Main Criteria: Indiana Academic Standards
Secondary Criteria: JoVE
Subject: Science
Grade: 9-12
Correlation Options: Show Correlated
Adopted: 2016

STANDARD / STRAND	IN.B.	Biology (B)
PROFICIENCY STATEMENT / SUBSTRAND	B.1.	Cellular Structure and Function
INDICATOR / STANDARD	B.1.1.	Compare and contrast the shape and function of the essential biological macromolecules (i.e. carbohydrates, lipids, proteins, and nucleic acids), as well as, how chemical elements (i.e. carbon, hydrogen, oxygen, nitrogen, phosphorus, and sulfur) can combine to form these biomolecules. 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 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 Alkenone Biomarker Analysis for Paleothermometry • 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 • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Annexin V and Propidium Iodide Labeling • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method • Biofuels: Producing Ethanol from Cellulosic Material

		• C. elegans Maintenance • Capillary Electrophoresis (CE) • 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 • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • 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 Development and Reproduction • 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 • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • 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 • Ion-Exchange Chromatography • Isolating Nucleic Acids from Yeast • Live Cell Imaging of Mitosis

		• MALDI-TOF Mass Spectrometry • Metabolic Labeling • Method of Standard Addition • Molecular Cloning • Mouse Genotyping • PCR: The Polymerase Chain Reaction • Photometric Protein Determination • Plasmid Purification • Protein Crystallization • Purification of a Total Lipid Extract with Column Chromatography • 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 • Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry • Restriction Enzyme Digests • Rodent Stereotaxic Surgery • SNP Genotyping • Separating Protein with SDS-PAGE • Separation of Mixtures via Precipitation • Sonication Extraction of Lipid Biomarkers from Sediment • Soxhlet Extraction of Lipid Biomarkers from Sediment • Spectrophotometric Determination of an Equilibrium Constant • Surface Plasmon Resonance (SPR) • 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
INDICATOR / STANDARD	**B.1.2.**	**Analyze how the shape of a molecule determines its role in the many different types of cellular processes (e.g., metabolism, homeostasis, growth and development, and heredity) and understand that the majority of these processes involve proteins that act as enzymes.**

		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 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 Alkenone Biomarker Analysis for Paleothermometry** **• 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** **• An Overview of bGDGT Biomarker Analysis for Paleoclimatology** **• Annexin V and Propidium Iodide Labeling** **• Bacterial Transformation: Electroporation** **• Bacterial Transformation: The Heat Shock Method** **• Biofuels: Producing Ethanol from Cellulosic Material** **• C. elegans Maintenance** **• Capillary Electrophoresis (CE)** **• 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** **• Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry** **• 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 Development and Reproduction** **• 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 • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • 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 • Ion-Exchange Chromatography • Isolating Nucleic Acids from Yeast • Live Cell Imaging of Mitosis • MALDI-TOF Mass Spectrometry • Metabolic Labeling • Method of Standard Addition • Molecular Cloning • Mouse Genotyping • PCR: The Polymerase Chain Reaction • Photometric Protein Determination • Plasmid Purification • Protein Crystallization • Purification of a Total Lipid Extract with Column Chromatography • 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 • Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry • Restriction Enzyme Digests • Rodent Stereotaxic Surgery • SNP Genotyping • Separating Protein with SDS-PAGE • Separation of Mixtures via Precipitation

		• Sonication Extraction of Lipid Biomarkers from Sediment • Soxhlet Extraction of Lipid Biomarkers from Sediment • Spectrophotometric Determination of an Equilibrium Constant • Surface Plasmon Resonance (SPR) • 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
INDICATOR / STANDARD	B.1.3.	Develop and use models that illustrate how a cell membrane regulates the uptake of materials essential for growth and survival while removing or preventing harmful waste materials from accumulating through the processes of active and passive transport. JoVE • 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 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 ATP Bioluminescence Assay • The TUNEL Assay • The Western Blot • Using Diffusion Tensor Imaging in Traumatic Brain Injury • Yeast Maintenance • Yeast Transformation and Cloning
INDICATOR / STANDARD	B.1.4.	Develop and use models to illustrate how specialized structures within cells (i.e. nuclei, ribosomes, Golgi, endoplasmic reticulum) interact to produce, modify, and transport proteins. JoVE • An Overview of Epigenetics • An Overview of Gene Expression • Chromatin Immunoprecipitation • DNA Methylation Analysis • Detecting Reactive Oxygen Species • Electrophoretic Mobility Shift Assay (EMSA) • Expression Profiling with Microarrays • Gene Silencing with Morpholinos • Genome Editing • Molecular Cloning • Quantifying Environmental Microorganisms and Viruses Using qPCR • RNA Analysis of Environmental Samples Using RT-PCR • RNA-Seq • Whole-Mount In Situ Hybridization
INDICATOR / STANDARD	B.1.5.	Develop and use a model to illustrate the hierarchical organization of interacting systems (cell, tissue, organ, organ system) that provide specific functions within multicellular organisms. JoVE • An Introduction to Aging and Regeneration • An Introduction to Behavioral Neuroscience • An Introduction to Caenorhabditis elegans • An Introduction to Cell Division • An Introduction to Cell Motility and Migration • An Introduction to Cellular and Molecular Neuroscience • An Introduction to Developmental Genetics • An Introduction to Developmental Neurobiology • An Introduction to Learning and Memory • An Introduction to Modeling Behavioral Disorders and Stress • An Introduction to Molecular Developmental Biology

		• An Introduction to Motor Control • An Introduction to Organogenesis • An Introduction to Reward and Addiction • An Introduction to Stem Cell Biology • An Introduction to the Chick: Gallus gallus domesticus • An Introduction to the Zebrafish: Danio rerio • Anesthesia Induction and Maintenance • Anxiety Testing • Approximate Number Sense Test • Assessing Dexterity with Reaching Tasks • Balance and Coordination Testing • Basic Care Procedures • Binocular Rivalry • Blood Withdrawal I • Blood Withdrawal II • C. elegans Chemotaxis Assay • C. elegans Development and Reproduction • C. elegans Maintenance • Calcium Imaging in Neurons • Chick ex ovo Culture • Co-Immunoprecipitation and Pull-Down Assays • Color Afterimages • Compound Administration I • Compound Administration II • Compound Administration III • Compound Administration IV • Considerations for Rodent Surgery • Crowding • Detecting Reactive Oxygen Species • Development and Reproduction of the Laboratory Mouse • Development of the Chick • Diagnostic Necropsy and Tissue Harvest • Dichotic Listening • Drosophila Development and Reproduction • 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 • Finding Your Blind Spot and Perceptual Filling-in • Fundamentals of Breeding and Weaning • Genetic Engineering of Model Organisms • Habituation: Studying Infants Before They Can Talk • Histological Sample Preparation for Light Microscopy • Histological Staining of Neural Tissue • In ovo Electroporation of Chicken Embryos • Inattentional Blindness • Incidental Encoding • Induced Pluripotency

		• Just-noticeable Differences • Measuring Reaction Time and Donders' Method of Subtraction • Measuring Verbal Working Memory Span • Mental Rotation • Modeling Social Stress • Motion-induced Blindness • Motor Learning in Mirror Drawing • Multiple Object Tracking • Murine In Utero Electroporation • Neuronal Transfection Methods • Object Substitution Masking • Patch Clamp Electrophysiology • Physiological Correlates of Emotion Recognition • Primary Neuronal Cultures • Prospect Theory • Rodent Stereotaxic Surgery • Self-administration Studies • Spatial Cueing • Sterile Tissue Harvest • The Ames Room • The Attentional Blink • The Inverted-face Effect • The McGurk Effect • The Precision of Visual Working Memory with Delayed Estimation • The Rubber Hand Illusion • The Staircase Procedure for Finding a Perceptual Threshold • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Verbal Priming • Visual Search for Features and Conjunctions • Visual Statistical Learning • Whole-Mount In Situ Hybridization • Zebrafish Reproduction and Development • fMRI: Functional Magnetic Resonance Imaging
STANDARD / STRAND	**IN.B.**	**Biology (B)**
PROFICIENCY STATEMENT / SUBSTRAND	**B.2.**	**Matter Cycles and Energy Transfer**
INDICATOR / STANDARD	B.2.1.	Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. JoVE • An Introduction to Cell Metabolism • Reconstitution of Membrane Proteins
INDICATOR / STANDARD	B.2.2.	Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new

		compounds are formed resulting in a net transfer of energy. **JoVE** **• An Introduction to Cell Metabolism** **• Biofuels: Producing Ethanol from Cellulosic Material** **• Detecting Reactive Oxygen Species** **• The ATP Bioluminescence Assay**
INDICATOR / STANDARD	**B.2.3.**	**Use mathematical and/or computational representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.** **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**
INDICATOR / STANDARD	**B.2.4.**	**Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.** **JoVE** **• An Introduction to Cell Metabolism**

		• An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • 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 • Detecting Reactive Oxygen Species • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Metabolic Labeling • 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 • The ATP Bioluminescence Assay
STANDARD / STRAND	**IN.B.**	**Biology (B)**
PROFICIENCY STATEMENT / SUBSTRAND	**B.3.**	**Interdependence**
INDICATOR / STANDARD	**B.3.1.**	**Use mathematical and/or computational representation to explain why the carrying capacity ecosystems can support is limited by the available energy, water, oxygen, and minerals and by the ability of ecosystems to recycle the remains of dead organisms.** **JoVE** • Algae Enumeration via Culturable Methodology • Analysis of Earthworm Populations in Soil • Bacterial Growth Curve Analysis and its Environmental Applications • C. elegans Maintenance • Carbon and Nitrogen Analysis of Environmental Samples • Culturing and Enumerating Bacteria from Soil 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 • Quantifying Environmental Microorganisms and Viruses Using qPCR • RNA Analysis of Environmental Samples Using RT-PCR • Soil Nutrient Analysis: Nitrogen, Phosphorus, and

		Potassium • Using GIS to Investigate Urban Forestry
INDICATOR / STANDARD	B.3.2.	Design, evaluate, and refine a model which shows how human activities and natural phenomena can change the flow of matter and energy in an ecosystem and how those changes impact the environment and biodiversity of populations in ecosystems of different scales, as well as, how these human impacts can be reduced. JoVE • Analysis of Earthworm Populations in Soil • Biofuels: Producing Ethanol from Cellulosic Material • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Determination of Moisture Content in Soil • Dissolved Oxygen in Surface Water • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Measuring Tropospheric Ozone • Nutrients in Aquatic Ecosystems • Self-report vs. Behavioral Measures of Recycling • Tree Identification: How To Use a Dichotomous Key • Tree Survey: Point-Centered Quarter Sampling Method • Turbidity and Total Solids in Surface Water • Water Quality Analysis via Indicator Organisms
INDICATOR / STANDARD	B.3.3.	Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, and identify the impact of changing conditions or introducing non-native species into that ecosystem. JoVE • Analysis of Earthworm Populations in Soil • Tree Survey: Point-Centered Quarter Sampling Method
STANDARD / STRAND	IN.B.	Biology (B)
PROFICIENCY STATEMENT / SUBSTRAND	B.4.	Inheritance and Variation in Traits
INDICATOR / STANDARD	B.4.1.	Develop and revise a model that clarifies the relationship between DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. 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 Development and Reproduction • C. elegans Maintenance • Cell Cycle Analysis • Chick ex ovo Culture • 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 • Fate Mapping • 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 • Neuronal Transfection Methods • PCR: The Polymerase Chain Reaction • Photometric Protein Determination • Plasmid Purification • Primary Neuronal Cultures • 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 • Restriction Enzyme Digests • SNP Genotyping • Testing For Genetically Modified Foods • The TUNEL Assay • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • 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
INDICATOR / STANDARD	B.4.2.	Construct an explanation for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells. <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 • DNA Methylation Analysis • Density Gradient Ultracentrifugation • Detecting Reactive Oxygen Species • Dialysis: Diffusion Based Separation • Drosophila Larval IHC • Electrophoretic Mobility Shift Assay (EMSA) • Enzyme Assays and Kinetics • Expression Profiling with Microarrays • FM Dyes in Vesicle Recycling • Förster Resonance Energy Transfer (FRET) • Gene Silencing with Morpholinos • Genetic Engineering of Model Organisms

