



Texas Hospital  
Association Foundation

# NUGGETS OF KNOWLEDGE

Presented by Infection Control Consultants of New Mexico

**ICCNM**

Infection Control Consultants of New Mexico

8/11/2022





# Welcome

IC Nuggets of Knowledge Series are monthly one-hour learning sessions using a web-based format to share information, network, and opportunity to address questions and concerns with ICCNM Consultants

When: 1:00 to 2:00 pm

2nd Thursday of the month

If you have feedback on this learning opportunity or have suggestions for future learning opportunities, feel free to reach out to me at any time!

- [ncostilla@tha.org](mailto:ncostilla@tha.org)





# Introductions

- Infection Control Consultants of NM (ICCNM Consulting)
- New Mexico based consulting company
- Consultants are certified in Infection Control (CIC)
- Presenters for this series
  - Kerry Flint, PhD
  - Terri Kangas-Feller
  - Barbara Mooney
  
- [www.iccnm.org](http://www.iccnm.org)



The background of the slide features a soft-focus photograph of two hands, one holding a small, round, white pill. The hands are positioned centrally, with the pill held between the fingers. The overall color palette is light green and white, with a subtle texture. On the left side, there is a decorative element consisting of thin, dark, curved lines and a solid red arrow pointing to the right.

# Infection Prevention

Fungi

Presented by Terri Kangas-Feller

Infection Control Consultants of New Mexico

8/11/2022





# Objectives

- Describe fungi lifecycles and environments
- Discuss common and threatening fungal infections
- Describe infection prevention measure to combat fungal infections
- Identify testing and treatment challenges



# Fungi

Mushrooms, Yeast, Mold





## Terms

**Fungi:** spore-producing organisms feeding on organic matter, including molds, yeast, mushrooms,

**Mycology:** Study of Fungi

**Mycotoxin:** Toxic substances produced by fungi

**Mold:** multicellular fungi

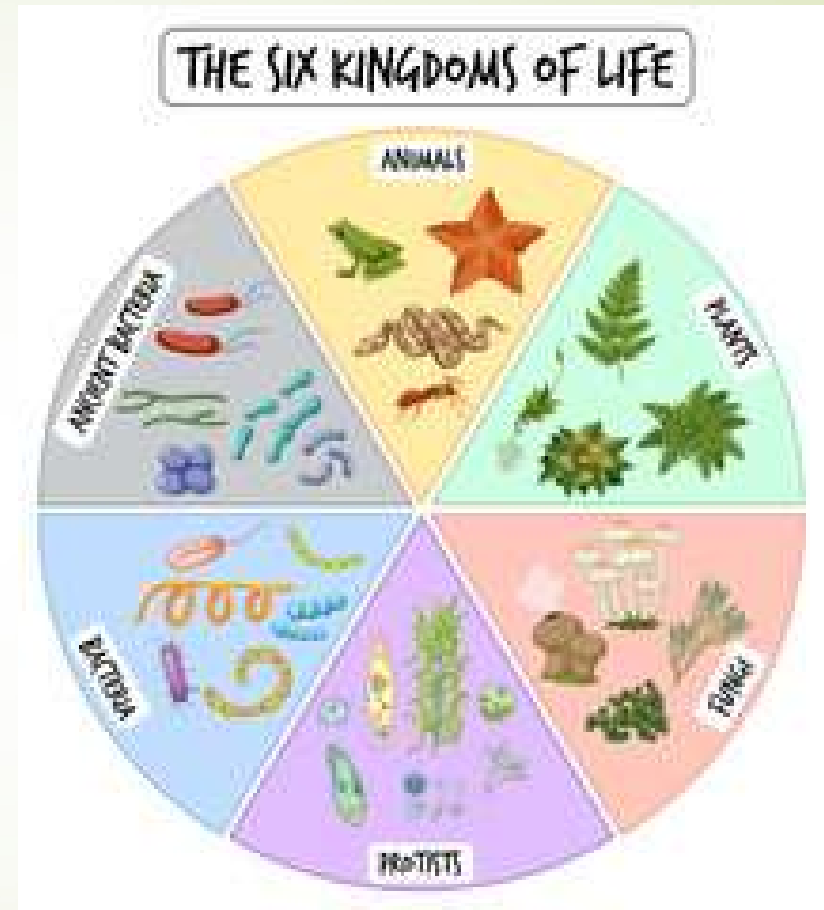
**Yeast:** Single cell microscopic fungus

