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Lesson Review

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Title: Bacteria Fuel
Company: SynBERC
Grade Level(s): 9,10,11,12

Subject Areas

- Science
- Technology

California Standards

Cell Biology

1. The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism's cells. As a basis for understanding this concept:

a. Students know cells are enclosed within semi permeable membranes that regulate their interaction with their surroundings.

c. Students know how prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure.

d. Students know the central dogma of molecular biology outlines the flow of information from transcription of ribonucleic acid (RNA) in the nucleus to translation of proteins on ribosomes in the cytoplasm.

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:

a. Students know the general pathway by which ribosomes synthesize proteins, using tRNAs to translate genetic information in mRNA.

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

e. Students know proteins can differ from one another in the number and sequence of amino acids.

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

a. Students know the general structures and functions of DNA, RNA, and protein.

b. Students know how to apply base-pairing rules to explain precise copying of DNA during semi conservative replication and transcription of information from DNA into mRNA.

Lesson Abstract:

During the bacteria fuel research project students will learn about cell structures and protein synthesis through the lense of biofuels. Students will learn about how to find bacteria that break down cellulose. Once they have found some decomposer bacteria from their neighborhood, students will learn how decomposer bacteria are used break cellulose into glucose. Students will isolate the bacteria that are better at breaking down cellulose. Finally, students will present their findings to their classmates and community members.

Procedures:

Connection between ETP & Fellowship: As a research supervisor at JBEI this summer I am helping 6 high school students work through a research project where they find bacteria that breakdown cellulose, isolate the bacteria, run the bacteria through PCR, and send the bacteria DNA up to LBNL for sequencing. For the students to understand the concepts required during the experiment we gave the students lectures and hands-on activities to review and teach concepts. I will not be able to complete all of the experiments we completed with the student researcher with my own students; however, I will be able to take back several of the steps. I will need to modify my classroom activities slightly due to a lack of lab equipment, but this summer is a great trial run of the curriculum.

Description of the need my ETP will fulfill: I teach in the School for Social Justice and Ecology at Berkeley High School. I am always trying to bring in the latest ideas from the Green Job Market into my curriculum. In the past I taught my students a few of the alternative fuels: solar, hydrogen, and wind. However, now with the knowledge I am gaining through my fellowship I will be able to teach them about biofuels as well. My fellowship at JBEI makes a great connection between Advanced Biology and the Green Job Market. I will be able to use my ETP to train my students for a career in biofuels as well as teach them the standards for cell biology and genetics. My ETP will allow my students to gain lab skills and the background knowledge necessary for an understanding of biofuels.

Purpose: Students will understand the difference between bacteria and plant cell structure. Students will find bacteria that breakdown cellulose with cellulases. Students will be able to explain how protein synthesis is related to the breakdown of cellulose.

Hypothesis: Bacteria that breakdown cellulose with cellulase can be used to convert cellulose into ethanol as an alternative to petroleum based fuel.

Materials (For each group of 4 students)

Materials for Soil Sample Collection

1. Falcon Tubes
2. Sharpie

Materials for Plating Soil Samples on Cellulose Paper

1. (4) Petri Dishes w/ ST21CX
2. (4) Autoclaved Cellulose Papers
3. Parafilm
4. Sharpie

Materials for LB Plate Making & Plating

1. (40) Petri Dishes
2. Deionized Water
3. 20g LB Agar Powder
4. 5g Tryptone
5. 2.5g yeast extract
6. 5g NaCl
7. 7.4g Agar
8. Environmental Samples
9. Parafilm

Materials for DNA Spooling Lab

1. Fruit: Suggestions: Kiwi, Strawberry, Plum, Nectarine, Banana, Tomato
2. (4) Sandwich size ziploc bags
3. (1) scissor
4. (4) 4"x4" pieces of cheesecloth
5. (4) Funnels
6. (8) Test tubes
7. 10 mL of rubbing alcohol
8. (4) Dixie Cups
9. 10 mL of Dish Soap
10. 10 grams of salt
11. Hazardous Diposal Container

Materials for Gram Staining

1. (4) Microscope Slides
2. (4) Microscope Cover Slips
3. (1) Microscope
4. (1) Bunsen Burner
5. (1) Forceps
6. (4) Sterile Loops

