

Yeast Infections

Candidiasis: pathogenic mechanisms, morphology, and clinical patterns

Candida albicans • Candida auris

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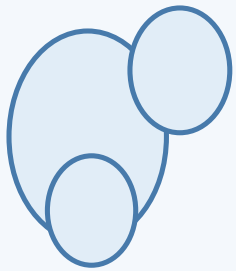
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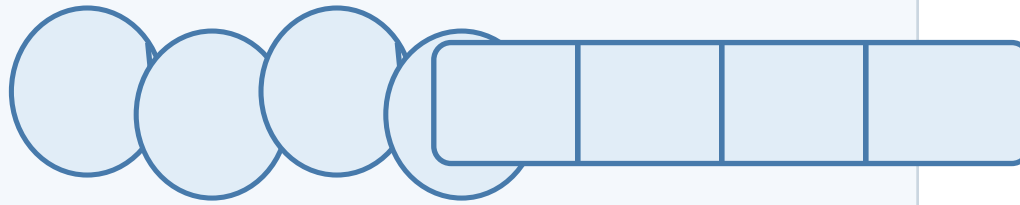
Learning objectives

- Distinguish yeast, pseudohyphae, and true hyphae in tissue.
- Connect Candida virulence and host-defense defects to infection patterns.
- Recognize mucocutaneous and disseminated candidiasis.
- Differentiate the clinical significance of *C. Albicans* and *C. Auris*.

Fungal growth forms frame diagnosis



Budding yeast



Pseudohyphae

Septate hyphae

Schematic fungal growth forms

- Yeasts grow as individual round-to-oval cells, chiefly by budding.
- Pseudohyphae are elongated buds remaining connected at constrictions.
- Mold hyphae are filamentous structures; Fungi are eukaryotes with cell walls.

Clinical categories of fungal infection

Category	Extent of involvement
Superficial / cutaneous	Superficial or keratinized skin, hair, and nails
Subcutaneous	Skin, subcutis, and lymphatics; rare systemic spread
Endemic	Dimorphic fungi capable of serious systemic illness
Opportunistic	May cause life-threatening illness with immunosuppression or devices

Candida is not a single-species diagnosis

- More than 200 Candida species.
- Approximately 15–20 are frequently encountered in human infections.
- Highlighted species include *C. Albicans*, *C. Auris*, *C. Glabrata*, *C. Tropicalis*, *C. Parapsilosis*, and *C. Krusei*.

C. Albicans and C. Auris are the focus of this lecture.

Candida albicans normally lives with its host

Mouth

Gut

Vagina

Skin

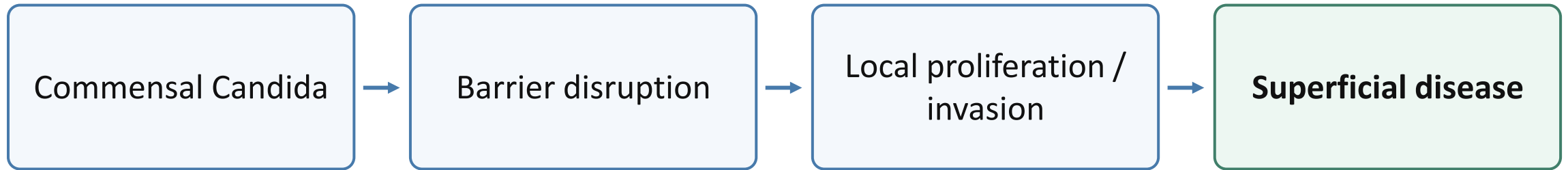
Schematic site map

- Typical colonization sites: Skin, mouth, gastrointestinal tract, and vagina.
- Organisms are usually benign members of the commensal microbiota.
- Infection commonly follows breach of epithelial or mucosal barriers.

C. Albicans is adapted to human-host residence

- No known environmental reservoir for C. Albicans.
- The fungus has adaptations that permit completion of its life cycle within the human host.
- This statement should not be extended to every Candida species.

Colonization becomes disease when barriers fail



- The same organism may be harmless on an intact surface yet pathogenic after breach.
- Clinical pattern depends on the tissue involved and host defenses.

Candidiasis spans localized and invasive disease

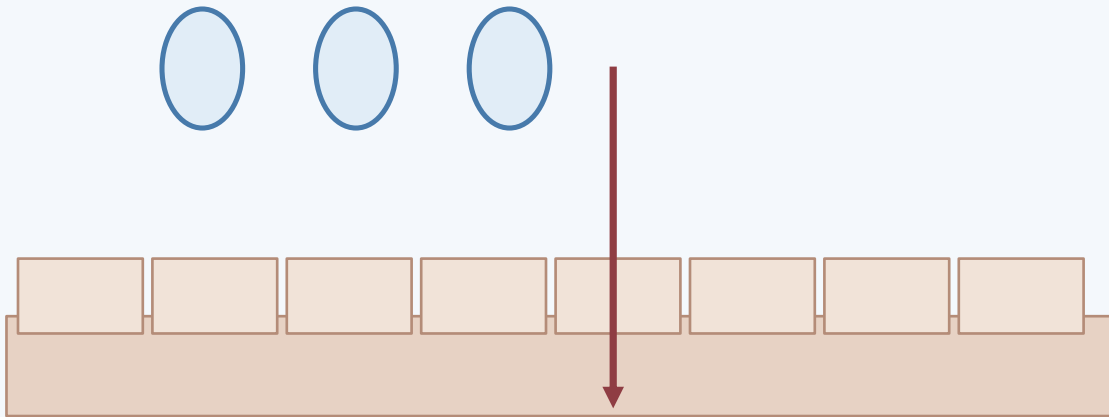
Localized disease	Systemic disease
Mucosal thrush, esophagitis, vaginitis	Bloodstream spread to distant tissues
Diaper rash and other cutaneous lesions	Abscesses, endocarditis, ocular or CNS disease
Often linked to surface or local defense changes	Strongly linked to profound neutropenia / devices

Susceptibility differs by host context

- Diabetes and burns predispose to superficial candidiasis.
- Intravenous catheters and peritoneal dialysis facilitate bloodstream entry.
- Neutropenia associated with leukemia, chemotherapy, or stem-cell transplantation predisposes to dissemination.

Barrier-associated risk: Skin and mucosa

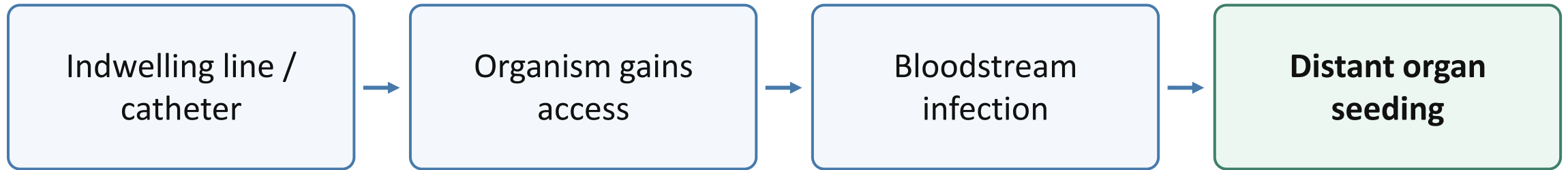
Candida near a weakened epithelial barrier



Schematic barrier crossing

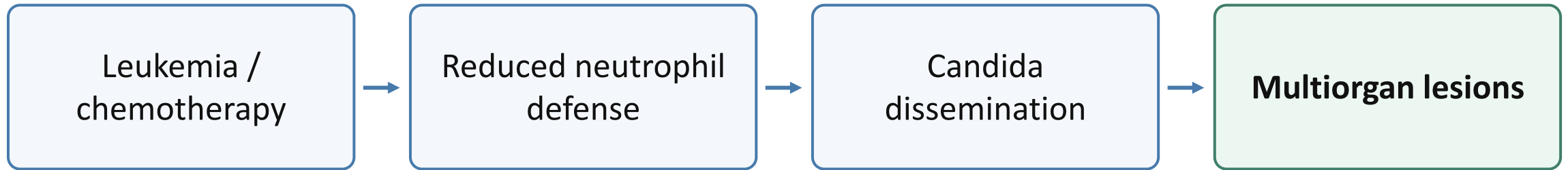
- Superficial infection appears where Candida encounters permissive mucosal or skin surfaces.
- Wet and intertriginous sites can support cutaneous infection.
- Antibiotic-associated loss of competing flora can precede oral thrush.

