, Critical thinking, Communication skills, Motivation, Certificates, Associate's Degree, Bachelor's Degree, Master's Degree, Ph.D

Resources-

Job search engines, Bureau of Labor Statistics, biotech-careers.org

Priority Standard 9.3 - Foundational Laboratory Skills

Big Idea(s):

- Developing strong lab habits early supports success in later technical applications
- Accurate scientific results depend on the correct use, calibration, and maintenance of laboratory tools
- Knowing how to choose, use, and care for lab equipment is essential to scientific identity and technical competence

Essential Question(s):

- How do we generate accurate, reliable results in a biotechnology lab?
- How do we choose the right lab equipment for a specific task?
- What does it mean to be responsible for your tools in the lab?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
9.3.1 Care and Use of Basic Lab Equipment <ul style="list-style-type: none"> ● Micropipette ● Balance / Analytical Balance ● Centrifuge ● pH meter ● Autoclave ● Incubator ● Spectrophotometer ● Dissecting microscope ● Compound microscope 	<ul style="list-style-type: none"> ● Identify major components of common laboratory equipment ● Describe the importance of calibration and maintenance ● Demonstrate routine cleaning and care for common laboratory equipment ● Demonstrate steps to use common laboratory equipment
9.3.2 Basic Glassware <ul style="list-style-type: none"> ● Erlenmeyer flask ● Graduated cylinder ● Beaker ● Test tube ● Volumetric flask 	<ul style="list-style-type: none"> ● Identify common types of glassware ● Demonstrate routine cleaning and care for common types of laboratory glassware
9.3.2 Math and Measurement	<ul style="list-style-type: none"> ● Identify correct lab tools and their units ● Explain the difference between accuracy and precision ● Measure mass, volume, temperature and Ph using proper laboratory technique ● Record and report measurements using correct units, scientific notation and appropriate scientific figures as needed

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
	<ul style="list-style-type: none"> ● Evaluate the quality of collected data by analyzing sources of measurement error
9.3.4 Documentation	<ul style="list-style-type: none"> ● Identify the required components of protocols and lab notebook entries ● Describe the purpose of Good Documentation Practices (GDP) ● Follow written protocols accurately

Technical Vocab-

Accuracy, precision, significant figure, scientific notation, conversion factor, kilo, micro, milli, micropipette, centrifuge, spectrophotometer, balance, pH meter, autoclave, dissecting microscope, compound microscope, erlenmeyer flask, graduated cylinder, volumetric flask, standard operating procedure, good documentation practice, protocol

Resources-

Manufacturers SOPs, BioRad textbook, classroom generated examples

Priority Standard 9.4 - Chemistry for Biotechnology

Big Idea(s):

- Accurate measurement and preparation are critical to ensure reliable and reproducible results in biotechnology
- Chemical properties and interactions influence biological reactions and experimental outcomes
- Scientists control chemical conditions to support biological systems and laboratory investigations

Essential Question(s):

- How do scientists control chemical conditions in biotechnology experiments?
- Why do chemical properties like concentration, pH and temperature matter in biological systems?
- How does chemistry help explain how enzymes and biomolecules function?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
9.4.1 Solutions	<ul style="list-style-type: none"> • Define solvent, solute, solution and molarity • Distinguish between solute and solvent in common laboratory solutions • Prepare a solution using correct measurements and labeling conventions • Compare solutions of different molarities to determine which is more concentrated • Explain how concentration affects the behavior of a solution
9.4.2 Dilutions	<ul style="list-style-type: none"> • Explain the purpose of a dilution in biotechnology experiments • Explain the relationship between dilution factor and concentration • Perform a serial dilution using correct laboratory technique • Generate and interpret a dilution curve from experimental data • Predict how changes in dilution will impact experimental outcomes
9.4.3 Buffers	<ul style="list-style-type: none"> • Define a buffer and its role in chemical and biological systems

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
	<ul style="list-style-type: none"> ● Explain why maintaining pH is critical for biological reactions ● Measure the pH of a solution using a pH meter or indicator ● Adjust the pH of a solution to a target range using buffering agents ● Analyze how pH changes could affect experimental results
9.4.4 Water and Chemical Interactions	<ul style="list-style-type: none"> ● Describe what it means for water to be a polar molecule ● Explain how hydrogen bonding affects solubility and biological systems ● Explain why water is an effective medium for chemical and biological reactions
9.4.5 Chemical Bonds and Structure - Function Relationships	<ul style="list-style-type: none"> ● Distinguish between covalent, ionic and hydrogen bonds ● Explain how chemical bonds contribute to the structure of biomolecules ● Describe how changes in chemical environment can affect molecular shape and function
9.4.6 Enzymes	<ul style="list-style-type: none"> ● Explain how temperature affects chemical and biological reaction rates ● Describe the function of enzymes ● Predict how changes in temperature may impact experimental results

Technical Vocab-

Solution, solute, solvent, buffer, concentration, dilution, stock solution, serial dilution, molarity, pH, polarity, hydrogen bond, enzyme, catalyst, activation energy, chemical bond

Resources-

BioRad Textbook, instructor generated materials

Priority Standard 9.5 - Molecular Biology Concepts

Big Idea(s):

- Living systems are built from molecules whose structure determines their function
- DNA stores and transmits genetic information that directs cellular activities
- Enzymes and membranes regulate chemical reactions and movement within cells
- Biotechnology applies molecular biology to study, modify, and use living systems

Essential Question(s):

- What is DNA, and why is it important?
- How do we use DNA in biotechnology?
- What role do enzymes play in living organisms and biotechnology?
- What ethical questions arise from using molecular biology in biotechnology?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
9.5.1 Biological Macromolecules	<ul style="list-style-type: none"> ● Identify the four major macromolecules ● Describe the role of the macromolecules in cells ● Explain how molecular structure relates to biological function
9.5.2 DNA and Genetic Information	<ul style="list-style-type: none"> ● Describe the structure of DNA ● Explain DNA's role as genetic material ● Explain the flow of genetic information from DNA to RNA to protein ● Describe how proteins produced from genetic instructions affect cell function
9.5.3 Enzymes and Biological Reactions	<ul style="list-style-type: none"> ● Describe enzymes as biological catalysts ● Explain how enzymes influence reaction rates in cells ● Predict how changes in conditions affect enzyme activity
9.5.4 Cell Membranes and Molecular Movement	<ul style="list-style-type: none"> ● Describe the structure and function of the cell membrane ● Explain diffusion and osmosis at the molecular level ● Predict how changes in solute concentration affect cells ● Explain how membranes maintain cellular homeostasis
9.5.2 Biotech Connections	<ul style="list-style-type: none"> ● Identify common biotechnology applications that rely on molecular biology ● Describe how understanding DNA, RNA and proteins is essential for developing biotechnology tools ● Discuss ethical considerations related to molecular biology

