Write
as
word

Time's Up!!!

MOLECULAR AND CELL BIOLOGY IIA: SCIENTIFIC PRACTICE (MCBG2036)

Dr Angela Botes

22 August 2018

Course Overview

- Broad over view of the fungal kingdom
  - *Diversity*
    - What's out there?
  - *Structure and Survival*
    - Cell structure, metabolism, reproduction
  - *Interactions*
    - Environment
    - With each other
    - With us

Intended learning outcomes (ILOs)

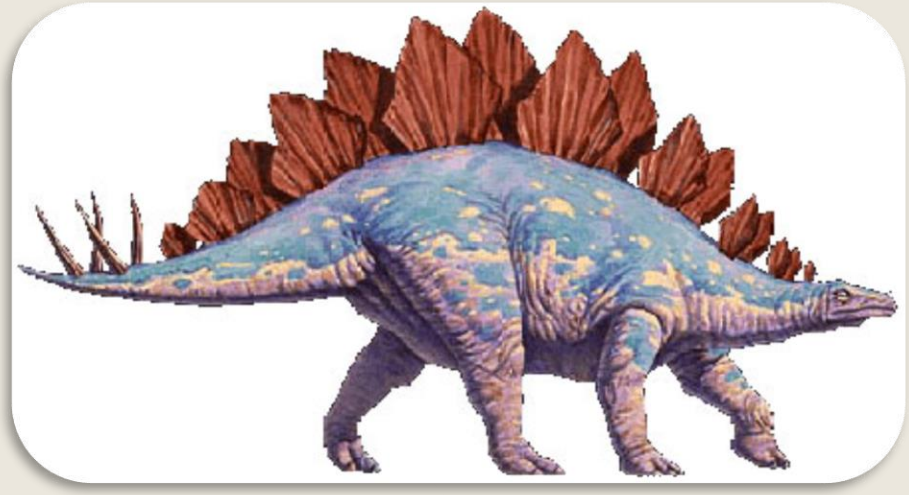
- Define the term / Hlalosa lentsoe
  - *Cytokinesis*
  - *Zymogenic*
- Illustrate and explain / Etsa mohlala le ho hlalosa
  - *The significance of the ribosomal gene cluster in terms of evolutionary origins*
  - *The fugnal cell wall structure*
- List and broadly disucss / Thathamisa le ho buisana haholo
  - *The 6 fungal phyla*
- Discuss and compare / Buisanang le ho bapisa
  - *Different types of eukaryotic cells*
- Distinguish between / Khetholla pakeng tsa
  - *A prokaryote and eukaryote*
  - *Different types of eukaryotic cells*
- Explain / Hlalosa
  - *The mechanical importance of a cell wall*
  - *The function of* S. cerevisiae *chitin synthases*

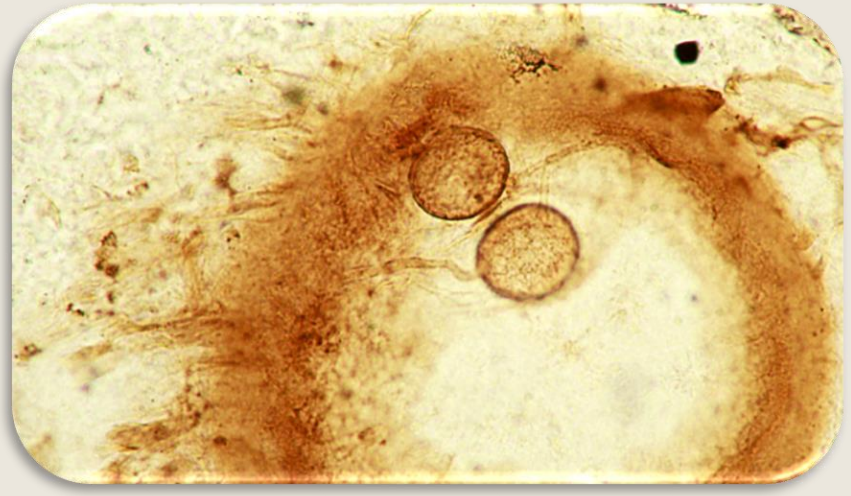
FUNGAL DIVERSITY

http://www.observerbd.com/2015/07/26/101228.php; http://www.nhm.ac.uk/our-science/our-work/origins-evolution-and-futures/symbionts.html

Evolutionary Origins

- Originated as a distinct group of unicellular eukaryotes in the Precambrian era
- Molecular clocks – 760 mya and 1 bya
- Oldest fossil – 400 myo
  - *Evidence of early symbiosis with plants*



