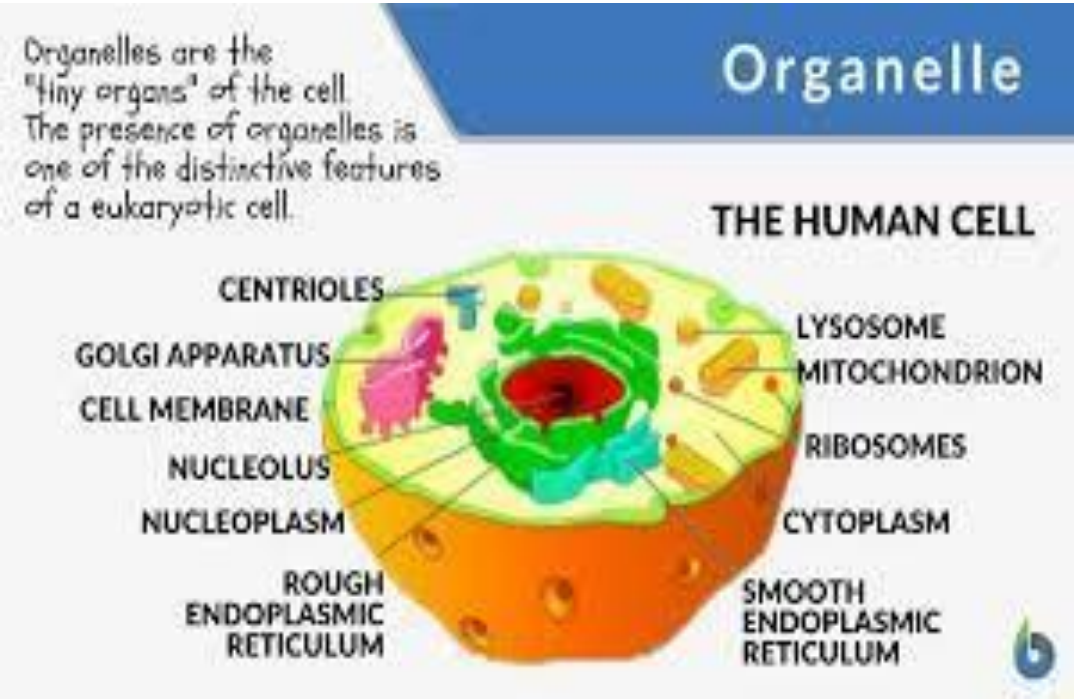
Functions of Organelles and their Biochemical importance



Objectives

- At the end of the lecture, students would be able to:
  - Define cell and its composition
  - Describe different cell organelles and their function
  - Know the functions of a individual cell

