ROBBINSVILLE PUBLIC SCHOOLS

OFFICE OF CURRICULUM AND INSTRUCTION

Science Department

Research in Molecular Biology

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BOARD OF EDUCATION INITIAL ADOPTION DATE:

Course Philosophy

Every individual will develop the appropriate techniques and methodology of scientific investigation to collect and evaluate data in molecular biology. Students will be able to employ these skills with their knowledge of experimental design to create solutions and solve real-world biological problems. Every student will be able to apply the fundamental principles of biology to current bioethical issues and be prepared to make responsible decisions concerning these social issues.

Course Description

Grade: 11-12
5 Credits Year
*Prerequisite/Co-requisite: Honors Biology
NOTE: This class will have approximately 24 seats available. Students must go through application and interview process to be selected for this class.

Students will read relevant and appropriate scientific literature. Students will develop and refine lab techniques such as cloning, PCR, gel electrophoresis, and restriction enzyme digests. Research skills will include but not limited to micro pipetting, transformation, isolating DNA, ELISA assay, blotting techniques, micro assay, immunoglobulin assay, and testing for GMOS. In addition, students will learn how to utilize bioinformatics to analyze data.

Integration of 21st Century Themes and Skills

Educational Technology
Standards: 8.1.12.F.1, 8.1.12.E.1
• **8.1.12.F.1 Education Technology and Critical Thinking:** Students use technology to plan and manage activities to develop a solution or complete a project. For example, students will collaborate on google sheets to share class data and documents to complete formal lab reports on a regular basis. Specifically, students will use this technology to complete their poster presentation at the completion of their lab series for their independent research project. • **8.1.12.E.1 Educational Technology and Research:** Students will locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media. For example, students will use a variety of digital resources to compile evidence to support their bioethics research papers. Students will evaluate sources for reliability, bias, and credibility.

Career Ready Practices

Standards: CRP4, CRP12

- **CRP4-** Communicate clearly and effectively and with reason. Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.
  Example: Students will demonstrate effective communication at the end of each lab when they discuss problems and scientific errors associated with the lab. Students will collaborate about ways to improve their practices. Additionally, at the end of the Independent Research Unit, students will prepare a professional science presentation to communicate the results of their work to members of the school community. Students will have the opportunity to improve their presentation skills with peer feedback and personal reflection practices.

- **CRP12**- Work productively in teams while using cultural global competence. Career-ready individuals positively contribute to every team, whether formal or informal. They apply an awareness of cultural difference to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings.
  Example: Students will work in strategic groups throughout the year to develop and demonstrate leadership in the Research Classroom. Groups will consist of Juniors, Seniors, and Advanced Senior Students. As the year progresses, younger students take charge of the groups to demonstrate the skills they have learned as they prepare to continue on in Research for their second year of practice. Futhermore, each group member is responsible for contributing to the success of every experiment. Group members must learn to support each other and work together effectively to complete lab assignments while under typical classroom time constraints.

Robbinsville Ready 21st Century Skill Integration

The following skills will be embedded throughout the curriculum and instruction of this course.

Collaborative Team Member: Robbinsville students will learn more by working together than in isolation. As educational theorist Lev Vygotsky advocated, learning is a social process. Many workplaces today encourage employees to work in teams to solicit diverse perspectives, brainstorm new

ideas and/or products, and solve problems. Further, collaboration fosters interpersonal relationships, self-management skills, cooperation, and a sense of collective responsibility. Collaborative team members are able to work with diverse groups of people who hold a variety of perspectives.

Effective Communicator: Robbinsville students must be able to clearly articulate their ideas orally, in writing, and across various media in order to successfully connect to the world around them. As the world becomes increasingly globalized, communication is more than just sharing one's ideas. Effective communicators are able to communicate their convictions, actively listen and analyze others' work to identify perspective and/or potential bias.

Emotionally Intelligent Learner: Robbinsville students who are emotionally intelligent learn to be empathetic, demonstrate integrity and ethical behavior, are kind, are self-aware, willing to change, and practice self-care. They are better able to cope with the demands of the 21st century digital society and workplace because they are reliable, responsible, form stable and healthy relationships, and seek to grow personally and professionally. Emotionally intelligent people are able to manage their emotions, work effectively on teams and are leaders who can grow and help to develop others.

Informed and Involved Citizen: Robbinsville students need to be digital citizens who are civically and globally aware. The concept of what it means to be "literate" has evolved along with 21st century technological and cultural shifts. Our progressive vision of literacy entails having our students explore real world problems in the classroom. Informed and involved citizens are able to safely and accurately communicate with people all around the world and are financially, environmentally and informationally literate.

Innovative Thinker: Robbinsville students must encompass innovative thinking skills in order be successful lifelong learners in the 21st century world. As stated by Karl Fisch and Scott McLeod in the short film Shift Happens, "We are currently preparing students for jobs that don't yet exist . . . using technologies that haven't been invented . . . in order to solve problems we don't even know are problems yet." Innovative thinkers are able to think analytically, solve problems critically, creatively engage in curiosity and tinkering, and demonstrate originality.

Resilient and Self-Directed Learner: Robbinsville students need to take risks and ultimately make independent and informed decisions in an ever-changing world. Author of Life, the Truth, and Being Free, Steve Maraboli stated, "Life doesn't get easier or more forgiving, we get stronger and more resilient." Self-directed scholars of the 21st century are able to set goals, initiate resolutions by seeking creative approaches, and adjust their thinking in light of difficult situations. Resilient students are able to take risks without fear of failure and overcome setbacks by utilizing experiences to confront new challenges. Resilient and self directed scholars will consistently embrace opportunities to initiate solutions and overcome obstacles.

Interdisciplinary Connections

CCSS.ELA-LITERACY.WHST.11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. Students practice writing informative/explanatory texts including scientific procedures, experiments, and technical processes throughout the year.

CCSS.ELA-LITERACY.RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. Students ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. Students expand their knowledge of molecular biology to understand the intricate processes of the central dogma including the unity and diversity of the genetic code with all of its possible applications.

CCSS.MATH.CONTENT.HSS.ID.A.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve. Students will summarize, represent, and interpret qualitative and quantitative data from labs on a regular basis. Students will analyze their data to determine if their results match with the current trends and expected spread of data. Specifically, in the Ecology Unit, students look at variables that effect the rate of enzyme reactions in BioFuels.

