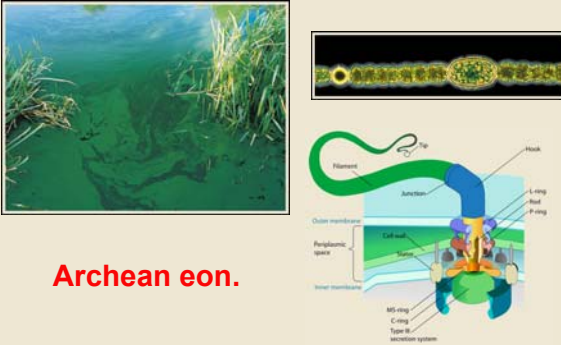


Archean eon



Archean eon.

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Geological time scale and building height

(1 floor – 60Ma, 72 floors, 12 feet/floor)

- **Major Eons (Ma)**
 - **Phanerozoic**
 - (543 Ma to present time, top 9 floors)
 - **Proterozoic**
 - (2,500 – 543 Ma, 33rd -63rd)
 - **Archean**
 - (3,800 – 2,500 Ma, 12th – 33rd)
 - **Hadean**
 - (4,600 – 3,800 Ma, 0-12th)



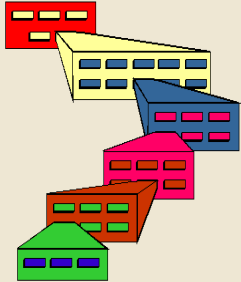
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The archea are going to dominate the planet. This will be the very simplest forms of life. This eon ends when we finally get an oxygen atmosphere

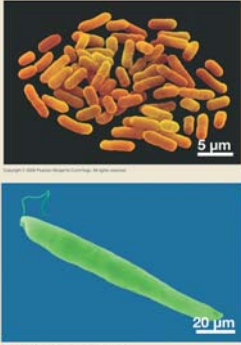
Linnaeus – Taxonomic hierarchy



- **Kingdoms**
 - Animalia
 - Plantae
 - Fungi
 - Protista
 - Monera

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Archean eon



Kingdom Monera
(includes all prokaryotes)


Kingdom Protista
(includes several groups of unicellular eukaryotes)

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The 2 single celled kingdoms:
Prokaryotes (Monera) - no nucleus or organelles
Eukaryote (Protista) - nucleus and membrane bound organelles



Kingdom Plantae

Kingdom Fungi

Kingdom Animalia

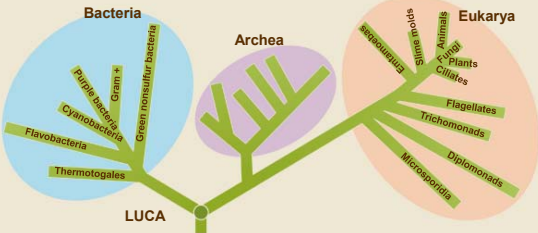
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Plants are the only things that have chloroplasts.
They can synthesis their own energy (autotrophes).
Fungi - Cannot synthesis their own energy (heterotrophs). An absorptive heterotroph. has to secrete enzymes to digest its food externally.
Animals - consume food and digest it internally.(ingestive herterotrophs)

Domains of life



Bacteria

Archaea

Eukarya

LUCA

Figure 3.20 and 18.16

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Got broken into the archea (can live in an oxygen free world)
Bacteria (Ubacteria)

Archean eon

**Prokaryotes - Domains
Bacteria and Archaea**

Figure 20.17
CBC *E. coli*

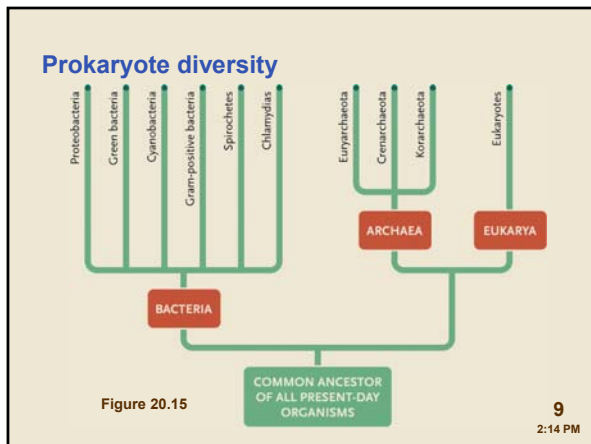
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Archaea, Eubacteria & Eukarya
(Table 20.2)

