



# Ecology & fungal physiology

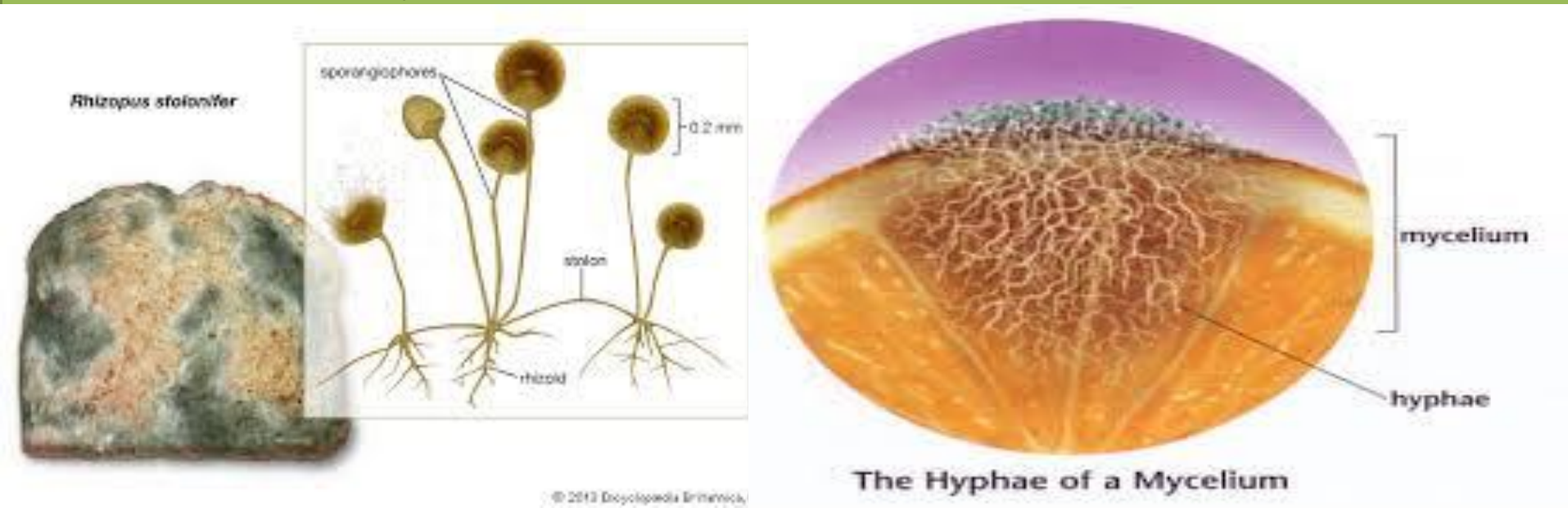
## Lecture (6)

By

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# 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.



If the 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.

Unlike green plants, which use carbon dioxide and light as sources of carbon and energy, respectively, fungi meet these two requirements by assimilating preformed matter; 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 are also 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.

The fungus breaks down the complex material by secreting digestive enzymes through their cell wall that will digest the complex organic compounds and convert them into simple molecules that can readily be transported through their cell walls.

For example, If a fungus is growing in wood, digestive enzymes would be secreted from the fungus, into the wood, and break down the complex compounds of wood, e.g. cellulose and lignin into simpler materials, such as simple sugars, which then can be transported into the mycelium

