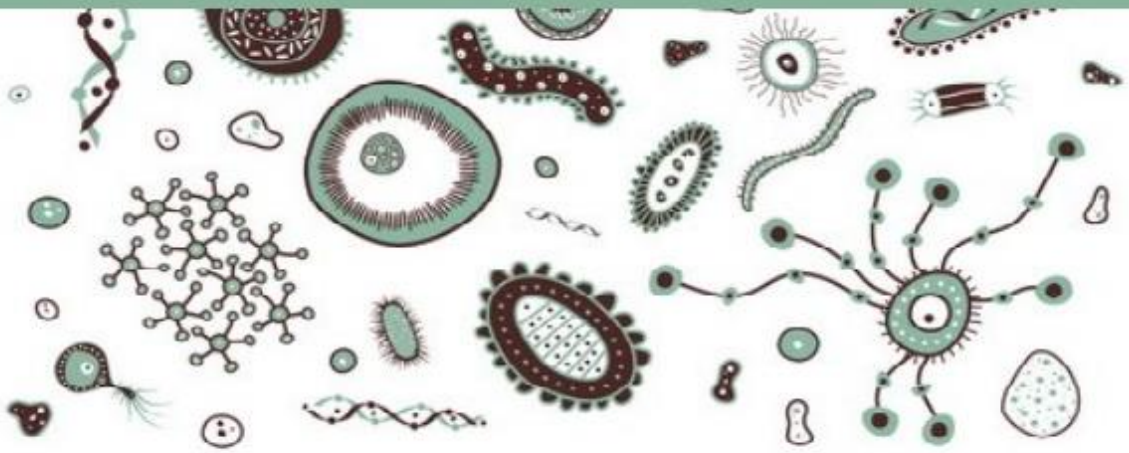
Microbiology



◉ Sheet ○ Slides

Number :19

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Subject: Mycology-1

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REVIEW:

- Fungi are classified into two major groups: **yeasts and molds.**

1)**Yeast** is associated with presence of single oval cell and might under certain conditions especially during infection of mucosal cells produce filaments or hyphae (tube-like structure).

2)**Molds** (or filamentous fungi) are widely distributed in the nature in the form of spores and filaments.

Each group is associated with special human, animal, or plant infections.

- Another way of saying this:

Initial growth from a single cell may follow either of two courses, yeast or mold. The first and simplest is the formation of a bud, which extends from a round or oblong parent, constricts, and forms a new cell, which separates from the parent. Fungi that reproduce in this manner are called yeasts.

- Fungi may also grow through the development of **hyphae,** which are tube-like extensions of the cell with thick, parallel walls. Most fungi form hyphal **septa**, which are cross-walls perpendicular to the cell walls that divide the hypha into subunits. Some species are nonspetate. Some fungi form structures called **pseudohyphae,** which differ from true hyphae in having recurring bud-like constrictions and less rigid cell walls. Mass of hyphae form mycelium.

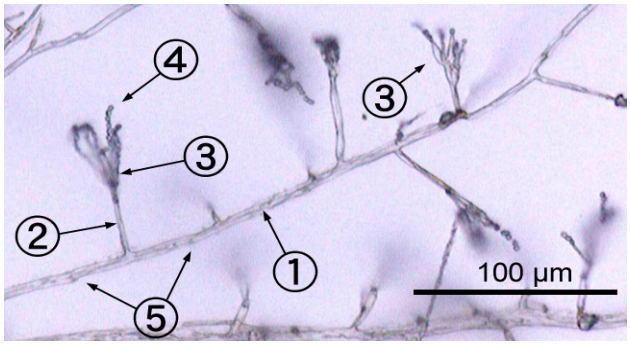
REPRODUCTION

Fungi may reproduce by either asexual or sexual process. The asexual form has **conidia (asexual spores)** as the reproductive element. The sexual form has **spores** as the reproductive element.

