Mycology Proficiency Testing Program
May 2011 Test Event
Critique

Wadsworth Center
New York State Department of Health
Dr. Vishnu Chaturvedi, Director

Dr. Ping Ren, Proficiency Testing Program Coordinator

Mycology Laboratory
Wadsworth Center
New York State Department of Health
120 New Scotland Avenue
Albany, NY 12208

Phone: (518) 474-4177
Fax: (518) 486-7971
E-mail: mycologpyt@wadsworth.org
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## Schedule of 2011 Mycology PT Mailouts*

<table>
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<tr>
<th>CATEGORY</th>
<th>POSTMARK DEADLINES</th>
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<td>September 27, 2011</td>
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<tr>
<td>September 27, 2011</td>
<td>November 14, 2011</td>
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*Mycology PT Program has a set of standard test strains, which typically represent characteristic features of the respective species. These strains will be made available to the participating laboratories for educational purposes. For practical reasons, no more than two strains will be shipped at any given time subject to a maximum of five strains per year. Preference will be given to laboratories that request test strains for remedial purposes following unsatisfactory performance.
TEST SPECIMENS AND GRADING POLICY

Test Specimens*

Two or more strains of yeast species were examined for inclusion in the proficiency test. The colony morphology of all yeast strains was studied on corn meal agar with Tween 80 plates inoculated by Dalmau or streak-cut method. Carbohydrate assimilation was studied with the API 20C AUX identification kit. The fermentations of carbohydrates, i.e., glucose, maltose, sucrose, lactose, trehalose, and cellobiose, were also investigated using classical approaches. Additional physiologic characteristics such as nitrate assimilation, urease activity, and cycloheximide sensitivity were investigated with the appropriate test media. The single strain that best demonstrated the morphologic and physiologic characteristics of the proposed test analyte was selected. Finally, ITS1 – ITS2 region of ribosomal genes was amplified, sequenced, and BLAST searched in two databases.

Grading Policy

A laboratory’s response for each sample is compared with the response that reflects 80 percent agreement of 10 referee laboratories and/or 80 percent of all participating laboratories. The referee laboratories are selected at random from among hospital laboratories participating in the program. They represent all geographical areas of New York State and must have a record of excellent performance during the preceding three years. The score in each event is established by total number of correct responses submitted by the laboratory divided by the number of organisms present plus the number of incorrect organisms reported by the laboratory multiplied by 100 as the formula shown below.

\[
\frac{\text{# of correct responses} \times 100}{\text{# of fungi present} + \text{# incorrect responses}}
\]

Acceptable results for antifungal susceptibility testing are based on consensus MIC values +/- 2 dilutions or interpretation per CLSI (NCCLS) guidelines or related, peer-reviewed publications. One yeast is to be tested against following drugs: amphotericin B, anidulafungin, caspofungin, flucytosine (5-FC), fluconazole, itraconazole, ketoconazole, micafungin, posaconazole, and voriconazole. The participating laboratories are allowed to select any number of antifungal drugs from the test panel based upon test practices in their facilities. A maximum score of 100 will be equally distributed to account for the drugs selected by an individual laboratory. If the result for any drug is incorrect then laboratory gets a score of zero for that particular test component or set.

A failure to attain an overall score of 80% is considered unsatisfactory performance. Laboratories receiving unsatisfactory scores in two out of three consecutive proficiency test events may be subject to ‘cease testing’.

*The use of brand and/or trade names in this report does not constitute an endorsement of the products on the part of the Wadsworth Center or the New York State Department of Health.
ANSWER KEY AND LABORATORY PERFORMANCE