		• Genome Editing • Introduction to Catalysis • Introduction to Mass Spectrometry • Invasion Assay Using 3D Matrices • Ion-Exchange Chromatography • MALDI-TOF Mass Spectrometry • Metabolic Labeling • Molecular Cloning • Photometric Protein Determination • Protein Crystallization • Quantifying Environmental Microorganisms and Viruses Using qPCR • RNA Analysis of Environmental Samples Using RT-PCR • RNA-Seq • 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 • Whole-Mount In Situ Hybridization • Yeast Transformation and Cloning
INDICATOR / STANDARD	B.4.3.	Construct a model to explain that the unique shape and function of each protein is determined by the sequence of its amino acids, and thus is determined by the sequence of the DNA that codes for this protein. <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 • DNA Methylation Analysis • Density Gradient Ultracentrifugation • Detecting Reactive Oxygen Species • Dialysis: Diffusion Based Separation • Drosophila Larval IHC • Electrophoretic Mobility Shift Assay (EMSA) • Enzyme Assays and Kinetics • Expression Profiling with Microarrays • FM Dyes in Vesicle Recycling • Förster Resonance Energy Transfer (FRET) • Gene Silencing with Morpholinos • Genetic Engineering of Model Organisms • Genome Editing

		• 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 • RNA Analysis of Environmental Samples Using RT-PCR • RNA-Seq • 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 • Whole-Mount In Situ Hybridization • Yeast Transformation and Cloning
INDICATOR / STANDARD	B.4.4.	Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. <u>JoVE</u> • An Introduction to Aging and Regeneration • An Introduction to Caenorhabditis elegans • An Introduction to Cell Division • An Introduction to Cell Motility and Migration • An Introduction to Developmental Genetics • An Introduction to Developmental Neurobiology • 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 Overview of Epigenetics • An Overview of Gene Expression • C. elegans Development and Reproduction • Cell Cycle Analysis • 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 • Live Cell Imaging of Mitosis • Murine In Utero Electroporation • RNA-Seq • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Whole-Mount In Situ Hybridization • Yeast Reproduction • Yeast Transformation and Cloning • Zebrafish Breeding and Embryo Handling • Zebrafish Reproduction and Development
INDICATOR / STANDARD	B.4.5.	Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and (3) mutations caused by environmental factors. <u>JoVE</u> • 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 • C. elegans Development and Reproduction • Drosophila Development and Reproduction • Genetic Crosses • Genetic Engineering of Model Organisms • Genetic Screens • Isolating Nucleic Acids from Yeast • Passaging Cells • SNP Genotyping • The ELISA Method • The TUNEL Assay • Yeast Reproduction • Zebrafish Maintenance and Husbandry
INDICATOR / STANDARD	B.4.6.	Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

		JoVE • An Introduction to Developmental Genetics • An Overview of Epigenetics • An Overview of Genetic Analysis • An Overview of Genetics and Disease • DNA Methylation Analysis • Fundamentals of Breeding and Weaning • Genetic Crosses • The ELISA Method
STANDARD / STRAND	IN.B.	Biology (B)
PROFICIENCY STATEMENT / SUBSTRAND	B.5.	Evolution
INDICATOR / STANDARD	B.5.1.	Evaluate anatomical and molecular evidence to provide an explanation of how organisms are classified and named based on their evolutionary relationships into taxonomic categories. JoVE • An Introduction to Caenorhabditis elegans • An Introduction to Drosophila melanogaster • An Introduction to Saccharomyces cerevisiae • 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 • Analysis of Earthworm Populations in Soil • Basic Chick Care and Maintenance • Basic Mouse Care and Maintenance • C. elegans Chemotaxis Assay • C. elegans Development and Reproduction • C. elegans Maintenance • Chick ex ovo Culture • Culturing and Enumerating Bacteria from Soil Samples • Detection of Bacteriophages in Environmental Samples • Development and Reproduction of the Laboratory Mouse • Development of the Chick • Drosophila Development and Reproduction • Drosophila Larval IHC • Drosophila Maintenance • Drosophila melanogaster Embryo and Larva Harvesting and Preparation • Filamentous Fungi • High-Performance Liquid Chromatography (HPLC) • In ovo Electroporation of Chicken Embryos • Introducing Experimental Agents into the Mouse • Isolating Nucleic Acids from Yeast • Mouse Genotyping • RNAi in C. elegans

		• Yeast Maintenance • Yeast Reproduction • Yeast Transformation and Cloning • Zebrafish Breeding and Embryo Handling • Zebrafish Maintenance and Husbandry • Zebrafish Microinjection Techniques • Zebrafish Reproduction and Development
INDICATOR / STANDARD	**B.5.2.**	**Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence including both anatomical and molecular evidence.** **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)
INDICATOR / STANDARD	**B.5.3.**	**Apply concepts of statistics and probability to support a claim that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.** **JoVE** • An Overview of Genetic Analysis
INDICATOR / STANDARD	**B.5.4.**	**Evaluate evidence to explain the role of natural selection as an evolutionary mechanism that leads to the adaptation of species, and to support claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and/or (3) the extinction of other species.** **JoVE** • An Overview of Genetic Analysis
INDICATOR / STANDARD	**B.5.5.**	**Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.**

		JoVE • An Introduction to the Chick: Gallus gallus domesticus • An Overview of Genetic Analysis
STANDARD / STRAND	IN.C.	Chemistry (C)
PROFICIENCY STATEMENT / SUBSTRAND	C.1.	Properties and States of Matter
INDICATOR / STANDARD	C.1.1.	Differentiate between pure substances and mixtures based on physical and chemical properties. JoVE • Calibration Curves • Capillary Electrophoresis (CE) • Chromatography-Based Biomolecule Purification Methods • Column Chromatography • Conducting Reactions Below Room Temperature • Cyclic Voltammetry (CV) • Degassing Liquids with Freeze-Pump-Thaw Cycling • Density Gradient Ultracentrifugation • Determining the Density of a Solid and Liquid • Determining the Mass Percent Composition in an Aqueous Solution • Dialysis: Diffusion Based Separation • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Fractional Distillation • Freezing-Point Depression to Determine an Unknown Compound • Gas Chromatography (GC) with Flame-Ionization Detection • High-Performance Liquid Chromatography (HPLC) • Internal Standards • Ion-Exchange Chromatography • Method of Standard Addition • Performing 1D Thin Layer Chromatography • Photometric Protein Determination • Sample Preparation for Analytical Preparation • Schlenk Lines Transfer of Solvents • Separation of Mixtures via Precipitation • Solid-Liquid Extraction • Solutions and Concentrations • Two-Dimensional Gel Electrophoresis
INDICATOR / STANDARD	C.1.2.	Use chemical properties, extensive, and intensive physical properties to identify substances. JoVE • Assembly of a Reflux System for Heated Chemical Reactions • Calibration Curves

		• Capillary Electrophoresis (CE) • Chromatography-Based Biomolecule Purification Methods • Co-Immunoprecipitation and Pull-Down Assays • Column Chromatography • Common Lab Glassware and Uses • Conducting Reactions Below Room Temperature • Coordination Chemistry Complexes • Cyclic Voltammetry (CV) • Degassing Liquids with Freeze-Pump-Thaw Cycling • Density Gradient Ultracentrifugation • Determining Rate Laws and the Order of Reaction • 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 • 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) • Ideal Gas Law • Internal Standards • Introduction to Catalysis • Introduction to Mass Spectrometry • Introduction to Titration • Ion-Exchange Chromatography • Le Châtelier's Principle • MALDI-TOF Mass Spectrometry • Metabolic Labeling • Method of Standard Addition • Nuclear Magnetic Resonance (NMR) Spectroscopy • Performing 1D Thin Layer Chromatography • Photometric Protein Determination • Preparing Anhydrous Reagents and Equipment • Protein Crystallization • Purifying Compounds by Recrystallization • Raman Spectroscopy for Chemical Analysis • Reconstitution of Membrane Proteins • Rotary Evaporation to Remove Solvent • Sample Preparation for Analytical Preparation • Scanning Electron Microscopy (SEM)

		• Schlenk Lines Transfer of Solvents • Separation of Mixtures via Precipitation • Solid-Liquid Extraction • Solutions and Concentrations • Spectrophotometric Determination of an Equilibrium Constant • Surface Plasmon Resonance (SPR) • Tandem Mass Spectrometry • The Ideal Gas Law • Two-Dimensional Gel Electrophoresis • Ultraviolet-Visible (UV-Vis) Spectroscopy • Using a pH Meter • X-ray Fluorescence (XRF)
INDICATOR / STANDARD	C.1.3.	Recognize observable macroscopic indicators of chemical changes. JoVE • Introduction to Titration • Le Châtelier's Principle • Passaging Cells • Physical Properties Of Minerals II: Polymineralic Analysis • Spectrophotometric Determination of an Equilibrium Constant • The ELISA Method
INDICATOR / STANDARD	C.1.4.	Describe physical and chemical changes at the particle level. JoVE • An Introduction to Cell Metabolism • Assembly of a Reflux System for Heated Chemical Reactions • Conducting Reactions Below Room Temperature • Cyclic Voltammetry (CV) • Degassing Liquids with Freeze-Pump-Thaw Cycling • Detecting Reactive Oxygen Species • Determining the Solubility Rules of Ionic Compounds • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Enzyme Assays and Kinetics • Fractional Distillation • Freezing-Point Depression to Determine an Unknown Compound • Growing Crystals for X-ray Diffraction Analysis • Introduction to Catalysis • Introduction to Titration • Le Châtelier's Principle • Nuclear Magnetic Resonance (NMR) Spectroscopy • Photometric Protein Determination • Preparing Anhydrous Reagents and Equipment • Proton Exchange Membrane Fuel Cells

		• Purifying Compounds by Recrystallization • Rotary Evaporation to Remove Solvent • Schlenk Lines Transfer of Solvents • Separation of Mixtures via Precipitation • Solid-Liquid Extraction • Solutions and Concentrations • The ATP Bioluminescence Assay • The ELISA Method • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy • Using a pH Meter
INDICATOR / STANDARD	C.1.5.	Describe the characteristics of solids, liquids, and gases and changes in state at the macroscopic and microscopic levels. JoVE • Assembly of a Reflux System for Heated Chemical Reactions • Degassing Liquids with Freeze-Pump-Thaw Cycling • Fractional Distillation • Freezing-Point Depression to Determine an Unknown Compound • Gas Chromatography (GC) with Flame-Ionization Detection • Growing Crystals for X-ray Diffraction Analysis • Ideal Gas Law • Physical Properties Of Minerals I: Crystals and Cleavage • Physical Properties Of Minerals II: Polymineralic Analysis • Preparing Anhydrous Reagents and Equipment • Protein Crystallization • Purifying Compounds by Recrystallization • Rotary Evaporation to Remove Solvent • Schlenk Lines Transfer of Solvents • Separation of Mixtures via Precipitation • Solid-Liquid Extraction • Solutions and Concentrations • The Ideal Gas Law • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy
INDICATOR / STANDARD	C.1.6.	Demonstrate an understanding of the law of conservation of mass through the use of particle diagrams and mathematical models. 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
INDICATOR / STANDARD	C.1.7.	Perform calculations involving density and distinguish among materials based on densities. JoVE • Determining the Density of a Solid and Liquid • Solid-Liquid Extraction
STANDARD / STRAND	IN.C.	Chemistry (C)
PROFICIENCY STATEMENT / SUBSTRAND	C.2.	Atomic Structure and the Periodic Table
INDICATOR / STANDARD	C.2.2.	Determine the number of protons, neutrons, and electrons in isotopes and calculate the average atomic mass from isotopic abundance data. JoVE • Freezing-Point Depression to Determine an Unknown Compound • Introduction to Mass Spectrometry • MALDI-TOF Mass Spectrometry • Metabolic Labeling • Tandem Mass Spectrometry
INDICATOR / STANDARD	C.2.3.	Write the full and noble gas electron configuration of an element, determine its valence electrons, and relate this to its position on the periodic table. JoVE • Coordination Chemistry Complexes
INDICATOR / STANDARD	C.2.4.	Use the periodic table as a model to predict the relative properties of elements based on the pattern of valence electrons and periodic trends. JoVE • Coordination Chemistry Complexes
INDICATOR / STANDARD	C.2.5.	Compare and contrast nuclear reactions with chemical reactions. JoVE • Co-Immunoprecipitation and Pull-Down Assays

