This consortial program is supported by the W.M. Keck Foundation of Los Angeles
Proposal Cover Sheet

Project Title: Science and Society: A New Interdisciplinary Core Course

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Faculty Department: Biology
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Proposed grant period: January 1, 2006 – December 31, 2006
Type of project: Design and Implementation of New Course

Summary

To ensure that Morehouse College students "understand the fundamental principles and processes of the natural world" (Appendix 1, core curriculum student learning outcome B.3), a team of Morehouse College faculty seeks to develop a new course entitled, Science and Society, that will take an integrated approach to learning and teaching science. Funds from ACS will enable us to develop a completely new core curriculum course that will focus on already defined student learning outcomes. The college will require this course for all matriculating students, both science majors and non-majors. We propose a course that will include an inquiry driven laboratory and peer-led team-learning workshops.

Our course development team consists of faculty representing biology, chemistry, psychology, mathematics, and physics. We will prepare innovative lecture and laboratory materials for the new course including 12 inquiry-based laboratory protocols, 12 peer-led team-learning workshops, and detailed outlines, case studies, and problems for lectures.

We anticipate that all students, whether science majors or non-majors, will 1) become confident in their understanding of the process of science, 2) understand the impact of scientific discoveries on our lives, and 3) make use of the scientific method in problem solving. Explicitly, our main goals are to ensure that all students understand the methods and ethics of scientific research and are knowledgeable about the history and philosophy of science, understand the process of biological evolution, understand fundamental physical laws and principles, and understand the inter-relatedness of science, mathematics, and systems thinking.

Project Description

Goals and Objectives. The overarching goal of this project is the preparation of innovative lecture and laboratory materials for a new interdisciplinary core curriculum science course entitled, Science and Society. Specifically, our faculty team will prepare 12 inquiry-based laboratory protocols, 12 peer-led team-learning workshops, and detailed "lecture" outlines based on discussion of case-studies and problem solving. We also propose to purchase laboratory equipment for one of the planned laboratory studies.

Background and Significance. During the past three years, a Morehouse College faculty group, the Core Curriculum Task Force, representing every academic area, undertook a comprehensive review of our core curriculum. The purpose of this review was to ensure that our objectives were clear and that we could demonstrate that students accomplish the intended outcomes. This review included the specification of a science objective, to "understand the fundamental principles and processes of the natural world", and four general outcome indicators (Appendix 1) to ensure that both science and non-science majors understand:

1. the method and ethics of scientific research and have knowledge of history and philosophy of science
2. biological evolution
3. fundamental physical laws and principles
4. the inter-relatedness of science, technology, mathematics, and systems thinking

In the summer 2004, a multi-disciplinary faculty design team outlined a one-semester course, “Science and Society”, which will be required of all Morehouse students. The design team specified detailed outcome indicators (see Appendix 1 and 2) that are guidelines for the development of lecture and laboratory materials as well as the development of evaluation instruments. The course we will develop has been approved for implementation on a trial basis starting in the 2007-2008 academic year and will be taught for a total of four semesters as part of a three-year trial of the new core curriculum.

The Science and Society course will be taught in a broadly interdisciplinary manner with faculty from two different departments team-teaching the course in each section. Thus, we propose to bring together six faculty (including the PI) from five departments (Biology, Chemistry, Physics, Psychology, and Mathematics) to develop lecture modules that will integrate science disciplines and take an inquiry-based approach to learning and teaching (D’Avanzo 1996). Inquiry-based learning has been shown to be very effective in engaging students’ interests, introducing real-world issues, fostering group and individual work, and making students active learners striving to solve problems (Udovic *et al* 2002, reviewed in NRC 2003). This kind of learning is necessarily interdisciplinary and requires students to integrate mathematical skills with their science knowledge. Such integration is among the specific recommendations of the National Research Council Committee on Undergraduate Biology Education (2003). We also propose to develop Peer-Led Team-Learning (PLTL) workshops for this course. PLTL has been a very effective means of improving student performance in majors science courses, particularly chemistry (Tien, Roth and Kampmeier 2002), but this method has not, to our knowledge, been attempted with non-science majors. This proposed course will have an inquiry based laboratory in which students would meet for one 4-hour meeting each week, so we also will develop laboratory protocols as a part of this mini-grant. The approach we propose will embrace six of the seven principles for good practice in undergraduate education: encouraging student-faculty contact, encouraging cooperation among students, encouraging active learning, giving prompt feedback, emphasizing time on task, and communicating high expectations (Chickering and Gamson 1991).

