Protozoans

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group of single celled organisms that have animal like characteristics
these organisms are precursors to the multi-cellular forms that are present

Things that animals do

- Maintain water and salt balance
- Obtain oxygen
- Remove metabolic wastes
- Obtain food
- Be able to move
- Sense and react to the environment
- Reproduce and perpetuate the species

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-get to see some of the traits that are characteristics of animals being carried out by single cells
-look at heterotrophics, the protozoans
-autotrophic/photosynthetic, the protist/algae
-things that animals do, issue is that the single celled organism much be able to do all of these things in their cell membrane
-all organisms much maintain their water and salt balance:must have a certain solidity to the cell, easiest to live in a marine environment (isotonic where live began)
-freshwater, going to get inundate - inside in hypertonic
-terrestrial, need to have waterproof membrane, going to get desiccated and lose water, makes salt levels rise
-need oxygen, mitochondria cycle, use oxygen to burn ATP
-waste, when metabolism burns organic compounds, which normally contain nitrogen molecules
-point of metabolism is to break down the molecules to get energy
-to get energy from amino acids, they need to be de-aminated, takes the ammonia/nitrogen group off of it
-removing the amino group is a key part of metabolism
-once animo is removed, you are left with carbon chains which can be broken down into 3 carbon pyruvate for mitochondria to harness ATP
-the nitrogen is extremely toxic, ammonia is able to block the Kreb's cycle

Things animals do – gas and nitrogenous waste

Advantages of small size

Protozoans are 0.005–0.3 mm in size.

Size	Surface	Volume	Surface/volume
0.5 mm	0.000007854	0000000001636	480,000
0.6 mm	0.1256	0.0004189	299
2.0 mm	12.57	4.189	3
5.0 mm	78.53	163.6	0.5

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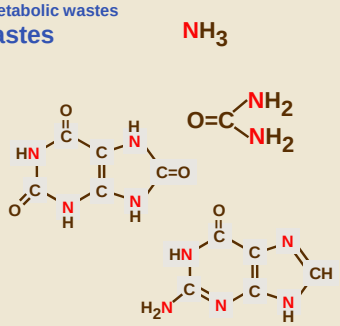
-these animals are living at the optimal surface to volume ratio
-have large surfaces compared to their volumes
-the contents of the cell, where biochemical processes are taken place occur in an amount of volume - so many enzymes/uL of cell volume - carrying out metabolism that needs oxygen to be diffused in or nitrogen to be diffused out or in an environment where it is difficult to live (freshwater = hypertonic cell), the surface of the cell becomes a limiting factor
-as the cell gets larger and larger, the surface does not increase at the same rate as the volume
-bag of biochemistry, the only way to bring things in or out - all occur over the surface area
-with large surface to volume ratio - organisms can rely on passive diffusion
-something bigger, ratio has dropped a lot - how do they deal with surface to volume issue?

Things animals do – metabolic wastes

Nitrogenous wastes



- Ammonia
- Urea
- Uric acid
- Guanine

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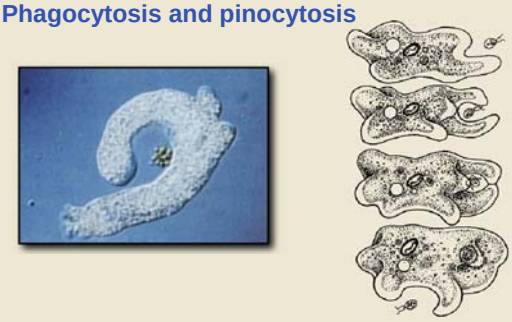
-ammonia: extremely dangerous metabolic waste
-if in aquatic environment, it can be diffused out
-if in marine environment, would be even easier because you wouldn't have to worry the difference in tonicity
-see that nitrogen gets packed into larger molecules - end up with compound that gets less and less toxic
-uric acid and guanine, extremely low toxicity

Things animals do – Obtain food

Phagocytosis and pinocytosis



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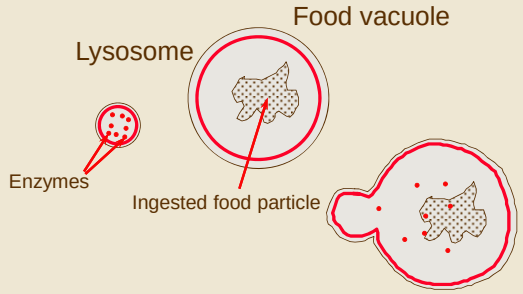
-they all need to obtain food: phago or pino? (possible exam question)
phago: cell eating - solid in chunk form, particulate form in fluid
pino: cell drinking - nutrients are dissolved in the fluid, organic molecule is in solution

Things animals do – Obtain food

Digestion



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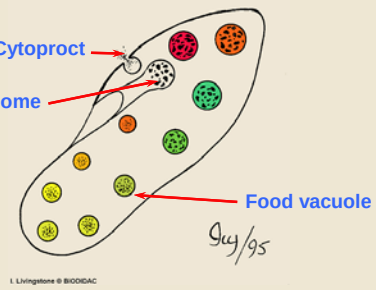
in both forms of eating- there is an invagination of the cell membrane
-have a food particle that is surrounded by the membrane of the cell - making a food vacuole into the cell
-need to digest to diffuse nutrients through the cell
-the digested food (particulate or dissolved) not capable of diffusing through the cell membrane to get to cytoplasm
-lysosome from the golgi apparatus - has digested enzymes, isolated from the cytoplasm with a plasma membrane
-lysosome fuses with the food vacuoles, so that digestion can occur - break them down into monomers that can be absorbed: intracellular digestion
-extracellular - enzymes are being dumped into a digestive tract - break down the particles into monomers then absorbing them through that surface

Things animals do – obtain food

Digestion



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the enzymes that fuse with the vacuole after phago or pino - the composition/characteristics of them change with time
-first enzymes that fuse are all optimal in alkaline conditions (pH > 0.7)
-breaking up the carbohydrates and proteins and eventually reach a point where they don't have the catalytic capacity to finish the job - causes another set of enzymes to turn on - those that function in acidic conditions - break down the things that alkaline enzymes where unable to
-then exocytosis to get rid of waste
-have two phases for digestion
-movement allows nutrients to be evenly distributed throughout cell - cytoplasmic streaming

Things animals do - locomotion

Types of protozoan movement

- **Pseudopods**
- **Undulipods**
  - **Cilia**
  - **Flagella**
- **No movement**
  - **Parasitic forms**

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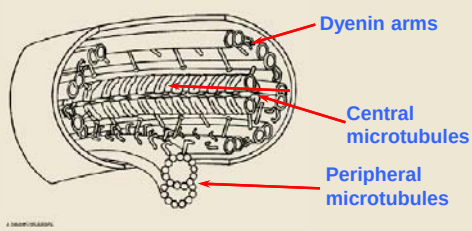
-all going to be locomotive
-move by one of two mechanism
-pseudopods - cytoplasmic streaming - ameoba
-undulipods - cilia and flagella
-rely on cytoplasmic extension with microtubule array inside of it that is arranged in a 9+2 organization
-some that don't move - parasites

Things animals do - locomotion

Undulipodia: 9 + 2 Organization

(Sliding microtubule hypothesis)