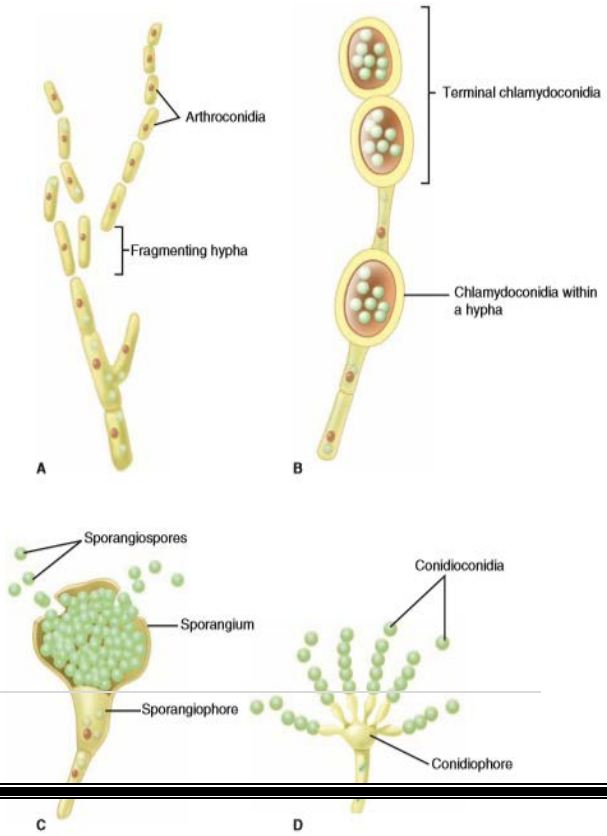
DIAGNOSIS

Normally, we don't have a lot of culture media like in bacteria. We rely on 3 types of media for fungi: sabouraud-dextrose agar, meat agar, and rice agar.

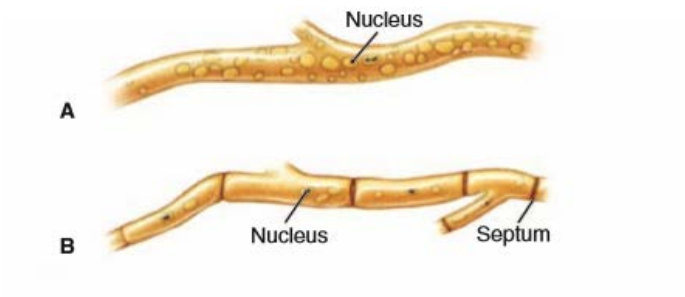
In relation to yeast we have certain biochemical tests in the form of fermentation tests for certain types of sugars like glucose, mannose, sucrose, galactose, etc. These help due to the fact that yeast cells normally ferment sugar products and **produce CO2, alcohol and end product in the form of organic compounds**. Whereas in filamentous fungi it's more difficult due to the fact that there is no biochemical test which can detect and differentiate between one and another. Even serological tests are considered non-specific. Therefore, we rely on morphological structures for identification (eg, composition of filaments, septated or non-septated, number of branching filaments, spores: micro or macrospores, number of compartments inside spores, attachment of spores on the end filamentous vesicles (head), etc.) However, in general, it is not easy to detect the accurate type of filamentous fungi in infected tissue due to the fact that we recognize the filaments during infection and not spores. The other arrangement (spores) is mainly recognized in vitro.



An environmental isolate of *Penicillium*



1. hypha 2. conidiophore 3. phialide 4. conidia 5. septa



A. non-septate hyphae with multiple nuclei.

B. septate hyphae divide nuclei into separate cells.

Asexual mold forms. Morphology of reproductive conidia and spores are used for identification.

DIMORPHISM

Some species can grow in either a yeast or a mold phase, depending on the environmental conditions. These species are known as **dimorphic fungi** eg, *Candida albicans*.

HUMAN MYCOSIS

Diseases caused by yeast or molds in humans.

