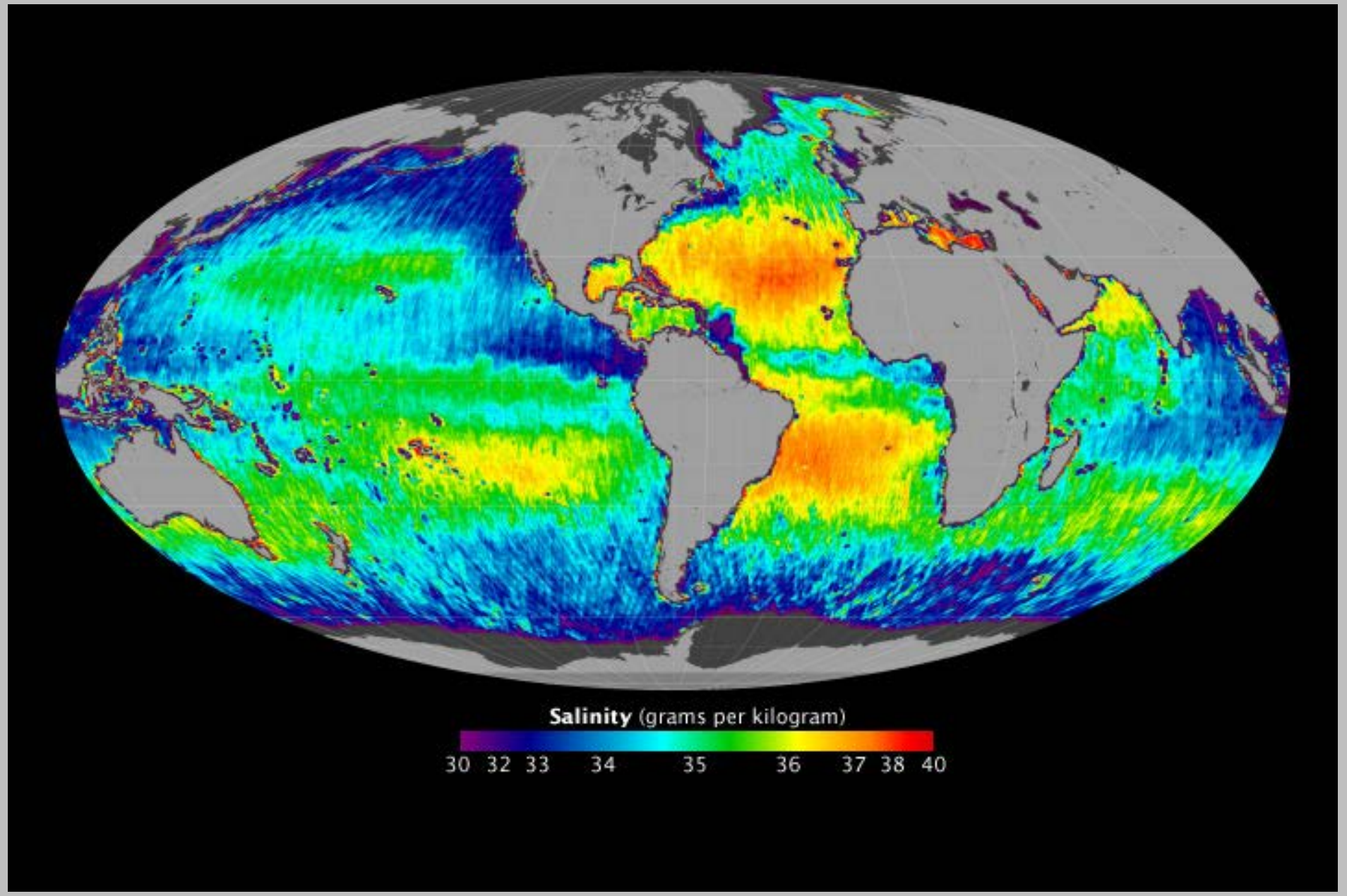
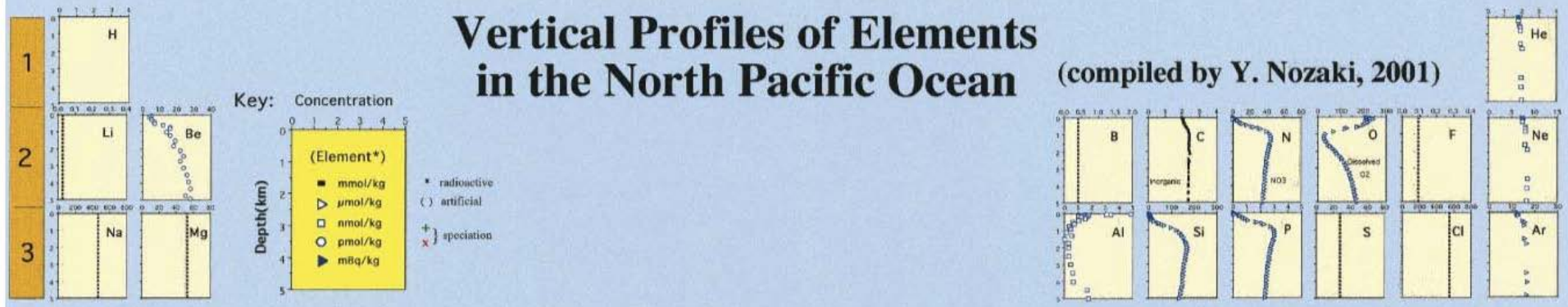
Ocean salinity



Vertical Profiles of Elements in the North Pacific Ocean

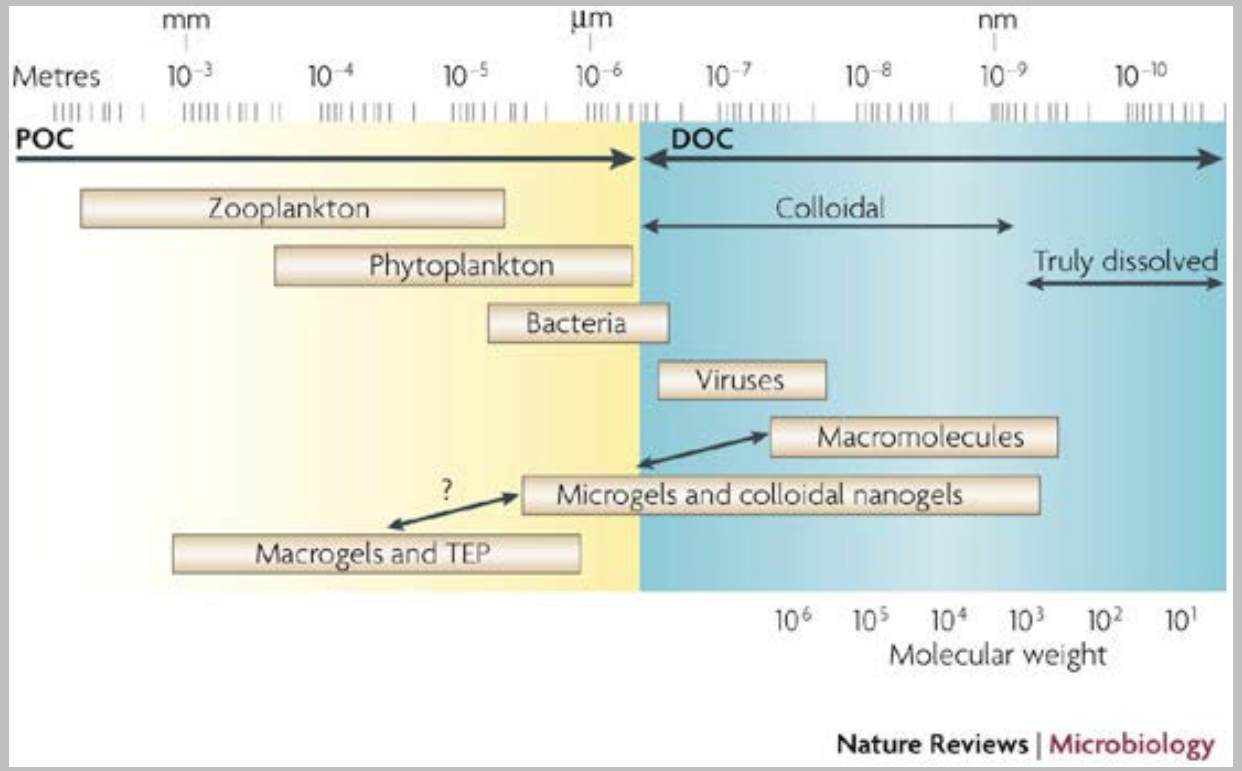
(compiled by Y. Nozaki, 2001)