| | Archaea | Eubacteria | Eukarya |
|----------------------------|---------------------------|-----------------------------|---------|
| Cell Wall | No peptidoglycan | Peptidoglycan | |
| Plasma membrane | Branched with ether links | Unbranched with ester links | |
| Operon genes | Yes | Yes | |
| Translation | Complex RNA polymerases | Simple RNA polymerase | |
| Nuclear envelope | No | No | |
| Circular Chromosome | Yes | Yes | |
| DNA/histones | Yes | No | |
| 1 st amino acid | Methionine | Formylmethionine | |



Bacteria gives us Archea and Eukarya, which are related.

Archean eon

Morphological diversity

- Size
- Shape
- Mobility
- Metabolism



Figure 20.2

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Names were based on shape.

E. coli: even though it has the same shape as the e. coli that is already inside us, their internal processes are actually very different.

Bacterial cells

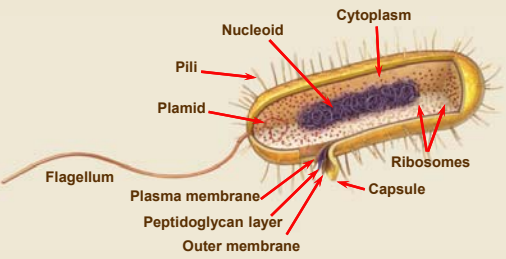


Figure 20.3

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Best surface:volume ratio of any organism.

- mathematically, when organisms are really small they have a large surface area compared to their volume. as an organism gets bigger, it has proportionally less surface area compared to its volume.

The outer membrane has a sugar and carbohydrate chains are mixed together to create the rigidity of the bacteria cell

Bacterial cell walls

Gram positive

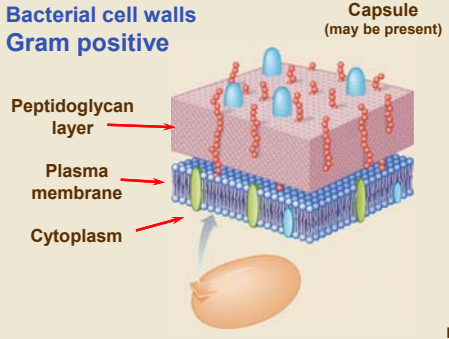


Figure 20.6a

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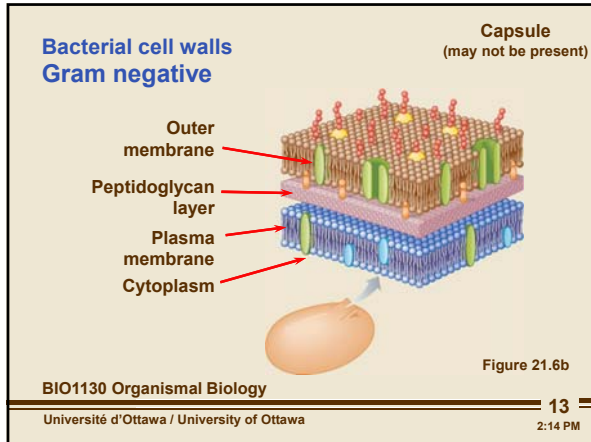
When you have a gram positive bacteria the

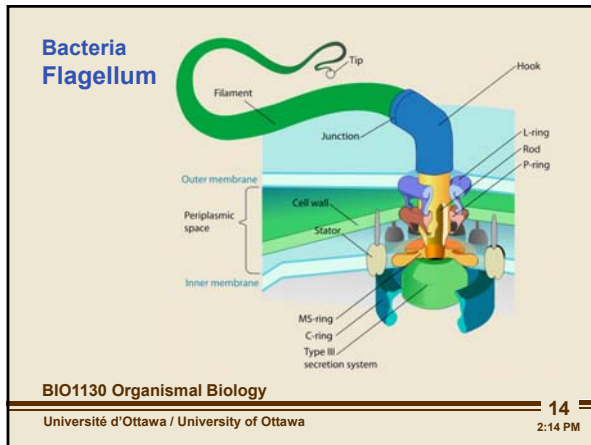
peptidoglycan sits outside the plasma layer
Gram positive - gram stain worked (stains peptidoglycan layers)

Gram negative - 2 phospholipid bi layers and peptidoglycan layer is stuck in between.

