

# MYCOLOGY

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# MYCOLOGY

- 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**

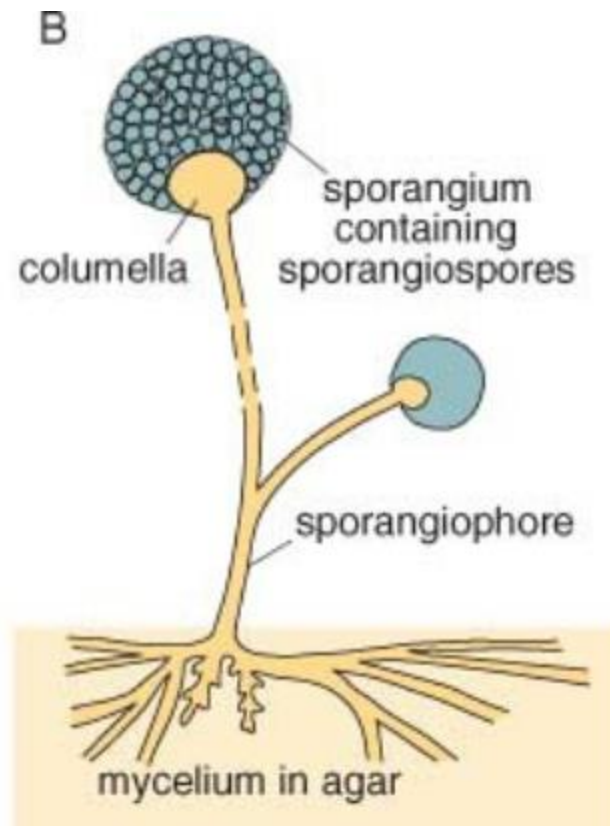
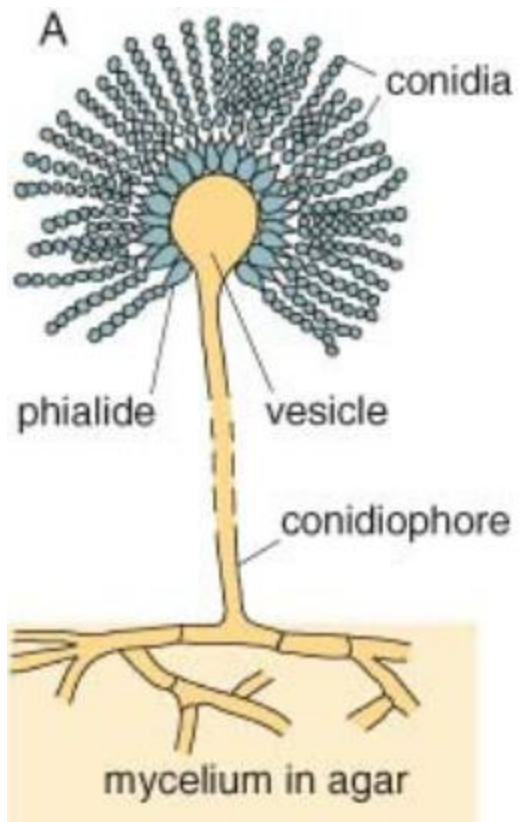




## MOULDS AND YEAST

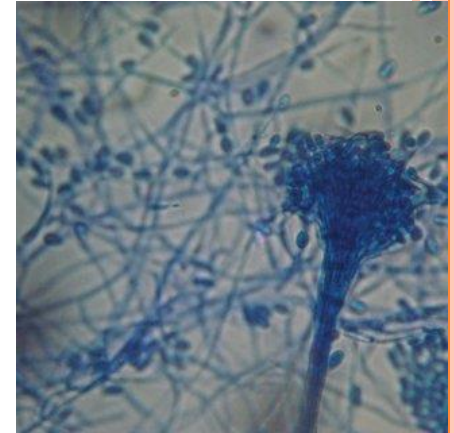
- Two main morphological forms of fungi are molds and yeasts
- Molds grow as branching filaments called hyphae (2-10 $\mu$ m) diameter whereas unicellular yeasts have an oval or spherical appearance 3-5  $\mu$ m in diameter
- **Dimorphic fungi** occur in both yeast and mold forms
- Some fungi like *Candida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