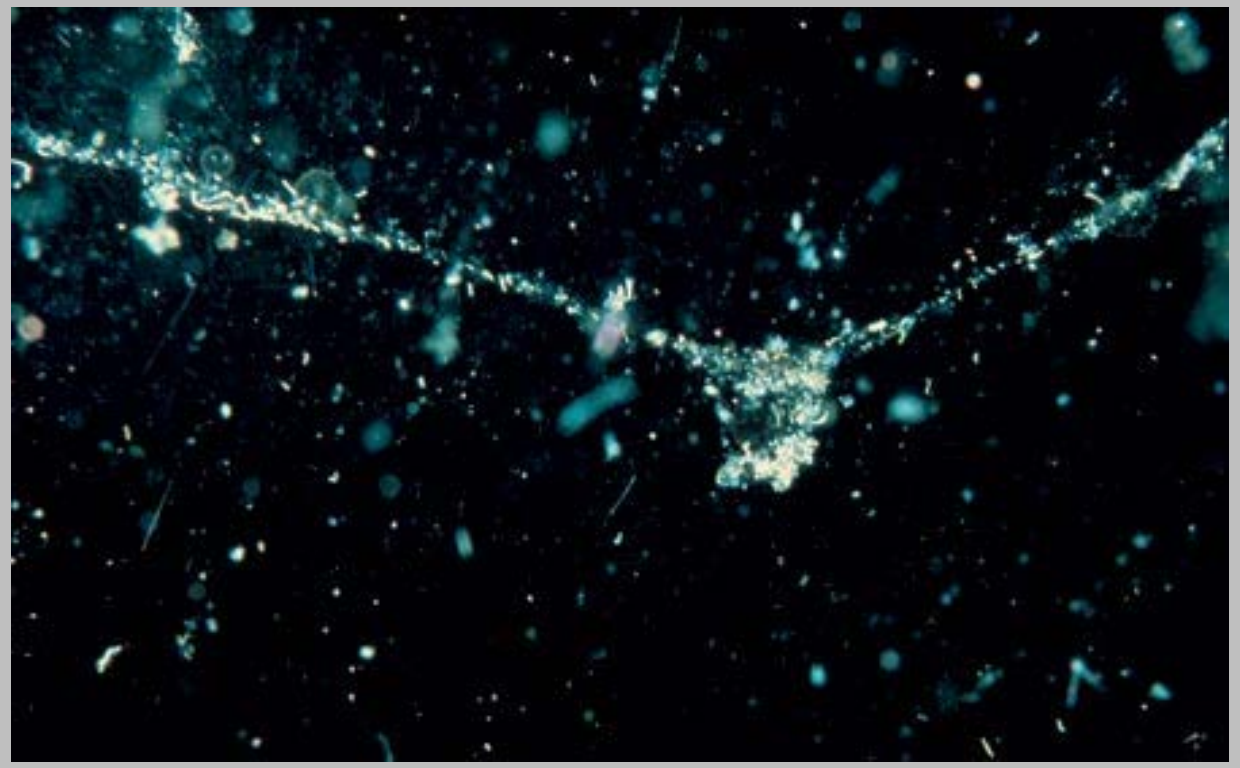


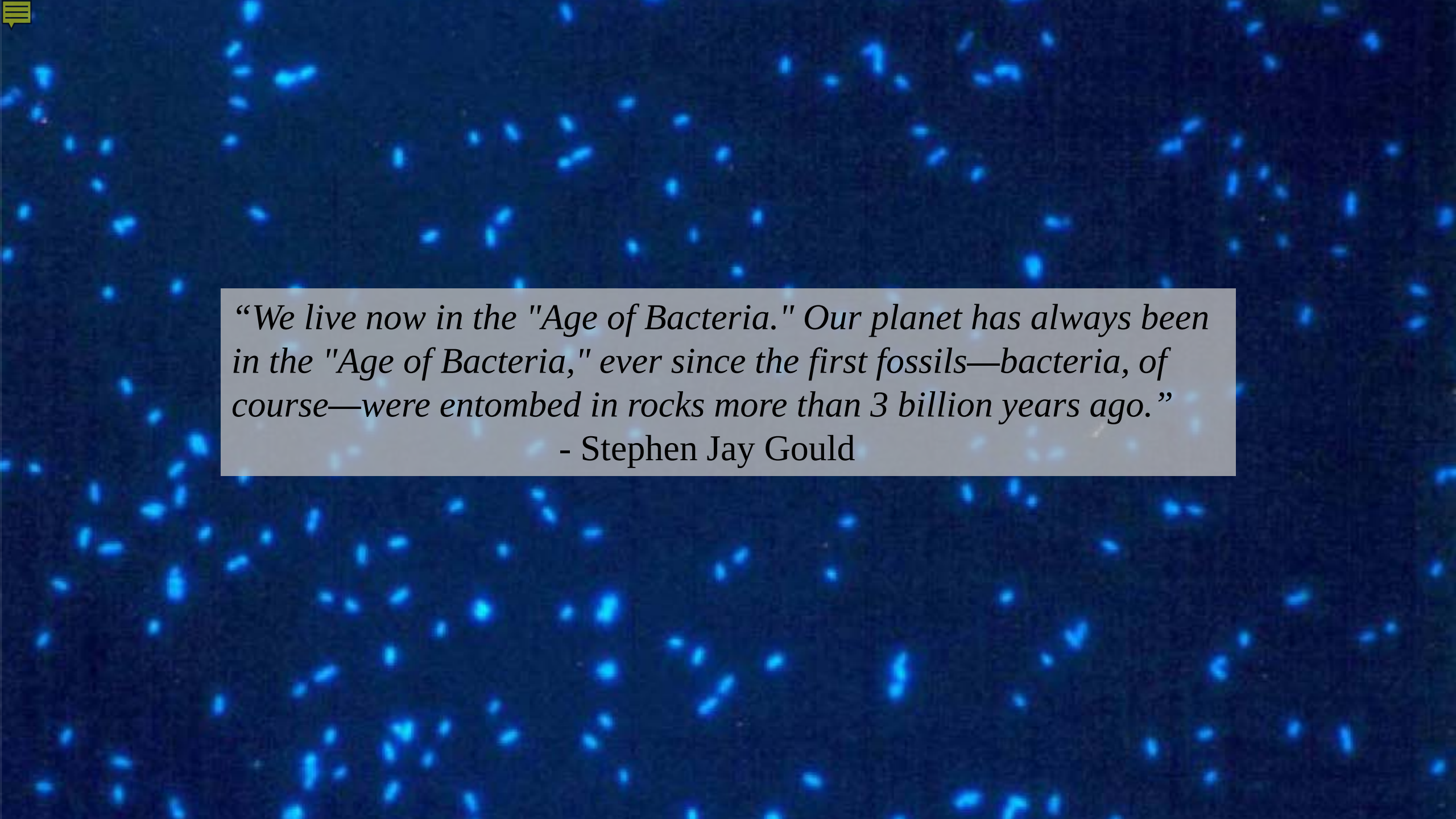
1A	2A	3A	4A	5A	6A	7A	8	1B	2B	3B	4B	5B	6B	7B	0
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	(Tc*)	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	L	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po*	At*	Rn*
Fr*	Ra*	A															

L	La	Ce	Pr	Nd	(Pm*)	Sm	Eu	Gd	Tb	Dy	Ho	Tm	Yb	Lu
A	Ac*	Th	Pa*	U*	(Np*)	(Pu*)	(Am*)	(Cm*)	(Bk*)	(Cf*)	(Es*)	(Fm*)	(Md*)	(No*)	(Lr*)

What else is in the ocean?

