



Title: Methanogenesis in Earth and Body	
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Course: Anatomy and Physiology, Biology, Life Science	Duration: Two class periods
Grade Level: 9-12	
Objective: The learner will compare and contrast the processes of making methane within human bodies and within the Earth.	
Summary of Lesson: After a brief introduction to fossil fuels students explore Arkansas Energy Rocks web site and view the Methanogenesis PowerPoint. Students use this background information to complete journal entries on methanogenesis.	
Standards: Common Core State Standards, Arkansas State Frameworks	
Science	
MC.2.B.2	Compare and contrast <i>prokaryotes</i> and <i>eukaryotes</i>
MC.3.B.3	Compare and contrast aerobic and anaerobic respiration (lactic acid and alcoholic fermentation)
CDL.7.B.1	Differentiate between the <i>domains</i> Bacteria and Archaea
CDL.7.B.2	Differentiate the characteristics of these kingdoms – Eubacteria and Archaea
CDL.7.B.9	Classify <i>bacteria</i> according to their characteristics and adaptations
CDL.7.B.10	Evaluate the medical and economic importance of <i>bacteria</i>
Common Core State Standards	



<u>CCSS.ELA-LITERACY.RST.9-10.2</u>	Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
<u>CCSS.ELA-LITERACY.RST.9-10.4</u>	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to <i>grades 9-10 texts and topics</i>
<u>CCSS.ELA-LITERACY.RST.9-10.5</u>	Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., <i>force, friction, reaction force, energy</i>).
<u>CCSS.ELA-LITERACY.RST.9-10.7</u>	Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
<p>Teacher Excellence Support System (TESS): Domain I: Planning and Preparation 1a: Demonstrating Knowledge of Content and Pedagogy 1c: Setting Instructional Outcomes 1d: Demonstrating Knowledge of Resources 1e: Designing Coherent Instruction 1f: Designing Student Assessments Domain III: Instruction 3a: Communicating with Students 3b: Using Questioning and Discussion Techniques 3c: Engaging Students in Learning 3d: Using Assessment in Instruction</p>	
<p>Instructional Strategies and Practices: Journaling (“Think, Pair, Share”), Games</p>	
<p>Bloom’s Level: (Highest Level Only) Analyze and Apply</p>	



Materials and Resources:

- www.arkansasenergyrocks.com
Arkansas Energy Rocks educational web site
- <http://theurbanfarmingguys.com/methane-biodigester-how-to>
Video on how to create a methane generator to model how methane is produced
- http://www.esrl.noaa.gov/gmd/infodata/lesson_plans/Methane%20gas%20Production.pdf
Simple instructions on how to build a methane generator as a demonstration
- Methanogens: Methanogenesis – Earth and Body PowerPoint
- Student Handout 1: Methanogenesis in Earth and Body Journal Writing Questions
- Student Handout 2: Methanogenesis in Earth and Body Exit Slip

Formative Assessment:

Exit Slip at the end of the PowerPoint.

Notes to Teacher:

Notes are included in the PowerPoint. A copy is also included in Day 2 of the lesson plan.

Student Activity:

Day 1:

1. After a brief introduction on fossil fuels, students will explore the Arkansas Energy Rocks website (www.arkansasenergyrocks.com) by playing the game, watching the videos, etc. This could also be homework if students have access to the internet.

There are several good websites that provide background information to introduce fossil fuels. Examples are included below:

<http://www.fossilfuels.org/an-introduction-to-fossil-fuels.html>

An Introduction to Fossil Fuels

<http://www.energyquest.ca.gov/story/chapter08.html>

Where Fossil Fuels Come From

http://en.wikipedia.org/wiki/Fossil_fuel

Wikipedia: Fossil Fuels

2. To illustrate how methane gas can be produced and used as an energy source, show one or both of the following videos:

<http://theurbanfarmingguys.com/methane-biodigester-how-to>

Video on how to create a methane generator to model how methane is produced



http://www.esrl.noaa.gov/gmd/infodata/lesson_plans/Methane%20gas%20Production.pdf

Simple instructions on how to build a methane generator as a demonstration

Day 2:

1. Before presenting the PowerPoint, provide students with **Student Handout 1: Journal Writing Questions** and allow time to read over the questions.
2. Show PowerPoint presentation over methanogenesis

Teacher Notes included in the PowerPoint:

Slide 1:

Title Page

Slide 2:

There are two types of cells- prokaryotic and eukaryotic. Eukaryotic cells have a nucleus to hold the cell's nuclear DNA. Organisms with these cells include the Kingdoms Fungi, Plantae, Animalia, and Protista (Many textbooks still say protists are in a Kingdom; however, they are now phyla). Prokaryotic cells do not have a nucleus to hold their DNA. Prokaryotic DNA is not membrane bound, rather is located in the cytoplasm of the cell. Prokaryotes include bacteria only. There are three domains: Eukarya (plants, animals, protists, fungi), Archaea, and Bacteria. We will concentrate on the Domain Archaea.

Slide 3:

Just a little information to refresh our memory on the Domain Bacteria.

Slide 4:

Why are these organisms thought to be the first to evolve on Earth? (They are able to live in harsh environments without oxygen. It is thought that the Earth did not have oxygen for some time.)

Slide 5

There are many types of archaeobacteria, but we will focus on one type- methanogens because they make methane – also known as natural gas. Anaerobic respiration is the process of making chemical energy the cell can use, ATP (Adenosine triphosphate), without oxygen.

Slide 6

Made in the rumen of the digestive tract

Slide 7:

(No notes)



Slide 8

Discuss aerobic respiration and explain how oxygen is depleted and carbon dioxide is produced as a waste product.

Slide 9

(No notes)

Slide 10

- 1. Anaerobic, archaeabacteria that produce methane*
- 2. Anaerobic respiration*
- 3. Extreme environments where no oxygen is found such as marshes, digestive tracts of animals*
- 4. Similarities: same metabolic pathway is used to form methane*
- 5. Differences: Body- takes a relatively short amount of time to produce methane; Earth- could take a very long time*

3. Distribute **Student Handout 2—Exit Slips** as students leave the classroom. Slips are due at the beginning of the class the following day.

Day 3

1. To conclude the lesson and review the information from the previous day, allow students to share information from their Exit Slips.

Student Handouts: (Printable copies of the handouts are available at:

<http://www.arkansasenergyrocks.com/educators/index.html>. Select Curriculum; then 9-12 Lesson Plan -- student handouts accompany each lesson plan.)

Methanogenesis in Earth and Body

Student Handout 1

Journal Writing Questions

Use the following questions to write an entry in your journal.

1. If you were a methanogen living inside the digestive tract of a cow, describe your journey to making ATP (Adenosine triphosphate)
2. If you were a methanogen living inside a landfill, describe your journey to making ATP (Adenosine triphosphate).
3. How is anaerobic respiration like aerobic respiration? How is it different?
4. If you could change one thing about methanogenesis, what would you change and why?
5. What might be the implications on the environment if methane was not produced?



6. What might be the implications on humans if methane was not produced?
7. If methanogens were pathogens, how would this impact your body?
8. How does structure follow function during methanogenesis in the cell of archaeabacteria?

**Methanogenesis in Earth and Body
Student Handout 2**

Exit Slip

1. What are methanogens?
2. What type of metabolic pathway do methanogens use to make ATP?
3. Where are methanogens found?
4. Create a Venn diagram to compare and contrast methanogenesis within the earth and body.