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Nematodes (Caenorhabditis)

WORMS

The worms in the pictures are nematodes, also called roundworms. Their scientific name is *Caenorhabditis elegans* (*Caeno*, recent; *rhabditis*, rod-like; *elegans*, elegant) and we know more about them than any other multi-cellular organism (what their parts are, how they develop and how they go together).

Researchers like to study them because, among other benefits, they are simple yet have a nervous system and have lots of interesting behaviors. They are also mostly transparent, allowing measurements inside living organisms, and can easily be genetically modified. They are small, about 1 millimeter in length, live about 2 to 3 weeks, and are found in temperate soil.

Scientists have used these worms to study many things, including nicotine addiction, Parkinson's disease, muscle atrophy, and aging. They even found a way to double the worms' life spans by mutating their genes. Some were in tests on board the Space Shuttle Columbia and were found in the wreckage, having survived its explosion.

Most of these worms are hermaphrodites and a few are males (fewer than 1 in 2000). A hermaphrodite can inseminate itself or mate with males, but cannot mate with another hermaphrodite. They lay eggs that hatch within a day. After a few days these baby worms develop into adults and can start laying eggs of their own. Each worm will lay between 300 and 1000 eggs in its lifetime.

If there isn't enough food in the environment interesting things happen. The worms will not lay their eggs, which instead hatch inside and kill the mother. Newly hatched worms go into a special stage where their mouths are plugged up and they can live for months. If food reappears, they redevelop into normal worms.

PROCESS

Some of these pictures and videos are of the worms crawling around, eating and otherwise interacting with microorganisms cultured from my fingers and hair. These various bacteria, fungi, and archaea live on and inside our bodies. There are over 1000 species of bacteria that live in and on us, and there are at least 10 times as many bacterial cells as human cells in each of our bodies.

The remainder of the pictures are of the worms interacting in and around various microscopic sculptures. I use photolithography, the same technique used to create computer chips, to make a negative of the designs on a silicon wafer. This wafer is like a mold used in a traditional casting process. I then use an optically-clear polymer to make the sculpture itself: mixing it, pouring it over the wafer, and peeling it off when it is set. I place this over the worms crawling around in their dishes of Agar, and, because the polymer is optically clear, I can take still images and videos through it with no distortion.

The sculptures can roughly be divided into four groups: *Meditations* are based on walking meditations, they have one route only; *Decisions* are star- or grid-like structures where the worms have choices about where to explore; *Duets* are two interlocking or nearby paths that don't allow passage between them –worms in each side can perhaps sense each other, but can not touch; and *Structures* are representational designs such as the man and woman copied from the Pioneer spacecraft and the outlines of worms.

The resulting images and videos are again divided into time periods: *Early Stage* images are of only a few worms recently placed in a sculpture; *Medium Stage* images are taken after a few days to a week, when the worms have bred and the paths are getting crowded with worms and detritus; and *Late Stage* images are taken after a few weeks, when the spaces inside the structure have become completely clogged and various microorganisms have started to grow alongside the worms.