

Organic Facts:

- In 5 hours, a single bacteria can give rise to more than a billion offspring, provided the proper growing conditions
- Human body has 10 times more bacterial cells than human cells
- Human hand has 157 (average) species of bacteria, even after washing. Belly button, inner forearm, buttocks, skin between fingers, and gluteal crease (plumbers' crack) can have up to 300 different species of bacteria. Skin is covered by a variety of bacteria, viruses, fungi and mites.
- There are an estimated 10 trillion bacteria in the human gut; some pathogenic, some synergistic
- A teaspoon of soil contains an estimated 500 billion bacteria; soil with high organic material can contain over 1 trillion
- One gram of soil contains over 1000 species of bacteria
- Most of the bacteria in soil (99.9999%) are inactive
- Mitochondria and chloroplasts are descendants of bacteria engulfed by larger microorganisms and have their own distinct DNA
- An acre of soil to plow depth (7 inches) weighs approximately 2 million pounds. To add 1% OM would require 20,000 pounds which is 450 pounds per 1000 sq. ft
- Organic matter in the soil must be constantly replenished since the microbial decomposition process turns the carbon-based material back into carbon dioxide and water, from whence it came.
- Plowing soil introduces oxygen and breaks up bound organic matter, increasing microbial decomposition and releasing the carbon-based material as carbon dioxide.
- Mice with bacteria-free intestines need to ingest 41% more calories.
- To grow plants and improve soil, C:N ratio of about 10 to 12:1 is best - greater ratio results in N not available; lower ratio results in increased OM decomposition
- To minimize the rate of decomposition of soil organic matter, carbon should be added with nitrogen. The balance between nitrogen and carbon is critical when growing plants – too much nitrogen speeds organic matter decomposition; too little starves plants.
- Raw organic material contributes more sticky gums and waxes that aggregate soil than does humus/compost because these substances have already been released during the primary decomposition
- Only about 1/3 of the organic material added to soil will ever be converted to humus. Most will return to the atmosphere the same year as Carbon Dioxide as it decays
- Bacteria and actinomycetes that are killed with anhydrous ammonia will recover within 1 or 2 weeks to levels higher than before the application; fungi may take up to 7 weeks to recover.
- Building organic matter in the soil is a very SLOW process. It is more feasible to stabilize and maintain existing humus than to try to rebuild
- Growth of plants primarily comes from carbon dioxide and water, which combine in the photosynthetic process to form carbohydrates, the major component of

plant mass. In a controlled experiment in 1649, Van Helmont demonstrated that a willow plant, which increased in weight by about 160 pounds in 5 years, reduced the weight of soil by only 2 ounces.

- Perennial plant growth builds organic matter in soils. Plants extract carbon dioxide from the air and water from the soil to build carbohydrates $(\text{CH}_2\text{O})_x$, which are used for energy and combined with minerals from the soil to build the structures and chemicals necessary for life. The decay of leaf matter and non-woody roots builds organic matter in the soils over time on a continual basis.
- Cropping, however, may decrease organic matter because organic matter is removed during harvesting; turning over soil increases oxygen, which increases microbial activity and the breakdown of organic matter; and inorganic nitrogen applications also increase microbial activity and decomposition of organic matter.
- Microorganisms decay organic matter in the soil and their activity results in soil aggregation in two ways: *chemical bonding* or gluing of particles together by their secretions; and *physical binding* or enmeshment by thread-like growths such as mycelium or hyphae. The fine roots of plants can also bind and aggregate soils.
- The interaction of the various microorganisms in the soil such as bacteria, fungi, actinomycetes and archaea; and other organisms such as earthworms, algae and nematodes is poorly understood. Improve soil conditions conducive to their growth – oxygen, moisture, organic carbon, mineral nutrients- and they will do the rest. There is no need to add these organisms to the soil as low populations are indicative of poor growing conditions, and activity will increase as soon as it is corrected. Adding these organisms without correcting the conditions will have little, if any, effect.
- Arbuscules mycorrhizae fungi (AMF), which form in symbiotic relationship with many plants, secrete a glyco-protein called glomalin (after the fungal genus, *Glomales*), discovered and named in 1996 by USDA researcher, Sara Wright. Glomalin is very effective at structuring soils and may contain up to 1/3 of the carbon in the soil. Growth of AMF occurs only with active root growth.
- The functional groups of natural organic polymers responsible for structuring soils and nutrient retention are primarily carboxyl ($\text{OH}-\text{C}=\text{O}$) and phenolic ($\text{C}_6\text{H}_5\text{OH}$), with a substantial fraction as carboxylic acid which can chelate multivalent ions such as Ca^{++} and Fe^{++} or Fe^{+++} . These groups can also be synthesized in structured or tailored organics, with significantly increased activity because of the number of functional groups that can be added to the carbon polymers. Nature had thousands of years to build up soil in forests and prairies but most homeowners would like the organic effect in their landscape within a few years.
- Managing organic matter in the soil is essentially managing carbon. The amount of carbon on earth is fixed and can neither be created nor destroyed, only recycled. Plants begin the process by extracting carbon dioxide from the air and combining it with water to form carbohydrates (hydrates of carbon). With few exceptions all other forms of life obtain their carbon from consuming plants or consuming other organisms that have. When the carbon compounds are recycled within an organism, the process is called “Biosynthetic”. When organisms are not

involved in recycling carbon, the process is called “Synthetic”. The carbon is identical in both processes and the only difference is the number and configuration of the carbons and the functional groups that are attached. In fact synthetic organic chemistry usually begins with natural organic hydrocarbons such as petroleum or natural gas although modern technology will increasingly allow the use of recyclable plant carbohydrates. Microorganisms recognize the carbon compounds as an energy source and both biosynthesized and synthesized organic carbon are decomposed, resulting in the release of plant nutrients and soil-structuring secretions.

- **Photosynthesis** combines inorganic carbon dioxide from the air and water from the soil to produce organic chemicals called carbohydrates (hydrated carbon). **Biosynthesis** combines the carbohydrates with inorganic nitrogen and mineral elements from the soil to produce all of the other organic chemicals and structures necessary for life such as proteins, fats, nucleic acids, and membranes and cell walls. **Composting** is the microbial decomposition process that consumes carbohydrates and other organic chemicals and returns them to inorganic carbon dioxide, water, nitrogen and the mineral elements.
- Friedrich Wohler – credited with founding the science of organics in 1828, with the formation of urea from inorganic compounds. Although urea is not considered truly organic today, it was the breakthrough that led to organic chemistry.
- Fungi decomposition retains more carbon in soil than bacterial decomposition – Research needed to manipulate microbial population. To date, best option is to improve soil conditions that promote microbial growth.