

Veterinary Microbiology

Opportunistic fungi and Mechanism of Mycotic Infection

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ภาควิชาจุลชีววิทยา คณะสัตวแพทยศาสตร์

จุฬาลงกรณ์มหาวิทยาลัย

Opportunistic fungi

Airborne fungi ✦ mould

✦ opportunistic fungi

Class Phycomycetes (Zygomycetes,
Sporangium fungi)

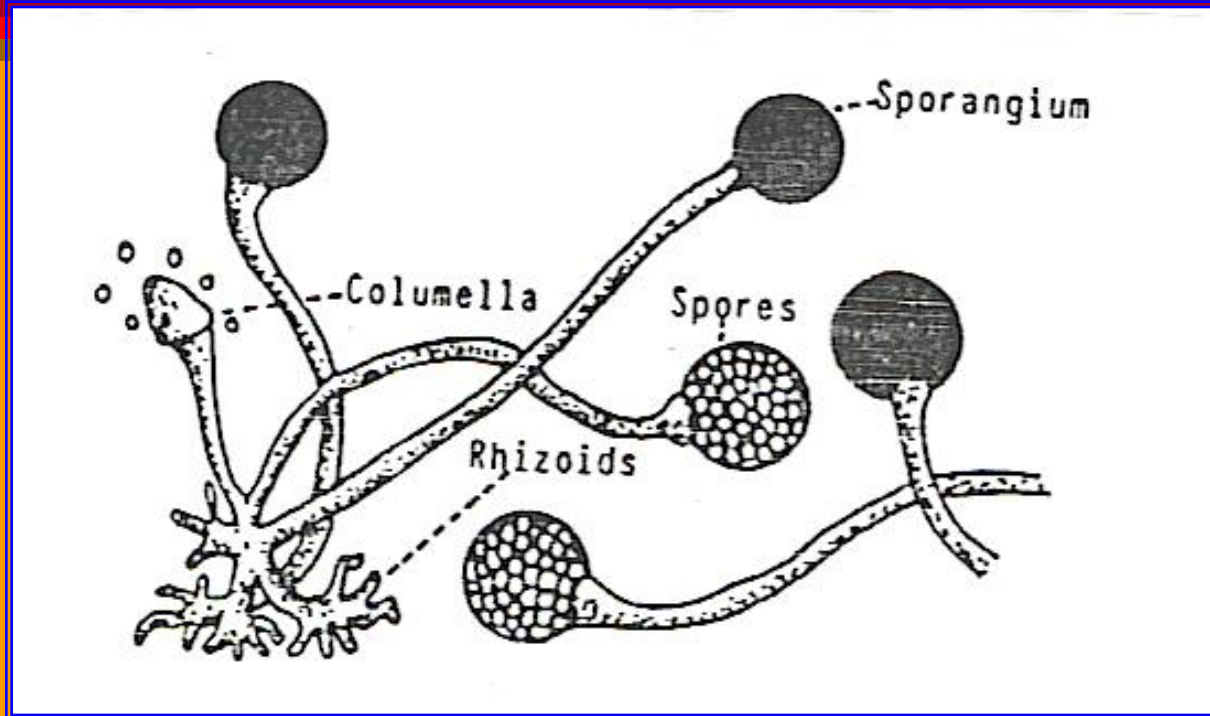
1. *Rhizopus spp.*
2. *Mucor spp.*
3. *Absidia spp.*
4. *Syncephalastrum spp.*

Class Deuteromycetes (Fungi imperfecti)

1. *Pennicillium* spp.
2. *Paecilomyces* spp.
3. *Scopulariopsis* spp.
4. *Aspergillus* spp.
5. *Fusarium* spp.
6. *Alternaria* spp.
7. *Helminthosporium* spp. (*Drechslera* spp.)
8. *Hormodendrum* spp. (*Cladosporium* spp.)
9. *Pullularia pullulans* (*Aureobasidium* spp.)

Rhizopus spp.

Class Zygomycete; Order Mucorales



Colony :- Very fast growing, quickly filling the plate with a dense, cottony, aerial mycelium, at first white, later becoming gray. Reverse is colorless or pale.



Rhizopus spp.



Colony: growth is rapid, dense, cottony, gray, fills tube. Reverse is colorless or pale.



***Rhizopus* spp.**

Microscopic :- Mycelium aseptate, with many stolons (hyphal branch) connecting groups of unbranched sporangiophores. At the point of connection, a cluster of rhizoids (rootlike hyphae) are attached to the substrate. The sporangiophores terminate with a dark-brown or black, spherical sporangium containing a columella. Spores oval, bluish or brown. Zygosporoes formed with compatible strain. Usually *R.oryzae* or *R.arrhizus* are the pathogenic species.

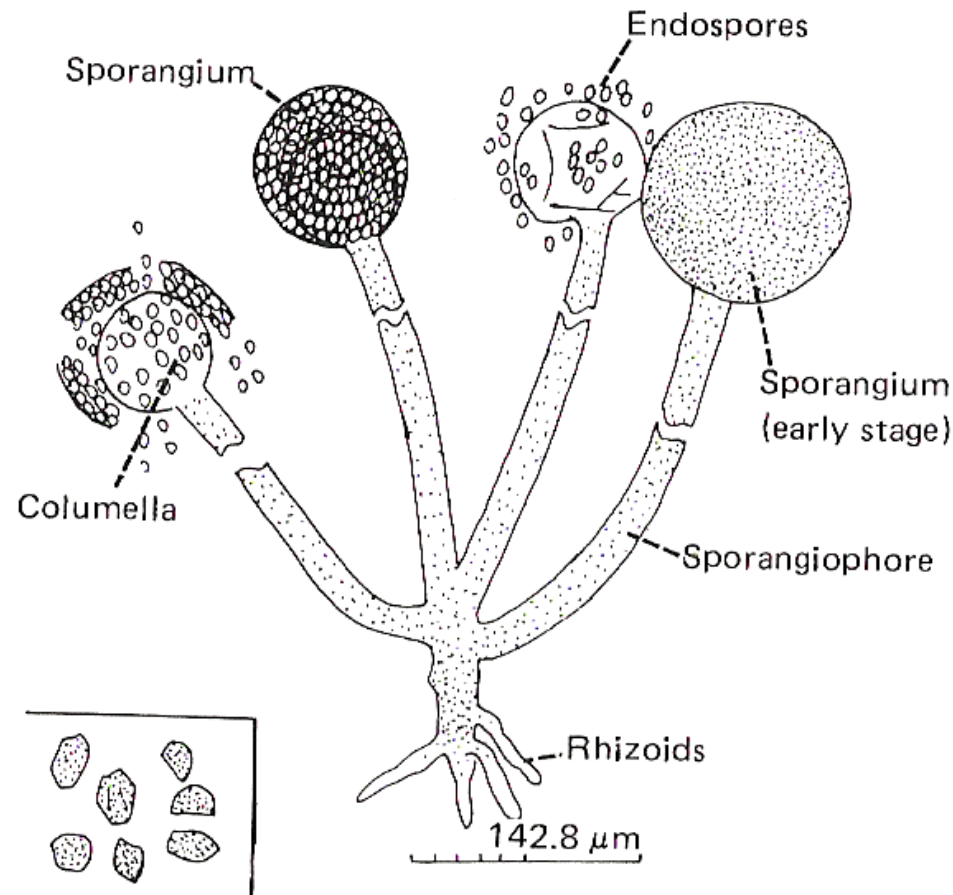
Microscopic

- Aseptate hypha
- Sporangium
- Endospore
- Sporangiphore
- Stolon
- Rhizoid

Pathogenicity :

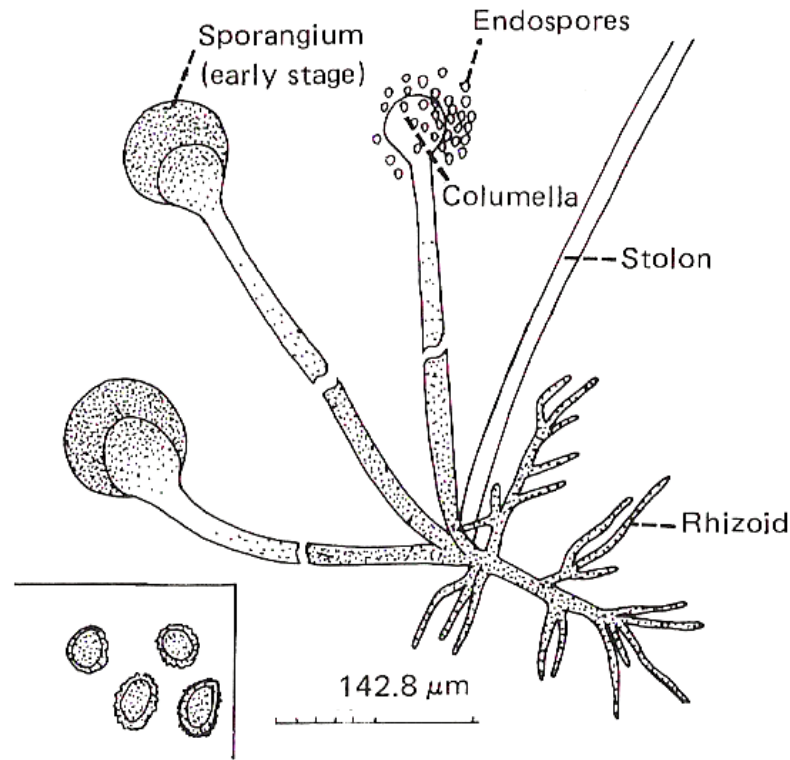
Mucormycosis (Zygomycosis), most frequently cause by *R. arrhizus*, *R. oryzae*, *R. rhizopodiformis* have recently been implicated (Bottone et.al.)

Rhizopus arrhizus (Class, Zygomycete;
Order, Mucorales)



Columellae are round and flattened, spore are grayish brown with longitudinal striation, vary in shape. Rhyzoid is pale.

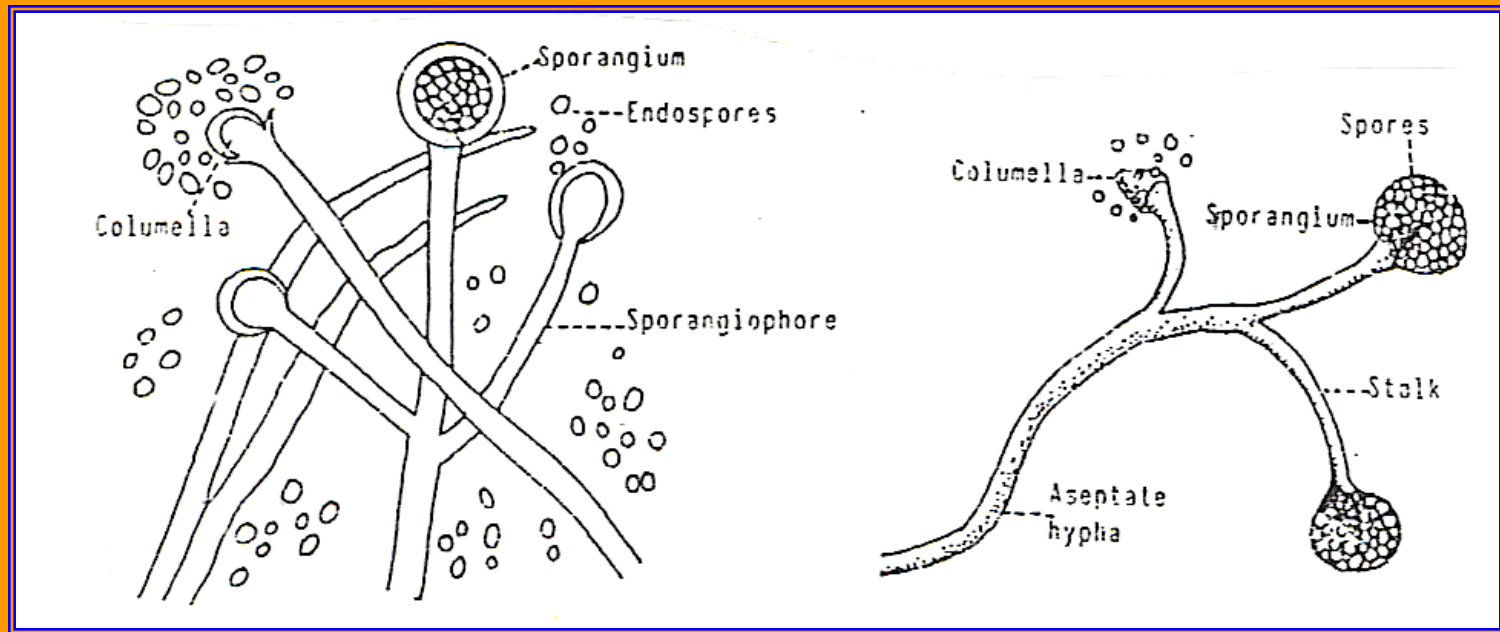
Rhizopus nigricans (Class, zygomycete;
Order, Mucorales)



Columellae are hemispheric, sporangia are hemispheric. Gray tube endospore are unequal in size and shape. Rhizoid are well develop and deep yellow or brown.
Pathogenicity : common mold, not pathogenic

Mucor spp.

Class Zygomycetes; Order Mucorales



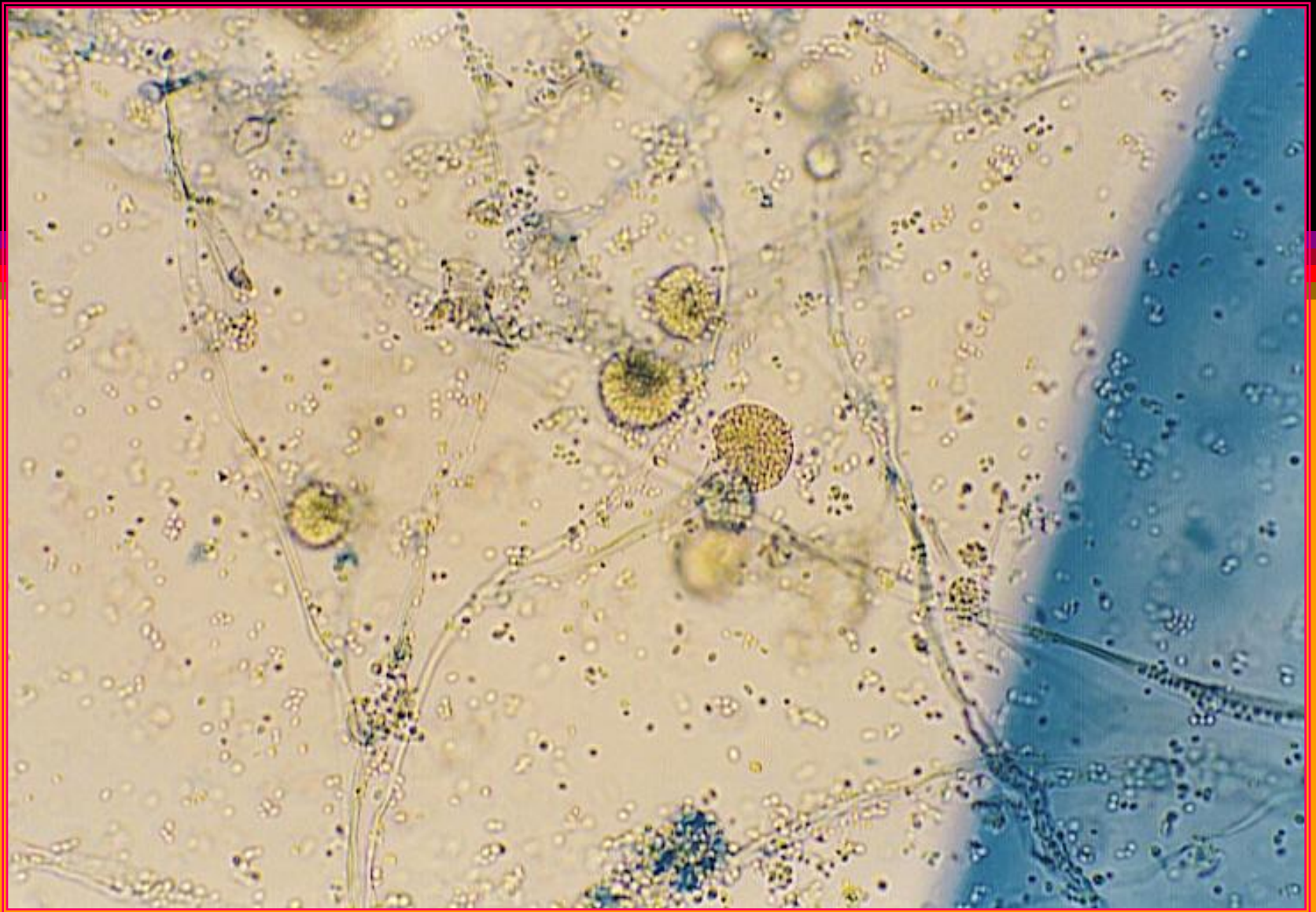
Colony :- Very fast growing, quickly filling a petri plate with cottony, aerial mycelium, at first white, later becoming dark gray, brown or yellow.



Colony : growth is rapid, dense, cottony, tan to gray. Fills tube or plate. Mature sporangia may be seen with the naked eyes.



Mucor spp.



Mucor spp.

Microscopic :-

Mycelium aseptate, forming many upright, single or branched sporangiophore, the tip of the sporangiophore bears a globose sporangium with the wall readily breaking off leaving a collar like base around the central columella. Spherical to elliptical spores are found between the sporangial wall and the columella. No rhizoids at the base of the sporangiophore. Some species are pathogenic.