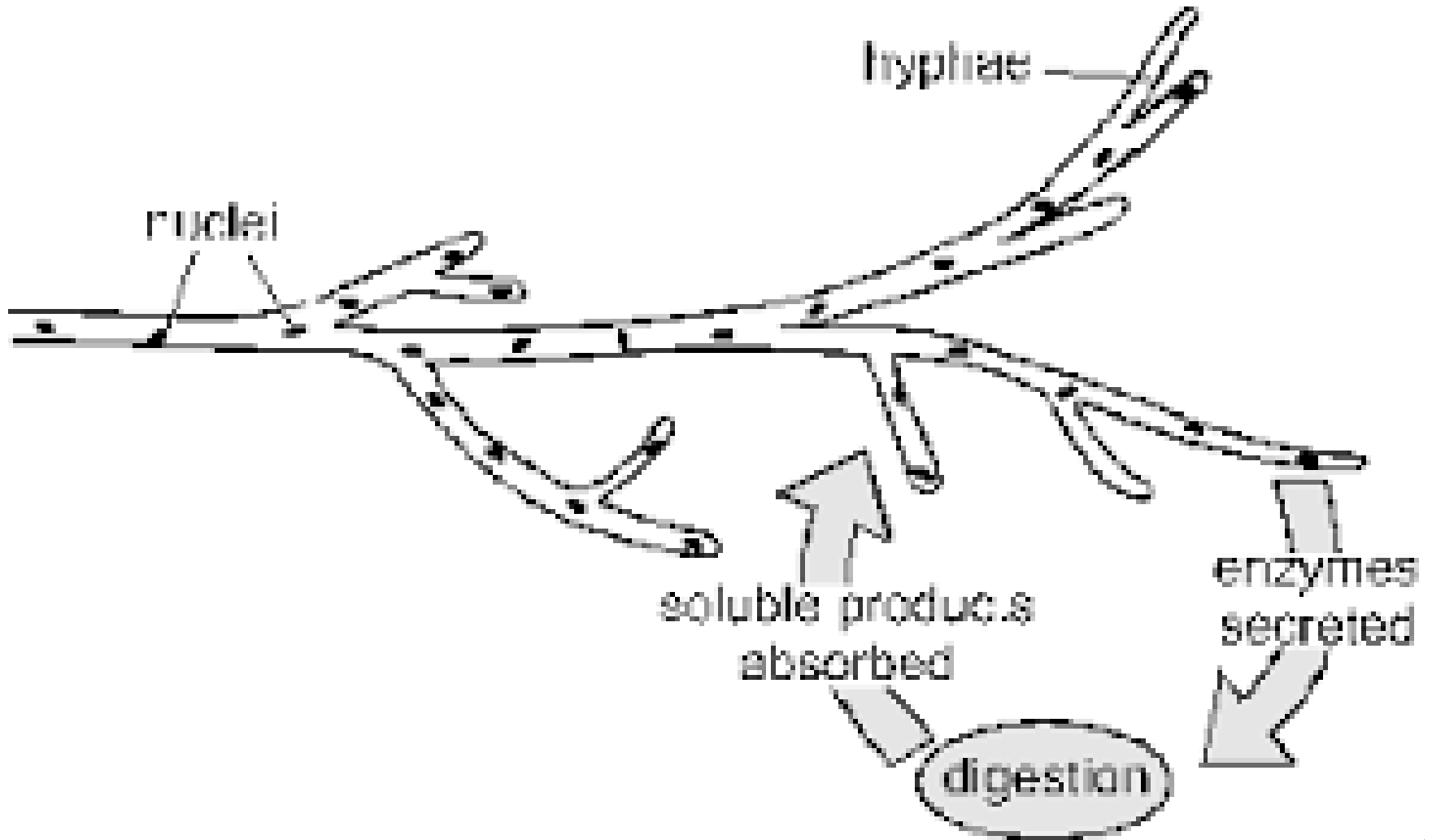