Technical Vocab-

Macromolecule, protein, carbohydrate, lipid, nucleic acid, DNA, RNA, enzyme, catalyst, central dogma, cell membrane, diffusion, osmosis

Resources-

BioRad textbook

Priority Standard 9.6 - Experimental Design and Data

Big Idea(s):

- Scientific investigations are systematic and purposeful
- Data is only as useful as the way it's collected, analyzed and interpreted
- Reading, writing and critiquing scientific literature ensures that findings contribute to the larger body of knowledge

Essential Question(s):

- Why are variables and controls critical for interpreting experimental data?
- How can reading and critiquing scientific literature improve the design of our own experiments?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
9.6.1 Scientific Investigations	<ul style="list-style-type: none"> ● Identify independent, dependent and controlled variables in an experiment ● Explain the purpose of controls and constants in an experiment ● Apply the steps of the scientific method to design, conduct and evaluate an investigation
9.6.2 Analyzing, Interpreting, and Presenting Scientific Data	<ul style="list-style-type: none"> ● Create simple graphs (bar, line, scatter plots) ● Construct basic tables and charts with labels and units using technology tools (e.g., spreadsheets) ● Describe relationships between variables
9.6.3 Communicating Scientific Findings	<ul style="list-style-type: none"> ● Identify the sections of a scientific journal article ● Explain the purposes of different parts of a journal articles ● Write simple abstracts or summaries of investigations

Technical Vocab-

Mean, median, range, independent variable, dependent variable, controlled variable, positive control, negative control, abstract, introduction, materials, methods, discussion, conclusion

Resources-

Access to primary literature, graphing software

Priority Standard 9.7 - Microbiology Concepts

Big Idea(s):

- Microorganisms are diverse and have unique structures that enable them to survive in a variety of environments and perform different biological functions
- Microorganisms are essential tools in biotechnology due to their varied abilities and characteristics
- Proper aseptic techniques and culture methods are essential for safely growing and studying microorganisms in the laboratory

Essential Question(s):

- What are microbes and how are they studied?
- How are microbes safely cultured and observed?
- What roles do microbes play in health, disease, and biotechnology?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
9.7.1 Background <ul style="list-style-type: none"> • Bacteria • Archaea • Fungi • Protists • Viruses 	<ul style="list-style-type: none"> • Explain the contributions of key scientists such as John Snow, Robert Koch and Louis Pasteur to the development of the field of microbiology • Identify and describe the major groups of microorganisms • Identify common structures of microorganisms and relate them to function
9.7.2 Aseptic Technique and Culture Prep	<ul style="list-style-type: none"> • Describe the purpose of different types of culture media • Prepare sterile media • Demonstrate the proper aseptic technique to prepare a workspace for microbial work • Demonstrate the inoculation of liquid and solid media using aseptic technique • Observe and record colony morphology characteristics • Prepare and view wet mount and dry mount slides of microorganisms • Perform Grams staining to view bacterial shapes
9.7.3 Microbes in Biotechnology	<ul style="list-style-type: none"> • Identify and describe microorganisms commonly used in biotechnology (e.g., <i>E.coli</i>, <i>Saccharomyces cerevisiae</i>, <i>Bacillus subtilis</i>) • Explain why specific microorganisms are chosen for specific biotech applications

Technical Vocab-

Aseptic, sterile, culture, media, inoculation, form, elevation, margin, pigment, opacity

Resources-

BioRad textbook

Priority Standard 9.8 - Biotech Projects

Big Idea(s):

- Incorporating all 9th grade objectives is essential to success in the completion of biotechnology projects
- Maintaining artifacts of work can build a scientist's resume

Essential Question:

How can a portfolio of projects and skills assist in obtaining a job?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
9.8.1 Biotech Projects	<ul style="list-style-type: none">• Proficiency will be determined by scoring a 3 or greater on individual proficiency scales• Demonstrate behavior expected for career employability
9.8.2 Biotechnology Portfolio	<ul style="list-style-type: none">• Uploading evidence of proficiencies completing project to portfolio• Update the competency checklist

Technical Vocab-
competency, portfolio, resume

Resources-
BioRad Textbook

Biotechnology 10th Grade Curriculum

Priority Standard 10.1 - Chemical Basis of Life

Big Idea(s):

- The structure and properties of matter determine biological function
- Life depends on chemical interactions governed by the laws of chemistry

Essential Question(s):

- How do the chemical properties of water and carbon make life possible?
- How does molecular structure influence biological function?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
10.1.1 Atomic Structure and Chemical Bonding	<ul style="list-style-type: none">• Describe the structure of atoms and the role of electrons• Distinguish between covalent, ionic and hydrogen bonds• Explain how bond type affects molecular stability and reactivity
10.1.2 Properties of Water	<ul style="list-style-type: none">• Define cohesion, adhesion, surface tension and heat capacity• Explain polarity and hydrogen bonding in water• Relate water's properties to biological systems
10.1.3 Carbon	<ul style="list-style-type: none">• Explain why carbon is the backbone of biological molecules• Identify major functional groups• Predict how functional groups affect molecular behavior
10.1.4 Solution Chemistry	<ul style="list-style-type: none">• Calculate molarity• Use $C_1V_1=C_2V_2$ for solution preparation• Prepare solutions accurately

Technical Vocab-

Atom, molecule, element, compound, covalent bond, ionic bond, hydrogen bond, polarity, hydrophilic, hydrophobic, cohesion, adhesion, pH, buffer, carbon, functional group

Resources-

Campbell Biology for AP 12th edition textbook

Priority Standard 10.2 - Macromolecules

Big Idea(s):

- Biological macromolecules have specific structures that determine their functions
- Cells build, modify, and break down macromolecules to sustain life

Essential Question(s):

- How does the structure of a macromolecule determine its function?
- How do cells build and break down macromolecules?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
10.2.1 Proteins	<ul style="list-style-type: none"> • Describe amino acid structure and peptide bonds • Explain the levels of protein structure • Describe protein denaturation and its effects
10.2.2 Enzymes and Catalysis	<ul style="list-style-type: none"> • Describe enzyme-substrate interactions • Explain how enzymes lower activation energy • Identify factors affecting enzyme activity
10.2.3 Carbohydrates	<ul style="list-style-type: none"> • Identify monosaccharides, disaccharides, and polysaccharides • Describe glycosidic bonds • Explain the process of dehydration synthesis and hydrolysis
10.2.4 Lipids	<ul style="list-style-type: none"> • Identify major lipid types • Explain hydrophobic interactions • Relate lipid structure to membrane formation and energy storage • Compare saturated and unsaturated fats
10.2.5 Nucleic Acids	<ul style="list-style-type: none"> • Identify components of nucleotides • Compare DNA and RNA structure • Explain the role of nucleic acids in information storage