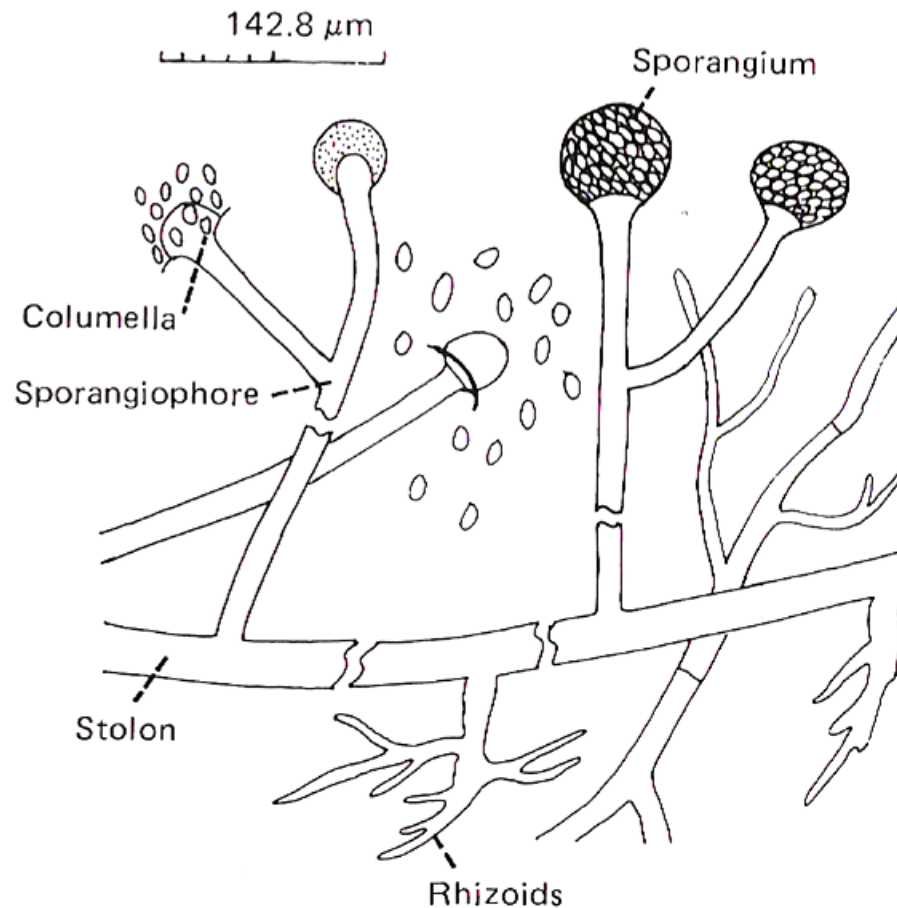
Microscopic : - Aseptate hypha

- Sporangiphore are branched
 - Sporangia
 - Endospore are round
 - Columella
 - Lacking rhizoid
 - Chlamydospores are often present

Pathogenicity : Mucormycosis (Zygomycosis, Phycomycosis)

***Absidia* spp.**

Class Zygomycetes; Order Mucorales



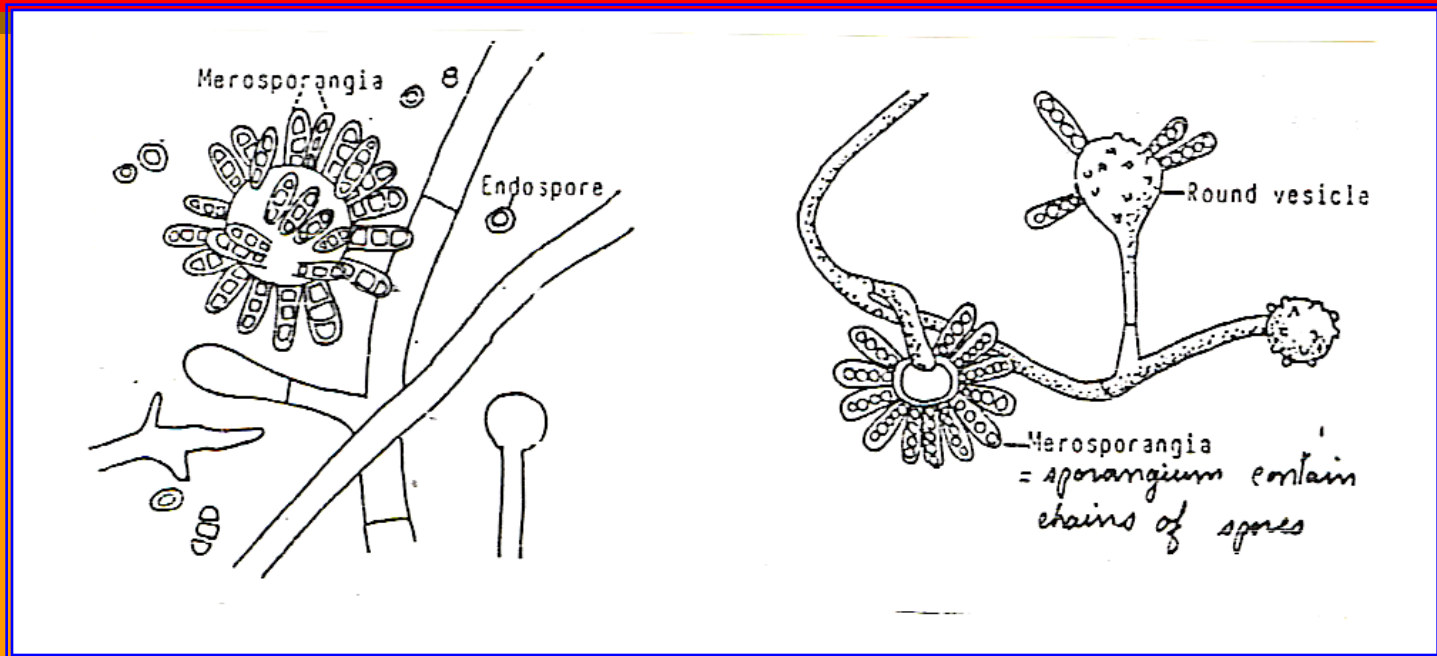
Colony : rapidly growing mold, fills tube or plate in one week, coarse, gray or brown, and woolly.

Microscopic : sporangiophores usually occur in groups of 2-5, rising from stolons at points away from rhizoid formation. Sporangia are pyriform (pear shaped). Spore are usually smooth walled and round or oval.

Pathogenicity : mucormycosis, common mold.

Syncephalastrum spp.

Class Zygomycetes; Order Mucorales



Colony :- Very fast growing, quickly covering the surface of the agar medium with dense, cottony, aerial mycelium which is at first white, then dark gray.



***Syncephalastrum* spp.**

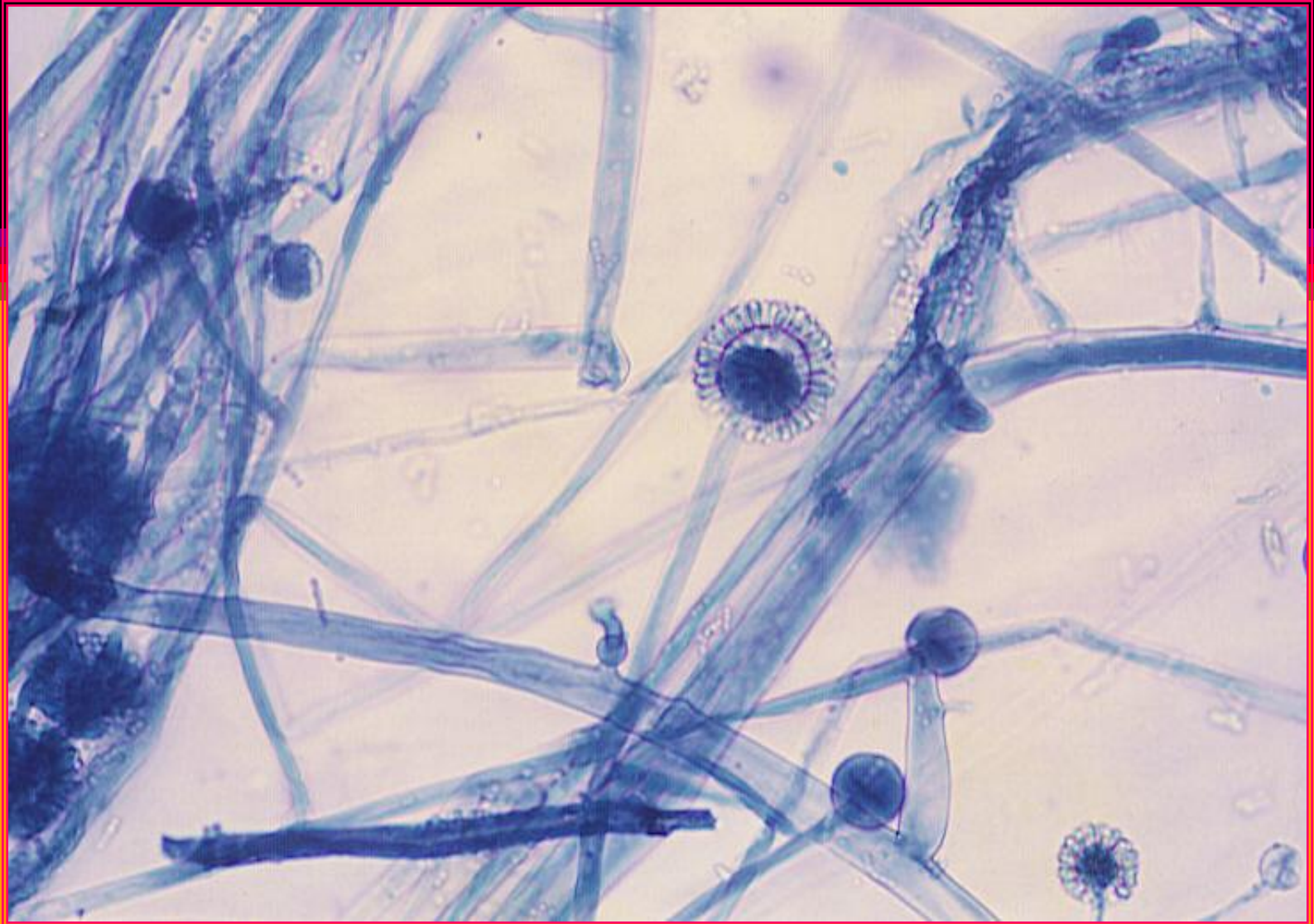


Syncephalastrum spp.

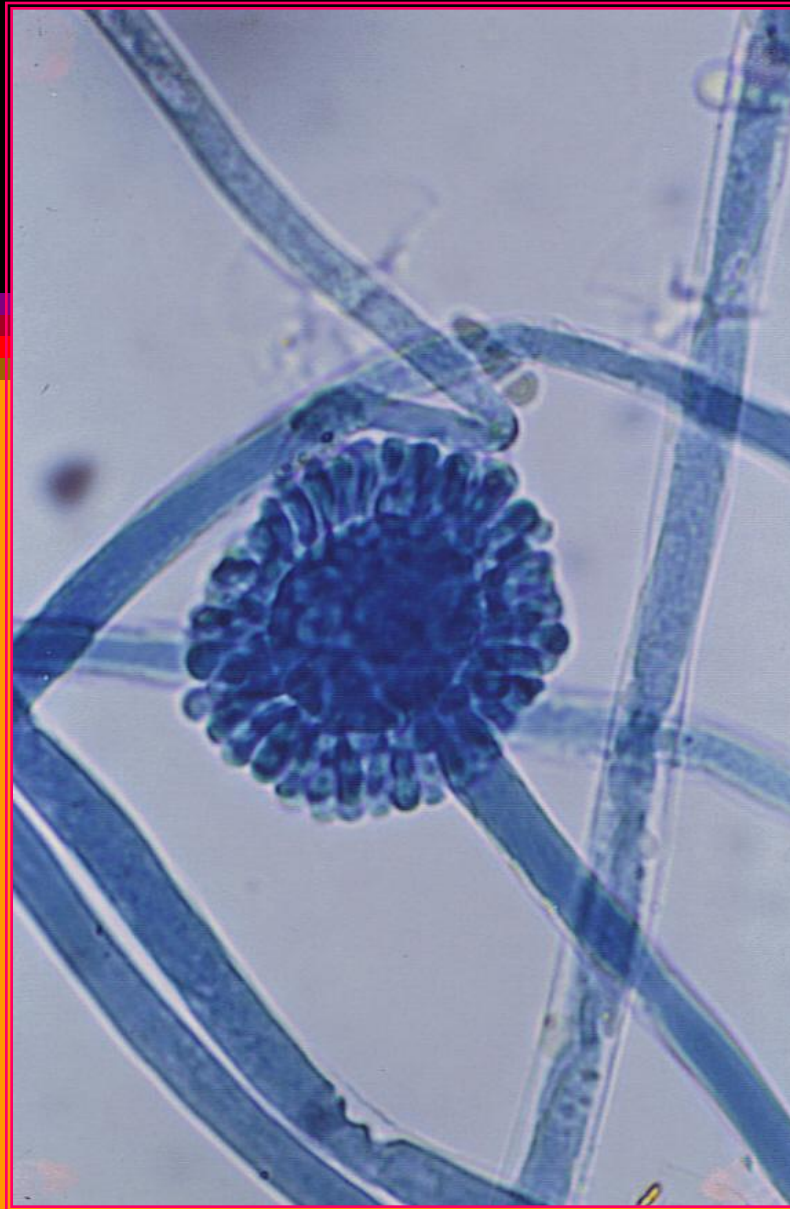
Colony : growth is rapid, cottony, or woolly, gray, fills tube.



***Syncephalastrum* spp.**



***Syncephalastrum* spp.**



***Synccephalastrum* spp.**

Microscopic : Mycelium aseptate, forming short sporangiophore sympodially, and terminated by an enlarged globose vesicle with many tubular sporangia (merosporangia) containing chain spores each sporangium.

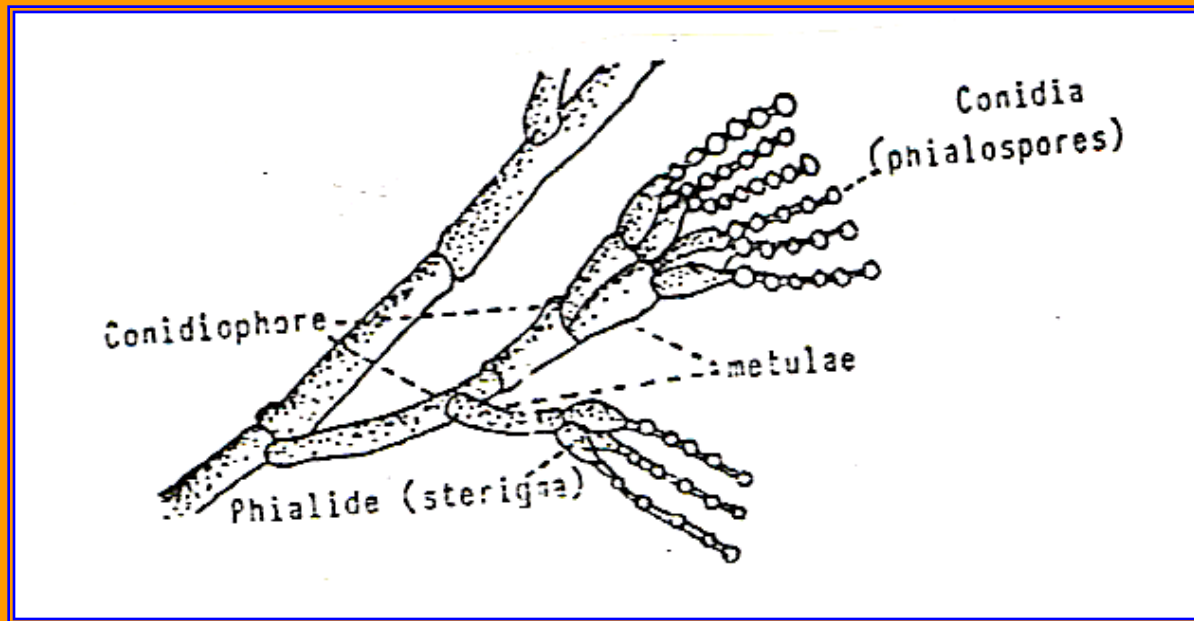
- Aseptate hypha
- Tubular sporangia containing a row of 3-5 to 10-18 round endospores
- Merospore (endospore)

- Round vesicle (swollen vesicle) at the tip of a sporangiophore
- Aseptate hypha, developing simple separation with age
- Rudimentary rhizoid are found

Pathogenicity : common soil isolate, nail invasion.

Penicillium spp.

Class Hyphomycete, Subdivision Ascomycotina;
Class Plectomycete



Colony :- Fast growing, at first white, becoming shades of green, blue-green, or other colours after conidia mature. Surface velvety to powdery due to abundance of conidia

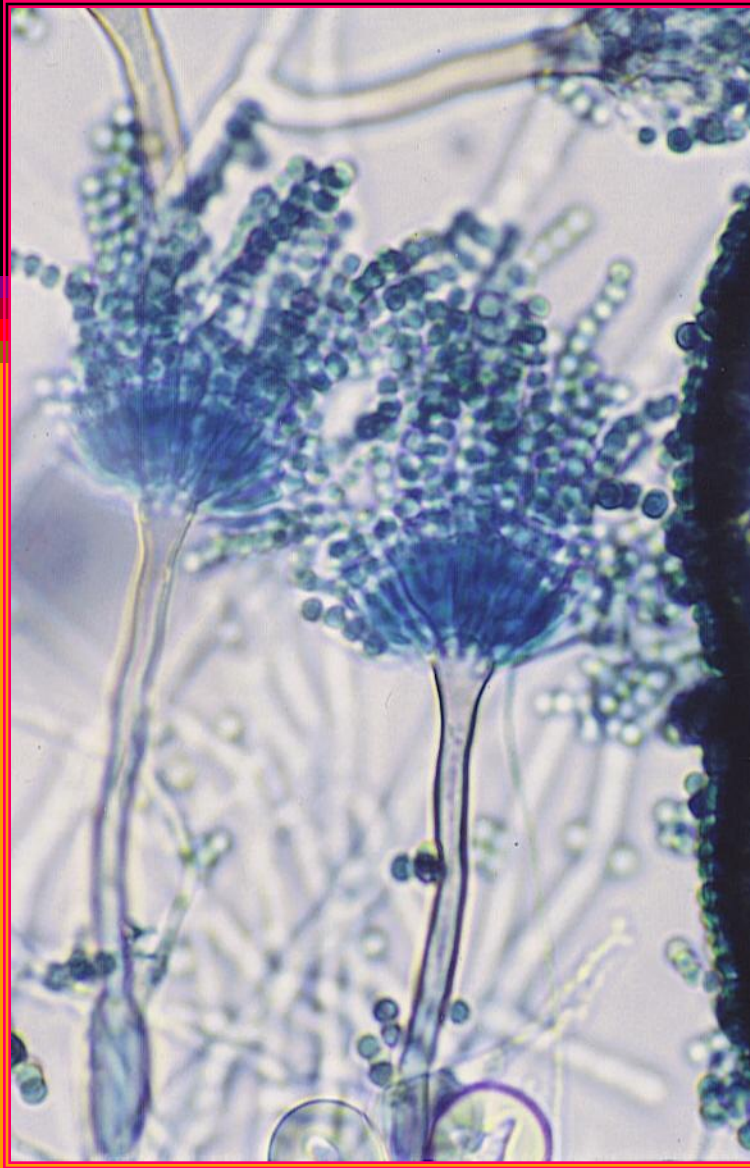


Penicillium spp.:

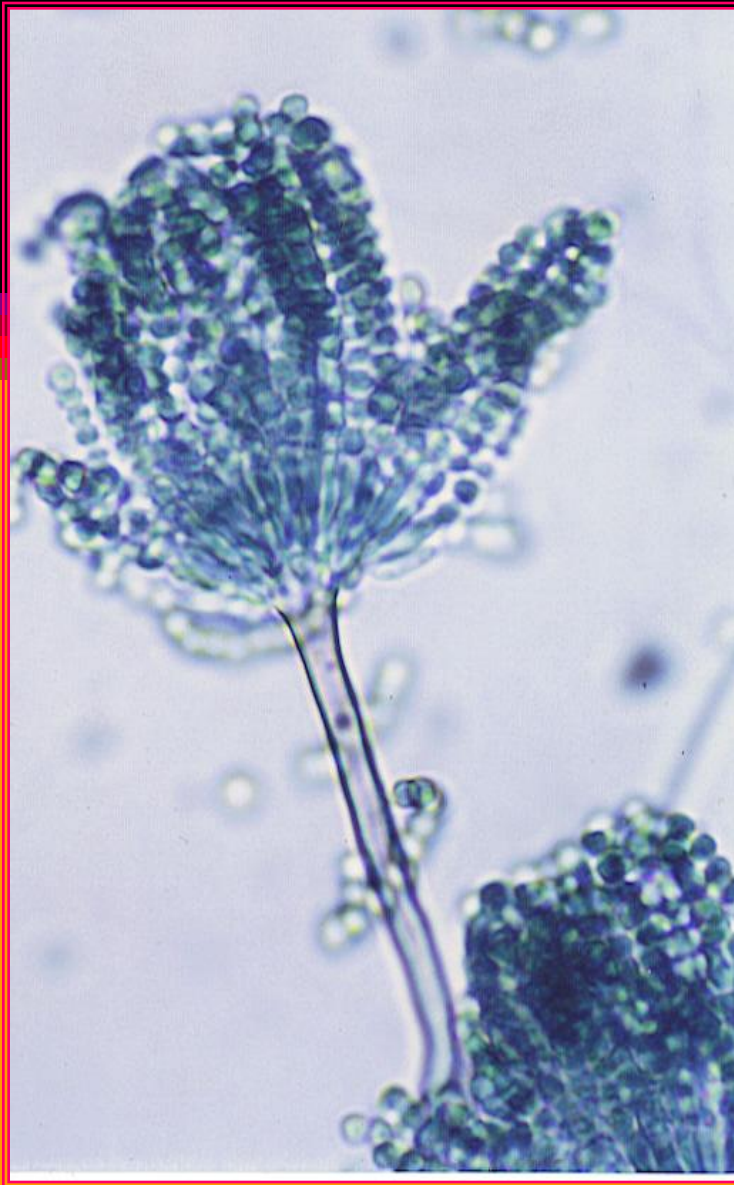
***Penicillium* spp.**

Colony : rapid growing, powdery, flat. Most isolates are bluish-green, becoming grayish-brown with age. Color may vary from white to pink to brown. Reverse may be colorless to deep red or brown.

