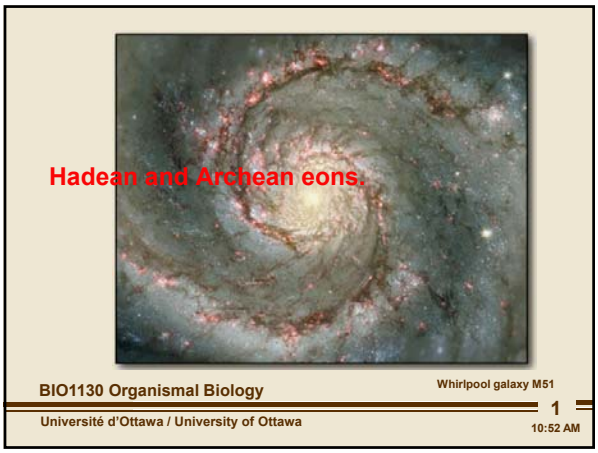
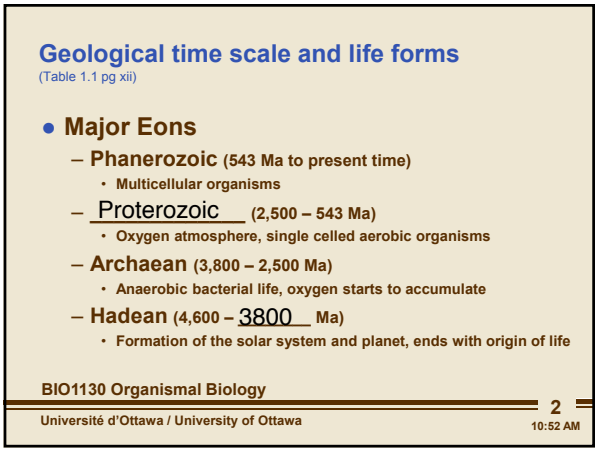
Hadean and Archean eons



hadean is a period of time in which we see the solar system is being formed. when we build suns and planets, what is happening is particles and pieces are bumping into and sticking into each other. as this happens, they're force of attraction gets bigger, and they attract more pieces of particle and dust. every once in a while one of them gets so big that there is kinetic energy associated and heat is generated. everyonce in a while one of these things get so hot it gets on an atomic level. when hydrogen and squeeze into each other, helium forms, nuclear fusion, and heat released to every waveform ie microwave etc. these things are basically giant nuclear bombs burning, radiating its energy out to other stars. it will pull more things but these things may stabalize and revolve around it.

Hadean era ends when life forms on planet. hadean approx 80 Billion years. Nothing is happening since the earth is still being formed. the sun is still not at its best yet. when it finally stabalizes, life forms.



Archeon 3.3 billion years.very fist life forms form and they are bacteria. 1/3 of history of time that life on planet. anaerobic, they can life without oxygen. they live off of methane, sulfur, etc. in their electron transport, they can grab many things to produce energy. one of these bactera split water molecules and release oxygen as waste. this happens for a long time. the bacteria is very effecient at this, and oxygen fills planet. 2.3 billion years of time there is NO oxygen on Earth. iron planet, so iron +oxygen =rust. the bacteria is around so long, it rusts everything, and it saturates the water. oxygen we breath today is the result of these bacteria which were around 2.3 billion years. aerobic bacteria forms, oxygen breathing. for the first 4.3 billion years, nothing more complicated than single cell things.

suddenly multicellular beings happen. wtf?

Hadean and Archean eons

Geological time scale and life forms
(Table 1.1 pg xii)

- **Major Era**
  - **Phanerozoic** (550 Ma to present time)
    - Cenozoic (65Ma to present time)
      - Dinosaurs disappear, mammals and birds
    - Mesozoic (251-65 Ma)
      - Flowering plants, dinosaurs, even more insects
    - Paleozoic (543-251 Ma)
      - Marine invertebrates, algae, "Cambrian explosion", first land plants and insects.
  - Proterozoic (2,500 – 543 Ma)
  - Archaean (3,800 – 2,500 Ma)
  - Hadean (4,600 – 3,800 Ma)

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4
10:52 AM

Paleozoic is old, mesozoic middle, cenozoic new. paleozoic, half of the life is developing in ocean. land plants. suddenly mass extinction. flowering plants go crazy and thrive. insects help polinate. flowering plant strategy is very successful, and takes over the planet. the insects adapt to the plants, and the lizards adapt to that. suddenly extinction again, and birds and mammals take over.

Geological time scale and building height
(1floor – 60Ma, 72 floors, 12 feet/floor)

- **Major Era**
  - **Phanerozoic**
    - Cenozoic
      (65 Ma to present time, 72nd floor)
    - Mesozoic
      (251-65 Ma, 65th to 71st)
    - Paleozoic
      (543-251 Ma, 63th to 65th)
  - Proterozoic (2,500 – 543 Ma)
  - Archaean (3,800 – 2,500 Ma)
  - Hadean (4,500 – 3,800 Ma)

Your life span = 0.0002 inches
Human hair = 0.001 inches

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formation of solar system, stabalization, and creation of planets. the secret is particles banging into each other and sticking. sun is 99% mass of solar system. everything else is spinning around this. huge amounts of debris moving around the sun as well. galaxies get close to each other and they rip each other apart because of all the mass and therefore gravity. all this stuff gets tossed away to every direction. the sun exerts so much force, that certain things can find an orbit around it. some stuff don't stabalize and get shot out/in. solar system that has at its core 4 planets which are very dense and solid (metal planets), and outer, the gas planets (aka saturn etc.) the sun is not able to heat them up enough so they don't form solids and are gasses. earth in its creation, a lot of stuff were bombarding it. still happening. meterorites can still crash into the planet. one of the last meteorites to hit earth was just as planet finally stabalized crust, that hit the planet and punched a hole in the crust. the metorite dissolved but magma spewed out from surface of earth, and that magma which got out and filled the hole is sudbury. so much minerals there and stuff because of the meterorite causing minerals to get out. another one is that one grazed the earth, and a lot of magma splattered out again. its the moon whoa. the moon formed because of an impact. that was the last extreme impact. it turned the planet into a liquified planet again as it just stabalized. this happened a lot, but it finally stabalized. when it finally did, earth is in a unique situation called the godilocks zone. the perfect planet. not too hot not too cold. the position of the planet can cause water to exist in all 3 forms :gas liquid solid. if we were closer to sun we would melt. if we were too far we would freeze. the shit slamming into the planet contains water. comets have huge amounts of frozen water. godilocks zone also refers to a planet of an appropriate size. it was such a good size it was able to hold on to all the gases and stuff that were created. mars can't do that. water vapour and sulfur dioxide etc all of it was being released, but it was able to be caught by the atmosphere. water falls back to earth, creates oceans. jupiter is extremely big. a lot of objects that fly in to solar system gets caught by jupiter's gravitational pull. its like a protector.

