Main Criteria: Colorado Academic Standards (CAS)
Secondary Criteria: JoVE
Subject: Science
Grade: 9-12
Correlation Options: Show Correlated
Adopted: 2009

CONTENT AREA	CO.1.	Physical Science
STANDARD	1.2.	Matter has definite structure that determines characteristic physical and chemical properties. Students can:
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	1.2.b.	Gather, analyze and interpret data on chemical and physical properties of elements such as density, melting point, boiling point, and conductivity JoVE • Assembly of a Reflux System for Heated Chemical Reactions • Common Lab Glassware and Uses • Conducting Reactions Below Room Temperature • Cyclic Voltammetry (CV) • Determining the Density of a Solid and Liquid • Determining the Mass Percent Composition in an Aqueous Solution • Fractional Distillation • Freezing-Point Depression to Determine an Unknown Compound • Growing Crystals for X-ray Diffraction Analysis • Introduction to Titration • Purifying Compounds by Recrystallization • Rotary Evaporation to Remove Solvent • Solid-Liquid Extraction • Using a pH Meter
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	1.2.c.	Use characteristic physical and chemical properties to develop predictions and supporting claims about elements' positions on the periodic table JoVE • Coordination Chemistry Complexes
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	1.2.d.	Develop a model that differentiates atoms and molecules, elements and compounds, and pure substances and mixtures

		JoVE **• Calibration Curves** **• Capillary Electrophoresis (CE)** **• Chromatography-Based Biomolecule Purification Methods** **• Co-Immunoprecipitation and Pull-Down Assays** **• Column Chromatography** **• Conducting Reactions Below Room Temperature** **• Coordination Chemistry Complexes** **• Cyclic Voltammetry (CV)** **• Degassing Liquids with Freeze-Pump-Thaw Cycling** **• Density Gradient Ultracentrifugation** **• Determining the Density of a Solid and Liquid** **• Determining the Empirical Formula** **• Determining the Mass Percent Composition in an Aqueous Solution** **• Determining the Solubility Rules of Ionic Compounds** **• Dialysis: Diffusion Based Separation** **• Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat** **• Electrophoretic Mobility Shift Assay (EMSA)** **• Enzyme Assays and Kinetics** **• FM Dyes in Vesicle Recycling** **• Fractional Distillation** **• Freezing-Point Depression to Determine an Unknown Compound** **• Förster Resonance Energy Transfer (FRET)** **• Gas Chromatography (GC) with Flame-Ionization Detection** **• Growing Crystals for X-ray Diffraction Analysis** **• High-Performance Liquid Chromatography (HPLC)** **• Internal Standards** **• Introduction to Mass Spectrometry** **• Ion-Exchange Chromatography** **• Lead Analysis of Soil Using Atomic Absorption Spectroscopy** **• MALDI-TOF Mass Spectrometry** **• Metabolic Labeling** **• Method of Standard Addition** **• Nuclear Magnetic Resonance (NMR) Spectroscopy** **• Performing 1D Thin Layer Chromatography** **• Photometric Protein Determination** **• Protein Crystallization** **• Purifying Compounds by Recrystallization** **• Raman Spectroscopy for Chemical Analysis** **• Reconstitution of Membrane Proteins** **• Sample Preparation for Analytical Preparation** **• Schlenk Lines Transfer of Solvents** **• Separation of Mixtures via Precipitation** **• Soil Nutrient Analysis: Nitrogen, Phosphorus, and**

		Potassium • Solid-Liquid Extraction • Solutions and Concentrations • Surface Plasmon Resonance (SPR) • Tandem Mass Spectrometry • Two-Dimensional Gel Electrophoresis • X-ray Fluorescence (XRF)
CONTENT AREA	CO.1.	Physical Science
STANDARD	1.3.	Matter can change form through chemical or nuclear reactions abiding by the laws of conservation of mass and energy. Students can:
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	1.3.a.	Recognize, analyze, interpret, and balance chemical equations (synthesis, decomposition, combustion, and replacement) or nuclear equations (fusion and fission) JoVE • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Assembly of a Reflux System for Heated Chemical Reactions • Column Chromatography • Conducting Reactions Below Room Temperature • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Coordination Chemistry Complexes • Cyclic Voltammetry (CV) • Degassing Liquids with Freeze-Pump-Thaw Cycling • Determining Rate Laws and the Order of Reaction • Determining the Empirical Formula • Determining the Solubility Rules of Ionic Compounds • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Enzyme Assays and Kinetics • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Fractional Distillation • Growing Crystals for X-ray Diffraction Analysis • Introduction to Catalysis • Introduction to Titration • Le Châtelier's Principle • MALDI-TOF Mass Spectrometry • Nuclear Magnetic Resonance (NMR) Spectroscopy • Performing 1D Thin Layer Chromatography • Photometric Protein Determination • Preparing Anhydrous Reagents and Equipment • Proton Exchange Membrane Fuel Cells • Purification of a Total Lipid Extract with Column Chromatography • Purifying Compounds by Recrystallization

		• Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry • Rotary Evaporation to Remove Solvent • Schlenk Lines Transfer of Solvents • Separation of Mixtures via Precipitation • Solid-Liquid Extraction • Solutions and Concentrations • Sonication Extraction of Lipid Biomarkers from Sediment • Soxhlet Extraction of Lipid Biomarkers from Sediment • Spectrophotometric Determination of an Equilibrium Constant • Tandem Mass Spectrometry • Ultraviolet-Visible (UV-Vis) Spectroscopy • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy • Using a pH Meter
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	1.3.b.	Predict reactants and products for different types of chemical and nuclear reactions JoVE • Assembly of a Reflux System for Heated Chemical Reactions • Conducting Reactions Below Room Temperature • Coordination Chemistry Complexes • Determining Rate Laws and the Order of Reaction • Determining the Empirical Formula • Determining the Solubility Rules of Ionic Compounds • Introduction to Catalysis • Introduction to Titration • Le Châtelier's Principle • Preparing Anhydrous Reagents and Equipment • Proton Exchange Membrane Fuel Cells • Solutions and Concentrations • Spectrophotometric Determination of an Equilibrium Constant • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	1.3.c.	Predict and calculate the amount of products produced in a chemical reaction based on the amount of reactants JoVE • Calibration Curves • Capillary Electrophoresis (CE) • Determining Rate Laws and the Order of Reaction • Determining the Empirical Formula • Determining the Mass Percent Composition in an Aqueous Solution • Freezing-Point Depression to Determine an Unknown Compound • Gas Chromatography (GC) with Flame-Ionization

		Detection • High-Performance Liquid Chromatography (HPLC) • Internal Standards • Introduction to Titration • Introduction to the Microplate Reader • Introduction to the Spectrophotometer • Le Châtelier's Principle • Making Solutions in the Laboratory • Method of Standard Addition • Photometric Protein Determination • Sample Preparation for Analytical Preparation • Solutions and Concentrations • Spectrophotometric Determination of an Equilibrium Constant • Understanding Concentration and Measuring Volumes
CONTENT AREA	**CO.1.**	**Physical Science**
STANDARD	**1.4.**	**Atoms bond in different ways to form molecules and compounds that have definite properties. Students can:**
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	1.4.a.	Develop, communicate, and justify an evidence-based scientific explanation supporting the current models of chemical bonding JoVE • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Chromatography-Based Biomolecule Purification Methods • Column Chromatography • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis • Determining the Solubility Rules of Ionic Compounds • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Gas Chromatography (GC) with Flame-Ionization Detection • Growing Crystals for X-ray Diffraction Analysis • High-Performance Liquid Chromatography (HPLC) • Ion-Exchange Chromatography • Performing 1D Thin Layer Chromatography • Preparing Anhydrous Reagents and Equipment • Purification of a Total Lipid Extract with Column Chromatography • Purifying Compounds by Recrystallization • Raman Spectroscopy for Chemical Analysis • Reconstitution of Membrane Proteins

		• Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry • Solid-Liquid Extraction • Solutions and Concentrations • Sonication Extraction of Lipid Biomarkers from Sediment • Soxhlet Extraction of Lipid Biomarkers from Sediment • Ultraviolet-Visible (UV-Vis) Spectroscopy • X-ray Fluorescence (XRF)
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	1.4.b.	Gather, analyze, and interpret data on chemical and physical properties of different compounds such as density, melting point, boiling point, pH, and conductivity JoVE • Chromatography-Based Biomolecule Purification Methods • Column Chromatography • Determining the Empirical Formula • Determining the Solubility Rules of Ionic Compounds • Dialysis: Diffusion Based Separation • Freezing-Point Depression to Determine an Unknown Compound • Growing Crystals for X-ray Diffraction Analysis • Performing 1D Thin Layer Chromatography • Purifying Compounds by Recrystallization • Separation of Mixtures via Precipitation
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	1.4.c.	Use characteristic physical and chemical properties to develop predictions and supporting claims about compounds' classification as ionic, polar or covalent JoVE • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Chromatography-Based Biomolecule Purification Methods • Column Chromatography • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis • Determining the Empirical Formula • Determining the Solubility Rules of Ionic Compounds • Dialysis: Diffusion Based Separation • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Freezing-Point Depression to Determine an Unknown Compound • Gas Chromatography (GC) with Flame-Ionization Detection