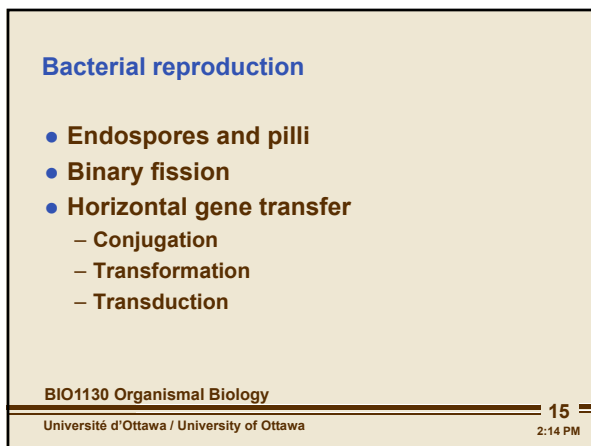
Penicillin disrupts the proper formation peptidoglycan layer in gram positive bacteria.

Archean eon



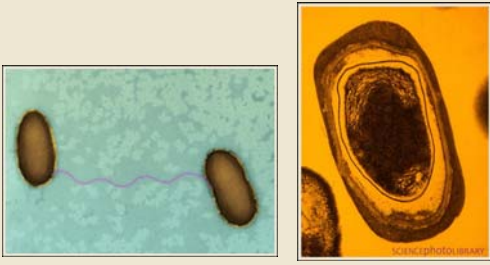


Most bacteria have a flagellum in order to move. Contains only 40 proteins. 23 of these proteins are the same in all bacteria. shows us one of the very first uses to use ATP. Uses proteins to fall through and nudge the hook causing it to spin and propel the bacteria. NOT THE FLAGELLUM OF A EUKRAYOTE. THIS IS A PROKAYOTE



Archean eon

Bacterial reproduction
Endospores and Pili



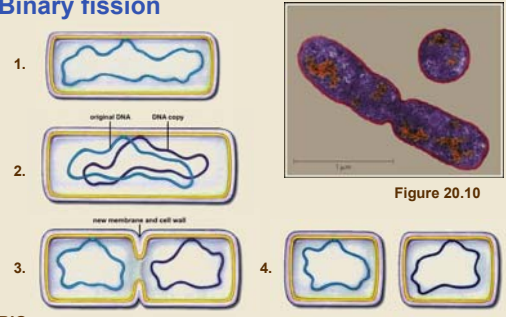
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bacteria can go dormant and even survive for millions of years.

Pilli are little hairs on the surface that are able to connect bacteria together and exchange materials

Bacterial reproduction
Binary fission



1. 2. 3. 4.

original DNA DNA copy

new membrane and cell wall

Figure 20.10

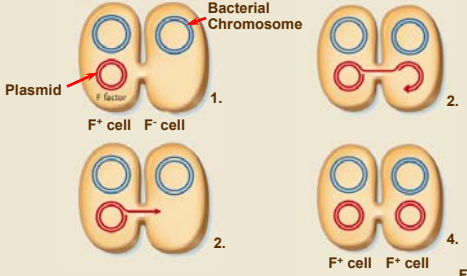
Figure 8.3

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Replicates DNA, attaches it to the cell wall, creates a new membrane and creates a perfect clone of the parent cell. This prevents mutations.

Bacterial reproduction: Horizontal gene transfer
Bacteria conjugation plasmid transfer



Plasmid F factor

Bacterial Chromosome

1. 2.

F⁺ cell F⁻ cell

2. 4.

