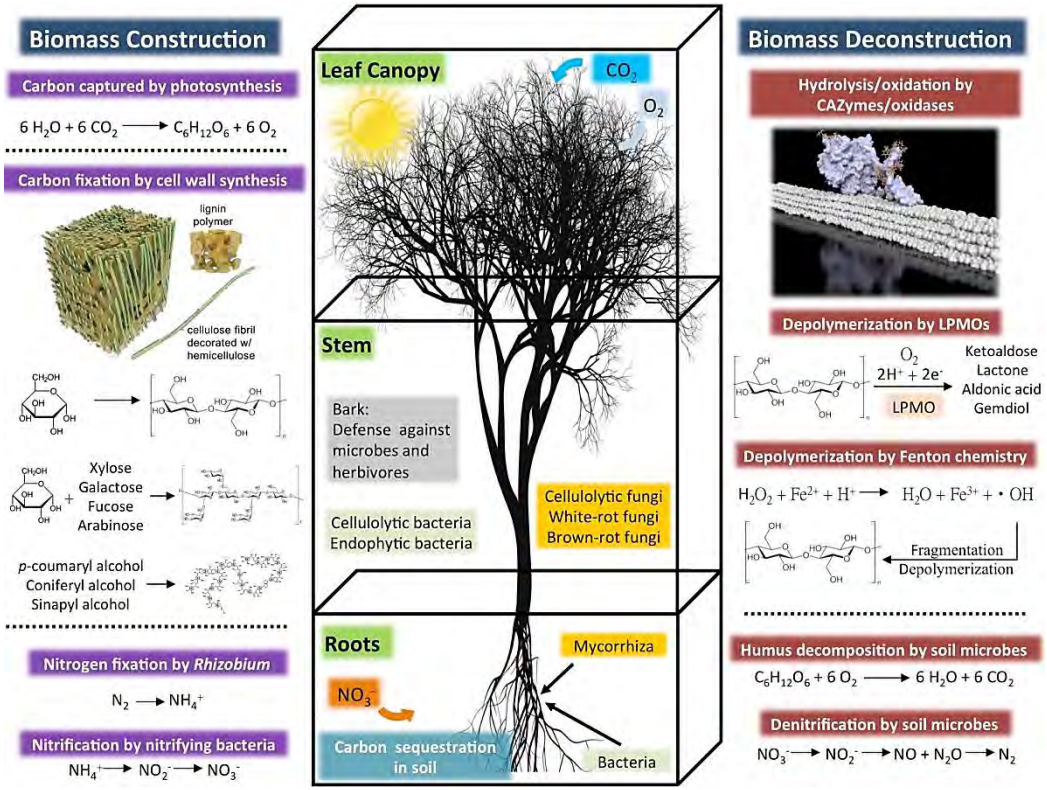
Review : Lignocellulose deconstruction in the biosphere

U.S. DEPARTMENT OF ENERGY | Office of Science

Background:

- The primary product of photosynthesis, cellulosic biomass, has evolved to be recalcitrant to deconstruction by microorganisms and their enzymes. This recalcitrance is due to natural barriers in plant meso-structure (bark, rind, and vascular networks); as well as the composition, structure, and chemical linkages in the plant cell wall.
- To overcome this natural recalcitrance, fungi and bacteria have developed a diverse set of enzymes and strategies suited for the ecosystem in which they occur.
- Biomass degrading microbes also rely on inter-microbial synergy to thrive in their natural environment.



Aims of the review:

- Provide a better understanding of carbon recycling in the biosphere; ranging from biomass synthesis to deconstruction by biotic or abiotic routes.
- Highlight the importance of the synergism between natural microbial communities within a given ecosystem.
- Show the complexity of the biomass deconstruction mechanisms that have evolved in nature.

Conclusions and remarks:

- Mankind has observed the terrestrial biosphere primarily from the perspective of its emergent properties. Now new trends toward multi-scale science will enable new levels of understanding.
- To enable deeper understanding of the fate of carbon in the biosphere, we must be able to observe and describe all (or most) of the chemical reactions, either biotic or abiotic, that impact the synthesis and deconstruction of plant biomass.
- Microbes have responded to plant defenses by producing or adapting numerous enzymatic solutions and are often aided in this process by collaboration with insects (termites) and animals (ruminants) which provide mechanical disruption.
- Carbon recycling in the biosphere is extremely complex and we are just beginning to understand its intricacies. Once this natural complexity is sufficiently understood, it may become possible to better harness chemical recycling in the biosphere to enhance production and conversion of energy crops; as well as ecosystem stability.

Bomble, *et al*., "Lignocellulose deconstruction in the biosphere," *Current Opinion in Chemical Biology* **41**, (December 2017)

BESC BioEnergy Science Center