Detailed Project Plan. The Science and Society course will consist of four topical modules (Appendix 2):

Module Subject	*Outcome Indicator Area*
Origin of the Universe (OTU)	Physical laws
Social Biology, Behavior and Evolution (SBE)	Evolution
Science and Terrorism (ST)	Physical laws, Interrelatedness
Energy, Climate and Pollution (ECP)	Physical laws, Interrelatedness

Each of these modules would be taught for three weeks and would include one laboratory meeting each week. The Energy, Climate and Pollution module (Appendix 2) represents the approach we will use. Lecture-discussion meetings will address basic concepts on the physics and biology of energy and matter flow in nature, pollution, population growth, waste management, human energy use, and climate change by considering current events, public policy and the science behind them. Weekly laboratory studies will be conducted in a guided inquiry manner to support and elaborate on the discussions held in the lecture section, and a PLTL workshop will focus on problem solving and reinforcing basic concepts from lectures. The three laboratory studies in this module will be on population models and human population growth, factors influencing decomposition in landfill disposal facilities, and solar energy and electrical efficiency. We propose to both write and fully test the laboratory on solar energy and electrical efficiency as a part of this mini-grant. In this laboratory study, students will collect electrical output and efficiency data from a full scale installed solar panel that is generating electricity that flows into the campus power grid. They will evaluate the power output per unit area of solar panel and extrapolate the surface area required to power a typical home. In another part of this same laboratory, they will evaluate differences between incandescent and compact fluorescent bulbs in heat and light production and energy use. In a third part of this laboratory, students will produce hydrogen gas by solar electrolysis of water and then produce electricity in a hydrogen fuel cell. This working model of a carbon-free energy system will be the basis for discussion about the challenges created by our carbon-based energy use.

In addition to the PI, five faculty from biology, chemistry, physics, mathematics and psychology have agreed to prepare implementation ready case-study problems for lectures with associated weekly PLTL modules and laboratory protocols. Each faculty member will prepare two weeks of materials (six 50-minute lecture-discussions, two 4-hours laboratories, and two 90-minute PLTL workshops). These are the deliverables that will be produced as a result of mini-grant support.

Prior Activities. Blumer was a member of the Core Curriculum Task Force and led the design team that proposed the Science and Society course (Appendix 2). Blumer has more than a decade of experience developing and disseminating innovative laboratory protocols and he is currently leading the PLTL implementation effort in the majors introductory biology courses at Morehouse College. The colleagues who have expressed interest in participating in this mini-grant project were either members of the design team in the summer of 2004 or were members of the Core Curriculum Task Force.

Time Table. We propose to begin activity on this project in January 2006 with a target of June 1, 2006 for one-half of the course materials (18 lecture-discussion outlines with case studies, 6 PLTL workshops and 6 laboratory protocols) to be completed. The remainder of the course materials will be developed during the summer and completed by September 1, 2006. Examinations for each module and for the course as a whole will be prepared as the modules are developed. Equipment for the laboratory on Solar Energy and Electrical Efficiency will be purchased in August and written protocols will be tested by a student laboratory assistant during the fall 2006. All written materials will be reviewed internally and revised during the fall 2006.

Proposed Budget. Total Budget Request $19,720

Faculty Stipends for five individuals (Biology, Chemistry, Physics, Psychology, and Mathematics: $1,500 each for development of written course materials. We are proposing more than the normal $5,000 stipend total so we can ensure the broadest possible faculty input for this interdisciplinary course. Stipend support is not proposed for the PI. Subtotal = $7,500

Student Laboratory Assistant stipend of $400/month for 3 months to test laboratory protocol on solar energy and electrical efficiency. Subtotal = $1,200

Laboratory Equipment for solar energy and electrical efficiency. Subtotal = $11,020

Solar panel installed outdoors, inverter and dedicated computer	$5000
Datalogger and Pyranometer 1 units	$1700
Solar power-fuel cell system and digital multimeters 4 units	$2720
Electrical supplies for light bulb evaluation	$200
Watt meters to evaluate light bulb energy use 4 units	$600
IR Thermometers to measure light bulb heat output 4 units	$800

<u>Context of Course in Curriculum</u>. The Science and Society course has been approved as part of a trial-run of a new core curriculum. In 2007-2008 and 2008-2009, this course will be taught to a sample of 100-200 students, both science and non-science majors. If the new core curriculum is approved for full implementation, this course will be required of all Morehouse students, approximately 700 each year.

