Chino Valley Unified School District
High School Course Description

CONTACTS	
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A. COVER PAGE - COURSE ID	
1. Course Title:	Biological Links to Energy and Environment (UCCI)
2. Transcript Title/Abbreviation:	Bio Connections
3. Transcript Course Code/Number:	5U05
4. Seeking Honors Distinction:	No
5. Subject Area/Category:	(d) Laboratory Science
6. Grade level(s):	10
7. Unit Value:	5 units per semester/10 total credits – science
8. Was this course previously approved by UC?	Yes
9. Is this course classified as a Career Technical Education course:	Yes
10. Is this course modeled after an UC approved course?	Yes
11. Repeatable:	Yes
12. Date of Board Approval:	June 12, 2014

13. Brief Course Description:

This course is a hands-on, biological exploration of cellular biology and the variety of chemical reactions that occur in specialized areas of organism cells. Specific attention is paid to energy acquisition and use in living organisms, complex ecosystems and the changing environment. This includes a fundamental look at cell type, function and structure. Students compare energy sources for plants and animal cells with renewable and non-renewable energy use by humans. Specific aspects to Career Technology Education (CTE) include an understanding of energy types, energy calculations, and how energy is derived from a variety of natural and man-made sources. Students explore how environmental change affects cell function and structure based the presence of pollutants in the environment. Students investigate protein synthesis and function as well as the composition and use of DNA and RNA. Students build on their knowledge of cellular functions to investigate environmental factors that can alter cell reproduction (mitosis and meiosis), genetic change (genotypes and phenotypes) and evolution. Students calculate energy production of macromolecules as a means to understanding various forms of energy. Students then relate this investigation of how things work to the internal environment of the human body and its ability to maintain homeostasis despite change in the outside environment. They do this by understanding the types and functions of organ systems such as the acquisition of oxygen and nutrients and the removal of toxic waste products. They also investigate how neurons transmit information and how the nervous system mediates communication between the different body parts and the body's interactions with the environment. Finally, students investigate ecology and biomass balance based on competing effects of human activities, population fluctuations, nutrient cycling, food chains, and food webs. Students investigate the viability of biomass and biofuel as an energy source as well as other major sources of power. Students continue to use the CTE content to understand the impact of environmental laws and regulation that affect the energy industry and its role in maintaining sustainability of our natural world. Throughout the course, students identify and describe careers, certifications and postsecondary education and training requirements to pursue a variety of environmental and energy-related fields.

14. Prerequisites:	None

15. Context for Course:

This course is an alternative to the traditional life science (high school biology) course. It provides students an opportunity to learn about biological processes in the context of energy and the environment. This course also provides students with an opportunity to explore and evaluate their personal energy needs as well as the use and implications of their personal energy choices on society, ecosystems, and natural resources. By providing relevant and meaningful instruction relating energy with biological processes, students are able to connect their learning with personal habits. Students also have an opportunity to practice career technical education skills through a variety of instructional practices such as research, laboratory practice, class discussions, presentations, debates and the incorporation of technology throughout the course.

16. History of Course Development:

This course was originally designed during the University of California Curriculum Institute held in November 2011. The creative team consisted of biology, chemistry, and environmental science teachers as well as career technical education instructors from the Energy, Utilities, and Engineering Technology sectors. Additional course scope was written by individuals during November. Once the platform of the course was written, the team reconvened in December (in person and via conference call) to discuss edits. The course scope and sequence was revised in January.

17. Textbooks:

TEXTBOOK 32376

Title: BSCS Biology an Ecological Approach (or Board Approved textbook in Biology)

Edition: 10th

Publication Date: 2006

Publisher: Kendall Hunt Publishing

Author(s): Sociological Practice Associates

URL Resource: http://www.kendallhunt.com/store-product.aspx?id=5671

Usage:

Primary Text

Read in entirety or near entirety

18. Supplemental Instructional Materials:

Unit I: Biological Systems and Environmental Change LD50 Lab http://yayscienceclass.com/.../APES_Unit_09_-_LD50_Salinization_Lab.pdf

Education and the Environment Initiative (2011), California Environmental Protection Agency Human Imprint B6B Student Workbook; URL Resource: http://www.calepa.ca.gov/Education/EEI/Curriculum/Biology/B6b/B6bSW.pdf
Education and the Environment Initiative (2011), California Environmental Protection Agency Ecosystem Change in California Student Workbook; URL Resource: http://www.calepa.ca.gov/Education/EEI/Curriculum/Biology/B6b
KQED Quest: How to Use Science Media Effectively for Enhancing Teaching and Learning; URL Resource: www.kqed.org/quest/downloads/QUESTMediaTips.pd
KQED Quest: Why Use Multimedia in Science Education? URL Resource: www.kqed.org/quest/downloads/QUESTWhyMedia.pdf
KQED Quest: Designing an Exploration on Google Maps; URL Resource: www.kqed.org/quest/files/download/52/QUEST_ExplorationCreation.pdf