Mycology – Identification and Identification Yeast Only

<table>
<thead>
<tr>
<th>Specimen Key</th>
<th>Validated Specimen</th>
<th>Other Acceptable Answers</th>
<th>Correct Responses / Total # Laboratories (%)</th>
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<tr>
<td>Y-1</td>
<td>Candida albicans</td>
<td>Candida albicans</td>
<td>121/122 (99)</td>
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<tr>
<td>Y-2</td>
<td>Candida lipolytica</td>
<td>Candida lipolytica</td>
<td>113/121 (93)</td>
</tr>
<tr>
<td>Y-3</td>
<td>Candida zeylanoides</td>
<td>Candida zeylanoides</td>
<td>121/121 (100)</td>
</tr>
<tr>
<td>Y-4</td>
<td>Cryptococcus neoformans</td>
<td>Cryptococcus neoformans</td>
<td>121/121 (100)</td>
</tr>
<tr>
<td>Y-5</td>
<td>Geotrichum candidum</td>
<td>Geotrichum candidum</td>
<td>121/121 (100)</td>
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</tbody>
</table>

   Geotrichum klebahnii
   Geotrichum penicillatum
   Geotrichum sp.

Mycology – Antifungal Susceptibility Testing for Yeasts  (S-1: Candida albicans M954)

<table>
<thead>
<tr>
<th>Drugs</th>
<th>Acceptable MIC (μg/ml) Range</th>
<th>Acceptable Interpretation</th>
<th>Acceptable Responses/Total # Laboratories (%)</th>
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<tbody>
<tr>
<td>Amphotericin B</td>
<td>0.25 – 1</td>
<td>Susceptible / No interpretation</td>
<td>24/24 (100)</td>
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<tr>
<td>Anidulafungin</td>
<td>≤ 0.015 – 0.12</td>
<td>Susceptible</td>
<td>17/17 (100)</td>
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<tr>
<td>Caspofungin</td>
<td>0.03 – 0.5</td>
<td>Susceptible</td>
<td>22/22 (100)</td>
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<tr>
<td>Flucytosine (5-FC)</td>
<td>0.03 – 0.5</td>
<td>Susceptible</td>
<td>27/27 (100)</td>
</tr>
<tr>
<td>Fluconazole</td>
<td>≥ 64</td>
<td>Resistant</td>
<td>33/33 (100)</td>
</tr>
<tr>
<td>Itraconazole</td>
<td>0.25 – 2</td>
<td>Susceptible-dose dependent / Resistant</td>
<td>31/31 (100)</td>
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<tr>
<td>Ketoconzole</td>
<td>0.12 – 3</td>
<td>Susceptible / No interpretation</td>
<td>6/6 (100)</td>
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<tr>
<td>Micafungin</td>
<td>0.015 – 0.12</td>
<td>Susceptible</td>
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<td>Posaconazole</td>
<td>0.25 – 2</td>
<td>Susceptible / No interpretation</td>
<td>18/18 (100)</td>
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<tr>
<td>Voriconazole</td>
<td>0.5 – 2</td>
<td>Susceptible / Susceptible-dose dependent</td>
<td>24/24 (100)</td>
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### TEST STATISTICS

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<tr>
<th></th>
<th>General</th>
<th>Yeast Only</th>
<th>Antifungal Susceptibility Testing for Yeasts</th>
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<tr>
<td>Number of participating laboratories</td>
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<td>53</td>
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<td>Number of referee laboratories</td>
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<td>33</td>
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<tr>
<td>Number of laboratories responding by deadline</td>
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<tr>
<td>Number of laboratories responding after deadline</td>
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<tr>
<td>Number of laboratories not responding</td>
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<tr>
<td>Number of laboratories successfully completing this test</td>
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<tr>
<td>Number of laboratories unsuccessfully completing this test</td>
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#### Number of Laboratories Using Commercial Yeast Identification System*

- API 20C AUX: 92
- Vitek: 13
- Vitek2 system: 55
- Remel Uni-Yeast-Tek: 10
- Microscan: 4
- Other: 15

#### Number of Laboratories Using Commercial Antifungal Susceptibility Testing System/Method*

- TREK Diagnostic System Sensititre YeastOne Panel: 25
- Etest: 5
- Disk diffusion: 1
- Viteck 2: 1
- Others †: 3

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*Include multiple systems used by some laboratories  
†Include laboratories using CLSI Microbroth dilution method
YEAST DESCRIPTIONS

Y-1 Candida albicans

Source: Blood / Urine / Skin

Laboratory Performance: No. Laboratories
Referee Laboratories with correct ID: 10
Laboratories with correct ID: 121
Laboratories with incorrect ID: 1
(Candida dubliniensis) (1)
Outcome: Validated

Clinical Significance: Candida albicans is the most common cause of candidiasis. It is ubiquitous in humans who probably encounter it initially during passage through the birth canal. The serious infections are generally seen in immunocompromised patients.

