phenol red as indicator. Then, under certain varying conditions, suspensions of living streptococci in the indifferent suspending fluids were allowed to act upon ethyl butyrate. In the active tubes the formation of butyric acid caused a more or less rapid change of color from pH 8.0 to 7.2. The rapidity of the change of color was taken as an indication of the activity of the lipolytic ferment under the given conditions.

With this method it was found that: (1) the acid production was more active in young cultures than in old; (2) there is an almost linear curve relationship between the speed of reaction and the concentration of the organisms; (3) the optimum temperature for the reaction is around 37.5°; (4) there is no action at 62° C. or above; (5) the property is destroyed by heating the bacteria to 60° C. or above for 10 minutes; (6) the optimum hydrogen ion concentration is around pH 7.8; (7) the activity is not increased by increasing the virulence of the organism by repeated rabbit passages; (8) the localization of the organism in the subcutaneous fat with a solution of this tissue in a certain clear cut clinical group of cases previously reported, is not due to a more active lipolytic ferment in the organisms recovered from these cases than is present in hemolytic streptococci from certain other clinically heterologous sources.

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The relation between the roots of plants and fungi.

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The relation of the roots of plants to the fungi in the soil forming a true symbiosis, is of importance not only in botany from the light it throws on some forms of plant nutrition, but in medicine also from the close relation between symbiosis and parasitism.

The roots of all annual plants and many others are closely related to the soil surfaces by fine hollow processes given off from the epidermic cells termed root hairs. While the leaves of the plant through the chlorophyl are the agents of production of the carbohydrates, the roots furnish the nitrogenous compounds and salts and the enormous amount of water which the plant requires. The roots of many of the shrubs and forest trees either have no root hairs or these are but slightly developed. This is especially the case in all of the ericaceæ and in most of the forest trees. The ericaceæ have very fine roots extending widely in the soil particularly in the surface humus.

The fine roots are accompanied by fungus hyphæ which extend upon the surface of the root, often forming a close surrounding mycelium, and certain of the hyphæ penetrate. The hyphæ on the surface are termed epitrophic and those penetrating endotrophic, but there is no sharp separation, both types being found in most plants. Some of these penetrating hyphæ extend along just beneath the epidermis, here and there sending short processes into the cells. The main cell invasion takes place from the hyphæ on the surface which sends fine haustoria into the epidermic cells, which by their extension and branching completely fill up the cells.

Much interest has been found in following the seasonal variation of the fungus relations. In the late summer and autumn in the *Epigaea repens,* the shrub most studied, there are great numbers of the invaded cells, the branching fungus within them giving a certain similarity to a kidney glomerulus. In the spring at the period of most active growth, the fungus filaments within the cells break up into a granular debris and disappear, the cell at the same time becoming more turgid. It seems probable that the fungus at this time contributes to the nutrition of the plant through its digestion by the intracellular enzymes, for the plant lays up no food supply. On the other hand the plant provides carbohydrates to the fungus during the active growth of the latter.

In the case of the forest trees such as the oaks, beeches, birches and all the coniferæ examined, the relation is different. All these trees have much coarser roots as compared with the ericaceæ, the latter having terminals often no more than 40 to 50 micra in diameter while the terminals of the forest trees are rarely less than twice this. They moreover terminate in a bulbous point which is to be regarded as a definite organ into whose structure both fungus and root enter. The fungal hyphæ extend along the root just as in the ericaceæ, but do not enter the cells though forming a close surrounding plexus. As the terminal is reached the fungal investment is closer, completely surrounding the root, and at the terminal bulb the outermost hyphæ form a dense, hard, black sclerotium with short branches having a more or less concentric arrangement. From this outstreaming short hyphæ all of about equal length, with no intercommunications and no septa, extend. These have no relation with the fungus in the surrounding humus. The fungus investment around the sclerotium extends between the epidermic cells which are literally buried in the fungus, but it does not extend into the parenchyma. Root hairs in these trees are entirely absent and the close relation to soil surfaces seems to be supplied by the hyphæ. In these trees also the relation of plant and fungus is one of mutual symbiosis, both being of equal dignity.

We are accustomed to think of the fungi as parasitic organisms but here there is no question of parasitism. Certain of these soil fungi are parasitic and pathogenic but most of them are not. There are certain conditions in which the plant becomes a parasite on the fungus as in the case of the *Monotropa uniflora* ordinarily known as the Indian pipe or corpse plant. This has no chlorophyl and is embedded in a fungus which forms a close investment over all underground parts and nourishes the plant during the brief period of growth, flowering, and fruiting.

Symbiosis has lately acquired great interest in medicine through the knowledge that certain organisms such as the Rickettsia may be symbionts in one organism such as the louse, and when transferred to another host may be pathogenic.