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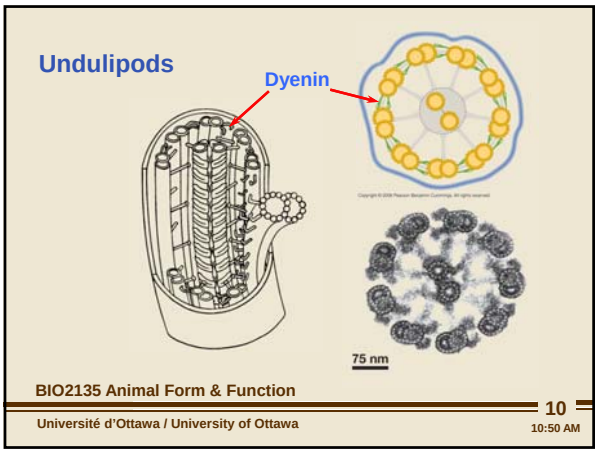
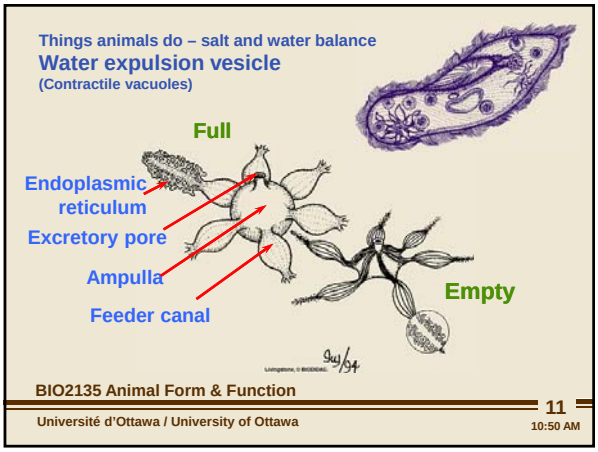
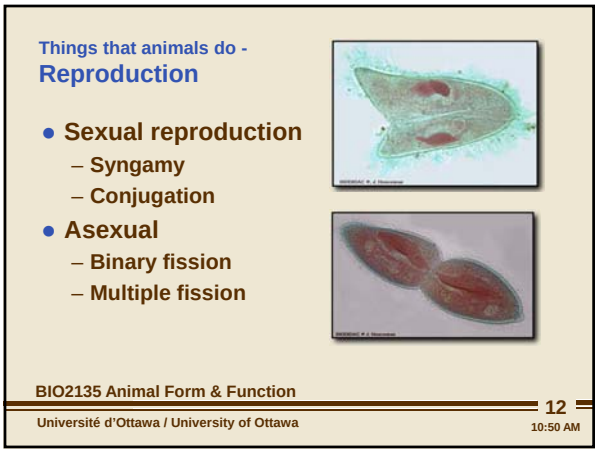
-arrangement of microtubules that have doubles around the sides, a pair in the center connected to each other by dyenin arms
-dyenin arms are the mechanism that creates movement
-dyenin arm= molecular motor that is attached to one microtubule free at one end and it is able to walk on the microtubule adjacent to it
-displaces one microtubule relative to the other instead of walking along it like on cytoskeleton - causes flagella to move- spin of rotate since it is in a circle





organelle that is related to water and salt balance - expulsion vesicle - in freshwater forms
-freshwater organism are going to be inundated with water because it is hypertonic to the system
-for a single celled organism to live in fresh water system, the water needs to be pumped out - cell burns extra ATP - uses it to pump water into the endomembrane system from the cytoplasm
-it will slowly fill up - endoplasmic reticulum, burns energy and pours water into the feeder canal which will then pool into the ampulla - when filled the springy membrane will squirt the water out
- has a contractile/water expulsion vesicle - found in ever single-celled protist
-osmoregulation



-every single organism is going to have to reproduce and perpetuate the species
-protozoans are eukaryotes - have major innovation: meiosis and recombination of chromosomes to create genetic variation
-most protist at one point will have a sexual reproduction cycle where gametes will fuse
-majority of protist life cycle is associated with asexual reproduction and binary fission, where we get 2 individuales
-will get cases where an individual will undergo multiple fissions- makes 2, 4, 6, 8, 16 individuals at once - known as multiple fission
fussion of gamates- syngamy
-ciliates that have 2 nuclei, a micro and a macronucleus - when they reproduce and there is genetic recombination - they exchange nuclear material between each other to make offspring (in euk cell)
-everything that we see in animals are happening in these single cells

Protist origins: Endosymbiont theory

- **Endosymbiont theory accounts for**
  - **Nuclear membranes**
  - **Intracellular membranes and spaces**
  - **Mitochondria (chloroplasts)**

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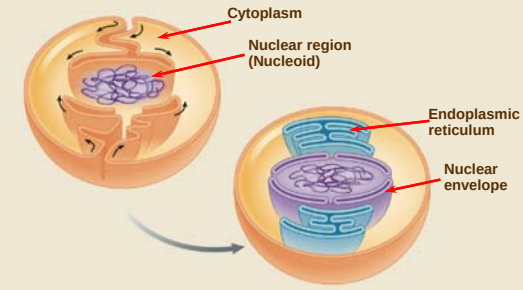
-where did the first eukaryote/single celled protist come from
-endosymbiont theory - based off of prepetuation of the plasma membrane infolding on the cell - increase surface area to supply the volume of the cell- solution to surface to volume ratio

Origin of the nuclear envelope



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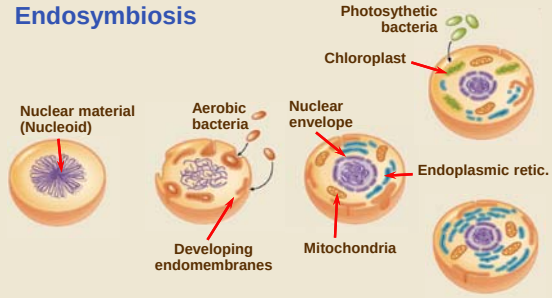
-those invaginations from the two different sides, ultimately met in the middle, making a membrane to incase the nuclear material (made a nuclear envelop)
- create two different environments (nuclear and cytoplasmic environments)
-nuclear - for DNA replication and transcription processes to makes mRNA
-cytoplasm - for translation of mRNA when it comes from the pores of the nuclear membrane
-this makes enzymes that will be used to catalyze reactions or they will make structural elements to the cell
nuclear envelope is a huge innovation

Endosymbiosis



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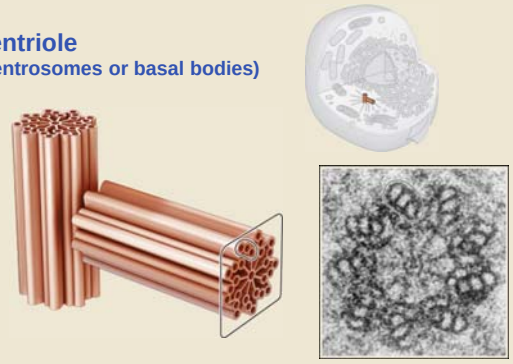
-endosymbiont theory where there is engulfing of bacterium for an energy source within
- in the past - big bacteria eat smaller bacteria - constantly engulfing
-have huge metabolic variation - get high energy electrons from many different source (metal/ carbon/ sun/ etc)
-at one point, bacterium remained intact once engulfed protected by its membrane (not digested by lysosomes of the larger cell)
- when bacterium was living free, it looking for three carbon pyruvate (which goes into the kreb cycle to build ATP)
-in larger cell- in cytoplasm, it breaks down glucose to make pyruvate
-makes bacterium that is in the cytoplasm happy because it has the pyruvate that it wants - it makes a surplus of ATP, which is diffused out to the larger cell - bacterium known as mitochondria
-larger cell is happy because it is now generating more ATP then it originally could with its own metabolic processes - it was a huge advantage that bacterium was not engulfed
proof of mitochondria is a bacteria - has bacterial characteristics - the inner wall, dna circular, gact composition, small ribosome that makes it own proteins, cell membrane
-happened only once- such a unique phenomenon that it became the dominant form
-trace the lineage from mitochondrial DNA sequences

