



Centers for Disease Control and Prevention
National Center for Emerging and Zoonotic Infectious Diseases

PACCARB March 23, 2023

Environmental Impact on Fungal Infections and AMR

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Disease-causing fungi are inextricably linked to our environment

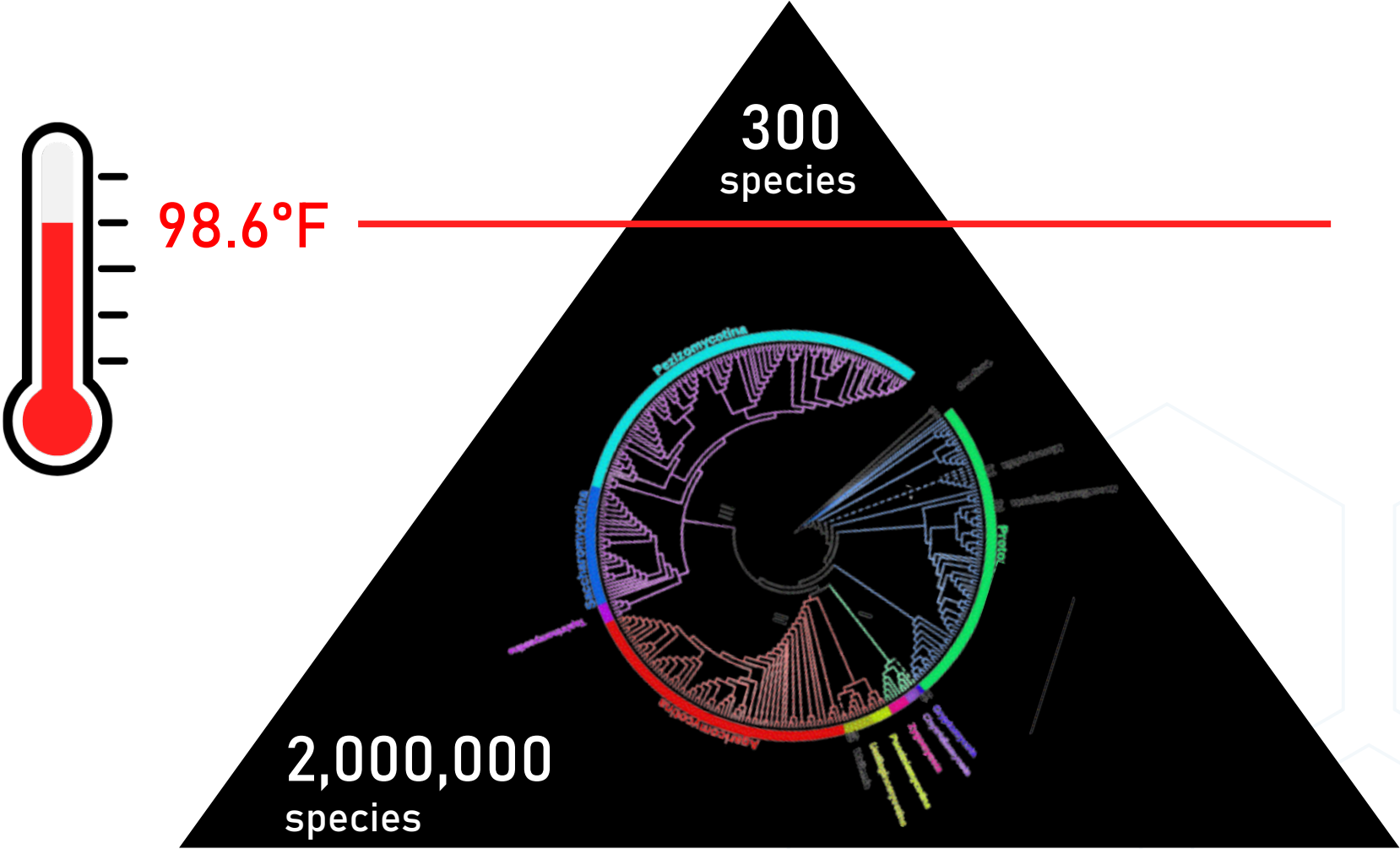


Trees: <https://tse3.mm.bing.net/th/id/OIP.zlrHb098BnMcQ04mgAD7dgHaLG?pid=ImgDet&rs=1>

Frogs: <https://www.the-scientist.com/news-opinion/frog-killing-chytrid-fungus-far-deadlier-than-scientists-realized-65680>


Water eutrophication: <https://www.haikudeck.com/cultural-eutrophication-uncategorized-presentation-5RsGAQXh1g#slide2>

Few fungi can grow at 98.6°F



*From a CDC fungal disease expert, here's what you need to know about **The Last of Us***

We may not need to worry about turning into zombies, but we do need to 'Think Fungus', the HBO show is right on that

Tom Chiller • Monday 20 February 2023 15:01 •  [Comments](#)