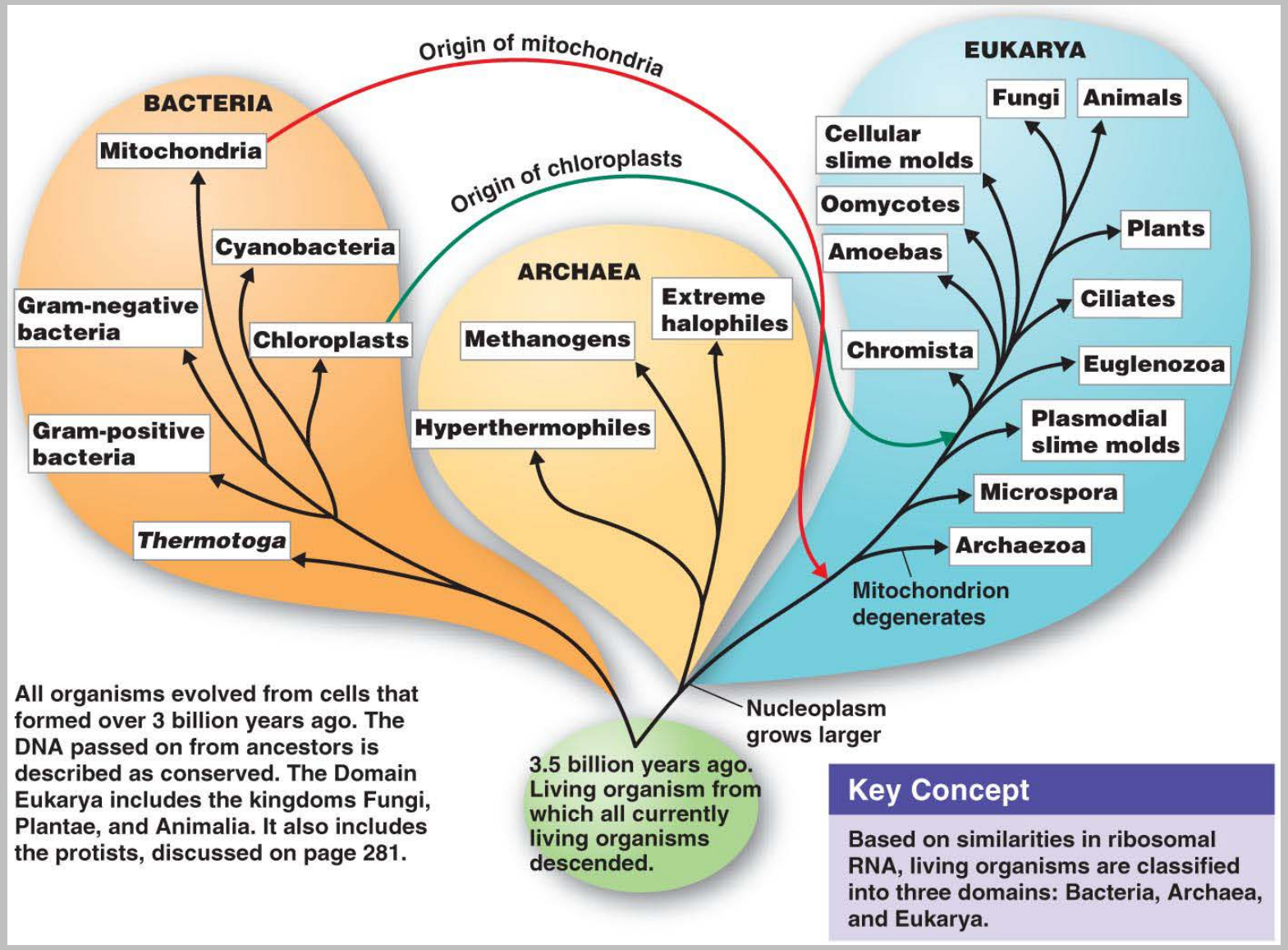





“We live now in the "Age of Bacteria." Our planet has always been in the "Age of Bacteria," ever since the first fossils—bacteria, of course—were entombed in rocks more than 3 billion years ago.”
- Stephen Jay Gould

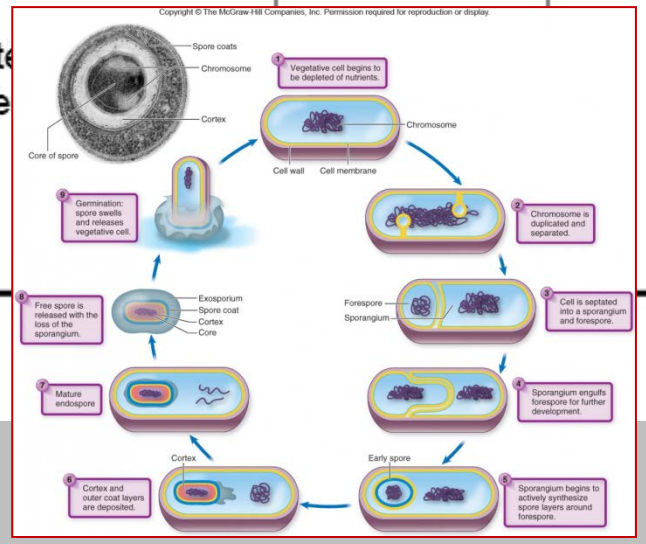
Based on differences in 16S rRNA genes

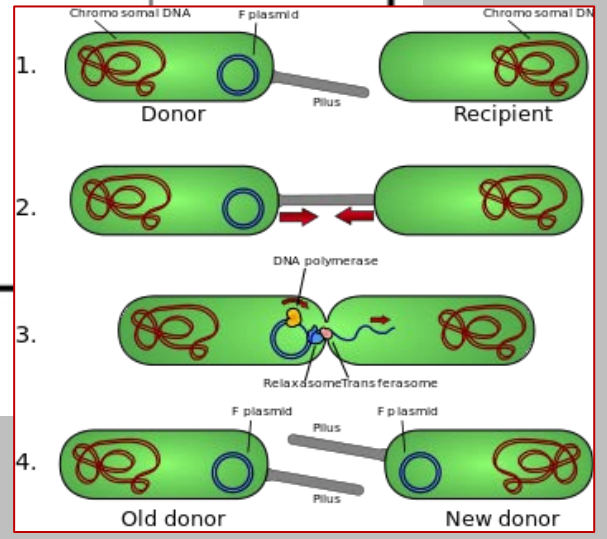
- 1977 Carl Woese proposed that Archaea are different from bacteria and constitute a new super-kingdom Archaebacteria.
- 1990 Woese adopted the term 'domain' for the three new branches of life and shortened the name Archaebacteria to Archaea.