Microscopic : - Septate hypha
- Conidiophores (Penicillus) are stiff and may be branched or unbranched
- Phialides or sterigma
- Metula (central branch of a conidiophore)
- Phialoconidia (conidia) usually round and may be rough (produced in basipital chains)



Penicillium spp.



Penicillium spp.



***Penicillium* spp.**

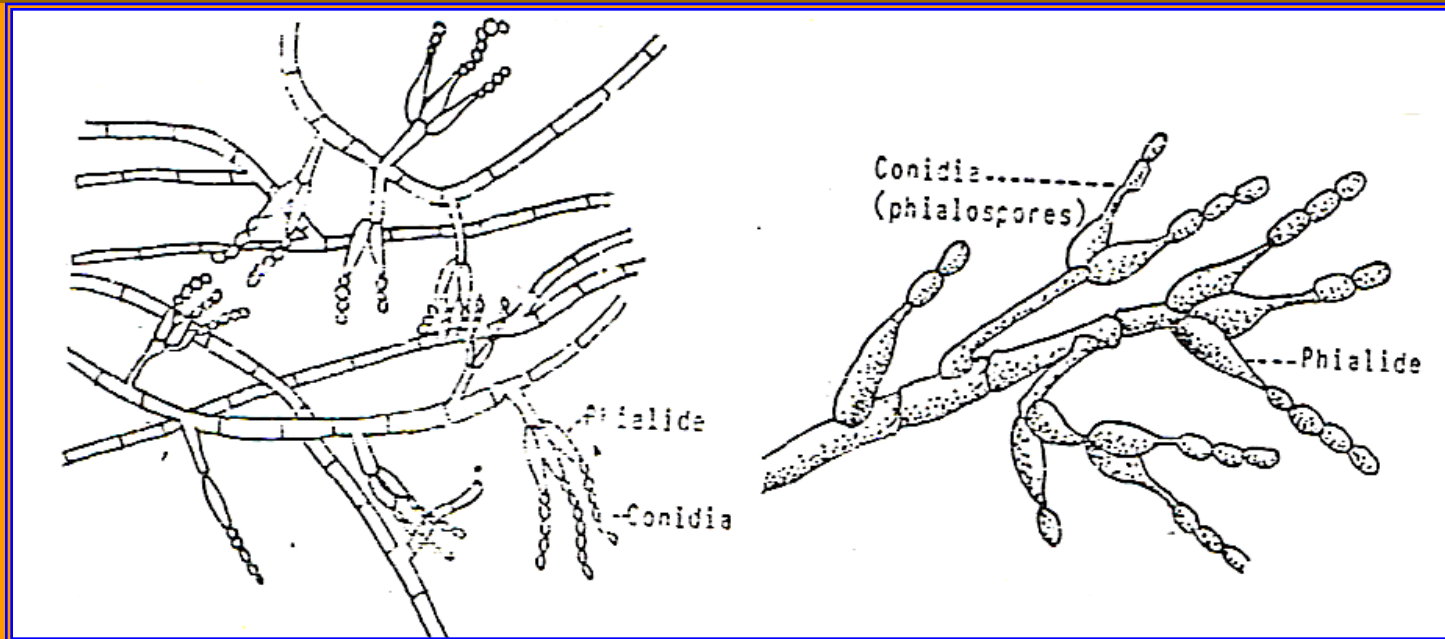
Microscopic : Brushlike conidiophores or “penicillus” developed from septate hyphae chains of conidia, one-celled, globose to elliptical, smooth or rough, cut off from flask-shape phialid (sterigmata). Spores separated on the basis of variation in branches (matulae) of the conidiophores, conidia and colonial characteristic. Occasionally pathogenic.

Pathogenicity : Laboratory contaminant, cause farmer's lung, cause penicilliosis, toxin producers

Inhibitory quality : Inhibitors of microorganism, antibiotic (penicillin), antifungal (griseofulvin)

***Paecilomyces* spp.**

(*Acremonium* spp., *Spicaria* spp., Class Hyphomycete)



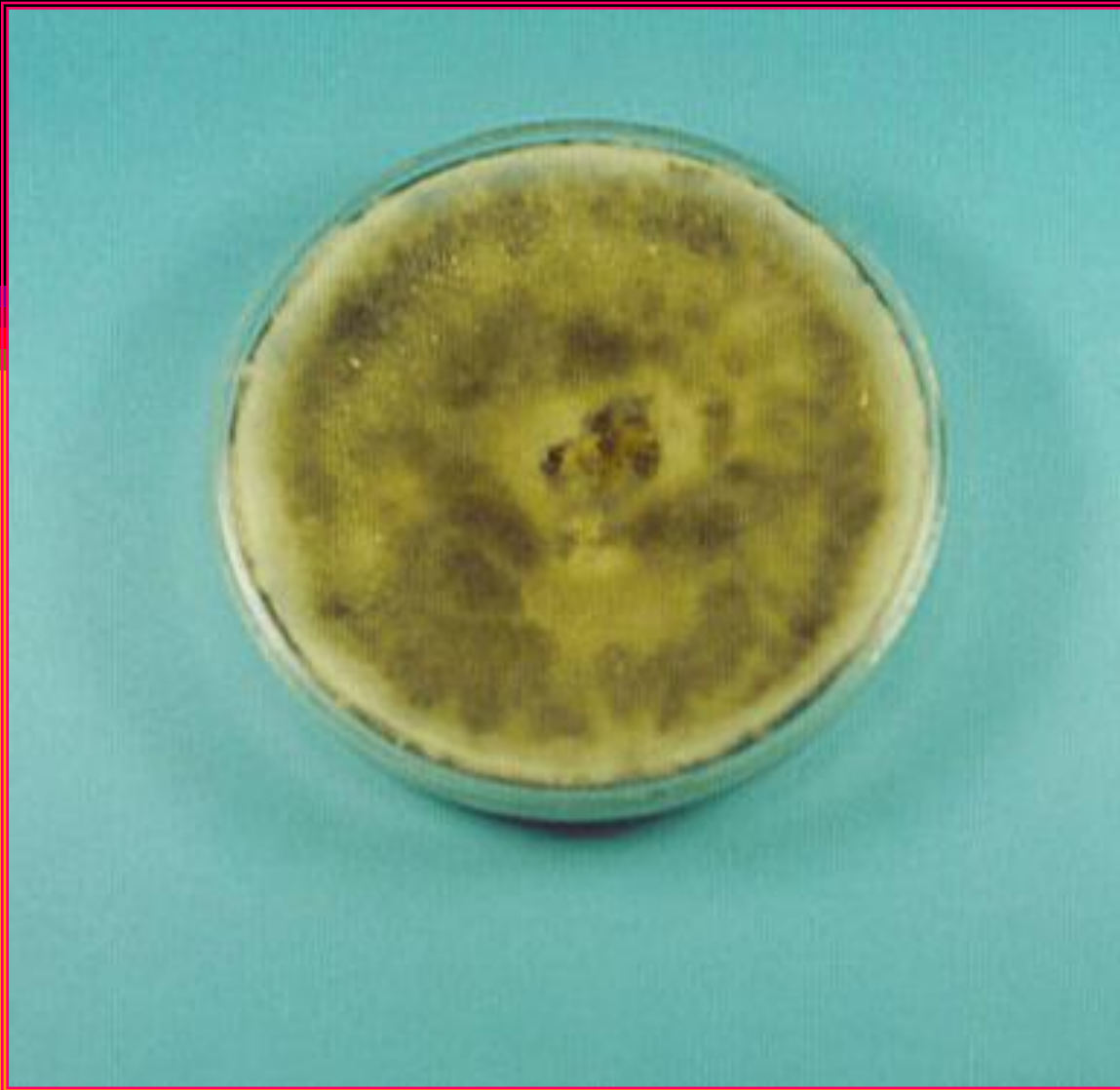
Colony :- Rather rapid growing, thin, spreading, powdery to velvety, becoming yellowish-brown, tan, gray-green. Violet, or white, depending upon species.

Microscopic : - Phialide (sterigma) graceful with bent axis develop in whorles or singly on hyphae

- Lemon shaped phialoconidia (conidia produces basipetally chain)

- Looseness of phialides and phialoconidia (differentiate from *penicillium* spp.)

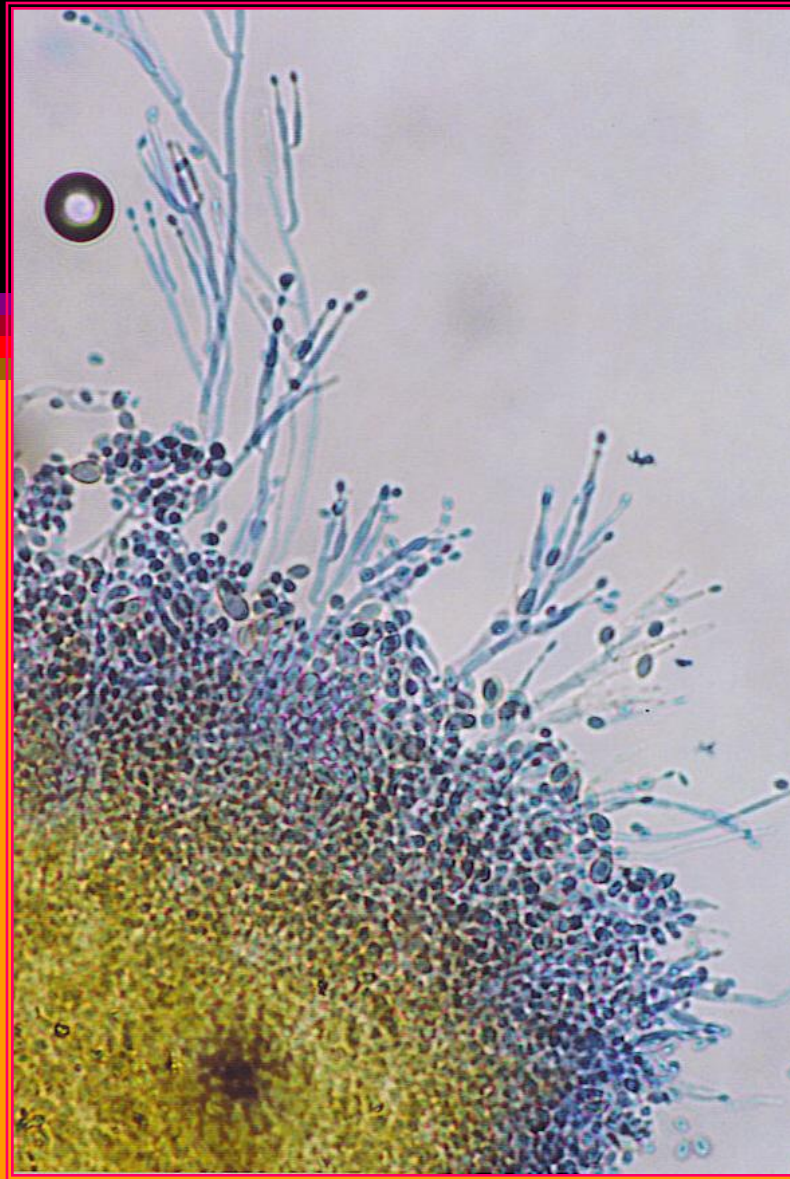
- This genus is similar to *Verticillium* and *Acremonium*



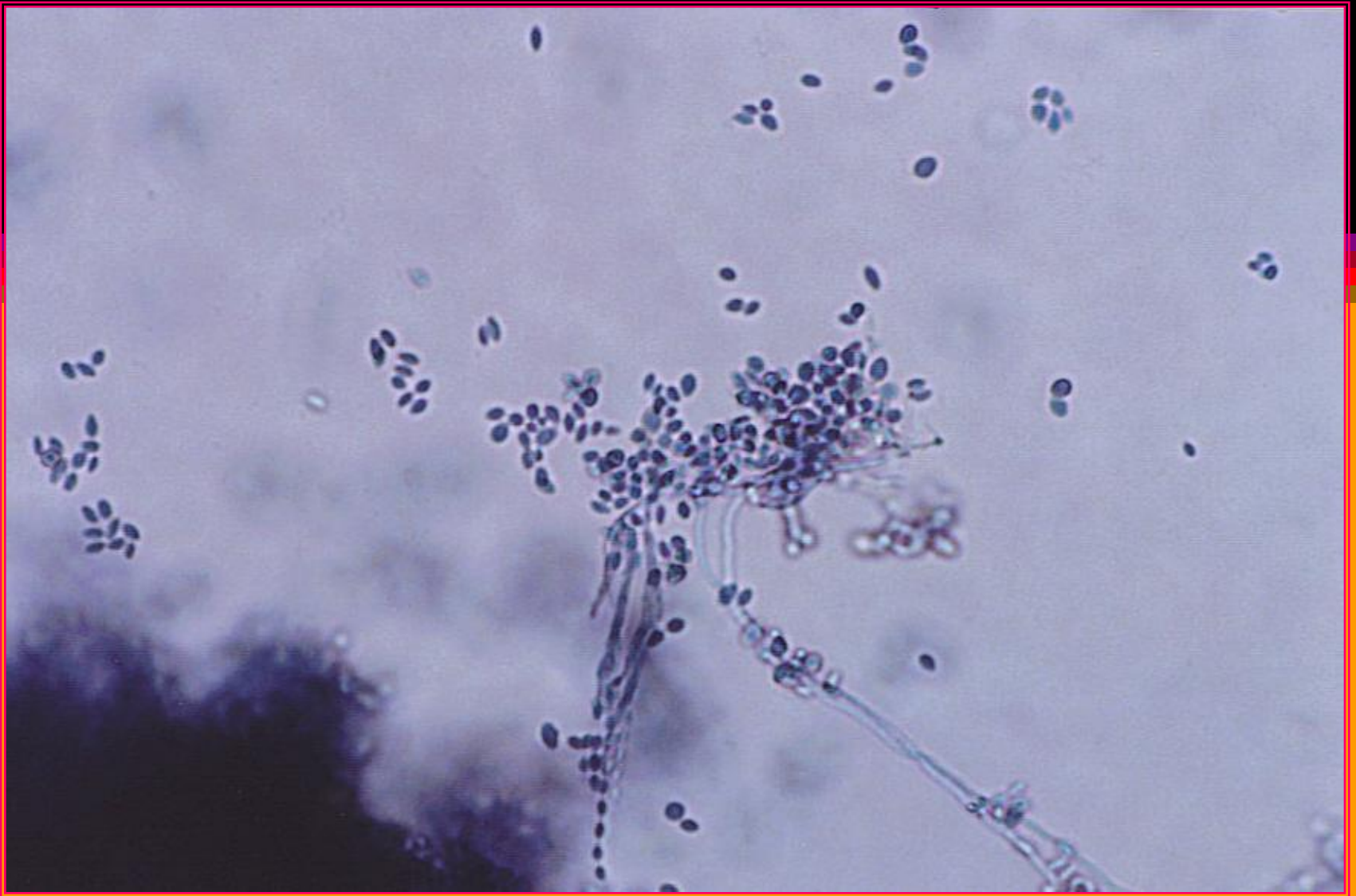
***Paecilomyces* spp.**



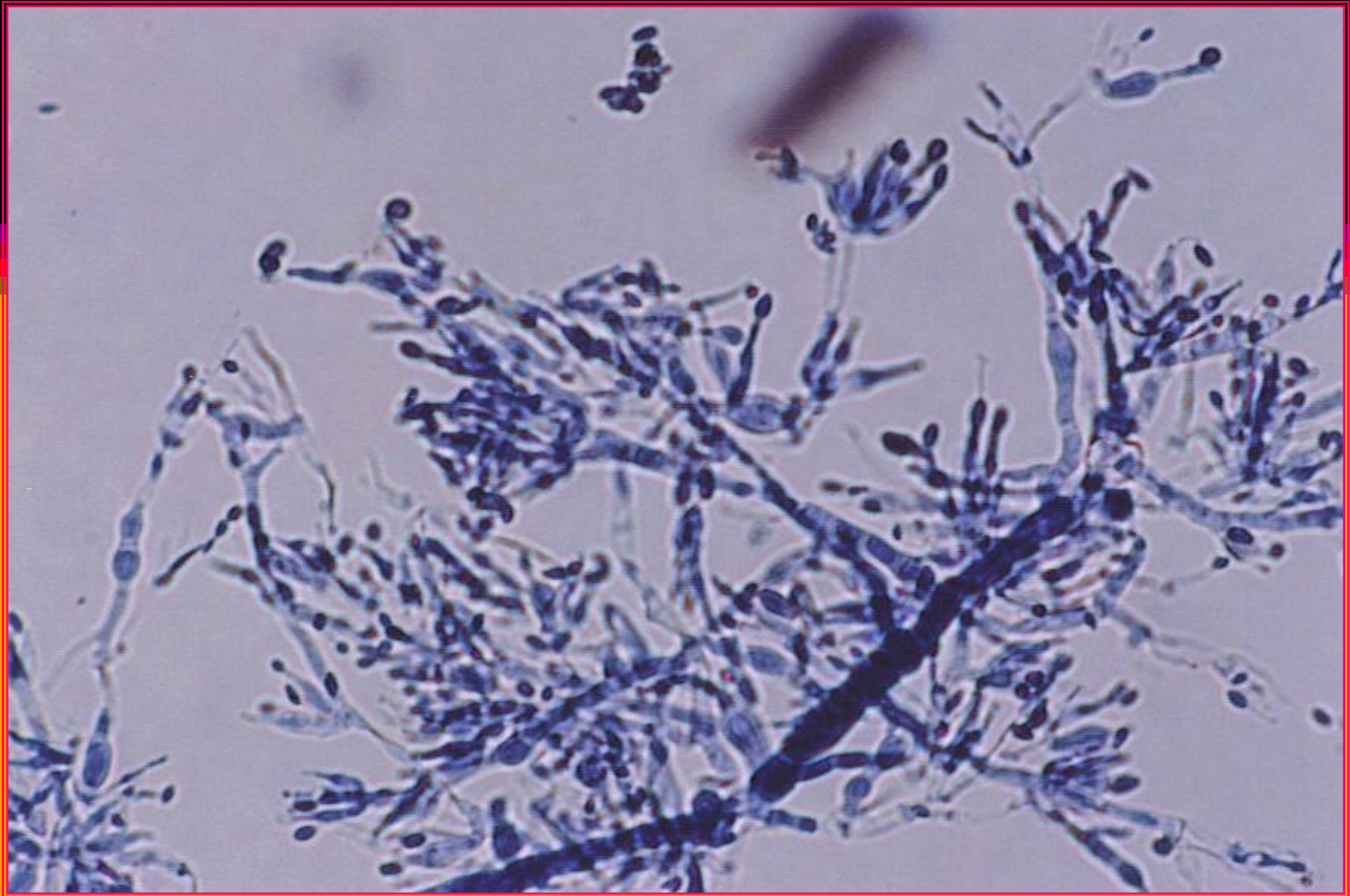
Colony : Greenish brown to grayish brown to pink, powdery to velvety or woolly, rapid, irregular growth (isolate are rarely green or characteristic that help to distinguish those from penicillium spp., which are more generally green)