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Galaxies

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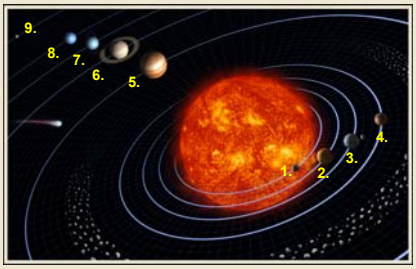
Our Solar system

Nat Geo Sun video

1. Mercury
2. Venus
3. Earth
4. Mars
5. Jupiter
6. Saturn
7. Uranus
8. Neptune
9. ~~Pluto~~



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Hadean eon

- Building phase
- stabilizing phase

Orion nubula (NASA)

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9
10:52 AM

mostly water. greenhhouse gases keep the planet ~~warm (sun is only about 70%). finally everything is stab~~le in the sense that there is no more stuff slamming into the ~~planet. 2/3rds into the Hadean era.~~

Earth 4,000 Ma

Figure 2.7

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10
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haedon, archaen, proterozoic, phanerozoic

Origins of life on earth

- **Special creation**
- **Extraterrestrial origins (** Panspermia**)**
- **Chemical evolution**

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11
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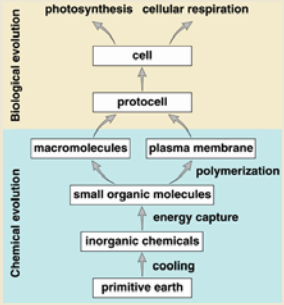
life is created by genetic elements, but where did the codons come from? only 3 explanations: god, life from other places arrive from asteroids (if you look at meteorites, there seems to be fossilized archaebacteria. the candidate planet is Mars), and chemical evolution, meaning it is unique to this planet

Origins of life on earth



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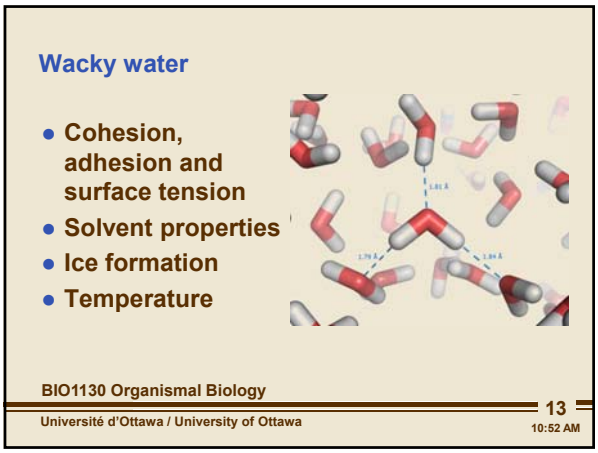
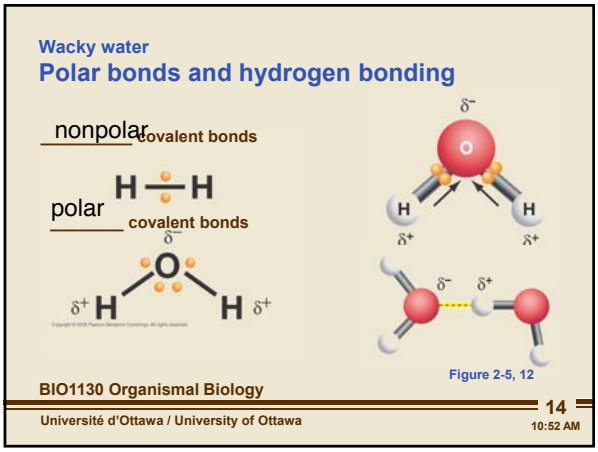
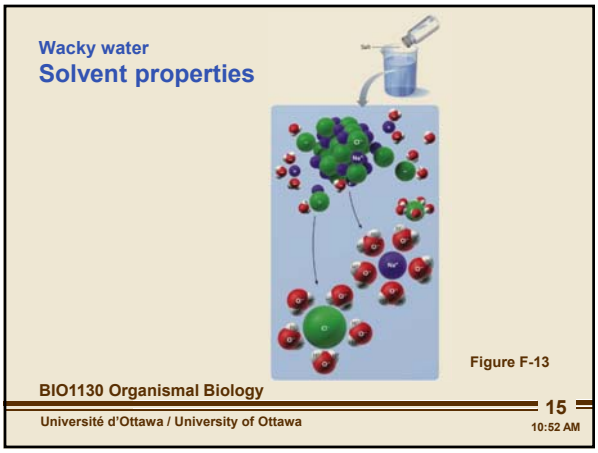
inorganic materials turned into organic chemicals. these contain CARBON. how did we get polymers, which became DNA and protein etc? how did we package them in the first plasma membrane?



there are very few things that contain in all 3 forms. water moves thru these transitions in the temp range of life. water is a universal solvent. forms ice which is weird, and behaves weirdly to temp. The secret is it is POLAR.



Hydrogen is nonpolar since its straight. water however is bent so it has more of a pull. it takes the electrons away from the hydrogen molecule. OXYGEN SLIGHTLY NEG AND OTHERS POS. this gives water its cohesiveness. Surface tension: it bonds to other drops of water are spherical because it has natural tendency to pull on each other and a sphere is the most effecient way. if you have a tube with water and allow water to evaporate off the top, water will get pulled up the tube from the bottom.



everything about life has charged particles .