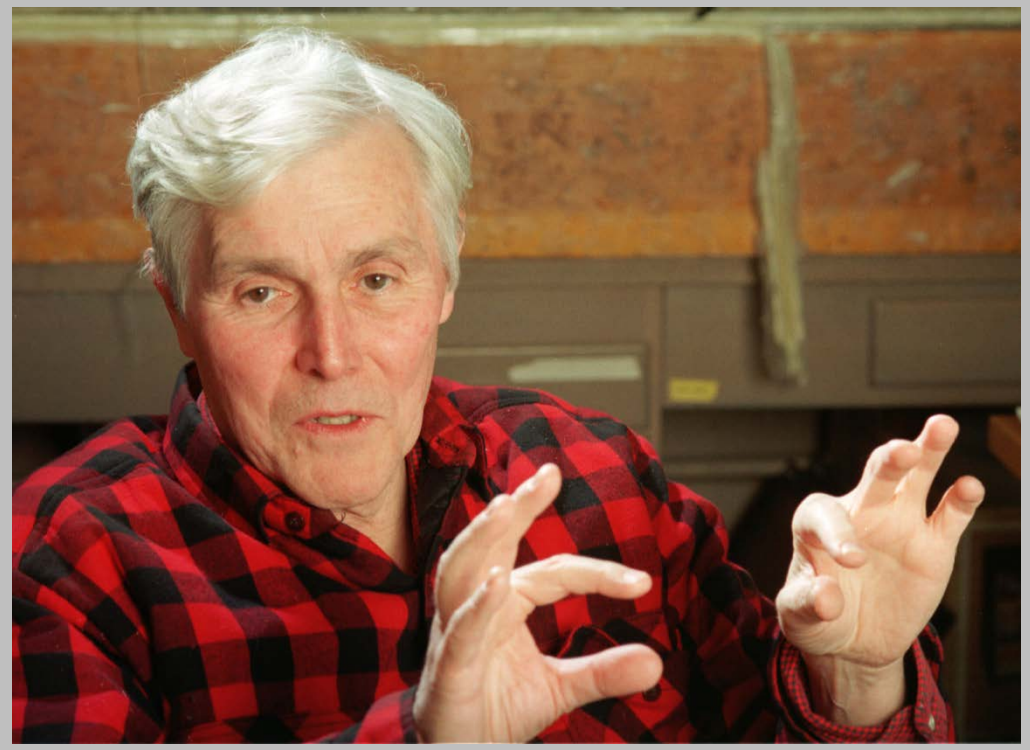
Bacteria vs. Archaea

	Shape	Cell wall	Nutrition	Habitat	Reproduction	Survival Tactics
Bacteria	Cocci- spherical Bacilli – rod Spirilli- spiral shape	With Peptidoglycan	Autotrophs (photosynthesis) Heterotrophs (predation)	Mostly mesophiles	Binary fission	Conjugation Endospores
Archaea	Cocci- spherical Bacilli – rod Spirilli - spiral shape	Without peptidoglycan	Autotrophs (methanogenesis) Hete (pre	Some extremophiles	Binary fission	Conjugation





Carl Woese



- "Wolfe recalls: 'One Nobel Prize winner, Salvador Luria, called me and said, 'Ralph, you're going to ruin your career. You've got to disassociate yourself from this nonsense!'"
- The hostility, Woese said, was shocking. Others soon followed, crossing boundaries of common courtesy by making fun of Woese. He was called a crank and a crackpot, being neither a microbiologist nor an evolutionist (Woese was a physicist).
- "Many leading biologists thought Woese was "crazy" and that his RNA tools couldn't possibly answer the question he was asking.

"I hadn't been trained as a microbiologist, so I didn't have this bias [about impossibility of bacterial classification]. (Woese)

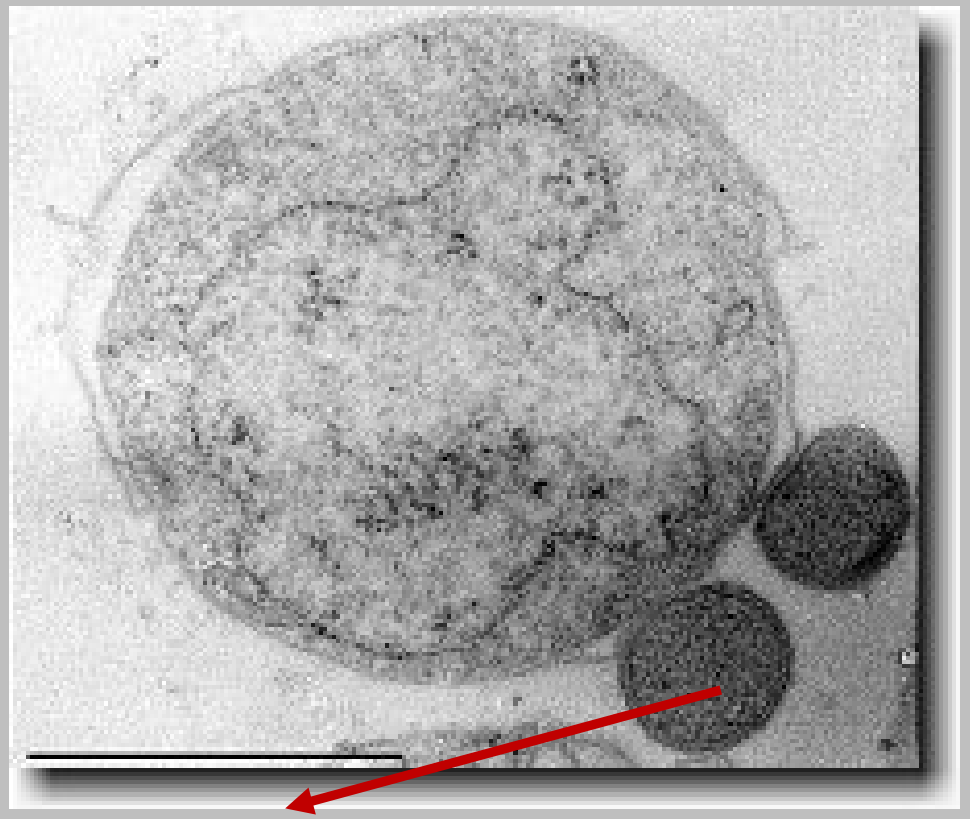
Table 13.4 Classification of Organisms into Six Kingdoms

Group	Kingdom	Characteristics	Examples
Prokaryotes: Single-celled organisms lacking a nucleus and other internal structural subdivisions; feed by absorption, photosynthesis, chemosynthesis.	Bacteria	Single chromosome, asexual reproduction, extreme metabolic diversity, no nucleus or cytoskeleton.	Bacteria, cyanobacteria ("blue-green algae").
	Archaea	Superficially similar to bacteria, but with many different genes capable of producing different kinds of enzymes; often live in extreme environments.	*Methanococcus, Pyrolobus,* "extremophiles."
Eukaryotes: Single- or multicelled organisms possessing a nucleus and other internal structural subdivisions; feed by absorption, photosynthesis, or ingestion of particles.	Protista	Usually unicellular, sexual or asexual reproduction, great genetic diversity.	Diatoms and dinoflagellates, radiolarians and foraminifera, single- and multicellular marine algae (seaweeds).
	Fungi	Usually multicellular, sexual or asexual reproduction; release enzymes that break down organic material for absorption.	Molds, mushrooms, symbionts within lichens.
	Plantae	Multicellular photosynthetic autotrophs, sexual or asexual reproduction.	Mosses, ferns, flowering plants.
	Animalia	Multicellular heterotrophs, sexual or asexual reproduction.	Invertebrates, vertebrates.

