

تفريغ مايكرو

اسم الموضوع: MYCOLOGY

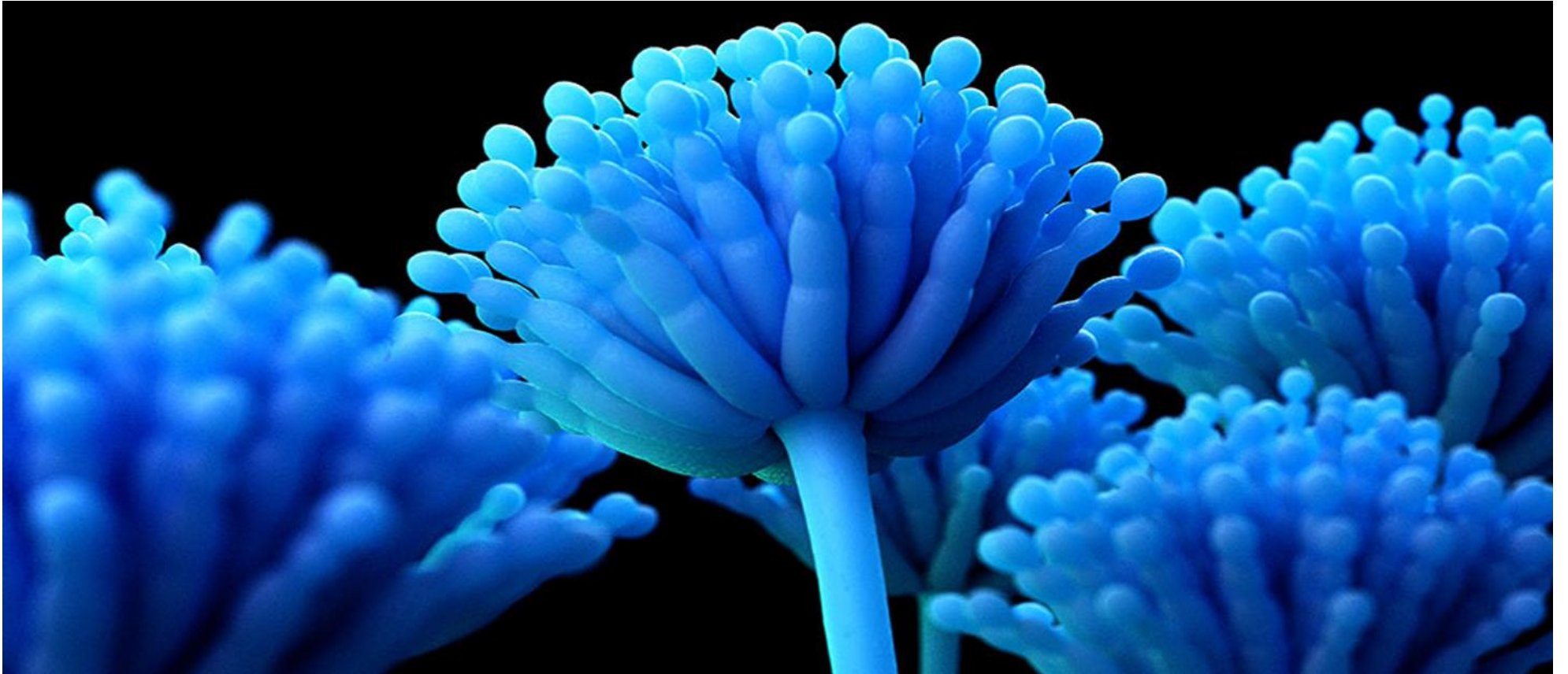
إعداد الصيدلاني / ة: ياسمين خليل 🌸



18

MYCOLOGY

Dr. Hala Tabl



Mycology

اللهم علمنا ما ينفعنا، وانفعنا
بما علمتنا وزدنا علماً.

Is the study of fungi

From greek “mykes” i.e mushroom





What are fungi

they have
heterotrophic
existence
يعني تعتمد على نفسها
في توافر الطاقة

Fungi are eukaryotic organisms

The natural habitat of most fungi is the environment. An important exception is **Candida albicans**, which is part of the normal human flora

هنا الفطريات الموجودة
في جسمنا وهي جزء من
normal flora

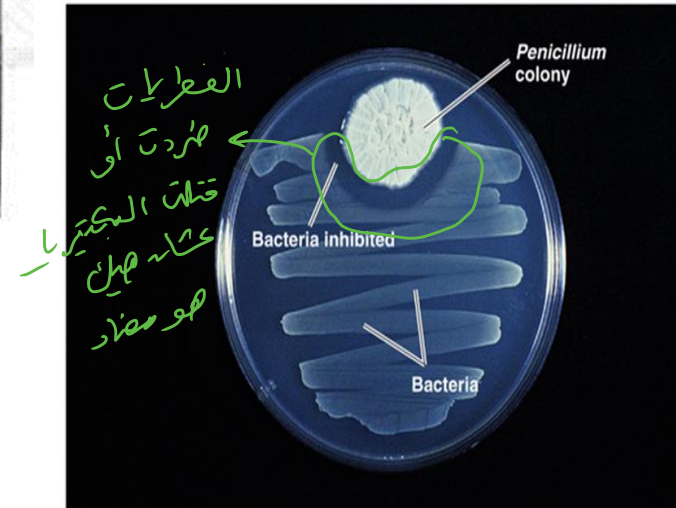
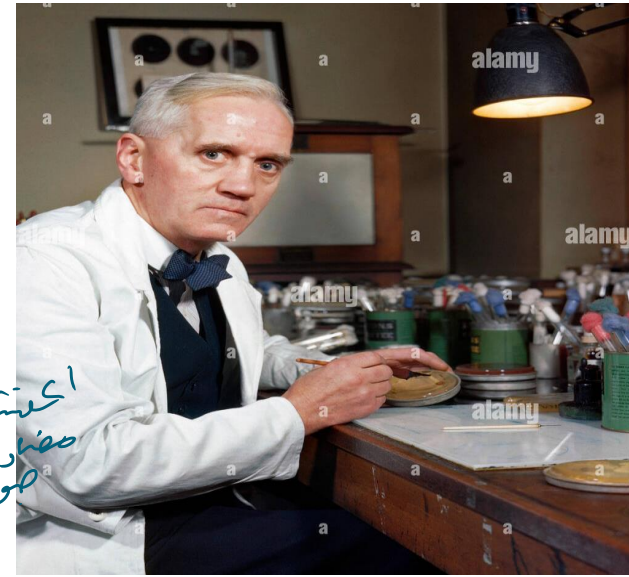
Importance of fungi

“Fungi has both **beneficial and harmful aspects**”

1) **Alexander Fleming**; *"When I woke up just after dawn on September 28, 1928, I certainly didn't plan to revolutionize all medicine by discovering the world's first antibiotic, or bacteria killer. But I suppose that was exactly what I did."*

1945 Nobel Prize in Medicine for the discovery of **penicillin** from saprophytic mold called "Penicillium notatum".

هو إلى
مكا هاي البطله
بعد
الحسنه
مضاد
طوي



2) **In Medicine:** *Production of many important drugs and antimicrobials, vaccines,..