General Differentiated Instruction Strategies

- Leveled texts
- Chunking texts
- Choice board
- Socratic Seminar
- Tiered Instruction
- Small group instruction
- Guided Reading
- Sentence starters/frames
- Writing scaffolds
- Tangible items/pictures
- Adjust length of assignment
- Repeat, reword directions
- Brain breaks and movement breaks
- Brief and concrete directions
- Checklists for tasks
- Graphic organizers
- Assistive technology (spell check, voice to type)
- Study guides
- Tiered learning stations
- Tiered questioning
- Data-driven student partnerships
- Extra time

Possible Additional Strategies for Special Education Students, At-Risk Students, and English Language Learners (ELLs)

Time/General	Processing	Comprehension	Recall
• Extra time for assigned tasks • Adjust length of assignment • Timeline with due dates for reports and projects • Communication system between home and school • Provide lecture notes/outline	• Extra Response time • Have students verbalize steps • Repeat, clarify or reword directions • Mini-breaks between tasks • Provide a warning for transitions • Reading partners	• Precise step-by-step directions • Short manageable tasks • Brief and concrete directions • Provide immediate feedback • Small group instruction • Emphasize multi-sensory learning	• Teacher-made checklist • Use visual graphic organizers • Reference resources to promote independence • Visual and verbal reminders • Graphic organizers
Assistive Technology	**Assessments and Grading**	**Behavior/Attention**	**Organization**
• Computer/whiteboard • Tape recorder • Spell-checker • Audio-taped books	• Extended time • Study guides • Shortened tests • Read directions aloud	• Consistent daily structured routine • Simple and clear classroom rules • Frequent feedback	• Individual daily planner • Display a written agenda • Note-taking assistance • Color code materials

Enrichment

The goal of Enrichment is to provide learners with the opportunity to participate in extension activities that are differentiated and enhance the curriculum. All enrichment decisions will be based upon individual student needs.

- Show a high degree of intellectual, creative and/or artistic ability and demonstrate this ability in multiple ways.
- Pose questions and exhibit sincere curiosity about principles and how things work.
- The ability to grasp concepts and make real world and cross-curricular connections.

- Generate theories and hypotheses and pursue methods of inquiry.
- Produce products that express insight, creativity, and excellence.
- Possess exceptional leadership skills.
- Evaluate vocabulary
- Elevate Text Complexity
- Inquiry based assignments and projects
- Independent student options
- Tiered/Multi-level activities
- Purposeful Learning Center
- Open-ended activities and projects
- Form and build on learning communities
- Providing pupils with experiences outside the 'regular' curriculum
- Altering the pace the student uses to cover regular curriculum in order to explore topics of interest in greater depth/breadth within their own grade level
- A higher quality of work than the norm for the given age group.
- The promotion of a higher level of thinking and making connections.
- The inclusion of additional subject areas and/or activities (cross-curricular).
- Using supplementary materials in addition to the normal range of resources.

Robbinsville Public Schools

Curriculum Map
Research in Molecular Biology

Relevant Standards	Standards Unpacked Skill / Concept / Process?	Enduring Understandings / Unit Goals/Objectives	Essential Questions	Unit Title / Suggested Timeline
AP Biology 3.A.1 DNA, and in some cases RNA, is the primary source of heritable information.	3.A.1.a Genetic information is transmitted from one generation to the next through DNA or RNA. 3.A.1.b DNA and RNA have structural similarities and differences that define function.	Students construct an explanation using models that demonstrate the unique structure and function of a DNA molecule. Students relate the importance of the genetic code across all domains of life. Students recognize that heritable information provides for the continuity of life.	How do living systems store, retrieve, and transmit genetic information critical to life processes?	**Unit 1: DNA Structure and Function (2 weeks)**
AP Biology 3.A.2 Heritable information is passed to the next generation via processes that include the cell cycle and mitosis or meiosis plus fertilization.	3.A.2.a The cell cycle is a complex set of stages that is highly regulated with checkpoints (both internal and external), which determine the ultimate fate of the cell.	LO 3.9 The student is able to construct an explanation, using visual representations and narratives, as to how DNA in chromosomes is transmitted to the next generation of cells via mitosis, specifically describing the steps of DNA Replication. [SP 6.2]	How do living systems store, retrieve, and transmit genetic information critical to life processes?	**Unit 2: DNA Replication (1 week)**
AP Biology 3.A.1 DNA, and in some cases RNA, is the primary source of heritable information.	3.A.1.c Genetic information flows from nucleotide sequences in a gene to a sequence of amino acids in a protein.	Students will be able to explain the process of the central dogma of molecular biology. Specifically, students will be able to describe how DNA codes for proteins and the role of proteins in biology.	How does the expression of genetic material control cell products which, in turn, determine the metabolism and nature of the cell?	**Unit 3: Protein Synthesis (2 weeks)**

	3.A.1.d Phenotypes are determined through protein activities.			
AP Biology 3.B Expression of genetic information involves cellular and molecular mechanisms.	3.B.1 Gene regulation results in differential gene expression, leading to cell specialization [3.B.1.a - 3.B.1.d]. 4.A.3 Interactions between external stimuli and regulated gene expression result in specialized cells, tissues, and organs. 3.C.1.a Alterations in a DNA sequence can lead to changes in the type or amount of the protein produced and the consequent phenotype.	LO 3.18 The student is able to describe the connection between the regulation of gene expression and observed differences between different kinds of organisms [SP 7.1] in both prokaryotic and eukaryotic organisms. LO 3.21 The student can use representations and models to describe how gene regulation influences cell products and function. [SP 1.4] LO 3.23 The student can use representations and models to describe the mechanisms of the regulation of gene expression. [SP 1.4] LO 4.7 The student is able to refine models to illustrate how interactions between external stimuli and gene expression result in specializaiton. [SP 1.3] LO 2.33 The student is able to justify scientific claims with scientific evidence to show that timing and coordination of several events are necessary for normal development in an organism and that these events are regulated by multiple mechanisms. [See SP 6.1] IE Cancer	How does the expression of genetic material control cell products which, in turn, determine the metabolism and nature of the cell?	**Unit 4: Gene Regulation (4 weeks)**

AP Biology 3.A.1 DNA, and in some cases RNA, is the primary source of heritable information	3.A.1.e Genetic Engineering techniques can manipulate the heritable information of DNA and RNA.	Illustrative examples of GE products to foster in the understanding of this concept include: GMOs, Transgenic Animals, Cloned Animals, and Phamaceuticals such as insulin Mastery of skills include: Electrophoresis, Plasmid-based transformation, Restriction enzyme analysis of DNA, Polymerase Chain Reactions (PCR)	How can humans use genetic engineering techniques to manipulate genetic information?	**Unit 5: BioTechnology (3 weeks)**
NGSS Science and Engineering Practices SP 6-8	SP 6: Developing explanation and designing solutions. SP 7: Engaging in arguments using evidence. SP 8: Obtaining, evaluating, and communicating results.	Recognize the interrelationship among science, society, and ethical considerations. Recognize the importance of scientific knowledge in bioethical decision making. Develop critical-reasoning skills, especially the ability to justify an ethical position. Enhance respectful dialogue among individuals with diverse perspectives.	What are ethical issues raised by the application of genetic engineering techniques?	**Unit 6: BioEthics (2 weeks)**
NGSS Science and Engineering Practices SP 4-5	SP 4: Analyzing and interpreting data. SP 5: Using mathematics and computational thinking.	The student is able to analyze data to identify molecular structure and subsequent function for example, protein folding. The student is able to combine biological concepts with computer programming to collate information.	How can we use our knowledge of the universal genetic code to analyze results and promote discussions and theories?	**Unit 7: BioInformatics (2 weeks)**
NGSS Science and Engineering Practices SP 4-8	SP 4: Analyzing and interpreting data. SP 5: Using mathematics and computational thinking.	The students will be able to apply the skills developed throughout the first half of the year to complete a multi-step independent study.	How can we use our knowledge of molecular biology to collect and analyze data to further develop and enhance our scientific theories?	**Unit 8: Independent Research (10-12 Weeks)**

