

# Medical mycology

Topics (just the very basics):

Mycoses are limited to few species

Opportunistic pathogens

Fungal infections are on the rise

Types of infections:

Skin

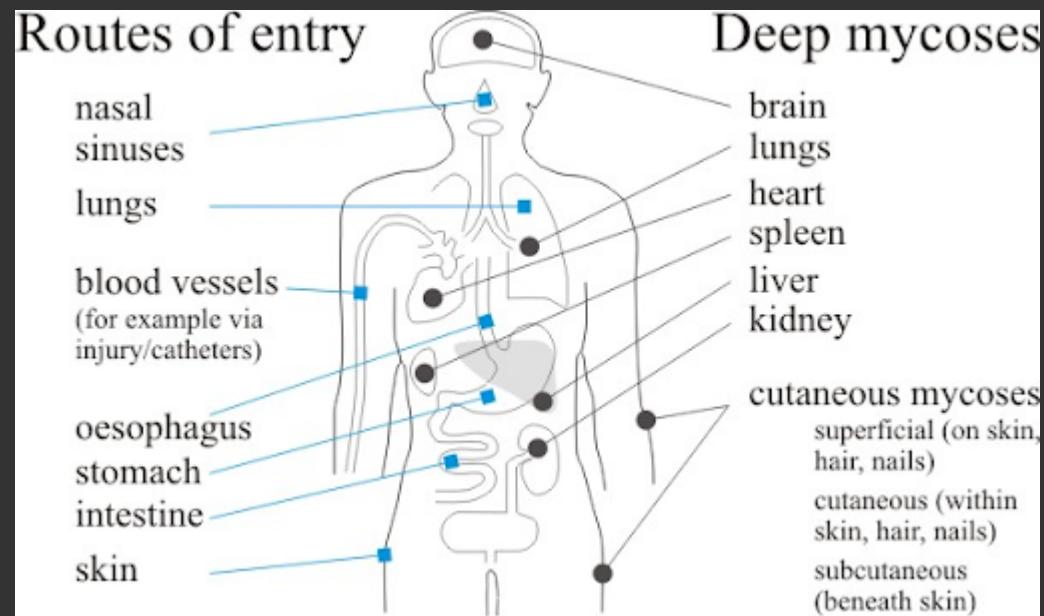
Systemic

Examples of mycoses

Human mycobiome

Beneficial human fungi

Allergens and toxins



Myths:

Rare  
Just for immunocompromised folks  
Only in the tropics  
Fungi can't handle warm body temp

Facts:

Widespread (and increasing)  
Most dangerous mycoses tend to only be a problem for immunocompromised  
But fungal infections are quite common  
Common everywhere, and those "tropical" diseases are finding their way everywhere lately  
Obviously, some fungi are fine with warm temps, though being warm-blooded is our major defense!

# FUNGAL DISEASES ARE ON THE RISE. IS ENVIRONMENTAL CHANGE TO BLAME?

*Scientists and physicians are looking for clues to a worrying increase in fungal infections and exploring ways to reduce the threat.*

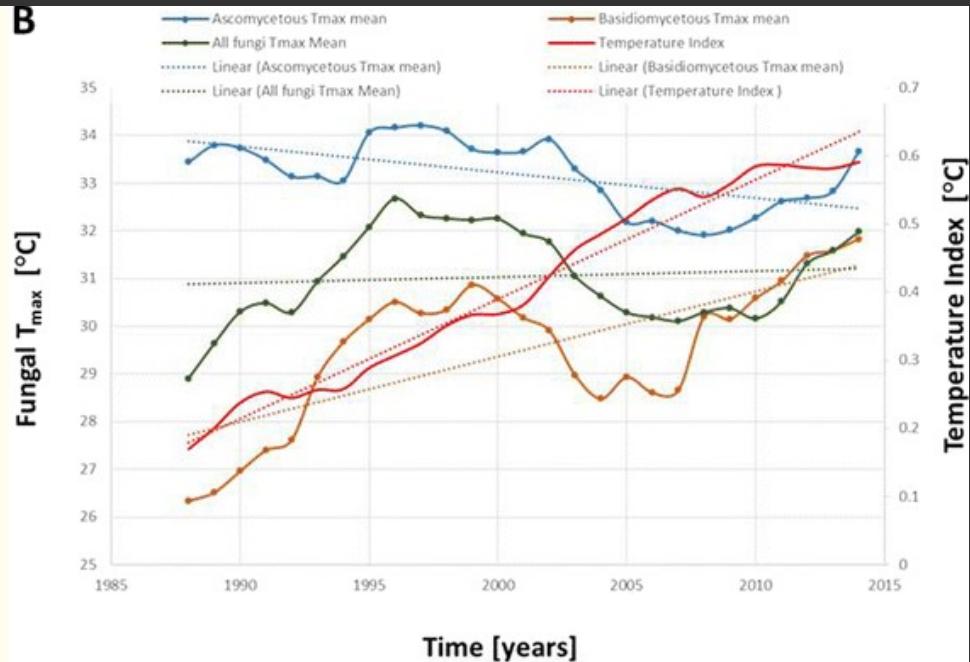
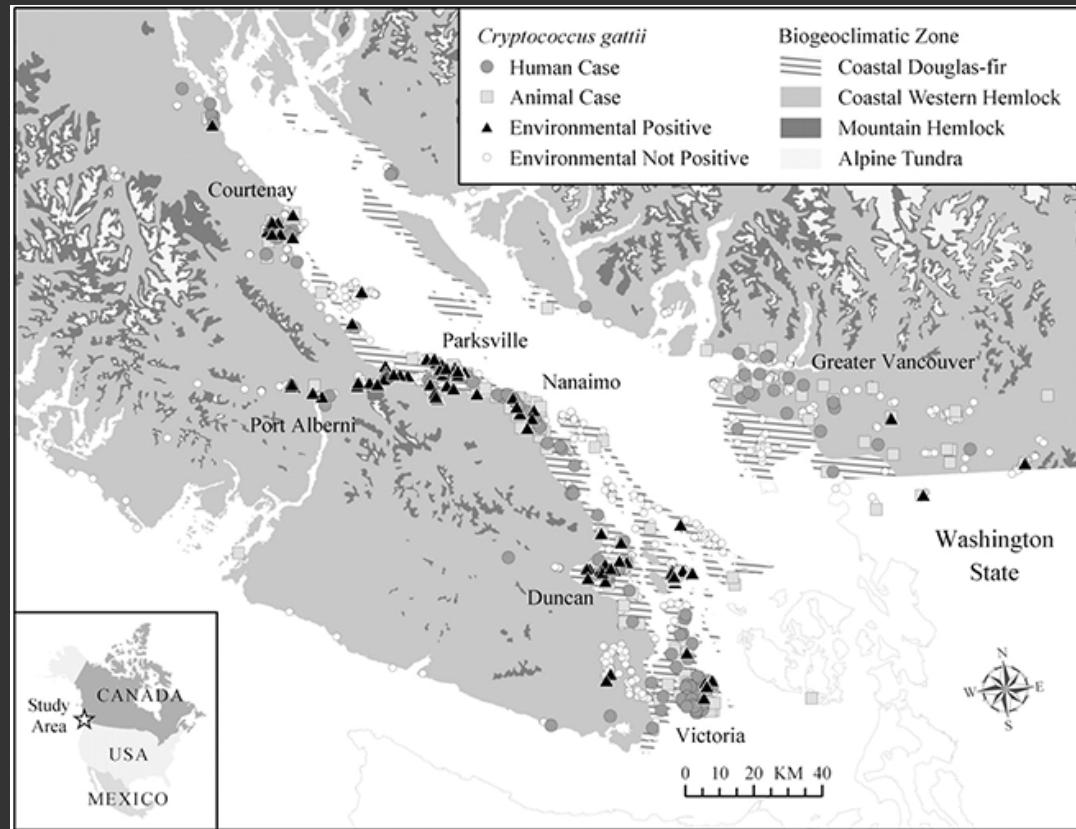
So far ~150 species of fungi are known to cause infections in humans  
Maybe 20-30 species are potentially major threats to health of the infected  
Just because of low numbers of infectious agents, doesn't mean low case counts!  
Fungal infections account for 1.5 Million deaths annually worldwide  
Many many more times that number of less threatening infections



