**Main Criteria:** Next Generation Science Standards (NGSS)

**Secondary Criteria:** JoVE

**Subject:** Science

**Grade:** 9-12

**Correlation Options:** Show Correlated

**Adopted:** 2013

<table>
<thead>
<tr>
<th>STRAND</th>
<th>NGSS.HS-PS</th>
<th>PHYSICAL SCIENCE</th>
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</thead>
<tbody>
<tr>
<td>TITLE</td>
<td>HS-PS1.</td>
<td>Matter and Its Interactions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students who demonstrate understanding can:</td>
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<tr>
<td>PERFORMANCE EXPECTATION</td>
<td>HS-PS1-1.</td>
<td>Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.</td>
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<tr>
<td>PERFORMANCE EXPECTATION</td>
<td>HS-PS1-2.</td>
<td>Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.</td>
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</tbody>
</table>

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
<table>
<thead>
<tr>
<th>PERFORMANCE EXPECTATION</th>
<th>HS-PS1-4.</th>
<th>Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.</th>
</tr>
</thead>
</table>
|                        | **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 |
| PERFORMANCE EXPECTATION | HS-PS1-5. | Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. |
|                        | **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 |
| PERFORMANCE EXPECTATION | HS-PS1-6. | Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. |
|                        | **JoVE**  | • Assembly of a Reflux System for Heated Chemical Reactions  
• Le Châtelier's Principle  
• Separation of Mixtures via Precipitation  
• Spectrophotometric Determination of an Equilibrium Constant |
| PERFORMANCE EXPECTATION | HS-PS1-7. | Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during 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  
• Preparing Anhydrous Reagents and Equipment  
• Proton Exchange Membrane Fuel Cells  
• Solutions and Concentrations |
<table>
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<th>NGSS.HS-PS.</th>
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<tbody>
<tr>
<td>&quot;Spectrophotometric Determination of an Equilibrium Constant • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy&quot;</td>
<td>PERFORMANCE EXPECTATION</td>
<td>HS-PS1-8.</td>
<td>Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. JoVE • Determining Rate Laws and the Order of Reaction</td>
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<td>&quot;Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. JoVE • Determining Rate Laws and the Order of Reaction&quot;</td>
<td>PERFORMANCE EXPECTATION</td>
<td>HS-PS2-3.</td>
<td>Students who demonstrate understanding can:</td>
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<td>PERFORMANCE EXPECTATION</td>
<td>STRAND</td>
<td>NGSS.HS-PS.</td>
<td>PHYSICAL SCIENCE</td>
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<tr>
<td>&quot;Students who demonstrate understanding can: • Applying scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. JoVE • Raman Spectroscopy for Chemical Analysis&quot;</td>
<td>PERFORMANCE EXPECTATION</td>
<td>HS-PS2-5.</td>
<td>Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. JoVE • fMRI: Functional Magnetic Resonance Imaging</td>
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<td>PERFORMANCE EXPECTATION</td>
<td>HS-PS2-6.</td>
<td>Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. JoVE • Le Châtelier's Principle</td>
</tr>
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<td>PERFORMANCE EXPECTATION</td>
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<td>NGSS.HS-PS.</td>
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<td>PERFORMANCE EXPECTATION</td>
<td>HS-PS3-1.</td>
<td>Students who demonstrate understanding can:</td>
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<td>PERFORMANCE EXPECTATION</td>
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<td>NGSS.HS-PS.</td>
<td>PHYSICAL SCIENCE</td>
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<td>&quot;Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. JoVE • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy&quot;</td>
<td>PERFORMANCE EXPECTATION</td>
<td>HS-PS3-2.</td>
<td>Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles or energy stored in fields.</td>
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<td>&quot;Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. JoVE • fMRI: Functional Magnetic Resonance Imaging&quot;</td>
<td>PERFORMANCE EXPECTATION</td>
<td>HS-PS3-7.</td>
<td>Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. JoVE • Le Châtelier's Principle</td>
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<td>PERFORMANCE EXPECTATION</td>
<td>HS-PS3-8.</td>
<td>Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. JoVE • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy</td>
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<td>&quot;Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. JoVE • Using Differential Scanning Calorimetry to Measure Changes in Enthalpy&quot;</td>
<td>PERFORMANCE EXPECTATION</td>
<td>HS-PS3-9.</td>
<td>Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles or energy stored in fields.</td>
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<td>STRAND</td>
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<tr>
<td>TITLE</td>
<td>HS-PS4. Waves and Their Applications in Technologies for Information Transfer</td>
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<tr>
<td>PERFORMANCE EXPECTATION</td>
<td>HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information.</td>
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<tr>
<td>PERFORMANCE EXPECTATION</td>
<td>HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.</td>
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**JoVE**
- Abdominal Exam II: Percussion
- Auscultation
- Cyclic Voltammetry (CV)
- Ear Exam
- Electrochemical Measurements of Supported Catalysts Using a Potentiostat/Galvanostat
- Percussion