Ecology: C. albicans is found as a commensal on humans and a number of other mammals. Also found on leaves, flowers, water, and soil.

Laboratory Diagnosis:
1. Culture – On Sabouraud’s dextrose agar at 25°C for 3 to 5 days, colonies were white to cream, glossy, smooth and soft (Figure 1).
2. Microscopic morphology – On cornmeal agar with Tween 80, round blastoconidia bunched together with pseudohyphae were easily seen. Thick walled, mostly terminal chlamydospores were prominent (Figure 2).
3. Differentiation from other yeasts – By morphological criterion, C. albicans is difficult to distinguish from C. dubliniensis. However, C. albicans grows well at 42°C and 45°C, but C. dubliniensis grows poorly or not at all at 42°C or 45°C. C. dubliniensis generally produces more abundant chlamydospores than C. albicans. If the CHEOMagar was used for diagnosis, bluish green color distinguishes C. albicans from dark-green color of C. dubliniensis. The positive germ tube test for C. albicans distinguishes it from C. tropicalis.
4. In vitro susceptibility testing – C. albicans is sensitive to amphotericin B, anidulafungin, caspofungin, micafungin, fluconazole, and posaconazole. Fluconazole-resistant isolates of C. albicans are also reported.
5. Molecular tests – Molecular tests are available for identification of C. albicans. A large number of DNA typing and nucleotide sequencing methods are available for molecular epidemiology of C. albicans strains.

Comments: One laboratory reported this specimen as C. dubliniensis, which can be distinguished by use of commercially available yeast identification systems and poor to no growth at 45°C.

Sequences alignment:

The identity of the test isolate was confirmed in Mycology PTP program by sequencing of its ITS1 and ITS2 regions of rDNA.

Query 1 CATTACTGATTTGCTTAATTGCACCACATGTGTTTTTCTTTGAAACAAACTTGCTTTGGC 60
Sbjct 30 CATTACTGATTTGCTTAATTGCACCACATGTGTTTTTCTTTGAAACAAACTTGCTTTGGC 89
Alignment of primary sequences of the ITS1 and ITS2 regions of Candida albicans WM 10.98 and PT specimen C. albicans M954.

**Further Reading:**


Figure 1. Four-day-old, white, glossy, and smooth colony of *Candida albicans* on Sabouraud’s dextrose agar.

Figure 2. Microscopic morphology of *Candida albicans* on corn meal agar with Tween 80 shows terminal chlamydosores on pseudohyphae with blastoconidia (left; 400× magnification, right; line diagram not to scale).
**Y-2 Candida lipolytica**

Source: Skin / Tissue / Urine

Laboratory Performance: No. Laboratories
Referee Laboratories with correct ID: 10
Laboratories with correct ID: 113
Laboratories with incorrect ID: 8
  - *Candida krusei* (4)
  - *Candida rugosa* (2)
  - *Trichosporon* sp. (2)
Outcome: Validated

**Clinical Significance:** *Candida lipolytica* causes catheter-related fungemia and sinusitis in immunocompromised patients. It is also reported from traumatic ocular infections. It has been isolated as a colonizer from human vagina.

**Ecology:** *C. lipolytica* has been isolated from humans, lower mammals and plants.

**Laboratory Diagnosis:**

1. **Culture** – On Sabouraud’s dextrose agar, after 7 days at 25°C, *C. lipolytica* colony was white to cream. The surface was wrinkled (Figure 3).

2. **Microscopic morphology** – On corn meal agar with Tween 80, *C. lipolytica* showed abundant, multibranched true hyphae and infrequent blastoconidia along the hyphae (Figure 4). *Yarrowia lipolytica*, the teleomorph (sexual form) of *C. lipolytica*, can form ascospores on yeast malt agar in 3 to 7 days at 25°C.

