

The title 'EMERGING SCIENCE' is rendered in a bold, white, sans-serif font with a slight glow effect. It is centered within a blue rectangular area. The background of this area is filled with faint, white, technical and mathematical motifs, including a grid, a sine wave, a coordinate system with axes labeled '2' and '-2', and various mathematical symbols like λ , $D^2\lambda$, and λ^2 .

EMERGING SCIENCE

Classroom Connections

TEACHER'S GUIDE Season III



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Classroom Connections TEACHER'S GUIDE

Classroom Connections is a companion piece to Vermont Public Television's **Emerging Science**, a locally produced television series featuring Vermonters at the frontiers of science.

This guide has been assembled by local teachers for use in high school classrooms.

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Special thanks to the following individuals who contributed to the content for **Classroom Connections**:

- Christal Brown, Danville School, Danville, Vt.
- Gail Hall, Vermont Department of Education
- Bill Muench, Burr & Burton Academy, Manchester, Vt.
- Andy Samara, South Burlington High School, S. Burlington, Vt.
- Brian Slopey, U-32 High School, Montpelier, Vt.
- Vermont Genetics Network (VGN),
a NIH/NCRR grant-funded program located at the University of Vermont.



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● Astronomy

Emerging Science – Episode 1

Activities developed by Bill Muench, Burr & Burton Academy, Manchester, Vt.

Overall Unit Enduring Questions

- What is the universe?
- How do we use telescopes, spectroscopy and radio telescopes to understand the cosmos?
- Why explore the moon, stars and the universe?

Pre-Viewing Activities

Define and explain the following terms:

- Galaxy
- Quasar
- Name of our galaxy
- Light year
- Speed of light/light year
- Dark matter/dark energy
- Hubble telescope
- Spectroscopy

You may want to show images of each item. The Hubble website, <http://www.nasa.gov/home/index.html>, has excellent material.

Viewing Activities/Questions

Print out the following questions and have the students answer them while watching the “Astronomy” episode of **Emerging Science**:

- What is cosmology?
- What is the universe?
- What does it mean to fly into space?
- What did Alan Bean do on his mission?
- What did Alan Bean do when he returned from the moon?
- What is a galaxy made of?
- Why is it that when we look at stars, we are looking back in time?
- Why look at far away galaxies?
- What is spectroscopy?
- What is the Hubble telescope? Where is it located?
- What is a pulsar?
- How are pulsars like lighthouses?
- What is radio astronomy?

Post-Viewing Activities

- Discuss answers to the questions above.
- Have the students go to <http://www.alanbeangallery.com/> and look through the paintings of Alan Bean. Which painting is their favorite? Why? They can even do an internal dialog with the character in the painting.
- Have each student choose a topic from the video clip that they found interesting or confusing and research it for a short presentation in class. Each student will teach the rest of the class about what they learned.
- Get spectroscopes and look at the spectral signatures of different items.
- Do you believe that we are alone in the universe? Why or why not?
- Is exploration of space important? Why or why not?

Extension Activities

- Watch selected episodes of programs like **Cosmos**, **The Planets** or **The Universe**.
- Visit a planetarium.
- Do some viewing at night or solar viewing during the day.
- Look for a local Astronomy Club and hold a star party.

Vermont Science Grade Expectations

- S9-12: 44 Solar System and planets
- S9-12: 45 Stars and energy of stars
- S9-12: 45 Changing technology in our investigations of the nature of the universe

● Ecological Economics

Emerging Science – Episode 2

Activities developed by Andy Samara, So. Burlington High School, S. Burlington, Vt.

Overall Unit Enduring Questions

- What is ecological economics?
- How have increases in energy costs affected Vermont farmers?
- What is an externalized cost of production?
- How are biofuels produced and what are they used for?
- How will sustainable agriculture help Vermont's economy?

Pre-Viewing Activities

Give students a list of vocabulary used in the video and article (see below). Define the vocabulary together as a large group and use some words as small group discussion/brainstorm topics.