**PERFORMANCE EXPECTATION**
HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

**PERFORMANCE EXPECTATION**
HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

**JoVE**
- fMRI: Functional Magnetic Resonance Imaging
- Gas Chromatography (GC) with Flame-Ionization Detection
- fMRI: Functional Magnetic Resonance Imaging

**STRA ND**
NGSS.HS-PS PHYSICAL SCIENCE

**TITLE**
HS-PS4. Waves and Their Applications in Technologies for Information Transfer

**PERFORMANCE EXPECTATION**
HS-PS4-2. Evaluate questions about the advantages of using a digital transmission and storage of information.

**PERFORMANCE EXPECTATION**
HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.

**JoVE**
- An Introduction to Drosophila melanogaster
- An Introduction to the Zebrafish: Danio rerio
- An Overview of Genetics and Disease
- Color Afterimages
- Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy
- Histological Sample Preparation for Light Microscopy
- Introduction to Fluorescence Microscopy
- Introduction to Light Microscopy
- Introduction to the Spectrophotometer
- Mouse Genotyping
<table>
<thead>
<tr>
<th>PERFORMANCE EXPECTATION</th>
<th>HS-PS4-5.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.</td>
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</tbody>
</table>

**JoVE**
- Abdominal Exam I: Inspection and Auscultation
- Abdominal Exam IV: Acute Abdominal Pain Assessment
- An Introduction to Behavioral Neuroscience
- An Introduction to Cognition
- An Introduction to Learning and Memory
- An Introduction to Motor Control
- An Introduction to Neuroanatomy
- An Introduction to Neurophysiology
- An Overview of Alkenone Biomarker Analysis for Paleothermometry
- An Overview of bGDGT Biomarker Analysis for Paleoclimatology
- Auscultation
- Color Afterimages
- Community DNA Extraction from Bacterial Colonies
- Conducting Reactions Below Room Temperature
- Conversion of Fatty Acid Methyl Esters by Saponification for Uk’37 Paleothermometry
- Coordination Chemistry Complexes
- 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
- Event-related Potentials and the Oddball Task
- Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction
- 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
• Language: The N400 in Semantic Incongruity
• 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
• Percussion
• Pericardiocentesis
• Peripheral Vascular Exam Using a Continuous Wave Doppler
• Photometric Protein Determination
• Physical Properties Of Minerals I: Crystals and Cleavage
• Plasmid Purification
• Protein Crystallization
• Purifying Compounds by Recrystallization
• Raman Spectroscopy for Chemical Analysis
• Removal of Branched and Cyclic Compounds by Urea Adduction for Uk’37 Paleothermometry
• Rodent Stereotaxic Surgery
• Solid-Liquid Extraction
• Sonication Extraction of Lipid Biomarkers from Sediment
• Soxhlet Extraction of Lipid Biomarkers from Sediment
• Spatial Cueing
• Spectrophotometric Determination of an Equilibrium Constant
• Surface Plasmon Resonance (SPR)
• Tandem Mass Spectrometry
• The Attentional Blink
• The Rubber Hand Illusion
• The Staircase Procedure for Finding a Perceptual Threshold
• Turbidity and Total Solids in Surface Water
• Ultraviolet-Visible (UV-Vis) Spectroscopy
Students who demonstrate understanding can:

<table>
<thead>
<tr>
<th>PERFORMANCE EXPECTATION</th>
<th>STRAND</th>
<th>NGSS.HS-LS.</th>
<th>LIFE SCIENCE</th>
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<tbody>
<tr>
<td>HS-LS1-1.</td>
<td>HS-LS1</td>
<td>From Molecules to Organisms: Structures and Processes</td>
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<tr>
<td>Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.</td>
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</table>

**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
- Detecting Reactive Oxygen Species
- Development and Reproduction of the Laboratory Mouse
- Drosophila melanogaster Embryo and Larva Harvesting and Preparation
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<tr>
<th>PERFORMANCE EXPECTATION</th>
<th>HS-LS1-2.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.</strong></td>
<td></td>
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</tbody>
</table>

**JoVE**
- 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

- 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
• An Introduction to Molecular Developmental Biology
• An Introduction to Motor Control
• An Introduction to Organogenesis
• An Introduction to Reward and Addiction
• An Introduction to Stem Cell Biology
• An Introduction to the Chick: Gallus gallus domesticus
• An Introduction to the Zebrafish: Danio rerio
• Anesthesia Induction and Maintenance
• Anxiety Testing
• Approximate Number Sense Test
• Assessing Dexterity with Reaching Tasks
• Balance and Coordination Testing
• Basic Care Procedures
• Binocular Rivalry
• Blood Withdrawal I
• Blood Withdrawal II
• C. elegans Chemotaxis Assay
• C. elegans Development and Reproduction
• C. elegans Maintenance
• Calcium Imaging in Neurons
• Chick ex ovo Culture
• Co-Immunoprecipitation and Pull-Down Assays
• Color Afterimages
• Compound Administration I
• Compound Administration II
• Compound Administration III
• Compound Administration IV
• Considerations for Rodent Surgery
• Crowding
• Detecting Reactive Oxygen Species
• Development and Reproduction of the Laboratory Mouse
• Development of the Chick
• Diagnostic Necropsy and Tissue Harvest
• Dichotic Listening
• Drosophila Development and Reproduction
• Drosophila Larval IHC
• Embryonic Stem Cell Culture and Differentiation
• Explant Culture for Developmental Studies
• Explant Culture of Neural Tissue
• Expression Profiling with Microarrays
• Fate Mapping
• Finding Your Blind Spot and Perceptual Filling-in
• Fundamentals of Breeding and Weaning
• Genetic Engineering of Model Organisms
• Habituation: Studying Infants Before They Can Talk
• Histological Sample Preparation for Light Microscopy
• Histological Staining of Neural Tissue
• In ovo Electroporation of Chicken Embryos
• Inattentive Blindness
• Incidental Encoding
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<th>PERFORMANCE EXPECTATION</th>
<th>HS-LS1-3.</th>
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<td>Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.</td>
<td></td>
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</tbody>
</table>

