

MYCOLOGY

Dr. Bincy Joseph
Assistant Professor
PGIVER, Jaipur

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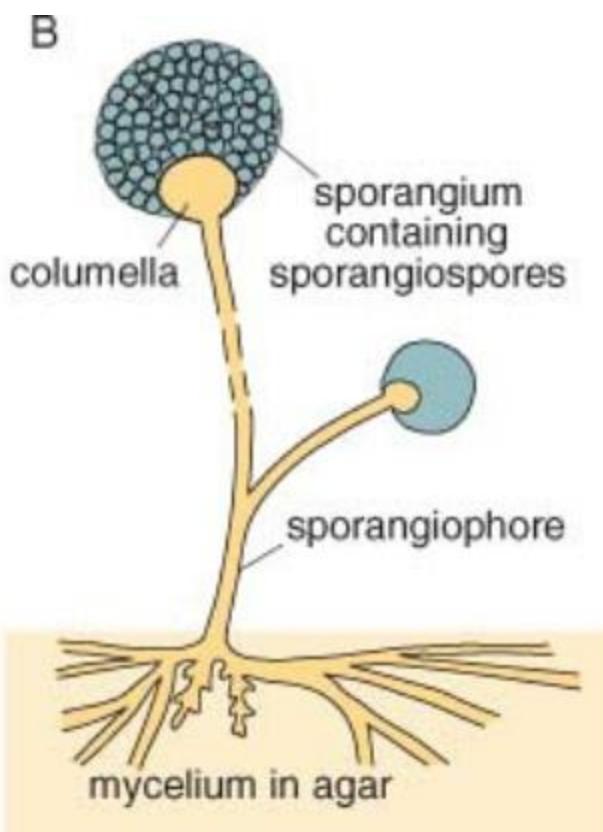
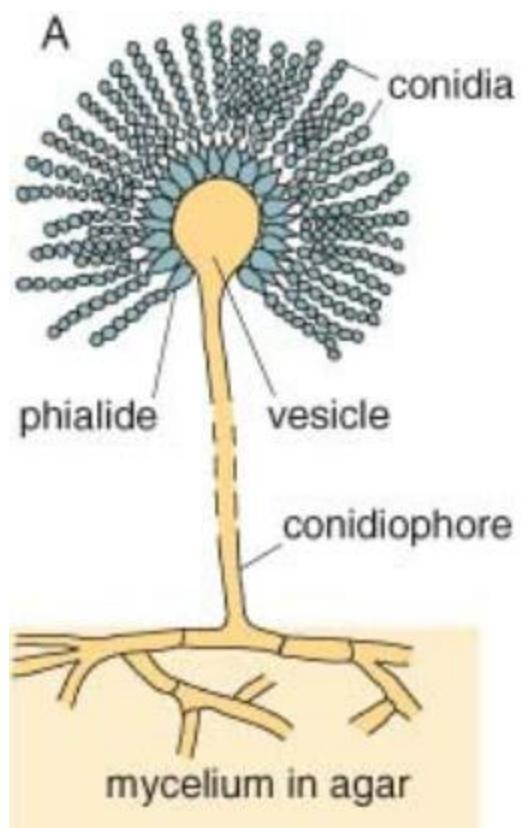
- Fungi are eukaryotic non photosynthetic heterotrophs which produce exoenzymes and obtain nutrients by absorption
- There are four phyla in the Kingdom Fungi
 - Ascomycota (Ascomycetes)**
 - Basidiomycota (Basidiomycetes)**
 - Zygomycota (Zygomycetes)**
 - Fungi imperfecti (deuteromycetes)**
- The first three phylum can be distinguished by the characteristics of their sexual form
- In case of **fungi imperfecti/ Deuteromycetes** the sexual form has not been found
- The sexual form of fungi also known as **teleomorphs**
- Most fungi of Veterinary importance are under **Deuteromycetes**





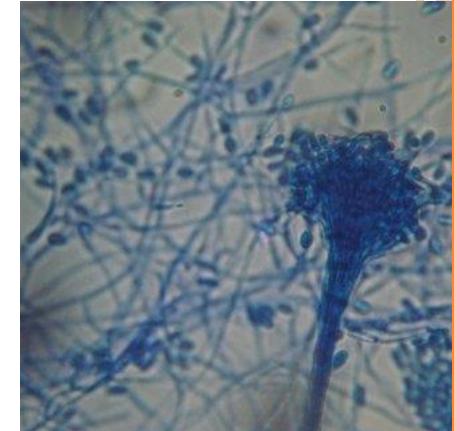
MOULDS AND YEAST

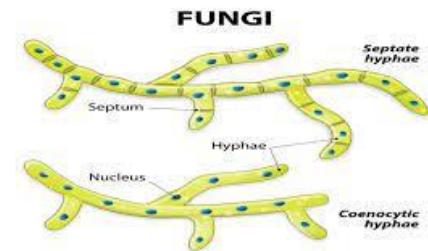
- Two main morphological forms of fungi are molds and yeasts
- Molds grow as branching filaments called hyphae (2-10 μm) diameter whereas unicellular yeasts have an oval or spherical appearance 3-5 μm in diameter
- **Dimorphic fungi** occur in both yeast and mold forms
- Some fungi like *Candida albicans* produce other forms in addition to mold and yeast form, hence they are known as **polymorphic**



CHARACTERISTIC OF FUNGI

- Fungi are **aerobic**
- Reproduction in fungi occur either sexually or asexually by the formation of spores
- A mass of interlacing hyphae form mycelium
- Fungi tolerate high osmotic pressure and **acidic environments as low as pH 5.0**
- Structure
- Hyphal cell wall contain carbohydrate components like **chitin** macromolecules with cellular cross linkages
- In Yeast cell wall contain protein complexed with polysaccharide and lipids
- The predominant sterol is **ergosterol** in contrast to cholesterol which is the predominant sterol in the cell membrane of animals





