

U.S. Department of Energy

# Microbial Genome Program

*Exploring genomes will reveal how organisms perform functions relevant to DOE missions*

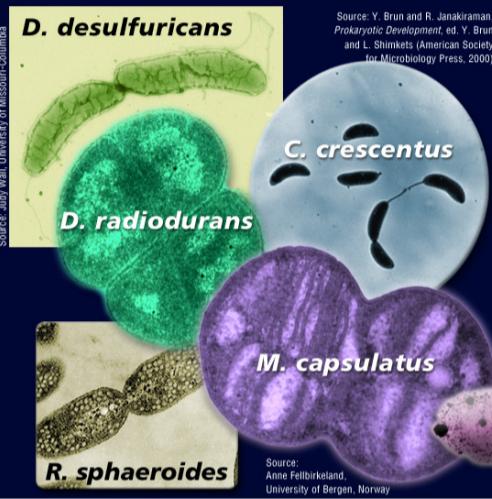
## Why Microbes?

Microbes have an enormous range of chemical capabilities, some of which surpass human technologies and have far-reaching implications for addressing DOE mission challenges. Researchers have only scratched the surface of understanding the diversity of microbes, which live in virtually all environments and make up a significant portion of the Earth's biomass.



## Bioremediation

*Cleanup of toxic-waste sites worldwide*

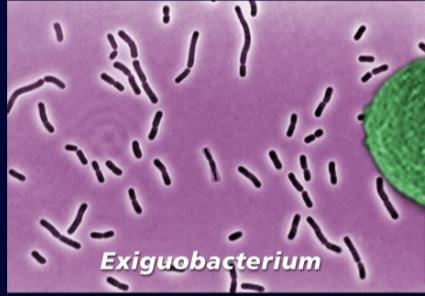


*Acidithiobacillus ferrooxidans*  
*Burkholderia* LB400  
*Caulobacter crescentus*  
*Dechloromonas* RCB  
*Dehalococcoides ethenogenes*  
*Deinococcus radiodurans* R1  
*Desulfobacterium hafniense* DCB-2  
*Desulfovibrio desulfuricans* G20  
*Desulfovibrio vulgaris*  
*Desulfuromonas acetoxidans*  
*Ferroplasma acidarmanus* fer1  
*Geobacter metallireducens*  
*Geobacter sulfurreducens*  
*Mesorhizobium* BNC1  
*Methylococcus capsulatus*  
*Novosphingobium aromaticivorans* F199  
*Pseudomonas fluorescens* PFO-1  
*Pseudomonas putida*  
*Ralstonia metallidurans* CH34  
*Rhodobacter sphaeroides* 2.4.1  
*Shewanella oneidensis* MR-1

Source: Jim Frederickson, Pacific Northwest National Laboratory

## Technology Development, Pilot Projects

*Production and biotechnology*

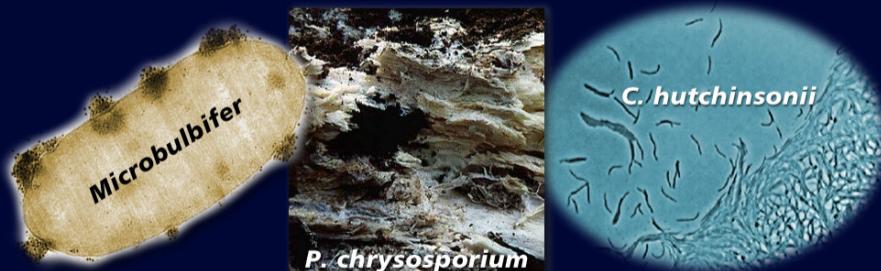


*Borrelia burgdorferi* B31  
*Brucella melitensis* 16M  
*Enterococcus faecium*  
*Exiguobacterium* 255-15 (NASA)  
*Haemophilus somnis* 129PT  
*Mycoplasma genitalium* G-37  
*Psychrobacter* 273-4 (NASA)  
*Streptococcus suis* 1591  
*Xylella fastidiosa* Dixon (almond)  
*Xylella fastidiosa* Ann1 (oleander)

