

British Mycological Society

A review of fungi in the curriculum

Education specialists on the British Mycological Society's Fungal Education and Outreach Committee have reviewed the main UK examination boards and the National Curriculum for Science (2023) for inclusion of fungi-related topics in secondary education.

The review specifically highlights missed opportunities to integrate fungi and fungal biology more deeply into the curriculum, particularly at Key Stage 3 (KS3, Years 7-9) and Key Stage 4 (GCSE/IGCSE, Years 10-11).

Key findings of the review

- For KS3, fungi are largely absent from the curriculum despite their relevance in topics such as cells, nutrition, respiration, reproduction, and ecosystem functioning. Suggestions include introducing fungal biology in terms of modes of reproduction, and their ecological roles (e.g. decomposers and bioremediation).
- At KS4, fungi are briefly mentioned in the curricula of some exam boards. The primary focus is on fungi as pathogens, in bioenergetics (anaerobic respiration in yeast), and ecosystems (decomposers). Opportunities for curriculum expansion could include consideration of a broader range of fungal pathogens, fungal biodiversity, fungal roles in nutrient cycling, and examples of fungal adaptations to environmental changes (including climate change).
- Looking at A-level and IB (Years 12-13), some secondary curricula touch on fungal topics such as cell structure, biodiversity, respiration, and biotechnology but, again, this could be expanded further to include coverage of fungal genetics, evolutionary significance, ecological roles, and potential for biotechnological applications (e.g. Quorn production, antibiotic discovery).

Recommendations

This review emphasises the educational potential of fungi to explore various core scientific concepts within biology, advocating for a more comprehensive integration of fungal biology into different elements of the curriculum.

We would encourage teachers to consider using easily available fungal materials to illustrate key concepts in all areas of biology. Further consideration should be given to the possibility of undertaking more fieldwork in the autumn term when the fungi are most often visible.

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TABLE 1: Key Stage 3 (Years 7, 8 and 9)

Body / Board	Number of times the words yeast, fungi, fungus or fungal are included	Topics where fungi can be included	Opportunities to stretch curriculum to include fungi
NC	0	Cells and organisation	Include yeast, hyphae and mycelium
NC	0	Nutrition and digestion	Fungal nutrition
NC	0	Reproduction	Asexual reproduction in yeasts. Sexual reproduction of mycelial fungi. Wind and insect-mediated spore dispersal.
NC	0	Cellular respiration	Anaerobic respiration in yeast
NC	0	Relationships in an ecosystem	Role of fungi as decomposers in food chains and food webs. Interdependence of plants, animals, and fungi. Mycorrhizal connections. Uses of fungi to tackle pollution through bioremediation. Importance of fungal reproduction for food security.
NC	0	Genetics and evolution	Differences between closely related fungal species. Importance of fungal biodiversity research and fungal biodiversity conservation. Fungal adaptation to environmental change. Fungal symbiosis and its role in evolution.

NC = National Curriculum for Science

TABLE 2: Key Stage 4 GCSE / IGCSE (Years 10 and 11)

Body / Board	Number of times the words yeast, fungi, fungus or fungal are included = 6	Currently taught	Opportunities to stretch curriculum to include fungi
NC, AQA Edexcel CCEA OCR 21C OCR G WJEC	1/ Living organisms include fungi. 2/ Cell biology of animals, plants and microorganisms (bacteria, fungi and protocists)	Cell structure of yeast	Cell biology of hyphal fungi including hyphal tips, branching, anastomosis and mycelium. Potential inclusion of mouldy oranges activity. Fungal microscopy and staining
NC, AQA Edexcel CCEA OCR 21C OCR G WJEC	3/ Health disease and medicines (bacteria, viruses and fungi as pathogens to plants and animals). 4/ Reasons antibiotics work against bacteria but not viruses, fungi or protists.	Examples of fungal pathogens ringworm, athletes' foot. Use of petri dishes to culture microorganisms. Impact of rusts and smuts on crops eg. Black sigatoka of banana. Potato blight (although not fungal). History of discovery of penicillin. Problem of antibiotic resistance. Impact of historic diseases.	Other human fungal pathogens. Potential link with history re potato blight (not fungal) and black death (not fungal). Potential fungal link with history of WW1 re antibiotic discovery regarding story of Alexander Flemming and potential inclusion of mouldy oranges activity. Ongoing work to find new antibiotics from the diversity of fungi and their interactions.
NC, AQA Edexcel CCEA OCR 21C OCR G WJEC	5/ Ecosystems: (role of decomposers such as bacteria and fungi in the breakdown of organic material	Nutrient cycling, Carbon and Nitrogen cycles.	Wood decay fungi and other saprophytic fungal decomposers. Mycorrhizae and plant mineral acquisition/. Phosphate cycling. Importance of cycling of other minerals e.g. Mg, K, particularly for plants.