Devices create a route to invasive candidiasis



- An indwelling device provides a clinically important context for bloodstream dissemination.
- Peritoneal dialysis is also identified as a risk setting.

Profound neutropenia increases systemic risk

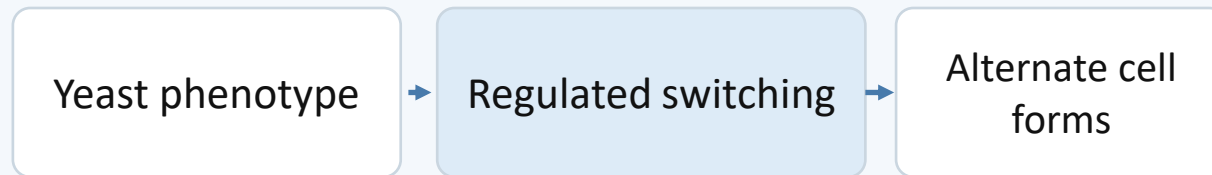


- Hematopoietic stem-cell transplantation is another source-listed setting.
- Severe disease can cause shock and disseminated intravascular coagulation.

Virulence reflects adaptation, not one toxin

- *C. Albicans* adapts its cellular phenotype to host conditions.
- Adhesion molecules bind host molecules and cellular surfaces.
- Secreted enzymes, oxidative-stress resistance, and biofilms contribute to persistence and invasion.

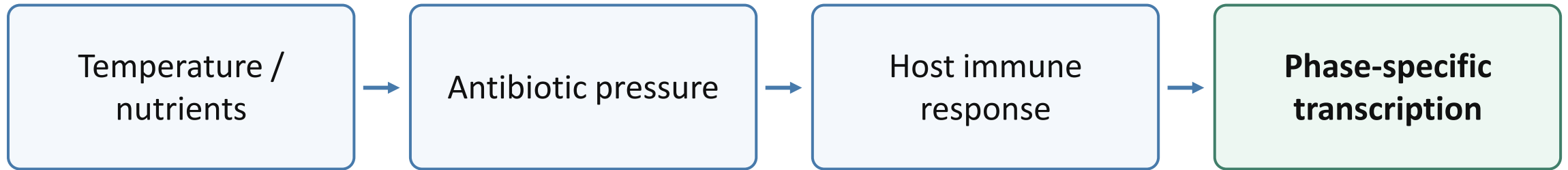
Phenotypic switching expands adaptive capacity



Original schematic

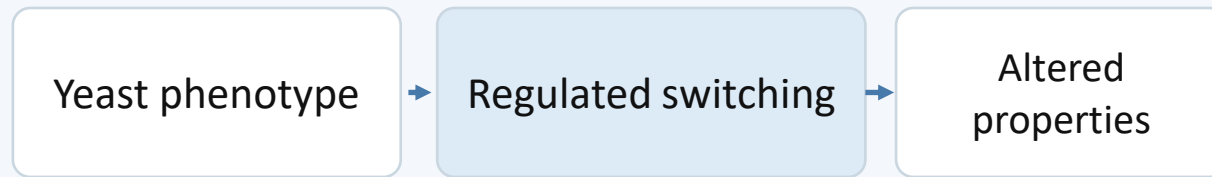
- That *C. Albicans* can adopt nine distinct cell shapes.
- Coordinated transcription of phase-specific genes supports switching.
- The forms can differ in colony appearance, antigenicity, and virulence.

Environmental cues can drive switching



- Source-listed cues can change the organism's phenotypic state.
- This is adaptive plasticity within the human host, not necessarily acquisition from the environment.

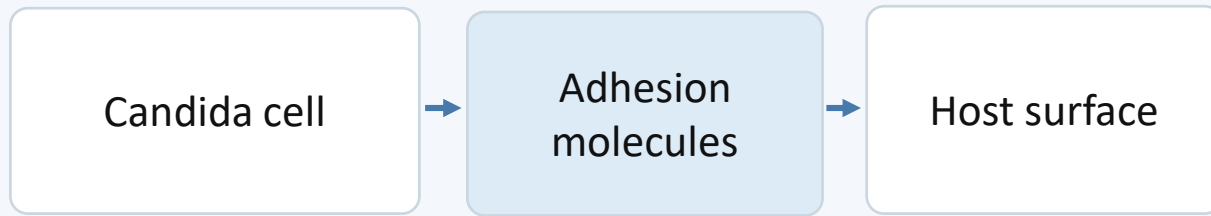
Switching alters the host–pathogen interface



Original schematic

- Phenotypic variants can differ in cell shape and colony morphology.
- Antigenicity can vary across phenotypic forms.
- The resulting states may exhibit different virulence properties.

Adhesins tether Candida to host surfaces

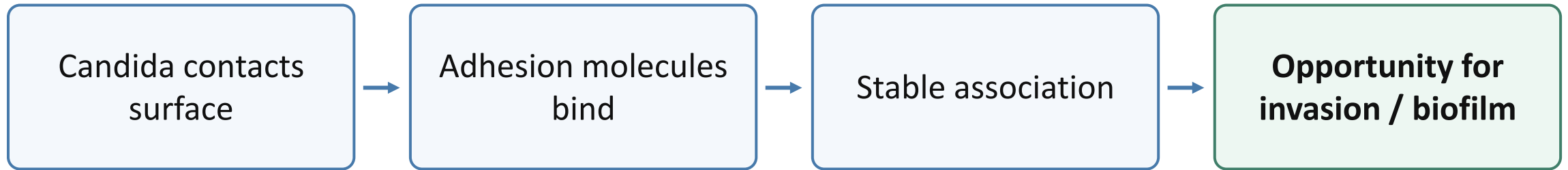


ECM ligands and epithelial/endothelial cells

Original schematic

- C. Albicans expresses many functionally distinct adhesion molecules.
- Binding substrates include fibrinogen, fibronectin, and laminin.
- Adhesion also occurs to epithelial and endothelial cells.

Adherence is the gateway to persistence



- The first adhesive interaction contributes to host-surface colonization and device-associated communities.
- A schematic causal summary of source-described mechanisms.

