Syllabus, Spring, 2007
CC106 Biodiversity: Causes and Consequences

Lecture location: SMG 105, 595 Commonwealth Avenue
Lecture time: Tuesdays and Thursdays 2:00 – 3:30 pm
Discussion location: CAS B06A, 725 Commonwealth Avenue
Laboratory location: BRB B23, 5 Cummington Street
Course web site: www.bu.edu/core/cc106

1. Course Description:

This course is designed to supply the conceptual framework for a lifelong understanding of the causes and consequences of biodiversity.

CC106 will center on an inclusive biodiversity equation that encapsulates both the creative forces that generate biological novelty and the destructive forces that eliminate it. These forces span the entire biological hierarchy from molecules to cells, organisms, societies, and ecosystems. Major topics will include the origin of life, the history of organismal complexity, the relationship of the biosphere to the geosphere, and the various forms of intimate interaction that exist between species, both beneficial and destructive.

Biodiversity and Human Welfare

Biodiversity is the wellspring of our health and prosperity. Biodiversity has impacted the course of human history and the outcomes of human conflicts, and it will continue to affect the fortunes of humanity. Considering this, we are dangerously ignorant of the profound effects our actions may have on biodiversity.

The broader impacts of human actions are often obscured by the complex manner in which humanity is integrated into the web of life. However, seen through the prism of scientific understanding, it becomes clear how human activity impacts biodiversity and biodiversity impacts human history. The concluding section of the course will evaluate aspects of human evolution and human history in light of biodiversity principles.

The Urgency of Biodiversity Issues

Throughout the course, urgent biodiversity issues will be addressed, including the genetic basis of disease, genetic engineering in medicine and agriculture, the periodic emergence of plagues, global climate change, habitat fragmentation, invasive species, extinctions, and the effects of culture on mankind's evolutionary future.

2. Instructors:
Johanna Gutlemer, Core Curriculum
Office hours: M/10-11, 2:15-3:15, CAS 119, E-mail: jogut[at]bu.edu

Daniel Hudon, Core Curriculum
Office hours: W/11:00-1:00, CAS 119, E-mail: hudon[at]bu.edu

Maureen Mazza, Department of Biology
Office hours: W/1-3, BRB 418, E-mail: tmmazza[at]bu.edu

Nathan Phillips, Department of Geography and Environment
Office hours: W/1-3; Tu/3:30-4:30, STO 441A, E-mail: nathan[at]bu.edu

Karen Warkentin, Department of Biology
Office hours: M 4-5 Tu/3:30-4:30, BRB 500, E-mail: kwarken[at]bu.edu

Fred Wasserman, Department of Biology
Office hours: Tu/3:30-5:30, BRB 423, E-mail: few[at]bu.edu
### Lecture Schedule:

