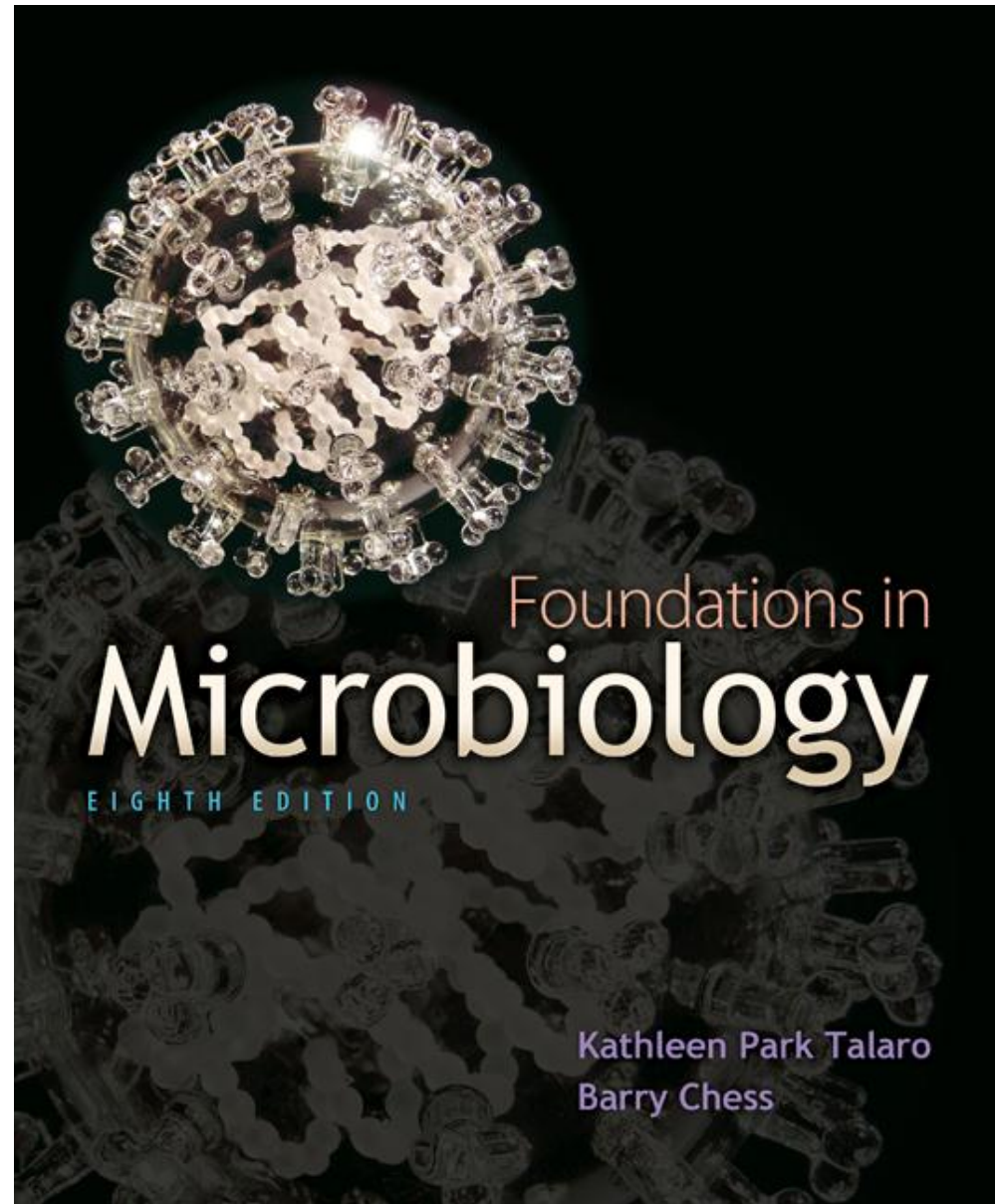


Chapter 22

The Fungi of Medical
Importance



22.1 Fungi as Infectious Agents

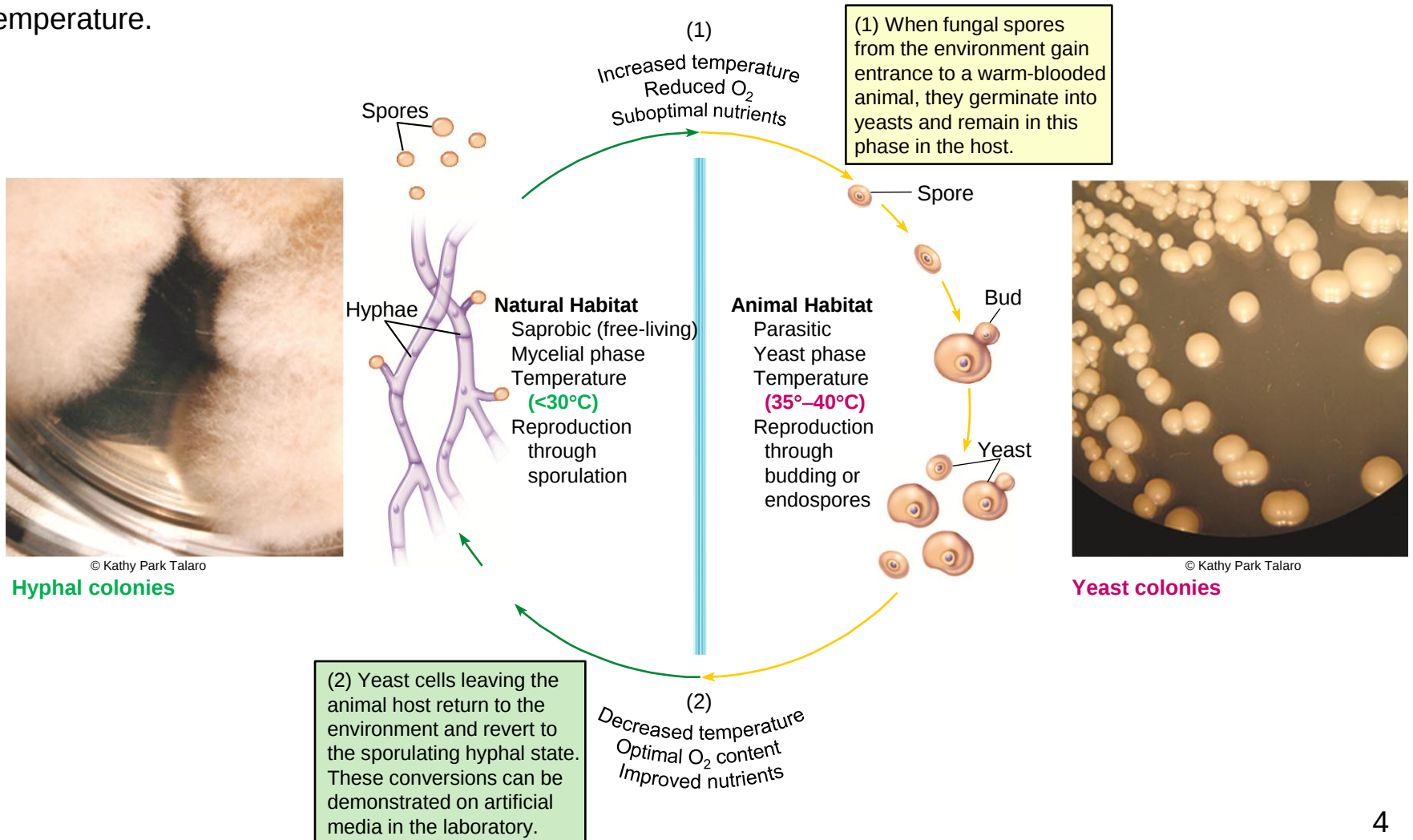
- Molds and yeasts are widely distributed in air, dust, fomites, and normal flora
- Humans are relatively resistant
- Fungi are relatively nonpathogenic
- Of the 100,000 fungal species, only 300 have been linked to disease in animals
- Fungi are the most common plant pathogens
- Human **mycoses** are caused by true fungal pathogens and opportunistic pathogens

Primary or True Fungal Pathogens

- **True** or **primary** fungal pathogen can invade and grow in a healthy, noncompromised host
- Most striking adaptation to survival and growth in the human host is the ability to switch from hyphal cells to yeast cells
- **Thermal dimorphism** – grow as molds at 30°C and as yeasts at 37°C

Figure 22.1 Thermal Dimorphism

Dimorphism is a phenomenon seen in true pathogens and is triggered by growth temperature.



