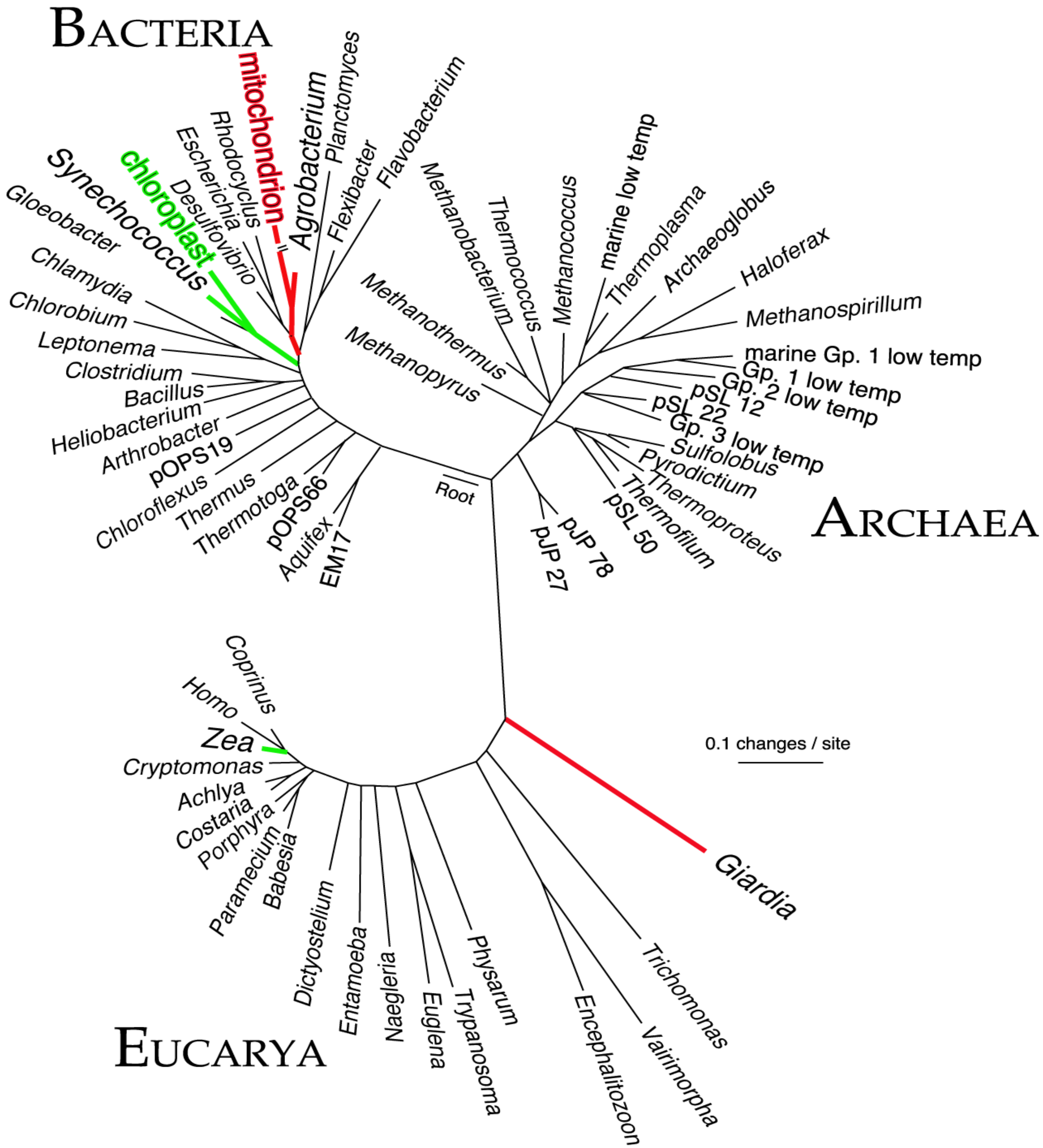
Why You Should Love Bacteria

A brief look at the unseen bugs who share our bodies and our planet

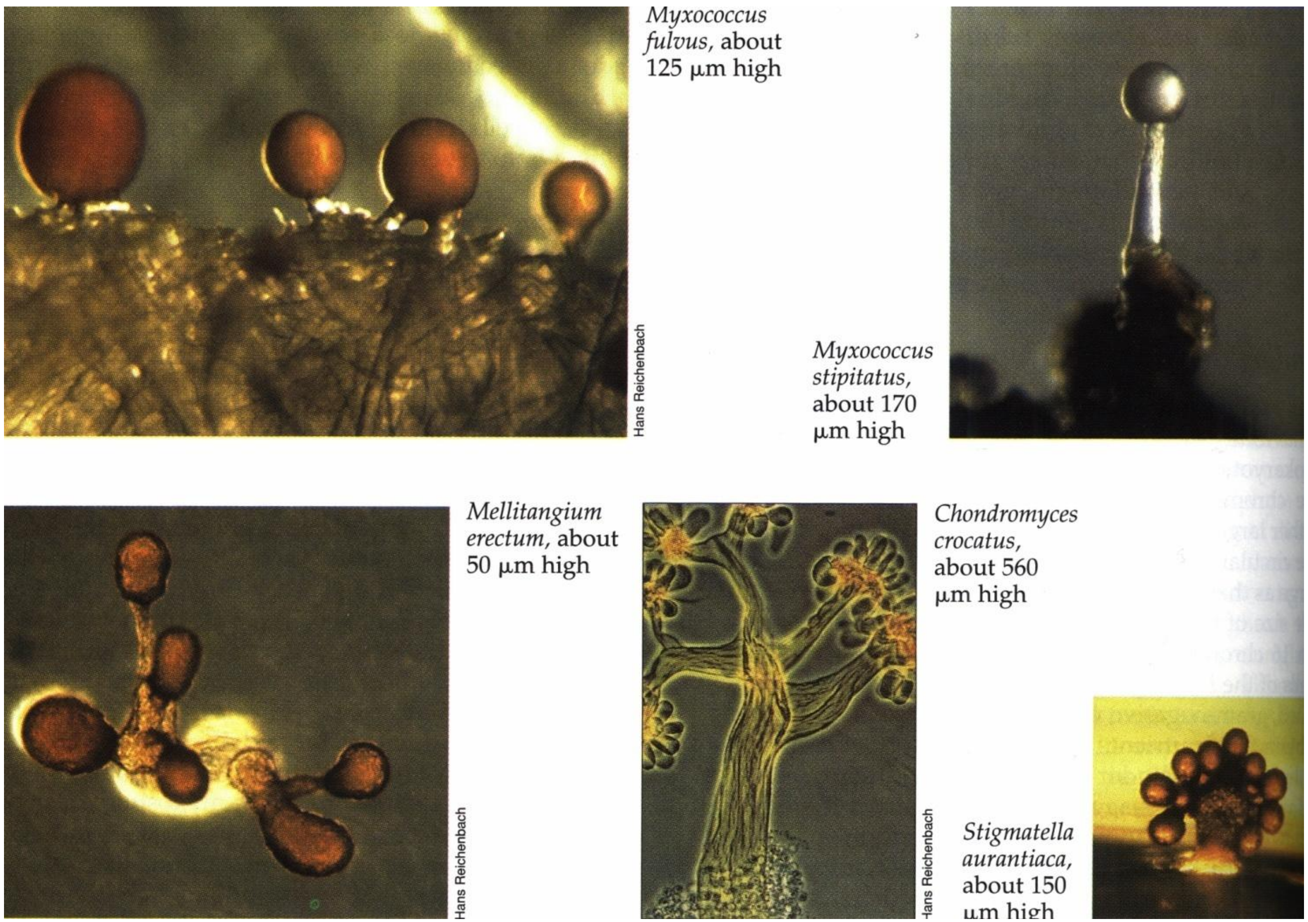
Tree of Life



BACTERIA
mitochondrion
Agrobacterium
Planctomyces
Flavobacterium
Flexibacter
Rhodocyclus
Escherichia
Desulfovibrio
chloroplast
Synechococcus
Gloeobacter
Chlamydia
Chlorobium
Leptonema
Clostridium
Bacillus
Heliobacterium
Arthrobacter
pOPS19
Chloroflexus
Thermus
Thermotoga
pOPS66
Aquifex
EM17
Root
Methanothermus
Methanopyrus
Methanobacterium
Thermococcus
Methanococcus
marine low temp
Thermoplasma
Archaeoglobus
Haloferax
Methanospirillum
marine Gp. 1 low temp
Gp. 1 low temp
Gp. 2 low temp
pSL 12
pSL 22
Gp. 3 low temp
Sulfolobus
Pyrodictium
Thermoproteus
Thermofilum
pSL 50
pJP 78
pJP 27
ARCHAEA
Coprinus
Homo
Zea
Cryptomonas
Achlya
Costaria
Porphyra
Paramecium
Babesia
Dictyostelium
Entamoeba
Naegleria
