Main Criteria: Utah Core Standards
Secondary Criteria: JoVE
Subject: Science
Grade: 9-12
Correlation Options: Show Correlated
Adopted: 2003

STANDARD / AREA OF LEARNING	UT.1.	Biology: Intended Learning Outcome: Use Science Process and Thinking Skills.
OBJECTIVE / STRAND	1.a.	Observe objects, events and patterns and record both qualitative and quantitative information. JoVE • Observational Research
OBJECTIVE / STRAND	1.b.	Use comparisons to help understand observations and phenomena. JoVE • An Introduction to Working in the Hood • An Introduction to the Centrifuge • An Introduction to the Micropipettor • Histological Sample Preparation for Light Microscopy • Introduction to Fluorescence Microscopy • Introduction to Light Microscopy • Introduction to Serological Pipettes and Pipettors • Introduction to the Bunsen Burner • Introduction to the Microplate Reader • Measuring Mass in the Laboratory • Regulating Temperature in the Lab: Applying Heat • Regulating Temperature in the Lab: Preserving Samples Using Cold
OBJECTIVE / STRAND	1.c.	Evaluate, sort, and sequence data according to given criteria. JoVE • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method • DNA Gel Electrophoresis • Gel Purification • Plasmid Purification • Separating Protein with SDS-PAGE

		• The ELISA Method • The Western Blot • Tree Identification: How To Use a Dichotomous Key • Using GIS to Investigate Urban Forestry
OBJECTIVE / STRAND	1.d.	Select and use appropriate technological instruments to collect and analyze data. <u>JoVE</u> • An Introduction to the Centrifuge • An Introduction to the Micropipettor • Histological Sample Preparation for Light Microscopy • Introduction to Fluorescence Microscopy • Introduction to Light Microscopy • Introduction to Serological Pipettes and Pipettors • Introduction to the Microplate Reader • Introduction to the Spectrophotometer • Regulating Temperature in the Lab: Applying Heat • Regulating Temperature in the Lab: Preserving Samples Using Cold
OBJECTIVE / STRAND	1.e.	Plan and conduct experiments in which students may: Identify a problem; Formulate research questions and hypotheses; Predict results of investigations based upon prior data; Identify variables and describe the relationships between them; Plan procedures to control independent variables; Collect data on the dependent variable(s); Select the appropriate format (e.g., graph, chart, diagram) and use it to summarize the data obtained; Analyze data, check it for accuracy and construct reasonable conclusions; Prepare written and oral reports of investigations. <u>JoVE</u> • Ethics in Psychology Research • Experimentation using a Confederate • From Theory to Design: The Role of Creativity in Designing Experiments • Manipulating an Independent Variable through Embodiment • Observational Research • Pilot Testing • Placebos in Research • Realism in Experimentation • Reliability in Psychology Experiments • Self-report vs. Behavioral Measures of Recycling • The Factorial Experiment • The Multi-group Experiment • The Simple Experiment: Two-group Design • Within-subjects Repeated-measures Design
OBJECTIVE / STRAND	1.g.	Develop and use classification systems.

		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** **• Bacterial Transformation: Electroporation** **• Bacterial Transformation: The Heat Shock Method** **• 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** **• DNA Gel Electrophoresis** **• 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** **• Gel Purification** **• In ovo Electroporation of Chicken Embryos** **• Introducing Experimental Agents into the Mouse** **• Isolating Nucleic Acids from Yeast** **• Mouse Genotyping** **• Plasmid Purification** **• RNAi in C. elegans** **• Separating Protein with SDS-PAGE** **• The ELISA Method** **• The Western Blot** **• Tree Identification: How To Use a Dichotomous Key** **• Tree Survey: Point-Centered Quarter Sampling Method** **• Using GIS to Investigate Urban Forestry** **• Yeast Maintenance** **• Yeast Reproduction** **• Yeast Transformation and Cloning** **• Zebrafish Breeding and Embryo Handling** **• Zebrafish Maintenance and Husbandry** **• Zebrafish Microinjection Techniques** **• Zebrafish Reproduction and Development**
OBJECTIVE / STRAND	**1.i.**	**Use mathematics as a precise method for showing relationships.**

		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 Metabolism** **• An Introduction to Cognition** **• An Introduction to Developmental Neurobiology** **• An Introduction to Drosophila melanogaster** **• An Introduction to Endocytosis and Exocytosis** **• An Introduction to Learning and Memory** **• An Introduction to Modeling Behavioral Disorders and Stress** **• An Introduction to Motor Control** **• An Introduction to Neurophysiology** **• An Introduction to Reward and Addiction** **• An Overview of Alkenone Biomarker Analysis for Paleothermometry** **• An Overview of Genetic Analysis** **• An Overview of Genetics and Disease** **• An Overview of bGDGT Biomarker Analysis for Paleoclimatology** **• Annexin V and Propidium Iodide Labeling** **• Anterograde Amnesia** **• Anxiety Testing** **• Approximate Number Sense Test** **• Are You Smart or Hardworking? How Praise Influences Children's Motivation** **• Assessing Dexterity with Reaching Tasks** **• Bacterial Growth Curve Analysis and its Environmental Applications** **• Balance and Coordination Testing** **• Basic Mouse Care and Maintenance** **• Binocular Rivalry** **• Blood Pressure Measurement** **• C. elegans Chemotaxis Assay** **• Calcium Imaging in Neurons** **• Categories and Inductive Inferences** **• Cell Cycle Analysis** **• Cell-surface Biotinylation Assay** **• Children's Reliance on Artist Intentions When Identifying Pictures** **• Chromatin Immunoprecipitation** **• Community DNA Extraction from Bacterial Colonies** **• Crowding** **• Culturing and Enumerating Bacteria from Soil Samples** **• DNA Methylation Analysis** **• Decision-making and the Iowa Gambling Task** **• Decoding Auditory Imagery with Multivoxel Pattern Analysis** **• Detecting Reactive Oxygen Species**

		• Development and Reproduction of the Laboratory Mouse • Dichotic Listening • Drosophila Development and Reproduction • Electro-encephalography (EEG) • Ethics in Psychology Research • Event-related Potentials and the Oddball Task • Executive Function and the Dimensional Change Card Sort Task • Executive Function in Autism Spectrum Disorder • Experimentation using a Confederate • Expression Profiling with Microarrays • Eye Tracking in Cognitive Experiments • FM Dyes in Vesicle Recycling • Fate Mapping • Fear Conditioning • From Theory to Design: The Role of Creativity in Designing Experiments • Gene Silencing with Morpholinos • Genetic Crosses • Genetic Screens • Habituation: Studying Infants Before They Can Talk • How Children Solve Problems Using Causal Reasoning • Inattentional Blindness • Incidental Encoding • Introducing Experimental Agents into the Mouse • Introduction to the Spectrophotometer • Invasion Assay Using 3D Matrices • Invertebrate Lifespan Quantification • Isolating Nucleic Acids from Yeast • Just-noticeable Differences • Language: The N400 in Semantic Incongruity • Learning and Memory: The Remember-Know Task • Manipulating an Independent Variable through Embodiment • Measuring Children's Trust in Testimony • Measuring Grey Matter Differences with Voxel-based Morphometry: The Musical Brain • Measuring Reaction Time and Donders' Method of Subtraction • Measuring Verbal Working Memory Span • Measuring Vital Signs • Memory Development: Demonstrating How Repeated Questioning Leads to False Memories • Mental Rotation • Metacognitive Development: How Children Estimate Their Memory • Modeling Social Stress • Motion-induced Blindness • Motor Learning in Mirror Drawing • Motor Maps

		• Multiple Object Tracking • Mutual Exclusivity: How Children Learn the Meanings of Words • Numerical Cognition: More or Less • Object Substitution Masking • Observational Research • PCR: The Polymerase Chain Reaction • Patch Clamp Electrophysiology • Pericardiocentesis • Peripheral Vascular Exam Using a Continuous Wave Doppler • Perspectives on Cognitive Psychology • Perspectives on Neuropsychology • Physiological Correlates of Emotion Recognition • Piaget's Conservation Task and the Influence of Task Demands • Pilot Testing • Placebos in Research • Plasmid Purification • Positive Reinforcement Studies • Prospect Theory • Purification of a Total Lipid Extract with Column Chromatography • RNA Analysis of Environmental Samples Using RT-PCR • RNA-Seq • RNAi in C. elegans • Realism in Experimentation • Reliability in Psychology Experiments • SNP Genotyping • Self-administration Studies • Self-report vs. Behavioral Measures of Recycling • Spatial Cueing • Spatial Memory Testing Using Mazes • The ATP Bioluminescence Assay • The Attentional Blink • The Costs and Benefits of Natural Pedagogy • The ELISA Method • The Factorial Experiment • The Inverted-face Effect • The Morris Water Maze • The Multi-group Experiment • The Precision of Visual Working Memory with Delayed Estimation • The Rouge Test: Searching for a Sense of Self • The Simple Experiment: Two-group Design • The Split Brain • The Staircase Procedure for Finding a Perceptual Threshold • The TUNEL Assay • The Transwell Migration Assay • The Western Blot

		• Using Diffusion Tensor Imaging in Traumatic Brain Injury • Using TMS to Measure Motor Excitability During Action Observation • Using Your Head: Measuring Infants' Rational Imitation of Actions • Verbal Priming • Visual Attention: fMRI Investigation of Object-based Attentional Control • Visual Search for Features and Conjunctions • Visual Statistical Learning • Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy • Within-subjects Repeated-measures Design • Yeast Maintenance • fMRI: Functional Magnetic Resonance Imaging
OBJECTIVE / STRAND	1.j.	Form alternative hypotheses to explain a problem. JoVE • The Multi-group Experiment • The Simple Experiment: Two-group Design
STANDARD / AREA OF LEARNING	UT.2.	Biology: Intended Learning Outcome: Manifest Scientific Attitudes and Interests.
OBJECTIVE / STRAND	2.b.	Raise questions about objects, events and processes that can be answered through scientific investigation. JoVE • The Multi-group Experiment • The Simple Experiment: Two-group Design
OBJECTIVE / STRAND	2.d.	Accept responsibility for actively helping to resolve social, ethical and ecological problems related to science and technology. JoVE • An Introduction to Organogenesis • An Introduction to Saccharomyces cerevisiae • Embryonic Stem Cell Culture and Differentiation • Ethics in Psychology Research • Passaging Cells • Realism in Experimentation • Reliability in Psychology Experiments • Self-administration Studies • Self-report vs. Behavioral Measures of Recycling • Testing For Genetically Modified Foods
OBJECTIVE / STRAND	2.e.	Evaluate scientifically related claims against available evidence. JoVE • Ethics in Psychology Research • Experimentation using a Confederate

		• From Theory to Design: The Role of Creativity in Designing Experiments • Manipulating an Independent Variable through Embodiment • Observational Research • Pilot Testing • Placebos in Research • Reliability in Psychology Experiments • Self-report vs. Behavioral Measures of Recycling • The Factorial Experiment • The Multi-group Experiment • The Simple Experiment: Two-group Design • Within-subjects Repeated-measures Design
OBJECTIVE / STRAND	2.f.	Reject pseudoscience as a source of scientific knowledge. JoVE • Ethics in Psychology Research • Experimentation using a Confederate • From Theory to Design: The Role of Creativity in Designing Experiments • Manipulating an Independent Variable through Embodiment • Observational Research • Pilot Testing • Placebos in Research • Reliability in Psychology Experiments • Self-report vs. Behavioral Measures of Recycling • The Factorial Experiment • The Multi-group Experiment • The Simple Experiment: Two-group Design • Within-subjects Repeated-measures Design
STANDARD / AREA OF LEARNING	UT.3.	Biology: Intended Learning Outcome: Demonstrate Understanding of Science Concepts, Principles and Systems.
OBJECTIVE / STRAND	3.c.	Apply principles and concepts of science to explain various phenomena. 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 Metabolism • An Introduction to Cognition • An Introduction to Developmental Neurobiology • An Introduction to Drosophila melanogaster • An Introduction to Endocytosis and Exocytosis • An Introduction to Learning and Memory • An Introduction to Modeling Behavioral Disorders and Stress

		• An Introduction to Motor Control • An Introduction to Neurophysiology • An Introduction to Reward and Addiction • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of Genetic Analysis • An Overview of Genetics and Disease • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Annexin V and Propidium Iodide Labeling • Anterograde Amnesia • Anxiety Testing • Approximate Number Sense Test • Are You Smart or Hardworking? How Praise Influences Children's Motivation • Assessing Dexterity with Reaching Tasks • Bacterial Growth Curve Analysis and its Environmental Applications • Balance and Coordination Testing • Basic Mouse Care and Maintenance • Binocular Rivalry • Blood Pressure Measurement • C. elegans Chemotaxis Assay • Calcium Imaging in Neurons • Categories and Inductive Inferences • Cell Cycle Analysis • Cell-surface Biotinylation Assay • Children's Reliance on Artist Intentions When Identifying Pictures • Chromatin Immunoprecipitation • Community DNA Extraction from Bacterial Colonies • Crowding • Culturing and Enumerating Bacteria from Soil Samples • DNA Methylation Analysis • Decision-making and the Iowa Gambling Task • Decoding Auditory Imagery with Multivoxel Pattern Analysis • Detecting Reactive Oxygen Species • Development and Reproduction of the Laboratory Mouse • Dichotic Listening • Drosophila Development and Reproduction • Electro-encephalography (EEG) • Ethics in Psychology Research • Event-related Potentials and the Oddball Task • Executive Function and the Dimensional Change Card Sort Task • Executive Function in Autism Spectrum Disorder • Experimentation using a Confederate • Expression Profiling with Microarrays • Eye Tracking in Cognitive Experiments • FM Dyes in Vesicle Recycling

		• Fate Mapping • Fear Conditioning • From Theory to Design: The Role of Creativity in Designing Experiments • Gene Silencing with Morpholinos • Genetic Crosses • Genetic Screens • Habituation: Studying Infants Before They Can Talk • How Children Solve Problems Using Causal Reasoning • Inattentional Blindness • Incidental Encoding • Introducing Experimental Agents into the Mouse • Introduction to the Spectrophotometer • Invasion Assay Using 3D Matrices • Invertebrate Lifespan Quantification • Isolating Nucleic Acids from Yeast • Just-noticeable Differences • Language: The N400 in Semantic Incongruity • Learning and Memory: The Remember-Know Task • Manipulating an Independent Variable through Embodiment • Measuring Children's Trust in Testimony • Measuring Grey Matter Differences with Voxel-based Morphometry: The Musical Brain • Measuring Reaction Time and Donders' Method of Subtraction • Measuring Verbal Working Memory Span • Measuring Vital Signs • Memory Development: Demonstrating How Repeated Questioning Leads to False Memories • Mental Rotation • Metacognitive Development: How Children Estimate Their Memory • Modeling Social Stress • Motion-induced Blindness • Motor Learning in Mirror Drawing • Motor Maps • Multiple Object Tracking • Mutual Exclusivity: How Children Learn the Meanings of Words • Numerical Cognition: More or Less • Object Substitution Masking • Observational Research • PCR: The Polymerase Chain Reaction • Patch Clamp Electrophysiology • Pericardiocentesis • Peripheral Vascular Exam Using a Continuous Wave Doppler • Perspectives on Cognitive Psychology • Perspectives on Neuropsychology • Physiological Correlates of Emotion Recognition • Piaget's Conservation Task and the Influence of Task

		Demands **• Pilot Testing** **• Placebos in Research** **• Plasmid Purification** **• Positive Reinforcement Studies** **• Prospect Theory** **• Purification of a Total Lipid Extract with Column Chromatography** **• RNA Analysis of Environmental Samples Using RT-PCR** **• RNA-Seq** **• RNAi in C. elegans** **• Realism in Experimentation** **• Reliability in Psychology Experiments** **• SNP Genotyping** **• Self-administration Studies** **• Self-report vs. Behavioral Measures of Recycling** **• Spatial Cueing** **• Spatial Memory Testing Using Mazes** **• The ATP Bioluminescence Assay** **• The Attentional Blink** **• The Costs and Benefits of Natural Pedagogy** **• The ELISA Method** **• The Factorial Experiment** **• The Inverted-face Effect** **• The Morris Water Maze** **• The Multi-group Experiment** **• The Precision of Visual Working Memory with Delayed Estimation** **• The Rouge Test: Searching for a Sense of Self** **• The Simple Experiment: Two-group Design** **• The Split Brain** **• The Staircase Procedure for Finding a Perceptual Threshold** **• The TUNEL Assay** **• The Transwell Migration Assay** **• The Western Blot** **• Using Diffusion Tensor Imaging in Traumatic Brain Injury** **• Using TMS to Measure Motor Excitability During Action Observation** **• Using Your Head: Measuring Infants' Rational Imitation of Actions** **• Verbal Priming** **• Visual Attention: fMRI Investigation of Object-based Attentional Control** **• Visual Search for Features and Conjunctions** **• Visual Statistical Learning** **• Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy** **• Within-subjects Repeated-measures Design** **• Yeast Maintenance** **• fMRI: Functional Magnetic Resonance Imaging**

OBJECTIVE / STRAND	**3.d.**	**Solve problems by applying science principles and procedures.** **<u>JoVE</u>** **• 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 Metabolism** **• An Introduction to Cognition** **• An Introduction to Developmental Neurobiology** **• An Introduction to Drosophila melanogaster** **• An Introduction to Endocytosis and Exocytosis** **• An Introduction to Learning and Memory** **• An Introduction to Modeling Behavioral Disorders and Stress** **• An Introduction to Motor Control** **• An Introduction to Neurophysiology** **• An Introduction to Reward and Addiction** **• An Overview of Alkenone Biomarker Analysis for Paleothermometry** **• An Overview of Genetic Analysis** **• An Overview of Genetics and Disease** **• An Overview of bGDGT Biomarker Analysis for Paleoclimatology** **• Annexin V and Propidium Iodide Labeling** **• Anterograde Amnesia** **• Anxiety Testing** **• Approximate Number Sense Test** **• Are You Smart or Hardworking? How Praise Influences Children's Motivation** **• Assessing Dexterity with Reaching Tasks** **• Bacterial Growth Curve Analysis and its Environmental Applications** **• Balance and Coordination Testing** **• Basic Mouse Care and Maintenance** **• Binocular Rivalry** **• Blood Pressure Measurement** **• C. elegans Chemotaxis Assay** **• Calcium Imaging in Neurons** **• Categories and Inductive Inferences** **• Cell Cycle Analysis** **• Cell-surface Biotinylation Assay** **• Children's Reliance on Artist Intentions When Identifying Pictures** **• Chromatin Immunoprecipitation** **• Community DNA Extraction from Bacterial Colonies** **• Crowding** **• Culturing and Enumerating Bacteria from Soil Samples** **• DNA Methylation Analysis** **• Decision-making and the Iowa Gambling Task**

		• Decoding Auditory Imagery with Multivoxel Pattern Analysis • Detecting Reactive Oxygen Species • Development and Reproduction of the Laboratory Mouse • Dichotic Listening • Drosophila Development and Reproduction • Electro-encephalography (EEG) • Ethics in Psychology Research • Event-related Potentials and the Oddball Task • Executive Function and the Dimensional Change Card Sort Task • Executive Function in Autism Spectrum Disorder • Experimentation using a Confederate • Expression Profiling with Microarrays • Eye Tracking in Cognitive Experiments • FM Dyes in Vesicle Recycling • Fate Mapping • Fear Conditioning • From Theory to Design: The Role of Creativity in Designing Experiments • Gene Silencing with Morpholinos • Genetic Crosses • Genetic Screens • Habituation: Studying Infants Before They Can Talk • How Children Solve Problems Using Causal Reasoning • Inattentional Blindness • Incidental Encoding • Introducing Experimental Agents into the Mouse • Introduction to the Spectrophotometer • Invasion Assay Using 3D Matrices • Invertebrate Lifespan Quantification • Isolating Nucleic Acids from Yeast • Just-noticeable Differences • Language: The N400 in Semantic Incongruity • Learning and Memory: The Remember-Know Task • Manipulating an Independent Variable through Embodiment • Measuring Children's Trust in Testimony • Measuring Grey Matter Differences with Voxel-based Morphometry: The Musical Brain • Measuring Reaction Time and Donders' Method of Subtraction • Measuring Verbal Working Memory Span • Measuring Vital Signs • Memory Development: Demonstrating How Repeated Questioning Leads to False Memories • Mental Rotation • Metacognitive Development: How Children Estimate Their Memory • Modeling Social Stress

		• Motion-induced Blindness • Motor Learning in Mirror Drawing • Motor Maps • Multiple Object Tracking • Mutual Exclusivity: How Children Learn the Meanings of Words • Numerical Cognition: More or Less • Object Substitution Masking • Observational Research • PCR: The Polymerase Chain Reaction • Patch Clamp Electrophysiology • Pericardiocentesis • Peripheral Vascular Exam Using a Continuous Wave Doppler • Perspectives on Cognitive Psychology • Perspectives on Neuropsychology • Physiological Correlates of Emotion Recognition • Piaget's Conservation Task and the Influence of Task Demands • Pilot Testing • Placebos in Research • Plasmid Purification • Positive Reinforcement Studies • Prospect Theory • Purification of a Total Lipid Extract with Column Chromatography • RNA Analysis of Environmental Samples Using RT-PCR • RNA-Seq • RNAi in C. elegans • Realism in Experimentation • Reliability in Psychology Experiments • SNP Genotyping • Self-administration Studies • Self-report vs. Behavioral Measures of Recycling • Spatial Cueing • Spatial Memory Testing Using Mazes • The ATP Bioluminescence Assay • The Attentional Blink • The Costs and Benefits of Natural Pedagogy • The ELISA Method • The Factorial Experiment • The Inverted-face Effect • The Morris Water Maze • The Multi-group Experiment • The Precision of Visual Working Memory with Delayed Estimation • The Rouge Test: Searching for a Sense of Self • The Simple Experiment: Two-group Design • The Split Brain • The Staircase Procedure for Finding a Perceptual Threshold

		• The TUNEL Assay • The Transwell Migration Assay • The Western Blot • Using Diffusion Tensor Imaging in Traumatic Brain Injury • Using TMS to Measure Motor Excitability During Action Observation • Using Your Head: Measuring Infants' Rational Imitation of Actions • Verbal Priming • Visual Attention: fMRI Investigation of Object-based Attentional Control • Visual Search for Features and Conjunctions • Visual Statistical Learning • Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy • Within-subjects Repeated-measures Design • Yeast Maintenance • fMRI: Functional Magnetic Resonance Imaging
STANDARD / AREA OF LEARNING	**UT.4.**	**Biology: Intended Learning Outcome: Communicate Effectively Using Science Language and Reasoning.**
OBJECTIVE / STRAND	**4.b.**	**Use precise scientific language in oral and written communication.** **JoVE** • Abdominal Exam I: Inspection and Auscultation • Abdominal Exam II: Percussion • Abdominal Exam III: Palpation • Abdominal Exam IV: Acute Abdominal Pain Assessment • Algae Enumeration via Culturable Methodology • An Introduction to Aging and Regeneration • An Introduction to Behavioral Neuroscience • 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 Cognition • An Introduction to Developmental Genetics • An Introduction to Developmental Neurobiology • An Introduction to Drosophila melanogaster • An Introduction to Endocytosis and Exocytosis • 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 Neuroanatomy • An Introduction to Neurophysiology

		• An Introduction to Organogenesis • An Introduction to Reward and Addiction • An Introduction to Saccharomyces cerevisiae • An Introduction to Stem Cell Biology • An Introduction to Transfection • An Introduction to the Centrifuge • An Introduction to the Chick: Gallus gallus domesticus • An Introduction to the Laboratory Mouse: Mus musculus • An Introduction to the Micropipettor • 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 • Analysis of Earthworm Populations in Soil • Anesthesia Induction and Maintenance • Ankle Exam • Annexin V and Propidium Iodide Labeling • Anterograde Amnesia • Anxiety Testing • Approximate Number Sense Test • Are You Smart or Hardworking? How Praise Influences Children's Motivation • Arterial Line Placement • Aseptic Technique in Environmental Science • Assessing Dexterity with Reaching Tasks • Auscultation • Bacterial Growth Curve Analysis and its Environmental Applications • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method • Balance and Coordination Testing • Basic Care Procedures • Basic Chick Care and Maintenance • Basic Life Support Part II: Airway/Breathing and Continued Cardiopulmonary Resuscitation • Basic Life Support: Cardiopulmonary Resuscitation and Defibrillation • Basic Mouse Care and Maintenance • Binocular Rivalry • Biofuels: Producing Ethanol from Cellulosic Material • Blood Pressure Measurement • Blood Withdrawal I • Blood Withdrawal II • C. elegans Chemotaxis Assay • C. elegans Development and Reproduction • C. elegans Maintenance • Calcium Imaging in Neurons • Cardiac Exam I: Inspection and Palpation • Cardiac Exam II: Auscultation

		• Cardiac Exam III: Abnormal Heart Sounds • Categories and Inductive Inferences • Cell Cycle Analysis • Cell-surface Biotinylation Assay • Central Venous Catheter Insertion: Femoral Vein with Ultrasound Guidance • Central Venous Catheter Insertion: Internal Jugular with Ultrasound Guidance • Central Venous Catheter Insertion: Subclavian Vein • Chick ex ovo Culture • Children's Reliance on Artist Intentions When Identifying Pictures • Chromatin Immunoprecipitation • Color Afterimages • Community DNA Extraction from Bacterial Colonies • Compound Administration I • Compound Administration II • Compound Administration III • Compound Administration IV • Comprehensive Breast Exam • Considerations for Rodent Surgery • Cranial Nerves Exam I (I-VI) • Cranial Nerves Exam II (VII-XII) • Crowding • Culturing and Enumerating Bacteria from Soil Samples • Cytogenetics • DNA Gel Electrophoresis • DNA Ligation Reactions • DNA Methylation Analysis • Decision-making and the Iowa Gambling Task • Decoding Auditory Imagery with Multivoxel Pattern Analysis • Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis • Detecting Reactive Oxygen Species • Detection of Bacteriophages in Environmental Samples • Development and Reproduction of the Laboratory Mouse • Development of the Chick • Diagnostic Necropsy and Tissue Harvest • Dichotic Listening • Dissolved Oxygen in Surface Water • Drosophila Development and Reproduction • Drosophila Larval IHC • Drosophila Maintenance • Drosophila melanogaster Embryo and Larva Harvesting and Preparation • Ear Exam • Elbow Exam • Electro-encephalography (EEG) • Embryonic Stem Cell Culture and Differentiation • Emergency Tube Thoracostomy (Chest Tube

		Placement) **• Emergent Lateral Canthotomy and Inferior Catholysis** **• Ethics in Psychology Research** **• Event-related Potentials and the Oddball Task** **• Executive Function and the Dimensional Change Card Sort Task** **• Executive Function in Autism Spectrum Disorder** **• Experimentation using a Confederate** **• Explant Culture for Developmental Studies** **• Explant Culture of Neural Tissue** **• Expression Profiling with Microarrays** **• Eye Exam** **• Eye Tracking in Cognitive Experiments** **• FM Dyes in Vesicle Recycling** **• Fate Mapping** **• Fear Conditioning** **• Filamentous Fungi** **• Finding Your Blind Spot and Perceptual Filling-in** **• Foot Exam** **• From Theory to Design: The Role of Creativity in Designing Experiments** **• Fundamentals of Breeding and Weaning** **• Gel Purification** **• Gene Silencing with Morpholinos** **• General Approach to the Physical Exam** **• Genetic Crosses** **• Genetic Engineering of Model Organisms** **• Genetic Screens** **• Genome Editing** **• Gram Staining of Bacteria from Environmental Sources** **• Habituation: Studying Infants Before They Can Talk** **• Hand and Wrist Exam** **• Hip Exam** **• Histological Sample Preparation for Light Microscopy** **• Histological Staining of Neural Tissue** **• How Children Solve Problems Using Causal Reasoning** **• In ovo Electroporation of Chicken Embryos** **• Inattentional Blindness** **• Incidental Encoding** **• Induced Pluripotency** **• Intra-articular Shoulder Injection for Reduction Following Anterior Shoulder Dislocation** **• Intraosseous Needle Placement** **• Introducing Experimental Agents into the Mouse** **• Introduction to Fluorescence Microscopy** **• Introduction to Light Microscopy** **• Introduction to Serological Pipettes and Pipettors** **• Introduction to the Microplate Reader** **• Introduction to the Spectrophotometer** **• Invasion Assay Using 3D Matrices** **• Invertebrate Lifespan Quantification** **• Isolating Nucleic Acids from Yeast**

		• Isolation of Fecal Bacteria from Water Samples by Filtration • Just-noticeable Differences • Knee Exam • Language: The N400 in Semantic Incongruity • Learning and Memory: The Remember-Know Task • Live Cell Imaging of Mitosis • Lower Back Exam • Lymph Node Exam • Male Rectal Exam • Manipulating an Independent Variable through Embodiment • Measuring Children's Trust in Testimony • Measuring Grey Matter Differences with Voxel-based Morphometry: The Musical Brain • Measuring Mass in the Laboratory • Measuring Reaction Time and Donders' Method of Subtraction • Measuring Verbal Working Memory Span • Measuring Vital Signs • Memory Development: Demonstrating How Repeated Questioning Leads to False Memories • Mental Rotation • Metacognitive Development: How Children Estimate Their Memory • Modeling Social Stress • Molecular Cloning • Motion-induced Blindness • Motor Exam I • Motor Exam II • Motor Learning in Mirror Drawing • Motor Maps • Mouse Genotyping • Multiple Object Tracking • Murine In Utero Electroporation • Mutual Exclusivity: How Children Learn the Meanings of Words • Neck Exam • Needle Thoracostomy (needle Decompression) for Temporizing Tension Pneumothorax Treatment • Neuronal Transfection Methods • Nose, Sinuses, Oral Cavity and Pharynx Exam • Numerical Cognition: More or Less • Nutrients in Aquatic Ecosystems • Object Substitution Masking • Observation and Inspection • Observational Research • Ophthalmoscopic Examination • PCR: The Polymerase Chain Reaction • Palpation • Passaging Cells • Patch Clamp Electrophysiology

		• Pelvic Exam I: Assessment of the External Genitalia • Pelvic Exam II: Speculum Exam • Pelvic Exam III: Bimanual and Rectovaginal Exam • Percussion • Percutaneous Cricothyrotomy (Seldinger Technique) • Pericardiocentesis • Peripheral Vascular Exam • Peripheral Vascular Exam Using a Continuous Wave Doppler • Peripheral Venous Cannulation • Perspectives on Sensation and Perception • Physiological Correlates of Emotion Recognition • Piaget's Conservation Task and the Influence of Task Demands • Pilot Testing • Placebos in Research • Plasmid Purification • Positive Reinforcement Studies • Primary Neuronal Cultures • Proper Adjustment of Patient Attire during the Physical Exam • Prospect Theory • Proton Exchange Membrane Fuel Cells • Quantifying Environmental Microorganisms and Viruses Using qPCR • RNA Analysis of Environmental Samples Using RT-PCR • RNA-Seq • RNAi in C. elegans • Realism in Experimentation • Recombineering and Gene Targeting • Regulating Temperature in the Lab: Applying Heat • Regulating Temperature in the Lab: Preserving Samples Using Cold • Reliability in Psychology Experiments • Respiratory Exam I: Inspection and Palpation • Respiratory Exam II: Percussion and Auscultation • Restriction Enzyme Digests • Rodent Handling and Restraint Techniques • Rodent Identification I • Rodent Identification II • Rodent Stereotaxic Surgery • SNP Genotyping • Self-administration Studies • Self-report vs. Behavioral Measures of Recycling • Sensory Exam • Separating Protein with SDS-PAGE • Shoulder Exam I • Shoulder Exam II • Spatial Cueing • Spatial Memory Testing Using Mazes • Sterile Tissue Harvest • Surgical Cricothyrotomy