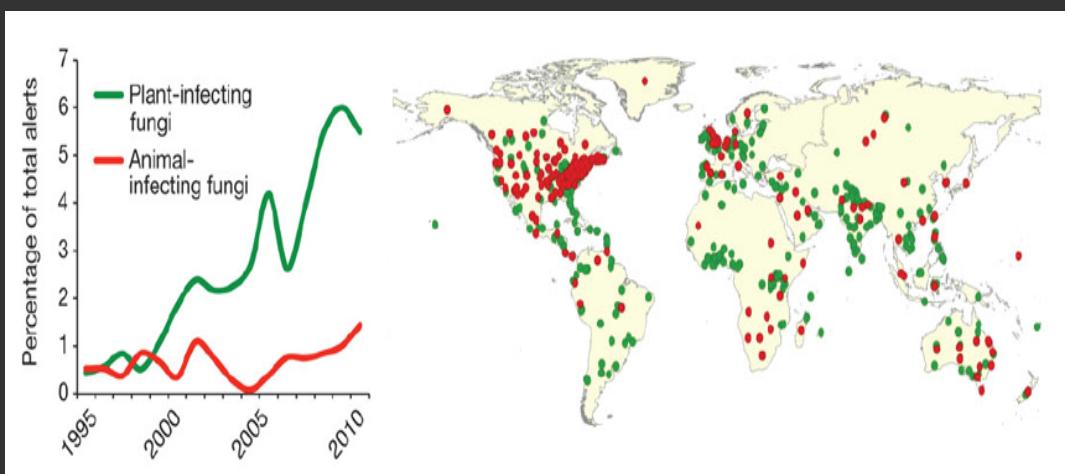
"A major factor protecting us from fungal disease is the difference in temperature between the human body and the outside environment. As fungi adapt to living at higher temperatures, we may begin to lose some of that natural protection"

- Arturo Casadevall

(This guy has really cool hypothesis about fungi being critical to the rise of mammals)



From 1999 - 2009, a bad outbreak of the "tropical" *Cryptococcus gattii* terrorized Canada's west coast



Other factors that help explain current drastic increase in mycoses:

- Environmental change - Old fungal diseases coming out of the freaking permafrost!
- Population growth in areas with endemic fungal pathogens
- Increase in HIV-related immunosuppressed status

# The four most common problem fungi:

## Candida

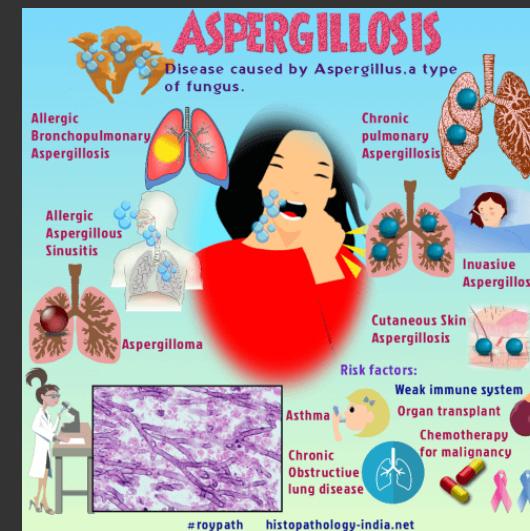
[CDC Link](#)