Vocabulary List:

Ecology

Economics

Ecological economics

Discussion Point

- Is the economy a subset of a larger ecological system or is the environment a subset of the economy?

Internal cost of production

External cost of production

Discussion Points

- How can we place a value on external costs of production?
- How would placing a value on external costs of production affect our economic system?

Tragedy of the commons

Discussion Point

- How would placing value on external costs of production affect the tragedy of the commons?

Agronomy

Biofuels

Hectare

Commodity

Subsidy

Have students read all or part of the following article and hold a brief discussion relating the vocabulary list and brainstorm questions to the article:

“Price Fixing: Why it is important to put a price on nature”

Jan. 18, 2010 article from The Economist online (http://www.economist.com/world/international/displaystory.cfm?story_id=15321193)

Viewing Activities/Questions

Watch the “Ecological Economics” episode of **Emerging Science** and have students take split-paged notes while watching. In the left hand column have students write the following questions:

- What problem is addressed in the film?
- What are the externalized environmental, geopolitical and economic costs of using and producing fossil fuels?
- Why don’t nationally-based subsidies make sense at a local level?
Explain the energy output of corn ethanol vs. fossil fuels.
- What important byproduct is a result of oil seed production?
Why is this byproduct significant?
- Why is it important to put a value on all costs of production?

In the right hand column have students write answers to the questions and any other notes or questions they may have during the video. At the conclusion of the video have students re-form into five small groups. Assign each group one of the five questions to explain to the larger group.

Post-Viewing Activities

Students will choose to be evaluated in one of two ways.

1. Write a persuasive essay answering the following question:

- How will sustainable agriculture help Vermont’s economy?

Have students write a minimum of five paragraphs, using specific examples from class activities to support their thesis statements. Students should use their brainstorm/vocabulary sheet, the article from The Economist and their own video notes to form their opinion and evidence.

2. Participate in small group-scored discussions.

Students will discuss the following questions:

- How have increases in energy costs affected Vermont farmers?
- How are biofuels produced and what are they used for?
- How will sustainable agriculture help Vermont’s economy?
- How can we place a value on external costs of production?
- How would placing a value on external costs of production affect our economic system?

Groups of three to five students, grouped by readiness, discuss each question for seven to 10 minutes. The teacher roams around the room and observes each group during their discussion of each question. Each time the instructor hears a relevant point directly related to classroom material they make a check next to the student's name. Student's grades will correlate with the amount of check marks they receive after all questions and discussions have concluded.

Students may take notes during the discussion to remember relevant points but class notes are not permitted during the discussion.

Extension Activities

A field trip to the UVM Extension farm in Alburgh would be beneficial to student learning on this topic. Contact Heather Darby at heather.darby@uvm.edu.

Vermont Science Grade Expectations

H&SS9-12:7

Students communicate their findings by:

- Developing and giving oral, written or visual presentations for various audiences.
- Soliciting and responding to feedback.
- Pointing out possibilities for continued or further research.

H&SS9-12:12

Students show understanding of human interaction with the environment over time by:

- Describing and analyzing how human activity and technology currently impact the environment in the U.S. and world, and speculating the impact in the future if current trends continue.
- Generating information related to the impact of human activities on the physical environment in the local, state, national or global community in order to draw conclusions and recommend actions (e.g., using charts and graphs to analyze the effects of overfishing along the coast of North America or the Philippine archipelago).
- Analyzing different viewpoints regarding resource use in the U.S. and world; expressing and supporting one's personal viewpoint (e.g., after debating the causes and/or existence of global warming, expressing one's opinion).
- Analyzing multiple factors in the interaction of humans and the environment (e.g., analyzing mediating factors that influence the relationship between population distribution and environmental change).
- Using information to analyze and evaluate the impact of current voluntary and involuntary migration patterns in the U.S. and world (e.g., census data).

