



**Weill Cornell
Medicine**

“*Weirdobacters*” cases of unusual organisms”

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Disclosures

Name	Type of relationship	Commercial supporter
Lars Westblade	Research	Accelerate Diagnostics, Inc.
		bioMérieux, Inc. (BioFire Diagnostics, LLC)
		Element Materials Technology
		Hardy Diagnostics
		Melinte Therapeutics
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		Selux Diagnostics, Inc.
		SNIPRBIOME
	Advisory board/ consulting	Roche Molecular Systems, Inc.
		Shionogi, Inc.
		Talis Biomedical
	Royalties	Co-author: Larone's Medically Important Fungi: A Guide to Identification, 7 th Edition ASM/Wiley
	Committees	ARLG Diagnostics Committee
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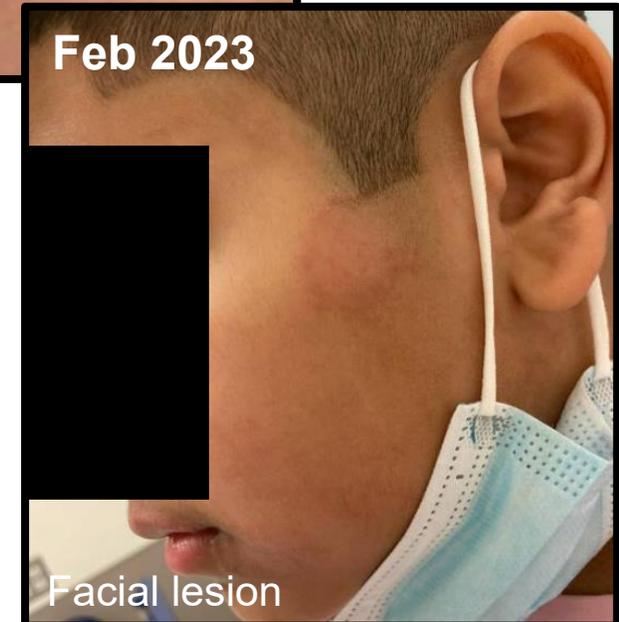
I will refer to content published in Larone's Medically Important Fungi: A Guide to Identification

Objectives

- Describe the clinical significance and presentation of microorganisms not commonly encountered or recognized in the clinical microbiology laboratory
- List their pertinent microbiologic features
- Discuss their treatment and antimicrobial susceptibility profiles

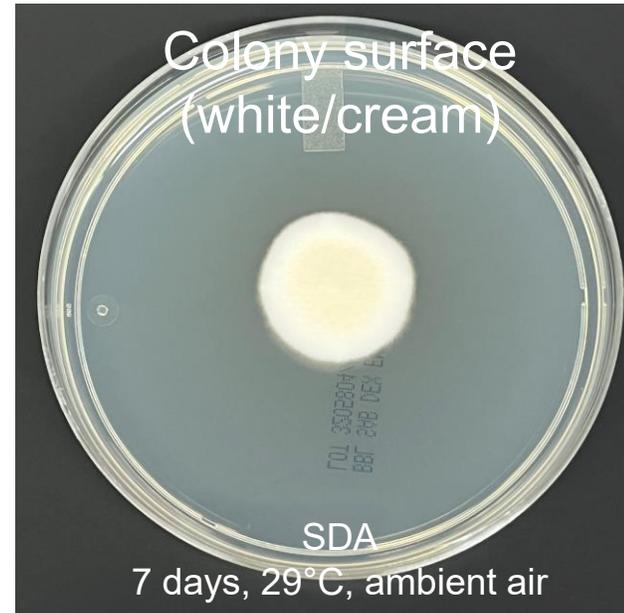
Case 1

- An 11-year-old male with a rash for 1 year presents to our institution's ED in February 2023
- He developed a rash in the US and then moved to Bangladesh for 1 year
- During that time, he was treated with azithromycin, pevitin (econazole + triamcinolone acetonide), terbinafine, and voriconazole
- His symptoms improved, but not completely resolved
- Brother had a similar rash



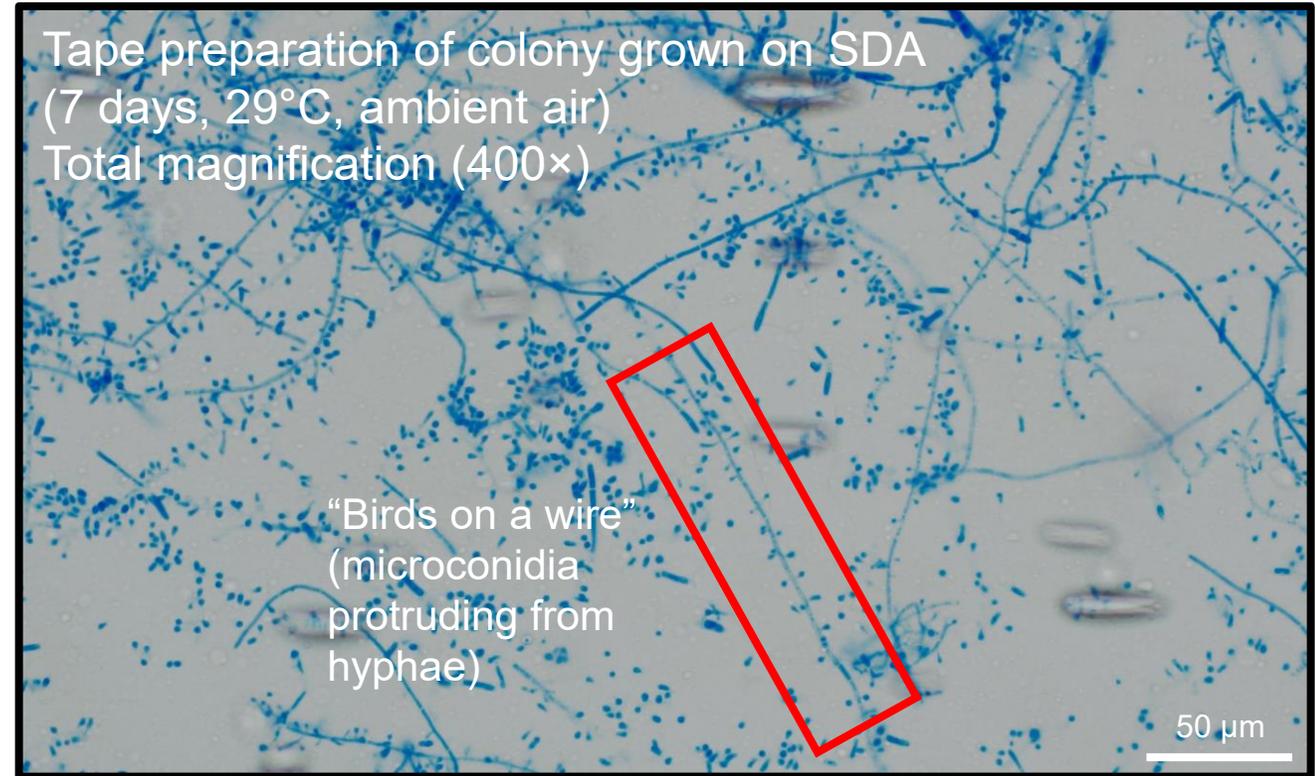
Case 1

- In the ED he was given Benadryl and hydrocortisone for presumed nummular eczema
- In March 2023, patient follows up with Dermatology service:
 - Skin scraping sent for fungal culture
 - Topical ketaconazole (2%) initiated
- Fungal elements observed in the direct specimen examination
- Mould recovered in culture



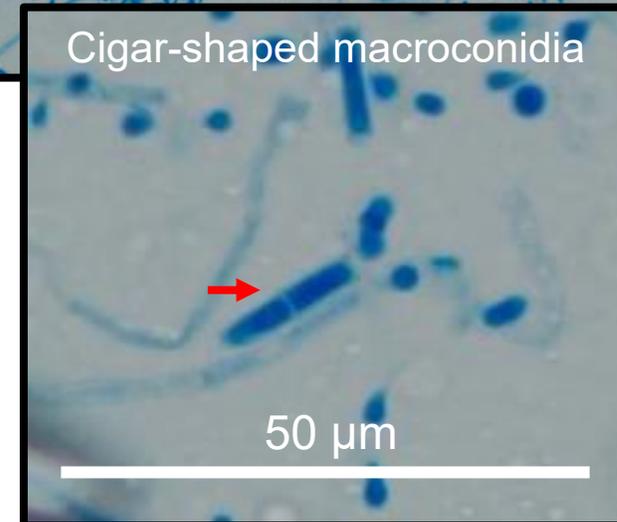
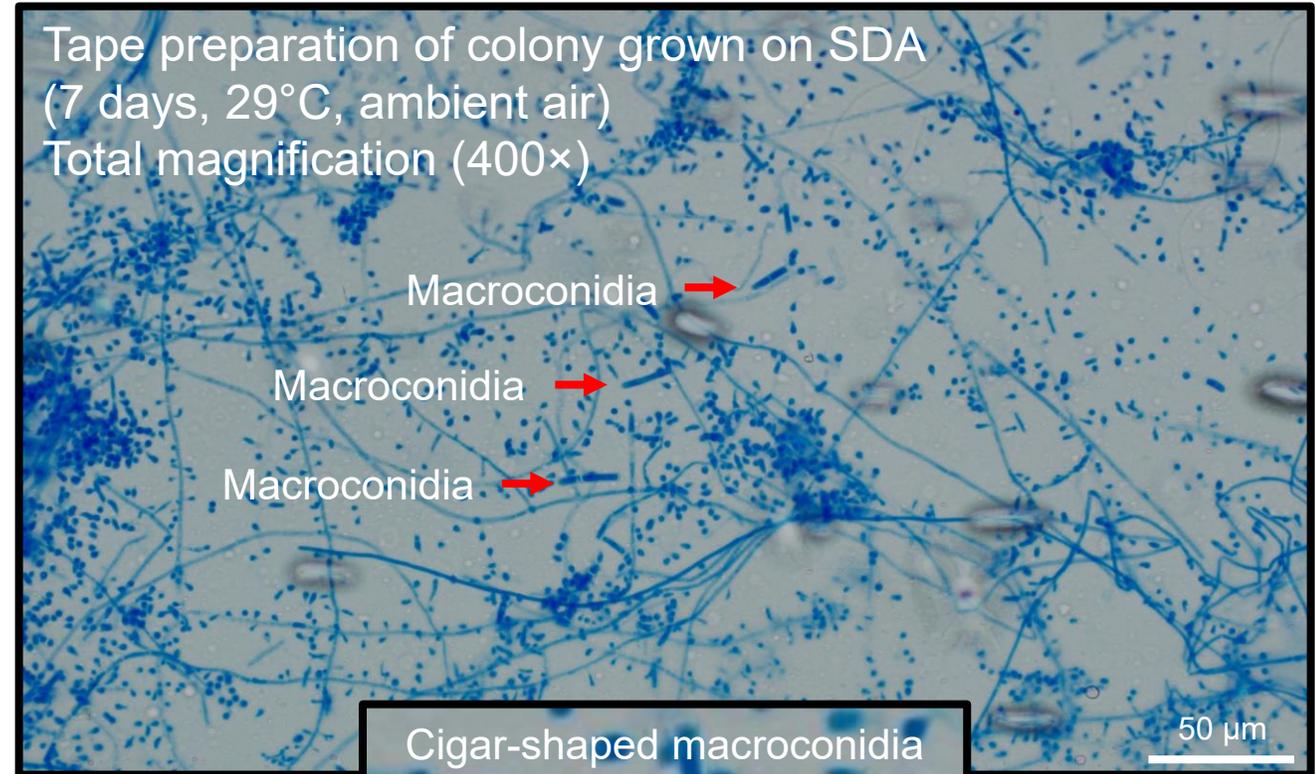
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Case 1

