**Mycology lectures2015 3rd year students, first lecture**

**Dr.Kareema Amine Al-Khafajii, professor ,Department Of Microbiology, College Of Medicine, University of Babylon.**

* **Mycology** is the study of fungus. All fungi are eukaryotic organisms, non-motile. Most of them are obligate aerobic, some are facultative aerobic. Some of them are capsulated, all fungi are ,heterotrophic, chemotrophic organisms. Gram positive, natural habitat is the environment .
* Fungi exhibit diverse lifestyles: it lives either: free in nature, saprophytic ,parasitic or mutalistic. Fungi live everywhere in the air, in water, on lands, in soil, and in and on plants and animals .

**Classification of fungi: Based on Sexual reproduction:**

1. Zygomycetes: which produce through production of zygospores.

2. Ascomycetes: which produce endogenous spores called ascospores in cells called asci.

3. Basidiomycetes: which produce exogenous spores called basidiospores in cells called basidia.

4. Deuteromycetes (Fungi imperfecti): fungi that are not known to produce any sexual spores (ascospores or basidiospores). This is a heterogeneous group of fungi where no sexual reproduction has yet been demonstrated.

**Based on Morphology:**

1. Moulds (Molds): Filamentous fungi Eg: Aspergillus sps, Trichophyton rubrum

2. Yeasts: Single celled cells that buds Eg: Cryptococcus neoformans, Saccharomyces cerviciae

3. Yeast like: Similar to yeasts but produce pseudohyphae Eg: Candida albicans

4. Dimorphic: Fungi existing in two different morphological forms at two different environmental conditions. They exist as yeasts in tissue and in vitro at 37oC and as moulds in their natural habitat and in vitro at room temperature. Eg: Histoplasma capsulatum, Blastomyces dermatidis, Paracoccidiodes, brasiliensis, Coccidioides immitis.

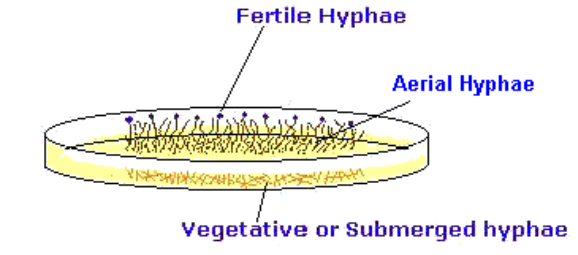
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**Moulds**: The thallus of mould is made of hyphae, which are cylindrical tube like structures that elongates by growth at tips. A mass of hyphae is known as mycelium. It is the hypha that is responsible for the filamentous nature of mould. The hyphae may be branched or unbranched. They may be septate or aseptate. Hyphae usually have cross walls that divide them into numerous cells. These cross walls, called septa have small pores through which cytoplasm is continuous throughout the hyphae. Therefore all hyphal fungi tend to be coenocytic (multinucleate). With exception of zygomycetes (Rhizopus, Mucor), all moulds are septate. Non-septate hyphae are considered to be more primitive because if a hyphal strand is damaged the entire strand dies. When a septate hyphal strand is damaged, the pores between adjacent compartments can be plugged, thus preventing death of the whole hyphal strand.

Mycelium are of three kinds:

1. Vegetative mycelium are those that penetrates the surface of the medium and absorbs nutrients.

2. Aerial mycelium are those that grow above the agar surface

3. Fertile mycelium are aerial hyphae that bear reproductive structures such as conidia or sporangia. Since hypha is the structural unit of mould, the mycelium imparts colour, texture and topography to the colony. Those fungi that possess melanin pigments in their cell wall are called phaeoid or dematiaceous and their colonies are coloured grey, black or olive. Examples are species of Cladosporium. Those hyphae that don't possess any pigment in their cell wall are called hyaline. ****

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**Yeasts:**

Yeast is a unicellular spherical to ellipsoid cell . They reproduce by budding, which result in blastospore (blastoconidia) formation. In some cases, as the cells buds the buds fail to detach and elongate thus forming a chain of elongated hyphae like filament called **pseudohyphae**. This property is seen in *Candia albicans*. The same species also have the ability to produce true hypha, which is seen as **germ tube**. The **difference** between the two is that there is a constriction in psueudohyphae at the point of budding, while the germ tube has **no** constriction.



Some yeast such as Cryptococcus and the yeast form of Blastomyces dermatatidis produce polysaccharide **capsule.**Capsules can be demonstrated by negative staining methods using India ink or Nigrosin.

Some yeasts **are pigmented**. Rhodotorula sps produces pink colonies due to carotenoid pigments whil some

yeasts such as Piedraia hortae are **dematiaceous,** producing brown to olivaceous colonies.

**True yeasts** such as Saccharomyces cerviciae **don't**  produce pseudohyphae . Yeast-like fungt may be , such as Candida albicans.