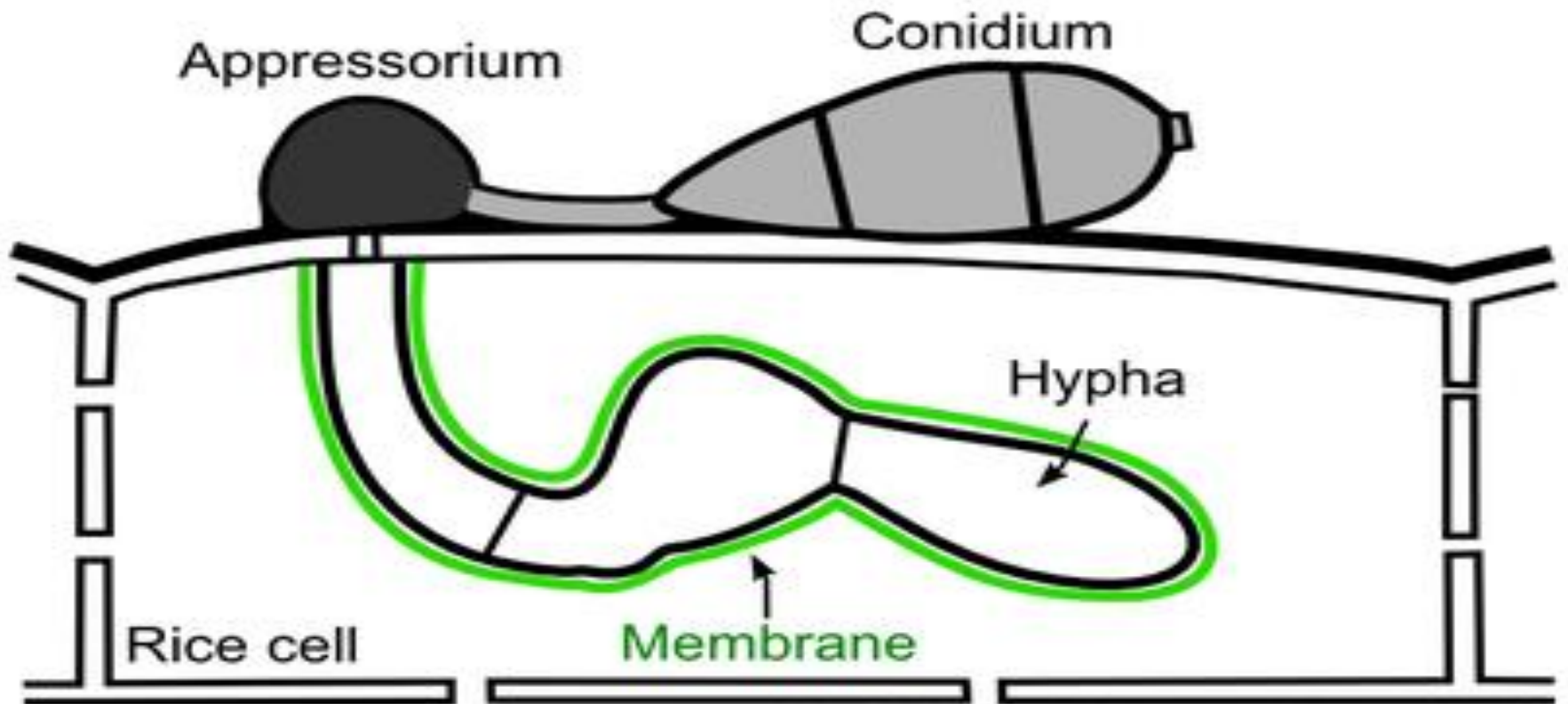


