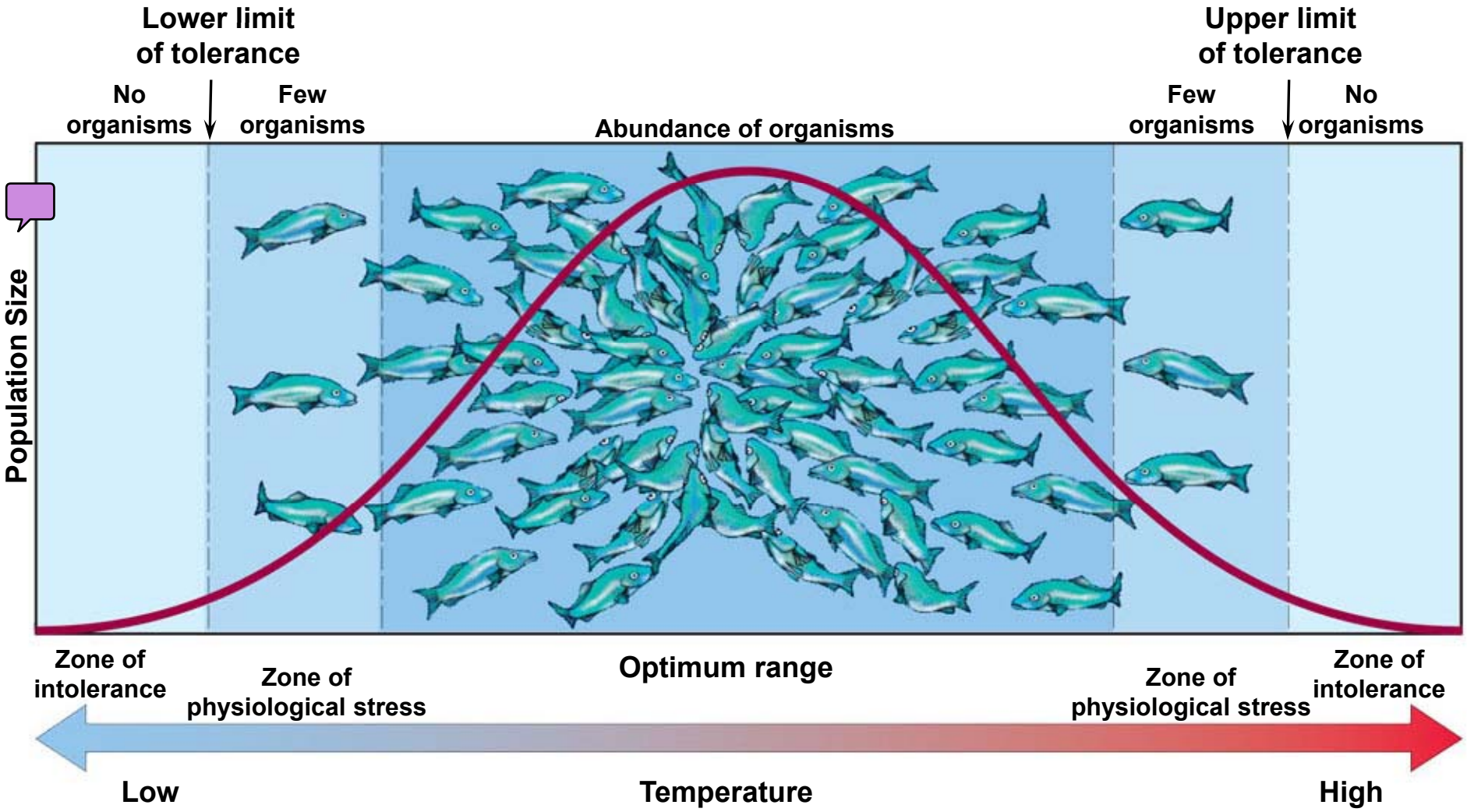
Life Sci 2H03 – Lecture 4
Life in Extreme Environments

What are the Conditions Needed for Life?

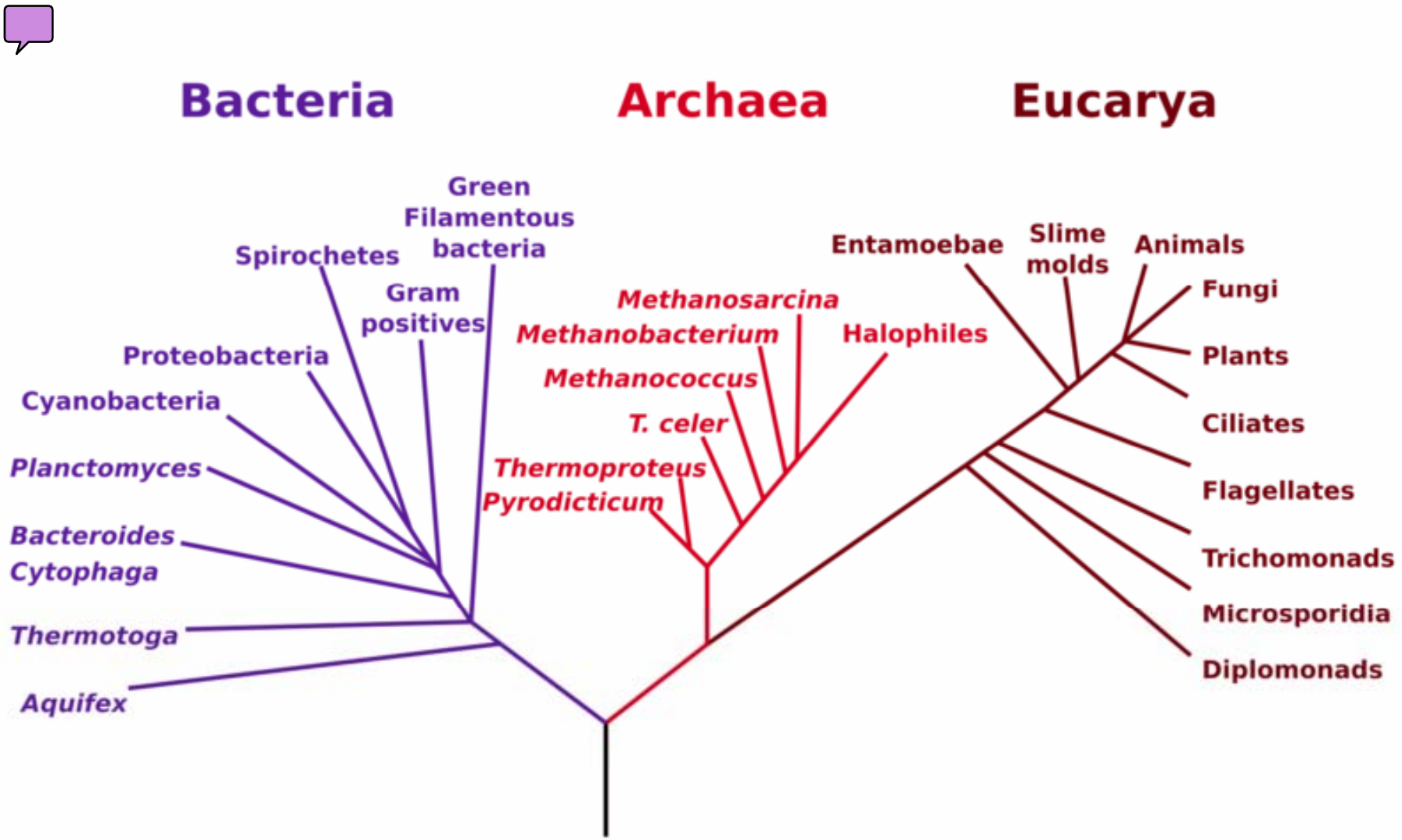
- Temperature:
- pH: 4-8
- Pressure:

