Bristol Public Schools

Office of Teaching & Learning

Department	Science
Department Philosophy	Bristol Public Schools science programing provides students with knowledge of the science and engineering practices, crosscutting concepts, and the core ideas of science and engineering to engage in public discussions on science related issues, to be critical consumers of scientific information related to their everyday lives, and continue to learn science throughout their lives. To ensure this level of scientific literacy, Bristol Public Schools anchor science units in phenomena, this practice promotes student ownership of learning and supports student application of the science content as it pertains to the real world. In each science unit, students work to explain phenomena through the applications of the three dimensions of the Next Generation Science Standards: (1) science and engineering practices, (2) disciplinary core ideas, and (3) cross cutting concepts. Bristol's use of phenom-based units and the three dimensions ensure that students connect with and build a deep conceptual understanding of science concepts. Throughout the kindergarten through grade 12 experience, this philosophy provides all Bristol students with the skills and concepts to be scientifically literate adults.
Course	Biotechnology & Forensics
Course Description for Program of Studies	Biotechnology and Forensics will expose students to the diverse fields of biotechnology including biomedical engineering, bio-molecular genetics, bioprocess engineering, agricultural and environmental engineering, and forensics. Lessons engage students in engineering design problems that can be accomplished in a high school setting related to biomechanics, cardiovascular engineering, biomedical devices, human interface, bioprocesses, forensics and bioethics.
Grade Level	11-12
Pre-requisites	Must pass Biology
Credit (if applicable)	1.0

UNIT 1: Biotechnology Safety and Measurement

UNWRAPPED STANDARDS

Standard	Dimensions of the NGSS Standard/ISTE		Concepts and Disciplinary-Specific Vocabulary
9-12 Science and Engineering Practices **Analyzing and Interpreting Data** Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.	**SEP**	**Analyzing and Interpreting Data** ● Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.	● Empirical, evidence, logical, reasoning, analysis, valid, effect, limitation, accuracy, precision
9-12 Nature of Science **Scientific Investigations Use a Variety of Methods**	**NoS**	**Scientific Investigations Use a Variety of Methods** ● Science investigations use diverse methods and do not always use the same set of procedures to obtain data.	● Experiment, factor, investigation, method, observable, observation, prediction, test, variable
Obtaining, Evaluating and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.	**SEP**	**Obtaining, Evaluating and Communicating Information** ● Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).	● Criteria, decision, digital, feedback, information, knowledge, media, objectivity, peer review, relevant, research, source, value

UNIT 1 DETAILS

Unit Essential Questions:

1. Why is effective communication necessary in science?
2. What are the basic tools of biotechnology?
3. Why is laboratory safety so important?
4. In the event of an emergency in the laboratory, what steps should you take to keep yourself and your classmates safe?
5. If you were to measure incorrectly, how would you know and what could happen to your experiment results?
6. What is the difference between accuracy and precision?

Learning Sequence	Student Learning Target(s): I can...	Summative Assessment Strategy	Priority NGSS Dimensions	Common Learning Experiences/Assessments
(1) Science Communication Why is effective communication necessary in science? What are the basic tools of biotechnology?	• I can communicate ideas for an experiment using various models or other media collected or documented. • I can amend ideas, notes and presentations based on personal view and feedback from others and will document them.	☐ Selected Response x Constructed Response x Performance ☐ Observation	**SEP** | **DCI** | **CCC** • Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).	Student Portfolio or Science Communication activities Optional: Math Skills and Basic Tools of the Biotech Lab ELA/Math Connection: CCSS.ELA-LITERACY.W.11-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
(2) Laboratory Safety Why is laboratory safety so important? In the event of an emergency in the laboratory, what steps should you take to keep yourself and your classmates safe?	• I can understand and follow laboratory safety procedures. • I can map the lab to locate and explain the proper usage of key pieces of safety equipment. • I can describe the best mode of action if faced with a laboratory safety issue.	☐ Selected Response x Constructed Response ☐ Performance ☐ Observation	**SEP** | **DCI** | **CCC** •	Zombie College video and corresponding pdfs ELA/Math Connection: N/A
(3) Scientific Measurement If you were to measure incorrectly, how would you know and what could happen to your experiment results? What is the difference between accuracy and precision?	• I can define the difference between precision and accuracy. • I can follow procedures to ensure accurate and precise laboratory measurements using a pipette.	☐ Selected Response x Constructed Response x Performance ☐ Observation	**SEP** | **DCI** | **CCC** • Science investigations use diverse methods and do not always use the same set of procedures to obtain data. • Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.	Optional activities: Micropipette color wheel and pptx Instrumentation Calibration lab ELA/Math Connection: CCSS.MATH.CONTENT.HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