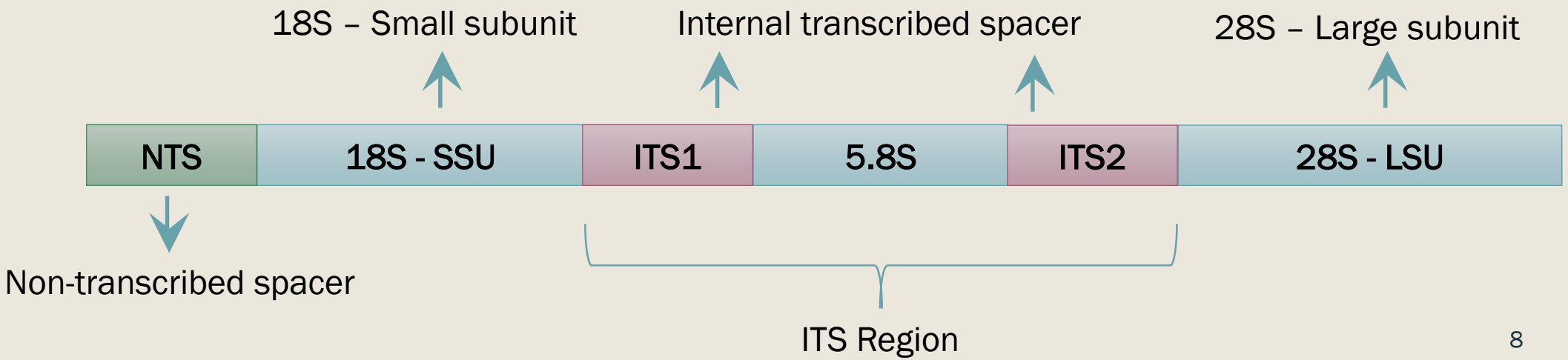


Fungal Classification

- Original classification – morphological characteristics
  - *Remember assignment*
- System advanced with the inclusion of microscopy and biochemistry
  - *Carbon / nitrogen assimilation*
- Molecular biology
  - *PCR – Polymerase Chain Reaction*
  - *Molecular classification*

Molecular Classification

- Evolutionary relationships are based on a ubiquitous eukaryotic gene cluster
- Ribosomal gene cluster (rRNA genes)
  - *3 subunits*
  - *200 copies per cell*
  - *ITS shows significant variation between closely related species and strains*
    - Non functional RNA – accumulates mutations

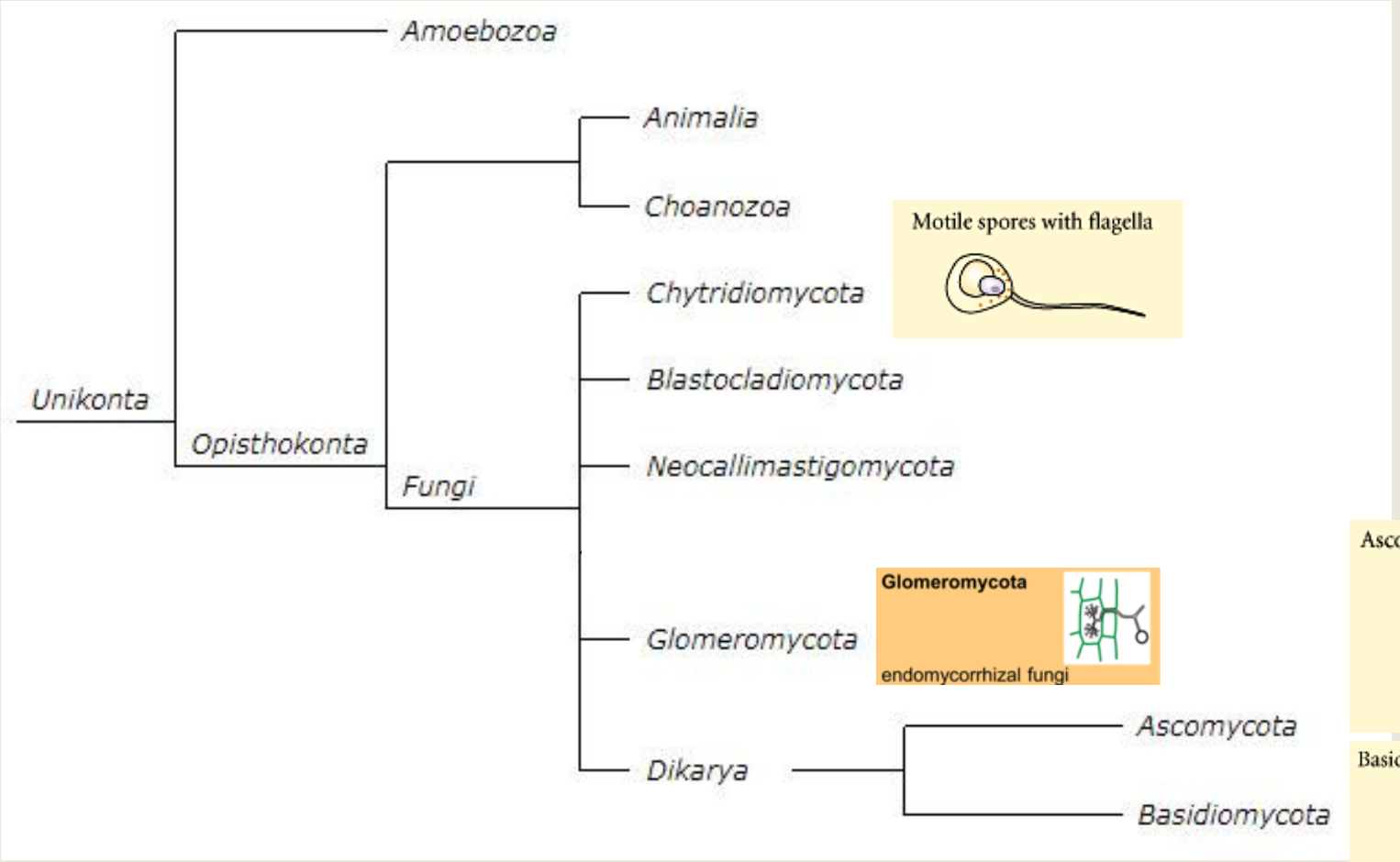


Fungal Phyla

- 6 phyla are recognized (revised 2017)
  - *Ascomycota*
  - *Basidiomycota*
  - *Blastocladiomycota*
  - *Chytridiomycota*
  - *Glomeromycota*
  - *Neocallimastigomycota*

