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Lesson Review

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Title: What Is Synthetic Biology?
Company:
Grade Level(s): 11,12,Community College,University Level

Subject Areas

- Science
- Technology

California Standards

Grade Twelve

California Science Content Standards.

Genetics

4.Genes are a set of instructions encoded in the DNA sequence of each organism that specify the sequence of amino acids in proteins characteristic of that organism. As a basis for understanding this concept:

b.Students know how to apply the genetic coding rules to predict the sequence of amino acids from a sequence of codons in RNA.

5.The genetic composition of cells can be altered by incorporation of exogenous DNA into the cells. As a basis for understanding this concept:

d.* Students know how basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, ligation, and transformation) is used to construct recombinant DNA molecules.

e.* Students know how exogenous DNA can be inserted into bacterial cells to alter their genetic makeup and support expression of new protein products.

National Education Technology Standards

2. Design and Develop Digital-Age Learning Experiences and Assessments

Teachers design, develop, and evaluate authentic learning experiences and assessments incorporating contemporary tools and resources to maximize content learning in context and to develop the knowledge, skills, and attitudes identified in the NETS•S.

Teachers:

a. design or adapt relevant learning experiences that incorporate digital tools and resources to promote student learning and creativity

3. Model Digital-Age Work and Learning Teachers exhibit knowledge, skills, and work processes representative of an innovative professional in a global and digital society. Teachers:

d. model and facilitate effective use of current and emerging digital tools to locate, analyze, evaluate, and use information resources to support research and learning.

Lesson Abstract:

A new field termed "synthetic biology" has emerged from the need to standardize and streamline basic molecular biology techniques to speed drug and diagnostic development. In this short computer-based set of exercises, students will use the unique vocabulary and

learn techniques to manipulate DNA that may become the standards for biotechnology in coming years.

Procedures:

NEED

These lessons are geared toward students in a high school or community college one-year biotechnology program. The online tutorials were written for college level students at UC Berkeley as their first exposure to "synthetic biology" by Chris Anderson and used here with his consent. (Anderson, John C.. "Arking:JCAOligoTutorialHome." openwetware.org. 31 March 2009. UCBerkeley. 25 Aug 2009

It assumes students' prior knowledge of basic molecular genetics techniques including PCR and restriction digests. I incorporate these lessons toward the end of the year and see them as a good fit for an AP Biology or high level Biotechnology course in high school or above. They would be considered beyond the scope of a typical high school biology curriculum.

CONNECTION TO FELLOWSHIP

In my fellowship I am part of the UCBerkeley iGEM Wet Team. iGEM is an international competition wherein labs from around the world compete to make a genetically-engineered machine (organism) which performs a specific useful function. I am learning the language and principles of synthetic biology along with team members in creating this organism and I will develop curriculum for my biotechnology class that draws directly from this knowledge. The designed curriculum is web-based and accessible to all.

REQUIREMENTS

This unit requires extensive daily computer use, ideally one per student, but I manage with one per three students. The instructor should have a computer linked to a video projector to walk students through certain parts of the online tutorials to avoid going to each screen to check exact DNA sequences. Instructors will need to go through the tutorials completely before assigning them to the students in order to anticipate student problems. There are worksheets for each tutorial which may be used during or after students have completed the tutorial, as assessments. There are also quizzes/activities embedded in the tutorials which are very useful assessments, basically cloning DNA on the computer according to given instructions.

OBJECTIVES

Students will be able to:
1) use a new language and set of standards that guide the field of synthetic biology.
2) explain the basic steps of cloning, including PCR amplification, bacterial transformation, ligation, digestion, and gel purification.
3) use ApE software to engage in the theoretical construction of the basic parts that comprise the standard.

INTRO TO SYNTHETIC BIOLOGY

Biological information gathering using high-throughput DNA sequencing techniques has greatly surpassed the ability to process and understand such information. Sequencing the human genome today is a task on the order of several days, not the original ten years, and new species of animals, plants and bacteria are sequenced weekly. Studying gene function, however, can be a laborious task, requiring extensive manipulation and isolation of genetic

material, usually in bacterial vectors such as E.coli. Many of these molecular biology processes use the same concepts of DNA cloning, but since each gene is a unique sequence, the protocols must be individualized. Hence, there exists a need to standardize these techniques, which is one aim of synthetic biology.

With this standardization comes a unique language and set of principles that guide it. This information will become the background knowledge for the next generation of biologists. Incorporating some of these concepts in a high school or college biotechnology program is well-timed for a student's possible progression into the arena of molecular genetics.

OUTLINE

DAY 1 (45min)
Tutorial: Basic Molecular Biology
http://andersonlab.qb3.berkeley.edu/Tutorials/Basic_Molecular_Biology.htm
Worksheet: SynBioUnit Tutorial 1 Basic MolBio.doc

DAY 2 (2hr)
Tutorial: ApE software installation
http://openwetware.org/wiki/Arking:JCATutorialIntro9
Worksheet: SynBioUnit Tutorial 2 ApE install.doc
Part 1 of Chris Anderson's talk on Intro to Synthetic Biology
http://www.youtube.com/watch?v=5F0PAB7fXZ4&eurl=http%3A%2F%2Fandersonlab.qb3.berkeley.edu%2FandersonResearch.html&feature=player_embedded

DAY 3 (2hr)
Tutorial: Overview of Cloning
http://openwetware.org/wiki/Arking:JCATutorialIntro7
Worksheet: SynBioUnit Tutorial 3 Cloning Overview.doc
Part 2 of Chris Anderson's talk on Intro to Synthetic Biology
http://www.youtube.com/watch?v=6mqi5Pk3S6A&eurl=http%3A%2F%2Fandersonlab.qb3.berkeley.edu%2FandersonResearch.html&feature=player_embedded

DAY 4-5 (2-3hrs)
Tutorial: Introduction to Oligo Design
http://openwetware.org/wiki/Arking:JCAOligoTutorial1
Worksheet: SynBioUnit Tutorial 4 Intro Oligo Designl.doc
You may choose to not complete the embedded "Now you try one" construction files and just walk through the examples, but if you want your students to really understand the language and have the time, it is valuable.

Keywords:
synthetic, biology, cloning, molecular genetics

Attachments:

- SynBioUnit ReadMe File.doc
- SynBioUnit Tutorial 1 Basic MolBio (student).doc
- SynBioUnit Tutorial 1 Basic MolBio (teacher).doc
- SynBioUnit Tutorial 2 ApE install (student).doc
- SynBioUnit Tutorial 2 ApE install (teacher).doc
- SynBioUnit Tutorial 3 Cloning Overview (student).doc
- SynBioUnit Tutorial 3 Cloning Overview (teacher).doc
- SynBioUnit Tutorial 4 Intro Oligo Design (student).doc
- SynBioUnit Tutorial 4 Intro Oligo Design (teacher).doc

- Unit Standards Assessment (student).doc
- Unit Standards Assessment (teacher).doc
- SynBioUnit Useful Links.doc