Lecture Number 4: **Eukaryotes II**

Topic:

- Division of labour in eukaryotic cells – organelles working together for cell survival (4: 77 and **5th Edition 4: 85).**
- The endomembrane system **(**4: 85 and **5th Edition 4: 93).**
- Endoplasmic reticulum **(**4: 85-86 and **5th Edition 4: 93-94).**
- Golgi apparatus, cisternae and vesicles **(**4: 86-88 and **5th Edition 4: 95-96).**
- Vacuoles and lysosomes **(**4: 88 and **5th Edition 4: 96).**
- The cytoskeleton in cell development and movement **(**4: 93-98 and **5th Edition 4: 101-106).**
- Actin filaments, microtubules & intermediate filaments **(**4: 93-96 and **5th Edition 4: 102-105)**.
- The cell wall as an important difference between plant and animal cells **(**4: 98 and **5th Edition 4: 106)**.

Lecturer: Dr Alex Johnson, School of BioSciences

Recommended Reading: Citations are provided for both the 4th and 5th Editions of Knox, Ladiges, Evans & Saint" *Biology"* (McGraw-Hill); citations for the 4th Edition are listed first, then the **5th Edition in bold** as Chap., page number, thus: (33: 784 and **5th Edition 34: 834)**

Theme/Objective: To understand the division of labour within eukaryotic cells, particularly the structure and function of the endomembrane system and cytoskeleton.

Keywords/concepts: cisternae, ribosome, endoplasmic reticulum, Golgi apparatus, Golgi stack, lysosome, microbody, vacuole, cell wall, cytoskeleton, actin filaments (also known as microfilaments), microtubules, intermediate filaments.

Summary of Lecture:

1. Division of labour in the cytoplasm: Organelles such as mitochondria and chloroplasts are fully integrated into the cytoplasm of eukaryotic cells, yet clearly carry out specific functions. As we discussed in the previous lecture, these organelles are believed to be derived from ancient endosymbionts. This division of labour within cells is characteristic of eukaryotes. In addition, there are many other membrane-bound organelles of the cytoplasm that carry out specific functions, and these components are generally said to be part of the endomembrane system.

2. The endomembrane system: a system of compartments that generally includes all of the membrane-bound components of the cell except mitochondria and chloroplasts, but including the nuclear envelope. Many components of the cytoplasm appear to be separate in electron micrographs, but they are in fact part of a continuum and are physically joined. The relationship of these membrane-bound components to one another is continually changing. Cells and cellular components are not static, as suggested in electron micrographs, but dynamic. The heart of the system is the endoplasmic reticulum (or ER), but also includes the Golgi apparatus, vacuoles, lysosomes and other membrane-bound vesicles such as microbodies.

3. Endoplasmic reticulum: The heart of the endomembrane system, consisting of membrane cisternae that ramify through the cytoplasm in the form of internal compartments and channels.

4. Golgi apparatus: Consists of flattened stacks of membranes or cisternae, called Golgi stacks, that function in the collection, packaging and distribution of molecules synthesized elsewhere in the cell.

5. Other membrane-bound components of the endomembrane system:

Vacuoles - Most common in plant cells where they may occupy a large portion of the whole cell. Vacuoles are surrounded by a membrane, called the tonoplast, that is similar in structure and function to the cell membrane. Vacuoles have several functions, including the maintenance of osmotic equilibrium, food storage, and use as a waste disposal dump.

Lysosomes contain hydrolytic enzymes for intracellular digestion, digesting either food taken into the cell in food vacuoles, or worn out cellular components. The enzymes are isolated in vesicles to prevent their general release into the cytoplasm.

6. Components of the cytoskeleton: If you were to remove all the organelles and the components of the endomembrane system from a cell, the cell would still retain its shape and be capable of certain movements if energy were available. The non-membrane components of cells responsible for these features of eukaryotic cells are referred to as the cytoskeleton.

Major elements of the cytoskeleton include cytoskeletal molecular motors called “motor proteins” (kinesin & dynein on microtubules and myosin on microfilaments):

a. Actin filaments (also termed microfilaments) - composed of actin protein that forms long filaments. Common motor is myosin.

b. Microtubules - composed of a protein called tubulin which is about 7 - 8 nm in diameter. Tubulin molecules are arranged in 13 protofilaments to form a cylinder that is 25 nm in diameter, but varies considerably in length. Common motors: kinesin & dynein.

c. Intermediate filaments - composed of proteins about 10 nm in diameter.

7. Differences between plant and animal cells: Simply put, plants have chloroplasts, vacuoles and cell walls, and animal cells don't. See these key differences in **Figs. 4.2 and 4.3** in your text (for both the 4^{th} and 5^{th} Editions).