https://biocyclopedia.com/index/fungus.php

Fungal Phyla



Ascomycota

- ~65 000 species
- Marine, freshwater, and terrestrial habitats
- Morphologically diverse
  - *Filamentous fungi and yeast species*
- Sexual spores (ascospore) produced in saclike structure (ascus/asci)
  - *Commonly called the sac fungi*
- Almost half the members form symbiotic relationships
  - *Lichens*
  - *Mycorrhizae*
- Great commercial importance
  - *Food production*
  - *Biopharma*
  - *Agricultural crop pathogens*

http://www.arctic.uoguelph.ca/cpl/organisms/Fungi/dikaryomycota.htm

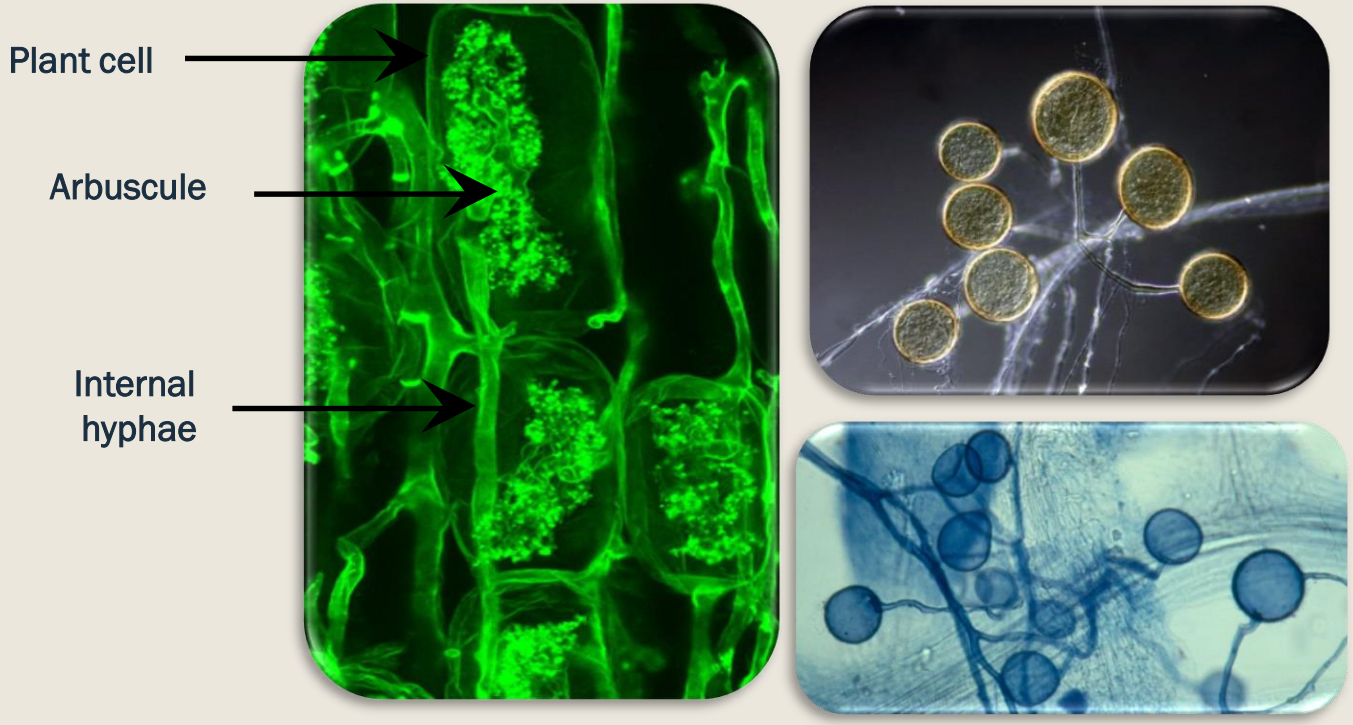
Basidiomycota

- ~30 000 species
- Mostly terrestrial habitats
- Morphologically diverse
  - *Filamentous fungi and yeast species*
- Sexual spores (basidiospores) produced on a basidium
  - *Commonly called the club fungi*
- Form symbiotic relationships
  - *Mycorrhizae*
- Great commercial importance
  - *Serve as food - Mycophagy*
  - *Agricultural crop pathogens*
    - Smut and Rusts
- Important wood decomposers
  - *Specifically lignin*

https://phys.org/news/2016-03-symbiosis-mycorrhizal-fungi-access-scarce.html ; http://website.nbm-mnb.ca/mycologywebpages/NaturalHistoryOfFungi/Glomeromycota.html

