COLLEGE OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES

GENERAL BIOLOGY I

(BIO 101)

What is Biology?

What is the origin of life?

PROPOSED THEORIES OF ORIGIN OF LIFE

- THE BIG BANG THEORY: life begins by a collision sparks of atmospheric molecules.

- THEORY OF EVOLUTION

- THEORY OF SPONTANEOUS GENERATION: This states that water or land bears the potential to generate, 'spontaneously', different kinds of organism. The theory implied continuity between living and non-living matter.

- THE CELL THEORY

LIFE BEGINS WITH CELL

- From huge menacing sharks to minuscule exotic orchids, life is very diverse. despite the diversity, all living things (organisms) share certain characteristics which give insight into the nature of life and help distinguish living things from non-living things.
- The complex organization of living things begins with small molecules (non-living: carbon hydrogen, oxygen, and nitrogen) that join to form larger molecules within a cell.
- **A cell is the smallest, most basic unit of life. although a cell is alive, it is made from non-living molecules.**

  Unicellular organisms: one single cell

  Multicellular organism: more than one cell.

- **In multicellular organisms, similar cells combine to form tissues, tissues make up organs (e.g. various tissues combine to form a heart, kidney, leaf etc.). Organs work together in Organ systems (e.g. heart and blood vessels form the cardiovascular system). Various organ systems work together within complex organisms.**

FORMULATION OF THE CELL THEORY:

In 1838, Theodor Schwann and Matthias Schleiden were enjoying after dinner coffee and talking about their studies on cells. When Schwann heard Schleiden describe plant cells with nuclei, he was struck by similarity of these plant cells to cells he had observed in animal tissues.

The two scientists went immediately to Schwann's lab to look at his slides.

Schwann in his book on animal and plant cells (1839), a treatise devoid of acknowledgements of anyone else's contributions, including that of Schleiden (1838) summarized his observations into three conclusions about cells:

- The cell is the unit of structure, physiology, and organization in living things.
- The cell retains a dual existence as a distinct entity and a building block in the construction of organisms.

- Cells form by free-cell formation, similar to the formation of crystals (spontaneous generation).

The first two principles (tenets) are correct, but the third is clearly wrong.

The correct interpretation of cell formation by division was finally promoted by others and formally enunciated in Rudolph Virchow's powerful dictum; 'Omnis cellula e cellula'…….. "All cells arise from pre-existing cells."

Modern Cell Theory

The following statements that represent the modern cell theory:

- All known living things are made up of cells
- The cell is the structural functional unit of all living things
- All cells arise from pre-existing cells by division. (Spontaneous Generation does not occur)
- Cells contain hereditary information which is passed from cell to cell during cell division.
- All cells are basically the same in chemical composition.
- All energy flow (metabolism and biochemistry) of life occurs within cells.

ASSIGNMENT

Give a summarized essay on scientists who have contributed to the knowledge of the discoveries of cells and their various contributions

CELL STRUCTURE ORGANIZATION

LECTURER: DR. E.O. OYEBANJI

OUTLINE

- Overview of cell.
- Cells under the microscope
- The two main types of cells: i) Prokaryotic cell ii) Eukaryotic cell
- Differences between prokaryotic and Eukaryotic cells.
- The bacterial cell (an example of prokaryotic cell).
- The plant and animal cells
- Comparison between plant and animal cells.

OVERVIEW OF CELL

- Both living and non-living things are composed of molecules made from chemical elements such as Carbon, Hydrogen, Oxygen, and Nitrogen.

- The organization of these molecules into cells is one feature that distinguishes living things from all other matter.

- **The cell is the smallest unit of matter that can carry out all the processes of life.**

- Every living thing - from the tiniest bacterium to the largest whale - is made of one or more cells.

  Unicellular- one cell

  Multicellular-more than one cell

The cell theory

Cell Theory consists of three principles:

a. All living things are composed of one or more cells.

b. Cells are the basic units of structure and function in an organism.

c. Cells come only from the replication of existing cells.