علوم



Antifungal Griseofulvin
from *Penicillium
griseofulvum*.



Ergot, used to induce uterine
contractions, from *Claviceps
purpurea*

*Fungi are widely used model organisms in genetic engineering.

هندسة وراثية

ربّج ادخل
والدّي الجنبه
بغير صاب
وحا عذاب



Blue cheese



Wine

كل هذول ناتجة من تخمر الفطريات
وكلهم نافعين غير ضارين إلا wine

3) Food industry and processing:

Fungi are used in the production of important foods (e.g., bread, cheese, wine,...).



Soy Sauce

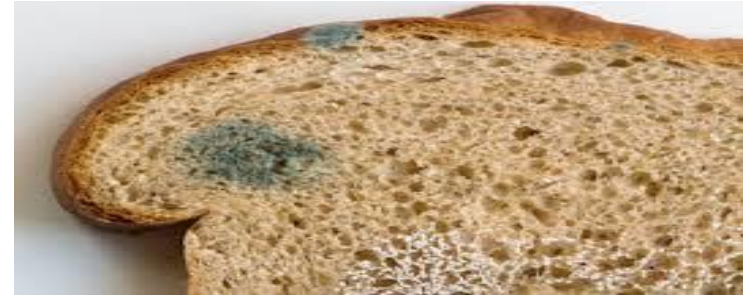


Bread

استخدام الخميرة



الماء هو ~
الجزء



4) They are common cause of damage to:

crops, foodstuffs, fabrics and building materials.



رطوبة
الجدران بقل
تجمع الفطريات



5) Few species of fungi can cause disease in human and animals.

Fungal diseases may be due to either:

Infection

Allergies → حساسية

Mycotoxins → إفراز الفطريات
السم

Structure of Fungi

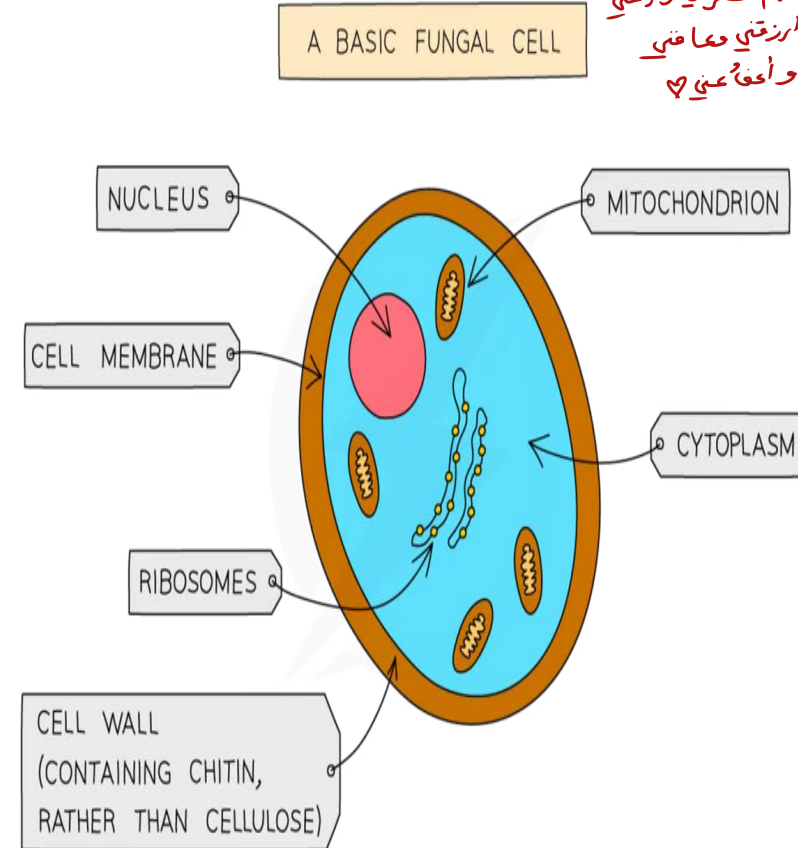
سُبْحَانَ اللَّهِ
الْحَمْدُ لِلَّهِ
كَأَنَّهُ إِلهٌ
اللَّهُ أَكْبَرُ

اللَّهُمَّ اغْفِرْ لِي وَلِرَبِّعِي
وَارْزُقْنِي وَفَاعِلِي
وَأَهْلِي عَنِّي

Fungi are **Eukaryotic** organisms

حَقِيقِيَّةَ الْبِنَاءِ

1. Have a **true nucleus** with nuclear membrane.
2. Have **membranous organelles** (e.g. Golgi apparatus, endoplasmic reticulum and mitochondria).



نوعه هو انه يكون فيه الخلايا حقيقية النواة -

3. Their cell membrane containing **ergosterol**.

➤ In contrast to:

وفي الانسان يختلف عن
البكتيريا والفطريات
← التي صنع

-Human cell membrane, which contains **cholesterol**.

-Bacterial cell membrane, which contains **phospholipids**.

➤ The main **target of some antifungal drugs** e.g. **Polyne and azole**

drugs.