- In the ED he was given Benadryl and hydrocortisone for presumed nummular eczema
- In March 2023, patient follows up with Dermatology service:
 - Skin scraping sent for fungal culture
 - Topical ketaconazole (2%) initiated
- Fungal elements observed in the direct specimen examination
- Urease-negative mold recovered in culture
- Isolate sent to New York State Department of Health (NYS DOH) for identification and antifungal susceptibility testing (AFST)



Case 1

Antifungal agent	MIC value (µg/mL)
Amphotericin B	0.5
Anidulafungin	≤0.015
Caspofungin	≤0.015
Fluconazole	64
Griseofulvin	4
Itraconazole	0.5
Ketoconazole	1
Micafungin	≤0.015
Posaconazole	0.5
Terbinafine	>128
Voriconazole	2

- What is the identification of the mould?
- Isolate identified as *T. indotineae* by DNA sequencing
- Identification of the isolate took 13 months from the onset of the patient's symptoms

Terbinafine MIC values ≥0.5 µg/mL considered non-wild-type (resistant)

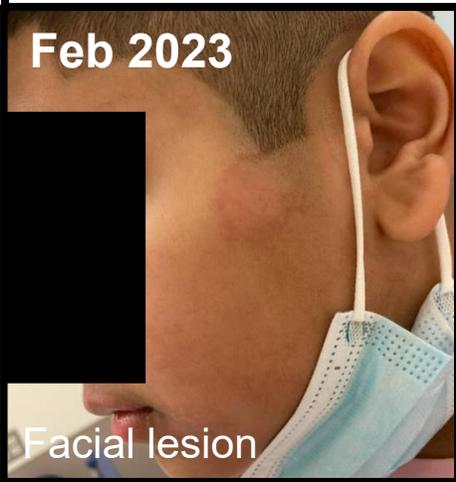
Case 1

- In April 2023, patient followed up with dermatology and therapy switched to griseofulvin
- In May 2023:
 - Facial lesion had resolved
 - Body/lesions had progressed (hyperpigmented)
 - Itraconazole (100 mg twice daily) and topical ketaconazole initiated

Feb 2023



Feb
2023



May
2023

May 2023



May 2023



Case 1



Feb
2023

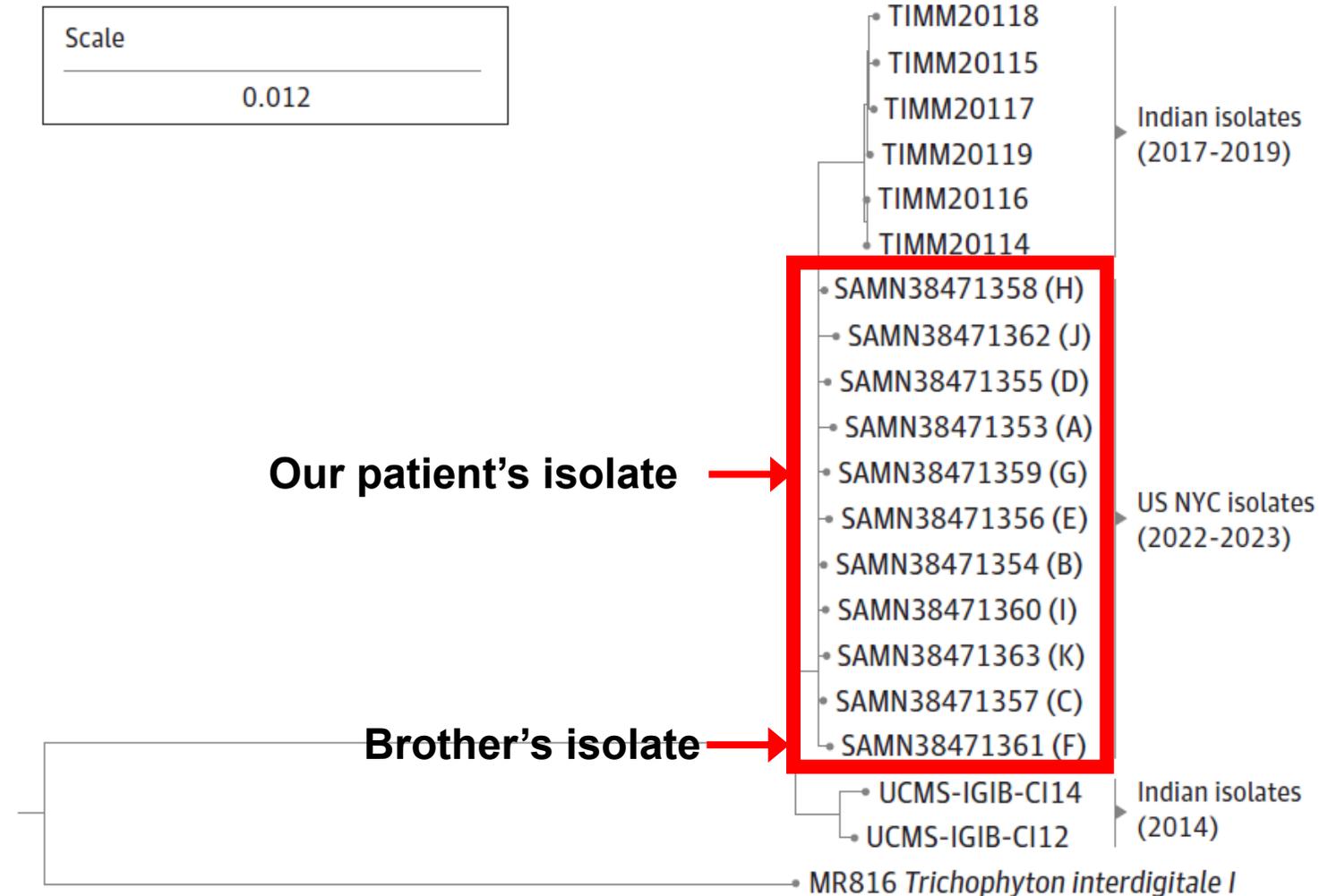
June
2023

- In June 2023, itraconazole continued for a total of 12 weeks (100 mg twice daily + clotrimazole)
- In July, he left for boarding school in India (lost to follow up) → improving on itraconazole

New York City *T. indotineae* isolates

New York City *T. indotineae* isolates recovered from 11 patients form a distinct cluster from Indian isolates

- 9 patients reported travel to Bangladesh within last two years
- No travel for 1 patient – local transmission
- Travel unknown for 1 patient



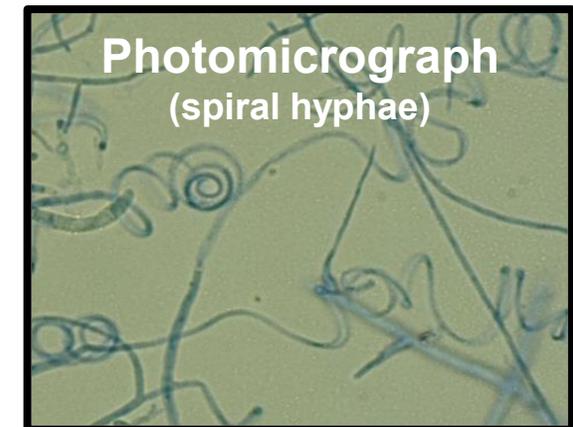
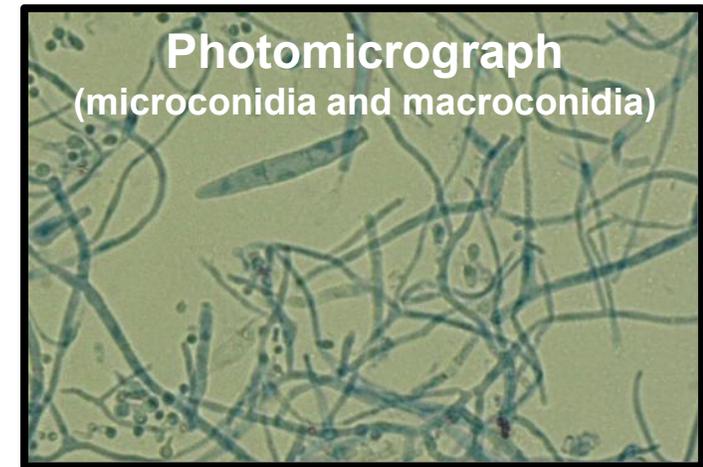
Case 1

- His brother was also infected with *T. indotineae* (both had traveled to Bangladesh within prior two years)
- Isolates recovered from both patients were genetically identical to one another (0 SNP difference between isolates, suggesting transmission between them)
- AFST results almost identical:
 - Terbinafine non-wild-type (resistant)
 - Our patient's isolate exhibited an itraconazole MIC value of 0.5 µg/mL, which is considered elevated, but he was improving on therapy (although lost to follow up)
- In a descriptive US study of 11 patients (which included our patient and his brother) with *T. indotineae* infection, itraconazole therapy did not fail but prolonged treatment durations were required (e.g., 100 mg, twice daily, 6 weeks)
 - In the study, our patient's isolate had the highest itraconazole MIC value
 - All other isolates displayed itraconazole MIC values ranging between 0.06-0.25 µg/mL

Antifungal agent	Our patient's isolate MIC value (µg/mL)	Brother's isolate MIC value (µg/mL)
Amphotericin B	0.5	0.5
Anidulafungin	≤0.015	≤0.015
Caspofungin	≤0.015	≤0.015
Fluconazole	64	16
Griseofulvin	4	4
Itraconazole	0.5	0.25
Ketoconazole	1	1
Micafungin	≤0.015	≤0.015
Posaconazole	0.5	0.25
Terbinafine	>128	>128
Voriconazole	2	2