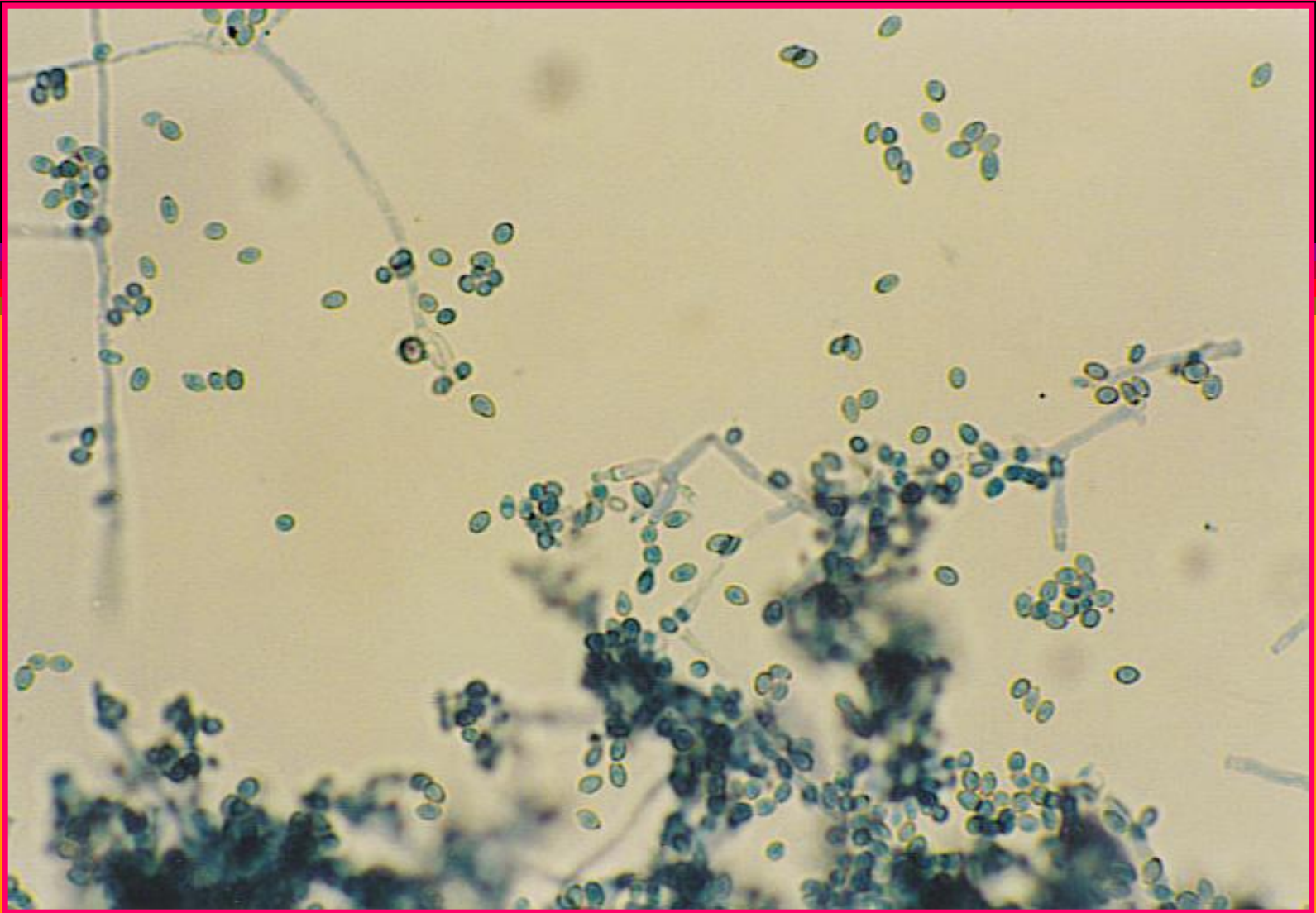
Paecilomyces spp.



***Paecilomyces* spp.**



***Paecilomyces* spp.**



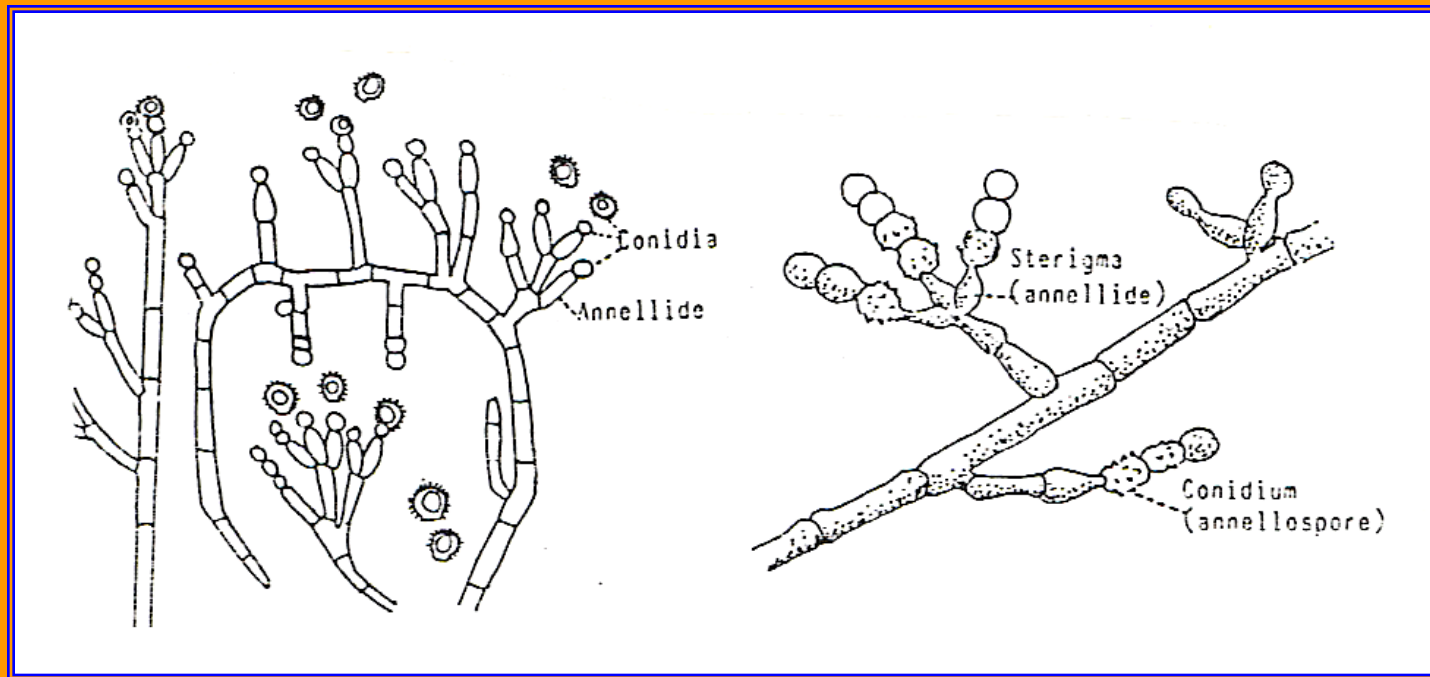
***Paecilomyces* spp.**

Microscopic :- Mycelium septate, with single phialides arising along hyphae with characteristic long, tapering, conidia-bearing tubes. Also “**penicillus**” or Penicillium-like conidiophore with phialides having elongated tips. Conidia (phialospore) in chain, elliptical. Reported in case of endocarditis following cardiac surgery.

Pathogenicity : rare cause of endocarditis, keratomycosis, and pulmonary diseases, laboratory contaminant

Scopulariopsis spp.

Class Hyphomycete



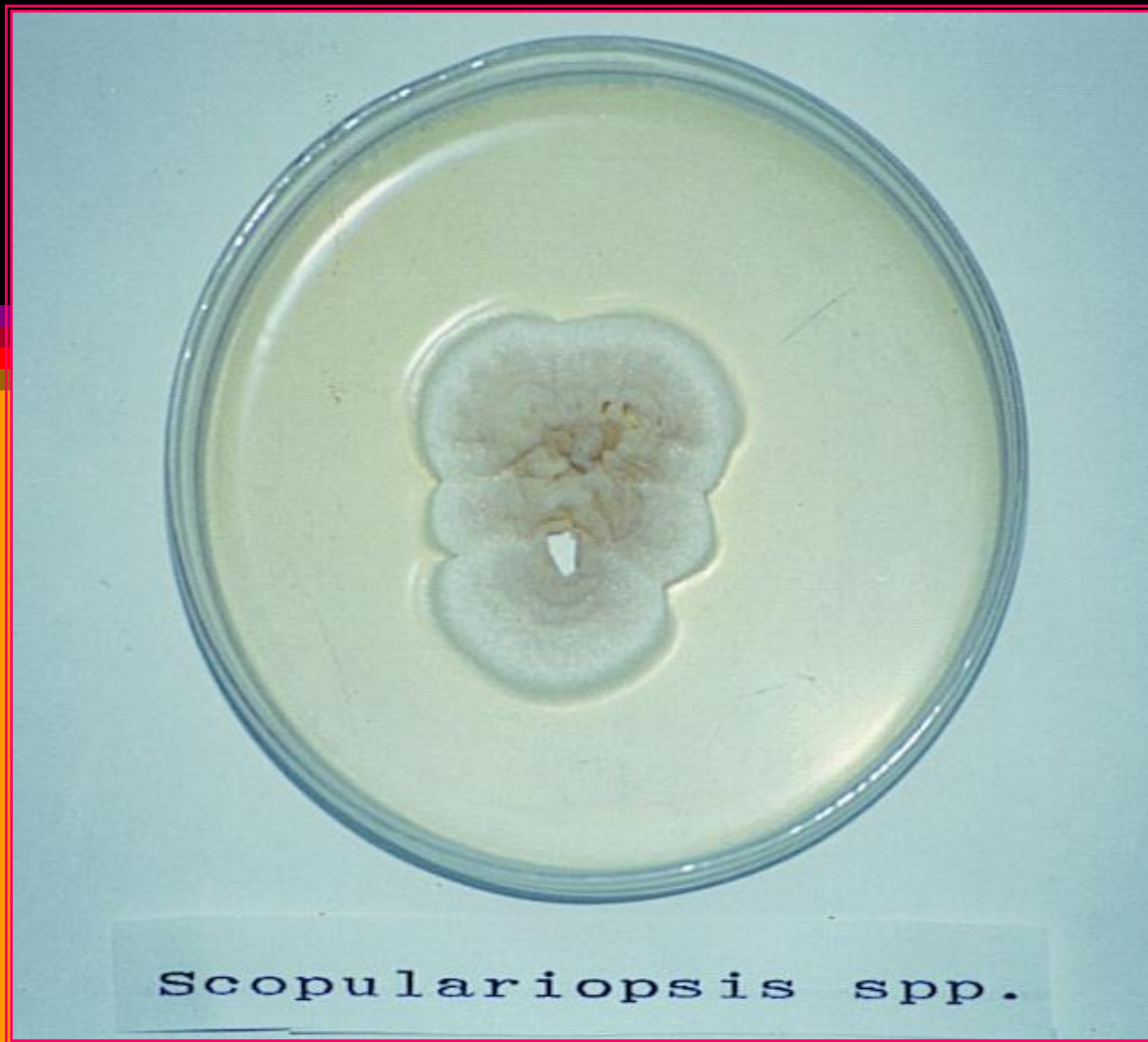
Colony :- Moderately slow growing, white at first, then becoming brown and powdery from heavy sporulation. Color and appearance somewhat like those of *Microsporum gypseum*

Microscopic : - conidia lemon shaped to round,
rough wall released from annellide

- conidiophore may branch similar to
penicillium spp.

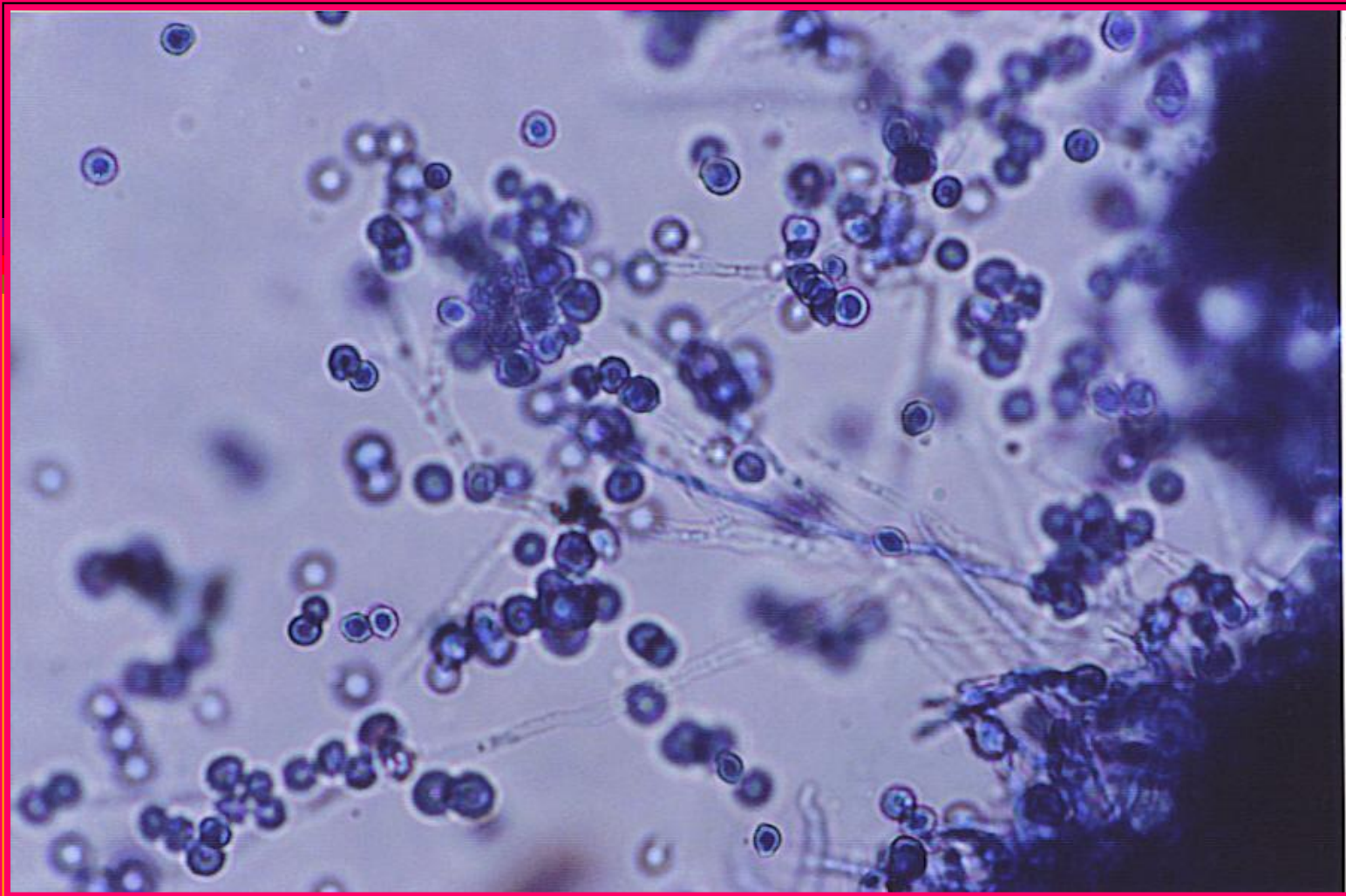
- annellide (sterigma, phialide) =
conidium producing (conidiogeneous) cell,
elongate slightly before the production of each
new conidium, a scarred tip, which is not always
easy to see, remains after the release of each
conidium

- conidia (out basipetally into chain)
break apart easily

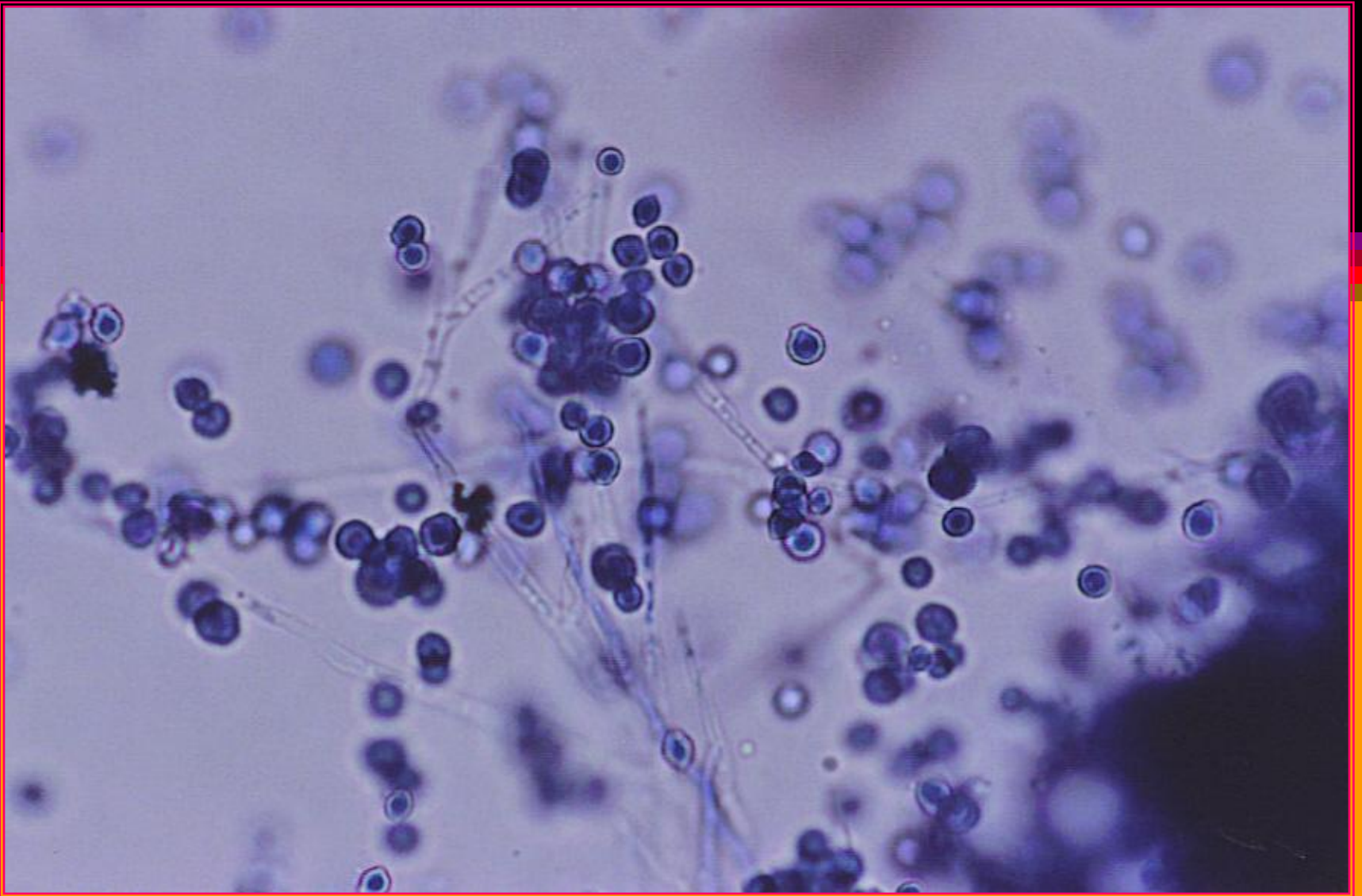


Scopulariopsis spp.