		• Testing For Genetically Modified Foods • The ATP Bioluminescence Assay • The Ames Room • The Attentional Blink • The Costs and Benefits of Natural Pedagogy • The ELISA Method • The Factorial Experiment • The Inverted-face Effect • The McGurk Effect • The Morris Water Maze • The Multi-group Experiment • The Precision of Visual Working Memory with Delayed Estimation • The Rouge Test: Searching for a Sense of Self • The Rubber Hand Illusion • The Simple Experiment: Two-group Design • The Split Brain • The Staircase Procedure for Finding a Perceptual Threshold • The TUNEL Assay • The Transwell Migration Assay • The Western Blot • Thyroid Exam • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Tree Identification: How To Use a Dichotomous Key • Tree Survey: Point-Centered Quarter Sampling Method • Turbidity and Total Solids in Surface Water • Using Diffusion Tensor Imaging in Traumatic Brain Injury • Using GIS to Investigate Urban Forestry • Using TMS to Measure Motor Excitability During Action Observation • Using Your Head: Measuring Infants' Rational Imitation of Actions • Verbal Priming • Visual Attention: fMRI Investigation of Object-based Attentional Control • Visual Search for Features and Conjunctions • Visual Statistical Learning • Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy • Water Quality Analysis via Indicator Organisms • Whole-Mount In Situ Hybridization • Within-subjects Repeated-measures Design • Yeast Maintenance • Yeast Reproduction • Yeast Transformation and Cloning • Zebrafish Breeding and Embryo Handling • Zebrafish Maintenance and Husbandry • Zebrafish Microinjection Techniques

		• Zebrafish Reproduction and Development • fMRI: Functional Magnetic Resonance Imaging
OBJECTIVE / STRAND	4.e.	Use mathematical language and reasoning to communicate information. <u>JoVE</u> • 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 Metabolism • An Introduction to Cognition • An Introduction to Developmental Neurobiology • An Introduction to Drosophila melanogaster • An Introduction to Endocytosis and Exocytosis • An Introduction to Learning and Memory • An Introduction to Modeling Behavioral Disorders and Stress • An Introduction to Motor Control • An Introduction to Neurophysiology • An Introduction to Reward and Addiction • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of Genetic Analysis • An Overview of Genetics and Disease • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Analysis of Earthworm Populations in Soil • Annexin V and Propidium Iodide Labeling • Anterograde Amnesia • Anxiety Testing • Approximate Number Sense Test • Are You Smart or Hardworking? How Praise Influences Children's Motivation • Assessing Dexterity with Reaching Tasks • Bacterial Growth Curve Analysis and its Environmental Applications • Balance and Coordination Testing • Basic Mouse Care and Maintenance • Binocular Rivalry • Biofuels: Producing Ethanol from Cellulosic Material • Blood Pressure Measurement • C. elegans Chemotaxis Assay • Calcium Imaging in Neurons • Carbon and Nitrogen Analysis of Environmental Samples • Categories and Inductive Inferences • Cell Cycle Analysis • Cell-surface Biotinylation Assay • Children's Reliance on Artist Intentions When Identifying Pictures

		• Chromatin Immunoprecipitation • Community DNA Extraction from Bacterial Colonies • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Crowding • Culturing and Enumerating Bacteria from Soil Samples • DNA Methylation Analysis • Decision-making and the Iowa Gambling Task • Decoding Auditory Imagery with Multivoxel Pattern Analysis • Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis • Detecting Reactive Oxygen Species • Development and Reproduction of the Laboratory Mouse • Dichotic Listening • Drosophila Development and Reproduction • Electro-encephalography (EEG) • Ethics in Psychology Research • Event-related Potentials and the Oddball Task • Executive Function and the Dimensional Change Card Sort Task • Executive Function in Autism Spectrum Disorder • Experimentation using a Confederate • Expression Profiling with Microarrays • Eye Tracking in Cognitive Experiments • FM Dyes in Vesicle Recycling • Fate Mapping • Fear Conditioning • From Theory to Design: The Role of Creativity in Designing Experiments • Fundamentals of Breeding and Weaning • Gene Silencing with Morpholinos • Genetic Crosses • Genetic Screens • Habituation: Studying Infants Before They Can Talk • How Children Solve Problems Using Causal Reasoning • Inattentional Blindness • Incidental Encoding • Introducing Experimental Agents into the Mouse • Introduction to the Spectrophotometer • Invasion Assay Using 3D Matrices • Invertebrate Lifespan Quantification • Isolating Nucleic Acids from Yeast • Just-noticeable Differences • Language: The N400 in Semantic Incongruity • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Learning and Memory: The Remember-Know Task • Manipulating an Independent Variable through Embodiment

		• Measuring Children's Trust in Testimony • Measuring Grey Matter Differences with Voxel-based Morphometry: The Musical Brain • Measuring Reaction Time and Donders' Method of Subtraction • Measuring Verbal Working Memory Span • Measuring Vital Signs • Memory Development: Demonstrating How Repeated Questioning Leads to False Memories • Mental Rotation • Metacognitive Development: How Children Estimate Their Memory • Modeling Social Stress • Motion-induced Blindness • Motor Learning in Mirror Drawing • Motor Maps • Multiple Object Tracking • Mutual Exclusivity: How Children Learn the Meanings of Words • Numerical Cognition: More or Less • Nutrients in Aquatic Ecosystems • Object Substitution Masking • Observational Research • PCR: The Polymerase Chain Reaction • Patch Clamp Electrophysiology • Pericardiocentesis • Peripheral Vascular Exam Using a Continuous Wave Doppler • Perspectives on Cognitive Psychology • Perspectives on Neuropsychology • Physiological Correlates of Emotion Recognition • Piaget's Conservation Task and the Influence of Task Demands • Pilot Testing • Placebos in Research • Plasmid Purification • Positive Reinforcement Studies • Prospect Theory • 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 • Realism in Experimentation • Reliability in Psychology Experiments • SNP Genotyping • Self-administration Studies • Self-report vs. Behavioral Measures of Recycling • Spatial Cueing

		• Spatial Memory Testing Using Mazes • The ATP Bioluminescence Assay • The Attentional Blink • The Costs and Benefits of Natural Pedagogy • The ELISA Method • The Factorial Experiment • The Inverted-face Effect • The Morris Water Maze • The Multi-group Experiment • The Precision of Visual Working Memory with Delayed Estimation • The Rouge Test: Searching for a Sense of Self • The Simple Experiment: Two-group Design • The Split Brain • The Staircase Procedure for Finding a Perceptual Threshold • The TUNEL Assay • The Transwell Migration Assay • The Western Blot • Using Diffusion Tensor Imaging in Traumatic Brain Injury • Using TMS to Measure Motor Excitability During Action Observation • Using Your Head: Measuring Infants' Rational Imitation of Actions • Verbal Priming • Visual Attention: fMRI Investigation of Object-based Attentional Control • Visual Search for Features and Conjunctions • Visual Statistical Learning • Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy • Water Quality Analysis via Indicator Organisms • Within-subjects Repeated-measures Design • Yeast Maintenance • fMRI: Functional Magnetic Resonance Imaging
STANDARD / AREA OF LEARNING	**UT.5.**	**Biology: Intended Learning Outcome: Demonstrate Awareness of Social and Historical Aspects of Science.**
OBJECTIVE / STRAND	**5.a.**	**Cite examples of how science affects human life.** **JoVE** • Abdominal Exam I: Inspection and Auscultation • Abdominal Exam II: Percussion • Abdominal Exam III: Palpation • Abdominal Exam IV: Acute Abdominal Pain Assessment • Algae Enumeration via Culturable Methodology • An Introduction to Aging and Regeneration • An Introduction to Behavioral Neuroscience • 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 Cognition • An Introduction to Developmental Genetics • An Introduction to Developmental Neurobiology • An Introduction to Drosophila melanogaster • An Introduction to Endocytosis and Exocytosis • 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 Neuroanatomy • An Introduction to Neurophysiology • An Introduction to Organogenesis • An Introduction to Reward and Addiction • 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 Epigenetics • An Overview of Gene Expression • An Overview of Genetic Analysis • An Overview of Genetic Engineering • An Overview of Genetics and Disease • Analysis of Earthworm Populations in Soil • Anesthesia Induction and Maintenance • Ankle Exam • Annexin V and Propidium Iodide Labeling • Anterograde Amnesia • Anxiety Testing • Approximate Number Sense Test • Are You Smart or Hardworking? How Praise Influences Children's Motivation • Arterial Line Placement • Aseptic Technique in Environmental Science • Assembly of a Reflux System for Heated Chemical Reactions • Assessing Dexterity with Reaching Tasks • Auscultation • Bacterial Growth Curve Analysis and its Environmental Applications • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method • Balance and Coordination Testing • Basic Care Procedures • Basic Chick Care and Maintenance

		• Basic Life Support Part II: Airway/Breathing and Continued Cardiopulmonary Resuscitation • Basic Life Support: Cardiopulmonary Resuscitation and Defibrillation • Basic Mouse Care and Maintenance • Binocular Rivalry • Biofuels: Producing Ethanol from Cellulosic Material • Blood Pressure Measurement • Blood Withdrawal I • Blood Withdrawal II • C. elegans Chemotaxis Assay • C. elegans Development and Reproduction • C. elegans Maintenance • Calcium Imaging in Neurons • Capillary Electrophoresis (CE) • Cardiac Exam I: Inspection and Palpation • Cardiac Exam II: Auscultation • Cardiac Exam III: Abnormal Heart Sounds • Categories and Inductive Inferences • Cell Cycle Analysis • Cell-surface Biotinylation Assay • Central Venous Catheter Insertion: Femoral Vein with Ultrasound Guidance • Central Venous Catheter Insertion: Internal Jugular with Ultrasound Guidance • Central Venous Catheter Insertion: Subclavian Vein • Chick ex ovo Culture • Children's Reliance on Artist Intentions When Identifying Pictures • Chromatin Immunoprecipitation • Chromatography-Based Biomolecule Purification Methods • Co-Immunoprecipitation and Pull-Down Assays • Color Afterimages • Column Chromatography • Community DNA Extraction from Bacterial Colonies • Compound Administration I • Compound Administration II • Compound Administration III • Compound Administration IV • Comprehensive Breast Exam • Considerations for Rodent Surgery • Coordination Chemistry Complexes • Cranial Nerves Exam I (I-VI) • Cranial Nerves Exam II (VII-XII) • Crowding • Culturing and Enumerating Bacteria from Soil Samples • Cyclic Voltammetry (CV) • Cytogenetics • DNA Gel Electrophoresis • DNA Ligation Reactions • DNA Methylation Analysis

		• Decision-making and the Iowa Gambling Task • Decoding Auditory Imagery with Multivoxel Pattern Analysis • Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis • Detecting Reactive Oxygen Species • Detection of Bacteriophages in Environmental Samples • Development and Reproduction of the Laboratory Mouse • Development of the Chick • Diagnostic Necropsy and Tissue Harvest • Dichotic Listening • Dissolved Oxygen in Surface Water • Drosophila Development and Reproduction • Drosophila Larval IHC • Drosophila Maintenance • Drosophila melanogaster Embryo and Larva Harvesting and Preparation • Ear Exam • Elbow Exam • Electro-encephalography (EEG) • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Embryonic Stem Cell Culture and Differentiation • Emergency Tube Thoracostomy (Chest Tube Placement) • Emergent Lateral Canthotomy and Inferior Catholysis • Enzyme Assays and Kinetics • Ethics in Psychology Research • Event-related Potentials and the Oddball Task • Executive Function and the Dimensional Change Card Sort Task • Executive Function in Autism Spectrum Disorder • Experimentation using a Confederate • Explant Culture for Developmental Studies • Explant Culture of Neural Tissue • Expression Profiling with Microarrays • Eye Exam • Eye Tracking in Cognitive Experiments • FM Dyes in Vesicle Recycling • Fate Mapping • Fear Conditioning • Filamentous Fungi • Finding Your Blind Spot and Perceptual Filling-in • Foot Exam • From Theory to Design: The Role of Creativity in Designing Experiments • Fundamentals of Breeding and Weaning • Gel Purification • Gene Silencing with Morpholinos • General Approach to the Physical Exam • Genetic Crosses

		• Genetic Engineering of Model Organisms • Genetic Screens • Genome Editing • Gram Staining of Bacteria from Environmental Sources • Growing Crystals for X-ray Diffraction Analysis • Habituation: Studying Infants Before They Can Talk • Hand and Wrist Exam • Hip Exam • Histological Staining of Neural Tissue • How Children Solve Problems Using Causal Reasoning • In ovo Electroporation of Chicken Embryos • Inattentional Blindness • Incidental Encoding • Induced Pluripotency • Intra-articular Shoulder Injection for Reduction Following Anterior Shoulder Dislocation • Intraosseous Needle Placement • Introducing Experimental Agents into the Mouse • Introduction to Mass Spectrometry • Introduction to Titration • Invasion Assay Using 3D Matrices • Invertebrate Lifespan Quantification • Isolating Nucleic Acids from Yeast • Isolation of Fecal Bacteria from Water Samples by Filtration • Just-noticeable Differences • Knee Exam • Language: The N400 in Semantic Incongruity • Learning and Memory: The Remember-Know Task • Live Cell Imaging of Mitosis • Lower Back Exam • Lymph Node Exam • MALDI-TOF Mass Spectrometry • Male Rectal Exam • Manipulating an Independent Variable through Embodiment • Measuring Children's Trust in Testimony • Measuring Grey Matter Differences with Voxel-based Morphometry: The Musical Brain • Measuring Reaction Time and Donders' Method of Subtraction • Measuring Verbal Working Memory Span • Measuring Vital Signs • Memory Development: Demonstrating How Repeated Questioning Leads to False Memories • Mental Rotation • Metabolic Labeling • Metacognitive Development: How Children Estimate Their Memory • Modeling Social Stress • Molecular Cloning • Motion-induced Blindness

		• Motor Exam I • Motor Exam II • Motor Learning in Mirror Drawing • Motor Maps • Mouse Genotyping • Multiple Object Tracking • Murine In Utero Electroporation • Mutual Exclusivity: How Children Learn the Meanings of Words • Neck Exam • Needle Thoracostomy (needle Decompression) for Temporizing Tension Pneumothorax Treatment • Neuronal Transfection Methods • Nose, Sinuses, Oral Cavity and Pharynx Exam • Nuclear Magnetic Resonance (NMR) Spectroscopy • Numerical Cognition: More or Less • Nutrients in Aquatic Ecosystems • Object Substitution Masking • Observation and Inspection • Observational Research • Ophthalmoscopic Examination • PCR: The Polymerase Chain Reaction • Palpation • Passaging Cells • Patch Clamp Electrophysiology • Pelvic Exam I: Assessment of the External Genitalia • Pelvic Exam II: Speculum Exam • Pelvic Exam III: Bimanual and Rectovaginal Exam • Percussion • Percutaneous Cricothyrotomy (Seldinger Technique) • Performing 1D Thin Layer Chromatography • Pericardiocentesis • Peripheral Vascular Exam • Peripheral Vascular Exam Using a Continuous Wave Doppler • Peripheral Venous Cannulation • Perspectives on Cognitive Psychology • Perspectives on Experimental Psychology • Perspectives on Neuropsychology • Perspectives on Sensation and Perception • Physiological Correlates of Emotion Recognition • Piaget's Conservation Task and the Influence of Task Demands • Pilot Testing • Placebos in Research • Plasmid Purification • Positive Reinforcement Studies • Primary Neuronal Cultures • Proper Adjustment of Patient Attire during the Physical Exam • Prospect Theory • Protein Crystallization

		• Proton Exchange Membrane Fuel Cells • Purifying Compounds by Recrystallization • Quantifying Environmental Microorganisms and Viruses Using qPCR • RNA Analysis of Environmental Samples Using RT-PCR • RNA-Seq • RNAi in C. elegans • Realism in Experimentation • Recombineering and Gene Targeting • Reliability in Psychology Experiments • Respiratory Exam I: Inspection and Palpation • Respiratory Exam II: Percussion and Auscultation • Restriction Enzyme Digests • Rodent Handling and Restraint Techniques • Rodent Identification I • Rodent Identification II • Rodent Stereotaxic Surgery • SNP Genotyping • Scanning Electron Microscopy (SEM) • Self-administration Studies • Self-report vs. Behavioral Measures of Recycling • Sensory Exam • Separating Protein with SDS-PAGE • Shoulder Exam I • Shoulder Exam II • Solutions and Concentrations • Spatial Cueing • Spatial Memory Testing Using Mazes • Sterile Tissue Harvest • Surface Plasmon Resonance (SPR) • Surgical Cricothyrotomy • Tandem Mass Spectrometry • Testing For Genetically Modified Foods • The ATP Bioluminescence Assay • The Ames Room • The Attentional Blink • The Costs and Benefits of Natural Pedagogy • The ELISA Method • The Factorial Experiment • The Inverted-face Effect • The McGurk Effect • The Morris Water Maze • The Multi-group Experiment • The Precision of Visual Working Memory with Delayed Estimation • The Rouge Test: Searching for a Sense of Self • The Rubber Hand Illusion • The Simple Experiment: Two-group Design • The Split Brain • The Staircase Procedure for Finding a Perceptual Threshold • The TUNEL Assay

		• The Transwell Migration Assay • The Western Blot • Thyroid Exam • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Tree Identification: How To Use a Dichotomous Key • Tree Survey: Point-Centered Quarter Sampling Method • Turbidity and Total Solids in Surface Water • Two-Dimensional Gel Electrophoresis • Using Diffusion Tensor Imaging in Traumatic Brain Injury • Using GIS to Investigate Urban Forestry • Using TMS to Measure Motor Excitability During Action Observation • Using Your Head: Measuring Infants' Rational Imitation of Actions • Using a pH Meter • Verbal Priming • Visual Attention: fMRI Investigation of Object-based Attentional Control • Visual Search for Features and Conjunctions • Visual Statistical Learning • Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy • Water Quality Analysis via Indicator Organisms • Whole-Mount In Situ Hybridization • Within-subjects Repeated-measures Design • Yeast Maintenance • Yeast Reproduction • Yeast Transformation and Cloning • Zebrafish Breeding and Embryo Handling • Zebrafish Maintenance and Husbandry • Zebrafish Microinjection Techniques • Zebrafish Reproduction and Development • fMRI: Functional Magnetic Resonance Imaging
OBJECTIVE / STRAND	5.b.	Give instances of how technological advances have influenced the progress of science and how science has influenced advances in technology. JoVE • Abdominal Exam I: Inspection and Auscultation • Abdominal Exam IV: Acute Abdominal Pain Assessment • Algae Enumeration via Culturable Methodology • An Introduction to Aging and Regeneration • An Introduction to Behavioral Neuroscience • 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 Cognition

		• An Introduction to Developmental Neurobiology • An Introduction to Drosophila melanogaster • An Introduction to Endocytosis and Exocytosis • An Introduction to Learning and Memory • An Introduction to Motor Control • An Introduction to Neuroanatomy • An Introduction to Neurophysiology • An Introduction to Organogenesis • An Introduction to Reward and Addiction • An Introduction to Saccharomyces cerevisiae • An Introduction to Stem Cell Biology • An Introduction to Transfection • An Introduction to the Centrifuge • An Introduction to the Laboratory Mouse: Mus musculus • An Introduction to the Micropipettor • An Overview of Epigenetics • An Overview of Genetic Analysis • An Overview of Genetic Engineering • An Overview of Genetics and Disease • Anesthesia Induction and Maintenance • Annexin V and Propidium Iodide Labeling • Arterial Line Placement • Auscultation • Bacterial Growth Curve Analysis and its Environmental Applications • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method • Basic Life Support: Cardiopulmonary Resuscitation and Defibrillation • Biofuels: Producing Ethanol from Cellulosic Material • Blood Pressure Measurement • Blood Withdrawal I • Blood Withdrawal II • Calcium Imaging in Neurons • Cardiac Exam II: Auscultation • Cardiac Exam III: Abnormal Heart Sounds • Cell Cycle Analysis • Cell-surface Biotinylation Assay • Central Venous Catheter Insertion: Femoral Vein with Ultrasound Guidance • Central Venous Catheter Insertion: Internal Jugular with Ultrasound Guidance • Central Venous Catheter Insertion: Subclavian Vein • Chromatin Immunoprecipitation • Color Afterimages • Community DNA Extraction from Bacterial Colonies • Compound Administration I • Compound Administration II • Compound Administration III • Compound Administration IV

		• Considerations for Rodent Surgery • Cranial Nerves Exam I (I-VI) • Cranial Nerves Exam II (VII-XII) • Crowding • Culturing and Enumerating Bacteria from Soil Samples • Cytogenetics • DNA Gel Electrophoresis • DNA Ligation Reactions • DNA Methylation Analysis • Decision-making and the Iowa Gambling Task • Decoding Auditory Imagery with Multivoxel Pattern Analysis • Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis • Detecting Reactive Oxygen Species • Detection of Bacteriophages in Environmental Samples • Diagnostic Necropsy and Tissue Harvest • Ear Exam • Electro-encephalography (EEG) • Embryonic Stem Cell Culture and Differentiation • Emergency Tube Thoracostomy (Chest Tube Placement) • Emergent Lateral Canthotomy and Inferior Catholysis • Event-related Potentials and the Oddball Task • Explant Culture of Neural Tissue • Expression Profiling with Microarrays • Eye Exam • Eye Tracking in Cognitive Experiments • FM Dyes in Vesicle Recycling • Fate Mapping • Fear Conditioning • Finding Your Blind Spot and Perceptual Filling-in • Gel Purification • General Approach to the Physical Exam • Genetic Crosses • Genetic Engineering of Model Organisms • Genetic Screens • Genome Editing • Gram Staining of Bacteria from Environmental Sources • Histological Sample Preparation for Light Microscopy • Histological Staining of Neural Tissue • Induced Pluripotency • Intra-articular Shoulder Injection for Reduction Following Anterior Shoulder Dislocation • Intraosseous Needle Placement • Introduction to Fluorescence Microscopy • Introduction to Light Microscopy • Introduction to Serological Pipettes and Pipettors • Introduction to the Spectrophotometer • Invasion Assay Using 3D Matrices • Isolation of Fecal Bacteria from Water Samples by

		Filtration **• Language: The N400 in Semantic Incongruity** **• Learning and Memory: The Remember-Know Task** **• Live Cell Imaging of Mitosis** **• Making Solutions in the Laboratory** **• Measuring Grey Matter Differences with Voxel-based Morphometry: The Musical Brain** **• Measuring Mass in the Laboratory** **• Measuring Vital Signs** **• Molecular Cloning** **• Motion-induced Blindness** **• Motor Exam II** **• Motor Maps** **• Murine In Utero Electroporation** **• Needle Thoracostomy (needle Decompression) for Temporizing Tension Pneumothorax Treatment** **• Nose, Sinuses, Oral Cavity and Pharynx Exam** **• Object Substitution Masking** **• Ophthalmoscopic Examination** **• PCR: The Polymerase Chain Reaction** **• Passaging Cells** **• Patch Clamp Electrophysiology** **• Pelvic Exam II: Speculum Exam** **• Pelvic Exam III: Bimanual and Rectovaginal Exam** **• Percussion** **• Percutaneous Cricothyrotomy (Seldinger Technique)** **• Pericardiocentesis** **• Peripheral Vascular Exam** **• Peripheral Vascular Exam Using a Continuous Wave Doppler** **• Peripheral Venous Cannulation** **• Physiological Correlates of Emotion Recognition** **• Plasmid Purification** **• Positive Reinforcement Studies** **• Proton Exchange Membrane Fuel Cells** **• Quantifying Environmental Microorganisms and Viruses Using qPCR** **• RNA-Seq** **• Recombineering and Gene Targeting** **• Regulating Temperature in the Lab: Applying Heat** **• Regulating Temperature in the Lab: Preserving Samples Using Cold** **• Respiratory Exam II: Percussion and Auscultation** **• Restriction Enzyme Digests** **• Rodent Stereotaxic Surgery** **• SNP Genotyping** **• Self-administration Studies** **• Separating Protein with SDS-PAGE** **• Spatial Cueing** **• Sterile Tissue Harvest** **• Surgical Cricothyrotomy**

		• Testing For Genetically Modified Foods • The ATP Bioluminescence Assay • The Attentional Blink • The ELISA Method • The Rubber Hand Illusion • The TUNEL Assay • The Transwell Migration Assay • The Western Blot • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Understanding Concentration and Measuring Volumes • Using Diffusion Tensor Imaging in Traumatic Brain Injury • Using GIS to Investigate Urban Forestry • Using TMS to Measure Motor Excitability During Action Observation • Visual Attention: fMRI Investigation of Object-based Attentional Control • X-ray Fluorescence (XRF) • Yeast Transformation and Cloning • fMRI: Functional Magnetic Resonance Imaging
OBJECTIVE / STRAND	5.c.	Understand the cumulative nature of scientific knowledge. <u>JoVE</u> • Abdominal Exam II: Percussion • An Introduction to Aging and Regeneration • An Introduction to Behavioral Neuroscience • An Introduction to Caenorhabditis elegans • An Introduction to Cell Death • An Introduction to Cell Division • An Introduction to Cell Metabolism • An Introduction to Cell Motility and Migration • An Introduction to Developmental Genetics • An Introduction to Developmental Neurobiology • An Introduction to Drosophila melanogaster • An Introduction to Endocytosis and Exocytosis • An Introduction to Learning and Memory • An Introduction to Molecular Developmental Biology • An Introduction to Neuroanatomy • An Introduction to Neurophysiology • An Introduction to Organogenesis • An Introduction to Saccharomyces cerevisiae • An Introduction to Stem Cell Biology • 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 Epigenetics • An Overview of Gene Expression • An Overview of Genetic Analysis

		• An Overview of Genetic Engineering • An Overview of Genetics and Disease • Anterograde Amnesia • Auscultation • C. elegans Maintenance • Cell Cycle Analysis • Color Afterimages • Development of the Chick • Drosophila Maintenance • General Approach to the Physical Exam • Genetic Crosses • Inattentional Blindness • Measuring Reaction Time and Donders' Method of Subtraction • Motion-induced Blindness • Object Substitution Masking • Percussion • Piaget's Conservation Task and the Influence of Task Demands • Spatial Cueing • The Attentional Blink • The Rubber Hand Illusion • The Split Brain • Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy • Yeast Transformation and Cloning
OBJECTIVE / STRAND	5.d.	Recognize contributions to science knowledge that have been made by both women and men. <u>JoVE</u> • An Introduction to Aging and Regeneration • An Introduction to Behavioral Neuroscience • An Introduction to Cell Division • An Introduction to Developmental Genetics • An Introduction to Drosophila melanogaster • An Introduction to Molecular Developmental Biology • An Introduction to Neuroanatomy • An Introduction to Neurophysiology • An Introduction to Organogenesis • An Introduction to Stem Cell Biology • 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 Epigenetics • An Overview of Gene Expression • An Overview of Genetic Analysis • An Overview of Genetic Engineering • An Overview of Genetics and Disease • Genetic Crosses

		• Piaget's Conservation Task and the Influence of Task Demands
STANDARD / AREA OF LEARNING	**UT.6.**	**Biology: Intended Learning Outcome: Demonstrate Understanding of the Nature of Science.**
OBJECTIVE / STRAND	6.i.	Understand that science and technology may raise ethical issues for which science, by itself, does not provide solutions. JoVE • An Introduction to Organogenesis • An Introduction to Saccharomyces cerevisiae • Biofuels: Producing Ethanol from Cellulosic Material • Embryonic Stem Cell Culture and Differentiation • Ethics in Psychology Research • Passaging Cells • Realism in Experimentation • Reliability in Psychology Experiments • Self-administration Studies • Testing For Genetically Modified Foods
STANDARD / AREA OF LEARNING	**UT.I.**	**Biology: Students will understand that living organisms interact with one another and their environment.**
OBJECTIVE / STRAND	**I.1.**	**Summarize how energy flows through an ecosystem.**
INDICATOR / CLUSTER	I.1.a.	Arrange components of a food chain according to energy flow. JoVE • Algae Enumeration via Culturable Methodology • An Introduction to Drosophila melanogaster • An Introduction to the Chick: Gallus gallus domesticus • 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 • Dissolved Oxygen in Surface Water • Filamentous Fungi • Quantifying Environmental Microorganisms and Viruses Using qPCR • RNA Analysis of Environmental Samples Using RT-PCR • Zebrafish Maintenance and Husbandry • Zebrafish Reproduction and Development
INDICATOR / CLUSTER	I.1.c.	Describe strategies used by organisms to balance the energy expended to obtain food to the energy gained from the food (e.g., migration to areas of seasonal abundance, switching type of prey based upon availability, hibernation or dormancy). JoVE

		• An Introduction to Drosophila melanogaster • An Introduction to the Chick: Gallus gallus domesticus • Zebrafish Maintenance and Husbandry • Zebrafish Reproduction and Development
INDICATOR / CLUSTER	I.1.d.	Compare the relative energy output expended by an organism in obtaining food to the energy gained from the food (e.g., hummingbird - energy expended hovering at a flower compared to the amount of energy gained from the nectar, coyote - chasing mice to the energy gained from catching one, energy expended in migration of birds to a location with seasonal abundance compared to energy gained by staying in a cold climate with limited food). JoVE • An Introduction to Cell Metabolism • An Introduction to Cellular and Molecular Neuroscience • Detecting Reactive Oxygen Species • Electrophoretic Mobility Shift Assay (EMSA) • Enzyme Assays and Kinetics • Förster Resonance Energy Transfer (FRET) • Histological Staining of Neural Tissue • Metabolic Labeling • The ATP Bioluminescence Assay
INDICATOR / CLUSTER	I.1.e.	Research food production in various parts of the world (e.g., industrialized societies' greater use of fossil fuel in food production, human health related to food product). 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 • Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium • Testing For Genetically Modified Foods
STANDARD / AREA OF LEARNING	UT.I.	Biology: Students will understand that living organisms interact with one another and their environment.
OBJECTIVE / STRAND	I.2.	Explain relationships between matter cycles and organisms.
INDICATOR / CLUSTER	I.2.a.	Use diagrams to trace the movement of matter through a cycle (i.e., carbon, oxygen, nitrogen, water) in a variety of biological communities and ecosystems. 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 / CLUSTER	**I.2.b.**	**Explain how water is a limiting factor in various ecosystems.** **JoVE** **• Algae Enumeration via Culturable Methodology** **• Detection of Bacteriophages in Environmental Samples** **• Dissolved Oxygen in Surface Water** **• Isolation of Fecal Bacteria from Water Samples by Filtration** **• Nutrients in Aquatic Ecosystems** **• Quantifying Environmental Microorganisms and Viruses Using qPCR** **• RNA Analysis of Environmental Samples Using RT-PCR** **• Turbidity and Total Solids in Surface Water** **• Water Quality Analysis via Indicator Organisms** **• Zebrafish Maintenance and Husbandry**
INDICATOR / CLUSTER	**I.2.c.**	**Distinguish between inference and evidence in a newspaper, magazine, journal, or Internet article that addresses an issue related to human impact on cycles of matter in an ecosystem and determine the bias in the article.** **JoVE**

		• Biofuels: Producing Ethanol from Cellulosic Material • 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 / CLUSTER	I.2.d.	Evaluate the impact of personal choices in relation to the cycling of matter within an ecosystem (e.g., impact of automobiles on the carbon cycle, impact on landfills of processed and packaged foods). JoVE • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Dissolved Oxygen in Surface Water • Introduction to Mass Spectrometry • Isolation of Fecal Bacteria from Water Samples by Filtration • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Measuring Tropospheric Ozone • Nutrients in Aquatic Ecosystems • Self-report vs. Behavioral Measures of Recycling • Turbidity and Total Solids in Surface Water • Water Quality Analysis via Indicator Organisms
STANDARD / AREA OF LEARNING	UT.I.	Biology: Students will understand that living organisms interact with one another and their environment.
OBJECTIVE / STRAND	I.3.	Describe how interactions among organisms and their environment help shape ecosystems.
INDICATOR / CLUSTER	I.3.a.	Categorize relationships among living things according to predator-prey, competition, and symbiosis. JoVE • Analysis of Earthworm Populations in Soil • C. elegans Development and Reproduction • Dissolved Oxygen in Surface Water • Genetic Crosses • Recombineering and Gene Targeting • Tree Survey: Point-Centered Quarter Sampling Method • Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy
INDICATOR / CLUSTER	I.3.b.	Formulate and test a hypothesis specific to the effect of changing one variable upon another in a small ecosystem.

