

COURSE CODE: *BIO 204*
COURSE TITLE: *Cell Biology*
NUMBER OF UNITS: *2 Units*
COURSE DURATION: *2 Hours per week*

COURSE DETAILS:

Course Coordinator: Prof M.S. Ayodele
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Office Location: B210, COLNAS Building
Other Lecturer: Dr G.A. Dedeke

COURSE CONTENT:

History and present trends in cell biology. Reproduction, cell division, cell differentiation and growth of cells. A brief study of the molecular basis of cell structure and development, organelles and nucleic acids.

COURSE REQUIREMENTS:

The course is compulsory for all 200 level students of the Biological Sciences and Biochemistry Departments. The candidates are presumed to have had at least, some introductory experience in the study of cells at 100 level through participation in BIO 101. The students are expected to attend and participate fully in all the theory and practical classes with not less than 70% attendance.

READING LIST:

LECTURE NOTES

INTRODUCTION

A deeper exposure to the study of cells is anticipated in BIO 204. Of importance is the emphatic understanding of those limited observations that can be made on the cell under light microscope. The detailed ultra structures especially of cell organelles, which can only be observed at higher magnifications provided by Electron Microscope, must be well noted!

There is therefore, the need for each candidate to ensure a personal experience in the observation and drawing of cells and cell components that can be viewed under the common laboratory light

microscope usually made available in our laboratory. Also necessary is the observation of the different types of plant and animal cells during the laboratory sessions. **This may possibly be the first opportunity and the only one for some of the candidates to actually see those features they had always memorized from textbooks.** This includes exciting observations of dividing cells in MITOSIS and MEIOSIS from animals and especially plants!

Amplified Course Synopsis for personal study

- History and present trends in Cell Biology
- Types of cells (Theory and Practical class on Plant and Animal cells)
- Cell Organelles – form and functions
- Cell multiplication – Forms of Reproduction at cellular level; cell division
- A brief study of the molecular basis of cell structure and development – macromolecules at cellular level: Nucleic acids, Proteins, carbohydrates and lipids
- Cell growth and Cell differentiation
- The Cell Cycle

History and Present Trends in Cell Biology

The cell was recorded to have been discovered by a monk Robert Hooke (1665) when he examined under a coarse, compound microscope very thin slices of cork and saw numerous tiny pores that he said looked like the walled compartment of a monk's cell or cubicle. Hooke by this association called them cells, the name they still bear. However, Hooke's observation gave no indication of the nucleus and other organelles found in most living cells because what he saw and described then were actually non-living cell walls. Anton Van Leeuwenhoek (1674) was the first man to witness a live cell under a microscope constructed by Zacharias Janssen. He described the algae *Spirogyra* and named the moving organisms animalcules meaning "little animals". He probably also saw bacteria. Ludolph Christian Treviranus and Johann Jacob Moldenhawer proposed that cells were separable into individual units. All these finally led Henri Dutrochet formulation of one of the fundamental tenets of modern cell theory by declaring that "The cell is the fundamental element of organization"

Classical Cell Theory:

Cell theory was founded on the observations of Hooke, Leeuwenhoek, Schleiden, Schwann, Virchow and others. The cell theory is a widely accepted explanation of the relationship between cells and living things. The cell theory states as follow: *All living things or organisms are made of cells and their products; New cells are created by old cells dividing into two; Cells are the basic building units of life.*

Credit for the development of cell theory is usually given to three scientists namely Theodore Schwann, Matthias Jakob Schleiden and Rudolf Virchow. Schwann and Schleiden (1839) suggested that cells were the basic unit of life, this theory accepted the first two tenets of modern cell theory but the cell theory of Schleiden differed from modern theory in that it proposed a method of spontaneous crystallization (generation) which he termed "Free Cell Formation". Virchow (1858) stated that all cells come from pre-existing cells, thus completing the classical cell theory.

Modern Cell Theory: This aspect of cell theory has the following generally accepted parts:

1. The cell is the fundamental unit of structure and function in living organisms.
2. All cells arise from pre-existing cells by division.
3. Energy flow (metabolism and biochemistry) occurs within cells.
4. Cells contain hereditary information (DNA) which is passed from cell to cell during cell division.
5. All cells are basically the same in chemical composition in organisms of similar species.
6. All known living things are made up of one or more cells.
7. Some organisms are made up of only one cell and are known as unicellular organisms.
8. Others are multicellular, composed of a number of cells.
9. The activity of an organism depends on the total activity of independent cells

Types of Cells:

1. PROKARYOTES
2. EUKARYOTES

PLANT CELLS:

These are Eukaryotic cells and are different from other cells in several key respects:

1. Large Central Vacuole is present
2. Cell Wall composed of cellulose is present
3. Plasmodesmata, specialized cell-cell communication pathways present
4. Plastids such as Chloroplasts are present
5. They are stationary

ANIMAL CELLS:

These are also Eukaryotic cells that differs from the Plant cells in not possessing all the above mentioned special features.