Cells can be cultured to produce more cells:

- In vitro = outside organism or cell
- In vivo = inside organism or cell

CELL DIVERSITY

- Not all cells are alike. Even cells within the same organism show enormous diversity in size, shape, and internal organization. The body contains around 10^{13} to 10^{14} cells of around 300 different cell types.

Cell size

1. A few types of cells are large enough to be seen by the unaided eye. The human egg (ovum) is the largest cell in the body, and can (just) be seen without the aid of a microscope.

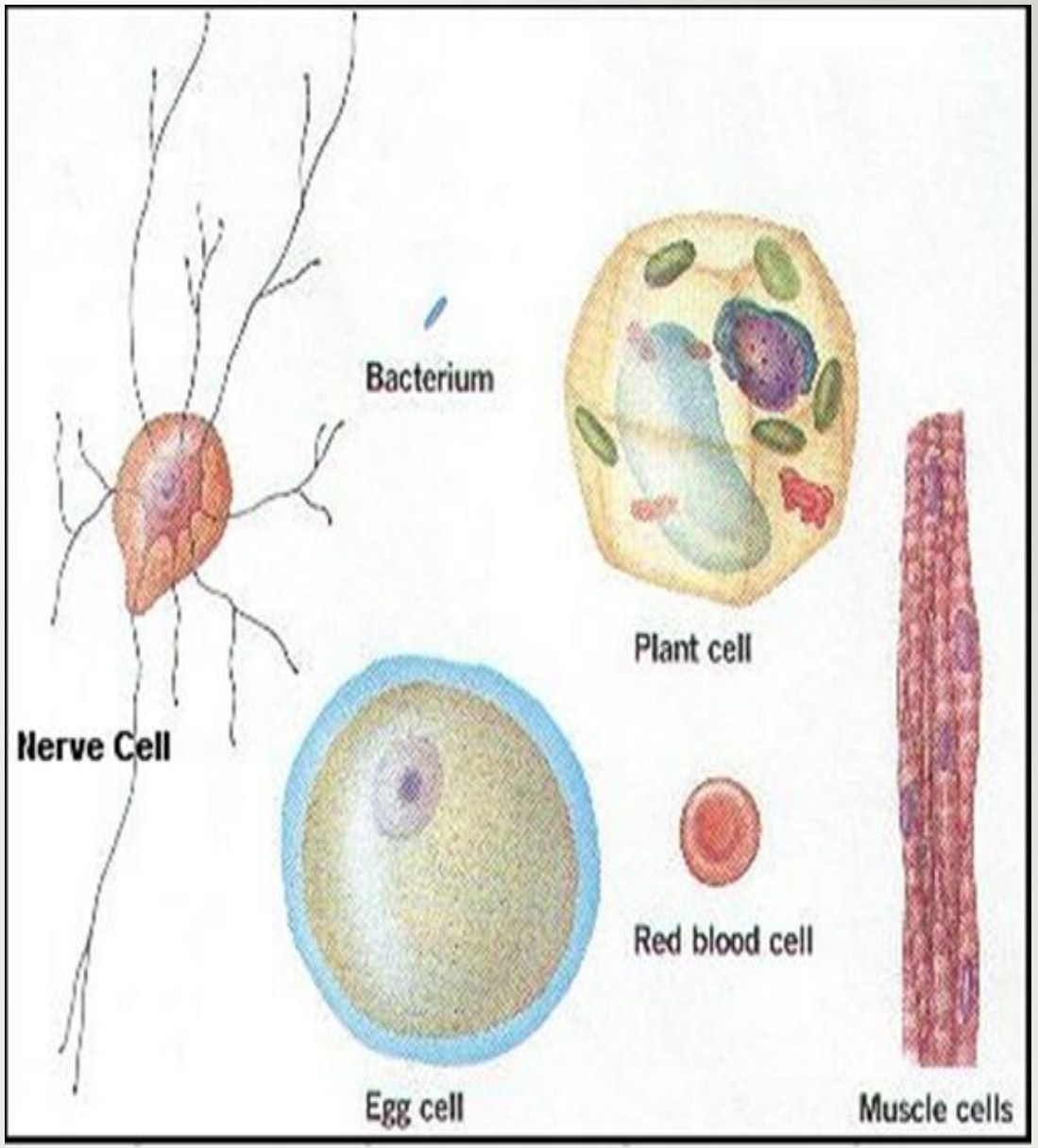
2. Most cells are small for two main reasons:
a). The cell's nucleus can only control a certain volume of active cytoplasm.
b). Cells are limited in size by their surface area to volume ratio.

