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University of Nevada, Reno

**Desert Ecology: A Course Design Looking Towards  
the Future Of Clark County, Nevada**

A thesis submitted in partial fulfillment  
of the requirements for the degree of  
Secondary Education: Biology and the Honors Program

by

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**UNIVERSITY  
OF NEVADA  
RENO**

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We recommend that the thesis  
prepared under our supervision by

**Sarah R. Lillehaug**

entitled

**Desert Ecology: A Course Design Looking Towards  
the Future Of Clark County, Nevada**

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**BACHELOR OF SCIENCE**

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## ABSTRACT

This curriculum depicts a class to teach students of the unique geologic, hydrologic, climatic, and biological characteristics of desert ecosystems. The course focuses on deserts to create a more environmentally-conscious citizenry of the Clark County School District, located in the Mojave Desert. The course covers the basics of desert ecology, desert formation, desert ecosystems, and human-desert interactions. Included are ten example lessons, spanning the three content-heavy units of the course. Each lesson plan addresses Nevada State Science Standards while setting strong, achievable objectives. The desired outcome of this course is a student that holds a greater appreciation for the Southern Nevada landscape, sustainable living, and green energy opportunities.

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## **I. Introduction**

There are over 300,000 students in the Clark County School District (CCSD), encompassing Las Vegas, Nevada and the surrounding area. In 2010, 68.1% of these students graduated and went into the world. These students, according to the mission statement, should have the knowledge, skills, attitudes, and values necessary to, "achieve academically, prosper economically, and participate in democracy" (CCSD, 2010). In 2008, the National Council for Science and the Environment said that proper education leads to "environmental protection, a sustainable economy, and a secure future" (NCSE, 2008,). The two objectives go hand-in-hand. Educational success and environmental education will lead to a cleaner future, economic prosperity in green jobs, and an aware public that can actively participate in democracy. With this in mind, a course has been drafted for the Clark County School District. This class focuses on desert ecology. The course is general, but parts of later units address the Mojave Desert specifically. The goals of the course are to introduce students to the unique desert ecosystem, the adaptations of organisms in these ecosystems, and look seriously at the past and future of human-desert interactions.

Every aspect of ecology is important. However, the Nevada landscape holds personal value to me and to the future of Nevada. What appears to be a barren desert is actually a diverse and fascinating habitat. The land holds possibilities for renewable solar, wind, and geothermal power. Educating the students of the CCSD about the wealth of culture and biodiversity their desert holds will allow them to serve as enlightened members of the state and nation.

## II. Literature Review

Curriculum is based heavily in the social forces of the time, the stages of student development, and learning styles (Parkay, 2006, p.6). The goals of curriculum can be extremely varied. Past and current interpretations show curriculum going far beyond simply providing information. Depending on how the course is taught, curriculum can even shape the way society grows (Parkay, 2006, p.7). Alongside teaching the subject matter, teachers are expected to champion values and instill students with a proper work ethic. While students are assessed on content, there is the expectation that students are acquiring other skills to make them viable members of the workforce, democracy, and society. With organizations like the National Council for Science and the Environment pushing ecological knowledge as an important trait for future citizens, curriculum should make a push for these skills (NCSE, 2008).

With a driving theme to work towards, curriculum then needs aspects of the major curriculum traditions. They are as follows: intellectual traditionalist, social behaviorist, experientialist, and critical reconstructionist. The intellectual traditionalist believes that curriculum imparts “great ideas.” In perspective desert ecology, this would be teaching ecological concepts for the sake of the concept. The environment is important because it encompasses part of what we are. The traditionalist believes that source material should be held above all else. A traditionalist approach would involve a lot of direct contact with the raw information gathered regarding desert ecology. In contrast, the social behaviorist believes that curriculum should teach practical, applicable skills. Knowledge of food webs and desert environment should directly benefit the student. The experientialist believes that the best knowledge comes out of interest and relevance. Famous

experientialist John Dewey believed that teaching was the antithesis of natural learning. The nature of the course as an elective touches on this curriculum theory. Students display an interest in the subject, and are therefore more suited to learn it. Finally, the critical reconstructionist believes that the current school system is plagued by hegemony. A critical reconstructionist approach would involve isolating cultural bias from the information of the course. Modern curriculum can follow more than one of these disciplines, integrating them to provide the best education as the teacher sees fit. (Schubert, 1996)

This curriculum draws heavily from the social behaviorist and experientialist traditions, while also touching on intellectual traditionalist. Being an elective class, it is already looking at the basis of experientialism. From there, there are the building blocks of ecological and biological knowledge. By relating these building blocks to the structure they will eventually become, an understanding of human life in the desert, the curriculum stays rooted in social behaviorism. The intellectual traditionalist is included in later units, while looking at source documents that describe the founding of desert cities and troubles humans faced.

There is the content of a curriculum, the ulterior goals, the justification through traditions, and then the methods. This class is based in constructivism. Constructivist learning theories believe that “students develop new knowledge through a process of active instruction.” Students must take an active role in their learning and not passively take in information. Constructivists believe that the curriculum should give students skills, knowledge, and values that are valuable in both academia and everyday life. They believe students should leave the class with expertise and a conceptual understanding of

the information. The curriculum should balance width and depth of information. This curriculum addresses this by providing both practical knowledge of the Clark County School District's environment alongside the foundations of ecological research science. The content should be organized around a small amount of powerful ideas. In the case of this curriculum, the power idea is adaptation. Everything is directed at extreme situations and how plants, animals, and humans have overcome these extreme situations. A teacher's role in a constructivist classroom should be to present and scaffold information, making the information more accessible for their students. This also means students must actively construct meaning from lessons. Finally, a student's prior knowledge is always the basis for instruction. This is established in the curriculum by constant reference to background knowledge, opinions, and previous materials. (Good and Brophy, 2003, p.420-421)

### **III. Methodology**

The course is presented as an 11<sup>th</sup> grade, year-long, elective science course. This class is set up in three distinct units. These units cover desert ecology, plant and animal adaptations to extreme weather, the consequences of human intervention and possibilities deserts hold for the future. It seeks to practically apply biology towards ecology in familiar landscape for the students. Many points in the class present the opportunity for students to focus their individual studies where they want to focus.

Emphasizing prior knowledge and applications are a focus of the course. Example lessons from each unit are presented in-depth to show what the course brings forward and encourages students to learn. There are three examples for the second unit, four for the third, then three for the final unit.

There is a brief opening period that serves as an introduction to the course and ecology. The majority of this time is to be left to the individual teacher. This is time for the teacher to establish relationships with the students. The class rules should be established within this introductory time, along with note-taking techniques, study advice for students, and vocabulary groups. This time may include a brief overview of the concepts of ecology that will be explored in the course.

The first official unit is an in-depth look at desert ecology. This encompasses “the unique geologic, hydrologic, climatic, and biological characteristics of Nevada’s bioregions,” as mentioned in Nevada’s state science standards (L.12.C.4). Qualities of the desert ecosystem are explored, including aridity and soil composition. The deserts of the world are briefly reviewed, and students are tasked with looking at these deserts more closely and preparing a presentation. Students will accumulate more information on desert conditions and suggestions of what to present in their desert groups. This is the first of the unit projects that will have students work together to complete and explore an objective.

The second unit explores desert flora and fauna through the adaptations they have made to extreme desert conditions. The unit begins by asking students to predict the kinds of adaptations they will find in desert life. Then, building off students suggestions, the class will explore flora and fauna adaptations. The bridge between flora and fauna is formed by a lesson on comprehensive food webs and interspecies coevolution. Students are expected to choose a particular desert resident and produce a comprehensive report of their preferred habitat, life cycle, and ecological role. These reports should emphasize the plant or animal’s ability to survive under conditions of extreme aridity or salinity.

The third unit examines human and desert interactions. It leads with a lesson detailing how unsuited human beings are to life in a desert. It looks at the minor adaptations to heat and salinity human bodies have and compares them to plant and animal adaptations. With that to begin the discussion, the class examines how humans have come to populate many desert areas on the planet. This includes the population of the Mojave Desert and certain lessons will touch on Nevada history and the settlement of Nevada. This leads into the future, where students will look forward at opportunities the desert presents for human life. The class will look at a national scale, while hypothesizing how to apply the concepts explored to global deserts. Students will design an experiment to apply plant or animal adaptations to aspects of human life such as housing or food production.

This course is presented as a sequence of example lesson plans from each unit. Some lessons will be labeled as “Introductory Lessons,” which are intended to be the first lesson in a unit. These hold activities to activate students’ background knowledge on the new topic and engage them with the material. Other lessons, example lessons, can occur at various times within the unit. Some are presented sequentially, while others draw from across the breadth of unit material.

The lesson plans are drafted with a class of 35 students in mind. This is well above the reported average 27 (CCSD, 2008, p.61). The meaning behind this decision was to account for increasing class-sizes and increased teacher responsibility. The number of group participants can be moved up or down depending on the number of groups desired in an activity.

The lesson plans included first mention the state standard being addressed. These standards have been taken from the Nevada State Science and Social Studies standards (Nevada, 2004). Nevada lacks standards for secondary ecology courses, so most standards are based on animal-ecosystem interactions. The section on pre-existing knowledge usually refers to a previous point in the course. In the early classes, and in introductory lessons, it will refer to initial Biology courses or students' background knowledge. Objectives are established for every lesson. Some objectives require multiple class periods to assess the fulfillment. Forms of assessment include multiple-choice quizzes, short-answer questions, and oral presentations. Multiple forms of assessment are used because traditional exams can cause anxiety and have a deteriorating effect on students (Fisher & Frey, 2008, p.157). Each lesson plan has a brief summary in the beginning for reader convenience, along with notes for teachers or substitutes.

The format of the lesson plan divides class activities into the teacher and students' responsibilities. One column depicts what the teacher is expected to put forward or present in the lesson. The other details assignments students are asked to complete. In some cases, the responsibilities are heavily shared and the columns are merged to signify this. A third column depicts the approximate amount of time devoted for each class activity. At the end there is an explanation of the work to be collected and the work to be assigned.

Each class leads with a warm-up activity that is meant to engage students or review information relevant for new material. The amount of time spent on this warm-up varies with the content of the day. Introductory lessons tend to have longer warm-ups for the teacher to explore pre-existing notions of new material. Some lessons will only

briefly cover the warm-up as a review. Warm-ups are collected as a participation activity. For a closing activity, each student is required to answer two focus questions that tie back to the class objectives. This serves as a minor assessment teachers can collect to see how students absorbed the information.

Each unit, excluding the introductory unit, has a unit project to review the content of the unit, extend student knowledge, and encourage additional exploration. For Unit I, this is a group project that explores the ecology of major deserts. Students are expected to prepare a 5-7 minute presentation on the details of their chosen desert. Each desert was explored in less detail early in the unit. Students' presentations will parallel the initial exploration lesson in-depth. Unit II hosts the desert wildlife project, where students are asked to choose a member of desert flora or fauna and create a poster and research paper. The poster is due at the end of the unit, while the research paper will last into Unit IV. Certain classes will be devoted to teaching good research skills and acquainting students with scientific writing.

