Course Title
Genetics, Genomics, Genethics: Molecular Biology

Course Description
Since the 1944 discovery that DNA is the universal genetic code, this young science has advanced by leaps and bounds: scientists can now decipher, examine and modify the blueprints for life. As its title suggests, this course emphasizes the relation between the underlying science of genetics, the study of genomes (genomics), and the social, ethical, and legal issues that this work gives rise to genethics. Learners investigate topics such as the history of genetic discovery and molecular lab techniques, and emerge with an understanding of the science and the technology behind breakthroughs like therapeutic cloning and the sequencing of the human genome.

The first part of the course gives learners an opportunity to grapple with the basics of genetics: the underlying science that deals with the transmission of hereditary characteristics and their mechanisms. Starting with an examination of the work of Gregor Mendel, it brings learners up to date on the foundations of modern genetics and explores related issues such as the nature-nurture debate, the theory of evolution, and the role of genetic diversity. The course goes on to investigate what’s involved in the study of genomics: the technology and science of all the DNA in a cell. Discussions focus on medical advances, and the goals of the Human Genome Project.

Advances in genome research lead directly to an examination of genethics, the social, ethical, and legal implications of developments such as genetically modified organisms, cloning for therapeutic and reproductive purposes, genetic enhancement of humans, and the ownership of genetic information. Throughout the course, online interaction, scientist-authored essays, video, and simulations enable students to investigate genetic variation and similarities and develop a structure for thinking about ethical issues.

Class Schedule
This is a six-week online graduate course with an additional week for assignment completion. The course is asynchronous and does not have specific meeting times. Assignments and discussions change on a weekly basis. Students are expected to complete work within the specific week it is assigned.

For the current schedule of offerings, please visit www.amnh.org/learn/calendar
Instructors

This graduate course is co-taught by an experienced educator along with a research scientist. For example, a recent course featured:

Mr. Steve Ryan  
Walsh Jesuit High School  
Cuyahoga Falls, Ohio

Dr. Claudia Englbrecht  
Bioinformatics  
National Research Center for Environment and Health

For current instructor information, please contact seminfo@amnh.org.

Format

1. Genetics, Genomics, Genethics is a six-week online graduate course with an additional week for assignment completion. Enrollment is restricted to current or future educators. No prior course in evolutionary science is required.

2. Weekly activities introduce the basic tools used in the field of biotechnology. A framework for examining ethical issues is used to examine and discuss the impacts of genetic technology on society. Computer interactives, image galleries, and videos will help learners visualize and master the content.

3. Online discussions encourage reflection on course content, support and model the inquiry process, and sustain interaction between the offering scientists, seminar instructors, and course members.

4. Final projects encourage learners to create an inquiry-based lesson plan focused on a key course concept that you might incorporate into your teaching practice or a research project to further explore a topic covered in the course.

Required Textbook

This course requires the following textbook.

Welcome to the Genome: A User’s Guide to the Genetic Past, Present, and Future  
by Rob DeSalle, Michael Yudell  
Hardcover: 240 pages; Dimensions (in inches): 9.6 x 7.7 x 0.7  
Publisher: Wiley; (September 2004) ISBN: 0471453315

Recommended Textbooks

The following textbooks are recommended as general references but are not required.

The Impact of the Gene: From Mendel's Peas to Designer Babies  
Limited availability — out of print  
by Colin Tudge  
Hardcover: 375 pages; Dimensions (in inches): 1.29 x 8.56 x 5.76  
Publisher: Hill & Wang Pub; (July 2001) ISBN: 0374175233
Genome: The Autobiography of a Species in 23 Chapters [ABRIDGED]
by Matt Ridley
Hardcover: 344 pages; Dimensions (in inches): 1.25 x 9.50 x 6.50
Publisher: HarperCollins; (February 2000)
ISBN: 0060194979

The Triple Helix: Gene, Organism, and Environment
by Richard C. Lewontin
Paperback: 136 pages; Dimensions (in inches): 0.40 x 7.53 x 4.98
Publisher: Harvard Univ Pr; Reprint edition (November 2001)
ISBN: 0674006771

The Mismeasure of Man
by Stephen Jay Gould
Paperback: 352 pages; Dimensions (in inches): 0.89 x 8.20 x 5.48
Publisher: W.W. Norton & Company; (June 1996)
ISBN: 0393314251

Pandora's Picnic Basket: The Potential and Hazards of Genetically Modified Foods
by Alan McHughen
Hardcover: 277 pages; Dimensions (in inches): 0.84 x 9.55 x 6.40
Publisher: Oxford Univ Pr; (September 2000)
ISBN: 0198506740

