

Pascack Valley Regional High School District

**Pascack Hills High School, Montvale, New Jersey
Pascack Valley High School, Hillsdale, New Jersey**

Course Name: Research in Molecular Genetics II & III

Born On: August, 2026
Board Approval: 8/24/26

New Jersey Curricular Mandates for Science Instruction

Disabled & LGBT:

18A:35-4.35 - History of disabled and LGBT persons included in middle and high school curriculum. A board of education shall include instruction on the political, economic, and social contributions of persons with disabilities and lesbian, gay, bisexual, and transgender people, in an appropriate place in the curriculum of middle school and high school students as part of the district's implementation of the New Jersey Student Learning Standards.

Diversity, Equity, and Inclusion (DEI):

C.18A:35-4.36a - Curriculum to include instruction on diversity and inclusion. 1. a. Beginning in the 2021-2022 school year, each school district shall incorporate instruction on diversity and inclusion in an appropriate place in the curriculum of students in grades kindergarten through 12 as part of the district's implementation of the New Jersey Student Learning Standards. b. The instruction shall: (1) highlight and promote diversity, including economic diversity, equity, inclusion, tolerance, and belonging in connection with gender and sexual orientation, race and ethnicity, disabilities, and religious tolerance; (2) examine the impact that unconscious bias and economic disparities have at both an individual level and on society as a whole; and (3) encourage safe, welcoming, and inclusive environments for all students regardless of race or ethnicity, sexual and gender identities, mental and physical disabilities, and religious beliefs. c. The Commissioner of Education shall provide school districts with sample learning activities and resources designed to promote diversity and inclusion.

Amistad Law:

N.J.S.A. 18A 52:16A-88 Every board of education shall incorporate the information regarding the contributions of African Americans to our country in an appropriate place in the curriculum of elementary and secondary school students.

Climate Change:

2026 NJSLS-Science: Earth's climate is now changing faster than at any point in the history of modern civilization, primarily as a result of human activities. Global climate change has already resulted in a wide range of impacts across New Jersey and in many sectors of its economy. The addition of academic standards that focus on climate change is important so that all students will have a basic understanding of the climate system, including the natural and human-caused factors that affect it. The underpinnings of climate change span across physical, life, as well as Earth and space sciences. The goal is for students to understand climate science as a way to inform decisions that improve quality of life for themselves, their community, and globally and to know how engineering solutions can allow us to mitigate impacts, adapt practices, and build resilient systems.

Dissection Law

N.J.S.A. 18A:35-4.25 and N.J.S.A. 18A:35-4.24 authorizes parents or guardians to assert the right of their children to refuse to dissect, vivisect, incubate, capture or otherwise harm or destroy animals or any parts thereof as part of a course of instruction.

Honors Research in Molecular Genetics II & III		
Unit Title	Approx # of weeks	Months
Planning & Carrying Out an Independent Research Investigation	Approx. 18 Weeks	September - January
Analyze Project Data & Communicate Research Findings	Approx. 18 weeks	February - June

Honors Research in Molecular Genetics II & III**Unit 1: Planning and Carrying Out an Independent Research Investigation**

Related Phenomena: Various biology-related phenomena can be explored throughout the unit using laboratory investigations, scientific literature, data analysis, and case studies. Suggested phenomena include:

Epigenetics and Phenotypic Variation

Despite having identical genomes, monozygotic twins often develop differences in disease susceptibility, behavior, and gene expression. Students may investigate how epigenetic modifications and environmental factors contribute to phenotypic variation.

Non-Genetic Antibiotic Resistance

Some bacterial strains survive exposure to high concentrations of antibiotics despite lacking known resistance genes. Students may investigate how persister cells, biofilm formation, and gene regulation contribute to antibiotic tolerance and resistance.

Microplastics and Aquatic Health

Microplastics accumulate in aquatic organisms and may disrupt endocrine and metabolic pathways. Students may investigate how microplastic exposure influences hormonal signaling, physiology, or gene expression in model organisms such as Daphnia or zebrafish.

Light-Regulated Gene Expression in Plants

Plants exposed to different wavelengths of light exhibit changes in growth and stress-response gene expression. Students may investigate how light quality and photoreceptor signaling pathways regulate plant gene networks.

Mitochondrial Dysfunction and Neurodegenerative Disease

Mitochondrial dysfunction has been linked to numerous neurodegenerative disorders, although the underlying mechanisms remain incompletely understood. Students may investigate how changes in mitochondrial function contribute to disease progression.