Unit II: Energy Flow in the Environment
Climate Status Investigation Lesson Plan: Too Cool for School; URL Resource: www.keystonecurriculum.org
Charles Moore: Sailing Great Pacific Garbage Patch 8 minute video; URL Resource:
http://www.ted.com/talks/capt_charles_moore_on_the_seas_of_plastic.html
Unit III: Basic Energy Mechanisms
NEED Secondary Science of Energy; URL Resource:
http://www.need.org/needpdf/Secondary%20Science%20of%20Energy.pdf
Electronic Snap Circuits SC-300 or similar electronics kit
Web Lab, Genotype to Phenotype (Dragon Genetics); URL Resource:
http://biologica.concord.org/webtest1/web_labs_genophenotype.htm (shockwave plug-in required)
Unit IV: Renewable Energy
Flinn Scientific Publication 141.00 Respiration versus Photosynthesis
Floating Leaf Disk Assay for Investigating Photosynthesis URL Resource:
http://www.elbiology.com/labtools/Leafdisk.html
Wind What is Wind? NEED Curriculum; URL Resource:
http://www.need.org/needpdf/infobook_activities/SecInfo/WindS.pdf
Wind for Schools Blade Design Activity and Calculating Wind Power NEED Curriculum; URL Resource:
http://www.need.org/needpdf/WindForSchools.pdf
Solar Energy/Education: Teaching Solar (2009), A Rahus Institute- Solar Schoolhouse Publication, by Tor Allen, Chapters 3- 5
Solar Schoolhouse solar cell kits or similar solar cell kit; URL Resource: www.solarschoolhouse.org
Power Struggle /PBS 20 minute video on Green Energy Dream; URL Resource: Â http://www.pbs.org/now/shows/503/
Geothermal Heats Up KQED 10:22 minutes Quest Video; URL Resource:
http://science.kqed.org/quest/video/geothermal-heats-up/
Geothermal Educator Guide KQED; URL Resource: http://science.kqed.org/quest/files/imp/220b_Geothermal.pdf
Geothermal Information Resources“ Geothermal Basics; URL Resource: http://geo-energy.org/
Toward Greener Biofuels and Greener Cars KQED Quest article; URL Resource:
http://science.kqed.org/quest/2009/10/05/toward-greener-biofuels-and-greener-cars/
From Waste to Watts: Biofuel Bonanza KQED 10:02 minutes Quest Video; URL Resource:
science.kqed.org/quest/video/from-waste-to-watts-biofuel-bonanza/
Algae Power KQED 10:44 minutes Quest Video; URL Resource: http://science.kqed.org/quest/video/algae-power/
Landfill Gas (Construction lab); URL Resource: http://climatelab.org/Landfill_Gas
Unit V: Energy Use & Sustainability
Calculating your Ecological Footprint; URL Resource: www.myfootprint.org
Unit VI: Policy and Ethics of Renewable Energy
California’s Clean Energy Future website with Energy Future Overview, Progress, News Releases and Implementation Plan; URL Resource: http://www.cacleanenergyfuture.org/
California Public Utilities Commission 10/06/2011 Alternate Proposed Decision of Commissioner Ferron; URL Resource:
http://docs.cpuc.ca.gov/WORD_PDF/AGENDA_DECISION/144595.pdf
California & U.S. Renewable Energy Legislation; URL Resource:
http://www.gosolarcalifornia.org/about/gosolar/legislation.php
AB758 comprehensive Energy Efficiency Program for Existing Buildings; URL Resource:
http://www.energy.ca.gov/ab758/

B. COURSE CONTENT

Course Purpose:

The purpose of this course is to integrate the concepts of cellular biology and the variety of chemical reactions that occur in specialized cells to energy acquisition and use in living organisms, complex ecosystems, and the changing environment. Student's outcomes are primarily based on biology content standards and the integration of CTE Energy and Utilities standards.

Course Outline:

Unit I: Introduction: Biological Systems and Environmental Change

1. LD 50 Lab: LD50: Lethal Dose for 50% of the sample population. Several versions of the LD50 lab can be found on line, but the LD50 lab of the effects of salt on radish seeds may be the most appropriate for this age level. The lab begins with pre-lab where students gain an understanding of the concept of LD50. Then students conduct a controlled experiment to test the toxicity of salt on the germination of radish seeds. Students must maintain a legal lab notebook as determined by the industrial standards as written in Basic Laboratory Methods in Biotechnology by Lisa Seidman. Students learn techniques required to perform a controlled scientific experiment that provides an analysis of the results and meaningful conclusions. Students identify the sources of experimental error.