Euglena
Trypanosoma
Physarum
Encephalitozoon
Vairimorpha
Trichomonas
Giardia
0.1 changes / site
EUCARYA

Anabaena St. Johns

Typical fruiting bodies of Myxobacteria

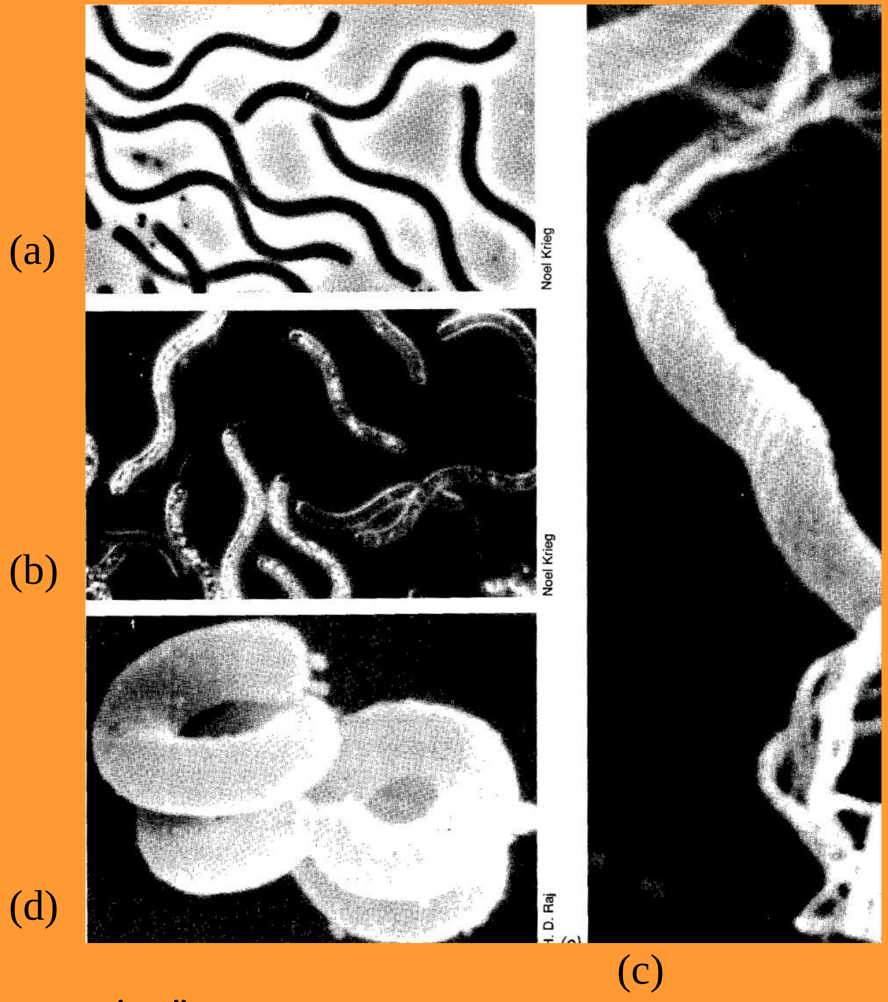


From "Brock Biology of Microorganisms"

Myxobacteria

Spiral Bacteria

Figure 16.48 (a) Photomicrograph by phase contrast of Spirillum volutans, a large spirillum. Cells are about 1.6 by 20-50 µm. (b) Spirillum volutans, by dark-field microscopy, showing flagellar bundles and volutin (polyphosphate) granules. (c) Scanning electron micrograph of an intestinal spirillum. Note the polar flagellar tufts and the spiral structure of the cell surface. (d) Scanning electron micrograph of cells of Spirosoma linguale. Cells are about 0.5 .m in diameter.



From "Brock Biology of Microorganisms"

Aquaspirillum

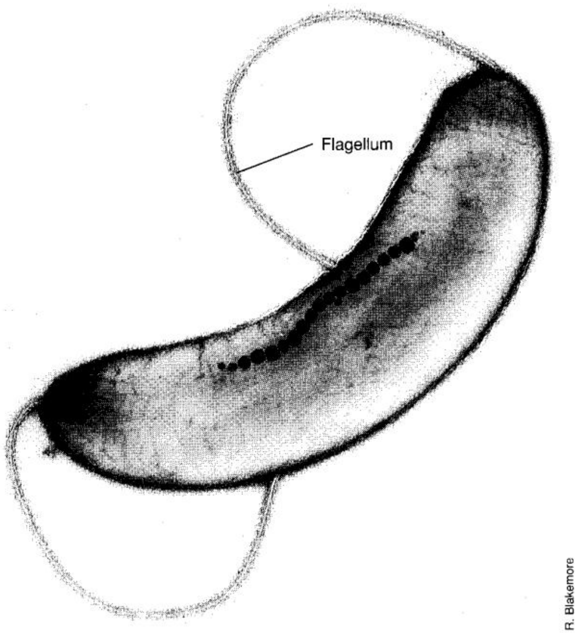
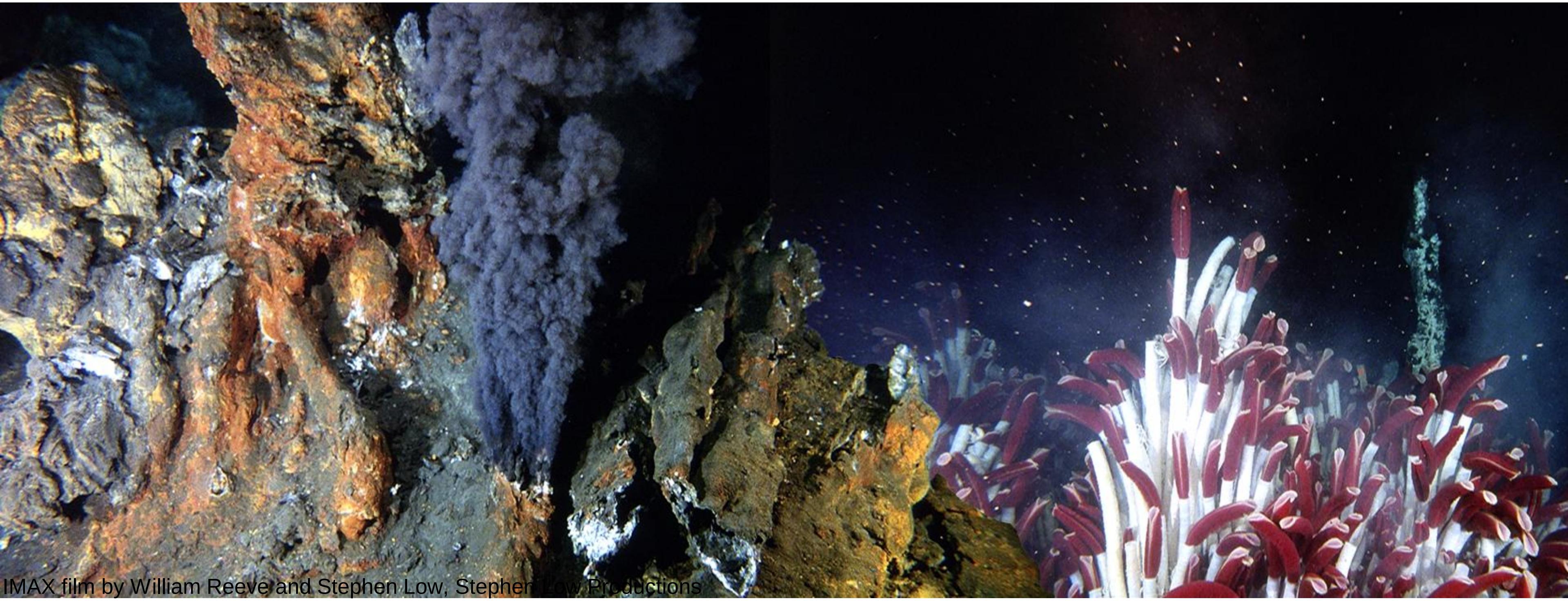


