

Key: Yellow highlight = required component

Bacteria and Bioremediation (←your title here!)

Subject Area(s) Biology, Life Science, Science and Technology (Select from [TE Subject Areas](#))

Curricular Unit Title

Header

<p>Image 1 Image file: ____? ADA Description: ____? <i>(Write as if describing the image to a blind person; do not repeat any caption content.)</i> Source/Rights: Copyright © http://fitterlondon.co.uk/wp-content/uploads/2015/04/FFA-Fat-Loss-Guts-Pic-1-585x418.png ____? Caption: ____?</p>
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Grade Level

12 (_8_-_12_)

Summary

In this unit, students learn about the variety of bacteria species found in the Earth and their benefit or harm to humans. Each group of students will research a different bacteria species and prepare a short presentation to the class about its structure, metabolism, and impact on humans. The class as a whole will then determine if the species is “good, bad, or indifferent.” The next lesson looks more deeply into Dehalococcoides, a species capable of dechlorinating toxic substances. In the third lesson students will complete a bioremediation card game where they have to dechlorinate TCE to ethane. In order to move to the next level, they must answer a question from a list of multiple choice questions generated by the class room teach.

Engineering Connection

Engineers design solutions using substances and species already present in nature. Examples include oil degrading bacteria, dehalogenating bacteria, wastewater microbes, and dairy culture bacteria. Engineers find ways to enhance the natural growing conditions and allow the bacteria to perform the engineering work of cleaning up and oil spill or breaking down harmful substances. In groundwater and wastewater treatment, engineers determine how to optimize conditions for the most efficient bacterial action.

Engineering Category = 1

Choose the category that best describes this unit’s amount/depth of engineering content:

1. Relating science and/or math concept(s) to engineering
2. Engineering analysis or partial design
3. Engineering design process

Keywords

Bioremediation, dehalogenation, bacteria, human microbiome, metabolism, aerobic, anaerobic

Educational Standards

Texas: Science [2010] [...show](#)

- Subchapter C. High School (9-12) [...show](#)
(69 lessons/activities/units aligned)
- Biology (9-11) [...show](#)
(12 lessons/activities/units aligned)

- Science concepts. The student knows that interdependence and interactions occur within an environmental system. The student is expected to: (9-11) [...show](#)
(no curriculum aligned)

Current Standard:

- compare variations and adaptations of organisms in different ecosystems; (9-11)
(no curriculum aligned)

Science concepts. The student knows the significance of various molecules involved in metabolic processes and energy conversions that occur in living organisms. The student is expected to: (9-11) [...show](#)
(no curriculum aligned)

Current Standard:

- compare the reactants and products of photosynthesis and cellular respiration in terms of energy and matter; (9-11)

Environmental Systems (11-12) [...show](#)
(5 lessons/activities/units aligned)

- Science concepts. The student knows the impact of human activities on the environment. The student is expected to: (11-12) [...show](#)
(5 lessons/activities/units aligned)

Current Standard:

- investigate the types of air, soil, and water pollution such as chlorofluorocarbons, carbon dioxide, pH, pesticide runoff, thermal variations, metallic ions, heavy metals, and nuclear waste; (11-12)

International Technology and Engineering Educators Association: Technology [2000]

Technology and Society (K-12) [...show](#)
(311 lessons/activities/units aligned)

- Standard 5. Students will develop an understanding of the effects of technology on the environment. (K-12) [...show](#)
(196 lessons/activities/units aligned)
- In order to discern the effects of technology on the environment, students should learn that: (K-12) [...show](#)
(189 lessons/activities/units aligned)

Current Standard:

- J. The alignment of technological processes with natural processes maximizes performance and reduces negative impacts on the environment. (9-12)

Current Standard:

- K. Humans devise technologies to reduce the negative consequences of other technologies. (9-12)

Only list educational standards that are common to the majority of the lessons and activities of the unit.

Source, year, standard number(s)/letter(s), grade band and text (its unique ID# is optional)

Related Lessons & Activities

Time Required

135 minutes (3 class periods)

Unit Overview

In this unit, students learn about the variety of bacteria species found in the Earth and their benefit or harm to humans. Each group of students will research a different bacteria species and prepare a short presentation to the class about its structure, metabolism, and impact on humans. The class as a whole will then determine if the species is “good, bad, or indifferent.” Some of these classifications will spark a discussion. The lesson will conclude with a description of the importance of the human microbiome and how few bacteria species are harmful relative to the total number of species.

The next lesson looks more deeply into Dehalococcoides, a species capable of dechlorinating toxic substances. Students will learn about reductive dehalogenation with a focus on metabolism in aerobic versus anaerobic conditions. Students will analyze the MSDS sheets for each of the four substances involved in dehalogenating Trichloroethylene (TCE) to Ethene. They then create a classification for the toxicity of each substance.

In the third lesson students will complete a bioremediation card game where they have to dechlorinate TCE to ethane. Drawing an oxygen card means you lose a turn to simulate the need for anaerobic conditions. Students must collect all the elements needed for the chemical reaction to occur. In order to move to the next level, they must answer a question from a list of multiple choice questions generated by the class room teach. The questions should cover material student should already know from what they’ve learned in class and serves as review for upcoming tests or quizzes.

Unit Schedule

Lesson 1: Bacteria: Good, Bad, or Indifferent?

Lesson 2: Bioremediation: TCE vs. Dehalococcoides

Lesson 3: Bioremediation Card Game and Biology Review

Summary Assessment

Lesson 1 assessment is if the class members understand and correctly classify the impact of a given bacteria species based on the group’s presentation.