The Brain–Gut Microbiome Connection

The composition of the gut microbiome influences digestion, immune function, mood, and cognitive performance. Students may investigate how microbial metabolites interact with host signaling pathways within the brain–gut axis.

Urban Heat Islands and Biodiversity

Urban heat islands alter local climates and affect biodiversity within densely populated environments. Students may investigate how temperature differences across urban landscapes influence insect diversity, plant phenology, or ecosystem health.

Artificial Intelligence in Medical Diagnosis

Machine learning algorithms can identify subtle patterns in medical images and physiological data that may indicate disease. Students may investigate

how artificial intelligence can improve the early detection of diseases such as diabetic retinopathy while considering the ethical and societal implications of these technologies.

Bioremediation Using Bacteria

Certain bacterial species can metabolize environmental pollutants and contribute to ecosystem restoration. Students may investigate the genetic pathways involved in the degradation of petroleum hydrocarbons or other contaminants and evaluate the role of biotechnology in environmental remediation.

Environmental Stress and Epigenetics

Chronic environmental stress can alter epigenetic markers that regulate gene expression and influence behavior. Students may investigate how environmental stress affects DNA methylation or other epigenetic mechanisms associated with neurological function.

Ocean Acidification and Marine Organisms

Increasing atmospheric carbon dioxide has resulted in ocean acidification, affecting marine organisms that rely on calcium carbonate for shell or skeletal formation. Students may investigate the molecular and physiological responses of marine organisms to changing ocean chemistry.

Invasive Species and Ecosystem Function

The introduction of invasive species can alter food webs, nutrient cycling, and biodiversity within freshwater ecosystems. Students may investigate how invasive organisms affect ecosystem stability and native species populations.

Synthetic Biology and Engineered Microorganisms

Advances in synthetic biology have enabled scientists to engineer microorganisms capable of producing pharmaceuticals, industrial compounds, and environmentally beneficial products. Students may investigate how engineered bacterial systems can be optimized to produce useful compounds while considering the ethical, environmental, and societal implications of synthetic biology.

Pacing: 18 weeks

New Jersey Student Learning Standards (NJSLs)

HS-LS1-1: Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.

HS-LS1-3: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

HS-LS3-1: Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

HS-LS3-2: Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.

HS-LS4-2: Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

HS-LS4-5: Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

HS-ESS3-5: Analyze geoscience data and results from global climate models to make an evidence-based forecast of climate change impacts.

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Asking Questions and Defining Problems - Ask questions that arise from examining models or theories to clarify relationships and refine scientific investigations. - Analyze complex real-world problems by specifying qualitative and quantitative criteria and constraints for successful solutions. Developing and Using Models - Develop, revise, and use models based on evidence to illustrate and predict relationships between systems or components of systems. Planning and Carrying Out Investigations - Plan and conduct investigations individually and collaboratively to produce data that serve as the basis for evidence while considering appropriate controls, variables, and safety procedures. - Evaluate and refine the design of an investigation to produce reliable and valid data. Analyzing and Interpreting Data - Analyze and interpret data using appropriate statistical, graphical, and computational tools to identify patterns, relationships, and sources of error.	LS1.A: Structure and Function - Systems of specialized cells within organisms help perform the essential functions of life. - All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions for forming proteins, which carry out most of the work of cells. LS1.B: Growth and Development of Organisms - Feedback mechanisms maintain homeostasis and regulate the internal environment of organisms. - Investigations of feedback mechanisms provide evidence for how organisms maintain stable internal conditions despite external changes. LS3.A: Inheritance of Traits - Each chromosome consists of a single, very long DNA molecule containing many genes. - Genes contain the instructions for producing proteins that influence the characteristics of organisms. LS3.B: Variation of Traits - Genetic variation results from meiosis, sexual reproduction, mutations, and environmental influences.	Patterns - Patterns observed in data can provide evidence to identify relationships, make predictions, and support scientific explanations. Cause and Effect - Empirical evidence is required to distinguish between cause and correlation and to support claims about mechanisms responsible for observed phenomena. Scale, Proportion, and Quantity - Scientific phenomena can be investigated and interpreted at different spatial, temporal, and organizational scales, from molecules and cells to organisms, populations, and ecosystems. Systems and System Models - Models can be used to represent biological, environmental, and engineered systems and to examine interactions among system components. Energy and Matter - Energy and matter are conserved as they move through biological systems, chemical processes, and ecosystems,