Unit III will have a creative project, where students will provide a scientifically accurate creative paper or presentation about the settlement of deserts. This project is less time-intensive due to the desert wildlife project's research requirement being due at the end of the unit and an additional unit project. The final project will ask students to write an experimental procedure. The procedure will test some aspect of plant or animal adaptation and apply it to aspects of human life. Students will not be expected to carry out the experiments, but they should be plausible and written so one could.

The textbook used for the course will be Desert Ecology: An Introduction to Life in the Arid Southwest by J. Sowell. The level of this text is on-par with college-level

reading, but does not drag down the writing with technical jargon. The text was chosen with the intent to scaffold. The book is a primary, but not solitary source of information. PowerPoint presentations and student research will scaffold the book. Additional information was taken from The Biology of Deserts, Man and the Biology of Arid Zones, and Ecology of the Nevada Test Site. These texts will provide extra information on flora and fauna.

Scaffolding is the process of taking material considered at the edge of a student's range and supporting the student to the material. There are many aspects of visual scaffolding, such as graphic organizers, word walls, and concept maps (Fisher & Frey, 2008, p.101). Multiple forms of note-taking will be taught, to give students the highest chances for success. Most students only show 20-40% efficiency when it comes to taking notes (Kiewra, 1985). Non-linear note-taking shows marked advantages, so the course encourages concept mapping (Makany & Dror, 2009).

There will be scaffolding for high-level language skills in order to promote student literacy. Most students graduate high school without a sufficient grip on academic language. Academic language can be difficult to acquire and thus requires scaffolding throughout the course. Academic language is directly linked to higher order thinking and the best way to encourage academic language is through classroom scaffolding (Zwiers, 2008, p. xv). Academic language will be modeled throughout the year and encouraged in student discussions. Classroom talks are enriched and brought to the next level through commentary that broadens students' vocabulary and encourages higher-level-thinking (Zwiers, 2008, p.62).

#### **IV. Anticipated Significance**

Nevada falls significantly behind other states when it comes to education. Student achievement is almost the lowest in the nation. The graduation rate is equally low (McRobbie & Makkonen, 2005). This course is an attempt to encourage students with non-traditional science classes. The emphasis on applied biology and ecology will make scientific concepts relevant to students' understanding of the world around them. This course also addresses serious concerns of environmental education. A 2008 study lists the challenges the United States faces in, "preventing global climate catastrophe, ensuring safe supplies of food and water, transforming our energy supply and reducing demand, managing ecosystems to minimize irreversible losses of biodiversity and protecting human health" (NCSE, 2008). The course emphasizes desert-based issues, which include water policy, sustainable energy, and protection of the desert ecosystem.

When it comes to environmental issues, many sources believe that investing in education can have a positive effect on these issues. There have been inquiries into Nevada's environmental education since 1974, when a survey was conducted of schools in Nevada. The survey asked about year-long environmental courses, courses that touched on environmental science, and the resources and training available for environmental science teachers. Around this time, the Tbilisi Intergovernmental Conference on Environmental Education was held. One of the goals established at this conference was, "Providing every person with opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to protect and improve the environment." (UNESCO, Tbilisi Declaration, 1978).

Environmental education is important. It has been called a “critical tool for engaging the public” (Potter, 2010 p. 23), and a “critical element of a national strategy for environmental protections, a sustainable economy, and a secure future” (NCSE, 2008). Organizations have also pushed for curriculum that emphasizes the connected nature of environmental science across traditional disciplines (NSFAC, 2005). This course hopes to inspire students, draw connections to other fields, and secure a more environmentally-conscious future.

## **V. Example Lesson Format**

### **Lesson Type and Title**

There are two types of lessons put forth in these samples: introductory lessons and example lessons. An introductory lesson is the first lesson in the unit. As such, it focuses on engagement activities and activating student's background knowledge. Example lessons are lessons taken from within the unit. In order to show the widest range of lessons, the example lessons may not be presented sequentially. The title of each lesson is a brief reflection of the lesson's content.

### **Rationale:**

This section describes the reasoning behind the lesson, why the information presented is important, and possible real-world applications of the knowledge presented.

### **State Standards:**

This section displays the Nevada State Science Standards addressed within the lesson.

### **Pre-Requisite Knowledge:**

Pre-requisite knowledge includes both potential background knowledge and material that should have been previously covered in previous science courses. Students will be required to take at least freshman-level biology before the desert ecology course.

### **Objectives:**

Measurable objectives are set for every class period. The end of class focus questions are based around these objectives in order to assess student learning. These objectives also factor into the unit projects and will be addressed on quizzes (Appendix C) and unit exams.

**Key Vocabulary:**

Vocabulary used in the lesson or necessary to understand the material presented.

These are also the terms used in the unit vocabulary exercises.

**Synopsis:**

This section is a brief summary of the activities of the lesson. It serves as a functional abstract for the lesson itself.

**Notes:**

Any details pertaining to student behavior warnings, ELL adaptations, or other concerns are written here.

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
Opener		
	<p>WARM UP: "The warm-up question is written here."            The warm up serves as an engagement activity. There is a warm-up question presented with every lesson. Acceptable answers to the warm-up questions and prompts for discussion appear here.</p>	
Body of Lesson		
	<p>This column details the presented material and teacher responsibilities in the lesson. Materials presented include PowerPoint presentations, case studies, student reflections, and new assignments. Suggestions are given for how to lead in-class discussions. The column to the left gives a brief estimate of the time provided for each activity. This number is only estimated.</p>	<p>The column details the student's responsibilities in class. This includes instructions for student activities, note-taking format (Appendix B), and alternate activities.</p>
Closer		
	<p>FOCUS QUESTIONS:            Each class ends with two focus questions that students are expected to answer and submit. These questions reflect back on the course objectives.</p>	
<p>Total Time: This is the total time given for the lesson. All lessons in this course are 50 minutes.            Assignments Due: This line details assignments due at the beginning of class or readings to be completed before class.            Assignments Given: This line details assignments given over the course of the class period. In-class assignments are also listed, denoted with "(In-class)."</p>		

After the lesson summary, any additional materials (PowerPoint outlines, in-class worksheets, quizzes, etc.) will be presented on the following pages.

## **VI. Example Lessons**

### **UNIT I. THE DESERT BIOME**

Before looking at the adaptations of desert life, students must understand the conditions that encompass desert life. This unit establishes the desert ecosystem, looks at its geography and geology, and how water shapes the environment.

Unit Objectives:

- Students will be able to identify and define the characteristics of a desert.
- Students will be able to name the factors that lead to desert formation and identify the reasons specific deserts formed.
- Students will be able to explain the all-encompassing importance of water in the desert biome.

Example Lessons Provided:

1.A: Introductory Lesson: What is a Desert?

This serves as the introductory lesson for the main course. Students will look at their own perception of deserts, then the characteristics that actually define deserts.

1.B: Example Lesson: Deserts of the World

This lesson takes place early in the unit, to establish an activity for the late unit. Students are given a brief overview of the worlds' deserts and the format to prepare a more in-depth look themselves.

1.C: Example Lesson: How are Deserts Formed?

This lesson lies into one of the unit objectives, establishing how and why deserts are formed. As such, the lesson happens in the early-middle of the unit.

**a. Introductory Lesson: “What is a Desert?”**

## Rationale:

Students can come into a course with a lot of misconceptions about desert ecosystems. Without experience, students rely on deserts as portrayed in popular media: sandy, hot, and with cacti littering the landscape. This lesson first addresses misconceptions about deserts, then uses those misconceptions to lead into aridity material. Students will understand what aspects of media deserts are common to all deserts, and what portrayals are only a fraction of the world’s deserts.

## State Standards:

L.12.C.4: Students know the unique geologic, hydrologic, climatic, and biological characteristics of Nevada’s bioregions. E/S

## Pre-Requisite Knowledge:

- Students should understand the differences between biomes on Earth.

## Objectives:

- Students will be able to identify and name characteristics of deserts.
- Students will be able to discuss the role of rain in classifying a desert.

## Key Vocabulary:

Precipitation. Aridity. Evapotranspiration. Hot deserts. Cold deserts. Sand deserts. Gravels deserts. Desert pavement. Plateau deserts. Mountain deserts.

## Synopsis:

This lesson serves as the student’s introduction to deserts in-depth. It serves to look at students’ mental perception of deserts and question it. The warm-up activity will activate student background knowledge. The opportunity to express themselves with a drawing will reach out to students’ creative sides. After the warm-up is completed, the differences that appeared can be discussed. After the discussion, the lesson leads into an introduction to desert classification.

## Notes:

Teachers should review material and be able to discuss desert stereotypes and categories of deserts with the students. This lesson falls very early in the year. The teacher could use the warm-up activity and discussion to build relationship with the students.

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
Opener		
10m	<p>WARM UP: "What defines a desert? Draw what you think a desert looks like."</p> <p>This should lead into a discussion on the nature of deserts. Did most drawings involve sand? Only 15-20% of deserts are actually composed of sand. Were there saguaro cacti? Those are actually only native to the Sonoran desert in Arizona.</p>	<p>Students are to activate their background knowledge of deserts and represent it visually. The quality of drawing is unimportant, as students may use simple symbols to depict their desert.</p>
Body of Lesson		
7m	<p>Show students the PowerPoint slide comparing four images of deserts (PowerPoint attached). Ask the students what all four deserts should have in common. If no student guesses correct, move on to the next slide.</p> <p>A desert is defined by low precipitation. The teacher should explain that deserts are defined by their low precipitation and variability of precipitation.</p>	<p>Students set up and maintain three-column notes (Appendix B). The first column should, for this section, be "Qualities of Deserts."</p>
12m	<p>Brief writing activity after the explanation of low precipitation and what it entails. Ask the students to write a situation in which there may be a lot of rain, but not viable rainfall.</p> <p>After the time allotted for writing, listen to student suggestion. Examples of non-viable rainfall are flash floods (gone too fast to sink into the soil) and snowfall (not useful for plant flowering). Evaporation of rainfalls should also be covered, and mentioned in the PowerPoint.</p>	<p>Students are asked to take introduced material and form a hypothesis. When can rainfall not be used?</p>
5m	<p>Discussion of hot deserts versus polar deserts. Because students now understand that a desert is not defined by heat, the existence of polar deserts can be accepted. Most of the deserts in the course will be hot deserts.</p>	<p>Students return to three-column notes. This column should be headed, "Classification of Deserts."</p>

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
8m	Types of desert soil introduced. While sand is what comes to most people's minds, only 15-20% of deserts are sandy deserts. There are gravel floors, known as desert pavement, rock floors, plateaus, and mountains.	Students should take notes on the five types of desert floor. The third column should be reserved for examples of these types of desert floor to be given next class.
Closer		
8min	<p><b>FOCUS QUESTIONS:</b></p> <ol style="list-style-type: none"> <li>1. What is an example of non-viable rainfall? Where might you find it?</li> <li>2. True or false: Most deserts have sandy bases.</li> </ol> <p>Teacher will draw attention to assignments for next class. Students will be asked to look ahead and be able to name deserts at the start of next class.</p>	
<p>Total Time: 50 MINUTES</p> <p>Assignments Due: Read Desert Ecology 1-3, Focus Questions</p> <p>Assignments Given: Read Desert Ecology pg. 18-23, briefly research deserts of the world.</p>		

## what is a DESERT?



## What do these places have in common?



## Precipitation

- Deserts receive less than 250mL (10in) of rain a year.
- Some fall between 250mL-500mL, but show variance.
- How can a desert get over 250mL of rainfall a year, while still being arid?