Dimorphic basidiomycete  
common and important part of mycobiome  
facultative pathogen

## Aspergillus

[CDC Link](#)

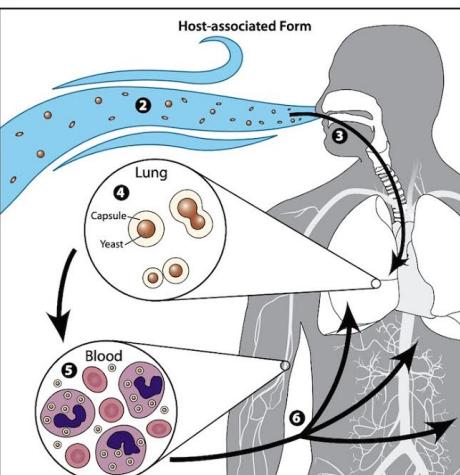
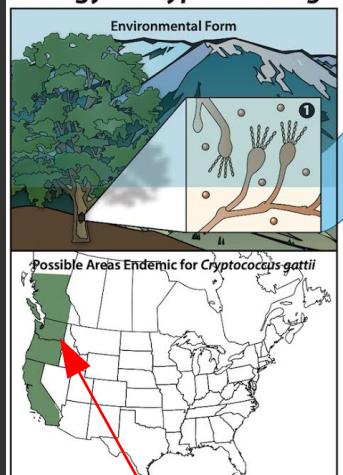


Ascomycete  
Opportunistic  
Many diseases

## Cryptococcus

[CDC Link](#)

### Biology of *Cryptococcus gattii*



That's new!

## Mucor

[CDC Link](#)

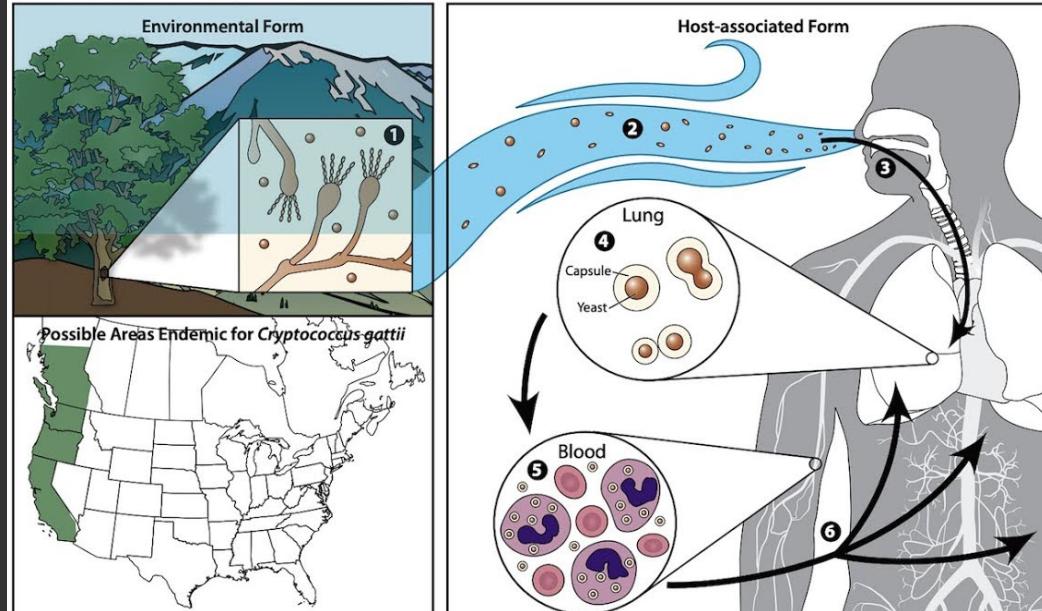


Zygomycete  
rare, but  
very serious  
infections

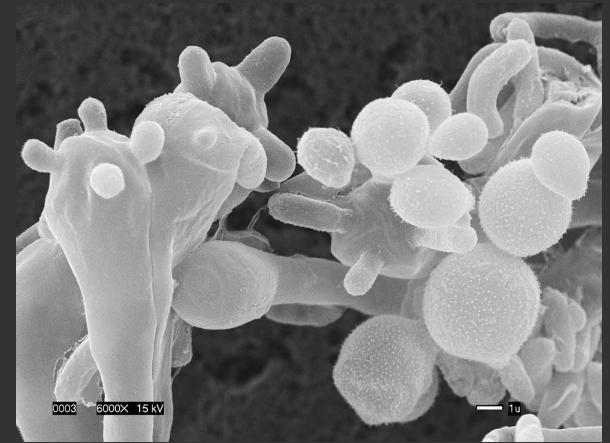
# *Cryptococcus gattii*

It's the anamorph of a jelly fungus...and it wants to kill you

## Biology of *Cryptococcus gattii*



Teleomorph: *Filobasidiella*  
Basidiomycota; Tremellales



Basidia

Can infect lungs/brain of healthy people  
Used to be limited to Papua New Guinea  
Anamorph is in yeast form  
Soil saprotroph...but also human pathotroph