Using Mathematics and Computational Thinking • Apply mathematical concepts, statistical analysis, and computational tools to analyze data, evaluate evidence, and support scientific conclusions. Constructing Explanations and Designing Solutions • Construct explanations based on valid and reliable evidence obtained from investigations, models, theories, simulations, peer review, and other scientific sources. • Design, evaluate, and refine solutions to complex real-world problems using scientific knowledge, evidence, and engineering design principles. Engaging in Argument from Evidence • Evaluate competing design solutions and scientific claims using evidence, reasoning, and scientific principles. • Defend conclusions and proposed investigations using empirical evidence and logical reasoning. Obtaining, Evaluating, and Communicating Information • Critically evaluate scientific information from multiple credible sources. • Communicate scientific ideas, research findings, and evidence	• Variations in traits provide the raw material upon which natural selection acts. LS4.B: Natural Selection • Natural selection occurs only when there is variation among individuals in a population and those variations influence survival and reproductive success. LS4.C: Adaptation • Adaptation is the result of natural selection acting over many generations, increasing the prevalence of advantageous traits within populations. ESS3.D: Global Climate Change • Current rates of global climate change are primarily the result of human activities. Scientific evidence from geoscience data and climate models can be used to understand and predict future climate conditions. ETS1.A: Defining and Delimiting Engineering Problems • Criteria and constraints include scientific, societal, environmental, and economic factors that define successful solutions to engineering problems. ETS1.B: Developing Possible Solutions • Complex engineering problems can be broken into smaller, more manageable problems that can be solved	providing a framework for understanding organism function and environmental change. Structure and Function • The structure of biological molecules, cells, organisms, and engineered systems determines their function and influences system performance. Stability and Change • Feedback mechanisms, environmental conditions, and evolutionary processes contribute to the stability or change of biological systems over time.
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clearly and accurately using written, oral, visual, and digital formats.	systematically and evaluated using scientific evidence.		
	ETS1.C: Optimizing the Design Solution Solutions are refined through testing, evaluation, modeling, and iterative redesign to improve performance while balancing trade-offs and constraints.		
Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
- What makes a good research question? - How do you use model organisms to study various phenomena? - How do we design and execute scientific experiments? - How can we use the engineering design process to design a solution to a real-world problem/issue? - How can we use data and outcomes from previous experiments to create and refine a research protocol?	Student will be able to: - Identify a topic of interest through conducting a literature review. - Design and execute independent or team-based investigations. - Identify the appropriate model organism when necessary. - Formulate a clear, testable, and original research question(s). - Develop a hypothesis grounded in peer-reviewed research. - Design a valid, ethical, and feasible experimental procedure grounded in peer-reviewed research. - Gather appropriate data from their experiments. - Use the appropriate statistics/mathematical model to evaluate raw data.	Literature Review Topic Exploration using the “Topic Exploration Wizard”. - Review the guidelines of posing scientific questions and designing scientific investigations. - Develop a scientific question, testable hypothesis and hypothetical experiment to investigate the impact of a specific phenomena or variable on molecular mechanisms of organisms. - Identify appropriate protocols for answering the scientific question. - Regular lab check-ins and mentoring	- Finalized Research proposal - Background literature summary - Midpoint data presentation - Revised experiment plan (if needed) - Execution of experiments or data collection. - Final data analysis and conclusions. (Use Science Buddies Rubrics to evaluate student progress and projects)

• How might outside mentors guide us in our research? • What does it mean to “think like a scientist” or “think like an engineer”? • How does collaboration enhance the research or design process? • How do we balance creativity and logic in scientific inquiry or engineering design? • Why is it important to question assumptions in scientific work? • What responsibilities do scientists and engineers have to the public and the planet?	• Create a research plan aligned with science fair or related program criteria, including timelines, care of organisms, and the training and precautions necessary to use different chemicals, materials and equipment. • Present and justify their research plan to peers and instructors for feedback.		
Interdisciplinary Connections	English Language Arts • RI.CR.11–12.1 Accurately cite a range of thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what an informational text says explicitly and inferentially, as well as interpretations of the text. • RI.MF.11–12.6 Synthesize complex information across multiple sources and formats to develop ideas, resolve conflicting information, or develop an interpretation that goes beyond explicit text information (e.g., express a personal point of view, new interpretation of the concept).		

