Successful Strategies for Attracting Liberal Arts Students to the Natural Sciences

Courses, Activities, and Resources

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Energy and Sustainability

A Model Interdisciplinary Science Course

Course Description: With the recognition that current energy sources and increasing energy consumption is primarily responsible for global warming, energy has become an important public issue. Newspaper editorials, for example, advocate that energy should be a central theme of elections and international politics. Debates about which alternate energy source are wise investments become politicized, as do decisions that must be made on how best to invest in scientific and technological advances for new, clean, efficient, sustainable energy sources for the future. For individuals to make informed decisions on these vital issues requires an understanding of the science and technology of energy, in addition to understanding the science of global warming. Solutions to this problem, through an examination of alternative sources of energy as well as redesign of houses, transportation systems and the like, are examined. The science, economics, and politics of each of each of these issues are thoroughly explored.

Course Overview: Starting with sessions on the history of the discovery of global climate change, and its relation to energy use, the course then turns to descriptions of energy from a physicist's and a chemist's point of view. It then deals with solar and nuclear sources of energy as alternatives to fossil fuels. The course ends with an alternative energy country project, detailed below.

Projects: Each student chooses a country, and proposes an alternative energy plan for that country, taking into account the particular geographical and social conditions in the country. There is a good deal of flexibility allowed; some students choose a city, while others have chosen things like a building or a corporation.

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Energy & Sustainability

Physics Activities

Early on in the Energy and Sustainability course, the students get two guest lectures from a physics professor in the department. The purpose of these two lectures is, first and foremost, to give students a more precise and more quantitative definition of the word "energy" than they may have from their colloquial understanding of the word. Next, they are exposed to the first and second laws of thermodynamics, both of which are essential ingredients to any discussion about energy. The fact that energy is never created or destroyed, and the fact that "using" energy results in an irreversible conversion of concentrated energy into diffuse heat – both of these understandings are

The project assigned during the physics portion of the course has a somewhat different goal. Students are asked to caclulate/estimate the total amount of energy they use during a typical day, week, or month. Besides getting students to think hard about how their daily activities involve both direct and indirect energy costs, the activity is designed to address the issue of **quantitative reasoning**. The activity gets students working in different systems of units, performing calculations that they themselves must devise, and introduces them to the sort of layered estimation problems (what are sometimes called "Fermi problems") that demand not a high degree of algebraic or calculation skills, but rather require a sort of "numerical literacy".

ACTIVITY: Personal Energy Inventory

PART ONE: Forms of Energy

Today in class we listed a number of different kinds of energy. The first part of this assignment is to make a LIST of the ways that you personally use these various forms of energy each day. Think about your daily activities from the time you wake up to the time you go to bed. What things do you do that involve the expenditure of energy?

List the things you do that directly use energy, and tell what type of energy is being used in each case. (food calories? electricity? fossil fuels?) Also think about some of things you do that might involve an indirect energy cost, and list those things as well.

The next step is more difficult - actually calculating HOW MUCH energy is being used in each case.

PART TWO: Calculations

In the first part of this exercise, we asked you to list a number of ways you use energy each day. In class today, we shared our lists, so you may have some things you want to add to your list now that you didn't think of the first time through.

The next task is to CALCULATE the total amount of energy you use in a typical day. Do this for each item in your list. Some of the items in your list might be easy to calculate directly, others may involve taking averages or making some estimates. For example, if you are calculating the energy you use in the form of food calories, you can actually keep track of what you eat in the course of a day, or you can base your calculation on the average caloric intake of an American adult. If you are interested in calculating the amount of electricity you use, you can look at the wattage of all your appliances multiplied by the time you use them, or you could simply read the number of kilowatt-hours off your power bill.

Whatever methods you use, be as precise as possible and explain how you arrived at your results. If you made estimates, explain the reasoning behind each step. What numbers did you need to know? How did you go about finding them? (Cite your sources.) What did you DO with the numbers once you had them? (Add, multiply, divide?)

Express the result for your typical daily energy use in BOTH Joules and in kilowatt-hours. Calculate the amount per MONTH and per YEAR as well.