Pathogenesis of the Fungi

- Portal of entry
 - **Primary mycoses**: respiratory portal; inhaled spores
 - **Subcutaneous**: inoculated skin; trauma
 - **Cutaneous and superficial**: contamination of skin surface
- Virulence factors – thermal dimorphism, toxin-like substances, capsules and adhesion factors, hydrolytic enzymes, inflammatory stimulants

22.2 Organization of Fungal Disease

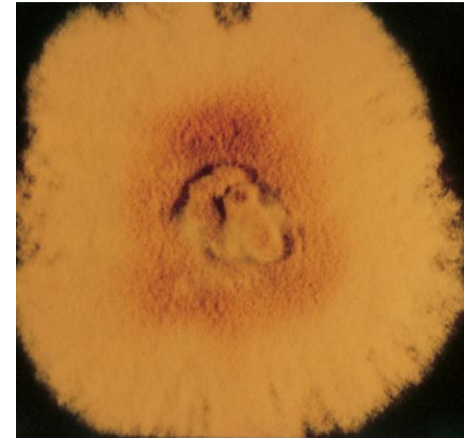
- Mycoses are presented according to type, level of infection, and degree of pathogenicity
 - **True pathogens**: systemic, cutaneous, and superficial mycoses
 - **Opportunistic mycoses**: has little or no virulence; host defenses must be impaired

Systemic Infections by True Pathogens

- Restricted to endemic regions of the world
- Infection occurs when matter containing conidia is disturbed
- Spores germinate in the lungs
- Infection can become systemic
- Spores may be inoculated into the skin
- All diseases result in immunity

Histoplasmosis: Ohio Valley Fever

- ***Histoplasma capsulatum*** – most common true pathogen; causes **histoplasmosis**
- Typically dimorphic
- Distributed worldwide, most prevalent in eastern and central regions of U.S.
- Grows in moist soil high in nitrogen content
- Inhaled conidia produce primary pulmonary infection that may progress to systemic involvement of a variety of organs and chronic lung disease
- Amphotericin B, ketoconazole



(a)

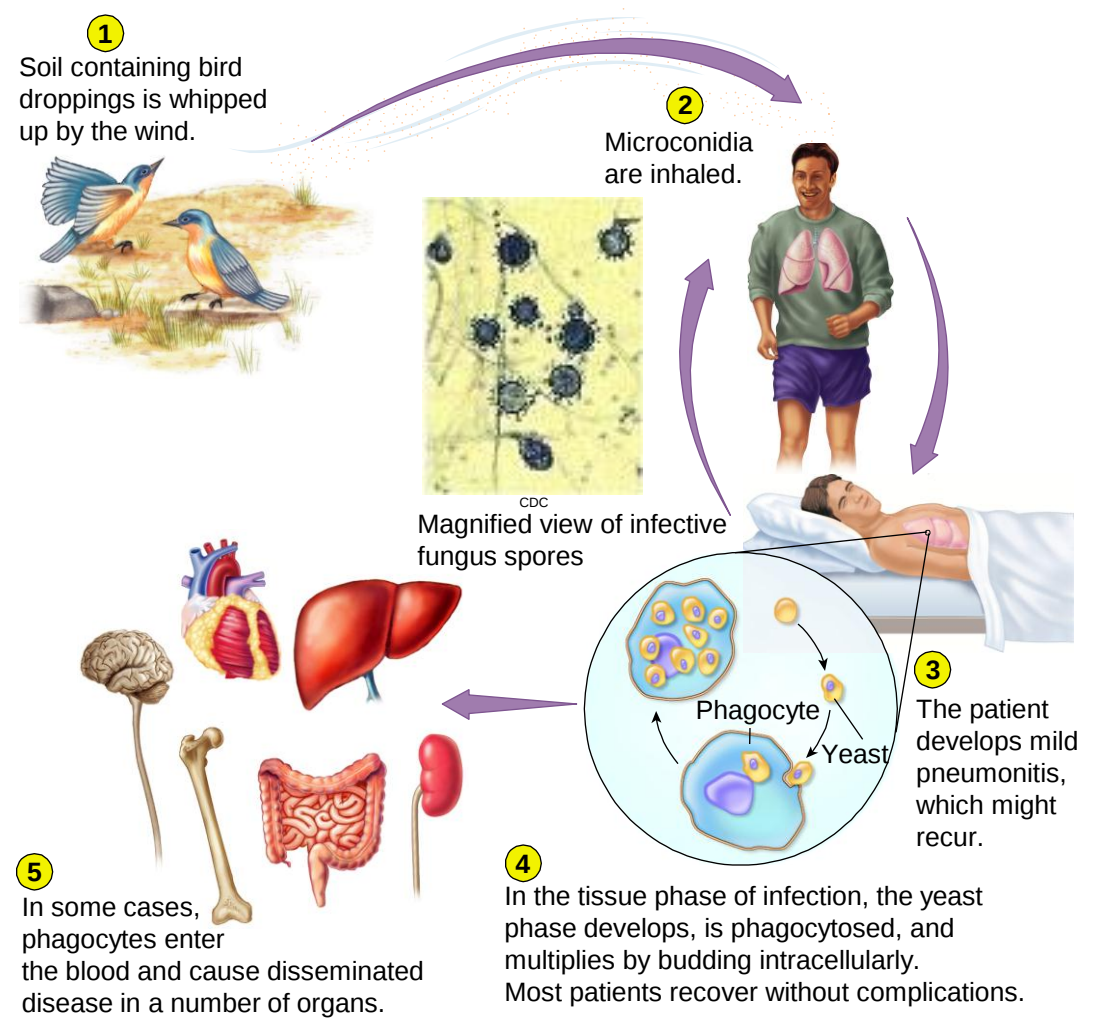
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(b)