		• Growing Crystals for X-ray Diffraction Analysis • High-Performance Liquid Chromatography (HPLC) • Ion-Exchange Chromatography • Performing 1D Thin Layer Chromatography • Preparing Anhydrous Reagents and Equipment • Purification of a Total Lipid Extract with Column Chromatography • Purifying Compounds by Recrystallization • Reconstitution of Membrane Proteins • Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry • Separation of Mixtures via Precipitation • Solid-Liquid Extraction • Solutions and Concentrations • Sonication Extraction of Lipid Biomarkers from Sediment • Soxhlet Extraction of Lipid Biomarkers from Sediment • Ultraviolet-Visible (UV-Vis) Spectroscopy
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	1.4.d.	Describe the role electrons play in atomic bonding JoVE • Coordination Chemistry Complexes
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	1.4.e.	Predict the type of bonding that will occur among elements based on their position in the periodic table JoVE • Coordination Chemistry Complexes
CONTENT AREA	CO.1.	Physical Science
STANDARD	1.5.	Energy exists in many forms such as mechanical, chemical, electrical, radiant, thermal, and nuclear, that can be quantified and experimentally determined. Students can:
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	1.5.c.	Use direct and indirect evidence to develop predictions of the types of energy associated with objects JoVE • Cyclic Voltammetry (CV) • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	1.5.d.	Identify different energy forms, and calculate their amounts by measuring their defining characteristics JoVE • An Introduction to Cell Metabolism • Detecting Reactive Oxygen Species • The ATP Bioluminescence Assay
CONTENT AREA	CO.1.	Physical Science
STANDARD	1.6.	When energy changes form, it is neither created not destroyed; however, because some is necessarily lost as

		heat, the amount of energy available to do work decreases. Students can:
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	1.6.c.	Describe energy transformations both quantitatively and qualitatively JoVE • fMRI: Functional Magnetic Resonance Imaging
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	1.6.d.	Differentiate among the characteristics of mechanical and electromagnetic waves that determine their energy JoVE • Nuclear Magnetic Resonance (NMR) Spectroscopy • Raman Spectroscopy for Chemical Analysis
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	1.6.e.	Examine, evaluate, question, and ethically use information from a variety of sources and media to investigate energy conservation and loss JoVE • Biofuels: Producing Ethanol from Cellulosic Material • Proton Exchange Membrane Fuel Cells
CONTENT AREA	CO.2.	Life Science
STANDARD	2.1.	Matter tends to be cycled within an ecosystem, while energy is transformed and eventually exits an ecosystem. Students can:
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.1.b.	Evaluate the potential ecological impacts of a plant-based or meat-based diet JoVE • An Introduction to Drosophila melanogaster • Basic Mouse Care and Maintenance • Drosophila Development and Reproduction • Drosophila Maintenance • Zebrafish Maintenance and Husbandry • Zebrafish Reproduction and Development
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.1.c.	Analyze and interpret data from experiments on ecosystems where matter such as fertilizer has been added or withdrawn such as through drought JoVE • Nutrients in Aquatic Ecosystems • Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium • Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.1.d.	Develop, communicate, and justify an evidence-based scientific explanation showing how ecosystems follow the laws of conservation of matter and energy JoVE

		• Algae Enumeration via Culturable Methodology • Analysis of Earthworm Populations in Soil • Bacterial Growth Curve Analysis and its Environmental Applications • Carbon and Nitrogen Analysis of Environmental Samples • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Dissolved Oxygen in Surface Water • Filamentous Fungi • Fundamentals of Breeding and Weaning • Nutrients in Aquatic Ecosystems • Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium • Using GIS to Investigate Urban Forestry
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.1.e.	Define and distinguish between matter and energy, and how they are cycled or lost through life processes JoVE • Algae Enumeration via Culturable Methodology • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Analysis of Earthworm Populations in Soil • Bacterial Growth Curve Analysis and its Environmental Applications • Carbon and Nitrogen Analysis of Environmental Samples • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Culturing and Enumerating Bacteria from Soil Samples • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Dissolved Oxygen in Surface Water • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Filamentous Fungi • Fundamentals of Breeding and Weaning • Metabolic Labeling • Nutrients in Aquatic Ecosystems • Purification of a Total Lipid Extract with Column Chromatography • Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry • Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium • Sonication Extraction of Lipid Biomarkers from Sediment • Soxhlet Extraction of Lipid Biomarkers from Sediment • Using GIS to Investigate Urban Forestry

CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.1.f.	Describe how carbon, nitrogen, phosphorus, and water cycles work JoVE • Algae Enumeration via Culturable Methodology • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Bacterial Growth Curve Analysis and its Environmental Applications • Carbon and Nitrogen Analysis of Environmental Samples • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Culturing and Enumerating Bacteria from Soil Samples • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Filamentous Fungi • Metabolic Labeling • Nutrients in Aquatic Ecosystems • Purification of a Total Lipid Extract with Column Chromatography • Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry • Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium • Sonication Extraction of Lipid Biomarkers from Sediment • Soxhlet Extraction of Lipid Biomarkers from Sediment
CONTENT AREA	CO.2.	Life Science
STANDARD	2.2.	The size and persistence of populations depend on their interactions with each other and on the abiotic factors in an ecosystem. Students can:
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.2.a.	Analyze and interpret data about the impact of removing keystone species from an ecosystem or introducing non-native species into an ecosystem JoVE • Analysis of Earthworm Populations in Soil • Tree Survey: Point-Centered Quarter Sampling Method
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.2.c.	Evaluate data and assumptions regarding different scenarios for future human population growth and their projected consequences JoVE • Biofuels: Producing Ethanol from Cellulosic Material • Nutrients in Aquatic Ecosystems

CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**2.2.d.**	**Examine, evaluate, question, and ethically use information from a variety of sources and media to investigate ecosystem interactions** **JoVE** **• Analysis of Earthworm Populations in Soil** **• Bacterial Growth Curve Analysis and its Environmental Applications** **• Culturing and Enumerating Bacteria from Soil Samples** **• Filamentous Fungi** **• Tree Survey: Point-Centered Quarter Sampling Method** **• Using GIS to Investigate Urban Forestry** **• Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy** **• Zebrafish Maintenance and Husbandry**
CONTENT AREA	**CO.2.**	**Life Science**
STANDARD	**2.3.**	**Cellular metabolic activities are carried out by biomolecules produced by organisms. Students can:**
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**2.3.a.**	**Identify biomolecules and their precursors/building blocks** **JoVE** **• An Introduction to Caenorhabditis elegans** **• An Introduction to Cell Death** **• An Introduction to Cell Division** **• An Introduction to Cell Metabolism** **• An Introduction to Cell Motility and Migration** **• An Introduction to Developmental Genetics** **• An Introduction to Molecular Developmental Biology** **• An Introduction to Saccharomyces cerevisiae** **• An Introduction to Transfection** **• An Overview of Epigenetics** **• An Overview of Gene Expression** **• An Overview of Genetic Analysis** **• An Overview of Genetic Engineering** **• An Overview of Genetics and Disease** **• Annexin V and Propidium Iodide Labeling** **• Bacterial Transformation: Electroporation** **• Bacterial Transformation: The Heat Shock Method** **• Biofuels: Producing Ethanol from Cellulosic Material** **• C. elegans Maintenance** **• Cell Cycle Analysis** **• Cell-surface Biotinylation Assay** **• Chromatin Immunoprecipitation** **• Chromatography-Based Biomolecule Purification Methods** **• Co-Immunoprecipitation and Pull-Down Assays** **• Column Chromatography** **• Community DNA Extraction from Bacterial Colonies** **• Cytogenetics** **• DNA Gel Electrophoresis**

		• DNA Ligation Reactions • DNA Methylation Analysis • Density Gradient Ultracentrifugation • Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis • Detecting Reactive Oxygen Species • Development and Reproduction of the Laboratory Mouse • Development of the Chick • Dialysis: Diffusion Based Separation • Drosophila Larval IHC • Drosophila melanogaster Embryo and Larva Harvesting and Preparation • Electrophoretic Mobility Shift Assay (EMSA) • Embryonic Stem Cell Culture and Differentiation • Enzyme Assays and Kinetics • Explant Culture for Developmental Studies • Expression Profiling with Microarrays • FM Dyes in Vesicle Recycling • Förster Resonance Energy Transfer (FRET) • Gel Purification • Gene Silencing with Morpholinos • Genetic Crosses • Genetic Engineering of Model Organisms • Genetic Screens • Genome Editing • In ovo Electroporation of Chicken Embryos • Induced Pluripotency • Introduction to Catalysis • Introduction to Mass Spectrometry • Invasion Assay Using 3D Matrices • Invertebrate Lifespan Quantification • Isolating Nucleic Acids from Yeast • Live Cell Imaging of Mitosis • MALDI-TOF Mass Spectrometry • Metabolic Labeling • Molecular Cloning • Mouse Genotyping • PCR: The Polymerase Chain Reaction • Photometric Protein Determination • Plasmid Purification • Protein Crystallization • Quantifying Environmental Microorganisms and Viruses Using qPCR • RNA Analysis of Environmental Samples Using RT-PCR • RNA-Seq • RNAi in C. elegans • Recombineering and Gene Targeting • Reconstitution of Membrane Proteins • Restriction Enzyme Digests • SNP Genotyping • Separating Protein with SDS-PAGE