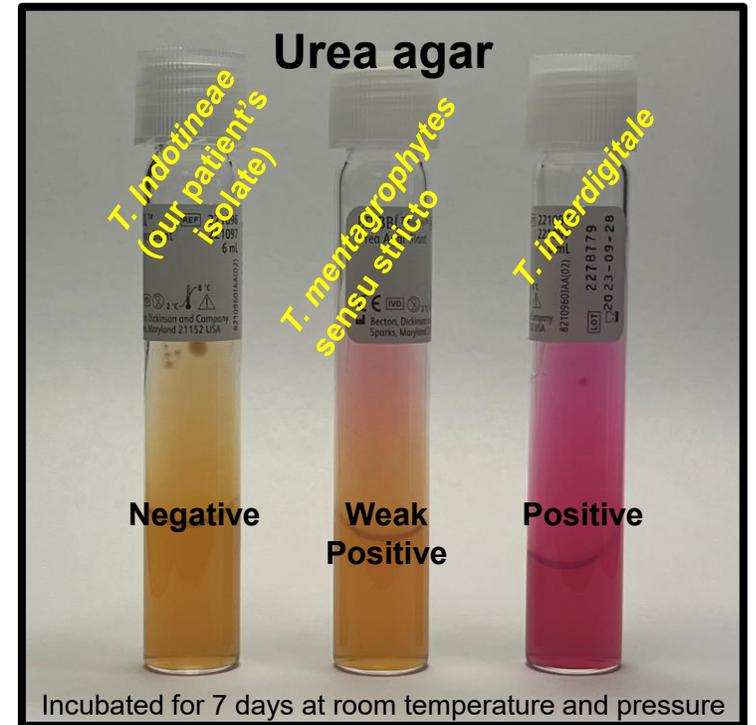
Trichophyton indotineae (formerly *T. mentagrophytes* genotype VIII)

- **Taxonomy:** member of the *Trichophyton mentagrophytes* species complex. Not possible to differentiate morphologically from other members of the species complex (e.g., *T. mentagrophytes sensu stricto*, *T. interdigitale*)
- **Pathogenicity:** patients present with extensive inflammatory red plaques on the body (tinea corporis), groin (tinea cruris), and face (tinea faciei). Infections are often recalcitrant to treatment with antifungals (e.g., terbinafine) typically used to treat tinea
- **Rate of growth:** moderate (mature in 6-10 days)
- **Colony morphology:**
 - Surface, flat granular colonies. Peripheral, white; medial beige to light brown
 - Reverse, light brown to yellowish
- **Microscopic morphology:**
 - Septate hyphae with round microconidia and sometimes thin-walled cigar-shaped macroconidia (4-8 × 20-50 μm) that contain 1-6 cells
 - Spiral hyphae often seen
- **Treatment:** often resistant to terbinafine. In the US, prolonged treatment with itraconazole has proven successful for terbinafine-resistant isolates



Urease activity

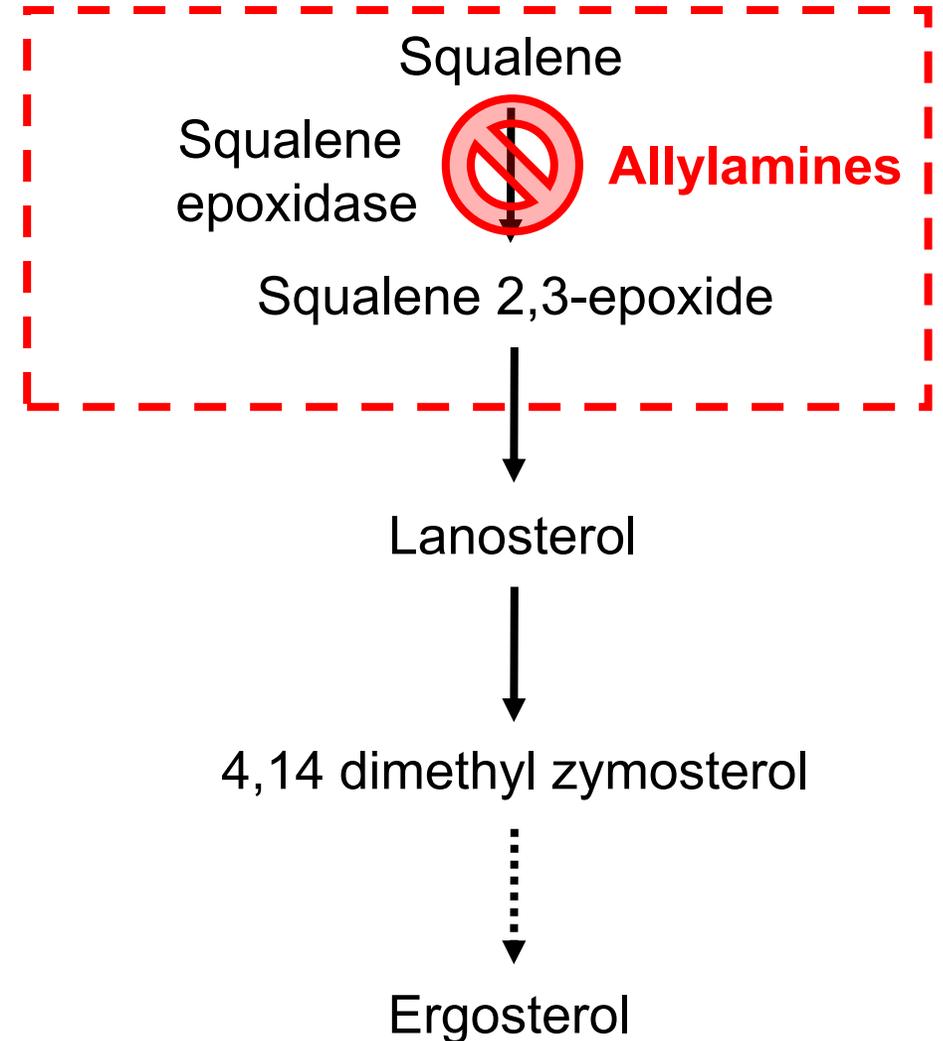
- Many medical microbiology laboratories do not, or cannot, identify dermatophytes to the genus (let alone species) level
- However, recommend attempting to accurately identify *T. indotineae* given its multi-drug resistance
- Urease activity used to differentiate similar conidia producing *Trichophyton* species
- Most *T. indotineae* isolates are urease negative at day 7
- Other members of the *T. mentagrophytes* species complex are urease positive
- Use urease to screen for isolates resembling *T. mentagrophytes* species complex for *T. indotineae*, confirm the identification using molecular methods (e.g., DNA sequencing or MALDI-TOF MS)



T. indotinaeae terbinafine resistance

- Terbinafine (an allylamine) inhibits squalene epoxidase
- Leads to accumulation of squalene and depletion of ergosterol resulting in membrane disruption and cell death
- Terbinafine resistance observed in *T. indotinaeae* is due to amino acid substitutions in squalene epoxidase (presumably prevent terbinafine binding)
- Our patient's isolate harbored the squalene epoxidase F397L variant (the most common substitution reported in terbinafine-resistant *T. indotinaeae* isolates)
- The F397L corresponds with terbinafine MIC values between 1 and >32 µg/mL (≥0.5 µg/mL is considered resistant)
- Terbinafine-resistant infections may require prolonged treatment (e.g., ≥2 months) with second-line therapies (itraconazole)

Allylamines:
inhibit squalene epoxidase
(inhibition of ergosterol biosynthesis)



T. indotineae: how did we get here?

- Suspected origin in Southeast Asia
- Global outbreak of multidrug-resistant *T. indotineae* driven by:
 - Use of over-the-counter steroid-antifungal creams
 - Indiscriminately prescribed antifungals
 - Use of antifungal brands with low efficacy
- Global travel and migration has resulted in spread to Europe, Middle East, North America (Canada and United States), and Oceania
- If suspicion for *T. indotineae* based on clinical presentation (extensive lesions, and/or treatment failure) or travel history, collect specimen for culture and alert your clinical microbiology laboratory
- Clinical microbiologists should ensure isolates suspicious for *T. indotineae* are identified to the species level



Steroid → suppression of local cellular immunity

Antifungal → antifungal resistance

Dermatophyte taxonomy

Three longstanding genera

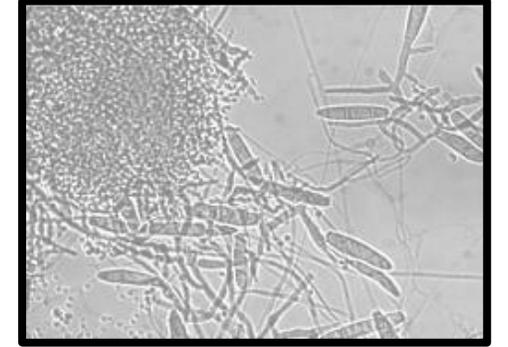
Epidermophyton



Microsporum

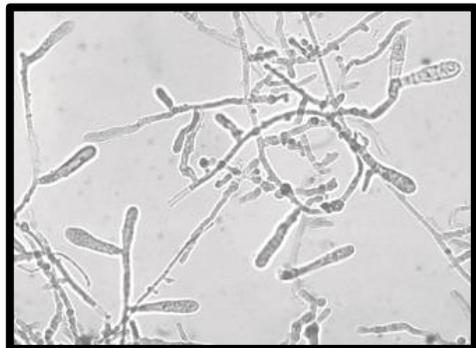


Trichophyton

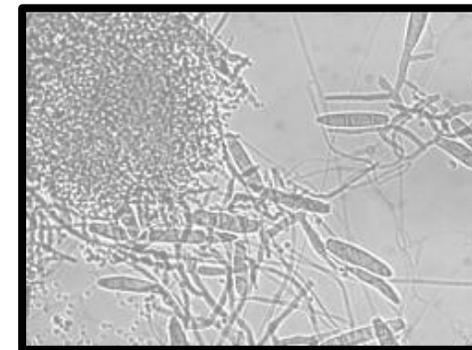


Dermatophyte taxonomy

Molecular phylogenetic studies have resulted in taxonomic changes



Epidermophyton floccosum



- **Microsporum:**

- *M. audouinii*
- *M. canis*
- *M. ferrugineum*

- **Lophophyton gallinae:**

- *L. gallinae* – zoophilic (*M. gallinae*)
- *L. gallinae* – geophilic (*M. vanbreuseghemii*)

- **Nannizzia:**

- *N. gypsea* spp. complex (*M. gypseum*)
- *N. nana* (*M. nannum*)

- **Paraphyton cookei spp. complex (*M. cookei*)**

- **Arthroderma:**

- *A. terrestre* (*T. terrestre*)
- *A. uncinatum* (*T. ajelloi*)

- **Trichophyton:**

- *T. mentagrophytes* spp. complex
- *T. rubrum*
- *T. tonsurans*
- *T. soudanense*
- *T. schoenleinii*
- *T. verrucosum*
- *T. violaceum*

Dermatophytes and dermatophytosis (ringworm or tinea)

- Filamentous fungi able to digest and obtain nutrients from keratin (skin, hair, and nails)
- Infection usually only involves keratinized layer of skin, as well as hair follicles, hair shafts, and nails → affect 20-25% of the world's population
- The disease tinea (ringworm) is the result of the host reaction to fungal cell wall and enzymes released by the fungus