- Both molds and yeast have well defined nuclear membrane, mitochondria and a network of microtubules
- Septa or cross walls often present on the hyphae
- Septa formed by the inward growth of cell wall have central pores through which nutrients and organelles may pass

GROWTH REPRODUCTION AND COLONIAL FORMATION

- Moulds tend to form large colonies with growth and extension of hyphae at their peripheries.
- In moulds in asexual reproduction two main types of spores are produced
- **Conidia** –produced on conidiophore
- Multicellular conidia called macro conidia and unicellular conidia called micro conidia are produced by Dermatophytes produced on the lateral branches of hyphae
- **Sporangiospores** produced within a sac like structure called sporangium on an aerial hyphae called sporangiophore
- Eg: By fungi in the phylum zygomycota

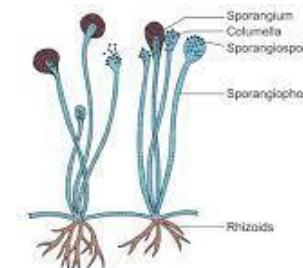
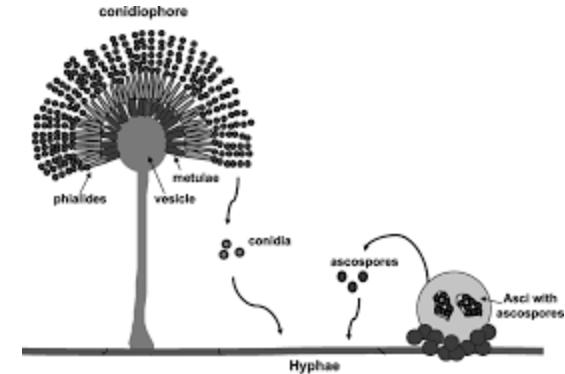
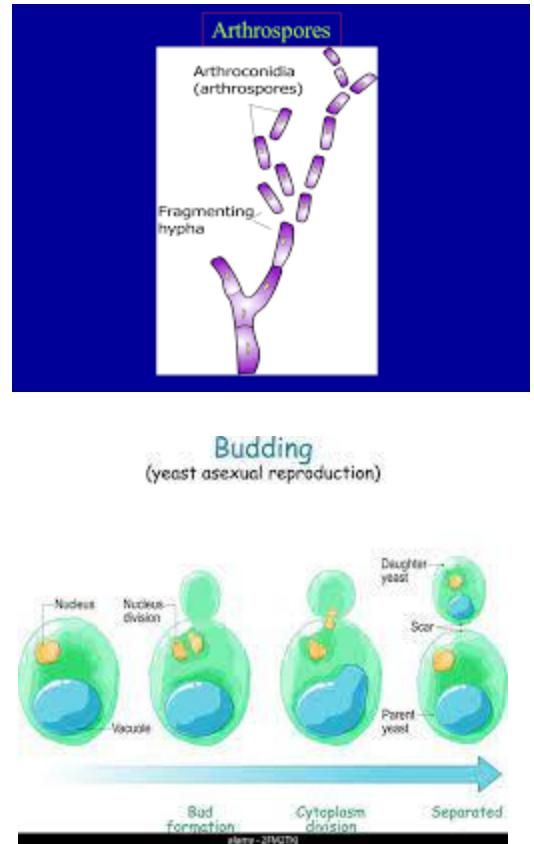


Figure 1.26: *Rhizopus*

- Arthroconidia are the conidia produced by the disintegration of hyphae within keratinised tissues
- In most yeast cells asexual reproduction is by budding
- Daughter cells separate from parent cells after the formation of crosswall at the point of budding
- The colonies of yeast like fungi are soft smooth and round



ASEXUAL SPORES

- **Arthroconidia or Arthospore**
- Spores are produced and are released during the process of fungal fragmentation
- Spores may be produced successively as in dermatophytes or intervening empty cells as in coccidioides
- **Blastoconidia/Blastospore**
- Conidia which are produced by budding
- Eg: *Candida albicans*
- **Chlamydoconidia/ Chamydospores**
- Thick walled resistant spores which contain storage products.
- These are produced by some fungi in unfavourable conditions

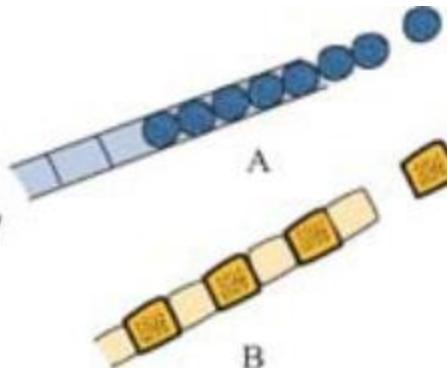


- **Macro conidia**
- Large multicelled conidia which are produced by Dermatophyte in culture
- **Micro conidia**
- Small conidia are produced by certain dermatophytes
- **Phialo conidia**
- Conidia produced from phialids
- The Phialides of Aspergillus species arise from a vesicle
- **Sporangiospores**
- Spore produced by zygomycetes such as rhizopus are released when mature sporangium ruptures



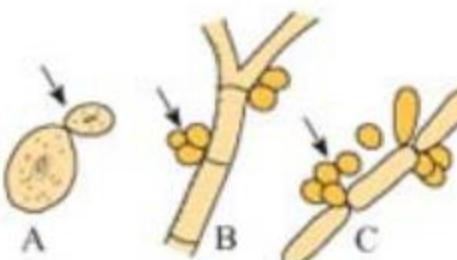
Arthroconidia (arthrospores)

Spores which are formed and subsequently released during the process of hyphal fragmentation. Spores may be formed successively as in dermatophytes (A), or with intervening empty cells as in *Coccidioides immitis* (B)