		• Conducting Reactions Below Room Temperature • Coordination Chemistry Complexes • Cyclic Voltammetry (CV) • Determining Rate Laws and the Order of Reaction • Determining the Solubility Rules of Ionic Compounds • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Enzyme Assays and Kinetics • Growing Crystals for X-ray Diffraction Analysis • Introduction to Catalysis • Introduction to Titration • Le Châtelier's Principle • Nuclear Magnetic Resonance (NMR) Spectroscopy • Photometric Protein Determination • Preparing Anhydrous Reagents and Equipment • Proton Exchange Membrane Fuel Cells • Purifying Compounds by Recrystallization • Rotary Evaporation to Remove Solvent • Separation of Mixtures via Precipitation • Spectrophotometric Determination of an Equilibrium Constant • The ELISA Method • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy • Using a pH Meter
INDICATOR / STANDARD	C.2.6.	Describe nuclear changes in matter, including fission, fusion, transmutations, and decays. JoVE • Determining Rate Laws and the Order of Reaction
INDICATOR / STANDARD	C.2.7.	Perform half-life calculations when given the appropriate information about the isotope. JoVE • Determining Rate Laws and the Order of Reaction
STANDARD / STRAND	IN.C.	Chemistry (C)
PROFICIENCY STATEMENT / SUBSTRAND	C.3.	Bonding and Molecular Structure
INDICATOR / STANDARD	C.3.1.	Investigate the observable characteristics of elements, ionic, and covalent compounds. 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** **• Lead Analysis of Soil Using Atomic Absorption Spectroscopy** **• Performing 1D Thin Layer Chromatography** **• Purifying Compounds by Recrystallization** **• Separation of Mixtures via Precipitation** **• Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium**
INDICATOR / STANDARD	**C.3.2.**	**Compare and contrast how ionic and covalent compounds form.** **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** **• 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** **• Growing Crystals for X-ray Diffraction Analysis** **• Lead Analysis of Soil Using Atomic Absorption Spectroscopy** **• Performing 1D Thin Layer Chromatography** **• 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** **• Separation of Mixtures via Precipitation** **• Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium** **• Sonication Extraction of Lipid Biomarkers from Sediment** **• Soxhlet Extraction of Lipid Biomarkers from Sediment** **• Ultraviolet-Visible (UV-Vis) Spectroscopy**
INDICATOR / STANDARD	**C.3.3.**	**Draw structural formulas for simple molecules and determine their molecular shape.** **JoVE** **• Determining the Empirical Formula**

INDICATOR / STANDARD	**C.3.4.**	**Write chemical formulas for ionic compounds and covalent compounds given their names and vice versa.** **JoVE** **• Determining the Empirical Formula** **• Purification of a Total Lipid Extract with Column Chromatography** **• Sonication Extraction of Lipid Biomarkers from Sediment**
INDICATOR / STANDARD	**C.3.5.**	**Use laboratory observations and data to compare and contrast ionic, covalent, network, metallic, polar, and non-polar substances with respect to constituent particles, strength of bonds, melting, and boiling points and conductivity; provide examples of each type.** **JoVE** **• An Overview of Alkenone Biomarker Analysis for Paleothermometry** **• An Overview of bGDGT Biomarker Analysis for Paleoclimatology** **• Capillary Electrophoresis (CE)** **• Chromatography-Based Biomolecule Purification Methods** **• Column Chromatography** **• Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry** **• Coordination Chemistry Complexes** **• 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** **• Electrophoretic Mobility Shift Assay (EMSA)** **• 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)** **• Introduction to Mass Spectrometry** **• Ion-Exchange Chromatography** **• MALDI-TOF Mass Spectrometry** **• 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** **• Solid-Liquid Extraction**

		• Solutions and Concentrations • Sonication Extraction of Lipid Biomarkers from Sediment • Soxhlet Extraction of Lipid Biomarkers from Sediment • Tandem Mass Spectrometry • Two-Dimensional Gel Electrophoresis • Ultraviolet-Visible (UV-Vis) Spectroscopy • X-ray Fluorescence (XRF)
INDICATOR / STANDARD	C.3.6.	Use structural formulas of hydrocarbons to illustrate carbon's ability to form single and multiple bonds within a molecule. JoVE • Assembly of a Reflux System for Heated Chemical Reactions • Coordination Chemistry Complexes • Fractional Distillation • Ion-Exchange Chromatography • MALDI-TOF Mass Spectrometry • Metabolic Labeling • Purification of a Total Lipid Extract with Column Chromatography • Sonication Extraction of Lipid Biomarkers from Sediment • Tandem Mass Spectrometry • Ultraviolet-Visible (UV-Vis) Spectroscopy
STANDARD / STRAND	IN.C.	Chemistry (C)
PROFICIENCY STATEMENT / SUBSTRAND	C.4.	Reactions and Stoichiometry
INDICATOR / STANDARD	C.4.1.	Describe, classify, and give examples of various kinds of reactions: synthesis (i.e., combination), decomposition, single displacement, double displacement, acid/base, and combustion. JoVE • Biofuels: Producing Ethanol from Cellulosic Material • Co-Immunoprecipitation and Pull-Down Assays • Conducting Reactions Below Room Temperature • Coordination Chemistry Complexes • Cyclic Voltammetry (CV) • Determining Rate Laws and the Order of Reaction • Determining the Solubility Rules of Ionic Compounds • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Enzyme Assays and Kinetics • Growing Crystals for X-ray Diffraction Analysis • Introduction to Catalysis • Introduction to Titration • Le Châtelier's Principle

		• Photometric Protein Determination • Preparing Anhydrous Reagents and Equipment • Proton Exchange Membrane Fuel Cells • Purifying Compounds by Recrystallization • Rotary Evaporation to Remove Solvent • Separation of Mixtures via Precipitation • Spectrophotometric Determination of an Equilibrium Constant • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy • Using a pH Meter
INDICATOR / STANDARD	C.4.2.	Predict products of simple reactions as listed in C.4.1. JoVE • Co-Immunoprecipitation and Pull-Down Assays • Conducting Reactions Below Room Temperature • Coordination Chemistry Complexes • Cyclic Voltammetry (CV) • Determining Rate Laws and the Order of Reaction • Determining the Solubility Rules of Ionic Compounds • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Enzyme Assays and Kinetics • Growing Crystals for X-ray Diffraction Analysis • Introduction to Catalysis • Introduction to Titration • Le Châtelier's Principle • Photometric Protein Determination • Preparing Anhydrous Reagents and Equipment • Proton Exchange Membrane Fuel Cells • Purifying Compounds by Recrystallization • Rotary Evaporation to Remove Solvent • Separation of Mixtures via Precipitation • Spectrophotometric Determination of an Equilibrium Constant • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy • Using a pH Meter
INDICATOR / STANDARD	C.4.3.	Balance chemical equations and use the law of conservation of mass to explain why this must be true. 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
INDICATOR / STANDARD	C.4.4.	Apply the mole concept to determine the mass, moles, number of particles, or volume of a gas at STP, in any given sample, for an element or compound. 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
INDICATOR / STANDARD	C.4.5.	Use a balanced chemical equation to calculate the quantities of reactants needed and products made in a chemical reaction that goes to completion. JoVE • Calibration Curves • Cyclic Voltammetry (CV) • Determining Rate Laws and the Order of Reaction • Determining the Empirical Formula • Determining the Mass Percent Composition in an Aqueous Solution • Introduction to Titration • Method of Standard Addition • Nuclear Magnetic Resonance (NMR) Spectroscopy

		• Solutions and Concentrations • Spectrophotometric Determination of an Equilibrium Constant
INDICATOR / STANDARD	C.4.6.	Perform calculations to determine the composition of a compound or mixture when given the necessary information. JoVE • Determining the Empirical Formula • Determining the Mass Percent Composition in an Aqueous Solution • Introduction to Mass Spectrometry • MALDI-TOF Mass Spectrometry • Tandem Mass Spectrometry
INDICATOR / STANDARD	C.4.7.	Apply lab data to determine the empirical and molecular formula of a compound. JoVE • Determining the Empirical Formula • Determining the Mass Percent Composition in an Aqueous Solution • Introduction to Mass Spectrometry • MALDI-TOF Mass Spectrometry • Tandem Mass Spectrometry
STANDARD / STRAND	IN.C.	Chemistry (C)
PROFICIENCY STATEMENT / SUBSTRAND	C.5.	Behavior of Gases
INDICATOR / STANDARD	C.5.1.	Use the kinetic molecular theory with the combined and ideal gas laws to explain changes in volume, pressure, moles, and temperature of a gas. JoVE • Determining Rate Laws and the Order of Reaction • Fractional Distillation • Ideal Gas Law • The Ideal Gas Law
INDICATOR / STANDARD	C.5.3.	Use lab data and a balanced chemical equation to calculate volume of a gas at STP and non STP conditions, assuming that the reaction goes to completion and the ideal gas law holds. JoVE • Calibration Curves • Capillary Electrophoresis (CE) • Determining Rate Laws and the Order of Reaction • 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 • Photometric Protein Determination • Sample Preparation for Analytical Preparation • Solutions and Concentrations • Spectrophotometric Determination of an Equilibrium Constant • Understanding Concentration and Measuring Volumes
STANDARD / STRAND	**IN.C.**	**Chemistry (C)**
PROFICIENCY STATEMENT / SUBSTRAND	**C.6.**	**Thermochemistry**
INDICATOR / STANDARD	**C.6.1.**	**Explain that atoms and molecules are in constant motion and that this motion increases as thermal energy increases.** **JoVE** • Conducting Reactions Below Room Temperature • Determining Rate Laws and the Order of Reaction • Fractional Distillation • Ideal Gas Law • Introduction to Catalysis • The Ideal Gas Law
INDICATOR / STANDARD	**C.6.2.**	**Distinguish between the concepts of temperature and heat flow in macroscopic and microscopic terms.** **JoVE** • Assembly of a Reflux System for Heated Chemical Reactions • Conducting Reactions Below Room Temperature • Determining Rate Laws and the Order of Reaction • Le Châtelier's Principle • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy
INDICATOR / STANDARD	**C.6.3.**	**Classify chemical reactions and phase changes as exothermic or endothermic based on enthalpy values. Use a graphical representation to illustrate the energy changes involved.** **JoVE** • Conducting Reactions Below Room Temperature • Determining Rate Laws and the Order of Reaction • Enzyme Assays and Kinetics

		• Introduction to Catalysis • Le Châtelier's Principle • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy
INDICATOR / STANDARD	C.6.4.	Perform calculations involving heat flow, temperature changes, and phase changes by using known values of specific heat, phase change constants, or both. JoVE • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy
STANDARD / STRAND	IN.C.	Chemistry (C)
PROFICIENCY STATEMENT / SUBSTRAND	C.7.	Solutions
INDICATOR / STANDARD	C.7.1.	Describe the composition and properties of solutions. JoVE • An Introduction to the Micropipettor • 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 • Calibration Curves • Capillary Electrophoresis (CE) • Column Chromatography • Conducting Reactions Below Room Temperature • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Cyclic Voltammetry (CV) • Degassing Liquids with Freeze-Pump-Thaw Cycling • Density Gradient Ultracentrifugation • 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 • 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) • Internal Standards • Introduction to Serological Pipettes and Pipettors

