SALINIZATION LAB
TEACHER LAB TEMPLATE

Lonnie Miller
El Diamante High School
Visalia Unified School District
Visalia, California

This lab was produced using the design format developed by the Environmental Literacy Council's educator advisory group with funding from the Department of Education's Fund for the Improvement of Postsecondary Education (FIPSE).

Permission to Reprint Statement

The Advanced Placement Program intends this publication for non-commercial use by AP teachers for course and exam preparation; permission for any other use must be sought from the AP Program. Teachers may reproduce this publication, in whole or in part, **in limited print quantities for non-commercial, face-to-face teaching purposes**. This permission does not apply to any third-party copyrights contained within this publication.

When educators reproduce this publication for non-commercial, face-to-face teaching purposes, the following source line must be included:

> **Salinization Lab, Teacher Lab Template. Copyright © 2003 by the College Entrance Examination Board. Reprinted with permission. All rights reserved. apcentral.collegeboard.com.**
> **This material may not be mass distributed, electronically or otherwise. This publication and any copies made from it may not be resold.**

The AP Program defines "limited quantities for non-commercial, face-to-face teaching purposes" as follows:

Distribution of up to 50 print copies from a teacher to a class of students, with each student receiving no more than one copy.

No party may share this copyrighted material electronically — by fax, Web site, CD-ROM, disk, e-mail, electronic discussion group, or any other electronic means not stated here. In some cases— such as online courses or online workshops — the AP Program may grant permission for electronic dissemination of its copyrighted materials. All intended uses not defined within "***non- commercial, face-to-face teaching purposes***" (including distribution exceeding 50 copies) must be reviewed and approved; in these cases, a license agreement must be received and signed by the requestor and copyright owners prior to the use of copyrighted material. Depending on the nature of the request, a licensing fee may be applied. Please use the required form accessible online. The form may be found at: http://www.collegeboard.com/inquiry/cbpermit.html. For more information, please see AP's Licensing Policy For AP® Questions and Materials.

Correlation to Topic Outline in Course Description

IV. Renewable and Nonrenewable Resources: Distribution, Ownership, Use, Degradation

A. Water

1. fresh: agricultural, industrial, domestic

V. Environmental Quality

A. Air/Water/Soil

Correlation to National Science Education Standards

Principles:

- Science is for all students.
- Learning science is an active process.

Teaching Standard A:

Teachers of science plan an inquiry-based science program for their students. In doing this, teachers

- Select science content and adapt and design curricula to meet the interests, knowledge, understanding, abilities, and experiences of students.

Teaching Standard B:

Teachers of science guide and facilitate learning. In doing this, teachers

- Focus and support inquiries while interacting with students
- Orchestrate discourse among students about scientific ideas
- Challenge students to accept and share responsibility for their own learning
- Encourage and model the skills of scientific inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize science

Teaching Standard C:

Teachers of science engage in ongoing assessment of their teaching and of student learning. In doing this, teachers

- Guide students in self-assessment

Teaching Standard D:

Teachers of science design and manage learning environments that provide students with the time, space, and resources needed for learning science. In doing this, teachers

- Structure the time available so that students are able to engage in extended investigations
- Create a setting for student work that is flexible and supportive of scientific inquiry
- Ensure a safe working environment

Teaching Standard E:

Teachers of science develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning. In doing this, teachers

- Display and demand respect for the diverse ideas, skills, and experiences of all students
- Enable students to have a significant voice in decisions about the content and context of their work and require students to take responsibility for the learning of all members of the community
- Nurture collaboration among students
- Model and emphasize the skills, attitudes, and values of scientific inquiry

Assessment Standard A:

Assessment must be consistent with the decisions they are designed to perform.

- Assessments are deliberately designed
- Assessments have explicitly stated purposes

Assessment Standard C:

The technical quality of the data collected is well matched to the decisions and actions taken on the basis of their interpretation.

