COURSE CODE: *BIO 101*

COURSE TITLE: *Introductory Biology 1*

NUMBER OF UNITS: *2 Units*

COURSE DURATION: *2 Hours per week*

COURSE DETAILS:

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COURSE CONTENT:

The Plant Cell. Prokaryotic and Eukaryotic Cells, Cell growth, Cell Division and Reproduction. Introduction to Plant Classification: General characteristics and morphology of cryptogams, pteridophytes, gymnosperms and angiosperms.

COURSE REQUIREMENTS:

This course is compulsory for students of most Colleges in the University. Students are expected to participate in all course activities and have a minimum of 75% attendance to be able to write the final examination.

READING LIST:

1. **Campbell, N.A. *Biology* 4th Ed. New York, Benjamin/cummings Publishing Co, Inc. 1996.**
2. **Uno, G., Storey, R and Moore, R, *Principle of Botany* McGraw Hill, New York.**
3. **Muhammed, S., Amusa, N.A., Soladoye, M.O. and Oyesiku, O.O. *Introductory Botany*. Bisi Bert Printing and Publishing Company, Nigeria**

LECTURE NOTES

THE CELL

A cell may be defined as the standard unit of biological activity bound by a membrane, and able to reproduce itself independently of any other living system. All living organisms, large and small, plant and animal, fish and fowl, man and microbe; are made up of cells. All cells are basically similar to each other, having many structural features in common. Organisms may be composed of only one cell, they are described as being unicellular or of many cells, multicellular. With the exception of eggs, which are the largest cells (in volume) known, cells are small and mostly invisible to the unaided eye. Consequently, our understanding of cells paralleled technical advances in the resolving power of microscopes. Englishman Robert Hooke first saw the remains of dead cells in1665 in a piece of cork as he was using his newly invented microscope and he coined the work "cell" to describe the tiny structures, thinking that they resembled the unadorned cells occupied by the monks. In 1838 Mathias Schleiden, a German botanist, announced that all plant tissues were composed of cells. A year later one of his countrymen, Theodor Schwann, described animal cells as being similar to plant cells. Schleiden and Schwann are thus credited with the unifying cell theory. Some 20 years after the announcement of Schleiden and Schwann, Rudolf Virchow, a great German physician, made another important generalization; cells come only from pre-existing cells.

Cells are separated from their external environment by an interface or plasma membrane. Everything inside the plasma membrane is sometimes referred to as protoplasm, consisting of the jelly like cytoplasm (cyto-cell, plasma-thing) and various structures collectively known as organelles, including the membrane, bound nucleus. Each organelle represents a highly specialized compartment or sub module in which particular functions of the cell are localized.

STRUCTURE AND FUNCTIONS

The Plasma membrane: Typically the eukaryotic cell is enclosed within a thin, sturdy, differentially permeable plasma membrane. This structure regulates the flow of materials between the cell and its surroundings. In some cells, such as nerve cells, the plasma membrane also is involved in intercellular communication. In other cells, such as intestinal epithelium, the plasma membrane is modified into numerous, small, finger like projection called microvilli that increase the surface area of the cell. Chemically, the membrane consists of lipid (fatty material) and protein.

Endoplasmic reticulum and ribosomes: transport, storage and synthesis: the endoplasmic reticulum is visible in great detail with the electron microscope and consists of an extensive network of membrane-enclosed spaces. The space is referred to as the Cisternea. The membrane of the endoplasmic reticulum may appear smooth along their outer surface. However, sometimes the outer surface is filled with small particles called ribosomes, and in this case the endoplasmic reticulum has a coarse appearance and is spoken of as rough. The R.E.R. is found with greater frequency and abundance in cells which are actively synthesizing protein. The manufacture of proteins in the cell is associated with the ribosomes which are dense particles containing protein and ribonucleic acid (RNA).

The E.R. by virtue of its extensive branching, functions in transport, the cisternea of the E.R. apparently function as roots for transport of certain substances within the cell. In some cases, the ER accumulates large masses of protein and acts in a storage capacity.

The Golgi complexes: is a stack of smooth, membranous cisternae that functions in the storage, modification and packaging of protein products, especially secretory products. It does not synthesize protein but may add polysaccharide to the complex. As its products mature, the ends of the cisternea pinch off and become membrane-bound vesicles in the cytoplasm. The contents of some of these secretory products are destined to be exported from a glandular cell. Others may contain digestive enzymes that remain in the cell that produce them. Such vesicles are called Lysosomes (literally "Loosening body", a body capable of causing lysis, or disintegration). The enzymes they contain are involved are so powerful that they kill the cell that formed them if the lysosomes membrane ruptures. In normal cells the enzymes remain safely enclosed within the protective membrane.

Mitochondria: these organelles are conspicuous organelles present in nearly all eukaryotic cells. They are diverse in size, number and shape; some are rodlike, and others are more or less spherical. They may be scattered uniformly within the cytoplasm, or they may be localized near cell surfaces and other regions where there is unusual metabolic activity. The mitochondrion is composed of a double membrane. The outer membrane is smooth, whereas the inner membrane is folded into numerous plate like projections called cristae. These characteristics features make mitochondria easy to identify among the organelles. They are often called' powerhouse of the cell' because enzymes located on the cristae carry out the energy yielding steps of aerobic metabolism. ATP, THE MOST IMPORTANT ENERGY STORAGE MOLECULE OF THE CELLS, IS PRODUCED IN THE ORGANELLE. Mitochondria are self-replicating.