The Double Helix: A Personal Account of the Discovery of the Structure of DNA
by James D. Watson ,Lawrence Bragg
Paperback: 143 pages; Dimensions (in inches): 0.50 x 7.00 x 4.25
Publisher: New American Library; Reissue edition (February 1991)
ASIN: 0451627873

The Science of Jurassic Park and the Lost World: Or, How to Build a Dinosaur
by Rob Desalle ,David Lindley
Hardcover: 194 pages; Dimensions (in inches): 0.75 x 8.25 x 5.75
Publisher: DIANE Publishing Co; (1997)
ISBN: 0788159364

Remaking Eden
by Lee Silver
Paperback: 400 pages; Dimensions (in inches): 1.07 x 8.03 x 5.29
Publisher: Avon; (October 1998)
ISBN: 0380792435

The Complete Idiot's Guide to Decoding Your Genes
by Linda Tagliaferro, Mark Vincent Bloom
Paperback: 400 pages; Dimensions (in inches): 1.10 x 9.08 x 7.34
Publisher: Alpha Books; 1st edition (August 13, 1999)
ISBN: 0028635868

Support Services
Technical support is available by calling (800) 649-6715 or emailing semadmin@amnh.org.
Grading

Assessments are based on a detailed grading rubric developed for this course:

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<tr>
<th>Component</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Course Assignments</td>
<td>30%</td>
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<tr>
<td>Course Participation &amp; Communication</td>
<td>40%</td>
</tr>
<tr>
<td>Final Project</td>
<td>30%</td>
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1. **Course assignments** will include reflection questions and written assignments.

2. **Class participation** will be evaluated based on the quality and consistency of contribution to the discussion forum. The grades for participation will be posted two weeks after each question opens.

3. **Final Project:** There are two options for the course project:

   **Option I: Application in the Classroom**
   This option is for learners who would like an opportunity to develop an application based on the course content that could be taught to students or other educators. The final form may be a unit or workshop plan (if it will be used as part of a professional development experience).

   **Option II: Application in Ethics**
   This option is for learners who would like an opportunity to further explore the ethical issues related to the Science content presented in this course. The task is to choose one of the ethical questions raised and examine various viewpoints or perspectives.

4. **Policy:** Everything submitted as an assignment, project, or discussion post must be an original work. References to resource materials are expected and proper citation is required. Assignments are due on the dates specified. Late submissions will be penalized 10%. Revised assignments that incorporate your instructor's feedback will be accepted until the course ends.

Weekly Overview and Expectations

**Week 1: Introduction**
During the first week learners are introduced to the course authors, Drs. Rob DeSalle and Claudia Englbrecht, and begin to explore the history of the science of genetics. An introductory essay defines key terms and previews the science, technology, and ethics of molecular biology. The history of genetics is examined with an in depth look at the experiments of Gregor Mendel. A foundation for the rest of the course is established by a review of some of the basics of genetics including how hereditary units, called genes, are transmitted and expressed. Learners are also introduced to a structure for thinking ethically that will frame an examination of social issues that arise as our knowledge of our genome increases.

**Expectations:**
- Review the course orientation.
- Determine the difference between genetics and genomics.
- Trace Gregor Mendel's work as the father of genetics, and become familiar with Mendel's basic tenets.
- Examine basic principles of inheritance such as autosomal dominant, autosomal recessive, sex linked, and complex traits.
- Begin to build an organizational structure for thinking about ethical issues.
- Respond to the Discussion Question: Mendel
- Respond to the Discussion Question: Genetic Basis for Disease
Week 2: Nature versus Nurture
Nature and nurture is a phrase used widely to express the long-standing debate about whether genes are the primary influence on who you are or whether environmental influences play a role. The first essay this week explores the evidence showing that neither of these extremes is correct; we are the result of cooperation between genes and the environment. Next we consider the evolution of species by means of mutation, natural selection, and chance. In the final essay this week, learners begin to wrestle with how the genetic revolution affects political and social issues as Guest Lecturer Barbara Schaal discusses genetic modification in plants. An assignment allows us to investigate the presence of genetically modified foods in our homes.

Expectations:
• Examine the "cooperation" between our genes and our environment.
• Learn how studies of twins tease out the impact of the environment on traits.
• Analyze what determines the evolution of a species.
• Examine the pros and cons of gene technology in agriculture.
• Trace the history of the genetic modification of plants.
• Respond to the Discussion Question: Nature vs. Nurture
• Respond to the Discussion Question: DNA and Variety

Week 3: The Human Genome
In the year 2000, the company Celera and the official Human Genome Project (in a joint venture) announced the first working draft of the human genome. During this week we will examine the importance of this announcement and look at some of its implications. The week begins by defining what a genome is and how it differs from person to person. We then review the history of genetic lab techniques and the impact technology has had on this science. The uses of model organisms, or genetic pets, are introduced and compared. In a guest lecture, Eric Green, the Director of the National Institutes of Health Sequencing Center, explains the history of and the reasons for the Human Genome Project. An assignment allows learners to explore an online catalog of human genes and genetic disorders and information from last week’s investigation of genetically modified food will serve as background for a discussion of this controversial topic. This week, learners also begin to consider the final project options.