Technical Vocab –

Monomer, polymer, dehydration synthesis, hydrolysis, amino acid, peptide bond, enzyme, activation energy, substrate, monosaccharide, polysaccharide, lipid, phospholipid, hydrophobic, nucleotide

Resources –
Campbell Biology for AP 12th edition textbook

Priority Standard 10.3 - Cell Structure and Metabolism

Big Idea(s):

- Cells are the basic units of life whose structures support specific functions
- Metabolic pathways allow cells to obtain, transform and use energy and matter

Essential Question(s):

- How does cell structure relate to cellular function?
- How do cells manage energy and materials through metabolism?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
10.3.1 Cell Types and Size Constraints	<ul style="list-style-type: none"> • Compare prokaryotic and eukaryotic cells • Compare plant and animal cells • Explain size and surface-area-to-volume constraints
10.3.2 Eukaryotic Cell Organelles	<ul style="list-style-type: none"> • Identify major organelles and their functions • Relate organelle structure to function • Explain compartmentalization in eukaryotic cells
10.3.3 Membrane Structure and Transport	<ul style="list-style-type: none"> • Describe the fluid mosaic model • Explain active and passive transport • Compare diffusion, facilitated diffusion, and active transport • Explain the role of membrane proteins • Explain osmosis and its biological significance
10.3.4 Metabolism and Energy	<ul style="list-style-type: none"> • Define metabolism, anabolic, and catabolic pathways • Explain the role of enzymes in metabolic pathways • Describe ATP structure and function • Explain energy coupling
10.3.5 The Cell Cycle	<ul style="list-style-type: none"> • Identify the stages of the cell cycle • Describe mitosis and cytokinesis • Explain how the cell cycle supports growth and repair • Explain how cell cycle regulation maintains cellular function

Technical Vocab-

Prokaryote, eukaryote, organelle, phospholipid bilayer, fluid mosaic model, diffusion, osmosis, active transport, metabolism, ATP, anabolic, catabolic

Resources-

Campbell Biology for AP 12th edition textbook

Priority Standard 10.4 - Cellular Respiration and Fermentation

Big Idea(s):

- Cells convert energy from one form to another using biochemical pathways
- Energy transformations are essential for maintain cellular organization and function

Essential Question(s):

- How do cells harvest and use energy?
- How do organisms store energy in chemical bonds?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
10.4.1 Cellular Respiration	<ul style="list-style-type: none"> • Identify the site of cellular respiration • Identify reactants and products of cellular respiration • Explain the role of ATP in energy transfer • Describe glycolysis, pyruvate oxidation, Krebs cycle, and electron transport chain • Explain oxidation-reduction reactions in electron transport
10.4.2 Fermentation	<ul style="list-style-type: none"> • Explain why fermentation occurs • Compare lactic acid and alcoholic fermentation • Describe the relationship between ATP production and NAD regeneration
10.4.3 Photosynthesis	<ul style="list-style-type: none"> • Describe the role of light in photosynthesis • Identify reactants and products of the light reactions • Explain the role of chlorophyll and the electron transport chain • Describe carbon fixation • Explain the role of ATP and NADPH
10.4.4 Respiration and Photosynthesis as Linked Pathways	<ul style="list-style-type: none"> • Compare and contrast respiration and photosynthesis • Trace matter and energy through respiration and photosynthesis • Explain how these pathways support ecosystems

Technical Vocab-

cellular respiration, glycolysis, Krebs cycle, electron transport chain, fermentation, NAD, photosynthesis, light reactions, Calvin cycle, carbon fixation, chlorophyll, redox reaction

Resources-

Campbell Biology for AP 12th edition textbook

Priority Standard 10.5 - Genetics and Gene Regulation

Big Idea(s):

- Genetic information is stored, expressed, and regulated through molecular mechanisms
- Patterns of inheritance arise from the behavior of chromosome and genes

Essential Question(s):

- How is genetic information stored and expressed?
- How do cells regulate gene expression to produce specific traits?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
10.5.1 Meiosis	<ul style="list-style-type: none"> • Describe the stages of meiosis • Explain how meiosis generates genetic variation • Explain segregation and independent assortment • Predict outcomes of sexual reproduction
10.5.2 Mendelian and Chromosomal Inheritance	<ul style="list-style-type: none"> • Define key principles of mendelian inheritance • Analyze monohybrid and dihybrid crosses • Predict genotypic and phenotypic ratios • Differentiate autosomal and sex-linked inheritance • Analyze inheritance patterns caused by chromosomal behavior
10.5.1 DNA structure, replication and repair	<ul style="list-style-type: none"> • Describe the chemical structure of DNA • Explain complementary base pairing and antiparallel orientation • Describe the steps of DNA replication • Explain the role of enzymes in replication • Explain the purpose of DNA repair mechanisms
10.5.2 Gene Expression	<ul style="list-style-type: none"> • Describe the stages of transcription • Explain RNA processing in eukaryotes • Describe the steps of translation • Analyze how gene expression is related to protein synthesis

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
10.5.3 Regulation of Gene Expression	<ul style="list-style-type: none"> ● Explain how gene expression is regulated in prokaryotes ● Explain how gene expression is regulated in eukaryotes ● Describe the role of promoters, enhancers and repressors ● Explain how environmental signals influence gene expression

Vocab-

Meiosis, segregation, independent assortment, genotype, phenotype, chromosome, DNA replication, transcription, translation, gene regulation, promoter, enhancer, repressor

Resources-

Campbell Biology for AP 12th edition textbook, genetics problem sets, simulations, diagrams

Priority Standard 10.6 - Biotechnology Techniques and Applications

Big Idea(s):

- Technical skill proficiency is essential for biological and biotechnology applications
- Biotechnology uses molecular tools to analyze and manipulate genetic information

Essential Question(s):

- What technical skills are required to work safely and effectively in a biotechnology lab?
- How do biotechnological tools allow scientists to study and modify genes?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
10.6.1 DNA Extraction and Purification	<ul style="list-style-type: none"> • Explain the purpose of DNA extraction • Describe the function of detergents, salts, and alcohol • Perform DNA extraction using standard protocols • Evaluate DNA quality and yield • Identify sources of error in extraction
10.6.2 Polymerase Chain Reaction	<ul style="list-style-type: none"> • Explain the purpose of PCR • Describe denaturation, annealing, and extension • Set up PCR reactions • Interpret PCR results • Evaluate PCR outcomes for success for failure
10.6.3 Gel Electrophoresis	<ul style="list-style-type: none"> • Explain how DNA fragments are separated • Prepare and run agarose gels • Interpret gel electrophoresis results • Estimate fragment size using a DNA ladder • Evaluate gel quality and limitations
10.6.4 Bacterial Transformation	<ul style="list-style-type: none"> • Explain the purpose of bacterial transformation • Describe the role of competent cells • Perform bacterial transformation using standard protocols • Interpret growth results using selection markers • Evaluate transformation efficiency
10.6.5 Bioinformatics Applications	<ul style="list-style-type: none"> • Explain the role of bioinformatics in genetics