CELL STRUCTURE:

Cells are fluid filled surrounded by a *cell membrane* or *plasma membrane*. In plants and prokaryotes this is usually covered by a cell wall. The membrane separate and protects the cell from its surrounding

environment and is made from a double layer of lipids called *phospholipid bilayer*. The fluid inside the cell is the *cytoplasm*. The membrane is said to be semi-permeable or selectively permeable.

The cell's shape is organized and maintained by the *cytoskeleton* which anchors organelles in place, helps during endocytosis, the uptake of external materials by a cell and cytokinesis. The eukaryotic cytoskeleton is composed of microfilaments, intermediate filaments and microtubules.

Two different kinds of genetic material exist in the cells namely deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). The biological information contained in a cell is encoded in its DNA or RNA sequence. There are three types of RNA – messenger RNA (mRNA)- transports genetic information and, ribosomal RNA (rRNA)- enzymatic functions in animals that use DNA for the genetic code itself and transfer RNA (tRNA) which are used to add amino acids during protein translation.

The Prokaryotic genetic material is organized in the nucleoid region of the cytoplasm in a simple circular DNA whereas the Eukaryotic genetic material is divided into different linear molecules called chromosomes inside a distinct nucleus.

CELL ORGANELLES:

Cells have a set of “little organs” called organelles, that are adapted and/or specialized for carrying out one or more vital functions. Both prokaryotic and eukaryotic cells have organelles but they are generally more complex in eukaryotes and may be membrane bound.

Several types of organelles are found in the cell, some are solitary (nucleus and golgi apparatus), others are can be numerous in hundreds to thousands (mitochondria, peroxisomes and lysosomes). The organelles are bathed by the cytosol which is the fluid that fills the cell. The organelles include the following:

1. Nucleus (cell's information centre or control tower).
2. Mitochondria (plant and animal cells) and Chloroplasts (plant cell) – referred to as the power house of the cell.
3. Endoplasmic Reticulum (ER) – eukaryotes only – the transport network for molecules targeted for certain modifications and specific destinations. There are two forms of this (a) Rough Endoplasmic Reticulum (RER) and Smooth Endoplasmic Reticulum (SER).
4. Golgi Apparatus – for processing and packaging macromolecules such as proteins and lipids that are synthesized by the cell.
5. Ribosomes – large molecular RNA and protein complex. Act as assembly line where RNA from the nucleus is used to synthesize proteins from amino acids.
6. Lysosomes and Peroxisomes – found in eukaryotes only –where old and worn out organelles, excess food particles, engulfed viruses and bacteria and toxic peroxides (plants only) are digested and destroyed. They are referred to as suicide bags of the cell because they can destroy or detonate the cell itself.

7. **Centrosome – the cytoskeleton organizer (composed of two centrioles) – produces the microtubules of a cell, which is a key component of the cytoskeleton.**
8. **Vacuoles – These are liquid filled spaces surrounded by a membrane for food, extra water and waste storages. Vacuoles of plant cells are usually larger than those of animals.**

CELL CYCLE:

The above is also referred to as *CELL DIVISION CYCLE* and is the series of events that takes place in a cell leading to its division and duplication or replication. In **Prokaryotic cells**, the cell cycle occurs via a process called *binary fission*. In **Eukaryotes**, the cell cycle can be divided into two brief periods: *Interphase* – cell growth stage, accumulation of nutrients needed for mitosis and duplicating its DNA and the *Mitosis (M) phase* – during which the cell splits itself into two distinct “daughter cells”. The cell division cycle is a vital process through which a single-celled fertilized egg develops into a mature organism, and the process by which body structures such as hair, skin, blood cells and internal organs are renewed.

Cell cycle consists of four distinct phases:

1. **Gap 0 (G0) phase:** A quiescent/senescent Stage or resting phase where the cell has left the cycle and stopped dividing.
2. **Gap 1 (G1) phase:** Part of Interphase Stage where the cell increase in size and a checkpoint control mechanism ensures that everything is ready for DNA synthesis.
3. **Synthesis (S) phase:** Part of Interphase stage during which DNA replication occurs.
4. **Gap 2 (G2) phase:** Part of the Interphase stage during which the cell continues to grow and the G2 checkpoint mechanism ensures that all needed materials are ready for entry into the mitosis (M) phase for division.
5. **Mitosis (M) phase** – this is the actual Cell division stage – cellular energy is focused on the orderly division of a single cell into two daughter cells. This phase is broken down into several distinct phases: *prophase, metaphase, anaphase, telophase and cytokinesis* (this last aspect is not strictly part of mitosis but directly follows mitosis during which cytoplasm is divided into two daughter cells).

Practical BIO 204: Items for observation:

1. Simple and Compound Microscope – observation of parts, usage and maintenance care
2. Plant cells of epidermal peel from waterleaf plant and Onion bulbs
3. Animal cells from individual inside-mouth-wall scrapping and drop of self-blood
4. General observation of different histological prepared slides of cells and tissues (plants and animals). These are abundantly available in the Laboratory

Quizzes: 1 unannounced and 1 short-gun. Attendance and participation in Practical class is a serious

condition for success in this course.