



Introduction to microbial ecology and ‘omics

Daniel Lundin

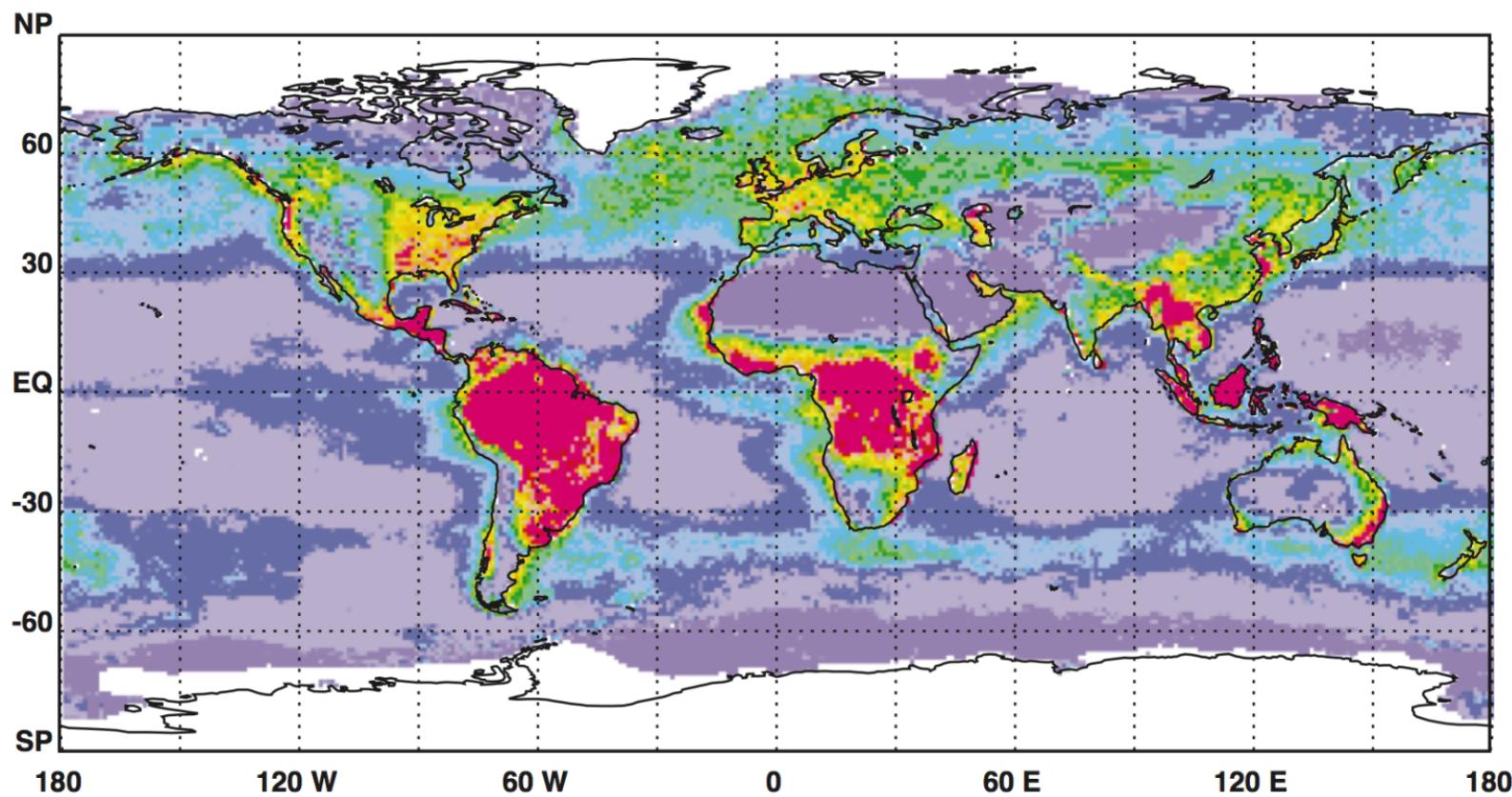


1 liter seawater:
20,000 “species”
 10^9 cells



Microscopic phytoplankton in the sea carry out as much photosynthesis as green plants on land (~140 million tons of carbon per day).