	● W.WR.11–12.5 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. ● W.IW.11–12.2 Write informative/explanatory texts (including the narration of historical events, scientific procedures/experiments, or technical processes) to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. ● SL.PI.11–12.4 Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. Mathematics ● MP.2 Reason abstractly and quantitatively. ● MP.4 Model with mathematics. ● MP.5 Use appropriate tools strategically. ● HS.S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots). ● HS.S-ID.6 Use statistics appropriate to the shape of the data distribution to compare center and spread of two or more different data sets and interpret differences in context.		
Career Readiness, Life Literacies, and Key Skills	● 9.2.12.CAP.1 Analyze personal skills, interests, and abilities to determine how they align with career and postsecondary opportunities. ● 9.2.12.CAP.4 Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them including educational training requirements, costs, loans, and debt repayment. ● 9.2.12.CAP.7 Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest. ● 9.4.12.CI.1 Demonstrate the ability to reflect, analyze, and use creative skills and ideas. ● 9.4.12.CT.2 Develop multiple solutions to a problem and evaluate which is the most effective. ● 9.4.12.IML.5 Evaluate, synthesize, and apply information on the ethical and legal use of technology		
Computer Science and Design Thinking	● 8.1.12.DA.5 Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. ● 8.1.12.DA.6 Create and refine computational models to better represent relationships among different elements of data collected from a phenomenon or process. ● 8.1.12.CS.1 Plan and develop computational solutions that use appropriate algorithms, data structures, and abstractions to solve complex problems. ● 8.2.12.ED.1 Apply a design thinking process to identify a real-world problem, generate possible solutions, test ideas, and refine the solution based on feedback.		
Modifications			
Multi-Lingual Learners	Students with Special Needs	At-Risk	Gifted and Talented
● Provide diagrams, flowcharts, and labeled images of experimental setups. ● Use graphic organizers (e.g., cause/effect charts, hypothesis vs. results tables) to help organize ideas.	● Break down experiments into smaller, clear steps. ● Use simple, direct language paired with visuals or demonstrations. ● Provide written and verbal instructions. ● Use checklists or task cards to guide progress.	● Foster a positive classroom culture where mistakes are valued as learning. ● Connect lessons to students' interests, backgrounds, and real-life experiences. ● Provide consistent	● Challenge students to design multi-variable experiments or novel bioinformatics pipelines. ● Assign tasks requiring critical evaluation of conflicting data or ethical implications. ● Support participation in science fairs, competitions, or publication of findings. ● Connect students with mentors or scientists in the field.

• Visuals help bridge language gaps and clarify abstract concepts. • Break down complex instructions into smaller, manageable steps. • Use sentence frames or starters (e.g., “I predict that...”, “The data shows...”). • Provide bilingual glossaries or translated materials if possible. • Emphasize “learning by doing” through experiments, models, and simulations. • Use videos, animations, and interactive tools to demonstrate scientific processes.	• Offer hands-on materials or tactile models for students with sensory needs. • Use videos or simulations as alternatives to physical experiments. • Give extended time for completing experiments and data recording. • Allow breaks during longer tasks. • Provide opportunities to repeat steps or practice skills. • Incorporate pictures, diagrams, flowcharts, and labeled tools.	encouragement and recognize effort. • Offer choices in topics, formats, or group/individual work. • Use small groups or peer mentoring to build skills and confidence. • Teach and model effective teamwork and communication skills. • Highlight how scientific skills relate to jobs and daily life. • Invite guest speakers or organize field trips to increase motivation. • Offer after-school tutoring, study sessions, or access to resource centers. • Encourage use of school counseling or mentoring programs to address socio-emotional needs.	• Explore ethical, social, or philosophical questions raised by genetic data. • Link bioinformatics to fields like computer science, math modeling, or health sciences.
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Honors Research in Molecular Genetics II & III

Unit 2: Analyze Project Data and Communicate Research Findings

Related Phenomena: Various biology-related phenomena can be explored throughout the unit using laboratory investigations, research articles, case studies, data analysis, and scientific communication. Suggested phenomena include:

Microplastic Presence in Local Waterways

Students may investigate how rainfall events affect the concentration of microplastics in local streams. Data may include microplastic particle count per liter of water, sampling location and time, and rainfall measurements. Students may calculate descriptive statistics, compare pre- and post-rainfall samples, create scatter plots showing rainfall amount versus microplastic concentration, and analyze trends across multiple rainfall events. Findings may be communicated through bar graphs, maps of sampling locations, heat maps, and discussions connecting runoff, urban pollution, and relevant EPA guidance.