هذه الأدوية يستهدفوا ergosterol عنه هي درسيهم

فيعملوا
inhibitions of
senses of
ergosterol

4. Their cell wall consists mainly of polysaccharides:

سكيتان
a) **Chitin**

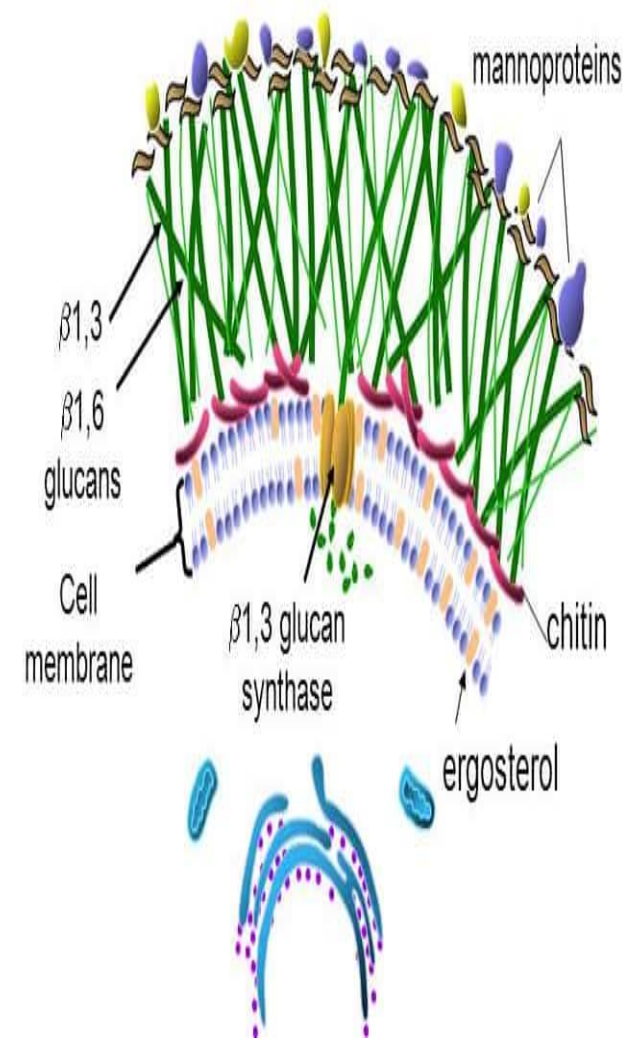
كاربوهيدرات
b) **β -glucan**

Medical importance of fungal cell wall: → بدنا نعرفه
عشاه غييز الغزفه
بين البكتيريا والخللا الكصفيه
هاد موجود في غشاء البكتيريا

➤ There is **NO peptidoglycan** as in bacteria; thus fungi are **insensitive to antibiotics**, such as penicillin.
دهو مكان هجوم المضاد

➤ β -glucan is the target of the antifungal drug, Echinocandin (e.g. Caspofungin). → inhibit the senses of β -glucan

➤ Hypersensitivity to its components.



Comparison between Fungi and Bacteria

اللهم انی انسا ان
الخلاص فی القول والعمل

Feature	Fungi	Bacteria
Diameter	Approximately 4 μm (<i>Candida</i>)	Approximately 1 μm (<i>Staphylococcus</i>)
Nucleus	Eukaryotic	Prokaryotic
Cytoplasm	Mitochondria and endoplasmic reticulum present	Mitochondria and endoplasmic reticulum absent
Cell membrane	Sterols present	Sterols absent (except <i>Mycoplasma</i>)
Cell wall content	Chitin	Peptidoglycan
Spores	Sexual and asexual spores for reproduction	Endospores for survival, not for reproduction
Thermal dimorphism	Yes (some)	No

Prokaryotes (Bacteria)

0.1-10 μm

No nuclear membrane

Single chromosome

No histones

Binary fission ^{نوع البسيط} ^{نوع الانقسام}

No organelles

Peptidoglycan

No ergosterol

70 S ribosomes

Eukaryotes (Fungi)