Field et al. Science 1998



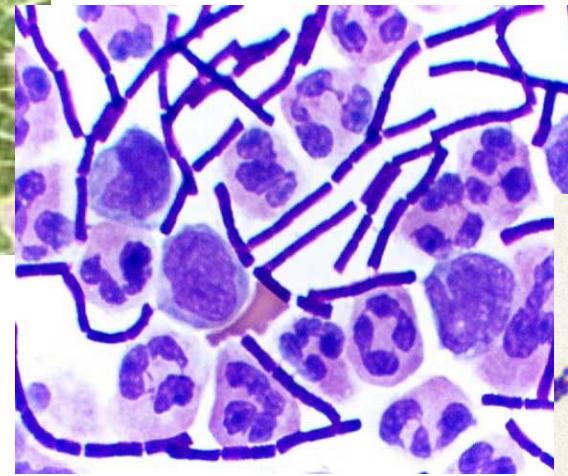
And around 50% of the organic matter produced is processed by marine bacteria!



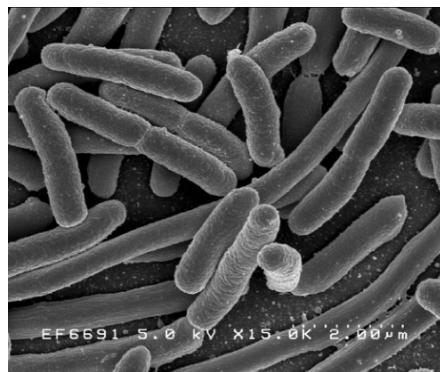
The microbial phenotype – what does it consist of?



Filamentous cyanobacteria

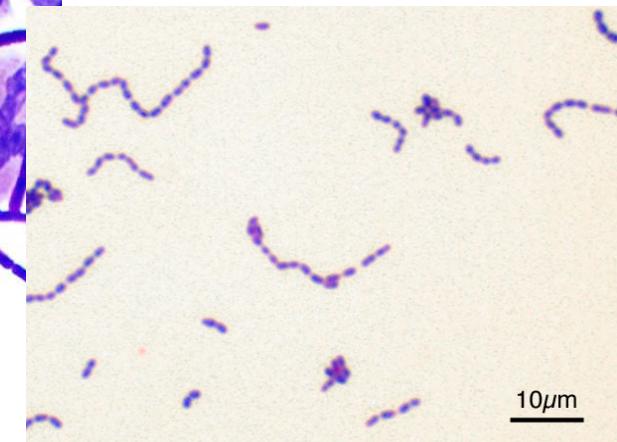


Bacillus anthracis



Escherichia coli

- Microbes are ultrastructurally similar
- Lifestyle (trophic strategy) and metabolic potential varies enormously!



Streptococcus mutans



How can we study microbes in natural environments?