Wacky water

Ice and water formation

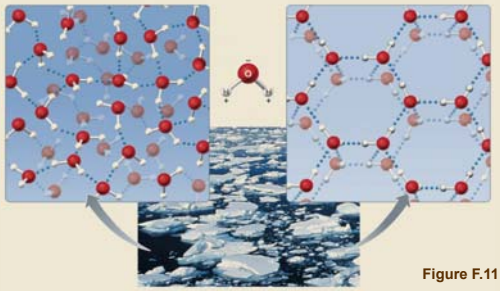


Figure F.11

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16

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when ice form, water turns into crystal latice forms. warm water floats to the top since cold water is denser and at the bottom. entropy is involved. as colder, less energy to bother them. near freezing, crystal latice and molecules start to spread out. this has more air in it, its less dense. So it gets denser and denser near freezing, and then suddenly its really not dense and starts to float. thats messed up. the consequence of this is that when water freezes on the planet, it freezes from the top down. lakes and rivers have ice on the surface, yet water underneith that. there is a period of time that the entire planet is all ice, with water trapped in the bottom. ICE ACTS AS INSULATION, because of air. no matter how cold it is outside, the water underneith is warmed.

Wacky water

Temperature

Specific heats of some liquids (joules)	
Liquids with high levels of hydrogen bonding	
Ammonia (NH_3)	4.70
Water (H_2O)	4.18
Liquids with moderate levels of hydrogen bonding	
Ethanol (CH_3CH_2OH)	2.44
Ethylene glycol ($HOCH_2CH_2OH$)	2.22
Liquids with low levels of hydrogen bonding	
Benzene (C_6H_6)	1.80
Zylene (C_8H_{10})	1.72
Sulfuric acid (H_2SO_4)	1.40

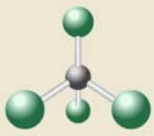
17

10:52 AM

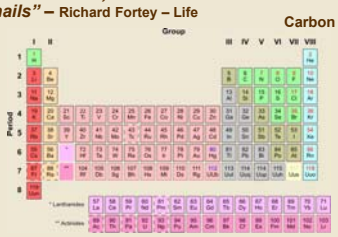
water gas largest specific heat, AKA its hardest to raise./lower its temp. oceans take a LOT of energy to change, so oceans act as a sort of buffer for the planet, as in the water won't burn up becuase of it.

Organic evolution

"Carbon is central to life carbon atoms link in chains, bind with other atoms to make the array of organic chemicals that constitute life itself, from DNA to toenails" – Richard Fortey – Life



Carbon molecule



18

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theres lots of carbon in the universe. its important because it sits in a part of the periodic table in which it is the most versitile material for building things. you can make rings and everything with it. also its very abundant. its basically the lego block of the periodic table. silica is quite simillar to carbon. could life form from silica?

Miller-Urey Apparatus

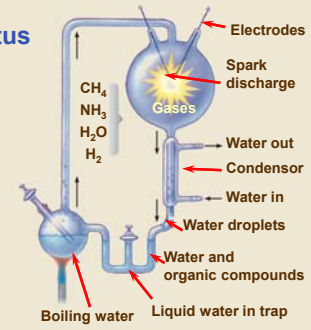

Figure 2.8

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19

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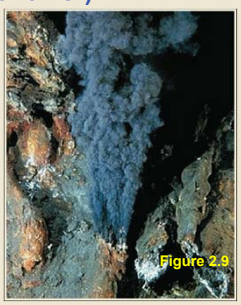
if we try to contain the circumstances of primitive earth, with like volcanoes and everything, they let everyihing happen just like earth had, they found organic chemicals in the water after they stopped the experiment. they found IMPORTANT things crucial to life. many of these show up pretty quickly. when these experiments were redone with CO2 we got amino acids, catalytic reactions spontaneously creating nucleotides. in other words, these things occur spontaneously. this experiemtn only happened for a month. the earth is billions of years old…

Chemical evolution

Origins of organics (monomer)

- Prebiotic soups
- Hydrothermal vents
- interstellar organics



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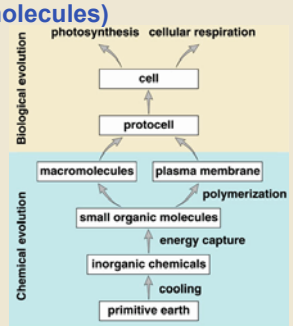
when you go down to core, theres lots of pressure creating weird things.

Chemical evolution

Biopolymers (macromolecules)

- Proteins
- Nucleic acids
- Carbohydrate
- Lipids



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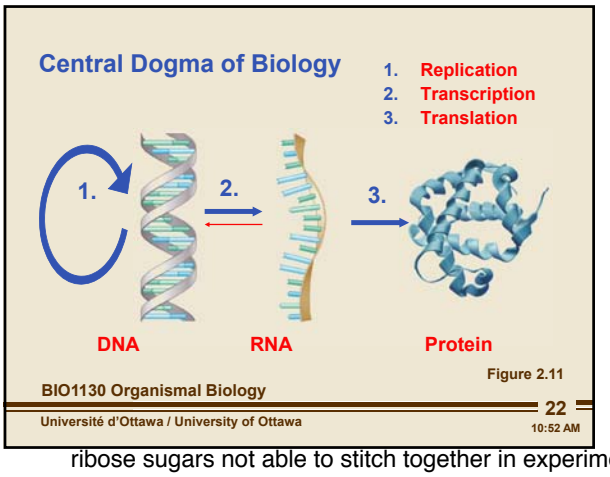
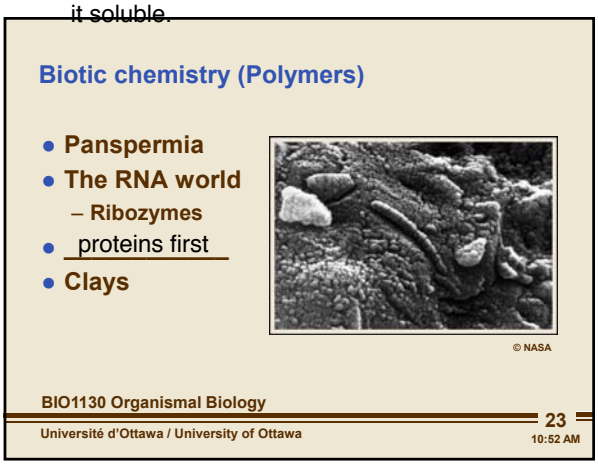
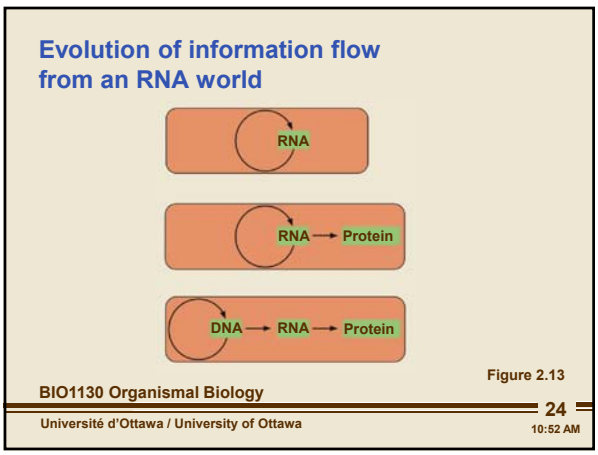
by the time we're just before life forms, all the building blocks are there. how did we get life tho? where did all the proteins and nucleic acids and everything come from? if panspermia was true, it would all make sense since they could arrive and take advantage of all the minerals that were formed.