DERMATOPHYTES

Dermatophytosis are **superficial (only affect epidermis)** skin infections of the skin, hair and nails (infection of keratinous tissue). They are caused by dermatophytes. The three genera of dermatophytes we will discuss are *Epidermophyton*, *Microsporum*, and *Trichophton*. They cause:

1)Tinea corposis(body)

2)Tinea unguium(hair)

3)Tinea capitis(scalp)

They are the same disease in different locations. Dermatophytes are molds

PATHOGENESIS

Dermatophytoses starts when skin lesions come in contact with dermatophyte hyphae or conidia. If you look at your hand you may not notice that you have tiny lesions that allow these fungi to enter. They only affect the epidermis (rarely reaching the subcutaneous tissue) causing hypo or hyperpigmentation and circular lesions usually in relation to exposed part of the skin (face/hands). This characteristic is the origin of the common name **ringworm** and Latin term *tinea* (worm). People thought the lesions were caused by worms because of its shape. Most infections are self-limiting.

TINEA CORPORIS

Small fragments of the filamentous fungi or spores can be implanted in damaged areas of the skin. Later, spores produce filaments that are associated with lesions. The filamentous form is responsible for the infection without replication or reproducing (production of spores).

Mode of transmission: through dust, or close contact with person infected with dermatophytes.

Tinea corporis can be caused by approximately more than 26 species of different dermatophytes.

First, we have the genus *Epidermophyton* , second genus *Microsporium* and *Trichophtyon* and each genus is composed of multiple different species which we won't mention their names. Their names are in relation to the color or the type of infection and lesion (growth characteristics)

PITYRIASIS (TINEA) VERSICOLOR

One of the most common causes of pityriasis versicolor is *Malassezia furfura*; lipophilic yeast that is part of the normal body flora. Under certain conditions (eg, moist: think obese people, skin folds, people who work under the sun and constantly sweat; stress; exposure UV; developing of fever of unknown cause) can change the color of the skin ”*versicolor*” and form spots in any part of the body. Tinea versicolor is not a dermatophyte but a lipophilic yeast.

TREATMENT

It is not serious and recovers within 1-2 weeks and requires no antifungal drugs. However, they may look unsightly or a person might associate it with a form of serious allergy.

DIAGNOSIS

Skin scrapings from infected person show elongated yeast cells and thin filaments. Culture is difficult for tinea versicolor.

TINEA CAPITIS (SCALP)

In relation to hair especially in children due to the fact that children produce less saturated fatty acids in their skin so that spores can infect the hair follicle or it can directly infect the hair shaft and produce extracellular products in the form of sticky material. This sticky material can be easily recognized during combing the hair. This is often infectious and can spread from one child to another, often observed in elementary schools. It is often associated with low standard hygiene and not washing the hair regularly. It can be transmitted from the environment as the spores are widely spread in the nature, from domestic animals carrying this filamentous fungi in their hairs, and again as we said human contact.

TREATMENT

Tinea capitis can be serious, causing damage to the hair follicle and should be treated with antifungal drugs to reduce the side effects on the scalp and reduce dissemination to other children.

Note: The causative agent of Tinea capitis can be only *Microsporium* or *Trichophyton* but not *Epidermophyton* which is mainly related to skin.

TINEA UNGUIUM

Can affect any age group, females more than males. At first, produces change in the color of the nail and then produces damage in the surface of the nail making it brittle. The nail is usually thick and black/brown in color according to the type of fungus. In general, 80% of nail infections are caused by dermatophytes especially *Microsporium* and *Trychophyton*. Nail infection can be also caused by *Aspergillus niger* but to a lesser extent.

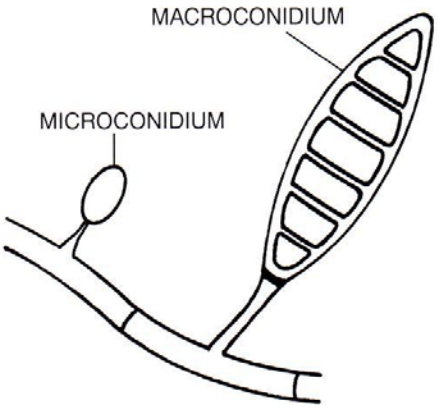
TREATMENT

Treatment is difficult and the use of antifungal drugs is not enough; surgical removal of the nail must be done. If infection, however, is only in the nail tip and did not reach the folding of the nail, then it can be controlled. Sometimes, areas infected by dermatophytes become secondarily infected with bacteria, in this case, it requires surgical treatment and intake of antifungal and antibacterial drugs.