Colony : may start as white, waxy, wrinkled, and spaghetti-like colony, becoming velvety and then powdery, light to tan, or brown, white tufts appear often 2 weeks, colonies are never green



***Scopulariopsis* spp.**



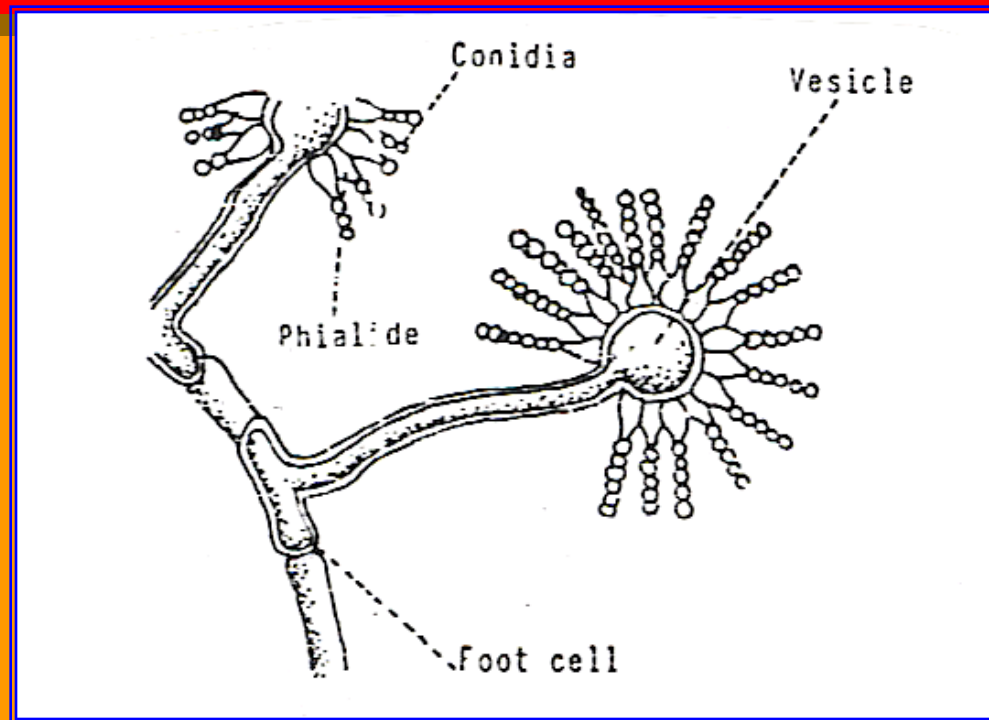
***Scopulariopsis* spp.**

Microscopic :- Mycelium septate with single, unbranched conidiophore or branched “**penicillus**” like conidiophores. Sterigmata (annellides) produce chains of lemon-shaped conidia (annellospores) usually echinulate. Occasionally in nail infection and deep seated granulomatous lesions.

Pathogenicity : onychomycosis, opportunist in keratitis and in otitis, common soil mold

Aspergillus spp.

Class Hyphomycete



Colony :- Slow to rapid growing, white at first, then shades of blue-green, yellow-green, black, tan or white. Surface velvety to cottony. Sometimes with deep red or lavender reverse.

Microscopic :- Mycelium septate, conidiophores long with vesicle like tip, surface containing many flask-shaped phialides and chains of conidia (phialospore) which are one-celled, spherical to elliptical, smooth or rough walled. Some species develop asci and ascospore. *A. fumigatus*, *A. flavus*, *A. terreus*, and *A. niger* are the most likely species encountered in pathologic material.

Pathogenicity : systemic subcutaneous, cutaneous, nail infection, toxin producer, cause of allergic reactions, common in environment, animals and birds are frequently infected.

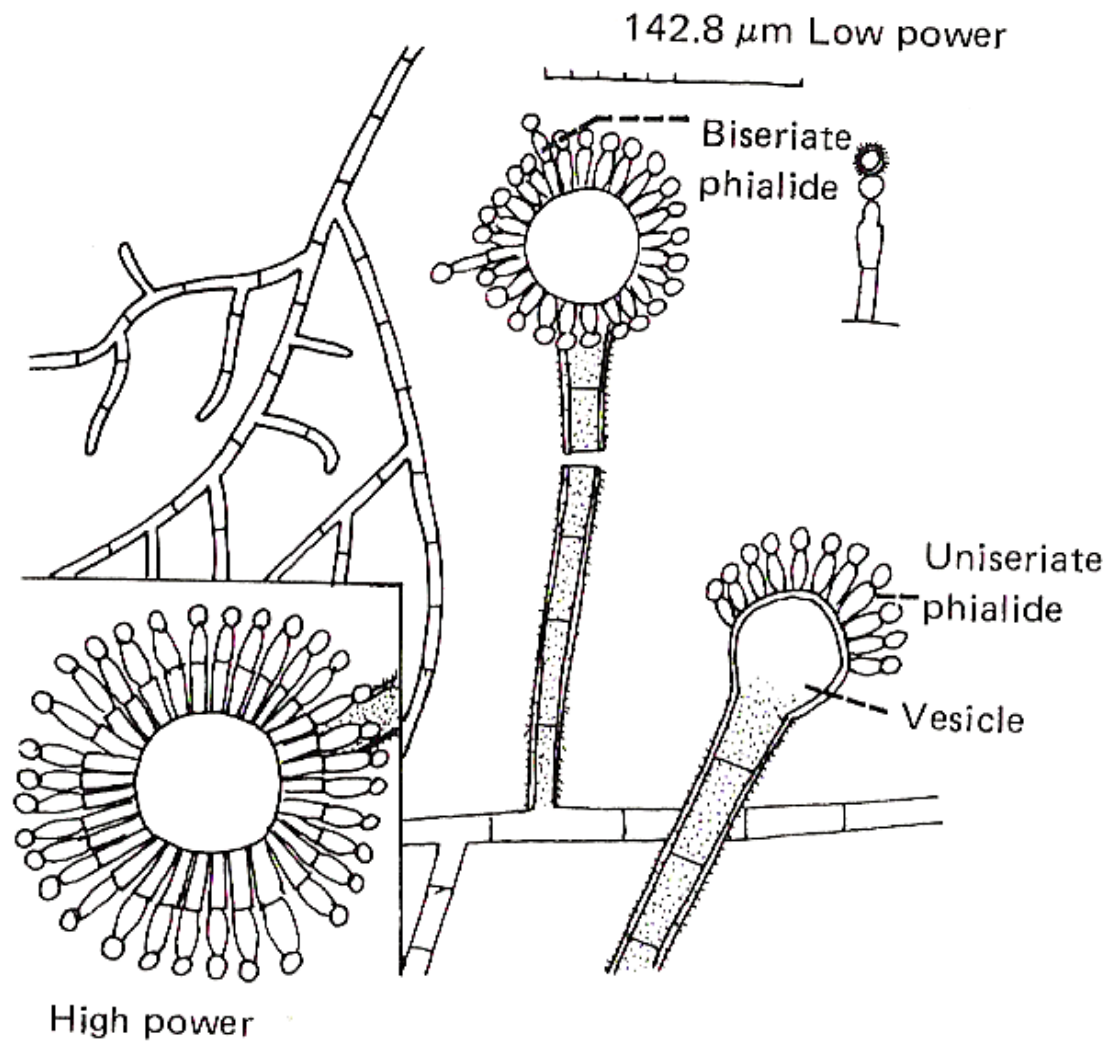
Aspergillus flavus

Colony : rough, woolly texture and greenish yellow color. Surface is bright green to deep yellow green, rough and woolly. Reverse side ranges from colorless to deep red – brown, grow better at 37°C than 25°C

Microscopic : - vesicle mature globose (round) or subglobose (almost round), young vesicle flask shape.
 - conidiophore rough walled
 - phialide (sterigma) biserial (2 rows)

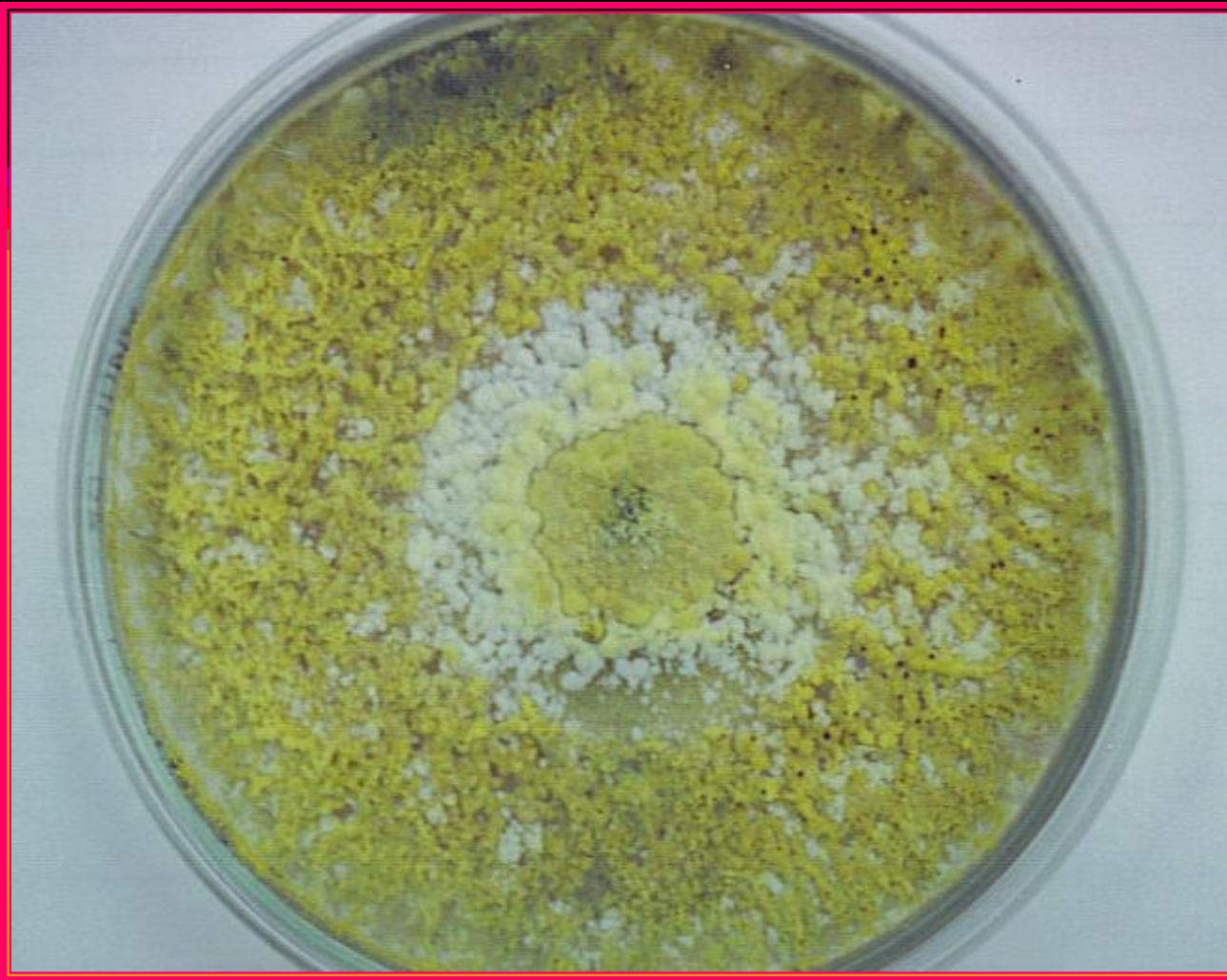
Pathogenicity : major toxin producer (afla toxin), bronchial and pulmonary lesion, skin lesion. Animals are frequently infected.

Aspergillus (flavus group)

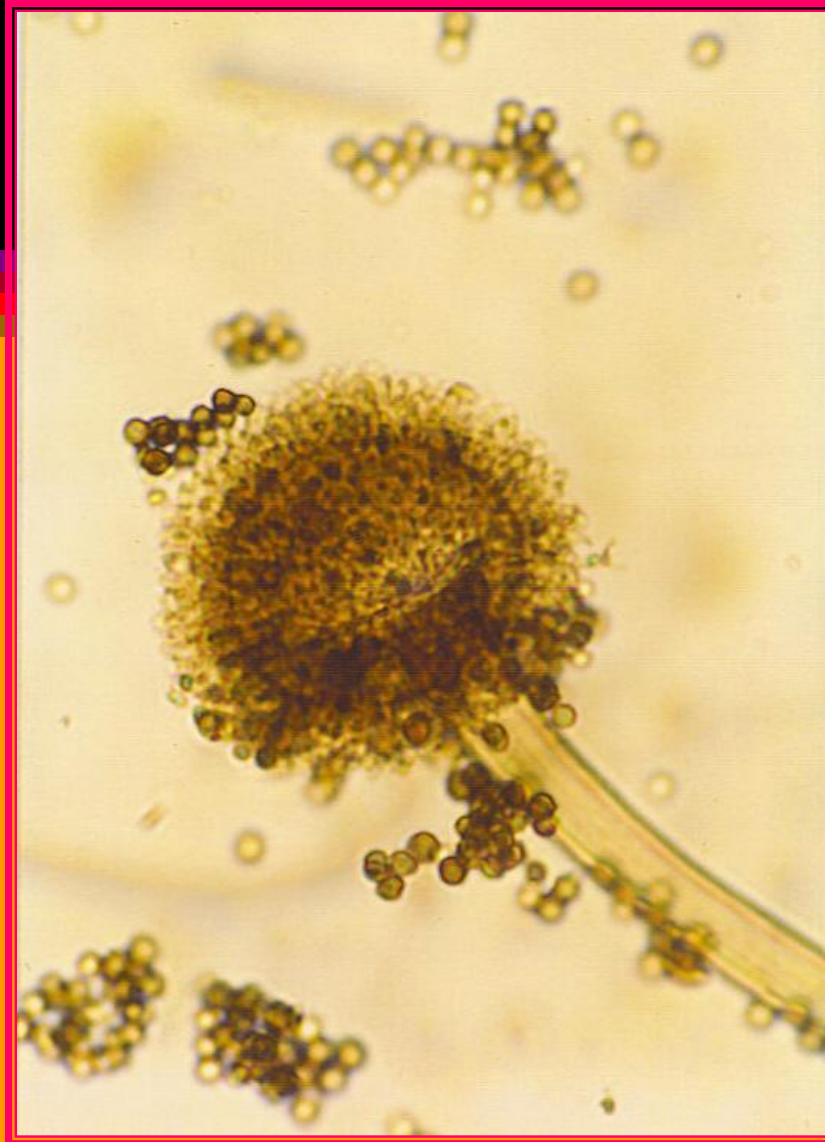


Colony of *Aspergillus flavus*





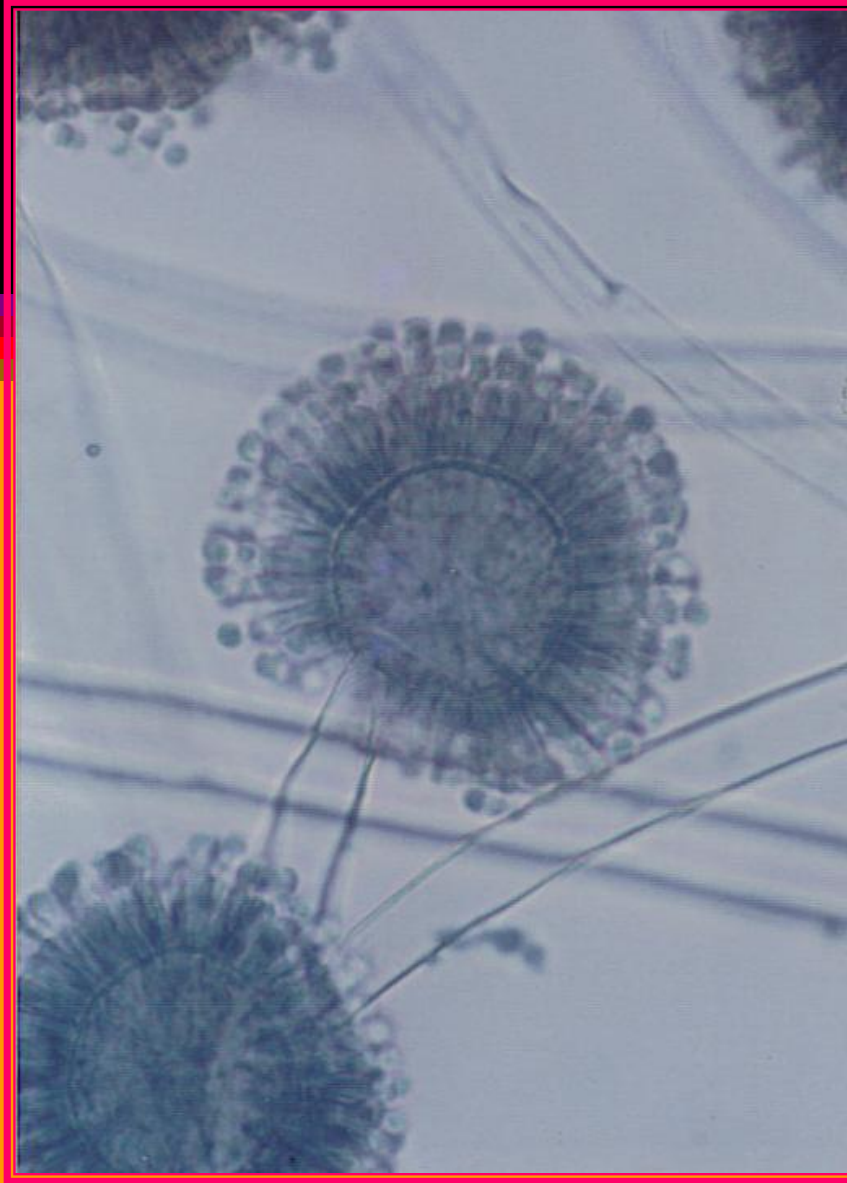
Aspergillus flavus



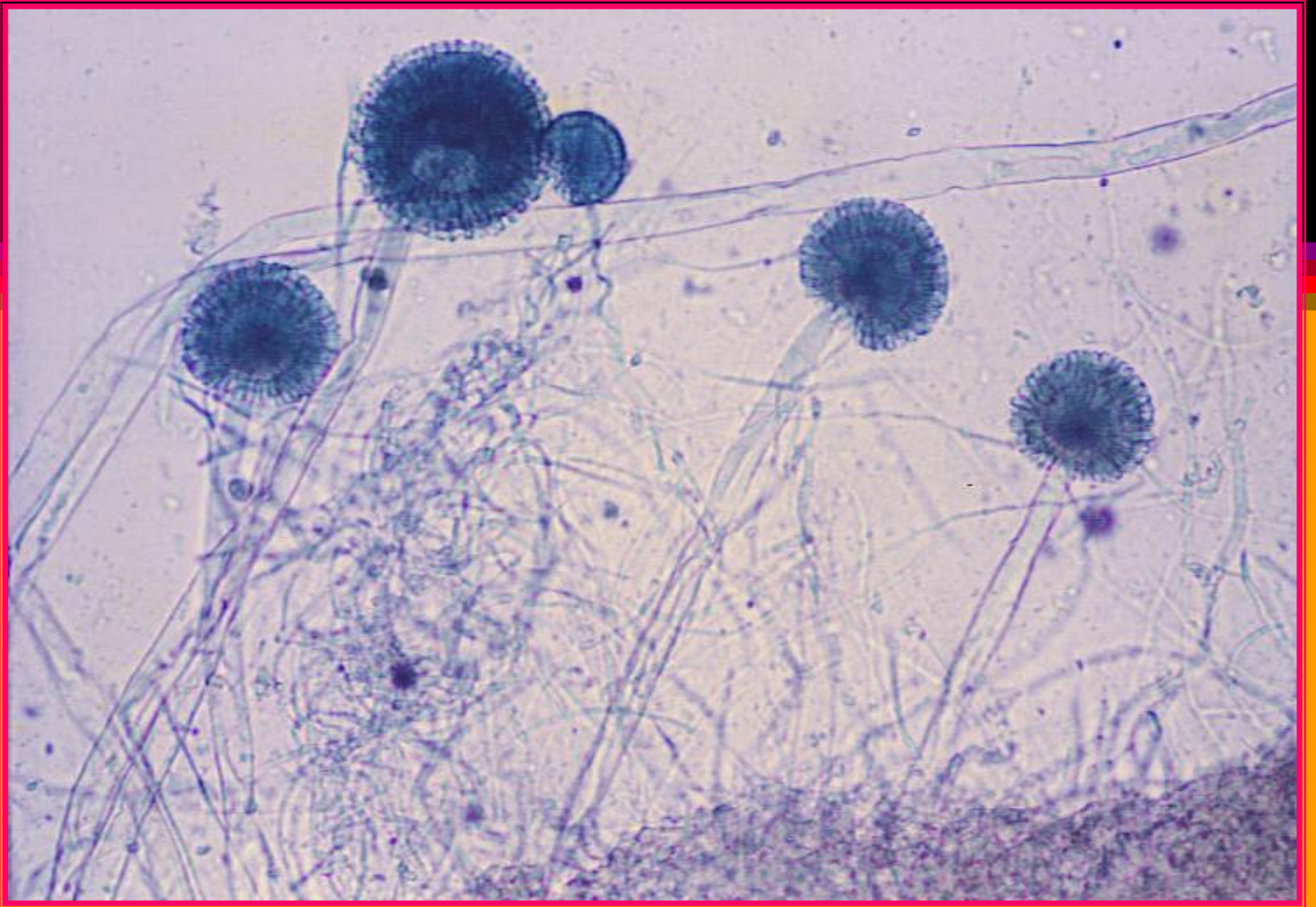
Aspergillus flavus



Aspergillus flavus



Aspergillus flavus



Aspergillus flavus

Aspergillus fumigatus

Colony : early growth in white, becoming blue green to gray, old culture become dark brown to dark gray. Texture is velvety and flat or folded (growth well at 37⁰-40⁰C, in soil, in higher 65⁰C)