ribose sugars not able to stitch together in experiments. never able to make nucleotides synthesise. there is another problem. if you use chemical tricks and force them together, they become unsoluble in water. the RNA cannot curl itself and so its nonpolar. they come out as solution. same thing happens with amino acids. clays are sedimentary things highly charged. in the microscopic shape of clay, they may have interacted with RNA to make it soluble.



the very first polymers to be formed were RNA strands or Ribozymes. this theory supported that protein was first and the self replicating things. eventually RNA became a



they coudl cary out catalytic reactions, and it could replicate itself. ultimately, it starts to make protein. they today still have the ability to make protein sequence. instead of being a code, it started to make protein, while it became the replicating component. at some point in time, RNA became a double strand to have a backup copy, so less damage, DNA, and this got duplicated instead. these steps are THEORETIC.

Bubble hypothesis for cells

- Microsphere
- Micelles
- Protobionts
  (Protocells)

Figure 2.10

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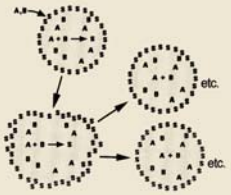
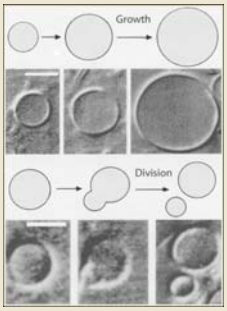
25
10:52 AM

when you dissolve oil into water, you get micelles. they turn into ring things because you make them so small they cannot interact with others beside them and the oil seperates from the water. microsphere is just a really smsll micelle. they are bubbles. it is not a solid bubble. inside the bubble is the same aqueous environment as the one surrounding it. in other words, the oil micelle has trapped a part of the environment inside it.

Micelle replication





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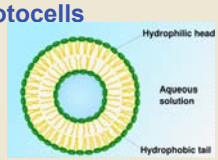
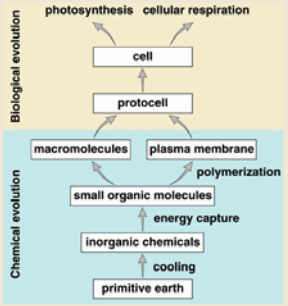
26
10:52 AM

~~micelles will replicate wtf. when the 2 soluble things re~~act, you get a non soluble thing as a product. the reaction takes place inside ~~the bubble, so the bubbles keep getting bigger. they don~~'t just grow, they divide into two.

Biological evolution:
Protocells





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27
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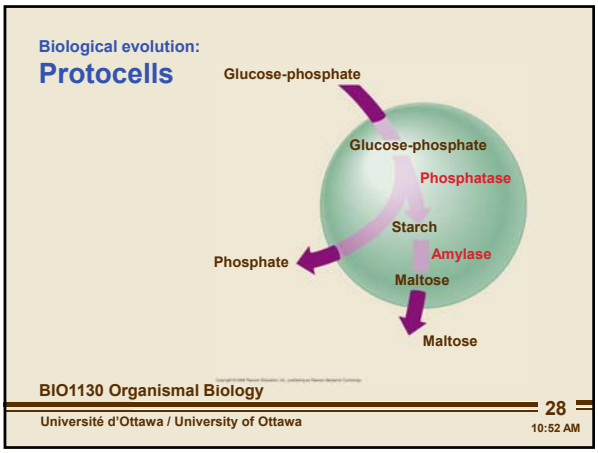
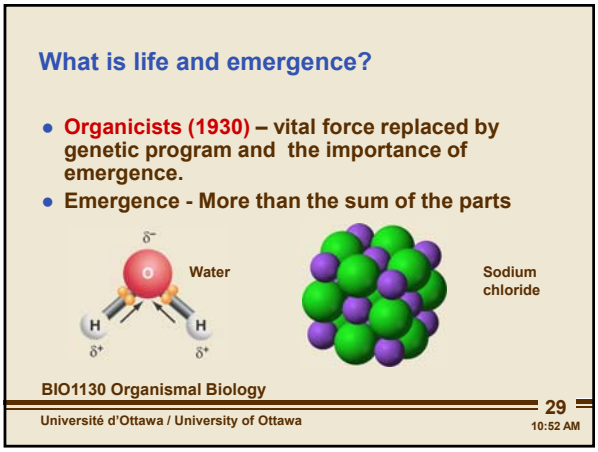
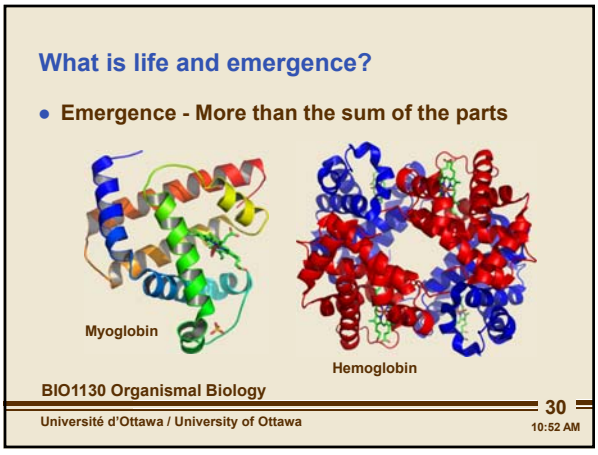
phospholipids do this. you get a bilipid layered micelle. IN OTHER WORDS WE CAN MAKE MEMBRANES



breake down gluclose phosphte to phohphate and amylase and finally maltose as a result. you can package these things inside a micelle, and this will function. how do we determine if this is life?



life is more than the sum of the parts - EMERGENCE. water contains emergence. sodium chloride is too, because if theres any oxygen around it, it will heat up and explode.



this happens because of the emergence propertiies of the myoglobin. hemogloin has another emergence in that when it binds, it simotaneously binds 4 oxy at once.