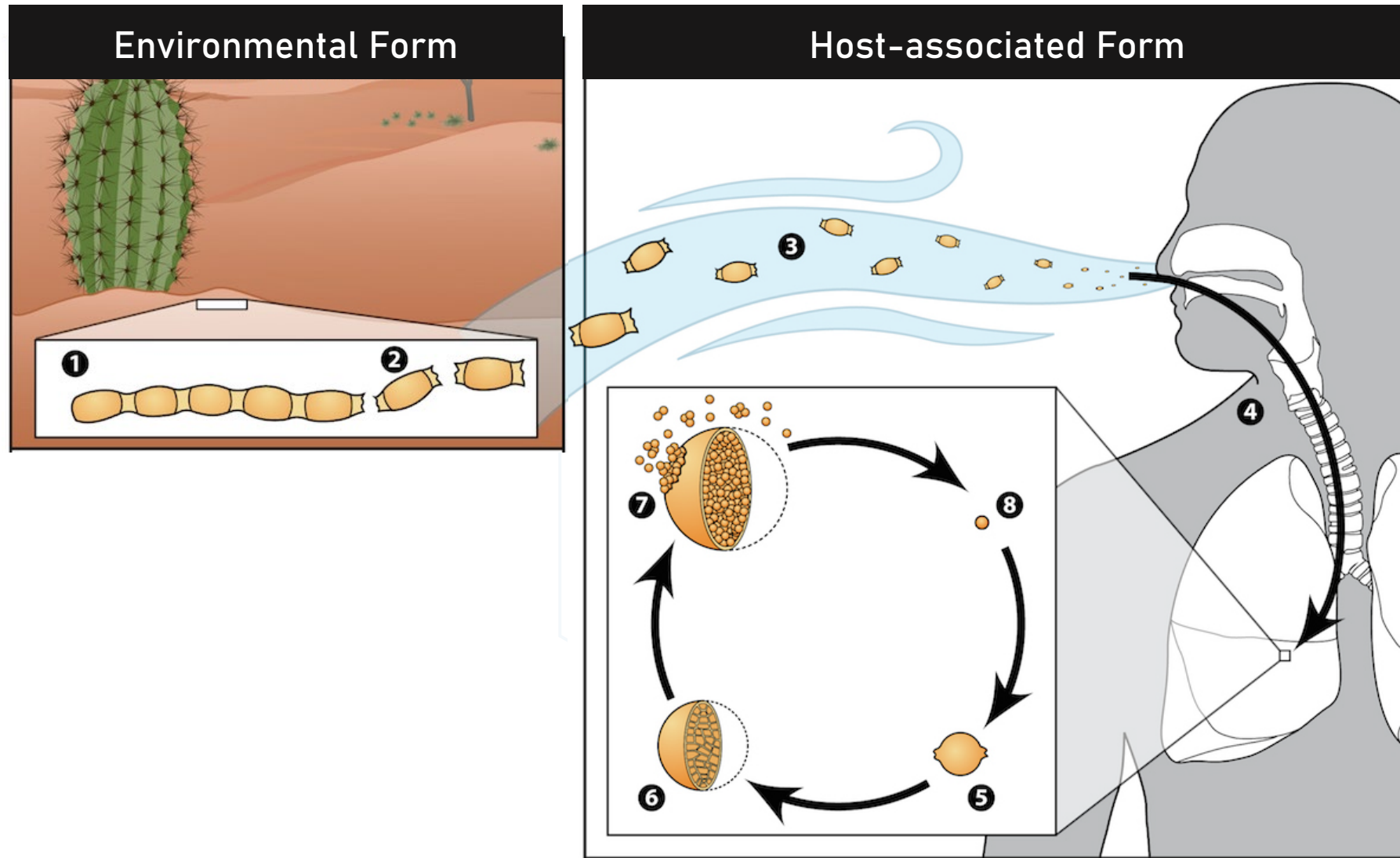
The Last of Us Poster (@Home Box Office, Inc.):
<https://i0.wp.com/www.pcmrace.com/wp-content/uploads/2022/11/Fgkht3XXoAE5FZO.jpg?ssl=1>

Valley Fever

Coccidioides immitis



Dimorphic fungi *Coccidioides* species converts from environmental form in soil to host-associated form