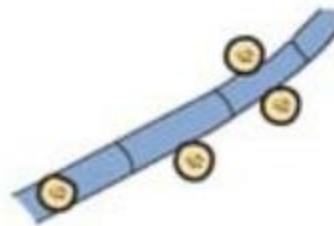
Blastoconidia (blastospores)

Conidia (arrows) which are produced by budding, as in *Candida albicans*, from a mother cell (A), from hyphae (B) or from pseudohyphae (C)



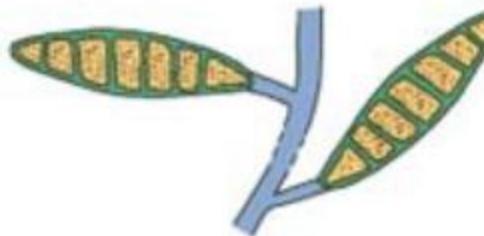
Chlamydoconidia (chlamydospores)

Thick-walled, resistant spores which contain storage products. These structures are formed by some fungi in unfavourable environmental conditions



Macroconidia

Large multi-celled conidia which are produced by dermatophytes in culture



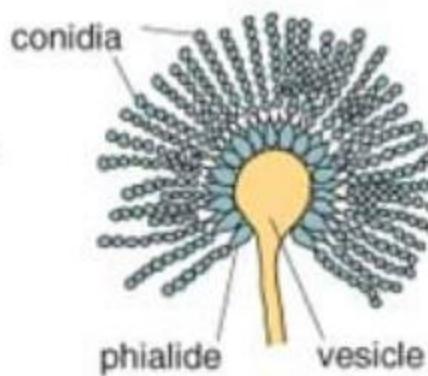
Microconidia

Small conidia which are produced by certain dermatophytes



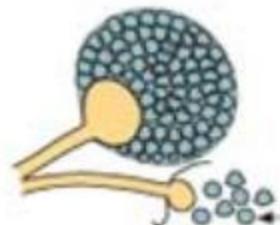
Phialoconidia

Conidia produced from phialides. The phialides of *Aspergillus* species arise from a vesicle



Sporangiospores

Spores (arrow), formed by zygomycetes such as *Rhizopus* species, are released when a mature sporangium ruptures



SEXUAL SPORES

- Sexual spores are produced by fungi in the phyla
- Ascomycota
- Basidimycota
- Zygomycota



- **Ascospores**
- Produced by members of Ascomycota. Ascospores are developed in a sac like structure called an ascus
- Asci are enclosed in a well defined structure termed ascocarp
- **Basidiospores**
- Produced by members of Basidiomycota on a club shaped structure called basidia
- **Zygosporangium**
- Produced by members of zygomycota
- Develop within a thick walled zygosporangium formed by the fusion of side projections of two compatible mycelium



Table 42.2 Sexual spores of fungi in the phyla *Ascomycota*, *Basidiomycota* and *Zygomycota*.

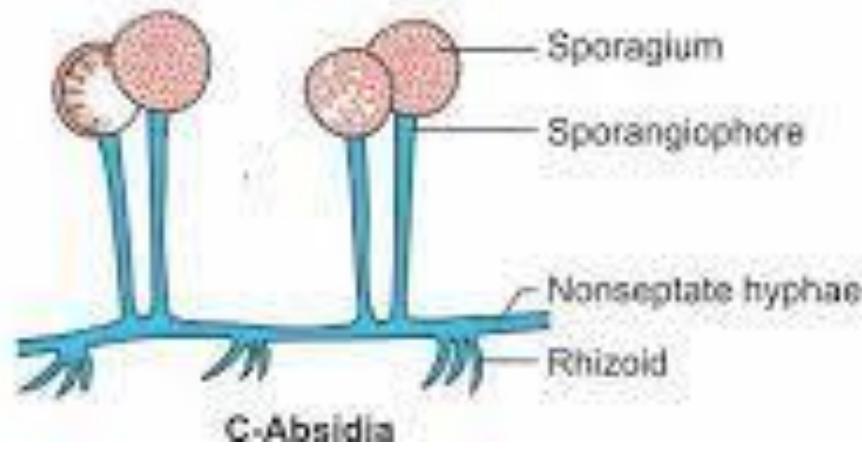
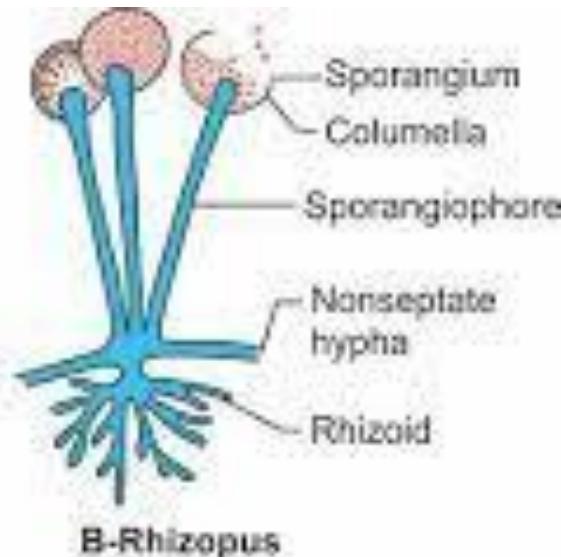
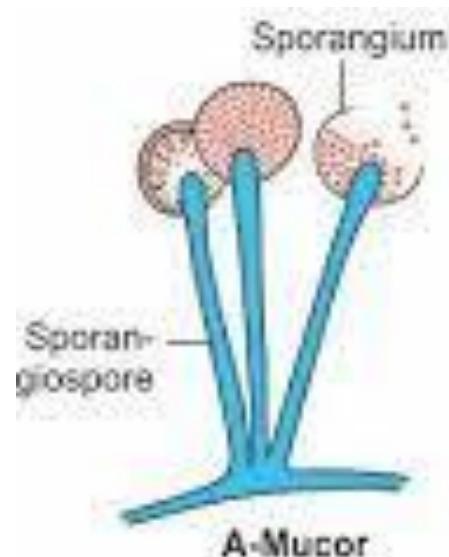
Spores	Comments
Ascospores	Produced by members of <i>Ascomycota</i> ; develop in a sac-like structure called an ascus. Asci may be enclosed in well defined structures termed ascocarps
Basidiospores	Produced by members of <i>Basidiomycota</i> on club-shaped structures called basidia
Zygospores	Produced by members of <i>Zygomycota</i> ; develop in a thick-walled zygosporangium, formed from the fusion of side projections of two compatible hyphae