Glomeromycota

- ~ 200 species
- Mostly terrestrial
- Most form symbiotic relationships with plants
  - *Majority form arbuscular mycorrhizae*
- Cannot survive without the plant roots
- They do not reproduce sexually
  - *Asexual spores glomerospores*

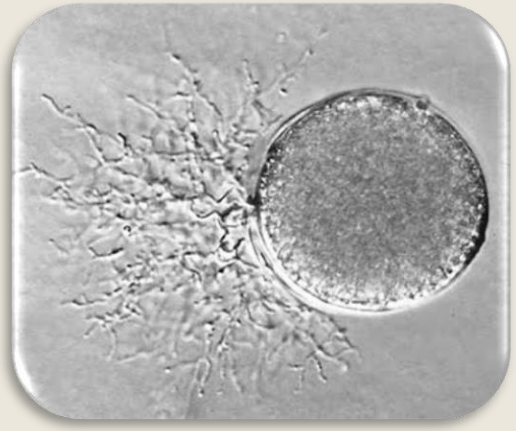


https://sites.google.com/site/plantevolutionarydiversity/chytridiomycota ; https://www4.uwsp.edu/biology/courses/botlab/lab17a.htm

Chytridiomycota

- ~1000 species
- Mostly aquatic
- Early diverging branch of kingdom Fungi
- Important decomposers
- Aquatic fungi that produce motile spores
  - *Zoospores*

- Video
  - *https://www.youtube.com/watch?v=D15qt7mPaqw*



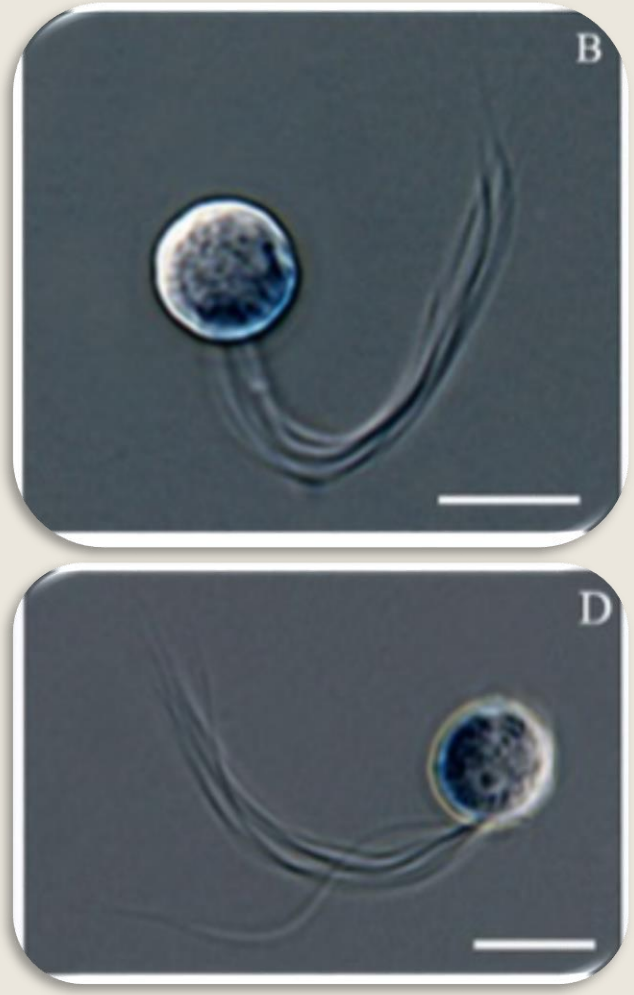
Blastocladiomycota

- Originally the order Blastocladiales
  - *Chytridiomycota*
- Early diverging branch of kingdom Fungi
- Aquatic fungi that produce motile spores
  - *Zoospores*
- Number of plant and animal pathogens
  - *Coelomomyces is a mosquito pathogen*
    - Explored as a biocontrol agent

Wang et al., 2017

Neocallimastigomycota

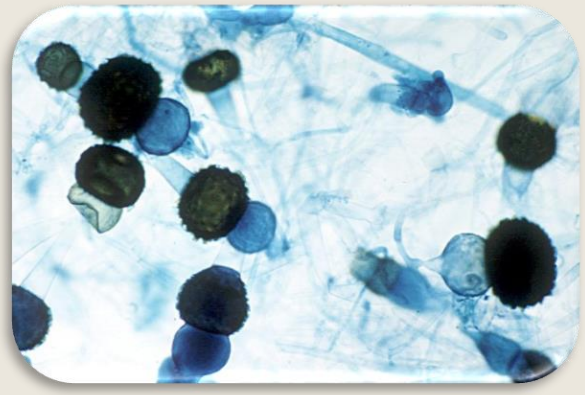
- 20 species
  - *Originally classified as Chytrids*
- All anaerobic
  - Symbionts found in the digestive tracts of larger herbivores
- Produce uni and mutliflagillated spores
  - *Zoospores*

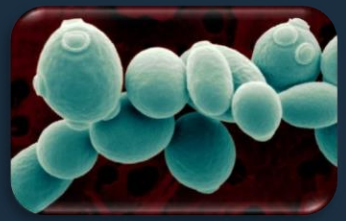


http://www231.pair.com/fzwester/courses/bis10v/week7/12zygomycetes.html

Zygomycetes

- Originally Zygomycota
  - *Most species reclassified*
- ~1000 species
- Mostly terrestrial
- Fast-growing molds
  - *Responsible for food rot*