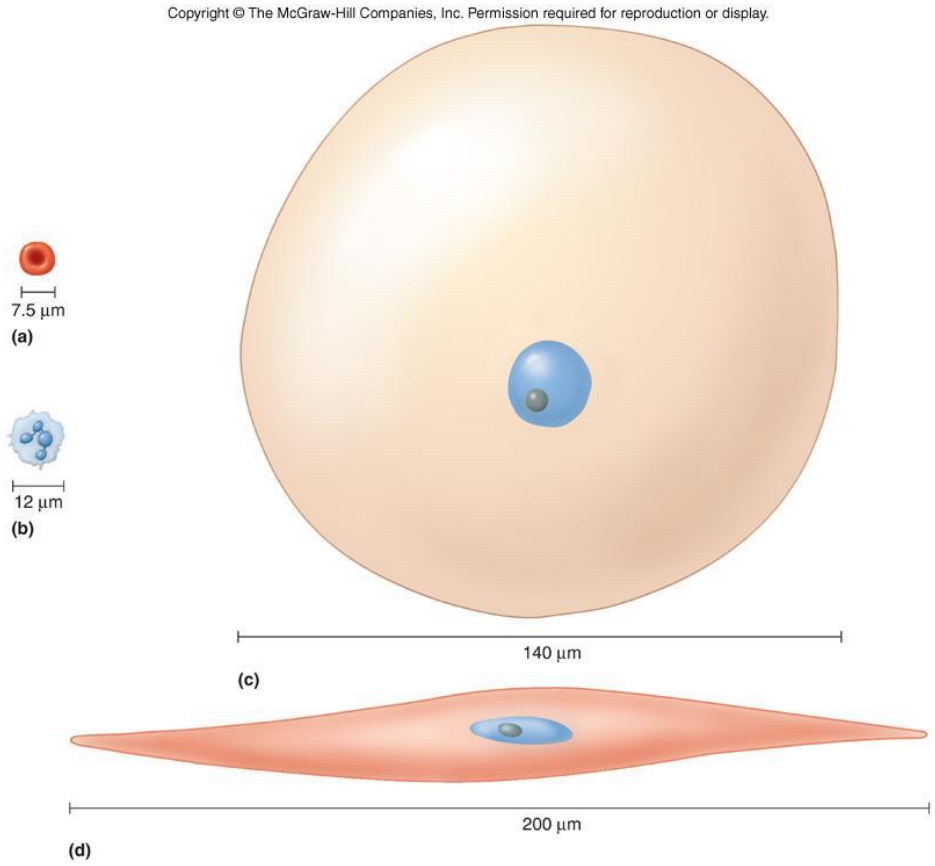
Introduction

- The basic organizational structure of the human body is the cell.

- There are 50-100 trillion (1,000,000,000,000; one million million; 10^{12}) cells in the human body.

- Differentiation is when cells specialize.

- As a result of differentiation, cells vary in size and shape due to their unique function.



What are Cell Organelles?

- The cellular components are called cell organelles.
- These cell organelles include both membrane and non-membrane bound organelles, present within the cells and are distinct in their structures and functions.
- They coordinate and function efficiently for the normal functioning of the cell.
- A few of them function by providing shape and support, whereas some are involved in reproduction of a cell.

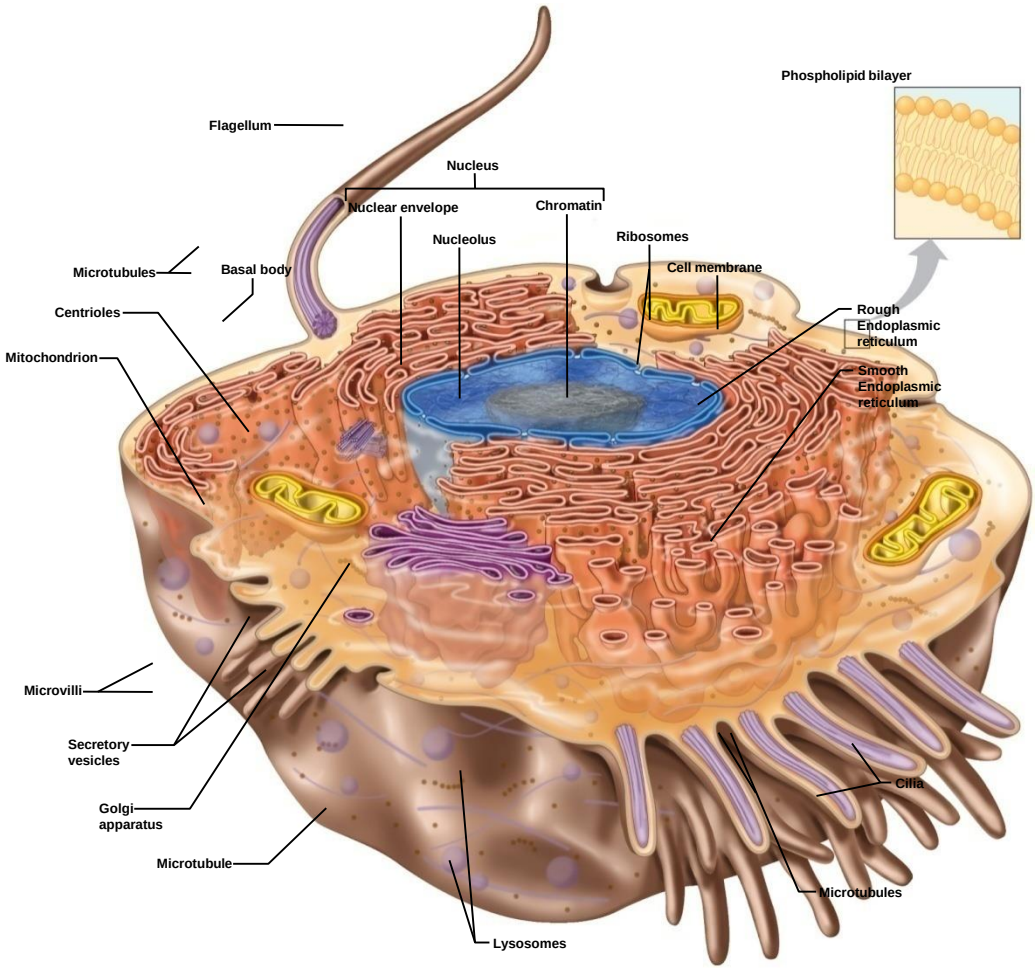
PROTOPLASM

- Different substances that make up cell are collectively called protoplasm

- Composition: mainly five basic substances:
    1. Water
    2. Electrolytes
    3. Carbohydrates
    4. Proteins
    5. Lipids