		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 / CLUSTER	**I.3.c.**	**Use data to interpret interactions among biotic and abiotic factors (e.g., pH, temperature, precipitation, populations, diversity) 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 / CLUSTER	**I.3.d.**	**Investigate an ecosystem using methods of science to gather quantitative and qualitative data that describe the ecosystem in detail.** **JoVE** **• An Introduction to Drosophila melanogaster** **• Analysis of Earthworm Populations in Soil** **• Basic Care Procedures** **• Basic Chick Care and Maintenance** **• Basic Mouse Care and Maintenance** **• C. elegans Maintenance** **• Chick ex ovo Culture** **• Drosophila Maintenance** **• Filamentous Fungi** **• Tree Survey: Point-Centered Quarter Sampling Method** **• Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy** **• Yeast Maintenance** **• Zebrafish Maintenance and Husbandry** **• Zebrafish Reproduction and Development**

INDICATOR / CLUSTER	I.3.e.	Research and evaluate local and global practices that affect ecosystems. JoVE • Analysis of Earthworm Populations in Soil • Bacterial Growth Curve Analysis and its Environmental Applications • Culturing and Enumerating Bacteria from Soil Samples • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Dissolved Oxygen in Surface Water • Filamentous Fungi • Introduction to Mass Spectrometry • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Measuring Tropospheric Ozone • Nutrients in Aquatic Ecosystems • Self-report vs. Behavioral Measures of Recycling • Tree Survey: Point-Centered Quarter Sampling Method • Turbidity and Total Solids in Surface Water • Using GIS to Investigate Urban Forestry • Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy • Water Quality Analysis via Indicator Organisms • Zebrafish Maintenance and Husbandry
STANDARD / AREA OF LEARNING	UT.II.	Biology: Students will understand that all organisms are composed of one or more cells that are made of molecules, come from preexisting cells, and perform life functions.
OBJECTIVE / STRAND	II.1.	Describe the fundamental chemistry of living cells.
INDICATOR / CLUSTER	II.1.a.	List the major chemical elements in cells (i.e., carbon, hydrogen, nitrogen, oxygen, phosphorous, sulfur, trace elements). 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 • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • 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
INDICATOR / CLUSTER	II.1.b.	Identify the function of the four major macromolecules (i.e., carbohydrates, proteins, lipids, nucleic acids). <u>JoVE</u> • An Introduction to Caenorhabditis elegans • An Introduction to Cell Death • An Introduction to Cell Division • An Introduction to Cell Metabolism • An Introduction to Cell Motility and Migration • An Introduction to Developmental Genetics • An Introduction to Molecular Developmental Biology • An Introduction to Saccharomyces cerevisiae • An Introduction to Transfection • An Overview of Epigenetics • An Overview of Gene Expression • An Overview of Genetic Analysis • An Overview of Genetic Engineering • An Overview of Genetics and Disease • Annexin V and Propidium Iodide Labeling • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method • C. elegans Maintenance • Cell Cycle Analysis • Cell-surface Biotinylation Assay • Chromatin Immunoprecipitation • Chromatography-Based Biomolecule Purification Methods • Co-Immunoprecipitation and Pull-Down Assays • Column Chromatography • Community DNA Extraction from Bacterial Colonies • Cytogenetics • DNA Gel Electrophoresis • DNA Ligation Reactions • DNA Methylation Analysis • Density Gradient Ultracentrifugation • Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis • Detecting Reactive Oxygen Species • Development and Reproduction of the Laboratory Mouse • Development of the Chick • Dialysis: Diffusion Based Separation • Drosophila Larval IHC • Drosophila melanogaster Embryo and Larva Harvesting and Preparation • Electrophoretic Mobility Shift Assay (EMSA)

		• Embryonic Stem Cell Culture and Differentiation • Enzyme Assays and Kinetics • Explant Culture for Developmental Studies • Expression Profiling with Microarrays • FM Dyes in Vesicle Recycling • Förster Resonance Energy Transfer (FRET) • Gel Purification • Gene Silencing with Morpholinos • Genetic Crosses • Genetic Engineering of Model Organisms • Genetic Screens • Genome Editing • In ovo Electroporation of Chicken Embryos • Induced Pluripotency • Introduction to Catalysis • Introduction to Mass Spectrometry • Invasion Assay Using 3D Matrices • Invertebrate Lifespan Quantification • Isolating Nucleic Acids from Yeast • Live Cell Imaging of Mitosis • MALDI-TOF Mass Spectrometry • Metabolic Labeling • Molecular Cloning • Mouse Genotyping • PCR: The Polymerase Chain Reaction • Photometric Protein Determination • Plasmid Purification • Protein Crystallization • Quantifying Environmental Microorganisms and Viruses Using qPCR • RNA Analysis of Environmental Samples Using RT-PCR • RNA-Seq • RNAi in C. elegans • Recombineering and Gene Targeting • Reconstitution of Membrane Proteins • Restriction Enzyme Digests • SNP Genotyping • Separating Protein with SDS-PAGE • Spectrophotometric Determination of an Equilibrium Constant • Tandem Mass Spectrometry • Testing For Genetically Modified Foods • The ATP Bioluminescence Assay • The ELISA Method • The TUNEL Assay • The Transwell Migration Assay • The Western Blot • Two-Dimensional Gel Electrophoresis • Ultraviolet-Visible (UV-Vis) Spectroscopy • Whole-Mount In Situ Hybridization • Yeast Maintenance

		• Yeast Transformation and Cloning • Zebrafish Breeding and Embryo Handling • Zebrafish Microinjection Techniques • Zebrafish Reproduction and Development
INDICATOR / CLUSTER	II.1.c.	Explain how the properties of water (e.g., cohesion, adhesion, heat capacity, solvent properties) contribute to maintenance of cells and living organisms. 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 Molecular Developmental Biology • An Introduction to Stem Cell Biology • Annexin V and Propidium Iodide Labeling • C. elegans Development and Reproduction • Calcium Imaging in Neurons • Cell-surface Biotinylation Assay • Detecting Reactive Oxygen Species • Determination of Moisture Content in Soil • Dissolved Oxygen in Surface Water • Electro-encephalography (EEG) • Embryonic Stem Cell Culture and Differentiation • Explant Culture of Neural Tissue • FM Dyes in Vesicle Recycling • Histological Staining of Neural Tissue • In ovo Electroporation of Chicken Embryos • Induced Pluripotency • Isolating Nucleic Acids from Yeast • Murine In Utero Electroporation • Nutrients in Aquatic Ecosystems • Patch Clamp Electrophysiology • Reconstitution of Membrane Proteins • The ATP Bioluminescence Assay • The TUNEL Assay • Tissue Regeneration with Somatic Stem Cells • Turbidity and Total Solids in Surface Water • Using Diffusion Tensor Imaging in Traumatic Brain Injury • Water Quality Analysis via Indicator Organisms • Yeast Maintenance • Yeast Reproduction • Yeast Transformation and Cloning
INDICATOR / CLUSTER	II.1.d.	Explain the role of enzymes in cell chemistry. JoVE • An Introduction to Cell Death • Biofuels: Producing Ethanol from Cellulosic Material

		• Co-Immunoprecipitation and Pull-Down Assays • DNA Ligation Reactions • Enzyme Assays and Kinetics • Introduction to Catalysis • Live Cell Imaging of Mitosis • Molecular Cloning • PCR: The Polymerase Chain Reaction • Restriction Enzyme Digests • The ELISA Method • The TUNEL Assay
STANDARD / AREA OF LEARNING	**UT.II.**	**Biology: Students will understand that all organisms are composed of one or more cells that are made of molecules, come from preexisting cells, and perform life functions.**
OBJECTIVE / STRAND	**II.2.**	**Describe the flow of energy and matter in cellular function.**
INDICATOR / CLUSTER	**II.2.a.**	**Distinguish between autotrophic and heterotrophic cells.** **JoVE** • An Introduction to Cell Metabolism • An Introduction to Cell Motility and Migration • An Introduction to Transfection • An Overview of Genetic Engineering • Bacterial Growth Curve Analysis and its Environmental Applications • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method • Culturing and Enumerating Bacteria from Soil Samples • Density Gradient Ultracentrifugation • Genetic Engineering of Model Organisms • Invasion Assay Using 3D Matrices • Molecular Cloning • Plasmid Purification • Recombineering and Gene Targeting • Reconstitution of Membrane Proteins • The Transwell Migration Assay
INDICATOR / CLUSTER	**II.2.b.**	**Illustrate the cycling of matter and the flow of energy through photosynthesis (e.g., by using light energy to combine CO_2 and H_2O to produce oxygen and sugars) and respiration (e.g., by releasing energy from sugar and O_2 to produce CO_2 and H_2O).** **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 • Dissolved Oxygen in Surface Water • 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 • Using GIS to Investigate Urban Forestry
INDICATOR / CLUSTER	II.2.c.	Measure the production of one or more of the products of either photosynthesis or respiration. JoVE • An Introduction to Cell Metabolism • Biofuels: Producing Ethanol from Cellulosic Material • Detecting Reactive Oxygen Species • The ATP Bioluminescence Assay
STANDARD / AREA OF LEARNING	UT.II.	Biology: Students will understand that all organisms are composed of one or more cells that are made of molecules, come from preexisting cells, and perform life functions.
OBJECTIVE / STRAND	II.3.	Investigate the structure and function of cells and cell parts.
INDICATOR / CLUSTER	II.3.a.	Explain how cells divide from existing cells. JoVE • An Introduction to Cell Death • An Introduction to Cell Division • An Introduction to Developmental Neurobiology • An Introduction to Molecular Developmental Biology • An Introduction to Saccharomyces cerevisiae • An Introduction to Stem Cell Biology • Annexin V and Propidium Iodide Labeling • Bacterial Growth Curve Analysis and its Environmental Applications • C. elegans Development and Reproduction • Cell Cycle Analysis • Detecting Reactive Oxygen Species • Embryonic Stem Cell Culture and Differentiation • Explant Culture of Neural Tissue • Induced Pluripotency • Live Cell Imaging of Mitosis

		• Murine In Utero Electroporation • Neuronal Transfection Methods • Primary Neuronal Cultures • The TUNEL Assay • Yeast Maintenance • Yeast Reproduction • Yeast Transformation and Cloning
INDICATOR / CLUSTER	II.3.b.	Describe cell theory and relate the nature of science to the development of cell theory (e.g., built upon previous knowledge, use of increasingly more sophisticated technology). JoVE • An Introduction to Cell Division
INDICATOR / CLUSTER	II.3.c.	Describe how the transport of materials in and out of cells enables cells to maintain homeostasis (i.e., osmosis, diffusion, active transport). JoVE • An Introduction to Endocytosis and Exocytosis • An Introduction to Neurophysiology • An Introduction to Transfection • Calcium Imaging in Neurons • Cell-surface Biotinylation Assay • Detecting Reactive Oxygen Species • FM Dyes in Vesicle Recycling • In ovo Electroporation of Chicken Embryos • Patch Clamp Electrophysiology • Reconstitution of Membrane Proteins • The TUNEL Assay • Using Diffusion Tensor Imaging in Traumatic Brain Injury • Yeast Transformation and Cloning
INDICATOR / CLUSTER	II.3.d.	Describe the relationship between the organelles in a cell and the functions of that cell. JoVE • An Introduction to Aging and Regeneration • An Introduction to Cell Death • An Introduction to Cell Division • An Introduction to Cell Metabolism • An Introduction to Transfection • Annexin V and Propidium Iodide Labeling • Cell Cycle Analysis • Density Gradient Ultracentrifugation • Detecting Reactive Oxygen Species • Enzyme Assays and Kinetics • Isolating Nucleic Acids from Yeast • Live Cell Imaging of Mitosis • Metabolic Labeling

		• The ATP Bioluminescence Assay • The TUNEL Assay
INDICATOR / CLUSTER	II.3.e.	Experiment with microorganisms and/or plants to investigate growth and reproduction. JoVE • Cyclic Voltammetry (CV) • Detection of Bacteriophages in Environmental Samples
STANDARD / AREA OF LEARNING	UT.III.	Biology: Students will understand the relationship between structure and function of organs and organ systems.
OBJECTIVE / STRAND	III.1.	Describe the structure and function of organs.
INDICATOR / CLUSTER	III.1.a.	Diagram and label the structure of the primary components of representative organs in plants and animals (e.g., heart - muscle tissue, valves and chambers; lung - trachea, bronchial, alveoli; leaf - veins, stomata; stem - xylem, phloem, cambium; root - tip, elongation, hairs; skin - layers, sweat glands, oil glands, hair follicles; ovaries - ova, follicles, corpus luteum). JoVE • Abdominal Exam I: Inspection and Auscultation • Abdominal Exam II: Percussion • Abdominal Exam III: Palpation • Abdominal Exam IV: Acute Abdominal Pain Assessment • An Introduction to Aging and Regeneration • An Introduction to Developmental Genetics • An Introduction to Developmental Neurobiology • An Introduction to Learning and Memory • An Introduction to Molecular Developmental Biology • An Introduction to Neuroanatomy • An Introduction to Organogenesis • Ankle Exam • Arterial Line Placement • Auscultation • Basic Life Support Part II: Airway/Breathing and Continued Cardiopulmonary Resuscitation • Basic Life Support: Cardiopulmonary Resuscitation and Defibrillation • Blood Pressure Measurement • C. elegans Development and Reproduction • Cardiac Exam I: Inspection and Palpation • Cardiac Exam II: Auscultation • Cardiac Exam III: Abnormal Heart Sounds • Central Venous Catheter Insertion: Femoral Vein with Ultrasound Guidance • Central Venous Catheter Insertion: Internal Jugular with Ultrasound Guidance • Central Venous Catheter Insertion: Subclavian Vein

		• Comprehensive Breast Exam • Cranial Nerves Exam I (I-VI) • Cranial Nerves Exam II (VII-XII) • Development and Reproduction of the Laboratory Mouse • Development of the Chick • Ear Exam • Elbow Exam • Emergency Tube Thoracostomy (Chest Tube Placement) • Emergent Lateral Canthotomy and Inferior Catholysis • Explant Culture for Developmental Studies • Explant Culture of Neural Tissue • Eye Exam • Fate Mapping • Foot Exam • General Approach to the Physical Exam • Genetic Engineering of Model Organisms • Hand and Wrist Exam • Hip Exam • Histological Staining of Neural Tissue • Intra-articular Shoulder Injection for Reduction Following Anterior Shoulder Dislocation • Intraosseous Needle Placement • Knee Exam • Lower Back Exam • Lymph Node Exam • Male Rectal Exam • Measuring Vital Signs • Motor Exam I • Motor Exam II • Murine In Utero Electroporation • Neck Exam • Needle Thoracostomy (needle Decompression) for Temporizing Tension Pneumothorax Treatment • Nose, Sinuses, Oral Cavity and Pharynx Exam • Observation and Inspection • Ophthalmoscopic Examination • Palpation • Pelvic Exam I: Assessment of the External Genitalia • Pelvic Exam II: Speculum Exam • Pelvic Exam III: Bimanual and Rectovaginal Exam • Percussion • Percutaneous Cricothyrotomy (Seldinger Technique) • Pericardiocentesis • Peripheral Vascular Exam • Peripheral Vascular Exam Using a Continuous Wave Doppler • Peripheral Venous Cannulation • Proper Adjustment of Patient Attire during the Physical Exam • Respiratory Exam I: Inspection and Palpation

		• Respiratory Exam II: Percussion and Auscultation • Rodent Stereotaxic Surgery • Sensory Exam • Shoulder Exam I • Shoulder Exam II • Surgical Cricothyrotomy • Thyroid Exam • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Tree Identification: How To Use a Dichotomous Key • Tree Survey: Point-Centered Quarter Sampling Method • Using GIS to Investigate Urban Forestry • Whole-Mount In Situ Hybridization • Zebrafish Reproduction and Development
INDICATOR / CLUSTER	III.1.b.	Describe the function of various organs (e.g. heart, lungs, skin, leaf, stem, root, ovary). <u>JoVE</u> • Abdominal Exam I: Inspection and Auscultation • Abdominal Exam II: Percussion • Abdominal Exam III: Palpation • Abdominal Exam IV: Acute Abdominal Pain Assessment • An Introduction to Aging and Regeneration • An Introduction to Behavioral Neuroscience • An Introduction to Caenorhabditis elegans • An Introduction to Cellular and Molecular Neuroscience • An Introduction to Cognition • An Introduction to Developmental Genetics • An Introduction to Developmental Neurobiology • An Introduction to Drosophila melanogaster • 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 Neuroanatomy • An Introduction to Neurophysiology • An Introduction to Organogenesis • An Introduction to Reward and Addiction • An Introduction to the Chick: Gallus gallus domesticus • An Introduction to the Laboratory Mouse: Mus musculus • An Introduction to the Zebrafish: Danio rerio • Anesthesia Induction and Maintenance • Ankle Exam • Anterograde Amnesia • Anxiety Testing • Approximate Number Sense Test • Arterial Line Placement • Assessing Dexterity with Reaching Tasks

		• Auscultation • Balance and Coordination Testing • Basic Chick Care and Maintenance • Basic Life Support Part II: Airway/Breathing and Continued Cardiopulmonary Resuscitation • Basic Life Support: Cardiopulmonary Resuscitation and Defibrillation • Basic Mouse Care and Maintenance • Binocular Rivalry • Blood Pressure Measurement • Blood Withdrawal I • Blood Withdrawal II • C. elegans Chemotaxis Assay • C. elegans Development and Reproduction • C. elegans Maintenance • Calcium Imaging in Neurons • Cardiac Exam I: Inspection and Palpation • Cardiac Exam II: Auscultation • Cardiac Exam III: Abnormal Heart Sounds • Central Venous Catheter Insertion: Femoral Vein with Ultrasound Guidance • Central Venous Catheter Insertion: Internal Jugular with Ultrasound Guidance • Central Venous Catheter Insertion: Subclavian Vein • Chick ex ovo Culture • Co-Immunoprecipitation and Pull-Down Assays • Color Afterimages • Compound Administration I • Compound Administration II • Compound Administration III • Compound Administration IV • Comprehensive Breast Exam • Considerations for Rodent Surgery • Cranial Nerves Exam I (I-VI) • Cranial Nerves Exam II (VII-XII) • Crowding • Decision-making and the Iowa Gambling Task • Decoding Auditory Imagery with Multivoxel Pattern Analysis • 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 • Drosophila Maintenance • Drosophila melanogaster Embryo and Larva Harvesting and Preparation • Ear Exam • Elbow Exam

		• Electro-encephalography (EEG) • Emergency Tube Thoracostomy (Chest Tube Placement) • Emergent Lateral Canthotomy and Inferior Catholysis • Event-related Potentials and the Oddball Task • Executive Function and the Dimensional Change Card Sort Task • Executive Function in Autism Spectrum Disorder • Explant Culture for Developmental Studies • Explant Culture of Neural Tissue • Eye Exam • Eye Tracking in Cognitive Experiments • Fate Mapping • Fear Conditioning • Finding Your Blind Spot and Perceptual Filling-in • Foot Exam • Fundamentals of Breeding and Weaning • Gene Silencing with Morpholinos • General Approach to the Physical Exam • Genetic Engineering of Model Organisms • Habituation: Studying Infants Before They Can Talk • Hand and Wrist Exam • Hip Exam • Histological Staining of Neural Tissue • In ovo Electroporation of Chicken Embryos • Inattentional Blindness • Incidental Encoding • Intra-articular Shoulder Injection for Reduction Following Anterior Shoulder Dislocation • Intraosseous Needle Placement • Introducing Experimental Agents into the Mouse • Invertebrate Lifespan Quantification • Just-noticeable Differences • Knee Exam • Language: The N400 in Semantic Incongruity • Learning and Memory: The Remember-Know Task • Lower Back Exam • Lymph Node Exam • Male Rectal Exam • Measuring Grey Matter Differences with Voxel-based Morphometry: The Musical Brain • Measuring Reaction Time and Donders' Method of Subtraction • Measuring Verbal Working Memory Span • Measuring Vital Signs • Mental Rotation • Modeling Social Stress • Motion-induced Blindness • Motor Exam I • Motor Exam II • Motor Learning in Mirror Drawing

		• Motor Maps • Mouse Genotyping • Multiple Object Tracking • Murine In Utero Electroporation • Mutual Exclusivity: How Children Learn the Meanings of Words • Neck Exam • Needle Thoracostomy (needle Decompression) for Temporizing Tension Pneumothorax Treatment • Neuronal Transfection Methods • Nose, Sinuses, Oral Cavity and Pharynx Exam • Object Substitution Masking • Observation and Inspection • Ophthalmoscopic Examination • Palpation • Patch Clamp Electrophysiology • Pelvic Exam I: Assessment of the External Genitalia • Pelvic Exam II: Speculum Exam • Pelvic Exam III: Bimanual and Rectovaginal Exam • Percussion • Percutaneous Cricothyrotomy (Seldinger Technique) • Pericardiocentesis • Peripheral Vascular Exam • Peripheral Vascular Exam Using a Continuous Wave Doppler • Peripheral Venous Cannulation • Physiological Correlates of Emotion Recognition • Primary Neuronal Cultures • Proper Adjustment of Patient Attire during the Physical Exam • Prospect Theory • RNAi in C. elegans • Respiratory Exam I: Inspection and Palpation • Respiratory Exam II: Percussion and Auscultation • Rodent Handling and Restraint Techniques • Rodent Identification I • Rodent Identification II • Rodent Stereotaxic Surgery • Self-administration Studies • Sensory Exam • Shoulder Exam I • Shoulder Exam II • Spatial Cueing • Spatial Memory Testing Using Mazes • Sterile Tissue Harvest • Surgical Cricothyrotomy • The Ames Room • The Attentional Blink • The Inverted-face Effect • The McGurk Effect • The Morris Water Maze

		• The Precision of Visual Working Memory with Delayed Estimation • The Rubber Hand Illusion • The Split Brain • The Staircase Procedure for Finding a Perceptual Threshold • Thyroid Exam • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Tree Identification: How To Use a Dichotomous Key • Tree Survey: Point-Centered Quarter Sampling Method • Using Diffusion Tensor Imaging in Traumatic Brain Injury • Using GIS to Investigate Urban Forestry • Using TMS to Measure Motor Excitability During Action Observation • Verbal Priming • Visual Attention: fMRI Investigation of Object-based Attentional Control • Visual Search for Features and Conjunctions • Visual Statistical Learning • Whole-Mount In Situ Hybridization • Within-subjects Repeated-measures Design • Zebrafish Breeding and Embryo Handling • Zebrafish Maintenance and Husbandry • Zebrafish Microinjection Techniques • Zebrafish Reproduction and Development • fMRI: Functional Magnetic Resonance Imaging
INDICATOR / CLUSTER	III.1.c.	Relate the structure of organs to the function of organs. JoVE • Abdominal Exam I: Inspection and Auscultation • Abdominal Exam II: Percussion • Abdominal Exam III: Palpation • Abdominal Exam IV: Acute Abdominal Pain Assessment • An Introduction to Aging and Regeneration • An Introduction to Behavioral Neuroscience • An Introduction to Caenorhabditis elegans • An Introduction to Cellular and Molecular Neuroscience • An Introduction to Cognition • An Introduction to Developmental Genetics • An Introduction to Developmental Neurobiology • An Introduction to Drosophila melanogaster • 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 Neuroanatomy • An Introduction to Neurophysiology

		• An Introduction to Organogenesis • An Introduction to Reward and Addiction • An Introduction to the Chick: Gallus gallus domesticus • An Introduction to the Laboratory Mouse: Mus musculus • An Introduction to the Zebrafish: Danio rerio • Anesthesia Induction and Maintenance • Ankle Exam • Anterograde Amnesia • Anxiety Testing • Approximate Number Sense Test • Arterial Line Placement • Assessing Dexterity with Reaching Tasks • Auscultation • Balance and Coordination Testing • Basic Chick Care and Maintenance • Basic Life Support Part II: Airway/Breathing and Continued Cardiopulmonary Resuscitation • Basic Life Support: Cardiopulmonary Resuscitation and Defibrillation • Basic Mouse Care and Maintenance • Binocular Rivalry • Blood Pressure Measurement • Blood Withdrawal I • Blood Withdrawal II • C. elegans Chemotaxis Assay • C. elegans Development and Reproduction • C. elegans Maintenance • Calcium Imaging in Neurons • Cardiac Exam I: Inspection and Palpation • Cardiac Exam II: Auscultation • Cardiac Exam III: Abnormal Heart Sounds • Central Venous Catheter Insertion: Femoral Vein with Ultrasound Guidance • Central Venous Catheter Insertion: Internal Jugular with Ultrasound Guidance • Central Venous Catheter Insertion: Subclavian Vein • Chick ex ovo Culture • Co-Immunoprecipitation and Pull-Down Assays • Color Afterimages • Compound Administration I • Compound Administration II • Compound Administration III • Compound Administration IV • Comprehensive Breast Exam • Considerations for Rodent Surgery • Cranial Nerves Exam I (I-VI) • Cranial Nerves Exam II (VII-XII) • Crowding • Decision-making and the Iowa Gambling Task • Decoding Auditory Imagery with Multivoxel Pattern

		Analysis **• 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** **• Drosophila Maintenance** **• Drosophila melanogaster Embryo and Larva Harvesting and Preparation** **• Ear Exam** **• Elbow Exam** **• Electro-encephalography (EEG)** **• Emergency Tube Thoracostomy (Chest Tube Placement)** **• Emergent Lateral Canthotomy and Inferior Catholysis** **• Event-related Potentials and the Oddball Task** **• Executive Function and the Dimensional Change Card Sort Task** **• Executive Function in Autism Spectrum Disorder** **• Explant Culture for Developmental Studies** **• Explant Culture of Neural Tissue** **• Eye Exam** **• Eye Tracking in Cognitive Experiments** **• Fate Mapping** **• Fear Conditioning** **• Finding Your Blind Spot and Perceptual Filling-in** **• Foot Exam** **• Fundamentals of Breeding and Weaning** **• Gene Silencing with Morpholinos** **• General Approach to the Physical Exam** **• Genetic Engineering of Model Organisms** **• Habituation: Studying Infants Before They Can Talk** **• Hand and Wrist Exam** **• Hip Exam** **• Histological Staining of Neural Tissue** **• In ovo Electroporation of Chicken Embryos** **• Inattentional Blindness** **• Incidental Encoding** **• Intra-articular Shoulder Injection for Reduction Following Anterior Shoulder Dislocation** **• Intraosseous Needle Placement** **• Introducing Experimental Agents into the Mouse** **• Invertebrate Lifespan Quantification** **• Just-noticeable Differences** **• Knee Exam** **• Language: The N400 in Semantic Incongruity** **• Learning and Memory: The Remember-Know Task** **• Lower Back Exam** **• Lymph Node Exam**

		• Male Rectal Exam • Measuring Grey Matter Differences with Voxel-based Morphometry: The Musical Brain • Measuring Reaction Time and Donders' Method of Subtraction • Measuring Verbal Working Memory Span • Measuring Vital Signs • Mental Rotation • Modeling Social Stress • Motion-induced Blindness • Motor Exam I • Motor Exam II • Motor Learning in Mirror Drawing • Motor Maps • Mouse Genotyping • Multiple Object Tracking • Murine In Utero Electroporation • Mutual Exclusivity: How Children Learn the Meanings of Words • Neck Exam • Needle Thoracostomy (needle Decompression) for Temporizing Tension Pneumothorax Treatment • Neuronal Transfection Methods • Nose, Sinuses, Oral Cavity and Pharynx Exam • Object Substitution Masking • Observation and Inspection • Ophthalmoscopic Examination • Palpation • Patch Clamp Electrophysiology • Pelvic Exam I: Assessment of the External Genitalia • Pelvic Exam II: Speculum Exam • Pelvic Exam III: Bimanual and Rectovaginal Exam • Percussion • Percutaneous Cricothyrotomy (Seldinger Technique) • Pericardiocentesis • Peripheral Vascular Exam • Peripheral Vascular Exam Using a Continuous Wave Doppler • Peripheral Venous Cannulation • Physiological Correlates of Emotion Recognition • Primary Neuronal Cultures • Proper Adjustment of Patient Attire during the Physical Exam • Prospect Theory • RNAi in C. elegans • Respiratory Exam I: Inspection and Palpation • Respiratory Exam II: Percussion and Auscultation • Rodent Handling and Restraint Techniques • Rodent Identification I • Rodent Identification II • Rodent Stereotaxic Surgery

		• Self-administration Studies • Sensory Exam • Shoulder Exam I • Shoulder Exam II • Spatial Cueing • Spatial Memory Testing Using Mazes • Sterile Tissue Harvest • Surgical Cricothyrotomy • The Ames Room • The Attentional Blink • The Inverted-face Effect • The McGurk Effect • The Morris Water Maze • The Precision of Visual Working Memory with Delayed Estimation • The Rubber Hand Illusion • The Split Brain • The Staircase Procedure for Finding a Perceptual Threshold • Thyroid Exam • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Tree Identification: How To Use a Dichotomous Key • Tree Survey: Point-Centered Quarter Sampling Method • Using Diffusion Tensor Imaging in Traumatic Brain Injury • Using GIS to Investigate Urban Forestry • Using TMS to Measure Motor Excitability During Action Observation • Verbal Priming • Visual Attention: fMRI Investigation of Object-based Attentional Control • Visual Search for Features and Conjunctions • Visual Statistical Learning • Whole-Mount In Situ Hybridization • Within-subjects Repeated-measures Design • Zebrafish Breeding and Embryo Handling • Zebrafish Maintenance and Husbandry • Zebrafish Microinjection Techniques • Zebrafish Reproduction and Development • fMRI: Functional Magnetic Resonance Imaging
INDICATOR / CLUSTER	III.1.d.	Compare the structure and function of organs in one organism to the structure and function of organs in another organism. JoVE • Abdominal Exam I: Inspection and Auscultation • Abdominal Exam II: Percussion • Abdominal Exam III: Palpation • Abdominal Exam IV: Acute Abdominal Pain Assessment

