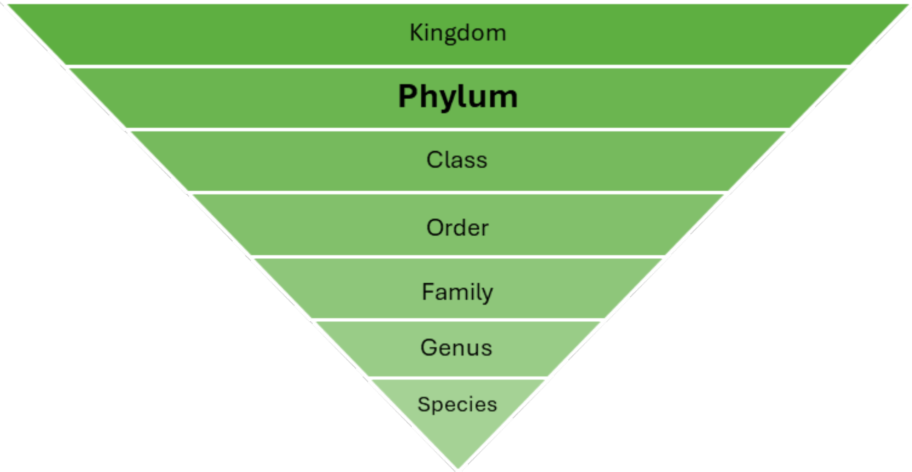
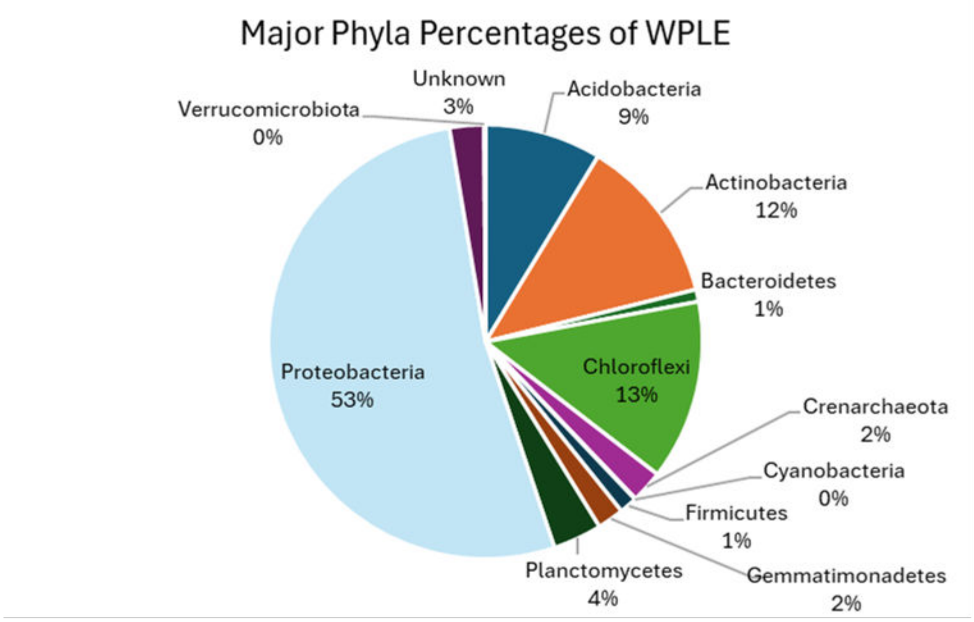
DNA Sequencing of Worm Power

As growers become more informed about the importance of soil health, knowing how microbes interact in the soil is critical to understanding their impact on the soil environment and the plants. Worm Power is utilizing Next Generation Sequencing (NGS), an emerging technology that identifies the microbes from a product sample by analyzing DNA, which is an organism's unique genetic pattern. These patterns are then analyzed using databases that identify the species based on the genetic code. The Linnaean classification system (below) is composed of seven levels that group organisms by similarities. Scientists still use this system today and thanks to DNA analysis, the classifications can change to reflect new information about how closely the organisms are related.



The NGS analysis of Worm Power Liquid Extract (WPLE) evaluated the number of sequences found by each phylum grouping. These sequences are DNA codes and are unique to individual species of bacteria found in the product. The NGS analysis of WPLE (below) shows the frequency of bacteria in each phylum. Looking at the phyla in WPLE gives insight to how the bacteria behave in the soil and interact with plants. Some of the largest notable phyla and their known characteristics are:



*sample averages from the Biodesign Institute core facilities at Arizona State University

Proteobacteria are the most abundant phylum in the soil and most phenotypically diverse. Their metabolic pathways oxidize sulfur to a plant available form. They also oxidize methane and hydrogen which drives carbon cycling.

Chloroflexota (Chloroflexi) are known for having organisms that can survive in harsh environments. They can survive in low nutrient soils because they are phototropic (use light for energy production). There are few cultured representatives for this phylum.

Actinobacteria have the ability to breakdown materials and drive nutrient cycling. They produce secondary compounds such as antimicrobials and plant growth promoting molecules. These bacteria help break down plant debris in the soil and supply nutrients to the plant. They also produce indolic compounds for phytohormones such as auxin that stimulate plant growth.

Acidobacteria are abundant in soils, however this phylum is hard to cultivate in laboratory conditions. They possess genes involved in diverse metabolic pathways, carbon regulation, nitrogen, and sulfur cycling. The known Acidobacteria genome has genetic functions that can help plant stress and starvation, acid tolerance, cellulose synthesis, siderophore synthesis, and secondary metabolites. These bacteria help with plant nutrient availability as well as adapting under different environmental conditions.

Planctomycetes are aerobic facultative chemoorganotroph (organism that obtains energy from the oxidation of reduced organic compounds). This metabolic process specializes in carbohydrate metabolism. The metabolic pathways are hypothesized to be much more diverse than what has been tested in the cultivated varieties. Certain lines have been able to oxidize ammonium to nitrate which is the first and rate-limiting step in nitrification.

Gemmatimonadetes. This phylum contains few cultured species. Members of this group can survive in stressful conditions such as saline soils. They have a potential role in the cycling of nutrients due to anoxygenic photosynthesis. Key biological processes in this group are associated with carbon assimilation, phosphorous acquisition, or nitrogen and sulfur metabolism.

Crenarchaeota are sulfur metabolizing bacteria and are generally associated with extreme environments like geysers and acidic soils. The bacteria are ammonia oxidizers and play an important role in nitrogen cycling. These bacteria make sulfur and nitrogen a form that is usable by plants.

Firmicutes (Bacillota) are chitin degraders, which are important for soil carbon cycling. Other functions like cell wall biosynthesis, plant growth promotion, and control of plant pathogens have been observed. This group contains the Bacillus genus, which is extensively studied and included in many soil amendments for fertility and plant health.

Bacteroidetes. (Bacteroidota) digest carbohydrates via a series of metabolic pathways. They are versatile for adaptation. They secrete a diverse array of carbohydrate activated enzymes that allow for motility in the soil to “hunt” for nutrition.

<u>Worm Power Liquid Extract is teeming with beneficial bacteria to promote nutrient uptake, soil health, and plant growth. The diversity in the product allows for the plant and soil to utilize the microbes as needed in each unique environment for healthier plants and increased yields</u>.

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