**Yeast like fungi**

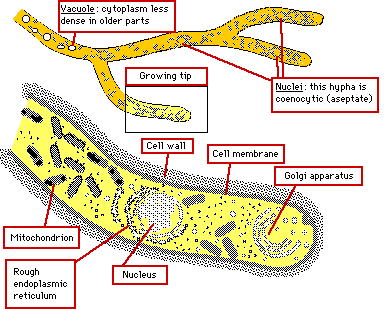
Grow partly as yeasts and partly as elongated cells resembling hyphae which are called pseudohyphae.e.g. Candida albicans

**The dimorphic fungi** :are phylogenetically related pathogens and include several species: *Coccidioides*, *Paracoccidioides*, *Blastomyces*, and *Histoplasma*. Together, these species are the most common etiologic agents of pulmonary infection by fungi in healthy hosts, causing over one million new infections each year in the United States alone. These **fungi exist** as a nonvirulent filamentous form in the soil and a budding yeast form (or in the case of*Coccidioides*, a related spherule/endospore form) in the host pulmonary system.

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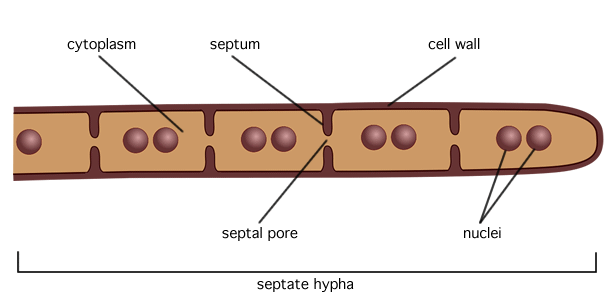
**Structure of fungi**

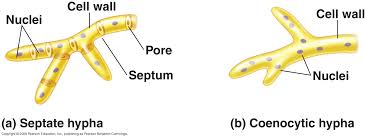
All fungi have typical eukaryotic morphology. They have rigid cell wall composed of chitin, which may be layered with mannans, glucans and other polysaccharides in association with polypeptides. Some lower fungi possess cellulose in their cell wall. Some fungi such as Cryptococcus and yeast form of Histoplasma capsulatum possess polysaccharide capsules that help them to evade phagocytosis. Inner to the cell wall is the plasma membrane that is a typical bi-layered membrane in addition to the presence of sterols. Fungal membranes possess ergosterol in contrast to cholesterol found in mammalian cells. The cytoplasm consists of various organelles such as mitochondria, golgi apparatus, ribosomes, endoplasmic reticulum, lysosomes, microtubules and a membrane enclosed nucleus. A unique property of nuclear membrane is that it persists throughout the metaphase of mitosis unlike in plant and animal cells where it dissolves and re-forms. The nucleus possesses paired chromosomes.



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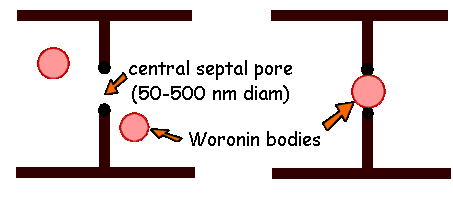
**Septum**(plural, **septa**): This structure can be thought of as a valve between adjacent hyphal cells to prevent the accidental loss of cell organelles between hyphal compartments. Pores within the septa allow the organelles and nutrients to flow freely when required. Not all fungi have septa. [**Oomycetes**](http://www.aber.ac.uk/fungi/fungi/taxonomy.htm) **lack septa**, and the form of septum varies from phylum to phylum. [**Ascomycetes**](http://www.aber.ac.uk/fungi/fungi/taxonomy.htm)**h**ave simple septa, with the pore being plugged with a **Woronin** body if damage occurs to the hypha.

Aseptate **or**[**coenocytic**](http://en.wikipedia.org/wiki/Coenocyte)**(without septa)**



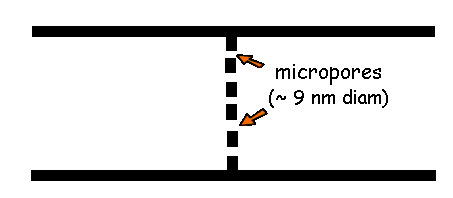
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Ascomycota and some mitosporic fungi:



* Hyphae of fungi belonging to these groups (and the Basidiomycota) possess perforated septa at regular intervals along their length.
* The septum consists of a simple plate with a relatively LARGE CENTRAL PORE (50-500 nm diameter) - this allows cytoplasmic streaming (the movement of organelles, incl. nuclei) between adjacent hyphal compartments.
* Cytoplasmic streaming enables sub-apical and intercalary (central) compartments of young hyphae to contribute towards growth of the hyphal tip - transporting nutrients and essential enzymes to the apex - so maximizing the capacity for somatic growth.
* Associated with each septum are spherical, membrane-bound organelles called [WORONIN BODIES](http://www.fungionline.org.uk/glossary.html#woronin) that ........
  + are composed of protein;
  + remain close to the septal pore and tend not to be disturbed by the cytoplasmic streaming taking place;
  + tend to be of the same or larger diameter than the septal pore and are, therefore, capable of blocking the pore;
  + will block the septal pore if the adjacent hyphal compartment is damaged or ageing and becoming highly vacuolated.
* Not all fungi belonging to the Acomycota possess Woronin bodies - those that don't often possess LARGE HEXAGONAL CRYSTALS OF PROTEIN in the cytoplasm that are capable of serving the same function, i.e. they can seal the septal pores of damaged or ageing hyphae.