- The feature that is claimed to be measured is actually measured
- Assessment tasks are authentic
- Students have adequate opportunity to demonstrate their achievements

Unifying Concepts and Processes Standard:

As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes:

- Systems, order, and organization
- Evidence, models, and organization
- Constancy, change, and measurement

Science As Inquiry Content Standard A:

As a result of activities in grades 9-12, all students should develop

- Understandings about scientific inquiry

Science in Personal and Social Perspectives Content Standard F:

As a result of activities in grades 9-12, all students should develop understanding of:

- Natural resources
- Environmental quality
- Science and technology in local, national, and global challenges

Life Science Standard 5:

Understand the structure and function of cells and organisms.

- knows that the complexity and organization of organisms accommodates the need for obtaining, transforming, transporting, releasing, and eliminating the matter and energy used to sustain the organism

Life Science Standard 6:

Understands relationships among organisms and their physical environment.

- knows ways in which humans can alter the equilibrium of ecosystems, causing potentially irreversible effects (e.g., human population growth, technology, and consumption; human destruction of habitats through direct harvesting, pollution, and atmospheric changes)

Introduction

Salt buildup is an existing or potential hazard on almost all of the 42 million acres of irrigated farmland in the United States. Much of the world's unused land is in arid and semiarid regions where irrigation will be necessary. Excessive salinity is presently costing the U.S. billions of dollars in lost food crops.

In the vast Wetlands Water District in Central California's San Joaquin Valley, which provides irrigation water to 600,000 acres of farmland in western Fresno and Kings Counties, as many as 190,000 acres have salinity levels that limit a grower's choice of crops. That usually means cotton or sugar beets, if they can grow anything at all.

Salt kills germinating seedlings by removing the water from their cells (plasmolysis, exomosis). Several salts and their ions are responsible: NaCl, CaCl, KCl, MgCl, $MgSO_4$, HCO_3 -- CO_3 -- $MgCO_3$, NO_3-, NH_4+, K+.

In this investigation, students will design an experiment to investigate the effect of salt on seed germination. After conducting the investigation, they will prepare a report on what they found.

Group Size

From individuals to groups of four or five students

Lab Length

Five to ten days -- one day to design and set up and five to 10 minutes on other days to check seed germination and measure growth.

Preparation and Prep Time

You should have covered water pollution and soil prior to this lab. This lab requires very little prep time as students are designing and conducting their own experiment, and the materials used are readily available.

Materials/Equipment

petri dishes
paper towels
tweezers for seed placement
balances
Ziploc bags
salts (NaCl and others if desired)
distilled water
test tubes
labels
graduated cylinders
flasks and beakers for mixing solutions

Suppliers

Seeds can be purchased locally from garden shops and home supply stores. Dollar discount stores often sell seeds at reduced prices. Local extension centers can be contacted for access to field-grade seeds. Seeds can also be ordered from a variety of companies. One source for heirloom and untreated organic seeds is http://www.greenpeople.org/seeds.htm, which lists seed companies by states.

Safety and Disposal

At the conclusion of the experiment, materials should be cooked, microwaved, or buried to eliminate spread of any plant-disease-causing agent. Even healthy seeds can harbor pathogens.

Teaching Tips

General tips (relating to the procedure or process):

- Be a resource for students on their experimental design procedures. A couple of leading questions from you can make their experiment much better. Use your teacher judgment on this. Some possible questions:
    - What will be measured? How? They need to understand that they are testing the effects of different concentrations of salts on germination.
    - What kind of water will be used as a base? How much salt is in the local tap water?

- What will you use as a control? The procedure they develop must include controls; at least a couple of seeds with no salt added, and if distilled water is used, a control with tap water, which is considered suitable for drinking and seed germination.
- How many seeds per treatment? How many seeds per treatment will be needed to see variation among seeds even if they are of the same variety and from the same lot?
- How often will you observe your seeds? (Seeds may germinate well, but then die.)

- You may want to review previous experiments with them to show steps you used in designing an experiment that they have done.
- Groups can share solutions to reduce wastage of materials and time mixing them if common salt percentages can be developed within a class.
- Each group needs to have a control. Controls are critical to any experiment. Distilled water should be considered, as some water suppliers are heavy in salt.