Plant Growth Under Different Light Spectrums

Students may investigate how different LED light colors affect basil plant growth. Data may include plant height, leaf count, biomass, light color, and growth time. Students may compare growth among treatment groups using statistical analysis, line graphs, box plots, and post-hoc comparisons when appropriate. Findings may be communicated through photographs, data tables, graphs, and conclusions addressing practical applications for hydroponics and urban agriculture.

Bacterial Resistance in Public Spaces

Students may investigate the effectiveness of natural antibacterial agents compared with commercial hand sanitizers. Data may include zones of inhibition for treatments such as garlic extract, honey, and alcohol-based sanitizer, with multiple bacterial strains included when appropriate. Students may calculate mean inhibition-zone diameter, compare treatment groups, create bar graphs with error bars, and evaluate variation across trials. Findings may be communicated through annotated Petri-dish images, infographics, graphs, and discussions of bacterial resistance and the potential use of natural products.

Solar Panel Efficiency in Urban and Rural Settings

Students may investigate how local air quality affects solar-panel output. Data may include daily wattage output, Air Quality Index, temperature, and humidity. Students may analyze correlations, use regression models, create scatter plots with regression lines, and compare daily energy-production trends with pollution levels. Findings may be communicated through dashboards, graphs, technical summaries, and conclusions focused on clean energy and urban-planning implications.

Cognitive Impact of Music Genres

Students may investigate whether different genres of music affect memory retention in high school students. Data may include test scores after exposure to classical music, rock music, silence, or other conditions, as well as optional participant information. Students may compare performance across conditions, create bar graphs and box plots, and calculate effect size where appropriate. Findings may be communicated through sample assessment materials, audience-appropriate graphs, and conclusions addressing possible implications for student study habits.

Pacing: 18 weeks

New Jersey Student Learning Standards (NJSLS)

HS-LS1-3: Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

HS-PS1-6: Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of product at equilibrium.

HS-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

HS-ETS1-4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
Asking Questions and Defining Problems - Ask questions that arise from analyzing data, evaluating evidence, and interpreting research findings to guide future investigations and engineering solutions. Developing and Using Models - Develop, revise, and use models and simulations to represent systems, explain observed phenomena, evaluate proposed solutions, and predict outcomes. Planning and Carrying Out Investigations - Evaluate and refine investigations based on the quality, reliability, and validity of collected data. Analyzing and Interpreting Data - Analyze and interpret data using statistical, graphical, and computational tools to identify patterns, evaluate evidence, and draw scientifically supported conclusions. Using Mathematics and Computational Thinking - Apply mathematical concepts, statistical analysis, and computational tools to evaluate evidence, model systems, analyze trends, and support scientific explanations. Constructing Explanations and Designing Solutions	LS1.B: Growth and Development of Organisms - Feedback mechanisms maintain homeostasis and regulate the internal environment of organisms. Investigations of biological systems provide evidence of how organisms respond to changing internal and external conditions. PS1.B: Chemical Reactions - Chemical processes can be optimized by changing reaction conditions to influence the amount of products formed at equilibrium. Scientific principles can be applied to improve the design and efficiency of chemical systems. ESS3.C: Human Impacts on Earth Systems - Scientists and engineers can make major contributions by developing technologies that reduce pollution, conserve natural resources, restore ecosystems, and minimize environmental degradation. ETS1.A: Defining and Delimiting Engineering Problems - Successful engineering solutions are developed by identifying criteria and constraints, including scientific, environmental, societal, and economic factors. ETS1.B: Developing Possible Solutions	Patterns - Patterns observed in data can be used to identify relationships, evaluate trends, support explanations, and generate new scientific questions. Cause and Effect - Empirical evidence is required to distinguish between cause and correlation and to evaluate scientific claims and engineering solutions. Scale, Proportion, and Quantity - Quantitative relationships, statistical analyses, and computational models provide evidence for understanding biological, chemical, environmental, and engineering systems across multiple scales. Systems and System Models - Models and simulations are used to represent complex biological, chemical, environmental, and engineered systems and to evaluate interactions among system components. Energy and Matter - Energy and matter flow through biological, chemical, and environmental systems and can be