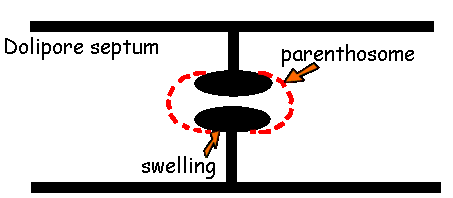
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Some other mitosporic fungi: 

* A number of mitosporic fungi possess septa with a single central pore, similar to that observed in the Ascomycota.
* But other mitosporic fungi may possess MULTIPERFORATE SEPTA.
* E.g. the septa of *Geotrichum candidum* (illustrated above) possess characteristic MICROPORES (approx. 9 nm diameter).
* The number of pores in each septum can vary up to a maximum of approx. 50.
* These micropores allow cytoplasmic continuity between adjacent hyphal compartments, but are too small to allow cytoplasmic streaming to occur to the extent observed in fungi possessing larger septal pores.

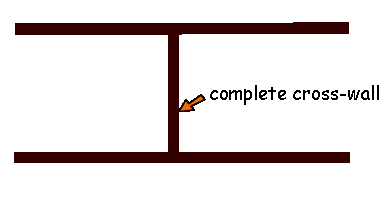
Basidiomycota:

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* The most complex type of septum is found in fungi belonging to **the Basidiomycota**.
* Each septum is characterized by a swelling around the central pore (DOLIPORE) and a hemispherical perforated cap (PARENTHOSOME) on either side of the pore - illustrated above.
* The perforated parenthosome allows cytoplasmic continuity but prevents the movement of major organelles.
* The plasma membrane lines both sides of the septum and the dolipore swelling, but the membrane of the parenthosome is derived from endoplasmic reticulum.

Oomycota and Zygomycota:



* In general, the [hyphae](http://www.fungionline.org.uk/glossary.html#hyphae) of fungi belonging to these groups are not regularly septate (although there are some exceptions).
* But septa in the form of COMPLETE CROSS-WALLS are formed to isolate old or damaged regions of the[mycelium](http://www.fungionline.org.uk/glossary.html#mycel) or to separate reproductive structures from somatic hyphae.

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Functions of septa:

* Act as STRUCTURAL SUPPORTS
  + The addition of plate-like cross-walls to what is essentially a long tube-like structure (hypha) will help stabilize it.
* Act as the FIRST LINE OF DEFENCE when part of a hypha is damaged
  + Large-pored septa that have Woronin bodies or large proteinaceous crystals associated with them have the advantage that cytoplasmic streaming can occur between adjacent compartments.
  + But at the same time a mechanism exists for rapidly sealing the septal pore under conditions of stress (e.g. if the hypha is damaged) thereby helping protect the mycelium.
* Facilitate DIFFERENTIATION in fungi
  + Septa can isolate adjacent compartments from one another so that different biochemical and physiological processes can occur within them - these may result in differentiation of the hyphae into specialized structures, such as those associated with sporulation.
  + It's unlikely to be coincidental that the most complex and highly differentiated sporulating structures we see are those produced by fungi possessing the most complex types of septa, i.e. fungi belonging to the Basidiomycota.

**Importance of fungi:** Fungi inhabit almost every niche in the environment and humans are exposed to these

organisms in various fields of life.

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**Beneficial Effects of Fungi** 1-Decomposition - nutrient and carbon recycling. 2-Biosynthetic factories. The fermentation property is used for the industrial production of alcohols, fats, citric acids oxalic and gluconic acids, 3-Important sources of antibiotics, such as Penicillin 4-Model organisms for biochemical and genetic studies. Eg: Neurospora crassa. 5-Saccharomyces cerviciae is extensively used in recombinant DNA technology, Vaccine,vitamins,insulins…etc. hich includes the HepatitisB. 6- Some fungi are edible (mushrooms). 7-Yeasts provide nutritional supplements such as vitamins and cofactors. 8-Penicillium is used to flavour Roquefort and Camembert cheeses 9-Ergot produced by Claviceps purpurea contains medically important alkaloids that help in inducing uterine contractions, controlling bleeding and treating migraine 10-Fungi (Leptolegnia caudate and Aphanomyces laevis) are used to trap mosquito larvae in paddy fields and in paddy fields and . thus help in malaria control

**Harmful Effects of Fungi**

Destruction of food, lumber, paper, and cloth.- 1

. Animal and human diseases, including allergies.- 2

3-Toxins produced by poisonous mushrooms and within food (Mycetism and Mycotoxicosis)

4-Plant diseases

. 5-Spoilage of agriculture produce such as vegetables and cereals in the godown

6-Damage the products such as magnetic tapes and disks, glass lenses, marble statues, bones and wax

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