Centriole
(Centrosomes or basal bodies)



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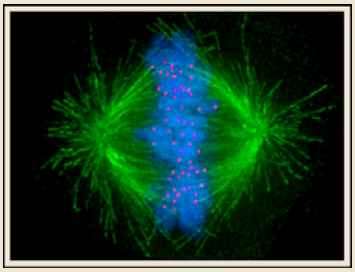
-looking at how to distinguish protozoans in the world - would look at locomotion, mitochondrial structure
-centriole/basal body structure: consists of triplette of microtubule with a single microtubule core
-comes in a pair of tubular protein that are always right angles to each other
-it is in a cytoplasmic area not bounded by a membrane but the composition around it is different form the rest of the cytoplasm content
-it sits inside the cell

Spindle fibers and chromosomes



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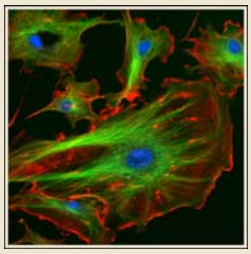
very important in cell division, when the cell is ready to divide
-centrioles will become unpaired and migrate toward the ends/poles of the cell
-once they are at their poles - build the microtubular fibres that extend across the cell - spindle fibres
-they control the growth of spindle fibers

Microtubules and cytoskeleton



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spindle fibres are composed of tubulant dimers - arranged in a helical pattern
and the microtubules somehow organizes them
-controls its growth from the far end by incorporating more dimers so the tubule can grow
-can also destroy them from the distal end moving forward
-there is a polarity in the strand because of the structure/build of the proteins- results in a distal and proximal
-during mitosis, motors are present on the surface of the microtubules
-grab chromosomes at their centromeres then the motors would walk along spindle fibres to separate genetic material towards the opposite poles -then cytokinesis and then cell divide
-when the cell isnt dividing, centrioles have a second role - coordinates the microtubular cytoskeleton of the cell
-important because the skeleton had the molecular motors that move along the microtubules

Origin of cellular motility – Cellular creeping

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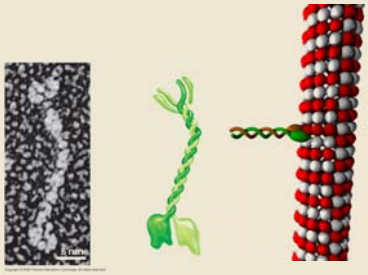
centrioles are essential if we are going to have euks
-taken circular DNA of a bacterium and changed it into multiple chromosomes (because it is easier to replicate small bits of many things)
-the many pieces of chromosomes, leads to genetic variation that is associated with meiosis
but it needs to be organized, euks would not exist if there wasnt a mechanism to pull the chromosome pairs apart
-centrioles now seem to be important to the origin of the euks.
-another thing centrioles can do: grows microtubules to push against the plasma membrane/cell wall, allows cell to move forward because grow at one end and diassembly at the other (so there is no structure)
-motors are moving and pulling the organelles with it - now everything moves together
-very likely that the original euk. sat on the substrate, relied on phagocytosis and getting movement was critical

Molecular motors

- Dyenin
- Kinesin
- Myosin



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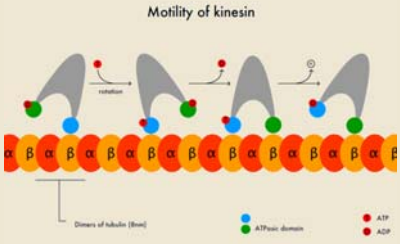
-dyenin and kinesin motors walk along microtubules strand
-their free end can hold onto things, so they walk along moving things through the cell
-the motors move based on the polarity of the cell
dyenin-walks towards centriole/brings it in
kinesin- walks away from the centriole/moves it away
-gives a unidirectional motor
-within first big euk. cell, the diffusion problems were solved by the centioles that was building a transport system that allow things to move through the cell
-didnt need to wait for diffusion to happen
-the motors could pick up the nutrient and move it around
-thought to be important now because centrioles give and active organized way to move things in the cell
-they also have to replicate themselves once the cell divides
-when they replicate and make the cytoskeleton, the centriole will also programs where organelles will be placed - explains why the nucleous is always in the same place in every cell and why water explusion vescicles are at each end of the paramecium
-structure in the cell is identically positioned in every cell - due to centriole
-ex. possible reason for why cancer occurs

Kinesin/Dyenin motors



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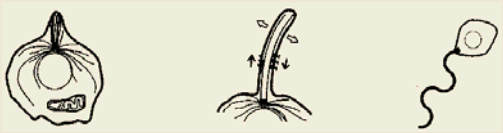
Origin of cellular motility



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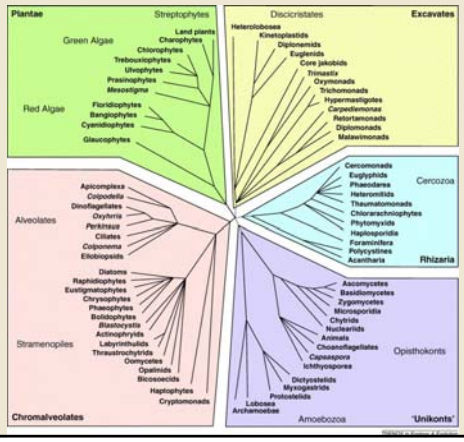
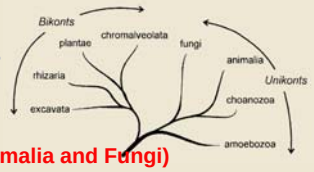
-believed that a centriole that is involved in building microtubules - produces and extention of the cytoplasm
hardens at one end and liquefies at the other end - process of cell gliding
-now have a cell that can move to a region that has more nutrients
- if we take a centriole structure and dedicate it to building microtubules associated with movement- part of the cell grew and gives the origin of cilia and 9+2 organization that use dyenin motors - flagella
-addition of second flagella is a major event
***DO NOT CONFUSED CELL GLIDING WITH AMOEBOID MOVEMENT



-look at all of the different protist groups there are close to 50-60 major protisa taxonomic groups
-separate them by their microtubles in terms of their flagella -end up with 5 large family whcih fall into 2 large catergories
-large kindom of organism
-need to find patterns to make observations
all of the major different families -large kingdom
bikonts- plants