## Writing Exercise!

- Deserts are judged by what we call **viable** rainfall, or rain that can be used
- Describe two situations in which precipitation might be non-viable

## Non-viable Precipitation

- Flash floods.
  - Rainfall is too abrupt
  - Doesn't soak into the soil, can't be used by plant life

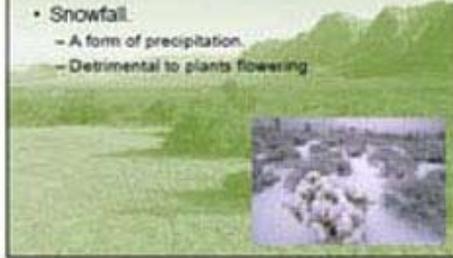


## Non-viable Precipitation

- High evapotranspiration.
  - Water evaporates before it can soak into the soil.

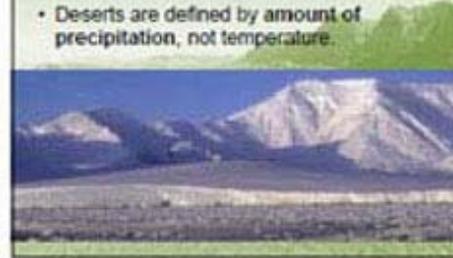
### Non-viable Precipitation

- Snowfall.
  - A form of precipitation.
  - Detrimental to plants flowering



### Snowy Deserts

- Deserts are defined by amount of precipitation, not temperature.



### Hot Deserts vs. Cold Deserts

<p><b>Hot Deserts</b></p> <ul style="list-style-type: none"> <li>• Numerous kinds of coverings.</li> <li>• Temperature may vary throughout the year</li> <li>• The majority of deserts in the world are hot deserts.</li> </ul>	<p><b>Cold Deserts</b></p> <ul style="list-style-type: none"> <li>• Covered in ice or snow, non-viable precipitation.</li> <li>• Temperature may vary or stay frozen year-round.</li> <li>• The Antarctic Desert, a cold desert, is the largest desert in the world.</li> </ul>
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### Desert Flooring

- Sand
  - Only 10-15% of the world's deserts are based in sand.
  - Forms distinctive "dunes."



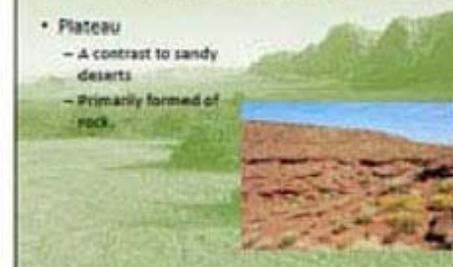
### Desert Flooring

- Gravel
  - Known as "desert pavement."
  - Stays in place due to the low precipitation.



### Desert Flooring

- Plateau
  - A contrast to sandy deserts
  - Primarily formed of rock.



### Desert Flooring

- Aridisols
  - Desert soils.
  - Primarily found in shrublands.
  - Low content of organic matter.



### **b. Example Lesson: “Deserts of the World”**

#### Rationale:

Students who will go on to become educated voters should have an idea of the world around them. Rather than focusing entirely on the Great American Desert and subdeserts, this class requires students to look at deserts around the world. It also will ask students to form groups and embark on a presentation project to extend their own knowledge.

#### State Standards:

G6.[6-8].1 Describe physical and human features, i.e., cultural characteristics, of places and regions in Nevada, the United States, and the world.

L.12.C.4: Students know the unique geologic, hydrologic, climatic, and biological characteristics of Nevada’s bioregions. E/S

#### Pre-Requisite Knowledge:

- Students will be aware of general concepts of geography.
- Students will be able to recall the qualities of deserts mentioned in the previous lesson.

#### Objectives:

- Students will describe and compare the varieties of deserts found around the world.
- Students will be able to identify the four major deserts of the United States on a map.

#### Key Vocabulary:

Sahara Desert. Gobi Desert. Atacama Desert. Antarctic Deserts. Great Basin Desert. Sonoran Desert. Chihuahuan Desert. Mojave Desert.

#### Synopsis:

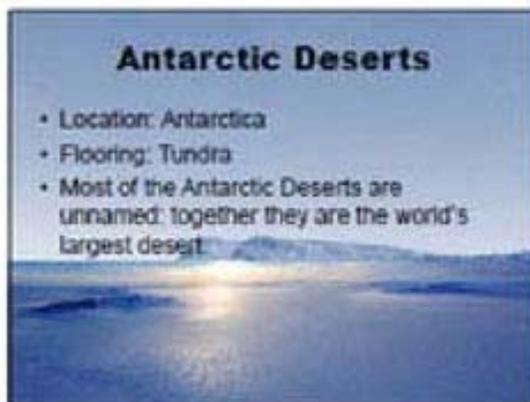
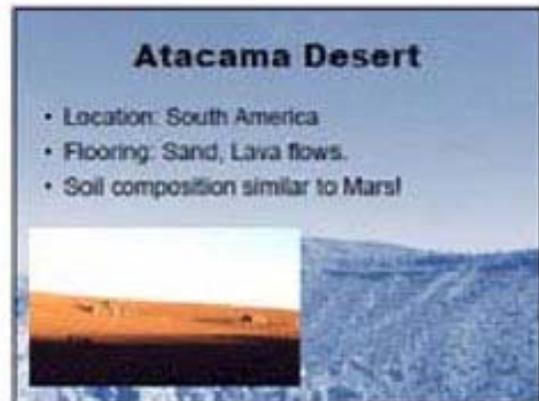
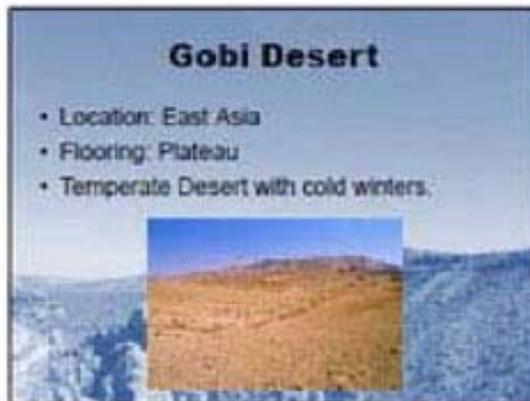
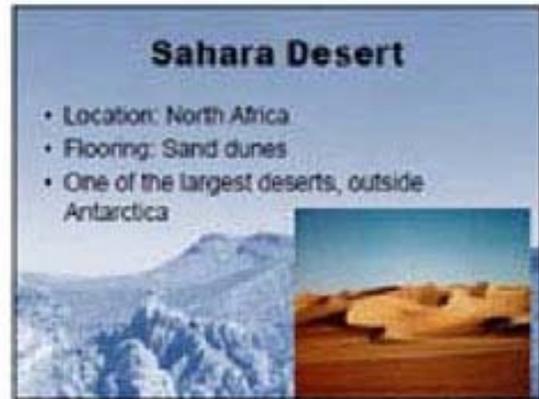
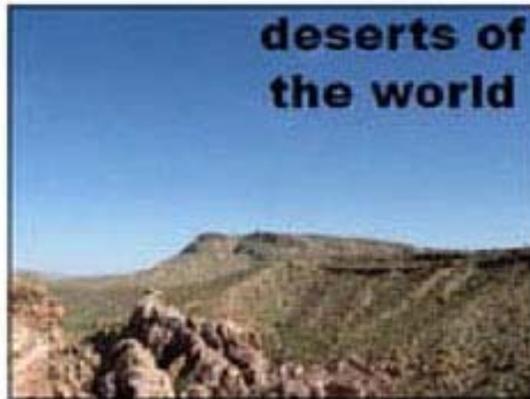
This lesson covers many places. Some are familiar names that will be brought up in the warm-up exercise, while others will be expanded on in the lecture. Students will be given an assignment, due towards the end of the unit. This assignment will mirror this lecture, only student-given and in further detail. This lecture has a lot of room for exploration of places within Nevada. Extra time may be given to discuss anecdotes of North American deserts. Should extra time be available, allow students to form groups of 3-4 for the Deserts presentation.

#### Notes:

Students should be reminded to focus on the material presented today. They will be expected to choose a desert to write a brief summary on before the end of the unit. This class period, occurring early in the year

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
Opener		
6m	<p>WARM UP: Name some famous deserts. Where are they located?</p> <p>This warm-up should be very easy and quick for the students, especially if they did the research homework assigned last class. After the time allotted, the students will share their answers with the class. Deserts will be written up on the board to make a healthy list.</p>	<p>Students should have done minor research on some famous deserts as homework from the previous class. Even if no research was done, some famous deserts should come to mind.</p>
Body of Lesson		
1m	<p>Looking at the list composed during the warm-up time, the teacher will mark deserts outside the US. The lecture will start on deserts of the world. The PowerPoint follows the format of showing an example, then describing the details of the example. Students should make note of every shown example.</p>	<p>Students will maintain three-column notes (Appendix B) on the deserts presented. The first column should have the name of the desert. The second column is for facts presented in the lecture. The third should be for research questions they would want to pursue.</p>
14m	<p><b>DESERTS PRESENTED:</b></p> <p><u>Sahara Desert</u>: N. Africa. Hot desert. Sand dunes. 2nd Largest Desert, largest outside of Antarctica's polar deserts.</p> <p><u>Gobi Desert</u>: Mongolia. Temperate desert with cold winters. Plateau. Was important to the Silk Road and part of Mongolian conquests.</p> <p><u>Atacama Desert</u>: South America. Coastal Desert. Sand &amp; Rock. The soil of the Atacama has been compared to that of Mars, and is actually used in NASA experiments.</p> <p><u>Antarctic Deserts</u>: Most are unnamed. Polar deserts. Bedrock floors, permafrost.</p>	<p>The information given for the deserts is fairly basic, relating to previous lecture's classifications. The primary focus of students should be exploring the third column, writing what interests them about each desert presented.</p>