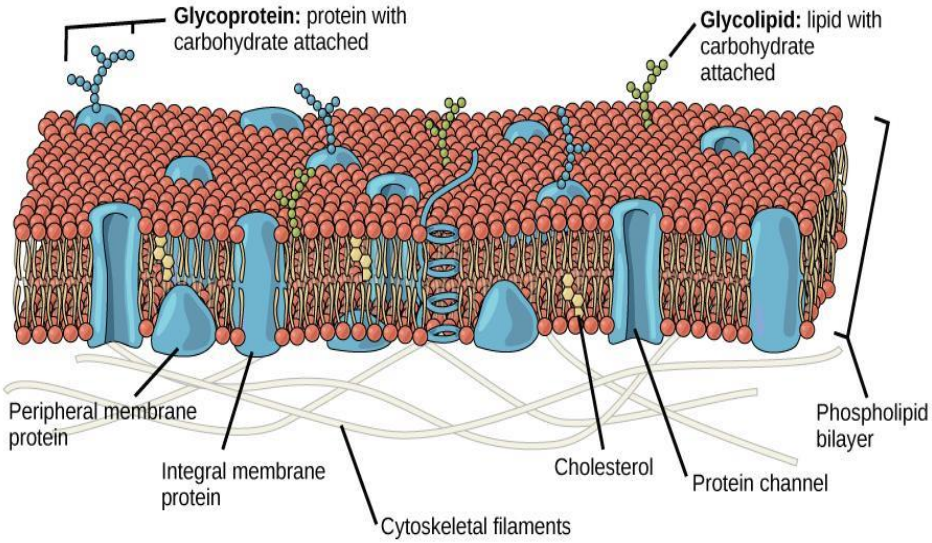
A Composite Cell

- Also called a 'typical' cell
- Major parts include:
  - Nuclear membrane and Nucleus
    - contains DNA
  - Cytoplasm
    - cellular contents between plasma membrane & nucleus
  - Cell membrane
    - selective barrier

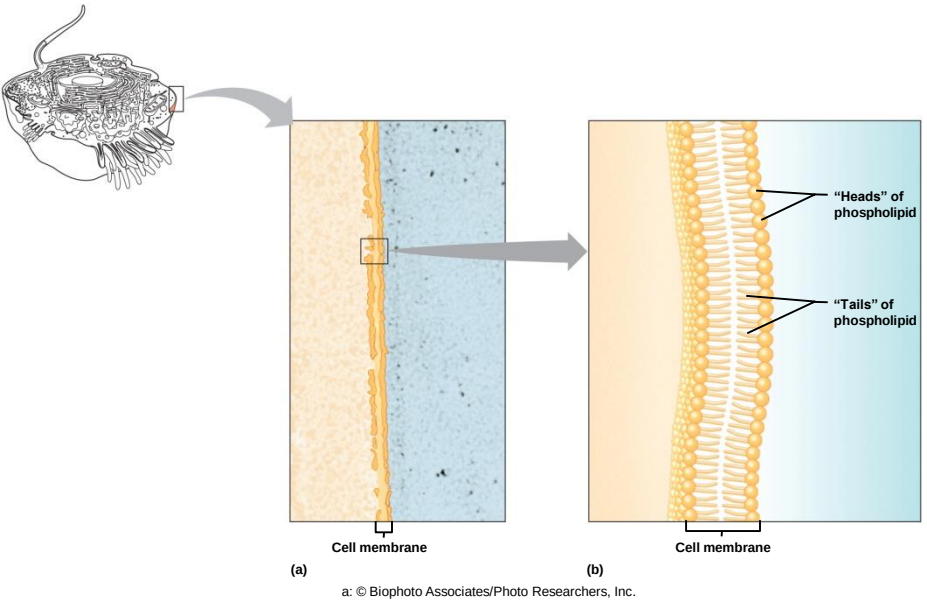


Cell Membrane

- Outer limit/covering of the cell that isolates individual cell from its neighbors.
- Controls what moves in and out of the cell
- Selectively permeable
- Phospholipid bilayer
  - Water-soluble “heads” form surfaces (hydrophilic)
  - Water-insoluble “tails” form interior (hydrophobic)
  - Permeable to lipid-soluble substances
- Cholesterol stabilizes the membrane
- Proteins (Integral/peripheral):
  - Receptors
  - Pores, channels and carriers
  - Enzymes