UNIT 2: Genomics and Genetic Engineering

UNWRAPPED STANDARDS

Standard	Dimensions of the NGSS Standard		Concepts and Disciplinary-Specific Vocabulary
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.	**SEP**	**Asking Questions and Defining Problems** ● Analyze complex real-world problems by specifying criteria and constraints for successful solutions.	● Consideration, qualitative, quantitative, specification, aspect, critical, mitigation, solution, criteria, constraint, feasible, principle, problem, specific
	DCI	**ETS1.A: Defining and Delimiting Engineering Problems** ● Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. ● Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.	
	CCC	**Influence of Science, Engineering, and Technology on Society and the Natural World** ● New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.	
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.	**SEP**	**Constructing Explanations and Designing Solutions** ● Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	● Iterative, criteria, limitation, systematically, tradeoff. Statistical, quantitative, qualitative, benefit, design, design solution, explanation, merit, reliable, theory
	DCI	**ETS1.C: Optimizing the Design Solution** ● Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.	
	CCC	● **N/A**	
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.	**SEP**	**Constructing Explanations and Designing Solutions** ● Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models,	● Organism, organ, cell, DNA, RNA, mRNA, tRNA, detect, response, external, function, functional, conceptual, precision, specialized, stimulus, structural, derive, mediate,

		theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	
	DCI	**LS1.A: Structure and Function** ● Systems of specialized cells within organisms help them 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 that code for the formation of proteins, which carry out most of the work of cells. (Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)	
	CCC	**Structure and Function** ● Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.	
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.	**SEP**	**Asking Questions and Defining Problems** ● Ask questions that arise from examining models or a theory to clarify relationships.	● Chromosome, formation, gene, genetic, genetic variation, protein, DNA, gene encoding, regulate, regulatory, segment
	DCI	**LS1.A: Structure and Function** ● All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. (secondary) (Note: This Disciplinary Core Idea is also addressed by HS-LS1-1.) **LS3.A: Inheritance of Traits** ● Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function.	
	CCC	**Cause and Effect** ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	
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	**SEP**	**Constructing Explanations and Designing Solutions** ● Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff	● Consideration, representation, systematic, tradeoff, limitations, constraints, criteria

impacts.		considerations.	
	DCI	**ETS1.B: Developing Possible Solutions** ● When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.	
	CCC	**Influence of Science, Engineering, and Technology on Society and the Natural World** ● New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.	

UNIT 2 DETAILS

Unit Essential Questions:

1. What is biotechnology?
2. What are the basics of the industry and what are some career hot spots?
3. How do world events impact biotechnological advances?
4. What are the 2 main types of cells and how are they distinguished?
5. What is the structure and function of DNA?
6. How can DNA be extracted from cells? What is the difference between DNA and RNA?
7. How are genes expressed from DNA to protein?
8. How can genes be mapped, mutated, and/or analyzed?
9. How should bioethics drive the future of biotechnology?
10. How are GM organisms created?
11. How can genetic engineering benefit humans?