- O_2
- H_2O
- CO_2

Range of Tolerance



Phylogenetic Tree of Life



Australian desert

12 month droughts

Atacama desert, Chile

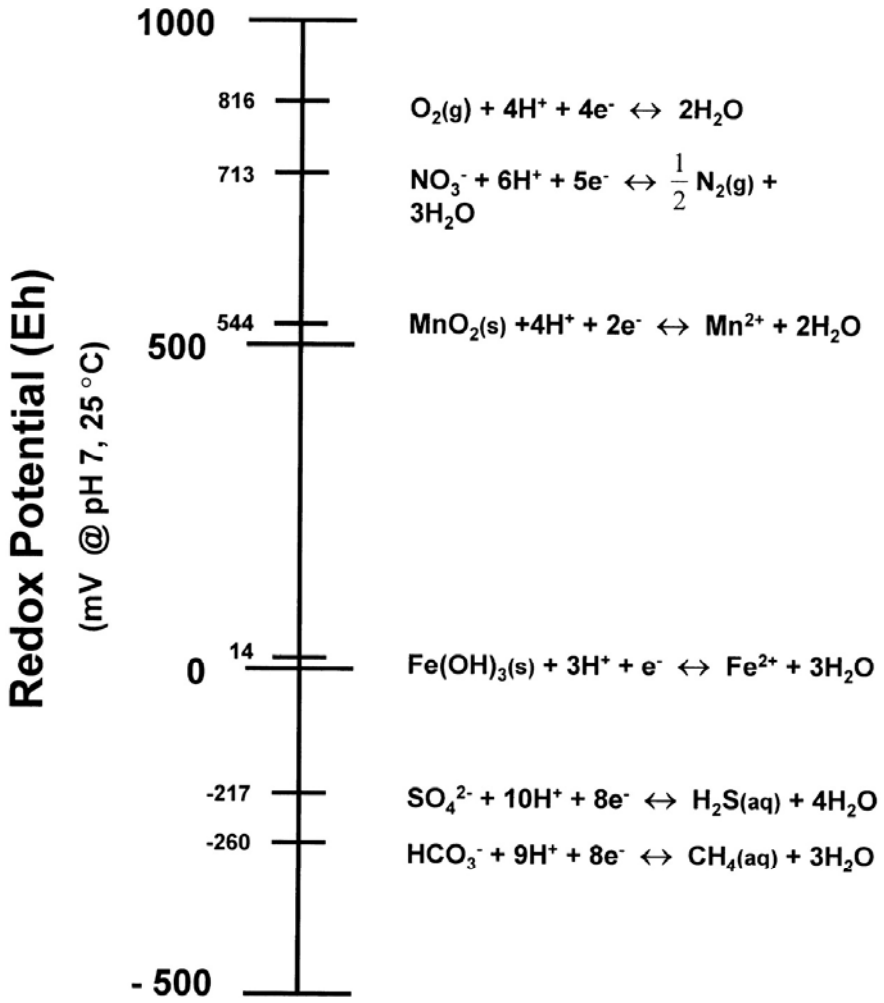
>1mm rain/year

Antarctic Ocean

water temp: -2°C

What exactly is an extreme environment?

- Liquid water:
- Life requires:
- Redox chemistry:

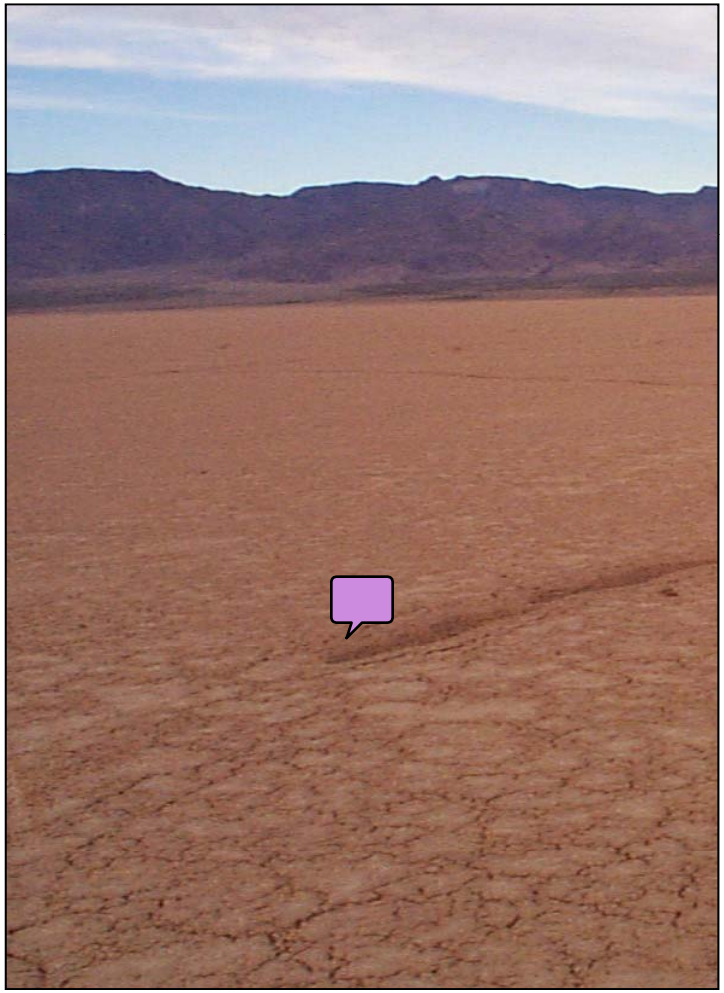


What is an extremophile?