A group of small cells has a relatively larger surface area than a single large cell of the same volume.

This is important because the nutrients, oxygen, and other materials a cell requires must enter through its surface.

As a cell grows larger at some point its surface area becomes too small to allow these materials to enter the cell quickly enough to meet the cell's need.

Cells come in a variety of shapes, and the shape helps determine the function of the cell (e.g. Nerve cells are long to transmit messages in the body, while red blood cells are disk shaped to move through blood vessels).



VIEWING CELLS UNDER THE MICROSCOPE

- The study of cell structure includes the fields of CYTOLOGY (for cells) and HISTOLOGY (for tissues). The function of cells is studied in CELL PHYSIOLOGY, BIOCHEMISTRY, and CYTOGENETICS.

- The first instrument used in studying cell structure was the light microscope, which remains an important tool today. Subsequently, the TRANSMISSION ELECTRON MICROSCOPE and the SCANNING ELECTRON MICROSCOPE were developed.

- Before an object can be viewed, it is necessary to stain the material and cut it into samples thin enough for a light beam or an electron beam to penetrate them.

- First, the tissue is treated, to "fix" the structures so they will not be altered by the staining and slicing. Usually this is done by using chemicals such as ALCOHOL and FORMALDEHYDE.

- Stains have been developed that react differently with different cell structures, depending on their chemical composition or enzymatic activity.

- The use of stains containing radioactive atoms, known as AUTORADIOGRAPHY, often involves feeding cells specific compounds with radioactive atoms and then observing the distribution of radioactive events on a photographic film emulsion.

Relative Powers of Microscopes:

1. Compound Light Microscope: maximum resolving power = 200 nm (maximum useful magnification = ~1000 X)
2. Transmission Electron Microscope: maximum resolving power = 0.5 nm (maximum useful magnification = >30,000 X)
3. Scanning Electron Microscope: Gives vivid 3-D images, but less magnification than transmission EM.

TYPES OF CELLS

The two main types of cells are the Prokaryotic and Eukaryotic cells. The Archaea which were originally thought to be prokaryotes and very related to the Eukaryotes was recently added.

1. Prokaryotes

- Pro = before; karyon = nucleus
- relatively small - 5 to 10 μm
- lack membrane-bound organelles
- earliest cell type.

The prokaryotes consist of Bacteria (Eubacteria) and Archaea (Archaeabacteria).

The Archaea:

- relatively small - 5 to 10 μm
- lack membrane-bound organelles
- Usually live in extreme environments (e.g. thermophiles, halophiles, etc)

2. Eukaryotes

- Eu = true; karyon = nucleus
- contain membrane-bound organelles
- Evolved from prokaryotes by endosymbiotic association of two or more prokaryotes
- Include Protists, Fungi, Animals, and Plants.