	SP 6: Developing explanation and designing solutions. SP 7: Engaging in arguments using evidence. SP 8: Obtaining, evaluating, and communicating results.			
AP Biology 3.C.1 Changes in genotype can result in changes in phenotype. **1.C.3.b Scientific evidence supports the idea that evolution continues to occur.**	3.C.1.d Changes in genotype may affect phenotypes that are subject to natural selection and may result in enhanced survival and reproduction. 3.C.3 Viral replication results in genetic variation and infection can introduce genetic variation into the hosts.	LO 3.24 The student is able to predict how a change in genotype, when expressed as a phenotype, provides a variation that can be subject to natural selection. [SP 6.4, 7.2] IE Antibiotic Resistance LO 3.29 The student is able to construct an explanation of how viruses introduce genetic variation in host organisms. [SP 6.2] IE Bacteriophage	How is the homeostasis of a biological system influenced by the system's environment? What do bacteria and viruses need to make us sick? Why aren't we always sick? How do infectious diseases spread and what can communities do to prevent it?	**Unit 9: Infectious Disease (4 Weeks)**
AP Biology 1.A.2.d Humans impact variations in other species. **1.C.3.b Scientific evidence supports the idea that evolution continues to occur.**	LO 1.10 The student is able to evaluate and refine evidence based on data that support biological artificial-selected evolution. [See SP 5.2] LO 1.22 The student is able to use data from a real or simulated population(s) to predict what will happen to the population in the future. [See SP 6.4]	Environmental Biotechnology is used to study the natural environment. In this field of study, technology is used to harness biological processes for commercial uses such as renewable resources, food, and biological remediation. Students will examine the intricate balance between the applications of genetics with the conservation of our natural resources.	How does human activity affect the biodiversity of ecosystems? How can humans analyze the biodiversity of an ecosystem? How do humans extract energy from biological organisms for practical purposes?	**Unit 10: Environmental Biotechnology (4 Weeks)**

Robbinsville Public Schools

Scope, Sequence, Pacing and Assessment

Research in Molecular Biology

Unit Title	Unit Understandings and Goals	Recommended Duration/ Pacing	Benchmark Assessments		
			Diagnostic (before)	Formative (during)	Summative (after)
DNA Structure and Function	Students construct an explanation using models that demonstrate the unique structure and function of a DNA molecule. Students relate the importance of the genetic code across all domains of life. Students recognize that heritable information provides for the continuity of life.	**2 Weeks**	Summer Assignment: Background Readings and Videos on DNA Structure and Function	Class Discussions, Questioning, Graphic Organizers, Visual Models, Inquiry Based Labs	Formal Uit Assesment on Background Topics 1-3
DNA Replication	Students are able to construct an explanation, using visual representations and narratives, as to how DNA in chromosomes is transmitted to the next generation of cells via mitosis, specifically describing the steps of DNA Replication. [LO 3.9][SP 6.2]	**1 Weeks**	Pre-Unit Self Assessment, Do Now WarmUps	Class Discussions, Questioning, Graphic Organizers, Constructive Quizzess, Visual Models, Inquiry Based Labs	Formal Uit Assesment on Background Topics 1-3
Protein Synthesis	Students will be able to explain the process of the central dogma of molecular biology. Specifically, students will be able to describe how DNA codes for proteins and the role of proteins in biology.	**2 Weeks**	Pre-Unit Self Assessment, Do Now WarmUps	Class Discussions, Questioning, Graphic Organizers, Think-Pair-Share, Visual Models, Peer/Self Assessment,	Formal Uit Assesment on Background Topics 1-3

				Inquiry Based Labs	
Gene Regulation	Students will be able to describe the connection between the regulation of gene expression and observed differences between different kinds of organisms. [SP 7.1] [LO 3.18] Students can use representations and models to describe how gene regulation influences cell products and function. [SP 1.4][LO 3.21] Students can use representations and models to describe the mechanisms of the regulation of gene expression. [SP 1.4][LO 3.23] Students will be able to refine models to illustrate how interactions between external stimuli and gene expression result in specializaiton. [SP 1.3][LO 4.7] Students will be able to justify scientific claims with scientific evidence to show that timing and coordination of several events are necessary for normal development in an organism and that these events are regulated by multiple mechanisms. [See SP 6.1] [LO 2.33]	**4 Weeks**	Brain Dump and Brainstorming, Pair Share, Do Now Warm-ups	Peer Teaching, Poster and/or Whiteboard Presentations, Discussions, Visual Models, Inquiry Based Labs	Formal Lab Report, MultiMedia Presentation with Rubric, PBL
BioTechnology	Examine and Explain illustrative examples of GE products to foster in the understanding of this concept include: GMOs, Transgenic Animals, Cloned Animals, and Phamaceuticals such as insulin Mastery of lab skills include: Electrophoresis, Plasmid-based transformation, Restriction	**3 Weeks**	Pre-Lab Quizzess, Brainstorming	Inquiry Based Lab Participation	Formal Lab Reports, PBL

	enzyme analysis of DNA, Polymerase Chain Reactions (PCR)				
BioEthics	Recognize the interrelationship among science, society, and ethical considerations. Recognize the importance of scientific knowledge in bioethical decision making. Develop critical-reasoning skills, especially the ability to justify an ethical position. Enhance respectful dialogue among individuals with diverse perspectives.	**2 Weeks**	KWL Chart, Class Discussion, Student Survey	Class Discussions and Debate to evaluate the quality of the justifications provided for their choice on an ethical topic based on sound/reliable evidence.	Writing Assignment with Rubric, Case Study Analysis
BioInformatics	The student is able to analyze data using online software to identify molecular structure and subsequent function for example, protein folding. The student is able to combine biological concepts with computer programming to collate information.	**2 Weeks**	Pre-Unit Self Assessment	Online Tutorials, Class Discussions, CheckIns by Teacher Appointment	3D Protein Model Using Online Imaging Software, PBL, Case Study Data Analysis
Independent Study	The students will be able to apply the skills developed throughout the first half of the year to complete a multi-step independent study.	**8-10 Weeks**	Pre-Lab Quizzes, Brainstorming	TA Group Checklists, Analysis/ Discussion Questions, Peer Whiteboard Reflections	Post-Lab Quizzes, PBL, Peer Poster Presentation Session