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
14m	<p>After a brief discussion of each world desert, the scale of vision will reduce. The next part of class will be devoted entirely to North American deserts.</p> <p><b>DESERTS PRESENTED:</b>  <u>Great Basin Desert:</u> California, N. Nevada, Utah, Idaho. Cool Desert. Largest in the United States.  <u>Sonoran Desert:</u> S.W. Arizona, S.E. California. Temperate desert. Subject to summer monsoon rains.  <u>Chihuahuan Desert:</u> New Mexico, Texas, S.E. Arizona. Hot desert. Primarily shrub plants.  <u>Mojave Desert:</u> S.E. California, S. Nevada, Arizona, Utah. "You are here!"</p>	<p>The primary focus of students should be exploring the third column, writing what interests them about each desert presented. Anecdotes may also be explored with excess class time given. Students who have lived on the West Coast may share experiences from living in these areas. Life in the Mojave can be briefly explored (It will be touched on in more detail in later units).</p>
10m	<p>With excess time, students are allowed to split into groups of 3-4. They should be allowed to register their groups with the teacher. They will not yet choose a desert. Each desert can only be chosen once. Students will have to come up with their three top choices tonight, to decide tomorrow.</p>	<p>Students should register in groups of 4-5. This should allow a class of 35 to have 7-9 groups. Each group will decide on a major desert. Students are not limited to the deserts explored in class.</p>
Closer		
5m	<p><b>FOCUS QUESTIONS:</b></p> <ol style="list-style-type: none"> <li>1. Compare two of the desert we have discussed today.</li> <li>2. List three American deserts.</li> </ol>	
<p>Total Time: 50 MINUTES  Assignments Due: Read Desert Ecology 18-23, Focus Questions  Assignments Given: Read Desert Ecology 3-12, choose top three desert options.</p>		



### Great Basin Desert

- Location: California, Northern Nevada, Utah, Idaho
- Flooring: Aridisol
- Largest desert in the United States
- Cool desert, getting snow in Winter



### Sonoran Desert

- Location: Southwest Arizona, Southeast California
- Flooring: Aridisol
- Subject to Summer monsoons
- Temperate desert, having a variety of temperatures



### Chihuahuan Desert

- Location: New Mexico, Texas, Southeast Arizona
- Flooring: Aridisol
- Primarily shrubland.
- Hot desert, with only minor temperature drops in Winter



### Mojave Desert

- Location: Southern Nevada, Southeast California, Arizona, Utah.
- Flooring: Aridisol
- You are here!
- Hot desert, with only minor temperature drops in Winter.



### c. Example Lesson: “How are Deserts Formed?”

#### Rationale:

This lesson relates back to qualities of deserts. Understanding the processes that make a desert form is an important part of understanding desertification later in the course. The causes can all be applied to the Mojave Desert, thus establishing a frame of reference for students in their own lives.

#### State Standards:

L.5.C.4: Students know all organisms, including humans, can cause changes in their environments. E/S

L.12.C.4: Students know the unique geologic, hydrologic, climatic, and biological characteristics of Nevada’s bioregions. E/S

#### Pre-Requisite Knowledge:

- Students are able to identify deserts of the world and place them on a map.
- Students recall the characteristics of deserts.

#### Objectives:

- Students will be able to name three ways water is lost from the atmosphere.
- Student will be able to hypothesize the reason for a desert’s formation based on geographical evidence.

#### Key Vocabulary:

Evapotranspiration. Rain-shadow effect. Latitude. Longitude.

#### Synopsis:

This lesson explores aridity as a cause of desert formation and location. Three causes are looked at in-depth: distance from sea, the rain-shadow effect, and latitude/longitude. Each of these will be discussed before leading into a group activity. The class will be split into groups and given additional materials, depicting the deserts covered last class. Based on the geographical information, students will be asked to hypothesize what lead to the desert being formed. At the end of class, students will come together to reach a consensus on the formation of deserts and add it to their notes.

#### Notes:

If the students are pursuing incorrect assumption of desert formation, try to redirect the focus of the investigation. Do not say they are wrong, but bring up issues they might not have considered.

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
Opener		
13m	<p>WARM UP: Look at the deserts we discussed last class. What are the similarities between them? What can we tell about how deserts are formed, from these similarities?</p> <p>This will be a more in-depth warm-up than the previous days. This is asking students to synthesize information; allow a little extra time for writing and discussion. Ask students to justify their hypothesis.</p>	<p>Students are expected to synthesize at least one hypothesis on the formation of deserts, based on the information they have acquired. It would be a good idea to try this with one of the top deserts selected.</p>
Body of Lesson		
1m	<p>Review of aridity as a quality of deserts. Aridity will be the main focus of the lesson today. Because deserts are defined by low precipitation and aridity, the class will explore ways that water is lost from the air on its way to a desert.</p>	<p>Students are to maintain three-column notes (Appendix B) on the causes of aridity. The first column should be the cause. The second column describes the cause in detail.</p>
5m	<p>The first section will approach the simplest explanation: distance from the sea. As air is carried over distance, it loses the moisture it carried from the sea. However, last class it was proven that a desert can exist by the sea (Atacama Desert). Explain that seaside deserts occur due to cold oceans and warmer land temperatures. Cold air holds less water than hot air. As the air is heated, it expands, but still holds the minimal moisture.</p>	<p>The third column will be left alone for now, to be filled in later in the class. It can be used for excess notes, if the student so desires.</p>
5m	<p>Next is the rain-shadow effect. This, again, deals with air contracting and expanding. Stop to ask students about air-pressure. If necessary, lead students to conclusion that air pressure is less at higher altitudes. This means that the air is less dense and cools more quickly. This means it rains frequently on the water-facing side of a mountain, and a desert forms on the opposite side.</p>	

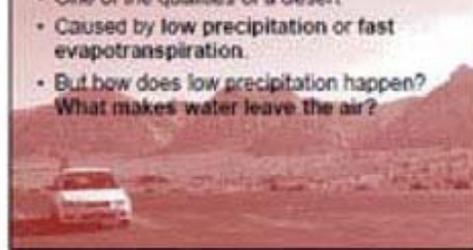
Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
5m	Next discussed is the tilt of the earth. Quickly review air currents caused by the Earth's tilt. Detail when the currents carry moist air, dry air, and when they are descending or ascending. Deserts tend to occur where the air is descending and dry.	
11m	After the note-taking section of the class is done, dismiss students into groups. They may use the groups chosen for the desert project or other groups. They are tasked with looking at the deserts provided last class and attempting to pinpoint their causes.	Students use this opportunity to fill in their third column with the deserts they believe were formed by the technique.
5m	After group discussion time, come together as a class to discuss hypotheses and agree on a cause for each desert. The agreed-upon method will be displayed on the overhead for students to copy, correct, or discuss in their notes.	Students that disagree with the conclusions drawn on the board can argue their point in their notes. Depending on the amount of disagreement; this can serve as a warm-up exercise next class.
Closer		
5m	<b>FOCUS QUESTIONS:</b> 1. Choose one of the ways water is lost from the atmosphere and explain why it happens. 2. What is one reason the Mojave Desert is a desert?	
Total Time: 50 MINUTES Assignments Due: Read Desert Ecology 3-12, Focus Questions. Assignments Given: Study Unit II Vocabulary		

## how are deserts formed?



## Aridity

- One of the qualities of a desert
- Caused by low precipitation or fast evapotranspiration.
- But how does low precipitation happen?  
What makes water leave the air?

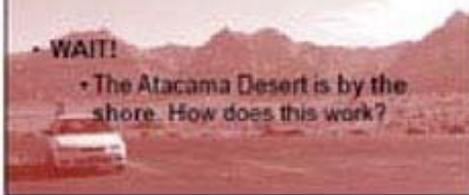


## Distance from the Sea

- Water is lost over the journey from the sea to the desert.

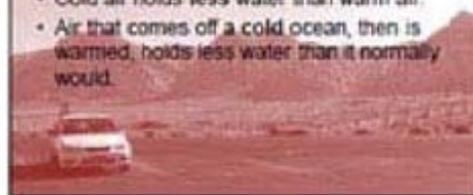
### • WAIT!

- The Atacama Desert is by the shore. How does this work?



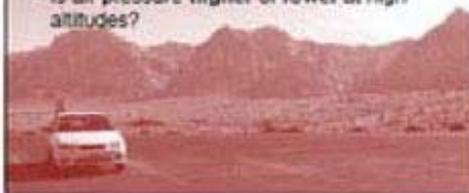
## Distance from the Sea

- The answer lies in the temperature of the water.
- Cold air holds less water than warm air.
- Air that comes off a cold ocean, then is warmed, holds less water than it normally would.

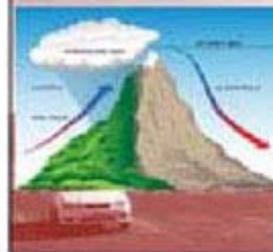


## Rain-shadow Effect

- Besides temperature, the amount of water air can hold is affected by pressure.
- Is air pressure higher or lower at high altitudes?

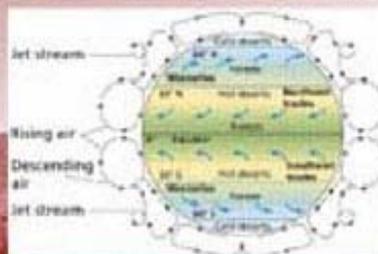


## Rain-shadow Effect



- Air pressure is lower.
- Less dense air cools quicker and precipitates
- When the air descends, it is dry.

## Latitude and Longitude



## **UNIT II. PLANT AND ANIMAL LIFE**

This unit serves as a large portion of the class time, exploring plant and animal adaptations to the desert environment. The unit begins with plant adaptations, looking at how the basic unit of the food chain survives in intense heat, aridity, and salinity. Animal adaptations come afterwards, since several animal adaptations involve co-existing with the plant species. Finally, the unit looks at the connections between plant and animal life in-depth, including food webs and co-evolution.

Unit Objectives:

- Students will identify and cite the reasons why desert flora and fauna have adapted in different ways.
- Students will be able to compare and contrast desert plants based on their ability to retain water, maximize energy, and reproduce successfully.
- Students will be able to compare and contrast animal adaptations based on the individual needs of groups, including mammals, reptiles, and insects.

Example Lessons Provided:

### **2.A: Introductory Lesson: Plant Adaptations**

This serves as the introductory lesson for the entire unit. The class starts with plants, the start of any food chain and one of the most important factors in an ecosystem. Students are engaged by pondering the mystery of desert plants, who manage to thrive in areas with low water content.

### 2.B: Example Lesson: Shantz Classifications

This lesson addresses plant classification based on reaction to drought. To understand unique adaptations, students must understand the variety of options desert plants take. This lesson has a highly variable position in the unit, depending on the students.

### 2.C: Example Lesson: Types of Photosynthesis

Another lesson necessary to understand the avenues a plant can take for adaptation and diversification. This lesson establishes some of the characteristics the Shantz classifications and other classifications of desert flora center around.

### 2.D: Example Lesson: Desert Food Web

This lesson serves to bring together the aspects of plant and animal adaptations to the desert. It would occur late in the unit, after students have been exposed to both plant and animal adaptations.

**a. Introductory Lesson: “Plant Adaptations”****Rationale:**

This is an introductory lesson, meant to review the concepts of the last unit and introduce students to the main themes of the new unit. Reviewing material from the previous exam reinforces concepts that will be in the upcoming unit. Then students will use the newly reinforced information to predict desert organism’s adaptations: the focus of the new unit.

**State Standards:**

L.12.C.1: Students know the relationships of organisms and their physical environment.

**Pre-Requisite Knowledge:**

- Students should understand the characteristics of a desert, and resources necessary for life.
- Students should be able to make predictions based on this knowledge.