<u>Institutional Support</u>. Implementation support for this new course will be provided by the Division of Science and Mathematics (letter attached in Appendix 3), including financial support to test and implement all laboratory studies that will be developed as a part of this mini-grant. Institutional support will include support for a thorough evaluation of

instructional effectiveness based on the outcome indicators specified for the course (Appendix 1).

Evaluation, Dissemination and Continuing Support

We will prepare for the thorough evaluation of the new Science and Society courses while also evaluating the existing non-science majors courses, Biological Sciences for Non-Majors (BIO 101) and Physical Sciences (PHY 102). Evaluations will measure student attitudes, skills and knowledge to determine whether the outcome indicators specified for the core curriculum have been successfully met. We plan to use the Science and Mathematics Values Inventory (SaM-VI) developed at Drury University to evaluate student attitudes in a pre-test, post-test format. Evaluation instruments for specific skills and knowledge (specific outcome indicators, Appendix 1) will be developed along with the course materials. It is our expectation that these evaluations also will be performed in a pre-test, post-test manner as part of an on-going instructional effectiveness effort. Success will be measured both in absolute terms, students successfully achieving the skills and knowledge specified by our outcome indicators, and in comparison to the existing non-science majors courses, better student outcomes in the new course than in the existing courses. Better student outcomes would be indicated by improved attitudes about science as well as greater success in achieving the skills and knowledge specified by our outcome indicators (Appendix 1).

Dissemination will be achieved by means of publications, presentations at national meetings, and website postings. The laboratory protocols and PLTL workshops that are produced as a result of this mini-grant will be prepared for presentation and publication. For example, the PI has previously presented and published laboratory protocols at the annual meeting of the Association of Biology Laboratory Education (ABLE) and in the Ecological Society of America, Teaching Issues and Experiments in Ecology (TIEE) electronic journal. We will pursue publication of laboratory protocols in these and other journals. Laboratory protocols and PLTL workshops will be posted on the ACS Science Reform Program web site and a Morehouse College web site where they can be readily accessed. Once the course is taught and evaluation data become available, we will have information comparing our new interdisciplinary inquiry-based learning approach to the traditional single discipline courses. Those data will become the basis for a research report that will be prepared for publication in a peer-reviewed journal such as Cell Biology Education.

Literature Cited

Chickering, A.W. and Z.F. Gamson (eds). 1991. *Applying the Seven Principles for Good Practice in Undergraduate Education.* Jossey-Bass, San Francisco. 104 pp.

D'Avanzo, C. 1996. Three ways to teach ecology labs by inquiry: guided, open-ended, and teacher-collaborative. Bulletin of the Ecological Society of America. 77:92-93.

NRC. 2003. *BIO 2010. Transforming Undergraduate Education for Future Research Biologists.* The National Academy Press, Washington, DC. 191 pp.

Tien, L.T., V. Roth, and J.A. Kampmeier. 2002. Implementation of a peer-led team learning instructional approach in an undergraduate organic chemistry course. Journal of Research in Science Teaching. 39:606-632.

Udovic, D., D. Morris, A. Dickman, J. Postlehwait, and P. Wetherwax. 2002. Workshop Biology: Demonstrating the effectiveness of active learning in an introductory biology course. Bioscience 52(3):272-281.