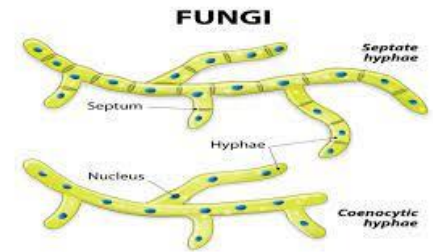




# CHARACTERISTIC OF FUNGI

- 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

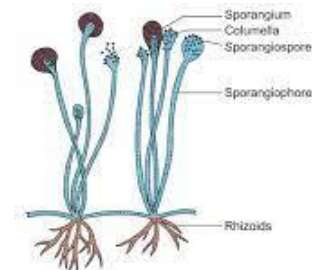
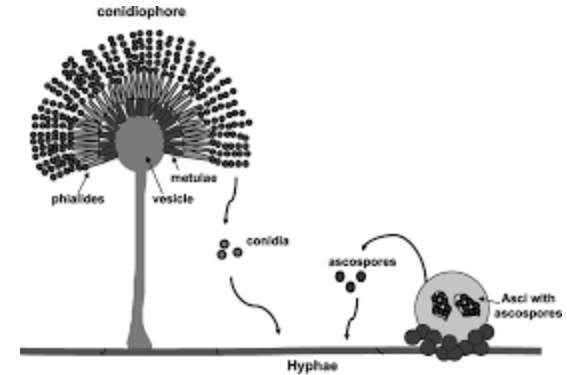
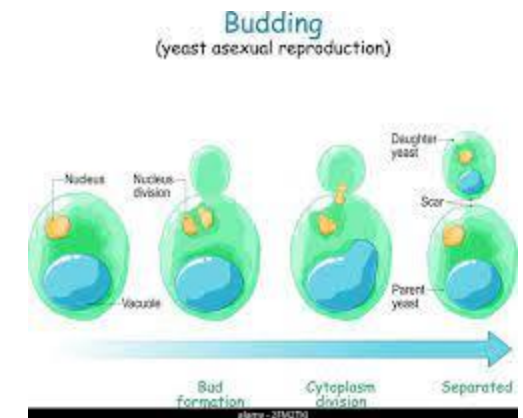


Figure 1.26: *Rhizopus*



- 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 Arthrospore**
- 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

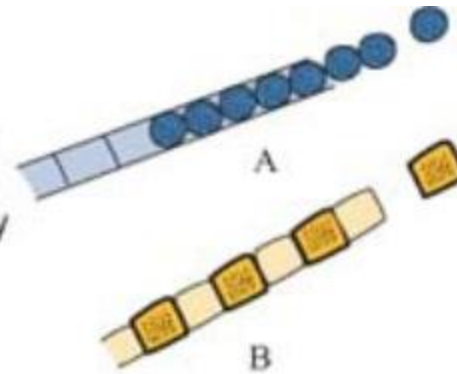


- **Macro conidia**
- Large multicelled conidia which are produced by Dermatophyte in culture
- **Micro conidia**
- Small conidia are produced by certain dermatophytes
- **Phialo conidia**
- Conidia produced from phialids
- The Phialides of Aspergillus species arise from a vesicle
- **Sporangiospores**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



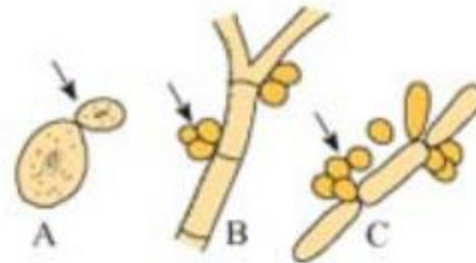
### **Arthroconidia** (arthrospores)

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)



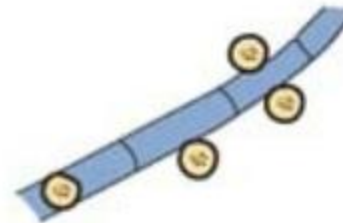
### **Blastoconidia** (blastospores)

