FUZZY MUD: SLIME MOLD MAP

LESSON OVERVIEW

Grade Levels: 6-8

In this lesson students will participate in a life sciences lab inspired by the book *Fuzzy Mud* by Louis Sachar. In the book, an organism engineered from slime mold escapes containment, causing an epidemic. For this lab, a cultured slime mold, *physarum polycephalum*, will be placed on a map of the United States. A food source will be positioned over major US cities. As the slime mold grows over 2 to 3 days, it will create an efficient network between the food sources, mimicking the interstate road network between major cities. An additional slime mold will be placed at the center of a circle. Around the circle will be several different types of food sources. The students will hypothesize about which food the slime mold will prefer and can make observations over 2 to 3 days. The lesson will conclude with a written analysis of the hypothesis and observations.

STANDARDS

NGSS **MS-LS1-5**	Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
CCSS **ELA.WHST.6-8.7**	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
CCSS **ELA.WHST.6-8.4**	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
CCSS **ELA.WHST.6-8.2**	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

OBJECTIVES

- Students will observe the growth of a slime mold, writing their observations in their lab notebooks.
- Students will predict the behavior of a slime mold, generating a hypothesis about which food it prefers.
- Students will write a 1 to 2 paragraph lab analysis of their hypothesis, observations, and results.

MATERIALS

- *Physarum polycephalum* slime mold can be obtained from Flinn Scientific: http://www.flinnsci.com/
- Rolled oats, crushed with a mortar and pestle or food processor
- Test food materials (pick 3): hard candy, brown sugar, crushed leaves, popcorn, small twigs, shredded paper
- Circular food container (any size that is large enough to be placed around the slime mold, such as a pie dish)
- Warm, dark location for culturing
- Laminated map of the US (sized to fit inside or beneath the food container)
- Optional: Go pro or other time lapse camera (could be a webcam with timelapse freeware)
- Culturing supplies (see the Flinn Sci Culturing Manual at http://www.flinnsci.com/media/406395/bf10586.pdf)

- Filter paper
- Petri dish
- Breathable container (plastic ware)
- Water

PROCEDURES

STEP 1: One day before the students begin, culture the slime mold according to the instructions of your supplier (if you purchase from Flinn Sci, there is a pdf file on the product page that explains how to do this). You will need to practice proper lab safety and sterilization techniques throughout the lab. The mold will take about 24 hours to grow over the crushed oats.

STEP 2: Before class, prepare the food container. Place a laminated map of the US beneath or inside of a larger, clear, breathable container. Put ground oats on top of several major cities on the map. Put salt over the Great Lakes and lightly sprinkle some salt over the Northern Rockies, taking care not to get salt anywhere else on the map. The salt will prevent the slime mold from growing in those areas.

STEP 3: Before class, prepare the food container. Inside the container, place 4 potential food sources in separate spots on the edge. One should be the same oat food used to culture the slime mold. The others can be candy, leaves, shredded paper, etc.

STEP 4: Briefly tell the students a little bit about slime molds. See the *Guiding Information* below for details. Have a discussion on the following items.

- Ask students how they think slime molds should be classified and why.
- Show a video of slime mold solving a maze: https://youtu.be/czk4xgdhdY4
- Ask students if they think slime molds are intelligent and what they think is happening.
- Ask if organisms can have intelligence without having a brain.

STEP 5: Tell the students about the slime mold they will be observing, *physarum polycephalum* (see *Guiding Information* below). Explain the lab to the students. Place a slime mold specimen in the center of the map, and a slime mold specimen in the center of the circular container with the food choices.

STEP 6: Ask students to think about what will happen with the map slime mold based on what they saw in the maze video and what they've talked about already. Tell students to briefly write their thoughts in their lab notebooks. Over the next two days, students will take 10 to 15 minutes of class time to look at the map slime mold and write down their observations in their notebooks. If you have access to a time lapse camera such as a GoPro, you can set it up to take a time lapse video of the map or the food experiment. Play this at the start of class for the duration of the experiment, so that students can make observations from the class video.