PROKARYOTIC CELLS

- Prokaryotic cells are less complex and are unicellular. They do not have a nucleus and membrane-bound organelles

- Most have a cell wall surrounding the cell membrane and a single, looped chromosome (genetic material) in the cytoplasm

- Example Include bacteria and blue-green algae; Found in the kingdom Monera

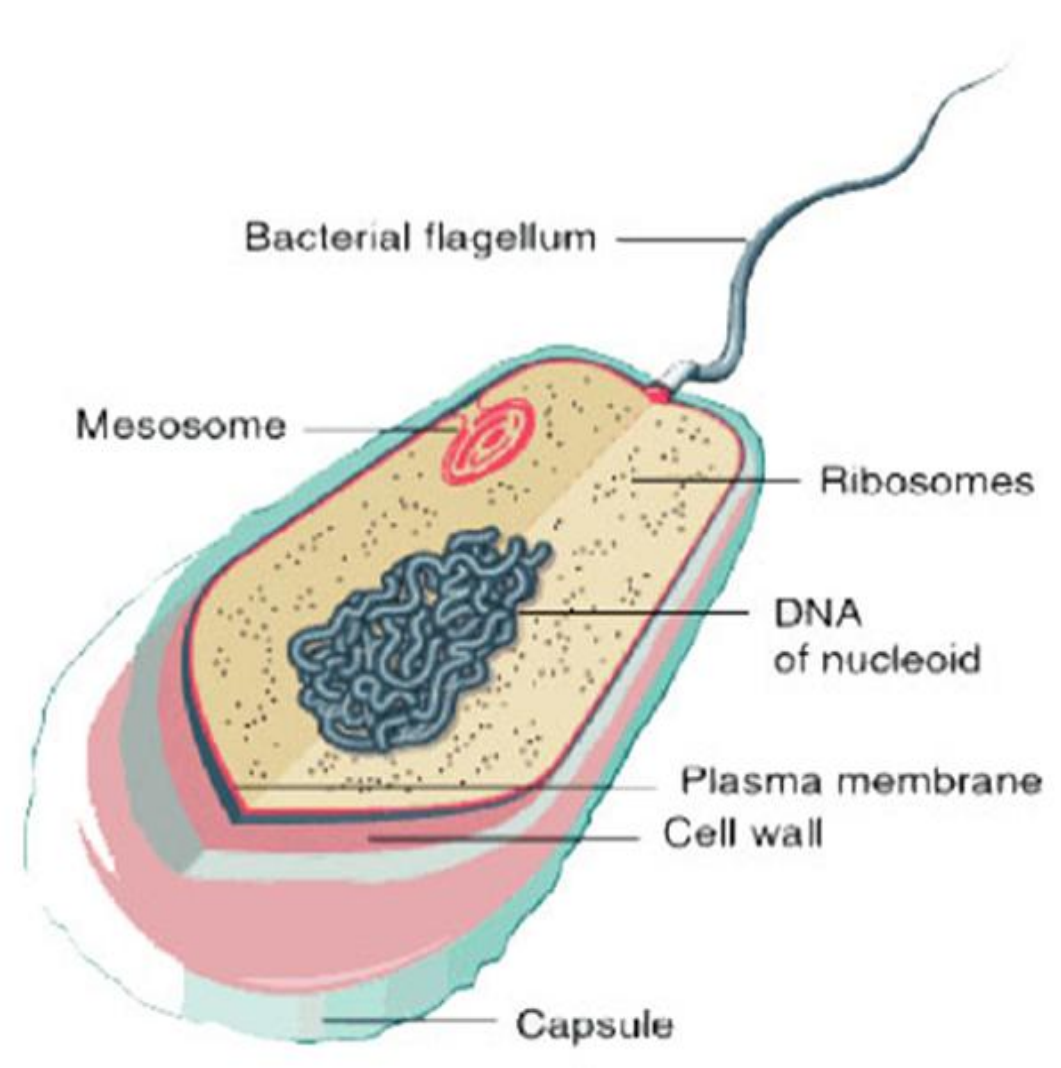


Fig: A bacterial cell

- Capsule - outer sticky protective layer
- Cell Wall - rigid structure which helps the bacterium maintain its shape

this is not the same as the cell wall of a plant cell

- Plasma membrane - separates the cell from the environment
- Mesosome - infolding of plasma membrane to aid in compartmentalization
- Nucleoid - region where the naked DNA is found
- Cytoplasm:

✓ semi-fluid cell interior
✓ no membrane-bound organelles
✓ location for metabolic enzymes
✓ location of ribosomes for protein synthesis

EUKARYOTIC CELLS

- These are more complex cells
- Includes both unicellular and multicellular organisms.
- They possess a true nucleus and membrane-bound organelles.
- Organelles are internal structures in cell that perform specific functions.
- Organelles are surrounded by a single or double membrane.
- The entire cell is surrounded by a thin cell membrane that controls what enters and leaves the cell.
- The Nucleus is located in the center of the cell and contains the genetic material (DNA). It controls the cell's activities

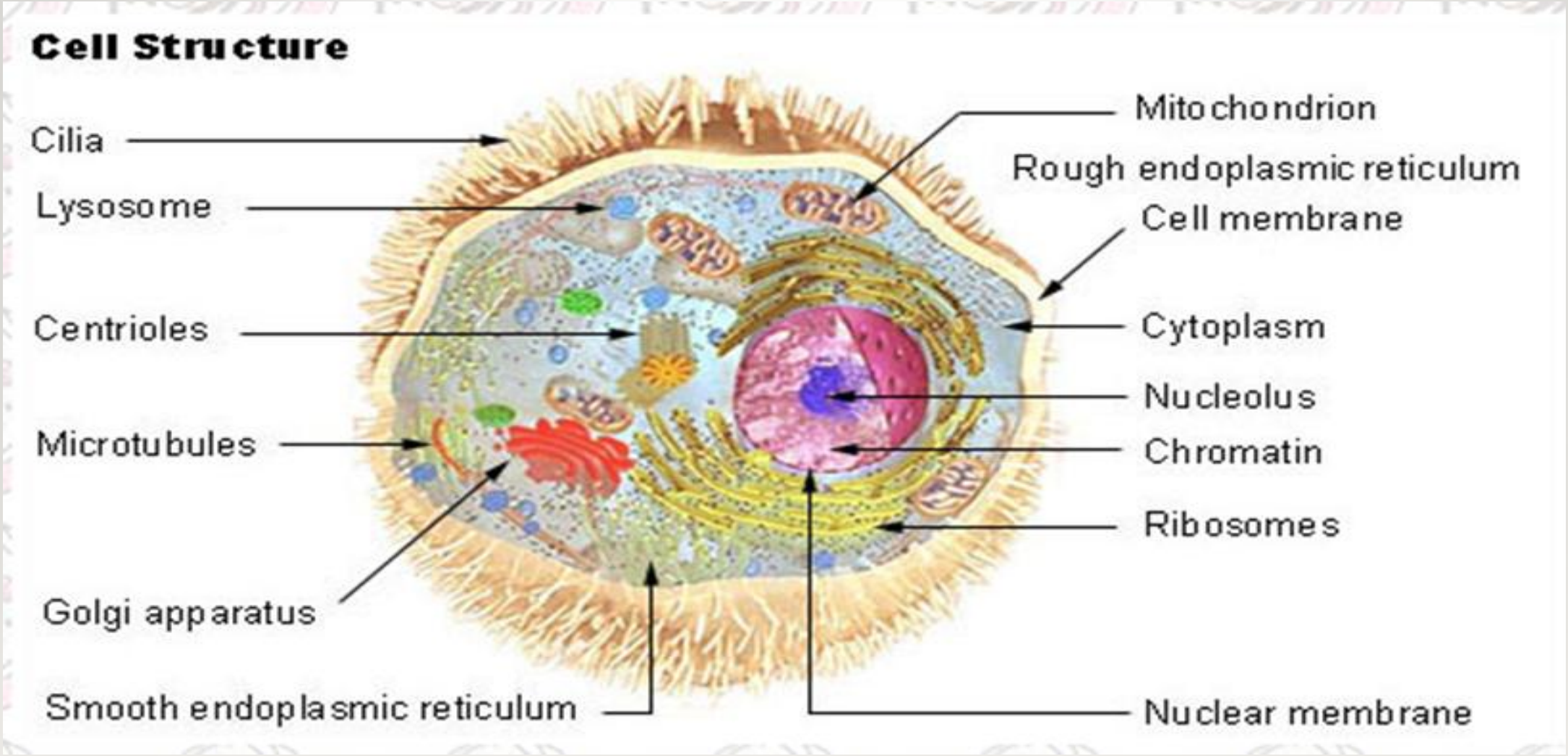
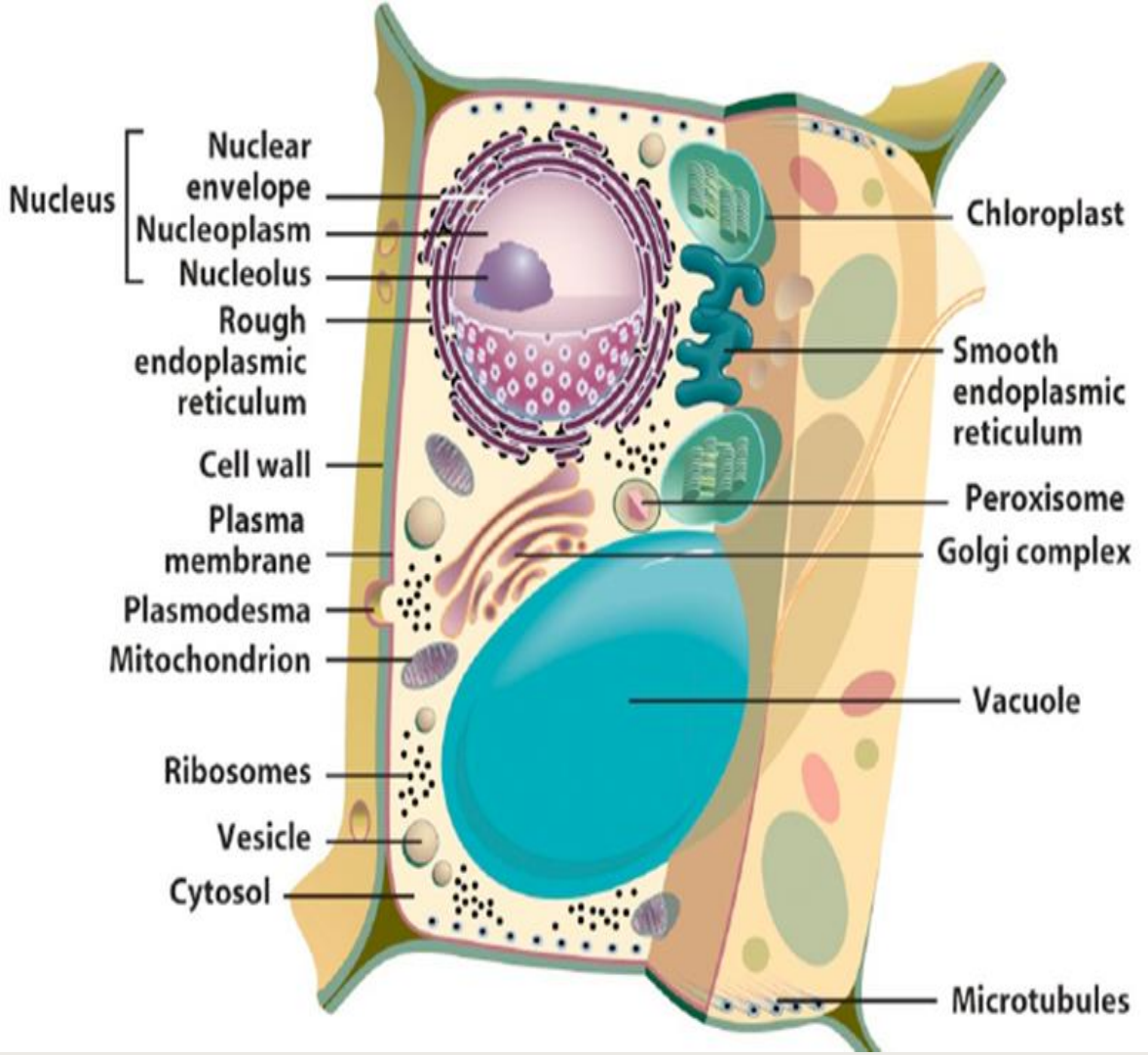