**JoVE**
- Abdominal Exam I: Inspection and Auscultation
- Abdominal Exam II: Percussion
- Abdominal Exam III: Palpation
- Abdominal Exam IV: Acute Abdominal Pain Assessment
- An Introduction to Cell Death
- An Introduction to Cell Division
- An Introduction to Cell Metabolism
- An Introduction to Cellular and Molecular Neuroscience
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<td>Arterial Line Placement</td>
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<td>Balance and Coordination Testing</td>
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<td>Basic Care Procedures</td>
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<tr>
<td>Basic Life Support Part II: Airway/Breathing and Continued Cardiopulmonary Resuscitation</td>
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<td>Basic Life Support: Cardiopulmonary Resuscitation and Defibrillation</td>
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<td>Basic Mouse Care and Maintenance</td>
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<td>Blood Pressure Measurement</td>
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<td>Blood Withdrawal II</td>
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<td>C. elegans Development and Reproduction</td>
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<td>Calcium Imaging in Neurons</td>
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<td>Cardiac Exam I: Inspection and Palpation</td>
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<td>Cardiac Exam II: Auscultation</td>
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<td>Cardiac Exam III: Abnormal Heart Sounds</td>
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<td>Cell-surface Biotinylation Assay</td>
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<td>Central Venous Catheter Insertion: Femoral Vein with Ultrasound Guidance</td>
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<td>Central Venous Catheter Insertion: Internal Jugular with Ultrasound Guidance</td>
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<td>Compound Administration II</td>
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<td>Compound Administration III</td>
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<td>Comprehensive Breast Exam</td>
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<td>Considerations for Rodent Surgery</td>
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<td>Cranial Nerves Exam II (VII-XII)</td>
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<td>Detecting Reactive Oxygen Species</td>
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<td>Emergency Tube Thoracostomy (Chest Tube Placement)</td>
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<td>Emergent Lateral Canthotomy and Inferior Catholysis</td>
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<td>FM Dyes in Vesicle Recycling</td>
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<td>Fear Conditioning</td>
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<td>Ophthalmoscopic Examination</td>
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<td>Patch Clamp Electrophysiology</td>
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<td>Pelvic Exam I: Assessment of the External Genitalia</td>
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<td>Pelvic Exam II: Speculum Exam</td>
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<td>Percussion</td>
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<tr>
<td>Percutaneous Cricothyrotomy (Seldinger Technique)</td>
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<td>Pericardiocentesis</td>
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<td>Peripheral Vascular Exam</td>
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<td>Peripheral Vascular Exam Using a Continuous Wave Doppler</td>
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<td>Peripheral Venous Cannulation</td>
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<td>Physiological Correlates of Emotion Recognition</td>
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<tr>
<td>Proper Adjustment of Patient Attire during the Physical Exam</td>
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<tr>
<td>Reconstitution of Membrane Proteins</td>
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<td>Respiratory Exam I: Inspection and Palpation</td>
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<tr>
<td>Respiratory Exam II: Percussion and Auscultation</td>
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<tr>
<td>Self-administration Studies</td>
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<tr>
<td>Sensory Exam</td>
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<tr>
<td>Shoulder Exam I</td>
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<tr>
<td>Shoulder Exam II</td>
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<tr>
<td>PERFORMANCE EXPECTATION</td>
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</table>

**JoVE**
- An Introduction to Aging and Regeneration
- An Introduction to Caenorhabditis elegans
- An Introduction to Cell Division
- An Introduction to Cell Motility and Migration
- An Introduction to Developmental Genetics
- An Introduction to Developmental Neurobiology
- An Introduction to Molecular Developmental Biology
- An Introduction to Organogenesis
- An Introduction to Saccharomyces cerevisiae
- An Introduction to Stem Cell Biology
- An Overview of Epigenetics
- An Overview of Gene Expression
- C. elegans Development and Reproduction
- Cell Cycle Analysis
- DNA Methylation Analysis
- Development and Reproduction of the Laboratory Mouse
- Development of the Chick
- Drosophila Larval IHC
- Embryonic Stem Cell Culture and Differentiation
- Explant Culture for Developmental Studies
- Explant Culture of Neural Tissue
- Expression Profiling with Microarrays
- Fate Mapping
- Gene Silencing with Morpholinos
- Genetic Engineering of Model Organisms
- Induced Pluripotency
- Live Cell Imaging of Mitosis
- Murine In Utero Electroporation
- RNA-Seq
- Tissue Regeneration with Somatic Stem Cells
- Transplantation Studies
- Whole-Mount In Situ Hybridization
<table>
<thead>
<tr>
<th>PERFORMANCE EXPECTATION</th>
<th>HS-LS1-5.</th>
<th>Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.</th>
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<tbody>
<tr>
<td></td>
<td>HS-LS1-6.</td>
<td>Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.</td>
</tr>
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</table>