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Figure 22.7 Events in *Histoplasma* Infection and Histoplasmosis



Coccidioidomycosis: Valley Fever

- ***Coccidioides immitis*** – causes **coccidioidomycosis**
- Distinctive morphology – blocklike arthroconidia in the free-living stage and spherules containing endospores in the lungs
- Lives in alkaline soils in semiarid, hot climates and is endemic to southwestern U.S.
- Arthrospores inhaled from dust, creates spherules, and can form nodules in the lungs
- Amphotericin B treatment

Figure 22.8 Events in *Coccidioides* Infection

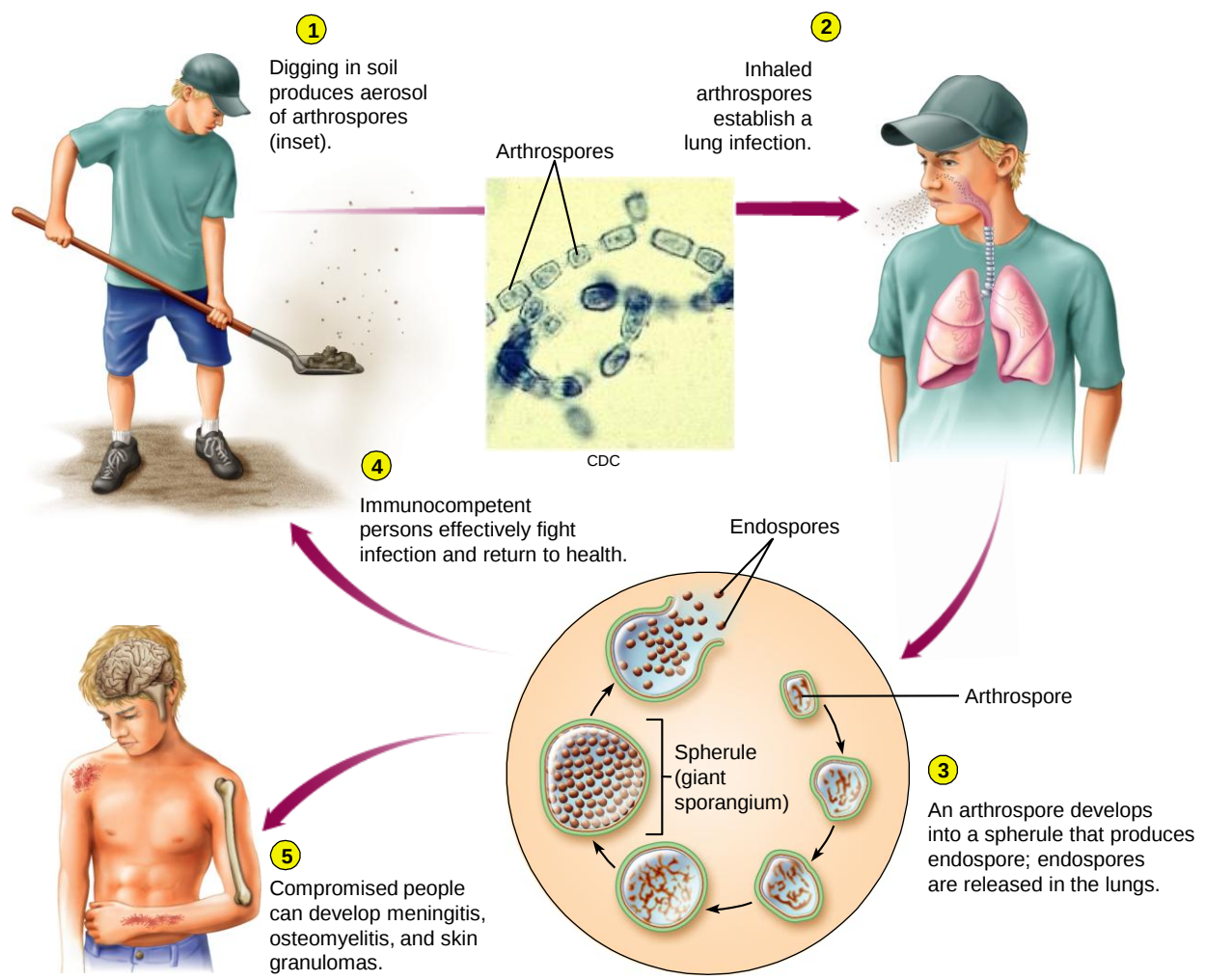


Figure 22.9 Disseminated coccidioidomycosis manifested by cutaneous lesions



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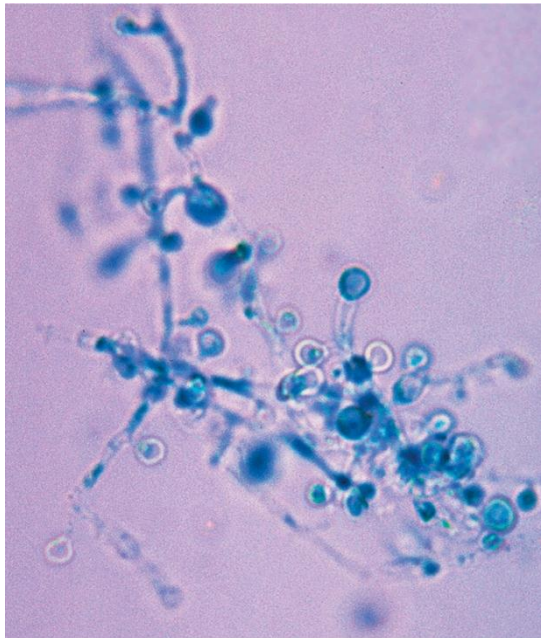


