



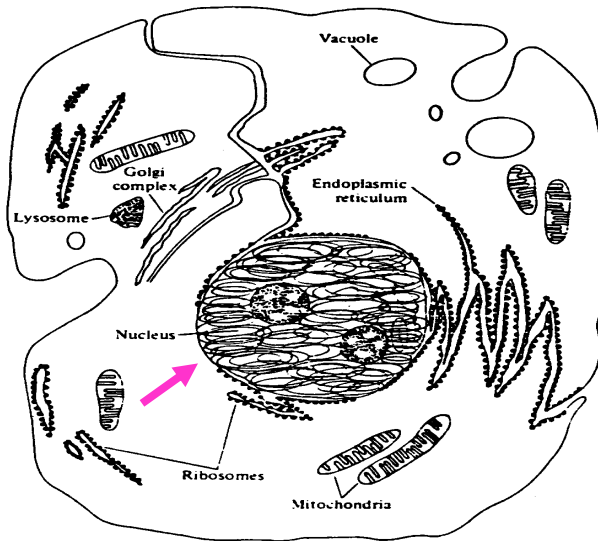
## EUCARYOTES



### Eukaryotes

- Eukaryotes have nuclear membrane and true nucleus, and membrane-bound organelles.
- Eukaryotes include **fungi (yeast and molds)**, **algae**, protozoa, and animal and plant cells.
- Eukaryotic cells are five to ten times larger than prokaryotic cells in diameter.
- Yeast is about 5 -10  $\mu\text{m}$ , animal 10  $\mu\text{m}$  and plant 20  $\mu\text{m}$ .

## Eucaryote Cell Structure

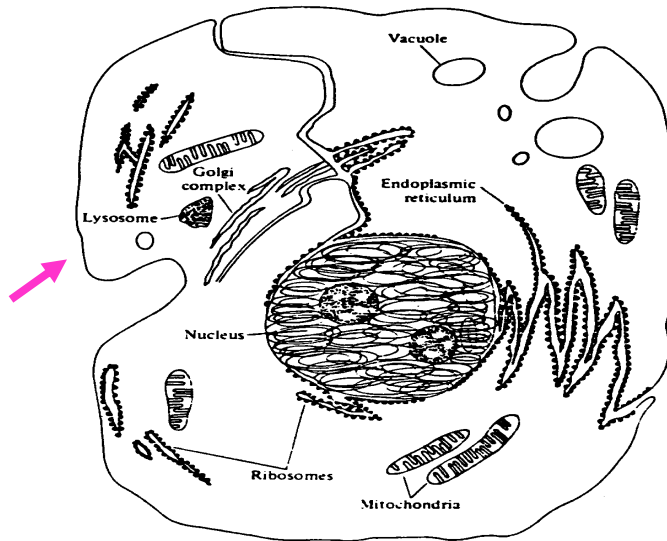


## Eucaryote Cell Structure

### Nucleus

- Nucleus contains chromosomes (DNA associated with small proteins) surrounded by a membrane.
- The membrane contains a pair of concentric and porous membrane.

## Eucaryote Cell Structure

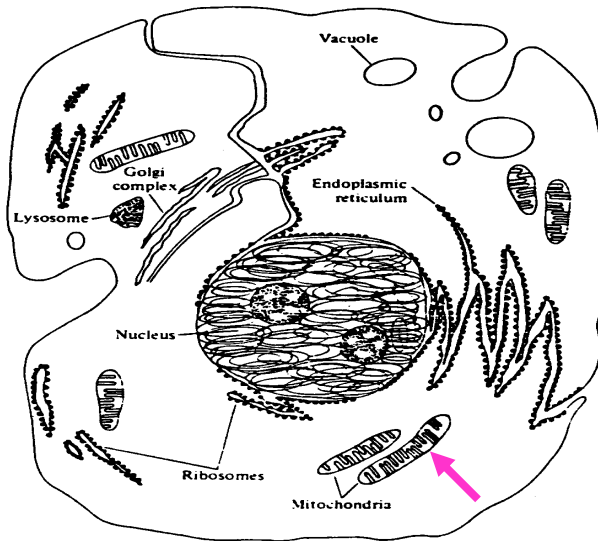


## Eucaryote Cell Structure

### Cell Wall and Membrane Structure

- Eucaryotes contain sterol which strengthen the wall structure and make the membrane less flexible.
- The cell wall of eucaryotes shows variations:
  - Fungi contain chitin
  - Plant cells contain cellulose
  - Animal cells do not have cell wall so that they are shear-sensitive and fragile