Energy & Sustainability

Chemistry Activities

A week or two after the students receive guest lectures on physics, they are given a similar series of lectures on topics in chemistry related to energy.

The chemistry and thermodynamics of combustion reactions are discussed to explain why the chemical energy of fossil fuels is our primary source of energy. In the activity below students compare the energy content of different molecules in kJ/g and kJ/m^3 to appreciate the importance of the phase of the compound (at room temperature and temperature). Through this activity students realize why coal is the dominant source of energy. They also begin to appreciate what the energy content of alternate energy must be if it is to be competitive with coal.

The class then reads the attached articles that introduce the concept of **"Energy Return on Energy Invested".** This allows for discussion of other factors besides energy content that must be accounted for in comparing energy sources, as well as "externalities" that perhaps should be accounted for.

ACTIVITY: Comparing Energy Sources

Below is a list of energy sources and the amount of energy given off (in kJ/mole) when each compound is burnt in oxygen – the heat of combustion. Chemical structures are on the next page.

Energy Source	**kJ/mole**	**kJ/gram**	**kJ/m^3**
C(s) (graphite)	394		
Methane CH_4(g)	890		
Octane (gasoline) C_8H_{18}(l)	5472		
Dodecane (diesel) $C_{12}H_{26}$(l)	8670		
Methanol CH_3OH(l)	726		
Ethanol C_2H_5OH(l)	1368		
Hydrogen H_2(g)	286		

1) Write balanced chemical reactions for the combustion of each in oxygen (O_2).

2) Complete the table by calculating the energy given off per gram and per m^3 (volume).

Densities (at 25^{o}C and 1 atmosphere pressure) and mass of 1 mole of each are given below

	Mass of 1 mole	**Density**
Carbon	12.01 g/mole	2250 kg/m^3
Methane	16.04 g/mole	0.656 kg/m^3
Octane	114.23 g/mole	702 kg/m^3
Dodecane	170.34 g/mole	749 kg/m^3
Methanol	32.04 g/mole	789 kg/m^3
Ethanol	46.07 g/mole	790 kg/m^3
Hydrogen	2.01 g/mole	0.082 kg/m^3

3) Which energy source would you choose on a mass basis?

4) Which energy source would you choose on a volume basis?

5) To increase the energy density (kJ/m^3) of the two gases (methane and hydrogen) what could you do? What issues would have to be considered in using these gases as energy sources?

6) How does the kJ/m^3 compare for gasoline and ethanol? What does this suggest in regards to using ethanol as a gasoline replacement?

7) In the calculation above we used the heat of combustion of carbon (as graphite) as a model for coal. The heat of combustion of coal varies from 15kJ/gram to 32 kJ/gram.

Why is the heat of combustion of coal different from carbon (graphite)?

Why does the heat of combustion of coal have a range of values?

8) The volume of one cup of water (16 ounces) is about 237 mL. The mass of this volume of water is about 237 grams. One calorie is the amount of energy required to increase the temperature of one gram (1g) water by one degree centigrade (1oC).

a) How much energy in calories is required to raise the temperature of a glass of water (237 grams) from room temperature (25oC) to boiling (100oC)?

b) Convert the energy in calories to J. *(1 calorie = 4.18 J)*

c) For every mole of methane burned, 890 kJ of energy is released. How many moles of methane would you need to heat one cup of water from 25°C to 100°C? How many grams of methane would you need to heat one cup of water from 25°C to 100°C? *(1kJ = 1000J)*

d) In doing the calculation in problem 3, what assumptions have you made?

e) The nuclear fission of uranium-235 (used in nuclear power plants) has an energy content of 88,250,000 kJ/gram. What mass of U235 would you need to heat one cup of water from 25°C to 100°C

9) Based on your calculations, which energy source would you choose and why? Identify other factors that may be relevant in choosing an energy source. For each, briefly explain why.

More Sample Courses and Projects

The Science and Politics of the Atom Bomb

Course Overview: Students first study the history of physics from 1896 to 1945, learning the epistemology of physics. The course then examines the controversial issue of whether nor not the use of the atom bomb over Hiroshima and Nagasaki hastened the end of World War II.

