GOFLAG
GENEALOGY OF FLAGELLATE PLANTS

LYCOPHYTES AND YOU

This guide offers suggestions for how to implement the "Lycophytes and You" activity. This activity was developed by the GoFlag project. A key goal of the project is to improve public awareness about plants in general and provide specific information about a special group of plants called flagellate plants.

Flagellate plants have existed on our planet for a long time and they offer some important clues on how plants evolve and adapt. There are several ways to classify flagellate plants based on their genetic and morphological traits but one of their most unique features is the absence of flowers.

"Lycophytes and You" is a 30-minute web-based activity that focuses on lycophytes – a group of flagellate plants – that plays a huge role in the formation of fossil fuels and energy production. The activity is designed to be self-contained – it includes relevant content, resources, and assessments, but it can be further customized based on the needs of your learners and learning context.

GRADE LEVEL

- Middle school,
- High school, and
- Introductory Biology courses in undergraduate programs

*You can find additional activities for this and other age groups on GoFlag Voyager.

LEARNING OBJECTIVES

- Identify the connections between lycophytes and energy production.
- Describe the benefits and drawbacks of using coal for energy production.
- Explain how lycophytes help scientists understand the evolution of other plants .
- Discuss "tree thinking" concepts.

CURRICULAR CONNECTIONS

- Decomposition
- Energy
- Evolution
- Chemistry

MATERIALS AND RESOURCES

- Link to online activity: Lycophytes and You
- Devices for students to view the activity (laptops, Chromebooks, tablets, smartphones)
- Internet connection

- Headphones (or speakers if used as a whole class activity)

IMPLEMENTATION SUGGESTIONS

- One face-to-face class, 30-minute activity, done individually or in small groups
- Two or more face-to-face classes, splitting the activity into 2-3 components, and stopping for small group or whole class discussions around concepts of interest (e.g., tree thinking)
- Homework activity that students complete on their own and produce an artifact or take a test
- Online activity in an online or blended course
- Optional or required enrichment activity following a class on related topics (e.g., energy)

PRE-ACTIVITY IDEAS (ANCHORING)

- Invite a botanist to introduce the concept of flagellate plants and discuss their importance.
- Show the students a slideshow of plant photos and ask them to describe the differences (e.g., do all plants have flowers?) as a way to introduce the notion of flagellate plants and tree thinking.
- Take the students to a museum of natural history to see real coal.
- Do a class activity about climate change (e.g., How Much Hotter is Your Hometown).

PROCEDURE

As a class activity, the material can be used to prompt discussions and reflections about energy production, plant evolution, tree thinking, and climate change. Here is a possible procedure:

Instructor

- Ask the students to write 3 problems that result from climate change
- Divide the class into groups of 4 and show the activity using the teacher computer and projector
- Stop the activity when you get to an assessment or interactive activity. Depending on time constraints, you can pre-select only a few of these questions and activities to be completed by the groups

Students

- Discuss and complete each question and activity as a group
- Share the group's answer with the class and explain how they came to that conclusion

Instructor-Class

- Discuss groups' responses as a class and follow up
- Explore all the hyperlinks in the activity. These resources are meant to elucidate concepts about lycophytes, energy production, and climate change.
  Example
  - "So, What can we do?" slide [correct answer: varies]

- Group Reponses: Students can reflect on possible alternative sources of energy and discuss how current limitations (e.g., costs) could be addressed by policy makers (e.g., reduce taxes) to speed the adoption of a more sustainable and environment-friendly energy production.
- Expand discussion: "What are some actions we can take to reduce climate change?" [possible answer: reduce meat consumption and select reusable or recyclable packaging]

PREREQUISITE KNOWLEDGE AND VOCABULARY

- **Carbon dioxide (CO_2)** is a colorless gas that consists of three atoms: one carbon and two oxygen. Its density is 60% higher than that of dry air. Carbon dioxide is the most significant long-lived greenhouse gas in Earth's atmosphere. Since the Industrial Revolution emissions from use of fossil fuels and deforestation have rapidly increased its concentration in the atmosphere, leading to global warming.
- **Coal** is a combustible black or brownish-black sedimentary found mainly in underground deposits. It has been widely used as fuel.
- **Lycophytes** are flowerless plants that lack seed, wood, fruits, and flowers. It is one of the oldest types of vascular plants and its decomposition over the years contributed to the formation of coal.

EXTENSION IDEAS

- Discuss the effects of climate change: How Much Hotter is Your Hometown
- Evaluate other factors that contribute to climate change: Meat
- Introduce the concept of tree thinking: Tree thinking
- Illustrate differences between non-flowering and flowering plants: Plants species
- Provide additional teaching and learning resources (e.g., high quality images): In defense of plants

ALIGNMENT WITH NEXT GENERATION SCIENCE STANDARDS

Middle School: MS-ESS3-5:Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century
High School: HS-ESS2-4: Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

ALIGNMENT WITH COMMON CORE STATE STANDARDS

RST.6-8.1: Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS3-5)
http://www.corestandards.org/ELA-Literacy/RST/6-8/