Lecture 6

A Survey of

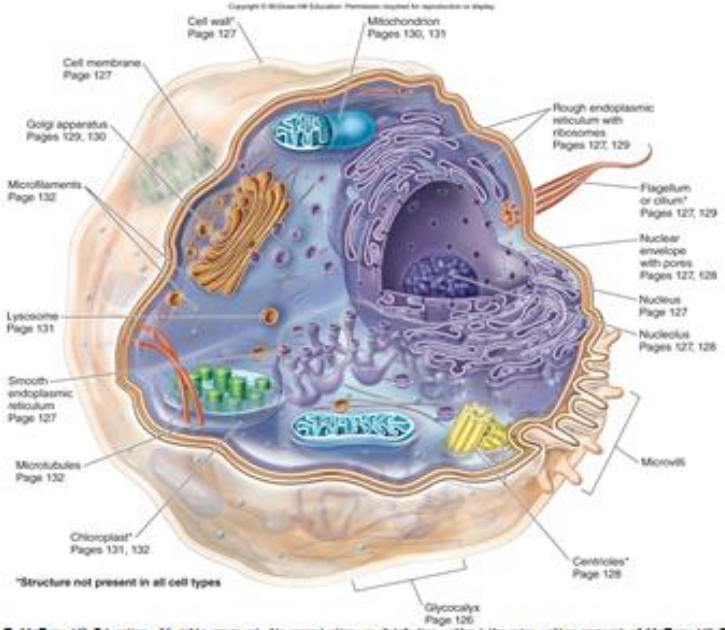
Eukaryotic Cells and Microorganisms

Eukaryotic Microbes

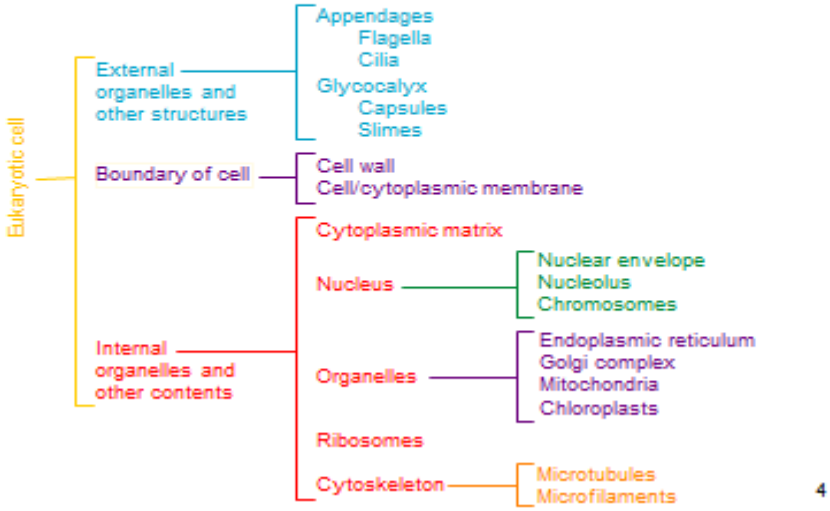
TABLE 5.1 Eukaryotic Organisms Studied in Microbiology

Unicellular, a Few Colonial	May Be Unicellular, Colonial, or Multicellular	Multicellular Except Reproductive Stages
Protozoa	Fungi Algae	Helminths (parasitic worms) Arthropods (animal vectors of diseases)