**Objectives:**

- Students will be able to predict adaptations of desert life based on their understanding of desert conditions and the factors necessary for life.

**Key Vocabulary:**

Adaptations.

**Synopsis:**

This lesson is the introduction to Unit III: Desert Inhabitants. It will begin with an opener question asking students to recount the qualities of a desert biome. This leads into an activity regarding adaptations animals make to survive in the desert biome. After some time is spent on this, tests will be passed back and there will be a Unit II Test review. To emphasize the importance of actually learning the material over the test, questions that were consistently missed will be reviewed in detail.

**Notes:**

This lesson takes place immediately after the Unit II Test. The length of the opener varies with the amount of trouble students had with the exam. As such, the time given for exam review and the time given for the prediction activity are variable. Adjust the numbers given according to how the class performs.

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
Opener		
5m	<p><b>WARM UP:</b> What are the characteristics of a desert? This warm-up is a review of Unit II core concepts. It should be easy to answer. The class has reviewed the answers to this question multiple times. Do not accept simple, one-word answers from the students. Use follow-up questions, and ask students to consider the causes of desert characteristics for the review later in class. Write the agreed characteristics on the board, and use them to transition into the body of the lesson.</p>	<p>Students will recall the characteristics of a desert and be able to describe them. This should be more than parroting the answer back.</p>
Body of Lesson		
3m	<p>The primary activity for today will be a preparatory exercise for students. They will be split into groups by a number system (e.x. "If you are a 1, please match with a 4.") to reinforce the diversity of students and allow for new mixes.</p>	<p>Students will number off 1-8. This will break a class of 35 students into eight groups of four and one group of three.</p>
18m	<p>Explain the activity: ask students to state, try and predict, or hypothesize adaptations of desert organisms. Provide books, magazines, or other booklets to give students frames of reference or suggestions. Students may also use internet references, although they should be monitored during that time.</p>	<p>Students will detail the pre-adaptation activity in two-column notes. One column will have a description of the organism. Common names can be used. The second column should detail the hypothesized adaptations.</p>

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
18m	After sufficient progress has been made on the adaptation activity, return the Unit II test to the students. Answers that were consistently missed will be reviewed as a class. The amount of time spent on this period is up to the individual teacher's discretion. The adaptations activity is collected for credit. Students may share any exceptional hypotheses with the class in the closing time.	Students will be asked to participate in the review, asking questions they have and answering other students questions when applicable. If a student has no questions, they are expected to remain quiet and work on materials for other classes.
Closer		
6m	<b>FOCUS QUESTIONS:</b> 1. What is one problem you got wrong on the Unit II exam? What is the correct answer? 2. Name an example of a desert organism, and a proposed adaptation they use to survive.	
<b>Total Time: 50 MINUTES</b> <b>Assignments Due: Adaptations Pre-Lesson Activity, Focus Questions.</b> <b>Assignments Given: Read Desert Ecology 24-45</b>		

### **b. Example Lesson: “Shantz Classifications”**

#### Rationale:

The Shantz classifications serve as a way for students to classify adaptations. Certain adaptations will only work with a certain set of circumstances. Future assignments will ask students to apply adaptations to human life. Obviously, not all adaptations will work. This is the first step in establishing that certain adaptations only work in certain builds.

#### State Standards:

L.5.C.5 Students know plants and animals have adaptations allowing them to survive in specific ecosystems.

#### Pre-Requisite Knowledge:

- Students should recall the six classifications of desert plants discussed last class.

#### Objectives:

- Students will be able to name and describe the four Shantz classifications.
- Students will understand the meaning of these classifications and be able to question and correct their fellow students on it.

#### Key Vocabulary:

Drought-escaping. Drought-evading. Drought-enduring. Drought-resisting. Annuals. Perennial grasses. Deep-rooted trees. CAM succulents. Deciduous shrubs. Evergreen shrubs.

#### Synopsis:

Students will be introduced to the Shantz classifications of desert plants. This separates plants into categories based on their method of obtaining and retaining water. The four Shantz classifications will be added to their notes, and used to revise and supplement the notes on types of desert plants taken last class. After the lecture, students will use Quiz-Quiz-Trade to test their knowledge and refine their definitions. This will serve as a good foundation for the 3.1 Vocabulary, assigned at the end of class.

#### Notes:

The Quiz-Quiz-Trade activity is a great opportunity for students to reinforce new information and build a strong foundation for the 3.1 Vocabulary. However, the teacher has be aware of the class and make sure students remain on-task. Should students abuse the time given; move the vocabulary assignments ahead and have the students work quietly.

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
Opener		
5m	<p>WARM UP: What are the conditions desert plants live under? What hazards do they face?</p> <p>This warm-up serves as a review of the need for adaptations. Today's lesson covers a series of adaptations for low water content. If salinity and heat are mentioned, those will be addressed next class. Herbivory is also a legitimate answer.</p>	<p>Students will review past concepts with this warm-up, brushing on the defining characteristics of deserts and their work on the adaptation pre-unit work.</p>
Body of Lesson		
17m	<p>Begin describing the four Shantz classifications using the powerpoint. These four are <b>drought-escaping, drought-evading, drought-enduring, and drought-resisting</b>. Each classification should give an explanation of their characteristics, and how they avoid drought.</p>	<p>Students will maintain three-column notes on the Shantz classifications. The first column lists the category and the second details their methods of retaining water. The third column is to be filled out alongside the third column of previous notes.</p>
8m	<p>The teacher should then call attention to previous notes on the types of desert plants. Students should be asked to try and match the type of plant to the Shantz classification. This should be handled as a class, comparing the characteristics of plant types with the characteristics of Shantz classifications.</p>	<p>During this discussion, students will fill in the third column of their Shantz Classification notes and Types of Desert Plants notes with their examples. Seeing the information in multiple contexts will reinforce the concept.</p>

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
15m	Students will begin a Quiz-Quiz-Trade (QQT) activity about the vocabulary they have learned over the past two classes. The teacher may provide a brief refresher on the rules of QQT. This should take no more than a few minutes to establish.	Student choose one of the six plant types or one of the four Shantz classifications. They write the name of the type/classification on one side of a provided card, then their definition on the other side. Then students are free to mingle with their classmates and quiz one-another. If a student gets the quiz wrong, it's the responsibility of the first student to explain the correct definition. The students then trade cards and continue the cycle.
Closer		
5m	<p><b>FOCUS QUESTIONS:</b></p> <ol style="list-style-type: none"> <li>1. Name three of the six Shantz classifications.</li> <li>2. Choose one of your answers from Part 1 and describe how this classification conserves water.</li> </ol> <p>Unit vocabulary assigned in the cool-down time. Students are given the first set of Unit III Vocabulary. Any questions about the vocabulary are fielded. Students are expected to have the vocabulary ready for Vocab Groups in a future class.</p>	
<p>Total Time: 50 MINUTES  Assignments Due: Focus Questions.  Assignments Given: Unit 3.1 Vocabulary (Appendix C.)</p>		



### The Shantz Classifications

- Drought-escaping
- Drought-evading
- Drought-enduring
- Drought-resisting

#### Drought-escaping

- "Escape" drought by not being there!
- Only their seeds persist during drought.
- Germinate and reproduce whenever water is present.

#### Drought-evading

- "Evade" drought by restricting growth.
- Plants do not grow during times of drought.
- Shed leaves or stem to minimize water loss.

#### Drought-enduring

- "Endure" drought by maximizing their potential water input.
- Grow year-long, regardless of drought.
- Long, deep-reaching roots to get water at any depth.

#### Drought-resisting

- "Resist" drought by storing water in their leaves and stems.
- Grow very slowly to limit water loss.
- Shallow roots to immediately take up any rainfall.

### Shantz Matching

<p><b>Classifications</b></p> <ul style="list-style-type: none"> <li>• Drought-escaping</li> <li>• Drought-evading</li> <li>• Drought-enduring</li> <li>• Drought-resisting</li> </ul>	<p><b>Kinds of Plants</b></p> <ul style="list-style-type: none"> <li>• Flowering Plants</li> <li>• Deciduous Shrubs</li> <li>• Evergreen Shrubs</li> <li>• CAM Succulents</li> <li>• Deep-rooted Trees</li> </ul>
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### Shantz Matching

<p><b>Drought-escaping</b></p> <ul style="list-style-type: none"> <li>• Annuals</li> <li>• Flowering plants</li> </ul>	<p><b>Drought-evading</b></p> <ul style="list-style-type: none"> <li>• Perennials</li> <li>• Deciduous Shrubs</li> </ul>
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Deer-horn Penstemon  
(*Castilleja spectabilis*)



Sonoran Sycamore  
(*Prosopis juliflora*)

### Shantz Matching

<p><b>Drought-enduring</b></p> <ul style="list-style-type: none"> <li>• Perennials</li> <li>• Evergreen Shrubs</li> </ul>	<p><b>Drought-resisting</b></p> <ul style="list-style-type: none"> <li>• Perennials</li> <li>• CAM Succulents</li> </ul>
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Creosote bush  
(*Larrea tridentata*)



Barrel Cactus  
(*Ferocactus wislizeni*)

**c. Example Lesson: “Types of Photosynthesis”****Rationale:**

This lesson shares a similar rationale to the previous shown Shantz classification lesson. Plants hold different adaptations of photosynthesis in order to efficiently use resources. CAM photosynthesis can also draw parallels to solar panels by showing efficiency during non-sunlit hours.

**State Standards:**

L.5.C.5. Students know plants and animals have adaptations allowing them to survive in specific ecosystems.

**Pre-Requisite Knowledge:**

- Students should understand that plants get their energy from the sunlight.
- Students understand the importance of water to plant life, and that adaptations must be made for desert-dwelling plants.

**Objectives:**

- Students will be able to compare and contrast C3, C4, and CAM photosynthesis.

**Key Vocabulary:**

C3 photosynthesis. C4 photosynthesis. CAM photosynthesis. Rubisco. Crassulacian Acid Metabolism. Malic acid.

**Synopsis:**

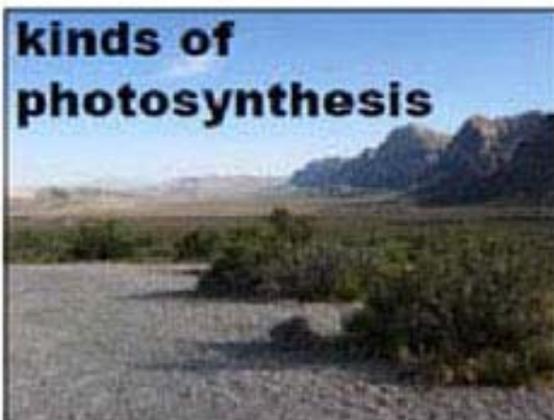
Students will begin with a vocabulary activity of the 3.1 vocabulary. They will split into groups to decide on the appropriate definition for the given terms. Afterwards, the class will launch into the different kinds of photosynthesis. Normal photosynthesis, also known as C3, will be briefly reviewed. Then C4 and CAM variants will be explained, alongside their importance to desert plant life.