<table>
<thead>
<tr>
<th>TOPIC</th>
<th>LECTURER</th>
<th>READINGS</th>
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<tbody>
<tr>
<td><strong>Section I. Introduction</strong></td>
<td></td>
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<tr>
<td>1. Biodiversity: Overview of the topic and course</td>
<td>January 16</td>
<td>Phillips</td>
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<tr>
<td></td>
<td></td>
<td>None</td>
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<tr>
<td>2. Earth’s Biodiversity – the Fossil Evidence</td>
<td>January 18</td>
<td>Hudon</td>
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<tr>
<td>Despite its known incompleteness, the fossil record continues to provide a wealth of information on the history of life on Earth as well as important evidence for evolution from a common ancestor</td>
<td></td>
<td>Campbell and Reece, pp. 510-533</td>
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<tr>
<td>3. The History of Life on Earth</td>
<td>January 23</td>
<td>Hudon</td>
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<tr>
<td>Life on Earth is closely tied to its environment. Major episodes in the evolution of life (its early evolution, the Cambrian explosion, mass extinctions) are examined in the context of environmental change.</td>
<td></td>
<td>Campbell and Reece, pp. 510-533</td>
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<tr>
<td>4. Evolution of Biodiversity</td>
<td>January 25</td>
<td>Wasserman</td>
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<tr>
<td><strong>Last Day to ADD Classes</strong></td>
<td>January 29</td>
<td></td>
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<tr>
<td>5. Evidence for macroevolution</td>
<td>January 30</td>
<td>Wasserman</td>
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<tr>
<td>6. The origin of species</td>
<td>February 1</td>
<td>Wasserman</td>
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<tr>
<td>Section II. Genes &amp; Genomes. Generation of biodiversity at the molecular level</td>
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<td>8. The Genetic Code and Protein Synthesis: How does the DNA code instruct the building of amino acid chains?</td>
<td>February 8 Gutlerner</td>
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<tr>
<td>9. Protein Function &amp; Diversity How do 20 amino acids arrange themselves to build all of the proteins necessary for an organism’s survival?</td>
<td>February 13 Gutlerner</td>
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<tr>
<td>Exam I</td>
<td>February 15 Covers: Lectures 1-8 + Discussions A-D</td>
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<tr>
<td>Last Day to DROP Classes Without Earning a ‘W’</td>
<td>February 16</td>
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<tr>
<td>Last Day to Change from Credit to Audit</td>
<td>February 16</td>
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<tr>
<td>University Holiday</td>
<td>February 19</td>
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<tr>
<td>Substitute Monday schedule</td>
<td>February 20</td>
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<tr>
<td>Section III. Cells &amp; Organisms. Development and Sexual Reproduction in the Generation of Biodiversity</td>
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<tr>
<td>10. The Evolution of Cellular Diversity: What did the earliest prokaryotic cells look like and how did eukaryotic cells evolve from them?</td>
<td>February 22 Gutlerner</td>
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<tr>
<td>11. Multicellular Development: an Engine of Diversity How did multicellularity evolve? (The problem of cooperation) How do cells within individuals become diverse? How is development organized to</td>
<td>February 27 Warkentin</td>
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<td>To be announced</td>
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Campbell and Reece Ch. 17 pp. 303 – 326
“Scientists Say they’ve found a code beyond genetics in DNA,” by Nicholas Wade
Campbell and Reece Chapter 5 pp. 71-80.
“Prions: Puzzling Infectious Proteins,” by Ruth Levy Guyer
“Study Finds Wider Tainting of Deer Body from a Disease,” by Sandra Blakeslee
| generate a diversity of multicellular forms? | March 1 | Warkentin | The Cooperative Gene’ Ch. 5 The ultimate existential absurdity |
| 12. Why Sex? What is sex? Who uses it, why and when? How did it evolve? Costs & benefits of sex. | March 6 | Warkentin | Why Sex Fun?’ Ch. 1 The animal with the weirdest sex life & Ch. 2 The battle of the sexes; Supplementary: ‘The Cooperative Gene’ Ch. 6 Darwinian mergers & acquisitions |
| 13. The Consequences of Sex. Why are there (usually) two sexes? How sex changed the world, or the generation of biodiversity via sexual selection | March 8 | Warkentin | Why is Sex Fun?” Ch. 3 Why don’t men breast-feed their babies? Ch. 4 Wrong time for love |
| Last Day to DROP Classes and Earn a 'W' | March 9 | | |
| University Holiday. Spring Break | March 10-18 | | |
| Integrating Forum I. Gay Marriage — Equal right, or special right? | March 22 | Guest Panelists | To be announced |
| Section IV. Environment. How the environment generates and maintains biodiversity | | | |
| 16. Linking the Environment to Biodiversity I | March 27 | Phillips | To be announced |
| Exam II | March 29 | | Covering lectures 9-15 + integrating forum I + discussion F-I + labs 2-4 |
| 17. Linking the Environment to Biodiversity II | April 3 | Phillips | To be announced |
| 18. The Biotic Environment / Organismal Co-Evolution Pathogens / Parasitism | April 5 | Phillips | To be announced |
| Section V. Humanity & Biodiversity. | | | |
20. Human Evolution and Human Diversity
Humans are apes.
Key evolutionary innovations during the evolution of *Homo sapiens*
Highlights of the fossil record of human evolution
Migrations out of Africa
Sources of human diversity.

**April 12**
Wasserman

**Required Readings:**

**Optional Readings:**

**Holiday**
April 16

**April 18**
No Discussion

**Integrating Forum II: Emerging Diseases.**
**April 17**
panel

**Required Reading:**
Gibbs & Soars
"Preparing for a Pandemic"
Supplemental Reading/Viewing:
Glass
"New Hope for Defeating Rotavirus" 60 Minutes, "The Virus Hunters"

**April 19**
Warkentin

**April 24**
Phillips

**April 21**
Warkentin

**April 24**
Phillips

Why, where, when and how did we start producing food, and why does this matter? - The ultimate role of biology and geography in human history

**April 19**
Warkentin

The lecture covers 'Guns, Germs & Steel' Part II. The rise & spread of food production. Ch. 4 & 5 required. The rest of the section recommended.