Protist Supergroups



- **Unikonts**
  - **Opisthokonta (Animalia and Fungi)**
  - **Amoebozoa**
- **Bikonts**
  - **Chromalveolata (Ciliophora and Apicomplexa)**
  - **Archaeplastida (Plantae)**
  - **Excavata (Euglenozoa)**
  - **Rhizaria**

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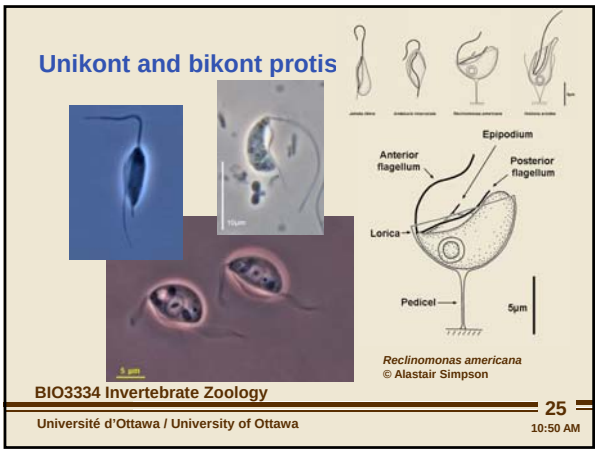
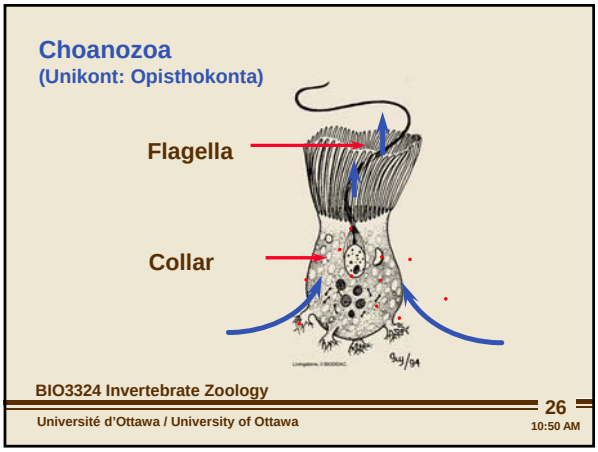
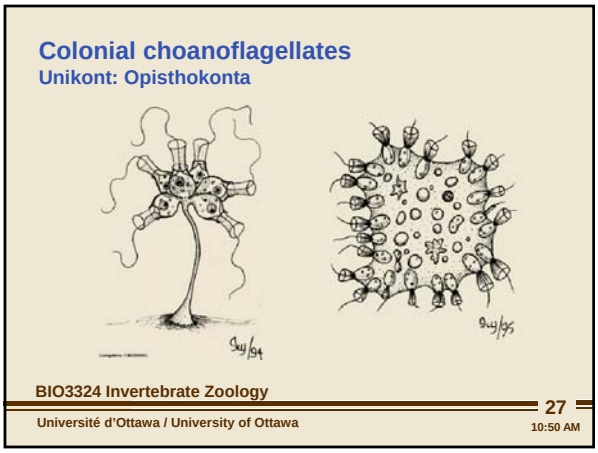
-5 large groups that fall into 2 different sections
unikonts- have 1 flagella
bikonts- have 2 flagellum
-transition of unikont to bikont is important
-
-look at the 6 super families, the way they are divided now
unikonts - opisthokonts- use the one flagella to get off the ground and swim and propel forward
-opisthokont structure is the ancestor to all animals and fungi - see the remnants of this structure in sperm
-ameobozoa - find a new way to change their cell shape, use myesis motors on actin fibers
-they will change their shape and make their cytoplasm flow by the myesin motors - amoeboid movement (unikont ancestors)
bikonts - ciliates - lots of basal bodies around the cell - has the most complex foldings of the plasma membrane - folding creates pockets for aveoli around the outsides of the organism (alveolates [plasma membranes as a result of this locomotion] chromalveolates [algea with similar structure])
-archaeplastida -bikonts that went to the top of the water column and endosymbiosed with the photosynthetic algae at the top - ancesters all plants
-excavata - group of bikonts that use cilate in a groove, still use flagella in to propel food towards them
-rhizaria (got rid of flagella like ameobas) - all of the ones that have pseudopods -use cytoplasmic flow assisted by microtubules
-all possible to figure this out just because of centrioles
-it is a protein structure that replicates itself - surprise it has no nucleic genetic material



transition from unikont to bikont is important - very first thing that this cell did as it was stuck on the substrate with a cilia that would pump and move water
- it didnt swim- propel water in and over the surface of the protist - bring food to itself so it can then pino/phago to pick up nutrients
-add another basal body/ flagella - make bikonts
-still use one flagella in the groove to propel water to collect food
-use second flagella so it could detached from substrate and could now swim through the water
-some rose to the top where there was photosynthetic algae - and consumed them
-some of the photosynthetic algae didn't get digested and stayed incorporated by endosymbiosis in the cell to become chloroplasts (ancestor to the plant)
-all of the force on plasma membrane can cause it to rip - reason as to why there is folding so it can reinforce itself



-choanozoa - type of unikont opistokont
-type of cell that feed by using a flagellum - create a water current to bring food to itself
-brings water current into the collar, made up of microvilli
-any particulate matter in the water will get trapped in the spaces of the microvilli - ingested by phago/pino cytosis
- sits at the base of the evolutionary animal tree



-the cells made an aggregate, work together in colonies
-able to work better together as there are more flagella to beat and make a stronger water current
-get more food-more energy-more likely to reproduce
-collar and flagellum sits at the base of the evolutionary tree or the animals

Things animals do - locomotion

Flagellar beat

Planar beat
Helicoid beat

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-in terms of locomotion - the flagellum in single celled protozoans has 2 ways of moving
-unikonts have flagellums that beats in one of 2 ways
-planar beat -flapping motion in one plane/motion
- consists of a power stroke that takes the full surface of the flagellum against the water
-recovery stroke- bend the flagellum back on itself so the resistant only touches a small surface of the water -get a net forward motion
-results in a motion that progresses forward and goes back a bit
-helicoid beat -also take the flagellum and by contracting the dyenin ares sequentially around the 9+2 organization- moving its in a spiral
-make it rotate creates a spinning motion - results in propelling organism forward
all unikonts use one of this two beats to move

Protist Supergroups

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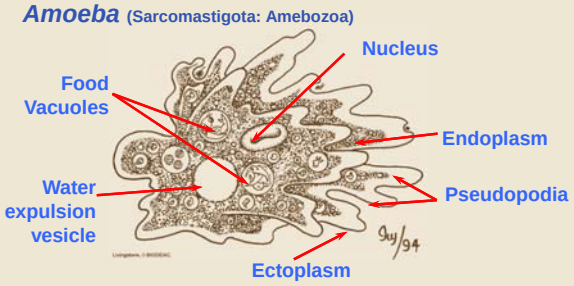
amoebozoa - very important group - no longer use flagella for movement
- ameoba shift to actin fibers and myesin motors
another organism that doesnt used kinesis, dyenin motors, centrioles or basal bodies