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
	<ul style="list-style-type: none"> ● Use sequence databases to identify DNA sequences ● Perform basic sequence alignment ● Interpret bioinformatics results ● Evaluate how computational tools support laboratory findings
10.6.6 Plant Biotechnology and Tissue Culture	<ul style="list-style-type: none"> ● Explain the purpose of plant tissue culture ● Demonstrate sterile technique ● Identify major plant hormone involved ● Analyze how hormone ratios influence cell differentiation ● Apply hormone signaling knowledge to predict outcomes

Vocab-

DNA extraction, PCR, primer, gel electrophoresis, transformation, competent cells, bioinformatics, tissue culture, sterile technique

Resources-

Molecular biology lab equipment, biotechnology kits, bioinformatics databases, lab manuals

Priority Standard 10.7 - Animal Structure and Physiology

Big Idea(s):

- The structure of animal tissues, organs, and systems determines their function
- Animal systems work together to maintain internal balance and support survival
- Exchange of matter and energy is essential for animal function and homeostasis

Essential Question(s):

- How does structure support function in animal systems?
- How do animal organ systems maintain homeostasis?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
10.7.1 Animal Organization	<ul style="list-style-type: none"> • Explain the relationship between structure and function in animals • Describe levels of biological organization • Explain the concept of homeostasis • Describe feedback mechanisms that maintain internal balance
10.7.2 Nutrition and Digestion	<ul style="list-style-type: none"> • Describe the purpose of digestion • Identify major organs of the digestive system and their functions • Explain how macromolecules are broken down and absorbed
10.7.3 Gas Exchange and Respiration	<ul style="list-style-type: none"> • Explain the purpose of gas exchange • Describe diffusion and surface-area-to-volume relationships • Compare respiratory structures in different animals • Explain how oxygen and carbon dioxide are transported in the body
10.7.4 Circulation and Transport	<ul style="list-style-type: none"> • Describe the components and functions of blood • Explain the structure and function of the heart • Compare open and closed circulatory systems • Explain how materials are transported to and from cells
10.7.5 Osmoregulation and Excretion	<ul style="list-style-type: none"> • Explain the importance of water and ion balance

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
	<ul style="list-style-type: none"> • Describe the function of kidneys and nephrons • Explain how waste products are removed from the body • Compare excretion systems in different animals
10.7.6 Nervous System	<ul style="list-style-type: none"> • Describe the structure and function of neurons • Explain how action potentials are generated and transmitted • Compare central and peripheral nervous systems • Explain how nervous signaling enables a rapid response
10.7.7 Musculoskeletal System	<ul style="list-style-type: none"> • Explain how muscles and bones interact to produce movement • Describe the structure of a skeletal muscle • Explain the sliding filament model of muscle contraction
10.7.8 Endocrine System	<ul style="list-style-type: none"> • Describe the role of hormones in regulating body functions • Compare endocrine and nervous signaling • Identify major endocrine glands and hormones • Explain how hormones maintain homeostasis
10.7.9 Immune System	<ul style="list-style-type: none"> • Describe the purpose of the immune system • Compare innate and adaptive immunity • Explain how the body recognizes pathogens • Describe the role of immune cells in defense

Vocab-

Homeostasis, negative feedback, positive feedback, ingestion, digestion, absorption, respiration, excretion, osmoregulation, nephron, reabsorption, neuron, action potential, synapse, neurotransmitter, CNS, PNS, sarcomere, actin, myosin, sliding filament model, target cell, receptor, signal transduction, innate immunity, adaptive immunity, antigen, antibody, pathogen

Resources-

Campbell Biology for AP 12th edition textbook

Priority Standard 10.8 - Basic Scientific Communication

Big Idea(s):

- Effective communication is essential to share scientific knowledge and collaborate with others
- Write and speaking about science requires precision, clarity, and appropriate use of technical language
- Data analysis informs and strengthens scientific communication

Essential Question(s):

- How do scientists clearly and effectively communicate their research findings?
- How can visual tools improve understanding of scientific data?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
10.8.1 Written Scientific Summaries	<ul style="list-style-type: none"> • Summarize experimental work and results clearly using appropriate scientific language • Distinguish between background information, methods, results, and conclusions at an introductory level • Write concise abstracts or result summaries based on laboratory investigations
10.8.2 Visual Communication	<ul style="list-style-type: none"> • Select appropriate visual types based on data and experimental goals • Create clearly labeled tables, graphs, and charts with appropriate units and titles • Write explanatory captions that accurately describe what a visual shows • Identify common errors in data visualization that can mislead interpretation
10.8.3 Oral Communication <ul style="list-style-type: none"> • Intro to laboratory meetings 	<ul style="list-style-type: none"> • Explain experimental procedures and results clearly in informal presentations or discussions • Use appropriate scientific vocabulary when discussing laboratory work • Respond to questions about data by referring to evidence and acknowledging uncertainty

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
10.8.4 Data Analysis and Statistics	<ul style="list-style-type: none"> • Calculate and interpret basic descriptive statistics (mean, range, simple measures of variability) • Identify trends and patterns in experimental data • Recognize outliers and propose reasonable explanations based on experimental context • Explain limitations of data and sources of experimental error

Technical Vocab-

Mean, standard deviation, error bars, descriptive statistics, visual/graphical abstract, lab meeting, peer feedback

Resources-

Graphing software, example abstracts, posters and lab meeting guidelines

Priority Standard 10.9 - Intro to Research

Big Idea(s):

- Scientific research begins with curiosity informed by existing knowledge
- Well-designed experiments arise from clear, testable questions grounded in background research
- Scientific investigations are iterative and often require refinement before meaningful data can be collected

Essential Question(s):

- How do scientists move from broad curiosity to a testable research question?
- How does background research inform experimental design?
- What makes an investigation feasible, ethical, and scientifically meaningful?