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



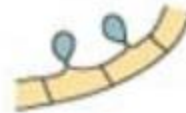
### Macroconidia

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



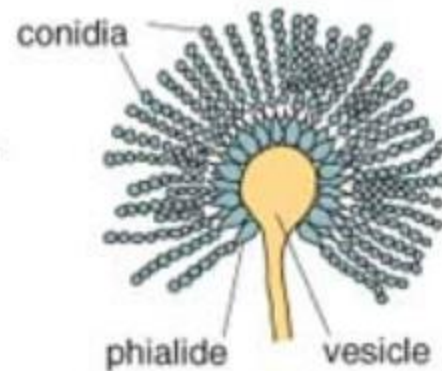
### Microconidia

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

- **Zygosporangia**

- 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     |



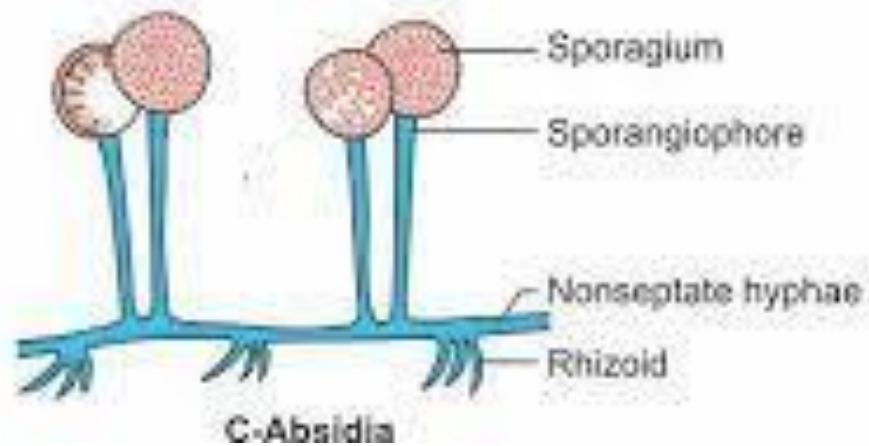
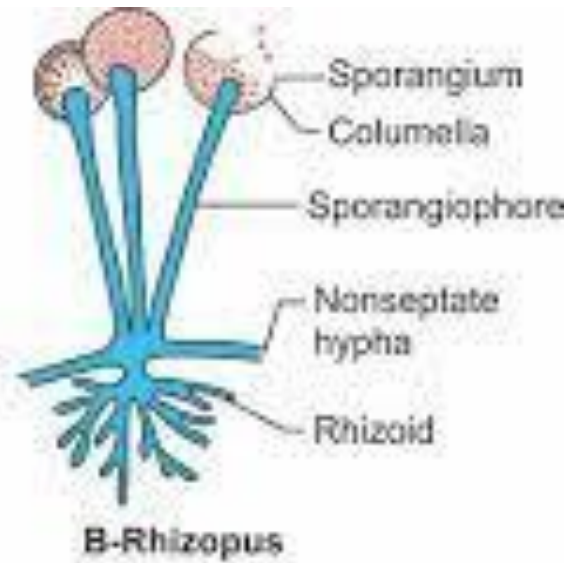
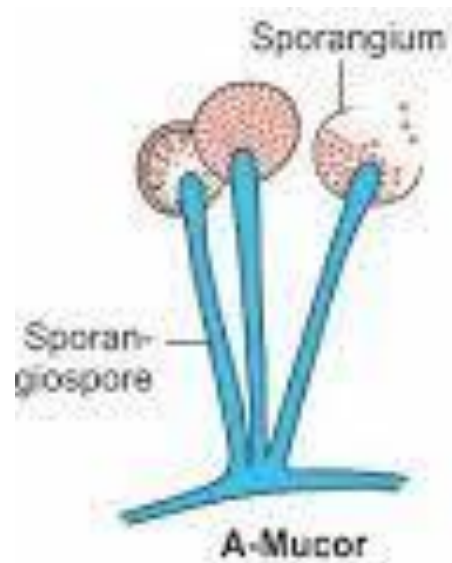
# REPRODUCTION IN ZYGOMYCETES