Potential Problems

- Overwatering seeds
- Seeds that are sterile
- Erratic watering, e.g., drying out over a weekend

Possible Variations

- Each group can use a different type or variety of seed.
- Have each group use a different salt or resultant ion: NaCl, CaCl, KCl, MgCl, $MgSO_4$, HCO_3 -- CO3 -- $MgCO_3$, NO_3-, NH_4+, K+.
- Examine a local area to look for halophytes and their adaptations to salt.

Sample Data

Pea seeds	
0% salt (control)	10 germinated
1% salt	10 germinated
2% salt	7 germinated
3% salt	2 germinated
4% salt	0 germinated
5% salt	0 germinated

Data Graphing and Analysis

Construct a graph on which you compare the percentage of salt concentration compared to the number of seeds that germinated. Be sure and give your graph a title and label the axis.

Postlab analysis and typical discussion questions:

- What relationship is there between the number of seeds that germinated and the salt concentration of the water?
- What errors might have occurred in your experiment that could have affected your data? How could they be corrected in future experiments?
- Did your experimental data support your hypothesis?
- Are your results applicable to "real life"? Why or why not?

Possible Assessments

I traditionally have done this lab as a research report. I have had students present their findings to the class and create visuals to accompany their report (using poster boards and PowerPoint slide shows).

Formal Research Report

Group Presentation

Extensions

Students could read up on salinization and salt-related issues and report to the class for bonus points.

- What salts are needed by people for good health and in what concentrations?
- What research is being done to enable plants to grow in salty water? (This is a very active area of research in biotechnology and research plots in the San Joaquin Valley in California.)

Sample 4-Point Rubric

Category	4	3	2	1
Components of the report	All required elements are present, and additional elements that add to the report (e.g., thoughtful comments, graphics) have been added.	All required elements are present.	One required element is missing, but additional elements that add to the report (e.g., thoughtful comments, graphics) have been added.	Several required elements are missing.
Experimental hypothesis	Hypothesized relationship between the variables and the predicted results is clear and reasonable based on what has been studied.	Hypothesized relationship between the variables and the predicted results is reasonable based on general knowledge and observations.	Hypothesized relationship between the variables and the predicted results has been stated, but appears to be based on flawed logic.	No hypothesis has been stated.
Procedures	Procedures are listed in clear steps. Each step is numbered and is a complete sentence. Control is included.	Procedures are listed in a logical order, but steps are not numbered and/or are not in complete sentences. Control is included.	Procedures are listed but are not in a logical order or are difficult to follow.	Procedures do not accurately list the steps of the experiment.
Conclusion	Conclusion includes whether the findings supported the hypothesis, possible sources of error, and what was learned from the experiment.	Conclusion includes whether the findings supported the hypothesis and what was learned from the experiment.	Conclusion includes what was learned from the experiment.	No conclusion was included in the report or shows little effort and reflection.
Analysis	The relationship between the variables is discussed and trends/patterns logically analyzed. Predictions are made about what might happen if part of the lab were changed or how the experimental design could be changed.	The relationship between the variables is discussed and trends/patterns logically analyzed.	The relationship between the variables is discussed, but no patterns, trends, or predictions are made based on the data.	The relationship between the variables is not discussed.

References/Resources

Cadillac Desert: The American West and Its Disappearing Water by Marc Reisner.
The definitive history of water resources in the American West and a very illuminating lesson in the political economy of limited resources anywhere.

General links

http://soils.usda.gov/sqi/files/Salinzation.pdf

http://oregonstate.edu/instruction/bi301/saliniz.htm

http://www.gps.caltech.edu/~arid/salt/salt.html

http://eces.org/ec/ecosystems/desertification.shtml

http://www.montysplantfood.com/docs/salinization.htm

Fertile Crescent links

http://www.popinfo.org/issues/history02.htm

http://stutzfamily.com/mrstutz/population/pophistorymodule/history-3.htm

Road Salt links

http://www.history.rochester.edu/class/roadsalt/home.html

http://www.mnplan.state.mn.us/issues/scan.htm?Id=1645

http://www.extension.umn.edu/extensionnews/1997/JN1026.html