Secreted proteinases facilitate tissue invasion

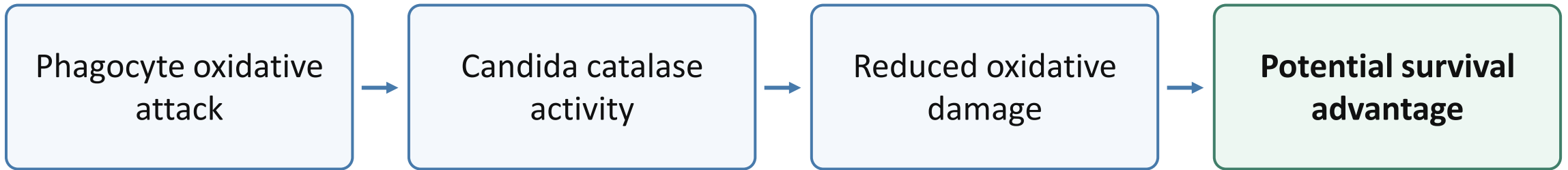


Secreted enzymes may degrade ECM

Original schematic

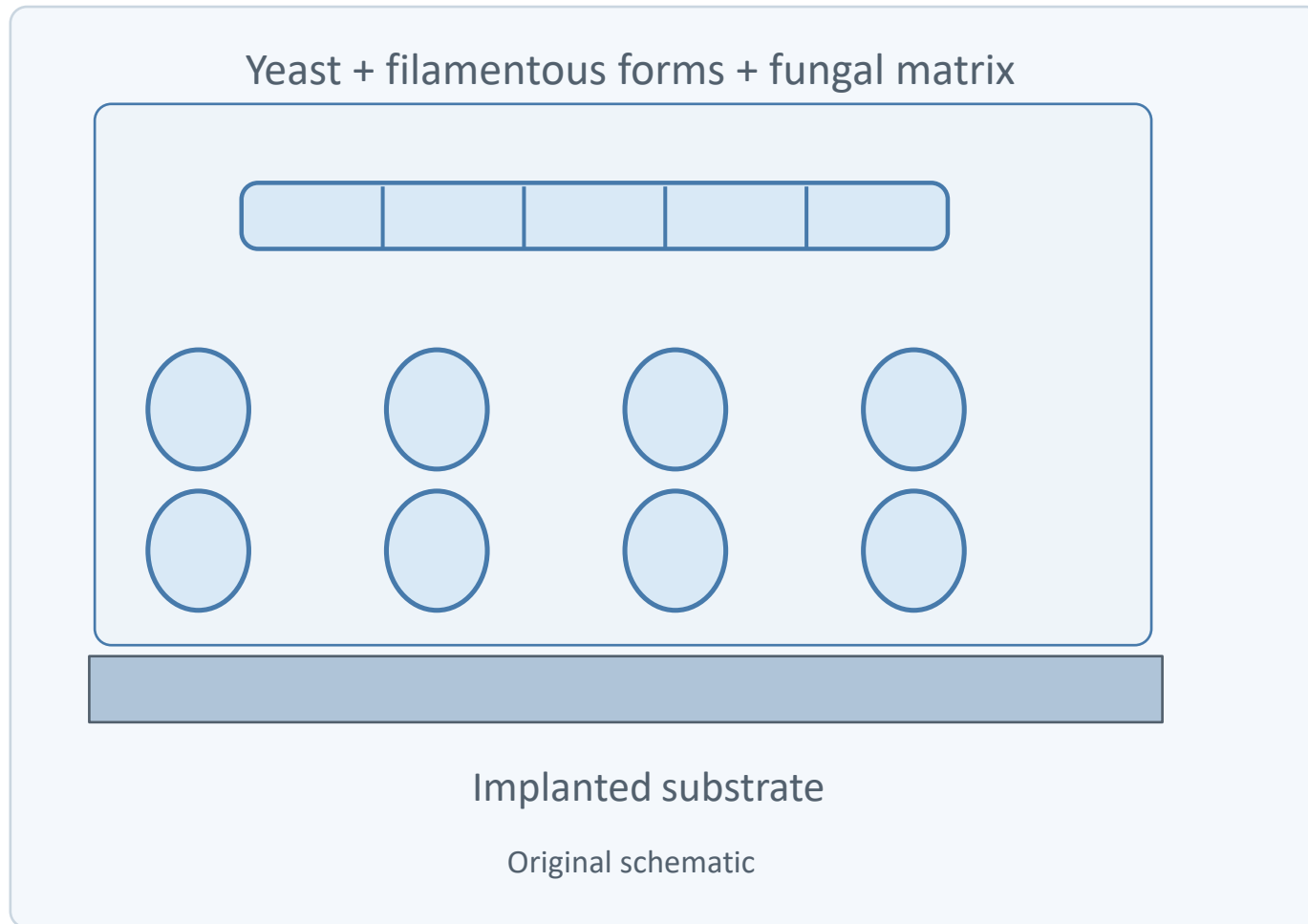
- At least nine secreted aspartyl proteinases are described.
- Degradation of extracellular matrix proteins may promote invasion.
- The source qualifies this role as a proposed contribution rather than a universal prerequisite.

Catalase counteracts a host killing pathway



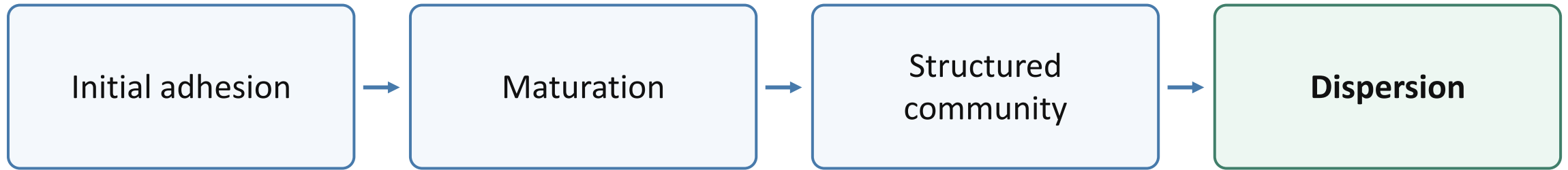
- Candida catalases may permit resistance to oxidative killing.
- Do not interpret this as complete protection from phagocytes.

Candida biofilms are mixed communities



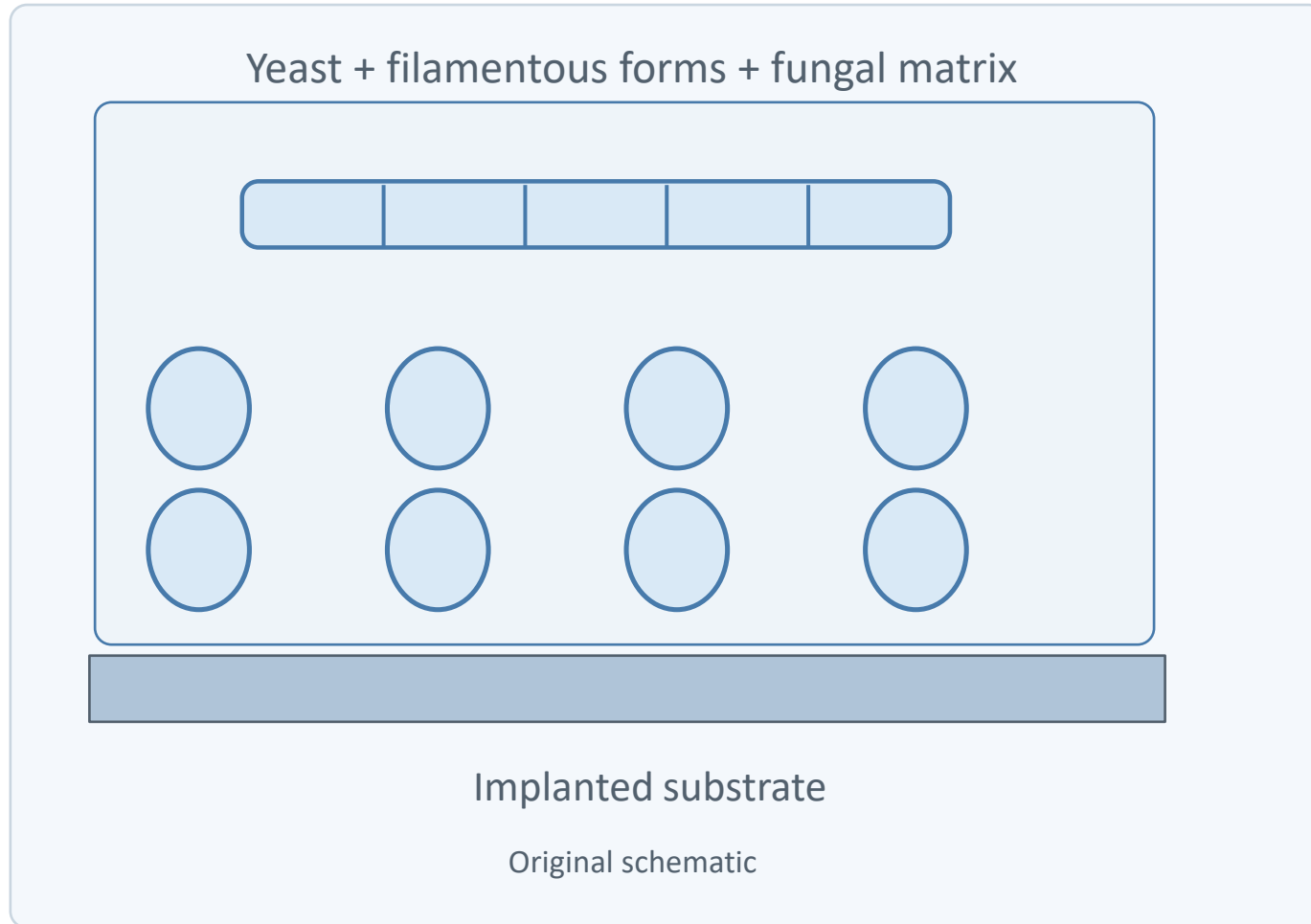
- Biofilms contain yeast and filamentous fungal forms.
- A fungal-derived extracellular matrix surrounds the community.
- At least 30 factors participating in biofilm formation.

Biofilm formation includes a dispersal phase



- Adhesion, maturation, and dispersion as regulated contributors.
- This diagram is a conceptual sequence rather than a precise time course.

