

# Fighting Fungi

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## Abstract

Fungi are one of the major Kingdoms on this planet which, like all other life forms, 'adapt to survive'. The human-fungus interaction is vast, with mycology being a major subset of microbiology and infectious diseases. This article attempts to be a neutral perspective: it not only describes how we fight off fungal infections by preventive and curative methods, but also how the fungi fight for survival in the available habitat that is largely controlled by humans. Two diseases are focused on, ringworm and mucormycosis. While the former is a troublemaker since time immemorial, mucormycosis has recently taken the limelight as an opportunistic infection in COVID-19 patients. The direct increase in the population of immunocompromised individuals in this pandemic may be due to an intensive use of steroids for treatment. The article also emphasises the need for early detection by a comprehensive diagnostic intervention (histopathology, direct microscopic examination, culture, (1,3)- $\beta$ -D-glucan, galactomannan, and PCR-based assays) to ensure effective treatments and also highlights the preventive measures which can be taken to save lives. It is prudent to know the risk factors, the types of invasive mycosis, the strengths and limitations of diagnostic methods, clinical settings, and the need for standard or individualized treatment for mucormycosis in COVID-19 patients.

**Keywords:** Fungus, tinea, ringworm, mucormycetes, mucormycosis, black fungus

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## Introduction

**F**ungi (Singular: fungus) are any of a kingdom (Fungi) of saprophytic and parasitic spore-producing eukaryotic (typically filamentous) organisms, formerly classified as plants that lack chlorophyll and include molds, rusts, mildews, smuts, mushrooms, and yeasts.<sup>[1]</sup> They are a unique kingdom whose members range from the microscopic Mucormycetes to the progenitor of antibiotics Penicillium. Like most organisms on this planet, they too follow the principle 'adapt to survive'. Naturally, when these fighting fungi interact with other species, including humans, they follow their basic survival instinct and find ways to grow. As this interaction is hampering our quality of life, and can even lead to death, we interpret this as disease.

## Tinea

Here, at our Urban Health Centre, the commonest fungal infection seen is "ringworm" or Tinea. This is a misnomer as this fungus is clearly not a worm (Tinea; late Middle English: from Latin, 'worm'). The infection is called "ringworm" because the lesion is an itchy, red, circular rash.<sup>[2]</sup> This contagious condition spreads easily. Human to human spread by direct, skin-to-skin contact with an infected person is a common mode of spread. Animal to human spread is also known if the animal has ringworm. Petting or grooming dogs or cats can cause this, but it is also fairly common in cows. It's possible for ringworm to spread by contact with objects or surfaces that an infected person or animal has recently touched or rubbed against, such as clothing, towels, bedding and linens, combs, and brushes. In rare cases, ringworm can be spread to humans by contact with infected soil. Infection would most likely occur only from prolonged contact with highly infected soil.<sup>[3]</sup> This disease typically responds well to antifungal therapy, but must be taken religiously. The fight for survival of fungi is aided by the poor compliance to medication by the patients, who either forget to take treatment regularly, or stop it halfway once symptoms reduce, only for it to flare up again immediately after. This has caused resistance to the commonly used topical ointments like miconazole. In addition, the moist climate, overcrowding and poor general hygiene makes it easy for the fungus to spread in urban slums. Seeing entire families present with the pathognomonic ring-like rash is not uncommon. Hence, we not only provide medication, but also education about cleanliness, need for consistent treatment which may take weeks to months, as well as ways to prevent spread to others.

## Mucormycetes

While tinea is the irritating 'stray dog' of the town, mucormycetes is the 'wolf'. This mould is widely found in our environment in soil and decaying organic matter. It is a deadly fungus that can cause opportunistic infections in immunocompromised people who come in contact with the spores. This mould has come to the limelight this year as a deadly superinfection in COVID-19 patients, especially in diabetics or organ transplant recipients. The black lesions over the nose and mouth are the reason why the salutation "Black Fungus" has been given to this disease. Progressive disease leads to loss of vision, systemic organ involvement and altered consciousness. Intracranial spread of the disease indicates poor prognosis. While new information is continuously being gathered, the overall mortality rate in mucormycosis is 54%.<sup>[4]</sup> The theories for this surge are multiple: steroids compromising the immunity of patients, spores entering from water used in oxygen humidifiers, reuse of masks which have become damp... the list goes on. It is plausible that immune dysregulation and lung damage stemming from COVID-19 immunopathology facilitate superinfection with fungus in a way that is at least partially distinct from other respiratory viruses. Be it rhinocerebral, pulmonary, gastrointestinal, cutaneous or disseminated, the fungus is notorious for rapid progression.<sup>[5]</sup> The one-two combination of COVID-19 (needing steroids) and mucormycosis (where steroids are contraindicated) is hard to withstand.

We fight the fungus with early identification and proper treatment. Warning signs and symptoms are looked for, including pain and redness over the eyes and nose, epistaxis, headache, bloody vomiting and altered mental status. Examination is a must, and may reveal facial swelling, ptosis, proptosis, ophthalmoplegia, panophthalmitis, palatal eschar or nasal eschar. While a KOH (potassium hydroxide) mount and fungal cultures are enough to identify the fungus, blood parameters, especially HbA1c and blood sugar levels are necessary while taking further action. Histopathology, direct microscopic examination, culture, (1,3)- $\beta$ -D-glucan, galactomannan, and PCR-based assays are the latest modalities for diagnosis.<sup>[6]</sup> CT PNS (Paranasal sinuses) helps judge the severity of structural damage while MRI with contrast of the orbit, PNS and brain shows soft tissue involvement. CT guided biopsy can also be done. Treatment requires teamwork by multiple specialties including but not limited to intensivist, microbiologist, radiologist, ENT specialist, ophthalmologist and dentist. Major facets of treatment

cover the following: blood sugar control, rapid reduction or discontinuation of steroids and other immunomodulating drugs if currently on, extensive surgical debridement of necrotic material and medical management using Amphotericin-B (5-10mg/kg/day).<sup>[7]</sup>

Prevention is better than cure, but, unlike the similarly ubiquitous spore-forming *Clostridium* bacilli that cause tetanus, there is no vaccine for this disease. The exposure to these fungal spores in the environment can be somewhat reduced by avoiding damp or moist areas, or use an N95 respirator.<sup>[8]</sup> Strict control of the blood sugar level is required in management of COVID-19 cases. Judicious use of steroids with proper dose and duration of therapy will help in this pandemic. Oral steroids are contraindicated in patients with normal oxygen saturation on room air, and systemic steroids should only be given to hypoxemic patients. Infection control measures have to be followed in wards, including cleaning and replacement of humidifier. Use of sterile normal saline for the humidifier bottle is a recommended with change done daily.<sup>[7]</sup>

### Conclusion

While fighting fungi, there is no clear winner. The late nobel laureate Joshua Lederberg wrote, "the future of humanity and microbes likely will unfold as episodes of a suspense thriller that could be titled 'Our Wits Versus Their Genes'".<sup>[9]</sup> Adaptation through resistance to routinely used antifungals is combated by us with development of newer drugs. Poor compliance to treatment by patients is taken advantage of by the fungi. While stepping into this battlefield, it is prudent to know the risk factors, the types of invasive mycoses, the strengths and limitations of available diagnostic methods at our current place of work, clinical condition of the patient, and the need for standard or individualized treatment for fungal infections. The stakes for us vary from a persistent itch to loss of vision and

even life itself, but it has always been about staying alive for the fighting fungi.

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