Nanobacteria Examples

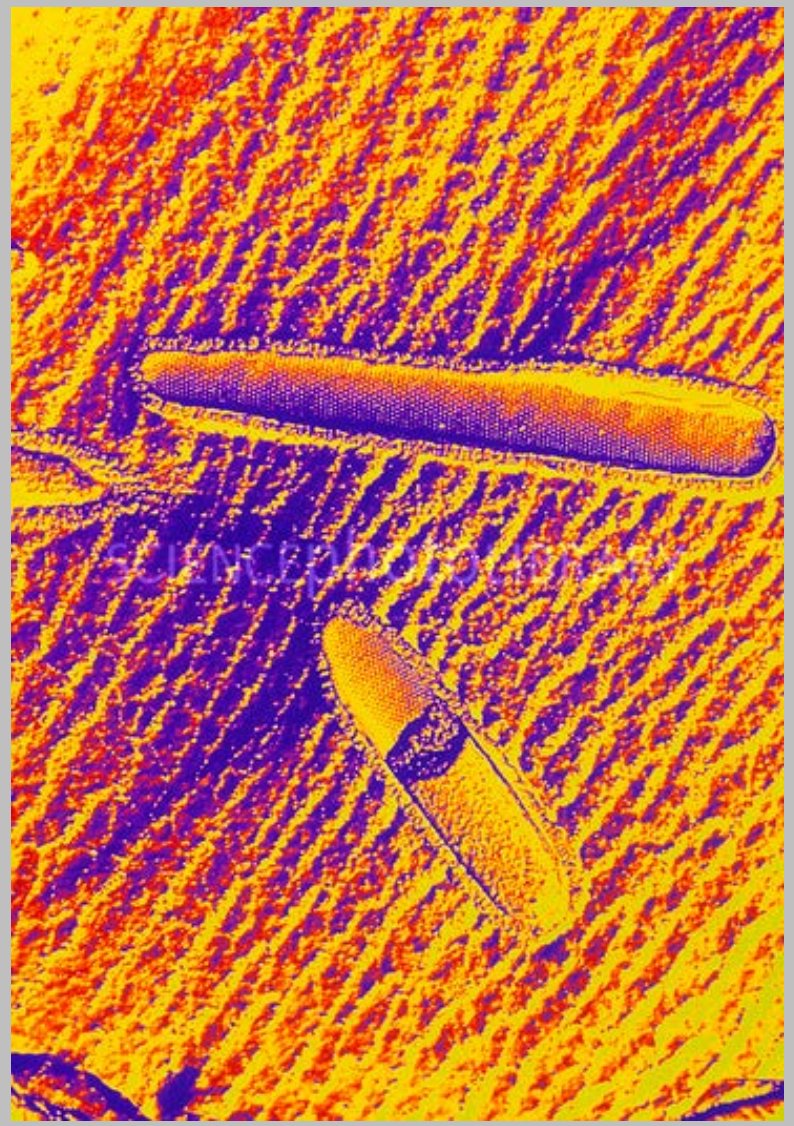
Ignicoccus hospitalis

2 µm



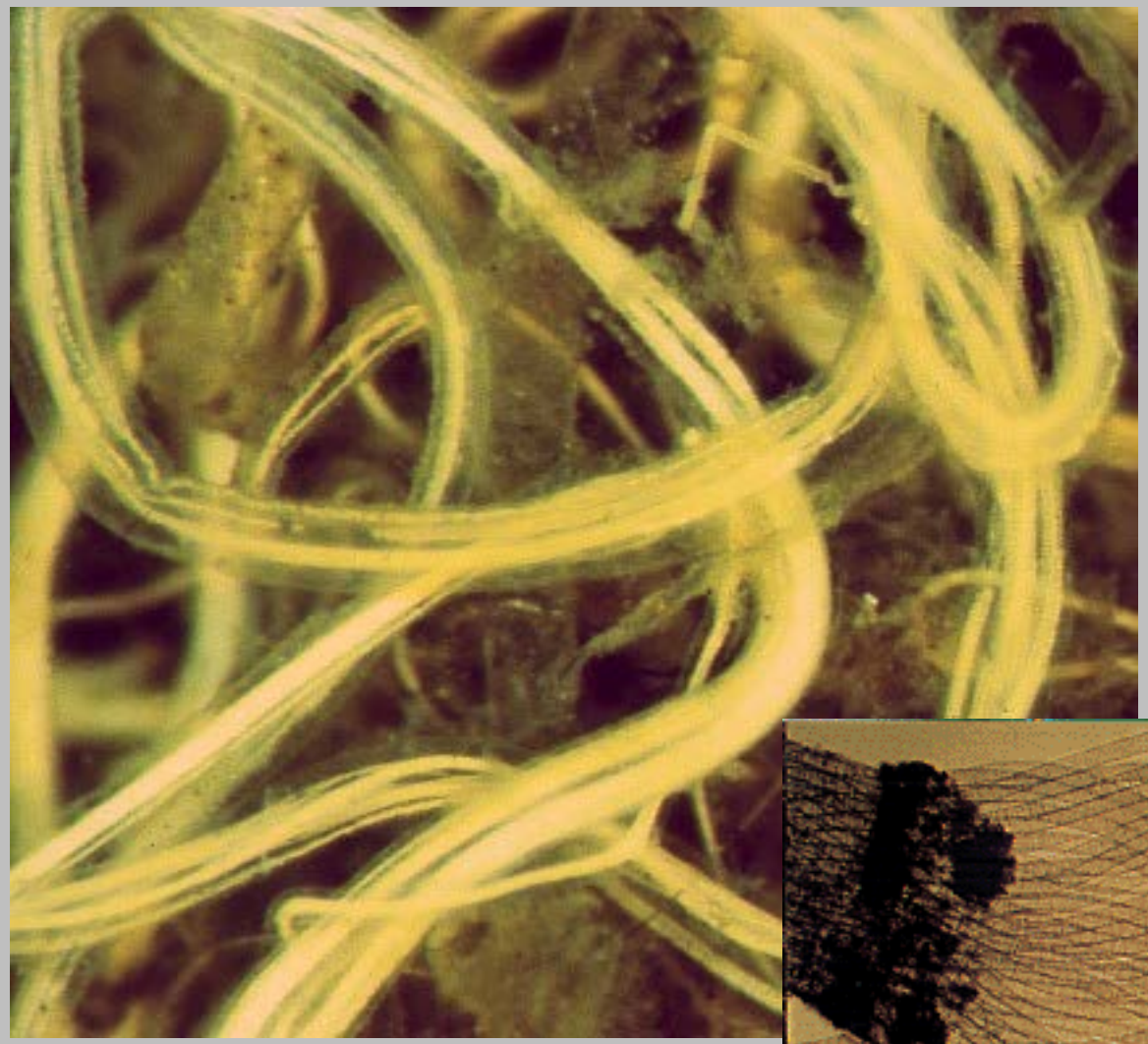
Nanoarchaeum equitans is a species of marine Archaea that was discovered in 2002 in a hydrothermal vent off the coast of Iceland on the Kolbeinsey Ridge by Karl Stetter.

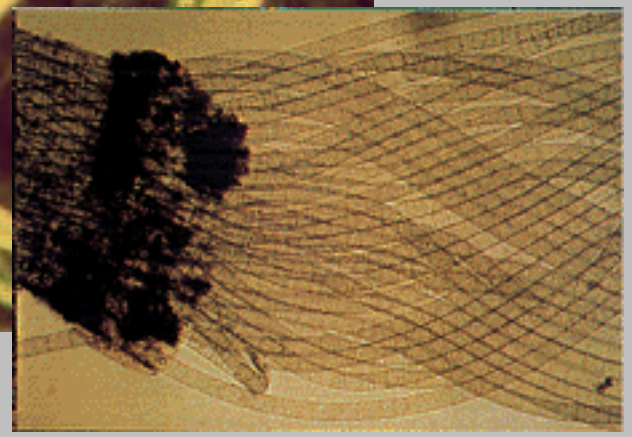
400 nm in size with 540 genes in genome.