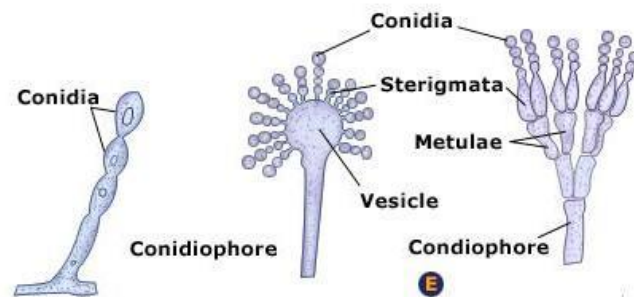
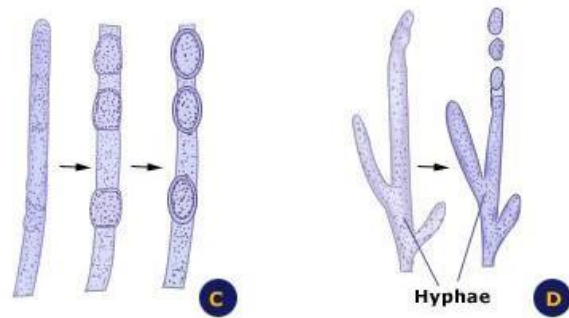
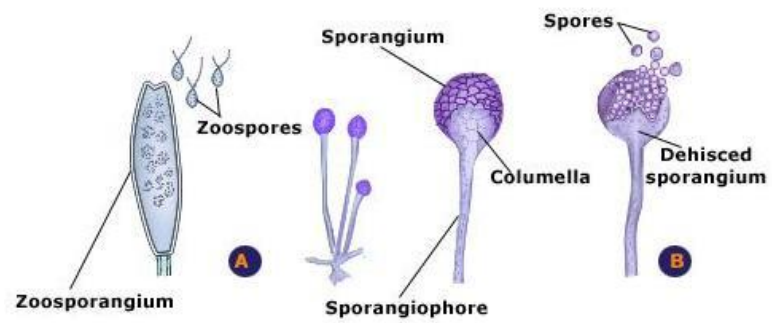
- Asexual reproduction
- Long non septate aerial filament called **sporangiophore** which have an expended tip called **columella**
- Surrounding which is a sac like closed structure called **sporangium**
- Sporangium contains numerous asexual spores called **sporangiospores**.
- When spores mature,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



- Sporangiospores are two types
- **Aplanospores** 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

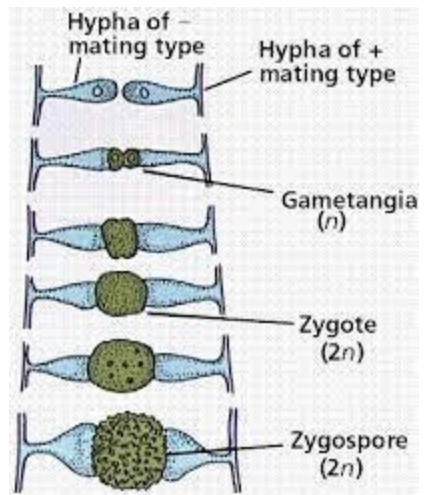






- Sexual reproduction
- Two types
- By fusion of like gametes
- By fusion of unlike gametes
- In the first two suitable adjacent hyphae come together and form short side branches called **suspensors**
- At the point the suspensors meet , a **gametangium** is formed
- The gametangia formed fused to form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



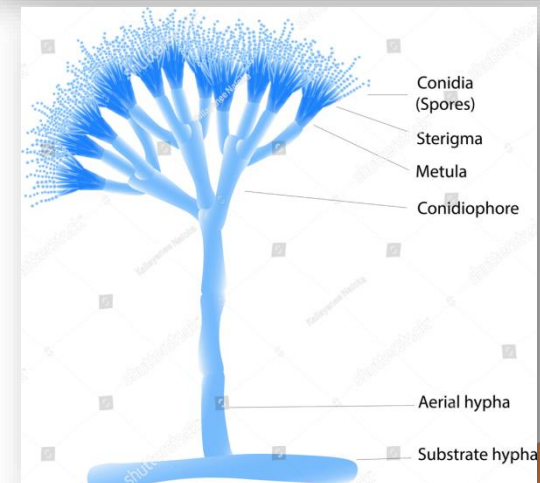
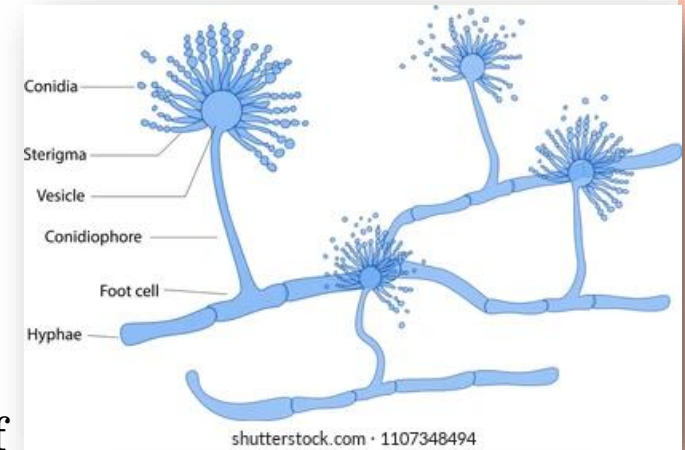