Learning Outcomes

<i>Students will know</i>	<i>As evidenced by: (oral, written, or performance)</i>
10.9.1 From topic to research question	<ul style="list-style-type: none"> • Differentiate between a broad topic, a research problem and a testable scientific question • Develop focused research questions based on observations, prior knowledge or background reading • Explain the characteristics of a strong, testable research question
10.9.2 Background Research and Scientific Literature <ul style="list-style-type: none"> • Scientific Databases 	<ul style="list-style-type: none"> • Use scientific databases to locate relevant primary and secondary sources • Read and interpret abstracts to identify research purpose, methods, and key findings • Summarize relevant background information to justify a proposed research question • Evaluate the credibility and relevance of scientific sources
10.9.3 Hypotheses and Predictions	<ul style="list-style-type: none"> • Distinguish between hypotheses and predictions • Formulate testable hypotheses grounded in background research • Explain the relationship between hypothesis, variables and experimental outcomes
10.9.4 Experimental Design	<ul style="list-style-type: none"> • Identify independent, dependent, and controlled variables in a proposed investigation

<i>Students will know</i>	<i>As evidenced by: (oral, written, or performance)</i>
	<ul style="list-style-type: none"> • Explain the role of controls and replication in experimental design • Evaluate feasibility, ethical considerations, and limitations of proposed investigations • Propose experimental approaches appropriate to available tools and constraints

Technical Vocab-

null hypothesis, alternative hypothesis, independent, dependent, controlled, blank, annotated bibliography

Priority Standard 10.10 - Production/ Projects

Big Idea(s):

- Apply advanced skills to the completion of shop projects
- Real world research projects are great for tying together both theory and hands on skills
- Real world research projects are a great way to demonstrate proficiency in competencies learned throughout the year

Essential Question(s):

- What is the importance of learning biotechnology skills?
- How does the application of soft skills affect the success of a project?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
10.10.1 Biotech production/ projects	<ul style="list-style-type: none"> • Proficiency will be determined by scoring a 3 or greater on individual scales • Uploading evidence of proficiencies completing project to portfolio
10.10.2 Employability Skills <ul style="list-style-type: none"> • Communication • Enthusiasm and attitude • Teamwork • Networking • Problem solving and critical thinking • Professionalism 	<ul style="list-style-type: none"> • Demonstrate behavior expected for career employability

Technical Vocab-

competency, portfolio, resume

Resources-

BioRad textbook

Biotechnology 11th Grade Curriculum

Priority Standard 11.1 - Research Design, Ethics, and Experimental Planning

Big Idea(s):

- High-quality research begins with intentional design and ethical reasoning
- Experimental plans must account for feasibility, variables, and data quality
- Ethical research requires transparency, safety, and accountability

Essential Question(s):

- How do scientists design experiments that produce reliable data?
- How do ethical considerations shape experimental choice?
- Why must experiments be repeatable and well-controlled?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
11.1.1 Research Design	<ul style="list-style-type: none"> • Analyze existing scientific literature to refine a research question or hypothesis that is feasible, testable and ethically sound • Identify independent, dependent, and controlled variables • Design an experiment that supports repeatability and valid data collection • Develop a testable null and alternative hypothesis
11.1.2 Research Ethics and Safety	<ul style="list-style-type: none"> • Apply ethical research practices including honest reporting and attribution • Identify project-specific safety considerations • Revise safety and ethics plans as research variables change
11.1.3 Experimental Planning	<ul style="list-style-type: none"> • Justify methodological choices using scientific reasoning • Identify limitations and constraints prior to experimentation • Revise research plans in response to feedback, feasibility constraints or ethical concerns

Technical Vocab-

Hypothesis, null hypothesis, alternative hypothesis, control, replication, bias, validity

Resources-

STEM research handbook

Priority Standard 11.2 - Experimental Execution, Iteration and Documentation

Big Idea(s):

- Scientific investigations evolve through iteration and troubleshooting
- Accurate documentation ensures integrity, traceability, and reproducibility
- Experimental execution must align with approved design

Essential Question(s):

- How do scientists respond to unexpected results or failures?
- Why is documentation critical to research credibility?
- How does iteration improve experimental outcomes?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
11.2.1 Experimental Execution	<ul style="list-style-type: none"> • Carry out experimental procedures aligned to an approved research plan • Repeat experiments as appropriate to ensure reliability • Maintain consistency in experimental conditions
11.2.2 Iteration and Troubleshooting	<ul style="list-style-type: none"> • Modify experimental design in response to preliminary data or challenges • Justify changes to methodology using evidence and reasoning
11.2.3 Documentation and Data Integrity	<ul style="list-style-type: none"> • Maintain accurate, complete scientific records using GDP • Demonstrate traceability of samples, reagents, and conditions • Differentiate between raw data, processed data, and interpreted results

Technical Vocab-

N/A

Resources-

STEM Student Research Handbook

Priority Standard 11.3 - Data Analysis, Interpretation, and Research

Big Idea(s):

- Data analysis transforms measurements into scientific conclusions
- Scientific claims must be supported by evidence and acknowledge uncertainty
- Clear communication enables evaluation and peer critique

Essential Question(s):

- How do scientists analyze data to support or refute hypotheses?
- How do researchers communicate findings to scientific audiences?
- How are limitations and uncertainty addressed in research?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
11.3.1 Data Analysis and Interpretation	<ul style="list-style-type: none"> • Analyze trends and patterns in experimental data • Apply appropriate descriptive and inferential statistics • Assess reliability, validity and sources of error • Select appropriate statistical test based on experimental design
11.3.2 Scientific Writing	<ul style="list-style-type: none"> • Organize a research paper using the IMRaD structure • Interpret results in discussion sections • Apply proper citation practices
11.3.3 Visual and Oral Communication	<ul style="list-style-type: none"> • Design effective scientific figures and tables • Create a scientific poster for a general audience • Present and defend research findings using evidence-based reasoning

Technical Vocab-

Mean, standard deviation, error bars, p-value, chi square test, t test, statistical significant IMRaD

Resources-

STEM Student Research Handbook

Priority Standard 11.4 - Public Health Applications of Biotechnology

Big Idea(s):

- Biotechnology plays a critical role in protecting population health
- Public health decisions are informed by biological data, risk assessment, and ethical considerations
- Laboratory science and public health policy are interconnected

Essential Question(s):

- How is biotechnology used to monitor, prevent, and control disease?
- How do biological data inform public health decisions?
- What ethical considerations arise at the intersection of biotechnology and public health?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
11.4.1 Foundations of Public Health	<ul style="list-style-type: none"> • Describe the history, philosophy and core functions of public health • Explain the population health approach and how it differs from individual medical care • Identify the roles of governmental, non-governmental and community organizations in public health systems
11.4.2 Determinants of Health	<ul style="list-style-type: none"> • Identify and explain environmental, social, cultural behavioral, biological and health service determinants of health • Analyze how inequities and social conditions contribute to population-level health outcomes • Apply determinants of health to real-world public health case studies
11.4.3 Evidence- Based Public Health	<ul style="list-style-type: none"> • Define health problems using population-level data • Analyze public health data to establish potential causes of health issues • Recommend and evaluate evidence-based interventions to address identified health concerns