The Eukaryotic Cell

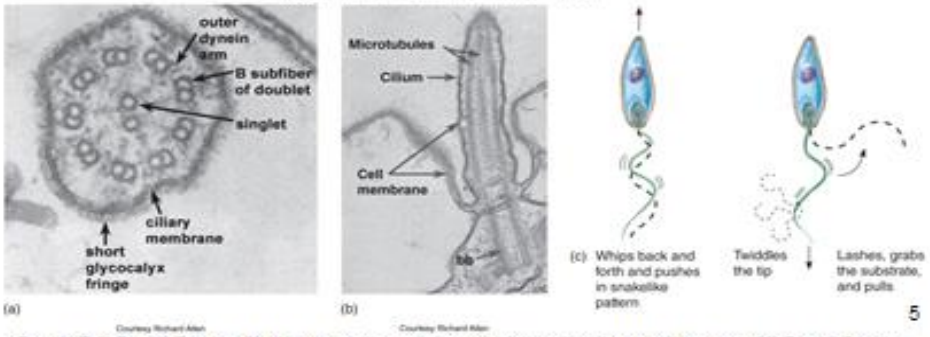


Organization of the Eukaryotic Cell



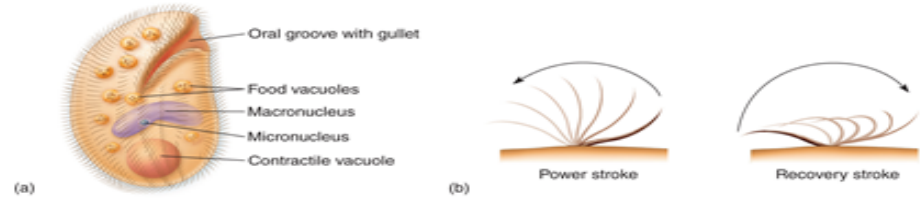
External Structures

- Locomotor appendages: **Flagella**
  - Long, sheathed cylinder containing microtubules in a 9+2 arrangement
  - Covered by an extension of the cell membrane
  - 10X thicker than prokaryotic flagella
  - Function in motility



External Structures

- Locomotor appendages: **Cilia**
  - Similar in overall structure to flagella, but shorter and more numerous
  - Found only on a single group of protozoa and certain animal cells
  - Function in motility, feeding, and filtering



External Structures

- **Glycocalyx**
  - An outermost boundary that comes into direct contact with environment
  - Usually composed of polysaccharides
  - Appears as a network of fibers, a slime layer or a capsule
  - Functions in adherence, protection, and signal reception
  - Beneath the glycocalyx
    - Fungi and most algae have a thick, rigid cell wall
    - Protozoa, a few algae, and all animal cells lack a cell wall and have only a membrane

Boundary of the Cell

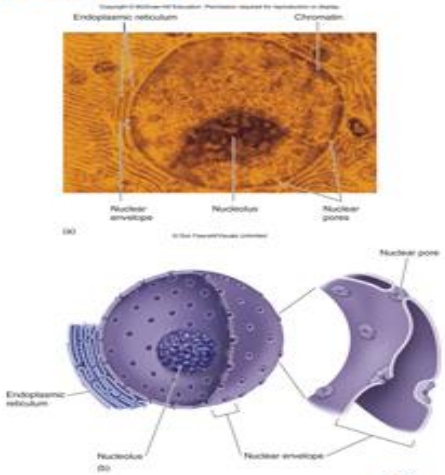
- **Cell wall**
  - Rigid, provides structural support and shape
  - Fungi have thick inner layer of polysaccharide fibers composed of chitin or cellulose and a thin layer of mixed glycans
  - Algae – varies in chemical composition; substances commonly found include cellulose, pectin, mannans, silicon dioxide, and calcium carbonate

Boundary of the Cell

- **Cytoplasmic (cell) membrane**
  - Typical bilayer of phospholipids and proteins
  - Sterols confer stability
  - Serves as selectively permeable barrier in transport
  - Eukaryotic cells also contain membrane-bound organelles that account for 60-80% of their volume

Internal Structures

- **Nucleus**
  - Compact sphere, most prominent organelle of eukaryotic cell
  - Nuclear envelope composed of two parallel membranes separated by a narrow space and is perforated with pores
  - Contains chromosomes
  - **Nucleolus** – dark area for rRNA synthesis and ribosome assembly