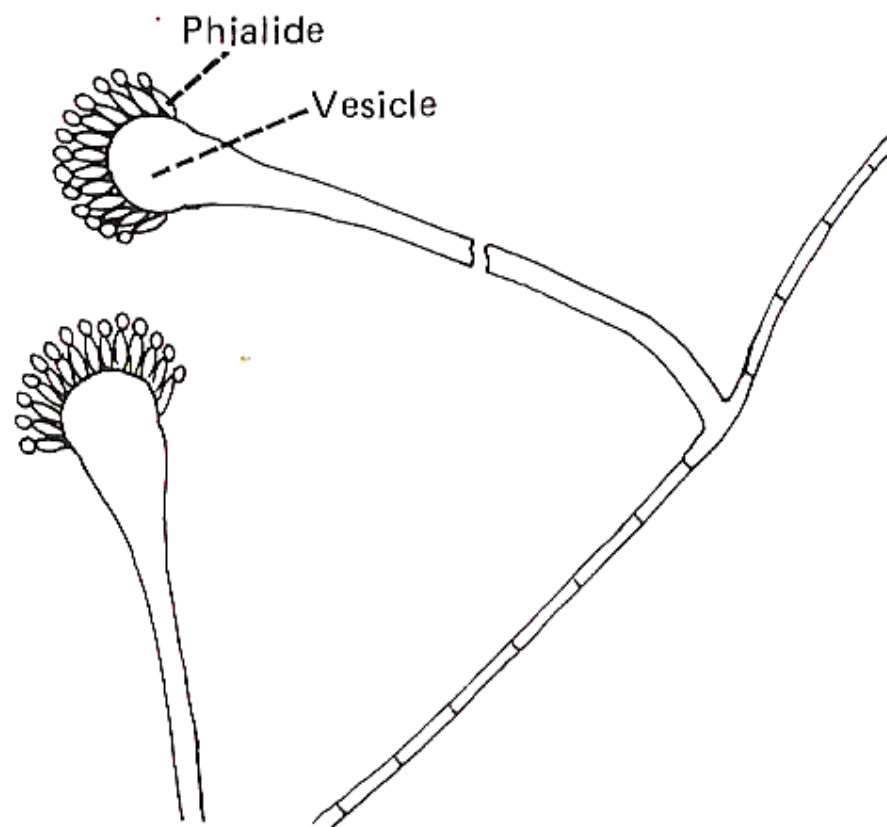
Microscopic : - vesicle flask shape

- phialide (sterigma) uniseriated (one row)
- smooth wall conidiophore

Pathogenicity : major systemic pathogen, cause of pulmonary aspergillosis, ear infection, cause of cutaneous or nail infection (not often), endotoxin are produced by growth on grain.

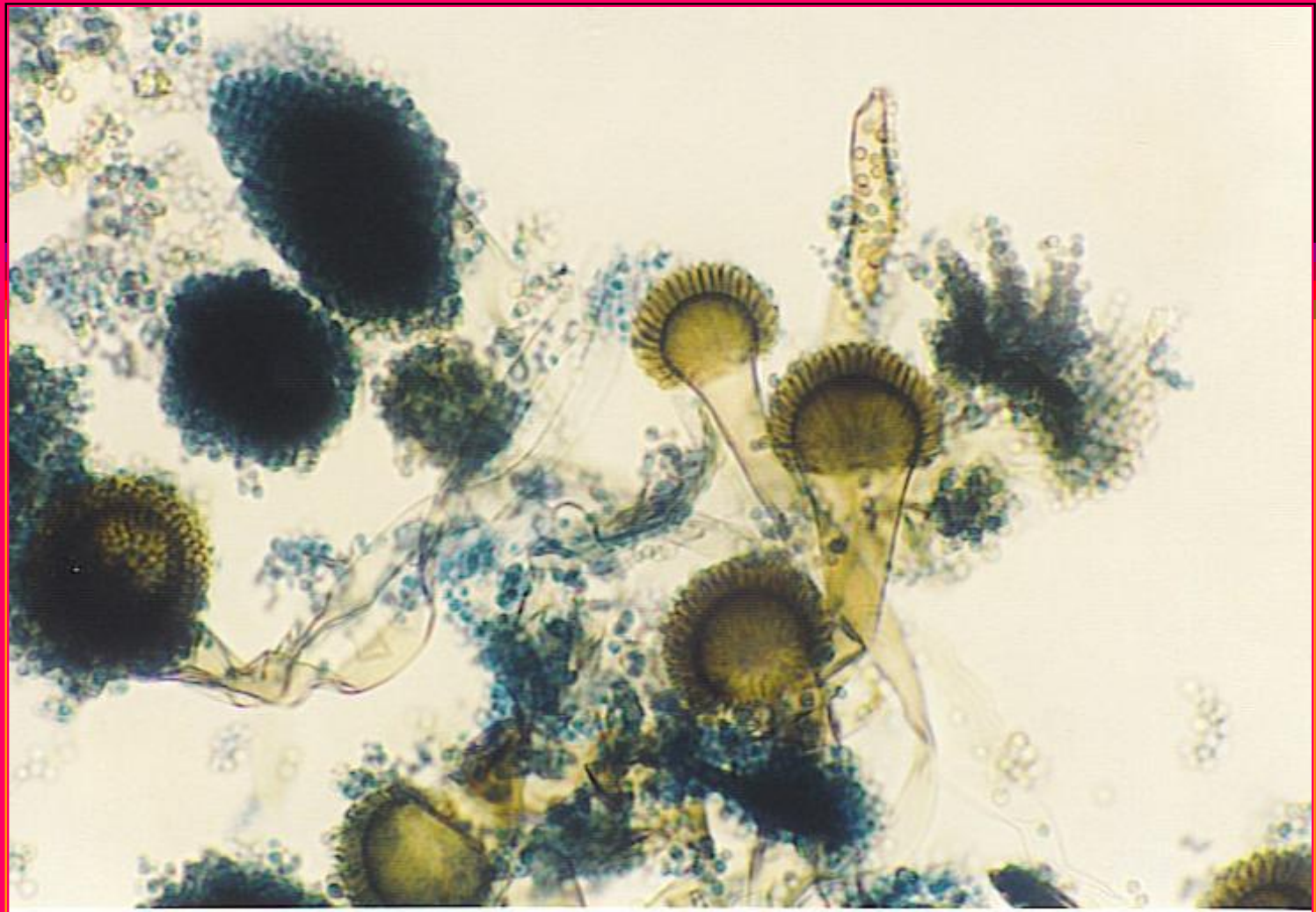
Aspergillus (fumigatus group)

36.2 μm (High power)





Aspergillus fumigatus



Aspergillus fumigatus

Aspergillus terreus

Colony : pale buff to dark brown, velvety folded.

Microscopic : - vesicle is small and hemisphere

- phialide (sterigma) biseriate (2 rows)

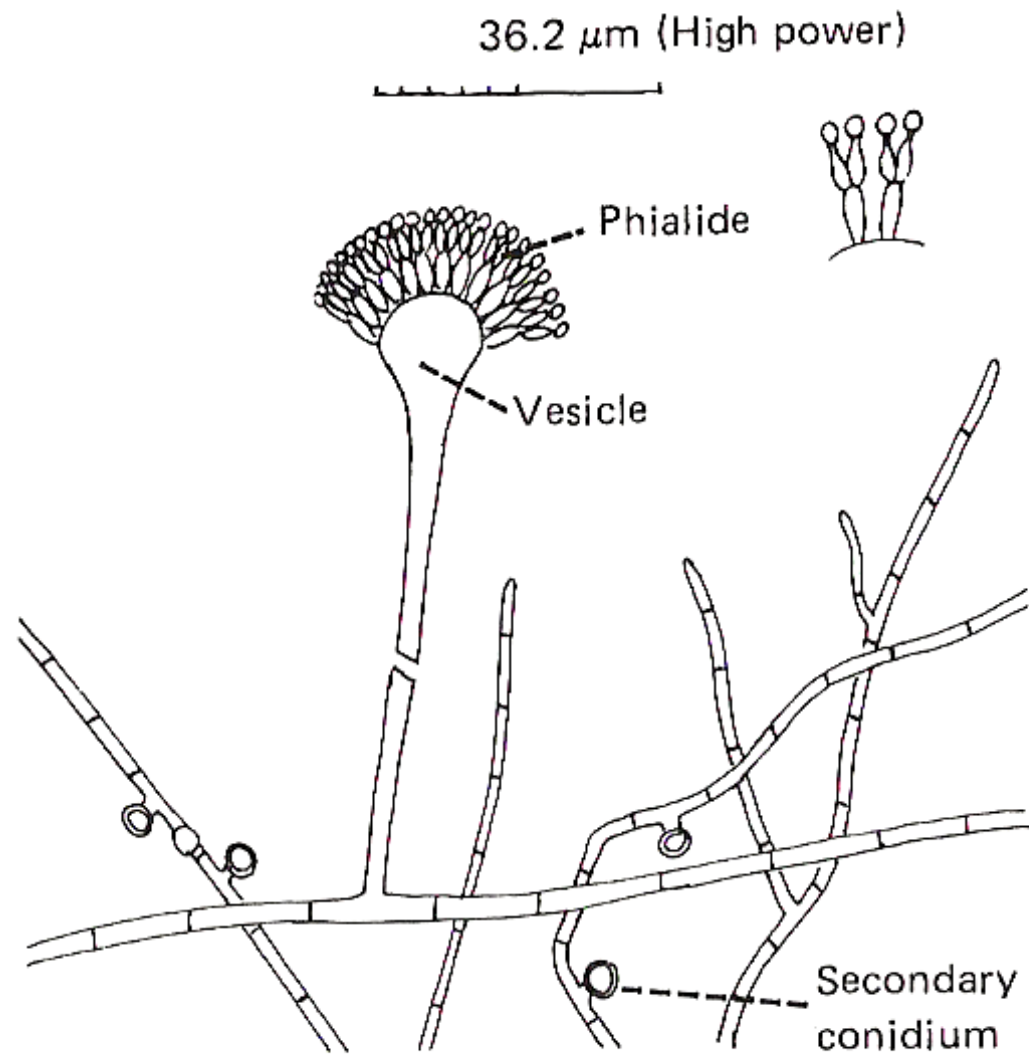
- phialoconidia (conidia) are small, 6-7

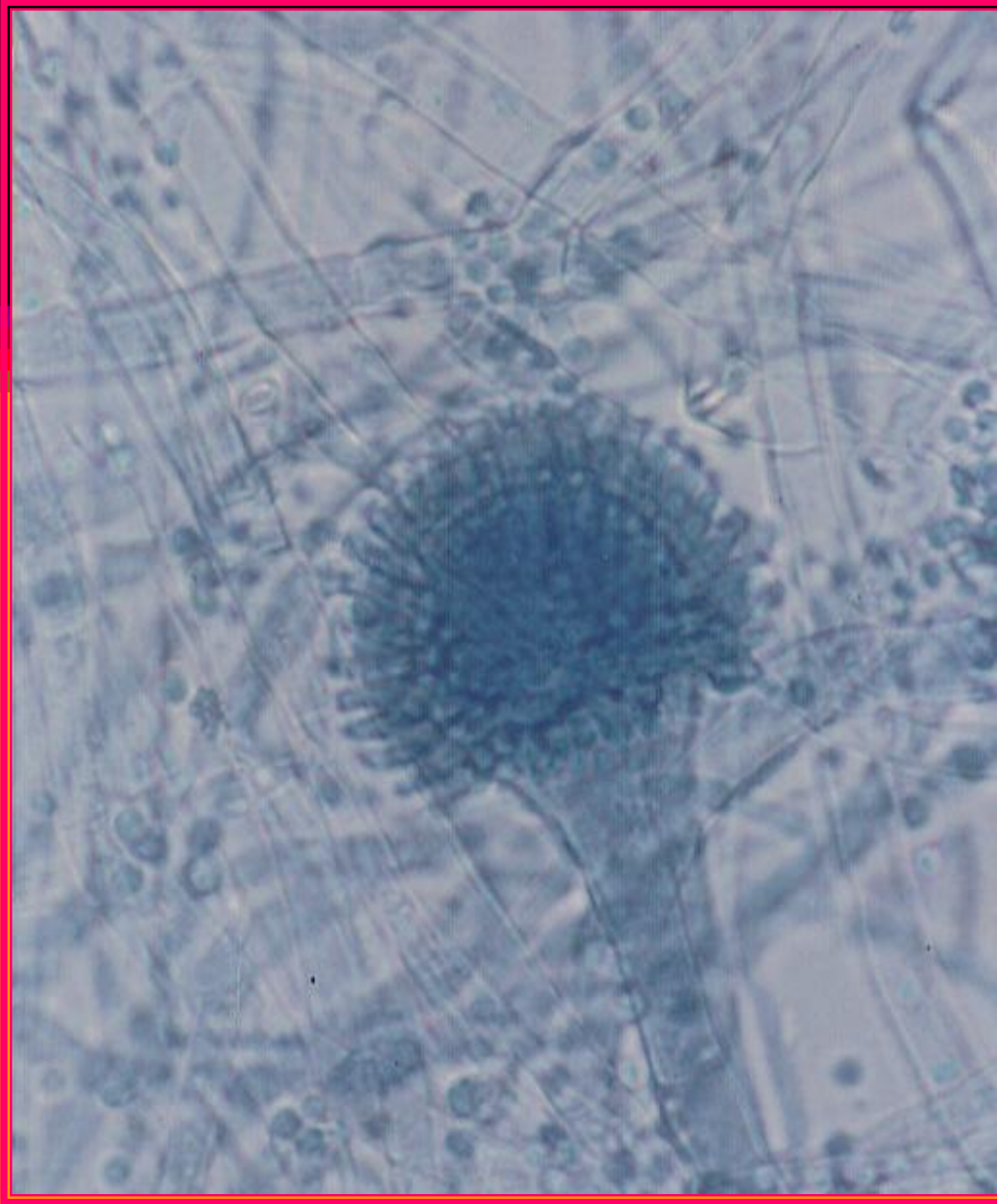
micron

- secondary conidia are seen, larger than phialoconidia and born directly on side of hypha or on a small hyphal projection

Pathogenicity : skin, nail and ear are infected, pulmonary invasion

Aspergillus (terreus group)





Aspergillus terreus

Aspergillus niger

Colony : surface is charcoal black, granular, flat , growth may be white at first. Reverse side is colorless to white.

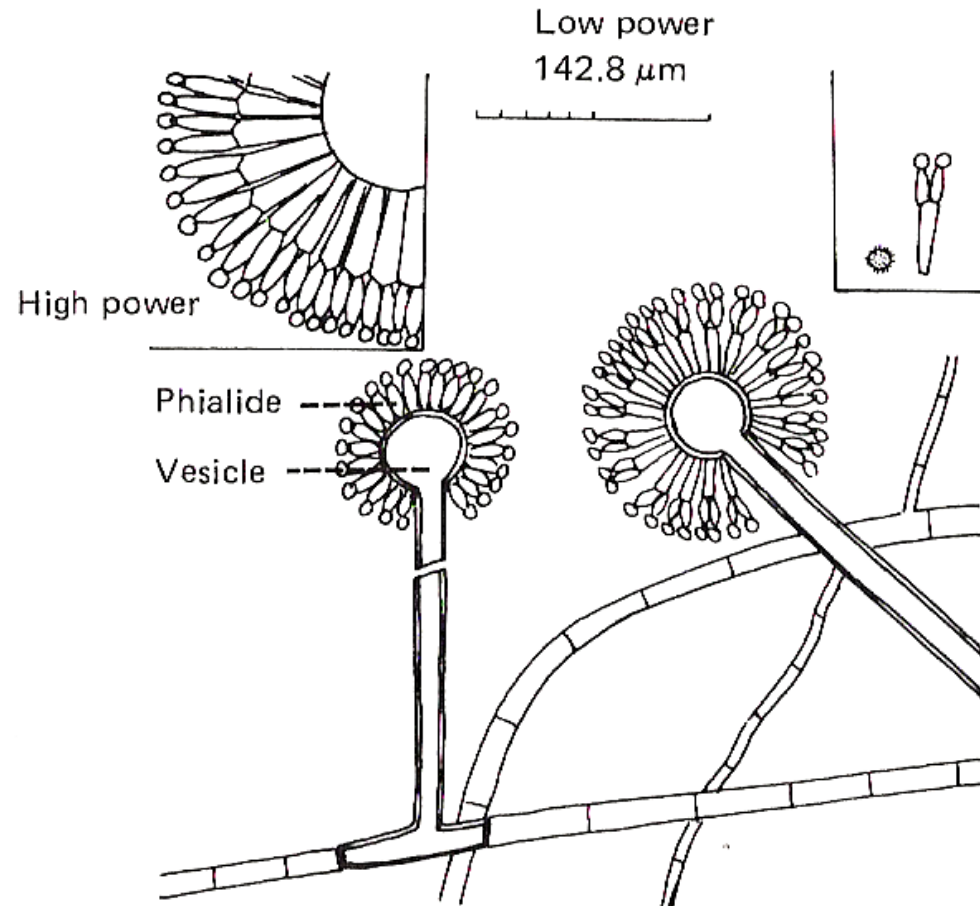
Microscopic : - vesicle is large and round (60-80 micron)

- phialide uniseriated or biseriated difficult to see (radiate heads with numerous black conidia)

- conidia black colour

Pathogenicity : ear infection, lung invader, mycetoma, oxalic acid is produced in animal feed, associated oxalic acid poisoning.