**Notes:**

Depending on the class make-up, more or less time can be spent on C3 Photosynthesis. If students do not understand C3, they will fail to recognize the differences of C4 or CAM.

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
Opener		
15m	<p><b>WARM UP: VOCABULARY GROUP</b>            Students should have completed the 3.1 vocabulary. If some is left over, they are free to complete it by comparing their answers to their vocabulary groups. Split students into their vocabulary groups. By the end of the allotted time, Vocab 3.1 should be collected.</p>	<p>Vocabulary groups will go over the 3.1 vocabulary, review the definitions they found and their examples. This is an opportunity for students that had trouble defining or locating the terms to learn from their peers. By the end of the activity, students should have supplemented their initial definitions.</p>
Body of Lesson		
5m	<p>The main lesson will begin with a brief review of C3 Photosynthesis. This is the form of photosynthesis used by most plants on earth. This concept should have been discussed in a previous science course. This section is largely review.</p>	<p>Students will be asked for the basic ingredients and products of photosynthesis. This is for the student's own review.</p>
12m	<p>At this point, students will be asked to assemble a photosynthesis flipbook. The teacher will then hand out colored and white paper. Each student will receive one colored piece and two white. They will be instructed to fold these over width-wise, creating a booklet. Two cuts will be made to divide the booklet into three sections.</p>	<p>Students will create the organizer. They are expected to label each section with a different kind of photosynthesis. The first, white page will explain how the kind of photosynthesis gets its name. The second will be an advantage of using this kind. The third will be a disadvantage. The fourth will be an example of a plant that uses the kind.</p>

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
13m	<p>After students are allowed to fill-in the C3 portion of the organizer, the powerpoint goes on to describe C4 and CAM photosynthesis. These are variants of photosynthesis used to get around the heat and desiccation potential of the desert.</p> <p><u>C3</u>: The default form of photosynthesis used by plants around the world. Stores C from CO<sub>2</sub> in a 3-carbon molecule. Photosynthesis happens in the leaves.</p> <p><u>C4</u>: Stores C in CO<sub>2</sub> in a 4-carbon molecule. Uses an additional enzyme, PEP Carboxylase. Photosynthesis happens in the inner cells.</p> <p><u>CAM</u>: Keeps stomata open only at night. Stores CO<sub>2</sub> as Crassulacean Acid.</p>	<p>Organizer notes on C3, C4, and CAM photosynthesis. Students should keep in mind qualities that can be compared and contrasted between the varieties of photosynthesis. Advantages and disadvantages can be derived from the qualities, although they should be marked individually.</p>
Closer		
5m	<p><b>FOCUS QUESTIONS:</b></p> <ol style="list-style-type: none"> <li>1. List an advantage and a disadvantage of CAM Photosynthesis.</li> <li>2. What is the primary difference between C3 and C4 Photosynthesis?</li> </ol>	
<p>Total Time: 50 MINUTES  Assignments Due: Read Desert Ecology p. 35-38, Focus Questions.  Assignments Given: Photosynthesis flipbook due next class.</p>		

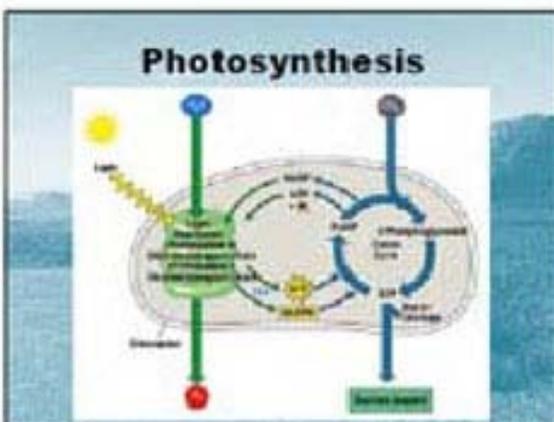


## Photosynthesis

$$6\text{CO}_2 + 6\text{H}_2\text{O} \xrightarrow{\text{light}} \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$$

Carbon dioxide    Water    Sugar    Oxygen

- Allows plants to turn sunlight into sugars.
- Fixes oxygen, allowing us to breathe.



## Photosynthesis

- Three variants of Photosynthesis:
  - C3 Photosynthesis
  - C4 Photosynthesis
  - CAM Photosynthesis

## C3 Photosynthesis

- The most common form of photosynthesis.
- Stores Carbon in a chain of three.
- Photosynthesis takes place in the leaves.

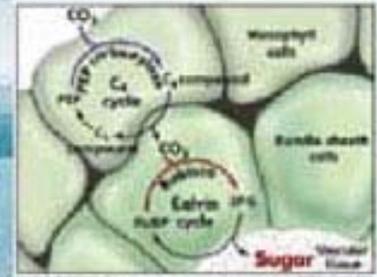
## Advantages & Disadvantages of C3

Advantages	Disadvantages
• Takes the least energy.	• High production leads to water loss.
• Doesn't require specialized enzymes.	• Stomata being open during the day leads to major water loss.
• Photosynthesizes while sun is present.	• Does not function well under high heat.

## C4 Photosynthesis

- Produces energy more quickly to limit time stomata are open
- Stores Carbon in a chain of four.
- Photosynthesis takes place in stem or other inner cells.
- Uses a special enzyme: PEP Carboxylase.

## C4 Photosynthesis



## Advantages & Disadvantages of C4

### Advantages

- Photosynthesizes while sun is present.
- Minimizes time with stomata open by using PEP Carboxylase.
- Functions well in high heat by delivering CO<sub>2</sub> to the nucleus.

### Disadvantages

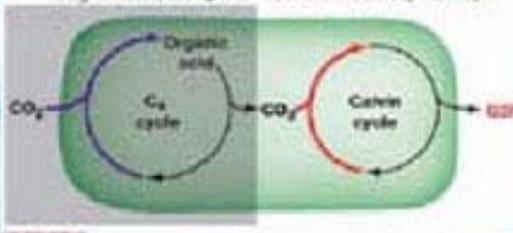
- Stomata being open during the day still leads to water loss.

## CAM Photosynthesis

- Collects sunlight during the day, opens stomata at night.
- Stores Carbon as crassulacean acid.
- Photosynthesis takes place in stem or other inner cells.

## CAM Photosynthesis

CO<sub>2</sub> is stored at night ... and used during the day.



## Advantages & Disadvantages of CAM

### Advantages

- Minimizes water loss by opening stomata in the cool night time.
- May CAM-like, not opening stomata until conditions improve.

### Disadvantages

- Inefficient. CAM plants grow very slowly because of their photosynthetic cycle.

**d. Example Lesson: “Desert Food Webs”****Rationale:**

After learning about the plant and animal life of the world’s deserts, students must look at the connection between organisms. Food webs are delicate. One species can play a critical role in shaping the entire environment. As educated citizens, students must be able to look beyond appearances and pay attention to habitat reduction that threatens key species.

**State Standards:**

L.8.C.1: Students know how matter and energy are transferred through food webs in an ecosystem. E/S

**Pre-Requisite Knowledge:**

- Students should recall plant and animal species that have been discussed over the unit.
- Students should understand how a food web shows the flow of energy in a system.

**Objectives:**

- Students will be able to identify and sort organisms into trophic levels.
- Students will be able to place organisms from the desert biome into a realistic food web.

**Key Vocabulary:**

Producers. Photoautotrophs. Consumers. Predators. Decomposers. Herbivore. Carnivore.

**Synopsis:**

This class occurs towards the end of the unit, after students have explored both plant and animal life in the desert. There will be a brief review of food webs and trophic levels, leading into an activity. The activity uses cards that have been assigned as homework for the various facets of Unit 3. These cards depict the plant and animal life that students will then arrange in a food web.

**Notes:**

The teacher may prepare extra animal cards to mix in with student-made cards. This could be used to present a challenge to students by introducing an animal not introduced in lecture.

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
Opener		
7m	<p>WARM UP: Draw a food web from any biome. Circle the top predators.</p> <p>This warm-up serves as a review and indicator of student background knowledge. If the warm-up seems to give them any trouble, add basic food web review.</p>	<p>Students will have a chance to explore their creativity with the food web. Students that are visual learners can literally draw their food web. Students that do fine with text alone can use text alone.</p>
Body of Lesson		
3m	<p>First is a brief review of food web, and of plants. This lesson takes place after several animal-based lessons, so take time as necessary to review plant life. Remind students that plants are producers, photoautotrophs, and at the bottom of the food web. In animal life, students can identify consumers and predators.</p>	<p>This should be familiar information for the students. No note-taking is required.</p>
3m	<p>Students will be divided into groups and asked to take out their animal cards. These cards have been made in homework and previous class periods. One side has a depiction of the animal, while the reverse side has information from the three-column notes taken on the animals. Each group will be given a food-web worksheet, as well.</p>	<p>If a student is lacking animal cards, other members of the group should be able to compensate him/her. Each group should work with approximately ten cards to make a community.</p>
15m	<p>Students will arrange the cards into a realistic food web and document it on their worksheet. The worksheet will let them label each member of the web at their trophic level. The teacher should check each group's web progress.</p>	<p>Students should work to make a realistic food web: this means no jackrabbits eating flesh or plants eating hawks.</p>

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
15m	After fifteen minutes, the group will surrender one animal from their group and send it to another ground. Each group will lose and gain one animal. Since every group has different animals, this should shift the food web dramatically. Students are asked to rearrange and document the new food web on their worksheet.	It is entirely up to the student which animal to surrender. They can use this to their advantage, trading out high level predators or overly-populous grazers. In a sense, they should choose which animal to surrender rationally.
Closer		
7m	<p><b>FOCUS QUESTIONS:</b></p> <ol style="list-style-type: none"> <li>1. Where do humans fit on the food web? What trophic level?</li> <li>2. The Chuckwalla is primary consumer that eats primarily plant life and supplements it diet with insects. List two results of the Chuckwalla going extinct.</li> </ol> <p>Students return to their seats and the class reviews the activity. A brief poll is taken of how many groups saw drastic change after the switch. How many had unstable environments to begin with? To end with? Attention is drawn to the questions on the worksheet, which will be due next class.</p>	
<p>Total Time: 50 MINUTES  Assignments Due: Focus Questions.  Assignments Given: Food Web Worksheet, due completed next class.</p>		

Name: \_\_\_\_\_  
Date: \_\_\_\_\_

# Desert Food Webs

## Round 1:

What ten organisms did you start with? List them here:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Draw the food web your group developed.

Tertiary Consumers

Secondary Consumers

Primary Consumers

Producers

What organism will you surrender for Round 2? Why?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Round 2:**

What organism was introduced to the ecosystem?

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What trophic level does the newcomer fall into?

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Did your food web change significantly? Draw the new food web.

Tertiary Consumers

Secondary Consumers

Primary Consumers

Producers

**Post-activity Questions:** *Answer on a separate sheet of paper and attach to submit.*

- 1) Was your Round 1 community a stable community? If so, why. If not, why not?
- 2) Did the organism you swapped out for Round 2 have the intended effect? Did it help balance the community?
- 3) Did you see drastic change between Round 1 and 2? Will there still be enough Producers to support the community?
- 4) Were there any organisms that fit into multiple trophic levels? Name and describe them.
- 5) Are any of the organisms in your communities (Round 1 and Round 2) that interact directly with humans? What would the result of human interaction do to the food web? (example: coyotes preying on livestock, and being hunted in return.)