STEP 7: Ask students to think about what food the slime mold will choose and why. Have them write out their own hypothesis using the structure, "If ____, then ____, because ____." Over the next two days, students will take a few minutes of class time to look at the food slime mold and write down their observations in their notebooks.

STEP 8: On the final day, after students are done making observations, have students describe what they observed and explain whether their observations helped them confirm or reject their hypotheses. Tell students to write a one to two paragraph analysis that includes their original hypothesis, their observations, and an explanation confirming or rejecting their hypothesis.

STEP 9: You may dry and save the slime mold for over a year or you may dispose of it according to your local regulations (see Flynn Sci pdf on the slime mold product page for saving and drying procedures).

GUIDING INFORMATION

Slime molds are **eukaryotic** organisms that do not fit well into any **Kingdom** classification. They can be classified as **Fungi** due to their method of reproduction. To reproduce, they create fruiting bodies that release spores just like other Fungi. However, slime molds are also similar to **Protista**. They are amoeba-like cells. Some slime molds are called **plasmodia**. These individuals are made up of only a single amoeboid cell that can grow to macroscopic sizes. Slime molds vary greatly in their characteristics. Some are microscopic, while others span several feet. They can be brown, bright yellow, orange, or even purple. Slime molds also exhibit strange behavior. When separated, the parts of the mold will try to regroup. A fascinating and important thing to note for this lesson plan is that slime molds can solve mazes and maps, picking the most efficient route between food sources. They are very good at picking the shortest path (some mathematicians have devoted themselves to coming up with ways to solve the shortest path problem, and this organism does it without a brain). The **plasmodium type slime mold** which you will be using has been studied for its ability to solve these things as well as for use in biosensors in robots and other computer circuitry. It is still unknown how the slime mold behaves this way.

Physarum polycephalum likes cool, dark, and moist places and shies away from the light. It feeds on decaying organic matter (i.e. leaves, trees), bacteria, fungus, and other microbes. The mold is easy to culture and should be in the vegetative active phase for this lab (keep it fed, and it will not go into the reproductive phase). This slime mold surrounds food and secretes enzymes to digest it. The wave movement that you see in time lapse videos (including the maze video linked in the steps above) is called **cytoplasmic streaming**. This slime mold is a single cell and contracts and dilates in order to move nutrients around. It takes around 3 minutes for the one pulse.

RUBRIC

	Target (3)	Meets (2)	Partially Meets (1)	Does Not Meet (0)
OBSERVATIONS & HYPOTHESIS	Does a great job conducting observations of the growth of the slime mold, recording data, and establishing a hypothesis.	Does an adequate job conducting observations of the growth of the slime mold, recording data, and establishing a hypothesis.	Makes an attempt but has trouble conducting observations of the growth of the slime mold, recording data, or establishing a hypothesis.	Does not make an acceptable attempt conducting observations of the growth of the slime mold, recording data, or establishing a hypothesis.
LAB ANALYSIS	The analysis addresses the scientific investigation and provides ample reasons and examples for the growth patterns of the mold.	The analysis addresses the scientific investigation and provides adequate reasons and examples for the growth patterns of the mold.	The analysis addresses the scientific investigation but does not provide adequate reasons and examples for the growth patterns of the mold.	The analysis does not provide adequate reasons and examples for the growth patterns of the mold.
GRAMMAR AND SPELLING	There are no spelling, punctuation, or grammar errors.	There are a couple spelling, punctuation, or grammar errors.	There are several spelling punctuation and grammar errors.	There are many spelling punctuation and grammar errors.
WRITING STRUCTURE	The analysis is very well organized. One idea or scene follows another in a logical sequence with clear transitions.	The analysis is well organized. One idea or piece of information may seem out of place. Clear transitions are used.	The analysis is a little hard to follow. The transitions are sometimes not clear.	Ideas and thoughts seem to be randomly arranged.
REQUIREMENTS	Meets all of the requirements for the project.	Meets most of the requirements for the project.	Meets some of the requirements for the project.	Does not meet the requirements for the project.
Total				/15