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
11.4.4 Public Health Data	<ul style="list-style-type: none"> • Interpret public health data sets related to disease, risk or environmental exposure • Explain the role of communication in promoting public health interventions • Discuss ethical considerations in public health decision-making, including individual rights and community well-being
11.4.5 Communicable and Non-Communicable Disease	<ul style="list-style-type: none"> • Compare communicable and non-communicable disease and their public health impacts • Explain the role of biotechnology in disease surveillance, diagnosis and prevention • Analyze public health strategies for controlling disease spread and reducing disease burden
11.4.6 Environmental Health, Safety and Policy	<ul style="list-style-type: none"> • Describe major environmental health risks and their impact on population health • Analyze the role of policy, regulation and enforcement in protecting public health • Connect environmental monitoring and laboratory testing to public health decision-making

Technical Vocab-

epidemiology, communicable disease, non-communicable disease, evidence-based intervention

Resources-

Riegelman & Kirkwood, Public Health 101 (3rd edition), UConn PUBH 1101 course materials, public health case studies, public health databases

Priority Standard 11.5 - Systems Biology

Big Idea(s):

- Evolution drives the diversity and unity of life
- Biological structure and function are interconnected across levels of organization
- Organisms interact within ecosystems through energy flow and nutrient cycling
- Biological systems are shaped by both historical processes and present environmental pressures

Essential Question(s):

- How do evolutionary mechanisms change populations over time?
- How does evolutionary history explain biological diversity?
- How does plant structure support survival and reproduction?
- How do ecological interactions influence population and ecosystem stability?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
11.5.1 Mechanisms of evolution	<ul style="list-style-type: none"> • Explain how mutation, natural selection, gene flow and genetic drift alter allele frequencies • Apply Hardy-Weinberg equilibrium to population genetics problems • Analyze how selection acts on phenotypes to influence population change • Interpret data sets demonstrating evolutionary change
11.5.2 Evolutionary History of Biological Diversity	<ul style="list-style-type: none"> • Construct and interpret phylogenetic trees • Explain mechanisms of speciation • Describe major evolutionary transitions in the history of life • Analyze evidence from fossil, anatomical, and molecular data • Compare major plant and animal lineages
11.5.3 Plant form and function	<ul style="list-style-type: none"> • Explain how plant structure relates to function at tissue and organ levels • Describe water and nutrient transport mechanisms • Analyze photosynthesis and plant energy acquisition

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
	<ul style="list-style-type: none"> • Relate plant adaptations to environmental conditions
11.5.4 Ecology	<ul style="list-style-type: none"> • Model population growth and regulation • Analyze species interactions within communities • Explain energy flow and trophic structure • Describe biogeochemical cycles • Evaluate human impacts on ecosystems and climate

Technical Vocab-

Natural selection, genetic drift, allele frequency, Hardy-Weinberg equilibrium, speciation, phylogeny, cladogram, meristem, transpiration, photosynthesis, carrying capacity, trophic level, biogeochemical cycle.

Resources-

Campbell Biology for AP 12th edition; BSC

Priority Standard 11.6 - Plant Biotechnology and Basic Plant Tissue Culture

Big Idea(s):

- Plant tissue culture enables controlled propagation and genetic consistency
- Aseptic technique and careful maintenance are critical for long-term culture success
- Biotechnology production systems require planning, monitoring, and consistency

Essential Question(s):

- How can plants be cloned and maintained under sterile conditions?
- What factors influence success and failure in plant tissue culture?
- How do laboratory practices support reliable biological production?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
11.6.1 Intro to Tissue Culture	<ul style="list-style-type: none"> • Explain the purpose of plant tissue culture • Explain the stages of plant tissue culture and micropropagation • Describe the role of media components and growth regulators • Explain the role of sterile technique in preventing contamination and ensuring culture viability
11.6.2 Media, Environment and Growth Factors	<ul style="list-style-type: none"> • Describe the function of tissue culture media components • Explain how environmental factors such as light, temperature and nutrient availability influence plant growth in culture • Predict how changes in growth conditions may affect culture success or failure
11.6.3 Culture Maintenance and Subculturing	<ul style="list-style-type: none"> • Perform subculturing procedures to maintain health plant cultures • Explain the purpose of regular subculturing in long-term plant tissue culture systems • Identify signs of healthy growth, stress or decline in culture plants
11.6.4 Contamination	<ul style="list-style-type: none"> • Identify signs of common culture contaminations • Describe how to prevent and manage contamination in tissue cultures

Technical Vocab-

Axial, internode, node, calli, seed, meristem, explant, subculturing, micropropagation, multiplication stage, root and stem formation, hardening off, biological safety cabinet

Resources-

Plant anatomy worksheet, BSC

Priority Standard 11.7 - Production / Projects

Big Idea(s):

- Incorporating all 11th grade objectives is essential to success in the creation of biotech projects/ production work
- Maintaining artifacts of work can build a resume

Essential Question:

What is the importance of “workmanship”

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
11.7.1 Research Projects	<ul style="list-style-type: none">• Proficiency will be determined by scoring a 3 or greater on individual project/production proficiency scales• Demonstrate behavior expected for career employability
11.7.2 Biotech Employability	<ul style="list-style-type: none">• Uploading evidence of proficiencies completing project to portfolio• Update the Competency Checklist

Technical Vocab-

workmanship, competency, portfolio, resume

Resources-

BioRad textbook

Biotechnology - 12th Grade Curriculum

Priority Standard 12.1 - Laboratory Leadership, Safety and Operations

Big Idea(s):

- A safe laboratory environment depends on proactive hazard identification, effective training, and adherence to safety protocols
- Senior lab members act as safety leaders, guiding and mentoring newer lab members to uphold standards

Essential Question(s):

- How can experienced lab members promote a culture of safety and accountability?
- What methods are effective for identifying and mitigating hazards in novel experiments?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
12.1.1 Laboratory Safety Leadership	<ul style="list-style-type: none"> • Demonstrate safe lab practices to new lab members • Model appropriate laboratory behavior and decision making • Observe laboratory practices and identify safety concerns • Provide feedback to peers regarding safety procedures
12.1.2 Hazard Identification and Risk Assessment	<ul style="list-style-type: none"> • Identify potential biological, chemical and physical hazards in laboratory protocols • Analyze experimental procedures to determine risk level • Conduct formal risk assessments for laboratory activities • Recommend appropriate safety controls or mitigation strategies
12.1.3 Personal Protective Equipment	<ul style="list-style-type: none"> • Select appropriate PPE for specific lab activities • Demonstrate correct PPE use to new lab members • Monitor PPE compliance during laboratory work • Provide feedback regarding PPE use