2. Energy Transformation in Trophic Levels: Students will work in small groups. Each team is given a set of materials including bilge pumps with PVC and a set of solar panels. Each team of students connects the solar panels in parallel with their pump and adjusts the height of the PVC until they get a sufficient flow from their pump. Teams then put a water turbine in place under the flow of water to generate water power. Teams use watt meters to measure the energy required to run the bilge pump vs. the amount of power generated by the water turbine. Once the system is constructed, students are then to experiment on their own with various lighting, placement of the water turbine, adjustment of water wheel, number of solar cells, and any other factor they can think of to maximize the efficiency of the exchange of energy between the number of watts from the solar panels used to run the bilge pump and the number of watts generated on the water turbine. This lab should be followed by a lab report that shares out on the experience, how it relates to energy loss in trophic levels, and maximum efficiency students were able to obtain vs. efficiency in an ecosystem.

Unit II: Energy Flow in the Environment

1. Predator-Prey Relationships: One important way in which energy is transferred in the environment is through predator/prey relationships. Predators can influence the rate of population growth of the prey. And prey can influence the rate of population growth of the predators. The relationship promotes healthier populations of both predators and prey by weeding out the weak and ultimately selecting for the best fit organisms. There is a natural selection "arms race" that occurs over time, and results in changes in gene frequencies.

The class is divided into three species of predators: spoons, knives, and forks. These predators forage on randomly dispersed prey individuals of five different species: lima beans, kidney beans, black-eyed peas, elbow macaroni, and shell macaroni. There are 200 of each type of prey or 1000 total prey items. Predators have one minute to forage for food. Capturing and eating a food item consists of capturing it with a trophic appendage (spoon, knife or fork) and putting it in the stomach (cup). NO HANDS ALLOWED. After the foraging period is up, everyone examines their stomach contents and count the number of each prey consumed. Class data is collected and then calculations determine the changes in both the predator and prey populations. Trophic appendages are then redistributed as indicated by the predator efficiencies. The reproductive rate of the prey is calculated and the number of prey necessary to account for the reproductive rate is counted out and distributed randomly over the foraging area.

Repeat the process for at least two generations. Graph the changes in the predator population and the changes in the prey populations using the starting numbers as your first data points.

Write a lab report. Analyze data and answer the following questions:

- Which predator and prey populations increased and which decreased?
- How has the predator/prey relationship affected natural selection in this community?

2. Energy flow from the Sun to the Environment: In this lab, students demonstrate the effects of various greenhouse gases have on energy flow (temperature.) Students use tennis ball containers simulate environmental conditions. One container is exposed to open air, another is capped, the third is capped with methane gas and the third is capped with carbon dioxide gas. Digital thermometers are used to collect temperature data (energy flow) each minute for ten minutes. As an extension to this lab, students can repeat the experiment by changing one variable for each container such a placing ice cubes or plants into the tennis ball containers that may reflect or absorb energy.

Unit III: Basic Energy Mechanisms

1. Web Lab: Dragon Genetics

2. Energy of a Peanut (or other food): This lab allows students to compare calories (energy) of a peanut to energy output when burned. Students mount the peanut on a needle or paperclip and place under a used soda can with 25 mL of water. Students measure temperature change of the water and using the equation q = C x m x Î”T determine the energy output of the peanut.

3. Science of Energy: Students use Science of Energy kits from NEED to explore the various forms of energy: kinetic, potential, mechanical, chemical, exothermic, endothermic, radiant, electrical (batteries and motors). The kits consist of six stations; each station addresses a different kind of energy. Station one addresses Potential and Kinetic energy, Station two addresses Chemical and Thermal energy, Station three addresses Radiant Energy, Station four addresses Energy of Metals, Station five addresses Chemical energy, and Station six addresses Electrical energy. Each station uses manipulatives and a worksheet to demonstrate specific energy content. For example, Station 1 uses a meter stick, superball and wind-up toy to teach the difference between potential and kinetic energy and how an object can convert energy from one form to another. By having students conduct engaging experiments at each station, they are able to define various forms of energy and discuss how energy transforms from one form to another. They apply what they have learned to a one-way energy flow of an ecosystem.

4. Snap Circuits: Snap Circuits are a series of educational labs from Elenco that provides an avenue for students to learn about electronics. There are several different size kits that contain from 100 to 500 different electronics projects. Kits contain batteries, snap circuits, resisters, capacitors, and varying electronic devices such as music boxes and fans. Each kit contains a set of visual and written instructions. In this lab students will use the snap-on circuits to explore and learn key vocabulary terms such as capacitors, resistors, parallel, and series while completing a circuit. Students can follow the instructions for a pre-determined design project or design their own. An advanced version of these kits includes a solar car.