Learning Sequence	Student Learning Target(s): I can...	Summative Assessment Strategy	Priority NGSS Dimensions	Common Learning Experiences/Assessments
(1) The Biotechnology Industry The field of biotechnology involves many career subsets. What are the basics of the industry and what are some career hot spots? How do world events impact biotechnological advances?	• I can explain the field of biotechnology and relate it to specific careers. • I can give examples of biotechnology in use • I can list some "hot spots" or locations where biotechnology is clustered in the United States • I can explain the impacts of world events on the field of biotechnology	☐ Selected Response x Constructed Response ☐ Performance ☐ Observation	**SEP** / **DCI** / **CCC** • (SEP) Analyze complex real-world problems by specifying criteria and constraints for successful solutions. • (DCI) Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. • (DCI) Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. • (CCC) New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.	Biotech Basics Slides Watch What would happen if you didn't sleep? ELA/Math Connection: CCSS.ELA-LITERACY.W.11-12.2 Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
(2) Cells and DNA The understanding of cells is vital in Biotechnology. What are the 2 main types of cells and how are they distinguished? What is the structure and function of	• I can differentiate between prokaryotic and eukaryotic cells • I can differentiate between a bacteria and a virus • I can model the structure of DNA	☐ Selected Response X Constructed Response X Performance	**SEP** / **DCI** / **CCC** • (DCI) All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins.	Measuring eukaryotic and prokaryotic cells using a microscope (lab) DNA Structure Video Article: Twinkling, star-shaped brain cells may hold key to why and how we sleep ELA/Math Connection:

DNA?				
(3) DNA Extraction DNA research, extraction, and manipulation is at the forefront of biotechnology. How can DNA be extracted from cells? What is the difference between DNA and RNA?	• I can describe the structure of DNA and extract DNA from fruits and myself. • I can explain the differences between DNA and RNA.	☐ Selected Response ☐ Constructed Response ☐ Performance ☐ Observation	**SEP** / **DCI** / **CCC** • (SEP) Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. • (DCI) Systems of specialized cells within organisms help them perform the essential functions of life. • (DCI) All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (Note: This Disciplinary Core Idea is also addressed by HS-LS3-1.)	DNA Extraction lab (strawberry and/or banana) or Virtual DNA Extraction Optional article: World's largest DNA sequencing of Viking skeletons reveals they weren't all Scandinavian and video ELA/Math Connection: CCSS.ELA-LITERACY.W.11-12.2 Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
(4) The Central Dogma of DNA The function of DNA from code to protein is central to biotechnology. How are genes expressed from DNA to protein?	• I can explain the Central Dogma of DNA and why DNA is important to living systems. • I can demonstrate how DNA is transcribed to form mRNA. • I can demonstrate how RNA is translated to form a protein using a codon chart.	☐ Selected Response ☒ Constructed Response ☐ Performance ☐ Observation	**SEP** / **DCI** / **CCC** • (DCI) All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. (secondary) (Note: This Disciplinary Core Idea is also addressed by HS-LS1-1.) • (DCI) Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. • (SEP) Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	Lab: Protein Synthesis (DNA to protein) Optional: Protein Synthesis Puzzles Optional DNA History video: Rosalind Franklin: DNA's unsung hero ELA/Math Connection: CCSS.ELA-LITERACY.W.11-12.2 Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