Projects: Students select a particular issue or controversy – the role of Lise Meitner, for example – and write a final paper. Course is taught seminar style, with students making presentations based on the reading.

Bibliography:

Bernstein, Jeremy. Hitler's Uranium Club : The Secret Recordings at Farm Hall. 2nd ed. New York, NY: Copernicus Books, 2001.

Conant, Jennet. 109 East Palace : Robert Oppenheimer and the Secret City of Los Alamos. New York: Simon & Schuster, 2005.

Frank, Richard B. Downfall : The End of the Imperial Japanese Empire. New York: Random House, 1999

Hasegawa, Tsuyoshi. Racing the Enemy : Stalin, Truman, and the Surrender of Japan. Cambridge, Mass.: Belknap Press of Harvard University Press, 2005.

Hershberg, James G. James B. Conant : Harvard to Hiroshima and the Making of the Nuclear Age. 1st ed. New York: Knopf, 1993.

McMillan, Priscilla Johnson. The Ruin of J. Robert Oppenheimer. New York: Viking, 2005.

Preston, Diana. Before the Fallout : From Marie Curie to Hiroshima. New York: Walker & Co., 2005.

Rhodes, Richard. The Making of the Atomic Bomb. New York: Simon & Schuster, 1986.

Sime, Ruth Lewin. Lise Meitner : A Life in Physics. California Studies in the History of Science ; V. 13. Berkeley: University of California Press, 1996.

Genes and Race

Course Overview. Starting with the history of race in humans as an idea, the course then turns to evolution, then a brief introduction to the science of genetics. We then read a number of articles on racial controversies, such as race and health and race and intelligence.

Projects: Students often will be assigned a "side" in an ongoing debate, as they would in a debate team, do some research on the issue, and proceed with the debate. An example would be "affirmative action."

Bibliography:

Chen, J. et al. "Racial Differences in the Use of Cardiac Catheterization after Acute Myocardial Infarction." N Engl J Med 344.No. 19 (2001)

Cooper, R. S. "Race, Genes, and Health--New Wine in Old Bottles?" Int J Epidemiol 32.1 (2003): 23-5.

Cooper, R. S., J. S. Kaufman, and R. Ward. "Race and Genomics." N Engl J Med 348.12 (2003): 1166-70.

Crick, Bernard. "Foreward." Race, the History of an Idea in the West. Ed. Ivan Hannaford. vols. Baltimore, MD: The Johns Hopkins University Press, 1996. xii.

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Hannaford, Ivan. Race : The History of an Idea in the West. Washington, D.C. Baltimore, Md.: Woodrow Wilson Center Press Johns Hopkins University Press, 1996

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Kahn, Jonathan. "Race in a Bottle." Scientific American August 2007: 40-45.

Bibliography (continued):

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Kittles, Rick A., and Kenneth M Weiss. "Race, Ancestry, and Genes: Implications for Defining Disease Risk." Annu. Rev. Genomics Hum Genet. 4 (2003): 33-67.

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Steele, Claude M., and Joshua Aronson. "Stereotype Threat and the Intellectual Test Performance of African Americans." Journal of Personality and Social Psychology 69.5 (1995): 797-811.

Weiss, Kenneth M, and Stephanie M. Fullerton. "Racing around, Getting Nowhere." Evolutionary Anthropology 14 (2005): 165-69.

The Chemistry of Life

Course Overview: Life depends on chemistry through the reactions and interactions between molecules that sustain it. In this course we will investigate fundamental concepts in chemistry and apply these to investigate the chemistry of the early earth under environmental conditions that prevailed, possible physical and chemical transformations of the environment of early earth that supported the formation of life, and discuss theories for how simple building blocks may have become the more complex molecules that are the basis of life. We will also look at the role of chemistry in sustaining life today. Through the course we will look at the following questions:

What is life? What are the conditions necessary for establishing and sustaining life as we know it?
What are the elements of life and where did they come from?
Why is liquid water essential for life?
Why is life carbon-based?
What is the role of energy in supporting life?
How did the simple molecular building blocks of life form and how did these become the complex systems necessary for life today?
Why is it such a challenge to understand how life began? What theories are being considered? How does science approach understanding the origins of life?