5. Connection of Energy and Ecosystems - photosynthesis (radiant energy). Using a PV cell, students in groups of 2-3 will measure the energy output of the cell using colorless, green, red and blue colored glass placed on top of the cell. Students will record volt data for each. They will prepare a 1-2 page lab report with this data and relate the results of the lab to their understanding of how plants absorb sunlight (and the potential effects of filtered light have on radiant energy absorbed by plants) and convert it to chemical energy through photosynthesis. This lesson teaches the economics of nature through the understanding of photosynthesis.

Unit IV: Renewable Energy

Core Labs:

1. Photosynthesis versus Respiration: In this Flinn Scientific lab students use elodea, snails and BTB to demonstrate the principles of how photosynthesis and cellular respiration occur in green plants when light is available.

2. Photosynthesis and Energy Production: Photosynthesis research can also be used to enhance energy production in a much more direct way. Although the overall photosynthesis process is relatively wasteful, the early steps in the conversion of sunlight to chemical energy are quite efficient. Why not learn to understand the basic chemistry and physics of photosynthesis, and use these same principles to build man-made solar energy harvesting devices? This has been a dream of chemists for years, but is now close to becoming a reality. In the laboratory, scientists can now

synthesize artificial photosynthetic reaction centers which rival the natural ones in terms of the amount of sunlight stored as chemical or electrical energy. More research will lead to the development of new, efficient solar energy harvesting technologies based on the natural process.

3. Students use Floating Leaf Disk Assay, a photosynthesis lab to understand how solar energy is captured and used.
   - Students measure the net rate of photosynthesis
   - Choose an experimental condition
   - Collect data in appropriate charts
   - Plot graphs based on data collected
   - Include error of analysis and suggestions for improvement in lab report

4. Wind Turbine Blade Design/Biomimicry: Biomimicry can be used as a tool to create more sustainable designs. Blade design and engineering is one of the most complicated and important aspects of current wind turbine technology. Engineers strive to design blades that extract as much energy from the wind as possible while also being durable, quiet and cheap. The Biomimicry process of consulting life's genius, described in the Design Spiral, can serve as a guide to help students use biomimicry to biologize a challenge of blade design. Then evaluate to ensure that the final design mimics nature at all levels form, process, and ecosystem. Blade Variables; What variables affect, how much energy the blades can capture? Length, number, pitch/angle, shape, weight, material, curvature, twist, wind speed, etc. Students break into groups of 2-4 and choose one factor that affects wind speed and one biological mimicry and then test that variable on their design. They will collect data and present their discoveries to the class. Evaluate to ensure that the final design mimics nature at all levels form, process, and ecosystem.

5. Solar Oven: The students are given a minimal assortment of materials and asked to create a solar oven. A passing score is merited by successfully melting the cheese on a plate of nachos.

6. Biofuel Production: Students will produce biodiesel using a variety of vegetable oils. Students will compare energy outputs of the biofuels based on the various sources of fuels. An extension of this lab is for students to compare their fuel to cellulosic ethanol production from switch grass (non-food crops) corn and/or yeast fermentation.

7. Cellulase Producing Bacteria in Soil: Students place soil collected from their home on an agar plate. Using a color assay reagent, students perform an experiment to determine the presence of cellulase producing bacteria in the soil.

Unit V: Physiology and Environmental Change

1. Eco-Footprint: Students revisit their eco-footprint from Unit II or recalculate based on changes implemented since that unit.

2. Relating neurological responses of different body parts to electrical circuits and connections: Students will apply the information gained from previous labs on electricity to simulate a neurological response such squeezing hands in a circle. Students gain an understanding that energy is transformed from mechanical to chemical to electrical back to chemical.

Enrichment Labs (optional):

1. Geothermal Energy: Students will conduct an experiment that uses heated water to turn a turbine. This is an inquiry lab where students have to design and test their ideas by using their knowledge of mechanical and heat energy.

2. Hydroelectric Energy: Students will be placed in a team of 3 students. Together they will build a hand-held model of a water wheel using the materials of their choice. The water wheel will be connected to a motor and LED, and placed a sink with a faucet. Each wheel will be evaluated for durability and ability to electrify the LED.

3. Solar Water Heater: Students design a passive solar water heater using Google Sketch Up or similar software. Students must make predictive calculations about how the temperature is affected by the microenvironment of the enclosure. After their design has been approved by the instructor, they will be provided with some materials, but many will have to come from used and recycled materials brought to class by the students.

4. Solar Greeting Card: Students will build a simple solar-powered device. Using materials provided by the instructor,

students will create an audio greeting card. The card has an original design, and when opened, plays a musical number when opened to expose the solar panel.
5. Landfill Gas (Construction Lab): Students will tie a string at one end around each item to be buried. They will put a label with the name of the item around the other end of the string. Fill the plastic cube half way with topsoil. Bury each item leaving the labeled end of the string out. Cover items with another layer of topsoil. Each student will write a hypothesis. (The students will decide if their landfill will be covered the entire 10 day and 20 day observation period or if the mini simulated landfill will receive sun, air and water each day.) After ten days have students uncover items and look at them under a microscope to see if they are decomposing. Rebury the items and make observations at the end of 20 days. After students record findings after 20 days incorporate the follow-up questions on the back of the worksheet. Students will discover items that start to decompose and release methane gas.
6. The Healthy Kitchen: Students investigate the energy requirements food grown locally by visiting a local farmers market and/or organic farming. Students will interview local/organic farmers, visit a farmers market and/or organic farm. As an extension, students can create a school garden project to demonstrate their understanding of a healthy kitchen.