- Clinical disease designated by the site of infection:
 - Tinea barbae: bearded areas of face and neck
 - Tinea capitis: scalp and hair shaft
 - Tinea corporis: glabrous skin on body parts not otherwise specified (usually the trunk of the body)
 - Tinea cruris: groin, perineum, perianal region
 - Tinea manuum: hand
 - Tinea pedis: feet
 - Tinea unguium: nails (onychomycosis nail infection caused by any fungus, not necessarily a dermatophyte)
- Species can exhibit anatomic specificity
- Dependent on human (anthropophilic) or animal (zoophilic) infection for survival
- 7 genera (3 longstanding members emboldened):
 - *Arthroderma*
 - ***Epidermophyton***
 - *Lophophyton*
 - ***Microsporum***
 - *Nannizzia*
 - *Paraphyton*
 - ***Trichophyton***
- Treatment:
 - Skin (topical): clotrimazole, miconazole, terbinafine, ketoconazole
 - Scalp (oral): griseofulvin, terbinafine, itraconazole, fluconazole

Degreef, 2008 *Mycopathologia*

Ameen, 2010 *Clin Dermatol*

de Hoog et al., 2017 *Mycopathologia*

<https://www.cdc.gov/fungal/diseases/ringworm/index.html>

Larone's medically important fungi: a guide to identification, 7th ed. 2023 ASM Press

Images: Degreef, 2008 *Mycopathologia*

Case 2

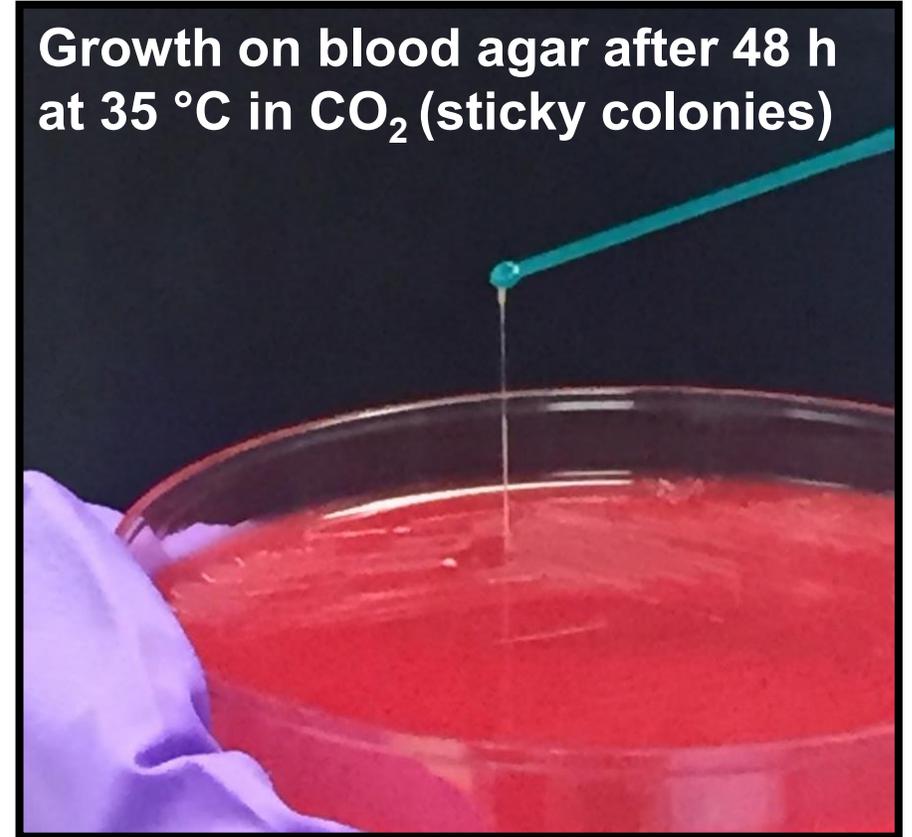
- Previously healthy 22-month-old boy presented to a community hospital ED the day of a dog bite
- Wound was irrigated, sutured, and he was prescribed amoxicillin
- He presented a day later to the same community hospital ED with purulent discharge from the eyelid. Sutures were removed and he was prescribed ampicillin-sulbactam
- That day, he was transferred to our hospital ED for care and the patient was placed on IV ceftriaxone and clindamycin
- Purulent material from the wound sent for culture → ~48 h after plating sticky, tan-colored colonies noted on chocolate agar

Case 2

Colony Gram stain



Growth on blood agar after 48 h at 35 °C in CO₂ (sticky colonies)



What is the identification of the bacterium?

Bergeyella zoohelcum
(MALDI-TOF MS and 16S rRNA gene sequencing)

***B. zoohelcum* infection**

- Formerly *Weeksella zoohelcum*
- Normal oral and nasal microbiota of cats and dogs (not thought to be pathogenic to animals)
- Mainly isolated from wounds caused by animal (mostly dog, but also cat) bites
- Infection can lead to meningitis, septicemia, and bacteremia



B. zoohelcum microbiology

- Obligate aerobe
- Grows on blood and chocolate agars, but does not grow on MacConkey agar
- Biochemicals:
 - Oxidase +
 - Indole +
 - Urease +
- Nonsaccharolytic, glucose non-fermenter

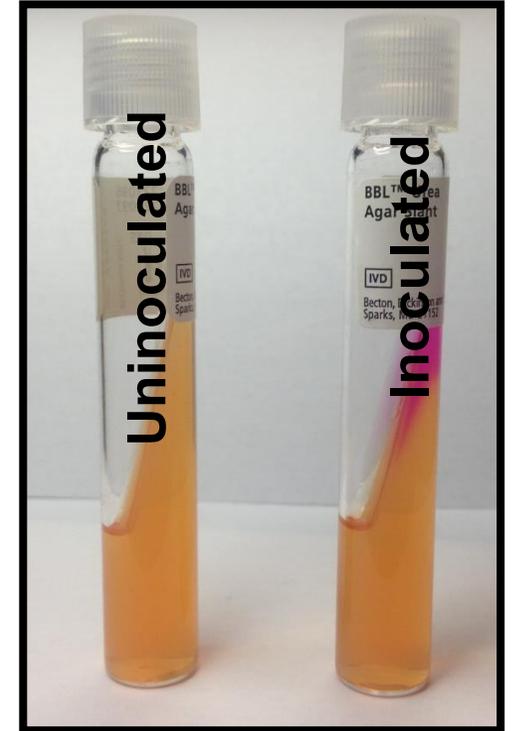
Growth/Test	<i>B. zoohelcum</i>	<i>W. virosa</i>
Colony (color)	Sticky (tan to yellow color) (MacConkey no growth)	Slimy (MacConkey no growth)
Oxidase	+	+
Indole	+	+
Pyrrolidonyl arylamidase	0	+
Urease	+ (rapid)	0

Abbreviations, + positive; 0, negative; V

~5 min



~15 min



What other bacteria are rapidly urease positive?

B. zoohelcum microbiology

- Obligate aerobe
- Grows on blood and chocolate agars, but does not grow on MacConkey agar
- Biochemicals:
 - Oxidase +
 - Indole +
 - Urease +
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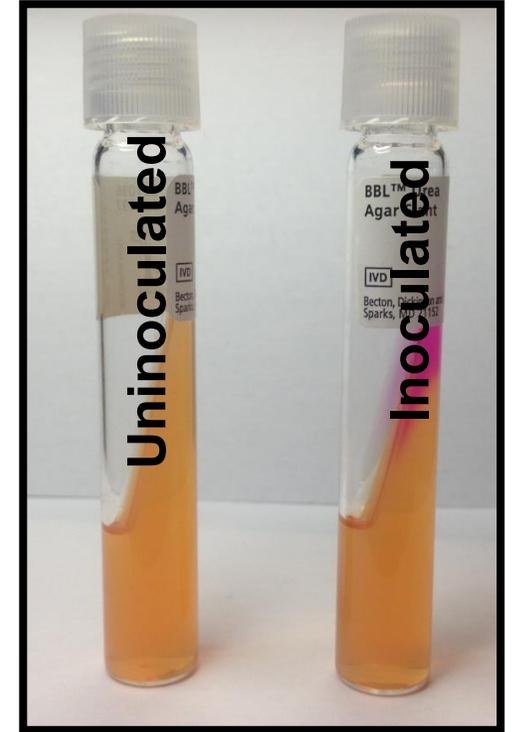
Abbreviations, + positive; 0, negative; V

Manual of Clinical Microbiology 13th edition (ASM Press 2023)

~5 min



~15 min



Rapidly urease positive bacteria:

Brucella species

Bordetella bronchiseptica

Corynebacterium urealyticum

Helicobacter pylori

Staphylococcus coagulans

***B. zoohelcum* treatment**

- Susceptible to penicillins (*W. virosa* is also susceptible to penicillins); helps differentiate from related *Chryseobacterium* and *Sphingobacterium* genera
- Intrinsically resistant to polymyxins
- For academic interest, AST data for our isolate obtained (no categorical interpretative criteria available for this organism)
- Our isolate exhibited low MIC values for all agents tested

Antimicrobial agent	MIC value (µg/mL)
Amoxicillin	0.12
Cefotaxime	0.03
Ceftriaxone	0.06
Clindamycin	≤0.12
Doxycycline	1
Erythromycin	≤0.25
Gentamicin	≤2
Levofloxacin	≤0.5
Meropenem	≤0.06
Penicillin	0.12
Tetracycline	2
Trimethoprim/Sulfamethoxazole	≤0.25

β-lactamase (cefinaise disk) test, negative

Case 2

- On the second day of hospitalization, antimicrobial therapy was changed to oral amoxicillin-clavulanate because of improving cellulitis to complete a 10-day total course of treatment
- Patient did not return to the hospital after their discharge

Microbiology of animal bite infections

- In US animal bites account for 300,000 visits to the emergency department each year (90% dog and cat bites)
- Occasional sequelae: meningitis, endocarditis, septic arthritis, and septic shock
- Prospective study including 107 subjects: 50 dog bites/57 cat bites
 - 3-18% of dog bites become infected
 - 20-80% of cat bites become infected
- Polymicrobial infections:
 - Aerobes/anaerobes from 56% of wounds
 - Aerobes alone from 36% of wounds
 - Anaerobes alone from 1%
 - No growth 7%
- *Pasteurella* species is the genus most commonly isolated from dog and cat bites
- Appropriate treatment: β -lactam/ β -lactamase inhibitor combination