Illustration of the process of absorption, the mechanism by which fungi consume their food.

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.



Modified from Valent and Khang (2010)

Although this process may seem very different than our own means of obtaining food. It is not that different. The essential difference between fungi and animal digestive systems is that fungi digest their food first and then "eat" it, while animals eat their food before digesting it. It is important to understand here that different kinds of fungi will secrete only a specific number of different enzymes. This means that they can only "eat" certain materials.



## **Mechanism of Nutrition**

The whole mycelium may have the power to absorb these nutrients or this task may be assigned to special portions of the mycelium. In saprophytic fungi the hyphae (*Mucor mucedo*) or rhizoidal hyphae (*Rhizopus stolonifer*) come in intimate contact with nutrients in the substratum and absorb soluble smaller molecules such as sugars and amino acids.

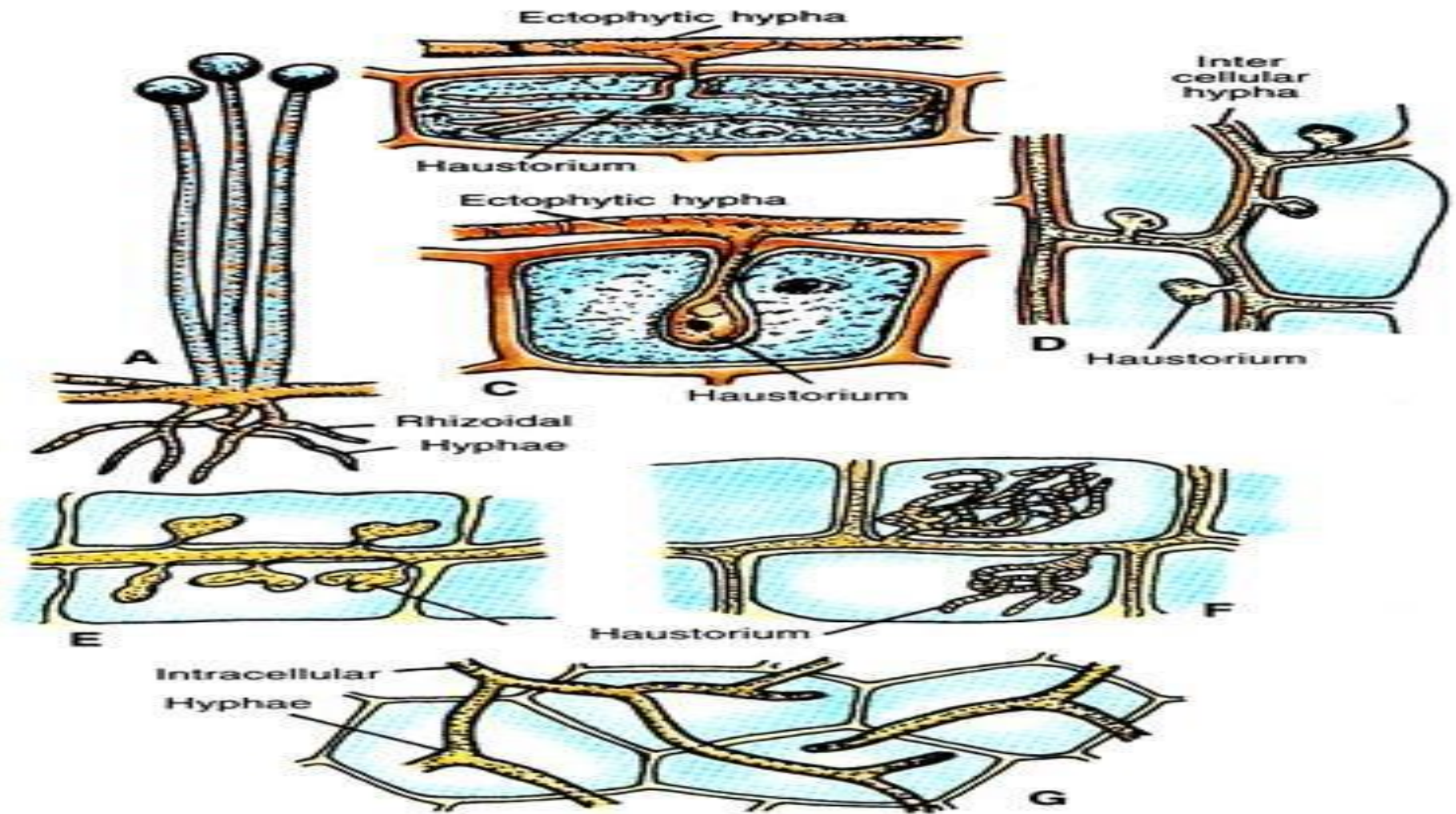
Insoluble complex substances such as proteins, lipids and Poly are first broken into soluble monomeres (digested) by secreting extra-cellular enzymes and then absorbed.

The fungal hyphae secrete enzymes which convert insoluble complex food materials in the substratum to soluble ones. The latter are then absorbed by direct diffusion either through the hyphal walls of the hyphae that penetrate the substratum or by the rhizoidal hyphae.

The mycelium of the parasites is rarely ectophytic but frequently it grows inside the host. The hyphae either ramify in the intercellular space between the host cells or penetrate into the host cells. The former are called intercellular hyphae and the latter intracellular hyphae.