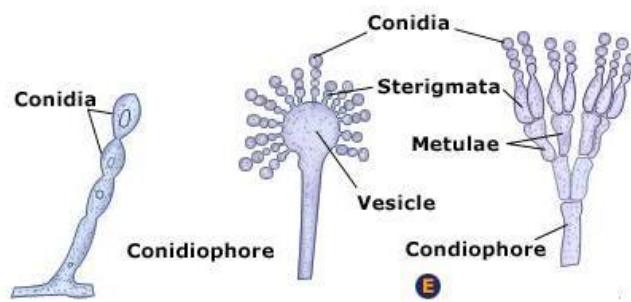
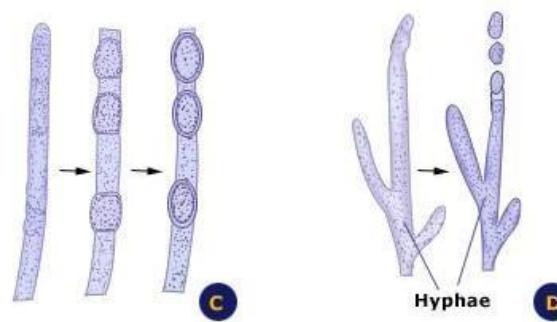
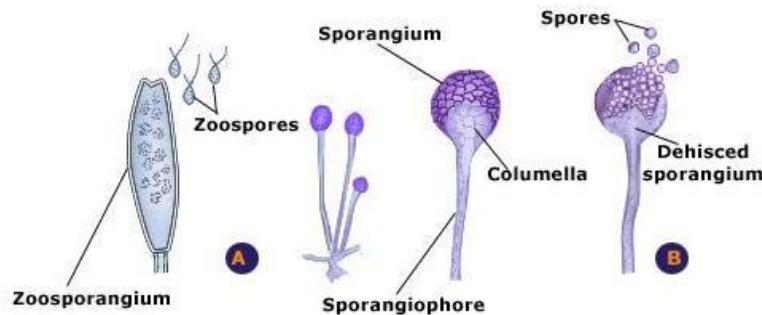
REPRODUCTION IN ZYgomycetes

- Asexual reproduction
- Long non septate aerial filament called **sporangiophore** which have an expended tip called **columella**
- Surrounding which is a sac like closed structure called **sporangium**
- Sporangium contains numerous asexual spores called **sporangiospores**.
- When spores mature, the sporangium ruptures and **sporangiospores** are released to initiate new hyphae and fungus

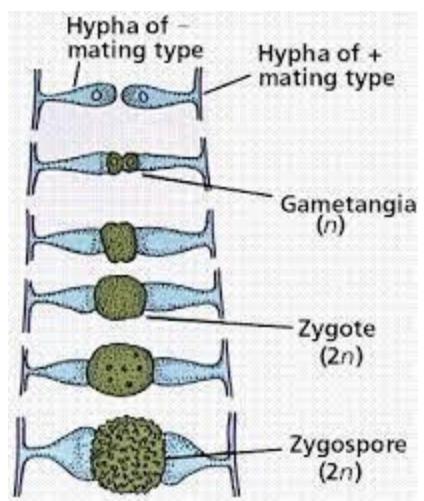


- Sporangiospores are two types
- **Aplanospore**s are non motile containing several nuclei
- **Zoospores** uninucleate and motile with one or more flagella
- All the species have horizontal hyphae which grows along with the surface of the medium
- It has got root like branched hyphae extending into the medium called **rhizoids**
- The horizontal hyphae or runner is known as **stolon**
- In mucor species rhizoids are absent
- In absidia rhizoids are away from sporangiophore and in rhizopus the rhizoids are situated just below sporangiospores





- Sexual reproduction
- Two types
- By fusion of like gametes
- By fusion of unlike gametes
- In the first two suitable adjacent hyphae come together and form short side branches called **suspensors**
- At the point the suspensors meet , a **gametangium** is formed
- The gametangia formed fused to form a **zygote**
- The zygote matures and produce spherical thick walled sexual spore called **zygospore**