Learning Objectives: Students will...

(i) Understand the role of molecular scale interactions in chemical processes
(ii) Understand the role of the environment in supporting chemical interactions
(iii) Understand and appreciate the relationship between molecular scale processes and macro-scale outcomes
(iv) Understand the process by which scientific understanding advances
(v) Apply fundamental chemical understanding to gain basic understanding of plausible theories on the chemical origins of life

This course includes many in-class activities that are done in groups of 2-3 students. Some of the activities include molecular modeling and simulations that are performed using SPARTAN STUDENT EDITION (Wavefunction, Inc). Two examples of activity done in class are below. In the first activity students explore the change in potential energy of two atoms as a function of inter-nuclear distance. Through this activity students appreciate that "attraction" corresponds to lowering of the potential energy as well as concepts such as "bond energy" and "bond distance" and factors that influence these. The second activity reinforces the role of energy in influencing outcomes by looking at changes in potential energy due to inter-molecular interactions.

Math Models in Nature

Course Description: This course combines aspects of quantitative reasoning and mathematical modeling. Quantitative reasoning is the ability to make sense of the numbers that surround us: to find patterns, to estimate, and to create mathematical models that help us make informed decisions. In this course students focus particularly on the role of difference equations to describe complex natural phenomena. Using computers as computational and graphical aids they develop the basic algebraic, computational, graphical, and statistical skills necessary to understand these models, and learn why difference equations are the primary tools in the emerging theories of chaos and complexity. This course also satisfies requirements in Writing.

Resources:

Elementary Mathematical Modeling Sanderfur, E., Brooks-Cole-Thomson Learning, 2003,
Mathematical Models in Biology: An Introduction, Allman, E., & Rhodes, J., Cambridge University Press, 2003
Environmental Math in the Classroom, Fusaro, B. & Kenshaft, P., Mathematical Association of America,
Mathematical Modeling for the Environment, Hadlock, C., Mathematical Association of America, 1998
Consider a Spherical Cow: A Course in Environmental Problem Solving, Harte, J., University Science Books, 1988
A Course in Mathematical Modeling, Mooney, D. & Swift, R. Mathematical Assocation of America, 1998

Course Structure and Learning Outcomes

The focus of this course will be twofold: (1) to understand how mathematical models are created and applied and to analyze the advantages and disadvantages of different models; and (2) to develop the specific algebraic, computation and graphical skills required to analyze these models. By the end of the class, students should be able to

- Employ a variety of strategies to solve problems
  (estimation, graphical and numerical analysis etc.)
- Use spreadsheets to evaluate functions, create graphs, etc.
- Recognize specific patterns in data
- Develop appropriate mathematical models (particularly difference equations)
- Extrapolate and make predictions using those models
- Identify advantages and limitations to these models
- Read and understand uses of mathematical models in primary literature

“Math Models in Nature” - Course Outline

1. Single Species Models
   - numerical and graphical analyses
   - explicit solutions
   - equilibrium points, periodicity and stability
   - working with linear, exponential and logarithmic functions

2. Age Structured Models and other Systems of Linear Difference Equations
   - numerical and graphical analyses
   - using matrices to find equilibria
   - exploring stability using eigenvectors

3. Density-Dependent Models
   - compensation and decompensation models (the logistic equation etc)
   - numerical and graphical analysis
   - finding and classifying equilibria
   - finding optimal harvesting levels

5. Two Species Models and Other Non-Linear Systems
   - predator-prey models
   - infectious disease models

6. Modeling Data with equations
   - review of basic descriptive statistics
   - linear regression and least squares fit
   - power, exponential and other forms of regression
   - understanding variance and indicators of fit
   - using trigonometric functions to model periodic data – modeling lynx data

7. Other topics as time permits

ACTIVITY: Introduction to Non-Linear Growth

Up to this point, we have assumed that the "growth rate" of a population is constant (such as 4%). In reality, growth rates are frequently "density dependent." This means that the growth rate depends on the current size of the population.

