# Seed Endophytes and Their Potential Applications

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Haiyan Li, Shobhika Parmar, Vijay K. Sharma, and James Francis White, Jr

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**Abstract**

With growing interest in the role of endophyte to the host plant ecology, health, and productivity, this chapter discusses seed-inhabiting endophytes. These endophytes were less recognized when compared with those found in the other parts of the plant. However, they cannot be ignored as they are the first one colonizing young seedlings and further determining the fate of the plant. These endophytes often have potential to improve seed germination and seedling growth. Recent advances in seed endophytes have proved that they can confer stress tolerance to the host plants, especially the heavy metal resistance. Microbial dynamic equilibrium with plant systems is vital for the germination, growth, and reproductive phases of plant life cycle. The colonization and transmission of seed endophytes suggests that host plants select an endophytic community having beneficial traits that can be passed to successive generations. Seed endophytes can

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facilitate the improvement of seed quality and plant growth of agriculturally important crops via different biotechnological applications; they have prospects in endophyte-mediated phytoremediation applications.

**Keywords**
Seed endophytes · Plant-microbe interaction · Plant growth promotion · Stress tolerance · Heavy metal toxicity

## 3.1 Background

Researchers believe that 400 million years ago when higher plants first came into existence on the earth, endophytic microbes also existed and may have facilitated plant evolution (Sun et al. 2012). The first endophytes to be described were outgrowths in wheat leaves called "exanthemata" (Unger 1833). Leveille (1846) documented these outgrowths as fungal structures in the leaves of wheat and called them "endophytic fungi" (Leveille 1846). However the term "endophytes" first of all was defined by de Bary in 1866 to symbolize all microbes that reside inside the living healthy plants. The earliest documentation of mutualistic symbiosis dates back to the Paleozoic era in the roots of the fossil tree *Amyelon radicians* which indicates that plant-fungal association was present (Bacon and Hill 1996). Krings et al. (2007) recorded three fungal endophytes in the thin sections of the early Devonian Rhynie chert plant *Nothia aphylla* that confirms the existence of endophyte 400 million years ago (Krings et al. 2007). Since then endophytic relationships may have evolved considerably. Several definitions of endophytes have been advanced by investigators as follows. Endophytes are microbes, generally bacteria or fungi, colonizing internal living tissues of plants without causing any disease symptoms (Petrini 1991; Hardoim et al. 2012; Lopez et al. 2012). Endophytes are any fungi isolated from internal symptomless plant tissues (Cabral et al. 1993). Endophytes are fungi that colonize the plant without causing any visible disease symptom at any specific moment (Schulz and Boyle 2005). Endophytes are the microbes that colonize living, internal tissues of plants without causing any immediate, overt negative effect (Bacon and White 2000). Endophyte was defined as a topographical term that includes bacteria, fungi, actinomycetes, and algae, which spend their whole or a period of life cycle either in symplast or apoplast region of healthy plant tissues without producing any disease or clinical symptoms (Kharwar et al. 2014). Ernst et al. (2003) defined endophyte establishment as a symbiotic relationship between plants and fungi. There are two types of endophyte mutualism: one is constitutive endophytic mutualism and another one is inducible endophytic mutualism. In constitutive endophytic mutualism, endophytes can flourish in infected plants, additionally vertically transmitted via seeds to next generation of the host. On the other hand, in inducible endophytic mutualism, the interior of the host tissues is severely colonized with localized infections which can evolve by numerous fungi (Carroll 1988). Endophytic microbes have attracted attention because they are

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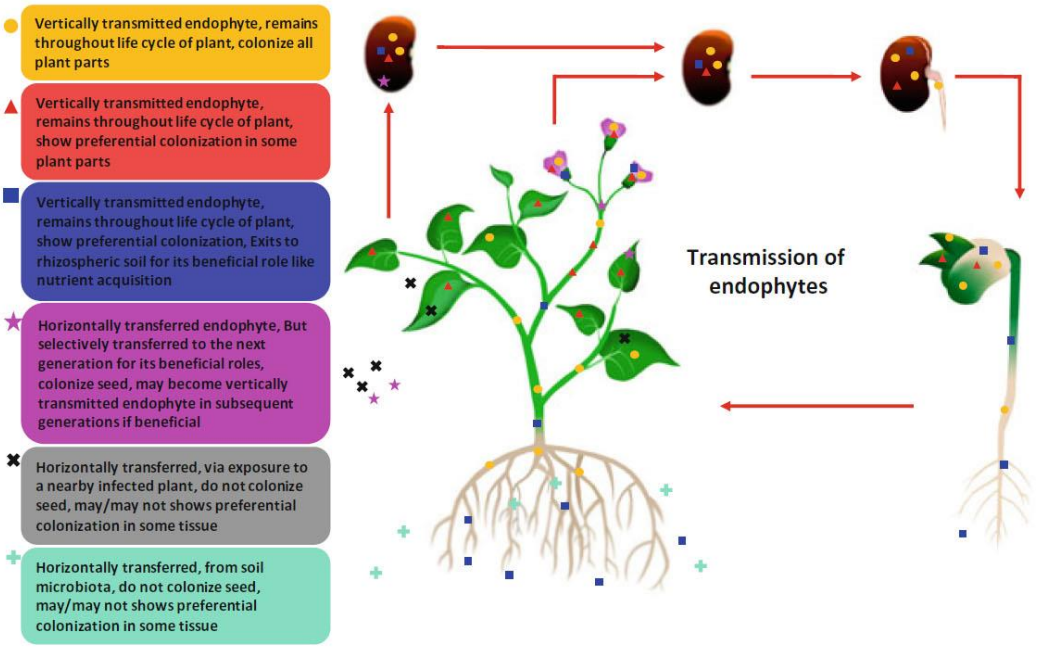


**Fig. 3.1** Transmission of endophytic microbiota to plants