# Zygomycete species that can infect humans:

*Rhizopus, Mucor, Rhizomucor, Cunninghamella, Apophysomyces, etc.*

Mucormycosis is a catch-all term for Zygomycete infections



Tends to be limited to opportunistic infections

Wide range of diseases and symptoms

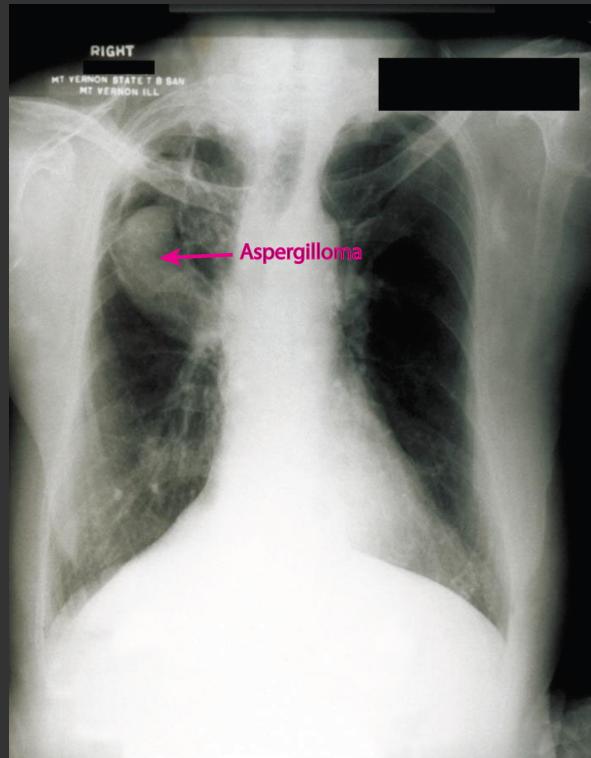
Very difficult to treat  
(sometimes surgery is the only option)

Real story -->



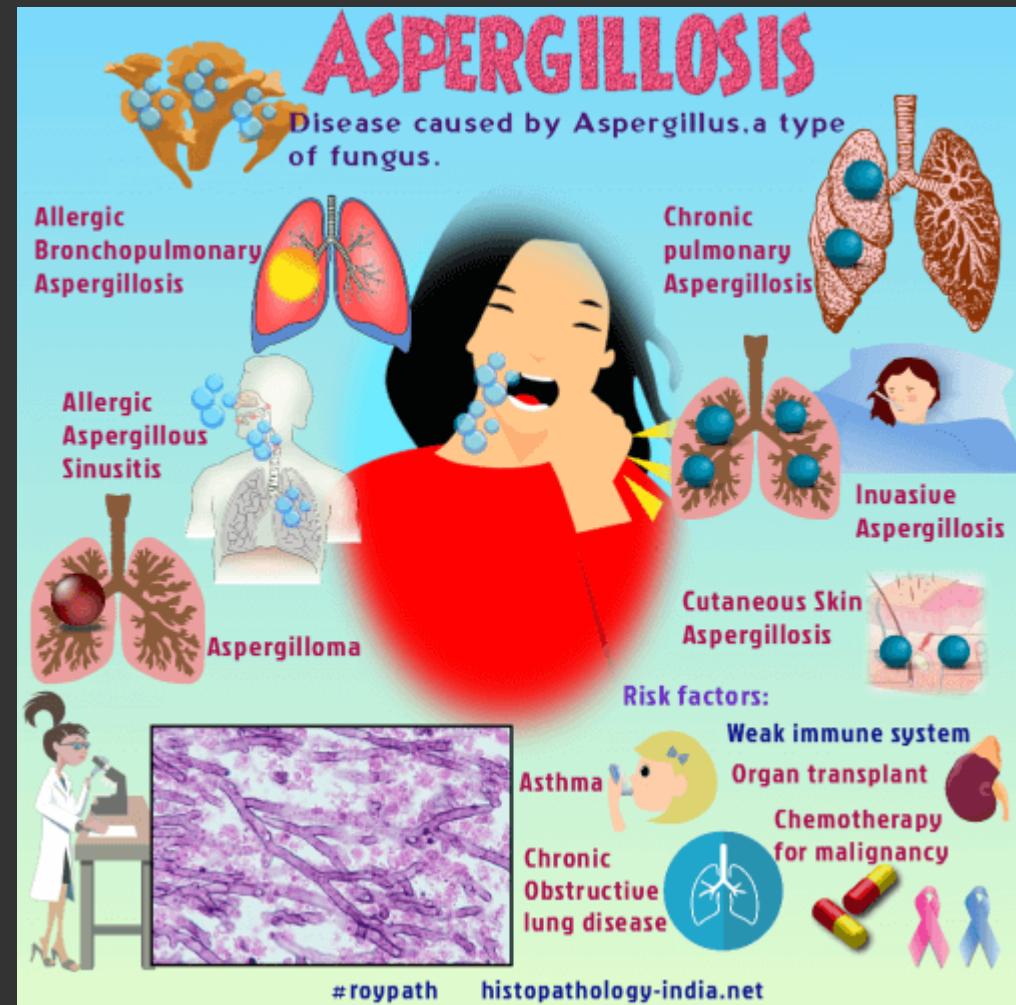
# Aspergillosis

Diseases caused by various *Aspergillus* agents



Lung, sinus, and cutaneous infections

Immunocompromised individuals at greatest risk



# Candidiasis

When your good friend turns on you

Immunocompromised indivs.

Or just normal hospital patients...

Major source of nosocomial infections

Pan Afr Med J. 2014; 19: 398.

Published online 2014 Dec 22. doi: [10.11604/pamj.2014.19.398.4960](https://doi.org/10.11604/pamj.2014.19.398.4960)