**Mushrooms:** Fungi with macroscopic fruiting body



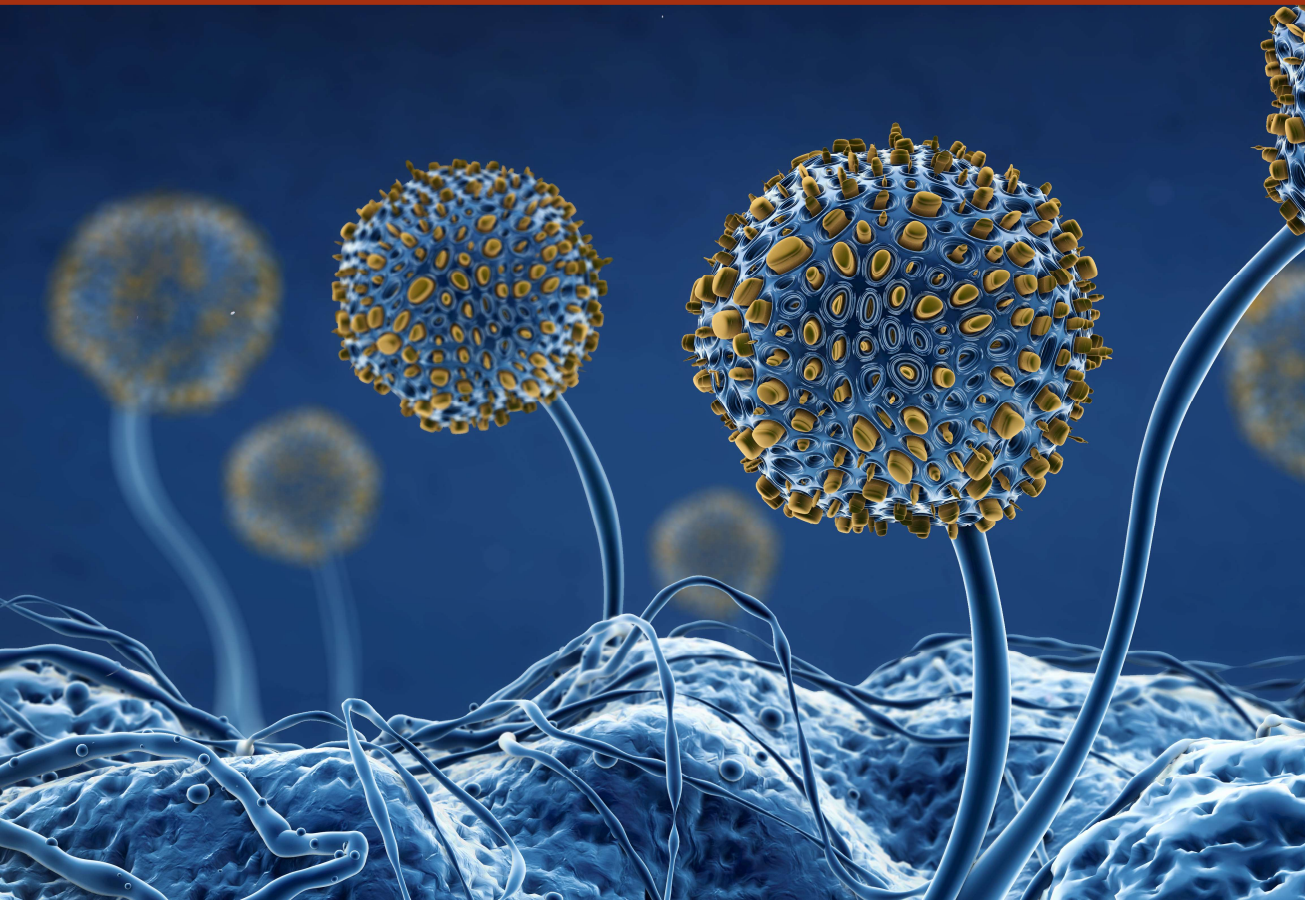
## Plant or Animal?

- Neither
- More like animals than plant





# Fungi Characteristics

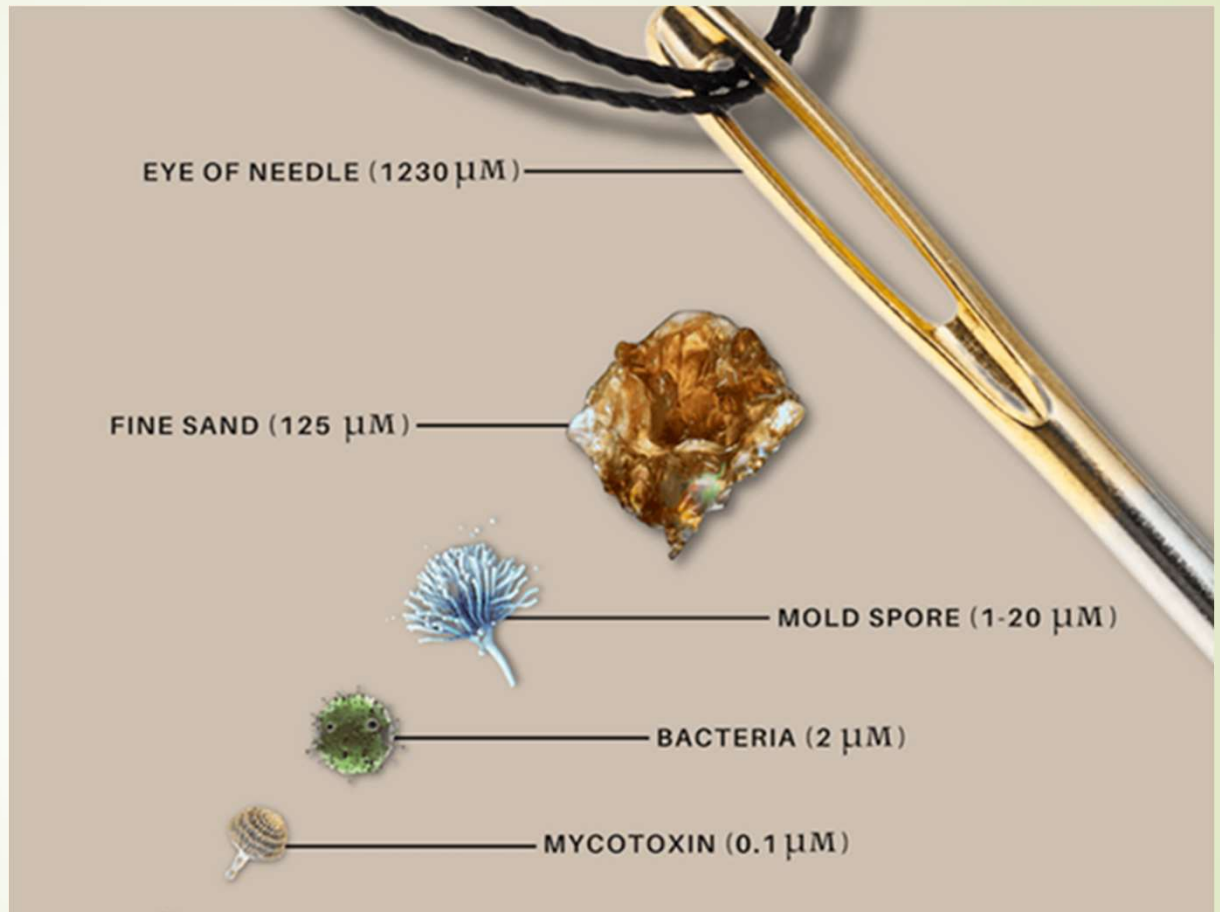


- Cell wall – chitin
- Heterotrophic can not make their own food
  - Decompose dead matter
  - Feed on living hosts
    - Parasitic
    - Symbiosis
      - Lichens
- Not mobile
- Mold spores 2-100 Microns



# Largest Living Thing on Earth

- All mushrooms are fungi
- Not all fungi are mushrooms
- Mushroom is the reproductive organ of the fungi
- 3.5 mile fungi in northwest





# Culinary Fungi

- Ustilago Maydi-Huitlacoche / Corn Smut
- Grifola Frondosa-Maitake
- Tuber Melanosporum-Black Truffle







