

- 1 **Archaea**
Chapter 17
- 2 **I. Phylogeny and General Metabolism**
 -
 - 17.1 Phylogenetic Overview of *Archaea*
 - 17.2 Energy Conservation and Autotrophy in *Archaea*
- 3 **17.1 Phylogenetic Overview of *Archaea***
 - share characteristics with *Bacteria* and *Eukarya*
 - two major groups
 - *Crenarchaeota*
 - *Euryarchaeota*
 - bioenergetics & metabolism similar to *Bacteria*
 - exception – methanogenesis
 - Autotrophy via several pathways
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- 5 **II. *Euryarchaeota***
 - 17.3 Extremely Halophilic *Archaea*
 - 17.4 Methane-Producing *Archaea*: Methanogens
 - 17.5 *Thermoplasmatales*
 - 17.6 *Thermococcales* and *Methanopyrus*
 - 17.7 *Archaeoglobales*
 - 17.8 *Nanoarchaeum* and *Aciduliprofundum*
- 6 **II. *Euryarchaeota***
 - *Euryarchaeota*
 - Physiologically diverse
 - Many inhabit extreme environments
 - high temperature, high salt, high acid
- 7 **17.3 Extremely Halophilic *Archaea***
 - 1 *Haloarchaea*
 - Extremely halophilic
 - Require high salt
 - binary fission
 - Do not form resting stages or spores
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 - Most are nonmotile
 - Most are obligate aerobes
 - solar salt evaporation ponds, salt lakes, and artificial saline habitats (salted foods)
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- 10 **17.4 Methane-Producing *Archaea*: Methanogens**
 - *Methanogens*
 - Microbes that produce CH₄
 - Found in many environments
 - diversity of cell wall chemistries
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- 14 **17.5 *Thermoplasmatales***
 - *Thermoplasmatales*
 - within the *Euryarchaeota*

- Contains 3 genera
 - *Thermoplasma*
 - *Ferroplasma*
 - *Picrophilus*
- Thermophilic and/or extremely acidophilic
- *Thermoplasma* and *Ferroplasma* lack cell walls
- 15 **17.6 Thermococcales and Methanopyrus**
 - Three phylogenetically related genera of hyperthermophilic *Euryarchaeota*
 - *Thermococcus*
 - *Pyrococcus*
 - *Methanopyrus*
 - branch near root of archaeal tree
- 16 **17.8 Nanoarchaeum and Aciduliprofundum**
 - *Nanoarchaeum equitans*
 - One of the smallest cellular organisms (~0.4 μm)
 - Obligate symbiont of the crenarchaeote *Ignicoccus*
- 17 **III. Crenarchaeota**
 - 17.9 Habitats and Energy Metabolism of *Crenarchaeota*
 - 17.10 Hyperthermophiles -Terrestrial Volcanic Habitats
 - 17.11 Hyperthermophiles -Submarine Volcanic Habitats
 - 17.12 Nonthermophilic *Crenarchaeota*
- 18 **17.9 Habitats and Energy Metabolism of Crenarchaeota**
 - *Crenarchaeota*
 - Inhabit temperature extremes
 - Most are obligate anaerobes
 - Chemoorganotrophs or chemolithotrophs
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- 21 **17.10 Hyperthermophiles from Terrestrial Volcanos**
 - *Sulfolobales*
 - *Sulfolobus*
 - Grows in sulfur-rich acidic hot springs
 - Aerobic chemolithotrophs that oxidize reduced sulfur or iron
 - *Acidianus*
 - Also lives in acidic sulfur hot springs
 - Able to grow using elemental sulfur aerobically and anaerobically
- 22 **17.10 Hyperthermophiles from Terrestrial Volcanos**
 - *Thermoproteales*
 - key genera *Thermoproteus*, *Thermofilum*, & *Pyrobaculum*
 - Inhabit neutral or slightly acidic hot springs or hydrothermal vents
- 23 **17.11 Hyperthermophiles from Submarine Volcanos**
 - Shallow-water thermal springs and deep-sea hydrothermal vents harbor the most thermophilic of all known *Archaea*
 - *Pyrodictium* and *Pyrolobus*
 - *Desulfurococcus* and *Ignicoccus*
 - *Staphylothermus*
- 24 **17.12 Nonthermophilic Crenarchaeota**
 - Nonthermophilic *Crenarchaeota* have been identified in cool or cold marine waters and terrestrial environments by culture-independent studies
 - Abundant in deep ocean waters

- Appear to be capable of nitrification
- 25 **IV. Evolution and Life at High Temperatures**
 - 17.13 An Upper Temperature Limit for Microbial Life
 - 17.14 Adaptations to Life at High Temperature
 - 17.15 Hyperthermophilic *Archaea*, H₂, & Microbial Evolution
- 26 **17.13 An Upper Temperature Limit for Microbial Life**
 - What are the upper temperature limits for life?
 - Laboratory experiments suggest 140–150°C
- 27 **17.14 Adaptations to Life at High Temperature**
 - *Stability of Monomers*
 - Protective effect of high concentration of cytoplasmic solutes
 - Use of more heat-stable molecules
 - nonheme iron proteins instead of proteins that use NAD and NADH
 - Protein structural features improve thermostability
 - Highly hydrophobic cores
 - Increased ionic interactions on protein surfaces
 - *Chaperonins*-refold partially denatured proteins
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- 28 **17.14 Adaptations to Life at High Temperature**
 - *DNA Stability*
 - High intracellular solute levels stabilize DNA
 - Reverse DNA gyrase
 - Introduces positive supercoils into DNA, which stabilizes DNA
 - Found only in hyperthermophiles
 - DNA-binding proteins (histones) compact DNA into nucleosome-like structures
- 29 **17.14 Adaptations to Life at High Temperature**
 - *Lipid Stability*
 - Possess dibiphytanyl tetraether type lipids; form a lipid monolayer membrane structure
- 30 **17.15 Hyperthermophilic *Archaea*, H₂, and Evolution**
 - Hyperthermophiles may be the closest descendants of ancient microbes
 - Hyperthermophilic *Archaea* and *Bacteria* are found on the deepest, shortest branches of the phylogenetic tree
 - The oxidation of H₂ is common to many hyperthermophiles and may have been the first energy-yielding metabolism
- 31 **Assignment (ch 17)**
 - Pick a specific archaea covered in this chapter and do additional research on them to put together a brochure containing the following information:
 - Cell shape and size
 - Special characteristics (flagella, etc)
 - Metabolism
 - Physiology
 - Ecology
 - Photos