Lesson 3 serves as the assessment for lesson 2 in successful completion of the game showing an understanding of the dehalogenation process and the regular classroom objectives from the teacher provided questions.

Attachments

Bacteria Good bad indifferent

TCE to ethane MSDS

Bioremediation Game Cards

Other

Redirect URL

Contributors

Supporting Program

Acknowledgements

Classroom Testing Information

Research a bacteria species or genus, and create a mini-presentation to share with your classmates that includes:

- 1. A description and drawing of your bacteria's structure**
- 2. A description and drawing of your bacteria's metabolism**
- 3. A description and drawing of how your bacteria affects human beings**

Your group will present your findings to the class on three slides (sheets of paper). Everyone has to speak.

The class will then vote on whether your species is good bad or indifferent!

Research a bacteria species or genus, and create a mini-presentation to share with your classmates that includes:

- 1. A description and drawing of your bacteria's structure**
- 2. A description and drawing of your bacteria's metabolism**
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The class will then vote on whether your species is good bad or indifferent!

Nitrosomonas

Dehalococcoides ethenogenes

Escherichia coli

Bordetella pertussis

Streptococcus pyogenes

Lactobacillus

Prochlorococcus

Alcanivorax borkumensis

Neptunomonas naphthovorans

Anabaena

Saccharopolyspora erythraea

Good

Bad

Indifferent

Good

Bad

Indifferent

Good

Bad

Indifferent

Good

Bad

Indifferent

Good

Bad

Indifferent

Good

Bad

Indifferent

Good

Bad

Indifferent

Good

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Bad

Indifferent

Good

Bad

Indifferent

С

С

С

Н

Н

Н

Н

Н

Н

C

C

C

Cl

Cl

Cl



O₂



H

H

H

Cl

Cl

Cl

H

H

H



Cl

Cl

O₂



You are dehalococcoides bacteria and you're competing against other dehalococcoides bacteria to dehalogenate/dechlorinate toxic TCE (trichloroethylene).

There are 6 different types of cards: **C, H, Cl,** ,  **and O₂.**

Use the element cards to make your chemical (_____, _____, _____, or _____) and the electron donor molecule (_____). You also need the correct number and type of card for your chemical's toxicity (skeleton(s) or teddy bear(s)). Because dehalococcoides can only metabolize in _____ conditions, you will lose a turn if you get an ___ card.

The game is like gin:

first deal to each team the number of cards you need to make TCE and its electron donor including toxicity: _____

each player can pick from the deck or the discard pile to find the cards she needs to make the molecules and toxicity

when the reactants and toxicity are completed and you're ready to dechlorinate, you must first go answer a science question

if you get it right, you can discard all your cards and then deal to the number of cards you need to make _____ and its electron donor including toxicity: _____

if you get it wrong, you lose this turn and have to wait until your turn comes around again to answer another questions

every time you complete a new set of reactants, you must answer a science questions

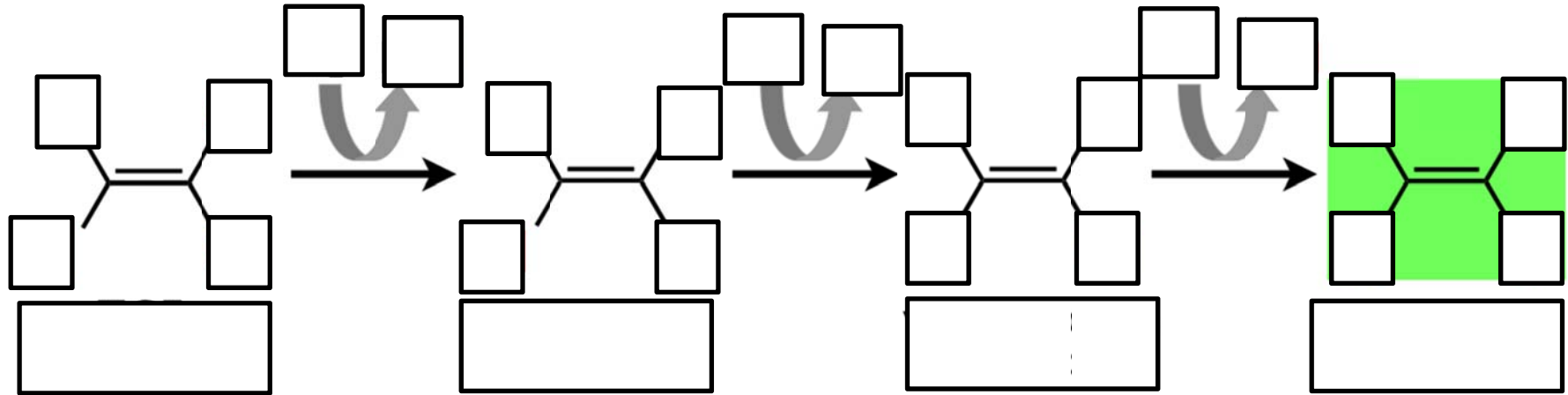
each time you're correct, deal out the number of cards you need for the next step (always including toxicity)

the first team to make ethane and its toxicity is the winner

if you pick up an oxygen card from the deck you lose a turn and have to wait until the next round to discard it!

Chemical				
Formula				
Molecular Structure				
Maximum Contaminant Level (MCL)				
Short-term Exposure Symptoms				
Carcinogenic? (yes/no)				

Reductive Dechlorination



Conditions necessary	
Electron donor/acceptor	