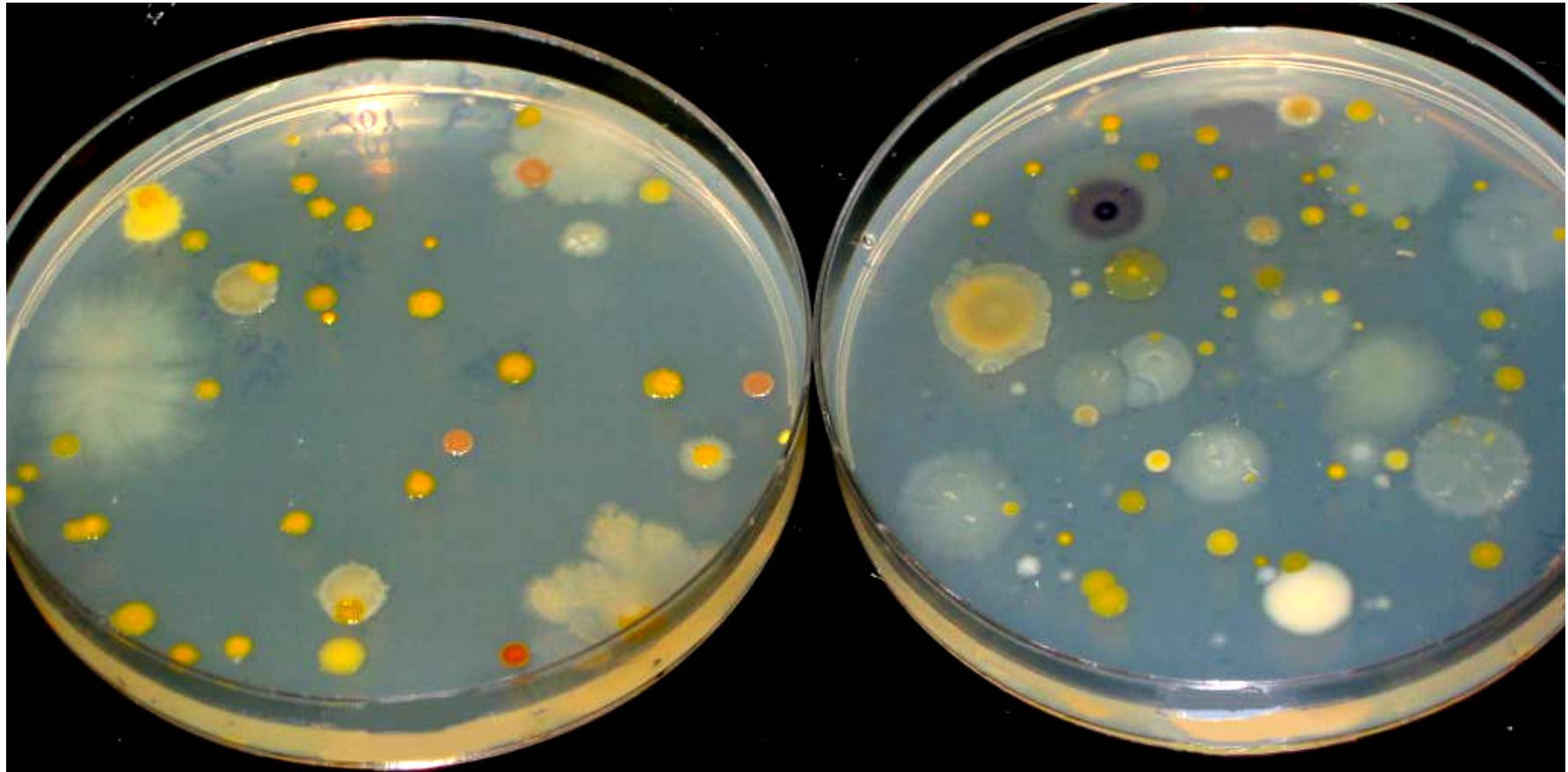


Photo: Jarone Pinhassi



1%



E. coli growth
(Wikimedia
commons)



Natural community experiments

- Primary production/CO₂ uptake
- Bacterial (heterotrophic) production/uptake of organic carbon
- Respiration
- Substrate utilization: carbohydrates, carboxylic acids, amino acids, nucleotides etc.
- ...





Scientific questions

- **Community composition:** *Who* are there?
- **Genetic potential:** What are they *capable of doing*?
 - Community as a whole vs. specific members
- **Expression of transcripts:** What are they *actually doing*?
 - Community as a whole vs. specific members