Source: J. Tiedje, Center for Microbial Ecology, Michigan State University

## Cellulose Degradation

*Efficient conversion of biomass to products such as ethanol, methane, and hydrogen*



*Clostridium thermocellum* ATCC27405  
*Cytophaga hutchinsonii* ATCC33406  
*Microbulbifer* 2-40  
*Phanerochaete chrysosporium*  
*Thermobifida fusca* YX

## Innovative, High-Impact Science

In 1994 DOE initiated the Microbial Genome Program as a spinoff of its Human Genome Program. MGP's goal is to generate biological solutions to challenging DOE missions in energy, environmental cleanup, biodefense, and global climate change. Scientists expect to find a vast repertoire of useful functions in the microbial world.

## Complementary DOE programs

### NABIR (Natural and Accelerated Bioremediation Research) Program

NABIR develops methods based on natural microbial processes for the bioremediation of contaminated soils, sediments, and groundwater.

### BI-OMP (Biotechnological Investigations—Ocean Margins Program)

Studies linkages between coastal carbon and nitrogen cycles and the processes affecting global change.

### Carbon Sequestration

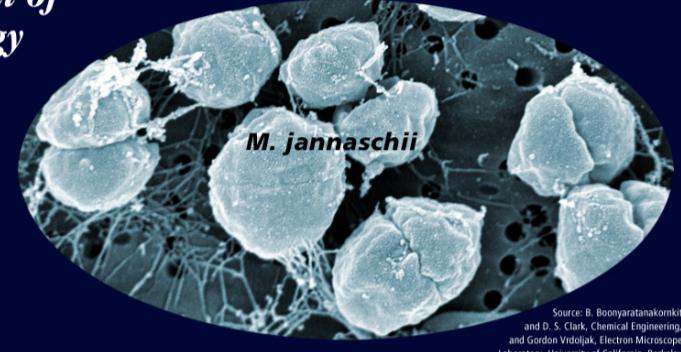
Explores strategies for sequestration of carbon in oceanic and terrestrial environments.

### Genomes to Life Program

Combines completed DNA sequence data with advanced high-throughput technologies to develop a fundamental understanding of life processes. Genomes to Life focuses on organisms with capabilities of interest to DOE.

## Energy Production

*Energy generation and development of renewable energy sources (e.g., methane and hydrogen)*



*Methanobacterium thermoautotrophicum* delta H  
*Methanococcoides burtonii* DSM6242  
*Methanococcus jannaschii* DSM2661  
*Methanopyrus kandleri* AV19  
*Methanosaeca barkeri* Fusaro

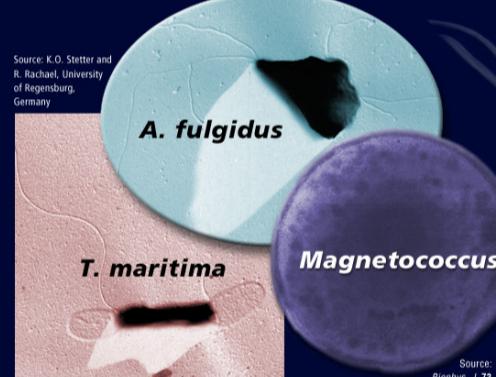
Source: B. Boonaratanaonkit and D. S. Clark, Chemical Engineering, and Gordon Vrdoljak, Electron Microscope Laboratory, University of California, Berkeley

## What's a Microbe? What's a Genome?

**Microbes** are the invisible bacteria, archaeae, protozoa, and fungi that inhabit our environment—our bodies, our food and water, and even the air we breathe. A **genome** is all the DNA in any organism. It contains the information that orchestrates the chemical reactions needed for all life functions.