F⁺ cell F⁺ cell

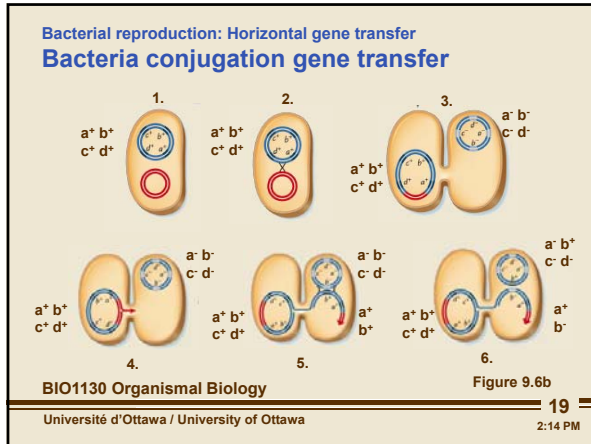
Figure 9.6a

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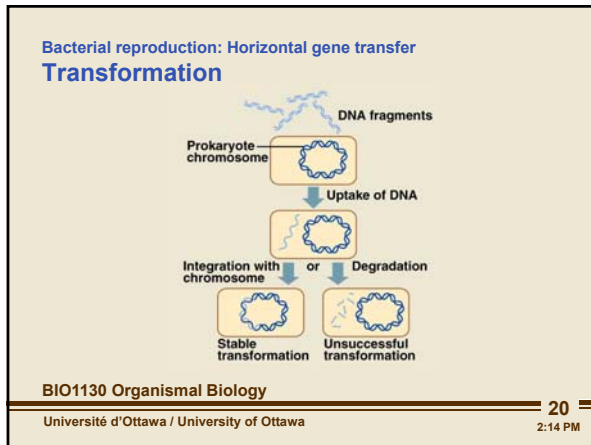
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This is often the site of bacteria antibiotic resistance. This occurs on the plasmid. You have a highly transferrable from that is very hard to treat. plasmid transfer

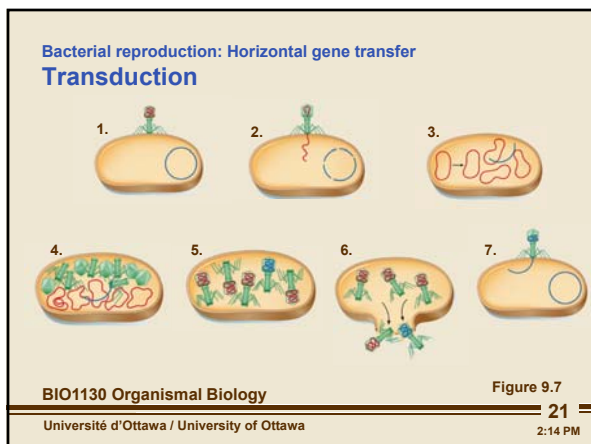
Archean eon



the plasmid is able to incorporate itself into the genome of the bacteria itself. When this happens, sometimes the break isn't clean and not at the right point. when the plasmid goes over to the new bacteria it takes a small chunk of the original bacteria with it. This can cause transfers between different organisms of the genomes. Increases genetic variability.



They are also able to pick up stray pieces of DNA in the environment and incorporate it into their own. Bacteria is able to experiment with life due to its extremely flexible genome.




Bacteria populations are controlled by fages. They are the simplest form of organisms out there. It synthesizes enzymes that will break down the DNA of the bacteria cell. It then destroys the bacteria's genome. Then replicates its own genome and undergoes protein synthesis. Finally once there's a whole bunch of fages forms, they self assemble into new virus particles in order to be released and find more bacteria to infect and kill.