Implanted devices can support biofilms

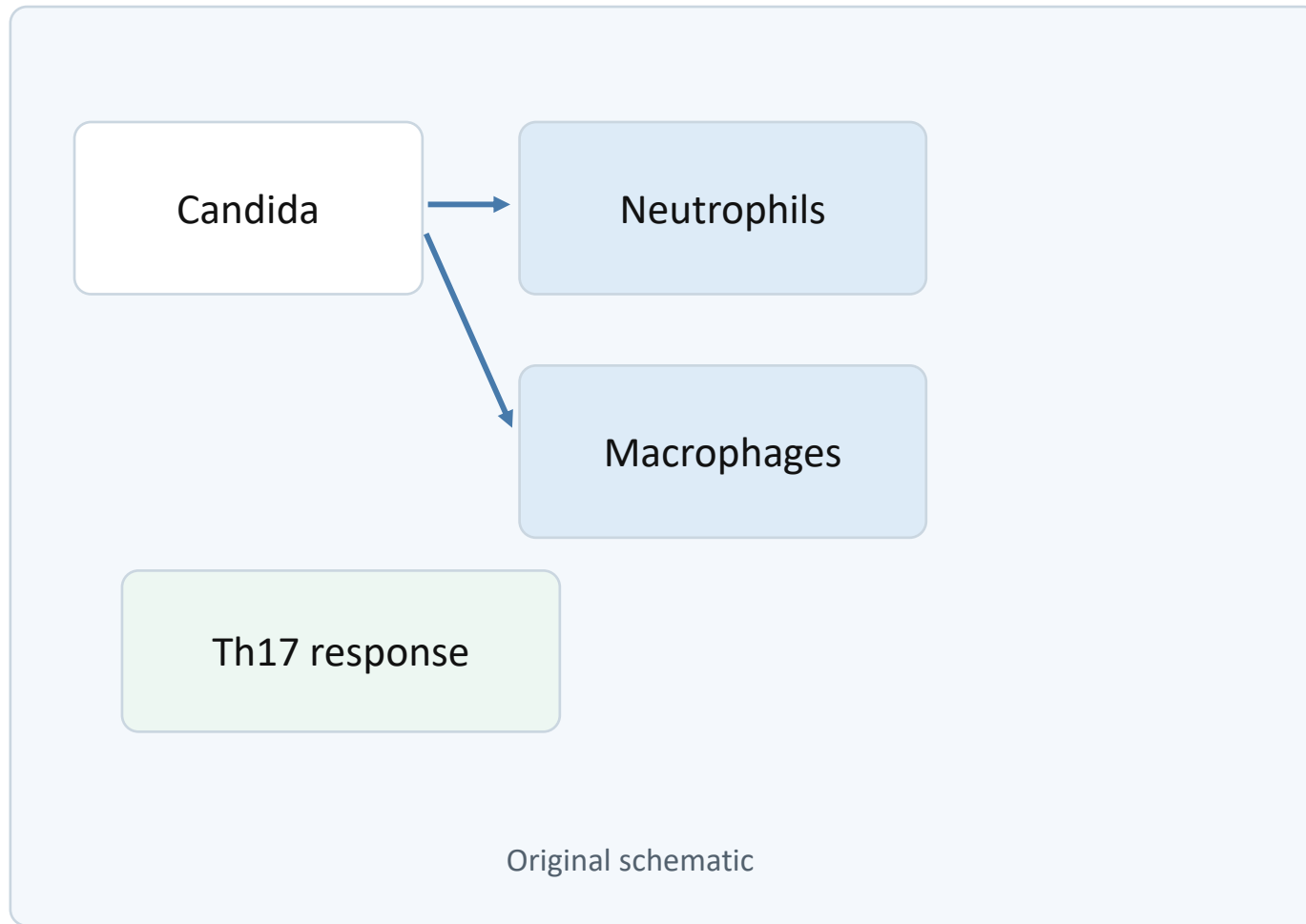


- *C. Albicans* can form biofilms on implanted medical devices.
- Biofilms reduce susceptibility to immune responses.
- The same architecture reduces susceptibility to antifungal drug therapy.

Biofilm biology explains clinical persistence

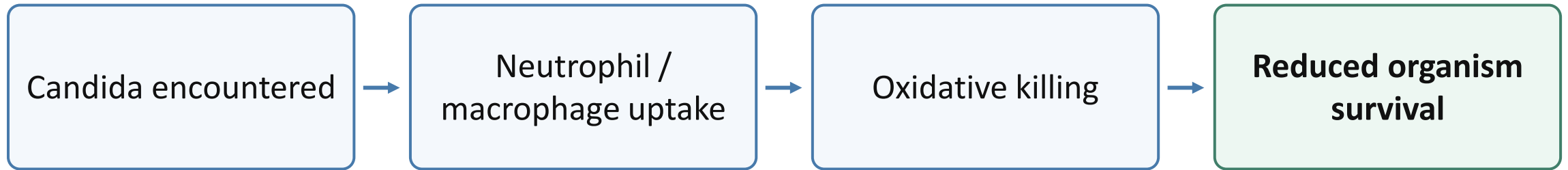
- Biofilm-associated cells occupy a shared extracellular matrix.
- The microbial community can include cells in several morphologic states.
- The combination of adhesion and reduced clearance matters in catheter-associated disease.

Three host-defense arms are emphasized



- Neutrophils provide rapid cellular defense.
- Macrophages phagocytose Candida and participate in oxidative killing.
- Th17 responses recruit additional inflammatory cells, supporting mucosal protection.

Phagocytes are an immediate barrier

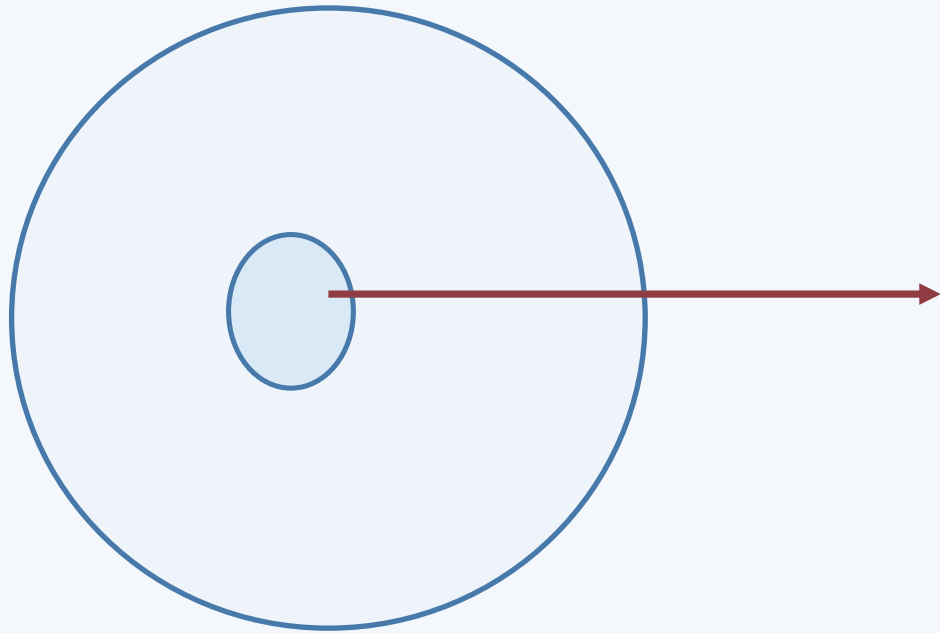


- Neutrophils and macrophages are both important first-line defenses.
- The pathway is compromised in specific phagocytic deficiencies.

