Lecture 1: General Introduction

The term "mycology" is derived from two Greek words "mykes" meaning mushroom which is a fungus and "logy" is study. Therefore, mycology is the study of fungi. Fungi are among the most diverse organism on Earth, and are considered only second to the insects in species diversity. Fungi represent the second largest group of eukaryotic organisms on earth, with estimates ranging from 1.5 to 5.1 million species. There are more than 80,000 species of fungi are now described and 1700 species will have added each year. This described species includes only less than 5% from 1.5 million species of fungi.

Importance of fungi:

Members of the fungal kingdom play significant roles in human life and have the ability to occupy a wide variety of natural and artificial niches. Fungi inhabit almost every niche in the environment and other organisms such as humans and plants are exposed to these organisms in various fields of life. It truly can be said that scarcely a day passes during which all of us are not benefited or harmed directly or indirectly by the inhabitants.

Beneficial Effects of Fungi:

1. Decomposition - nutrient and carbon recycling. Fungi are most important on Earth as agents of decay. This is quite clear in forest ecosystems where fungi are the principal agents that decompose cellulose and lignin the primary components of wood (sometimes this decay is destructive of a wide variety of woods products, including lumber, railroad ties, ...).
2. Biosynthetic factories. The fermentation property is used for the industrial production of alcohols (brewing and baking), fats, citric acid (for soft drinks), oxalic and gluconic acids.
3. Important sources of antibiotics, such as Penicillin as well as those used as cholesterol-lowering, antibiotic, or immunomodulatory agents. Some notable examples include pravastatin,13 cyclosporine, amoxicillin and fingolimod (sold as Gilenya).
4. Model organisms for biochemical and genetic studies. Eg: *Neurospora crassa*
5. Used in recombinant DNA technology. *Saccharomyces cerviciae* is extensively, which includes the Hepatitis B Vaccine.
6. Some fungi are edible (mushrooms).
7. Some fungi provide significant benefits to both the fungi and the host plants involved. This association known as mycorrhizae.
8. Yeasts provide nutritional supplements such as vitamins and cofactors.

9. Some are used to flavouring cheese (Roquefort and Camembert cheeses) such as *Penicillium*.
10. Ergot produced by *Claviceps purpurea* contains medically important alkaloids that help in inducing uterine (womb), contractions, controlling bleeding and treating migraine.
11. Fungi used as traps. *Leptolegnia caudate* and *Aphanomyces laevis* are used to trap mosquito larvae in paddy fields and thus help in malaria control.
12. Some fungi are used to compete other harmful fungi as antagonistic fungi such as *Trichoderma harzianum* used against many plant pathogenic fungi. Others are used to control some harmful insects (they called entomopathogenic fungi) as a biological control of harmful insects.

Harmful Effects of Fungi:

1. Destruction of food, lumber, paper, and cloth.
2. Animal and human diseases (mycoses), including allergies.
3. Toxins produced by poisonous mushrooms and within food (Mycetism and Mycotoxicosis).
4. Plant diseases. Over 70% of all plant diseases are caused by fungi.
5. Spoilage of agriculture products such as vegetables and cereals in the warehouses.
6. Damage the products such as magnetic tapes and disks, glass lenses, marble statues, bones and wax.

What are fungi?

Traditionally biologists have defined fungi as eukaryotic, spore-producing, achlorophylous organisms with absorptive nutrition that generally reproduce both sexually and asexually and whose usually filamentous, branched somatic structures, known as hyphae, typically are surrounded by cell walls.

This definition is not perfect as any, like all definitions. It has become increasingly apparent in recent years that the organisms traditionally referred to as fungi are not all closely related. This has prompted some authors to use the term '' fungi'' in a very general sense and the term '' Fungi'' with capital F specifically for the so-called true fungi that appear to be related to one another.

General characteristics of fungi:

Based on their lifestyle, fungi may be circumscribed (defined) by the following set of characteristics:

1. They are eukaryotic; cells contain membrane bound cell organelles including nuclei, mitochondria, golgi apparatus, endoplasmic reticulum, lysosomes etc. They also exhibit mitosis.
2. Nutrition. Heterotrophic (lacking photosynthesis), feeding by absorption (osmiotrophic; they obtain their nutrients by absorption) rather than ingestion. They are chemo-heterotrophs (require organic compounds for both carbon and energy sources) and fungi lack chlorophyll and are therefore not autotrophic.
3. Have ergosterols in their membranes and possesses 80S ribosomes.
4. Have a rigid cell wall and are therefore non-motile, a feature that separates them from animals. All fungi possess cell wall made of chitin. Vegetative state. On or in the substratum, typically as a non-motile mycelium of hyphae showing internal protoplasmic streaming. Motile reproductive states may occur. Cell wall typically present, usually based on glucans and chitin, rarely on glucans and cellulose (Oomycota).
5. Habitat. Ubiquitous in terrestrial and freshwater habitats, less so in the marine environment.
6. Ecology. Important ecological roles as saprotrophs, mutualistic symbionts, parasites, or hyperparasites.
7. All fungi require water and oxygen and there are no obligate anaerobes.
8. Typically reproduce asexually and/or sexually by producing spores.
9. Propagules. These are typically microscopically small spores produced in high numbers. Motile spores are confined to certain groups. They grow either reproductively by budding or non-reproductively by hyphal tip elongation.
10. Distribution. Cosmopolitan
11. Food storage is generally in the form of lipids and glycogen.
12. The body of fungi consist of the filaments or hyphae (sing. hypha; hypha=web)
13. Nuclear status. Eukaryotic, uni- or multinucleate, the thallus being homo- or heterokaryotic, haploid, dikaryotic or diploid, the latter usually of short duration (but exceptions are known from several taxonomic groups).
14. Life cycle. Simple or, more usually, complex.