Archean eon

Metabolic diversity in ATP production and carbon sources (Table 20.1 in part)

- **Autotrophic**
 - Photoautotrophs
 - Chemoorganotrophs
 - Chemolithotrophs
- **Heterotrophs**
 - Photoheterotrophs
 - Chemoorganoheterotrophs
 - Chemolithotrophic heterotrophs



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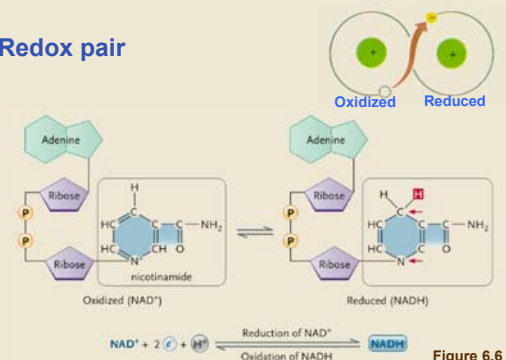
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With carbon - build carbon carbon bonds. Where does the energy come from to build these bonds.

autotroph - if you use energy to build carbon carbon bonds from carbon dioxide

heterotrophes - take existing molecules that contain carbon and cleave it off to use for itself.

Redox pair



Oxidized (NAD⁺) Reduced (NADH)

$NAD^+ + 2 e^- + H^+ \rightarrow NADH$

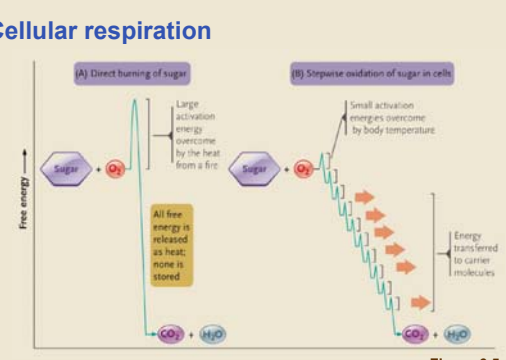
Reduction of NAD⁺ Oxidation of NADH

Figure 6.6

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Cellular respiration



(A) Direct burning of sugar (B) Stepwise oxidation of sugar in cells

Free energy

Sugar + O₂ → CO₂ + H₂O

Large activation energy overcome by the heat from a fire

Small activation energies overcome by body temperature

All free energy is released as heat; none is stored

Energy transferred to carrier molecules

Figure 6.5

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Archean eon

Metabolic diversity

| Initial electron donor | Electron acceptor | By products | |
|--|---|---|-------------------------------------|
| | | From electron donor | From electron acceptor |
| Sugar | O ₂ | CO ₂ | H ₂ O |
| H ₂ or organics | SO ₄ ²⁻ (Sulfate) | H ₂ O or CO | H ₂ S (hydrogen sulfide) |
| H ₂ | CO ₂ | H ₂ O | CH ₄ (Methane) |
| CH ₄ | O ₂ | CO ₂ | H ₂ O |
| S ²⁻ or H ₂ S | O ₂ | SO ₄ ²⁻ (Sulfate) | H ₂ O |
| Organics | Fe ³⁺ | CO ₂ | Fe ²⁺ |
| NH ₃ (Ammonia) | O ₂ | NO ₂ ⁻ (Nitrite) | H ₂ O |
| NO ₂ ⁻ (Nitrite) | O ₂ | NO ₃ ⁻ (Nitrate) | H ₂ O |

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Bacterial importance

- Disease
- Nitrogen fixation
- Decomposition
- Unique biochemical pathways
- Extremophiles (Archea)

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Bacteria in combination with fungi is important in decomposition

Prokaryotes and humans


| Transmission | Disease - <i>Bacterium</i> |
|--------------------|--|
| Airborne | Legionellosis - <i>Legionella pneumophila</i> Diphtheria - <i>Corynebacterium diphtherium</i> Tuberculosis - <i>Mycobacterium tuberculosis</i> |
| Arthropod | Lyme disease - <i>Borrelia burgdorferi</i> Bubonic plague - <i>Yersinia pestis</i> |
| Direct contact | Gonorrhea - <i>Neisseria gonorrhoeae</i> Anthrax - <i>Bacillus anthracis</i> |
| Food or waterborne | Food poisoning - <i>Salmonella enteritidis</i> Cholera - <i>Vibrio cholerae</i> Listeriosis - <i>Listeria monocytogenes</i> |