Phagocytic defects have predictable consequences

Impairment	Source-described implication
Neutropenia	Increased risk of C. albicans infection
Defective phagocyte oxidase	Reduced oxidative antimicrobial activity
Myeloperoxidase defects	Increased vulnerability to Candida infection

Filamentous forms can evade phagosomes

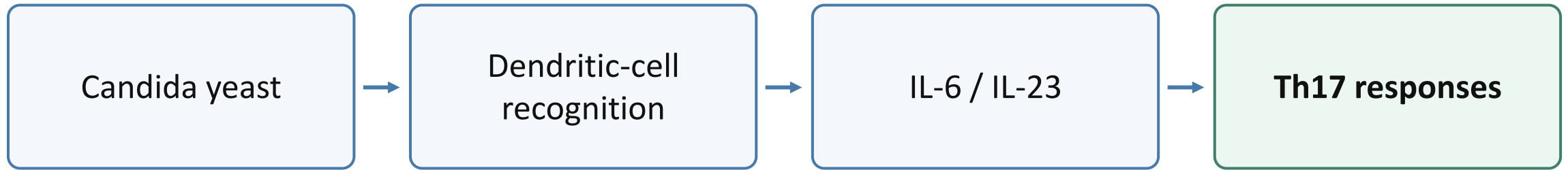


Filamentous forms may escape phagosome

Original schematic

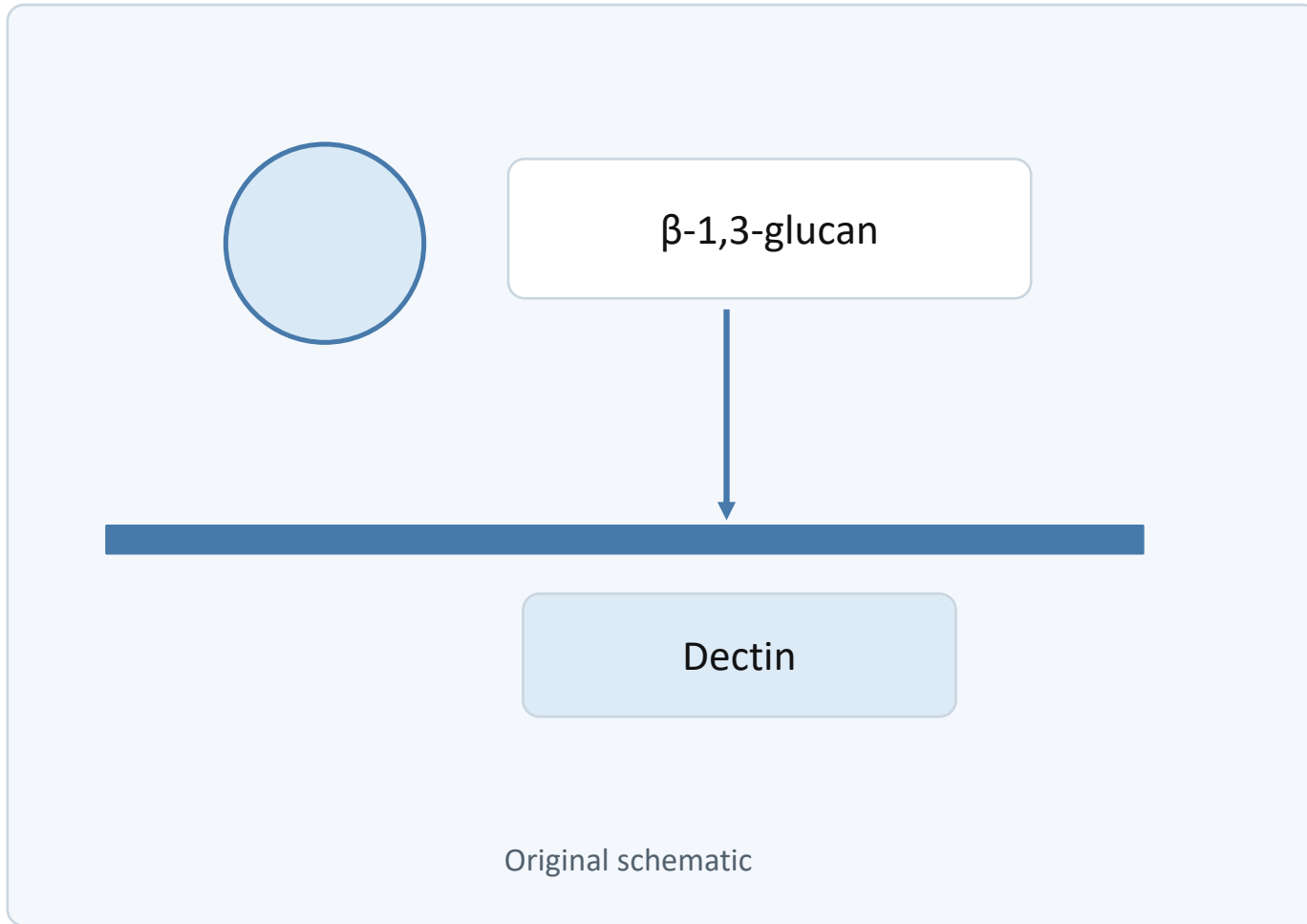
- *Candida* morphotypes after phagocytosis.
- Filamentous forms can escape from the phagosome into the cytoplasm.
- Yeast forms do not show this escape behavior.

Dendritic sensing starts a protective cascade



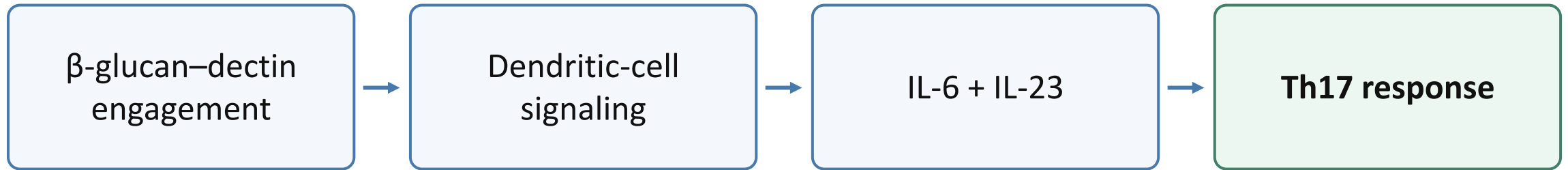
- Yeast forms can activate dendritic cells by several pathways.
- This example highlights one source-described β -glucan pathway.

β -1,3-glucan engages dectin



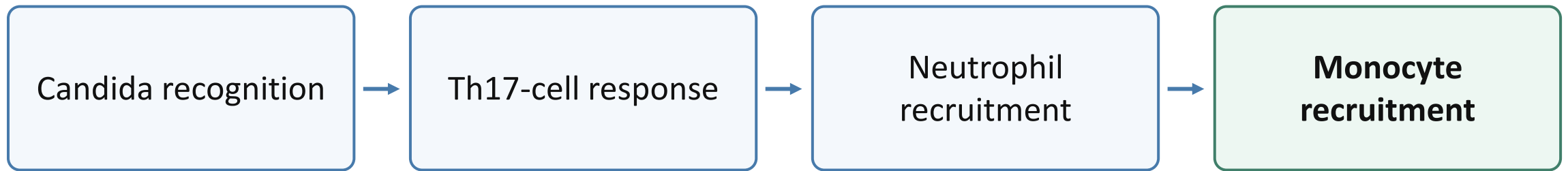
- Candida yeast expresses β -1,3-glucan.
- The fungal ligand interacts with dectin on dendritic cells.
- Downstream cytokine production promotes Th17 responses.

IL-6 and IL-23 support Th17 responses



- The source links the lectin recognition event to cytokines and adaptive immune support.
- Cytokine labels are mechanistic; No unreported concentrations are inferred.