Things animals do - locomotion

Amoeba **(Sarcomastigota: Amebozoa)**



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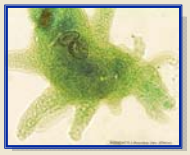
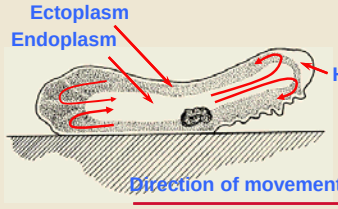
-distinguishing element to amoeba -have fleshy cytoplasmic legs called pseudopods
- they extend forwards by having cytoplasm flow within them results in net forward movement of the ameoba
-there is two types of cytoplasm that is shown at the front end
-rigid (cylinder) and inside the cytoplasm is flowing forward
-at the opposite end we see that there is cytoplasm that was in a solid state gets liquefied and if moving forward
-basically have a cell that is rigid cylindrical sleeve, with cytoplasm following through the center of the sleeve and solidify at the edges, at posterior end rigid cytoplasm is liquefying
-this is not cell gidling (not microtubules that pushed against the wall)
-actin globular protein- when they polymerise they form chains - actin fibers - have myesin motor can walk along the cytoplasm material can be pulled along -

Things animals do – locomotion

Pseudopod locomotion

(Amebozoa)





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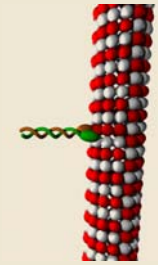
what happens in this moleculte
-actin is a globular protein and when it is in its monomeric form it is not gel
-no rigidity to it
when the actin polymerise with each other, form chains - now can have myesin motors attach and crawl on them to carry things attached to the motors and drag things along (cytoplasmic materials)
-very similar to dyenin and kinesin motors
-at anterior end - see actin polymerize, myesin motors get onto the actin monomers, start crawling along and dragging cytoplasm with them
-myesin and actin interact with the cytoskeleton -myesin motors can squeeze actin fibres pass actin fibers- known as sliding muscles - changes the shape of the cell
-squeezing motion makes the cell move forward as well
- ectoplasm - solid gel like matirx
- endoplasm-fluid/liquid moves forward, hits the hyaline cap at the front where it deflects and solidifies which gives structural rigidity to the cytoplasm and the inside has the flowing endoplasm
get a locomotion that is based on actin fibers and myesin motors - doesn't have the poslity and rigidity of the microtubule skeleton
-you can assemble and disassemble any where along the surface of the cell - dont need a microtubule organizing region to build the cytoskeleton and move everything across
-you can move in any direction you want = grow a psuedopod to move in another direction just by polymerizing acting and squeezing the cytoplasm, pushing it forward
-give better/flixible movement no longer need flagella
-said bye to dyenin and kinesin motors only in flagellum

Molecular motors

- Dyenin
- Kinesin
- Myosin



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***Vorticella*: Myonemes**

Alveolate: Ciliophora

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-also important to know that actin and myesin also appear in a different form - can form permenant actin strands
-refers to myonemes - actin fibers that can contract very rapidily
vorticella - stick itself on a stock and uses cilia to move in food (consumed via phago or pino) to find its nutrients
-but it something comes along and bumps into it, (predator)
-myonemes will contract rapidly, myosin motor contract rapidly and shorten the stock so it can move out of the way into the debris to give itself protection
-end up with actin and myosin occuring in two places,
-ameobozoa- for movement on the pseudopods
-myonemes - voticella used for protection
actin and myosis and not only associated with ameoboid motion
-when we look at diploblast organism- missing mesoderm which is used to make muscles
-going to end up seeing actin fibers that can contract because they dont have muscles

Protist Supergroups

- Unikonts
  - Opisthokonta (Animalia and Fungi)
  - Amoebozoa
- Bikonts
  - Chromalveolata (Ciliophora and Apicomplexa)
  - Archaeplastida (Plantae)
  - Excavata (Euglenozoa)
  - Rhizaria

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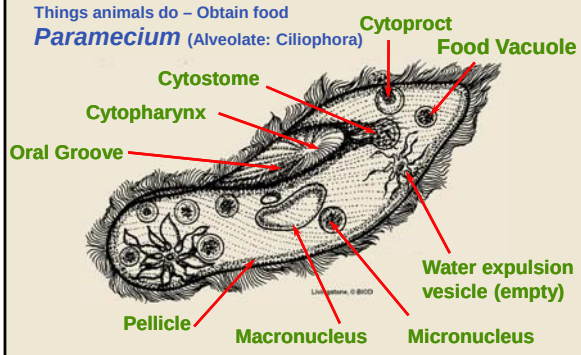
in bikonts - the chromalveolates -brown algea
-the alveolates are organisms with massively reinforces plasma membranes
-has reinforced plasma membranes

aplicomplexa- group of organism that are pathogens - have a highly infolded membrane system (like alveoli)
-called an aplical complex-set of organelles that are inside the cell used to penetrate the host cell to be able to infect them
-highly modified bikonts

Things animals do – Obtain food

Paramecium (Alveolate: Ciliophora)



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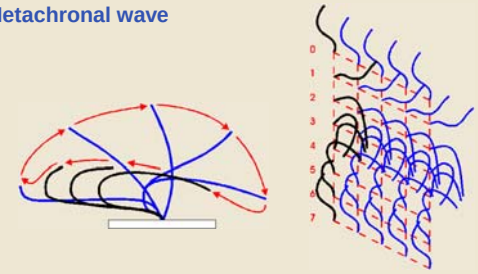
-gone one step closer and became ciliates
-now there are thousands of 9+2 cillia all over the surface of the organism for motion
-for all of the power in cilia it is easy for cell to rupture- need a reinforcing structure to ensure that membrane wont rip
-structure underneath to reinforce it: pellicle
-all parameseum all look the same- all have common shape due to underlying membrane structure
-dont want anywhere on the surface to rupture or break- need the forces from cilia to be diffuse evenly across the entire surface
-problem with the structure - if you want to feed it will be hard for it to eat (hard to form food vacuole with the pellicle)
-2 places without the reinforcing array
- one for eating - ingestion -cytostome
- digestion of food and circles around the cell (acidic to basic digestion)
-allows for distribution of nutrients through the entire body
- one for egestion - cytoproct - where food will be removed
-they live in freshwater- need to deal with innondation - make organelle known as the water explusion vesicle
-

Things animals do - locomotion

Ciliar movement: Metachronal wave



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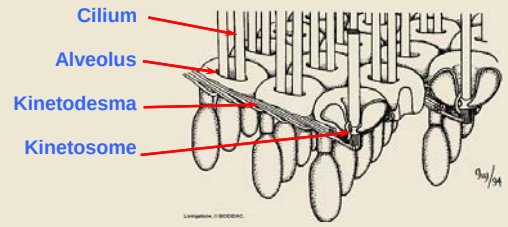
another problem due to cilia- coordination for movment
-if they are all doing the planer beat, they end up getting tangled up with each other
-on surface - power beat is in one direction and the recovery beat is at right angles
-does recovery stroke in an adjacent plane -so that nothing gets tangled
-not the best way to swim- moves forward with the first stroke but then on recovery stroke, if it is all done at the same time the organism is going to move a little be back
- solution, not everyone does the stroke at the same time
-does a metachronalwave - a wave that is out of synch
-end result ~ same proportion in power and recovery stroke -get fine motion

Things animals do - locomotion

Pellicle structure (Alveolate: Ciliophora)