What is life?
(Figure 2.2)

- **Self replicating** - Life from life with a genetic program
- **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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31
10:52 AM

no micelles are not life because they do not meet all of these requirements. also its not really replicating, theres no DNA and other activities happening.

for the very first time last summer, they artificially made a cell which was able to self replicate. they stripped the genome of a cell and put in an artifically made genome. we are now able to complete everything EXCEPT for EVOLVING. dayum.

Prokaryotes - Domains Bacteria and Archaea

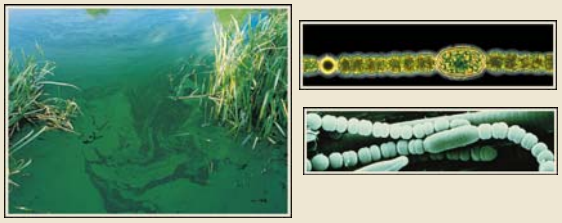

Figure 2.17

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32
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Hadean Eon
Archaean Eon
Proterozoic Eon
Phanaerozic
-Paleozoic Era
-Cambrian, Ordivician, Silurian,Devonian,Carboniferous, Permian periods
-Mesozoic era
-Triassic, Jurassic, and Cretaceous
-Cenozoic era
-Paleogene and Neogene periods

prokaryotes

Prokaryote diversity

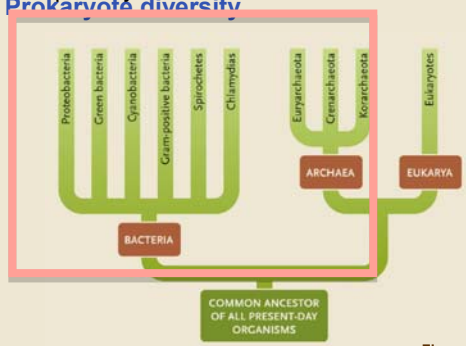

Figure 21.15
33
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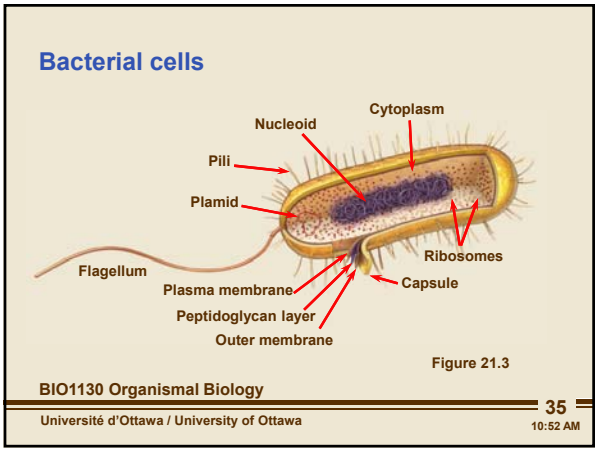
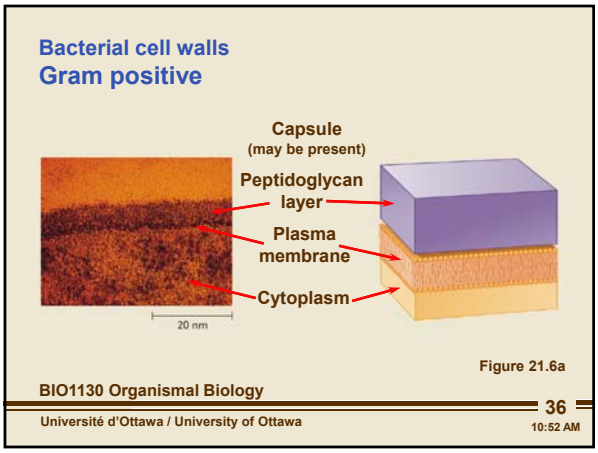
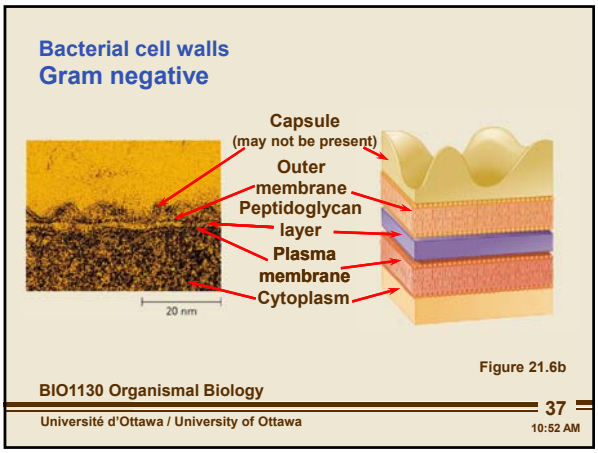


plasma membrane contains cell wall. there are no internal membrane structures. the DNA is just suspended inside the cytoplasm. its just a large piece of DNA coiled around itself as the nucleoid. it is completely bathed in cytoplasm. the cytoplasm is packed full of ribosomes. the cell wall may have extensions known as pilli and also a flagellum to create a propulsive force to create movement.

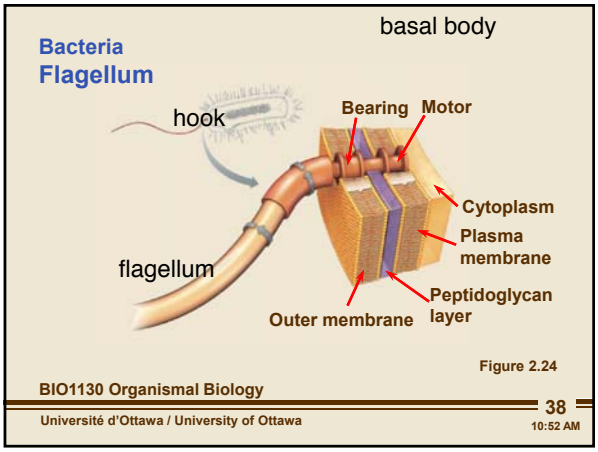
plasmid for gene transfer between groups. the cytoplasm is loaded with ribosomes. the cell wall is made up of the peptidoglycan layer and outer membrane. the cell wall protects the cell from osmotic pressure. peptidoglycan forms a matrix to stabalize the cell wall to give cell rigidity. it is a mesh work shape. made out of peptides and sugars. 2 sugars are used and they form dymers. they're like stuck beside each other and they're really long. an amino acid is attached to one of these, and they are all sugars. these sugar things make the cell wall. found nowhere else in the living world except in the bacteria. not even found in archea.