Th17 responses reinforce cellular recruitment

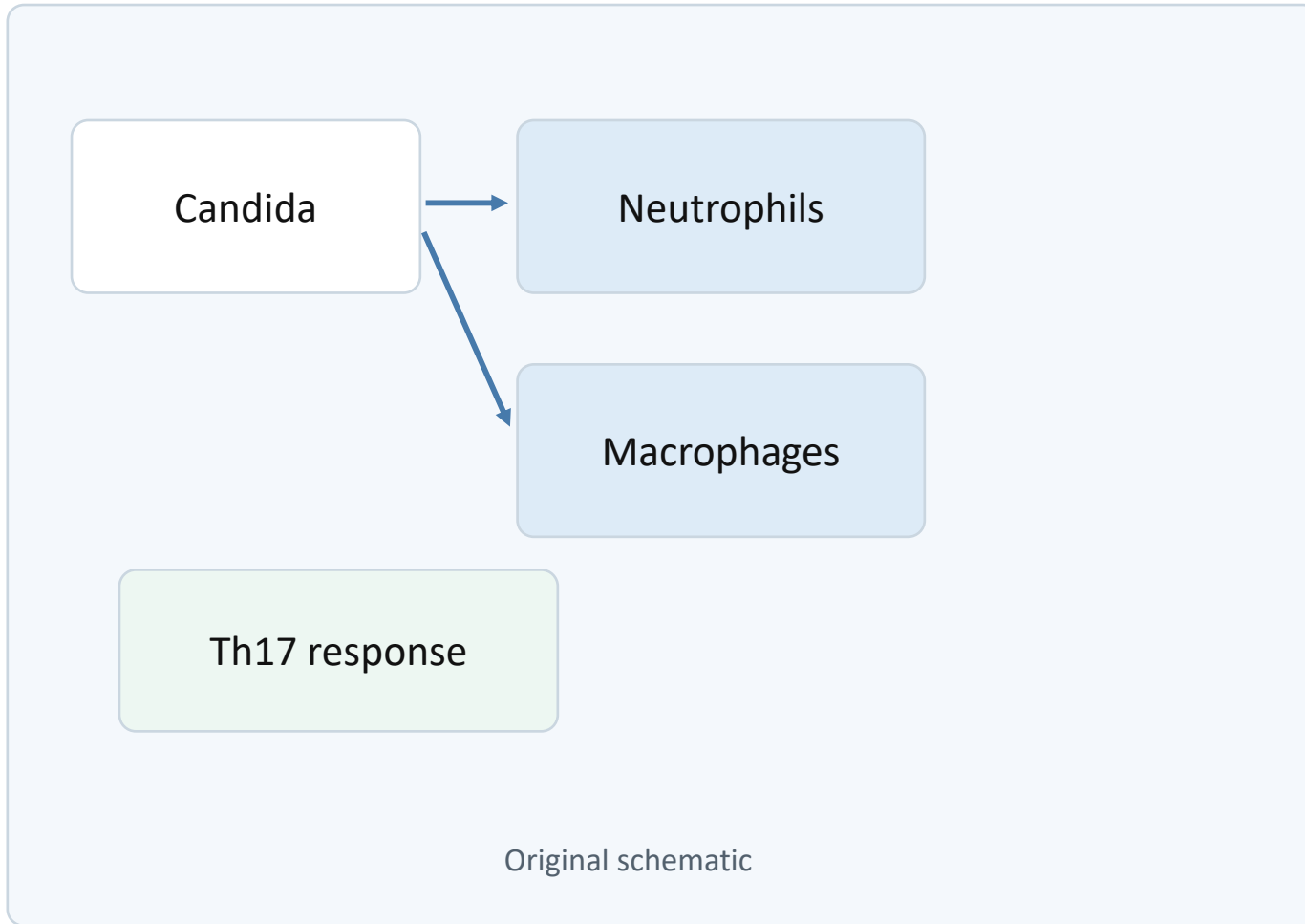


- Th17-mediated recruitment is important in protection from mucocutaneous Candida infection.
- The source does not equate Th17 activity with a single antimicrobial effector.

Defective T-cell/Th17 immunity causes recurrence

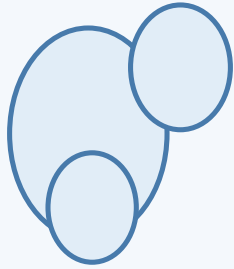
- Low T-cell counts due to HIV are associated with recurrent mucocutaneous candidiasis.
- Inherited defects affecting Th17 development or function can produce similar susceptibility.
- Acquired abnormalities in this axis may also impair mucosal protection.

Disease severity reflects pathogen $\times$ host



- Adhesion, phenotypic switching, and biofilm formation increase fungal fitness.
- Phagocytes protect against tissue invasion and dissemination.
- Th17-associated recruitment is particularly important for mucocutaneous defense.

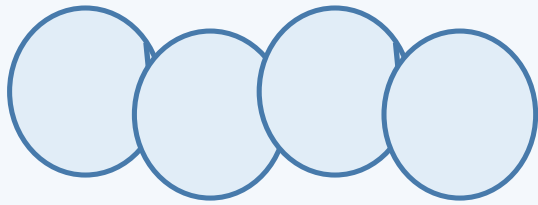
Yeast forms: Budding round-to-oval cells



Schematic fungal growth forms

- Candida appears as yeast in histologic sections.
- Yeast are round-to-oval fungal cells that mainly reproduce by budding.
- Yeast may coexist with other Candida growth forms in a specimen.

Pseudohyphae: Constrictions are the clue



Schematic fungal growth forms

- Elongated budding cells remain connected end to end.
- Narrowings occur at the junctions of adjacent cells.
- Pseudohyphae as a useful diagnostic clue.

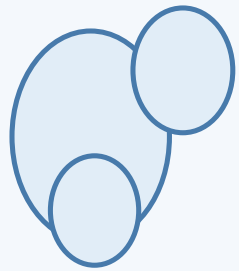
True hyphae show filamentous septated growth



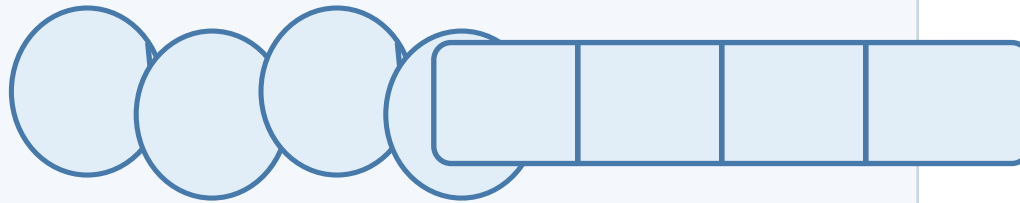
Schematic fungal growth forms

- True hyphae are reported less commonly than yeast/pseudohyphae in tissue.
- The source identifies septa as a defining structural feature.
- Reduced oxygen tension is one associated condition noted.

A tissue section can contain mixed forms



Budding yeast



Pseudohyphae

Septate hyphae

Schematic fungal growth forms

- Yeast, pseudohyphae, and true hyphae can coexist.
- One section should not be expected to show only a single morphotype.
- Interpret fungal elements alongside the site and tissue reaction.

Histologic stains make fungal elements visible

Stain	Textbook role
Hematoxylin–eosin	Organisms can be visible in routine tissue sections
Gömöri methenamine silver	Special fungal stain often improves visualization
Periodic acid–Schiff	Special stain often improves visualization