		• Introduction to Titration • Introduction to the Microplate Reader • Introduction to the Spectrophotometer • Ion-Exchange Chromatography • Le Châtelier's Principle • Making Solutions in the Laboratory • Method of Standard Addition • Performing 1D Thin Layer Chromatography • Photometric Protein Determination • Preparing Anhydrous Reagents and Equipment • 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 • Sample Preparation for Analytical Preparation • 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 • Two-Dimensional Gel Electrophoresis • Understanding Concentration and Measuring Volumes • Using a pH Meter
INDICATOR / STANDARD	**C.7.2.**	**Explain how temperature, pressure, and polarity of the solvent affect the solubility of a solute.** **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 • Degassing Liquids with Freeze-Pump-Thaw Cycling • Determining the Solubility Rules of Ionic Compounds • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Growing Crystals for X-ray Diffraction Analysis • 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 • Sample Preparation for Analytical Preparation • 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
INDICATOR / STANDARD	C.7.3.	Describe the concentration of solutes in a solution in terms of molarity. Perform calculations using molarity, mass, and volume. Prepare a sample of given molarity provided a known solute. JoVE • Calibration Curves • Capillary Electrophoresis (CE) • Determining Rate Laws and the Order of Reaction • 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 • Photometric Protein Determination • Sample Preparation for Analytical Preparation • Solutions and Concentrations • Spectrophotometric Determination of an Equilibrium Constant • Understanding Concentration and Measuring Volumes
STANDARD / STRAND	IN.C.	Chemistry (C)
PROFICIENCY STATEMENT / SUBSTRAND	C.8.	Acids and Bases
INDICATOR / STANDARD	C.8.1.	Classify solutions as acids or bases and describe their characteristic properties. JoVE • Assembly of a Reflux System for Heated Chemical Reactions • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Introduction to Titration • Ion-Exchange Chromatography • Le Châtelier's Principle

		• Two-Dimensional Gel Electrophoresis • Using a pH Meter
INDICATOR / STANDARD	C.8.2.	Compare and contrast the strength of acids and bases in solutions. JoVE • Assembly of a Reflux System for Heated Chemical Reactions • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Introduction to Titration • Ion-Exchange Chromatography • Le Châtelier's Principle • Two-Dimensional Gel Electrophoresis • Using a pH Meter
INDICATOR / STANDARD	C.8.3.	Given the hydronium ion and/or the hydroxide ion concentration, calculate the pH and/or the pOH of a solution. Explain the meanings of these values. JoVE • Introduction to Titration • Using a pH Meter
STANDARD / STRAND	IN.ES.	Earth and Space Science (ES)
PROFICIENCY STATEMENT / SUBSTRAND	ES.3.	Earth Cycles and Systems
INDICATOR / STANDARD	ES.3.1.	Create flowcharts that show the exchange of carbon and oxygen between the lithosphere, hydrosphere, biosphere, and atmosphere, including carbon dioxide and methane. Explain how human activities such as farming and industry, temperature change in oceans, and natural processes such as volcanic eruptions can speed or slow the cycling from reservoirs within the solid earth and oceans into the atmosphere. JoVE • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • 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 • Dissolved Oxygen in Surface Water • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction

		• Measuring Tropospheric Ozone • Metabolic Labeling • 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 • Using GIS to Investigate Urban Forestry
INDICATOR / STANDARD	ES.3.2.	Create diagrams and flowcharts that show the cycling between the lithosphere, hydrosphere, biosphere, and atmosphere for nitrogen. Complete the same for phosphorus, excluding the atmosphere. Explain how human activities can alter the amounts of both phosphorus and nitrogen between these layers. 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 • Using GIS to Investigate Urban Forestry
INDICATOR / STANDARD	ES.3.3.	Analyze and explain how events on one side of the world can alter temperature and precipitation around the globe. Analyze and explain the possible effects of natural and human-driven processes on our atmosphere and climate.

		JoVE • Biofuels: Producing Ethanol from Cellulosic Material
INDICATOR / STANDARD	ES.3.4.	Evaluate the use of sustainable versus nonrenewable resources. Explain the consequences of overuse and continued increased consumption of limited resources. Analyze and evaluate the benefits of researching, designing, and developing sustainable resources for private use and industry. JoVE • Biofuels: Producing Ethanol from Cellulosic Material • Proton Exchange Membrane Fuel Cells
STANDARD / STRAND	IN.ES.	Earth and Space Science (ES)
PROFICIENCY STATEMENT / SUBSTRAND	ES.4.	The Atmosphere and Hydrosphere
INDICATOR / STANDARD	ES.4.1.	Create a model that shows the composition, distribution, and circulation of gases in Earth's atmosphere. Show how carbon and oxygen cycles affect the composition through gas exchange with organisms, oceans, the solid earth, and industry. JoVE • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • 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 • Measuring Tropospheric Ozone • Metabolic Labeling • 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 • Using GIS to Investigate Urban Forestry
INDICATOR / STANDARD	ES.4.3.	Create a presentation that demonstrates the process of the water cycle on both local and global scales. Illustrate the process of water cycling both from the solid earth to

		the atmosphere and around the solid earth. Examine the interaction of ground water, surface water, and ocean circulation. Illustrate the effects of human activity on water systems. JoVE • Dissolved Oxygen in Surface Water • Introduction to Mass Spectrometry • Making a Geologic Cross Section • Nutrients in Aquatic Ecosystems • Turbidity and Total Solids in Surface Water • Water Quality Analysis via Indicator Organisms
INDICATOR / STANDARD	ES.4.5.	Chart and explain the changes in weather as it relates to humidity, air pressure, and temperature. Explain how these factors result in local wind patterns and cloud cover. Explain the origin, life cycle, and behavior of weather systems, especially severe weather. Create an emergency plan for severe storms, both summer and winter. JoVE • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Measuring Tropospheric Ozone
INDICATOR / STANDARD	ES.4.6.	Differentiate between weather and climate. Examine long term, natural climate change and periods of glaciation as influenced by Milankovitch Cycles due to the gravity of other solar system bodies (obliquity and precession of axis and eccentricity of orbit). Explain how these are different from any short term (less than thousands of years) changes to climate. JoVE • Biofuels: Producing Ethanol from Cellulosic Material
STANDARD / STRAND	IN.ES.	Earth and Space Science (ES)
PROFICIENCY STATEMENT / SUBSTRAND	ES.5.	The Solid Earth
INDICATOR / STANDARD	ES.5.1.	Construct a lab to analyze minerals based on their physical and chemical properties. Explain how rocks may contain many minerals, one mineral, or no minerals, and minerals can be made of either single elements (such as gold) or compounds (such as silicates). JoVE • Igneous Intrusive Rock • Igneous Volcanic Rock • Physical Properties Of Minerals I: Crystals and Cleavage • Physical Properties Of Minerals II: Polymineralic Analysis

		• Purification of a Total Lipid Extract with Column Chromatography
INDICATOR / STANDARD	ES.5.2.	Create a rock cycle flowchart or diagram that demonstrates the processes involved in the formation, breakdown, and reformation of igneous, sedimentary, and metamorphic rock. Show how each type can melt and reform igneous rock, undergo the various metamorphic processes, and undergo physical and chemical weathering to form sedimentary rock. JoVE • Igneous Intrusive Rock • Igneous Volcanic Rock
INDICATOR / STANDARD	ES.5.3.	Construct a model that demonstrates the difference between weathering, erosion, transportation of material, deposition, and new soil and sedimentary rock formation. Differentiate between types of physical and chemical weathering. JoVE • Turbidity and Total Solids in Surface Water
INDICATOR / STANDARD	ES.5.4.	Differentiate between relative and absolute geological time. Detail how sedimentary rock can be dated based on relative-age dating and positioning, while igneous formations can be radiometrically dated. Differentiate between radiocarbon dating used for organic materials and other types of radiometric dating for inorganic rock formation. JoVE • Making a Geologic Cross Section
INDICATOR / STANDARD	ES.5.5.	Create a timeline detailing the processes that have occurred in Indiana to create mostly sedimentary bedrock. Explain how changing sea levels, climate, and glaciation have shaped Indiana geology. JoVE • Igneous Intrusive Rock • Igneous Volcanic Rock • Using Topographic Maps to Generate Topographic Profiles
INDICATOR / STANDARD	ES.5.6.	Create models or diagrams to show how plate movement and sea level changes have changed continental land masses over time. Include the creation and destruction of inland seas, sedimentary rock formations including evaporites and biochemical formations, and the shaping and destruction of surface features. JoVE

		• Igneous Intrusive Rock • Igneous Volcanic Rock • Using Topographic Maps to Generate Topographic Profiles
STANDARD / STRAND	**IN.ES.**	**Earth and Space Science (ES)**
PROFICIENCY STATEMENT / SUBSTRAND	**ES.6.**	**Earth Processes**
INDICATOR / STANDARD	**ES.6.1.**	**Construct a diagram or model that identifies and describes the physical and chemical properties of the crust, mantle, outer core, and inner core of Earth.** **JoVE** • Determining Spatial Orientation of Rock Layers with the Brunton Compass • Igneous Intrusive Rock • Igneous Volcanic Rock • Using Topographic Maps to Generate Topographic Profiles
INDICATOR / STANDARD	**ES.6.2.**	**Explain how Earth's fluid outer core creates the magnetosphere and how this helps protect both humans and technology (such as satellites) from solar winds.** **JoVE** • Determining Spatial Orientation of Rock Layers with the Brunton Compass
INDICATOR / STANDARD	**E.S.6.4.**	**Create a timeline to show the development of modern tectonic plate theory. Identify and explain how the evidence from the theory of continental drift, seafloor spreading, and paleomagnetism built upon each other to support tectonic plate theory.** **JoVE** • Determining Spatial Orientation of Rock Layers with the Brunton Compass • Igneous Intrusive Rock • Igneous Volcanic Rock • Using Topographic Maps to Generate Topographic Profiles
INDICATOR / STANDARD	**E.S.6.5.**	**Create models that demonstrate different types of orogeny resulting from plate tectonics. Show how the interactions between oceanic and continental plates create different geological features (such as volcanic island arcs or high altitude plateaus) depending on what types of plates are involved in the motions along different plate boundaries.** **JoVE** • Igneous Volcanic Rock