22. Biodiversity as a Factor in Human Conflicts
Geography, crops, livestock, and germs shape the organization of societies and the outcomes of conflict in America.

**April 24**
Phillips

Guns, Germs, & Steel:
"A Natural Experiment of History", pp. 53-66
"Collision at Cajamarca" pp. 67-87
"Lethal Gift of Livestock" pp. 195-214
<table>
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<tr>
<th>23. Anthropogenic Environmental Changes</th>
<th>April 26 Phillips</th>
<th>To be announced</th>
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<tr>
<td>Integrating Forum III: Climate Change and Biodiversity</td>
<td>May 1 panel</td>
<td>To be announced</td>
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<tr>
<td>24. Conservation of Biodiversity</td>
<td>May 3 Phillips</td>
<td>To be announced</td>
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<tr>
<td>Last day of classes</td>
<td>May 3</td>
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<tr>
<td>Final Exam</td>
<td>May 7, 2:00-4:00</td>
<td>Covering lectures 16-24 + integrating forums II and III + discussion F-I + labs 2-4</td>
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4. Lab Schedule:

**Important notices:**

**Attendance:** Attendance at lab is mandatory. If you miss a lab, you will receive a zero for that lab. If you miss two labs, you will receive a zero for the lab portion of your grade (20%).

**Lab Manual:** The instructions for each lab can be downloaded through this page as individual Adobe Acrobat files. It is strongly recommended that you read the background material and review the exercises that you will be performing before coming to lab. You do not need to print the entire manual. However, you must print out the instructions for performing the lab exercises and the pages required for your lab report.

**Lab Exercises:** During the course of the two-hour lab period, you and your lab partner should be able to accomplish the exercises (gather the data). The questions and calculations required to complete the lab report can be performed outside of the lab session.

**Lab Reports:** Lab reports for the first four labs are due during the following lab period. The report for lab five will be due during lecture on the date specified in the schedule below.

**Location:** All labs will be held in BRB B23 (located at 5 Cummington Street).

### Lab 1. Evolutionary Pattern & Process

**Part A** / This lab explores the widespread pattern of nested similarity in organisms. It was this pattern that led the earliest evolutionary theorists (e.g., Erasmus Darwin, Jean Baptiste Lamarck, Alfred Wallace, Charles Darwin) to develop the hypothesis of "descent with modification." By examining the traits of real organisms and paper beetles you will learn that nested similarity is consistent with "descent with modification" but inconsistent with "special creation."

**Part B** / Darwin and Wallace first recognized the role of natural selection. For natural selection to operate, there

<table>
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<tr>
<th>Lab</th>
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<tbody>
<tr>
<td>1. Evolutionary Pattern &amp; Process</td>
<td>GROUP 1</td>
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<tr>
<td></td>
<td>L1 / Monday 10-12</td>
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<td>L3 / Monday 12-2</td>
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<td>L5 / Monday 2-4</td>
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<td>LAB: Monday 1/22/07</td>
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<td></td>
<td>DUE: Monday 2/5/07</td>
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<td></td>
<td>GROUP 2</td>
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<td></td>
<td>M1 / Wednesday 10-12</td>
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<td>M3 / Wednesday 12-2</td>
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<td>M5 / Wednesday 2-4</td>
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<td></td>
<td>LAB: Wednesday 1/24/07</td>
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<tr>
<td></td>
<td>DUE: Wednesday 2/7/07</td>
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must be variation in a population, the variation must be heritable (i.e., caused by genetic mutation), and this heritable variation must cause differences in the survival and reproduction of individuals. Using a simple simulation, you will test the importance of variability, heritability, and mutation.

II. Human Evolution.
Part 1. Morphological Evidence

This lab introduces you to the field of morphological phylogenetics. A phylogeny is an evolutionary tree that depicts the relationships among biological entities (e.g., kingdoms, species, individuals, or genes). A morphological phylogeny is an evolutionary tree based on anatomical comparisons of organisms. You will characterize the cranial anatomy of modern apes, modern humans, and fossil hominids in order to generate a phylogeny.

This lab will also teach you how to think about and describe biodiversity at the morphological level — how to systematically characterize organisms based on their phenotypes.