DIAGNOSIS

Identification of dermatophytes can be done by taking small pieces of skin, nail, or hair + 10% KOH and warming of the smear in order to release the spores. Under the microscope, look for the presence of filaments and microspore or macrospores and which are not easily recognized because, again, **spores can be observed only during growth of fungi in vitro not in vivo.** The same specimen taken from the infected part can be cultured, first you can observe the filaments then spores begin to be produced. According to the growth aerial mycelium (presence vertical filaments called **condiophores**, presence of vesicle and the color of the spores; micro or macroconidia you can identify the fungus. The macroconidia is seen as a large sac-like structure which has a number of compartments depending on the type of fungi (2,4,6,8)(See the pictures below).In addition to growth pattern, growth time can also help identify the fungus (eg,

dermatophytes grow slowly 2-6 weeks while other fungi like *penicillium* and *aspergillus* only take 3 days).



Yeast

We have two types of yeasts: non-pathogenic yeast which is associated with budding rarely introduce filaments in vivo. Production of filaments is obligatory to cause infection in tissue, because filaments will affect the mucosa of cells or the epidermis. We have within the pathogenic yeast a group called *Candida.*

CANDIDA

Candida is considered part of our normal body flora with *Candida albicans* being the most common cause of opportunistic infections. *Candida albicans* is present in few numbers as part of the intestinal, oral and genital flora of many healthy persons. Infections are mostly endogenous not exogenous.

PATHOGENESIS

Under normal conditions, *Candida albicans* doesn't cause infection. However, if there is deficiency in the immune system (eg, HIV patients, children), risk factors that increase its number (administration of antimicrobial drugs), or disruptions in the mucosa (catheters, x-ray exposure, malignancy and use of chemotherapy) then this pathogen might gain access to the mucosa and change from its yeast form (the non-pathogenic form) to the hyphal form (associated with infection). Pain is associated with this type of Candida.

MANIFESTATIONS

C. albicans causes lesions in the mucosa. Oral lesions (white plaques, hence the name "*albicans*"), called thrush, occur on the tongue and in the oral cavity usually in children and in the immune-compromised (eg,HIV; this picture shows white plaques on this AIDS patient's tongue). Under certain conditions, this thrush might spread to the throat, pharynx, larynx, and even the lungs especially in HIV patients causing death. 20-30% of HIV patients died following candidiasis in the lungs which cannot be easily eradicated by the use of antimicrobial drugs. Therefore, cell-mediated immunity plays a role in protection.

DIAGNOSIS

Easily recognized under the microscope. A throat swap from a healthy person shows budding yeast cells; hyphae are associated with infection.

Candida albicans.

You can notice the presence of oval cells and hyphae.

TREATMENT

Candida albicans associated with 70% of the cases. The other types of *Candida* like tropicalis are less associated with candidiasis. Some these are considered resistant to fluconazole an antifungal drug used in treatment of candidiasis. Therefore it is important to identify the species. If patient did not respond to treatment within two to three days, you have to culture in order to use another type of drug. Removal of catheters, stopping the use of the offending antimicrobial drug or toxic drug, increase in the number of leukocytes is often associated with recovery without the use of antifungal drugs.

CRYPTOCOCCUS NEOFORMANS

It is not part of the normal body flora and is found in feces of birds and in the environment. It is only pathogenic in immunocompromised patients as in HIV patients or other patients with decreased immunity or in associated with transplantation of organs or stem cells and bone marrow.

PATHOGENESIS

Cryptococcus neoformans are more related to the upper respiratory tract. At the beginning, it starts with very simple sinusitis and later can disseminate to the lungs and produce micro abscesses and later might disseminate to the blood stream and to meninges causing chronic meningitis.