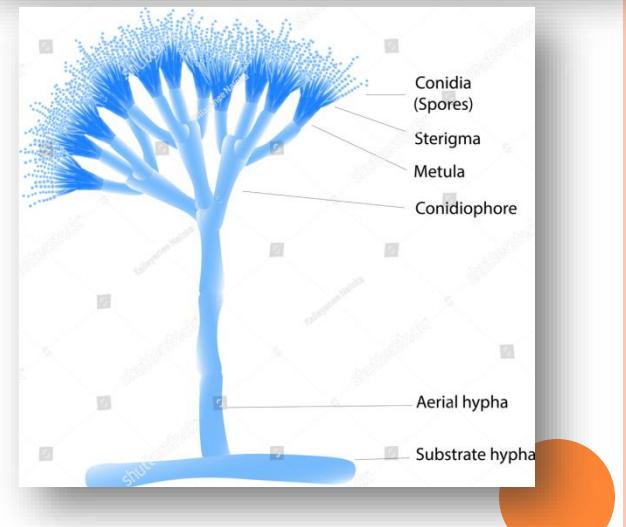
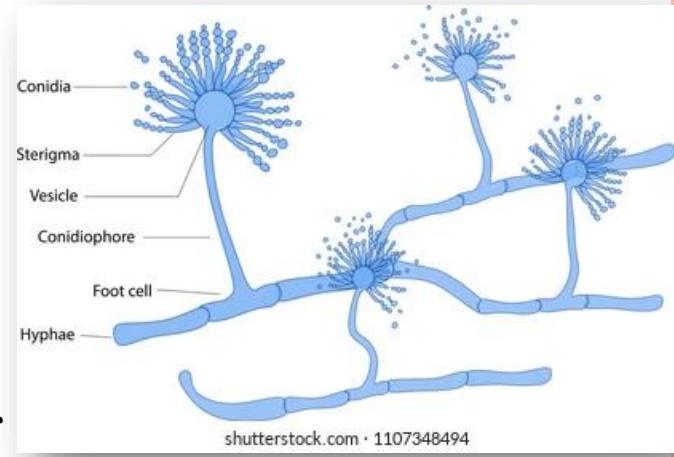


- In the second type there is specialised female structure called **oogonium** fertilised by transfer of nucleus from the male structure called **antheridium**
- The sexual spore formed is called **oospore**. The structure which contain the oospore is called **oosphere**



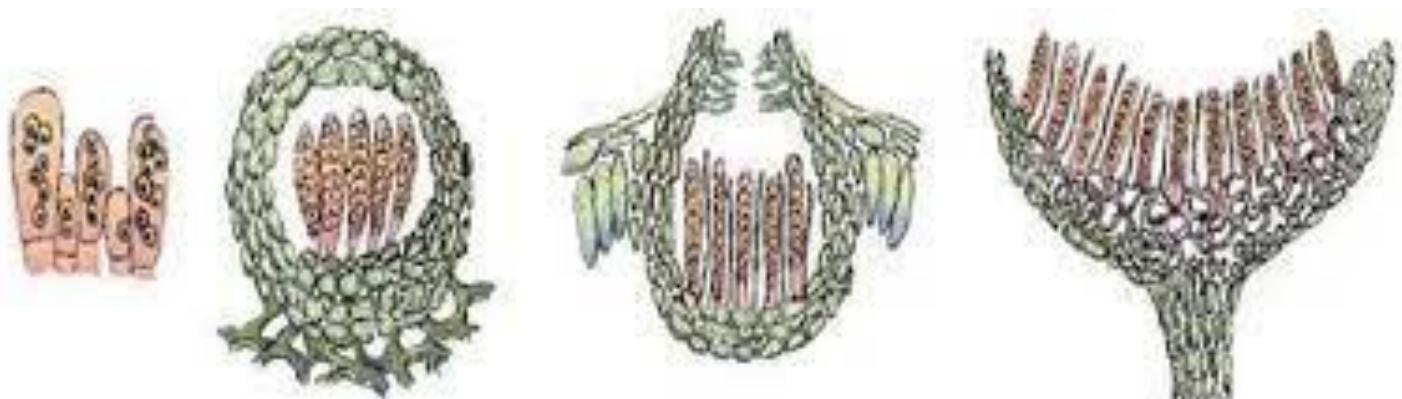
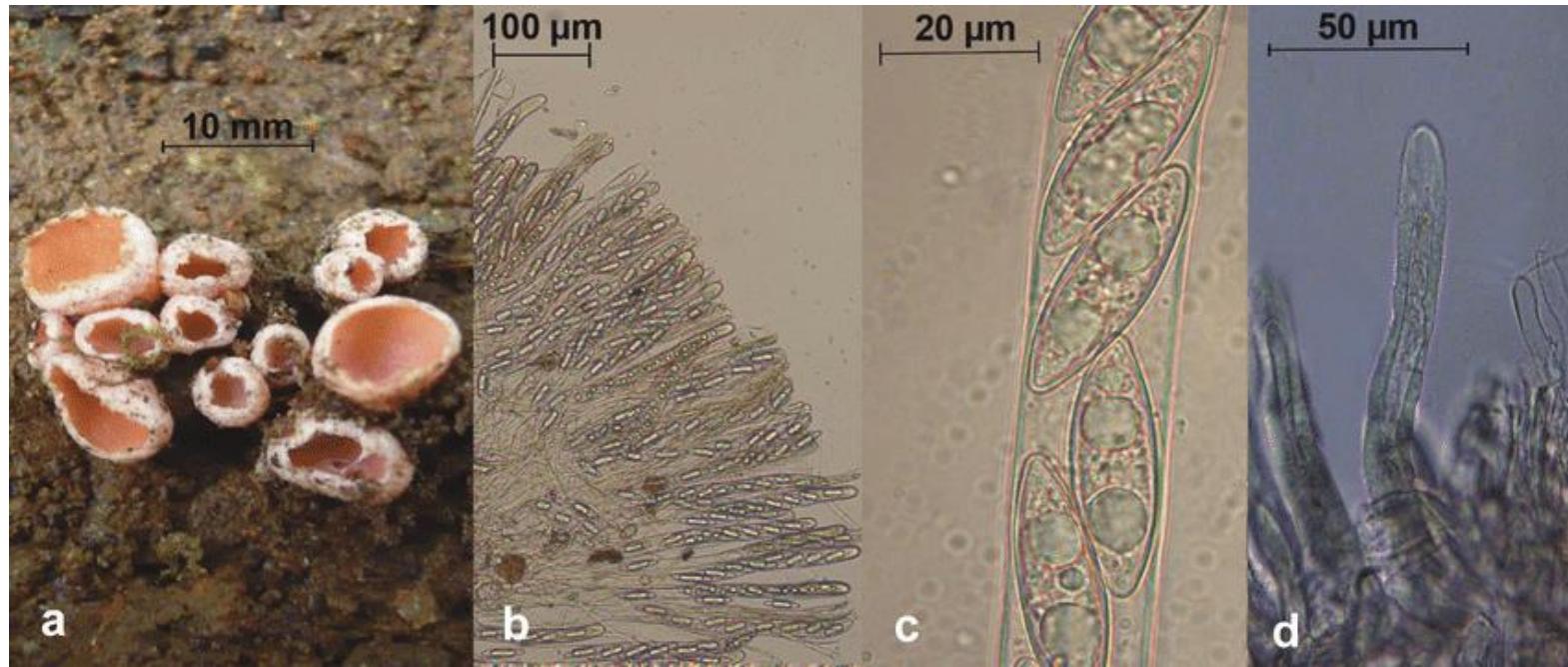
REPRODUCTION IN ASCOMYCETES