3. **Differentiation from other yeasts** – *C. lipolytica* grows on media containing cycloheximide, grows well at 25°C, is urease positive, and negative on nitrate reactions. Sugars are not fermented by *C. lipolytica*. No growth at 42°C and positive growth on media containing cycloheximide differentiates it from *C. krusei*. Positive urease reaction and growth on media containing cycloheximide differentiates it from *C. lambia*. *C. lipolytica* is differentiated from *Geotrichum* species by negative urease reaction by the later. On the API 20C AUX, a specific assimilation biocode differentiates this organism from the Genus *Trichosporon*.

4. **In vitro susceptibility testing** – *C. lipolytica* is less susceptible to amphotericin B, but more susceptible to caspofungin. Most isolates are susceptible to azoles like fluconazole and ketoconazole and 5FC, but resistant to itraconazole.

5. **Molecular tests** – Comparisons of partial rRNA/rDNA sequences analysis demonstrated that *C. lipolytica* is distinctly related to selected members of Genus *Candida*. Randomly amplified polymorphic DNA (RAPD) PCR has been used for the identification of *C. lipolytica* isolates from dairy products (1, 2).

**Comments:** *C. lipolytica* can be differentiated from *C. krusei/inconspicua* and *C. rugosa* by its positive growth on the media containing cycloheximide. *Trichosporon* sp. produces arthroconidia, but *C. lipolytica* does not.

**Sequences alignment:**

The identity of the test isolate was confirmed in Mycology PTP program by sequencing of its ITS1 and ITS2 regions of rDNA.
Alignment of primary sequences of the ITS1 and ITS2 regions of Candida lipolytic ATCC9773 and PT specimen C. lipolytic M1561.

Further Reading:
**Figure 3.** Seven-day-old, white to cream colony with wrinkled surface of *Candida lypolytica* on Sabouraud’s dextrose agar.

**Figure 4.** Microscopic morphology of *Candida lypolytica* on corn meal agar with Tween 80 showing multibranched, true hyphae, and few blastoconidia (A, 400× magnification; B, line drawing not to scale).
**Y-3 *Candida zeylanoides***

Source: Nail / Urine

Laboratory Performance:
Referee Laboratories with correct ID: 10
Laboratories with correct ID: 121
Laboratories with incorrect ID: 0
Outcome: Validated

**Clinical Significance:** *Candida zeylanoides* is a relatively rare pathogen in humans. In immunocompromised patients, *C. zeylanoides* causes fungemia, endocarditis, and arthritis. In immunocompetent patients, it causes skin and nail infections.

**Ecology:** *C. zeylanoides* is cosmopolitan, found in water, meat, and on human body.

**Laboratory Diagnosis:**
1. **Culture** – On Sabouraud’s dextrose agar after 7 days at 25°C, colony was smooth, cream-colored, butyrous, raised (Figure 5).
2. **Microscopic morphology** – On corn meal agar with Tween 80, *C. zeylanoides* formed long pseudohyphae, with verticillate, ovoid blastoconidia (Figure 6). Blastoconidia were produced in whorls around the pseudohyphae.
3. **Differentiation from other yeasts** – *C. zeylanoides* does not ferment any carbohydrates, grows at 37°C, grows on media containing cycloheximide, and assimilates limited carbohydrates.
4. **In vitro susceptibility testing** – *C. zeylanoides* is susceptible to amphotericin B and to the commonly used azoles.
5. **Molecular tests** – Multiplex PCR using ITS1 and ITS2 was reported for rapid detection and identification of yeast strains.

**Comments:** All of the participating laboratories correctly identified this specimen.

**Sequence alignment:**

The identity of the test isolate was confirmed in Mycology PTP program by sequencing of its ITS1 and ITS2 regions of rDNA.