**JoVE**
- An Introduction to Cell Metabolism
- Reconstitution of Membrane Proteins
- An Introduction to Caenorhabditis elegans
- An Introduction to Cell Death
- An Introduction to Cell Division
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- An Introduction to Saccharomyces cerevisiae
- An Introduction to Transfection
- An Overview of Alkenone Biomarker Analysis for Paleothermometry
- An Overview of Epigenetics
- An Overview of Gene Expression
- An Overview of Genetic Analysis
- An Overview of Genetic Engineering
- An Overview of Genetics and Disease
- An Overview of bGDGT Biomarker Analysis for Paleoclimatology
- Annexin V and Propidium Iodide Labeling
- Bacterial Transformation: Electroporation
- Bacterial Transformation: The Heat Shock Method
- Biofuels: Producing Ethanol from Cellulosic Material
- C. elegans Maintenance
- Carbon and Nitrogen Analysis of Environmental Samples
- Cell Cycle Analysis
- Cell-surface Biotinylation Assay
- Chromatin Immunoprecipitation
- Chromatography-Based Biomolecule Purification Methods
- Co-Immunoprecipitation and Pull-Down Assays
- Column Chromatography
- Community DNA Extraction from Bacterial Colonies
- Conversion of Fatty Acid Methyl Esters by
Saponification for Uk'37 Paleothermometry
- Cytogenetics
- DNA Gel Electrophoresis
- DNA Ligation Reactions
- DNA Methylation Analysis
- Density Gradient Ultracentrifugation
- Detecting Environmental Microorganisms with the Polymerase Chain Reaction and Gel Electrophoresis
- Detecting Reactive Oxygen Species
- Development and Reproduction of the Laboratory Mouse
- Development of the Chick
- Dialysis: Diffusion Based Separation
- Drosophila Development and Reproduction
- Drosophila Larval IHC
- Drosophila melanogaster Embryo and Larva Harvesting and Preparation
- Electrophoretic Mobility Shift Assay (EMSA)
- Embryonic Stem Cell Culture and Differentiation
- Enzyme Assays and Kinetics
- Explant Culture for Developmental Studies
- Expression Profiling with Microarrays
- Extraction of Biomarkers from Sediments - Accelerated Solvent Extraction
- FM Dyes in Vesicle Recycling
- Förster Resonance Energy Transfer (FRET)
- Gel Purification
- Gene Silencing with Morpholinos
- Genetic Crosses
- Genetic Engineering of Model Organisms
- Genetic Screens
- Genome Editing
- In ovo Electroporation of Chicken Embryos
- Induced Pluripotency
- Introduction to Catalysis
- Introduction to Mass Spectrometry
- Invasion Assay Using 3D Matrices
- Invertebrate Lifespan Quantification
- Ion-Exchange Chromatography
- Isolating Nucleic Acids from Yeast
- Live Cell Imaging of Mitosis
- MALDI-TOF Mass Spectrometry
- Metabolic Labeling
- Method of Standard Addition
- Molecular Cloning
- Mouse Genotyping
- Nutrients in Aquatic Ecosystems
- PCR: The Polymerase Chain Reaction
- Photometric Protein Determination
- Plasmid Purification
- Protein Crystallization
PERFORMANCE EXPECTATION

HS-LS1-7.

Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.

JoVE
• An Introduction to Cell Metabolism
• Biofuels: Producing Ethanol from Cellulosic Material
• Detecting Reactive Oxygen Species
• The ATP Bioluminescence Assay