		• An Introduction to Aging and Regeneration • An Introduction to Behavioral Neuroscience • An Introduction to Caenorhabditis elegans • An Introduction to Cellular and Molecular Neuroscience • An Introduction to Cognition • An Introduction to Developmental Genetics • An Introduction to Developmental Neurobiology • An Introduction to Drosophila melanogaster • 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 Neuroanatomy • An Introduction to Neurophysiology • An Introduction to Organogenesis • An Introduction to Reward and Addiction • An Introduction to the Chick: Gallus gallus domesticus • An Introduction to the Laboratory Mouse: Mus musculus • An Introduction to the Zebrafish: Danio rerio • Anesthesia Induction and Maintenance • Ankle Exam • Anterograde Amnesia • Anxiety Testing • Approximate Number Sense Test • Arterial Line Placement • Assessing Dexterity with Reaching Tasks • Auscultation • Balance and Coordination Testing • Basic Chick Care and Maintenance • Basic Life Support Part II: Airway/Breathing and Continued Cardiopulmonary Resuscitation • Basic Life Support: Cardiopulmonary Resuscitation and Defibrillation • Basic Mouse Care and Maintenance • Binocular Rivalry • Blood Pressure Measurement • Blood Withdrawal I • Blood Withdrawal II • C. elegans Chemotaxis Assay • C. elegans Development and Reproduction • C. elegans Maintenance • Calcium Imaging in Neurons • Cardiac Exam I: Inspection and Palpation • Cardiac Exam II: Auscultation • Cardiac Exam III: Abnormal Heart Sounds • Central Venous Catheter Insertion: Femoral Vein with Ultrasound Guidance • Central Venous Catheter Insertion: Internal Jugular with Ultrasound Guidance

		• Central Venous Catheter Insertion: Subclavian Vein • Chick ex ovo Culture • Co-Immunoprecipitation and Pull-Down Assays • Color Afterimages • Compound Administration I • Compound Administration II • Compound Administration III • Compound Administration IV • Comprehensive Breast Exam • Considerations for Rodent Surgery • Cranial Nerves Exam I (I-VI) • Cranial Nerves Exam II (VII-XII) • Crowding • Decision-making and the Iowa Gambling Task • Decoding Auditory Imagery with Multivoxel Pattern Analysis • 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 • Drosophila Maintenance • Drosophila melanogaster Embryo and Larva Harvesting and Preparation • Ear Exam • Elbow Exam • Electro-encephalography (EEG) • Emergency Tube Thoracostomy (Chest Tube Placement) • Emergent Lateral Canthotomy and Inferior Catholysis • Event-related Potentials and the Oddball Task • Executive Function and the Dimensional Change Card Sort Task • Executive Function in Autism Spectrum Disorder • Explant Culture for Developmental Studies • Explant Culture of Neural Tissue • Eye Exam • Eye Tracking in Cognitive Experiments • Fate Mapping • Fear Conditioning • Finding Your Blind Spot and Perceptual Filling-in • Foot Exam • Fundamentals of Breeding and Weaning • Gene Silencing with Morpholinos • General Approach to the Physical Exam • Genetic Engineering of Model Organisms • Habituation: Studying Infants Before They Can Talk • Hand and Wrist Exam • Hip Exam

		• Histological Staining of Neural Tissue • In ovo Electroporation of Chicken Embryos • Inattentional Blindness • Incidental Encoding • Intra-articular Shoulder Injection for Reduction Following Anterior Shoulder Dislocation • Intraosseous Needle Placement • Introducing Experimental Agents into the Mouse • Invertebrate Lifespan Quantification • Just-noticeable Differences • Knee Exam • Language: The N400 in Semantic Incongruity • Learning and Memory: The Remember-Know Task • Lower Back Exam • Lymph Node Exam • Male Rectal Exam • Measuring Grey Matter Differences with Voxel-based Morphometry: The Musical Brain • Measuring Reaction Time and Donders' Method of Subtraction • Measuring Verbal Working Memory Span • Measuring Vital Signs • Mental Rotation • Modeling Social Stress • Motion-induced Blindness • Motor Exam I • Motor Exam II • Motor Learning in Mirror Drawing • Motor Maps • Mouse Genotyping • Multiple Object Tracking • Murine In Utero Electroporation • Mutual Exclusivity: How Children Learn the Meanings of Words • Neck Exam • Needle Thoracostomy (needle Decompression) for Temporizing Tension Pneumothorax Treatment • Neuronal Transfection Methods • Nose, Sinuses, Oral Cavity and Pharynx Exam • Object Substitution Masking • Observation and Inspection • Ophthalmoscopic Examination • Palpation • Patch Clamp Electrophysiology • Pelvic Exam I: Assessment of the External Genitalia • Pelvic Exam II: Speculum Exam • Pelvic Exam III: Bimanual and Rectovaginal Exam • Percussion • Percutaneous Cricothyrotomy (Seldinger Technique) • Pericardiocentesis • Peripheral Vascular Exam

		• Peripheral Vascular Exam Using a Continuous Wave Doppler • Peripheral Venous Cannulation • Physiological Correlates of Emotion Recognition • Primary Neuronal Cultures • Proper Adjustment of Patient Attire during the Physical Exam • Prospect Theory • RNAi in C. elegans • Respiratory Exam I: Inspection and Palpation • Respiratory Exam II: Percussion and Auscultation • Rodent Handling and Restraint Techniques • Rodent Identification I • Rodent Identification II • Rodent Stereotaxic Surgery • Self-administration Studies • Sensory Exam • Shoulder Exam I • Shoulder Exam II • Spatial Cueing • Spatial Memory Testing Using Mazes • Sterile Tissue Harvest • Surgical Cricothyrotomy • The Ames Room • The Attentional Blink • The Inverted-face Effect • The McGurk Effect • The Morris Water Maze • The Precision of Visual Working Memory with Delayed Estimation • The Rubber Hand Illusion • The Split Brain • The Staircase Procedure for Finding a Perceptual Threshold • Thyroid Exam • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Tree Identification: How To Use a Dichotomous Key • Tree Survey: Point-Centered Quarter Sampling Method • Using Diffusion Tensor Imaging in Traumatic Brain Injury • Using GIS to Investigate Urban Forestry • Using TMS to Measure Motor Excitability During Action Observation • Verbal Priming • Visual Attention: fMRI Investigation of Object-based Attentional Control • Visual Search for Features and Conjunctions • Visual Statistical Learning • Whole-Mount In Situ Hybridization • Within-subjects Repeated-measures Design

		• Zebrafish Breeding and Embryo Handling • Zebrafish Maintenance and Husbandry • Zebrafish Microinjection Techniques • Zebrafish Reproduction and Development • fMRI: Functional Magnetic Resonance Imaging
INDICATOR / CLUSTER	III.1.e.	Research and report on technological developments related to organs. <u>JoVE</u> • Abdominal Exam I: Inspection and Auscultation • Abdominal Exam IV: Acute Abdominal Pain Assessment • Algae Enumeration via Culturable Methodology • An Introduction to Aging and Regeneration • An Introduction to Behavioral Neuroscience • An Introduction to Cell Metabolism • An Introduction to Cognition • An Introduction to Developmental Genetics • An Introduction to Endocytosis and Exocytosis • An Introduction to Learning and Memory • An Introduction to Molecular Developmental Biology • An Introduction to Motor Control • An Introduction to Neuroanatomy • An Introduction to Neurophysiology • An Introduction to Organogenesis • An Introduction to Saccharomyces cerevisiae • An Introduction to Stem Cell Biology • An Introduction to the Laboratory Mouse: Mus musculus • An Overview of Genetic Analysis • An Overview of Genetic Engineering • An Overview of Genetics and Disease • Arterial Line Placement • Assembly of a Reflux System for Heated Chemical Reactions • Auscultation • Bacterial Growth Curve Analysis and its Environmental Applications • Basic Life Support: Cardiopulmonary Resuscitation and Defibrillation • Blood Pressure Measurement • C. elegans Development and Reproduction • Calcium Imaging in Neurons • Capillary Electrophoresis (CE) • Cardiac Exam II: Auscultation • Cardiac Exam III: Abnormal Heart Sounds • Central Venous Catheter Insertion: Femoral Vein with Ultrasound Guidance • Central Venous Catheter Insertion: Internal Jugular with Ultrasound Guidance • Central Venous Catheter Insertion: Subclavian Vein

		• Chromatin Immunoprecipitation • Chromatography-Based Biomolecule Purification Methods • Co-Immunoprecipitation and Pull-Down Assays • Column Chromatography • Community DNA Extraction from Bacterial Colonies • Coordination Chemistry Complexes • Cranial Nerves Exam I (I-VI) • Cranial Nerves Exam II (VII-XII) • Culturing and Enumerating Bacteria from Soil Samples • Cyclic Voltammetry (CV) • Cytogenetics • DNA Ligation Reactions • DNA Methylation Analysis • Decision-making and the Iowa Gambling Task • Decoding Auditory Imagery with Multivoxel Pattern Analysis • Detecting Reactive Oxygen Species • Detection of Bacteriophages in Environmental Samples • Development and Reproduction of the Laboratory Mouse • Development of the Chick • Ear Exam • Electro-encephalography (EEG) • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Embryonic Stem Cell Culture and Differentiation • Emergency Tube Thoracostomy (Chest Tube Placement) • Emergent Lateral Canthotomy and Inferior Catholysis • Enzyme Assays and Kinetics • Event-related Potentials and the Oddball Task • Explant Culture for Developmental Studies • Expression Profiling with Microarrays • Eye Exam • Eye Tracking in Cognitive Experiments • Fate Mapping • Fear Conditioning • General Approach to the Physical Exam • Genetic Crosses • Genetic Engineering of Model Organisms • Genetic Screens • Genome Editing • Gram Staining of Bacteria from Environmental Sources • Growing Crystals for X-ray Diffraction Analysis • Induced Pluripotency • Intra-articular Shoulder Injection for Reduction Following Anterior Shoulder Dislocation • Intraosseous Needle Placement • Introducing Experimental Agents into the Mouse • Introduction to Mass Spectrometry

		• Introduction to Titration • Isolation of Fecal Bacteria from Water Samples by Filtration • Language: The N400 in Semantic Incongruity • Learning and Memory: The Remember-Know Task • Live Cell Imaging of Mitosis • MALDI-TOF Mass Spectrometry • Measuring Grey Matter Differences with Voxel-based Morphometry: The Musical Brain • Measuring Vital Signs • Metabolic Labeling • Molecular Cloning • Motor Exam II • Motor Maps • Needle Thoracostomy (needle Decompression) for Temporizing Tension Pneumothorax Treatment • Nose, Sinuses, Oral Cavity and Pharynx Exam • Nuclear Magnetic Resonance (NMR) Spectroscopy • Ophthalmoscopic Examination • Patch Clamp Electrophysiology • Pelvic Exam II: Speculum Exam • Pelvic Exam III: Bimanual and Rectovaginal Exam • Percussion • Percutaneous Cricothyrotomy (Seldinger Technique) • Performing 1D Thin Layer Chromatography • Pericardiocentesis • Peripheral Vascular Exam • Peripheral Vascular Exam Using a Continuous Wave Doppler • Peripheral Venous Cannulation • Physiological Correlates of Emotion Recognition • Protein Crystallization • Purifying Compounds by Recrystallization • Quantifying Environmental Microorganisms and Viruses Using qPCR • RNA-Seq • Recombineering and Gene Targeting • Respiratory Exam II: Percussion and Auscultation • SNP Genotyping • Scanning Electron Microscopy (SEM) • Solutions and Concentrations • Surface Plasmon Resonance (SPR) • Surgical Cricothyrotomy • Tandem Mass Spectrometry • The ATP Bioluminescence Assay • The ELISA Method • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Two-Dimensional Gel Electrophoresis • Using Diffusion Tensor Imaging in Traumatic Brain Injury

		• Using TMS to Measure Motor Excitability During Action Observation • Using a pH Meter • Visual Attention: fMRI Investigation of Object-based Attentional Control • Whole-Mount In Situ Hybridization • Zebrafish Reproduction and Development • fMRI: Functional Magnetic Resonance Imaging
STANDARD / AREA OF LEARNING	**UT.III.**	**Biology: Students will understand the relationship between structure and function of organs and organ systems.**
OBJECTIVE / STRAND	**III.2.**	**Describe the relationship between structure and function of organ systems in plants and animals.**
INDICATOR / CLUSTER	**III.2.a.**	**Relate the function of an organ to the function of an organ system.** **JoVE** • Abdominal Exam I: Inspection and Auscultation • Abdominal Exam II: Percussion • Abdominal Exam III: Palpation • Abdominal Exam IV: Acute Abdominal Pain Assessment • An Introduction to Aging and Regeneration • An Introduction to Behavioral Neuroscience • An Introduction to Caenorhabditis elegans • An Introduction to Cell Motility and Migration • An Introduction to Cellular and Molecular Neuroscience • An Introduction to Cognition • 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 Neuroanatomy • An Introduction to Neurophysiology • 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 • Ankle Exam • Anterograde Amnesia • Anxiety Testing • Approximate Number Sense Test • Assessing Dexterity with Reaching Tasks • Balance and Coordination Testing • Basic Care Procedures • Basic Life Support Part II: Airway/Breathing and

		Continued Cardiopulmonary Resuscitation **• Basic Life Support: Cardiopulmonary Resuscitation and Defibrillation** **• Binocular Rivalry** **• Blood Pressure Measurement** **• Blood Withdrawal I** **• Blood Withdrawal II** **• C. elegans Chemotaxis Assay** **• C. elegans Development and Reproduction** **• C. elegans Maintenance** **• Calcium Imaging in Neurons** **• Cardiac Exam I: Inspection and Palpation** **• Cardiac Exam II: Auscultation** **• Cardiac Exam III: Abnormal Heart Sounds** **• Co-Immunoprecipitation and Pull-Down Assays** **• Color Afterimages** **• Compound Administration I** **• Compound Administration II** **• Compound Administration III** **• Compound Administration IV** **• Comprehensive Breast Exam** **• Considerations for Rodent Surgery** **• Cranial Nerves Exam I (I-VI)** **• Cranial Nerves Exam II (VII-XII)** **• Crowding** **• Decision-making and the Iowa Gambling Task** **• Decoding Auditory Imagery with Multivoxel Pattern Analysis** **• 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** **• Elbow Exam** **• Electro-encephalography (EEG)** **• Embryonic Stem Cell Culture and Differentiation** **• Emergency Tube Thoracostomy (Chest Tube Placement)** **• Event-related Potentials and the Oddball Task** **• Executive Function and the Dimensional Change Card Sort Task** **• Executive Function in Autism Spectrum Disorder** **• Explant Culture for Developmental Studies** **• Explant Culture of Neural Tissue** **• Expression Profiling with Microarrays** **• Eye Exam** **• Fate Mapping** **• Finding Your Blind Spot and Perceptual Filling-in** **• Foot Exam** **• Fundamentals of Breeding and Weaning**

		• Genetic Engineering of Model Organisms • Habituation: Studying Infants Before They Can Talk • Hand and Wrist Exam • Hip Exam • Histological Staining of Neural Tissue • In ovo Electroporation of Chicken Embryos • Inattentional Blindness • Incidental Encoding • Induced Pluripotency • Intra-articular Shoulder Injection for Reduction Following Anterior Shoulder Dislocation • Intraosseous Needle Placement • Just-noticeable Differences • Knee Exam • Language: The N400 in Semantic Incongruity • Learning and Memory: The Remember-Know Task • Lower Back Exam • Male Rectal Exam • Measuring Grey Matter Differences with Voxel-based Morphometry: The Musical Brain • Measuring Reaction Time and Donders' Method of Subtraction • Measuring Verbal Working Memory Span • Measuring Vital Signs • Mental Rotation • Modeling Social Stress • Motion-induced Blindness • Motor Exam I • Motor Exam II • Motor Learning in Mirror Drawing • Motor Maps • Multiple Object Tracking • Murine In Utero Electroporation • Mutual Exclusivity: How Children Learn the Meanings of Words • Neck Exam • Needle Thoracostomy (needle Decompression) for Temporizing Tension Pneumothorax Treatment • Neuronal Transfection Methods • Object Substitution Masking • Ophthalmoscopic Examination • Patch Clamp Electrophysiology • Pelvic Exam I: Assessment of the External Genitalia • Pelvic Exam II: Speculum Exam • Pelvic Exam III: Bimanual and Rectovaginal Exam • Percutaneous Cricothyrotomy (Seldinger Technique) • Pericardiocentesis • Peripheral Vascular Exam • Peripheral Vascular Exam Using a Continuous Wave Doppler • Perspectives on Sensation and Perception • Physiological Correlates of Emotion Recognition

		• Primary Neuronal Cultures • Prospect Theory • Respiratory Exam I: Inspection and Palpation • Respiratory Exam II: Percussion and Auscultation • Rodent Stereotaxic Surgery • Self-administration Studies • Sensory Exam • Shoulder Exam I • Shoulder Exam II • Spatial Cueing • Spatial Memory Testing Using Mazes • Sterile Tissue Harvest • Surgical Cricothyrotomy • 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 Split Brain • The Staircase Procedure for Finding a Perceptual Threshold • Thyroid Exam • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Using Diffusion Tensor Imaging in Traumatic Brain Injury • Using TMS to Measure Motor Excitability During Action Observation • Verbal Priming • Visual Attention: fMRI Investigation of Object-based Attentional Control • Visual Search for Features and Conjunctions • Visual Statistical Learning • Whole-Mount In Situ Hybridization • Within-subjects Repeated-measures Design • Zebrafish Reproduction and Development • fMRI: Functional Magnetic Resonance Imaging
INDICATOR / CLUSTER	III.2.b.	Describe the structure and function of various organ systems (i.e., digestion, respiration, circulation, protection and support, nervous) and how these systems contribute to homeostasis of the organism. JoVE • Abdominal Exam I: Inspection and Auscultation • Abdominal Exam II: Percussion • Abdominal Exam III: Palpation • Abdominal Exam IV: Acute Abdominal Pain Assessment • An Introduction to Aging and Regeneration

		• An Introduction to Behavioral Neuroscience • An Introduction to Caenorhabditis elegans • An Introduction to Cell Motility and Migration • An Introduction to Cellular and Molecular Neuroscience • An Introduction to Cognition • 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 Neuroanatomy • An Introduction to Neurophysiology • 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 • Ankle Exam • Anterograde Amnesia • Anxiety Testing • Arterial Line Placement • Assessing Dexterity with Reaching Tasks • Auscultation • Balance and Coordination Testing • Basic Care Procedures • Basic Life Support Part II: Airway/Breathing and Continued Cardiopulmonary Resuscitation • Basic Life Support: Cardiopulmonary Resuscitation and Defibrillation • Basic Mouse Care and Maintenance • Blood Pressure Measurement • Blood Withdrawal I • Blood Withdrawal II • C. elegans Chemotaxis Assay • C. elegans Development and Reproduction • C. elegans Maintenance • Calcium Imaging in Neurons • Cardiac Exam I: Inspection and Palpation • Cardiac Exam II: Auscultation • Cardiac Exam III: Abnormal Heart Sounds • Central Venous Catheter Insertion: Femoral Vein with Ultrasound Guidance • Central Venous Catheter Insertion: Internal Jugular with Ultrasound Guidance • Central Venous Catheter Insertion: Subclavian Vein • Color Afterimages • Compound Administration I • Compound Administration II

		• Compound Administration III • Compound Administration IV • Comprehensive Breast Exam • Considerations for Rodent Surgery • Cranial Nerves Exam I (I-VI) • Cranial Nerves Exam II (VII-XII) • Crowding • Decision-making and the Iowa Gambling Task • Decoding Auditory Imagery with Multivoxel Pattern Analysis • Development and Reproduction of the Laboratory Mouse • Development of the Chick • Diagnostic Necropsy and Tissue Harvest • Drosophila Development and Reproduction • Drosophila Larval IHC • Ear Exam • Elbow Exam • Electro-encephalography (EEG) • Embryonic Stem Cell Culture and Differentiation • Emergency Tube Thoracostomy (Chest Tube Placement) • Emergent Lateral Canthotomy and Inferior Catholysis • Event-related Potentials and the Oddball Task • Executive Function and the Dimensional Change Card Sort Task • Executive Function in Autism Spectrum Disorder • Explant Culture for Developmental Studies • Explant Culture of Neural Tissue • Expression Profiling with Microarrays • Eye Exam • Fate Mapping • Fear Conditioning • Finding Your Blind Spot and Perceptual Filling-in • Foot Exam • Fundamentals of Breeding and Weaning • General Approach to the Physical Exam • Genetic Engineering of Model Organisms • Hand and Wrist Exam • Hip Exam • Histological Staining of Neural Tissue • In ovo Electroporation of Chicken Embryos • Inattentional Blindness • Induced Pluripotency • Intra-articular Shoulder Injection for Reduction Following Anterior Shoulder Dislocation • Intraosseous Needle Placement • Just-noticeable Differences • Knee Exam • Language: The N400 in Semantic Incongruity • Learning and Memory: The Remember-Know Task

		• Lower Back Exam • Lymph Node Exam • Male Rectal Exam • Measuring Grey Matter Differences with Voxel-based Morphometry: The Musical Brain • Measuring Vital Signs • Modeling Social Stress • Motion-induced Blindness • Motor Exam I • Motor Exam II • Motor Maps • Murine In Utero Electroporation • Mutual Exclusivity: How Children Learn the Meanings of Words • Neck Exam • Needle Thoracostomy (needle Decompression) for Temporizing Tension Pneumothorax Treatment • Neuronal Transfection Methods • Nose, Sinuses, Oral Cavity and Pharynx Exam • Object Substitution Masking • Observation and Inspection • Ophthalmoscopic Examination • Palpation • Patch Clamp Electrophysiology • Pelvic Exam I: Assessment of the External Genitalia • Pelvic Exam II: Speculum Exam • Pelvic Exam III: Bimanual and Rectovaginal Exam • Percussion • Percutaneous Cricothyrotomy (Seldinger Technique) • Pericardiocentesis • Peripheral Vascular Exam • Peripheral Vascular Exam Using a Continuous Wave Doppler • Peripheral Venous Cannulation • Perspectives on Sensation and Perception • Physiological Correlates of Emotion Recognition • Primary Neuronal Cultures • Proper Adjustment of Patient Attire during the Physical Exam • Respiratory Exam I: Inspection and Palpation • Respiratory Exam II: Percussion and Auscultation • Rodent Stereotaxic Surgery • Self-administration Studies • Sensory Exam • Shoulder Exam I • Shoulder Exam II • Spatial Cueing • Spatial Memory Testing Using Mazes • Sterile Tissue Harvest • Surgical Cricothyrotomy • The Ames Room

		• The Attentional Blink • The Inverted-face Effect • The McGurk Effect • The Rubber Hand Illusion • The Split Brain • The Staircase Procedure for Finding a Perceptual Threshold • Thyroid Exam • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Tree Identification: How To Use a Dichotomous Key • Using Diffusion Tensor Imaging in Traumatic Brain Injury • Using TMS to Measure Motor Excitability During Action Observation • Using a pH Meter • Verbal Priming • Visual Attention: fMRI Investigation of Object-based Attentional Control • Whole-Mount In Situ Hybridization • Within-subjects Repeated-measures Design • Zebrafish Maintenance and Husbandry • Zebrafish Reproduction and Development • fMRI: Functional Magnetic Resonance Imaging
INDICATOR / CLUSTER	III.2.c.	Examine the relationships of organ systems within an organism (e.g., respiration to circulation, leaves to roots) and describe the relationship of structure to function in the relationship. <u>JoVE</u> • Abdominal Exam I: Inspection and Auscultation • Abdominal Exam II: Percussion • Abdominal Exam III: Palpation • Abdominal Exam IV: Acute Abdominal Pain Assessment • An Introduction to Aging and Regeneration • An Introduction to Behavioral Neuroscience • An Introduction to Caenorhabditis elegans • An Introduction to Cell Motility and Migration • An Introduction to Cellular and Molecular Neuroscience • An Introduction to Cognition • 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 Neuroanatomy • An Introduction to Neurophysiology • 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 • Ankle Exam • Anterograde Amnesia • Anxiety Testing • Assessing Dexterity with Reaching Tasks • Balance and Coordination Testing • Basic Care Procedures • Basic Life Support Part II: Airway/Breathing and Continued Cardiopulmonary Resuscitation • Basic Life Support: Cardiopulmonary Resuscitation and Defibrillation • Blood Pressure Measurement • Blood Withdrawal I • Blood Withdrawal II • C. elegans Chemotaxis Assay • C. elegans Development and Reproduction • C. elegans Maintenance • Calcium Imaging in Neurons • Cardiac Exam I: Inspection and Palpation • Cardiac Exam II: Auscultation • Cardiac Exam III: Abnormal Heart Sounds • Color Afterimages • Compound Administration I • Compound Administration II • Compound Administration III • Compound Administration IV • Comprehensive Breast Exam • Considerations for Rodent Surgery • Cranial Nerves Exam I (I-VI) • Cranial Nerves Exam II (VII-XII) • Crowding • Decision-making and the Iowa Gambling Task • Decoding Auditory Imagery with Multivoxel Pattern Analysis • Development and Reproduction of the Laboratory Mouse • Development of the Chick • Diagnostic Necropsy and Tissue Harvest • Drosophila Development and Reproduction • Drosophila Larval IHC • Elbow Exam • Electro-encephalography (EEG) • Embryonic Stem Cell Culture and Differentiation • Emergency Tube Thoracostomy (Chest Tube Placement) • Event-related Potentials and the Oddball Task • Executive Function and the Dimensional Change Card

		Sort Task **• Executive Function in Autism Spectrum Disorder** **• Explant Culture for Developmental Studies** **• Explant Culture of Neural Tissue** **• Expression Profiling with Microarrays** **• Eye Exam** **• Fate Mapping** **• Finding Your Blind Spot and Perceptual Filling-in** **• Foot Exam** **• Fundamentals of Breeding and Weaning** **• Genetic Engineering of Model Organisms** **• Hand and Wrist Exam** **• Hip Exam** **• Histological Staining of Neural Tissue** **• In ovo Electroporation of Chicken Embryos** **• Inattentional Blindness** **• Induced Pluripotency** **• Intra-articular Shoulder Injection for Reduction Following Anterior Shoulder Dislocation** **• Intraosseous Needle Placement** **• Just-noticeable Differences** **• Knee Exam** **• Language: The N400 in Semantic Incongruity** **• Learning and Memory: The Remember-Know Task** **• Lower Back Exam** **• Male Rectal Exam** **• Measuring Grey Matter Differences with Voxel-based Morphometry: The Musical Brain** **• Measuring Vital Signs** **• Modeling Social Stress** **• Motion-induced Blindness** **• Motor Exam I** **• Motor Exam II** **• Motor Maps** **• Murine In Utero Electroporation** **• Mutual Exclusivity: How Children Learn the Meanings of Words** **• Neck Exam** **• Needle Thoracostomy (needle Decompression) for Temporizing Tension Pneumothorax Treatment** **• Neuronal Transfection Methods** **• Object Substitution Masking** **• Ophthalmoscopic Examination** **• Patch Clamp Electrophysiology** **• Pelvic Exam I: Assessment of the External Genitalia** **• Pelvic Exam II: Speculum Exam** **• Pelvic Exam III: Bimanual and Rectovaginal Exam** **• Percutaneous Cricothyrotomy (Seldinger Technique)** **• Pericardiocentesis** **• Peripheral Vascular Exam** **• Peripheral Vascular Exam Using a Continuous Wave**

		Doppler **• Perspectives on Sensation and Perception** **• Physiological Correlates of Emotion Recognition** **• Primary Neuronal Cultures** **• Respiratory Exam I: Inspection and Palpation** **• Respiratory Exam II: Percussion and Auscultation** **• Rodent Stereotaxic Surgery** **• Self-administration Studies** **• Sensory Exam** **• Shoulder Exam I** **• Shoulder Exam II** **• Spatial Cueing** **• Spatial Memory Testing Using Mazes** **• Sterile Tissue Harvest** **• Surgical Cricothyrotomy** **• The Ames Room** **• The Attentional Blink** **• The Inverted-face Effect** **• The McGurk Effect** **• The Rubber Hand Illusion** **• The Split Brain** **• The Staircase Procedure for Finding a Perceptual Threshold** **• Thyroid Exam** **• Tissue Regeneration with Somatic Stem Cells** **• Transplantation Studies** **• Using Diffusion Tensor Imaging in Traumatic Brain Injury** **• Using TMS to Measure Motor Excitability During Action Observation** **• Verbal Priming** **• Visual Attention: fMRI Investigation of Object-based Attentional Control** **• Whole-Mount In Situ Hybridization** **• Within-subjects Repeated-measures Design** **• Zebrafish Reproduction and Development** **• fMRI: Functional Magnetic Resonance Imaging**
INDICATOR / CLUSTER	**III.2.d.**	**Relate the tissues that make up organs to the structure and function of the organ.** **JoVE** **• An Introduction to Aging and Regeneration** **• An Introduction to Cell Motility and Migration** **• An Introduction to Developmental Genetics** **• An Introduction to Developmental Neurobiology** **• An Introduction to Molecular Developmental Biology** **• An Introduction to Organogenesis** **• An Introduction to Stem Cell Biology** **• C. elegans Development and Reproduction** **• Chick ex ovo Culture** **• Detecting Reactive Oxygen Species**

		• Development and Reproduction of the Laboratory Mouse • Development of the Chick • Diagnostic Necropsy and Tissue Harvest • 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 • Genetic Engineering of Model Organisms • Histological Sample Preparation for Light Microscopy • Histological Staining of Neural Tissue • In ovo Electroporation of Chicken Embryos • Induced Pluripotency • Murine In Utero Electroporation • Sterile Tissue Harvest • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Whole-Mount In Situ Hybridization • Zebrafish Reproduction and Development
INDICATOR / CLUSTER	III.2.e.	Compare the structure and function of organ systems in one organism to the structure and function in another organism (e.g., chicken to sheep digestive system; fern to peach reproductive system). <u>JoVE</u> • An Introduction to Aging and Regeneration • An Introduction to Behavioral Neuroscience • An Introduction to Caenorhabditis elegans • 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 • 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 • 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 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 • 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 / AREA OF LEARNING	**UT.IV.**	**Biology: Students will understand that genetic information coded in DNA is passed from parents to offspring by sexual and asexual reproduction. The basic structure of DNA is the same in all living things. Changes in DNA may alter genetic expression.**
OBJECTIVE / STRAND	**IV.1.**	**Compare sexual and asexual reproduction.**
INDICATOR / CLUSTER	**IV.1.a.**	**Explain the significance of meiosis and fertilization in genetic variation.** **JoVE** • An Introduction to Caenorhabditis elegans • An Introduction to Cell Division • An Introduction to Saccharomyces cerevisiae • An Introduction to the Chick: Gallus gallus domesticus • An Introduction to the Zebrafish: Danio rerio • C. elegans Development and Reproduction • Development and Reproduction of the Laboratory Mouse • Development of the Chick • Drosophila Development and Reproduction • Drosophila melanogaster Embryo and Larva Harvesting and Preparation • Fundamentals of Breeding and Weaning • Genetic Crosses • Genetic Screens • Recombineering and Gene Targeting • Yeast Maintenance • Yeast Reproduction • Zebrafish Breeding and Embryo Handling • Zebrafish Reproduction and Development

INDICATOR / CLUSTER	**IV.1.b.**	**Compare the advantages/disadvantages of sexual and asexual reproduction to survival of species.** **JoVE** **• An Introduction to Caenorhabditis elegans** **• An Introduction to Saccharomyces cerevisiae** **• An Introduction to the Chick: Gallus gallus domesticus** **• An Introduction to the Zebrafish: Danio rerio** **• An Overview of Genetic Analysis** **• C. elegans Development and Reproduction** **• Development and Reproduction of the Laboratory Mouse** **• Development of the Chick** **• Drosophila Development and Reproduction** **• Drosophila melanogaster Embryo and Larva Harvesting and Preparation** **• Fundamentals of Breeding and Weaning** **• Genetic Crosses** **• Genetic Screens** **• SNP Genotyping** **• Yeast Maintenance** **• Yeast Reproduction** **• Zebrafish Breeding and Embryo Handling** **• Zebrafish Maintenance and Husbandry** **• Zebrafish Reproduction and Development**
INDICATOR / CLUSTER	**IV.1.c.**	**Formulate, defend, and support a perspective of a bioethical issue related to intentional or unintentional chromosomal mutations.** **JoVE** **• An Introduction to Aging and Regeneration** **• An Introduction to Caenorhabditis elegans** **• An Introduction to Cell Death** **• An Introduction to Cell Division** **• An Introduction to Cell Metabolism** **• An Introduction to Cell Motility and Migration** **• An Introduction to Cognition** **• An Introduction to Developmental Genetics** **• An Introduction to Drosophila melanogaster** **• An Introduction to Endocytosis and Exocytosis** **• An Introduction to Modeling Behavioral Disorders and Stress** **• An Introduction to Molecular Developmental Biology** **• An Introduction to Motor Control** **• 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 Epigenetics** **• An Overview of Gene Expression** **• An Overview of Genetic Analysis** **• An Overview of Genetic Engineering** **• An Overview of Genetics and Disease** **• Bacterial Transformation: Electroporation** **• Bacterial Transformation: The Heat Shock Method** **• C. elegans Development and Reproduction** **• Cell Cycle Analysis** **• Chick ex ovo Culture** **• Chromatin Immunoprecipitation** **• Chromatography-Based Biomolecule Purification Methods** **• Coordination Chemistry Complexes** **• Cytogenetics** **• DNA Ligation Reactions** **• DNA Methylation Analysis** **• Detecting Reactive Oxygen Species** **• Development and Reproduction of the Laboratory Mouse** **• Development of the Chick** **• Ear Exam** **• Embryonic Stem Cell Culture and Differentiation** **• Explant Culture for Developmental Studies** **• Explant Culture of Neural Tissue** **• Expression Profiling with Microarrays** **• 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** **• Introducing Experimental Agents into the Mouse** **• Invasion Assay Using 3D Matrices** **• Invertebrate Lifespan Quantification** **• Isolating Nucleic Acids from Yeast** **• Live Cell Imaging of Mitosis** **• Lymph Node Exam** **• Male Rectal Exam** **• Molecular Cloning** **• Mouse Genotyping** **• Murine In Utero Electroporation** **• Neuronal Transfection Methods** **• Passaging Cells** **• Pelvic Exam II: Speculum Exam** **• Pelvic Exam III: Bimanual and Rectovaginal Exam**

		• Plasmid Purification • Primary Neuronal Cultures • RNAi in C. elegans • Recombineering and Gene Targeting • Restriction Enzyme Digests • Rodent Stereotaxic Surgery • SNP Genotyping • Solid-Liquid Extraction • Testing For Genetically Modified Foods • The TUNEL Assay • The Transwell Migration 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
STANDARD / AREA OF LEARNING	**UT.IV.**	**Biology: Students will understand that genetic information coded in DNA is passed from parents to offspring by sexual and asexual reproduction. The basic structure of DNA is the same in all living things. Changes in DNA may alter genetic expression.**
OBJECTIVE / STRAND	**IV.2.**	**Predict and interpret patterns of inheritance in sexually reproducing organisms.**
INDICATOR / CLUSTER	**IV.2.a.**	**Explain Mendel's laws of segregation and independent assortment and their role in genetic inheritance.** **JoVE** • Genetic Crosses
INDICATOR / CLUSTER	**IV.2.b.**	**Demonstrate possible results of recombination in sexually reproducing organisms using one or two pairs of contrasting traits in the following crosses: dominance/recessive, incomplete dominance, codominance, and sex-linked traits.** **JoVE** • An Introduction to Caenorhabditis elegans • An Introduction to Developmental Genetics • An Introduction to Drosophila melanogaster • An Overview of Epigenetics • An Overview of Genetic Analysis • An Overview of Genetics and Disease • C. elegans Development and Reproduction • DNA Methylation Analysis • Drosophila Development and Reproduction • Fundamentals of Breeding and Weaning • Genetic Crosses

		• Genetic Screens • Mouse Genotyping
INDICATOR / CLUSTER	IV.2.c.	Relate Mendelian principles to modern-day practice of plant and animal breeding. <u>JoVE</u> • 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 / CLUSTER	IV.2.d.	Analyze bioethical issues and consider the role of science in determining public policy.