Infectious Disease	LO 2.33 The student is able to justify scientific claims with scientific evidence to show that timing and coordination of several events are necessary for normal development of an organism and that these events are regulated by multiple mechanisms. Students can make predictions about effect of mutated checkpoints on cellular division processes. [See SP 6.1] IE Cancer. LO 3.24 The student is able to predict how a change in genotype, when expressed as a phenotype, provides a variation that can be subject to natural selection. [SP 6.4, 7.2] IE Antibiotic Resistance. LO 3.29 The student is able to construct an explanation of how viruses introduce genetic variation in host organisms. [SP 6.2] IE Bacteriophage.	**4 Weeks**	Pre-Lab Quizzes, Student Survey	Guided Inquiry Labs, Collaborative Group Work	Formal Lab Report, Writing Assignment with Rubric
Environmental Biotechnology	Environmental Biotechnology is used to study the natural environment. In this field of study, technology is used to harness biological processes for commercial uses such as renewable resources, food, and biological remediation. Students will examine the intricate balance between the applications of genetics with the conservation of our natural resources. LO 1.10 Students will evaluate and refine evidence based on data that support biological artificial-selected evolution and changes to biodiversity. [See SP 5.2]	**4 Weeks**	Pre-Lab Quizzes, Student Survey	Guided Inquiry Labs, Collaborative Group Work, Extension Questions, Class Discussions	Formal Lab Report, PBL, Peer Presentations

	LO 1.22 Students will use data from a real or simulated population(s) to predict what will happen to the population in the future. [See SP 6.4]				

Robbinsville Public Schools

Unit # 1: DNA Structure and Function

Enduring Understandings:	**Essential Questions:**
Students construct an explanation using models that demonstrate the unique structure and function of a DNA molecule. Students relate the importance of the genetic code across all domains of life. Students recognize that heritable information provides for the continuity of life.	How do living systems store, retrieve, and transmit genetic information critical to life processes?

Guiding / Topical Questions with Specific Standards		**Content, Themes, Concepts, and Skills**	**Teaching Strategies**	**Instructional Resources and Materials**	**Assessment Strategies**
3.A.1	How is the hereditary information in genes inherited and expressed? How does DNA control growth and function of cells?	Students will compare the structural components of DNA and RNA. Students will explain that genetic information is transmitted from one generation to the next through DNA or RNA.	Guided Notes, Direct Instruction, Small Cooperative Groups, Video Guides, Discussion	Powerpoint, AP Biology Campbell Textbook, Online Videos	Graphic Organizers, Discussion, Questioning, Unit Assessment
3.A.1, SP1	How is structure related to function at all biological levels of organization?	Students will compare the structural components of DNA and RNA. Students will explain that genetic information is transmitted from one generation to the next through DNA or RNA.	DNA Model Building	Model Kit	Discussion, Visual Models, Informal Q/A
3.A.1 , SP 3, SP 4	How is structure related to function at all biological levels of organization?	Students will practice sterile technique to remove DNA from various types of cells. Students will learn how to extract DNA using proper tools and techniques.	DNA Extraction Lab/Skills	Ethanol, Banana/Strawberry or Cheek Cell, Lysis Solution	Pre and Post Lab Assessment, Inquiry Based Lab, Analysis Questions

Robbinsville Public Schools

Unit # 2: DNA Replication

Enduring Understandings:	**Essential Questions:**
Students are able to construct an explanation, using visual representations and narratives, as to how DNA in chromosomes is transmitted to the next generation of cells via mitosis, specifically describing the steps of DNA Replication. [LO 3.9][SP 6.2]	How do living systems store, retrieve, and transmit genetic information critical to life processes?

Guiding / Topical Questions with Specific Standards		**Content, Themes, Concepts, and Skills**	**Teaching Strategies**	**Instructional Resources and Materials**	**Assessment Strategies**
3.A.2	How is the hereditary information in genes inherited and expressed?	Students will be able to explain the complex set of highly regulated stages with checkpoints (both internal and external), which determine the ultimate fate of the cell.	Guided Notes, Direct Instruction, Small Cooperative Groups, Video Guides, Discussion	Powerpoint, AP Biology Campbell Textbook, Online Videos (TedEd Talk: Telomeres, Bozeman, CrashCours)	Class Discussions, Questioning, Graphic Organizers, Visual Models, Inquiry Based Labs, Unit Assessment
3.A.2, SP 1	How is the hereditary information in genes inherited and expressed?	Students will create visual models and diagrams to demonstrate the process of DNA Replication in Eukaryotic and Prokaryotic cells.	DNA Replication Modeling/Posters	Paper/Pencil Lab	Activity Analysis Questions, Unit Assessment

Robbinsville Public Schools

Unit # 3: Protein Synthesis

Enduring Understandings:.	**Essential Questions:**
Students will be able to explain the process of the central dogma of molecular biology. Specifically, students will be able to describe how DNA codes for proteins and the role of proteins in biology.	How does the expression of genetic material control cell products which, in turn, determine the metabolism and nature of the cell?

Guiding / Topical Questions with Specific Standards		**Content, Themes, Concepts, and Skills**	**Teaching Strategies**	**Instructional Resources and Materials**	**Assessment Strategies**
3.A.1, SP 1	How is the hereditary information in genes inherited and expressed? How does DNA control growth and function of cells?	Students will describe how genetic information flows from nucleotide sequences in a gene to a sequence of amino acids in a protein. Students will describe how the phenotype of an individual is determined through protein activities.	Protein Modeling or Protein Folding Activity to envision the process of protein synthesis including transcription, post-transcriptional processing, translation, and the effect of mutations.	Element Model Kit, Practice Worksheets, AP Biology Campbell Textbook	Discussion, Informal Q/A, Questioning, Graphic Organizers, Think-Pair-Share, Visual Models
3.A.1, SP 4-7	How is the hereditary information in genes inherited and expressed? How does DNA control growth and function of cells?	Students will measure protein concentrations, practice Beer's law, learn to use a spectrophotometer, and learn to use a micropipet.	Got Protein: Inquiry Based Lab that introduces proteomics & provides the tools to develop protein-based experiments.	(Yr 2) Got Protein? BioRad Kit	Formal Lab Report

Robbinsville Public Schools

Unit # 4: Gene Regulation

Enduring Understandings:	**Essential Questions:**
Expression of genetic information involves cellular and molecular mechanisms. Gene regulation results in differential gene expression, leading to cell specialization. Interactions between external stimuli and regulated gene expression result in specialized cells, tissues, and organs.	How does the expression of genetic material control cell products which, in turn, determine the metabolism and nature of the cell?