Key Assignments:

Unit I: Introduction: Biological Systems and Environmental Change

1. What do living things need to survive?

As a brain-storming class activity, students determine the essential components for life: excretion, food, energy, reproduction, oxygen, cells. In groups of four, they observe an unlit candle and then a lit candle. They make as many observations as possible of both candles. Conclusion: is the lit candle alive, since it exhibits so many characteristics of life? Assignment: pick any organism and identify the six essentials for life that fits the organism. Each essential of life should be one paragraph and the paper should be no more than two pages, single spaced and typed (12 fonts).

2. How does cell structure and function affect living things?

This is a second assignment in the progression of understanding what living things need for survival. Students prepare a visual that compares and contrasts different prokaryotic and eukaryotic cell structures using pictures and online resources. They can present their visual electronically through their digital photography (multimedia) class or on poster board.

3.Environmental Toxins and the Reaction of the Ecosystem

Students create a multimedia project either through a PowerPoint presentation (no more than ten slides) or video clip (no more than five minutes) accessing the KQED Quest site and the other appropriate web-hosting formats. Students select a topic related to the impact on an environmental toxin (specifically relating situations involving nonrenewable pollutants for example the BP oil spill summer of 2010) and the reaction of the ecosystem to the situation. Students will make a multimedia presentation to the class using this information including a description of the situation, reaction of the community, government agencies and biological impact.

Unit II: Energy Flow in the Environment

1. Food Web Activity

Students choose a biome and design a food web (based on that biome) on a poster board which will include at least two decomposers, four producers and ten consumers. Students present their findings in a 1-2 page paper (attached to their poster board) on their chosen food web. The paper should present information on the following topics:

- Average precipitation and temperature for that biome
- Adaptation feature for each producer/consumer in their food web
- Describe energy flow in food web

2. Changes in Biodiversity

Students are arranged in groups of 3-4. Each group is given a before/after photo of a habitat. (The before photo shows the native land and the after photo shows the influence of human activities on that habitat.) Students prepare/deliver a 3-5 minute presentation (every group member must present) that discusses the type of habitat lost and/or changed and how that has impacted/might has impacted the biodiversity of that area. As an extension to this assignment: students

can predict what must be done to restore the impacted area.
3. Charles Moore: Sailing Great Pacific Garbage Patch

- View presentation on Ted.com (8 min)

Questions:

1. Summarize what it is?
2. How/why did this happen?
3. Can anything be done?
4. Your personal reactions.

4. Myfootprint.org:
Students take the online quiz. Ecological Footprint Quiz estimates the amount of land and ocean area required to sustain an individual's consumption patterns and absorb their wastes on an annual basis. After answering 27 easy questions students will be able to compare their Ecological Footprint to others and learn how to reduce their impact on the Earth. Ecological footprint is expressed in "global hectares" (gha) or "global acres" (ga), which are standardized units that take into account the differences in biological productivity of various ecosystems impacted by your consumption activities. The quiz footprint is broken down into four consumption categories: carbon (home energy use and transportation), food, housing, and goods and services. The result of a footprint is also broken down into four ecosystem types or biomes: cropland, pastureland, forestland, and marine fisheries. After completing the quiz:

- Summarize your results in two paragraphs.
- Compare results to global averages.
- Take action; look at ways in each consumption category to reduce your footprint.

Unit III: Basic Energy Mechanisms
1. Homeostasis: In this assignment students go outside with jump ropes and stop watches. Students take pulse, breaths per minute and perspiration levels before and after jumping rope for 2 minutes. They repeat this three times with extended time each time. Students prepare a 1-2 page lab report that explains what they did and why and how their body maintained homeostasis. In their lab reports, students evaluate connection of biological systems to energy balance (in=out). Homeostasis is taught using the regular text as is an understanding of the part energy plays in maintaining that balance. As an extension to this assignment, students can pick a picture of an extreme environment and discuss what kind of adaptations or adjustments their body would have to make to maintain homeostasis.
2. Units and Conversions (volts, watts, BTUs) In this assignment, students use appliance output data and conversion tables to understand how energy units relate to one another. This assignment focuses on math and dimensional analysis to help students understand how to calculate and convert energy units used in the professional workplace. Once students have a working knowledge of energy units they play the role of energy auditors. Using a Kill-A-Watt meter, they collect the volt output and kilowatt hour measurements of at least ten electronic/plug-in devices as home. With this data they also determine the average amount of time the device is on and create a data table documenting the voltage, power, number of hours/days and energy per day for each device.