- Construct evidence-based explanations using valid and reliable scientific data. - Evaluate, refine, and optimize proposed engineering solutions using scientific principles, modeling, and evidence. Engaging in Argument from Evidence - Critically evaluate scientific claims, competing explanations, and engineering solutions using empirical evidence and logical reasoning. - Defend conclusions and recommendations based on scientific evidence. Obtaining, Evaluating, and Communicating Information - Evaluate the credibility, accuracy, and limitations of scientific information from multiple sources. - Communicate scientific findings clearly and accurately through written reports, scientific presentations, posters, data visualizations, and digital media appropriate for technical and public audiences.	- Complex engineering problems can be broken into smaller, more manageable problems. Multiple solutions should be developed, tested, evaluated, and compared using scientific evidence and established design criteria. ETS1.C: Optimizing the Design Solution - Design solutions are continually refined through modeling, testing, evaluation, and optimization to improve performance while balancing trade-offs among competing criteria and constraints.	analyzed to explain system behavior and predict outcomes. Structure and Function - The structure of biological molecules, organisms, engineered systems, and technological designs influences the function, performance, and efficiency. Stability and Change - Stability and change within biological, chemical, environmental, and engineered systems can be explained through feedback mechanisms, environmental influences, and the continual refinement of scientific and engineering solutions.
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Essential Questions	Student Learning Objectives	Suggested Tasks/Activities	Evidence of Learning (Assessment)
How do we ensure that data collected in an investigation is valid and reliable?	Student will be able to:	Investigate and research the observable effects of a specific phenomena/ on	Check-in Conferences or Journals

- How do patterns in data help us draw meaningful conclusions? - What is the role of evidence in supporting or refuting a scientific claim? - How do ethical considerations influence scientific research? - How do scientists communicate their findings effectively? - How do we evaluate the effectiveness of a solution or prototype? - What trade-offs must be made in developing a successful design? - How can failure lead to innovation in engineering? - In what ways can engineering solutions impact society or the environment—for better or worse?	- Identify trends and patterns in their data. - Use graphs, tables, or statistical tools to support conclusions. - Compare data to hypotheses or expected outcomes. - Recognize sources of error or uncertainty. - Develop evidence-based explanations of their findings. - Justify their conclusions using data and scientific reasoning. - Use models or simulations to support claims. - Present their research clearly using appropriate formats (oral, written, visual, digital).	living organisms. (Review of images of phenomena and article analysis to analyze data). - Continue to discuss articles and case studies with peers to determine the relationship between the phenomena/variable and known mechanisms present in the case studies and articles as it relates to the data collected. - Regular lab check-ins and mentoring - Use graphs and statistics to represent and evaluate data. - Draw conclusions from data that addresses the question originally being asked. - Explain experimental processes and conclusions with other students and faculty. - Evaluate data and published literature to create follow up questions and experiments. Resources: Science Buddies has a plethora of tools to guide students through authentic science and engineering research investigations. The Terra STEM Fair has a site where students will submit their	- One-on-one or small group progress discussions, or regular entries in a lab notebook. (Assesses: Reflection, troubleshooting, metacognition, progress monitoring.) Peer or Self-Assessment - Guided rubrics to review each other's work or reflect on personal progress. (Assesses: Critical thinking, collaboration, self-awareness.) Summative Assessments (Final Products) - Written document with abstract, introduction, methods, data, results, and conclusion/design evaluation. (Assesses: Content understanding, scientific reasoning, writing, data literacy.) Data Analysis Submission - Raw data sets, graphs, calculations, and interpretation of results.
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		project proposals and research for analysis and feedback from local scientists and researchers.	(Assesses: Math skills, data visualization, critical analysis, understanding of experimental design.) Presentation or Poster at Science Fair/Symposium - Students communicate their findings orally and visually. (Assesses: Communication skills, argument from evidence, clarity of thinking, professionalism.) Visual Display (Tri-Fold Poster, Digital Slides, etc.) - Includes visuals like charts, images, models, and key info. (Assesses: Visual communication, synthesis of information, design thinking.) Q&A with Judges, Teachers, or Peers - On-the-spot defense of the project. (Assesses: Depth of understanding, confidence, reasoning)
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			under pressure.) Reflection-Based Assessments - Prompts might include: “What would you do differently?” “What challenges did you overcome?” “What did you learn about science/yourself?” (Assesses: Critical thinking, learning process insight, personal growth.) Feedback Response - Students revise or respond to feedback from others- judges or peers. (Assesses: Receptivity to feedback, iterative improvement, communication.) Resources: Science Buddies has a plethora of tools to guide students through authentic science and engineering research investigations and provide rubrics for teacher, peer and self evaluation.
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			The Terra STEM Fair has a site where students will submit their project proposals and research for analysis and feedback from local scientists and researchers. Students will also have the opportunity to resubmit their research with revisions based upon feedback.
Interdisciplinary Connections	<u>English Language Arts</u> • RI.CR.11–12.1 Accurately cite a range of thorough textual evidence and make relevant connections to strongly support a comprehensive analysis of multiple aspects of what an informational text says explicitly and inferentially, as well as interpretations of the text. • RI.MF.11–12.6 Synthesize complex information across multiple sources and formats to develop ideas, resolve conflicting information, or develop an interpretation that goes beyond explicit text information (e.g., express a personal point of view, new interpretation of the concept). • W.IW.11–12.2 Write informative/explanatory texts (including the narration of historical events, scientific procedures/experiments, or technical processes) to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. • W.WR.11–12.5 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. • SL.PI.11–12.4 Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience. <u>Mathematics</u> • MP.2 Reason abstractly and quantitatively. • MP.4 Model with mathematics. • MP.5 Use appropriate tools strategically. • HS.S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots). • HS.S-ID.6 Use statistics appropriate to the shape of the data distribution to compare center and spread of two or more different data sets and interpret differences in context.		
Career Readiness, Life Literacies, and Key Skills	• 9.2.12.CAP.4 Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them including educational training requirements, costs, loans, and debt repayment.		