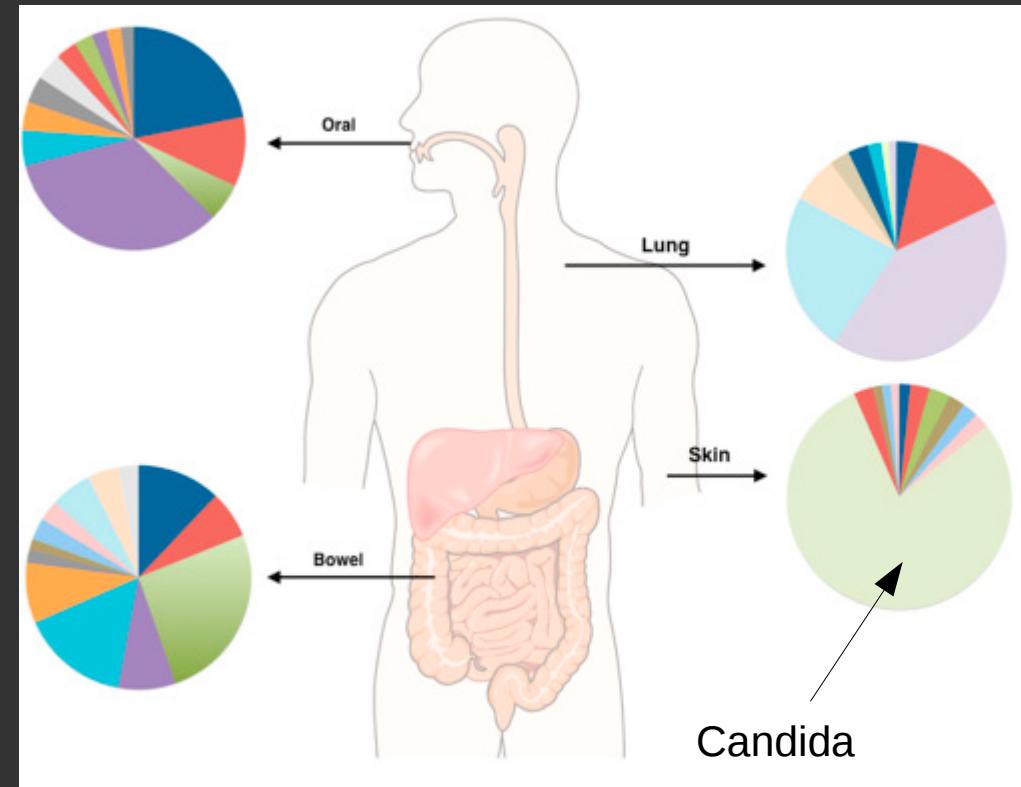
PMCID: PMC4430144

PMID: [25995794](https://pubmed.ncbi.nlm.nih.gov/25995794/)

A surveillance of nosocomial candida infections: epidemiology and influences on mortality in intensive care units

Zehra Karacaer,<sup>1,8</sup> Oral Oncul,<sup>2</sup> Vedat Turhan,<sup>2</sup> Levent Gorenek,<sup>2</sup> and Mustafa Ozyurt<sup>2</sup>

► Author information ► Article notes ► Copyright and License Information Disclaimer



Courtesy of Tasneem Poonawalla, M.D., Pharm.D; Dermatology Resident, University of Wisconsin; and Dayna Diven, M.D., Clinical Professor, Department of Dermatology, University of Texas Medical Branch.

Candida sp. is a major component of healthy skin

But it has no moral qualms about eating you if it gets a chance

## Problems treating mycoses

Antibiotics and dysbiosis

Careless medical staff

Drug resistance (largely from agriculture)

Limited fungal targets for drugs that don't affect human cells as well

# THE MYCOBIOME

Fungus lives in and on the human body. Scientists have found several species of fungus that may affect your microbiome's balance.

Candida is the most common species found in the human mycobiome. When the balance of a microbial community is disrupted, Candida will flourish.

## ORAL FUNGUS



- Alternaria
- Aspergillus
- Aureobasidium
- Candida
- Cladosporium
- Cryptococcus
- Fusarium
- Gibberella
- Glomus
- Pichia
- Saccharomyces
- Teratosphaeria

## GUT FUNGUS



- Aspergillus
- Candida
- Cladosporium
- Cryptococcus
- Fusarium
- Penicillium
- Pneumocystis
- Mucor
- Saccharomyces