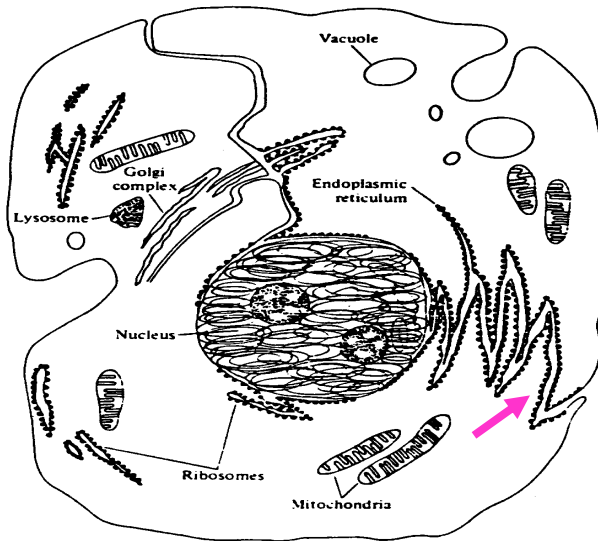
## Eucaryote Cell Structure



## Eucaryote Cell Structure

- There are **membrane-bounded organelles** with specialized functions, suspended in the cytoplasm of a eucaryotic cell.
- **Mitochondria** are the powerhouses of a eukaryotic cell, where respiration takes place. It reduces oxygen and store energy in ATP (Adenosine triphosphate).
- **Shape:** Mitochondria have cylindrical shape with 1  $\mu\text{m}$  in diameter and 2-3  $\mu\text{m}$  in length.

## Eucaryote Cell Structure

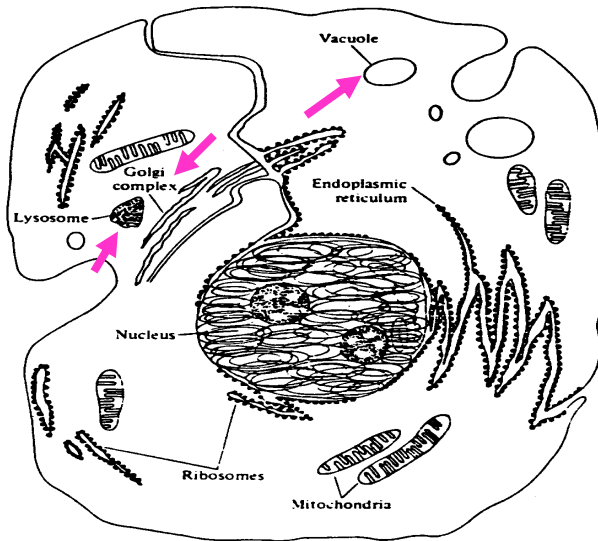


## Eucaryote Cell Structure

### Organelles (*CONT.*) :

- **Endoplasmic reticulum** is a complex, convoluted membrane system leading from the cell membrane into the cell.
  - The rough endoplasmic reticulum containing ribosomes is the site for protein synthesis.
  - The smooth one is involved with lipid synthesis.

## Eucaryote Cell Structure



## Eucaryote Cell Structure

### Organelles (*CONT.*) :

- **Lysosomes** are very small membrane-bound particles that contain and release digestive enzymes, contributing to digestion of nutrients and invading substances.
- Enzymes in lysosomes:
  - Lipases digest lipids.
  - Carbohydrase digests carbohydrates (sugars).
  - Proteases digest proteins.



## Eucaryote Cell Structure

### Organelles (*CONT.*) :

- **Vacuole** are of low density and responsible for food digestion, osmotic regulation and waste product storage.
  - **Golgi complexes** are small particles composed of membrane aggregates.
    - Responsible for the secretion of proteins.
    - Golgi are sites where proteins are modified, important for protein function in the body.
- 



## Eucaryote Cell Structure

### Organelles (*CONT.*) :

- **Chloroplasts** are relatively large, chlorophyll-containing, green organelles that are responsible for photosynthesis in algae or plant cells.
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# Eucaryotic Cell Reproduction

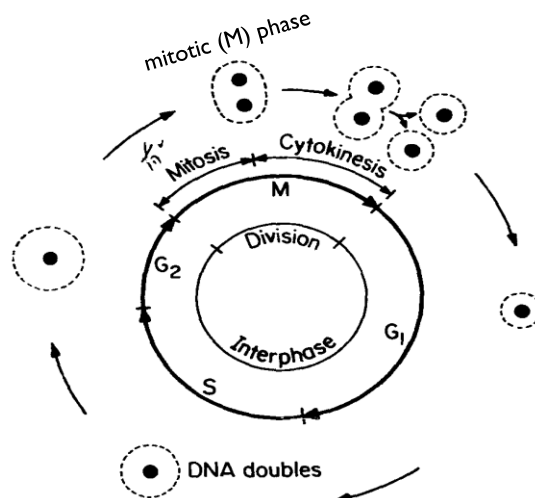
## Cell Division (Asexual)