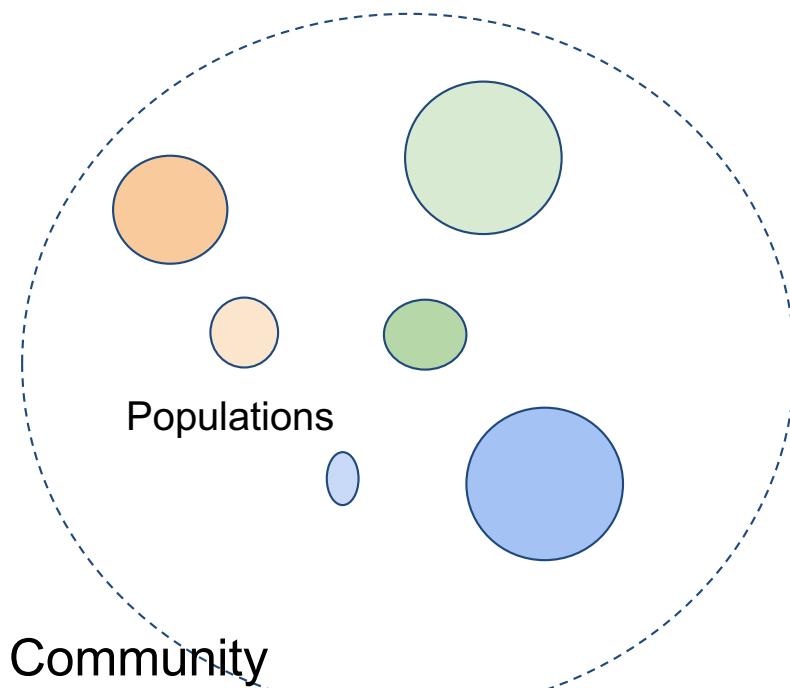


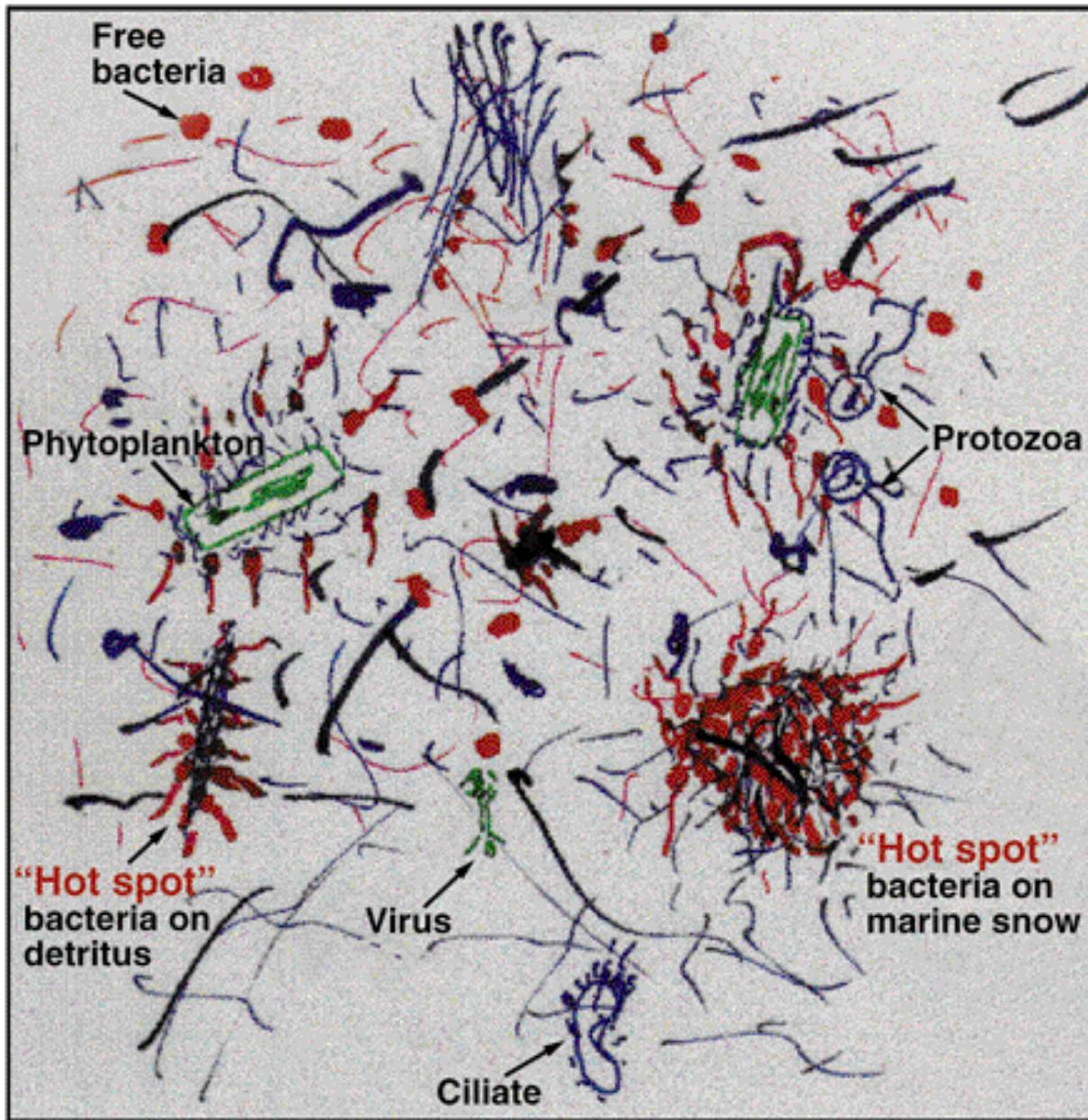
Methodology

- Metagenomics: **shotgun** sequencing of environmental **DNA**
- Metatranscriptomics: **shotgun** sequencing of environmental **RNA**
- Amplicon sequencing: sequencing of PCR products (DNA or RNA)