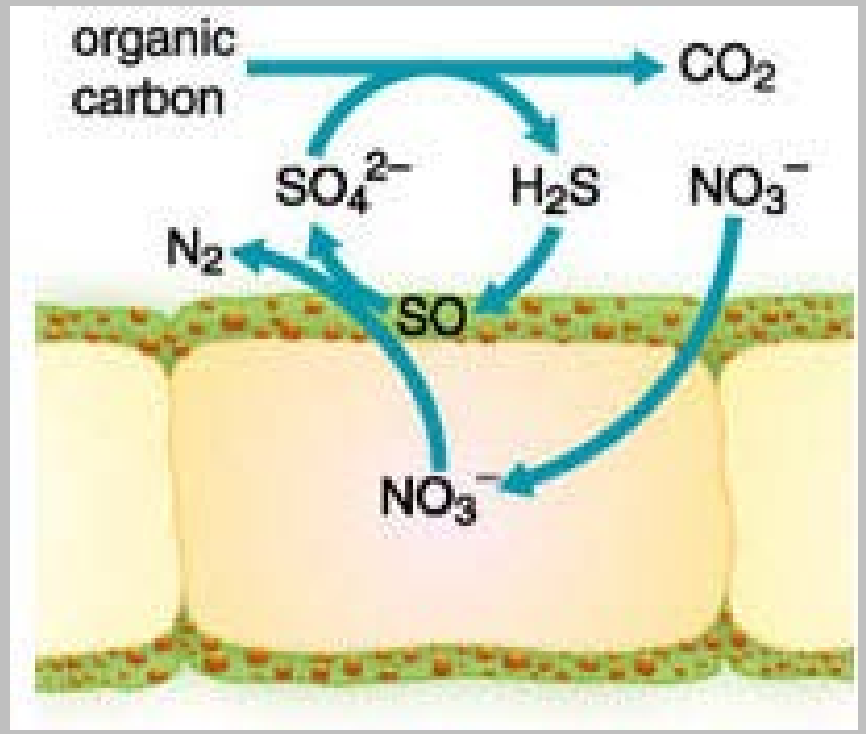
Thermoproteus
300 nm

Large bacteria Examples

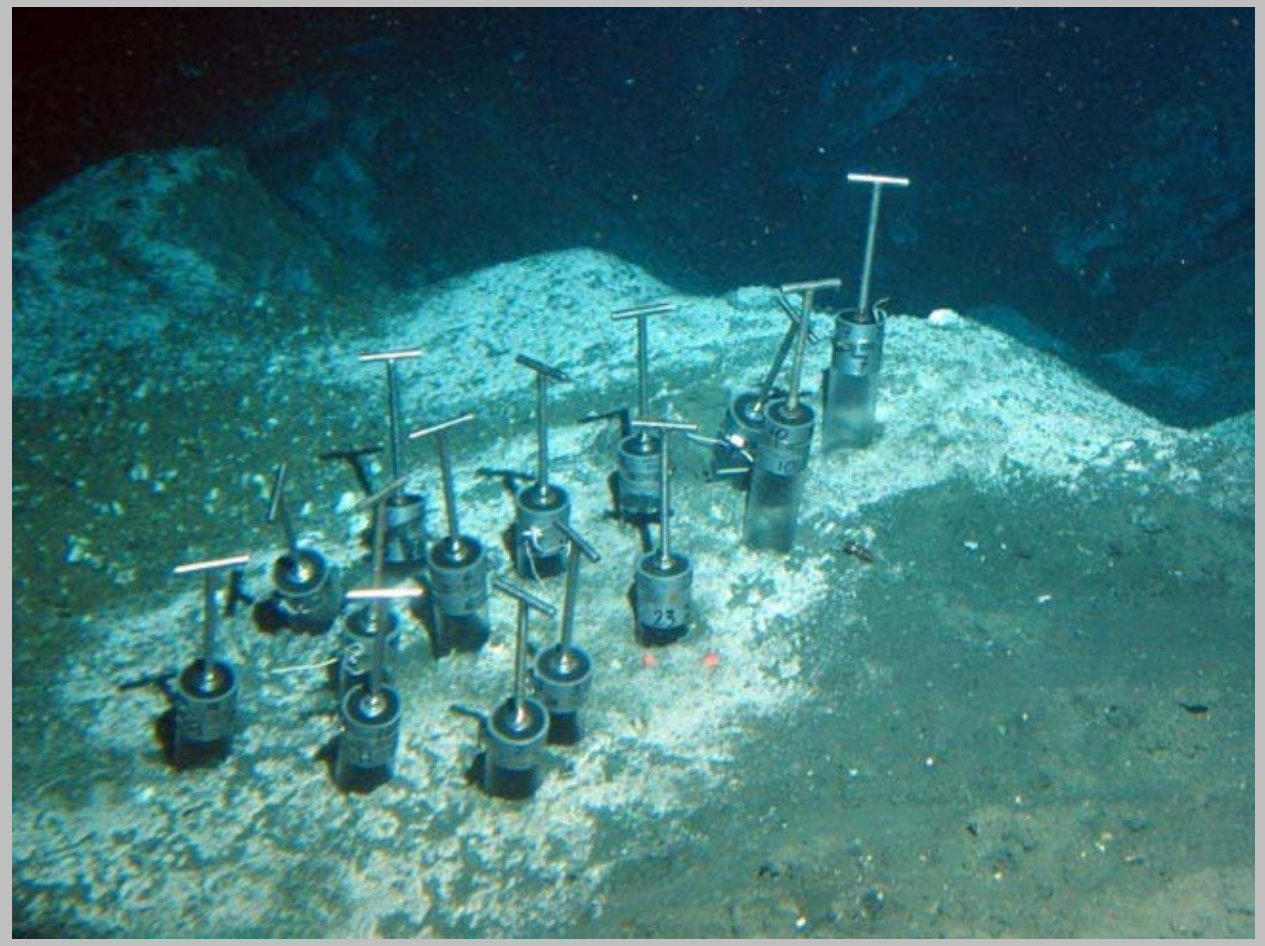




Thioploca araucae



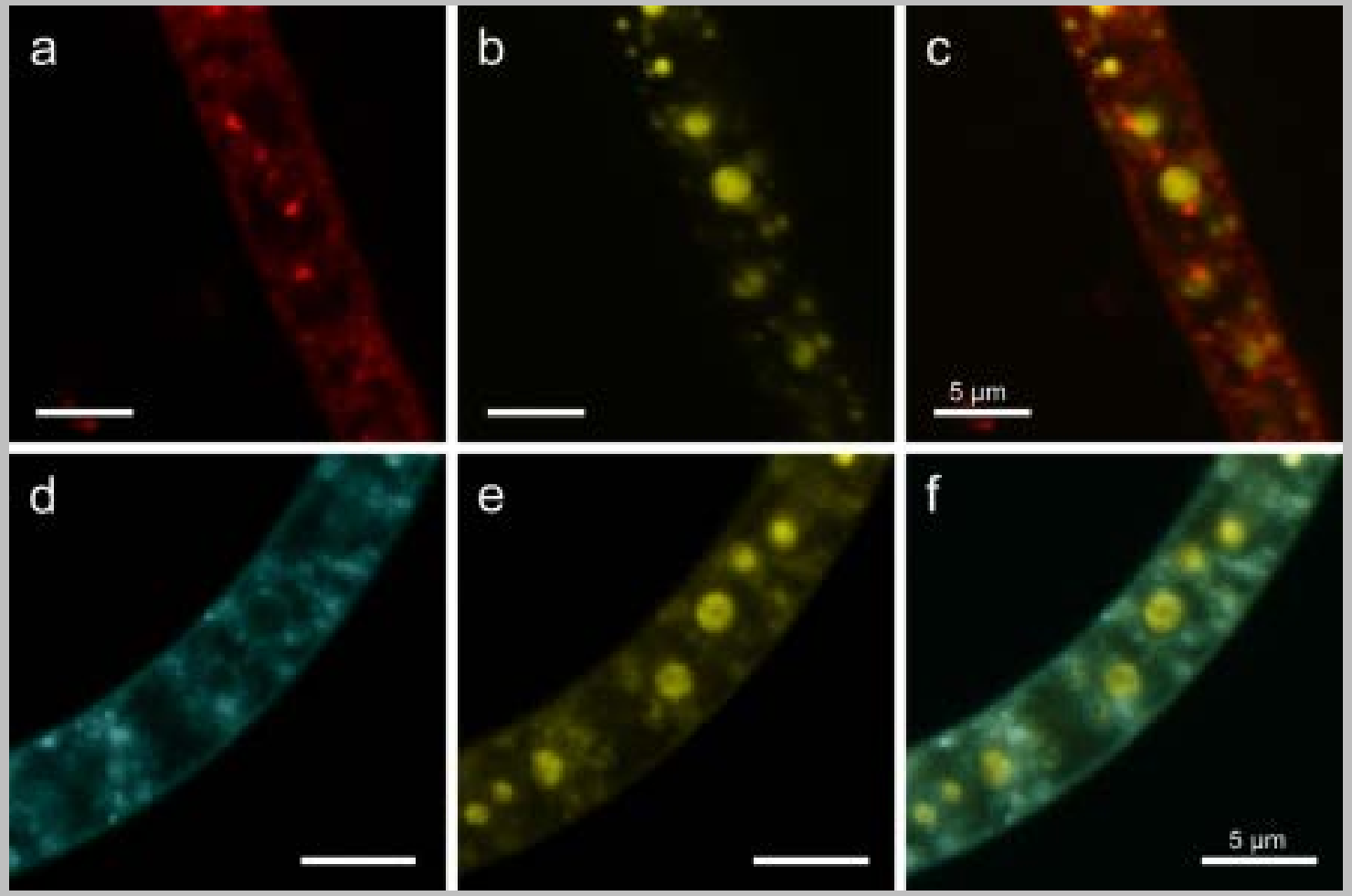
Beggiatoa



Deep sea cold seep – Eel River Seep

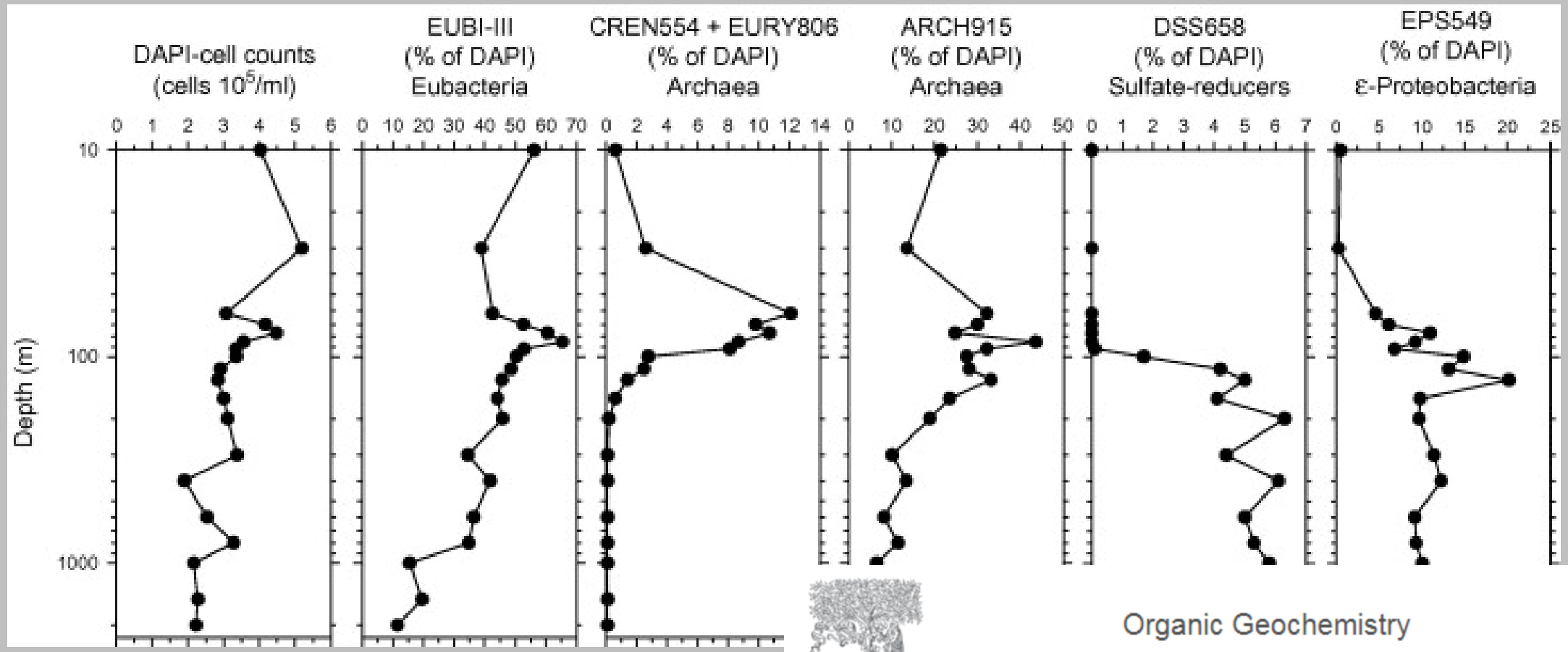
Salt Marsh

Growth in Nature



Brock et al. (2011)

Fluorescence of Beggiatoa strain 35Flor filaments obtained by dual staining with DAPI for polyphosphate and Nile Red or MDY-64 for lipid detection. a Lipid layers o spherical structure and different sizes are visible by staining with Nile Red. b In the same filament, stained with DAPI, polyphosphate inclusions of different sizes are visible by a yellow fluorescence signal. c An overlay of the Nile Red and DAPI fluorescence shows the existence of lipid layers