

## Factoids about Bacteria and Fungi

By Tom Bettman

There are about 5,000,000,000,000,000,000,000,000 bacteria on earth, and (only) about 6,500,000,000 people. Bacteria have been on earth about 3 ½ billion years and evolved nearly all the metabolic pathways and enzyme systems used by living creatures. Humans contain more bacterial cells than our “own” cells even when we are healthy! Mitochondria are a highly evolved Group A proteobacter, once free living organisms capable of “detoxifying” free oxygen, which were engulfed by other cells 2 ½ billion years ago and now manage the oxidative metabolism of all living cells. Chloroplasts, organelles responsible for the photosynthesis in all green plants, were once cyanobacteria engulfed by a plant progenitor billions of years ago. Bacteria measure .2 to 600 micrometers in length, usually 1-2 micrometers (a human hair is 50-100 micrometers in diameter). Under ideal circumstances bacteria can double their numbers every 20 minutes. Bacteria don't do sex but they do conjugate, freely exchanging genetic information even amongst different species, for example antibiotic resistance traits. Some bacteria are motile, moving short distances in their stiff water environment by rapidly beating flagella-like structures. Like fungi they create enzymes which dissolve complex polymers such as cellulose, lignin, and chitin (think enzymes cellulase, ligninase, and phenol oxidase), and then absorb the dissolved nutrients. Bacteria create protective layers of slime, usually neutral or alkaline in pH. They dominate garden soils and good garden composts. Bacteria cycle nutrients, combat (and cause) diseases, and help form good soil texture. They rarely die of old age, usually being eaten by something which then releases the excess nitrogen in a form suitable for plants. Bacteria literally run the nitrogen cycle, “fixing” atmospheric nitrogen into ammonia (Rhyzobium, Azobacter-think enzyme nitrogenase), in neutral pH convert ammonia into nitrite, (Nitrosomonas), convert nitrite into nitrate (Nitrobacter), and finally “denitrify” the nitrates back into atmospheric nitrogen. They inhabit virtually all the earth's surface environments and thrive in temperatures ranging from below zero to well over 100 C. under intense pressure beneath the sea.

If Bacteria excel in replication, fungi excel in growth. A fungal hypha 10-40 micrometers in diameter can grow as much as 40 micrometers in a minute! You try growing eight feet in a

minute. The growth is not random, but rather can be demonstrated to exhibit tropism towards nutrients, light, and even other attractive hyphae. Tens of thousands of species have been described already; there are probably several times that many yet unnamed. Fungal polymer destroying enzymes are even more capable than those of most bacteria. Fungi “gone over to the dark side” can dissolve oak trees (sudden oak death), as well as elms and chestnuts. We are fortunate that, in the long evolutionary run, cooperation is usually more successful than unalloyed aggression. 80 percent of living plants are known to have symbiotic relationships with fungi, trading sugars and proteins for water and minerals. Fungi tend to create and maintain an acid environment, keeping available nitrogen in the ammonia form, predominating forest soils and good compost for trees and shrubs. Individual fungi are known to live for thousands of years and extend over many acres.

Actinomycetes are now considered bacteria but grow hypha-like structures, create very capable cellulase and ligninase enzymes, and are active over a broad range of pH.

Both bacteria and fungi can exhibit incredible “watchful waiting;” dormant forms such as endospores have proven viable after tens, hundreds, even thousands of years.

Books you might like;

A Field Guide to Bacteria, Cornell University Press, Betsy Dyer, 2003

What is Life?, by Margulis and Sagan (sorry I loaned it out so I lack some info.)

Teaming with Microbes, Timber Press, Jeff Lowenfels & Wayne Lewis, 2006

The Ancestors’ Tale, Richard Dawkins (loaned this one too)