Oral thrush forms a pseudomembrane

Pseudomembrane: Fungal elements + debris

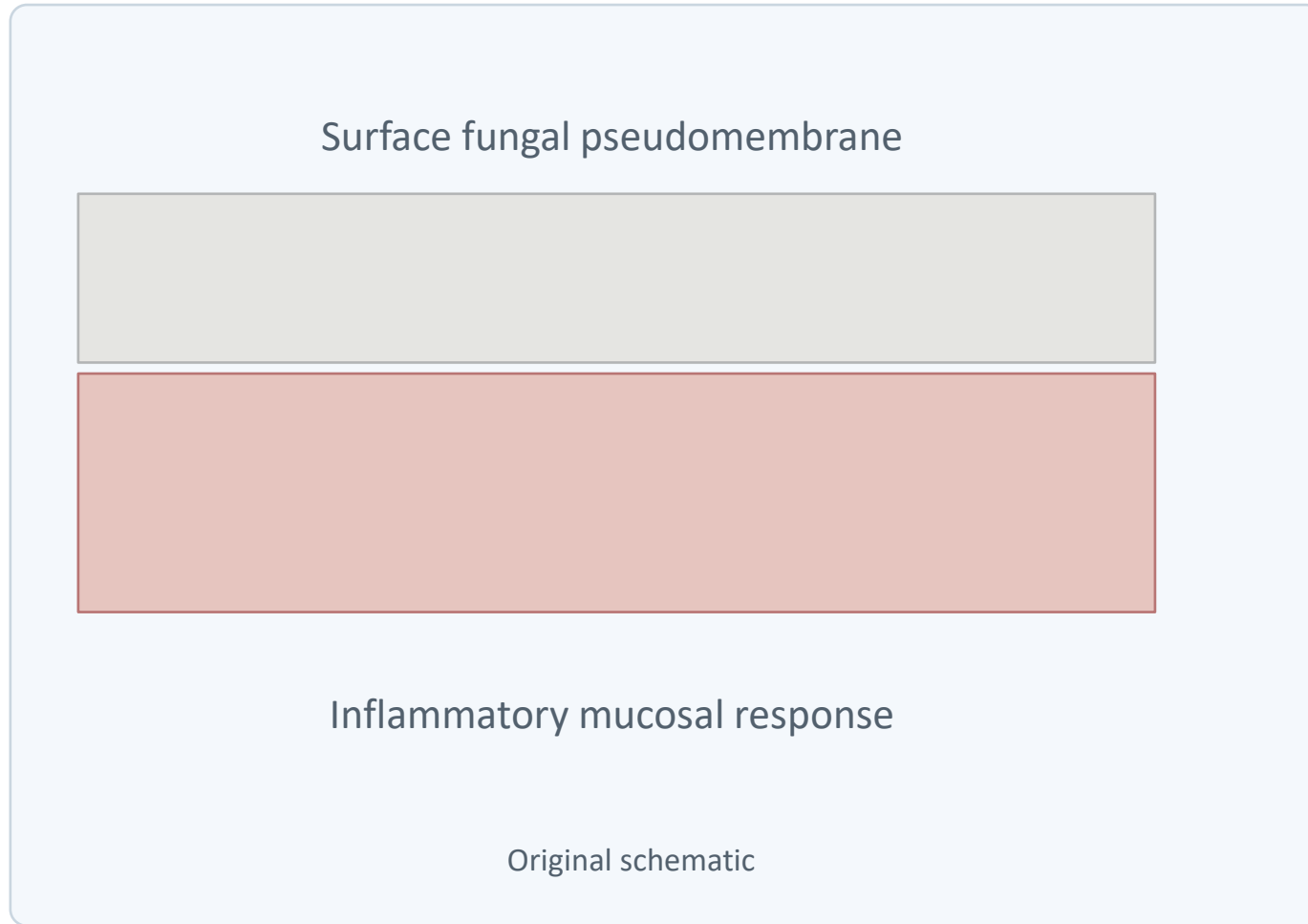


Congested mucosa

Original schematic

- Superficial proliferation produces gray-white, dirty-looking plaques.
- The pseudomembrane comprises fungal organisms and inflammatory debris.
- This is a characteristic mucosal presentation of candidiasis.

Thrush is not confined to surface deposits



- The superficial plaque contains matted organisms and inflammatory material.
- Underlying mucosa exhibits congestion and inflammation.
- A surface lesion therefore represents both organisms and a host response.

Settings associated with oral thrush

Host / exposure	Source-defined association
Newborns or debilitated patients	Susceptibility to oropharyngeal candidiasis
Inhaled/oral steroids for asthma	Thrush can occur in treated children
Broad-spectrum antibiotic course	Reduced competing normal bacterial flora
HIV infection	Important setting for oral thrush

Unexplained thrush requires clinical attention

- Robbins advises evaluating unexplained oral thrush for HIV infection.
- The inference is prompted by a change in expected host susceptibility.
- A thrush lesion alone does not establish an HIV diagnosis.

Esophageal candidiasis causes swallowing symptoms

Esophageal mucosa

White plaques

Dysphagia / pain

Original schematic

- Common clinical contexts include AIDS and hematologic malignancy.
- Patients may present with swallowing difficulty or pain and retrosternal pain.
- Endoscopy can show white plaques and pseudomembranes.

Oral versus esophageal candidiasis

Oral thrush	Candida esophagitis
Gray-white mucosal pseudomembranes	White esophageal plaques/pseudomembranes
Risk: newborns, steroids, antibiotic use, HIV	Risk: AIDS, hematologic malignancies
Lesion primarily in oral cavity	Swallowing complaints and retrosternal discomfort

Vulvovaginal candidiasis has a characteristic syndrome

Predisposition

Pruritus

Curd-like discharge

Original schematic

- The source emphasizes diabetes, pregnancy, and oral contraceptive use as associated settings.
- Typical symptoms include intense itching.
- A thick curd-like discharge is described.

Cutaneous candidiasis: Nail and follicular disease

Pattern	Site
Onychomycosis	Nail plate
Paronychia	Nail folds
Folliculitis	Hair follicles

Intertrigo follows the anatomy of moist folds

Opposing skin folds

Moist environment

Candidal intertrigo

Original schematic

- Candidal intertrigo affects moist, opposing skin surfaces.
- Examples include axillae and interdigital webs.
- Anatomical site is an important clue to the superficial pattern.

Other cutaneous presentations are site-defined

Lesion	Characteristic site
Balanitis	Penile skin
Diaper rash	Infant perineum in contact with wet diapers
Intertrigo	Axillae and finger/toe web spaces

Mucocutaneous patterns form a location map

Oral cavity

Esophagus

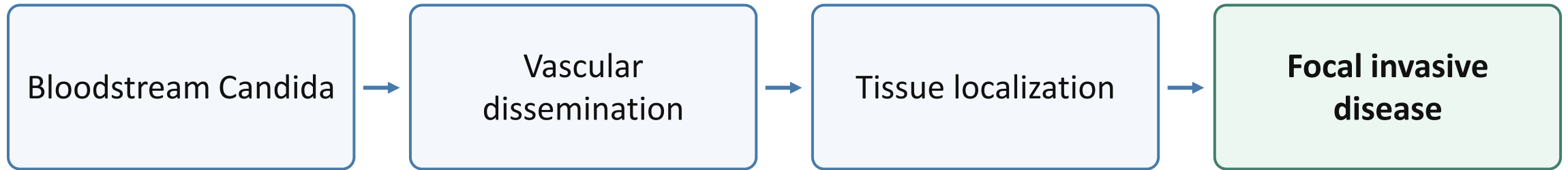
Vagina

Skin + nails

Schematic site map

- Mouth and esophagus: Pseudomembranous disease.
- Vagina: Pruritus and curd-like discharge.
- Skin, nails, folds, follicles, and perineum: Named cutaneous patterns.

Bloodstream spread seeds distant organs



- Robbins specifically describes invasive candidiasis as hematogenous.
- The organs involved determine the pathology and clinical consequences.

Deep-organ candidiasis: Focal suppurative disease

Organ	Reported lesion
Kidney	Renal abscesses
Liver	Hepatic abscesses
Myocardium	Myocardial abscesses
Brain	Microabscesses

Cardiac infection includes endocarditis

Myocardial abscess

Endocarditis

Valvular context

Original schematic

- Disseminated disease may involve myocardial abscesses.
- Candida can infect valves and cause endocarditis.
- Robbins characterizes Candida spp. As the leading cause of fungal endocarditis.

CNS and ocular involvement extend the differential

Brain microabscesses

Meningitis

Endophthalmitis

Original schematic

- Brain lesions include microabscesses and meningitis.
- Endophthalmitis may involve virtually any ocular structure.
- In high-risk hosts, distant fungal seeding should be clinically considered.

Tissue inflammation is host-dependent

Minimal

Suppurative

Granulomatous

Host immune state changes the tissue response

Original schematic

- Candida may elicit little inflammation in some immunocompromised patients.
- A suppurative reaction is a common inflammatory pattern.
- Granulomatous inflammation occurs occasionally.

Candida endocarditis: Clinical contexts

Clinical setting	Textbook emphasis
Prosthetic heart valve	Important predisposing substrate
Intravenous drug use	Tricuspid valve involvement is highlighted

Dissemination is especially dangerous in acute leukemia

- Profound neutropenia after chemotherapy is a high-risk state.
- The burden may be multiorgan rather than restricted to a mucosal site.
- Severe disseminated disease can be accompanied by shock and DIC.