## LUNG FUNGUS

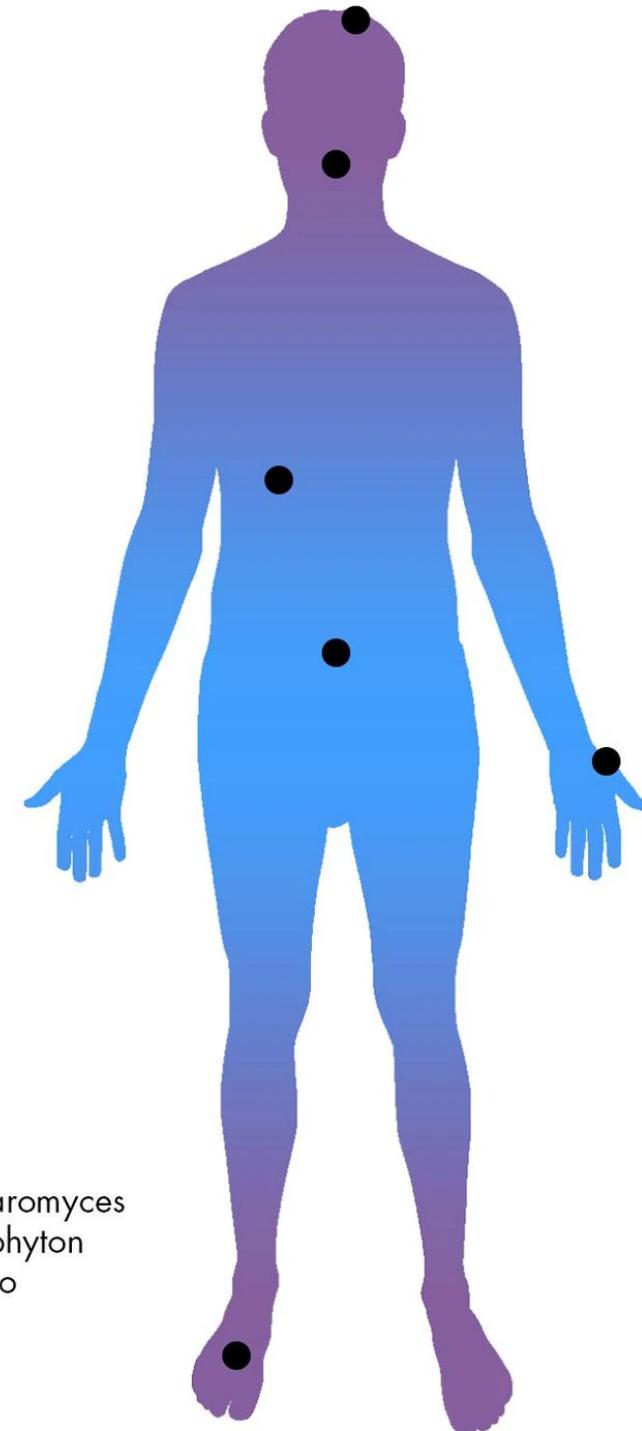


- Aspergillus
- Candida
- Cladosporium
- Penicillium
- Cryptococcus

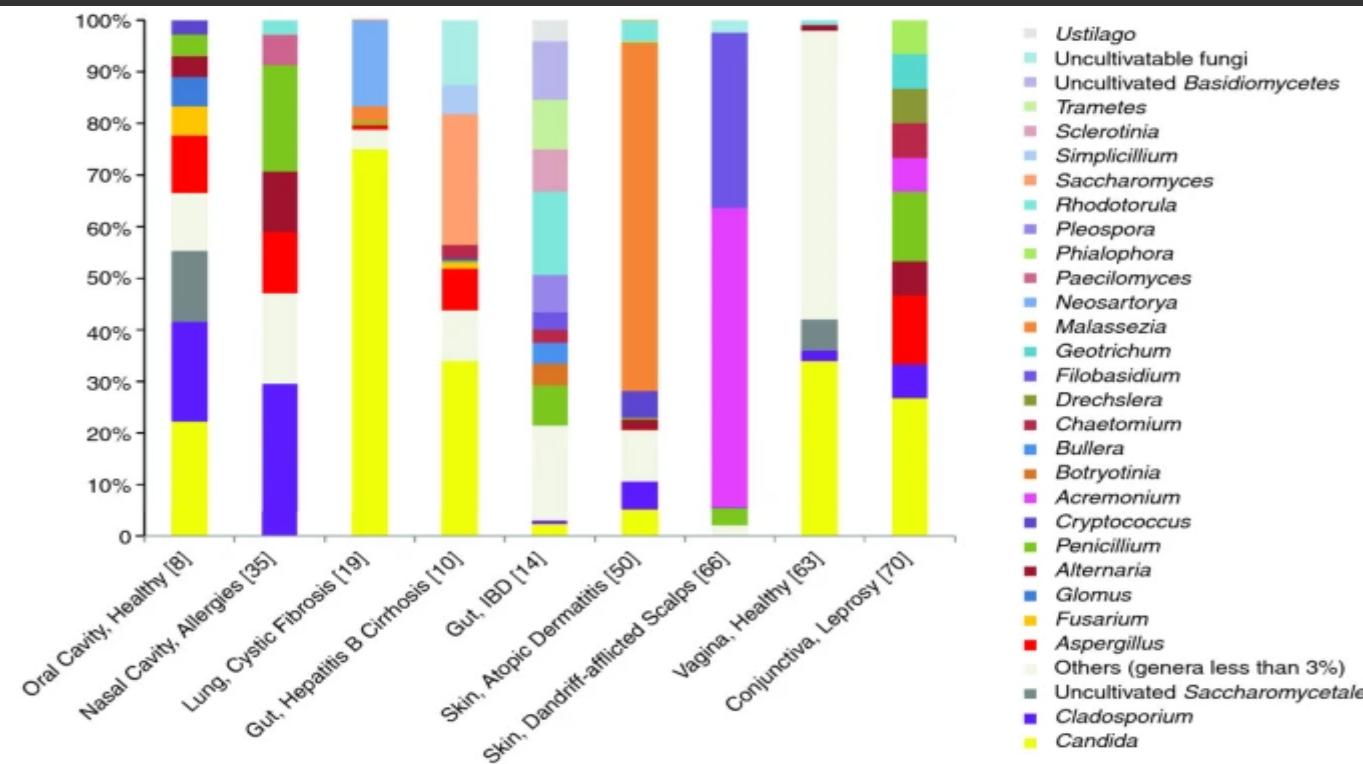
## SKIN FUNGUS



- Aspergillus
- Candida
- Chrysosporium
- Cryptococcus
- Debaryomyces
- Epicoccum
- Epidermophyton
- Leptosphaerulina
- Malassezia
- Microsporum
- Penicillium
- Phoma
- Saccharomyces
- Trichophyton
- Ustilago



Some of my research students have tried to study the human oral mycobiome ... but then they switched to bacteria



## Swoosh For Science

FREE DENTAL HYGIENE KITS!

Come swoosh for science to help us learn how lifestyle influences the fungal microbes in your mouth!!



