The Three Domains an overview

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LIVING ORGANISMS

EUKARYOTES

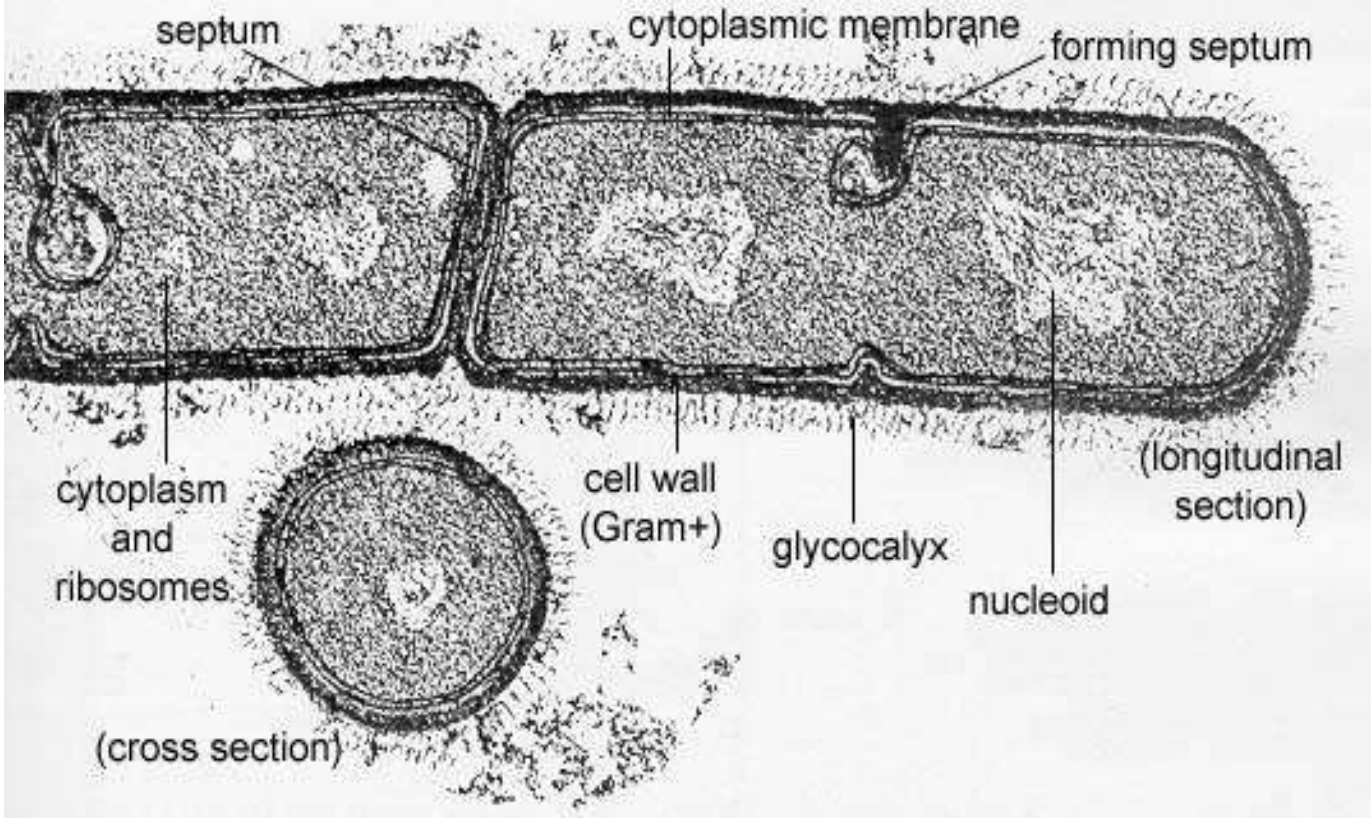
PROKARYOTES

EUBACTERIA ARCHAEA

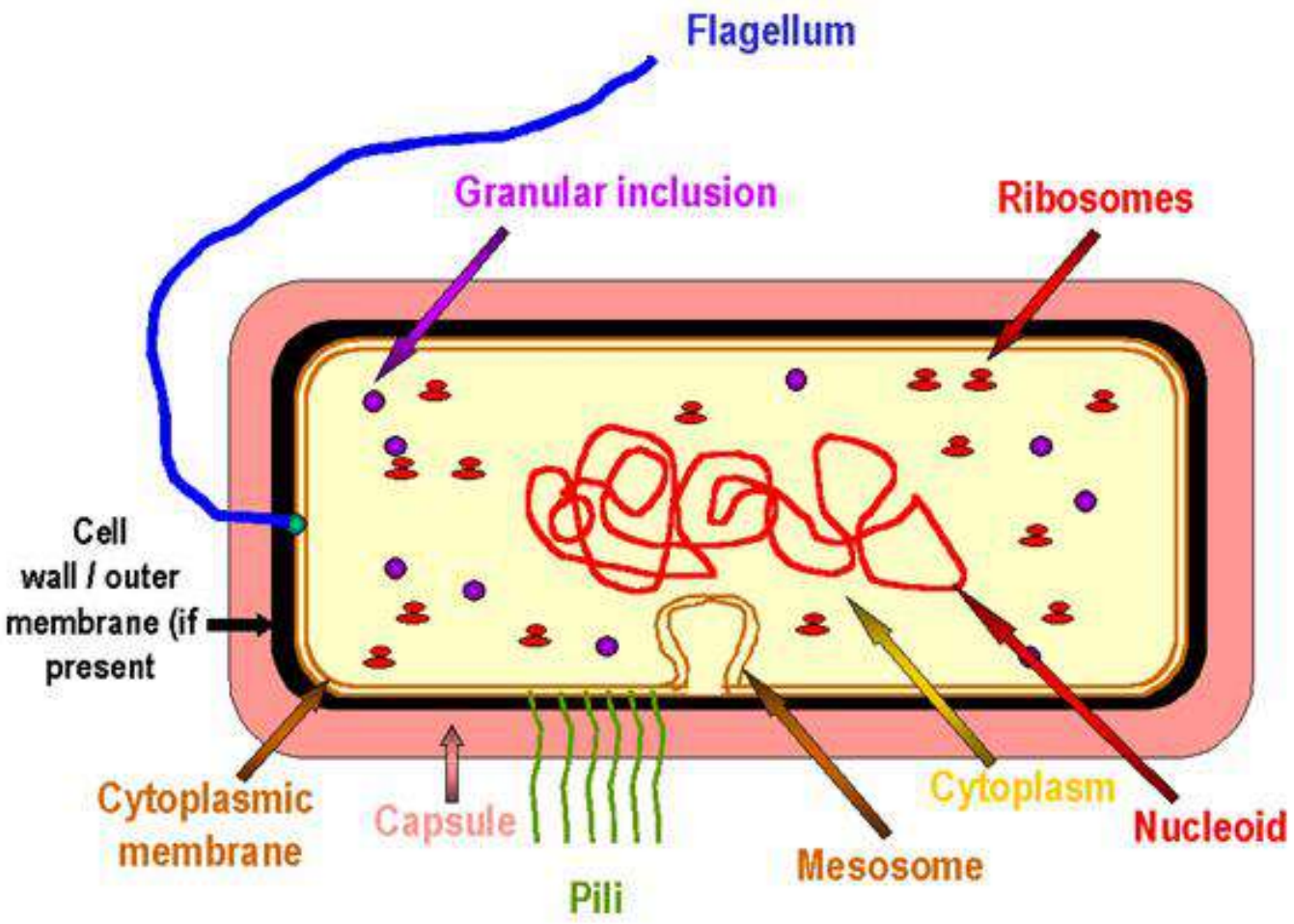
BACTERIA

- Prokaryotes
- Microscopic
- Most numerous on Earth
- Most Ancient
- Evolution has yielded many species adapted to survive where no other organisms can.
- Groups based on:
  - Structure, physiology, reaction to specific types of stain,
  - molecular composition (ribotyping)
    - Eubacteria= True bacteria
    - Archaebacteria =Primitive bacteria

Prokaryotic Cell (*Bacillus megaterium*)



Prokaryotic Cell- A schematic diagram



Prokaryotes

- *Eubacter* "True" bacteria
  - cell wall contains murein
  - clinical or environmental
  - human and animal pathogens
- *Archaea*
  - cell wall contains pseudo-murein
  - environmental organisms