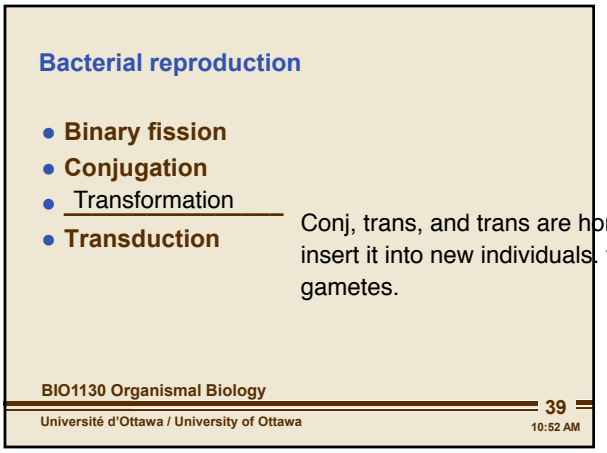
By staining cells, some structures would stand out. this was a great discovery in the research of cells. Scientist Gram discovered that some cells accpeted the stain (gram positive) and some didn't (g neg). Gram stains were picking up 2 very distinct types of cell wall designs. in the positive ones, the peptidoglycan layer was absorbing all the stain, making it g pos.



gram negative bacteria have a second cell membrane on the very outside. the stain was negative because the stain could never make it to the peptdoglycan layer. the gram negative bacteria are the most pathenogenic. they arer the ones that are most often toxic and generally bad. gram negative bacteria are embedded in the plasma membrane. these are the ones that cause most diseases. the region between the 2 cell membranes are called periplasm. some things contain a capsule also. they allow bacteria to stick together and stick to other surfaces. capsules are very soluble to water though. the capsule is always slopped off in experiments because of this. THE PERIPLASM IS IN THE PEPTIGLYCAN.

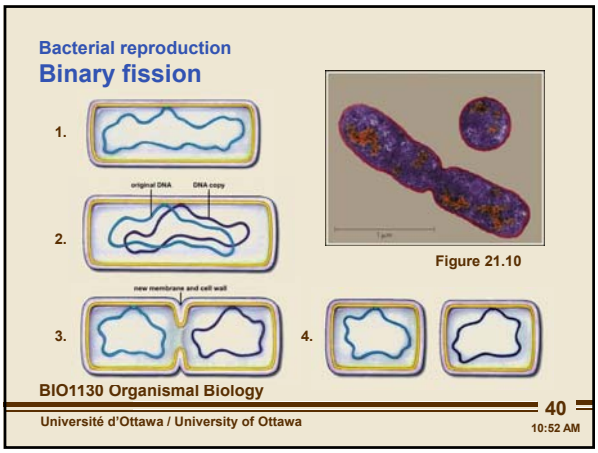


composed of 20 proteins. the motor spins around in circles, much like an electric motor. the hook connects the flagellum with the motor. the bearings are special proteins that make a bearing with the central driveshaft spinning inside it. it is a protective sleeve against the motor and the membrane. gram negative have more bearings.complex proteins with a hole in the middle. atp is used to power the motor. passing a proton inside the cytoplasm out to the peptidoglycan layer. protonss build up on one side, and the protons fall down through a gradient, synthesiszing adp into atp. this falling motion nudges the shaft of the motor. this happens a lot and very fast. this is once again unique to bacteria.

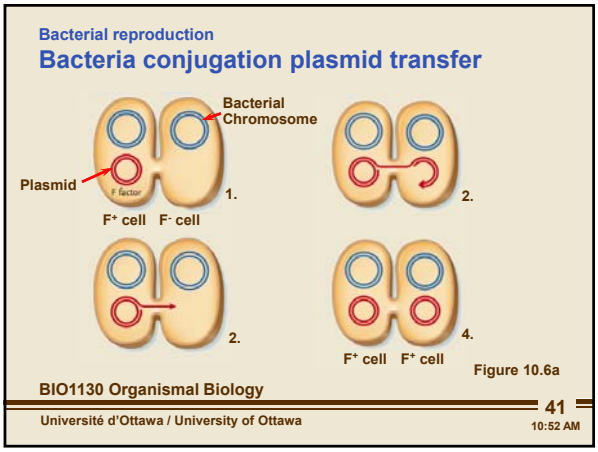


NOT involved in sexual reproduction. AKA they cannot split gametes and diversify it. Basically they can't do what mendel tells us

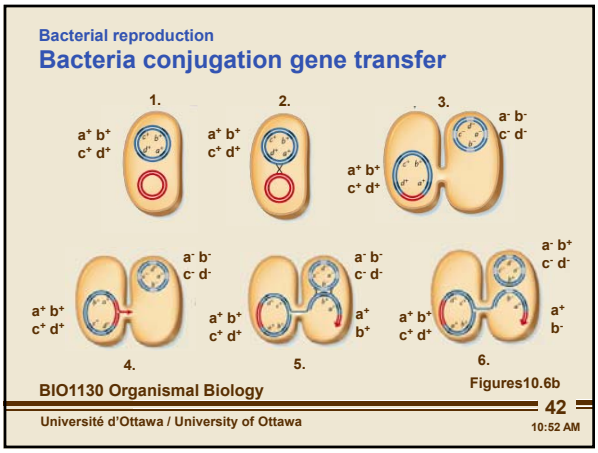
Conj, trans, and trans are horizontal gene transfer. they are gonna get some dna from somewhere and then insert it into new individuals. vertigo ~~gene transfer is like human reproduction, where you pass~~ shit on with gametes.



Binary fission duplicate genome, and allocate one copy to each. when the cells divide, you get 2 exact copies. Plasmids replicate by themselves. Doesnt' matter how much each daughter gets, as they can just replicate them back. DNA replication makes very few errors. Only mutation can provide variation.