Figure 16.49 Negatively stained electron micrograph of a magnetotactic spirillum, *Aquaspirillum magnetotacticum*. A cell measures 0.3 × 2 μm. This bacterium contains particles of Fe_3O_4 (magnetite) called magnetosomes arranged in a chain; the particles align the cell along geomagnetic lines. The organism was isolated from a water treatment plant in Durham, New Hampshire.

From "Brock Biology of Microorganisms"

Vent Environment

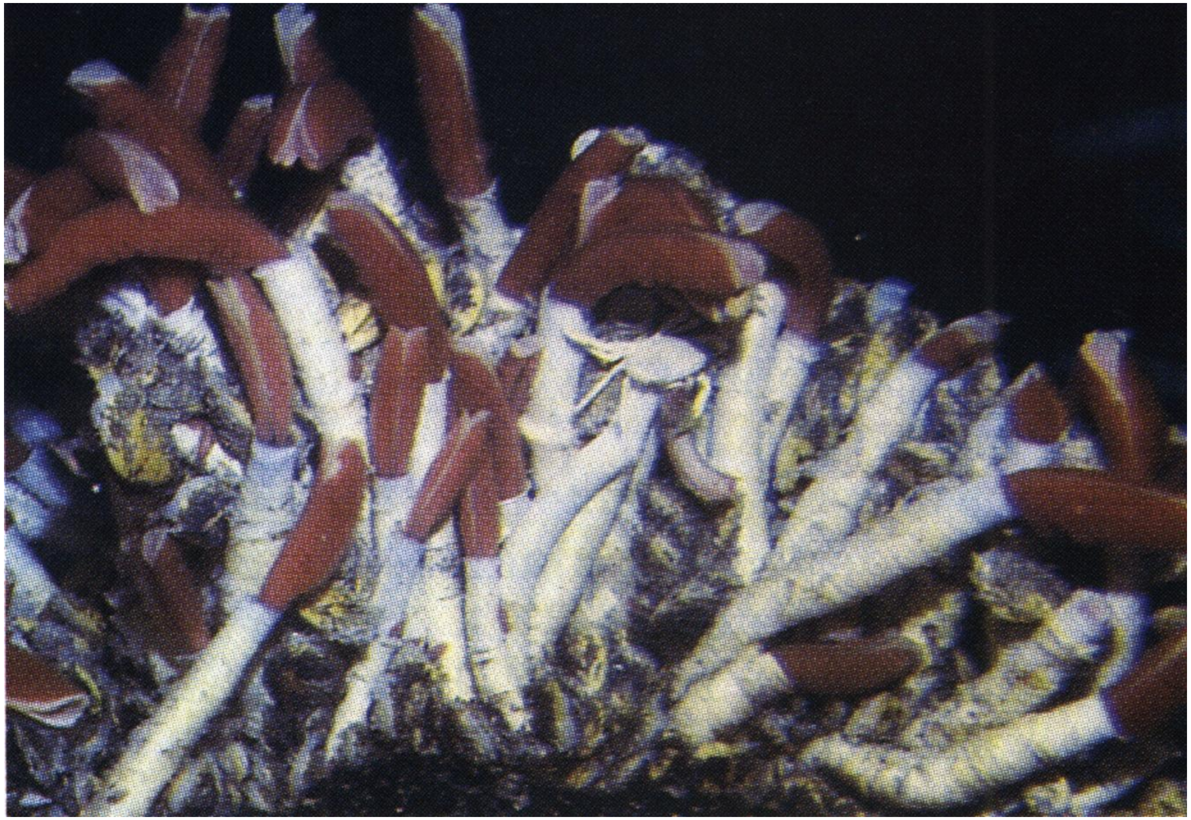


~350˚C ~20˚C

- Extreme temperature & chemical gradients
- Dense faunal communities
- Dynamic fluid flux, tectonics, magmatics
- Local extinction, population turnover