INDICATOR / STANDARD	E.S.6.6.	Create models and differentiate between shield, composite, and cinder cone volcanoes. Explain how volcanoes form, how the chemical composition of lava affects the type of volcanoes formed, and how the location (such as hot spots or along continental or oceanic margins) can affect the types of magma present. JoVE • Igneous Intrusive Rock • Igneous Volcanic Rock
STANDARD / STRAND	IN.ENV.	Environmental Science (ENV)
PROFICIENCY STATEMENT / SUBSTRAND	Env.1.	Environmental Systems
INDICATOR / STANDARD	Env.1.2.	Understand and explain that human beings are part of Earth's ecosystems and give examples of how human activities can, deliberately or inadvertently, alter ecosystems. JoVE • Biofuels: Producing Ethanol from Cellulosic Material • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Dissolved Oxygen in Surface Water • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Measuring Tropospheric Ozone • Nutrients in Aquatic Ecosystems • Tree Identification: How To Use a Dichotomous Key • Tree Survey: Point-Centered Quarter Sampling Method • Turbidity and Total Solids in Surface Water • Water Quality Analysis via Indicator Organisms
INDICATOR / STANDARD	Env.1.3.	Recognize and describe the difference between systems in equilibrium and systems in disequilibrium. Describe how steady state is achieved through negative and positive feedback loops. JoVE • Analysis of Earthworm Populations in Soil • Determination of Moisture Content in Soil • Dissolved Oxygen in Surface Water • Nutrients in Aquatic Ecosystems • Tree Survey: Point-Centered Quarter Sampling Method • Turbidity and Total Solids in Surface Water
INDICATOR / STANDARD	Env.1.4.	Diagram the cycling of carbon, nitrogen, phosphorus, and water and describe the human impacts on each. 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** **• Determining the Solubility Rules of Ionic Compounds** **• Dissolved Oxygen in Surface Water** **• Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction** **• Filamentous Fungi** **• Introduction to Mass Spectrometry** **• Le Châtelier's Principle** **• Lead Analysis of Soil Using Atomic Absorption Spectroscopy** **• Measuring Tropospheric Ozone** **• 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** **• Turbidity and Total Solids in Surface Water** **• Using GIS to Investigate Urban Forestry** **• Water Quality Analysis via Indicator Organisms**
INDICATOR / STANDARD	**Env.1.5.**	**Identify and measure biological, chemical, and physical (abiotic and biotic) factors within an ecosystem.** **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** **• 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 • Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy
INDICATOR / STANDARD	Env.1.6.	Describe the difference between weather and climate. Locate, identify, and describe the major Earth biomes. Explain how biomes are determined by climate (temperature and precipitation patterns) that support specific kinds of plants. JoVE • Tree Identification: How To Use a Dichotomous Key • Tree Survey: Point-Centered Quarter Sampling Method • Using GIS to Investigate Urban Forestry
INDICATOR / STANDARD	Env.1.7.	Identify tools and technologies used to adapt and alter environments and natural resources in order to meet human physical and cultural needs. JoVE • Biofuels: Producing Ethanol from Cellulosic Material • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Dissolved Oxygen in Surface Water • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Measuring Tropospheric Ozone • Nutrients in Aquatic Ecosystems • Proton Exchange Membrane Fuel Cells • Turbidity and Total Solids in Surface Water
STANDARD / STRAND	IN.ENV.	Environmental Science (ENV)
PROFICIENCY STATEMENT / SUBSTRAND	Env.2.	Flow of Matter and Energy
INDICATOR / STANDARD	Env.2.1.	Describe how matter cycles through sources and sinks and how energy is transferred. Explain how matter and energy move between and within components of an environmental system. 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**
INDICATOR / STANDARD	**Env.2.4.**	**Recognize and describe the different sources of energy, including fossil fuels, nuclear, and alternative sources of energy provided by water, wind, geothermal, biomass/biofuels, and the sun.** **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** **• Fractional Distillation** **• Proton Exchange Membrane Fuel Cells** **• Raman Spectroscopy for Chemical Analysis**
INDICATOR / STANDARD	**Env.2.5.**	**Give examples of the various forms and uses of fossil fuels and nuclear energy in our society.** **JoVE** **• Biofuels: Producing Ethanol from Cellulosic Material** **• Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy** **• Fractional Distillation** **• Proton Exchange Membrane Fuel Cells**
INDICATOR / STANDARD	**Env.2.6.**	**Understand and describe how layers of energy-rich organic material have been gradually turned into great coal beds and oil pools by the pressure of the overlying earth. Recognize that by burning these fossil fuels,**

		people are passing stored energy back into the environment as heat and releasing large amounts of matter such as carbon dioxide and other air pollutants. JoVE • Biofuels: Producing Ethanol from Cellulosic Material • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Fractional Distillation • Proton Exchange Membrane Fuel Cells
INDICATOR / STANDARD	Env.2.7.	Differentiate between renewable and nonrenewable resources, and compare and contrast the pros and cons of using nonrenewable resources. JoVE • Biofuels: Producing Ethanol from Cellulosic Material • Proton Exchange Membrane Fuel Cells
INDICATOR / STANDARD	Env.2.8.	Cite examples of how all fuels, renewable and nonrenewable, have advantages and disadvantages that society must question when considering the trade-offs among them, such as how energy use contributes to the rising standard of living in the industrially developing nations. However, explain that this energy use also leads to more rapid depletion of Earth's energy resources and to environmental risks associated with the use of fossil and nuclear fuels. JoVE • Biofuels: Producing Ethanol from Cellulosic Material • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Fractional Distillation • Proton Exchange Membrane Fuel Cells • Raman Spectroscopy for Chemical Analysis
INDICATOR / STANDARD	Env.2.11.	Recognize and describe the role of natural resources in providing the raw materials for an industrial society. JoVE • Biofuels: Producing Ethanol from Cellulosic Material • Igneous Intrusive Rock • Tree Identification: How To Use a Dichotomous Key • Tree Survey: Point-Centered Quarter Sampling Method • Using GIS to Investigate Urban Forestry
STANDARD / STRAND	IN.ENV.	Environmental Science (ENV)
PROFICIENCY STATEMENT / SUBSTRAND	Env.3.	Natural Disasters
INDICATOR / STANDARD	Env.3.1.	Identify and describe geomorphic processes controlled by tectonics (i.e. volcanic activity, uplift, and shaping of landforms).

		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
INDICATOR / STANDARD	Env.3.4.	Identify natural Earth hazards, such as earthquakes and hurricanes, and identify the regions in which they occur as well as the short-term and long-term effects on the environment and on people. JoVE • Igneous Intrusive Rock • Igneous Volcanic Rock
STANDARD / STRAND	IN.ENV.	Environmental Science (ENV)
PROFICIENCY STATEMENT / SUBSTRAND	Env.4.	Environmental Policy
INDICATOR / STANDARD	Env.4.1.	Explain environmental policies/organizations (Clean Water Act, Clean Air Act, Endangered Species Act, Species Survival Plan, Resource Conservation and Recovery Act, Department of Energy, and the World Health Organization) and identify their impact. JoVE • Biofuels: Producing Ethanol from Cellulosic Material • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Lead Analysis of Soil Using Atomic Absorption Spectroscopy
INDICATOR / STANDARD	Env.4.2.	Understand that environmental policies/decisions have negative and positive impacts on people, societies, and the environment. JoVE • Biofuels: Producing Ethanol from Cellulosic Material • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Self-report vs. Behavioral Measures of Recycling
STANDARD / STRAND	IN.ENV.	Environmental Science (ENV)
PROFICIENCY STATEMENT / SUBSTRAND	Env.5.	Biodiversity

INDICATOR / STANDARD	**Env.5.1.**	**Explain how variation within a species increases the chances of survival of the species under changing environmental conditions.** **JoVE** **• An Overview of Genetic Analysis**
INDICATOR / STANDARD	**Env.5.2.**	**Explain how the great diversity of species increases the chance that at least some living organisms will survive in the event of major global changes.** **JoVE** **• An Overview of Genetic Analysis** **• Analysis of Earthworm Populations in Soil** **• Tree Identification: How To Use a Dichotomous Key** **• Tree Survey: Point-Centered Quarter Sampling Method**
INDICATOR / STANDARD	**Env.5.3.**	**Explain genetic engineering and identify implications on the environment and society.** **JoVE** **• An Introduction to Aging and Regeneration** **• An Introduction to Drosophila melanogaster** **• An Introduction to Molecular Developmental Biology** **• An Introduction to Neurophysiology** **• 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 Laboratory Mouse: Mus musculus** **• An Introduction to the Zebrafish: Danio rerio** **• An Overview of Gene Expression** **• An Overview of Genetic Engineering** **• Bacterial Transformation: Electroporation** **• Bacterial Transformation: The Heat Shock Method** **• C. elegans Development and Reproduction** **• Chick ex ovo Culture** **• DNA Ligation Reactions** **• Development and Reproduction of the Laboratory Mouse** **• Development of the Chick** **• Embryonic Stem Cell Culture and Differentiation** **• Explant Culture for Developmental Studies** **• Explant Culture of Neural Tissue** **• Fate Mapping** **• Fundamentals of Breeding and Weaning** **• Gene Silencing with Morpholinos** **• Genetic Crosses** **• Genetic Engineering of Model Organisms** **• Genetic Screens** **• Genome Editing**

		• In ovo Electroporation of Chicken Embryos • Induced Pluripotency • Invertebrate Lifespan Quantification • Molecular Cloning • Mouse Genotyping • Murine In Utero Electroporation • Neuronal Transfection Methods • Plasmid Purification • Primary Neuronal Cultures • RNAi in C. elegans • Recombineering and Gene Targeting • Restriction Enzyme Digests • Rodent Stereotaxic Surgery • Solid-Liquid Extraction • 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 Maintenance and Husbandry • Zebrafish Microinjection Techniques • Zebrafish Reproduction and Development
INDICATOR / STANDARD	**Env.5.4.**	**Describe, provide examples, and contrast GMO products, organic products, and conventional products. Describe and explain the environmental concerns associated with GMOs.** **JoVE** • An Introduction to Aging and Regeneration • An Introduction to Drosophila melanogaster • An Introduction to Molecular Developmental Biology • An Introduction to Organogenesis • An Introduction to Stem Cell Biology • An Introduction to Transfection • 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 Engineering • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method • C. elegans Development and Reproduction • Chick ex ovo Culture • DNA Ligation Reactions • Development and Reproduction of the Laboratory Mouse • Development of the Chick • Embryonic Stem Cell Culture and Differentiation • Explant Culture for Developmental Studies

		• Fate Mapping • Fundamentals of Breeding and Weaning • Gene Silencing with Morpholinos • Genetic Engineering of Model Organisms • In ovo Electroporation of Chicken Embryos • Induced Pluripotency • Invertebrate Lifespan Quantification • Molecular Cloning • Mouse Genotyping • Plasmid Purification • RNAi in C. elegans • Restriction Enzyme Digests • Solid-Liquid Extraction • Testing For Genetically Modified Foods • The TUNEL Assay • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Whole-Mount In Situ Hybridization • Zebrafish Breeding and Embryo Handling • Zebrafish Maintenance and Husbandry • Zebrafish Microinjection Techniques • Zebrafish Reproduction and Development
INDICATOR / STANDARD	Env.5.5.	Identify the indirect and direct threats to biodiversity (e.g. habitat loss and destruction, invasion by exotic species, commercial over fishing and hunting, pollution, climate change, and bioaccumulation and biomagnification of toxins). JoVE • Algae Enumeration via Culturable Methodology • Analysis of Earthworm Populations in Soil • Biofuels: Producing Ethanol from Cellulosic Material • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Determining the Solubility Rules of Ionic Compounds • Dissolved Oxygen in Surface Water • Introduction to Mass Spectrometry • Le Châtelier's Principle • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Measuring Tropospheric Ozone • Nutrients in Aquatic Ecosystems • Tree Survey: Point-Centered Quarter Sampling Method • Turbidity and Total Solids in Surface Water • Water Quality Analysis via Indicator Organisms
INDICATOR / STANDARD	Env.5.6.	Identify and explain the three levels of biodiversity: genetic, species, and ecosystem. JoVE • An Overview of Genetic Analysis • Analysis of Earthworm Populations in Soil

		• C. elegans Development and Reproduction • SNP Genotyping • Tree Identification: How To Use a Dichotomous Key • Tree Survey: Point-Centered Quarter Sampling Method • Yeast Reproduction • Zebrafish Maintenance and Husbandry
STANDARD / STRAND	**IN.ENV.**	**Environmental Science (ENV)**
PROFICIENCY STATEMENT / SUBSTRAND	**Env.6.**	**Population**
INDICATOR / STANDARD	**Env.6.1.**	**Demonstrate, calculate, and explain how factors such as birth rate, death rate, and migration rate determine growth rates of populations.** **JoVE** • Algae Enumeration via Culturable Methodology • An Introduction to the Chick: Gallus gallus domesticus • An Introduction to the Laboratory Mouse: Mus musculus • An Introduction to the Zebrafish: Danio rerio • Analysis of Earthworm Populations in Soil • Aseptic Technique in Environmental Science • Bacterial Growth Curve Analysis and its Environmental Applications • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method • Basic Mouse Care and Maintenance • C. elegans Maintenance • Culturing and Enumerating Bacteria from Soil Samples • Detection of Bacteriophages in Environmental Samples • Dissolved Oxygen in Surface Water • Drosophila Maintenance • Drosophila melanogaster Embryo and Larva Harvesting and Preparation • Filamentous Fungi • Isolation of Fecal Bacteria from Water Samples by Filtration • Passaging Cells • Plasmid Purification • Quantifying Environmental Microorganisms and Viruses Using qPCR • Yeast Maintenance • Yeast Reproduction
INDICATOR / STANDARD	**Env.6.2.**	**Explain how the size and rate of growth of the human population in any location is affected by economic, political, religious, technological, and environmental (resource availability) factors.** **JoVE** • Nutrients in Aquatic Ecosystems