- In the second type there is specialised female structure called **oogonium** fertilised by transfer of nucleus from the male structure called **antheridium**
- The sexual spore formed is called **oospore**. The structure which contain the oospore is called **oosphere**



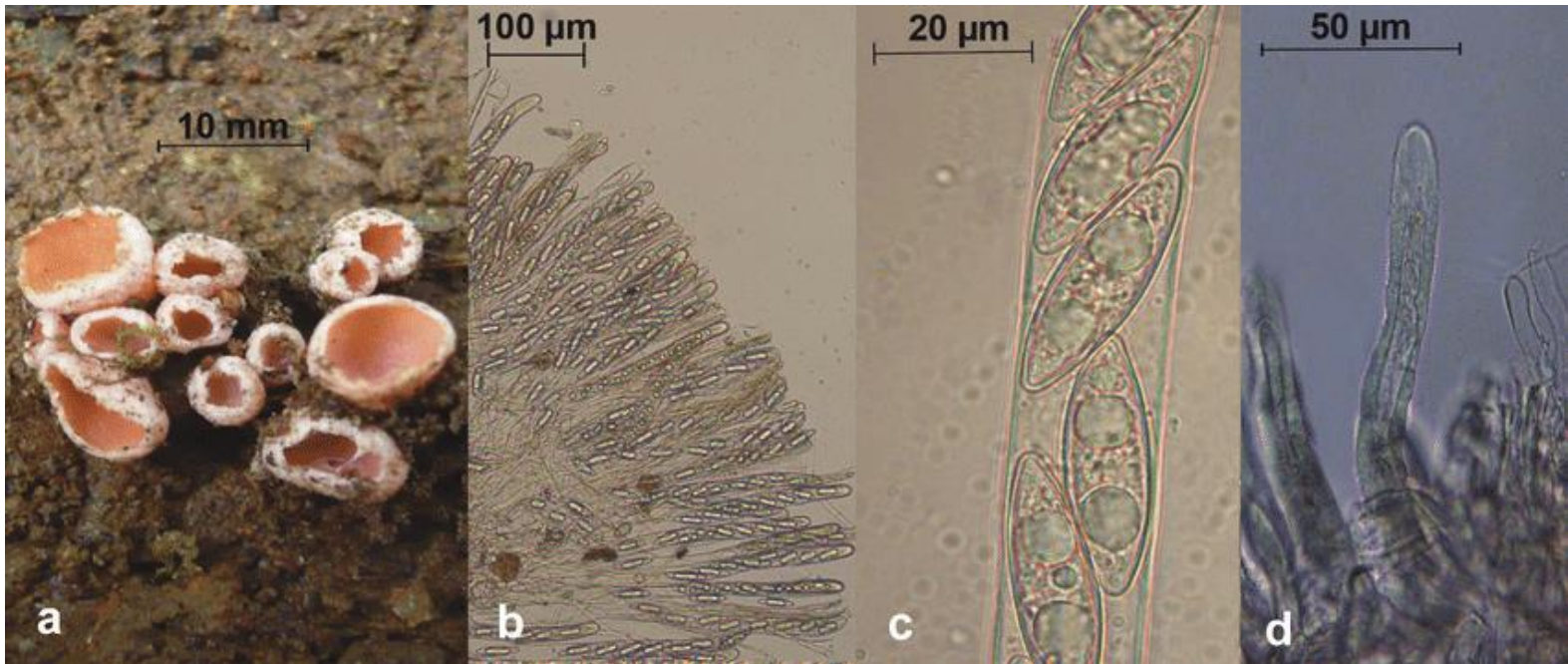
# REPRODUCTION IN ASCOMYCETES

- 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 **metulae** 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 formed 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
- **Perithecium** 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