H&SS9-12:20

Students make economic decisions as a consumer, producer, saver, investor and citizen by:

- Using economic terms to analyze and interpret global economic issues and problems (e.g., should there be debt relief for economically unstable countries?).
- Examining the causes and long term effects of people's needs and/or wants exceeding their available resources, and proposing possible solutions (e.g., distribution and use of fresh water).
- Developing strategies for earning and spending utilizing a system of accounting (e.g., creating a budget).
- Analyzing the impact of media, time and place on buying and saving (e.g., advertising, current events).
- Demonstrating understanding of patterns and interdependence locally, nationally and globally that are involved in the production of a product or service (e.g., supply and demand).

S9-12:34

Fossil Fuels

- Use of fossil fuels
- Energy released by different fuels

● Food Pathogens

Emerging Science – Episode 3

Activities developed by Brian Slopey, U-32 High School, Montpelier, Vt.

Overall Unit Enduring Questions

- What is a food pathogen?
- How does food get contaminated with a pathogen?
- How can we avoid getting ill from food pathogens?
- How can we know if a food is contaminated with a pathogen?

Pre-Viewing Activities

Ask student groups to brainstorm the following:

- Diseases or symptoms of diseases that could be caused by contaminated foods.
- Ways to prevent the contamination of food.
- Ways to tell if a food is contaminated.

Ask each group to draw a diagram showing how a food could get contaminated and pass this contamination on to a human.

Depending on level of students, read portions of the following article (<http://www.aolnews.com/nation/article/food-safety-in-2010/19296801>) aloud or have students read it to themselves. Hold a short discussion. Then go to this web page (<http://www.extension.iastate.edu/foodsafety/lesson/11/L1p8.html>) and go through the lessons.

Viewing Activities/Questions

Watch the “Food Pathogens” episode of **Emerging Science** and have the students answer the following questions:

- What are food pathogens?
- Why are food pathogens a problem?
- What is the number one food pathogen in the United States and what is known about it?
- How do these bacteria get from one place to another?
- How can pathogens be detected?

Post-Viewing Activities

Have the students use the web pages below to research a food pathogen.

<http://www.fda.gov/Food/FoodSafety/FoodborneIllness/FoodborneIllnessFoodbornePathogensNaturalToxins/BadBugBook/default.htm>
<http://www.fightbac.org/content/view/full/14/21/>

Then have them design an informational brochure (folded paper with six sides available) that is attractive and covers the following:

- What is ___?
- What sort of germ is ___?
- How can ___ infections be diagnosed?
- How can ___ infections be treated?
- Are there long-term consequences to a ___ infection?
- How do people catch ___ ?
- What can a person do to prevent this illness?
- How common is ___ ?
- How can I learn more about this and other public health problems?

Vermont Science Grade Expectations

S9-12:42

Students demonstrate their understanding of the patterns of human health/disease by:

- Identifying a variety of nonspecific means of protection for the human body and explaining how these maintain human health (i.e., prevent disease).

Science Concepts:

- a. The human body protects itself against infectious diseases (caused by microorganisms, viruses and animal parasites) through physical protection and physiological (immune) responses.
- e. The severity of human disease depends upon many factors, such as resistance to disease and the virulence of the infecting organism.

S9-12:1

Students demonstrate their understanding of scientific questioning by:

- Framing testable questions showing evidence of observations and prior knowledge to illustrate cause and effect.
- Developing a testable question appropriate to the scientific domain being investigated.

● Disease Origins and Transmission

Emerging Science – Episode 4

Activities developed by Cristal Brown, Danville School, Danville, Vt.

Overall Unit Enduring Questions

- How can knowledge of diseases in animal populations help medical doctors keep the human population healthy?
- How can scientists use the concept of “one health” to improve overall health for the world’s people?
- How has our modern lifestyle made it harder for epidemiologists to track disease vectors?

Pre-Viewing Questions

- How do you think most disease is spread?
- What do scientists need to study to decrease the spread of disease?