# Fungi in medicine

- Statins
- Penicillin – Mold Juice
- Cyclosporin
- Cephalosporin



# Fungi in Human Disease

## Common

- Onychomycosis
- Tinea
  - Pedis
  - ringworm
- Candidiasis
  - Thrush
  - Vaginal

## Immune Compromised

- Aspergillosis
- Candida Auris
- Pneumocystis Jirovecii

## Travel

- Histoplasmosis
- Coccidioidomycosis- Valley Fever









## Patient Risk Factors

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Corticosteroids

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TNF inhibitors

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Chemotherapy

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Organ Transplant

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Travel

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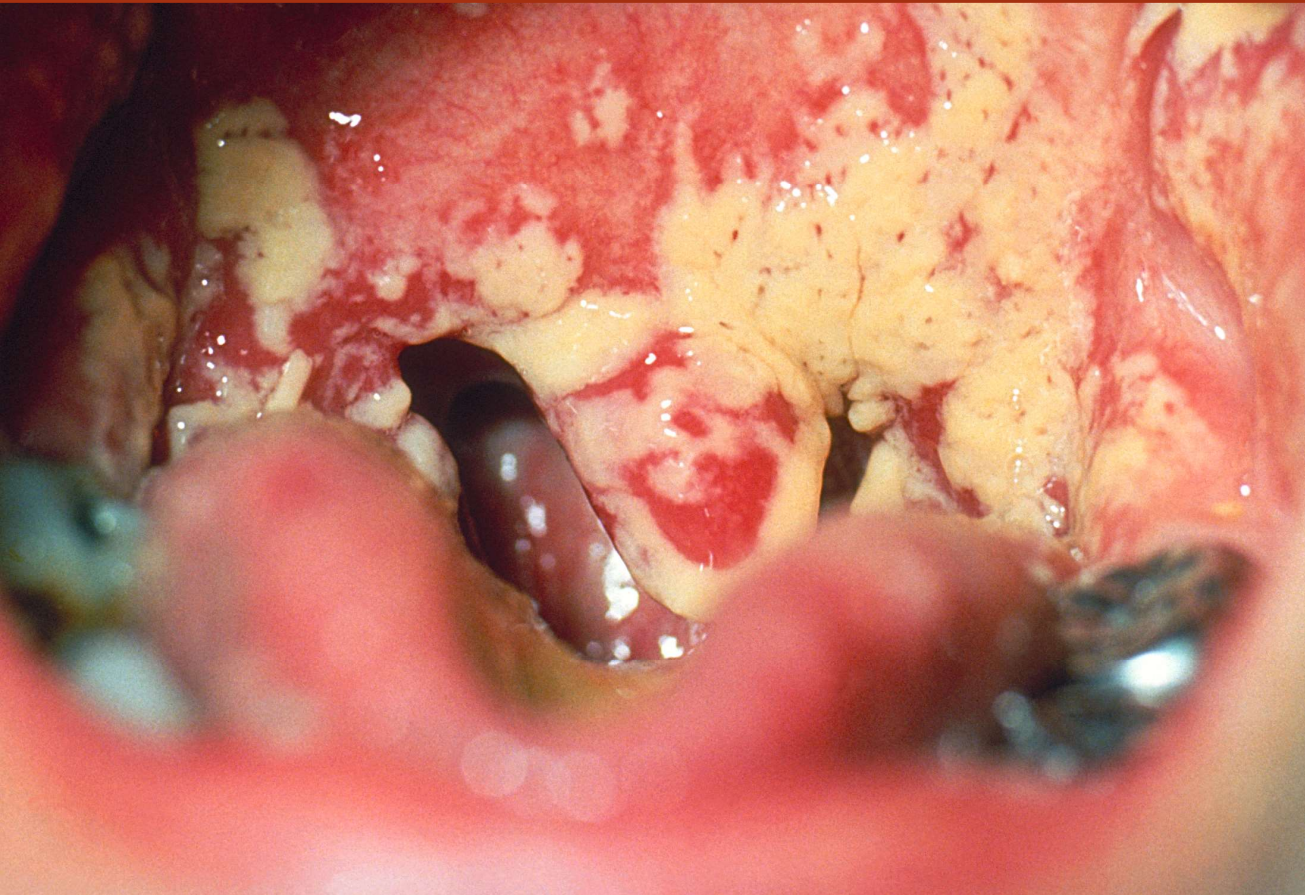
Working outside