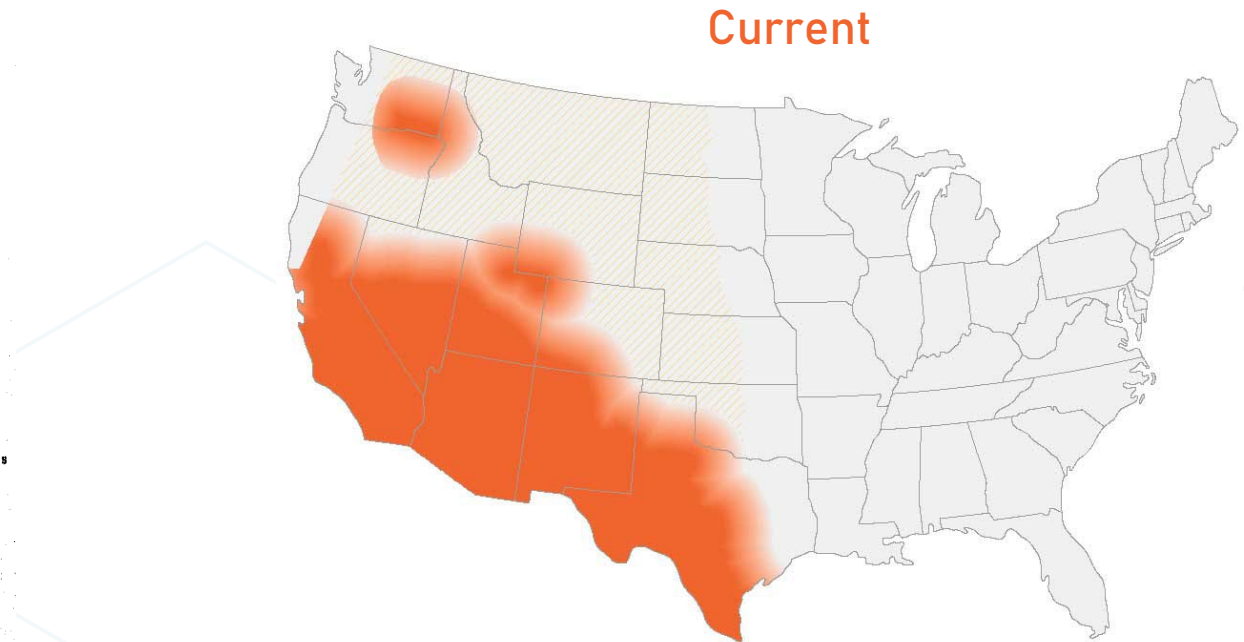
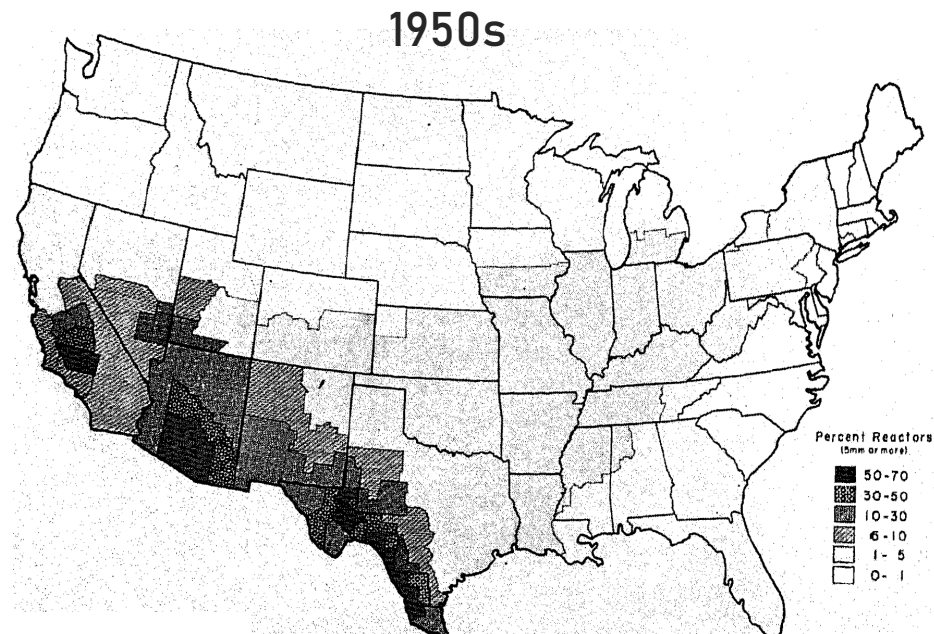


- **70% of Valley Fever patients were diagnosed incorrectly, and most prescribed multiple courses of antibiotics instead of antifungals**
- **Overuse and misuse of antibiotics promotes antimicrobial resistance**