STRAND
NGSS.HS-LS. LIFE SCIENCE
<table>
<thead>
<tr>
<th>PERFORMANCE EXPECTATION</th>
<th>HS-LS2-2.</th>
<th>Ecosystems: Interactions, Energy, and Dynamics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students who demonstrate understanding can:</td>
<td>Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.</td>
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<tr>
<td>JoVE</td>
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<tr>
<td>• Algae Enumeration via Culturable Methodology</td>
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<td>• An Introduction to the Chick: Gallus gallus domesticus</td>
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<td>• An Introduction to the Laboratory Mouse: Mus musculus</td>
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<tr>
<td>• Analysis of Earthworm Populations in Soil</td>
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<tr>
<td>• Aseptic Technique in Environmental Science</td>
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<td>• Bacterial Growth Curve Analysis and its Environmental Applications</td>
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<td>• Bacterial Transformation: Electroporation</td>
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<td>• Bacterial Transformation: The Heat Shock Method</td>
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<tr>
<td>• Basic Mouse Care and Maintenance</td>
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<td>• C. elegans Maintenance</td>
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<td>• Culturing and Enumerating Bacteria from Soil Samples</td>
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<td>• Detection of Bacteriophages in Environmental Samples</td>
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<td>• Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy</td>
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<td>• Dissolved Oxygen in Surface Water</td>
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<td>• Drosophila Maintenance</td>
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<td>• Drosophila melanogaster Embryo and Larva Harvesting and Preparation</td>
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<td>• Filamentous Fungi</td>
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<tr>
<td>• Introduction to Mass Spectrometry</td>
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<td>• Isolation of Fecal Bacteria from Water Samples by Filtration</td>
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<td>• Lead Analysis of Soil Using Atomic Absorption Spectroscopy</td>
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<td>• Measuring Tropospheric Ozone</td>
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<td>• Nutrients in Aquatic Ecosystems</td>
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<td>• Passaging Cells</td>
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<td>• Plasmid Purification</td>
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<td>• Quantifying Environmental Microorganisms and Viruses Using qPCR</td>
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<td>• Tree Identification: How To Use a Dichotomous Key</td>
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<td>• Tree Survey: Point-Centered Quarter Sampling Method</td>
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<td>• Turbidity and Total Solids in Surface Water</td>
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<td>• Water Quality Analysis via Indicator Organisms</td>
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<td>• Yeast Maintenance</td>
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<td>• Yeast Reproduction</td>
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<tr>
<td>PERFORMANCE EXPECTATION</td>
<td>HS-LS2-3.</td>
<td>Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.</td>
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<tr>
<td>PERFORMANCE EXPECTATION</td>
<td>HS-LS2-4.</td>
<td>Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.</td>
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</tbody>
</table>
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|                         |          | • Analysis of Earthworm Populations in Soil  
|                         |          | • Bacterial Growth Curve Analysis and its Environmental Applications  
|                         |          | • Carbon and Nitrogen Analysis of Environmental Samples  
|                         |          | • Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy  
|                         |          | • Dissolved Oxygen in Surface Water  
|                         |          | • Filamentous Fungi  
|                         |          | • Fundamentals of Breeding and Weaning  
|                         |          | • Nutrients in Aquatic Ecosystems  
|                         |          | • Soil Nutrient Analysis: Nitrogen, Phosphorus, and Potassium  
|                         |          | • Using GIS to Investigate Urban Forestry  
|                         |          | **JoVE**  
|                         |          | • Alkenone Biomarker Analysis for Paleothermometry  
|                         |          | • An Overview of Alkenone Biomarker Analysis for Paleothermometry  
|                         |          | • bGDGT Biomarker Analysis for Paleoecology  
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|                         |          | • 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  
<p>|</p>
<table>
<thead>
<tr>
<th>PERFORMANCE EXPECTATION</th>
<th>HS-LS2-5.</th>
<th>Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td><strong>JoVE</strong></td>
</tr>
</tbody>
</table>
|                         |           | • An Introduction to Cell Metabolism  
• Biofuels: Producing Ethanol from Cellulosic Material  
• Detecting Reactive Oxygen Species  
• The ATP Bioluminescence Assay |
| PERFORMANCE EXPECTATION | HS-LS2-7. | Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.                                                                                      |
|                         |           | **JoVE**                                                                                                                                                                                                 |
|                         |           | • Biofuels: Producing Ethanol from Cellulosic Material  
• Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy  
• Measuring Tropospheric Ozone  
• Proton Exchange Membrane Fuel Cells  
• Self-report vs. Behavioral Measures of Recycling  
• Using GIS to Investigate Urban Forestry |
| STRAND | NGSS.HS-LS. | LIFE SCIENCE |
| TITLE | HS-LS3. | Heredity: Inheritance and Variation of Traits |