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Invasive Devices



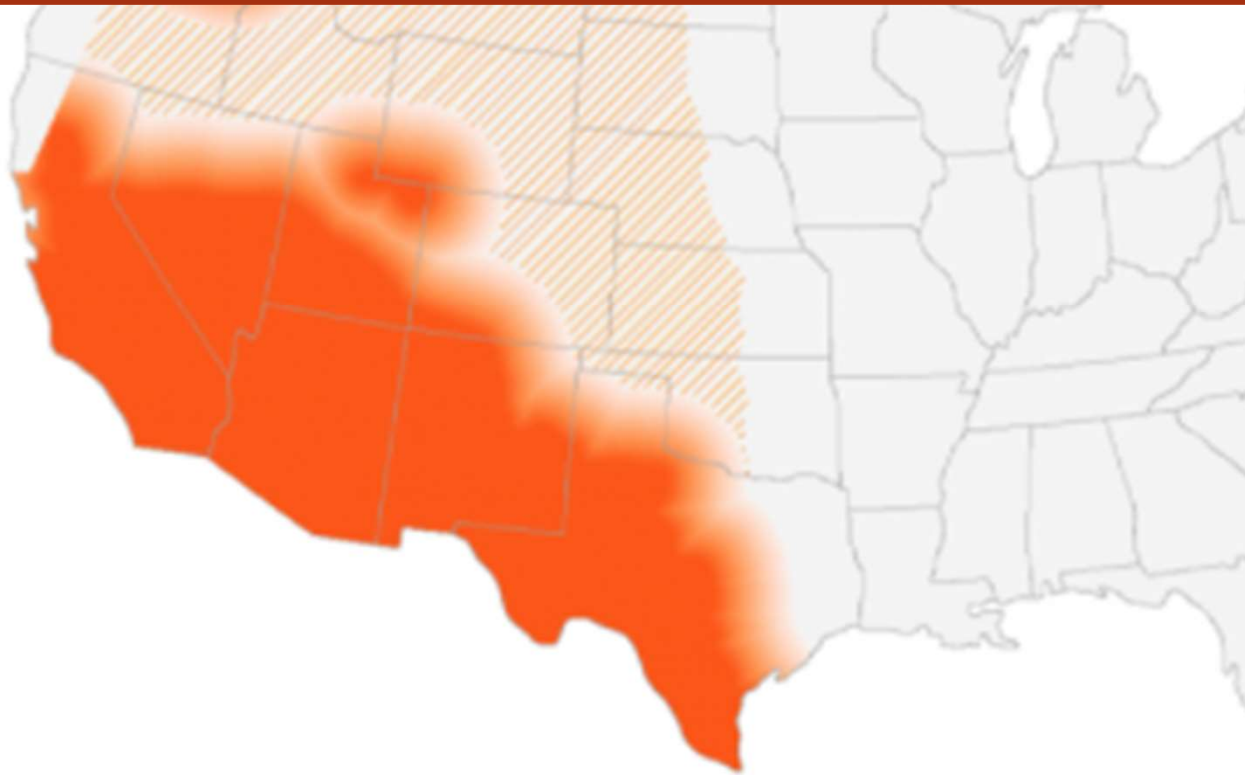
# Candida Albicans



- Three different morphologies
  - Yeast
  - Pseudohyphae
  - Filamentous hyphae
    - Candidalysin toxin
    - Invasive Candidiasis
    - Two week IV therapy after no more candida in the blood stream



# Valley Fever



- Lives in soil
- Common respiratory symptoms 1-3 weeks after exposure
- Blood test, biopsy, CT scan
- 10% develop severe disease
- Lifelong immunity
- No person to person spread
- Treatment up to 6 months



# Candia Auris

- Notifiable Condition within 1 workday
- Mortality rates in US above 22% (59% globally)
- Identified 2009 Japan
- 1996 S. Korea
- EPA List P- 11 products
  - EPA K list (C. diff)
- Microbes supercharged to expel tx
- 98.6-104 F optimal growth
- Incubation period not well defined



<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6253340/>

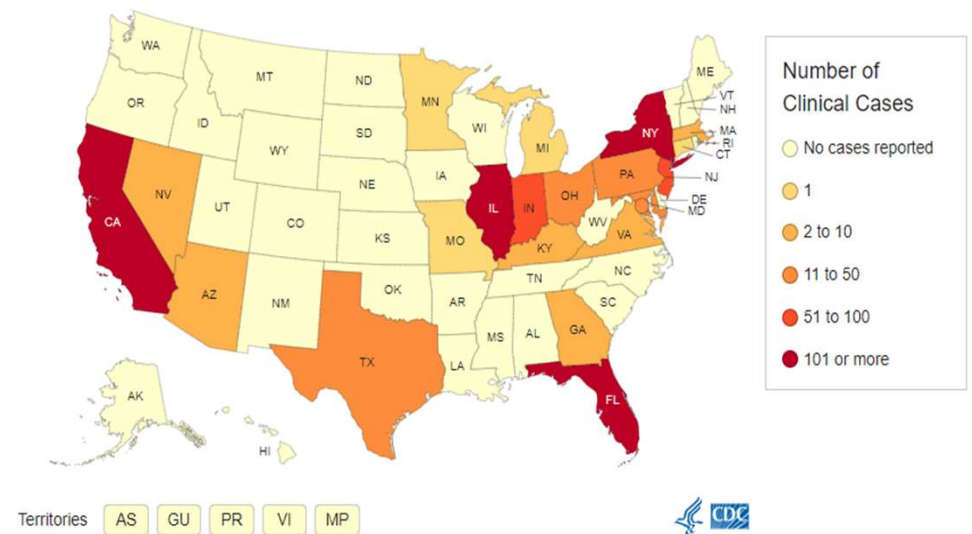


# Candida Auris in Texas

Reported clinical cases of *Candida auris*, 2013-2016



Reported clinical cases of *Candida auris*, January 01, 2021-December 31, 2021







# Treatment

Antifungals

Antimycotic



# Antifungals

## Azoles

- Stop fungal growth, damages cell membrane
- Some OTC
- Drug interactions arrhythmias
- Liver side effects
- Fluconazole

## Echinocandins

- Damage fungal wall
- IV
- Initial *C. auris* tx
- Caspofungin

## Polyenes

- Destroy fungus cell
- IV Amphotericin B
- Topical Nystatin
- Kidney side effects

## Misc.

- Lamisil
- Kidney side effects



# Antifungal Resistance

- Treatment Failure
- MIC limitations
- Infection prevention activities
- Surveillance
- Susceptibility Testing for new antifungals
- Whole genome sequencing on resistant fungi

## Moving Forward to Combat Antifungal Resistance

As part of the 2020 U.S. National Action Plan, CDC and partner agencies are taking action to address antifungal resistance. The activities below are a snapshot of the antifungal resistance activities, including prevention, One Health surveillance, diagnostics and lab capacity building, research, and international collaboration.

### Prevention



- Support state and local health departments to help healthcare facilities contain the spread of *C. auris* through screening and infection control.
- Incorporate antifungal stewardship into existing CDC and state antibiotic stewardship programs.



### One Health Surveillance

- Work with internal and external partners to conduct environmental surveillance for antifungal-resistant *Aspergillus fumigatus* (*A. fumigatus*) in diverse crops and settings across the United States.



### Advanced Diagnostics

- Develop antifungal susceptibility testing assays for new antifungal drugs.
- Validate advanced diagnostic tests to detect antifungal-resistant yeast and molds.
- Work with the Clinical and Laboratory Standards Institute to develop quality control standards for new antifungals.



### Research

- Expand databases of whole-genome sequencing data on *C. auris*, *A. fumigatus*, and other resistant fungi.
- Examine the impact of antibiotics and antifungal drugs on the fungal microbiome and relationships to bacteria and other microbes.
- Study the effectiveness of different disinfectants against *C. auris*.



### International Collaboration

- Strengthen international surveillance and containment of *C. auris* and other types of antifungal-resistant *Candida*.
- Provide technical assistance and training to foreign ministries of health to expand local capacity to detect and identify antifungal-resistant *Candida*.