Viewing Activities/Questions

Watch the “Disease Origins and Transmission” episode of **Emerging Science** and answer the following questions:

- What do scientists mean by humancentric medical practice?
- What is a zoonotic disease?
- What are disease vectors and how do scientists use them?
- How does the concept of “one health” differ from the ideas about health which have been used for many years?
- Why would scientists be concerned about tuberculosis in bovine populations among rural African people?
- Describe the lifestyle of an agro-pastoralist.
- What caused the change from a strictly pastoral lifestyle to the agro-pastoral lifestyle of some African people?
- What three groups compete for water in this area of rural Africa?
- What modern changes have decreased timelines for disease vectors world-wide?

Post-viewing Activities

Adapted from **Top Shelf Human Anatomy & Physiology**, Portland, Maine: J. Weston Walch, 2006.

Materials Needed:

Goggles

Small paper cups (3 oz)

0.25M NaOH, 40-50 ml

Distilled or tap water
GloGerm lotion
Aprons as needed
Beral pipets or droppers
Phenolphthalein solution, 1-2 ml
UV (ultraviolet) light
Paper towels

Part I - Fluid Disease Transmission

- TREAT ALL FLUIDS IN THIS ACTIVITY AS DANGEROUS -

1. Have each student obtain a small cup of fluid and two pipettes.
One student will receive NaOH, the others will receive distilled water.
The instructor must make sure that the students do not know at the outset who has the NaOH, the “disease” solution, but should keep track of which student has which fluid.
2. Students should fill one pipette about half-full of the solution in their cup, and set it aside on a paper towel. Do not use the solution in this pipette during the activity. It will be used at the end of the activity.
3. Students should fill the second pipette with fluid from the cup.
4. Each student finds another student with whom to exchange fluids. The student’s pipette is emptied into the other student’s cup, and vice-versa.
5. Make sure students write down the other student’s name and “Exchange 1.”
6. Students fill their pipettes again from their own cups.
7. Students repeat the exchange process with a second student, being sure to record which student the fluid was exchanged with.
8. Students repeat the exchange sequence with a third student.
9. The instructor will test the fluid in each cup to see whether students have the disease by adding two to three drops of phenolphthalein solution to each cup. If students have contracted the disease, the fluid in the cup will turn pink.
10. As a class, track the students who got the disease and those who did not get the disease.
11. Without consulting the instructor, students work with others to determine which student originally had the disease.
12. Students write down conclusions and ask the teacher to test the set-aside fluid of the students the class thinks were the original disease carriers.
13. Students complete the following sentence:
Beginning with one student carrier, _____ students out of _____ had the disease after only three exchanges.
This represents _____ percent of our class.

Part II - Contact Disease Transmission

1. Prior to the class entering the classroom, choose an item students commonly handle and smear the GloGerm lotion (available from various science suppliers) on it. The door handle and/or faucet handle work well.
2. Once the class has assembled, dim the classroom lights and pass around a hand-held UV light for students to check to see whether they have been exposed to the germs (the GloGerm lotion).
3. Have students read the correct hand-washing technique proposed by the CDC or the Mayo Clinic (<http://www.cdc.gov/Features/HandWashing/> or <http://www.mayoclinic.com/health/hand-washing/HQ00407>) and use it to wash their hands. Students should estimate what percentage of the germs remain on their hands after using the hand-washing technique.
4. Have students who were exposed check their hands again to see the results of their hand-washing. Students should write down their observations and develop a plan for decreasing the number of germs which remain on the skin.

Extension Activities

- Invite the school nurse to explain how outbreaks of various contagious diseases are handled in your school and the measures used to prevent such outbreaks.
- Invite a local health care provider (MD, FNP, etc.) to explain how outbreaks are handled on a county- or state-wide basis.
- Have students research, on the CDC website (www.cdc.gov), how the CDC handles outbreaks and epidemics.

Vermont Science Grade Expectations

- S9-12:42 The Human Body
S9-12:1-8 Inquiry
S9-12:39 Mutations that occur in disease-causing organisms

— Science Career Opportunities —

Resource list compiled by Vermont Genetics Network (VGN), a NIH/NCRR grant-funded program located at the University of Vermont.

