<u>FUNGAL NUTRITION</u>

Fungal nutrition is depends on Saprotrophic nutrition or lysotrophic nutrition, which is a process of **chemoheterotrophic extracellular digestion** involved in the processing of decayed organic matter.

All fungi require organic nutrients for their energy source and as carbon nutrients for cellular synthesis. But a broad distinction can be made according to how these nutrients are obtained:
(i) by growing as a **parasite** (or a **pathogen** a disease-causing agent) of another living organism.
(ii) by growing as a **saprotroph** (saprophyte) on nonliving materials.
(iii) by growing as a **symbiont** in association with another organism.

As a parasitic nutrition fungi are **Obligatory parasite** [An obligate parasite or holoparasite, is a parasitic organism that cannot complete its life-cycle without exploiting a suitable host. If an obligate parasite cannot obtain a host it will fail to reproduce. e.g. *Puccinia*] or **Facultative parasite** [A facultative parasite is an organism that may resort to parasitic activity, but does not absolutely rely on any host for completion of its life cycle. Examples of facultative parasitism occur among many species of fungi. e.g *Armillaria*].

The host-specific fungi are termed **biotrophic parasites** (*bios* = life; *trophy* = feeding) because they feed from living host cells without killing them, often by producing special nutrient absorbing structures to tap the host’s reserves. At the other end of the spectrum are many common fungi that aggressively attack plant tissues. They are termed **necrotrophic** parasites (*necros* = death) because they kill the host tissues as part of the feeding process **–** for example by producing toxins or degradative enzymes. The fungal (or fungus-like) parasites of plants are enormously significant, accounting for more than 70% of all the major crop diseases, and for many devastating epidemics.

Symbiosis is one of the interesting part of fungus nutrition manner, **Lichen** and **Mycorrhizal association** is most acceptable for that sense.

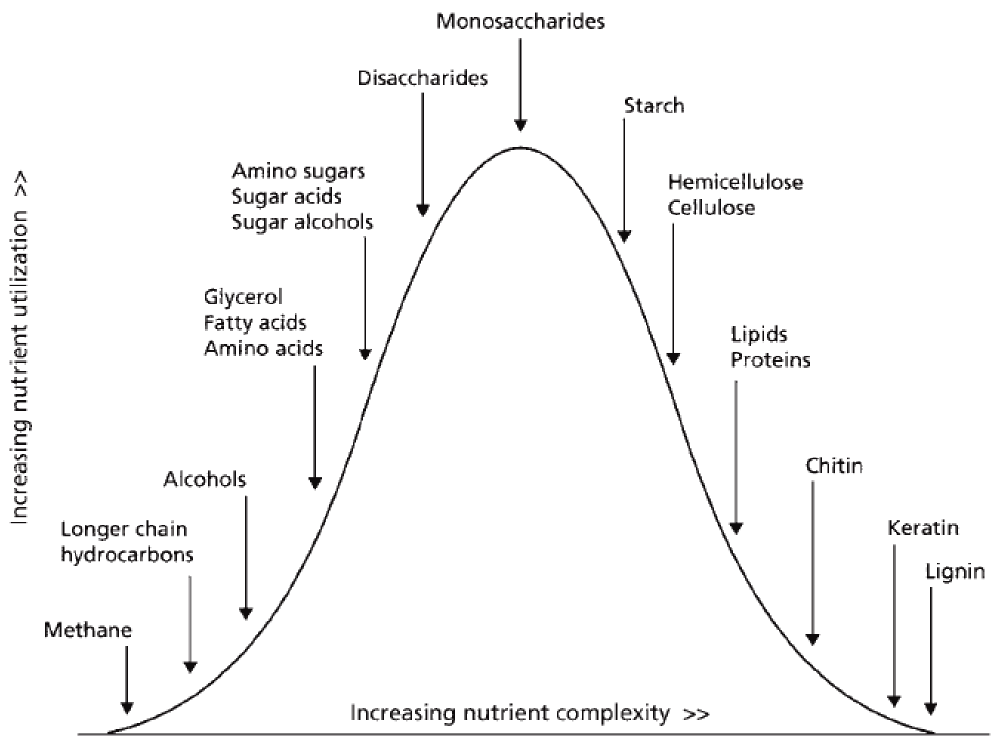
The Lichen is special association of a mycobiont (fungus) and a photobiont (alga or cyanobacterium) forming a stable self-sustaining thallus and losing their own entities. In this association mycobiont is depends on the algal photosynthesis.

Most land plants live in mutualistic symbiosis with fungi in their roots: this structural, functional unit is called mycorrhiza. Mycorrhizae are “dual organs of absorption formed when symbiotic fungi inhabit healthy absorbing organs (roots, rhizomes or thalli) of most terrestrial plants and many aquatics and epiphytes.” (Trappe). Different types of mycorrhizae can be distinguished according to the plant and fungal partners and structural characteristics. Important distinctions are whether the hyphae colonizing the plant grow intracellularly (endomycorrhizae) or only intercellularly in the plant tissue (ectomycorrhizae) or both (ectendomycorrhizae).

