



Lesson Plan

Mycelium

Created: 03/2019 by the National FFA Organization

Michaela's supervised agricultural experience (SAE) program started when she noticed the environmental effect of the waste runoff from her pigs. Learn how her search for a cost-effective solution led to her work with mycelium.

STUDENT LEARNING OBJECTIVES:

After completing these activities, students will ...

1. Define what mycelium is and understand how it is related to mushrooms and fungi.
2. Discover how fungi are being used to help meet global needs.
3. Analyze one potential innovation using mycelium.

TIME REQUIRED: 120 minutes

RESOURCES/REFERENCES:

1. Video: "Mycelium SAE | Michaela Carmichael," <https://vimeo.com/342621734>
2. Article: "Nine Ways Mushrooms Could Drastically Improve the World," <https://blog.ted.com/9-ways-mushrooms-could-drastically-improve-the-world/>
3. Article and Video: "Surprising New Uses for Mushrooms, From Houses to Packaging," <https://www.nationalgeographic.com/news/2016/07/mushroom-surprising-uses-building-material-medicines-fungi/>

EQUIPMENT AND SUPPLIES NEEDED:

1. A copy of the "My-Celi-What?" worksheet for each student
2. A copy of the "Fungus to the Rescue!" worksheet for each student
3. A copy of the "Fungi Innovation Creative Project Rubric" for each student
4. Internet access to play the video in real time or embed it in a PowerPoint ahead of time
5. Technology access for students to read the articles or they could be printed for students

STUDENT ACTIVITY SHEETS:

Direct access to student activity sheets without lesson plan or answer key for easy upload to learning management systems or printing for classwork.

<https://ffa.box.com/s/avrc9asi5rrgo3nbodxrv5rxq1fwsehn> (Word)

<https://ffa.box.com/s/qxp1l3najthwcatml4vlmsuspf8q6wdd> (PDF)

CROSS-CURRICULAR CONNECTIONS:

Science	English/Language Arts
Research the innovative uses of mycelium	Summarize articles and highlight key points

THESE ACTIVITIES ARE ALIGNED TO THE FOLLOWING STANDARDS:

AFNR Performance Element

- NRS.02. Analyze the interrelationships between natural resources and humans.

FFA Precept

- FFA.PL-A.Action Assume responsibility and take the necessary steps to achieve the desired results, no matter what the goal or task at hand.
- FFA.PG-J.Mental Growth: Embrace cognitive and intellectual development relative to reasoning, thinking and coping.

Common Career Technical Core

- AG-NR2 Analyze the interrelationships between natural resources and humans.

NASDCTEc

- AGPE01.03 Apply scientific principle and processes when planning and conducting natural resource management activities to determine the need, feasibility and application of logical, reasoned solutions to natural resource system problems and issues.

AFNR Cluster Skills

- CS.06. Analyze the interaction among AFNR systems in the production, processing and management of food, fiber and fuel and the sustainable use of natural resources.

Common Core – Reading: Informational Text

- CCSS.ELA-Literacy.RI.9-10.3 Analyze how the author unfolds an analysis or series of ideas or events, including the order in which the points are made, how they are introduced and developed, and the connections that are drawn between them.

Common Core – Speaking and Listening

- CCSS.ELA-Literacy.SL.9-10.1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

Common Core – Science & Technical Subjects

- CCSS.ELA-Literacy.RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- CCSS.ELA-Literacy.RST.11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- CCSS.ELA-Literacy.RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- CCSS.ELA-Literacy.RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
- CCSS.ELA-Literacy.RST.9.10.9 Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Common Core – Literacy in Science & Technical Subjects: Writing

- CCSS.ELA-Literacy.WHST.9.10.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- CCSS.ELA-Literacy.WHST.9.10.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- CCSS.ELA-Literacy.WHST.9.10.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- CCSS.ELA-Literacy.WHST.9.10.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
- CCSS.ELA-Literacy.WHST.9.10.9 Draw evidence from informational texts to support analysis, reflection, and research.

Next Generation Science

- HS-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- HS-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
- HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Green/Sustainability Knowledge and Skill Statements

- AFNR Career Cluster, Statement 1 Apply understanding of ecosystems and systems thinking to the management of natural resources to maximize the health and productivity of the environment, agriculture, communities, and society.