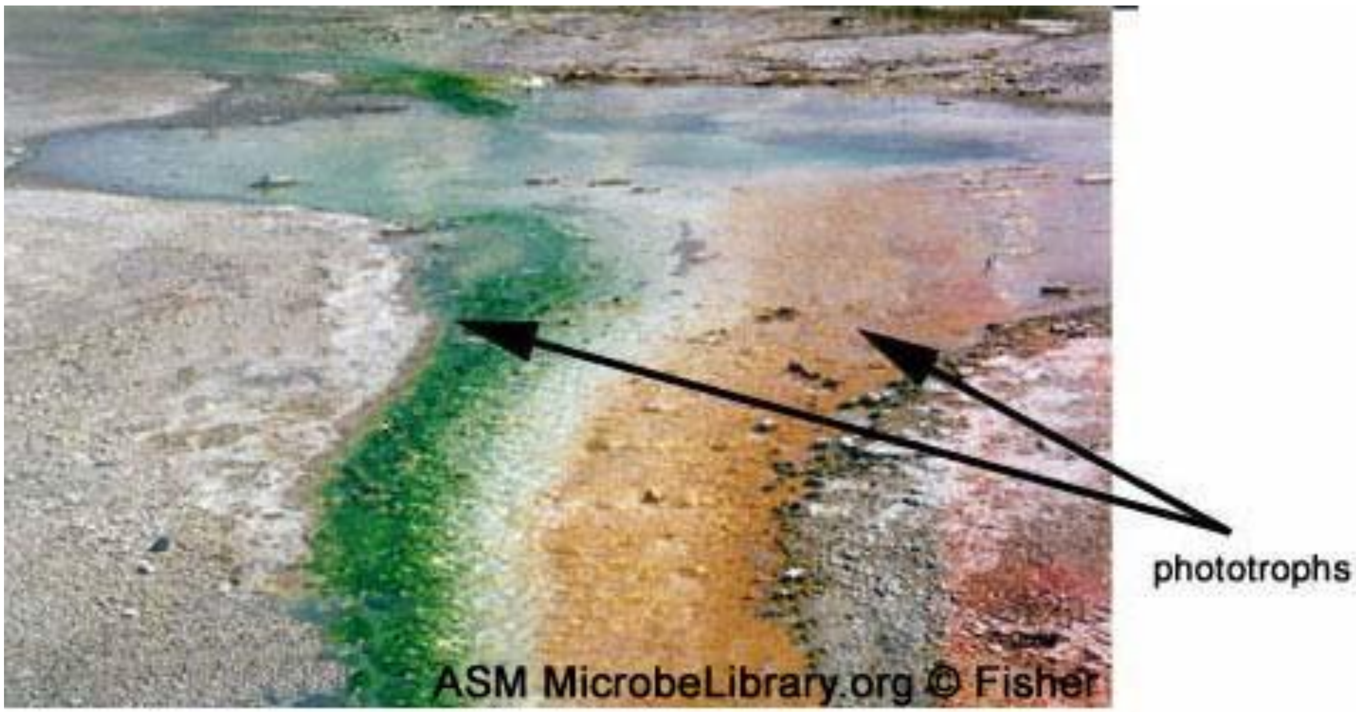
Tube Worms

Tube worms (*Riftia pachyptila*) from a habitat near a deep-sea thermal vent



***From "Brock Biology of Microorganisms*"**

Yellowstone geothermal pools



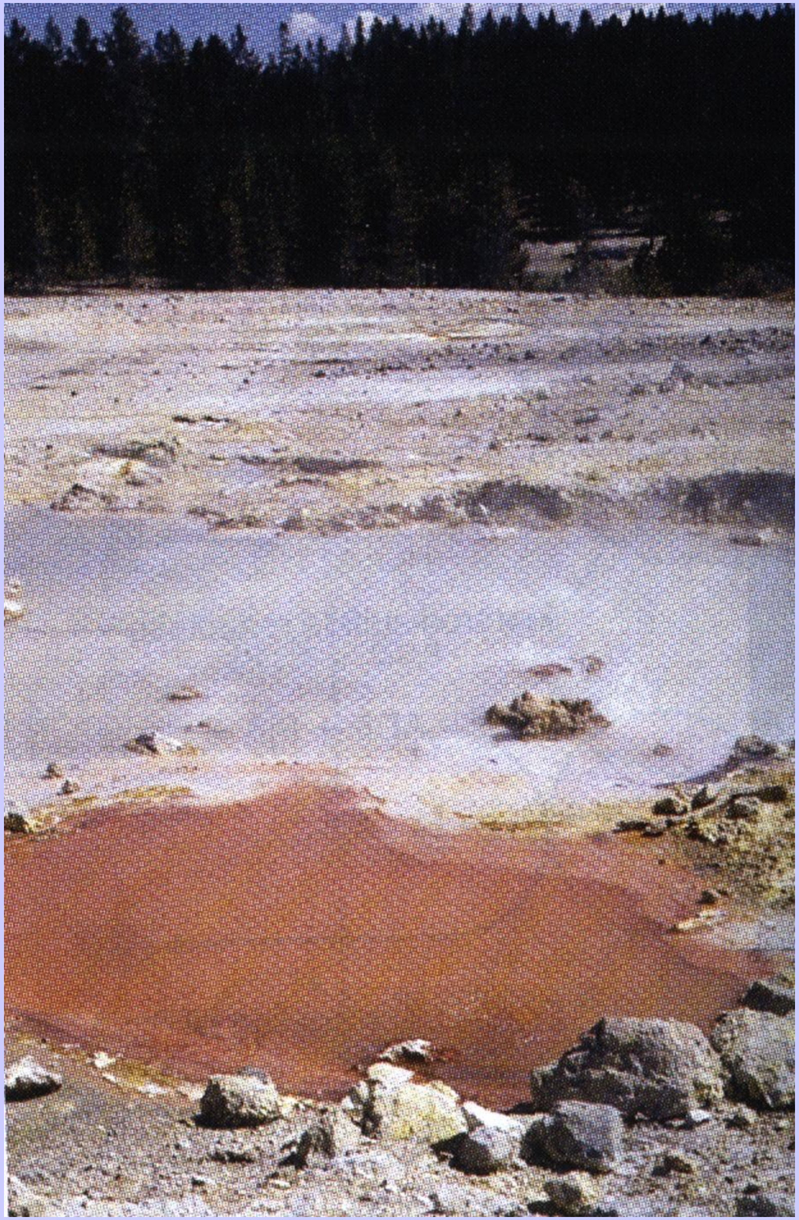
Central growth of *non-phototrophic* organisms flanked by *phototrophs* in hot spring outflow.

Sulfur-rich hot spring in Yellowstone National Park containing Sulfolobus (Archaea)

From "Brock Biology of Microorganisms"

Iron-rich geothermal spring in Yellowstone National Park containing Sulfolobus (Archaea)

From "Brock Biology of Microorganisms"



Humans and Bacteria

	Humans	**Bacteria**
# Cells	10^{13}	10^{14} (100 trillion)
# Strains	1	>20,000
# DNA Bases	3×10^{9}	$>6 \times 10^{9}$
# Genes	24,000	>1,000,000

Representative Microorganisms in the Normal Flora of Humans

Anatomical site	**Organism**[a]
Skin	*Staphylococcus, Corynebacterium, Acinetobacter, Pityrosporum (yeast), Propionibacterium*
Mouth	*Streptococcus, Lactobacillus, Fusobacterium, Veillonella, Corynebacterium, Neisseria, Actinomyces*
Respiratory tract	*Streptococcus, Staphylococcus, Corynebacterium, Neisseria*
Gastrointestinal tract	*Lactobacillus, Streptococcus, Bacteroides, Bifidobacterium, Eubacterium, Peptococcus, Peptostreptococcus, Ruminococcus, Clostridium, Escherichia, Klebsiella, Proteus, Enterococcus*
Urogenital tract	*Escherichia, Klebsiella, Proteus, Neisseria, Lactobacillus* (vagina of mature females)

From "Brock Biology of Microorganisms"

[a]Many of the genera listed also contain human pathogens.

High-speed photograph of an unstifled sneeze

From "Brock Biology of Microorganisms"