(5) Genomics and Gene Expression Biotechnology uses the Central Dogma to research and manipulate DNA. How can genes be mapped, mutated, and/or analyzed?	• I can explain how genomics is used to study many genes via a DNA microarray • I can experiment to differentiate genes using a DNA microarray • I can model how a gene is turned “on” or “off” and describe epigenetics		SEP / DCI / CCC • (DCI) Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. • (DCI) Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.	Microarray lab virtually or DNA Microarray via Edvotek Optional article: Intro to Epigenetics ELA/Math Connection: CCSS.ELA-LITERACY.W.11-12.2 Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.
(6) Bioethics Some of the uses of biotechnology are controversial in terms of the effects on the environment and ethical issues they raise. How should bioethics drive the future of biotechnology?	• I can create my own definition of bioethics • I can differentiate between morals, values and ethics and relate them to biotechnology. • I can elaborate on the central theme of bioethics: “We can, but should we?”		SEP / DCI / CCC • (SEP) Analyze complex real-world problems by specifying criteria and constraints for successful solutions. • (DCI) Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. • (DCI) Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. • (CCC) New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.	Bioethics Case Studies - Socratic Seminar, FlipGrid, or other discussion setup Optional sources: Center for Practical Bioethics and NCBI
(7) Genetic Engineering and Restriction Enzymes Scientists can now select specific genes to modify and even insert genes from other organisms. How are GM organisms created? How can genetic engineering benefit humans?	• I can describe how selective breeding can be accelerated by genetic engineering. • I can model the role of restriction enzymes in creating genetically modified organisms. • I can explain the benefits of genetic engineering. • I can interpret Gel Electrophoresis to solve scientific questions		SEP / DCI / CCC • (SEP) Analyze complex real-world problems by specifying criteria and constraints for successful solutions. • (DCI) Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. • (CCC) New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.	Video: The Deadliest Being on Planet Earth And MIT’s Genetic Engineering Video Gel Electrophoresis Lab (practical or virtual - one option is here) Optional: Go to http://biotech.emcp.net/nebecomm to research restriction endonucleases available from New England BioLabs ELA/Math Connection: CCSS.ELA-LITERACY.W.11-12.2 Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

	Selected Response
x	Constructed Response
x	Performance
	Observation

	Selected Response
	Constructed Response
	Performance
	Observation

	Selected Response
	Constructed Response
	Performance
	Observation

UNIT 3: Biomedical Engineering

UNWRAPPED STANDARDS

Standard	Dimensions of the NGSS Standard		Concepts and Disciplinary-Specific Vocabulary
HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.	**SEP**	**Developing and Using Models** ● Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.	● Protein synthesis, protein structure, organic compounds, living system, derive, tissue, structural, specialized, organism, hierarchical, evidence, empirical evidence, quantitative, qualitative
	DCI	**LS1.A: Structure and Function** ● Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.	
	CCC	**Systems and System Models** ● Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.	
Connections to Engineering, Technology, and Applications of Science	**NoS**	**Interdependence of Science, Engineering and Technology** ● Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. ● Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. **Influence of Science, Engineering, and Technology on Society and the World** ● Modern civilization depends on major technological systems. ● Engineers continuously modify these systems to increase benefits while decreasing costs and risks. ● New technologies can have deep impacts on society and the environment, including some that are not anticipated. ● Analysis of costs and benefits is a critical aspect of decisions about technology.	Influence, interaction, natural, natural world, risk, scientist, society, standard, engineer, research and development

UNIT 3 DETAILS

Unit Essential Questions:

1. What are some careers I can pursue in biomedical engineering? What are the various fields under this career umbrella?
2. How can microorganisms be utilized or manipulated to help humans?
3. How can organisms be cloned? What are the benefits and controversy surrounding cloning?
4. What are stem cells? How can they be used to help humans?
5. What is regenerative medicine?
6. What are the five functions of the skeletal system?
7. What two major functions do muscles perform in addition to movement?
8. How does the muscular system assist the skeletal system in body movements?
9. How could an engineer utilize knowledge of the skeletal system and muscular system in designing joint replacements?
10. What are the major types of joints?
11. How does myocardial infarction or heart attack affect the pathway of blood flow and the functions of the heart?
12. How do electrical signals correspond to the cardiac cycle? How can an ECG be interpreted?
13. What are some examples of prosthetic devices that can be used for correcting cardiac defects or monitoring cardiac defects or functions?