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Query: TACTAAAAACTTCAaatatatattgaattttaggaatttatattatattatattatattatattttttttttgatt 180

Sbjct: TACTAAAAACTTCAaatatatattgaattttaggaatttatattatattatattatattatattatattatattttagatt 231

Query: aaattCAAATAACTCTCAAAAACTTTCAACAAACGGGATCCTTTGGTCTTCGATCGAAGA 240

Sbjct: AAATCAAAAATCTTCAAAAACCTTTCAACAAACGGGATCCTTTGGTCTTCGATCGAAGA 291
Alignment of primary sequences of the ITS1 and ITS2 regions of *Candida zeylanoides* TJY13a and PT specimen *C. zeylanoides* M1564.

**Further Reading:**


**Figure 5.** Seven-day-old, colony creamish white, butryous, raised colony of *Candida zeylanoides* on Sabouraud’s dextrose agar.

**Figure 6.** Microscopic morphology of *Candida zeylanoides* on corn meal agar with Tween 80, showing long pseudohyphae with verticillate, ovoid blastoconidia (left; 200x magnification, right; line drawing not to scale).
**Y-4 Cryptococcus neoformans**

Source: CSF / Skin / Urine

Laboratory Performance:
Referee Laboratories with correct ID: 10
Laboratories with correct ID: 121
Laboratories with incorrect ID: 0
Outcome: Validated

**Clinical Significance:** The incidence of cryptococcosis due to *Cryptococcus neoformans* infection increased with the spread of AIDS and other immunosuppressive conditions. *Cr. neoformans* var. *grubii* and var. *neoformans* mainly cause meningoencephalitis in patients with AIDS or other underlying immune dysfunctions. *Cr. neoformans* var. *neoformans* infections are more likely to have cutaneous involvement, and to infect older patients, than are infections caused by *Cr. grubii*. *Cr. gattii* causes pulmonary cryptococcosis and systemic cryptococcosis in normal and immunocompromised hosts.

**Ecology:** *Cryptococcus neoformans* var. *neoformans* and var. *grubii* are commonly found in avian (pigeon) droppings. Both varieties have world-wide distributions, while *Cr. neoformans* var. *neoformans* is more common in Southern Europe. *Cr. gattii* is commonly found on *Eucalyptus* and other trees and mainly distributed in Australia, Southeast Asia, Southern California, Pacific Northwest, Vancouver Island, British Columbia, Canada, and South America.

**Laboratory Diagnosis:**
1. **Culture** – On Sabouraud’s dextrose agar after 7 days at 25°C, colony was cream to tan in color, smooth, moist, and soft (Figure 7).
2. **Microscopic morphology** – On corn meal agar with Tween 80, *Cr. neoformans* cells were large and round, with no pseudohyphae or true hyphae. In India-ink preparation, encapsulated yeasts were seen (Figure 8).
3. **Differentiation from other yeasts** – *Cr. neoformans* does not ferment any carbohydrates and does not grow on media containing cycloheximide, but it grows at 37°C. *Cr. neoformans* produces dark brown colonies on niger seed agar. It produces urease enzyme and it is negative on nitrate reaction. *Cr. neoformans* and *Cr. gattii* are distinguished by 1) differential media. *Cr. gattii* growth on canavanine-glycine-bromthymol blue (CGB) agar turn the medium blue-green after 2 – 5 days of incubation at 25°C; 2) PCR technique: *Cr. gattii* can be differentiated from the other two varieties using a number of primers; 3) serotyping: *Cr. neoformans* var. *grubii* is serotype A, *Cr. neoformans* var. *neoformans* is serotype D, *Cr. gattii* is serotype B and C.
4. **In vitro susceptibility testing** – Most isolates are susceptible to amphotericin B, 5-flucytocine, and to azoles like fluconazole, itraconazole, and posaconazole. A few isolates with high MIC to fluconazole have been isolated from AIDS patients.
5. **Molecular tests** – *Cr. neoformans* is one of the most intensely studied pathogenic fungi. The molecular biology of this organism has revealed various virulence factors and unique genotypes among clinical strains (6).

**Comments:** Originally, *Cryptococcus neoformans* was described as comprising of two varieties: *Cr. neoformans* var. *neoformans* (serotypes A & D) and *Cr. neoformans* var. *gattii* (serotype B & C). Recently, *Cr. neoformans* was further subdivided into two varieties: *Cr. neoformans* var. *grubii* (serotype A) and *Cr.
Sequence alignment

The identity of the test isolate was confirmed in the Mycology PTP program by sequencing of its ITS2 region of rDNA.