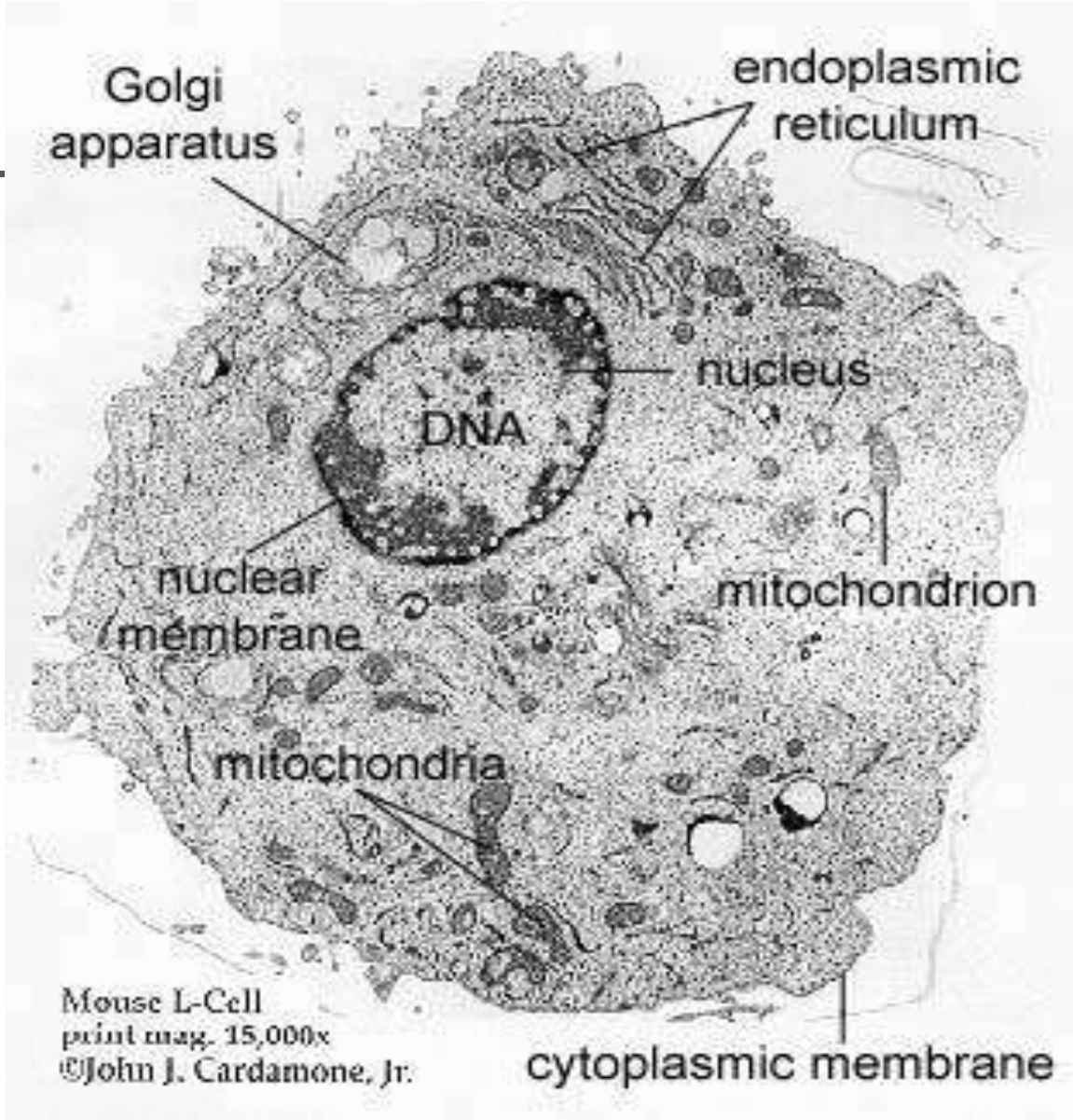
Eubacteria

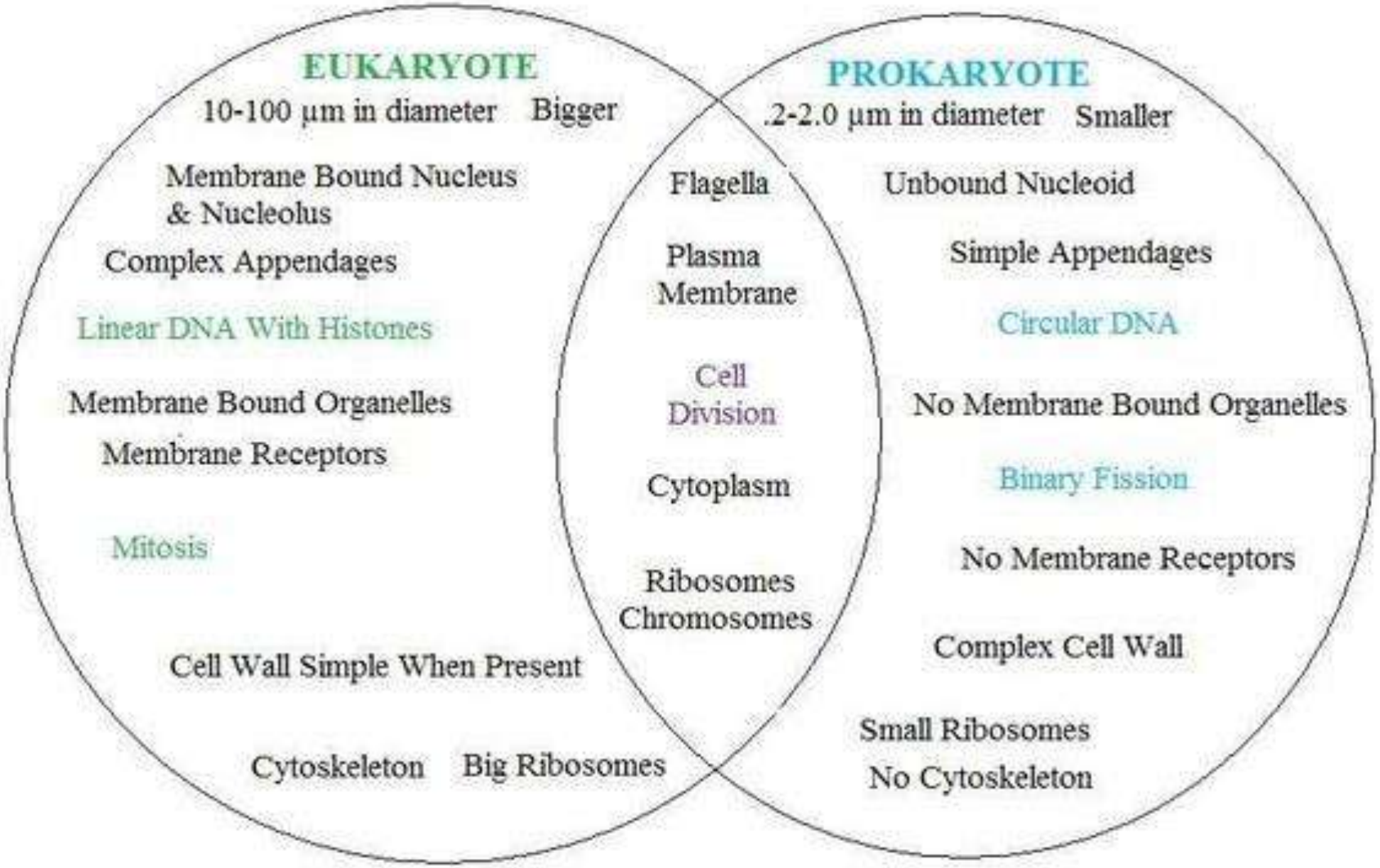
- Not compartmentalized
- Cell membranes lack sterols
- Cell wall composed of peptidoglycan
- True nucleus absent - nucleoid
- Single circular chromosome
- Ribosomal are 70S
  - subunits
    - 30S (16S rRNA)
    - 50S (5S & 23S rRNA)

Eukaryotes

- plants
- animals
- fungi

Eukaryotic Cell (L-Cell)




EUKARYOTE
10-100 µm in diameter
Bigger
Membrane Bound Nucleus & Nucleolus
Complex Appendages
Linear DNA With Histones
Membrane Bound Organelles
Membrane Receptors
Mitosis
Cell Wall Simple When Present
Cytoskeleton
Big Ribosomes
PROKARYOTE
.2-2.0 µm in diameter
Smaller
Unbound Nucleoid
Simple Appendages
Circular DNA
No Membrane Bound Organelles
Binary Fission
No Membrane Receptors
Complex Cell Wall
Small Ribosomes
No Cytoskeleton
Flagella
Plasma Membrane
Cell Division
Cytoplasm
Ribosomes
Chromosomes