		• Spectrophotometric Determination of an Equilibrium Constant • Tandem Mass Spectrometry • Testing For Genetically Modified Foods • The ATP Bioluminescence Assay • The ELISA Method • The TUNEL Assay • The Transwell Migration Assay • The Western Blot • Two-Dimensional Gel Electrophoresis • Ultraviolet-Visible (UV-Vis) Spectroscopy • Whole-Mount In Situ Hybridization • Yeast Maintenance • Yeast Transformation and Cloning • Zebrafish Breeding and Embryo Handling • Zebrafish Microinjection Techniques • Zebrafish Reproduction and Development
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.3.b.	Develop, communicate, and justify an evidence-based explanation that biomolecules follow the same rules of chemistry as any other molecule JoVE • An Introduction to Cell Division • An Introduction to Cell Metabolism • An Introduction to Saccharomyces cerevisiae • An Introduction to Transfection • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method • Cell Cycle Analysis • Cell-surface Biotinylation Assay • Chromatography-Based Biomolecule Purification Methods • Co-Immunoprecipitation and Pull-Down Assays • Cyclic Voltammetry (CV) • DNA Gel Electrophoresis • DNA Ligation Reactions • Density Gradient Ultracentrifugation • Detecting Reactive Oxygen Species • Dialysis: Diffusion Based Separation • Drosophila Larval IHC • Electrophoretic Mobility Shift Assay (EMSA) • Enzyme Assays and Kinetics • FM Dyes in Vesicle Recycling • Förster Resonance Energy Transfer (FRET) • Gel Purification • Introduction to Catalysis • Introduction to Mass Spectrometry • Ion-Exchange Chromatography • MALDI-TOF Mass Spectrometry • Metabolic Labeling • Method of Standard Addition

		• Molecular Cloning • Nuclear Magnetic Resonance (NMR) Spectroscopy • PCR: The Polymerase Chain Reaction • Passaging Cells • Photometric Protein Determination • Plasmid Purification • Protein Crystallization • Reconstitution of Membrane Proteins • Restriction Enzyme Digests • Sample Preparation for Analytical Preparation • Separating Protein with SDS-PAGE • Surface Plasmon Resonance (SPR) • Tandem Mass Spectrometry • The ATP Bioluminescence Assay • The ELISA Method • The Western Blot • Two-Dimensional Gel Electrophoresis • Ultraviolet-Visible (UV-Vis) Spectroscopy
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.3.c.	Develop, communicate, and justify an evidence-based explanation regarding the optimal conditions required for enzyme activity JoVE • An Introduction to Cell Death • Biofuels: Producing Ethanol from Cellulosic Material • Co-Immunoprecipitation and Pull-Down Assays • DNA Ligation Reactions • Enzyme Assays and Kinetics • Introduction to Catalysis • Live Cell Imaging of Mitosis • Molecular Cloning • PCR: The Polymerase Chain Reaction • Restriction Enzyme Digests • The ELISA Method • The TUNEL Assay
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.3.d.	Infer the consequences to organisms of suboptimal enzyme function - such as altered blood pH or high fever - using direct and indirect evidence JoVE • An Introduction to Cell Death • Biofuels: Producing Ethanol from Cellulosic Material • Co-Immunoprecipitation and Pull-Down Assays • DNA Ligation Reactions • Enzyme Assays and Kinetics • Introduction to Catalysis • Live Cell Imaging of Mitosis • Measuring Vital Signs • Molecular Cloning • PCR: The Polymerase Chain Reaction • Restriction Enzyme Digests

		• The ELISA Method • The TUNEL Assay
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**2.3.e.**	**Analyze and interpret data on the body's utilization of carbohydrates, lipids, and proteins** **JoVE** • An Introduction to Caenorhabditis elegans • An Introduction to Cell Death • An Introduction to Cell Division • An Introduction to Cell Metabolism • An Introduction to Cell Motility and Migration • An Introduction to Developmental Genetics • An Introduction to Molecular Developmental Biology • An Introduction to Saccharomyces cerevisiae • An Introduction to Transfection • An Overview of Epigenetics • An Overview of Gene Expression • An Overview of Genetic Analysis • An Overview of Genetic Engineering • An Overview of Genetics and Disease • Annexin V and Propidium Iodide Labeling • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method • C. elegans Maintenance • Cell Cycle Analysis • Cell-surface Biotinylation Assay • Chromatin Immunoprecipitation • Chromatography-Based Biomolecule Purification Methods • Co-Immunoprecipitation and Pull-Down Assays • Column Chromatography • Community DNA Extraction from Bacterial Colonies • Cytogenetics • DNA Gel Electrophoresis • DNA Ligation Reactions • DNA Methylation Analysis • Density Gradient Ultracentrifugation • Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis • Detecting Reactive Oxygen Species • Development and Reproduction of the Laboratory Mouse • Development of the Chick • Dialysis: Diffusion Based Separation • Drosophila Larval IHC • Drosophila melanogaster Embryo and Larva Harvesting and Preparation • Electrophoretic Mobility Shift Assay (EMSA) • Embryonic Stem Cell Culture and Differentiation • Enzyme Assays and Kinetics • Explant Culture for Developmental Studies

		• Expression Profiling with Microarrays • FM Dyes in Vesicle Recycling • Gel Purification • Gene Silencing with Morpholinos • Genetic Crosses • Genetic Engineering of Model Organisms • Genetic Screens • Genome Editing • In ovo Electroporation of Chicken Embryos • Induced Pluripotency • Introduction to Catalysis • Introduction to Mass Spectrometry • Invasion Assay Using 3D Matrices • Invertebrate Lifespan Quantification • Isolating Nucleic Acids from Yeast • Live Cell Imaging of Mitosis • MALDI-TOF Mass Spectrometry • Metabolic Labeling • Molecular Cloning • Mouse Genotyping • PCR: The Polymerase Chain Reaction • Photometric Protein Determination • Plasmid Purification • Protein Crystallization • Quantifying Environmental Microorganisms and Viruses Using qPCR • RNA Analysis of Environmental Samples Using RT-PCR • RNA-Seq • RNAi in C. elegans • Recombineering and Gene Targeting • Reconstitution of Membrane Proteins • Restriction Enzyme Digests • SNP Genotyping • Separating Protein with SDS-PAGE • Tandem Mass Spectrometry • Testing For Genetically Modified Foods • The ATP Bioluminescence Assay • The ELISA Method • The TUNEL Assay • The Transwell Migration Assay • The Western Blot • Two-Dimensional Gel Electrophoresis • Whole-Mount In Situ Hybridization • Yeast Maintenance • Yeast Transformation and Cloning • Zebrafish Breeding and Embryo Handling • Zebrafish Microinjection Techniques • Zebrafish Reproduction and Development
CONTENT AREA	**CO.2.**	**Life Science**
STANDARD	**2.4.**	**The energy for life primarily derives from the interrelated processes of photosynthesis and cellular respiration.**

		Photosynthesis transforms the sun's light energy into the chemical energy of molecular bonds. Cellular respiration allows cells to utilize chemical energy when these bonds are broken. Students can:
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**2.4.a.**	**Develop, communicate, and justify an evidence-based scientific explanation the optimal environment for photosynthetic activity** **JoVE** **• An Introduction to Cell Metabolism**
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**2.4.b.**	**Discuss the interdependence of autotrophic and heterotrophic life forms such as depicting the flow of a carbon atom from the atmosphere, to a leaf, through the food chain, and back to the atmosphere** **JoVE** **• Algae Enumeration via Culturable Methodology** **• An Introduction to Drosophila melanogaster** **• An Introduction to the Chick: Gallus gallus domesticus** **• An Overview of Alkenone Biomarker Analysis for Paleothermometry** **• An Overview of bGDGT Biomarker Analysis for Paleoclimatology** **• Analysis of Earthworm Populations in Soil** **• Bacterial Growth Curve Analysis and its Environmental Applications** **• Carbon and Nitrogen Analysis of Environmental Samples** **• Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry** **• Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy** **• Dissolved Oxygen in Surface Water** **• Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction** **• Filamentous Fungi** **• Fundamentals of Breeding and Weaning** **• Metabolic Labeling** **• Nutrients in Aquatic Ecosystems** **• Purification of a Total Lipid Extract with Column Chromatography** **• Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry** **• Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium** **• Sonication Extraction of Lipid Biomarkers from Sediment** **• Soxhlet Extraction of Lipid Biomarkers from Sediment** **• Using GIS to Investigate Urban Forestry** **• Zebrafish Maintenance and Husbandry** **• Zebrafish Reproduction and Development**

CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**2.4.c.**	**Explain how carbon compounds are gradually oxidized to provide energy in the form of adenosine triphosphate (ATP), which drives many chemical reactions in the cell** **JoVE** **• An Introduction to Cell Metabolism** **• An Introduction to Cell Motility and Migration** **• Detecting Reactive Oxygen Species** **• Invasion Assay Using 3D Matrices** **• The ATP Bioluminescence Assay** **• The Transwell Migration Assay**
CONTENT AREA	**CO.2.**	**Life Science**
STANDARD	**2.5.**	**Cells use passive and active transport of substances across membranes to maintain relatively stable intracellular environments. Students can:**
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**2.5.a.**	**Analyze and interpret data to determine the energy requirements and/or rates of substance transport across cell membranes** **JoVE** **• An Introduction to Endocytosis and Exocytosis** **• Cell-surface Biotinylation Assay** **• Dialysis: Diffusion Based Separation** **• FM Dyes in Vesicle Recycling** **• In ovo Electroporation of Chicken Embryos** **• Reconstitution of Membrane Proteins** **• Yeast Transformation and Cloning**
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**2.5.b.**	**Compare organisms that live in freshwater and marine environments, and identify the challenges of osmotic regulation for these organisms** **JoVE** **• An Introduction to the Zebrafish: Danio rerio** **• Zebrafish Breeding and Embryo Handling** **• Zebrafish Maintenance and Husbandry** **• Zebrafish Microinjection Techniques** **• Zebrafish Reproduction and Development**
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**2.5.c.**	**Diagram the cell membrane schematically, and highlight receptor proteins as targets of hormones, neurotransmitters, or drugs that serve as active links between intra and extracellular environments** **JoVE** **• An Introduction to Cell Death** **• An Introduction to Cell Division** **• An Introduction to Cellular and Molecular Neuroscience** **• An Introduction to Developmental Neurobiology** **• An Introduction to Endocytosis and Exocytosis** **• An Introduction to Neurophysiology** **• An Introduction to Transfection**

		• Annexin V and Propidium Iodide Labeling • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method • Calcium Imaging in Neurons • Cell Cycle Analysis • Cell-surface Biotinylation Assay • Detecting Reactive Oxygen Species • Electro-encephalography (EEG) • Explant Culture of Neural Tissue • FM Dyes in Vesicle Recycling • Histological Staining of Neural Tissue • In ovo Electroporation of Chicken Embryos • Live Cell Imaging of Mitosis • Murine In Utero Electroporation • Neuronal Transfection Methods • Patch Clamp Electrophysiology • Plasmid Purification • Primary Neuronal Cultures • Protein Crystallization • Reconstitution of Membrane Proteins • The TUNEL Assay • The Western Blot • Yeast Maintenance • Yeast Transformation and Cloning
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.5.d.	Use tools to gather, view, analyze, and interpret data produced during scientific investigations that involve passive and active transport JoVE • An Introduction to Endocytosis and Exocytosis • An Introduction to Neurophysiology • An Introduction to Transfection • Calcium Imaging in Neurons • Cell-surface Biotinylation Assay • Detecting Reactive Oxygen Species • Dialysis: Diffusion Based Separation • FM Dyes in Vesicle Recycling • In ovo Electroporation of Chicken Embryos • Patch Clamp Electrophysiology • Reconstitution of Membrane Proteins • The TUNEL Assay • Yeast Transformation and Cloning
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.5.e.	Use computer simulations and models to analyze cell transport mechanisms JoVE • An Introduction to Endocytosis and Exocytosis • An Introduction to Neurophysiology • An Introduction to Transfection • Calcium Imaging in Neurons • Cell-surface Biotinylation Assay

		• Detecting Reactive Oxygen Species • FM Dyes in Vesicle Recycling • In ovo Electroporation of Chicken Embryos • Patch Clamp Electrophysiology • Reconstitution of Membrane Proteins • The TUNEL Assay • Yeast Transformation and Cloning
CONTENT AREA	**CO.2.**	**Life Science**
STANDARD	**2.6.**	**Cells, tissues, organs, and organ systems maintain relatively stable internal environments, even in the face of changing external environments. Students can:**
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**2.6.a.**	**Discuss how two or more body systems interact to promote health for the whole organism** **JoVE** • Abdominal Exam I: Inspection and Auscultation • Abdominal Exam II: Percussion • Abdominal Exam III: Palpation • Abdominal Exam IV: Acute Abdominal Pain Assessment • An Introduction to Behavioral Neuroscience • An Introduction to Cellular and Molecular Neuroscience • An Introduction to Cognition • An Introduction to Learning and Memory • An Introduction to Motor Control • An Introduction to Neuroanatomy • An Introduction to Neurophysiology • An Introduction to Reward and Addiction • Anesthesia Induction and Maintenance • Ankle Exam • Anterograde Amnesia • Anxiety Testing • Arterial Line Placement • Assessing Dexterity with Reaching Tasks • Auscultation • Balance and Coordination Testing • Basic Care Procedures • Basic Life Support Part II: Airway/Breathing and Continued Cardiopulmonary Resuscitation • Basic Life Support: Cardiopulmonary Resuscitation and Defibrillation • Basic Mouse Care and Maintenance • Blood Pressure Measurement • Blood Withdrawal I • Blood Withdrawal II • Calcium Imaging in Neurons • Cardiac Exam I: Inspection and Palpation • Cardiac Exam II: Auscultation • Cardiac Exam III: Abnormal Heart Sounds • Central Venous Catheter Insertion: Femoral Vein with Ultrasound Guidance

		• Central Venous Catheter Insertion: Internal Jugular with Ultrasound Guidance • Central Venous Catheter Insertion: Subclavian Vein • Compound Administration I • Compound Administration II • Compound Administration III • Compound Administration IV • Comprehensive Breast Exam • Considerations for Rodent Surgery • Cranial Nerves Exam I (I-VI) • Cranial Nerves Exam II (VII-XII) • Decoding Auditory Imagery with Multivoxel Pattern Analysis • Diagnostic Necropsy and Tissue Harvest • Ear Exam • Elbow Exam • Emergency Tube Thoracostomy (Chest Tube Placement) • Emergent Lateral Canthotomy and Inferior Catholysis • Eye Exam • Fear Conditioning • Foot Exam • General Approach to the Physical Exam • Hand and Wrist Exam • Hip Exam • Histological Staining of Neural Tissue • Intra-articular Shoulder Injection for Reduction Following Anterior Shoulder Dislocation • Intraosseous Needle Placement • Knee Exam • Learning and Memory: The Remember-Know Task • Lower Back Exam • Lymph Node Exam • Male Rectal Exam • Measuring Vital Signs • Modeling Social Stress • Motor Exam I • Motor Exam II • Motor Learning in Mirror Drawing • Motor Maps • Neck Exam • Needle Thoracostomy (needle Decompression) for Temporizing Tension Pneumothorax Treatment • Nose, Sinuses, Oral Cavity and Pharynx Exam • Observation and Inspection • Ophthalmoscopic Examination • Palpation • Patch Clamp Electrophysiology • Pelvic Exam I: Assessment of the External Genitalia • Pelvic Exam II: Speculum Exam • Pelvic Exam III: Bimanual and Rectovaginal Exam • Percussion

		• Percutaneous Cricothyrotomy (Seldinger Technique) • Pericardiocentesis • Peripheral Vascular Exam • Peripheral Vascular Exam Using a Continuous Wave Doppler • Peripheral Venous Cannulation • Physiological Correlates of Emotion Recognition • Proper Adjustment of Patient Attire during the Physical Exam • Respiratory Exam I: Inspection and Palpation • Respiratory Exam II: Percussion and Auscultation • Rodent Stereotaxic Surgery • Self-administration Studies • Sensory Exam • Shoulder Exam I • Shoulder Exam II • Spatial Memory Testing Using Mazes • Sterile Tissue Harvest • Surgical Cricothyrotomy • The Split Brain • Thyroid Exam • Tree Identification: How To Use a Dichotomous Key • Using a pH Meter • Zebrafish Maintenance and Husbandry • fMRI: Functional Magnetic Resonance Imaging
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.6.b.	Analyze and interpret data on homeostatic mechanisms using direct and indirect evidence to develop and support claims about the effectiveness of feedback loops to maintain homeostasis JoVE • Abdominal Exam I: Inspection and Auscultation • Abdominal Exam II: Percussion • Abdominal Exam III: Palpation • Abdominal Exam IV: Acute Abdominal Pain Assessment • An Introduction to Cell Death • An Introduction to Cell Division • An Introduction to Cell Metabolism • An Introduction to Cellular and Molecular Neuroscience • An Introduction to Cognition • An Introduction to Developmental Neurobiology • An Introduction to Endocytosis and Exocytosis • An Introduction to Learning and Memory • An Introduction to Molecular Developmental Biology • An Introduction to Reward and Addiction • An Introduction to Stem Cell Biology • Anesthesia Induction and Maintenance • Ankle Exam • Annexin V and Propidium Iodide Labeling • Arterial Line Placement