		JoVE **• An Introduction to Aging and Regeneration** **• 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 Growth Curve Analysis and its Environmental Applications** **• Bacterial Transformation: Electroporation** **• Bacterial Transformation: The Heat Shock Method** **• Biofuels: Producing Ethanol from Cellulosic Material** **• C. elegans Development and Reproduction** **• Chick ex ovo Culture** **• Cyclic Voltammetry (CV)** **• 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** **• RNA Analysis of Environmental Samples Using RT-PCR** **• 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
STANDARD / AREA OF LEARNING	**UT.IV.**	**Biology: Students will understand that genetic information coded in DNA is passed from parents to offspring by sexual and asexual reproduction. The basic structure of DNA is the same in all living things. Changes in DNA may alter genetic expression.**
OBJECTIVE / STRAND	**IV.3.**	**Explain how the structure and replication of DNA are essential to heredity and protein synthesis.**
INDICATOR / CLUSTER	**IV.3.a.**	**Use a model to describe the structure of DNA.** **JoVE** • An Introduction to Caenorhabditis elegans • An Introduction to Cell Death • An Introduction to Cell Division • An Introduction to Cellular and Molecular Neuroscience • An Introduction to Developmental Genetics • An Introduction to Molecular Developmental Biology • An Introduction to Saccharomyces cerevisiae • An Introduction to Transfection • An Overview of Epigenetics • An Overview of Gene Expression • An Overview of Genetic Analysis • An Overview of Genetic Engineering • An Overview of Genetics and Disease • Annexin V and Propidium Iodide Labeling • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method • Cell Cycle Analysis • Chromatin Immunoprecipitation • Community DNA Extraction from Bacterial Colonies • Cytogenetics • DNA Gel Electrophoresis • DNA Ligation Reactions • DNA Methylation Analysis • Density Gradient Ultracentrifugation • Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis • Development and Reproduction of the Laboratory Mouse • Drosophila melanogaster Embryo and Larva Harvesting and Preparation

		• Electrophoretic Mobility Shift Assay (EMSA) • Embryonic Stem Cell Culture and Differentiation • Enzyme Assays and Kinetics • Explant Culture for Developmental Studies • Expression Profiling with Microarrays • Förster Resonance Energy Transfer (FRET) • Gel Purification • Gene Silencing with Morpholinos • Genetic Crosses • Genetic Engineering of Model Organisms • Genetic Screens • Genome Editing • In ovo Electroporation of Chicken Embryos • Induced Pluripotency • Isolating Nucleic Acids from Yeast • Live Cell Imaging of Mitosis • Molecular Cloning • Mouse Genotyping • PCR: The Polymerase Chain Reaction • Photometric Protein Determination • Plasmid Purification • Protein Crystallization • Quantifying Environmental Microorganisms and Viruses Using qPCR • RNA Analysis of Environmental Samples Using RT-PCR • RNA-Seq • Recombineering and Gene Targeting • Restriction Enzyme Digests • SNP Genotyping • Testing For Genetically Modified Foods • The TUNEL Assay • Two-Dimensional Gel Electrophoresis • Whole-Mount In Situ Hybridization • Yeast Maintenance • Yeast Transformation and Cloning • Zebrafish Breeding and Embryo Handling
INDICATOR / CLUSTER	IV.3.b.	Explain the importance of DNA replication in cell reproduction. JoVE • An Introduction to Cell Division • Cell Cycle Analysis • DNA Ligation Reactions • Genetic Screens • Live Cell Imaging of Mitosis • Method of Standard Addition • Molecular Cloning • PCR: The Polymerase Chain Reaction • Restriction Enzyme Digests • Yeast Maintenance • Yeast Transformation and Cloning

INDICATOR / CLUSTER	**IV.3.c.**	**Summarize how genetic information encoded in DNA provides instructions for assembling protein molecules.** **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 / CLUSTER	**IV.3.d.**	**Describe how mutations may affect genetic expression and cite examples of mutagens.** **JoVE** **• An Introduction to Aging and Regeneration** **• An Introduction to Caenorhabditis elegans** **• An Introduction to Cell Death** **• An Introduction to Cell Division** **• An Introduction to Developmental Genetics** **• An Introduction to Drosophila melanogaster** **• An Introduction to Modeling Behavioral Disorders and Stress** **• An Introduction to Saccharomyces cerevisiae** **• An Introduction to Transfection** **• An Introduction to the Zebrafish: Danio rerio** **• An Overview of Epigenetics** **• An Overview of Gene Expression** **• An Overview of Genetic Analysis** **• An Overview of Genetics and Disease** **• Genetic Engineering of Model Organisms** **• Genetic Screens** **• Isolating Nucleic Acids from Yeast** **• Passaging Cells** **• The TUNEL Assay**
INDICATOR / CLUSTER	**IV.3.e.**	**Relate the historical events that lead to our present understanding of DNA to the cumulative nature of science knowledge and technology.** **JoVE** **• An Introduction to Developmental Genetics** **• An Overview of Gene Expression**

		• An Overview of Genetic Analysis • An Overview of Genetic Engineering
INDICATOR / CLUSTER	**IV.3.f.**	**Research, report, and debate genetic technologies that may improve the quality of life (e.g., genetic engineering, cloning, gene splicing).** **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
STANDARD / AREA OF LEARNING	**UT.V.**	**Biology: Students will understand that biological diversity is a result of evolutionary processes.**
OBJECTIVE / STRAND	**V.1.**	**Relate principles of evolution to biological diversity.**
INDICATOR / CLUSTER	**V.1.a.**	**Describe the effects of environmental factors on natural selection.** **JoVE** • An Overview of Genetic Analysis
INDICATOR / CLUSTER	**V.1.b.**	**Relate genetic variability to a species' potential for adaptation to a changing environment.** **JoVE** • An Overview of Genetic Analysis • C. elegans Development and Reproduction • SNP Genotyping • Yeast Reproduction • Zebrafish Maintenance and Husbandry
INDICATOR / CLUSTER	**V.1.d.**	**Compare selective breeding to natural selection and relate the differences to agricultural practices.** **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
STANDARD / AREA OF LEARNING	**UT.V.**	**Biology: Students will understand that biological diversity is a result of evolutionary processes.**
OBJECTIVE / STRAND	**V.2.**	**Cite evidence for changes in populations over time and use concepts of evolution to explain these changes.**
INDICATOR / CLUSTER	V.2.a.	Cite evidence that supports biological evolution over time (e.g., geologic and fossil records, chemical mechanisms, DNA structural similarities, homologous and vestigial structures). 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 / CLUSTER	V.2.b.	Identify the role of mutation and recombination in evolution.

		JoVE • An Introduction to the Chick: Gallus gallus domesticus • An Overview of Genetic Analysis
INDICATOR / CLUSTER	V.2.c.	Relate the nature of science to the historical development of the theory of evolution. JoVE • An Overview of Genetic Analysis
INDICATOR / CLUSTER	V.2.d.	Distinguish between observations and inferences in making interpretations related to evolution (e.g., observed similarities and differences in the beaks of Galapagos finches leads to the inference that they evolved from a common ancestor; observed similarities and differences in the structures of birds and reptiles leads to the inference that birds evolved from reptiles). 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 / CLUSTER	V.2.e.	Review a scientific article and identify the research methods used to gather evidence that documents the evolution of a species. JoVE • An Introduction to the Chick: Gallus gallus domesticus • An Overview of Genetic Analysis • High-Performance Liquid Chromatography (HPLC)
STANDARD / AREA OF LEARNING	UT.V.	Biology: Students will understand that biological diversity is a result of evolutionary processes.
OBJECTIVE / STRAND	V.3.	Classify organisms into a hierarchy of groups based on similarities that reflect their evolutionary relationships.
INDICATOR / CLUSTER	V.3.a.	Classify organisms using a classification tool such as a key or field guide. JoVE • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method • DNA Gel Electrophoresis • Gel Purification • Plasmid Purification • Separating Protein with SDS-PAGE

		• The ELISA Method • The Western Blot • Tree Identification: How To Use a Dichotomous Key • Using GIS to Investigate Urban Forestry
INDICATOR / CLUSTER	V.3.b.	Generalize criteria used for classification of organisms (e.g., dichotomy, structure, broad to specific). <u>JoVE</u> • 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 • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method • 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 • DNA Gel Electrophoresis • 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 • Gel Purification • In ovo Electroporation of Chicken Embryos • Introducing Experimental Agents into the Mouse • Isolating Nucleic Acids from Yeast • Mouse Genotyping • Plasmid Purification • RNAi in C. elegans • Separating Protein with SDS-PAGE • The ELISA Method • The Western Blot • Tree Identification: How To Use a Dichotomous Key • Tree Survey: Point-Centered Quarter Sampling Method • Using GIS to Investigate Urban Forestry • 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 / CLUSTER	V.3.c.	Explain how evolutionary relationships are related to classification systems. JoVE • An Introduction to the Chick: Gallus gallus domesticus • An Introduction to the Zebrafish: Danio rerio
INDICATOR / CLUSTER	V.3.d.	Justify the ongoing changes to classification schemes used in biology. 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 • 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 • In ovo Electroporation of Chicken Embryos • Introducing Experimental Agents into the Mouse • Isolating Nucleic Acids from Yeast • Mouse Genotyping • RNAi in C. elegans • Tree Identification: How To Use a Dichotomous Key • Tree Survey: Point-Centered Quarter Sampling Method • Using GIS to Investigate Urban Forestry • Yeast Maintenance • Yeast Reproduction • Yeast Transformation and Cloning • Zebrafish Breeding and Embryo Handling • Zebrafish Maintenance and Husbandry

		• Zebrafish Microinjection Techniques • Zebrafish Reproduction and Development
STANDARD / AREA OF LEARNING	**UT.1.**	**Chemistry: Intended Learning Outcome: Use Science Process and Thinking Skills.**
OBJECTIVE / STRAND	1.d.	Select and use appropriate technological instruments to collect and analyze data. JoVE • An Introduction to the Micropipettor • Common Lab Glassware and Uses • Determining the Density of a Solid and Liquid • Introduction to Serological Pipettes and Pipettors • Introduction to the Microplate Reader • Introduction to the Spectrophotometer • Making Solutions in the Laboratory • Measuring Mass in the Laboratory • Regulating Temperature in the Lab: Applying Heat • Regulating Temperature in the Lab: Preserving Samples Using Cold • Understanding Concentration and Measuring Volumes
OBJECTIVE / STRAND	1.e.	Plan and conduct experiments in which students may: Identify a problem; Formulate research questions and hypotheses; Predict results of investigations based upon prior data; Identify variables and describe the relationships between them; Plan procedures to control independent variables; Collect data on the dependent variable(s); Select the appropriate format (e.g., graph, chart, diagram) and use it to summarize the data obtained; Analyze data, check it for accuracy and construct reasonable conclusions; Prepare written and oral reports of investigations. JoVE • Calibration Curves • Capillary Electrophoresis (CE) • Chromatography-Based Biomolecule Purification Methods • Cyclic Voltammetry (CV) • Density Gradient Ultracentrifugation • Dialysis: Diffusion Based Separation • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Gas Chromatography (GC) with Flame-Ionization Detection • High-Performance Liquid Chromatography (HPLC) • Internal Standards • Introduction to Mass Spectrometry • Ion-Exchange Chromatography • Method of Standard Addition • Preparing Anhydrous Reagents and Equipment

		• Protein Crystallization • Raman Spectroscopy for Chemical Analysis • Sample Preparation for Analytical Preparation • Scanning Electron Microscopy (SEM) • Two-Dimensional Gel Electrophoresis • X-ray Fluorescence (XRF)
OBJECTIVE / STRAND	1.g.	Develop and use classification systems. JoVE • 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
OBJECTIVE / STRAND	1.i.	Use mathematics as a precise method for showing relationships. 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 • 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 • Introduction to the Microplate Reader • Introduction to the Spectrophotometer • Ion-Exchange Chromatography • Le Châtelier's Principle • MALDI-TOF Mass Spectrometry • Making Solutions in the Laboratory • 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 • Understanding Concentration and Measuring Volumes • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy • Using a pH Meter • X-ray Fluorescence (XRF)
STANDARD / AREA OF LEARNING	**UT.2.**	**Chemistry: Intended Learning Outcome: Manifest Scientific Attitudes and Interests.**
OBJECTIVE / STRAND	**2.d.**	**Accept responsibility for actively helping to resolve social, ethical and ecological problems related to science and technology.** **JoVE** • Calibration Curves • Capillary Electrophoresis (CE) • Chromatography-Based Biomolecule Purification Methods • Co-Immunoprecipitation and Pull-Down Assays • Cyclic Voltammetry (CV) • Density Gradient Ultracentrifugation • 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 • Freezing-Point Depression to Determine an Unknown Compound • Förster Resonance Energy Transfer (FRET) • Gas Chromatography (GC) with Flame-Ionization Detection • High-Performance Liquid Chromatography (HPLC) • Internal Standards • Introduction to Mass Spectrometry • Ion-Exchange Chromatography • Le Châtelier's Principle • MALDI-TOF Mass Spectrometry • Metabolic Labeling • Method of Standard Addition • Nuclear Magnetic Resonance (NMR) Spectroscopy • Photometric Protein Determination • Protein Crystallization • Proton Exchange Membrane Fuel Cells • Raman Spectroscopy for Chemical Analysis • Reconstitution of Membrane Proteins • Sample Preparation for Analytical Preparation • Scanning Electron Microscopy (SEM) • Solid-Liquid Extraction • Surface Plasmon Resonance (SPR) • Tandem Mass Spectrometry • Two-Dimensional Gel Electrophoresis

		• Ultraviolet-Visible (UV-Vis) Spectroscopy • Using a pH Meter • X-ray Fluorescence (XRF)
OBJECTIVE / STRAND	2.e.	Evaluate scientifically related claims against available evidence. <u>JoVE</u> • Calibration Curves • Capillary Electrophoresis (CE) • Chromatography-Based Biomolecule Purification Methods • Cyclic Voltammetry (CV) • Density Gradient Ultracentrifugation • Dialysis: Diffusion Based Separation • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Gas Chromatography (GC) with Flame-Ionization Detection • High-Performance Liquid Chromatography (HPLC) • Internal Standards • Introduction to Mass Spectrometry • Ion-Exchange Chromatography • Method of Standard Addition • Preparing Anhydrous Reagents and Equipment • Protein Crystallization • Raman Spectroscopy for Chemical Analysis • Sample Preparation for Analytical Preparation • Scanning Electron Microscopy (SEM) • Two-Dimensional Gel Electrophoresis • X-ray Fluorescence (XRF)
OBJECTIVE / STRAND	2.f.	Reject pseudoscience as a source of scientific knowledge. <u>JoVE</u> • Calibration Curves • Capillary Electrophoresis (CE) • Chromatography-Based Biomolecule Purification Methods • Cyclic Voltammetry (CV) • Density Gradient Ultracentrifugation • Dialysis: Diffusion Based Separation • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Gas Chromatography (GC) with Flame-Ionization Detection • High-Performance Liquid Chromatography (HPLC) • Internal Standards • Introduction to Mass Spectrometry • Ion-Exchange Chromatography • Method of Standard Addition • Preparing Anhydrous Reagents and Equipment • Protein Crystallization

		• Raman Spectroscopy for Chemical Analysis • Sample Preparation for Analytical Preparation • Scanning Electron Microscopy (SEM) • Two-Dimensional Gel Electrophoresis • X-ray Fluorescence (XRF)
STANDARD / AREA OF LEARNING	**UT.3.**	**Chemistry: Intended Learning Outcome: Demonstrate Understanding of Science Concepts, Principles and Systems.**
OBJECTIVE / STRAND	**3.c.**	**Apply principles and concepts of science to explain various phenomena.** **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 • 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 • Introduction to the Microplate Reader • Introduction to the Spectrophotometer

		• Ion-Exchange Chromatography • Le Châtelier's Principle • MALDI-TOF Mass Spectrometry • Making Solutions in the Laboratory • 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 • Understanding Concentration and Measuring Volumes • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy • Using a pH Meter • X-ray Fluorescence (XRF)
OBJECTIVE / STRAND	3.d.	Solve problems by applying science principles and procedures. <u>JoVE</u> • 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 • 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 • Introduction to the Microplate Reader • Introduction to the Spectrophotometer • Ion-Exchange Chromatography • Le Châtelier's Principle • MALDI-TOF Mass Spectrometry • Making Solutions in the Laboratory • 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 • Understanding Concentration and Measuring Volumes • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy • Using a pH Meter • X-ray Fluorescence (XRF)
STANDARD / AREA OF LEARNING	**UT.4.**	**Chemistry: Intended Learning Outcome: Communicate Effectively Using Science Language and Reasoning.**
OBJECTIVE / STRAND	**4.b.**	**Use precise scientific language in oral and written communication.** **JoVE** • An Introduction to the Centrifuge • An Introduction to the Micropipettor • 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 Serological Pipettes and Pipettors • Introduction to Titration • Introduction to the Microplate Reader • Introduction to the Spectrophotometer • Ion-Exchange Chromatography • Le Châtelier's Principle • MALDI-TOF Mass Spectrometry • Making Solutions in the Laboratory • Measuring Mass in the Laboratory • 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 • Regulating Temperature in the Lab: Applying Heat • Regulating Temperature in the Lab: Preserving Samples Using Cold • 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 • Understanding Concentration and Measuring Volumes • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy • Using a pH Meter • X-ray Fluorescence (XRF)
OBJECTIVE / STRAND	4.e.	Use mathematical language and reasoning to communicate information. 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** **• 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** **• Introduction to the Microplate Reader** **• Introduction to the Spectrophotometer** **• Ion-Exchange Chromatography** **• Le Châtelier's Principle** **• MALDI-TOF Mass Spectrometry** **• Making Solutions in the Laboratory** **• 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 • Understanding Concentration and Measuring Volumes • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy • Using a pH Meter • X-ray Fluorescence (XRF)
STANDARD / AREA OF LEARNING	**UT.5.**	**Chemistry: Intended Learning Outcome: Demonstrate Awareness of Social and Historical Aspects of Science.**
OBJECTIVE / STRAND	**5.a.**	**Cite examples of how science affects human life.** **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 Differential Scanning Calorimetry to Measure Changes in Enthalpy** **• Using a pH Meter** **• X-ray Fluorescence (XRF)**
OBJECTIVE / STRAND	**5.b.**	**Give instances of how technological advances have influenced the progress of science and how science has influenced advances in technology.** **JoVE** **• An Introduction to the Micropipettor** **• 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 Serological Pipettes and Pipettors • Introduction to Titration • Introduction to the Spectrophotometer • Ion-Exchange Chromatography • Le Châtelier's Principle • MALDI-TOF Mass Spectrometry • Making Solutions in the Laboratory • Measuring Mass in the Laboratory • 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 • Proton Exchange Membrane Fuel Cells • Purifying Compounds by Recrystallization • Raman Spectroscopy for Chemical Analysis • Reconstitution of Membrane Proteins • Regulating Temperature in the Lab: Applying Heat

		• Regulating Temperature in the Lab: Preserving Samples Using Cold • 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 • Understanding Concentration and Measuring Volumes • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy • Using a pH Meter • X-ray Fluorescence (XRF)
OBJECTIVE / STRAND	5.c.	Understand the cumulative nature of scientific knowledge. JoVE • Le Châtelier's Principle • Rotary Evaporation to Remove Solvent
OBJECTIVE / STRAND	5.d.	Recognize contributions to science knowledge that have been made by both women and men. JoVE • Ideal Gas Law • Rotary Evaporation to Remove Solvent • The Ideal Gas Law
STANDARD / AREA OF LEARNING	UT.6.	Chemistry: Intended Learning Outcome: Demonstrate Understanding of the Nature of Science.
OBJECTIVE / STRAND	6.i.	Understand that science and technology may raise ethical issues for which science, by itself, does not provide solutions. JoVE • Determining the Solubility Rules of Ionic Compounds • Freezing-Point Depression to Determine an Unknown Compound • Introduction to Mass Spectrometry • Le Châtelier's Principle • Solid-Liquid Extraction • Using a pH Meter
STANDARD / AREA OF LEARNING	UT.I.	Chemistry: Students will understand that all matter in the universe has a common origin and is made of atoms,

		which have structure and can be systematically arranged on the periodic table.
OBJECTIVE / STRAND	I.1.	Recognize the origin and distribution of elements in the universe.
INDICATOR / CLUSTER	I.1.b.	Recognize that all matter in the universe and on earth is composed of the same elements. JoVE • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium
INDICATOR / CLUSTER	I.1.c.	Identify the distribution of elements in the universe. JoVE • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium
STANDARD / AREA OF LEARNING	UT.I.	Chemistry: Students will understand that all matter in the universe has a common origin and is made of atoms, which have structure and can be systematically arranged on the periodic table.
OBJECTIVE / STRAND	I.2.	Relate the structure, behavior, and scale of an atom to the particles that compose it.
INDICATOR / CLUSTER	I.2.b.	Evaluate the limitations of using models to describe atoms. JoVE • Determining the Empirical Formula
INDICATOR / CLUSTER	I.2.c.	Discriminate between the relative size, charge, and position of protons, neutrons, and electrons in the atom. JoVE • Coordination Chemistry Complexes • Scanning Electron Microscopy (SEM) • X-ray Fluorescence (XRF)
INDICATOR / CLUSTER	I.2.e.	Relate the mass and number of atoms to the gram-sized quantities of matter in a mole. JoVE • Ideal Gas Law • The Ideal Gas Law
STANDARD / AREA OF LEARNING	UT.I.	Chemistry: Students will understand that all matter in the universe has a common origin and is made of atoms, which have structure and can be systematically arranged on the periodic table.

OBJECTIVE / STRAND	**I.3.**	**Correlate atomic structure and the physical and chemical properties of an element to the position of the element on the periodic table.**
INDICATOR / CLUSTER	**I.3.b.**	**Compare the number of protons and neutrons in isotopes of the same element.** **JoVE** **• Metabolic Labeling**
INDICATOR / CLUSTER	**I.3.c.**	**Identify similarities in chemical behavior of elements within a group.** **JoVE** **• Coordination Chemistry Complexes**
INDICATOR / CLUSTER	**I.3.d.**	**Generalize trends in reactivity of elements within a group to trends in other groups.** **JoVE** **• Coordination Chemistry Complexes**
INDICATOR / CLUSTER	**I.3.e.**	**Compare the properties of elements (e.g., metal, nonmetallic, metalloid) based on their position in the periodic table.** **JoVE** **• Coordination Chemistry Complexes** **• Surface Plasmon Resonance (SPR)**
STANDARD / AREA OF LEARNING	**UT.II.**	**Chemistry: Students will understand the relationship between energy changes in the atom specific to the movement of electrons between energy levels in an atom resulting in the emission or absorption of quantum energy. They will also understand that the emission of high-energy particles results from nuclear changes and that matter can be converted to energy during nuclear reactions.**
OBJECTIVE / STRAND	**II.1.**	**Evaluate quantum energy changes in the atom in terms of the energy contained in light emissions.**
INDICATOR / CLUSTER	**II.1.a.**	**Identify the relationship between wavelength and light energy.** **JoVE** **• Coordination Chemistry Complexes** **• Förster Resonance Energy Transfer (FRET)** **• Gas Chromatography (GC) with Flame-Ionization Detection** **• Introduction to Fluorescence Microscopy** **• Introduction to the Microplate Reader** **• Lead Analysis of Soil Using Atomic Absorption Spectroscopy** **• MALDI-TOF Mass Spectrometry** **• Method of Standard Addition**

		• Nuclear Magnetic Resonance (NMR) Spectroscopy • Raman Spectroscopy for Chemical Analysis • Tandem Mass Spectrometry • X-ray Fluorescence (XRF)
INDICATOR / CLUSTER	II.1.b.	Examine evidence from the lab indicating that energy is absorbed or released in discrete units when electrons move from one energy level to another. <u>JoVE</u> • Coordination Chemistry Complexes • Förster Resonance Energy Transfer (FRET) • Gas Chromatography (GC) with Flame-Ionization Detection • Introduction to Fluorescence Microscopy • Introduction to the Microplate Reader • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • MALDI-TOF Mass Spectrometry • Method of Standard Addition • Nuclear Magnetic Resonance (NMR) Spectroscopy • Raman Spectroscopy for Chemical Analysis • Tandem Mass Spectrometry • X-ray Fluorescence (XRF)
INDICATOR / CLUSTER	II.1.c.	Correlate the energy in a photon to the color of light emitted. <u>JoVE</u> • Coordination Chemistry Complexes • Förster Resonance Energy Transfer (FRET) • Gas Chromatography (GC) with Flame-Ionization Detection • Introduction to Fluorescence Microscopy • Introduction to the Microplate Reader • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • MALDI-TOF Mass Spectrometry • Method of Standard Addition • Nuclear Magnetic Resonance (NMR) Spectroscopy • Raman Spectroscopy for Chemical Analysis • Tandem Mass Spectrometry • X-ray Fluorescence (XRF)
INDICATOR / CLUSTER	II.1.d.	After observing spectral emissions in the lab (e.g., flame test, spectrum tubes), identify unknown elements by comparison to known emission spectra. <u>JoVE</u> • Coordination Chemistry Complexes • Förster Resonance Energy Transfer (FRET) • Gas Chromatography (GC) with Flame-Ionization Detection

		• Introduction to Fluorescence Microscopy • Introduction to the Microplate Reader • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • MALDI-TOF Mass Spectrometry • Method of Standard Addition • Nuclear Magnetic Resonance (NMR) Spectroscopy • Raman Spectroscopy for Chemical Analysis • Tandem Mass Spectrometry • X-ray Fluorescence (XRF)
STANDARD / AREA OF LEARNING	UT.II.	Chemistry: Students will understand the relationship between energy changes in the atom specific to the movement of electrons between energy levels in an atom resulting in the emission or absorption of quantum energy. They will also understand that the emission of high-energy particles results from nuclear changes and that matter can be converted to energy during nuclear reactions.
OBJECTIVE / STRAND	II.2.	Evaluate how changes in the nucleus of an atom result in emission of radioactivity.
INDICATOR / CLUSTER	II.2.b.	Interpret graphical data relating half-life and age of a radioactive substance. JoVE • Determining Rate Laws and the Order of Reaction
STANDARD / AREA OF LEARNING	UT.III.	Chemistry: Students will understand chemical bonding and the relationship of the type of bonding to the chemical and physical properties of substances.
OBJECTIVE / STRAND	III.1.	Analyze the relationship between the valence (outermost) electrons of an atom and the type of bond formed between atoms.
INDICATOR / CLUSTER	III.1.a.	Determine the number of valence electrons in atoms using the periodic table. JoVE • Coordination Chemistry Complexes
INDICATOR / CLUSTER	III.1.b.	Predict the charge an atom will acquire when it forms an ion by gaining or losing electrons. JoVE • Capillary Electrophoresis (CE) • Chromatography-Based Biomolecule Purification Methods • Determining the Solubility Rules of Ionic Compounds • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Electrophoretic Mobility Shift Assay (EMSA) • Introduction to Mass Spectrometry • Ion-Exchange Chromatography