Coccidioides species primarily endemic to Southwestern United States

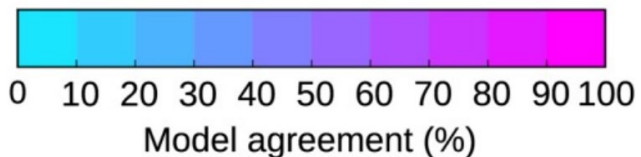
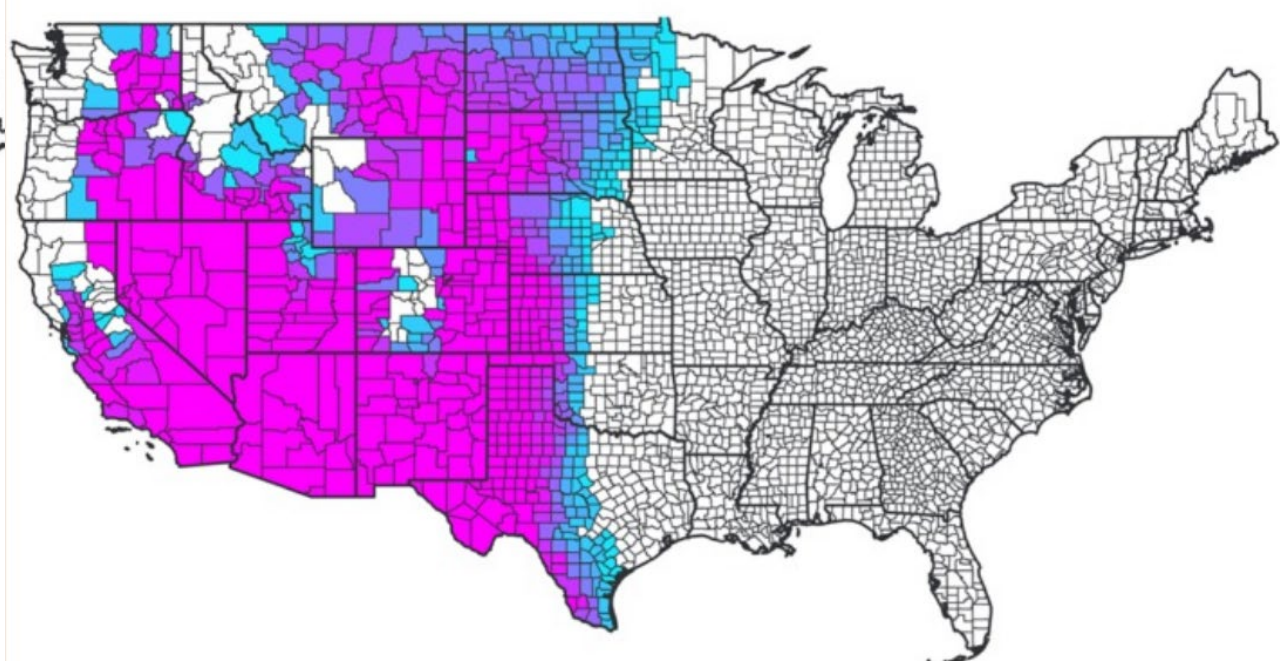
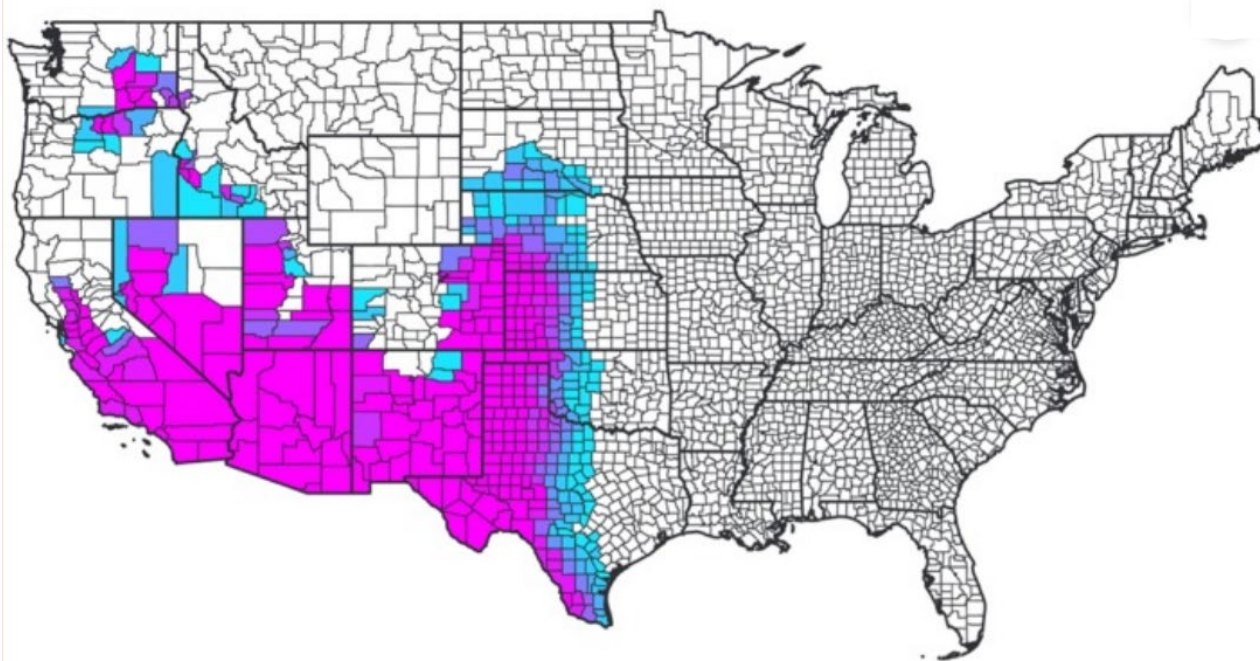
Areas of endemicity



Climate modeling analyzing temperature and precipitation patterns predicts expansion of Valley Fever endemic range

2035

2095



Combination of extreme climate events are leading to more people at risk for Valley Fever



Haboob dust storm: https://twitter.com/arizona_3L/status/1311161211308843009/photo/1

Wildfire: <https://www.nytimes.com/2021/11/17/climate/climate-change-wildfire-risk.html>

Drought: <https://time.com/4521057/megadrought-california-climate-change/>

Flooding: <https://news.stanford.edu/press-releases/2017/03/21/heavy-california-climate-change/>