Fig: Structure of a typical Eukaryotic cell

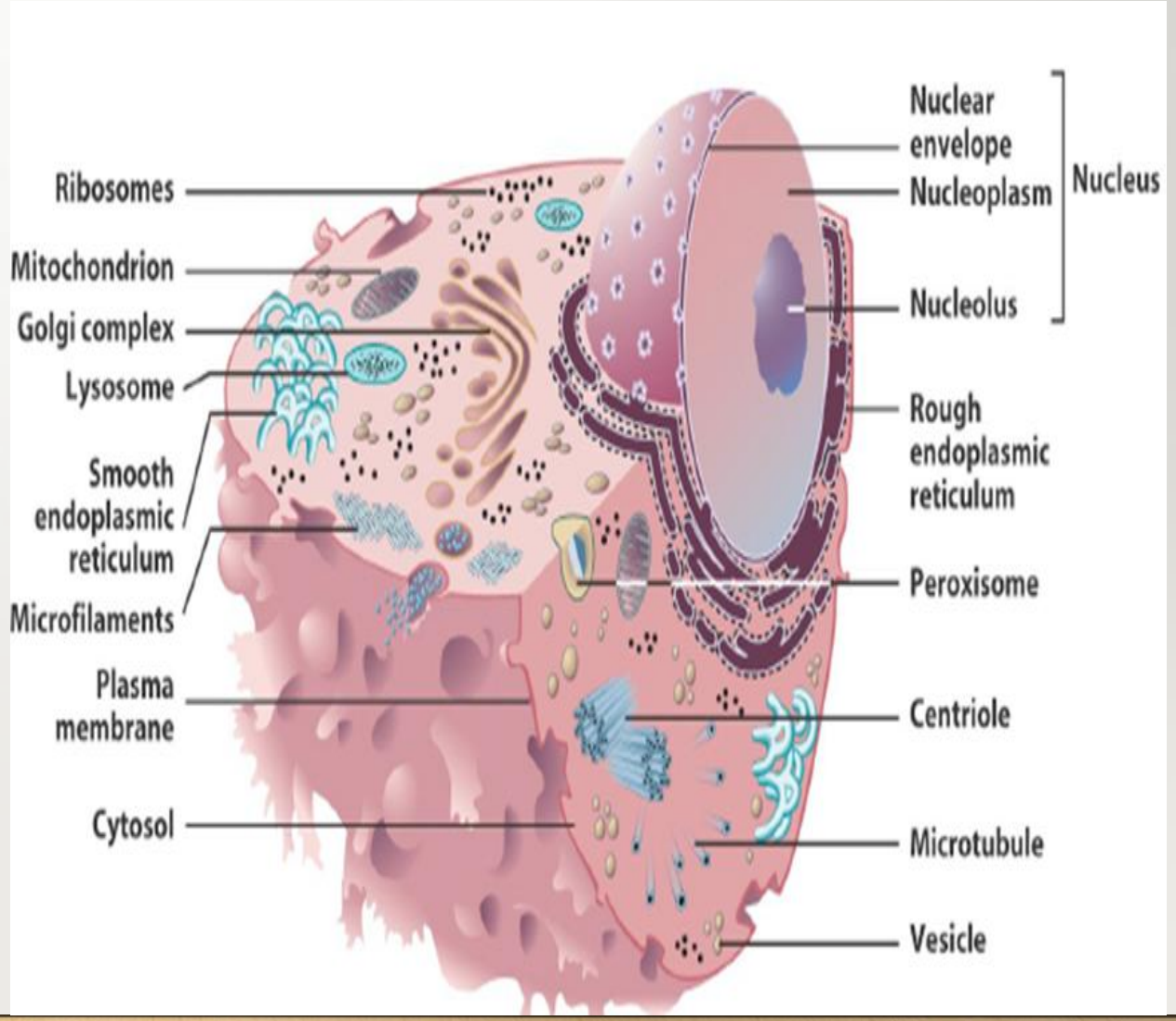
DIFFERENCES BETWEEN PROKARYOTIC AND EUKARYOTIC CELLS