Duration of Unit: 4 weeks

Guiding / Topical Questions with Specific Standards		**Content, Themes, Concepts, and Skills**	**Teaching Strategies**	**Instructional Resources and Materials**	**Assessment Strategies**
LO 3.21, SP 1.4	How does gene regulation influence cell products and function?	Students will present a specific type of gene regulation (in either prokaryotes or eukaryotes) to the class. Students will be able to explain different modes of gene regulation at various stages of protein synthesis in an organism.	Peer Teaching and Presentations	Powerpoint, Whiteboard, AP Biology Campbell Textbook	Collaborative Group Work, MultiMedia Presentation with Rubric, PBL
LO 4.7, SP 1.3	How do the interactions between external stimuli and gene expression result in specializaiton?	Students will examine a model organism and discuss criteria for model organisms. Students will induce a mutation into the model organism to modify gene expression. Students will observe the effect of mutations on phenotype. Students will enhance their microscopy skills and sterile technique protocol.	RNAi Silencing Gene Expression in C. Elegans	(Yr 1) RNAi Silencing Gene Expression in C. Elegans - Carolina Kit	Formal Lab Report
LO 3.18, SP 7.1	What is the connection between the regulation of gene expression and observed differences	Students model how scientists use DNA microarrays to determine levels of gene expression in breast cancer patients, and then choose treatments based on what they learn.	MicroArray and Cancer: Ghost in Your Genes	(Yr 1) Acids, Bases, Buffers, Well Plate, Pipettes, Phenolphthalein	Discussion and Analysis Questions, Lab Participation

	between different kinds of organisms?	Students will be able to define important terminology. Students will be able to describe how microarrays are used to determine gene expression. Students will be able to explain how understanding gene expression can lead to improved treatments for disease such as cancer.			
SP 6.1, LO 2.33	How does the loss of regulation for timing and coordination of the cell cycle lead to cancer?	This microarray introduces students to the complexities of gene expression and the role of gene expression in cancer. Students will compare the relative expression levels of 6 different genes in healthy lung cells and lung cancer cells. Students will discuss the significance of the relative expression levels with respect to the genes' roles in causing cancer.	DNA Chips - MicroArray	(Yr 2) Carolina Kit	Discussion and Analysis Questions, Lab Participation
LO 3.23, SP 1.4	What are the mechanisms for the regulation of gene expression?	Students will be able to clone promoters into plasmids followed by an E.Coli transformation on Amp-R plates. Competent colonies will take up the promoters successfully. Finally, students will use ImageJ Online Software for scientific image analysis.	Inquiry-Based Lab: pClone Exploring Promoters Kit	(Yr 2) pClone Exploring Promoters Kit by Carolina	Formal Lab Report

Unit # 5: Biotechnology

Enduring Understandings:	**Essential Questions:**
Genetic Engineering techniques can manipulate the heritable information of DNA and RNA due to the universality of its structure and function among living organisms.	How can humans use genetic engineering techniques to manipulate genetic information? How has our knowledge of genetics changed society?

Guiding / Topical Questions with Specific Standards		**Content, Themes, Concepts, and Skills**	**Teaching Strategies**	**Instructional Resources and Materials**	**Assessment Strategies**
3.A.1.e SP 4&5	How can we seperate DNA segments for analysis?	Students will use gel electrophoresis techniques to separate varying sizes of DNA fragments for comparison. Students will gain practice making gels, making buffer, loading DNA samples and ladders, and running gels.	DNA Off to the Races and/or Colorful Dye Electrophoresis Lab	TBE Buffer, Agarose Gel, Electrophoresis Chambers with power source, DNA or Dye Samples, DNA Ladder	Group Participation, Lab Analysis Questions
3.A.1.e SP 1-7	How can we compare illlustrative examples of genetic engineering to practical lab protocol? How can we cut DNA for analysis and modification?	The techniques introduced in this exercise form the basis of recombinant DNA technology techniques, DNA fingerprinting, and forensic DNA analysis. • Understand the use of restriction enzymes as biotechnology tools • Become familiar with principles and techniques of agarose gel electrophoresis • Generate a standard curve from a series of DNA size standards • Estimate DNA fragments sizes from agarose gel data	Inquiry-based Lab: Restriction Digest Using Lambda DNA	(Yr 1 & 2): Restriction Digest Using Lambda DNA (BioRad Kit) Gel Electrophoresis, Ice Bath, Hot Water Bath, Restriction Enzymes, Petri Dishes, Ampicillin, Agar	Pre/Post Lab Quiz, Formal Lab Report, Informal Class Participation/Group Collaboration
3.A.1.e SP 2-7	What are phenotypic effects of adding the gene for GFP (green fluorescent protein)?	Students will practice three molecular biology lab techniques including transformation, protein purification, and protein gel electrophoresis - commonly used in biological research and its areas of application.	(Yr 1): 1-Step Module Green Gene or pViB Transformation Kit	Polyacrylamide Gels, Protein Marker, Gel Electrophoresis Setup, Microcentrifuge, Luria Broth, Culture	Pre/Post Lab Quiz, Formal Lab Report, Informal Class Participation/Group Collaboration

			(Yr 2): Green Gene Colony Transformation and Purification 3-Step Module (Carolina Kit)	Tubes, Amipicillin, E.Coli, Petri Dishes, Incubator, Ice Bath	
3.A.1.e SP 3-7	How can we measure human diversity at the molecular level?	Students use real-world forensic techniques to extract DNA from their hair follicles or cheek cells, and then use PCR amplification and electrophoresis to fingerprint their own DNA at a specific genetic locus. Students will be able to directly measure human diversity at the molecular level, extract and amplify genomic DNA from their own samples, compare results to online data.	(Yr 1): BioRad Kit, PV92 with PCR	PCR Machine, Primers, Controls, DNA Samples, Micropipette Tubes, Pipettemen, Extraction Matrix, Mass Ruler, Electrophoresis Setup, DNA Stain, PCR Tubes	Group Participation, Lab Analysis Questions, Pre/Post Lab Quiz
3.A.1.e SP 5&6	How can we apply our knowledge of lab skills (gel electrophoresis) to real world scenarios?	Students will gain an introduction to PCR procedures and protocol to simulate DNA profiling as it is commonly used in forensic laboratories. The laboratory activity is designed to introduce the concepts of PCR, which is widely used in forensics, diagnostics, and archaeological procedures. The laboratory is performed without the need for complex genomic DNA extraction steps.	(Yr 2): Crime Scene Investigation with PCR Basics	Case Study, Gel Electrophoresis Setup, PCR Setup (BioRad Kit)	Group Participation, Lab Analysis Questions, Pre/Post Lab Quiz, Formal Lab Report
3.A.1.e	How do humans currently use genetic engineering techniques to manipulate genetic information?	Students will examine real-world illustrative examples of biotechnology to foster an understanding of this concept including topics such as: GMOs, Transgenic Animals, Cloned Animals, and Phamaceuticals.	Read and Analyze Scientific Literature, Read and Discuss Current Events	Chromebooks	Writing Prompt Rubric, Class Discussion Participication

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Unit # 6: BioEthics

Enduring Understandings:	**Essential Questions: :**
There is an interrelationship that exists among science, society, and ethical considerations. Students should recognize the importance of scientific knowledge in bioethical decision making and develop critical-reasoning skills, especially the ability to justify an ethical position. Discussions also enhance respectful dialogue among individuals with diverse perspectives.	What are ethical issues raised by the application of genetic engineering techniques?