Aspergillosis

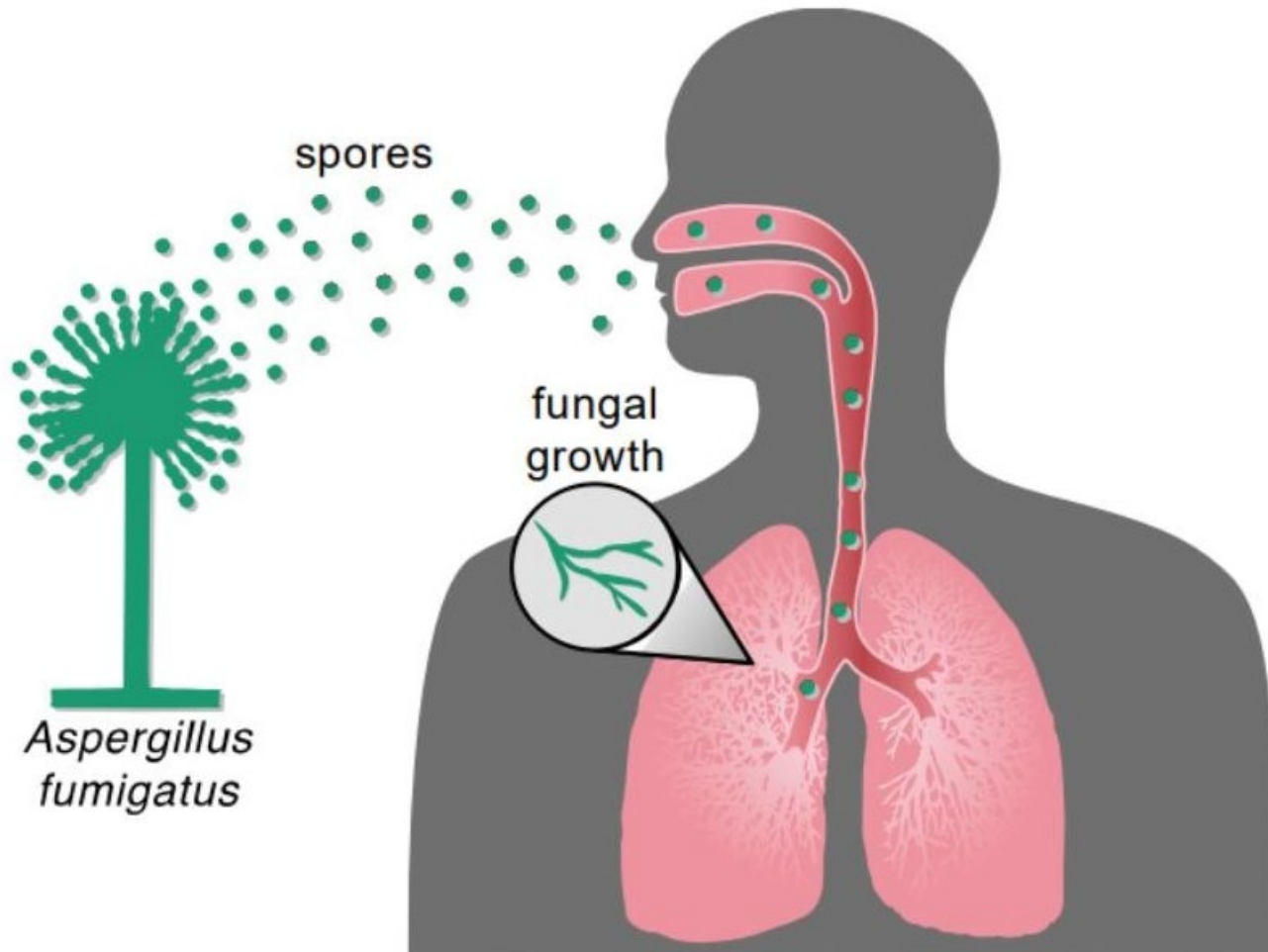
A microscopic image of Aspergillus fumigatus. The image shows several spherical, multi-cellular spore heads (conidia) attached to long, thin, branching hyaline (colorless) filaments (sterigmata). The spores are small, round, and have a distinct, textured surface. The background is a dark, deep blue, which makes the pinkish-purple spores stand out. The overall appearance is that of a highly branched, tree-like structure of spores.

Aspergillus fumigatus

**Agricultural fungicides are driving drug-resistant
Aspergillus fumigatus infections**



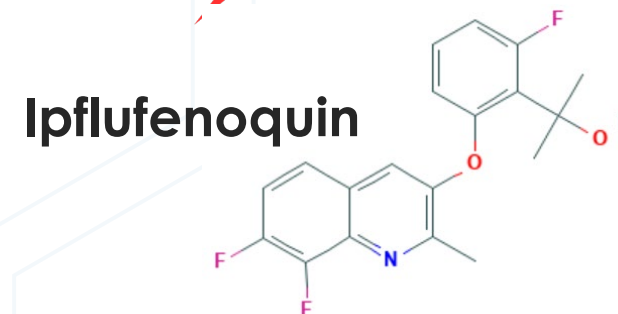
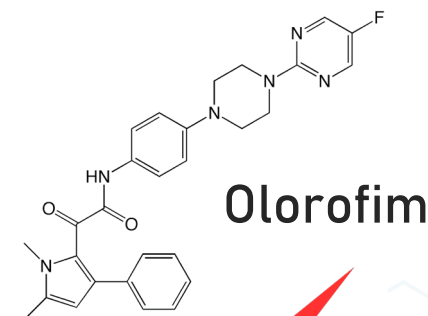
Azole-resistant *A. fumigatus* infections linked to environmental azole fungicide use



- Severe invasive infections with >40% mortality rates
- Azole antifungal drugs are 1st line therapy
- Reporting azole-resistant infections in persons with no prior azole therapy
- 2 genotypes of azole-resistant *A. fumigatus* specifically linked to fungicide use
 - TR34/L98H
 - TR46/Y121F/T289A

Promising clinical antifungal effective against azole-resistant aspergillosis shares mechanism of action with recently authorized agricultural fungicide