Learning Sequence	**Student Learning Target(s):** I can...	**Summative Assessment Strategy**	**Priority NGSS Dimensions**	**Common Learning Experiences/Assessments**
(1) Introduction to Biomedical Engineering What are some careers I can pursue in BME? What are the various fields under this career umbrella?	• I can define biomedical engineering. • I can list and explain several careers in biomedical engineering and search for career opportunities in CT.	☐ Selected Response ☒ Constructed Response ☐ Performance ☐ Observation	**SEP** | **DCI** | **CCC** **Influence of Science, Engineering, and Technology on Society and the World** • Modern civilization depends on major technological systems. • Engineers continuously modify these systems to increase benefits while decreasing costs and risks. • New technologies can have deep impacts on society and the environment, including some that are not anticipated. • Analysis of costs and benefits is a critical aspect of decisions about technology.	Optional: Use EMB Career Guide ELA/Math Connection: CCSS.ELA-LITERACY.W.11-12.7 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.
(2) Microbiology in Biotechnology How can microorganisms be utilized or manipulated to help humans?	• I can use prior knowledge of restriction enzymes to understand how insulin was first produced. • I can analyze the experiments of Griffith, Avery, and other scientists that led to our understanding of transformation. • I can see and explain the lab process to transform bacteria.	☐ Selected Response ☒ Constructed Response ☒ Performance ☐ Observation	**SEP** | **DCI** | **CCC** • (DCI) Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. **Interdependence of Science, Engineering and Technology** • Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. • Many R&D projects may involve scientists, engineers, and others with wide ranges of	Discussion or activity focused on the history of insulin pGlo Transformation Project or Lab (practical or virtual) Optional: DNA discovery notes to supplement transformation ELA/Math Connection:

			expertise.	
(3) Gene Editing and CRISPR How can CRISPR technology be used for scientific research and to treat and present diseases?	• I can explain what CRISPR and Cas9 are to explain their function in gene editing • I can describe how CRISPR is used to treat genetic disease. • I can hypothesize how CRISPR can be used in the future of medicine and biotechnology.		**SEP** / **DCI** / **CCC** • (NoS) Engineers continuously modify these systems to increase benefits while decreasing costs and risks. • (NoS) New technologies can have deep impacts on society and the environment, including some that are not anticipated. • (NoS) Analysis of costs and benefits is a critical aspect of decisions about technology.	Discuss how CRISPR is used to treat Sickle Cell Anemia and/or Cancer Gene Editing Video (CRISPR) Optional: New Scientist Article ELA/Math Connection:
(4) Stem Cells, Cloning, and Regenerative Medicine How can organisms be cloned? What are the benefits and controversy surrounding cloning? What are stem cells? How can they be used to help humans? What is regenerative medicine?	• I can describe the process of cloning. • I can explain the differences between embryonic and adult stem cells. • I can describe how stem cells are used to treat disease. • I can predict how stem cells can be engineered to avoid using embryos. • I can experiment with Planaria to understand regenerative medicine		**SEP** / **DCI** / **CCC** • (DCI) Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. • (NoS) Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. • (NoS) Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.	Bioethics of stem cell research (discussion or Socratic Seminar) Go GoStem Cells by Utah Genetics (if Flash version is updated) STO Stem Cell Lab Activity or comparable Planaria Regeneration Lab Activity (Ward's or other) ELA/Math Connection: CCSS.ELA-LITERACY.RST.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
(5) Joint Replacements and Orthopedic Implants What are the five functions of the skeletal system? What two major functions do muscles perform in addition to movement? How does the muscular system assist the skeletal system in body movements? How could an engineer utilize knowledge of the skeletal system and muscular system in designing joint replacements? What are the major types of joints?	• I can list the 5 functions of the skeletal system and identify the types of joints found at its articulations. • I can explain how muscles aid in movement of the body. • I can model a synovial joint and explain the procedures involved in replacement joint surgery.	x Constructed Response x Performance	**SEP** / **DCI** / **CCC** • (DCI) Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. • (SEP) Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.	Joint Replacement Project or Broken Bones Lab from Flinn Optional: Radiology Reference Guide, Board Exam and Practical Lab ELA/Math Connection: CCSS.ELA-LITERACY.RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