## **UNIT III. HUMANS AND DESERTS**

### Rationale:

The final unit takes the course theme of adaptations and applies it to human life in the desert. This unit makes many historical allusions and consistently ties into real-world applications. The groundwork established by the previous units allows students to see the issue of human life in the desert and sustainability through an educated lens. Students will also be made aware of the opportunities that exist for research, sustainability, and future green jobs.

### Unit Objectives:

- Students will examine and explain how humans have established themselves so well in the desert ecosystem, despite physical incompatibilities.
- Students will demonstrate understanding of plant and animal adaptations by choosing an adaptation and applying to an appropriate human concern.
- Students will look towards the future by critically examining Nevada's options in green energy, water management, and sustainable living.

### Example Lessons Provided:

#### 3.A: Introductory Lesson: Humans in the Desert

After looking at animal adaptations in the previous unit, Unit III opens with the particular species of animal known as a human. Students are engaged by considering how well-suited humans are to the desert and how humans compensate for biological failings.

### 3.B: Example Lesson: Using Nature's Adaptations

This lesson uses inquiry to encourage students to explore the world around them. Students look at pre-existing adapted plant or animal adaptations and pursue their own by writing a science experiment. This lesson occurs fairly early in the unit, to give students time to perfect the project assigned.

### 3.C: Example Lesson: Renewable Energy

Students explore the cost-effectiveness of current renewable energy resources, while looking at opportunities specific to Nevada. This lesson falls late in the unit, tying into the focus on real-world applications.

### **a. Introductory Lesson: “Humans in the Desert.”**

#### Rationale:

In modern society, students may not realize what a miracle it is that human cities survive and thrive in a desert. This lesson is an introductory lesson, meant to grab student’s attention with a story of human life before the conveniences of air condition or water fountains.

#### State Standards:

L.12.C.4: Students know the unique geologic, hydrologic, climatic, and biological characteristics of Nevada’s bioregions. E/S

L.5.C.5: Students know plants and animals have adaptations allowing them to survive in specific ecosystems. E/S

#### Pre-Requisite Knowledge:

- Students should have experience and anecdotal evidence of human survival in the desert.
- Students should be aware of basic body functions, and prepared to associate them with thermoregulation.

#### Objectives:

- Students will be able to explain how human thermoregulation works and the troubles it encounters in intense desert heat.
- Students will be able to convey information about human adaptations to extreme heat and salinity to their peers through a jigsaw exercise.

#### Key Vocabulary:

Thermoregulation. Osmoregulation. Dehydration. Hyperthermia. Acclimation.

#### Synopsis:

Students will be introduced to human and desert interactions through the lenses of past and present. The warm up shows human-desert interaction through the lens of modern conveniences. After the warm-up, the class discusses the case of Pablo Valencia, who was lost in the deserts of the Southwest in 1905 and survived a whole week. From there, the class splits into five jigsaw groups to look at sections of the chapter. One group covers thermoregulation, one osmoregulation, one dehydration and hyperthermia, one acclimation, and one the impact of clothing. Then each expert returns to their home group to share information. Finally, the class tries to attribute causes to Valencia’s symptoms.

#### Notes:

Adjust the amount of time given for each section as necessary. The teacher should monitor students during the jigsaw time, and urge students to use this time productively.

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
Opener		
10m	<p>WARM UP: How do you keep cool in the summers? This warm-up starts a train of anecdotal evidence for human survival in the desert. Obviously, no student goes out and stands in the sunlight to keep cool. Students should show understanding of how thermoregulation works through their actions (dousing with water, sitting by a fan to aid heat dissipation).</p>	<p>Students get to enter the new unit with their own personal experiences. The warm-up associates the abstract concepts of thermoregulation with techniques they use every summer to cool down.</p>
Body of Lesson		
10m	<p>Initially, the class will stay together for a group discussion. As a group, the class will examine the case of Pablo Valencia, detailed on pages 152-153 of <u>Desert Ecology</u>. The teacher will document the observable characteristics student suggest of Valencia after being discovered in the desert. A list will be maintained on the board to be reviewed later.</p>	<p>Students are to read pages 152-153, making note of the specific symptoms Valencia displays. They can begin thinking of the causes, but the group discussion only handles the observable effects.</p>
10m	<p>Students are divided into jigsaw groups. One group will cover pages 154-155, Thermoregulation. One will cover 155-158, Osmoregulation. One will cover 158-160, Dehydration and hyperthermia. One will cover 160-161, Acclimation. The last will cover 161-163, Clothing. Should you have an uneven number of students, have minimal students discussing the impact of clothing.</p>	<p>Students within the group go over the content of their respective pages, making notes on what is important or relevant from the reading. They also discuss the modern implications and relation to the Valencia case.</p>

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
10m	After the expert groups of the jigsaw have their discussion, students are returned to their home groups. Home groups should have one member from each expert group. Time is given to share information acquired by each group member.	Each group member shares his/her expert information with the home group. This technique lets students be their own teacher and share information on a peer-to-peer level.
Closer		
10m	<p><b>FOCUS QUESTIONS:</b></p> <ol style="list-style-type: none"> <li>1. How much water can the human body stand to lose? What starts to go first when body water concentration is low?</li> <li>2. What is an example of acclimation?</li> </ol> <p>For the closing activity, focus is brought back to the board. The class will go over the physical symptoms they recorded and attribute the symptoms to dehydration, hyperthermia, or spot where human thermoregulation and osmoregulation failed and why.</p>	
<p>Total Time: 50 MINUTES  Assignments Due: Jigsaw Worksheet, Focus Questions.  Assignments Given: n/a</p>		

Name: \_\_\_\_\_

Expert Group: \_\_\_\_\_

Date: \_\_\_\_\_

## Jigsaw Activity: The Fate of Pablo Valencia

Thermoregulation Notes:

Osmoregulation Notes:

Dehydration & Hyperthermia Notes:

Acclimation Notes:

## Clothing Notes:

1) What symptoms of Dehydration and Hyperthermia did Pablo Valencia show?

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2) What did the steps Pablo Valencia took do to help his natural Thermoregulation and Osmoregulation?

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3) What are some steps you can take to stay cool when exploring the deserts of the world? Name at least three.

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### **b. Example Lesson: “Using Nature’s Adaptations.”**

#### Rationale:

Students have been fortifying their knowledge of plant and animal adaptations over the course of Unit III. Now, in Unit IV, students are asked to apply this knowledge. They can look at pre-existing applications (e.g. the concept of albedo and home roofing), or explore future innovations for desert living.

#### State Standards:

N.8.A.4: Students know how to design and conduct a controlled experiment.

E/L

N.12.A.5: Students know models and modeling can be used to identify and predict cause-effect relationships. I/S

L.5.C.5: Students know plants and animals have adaptations allowing them to survive in specific ecosystems. E/S

#### Pre-Requisite Knowledge:

- Students will recall plant and animal adaptations covered in Unit 3.
- Students will know how to write a proper hypothesis, and detail the steps required to prove or disprove the hypothesis.

#### Objectives:

- Students will apply animal adaptations to human living situations in the desert.
- Students will develop a hypothesis and plan an experiment around their hypothesis.

#### Key Vocabulary:

n/a

#### Synopsis:

This class period is entirely student-based. At the beginning of class, the teacher will introduce the project and explain the guidelines. From there, students will be asked to work in small groups to brainstorm ideas. Each student will be developing his/her hypothesis individually, but refining it with the help of their small groups. The instructor should spend time with each group over this class period and may contribute to group discussions if he/she sees fit.

#### Notes:

With students discussing their concepts together, there is increased risk of plagiarism or similar ideas mixing. Remind students of the school’s plagiarism policies and any personal policies. Similarity is accepted, identical work is not. Remind students there are multiple ways to test a hypothesis.

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
Opener		
15m	<p>WARM UP: List two plant and two animal adaptations to desert conditions.</p> <p>This warm-up ties heavily into the activity to be done today. Students will be attempting to apply these adaptations to human living situations. So, this warm-up serves as a good review to get the various adaptations in students' minds again. Have the class share their various adaptations.</p>	<p>Students should be able to recall certain adaptations easily. The purpose of the group discussion of adaptations is to try and pick out more unexamined options to base a hypothesis around.</p>
Body of Lesson		
10m	<p>At this point, the teacher will explain the assignment. Students are to develop a hypothesis and design an experiment to test this hypothesis. The experiment should have to do with desert life adaptations looked at in Unit III, and try to apply these to facets of human life. Good examples would be in architecture, water storage, or other aspects of sustainable living.</p>	<p>Students will receive a hand-out, detailing what is expected of them for this assignment. They should refer to this throughout the class period.</p>
5m	<p>Students are then divided into groups of four to five. These groups are strictly for brain-storming. The assignment is to be submitted individually. The teacher should provide additional resources, should students need inspiration.</p>	<p>Students cooperate to brainstorm ways of adapting plant and animal techniques to human living. Each group should come up with at least five ideas.</p>
15m	<p>It is the teacher's responsibility to check on student's brainstorming progress. If groups are working inefficiently, try to balance them out by suggestion. The teacher should have time to consult with all of the formed groups.</p>	<p>Students in the groups should delegate a scribe to record the brainstorming suggestions. They will be collected at the end of class and used as a participation grade.</p>
10m	<p>Towards the end of class, students should be asked to copy the ideas that struck them as viable onto a separate sheet of paper. The sheet used by the group will be collected.</p>	

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
Closer		
5m	<p><b>FOCUS QUESTION:</b></p> <ol style="list-style-type: none"> <li>1. Name two adaptations you want to use in this project.</li> <li>2. How are you thinking of applying them?</li> </ol> <p>In closing time, double-check that papers from each group have been collected and have the group members' names on them. Assign homework of three hypothesis rough drafts due next class.</p>	
<p>Total Time: 50 MINUTES  Assignments Due: Focus Questions.  Assignments Given: Three hypothesis rough-drafts to be expanded on next class.</p>		

## Adaptation Experimentation

Welcome to Unit IV, Scientists! This unit's project is going to be designing an experiment to apply some of the adaptations we learned over Unit III. Wouldn't life in the desert be easy if we could use the plant and animal adaptations we've seen? Here's our chance to find out!

For this project, you will have to:

- 1) Draft three hypotheses of how to apply an animal adaptation to human life (example: using the concept of albedo in roofing to minimize heat gain in the house).
- 2) Select a hypothesis to work with.
- 3) Design an experiment to test the hypothesis.
- 4) Submit a write-up containing the experiment's:
  - a. **Title:** The title of your experiment. Feel free to be creative here!
  - b. **Purpose:** The purpose of your experiment. What adaptation are you testing? Where was it observed?
  - c. **Hypothesis:** How do you think the adaptation will work, when applied to your subject? Must be written in proper "if, then" format!
  - d. **Materials:** Include EVERYTHING you'll need to use.
  - e. **Procedures:** Must be detailed. A stranger should be able to pick up your write-up and do this experiment!