III. Human Evolution.
Part 2. Molecular Evidence

In this lab, you will construct a molecular phylogeny of human populations, non-human apes, and extinct hominids (Neanderthals) using published mitochondrial DNA sequences. You will compare the evolutionary tree you obtain using molecular data with the evolutionary tree you obtained using morphological data in lab II.

This lab will also address the issue of human genetic
diversity. Pictured below is a 1988 cover from *Newsweek* reporting on new findings from the study of mitochondrial DNA suggesting that all modern humans could trace the ancestry to a single "mitochondrial Eve" living in Africa more than 100,000 years ago.

### IV. Biosphere 3, part A

In this lab, you will create your own self-contained biosphere by adding primary producers (e.g., algae), primary consumers (e.g., rotifers), and secondary consumers (e.g., sea anemones) to a small aquatic environment. Your experiment will test hypotheses about the composition of biological communities.

Pictured below is *Biosphere 2*, a research facility located about 30 miles north of Tucson, Arizona. This facility, currently operated in part by Columbia University, is used to investigate hypotheses about the diversity and stability of ecological communities under various environmental conditions. Originally, it began as a failed attempt to create a self contained mesocosm that could sustain human life. However, as oxygen levels fell, carbon dioxide levels rose, and the 8 biospherians split into two mutually antagonistic factions, the experiment failed. More information is available at: http://www.desertusa.com/mag99/apr/stories/bios2.html

### V. Biosphere 3, part B

In this lab, you will record data from your biosphere experiments set up during the last lab. You will also begin "THE GREAT BIOSPHERE COMPETITION." Each person will get one attempt to construct what they hope is "the world’s most stable micro-ecosystem." The winner is the person whose ecosystem is the last to contain a living shrimp (seconds, minutes, hours, days, weeks, months, years....who can say?). Competition entries will be maintained by the course coordinator until they kick the proverbial bucket. Winners will be chosen by September 1.
2007. If no clear winner has emerged, the winner will be randomly selected from the living ecosystems. First and second runners-up will also be chosen.

Pictured below is Ecosphere 2, a commercially produced self-contained micro-ecosystem. Think of this as your competition. More information is available at: http://www.eco-sphere.com/home.htm

5. Grading

TIPS FOR RECEIVING A GOOD GRADE IN CC106:

1. LECTURE: Attend all lectures and try to understand the key concepts that are covered and how the data support the conclusions.
2. DISCUSSION: Attend all discussions. Come prepared for discussion and be actively engaged.
3. LAB: Attend all labs. Come prepared for lab, and do your best to complete and understand the exercises. Carefully and thoroughly complete the lab reports and submit them to your lab instructor by the deadline.
4. ASK FOR HELP! Ask your discussion leader or lab instructor for help if you are struggling. Don't wait until the eve of an exam.

GRADING POLICIES
The following grading policies were devised by the faculty of CC106 to promote fairness and to reward effort.

1. The Core versus Divisional Studies. The students of CC106 receive comparable grades to students in Divisional Studies natural science courses. Based on this standard, the mean grade will be approximately 2.9 (between a B- and a B).
2. The Curve. Once the numerical scores for all of the individual components of the course have been tallied for every student, letter grades will be assigned according to a curve, with the mean grade for the course being a 2.9. If your overall numerical score is close to the mean for the class, you can expect to receive a B or B-. A higher numerical score will translate into a proportionately higher letter grade. A lower numerical score will translate into a proportionately lower letter grade. The instructors cannot anticipate in advance the precise correspondence between numerical scores and letter grades.

THERE IS NO CURVE APPLIED TO INDIVIDUAL EXAMS, QUIZZES, OR ASSIGNMENTS.
3. Warnings

A. Exams. All exams are mandatory. In fairness to all students, an unexcused absence from either of the two midterm exams or the final exam will result in a student failing the course regardless of that student’s overall numerical score in the class. Make-up exams will be given in the case of documented medical or family emergencies. Make-up exams may also be given in the case of extracurricular conflicts if prior arrangements are made with your professor.

B. Labs. All labs are mandatory. In fairness to all students, the first unexcused absence from a laboratory session will result in a grade of zero for that lab. Two unexcused absences from lab will result in a student failing the course regardless of that student’s overall numerical score in the class. As with exams, accommodations will be made in the case of documented medical or family emergencies. Alternate scheduling may also be devised in the case of extracurricular conflicts (make prior arrangements with your lab instructor).

