Lec.4

Fungal Nutrition

Yeasts and fungi have relatively simple nutritional needs and most species would be able to survive quite well in aerobic conditions if supplied with glucose, ammonium salts, inorganic ions and a few growth factors. Macronutrients, supplied at millimolar concentrations, comprise sources sources of carbon, nitrogen, oxygen, sulfur, phosphorus, potassium and magnesium; and Micronutrients, supplied at micromolarconcentrations,comprisingtrace elements like calcium, copper, iron, manganese and zinc, would be required for fungal cell growth.

Some fungi are oligotrophic, apparently growing with very limited nutrient supply, surviving by living in very low quantities of volatile organic compounds from the atmosphere.

Element	Common sources	Cellular functions
Carbon	**Sugars**	**Structural element of fungal cells in combination with hydrogen, oxygen and nitrogen. Energy source**
Hydrogen	**Protons from acidic environments**	**Transmembrane proton motive force vital forfungal nutrition. Intracellular acidic pH (around5–6) necessary for fungal metabolism**
Oxygen	**Air, O_2**	**Substrate for respiratory and other mixed-function oxidative enzymes. Essential for ergosterol and unsaturated fatty acid synthesis**
Nitrogen	**NH_4^+ salts, urea, amino acids**	**Structurally and functionally as organic amino nitrogen in proteins and enzymes**
Phosphorus	**Phosphates**	**Energy transduction, nucleic acid and membrane structure**
Potassium	**K^+ salts**	**Ionic balance, enzyme activity**
Magnesium	**Mg^{2+} salts**	**Enzyme activity, cell and organelle structure**
Sulfur	**Sulfates, methionine**	**Sulfydryl amino acids and vitamins**
Calcium	**Ca^{2+} salts**	**Possible second messenger in signal transduction**
Copper	**Cupric salts**	**Redox pigments**
Iron	**Ferric salts. Fe^{3+} is chelated by siderophores and released as Fe^{2+} within the cell**	**Haem-proteins, cytochromes**
Manganese	**Mn^{2+} salts**	**Enzyme activity**
Nickel	**Ni^{2+} salts**	**Enzyme activity**
Molybdenum	**Na_2MoO_4**	**Nitrate metabolism, vitamin B12**

chemoorganotrophs, fungi need fixed forms of organic compounds for their carbon and energy supply. Sugars are widely utilized for fungal growth and can range from simple hexoses, like glucose, to polysaccharides, like starch and cellulose. Some fungi can occasionally utilize aromatic hydrocarbons (e.g. lignin by the white-rot fungi).
Fungi are non-diazotrophic (cannot fix nitrogen) and need to be supplied with nitrogenous compounds, either in inorganic form, such as ammonium salts, or in organic form, such as amino acids. Ammonium sulfate is a commonly used nitrogen source in fungal growth media, since it also provides a source of utilizable sulfur.

phosphorus is essential for biosynthesis of fungal nucleic acids, phospholipids, ATP and glycophosphates. Hence, the phosphate content of fungi is considerable (e.g. in yeast cells it accounts for around 3–5% of dry weight; the major part of this is in the form of orthophosphate (H2PO4−), which acts as a substrate and enzyme effectors).
The fungal vacuole can serve as a storage site for phosphate in the form of complexed inorganic polyphosphates (also referred to as volutin granules). Both nitrogen and phosphorus availability may be growth limiting in nature.

filamentous fungi have evolved a number of biochemical and morphological strategies allowing capture of often poorly available phosphorus within the natural environment. Plants exploit such efficiency during symbioses between their roots and certain mycorrhizal fungi. The major storage form of phosphorus in plants is phytic acid (myo-inositol hexa- dihydrogenphosphate), which is poorly utilized by monogastrics (e.g. humans, pigs, poultry), and fungal (and yeast) phytases have applications in reducing phytate content of foods and feeds.

Concerning requirements for minerals, potassium, magnesium and several trace elements are necessary for fungal growth. Potassium and magnesium are macroelements required in millimolar concentrations, primarily as enzyme cofactors, whereas other microelements (trace elements) are generally required in the micromolar range. These include Mn, Ca Fe, Zn, Cu, Ni, Co and Mo. Toxic minerals (e.g. Ag, As, Ba, Cs, Cd, Hg, Li, Pb) adversely affect fungal growth generally at concentrations greater than 100 μM.

fungal growth factors are organic compounds occasionally needed in very low concentrations for specific enzymatic or structural roles, but not as energy sources. These include vitamins (e.g. thiamine, biotin), purines, pyrimidines, nucleosides, nucleotides, amino acids, fatty acids and sterols. For fungi to have a growth factor requirement, this indicates that cells cannot synthesize the particular factor, resulting in the curtailment of growth without its provision in culture media. Some fungi (e.g. *Aspergillus niger*, *Penicillium chrysogenum*) have very simple nutritional needs and are able to synthesize their own growth factors from glucose.