Disease Discovery

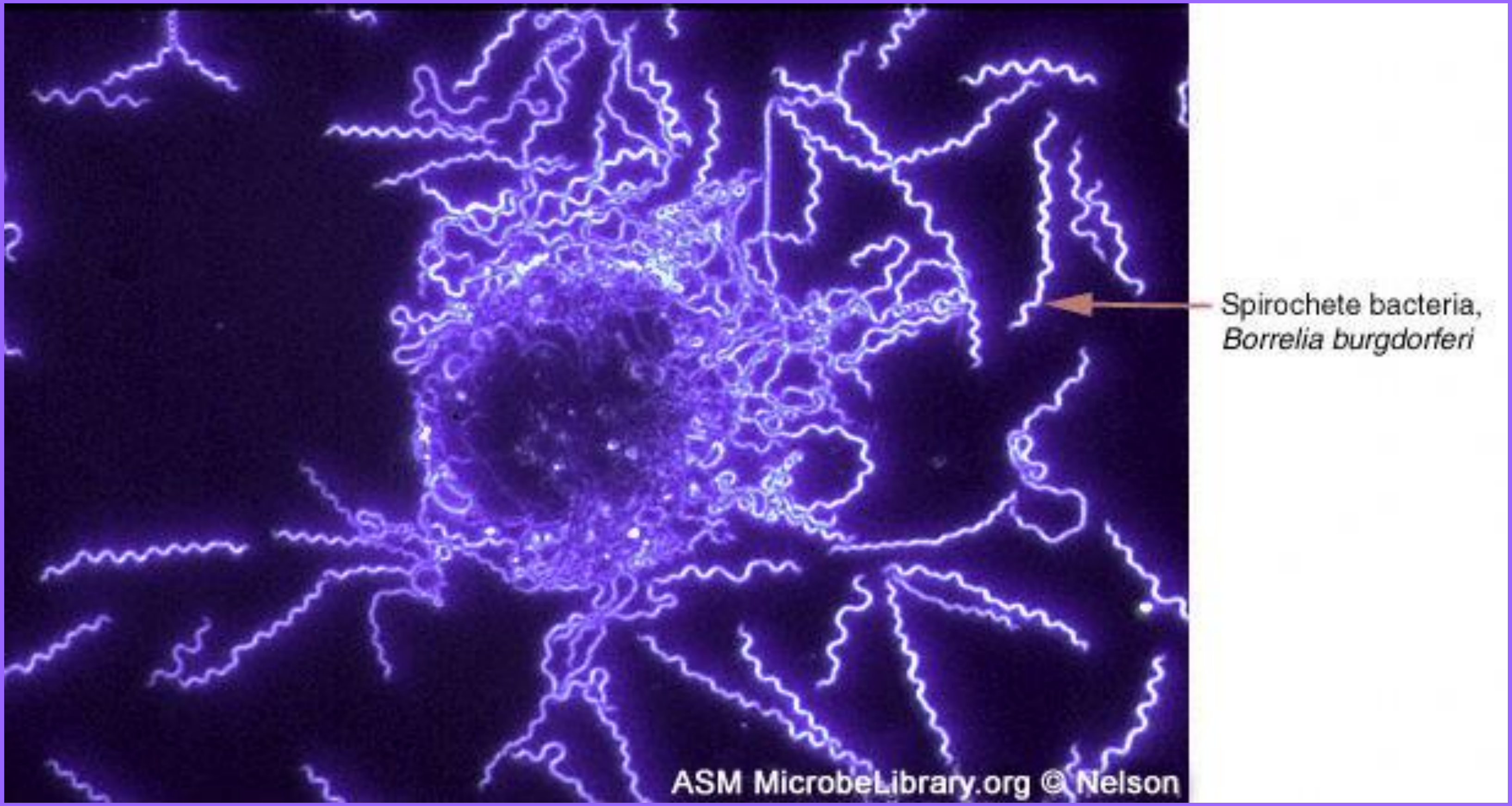
Year	Disease	Organism	Discoverer
1877	Anthrax	*Bacillus anthracis*	Koch, R.
1878	Suppuration	*Staphylococcus*	Koch, R.
1879	Gonorrhea	*Neisseria gonorrhoeae*	Neisser, A.L.S.
1880	Typhoid fever	*Salmonella typhi*	Eberth, C.J.
1881	Suppuration	*Streptococcus*	Ogston, A.
1882	Tuberculosis	*Mycobacterium tuberculosis*	Koch, R.
1883	Cholera	*Vibrio cholerae*	Koch, R.
1883	Diptheria	*Corynebacterium diphtheriae*	Klebs, T.A.E.
1884	Tetanus	*Clostridium tetani*	Nicolaier, A.
1885	Diarrhoea	*Escherichia coli*	Escherich, T.
1886	Pneumonia	*Streptococcus pneumoniae*	Fraenkel, A.
1887	Meningitis	*Neisseria meningitidis*	Weichselbaum, A.
1888	Food poisoning	*Salmonella enteritidis*	Gaertner, A.A.H.
1892	Gas gangrene	*Clostridium perfringens*	Welch, W.H.
1894	Plague	*Yersinia pestis*	Kitasato, S., Yersin, A.J.E. (independently)
1896	Botulism	*Clostridium botulinum*	van Ermengem, E.M.P.
1898	Dysentery	*Shigella dysenteriae*	Shiga, K.
1900	Paratyphoid	*Salmonella paratyphi*	Schottmüller, H.
1903	Syphilis	*Treponema pallidum*	Schaudinn, F.R. and Hoffman, E.
1906	Whooping cough	*Bordetella pertussis*	Bordet, J. and Gengou, O.

From "Brock Biology of Microorganisms"