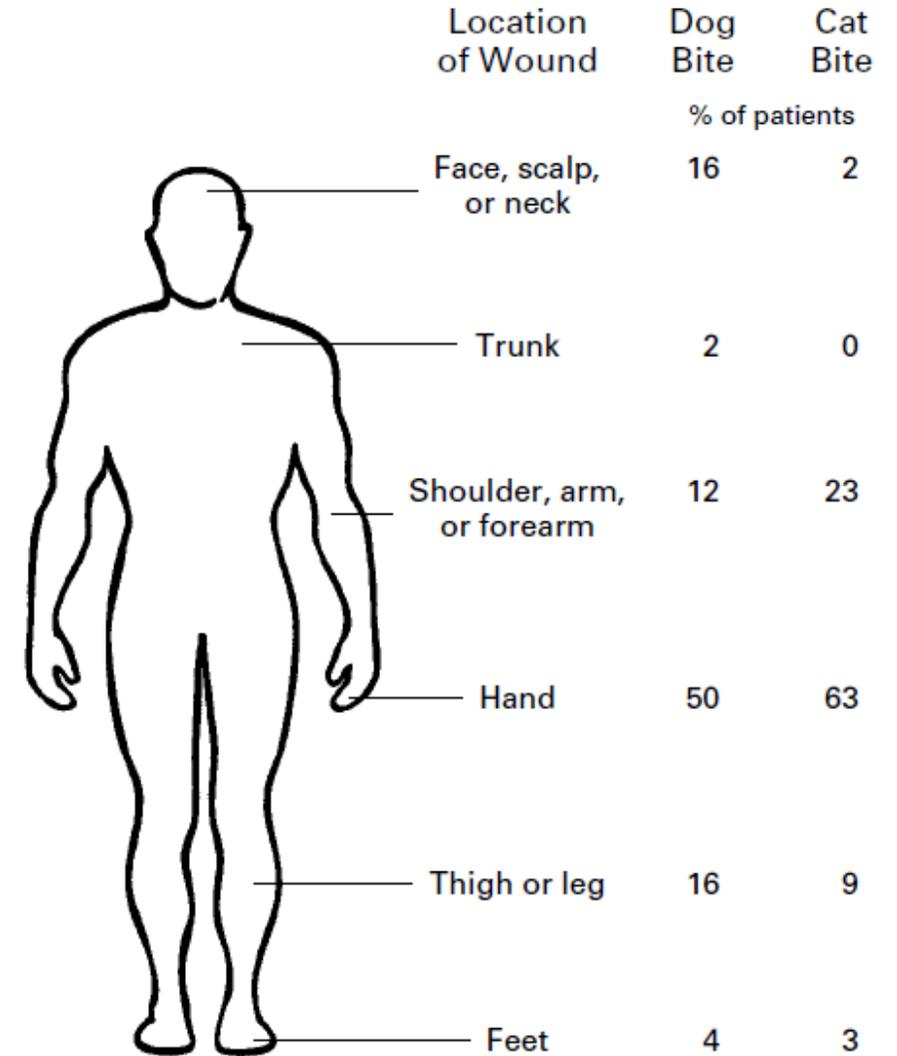


Figure 1. Location of Wound Infections in 50 Patients Bitten by Dogs and 57 Patients Bitten by Cats.

What other microorganisms are associated with animal bites?

Microorganisms associated with animal bite infections

- *Aeromonas* species
- *Anaerobiospirillum succiniciproducens*
- (Animal-associated) *Capnocytophaga* species (*C. canimorsus*, *C. cynodegmi*)
- *Bergeyella zoohelcum*
- *Neisseria animaloris*
- *Neisseria weaveri*
- *Neisseria zoodegmatidis*
- ***Pasteurella* species**
- *Staphylococcus pseudintermedius*

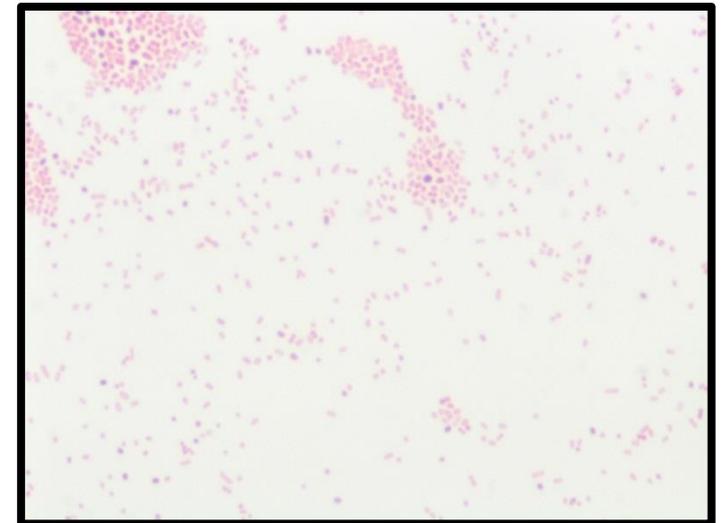
Pasteurella species

- Growth on blood and chocolate agars, but not MacConkey agar
- Biochemicals (COIN):
 - **C**atalase +
 - **O**xidase +
 - **I**ndole +
 - **N**itrate reduction +
- Susceptible to penicillin (zone size with 10 U penicillin disk) – somewhat unique for a gram-negative bacterium to be susceptible to penicillin

P. multocida on blood agar

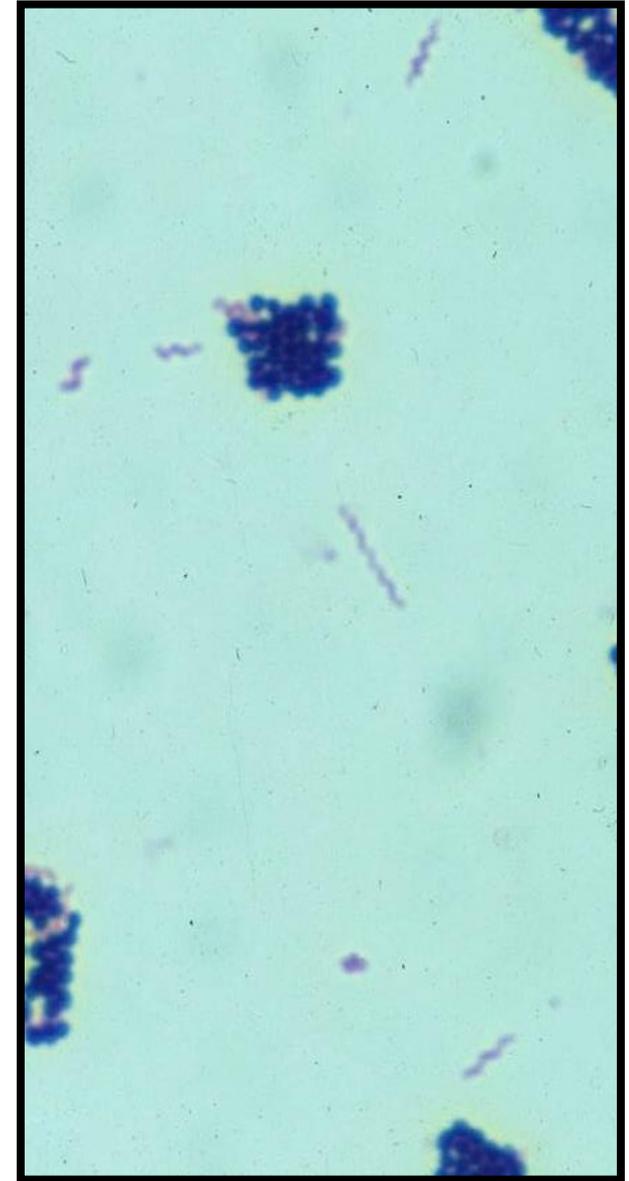


Pasteurella multocida Gram stain:
Small gram-negative coccoid bacillus



Anaerobiospirillum succiniciproducens

- Image associated with a case of bacteremia in a patient who kissed their dog
- Anaerobic, long spiral gram-negative bacillus
- Corkscrew motility
- Associated with dog and cat feces



Case 3

- A 12-month-old male with trilateral retinoblastoma status post 3 cycles of chemotherapy presents to an outside hospital with fever and neutropenia in December 2023
- Patient had methicillin-susceptible *Staphylococcus aureus* (MSSA) bacteremia that was successfully treated
- Central venous catheter (CVC) was removed given prior MSSA bacteremia in October 2023 and MSSA bacteremia at this presentation
- After removal of CVC, he had persistent lethargy and CT imaging revealed multiple brain infarcts and he was transferred to our institution

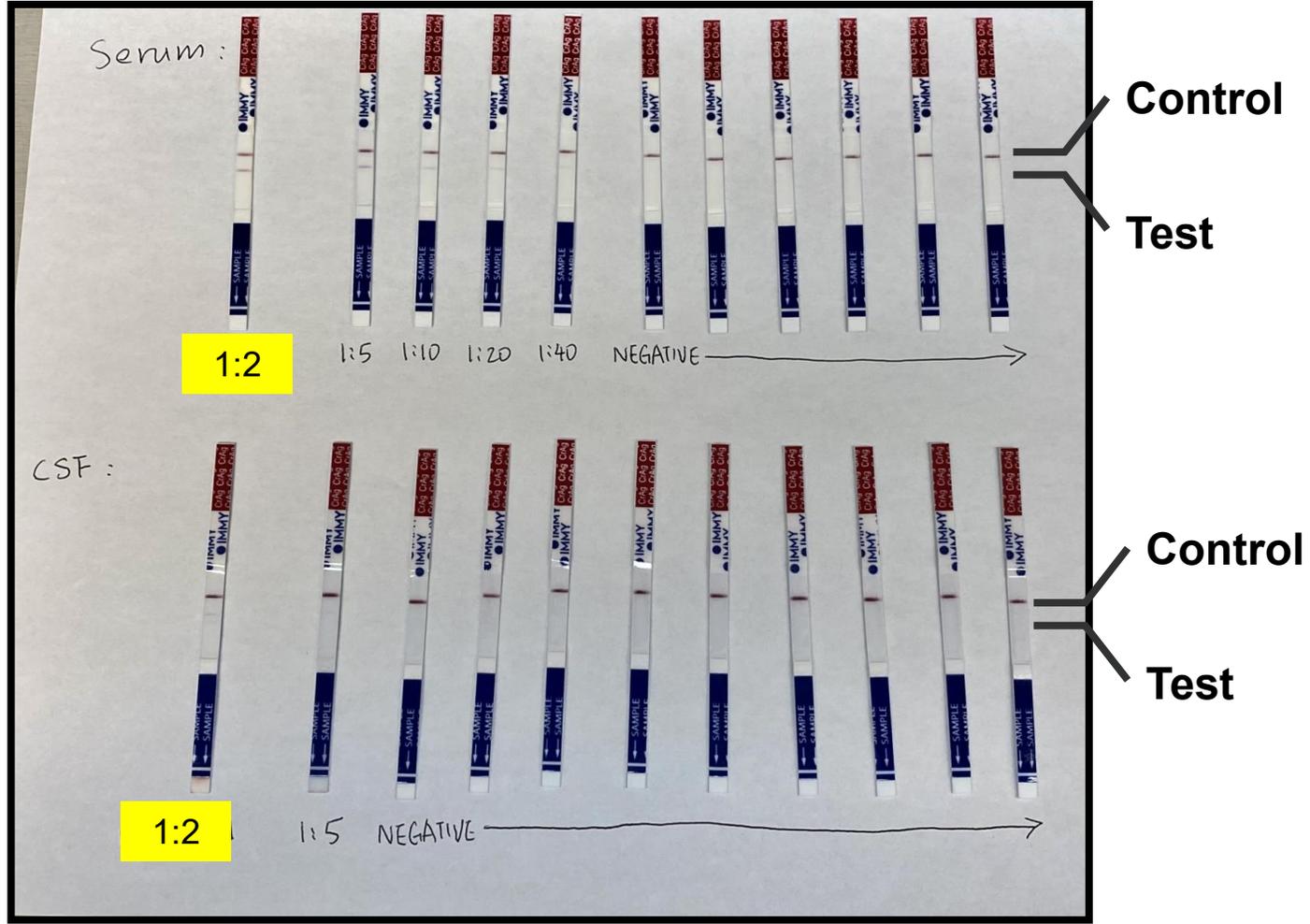
Case 3

- Magnetic resonance imaging revealed multiple mycotic aneurysms, for which he underwent coil embolization
- Repeat imaging revealed basilar leptomeningeal enhancement followed by hydrocephalus. External ventricular drain placed
- Lumbar puncture performed and cerebrospinal fluid (CSF) collected

Case 3

- CSF profile:
 - Glucose, 39 mg/dL - low
 - Protein, 105.9 mg/dL - high
 - WBC, 90 cells/ μ L, 77% PMNs - high
- Lateral flow immunoassay (LFA) cryptococcal antigen (CrAg) test:
 - CSF, 1:5
 - Serum, 1:40
- (1,3)- β -D-glucan (BDG):
 - CSF, 3,770 pg/mL
 - Serum, 211 pg/mL
- CSF Gram stain, no organism seen; few PMNs (cultures no growth)

CrAg test results



Case 3

- Based on basilar leptomeningeal enhancement, and CrAg and BDG results, amphotericin and fluconazole initiated for fungal (cryptococcal?) meningitis
- Broad anti-bacterial (nafcillin and meropenem) and *Mycobacterium tuberculosis* therapy also initiated
- ***Any thoughts about the CrAg and BDG test results?***

What yeasts can cross-react with CrAg tests?