Once their table is complete, they use the following conversion (1 kWh=3.41 x 103 BTU) to convert their energy in BTU. Once the students know how many BTUs of energy these collective devices use, they can determine the amount of coal, oil, natural gas and uranium 235 required to power these appliances based on the following conversions:

- 1 lb. bituminous coal=12,000 BTU
- 1 barrel oil=5.6 x 106 BTU
- 1cft natural gas=1,030 BTU
- 1 g U235=4.0 x 107 BTU

As an extension to this assignment students determine the cost of these fuel types based on current economic pricing and determine the least and most expensive fuel to completely power the devices on their list.

Unit IV: Renewable Energy
1. NOW with Bill Moyers. For Educators. Wind Power/PBS http://www.pbs.org/now/classroom/wind.html#

Students watch video and answer reaction questions which are included on the website.
2. KQED: Quest Video:
http://science.kqed.org/quest/video/geothermal-heats-up/ students use worksheets that are provided for teacher at the link.
http://science.kqed.org/quest/files/imp/220b_Geothermal.pdf
3. Earth's Heat:
Students investigate the creation and distribution of this resource, introducing the concept of a geothermal reservoir. It begins with an overview of Earth's structure, and the heat within. Students identify and describe heat as an important component of the structure and behavior of planet Earth, create a scaled model of the planet, and map its heat both by depth and on Earth's surface.

Students will construct an accurately scaled visual model of the earth, which visualizes and summarizes basic behavior of Earth's heat, including convection currents, geothermal reservoirs, and surface patterns and use metric units in a scientific illustration and in conversion problems
4. Converting Earth's Heat to Electricity:
Investigate one major benefit of geothermal energy: the generation of electricity. The importance of energy capture and conversion to electricity are investigated and applied, including the promise of emerging technologies in the field of geothermal energy. Students can see the potential for this resource in an exciting future that addresses both energy supply and environmental challenges. The goal is to move citizens towards a more sustainable energy future. Students will be given worksheets that enable them to identify and describe energy conversions in generation of electricity, apply energy conversions to electricity generation, trace energy forms and conversions from source to student electricity use, and compare advantages and disadvantages of different forms of energy production, based on conversion efficiency, as well as connections to environmental and human health
5. Guest Speaker: A PV Solar Installation, Start to Finish (with notes)
Students use fill in notes for the entire presentation.
Annotated Illustration: A PV Solar Installation, Start to Finish
6. Cellulosic Biofuel: KQUED quest: science.kqed.org/quest/tag/cellulosic-biofuel/
science.kqed.org/quest/video/from-waste-to-watts-biofuel-bonanza/
science.kqed.org/quest/2011/03/25/how-green-is-biomass-energy/
science.kqed.org/quest/audio/the-new-clean-tech/
Students fill in worksheet while watching videos.

Unit V: Physiology and Environmental Change

1. Concept Map:
Students will create a concept map under the umbrella of Homeostasis of the following terms: environmental conditions, range of tolerance, zone of intolerance, optimum range, acclimation, and threshold effect.
2. Homeostasis:
Students are given various pictures of different biomes. In a group of 2-3, students identify biotic and abiotic factors that affect environmental equilibrium (homeostasis) of those biomes (2 or 3). They create this list for each biome and turn it in as a group. The list should be no more than two pages long.
3. Living Green:
Students use a worksheet to evaluate water, energy and product use in their own lives. Based on their self-evaluation, they prepare a one page paper that makes recommendations about choice selection with the good of the environment in mind.
4. Finding a Green Job:
This assignment uses a software program to guide students into identifying personal skills, career interests, and science skills to explore a green job. First students have to write down an explanation and create a picture (8½ x 11) of what green means to them. Once completed, they will use their basic understanding of green and the software program

focusing on 21st Century Skills and student interests, to research at least three green careers/jobs. Students use internet resources to investigate and create a 2-3 page career out-look paper. Their paper includes a description of at least three green jobs, salary, education level including certification programs, and technical skills required for each job they have selected. It is beneficial for the student if they arrange their job list in order of preference. As an extension to this assignment, students can research post-secondary education programs that can qualify them for their dream-green job and what they need to do in high school in order to be accepted into that post-secondary education program.

5. Genetically Modified Foods Report:

Students relate their understanding of genetics and edible plant components to research on line and/or magazine articles that discuss the use of technology to modify food crops. Articles must focus on genetic engineering techniques. Students prepare a 2-3 page report detailing the purpose of creating the genetically modified foods, the benefits and dangers of the technology as well as the alternative(s) if the technology was not developed.