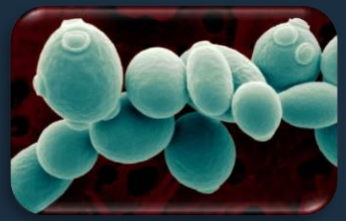





http://www.mushroomexpert.com

AFTER THE BREAK…

…Fungal Cell Structure



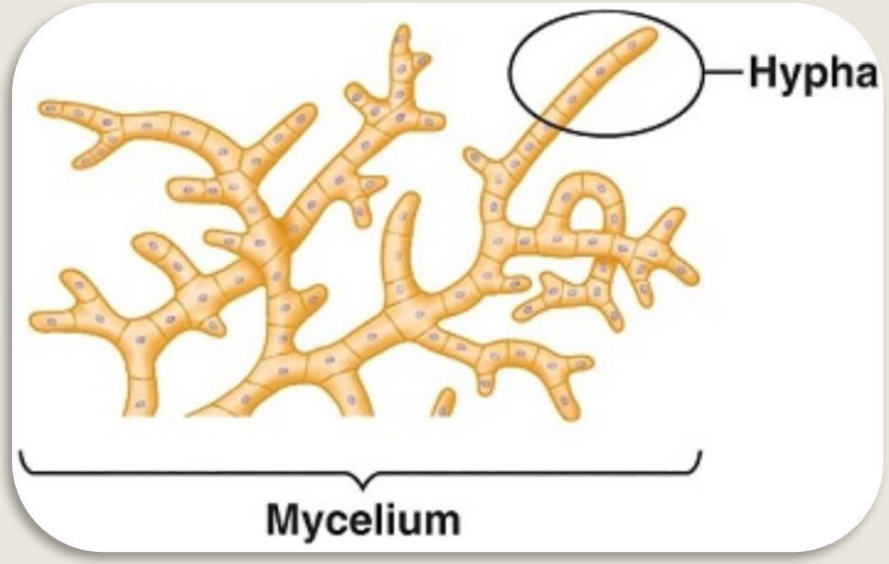


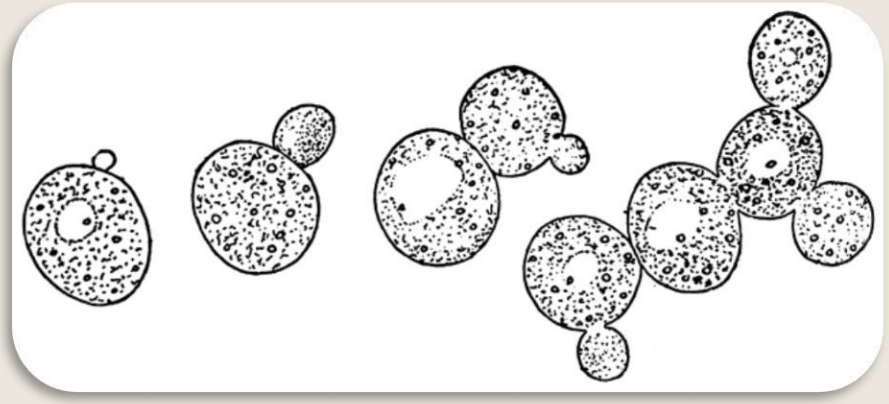

http://www.mushroomexpert.com

FUNGAL CELL STRUCTURE

Fungal cell structure

- Filamentous or unicellular
- Eukaryotes
- Eukaryotes vs Prokaryotes?