Characteristic	Prokaryotes	Eukaryotes
Size of cell	Typically 0.2-2.0 m m in diameter	Typically 10-100 m m in diameter
Nucleus	No nuclear membrane or nucleoli (nucleoid)	True nucleus, consisting of nuclear membrane & nucleoli
Membrane-enclosed organelles	Absent	Present; examples include lysosomes, Golgi complex, endoplasmic reticulum, mitochondria & chloroplasts
Flagella	Consist of two protein building blocks	Complex; consist of multiple microtubules
Glycocalyx	Present as a capsule or slime layer	Present in some cells that lack a cell wall
Cell wall	Usually present; chemically complex (typical bacterial cell wall includes peptidoglycan)	When present, chemically simple
Plasma membrane	No carbohydrates and generally lacks sterols	Sterols and carbohydrates that serve as receptors present
Cytoplasm	No cytosketeton or cytoplasmic streaming	Cytoskeleton; cytoplasmic streaming
Ribosomes	Smaller size (70S)	Larger size (80S); smaller size (70S) in organelles
Chromosome (DNA) arrangement	Single circular chromosome; lacks histones	Multiple linear chromosomes with histones
Cell division	Binary fission	Mitosis
Sexual reproduction	No meiosis; transfer of DNA fragments only (conjugation)	Involves Meiosis

Prokaryotic versus Eukaryotic Chromosomes

Prokaryotic Chromosomes	Eukaryotic Chromosomes
• Many prokaryotes contain a single circular chromosome. • Prokaryotic chromosomes are condensed in the nucleoid via DNA supercoiling and the binding of various architectural proteins. • Because prokaryotic DNA can interact with the cytoplasm, transcription and translation occur simultaneously. • Most prokaryotes contain only one copy of each gene (i.e., they are haploid). • Nonessential prokaryotic genes are commonly encoded on extrachromosomal plasmids. • Prokaryotic genomes are efficient and compact, containing little repetitive DNA.	• Eukaryotes contain multiple linear chromosomes. • Eukaryotic chromosomes are condensed in a membrane-bound nucleus via histones. • In eukaryotes, transcription occurs in the nucleus, and translation occurs in the cytoplasm. • Most eukaryotes contain two copies of each gene (i.e., they are diploid). • Some eukaryotic genomes are organized into operons, but most are not. • Extrachromosomal plasmids are not commonly present in eukaryotes. • Eukaryotes contain large amounts of noncoding and repetitive DNA.

Archaebacteria

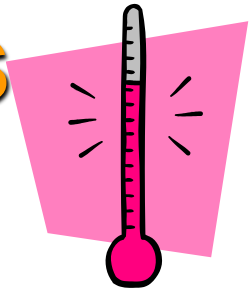
- Primitive bacteria
- Not compartmentalized
- Cell membranes phospholipids have ether linkage
- Cell wall not composed of true peptidoglycan
- True nucleus absent - nucleoid
- Single circular chromosome, associated with histones
- Ribosomal are 70S subunits
  - 30S (16S rRNA)
  - 50S (5S & 23S rRNA)

Archaebacteria

- **Methanogens:** Harvest energy by converting H_2 and CO_2 into methane gas
  - Anaerobic
  - live in rumen
- **Extreme halophiles:** Salt loving
  - live in Great Salt Lake, and Dead sea.
- **Thermoacidophiles:** Like acidic environment and high temperatures.
  - Live in Hot Springs, volcanic vents