Living types of fungi

The fungi are heterotrophs and exhibit absorptive nutrition. This means that they do not fix carbon. Factors like moisture, temperature, pH, and oxygen are factors influence the growth of fungi. There is a tremendous diversity exist among fungi. Most fungi do not grow well in submerged in water due to low content of oxygen in water. Therefore, the majority of fungi are aerobes, although some species including certain types of yeasts, are capable of a facultative anaerobic.

There are two major living types in fungi:

1- Saprobes (saprophytes): include many fungi that obtain their food by attacking dead organic matter.

2- Parasites: include a considerable number of species live on plants, animals, or in some cases even on other fungi. The majority of parasitic fungi, however, capable of living on dead organic materials.

   Most saprobs and parasites are detrimental to dead and/or living hosts. It is, however, there is a variety of other species form mutualistic (symbiotic) relationships with plants or animals.

The body of fungi

The body (soma) of fungi is called thallus, it typically consists of microscopic, tubular, threadlike hyphae that branch in all directions, spreading over or within whatever substrate the fungus uses for food. Collectively, these structures make up the body of the fungus, which is termed the mycelium (pl.mycelia). However, not all fungi produce mycelia composed of hyphae. Many forms, commonly referred to as yeasts, exist as single cells.

Fungal hyphae are composed of a thin, usually transparent, tubular wall filled or lined with a layer of protoplasm varying in thickness. There are two types of hyphae:

1- Septate hyphae: the hyphae are interrupted at some point by partitions, or cross walls, called septa (sing. septum).

2- Aseptate (nonseptate) hyphae: the hyphae are lack of regularly spaced septa. Sometimes the term coenosytic ((Gr. koinos = shared, in common; kytos = a hollow vessel, here meaning cell).) also is used to describe aseptate hyphae.

Each fungi (hyphae) is surrounded by a definite cell wall. This wall is the structure that gives fungi most of their unique features. These features include:

a) The cell wall has ability to safely contain turgor pressure (The pressure exerted by water inside the cell against the cell wall) which is the main reason for the survival and evolution of fungi.

b) The cell wall confers shape to the hyphae

c) It acts as a filter controlling to some extent what enters the fungal protoplast

d) It protects the protoplast against environmental hazards

e) It functions in the recognition of events associated with sexual reproduction, and also with various interactions of fungi with potential plant and animal symbiots.

Cell wall structure:

Fungal cell wall is a dynamic structure that is subject to change and modification at different stages in the life cycle of a fungus. It is composed basically of a skeletal or microfibrillar component to the inner side of the wall which is usually embedded in an amorphous matrix material that extends to the outer surface of the wall. The skeleton component consists of highly crystalline, water-insoluble materials that include B-linked glucans and chitin, while the matrix consists mainly of polysaccharides that are mostly water soluble. There are other different components that may present in the cell walls of fungi include lipids, melanins, etc. Cellulose, however, is present in a few fungi but it is absent in most true fungi. Cellulose is the characteristic component of the walls of stramenopiles , including Oomycota.

Hyphae

The hyphae of most fungi tend to go unnoticed in nature because they are usually underground or inside the materials or hosts on which they grow. However, the hyphae of many different species do routinely become recognized to form larger structures that are easily visible to the naked eye. These include a variety of different types of spore-producing structures. For instance, stromata (sing. stroma=mattress) and sclerotia (sing. sclerotium; skleros=hard) are two examples for these structures. A stroma is a compact, somatic structure much like a miniature mattress of a cushion on which or in which fruiting bodies usually are formed. Sclerotia are hard resting bodies resistant to unfavourable conditions; they come in various sizes and shapes and may remain dormant for long periods of time and then germinate on the return of favourable conditions.

If the nuclei are genetically identical, as in a mycelium derived from a single uninucleate spore, the mycelium is said to be homokaryotic, but a cell or mycelium contains nuclei of different where genotype, e.g. as a result of fusion (anastomosis) of genetically different hyphae, it is said to be heterokaryotic. A special condition is found in the mycelium of many Basidiomycota in which each cell contains two genetically distinct nuclei. This condition is dikaryotic, to distinguish it from mycelia which are monokaryotic. It should be noted that septa, where present, are usually perforated and allow for the exchange of cytoplasm or organelles. A few species, including certain pathogens of humans and animals, are **dimorphic**, i.e. capable of switching between hyphal and yeast-like growth forms. Intermediate stages between yeast cells and true hyphae also occur and are termed **pseudohyphae**.

Possible questions of this section

1. What is mycology? What is the origin of the word?
2. What is the medicinal importance of fungi?
3. What is the economic importance of fungi?
4. What does it mean by antagonistic fungi?
5. What are the differences between eukaryotic and prokaryotic organisms?
6. Why fungi are not motile microorganisms?
7. Where would be the position of symbiotic fungi in existence of saprobes and parasites?
8. What will be the benefits of fungi being septate or aspetate?
9. What are the reasons of having a unique feature of fungi?
10. Sclerotia, as a mycelium aggregate, are a useful structure in some fungi?
11. Biotrophs normally don't kill their hosts?
12. Mitotic spores are varying greatly?