THE FANTASTIC FUNGI OF THE LAST OF US

Overview:
In this additional **Fabulous Fungi** resource, students will learn about Cordyceps fungus, the inspiration for *The Last of Us*, and have a go at stopping the spread of a fungal infection. They will also have a chance to discuss the role of media and culture in spreading information about science.

**Learning Objectives:**

**Experimental skills and investigations:**
- Ask questions and develop a line of enquiry based on observations of the real world, alongside prior knowledge and experience
- Make predictions using scientific knowledge and understanding
- Select, plan, and carry out the most appropriate types of scientific enquiries to test predictions, including identifying independent, dependent and control variables
- Use appropriate techniques, apparatus, and materials during laboratory work, paying attention to health and safety
- Make and record observations and measurements using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements

**Analysis and evaluation:**
- Present reasoned explanations, including explaining data in relation to predictions and hypotheses

**Resources:**
- Fresh yeast in 2g blocks
- 3 Agar plates
- Pen to label
- Inoculating loop
- Beaker
- Fungal treatment cream, e.g. Clotrimazole for thrush
- Stirrer
- 100ml distilled water
- Bunsen burner
- Tweezers

**Make sure to check out the rest of our resources on our website**
**WHAT IS CORDYCEPS?**

Cordyceps (often also referring to the genus *Ophiocordyceps*) is a group of fungi containing about 400 different species. Many species feed on insects in a way so gruesome one species, *Ophiocordyceps unilateralis*, is known as the “zombie-ant fungus”! Once spores from the fungus land on an insect, it invades the insect’s body and takes control of their muscles. It forces the insect to climb higher and bite onto a leaf. The fungus kills the insect, and breaks through its body to release spores. Another species, *O. sinensis*, infects the caterpillars of the ghost moth. This fungus is believed to have anti-inflammatory and anti-cancer properties. In 2019 it cost $140,000 per pound! Unfortunately overcollection for this reason and climate change are causing it to decline. Cordyceps was *featured in Planet Earth*, and it inspired game creator Neil Druckmann to make the video game *The Last of Us*, where due to climate change the fungus evolves to prey on humans. It has now been made into a TV show.

1: Climate change can cause the spread of fungal diseases

**A: Fact!** Due to climate change, some fungi are evolving to adapt to warmer temperatures. This means, as a side-effect, that they can better tolerate the high body temperatures of humans. Doctors have already reported spikes of *Candida* and *Aspergillus* infections in hospitals. However, climate change is also harming species of fungi that are important to ecosystem function.

2: Fungal diseases are difficult to treat and create vaccines for

**A: Fact!** As fungi adapt so quickly, they can quickly become immune to anti-fungal medications. Currently, no vaccines for fungal infections exist. Fungi are more closely related to animals than plants, so their cells are similar to ours. This means making effective treatments very difficult.

3: Cordyceps can infect humans

**A: Fiction!** Don’t worry, a zombie-like fungal infection in humans is extremely unlikely, humans and insects are just too different! Cordyceps doesn’t even grow inside the brain! There are fungi that live on and in our bodies, and most of the time they don’t cause us any issues - unless our immune system is compromised. Fungal infections also rarely spread between people.
FABULOUS FUNGI
While it’s fun to imagine scary fungi, let’s take a look at why they’re actually heroes!

The life-saving drug Penicillin is made from fungus

Fungi might be able to break down plastic and be an alternative to harmful materials

Fungi can be delicious and are used to make alternatives to meat

Some fungi are deadly - containing poisonous chemicals. They sometimes have dramatic names like death cap or destroying angel

Fungi give us bread, beer, and cheese!

Without fungi, many plants wouldn't be able to grow!

The “wood wide web” is made up of fungi underground! It connects trees and other plants, allowing them to talk to each other! Fungi can also talk to each other using electrical signals

Some fungi are bioluminescent - they glow in the dark! By placing these genes into trees we could have green street lighting!

The largest organism on Earth is a honey fungus covering almost 4 square miles!

“Zombie-ant fungus” was first described by the British naturalist Alfred Russel Wallace, co-discoverer of evolution, in 1859

WHAT OTHER FANTASTIC FUNGI FACTS CAN YOU FIND?
LET'S DISCUSS...

- Do you think stories like *The Last of Us* can be a good way to learn about different scientific topics? Why or why not? Maybe compare to other stories you know that have scientific topics, like *Jaws* or *Jurassic Park*.
- If you wanted to make a game or TV show about how cool fungi can be and how they can help us, how would you do it?
- Do you think *The Last of Us* and other sci-fi stories are a good way to bring the threat of climate change to general audiences?
- How could vital processes like decomposition and plant growth be affected if fungi suffered due to climate change?

STOP A FUNGAL PANDEMIC: ACTIVITY

1. Have 3 Petri dishes labelled for the students to use as follows:
2. Dish 1: left with nothing on; Dish 2: a line of antifungal cream down the middle of the plate; Dish 3: completely covered with antifungal cream.
3. The dishes should also be labelled with the students’ name, date, and how much cream was used (if any).
4. Place the 2g of fresh yeast into the beaker, add the water and stir. Place the beaker onto the Bunsen burner for roughly 5 minutes or until it is gently simmering to sterilise.
5. Once the yeast has cooled down, dip the inoculating loop into the mixture and smear on the plate. Smear one side of the line of cream in Dish 2. Sterilise between dishes or use a new loop.
6. Once all 3 dishes have been filled, place them in the incubator at 40 degrees and leave for 5 days.
7. Observe and record results appropriately, using the scientific methods to hypothesise, plan, gather evidence, analyse and interpret data and draw conclusions.

Share your investigation outcomes by relating your conclusions to real-world issues:

- What does your evidence indicate about how fungal growth can be accelerated, e.g. for enabling populations to have healthier lifestyles – e.g. penicillin becoming commercialised for world-wide health needs?
- What are the perfect conditions for fungus to grow?
- What does your evidence indicate about how fungal growth can be slowed down, e.g. limiting the spread of fungal infections?
**ADDITIONAL RESOURCES**

- How Fungi Shaped Our World and Could Save It - YouTube video
- Cordyceps: Attack of the Killer Fungi - Planet Earth - YouTube video
- How to Spot Fungi: Kew Gardens - YouTube video
- The wonderful world of fungi - Kew Gardens articles
- Fungi - links to the scientific fungi resources and databases at Kew Gardens
- Fungi ID - The Wildlife Trusts
- Creating the Clickers: The Last of Us behind the scenes - YouTube video about how the people behind the TV show were inspired by real fungi to create the Infected. Lots of cool information about practical effects but be warned: it is a bit spooky!

Make sure to check out our Fabulous Fungi resources created with the Great Science Share for Schools - learn about what fungi are, how to identify some common UK species, and why they’re so important

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