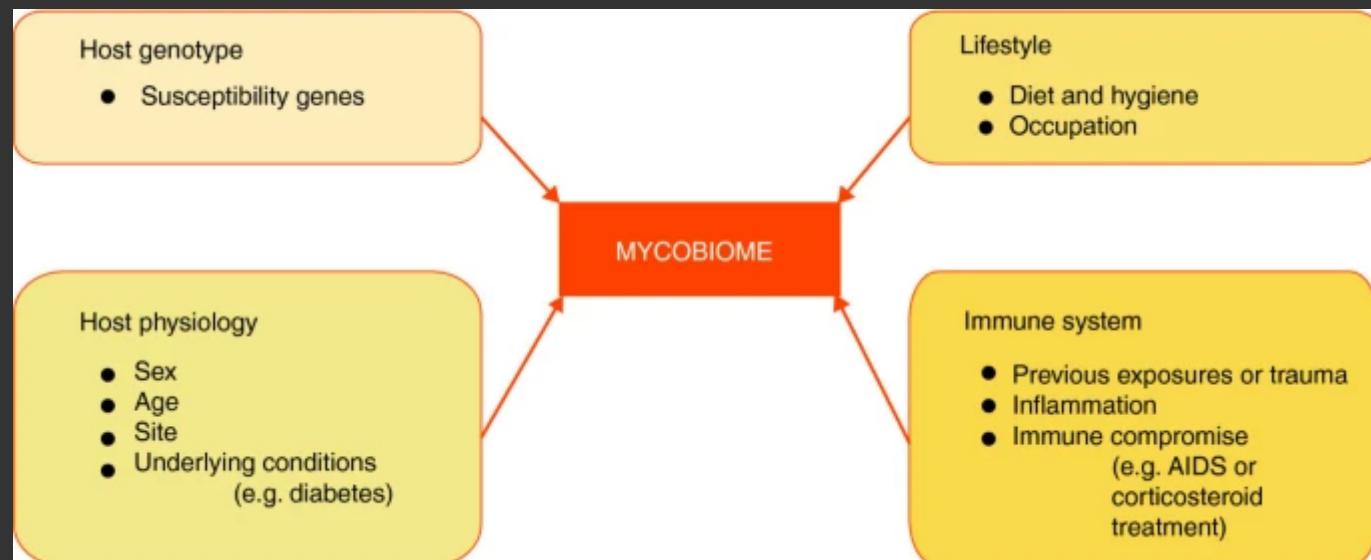
SB Atrium

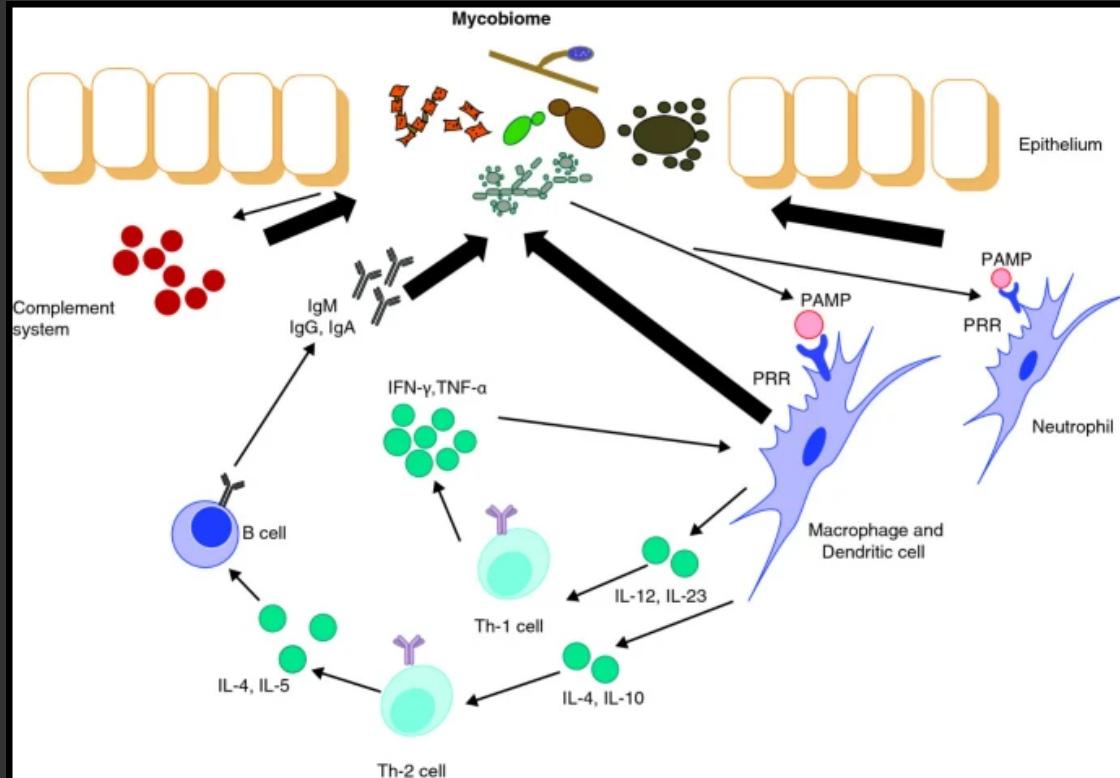
Feb 9, 12, & 16

10:00 – 12:00

FOLLOW ON INSTAGRAM FOR RESEARCH UPDATES:  
@SWOOSH4SCIENCE

Lead Investigator: Dr. Geoffrey Zahn (gzahn@uvu.edu)  
Student Researchers: Harrison Haws & Nicholas Long