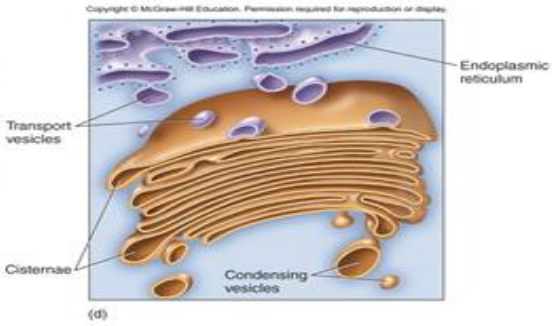


Internal Structures

- Endoplasmic reticulum – two types:
  - **Rough endoplasmic reticulum (RER)** – originates from the outer membrane of the nuclear envelope and extends in a continuous network through cytoplasm; rough due to ribosomes; proteins synthesized and shunted into the ER for packaging and transport; first step in secretory pathway
  - **Smooth endoplasmic reticulum (SER)** – closed tubular network without ribosomes; functions in nutrient processing, synthesis, and storage of lipids

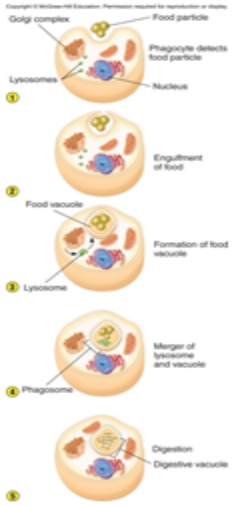
Internal Structures

- **Golgi apparatus**
  - Modifies, stores, and packages proteins
  - Consists of a stack of flattened sacs called cisternae



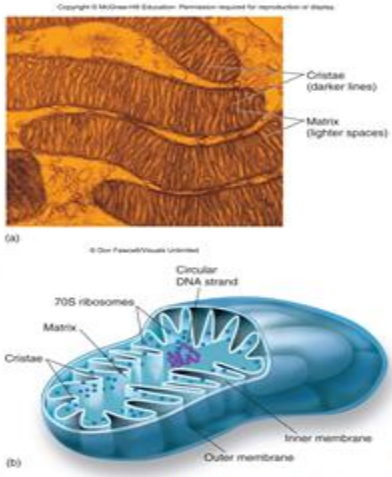
Internal Structures

- **Lysosomes**
  - Vesicles containing enzymes that originate from Golgi apparatus
  - Involved in intracellular digestion of food particles and in protection against invading microbes
- **Vacuoles**
  - Membrane bound sacs containing particles to be digested, excreted, or stored
- **Phagosome**
  - vacuole merged with a lysosome



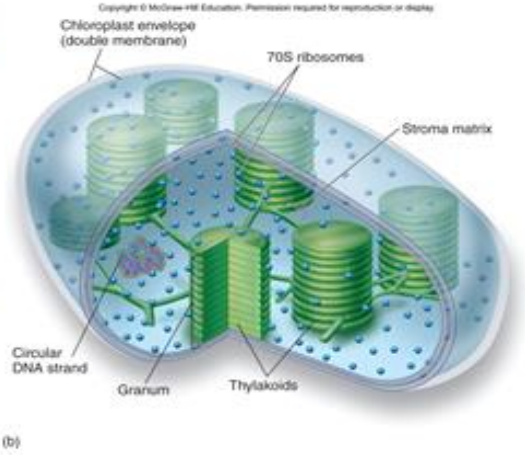
Internal Structures

- **Mitochondria**
  - Function in energy production
  - Consist of an outer membrane and an inner membrane with folds called **cristae**
  - Cristae hold the enzymes and electron carriers of aerobic respiration
  - Divide independently of cell
  - Contain DNA and prokaryotic ribosomes