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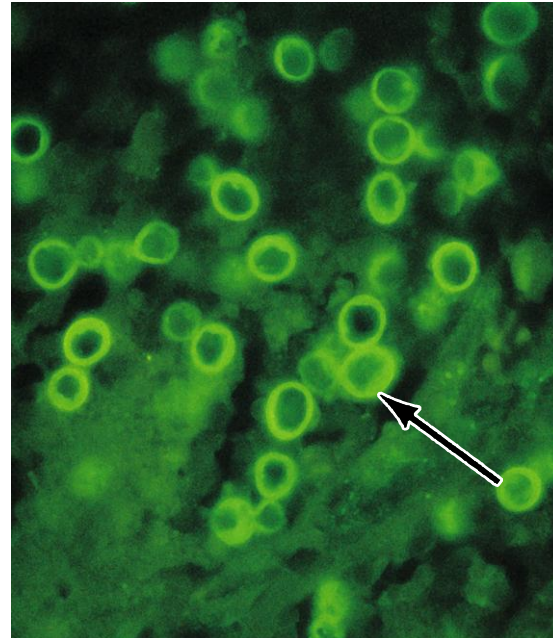
Blastomyces dermatitidis: North American Blastomycosis

- ***Blastomyces dermatitidis*** – causes **blastomycosis**
- Dimorphic
- Free-living species distributed in soil of a large section of the midwestern and southeastern U.S.

Figure 22.11
The dimorphic nature of
Blastomyces dermatitidis



(a) Hyphal filaments



(b) Fluorescent staining of lung tissue

Blastomyces dermatitidis: North American Blastomycosis

- Inhaled 10-100 conidia convert to yeasts and multiply in lungs
- Symptoms include cough and fever
- Chronic cutaneous, bone, and nervous system complications
- Amphotericin B

Figure 22.12 cutaneous blastomycosis in the hand and wrist as a complication of disseminated infection.