AFNR Career Ready Practices

- CRP.02. Apply appropriate academic and technical skills. Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive.
- CRP.04. Communicate clearly, effectively, and with reason. Career-ready individuals communicate thoughts, ideas and action plans with clarity, whether using written, verbal and/or visual methods.
- CRP.06. Demonstrate creativity and innovation. Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization.
- CRP.07. Employ valid and reliable research strategies. Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies.
- CRP.08. Utilize critical thinking to make sense of problems and persevere in solving them. Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem.

Partnership for 21st Century Skills

- Critical Thinking and Problem Solving
- Information Literacy
- Information, Communications, and Technology Literacy
- Productivity and Accountability
- Think Creatively

LESSON PLAN:

1. *Bell Ringer:* Have students list three reasons why they either like or dislike mushrooms.
2. *Introduction:* Agriculture often gives us the opportunity to discover and test new ways to use something that seems pretty common. Today, we will learn how one student is using mushrooms to solve a problem at her home.
3. *Activity:*
 - a. Each student needs a copy of the worksheet "My-Celi-What?" Have students complete the worksheet as they watch the video "Mycelium SAE | Michaela Carmichael," available at <https://vimeo.com/342621734>. When students are done, have a class discussion about mycelium. Determine if students were surprised it could filter pollutants from waste, and discuss what characteristics of mycelium and mushrooms might make this possible.
 - b. Students will need technology access so they can read two articles online (see the Resources/References section), or the articles can be printed ahead of time. (The article from *National Geographic* also has a summary video that shows students what the article is discussing.) Give each student a copy of the "Fungus to the Rescue!" worksheet. Students will summarize the two articles while specifically highlighting the potential innovative uses for fungi. After they have completed Part 1, they will identify one use that interests them most and will use a creative method of their choice to share the innovative way the fungi are being used, a potential world problem it could help solve and why it stood out to them. Use the "Fungi Innovation Creative Project Rubric" to assess student work for Part 2 of the worksheet.
4. *Follow-up:* Have students share their creative pieces with the class and discuss the various potential uses for fungi.
5. *Optional – Extended Learning Opportunities (Not factored into time requirement):*
 - a. This should take 30 minutes.
 - b. Growing shitake mushrooms doesn't require much space. All one needs is a place where some small logs can be placed that is cool and shady. Have students research how to grow shitake mushrooms and how they could potentially sell them to local stores and people.
6. *Exit Ticket:* Have students respond to the following prompt on their own paper: Michaela learned new skills, such as identifying mushrooms, through her SAE. What skills have you gained from your SAE? (If you don't have an SAE, what skills could you gain from an SAE in the future?)

NAME: _____

Aligned to the following standards:
NRS.02; FFA.PL-A; FFA.PG-J; AG-NR2; AGPE01.03; CS.06; CCSS.RI.9-10.3; CCSS.SL.9-10.1; CCSS.RST.11-12.1; CCSS.RST.11-12.2; CCSS.RST.11-12.7; CCSS.RST.11-12.8; CCSS.RST.9.10.9; CCSS.WHST.9.10.2; CCSS.WHST.9.10.4; CCSS.WHST.9.10.7; CCSS.WHST.9.10.9; MP5; HS-ESS3-1; HS-ESS3-2; HS-ESS3-4; AFNR Career Cluster, Statement 1; CRP.02; CPR.04; CRP.06; CRP.07; CRP.08

My-Celi-What?

DIRECTIONS:

Complete the questions below as you watch the video "Mycelium SAE | Michaela Carmichael," available at <https://vimeo.com/342621734>.



Why did Michaela start this SAE?



What is mycelium?

How does mycelium filter the wastewater?

What steps did Michaela take to implement her SAE?



What pollutants did Michaela identify?

- A. E. coli
- B. Coliform
- C. Heavy metals
- D. All of the above

What career does Michaela hope to have?

How will her SAE help her in her future career?

NAME: _____

Fungus to the Rescue!

Aligned to the following standards:
NRS.02; FFA.PL-A; FFA.PG-J; AG-NR2; AGPE01.03; CS.06; CCSS.RI.9-10.3; CCSS.SL.9-10.1; CCSS.RST.11-12.1; CCSS.RST.11-12.2; CCSS.RST.11-12.7; CCSS.RST.11-12.8; CCSS.RST.9.10.9; CCSS.WHST.9.10.2; CCSS.WHST.9.10.4; CCSS.WHST.9.10.7; CCSS.WHST.9.10.9; MP5; HS-ESS3-1; HS-ESS3-2; HS-ESS3-4; AFNR Career Cluster, Statement 1; CRP.02; CPR.04; CRP.06; CRP.07; CRP.08

DIRECTIONS:

Mycelium isn't only useful for filtering water. Complete the following activities to learn more about fungi and its many potential uses.