	● 9.2.12.CAP.7 Use online resources to examine licensing, certification, and credentialing requirements at the local, state, and national levels to maintain compliance with industry requirements in areas of career interest. ● 9.4.12.CI.1 Demonstrate the ability to reflect, analyze, and use creative skills and ideas. ● 9.4.12.CT.2 Develop multiple solutions to a problem and evaluate which is the most effective. ● 9.4.12.IML.5 Evaluate, synthesize, and apply information on the ethical and legal use of technology. ● 9.4.12.IML.6 Use information from multiple sources to analyze a real-world problem and propose a solution.			
Computer Science and Design Thinking	● 8.1.12.DA.5 Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. ● 8.1.12.DA.6 Create and refine computational models to better represent relationships among different elements of data collected from a phenomenon or process. ● 8.1.12.CS.1 Plan and develop computational solutions that use appropriate algorithms, data structures, and abstractions to solve complex problems. ● 8.2.12.ED.1 Apply a design thinking process to identify a real-world problem, generate possible solutions, test ideas, and refine the solution based on feedback.			
Modifications				
Multi-Lingual Learners	Students with Special Needs	At-Risk	Gifted and Talented	
● Provide diagrams, flowcharts, and labeled images of experimental setups. ● Use graphic organizers (e.g., cause/effect charts, hypothesis vs. results tables) to help organize ideas. ● Visuals help bridge language gaps and clarify abstract concepts. ● Break down complex instructions into smaller, manageable steps. ● Use sentence frames or starters (e.g., “I predict that...”, “The data shows...”). ● Provide bilingual glossaries or translated materials if possible. ● Emphasize “learning by doing” through experiments, models, and simulations. ● Use videos, animations, and interactive tools to demonstrate scientific processes.	● Break down experiments into smaller, clear steps. ● Use simple, direct language paired with visuals or demonstrations. ● Provide written and verbal instructions. ● Use checklists or task cards to guide progress. ● Offer hands-on materials or tactile models for students with sensory needs. ● Use videos or simulations as alternatives to physical experiments. ● Give extended time for completing experiments and data recording. ● Allow breaks during longer tasks. ● Provide opportunities to repeat steps or practice skills. ● Incorporate pictures, diagrams, flowcharts, and labeled tools.	● Foster a positive classroom culture where mistakes are valued as learning. ● Connect lessons to students’ interests, backgrounds, and real-life experiences. ● Provide consistent encouragement and recognize effort. ● Offer choices in topics, formats, or group/individual work. ● Use small groups or peer mentoring to build skills and confidence. ● Teach and model effective teamwork and communication skills. ● Highlight how scientific skills relate to jobs and daily life. ● Invite guest speakers or organize field trips to increase motivation. ● Offer after-school tutoring.	● Challenge students to design multi-variable experiments or novel bioinformatics pipelines. ● Assign tasks requiring critical evaluation of conflicting data or ethical implications. ● Support participation in science fairs, competitions, or publication of findings. ● Connect students with mentors or scientists in the field. ● Explore ethical, social, or philosophical questions raised by genetic data. ● Link bioinformatics to fields like computer science, math modeling, or health sciences.	