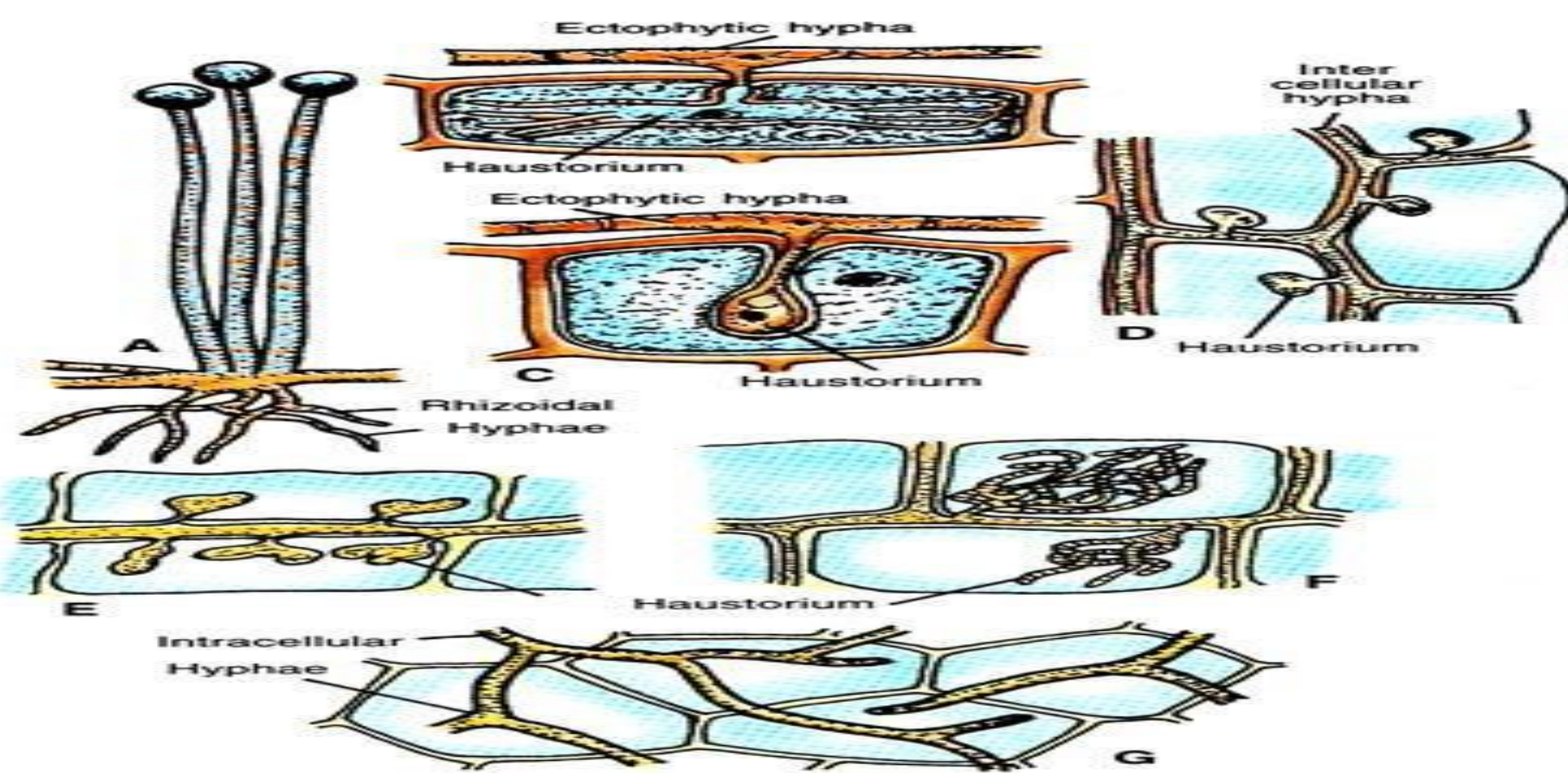
The intercellular hyphae obtain nutrition through the cell walls or membranes of the host cells. This they do by secreting an enzyme upon the plasma membrane of the host cell.

It makes the membrane more permeable to the contained solutes. The latter diffuse out and are absorbed by the hyphal walls. The hyphal walls of the intracellular hyphae come in direct contact with the host protoplasm and obtain food by direct diffusion.



**Fig. 1.15 (A-G).** *Fungi. Modes of Nutrition. Explanation in the text.*

The intercellular hyphae of some highly specialised (obligate) plant parasites give out slender lateral outgrowths. The hyphal outgrowth punctures the host cell wall making a minute pore through which it enters the host cell. Within the host cell, it enlarges to form a globose (D), lobed (B), or branched (F) absorptive organ.