Communities and populations

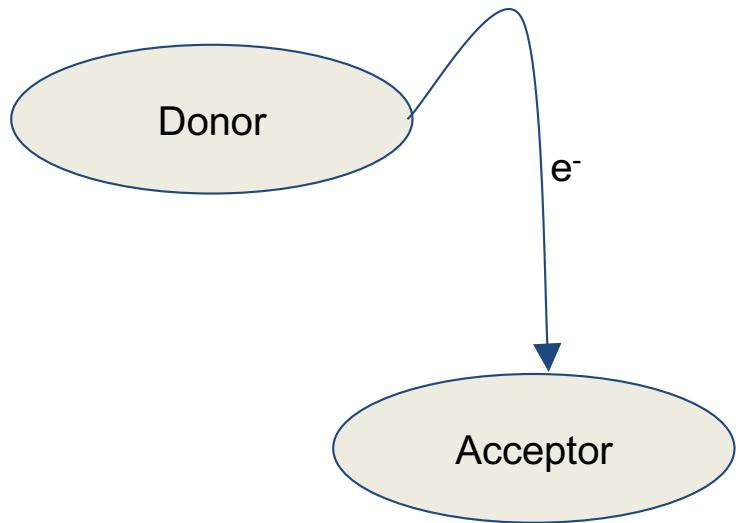




| | | |
|-----------------|----------------------------------|--------------------|
| | CO ₂ as carbon source | Organic carbon |
| Chemical energy | Chemoautotroph | (Chemo)heterotroph |
| Sunlight | Photoautotroph | Photoheterotroph |