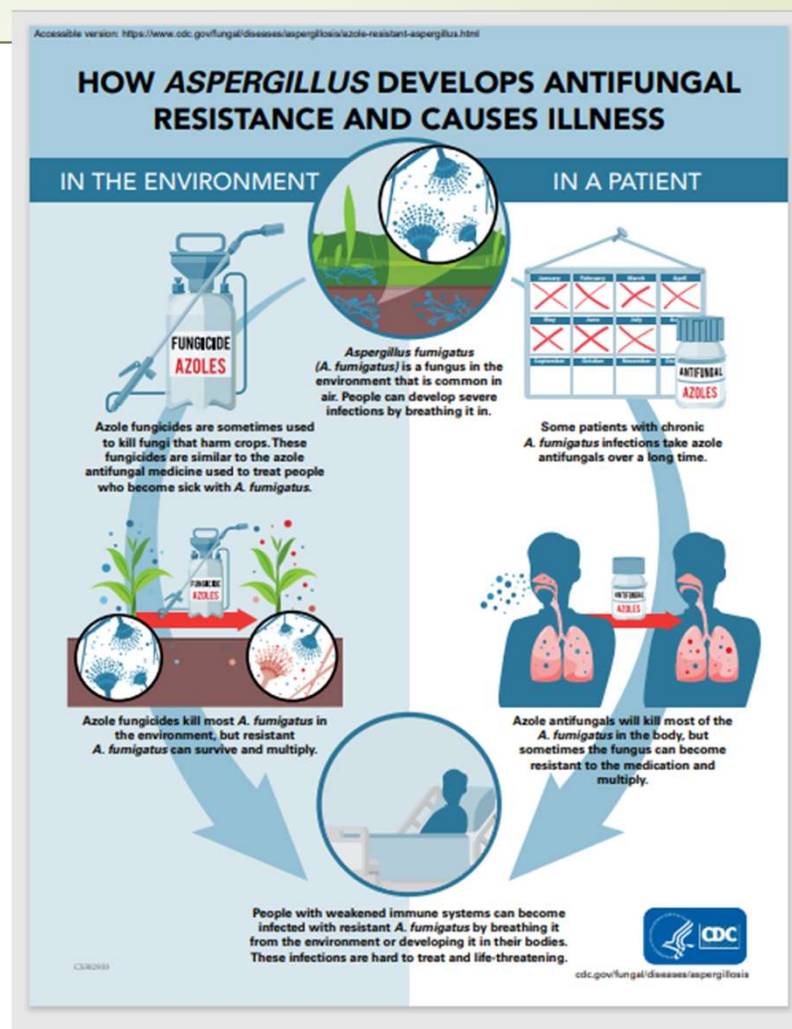
Learn more about CDC's AR Solutions Initiative:  
[www.cdc.gov/DrugResistance/solutions-initiative](http://www.cdc.gov/DrugResistance/solutions-initiative)



U.S. Department of  
Health and Human Services  
Centers for Disease Control and Prevention  
8/11/2022

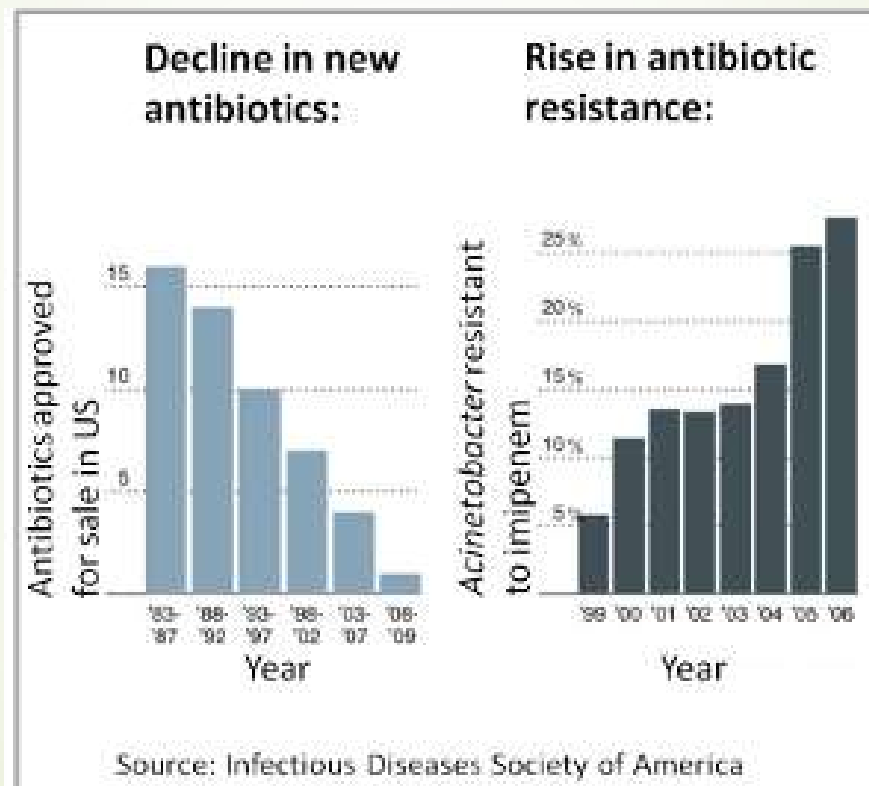


# Agriculture





# The business problem with resistance





# Diagnostic Testing







# Superficial and Systemic Testing

## Skin, Hair, Mucous Membranes and Nails

- Scraping, hair, scalp scale, nail clipping, skin biopsy, swab
- Microscopy
  - Florescent, KOH, Wet mount, staining
- Surveillance of high-risk patients, groin and axilla swab

## Blood, Heart, Brain, Eyes, Bones (IFD) Invasive Fungal Disease

- Culture
- PCR
- Antigen may not distinguish species
- Antibody recent or past
- Radiological
- CT or MRI –Blood cultures MRI
- MALDI-TOF-DNA sequencing



# C. auris

- No phenotypic differences from other candida species
- No antifungal breakpoints
- Ensure your lab can detect it
- In the United States, about 90% of *C. auris* isolates have been resistant to fluconazole, about 30% have been resistant to amphotericin B, and less than 5% have been resistant to echinocandins.
- 1278 Cases annually in U.S. 2021
- (800 2020, 471 2019)

Triazole Class Drugs	Tentative MIC Breakpoints (µg/mL)	Comment
Fluconazole	≥32	Modal minimum inhibitory concentration (MIC) to fluconazole among isolates tested at CDC was ≥256; isolates with MICs ≥32 were shown to have a resistance mutation in the <i>Erg11</i> gene, making them unlikely to respond to fluconazole.
Voriconazole and other second generation triazoles	N/A	Consider using fluconazole susceptibility as a surrogate for second generation triazole susceptibility assessment. However, isolates that are resistant to fluconazole may respond to other triazoles occasionally. The decision to treat with another triazole will need to be made on case-by-case basis.