Guiding / Topical Questions with Specific Standards		**Content, Themes, Concepts, and Skills**	**Teaching Strategies**	**Instructional Resources and Materials**	**Assessment Strategies**
SP 6-8	**NGSS Science and Engineering Practices SP 6-8** Construct explanations and design solutions. Engage in argument from evidence. Obtain, evaluate, and communicate information.	Students will develop explanations and design solutions to common bioethical concerns. Students will engage in arguments using evidence to communicate views and justify claims.	Research paper on various topics of bioethical controversy including stem cells, organ donation, gene therapy, responsibility of emerging disease, bioterrorism, eugenics, and cloning.	Chromebooks	Writing Assignment with Rubric
SP 6-8	**NGSS Science and Engineering Practices SP 6-8** Construct explanations and design solutions. Engage in argument from evidence. Obtain, evaluate, and communicate information.	Students will develop explanations and design solutions to common bioethical concerns. Students will engage in arguments using evidence to communicate views and justify claims.	Class discussion and debate: Groups will present a specific side of a bioethical argument (pro/con) using evidence to support and justify their claims.	Whiteboard, Powerpoint, Projector, AP Biology Campbell Textbook, Chromebooks	Group Collaboration and Participation

SP 6-8	**NGSS Science and Engineering Practices SP 6-8** Construct explanations and design solutions. Engage in argument from evidence. Obtain, evaluate, and communicate information.	Students will develop explanations and design solutions to common bioethical concerns. Students will engage in arguments using evidence to communicate views and justify claims.	Case study analysis, discussions, and critique of previous court cases	Case Study Examples: *Tragic Choices and MMR, Bad Blood, Modern Frankenstein*	Analysis and Extension Questions, Student Survey, Class Participation
SP 6-8	**NGSS Science and Engineering Practices SP 6-8** Construct explanations and design solutions. Engage in argument from evidence. Obtain, evaluate, and communicate information.	Students will develop explanations and design solutions to common bioethical concerns. Students will engage in arguments using evidence to communicate views and justify claims.	Movie: GATTACA 1997 Students analyze the impact of genetic modification of humans on society including changes to prejudices, socioeconomic status, and injustices.	Movie	Movie Questions, Class Discussion and Extension on health insurance premiums and Pre-existing conditions

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Unit # 7: BioInformatics

Enduring Understandings:	**Essential Questions:**
The student is able to analyze data using online software to identify molecular structure and subsequent function for example, protein folding. The student is able to combine biological concepts with computer programming to collate information.	How can we use our knowledge of the universal genetic code to analyze results and promote discussions and theories?

Guiding / Topical Questions with Specific Standards		**Content, Themes, Concepts, and Skills**	**Teaching Strategies**	**Instructional Resources and Materials**	**Assessment Strategies**
SP4-5	**NGSS Science and Engineering Practices SP 4-5** Analyze and interpret data. Use mathematics and computational thinking.	Students will examine the ways in which the NCBI online database classifies and organizes information on DNA sequences, evolutionary relationships, and scientific publications. Students will familiarize themselves with basic vocabulary and commands using NCBI. Students will identify an unknown nucleotide sequence from an insect endosymbiont by using the NCBI search tool BLAST.	Discover the Microbes Within: Wolbachia Project	Chromebooks, NCBI and PubMed, Video Tutorials	Post-Lab Assessment Questions, Class Discussion and DeBriefing, Individual Student Check-Ins
SP4-5	**NGSS Science and Engineering Practices SP 4-5** Analyze and interpret data. Use mathematics and computational thinking.	Students will verify the presence of a gene by identifying its key components. Students will identify key components of an operon. Students will predict the function of a protein based on its gene sequence.	Interpreting a Genome & Genome Annotiation	Online tools: Artemis, Chromebooks	Scheduled Teacher Check-Ins, Post-Lab Analysis Questions, Class Participation

		Students will perform the basic steps for annotating a genome.			
SP4-5	**NGSS Science and Engineering Practices SP 4-5** Analyze and interpret data. Use mathematics and computational thinking.	Students will perform a BLAST to align protein sequences. Students will examine the protein structure and identify where the mutation is located. Students will explain and discuss ethical considerations of genetic testing for their assigned condition.	BRCA Family Case Study: Students will use NCBI to BLAST BRCA sequences for various family members to determine their risk for developing Breast Cancer.	Online tools and databases NCBI, PubMed, Chromebooks	BRCA Lab Assessment Questions
SP4-5	**NGSS Science and Engineering Practices SP 4-5** Analyze and interpret data. Use mathematics and computational thinking.	In this lab, students serve as public health specialists and design a DNA probe to diagnose carriers of Sickle Cell Anemia. They use the UCSC Genome Browser and Primer3 primer design websites. The accompanying PowerPoint reviews genetic disease, recessive inheritance, and circulatory system physiology.	Sickle Cell Anemia PBS Video,	UCSC BioInformatics Online Database	Informal Lab Report with Analysis and Extension Questions, Class Participation

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Unit # 8: Independent Study

Enduring Understandings:	**Essential Questions:**
The students will be able to apply the skills developed throughout the first half of the year to complete a multi-step independent study. The actual series of investigation will vary from year to year.	How can we use our knowledge of molecular biology to collect and analyze data to further develop and enhance our scientific theories?

Guiding / Topical Questions with Specific Standards		**Content, Themes, Concepts, and Skills**	**Teaching Strategies**	**Instructional Resources and Materials**	**Assessment Strategies**
SP 4-8	**NGSS Science and Engineering Practices SP 4-8** Analyze and interpret data. Use mathematics and computational thinking. Construct explanations and design solutions. Engage in argument from evidence. Obtain, evaluate, and communicate information.	In this controlled experiment, students will test to see if the GADP gene is a highly conserved gene (needed for glycolysis) found in their specific plant species. Students will extract DNA, purify samples, transform, ligate, and send samples for sequencing. Students will analyze their DNA sequences to determine if they successfully isolated the GADP gene.	(Yr 1): Cloning Explorer Series, GADP Conserved gene of glycolysis (10 weeks)	BioRad Series Kit, AP Biology Campbell Textbook	Pre/Post Lab Quizzes, Group Collaboration and Participation, Checklists, Analysis/Discussion Questions, Teacher Conference, Peer Poster Presentation
SP 4-8	**NGSS Science and Engineering Practices SP 4-8** Analyze and interpret data. Use mathematics and computational thinking. Construct explanations and design solutions. Engage in argument from evidence. Obtain, evaluate, and communicate information.	In this controlled experiment, students express, affinity purify, and perform enzymatic analysis on the recombinant protein dihydrofolate reductase (DHFR). DHFR is an essential protein in nucleic acid synthesis and was one of the first targets for cancer chemotherapy.	(Yr 2): Protein Expression and Purification Series (10-12 Weeks)	BioRad Series Kit, AP Biology Campbell Textbook	Pre/Post Lab Quizzes, Group Collaboration and Participation, Checklists, Analysis/Discussion Questions, Teacher Conference, Peer Poster Presentation

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Unit # 9: Infectious Disease

Enduring Understandings:	**Essential Questions:**
Alterations in a DNA sequence can lead to changes in the type of or amount of the protein produced and the consequent phenotype (3.C.1.a). Changes in genotype may affect phenotypes that are subject to natural selection and may result in enhanced survival and reproduction (3.C.1.d). Viral replication results in genetic variation and infection can introduce genetic variation into the hosts (3.C.3).	How is the homeostasis of a biological system influenced by the system's environment?