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
12.1.4 Laboratory Roles and Operations	<ul style="list-style-type: none"> • Identify essential day - to - day laboratory tasks • Describe roles and responsibilities within a laboratory team • Develop clear laboratory job descriptions • Analyze workflows to identify inefficiencies • Evaluate how lab roles contribute to lab operation
12.1.5 Training, Mentorship and Management	<ul style="list-style-type: none"> • Demonstrate lab procedures to new members • Model responsibility and accountability in lab work • Provide constructive, actionable feedback
12.1.6 Project and Resource Management	<ul style="list-style-type: none"> • Develop a project management plan for laboratory work • Organize time, materials and responsibilities • Monitor project progress • Evaluate project outcomes against goals • Propose improvements to laboratory management practices

Technical Vocab-

SOP, hazard, PPE, risk assessment, laboratory manager, laboratory workflow, project management, training protocol, mitigation strategy

Resources-

SDS binder, lab equipment required for safety procedure demonstrations and critiquing

Priority Standard 12.2 - Microbial Diversity and Physiology

Big Idea(s):

- Microorganisms exhibit vast diversity in structure, metabolism, and environmental adaptation
- Microbial physiology determines where organisms can live and how they obtain energy

Essential Question(s):

- How do metabolic and physiological differences shape microbial diversity?
- Why do different microbes thrive under different environmental conditions?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
12.2.1 Microbial Diversity	<ul style="list-style-type: none"> • Describe major groups of microorganisms • Compare prokaryotic and eukaryotic microorganisms • Analyze how genetic and metabolic diversity contributes to ecological roles
12.2.2 Microbial Metabolism	<ul style="list-style-type: none"> • Differentiate aerobic, anaerobic, and facultative metabolism • Compare respiration and fermentation as energy-generating pathways • Predict growth outcomes based on metabolic strategy
12.2.3 Environmental Influence on Microbial Growth	<ul style="list-style-type: none"> • Explain how temperature, pH, oxygen and nutrients affect microbial survival • Analyze how environmental conditions select for specific microbes • Evaluate how sampling conditions influence observed diversity
12.2.4 Microbial Growth Dynamics	<ul style="list-style-type: none"> • Describe phases of the microbial growth curve • Interpret growth curves using logarithmic scales • Analyze factors affecting population growth and carrying capacity

Technical Vocab-

Microorganism, microbial diversity, prokaryote, eukaryote, bacteria, archaea, fungi, protist, virus, metabolism, aerobic, anaerobic, obligate, facultative, respiration, fermentation, environmental niche, growth rate, carrying capacity, lag, log/exponential, stationary, death

Resources-

Tiny Earth Manual, primary microbiology literature, instructor generated case studies

Priority Standard 12.3 - Microbial Cultivation and Isolation

Big Idea(s):

- Growth conditions influence microbial behavior and experimental outcomes
- Cultivation methods influence experimental outcomes and conditions

Essential Question(s):

- How do growth conditions influence microbial isolation?
- What are the limitations of culture-based microbiology?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
12.3.1 Media and Growth Conditions	<ul style="list-style-type: none"> • Select appropriate media based on microbial metabolic requirements • Differentiate selective, differential, and enriched media • Predict growth outcomes based on media composition
12.3.2 Isolation Techniques	<ul style="list-style-type: none"> • Compare quadrant streaking, spread plating, and pour plating • Determine appropriate isolate methods based on experimental goals • Evaluate how isolation technique affects colony diversity
12.3.3 Microbial Population Estimation	<ul style="list-style-type: none"> • Explain the purpose of serial dilutions and CFU calculations • Interpret CFU data to estimate population size • Analyze sources of error in population measurements

Technical Vocab-

Culture, aseptic technique, media, agar, selective media, differential media, enriched media, isolation, inoculation, incubation, colony, colony-forming unit (CFU), serial dilution, dilution factor, viable count, contamination

Resources-

Tiny Earth Manual, primary microbiology literature, instructor generated case studies

Priority Standard 12.4 - Microbial Identification and Characterization

Big Idea(s):

- Microorganisms are identified using multiple lines of phenotypic and molecular evidence
- No single method is sufficient for accurate microbial identification

Essential Question(s):

- How do microbiologists identify unknown microorganisms?
- What are the strengths and limitations of different identification methods?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
12.4.1 Colony and Cellular Characteristics	<ul style="list-style-type: none"> • Describe colony morphology characteristics (form, margin, elevation, pigmentation, opacity) • Compare cell morphology and staining results to differentiate microbial groups • Interpret phenotypic traits to narrow microbial identify
12.4.2 Gram Staining and Cell Wall Structure	<ul style="list-style-type: none"> • Explain the structural differences between Gram-positive and Gram-negative bacteria • Describe how cell wall composition influences Gram staining outcomes • Interpret Gram staining results to inform further characterization and analysis • Evaluate limitations of Gram staining as an identification tool
12.4.3 Biochemical and Media-Based Characterization	<ul style="list-style-type: none"> • Interpret growth patterns on selective and differential media • Analyze biochemical behavior to infer microbial traits • Evaluate limits of phenotype-based identification
12.4.5 Antibiotic Sensitivity	<ul style="list-style-type: none"> • Explain mechanisms of action of common antibiotics • Distinguish between bacteriostatic and bactericidal effects • Interpret zones of inhibition as indicators of microbial susceptibility

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
	<ul style="list-style-type: none"> ● Evaluate limitations of zone assays in determining antibiotic effectiveness
12.4.6 Molecular characterization <ul style="list-style-type: none"> ● DNA extraction ● PCR as an identification tool 	<ul style="list-style-type: none"> ● Explain why 16S rRNA sequencing is considered a gold standard for bacterial identification ● Describe how PCR and sequence comparison are used to support microbial identification ● Compare molecular identification methods to phenotypic approaches and evaluate their advantages and limitations

Technical Vocab-

Colony morphology, form, margin, elevation, pigmentation, opacity, cell morphology, Gram stain, Gram-positive, Gram-negative, peptidoglycan, antibiotic susceptibility, bacteriostatic, bactericidal, zone of inhibition, molecular identification, DNA extraction, PCR, 16S rRNA, sequence alignment, phenotypic identification, genotypic identification

Resources-

Tiny Earth Manual

Priority Standard 12.5 - Molecular Genetics and DNA Analysis

Big Idea(s):

- Genetic information can be analyzed at the molecular and chromosomal level
- Patterns in DNA and chromosomes provide evidence for inheritance and variance

Essential Question(s):