Unit VI: Policy and Ethics of Renewable Energy

1. Environmental Policies:

Students create multimedia presentation in groups, using collaborative tools such as Google docs, to present one of the environmental policies for CA. In that presentation students are asked to look at the policy from at least three different perspectives. i.e. Environmental list, landowner, economist, etc.

2. Environmental Impact:

Take a situation and show the impact on the environment when an individual acts in his/her own self-interest (i.e. Tragedy of the Commons). Research and write a report that describes the impact of the situation. Include a personal reaction for to the circumstances.

3. Decision making based on values assignment:

Students are assigned one renewable resource to evaluate. In a power point presentation (no more than ten slides,) students address the following features of that energy resource:

- Aesthetic What is beautiful or pleasing
- Economic Gain or loss of money or jobs
- Environmental Protection of natural resources
- Educational Accumulation and use of knowledge
- Ethical/Moral What is right or wrong
- Health Maintenance of human health and prevention of sickness of disability
- Recreational Providing for human leisure activities
- Scientific Knowledge gained by scientific research
- Social/Cultural Maintaining human communities and respecting their values and traditions

4. Pros and Cons:

To evaluate the pros and cons of an issue, look over the above list of values. Pick three or four values that seem relevant to the issue the student is studying. For instance, if the student is researching the use of animals in testing medications, he/she might select Economic, Ethical/Moral, Health, and Scientific as four values that seem fundamental to the issue. Then, the student makes a chart by putting pros and cons for both short and long term consequences for the values they have selected. The pros/cons are placed on the right of the chart and the values selected along the top.

5. Economic Ethical/Moral Health Scientific:

- Positive Short-term consequences-Animals are cheaper to experiment on than are humans.
- Negative Short-term consequences-Animals cost money to properly care for.
- Positive Long-term consequences-Medications might become available more cheaply than if they had been tested on humans.
- Negative Long-term consequences-Animal testing might result in bad public relations for the company.

Step 1: Students examine the question: Should Dams on the Elwha River be removed? They look over the list of values

first chart and then make a table showing the positive and negative consequences of dam removal.
Step 2: Once students have considered three or four aspects of dam removal, they write a short essay explaining their position.

6. Case Study- American Field Guide Teacher Resources: Salmon vs. Dams:
   - Access this lesson plan online at: www.pbs.org/americanfieldguide/teachers

This lesson is derived from real testimony given to Congress regarding two small dams in the pristine Olympic National Park in Washington. In this lesson, students use roll playing to discuss the merits of tearing down these dams so that the Elwha River can run free. The activity is presented in the form of a council meeting to encourage students to try to build consensus in finding solutions instead of militantly standing behind their own viewpoints. Students use role playing to conduct an Elwha River Council meeting. They try to come up with a consensus solution to a conflict between the needs of society and the environment.

- Characterize the two sides of Salmon vs. Dams in terms of:
- Issues surrounding population growth
- Energy use
- Resources use
- Sustainable development

7. Renewable Energy Agencies Newsletter:
Students research and create a newsletter for two Renewable Energy Agencies. EX: Environmental Protection Agency (EPA), American Council on Renewable Energy (ACORE) and The International Renewable Energy Agency (IRENA). See http://www.pbs.org/americanfieldguide/teachers.

8. Field Study- Renewable Energy Distribution:
   - Students contact two local agencies.
   - Collect information on market issues regarding renewable energy.
   - Analyze Data.
   - Create a poster advertising the most successful form of renewal energy for your community.
   - Resource Website: Distributed Energy Forecasts.
   - http://www.pikeresearch.com/research/renewable-distributed-energy-generation.

9. Preparing for the Future:
   - In groups of two choose a Developed country or Developing country that participated in most recent summit.
   - Investigate the country's position toward energy use and climate change.
   - Write a four page proposal for the next Earth Summit that gives your country's position, in terms of renewable energy, on economic growth, protection of environmental resources and meets energy needs of the population.
   - Present your proposal to the class. Be sure to include:
   a. Class engagement activity
   b. visual (Trifold or PowerPoint)
   c. Q & A session

Instructional Methods and/or Strategies:

Unit I: Introduction to Energy and the Environment

1. Cooperative Learning: Students will work in a team to perform laboratory procedure for the LD50 Lab. Defining roles is a key component of cooperative learning where students share the responsibility for learning. The literature on cooperative learning describes a variety of roles: ones commonly used in science classes include group leader, data recorder, measurer, equipment manager, liaison/questioner, artist/illustrator, researcher, timekeeper, and note taker.
2. Questioning strategies: Questioning strategies about factors that have caused environmental change considers the kinds of responses that can be made to a question (different kinds of questions and their customary responses, and

different kinds of response to the same kind of question).
3. Fill-In Notes: For each lecture, typically as a wrap-up to an activity, students will be provided with fill-in notes. This will allow student engagement during brief lectures and well as maintain focus.
4. Literacy strategies: Students will use read environmental change case studies using â€œtalk to the textâ€ then compare notes with a partner to check for understanding.