| Students who demonstrate understanding can: | |
| PERFORMANCE EXPECTATION | HS-LS3-1. | Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. |
|                         |           | **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 Drosophila melanogaster  
• An Introduction to Molecular Developmental Biology  
• An Introduction to Saccharomyces cerevisiae  
• An Introduction to Transfection  
• An Introduction to the Zebrafish: Danio rerio  
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• 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
<table>
<thead>
<tr>
<th>PERFORMANCE EXPECTATION</th>
<th>HS-LS3-2.</th>
<th>Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS-LS3-3.</td>
<td></td>
<td>Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.</td>
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<td>JoVE</td>
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<td>• Genetic Crosses</td>
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<td>• The ELISA Method</td>
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<td>• Yeast Reproduction</td>
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<td>• Zebrafish Maintenance and Husbandry</td>
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<td>STRAND</td>
<td>NGSS.HS-LS.</td>
<td>LIFE SCIENCE</td>
</tr>
<tr>
<td>TITLE</td>
<td>HS-LS4.</td>
<td>Biological Evolution: Unity and Diversity</td>
</tr>
<tr>
<td>PERFORMANCE EXPECTATION</td>
<td>HS-LS4-1.</td>
<td>Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.</td>
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</tbody>
</table>
|                         |          | **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) |
| PERFORMANCE EXPECTATION | HS-LS4-2. | Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment. |
|                         |          | **JoVE**  
|                         |          | • An Introduction to the Chick: Gallus gallus domesticus  
|                         |          | • An Overview of Genetic Analysis |
| PERFORMANCE EXPECTATION | HS-LS4-3. | Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. |
|                         |          | **JoVE**  
|                         |          | • An Overview of Genetic Analysis |
| PERFORMANCE EXPECTATION | HS-LS4-4. | Construct an explanation based on evidence for how natural selection leads to adaptation of populations. |
|                         |          | **JoVE**  
|                         |          | • An Overview of Genetic Analysis |
| PERFORMANCE EXPECTATION | HS-LS4-5. | Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. |
|                         |          | **JoVE**  
|                         |          | • Algae Enumeration via Culturable Methodology  
<p>|                         |          | • An Introduction to the Chick: Gallus gallus domesticus |</p>
<table>
<thead>
<tr>
<th>PERFORMANCE EXPECTATION</th>
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<th>TITLE</th>
<th>EARTH AND SPACE SCIENCE</th>
</tr>
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<tbody>
<tr>
<td>HS-LS4-6.</td>
<td>NGSS.HS-ESS.</td>
<td>Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.</td>
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<td></td>
<td>HS-E1.</td>
<td></td>
<td>• Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy</td>
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<td>• Lead Analysis of Soil Using Atomic Absorption Spectroscopy</td>
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<td>• Self-report vs. Behavioral Measures of Recycling</td>
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<tr>
<td>HS-ESS1.</td>
<td></td>
<td>Earth’s Place in the Universe</td>
<td></td>
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<tr>
<td>Students who demonstrate understanding can:</td>
<td></td>
<td>Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun’s core to release energy that eventually reaches Earth in the form of radiation.</td>
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<tr>
<td>HS-ESS1-1.</td>
<td></td>
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<td>• Turbidity and Total Solids in Surface Water</td>
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<tr>
<td>HS-ESS1-5.</td>
<td></td>
<td>Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.</td>
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<tr>
<td>STRAND</td>
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<td>EARTH AND SPACE SCIENCE</td>
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<tr>
<td>TITLE</td>
<td>HS-ESS2.</td>
<td>Earth’s Systems</td>
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<td>Students who demonstrate understanding can:</td>
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<tr>
<td>PERFORMANCE EXPECTATION</td>
<td>HS-ESS2-1.</td>
<td>Develop a model to illustrate how Earth’s internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.</td>
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<td>JoVE</td>
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<td></td>
<td>• Igneous Intrusive Rock</td>
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<td>• Igneous Volcanic Rock</td>
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<td>• Making a Geologic Cross Section</td>
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<td>• Turbidity and Total Solids in Surface Water</td>
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<td>• Using Topographic Maps to Generate Topographic Profiles</td>
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<tr>
<td>PERFORMANCE EXPECTATION</td>
<td>HS-ESS2-2.</td>
<td>Analyze geoscience data to make the claim that one change to Earth’s surface can create feedbacks that cause changes to other Earth’s systems.</td>
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<td>• Determining the Solubility Rules of Ionic Compounds</td>
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<td>• Dissolved Oxygen in Surface Water</td>
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<td>• Le Châtelier's Principle</td>
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<td>• Water Quality Analysis via Indicator Organisms</td>
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<td>PERFORMANCE EXPECTATION</td>
<td>HS-ESS2-5.</td>
<td>Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.</td>
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<td>JoVE</td>
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<td>PERFORMANCE EXPECTATION</td>
<td>HS-ESS2-6.</td>
<td>Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.</td>
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</table>
|                          |            | **JoVE**<br>• 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 |