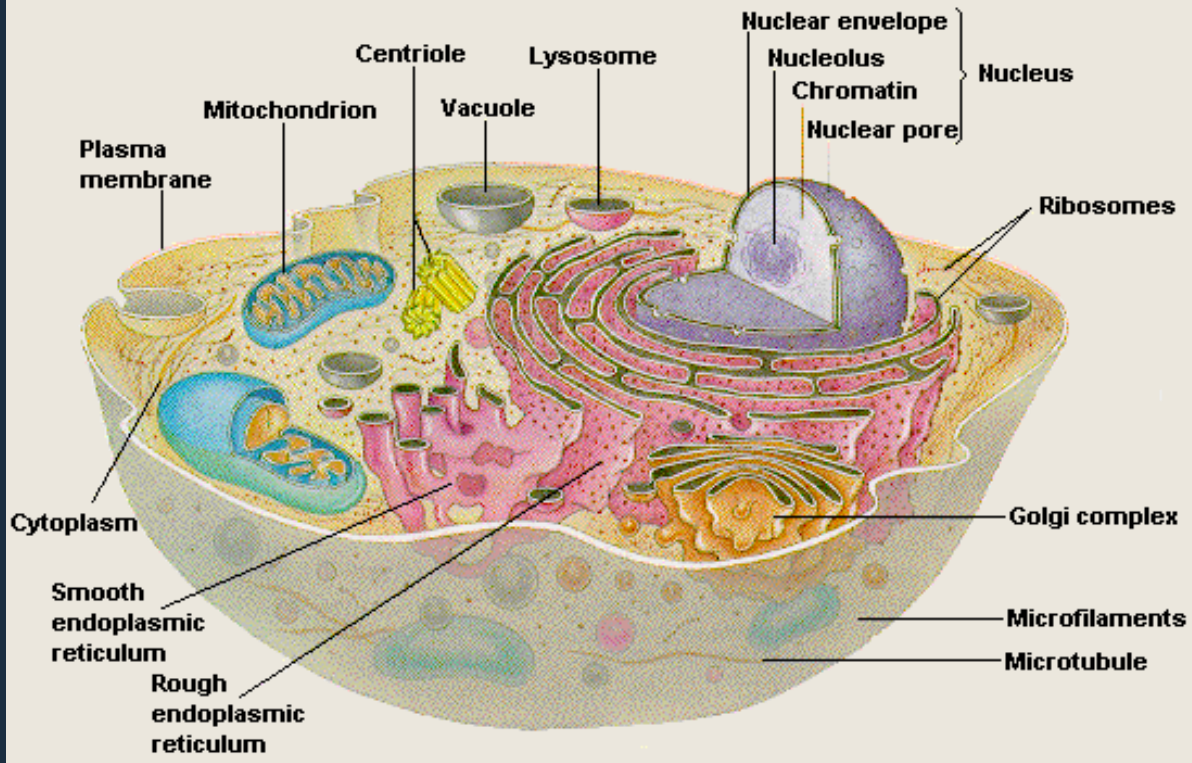
Prokaryotes vs Eukaryotes

Feature	Eukaryote	Prokaryote
Nucleus	Present	Absent (Nucleoid)
Chromosomes	Present	Absent (Circular DNA)
Membrane bound organelles	Present	Absent
Reproduction	Mitosis and Meiosis	Binary fission
Average size	Larger	Smaller

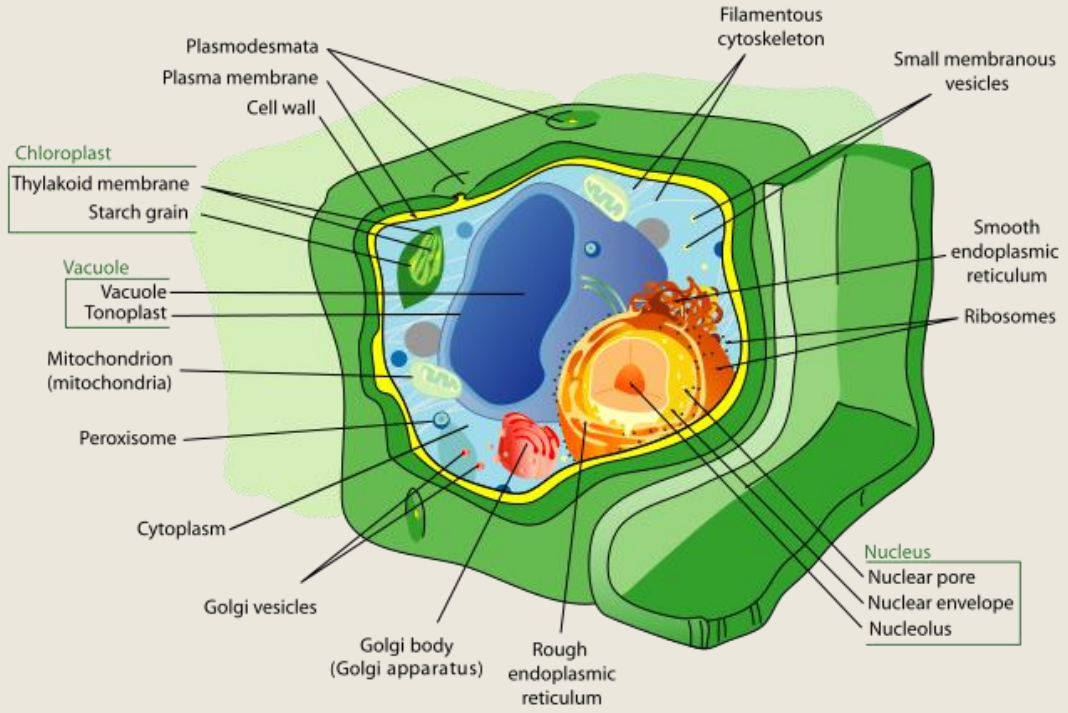
https://en.wikipedia.org/wiki/File:Plant_cell_structure-en.svg

Differences amongst eukaryotic cells?