Part 1

DIRECTIONS:

Read both of the following short articles. (You can also watch the *National Geographic* summary video rather than read the article.) Write a paragraph summarizing each article and highlighting the uses of the fungi.

- "Nine Ways Mushrooms Could Drastically Improve the World," <https://blog.ted.com/9-ways-mushrooms-could-drastically-improve-the-world/>
- "Surprising New Uses for Mushrooms, From Houses to Packaging," <https://www.nationalgeographic.com/news/2016/07/mushroom-surprising-uses-building-material-medicines-fungi/>

Summary of "Nine Ways Mushrooms Could Drastically Improve the World"	Summary of "Surprising New Uses for Mushrooms, From Houses to Packaging"



NAME: _____

Part 2

DIRECTIONS:

Identify the fungi use that you found most interesting. In the space below, share the innovative way the fungi are being used, a potential world problem it could help solve and why it stood out to you the most. You can share this information in any format you choose. You can write a short paper or speech, draw a picture, create a video storyboard or comic strip, etc.

Aligned to the following standards:

NRS.02; FFA.PL-A; FFA.PG-J; AG-NR2; AGPE01.03; CS.06; CCSS.RI.9-10.3; CCSS.SL.9-10.1; CCSS.RST.11-12.1; CCSS.RST.11-12.2; CCSS.RST.11-12.7; CCSS.RST.11-12.8; CCSS.RST.9.10.9; CCSS.WHST.9.10.2; CCSS.WHST.9.10.4; CCSS.WHST.9.10.7; CCSS.WHST.9.10.9; MP5; HS-ESS3-1; HS-ESS3-2; HS-ESS3-4; AFNR Career Cluster, Statement 1; CRP.02; CPR.04; CRP.06; CRP.07; CRP.08



NAME: _____

Aligned to the following standards:
NRS.02; FFA.PL-A; FFA.PG-J; AG-NR2; AGPE01.03; CS.06; CCSS.RI.9-10.3; CCSS.SL.9-10.1; CCSS.RST.11-12.1; CCSS.RST.11-12.2; CCSS.RST.11-12.7; CCSS.RST.11-12.8; CCSS.RST.9.10.9; CCSS.WHST.9.10.2; CCSS.WHST.9.10.4; CCSS.WHST.9.10.7; CCSS.WHST.9.10.9; MP5; HS-ESS3-1; HS-ESS3-2; HS-ESS3-4; AFNR Career Cluster, Statement 1; CRP.02; CPR.04; CRP.06; CRP.07; CRP.08

KEY: My-Celi-What?

DIRECTIONS:

Complete the questions below as you watch the video "Mycelium SAE | Michaela Carmichael," available at <https://vimeo.com/342621734>.



Why did Michaela start this SAE?

She noticed that the wastewater from her pigs was causing algae growth and damaging the grass.



What is mycelium?

It is the nervous system of a mushroom.

How does mycelium filter the wastewater?

The mycelium becomes implanted into any kind of forest material, and it continues to grow and interconnect. It is the biggest organism in the world. It is densely packed, so as the water filters through, the mycelium filters it and the wastewater comes out with the pollutants removed.

What steps did Michaela take to implement her SAE?



She tested the water to determine what type of pollutants were in the wastewater.



She then identified what types of mushrooms would target those specific pollutants.



Finally, she inoculated the burlap sacks with the mycelium and placed the bags where the wastewater would filter through them.

What pollutants did Michaela identify?

- A. E. coli
- B. Coliform
- C. Heavy metals
- D. All of the above

What career does Michaela hope to have?

A veterinary scientist

How will her SAE help her in her future career?
She'll be better able to inform the community about how to ensure not only animal health but also environmental health.