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Table 2 continued

NC, AQA Edexcel CCEA OCR 21C OCR G WJEC		Impact of environmental change on biodiversity and the need for biodiversity conservation	Examination of combined effects of anthropogenic climate change and habitat fragmentation on fungi. Example of <i>Favolaschia calocera</i> increasing its range North and South of the tropics
NC, AQA Edexcel CCEA OCR G WJEC		importance of interactions between organisms in an ecosystem	Role of mutual symbiosis using mycorrhizal relationships and lichenisation as examples.
NC, AQA Edexcel CCEA OCR 21C OCR G WJEC		effects of interspecific and intraspecific competition, predation, parasitism, mutualism and commensalism	Role of mycorrhizae Role of mutualism in lichenisation and importance of lichens Lichens as indicator species of air quality
NC, AQA Edexcel CCEA OCR 21C OCR G WJEC	6/ Bioenergetics – anaerobic respiration in yeast	Anaerobic respiration in animals, plants and microorganisms such as bacteria and yeast	Anaerobic respiration and fermentation in yeast.
NC, AQA Edexcel CCEA OCR G WJEC		Evidence for evolution: Evolution of antibiotic resistance and insecticide resistance.	Another example of evolution being rapid rise of fungicide resistance.

Table 3: A-level / IB (Years 12 and 13)

Body / Board	Topics	Currently taught	Opportunities to stretch curriculum for greater inclusion of fungi
AQA	Biological molecules	Large bio-polymers and their monomers.	chitin structure in cell walls of yeasts and other fungi.
AQA	Cell Structure	Yeast cell ultrastructure Including cell wall.	Hyphal fungi, their variation and their reproduction, the structure of hyphal cell walls and their variation.
AQA	Energy transfers in and between organisms	Photosynthates are consumed by bacteria, animals and fungi.	Fungi being evolutionarily closer to animals than they are to plants.
AQA OCR	Cell Cycle and Mitosis	Gene expression during cell cycle.	Chromosomes of yeasts during mitosis. Apoptosis and anti-oncogenes History of discovery of cell cycle stages in yeast.
AQA	Reproduction	Asexual reproduction of yeast.	Sexual reproduction of mycelial fungi.
OCR WJEC Eduqas CIE	Classification	5 kingdoms including the fungal kingdom (<i>should be 6</i>).	Close evolutionary relatedness between fungi and animals. Eukaryotic Opisthokonts.
AQA	Biodiversity	Genetic variation & Species richness	Yeast mutants and their link to history of cell cycle. Genetic variation within fungi. Difference between number of already discovered fungal species and their estimated biodiversity. Compare rates of discovery of new fungal species with other taxonomic groups. Classes attending Autumn fungal forays perhaps with BMS local fungal groups. Collecting data on richness and abundance of fungi / lichen to calculate Simpson's diversity index comparing different local sites in the Autumn term.