<u>The carbon and energy sources of fungi</u>

An enormous range of organic compounds can be utilized by one fungus or another. This is illustrated diagrammatically in under figure, where nutrients are arranged in approximate order of structural complexity from left to right, and in approximate order of their degree of utilization (vertical axis). At one extreme, the simplest organic compound, methane (CH4), can be used by a few yeasts. The fungi which have ability to decay the wood fiber is termed as **Lignicolous fungi** and even they have the capacity to break the pentose sugar.

Several more yeasts (e.g. *Candida* spp.) and a few mycelial fungi can grow on the longer-chain hydrocarbons (C9 or larger) in petroleum products. The main limitation with these compounds, as with methane, is that they are not miscible with water and so growth is restricted to the water–hydrocarbon interface [e.g. kerosene: *Amorphotheca resinae* and *Paecilomyces varioti*]. A larger number of fungi can utilize the common alcohols such as methanol and ethanol. In fact, ethanol is an excellent carbon source for *Candida utilis, Emericella nidulans*, and *Armillaria mellea*, and it can even be their preferred carbon substrate. Glycerol and fatty acids will support the growth of several fungi, and can be the preferred substrates for a few fungi such as the common **"sewage fungus,"** *Leptomitus lacteus* (Oomycota). Amino acids also can be utilized, but they contain excess nitrogen in relation to their carbon content, so ammonium is released during their metabolism and this can often lower the pH to growth-inhibitory levels unless the culture medium is strongly buffered.



Some of the major carbon substrates of fungi.

Mineral nutrient requirements of fungi

Fungi need many mineral nutrients in at least trace amounts but nitrogen, phosphorus, and iron merit special mention because of their significance for fungal activities and interactions in nature.

Nitrogen

Of all the mineral nutrients, nitrogen is required in the largest amounts and can often be the limiting factor for fungal growth in natural habitats. Fungi do not fix atmospheric N2 but they can use many combined forms of nitrogen. Most fungi can use ammonia or ammonium (NH4) as a nitrogen source. By referring to the nitrogen assimilation pathway it is clear that any fungus that can use NO3 must also be able to use the other forms of nitrogen towards the right. But, the regulatory controls on nitrogen uptake ensure that nitrogen sources are not necessarily used in the ways we might expect.

Phosphorus

All organisms need significant amounts of phosphorus, in the form of phosphates, for production of sugar phosphates, nucleic acids, ATP, membrane phospholipids, etc. But phosphorus is often poorly available in natural environments, because even soluble phosphate fertilizers are soon rendered insoluble when they complex with organic matter or with calcium and magnesium ions in soil. Plant roots, in particular, have difficulty in extracting phosphorus from soil, because they deplete the small pool of soluble phosphate in their immediate vicinity and then have to depend on the slow solubilization and diffusion of phosphate from further away.

• They respond to critically low levels of available phosphorus by increasing the activity of their phosphorus-uptake systems;
• They release phosphatase enzymes that can cleave phosphate from organic sources;
• They solubilize inorganic phosphates by releasing organic acids to lower the external pH;
• Their hyphae, with a high surface area/volume ratio, extend continuously into fresh zones of soil.

Iron

Iron is needed in relatively small amounts but is essential as a donor and acceptor of electrons in cellular processes, including the cytochrome system in aerobic respiration. Iron normally occurs in the ferric (Fe3+) form, insolubilized as ferric oxides or hydroxides at a pH above 5.5, and it is taken up by a different process compared with other mineral nutrients.
Iron must be “captured” from the environment by the release of iron-chelating compounds termed **Siderophores**. These compounds chelate a ferric ion (Fe3+) then they are reabsorbed through a specific membrane protein and Fe3+ is reduced to Fe2+ within the cell, causing its release because the siderophores has a lower affinity for Fe2+ than for Fe3+. Finally, the

siderophore is exported again to capture a further ferric ion. Siderophores and their specific membrane proteins are produced only in response to iron-limiting conditions. All the fungal siderophores that have been characterized to date are of the **hydroxamate** type.Their structures, functions, and applications are reviewed by Renshaw *et al*. (2002). Despite their high affinity for Fe^{3+}, these fungal siderophores have much lower affinity than do the siderophores (e.g. **pseudobactin** and **pyoverdine**) produced by fluorescent pseudomonads which are common on plant roots. This raises the possibility that fluorescent pseudomonads could be used for the control of plant-pathogenic fungi in the root zone of crops. For example, pseudobactin-producing pseudomonads can suppress germination of the chlamydospores of *Fusarium oxysporum* on low-iron media, whereas mutant pseudomonads, deficient in siderophore production, are ineffective.
That competition for iron is only one of several ways in which *Pseudomonas* spp. can control plant pathogenic fungi.