Nuclear DNA replicates

Nucleus division  
(mitosis)

Cell division and  
separation (cytokinesis)

## Cell Division Cycle (Mitosis)



[http://highered.mcgraw-hill.com/sites/0072437316/student\\_view0/chapter1/animations.html#](http://highered.mcgraw-hill.com/sites/0072437316/student_view0/chapter1/animations.html#)

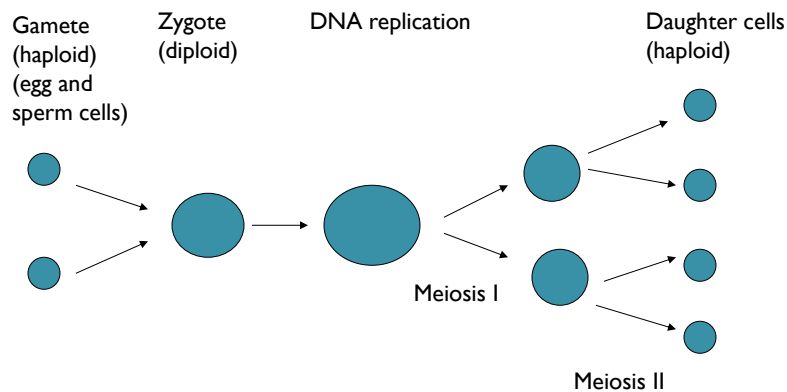


## Mitosis

### Mitosis results in:

- Two identical daughter cells with a roughly equal distribution of organelles and other cellular components.
- Each daughter cell is the genetic equivalent of the parent cell.

## Meiosis Sexual Reproduction





## Meiosis

- Meiosis forms the basis of sexual reproduction and can only occur in eukaryotes.
- The formation of a **zygote** (a **diploid** cell) is from fusion of two **haploid** cells (**gametes**).
- Each **haploid** cell has a set of chromosome.
- The **diploid** cells contains twice as many chromosome as does the gamete.
- The **diploid** cells divide two times (meiosis) to form new haploid cells.



## Meiosis

### In Meiosis:

- The diploid cell's chromosomes (DNA) is replicated **once** and separated **twice**, producing **four** sets of haploid cells each containing **half** of the original cell's chromosomes.
- These resultant haploid cells will fertilize with other haploid cells of the opposite gender to form a diploid cell again.

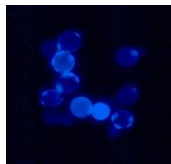
<http://www.csuchico.edu/~jbell/Biol207/animations/meiosis.html>

## MICROSCOPIC EUCARYOTES

- Fungi: yeast and mold
- Algae

### Fungi

- Fungi are heterotrophs which need to take nutrients from the environment for living.
- They are larger than bacteria.



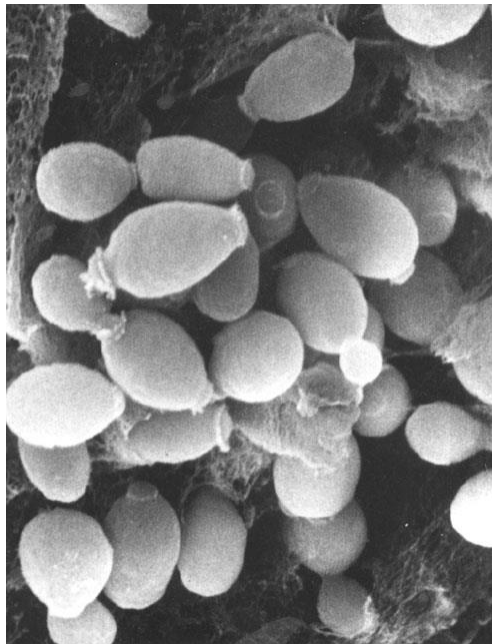
- Two major groups are **yeast** and **mold**.