		• Assessing Dexterity with Reaching Tasks • Auscultation • Balance and Coordination Testing • Basic Care Procedures • Basic Life Support Part II: Airway/Breathing and Continued Cardiopulmonary Resuscitation • Basic Life Support: Cardiopulmonary Resuscitation and Defibrillation • Basic Mouse Care and Maintenance • Blood Pressure Measurement • Blood Withdrawal I • Blood Withdrawal II • C. elegans Development and Reproduction • Calcium Imaging in Neurons • Cardiac Exam I: Inspection and Palpation • Cardiac Exam II: Auscultation • Cardiac Exam III: Abnormal Heart Sounds • Cell-surface Biotinylation Assay • Central Venous Catheter Insertion: Femoral Vein with Ultrasound Guidance • Central Venous Catheter Insertion: Internal Jugular with Ultrasound Guidance • Central Venous Catheter Insertion: Subclavian Vein • Compound Administration I • Compound Administration II • Compound Administration III • Compound Administration IV • Comprehensive Breast Exam • Considerations for Rodent Surgery • Cranial Nerves Exam I (I-VI) • Cranial Nerves Exam II (VII-XII) • Detecting Reactive Oxygen Species • Diagnostic Necropsy and Tissue Harvest • Ear Exam • Elbow Exam • Electro-encephalography (EEG) • Embryonic Stem Cell Culture and Differentiation • Emergency Tube Thoracostomy (Chest Tube Placement) • Emergent Lateral Canthotomy and Inferior Catholysis • Explant Culture of Neural Tissue • Eye Exam • FM Dyes in Vesicle Recycling • Fear Conditioning • Foot Exam • General Approach to the Physical Exam • Hand and Wrist Exam • Hip Exam • Histological Staining of Neural Tissue • In ovo Electroporation of Chicken Embryos • Induced Pluripotency

		• Intra-articular Shoulder Injection for Reduction Following Anterior Shoulder Dislocation • Intraosseous Needle Placement • Isolating Nucleic Acids from Yeast • Knee Exam • Lower Back Exam • Lymph Node Exam • Male Rectal Exam • Measuring Vital Signs • Motor Exam I • Motor Exam II • Murine In Utero Electroporation • Neck Exam • Needle Thoracostomy (needle Decompression) for Temporizing Tension Pneumothorax Treatment • Nose, Sinuses, Oral Cavity and Pharynx Exam • Observation and Inspection • Ophthalmoscopic Examination • Palpation • Patch Clamp Electrophysiology • Pelvic Exam I: Assessment of the External Genitalia • Pelvic Exam II: Speculum Exam • Pelvic Exam III: Bimanual and Rectovaginal Exam • Percussion • Percutaneous Cricothyrotomy (Seldinger Technique) • Pericardiocentesis • Peripheral Vascular Exam • Peripheral Vascular Exam Using a Continuous Wave Doppler • Peripheral Venous Cannulation • Physiological Correlates of Emotion Recognition • Proper Adjustment of Patient Attire during the Physical Exam • Reconstitution of Membrane Proteins • Respiratory Exam I: Inspection and Palpation • Respiratory Exam II: Percussion and Auscultation • Self-administration Studies • Sensory Exam • Shoulder Exam I • Shoulder Exam II • Spatial Memory Testing Using Mazes • Sterile Tissue Harvest • Surgical Cricothyrotomy • The ATP Bioluminescence Assay • The TUNEL Assay • Thyroid Exam • Tissue Regeneration with Somatic Stem Cells • Tree Identification: How To Use a Dichotomous Key • Using a pH Meter • Yeast Maintenance • Yeast Reproduction

		• Yeast Transformation and Cloning • Zebrafish Maintenance and Husbandry
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.6.c.	Distinguish between causation and correlation in epidemiological data, such as examining scientifically valid evidence regarding disrupted homeostasis in particular diseases <u>JoVE</u> • Abdominal Exam IV: Acute Abdominal Pain Assessment • An Introduction to Aging and Regeneration • An Introduction to Cell Division • An Introduction to Endocytosis and Exocytosis • An Introduction to Modeling Behavioral Disorders and Stress • An Introduction to Motor Control • An Introduction to Saccharomyces cerevisiae • An Introduction to Stem Cell Biology • An Introduction to the Laboratory Mouse: Mus musculus • An Introduction to the Zebrafish: Danio rerio • An Overview of Gene Expression • An Overview of Genetic Analysis • An Overview of Genetic Engineering • An Overview of Genetics and Disease • Basic Care Procedures • Basic Mouse Care and Maintenance • Chromatography-Based Biomolecule Purification Methods • Co-Immunoprecipitation and Pull-Down Assays • Culturing and Enumerating Bacteria from Soil Samples • Cytogenetics • Detection of Bacteriophages in Environmental Samples • Embryonic Stem Cell Culture and Differentiation • Gene Silencing with Morpholinos • Genetic Crosses • Genetic Screens • Gram Staining of Bacteria from Environmental Sources • Isolation of Fecal Bacteria from Water Samples by Filtration • Pelvic Exam III: Bimanual and Rectovaginal Exam • Protein Crystallization • RNA Analysis of Environmental Samples Using RT-PCR • RNA-Seq • Recombineering and Gene Targeting • Respiratory Exam I: Inspection and Palpation • SNP Genotyping • Testing For Genetically Modified Foods • Tissue Regeneration with Somatic Stem Cells • Using GIS to Investigate Urban Forestry • Whole-Mount In Situ Hybridization

CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**2.6.d.**	**Use computer simulations and models of homeostatic mechanisms** **<u>JoVE</u>** **• Abdominal Exam I: Inspection and Auscultation** **• Abdominal Exam II: Percussion** **• Abdominal Exam III: Palpation** **• Abdominal Exam IV: Acute Abdominal Pain Assessment** **• An Introduction to Cell Death** **• An Introduction to Cell Division** **• An Introduction to Cell Metabolism** **• An Introduction to Cellular and Molecular Neuroscience** **• An Introduction to Cognition** **• An Introduction to Developmental Neurobiology** **• An Introduction to Endocytosis and Exocytosis** **• An Introduction to Learning and Memory** **• An Introduction to Molecular Developmental Biology** **• An Introduction to Reward and Addiction** **• An Introduction to Stem Cell Biology** **• Anesthesia Induction and Maintenance** **• Ankle Exam** **• Annexin V and Propidium Iodide Labeling** **• Arterial Line Placement** **• Assessing Dexterity with Reaching Tasks** **• Auscultation** **• Balance and Coordination Testing** **• Basic Care Procedures** **• Basic Life Support Part II: Airway/Breathing and Continued Cardiopulmonary Resuscitation** **• Basic Life Support: Cardiopulmonary Resuscitation and Defibrillation** **• Basic Mouse Care and Maintenance** **• Blood Pressure Measurement** **• Blood Withdrawal I** **• Blood Withdrawal II** **• C. elegans Development and Reproduction** **• Calcium Imaging in Neurons** **• Cardiac Exam I: Inspection and Palpation** **• Cardiac Exam II: Auscultation** **• Cardiac Exam III: Abnormal Heart Sounds** **• Cell-surface Biotinylation Assay** **• Central Venous Catheter Insertion: Femoral Vein with Ultrasound Guidance** **• Central Venous Catheter Insertion: Internal Jugular with Ultrasound Guidance** **• Central Venous Catheter Insertion: Subclavian Vein** **• Compound Administration I** **• Compound Administration II** **• Compound Administration III** **• Compound Administration IV**

		• Comprehensive Breast Exam • Considerations for Rodent Surgery • Cranial Nerves Exam I (I-VI) • Cranial Nerves Exam II (VII-XII) • Detecting Reactive Oxygen Species • Diagnostic Necropsy and Tissue Harvest • Ear Exam • Elbow Exam • Electro-encephalography (EEG) • Embryonic Stem Cell Culture and Differentiation • Emergency Tube Thoracostomy (Chest Tube Placement) • Emergent Lateral Canthotomy and Inferior Catholysis • Explant Culture of Neural Tissue • Eye Exam • FM Dyes in Vesicle Recycling • Fear Conditioning • Foot Exam • General Approach to the Physical Exam • Hand and Wrist Exam • Hip Exam • Histological Staining of Neural Tissue • In ovo Electroporation of Chicken Embryos • Induced Pluripotency • Intra-articular Shoulder Injection for Reduction Following Anterior Shoulder Dislocation • Intraosseous Needle Placement • Isolating Nucleic Acids from Yeast • Knee Exam • Lower Back Exam • Lymph Node Exam • Male Rectal Exam • Measuring Vital Signs • Motor Exam I • Motor Exam II • Murine In Utero Electroporation • Neck Exam • Needle Thoracostomy (needle Decompression) for Temporizing Tension Pneumothorax Treatment • Nose, Sinuses, Oral Cavity and Pharynx Exam • Observation and Inspection • Ophthalmoscopic Examination • Palpation • Patch Clamp Electrophysiology • Pelvic Exam I: Assessment of the External Genitalia • Pelvic Exam II: Speculum Exam • Pelvic Exam III: Bimanual and Rectovaginal Exam • Percussion • Percutaneous Cricothyrotomy (Seldinger Technique) • Pericardiocentesis • Peripheral Vascular Exam