Curriculum Vitae of Principal Investigator

Lawrence S. Blumer

i. Professional Preparation:

University of Michigan	Secondary Education-Biology	BGS 1974
University of Michigan	Zoology	MS 1978
University of Michigan	Biological Sciences	PhD 1982
Ohio State University	Postdoctoral	1985-1987

ii. Appointments:

University of Michigan	Lecturer	1982-1985
Ohio State University	Lecturer	1986
Kenyon College	Visiting Assistant Professor	1987-1990
Morehouse College	Associate Professor	1990-present

iii. Publications:

Publications related to curriculum development and laboratory instruction

Blumer, L. S. 1997. Phenotypic variation in plants. Pages 231-247, in Tested Studies for Laboratory Teaching, Volume 18 (J.C. Glase, Editor). Proceedings of the 18th Workshop/Conference of the Association for Biology Laboratory Education (ABLE), 320 pages.

Beck, C., Blumer, L., and Brown, T*. 2003. Effects of salinity on metabolic rate of black mollies. Pages 211-222, in Tested Studies for Laboratory Teaching, Volume 24 (M. O'Donnell, Editor). Proceedings of the 24th Workshop/Conference of the Association for Biology Laboratory Education (ABLE), 334 pages. (*undergraduate student)

Beck, C.W., Guinan, J.A., Blumer, L.S., and Matthews, R.W. 2004. Exploring the Lotka-Volterra Competition Model with Two Species of Parasitoid Wasps. Ecological Society of America, Teaching Issues and Experiments in Ecology, Volume 2, published on-line at www.tiee.ecoed.net

Olvido, A., and Blumer, L. 2004. Introduction to Mark-Recapture Census Methods Using the Seed Beetle, *Callosobruchus maculatus*, Invited Major Workshop, Presented at the 26th Annual Meeting of the Association for Biology Laboratory Education (ABLE), (submitted for publication in the conference proceedings).

Guinan, J., Beck, C., Blumer, L., and Matthews, R. 2004. Competition Within and Between Species of Parasitoid Wasps, Invited Major Workshop, Presented at the 26th Annual Meeting of the Association for Biology Laboratory Education (ABLE), (submitted for publication in the conference proceedings).

Other significant publications

Earley, R.L., Blumer, L.S., and Grober, M.S. 2003. The gall of subordination: Changes in gallbladder function associated with social stress. Proc R Soc London Series B. 03PB0465:1-7 (internet publication) and 2004, 271:7-13 (in printed journal).

Downhower, J.F., and Blumer, L.S. 1989, Size of aquatic endotherms. Nature (London) 341:192.

Downhower, J.F., Blumer, L.S., and Brown, L. 1987. Seasonal variation in sexual selection in the mottled sculpin. Evolution, 41:1386-1394.

Downhower, J.F., Blumer, L.S., and Brown, L. 1987. Opportunity for selection: An appropriate measure for evaluating variation in the potential for selection? Evolution, 41:1395-1400.

Blumer, L.S. 1986. Parental care sex differences in the brown bullhead, *Ictalurus nebulosus* (Pisces, Ictaluridae). Behav. Ecol. Sociobiol., 19:97-104.

Blumer, L.S. 1985. The significance of biparental care in the brown bullhead, *Ictalurus nebulosus*. Env. Biol. Fish., 12:231-236.

Dominey, W.J., and Blumer, L.S. 1984. Cannibalism of early life stages in fishes. In: Infanticide: Comparative and Evolutionary Perspectives. G. Hausfater and S. Blaffer Hrdy (eds.), p. 43-64. Aldine, New York.

Blumer, L.S. 1982. A bibliography and categorization of bony fishes exhibiting parental care. Zool. J. Linnean Soc. London, 75:1-22.

Blumer, L.S. 1979. Male parental care in the bony fishes. Q. Rev. Biol., 54:149-161.

iv. Synergistic Activities:

Presented at three Project Kaleidoscope meetings:

1992, Curriculum reform and facilities for undergraduate science. Invited Lecture, Project Kaleidoscope Workshop, Lake Forest College, IL

1996, Where we are and where we go from here: Faculty involvement in academic building design and construction. Invited Lecture, Project Kaleidoscope Workshop, Atlanta, GA

1999, Integrating education technology in science learning and teaching at Morehouse College. Invited Lecture, Project Kaleidoscope 10th Anniversary Meeting, University of Maryland, College Park, MD

Presented at Associated Colleges of the South GIS Symposium:

2003, Using GIS in Case Study Learning, Invited Lecture, Associated Colleges of the South GIS Symposium, Southwestern University, Georgetown, TX

v. Teaching Experience

Morehouse College, 1990-present

Environmental Biology, 13 semesters
General Biology for Science Majors, 5 semesters
Biological Sciences for non-majors, 17 semesters
Ecology and Ecology Laboratory, 18 semester

Disclosure Statement

Current and pending support for Lawrence Blumer in 2006:

I have committed one-month of effort per academic year to the Center for Behavioral Neuroscience NSF grant at Georgia State University on which Morehouse College is a subcontractor. I also have committed one summer month and 2.2 academic year months to the NSF HRD-HBCU grant to Morehouse College, Curriculum Reform and Laboratory Enhancement for Science Technology Engineering and the Mathematics. A pending grant proposal to NSF, Developing Bean Beetles as a Model System for Undergraduate Laboratories, if funded would commit 2 summer months and would result in shifting the summer support in the current HRD-HBCU grant entirely to the academic year.

Appendix 1

Science and Society
Goals and Outcome Indicators (Course Subject Modules in Parentheses)

Goal A: Ensure that the student possesses fundamental intellectual skills

Expected (Student Learning) Outcome:

A.3 Demonstrate critical thinking

General Indicator:

A.3.a Comprehend information from diverse sources and identify key issues (in science: interpret results of an experiment)

General Indicator:

A.3.b Construct logical, well-developed arguments (in science: discuss the broader implications of experimental results)

General Indicator:

A.3.e Analyze a subject by identifying its constituent parts and their relationship (in science: present (written and oral) a scientific study in the context of current knowledge)

Goal B: Broaden the student's perspective beyond that afforded by a major or minor Concentration

Expected (Student Learning) Outcome:

B.3 Understand the fundamental principles and processes of the natural world

General Indicator:

B.3.a Understand the method and ethics of scientific research; Have knowledge of history and philosophy of science

Specific Indicators:

B.3.a.i Discuss the process of the scientific method (SBE, ECP, OTU, ST)
B.3.a.ii Design and conduct experiments utilizing the scientific method (SBE, ECP, OTU, ST)
B.3.a.iii Discuss the importance of testable hypotheses in scientific research (SBE, ECP, OTU, ST)
B.3.a.iv Describe the current methods for protecting human subjects in research studies (SBE, ST)
B.3.a.v Recognize examples of ethical challenges in scientific research (SBE, ST)
B.3.a.vi Describe a series of inter-related experiments that show how scientific discovery is sequential and relies on the findings of prior researchers

Ex. Discovery that DNA is the genetic material (SBE)
The development of atomic theory in physics (OTU)

B.3.a.vii Distinguish the differences between science and non-science, and discuss the limits of scientific knowledge (SBE,ECP, OTU)
Ex. Race-IQ relationship
Natural selection versus creationism issue

General Indicator:

B.3.b Understand biological evolution

Specific Indicators:

B.3.b.i Describe the relationship between genes, alleles and chromosomes (SBE, ST)
B.3.b.ii Differentiate between the genotype, the environment and the phenotype and discuss their relationships (SBE, ST)
B.3.b.iii Evaluate the meaning of heritability and the causes for phenotypic variation (SBE)
B.3.b.iv Categorize the dominance relationships between alleles (SBE)
B.3.b.v Discriminate between homozygous and heterozygous genotypes (SBE)
B.3.b.vi Calculate gamete frequencies and propose resulting offspring phenotype and genotype frequencies in one and two locus controlled breeding experiments (SBE)

B.3.b.vii Explain the requirements for natural selection and differentiate between those requirements and the requirements for evolution by natural selection (SBE, ST)
B.3.b.viii Describe and illustrate the forms of natural selection (directional, stabilizing, disruptive) (SBE, ST)
B.3.b.ix Define and explain sexual selection and artificial selection (SBE, ST)
B.3.b.x Discuss the causes for evolution other than selection and justify their relative importance (SBE, ST)
B.3.b.xi Describe and evaluate evidence on the origin of modern humans (SBE)
B.3.b.xii Explain how selfish phenotypes replace non-selfish phenotypes as a consequence of evolution by natural selection (SBE)
B.3.b.xiii Discuss the costs and benefits of sociality in evolutionary terms (SBE)