for most of the large and some of the small polyphosphate inclusions. d Staining with MDY-64 reveals the same pattern of lipid layers as for Nile Red staining. e Polyphosphate inclusions of different sizes. f The overlay of MDY-64 and DAPI fluorescence reveals that most polyphosphate inclusions are enclosed by a lipid layer indicating a membrane. Note The detected internal lipid layers do not exclusively surround polyphosphate inclusions. Scale bars represent 5 µm



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Organic Geochemistry

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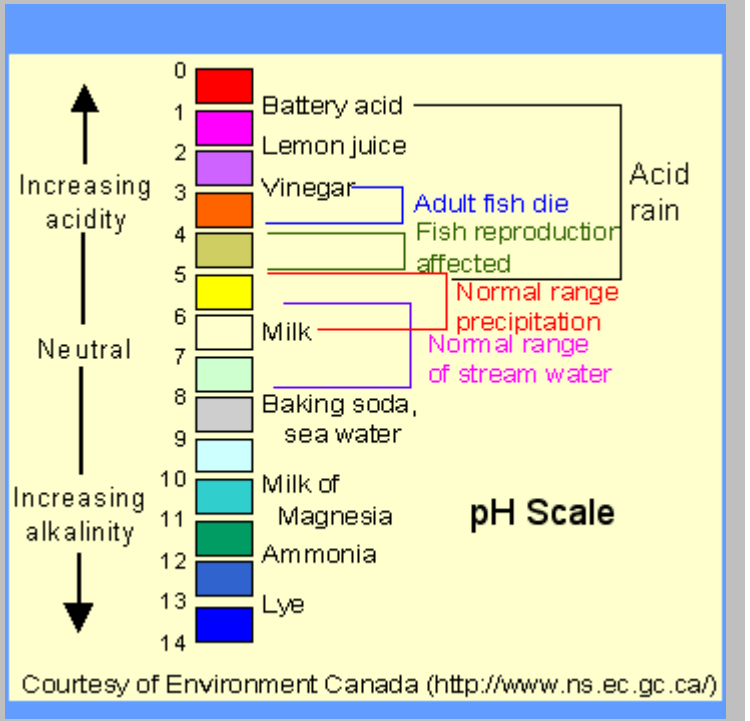
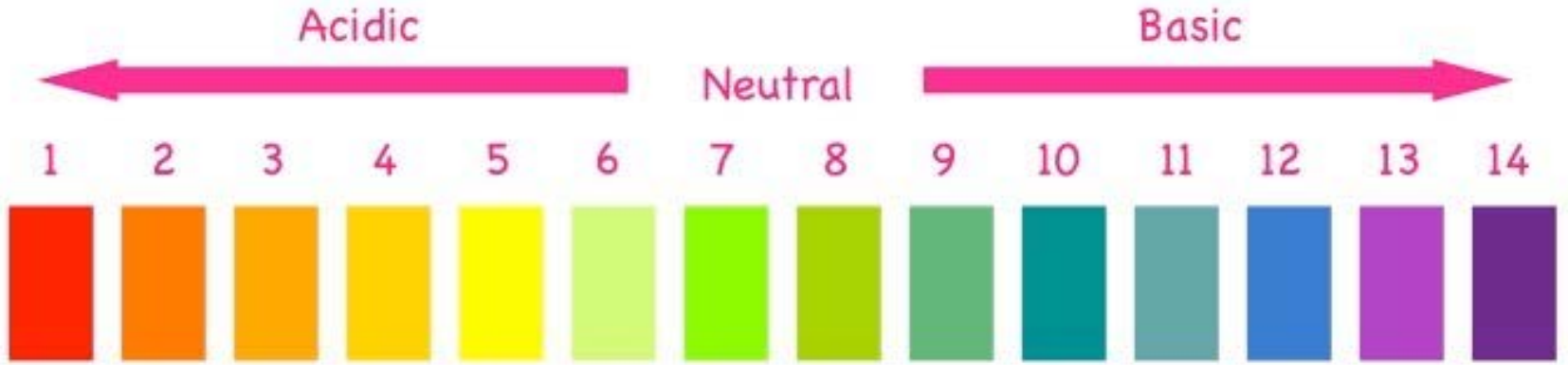
Microbial ecology of the stratified water column of the Black Sea as revealed by a comprehensive biomarker study