National Resources

American Association for the Advancement of Science (AAAS)

AAAS is an international non-profit organization dedicated to advancing science around the world by serving as an educator, leader, spokesperson and professional association.

AAAS Career Support – <http://php.aaas.org/programs/centers/careers/index.php>

AAAS Advice-filled Articles –

http://sciencecareers.sciencemag.org/career_magazine

Association for Women in Science (AWIS)

The Association for Women in Science is dedicated to achieving equity and full participation for women in science, mathematics, engineering and technology.

www.awis.org/

Biomedical Sciences

Listing of opportunities for undergraduates and recent college graduates in New England.

<http://www.bscp.org/resourcedirectory.asp>

BNET Business Network

Information for undergraduates leaving the classroom for research.

http://findarticles.com/p/articles/mi_qn4188/is_20070213/ai_n17221038

Brigham and Women's Hospital (BWH)

BWH is a teaching affiliate of Harvard Medical School.

www.brighamandwomens.org/

Bristol-Myers Squibb Pharmaceutical Company

Listing of career opportunities.

<http://www.bms.com/careers/Pages/home.aspx>

Careers.md

Information on various healthcare careers.

www.careers.md/

Dartmouth-Hitchcock Medical Center

Dartmouth-Hitchcock is New Hampshire's only academic medical center and is affiliated with Dartmouth College.

<http://www.dhmc.org/>

Duke University Career Center

Duke University Career Center provides career services to undergraduate and graduate students.

http://www.dukealumni.com/olc/pub/DUKE/careers/careers_1.html

Environmental Protection Agency (EPA) Careers

Information about student opportunities and programs.

www.epa.gov/careers/stuopp.html

Howard Hughes Medical Institute (HHMI)

HHMI is a non-profit medical research organization whose mission is to advance biomedical research and science education in the U.S.

www.hhmi.org/

Johns Hopkins University

Part of the mission of Johns Hopkins University is to foster independent and original research.

www.jhu.edu/

Mathematical Association of America (MAA)

MAA is the largest mathematical society in the world that focuses on mathematics for students, faculty and all who are interested in the mathematical sciences.

www.maa.org/students/undergrad/

Mayo Clinic

The Mayo Clinic is the world's first and largest integrated non-profit group medical practice.

www.mayo.edu/

National Institutes of Health (NIH)

NIH is part of the U.S. Department of Health and Human Services and is the primary federal agency for conducting and supporting medical research.

General Information – www.nih.gov/

Listing of Career Opportunities - <http://grants.nih.gov/training/resources.htm>

National Science Foundation (NSF)

NSF is an independent federal agency created by Congress in 1950 to promote the progress of science; to advance the national health, prosperity and welfare.

General Information – <http://nsf.gov/>

Career Opportunities – www.nsf.gov/about/career_opps/

New Scientist Jobs

Search for jobs in the field of science.

www.newscientistjobs.com/jobs/default.aspx

PhDs.org

Job listings and advice on getting into graduate school.

www.phds.org/

Pfizer Pharmaceutical Company

Listing of career opportunities.

www.pfizer.com/careers/

Robert Wood Johnson Foundation

The mission of the Robert Wood Johnson Foundation is to improve the health and health care of all Americans.

www.rwjf.org/

Science Careers From the Journal “Science”

Search engine for science careers.

<http://scjobs.sciencemag.org/search/jobs.aspx>

University Medical Center at Princeton

University Medical Center at Princeton, a unit of Princeton HealthCare System, has been a leading teaching hospital for more than 30 years.

www.princetonhcs.org/page3942.aspx

Weill Medical College of Cornell University

Weill Medical College of Cornell University is among the top-ranked clinical and medical research centers in the country.

www.med.cornell.edu/

Woods Hole Oceanographic Institution (WHOI)

WHOI is the largest non-profit oceanographic institution in the world.

www.whoi.edu/

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