Helicobacter pylori

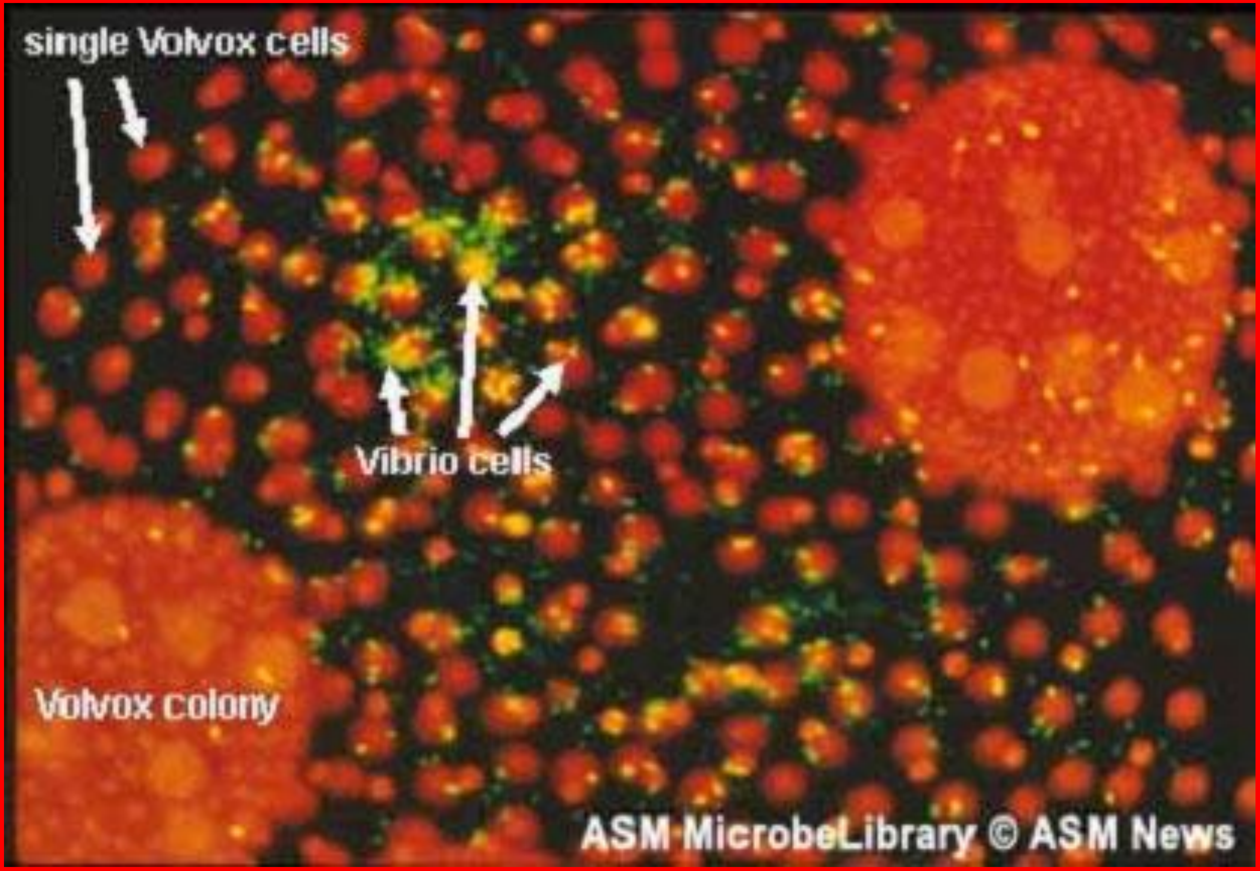
Lyme disease

Borrelia

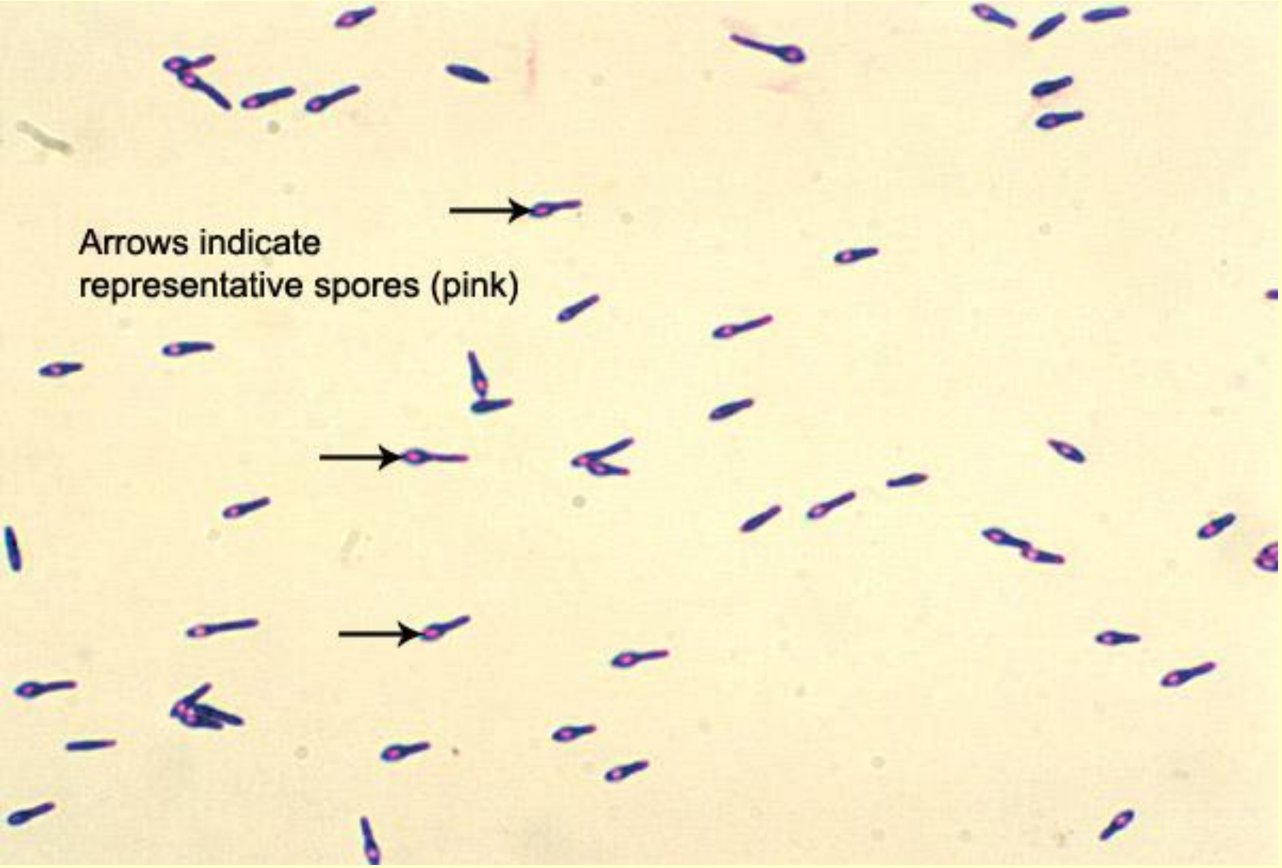


Spirochete bacteria,
Borrelia burgdorferi
ASM MicrobeLibrary.org © Nelson

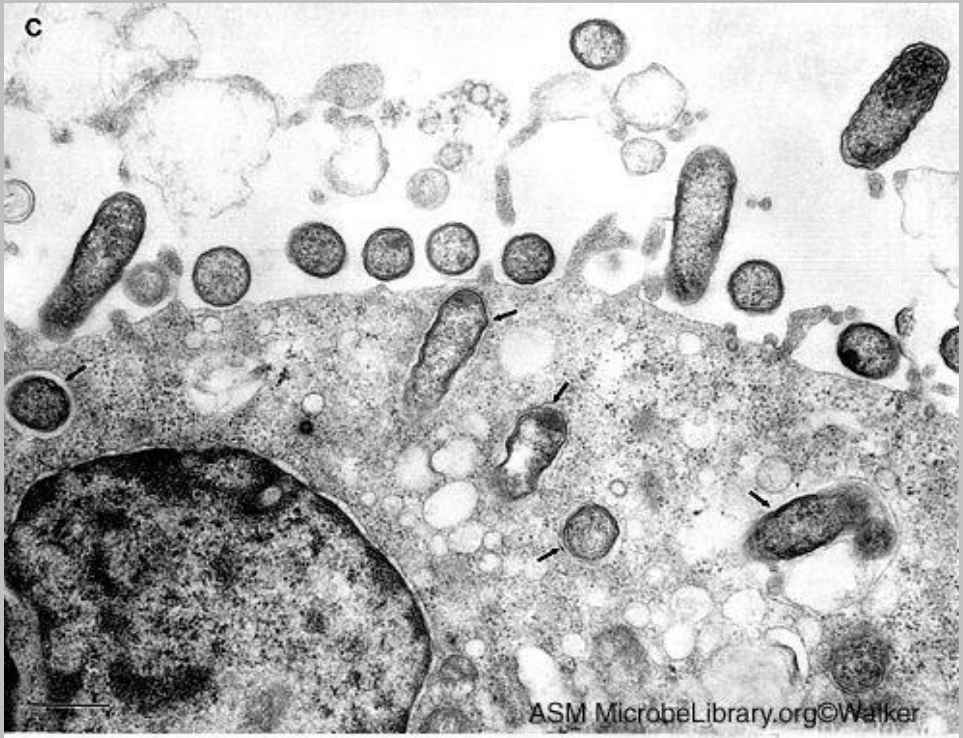
Vibrio cholerae and Volvox



Clostridium botulinum

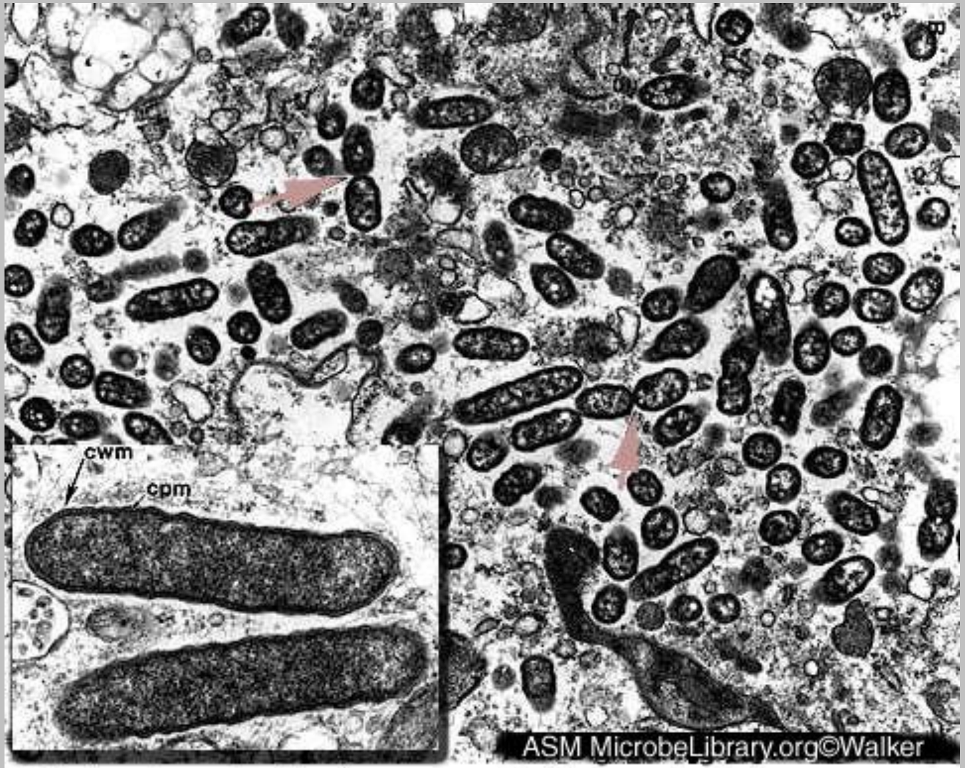


Typhus caused by Rickettsia



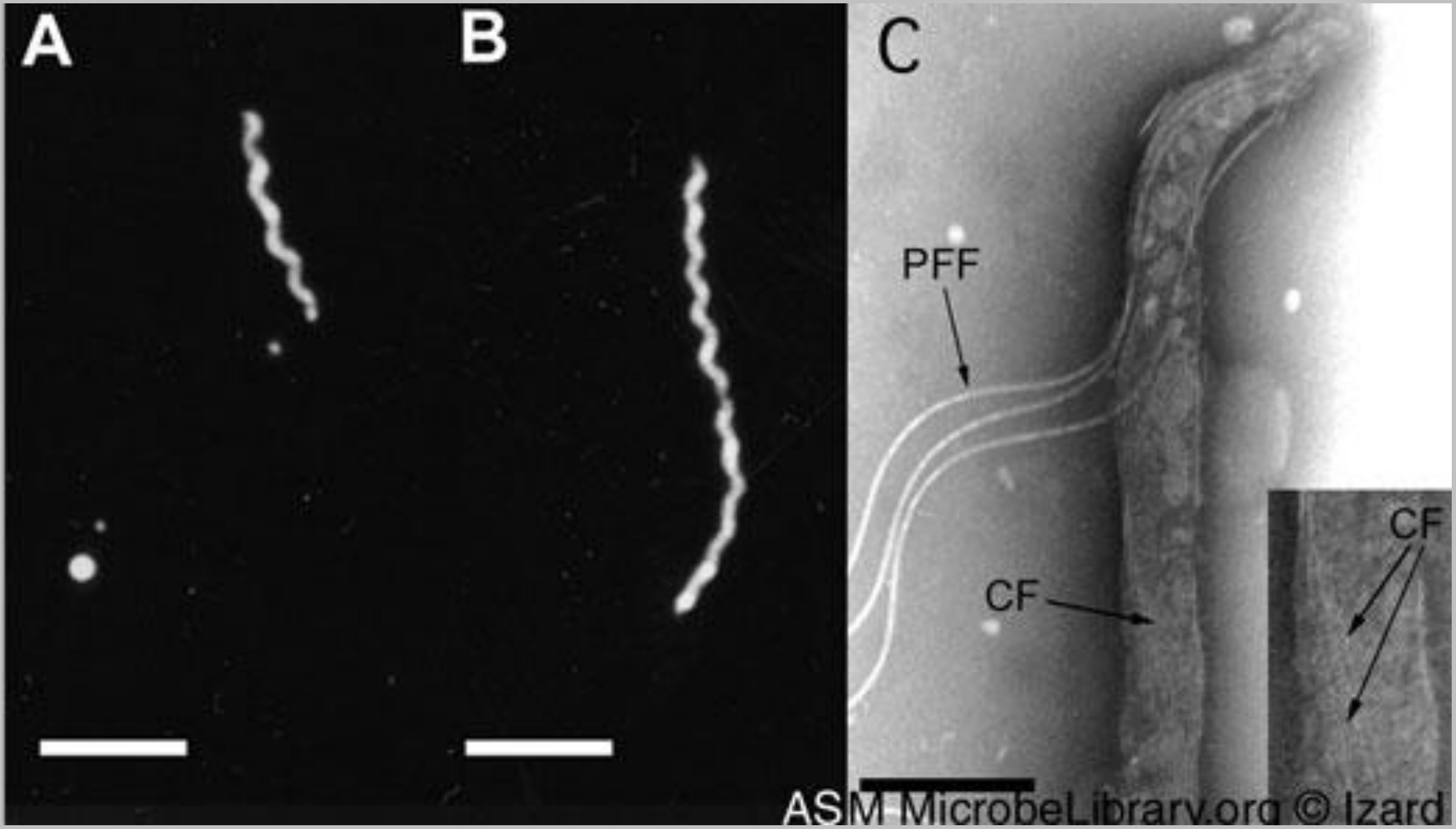
Attachment of rickettsiae to the surface of an endothelial cell is followed by their entry into the cell via rickettsia-induced