- Asexual reproduction
- *Aspergillus spp.* produce long septate aerial modified hyphae known as **conidiophore** which ends in terminal expansion or swollen called **conidiophore vesicle**.
- From surface of vesicle numerous club shaped structures called **sterigmata or phialides** arise.
- From tip of sterigmata, unicellular long chain of asexual spores which may be uninucleate or multinucleate
- In **Penicillium species** the conidiophore vesicle is absent
- It produce lateral side branches called **metullae** from end of which finger like projections (sterigmata) arise which has asexual spores
- This arrangement gives penicillium species a characteristic **brush like appearance**.
- Asexual spores of aspergillus and and penicillium spp. are called **conidia or conidiospores** (phialospores and phialoconidia)



- Sexual reproduction
- Sexual spores are developed **endogenously** in a rounded or elongated sac like structure called **ascus**
- The spores fromed inside are called ascospores
- Usually one ascus has 4 to 8 ascospores.
- Ascus may be formed within a fruiting body called **ascocarp**.
- Ascocarp are of two types
- **Cleistothecium type-** which is largely fairly round closed many celled structure in which asci or ascocarps are formed
- **Peritheциum** which is a large round or pear shaped structure containing small rounded opening.it contains asci and ascospores
- **Apothecium** discoid or cupped body bearing asci on the exposed flat or concave surface.





Naked asci

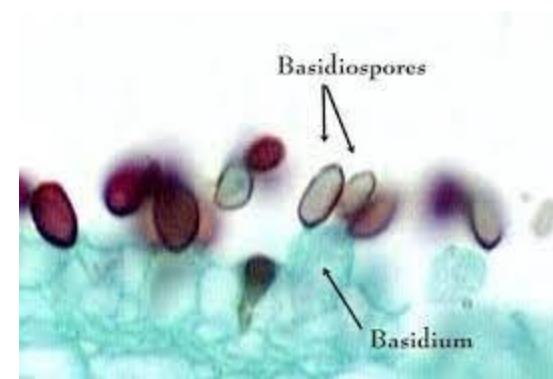
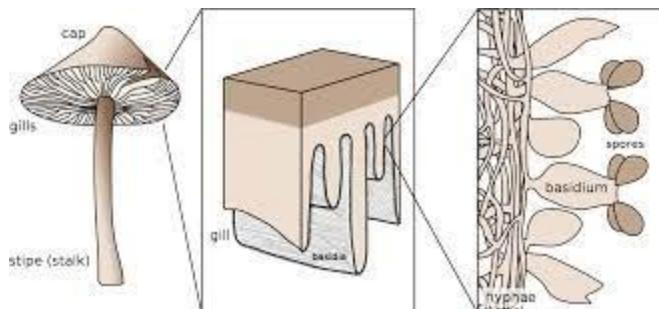
Cleistothecium

Perithecium

Apothecium

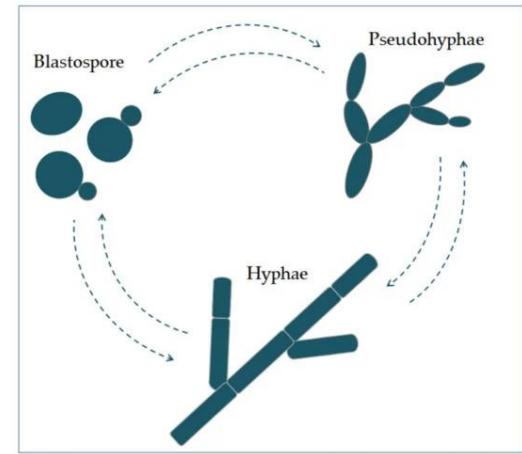
REPRODUCTION IN BASIDIOMYCETES

- Asexual reproduction by production of **conidia**
- Sexual reproduction – sexual spores develop exogenously on a club shaped structure called **basidium**
- Sexual spores are called **basidiospores** usually basidium bears **four spores**