The logistic model is the simplest density dependent model. It assumes:

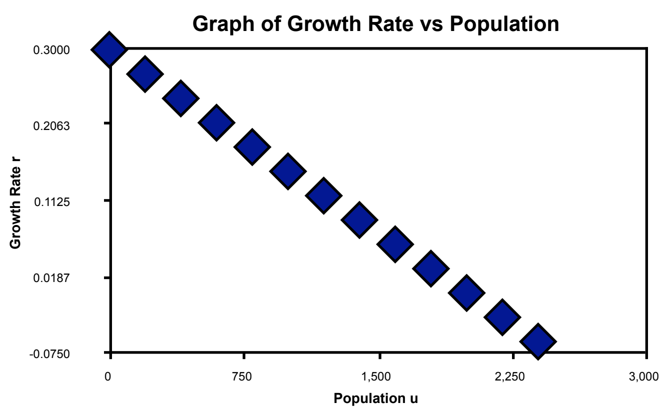
(i) When the population is small, the growth rate is large as there are ample resources for the population to expand.

(ii) As the population grows, there is increased competition for these resources, and the growth rate decreases.

(iii) There is crucial population level called the carrying capacity, when the competition for resources causes individuals to die at a rate equal to the natural birth rate. At this rate the growth rate of the population rate is exactly zero.

(iv) If the population is larger then the carrying capacity, the competition for resources causes individuals to die faster than they can be replaced. Thus the growth rate is negative.

Below is a graph of growth rate (vertical axis) versus population (horizontal axis).



Problem 1

a) Indicate on the graph how each of the observations (i)-(iv) above is illustrated in the graph.

b) Label the carrying capacity on the graph.

c) The r-intercept, which is the growth rate corresponding to a "zero-population" is called the "intrinsic growth rate". Label the intrinsic growth rate on the graph.

d) Find an equation for r in terms of u (use the formula for a straight line).

e) Use the basic difference equation model, u(n) = u(n-1) + r u(n-1). Substitute your equation for r into this equation, writing "u(n-1)" whenever you have a "u".

f)) Use Excel to investigate the population. Experiment with different initial populations.

g) Based on the your observations in (f), what is the equilibrium value? Is it stable?

h) Use algebra to find the equilibrium. (Hint – this will be a quadratic equation!)

Problem 2

Assume that a population has in intrinsic growth rate of 5% and a carrying capacity of 1000.

a) Sketch the graph of r versus u.

b) Repeat steps (d)-(h) as above.

Find an equation for u.

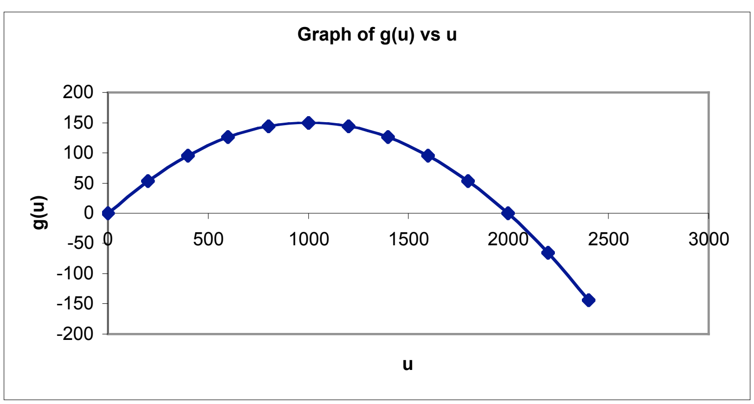
Further Analysis

Another way to analyze the logistic equation is to focus on the *change* in the population rather than the *rate* of population growth. To do this, note that "change in population" = "rate of growth" times "population". Symbolically, if we let g(u) stand for "change in population", then g(u) = r u

Problem 3

a) Substitute the equation for r from part (d) into the equation for g(u). (You do not have to worry about adding "n's".

b) Your equation should be $g(u) = 0.3u - 0.00015u^2$. Below is a graph of g(u) versus u.