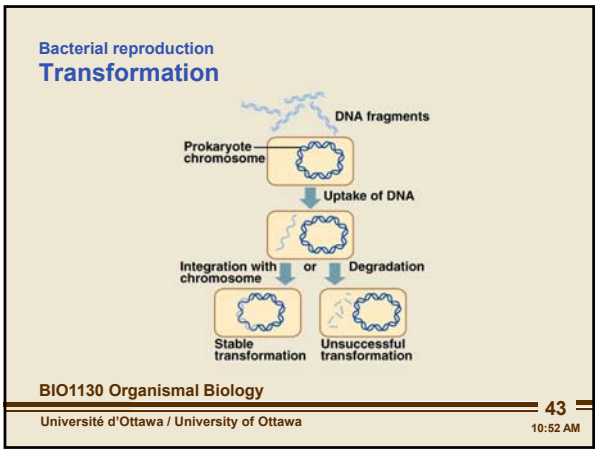


Must have at least one plasmid in each. The pillus(the thing being stretched between the two act as a bridge. it brings in a dna thing and then the new plasmid will dna thing will form itself. you now have a new plasmid. the plasmids are the site of antibiotic resisitance in bacteria. the resistance ability is found INSIDE the plasmid. holy crap

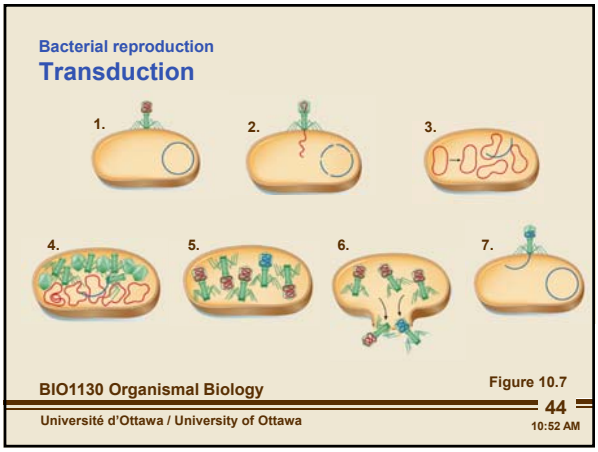


someimtes the plasmid will connect itself into another gene. it might be because the bacterial cell is starting to die, and then the plasmids will sorta hide and shit inside the genome. when it gets better, they come back out. in conjugation shit gets mixed up.

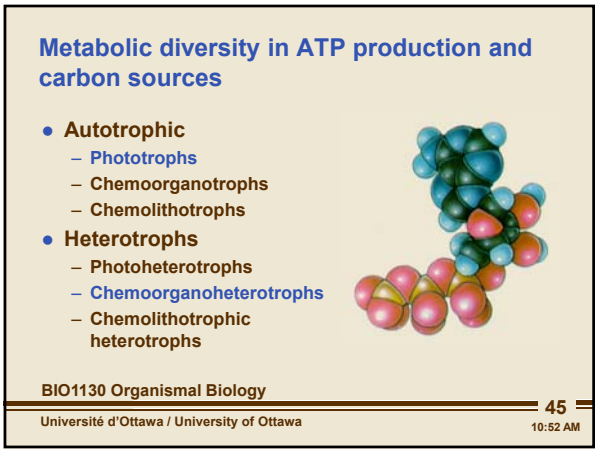
plasmid driven transformation is conjugatiion.



bacteria can take fragmented gabage dna floating around and absorb them and incorporate it in their own genome. they be scavaging for dna. they can keep it if they like it. its been billions of years since bacteria has formed. theres so much variety jeez. TRANSFORMATION IS THE ABILITY TO INCORPORATE OUTSIDE DNA



a virus is basically a protein package with a genome inside it. a virus has no genome and protein functions. it searches out for a cell and it will inject its genome into the host cell. it shuts down and destroys the host's dna system. bactereophages are viruses that feed on bacteria and destroys them in order to replicate itself. when theres enough copies, its gonna code out the protein that makes the package. when theres enough shit to reassemble the virus, it reassembles the viruses and has one genome in each head. the virus replication isn't perfect though. sometimes the original bacteria dna may get packaged inside a virus. when all is good, it kills the bacteria and goes out to kill more bacteria. oh shit if the original dna thing goes out to infect another bacteria, its gonna be horizontal w/e. bacteria always like to try out new shit, so it'll accept the new thing. the virus replaces the thing about scavenging for DNA baically.



carbon carbon bonds to build shit. carbon oxygen bonds to form environmental things. those are the 2 ways to get carbon. to build things we need energy, aka the use of ATP. getting electrons from lights and pigments. aka photosynthesis. NADH is created this way which eventually makes ATP. another way to get electrons is to use existing carbon bonds and get the energy by breaking the carbon bonds. when you break those carbon bonds you're gonna get energy. this group of things is going to force the carbon carbon bonds through the krebs cycles an all that to break them. pyruvate is the building block. Chemoorganotrophs contain multicellular things like fungi. Phototrophs contain plantae. another place to get high energy is from minerals.

Redox pair

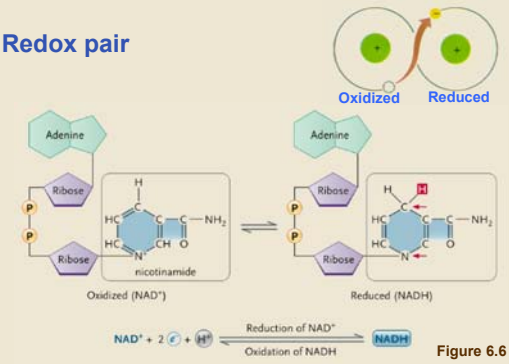


Figure 6.6

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46

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an object loses an electron and passes it to another object, so the ~~object now is positive and stuff. the object that recieves~~ gets its positive charge REDUCED. this transfer always has a release of ~~energy. a famouse trapping system is called electron transfer chain.~~ the passing down of protons down a gradient to drive the synthesis ~~of ATP. NAD converted to NADH it is recieveing and electron and is~~ recieving higher energy. it has been reduced.

