**L.1 –Biotechnology Mycology D.Ibtihal Muiz**

**An introduction to fungal form, fungal cell wall architecture and**

**hyphal growth**

**Introduction**   
 Fungi have the several features that distinguish them from other organisms. They have a filamentous branching system of cells, with apical growth, lateral branching and a heterotrophic nutrition. They are characterized by a life cycle that begins with germination from a spore or resting structure, followed by a period of growth as a substrate is exploited to produce biomass. Finally there is a period of sporulation, where propagules are formed that can be disseminated from the parent mycelium -   
 They are vital to the biosphere for many reasons, not least for their decomposing activities on dead substrates that ensure the release of nutrients like carbon, minerals and nitrogen back into the biosphere.

There are about 250.000 species of flowering plants in the world, there are probably six times as many fungi - about 1,500,000 fungi,

The fungi (singular fungus ) are a kingdom of eukaryotic organisms . The are heterotrophic and digest their food externally , absorbing nutrient molecules into their cells . Yeasts , molds and mushroom are examples of fungi . Their vegetative cells usually have chitinous cell walls (chitin is a polymer composed of N-actetylglucosamine). Fungi live in their food, secreting digestive enzymes that break food polymers into monomers and oligomers that can be absorbed through the fungal cell wall   
 The branch of biology involving the study of fungi is knownas mycology (Gr. Mykes mushroom  + logos = discourse).

Mycology is the study of fungi, mykes (Gr.) - cap.; mushroom, fungus (L.) = sphongos (Gr.)—sponge.   
Mycology is improperly coined; according to the rules of Greek grammar it should be mycetology. there are approximately 70,000 described species of fungi, however, it is estimated that there are over I million species of fungi on the planet.

**Taxonomy** The origin of the fungi appears to be very ancient. They first appear in the fossil record coincidentally with the appearance of the land plants. This was in the Devonian period around 400 million years ago. The early microscopists found that fungi were simple to study, and they first observed division of cells by watching yeasts under the microscope.   
They were one of the earliest groups to be classified, and the earliest scheme was drawn up in 1588. Early biological science was much obsessed with categorizing things and researchers constructed taxonomic systems based solely on structure. However, for the fungi, this created a polyphyletic group that contained microorganisms that had very different ancestors.   
 Taxonomic thinking today now prefers a monophyletic classification, where all groups within a phylum are descendants of one ancestor. Therefore current taxonomy relies or.studying characters that are features or attributes of an individual organism that can be used to compare it with another organism. These features can be morphological, anatomical, ultra-structural, biochemical or based on sequences of nucleic acids.   
Fungi are referred to as the True Fungi, or Eumycota, and are currently divided into four (plus one form class) major phyla on the basis of the morphology and sexual reproduction. New information based on presence and type of mitochondria, and the DNA sequencing of ribosomal RNA, place the members of the fungi into a complex phylogenetic tree.

**Table 1. Features of the main groups of fungi.**

**Group: Perforate septic Asexual Sexual   
 *+/-*  sporulation: sporulation:**

*Zygomycotina*  - *non-motile* zygospore   
 sporangiospores

*Chytridiomycotina* - motile zoospores oospore

*Ascomycotina* + conidiospores ascospore

*Basidiomycotina*  + rare basidiospore

*Deuteromycotina*  + conidiospores none

Two of the phyla are sometimes incorrectly described as Lower fungi, the *Zygomycotina* and the *Chytridiomycotina.* In the lower fungi vegetative mycelium is non-septate, and complete septa are only found in reproductive structures. Asexual reproduction is by the formation of sporangia, sexual reproduction by the formation of zygospores. We will return to these details later.  
 The other two phyla are sometimes described as the Higher fungi and have a more complex mycelium with elaborate, perforate septa. They are divided into the *Ascomycotina* and the *Basidiomycotina.* Members of the *Ascomycotina* produce asexual conidiospores and sexual ascospores in sac-shaped cells called asci. Fungi from the *Basidiomycotina* rarely produce asexual spores, and produce their sexual spores from club-shaped basidia in complex fruit bodies.   
 A particular problem for some of the fungi is that they do not possess sexual stages., and this lead to the construction of an artificial taxonomic group based on the asexual, mitosporic stage of the fungus. This group is a form group called the *Deuteromycetes,* or Imperfect fungi. However, using the current cladistic approaches mycologists are slowly establishing links between these species and other species with sexual stages.   
It is important to know the taxonomic terms for the kingdom.

Kingdom: Fungi   
Division: *Eumycota*(sub-division) e.g. *Basidiomycotina*Class: e.g. *Basidiomycetes*Order: e.g. *Agaricales*

Family: e.g. *Agaricaceae*Genus: e.g. *Agaricus*Specie: e.g. *Agaricus bisporus* - The mushroom!

**Cell biology of the fungi**  
 Their basic cellular unit is described as a hypha. This is usually a tubular cell which is surrounded by a rigid, chitin-containing cell wall. The hypha extends by tip growth, and multiplies by branching, creating a fine network called a mycelium. Hyphae contain nuclei, mitochondria, ribosomes, Golgi and membrane-bound vesicles within a plasma-membrane bound cytoplasm. The sub-cellular structures are supported and organized by micro-tubules and endoplasmic reticulum. Not all fungi are multicellular, some are unicellular and are termed yeasts. These grow by binary fission or budding, creating new individuals from the parent cell.