Stuart G. Wakeham [a], Rudi Amann [b], Katherine H. Freeman [c], Ellen C. Hopmans [d], Bo Barker Jørgensen [b], Isabell F. Putnam [a], Stefan Schouten [d], Jaap S. Sinninghe Damsté [d], Helen M. Talbot [e], Dagmar Woebken [b]



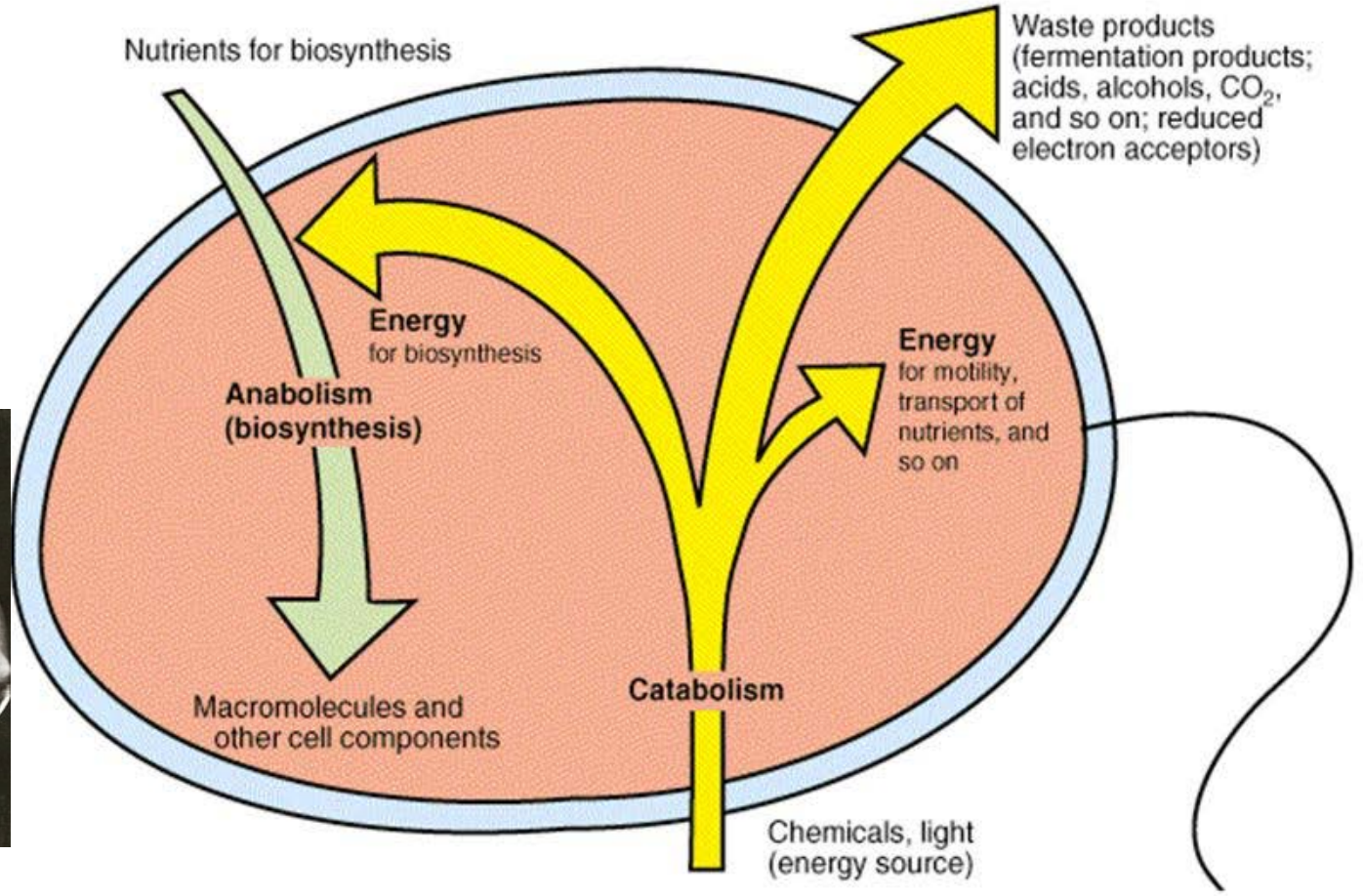


Examples of pH Conditions:

pH 2	pH 4	pH 5	pH 7	pH 7.4	pH 10	pH 12
gastric juices	tomato juice	human urine	pure water	human blood	hand soap	household bleach

Microbial Nutrition

Cell metabolism



Naming Energy Metabolisms

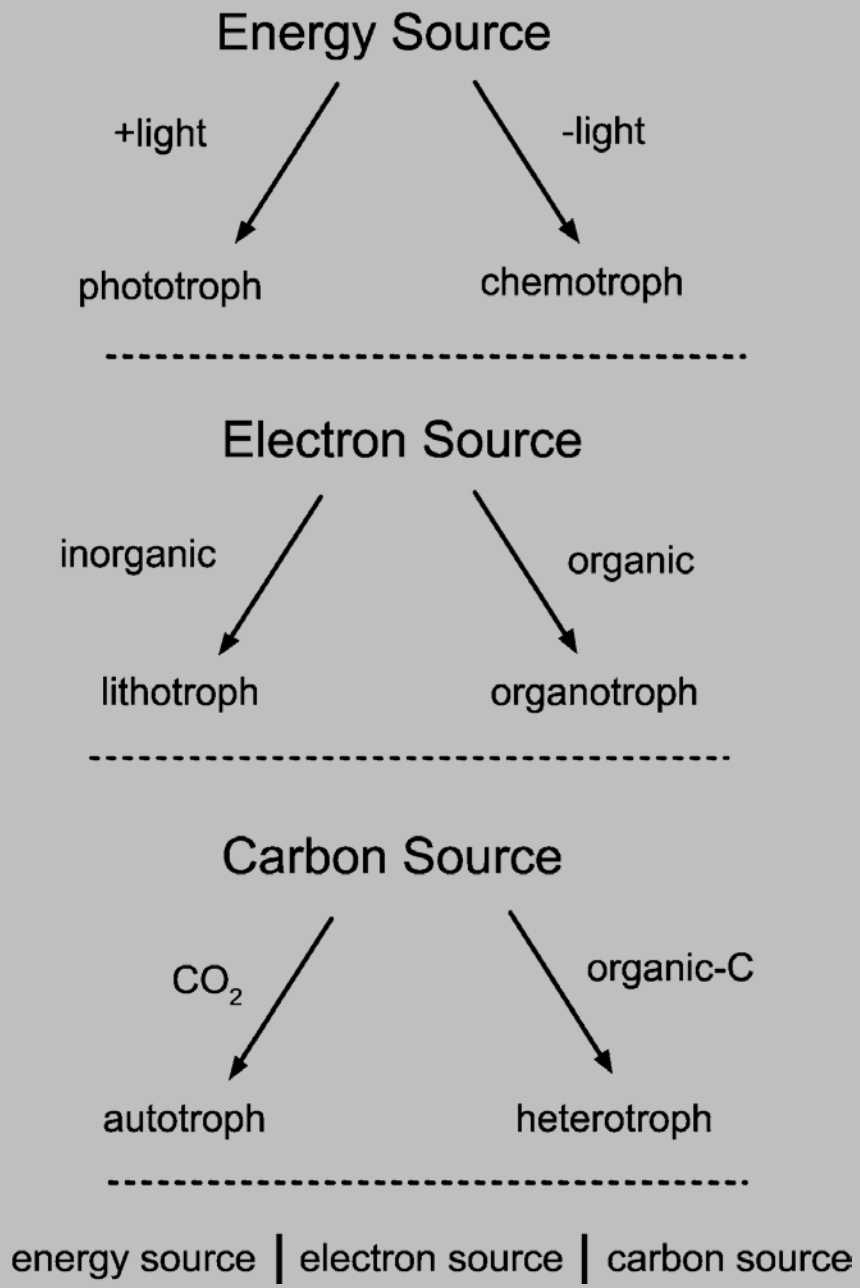


Figure from Canfield et al. (2005)