General Indicator:

B.3.c Understand fundamental physical laws and principles

Specific Indicators:

B.3.c.i Describe the laws of thermodynamics and interpret the implications of these laws (ECP, OTU)
B.3.c.ii Compare the different forms of energy, their properties, and the inter-conversions between energy forms (CEP, OTU)
Ex. Radiation and energy relations

B.3.c.iii Define the laws of Newtonian mechanics and model the relationships between force, momentum, and inertia (OTU)
B.3.c.iv Illustrate the importance of proportionality in physical, chemical, and biological processes (ECP)
B.3.c.v Explain the principles of electrical conductivity and apply these principles to electron flow dynamics (ECP)
B.3.c.vi Contrast the interactions between atoms, ions, and molecules, and discuss the significance of these interactions (ECP, OTU, ST)
B.3.c.vii Compare current scientific theories about the origin of the universe (OTU)
B.3.c.viii Describe the interactions between sub-atomic particles and illustrate the implications of these interactions (ECP, OTU)
B.3.c.ix Describe the fundamental principles of Modern Physics (quantum mechanics and special relativity) and model the relationships between matter and energy (OTU)

General Indicator:

B.3.d Understand the inter-relatedness of science, technology, mathematics and system thinking

Specific Indicators:

B.3.d.i Discuss examples of scientific contributions by African Americans and the impact of their discoveries on technology (This must be fully integrated in the context of lecture modules and be relevant to the other outcome indicators)
B.3.d.ii Apply mathematical (concepts) models to physical, chemical and biological processes (including statistics) (SBE, ECP, OTU, ST)
B.3.d.iii Explain how the methods of science are applied to everyday activities (SBE, ECP, ST)
B.3.d.iv Illustrate how mathematics, science, technology and systems thinking are interdependent and interrelated (ECP, OTU, ST)
B.3.d.v Analyze examples of scientific discoveries that had unexpected positive or negative technological consequences and impact on society (SBE, ST)

Appendix 2

Science and Society Course Outline (Specific Outcome Indicators in Parentheses)

Module: Origin of the Universe (OTU)

Laboratory for Week I : The basic forces of nature
(A.3.a, b, e) (B.3.a.i, ii, iii) (B.3.d.ii)

Lecture 1. (B.3.a.vii) (B.3.c.vii)

Where did everything come from?

Big-Bang Theory: evidence and observational history

Lecture 2. (B.3.c.ii, iii, v)

What are the basic forces and the interactions between these forces?

Nuclear, Gravitational, Electromagnetic, Weak Forces

Lecture 3. (B.3.c.viii)

Why does matter dominate the universe?

Matter and anti-matter
Origin of the elements

Laboratory for Week 2: Atomic Emissions Spectra
(A.3.a,b,e) (B.3.a.i,ii,iii) (B.3.d.ii)

Lecture 4 (B.3.c.ix)

What are the relationships between Matter and Energy?
What are the relationships between Space and Time?

Relativity and special relativity

Lecture 5 (B.3.c.i, ii, vi, viii)

What is the origin of the stars?

Nuclear reactions and the behavior of atoms

Life cycles of stars

Lecture 6 (B.3.c.iii)

What is the origin of our solar system?

Gravitation and orbits

Newton's laws of motion

Laboratory for Week 3: Red shift: The origin and end of the Universe
(A.3.a,b,e) (B.3.a.i,ii,iii) (B.3.c.vii) (B.3.d.ii,iv)

Lecture 7. (B.3.c.i,vii)

What is the origin of the planets?

Planet types: gas giants and rocks
Atmosphere formation
Moons

Lecture 8. (B.3.c.i,ii, v)

What is so special about Earth?

Magnetic fields
Crust, continents and rock formation
Orbit, axis tilt, rotation
Origin of seasonality
Lightning and water

Lecture 9. (B.3.c.vii)

How does the universe end?

