



Title: Methanogenesis in Earth and Body			
Author: Candace Campbell Brookland High School Brookland			
Course: Anatomy and Physiology, Biology, Environmental Science, Earth Science, Chemistry II			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.			
Arkansas State Standards:			
SUBJECTS:	GRADE LEVELS:	CODE:	STANDARD:
Chemistry II	9-12	CII-PS1-5	Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
		CII-PS4-1AR	Plan and carry out investigations to examine stability and change exhibited by gas particles in a closed system.
		CII-PS4-2AR	Argue from evidence cause and effect relationships of factors influencing behavior of gas particles.
Biology	9-12	BI-LS1-7	Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.



		BI-LS2-3	Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
Anatomy And Physiology	9-12	HAP-LS6-1AR	Construct and revise an explanation based on evidence for the cycling of matter and flow of energy among body systems and their associated processes.
Environmental Science	9-12	EVS-ESS2-6	Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
Earth Science	9-12	ES-ESS2-6	Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
Language Arts	9-12	RI.9-10.2	Examine a grade-appropriate informational text. <ul style="list-style-type: none"> ● Provide an objective summary of the text. ● Determine a central idea of a text and analyze its development over the course of the text, including how it emerges and is shaped and refined by specific details.
		RI.11-12.2	Examine a grade-appropriate informational text. <ul style="list-style-type: none"> ● Provide an objective summary of the text. ● Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis.
		RI.9-10.4	Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze the cumulative impact of specific word choices on meaning and tone.
		RI.11-12.4	Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an



			author uses and refines the meaning of a key term or terms over the course of a text, including words with multiple meanings or language that is particularly fresh, engaging, or beautiful.
<p>Teacher Excellence Support System (TESS): <u>Domain I: Planning and Preparation</u> 1a: Demonstrating Knowledge of Content and Pedagogy 1c: Setting Instructional Outcomes 1d: Demonstrating Knowledge of Resources 1e: Designing Coherent Instruction 1f: Designing Student Assessments <u>Domain III: Instruction</u> 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>			
<p>Materials and Resources:</p> <ul style="list-style-type: none"> ● www.arkansasenergyrocks.com Arkansas Energy Rocks educational website ● https://www.youtube.com/watch?v=3AZv6MjZylo Video on how to create a methane generator to model how methane is produced ● https://www.esrl.noaa.gov/gmd/infodata/lesson_plans/Methane%20gas%20Production.pdf Simple instructions on how to build a methane generator as a demonstration <p>(These websites may change over time. If a website is no longer available, use the key words and phrases from the lesson to find more current resources.)</p> <ul style="list-style-type: none"> ● 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 			
<p>Formative Assessment:</p>			



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 at <http://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:

(These websites may change over time. If a website is no longer available, use the key words and phrases from the lesson to find more current resources.)

<http://greendustriesblog.com/greendustries/2011/05/25/where-do-fossil-fuels-come-from/>

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:

<https://www.youtube.com/watch?v=3AZv6MjZylo>

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

https://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 <https://arkansasenergyrocks.com/educators/lesson-plans-9-12/>

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.