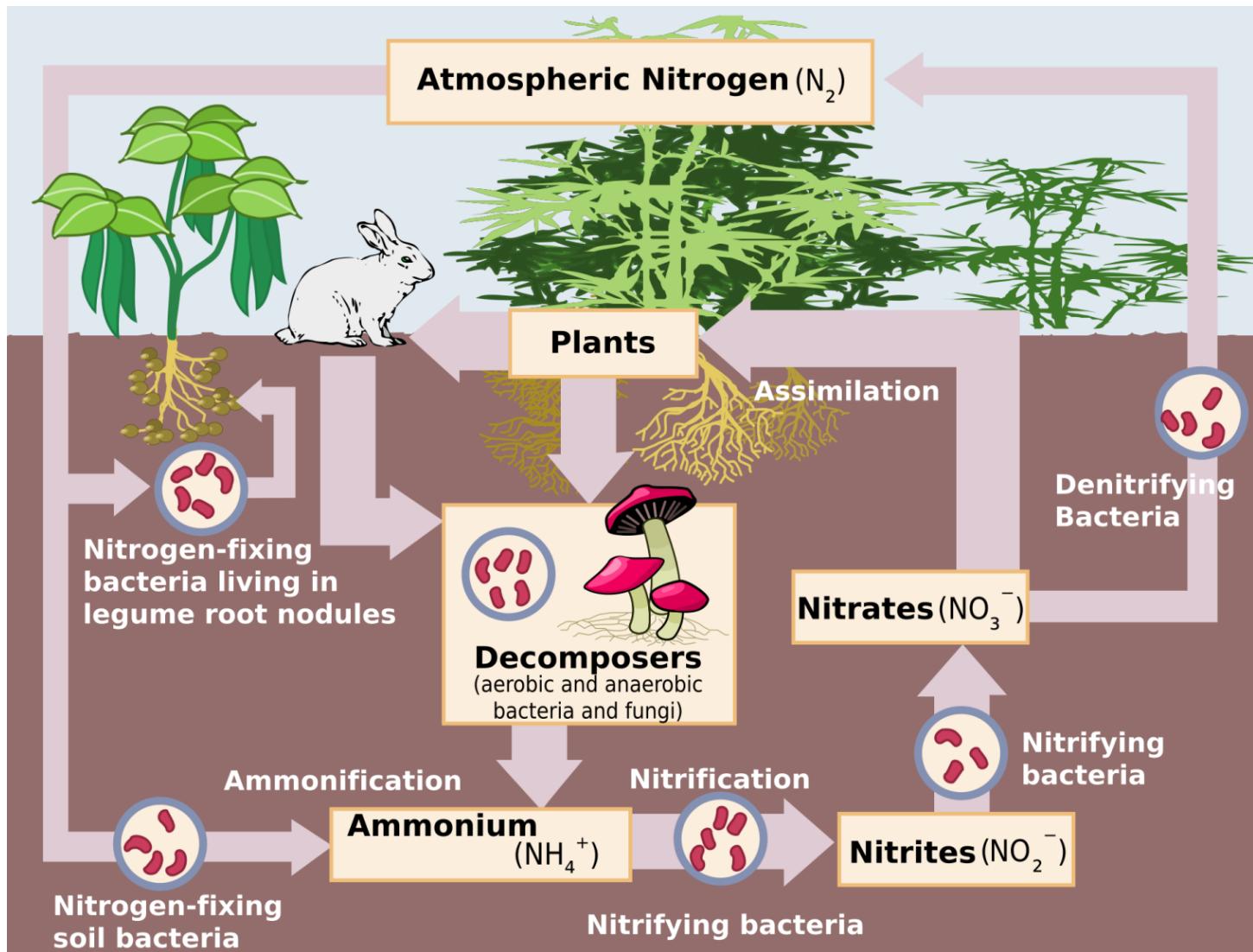


Oxygen and other electron acceptors

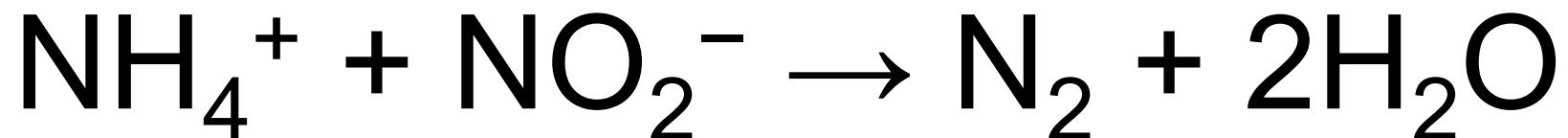


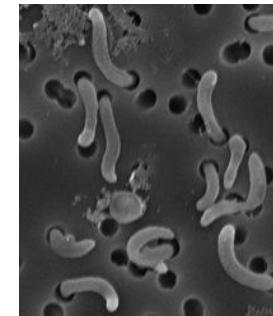
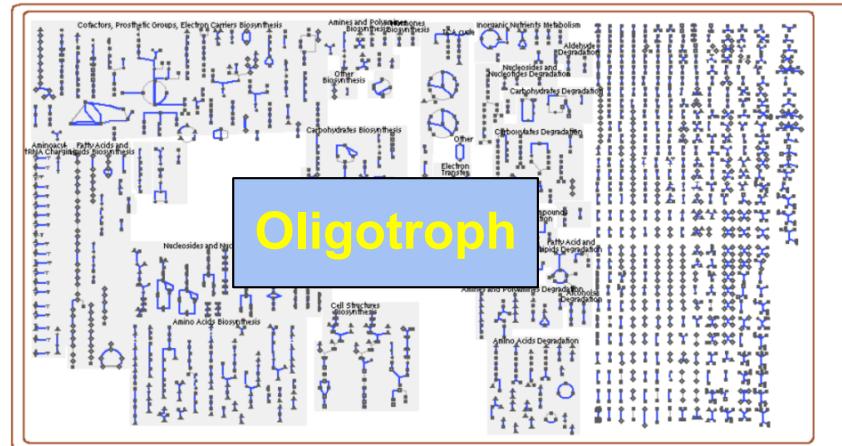
| Donor | Product | Redox potential |
|-------------|-----------|-----------------|
| O_2 | H_2O | +0.82 |
| Fe^{3+} | Fe^{+2} | +0.75 |
| NO_3^- | NO_2^- | +0.40 |
| SO_4^{2-} | HS^- | -0.22 |
| CO_2 | CH_4 | -0.25 |
| S^0 | HS^- | -0.27 |
| CO_2 | Acetate | -0.30 |