10-100 μm

Nuclear membrane

multiple

Histones

Mitotic division ^{معتبة}

Organelles

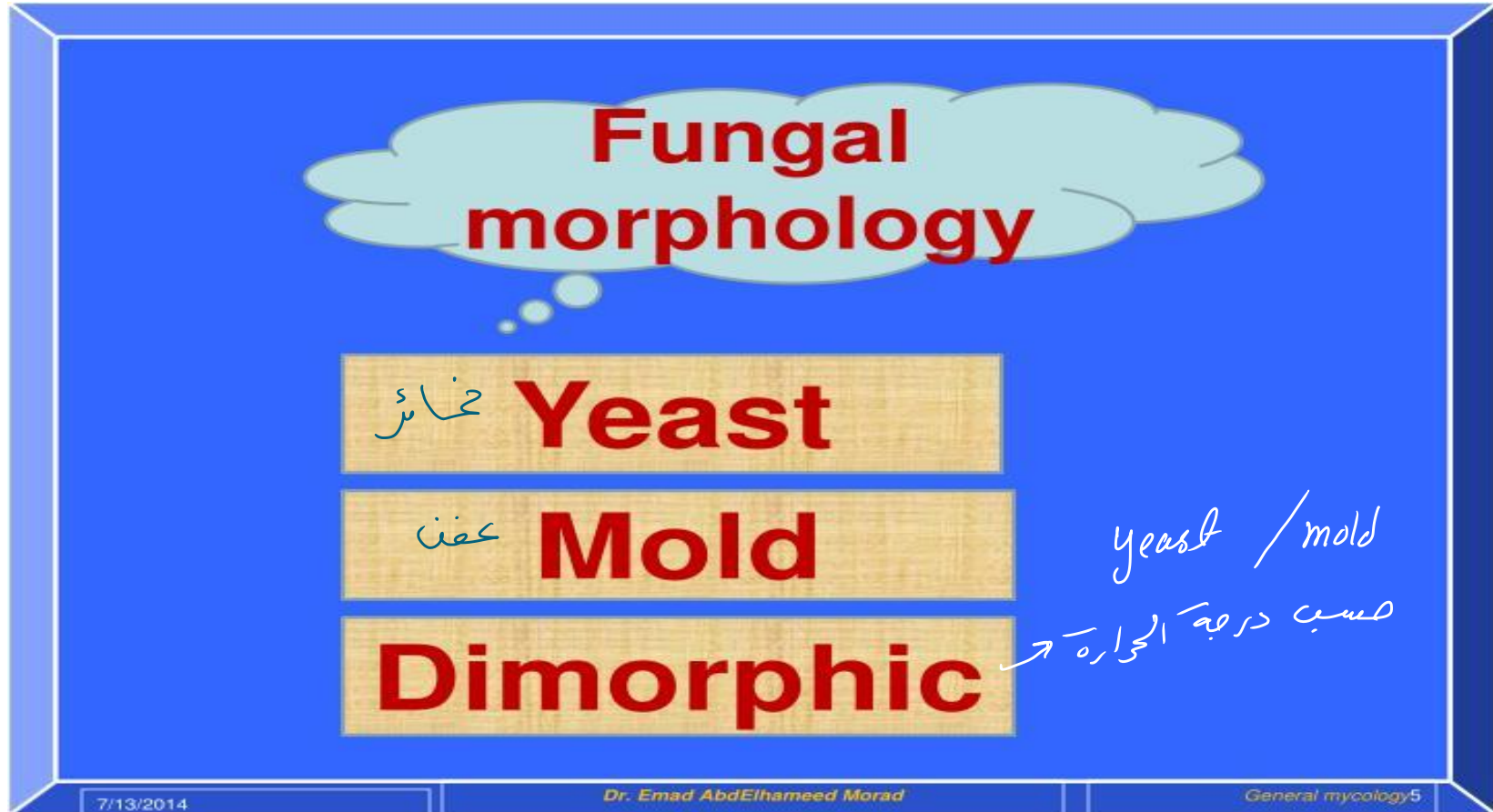
Chitin

Ergosterol

80 S ribosomes

تصنيف الفطريات بناءً على خصائصها الشكلية والبيئية

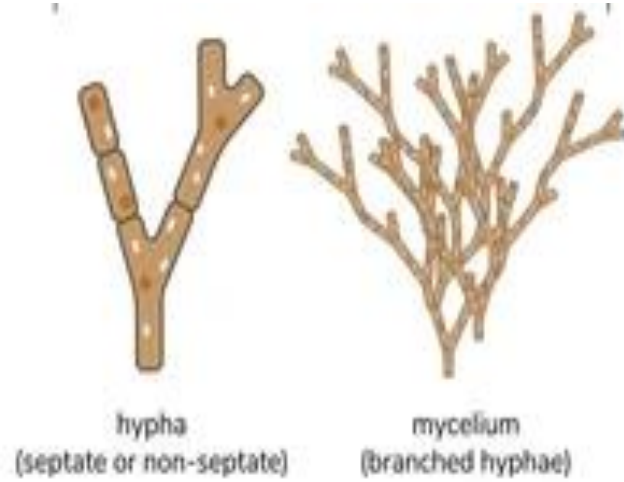
Morphological classification of fungi



filaments ~ يَكُوْنُ

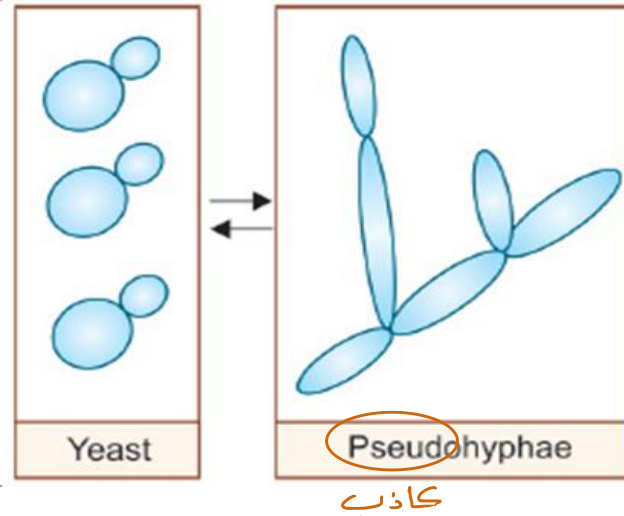
1-Mold (filamentous fungi):

- They are multicellular fungi which produce hyphae (i.e) microscopic long branching filaments.
- Example: Dermatophytes & Aspergillus.



2-Yeasts (Budding fungi): (no hyphae)

- Oval or rounded single cell, Reproduce by budding.
- Some yeasts may have elongated budding cells linked in branches called pseudo-hyphae.
- Example: Candida & Cryptococcus.



السمم إلى أساليب الحسني وزيادة

① إذا ظهرت حرارة الغرفة أي أننا زرعته في المحلول المختبر فلاحظه عفن

3-Dimorphic fungi: (Dimorphism)

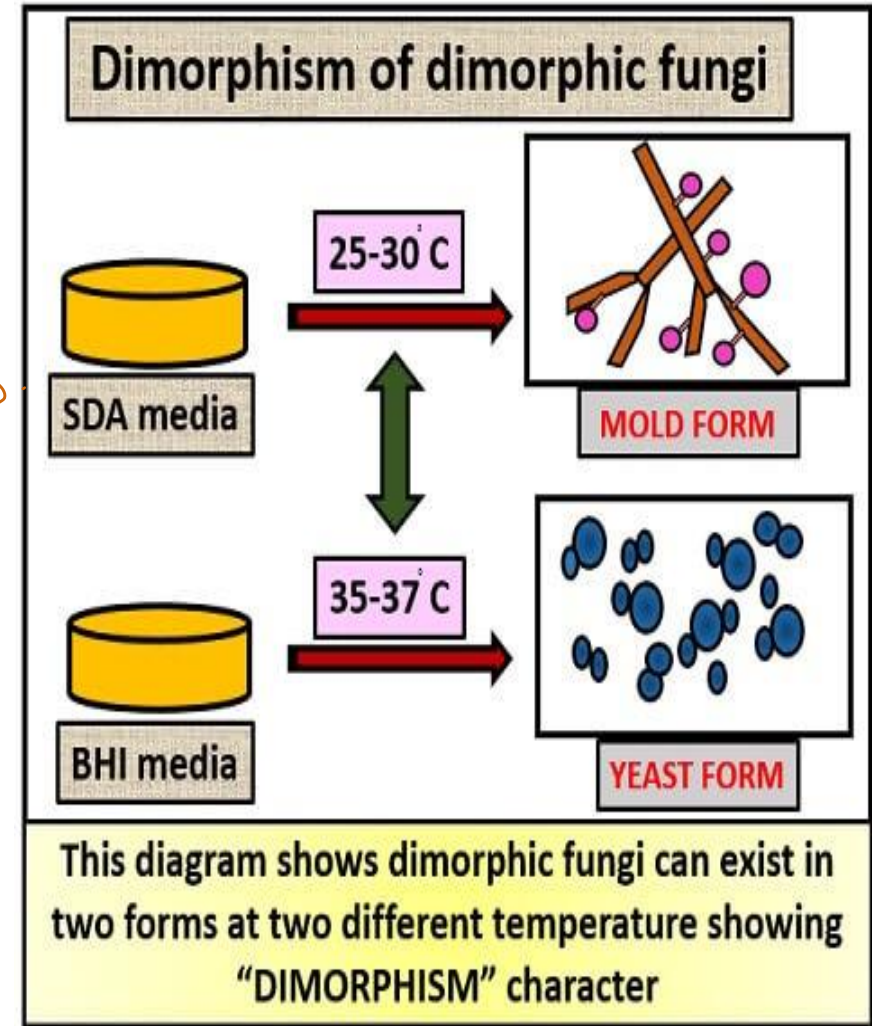
Some fungi can occur in 2 different forms:

- In ^① nature or in ^② culture at room temperature, they occur in a filamentous form (molds).
- In infected tissues or when incubated at 37°C they occur in a yeast form.