Polyene Class Drug	Tentative MIC Breakpoints (µg/mL)	Comment
Amphotericin B	≥2	Recent pharmacokinetic/pharmacodynamic analysis of <i>C. auris</i> in a mouse model of infection indicates that under standard dosing, the breakpoint for amphotericin B should be 1 or 1.5, similar to what has been determined for other <i>Candida</i> species. Therefore, isolates with an MIC of ≥2 should now be considered resistant. If using Etest for amphotericin B and an MIC of 1.5 is determined, that value should be rounded up to 2.

Echinocandin Class Drugs	Tentative MIC Breakpoints (µg/mL)	Comment
Anidulafungin	≥4	Tentative breakpoints are based on the modal distribution of echinocandin MICs of approximately 100 isolates from diverse geographic locations.
Caspofungin	≥2	
Micafungin	≥4	





# Culture

- ▀ Days to weeks to grow
- ▀ Highly trained lab personnel
- ▀ Collection difficulties (deep tissue)
- ▀ Colonization versus infection
- ▀ Phenotypic similarities
- ▀ Allows sensitivity testing
- ▀ Delay in treatment
- ▀ Sensitivity issues for some species
- ▀ Commensal contamination



# Standardization of Testing



Identification Method	Organism <i>C. auris</i> can be misidentified as
Vitek 2 YST*	<i>Candida haemulonii</i> <i>Candida duobushaemulonii</i>
API 20C	<i>Rhodotorula glutinis</i> (characteristic red color not present) <i>Candida sake</i>
API ID 32C	<i>Candida intermedia</i> <i>Candida sake</i> <i>Saccharomyces kluyveri</i>
BD Phoenix yeast identification system	<i>Candida haemulonii</i> <i>Candida catenulata</i>
MicroScan	<i>Candida famata</i> <i>Candida guilliermondii</i> ** <i>Candida lusitanae</i> ** <i>Candida parapsilosis</i> **
RapID Yeast Plus	<i>Candida parapsilosis</i> **



# Misidentification

## Tests Which Misidentify *C. auris* as Other *Candida* Species<sup>1,28,30-32,55</sup>

API 20CAUX

API Candida

Phoenix (BD Diagnostics)

Vitek

MicroScan (Beckman Coulter)

Vitek MS (bioMérieux)

## Tests Which Correctly Identify *C. auris*<sup>33,34</sup>

Bruker Biotyper MALDI-TOF (RUO libraries (v 2014[5627] and CA system library (v claim4))

bioMérieux VITEK MS MALDI-TOF (ROU library (Saramis v 4.14))

VITEK 2 YST (Software v 8.01)

Polymerase chain reaction (PCR)

Amplified fragment length polymorphism fingerprinting



# Do fungal infections lead to antibiotic resistance? A Case Study

- A female in her late 20s presented to her PCP with congestion, headaches, dry cough, some dizziness and gum pain after returning from a trip to Asia. She was initially diagnosed with a viral URI.
- With no improvement of her symptoms, she was later diagnosed with sinusitis- because of the congestion and pain. She was prescribed amoxicillin but with no improvement, was switched to azithromycin. Since her shortness of breath became worse, she saw her primary care physician again and was switched to moxifloxacin.
- Chest CT showed a focal left hilar opacity, approximately 3.5 x 3 cm. The etiology of the left hilar mass was not clear. The differential diagnosis would most likely include infectious causes.
- Bacterial pneumonia? Maybe, but Patient has been on antibiotics with no remission.
- Fungal pneumonia? Patient is not immunocompromised, so less likely.
- Lung Cancer? Possible, but the patient is young.
- It was decided to proceed with bronchoscopy with lavage and possible biopsies, if needed.
- *Aspergillus fumigatus*

Molecular Diagnosis of Invasive Aspergillosis | University of Washington  
Laboratory Medicine: Molecular Diagnosis, Microbiology Division



# Prevention Measures



# Prevention Considerations

- Prophylaxis – high risk immunocompromised
- HEPA in high risk wards- Hematology and Stem Cell Transplant units
- ICRA for any renovations
- Remove devices
- Bundles for bacterial infections
- Where was the device accessed

## ➤ Transmission Precautions

- Direct contact
- Inhalation



<https://isid.org/guide/infectionprevention/bundles/>





# Environmental Considerations

- Cardboard
- Wallboard
- Construction and Renovation
- Leaks
- Aromatherapy
- Plants
- Fountains
- Rapid variations in temperature
- Temperature control in surgical suites
- Filtration
- HVAC Systems
- Candida auris viable wet and dry on multiple surfaces





# Are fungi easy to kill?

- Remove stained items
- Detergent and water
- Sporicidal
- Spores
- Hundreds of years
- Extreme heat and cold
- Yeast survives freezing up to 140F





# Disinfectants

## Disinfectants

- EPA P list – 11 products
  - Or EPA K list (c. diff)
  - H<sub>2</sub>O<sub>2</sub>
  - Na ClO
- Quaternary ammonia alone does not achieve adequate log reduction of *C. auris*
- Many early disinfectants did not have antifungal activity
- [List P: Antimicrobial Products Registered with EPA for Claims Against Candida Auris | US EPA](#)





## Where Mold Hides

- Dead spaces
- Bathrooms
- (HVAC) Heating and Air System
- Water Heater / boiler Room
- Doors and Windows
- Kitchens
- Basements
- Crawl Spaces
- Any Moist Areas
- Unventilated storage areas, biohazard areas
- Behind Ceiling Tiles
- Under Carpets





## Sampling

- Mold spores are ubiquitous
- No need to sample if you see mold
- No EPA or federal limits on mold spore counts
- Air sampling, lift tape and swabs
- Outbreak investigation

Resources for Public Health Professionals | US EPA <https://www.epa.gov/mold/resources-public-health-professionals>



# We Found Mold! Now What

Received: 07/28/2017  
 Analyzed: 07/28/2017  
 Order ID: 131703333  
 Proj: ~~131703333-0006~~