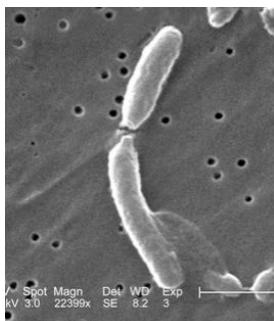
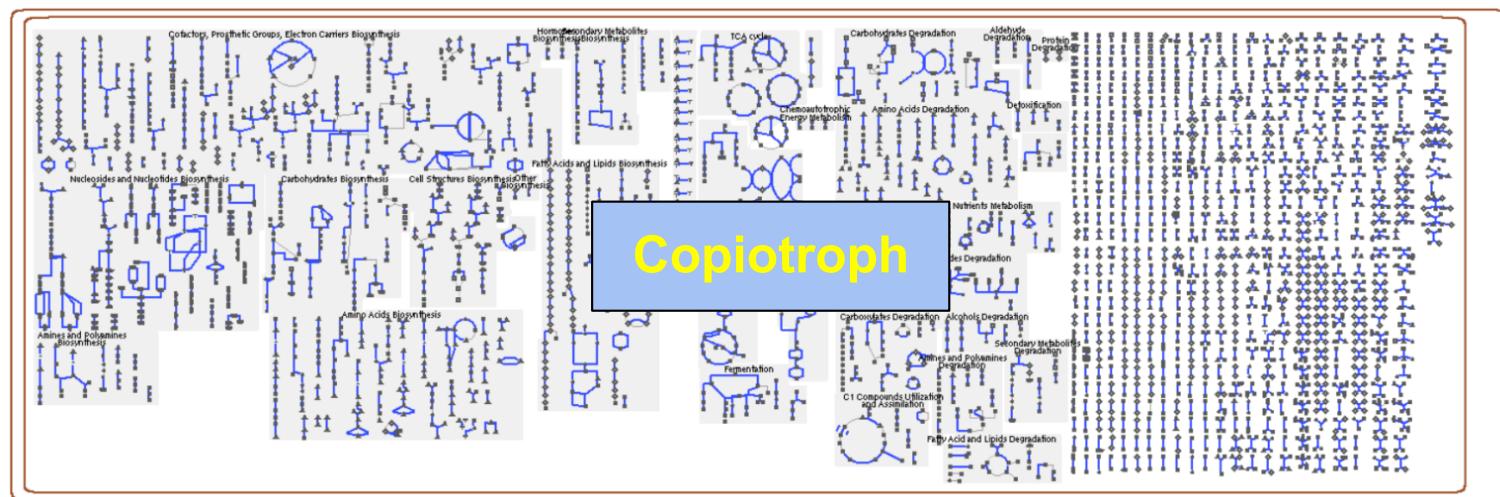


Anammox: The ultimate in weird redox chemistry





Candidatus Pelagibacter ubique: 1415 genes



Photobacterium angustum, 4743 genes

"Cellular overviews" from <http://www.biocyc.org>



How do we know all this?