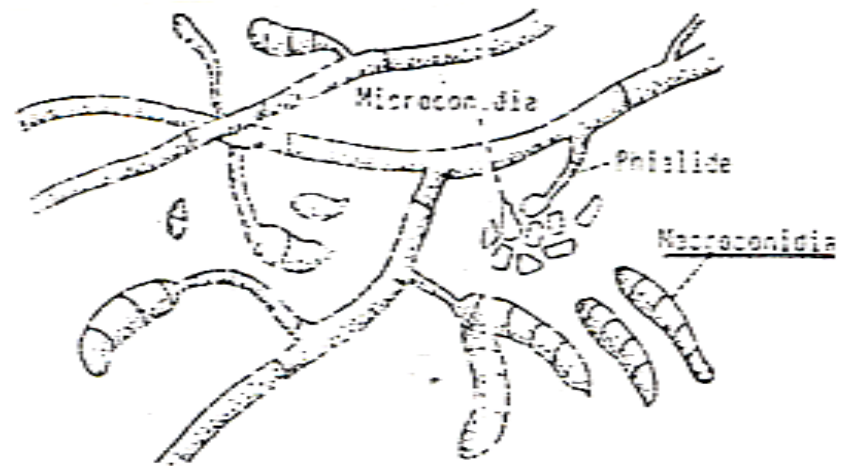
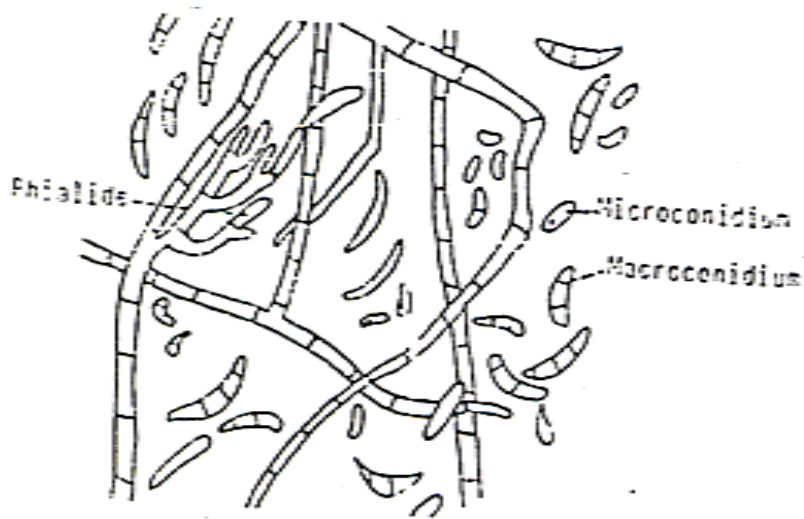
Aspergillus (niger group)



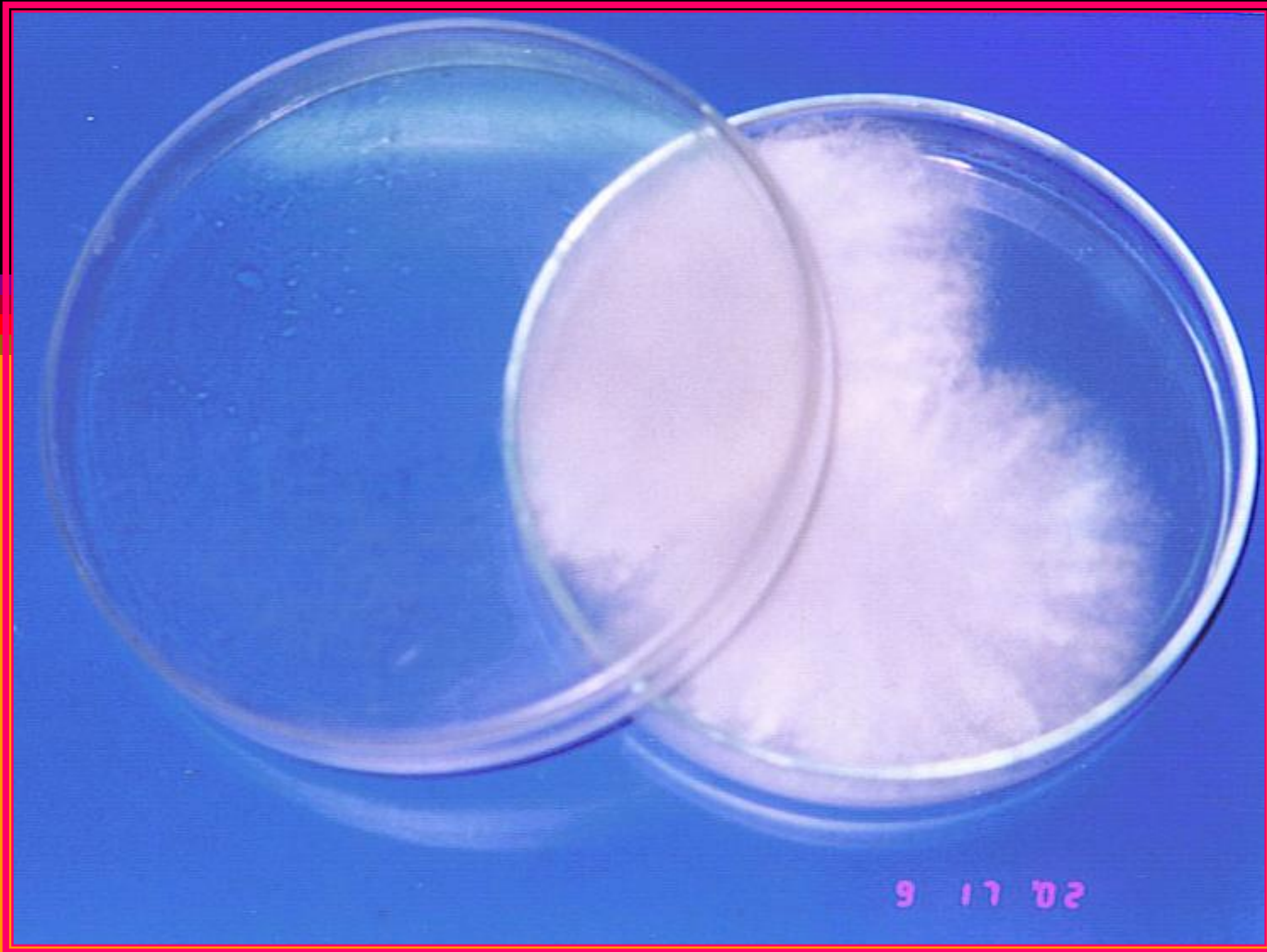
Aspergillus niger

Fusarium spp.

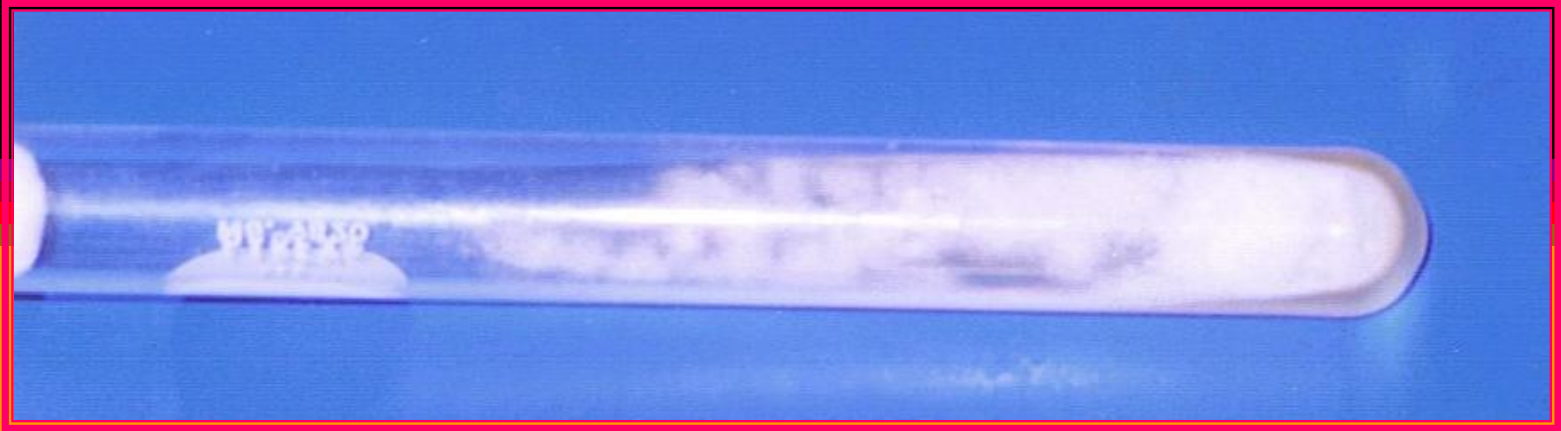
Class Hyphomycete



Colony :- Fast growing, at first white, cottony or woolly, frequently becoming pink, purple, or yellow in the hyphae or in the substrate.



Colony : growth is rapid, cottony, white, turning to rose or lavender, may be inhibited by cycloheximide.



***Fusarium* spp.**



Microscopic : - two kinds conidia (macroconidia, microconidia)

- phialide (sterigma produce conidia)

- macroconidia are slender multicelled with 2-11 septation, sickle shaped or fusiform

- microconidia one or two cells conidia



***Fusarium* spp.**



***Fusarium* spp.**



***Fusarium* spp.**



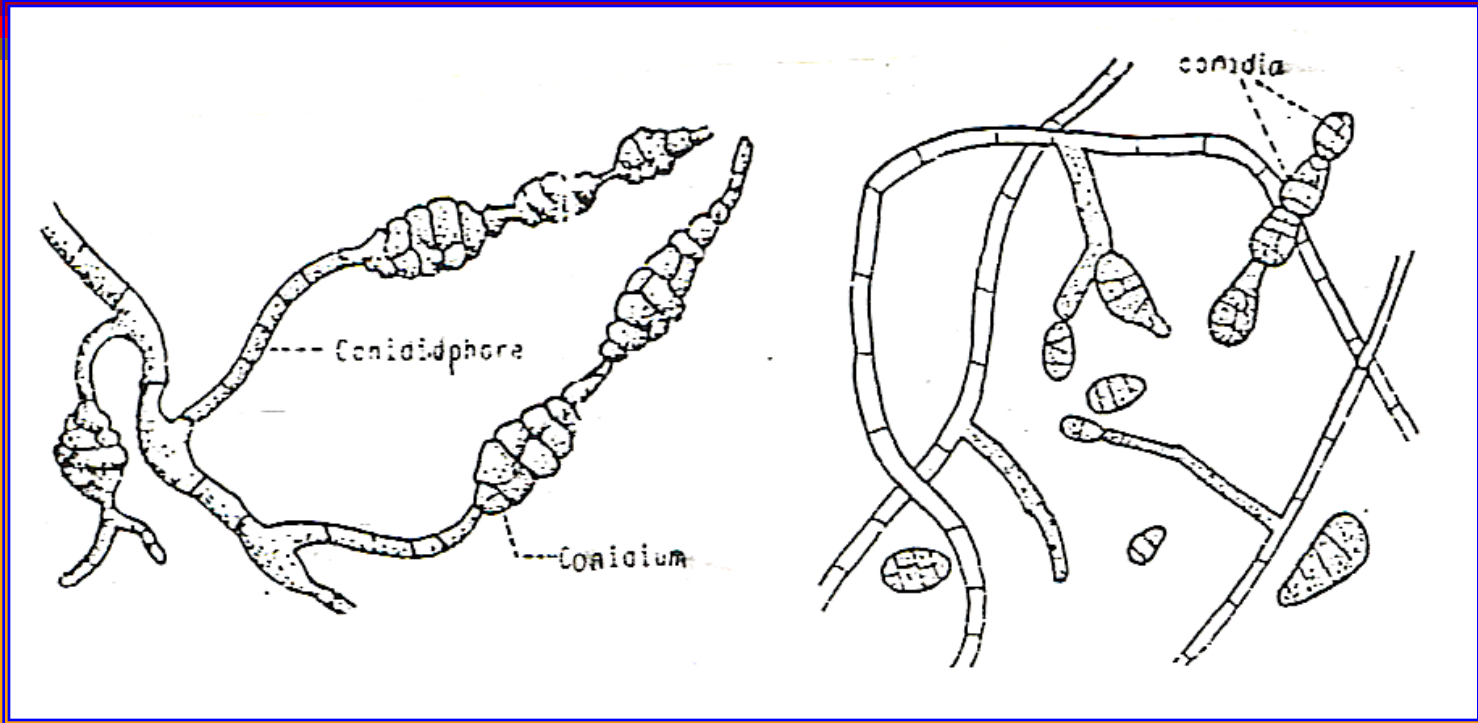
Fusarium spp.

Microscopic :- Mycelium septate, phialides borne singly or in packed group (sporodochia). Conidiophore short, branched irregularly, or in whorls. Conidia (phialospores) of two types macroconidia one celled, oval or elongated; some conidia two or three-celled, elongated and curved. A common cause of mycotic keratitis and occasionally isolated from skin lesion of burn patients.

Pathogenicity : mycotic keratitis (eye invader), onychomycosis, toxin producer.

Alternaria spp.

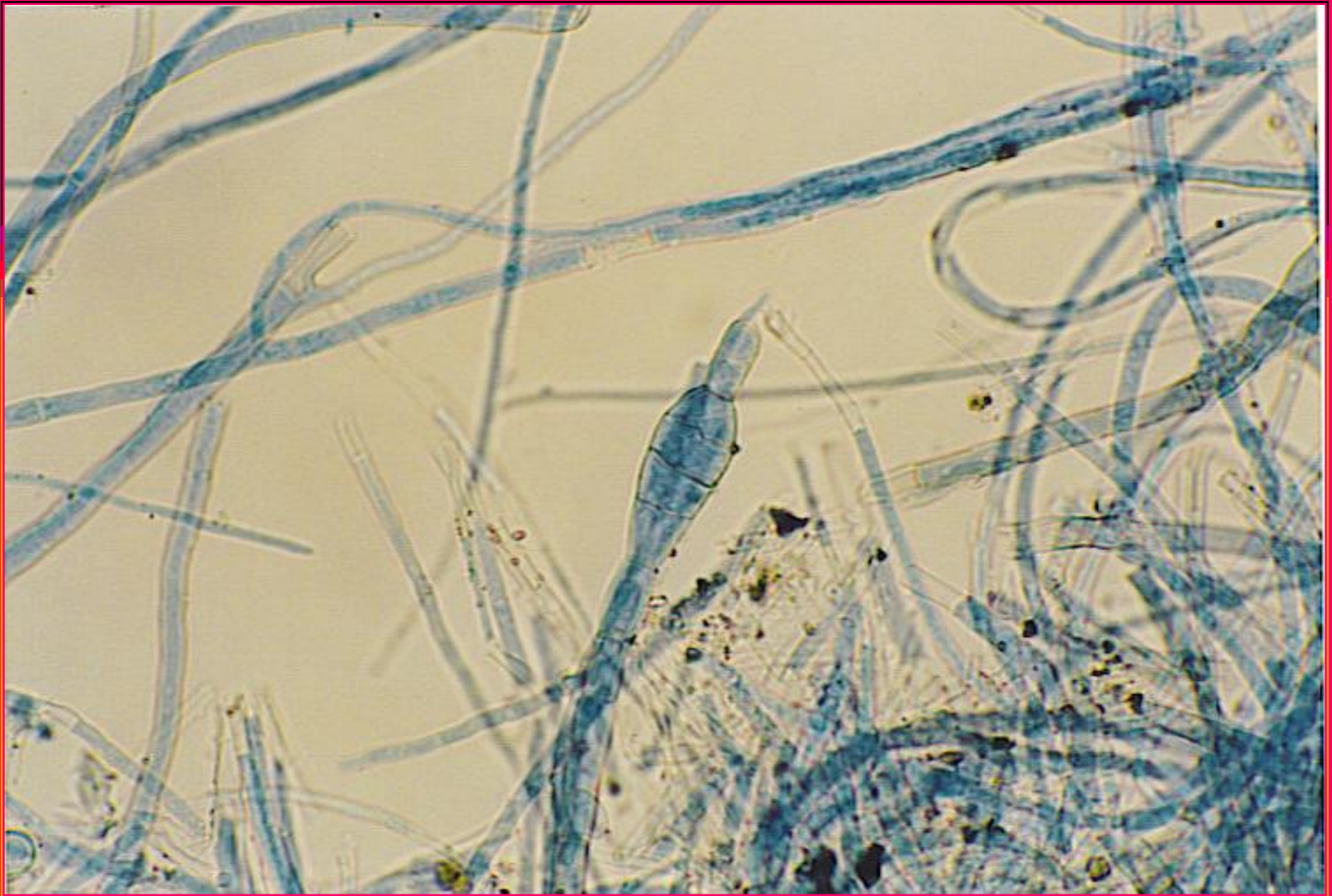
Class Hyphomycete



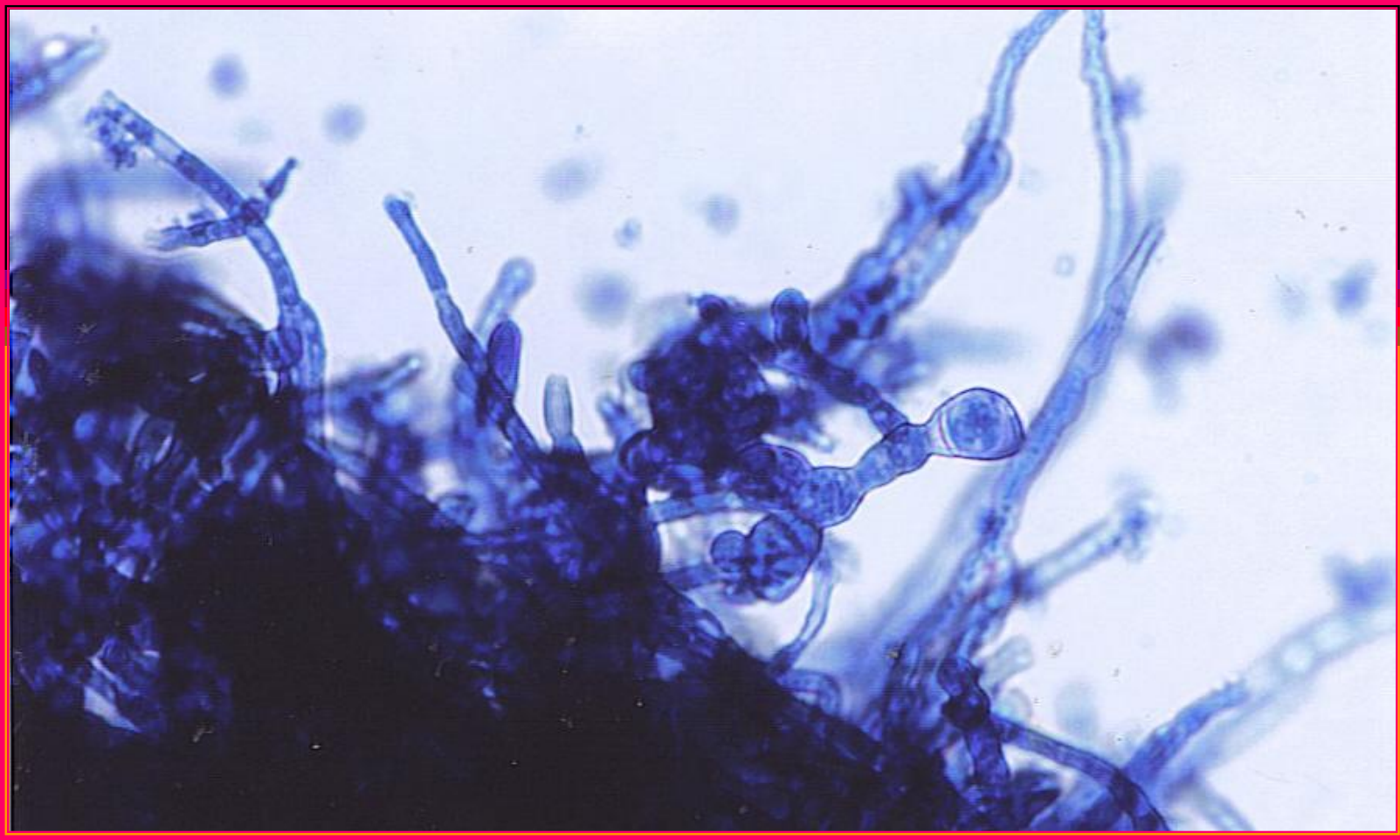
Colony :- Fast growing, dense, grayish at first, becoming greenish-gray, brown, or black with gray edges. Surface overgrown with loose gray to white aerial mycelium. Reverse side of colony black.



Colony : rapid woolly growth, surface vary from white to gray to brown to dark green, reverse is brown or black.