Cell Membrane



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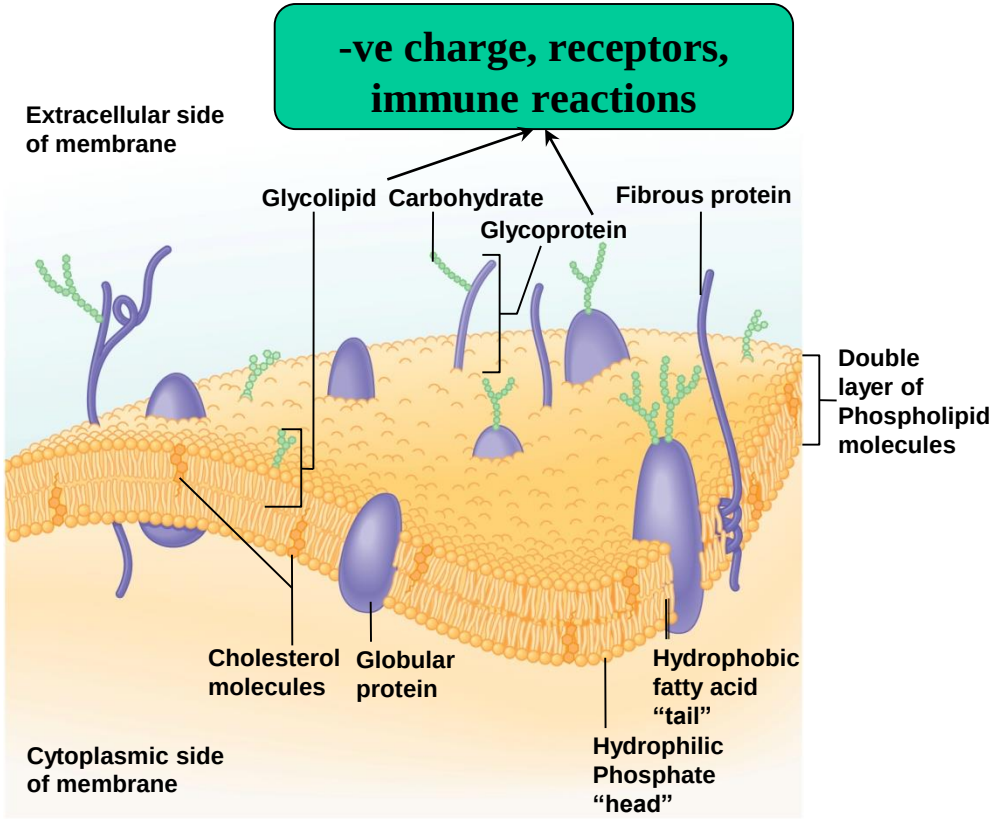
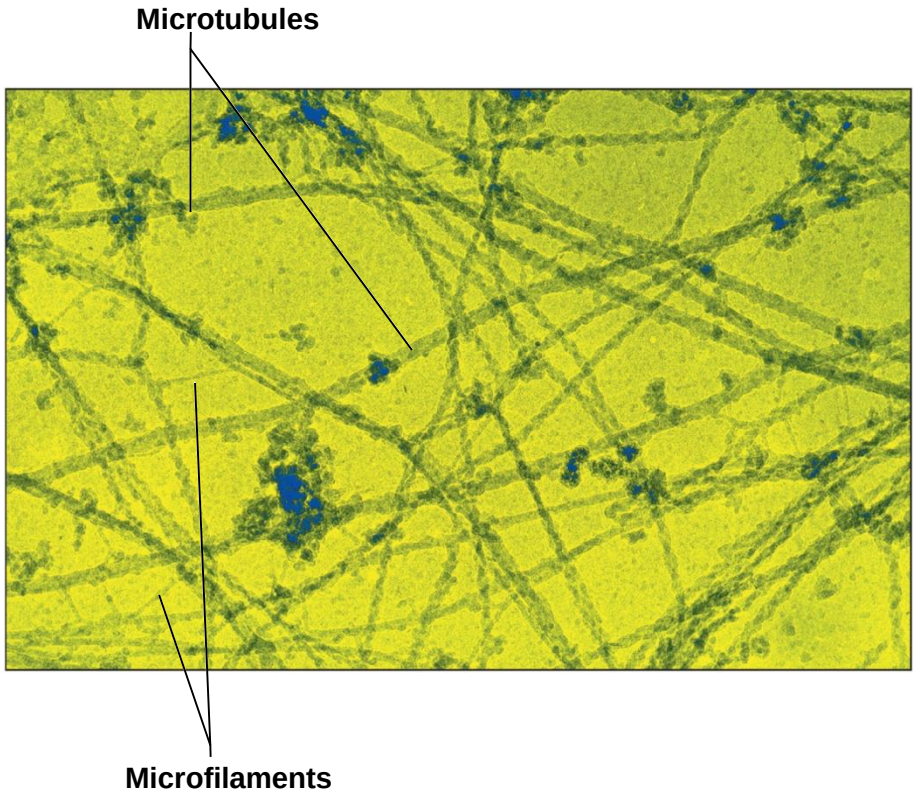