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Archean eon

Nitrogen fixation

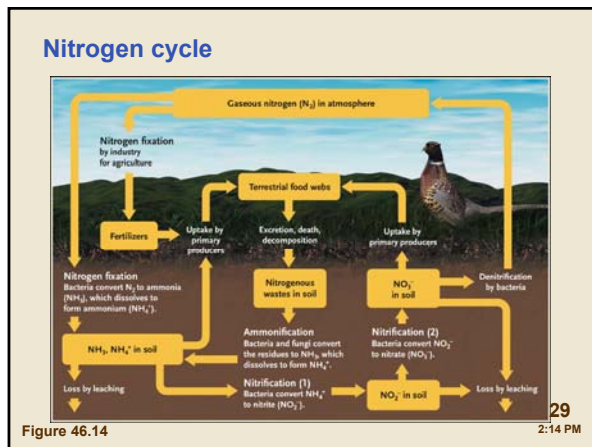
$$\text{N}_2 + 8\text{H}^+ + 8\text{e}^- + 16 \text{ATP} \rightarrow 2\text{NH}_3 + \text{H}_2 + 16\text{ADP} + 16 \text{P}_i$$


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Bacteria is the only organism that can take elemental nitrogen and incorporate it into a compound that can then be incorporated in other compounds, (NH₃)



Lightning can also produce nitrogen. Nitrogen is one of the limiting factors of the environment. We use nitrogen in fertilizers which promotes leafy tissue growth. This then runs off into the streams and rivers as run off, which then causes the algae blooms in huge numbers. When they die the decomposition cycle then strips all of the oxygen out of the water, killing anything in the water. Every year there is a dead zone in the golf of Mexico for thousands of miles, where the nitrogen has run from the Mississippi river and kills everything in its path.

Extremophiles (Archaea)



Halophiles

Thermophiles

Figure 20.20

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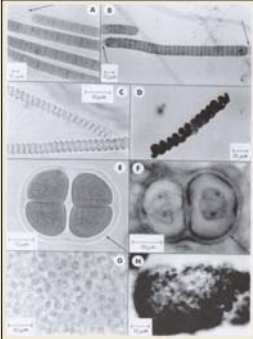
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Halophiles like his salt concentrations
 Thermophiles like to live in high head conditions.
 We do not know a lot about these because we cant artificially culture most of them in a lab. It is almost impossible to artificially create their conditions that are necessary.

Archean eon

Fossil bacteria



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Stromatolites

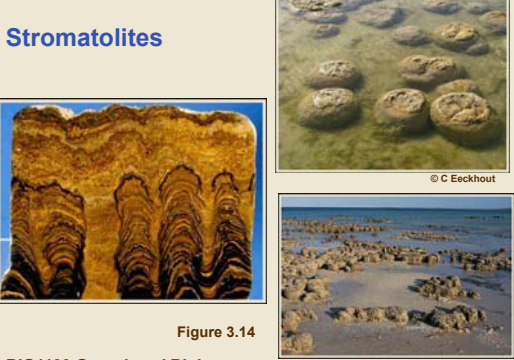


Figure 3.14

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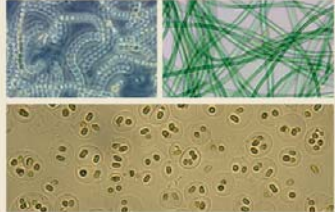
This bacteria lives on top of itself. Layers and layers of this bacteria form on top of each other.

Cyanobacteria and earth's evolution

$\text{CO}_2 + \text{H}_2\text{O} + \text{light}$

↓

$(\text{CH}_2\text{O})_n + \text{H}_2\text{O} + \text{O}_2$



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The very first bacteria that used protons from water and combined it with light to form energy.