***Alternaria* spp.**



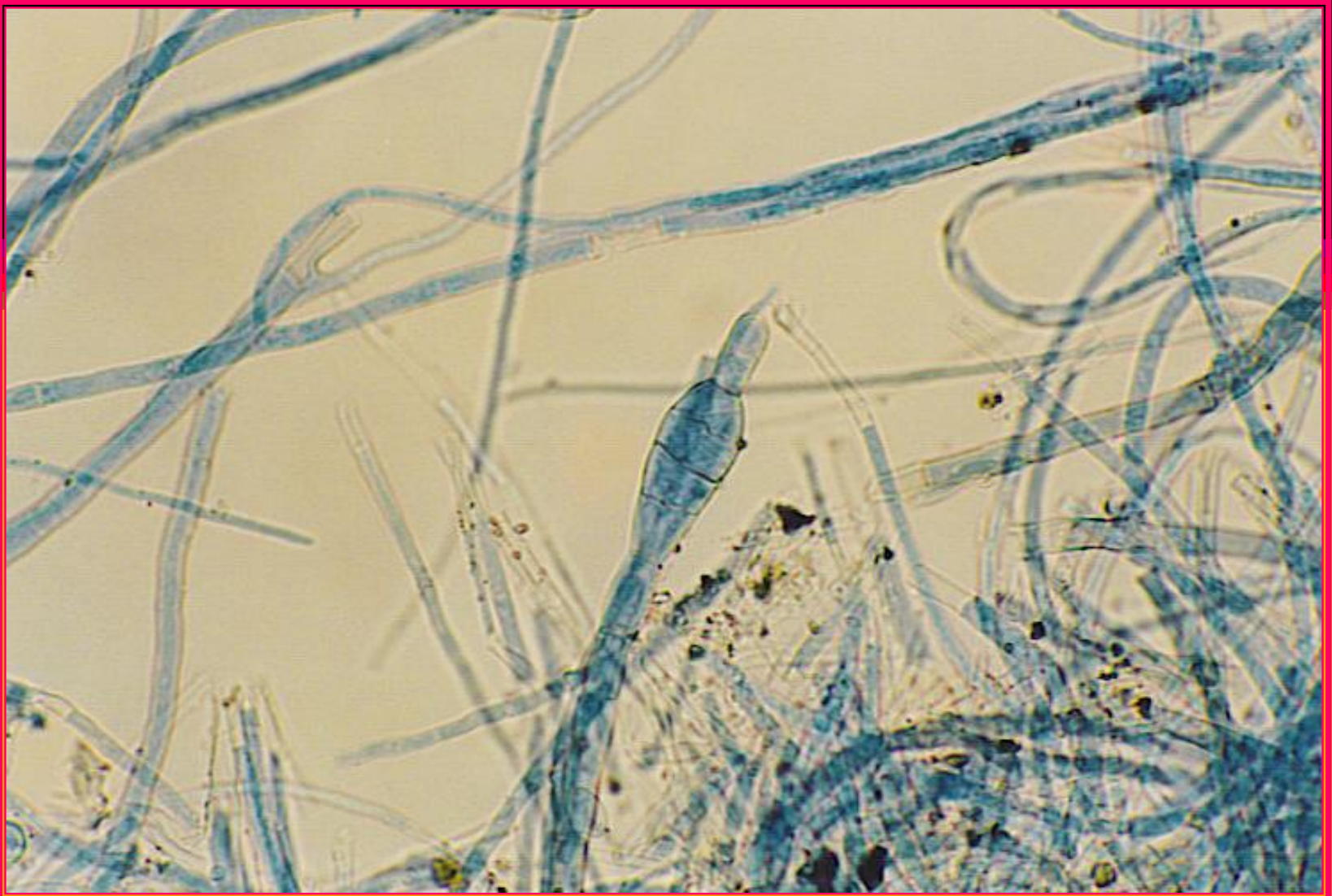
Microscopic : - macroconidia longitudinally and transversely septate, dark yellow or brown in chain (acropetally) or directly on the side of the conidiophore

- microconidia

Alternaria alternata
Medical Mycology Research
Center, UTMH Galveston



***Alternaria* spp.**



***Alternaria* spp.**



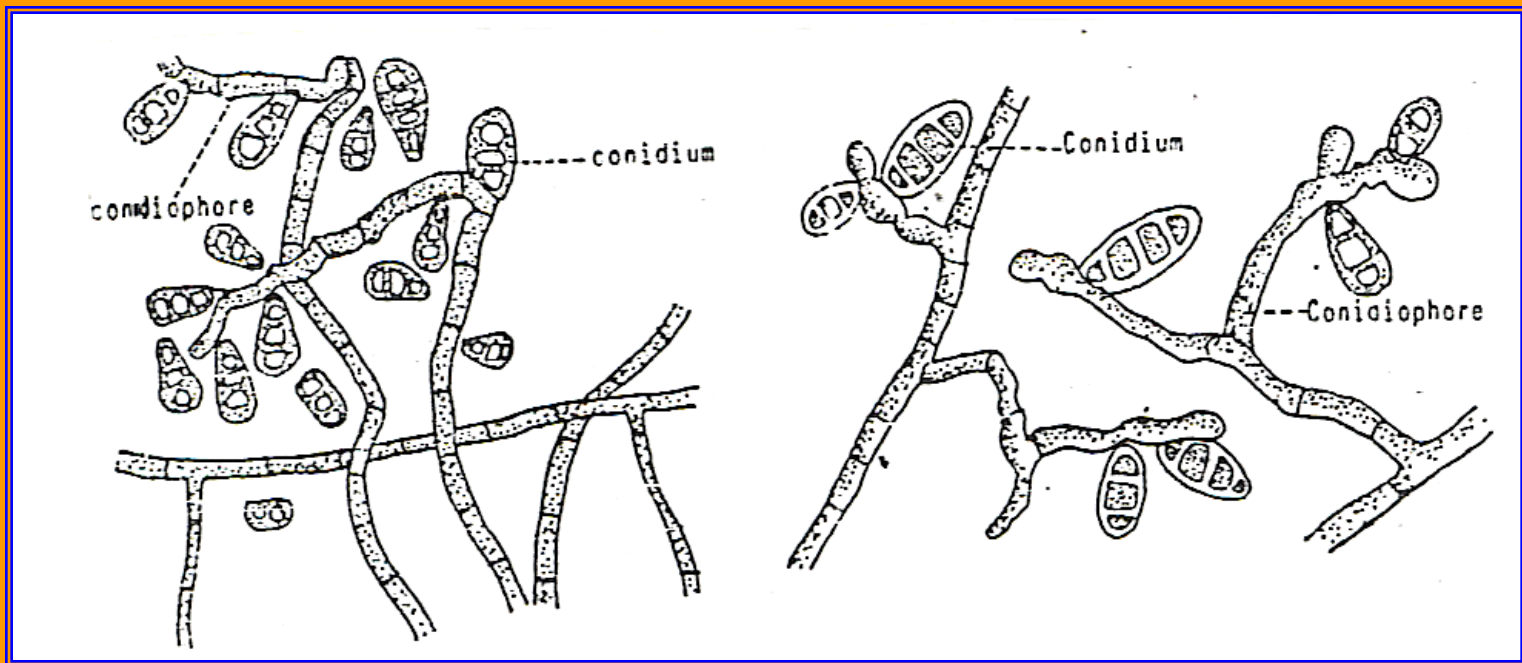
Alternaria spp.

Microscopic :- Mycelium dark, septate conidia (porospores) produced at end of conidiophores (hyphal branches) in chains, dark brown, with transverse and longitudinal septa (muriform), variable in shape, with youngest conidia produce at tip of chain. A genus of importance in allergies.

Pathogenicity : allergy, caused of cutaneous mycosis (rare), common mold

Helminthosporium spp. (*Drechslera* spp.)

Class Hyphomycete



Colony :- Fast growing, grayish-brown, becoming darker or black in center, velvety to woolly surface



Colony : growth is rapid. Surface is gray, sometimes with a slight pink in early growth, surface is woolly with dark reverse.



Microscopic : Tretoconidia (multiseptate conidia) are produced through brown smooth walled conidiophore.



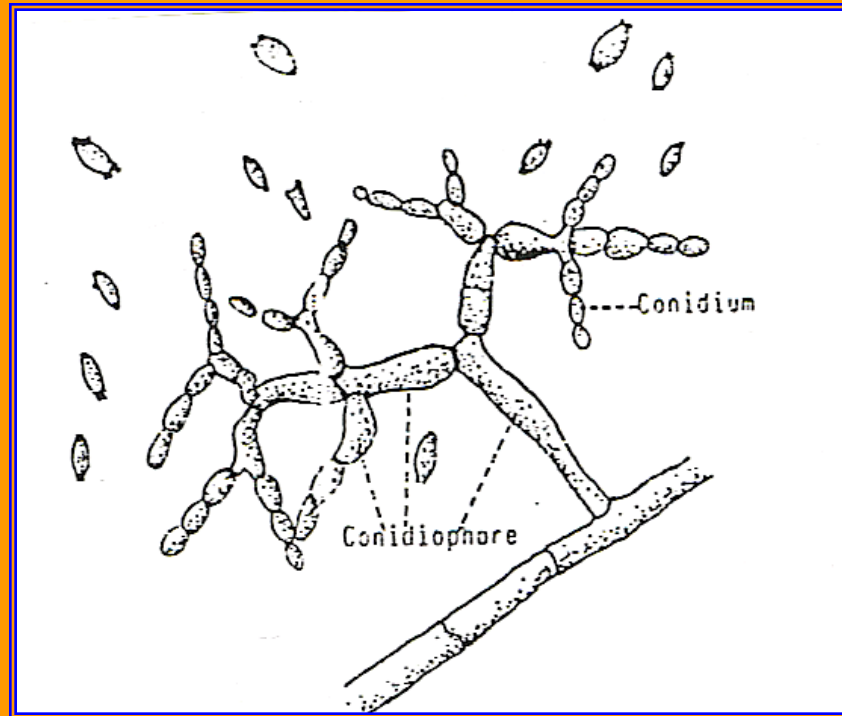
Helminthosporium spp.

Microscopic : Hyphae septate, dark, with long or short, simple or branched, septate conidiophores that are twisted or bent at the tip. Conidia (porospores) cylindrical to elliptical, dark, with usually more than three cells. Loosely attached to the twisted or bent tip of conidiophore, brown, indeterminate, extend by sympodial growth. Occasionally pathogenic animals.

Pathogenicity : rare pathogen, agent of meningoencephalitis, primary cutaneous phaeohyphomycosis.

Hormodendrum spp. ***(Cladosporium spp.)***

Class Hyphomycete



Colony :- Moderately slow growing, dark gray-green, reverse side brownish-gray or black. Surface powdery to velvety.



Colony : growth is rapid to moderate, velvety, folded, dark olive green, gray green, black or brown. Reverse of colony is black (laboratory contaminant is proteolytic fungi, pathogenic is not proteolytic)

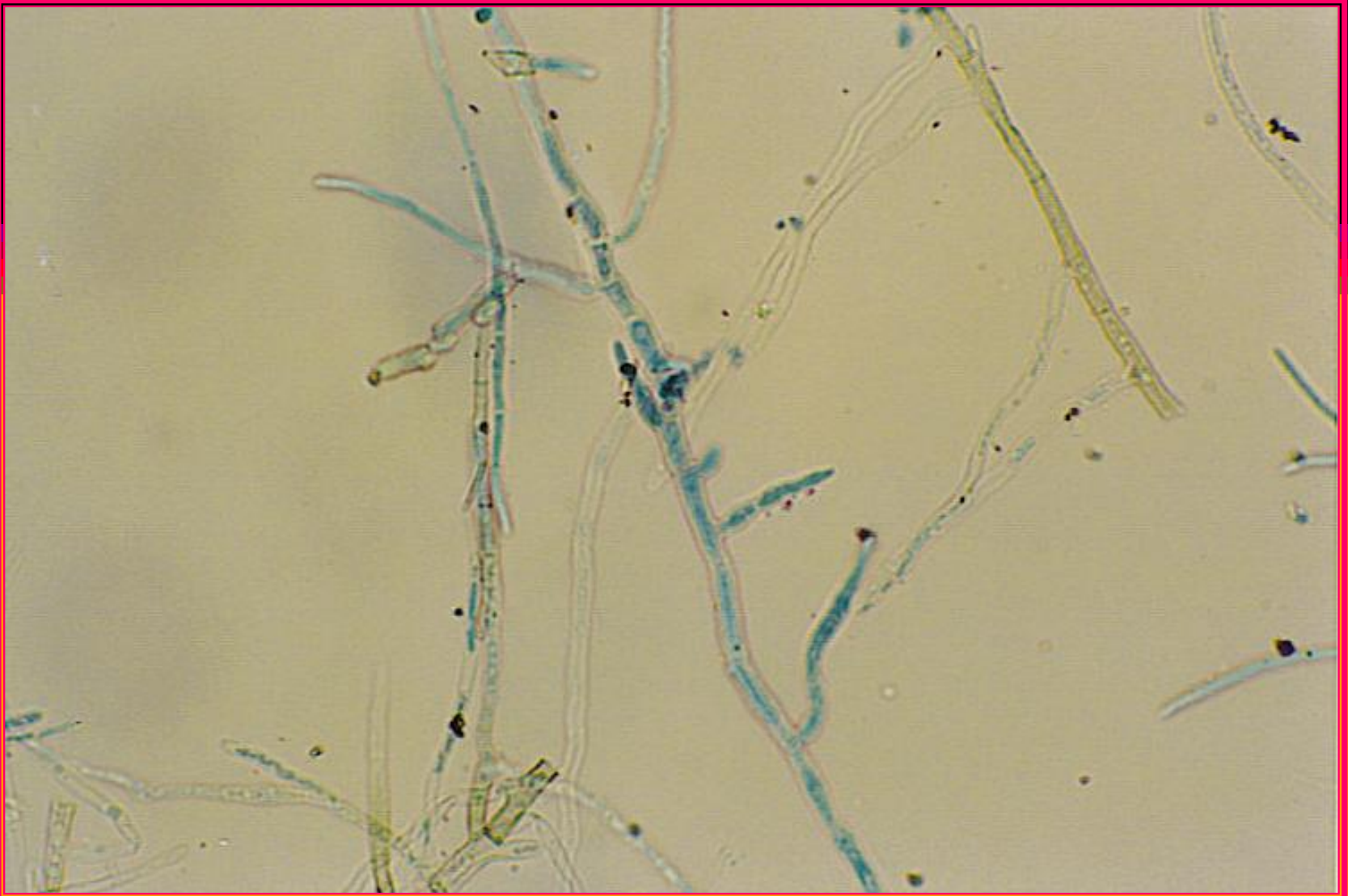
Microscopic : - conidia vary in size (depend on species), may be rough (echinulate) or smooth, may be single celled or with septation

- scar at the attachment point, known as disjunctor are permanent in conidia and conidiogamous cell

- hyphae are dark and segmented, early hyphae may be hyaline (light)

- conidiophore are pigmented and either branched or unbranched

- conidiogamous cell produces conidia from two or more points (polyblastic), these are generally called shield cell. Conidia are produced acropetally in chain.



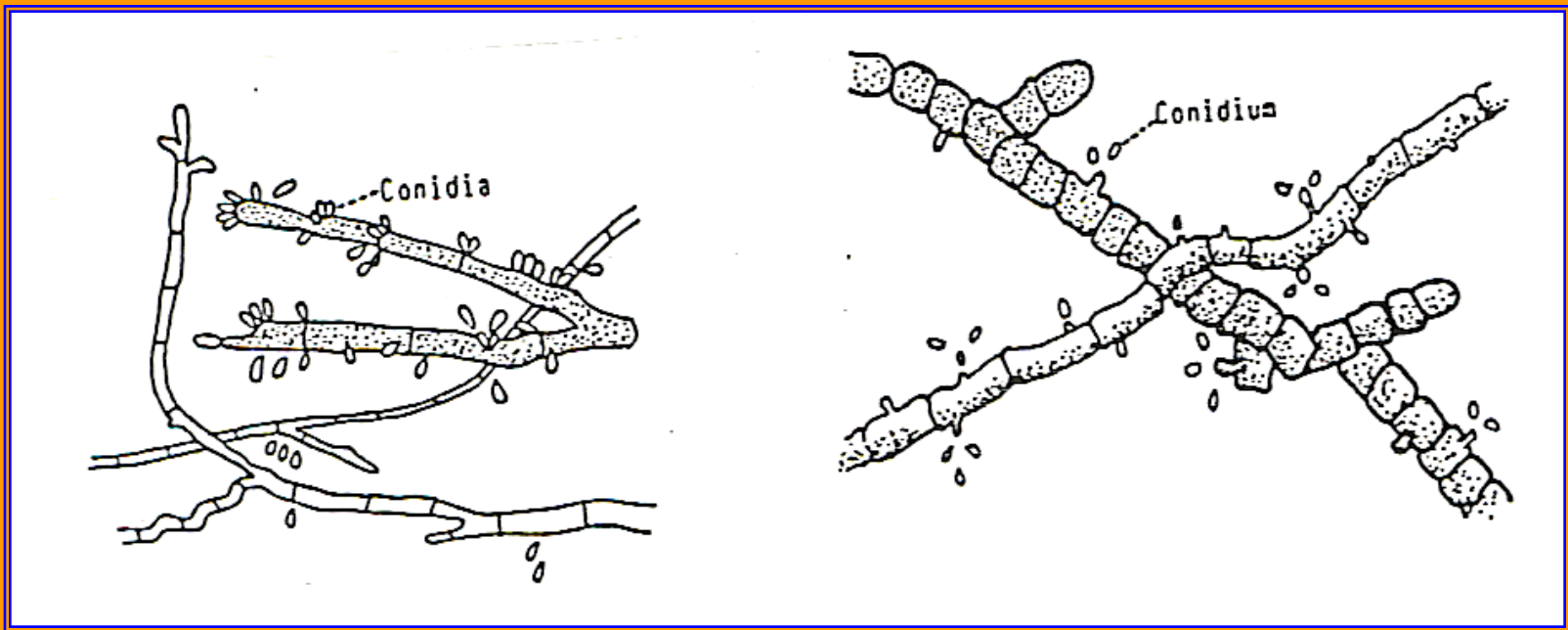
***Hormodendrum* spp.**

Microscopic : Hyphae septate, brown to olive in color, conidiophore dark, varied in length, forming branches with repeated forking, terminating in chain of conidia (blastoconidia). Conidia one-celled (occasionally two-celled), ovate to cylindrical with pointed ends, in some cases lemon-shaped. *C.carrionii* and *C.trichoides* are pathogenic and slow-growing species.

Pathogenicity : pathogenic species with Cladosporium type of sporulation, *Cladosporium carrionii* , *C.trichoides* , *Fonsecaea pedrosoi*.

Pullularia pullulans (*Aureobasidium pullulans*)

Class Hyphomycete



Colony :- Young colony at first white or pinkish and yeastlike, later becoming wrinkled, black, leathery, and shiny when masses of conidia are formed.

Microscopic :- Young mycelium thin-walled, producing many elliptical conidia (blastoconidia) by budding. Older hyphae are dark, thick-walled, with a short tube developed after germination to bud off elliptical conidia. The conidia mass make up the shiny surface of the colony.

Microscopic : thick walled, black, large hyphal cells and delicate thin walled hyphae produce conidia that continue to multiply by budding.

Pathogenicity : rarely seen as a pathogen, commonly isolated as a contaminant mold.

Mechanisms of mycotic infection.

- Tissue invasion (mycosis)
- Toxin production (mycotoxicosis)
- Induction of hypersensitivity

Tissue invasion (Mycosis)

- **Dematomycoses** skin disease cause by opportunistic fungi (*Candida* spp.) and *Malassezia pachydermatis*
- **Dermatophytoses** skin disease cause by dermatophyte (*Epidermophyton*, *Microsporum*, *Trichophyton*) infect keratinized structure of human or animal
- **Phaeohyphomycosis** skin disease cause by Dematiaceous fungi, infect dermis and subcutis (localized fungal invasion) → after penetration by a foreign body → mycetoma (tumourlike granulomatous lesion by saprophyte) → pseudomycetoma by dermatophyte and saprophyte

Fungal diseases categorized according to sites of lesions.

Category	Sites of lesions
Superficial mycoses	Skin, other keratinized structures and mucous membranes
Subcutaneous mycoses	Dermis and subcutaneous tissues
Systemic mycoses	Respiratory and digestive tracts and other organ systems

Factors which may predispose to fungal invasion of tissues.

- Immunosuppression
- Prolonged antibiotic therapy
- Immunological defects
- Immaturity, ageing and malnutrition
- Exposure to heavy challenge of fungal spores
- Traumatized tissues
- Persistent moisture on skin surface
- Some neoplastic conditions

Toxin production (Mycotoxicooses)

important group of disease resulting from a ingestion of fungal toxin (store food, crops)

Hypersensitivity reaction to fungal infection is rare in domestic animals, may associated with chronic pulmonary disease in cattle, horse.

END