Microfilaments and microtubules

- Thin rods and tubules
- Support cytoplasm
- Form flagellum of sperm
- Form cilia of ciliated epithelium

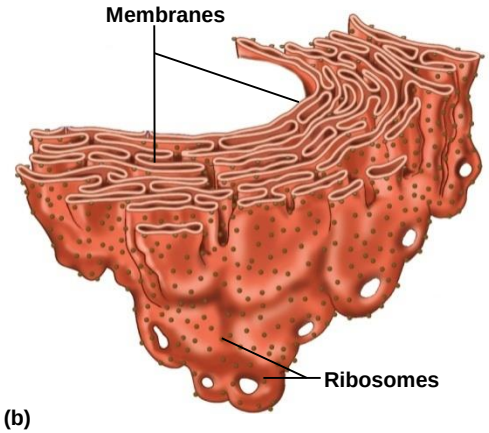


Organelles

Endoplasmic Reticulum (ER)

- Connected, membrane-bound sacs, canals, and flat vesicles

- Rough ER
  - Studded with ribosomes
- Smooth ER
  - Lipid synthesis



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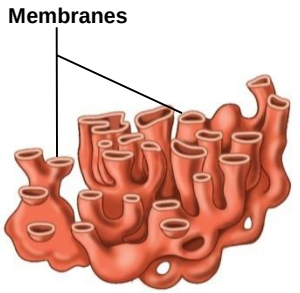


(c)

Ribosomes

- Free floating or connected to ER
- Provide structural support and enzyme activity to amino acids to form protein (protein synthesis)

Organelles

Golgi apparatus

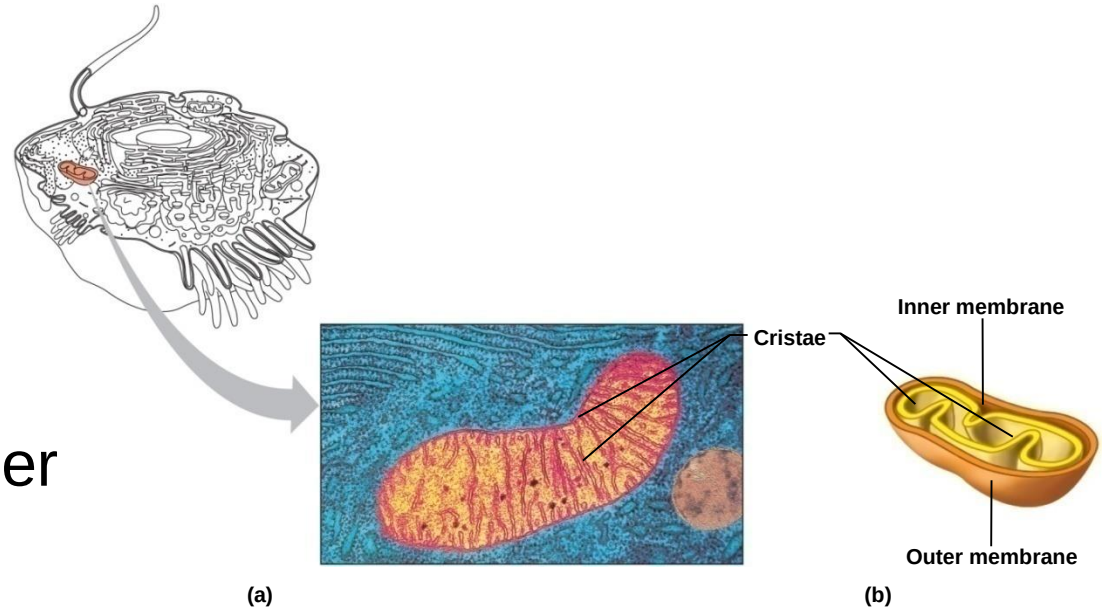
- Stack of flattened, membranous sacs
- Modifies, packages and delivers proteins

Inclusions

- Store substances

Mitochondria

- self replicative with inner partitions
- Generate energy



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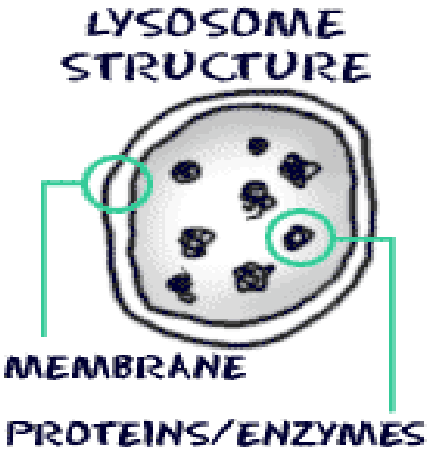
Organelles

