

## Kingdom/Domain System Evolution

1. 2 Kingdoms - Plants  
- Animals
2. 5 Kingdom System - Manera  
- Plant  
- Animal  
- Fungi  
- Protists
- wrong because this is saying that all the differences are equal, which is false because they evolved at different times*
3. 3 Domain System - Current System. Domains are more broad than kingdom

## Bacteria V. Archaea

- Archaea = Hottest places on earth
- Archaea cell membrane - Formed by phospholipid bilayer
- Hydrocarbon chains can be linked so their lipids can be a monolayer. Makes membrane more stable/loss fluid. Helps retain integrity*

## Bacterial Peptidoglycan

- Carbohydrate chains cross linked with amino acids
- Plant cell walls are made of cellulose in strands
  - Cellulose doesn't contain the cross linked amino acids that connect the chains (PLANTS = cellulose)
- Cross link= very strong substance. need this because bacteria is single celled*

## What Unites Prokaryotes

- All are conditional with known exceptions**
- Unicellularity: *almost* always single-celled
- Cell size: *mostly* very small
- Chromosomes: *typically* have a single circular chromosome, genetical material can be exchanged via HGT
- Cell division: *mainly* occurs by binary fission, no mechanism for sexual reproduction (asexual reproduction)
- Internal compartmentation: *no true* membrane bound organelles
- Flagella: *simple structure* allows only for simple mechanism

**Metabolic diversity: can be capable of metabolic feats requiring remarkable chemistry**

## Gram Stain- Often first step in treatment

- Gram-stains are still ofte the first figure in clinical articles about pathogens

## How does genetic diversity arise?

### Examples of Horizontal Gene Transfer

- | Conjugation   | Transduction  |
|---|---|
| 1. One strand of F+ cell plasmid DNA breaks at arrowhead          | 1. Phage infects bacterial donor cell with A+ and B+ alleles        |
| 2. Broken strand peels off and enters F- Cell                     | 2. Phage DNA is replicated and proteins synthesized                 |
| 3. Donor and recipient cells synthesize complementary DNA strands | 3. Fragment of DNA with A+ allele is packaged within a phage capsid |
| 4. Recipient cell is now a recombinant F+ cell                    | 4. Phage with A+ allele infects bacterial recipient cell            |

## How does genetic diversity arise? (cont)

5. Incorporation of phage DNA creates recombinant with genotype A+B
- Chromosomes are mostly single celled and horizontal transfer can be given to anyone in the same environment*
- Pili merge and join cytoplasm
- plasmids:** where antibiotic genes are held
- Virus serving as a boat for exchange of genetic material*

## Cellular Life

- Unicellular - Most of earths organisms in history
- Multicellular - Fungi, Plants, Animals

## Domains

*Archaea are more closely related to eukarya than bacteria*

	Bacteria	Archaea	Eukarya
<b>Nuclear Envelope</b>	Absent	Absent	Present
<b>Membrane enclosed Organelles</b>	Absent	Absent	Present
<b>Peptidoglycan in Cell Walls</b>	Present	Absent	Absent
<b>Membrane Lipids</b>	Unbranched Hydrocarbons	Some branched hydrocarbons	Unbranched hydrocarbons
<b>HNA Polymerase</b>	One kind	several kinds	several kinds



## Domains (cont)

<b>Initiator amino acid for protein synthesis</b>	Formyl-methionine	Methionine	Methionine
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<b>Introns in genes</b>	Very rare	present in some genes	present in many genes
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<b>Responsible to the antibiotics streptomycin and chloramphenicol</b>	Growth usually inhibited	Growth not inhibited	Growth not inhibited
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<b>Histones associated with DNA</b>	Absent	Present in some species	Present
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<b>Circular Chromosome</b>	Present	Present	Absent
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<b>Growth at temperatures &gt;100C</b>	No	Some Species	No
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Archea membrane lipids can form monomers

Introns show more complex genetically

Histones allow packaging of DNA. No histones means doesn't have to be as compacted