		study sessions, or access to resource centers. Encourage use of school counseling or mentoring programs to address socio-emotional needs.	
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Professional Learning Course Resources

- 2026 New Jersey Student Learning Standards for Science – <https://www.nj.gov/education/standards/science/>
- New Jersey Student Learning Standards (All Content Areas) – <https://www.nj.gov/education/standards/>
- New Jersey Department of Education Climate Change Resources – <https://www.nj.gov/education/climate/>
- Rutgers Waksman Student Scholars Program – <https://wssp.rutgers.edu/>
- Rutgers Waksman Student Scholars Program Resources – <https://wssp.rutgers.edu/resources/>
- Rutgers Waksman Student Scholars Program Lecture Notes – <https://wssp.rutgers.edu/lecture-notes-students-2024>
- Rutgers Waksman Student Scholars Program DNA Sequence Analysis Program (DSAP) – <https://benzer.rutgers.edu/DSAP/>
- Terra STEM Fair – <https://terrasciencefair.org/>
- Science Buddies – <https://www.sciencebuddies.org/>
- Society for Science – <https://www.societyforscience.org/>
- American Society for Microbiology (ASM) – <https://asm.org/>
- National Center for Biotechnology Information (NCBI) – <https://www.ncbi.nlm.nih.gov/>
- NCBI Gene Database – <https://www.ncbi.nlm.nih.gov/gene>
- NCBI BLAST – <https://blast.ncbi.nlm.nih.gov/>
- NCBI GenBank – <https://www.ncbi.nlm.nih.gov/genbank/>
- NCBI Genome Data Viewer – <https://www.ncbi.nlm.nih.gov/genome/gdv/>
- NCBI Sequence Read Archive – <https://www.ncbi.nlm.nih.gov/sra>
- PubMed – <https://pubmed.ncbi.nlm.nih.gov/>
- National Library of Medicine – <https://www.nlm.nih.gov/>
- National Institutes of Health – <https://www.nih.gov/>
- National Human Genome Research Institute – <https://www.genome.gov/>
- MedlinePlus Genetics – <https://medlineplus.gov/genetics/>
- DNA Learning Center (Cold Spring Harbor Laboratory) – <https://dnlc.cshl.edu/>
- HHMI BioInteractive – <https://www.biointeractive.org/>
- BioInteractive Virtual Labs – <https://www.biointeractive.org/classroom-resources>
- University of Utah Learn.Genetics – <https://learn.genetics.utah.edu/>
- European Bioinformatics Institute (EMBL-EBI) – <https://www.ebi.ac.uk/>
- UniProt Protein Knowledgebase – <https://www.uniprot.org/>
- Protein Data Bank (RCSB PDB) – <https://www.rcsb.org/>
- DNA Subway (CyVerse) – <https://dnasubway.cyverse.org/>
- DNA from the Beginning – <https://www.dnafb.org/>
- Google Scholar – <https://scholar.google.com/>
- Nature Education Scitable – <https://www.nature.com/scitable/>

- National Center for Case Study Teaching in Science – <https://sciencecases.lib.buffalo.edu/>
- OpenStax Biology 2e – <https://openstax.org/details/books/biology-2e>
- Khan Academy Biology – <https://www.khanacademy.org/science/biology>
- ExploreLearning Gizmos – <https://www.explorelearning.com/>
- Centers for Disease Control and Prevention (CDC) – <https://www.cdc.gov/>
- World Health Organization (WHO) – <https://www.who.int/>
- United States Department of Agriculture (USDA) Agricultural Research Service – <https://www.ars.usda.gov/>
- The Arabidopsis Information Resource (TAIR) – <https://www.arabidopsis.org/>
- Duckweed Forum – <https://www.ruduckweed.org/>
- U.S. Environmental Protection Agency (EPA) – <https://www.epa.gov/>
- Our World in Data – <https://ourworldindata.org/>
- National Science Teaching Association (NSTA) – <https://www.nsta.org/>
- U.S. Bureau of Labor Statistics Occupational Outlook Handbook – <https://www.bls.gov/ooh/>
- O*NET OnLine – <https://www.onetonline.org/>
- CareerOneStop – <https://www.careeronestop.org/>
- ExploreHealthCareers.org – <https://explorehealthcareers.org/>
- New Jersey Career Assistance Navigator (NJCAN) – <https://portal.njcis.intocareers.org/>
- New Jersey Department of Labor and Workforce Development – <https://www.nj.gov/labor/>