Module: Social Biology, Behavior and Evolution (SBE)

Laboratory for Week l: Monohybrid genetics and natural selection in *Drosophila*
(A.3.a,b,e) (B.3.a.i,ii,iii) (B.3.d.ii)

Lecture l. (B.3.b.ii,vii,viii)

Read news article on the increase incidence of multi-drug resistant gonorrhea. What has caused this bacterial disease to change over time? Discussion
Proximate and Ultimate questions
Hypothesis on a mechanism for evolutionary change: Natural Selection
Requirements for Natural Selection and Evolution by Natural Selection
Meaning of Phenotype and Causes for Phenotypic Variation
Forms of Selection and Evolution

Lecture 2. (B.3.b.i,ii,iii,iv,v,vi) (B.3.d.ii)

Why do monozygotic twins look alike?
Relationship between genes, alleles and chromosomes
Allelic dominance relationships in diploid organisms
How gametes are formed and what they contain
Mendelian genetics: monohybrid and dihybrid examples in humans

Lecture 3. (B.3.b.vii.x)

What causes natural selection? Discussion
Darwin’s Hostile Forces of Nature
The meaning of adaptation and the goal of natural selection
Natural Selection as the principal guiding force for evolutionary change
What is the purpose of life? Dawin’s challenge
Inclusive fitness effects

Laboratory for Week 2: Causes for phenotypic variation in nature
(A.3.a.b.e) (B.3.a.i,ii,iii) (B.3.b.iii) (B.3.d.ii)

Lecture 4. (B.3.b.vi, xii) (B.3.d.ii)

Extremes in social behavior: self-sacrifice
Inclusive fitness effects and apparent altruism
The importance of the coefficient of relationship
Pedigree analysis to calculate coefficients
Genetics of gamete analysis

Lecture 5. (B.3.a.vii, B.3.b.xii, B.3.d.iii)

Do humans exhibit true altruism? Discussion
Human behavior and natural selection
Is this a vulgar theory or a subversive theory?
Limits to an evolutionary view of human behavior

Lecture 6. (B.3.b.xi)

Speciation and Macro-Evolutionary Processes
What is the origin of modern humans?
Archeological evidence
Biochemical-mitochondrial evidence
Socio-cultural evidence

Laboratory for Week 3: Sexual selection in humans? Survey on mate choice and offspring preference (A.3.a,b,e) (B.3.a.i,ii,iii,iv,v,vii) B.3.d.ii,iii)

Lecture 7. (B.3.b.ix)

Why are the sexes so different?
Why are there sexes?
Sexual selection: meaning and processes
Consequences of intra-sexual competition
Consequences of female choice

Lecture 8. (B.3.a.iii) B.3.b.ix)

What is the mating system of humans?
Is there a relationship between mating systems and sexual selection?
Comparative methods and hypothesis testing

Risk taking and mortality patterns

Lecture 9. (B.3.b.xiii)

Parental investment and parental care
Patterns and variation in animals
Group living
Defenses by prey
Organized hunters
Selfish herd effects
Limits to group benefits

Module: Science and Terrorism (ST)

There will be dilemma-based discussions centered on a theme for the day. There may be a guest speaker who discusses the role of the CDC and/or biosafety.

Lecture 1: Define terrorism: modes and thinking (explosives, chemicals, biologicals, extortion, religious, political) B.3.a.vi) (B.3.d.v)

a. defensive thinking: e.g., American homeland security, Israel/Palestine conflict
b. effect on society, economy, politics, global role. Are US citizens terrorists?

Lecture 2: How do bioterrorism agents work? What counts as a BIOterrorism agent? (B.3.d.v)

a. Identification of real biothreats
    i. pathogens versus symbionts
    ii. enterohemorrhagic e.coli 0157:H7 versus commensal E.coli C25
b. How smallpox, anthrax, ebola affect human and nonhuman populations and individuals
c. Deployment and development possibilities; are they a “real” threat?

Lecture 3: Are diseases bioterrorism agents? (B.3.b.vii, viii, ix,x)

a. History and effect of disease on populations; what diseases count? (Cholera? Plague?

c. How did human populations come by HIV/Hanta virus/SARS? Is HIV/AIDS a Government conspiracy (debate)? Are Hanta virus, SARS? Does it matter where it all began, i.e., are there bioterror threats?