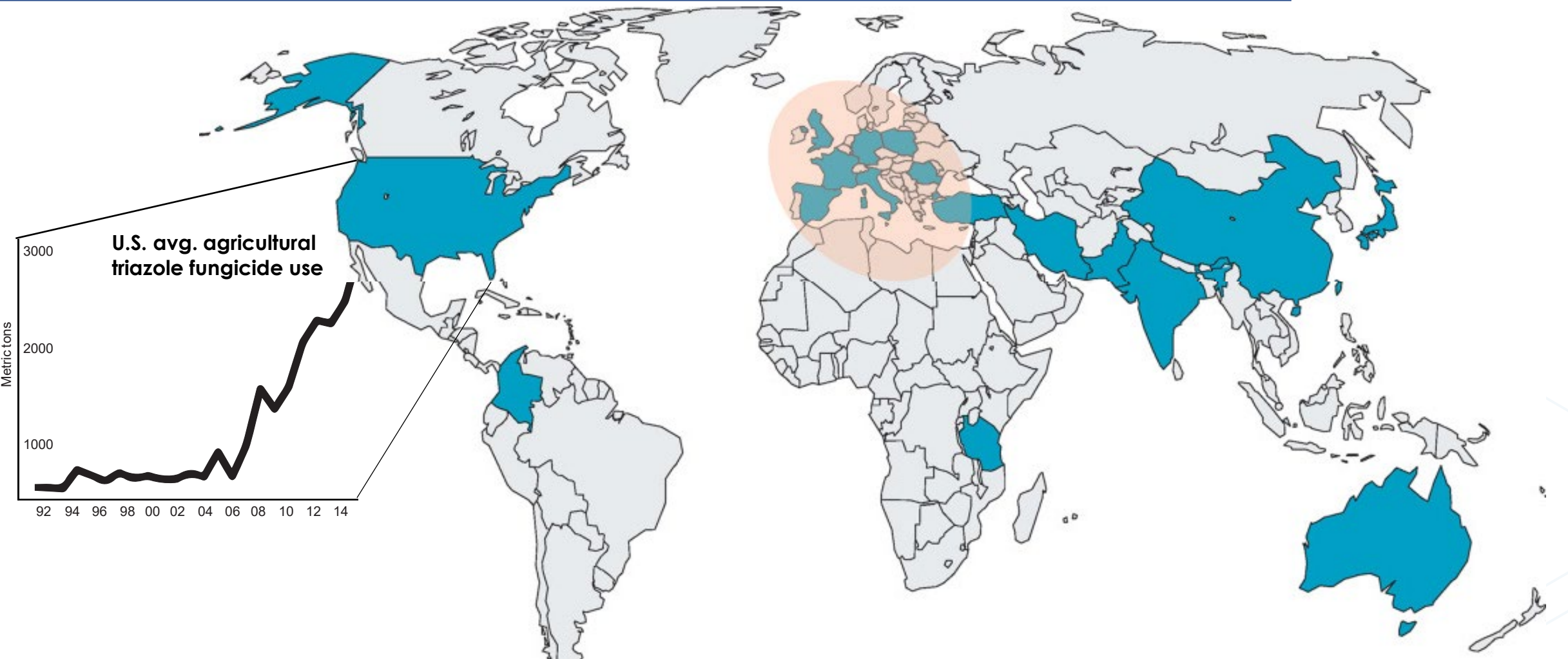
Development pipelines



Olorofim figure: <https://www.mdpi.com/2309-608X/6/3/122/htm>

Ipflufenoquin figure: <https://pubchem.ncbi.nlm.nih.gov/compound/Ipflufenoquin>

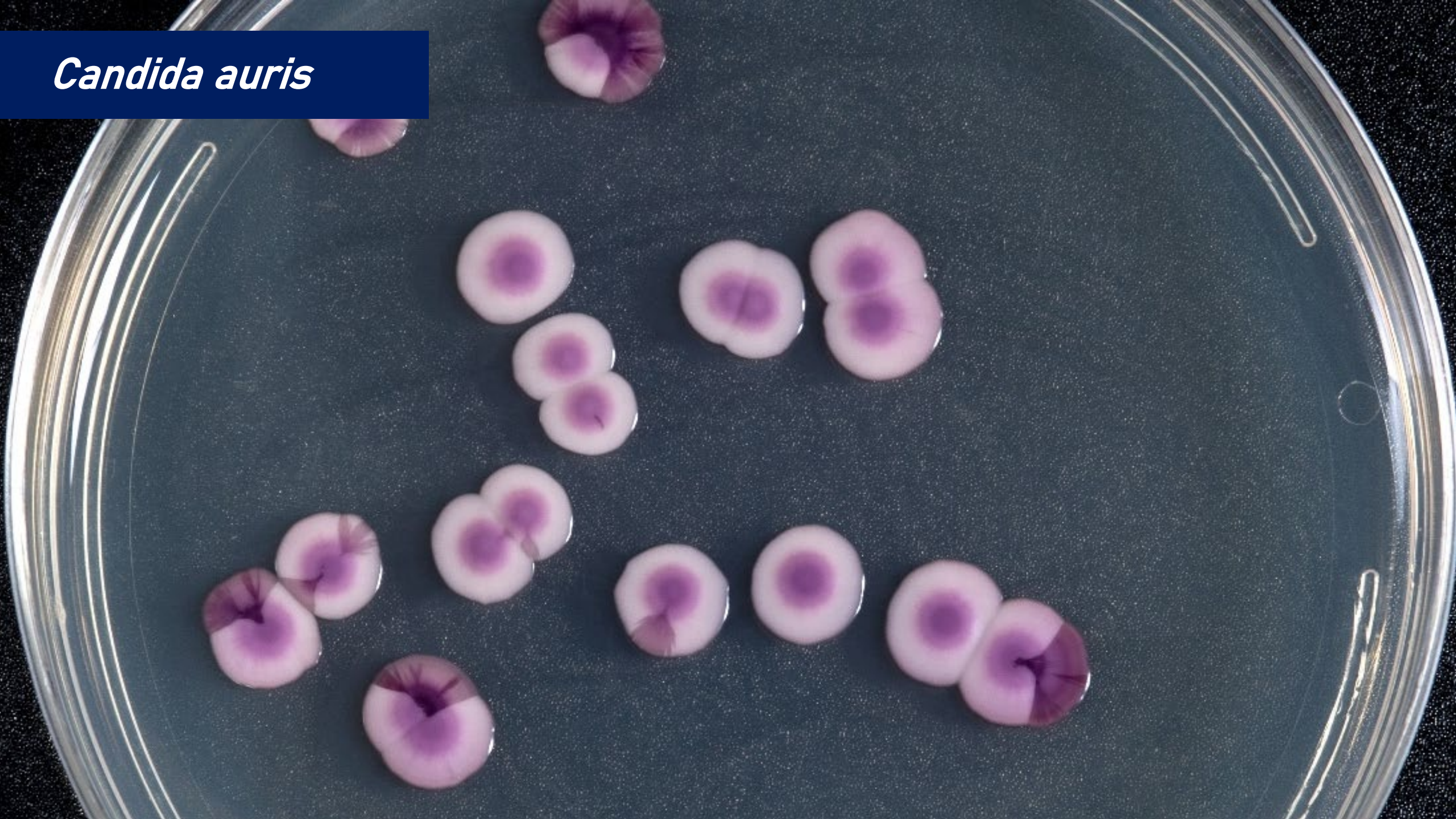