- *Rhodotorula*
- *Trichosporon*

What fungi do not elicit a positive BDG result?

- *Blastomyces*
- *Cryptococcus*
- Mucorales

Case 3

- Sequencing of plasma microbial cell free-DNA (Karius Test), *Trichosporon inkin* detected (and *Enterococcus faecium* and *Raoultella ornithinolytica*)
- Fluconazole changed to voriconazole for better *Trichosporon* coverage. Broad range anti-bacterial therapy continued. *M. tuberculosis* therapy stopped
- Next-generation sequencing of CSF specimen (performed at UCSF) detected *Trichosporon inkin* only
- The cross-reactive CrAg test and positive BDG test support the identification of *T. inkin*
- *T. inkin* was not recovered in culture

Fungal susceptibility app.

Fungal susceptibility app.

Download the app from either the Apple store for iPhone or Google Play for an Android phone.

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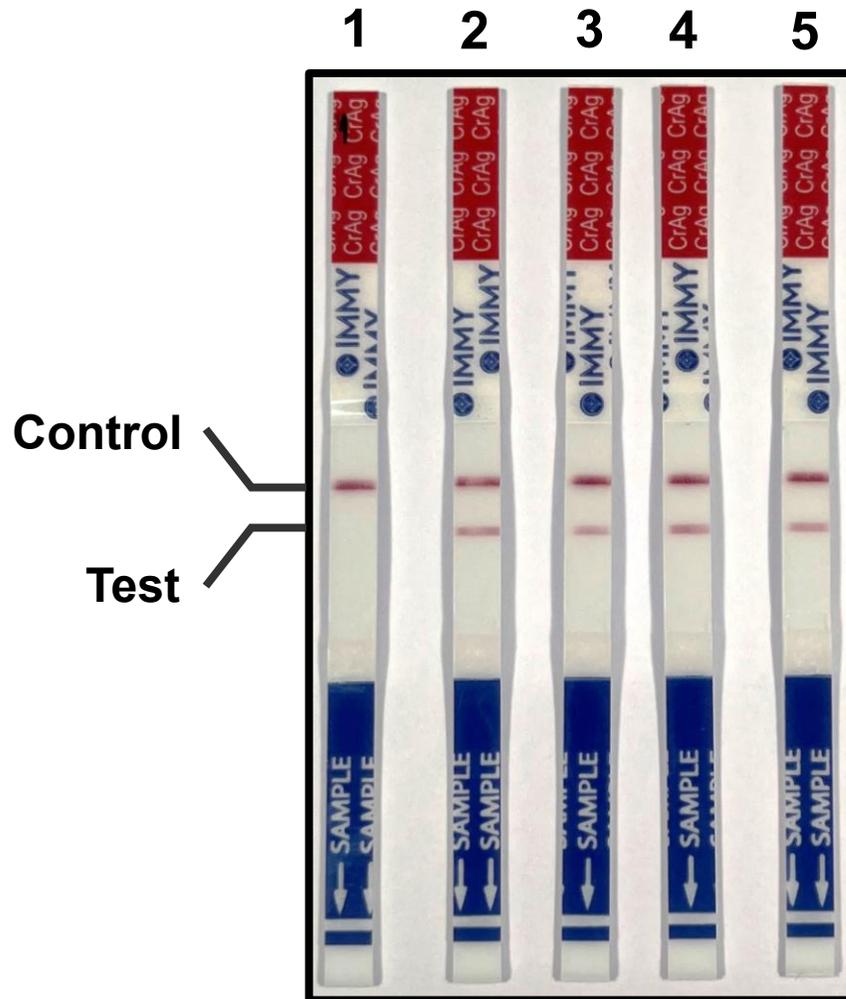
*This content is intended for Healthcare professionals only and is based on the Descriptions of Medical Fungi textbook.
PP-AIP-AUS-0025. 01/22.

T. inkin antifungal minimum inhibitory concentration distributions

Trichosporon inkin (1); MIC $\mu\text{g/mL}$.

	No	≤ 0.016	0.03	0.06	0.125	0.25	0.5	1	2	4	≥ 8
AmB	6					2	2	1		1	
FLU	6							1	3	1	1
VORI	6		1	1	2	2					
POSA	6				2	1	2	1			
ITRA	6				2	2	2				

T. inkin cross reacts with the CrAg LFA



1. *C. albicans* ATCC 90028 (negative control)
2. *C. gattii* ATCC 32609 (positive control)
3. *T. inkin* – isolate 1
4. *T. inkin* – isolate 2
5. *T. inkin* – isolate 3

Trichosporon

- Basidiomycetous yeast widely dispersed in the environment
- Species recovered from clinical specimens include:
 - *Trichosporon asahii*
 - *Trichosporon asteroides*
 - *Trichosporon cutaneum* (*Cutaneotrichosporon cutaneum*)
 - *Trichosporon inkin*
 - *Trichosporon mucoides* (*Cutaneotrichosporon mucoides*)
 - *Trichosporon mycotoxinovorans* (*Apiotrichum mycotoxinovorans*)
 - *Trichosporon ovoides*
- Normal microbiota in human skin, nails, and mouth

Trichosporon clinical presentation

- Increasingly involved in localized and disseminated infections
- Immunocompromised patients with neutropenia are especially susceptible
- Type and site of infection are somewhat predictive of the involved species

Organism	Infection
<i>Trichosporon asahii</i>	Systemic, predilection for hematogenous dissemination; cause of summer-type hypersensitivity pneumonitis in Japan
<i>Trichosporon asteroides</i>	Systemic and superficial infections
<i>Trichosporon cutaneum</i>	Rarely skin lesions and white piedra of underarm hairs
<i>Trichosporon inkin</i>	White piedra of pubic hairs, occasionally systemic
<i>Trichosporon mucoides</i>	Systemic, predilection for CNS; also infects hair and nails
<i>Trichosporon mycotoxinovorans</i>	Colonization and infection in cystic fibrosis patients
<i>Trichosporon ovoides</i>	White piedra of head hairs; occasional skin lesions

- Treatment: voriconazole
- Intrinsically resistant to echinocandins
- *T. asahii* inhibited by amphotericin B, but resistant to its fungicidal effects

White piedra

White to beige nodules, distributed at irregular intervals along hair shaft

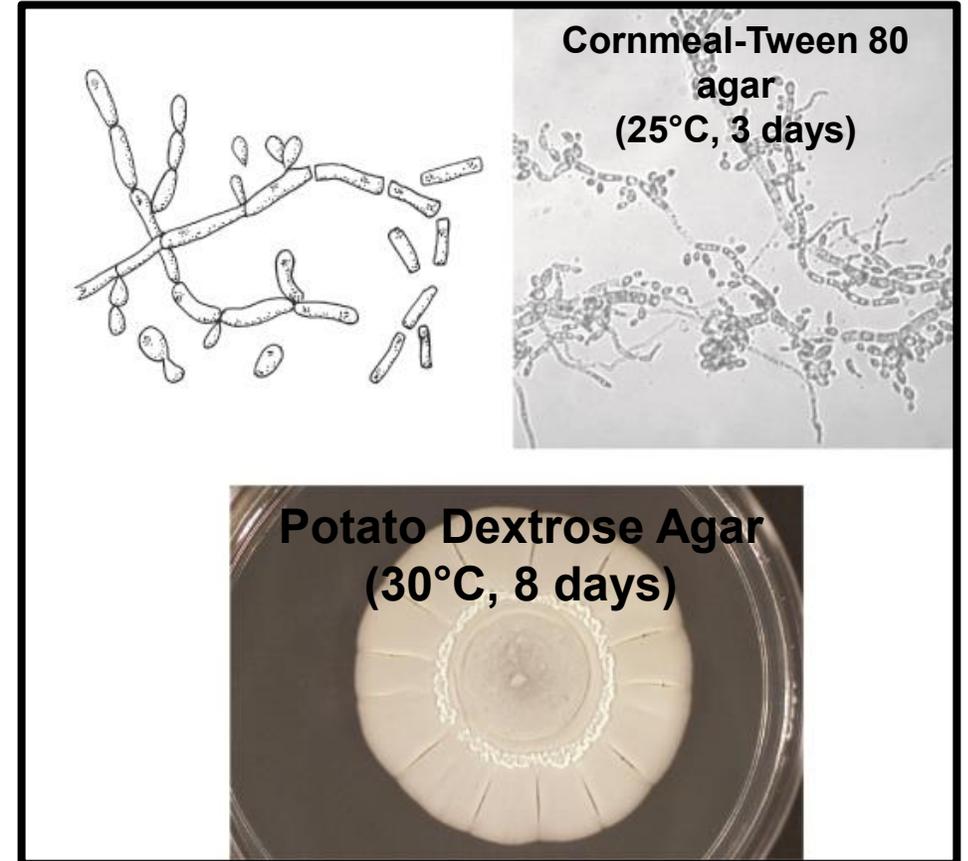


Nodule (magnification, 150×)



Trichosporon microbiology

- Colony morphology:
 - Growth rate, rapid (within 5 days) to moderate (6-10 days)
 - Colonies moist, surface may become wrinkled, powdery or crumb-like, and center may become heaped
 - Initially cream-colored, often darkens to yellowish gray
- Microscopic morphology (cornmeal-Tween 80):
 - Blastoconidia
 - Pseudohyphae
 - True hyphae
 - Arthroconidia (2-4 × 3-9 μm) observed in older cultures
- Biochemical tests:
 - Urease, positive (*Geotrichum* species are urease negative)
 - Can cross-react with CrAg tests



Organism	Urease	Blastoconidia	Pseudohyphae	True hyphae	Arthroconidia
<i>Trichosporon</i>	+	+	+	+	+
<i>Geotrichum</i>	0	0	0	+	+