STANDARD / STRAND	IN.ENV.	Environmental Science (ENV)
PROFICIENCY STATEMENT / SUBSTRAND	Env.7.	Pollution
INDICATOR / STANDARD	Env.7.1.	Identify evidence, consequences, and prevention for climate change produced by anthropogenic sources. 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 • Using GIS to Investigate Urban Forestry
INDICATOR / STANDARD	Env.7.2.	Differentiate between natural pollution and pollution caused by humans. JoVE • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Dissolved Oxygen in Surface Water • Introduction to Mass Spectrometry • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Making a Geologic Cross Section • Measuring Tropospheric Ozone • Nutrients in Aquatic Ecosystems • Turbidity and Total Solids in Surface Water • Water Quality Analysis via Indicator Organisms
INDICATOR / STANDARD	Env.7.3.	Compare and contrast the effects of environmental stressors (i.e. herbicides, pesticides) on plants and animals. Give examples of secondary effects on other environmental components. JoVE • Algae Enumeration via Culturable Methodology • Determining the Solubility Rules of Ionic Compounds • Dissolved Oxygen in Surface Water • Introduction to Mass Spectrometry • Le Châtelier's Principle • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Nutrients in Aquatic Ecosystems • Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium • Turbidity and Total Solids in Surface Water • Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy • Water Quality Analysis via Indicator Organisms

INDICATOR / STANDARD	**Env.7.4.**	**Explain what common household toxins are, what to do in an emergency, and how to properly dispose.** **JoVE** **• Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy** **• Dissolved Oxygen in Surface Water** **• Introduction to Mass Spectrometry** **• Lead Analysis of Soil Using Atomic Absorption Spectroscopy** **• Measuring Tropospheric Ozone** **• Nutrients in Aquatic Ecosystems** **• Turbidity and Total Solids in Surface Water** **• Water Quality Analysis via Indicator Organisms**
INDICATOR / STANDARD	**Env.7.5.**	**Identify and describe the major air pollutants and their sources and impacts on the environment and human health.** **JoVE** **• Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy** **• Measuring Tropospheric Ozone**
INDICATOR / STANDARD	**Env.7.6.**	**Understand and explain how the burning of fossil fuels releases energy, waste heat, and matter (air pollutants).** **JoVE** **• Biofuels: Producing Ethanol from Cellulosic Material** **• Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy** **• Fractional Distillation** **• Proton Exchange Membrane Fuel Cells**
INDICATOR / STANDARD	**Env.7.7.**	**Describe and explain the product life cycle and waste stream and its implications to waste management. Explain the difference between reduce, reuse, and recycle.** **JoVE** **• Dissolved Oxygen in Surface Water** **• Isolation of Fecal Bacteria from Water Samples by Filtration** **• Nutrients in Aquatic Ecosystems** **• Self-report vs. Behavioral Measures of Recycling** **• Turbidity and Total Solids in Surface Water**
STANDARD / STRAND	**IN.ENV.**	**Environmental Science (ENV)**
PROFICIENCY STATEMENT / SUBSTRAND	**Env.8.**	**Natural and Anthropogenic Resource Cycles**
INDICATOR / STANDARD	**Env.8.1.**	**Demonstrate a knowledge of the distribution of natural resources in the U.S. and the world, and explain how natural resources influence relationships among nations.**

		JoVE **• Biofuels: Producing Ethanol from Cellulosic Material** **• Igneous Intrusive Rock** **• Tree Identification: How To Use a Dichotomous Key** **• Tree Survey: Point-Centered Quarter Sampling Method** **• Using GIS to Investigate Urban Forestry**
INDICATOR / STANDARD	**Env.8.2.**	**Understand and describe the concept of integrated natural resource management and the values of managing natural resources as an ecological unit.** **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**

INDICATOR / STANDARD	**Env.8.4.**	**Describe how agricultural technology requires trade-offs between increased production and environmental harm and between efficient production and social values.** **JoVE** **• An Overview of Genetic Engineering** **• Biofuels: Producing Ethanol from Cellulosic Material** **• Carbon and Nitrogen Analysis of Environmental Samples** **• Determination of Moisture Content in Soil** **• Nutrients in Aquatic Ecosystems** **• Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium** **• Testing For Genetically Modified Foods** **• Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy**
INDICATOR / STANDARD	**Env.8.5.**	**Describe and examine how water is controlled in developed and undeveloped nations.** **JoVE** **• Dissolved Oxygen in Surface Water** **• Introduction to Mass Spectrometry** **• Making a Geologic Cross Section** **• Nutrients in Aquatic Ecosystems** **• Turbidity and Total Solids in Surface Water** **• Water Quality Analysis via Indicator Organisms**
INDICATOR / STANDARD	**Env.8.6.**	**Understand and describe the concept and the importance of natural and human recycling in conserving our natural resources.** **JoVE** **• Analysis of Earthworm Populations in Soil** **• Carbon and Nitrogen Analysis of Environmental Samples** **• Dissolved Oxygen in Surface Water** **• Filamentous Fungi** **• Quantifying Environmental Microorganisms and Viruses Using qPCR** **• RNA Analysis of Environmental Samples Using RT-PCR** **• Self-report vs. Behavioral Measures of Recycling**
INDICATOR / STANDARD	**Env.8.7.**	**Understand and explain that waste management includes considerations of quantity, safety, degradability, and cost. Also understand that waste management requires social and technological innovations because waste-disposal problems are political and economic as well as technical.** **JoVE** **• Dissolved Oxygen in Surface Water** **• Isolation of Fecal Bacteria from Water Samples by**

		Filtration • Nutrients in Aquatic Ecosystems • Self-report vs. Behavioral Measures of Recycling • Turbidity and Total Solids in Surface Water
STANDARD / STRAND	IN.ICP.	Integrated Chemistry and Physics (ICP)
PROFICIENCY STATEMENT / SUBSTRAND	ICP.4.	Energy
INDICATOR / STANDARD	ICP.4.2.	Identify forms of energy present in a system (kinetic, gravitational, elastic, etc.), and pictorially represent the distribution of energies, such as using pie or bar charts. JoVE • An Introduction to Cell Metabolism • Detecting Reactive Oxygen Species • The ATP Bioluminescence Assay
STANDARD / STRAND	IN.ICP.	Integrated Chemistry and Physics (ICP)
PROFICIENCY STATEMENT / SUBSTRAND	ICP.5.	Particle Theory of Matter
INDICATOR / STANDARD	ICP.5.1.	Develop pictorial representations which show that matter is made of particles. JoVE • Coordination Chemistry Complexes • Nuclear Magnetic Resonance (NMR) Spectroscopy • Raman Spectroscopy for Chemical Analysis • X-ray Fluorescence (XRF)
INDICATOR / STANDARD	ICP.5.2.	Describe the assumptions used to develop the kinetic theory of gasses. JoVE • Degassing Liquids with Freeze-Pump-Thaw Cycling • Determining Rate Laws and the Order of Reaction • Fractional Distillation • Gas Chromatography (GC) with Flame-Ionization Detection • Ideal Gas Law • Schlenk Lines Transfer of Solvents • Separation of Mixtures via Precipitation • The Ideal Gas Law
INDICATOR / STANDARD	ICP.5.3.	At the particle level, describe the relationship between temperature and the average kinetic energy of particles in the system and describe how a thermometer measures the temperature of a system. JoVE • Conducting Reactions Below Room Temperature • Fractional Distillation

		• Freezing-Point Depression to Determine an Unknown Compound • Ideal Gas Law • Regulating Temperature in the Lab: Applying Heat • Regulating Temperature in the Lab: Preserving Samples Using Cold • The Ideal Gas Law
INDICATOR / STANDARD	ICP.5.4.	Distinguish "temperature" from "thermal energy," compare and contrast the Fahrenheit, Celsius, and Kelvin temperature scales, and convert temperatures between them. JoVE • Conducting Reactions Below Room Temperature • Freezing-Point Depression to Determine an Unknown Compound • Ideal Gas Law • Regulating Temperature in the Lab: Applying Heat • Regulating Temperature in the Lab: Preserving Samples Using Cold • The Ideal Gas Law
INDICATOR / STANDARD	ICP.5.5.	Evaluate graphical or pictorial representations that describe the relationship among the volume, temperature, and number of molecules and the pressure exerted by the system to qualitatively and quantitatively describe how changing any of those variables affects the others. JoVE • Determining Rate Laws and the Order of Reaction • Ideal Gas Law • The Ideal Gas Law
INDICATOR / STANDARD	ICP.5.6.	Describe and demonstrate how the kinetic theory can be extended to describe the properties of liquids and solids by introducing attractive forces between the particles. JoVE • Degassing Liquids with Freeze-Pump-Thaw Cycling • Fractional Distillation • Growing Crystals for X-ray Diffraction Analysis • Ideal Gas Law • Physical Properties Of Minerals I: Crystals and Cleavage • Physical Properties Of Minerals II: Polymineralic Analysis • Protein Crystallization • Purifying Compounds by Recrystallization • Schlenk Lines Transfer of Solvents • Separation of Mixtures via Precipitation • Solid-Liquid Extraction • The Ideal Gas Law

INDICATOR / STANDARD	ICP.5.7.	Analyze a heating / cooling curve to describe how adding or removing thermal energy from a system changes the temperature or state of an object and be able to identify the melting and freezing temperatures of the system. JoVE • Conducting Reactions Below Room Temperature • Freezing-Point Depression to Determine an Unknown Compound • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy
INDICATOR / STANDARD	ICP.5.8.	Collect and use experimental data to determine the number of items in a sample without actually counting them and qualitatively relate this to Avogadro's hypothesis. JoVE • Ideal Gas Law • The Ideal Gas Law
STANDARD / STRAND	IN.ICP.	Integrated Chemistry and Physics (ICP)
PROFICIENCY STATEMENT / SUBSTRAND	ICP.6.	Describing Substances
INDICATOR / STANDARD	ICP.6.1.	Distinguish between elements, mixtures, and compounds based on their composition and bonds and be able to construct or sketch particle models to represent them. JoVE • Calibration Curves • Capillary Electrophoresis (CE) • Chromatography-Based Biomolecule Purification Methods • Column Chromatography • Conducting Reactions Below Room Temperature • Cyclic Voltammetry (CV) • Degassing Liquids with Freeze-Pump-Thaw Cycling • Density Gradient Ultracentrifugation • Determining the Empirical Formula • Determining the Solubility Rules of Ionic Compounds • Dialysis: Diffusion Based Separation • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Fractional Distillation • 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) • Internal Standards

		• Ion-Exchange Chromatography • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Method of Standard Addition • Performing 1D Thin Layer Chromatography • Photometric Protein Determination • Purifying Compounds by Recrystallization • 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 • Two-Dimensional Gel Electrophoresis
INDICATOR / STANDARD	ICP.6.2.	Develop graphical and mathematical representations to show that mixtures can be made in any proportion and separated based on the properties of the components of the mixture and apply those representations to quantitatively determine the ratio of components. JoVE • An Introduction to the Centrifuge • Assembly of a Reflux System for Heated Chemical Reactions • Calibration Curves • Capillary Electrophoresis (CE) • Carbon and Nitrogen Analysis of Environmental Samples • Chromatography-Based Biomolecule Purification Methods • Co-Immunoprecipitation and Pull-Down Assays • Column Chromatography • Conducting Reactions Below Room Temperature • Cyclic Voltammetry (CV) • Degassing Liquids with Freeze-Pump-Thaw Cycling • Density Gradient Ultracentrifugation • 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) • Fractional Distillation • Gas Chromatography (GC) with Flame-Ionization Detection • High-Performance Liquid Chromatography (HPLC) • Internal Standards • Ion-Exchange Chromatography