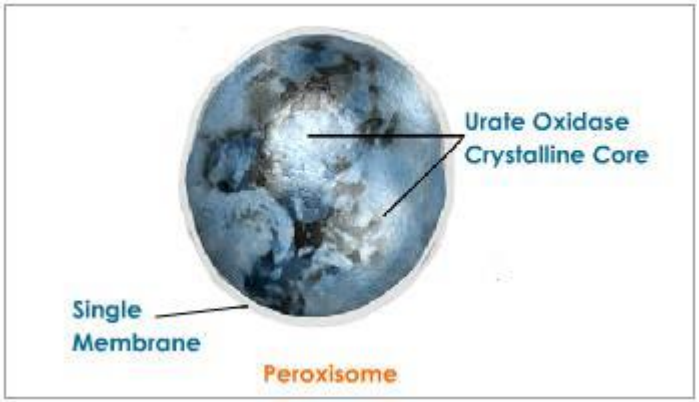
Lysosomes

- Enzyme-containing sacs (lipases, proteases, glycosidase, nucleases, lysozyme)
- Provide an intracellular digestive system.



Peroxisomes

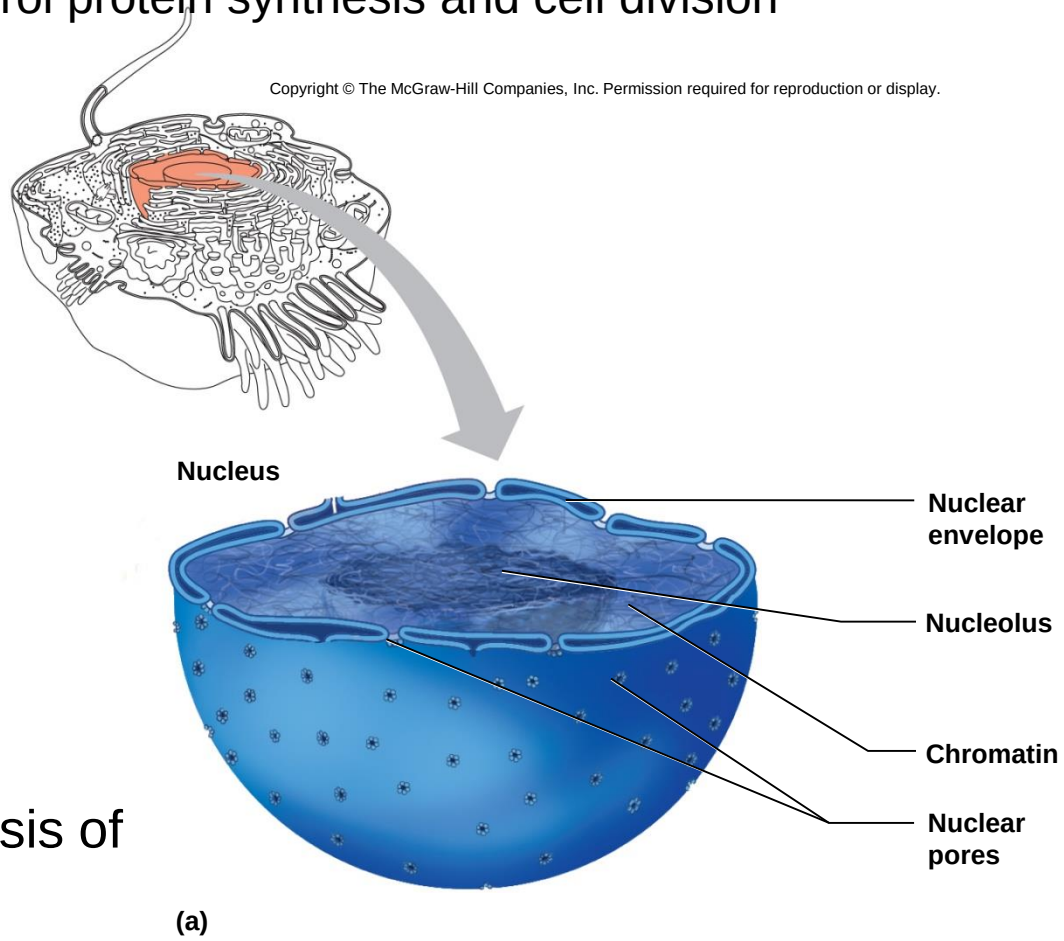
- Enzyme-containing sacs (oxidases, catalases)
- Provide a detoxifying mechanism to cell.