## Fungi:

### Yeast

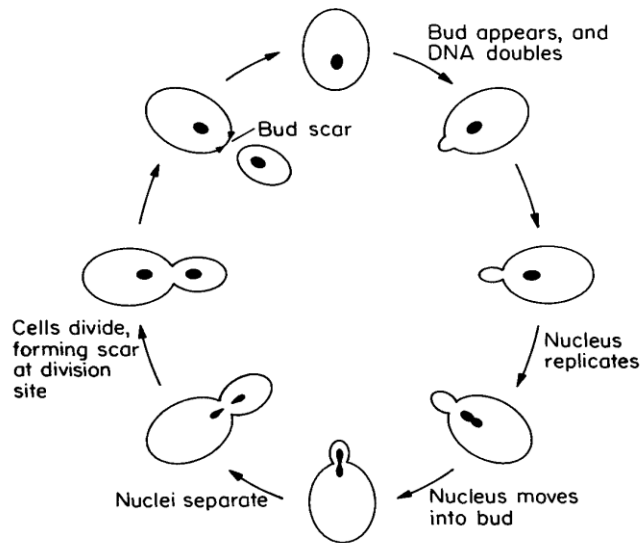
- Single-celled
- Size: 5 to 10  $\mu\text{m}$  in diameter.
- Shape: spherical, cylindrical, or oval.
- Baker's yeast (*Saccharomyces cerevisiae*) is the most widely used yeast.
- Reproduction: by sexual or asexual means
  - Asexual reproduction is by either budding or fission.
    - **Budding:** a small bud cell forms on the cell, which gradually enlarge and separate from the mother cells.
    - Most yeasts reproduce by budding.

## Yeast



[http://www.sbs.utexas.edu/mycology/sza\\_images\\_SEM.htm](http://www.sbs.utexas.edu/mycology/sza_images_SEM.htm)

## Budding



## Yeast Reproduction

- **Asexual:**
  - **Fission:** similar to budding but the cells grow to certain size and divide into two equal cells.
  - Only a few yeast species can reproduce by fission.
- **Sexual:** involves the formation of a zygote from the fusion of two haploid cells, each having a single set of chromosome.

## Yeast

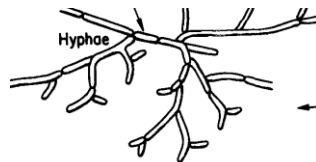
Yeasts are very important economically:

- Responsible for fermentation of bread and beer. (*Saccharomyces cerevisiae*)
- Ethanol production
- Wastewater treatment:
  - a mixed culture of yeasts (*Candida tropicalis*, and *Yarrowia*) on hydrocarbons, or gas oil
- Yeasts and *Bacterium xylinum* in Kombucha, fermented sweet



## Fungi: Mold

- Molds are filamentous fungi and have a mycelial structure.



- *Mycelium* is highly branched system of tubes that contains mobile cytoplasm with many nuclei.
- Hyphae are long thin filaments on the mycelium.

## Molds

- Molds are very important economically:
  - Mushroom (*Agaricus bisporus*) farming is a large industry in many countries



- Food industry
  - *Aspergillus niger* for citric acid production
- Antibiotics production
  - *Penicillium notatum*

## Molds

### Size:

- When grown on moist solid nutrient surface, the filamentous form is 5-20  $\mu\text{m}$ .
- When grown in submerged culture, it can form cell aggregates and pellets, of size varies between 50  $\mu\text{m}$ -1mm.
  - Can cause nutrient-transfer (mainly oxygen) problem in the pellet, but
  - pellet formation reduces broth viscosity, which can improve bulk oxygen transfer.

## Algae

- Algae are usually unicellular
- Also, plantlike multicellular structures present in marine water
- Like plants, most algae use the energy of sunlight to make their own food (photosynthesis).
- Algae lack the roots, leaves, and other structures typical of true plants
- Algae contain chloroplast which is responsible for photosynthesis.

## Algae

- They are in the size of 10-30  $\mu\text{m}$ .
- Algae can reproduce asexually or sexually.
  - Many of algae incorporate both sexual and asexual modes of reproduction.
- Marine algae and seaweeds produce gelling agents such as alginic acid and agar.

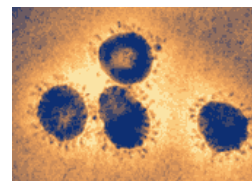




## Virus

## Virus

- Not free-living organisms, obligate parasite of other living cells.
- Size: 30-200nm.
- Can not capture or store free energy.
- Not functionally active except when inside their host cells.
- Can do harm but also be useful biotechnology tools (e.g. vaccines).



SARS Coronavirus virion

# Virus

- **Bacteriophage** or phage: virus infecting bacteria.
- **Virus reproduction:**
  - Virus contains genetic materials such as DNA and RNA which is covered by a protein coat called **capsid**.
  - They can reproduce only by invading and controlling other cells as they lack the cellular machinery for self-reproduction.