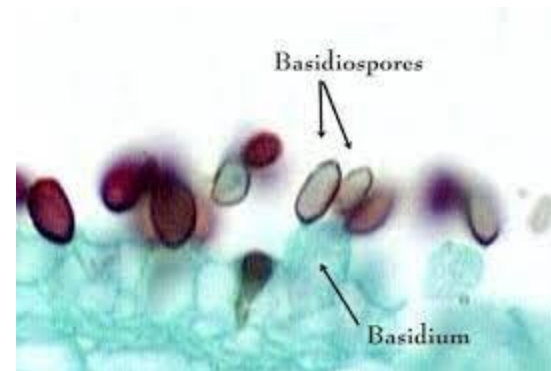
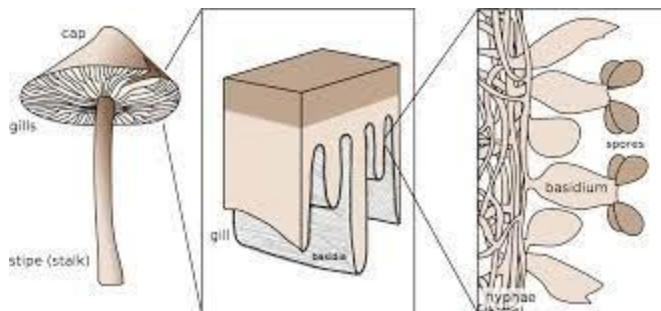


Apothecium



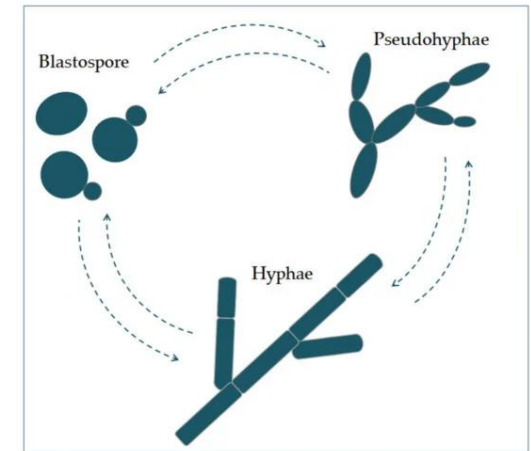
# REPRODUCTION IN BASIDIOMYCETES

- 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**

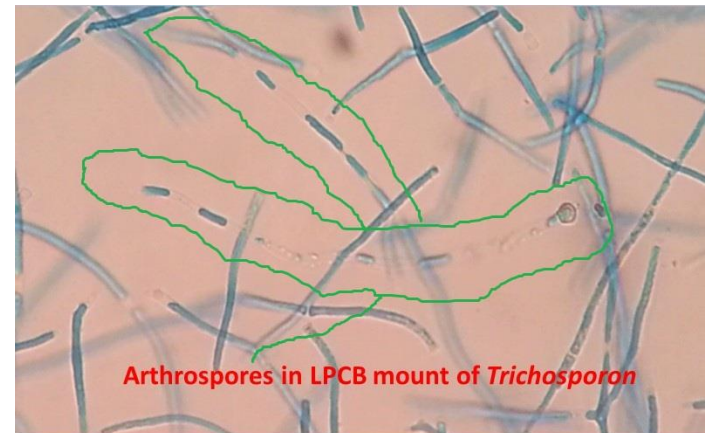
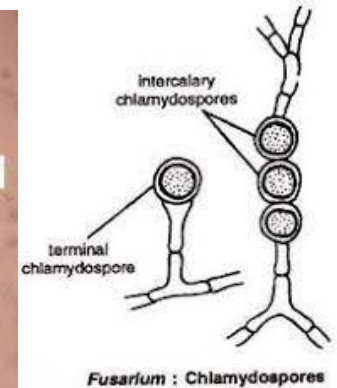
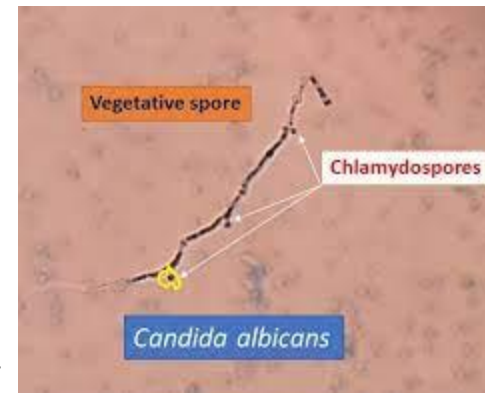