		• MALDI-TOF Mass Spectrometry • Method of Standard Addition • Performing 1D Thin Layer Chromatography • Photometric Protein Determination • Purification of a Total Lipid Extract with Column Chromatography • Rotary Evaporation to Remove Solvent • Sample Preparation for Analytical Preparation • Schlenk Lines Transfer of Solvents • Separation of Mixtures via Precipitation • Solid-Liquid Extraction • Solutions and Concentrations • Tandem Mass Spectrometry • Two-Dimensional Gel Electrophoresis
INDICATOR / STANDARD	ICP.6.3.	Cite the evidence that supports the idea that some pure substances are combined of elements in a definite ratio, as for example seen in electrolysis of water. JoVE • Calibration Curves • Capillary Electrophoresis (CE) • Chromatography-Based Biomolecule Purification Methods • Column Chromatography • Cyclic Voltammetry (CV) • DNA Gel Electrophoresis • Determining Rate Laws and the Order of Reaction • 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) • Freezing-Point Depression to Determine an Unknown Compound • Gel Purification • Growing Crystals for X-ray Diffraction Analysis • High-Performance Liquid Chromatography (HPLC) • Ion-Exchange Chromatography • Performing 1D Thin Layer Chromatography • Proton Exchange Membrane Fuel Cells • Purifying Compounds by Recrystallization • Separating Protein with SDS-PAGE • Separation of Mixtures via Precipitation • The Western Blot • Two-Dimensional Gel Electrophoresis
INDICATOR / STANDARD	ICP.6.4.	Given the periodic table, determine the atomic mass, atomic number, and charges for any element.

		JoVE • Freezing-Point Depression to Determine an Unknown Compound • Introduction to Mass Spectrometry • MALDI-TOF Mass Spectrometry • Tandem Mass Spectrometry
INDICATOR / STANDARD	ICP.6.5.	Given a periodic table, understand and describe the significance of column location for the elements by calculation of molar ratios of known compounds. JoVE • Coordination Chemistry Complexes
INDICATOR / STANDARD	ICP.6.6.	Develop graphical and mathematical representations that describe the relationship between volume and mass of an object, describe the slope in terms of the object's density, and apply those representations to qualitatively and quantitatively determine the mass or volume of any object. JoVE • Determining the Density of a Solid and Liquid • Solid-Liquid Extraction
INDICATOR / STANDARD	ICP.6.7.	Describe how both density and molecular structure are applicable in distinguishing the properties of gases from those of liquids and solids. JoVE • Degassing Liquids with Freeze-Pump-Thaw Cycling • Fractional Distillation • Gas Chromatography (GC) with Flame-Ionization Detection • Growing Crystals for X-ray Diffraction Analysis • Ideal Gas Law • Physical Properties Of Minerals I: Crystals and Cleavage • Physical Properties Of Minerals II: Polymineralic Analysis • Protein Crystallization • Purifying Compounds by Recrystallization • Schlenk Lines Transfer of Solvents • Separation of Mixtures via Precipitation • Solid-Liquid Extraction • The Ideal Gas Law
STANDARD / STRAND	IN.ICP.	Integrated Chemistry and Physics (ICP)
PROFICIENCY STATEMENT / SUBSTRAND	ICP.7.	Representing Chemical Change
INDICATOR / STANDARD	ICP.7.1.	Pictorially or mathematically represent chemical changes using particle diagrams and chemical equations.

		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**
INDICATOR / STANDARD	**ICP.7.2.**	**Demonstrate the Law of Conservation of Matter in terms of atoms and mass of substances by balancing equations.** **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** **• 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**
INDICATOR / STANDARD	**ICP.7.3.**	**Differentiate the basic types of reactions, for example: synthesis, decomposition, combustion, single replacement, and double replacement.** **JoVE** **• An Introduction to the Micropipettor** **• Co-Immunoprecipitation and Pull-Down Assays** **• Common Lab Glassware and Uses** **• Conducting Reactions Below Room Temperature** **• Coordination Chemistry Complexes** **• Cyclic Voltammetry (CV)** **• Determining Rate Laws and the Order of Reaction** **• Determining the Solubility Rules of Ionic Compounds**

		• Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Enzyme Assays and Kinetics • Growing Crystals for X-ray Diffraction Analysis • Introduction to Catalysis • Introduction to Serological Pipettes and Pipettors • Introduction to Titration • Introduction to the Microplate Reader • Introduction to the Spectrophotometer • Le Châtelier's Principle • Making Solutions in the Laboratory • Measuring Mass in the Laboratory • Photometric Protein Determination • Preparing Anhydrous Reagents and Equipment • Proton Exchange Membrane Fuel Cells • Purifying Compounds by Recrystallization • Regulating Temperature in the Lab: Applying Heat • Regulating Temperature in the Lab: Preserving Samples Using Cold • Rotary Evaporation to Remove Solvent • Separation of Mixtures via Precipitation • Spectrophotometric Determination of an Equilibrium Constant • Understanding Concentration and Measuring Volumes • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy • Using a pH Meter
INDICATOR / STANDARD	ICP.7.4.	Using balanced equations and stoichiometric calculations, demonstrate the principle of Conservation of Matter in terms of atoms and mass. JoVE • Assembly of a Reflux System for Heated Chemical Reactions • Calibration Curves • Conducting Reactions Below Room Temperature • Coordination Chemistry Complexes • Determining Rate Laws and the Order of Reaction • Determining the Empirical Formula • Determining the Mass Percent Composition in an Aqueous Solution • Determining the Solubility Rules of Ionic Compounds • Introduction to Catalysis • Introduction to Titration • Method of Standard Addition • 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
STANDARD / STRAND	IN.ICP.	Integrated Chemistry and Physics (ICP)
PROFICIENCY STATEMENT / SUBSTRAND	ICP.8.	Electricity and Magnetism
INDICATOR / STANDARD	ICP.8.1.	Describe electrical current in terms of the motion of electrons within a device and relate the rate of motion of the electrons to the amount of current measured. JoVE • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat
INDICATOR / STANDARD	ICP.8.3.	Describe on a macroscopic scale how any distribution of magnetic materials (e.g. iron filings, ferrofluid, etc.) aligns with the magnetic field created by a simple magnet. JoVE • Introduction to Mass Spectrometry • Nuclear Magnetic Resonance (NMR) Spectroscopy
STANDARD / STRAND	IN.ICP.	Integrated Chemistry and Physics (ICP)
PROFICIENCY STATEMENT / SUBSTRAND	ICP.9.	Waves
INDICATOR / STANDARD	ICP.9.4.	Describe how interacting waves produce different phenomena than singular waves in a medium (e.g. periodic changes in volume of sound or resonance). JoVE • Raman Spectroscopy for Chemical Analysis
INDICATOR / STANDARD	ICP.9.5.	Describe and provide examples of how modern technologies use mechanical or electromagnetic waves and their interactions to transmit information. JoVE • An Introduction to Behavioral Neuroscience • An Introduction to Cognition • An Introduction to Learning and Memory • An Introduction to Motor Control • An Introduction to Neuroanatomy • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Auscultation • Central Venous Catheter Insertion: Femoral Vein with Ultrasound Guidance • Central Venous Catheter Insertion: Internal Jugular with Ultrasound Guidance

		• Color Afterimages • Community DNA Extraction from Bacterial Colonies • Conducting Reactions Below Room Temperature • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Coordination Chemistry Complexes • Decision-making and the Iowa Gambling Task • Decoding Auditory Imagery with Multivoxel Pattern Analysis • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Determining the Empirical Formula • Electro-encephalography (EEG) • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Eye Tracking in Cognitive Experiments • Fear Conditioning • Finding Your Blind Spot and Perceptual Filling-in • Förster Resonance Energy Transfer (FRET) • Gas Chromatography (GC) with Flame-Ionization Detection • Growing Crystals for X-ray Diffraction Analysis • Internal Standards • Intra-articular Shoulder Injection for Reduction Following Anterior Shoulder Dislocation • Introduction to Catalysis • Introduction to Mass Spectrometry • Introduction to the Spectrophotometer • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Learning and Memory: The Remember-Know Task • MALDI-TOF Mass Spectrometry • Measuring Grey Matter Differences with Voxel-based Morphometry: The Musical Brain • Metabolic Labeling • Method of Standard Addition • Motion-induced Blindness • Motor Maps • Nuclear Magnetic Resonance (NMR) Spectroscopy • Nutrients in Aquatic Ecosystems • Pericardiocentesis • Peripheral Vascular Exam • Peripheral Vascular Exam Using a Continuous Wave Doppler • Photometric Protein Determination • Physical Properties Of Minerals I: Crystals and Cleavage • Plasmid Purification • Protein Crystallization • Purifying Compounds by Recrystallization • Raman Spectroscopy for Chemical Analysis • Removal of Branched and Cyclic Compounds by Urea

		Adduction for Uk'37 Paleothermometry • Solid-Liquid Extraction • Sonication Extraction of Lipid Biomarkers from Sediment • Soxhlet Extraction of Lipid Biomarkers from Sediment • Spatial Cueing • Spectrophotometric Determination of an Equilibrium Constant • Tandem Mass Spectrometry • The Attentional Blink • The Rubber Hand Illusion • Ultraviolet-Visible (UV-Vis) Spectroscopy • Using Diffusion Tensor Imaging in Traumatic Brain Injury • Using TMS to Measure Motor Excitability During Action Observation • Visual Attention: fMRI Investigation of Object-based Attentional Control • X-ray Fluorescence (XRF) • Yeast Maintenance • fMRI: Functional Magnetic Resonance Imaging
STANDARD / STRAND	**IN.ICP.**	**Integrated Chemistry and Physics (ICP)**
PROFICIENCY STATEMENT / SUBSTRAND	**ICP.10.**	**Nuclear Energy**
INDICATOR / STANDARD	**ICP.10.5.**	**Explain the potential applications and possible consequences as the result of nuclear processes such as the generation of energy at nuclear power plants, including the potential damage that radioactivity can cause to biological tissues.** **JoVE** • An Introduction to Drosophila melanogaster • An Overview of Genetics and Disease
STANDARD / STRAND	**IN.PI.**	**Physics I (PI)**
PROFICIENCY STATEMENT / SUBSTRAND	**PI.5.**	**Linear Momentum In One Dimension**
INDICATOR / STANDARD	**PI.5.3.**	**Demonstrate that when two objects interact through a collision or separation that both the force experienced by each object and change in linear momentum of each object are equal and opposite, and as the mass of an object increases, the change in velocity of that object decreases.** **JoVE** • Raman Spectroscopy for Chemical Analysis
INDICATOR / STANDARD	**PI.5.5.**	**Classify an interaction (e.g. collision or separation) between two objects as elastic or inelastic based on the**

		change in linear kinetic energy of the system. JoVE • Raman Spectroscopy for Chemical Analysis
STANDARD / STRAND	IN.PI.	Physics I (PI)
PROFICIENCY STATEMENT / SUBSTRAND	PI.7.	Mechanical Waves and Sound
INDICATOR / STANDARD	PI.7.2.	Understand that a mechanical wave requires a medium to transfer energy, unlike an electromagnetic wave, and that only the energy is transferred by the mechanical wave, not the mass of the medium. JoVE • Abdominal Exam II: Percussion • Auscultation • Percussion • The Staircase Procedure for Finding a Perceptual Threshold
INDICATOR / STANDARD	PI.7.3.	Develop graphical and mathematical representations that describe the relationship between the frequency of a mechanical wave and the wavelength of the wave and apply those representations to qualitatively and quantitatively describe how changing the frequency of a mechanical wave affects the wavelength and vice versa. JoVE • Auscultation • Percussion
INDICATOR / STANDARD	PI.7.4.	Describe the slope of the graphical representation of wavelength vs. the inverse of the frequency in terms of the speed of the mechanical wave. JoVE • Auscultation • Percussion
INDICATOR / STANDARD	PI.7.5.	Apply the mechanical wave model to sound waves and qualitatively and quantitatively determine how the relative motion of a source and observer affects the frequency of a wave as described by the Doppler Effect. JoVE • Peripheral Vascular Exam Using a Continuous Wave Doppler
STANDARD / STRAND	IN.PI.	Physics I (PI)
PROFICIENCY STATEMENT / SUBSTRAND	PI.8.	Simple Circuit Analysis