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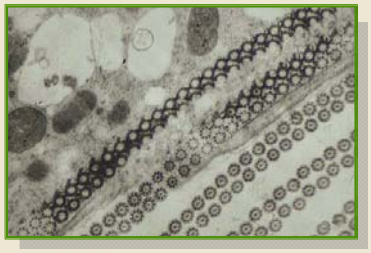
-what happens is the microtubular strands from the base of each basal body
-it sends out from its other strand- microtubules that are woven through the strands of the adjacent flagellum - continues along the surface of the organism
-end up with a reinforcing network of microtubular structures from kinetosome (kinetodesma) - provides it with rigidity
-when you look at the structure of the plasma membrane - it is folded and has pockets, multilayered
-has alveoli - airpockets
-organisms known as alveolates

Things animals do - locomotion

Pellicle structure



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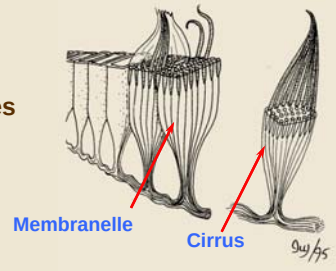
-see the organization - basla bodies for the cilia on the surface - they are organized in tracts
-gives ciliates that reinforcing structure to deal with the power from the cilia

Things animals do - locomotion
Compound ciliature

- **Undulating membranes**
- **Membranelles**
- **Cirrus**



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-paramecium- can modify their cilias
-they their adjacent cilia, wrap them together - cluster together
-either a cirrus
-or membranelle - makes something that can wave back and forth
-take the cilia -make membranes to guide food
-make cirrus that can be used as legs

Things animals do - locomotion

Euplotes

Alveolate: Ciliophora

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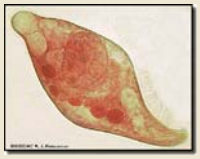
can have a ciliate with distinct shape -some made a membrane to direct food to the cytostome -and the ones at the bottom are used for walking

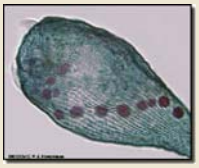
Things animals do - reproduction

Nuclear organization

Alveolate: Ciliophora

- Macronucleus
- Micronucleus





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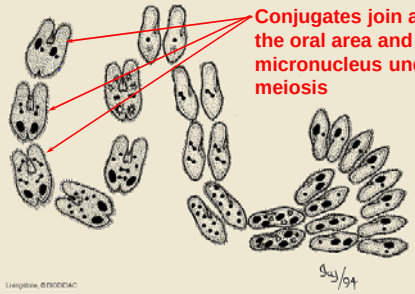
-ciliophora have unusual nuclear arrangement
-they have 2 different types of nuclei - micro and macro nucleous
-only protist group that does this
-what happens- a ciliates undergoes reproduction, need all the combinations and advantages of meiosis
-haploid genome of one with haploid genome with another, and when it goes back to diploid state
-most protists will increase their number by asexual binary fission
-cilates, when they get their full grown complement set - nucleus divides into 2 separate nuclei - one of them will be the micronuclus - sits in the cytoplasm never used for anything during the life of the paramecium
- wont be use for transcription or translation
- will divide in 2 for binary fission but it is set aside a copy of the genome in the micronucleus -other nucleus undergoes division -increase it chromosome count
-micronucleus is 2n, macronucleus is polyploidy
-macro have the genetic material that is use for the cell (nuclear material where there will be transcription/translation/proteins etc sometimes this material is damaged
-when we want to combine haploid genomes - not going to use the genome that is potentially damaged
-more genomes the better - gives a way for a small cell to respond quickly - create rapid product and copies of the genome
- issue in reproduction - macronucleus is in the way -solved by conjugation

Things animals do - reproduction

Conjugation - Alveolata: Ciliophora



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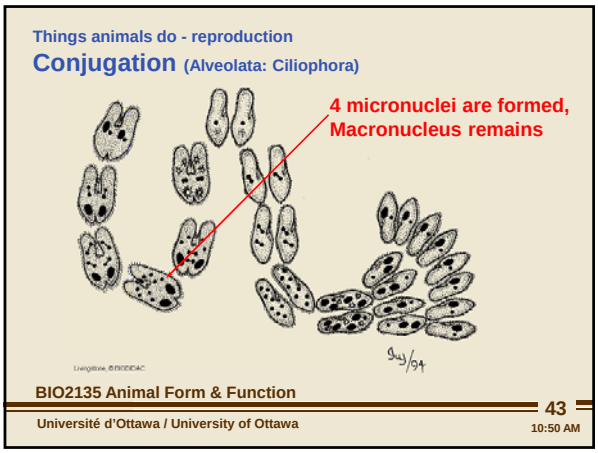
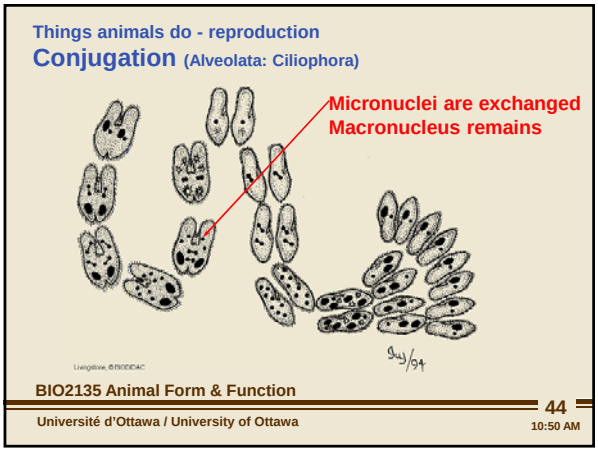
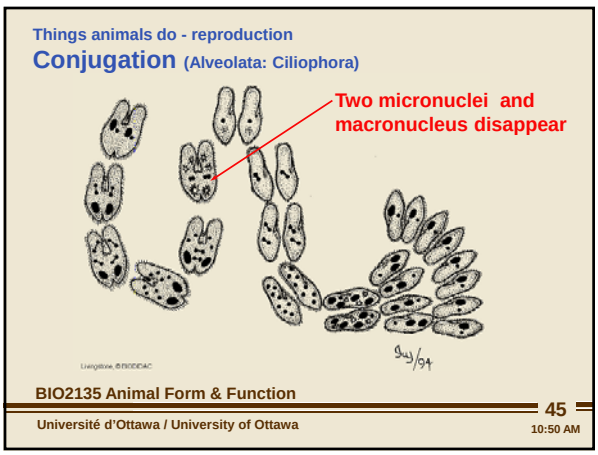
conjugation (gets its name from bacterial conjugation) - cytoplasmic bridge of pili to exchange of DNA and when the two cells separate from each other, they still maintain their identity
-everything is the same except they have new genetic material
-2 paramecia - swap genetic material, separate, same individuals but genetic composition size will change
-first step - get rid of the macronucleus - disolve and breakdown in the cytoplasm -free up nucleic acids that can be used later one to make new DNA
-second step -leave only the micronucleus in diploid state going to get meiosis - which will make 4 products
-going to exchange them and then 2 cells separate, new complementary genome from the fusion of two different individuals - create haploid material that will be exchange to make the new diploid nucleus
-third step - have to build macronucleus to go back to original state



2 paramesium meet up - join together for cytoplasmic streaming
- micronucleus undergoes meiosis - make 2 products and then make 4 products - all halpoid (n)
-happens in both parameciums