		• Peripheral Vascular Exam Using a Continuous Wave Doppler • Peripheral Venous Cannulation • Physiological Correlates of Emotion Recognition • Proper Adjustment of Patient Attire during the Physical Exam • Reconstitution of Membrane Proteins • Respiratory Exam I: Inspection and Palpation • Respiratory Exam II: Percussion and Auscultation • Self-administration Studies • Sensory Exam • Shoulder Exam I • Shoulder Exam II • Spatial Memory Testing Using Mazes • Sterile Tissue Harvest • Surgical Cricothyrotomy • The ATP Bioluminescence Assay • The TUNEL Assay • Thyroid Exam • Tissue Regeneration with Somatic Stem Cells • Tree Identification: How To Use a Dichotomous Key • Using a pH Meter • Yeast Maintenance • Yeast Reproduction • Yeast Transformation and Cloning • Zebrafish Maintenance and Husbandry
CONTENT AREA	**CO.2.**	**Life Science**
STANDARD	**2.7.**	**Physical and behavioral characteristics of an organism are influenced to varying degrees by heritable genes, many of which encode instructions for the production of proteins. Students can:**
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**2.7.a.**	**Analyze and interpret data that genes are expressed portions of DNA.** **JoVE** • An Introduction to Aging and Regeneration • An Introduction to Caenorhabditis elegans • An Introduction to Cell Death • An Introduction to Cell Division • An Introduction to Cellular and Molecular Neuroscience • An Introduction to Developmental Genetics • An Introduction to Drosophila melanogaster • An Introduction to Molecular Developmental Biology • An Introduction to Organogenesis • An Introduction to Saccharomyces cerevisiae • An Introduction to Stem Cell Biology • An Introduction to Transfection • An Introduction to the Chick: Gallus gallus domesticus • An Introduction to the Zebrafish: Danio rerio • An Overview of Epigenetics • An Overview of Gene Expression

		• An Overview of Genetic Analysis • An Overview of Genetic Engineering • An Overview of Genetics and Disease • Annexin V and Propidium Iodide Labeling • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method • C. elegans Maintenance • Chick ex ovo Culture • Chromatin Immunoprecipitation • Cytogenetics • DNA Ligation Reactions • DNA Methylation Analysis • Development and Reproduction of the Laboratory Mouse • Electrophoretic Mobility Shift Assay (EMSA) • Explant Culture for Developmental Studies • Expression Profiling with Microarrays • Fate Mapping • Gene Silencing with Morpholinos • Genetic Crosses • Genetic Engineering of Model Organisms • Genetic Screens • In ovo Electroporation of Chicken Embryos • Isolating Nucleic Acids from Yeast • Molecular Cloning • Mouse Genotyping • Neuronal Transfection Methods • PCR: The Polymerase Chain Reaction • Plasmid Purification • Primary Neuronal Cultures • Protein Crystallization • RNA Analysis of Environmental Samples Using RT-PCR • RNA-Seq • RNAi in C. elegans • Restriction Enzyme Digests • SNP Genotyping • Testing For Genetically Modified Foods • The TUNEL Assay • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Whole-Mount In Situ Hybridization • Yeast Transformation and Cloning • Zebrafish Breeding and Embryo Handling • Zebrafish Microinjection Techniques • Zebrafish Reproduction and Development
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.7.b.	Analyze and interpret data on the processes of DNA replication, transcription, translation, and gene regulation, and show how these processes are the same in all organisms JoVE

		• An Introduction to Aging and Regeneration • An Introduction to Caenorhabditis elegans • An Introduction to Cell Death • An Introduction to Cell Division • An Introduction to Cellular and Molecular Neuroscience • An Introduction to Developmental Genetics • An Introduction to Developmental Neurobiology • An Introduction to Molecular Developmental Biology • An Introduction to Organogenesis • An Introduction to Stem Cell Biology • An Introduction to Transfection • An Introduction to the Zebrafish: Danio rerio • An Overview of Epigenetics • An Overview of Gene Expression • An Overview of Genetic Analysis • An Overview of Genetic Engineering • An Overview of Genetics and Disease • Annexin V and Propidium Iodide Labeling • Cell Cycle Analysis • Chick ex ovo Culture • Chromatin Immunoprecipitation • DNA Ligation Reactions • DNA Methylation Analysis • Detecting Reactive Oxygen Species • Development and Reproduction of the Laboratory Mouse • Development of the Chick • Drosophila Development and Reproduction • Drosophila melanogaster Embryo and Larva Harvesting and Preparation • Electrophoretic Mobility Shift Assay (EMSA) • Embryonic Stem Cell Culture and Differentiation • Explant Culture for Developmental Studies • Explant Culture of Neural Tissue • Expression Profiling with Microarrays • Fate Mapping • Gene Silencing with Morpholinos • Genetic Crosses • Genetic Engineering of Model Organisms • Genetic Screens • Genome Editing • Histological Staining of Neural Tissue • In ovo Electroporation of Chicken Embryos • Induced Pluripotency • Introduction to the Microplate Reader • Isolating Nucleic Acids from Yeast • Live Cell Imaging of Mitosis • Method of Standard Addition • Molecular Cloning • Mouse Genotyping • Murine In Utero Electroporation

		• PCR: The Polymerase Chain Reaction • Protein Crystallization • Quantifying Environmental Microorganisms and Viruses Using qPCR • RNA Analysis of Environmental Samples Using RT-PCR • RNA-Seq • RNAi in C. elegans • Restriction Enzyme Digests • Rodent Stereotaxic Surgery • Testing For Genetically Modified Foods • The TUNEL Assay • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Whole-Mount In Situ Hybridization • Yeast Maintenance • Yeast Transformation and Cloning • Zebrafish Breeding and Embryo Handling • Zebrafish Microinjection Techniques • Zebrafish Reproduction and Development
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.7.c.	Recognize that proteins carry out most cell activities and mediate the effect of genes on physical and behavioral traits in an organism <u>JoVE</u> • An Introduction to Cell Motility and Migration • An Introduction to Saccharomyces cerevisiae • An Overview of Epigenetics • An Overview of Gene Expression • Cell-surface Biotinylation Assay • Chromatin Immunoprecipitation • Co-Immunoprecipitation and Pull-Down Assays • Density Gradient Ultracentrifugation • Dialysis: Diffusion Based Separation • Drosophila Larval IHC • Electrophoretic Mobility Shift Assay (EMSA) • Enzyme Assays and Kinetics • FM Dyes in Vesicle Recycling • Förster Resonance Energy Transfer (FRET) • Genetic Engineering of Model Organisms • Introduction to Catalysis • Introduction to Mass Spectrometry • Invasion Assay Using 3D Matrices • Ion-Exchange Chromatography • MALDI-TOF Mass Spectrometry • Metabolic Labeling • Photometric Protein Determination • Protein Crystallization • Reconstitution of Membrane Proteins • Separating Protein with SDS-PAGE • Separation of Mixtures via Precipitation • Surface Plasmon Resonance (SPR)

		• Tandem Mass Spectrometry • The ELISA Method • The Transwell Migration Assay • The Western Blot • Two-Dimensional Gel Electrophoresis • Yeast Transformation and Cloning
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.7.d.	Evaluate data showing that offspring are not clones of their parents or siblings due to the meiotic processes of independent assortment of chromosomes, crossing over, and mutations JoVE • An Introduction to Aging and Regeneration • An Introduction to Caenorhabditis elegans • An Introduction to Cell Death • An Introduction to Cell Division • An Introduction to Developmental Genetics • An Introduction to Drosophila melanogaster • An Introduction to Modeling Behavioral Disorders and Stress • An Introduction to Saccharomyces cerevisiae • An Introduction to Transfection • An Introduction to the Chick: Gallus gallus domesticus • An Introduction to the Zebrafish: Danio rerio • An Overview of Epigenetics • An Overview of Gene Expression • An Overview of Genetic Analysis • An Overview of Genetics and Disease • C. elegans Development and Reproduction • Development and Reproduction of the Laboratory Mouse • Development of the Chick • Drosophila Development and Reproduction • Drosophila melanogaster Embryo and Larva Harvesting and Preparation • Fundamentals of Breeding and Weaning • Genetic Crosses • Genetic Engineering of Model Organisms • Genetic Screens • Isolating Nucleic Acids from Yeast • Passaging Cells • The TUNEL Assay • Yeast Maintenance • Yeast Reproduction • Zebrafish Breeding and Embryo Handling • Zebrafish Reproduction and Development
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.7.e.	Explain using examples how genetic mutations can benefit, harm, or have neutral effects on an organism JoVE • An Introduction to Aging and Regeneration