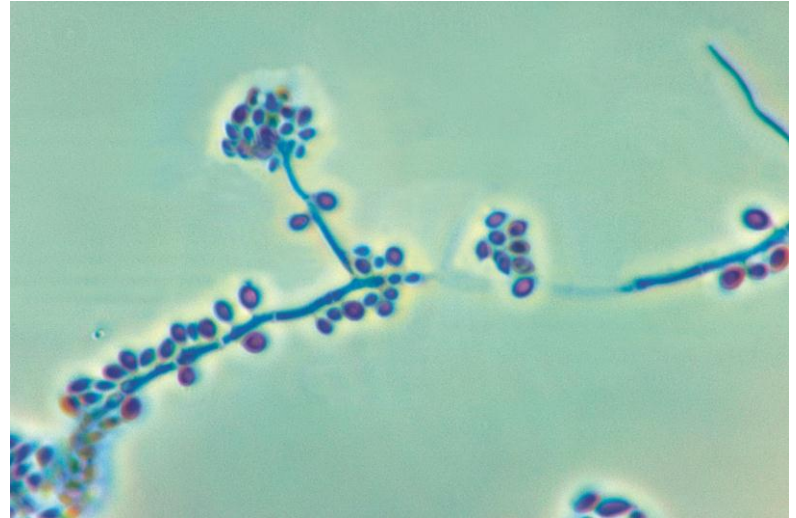
22.3 Subcutaneous Mycoses

- **Subcutaneous mycoses**: when fungi are transferred directly into traumatized skin, they can invade
- Most species in this group are greatly inhibited by higher temperatures of the blood and viscera
- Diseases are progressive

Sporothrix schenckii

- **Sporotrichosis**
(rose-gardener's disease)
- Very common saprobic fungus that decomposes plant matter in soil
- Infects appendages and lungs
- Lymphocutaneous variety occurs when contaminated plant matter penetrates the skin and the pathogen forms a nodule, then spreads to nearby lymph nodes —————→

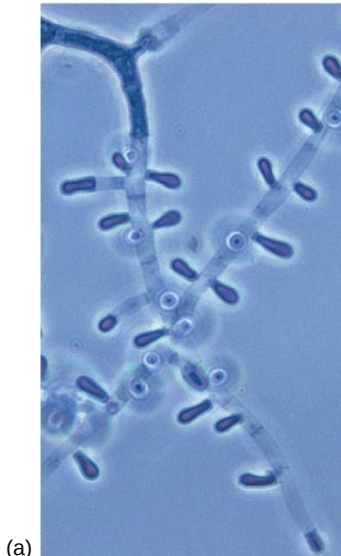
Hyphal phase



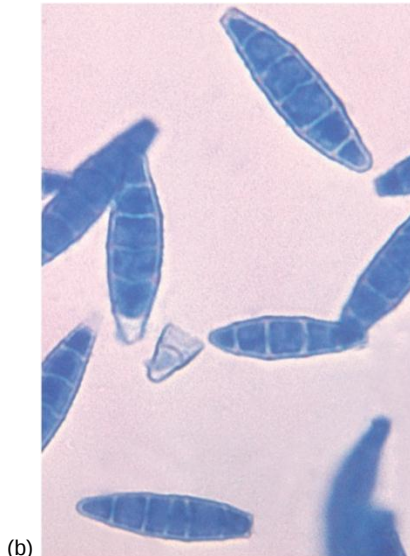
22.4 Cutaneous Mycoses

- Infections strictly confined to keratinized epidermis (skin, hair, nails) are called **dermatophytoses** – ringworm and tinea
- 39 species in the genera *Trichophyton*, *Microsporum*, *Epidermophyton*
- Closely related and morphologically similar
- Causative agent of ring worm varies case to case

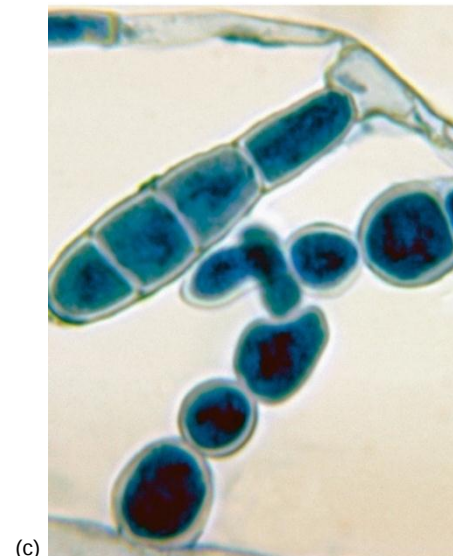
Trichophyton



Microsporum



Epidermophyton



Characteristics of Dermatophytes

- Natural reservoirs – humans, animals, and soil
- Hardiness of the dermatophyte spores, presence of abraded skin, and intimate contact promote infection
- Long infection period followed by localized inflammation and allergic reactions to fungal proteins

Epidemiology and Pathology of Dermatophytes

- Ringworm of scalp (**tinea capitis**) affects scalp and hair-bearing regions of head; hair may be lost →
- Ringworm of beard (**tinea barbae**) affects the chin and beard of adult males; contracted mainly from animals
- Ringworm of body (**tinea corporis**) occurs as →
inflamed, red ring lesions anywhere on smooth skin