		• MALDI-TOF Mass Spectrometry • Tandem Mass Spectrometry • Two-Dimensional Gel Electrophoresis
INDICATOR / CLUSTER	III.1.c.	Predict bond types based on the behavior of valence (outermost) electrons. JoVE • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Chromatography-Based Biomolecule Purification Methods • Column Chromatography • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis • Determining the Solubility Rules of Ionic Compounds • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Gas Chromatography (GC) with Flame-Ionization Detection • Growing Crystals for X-ray Diffraction Analysis • High-Performance Liquid Chromatography (HPLC) • Ion-Exchange Chromatography • Performing 1D Thin Layer Chromatography • Preparing Anhydrous Reagents and Equipment • Purification of a Total Lipid Extract with Column Chromatography • Purifying Compounds by Recrystallization • Reconstitution of Membrane Proteins • Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry • Solid-Liquid Extraction • Solutions and Concentrations • Sonication Extraction of Lipid Biomarkers from Sediment • Soxhlet Extraction of Lipid Biomarkers from Sediment • Ultraviolet-Visible (UV-Vis) Spectroscopy • X-ray Fluorescence (XRF)
INDICATOR / CLUSTER	III.1.d.	Compare covalent, ionic, and metallic bonds with respect to electron behavior and relative bond strengths. JoVE • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry

		• Determining the Solubility Rules of Ionic Compounds • 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 • Ultraviolet-Visible (UV-Vis) Spectroscopy • X-ray Fluorescence (XRF)
STANDARD / AREA OF LEARNING	**UT.III.**	**Chemistry: Students will understand chemical bonding and the relationship of the type of bonding to the chemical and physical properties of substances.**
OBJECTIVE / STRAND	**III.2.**	**Explain that the properties of a compound may be different from those of the elements or compounds from which it is formed.**
INDICATOR / CLUSTER	III.2.a.	Use a chemical formula to represent the names of elements and numbers of atoms in a compound and recognize that the formula is unique to the specific compound. JoVE • Determining the Empirical Formula
INDICATOR / CLUSTER	III.2.b.	Compare the physical properties of a compound to the elements that form it. JoVE • Chromatography-Based Biomolecule Purification Methods • Column Chromatography • Coordination Chemistry Complexes • Determining the Empirical Formula • Determining the Solubility Rules of Ionic Compounds • Dialysis: Diffusion Based Separation • Electrophoretic Mobility Shift Assay (EMSA) • Freezing-Point Depression to Determine an Unknown Compound • Growing Crystals for X-ray Diffraction Analysis • Introduction to Catalysis • Performing 1D Thin Layer Chromatography • Physical Properties Of Minerals I: Crystals and Cleavage • Physical Properties Of Minerals II: Polymineralic Analysis • Protein Crystallization • Purifying Compounds by Recrystallization • Reconstitution of Membrane Proteins • Separation of Mixtures via Precipitation

INDICATOR / CLUSTER	III.2.c.	Compare the chemical properties of a compound to the elements that form it. JoVE • Chromatography-Based Biomolecule Purification Methods • Column Chromatography • Determining the Empirical Formula • Determining the Solubility Rules of Ionic Compounds • Dialysis: Diffusion Based Separation • Freezing-Point Depression to Determine an Unknown Compound • Growing Crystals for X-ray Diffraction Analysis • Performing 1D Thin Layer Chromatography • Purifying Compounds by Recrystallization • Separation of Mixtures via Precipitation
INDICATOR / CLUSTER	III.2.d.	Explain that combining elements in different proportions results in the formation of different compounds with different properties. JoVE • Chromatography-Based Biomolecule Purification Methods • Column Chromatography • Determining the Empirical Formula • Determining the Solubility Rules of Ionic Compounds • Dialysis: Diffusion Based Separation • Freezing-Point Depression to Determine an Unknown Compound • Growing Crystals for X-ray Diffraction Analysis • Performing 1D Thin Layer Chromatography • Purifying Compounds by Recrystallization • Separation of Mixtures via Precipitation
STANDARD / AREA OF LEARNING	UT.III.	Chemistry: Students will understand chemical bonding and the relationship of the type of bonding to the chemical and physical properties of substances.
OBJECTIVE / STRAND	III.3.	Relate the properties of simple compounds to the type of bonding, shape of molecules, and intermolecular forces.
INDICATOR / CLUSTER	III.3.a.	Generalize, from investigations, the physical properties (e.g., malleability, conductivity, solubility) of substances with different bond types. JoVE • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Chromatography-Based Biomolecule Purification Methods • Column Chromatography

		• Conducting Reactions Below Room Temperature • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Coordination Chemistry Complexes • Degassing Liquids with Freeze-Pump-Thaw Cycling • Density Gradient Ultracentrifugation • Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis • 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 • Fractional Distillation • Gas Chromatography (GC) with Flame-Ionization Detection • Growing Crystals for X-ray Diffraction Analysis • High-Performance Liquid Chromatography (HPLC) • Introduction to Catalysis • Ion-Exchange Chromatography • MALDI-TOF Mass Spectrometry • Nuclear Magnetic Resonance (NMR) Spectroscopy • 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 • 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 • Tandem Mass Spectrometry • Two-Dimensional Gel Electrophoresis • Ultraviolet-Visible (UV-Vis) Spectroscopy • X-ray Fluorescence (XRF)
INDICATOR / CLUSTER	III.3.b.	Given a model, describe the shape and resulting polarity of water, ammonia, and methane molecules. JoVE • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology

		• Chromatography-Based Biomolecule Purification Methods • Column Chromatography • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Gas Chromatography (GC) with Flame-Ionization Detection • Growing Crystals for X-ray Diffraction Analysis • High-Performance Liquid Chromatography (HPLC) • Ion-Exchange Chromatography • Performing 1D Thin Layer Chromatography • Preparing Anhydrous Reagents and Equipment • Proton Exchange Membrane Fuel Cells • 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 • Ultraviolet-Visible (UV-Vis) Spectroscopy
INDICATOR / CLUSTER	III.3.c.	Identify how intermolecular forces of hydrogen bonds in water affect a variety of physical, chemical, and biological phenomena (e.g., surface tension, capillary action, boiling point). JoVE • High-Performance Liquid Chromatography (HPLC) • Preparing Anhydrous Reagents and Equipment • Proton Exchange Membrane Fuel Cells
STANDARD / AREA OF LEARNING	UT.IV.	Chemistry: Students will understand that in chemical reactions matter and energy change forms, but the amounts of matter and energy do not change.
OBJECTIVE / STRAND	IV.1.	Identify evidence of chemical reactions and demonstrate how chemical equations are used to describe them.
INDICATOR / CLUSTER	IV.1.a.	Generalize evidences of chemical reactions. JoVE • An Introduction to Cell Metabolism • Cyclic Voltammetry (CV) • Detecting Reactive Oxygen Species • Enzyme Assays and Kinetics

		• Introduction to Titration • Le Châtelier's Principle • Passaging Cells • Physical Properties Of Minerals II: Polymineralic Analysis • Proton Exchange Membrane Fuel Cells • Spectrophotometric Determination of an Equilibrium Constant • The ATP Bioluminescence Assay • The ELISA Method
INDICATOR / CLUSTER	IV.1.b.	Compare the properties of reactants to the properties of products in a chemical reaction. 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 / CLUSTER	IV.1.c.	Use a chemical equation to describe a simple chemical reaction. 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 / CLUSTER	IV.1.d.	Recognize that the number of atoms in a chemical reaction does not change. 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 / CLUSTER	IV.1.e.	Determine the molar proportions of the reactants and products in a balanced chemical reaction. JoVE • Assembly of a Reflux System for Heated Chemical Reactions • Calibration Curves • Capillary Electrophoresis (CE) • 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 • Freezing-Point Depression to Determine an Unknown Compound • Ideal Gas Law • Internal Standards • Introduction to Catalysis • Introduction to Titration • Introduction to the Microplate Reader • Le Châtelier's Principle • Making Solutions in the Laboratory • Photometric Protein Determination • Preparing Anhydrous Reagents and Equipment • Proton Exchange Membrane Fuel Cells • Sample Preparation for Analytical Preparation • Solutions and Concentrations

		• Spectrophotometric Determination of an Equilibrium Constant • The Ideal Gas Law • Understanding Concentration and Measuring Volumes • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy
INDICATOR / CLUSTER	IV.1.f.	Investigate everyday chemical reactions that occur in a student's home (e.g., baking, rusting, bleaching, cleaning). JoVE • 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
STANDARD / AREA OF LEARNING	UT.IV.	Chemistry: Students will understand that in chemical reactions matter and energy change forms, but the amounts of matter and energy do not change.
OBJECTIVE / STRAND	IV.2.	Analyze evidence for the laws of conservation of mass and conservation of energy in chemical reactions.
INDICATOR / CLUSTER	IV.2.a.	Using data from quantitative analysis, identify evidence that supports the conservation of mass in a chemical reaction. JoVE • Determining the Empirical Formula
INDICATOR / CLUSTER	IV.2.c.	Report evidence of energy transformations in a chemical reaction. JoVE • 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 / CLUSTER	IV.2.d.	After observing or measuring, classify evidence of temperature change in a chemical reaction as endothermic or exothermic. JoVE • 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 / CLUSTER	IV.2.e.	Using either a constructed or a diagrammed electrochemical cell, describe how electrical energy can be produced in a chemical reaction (e.g., half reaction, electron transfer). JoVE • Calibration Curves • Cyclic Voltammetry (CV) • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Proton Exchange Membrane Fuel Cells
INDICATOR / CLUSTER	IV.2.f.	Using collected data, report the loss or gain of heat energy in a chemical reaction. JoVE • 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
STANDARD / AREA OF LEARNING	UT.V.	Chemistry: Students will understand that many factors influence chemical reactions and some reactions can achieve a state of dynamic equilibrium.
OBJECTIVE / STRAND	V.1.	Evaluate factors specific to collisions (e.g., temperature, particle size, concentration, and catalysts) that affect the rate of chemical reaction.
INDICATOR / CLUSTER	V.1.a.	Design and conduct an investigation of the factors affecting reaction rate and use the findings to generalize the results to other reactions. JoVE • Conducting Reactions Below Room Temperature • Coordination Chemistry Complexes • Determining Rate Laws and the Order of Reaction • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat

		• Enzyme Assays and Kinetics • Introduction to Catalysis
INDICATOR / CLUSTER	V.1.b.	Use information from graphs to draw warranted conclusions about reaction rates. JoVE • Conducting Reactions Below Room Temperature • Coordination Chemistry Complexes • Determining Rate Laws and the Order of Reaction • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Enzyme Assays and Kinetics • Introduction to Catalysis
INDICATOR / CLUSTER	V.1.c.	Correlate frequency and energy of collisions to reaction rate. JoVE • Conducting Reactions Below Room Temperature • Determining Rate Laws and the Order of Reaction • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Enzyme Assays and Kinetics • Introduction to Catalysis
INDICATOR / CLUSTER	V.1.d.	Identify that catalysts are effective in increasing reaction rates. JoVE • Coordination Chemistry Complexes • Determining Rate Laws and the Order of Reaction • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Enzyme Assays and Kinetics • Introduction to Catalysis
STANDARD / AREA OF LEARNING	UT.V.	Chemistry: Students will understand that many factors influence chemical reactions and some reactions can achieve a state of dynamic equilibrium.
OBJECTIVE / STRAND	V.2.	Recognize that certain reactions do not convert all reactants to products, but achieve a state of dynamic equilibrium that can be changed.
INDICATOR / CLUSTER	V.2.a.	Explain the concept of dynamic equilibrium. JoVE • Assembly of a Reflux System for Heated Chemical Reactions • Le Châtelier's Principle • Spectrophotometric Determination of an Equilibrium Constant
INDICATOR / CLUSTER	V.2.b.	Given an equation, identify the effect of adding either product or reactant to a shift in equilibrium.

		JoVE • Assembly of a Reflux System for Heated Chemical Reactions • Le Châtelier's Principle • Spectrophotometric Determination of an Equilibrium Constant
INDICATOR / CLUSTER	V.2.c.	Indicate the effect of a temperature change on the equilibrium, using an equation showing a heat term. JoVE • Assembly of a Reflux System for Heated Chemical Reactions • Le Châtelier's Principle • Spectrophotometric Determination of an Equilibrium Constant • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy
STANDARD / AREA OF LEARNING	UT.VI.	Chemistry: Students will understand the properties that describe solutions in terms of concentration, solutes, solvents, and the behavior of acids and bases.
OBJECTIVE / STRAND	VI.1.	Describe factors affecting the process of dissolving and evaluate the effects that changes in concentration have on solutions.
INDICATOR / CLUSTER	VI.1.a.	Use the terms solute and solvent in describing a solution. 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 • 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 • Internal Standards • Introduction to Serological Pipettes and Pipettors • Introduction to the Microplate Reader • Ion-Exchange Chromatography • Making Solutions in the Laboratory • Method of Standard Addition • 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 • Rotary Evaporation to Remove Solvent • Sample Preparation for Analytical Preparation • Schlenk Lines Transfer of Solvents • Solid-Liquid Extraction • Sonication Extraction of Lipid Biomarkers from Sediment • Soxhlet Extraction of Lipid Biomarkers from Sediment • Understanding Concentration and Measuring Volumes
INDICATOR / CLUSTER	VI.1.b.	Sketch a solution at the particle level. <u>JoVE</u> • 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 / CLUSTER	**VI.1.c.**	**Describe the relative amount of solute particles in concentrated and dilute solutions and express concentration in terms of molarity and molality.** **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 • Separation of Mixtures via Precipitation • Solutions and Concentrations • Spectrophotometric Determination of an Equilibrium Constant • Understanding Concentration and Measuring Volumes
INDICATOR / CLUSTER	VI.1.d.	Design and conduct an experiment to determine the factors (e.g., agitation, particle size, temperature) affecting the relative rate of dissolution. JoVE • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Determining the Solubility Rules of Ionic Compounds • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Freezing-Point Depression to Determine an Unknown Compound • 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 • Separation of Mixtures via Precipitation • Solutions and Concentrations • Sonication Extraction of Lipid Biomarkers from Sediment • Soxhlet Extraction of Lipid Biomarkers from Sediment
INDICATOR / CLUSTER	VI.1.e.	Relate the concept of parts per million (PPM) to relevant environmental issues found through research. 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 • Internal Standards

		• Introduction to Titration • Introduction to the Microplate Reader • 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 • Using a pH Meter
STANDARD / AREA OF LEARNING	**UT.VI.**	**Chemistry: Students will understand the properties that describe solutions in terms of concentration, solutes, solvents, and the behavior of acids and bases.**
OBJECTIVE / STRAND	**VI.2.**	**Summarize the quantitative and qualitative effects of colligative properties on a solution when a solute is added.**
INDICATOR / CLUSTER	VI.2.a.	Identify the colligative properties of a solution. JoVE • Freezing-Point Depression to Determine an Unknown Compound • Solutions and Concentrations
INDICATOR / CLUSTER	VI.2.b.	Measure change in boiling and/or freezing point of a solvent when a solute is added. JoVE • Conducting Reactions Below Room Temperature • Freezing-Point Depression to Determine an Unknown Compound
INDICATOR / CLUSTER	VI.2.c.	Describe how colligative properties affect the behavior of solutions in everyday applications (e.g., road salt, cold packs, antifreeze). JoVE • Assembly of a Reflux System for Heated Chemical Reactions • Calibration Curves • Capillary Electrophoresis (CE) • Column Chromatography • Conducting Reactions Below Room Temperature • 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

		• 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 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 • Purifying Compounds by Recrystallization • 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 • Spectrophotometric Determination of an Equilibrium Constant • Two-Dimensional Gel Electrophoresis • Understanding Concentration and Measuring Volumes • Using a pH Meter
STANDARD / AREA OF LEARNING	**UT.VI.**	**Chemistry: Students will understand the properties that describe solutions in terms of concentration, solutes, solvents, and the behavior of acids and bases.**
OBJECTIVE / STRAND	**VI.3.**	**Differentiate between acids and bases in terms of hydrogen ion concentration.**
INDICATOR / CLUSTER	**VI.3.a.**	Relate hydrogen ion concentration to pH values and to the terms acidic, basic or neutral. 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 / CLUSTER	**VI.3.c.**	Determine the concentration of an acid or a base using a simple acid-base titration.

		JoVE • Dissolved Oxygen in Surface Water • Introduction to Titration • Solutions and Concentrations
INDICATOR / CLUSTER	VI.3.d.	Research and report on the uses of acids and bases in industry, agriculture, medicine, mining, manufacturing, or construction. JoVE • Cyclic Voltammetry (CV) • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Proton Exchange Membrane Fuel Cells
INDICATOR / CLUSTER	VI.3.e.	Evaluate mechanisms by which pollutants modify the pH of various environments (e.g., aquatic, atmospheric, soil). JoVE • Using a pH Meter
STANDARD / AREA OF LEARNING	UT.1.	Earth Systems Science: Intended Learning Outcome: Use Science Process and Thinking Skills.
OBJECTIVE / STRAND	1.g.	Develop and use classification systems. JoVE • Igneous Intrusive Rock • Physical Properties Of Minerals I: Crystals and Cleavage • Physical Properties Of Minerals II: Polymineralic Analysis
OBJECTIVE / STRAND	1.h.	Construct models, simulations and metaphors to describe and explain natural phenomena. 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
OBJECTIVE / STRAND	1.i.	Use mathematics as a precise method for showing relationships. JoVE • Determining Spatial Orientation of Rock Layers with the Brunton Compass • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Making a Geologic Cross Section • Physical Properties Of Minerals I: Crystals and Cleavage • Physical Properties Of Minerals II: Polymineralic

		Analysis • Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry • Sonication Extraction of Lipid Biomarkers from Sediment
STANDARD / AREA OF LEARNING	**UT.2.**	**Earth Systems Science: Intended Learning Outcome: Manifest Scientific Attitudes and Interests.**
OBJECTIVE / STRAND	2.d.	Accept responsibility for actively helping to resolve social, ethical and ecological problems related to science and technology. 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 • Turbidity and Total Solids in Surface Water
STANDARD / AREA OF LEARNING	**UT.3.**	**Earth Systems Science: Intended Learning Outcome: Demonstrate Understanding of Science Concepts, Principles and Systems.**
OBJECTIVE / STRAND	3.b.	Distinguish between examples and non examples of concepts that have been taught. JoVE • Using GIS to Investigate Urban Forestry
OBJECTIVE / STRAND	3.c.	Apply principles and concepts of science to explain various phenomena. JoVE • Determining Spatial Orientation of Rock Layers with the Brunton Compass • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Making a Geologic Cross Section • Physical Properties Of Minerals I: Crystals and Cleavage • Physical Properties Of Minerals II: Polymineralic Analysis • Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry • Sonication Extraction of Lipid Biomarkers from Sediment
OBJECTIVE / STRAND	3.d.	Solve problems by applying science principles and procedures. JoVE • Determining Spatial Orientation of Rock Layers with

		the Brunton Compass • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Making a Geologic Cross Section • Physical Properties Of Minerals I: Crystals and Cleavage • Physical Properties Of Minerals II: Polymineralic Analysis • Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry • Sonication Extraction of Lipid Biomarkers from Sediment
STANDARD / AREA OF LEARNING	**UT.4.**	**Earth Systems Science: Intended Learning Outcome: Communicate Effectively Using Science Language and Reasoning.**
OBJECTIVE / STRAND	**4.b.**	**Use precise scientific language in oral and written communication.** **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 • Determination of Moisture Content in Soil • Determining Spatial Orientation of Rock Layers with the Brunton Compass • Dissolved Oxygen in Surface Water • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Igneous Intrusive Rock • Igneous Volcanic Rock • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Making a Geologic Cross Section • Measuring Mass in the Laboratory • Measuring Tropospheric Ozone • Nutrients in Aquatic Ecosystems • Physical Properties Of Minerals I: Crystals and Cleavage • Physical Properties Of Minerals II: Polymineralic Analysis • 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
OBJECTIVE / STRAND	4.e.	Use mathematical language and reasoning to communicate information. JoVE • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Determination of Moisture Content in Soil • Determining Spatial Orientation of Rock Layers with the Brunton Compass • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Making a Geologic Cross Section • Measuring Tropospheric Ozone • Nutrients in Aquatic Ecosystems • Physical Properties Of Minerals I: Crystals and Cleavage • Physical Properties Of Minerals II: Polymineralic Analysis • 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
STANDARD / AREA OF LEARNING	UT.5.	Earth Systems Science: Intended Learning Outcome: Demonstrate Awareness of Social and Historical Aspects of Science.
OBJECTIVE / STRAND	5.a.	Cite examples of how science affects human life. JoVE • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Analysis of Earthworm Populations in Soil • Biofuels: Producing Ethanol from Cellulosic Material • Carbon and Nitrogen Analysis of Environmental Samples • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Determination Of Nox in Automobile Exhaust Using

		UV-VIS Spectroscopy **• Determining Spatial Orientation of Rock Layers with the Brunton Compass** **• Dissolved Oxygen in Surface Water** **• Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction** **• Igneous Intrusive Rock** **• Igneous Volcanic Rock** **• Lead Analysis of Soil Using Atomic Absorption Spectroscopy** **• Making a Geologic Cross Section** **• Measuring Tropospheric Ozone** **• Nutrients in Aquatic Ecosystems** **• Physical Properties Of Minerals I: Crystals and Cleavage** **• Physical Properties Of Minerals II: Polymineralic Analysis** **• 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**
OBJECTIVE / STRAND	**5.b.**	**Give instances of how technological advances have influenced the progress of science and how science has influenced advances in technology.** **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** **• 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 • Measuring Mass in the Laboratory • Measuring Tropospheric Ozone • Nutrients in Aquatic Ecosystems • Physical Properties Of Minerals I: Crystals and Cleavage • Physical Properties Of Minerals II: Polymineralic Analysis • 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 • Turbidity and Total Solids in Surface Water • Using GIS to Investigate Urban Forestry
OBJECTIVE / STRAND	5.c.	Understand the cumulative nature of scientific knowledge. JoVE • Determining Spatial Orientation of Rock Layers with the Brunton Compass • Making a Geologic Cross Section
STANDARD / AREA OF LEARNING	UT.6.	Earth Systems Science: Intended Learning Outcome: Demonstrate Understanding of the Nature of Science.
OBJECTIVE / STRAND	6.i.	Understand that science and technology may raise ethical issues for which science, by itself, does not provide solutions. 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 • Turbidity and Total Solids in Surface Water
STANDARD / AREA OF LEARNING	UT.II.	Earth Systems Science: Students will understand that the features of Earth's evolving environment affect living systems, and that life on Earth is unique in the solar system.

OBJECTIVE / STRAND	**II.2.**	**Analyze how ecosystems differ from each other due to abiotic and biotic factors.**
INDICATOR / CLUSTER	**II.2.a.**	**Observe and list abiotic factors (e.g., temperature, water, nutrients, sunlight, pH, topography) in specific ecosystems.** **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 / CLUSTER	**II.2.b.**	**Observe and list biotic factors (e.g., plants, animals, organic matter) that affect a specific ecosystem (e.g., wetlands, deserts, aquatic).** **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** **• Dissolved Oxygen in Surface Water** **• Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction** **• 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** **• 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** **• Visualizing Soil Microorganisms via the Contact Slide**

		Assay and Microscopy **• Water Quality Analysis via Indicator Organisms** **• Zebrafish Maintenance and Husbandry**
INDICATOR / CLUSTER	**II.2.c.**	**Predict how an ecosystem will change as a result of major changes in an abiotic and/or biotic factor.** **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 / CLUSTER	**II.2.e.**	**Analyze interactions within an ecosystem (e.g., water temperature and fish species, weathering and water pH).** **JoVE** **• 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** **• Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry** **• Culturing and Enumerating Bacteria from Soil Samples** **• Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction** **• Filamentous Fungi** **• 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** **• Tree Survey: Point-Centered Quarter Sampling Method** **• Using GIS to Investigate Urban Forestry** **• Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy** **• Zebrafish Maintenance and Husbandry**
INDICATOR / CLUSTER	**II.2.f.**	**Plan and conduct an experiment to investigate how abiotic factors influence organisms and how organisms influence the physical environment.** **JoVE** **• Analysis of Earthworm Populations in Soil** **• Bacterial Growth Curve Analysis and its Environmental Applications**

		• Culturing and Enumerating Bacteria from Soil Samples • Dissolved Oxygen in Surface Water • Filamentous Fungi • Tree Survey: Point-Centered Quarter Sampling Method • Using GIS to Investigate Urban Forestry • Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy • Zebrafish Maintenance and Husbandry
STANDARD / AREA OF LEARNING	UT.II.	Earth Systems Science: Students will understand that the features of Earth's evolving environment affect living systems, and that life on Earth is unique in the solar system.
OBJECTIVE / STRAND	II.3.	Examine Earth's diversity of life as it changes over time.
INDICATOR / CLUSTER	II.3.a.	Observe and chart the diversity in a specific area. JoVE • Analysis of Earthworm Populations in Soil • Tree Identification: How To Use a Dichotomous Key • Tree Survey: Point-Centered Quarter Sampling Method
INDICATOR / CLUSTER	II.3.b.	Compare the diversity of life in various biomes specific to number of species, biomass, and type of organisms. JoVE • Dissolved Oxygen in Surface Water • 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 • Using GIS to Investigate Urban Forestry • Water Quality Analysis via Indicator Organisms • Zebrafish Maintenance and Husbandry
INDICATOR / CLUSTER	II.3.e.	Evaluate the biological, esthetic, ethical, social, or economic arguments with regard to maintaining biodiversity. JoVE • 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 / AREA OF LEARNING	UT.III.	Earth Systems Science: Students will understand that gravity, density, and convection move Earth's plates and this movement causes the plates to impact other Earth systems.
OBJECTIVE / STRAND	III.1.	Explain the evidence that supports the theory of plate tectonics.
INDICATOR / CLUSTER	III.1.a.	Define and describe the location of the major plates and plate boundaries.

		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 / CLUSTER	III.1.b.	Compare the movement and results of movement along convergent, divergent, and transform plate boundaries. 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 / CLUSTER	III.1.e.	Evaluate the evidence for the current theory of plate tectonics. JoVE • Determining Spatial Orientation of Rock Layers with the Brunton Compass • Igneous Intrusive Rock • Igneous Volcanic Rock • Making a Geologic Cross Section • Using Topographic Maps to Generate Topographic Profiles
STANDARD / AREA OF LEARNING	UT.III.	Earth Systems Science: Students will understand that gravity, density, and convection move Earth's plates and this movement causes the plates to impact other Earth systems.
OBJECTIVE / STRAND	III.2.	Describe the processes within Earth that result in plate motion and relate it to changes in other Earth systems.
INDICATOR / CLUSTER	III.2.b.	Model the movement of materials within Earth. JoVE • Igneous Volcanic Rock
INDICATOR / CLUSTER	III.2.c.	Model the movement and interaction of plates. 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 / CLUSTER	III.2.d.	Relate the movement and interaction of plates to volcanic eruptions, mountain building, and climate changes. 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 / CLUSTER	III.2.e.	Predict the effects of plate movement on other Earth systems (e.g., volcanic eruptions affect weather, mountain building diverts waterways, uplift changes elevation that alters plant and animal diversity, upwelling from ocean vents results in changes in biomass). 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
STANDARD / AREA OF LEARNING	UT.IV.	Earth Systems Science: Students will understand that water cycles through and between reservoirs in the hydrosphere and affects the other spheres of the Earth system.
OBJECTIVE / STRAND	IV.1.	Explain the water cycle in terms of its reservoirs, the movement between reservoirs, and the energy to move water. Evaluate the importance of freshwater to the biosphere.
INDICATOR / CLUSTER	IV.1.a.	Identify the reservoirs of Earth's water cycle (e.g., ocean, ice caps/glaciers, atmosphere, lakes, rivers, biosphere, groundwater) locally and globally, and graph or chart relative amounts in global reservoirs. JoVE • Dissolved Oxygen in Surface Water • Nutrients in Aquatic Ecosystems • Turbidity and Total Solids in Surface Water
INDICATOR / CLUSTER	IV.1.c.	Relate the physical and chemical properties of water to a water pollution issue. 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 / CLUSTER	IV.1.d.	Make inferences about the quality and/or quantity of freshwater, using data collected from local water systems. JoVE • Dissolved Oxygen in Surface Water • Nutrients in Aquatic Ecosystems • Turbidity and Total Solids in Surface Water • Water Quality Analysis via Indicator Organisms
INDICATOR / CLUSTER	IV.1.e.	Analyze how communities deal with water shortages, distribution, and quality in designing a long-term water use plan. JoVE • Dissolved Oxygen in Surface Water • Nutrients in Aquatic Ecosystems • Turbidity and Total Solids in Surface Water • Water Quality Analysis via Indicator Organisms
STANDARD / AREA OF LEARNING	UT.IV.	Earth Systems Science: Students will understand that water cycles through and between reservoirs in the hydrosphere and affects the other spheres of the Earth system.
OBJECTIVE / STRAND	IV.2.	Analyze the physical and biological dynamics of the oceans.
INDICATOR / CLUSTER	IV.2.e.	Describe how changing sea levels could affect life on Earth. JoVE • Biofuels: Producing Ethanol from Cellulosic Material
STANDARD / AREA OF LEARNING	UT.V.	Earth Systems Science: Students will understand that Earth's atmosphere interacts with and is altered by the lithosphere, hydrosphere, and biosphere.
OBJECTIVE / STRAND	V.1.	Describe how matter in the atmosphere cycles through other Earth systems.
INDICATOR / CLUSTER	V.1.a.	Trace movement of a carbon atom from the atmosphere through a plant, animal, and decomposer, and back into the atmosphere. JoVE • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Conversion of Fatty Acid Methyl Esters by

		Saponification for Uk'37 Paleothermometry **• Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy** **• 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** **• Using GIS to Investigate Urban Forestry**
INDICATOR / CLUSTER	**V.1.b.**	**Diagram the nitrogen cycle and provide examples of human actions that affect this cycle (e.g., fertilizers, crop rotation, fossil fuel combustion).** **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** **• Le Châtelier's Principle** **• 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 / CLUSTER	V.1.c.	Interpret evidence suggesting that humans are influencing the carbon cycle. JoVE • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Measuring Tropospheric Ozone
INDICATOR / CLUSTER	V.1.d.	Research ways the biosphere, hydrosphere, and lithosphere interact with the atmosphere (e.g., volcanic eruptions putting ash and gases into the atmosphere, hurricanes, changes in vegetation). JoVE • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Dissolved Oxygen in Surface Water • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Measuring Tropospheric Ozone • 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
STANDARD / AREA OF LEARNING	UT.V.	Earth Systems Science: Students will understand that Earth's atmosphere interacts with and is altered by the lithosphere, hydrosphere, and biosphere.
OBJECTIVE / STRAND	V.2.	Trace ways in which the atmosphere has been altered by living systems and has itself strongly affected living systems over the course of Earth's history.
INDICATOR / CLUSTER	V.2.a.	Define ozone and compare its effects in the lower and upper atmosphere. JoVE • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Measuring Tropospheric Ozone
INDICATOR / CLUSTER	V.2.b.	Describe the role of living organisms in producing the ozone layer and how the ozone layer affected the

		development of life on Earth. JoVE • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Measuring Tropospheric Ozone
INDICATOR / CLUSTER	V.2.c.	Compare the rate at which CO2 is put into the atmosphere to the rate at which it is removed through the carbon cycle. 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 • 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 • Using GIS to Investigate Urban Forestry
INDICATOR / CLUSTER	V.2.e.	Research, evaluate, and report on international efforts to protect the atmosphere. 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 • Measuring Tropospheric Ozone • Proton Exchange Membrane Fuel Cells • Using GIS to Investigate Urban Forestry
STANDARD / AREA OF LEARNING	UT.VI.	Earth Systems Science: Students will understand the source and distribution of energy on Earth and its effects on Earth systems.
OBJECTIVE / STRAND	VI.1.	Describe the transformation of solar energy into heat and chemical energy on Earth and eventually the radiation of energy to space.