Guiding / Topical Questions with Specific Standards		**Content, Themes, Concepts, and Skills**	**Teaching Strategies**	**Instructional Resources and Materials**	**Assessment Strategies**
3.C.1	What do bacteria and viruses need to make us sick? How do they make us sick? Why aren't we always sick? How do vaccines protect humans against viral infections?	LO 3.29 The student is able to construct an explanation of how viruses introduce genetic variation in host organisms. [SP 6.2] IE Bacteriophage. Student is able to construct an explanation of how bacteria enter host organisms and replicate. Student is able to explain the mechanisms used by antibiotics to destroy bacterial communities. Student is able to briefly describe the role of the immune system in fighting infections. Student is able to construct an explanation of how vaccines are formulated, the risks involved, and the benefit of herd immunity.	Lecture, Direct Instruction, Video Guided Notes	Powerpoint, Youtube, Whiteboard, Campbell AP Biology Textbook, Microscopes	Formal Assessment: Quiz, Class Discussions

3.C.1, SP 1	How do scientists determine the disease agent that causes an illness? How do scientists prevent future outbreaks?	The goal of this lesson is to engage students in the analysis of information, allowing them to arrive at conclusions and develop action plans based on that analysis. During the activity, students will apply their newly acquired knowledge of epidemiology to identify the agent responsible for an outbreak of a mysterious illness. Students must then present a proposal identifying the cause of the disease and measures to prevent future outbreaks.	Yr 1: Poisoned Picnic Case Study	CDC Website	Extension Questions and Analysis, Class Participation and Presentation
3.C.1, SP 3	How do scientists determine the disease agent that causes an illness? How do scientists prevent future outbreaks?	Healthcare professionals, government officials and everyday people find themselves in the midst of a worldwide epidemic as the CDC works to find a cure. Students will analyze their tactics to treat patients and reduce the spread of disease.	Yr 1: Contagion	Netflix Series	Extension and Analysis Questions, Class Participation and Discussions
3.C.1, SP 2-7	How do we determine the existence and biodiversity of bacteria around us?	Students are introduced to the concept of engineering biological organisms and studying their growth to be able to identify periods of fast and slow growth. They learn that bacteria are found everywhere, including on the surfaces of our hands. Student groups study three different conditions under which bacteria are found and compare the growth of the individual bacteria from each source. In addition to monitoring the quantity of bacteria from differ conditions, they record the growth of bacteria over time, which is an excellent tool to study	Yr 1: Bacteria Are EveryWhere! Practice with sterile technique, plating bacteria	Microscopes, Petri Dishes, Sterile Swabs, Agar, Incubator	Formal Lab Report

		binary fission and the reproduction of unicellular organisms.			
3.C.1, SP 1	How do infectious diseases spread and what can communities do to prevent it?	Students will research the cause, spread, and effect of a specific infectious disease. Students will examine the specialized features of their microbe that aid in its virulence to members of society. Students will practice modeling and presentation techniques.	Yr 1: Microbe modeling: Peer teaching	Various craft supplies for modeling	Model Evaluation, Peer Presentation
3.C.1, SP 2-7	How do human activities such as the use of antibiotics cause bacteria to evolve over time?	LO 3.24 The student is able to predict how a change in genotype, when expressed as a phenotype, provides a variation that can be subject to natural selection. [SP 6.4, 7.2] IE Antibiotic Resistance.	Yr 1: Evolving Bacteria Lab	Ampicillin, E.Coli, Agar, Petri Dishes, Incubator	Formal Lab Report, Class discussion and Participation
3.C.1, SP 2-7	How are bacteria beneficial and detrimental to human health?	In this laboratory activity, students examine both the risks and benefits of bacteria to better understand their role in disease and food production. Students search to find the bacterial culprit behind a new disease called "Yogurtness". Students will use Koch's postulates along with microscopes, agar plates, and their powers of observation, to identify the guilty microbe in this inquiry-based activity.	Yr 2: Microbes and Your Health	Wards Kit	Formal Lab Report, Class discussion and Participation
3.C.1, SP 2-7	How do infectious diseases spread and what can communities do to prevent it?	Students take their skill set one step further with this student-driven discovery process based on a real-world Shigella outbreak of 2000. Students use scientific reasoning to mimic a foodborne outbreak investigation and design an experiment using gel electrophoresis to determine the source of the outbreak.	Yr 2: Foodbourne Outbreak Investigation	MiniOne Kit	Formal Lab Report, Class discussion and Participation

		Students evaluate and critique experimental approaches used by their own team and by others in the class.			
3.C.1, SP 2-7	How do human activities such as the use of antibiotics cause bacteria to evolve over time?	Students learn about gene transfer between bacterial strains. In 1 of the included strains of *E. coli*, the gene for antibiotic resistance for streptomycin is located on the chromosome. In the other, the gene for antibiotic resistance for ampicillin occurs as extrachromosomal plasmid DNA. Through the process of streaking the conjugated bacteria on 4 different types of antibiotic selective media, students determine which bacterial strain is the donor strain.	Yr 2: Advanced Bacterial Conjugation	Carolina Kit	Formal Lab Report, Class discussion and Participation
3.C.1, SP 4-7	How do scientists test for the presence of antibiotics in infected persons?	Students follow the ELISA procedure employed by medical laboratories to test for the presence of serum antibodies against the Human Immunodeficiency Virus (HIV). The ELISA (Enzyme-Linked Immunosorbent Assay) test is used for the initial screening of human blood to identify individuals who may be infected by HIV.	Yr 2: AIDS Simutest (ELISA)	Carolina Kit with simulated reagents and pre-sensitized microplates	Formal Lab Report, Class discussion and Participation, Peer presentation on specific screening test
3.C.1, SP 4-7	How do scientists test for the presence of antibiotics in infected persons?	Infectious mononucleosis is commonly known as the "kissing disease." The causative agent is Epstein-Barr virus (EBV) which can be transmitted through saliva during kissing. In this experiment, students search for the presence of EBV using the ELISA reaction to detect specific viral proteins.	Yr 2: In Search of the Kissing Disease	Wards Kit Instructions, samples, antigens; antibodies, various solutions and reagents, pipettes and microtest tubes, incubation oven, micropipettes with tips, laboratory glassware, distilled or deionized water.	Formal Lab Report, Class discussion and Participation

3.C.1	Where do new infectious diseases come from? How do scientists asses the risk of a pandemic? How do scientists prevent a pandemic?	Students examine where new infectious diseases come from, how scientists assess the risk of a pandemic, and how we might go about preventing one. This case study explores these questions by focusing on HIV, a pandemic that began as an emerging disease.	Patient Zero - Buffalo Case Study	Paper/Pencil	Case study analysis and extension questions

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Unit # 10: Environmental Biotechnology

Enduring Understandings:	**Essential Questions:**
Environmental Biotechnology is used to study the natural environment. In this field of study, technology is used to harness biological processes for commercial uses such as renewable resources, food, and biological remediation. Students will examine the intricate balance between the applications of genetics with the conservation of our natural resources.	How does human activity affect the biodiversity of ecosystems? How can humans analyze the biodiversity of an ecosystem? How do humans extract energy from biological organisms for practical purposes?