Archean eon

Oxygenation of the planet




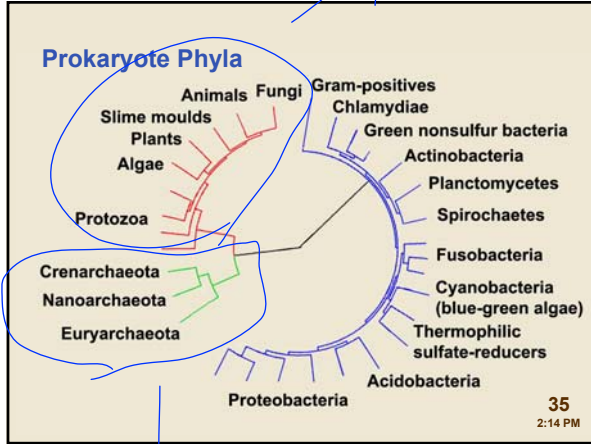
Figure 3.18

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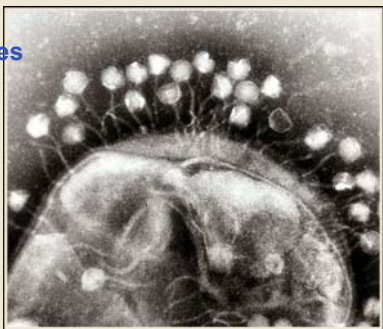
Prokaryote Phyla



Animals Fungi
Slime moulds Plants
Algae
Protozoa
Crenarchaeota
Nanoarchaeota
Euryarchaeota
Gram-positives
Chlamydiae
Green nonsulfur bacteria
Actinobacteria
Planctomycetes
Spirochaetes
Fusobacteria
Cyanobacteria (blue-green algae)
Thermophilic sulfate-reducers
Acidobacteria
Proteobacteria

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Viruses



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Viruses are not living, they only have the genetic material to make themselves, but don't have the tools to do it. It is a piece of genetic material that is looking for a living cell to use its resources. They are basically the bare minimum.

Archean eon

Virus morphology

Helical

Polyhedral

Enveloped

Complex enveloped

H1N1 an enveloped virus

BIO1130 Organismal Biology Figure 21.1

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We can take viruses and break them down into 2 basic forms. Whether or not they have an envelope or not, (bilipid layer). Viruses dont have DNA they have nucleic material.

Virus morphology

Nonenveloped virus

Enveloped virus

Genome (DNA or RNA) inside

Capsid (protein)

Genome (in this case, RNA)

Capsid (protein)

Envelope (phospholipid bilayer)

Viral enzymes

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Virus morphology

Head

Viral DNA inside

Capsid Protein

Sheath

Tail

Baseplate

Recognition fibers

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Archean eon

Viruses aren't cells?

- No cell membrane
- No ribosomes
- No mitochondria
- DNA (RNA) wrapped in a protein coat

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Viral phases in replication

- Entry
- Transcription and viral protein production
- Replication of viral genome
- Assembly of virions
- Exit
- Transmission to new host

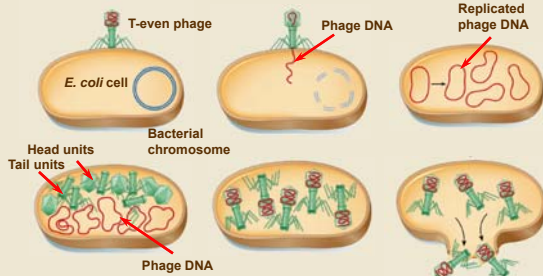
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Viruses – Replication



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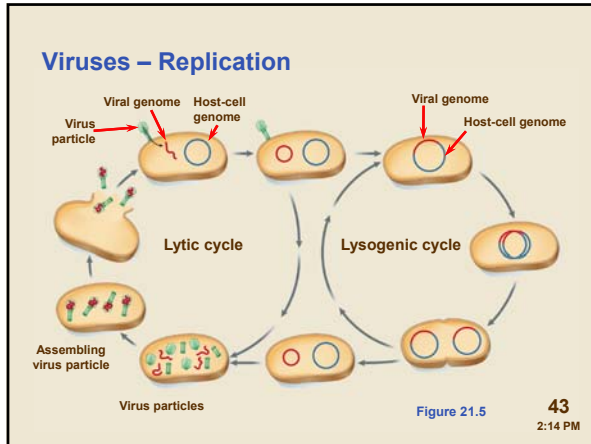
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Figure 21.4