Example: *Histoplasma capsulatum*

أصله على

dimorphic fungi



Fungal reproduction

بتيير دودة hyphae بتعمل ما سها انشي دوا د hyphae بعمل ماله ذكر وبمسير تزاوج
وينتج منهم zygospore

(1) Sexual reproduction (perfect fungi):

أم (n) أب (n)

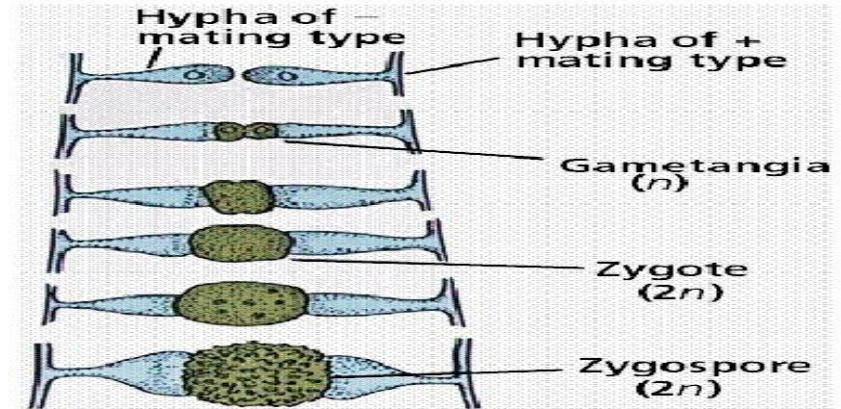
When two parents' spores combine to
produce a **zygospore**.

تكاثر جنسي وهي الأكثر شيوعاً

(2) Asexual reproduction (imperfect fungi):

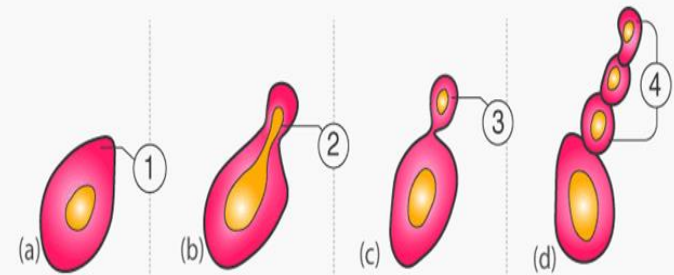
تكاثر عن طريق البراعم

- **Most** of the common pathogenic species are
imperfect fungi and propagate by forming
Asexual spores e.g. **Budding**.



REPRODUCTION IN FUNGI : YEAST

BYJU'S
The Learning App



1 Yeast Cell | 2 Developing Bud | 3 New Bud | 4 Chain of buds

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HUMAN MYCOSES

(Clinical classification of fungi)

Type	Anatomic Location	Representative Disease	Genus of Causative Organism(s)
Cutaneous	Dead layer of skin	Tinea versicolor	<i>Malassezia</i>
	Epidermis, hair, nails	Dermatophytosis (ringworm)	<i>Microsporum, Trichophyton, Epidermophyton</i>
Subcutaneous	Subcutis	Sporotrichosis	<i>Sporothrix</i>
		Mycetoma	Several genera
Systemic	Internal organs	Coccidioidomycosis	<i>Coccidioides</i>
		Histoplasmosis	<i>Histoplasma</i>
		Blastomycosis	<i>Blastomyces</i>
		Paracoccidioidomycosis	<i>Paracoccidioides</i>
Opportunistic	Internal organs	Cryptococcosis	<i>Cryptococcus</i>
		Candidiasis	<i>Candida</i>
		Aspergillosis	<i>Aspergillus</i>
		Mucormycosis	<i>Mucor, Rhizopus</i>

Superficial Mycoses

← روح تأثر على المنطقة الخارجية
من الجسم (أماكن سطحية)

Affect the **skin, mucous membrane, hair or nails**.

(1) Pityriasis versicolor (Tinea versicolor).

فنجي
نخالة صلوية / مبرقشة
(صاحبها ليع والاسماء صريح)

- Caused by **Malassezia furfur** on skin
صاحبها لا شيء واحد ↓
- Cause de-pigmentation of the skin (only cosmetic importance).
صاحبه فاتح من الجسم والثاني ضامه وصريح



(2) Candidiasis of the Skin / mucous membranes (Moniliasis)

تسببه
Yeast

- **Candida albicans** (normal flora of the mucous membranes).
لما تكونه مناعتي ضئيلة فصارح تعمل لرشى والمثلية إذا معدني ضعيفة
 - **Opportunistic** fungi which dominate with impaired immunity
 - Affect warm, moist areas of the **skin** (Axilla, Groin, diaper rash,...),
عامة صلبة
- mucous membranes (Oral thrush, vaginal thrush).
تسبب أماكن
دافئة + رطبة



[اللبط + الماء + صكاه تغير الحفاظان عند الأكل ...]

(3) **Dermatophytosis (Ringworm infection)** → filamentous fungi

روح تيجي من الاستحمام بهاد الماء
تو ترفقظ من الماء طبعه إلى فيها كبراشين

➤ Dermatophytes are 3 genera: **Microsporum, Trichophyton, Epidermophyton**

➤ They infect only the superficial **keratinized** layers of the **Skin, Hair and Nails**.
مستحيل تنزل على الطبقة التحت من الجلد أو الدم أو أي عضو أعمق
محدوى فطرية

➤ Cause **Tinea**, contagious disease characterized by itchy, scaly, red circular or **ring-like lesions** (hence the name ringworm).

و تنتقل من استخدام خوط الاستحمام من مدغشرك
أو في غرف تغيير الملابس في المحلات أو فرشة السفر...

تكون دائرة حمراء عليها بثور كل ما تتوسع و تكبر رجع يختفي الأمر من الوسط
وتعمل علامة حلقة زينة هيك باللباية بكونه د بالنهاية



Tinea capitis (scalp)



Tinea corporis (body)



تظهر لنا يصير عرقه بين الأصابع
Tinea pedis (Athlete's foot)
يشكل متكرر

فجوة فطرية ناتجة عن تعيش في التربة وعاء النباتات وتوصل لها يصير تو اهل بينها
وبين الجلد البشري

Subcutaneous Mycoses

These are caused by fungi that grow **in soil and on vegetation** and acquired only when the fungus is **implanted** into subcutaneous tissues by **trauma**.

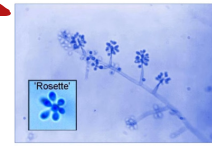
Involves skin, muscle and connective tissue immediately below the skin

زوي العودة

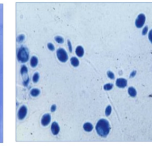
(1) Sporotrichosis "Rose gardener's disease" *Dimorphic fungi*

- ^{yeast} Caused by Sporothrix schenckii.
- ^{شون الدرد} Spores introduced by rose thorn.