Nutrition and Ecology

Like animals, fungi are heterotrophs: They cannot make their own food as plants and algae can. But unlike animals, fungi do not ingest (eat) their food. Instead, a fungus absorbs nutrients from the environment outside of its body. Many fungi accomplish this task by secreting powerful hydrolytic enzymes into their surroundings. These enzymes break down complex molecules to smaller organic compounds that the fungi can absorb into their bodies and use. Other fungi use enzymes to penetrate the walls of cells, enabling the fungi to absorb nutrients from the cells. Collectively, the different enzyme found in various fungal species can digest compounds from a wide range of sources, living or dead.

this diversity of food sources corresponds to the varied roles of fungi in ecological communitities, with different species living as decomposers, parasites, or mutualists.

Symbiotic relation ships

1- Decomposer fungi break down and absorb nutrients from nonliving organic material, such as fallen rots, animal corpses, and the wastes of living organisms.

2-Parasitic fungi absorb nutrients from the cells of living hosts. Some parasitic fungi are pathogenic, including many species that cause diseases in plants.

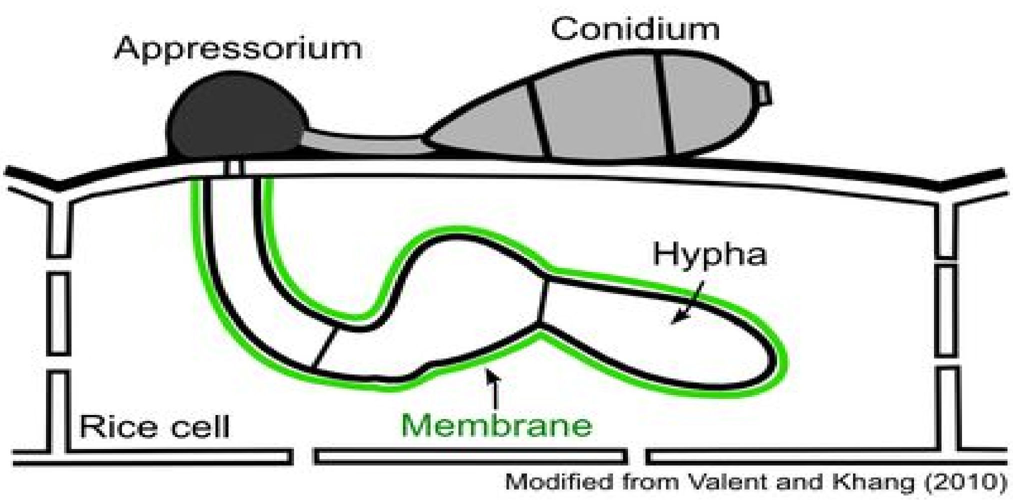
3- Mutualistic fungi also absorb nutrients from a host organism, but they reciprocate with actions that benefit the host. For example, mutualistic fungi that live inside certain termite species use their enzyme to break down wood, as do mutualistic protists in other termite نمل ابيض species.

unlike green plants, which use carbon dioxide and light as sources of carbon and energy, carbohydrates are the preferred nutrient source. Fungi can readily absorb and metabolize a variety of soluble carbohydrates, such as glucose, xylose, sucrose, and fructose, but aralso characteristically well equipped to use insoluble carbohydrates like starches, cellulose, hemicelluloses, and lignin. To do so, they must first digest these polymers extracellularly. Saprobic fungi obtain their food from dead organic material; parasitic fungi do so by feeding on living organisms (usually plants),thus causing disease.

Mode of Nutrition: Absorption

The mode of nutrition or the matter in which fungi "eat" is called absorption. Among eukaryotes, absorption is unique to the fungi. Fungi obtain their food by transporting it through their cell walls. In order to eat, the spores that give rise to fungi must be dispersed to a location where there is food and after the spore germinates, the mycelium of the fungus must grow into its food. Another word, usually fungi must live in their food if they are to eat. food is composed of simple molecules such as glucose or sucrose, soluble food can be immediately transported through their cell walls. However, most food that a fungus might consume is composed of complex, organic compounds, e.g., cellulose, lignin ,pectin, starch, etc., which is insoluble. In order for this food to be utilized by the fungus, it must be broken down into simpler molecules that can be transported through their cell walls.

food must enter the hyphae in solution, and, since most fungi have no special absorbing organs, the entire mycelia surface is capable of taking in materials dissolved in water. Some fungi, however, produce special root like hyphae, called rhizoids, which anchor the thallus to the growth surface and probably also absorb food. Many parasitic fungi are even more specialized in this respect, producing special absorptive organs called haustoria in Fig. 1.