CDC



CDC

Pathogenesis

- Ringworm of groin (**tinea cruris**) “jock itch” affects groin and scrotal regions
- Ringworm of foot and hand (**tinea pedis** and **tinea manuum**) is spread by exposure to public surfaces; occurs between digits and on soles
- Ringworm of nails (**tinea unguium**) is a persistent colonization of the nails of the hands and feet that distorts the nail bed

Figure 22.18 Ringworm of the extremities



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22.6 Opportunistic Mycoses

- All have predisposing factors
 - Candida* – dominant opportunistic pathogen
 - Cryptococcus* – opportunistic pathogen

Infections by *Candida*: Candidiasis

- ***Candida albicans***
- Widespread yeast
- Infections can be short-lived, superficial skin irritations to overwhelming, fatal systemic diseases
- Budding cells of varying size that may form both elongate pseudohyphae and true hyphae
- Forms off-white, pasty colony with a yeasty odor

Diseases of *Candida albicans*

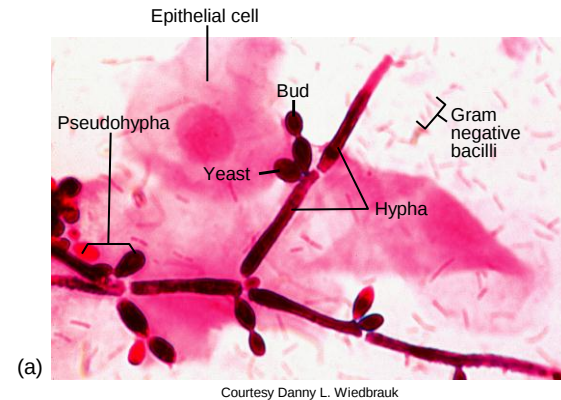
- Normal flora of oral cavity, genitalia, large intestine or skin of 20% of humans
- Account for 70% of nosocomial fungal infections
- **Thrush** – occurs as a thick, white, adherent growth on the mucous membranes of mouth and throat
- **Vulvovaginal yeast infection** – painful inflammatory condition of the female genital region that causes ulceration and discharge
- **Cutaneous candidiasis** – occurs in chronically moist areas of skin and in burn patients

Figure 22.21 *Candida albicans* infection of the mouth (oral thrush)



Diagnosis and Treatment

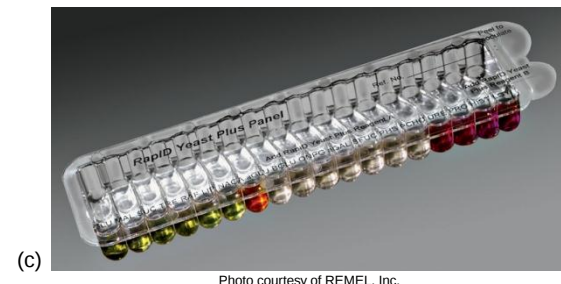
- Presumptive diagnosis made if budding yeast cells and pseudohyphae are found; germ tube
- Growth on selective, differential media differentiates *Candida* species
- Topical antifungals for superficial infections, amphotericin B and fluconazole for systemics



Stain of a vaginal smear



Pale blue colonies



Rapid ID test

Cryptococcus neoformans

- ***Cryptococcus neoformans*** causes **cryptococcosis**
- A widespread encapsulated yeast that inhabits soil around pigeon roosts
- Common infection of AIDS, cancer, or diabetes patients
- Infection of lungs leads to cough, fever, and lung nodules
- Dissemination to meninges and brain can cause severe neurological disturbance and death