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<tr>
<th>PERFORMANCE EXPECTATION</th>
<th>HS-ESS2-7.</th>
<th>Construct an argument based on evidence about the simultaneous coevolution of Earth’s systems and life on Earth.</th>
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|                          |            | **JoVE**<br>• An Overview of Alkenone Biomarker Analysis for Paleothermometry  
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<th>STRAND</th>
<th>NGSS.HS-ESS.</th>
<th>EARTH AND SPACE SCIENCE</th>
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<tbody>
<tr>
<td>TITLE</td>
<td>HS-ESS3.</td>
<td>Earth and Human Activity</td>
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<td>Students who demonstrate understanding can:</td>
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<tr>
<td>PERFORMANCE EXPECTATION</td>
<td>HS-ESS3-1.</td>
<td>Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human</td>
</tr>
</tbody>
</table>

| PERFORMANCE EXPECTATION | HS-ESS3-2. | Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. | JoVE  
- Biofuels: Producing Ethanol from Cellulosic Material  
- Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy  
- Dissolved Oxygen in Surface Water  
- Igneous Intrusive Rock  
- Igneous Volcanic Rock  
- Lead Analysis of Soil Using Atomic Absorption Spectroscopy  
- Measuring Tropospheric Ozone  
- Nutrients in Aquatic Ecosystems  
- Proton Exchange Membrane Fuel Cells  
- 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 |
| PERFORMANCE EXPECTATION | HS-ESS3-3. | Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. | JoVE  
- Biofuels: Producing Ethanol from Cellulosic Material  
- Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy  
- Fractional Distillation  
- Igneous Intrusive Rock  
- Proton Exchange Membrane Fuel Cells  
- Raman Spectroscopy for Chemical Analysis  
- Electrophoretic Mobility Shift Assay (EMSA)  
- Lead Analysis of Soil Using Atomic Absorption Spectroscopy  
- Measuring Tropospheric Ozone  
- Proton Exchange Membrane Fuel Cells  
- Self-report vs. Behavioral Measures of Recycling  
- Tree Identification: How To Use a Dichotomous Key  
- Tree Survey: Point-Centered Quarter Sampling Method  
- Using GIS to Investigate Urban Forestry |
<p>| PERFORMANCE EXPECTATION | HS-ESS3-4. | Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. |</p>
<table>
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<tr>
<th>PERFORMANCE EXPECTATION</th>
<th>HS-ESS3-5.</th>
<th>Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERFORMANCE EXPECTATION</td>
<td>HS-ESS3-6.</td>
<td>Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.</td>
</tr>
</tbody>
</table>

**Engineering Design**

**NGSS.HS-ETS.** Engineering Design

**TITLE** HS-ETS1.

**PERFORMANCE EXPECTATION** HS-ETS1-1.

Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

**JoVE**

- Biofuels: Producing Ethanol from Cellulosic Material
- Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy
- Measuring Tropospheric Ozone
- Proton Exchange Membrane Fuel Cells
- Raman Spectroscopy for Chemical Analysis
- Using GIS to Investigate Urban Forestry
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<th>HS-ETS1-3.</th>
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<tr>
<td></td>
<td>Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</td>
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</tbody>
</table>

JoVE
- Biofuels: Producing Ethanol from Cellulosic Material
- Determination Of Nox in Automobile Exhaust Using UV-VIS Spectroscopy
- Measuring Tropospheric Ozone
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