phagocytosis. Following phagocytosis, the phagosome membrane (arrow) is lost and the rickettsiae escape into the host cell cytoplasm. Bar = 0.5 μm

Rickettsia



Following release from the phagosomes, rickettsiae grow free in the cytoplasm of cultured cells, dividing by binary fission (seen at arrows). Inset highlights the outer and inner membranes of rickettsia.

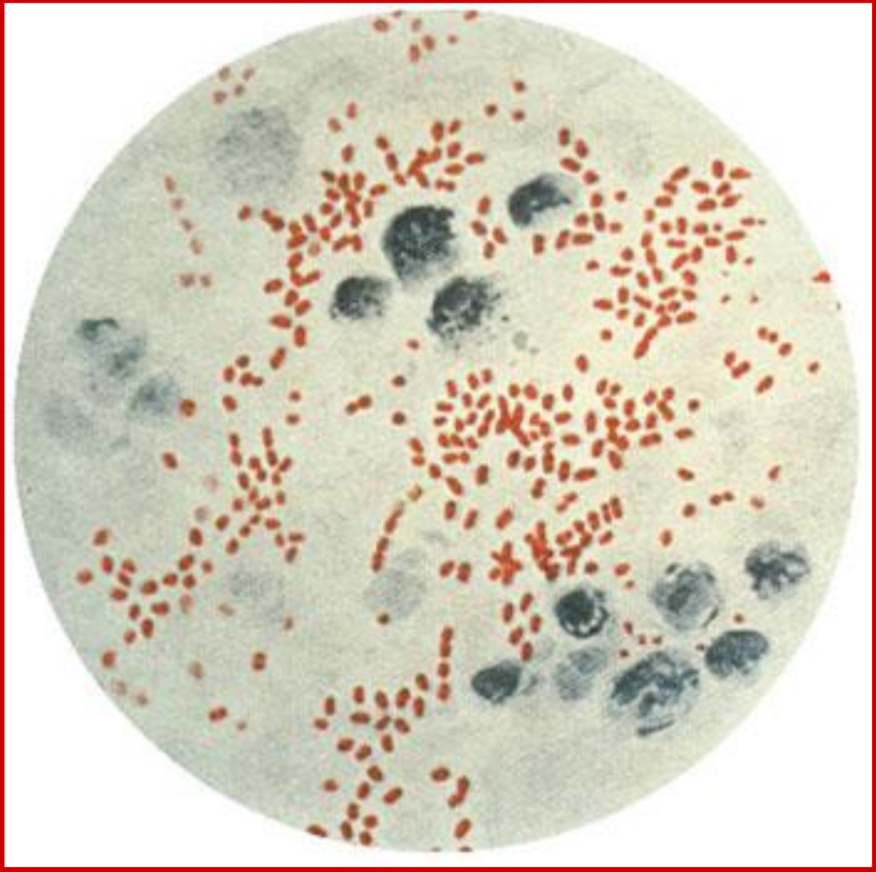
Treponema denticola



Yersinia pestis ingunial bubo

Yersinia pestis gangrene

Yersinia pestis



Probiotics – Our Friends!