Mammalian cell

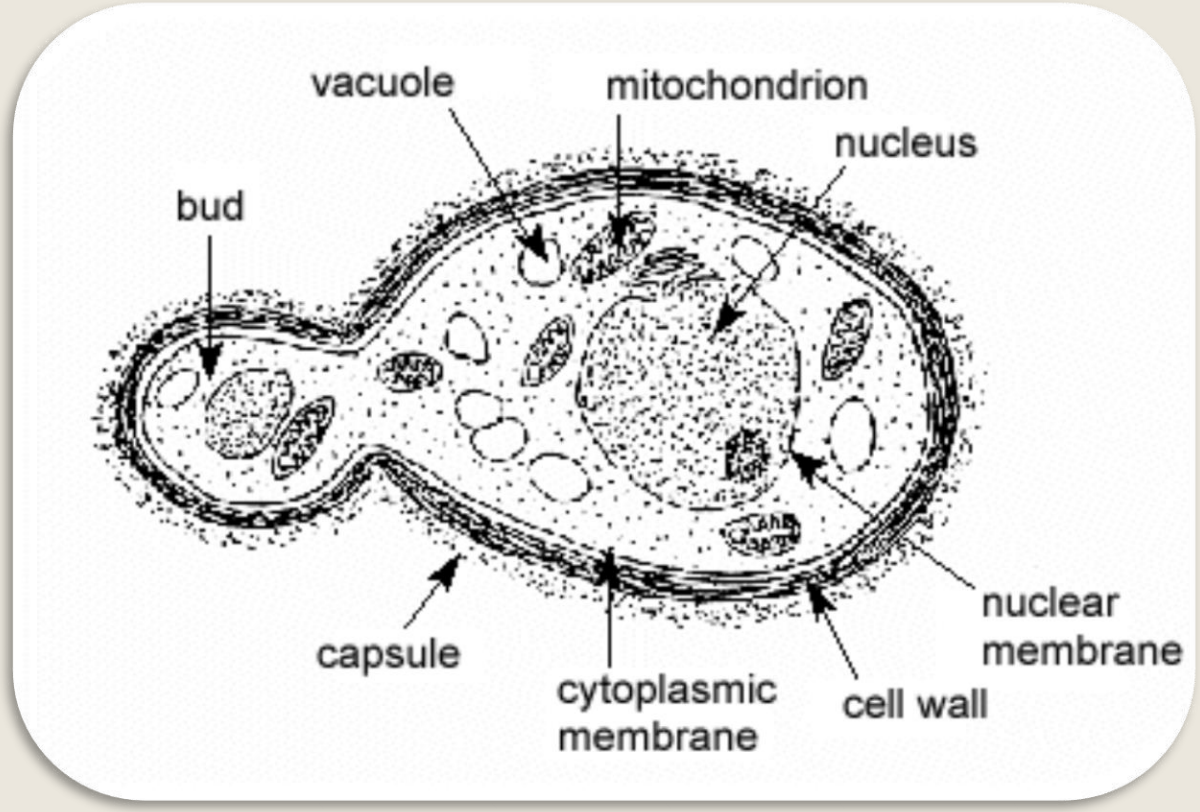


Plant cell

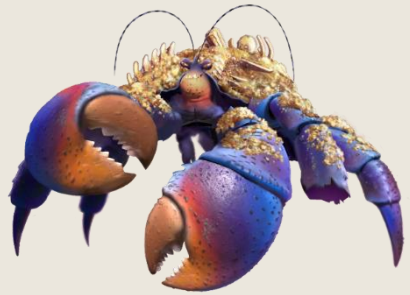


https://www.polyvore.com/disney_characters_2009-present/collection?id=6538903

Fungal cell structure



- Important differences
  - *Cell wall containing chitin*
    - Fibrous substance consisting of polysaccharides,
    - Major constituent in the exoskeleton of arthropods
  - *No chloroplasts*
  - *Multiple vacuoles*



Summary

Organelle	Mammal	Plant	Fungi
Cell Membrane	Yes	Yes	Yes
Cell Wall	No	Yes (Cellulose)	Yes (Chitin)
Chloroplast	No	Yes	No
Endoplasmic reticulum	Yes	Yes	Yes
Mitochondria	Yes	Yes	Yes
Vacuole	Yes (Multiple)	Yes (Single)	Yes (Multiple)

Fungal Cell Wall

- Why do they need a cell wall?

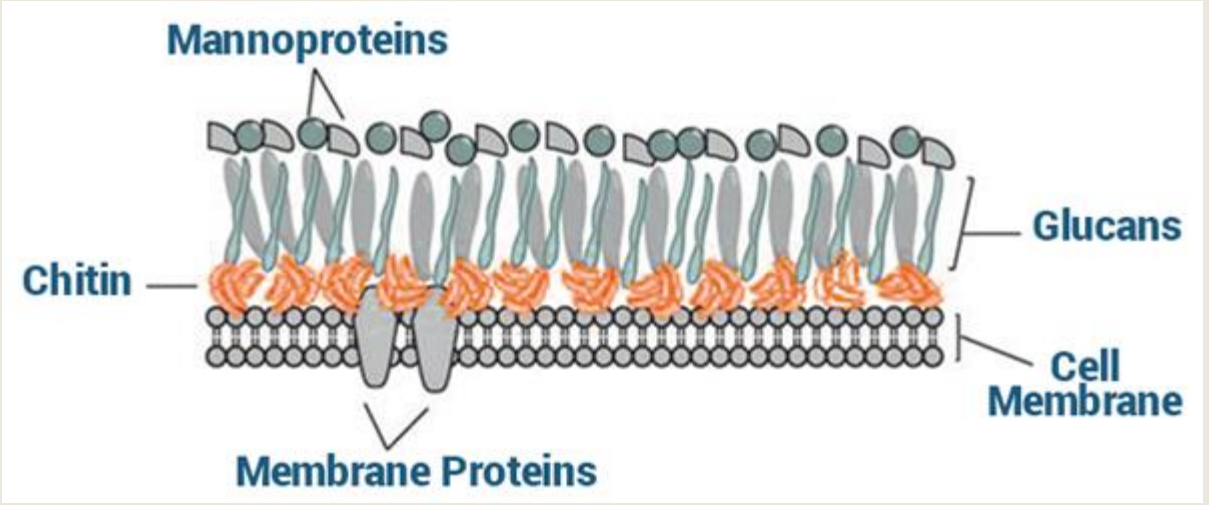
- [Sugar] and [salt] higher in the cell than the surrounding medium
  - *Osmotic differential*