Cell Nucleus

- Is the control center of the cell, control protein synthesis and cell division

- Nuclear envelope
  - Porous double membrane
  - Separates nucleoplasm from cytoplasm
- Nucleolus
  - Dense collection of RNA and proteins
  - Site of ribosome production
- Chromatin
  - Fibers of DNA and proteins
  - Stores information for synthesis of proteins

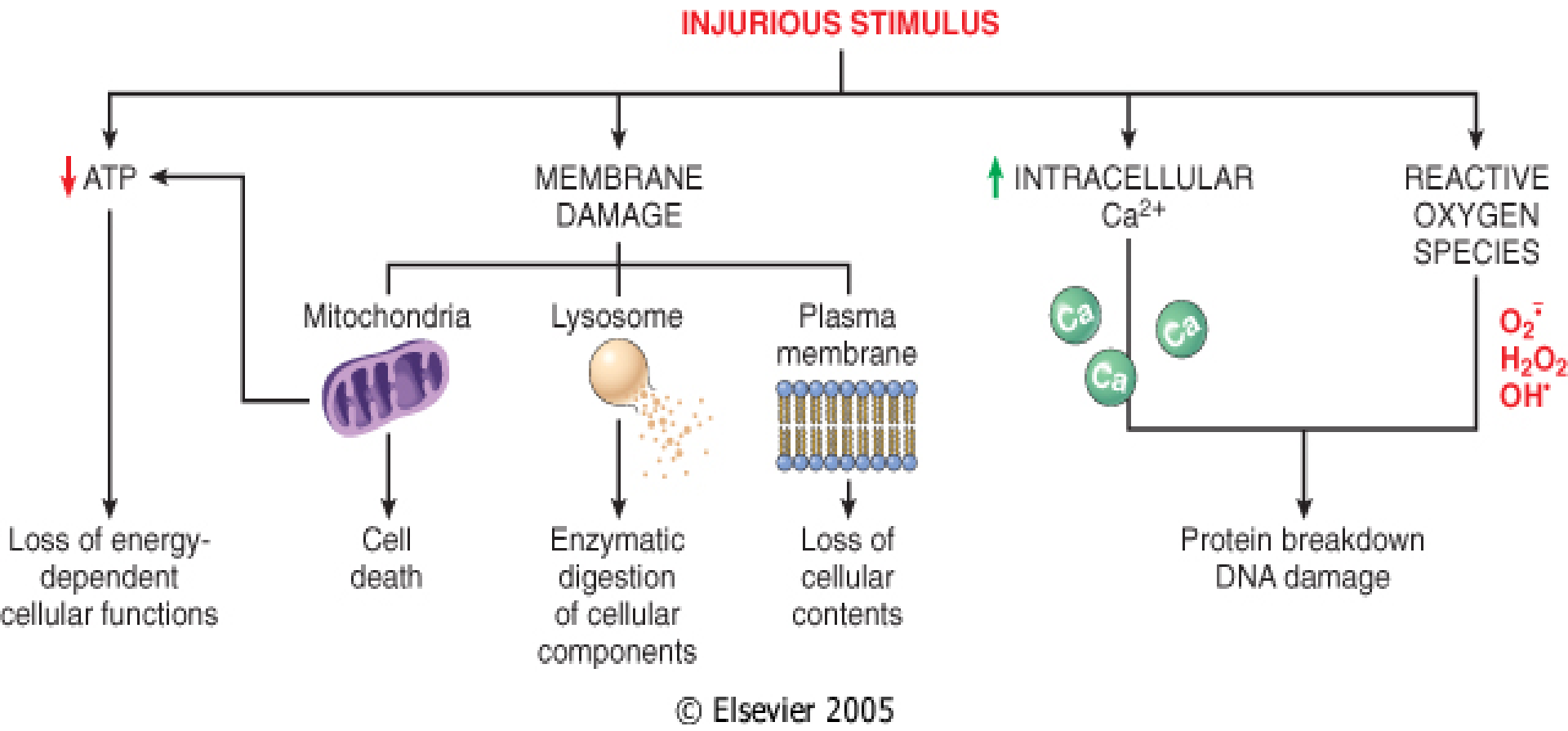


Important targets of injury

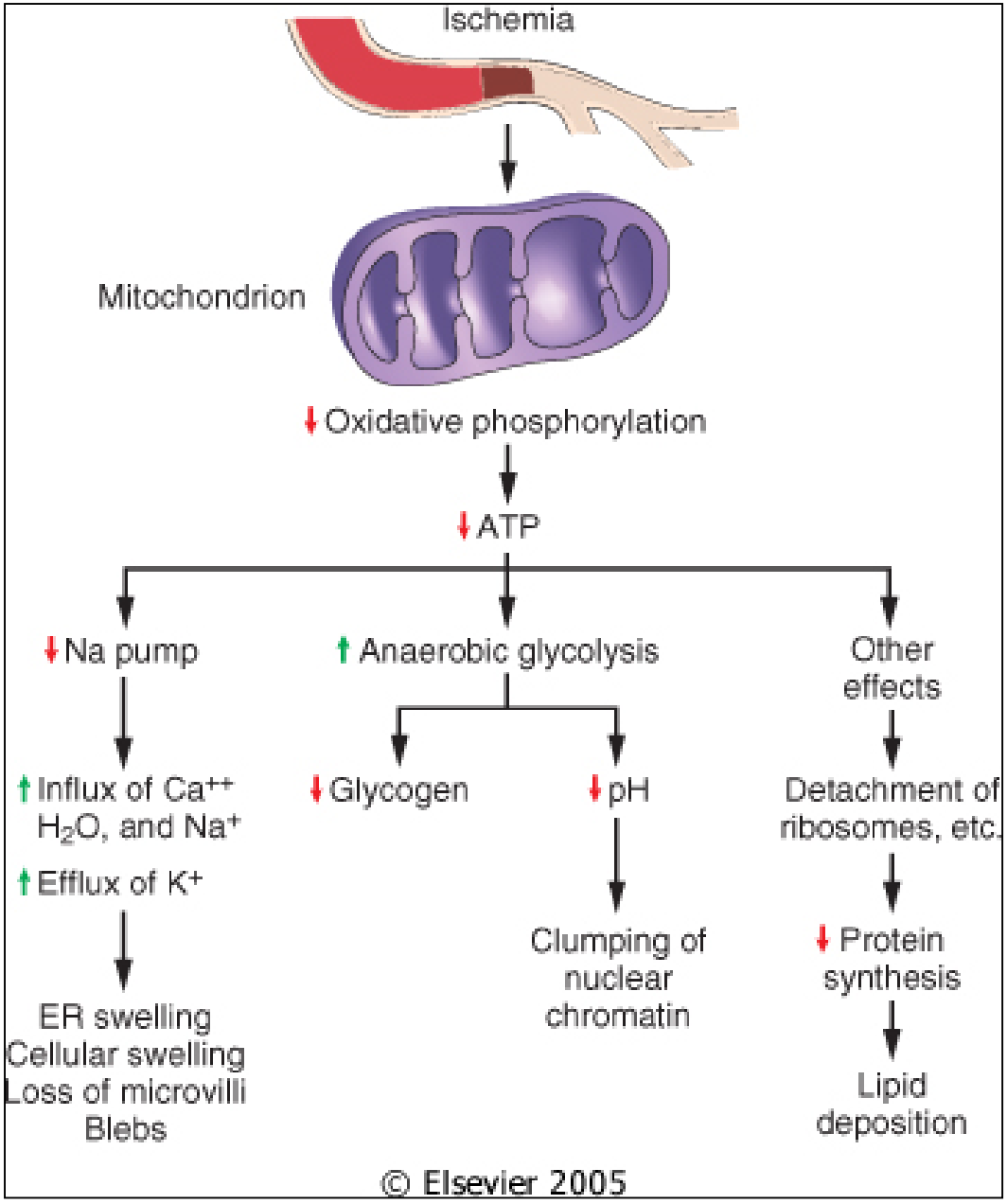
- Mitochondria (aerobic respiration; apoptotic signals)
- Membranes (cell and sub cellular organelles)
- Protein synthesis machinery
- Cytoskeleton
- Genetic apparatus (DNA)

Mechanisms of cellular injury

- ATP depletion
- Mitochondrial damage
- Membrane damage
- Altered ion concentrations (Na, K, Ca)
- Activation of proteases, phospholipases
- Inactivation of enzymes
- Proteolysis of cytoskeleton
- Detachment of ribosomes
- DNA damage



Cellular and biochemical sites of damage in cell injury


Ischemia
Mitochondrion
↓ Oxidative phosphorylation
↓ ATP
↓ Na pump
↑ Anaerobic glycolysis
Other effects
↑ Influx of Ca++ H2O, and Na+
↑ Efflux of K+
ER swelling
Cellular swelling
Loss of microvilli
Blebs
↓ Glycogen
↓ pH
Clumping of nuclear chromatin
Detachment of ribosomes, etc.
↓ Protein synthesis
Lipid deposition
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