Lactobacillus

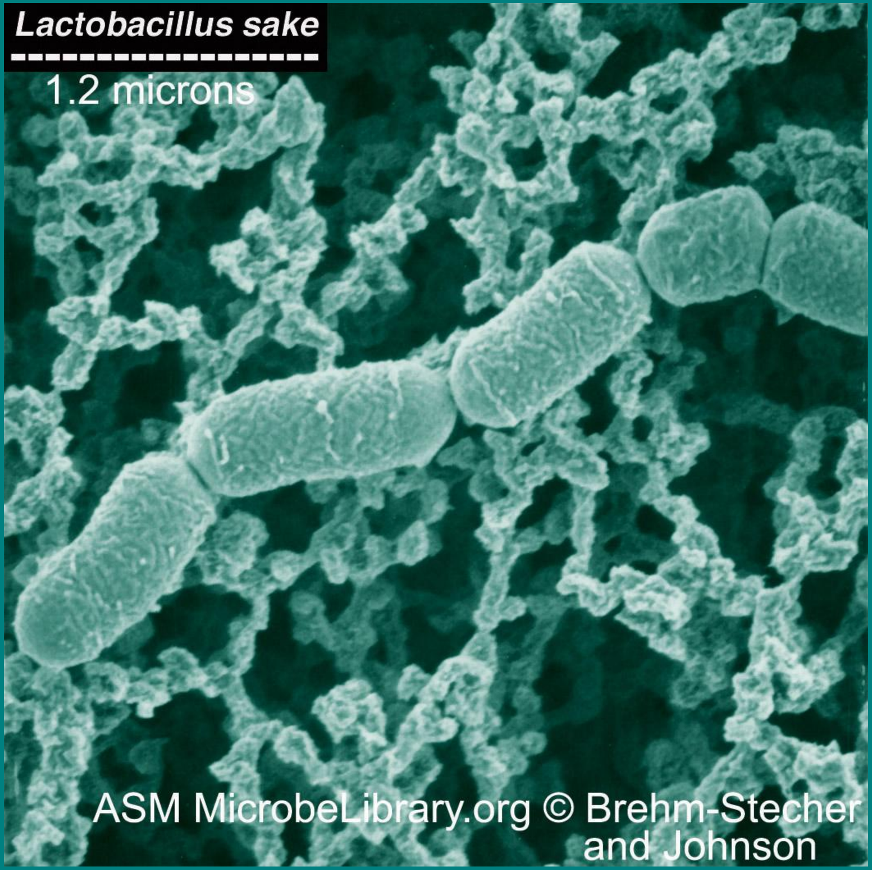
Bifidobacteria

Helicobacter

?????


Helps Boost
Calcium
Absorption*
nonfat
yogurt
GRADE A

Lactobacillus sake



Probiotics – Our Friends!

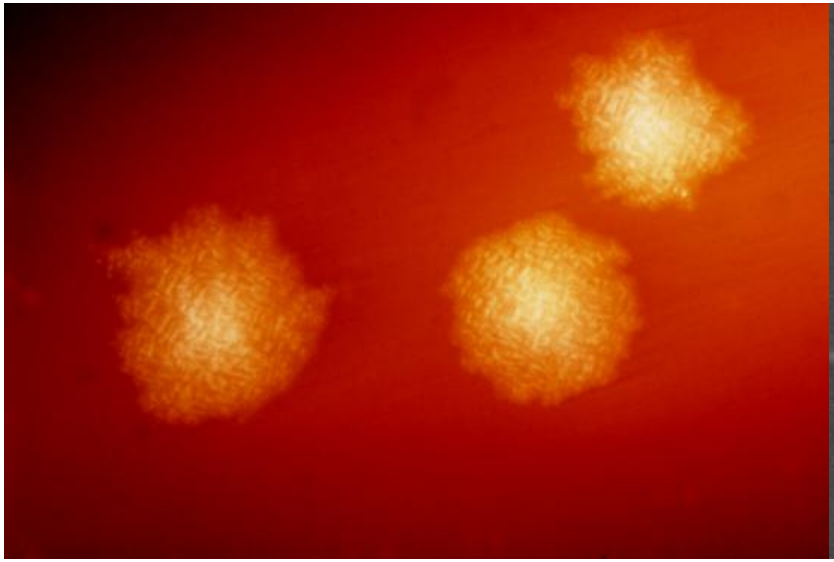
Lactobacillus

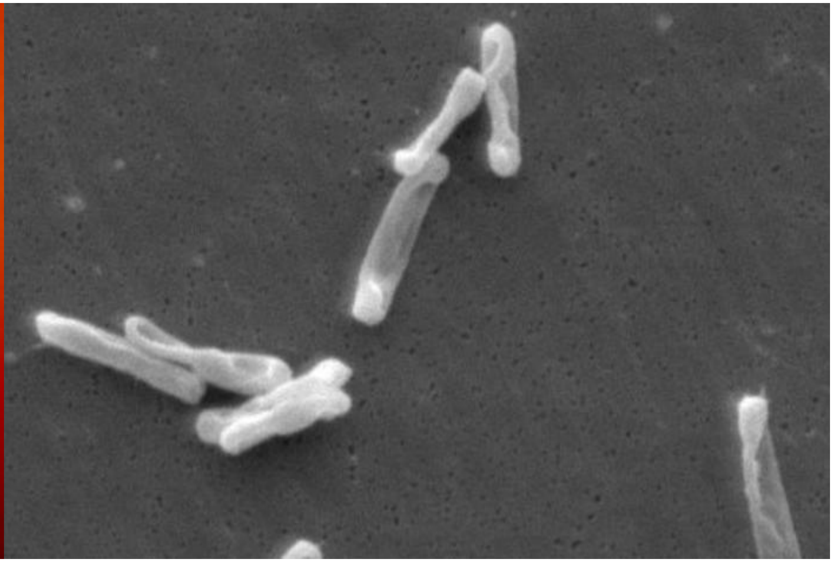
Bifidobacteria

Helicobacter

?????

Clostridium difficile (colitis)





Increasingly resistant to vancomycin and fidaxomicin

Casugel ™ Capsules

DRcaps acid resistant hypromellose capsules

Balance between protection and targeted release

Unfortunately, they are translucent….

Key Performance Claims

- ✓ New & Improved
- ✓ Acid Resistant
- ✓ Slower to Dissolve Than Gelatin or Standard HPMC
- ✓ Minimize the risk of bad aftertaste

Courtesy of E. Hohmann

Referrals: ehohmann@partners.org; jsauk@partners.org

Mars

Image Credit: NASA and the Hubble Heritage Team (STScI/AURA)

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ASM – MicrobeLibrary (www.microbelibrary.org)

Brock – Biology of Microorganisms

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