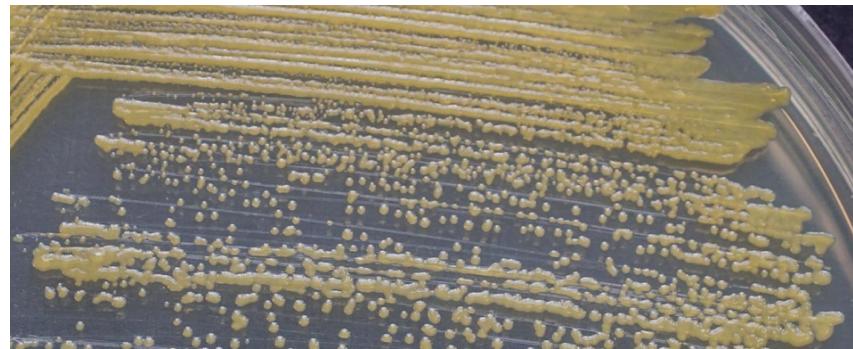


Examples of marine model bacteria

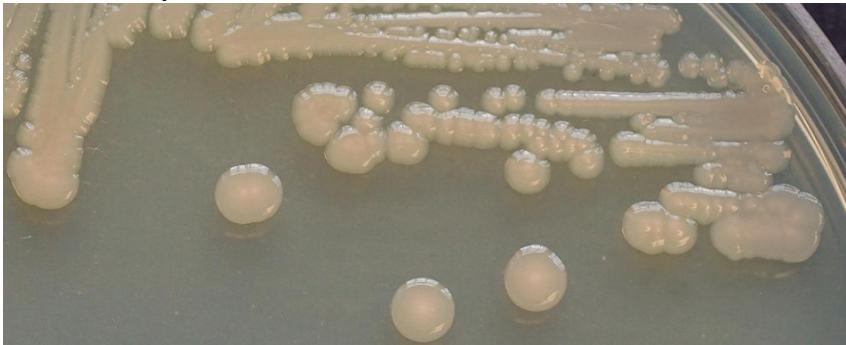
Ruegeria pomeroyi DSS-3



Dokdonia sp. MED134



Vibrio sp. AND4



Polaribacter sp. MED152



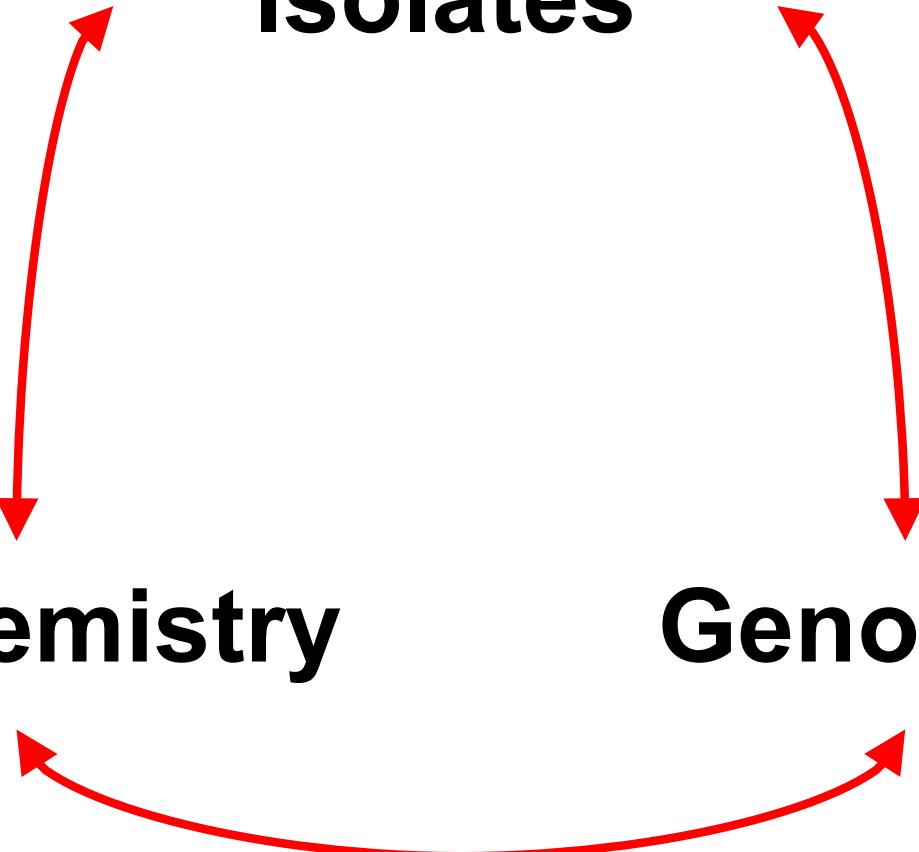
Photographs by Shalabh Sharma



Isolates

Biochemistry

Genomics



The Funding



Vetenskapsrådet



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GRUNDAD AV HOLGER CRAFOORD 1980