(6) Cardiovascular Engineering How does myocardial infarction or heart attack affect the pathway of blood flow and the functions of the heart? How do electrical signals correspond to the cardiac cycle? How can an ECG be interpreted? What are some examples of prosthetic devices that can be used for correcting cardiac defects or monitoring cardiac defects or functions?	• I can draw and label the anatomy of the human heart • I can explain the cardiac conduction system and interpret a basic ECG • I can explain the function of a pacemaker and other devices used to monitor and/or correct heart disorders	<table><tr><td></td><td>Selected Response</td></tr><tr><td>x</td><td>Constructed Response</td></tr><tr><td></td><td>Performance</td></tr><tr><td></td><td>Observation</td></tr></table>	**SEP** / **DCI** / **CCC** • (DCI) Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. • (SEP) Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. • (NoS) Engineers continuously modify these systems to increase benefits while decreasing costs and risks. • (NoS) New technologies can have deep impacts on society and the environment, including some that are not anticipated. • (NoS) Analysis of costs and benefits is a critical aspect of decisions about technology.	Optional Case Study: A Tiny Heart ELA/Math Connection: CCSS.ELA-LITERACY.RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

UNIT 4: Forensics

UNWRAPPED STANDARDS

Standard	Dimensions of the NGSS Standard		Concepts and Disciplinary-Specific Vocabulary
Constructing Explanations and Designing Solutions: ● Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.	**NoS**	● Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables. ● Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	● Basis, benefit, design, design solution, explanation, idea, merit, reliable, solution, theory, simulation, assumption
Analyzing and Interpreting Data ● Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.	**NoS**	● Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.	● Statistical analysis, model, evaluate, system, accurate, analysis, assumption, comparison, data, finding, inference, interpretation, technique
Cause and Effect: Mechanism and Prediction: ● Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.	**CCC**	● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. ● Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. ● Systems can be designed to cause a desired effect. ● Changes in systems may have various causes that may not have equal effects.	● Causality, causation, correlation, effect, result, empirical evidence, scale mechanism

UNIT 4 DETAILS

Unit Essential Questions:

1. How has the field of forensic science evolved from its inception?
2. What impact has forensics had on solving criminal investigations?
3. How is a crime scene processed? What types of evidence must be gathered at a crime scene?
4. How are fingerprints collected at a crime scene? What are the 3 fingerprint principles? What are the 3 classes of fingerprints and how are they analyzed?
5. How is blood identified and collected at a crime scene? What can blood tell us about a crime scene?
6. What techniques are necessary to attain an uncontaminated DNA sequence that can be compared to known data by a forensic scientist or pathologist?
7. How are DNA sequences compared to each other?
8. How can hair and fibers collected at a crime scene be analyzed by forensic scientists?
9. What are the limits of forensics?
10. What is the main goal of the Innocence Project?
11. What possibilities still exist in the field of forensics?

Learning Sequence	Student Learning Target(s): I can...	Summative Assessment Strategy	Priority NGSS Dimensions	Common Learning Experiences/Assessments
(1) History and Development of Forensic Science How has the field of forensic science evolved from its inception? What impact has forensics had on solving criminal investigations?	• I can explain what forensics is and the role of a forensic scientist • I can describe the Locard Exchange Principle and list other scientists like Alec Jeffreys who contributed to the field of forensics • I can explain the services provided of a basic crime lab • I can differentiate between CSI myths and facts (CSI Effect)	☐ Selected Response ☒ Constructed Response ☒ Performance ☐ Observation	**SEP** / **DCI** / **CCC** • Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables. • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	Case study in Forensic Science of either Colin Pitchfork, Robert Durst, Robert Crafts, or other historical case. Optional exploration of Chemical & Engineering News ELA/Math Connection: 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.
(2) Evidence Collection How is a crime scene processed? What types of evidence must be gathered at a crime scene?	• I can identify the seven S's of crime scene investigation • I can differentiate between direct and circumstantial evidence at a crime scene. • I can evaluate the importance of eyewitness testimony	☐ Selected Response ☒ Constructed Response ☐ Performance ☐ Observation	**SEP** / **DCI** / **CCC** • Evaluate the impact of new data on a working explanation and/or model of a proposed process or system. • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	Forensic File episodes "Body of Evidence" or "The Disappearance of Helle Crafts" or comprable. ELA/Math Connection:
(3) Fingerprinting Basics How are fingerprints collected at a crime scene?	• I can explain the 3 fundamental principles of fingerprints? • I can collect latent fingerprints • I can identify which class of fingerprint I have collected and identify ridge	☐ Selected Response ☒ Constructed Response	**SEP** / **DCI** / **CCC** • Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own	Fingerprinting lab - students create, collect, and analyze latent prints