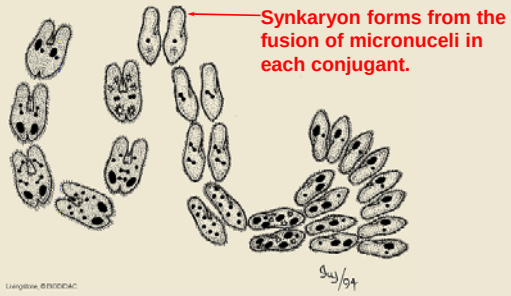


one of the micronuclei form paramecium A is going to fuse with one of the micronucleus of paramecium B and vice verca.
-so one of A fuses with B and one of B fuses with A
- this results in a diploid nucleus
- contains material from 2 haploid from two separate individuals
-the returning to diploid state - sends a signal to destroy the macronucleus and the left over haploid nuclei that are still present



what happens is
-2 macronuclei that werent used in the recombination are destroyed in each of the cells and it disappears
-end up with diploid nucleus that is the combination of 2 different genomes and got rid of all of the other nuclear material

Things animals do - reproduction
Conjugation Alveolata: Ciliophora



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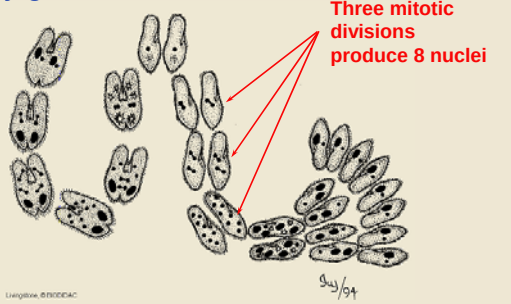
-at this point the two cells separate - this stage synkaryon - nucleus that is fused from two individuals
-done through haploid recombination
-
-now destroyed the old macro, had genetic recombination, have one new diploid nucleus
-need to build a new macronucleus

Things that animals do - reproduction
Conjugation (Alveolata: Ciliophora)



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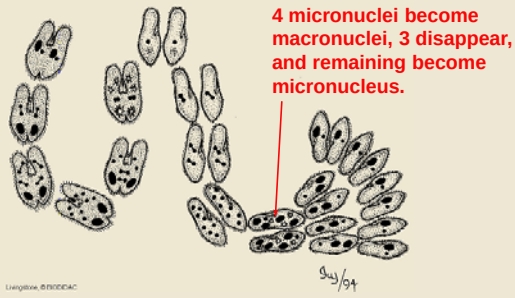
-in this case, there is one round of binary fission, and each cell produces two nuclei
-then another round so there are 4
-and one more time (2^3) so there are 8 nuclei with no cytokenisis
-this part varies - it could have stopped at 4 or continued to 32, nuclei could have dissolve before hand
-now have 8 nuclei - the nucleus that is going to drive/control cytokenesis and cell division is going to be a standard diploid nucleus
-if the cell is going to divide - there will only be one micro that controls everything
we also need the macronucleus

Things that animals do - reproduction
Conjugation (Alveolata: Ciliophora)



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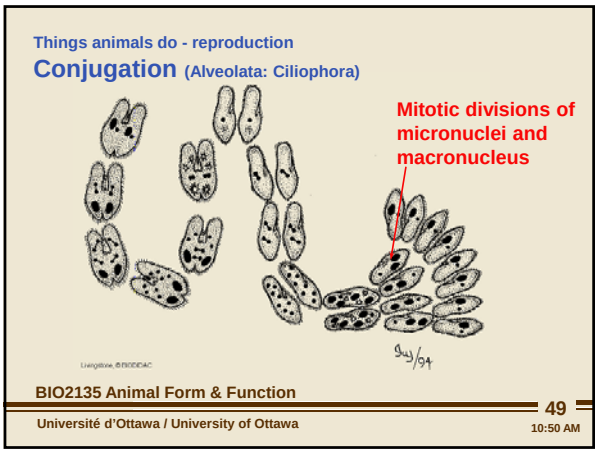
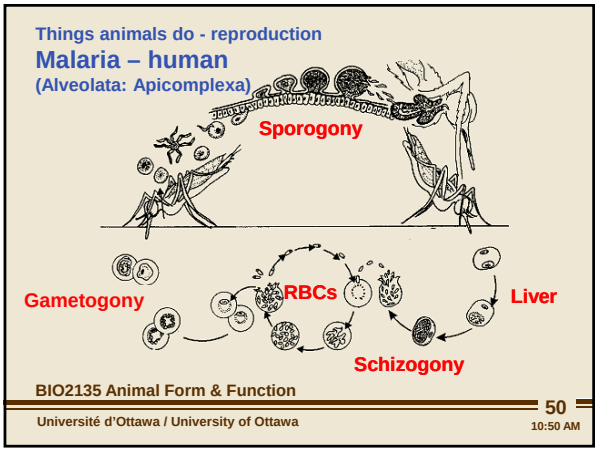
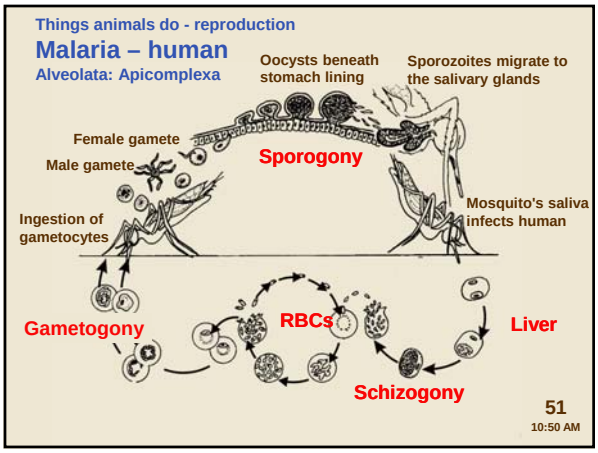
-of the 8 micronuclei, half of them develop into macronuclei
-can only have one micronucleus cause that will be the one that drive cell division
-other 3 micronuclei dissolve and disappear so there is only one leftover
-now undergoes cell division
- that nucleus is going to undergo mitotic division (spindle fibers, cell as being pulled apart - binary fission)
-from binary fission there will be 2 macronuclei in each cell
-micronuclei will diivde once again and partitions 1 macro nucleus into each cell
-back original state and then the whole conjugation cycle repeats
all ciliates do thing- their solution to deal with the macro/micro nucleis



all ciliates do this- their solution to the fact that they have macronucleus that has one function and a micronucleus that drive genetic recombination associated with reproduction



-malaria life cycle - give example of sexual recombination with zygotes - a new individual
-get typical reproduction by fusion of gametes
-common theme in parasitic life cycles- need to be able to survive in the host without being rejected, and unique mechanisms to get between different hosts
-in a parasite if it is going to be successful in two different indifviduals
- need to be able to increase their numbers massively to increase probability of infecting another host
-
-malaria cycle- goes between a mosquito and a human
-2 different names for the host
-diffinitive host - where sperm and egg meet to make a zygote
-intermediate host
-difference is where we get the genetic recombination
(possible test question) compare the adaptations of a parasite to is intermediate host