C. Discussion. Attendance at discussion is mandatory. In fairness to all students, any student who misses a quiz due to an unexcused absence from discussion will earn a zero for that quiz. At the end of the year, discussion leaders will drop each student’s lowest quiz grade, but zeroes awarded for unexcused absences may not be dropped.

Components of your grade

Midterm Exam 1, February 15 (20% of final grade). This exam will cover material from lectures 1-8 and discussions A-D. Questions will be in multiple choice format. The material contained in the lecture notes will be heavily emphasized. You will be expected to understand the required readings, particularly as they pertain to the material covered in lecture. You will not be asked to remember details from the readings that were not covered in the lecture notes.

Midterm Exam 2 March 29 (20% of final grade). This exam will cover material from lectures 9-16, integrating forum I, and discussions F-I. The format and emphasis on the lecture notes will be the same as for Midterm I.

Final Exam May 7, 2-4pm (20% of final grade). This exam will cover material from lectures 17-24, integrating forums II and III, and discussions J-end. The format and emphasis on the lecture notes will be the same as for Midterm I & II.

Discussion (20% of final grade). Short quizzes (or exercises) will be given during each discussion. Quizzes will focus on issues that were covered in lecture and the readings that are assigned for each discussion. Additionally, one quarter of your discussion grade (or 5% of your total course grade) will be based on writing assignments assigned by your discussion instructor.

Laboratory (20% of final grade). The labs will require you to perform exercises and answer questions. You will work in teams of two and you will each receive the same grade for the material you submit to your lab instructor.
6. Readings:

1. *Evolution & Ecology of the Organism*
   Rose & Mueller, 2005
   ISBN: 978-0130104045
   
   From the preface: "The general theme of the book is the interconnectedness of organism, environment, and evolution."
   This text is a recommended (but not required) reference book for the course. Several copies are available for 24-hour loan in the Core office.

2. *Biodiversity*
   Campbell and Reece, 2002
   (custom edition for Boston University)
   
   From the introduction: "Modern biology is as important as it is inspiring. Genetics and cell biology are revolutionizing medicine and agriculture. Molecular biology is providing new tools for anthropology, helping us trace the origin and dispersal of humans. Ecology is helping us evaluate environmental issues, such as the causes and consequences of global warming. These are just a few examples of how biology is weaving into the fabric of our culture as never before."
   This text is a recommended (but not required) reference book for the course. Several copies are available for 24-hour loan in the Core office.

   Mark Ridley, 2001
   ISBN: 978-0743201612
   
   "Why isn't all life pond scum? Why are there multimillion-celled, long-lived monsters like us, built from tens of thousands of cooperating genes? Mark Ridley presents a new explanation of how complex large life forms like ourselves came to exist, showing that the answer to the greatest mystery of evolution for modern science is not the selfish gene; it is the cooperative gene."
   TWO CHAPTERS are required reading for the course. PDF files for these chapters will be posted on the course website.

4. *Guns, Germs and Steel: The Fates of Human Societies*
   Jared Diamond, 1999
   ISBN: 978-0393317558
   
   "Why did Eurasians conquer, displace, or decimate Native Americans, Australians, and Africans, instead of the reverse? ...evolutionary biologist Jared Diamond stunningly dismantles racially based theories of human history by revealing the environmental factors actually responsible for history's broadest patterns."
Several chapters are required reading for the course. Purchase of this book is recommended. (about $12)

5. Why is Sex Fun? The Evolution of Human Sexuality
Jared Diamond, 1998
ISBN: 978-0465031269

"This book, written by an evolutionary biologist, explains how all the weird quirks of human sexuality came to be: sex with no intention of procreation, invisible fertility, sex acts pursued in private--all common to us, but very different from most other species. Why Is Sex Fun? asks us to look at ourselves in a brand-new way, and richly rewards us for doing so." -Amazon.com Editorial Review

Several chapters are required reading for the course. Purchase of this book is recommended. (about $11)

7. Academic Conduct:

It is each student's responsibility to know and understand the provisions of the Academic Conduct Code in the College of Arts and Sciences. The Code is available online at http://www.cs.bu.edu/ugradprogram/conduct.html. Cases of suspected misconduct will be referred to the Dean of the College. If the Dean's office comes to the conclusion that cheating or plagiarism have occurred, a grade of zero will be awarded for the assignment in question.