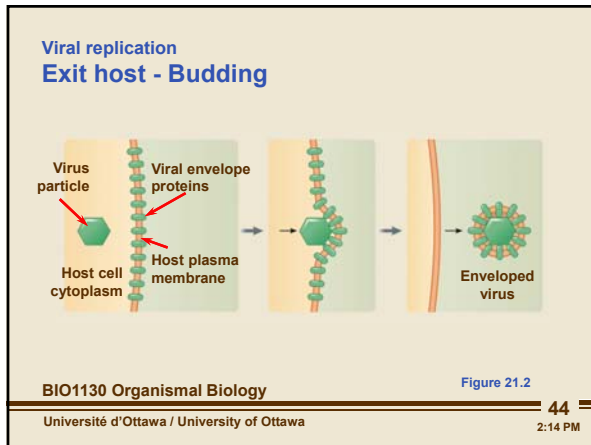
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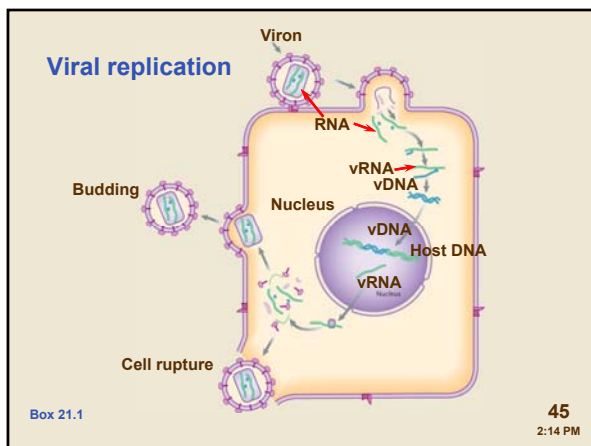
Archean eon



Viruses are also able to put themselves into the genome of a cell and sit there not doing anything for a long time. As the bacteria replicates the bacteria is then replicated until the virus then begins its actual processor self assembly. Up to 8% of your genome is viral DNA that has been incorporated into our DNA that we don't know anything about. These are probably old viruses that were flawed in some way and actually become like little relics of the evolutionary past of viruses.



When the envelope virus escapes, it raps itself in the plasma membrane of the host cell and adds key proteins. It often has a recognition factor since they have stolen the plasma membrane of another cell.



Archean eon

Prions and viroids

- **Bovine spongiform encephalopathy**

Normal Aberrant

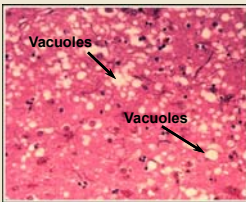
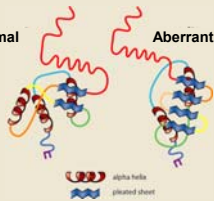


Figure 21.6

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Unusual proteins that have 2 different folding _____ confirmations. take a protein string that was folded one way, and changing it to the aberrant form. This is extremely sticky, creating a growing chain with multiple terminal ends. Each of those ends is catalytic to make that protein from the non harmful to harmful form. Protein that is generating itself from another protein. Mad cow disease* causing the nervous system to fail. It is almost indestructible, highly stable, doesn't have genetic material. The digestive system cannot break it down.

Self replicating protein that has a biological function that can be passed from one generation to the next but without any genetic material at all.

Viroids block protein production in plants by blocking the translation of the message of the protein. Can be very deadly in plants causing death of leaves and tissue as well as being transmitted between plants.

A piece of RNA that replicates itself within plant cells and shuts down everything that is happening in the cell by blocking mRNA transmission.

They then found the viroids in humans (Hepatitis D). It is with hepatitis B and once you get hep B and the viroid is present, it will begin shutting down the mRNA in the human.

What is life?
(Figure 3.3)

- **Organized** – with the cell as the fundamental unit
- **Metabolizing** - Capturing and releasing energy
- **Self regulating** - A delicate balance
- **Reproduce** – life from life
- **Evolving** - Adapting and changing
- **Responding** - Sensing and interacting with the surrounding world
- **Growth** – increase in size

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