	Prokaryotes	Eukaryotes
Typical organisms	bacteria	Protoctista, fungi, plants, animals
Typical size	~ 1-10 µm	~ 10-100 µm (sperm cells) apart from the tail, are smaller)
Type of nucleus	Nuclear body **No nucleus**	real nucleus with nuclear envelope
DNA	circular (ccc DNA)	linear molecules (chromosomes) with histone proteins
Ribosomes	70S	80S
Cytoplasmatic structure	very few structures	highly structured by membranes and a cytoskeleton
Cell movement	Flagellae/cilia made of flagellin	flagellae and cilia made of tubulin
Mitochondria	none	1 - 100 (though RBC's have none)
Chloroplasts	none	in algae and plants
Organization	usually single cells	single cells, colonies, higher multicellular organisms with specialized cells
Cell division	Binary fission (simple division)	Mitosis (normal cell replication) Meiosis (gamete production)

PLANT AND ANIMAL CELLS



a. A plant cell



b. An animal cell

- Most of the organelles and other parts of the cell are common to all Eukaryotic cells. Cells from different organisms have an even greater difference in structure.

- Plant and animal cells have several differences and similarities. For example, animal cells do not have a cell wall or chloroplasts but plant cells do. Animal cells are round and irregular in shape while plant cells have fixed, rectangular shapes.

- Plant and animal cells are both eukaryotic cells, so they have several features in common, such as the presence of a cell membrane, and cell organelles like the nucleus, mitochondria and endoplasmic reticulum.

- Plant cells have three additional structures not found in animal cells:

- Cellulose cell walls
- Chloroplasts
- A central vacuole.

Comparison between Plant and Animal Cells

	Animal Cell	Plant Cell
Cell wall	Absent	Present (formed of cellulose)
Shape	Round (irregular shape)	Rectangular (fixed shape)
Vacuole	One or more small vacuoles (much smaller than plant cells).	One, large central vacuole taking up 90% of cell volume.
Centrioles	Present in all animal cells	Only present in lower plant forms.
Chloroplast	Animal cells don't have chloroplasts.	Plant cells have chloroplasts because they make their own food.
Cytoplasm	Present	Present
Endoplasmic Reticulum (Smooth and Rough)	Present	Present

Ribosomes	Present	Present
Mitochondria	Present	Present
Plastids	Absent	Present
Golgi Apparatus	Present	Present
Plasma Membrane	Only cell membrane	Cell wall and a cell membrane
Microtubules/ Microfilaments	Present	Present
Flagella	May be found in some cells	May be found in some cells
Lysosomes	Lysosomes occur in cytoplasm.	Lysosomes usually not evident.
Nucleus	Present	Present
Cilia	Present	Most plant cells do not contain cilia.

Comparison between Prokaryotic, Plant and Animal cells

		Eukaryotic	
Structure	Prokaryotic	Animal	Plant
Cell Membrane	YES	YES	YES
Cell Wall	YES	NO	YES
Nucleus	NO	YES	YES
Mitochondria	NO	YES	YES
Chloroplasts	NO	NO	YES
ER	NO	YES	YES
Ribosomes	YES, (small)	YES, large	YES, large
Vacuoles	NO	YES, small	YES
Lysosomes	NO	YES, usually	NO, usually
Cytoskeleton	NO	YES	YES
Centrioles	NO	YES	NO

NEXT LECTURE:

FUNCTIONS OF CELLULAR ORGANELLES