DIAGNOSIS

Many cases of chronic meningitis which prove to be negative by culture for bacteria and viruses might be associated with *Cryptococcus* especially if it is associated with severe headache and brain-like lesions. However, it might not be easily detected due to the fact that CSF (cerebrospinal fluid) often contains few numbers of this organism and in order to demonstrate the large capsule associated with this organism you require centrifugationand a lot of experience. Normally, we use india ink at the beginning and later other stains or antiserum.

TREATMENT

Infection can be so severe and dangerous if not eradicated in the first stage. In the second stage, the patient often dies following complications in the CNS.

ASPERGILLUS:

Aspergillus are widely distributed molds in the nature. Their spores are found in homes, schools, hospitals, basically everywhere due to the fact that they are associated with plants, food, and dust. They are not part of the normal body flora. Again, only associated with immunocompromised patients or during contamination of equipments in respiratory surgeries.

PATHOGENESIS

Aspergillus spores are small enough to reach the alveoli when inhaled, but disease only occurs in the immunocompromised or during surgical procedures (contamination). At the beginning, aspergillus causes infection which cannot be recognized, slowly progresses in the sinuses, and later disseminate to the lungs (especially in patients with chronic obstructive lung disease) and produce micro-lesions. Those micro-lesions can increase in size causing granuloma and formation of aspergillus ball which produce damage to lung tissue and blood vessels and associated late with the death of the person. Rarely does Aspergillus disseminate to blood and meninges, it might however reach the liver or the kidney and cause damage. This is one type of infection caused by *Aspergillus*. However, *Aspergillus*mostly causes clinical allergy (pulmonary aspergillosis) characterized by the presence of asthma, eosinophilia, and other clinical features. It is not a true invasive aspergillosis but only allergic reaction to the spores of *Aspergillus*.

Localized infection recognized in the oral cavity, skin, etc, following surgical manipulation and contamination of wounds can be easily treated by surgical means and there is no need for antifungal drugs. Whereas in pulmonary tuberculosis, antifungal drugs are not enough because they cannot penetrate the granuloma and get rid of it. Therefore, surgery is also needed.

Extra information:

Why pulmonary tuberculosis?

Pulmonary tuberculosis produces cavities in the lung tissue where WBCs cannot reach so *Aspergillus* can grow freely and form Aspergilloma. Other diseases can also do the same.

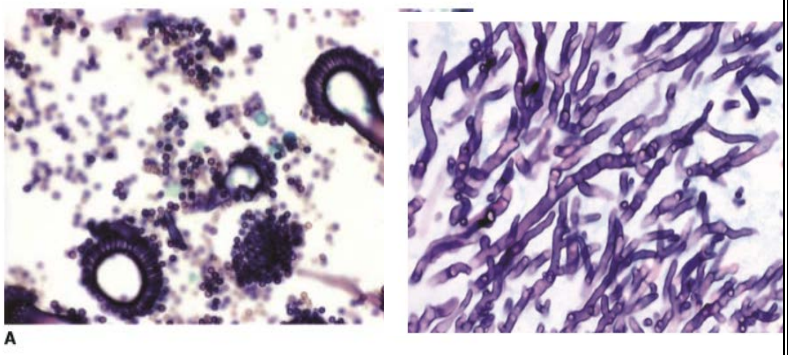
Often, swimmers might develop externa otitis aspergillosis especially if they have damage in the external ear and this is called otomycosis which is caused by colored *Aspergillus*(black or yellow).

The three most species associated with infection are:

- *Aspergillus fumigatus*: name according to its blueish
- *Asperigillus niger*
- *Aspergillus flavus*: which is not only invasive but is also toxic and associated with the release of aflatoxins. Often contaminates carbohydrates (rice), proteins, milk powder, and even fatty acid in nuts especially if not well dried. It causes severe liver cirrhosis and carcinoma which is highly fatal. 1 microgram of aflatoxin is enough to kill a person or an animal.

DIAGNOSIS

Specimen from lesion shows hyphae and later production of aerial mycelium carrying the spores. As we said, according to the color of the spores and structures carrying them we can identify the causative agent.



The End.