**Fig. 1.15 (A-G).** *Fungi.* Modes of Nutrition. Explanation in the text.

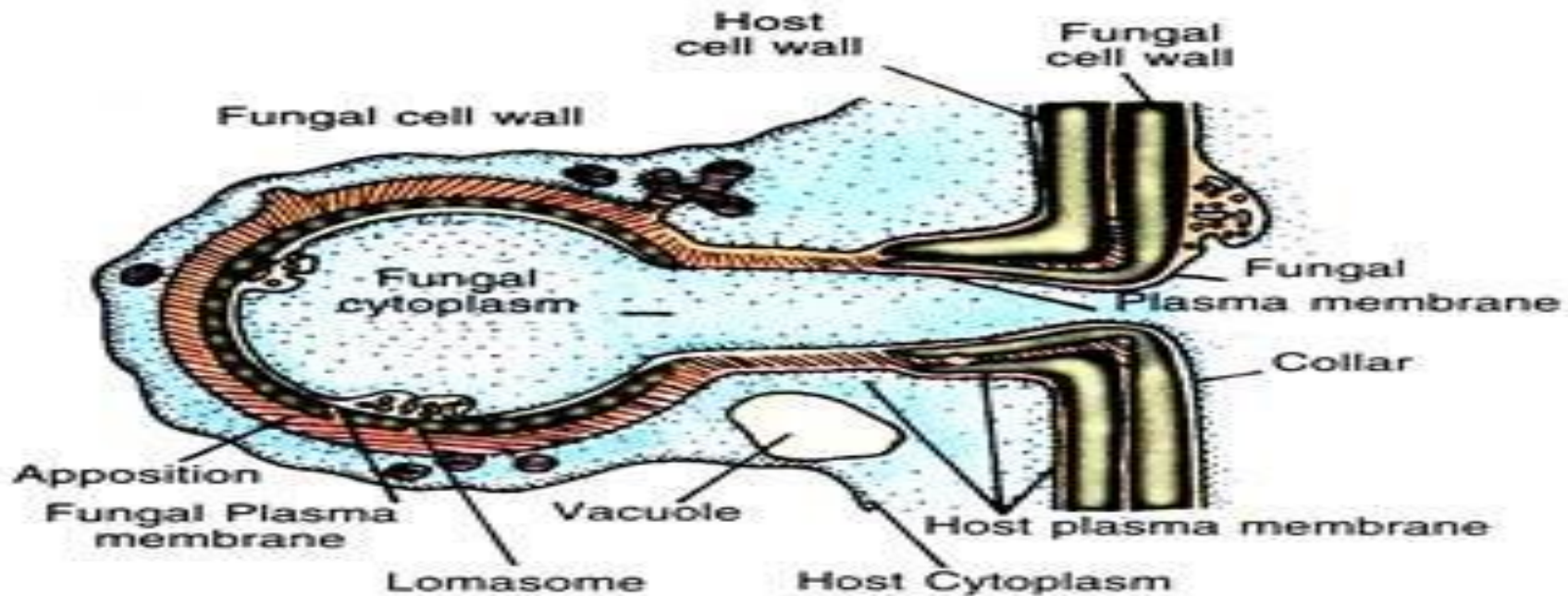
This type of feeding organ of the parasitic fungi is called a haustorium. It is markedly specialised in structure to absorb nutrition from the host tissues. The haustorium is intracellular and thus robs the host of its food without killing it. Haustoria are characteristic of obligate parasites.

They vary in shape and size in different fungi. In *Albugo* the haustorium is a button-like (D) or spherical structure.

Each haustorium (Fig. 1.16) usually consists of two parts, a constricted region which is in the form of a narrow penetration tube and the expanded or branched region on the host cell. The penetration tube is usually clasped by a 'collar' of host wall material. The enlarged or expanded region of the haustorium causes Invagination of the cytoplasmic membrane of the host cell.

The latter remains closely appressed to the wall of the haustorium.

The secretion from the haustorium upon the plasma membrane of the host makes it permeable to solutes contained in the sap cavity. They diffuse out and are then absorbed by the haustorium parasitic fungi do not produce haustoria in artificial cultures.



**Fig. 1.16 Fungi.** A section through an haustorium of *Albugo candida* based on an electron micrograph. (After Berlin and Bowen)

The fungi, as mentioned above, are unable to synthesize sugars from carbon dioxide and water. They, however, can synthesize from soluble sugars the more complex carbohydrates which are the chief components of their cell walls.

They are also able to synthesize proteins and eventually protoplasm if supplied with carbohydrates and simple nitrogen compounds such as ammonium salts.

Besides ammonium salts, they can absorb and utilize many complex but soluble organic nitrogenous compounds.

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