Test Report: Air-O-Cell™ Analysis of Fungal Spores & Particulates by Optical Microscopy (Methods EMSL 05-TP-003, ASTM D7391)

Lab Sample Number:	131703333-0006	131703355-0006	131703333-0008	131703333-0009	131703333-0010
Client Sample ID:	072817-A06	A6	072817-A08	072817-A09	072817-A10
Volume (L):	150	150	159	159	159
Sample Location:	Admitting-HVAC	Outside	New Pharm-HVAC	New HR-HVAC on	Campus
Spore Types	Count/m?	Count/m?	Count/m?	Count/m?	Count/m?
Alternaria	-	40	-	-	20
Ascomycetes	570	100	100	-	-
Aspergillus/Penicillium	680	-	-	100	230
Basidiospores	4360	7750	1200	-	700
Bipolaris++	-	-	-	-	-
Chaetomium	-	-	-	-	-
Cladosporium	700	680	40	-	40
Curvularia	-	7*	-	-	-
Epicoccum	-	20	-	-	-
Fusarium	-	-	-	-	-
Ganoderma	310	740	40	-	20
Myxomycetes++	100	70	40	-	20
Pithomyces	-	20	-	-	-
Rust	-	-	-	-	-
Scopulariopsis	-	-	-	-	-
Stachybotrys	-	-	-	-	-
Torula	-	-	-	-	-
Ulocladium	-	-	-	-	-
Unidentifiable Spores	-	-	-	-	-
Zygomycetes	-	-	-	-	-
Zygophiala	-	20	-	-	-
<b>Total Fungi</b>	<b>6720</b>	<b>9447</b>	<b>1420</b>	<b>100</b>	<b>1030</b>
Hyphal Fragment	-	-	-	-	-
Insect Fragment	-	-	-	-	-
Pollen	20	-	-	-	-
Analyt. Sensitivity 600x	22	22	21	21	21
Analyt. Sensitivity 300x	7*	7*	6*	6*	6*
Skin Fragments (1-4)	3	1	1	1	1
Fibrous Particulate (1-4)	2	1	1	1	1
Background (1-5)	3	2	1	3	1

- Air testing over \$500 per test



# Is dry mold safe?

- ▶ Dormant mold can trigger reactions
- ▶ Mold will reactivate and grow again when exposed to moisture
- ▶ Microscopic mold hides
- ▶ It can travel great distances in the air or HVAC system
- ▶ Clings to clothing







# Cardboard

- Mold eats Cellulose
- Humidity 60% and Room temperature
- Hyphae grow into the material – not visible
- Discard at shipping and receiving area
- Transfer to plastic or nonporous containers
- Eliminate corrugated cardboard from patient care areas



# Construction and Renovation

- ICRA Infection Control Risk Assessment for renovations
- Air Scrubbers
- Negative air pressure
- Vent outdoors
- Tacky mats
- Covered debris
- Environment of Care
- Lumberyard agreements

[Construction Matrix \(apic.org\)](https://apic.org/Resource/TinyMceFileManager/Education/ASC_Intensive/Resources_Page/ICRA_Risk_Assessment_for_Construction_and_Renovation.pdf)

[https://apic.org/Resource/TinyMceFileManager/Education/ASC\\_Intensive/Resources\\_Page/ICRA\\_Risk\\_Assessment\\_for\\_Construction\\_and\\_Renovation.pdf](https://apic.org/Resource/TinyMceFileManager/Education/ASC_Intensive/Resources_Page/ICRA_Risk_Assessment_for_Construction_and_Renovation.pdf)

**Step Two:**  
Using the following table, *Identify the Patient Risk Groups* that will be affected.  
If more than one risk group will be affected, select the higher risk group:

Low Risk	Medium Risk	High Risk	Highest Risk
<ul style="list-style-type: none"> <li>Office areas</li> </ul>	<ul style="list-style-type: none"> <li>Cardiology</li> <li>Echocardiography</li> <li>Endoscopy</li> <li>Nuclear Medicine</li> <li>Physical Therapy</li> <li>Radiology/MRI</li> <li>Respiratory Therapy</li> </ul>	<ul style="list-style-type: none"> <li>CCU</li> <li>Emergency Room</li> <li>Labor &amp; Delivery</li> <li>Laboratories (specimens)</li> <li>Medical Units</li> <li>Newborn Nursery</li> <li>Outpatient Surgery</li> <li>Pediatrics</li> <li>Pharmacy</li> <li>Post Anesthesia Care Unit</li> <li>Surgical Units</li> </ul>	<ul style="list-style-type: none"> <li>Any area caring for immunocompromised patients</li> <li>Burn Unit</li> <li>Cardiac Cath Lab</li> <li>Central Sterile Supply</li> <li>Intensive Care Units</li> <li>Negative pressure isolation rooms</li> <li>Oncology</li> <li>Operating rooms including C-section rooms</li> </ul>

**Step 2**

**Step Three: Match the**  
Patient Risk Group (Low, Medium, High, Highest) with the planned ...  
Construction Project Type (A, B, C, D) on the following matrix, to find the ...  
Class of Precautions (I, II, III or IV) or level of infection control activities required.  
Class I-IV or Color-Coded Precautions are delineated on the following page.

**IC Matrix - Class of Precautions: Construction Project by Patient Risk**

Patient Risk Group	Construction Project Type			
	TYPE A	TYPE B	TYPE C	TYPE D
LOW Risk Group	I	II	II	III/IV
MEDIUM Risk Group	I	II	III	IV
HIGH Risk Group	I	II	III/IV	IV
HIGHEST Risk Group	II	III/IV	III/IV	IV

Note: Infection Control approval will be required when the Construction Activity and Risk Level indicate that **Class III** or **Class IV** control procedures are necessary.

**Step 3**

Steps 1-3: Adapted with permission V Kennedy, B Barnard, St Luke Episcopal Hospital, Houston TX; C Fine CA. Steps 4-14: Adapted with permission Fairview University Medical Center Minneapolis MN. Forms modified / updated; provided courtesy of Juliana Barbery, ICSC Inc. Beverly Hills 90 2002. [jbarbery@icscinc.org](mailto:jbarbery@icscinc.org) / Updated, 2008.