Alignment of primary sequences of the ITS1 and ITS2 regions of Cr. neoformans var. grubii SHCZ112 and PT specimen Cr. neoformans M2718.

Further Reading:


Figure 7. Seven-day-old, cream to tan colored, smooth, moist, and soft colony of *Cryptococcus neoformans* on Sabouraud’s dextrose agar.

Figure 8. Microscopic morphology of *Cryptococcus neoformans* on corn meal agar with Tween 80. (Upper panel) Round, large blastoconidia. (Right, 400× magnification; Left, line drawing not to scale) (Lower panel) India-ink preparation revealing capsules (right, 1000× magnification; Left, line drawing not to scale).
**Y-5 Geotrichum candidum**

Source: Bronchial wash / Hand

Laboratory Performance:
Referee Laboratories with correct ID: 10
Laboratories with correct ID: 121
Laboratories with incorrect ID: 0
Outcome: Validated

**Clinical Significance:** *Geotrichum candidum* commonly causes pulmonary infections in immunocompromised patients. It also produces lesions in alimentary tract, vagina, and skin. *G. candidum* has also been reported to cause fungemia and disseminated infection.

**Ecology:** *G. candidum* is cosmopolitan in distribution. It has been isolated from air, water, plants, milk, and milk products. It is found as a commensal in pulmonary and gastrointestinal tract of humans.

**Laboratory Diagnosis:**
1. Culture – On Sabouraud’s dextrose agar after 7 days at 25°C, colony grew rapidly, it was white to cream colored, flat with aerial mycelium, (Figure 9).
2. Microscopic morphology – On corn meal agar with Tween 80, true hyphae with arthroconidia were seen (Figure 10). Arthroconidia formation was by the fragmentation of hyphae, no disjunctor cells (empty cells between the arthroconidia) and no blastoconidia were formed.
3. Differentiation from other yeasts – *G. candidum* grew on the media containing cycloheximide, negative on urease reaction, grew sparingly at 37°C. It was differentiated from *Trichosporon* species by absence of blastoconidia, no growth at higher temperatures (40, 42, & 45°C).

**Blastoschizomyces capitatus** could be differentiated from *G. candidum* by the lack of growth on a medium containing D-xylose as a carbon source and its growth at 45°C. *G. candidum* was differentiated from arthroconidia forming molds by its colony morphology. Microscopically *Arthrographis* and *Odiodendron* had conidiophores while *Malbranchea* and *Coccidioides immitis* had disjunctor cells.

4. *In vitro* susceptibility testing – Limited studies suggested that most isolates were susceptible to amphotericin B and to azoles like fluconazole and itraconazole.

5. Molecular tests – Randomly amplified polymorphic DNA (RAPD) PCR had been used for the identification of *G. candidum* isolated from cheese. Using DNA/DNA reassociation techniques, de Hoog et al (1986 and 1990) found the relatedness between *G. candidum* and its teleomorph (sexual state) *Galactomyces geotrichum*.

**Comments:** In this test event, both *Geotrichum candidum* and *Geotrichum klebahnii* (*Geochichum penicillatum*) were accepted as correct answers since both API 20C AUX and Vitek 2 identification system could not clearly differentiate them. Mannitol assimilation test could be used for further differentiation. *G. candidum* is heterothallic. Its teleomorph is *Galactomyces candidus*.

**Sequence alignment**

The identity of the test isolate was confirmed in the Mycology PTP program by sequencing of its ITS2 region of rDNA.
Alignment of primary sequences of the ITS1 and ITS2 regions of Geotrichum candidum ITEM10458 and PT specimen G. candidum M1564.

**Further Reading:**


Figure 9. Seven-day-old, white and mold like colony of *Geotrichum candidum* on Sabouraud’s dextrose agar.