## Biotechnology and Applied Microbiology

*Production of chemicals to improve process efficiency*

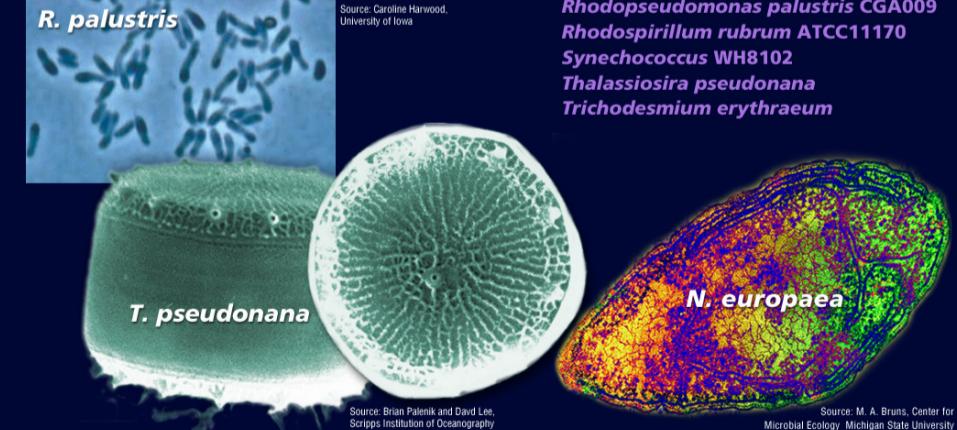


*Aquifex aeolicus* VF5  
*Archaeoglobus fulgidus* DSM4304  
*Bifidobacterium longum* DJO10A  
*Brevibacterium linens* BL2  
*Clostridium acetobutylicum*  
*Ehrlichia chaffeensis* Sapulpa  
*Ehrlichia canis* Jake  
*Halobacterium halobium*  
*Lactobacillus brevis* ATCC367  
*Lactobacillus bulgaricus* ATCCBA-365  
*Lactobacillus casei* ATCC334  
*Lactobacillus gasseri* ATCC33323  
*Lactococcus lactis* cremoris SK11  
*Leuconostoc mesenteroides*  
*Magnetococcus* MC-1  
*Magnetospirillum magnetotacticum* MS-1 ATCC31632  
*Oenococcus oeni* PSU1  
*Pediococcus pentosaceus* ATCC25745  
*Pseudomonas syringae* B728a  
*Pyrobaculum aerophilum*  
*Pyrococcus furiosus*  
*Streptococcus thermophilus* LMD-9  
*Thermotoga maritima* M5B8

Source: R. B. Frankel et al., *Biophys. J.* 73, 994–1000 (1997)

## Carbon Sequestration

*Management of global carbon to help stabilize climate*



*Azotobacter vinelandii* AvOP  
*Chlorobium tepidum*  
*Chloroflexus aurantiacus* J-10-f1  
*Nitrosomonas europaea* ATCC25978  
*Nostoc punctiforme* ATCC29133  
*Prochlorococcus marinus* MED4  
*Prochlorococcus marinus* MIT9313  
*Rhodopseudomonas palustris* CGA009  
*Rhodospirillum rubrum* ATCC11170  
*Synechococcus WH8102*  
*Talassiosira pseudonana*  
*Trichodesmium erythraeum*

Source: Brian Palenik and David Lee, Scripps Institution of Oceanography

Source: M. A. Bruns, Center for Microbial Ecology Michigan State University

## Web Sites

Microbial Genome Program: [www.ornl.gov/microbialgenomes](http://www.ornl.gov/microbialgenomes)  
 Genomes to Life: [DOEGenomesToLife.org](http://DOEGenomesToLife.org)  
 DOE Joint Genome Institute: [www.jgi.doe.gov](http://www.jgi.doe.gov)  
 Microbial Genomes: [genome.ornl.gov/microbial](http://genome.ornl.gov/microbial)  
 Comprehensive Microbial Resource: [bit.integratedgenomics.com/GOLD](http://bit.integratedgenomics.com/GOLD)  
 Natural and Accelerated Bioremediation Research: [www.lbl.gov/NABIR](http://www.lbl.gov/NABIR)  
 BI-OMP: [www.sc.doe.gov/ober/GC/omp.html](http://www.sc.doe.gov/ober/GC/omp.html)  
 Carbon Sequestration Program: [ciaci2.esd.ornl.gov/](http://ciaci2.esd.ornl.gov/)  
 Human Genome Project: [www.ornl.gov/bgmis](http://www.ornl.gov/bgmis)

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