Candida auris is an emerging healthcare pathogen

Critical illness

Antifungal resistance

Healthcare outbreaks

Original schematic

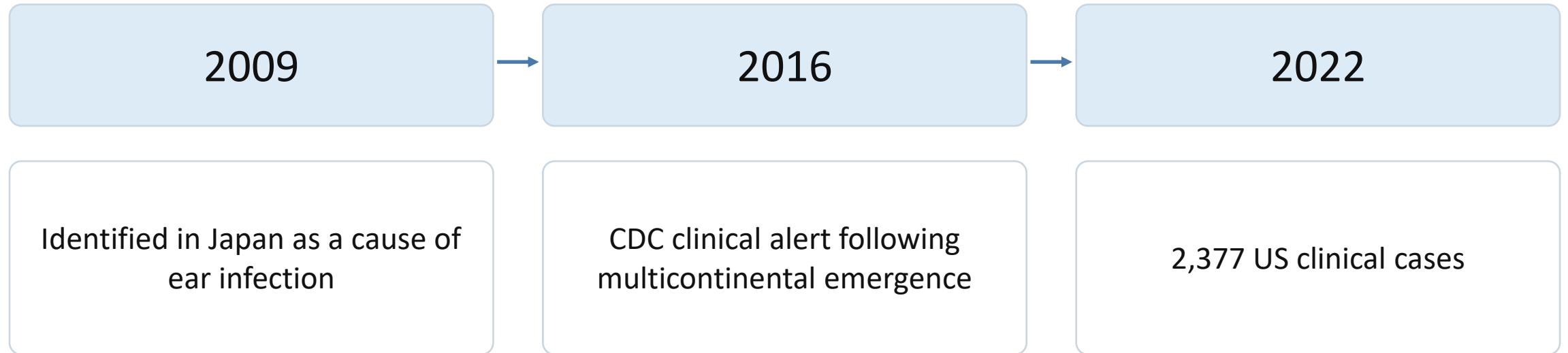
- Disease disproportionately affects critically ill and immunocompromised patients.
- Reported infections can involve blood, gastrointestinal tract, wounds, or other sites.
- The source emphasizes antimicrobial resistance, colonization, and nosocomial outbreaks.

Invasive C. Auris disease carries high severity

- 30%–60% mortality in patients with invasive C. Auris infection.
- This is an historical textbook summary, not an individualized prognosis.
- Severity must be interpreted in the context of critical illness and comorbidity.

Reported textbook estimate; Not a contemporary surveillance update.

C. Auris: Documented emergence milestones



C. Auris colonization is not synonymous with infection

Colonization	Invasive / clinical infection
Sites: nostrils, groin, axilla, rectum	Sites include bloodstream, gut, wounds, others
Most colonized individuals do not become ill	Severe invasive illness can occur
Carriage is epidemiologically significant	Clinical syndrome requires separate interpretation

C. Auris colonizes multiple body surfaces

Nostrils

Axilla

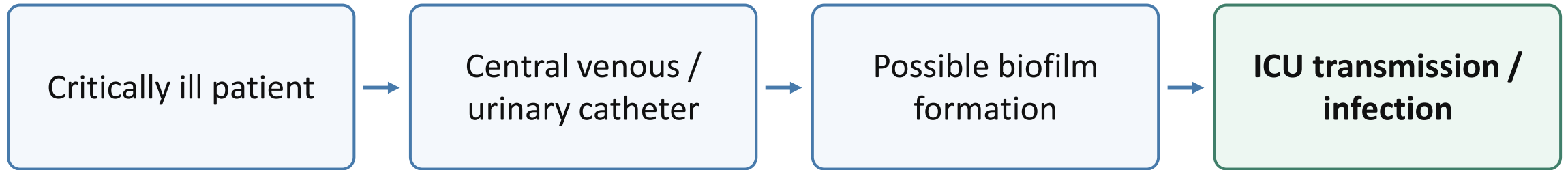
Groin

Rectum

Schematic site map

- Colonization is reported in nostrils, groin, axilla, and rectum.
- Most colonized patients do not develop clinical disease.
- Carriage and healthcare environmental persistence create outbreak concerns.

Catheter-associated C. Auris outbreaks are a concern



- ICU outbreaks occur among catheterized patients.
- The source suggests, rather than conclusively establishes, biofilm formation as a virulence mechanism.

Environmental persistence complicates control

Dry / moist surfaces

Survival up to 14 days

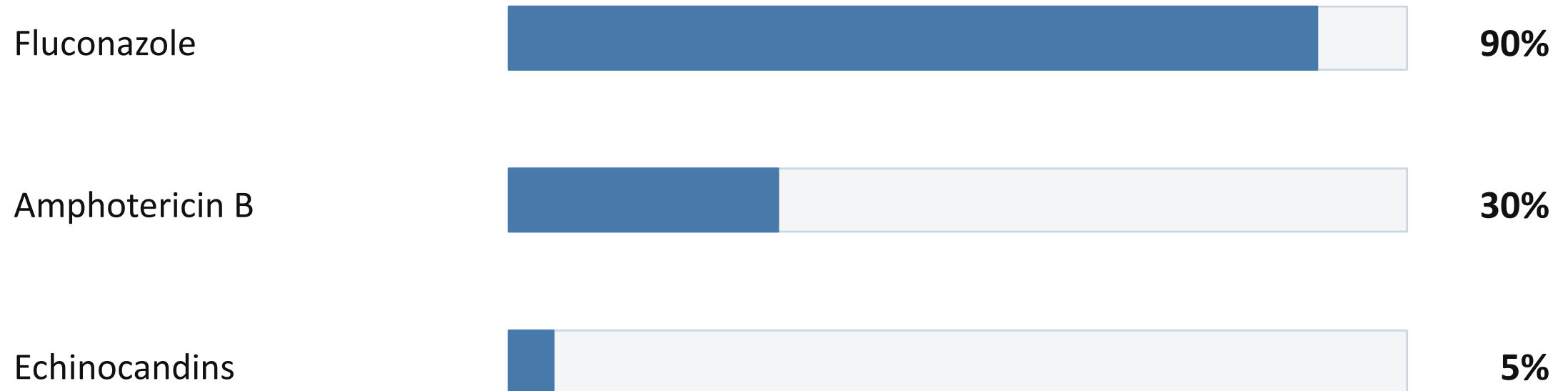
Cleaning challenge

Original schematic

- Survival on dry and moist surfaces for up to 14 days.
- Elimination of environmental sources is challenging in healthcare facilities.
- The value is source-specific and should not be generalized to all cleaning conditions.

C. Auris: Source-reported antifungal resistance

Historical resistance percentages reported in the source textbook



Figures reflect Robbins (2026), not a live susceptibility surveillance database.

Broad antifungal resistance changes risk assessment

- The source reports resistance to several major antifungal classes.
- Pan-resistant strains have also been reported.
- Specific susceptibility determination is distinct from identifying Candida in tissue.

C. Albicans and C. Auris pose different challenges

C. albicans	C. auris
Usually commensal on host surfaces	Often colonizes critically ill healthcare patients
Broad mucocutaneous and invasive patterns	Outbreaks and device-associated infection emphasized
Host barrier / Th17 / neutrophil mechanisms elaborated	Resistance and environmental persistence highlighted

Diagnosis: Integrate specimen, morphology, and setting

Evidence level	Interpretation
Tissue morphology	Candida yeast and pseudohyphae can support tissue recognition
Stains	H&E, PAS, and GMS aid visualization
Species determination	Histology alone may not definitively identify fungal species
Clinical context	Host immunity and evidence of tissue invasion matter

Clinical application: White oral plaques

An otherwise healthy adult develops gray-white oral plaques after a broad-spectrum antibiotic course.

What mechanism links the exposure to thrush?

Antibiotics can reduce competing normal bacterial microbiota, permitting florid *Candida* proliferation.

Clinical application: Catheter and neutropenia

A patient receiving induction chemotherapy for acute leukemia has profound neutropenia and an indwelling venous catheter.

What disease pattern must remain in the differential?

Bloodstream and disseminated candidiasis, with potential abscesses, valve involvement, and other organ disease.

Clinical application: Persistent hospital colonization

A critically ill ICU patient is colonized with *C. Auris* in the axilla and has a urinary catheter.

Does colonization alone establish invasive infection?

No. Most colonized patients do not become sick; Catheter risk and possible environmental spread require context-specific assessment.

Integrative summary: Connect form, host, and site

- Candida disease begins with commensal overgrowth or barrier breach and is promoted by adhesins, enzymes, and biofilms.
- Yeast and pseudohyphae provide diagnostic morphology; Th17 cells and phagocytes provide major host protection.
- Mucocutaneous disease differs from hematogenous dissemination; C. Auris additionally raises outbreak and resistance concerns.

Primary reference

- Robbins, Cotran & Kumar: Pathologic Basis of Disease, 11th ed. (2026), Chapter 8, pages 348–350.
- Foundational fungal classification, *Candida albicans* pathogenesis and morphology, clinical candidiasis, and *Candida auris*.
- Original textbook Figure 8.43 was not reproduced; morphologic illustrations in this deck are explicitly schematic.