		• An Introduction to Caenorhabditis elegans • An Introduction to Cell Death • An Introduction to Cell Division • An Introduction to Developmental Genetics • An Introduction to Drosophila melanogaster • An Introduction to Modeling Behavioral Disorders and Stress • An Introduction to Saccharomyces cerevisiae • An Introduction to Transfection • An Introduction to the Zebrafish: Danio rerio • An Overview of Epigenetics • An Overview of Gene Expression • An Overview of Genetic Analysis • An Overview of Genetics and Disease • Genetic Engineering of Model Organisms • Genetic Screens • Isolating Nucleic Acids from Yeast • Passaging Cells • The TUNEL Assay
CONTENT AREA	**CO.2.**	**Life Science**
STANDARD	**2.8.**	**Multicellularity makes possible a division of labor at the cellular level through the expression of select genes, but not the entire genome. Students can:**
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**2.8.a.**	**Develop, communicate, and justify an evidence-based scientific explanation of how cells form specialized tissues due to the expression of some genes and not others** **JoVE** • An Introduction to Aging and Regeneration • An Introduction to Caenorhabditis elegans • An Introduction to Cell Motility and Migration • An Introduction to Developmental Genetics • An Introduction to Developmental Neurobiology • An Introduction to Molecular Developmental Biology • An Introduction to Organogenesis • An Introduction to Stem Cell Biology • An Overview of Epigenetics • An Overview of Gene Expression • C. elegans Development and Reproduction • DNA Methylation Analysis • Development and Reproduction of the Laboratory Mouse • Development of the Chick • Drosophila Larval IHC • Embryonic Stem Cell Culture and Differentiation • Explant Culture for Developmental Studies • Explant Culture of Neural Tissue • Expression Profiling with Microarrays • Fate Mapping • Gene Silencing with Morpholinos

		• Genetic Engineering of Model Organisms • Induced Pluripotency • Murine In Utero Electroporation • RNA-Seq • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Whole-Mount In Situ Hybridization • Zebrafish Breeding and Embryo Handling • Zebrafish Reproduction and Development
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.8.b.	Analyze and interpret data that show most eukaryotic deoxyribonucleic acid (DNA) does not actively code for proteins within cells <u>JoVE</u> • An Introduction to Caenorhabditis elegans • An Introduction to Cell Death • An Introduction to Cell Division • An Introduction to Cellular and Molecular Neuroscience • An Introduction to Developmental Genetics • An Introduction to Molecular Developmental Biology • An Introduction to Saccharomyces cerevisiae • An Introduction to Transfection • An Overview of Epigenetics • An Overview of Gene Expression • An Overview of Genetic Analysis • An Overview of Genetic Engineering • An Overview of Genetics and Disease • Annexin V and Propidium Iodide Labeling • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method • Cell Cycle Analysis • Chromatin Immunoprecipitation • Community DNA Extraction from Bacterial Colonies • Cytogenetics • DNA Gel Electrophoresis • DNA Ligation Reactions • DNA Methylation Analysis • Density Gradient Ultracentrifugation • Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis • Development and Reproduction of the Laboratory Mouse • Drosophila melanogaster Embryo and Larva Harvesting and Preparation • Electrophoretic Mobility Shift Assay (EMSA) • Embryonic Stem Cell Culture and Differentiation • Enzyme Assays and Kinetics • Explant Culture for Developmental Studies • Expression Profiling with Microarrays • Förster Resonance Energy Transfer (FRET) • Gel Purification

		• Gene Silencing with Morpholinos • Genetic Crosses • Genetic Engineering of Model Organisms • Genetic Screens • Genome Editing • In ovo Electroporation of Chicken Embryos • Induced Pluripotency • Isolating Nucleic Acids from Yeast • Live Cell Imaging of Mitosis • Molecular Cloning • Mouse Genotyping • PCR: The Polymerase Chain Reaction • Photometric Protein Determination • Plasmid Purification • Protein Crystallization • Quantifying Environmental Microorganisms and Viruses Using qPCR • RNA Analysis of Environmental Samples Using RT-PCR • RNA-Seq • Recombineering and Gene Targeting • Restriction Enzyme Digests • SNP Genotyping • Testing For Genetically Modified Foods • The TUNEL Assay • Two-Dimensional Gel Electrophoresis • Whole-Mount In Situ Hybridization • Yeast Maintenance • Yeast Transformation and Cloning • Zebrafish Breeding and Embryo Handling
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.8.c.	Develop, communicate, and justify an evidence-based scientific explanation for how a whole organism can be cloned from a differentiated - or adult - cell JoVE • An Introduction to Saccharomyces cerevisiae • An Introduction to the Zebrafish: Danio rerio • An Overview of Genetic Engineering • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method • DNA Ligation Reactions • Genetic Engineering of Model Organisms • Molecular Cloning • Plasmid Purification • Recombineering and Gene Targeting • Yeast Transformation and Cloning
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.8.d.	Analyze and interpret data on medical problems using direct and indirect evidence in developing and supporting claims that genetic mutations and cancer are brought about by exposure to environmental toxins, radiation, or smoking

		JoVE • An Introduction to Cell Death • An Introduction to Cell Division • An Introduction to Cell Metabolism • An Introduction to Cell Motility and Migration • An Introduction to Drosophila melanogaster • An Introduction to Organogenesis • An Introduction to the Chick: Gallus gallus domesticus • An Introduction to the Zebrafish: Danio rerio • An Overview of Genetic Engineering • An Overview of Genetics and Disease • Cell Cycle Analysis • Chick ex ovo Culture • Coordination Chemistry Complexes • DNA Methylation Analysis • Detecting Reactive Oxygen Species • Ear Exam • Expression Profiling with Microarrays • Genome Editing • Introducing Experimental Agents into the Mouse • Invasion Assay Using 3D Matrices • Live Cell Imaging of Mitosis • Lymph Node Exam • Male Rectal Exam • Mouse Genotyping • Pelvic Exam II: Speculum Exam • Pelvic Exam III: Bimanual and Rectovaginal Exam • Peripheral Vascular Exam Using a Continuous Wave Doppler • Respiratory Exam I: Inspection and Palpation • The TUNEL Assay • The Transwell Migration Assay
CONTENT AREA	**CO.2.**	**Life Science**
STANDARD	**2.9.**	**Evolution occurs as the heritable characteristics of populations change across generations and can lead populations to become better adapted to their environment. Students can:**
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**2.9.a.**	**Develop, communicate, and justify an evidence-based scientific explanation for how Earth's diverse life forms today evolved from common ancestors** **JoVE** • An Introduction to the Chick: Gallus gallus domesticus • An Introduction to the Zebrafish: Danio rerio • An Overview of Genetic Analysis
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**2.9.b.**	**Analyze and interpret multiple lines of evidence supporting the idea that all species are related by common ancestry such as molecular studies, comparative anatomy, biogeography, fossil record and embryology**

		JoVE • An Introduction to Caenorhabditis elegans • An Introduction to Drosophila melanogaster • An Introduction to the Chick: Gallus gallus domesticus • An Introduction to the Laboratory Mouse: Mus musculus • An Introduction to the Zebrafish: Danio rerio • An Overview of Genetic Analysis • Drosophila Development and Reproduction • Drosophila melanogaster Embryo and Larva Harvesting and Preparation • High-Performance Liquid Chromatography (HPLC)
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.9.d.	Analyze and interpret data on how evolution can be driven by three key components of natural selection - heritability, genetic variation, and differential survival and reproduction JoVE • An Introduction to the Chick: Gallus gallus domesticus • An Overview of Genetic Analysis
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	2.9.e.	Generate a model - an evolutionary tree - showing how a group of organisms is most likely diverged from common ancestry JoVE • An Introduction to the Chick: Gallus gallus domesticus • An Introduction to the Zebrafish: Danio rerio
CONTENT AREA	CO.3.	Earth Systems Science
STANDARD	3.1.	The history of the universe, solar system and Earth can be inferred from evidence left from past events. Students can:
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	3.1.a.	Develop, communicate, and justify an evidence-based scientific explanation addressing questions about Earth's history JoVE • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Igneous Intrusive Rock • Making a Geologic Cross Section • Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	3.1.b.	Analyze and interpret data regarding Earth's history using direct and indirect evidence

		JoVE • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Igneous Intrusive Rock • Making a Geologic Cross Section • Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	3.1.d.	Seek, evaluate, and use a variety of specialized resources available from libraries, the Internet, and the community to find scientific information on Earth's history JoVE • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Igneous Intrusive Rock • Making a Geologic Cross Section • Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry
CONTENT AREA	CO.3.	Earth Systems Science
STANDARD	3.2.	As part of the solar system, Earth interacts with various extraterrestrial forces and energies such as gravity, solar phenomena, electromagnetic radiation, and impact events that influence the planet's geosphere, atmosphere, and biosphere in a variety of ways. Students can:
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	3.2.a.	Develop, communicate, and justify an evidence-based scientific explanation addressing questions around the extraterrestrial forces and energies that influence Earth JoVE • Turbidity and Total Solids in Surface Water
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	3.2.b.	Analyze and interpret data regarding extraterrestrial forces and energies JoVE • Turbidity and Total Solids in Surface Water
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	3.2.c.	Clearly identify assumptions behind conclusions regarding extraterrestrial forces and energies and provide feedback on the validity of alternative explanations JoVE • Turbidity and Total Solids in Surface Water