# DEUTEROMYCETES- FUNGI IMPERFECTI

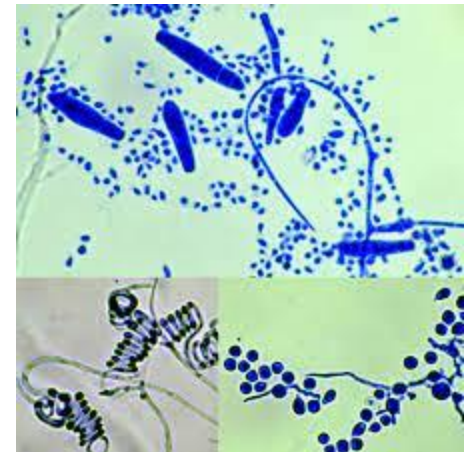
- Only asexual reproduction seen
- Asexual spores of Deuteromycetes are called as **thallospores**
- They are derived from original hyphae itself, not from modified ones
- **Blastospores/bastoconidium in yeast**: Spores produced from budding process from vegetative cells or from a hyphae
- The bud constrict 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*
- **Arthrospores**
- 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 thyrsé” or in clusters “en grappe”

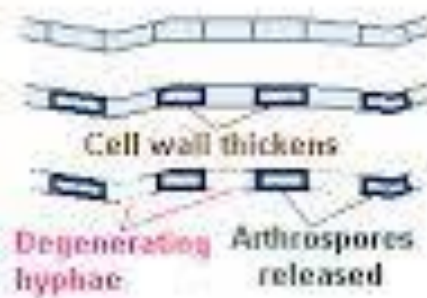
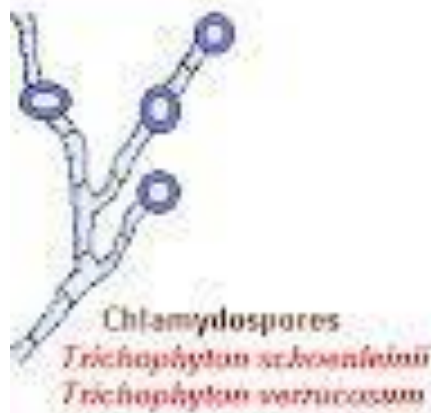


- Macro conidia
- Usually larger and elongated
- In microsporum spp. they are multiseptate, fusiform or spindle shaped some time thick walled or with wrinkled wart like walls
- In Trichophyton spp. they are long thin multiseptate, smooth walled and cigar shaped
- In Epidermophyton spp. oval or pear shaped 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 corneum of 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 verucossum*
- 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,<br>T. Equinum<br>T. Violaceum<br>T. Mentagrophytes<br>T. Schoenlenii<br>T. Gallinae<br>T. simii | M. nanum<br>M. Distortum<br>M. Gypseum<br>M. Canis<br>M. Audouini<br>M. gallinae | Epidermophyton<br>floccosum |



# 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 healed appearance and inflamed periphery
- Lesions are by toxins, allergens and enzymes like keratinase and collagenase



- 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 *Trichophyton 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 verrucosum* 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 using Wood's lamp or UV lamp
- If infected hair is shown on wood lamp, there will be apple green fluorescence due to the production of metabolite of Tryptophan by the organism
- In positive 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 OR HAIR

- Before collection of these , clean the area with 70% alcohol. Scrape skin from old and new lesions with blunt scalpel or razor blade until blood oozes to come out
- Better to pluck hair
- Take skin scraping or hair on a clean slide and add 2-3 drop of 10-20 % KOH ( Keratolytic). Gently warm the slide at 60°C for 5-10 minutes. Put coverslip and examine under low and high power
- KOH cause partial digestion 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 be seen on external surface of hair and such arrangement called ectothrix
- *M. canis*
- *T. verrucosum*
- *T. mentagrophytes*
- In some other case large spore arranged linearly within hair shaft called endothrix
- *T. violaceum*
- *T. schoenleinii* along with spore. Large number of air bubbles also seen
- *T. gallinae*, *T. simii*, *T. rubrum* will not affect hair