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Table 3 continued

AQA	Ecological succession	Plant colonisation succession towards climax community	Succession of fungal decomposition looking at wood decay.
AQA	Biodiversity conservation	In situ and ex situ methods	Consideration of value of wood decay, dead wood, and provision of nesting sites and refuges for many species of animal. Also the nutritional value of mycelium for many invertebrates at base of food web.
AQA OCR Edexcel WJEC Eduqas CIE	Mathematical skills	Using a logarithmic scale for the growth rate of a microorganism such as yeast	Measurement of growth rate of a cultured mycelium.
OCR WJEC Eduqas CIE	Research skills	Investigation into respiration rate of <i>Saccharomyces cerevisiae</i>	Consideration of the large number of other species of yeasts, and that yeasts represent ways for mycelia to clone themselves through water borne transport and dispersal.
AQA	Nutrition / Digestion	Mammalian digestion of large biological molecules	Fungal digestion with exo-enzymes
WJEC Eduqas	Saprotrophic nutrition	saprotrophic nutrition involving the secretion of enzymes, external digestion of food substances followed by absorption of the products of digestion into the organism, e.g. fungi	Examination of wood decay fungi, potential fungal foray in the autumn, possible culturing of sulphur tuft (<i>Hypholoma fasciculare</i>) with wood blocks as food to see chord formation.
AQA	Transport	Mass transport in plants and animals	Mass transport in fungi via protoplasmic streaming, mycelial chords and mycelial fans.
OCR	Communicable disease	Black sigatoka (bananas) Athlete's foot (humans)	Corn smut <i>Ustilago maydis</i> - the ancient Mayan delicacy of Mexico. Other human pathogenic fungi including ringworm.
OCR	Genetic control of development	Cell differentiation, stem cells development, embryonic development, cell specialisation. Similar homeobox gene sequences between fungi, animals and plants.	Examination of a fungal homeobox gene sequence in comparison to those of animals and plants.
OCR	Biotechnology	Advantages and disadvantages of using microorganisms to make food for human consumption.	Biotechnology using fungi including: Composting systems to produce heat and soil. Fungal cultivation of wood-decay and non mycorrhizal species of soil <i>Agaricus sp.</i> Consideration of difficulties of cultivation of mycorrhizal species such as truffles and chanterelles. Examination of history and origin of cultivation of Quorn mycoprotein.
OCR WJEC Eduqas CIE	Respiration	Investigation into yeast respiration using aerobic and anaerobic conditions	Biological production of alcohols. Mycelial fungal respiration and production of the characteristic aromas of many mycelial fungi.
Edexcel	Anthropogenic climate change	Effects on biodiversity and migration as well as movement of biomes predicted in IPCC reports	Example of <i>Favolaschia calocera</i> increasing its range North and South of the tropics.

Compendium of current fungal educational websites and webpages

BBC Earth: [8 fantastic facts about fungi | BBC Earth](#)

BBC News: <https://www.bbc.co.uk/news/science-environment-45486844>

BBC Science Focus: [Fungi: Absolutely everything you need to know about these surprising lifeforms - BBC Science Focus Magazine](#)

BBC Studios: Cordyceps - attack of killer fungi with Sir David Attenborough: <https://www.youtube.com/watch?v=XuKjBIBBAL8>

BBC Studios: Timelapse fungi with Sir David Attenborough: <https://www.youtube.com/watch?v=puDkLFcCZyl>

BBC: [These fungi facts will blow your mind!](#) 🍄 📺 BBC - YouTube

BMS Secondary Education: [Secondary : British Mycological Society \(britmycolsoc.org.uk\)](#)

Fungi Perfecti: Paul Stammets <https://fungi.com/>

Kew Endeavour: School science resources projects and competitions: <https://endeavour.kew.org/challenge>

Kew Gardens: State of the World's Plants and Fungi: <https://www.kew.org/science/state-of-the-worlds-plants-and-fungi>

Kew Gardens: [What in earth? Understanding what fungi really are | Kew](#)

Linnean Society: [Discover More: Fungi | The Linnean Society](#)

Linnean Society: <https://www.linnean.org/learning/fabulous-fungi>

Microbiology society: [Fungi | What is microbiology? | Microbiology Society](#)

National Trust: [Facts about fungi | National Trust | National Trust](#)

Netflix clip: ants and fungi with Sir David Attenborough: <https://www.youtube.com/watch?v=ROQrbWkV4HI>

New Forest National Park: [Fungi - New Forest National Park Authority \(newforestnpa.gov.uk\)](#)

New Scientist: [Fungi news, articles and features | New Scientist](#)

Plantlife: <https://www.plantlife.org.uk/>

RHS: [10 fun facts about fungi / RHS Gardening](#)

The Guardian: [Fungi | Science | The Guardian](#)

The Wildlife Trusts: [Fungi | The Wildlife Trusts](#)

Trees for Life: [Fungi in Scotland | Trees for Life](#)

UK Fungus Day: <https://www.ukfungusday.co.uk/>

United Nations: [Benefits of Fungi for the Environment and Humans \(decadeonrestoration.org\)](#)

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University of Sheffield: [Fungi stores a third of carbon from fossil fuel emissions and could be essential to reaching net zero | News | The University of Sheffield](#)

WHO: [WHO releases first-ever list of health-threatening fungi](#)

Woodland Trust: [Fungi and Lichens - Woodland Trust](#)