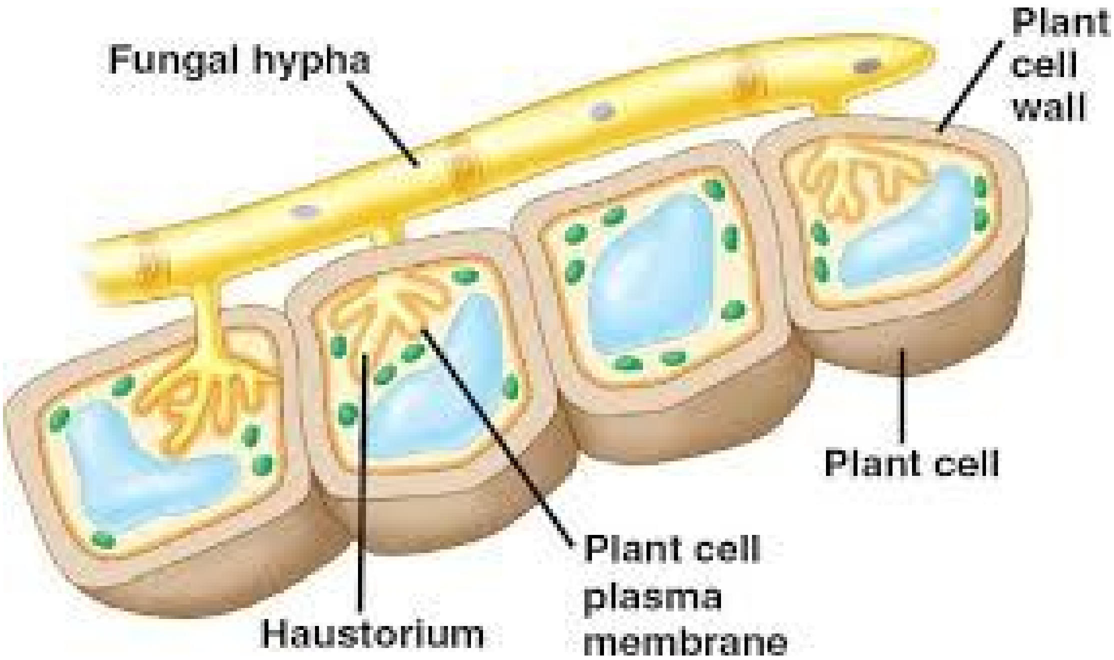


Fig 1: show the haustorium

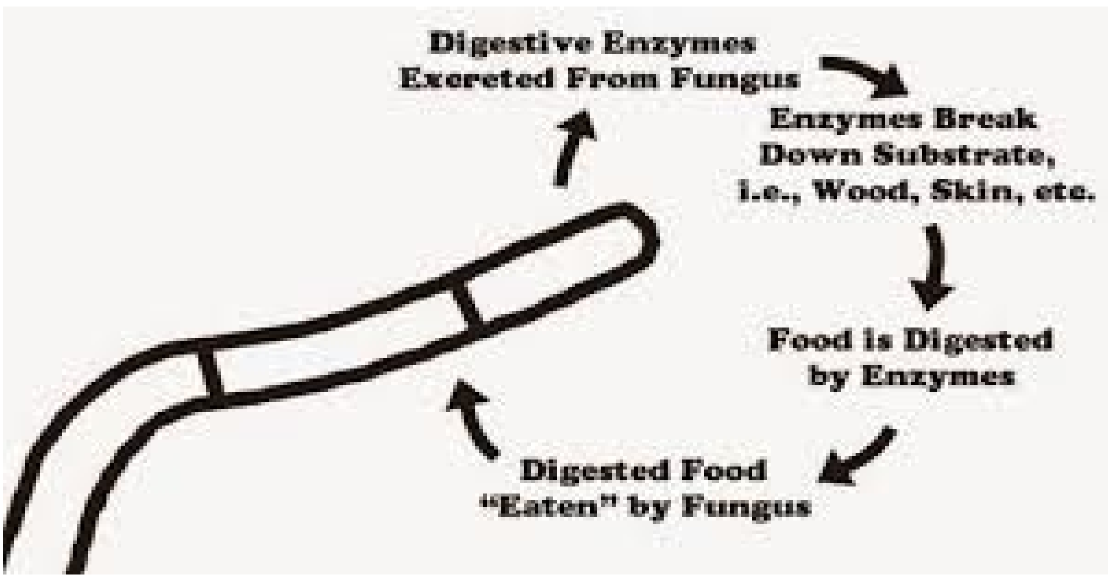


Figure 2: Illustration of the process of absorption, the mechanism by which fungi consume their food.