مع الوقت راح
تصير قرحه ulcer



Mold phase: Septate hyphae with conidia in clusters with characteristic flowery shape.



Yeast phase: Round or cigar-shaped budding yeasts



(2) Mycetoma "Madura foot" → mold only

في التربة والاذرا مني الترابي وصش هو جوده على النبات من فوه

- Caused by Madurella mycetomatis.
- Foot is the common site and usually called "**Madura foot**".



الهم! نبي أسالك العفوا والعافية من الدنيا والآخرة

عدد من خطرت ناتجة من
الاستنشاق منه وبعد ذلك تنتشر في الجسم

Systemic Mycoses

Mostly begin as primary pulmonary lesions that may disseminate to any organ.

هنا تنتقل عن طريق الدم وليس ان يستنشق (صحيح)

1) **Candidiasis**: Infection is mostly blood borne e.g. Central venous catheters, intravenous drug use, Major surgery,..)

صحيح عند طريقه جراحيه ، محددات في الوريد ، كانيولا (cannula) ...

2) **Histoplasmosis**: (*Histoplasma capsulatum*) bird excreta, especially bats.

Inhalation of spores (pulmonary infection) → Reticuloendothelial system.

3) **Cryptococcosis**: (*Cryptococcus neoformans*) pigeon faeces

Inhalation of spores (pulmonary infection) → Meninges (**Meningitis**).

4) **Coccidioidomycosis**: (*Coccidioides immitis*)

Inhalation of spores (pulmonary infection) → disseminate to any organ.

5) **Aspergillosis:** mold on air, water, soil, ...

① **Aspergillus Fumigatus:** on lungs (بالتلوي العدوى من الاستنشاق) → غالباً يصيب الناس عندها
أمثلة صعبة في الرئة

Causes **pulmonary Aspergillosis**, (in patients with a pre-existing lung disease) →
بعد نزع رئة ينتشر لأي عضو
disseminate to any organ.

② **Aspergillus Niger:** ^{الأذن} on ear → عن طريق غشاء البقعة

Causes **otomycosis**, chronic infection of the external auditory meatus.

② **Aspergillus Flavus:** → يصيب سموم
ويعبئ سم في الكبد

Produce **aflatoxins** which cause neoplasm in liver (Cancer liver)



Opportunistic Mycoses

هنا الفطريات التي لا يتحمل
أمرها عند الناس إلى ضاعتها
منه

Fungi that induce disease in **immunocompromised individuals** (those with impaired immunity).

- **Candida spp.**
- **Cryptococcus spp.**
- **Aspergillus spp.**
- **Mucormycetes (Mucor, and Rhizopus)**
- **Pneumocystis jiroveci.** الفطر الأسود

السّموم التي تُفرز
في الفطريات

MYCOTOXINS

غير صديق
للبشر

Examples:

- (1) **Poisonous mushrooms** (e.g. **Amanita** mushroom) is potent hepatotoxin.
- (2) **Aflatoxin**, produced by ~~*Aspergillus flavus*~~, causes neoplasm in liver (Cancer Liver).
- (3) **Ergotism**, is caused by the mold *Claviceps purpurea*, which infects grains and produces alkaloids (e.g., ergotamine) that cause vascular and neurologic effects.

Amanita phalloides
"Death angel mushroom"



Laboratory diagnosis

A) Specimens: according to site of infection *ring worm*

✓ **Skin scales**

✓ **Infected nail**

✓ **Hair**

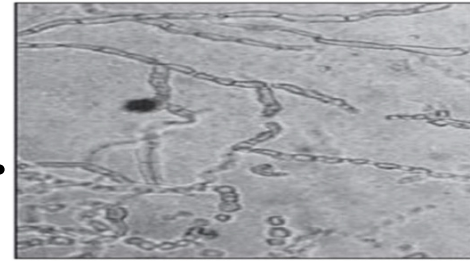
✓ **Others: Pus, urine, sputum, CSF, blood,..**

القائمة بخاصة صلبة التي استعملت في اختبارها بسهولة

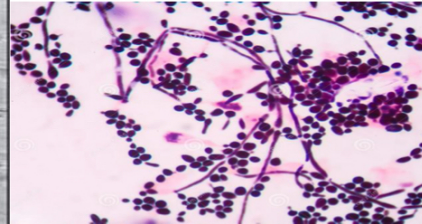
Thick keratinized samples are dissolved in KOH

KOH digest the keratin, leaving the alkali-resistant fungi intact → Easily visualized

كلم
نفس
ميكروسكوب
microscope



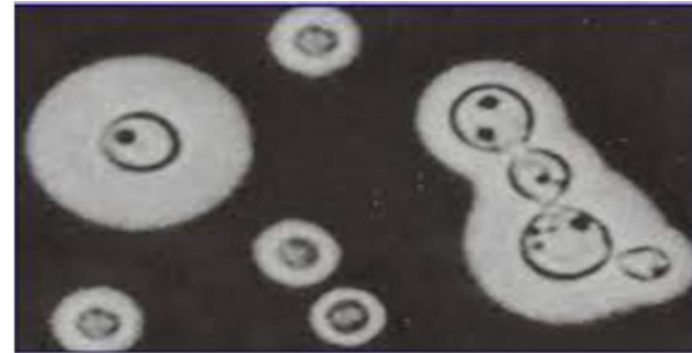
KOH preparation
Dermatophytes



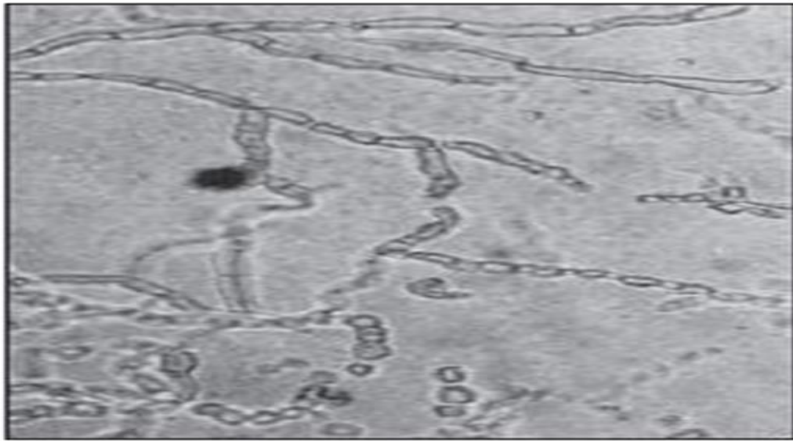
Gram stain
Candida

B) Microscopic examination:

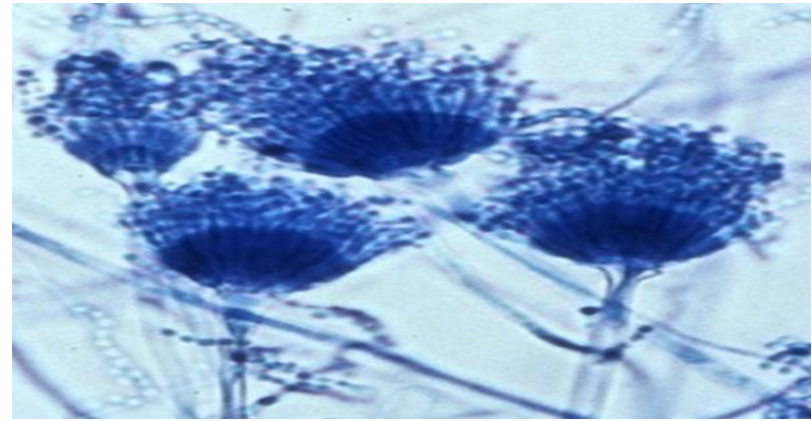
- Unstained (after treatment with KOH)
- Fungal stains :
 - ✓ lactophenol cotton blue
 - ✓ Calcofluor white
 - ✓ India ink
 - ✓ Gram stain



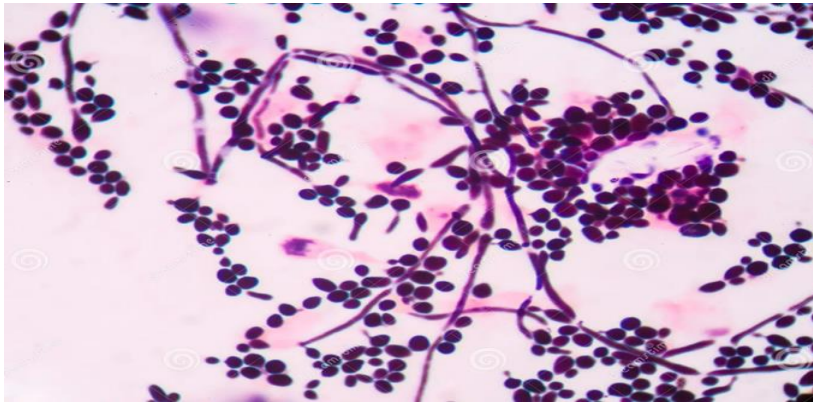
India ink
Cryptococcus



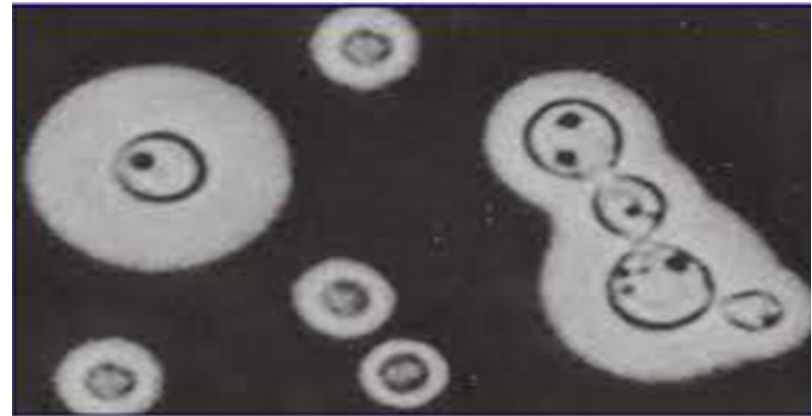
KOH preparation
Dermatophytes



lactophenol cotton blue
Aspergillus fumigatus



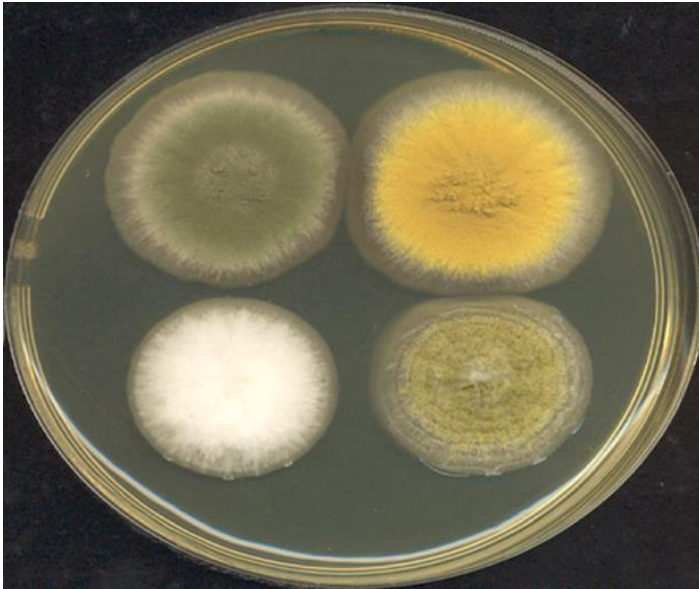
Gram stain
Candida



India ink
Cryptococcus

C) Fungal culture:

Sabouraud's dextrose agar (SDA): commonly used *antibiotic*
(contain chloramphenicol + cyclohexamide) → inhibit bacterial growth)



Mold colonies

↪ *areal growth*



Yeast colonies

D) Biochemicals: sugar fermentation, urease test,....

E) Molecular: PCR

F) Serology:

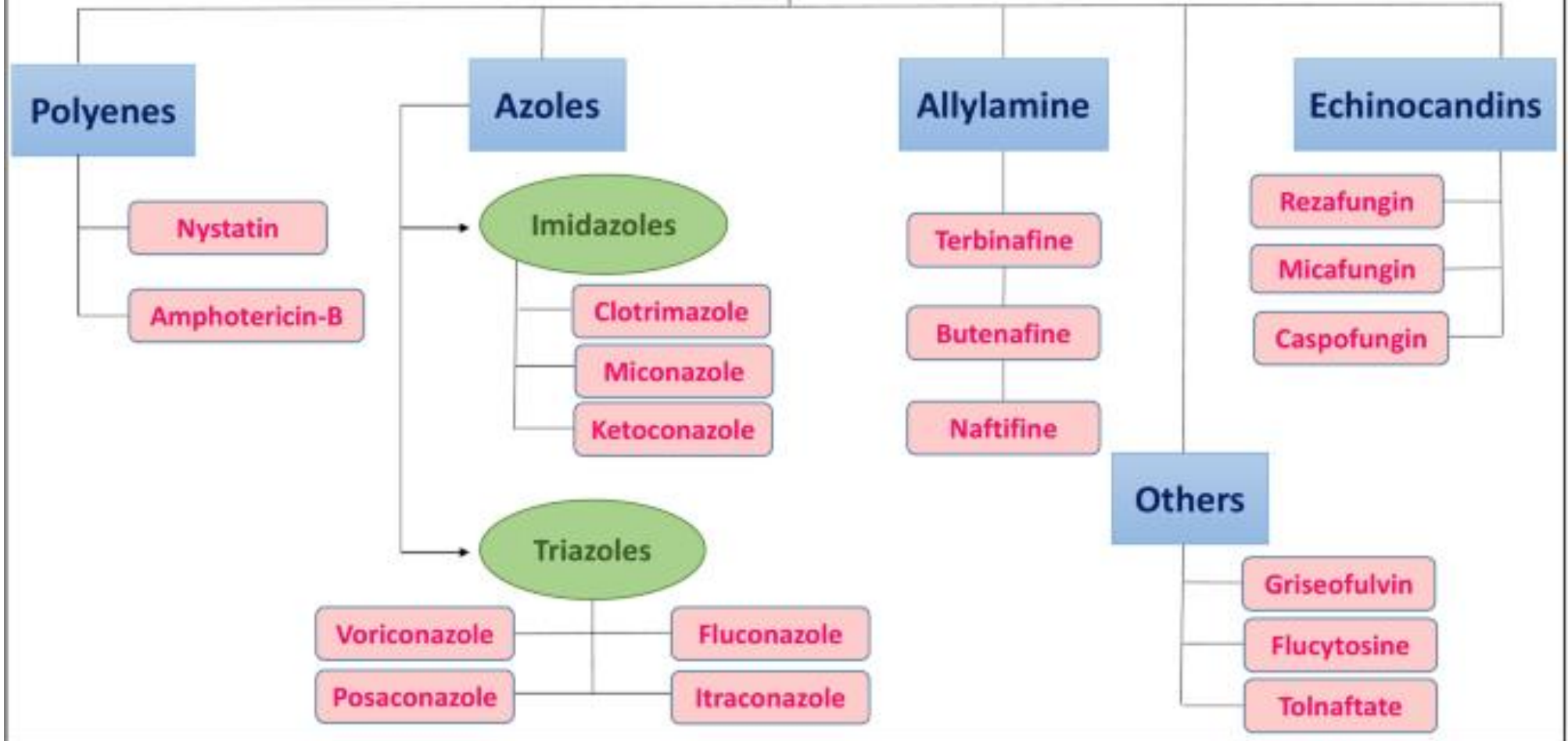
أجسام مضادة

➤ Tests for the presence of antibodies in the patient's serum are useful in diagnosing systemic mycoses.

➤ Detection of fungal Ag in serum or body fluids: e.g: β D-glucan

Antifungal Drugs

اللهم اغفر لي ما صلتني من عيبي



A) Polyenes:

Binds to ergosterol and disrupts fungal cell membranes.

Nystatin: → ^{> lies} Candida

Used for topical treatment (Not well absorbed orally and too toxic for I.V).

Amphotericin B:

The most effective drug in treatment of severe systemic (deep) mycosis.

B) Azoles:

Inhibits ergosterol synthesis

Miconazole and Clotrimazole: are effective in topical treatment of dermatophytosis & superficial candidiasis.

Ketoconazole, Itraconazole: are well absorbed from GIT so; given orally.

Fluconazole: penetrates C.N.S. and so effective in fungal meningitis either orally or I.V.

C) Allylamines:

Inhibits ergosterol synthesis

Terbinafine: treatment of dermatophytosis.

D) Echinocandins:

Inhibits synthesis of D-glucan, a component of fungal cell wall.

Caspofungin: Used in invasive fungal infections

اللهم صلّ وسلم وبارك
على محمد

E) Others:

Griseofulvin:

It blocks mitosis.

Active against all dermatophyte.

Topical application is ineffective. The drug is well absorbed from intestine, so it is given orally. The drug is deposited in diseased skin (keratophilic).

Flucytosine:

- **Inhibit fungal DNA synthesis.**
- Penetrates C.N.S. and so effective in fungal meningitis.
- Oral flucytosine and I.V. Amphotericin B → Synergism.
 - ✓ To delay resistance to Flucytosine.
 - ✓ Also Amphotericin B increases cell membrane permeability of the fungus and this allows flucytosine to go through.

A girl who pricked her finger while pruning some rose bushes, develops a local pustule that progresses to an ulcer. Several nodules then develop along her forearm. The most likely agent is:

A) *Aspergillus fumigatus*.

☒ B) *Sporothrix schenckii*.

C) *Madurella mycetomatis*.

D) *Candida albicans*.

E) *Histoplasma capsulatum*.

وَبِّ اَرْحَمِ اَيْيِهِمْ وَالتَّغْفِرُ لَهُ
وَعَامَةً وَاعْفُ عَنْهُ وَاجْعَلْ
وَأَهْلَهُ مِنَ الْيُودِ س

A 50-year-old woman receiving chemotherapy via a subclavian catheter for acute leukemia. She presented with fever and stiffness in the neck with clinical suspicion of meningitis. CSF culture grew budding yeasts that formed germ tubes. The organism most likely causing this infection is:

A) *Cryptococcus neoformans*.

☒ B) *Candida albicans*.

C) *Candida krusei*.

D) *Histoplasma capsulatum*.

E) *Candida tropicalis*.

Aspergillus fumigatus can be involved in a variety of clinical conditions.

Which one of the following is LEAST likely to occur?

- A) Tissue invasion in immunocompromised host.
- B) Allergy following inhalation of airborne particles of the fungus.
- C) Colonization of tuberculous cavities in the lung.
- D) Thrush.**
- E) Pneumonia and hemoptysis.

A 30-year-old woman has a painless ulcer on her tongue. She is an immunocompromised patient. Biopsy of the lesion revealed yeasts within macrophages.

What is the most likely diagnosis?

- A) Candidiasis.
- B) Cryptococcosis.
- C) Sporotrichosis.
- D) Histoplasmosis.**
- E) Aspergillosis.

Mycotoxins are toxins produced by fungi.

Which of the following statements best describes aflatoxin?

A) It is readily treated with antifungal drugs.

B) It is transmissible between persons.

C) It causes chronic damage and neoplasm in liver.

D) It is produced by poisonous mushrooms.

E) It is produced by *Aspergillus fumigatus*.