NAME: _____

Aligned to the following standards:
NRS.02; FFA.PL-A; FFA.PG-J; AG-NR2; AGPE01.03; CS.06; CCSS.RI.9-10.3;
CCSS.SL.9-10.1; CCSS.RST.11-12.1; CCSS.RST.11-12.2; CCSS.RST.11-12.7;
CCSS.RST.11-12.8; CCSS.RST.9.10.9; CCSS.WHST.9.10.2; CCSS.WHST.9.10.4;
CCSS.WHST.9.10.7; CCSS.WHST.9.10.9; MP5; HS-ESS3-1; HS-ESS3-2; HS-ESS3-4;
AFNR Career Cluster, Statement 1; CRP.02; CPR.04; CRP.06; CRP.07; CRP.08

KEY: Fungus to the Rescue!

DIRECTIONS:

Mycelium isn't only useful for filtering water. Complete the following activities to learn more about fungi and its many potential uses.

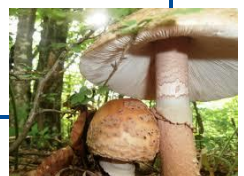
Part 1

DIRECTIONS:

Read both of the following short articles. (You can also watch the *National Geographic* summary video rather than read the article.) Write a paragraph summarizing each article and highlighting the uses of the fungi.

- "Nine Ways Mushrooms Could Drastically Improve the World," <https://blog.ted.com/9-ways-mushrooms-could-drastically-improve-the-world/>
- "Surprising New Uses for Mushrooms, From Houses to Packaging," <https://www.nationalgeographic.com/news/2016/07/mushroom-surprising-uses-building-material-medicines-fungi/>

Summary of "Nine Ways Mushrooms Could Drastically Improve the World"	Summary of "Surprising New Uses for Mushrooms, From Houses to Packaging"
Summaries will vary, but these are the uses students should highlight in their summaries: • Help the coming phosphorus crisis by improving plant's ability to absorb it • Clean polluted soil • Treat smallpox and other poxviruses • Treat and even cure the flu • Kill insects • "Life Box," a cardboard box is made with mycorrhizal, then soil, tree seeds and water are added to potentially grow a forest • Make fuel (a mycelium-based ethanol) • Mushroom burial suit to remove toxins from bodies and speed composition • Replacement for Styrofoam	Summaries will vary, but these are the uses students should highlight in their summaries: • Create building materials, such as a lightweight brick, a Styrofoam substitute, biodegradable packaging, particleboard and wall tiles • Testing is being done to determine its strength, fire resistance and insulation power to determine if complete structures can be built with the fungi • Could help doctors fight superbugs (antimicrobial- and antibiotic-resistant bacteria)



NAME: _____

Fungi Innovation Creative Project Rubric

	20–16 Points	15–11 Points	10–6 Points	5–0 Points
Content	Covers topic in depth with details and examples; subject knowledge is excellent; focuses on an important concept	Includes essential knowledge about the topic; subject knowledge is good; focuses on an important concept	Includes essential information about the topic but there are one or two factual errors; focus may be unclear	Content is minimal OR there are several factual errors; focus is unclear.
Effort	Product shows a great amount of time spent and very careful, neat work.	Product shows a good amount of time spent and careful, neat work.	Product shows some amount of time spent and is slightly lacking neatness.	Product shows a minimal amount of time spent and is lacking neatness.
Originality and Creativity	Product shows a large amount of original thought and critical thinking. Work is creative and inventive.	Product shows some original thought and critical thinking. Work shows new ideas and insights.	A few original touches enhance the project to show some understanding of the material.	Shows little creativity, originality and/or effort in understanding the material or following project directions
Appearance (for artistic products) and/or Neatness and Grammar (for written products)	Makes excellent use of color, graphics, effects, etc. to enhance the product Exceptionally neat in design, writing and layout with no grammatical or mechanical mistakes	Makes good use of color, graphics, effects, etc. to enhance the presentation Neat in design, writing and layout with a few grammatical/mechanical mistakes, which are not distracting	Makes some use of color, graphics, effects, etc. to enhance the presentation, but occasionally these detract from the content. Acceptably neat but may be messy at times and/or show lack of organization with several grammatical/mechanical mistakes, which are distracting	Use of minimal color, graphics, effects, etc. to enhance the presentation, which often detract from the content Distractingly messy; does not show pride in work; has many grammatical or mechanical mistakes throughout the project; clearly not proofread
Overall Effectiveness and Completion	Project is engagingly organized and presents material that is captivating for the intended audience.	Project is somewhat organized, complete and holds the attention of the intended audience.	Project is disorganized and incomplete at times and is somewhat able to hold the attention of the intended audience.	Project is incomplete and not easy to follow.