Figure 22.24 disseminated case of cutaneous cryptococcosis

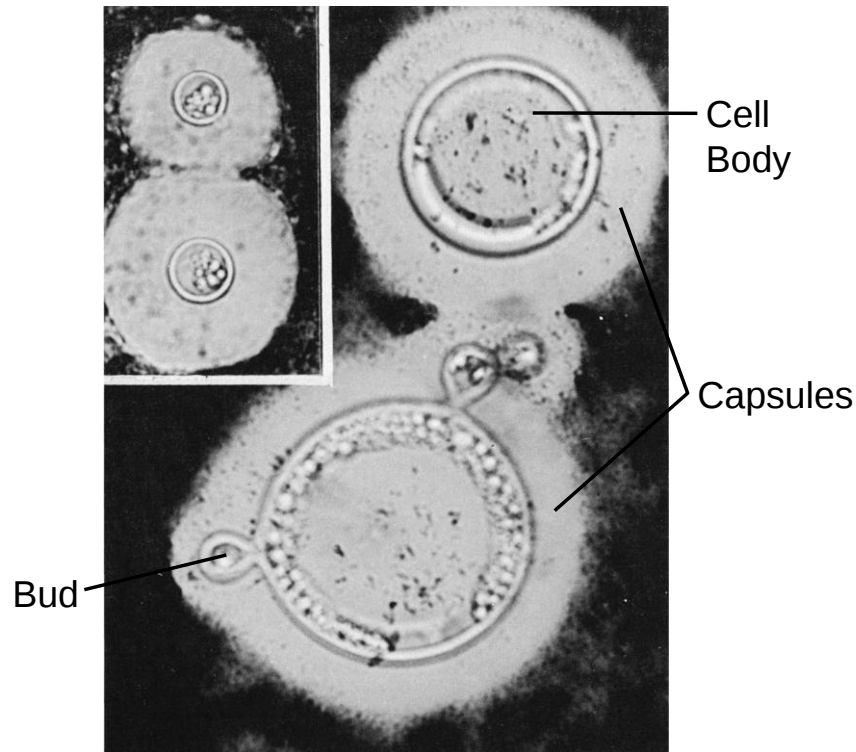


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Diagnosis and Treatment

- Negative stain demonstrating encapsulated budding yeast
- Biochemical tests, serological testing
- Systemic infection requires amphotericin B and fluconazole

Figure 22.23 negative stain with India Ink



Pneumocystis (carinii) jiroveci and *Pneumocystis* Pneumonia

- A small, unicellular fungus that causes **pneumonia (PCP)**, the most prominent opportunistic infection in AIDS patients
- This pneumonia forms secretions in the lungs that block breathing and can be rapidly fatal if not controlled with medication
- Pentamidine and cotrimoxazole

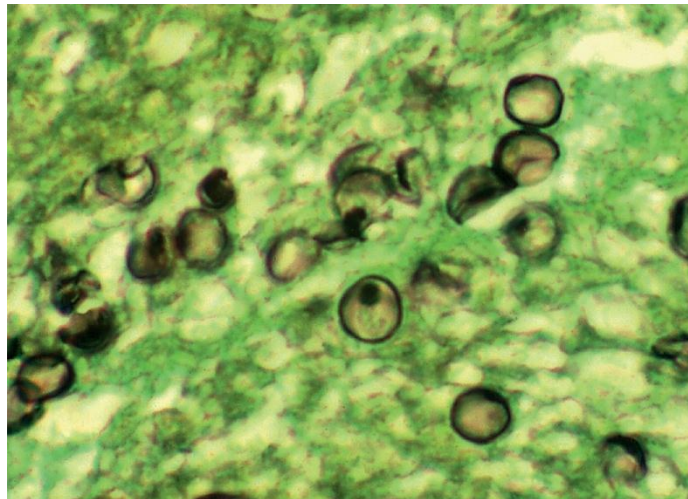
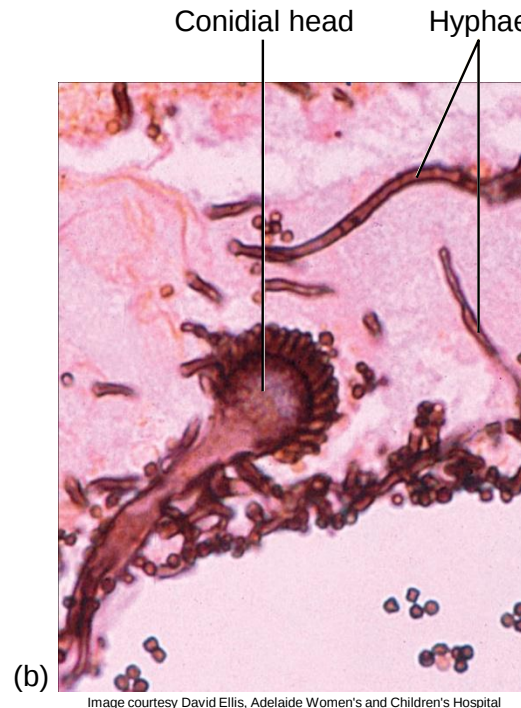


Figure 22.25 in lung tissue

Aspergillosis: Diseases of the Genus *Aspergillus*

- Very common airborne soil fungus
- 600 species, 8 involved in human disease; *A. fumigatus* most commonly
- Serious opportunistic threat to AIDS, leukemia, and transplant patients

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Aspergillosis: Diseases of the Genus *Aspergillus*

- Infection usually occurs in lungs – spores germinate in lungs and form fungal balls; can colonize sinuses, ear canals, eyelids, and conjunctiva
- Invasive aspergillosis can produce necrotic pneumonia, and infection of brain, heart, and other organs
- Amphotericin B and nystatin

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(a)

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