Figure 10. Microscopic morphology of *Geotrichum candidum* on corn meal agar with Tween 80 showing arthroconidia (400 × magnification).
ANTIFUNGAL SUSCEPTIBILITY TESTING FOR YEASTS

**Introduction:** Documents of M27-A3 and M27-S3 published by Clinical Laboratory Standards Institute (CLSI; formerly National Committee for Clinical Laboratory Standards, NCCLS) is the current standard reference guide for antifungal susceptibility testing of pathogenic yeasts. FDA approved devices for antifungal susceptibility testing of yeasts includes Sensititre YeastOne Colorimetric Panel (Trek Diagnostic Systems Inc. Cleveland, OH) and Etest (AB BIODISK North America, Inc. Piscataway, NJ). The disk diffusion method approved by CLSI (M44-A) is another alternative for antifungal susceptibility testing of yeasts. There are 10 drugs in the antifungal susceptibility testing panel of NYSDOH Mycology Proficiency Test Program - amphotericin B, anidulafungin, caspofungin, flucytosine (5-FC), fluconazole, itraconazole, ketoconazole, micafungin, posaconazole, and voriconazole. The participating laboratories are allowed to select any number of antifungal drug(s) from the test panel for testing based upon usual practices in their facilities.

**Materials & Results:** *Candida albicans* (S-1) was the analyte in the May 25, 2011 antifungal proficiency testing event. Thirty laboratories participated in this event. The S-1 isolate was validated by all the participating laboratories. The acceptable results for antifungal susceptibility testings were based on consensus MIC values or interpretation per NCCLS/CLSI guidelines or other publications (Table 1).

<table>
<thead>
<tr>
<th>Antifungal Agent</th>
<th>Susceptible (S)</th>
<th>Susceptible-dose dependent (S-DD)</th>
<th>Intermediate (I)</th>
<th>Resistant (R)</th>
<th>Nonsusceptible (NS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amphotericin B¹</td>
<td>≤2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>&gt;2</td>
</tr>
<tr>
<td>Anidulafungin</td>
<td>≤2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>&gt;2</td>
</tr>
<tr>
<td>Caspofungin</td>
<td>≤8</td>
<td>16-32</td>
<td>-</td>
<td>≥64</td>
<td>-</td>
</tr>
<tr>
<td>Fluconazole²</td>
<td>≤4</td>
<td>-</td>
<td>8-16</td>
<td>≥32</td>
<td>-</td>
</tr>
<tr>
<td>Flucytosine (5-FC)</td>
<td>≤0.125</td>
<td>0.25-0.5</td>
<td>-</td>
<td>≥1</td>
<td>-</td>
</tr>
<tr>
<td>Itraconazole</td>
<td>≤2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>&gt;2</td>
</tr>
<tr>
<td>Ketoconazole³</td>
<td>≤1</td>
<td>2</td>
<td>-</td>
<td>≥4</td>
<td>-</td>
</tr>
<tr>
<td>Micafungin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posaconazole⁴</td>
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<td></td>
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</tr>
</tbody>
</table>

* Adapted from CLSI document M27-S3 (2008)

¹ For Amphotericin B, there are no breakpoints, but > 1 is considered resistant.

² Isolates of *Candida krusei* are assumed to be intrinsically resistant to fluconazole, and their MICs should not be interpreted using this scale.

³ For Ketoconazole, there is no assigned interpretative breakpoint.

⁴ For Posaconazole, apply the voriconazole MIC interpretation as surrogate breakpoints (susceptible, ≤1 µg/ml; susceptible-dose dependent, 2 µg/ml; resistant, ≥4 µg/ml). (Pfaller, M.A., Messer, S.A., Boyken, L., Tendolkar, S., Hollis, R.J., and Diekema, D.J. Selection of a surrogate agent (fluconazole or voriconazole) for initial susceptibility testing of posaconazole against *Candida* spp.: results from a global antifungal surveillance program. *J. Clin. Microbiol.* 2008: 46: 551-559.)
Table 2. Antifungal MICs (µg/ml) Reported by the Participating Laboratories