Cellular respiration

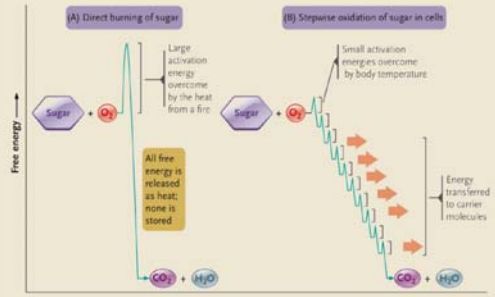

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Figure 6.5

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47

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in cellular resperition we try to harness this energy in more steps to become more effecient. bacteria do this rather quickly but sloppily. so now we have our carbon sources from CO2 or existing carbon carbon bonds. we now need to talk about where the electrons are coming from.

Metabolic diversity

		By products	
Initial electron donor	Electron acceptor	From electron donor	From electron acceptor
Sugar	O_2	CO_2	H_2O
H_2 or organics	SO_4^{2-} (Sulfate)	H_2O or CO	H_2S (hydrogen sulfide)
H_2	CO_2	H_2O	CH_4 (Methane)
CH_4	O_2	CO_2	H_2O
S^{2-} or H_2S	O_2	SO_4^{2-} (Sulfate)	H_2O
Organics	Fe^{3+}	CO_2	Fe^{2+}
NH_3 (Ammonia)	O_2	NO_2^- (Nitrite)	H_2O
NO_2^- (Nitrite)	O_2	NO_3^- (Nitrate)	H_2O

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48

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We use O2 as the electron accepeted.

Bacterial importance

- **Disease**
- Nitrogen Fixation
- **Decomposition**
- **Unique biochemical pathways**
- **Extremophiles (Archea)**

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49
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Bacteria are a major cause of diseases in major organisms. Also going to be important in nitrogen fixation. they are gonna take ammonia in the air and make it into organic materials. Fungi are important in decomposing plant material.Bacteria may become useful in cleaning up the Earth.

Prokaryotes and humans

Transmission	Disease - *Bacterium*
Airborne	Legionellosis - *Legionella pneumophobia* Diptheria - *Corynebacterium diphtherium* Tuberculosis – *Mycobacterium tuberculosis*
Arthropod	Lyme disease – *Borrelia burgdorfei* Bubonic plague – *Yersinia pestis*
Direct contact	Gonorrhea – *Neisseria gonoffhoeae* Anthrax – *Bacillus anthracis*
Food or waterborne	Food poisoning – *Salmonella enteritidis* Cholera – *Vibrio cholerae* Listeriosis - *Listeria monocytogenes*

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50
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Most of the bacteria are becoming resistant to the antibiotics. What happens is that when you use antibiotics, you don't always get a 100% kill, and you have bacterial survivors. They have some sort of attribute that allows them to be ressitant to the medicine. They reproduce and they pass the trait on to the next generation. You will have to make the dose even higher for the next generation since they could survive that dose. This cycle keeps going, and this is sort of like a natural selection cycle.

Nitrogen fixation

$N_2 + 8H^+ + 8e^- + 16\ ATP$

$\downarrow$

$2NH_3 + H_2 + 16ADP + 16\ P_i$

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51
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Nitrogen is important because nitrogen ends up in amino acids. DNA contains nitrogen. The whole central dogma is based on nitrogen, yet there is very little synthesis methods of nitrogen, bacteria is one of them

Nitrogen cycle

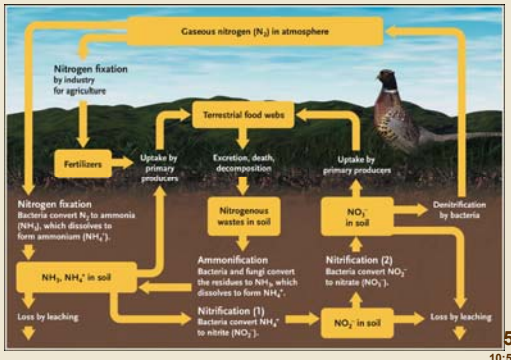


Figure 47.14

Extremophiles (Archaea)

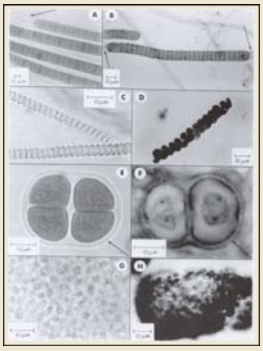
Halophiles

Thermophiles

Figure 21.20

They live in extreme environments (100 degree places). Most cells proteins denature. Heatloving - Thermophiles. Can't be too cold either because ice crystals form and pierce the membrane. Can't be too salty either, but Archaea bacteria enjoy all these environments.

Fossil bacteria



One sideare fossils.

Stromatolites

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Figure 2.14

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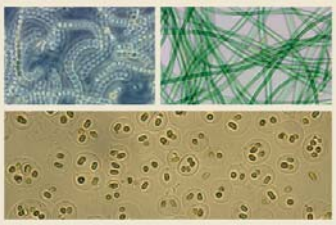
Bacterial mats. They grew and adhered to each other and became very abundant. As they grew and grew, the ones on the bottom died. You can see this fossilization proccess still occuring in Austrailia. They are in an extremely salene environment.

Cyanobacteria and earth's evolution

$CO_2 + H_2O + light$

$\downarrow$

$(CH_2O)_n + H_2O + O_2$



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56

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These bacteria figured out how to take energy of light as energy source and carbon dioxide as its carbon source. They split a water molecule and incorporate some of that hydrogen into the carbon molecule and the byproduct of this reaction is oxygen. This is the origin of oxygen on Earth. This is such an effective method. These bacteria become the dominant species on the planet at one point. They are successful because of the abundance of water that they live in. When the water starts to become rich in oxygen, all the minerals on the planet start to become oxidized. The entire planet rusts. Ultimately all the material that the water has contact with rusted. The water has reached its capacity point and it releases it into the air. When everytihng is rusted, oxygen fills the air. This is the first time it exists as O2. Oxygen atmosphere is created. The oxygen very high up starts to react with each other and creates ozone. Filters out ultraviolet light. This bacteria basically gave us O2 and ozone layer.

Bacterial evolution

- **Cyanobacteria**
- **Asexual reproduction**
- **"Living fossils"**

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57

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These bacteria from above are STILL THERE TODAY. Bacteria have global distribution. They are found everywhere around the glove. They do not need other bacteria to reproduce, since they are asexual. They are extremely successful.