INDICATOR / STANDARD	PI.8.5.	Qualitatively and quantitatively describe how changing the voltage or resistance of a simple series (i.e. loop) circuit affects the voltage, current, and power measurements of individual resistive devices and for the entire circuit. JoVE • Cyclic Voltammetry (CV) • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat
STANDARD / STRAND	IN.PII.	Physics II (PII)
PROFICIENCY STATEMENT / SUBSTRAND	PII.1.	Energy and Momentum in Two Dimensions
INDICATOR / STANDARD	PII.1.2.	For a system consisting of a two objects with no net external forces applied, qualitatively and quantitatively analyze a two dimensional interaction (i.e. collision or separation) to show that the total linear momentum of the system remains constant. JoVE • Raman Spectroscopy for Chemical Analysis
INDICATOR / STANDARD	PII.1.4.	Classify interactions between two objects moving in two dimensions as elastic, inelastic, and completely inelastic. JoVE • Raman Spectroscopy for Chemical Analysis
STANDARD / STRAND	IN.PII.	Physics II (PII)
PROFICIENCY STATEMENT / SUBSTRAND	PII.2.	Temperature and Thermal Energy Transfer
INDICATOR / STANDARD	PII.2.1.	Develop graphical and mathematical representations that describe the relationship among the temperature, thermal energy, and thermal energy transfer (i.e. heat) in the kinetic molecular theory and apply those representations to qualitatively and quantitatively describe how changing the temperature of a substance affects the motion of the molecules. JoVE • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy
INDICATOR / STANDARD	PII.2.4.	Develop graphical and mathematical representations that describe the relationship among the volume, temperature, and number of molecules of an ideal gas in a closed system and the pressure exerted by the system and apply those representations to qualitatively and quantitatively describe how changing any of those variables affects the others.

		JoVE • Determining Rate Laws and the Order of Reaction • Ideal Gas Law • The Ideal Gas Law
INDICATOR / STANDARD	PII.2.5.	Describe the slope of the graphical representation of pressure vs. the product of: the number of particles, temperature of the gas, and inverse of the volume of the gas in terms of the ideal gas constant. JoVE • Determining Rate Laws and the Order of Reaction • Ideal Gas Law • The Ideal Gas Law
INDICATOR / STANDARD	PII.2.6.	Using PV graphs, qualitatively and quantitatively determine how changes in the pressure, volume, or temperature of an ideal gas allow the gas to do work and classify the work as either done on or done by the gas. JoVE • Determining Rate Laws and the Order of Reaction • Ideal Gas Law • The Ideal Gas Law
STANDARD / STRAND	IN.PII.	Physics II (PII)
PROFICIENCY STATEMENT / SUBSTRAND	PII.3.	Fluids
INDICATOR / STANDARD	PII.3.1.	For a static, incompressible fluid, develop and apply graphical and mathematical representations that describe the relationship between the density and the pressure exerted at various positions in the fluid, and apply those representations to qualitatively and quantitatively describe how changing the depth or density affects the pressure. JoVE • Determining the Density of a Solid and Liquid • Ideal Gas Law • The Ideal Gas Law
STANDARD / STRAND	IN.PII.	Physics II (PII)
PROFICIENCY STATEMENT / SUBSTRAND	PII.4.	Electricity
INDICATOR / STANDARD	PII.4.4.	For a single isolated charge, develop graphical and mathematical representations that describe the relationship between the amount of charge, the distance from the charge and the electric potential created by the charge and apply those representations to qualitatively and quantitatively describe how changing either the

		amount of charge or distance from the charge affects the electric potential. JoVE • Cyclic Voltammetry (CV) • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat
INDICATOR / STANDARD	PII.4.6.	Distinguish between electric potential energy and electric potential (i.e. voltage). JoVE • Cyclic Voltammetry (CV) • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat
INDICATOR / STANDARD	PII.4.7.	Apply conservation of energy to determine changes in the electric potential energy, translational kinetic energy, and speed of a single charged object (i.e. a point particle) placed in a uniform electric field. JoVE • Cyclic Voltammetry (CV) • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat
STANDARD / STRAND	IN.PII.	Physics II (PII)
PROFICIENCY STATEMENT / SUBSTRAND	PII.5.	Simple and Complex Circuits
INDICATOR / STANDARD	PII.5.1.	Relate the idea of electric potential energy to electric potential (i.e. voltage) in the context of electric circuits. JoVE • Cyclic Voltammetry (CV) • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat
INDICATOR / STANDARD	PII.5.5.	Explain and analyze simple arrangements of electrical components in series and parallel DC circuits in terms of current, resistance, voltage and power. Use Ohm's and Kirchhoff's laws to analyze DC circuits. JoVE • Nuclear Magnetic Resonance (NMR) Spectroscopy
STANDARD / STRAND	IN.PII.	Physics II (PII)
PROFICIENCY STATEMENT / SUBSTRAND	PII.6.	Magnetism
INDICATOR / STANDARD	PII.6.1.	Describe the magnetic properties of ferromagnetic, paramagnetic, and diamagnetic materials on a macroscopic scale and atomic scale.

		JoVE **• Determining Spatial Orientation of Rock Layers with the Brunton Compass** **• Introduction to Mass Spectrometry** **• MALDI-TOF Mass Spectrometry** **• Nuclear Magnetic Resonance (NMR) Spectroscopy** **• Tandem Mass Spectrometry**
INDICATOR / STANDARD	**PII.6.3.**	**Describe the motion of a charged or uncharged particle through a uniform magnetic field.** **JoVE** **• Introduction to Mass Spectrometry** **• Nuclear Magnetic Resonance (NMR) Spectroscopy**
INDICATOR / STANDARD	**PII.6.4.**	**Determine the magnitude of the magnetic force acting on a charged particle moving through a uniform magnetic field and apply the right hand rule to determine the direction of either the magnetic force or the magnetic field.** **JoVE** **• Introduction to Mass Spectrometry** **• Nuclear Magnetic Resonance (NMR) Spectroscopy**
INDICATOR / STANDARD	**PII.6.5.**	**Describe the practical uses of magnetism in motors, electronic devices, mass spectroscopy, MRIs, and other applications.** **JoVE** **• An Introduction to Behavioral Neuroscience** **• An Introduction to Cognition** **• An Introduction to Learning and Memory** **• An Introduction to Motor Control** **• An Introduction to Neuroanatomy** **• Color Afterimages** **• Community DNA Extraction from Bacterial Colonies** **• Conducting Reactions Below Room Temperature** **• Coordination Chemistry Complexes** **• Decision-making and the Iowa Gambling Task** **• Decoding Auditory Imagery with Multivoxel Pattern Analysis** **• Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy** **• Determining the Empirical Formula** **• Electro-encephalography (EEG)** **• Eye Tracking in Cognitive Experiments** **• Fear Conditioning** **• Finding Your Blind Spot and Perceptual Filling-in** **• Förster Resonance Energy Transfer (FRET)** **• Gas Chromatography (GC) with Flame-Ionization Detection** **• Growing Crystals for X-ray Diffraction Analysis**

		• Internal Standards • Introduction to Catalysis • Introduction to Mass Spectrometry • Introduction to the Spectrophotometer • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Learning and Memory: The Remember-Know Task • MALDI-TOF Mass Spectrometry • Measuring Grey Matter Differences with Voxel-based Morphometry: The Musical Brain • Metabolic Labeling • Method of Standard Addition • Motion-induced Blindness • Motor Maps • Nuclear Magnetic Resonance (NMR) Spectroscopy • Nutrients in Aquatic Ecosystems • Photometric Protein Determination • Plasmid Purification • Purifying Compounds by Recrystallization • Raman Spectroscopy for Chemical Analysis • Solid-Liquid Extraction • Spatial Cueing • Spectrophotometric Determination of an Equilibrium Constant • Tandem Mass Spectrometry • The Attentional Blink • The Rubber Hand Illusion • Ultraviolet-Visible (UV-Vis) Spectroscopy • Using Diffusion Tensor Imaging in Traumatic Brain Injury • Using TMS to Measure Motor Excitability During Action Observation • Visual Attention: fMRI Investigation of Object-based Attentional Control • X-ray Fluorescence (XRF) • Yeast Maintenance • fMRI: Functional Magnetic Resonance Imaging
STANDARD / STRAND	**IN.PII.**	**Physics II (PII)**
PROFICIENCY STATEMENT / SUBSTRAND	**PII.7.**	**Electromagnetic Induction**
INDICATOR / STANDARD	**PII.7.1.**	**Given the magnitude and direction of a uniform magnetic field, calculate the flux through a specified area in terms of the field magnitude and the size and orientation of the area with respect to the field.** **JoVE** **• Gas Chromatography (GC) with Flame-Ionization Detection**
STANDARD / STRAND	**IN.PII.**	**Physics II (PII)**

PROFICIENCY STATEMENT / SUBSTRAND	**PII.8.**	**Geometric Optics**
INDICATOR / STANDARD	**PII.8.2.**	**Develop graphical, mathematical, and pictorial representations (e.g. ray diagrams) that describe the relationship between the angles of incidence and refraction of monochromatic light passed between two different media and apply those representations to qualitatively and quantitatively describe how changing the angle of incidence affects the angle of refraction.** **JoVE** **• Color Afterimages** **• Crowding** **• Finding Your Blind Spot and Perceptual Filling-in** **• Histological Sample Preparation for Light Microscopy** **• Inattentional Blindness** **• Introduction to Fluorescence Microscopy** **• Introduction to Light Microscopy** **• Just-noticeable Differences** **• Motion-induced Blindness** **• Object Substitution Masking** **• Spatial Cueing** **• Spectrophotometric Determination of an Equilibrium Constant** **• Surface Plasmon Resonance (SPR)** **• The Ames Room** **• The Attentional Blink** **• The Inverted-face Effect**
STANDARD / STRAND	**IN.PII.**	**Physics II (PII)**
PROFICIENCY STATEMENT / SUBSTRAND	**PII.9.**	**Particle and Wave Nature of Light**
INDICATOR / STANDARD	**PII.9.1.**	**Develop the relationship among frequency, wavelength, and energy for electromagnetic waves across the entire spectrum.** **JoVE** **• Ultraviolet-Visible (UV-Vis) Spectroscopy**
INDICATOR / STANDARD	**PII.9.2.**	**Explain how electromagnetic waves interact with matter both as particles (i.e. photons) and as waves and be able to apply the most appropriate model to any particular scenario.** **JoVE** **• Nuclear Magnetic Resonance (NMR) Spectroscopy** **• Raman Spectroscopy for Chemical Analysis**
INDICATOR / STANDARD	**PII.9.6.**	**Develop graphical and mathematical representations that describe the relationship between the angle between two polarizing filters and the intensity of light passed**

		through the filters from an unpolarized light source and apply those representations to qualitatively and quantitatively describe how changing the angle between polarizing filters affects the intensity of light passing through both filters. JoVE • MALDI-TOF Mass Spectrometry • Raman Spectroscopy for Chemical Analysis
STANDARD / STRAND	IN.PII.	Physics II (PII)
PROFICIENCY STATEMENT / SUBSTRAND	PII.10.	Modern Physics
INDICATOR / STANDARD	PII.10.4.	Apply the conservation of mass, conservation of charge, and conservation of linear momentum principles to describe the results of a radioactive particle undergoing either alpha or beta decay. JoVE • Determining the Empirical Formula