S-1: Candida albicans

<table>
<thead>
<tr>
<th>Drugs (µg/ml)</th>
<th>Total # of labs</th>
<th>≤0.015</th>
<th>0.03</th>
<th>0.06</th>
<th>0.12</th>
<th>0.19</th>
<th>0.25</th>
<th>0.38</th>
<th>0.5</th>
<th>1</th>
<th>1.5</th>
<th>2</th>
<th>3</th>
<th>≥32</th>
<th>≥64</th>
<th>128</th>
<th>256</th>
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<tbody>
<tr>
<td>Amphotericin B</td>
<td>24</td>
<td></td>
<td>2</td>
<td>1</td>
<td>19</td>
<td>2</td>
<td></td>
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</tr>
<tr>
<td>Anidulafungin</td>
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<td>8</td>
<td>6</td>
<td>1</td>
<td>2</td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Caspofungin</td>
<td>22</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>11</td>
<td>2</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flucytosine (5-FC)</td>
<td>27</td>
<td>1</td>
<td>17</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>1</td>
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<td>1</td>
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<tr>
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<td>13</td>
<td>4</td>
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<tr>
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<td>11</td>
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<td>18</td>
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<td>2</td>
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</tbody>
</table>
Table 3. Antifungal Susceptibility Interpretations Reported by the Participating Laboratories

**S-1: Candida albicans**

<table>
<thead>
<tr>
<th>Antifungal Agent</th>
<th>Total # of labs</th>
<th>Susceptible</th>
<th>Susceptible-dose dependent</th>
<th>Resistant</th>
<th>No interpretation</th>
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<tr>
<td>Amphotericin B</td>
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<td>15</td>
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<tr>
<td>Flucytosine (5-FC)</td>
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<tr>
<td>Fluconazole</td>
<td>33</td>
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<tr>
<td>Itraconazole</td>
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<td>2</td>
<td>14</td>
<td>15</td>
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<tr>
<td>Ketoconazole</td>
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<td>17</td>
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<tr>
<td>Posaconazole</td>
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<td>11</td>
<td>2</td>
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<td>24</td>
<td>21</td>
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<td>1</td>
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</table>
Further Reading:


MYCOLOGY PT PROGRAM   
FUNGAL IDENTIFICATION SURVEY  

Q1. What is the level of identification provided by your laboratory for yeasts recovered from clinical specimens:

- Identify all yeast to genus and species
- Identify only clinically relevant yeast genus and species
- Identify all yeast to genus only
- Do not identify yeast

![Bar chart showing the level of identification for yeasts](chart1.png)

Q2. What is the level of identification provided by your laboratory for molds recovered from clinical specimens:

- Identify all mold to genus and species
- Identify only clinically relevant mold to genus and species
- Identify all mold to genus only
- Do not identify molds

![Bar chart showing the level of identification for molds](chart2.png)

*These are laboratories hold Mycology Identification Yeast Only permit  
‡One laboratory with comprehensive permit responded in this subcategory
Q3. How is the decision made about the appropriate level of fungal identification needed for any clinical specimen:
- Decision of the Laboratory Director
- Instructions from the Requesting Physician
- Recommendations of the professional societies
- Other, please specify __________________________

*More than one option was selected
‡ Multiple options were selected

Q4. Do you use reference laboratories for further identification of fungal isolates? If yes, where these specimens are tested?
- Do not use a reference laboratory
- Refer to New York State permitted laboratory
- Refer to Wadsworth Center
- Other, please specify __________________________

*More than one option was selected
Q5. Do you anticipate any change in fungal identification services in near future?

☐ Yes  ☐ No

![Bar chart showing responses to Q5]
1. American Type Culture Collection (http://www.atcc.org/)
2. Agricultural Research Service Culture Collection, USDA (http://nrrl.ncaur.usda.gov/)
9. The Centraalbureau voor Schimmelcultures (CBS) Fungal Biodiversity Centre (http://www.cbs.knaw.nl/About/)
18. Japan Collection of Microorganisms (http://www.jcm.riken.go.jp/)


34. The United Kingdom National Culture Collection UKNCC (http://www.ukncc.co.uk/html/Databases/search.asp)

35. University of Alberta Microfungus Collection (http://www.devonian2.ualberta.ca/uamh/)