Expectations:
• Learn about the Human Genome Project.
• Recognize the elements that comprise a genome.
• Trace the genetic discoveries and the development of molecular lab techniques from the 1940s to the present
• Become familiar with the molecular laboratory techniques used for extracting, sequencing, and analyzing DNA sequences.
• Examine why particular organisms (e.g., the fruit fly) are considered genetic model organisms.
• Determine the importance of having model organisms to study.
• Respond to the Discussion Question: OMIM
• Complete Genetically Modified Organisms assignment
• Present preliminary thoughts on the final project

Week 4: Applications of the Human Genome Project
The Human Genome Project (HGP) is not yet finished, and there have already been issues raised about how to handle and use the enormous amount of data it has generated. This week, learners find out how a new technology called microarrays is opening up all kinds of new possibilities. In a guest lecture, Leroy Hood presents his suggestions and his approach to processing and interpreting the volume of data that grows daily. One of the major long-term goals of the HGP is the assessment of human variation. Why is human variation so interesting, and why could it become important for everybody? Learners will gain insight into recent scientific advancements on this subject. A computer simulation will allow manipulation of variables involved in the process of Polymerase Chain Reaction (PCR).
Expectations:
- Recognize tools used for measuring gene activity.
- Consider the problems of handling, using, and understanding the enormous amounts of data generated by the Human Genome Project.
- Explore the idea of differences between genomes, and genetic variation within humans.
- Recognize important genetic similarities and differences and the implications of these constants and variations.
- Interact with the Polymerase Chain Reaction simulation to determine what lab techniques can reveal about DNA sequence.
- Complete the PCR assignment
- Respond to the Discussion Question: The Human Genome Project and You

Week 5: The Ethical Implications of Reshaping our World
The Genomic Age has yielded amazing breakthroughs, but it will also affect and challenge our traditional views of morality and ethics. In a short summary, Dr. Rob DeSalle introduces the complex subject of genetics and defines several questions that society is likely to face in the near future. In a guest lecture, David and Sheila Rothman discuss the pros and cons of using human gene-technology for the purpose of life improvement rather than to cure disease. The implications of new cloning technologies are presented, with some focus on the controversy surrounding the issue of cloning humans. A unique application of PCR for the identification and conservation of an endangered species is discussed. An assignment provides an opportunity for the consideration of ethical issues involved in the treatment of Parkinson’s disease. Learners submit an outline of their final project.

Expectations:
- Learn about the ethical issues that arise as our knowledge of our genome increases.
- Reflect on possible uses and abuses of the new genetic technology.
- Investigate the differences between cure and genetic enhancement in humans.
- Review the techniques used in cloning.
- Examine the pros and cons of increasing our life spans.
- Complete the Assignment: Parkinson's Disease
- Respond to the Discussion Question: Cure and Enhancement
- Complete an outline of the Final Project

Week 6: The Ethical Implications of Reshaping our World (Part II)
The Genomic Age has yielded amazing progress and breakthroughs in science, but it will also affect and challenge our traditional views of morality and ethics. In a short summary, Rob DeSalle introduces the complex subject of genetics. In a guest lecture, David and Sheila Rothman discuss the pros and cons of genetic enhancement and the use of gene-technology for the purpose of life improvement rather than to cure disease. The implications of new cloning technologies are presented, with some focus on the controversy surrounding the issue of cloning humans. Medicine in our present time allows us to live much longer than our predecessors ever could have dreamed. What will the future bring? Learners submit an outline of their final project. DNA fingerprinting. Troy Duster with the social spin-offs of genetic technology and the possibility that this tech can lead to discrimination for some members of the population. Arthur Caplan discusses some actual moral dilemmas that have been faced be clinics today. Promise to be more common and more difficult as the technology advances.

Expectations:
- Learn about the ethical issues that arise as our knowledge of our genome increases.
- Reflect on possible uses and abuses of the new genetic technology.
- Investigate the differences between cure and genetic enhancement.
- Review the techniques used in cloning, and discuss the ways in which cloning might be used.
- Examine the pros and cons of increasing our life spans.
- Respond to the Discussion Question: Hypothetically . . .
- Complete the Assignment: Parkinson's Disease Part II
• Complete the Final Project