Lecture 4: Are our crops safe? (B.3.b.i,ii)

a. the effects of alteration of crops and supplies on public health, genetic fitness
b. genetic modification and the human food supply

Case Study: Cry9C corn, BT toxin and compromised food supplies

Lecture 5: What chemical agents can be used in terrorism? (B.3.c.vi)

a. how do they work on people/animals/plants?
b. What does cyanide, sarin, VI, do to the body?
c. Are these real threats to our safety?

d. Toxic substances and water supply safety
    i. toxicity and concentration

Case Study: Historical Perspective: Arsenic, Lead and Cyanide Poisoning

Lecture 6: How are chemical agents developed and deployed? (B.3.c.vi)

a. Aerosolization and surface tension (chemical)
b. Aerosolization and spore size (biological)

Lecture 7: Defining the "dirty bomb" and nuclear weapons (B.3.d.v)

a. Development and deployment possibilities
    i. Concepts in nuclear technology
        a. Energy, Mass defect and radiation (B-decay)
    ii. Warhead design
        b tactical missles
        c. depth penetrating bombs
        d. SCUDs and the First Gulf War

b. The realities of the global and local effects of radiation or chemicals from the bomb (Are they a REAL danger, or is the threat the danger?)

Lecture 8: How does science protect us from terrorism? (B.3.d.iiii,iv)

a. Detection of dirty bombs, damaged crops
b. Genetically engineered foods
c. Disease identification and elimination (SARS, anthrax, vaccination, smallpox, vaccine)

Lecture 9: The role of the hacker in technological terrorism (B.3.d.ii)

a. If you spread a computer virus, are you a terrorist?
b. Social, economic and political implications of terrorism using computer technology

Module: Energy, Climate and Pollution (ECP)

Laboratory for Week 1: Modeling population growth and human population growth today (A.3.a,b.e) (B.3.a.i.ii.iii) (B.3.d.ii)

Lecture 1. (B.3.c.i,iv,vi) (B.3.d.v)

What is the worst pollution? Discussion
What are the most dangerous chemical contaminants? Discussion
    The fate of matter in nature
    The fate of persistent matter
Biological accumulation and biological magnification
How does energy flow occur in nature?

How does matter flow occur in nature?

Lecture 2 (B.3.d.ii,iv,v)

Are oil spills more damaging than agricultural pesticide runoff?
Impacts of agricultural wastes
How does population growth put demands on agricultural production?
What are the alternatives to industrial agriculture?
Is sustainable agriculture possible?

Lecture 3. (B.3.d.iii,iv)

What about population growth? Are there too many people?
What do we know from other species?
Models of population change and predictions for humans
What is happening in the world today?
Is the problem too many people or too much consumption?

Laboratory for Week 2: Factors influencing decomposition in landfill disposal facilities
(A.3.a.b.e) (B.3.a.i,ii,iii) (B.3.d.ii,iii)

Lecture 4. (B.3.a.vii) (B.3.c.iv,vi)

Is there a waste disposal crisis in the United States?
Where does your garbage go?
What do we produce as waste?
How much do we produce?
What are the alternatives for disposal?
What are the costs and benefits of waste disposal alternatives?
Who should accept your waste? Is environmental justice important?

Lecture 5. (B.3.c.i,ii,viii)

Where do we get energy and for what do we use it?
- Fossil fuels
- Hydroelectric
- Nuclear
- Biomass
- Solar and Wind

What are the costs of our dependence on fossil fuels?

Lecture 6. (B.3.c.i,ii,iv,vii)

What are the causes for the greenhouse effect?
Is global warming a reality?
What will be the impact of global warming?

Laboratory for Week 3: Solar energy and electrical efficiency
(A.3.a,b,e) (B.3.a.i,ii,iii) (B.3.c.v) (B.3.d.ii,iv)

Lecture 7. (B.3.c.i,ii,iv,viii)

Global warming and global cooling
What can we do about this?
Energy alternatives and efficiency
Can we reduce greenhouse gas concentrations?

Lecture 8. (B.3.c.i,ii,iv,viii) (B.3.d.ii,iii)

The ozone hole, UV and the risks of sunburn
I thought ozone was bad for us?
Global impacts ultra-violet radiation
International treaty solutions

Lecture 9. (B.3.c.iv,vi) (B.3.d.ii)

Acid rain can ruin your day
What is acid rain?
What causes acid rain?
Dead lakes and scorched trees
What can be done about this?