- How is genetic information organized and analyzed at the molecular level?
- How do different DNA analysis methods reveal genetic differences?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
12.5.1 DNA Structure and Variation and Mutation	<ul style="list-style-type: none"> • Identify sequence differences among DNA samples • Classify mutations by type and scale • Explain how mutations affect DNA analysis • Analyze DNA sequences to locate potential mutations
12.5.2 Chromosome Structure and Function	<ul style="list-style-type: none"> • Describe chromosome organization and levels of DNA packaging • Distinguish between structural and numerical chromosomal changes • Evaluate the impact of chromosomal changes on organismal phenotype
12.5.3 Karyotyping and Chromosomal Analysis	<ul style="list-style-type: none"> • Identify normal and abnormal human karyotypes • Analyze karyotype data to detect chromosomal abnormalities • Differentiate among types of chromosomal disorders • Interpret karyotype evidence in diagnostic scenarios • Evaluate the strengths and limitations of karyotyping as a genetic tool
12.5.4 Restriction Enzymes and Restriction Digests	<ul style="list-style-type: none"> • Identify restriction enzyme recognition sites • Predict fragment sizes from restriction digests • Compare single and double digests • Explain how restriction digests reveal genetic variation

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
	<ul style="list-style-type: none"> • Interpret restriction digest maps • Construct restriction digest maps • Explain the limitations of restriction analysis

Technical Vocab-

Mutation, polymorphism, chromosome, karyotype, restriction enzyme, restriction site, restriction digest, restriction map, fragment length

Resources-

DNA sequence datasets, Restriction enzyme charts, Karyotype images, Restriction digest map problems

Priority Standard 12.6 - Molecular Diagnostics

Big Idea(s):

- Genes can be transferred and analyzed using recombinant DNA technology
- Molecular diagnostics use genetic evidence to detect variation and disease

Essential Question(s):

- How is genetic material transferred and analyzed in biotechnology?
- How do molecular tools support genetic diagnosis?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
12.6.1 Plasmids and Gene Transfer	<ul style="list-style-type: none"> • Identify key features of plasmids used in gene transfer • Describe plasmid structure and function • Explain principles of bacterial transformation • Evaluate gene transfer as a genetic tool
12.6.2 Plasmid Purification	<ul style="list-style-type: none"> • Explain the purpose of plasmid purification • Analyze plasmid data generated from purification • Interpret plasmid quality for downstream applications • Evaluate limitations of plasmid purification methods
12.6.3 DNA Sequencing	<ul style="list-style-type: none"> • Describe the purpose of DNA sequencing • Interpret sequencing output to identify genetic variation • Analyze sequence data relative to a reference genome • Compare sequencing to other DNA analysis methods • Evaluate sequencing as a diagnostic and research tool
12.6.4 Molecular Diagnostic Techniques	<ul style="list-style-type: none"> • Identify genetic variation using molecular data • Analyze diagnostic datasets to detect mutations • Compare diagnostic approaches based on available data

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
	<ul style="list-style-type: none">• Evaluate the reliability of molecular diagnostic methods

Technical Vocab-

Plasmid, transformation, recombinant DNA, miniprep, DNA sequencing, mutation, molecular diagnostics

Tools-

Plasmid maps, sequencing output files, diagnostic case studies, bioinformatics tools and databases

Priority Standard 12.7 - Human Genetic Disorders and Genetic Therapies

Big Idea(s):

- Genetic disorders result from changes in DNA or chromosomes
- Biotechnology can be used to treat or manage genetic disease

Essential Question(s):

- How do genetic changes lead to disease?
- How can biotechnology be used to treat genetic disorders?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
12.7.1 Genetic Mutations and Human Disease	<ul style="list-style-type: none"> • Identify mutations associated with genetic disorders • Classify mutations by molecular effect • Analyze how mutations alter gene function • Interpret genotype-phenotype data • Evaluate mutation severity using genetic evidence
12.7.2 Genetic Disorders and Diagnosis	<ul style="list-style-type: none"> • Analyze genetic data to identify disorders • Evaluate diagnostic strategies using genetic data • Justify conclusions using molecular evidence
12.7.3 Genetic Therapies	<ul style="list-style-type: none"> • Describe genetic-based therapeutic approaches • Compare strategies for treating genetic disorders • Analyze how therapies target molecular defects • Evaluate benefits and risks of genetic therapies
12.7.4 Drug Discovery and Clinical Trials	<ul style="list-style-type: none"> • Identify genetic targets used in medical treatments • Analyze how genetic information guides therapy development • Interpret clinical data related to genetic treatments • Compare treatment approaches based on genetic evidence • Evaluate ethical and practical considerations

Technical Vocab-

Genetic disorder, biologic, gene therapy, CRISPR, clinical trial, target gene, mutation

Resources-

Case studies

Priority Standard 12.8 - Population Genetics and Genetic Variation

Big Idea(s):

- Genetic variation exists within and among populations
- Population - level processes influence allele frequencies over time

Essential Question(s):

- How do genes change in populations?
- How can genetic data be used to study population variation?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
12.8.1 Genetic Variation in Populations	<ul style="list-style-type: none"> • Define sources of genetic variation • Analyze population data to identify variation • Compare genetic diversity among populations • Interpret genetic variation using molecular data • Evaluate factors influencing population diversity
12.8.2 Hardy-Weinberg Equilibrium	<ul style="list-style-type: none"> • Calculate allele and genotype frequencies • Apply Hardy-Weinberg equations to population data • Analyze deviations from equilibrium
12.8.3 Evolutionary Forces	<ul style="list-style-type: none"> • Analyze population data to detect genetic change • Interpret effects of selection and drift • Evaluate evidence for evolutionary processes • Justify conclusions using quantitative data
12.8.4 Human Population Genetics	<ul style="list-style-type: none"> • Analyze human genetic datasets • Compare genetic variation across populations • Interpret population-level genetic trends • Evaluate societal and ethical considerations

Technical Vocab-

Allele frequency, Hardy–Weinberg equilibrium, genetic drift, selection, bottleneck, population genetics

Resources-

Case studies, genetic databases

Priority Standard 12.9 - Production/ Projects

Big Idea(s):

- Biotechnology projects are driven by defined goals and real-world constraints
- Effective projects apply selected technical skills strategically
- Professional biotechnology work requires planning, documentation, evaluation and reflection

Essential Question(s):

- How can biotechnology skills be applied to address a specific scientific, production, or technical problem
- How do professionals plan, execute and evaluate complex biotechnology projects?
- What criteria define success in an applied biotechnology project?

Learning Outcomes

<i>Students will know:</i>	<i>As evidenced by: (oral, written, or performance)</i>
12.9.1 Production/ Projects	<ul style="list-style-type: none"> • Proficiency will be determined by scoring a 3 or greater on individual project/production proficiency scales selected areas, as appropriate to the scope and goals of the project • Apply selected biotechnology skills strategically to meet defined project objectives • Demonstrate appropriate technical accuracy, documentation, and problem-solving within the chosen project scope • Demonstrate behaviors expected for career employability
12.9.2 Biotech Employability	<ul style="list-style-type: none"> • Uploading evidence of completed project work • Update the Competency Checklist

Technical Vocab-

workmanship, competency, portfolio, resume

Resources-

BioRad textbook