Label the equilibrium values on the graph of g? Does this make sense? Label the regions where the population is increasing and where the population is decreasing.

ACTIVITY: Sex Determination, Gender, and Sexual Orientation

These readings and the associated "Controversial Quote" assignment provide a scientific perspective on sex determination and sexual behaviors (the biological definition of sex) at two levels: DNA/chromosomes; and proteins/hormones. The assignment has been used in a freshman genetics course as well as a history of sexuality gender studies course. The aim is to highlight the biological underpinnings responsible for sexual diversity and sexual orientation. The first student learning outcome is to view sex as a continuous phenotype, rather than a discontinuous one made up of only male and female outcomes. The second learning outcome is for students to demonstrate cultural competence and to appreciate and respect sexual diversity in the human population. Later in the genetics course, sex and gender roles are revisited during sessions on reproduction, the frequency of meiotic defects in each sex, and prenatal testing for defects such as Trisomy 21 using readings from standard biology textbooks as well as Rayna Rapp's excellent review of gender roles using an anthropological lens, in Testing Women Testing the Fetus: The Social Impact of Amniocentesis in America.

READING ASSIGNMENT and QUESTIONS

Because science is not separate from, but rather is complementary to, other academic disciplines, the readings and video selections draw from biology, but connect to readings in gender studies. We will use these resources to frame a discussion that moves from biological definitions of sex to cultural views on gender and, specifically, sex stereotypes. The Controversial Quote Assignment will help you prepare for discussion. Most of readings are short, 1-3 pages in length, but the Ridley reading is a bit longer and dense so spend some time on this one. (#6).

MULTIMEDIA

1. Phyllis. Ward. 2000. Is it a Boy or a Girl? Great Falls VA: Discovery Channel. Cable broadcast. March 26.
2. HHMI. "Gender Testing of a Female Athlete" at the HHMI Biology Interactive site http://www.hhmi.org/biointeractive/gendertest/gendertest.swf

READINGS

Readings about Chromosomes and Sex Determination

3. Miller, K. (1995). Whither the Y. Discover 16(2) 36-37.
4. Genetics Review Group. (1995). One for a boy, two for a girl? Current Biology. **5**:37-39. (genetics course only)
5. Graves, J. A. M. (Sept 2000). Human Y chromosome, sex determination, and spermatogenesis- a feminist view. (genetics course only)

Readings on Proteins/ Hormones and Gene Environment Interactions for Mating Behaviour

6. Ridley, M. "A Plethora of Instincts" *In* The Agile Gene: How Nature Turns on Nurture. HarperCollins. 2003: 38-50.

Readings that address sex stereotypes

7. Turner, G. (1996). Intelligence and the X Chromosome. The Lancet. 347:1814-1815.
8. Edlin. Sexism: Prejudice against Women. p. 233 *In* Human Genetics. Jones and Bartlett Publishing. 1990.

Readings that discuss genetics and sexual orientation

9. Do genes play a role in determining whether a man is gay or heterosexual? Medical Study News, January 31, 2005. http://www.news-medical.net/?id=7585. Complete study published in Human Genetics. March.

Optional Readings address the sex stereotype effect on women in the workforce (math and science)

10. Barres, B. (July2006). Does gender matter? Nature. 442:133-136.
11. Lawrence, P. (Jan 2006). Men, women, and ghosts in science. PLOS Biology. http://biology.plosjournals.org/perlserv?request=get-document&doi=10.1371/journal.pbio.0040019

THOUGHT QUESTIONS

1. Describe three different ways that sex can be determined, using examples from organisms other than humans. Might there be an evolutionary reason for these differences?
2. Do the texts point to a new way of biologically defining one's sex? Does this also affect notions of gender?
3. Peter Trinkle, board president of a peer support education organization for intersex, argues that the term "intersex" seems to imply an accepted biological diversity, while "disorders of sexual development" implies a pathology that must be corrected. Furthermore, intersex is in line with feminist ideology that supports a mixing of male and female characteristics and moves away from a strict dichotomy. More recently, "diversity of sexual development" has been proposed. Which of these terms, if any, do you find useful, offensive, or inappropriate?
4. How are hormones such as vasopressin and oxytocin expressed differently in males and females? What about intersex? What about during courtship, mating and post mating behavior?
5. Given the continuum model of sex determination, should we revisit policies and categories regarding scholarship eligibility or census data collection? Do you see analogies with the "one drop rule?"
6. Should scientific data like that presented by Ridley hit the mainstream? Do you think science supports or refutes sex/gender stereotypes? How are science and medicine different?