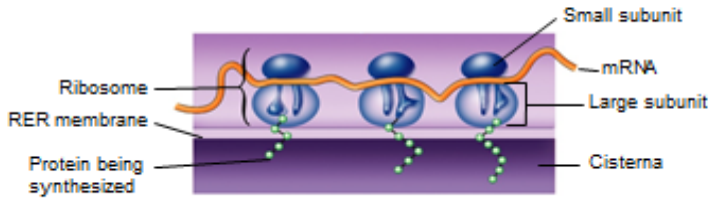
Internal Structures

- **Chloroplast**
  - Convert the energy of sunlight into chemical energy through photosynthesis
  - Found in algae and plant cells
  - Outer membrane covers inner membrane folded into sacs, **thylakoids**, stacked into **grana**
  - Primary producers of organic nutrients for other organisms



Internal Structures

- **Ribosomes**
  - Composed of rRNA and proteins
  - Scattered in cytoplasm or associated with RER
  - Larger than prokaryotic ribosomes
  - Function in protein synthesis



16

Comparing Prokaryotes, Eukaryotes & Viruses

TABLE 5.2 A General Comparison of Prokaryotic and Eukaryotic Cells and Viruses

Function or Structure	Characteristic*	Prokaryotic Cells	Eukaryotic Cells	Viruses**
Genetics	Nucleic acids	+	+	+
	True nucleus	−	+	−
	Nuclear envelope	−	+	−
	Nucleoid	+	−	−
Reproduction	Mitosis	−	+	−
	Production of sex cells	+/−	+	−
	Binary fission	+	+	−
Biosynthesis	Independent	+	+	−
	Golgi apparatus	−	+	−
	Endoplasmic reticulum	−	+	−
	Ribosomes	+***	+	−
Respiration	Enzymes	+	+	−
	Mitochondria	−	+	−
Photosynthesis	Pigments	+/−	+/−	−
	Chloroplasts	−	+/−	−
Motility/locomotor structures	Flagella	+/−***	+/−	−
	Cilia	−	+/−	−
Shape/protection	Cell membrane	+	+	+/−
	Cell wall	+/−***	+/−	− (have capsids instead)
	Capsule	+/−	+/−	−
Size (in general)		0.5–3 μm****	2–100 μm	< 0.2 μm

*+ means most members of the group exhibit this characteristic; − means most lack it; +/− means some members have it and some do not.
**Viruses cannot participate in metabolic or genetic activity outside their host cells.
***The prokaryotic type is structurally very different.
****Much smaller and much larger bacteria exist; see 4.1 Secret World of Microbes.

17

Survey of Eukaryotic Microbes

Fungi

Algae

Protozoa

Kingdom Fungi

- 100,000 species divided into 2 groups:
  - Macroscopic fungi (mushrooms, puffballs, gill fungi)
- Microscopic fungi (molds, yeasts) Exist in two morphologies:
  - **Yeast** – round ovoid shape, asexual reproduction
  - **Hyphae** – long filamentous fungi or molds
- Some exist in either form – **dimorphic** –characteristic of some pathogenic molds
  - Majority are unicellular or colonial; a few have cellular specialization

The Protists

Algae - eukaryotic organisms, usually unicellular and colonial, that photosynthesize with chlorophyll *a*.Protozoa - unicellular eukaryotes that lack tissues and share similarities in cell structure, nutrition, life cycle, and biochemistry.

Algae

- Photosynthetic organisms Microscopic forms are unicellular, colonial, filamentous
- Macroscopic forms are colonial and multicellular
- Contain chloroplasts with chlorophyll and other pigments
- Cell wall
- May or may not have flagella
- Most are free-living in fresh and marine water – **plankton**
- Provide basis of food web in most aquatic habitats
- Produce large proportion of atmospheric O_2

Protozoa

- Diverse group of 65,000 species
- Vary in shape, lack a cell wall
- Most are unicellular; colonies are rare
- Most are harmless, free-living in a moist habitat
- Some are animal parasites and can be spread by insect vectors
- All are heterotrophic – lack chloroplasts
- Cytoplasm divided into ectoplasm and endoplasm
- Feed by engulfing other microbes and organic matter