Unit II: Energy Flow in the Environment

1. Multimedia presentations-Interactive instruction where students work on cooperative projects while they explore current issues an important instructional and learning component in this class using the case studies of the Pacific Garbage Patch
2. Fill-In Notes: For each lecture, typically as a wrap-up to an activity, students will be provided with fill-in notes. This will allow student engagement during brief lectures and well as maintain focus.
3. Cooperative learning and using current Internet websites to explore Renewable Energy: (In the context of the NEED for renewable energy)

Unit III: Basic Energy Mechanisms

1. Inquiry Labs: Students begin the unit with an inquiry-based lab investigating the various forms of energy using the NEED science of energy kits.
2. Fill-In Notes: For each lecture, typically as a wrap-up to an activity, students will be provided with fill-in notes. This will allow student engagement during brief lectures and well as maintain focus.
3. Student Presentations: At the end of the unit students are required to present their energy audit data and efficiency recommendations. Oral presentations enable students to learn presentation skills, organization of data and presentation of data.

Unit IV: Renewable Energy

1. Inquiry Labs: Wind turbine blade design and biofuel lab.
2. Cooperative Learning: Wind turbine blade design and biofuel lab.
3. Fill-In Notes: For each lecture, typically as a wrap-up to an activity, students will be provided with fill-in notes. This will allow student engagement during brief lectures and well as maintain focus.
4. Student Presentations: At the end of the unit students are required to present their energy audit data and efficiency recommendations. Oral presentations enable students to learn presentation skills, organization of data and presentation of data.

Unit V: Physiology and Environmental Change

1. Identifying Similarities and Differences-students will contrast and compare the biological concepts of homeostasis and the stresses placed on the environment.
2. Homework and practice-students have to investigate green building materials and apply these concepts to their green building design and construction
3. Nonlinguistic representations-Green Building Design requires students to build a solar greenhouse as a full-scale model based on the lessons learned in electricity and energy efficiency, and green building materials.
4. Cooperative Learning-students will practice 21st century skills to perform project presentations

Unit VI: Policy and Ethics of Renewable Energy

1. Fill in notes- For each lecture, typically as a wrap-up to an activity, students will be provided with fill-in notes. This will allow students to maintain engagement during brief lectures as well as maintain focus.
2. Multimedia presentations-Interactive instruction; students cooperative projects are an important instructional and learning component in this class.
3. Debate: students will present their findings for developed or developing countries. Groups designate if they strongly agree, agree, strongly disagree or disagree with the information presented by their peers. Teacher will ask leading

questions and students will defend their opinion.
4. Reading assignments-Independent study, students are expected to research, access, and retrieve materials for the unit.
5. Creative design- students create visuals to communicate information regarding renewable energy.

Assessment Including Methods and/or Tools:

Unit I: Introduction to Energy and the Environment
1. Lab Safety Quiz (example Flinn Safety Quiz found on the Flinn Scientific Website http://www.flinnsci.com/
2. Writing samples /Lab Notebook-LD-50 Lab write up
3. Scientific research- PowerPoint presentation (based on a rubric).
4. Basic Laboratory Methods in Biotechnology by Lisa Seidman

Unit II: Energy Flow in the Environment
1. Rubric: Food Web Poster Presentation
2. Lab Report: Energy loss in systems
3. Summaries and reactions: key assignments 1-4
4. Lab Report: The Greenhouse Effect

Unit III: Basics of Energy Mechanisms
1. Lab Report: Students will prepare a lab report for the photosynthesis versus respiration lab
2. Quiz: These make allow teachers to assess student understanding as the unit progresses
3. Project: Students will create a project that demonstrates energy flow using at least three forms (types) of energy

Unit IV: Renewable Energy
1. Lab Report: Wind Turbine Blade Design
2. Quiz: Key Terms and Concepts
3. Lab Notebook: Wind Turbine Blade and Biofuel Production Lab

Unit V: Physiology and Environmental Change
1. Quiz of vocabulary terms
2. Research paper: They pick a biome or ecosystem that explores the factors that contribute to achieving homeostasis. Students will have to identify the cause and effect relationships through the use of nonrenewable resources how these ecosystems try to maintain homeostasis.

Unit VI: Policy and Ethics of Renewable Energy
1. Multimedia presentation - student demonstrate understanding of current energy regulations and policies
2. Written report- Students take a real world situation and report on environmental impacts.
3. Essay- students use a case study to determine how personal values affect environmental decision making.
4. Debate-students debate performance reflects an understanding of energy flow in biological systems.
5. Newsletter-students newsletter design describes their understanding of the role of each agency in renewable energy.
6. Poster- students design advertises a form of renewable energy.
7. Reading Assignment- students will read the given online material and use the information to create additional documents.