7. Solution #1
8. Solution #2
9. Solution #3
10. Solution #4

Materials for Serial Dilution

1. 20 Test Tubes
2. (4) Sterile Loops
3. (4) LB + Agar Plates
4. Parafilm
5. (1) Scissor
6. (1) Sharpie

Materials for Bubble Membrane

1. (2) Plastic Dinner Plates
2. (2) Bubble Straw Tools
3. (2) Plastic Ring 2" Diameter (Film Canister Cut works well)
4. 100 mL of Dish Soap
5. (2) Paper Clips

Materials for Amylase Assay

1. Potato
2. Lugol's Iodine
3. Water
4. Test Tubes
5. Glass Stirring Rod
6. Plastic Disposable Pipet

Materials for Cellulase Assay

1. Congo Red Stain

OUTLINE:

- Suggestion for Summer Before Unit: Attend Saturday Workshops with East Bay Biotechnology Program www.ebbep.org/workshops.html
- 2 Months before the unit: Call JBEI to arrange tour and guest speaker

2 Months before Unit:

- Day 1: Collect Soil Samples (attached)
- Day 2: Plate Soil Samples on Cellulose Paper w/ST21CX (attached)

Week 1: Biofuels/ Climate Change

- Day 1: Intro to Biofuels PPT (attached)
- Day 2: Make LB Plates (attached) [modified from People.bu.edu]
- Day 3: Plate Environmental Samples on to LB Plates (attached)
- Day 4: Intro to Google Docs (attached) /Research: Who can breakdown cellulose? (attached)
- Day 5: Compare LB Plates w/ Cellulose Paper Plates (attached)

Week 2: Eukaryotes/ Prokaryotes

- Day 1: Intro to Cell Structure PPT (attached)
- Day 2: Bubble Cell Membrane Activity (attached) [modified from Cellular Soap Opera Activity form the Exploratorium]
- Day 3: Plant vs. Bacteria Cell Comparison (attached)
- Day 4: Gram Staining of Environmental Samples (attached)
- Day 5: Cheek Cell Staining Lab (attached)

Week 3: DNA & DNA Replication

- Day 1: Intro to DNA PPT (attached)
- Day 2: Carolina DNA Models www.carolina.com/product/dna+simulation+beads+set.do
- Day 3: Paper DNA Models(attached: pa5y.pdf) [© CSIRO's Double Helix Science Club]
- Day 4: DNA Spooling Lab (attached) [modified from Sara Agee, Ph.D., Science Buddies]
- Day 5: Online Electrophoresis (attached)

Week 4: Protein Synthesis

- Day 1: Protein Synthesis PPT (attached)
- Day 2: Codon Bingo (3 attachments: Instructions, Amino Acid Chart, Bingo Card)
- Day 3: Make CMC Plates (attached) [Written by Rowan Driscoll]
- Day 4: 16S Ribosomal DNA Sequence Analysis of unknown bacteria (attached)/ Amino Acid Sequence from 16S ribosomal gene sequence (attached)
- Day 5: Intro to Enzymes & Assays/ Plating Bacteria on CMC (attached)

Week 5: Enzymes & Assays

- Day 1: Spit Enzyme Assay (attached)
- Day 5: Congo Red Cellulose Assays (attached)
- Day 2: Observe Congo Red Plates
- Day 3: **Concept Map Exam**
- Day 4: **Multiple Choice Exam**

Teacher Notes

- **Before beginning this project I highly recommend visiting JBEI's website to find out the lastest ideas in biofuels research. In addition, the are a few places to get the items listed above for reduced prices: RAFT & Biolink.**

Keywords:
biofuels, biotechnology, bacteria,

Attachments:

Amino_Acid_Sequence_of_16S_Gene.pdf
Biofuels_Concept_Map.pdf
BubbleChallengeBest.doc
Cell_Membranes.ppt
CheekCell.doc
CodonBingo.doc
Codon_Bingo_Amino_Acid_Chart.pdf
Codon_Bingo_Instructions.pdf
Comparison_of_LB_Cellulose_Paper.pdf
Congo_Red_Assay_Observations-1.pdf
Congo_Red_Staining.pdf
CMC_Plates-1.pdf
DNA.ppt
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DNAModel.doc
Biofuels Concept Map.doc
Gram_Stain_Protocol.pdf
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