You will be graded on:	
Hypotheses Drafts	10
Purpose	25
Hypothesis	30
Materials	25
Procedures	50
<b>TOTAL</b>	<b>150 POINTS</b>

### c. Example Lesson: “Renewable Energy.”

#### Rationale:

Renewable energy is the future. Educated voters should understand the need to minimize reliance on foreign oil, produce green jobs, and create a sustainable future. This is the first step in exploring Nevada’s green opportunities. These are steps individuals can take to harness wind, geothermal heat, and solar energy.

#### State Standards:

N.12.B.2: Students know consumption patterns, conservation efforts, and cultural or social practices in countries have varying environmental impacts. E/S

#### Pre-Requisite Knowledge:

- Students will have mental associations with “alternative energy,” “green energy,” and sustainability.

#### Objectives:

- Students will be able to name and describe the types of green energy available in Nevada.
- Students will use the internet to find estimates start-up costs and pay-offs, and calculate the time until green energy “pays for itself.”

#### Key Vocabulary:

Wind power. Solar power. Geothermal power.

#### Synopsis:

The warm up question looks at where students have seen alternative energy in their own lives. The class is split into groups in order to dissect these forms of energy and look at the cost-efficiency. Students will look at the start-up costs of these forms of alternative energy, and the pay-offs received by generating more of their own energy. Students then analyze the information they have collected and make judgments on green energy opportunities in Nevada.

#### Notes:

Suggest that students look at the websites of companies that install forms of household renewable energy to get price estimates. Most websites have a rough estimate, although the number does vary depending on the place. Students can also look at public buildings that have invested in green energy.

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
Opener		
7m	<p>WARM UP: Does your house use any form of renewable energy? How do you minimize energy use at home?</p> <p>This warm up is to facilitate conversation about renewable energy use. In many cases, students will not have any kind of renewable energy in their homes, but they could have techniques to minimize energy use.</p>	<p>Students describe their experience with alternative energy. It could be from their own home, a friend's home, or simply something they have heard of. They may also describe techniques used to minimize energy waste.</p>
Body of Lesson		
7m	<p>Students will be introduced to a brief powerpoint on the primary forms of alternative energy in Nevada. The powerpoint will detail solar energy, geothermal energy, and wind energy. Each slide will explain to students where the energy comes from, how it is harnessed, and why Nevada is a good source of the energy.</p>	<p>Students will take three-column notes on the kinds of alternative energy presented here. The first column details the kind of energy, the second column its source, the third column has Nevada-specific details.</p>
20m	<p>Students are split into groups of three. Each group is assigned a form of renewable energy. That group is responsible for looking at the set-up costs of the form of renewable energy, then, the pay offs. They should use school computers to find a reliable estimate of these costs, and average how long it takes for these forms to pay for themselves. Teacher supervision is very important when letting students do their own research.</p>	<p>Students in the computer lab should understand that this activity is a privilege. Stick to reputable websites, such as the companies that would be installing the renewable energy devices. Groups of three should leave a class of 35 with approximately 11 groups. Approximately three-four groups will be devoted to each form of energy.</p>

Time	Teacher's Role/Presented Material	Students Role/In-class Assignments
10m	When the students have their numbers together, regroup the class to discuss the results. Get the average numbers from students and assemble them in a table on the board. Step back to examine these numbers and ask students what they tell about alternative energy. Is it currently cost-efficient? What should be considered that doesn't show up in these numbers? What would numbers look like in different states? In different parts of the world?	Students will provide the information they research for start-up costs and rate of pay-off. When the entire classes' information is available, students will participate in the discussion, answering questions to the best of their ability.
Closer		
6m	<p><b>FOCUS QUESTIONS:</b></p> <ol style="list-style-type: none"> <li>1. Which form of alternative energy seems most viable currently? Why?</li> <li>2. What are some ways to minimize start-up costs of alternative energy?</li> </ol> <p>Students will be assigned a summary paragraph of the exercise done today. This must reflect what was learned, what the numbers mean, where any error could be in the numbers, and their current suggestions for alternative energy in Nevada.</p>	
<p>Total Time: 50 MINUTES  Assignments Due: Focus Questions.  Assignments Given: Summary Paragraph on Green Energy Activity</p>		



## Nevada and Green Energy

- Solar Energy
- Geothermal Energy
- Wind Energy

## Solar Energy

- Energy generated from sunlight.
- Collected using solar panels that convert sunlight to electricity.
- Nevada's frequent sunshine provides a good opportunity for solar power!



## Geothermal Energy

- Energy generated from the heat of the earth.
- Collected using steam power plants.
- Deserts provide ample space to harvest energy!



## Wind Energy

- Energy generated from wind.
- Collected using windmills that charge a turbine.
- Northern Nevada winds are frequent and strong enough to justify turbines.



## Group Activity!

Name: \_\_\_\_\_

Date: \_\_\_\_\_

# Renewable Energy

**Form of Renewable Energy:**

**Start-up Costs:**

**Yearly Pay-off:**

**Years until it pays for itself?:**

Calculate when  $[(\text{Pay-offs}) \times (\# \text{ of Years})] - (\text{Start-up Costs}) \leq 0$ . Show work.

## Class Data Table

	Start-up Costs	Yearly Pay-off	# of Years
Solar Power			
Geothermal Power			
Wind Power			

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**APPENDIX A.**Graphic Organizers:

Used in: Unit II, Lesson C.

Graphic organizers serve to organize information visually. Rather than seeing the information massed together in text, students are able to organize the information themselves. This allows them to quickly pull the information from their mind, since they have already categorized it. The three varieties of photosynthesis lend themselves well to compare/contrast questions. The organizer is assigned with these questions in mind.

Group Activities:

Used in: Unit I, Lessons B and C. Unit II, Lessons A and D. Unit III, Lesson C.

Group activities get students working in peer groups, rather than directly with the teacher. Although students do not get the advantage of the teacher's knowledge and use of academic language, group activities grant students freedom. Students can ask questions of their peers that they would feel embarrassed asking the teacher directly. They may also be able to explain things more naturally from a student's perspective.

The group activities used in the example lessons comes in three varieties. The activities used in 1.C and 2.A are predictive activities. Students pool their background knowledge in order to make predictions about upcoming lessons. The activities used in 2.D and 3.C are concept-checking activities. These allow students to explore the information given using research information, such as the internet in lesson 3.C, or student-generated tools, such as the animal cards in lesson 2.D. Finally, the group activity presented in lesson

1.B is a formative assessment. Group members work together to show their mastery of a subject through research and presentation

Jigsaw Activity:

Used in: Unit III, Lesson A.

Jigsaw activities involve information being put together like pieces of a puzzle by members of a group. Students are part of two groups of Jigsaw activities: a home group and an expert group. Expert groups consist of one person from each home group. These students work on one part of the lesson exclusively. They become experts in that material. When they return to the home group, each expert then explains their material to the rest of the group. Lesson 4.A has a lot of opportunity for student discussion to really let the expert groups flourish.

Quiz-Quiz-Trade:

Used in: Unit II, Lesson B.

Students quiz one another in a Quiz-Quiz-Trade activity. Each student designs a card with key vocabulary on one side and the definition on the opposite side. They then quiz their classmates on the vocabulary. If the opposing student correctly defines the term, the two trade cards and move on. If the opposing student cannot correctly define the term, the first student explains the definition to them. Quiz-Quiz-Trade allows students to explain vocabulary in terms they understand, furthering their content knowledge.

**APPENDIX B.**

Heading	Details	Example
Shantz Classifications	<ul style="list-style-type: none"> <li>-Developed in the 1930s</li> <li>-Show the differences in how plants handle drought</li> <li>-four classifications</li> </ul>	
Drought-escaping	<ul style="list-style-type: none"> <li>-usually ephemeral annuals</li> <li>-grow only when water is available</li> <li>-growth restricted by water present</li> </ul>	<p><b>Desert Indian Paintbrush</b> <i>Castilleja augustifolia</i></p>
Drought-evading	<ul style="list-style-type: none"> <li>-usually have distinct shape changes to maximize moisture</li> <li>-deep roots, up to 25 ft.</li> <li>-stem succulence</li> <li>-CAM photosynthesis</li> </ul>	<p><b>Screwbean Mesquite</b> <i>Prosopis pubescens</i></p>
Drought-enduring	<ul style="list-style-type: none"> <li>-usually desert shrubs</li> <li>-can shed their leaves during periods of drought</li> <li>-rapid gas exchange to cool plant</li> </ul>	<p><b>Creosote bush</b> <i>Larrea tridentata</i></p>
Drought-resisting	<ul style="list-style-type: none"> <li>-usually succulent plants such as cacti</li> <li>-moderate gas exchange to cool plant</li> <li>-stomata close at low moisture levels</li> </ul>	<p><b>Barrel Cactus</b> <i>Ferocactus acanthodes</i></p>

## APPENDIX C.

**3.1 Vocabulary**

annual

perennial

deciduous

evergreen

CAM succulents

deep-rooted trees

drought-escaping

drought-evading

drought-enduring

drought-resisting

ephemeral

stomata

xerophytes

C3 Photosynthesis

C4 Photosynthesis

CAM Photosynthesis

crassulacian acid metabolism

malic acid

rubisco

boundary layer

albedo

glycophytes

halophyte

## APPENDIX D.

**Plant Adaptations Quiz**

1. Annual plants usually are NOT...

- a. shallow-rooted
- b. opportunistic
- c. heat-resistant
- d. fast-growing

2. True or False: Perennial plants die entirely at the end of a season.

- a. True
- b. False

For Questions 3-6, match the description to the Shantz classification.

3. These kinds of plants usually only grow when water is available.	a. Drought-enduring
4. These kinds of plants close their stomata when water potential is low.	b. Drought-resisting
5. These kinds of plants have deep roots or store water in their stems.	c. Drought-escaping
6. These kinds of plants shed their leaves during times of drought.	d. Drought-evading.

7. The CAM in CAM Photosynthesis stands for...

- a. Coarse Arid Metabolism
- b. Crassulacian Acid Metabolism
- c. Cat-Attracting Monomers
- d. It doesn't stand for anything.

8. The enzyme used in photosynthesis is...

- a. rubisco
- b. malic acid
- c. helicase
- d. ligase

9. Halophytes are plants that have adjusted to high levels of salt. Which is NOT an adaptation these plants have made?
- Selectively-permeable membranes in their roots.
  - Salt-holding vacuoles
  - Enzymes that use ground salts to function
  - Salt-exuding glands.
10. What is best word to substitute for “albedo”?
- thickness
  - waxiness
  - ion-exchange
  - reflective nature
11. Write a paragraph comparing and contrasting C4 photosynthesis and CAM photosynthesis. Why would a plant use one of these over C3 photosynthesis? Why would a plant use one over the other?

## **Plant Adaptations Answer Key**

1.C

2.B

3.C

4.B

5.A

6.D

7.B

8.A

9.C

10.D

11. Must mention time stomata are open. Must mention additional structures or enzymes necessary for photosynthesis. Must mention water retention.