Lecture 04 - Eukaryotes

Topics
- Eukaryotes
- External structures
- Internal structures
- Fungi
- Protists
- Helminths

Some Eukaryotes

What makes something eukaryotic?
- External and internal structures are more complex than prokaryotes
- Lots of membranes to divide things inside
- Examples of eukaryotes
  - Yeast
  - Protozoa
  - Algae
  - Helminths
  - Animal cells
External Structures

• Appendages
  – Flagella
  – Cilia
• Glycocalyx
• Cell wall
• Cell membrane

Eukaryotic Flagella

Eukaryotic Movement - Flagella and Cilia
A flagellum enables locomotion, and is composed of microtubules, arranged in a 9 + 2 fashion.

Microtubules

Eukaryotic Cilia

- Shorter, more numerous than flagella
- Coordinated beating
- Also used to move substances past the surface of the cell

More Cilia

Paramecium have cilia, similar to flagella but smaller and more numerous.
Glycocalyx

- Complex outer layer
  - polysaccharides and network fibers
- Protection
- Adherence
- Reception of signals from other cells and the environment

Cell wall

- Chitin
- Glycoprotein
- Mixed glycans

Cell membrane

- Various sterols within the membrane will increase rigidity and stability
- Some cells will only possess a membrane
- Embedded transport proteins
Glycocalyx, glycan layer, and membrane.

Internal Structures
- Nucleus
- *Endoplasmic reticulum
- *Golgi apparatus
- Mitochondria
- *Chloroplast (photosynthetic cells only)
- Ribosomes
- Cytoskeleton

*Nucleus
- Membrane bound organelle
- Chromatin-chromosomal DNA
- Nucleolus- site for RNA synthesis
- Histones-proteins that associate with DNA during mitosis
An transmission electron micrograph (TEM) of a nucleus and its contents

Micro for health Sciences

Organelles cooperate in protein synthesis and transport.

The transport process

Lysosomes are transitional vesicles containing enzymes for digestion.

The origin and action of lysosomes in phagocytosis
Mitochondria

- Site of energy generation
- Cristae - folds of the inner membrane
- Matrix - consist of ribosomes, DNA, and enzymes

Ribosomes

- Associated with proteins synthesis
- Present in the cytoplasm and the surface of the ER

Cytoskeleton

- Anchor organelles
- Cellular structural support
- Enable cell shape changes
- Two types
  - Microfilaments
  - Microtubules
Microfilaments allow movement of molecules in the cytoplasm. Microtubules maintain cell shape and enable molecule movement within the cell.

Fungi – just everywhere!

- Present in nature (ex. mushrooms)
- Medically important (ex. athlete’s foot)
- Industrially important (ex. fermentation)

Fungi

- Classification
  - Morphology
  - Reproduction (asexual and sexual)
Morphology and Reproduction

• Hyphae cell
  – Septate
  – nonseptate
• Yeast cells
  – Single cells
  – Pseudohyphae
• Reproduction
  – Asexual and sexual process

A scanning electron micrograph (SEM) of hyphae cells

SEM of yeast cells, and budding reproductive process.
Rhizopus, and its stages of hyphae reproduction.

Functional hyphae types.

Asexual spore formation – involves mitotic division of a single parental cell

Types of asexual mold spores

Sexual spore formation involves the fusion of two parental nuclei followed by meiosis

Formation of zygosporic spores
Mushrooms undergo sexual spore formation.

Subkingdoms of Fungi

- **Amastigomycota** (non-flagellated)
  - **Perfect**
    - (both sexual and asexual stage is known)
      - examples: *Penicillium* sp. (ascomycete), *Rhizopus* sp. (zygomycete)
  - **Imperfect** [Deuteromycetes]
    - (no sexual stage is known, only asexual)
      - example *Mycelium* sp.

- **Mastigomycota**
  - (spores and gametes are motile, flagellated)
    - example *Chytridiomycetes* sp.

Black bread mold is classified as an Amastigomycota (Perfect).
Penicillium is another example of Amastigomycota (Perfect).

A common Ascomycete

Mycelium is classified as an Amastigomycota (Imperfect).

Mycelium and spores of a representative of Deuteromycota

Fungi can cause superficial and systemic infections.

There is a table in the book that lists major human fungal infections.
Protista

- Algae
- Protozoa

Algae

- Photosynthetic
- Inhabitants of fresh and marine waters
- Most are not considered human pathogens
- Pathogens produce toxins (e.g., red tide)
- Unique morphology enables identification

Algae contain chlorophylls, green, yellow, red and brown.
Protozoa

- Complex structure and function
  - Ectoplasm and endoplasm
  - Pseudopods, flagella, cilia
- Inhabitants of fresh water and soil
  - Heterotrophs
- Reproduction (asexual)
  - Trophozoite
  - Encystment

Complex structure associated with the protozoa *Trichomonas vaginalis*.

Structure of a typical mastigophoran

Typical life cycle for protozoa
Medically important protozoa

- Amoeboid protozoa
  - Causes brain infections
- Flagellated protozoa
  - Example: Giardiasis
- Apicomplexan protozoa
  [organelle called an apical complex]
  - Example: Malaria

Pathogenic amoebas, and nonpathogenic shelled amoebas

Examples of sarcodinians

Ciliated protozoa, generally free-living and harmless
Apicomplexia, artist's rendition, usually intracellular parasite. Defined by presence of apical complex (next slide). Malaria (Plasmodium sp.) is a good example.

Apical complex

Cycle of protozoan transmission: can include the protozoa, host and vectors, often a complex life cycle.

Transmission in Schistosoma sp. infection. Thanks to CDC.
Stages of development and transmission - amoebic dysentery in the human host.

Helminths – 3 kinds

- Tapeworms (Cestodes, "flat", segments, hermaphroditic)
- Flukes (Trematodes, "flat", no segments, some hermaphroditic, blood flukes are bisexual)
- Roundworms (Nematodes, cylindrical, bisexual)

Unique structural morphology enables identification

Helminths are multicellular animals with organ-like systems.
Humans serve as a host for the life cycle of many different parasitic helminths.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Common Type of Disease or Worm</th>
<th>Life Cycle Requirement</th>
<th>Spread to Humans By</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>