## Internal Membrane or Organelles?

Some internal membranes are complex invaginations of the Plasma Membrane

<b>Aerobic Prokaryote</b>	<b>Photosynthetic Prokaryote</b>
Respiratory membrane	Thylakoid Membrane

Cyanobacteria--> started O2 release

## Metabolic Diversity of Prokaryotes

Carbon Source	Energy Source
A. Autotrophs	A. Phototrophs
B. Heterotrophs	B. Chemotrophs
	--Organic (Chemoorganotrophs)
	--Inorganic (Chemolithotrophs)

## Prokaryotic metabolism varies with respect to O2

Obligate aerobes require O2 for cellular respiration

Obligate anaerobes are poisoned by O2 and use fermentation or **anaerobic respiration**, in which substances other than O2 act as electron acceptors

Facultative anaerobes use O2 if it is available, but can survive without it

## Nitrogen Metabolism

Prokaryotes undergo NITROGEN FIXATION

## Additional Points

1. Source of Carbon: *biomolecules have carbon skeletons*  
-Where does the organism get the carbon atom from?

--**heterotrophs**: Organic molecules

2. Acquire energy to arrange carbon atoms  
-phototrophs=sun  
-Chemotrophs=organic

Oxygen has nothing to do with this at this time

**Facultative**: can survive with or without O2

**Nitrogen Metabolism**: Need nitrogen!

-can only get it from other molecules

*only thing that can break the triple bond of nitrogen is prokaryotes. N2= most on earth*

-not found purely in the environment. "chillin with other species"

## First Cellular Life Form Appearance

3.9 Billion Years Ago

For 3.9 Billion Years life has been evolving to the present life forms

- Humans organise life by phylogeny

*Closest # = least # of nucleotide differences*  
*more differences in sequence, the longer the time difference*

## Interesting Facts

It is estimated that only 1-10% of bacteria species are known

We think that maybe 1% of archaea species are known

## Why are so few prokaryotic species known?

We don't know more about bacteria because they have just been studied by growing them in a lab.

Most bacteria metabolisms are so complex they can't figure out how to get them to grow on their own, in a lab

## Cell walls are found in which of the following domains?

Bacteria, Archaea, Eukarya

- Cell walls in all domains (cell walls are made of peptidoglycans)

## Prokaryotic Shape

*There is no correlation between prokaryotic cell shape and gram-stain or other test*

**Bacillus**: 0.5um

**Coccus**: 2um  
*strep*

**Spirillum**: 3um  
*lyme disease*

There is no correlation between prokaryotic cell shape and gram-stain or other test



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## Bacterial Cell Wall

Bacteria can be classified by their cell wall

Gram (+)

Gram (-)

- Teichoic acid  
only in G+

- LPS major endotoxin

- Lipoteichoic Acid  
(LTA)

Thin peptidoglycan and  
outer/inner membrane

peptidoglycan very  
thick and only one  
membrane

- Outer lipid--> LPS  
**one of the major  
endotoxins that causes  
the body to get sick**

*Cell wall of bacteria=traditional classification*

*Gram stains change approach to treatment*

## The Gram Stain-Identifies Bacterial Category

1. Bacteria are stained with crystal violet  
*all cells are stained purple*

2. Iodine stabilizes the crystal violet with the  
cellular material

3. Alcohol may extract the crystal violet from the  
cell

*The stain complex is removed from the gram-  
negative cells (makes them white/clear) and  
remains in the gram-positive cells (stays purple)*

4. Bacteria are stained with safranin

*Gram-negative cells are stained pink; gram  
positive cells are still purple*

All microbes can be stained in this way. But  
with cells **in the Domain Bacteria** (only), the  
staining makes predictions about envelope  
structure.

*cell wall and membranes*

## Other Notes

Alcohol breaks down membrane and wash out  
iodine

- + doesn't allow this to happen

This procedure only works for bacteria

## Domains

**Bacteria** most abundant organisms on  
- earth. Highly diverse and poorly  
**prokaryo** understood.  
**tic**

**Archaea** But different from bacteria. Very  
- poorly understood

**prokaryo**  
**tic**

*Each domain is monophyletic*

Monophyl etic Contain all decedents of common  
ancestor



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