



Classroom Lesson Development

Title of Lesson **Molecular Genomics and Human Diversity**

RET Project Connection Toxicity Study of Novel Neuroprosthetic Implant Materials.
Department of Chemical Engineering: Biological Surface Modification and Microfluidics Laboratory, Northeastern University, Boston, MA.
Summer 2008

We generated a 3-D Collagen Matrix seeded with neuronal cells to test novel neuroprosthetic implant materials. The 3-D collagen matrix will allow for testing a greater number of novel materials and their impact within the biological milieu (in terms of toxicity, immune response, cellular adhesion and attachment, functional preservation). The evaluative techniques included fluorescence microscopy and 3-D confocal imaging using the Keck Confocal Microscope at Northeastern University.

RET Teacher Rocco Cieri

School Medford High School

Town/District Medford Public Schools

Subject(s) taught Biology (AP Biology, Biology I)

Subjects covered in lesson Biology, Human Genetics, Social Sciences, Human Variation

Grades appropriate 9-12

Lesson duration > 1 week

Goals/Objectives of lesson Students will...

- explore patterns of human genetic variation
- learn about mtDNA and the molecular clock
- compare mtDNA sequences from diverse human populations
- explore what mtDNA tells us about human diversity
- explore how migration patterns and gene flow has resulted in most human variation being within groups rather than between groups

Background information see attachment

Essential questions What is the relationship between molecular genomics and understanding human diversity?

Links to Frameworks and Standards

National Content Standard G: History and Nature of Science -
UNDERSTANDINGS ABOUT SCIENCE AND TECHNOLOGY

1. Scientists in different disciplines ask different questions, use different methods of investigation, and accept different types of evidence to support their explanations. Many scientific investigations require the contributions of individuals from different disciplines, including engineering. New disciplines of science, such as geophysics and biochemistry often emerge at the interface of two older disciplines.
2. Science often advances with the introduction of new technologies. Solving technological problems often results in new scientific knowledge. New technologies often extend the current levels of scientific understanding and introduce new areas of research.
3. Creativity, imagination, and a good knowledge base are all required in the work of science and engineering.
4. Science and technology are pursued for different purposes. Scientific inquiry is driven by the desire to understand the natural world, and technological design is driven by the need to meet human needs and solve human problems. Technology, by its nature, has a more direct effect on society than science because its purpose is to solve human problems, help humans. (NSES, 1996, p. 199)

Life Science Standards (NSES): The Molecular Basis of Heredity
THE MOLECULAR BASIS OF HEREDITY

[See Content Standard B (grades 9-12)]

1. In all organisms, the instructions for specifying the characteristics of the organism are carried in DNA, a large polymer formed from subunits of four kinds (A, G, C, and T). The chemical and structural properties of DNA explain how the genetic information that underlies heredity is both encoded in genes (as a string of molecular "letters") and replicated (by a templating mechanism). Each DNA molecule in a cell forms a single chromosome.
2. Most of the cells in a human contain two copies of each of 22 different chromosomes. In addition, there is a pair of chromosomes that determines sex: a female contains two X chromosomes and a male contains one X and one Y chromosome. Transmission of genetic information to offspring occurs through egg and sperm cells that contain only one representative from each chromosome pair. An egg and a sperm unite to form a new individual. The fact that the human body is formed from cells that contain two copies of each chromosome—and therefore two copies of each gene—explains many features of human heredity, such as how variations that are hidden in one generation can be expressed in the next.
3. Changes in DNA (mutations) occur spontaneously at low rates. Some of these changes make no difference to the organism, whereas others can change cells and organisms. Only mutations in germ cells can create the variation that changes an organism's offspring. (NSES, 1996, p. 185)

Science in Personal and Social Perspectives: Science and Technology in local, national and global challenges.

History and Nature of Science: Science as a Human Endeavor, Nature of Scientific Knowledge, Historical Perspectives

State Genetics: Genes allow for the storage and transmission of genetic information. They are a set of instructions encoded in the nucleotide sequence of each organism. Genes code for the specific sequences of amino acids that comprise the proteins characteristic to that organism.

3.1 Describe the basic structure (double helix, sugar/phosphate backbone, linked by complementary nucleotide pairs) of DNA, and describe its function in genetic inheritance.

3.3 Explain how mutations in the DNA sequence of a gene may or may not result in phenotypic change in an organism. Explain how mutations in gametes may result in phenotypic changes in offspring.

Evolution: Evolution is the result of genetic changes that occur in constantly changing environments. Over many generations, changes in the genetic make-up of populations may affect biodiversity through speciation and extinction

5.1 Explain how evolution is demonstrated by evidence from the fossil record, comparative anatomy, genetics, molecular biology, and examples of natural selection.

Inquiry: Scientific literacy can be achieved as students inquire about the biological world. The curriculum should include substantial hands-on laboratory and field experiences, as appropriate, for students to develop and use scientific skills in biology, along with the inquiry skills listed below.

SIS1. Make observations, raise questions, and formulate hypotheses.

SIS2. Design and conduct scientific investigations.

SIS3. Analyze and interpret results of scientific investigations.

SIS4. Communicate and apply the results of scientific investigations.

Local same as state frameworks

Materials required PCR - Protocol (attached)
access to computer with high-speed internet
DVD (Race- The Power of an Illusion) and DVD Player with
Television

Lesson development Explore student preconceptions about race.
Understand the biological definition of race.
Carry out a mtDNA isolation, amplification, and sequencing protocol that can test our current notion of race.
Analyze and interpret results.
Compare results with larger, world-wide sequence data sets.

References Race: The Power of an Illusion:
http://www.pbs.org/race/000_General/000_00-Home.htm

NSES. 1996. NRC.
http://www.nap.edu/catalog.php?record_id=4962

Massachusetts Curriculum Frameworks:
<http://www.doe.mass.edu/frameworks/current.html>