Azole-resistant *A. fumigatus* linked to fungicide use is a global One Health AMR threat



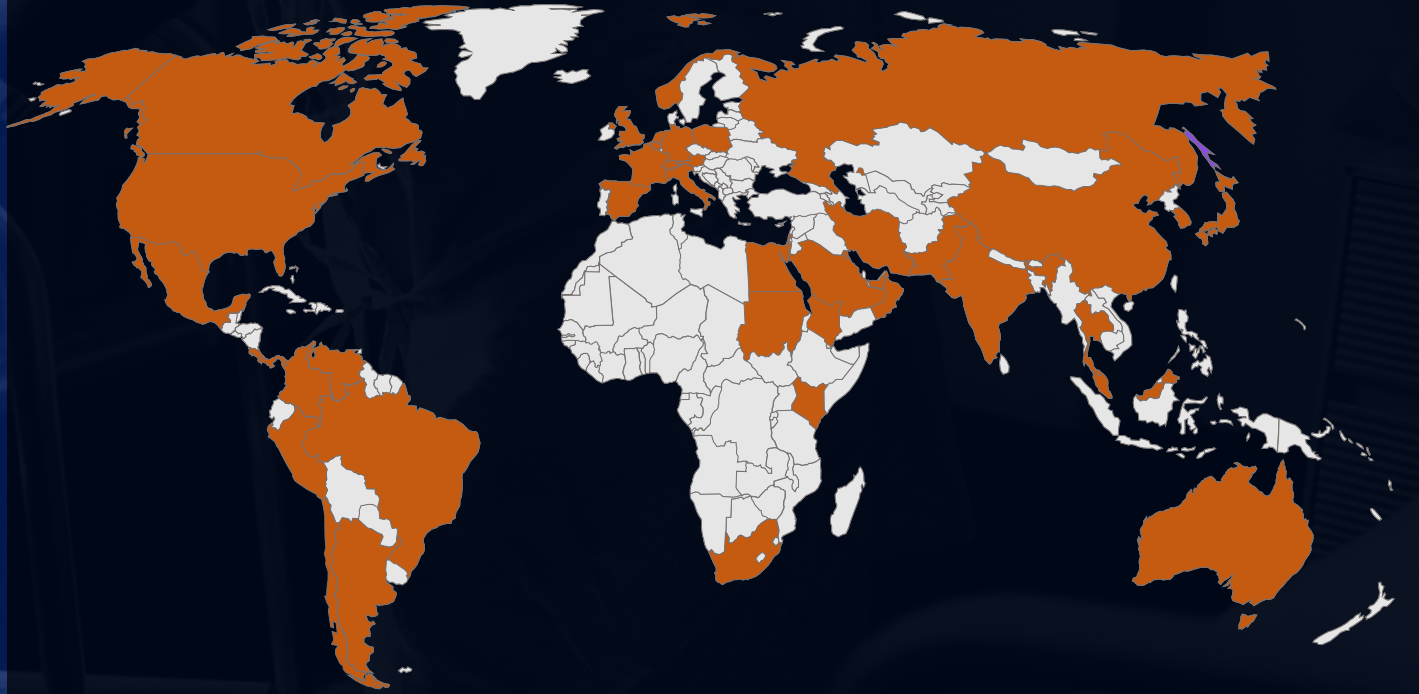
Countries reporting azole-resistant *Aspergillus fumigatus* with TR₃₄/L98H or TR₄₆/Y121F/T289A modifications as of 2017