- an organism that thrives in extreme environments

1) Physical extremes
- Temperature
- Radiation

2) Geochemical extremes
- Salinity
- pH



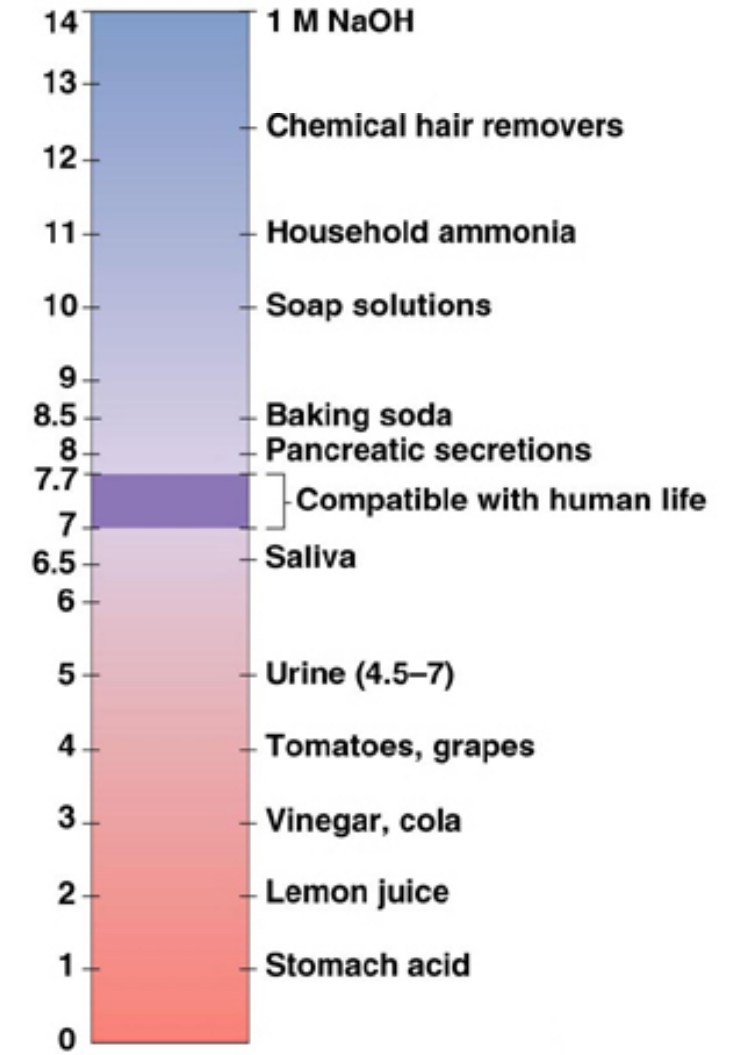
Types of Extremophiles

- **Acidophile:**

- **Alkaliphile:** An organism that grows best at high pH values

- **Anaerobe**

- Thrives under conditio
- where there is oxygem exposur
- oxygen is lethal to these organis
- **Endolith**



Types of Extremophiles (2)

- **Methanogen:** An organism that produces methane
- rb ca d an en og dr hy h te of n tio ac re e th m fro
- **(Hyper)Thermophile**
- **Xerophile**

Temperature

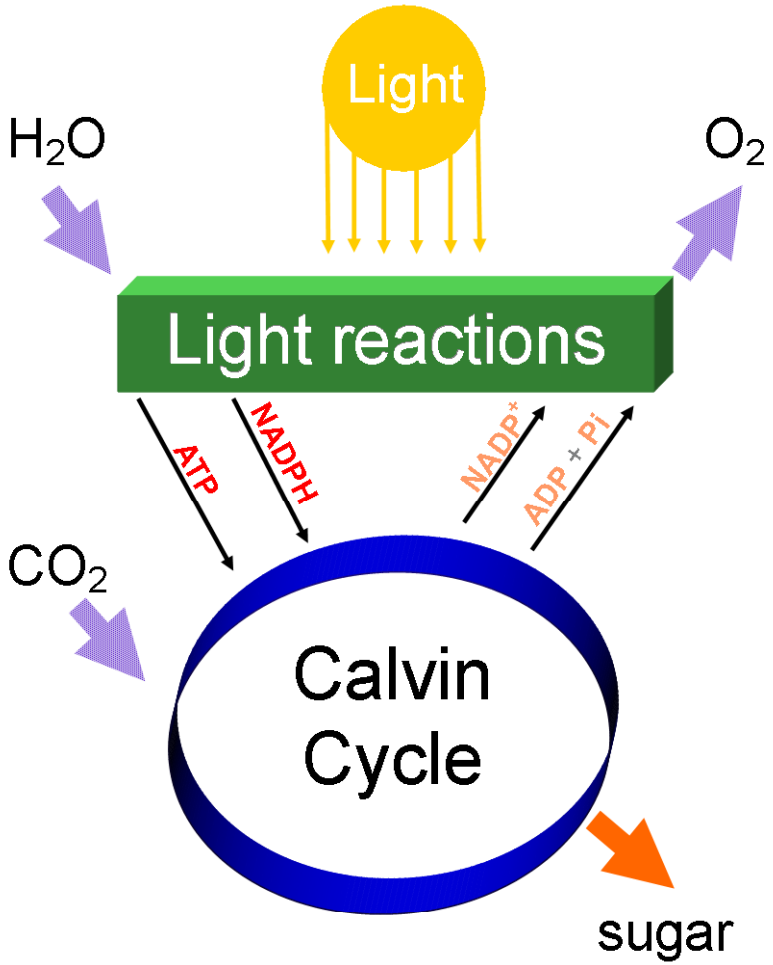
Challenges:

- low:

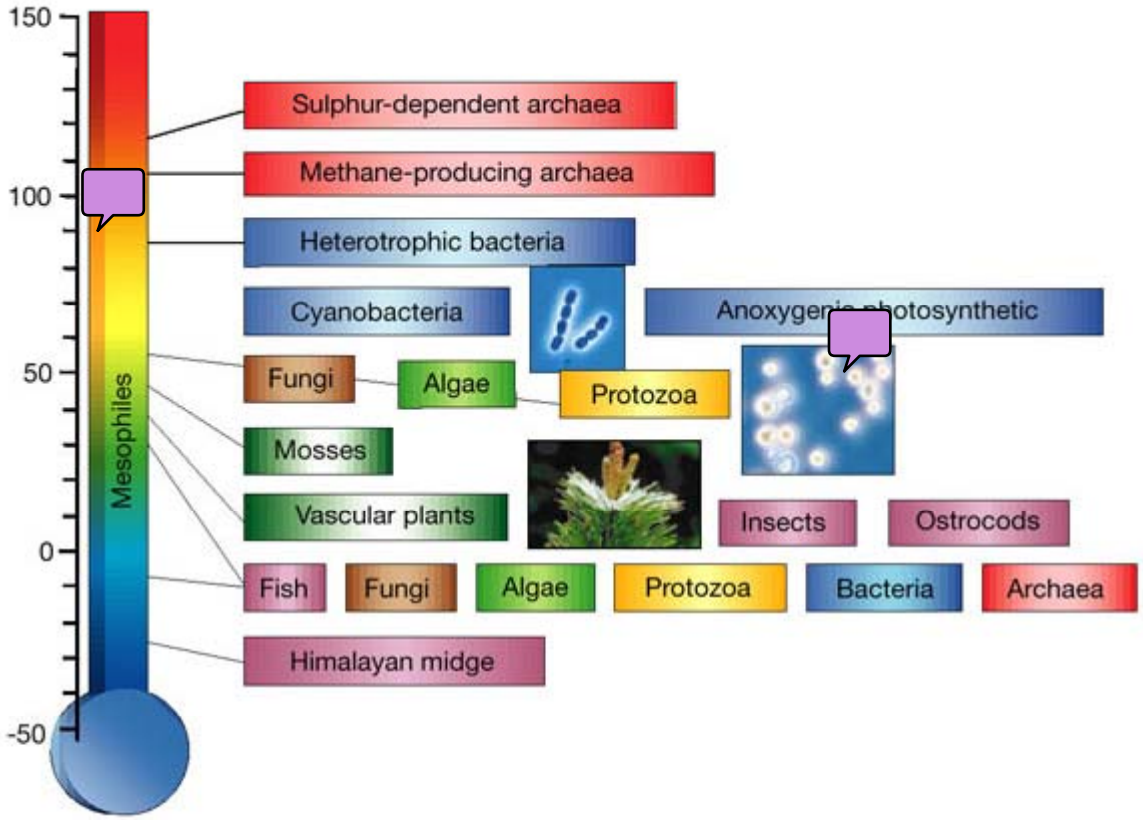
structural deformation by ice crystals

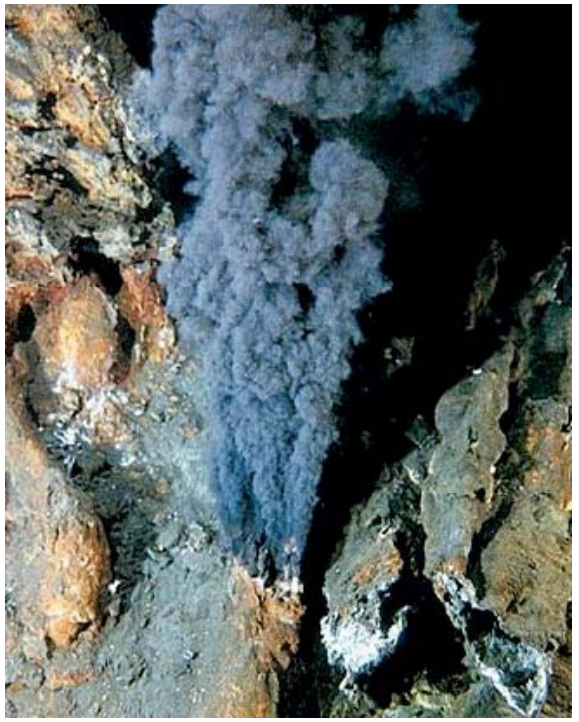
- high:

- Problems at high temperature for aquatic organisms requiring O_2 or CO_2



- Most hyperthermophilic organisms:
- *Pyrolobus fumarii:*

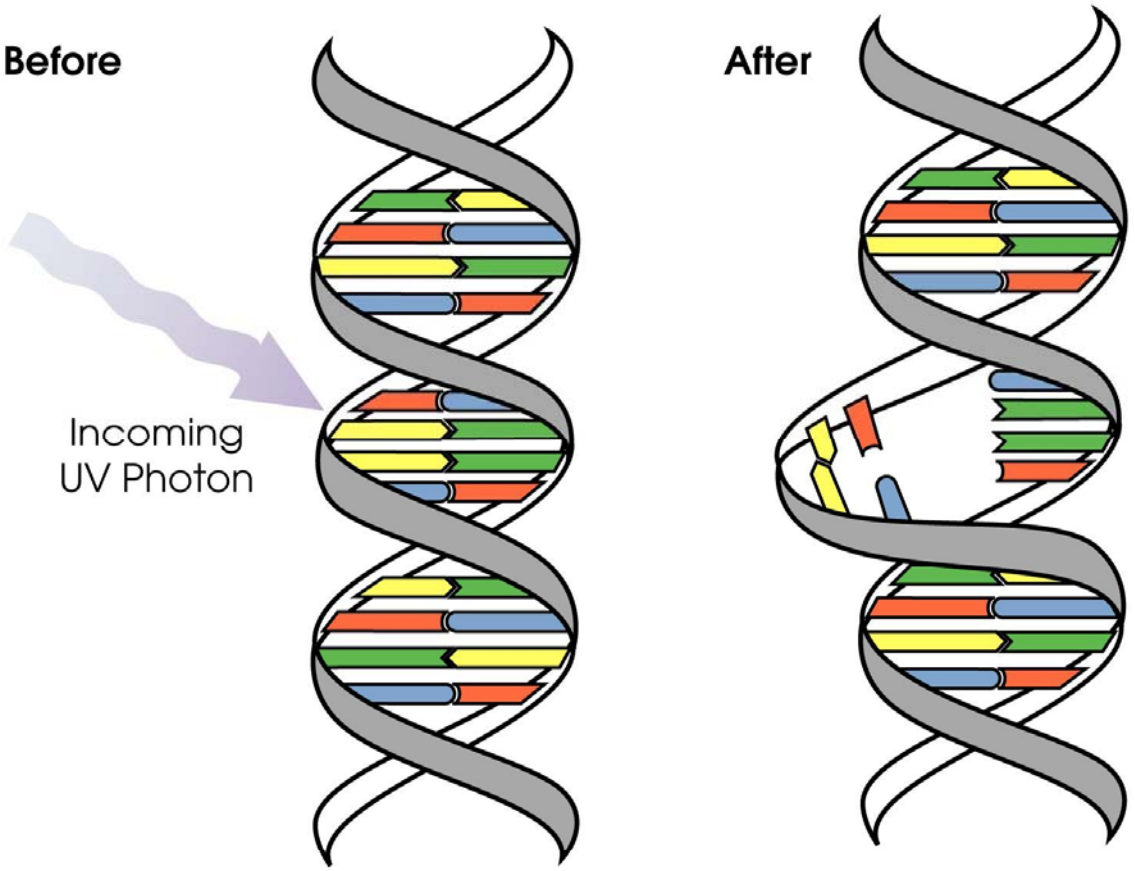




Radiation

- Energetic ions

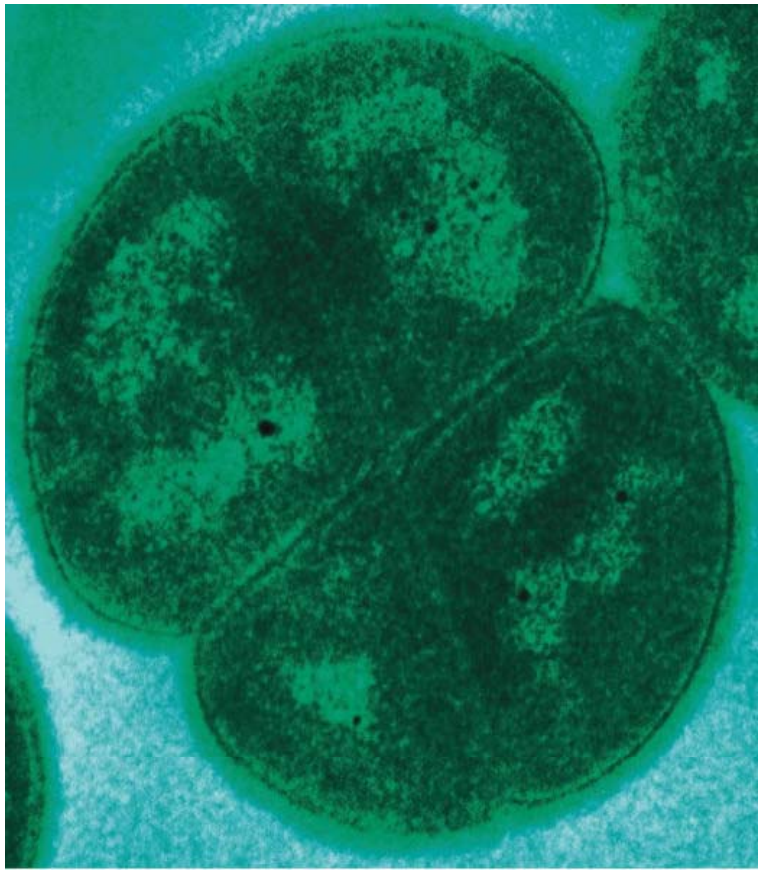
- Extreme levels of radiation:

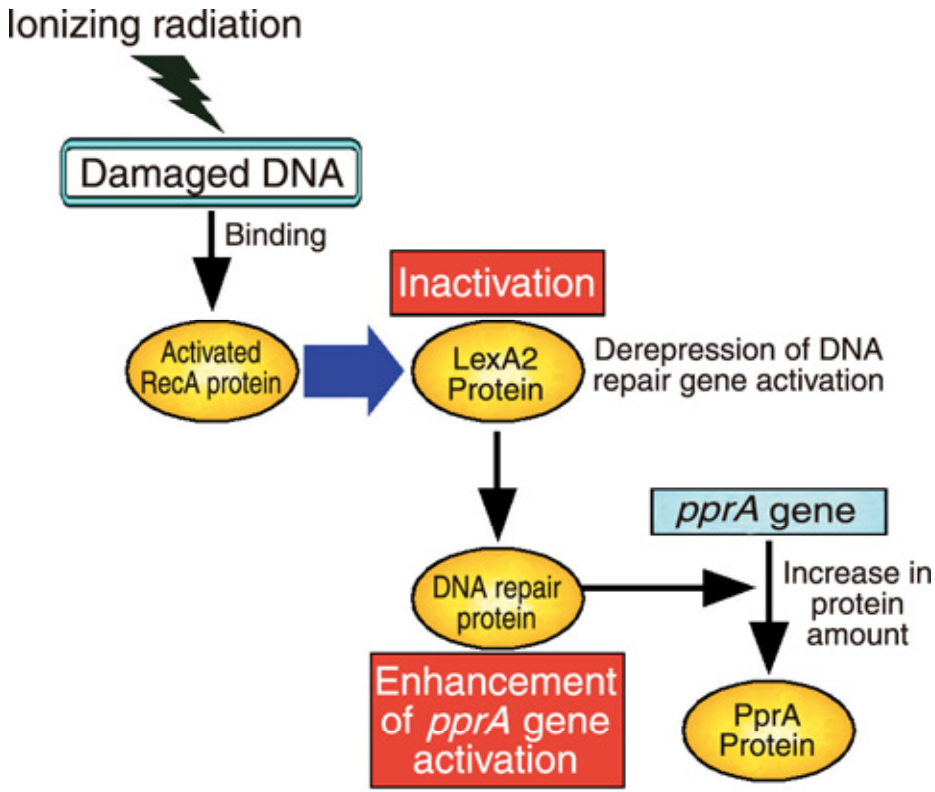


- *Deinococcus radiodurans* withstands:

20 kilo Gray of gamma radiation

- can be isolated from:

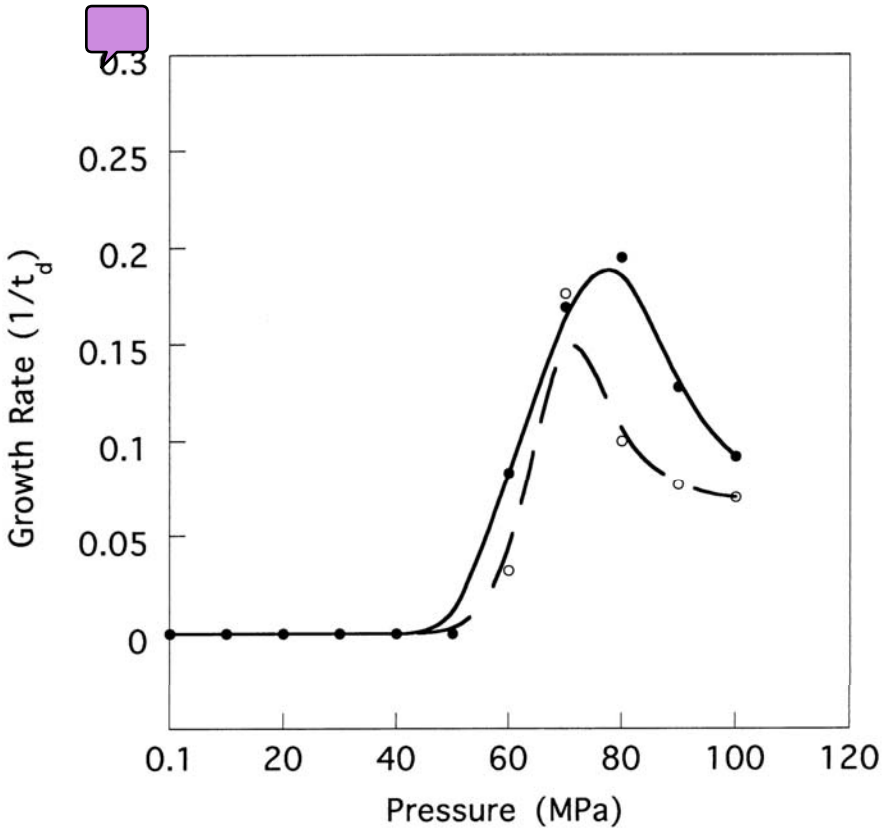




Pressure

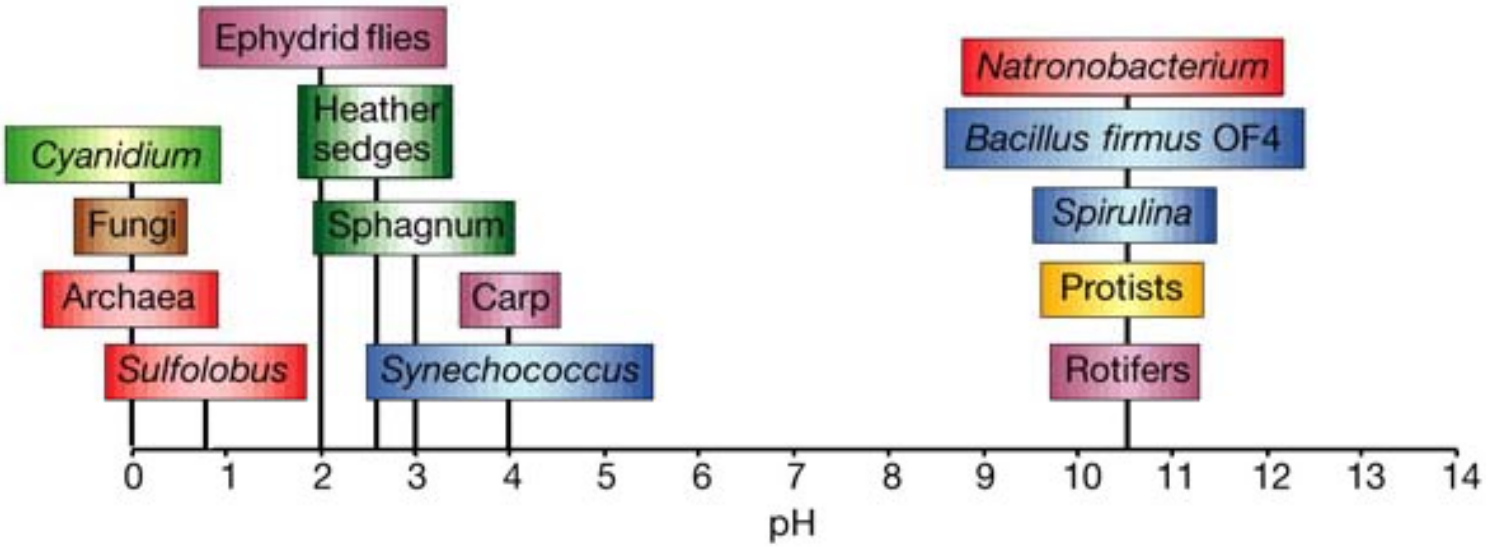
- Mariana trench:

The world's deepest sea floor at

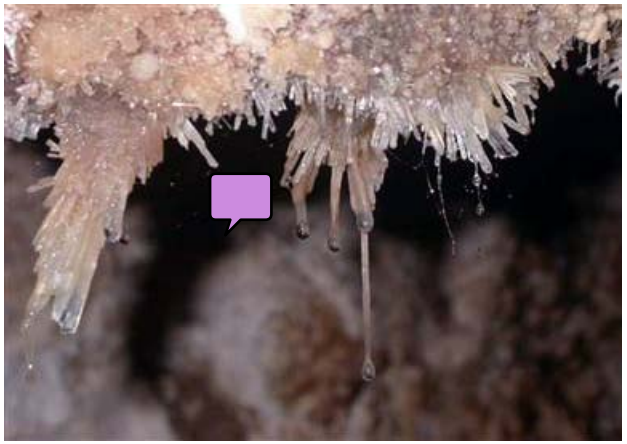


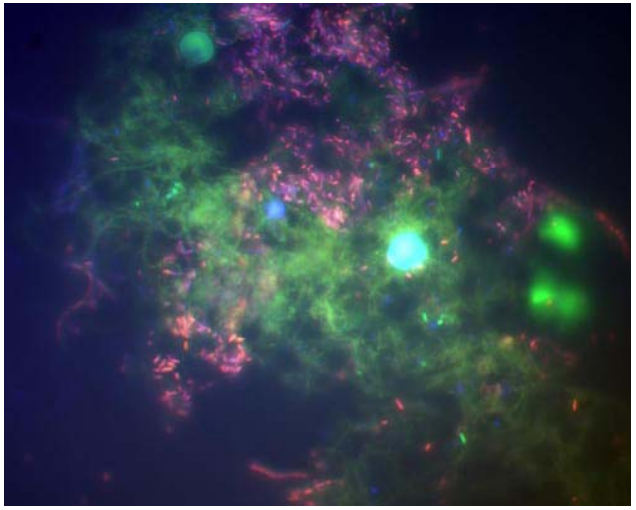
pH

- or g1 lo '
- Biological processes tend to occur towards the middle range of the pH spectrum: pH 7-8
- in l fal en oft H p tal en m on vir en d an ar llul ce ra int



- *Ferroplasma acidarmanus:*
- in acid mine drainage:

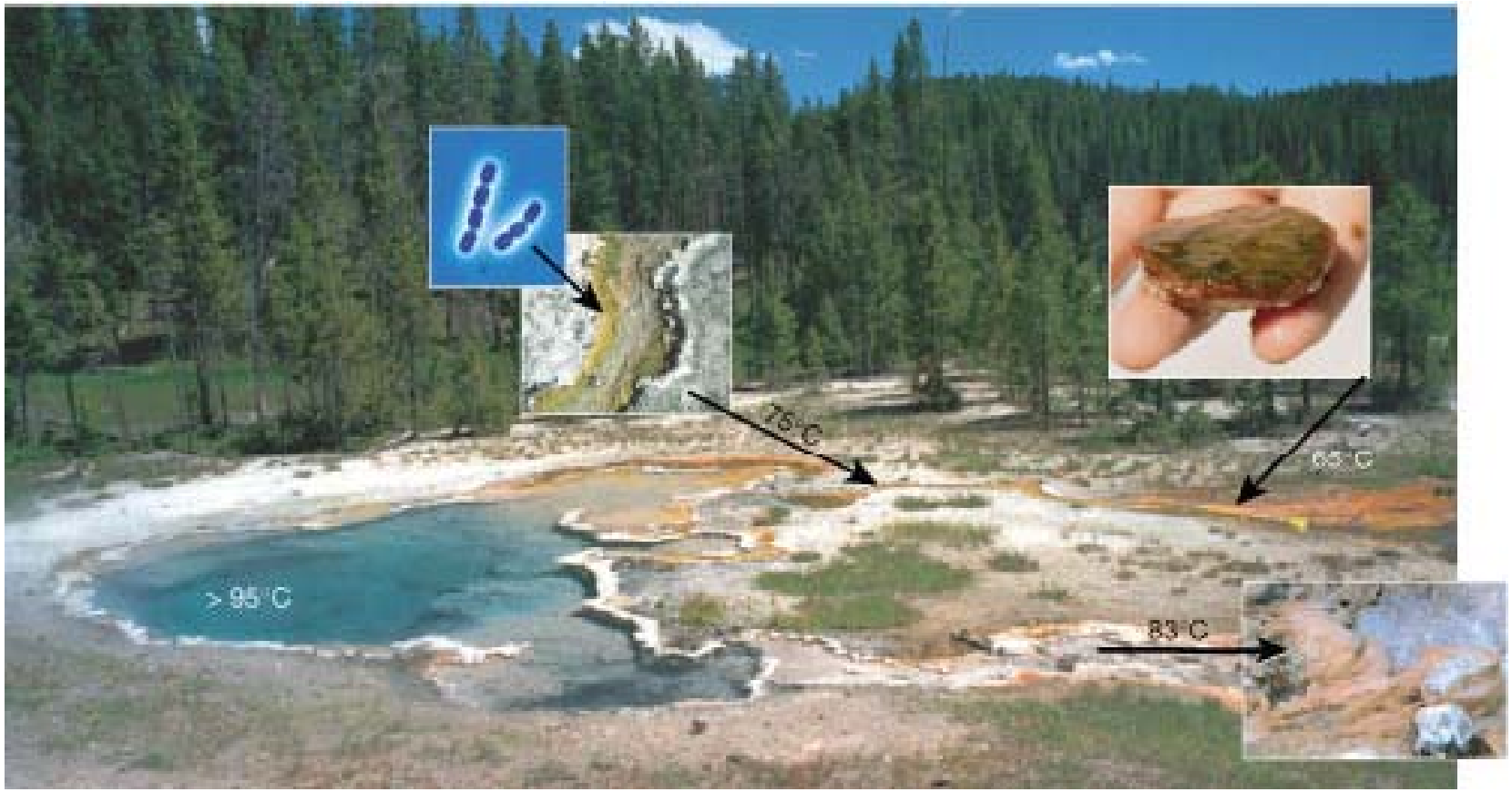




Octopus Spring, Yellowstone

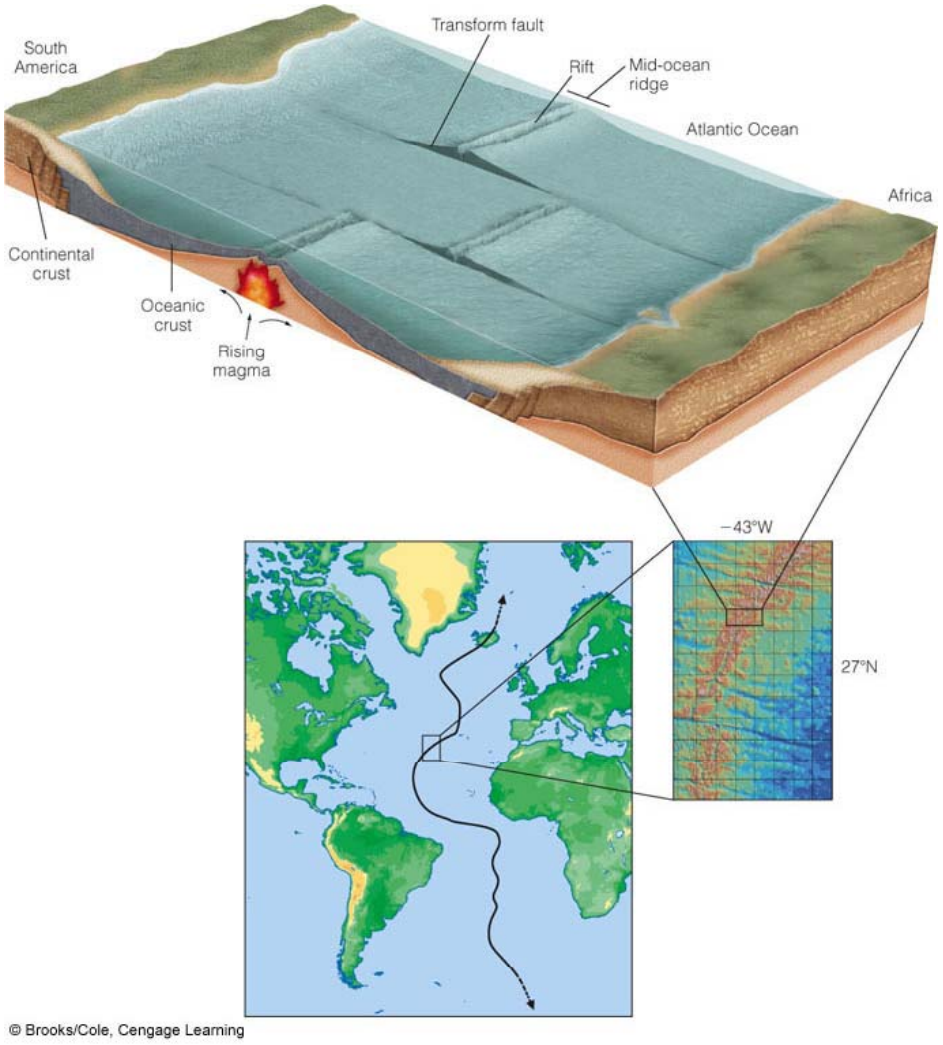
- alkaline (pH 8.8-8.3)

- Water:



Deep Sea Hydrothermal Vents

- Found near mid-ocean ridges



- High pressure and temperature as high as 400°C

- Water remains liquid due to:

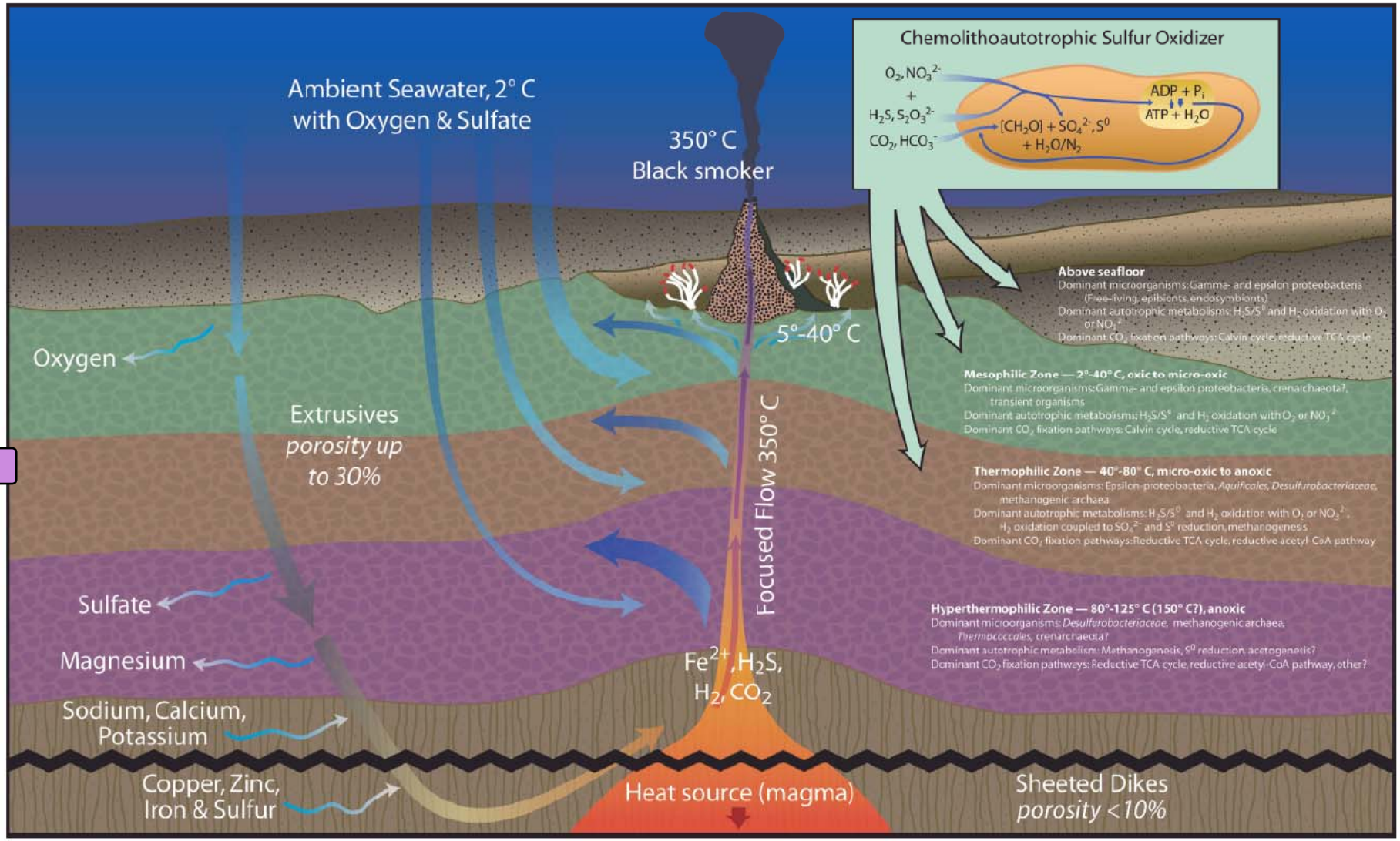
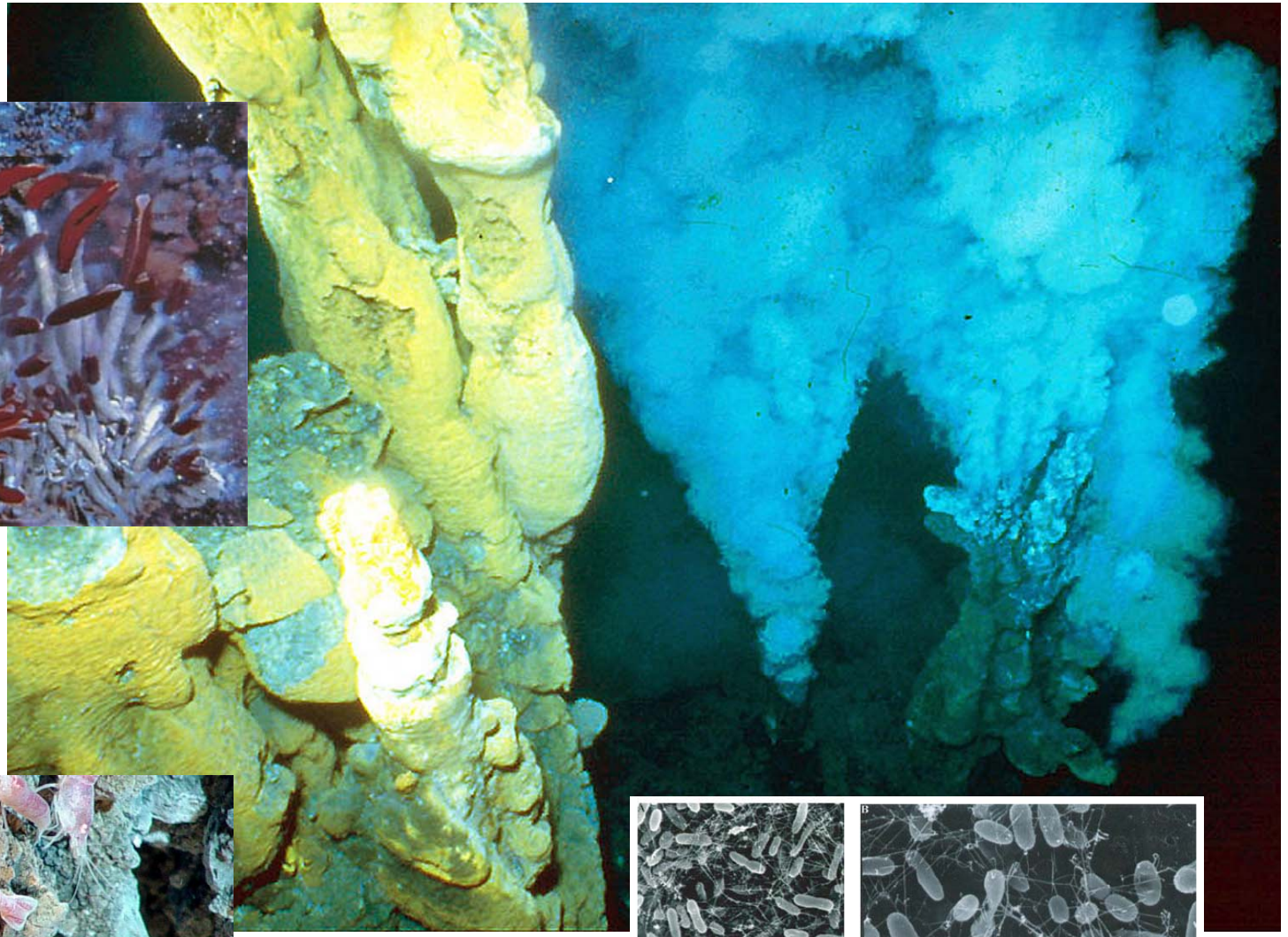
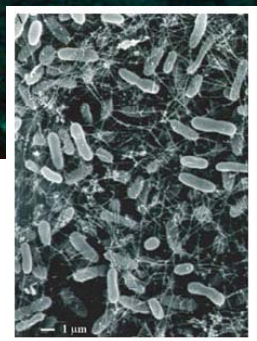
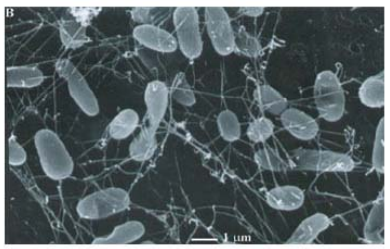
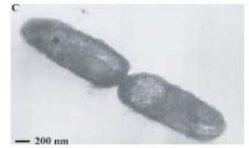


Fig. 19.1 A mid-ocean ridge hydrothermal vent site and potential microbial habitats in the subseafloor. Seawater cycles through the seafloor where it is geothermally altered. Hot, reducing fluid containing millimolar concentrations of H2S ascend to the seafloor either exiting undiluted






B
1 µm


C
200 nm


D
500 nm

The Ultimate Extremophiles: Tardigrades