What are the 3 fingerprint principles? What are the 3 classes of fingerprints and how are they analyzed?	characteristics and patterns. • I can explain how AFIS and biometrics can be used to track criminals.		Performance Observation	investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	ELA/Math Connection: CCSS.ELA-LITERACY.RST.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
(4) Serology and Blood Spatter How is blood identified and collected at a crime scene? What can blood tell us about a crime scene?	• I can define forensic serology and classify crime scene blood. • I can explain how blood is identified and collected at a crime scene. • I can differentiate between the human blood types in a laboratory setting • I can explain how blood is characterized by a criminalist at a crime scene • I can interpret blood spatter patterns at a simulated crime scene.		Selected Response x Constructed Response x Performance Observation	**SEP** **DCI** **CCC** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.	Simulated Blood Typing Lab or equivalent. Blood Spatter Lab or equivalent Forensic Files “The House that Roared” or comparable ELA/Math Connection: CCSS.ELA-LITERACY.RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
(5) DNA Profiling What techniques are necessary to attain an uncontaminated DNA sequence that can be compared to known data by a forensic scientist or pathologist? How are DNA sequences compared to each other?	• I can explain the processes of Southern blotting and gel electrophoresis • I can compare DNA between different individuals as demonstrated by electrophoresis in a laboratory setting • I can explain how PCR is used to copy and amplify miniscule traces of DNA.		Selected Response x Constructed Response x Performance Observation	**SEP** **DCI** **CCC** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. • Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.	Electrophoresis Lab (actual, simulation, or virtual) ELA/Math Connection: 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.
(6) Hair and Fiber Analysis How can hair and fibers collected at a crime scene be analyzed by forensic scientists?	• I can draw and label the anatomy of human hair • I can differentiate human hair from other mammals and identify its structural components. • I can differentiate between different fibers like cotton, silk, and synthetics • I can understand how hair and fiber may be misconstrued and non-admissible in court.		Selected Response x Constructed Response Performance Observation	**SEP** **DCI** **CCC** • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. • Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.	Hair and Fiber Analysis Lab (or comparable comparison microscopy virtual lab). Optional Case Study: Atlanta Child Murders ELA/Math Connection: CCSS.ELA-LITERACY.RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

(7) The Limits of Forensic Science What are the limits of forensics? What is the main goal of the Innocence Project? What possibilities still exist in the field of forensics?	● I can explain how forensic technology has advanced and how certain methods of evidence collection have been reevaluated (lie detector, eyewitness testimony, hair analysis, etc). ● I can describe other forensic science specialties that can be useful in an investigation ● I can explain the goal and mission of the Innocence Project			**SEP**	**DCI**	**CCC**	Innocence Project Presentation or Case Studies (ex. Ronald Cotton) Optional: - CSI Wildlife via HHMI - Forensic Specialties Project (research a topic/field that was not covered - Glass Analysis, Forensic Odontology, Forensic Psychology, Forensic Entomology, etc)
				● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. ● Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. ● Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.			ELA/Math Connection: 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.

	Selected Response
x	Constructed Response
	Performance
	Observation