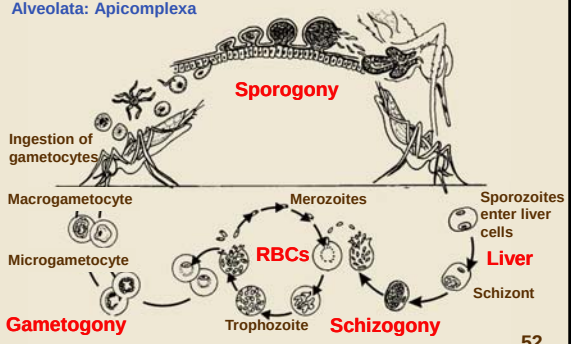


-mosquito takes its blood meal from the human- where there is the gametocytes (cell that makes gametes)
- they are not gametes yet - they are haploid
- when they get ingested into the digestive tract, the chemical environment stimulates the development of the gametocyte into its appropriate gamete
- get a nutrient rich gamete equivalent of an egg and a motile smaller gamete equivalent of a sperm - then they fuse and make a zygote
- zygote is going to embed in the wall of the mosquito and immediately undergo meiosis to the haploid state
-haploid products arent going to be gametes - occurs much later
- when we have haploid products of meiosis not turn into gametes - they turn into spores - just like the plant life cycle
-sporogony - process of making spores - the oocyst embed to the wall and when it undergoes that meiotic division - haploid products undergo thousands to mitotic divisions - to make sporozoites which are mobile
- they swim in the mosquitos blood and swim to the salivary glands (they are haploid)
-when mosquito takes a blood meal, it injects into the human salivary secretions that are use to keep the blood liquid - dont want the blood to coagulate
-saliva is an anticoagulant so it is mixed with the blood before it is taken back up
-saliva contains the sporozoites

Things animals do - reproduction

Malaria – human

Alveolata: Apicomplexa



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- sporozoites are injected into the human blood stream, the blood tends flow to the liver system for filtration
  - they first encounter the liver cells where they will embed themselves

-a single sporozoite will invade a liver cell, undergo a morphological change, -schizogony -undergo mitosis and produce hundreds of new cells inside the liver cell

-vast majority of the cells have eaten the contents of the liver cell - they will burst and release into the blood stream - merozoites (cell designed to travel in the blood stream to find red blood cells, not be attacked by the immune system)

-when it find a red blood cell it will invade it - changes its morphology from merozoites to trophozoites (cell that is inside and feeding on the red blood cell - eats the hemoglobin, undergoes cell divisions) - end up with a packet of trophozoites

-when there is no more food, trophozoites undergo a morphological change to become a merozoites once again to find more red blood cells to invade to become trophozoites (this cycle repeats over and over)

-residual cells that are still in the liver can reinnoculate

-rupture of RBC occur at the same time - causes a dramatic decline in blood cell count

- this changes physiology of the human host - makes them sweaty and chills

-fever makes you warm and sweaty which attracts mosquitoes

-last step - not all cells trophozoites become merozoites

-there is a small percentage that become gametozoites - where mosquitoes will then ingest to complete the life cycle

Protist Supergroups

- **Unikonts**
  - Opisthokonta (Animalia and Fungi)
  - Amoebozoa
- **Bikonts**
  - Chromalveolata (Ciliophora and Apicomplexa)
  - Archaeplastida (Plantae)
  - Excavata (Euglenozoa)
  - Rhizaria

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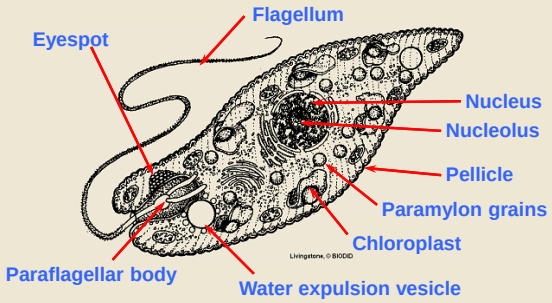
-next group - excavata

Things that animals do – sense their environment

Euglena **(Discicristata: Euglenozoa)**



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-original architecture in euglena

- the excavate/pocket that is deep inside the organism where the flagellum is anchored

-there are two roots to the flagella that are attached to the edge of the excavate

- one flagellum is extremely long and the other is extremely small and they fused together in the pocket

- technically a unikont but they are two flagella present - one is fused to the base of the other inside the excavate groove- leads to long skinny flagella

-euglena as a bikont is in plants -has photosyntetic properties (some are green because of chloroplasts)

-they are strange because they can still survive off organic material in the water if there is not enough light for photosynthesis - some euglena have actually lost their chloroplasts

-when they dont have light, they act like protozoan to eat their food

- depending on the intensity of the light they will be attracted or repelled by it

-meaning that they have the ability to orient towards light

-there is an orange spot in euglena (filled with chorotonoid pigment) eye spot and vision

-right in front of the the eye spot is where the two flagellum fuse

-depending on orientation, the escavate/pocket blocks light - chorotonoid pigments arent going to change their configuration to send a signal that they are being excited by the light

-but as euglena moves, the eyes spot cant get partial/full illumination - this information somehow gets transmitted to the flagella - changes the way it beats so it knows whether or not to move towards or away from the light

-like ciliates- also have pelicle structure on membrane to prevent ripping - however they wont use plasma membrane folding

Protist Supergroups

- Unikonts
  - Opisthokonta (Animalia and Fungi)
  - Amoebozoa
- Bikonts
  - Chromalveolata (Ciliophora and Apicomplexa)
  - Archaeplastida (Plantae)
  - Excavata (Euglenozoa)
  - Rhizaria

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-last group- rhizaria
-they dont have flagella -have pseudopods
-for a long time amoebozoa and rhizaria where in the same group because they used pseudopods
-rhizaria has pseudopods that are supported internally by a microtubular array
- not in 9+2 organization but it is an organized set of microtubules with dyenin and kinesin motors moving around, allowing cytoplasmic streaming to occur
-both is unikonts and bikonts have organism that ditched flagella for locomotion

Protozoan skeletons: Tests

- Calcium Carbonate
  - Granuloreticulosae
- Silica
  - Rhizopods

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-they live in delicate shells
- made of calcium carbonate -aka calcium mineral
- silica - glass
-with glass structure- they are little holes all over the surface - where the pseudopods would have stuck out
-calcarius (those made of calcium carbonate) - have shells that are sequins that grow bigger and bigger as the organism moves forward
- the protoplast lives within the shell with its pseudopods sticking out and when it gets bigger, it bigs another shell and attaches it to the old shell - get increasingly increment large shells
-calcium carbonate is a big building block
-in cambria- organism found ways to remove and sequester calcium that was dissolved in the oceans- mineralize them to make casings and skeletons
-protect their cytoplasm by putting a calcium or silica case around it
-the two are not equal
-if it is at the top it is happy but issue with using calcium- if there is an extreme amount of pressure on the calcium from the weight of the water column - it start to dissolve
-in deep waters organism wont be able to crystallize calcium from the water, they pull out silica
-will also able to attract silica at the top as well -since it has no limit

Protozoan skeletons
(Granuloreticulosea)

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-as they die, their shells sink to the bottom - building sediment which makes rock
-rhizarian calcarius shells that have settled - eventually piled up build up to make a cliff
- there was no decomposition because there was no water so shells ended up mineralizing
-white cliffs of dover