  - *Causes an influx of water*
  - *Cell membrane expands and presses against the cell wall*
  - *Tugor / hydrostatic pressure*
    - Mechanical process
  - *Prevents cell rupture*

https://byjus.com/biology/fungal-cell-wall/

Fungal Cell Wall

- Highly dynamic
- Extends in certain regions
  - *Hyphal tips and yeast buds*
- Porous
- Chitin, glucans (polymers of glucose), cell wall proteins (CWP)



Fungal Cell Wall – Chitin

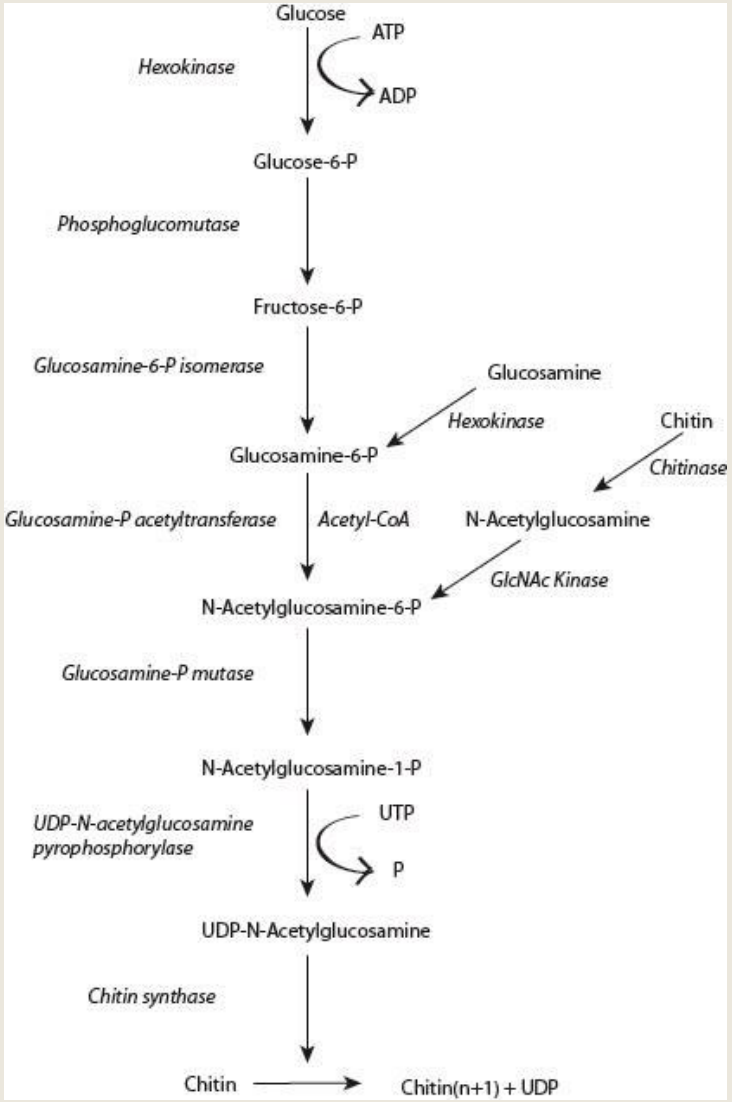
- Fibrous substance consisting of polysaccharides,
  - *Major constituent in the exoskeleton of arthropods*
  - *Higher [chitin] in filamentous species*

- β-1-4-linked N-acetyl-D-glucosamine monomers
- Adjacent chitin chains form hydrogen bonds and assemble into antiparallel arrays – microfibrils
  - *Tremendous tensile strength*

- Important role in fungal pathogenesis
- Important drug target

Fungal Cell Wall – Chitin Synthesis

- Chitin synthase
- Integral membrane protein
- Two families
  - *Family 1 – 3 classes (I, II, III)*
  - *Family 2 – 4 classes (IV, V, VI, VII)*
  - *Based on amino acid sequence*
- Classes (III, V, VI, VII) are specific to filamentous fungi



Fungal Cell Wall – Chitin Synthesis

- *Saccharomyces cerevisiae*
  - *3 chitin synthases*
- Chs1p (*CHS1*)
  - *Repairing the chitin septum during cytokinesis*
- Chs2p (*CHS2*)
  - *Required for chitin synthesis in the primary septum during cytokinesis*
- Chs3p (*CHS3*)
  - *Required for synthesis of the majority of cell wall chitin*

Cell division stage during which the cytoplasm of a single eukaryotic cell divides into two daughter cells.

Requires activation of zymogenic form

Inactive precursor of an enzyme

NEXT TIME…

…Cell growth and sexual reproduction