Abbreviations: 0, negative; +, positive

Case 3

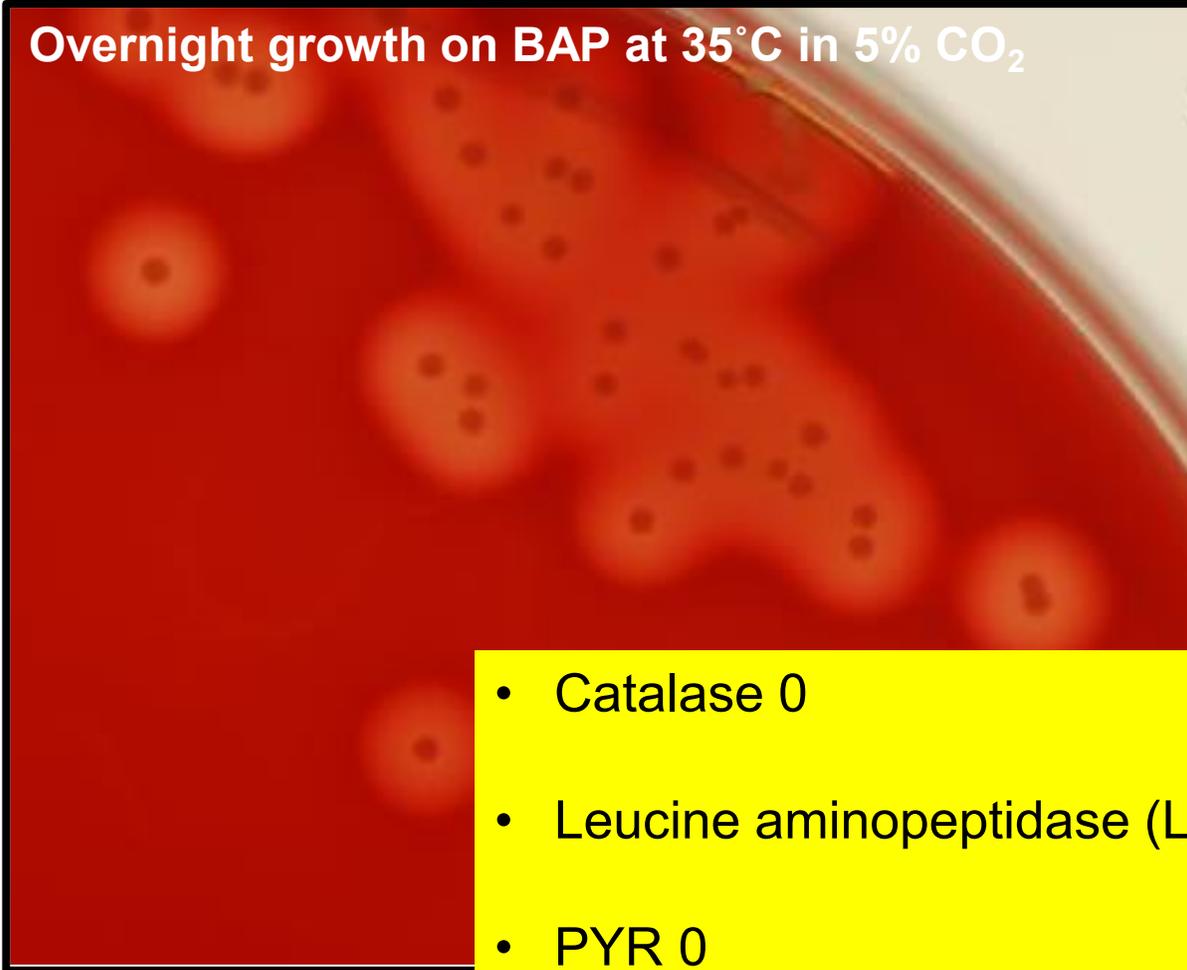
- Patient had a complicated course with development of intraventricular hemorrhage and hydrocephalus, likely from aneurysm rupture, requiring external ventricular drain placement
- Subsequent MRIs revealed improvement of leptomeningeal enhancement, but the patient continued to develop new punctate infarcts and mycotic aneurysms in anterior and posterior cerebral circulations
- Once the patient was on appropriate (voriconazole) antifungal therapy, dexamethasone was initiated to reduce CNS inflammation
- CSF BDG levels decreased while on antifungal therapy
- Patient required ventriculoperitoneal shunt placement for hydrocephalus and was discharged on voriconazole. They demonstrated significant neurologic improvement in the outpatient setting
- Six months after his initial diagnosis, repeat CSF BDG and CSF mNGS were repeated and both were negative

Case 4

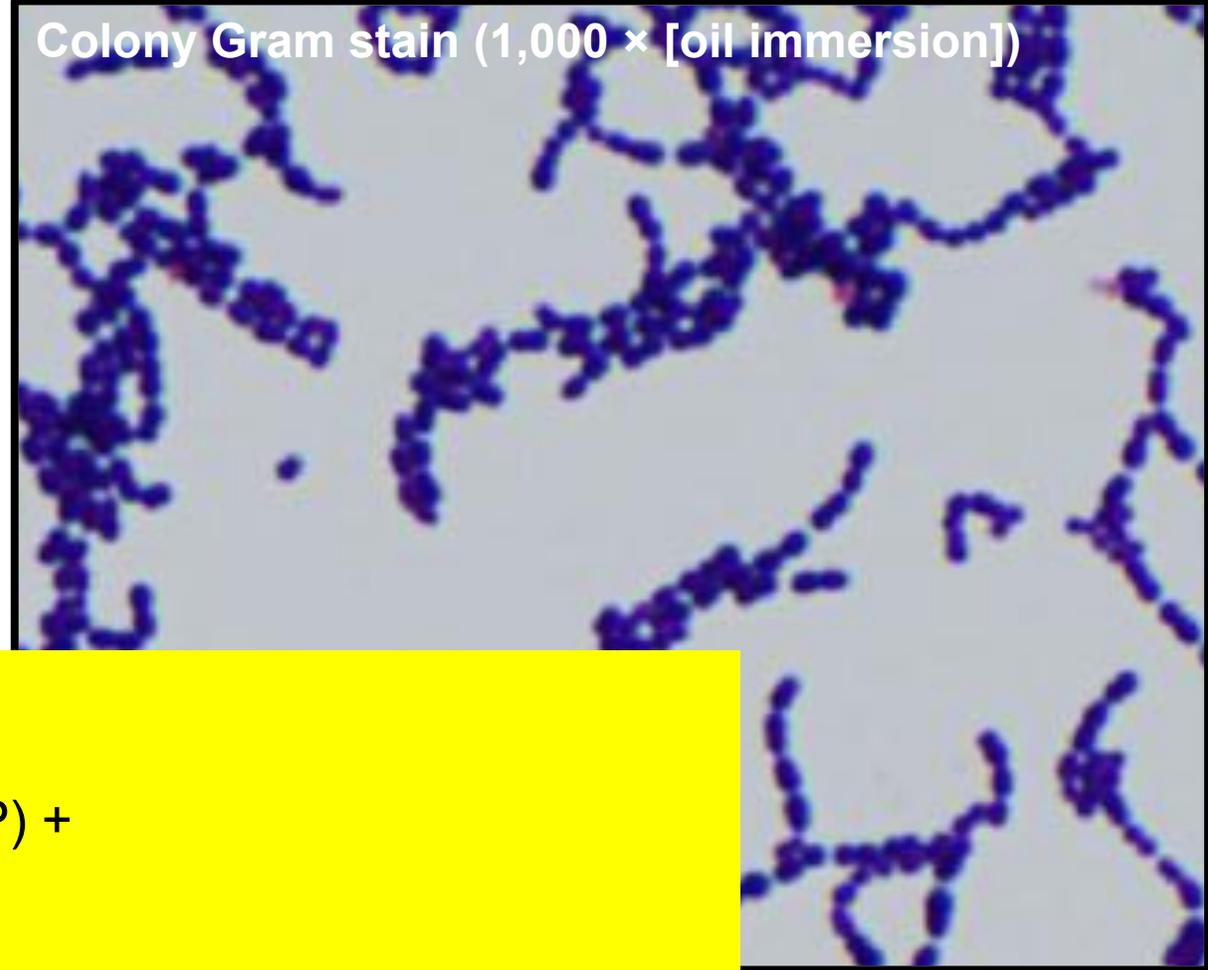
- A 29-year-old woman seen in her 3rd pregnancy:
 - 1st pregnancy, premature rupture of membranes → spontaneous delivery of a preivable infant at 5 months
 - 2nd pregnancy, spontaneous abortion at 7 weeks
- Had a history of abnormal cervical cytology smears → colposcopy and loop electrosurgical excision procedure
- Vagino-rectal culture taken at 39 weeks for *Streptococcus agalactiae* (Group B *Streptococcus* [GBS])

Case 4

Overnight growth on BAP at 35°C in 5% CO₂

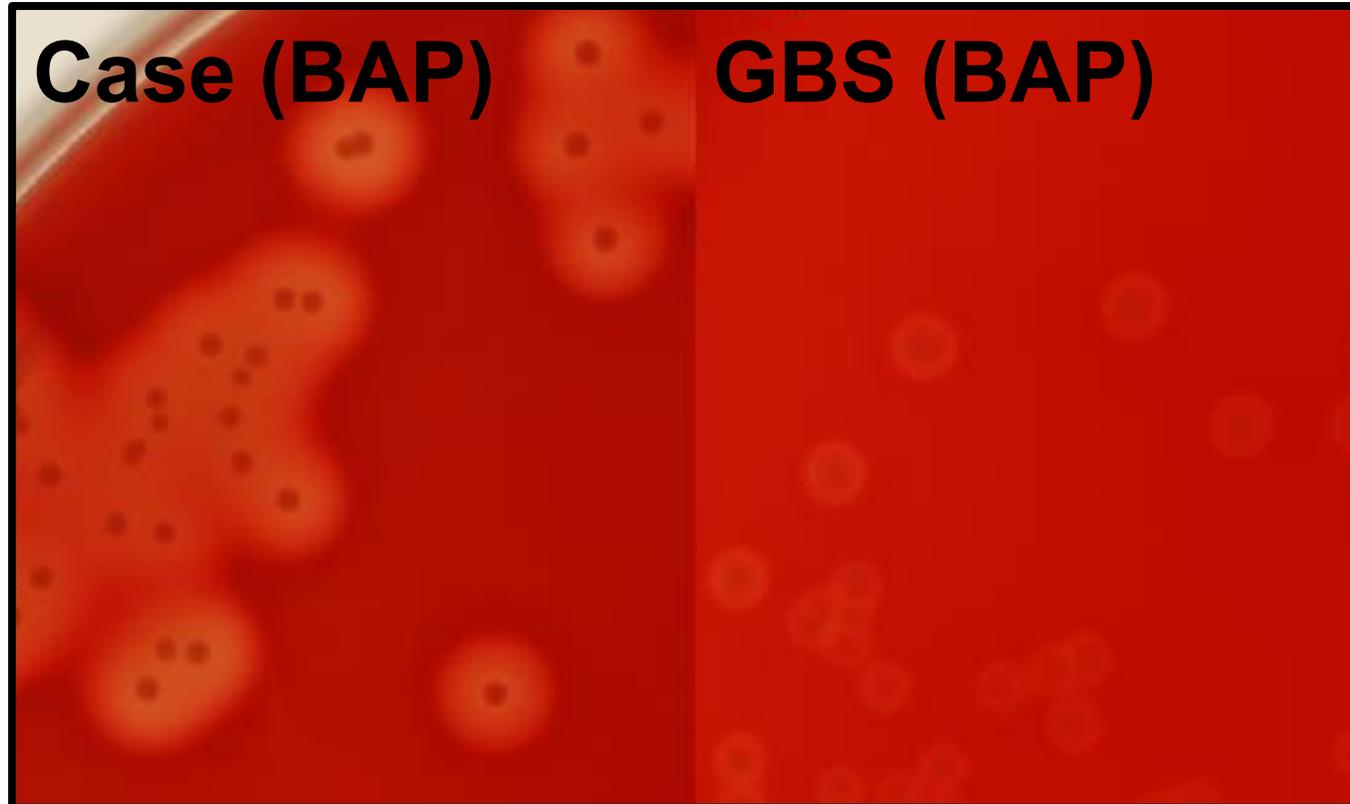


Colony Gram stain (1,000 × [oil immersion])



- Catalase 0
- Leucine aminopeptidase (LAP) +
- PYR 0
- Group B streptococcus (GBS) latex typing reagent, weak +
- **What about that zone of β-hemolysis?**

Case 4



What is your differential?