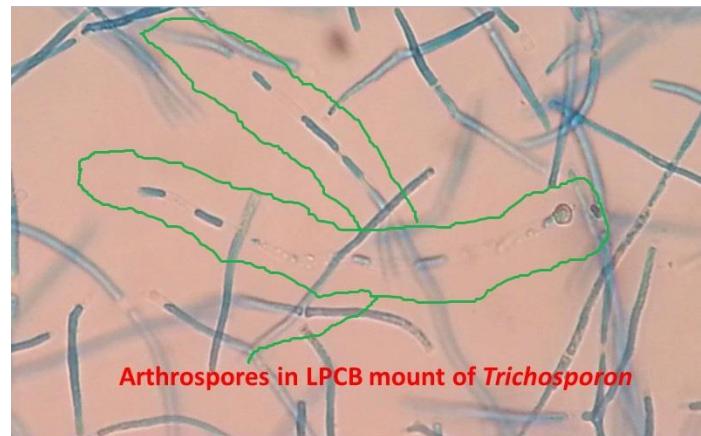
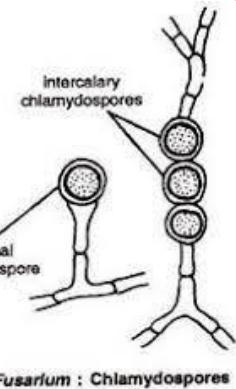
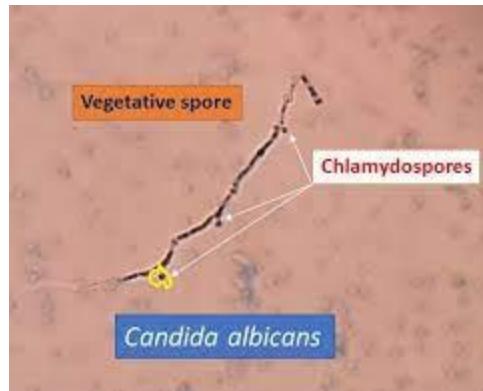


DEUTEROMYCETES- FUNGI INPERFECTI

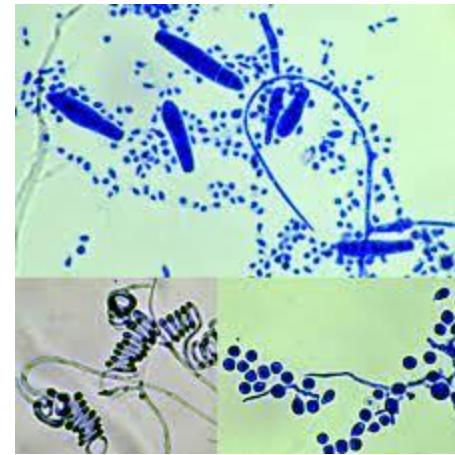
- Only asexual reproduction seen
- Asexual spores of Deuteromycetes are called as **thallospores**
- They are derived from original hyphae itself, not from modified ones
- **Blastospores/bastoconidium in yeast :**
Spores produced from budding process from vegetative cells or from a hyphae
- The bud constrict at the base and detach from mother to reproduce further by budding
- It is seen in *Candida albicans* and *Cryptococcus neoformans*
- **Pseudohyphae** – filaments composed of elongated budding cells that failed to detach in *Candida albicans*



- **Chlamydospores:** Thick walled resistant spores formed by the direct differentiation of hyphae.
- It is seen in *Candida albicans* and *Histoplasma capsulatum*
- **Arthrospheres**
- Formed by fragmentation of hyphae. It is very common in **dermatophytes**
- In addition dermatophytes produce macro conidia and microconidia
- **Microconidia:** very small asexual spores of various shapes and size which may occur on side of hyphae “en thyrse” or in clusters “en grappe”

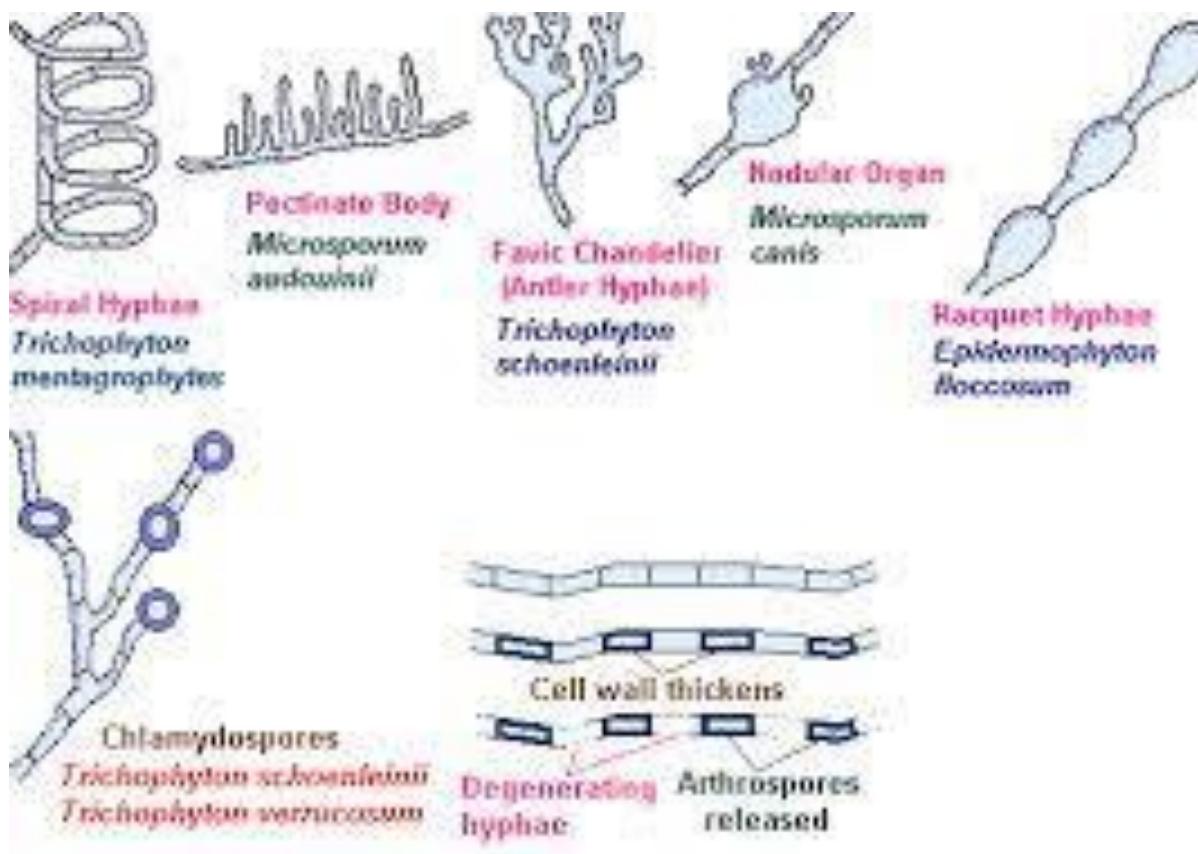


- Macro conidia
- Usually larger and elongated
- In *Microsporum* spp. they are multiseptate, fusiform or spindle shaped some time thick walled or with wrinkled wart like walls
- In *Trichophyton* spp. they are long thin multiseptate, smooth walled and cigar shaped
- In *Epidermophyton* spp. oval or pear shaped and have only few septa



