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Mushroom surprise

David Moore
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Fungi are neither bacteria nor plants. David Moore dispels some myths and propagates inspiration

"Hands up those who think fungi are plants," asked a pupil at one of our workshops last year. About 15 out of the 170 pupils on a summer school for Year 10 did so; but 150 hands went up when we asked "how many think fungi are bacteria?".

We're used to battling against the mistaken idea that fungi are plants, but it was a shock to find that so many GCSE pupils believe that fungi are bacteria. It's a bigger error than bringing them up to believe that whales are fish; at least whales and fish are in the same biological kingdom.

The problem seems to result from two faults with the national curriculum.

One is that the mention of fungi is restricted almost exclusively to them as decomposers in nutrient recycling. Unfortunately, curriculum specification references to "decomposers" always link fungi and bacteria, with phrases such as "Describe the role of decomposers, such as bacteria and fungi" (OCR GCSE biology and science double award A); "When putrefying (decay) bacteria and fungi break down the waste products from dead animals and plants ammonium compounds are produced" (AQA biology (human) and science double award (co-ordinated)); "Decomposers: The role of bacteria and fungi" (CCEA GCSE science: biology and single award - modular); "Soil bacteria and fungi act as decomposers" (WJEC science biology and double award). This consistent linkage creates a misunderstanding in the minds of many pupils.

The national curriculum does nothing to dispel this because its second, and fundamental, fault is that it ignores the fungal kingdom. Pupils are ignorant about fungi because the national curriculum is ignorant about fungi.

Does it matter? Definitely. Practically, because activities of fungi are crucially important in our everyday lives. Educationally, because fungi form what is arguably the largest kingdom of higher organisms on the planet.

Fungi are not bacteria, because fungi are eukaryotes, with the complex cell structures and abilities to make tissues and organs that we expect of higher organisms. Fungi are a kingdom of higher organisms alongside animals and plants, and awareness and understanding of them ought to be an essential educational goal for even the youngest children since we encounter fungi and their products every day. Teaching biology without teaching about fungi is like trying to teach reading with only two-thirds of the alphabet.

Currently, little fungal biology appears in the national curriculum, which only compares animals with plants. But fungi are not plants; they are so different from plants that no amount of plant biology will give an adequate understanding of any fungus. Similarly, although more closely related, in molecular terms, to animals than to plants, fungi are not animals and a deficiency of fungal biology cannot be compensated by more zoology. Yet none of the GCSE specifications (not even those for GCSE biology) state that fungi are not plants, nor do they state that fungi are higher organisms/eukaryotes.

Kingdom fungi needs to be portrayed as a major eukaryotic kingdom; fungi have their own unique cell biology, biology and lifestyle, and play a crucial role in every ecosystem and food web.

Fungi are not just mushrooms, yeast and moulds. Fungi (known as anaerobic chytrids) digest the grass eaten by cows (and all other herbivores) and by so doing indirectly provide the milk for our breakfast, the steak for dinner and the leather for shoes.

Fungi make plant roots work (more than 95 per cent of all terrestrial plants depend on mycorrhizal fungi) and, even leaving aside the effect of this on the evolution of land plants, by so doing mycorrhizal fungi help provide the corn for

our cornflakes, oats for our porridge, potatoes, lettuce, cabbage, peas, celery, herbs, spices, cotton, flax, and timber.

And even oxygen for our breath.

The characteristic fungal lifestyle is the secretion of enzymes into their environment to digest nutrients externally; we harness this feature in our biotechnology to produce enzymes to start our cheese-making, clarify our fruit juices, distress denim for "stone washed" jeans, and, conversely, provide fabric conditioners to repair day-to-day damage to our clothes in the weekly wash.

Fungi also produce a range of compounds to compete with other organisms in their ecosystem; when we harness these for our own purposes we create products like cyclosporin, which prevents organ rejection by suppressing the immune response in transplant patients, the statins, which keep so many people alive by controlling cholesterol levels, and even today's most widely used agricultural fungicides, the strobilurins.

None of these interesting facts appear in any of the current GCSE specifications (not even those for 2006). Instead, we find the same stories about yeast fermentations (bread and alcohol) and the discovery of penicillin. We don't underestimate their importance, but penicillin was discovered in 1928 and industrialised in the mid-1940s.

What can we do about it? Lobbying educational advisors and examining boards hasn't got us far. Indeed, we have a letter from a science advisor for the QCA (March 9, 2005) that states: "I suspect that one reason why many of the interesting points you raise in your letter are not taught or assessed is that teachers and examiners are not aware of them themselves." It appears that it's not only children who need educating.

The British Mycological Society has devised resources to use within the current national curriculum. These have all been successfully classroom-tested with groups of pupils ranging from Year 8 to Year 11.

Individually, they provide for stand-alone lessons: pupil understanding and awareness of fungi can be improved with as little as one to five hours of "fungus-oriented" lessons.

So, if you think fungi are bacteria: you're wrong.

David Moore, Stephanie Roberts, Charlotte Quinn, Ruth Townley and Kelly Fryer make up the Faculty of Life Science's 2005 microbiology curriculum development team at Manchester University; www.fungi4schools.org

Lessons in fungi

Cite fungi as a distinct group of organisms different from animals and plants: Key stage 2/science 2: Distinguish between animals, plants and fungi (eukaryotes) and bacteria (prokaryotes).

Key stage 3/science 2 and key stage 4: emphasise differences between animal, plant and fungal cells.

Key stage 4 life processes and living things 1a & b: differences in nutrition characterise the three eukaryotic kingdoms.

Key stage 4 life processes and living things 5d & e: fungi are major contributors to food chains and energy transfer in ecosystems

resources

Work-sheets and classroom materials can be downloaded free from: www.fungi4schools.org'How the Mushroom Got its Spots' is a guide to fungi: www.bbsrc.ac.uk/society/schools/resources/Welcome.htmlwww.fungi4schools.orgThe Fungi Name Trail is a key to common fungi in a foldout chart.Field Studies Council: www.field-studies-council.org/publications 'Fungus Fred goes Foraying' is a story book for seven to 11 year-olds.

These resources will be available from the British Mycological Society on stand C10 at the Association for Science Education conference exhibition, January 5-7