**Humans have utilized/interacted with fungi for thousands of years**

1. **Religion:**

1-Egypt : the god Osiris produced wine as a gift to humans   
2-Greece: Dionysus the god of win& (among other things)   
3-Rome: Bacchus the god of wine; mushrooms produced by thunderbolts thrown to earth by Jupiter   
4-Guatemaula & Mexico: mushrooms produced by thunderbolts; use of hallucinogenic mushrooms in rituals

**B. History:**1-Ergotism in Europe caused by the fungus *Claviceps purpurea*

2-Irish potato famine caused by the ‘fungus' *Phytophthora infestans*

**C. Economics and Industry** 1-Food industry: commercial cultivation, cheese, tempeh, food spoilage, mycotoxins

2-Medicine: vitamins, antibiotics   
3-Industrial: organic acids  
4-Pathogens: animal & plant

**D. Major advances in science**   
l*-Neurospora crassa:* discovered by Shearer& Dodge in 1927 initiated the field of haploid genetics led to development of many modern genetic theories, Beadle & Tatum: Nobel prize for one gene-one enzyme; other biochemical pathways

2-discovery of antibiotics   
3-theory of symbiosis   
**Early scientists and mycologists**   
I-Van Leeuwenhoek - invention of the microscope, 17th century   
2-Pier’ Antonio Micheli - “Father” or founder of modern mycology; Italian botanist,   
1729 publication ‘Nova Plantarum Genera”; included his studies on fungi

**What arc fungi?**Eukaryotic, spore-bearing, heterotrophic organisms that produce extracelluar enzymes and absorbtheir nutrition

**Why Are Fungi Important to us?**1. What features distinguish fungi from other groups of organisms?   
2. In what ways are fungi typical eukaryotes?   
3. Why are fungi important?

**Nature of fungi *and* fungi-like organisms**

1- Fungi and fungi—like organisms are classified into three different kingdoms, reflecting their true genetic diversity. Yet they are considered together because many aspects of their life cycles, nutrition and pathology are similar.   
2-All true fungi and fungi-like organisms are **eukaryotic** (mitochondria and membrane-bound nucleus and organelles) varying from a few microns to several kilometers in size.   
3-They reproduce by **spores** and usually exist in thread-like chains of cells known as **hyphae.**   
4- They are almost always **heterotrophic,** butsome areautotrophic and can fix carbon dioxide using energy from the oxidation of (amino organic) nitrogen.   
5. all fungi are able to obtain food from other organisms either living or dead.   
6-the origin of fungi is still controversial but they are about I billion years old and derived from ancient **algal or** **protozoan** line (main fungal line) and more recently from the **siphonaceous crysophyte** algae (yellow-green or golden algae) (Oomycetes).   
7-Fungi are distinct from higher plants and animals: they have **polysaccharide** fibrillar cell walls, They can synthesize The **benzene** ring, and have biosynthetic pathways for **lysine, ethylene** and hundreds of other molecules.

**The fungal lifestyle**   
 we can think of fungi in a ’narrow’ taxonomic sense or in terms of lifestyle. This distinction is necessary because some of the organisms that we regard as fungi - the extremely important **potato blight** pathogen *(Phytophthora infestans)* is one example - are quite unrelated to the true fungi and belong to a separate kingdom of organisms However, we can define the fungi broadly in terms of lifestyle and accommodate all these organisms.   
1. Typically, fungi grow as filaments termed hyphae (singular: hypha). about 5-10 micrometres diameter. Hyphae are surrounded by a wall and extend at their tips, while drawing the protoplasm forwards as they grow. So fungi exhibit **apical growth**. The hyphae branch repeatedly to form the ’body’ of a fungus, termed the **mycelium**. The only major departure from the mycelial growth form is found in the unicellular **yeasts**, but even yeasts can produce hyphae in appropriate –conditions.   
2. All fungi **depend on pre. Formed organic nutrients** for energy and for synthesis of cellular materials. They obtain these nutrients in a characteristic way - by **absorbing simple, soluble nutrients** (sugars, amino acids, etc.) through their walls, and by **releasing extracellular enzymes** to degrade polymers that they cannot absorb.   
3. Fungi are **dispersed by means** of spores of almost infinite variety, produced by either an asexual or a sexual process **.**

**Fungi** are one of the three major groups of eukaryotic organisms, equivalent in status to plants and animals. They have major environmental and economic significance:

1.Fungi are the major decomposers of organic matter, especially of structural polymers such as cellulose, the most abundant on earth

2. Fungi cause about 70% of all the major crop disease .

3. By forming mycorrhizas with most land plant, fungi play a vital role in mineral nutrient uptake and in vegetational dynamics

4. the diverse metabolic pathways of fungi generate many commercial products such as ethanol, organic acids, enzymes, antibiotics, etc., but also some extremely potent toxins that affect human and animal health

5. with the advent of transplant surgery and the increase in immunosuppressive conditions including AIDS fungi are emerging as a significant group of life- threatening human pathogens .