CONTROVERSIAL QUOTE CONTENT

1. Include a quotation or excerpt from one reading from the date the assignment is due
2. Present a summary or interpretation of the selected quote. This should demonstrate awareness of the context (the rest of the reading) from which the quote was taken
3. Present an original idea/informed opinion related to the quote, make connections to other readings/ videos, provide evidence for your stance, and use citations for your sources.

Science and Religion: Anomalies and Miracles

Course Overview: *Science and Religion* is a brand new course, and the first course co-taught by faculty in the Science and Religious Studies programs. We have tried to structure this course around non-confrontational exploration of the ways that science and religion deal with a similar theme. This is not to say that there will not be clear differences and disagreements between the methods and conclusions of the two. But we want to avoid setting up the dichotomy of science versus religion from the start. A typical "Science and Religion" course often views history as a series of struggles in which new ideas in science continually supplant the old superstitions of religions. Instead of focusing on the conflicts between religion and science, we want to explore the way both subjects address a similar issue and work towards a constructive understanding and appreciation of the two approaches.

The issue we have chosen to build our course around is - How do science and religion deal with the unexplained and the unexpected? In other words, how does a particular worldview handle the introduction of an event or an idea that does not "fit"?

In order to avoid superficial generalities about the beliefs and practices of both science and religion, we have chosen to narrow the readings, from the religious side, at least, to Christian theologians working in different historical situations and with different positions vis-à-vis ecclesiastical organization. Students are welcome to volunteer perspectives from outside the Christian tradition (though they are cautioned against making generalizations about entire religious traditions, e.g. "The Buddhist perspective on miracles is…") We hope the course will open up the diversity of approaches, among scientists as well as theologians, in tackling the problem of the anomalous and miraculous.

Learning Objectives: Students will…

- Establish and evaluate various working definitions of "religion" and "science".
- Establish and evaluate various working definitions of "miraculous" and "anomalous".
- Recognize the particular concerns of science and religion and appreciate their differences.
- Examine the role that "significance" plays in the human interpretation of rare or unusual occurrences.
- Describe the similar challenges faced by scientific and religious orthodoxies in the face of singular or unexplained events.

Life in the Cosmos

Course Overview: It is easy to dismiss the discussion of extraterrestrial life as a topic best suited to science fiction movies and UFO conspiracy theorists. But the question of "Are we alone?" is one of the most important and profound in all of science, and we are just now beginning to develop the tools to allow us to search for an answer. Astronomers are discovering extrasolar planetary systems by the dozens - a few of them with remarkably Earth-like planets. Chemists are beginning to unlock secrets of how life began on our own planet. And biologists studying "extremophiles" on Earth have broadened our definition of what sorts of environments are suitable for life. In this course, students apply the tools of physics, chemistry, biology, and astronomy to explore the current state of the search for life within our solar system and beyond.

Topics:

A Tour of the Cosmos
The History of Life on Earth
The Tools of Astronomy
A Tour of the Solar System
The Earth as a Planet
Water and Life (Bhawani)
The Processes of Life (Katayoun)
Evolution and Natural Selection (read Darwin!!)
The Origin of Life on Earth
Comets, Impacts, and Life
Planets and Habitability - Our Solar System
Mars, Europa, and Titan
Habitable Zones
Stars & Stellar Evolution
Extrasolar planets
The Galactic Environment
The Drake Equation and SETI
How to Talk to Aliens
Encoding and Decoding a message
The Voyager Interstellar Record
UFOs: A Scientific View
Relativity and Interstellar Travel
The Fermi Paradox

Course Materials:

Life in the Universe, 2nd edition by Bennett & Shostak