Streptococcus porcinus (MALDI-TOF MS)

Streptococcus pseudoporcinus (16S rRNA gene sequencing)

S. pseudoporcinus, microbiology

- Nonhuman (porcine) isolates → *S. porcinus*
- Human isolates → *S. pseudoporcinus*
- *S. pseudoporcinus* (Lancefield antigen: E, P, NG1, untypeable) can cross-react with commercial Group B typing reagents (false-positive GBS [resulting in *S. pseudoporcinus* being underrecognized])
- Key *S. pseudoporcinus* biochemicals (very similar to *S. agalactiae* [GBS])
 - Large colonies, >0.5 mm after 24 h incubation
 - CAMP factor +
 - Hippurate +
 - Bacitracin resistant
 - Isolated from the female genital tract
 - Susceptible to penicillin
- May be indistinguishable from GBS when recovered on GBS chromogenic agars, however, not detected by GBS molecular assays (should it be?)
- Identified by MALDI-TOF MS (Vitek MS and MALDI Biotyper) either as *S. porcinus* or *S. pseudoporcinus* (if identified as *S. porcinus*, human isolates are almost certainly *S. pseudoporcinus*)

Group B antigen-positive or cross-reactive streptococci

Phenotype/ biochemical	<i>Streptococcus</i> <i>agalactiae</i> ATCC 13813 ^T	<i>Streptococcus</i> <i>halichoeri</i> CCUG 48324 ^T (subsp. <i>halichoeri</i>)	<i>Streptococcus</i> <i>halichoeri</i> (Human Isolates; subsp. <i>hominis</i>)	<i>Streptococcus</i> <i>porcinus</i>	<i>Streptococcus</i> <i>pseudoporcinus</i>
Hemolysis	β (soft/narrow)	γ	γ	β (large)	β (large)
LAP	+	+	+	+	+
PYR	0	+	+	V	V
Bile-esculin	0	0	+	0	V
6.5% NaCl	+	+	+	+	+
Esculin	0	0	+	+	+
Arginine	+	+	+	+	+
Hippurate	+	0	0	0	+

Abbreviations: LAP, leucine aminopeptidase; 0, negative; +, positive; PYR, pyrrolidonyl arylamidase; V, variable

Group B antigen-positive or cross-reactive streptococci

Phenotype/ biochemical	<i>Streptococcus agalactiae</i> ATCC 13813 ^T	<i>Streptococcus halichoeri</i> CCUG 48324 ^T (subsp. <i>halichoeri</i>)	<i>Streptococcus halichoeri</i> (Human Isolates; subsp. <i>hominis</i>)	<i>Streptococcus porcinus</i>	<i>Streptococcus pseudoporcinus</i>
Hemolysis	β (soft/narrow)	γ	γ		
LAP	+	+	+		
PYR	0	+	+		
Bile-esculin	0	0	+		
6.5% NaCl	+	+	+		
Esculin	0	0	+		
Arginine	+	+	+		
Hippurate	+	0	0		

- *S. halichoeri* isolates catalase + (strongly catalase + on media with blood; catalase reaction slower and weaker on non-blood containing media)
- Genome encodes catalase gene
- Unclear if there are 2 subspecies (as proposed by Shewmaker *et al.* (additional studies needed))
- Human and canine isolates genetically similar, suggesting transmission between humans and dogs
- Is present in MALDI-TOF MS database (Bruker Daltonics, Inc.)

Abbreviations: LAP, leucine aminopeptidase; 0, negative; +, positive; PYR, pyrrolidonyl arylamidase; V, variable

S. halichoeri recovered from animals (gray seal, canines, fur animals [e.g., mink, fox]) and humans

Clinical significance of *S. pseudoporcinus* in pregnancy

- 1.6% (60/3,704) of women colonized in pregnancy, and colonization occurs primarily in African American women
- Compared to women colonized with GBS, women colonized with *S. pseudoporcinus* more frequently experienced preterm premature rupture of membranes (PPRM) or spontaneous preterm birth
- No significant difference in rates of chorioamnionitis, postpartum fever, endomyometritis, or wound infections between GBS and *S. pseudoporcinus* colonization groups
- Neonates delivered by women colonized with *S. pseudoporcinus* were more frequently admitted to the NICU, but there were no difference in rates of neonatal sepsis or respiratory distress syndrome between GBS and *S. pseudoporcinus* carriers
- Value in reporting *S. pseudoporcinus* colonization in the medical record and indicating its association with PPRM and spontaneous preterm birth

Case 4

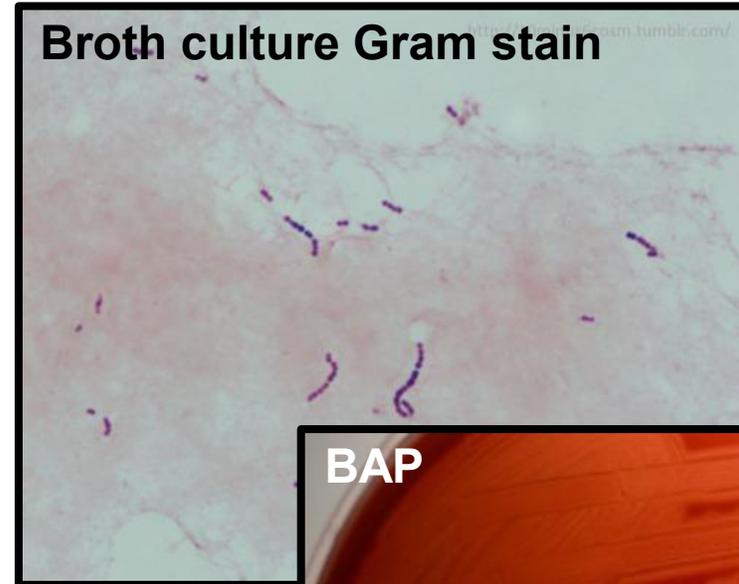
- Patient required Cesarean delivery at gestational age 39.3 weeks after failed induction of labor for severe gestational hypertension/preeclampsia
- No premature rupture of membranes → no intrapartum antibiotics administered
- Both patient and infant did well

What *Streptococcus* species is a fish pathogen and has been associated with invasive human infections?

Streptococcus iniae

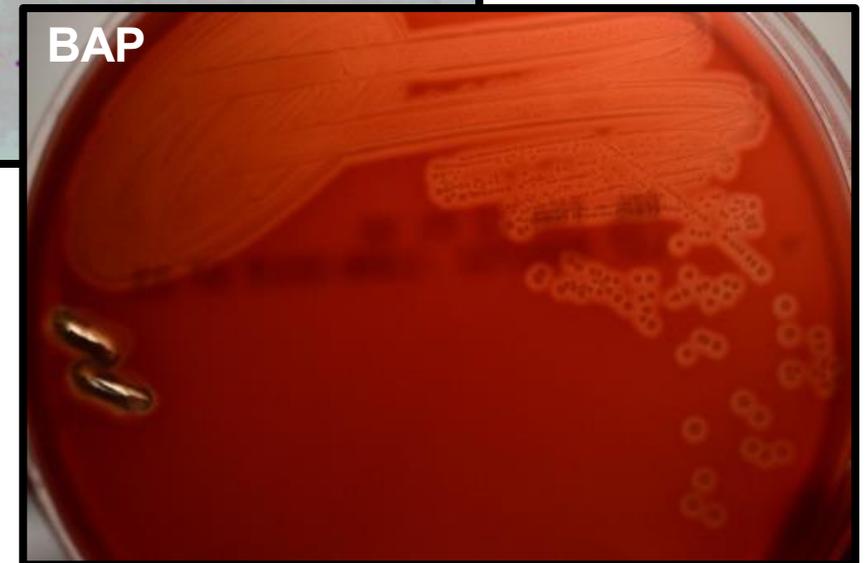
- Associated with invasive infections in humans after handling fish (e.g., farmed fish such as Tilapia)
- Can cause cellulitis, endocarditis, and osteomyelitis in humans
- Gram-positive cocci in chains (best observed after growth in broth [as for most organisms])
- Isolates β -hemolytic after 24 h incubation (can appear alpha-hemolytic initially). No Lancefield group carbohydrate antigen (untypeable)
- Not accurately identified by biochemical systems; e.g., *Streptococcus dysgalactiae* subspecies *equismilis*, *S. porcinus*, or *S. pseudoporcinus* (is present in MALDI-TOF MS database, Bruker Daltonics, Inc.)
- *S. iniae* is closely related to *Streptococcus hongkongensis*, which can also cause invasive infections in humans that handle fish

Broth culture Gram stain



- Catalase 0
- PYR +
- CAMP factor +

BAP



But *Weirdobacter*

But *Weirdobacter weirdii* is an **abomination** under the rules of the International Code of Nomenclature of Prokaryotes. You can only use non-Latin or non-Greek words if they are proper nouns or no equivalent exist in Latin or Greek. And if you do import words from other languages, they become Latinised and so take -i- as the connecting vowel rather than -o-, i.e. *Weirdibacter*. And -ii is the genitive ending of a noun, typically a Latinised proper noun, whereas weird is an adjective.

Better would something like

***Extraordinaribacter extraordinarius*. L. masc. adj. *extraordinarius*, extraordinary; N.L. masc. n. *bacter*, a rod; N.L. masc. n. *Extraordinaribacter* an extraordinary bacterium; L. masc. adj. *extraordinarius*, extraordinary; <https://en.wiktionary.org/wiki/extraordinarius>
This is nearly a tautonym, which would be disallowed under the Code, but not quite.**

Cheers
Mark

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**Weill Cornell
Medicine**

“Extraordinaribacters” **cases of unusual organisms”**

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February 28, 2026
First Coast ID/CM Symposium
33rd Annual Meeting

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