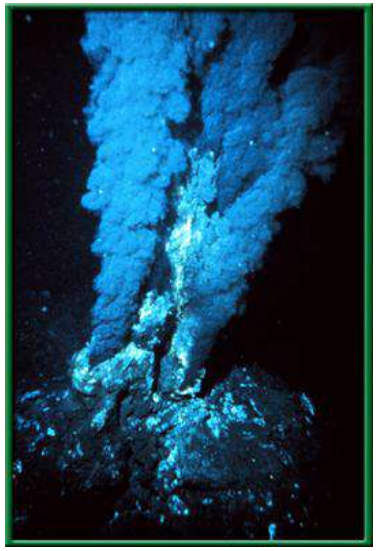
1. Thermophiles

"heat lovers"



a) Love high temperatures

b) Live in hot springs, deep ocean thermal vents



Deep sea thermal vents

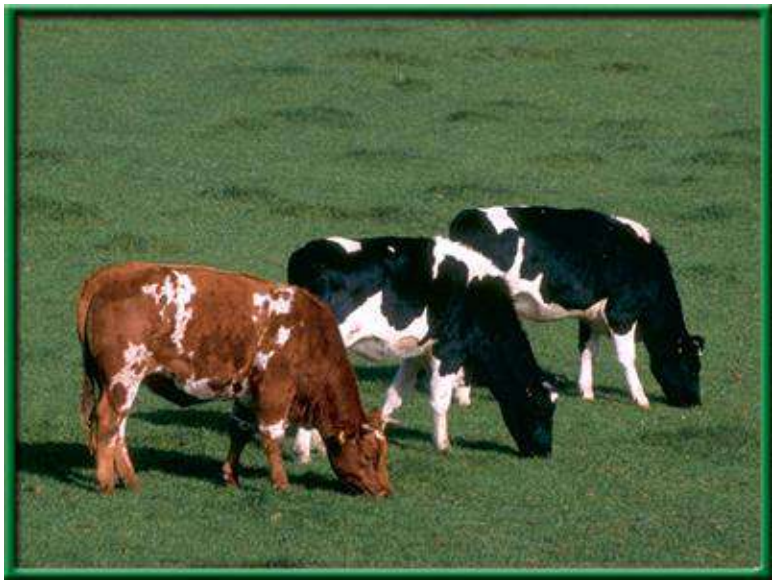
Morning Glory Pool, Upper Geyser Basin, Yellowstone National Park, Wyoming

Grand Prismatic Spring, Yellowstone National Park, Wyoming

2. Methonogens
"methane makers"

a) Convert CO_2 and H_2 to CH_4 (methane) w/o O_2 to make ATP

b) live in swamps, mud, sewage and animal guts



3. Halophiles
"salt lovers"

a) Tolerate high salt environments

b) Live in salt marshes, Dead sea, brackish ponds, salt lakes, volcanic vents on seafloor

halophiles

Table 4-1 **A Comparison of Some Properties of Bacterial, Archaeal, and Eukaryotic Cells***

	Prokaryotes			
Property	**Bacteria**	**Archaea**	**Eukaryotes**	**Refer to:**
Typical size	Small (1–5 μm)	Small (1–5 μm)	Large (10–100 μm)	—
Nucleus and organelles	No	No	Yes	Table 4-2
Microtubules and microfilaments	Actin-like and tubulin-like proteins	Actin-like and tubulin-like proteins	Actin and tubulin proteins	Chapter 15
Exocytosis and endocytosis	No	No	Yes	Chapter 12
Cell wall	Peptidoglycan	Varies from proteinaceous to peptidoglycan-like	Cellulose in plants, fungi; none in animals, protozoa	Chapter 17
Mode of cell division	Binary fission	Binary fission	Mitosis or meiosis plus cytokinesis	Chapter 19
Typical form of chromosomal DNA	Circular, few associated proteins	Circular, associated with histone-like proteins	Linear, associated with histone proteins	Chapter 18
RNA processing	Minimal	Moderate	Extensive	Chapter 21
Transcription initiation	Bacterial type	Eukaryotic type	Eukaryotic type	Chapter 21
RNA polymerase	Bacterial type	Some features of both bacterial, eukaryotic types	Eukaryotic type	Chapter 21
Ribosome size and number of proteins	70S with 55 proteins	70S with 65 proteins	80S with 78 proteins	Chapter 22
Ribosomal RNAs	Bacterial type	Archaeal type	Eukaryotic type	Chapter 21
Translation initiation	Bacterial type	Eukaryotic type	Eukaryotic type	Chapter 22
Membrane phospholipids	Glycerol-3-phosphate + linear fatty acids	Glycerol-1-phosphate + branched polyisoprenoids	Glycerol-3-phosphate + linear fatty acids	Chapter 7

*This table lists many features that we have not yet discussed in detail. Its main purpose is to point out that, despite some sharing of characteristics, each of the three main cell types has a unique set of properties.