Hello students, welcome to today's e-learning session. CToday we will look at the beneficial associations of mycorrhizae.

What are mycorrhizae? These are a distinct morphological structure which develops as a result of a symbiotic association between the root and a fungus. They seen in different plants in different ecosystems. There are three main types of mycorrhizae,

the Ecto, the Endomycorrhizae and the actinomycorrhizae, of which the Ectomycorrhizae and the endomycorrhizae are important agriculturally.

In ectomycorrhizae the fungus will form a mantle or outer covering around the root. There is no penetration of the hyphae into this plant cells. The fungal mycelium penetrates between the cells in the cortex of the root. You will have a distinct Hartig net which is present between the cells. The hyphae also extend out into the soil, and these hyphae go into the soil as extramatrical hyphae.

The nutrients absorbed by the fungal mantal at transported to the root through this hartig net. Let us see the visible features of Ecto mycorrhizae.

So if you see this is the mantal, this is the hyphae which penetrate between the cortical cells, they don't go inside the cell right? And they form this Hartig net, so all this inside becomes the hartig net.

The mantle is the hyphal sheeth which surrounds the root region. It can be either a loose network or it can be complex stratified arrangement of tissue. The thickness of the mantle can be up to 2mm. And it can be up to 20 to 40% of the mycorrhizal root weight. The mantal suppresses the development of the plant symbiotic root hair, so the plant will not be able to give out root hairs, but the mantle will supply nutrients.

The Hartig net is involved in nutrient and carbon exchange, the depth of penetration differs between the species. Sometimes the Hartig net will only be in the epidermal region, but in most gymnosperms the hyphae or the Hartig net will penetrate into the cortical cells, or sometimes even up to the Endodermis, which are the host and the symbionts.

The host include woody plants, for example the birch, eucalyptus, oak.

They also involve coniferous plants like the Pines Firs, spruces. Mycorrhizae mainly belong to the Basidiomycota.

You also have Ascomycota and Zygomycota which are represented.

How does this formation happen? The mycelial hyphae recognize, hey make contact and adhere to the root epidermal cells. Next they proliferate on the root surface and they form that entire mantle around the root surface. Some hyphae can penetrate the epidermal regions in angiosperms, or up to the cortical region in the gymnosperms and thus they form the Hartig net.

In response, the host produces polyphenols in the cells and deposits secondary metabolites in the cell walls.

The senescence of the Hartig net hyphae occurs in older areas of the root, but the mantle in older areas will still persist, but sometimes it becomes inactive as the mantal grows older.

Older ectomycorrhizal roots function as propagules or as storage structures. The role of the Ectomycorrhizae is mainly as biofertilizers, that is for phosphorus and nitrogen mobilization and they help in the overall plant health.

How does mobilization of nitrogen occur?

The ectomycorrhizae secrete enzymes like proteases. This helps in assimilation of organic nitrogen.

The ammonia, and inorganic phosphorus, are imported from the symbiotic interface into the cells of the plant as mineral or organic forms of nitrogen like ammonia. Nitrates are absorbed by the extra radical mycelia - the ones that are in the soil.

They also help in solubilization of phosphate because they produce certain organic acids or they produce

certain enzymes like phosphatases which solubilizes the phosphate. These mycorrhizae also benefit the plant with their overall health. These extra matrical hyphae extend over a large volume much beyond the reach of the plant roots, so the ability of these plants to absorb in solid insoluble nutrients like phosphorus becomes better.

Hormones produced by the fungus will help to change the physiological state of the root and help the root to take up more nutrients and water. They also provide a physical barrier and they improve the resistance of the plant root to root pathogens, they increase the tolerance of the plant to drought ,high temperature, pH and extreme heavy metals.

How does this association benefit the fungus?

The ecto mycorrhizae depends on the plant for soluble carbohydrates, organic growth factors, vitamins, amino acids etc.

The next are the Endo mycorrhizae.

These are fungi which grow intracellularly and they form structures within the cortical cells. A,t the plant fungus interface the membranes of the fungus and the plant are in direct contact with each other.

There are three types of endo mycorrhizae, the arbuscular or formerly it was called as a VAM, the Ericoid and the orchid mycorrhizae.

The ericoid mycorrhizae are found in inhospitable conditions, and these help in the plant to take up nitrogen and phosphorus. They also regulate the uptake of iron, manganese and aluminium.

The orchid mycorrhizae are found in orchid plants specially at the early seedling stage. Mature orchids also have these orchid mycorrhizae, but they rely less on these mycorrhizae.

The last are arbuscular mycorrhizae, these arbuscular mycorrhizae are a type of mycorrhizae in which the fungus penetrates the cortical cell of the root In vascular plants. It's character characterized by the formation of unique structures called the arbuscules and the vesicles and the important fungi are the phylum Glomeromycota.

All arbuscular mycorrhizal fungi Are obligate biotrophs. That means it completely depends on the plant for their survival. AM fungi show little or no host specificity. These help the plant to capture nutrients ike phosphorus, sulfur, nitrogen. They form intracellular hyphae in the cortex and they form the Arbuscules and the vesicles. So your if you see this is a picture it shows you the arbuscules and the vesicles in the plant in the root region.

Arbuscular mycorrhizal associations. They start off with this spores which germinate. Once the spores germinate, the soil hyphae grow towards the root and they establish contact on the root surface. One or more hyphae will produce swellings called appresoria and these appressoria penetrate into the epidermis or the cortex and thus the enter into the root. Then the hyphae cross the hypodermis and they branch out into the outer cortex.

Once inside the aseptate hyphae will spread along the cortex in both directions and then they will form

these two main structures. Arbuscules are formed about two days after penetration. And as they keep on branching, the width of the Arbuscules become finer and thinner. The vesicles are hyphal swellings n the root cortex and vesicles, have lipid and cytoplasm. Vesicles are formed after the Arbuscules but they continue to develop even when the arbuscules grow. Old vesicles develop thick walls in older roots and they help in storage of lipid and phosphorus.

The functions of the endo mycorrhiza: they aid in uptake of water, Inorganic phosphorus, nitrogen.

In exchange for the mycorrhiza providing all these nutrients, the plants help the mycorrhizae with carbon.

The AM fungi which grow from the plant root have a high surface to volume ratio, increasing the available area for nutrients to be absorbed. These hyphae are finer than the roots, and therefore they enter into pores in the soil where the roots cannot enter, and this is beneficial in areas where drought is common or where the soil and nutrient amount is low.

The differences between the two. In Endo mycorrhizae the fungi produces typical vesicles and arbuscules While in ectomycorrhizae the fungi produce majority of structures outside.

These are commonly associated with agricultural crops while the Ecto are found in temperate forests. Endo have a loose network of hyphae while the ecto form a complex mantle. The endo cannot be cultured on artificial media while the ecto can be cultured on artificial media,

At the end have a look at this slide and see whether you can answer these questions.