Guiding / Topical Questions with Specific Standards		**Content, Themes, Concepts, and Skills**	**Teaching Strategies**	**Instructional Resources and Materials**	**Assessment Strategies**
4.C.2	How do we extract energy from biological organisms for practical purposes?	Students will measure the enzymatic activity of cellobiase (part of the cellulase family) using spectrophotometry to identify the optimal conditions for the enzyme. Students will apply their knowledge of the controlled experiment to test the reaction rate of mushrooms as an energy source.	YR 1: BioFuels	BioRad Kit, Multi-part lab protocol	Formal Lab Report
4.C.2	How does human activity affect the biodiversity of ecosystems?	Students will construct explanations of the impact of human activity on environmental factors including changes to biodiversity. Students will learn how to conduct a research technique known as random sampling to determine the population density of an ecosystem. Students will treat the population with manmade chemicals and continue to test and monitor how humans impact this subsampling of the environment. Students can further extend this activity by	Yr 2: Marine Microbes and Soil Sampling	Outdoor activity, sampling equipment, microscopes	Formal Lab Report, Class Discussion, Peer Presentations

		developing solutions to common environmnetal problems caused by human activity on land/water.			
4.C.2	How can we use sequencing and bioinformatics to determine biodiversity of fish in the environment?	Students will perform an advanced PCR to determine the species of a fish sample based on its DNA sequence of the cytochrome c oxidase I gene.	Yr 1 and 2: Fish Barcoding	BioRad Kit, Multi-part lab protocol, Additional fee for sequencing module	Formal Lab Report
4.C.2	How can environmental biotechnology be used to increase crop yield? How does genetic manipulation affect the biodiversity of our crops?	In this guided-inquiry approach, students will determine the presence of GMO sequences in their food samples. Students will extract and amplify DNA. Students will perform genuine diagnostic procedures. Students will use PCR and Gel Electrophoresis.	Yr 1: GMOs	BioRad Kit, Multi-part lab protocol	Formal Lab Report
4.C.2	What are the ethical, economic, social, and practical issues involved in creating a new drug to market?	This lab provides a biotechnology curriculum that takes students on an adventure starting in the rainforest in the Andes, continuing to a biotechnology company engaged in developing new pharmaceutical compounds, and finally to the Food and Drug Administration. Students will apply the principles of DNA restriction analysis, bacterial transformation, and protein purification. Students will be introduced to the world of commercial biotechnology.	Yr 2: Secrets of the Rainforest	BioRad Kit, Multi-part lab protocol	Formal Lab Report

English Language Learner (ELL) Resources

- Learning style quiz for students- http://www.educationplanner.org/students/self-assessments/learning-styles-quiz.shtml
- "Word clouds" from text that you provide-http://www.wordle.net/
- Bilingual website for students, parents and educators: http://www.colorincolorado.org/
- Learn a language for FREE-www.Duolingo.com
- Time on task for students-http://www.online-stopwatch.com/
- Differentiation activities for students based on their Lexile-www.Mobymax.com
- WIDA-http://www.wida.us/
- Everything ESL - http://www.everythingESL.net
- ELL Tool Box Suggestion Sitehttp://www.wallwisher.com/wall/elltoolbox
- Hope4Education - http://www.hope4education.com
- Learning the Language http://blogs.edweek.org/edweek/learning-the-language/
- FLENJ (Foreign Language Educators of NJ) 'E-Verse' wiki: http://www.flenj.org/Publications/?page=135
- OELA - http://www.ed.gov/offices/OBEMLA
- New Jersey Department of Education- Bilingual Education information http://www.state.nj.us/education/bilingual/

Special Education Resources

- Animoto -Animoto provides tools for making videos by using animation to pull together a series of images and combining with audio. Animoto videos or presentations are easy to publish and share. https://animoto.com
- Bookbuilder -Use this site to create, share, publish, and read digital books that engage and support diverse learners according to their individual needs, interests, and skills. http://bookbuilder.cast.org/
- CAST -CAST is a non-profit research and development organization dedicated to Universal Design for Learning (UDL). UDL research demonstrates that the challenge of diversity can and must be met by making curriculum flexible and responsive to learner differences. http://www.cast.org
- CoSketch -CoSketch is a multi-user online whiteboard designed to give you the ability to quickly visualize and share your ideas as images. http://www.cosketch.com/
- Crayon -The Crayon.net site offers an electronic template for students to create their own newspapers. The site allows you to bring multiple sources together, thus creating an individualized and customized newspaper. http://crayon.net/ Education Oasis -Education Oasis offers a collection of graphic organizers to help students organize and retain knowledge – cause and effect, character and story, compare and

contrast, and more! http://www.educationoasis.com/printables/graphic-organizers/

- Edutopia -A comprehensive website and online community that increases knowledge, sharing, and adoption of what works in K-12 education. We emphasize core strategies: project-based learning, comprehensive assessment, integrated studies, social and emotional learning, educational leadership and teacher development, and technology integration. http://www.edutopia.org/
- Glogster -Glogster allows you to create "interactive posters" to communicate ideas. Students can embedded media links, sound, and video, and then share their posters with friends. http://edu.glogster.com/?ref=personal
- Interactives – Elements of a Story -This interactive breaks down the important elements of a story. Students go through the series of steps for constructing a story including: Setting, Characters, Sequence, Exposition, Conflict, Climax, and Resolution. http://www.learner.org/interactives/story/index.html
- National Writing Project (NWP) -Unique in breadth and scale, the NWP is a network of sites anchored at colleges and universities and serving teachers across disciplines and at all levels, early childhood through university. We provide professional development, develop resources, generate research, and act on knowledge to improve the teaching of writing and learning in schools and communities. http://www.nwp.org
- Pacecar -Vocab Ahead offers videos that give an active demonstration of vocabulary with audio repeating the pronunciation, definition, various uses, and synonyms. Students can also go through flash cards which give a written definition and visual representation of the word. http://pacecar.missingmethod.com/