- In addition dermatophytes produce abnormal hyphal forms like
- **Racquet hyphae**
- Composed of chain of individual elongated hyphal cells expanded at one end and resemble a tennis racquet
- **Spiral or coiled hyphae**
- Coiled or cork screw shaped which resemble the shape of plant tendrils
- **Pectinate hyphae**
- Resemble tooth of a comb
- **Favic Chandliers**
- Irregular projections on one or both side of hyphae similar to antlers/ stag horns (very characteristic of *Trichophyton schoenleinii*)
- **Nodular body** : hyphae may intervene and form hard dormant nodular bodies





MYCOSES

- Diseases caused by fungi is called mycoses
- Disease are three types based on the tissues affected
- Superficial mycoses/ Dermatomycoses
- S/c or Intermediary mycoses
- Deep / visceral or systemic mycoses



SPERFICIAL MYCOSES- DERMATOPHYTOSIS

- Caused by Dermatophytes
- generally known as ring worm fungi.
- This require keratin for their growth and affect stratum corneumof skin hair nail etc
- there are three important genera
- *Trichophyton*
- *Microsporon*
- *Epidermophyton*
- This organism are classified under Ascomycetes



- Based on tropism dermatophytes are classified as
- Zoophilic- present in animals
 - *M. canis* and *Trichophyton verucosum*
- Geophilic : Natural habitat is soil
 - *M. gypseum*
 - *M. nanum*
 - *T. simii*
- Anthropophilic: Primarily infect human being
 - *T. rubrum*
 - *E. floccosum*



- The disease produced by Trichophyton and microsporon in human being is called Tinea
- Both microsporon and Trichophyton produce disease in animals and human being
- Trichophyton will affect skin, hair and nail
- Microsporum will affect skin and hair
- Epidermophyton affects nail and skin



IMPORTANT SPECIES ARE

Trichophyton	Microsporon	Epidermophyton
T. verrucosum,	M. nanum	Epidrmophyton
T. Equinum	M. Distortum	floccosum
T. Violaceum	M. Gypseum	
T. Mentagrophytes	M. Canis	
T. Schoenlenii	M. Audouini	
T. Gallinae	M. gallinae	
T. simii		



PATHOGENESIS

- These organism cause hydrolysis of keratin
- As a result of infection the host mount inflammatory response
- Organism can not thrive in an area of intense infection and will move to periphery
 - so it will produce ring like lesions
- Central area will have heated appearance and inflammed periphery
- Lesions are by toxins, allergens and enzymes like keratinase and collaginase



- Disease in four forms
- Subclinical
- Classical ring worm
- Generalised form
- Kerion / tumor like lesions in dogs



CLINICAL SIGNS

- In dogs and cat important organism is *Microsporon canis*
- Main lesion occur in face and extremity
- it will produce crusty alopecia lesion
- in cattle important organism is *Trichphyton verucosum* and *T. mentagrophytes*
- lesions mainly in face and neck region
- Extent of lesion may vary
- it can be mild infection characterised by eruption and alopecia
- Chronic lesions are yellowish brown, very thick asbestose like

- In horse Trichopyton equinum and Trichophyton mentagrophytes lesions are seen in withers, saddle and girth.
- Lesion can be either urticarial eruption or deep ulcerative nodule
- In sheep and goat organism are Trichophyton veerrucosum and T. mentagrophytes
- In pigs
- T. verrucosum
- T. mentagrophytes
- M.nanum
- In pig urticarial lesion on the base of ear and trunk

- In poultry
- *T. gallinae*
- *M.galline*
- disease is known as avian ring worm or favus
- Disease seen as white patchy crust on comb and wattle

DIAGNOSIS

- Symptoms and lesions
- Ring worm appearance
- Examination of infected hair usin Wood's lamp or UV lamp
- If infected hair is shown on wood lamp, there will be apple green florescence due to the production of metabolite of Tryptophan by the organism
- In positve infection by M canis, M. distortum and M. audonii
- False positive with dandruff or application of salicylic acid or petroleum jelly

DIRECT MICROSCOPICAL EXAMINATION OF SKIN SCRAPPING OT HAIR

- Before collection of these , clean the area with 70% alcohol. Scrape skin from old and new lesions with blunt scalpel or razor blade untill blood oozes to come out
- Better to pluck hair
- Take skin scarpping or hair o n a clean slide and add 2-3 drop of 10-20 % KOH (Keratlytic). Gently warm the slide at 60oC for 5-1 minutes. Put coverslip and examine under low and high power
- KOH cause partial digstion of Keratin leading to clearing of specimen



STAIN WITH LACTOPHENOL COTTON BLUE

- In DME of arthrospores of fungi. Most fungal agents of animals, spores can seen on external surface of hair and such arrangement called ectothrix
- *M. canis*
- *T. verrucosum*
- *T. mentagrophytes*
- In some other case large spore arranged lineraly within hair shaft called endothrix
- *T. violaceum*
- *T. schoelleiniialong* with spore. Large number of air bubbles also seen
- *T. gallinae*, *T. simii*, *T.rubrum* will not affect hair