

Teaching Guide for: Archaea and the Tree of Life

Speaker: Dipti Nayak

Video link: <https://www.ibiology.org/microbiology/archaea/>

Major topics

- Microbiology
- Evolution

Overview

Before 1977, all life on Earth was classified into two groups: single-celled microorganisms and complex cellular life such as fungi, plants, and animals. A groundbreaking discovery in 1977 rewrote the tree of life and introduced a whole new domain of organisms known as the archaea - mysterious microbes that are genetically distinct from bacteria. Fast forward to the 21st century, and again new discoveries about archaea are leading scientists to reshape the tree of life and rewrite the evolutionary history of complex organisms. Dr. Dipti Nayak introduces the fascinating organisms known as archaea and explains how they are helping scientists answer the question *Where do we come from?*

Learning objectives

1. List the similarities and differences between prokaryotic and eukaryotic cells.
2. Identify archaea as a distinct domain of life and name some of their characteristics.
3. Describe how scientists use DNA sequences to understand evolutionary relationships and differentiate between microorganisms.
4. Discuss how scientific theories change as new evidence is collected, with a focus on the tree of life.

Sub topics

1. Prokaryotes and eukaryotes
2. Archaea
3. Phylogenetics
4. Evolution of eukaryotes
5. Process of science

Video chapters

Chapter 1: Introduction - Archaea and the Tree of Life (0:00-1:48)

Learning objective(s) covered: 1

Sub topic(s) covered: 1

Suggested review question: Compare and contrast prokaryotes and eukaryotes.

Chapter 2: A New Branch (1:49-7:38)

Learning objective(s) covered: 2, 3

Sub topic(s) covered: 2, 3

Suggested review question: Describe what information scientists use to differentiate between archaea and bacteria, even though they look very similar under a microscope.

Chapter 3: A New Tree: Asgard-Loki (7:39-12:38)

Learning objective(s) covered: 4

Sub topic(s) covered: 4, 5

Suggested review question: Using a diagram, compare and contrast Woese's 3-domain tree with the 2-domain tree that emerged after the discovery of the Asgard archaea. Describe the evidence scientists used to support each of the trees.

Relevant literature

Woese C and Fox GE. 1977. [Phylogenetic structure of the prokaryotic domain: The primary kingdoms](#). *Proceedings of the National Academy of Sciences* 74(11): 5088-5090.

Woese C, Kandler O, & Wheelis M. 1990. [Towards a natural system of organisms: Proposal for the domains Archaea, Bacteria, and Eucarya](#). *Proceedings of the National Academy of Sciences* 87: 4576-4579.

Spang A et al. 2015. [Complex archaea that bridge the gap between prokaryotes and eukaryotes](#). *Nature* 521(7551): 173-179.

Eme L et al. 2017. [Archaea and the origin of eukaryotes](#). *Nature Reviews Microbiology* 15(12): 711-723.

Related resources

[What are prokaryotes?](#) Explainer video from XBio

[What are eukaryotes?](#) Explainer video from XBio

[What is evolution?](#) Explainer video from XBio

[What are genes?](#) Explainer video from XBio

[Membrane organelles](#). Multimedia narrative from XBio

[Creating phylogenetic trees from DNA sequences](#). Student activity from HHMI BioInteractive.

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