8/11/2022



# Mortality and Morbidity



	<b>Inpatient Hospital Infection Rates 7 Months Pre Harvey</b>	<b>Inpatient Hospital Infection Rates 7 Months Post Harvey</b>
Aspergillus	0.1506	0.1621
Mucorales	0.0167	0.0000
Fusarium	0.0167	0.0085
Scedosporium	0.0000	0.0000
Total	0.1840	0.1706
	<b>Inpatient Service Line Infection Rates 7 Months Pre Harvey</b>	<b>Inpatient Service Line Infection Rates 7 Months Pre Harvey</b>
MM/Lymphoma	0.3185	0.2441
Solid Tumor	0.0588	0.0594
Leukemia	0.3655	0.5052
Stem Cell Transplant	0.1835	0.184



# Mortality in Susceptible Patients

- During Construction or Renovation
- Aspergillosis

Clinical Infectious Diseases, Volume 61, Issue 3,  
1 August 2015, Pages 433–444,  
<https://doi.org/10.1093/cid/civ297>

**Table 2.** Fungal Infections and Associated Mortality by Each Underlying Disease During Construction, Renovation, or Demolition

Underlying Diseases	No. of Articles Published	No. of Patients Infected	No. of Patients Died	Mortality, No. <sup>a</sup> (%)
Hematologic malignancies or bone marrow transplant	26	414	148	131/288 (45.5)
Other malignancies, transplant, and/or immunosuppressed patients	13	105	38	38/60 (63.3)
Patients in intensive care unit	3	8	2	2/4 (50)
Rheumatology patients	2	6	4	4/6 (66.7)
After surgery	2	8	1	1/8 (12.5)
Premature infant	2	3	2	2/3 (66.7)
Nephrology and dialysis patients	1	3	2	2/3 (66.7)
Total	49	547	197	180/372 (48.4)

a. Mortality was defined as death attributable to the infection.





# A Growing Neglected Crisis

- US
  - 75,000 hospitalizations
  - 7.2 Billion in direct cost
  - Invasive Aspergillosis 30-95%
  - Candidemia 25%
- Global Estimates
  - 1.5M
- Comorbidities
  - COPD
  - HIV/Aids
- IV drug use
  - Clean skin
  - Cleaning needles
  - Bexar County needle exchange

[Fungal infections in humans: the silent crisis - PMC \(nih.gov\)](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7278517/)  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7278517/>





8/11/2022





- Know lab capability
- Know patient risk factors
- Surveillance and reporting
- Notify receiving facilities
- Awareness of global and local initiatives

- Antimicrobial Stewardship
- Heightened environmental cleaning and rounding
- Contact precautions
- Hand hygiene
- Educate





Prevention Saves Lives

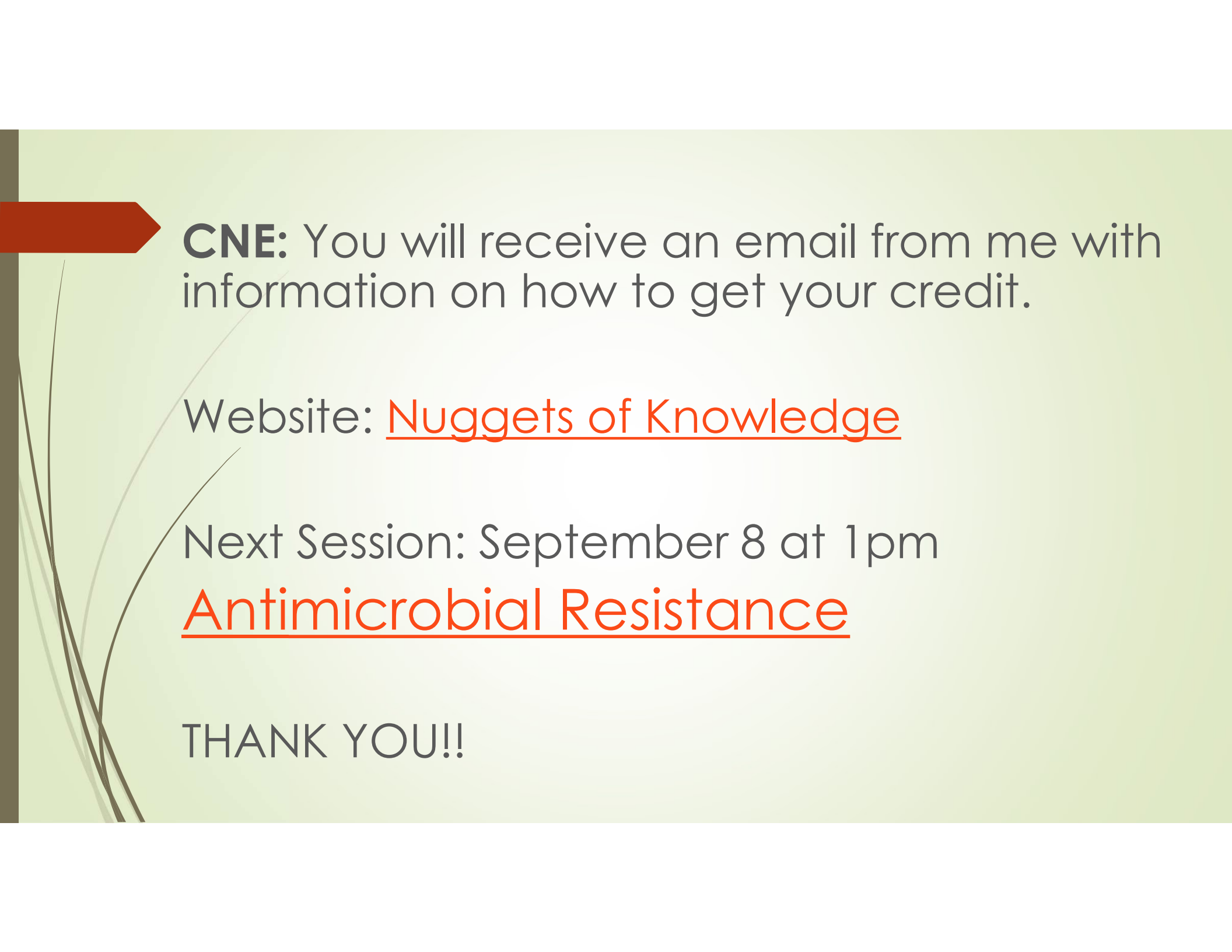
8/11/2022



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Next Session: September 8 at 1pm  
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