Perlin DS, et al. Lancet Infect Dis. 2017

Candida auris



Fungal Superbug *Candida auris*

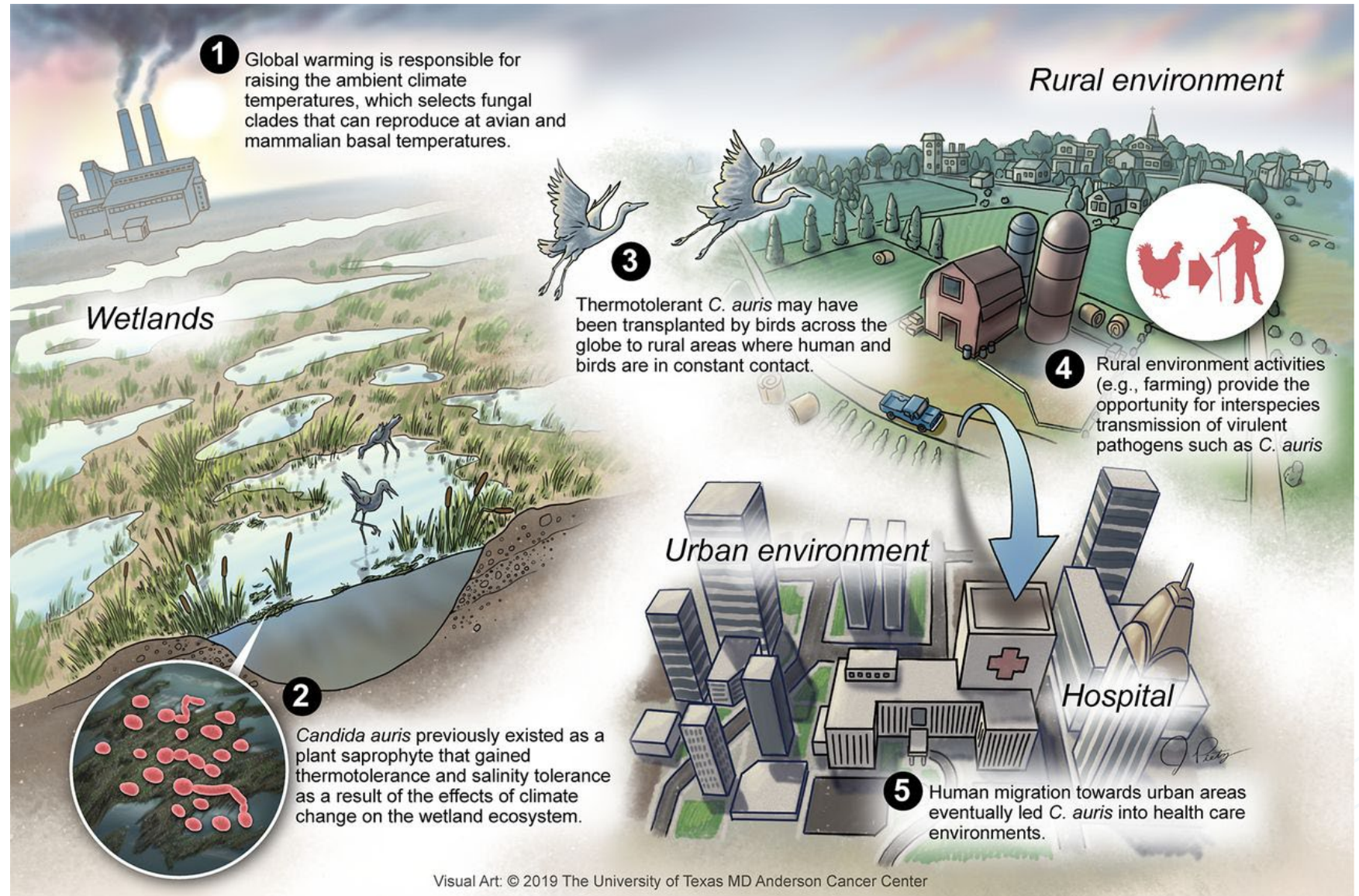


- Emerged suddenly
- Reported in >40 countries
- Highly transmissible healthcare-associated infection
- Highly resistant to antifungal drugs
- Increasing rates of pan-resistance

One theory suggests *C. auris* emerged because of environmental changes

TIME

On the Emergence of *Candida auris*: Climate Change, Azoles, Swamps, and Birds



NEWS

HEALTH & MEDICINE

A deadly fungus behind hospital outbreaks was found in nature for the first time

The discovery could spur search expeditions for the yeast in more places



Researchers found the yeast *Candida auris* in the Andaman Islands (shown) in the Indian Ocean, the first time the fungus has been isolated in the environment.

How does such a *Candida* species emerge?

- Universally azole-resistant
- Survives in high temperatures
- Survives in high salinity
- Tolerant to typical disinfectants



Take aways

- Most disease-causing fungi originate from the environment
- Environmental changes can affect what fungi emerge, where fungi spread, and what fungi dominate in a geographic area
- Increasing and inappropriate use of environmental azoles will lead to more drug-resistant fungal pathogens that can affect humans



THINK FUNGUS. SAVE LIVES.

Some fungal infections can look like other illnesses.
Early diagnosis and proper treatment are essential.



For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348
www.cdc.gov/fungal

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.