## Kingdom/Domain System Evolution

| | |
|---|---|
| 1. 2 Kingdoms | - Plants<br>- Animals |
| 2. 5 Kingdom System | - Manera<br>- Plant<br>- Animal<br>- Fungi<br>- Protists<br>*wrong bbecause 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 sincle 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 t bacteria*

| | Bacteria | Archaea | Euka |
|---|---|---|---|
| **Nuclear Envelope** | Absent | Absent | Pres |
| **Membrane-enclosed Organelles** | Absent | Absent | Pres |
| **Peptidoglycan in Cell Walls** | Present | Absent | Abse |
| **Membrane Lipids** | Unbranched Hydrocarbons | Some branced hydrocarbons | Unbr hydr arbo |
| **HNA Polymerase** | One kind | several kinds | seve kinds |



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## Domains (cont)

| | | | |
|---|---|---|---|
| **Initiator amino acid for protein synthesis** | Formyl-methi-onine | Methionine | Methionine |
| **Introns in genes** | Very rare | present in some genes | present in many genes |
| **Responsible to the antibi-otics strept-omycin and chloramph-omicol** | Growth usually inhibited | Growth not inhibited | Growth not inhibited |
| **Histones associated with DNA** | Absent | Present in some species | Present |
| **Circular Chromosome** | Present | Present | Absent |
| **Growth at temperatures >100C** | No | Some Species | No |

*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

| Aerobic Prokaryote | Photosynthetic Prokaryote |
|---|---|
| Respiratory membrane | Thylakoid Membrane |

*Cyanobacteria--> started O2 release*

## Metabolic Diversity of Prokaryotes

| Carbon Source | Energy Source |
|---|---|
| A. Autotrophs B. Hetero-trophs | A.Phototrophs B.Chemotrophs --Organic (Chemo**organo**trophs) --Inorganic (Chemo**litho**trophs) |

**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 respir-ation,** in which substances other than O2 act as electron acceptors

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

**Nitrogen Metabolism**

Prokaryotes ungergo 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. Aquire energy to arrange carbon atoms
*-phototrophs=sun*
*-Chemotrophs=organic*

Oxygen has nothing to do with this at this time

**Phacaltative**: 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"

## Domains

| | |
|---|---|
| **Bacteria - prokar-yotic** | most abundant organisms on earth. Highly diverse and poorly understood. |
| **Archaea - prokar-yotic** | But different from bacteria. Very poorly understood |

*Each domain is monophyletic*

| | |
|---|---|
| Monoph yletic | Contain all decendents of common ancestor |

## 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 know

We think that maybe 1% of archaea species are known

**Why are so few prokaryotic species known?**

We dont know more about bacteria because they have just been studied by growing them in a lab.

Most bacteria metabolisms are so complex they cant 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)



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## 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

## 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 safanin
*Gram-negative cells are stained pink; gram ppositive cells are still purple*

## Bacterial Cell Wall (cont)

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



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