

Arbuscular mycorrhizal Fungi as Inspiration for Sustainable Technology

Maria J. Torres ^{1,2}, Geisianny Moreira ^{1,3}, Jehangir H. Bhadha ^{1,4} and Eric S. McLamore ^{1,3,5,*}

¹ Science and Technologies for Phosphorus Sustainability (STEPS) Center, Raleigh, NC 27606, USA;

mtorre3@clemson.edu (M.T.); gamm.bio@gmail.com (G.M.); jango@ufl.edu (J.B.)

² Department of Plant and Environmental Sciences, Clemson University, Clemson, SC 29634, USA

³ Department of Agricultural Sciences, Clemson University, Clemson, SC 29634, USA

⁴ Department of Soil, Water & Ecosystem Sciences, University of Florida, Gainesville, FL 32611, USA

⁵ Department of Environmental Engineering and Earth Sciences, Clemson University, Clemson, SC 29634, USA

* Correspondence: emclamo@clemson.edu

Supplementary Material:

Definitions of key terms are provided below, *verbatim* from reputable sources. This glossary is intended to aid early learners interested in this topic.

A

Arbuscular mycorrhizal- "Soil fungi which form a mutualistic symbiosis with the roots of plants". Source: Science Direct ([link](#)).

Arbuscule- "A highly branched fungal structure occurring within the cortical cells of roots colonized by arbuscular mycorrhizal fungi". Source: Nature.com ([link](#)).

Association- "A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit". Source: NESoil.com ([link](#)).

C

Condensed phosphorus- Inorganic polyphosphates existing as linear, cyclic, or branched structures. Source: Dürr-Mayer et al (2021) ([link](#)).

Cortex- "The tissue of a root confined externally by the epidermis (the "skin" of the root) and internally by the endodermis (the tissues encircling the vascular tissues)". Source: Nature.com ([link](#)).

D

Dihydrogen phosphate anion- "A monovalent inorganic anion that consists of phosphoric acid in which one of the three OH groups has been deprotonated". Source: PubChem ([link](#)).

Dissolved inorganic phosphorus- "That portion of dissolved phosphorus that readily forms the phosphomolybdate blue complex". Source: Science Direct ([link](#)).

E

Ectomycorrhizae- "A plant-fungus relationship where the fungal hyphae extend into the plant root and occupy the area between the cortical cells, forming a Hartig net". Source: Nature.com ([link](#)).

Ectorrhizosphere- "The area surrounding (extracellularly) the root where microbes fed by root derived compounds may colonize". Source: Nature.com ([link](#)).

Endodermis- "A single layer of cells enclosing the vascular tissue of the root". Source: Nature.com ([link](#)).

Endomycorrhizae- "A plant-fungus relationship where the fungal hyphae extend into the plant root and occupy the area between and within (intracellularly) the cortical cells". Source: Nature.com ([link](#)).

Endorhizosphere- “The region in the root which microbes fed by root derived compounds may colonize including root cortex, epidermis and root hairs”. Source: Nature.com ([link](#)).

Enzyme- “Proteins consider as biological catalyts”. Source: LibreTexts Biology ([link](#)).

Epidermis- “The outermost layer of cells in the plant”. Source: LibreTexts Biology ([link](#)).

Exudates- “Compounds released into the soil/rhizosphere by plant roots”. Source: Nature.com ([link](#)).

H

Hyphae- “The primary cell bodies of fungal organisms”. Souce: LibreTexts Biology ([link](#)).

I

Insoluble phosphorus- Compounds which form because of precipitation with metals to form insoluble complexes. In alkaline soils, P complexes with calcium (alkaline soils); in acidic soils P complexes with iron, silicate, and/or aluminum (acidic soils). P can also adsorb on clay to form insoluble complexes. Source: Paul and Frey (2023) ([link](#)).

Inositol phosphates- Also referred to as phytic acids, it is a major source of organic phosphorus in soil. One example is as follows: “Myo-inositol hexakisphosphate has a role as an iron chelator, an antineoplastic agent, a signalling molecule, a metabolite, a mouse metabolite and a cofactor.” Source; PubChem ([link](#)).

M

Monohydrogen phosphate anion- “A divalent inorganic anion that consists of phosphoric acid in which one of the three OH groups has been deprotonated”. Source: PubChem ([link](#)).

Mutualism- “Association between organisms of two different species in which each benefits”. Source: Encyclopedia Britannica ([link](#)).

Mycelium- “The mass of branched, tubular filaments (hyphae) of fungi”. Source: Encylopedia Britannica ([link](#)).

Mycorrhiza- “Derived from the Greek words myco meaning fungus and rhizo meaning root, refers to the fungal partner of a mutualistic association between vascular plant roots and their symbiotic fungi”. Source: LibreTexts Biology ([link](#)).

N

Nutrient- “Essential substances to sustain life”. Source: Libretexts Biology ([link](#)).

O

Organic phosphorus- An organic form of phosphorus, where its atom (P) is covalently bonded to a carbon, either directly or via phosphodiester bonds. Source-McLaren et al (2020) ([link](#)).

P

Phosphatase- Proteins which dephosphorylate esters by hydrolysis. Source: LibreTexts Biology ([link](#)).

Phospholipid- Phospholipids are fat derivatives in which one fatty acid has been replaced by a phosphate group and one of several nitrogen-containing molecules. Source: LibreTexts Biology ([link](#)).

Phosphonates- Phosphonates (or phosphonic acids) are a broad family of organic molecules based on phosphorus (chemical symbol P), carbon (C), oxygen (O) and hydrogen (H). Source: Phosphonates Europe ([link](#)).

Photosynthate- “The products of photosynthesis are called photosynthates, which are usually in the form of simple sugars such as sucrose”. Source: LibreTexts Biology ([link](#)).

Phytohormones- “Plant derived hormones which regulate physiological processes”. Source: Nature.com ([link](#)).

Phosphate transporter- Transmembrane proteins has a high affinity for phosphate, and transports the ion across the soil–root interface or in

translocation to other plant tissues. Source: Raush and Bucher (2002). ([link](#)).

R

Rhizosphere- "The zone of chemical, biological, and physical influence generated by root growth and activity. The concept usually pertains to the soil-root interface but is sometimes extrapolated to other media-root interfaces". Source: Nature.com ([link](#)).

S

Symbiosis- Symbiosis is a close relationship between two species in which at least one species benefits. Source: LibreTexts Biology ([link](#))

Strigolactones- Hormone-like molecules that are manufactured and secreted by plant root tissues. These molecules play an important role in promoting germination and/or signaling of mycorrhizal fungi. Source: LibreTexts Biology ([link](#))

V

Vesicles- "Membrane-bound sacs that function in storage and transport". Source: LibreTexts Biology ([link](#))