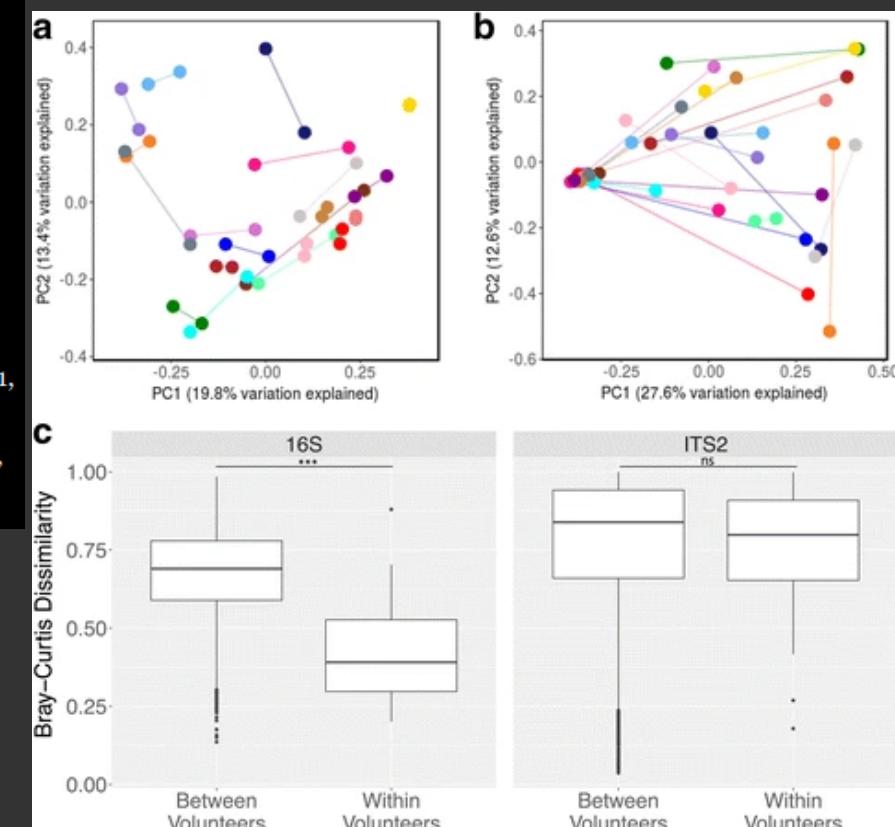


**Interaction between the mycobiome and the immune system.** Several pattern recognition receptors (PRRs) on phagocytes specifically recognize the pathogen-associated molecular patterns (PAMPs) of fungi. Following this pattern recognition, macrophage and dendritic cells mature and activate T cells through an antigen-presenting process. Activated T cells differentiate into either Th-1, which promotes the phagocytosis of fungi, or Th-2, which activates B cells to release fungi-specific antibodies, depending by which cytokines they are stimulated. IFN, interferon; IL, interleukin; TNF, tumor necrosis factor. (Figure design inspired by the information reported in [16] and [53].)

Human mycobiome research is still newish...

Noticing a lot of interesting patterns:

- Interaction with immune system
- Fungi as disease treatments
- Triggers for pathogenicity switch
- Effect on bacterial microbiome
- Nobody's looked at dysbiosis yet



Maybe less stable than bacterial microbiome? Why?

# Fungal spores as allergens

Spores often in higher concentrations than pollen grains in air  
Estimated 6% of population is allergic to fungal spores

Not reliant on immunocompromise

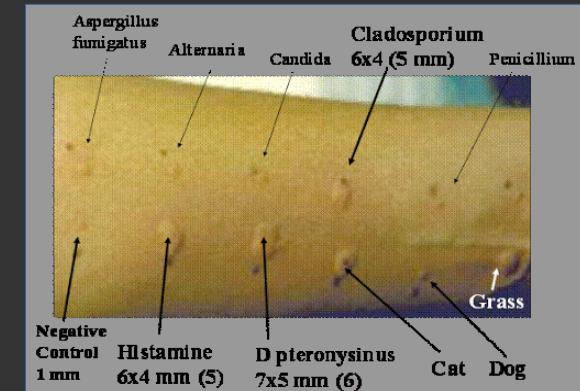


"Black mold"  
*Stachybotrys spp.*  
Ascomycota; Sordariomycetes  
Not a pathogen...an allergen

Fungal allergens evoke a broad response in sensitive individuals (Type I, II, III, and IV allergies)

Dermatitis, asthma, rhinitis

Good overview paper link



	Prevalence, %	
	total population	atopics
<b>ASCOMYCOTA</b>		
<b>Pezizomycota</b>		
<i>Acremonium (Cephalosporium)</i>	16 <sup>a</sup> [267]	
<i>Alternaria</i>	3.6–5.5 [20, 180] 12.6 [46]	66.1 <sup>b</sup> [46] 39.4 [22] 14.6 <sup>c</sup> [179] 13.5 <sup>c</sup> [183] 3–14.6 [181, 182]
<i>Aspergillus</i>	2.4 [46]	27.6 [22] 21.3 <sup>c</sup> [179] 15 [182] 5 <sup>c</sup> [183]
<i>Aureobasidium</i>		20.5 <sup>d</sup> [22]
<i>Bipolaris</i> ( <i>Drechslera, Helminthosporium</i> )		36.8 [22] 18.8 <sup>c</sup> [179]
<i>Botrytis</i>		28.2 <sup>d</sup> [22]
<i>Chaetomium</i>		7.4 [268]
<i>Chrysosporium</i>		
<i>Cladosporium</i>	2.5 [46] 2.9 [20]	3–18.2 [181, 182] 15.9 <sup>c</sup> [179] 7.4 <sup>c</sup> [183]
<i>Claviceps</i>		
<i>Curvularia</i>		18.4 [22] 28 [184]
<i>Cylindrocarpon</i>		

# Mycotoxins



*Amanita spp.*

- Destroying angel or Death Cap  
(This one mushroom could kill 5-6 people easily)



*Claviceps spp.*

- Ergot



Post-harvest food toxins from fungi:

Ochratoxin A

Patulin

deoxynivalenol

nivalenol

T-2 and HT-2 toxins

...the list goes on (Google it)



Eating this corn causes liver damage

# Assignments

## 1. Read Huffnagle & Noverr, 2013

- This is a look at the human mycobiome

## 2. You will have a Canvas quiz on the assigned readings and will also have to participate in a Slack discussion about them.

## 3. Go through the CDC website links about fungal infections (found in this slideshow)

- Create a new powerpoint slide about one of the fungal infection types not covered in these slides
- Be sure to find sources outside of the CDC site for more info/pictures etc.
- Turn in on Canvas