INDICATOR / CLUSTER	VI.1.b.	Describe the pathways for converting and storing light energy as chemical energy (e.g., light energy converted to chemical energy stored in plants, plants become fossil fuel). JoVE • An Introduction to Cell Metabolism • Turbidity and Total Solids in Surface Water
INDICATOR / CLUSTER	VI.1.c.	Investigate the conversion of light energy from the sun into heat energy by various Earth materials. JoVE • Turbidity and Total Solids in Surface Water
INDICATOR / CLUSTER	VI.1.f.	Research global changes and relate them to Earth systems (e.g., global warming, solar fluctuations). JoVE • Biofuels: Producing Ethanol from Cellulosic Material
STANDARD / AREA OF LEARNING	UT.1.	Physics: Intended Learning Outcome: Use Science Process and Thinking Skills.
OBJECTIVE / STRAND	1.d.	Select and use appropriate technological instruments to collect and analyze data. JoVE • Common Lab Glassware and Uses
STANDARD / AREA OF LEARNING	UT.2.	Physics: Intended Learning Outcome: Manifest Scientific Attitudes and Interests.
OBJECTIVE / STRAND	2.d.	Accept responsibility for actively helping to resolve social, ethical and ecological problems related to science and technology. JoVE • Biofuels: Producing Ethanol from Cellulosic Material • Proton Exchange Membrane Fuel Cells • Raman Spectroscopy for Chemical Analysis
STANDARD / AREA OF LEARNING	UT.4.	Physics: Intended Learning Outcome: Communicate Effectively Using Science Language and Reasoning.
OBJECTIVE / STRAND	4.b.	Use precise scientific language in oral and written communication. JoVE • Measuring Mass in the Laboratory
OBJECTIVE / STRAND	4.e.	Use mathematical language and reasoning to communicate information. JoVE • Determining the Empirical Formula

STANDARD / AREA OF LEARNING	**UT.5.**	**Physics: Intended Learning Outcome: Demonstrate Awareness of Social and Historical Aspects of Science.**
OBJECTIVE / STRAND	**5.b.**	**Give instances of how technological advances have influenced the progress of science and how science has influenced advances in technology.** **JoVE** **• An Introduction to the Centrifuge** **• Electro-encephalography (EEG)** **• Measuring Mass in the Laboratory**
STANDARD / AREA OF LEARNING	**UT.6.**	**Physics: Intended Learning Outcome: Demonstrate Understanding of the Nature of Science.**
OBJECTIVE / STRAND	**6.i.**	**Understand that science and technology may raise ethical issues for which science, by itself, does not provide solutions.** **JoVE** **• Raman Spectroscopy for Chemical Analysis**
STANDARD / AREA OF LEARNING	**UT.I.**	**Physics: Students will understand how to measure, calculate, and describe the motion of an object in terms of position, time, velocity, and acceleration.**
OBJECTIVE / STRAND	**I.2.**	**Analyze the motion of an object in terms of velocity, time, and acceleration. (Related Internet Resources)**
INDICATOR / CLUSTER	**I.2.d.**	**Describe the acceleration of an object moving in a circular path at constant speed (i.e., constant speed, but changing direction).** **JoVE** **• An Introduction to the Centrifuge**
STANDARD / AREA OF LEARNING	**UT.II.**	**Physics: Students will understand the relation between force, mass, and acceleration.**
OBJECTIVE / STRAND	**II.1.**	**Analyze forces acting on an object. (Related Internet Resources)**
INDICATOR / CLUSTER	**II.1.a.**	**Observe and describe forces encountered in everyday life (e.g., braking of an automobile - friction, falling rain drops - gravity, directional compass - magnetic, bathroom scale - elastic or spring).** **JoVE** **• Determining Spatial Orientation of Rock Layers with the Brunton Compass** **• Introduction to Mass Spectrometry** **• Nuclear Magnetic Resonance (NMR) Spectroscopy**
INDICATOR / CLUSTER	**II.1.c.**	**Measure the forces on an object using appropriate tools.** **JoVE** **• Measuring Mass in the Laboratory**

STANDARD / AREA OF LEARNING	**UT.III.**	**Physics: Students will understand the factors determining the strength of gravitational and electric forces.**
OBJECTIVE / STRAND	**III.1.**	**Relate the strength of the gravitational force to the distance between two objects and the mass of the objects (i.e., Newton's law of universal gravitation). (Related Internet Resources)**
INDICATOR / CLUSTER	**III.1.b.**	**Distinguish between mass and weight.** **JoVE** **• Determining the Density of a Solid and Liquid** **• Measuring Mass in the Laboratory**
STANDARD / AREA OF LEARNING	**UT.III.**	**Physics: Students will understand the factors determining the strength of gravitational and electric forces.**
OBJECTIVE / STRAND	**III.2.**	**Describe the factors that affect the electric force (i.e., Coulomb's law). (Related Internet Resources)**
INDICATOR / CLUSTER	**III.2.a.**	**Relate the types of charge to their effect on electric force (i.e., like charges repel, unlike charges attract).** **JoVE** **• Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat** **• Testing For Genetically Modified Foods**
INDICATOR / CLUSTER	**III.2.b.**	**Describe how the amount of charge affects the electric force.** **JoVE** **• Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat**
INDICATOR / CLUSTER	**III.2.d.**	**Research and report on electric forces in everyday applications found in both nature and technology (e.g., lightning, living organisms, batteries, copy machine, electrostatic precipitators).** **JoVE** **• Biofuels: Producing Ethanol from Cellulosic Material** **• Calibration Curves** **• Cyclic Voltammetry (CV)** **• Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat** **• MALDI-TOF Mass Spectrometry** **• Method of Standard Addition** **• Preparing Anhydrous Reagents and Equipment** **• Proton Exchange Membrane Fuel Cells** **• Raman Spectroscopy for Chemical Analysis** **• Tandem Mass Spectrometry** **• Using a pH Meter**

STANDARD / AREA OF LEARNING	**UT.IV.**	**Physics: Students will understand transfer and conservation of energy.**
OBJECTIVE / STRAND	**IV.1.**	**Determine kinetic and potential energy in a system. (Related Internet Resources)**
INDICATOR / CLUSTER	**IV.1.a.**	**Identify various types of potential energy (i.e., gravitational, elastic, chemical, electrostatic, nuclear).** **JoVE** **• Cyclic Voltammetry (CV)** **• Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat**
STANDARD / AREA OF LEARNING	**UT.IV.**	**Physics: Students will understand transfer and conservation of energy.**
OBJECTIVE / STRAND	**IV.2.**	**Describe conservation of energy in terms of systems. (Related Internet Resources)**
INDICATOR / CLUSTER	**IV.2.b.**	**Relate the transformations between kinetic and potential energy in a system (e.g., moving magnet induces electricity in a coil of wire, roller coaster, internal combustion engine).** **JoVE** **• fMRI: Functional Magnetic Resonance Imaging**
INDICATOR / CLUSTER	**IV.2.d.**	**Evaluate social, economic, and environmental issues related to the production and transmission of electrical energy.** **JoVE** **• Biofuels: Producing Ethanol from Cellulosic Material** **• Proton Exchange Membrane Fuel Cells**
STANDARD / AREA OF LEARNING	**UT.IV.**	**Physics: Students will understand transfer and conservation of energy.**
OBJECTIVE / STRAND	**IV.3.**	**Describe common energy transformations and the effect on availability of energy. (Related Internet Resources)**
INDICATOR / CLUSTER	**IV.3.c.**	**Describe the transformation of mechanical energy into electrical energy and the transmission of electrical energy.** **JoVE** **• Biofuels: Producing Ethanol from Cellulosic Material** **• Proton Exchange Membrane Fuel Cells** **• Raman Spectroscopy for Chemical Analysis**
INDICATOR / CLUSTER	**IV.3.d.**	**Research and report on the transformation of energy in electrical generation plants (e.g., chemical to heat to electricity, nuclear to heat to mechanical to electrical, gravitational to kinetic to mechanical to electrical), and include energy losses during each transformation.** **JoVE** **• Biofuels: Producing Ethanol from Cellulosic Material**

		• Proton Exchange Membrane Fuel Cells • Raman Spectroscopy for Chemical Analysis
STANDARD / AREA OF LEARNING	**UT.V.**	**Physics: Students will understand the properties and applications of waves.**
OBJECTIVE / STRAND	**V.1.**	**Demonstrate an understanding of mechanical waves in terms of general wave properties. (Related Internet Resources)**
INDICATOR / CLUSTER	**V.1.a.**	**Differentiate between period, frequency, wavelength, and amplitude of waves.** **JoVE** • Auscultation • Percussion • The Staircase Procedure for Finding a Perceptual Threshold
INDICATOR / CLUSTER	**V.1.b.**	**Investigate and compare reflection, refraction, and diffraction of waves.** **JoVE** • Abdominal Exam II: Percussion • Auscultation • Percussion • Peripheral Vascular Exam Using a Continuous Wave Doppler
INDICATOR / CLUSTER	**V.1.c.**	**Provide examples of waves commonly observed in nature and/or used in technological applications.** **JoVE** • Abdominal Exam I: Inspection and Auscultation • Abdominal Exam II: Percussion • Abdominal Exam IV: Acute Abdominal Pain Assessment • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Auscultation • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Ear Exam • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Percussion • Peripheral Vascular Exam Using a Continuous Wave Doppler • Raman Spectroscopy for Chemical Analysis • 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 Staircase Procedure for Finding a Perceptual Threshold
INDICATOR / CLUSTER	V.1.d.	Identify the relationship between the speed, wavelength, and frequency of a wave. JoVE • Auscultation • Percussion • Ultraviolet-Visible (UV-Vis) Spectroscopy
INDICATOR / CLUSTER	V.1.e.	Explain the observed change in frequency of a mechanical wave coming from a moving object as it approaches and moves away (i.e., Doppler effect). JoVE • Auscultation • Percussion • Peripheral Vascular Exam Using a Continuous Wave Doppler
INDICATOR / CLUSTER	V.1.f.	Explain the transfer of energy through a medium by mechanical waves. JoVE • Abdominal Exam II: Percussion • Auscultation • Percussion
STANDARD / AREA OF LEARNING	UT.V.	Physics: Students will understand the properties and applications of waves.
OBJECTIVE / STRAND	V.2.	Describe the nature of electromagnetic radiation and visible light. (Related Internet Resources)
INDICATOR / CLUSTER	V.2.a.	Describe the relationship of energy to wavelength or frequency for electromagnetic radiation. JoVE • Nuclear Magnetic Resonance (NMR) Spectroscopy • Raman Spectroscopy for Chemical Analysis • Ultraviolet-Visible (UV-Vis) Spectroscopy
INDICATOR / CLUSTER	V.2.b.	Distinguish between the different parts of the electromagnetic spectrum (e.g., radio waves and x-rays or visible light and microwaves). JoVE • Ultraviolet-Visible (UV-Vis) Spectroscopy
INDICATOR / CLUSTER	V.2.c.	Explain that the different parts of the electromagnetic spectrum all travel through empty space and at the same speed. JoVE • Ultraviolet-Visible (UV-Vis) Spectroscopy

INDICATOR / CLUSTER	**V.2.e.**	**Provide examples of the use of electromagnetic radiation in everyday life (e.g., communications, lasers, microwaves, cellular phones, satellite dishes, visible light).** **<u>JoVE</u>** **• 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** **• Cranial Nerves Exam I (I-VI)** **• 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** **• Ear Exam** **• Electro-encephalography (EEG)** **• Emergent Lateral Canthotomy and Inferior Catholysis** **• Eye Exam** **• 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** **• Histological Sample Preparation for Light Microscopy** **• Internal Standards** **• Introduction to Catalysis** **• Introduction to Fluorescence Microscopy** **• Introduction to Light Microscopy** **• 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 • Ophthalmoscopic Examination • Photometric Protein Determination • Physical Properties Of Minerals I: Crystals and Cleavage • Plasmid Purification • Protein Crystallization • 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 • Turbidity and Total Solids in Surface Water • 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

Grade: **9** - Adopted: **2013**

STANDARD / AREA OF LEARNING	**UT.CC.RST.9-10.**	**Reading Standards for Literacy in Science and Technical Subjects**
OBJECTIVE / STRAND		**Craft and Structure**
INDICATOR / CLUSTER	**RST.9-10.4.**	**Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.** **JoVE** • Abdominal Exam I: Inspection and Auscultation • Abdominal Exam II: Percussion • Abdominal Exam III: Palpation • Abdominal Exam IV: Acute Abdominal Pain Assessment • Algae Enumeration via Culturable Methodology • An Introduction to Aging and Regeneration • An Introduction to Behavioral Neuroscience • 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 Cognition • An Introduction to Developmental Genetics • An Introduction to Developmental Neurobiology • An Introduction to Drosophila melanogaster • An Introduction to Endocytosis and Exocytosis • 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 Neuroanatomy • An Introduction to Neurophysiology • An Introduction to Organogenesis • An Introduction to Reward and Addiction • An Introduction to Saccharomyces cerevisiae • An Introduction to Stem Cell Biology • An Introduction to Transfection • An Introduction to Working in the Hood • An Introduction to the Centrifuge • An Introduction to the Chick: Gallus gallus domesticus • An Introduction to the Laboratory Mouse: Mus musculus • An Introduction to the Micropipettor • An Introduction to the Zebrafish: Danio rerio • 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 • Analysis of Earthworm Populations in Soil • Anesthesia Induction and Maintenance • Ankle Exam • Annexin V and Propidium Iodide Labeling • Anterograde Amnesia • Anxiety Testing • Approximate Number Sense Test • Are You Smart or Hardworking? How Praise Influences Children's Motivation • Arterial Line Placement • Aseptic Technique in Environmental Science • Assembly of a Reflux System for Heated Chemical Reactions • Assessing Dexterity with Reaching Tasks • Auscultation • Bacterial Growth Curve Analysis and its Environmental Applications • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method

		• Balance and Coordination Testing • Basic Care Procedures • Basic Chick Care and Maintenance • Basic Life Support Part II: Airway/Breathing and Continued Cardiopulmonary Resuscitation • Basic Life Support: Cardiopulmonary Resuscitation and Defibrillation • Basic Mouse Care and Maintenance • Binocular Rivalry • Biofuels: Producing Ethanol from Cellulosic Material • Blood Pressure Measurement • Blood Withdrawal I • Blood Withdrawal II • C. elegans Chemotaxis Assay • C. elegans Development and Reproduction • C. elegans Maintenance • Calcium Imaging in Neurons • Calibration Curves • Capillary Electrophoresis (CE) • Carbon and Nitrogen Analysis of Environmental Samples • Cardiac Exam I: Inspection and Palpation • Cardiac Exam II: Auscultation • Cardiac Exam III: Abnormal Heart Sounds • Categories and Inductive Inferences • Cell Cycle Analysis • Cell-surface Biotinylation Assay • Central Venous Catheter Insertion: Femoral Vein with Ultrasound Guidance • Central Venous Catheter Insertion: Internal Jugular with Ultrasound Guidance • Central Venous Catheter Insertion: Subclavian Vein • Chick ex ovo Culture • Children's Reliance on Artist Intentions When Identifying Pictures • Chromatin Immunoprecipitation • Chromatography-Based Biomolecule Purification Methods • Co-Immunoprecipitation and Pull-Down Assays • Color Afterimages • Column Chromatography • Common Lab Glassware and Uses • Community DNA Extraction from Bacterial Colonies • Compound Administration I • Compound Administration II • Compound Administration III • Compound Administration IV • Comprehensive Breast Exam • Conducting Reactions Below Room Temperature • Considerations for Rodent Surgery • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry

		• Coordination Chemistry Complexes • Cranial Nerves Exam I (I-VI) • Cranial Nerves Exam II (VII-XII) • Crowding • Culturing and Enumerating Bacteria from Soil Samples • Cyclic Voltammetry (CV) • Cytogenetics • DNA Gel Electrophoresis • DNA Ligation Reactions • DNA Methylation Analysis • Decision-making and the Iowa Gambling Task • Decoding Auditory Imagery with Multivoxel Pattern Analysis • Degassing Liquids with Freeze-Pump-Thaw Cycling • Density Gradient Ultracentrifugation • Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis • Detecting Reactive Oxygen Species • Detection of Bacteriophages in Environmental Samples • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Determination of Moisture Content in Soil • Determining Rate Laws and the Order of Reaction • Determining Spatial Orientation of Rock Layers with the Brunton Compass • 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 • Development and Reproduction of the Laboratory Mouse • Development of the Chick • Diagnostic Necropsy and Tissue Harvest • Dialysis: Diffusion Based Separation • Dichotic Listening • Dissolved Oxygen in Surface Water • Drosophila Development and Reproduction • Drosophila Larval IHC • Drosophila Maintenance • Drosophila melanogaster Embryo and Larva Harvesting and Preparation • Ear Exam • Elbow Exam • Electro-encephalography (EEG) • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Electrophoretic Mobility Shift Assay (EMSA) • Embryonic Stem Cell Culture and Differentiation • Emergency Tube Thoracostomy (Chest Tube Placement) • Emergent Lateral Canthotomy and Inferior Catholysis

		• Enzyme Assays and Kinetics • Ethics in Psychology Research • Event-related Potentials and the Oddball Task • Executive Function and the Dimensional Change Card Sort Task • Executive Function in Autism Spectrum Disorder • Experimentation using a Confederate • Explant Culture for Developmental Studies • Explant Culture of Neural Tissue • Expression Profiling with Microarrays • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction • Eye Exam • Eye Tracking in Cognitive Experiments • FM Dyes in Vesicle Recycling • Fate Mapping • Fear Conditioning • Filamentous Fungi • Finding Your Blind Spot and Perceptual Filling-in • Foot Exam • Fractional Distillation • Freezing-Point Depression to Determine an Unknown Compound • From Theory to Design: The Role of Creativity in Designing Experiments • Fundamentals of Breeding and Weaning • Förster Resonance Energy Transfer (FRET) • Gas Chromatography (GC) with Flame-Ionization Detection • Gel Purification • Gene Silencing with Morpholinos • General Approach to the Physical Exam • Genetic Crosses • Genetic Engineering of Model Organisms • Genetic Screens • Genome Editing • Gram Staining of Bacteria from Environmental Sources • Growing Crystals for X-ray Diffraction Analysis • Habituation: Studying Infants Before They Can Talk • Hand and Wrist Exam • High-Performance Liquid Chromatography (HPLC) • Hip Exam • Histological Sample Preparation for Light Microscopy • Histological Staining of Neural Tissue • How Children Solve Problems Using Causal Reasoning • Ideal Gas Law • Igneous Intrusive Rock • Igneous Volcanic Rock • In ovo Electroporation of Chicken Embryos • Inattentional Blindness • Incidental Encoding • Induced Pluripotency

		• Internal Standards • Intra-articular Shoulder Injection for Reduction Following Anterior Shoulder Dislocation • Intraosseous Needle Placement • Introducing Experimental Agents into the Mouse • Introduction to Catalysis • Introduction to Fluorescence Microscopy • Introduction to Light Microscopy • Introduction to Mass Spectrometry • Introduction to Serological Pipettes and Pipettors • Introduction to Titration • Introduction to the Bunsen Burner • Introduction to the Microplate Reader • Introduction to the Spectrophotometer • Invasion Assay Using 3D Matrices • Invertebrate Lifespan Quantification • Ion-Exchange Chromatography • Isolating Nucleic Acids from Yeast • Isolation of Fecal Bacteria from Water Samples by Filtration • Just-noticeable Differences • Knee Exam • Language: The N400 in Semantic Incongruity • Le Châtelier's Principle • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Learning and Memory: The Remember-Know Task • Live Cell Imaging of Mitosis • Lower Back Exam • Lymph Node Exam • MALDI-TOF Mass Spectrometry • Making Solutions in the Laboratory • Making a Geologic Cross Section • Male Rectal Exam • Manipulating an Independent Variable through Embodiment • Measuring Children's Trust in Testimony • Measuring Grey Matter Differences with Voxel-based Morphometry: The Musical Brain • Measuring Mass in the Laboratory • Measuring Reaction Time and Donders' Method of Subtraction • Measuring Tropospheric Ozone • Measuring Verbal Working Memory Span • Measuring Vital Signs • Memory Development: Demonstrating How Repeated Questioning Leads to False Memories • Mental Rotation • Metabolic Labeling • Metacognitive Development: How Children Estimate Their Memory • Method of Standard Addition

		• Modeling Social Stress • Molecular Cloning • Motion-induced Blindness • Motor Exam I • Motor Exam II • Motor Learning in Mirror Drawing • Motor Maps • Mouse Genotyping • Multiple Object Tracking • Murine In Utero Electroporation • Mutual Exclusivity: How Children Learn the Meanings of Words • Neck Exam • Needle Thoracostomy (needle Decompression) for Temporizing Tension Pneumothorax Treatment • Neuronal Transfection Methods • Nose, Sinuses, Oral Cavity and Pharynx Exam • Nuclear Magnetic Resonance (NMR) Spectroscopy • Numerical Cognition: More or Less • Nutrients in Aquatic Ecosystems • Object Substitution Masking • Observation and Inspection • Observational Research • Ophthalmoscopic Examination • PCR: The Polymerase Chain Reaction • Palpation • Passaging Cells • Patch Clamp Electrophysiology • Pelvic Exam I: Assessment of the External Genitalia • Pelvic Exam II: Speculum Exam • Pelvic Exam III: Bimanual and Rectovaginal Exam • Percussion • Percutaneous Cricothyrotomy (Seldinger Technique) • Performing 1D Thin Layer Chromatography • Pericardiocentesis • Peripheral Vascular Exam • Peripheral Vascular Exam Using a Continuous Wave Doppler • Peripheral Venous Cannulation • Perspectives on Sensation and Perception • Photometric Protein Determination • Physical Properties Of Minerals I: Crystals and Cleavage • Physical Properties Of Minerals II: Polymineralic Analysis • Physiological Correlates of Emotion Recognition • Piaget's Conservation Task and the Influence of Task Demands • Pilot Testing • Placebos in Research • Plasmid Purification • Positive Reinforcement Studies • Preparing Anhydrous Reagents and Equipment

		• Primary Neuronal Cultures • Proper Adjustment of Patient Attire during the Physical Exam • Prospect Theory • Protein Crystallization • Proton Exchange Membrane Fuel Cells • Purification of a Total Lipid Extract with Column Chromatography • Purifying Compounds by Recrystallization • Quantifying Environmental Microorganisms and Viruses Using qPCR • RNA Analysis of Environmental Samples Using RT-PCR • RNA-Seq • RNAi in C. elegans • Raman Spectroscopy for Chemical Analysis • Realism in Experimentation • Recombineering and Gene Targeting • Reconstitution of Membrane Proteins • Regulating Temperature in the Lab: Applying Heat • Regulating Temperature in the Lab: Preserving Samples Using Cold • Reliability in Psychology Experiments • Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry • Respiratory Exam I: Inspection and Palpation • Respiratory Exam II: Percussion and Auscultation • Restriction Enzyme Digests • Rodent Handling and Restraint Techniques • Rodent Identification I • Rodent Identification II • Rodent Stereotaxic Surgery • Rotary Evaporation to Remove Solvent • SNP Genotyping • Sample Preparation for Analytical Preparation • Scanning Electron Microscopy (SEM) • Schlenk Lines Transfer of Solvents • Self-administration Studies • Self-report vs. Behavioral Measures of Recycling • Sensory Exam • Separating Protein with SDS-PAGE • Separation of Mixtures via Precipitation • Shoulder Exam I • Shoulder Exam II • Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium • Solid-Liquid Extraction • Solutions and Concentrations • Sonication Extraction of Lipid Biomarkers from Sediment • Soxhlet Extraction of Lipid Biomarkers from Sediment • Spatial Cueing • Spatial Memory Testing Using Mazes

		• Spectrophotometric Determination of an Equilibrium Constant • Sterile Tissue Harvest • Surface Plasmon Resonance (SPR) • Surgical Cricothyrotomy • Tandem Mass Spectrometry • Testing For Genetically Modified Foods • The ATP Bioluminescence Assay • The Ames Room • The Attentional Blink • The Costs and Benefits of Natural Pedagogy • The ELISA Method • The Factorial Experiment • The Ideal Gas Law • The Inverted-face Effect • The McGurk Effect • The Morris Water Maze • The Multi-group Experiment • The Precision of Visual Working Memory with Delayed Estimation • The Rouge Test: Searching for a Sense of Self • The Rubber Hand Illusion • The Simple Experiment: Two-group Design • The Split Brain • The Staircase Procedure for Finding a Perceptual Threshold • The TUNEL Assay • The Transwell Migration Assay • The Western Blot • Thyroid Exam • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Tree Identification: How To Use a Dichotomous Key • Tree Survey: Point-Centered Quarter Sampling Method • Turbidity and Total Solids in Surface Water • Two-Dimensional Gel Electrophoresis • Ultraviolet-Visible (UV-Vis) Spectroscopy • Understanding Concentration and Measuring Volumes • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy • Using Diffusion Tensor Imaging in Traumatic Brain Injury • Using GIS to Investigate Urban Forestry • Using TMS to Measure Motor Excitability During Action Observation • Using Topographic Maps to Generate Topographic Profiles • Using Your Head: Measuring Infants' Rational Imitation of Actions • Using a pH Meter • Verbal Priming • Visual Attention: fMRI Investigation of Object-based

		Attentional Control **• Visual Search for Features and Conjunctions** **• Visual Statistical Learning** **• Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy** **• Water Quality Analysis via Indicator Organisms** **• Whole-Mount In Situ Hybridization** **• Within-subjects Repeated-measures Design** **• X-ray Fluorescence (XRF)** **• Yeast Maintenance** **• Yeast Reproduction** **• Yeast Transformation and Cloning** **• Zebrafish Breeding and Embryo Handling** **• Zebrafish Maintenance and Husbandry** **• Zebrafish Microinjection Techniques** **• Zebrafish Reproduction and Development** **• fMRI: Functional Magnetic Resonance Imaging**
INDICATOR / CLUSTER	**RST.9-10.5.**	**Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).** **JoVE** **• Abdominal Exam I: Inspection and Auscultation** **• Abdominal Exam II: Percussion** **• Abdominal Exam III: Palpation** **• Abdominal Exam IV: Acute Abdominal Pain Assessment** **• Algae Enumeration via Culturable Methodology** **• An Introduction to Aging and Regeneration** **• An Introduction to Behavioral Neuroscience** **• 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 Cognition** **• An Introduction to Developmental Genetics** **• An Introduction to Developmental Neurobiology** **• An Introduction to Drosophila melanogaster** **• An Introduction to Endocytosis and Exocytosis** **• 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 Neuroanatomy** **• An Introduction to Neurophysiology** **• An Introduction to Organogenesis** **• An Introduction to Reward and Addiction** **• An Introduction to Saccharomyces cerevisiae**

		• An Introduction to Stem Cell Biology • An Introduction to Transfection • An Introduction to Working in the Hood • An Introduction to the Centrifuge • An Introduction to the Chick: Gallus gallus domesticus • An Introduction to the Laboratory Mouse: Mus musculus • An Introduction to the Micropipettor • An Introduction to the Zebrafish: Danio rerio • 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 • Analysis of Earthworm Populations in Soil • Anesthesia Induction and Maintenance • Ankle Exam • Annexin V and Propidium Iodide Labeling • Anterograde Amnesia • Anxiety Testing • Approximate Number Sense Test • Are You Smart or Hardworking? How Praise Influences Children's Motivation • Arterial Line Placement • Aseptic Technique in Environmental Science • Assembly of a Reflux System for Heated Chemical Reactions • Assessing Dexterity with Reaching Tasks • Auscultation • Bacterial Growth Curve Analysis and its Environmental Applications • Bacterial Transformation: Electroporation • Bacterial Transformation: The Heat Shock Method • Balance and Coordination Testing • Basic Care Procedures • Basic Chick Care and Maintenance • Basic Life Support Part II: Airway/Breathing and Continued Cardiopulmonary Resuscitation • Basic Life Support: Cardiopulmonary Resuscitation and Defibrillation • Basic Mouse Care and Maintenance • Binocular Rivalry • Biofuels: Producing Ethanol from Cellulosic Material • Blood Pressure Measurement • Blood Withdrawal I • Blood Withdrawal II • C. elegans Chemotaxis Assay

		• C. elegans Development and Reproduction • C. elegans Maintenance • Calcium Imaging in Neurons • Calibration Curves • Capillary Electrophoresis (CE) • Carbon and Nitrogen Analysis of Environmental Samples • Cardiac Exam I: Inspection and Palpation • Cardiac Exam II: Auscultation • Cardiac Exam III: Abnormal Heart Sounds • Categories and Inductive Inferences • Cell Cycle Analysis • Cell-surface Biotinylation Assay • Central Venous Catheter Insertion: Femoral Vein with Ultrasound Guidance • Central Venous Catheter Insertion: Internal Jugular with Ultrasound Guidance • Central Venous Catheter Insertion: Subclavian Vein • Chick ex ovo Culture • Children's Reliance on Artist Intentions When Identifying Pictures • Chromatin Immunoprecipitation • Chromatography-Based Biomolecule Purification Methods • Co-Immunoprecipitation and Pull-Down Assays • Color Afterimages • Column Chromatography • Common Lab Glassware and Uses • Community DNA Extraction from Bacterial Colonies • Compound Administration I • Compound Administration II • Compound Administration III • Compound Administration IV • Comprehensive Breast Exam • Conducting Reactions Below Room Temperature • Considerations for Rodent Surgery • Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry • Coordination Chemistry Complexes • Cranial Nerves Exam I (I-VI) • Cranial Nerves Exam II (VII-XII) • Crowding • Culturing and Enumerating Bacteria from Soil Samples • Cyclic Voltammetry (CV) • Cytogenetics • DNA Gel Electrophoresis • DNA Ligation Reactions • DNA Methylation Analysis • Decision-making and the Iowa Gambling Task • Decoding Auditory Imagery with Multivoxel Pattern Analysis

		• Degassing Liquids with Freeze-Pump-Thaw Cycling • Density Gradient Ultracentrifugation • Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis • Detecting Reactive Oxygen Species • Detection of Bacteriophages in Environmental Samples • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Determination of Moisture Content in Soil • Determining Rate Laws and the Order of Reaction • Determining Spatial Orientation of Rock Layers with the Brunton Compass • 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 • Development and Reproduction of the Laboratory Mouse • Development of the Chick • Diagnostic Necropsy and Tissue Harvest • Dialysis: Diffusion Based Separation • Dichotic Listening • Dissolved Oxygen in Surface Water • Drosophila Development and Reproduction • Drosophila Larval IHC • Drosophila Maintenance • Drosophila melanogaster Embryo and Larva Harvesting and Preparation • Ear Exam • Elbow Exam • Electro-encephalography (EEG) • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Electrophoretic Mobility Shift Assay (EMSA) • Embryonic Stem Cell Culture and Differentiation • Emergency Tube Thoracostomy (Chest Tube Placement) • Emergent Lateral Canthotomy and Inferior Catholysis • Enzyme Assays and Kinetics • Ethics in Psychology Research • Event-related Potentials and the Oddball Task • Executive Function and the Dimensional Change Card Sort Task • Executive Function in Autism Spectrum Disorder • Experimentation using a Confederate • Explant Culture for Developmental Studies • Explant Culture of Neural Tissue • Expression Profiling with Microarrays • Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction

		• Eye Exam • Eye Tracking in Cognitive Experiments • FM Dyes in Vesicle Recycling • Fate Mapping • Fear Conditioning • Filamentous Fungi • Finding Your Blind Spot and Perceptual Filling-in • Foot Exam • Fractional Distillation • Freezing-Point Depression to Determine an Unknown Compound • From Theory to Design: The Role of Creativity in Designing Experiments • Fundamentals of Breeding and Weaning • Förster Resonance Energy Transfer (FRET) • Gas Chromatography (GC) with Flame-Ionization Detection • Gel Purification • Gene Silencing with Morpholinos • General Approach to the Physical Exam • Genetic Crosses • Genetic Engineering of Model Organisms • Genetic Screens • Genome Editing • Gram Staining of Bacteria from Environmental Sources • Growing Crystals for X-ray Diffraction Analysis • Habituation: Studying Infants Before They Can Talk • Hand and Wrist Exam • High-Performance Liquid Chromatography (HPLC) • Hip Exam • Histological Sample Preparation for Light Microscopy • Histological Staining of Neural Tissue • How Children Solve Problems Using Causal Reasoning • Ideal Gas Law • Igneous Intrusive Rock • Igneous Volcanic Rock • In ovo Electroporation of Chicken Embryos • Inattentional Blindness • Incidental Encoding • Induced Pluripotency • Internal Standards • Intra-articular Shoulder Injection for Reduction Following Anterior Shoulder Dislocation • Intraosseous Needle Placement • Introducing Experimental Agents into the Mouse • Introduction to Catalysis • Introduction to Fluorescence Microscopy • Introduction to Light Microscopy • Introduction to Mass Spectrometry • Introduction to Serological Pipettes and Pipettors • Introduction to Titration

		• Introduction to the Bunsen Burner • Introduction to the Microplate Reader • Introduction to the Spectrophotometer • Invasion Assay Using 3D Matrices • Invertebrate Lifespan Quantification • Ion-Exchange Chromatography • Isolating Nucleic Acids from Yeast • Isolation of Fecal Bacteria from Water Samples by Filtration • Just-noticeable Differences • Knee Exam • Language: The N400 in Semantic Incongruity • Le Châtelier's Principle • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Learning and Memory: The Remember-Know Task • Live Cell Imaging of Mitosis • Lower Back Exam • Lymph Node Exam • MALDI-TOF Mass Spectrometry • Making Solutions in the Laboratory • Making a Geologic Cross Section • Male Rectal Exam • Manipulating an Independent Variable through Embodiment • Measuring Children's Trust in Testimony • Measuring Grey Matter Differences with Voxel-based Morphometry: The Musical Brain • Measuring Mass in the Laboratory • Measuring Reaction Time and Donders' Method of Subtraction • Measuring Tropospheric Ozone • Measuring Verbal Working Memory Span • Measuring Vital Signs • Memory Development: Demonstrating How Repeated Questioning Leads to False Memories • Mental Rotation • Metabolic Labeling • Metacognitive Development: How Children Estimate Their Memory • Method of Standard Addition • Modeling Social Stress • Molecular Cloning • Motion-induced Blindness • Motor Exam I • Motor Exam II • Motor Learning in Mirror Drawing • Motor Maps • Mouse Genotyping • Multiple Object Tracking • Murine In Utero Electroporation

		• Mutual Exclusivity: How Children Learn the Meanings of Words • Neck Exam • Needle Thoracostomy (needle Decompression) for Temporizing Tension Pneumothorax Treatment • Neuronal Transfection Methods • Nose, Sinuses, Oral Cavity and Pharynx Exam • Nuclear Magnetic Resonance (NMR) Spectroscopy • Numerical Cognition: More or Less • Nutrients in Aquatic Ecosystems • Object Substitution Masking • Observation and Inspection • Observational Research • Ophthalmoscopic Examination • PCR: The Polymerase Chain Reaction • Palpation • Passaging Cells • Patch Clamp Electrophysiology • Pelvic Exam I: Assessment of the External Genitalia • Pelvic Exam II: Speculum Exam • Pelvic Exam III: Bimanual and Rectovaginal Exam • Percussion • Percutaneous Cricothyrotomy (Seldinger Technique) • Performing 1D Thin Layer Chromatography • Pericardiocentesis • Peripheral Vascular Exam • Peripheral Vascular Exam Using a Continuous Wave Doppler • Peripheral Venous Cannulation • Perspectives on Sensation and Perception • Photometric Protein Determination • Physical Properties Of Minerals I: Crystals and Cleavage • Physical Properties Of Minerals II: Polymineralic Analysis • Physiological Correlates of Emotion Recognition • Piaget's Conservation Task and the Influence of Task Demands • Pilot Testing • Placebos in Research • Plasmid Purification • Positive Reinforcement Studies • Preparing Anhydrous Reagents and Equipment • Primary Neuronal Cultures • Proper Adjustment of Patient Attire during the Physical Exam • Prospect Theory • Protein Crystallization • Proton Exchange Membrane Fuel Cells • Purification of a Total Lipid Extract with Column Chromatography • Purifying Compounds by Recrystallization

		• Quantifying Environmental Microorganisms and Viruses Using qPCR • RNA Analysis of Environmental Samples Using RT-PCR • RNA-Seq • RNAi in C. elegans • Raman Spectroscopy for Chemical Analysis • Realism in Experimentation • Recombineering and Gene Targeting • Reconstitution of Membrane Proteins • Regulating Temperature in the Lab: Applying Heat • Regulating Temperature in the Lab: Preserving Samples Using Cold • Reliability in Psychology Experiments • Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry • Respiratory Exam I: Inspection and Palpation • Respiratory Exam II: Percussion and Auscultation • Restriction Enzyme Digests • Rodent Handling and Restraint Techniques • Rodent Identification I • Rodent Identification II • Rodent Stereotaxic Surgery • Rotary Evaporation to Remove Solvent • SNP Genotyping • Sample Preparation for Analytical Preparation • Scanning Electron Microscopy (SEM) • Schlenk Lines Transfer of Solvents • Self-administration Studies • Self-report vs. Behavioral Measures of Recycling • Sensory Exam • Separating Protein with SDS-PAGE • Separation of Mixtures via Precipitation • Shoulder Exam I • Shoulder Exam II • Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium • Solid-Liquid Extraction • Solutions and Concentrations • Sonication Extraction of Lipid Biomarkers from Sediment • Soxhlet Extraction of Lipid Biomarkers from Sediment • Spatial Cueing • Spatial Memory Testing Using Mazes • Spectrophotometric Determination of an Equilibrium Constant • Sterile Tissue Harvest • Surface Plasmon Resonance (SPR) • Surgical Cricothyrotomy • Tandem Mass Spectrometry • Testing For Genetically Modified Foods • The ATP Bioluminescence Assay

		• The Ames Room • The Attentional Blink • The Costs and Benefits of Natural Pedagogy • The ELISA Method • The Factorial Experiment • The Ideal Gas Law • The Inverted-face Effect • The McGurk Effect • The Morris Water Maze • The Multi-group Experiment • The Precision of Visual Working Memory with Delayed Estimation • The Rouge Test: Searching for a Sense of Self • The Rubber Hand Illusion • The Simple Experiment: Two-group Design • The Split Brain • The Staircase Procedure for Finding a Perceptual Threshold • The TUNEL Assay • The Transwell Migration Assay • The Western Blot • Thyroid Exam • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Tree Identification: How To Use a Dichotomous Key • Tree Survey: Point-Centered Quarter Sampling Method • Turbidity and Total Solids in Surface Water • Two-Dimensional Gel Electrophoresis • Ultraviolet-Visible (UV-Vis) Spectroscopy • Understanding Concentration and Measuring Volumes • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy • Using Diffusion Tensor Imaging in Traumatic Brain Injury • Using GIS to Investigate Urban Forestry • Using TMS to Measure Motor Excitability During Action Observation • Using Topographic Maps to Generate Topographic Profiles • Using Your Head: Measuring Infants' Rational Imitation of Actions • Using a pH Meter • Verbal Priming • Visual Attention: fMRI Investigation of Object-based Attentional Control • Visual Search for Features and Conjunctions • Visual Statistical Learning • Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy • Water Quality Analysis via Indicator Organisms • Whole-Mount In Situ Hybridization

		• Within-subjects Repeated-measures Design • X-ray Fluorescence (XRF) • Yeast Maintenance • Yeast Reproduction • Yeast Transformation and Cloning • Zebrafish Breeding and Embryo Handling • Zebrafish Maintenance and Husbandry • Zebrafish Microinjection Techniques • Zebrafish Reproduction and Development • fMRI: Functional Magnetic Resonance Imaging
STANDARD / AREA OF LEARNING	**UT.CC.RST.9-10.**	**Reading Standards for Literacy in Science and Technical Subjects**
OBJECTIVE / STRAND		**Integration of Knowledge and Ideas**
INDICATOR / CLUSTER	**RST.9-10.7.**	**Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.** **JoVE** • Algae Enumeration via Culturable Methodology • 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 Metabolism • An Introduction to Cognition • An Introduction to Developmental Neurobiology • An Introduction to Drosophila melanogaster • An Introduction to Endocytosis and Exocytosis • An Introduction to Learning and Memory • An Introduction to Modeling Behavioral Disorders and Stress • An Introduction to Motor Control • An Introduction to Neurophysiology • An Introduction to Reward and Addiction • An Overview of Alkenone Biomarker Analysis for Paleothermometry • An Overview of Genetic Analysis • An Overview of Genetics and Disease • An Overview of bGDGT Biomarker Analysis for Paleoclimatology • Analysis of Earthworm Populations in Soil • Annexin V and Propidium Iodide Labeling • Anterograde Amnesia • Anxiety Testing • Approximate Number Sense Test • Are You Smart or Hardworking? How Praise Influences Children's Motivation • Assembly of a Reflux System for Heated Chemical Reactions • Assessing Dexterity with Reaching Tasks

		• Bacterial Growth Curve Analysis and its Environmental Applications • Balance and Coordination Testing • Basic Mouse Care and Maintenance • Binocular Rivalry • Biofuels: Producing Ethanol from Cellulosic Material • Blood Pressure Measurement • C. elegans Chemotaxis Assay • Calcium Imaging in Neurons • Calibration Curves • Capillary Electrophoresis (CE) • Carbon and Nitrogen Analysis of Environmental Samples • Categories and Inductive Inferences • Cell Cycle Analysis • Cell-surface Biotinylation Assay • Children's Reliance on Artist Intentions When Identifying Pictures • Chromatin Immunoprecipitation • Chromatography-Based Biomolecule Purification Methods • Co-Immunoprecipitation and Pull-Down Assays • Column Chromatography • 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 • Crowding • Culturing and Enumerating Bacteria from Soil Samples • Cyclic Voltammetry (CV) • DNA Methylation Analysis • Decision-making and the Iowa Gambling Task • Decoding Auditory Imagery with Multivoxel Pattern Analysis • Degassing Liquids with Freeze-Pump-Thaw Cycling • Density Gradient Ultracentrifugation • Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis • Detecting Reactive Oxygen Species • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Determination of Moisture Content in Soil • Determining Rate Laws and the Order of Reaction • Determining Spatial Orientation of Rock Layers with the Brunton Compass • 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 • Development and Reproduction of the Laboratory

		Mouse **• Dialysis: Diffusion Based Separation** **• Dichotic Listening** **• Dissolved Oxygen in Surface Water** **• Drosophila Development and Reproduction** **• Electro-encephalography (EEG)** **• Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat** **• Electrophoretic Mobility Shift Assay (EMSA)** **• Enzyme Assays and Kinetics** **• Ethics in Psychology Research** **• Event-related Potentials and the Oddball Task** **• Executive Function and the Dimensional Change Card Sort Task** **• Executive Function in Autism Spectrum Disorder** **• Experimentation using a Confederate** **• Expression Profiling with Microarrays** **• Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction** **• Eye Tracking in Cognitive Experiments** **• FM Dyes in Vesicle Recycling** **• Fate Mapping** **• Fear Conditioning** **• Fractional Distillation** **• Freezing-Point Depression to Determine an Unknown Compound** **• From Theory to Design: The Role of Creativity in Designing Experiments** **• Förster Resonance Energy Transfer (FRET)** **• Gas Chromatography (GC) with Flame-Ionization Detection** **• Gene Silencing with Morpholinos** **• Genetic Crosses** **• Genetic Screens** **• Growing Crystals for X-ray Diffraction Analysis** **• Habituation: Studying Infants Before They Can Talk** **• High-Performance Liquid Chromatography (HPLC)** **• How Children Solve Problems Using Causal Reasoning** **• Ideal Gas Law** **• Igneous Intrusive Rock** **• Igneous Volcanic Rock** **• Inattentional Blindness** **• Incidental Encoding** **• Internal Standards** **• Introducing Experimental Agents into the Mouse** **• Introduction to Catalysis** **• Introduction to Mass Spectrometry** **• Introduction to Titration** **• Introduction to the Microplate Reader** **• Introduction to the Spectrophotometer** **• Invasion Assay Using 3D Matrices** **• Invertebrate Lifespan Quantification**

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		• Physiological Correlates of Emotion Recognition • Piaget's Conservation Task and the Influence of Task Demands • Pilot Testing • Placebos in Research • Plasmid Purification • Positive Reinforcement Studies • Preparing Anhydrous Reagents and Equipment • Prospect Theory • Protein Crystallization • Proton Exchange Membrane Fuel Cells • Purification of a Total Lipid Extract with Column Chromatography • Purifying Compounds by Recrystallization • Quantifying Environmental Microorganisms and Viruses Using qPCR • RNA Analysis of Environmental Samples Using RT-PCR • RNA-Seq • RNAi in C. elegans • Raman Spectroscopy for Chemical Analysis • Realism in Experimentation • Reconstitution of Membrane Proteins • Reliability in Psychology Experiments • Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry • Rotary Evaporation to Remove Solvent • SNP Genotyping • Sample Preparation for Analytical Preparation • Scanning Electron Microscopy (SEM) • Schlenk Lines Transfer of Solvents • Self-administration Studies • Self-report vs. Behavioral Measures of Recycling • Separation of Mixtures via Precipitation • Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium • Solid-Liquid Extraction • Solutions and Concentrations • Sonication Extraction of Lipid Biomarkers from Sediment • Soxhlet Extraction of Lipid Biomarkers from Sediment • Spatial Cueing • Spatial Memory Testing Using Mazes • Spectrophotometric Determination of an Equilibrium Constant • Surface Plasmon Resonance (SPR) • Tandem Mass Spectrometry • Testing For Genetically Modified Foods • The ATP Bioluminescence Assay • The Attentional Blink • The Costs and Benefits of Natural Pedagogy • The ELISA Method • The Factorial Experiment

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STANDARD / AREA OF LEARNING	**UT.CC.WHST.9-10.**	**Writing Standards for Literacy in Science and Technical Subjects**
OBJECTIVE / STRAND		**Text Types and Purposes**
INDICATOR / CLUSTER	**WHST.9-10.1.**	**Write arguments focused on discipline-specific content.**

EXPECTATION / STANDARD	WHST.9-10.1(a)	Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. JoVE • The Multi-group Experiment • The Simple Experiment: Two-group Design
STANDARD / AREA OF LEARNING	UT.CC.WHST.9-10.	Writing Standards for Literacy in Science and Technical Subjects
OBJECTIVE / STRAND		Text Types and Purposes
INDICATOR / CLUSTER	WHST.9-10.2.	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
EXPECTATION / STANDARD	WHST.9-10.2(a)	Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. JoVE • The Multi-group Experiment • The Simple Experiment: Two-group Design
EXPECTATION / STANDARD	WHST.9-10.2(d)	Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. JoVE • Abdominal Exam I: Inspection and Auscultation • Abdominal Exam II: Percussion • Abdominal Exam III: Palpation • Abdominal Exam IV: Acute Abdominal Pain Assessment • Algae Enumeration via Culturable Methodology • An Introduction to Aging and Regeneration • An Introduction to Behavioral Neuroscience • 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 Cognition • An Introduction to Developmental Genetics • An Introduction to Developmental Neurobiology • An Introduction to Drosophila melanogaster • An Introduction to Endocytosis and Exocytosis • 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 Neuroanatomy** **• An Introduction to Neurophysiology** **• An Introduction to Organogenesis** **• An Introduction to Reward and Addiction** **• An Introduction to Saccharomyces cerevisiae** **• An Introduction to Stem Cell Biology** **• An Introduction to Transfection** **• An Introduction to Working in the Hood** **• An Introduction to the Centrifuge** **• An Introduction to the Chick: Gallus gallus domesticus** **• An Introduction to the Laboratory Mouse: Mus musculus** **• An Introduction to the Micropipettor** **• An Introduction to the Zebrafish: Danio rerio** **• 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** **• Analysis of Earthworm Populations in Soil** **• Anesthesia Induction and Maintenance** **• Ankle Exam** **• Annexin V and Propidium Iodide Labeling** **• Anterograde Amnesia** **• Anxiety Testing** **• Approximate Number Sense Test** **• Are You Smart or Hardworking? How Praise Influences Children's Motivation** **• Arterial Line Placement** **• Aseptic Technique in Environmental Science** **• Assembly of a Reflux System for Heated Chemical Reactions** **• Assessing Dexterity with Reaching Tasks** **• Auscultation** **• Bacterial Growth Curve Analysis and its Environmental Applications** **• Bacterial Transformation: Electroporation** **• Bacterial Transformation: The Heat Shock Method** **• Balance and Coordination Testing** **• Basic Care Procedures** **• Basic Chick Care and Maintenance** **• Basic Life Support Part II: Airway/Breathing and Continued Cardiopulmonary Resuscitation** **• Basic Life Support: Cardiopulmonary Resuscitation and**

		Defibrillation **• Basic Mouse Care and Maintenance** **• Binocular Rivalry** **• Biofuels: Producing Ethanol from Cellulosic Material** **• Blood Pressure Measurement** **• Blood Withdrawal I** **• Blood Withdrawal II** **• C. elegans Chemotaxis Assay** **• C. elegans Development and Reproduction** **• C. elegans Maintenance** **• Calcium Imaging in Neurons** **• Calibration Curves** **• Capillary Electrophoresis (CE)** **• Carbon and Nitrogen Analysis of Environmental Samples** **• Cardiac Exam I: Inspection and Palpation** **• Cardiac Exam II: Auscultation** **• Cardiac Exam III: Abnormal Heart Sounds** **• Categories and Inductive Inferences** **• Cell Cycle Analysis** **• Cell-surface Biotinylation Assay** **• Central Venous Catheter Insertion: Femoral Vein with Ultrasound Guidance** **• Central Venous Catheter Insertion: Internal Jugular with Ultrasound Guidance** **• Central Venous Catheter Insertion: Subclavian Vein** **• Chick ex ovo Culture** **• Children's Reliance on Artist Intentions When Identifying Pictures** **• Chromatin Immunoprecipitation** **• Chromatography-Based Biomolecule Purification Methods** **• Co-Immunoprecipitation and Pull-Down Assays** **• Color Afterimages** **• Column Chromatography** **• Common Lab Glassware and Uses** **• Community DNA Extraction from Bacterial Colonies** **• Compound Administration I** **• Compound Administration II** **• Compound Administration III** **• Compound Administration IV** **• Comprehensive Breast Exam** **• Conducting Reactions Below Room Temperature** **• Considerations for Rodent Surgery** **• Conversion of Fatty Acid Methyl Esters by Saponification for Uk'37 Paleothermometry** **• Coordination Chemistry Complexes** **• Cranial Nerves Exam I (I-VI)** **• Cranial Nerves Exam II (VII-XII)** **• Crowding** **• Culturing and Enumerating Bacteria from Soil Samples**

		• Cyclic Voltammetry (CV) • Cytogenetics • DNA Gel Electrophoresis • DNA Ligation Reactions • DNA Methylation Analysis • Decision-making and the Iowa Gambling Task • Decoding Auditory Imagery with Multivoxel Pattern Analysis • Degassing Liquids with Freeze-Pump-Thaw Cycling • Density Gradient Ultracentrifugation • Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis • Detecting Reactive Oxygen Species • Detection of Bacteriophages in Environmental Samples • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy • Determination of Moisture Content in Soil • Determining Rate Laws and the Order of Reaction • Determining Spatial Orientation of Rock Layers with the Brunton Compass • 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 • Development and Reproduction of the Laboratory Mouse • Development of the Chick • Diagnostic Necropsy and Tissue Harvest • Dialysis: Diffusion Based Separation • Dichotic Listening • Dissolved Oxygen in Surface Water • Drosophila Development and Reproduction • Drosophila Larval IHC • Drosophila Maintenance • Drosophila melanogaster Embryo and Larva Harvesting and Preparation • Ear Exam • Elbow Exam • Electro-encephalography (EEG) • Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat • Electrophoretic Mobility Shift Assay (EMSA) • Embryonic Stem Cell Culture and Differentiation • Emergency Tube Thoracostomy (Chest Tube Placement) • Emergent Lateral Canthotomy and Inferior Catholysis • Enzyme Assays and Kinetics • Ethics in Psychology Research • Event-related Potentials and the Oddball Task • Executive Function and the Dimensional Change Card

		Sort Task **• Executive Function in Autism Spectrum Disorder** **• Experimentation using a Confederate** **• Explant Culture for Developmental Studies** **• Explant Culture of Neural Tissue** **• Expression Profiling with Microarrays** **• Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction** **• Eye Exam** **• Eye Tracking in Cognitive Experiments** **• FM Dyes in Vesicle Recycling** **• Fate Mapping** **• Fear Conditioning** **• Filamentous Fungi** **• Finding Your Blind Spot and Perceptual Filling-in** **• Foot Exam** **• Fractional Distillation** **• Freezing-Point Depression to Determine an Unknown Compound** **• From Theory to Design: The Role of Creativity in Designing Experiments** **• Fundamentals of Breeding and Weaning** **• Förster Resonance Energy Transfer (FRET)** **• Gas Chromatography (GC) with Flame-Ionization Detection** **• Gel Purification** **• Gene Silencing with Morpholinos** **• General Approach to the Physical Exam** **• Genetic Crosses** **• Genetic Engineering of Model Organisms** **• Genetic Screens** **• Genome Editing** **• Gram Staining of Bacteria from Environmental Sources** **• Growing Crystals for X-ray Diffraction Analysis** **• Habituation: Studying Infants Before They Can Talk** **• Hand and Wrist Exam** **• High-Performance Liquid Chromatography (HPLC)** **• Hip Exam** **• Histological Sample Preparation for Light Microscopy** **• Histological Staining of Neural Tissue** **• How Children Solve Problems Using Causal Reasoning** **• Ideal Gas Law** **• Igneous Intrusive Rock** **• Igneous Volcanic Rock** **• In ovo Electroporation of Chicken Embryos** **• Inattentional Blindness** **• Incidental Encoding** **• Induced Pluripotency** **• Internal Standards** **• Intra-articular Shoulder Injection for Reduction Following Anterior Shoulder Dislocation**

		• Intraosseous Needle Placement • Introducing Experimental Agents into the Mouse • Introduction to Catalysis • Introduction to Fluorescence Microscopy • Introduction to Light Microscopy • Introduction to Mass Spectrometry • Introduction to Serological Pipettes and Pipettors • Introduction to Titration • Introduction to the Bunsen Burner • Introduction to the Microplate Reader • Introduction to the Spectrophotometer • Invasion Assay Using 3D Matrices • Invertebrate Lifespan Quantification • Ion-Exchange Chromatography • Isolating Nucleic Acids from Yeast • Isolation of Fecal Bacteria from Water Samples by Filtration • Just-noticeable Differences • Knee Exam • Language: The N400 in Semantic Incongruity • Le Châtelier's Principle • Lead Analysis of Soil Using Atomic Absorption Spectroscopy • Learning and Memory: The Remember-Know Task • Live Cell Imaging of Mitosis • Lower Back Exam • Lymph Node Exam • MALDI-TOF Mass Spectrometry • Making Solutions in the Laboratory • Making a Geologic Cross Section • Male Rectal Exam • Manipulating an Independent Variable through Embodiment • Measuring Children's Trust in Testimony • Measuring Grey Matter Differences with Voxel-based Morphometry: The Musical Brain • Measuring Mass in the Laboratory • Measuring Reaction Time and Donders' Method of Subtraction • Measuring Tropospheric Ozone • Measuring Verbal Working Memory Span • Measuring Vital Signs • Memory Development: Demonstrating How Repeated Questioning Leads to False Memories • Mental Rotation • Metabolic Labeling • Metacognitive Development: How Children Estimate Their Memory • Method of Standard Addition • Modeling Social Stress • Molecular Cloning

		• Motion-induced Blindness • Motor Exam I • Motor Exam II • Motor Learning in Mirror Drawing • Motor Maps • Mouse Genotyping • Multiple Object Tracking • Murine In Utero Electroporation • Mutual Exclusivity: How Children Learn the Meanings of Words • Neck Exam • Needle Thoracostomy (needle Decompression) for Temporizing Tension Pneumothorax Treatment • Neuronal Transfection Methods • Nose, Sinuses, Oral Cavity and Pharynx Exam • Nuclear Magnetic Resonance (NMR) Spectroscopy • Numerical Cognition: More or Less • Nutrients in Aquatic Ecosystems • Object Substitution Masking • Observation and Inspection • Observational Research • Ophthalmoscopic Examination • PCR: The Polymerase Chain Reaction • Palpation • Passaging Cells • Patch Clamp Electrophysiology • Pelvic Exam I: Assessment of the External Genitalia • Pelvic Exam II: Speculum Exam • Pelvic Exam III: Bimanual and Rectovaginal Exam • Percussion • Percutaneous Cricothyrotomy (Seldinger Technique) • Performing 1D Thin Layer Chromatography • Pericardiocentesis • Peripheral Vascular Exam • Peripheral Vascular Exam Using a Continuous Wave Doppler • Peripheral Venous Cannulation • Perspectives on Sensation and Perception • Photometric Protein Determination • Physical Properties Of Minerals I: Crystals and Cleavage • Physical Properties Of Minerals II: Polymineralic Analysis • Physiological Correlates of Emotion Recognition • Piaget's Conservation Task and the Influence of Task Demands • Pilot Testing • Placebos in Research • Plasmid Purification • Positive Reinforcement Studies • Preparing Anhydrous Reagents and Equipment • Primary Neuronal Cultures

		• Proper Adjustment of Patient Attire during the Physical Exam • Prospect Theory • Protein Crystallization • Proton Exchange Membrane Fuel Cells • Purification of a Total Lipid Extract with Column Chromatography • Purifying Compounds by Recrystallization • Quantifying Environmental Microorganisms and Viruses Using qPCR • RNA Analysis of Environmental Samples Using RT-PCR • RNA-Seq • RNAi in C. elegans • Raman Spectroscopy for Chemical Analysis • Realism in Experimentation • Recombineering and Gene Targeting • Reconstitution of Membrane Proteins • Regulating Temperature in the Lab: Applying Heat • Regulating Temperature in the Lab: Preserving Samples Using Cold • Reliability in Psychology Experiments • Removal of Branched and Cyclic Compounds by Urea Adduction for Uk'37 Paleothermometry • Respiratory Exam I: Inspection and Palpation • Respiratory Exam II: Percussion and Auscultation • Restriction Enzyme Digests • Rodent Handling and Restraint Techniques • Rodent Identification I • Rodent Identification II • Rodent Stereotaxic Surgery • Rotary Evaporation to Remove Solvent • SNP Genotyping • Sample Preparation for Analytical Preparation • Scanning Electron Microscopy (SEM) • Schlenk Lines Transfer of Solvents • Self-administration Studies • Self-report vs. Behavioral Measures of Recycling • Sensory Exam • Separating Protein with SDS-PAGE • Separation of Mixtures via Precipitation • Shoulder Exam I • Shoulder Exam II • Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium • Solid-Liquid Extraction • Solutions and Concentrations • Sonication Extraction of Lipid Biomarkers from Sediment • Soxhlet Extraction of Lipid Biomarkers from Sediment • Spatial Cueing • Spatial Memory Testing Using Mazes

		• Spectrophotometric Determination of an Equilibrium Constant • Sterile Tissue Harvest • Surface Plasmon Resonance (SPR) • Surgical Cricothyrotomy • Tandem Mass Spectrometry • Testing For Genetically Modified Foods • The ATP Bioluminescence Assay • The Ames Room • The Attentional Blink • The Costs and Benefits of Natural Pedagogy • The ELISA Method • The Factorial Experiment • The Ideal Gas Law • The Inverted-face Effect • The McGurk Effect • The Morris Water Maze • The Multi-group Experiment • The Precision of Visual Working Memory with Delayed Estimation • The Rouge Test: Searching for a Sense of Self • The Rubber Hand Illusion • The Simple Experiment: Two-group Design • The Split Brain • The Staircase Procedure for Finding a Perceptual Threshold • The TUNEL Assay • The Transwell Migration Assay • The Western Blot • Thyroid Exam • Tissue Regeneration with Somatic Stem Cells • Transplantation Studies • Tree Identification: How To Use a Dichotomous Key • Tree Survey: Point-Centered Quarter Sampling Method • Turbidity and Total Solids in Surface Water • Two-Dimensional Gel Electrophoresis • Ultraviolet-Visible (UV-Vis) Spectroscopy • Understanding Concentration and Measuring Volumes • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy • Using Diffusion Tensor Imaging in Traumatic Brain Injury • Using GIS to Investigate Urban Forestry • Using TMS to Measure Motor Excitability During Action Observation • Using Topographic Maps to Generate Topographic Profiles • Using Your Head: Measuring Infants' Rational Imitation of Actions • Using a pH Meter • Verbal Priming

		• Visual Attention: fMRI Investigation of Object-based Attentional Control • Visual Search for Features and Conjunctions • Visual Statistical Learning • Visualizing Soil Microorganisms via the Contact Slide Assay and Microscopy • Water Quality Analysis via Indicator Organisms • Whole-Mount In Situ Hybridization • Within-subjects Repeated-measures Design • X-ray Fluorescence (XRF) • Yeast Maintenance • Yeast Reproduction • Yeast Transformation and Cloning • Zebrafish Breeding and Embryo Handling • Zebrafish Maintenance and Husbandry • Zebrafish Microinjection Techniques • Zebrafish Reproduction and Development • fMRI: Functional Magnetic Resonance Imaging
STANDARD / AREA OF LEARNING	**UT.CC.WHST.9-10.**	**Writing Standards for Literacy in Science and Technical Subjects**
OBJECTIVE / STRAND		**Text Types and Purposes**
INDICATOR / CLUSTER	**WHST.9-10.3.**	**(See note; not applicable as a separate requirement)**
EXPECTATION / STANDARD	**WHST.9-10.3(a)**	**Note: Students' narrative skills continue to grow in these grades. The Standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.** **JoVE** • Ethics in Psychology Research • Experimentation using a Confederate • From Theory to Design: The Role of Creativity in Designing Experiments • Manipulating an Independent Variable through Embodiment • Observational Research • Pilot Testing • Placebos in Research • Realism in Experimentation • Reliability in Psychology Experiments • The Factorial Experiment • The Multi-group Experiment • The Simple Experiment: Two-group Design • Within-subjects Repeated-measures Design