CONTENT AREA	CO.3.	Earth Systems Science
STANDARD	3.3.	The theory of plate tectonics helps explain geological, physical, and geographical features of Earth. Students can:
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	3.3.a.	Develop, communicate, and justify an evidence-based scientific explanation about the theory of plate tectonics and how it can be used to understand geological, physical, and geographical features of Earth JoVE • Determining Spatial Orientation of Rock Layers with the Brunton Compass • Igneous Intrusive Rock • Igneous Volcanic Rock • Making a Geologic Cross Section • Using Topographic Maps to Generate Topographic Profiles
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	3.3.b.	Analyze and interpret data on plate tectonics and the geological, physical, and geographical features of Earth JoVE • Igneous Volcanic Rock
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	3.3.c.	Understand the role plate tectonics has had with respect to long-term global changes in Earth's systems such as continental buildup, glaciations, sea-level fluctuations, and climate change JoVE • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Determining Spatial Orientation of Rock Layers with the Brunton Compass • Igneous Intrusive Rock • Igneous Volcanic Rock • Making a Geologic Cross Section • Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry • Using Topographic Maps to Generate Topographic Profiles
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	3.3.d.	Investigate and explain how new conceptual interpretations of data and innovative geophysical technologies led to the current theory of plate tectonics JoVE • Determining Spatial Orientation of Rock Layers with the Brunton Compass

		• Igneous Intrusive Rock • Igneous Volcanic Rock • Making a Geologic Cross Section • Using Topographic Maps to Generate Topographic Profiles
CONTENT AREA	**CO.3.**	**Earth Systems Science**
STANDARD	**3.4.**	**Climate is the result of energy transfer among interactions of the atmosphere, hydrosphere, geosphere, and biosphere. Students can:**
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	3.4.d.	Identify mechanisms in the past and present that have changed Earth's climate JoVE • Biofuels: Producing Ethanol from Cellulosic Material
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	3.4.e.	Analyze the evidence and assumptions regarding climate change JoVE • Biofuels: Producing Ethanol from Cellulosic Material
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	3.4.f.	Interpret evidence from weather stations, buoys, satellites, radars, ice and ocean sediment cores, tree rings, cave deposits, native knowledge, and other sources in relation to climate change JoVE • Biofuels: Producing Ethanol from Cellulosic Material
CONTENT AREA	**CO.3.**	**Earth Systems Science**
STANDARD	**3.5.**	**There are costs, benefits, and consequences of exploration, development, and consumption of renewable and nonrenewable resources. Students can:**
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	3.5.a.	Develop, communicate, and justify an evidence-based scientific explanation regarding the costs and benefits of exploration, development, and consumption of renewable and nonrenewable resources JoVE • Bacterial Growth Curve Analysis and its Environmental Applications • Biofuels: Producing Ethanol from Cellulosic Material • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Measuring Tropospheric Ozone • Proton Exchange Membrane Fuel Cells • Raman Spectroscopy for Chemical Analysis • Using GIS to Investigate Urban Forestry
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	3.5.b.	Evaluate positive and negative impacts on the geosphere, atmosphere, hydrosphere, and biosphere in regards to resource use

		JoVE **• An Overview of Alkenone Biomarker Analysis for Paleothermometry** **• An Overview of bGDGT Biomarker Analysis for Paleoclimatology** **• Analysis of Earthworm Populations in Soil** **• Biofuels: Producing Ethanol from Cellulosic Material** **• Carbon and Nitrogen Analysis of Environmental Samples** **• Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry** **• Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy** **• Determining Spatial Orientation of Rock Layers with the Brunton Compass** **• Dissolved Oxygen in Surface Water** **• Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction** **• Igneous Intrusive Rock** **• Introduction to Mass Spectrometry** **• Lead Analysis of Soil Using Atomic Absorption Spectroscopy** **• Making a Geologic Cross Section** **• Measuring Tropospheric Ozone** **• Nutrients in Aquatic Ecosystems** **• Proton Exchange Membrane Fuel Cells** **• Purification of a Total Lipid Extract with Column Chromatography** **• Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry** **• Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium** **• Sonication Extraction of Lipid Biomarkers from Sediment** **• Soxhlet Extraction of Lipid Biomarkers from Sediment** **• Tree Identification: How To Use a Dichotomous Key** **• Tree Survey: Point-Centered Quarter Sampling Method** **• Turbidity and Total Solids in Surface Water** **• Using GIS to Investigate Urban Forestry** **• Using Topographic Maps to Generate Topographic Profiles** **• Water Quality Analysis via Indicator Organisms**
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**3.5.c.**	**Create a plan to reduce environmental impacts due to resource consumption** **JoVE** **• Biofuels: Producing Ethanol from Cellulosic Material** **• Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy** **• Measuring Tropospheric Ozone** **• Proton Exchange Membrane Fuel Cells**

		• Tree Identification: How To Use a Dichotomous Key • Tree Survey: Point-Centered Quarter Sampling Method • Using GIS to Investigate Urban Forestry
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	3.5.d.	Analyze and interpret data about the effect of resource consumption and development on resource reserves to draw conclusions about sustainable use JoVE • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Analysis of Earthworm Populations in Soil • Biofuels: Producing Ethanol from Cellulosic Material • Carbon and Nitrogen Analysis of Environmental Samples • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Determining Spatial Orientation of Rock Layers with the Brunton Compass • Dissolved Oxygen in Surface Water • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Making a Geologic Cross Section • Measuring Tropospheric Ozone • Nutrients in Aquatic Ecosystems • Proton Exchange Membrane Fuel Cells • Purification of a Total Lipid Extract with Column Chromatography • Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry • Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium • Sonication Extraction of Lipid Biomarkers from Sediment • Soxhlet Extraction of Lipid Biomarkers from Sediment • Tree Identification: How To Use a Dichotomous Key • Tree Survey: Point-Centered Quarter Sampling Method • Turbidity and Total Solids in Surface Water • Using GIS to Investigate Urban Forestry • Using Topographic Maps to Generate Topographic Profiles
CONTENT AREA	CO.3.	Earth Systems Science
STANDARD	3.6.	The interaction of Earth's surface with water, air, gravity, and biological activity causes physical and chemical changes. Students can:

CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**3.6.a.**	**Develop, communicate, and justify an evidence-based scientific explanation addressing questions regarding the interaction of Earth's surface with water, air, gravity, and biological activity** **JoVE** **• Turbidity and Total Solids in Surface Water**
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**3.6.b.**	**Analyze and interpret data, maps, and models concerning the direct and indirect evidence produced by physical and chemical changes that water, air, gravity, and biological activity create** **JoVE** **• Determining Spatial Orientation of Rock Layers with the Brunton Compass** **• Making a Geologic Cross Section** **• Turbidity and Total Solids in Surface Water** **• Using Topographic Maps to Generate Topographic Profiles**
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**3.6.c.**	**Evaluate negative and positive consequences of physical and chemical changes on the geosphere** **JoVE** **• An Overview of Alkenone Biomarker Analysis for Paleothermometry** **• An Overview of bGDGT Biomarker Analysis for Paleoclimatology** **• Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry** **• Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy** **• Dissolved Oxygen in Surface Water** **• Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction** **• Purification of a Total Lipid Extract with Column Chromatography** **• Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry** **• Sonication Extraction of Lipid Biomarkers from Sediment** **• Soxhlet Extraction of Lipid Biomarkers from Sediment** **• Turbidity and Total Solids in Surface Water** **• Using GIS to Investigate Urban Forestry**
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	**3.6.d.**	**Use remote sensing and geographic information systems (GIS) data to interpret landforms and landform impact on human activity** **JoVE** **• Determining Spatial Orientation of Rock Layers with the Brunton Compass**

		• Making a Geologic Cross Section • Using GIS to Investigate Urban Forestry • Using Topographic Maps to Generate Topographic Profiles
CONTENT AREA	CO.3.	Earth Systems Science
STANDARD	3.7.	Natural hazards have local, national and global impacts such as volcanoes, earthquakes, tsunamis, hurricanes, and thunderstorms. Students can:
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	3.7.a.	Develop, communicate, and justify an evidence-based scientific explanation regarding natural hazards, and explain their potential local and global impacts JoVE • Igneous Volcanic Rock
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	3.7.b.	Analyze and interpret data about natural hazards using direct and indirect evidence JoVE • Igneous Volcanic Rock
CONCEPTS AND SKILLS / EVIDENCE OUTCOMES	3.7.c.	Make predictions and draw conclusions about the impact of natural hazards on human activity - locally and globally JoVE • Igneous Volcanic Rock