Chloroplast: the food we eat and the oxygen we breathe are produced by organelles called chloroplasts. They are found in green plants. They are disc-shaped bodies containing a green pigment called chlorophyll. The complex chemical processes of photosynthesis take place in the chloroplast where the energy of sunlight is trapped and utilized for the synthesis of complex organic materials from simple inorganic molecules. Each chloroplast is surrounded by two membranes that enclosed its contents and separate if from the cytoplasm. The internal portion of the chloroplast consists mainly of two parts: a fluid matrix (stroma) surrounding a complex membrane. The membrane system generally consists of a series of multilayered fluid-filled discs (grana) resembling a stack of coins and a system of closed flat sacs (lamellae) extending throughout the chloroplast and connecting the grana. Higher plants contain a variety of intracellular bodies called plastids. Usually there are two types; the chloroplasts (colored bodies) and leucoplasts (white or colorless bodies). Chloroplasts belong to the chloroplast group. Other kinds of chloroplasts give many flowers and leaves their kinds of chloroplasts give many flowers and leaves their colors or yellow, orange or red. Leucoplasts serve as storage deposits for the cell and contain oil, starch grains, and protein.

Vacuoles: inner space: the cell may contain fluid filled spaces surrounded by a membrane, called vacuoles. Plants cells have more prominent vacuoles in young plant cells the vacuoles are many and they are rather small, but as the plant ages (gets older). These vacuoles fuse to form a large, conspicuous central vacuole. The hydrostatic (fluid) pressure of the vacuole forces the cytoplasm to the periphery of the cell, and there it remains as a thin layer closely pressed against the plasma membrane. The vacuole of plant cells contains primarily water and some other substances together called cell sap; because cell sap has a higher osmotic pressure than the external medium, water moves into the cell and the cell becomes turgid. It does not burst because it is surrounded by a rigid cell wall. The turgid nature of the plant cell contributes to the strength of certain plant stems and the crispness of vegetables such as celery and lettuce. The plant cell stores a number of important substances in the variety fluids of the vacuole, and these include amino acids, proteins, salts, sugars, and the red pigment anthocyanin. The red color of roses and red onions is due to the presence of anthocynanins in their vacuolar fluid. Vacuoles are formed in animal cells during the processes of pinocytosis and phagocytosis.

Microtubules and microfilament: cellular movement involves two kinds of rod like structures; microtubules and microfilaments. Microtubules are capable of rapid assembly and disassembly and are primarily composed of the protein tubulin. Microtubules are the structural framework of cilia and flagella; in the mitotic spindle, microtubules act to move the chromosomes during cell division. The threadlike microfilaments are smaller in diameter than microtubules and do not contain tubulin. They are often associated with the inner surface of the plasma membrane where they occur in bundles and sheets. The muscle-like contractions of microfilaments are involved in cell movement and changes of cell shape and in cytoplasm streaming.

Centrioles, cilia and flagella: The centriole ("central body") is a dark central body just outside the nucleus. This densely stained granule plays an important role in the division of animal cells. Centrioles are not indispensable during cell division; however the cells of higher plants contain no centrioles, and yet are still capable of dividing properly. The centrioles under the election microscope consist of a circlet of nine microtubules, each of which is further subdivided into three smaller tubules. Centrioles are self replicating.

The surface of many cells has short hair like or long whiplike appendages that move fluid across the surface of the cell. If the cell is free to move on its own, the appendages can propel the cell in a watery medium. The hair like appendages are called cilia and the whip like appendages are called flagella. The cells of the fallopian tubes of the female (human) reproductive system and the cells of the trachea are lined with cilia. Spermatozoa produced in the tests of the human male are motile because of the activity of their lashing tails, which are really flagella.

In cells that bear cilia and flagella, the centriole replicates itself, and the copies migrate to the cell surface, where they become basal bodies that in turn give rise to the cilia and flagella. Every cilium and every flagellum is covered by the plasma membrane, and internal to this is a ring of nine pairs of microtubules surrounding two central tubules. Only the cylinder of nine tubules continues below the cell surface and there it forms the basal body, which appears structurally identical to the centriole. The ability to move rhythmically or to beat is an inherent property of cilia and flagella, and even when detached from the cell, they can be made to move.

Nucleus: The most conspicuous feature of a cell viewed with a microscope is the nucleus. The nucleus is a relatively large structure, spherical or avoids in shape and separated from the cytoplasm by a nuclear membrane. The electron microscope reveals that the nuclear envelope really consists of two membranes and that the membranes have pores that appear to connect the inside of the nucleus (nucleolus) with the cytoplasm. The nucleus contains chromatin and one or denser, granular structures called nucleoli (nucleolus). The chromatin is a complex of DNA and histone and nonhistone protein and carries the genetic information of the cell. Nucleoli are specialized parts of certain chromosomes that carry multiple copies of the DNA information to synthesize ribosomal RNA. After transcription from the nucleolar DNA, the ribosomal RNA combines with several different proteins to form a ribosome, detach from the nucleolus and passes through unclear pores to the cytoplasm. The nucleolus may be thought of as the cell's pacemaker since any change in the activity of the nucleolus will result in a change in the growth rate of the cell.

Prokaryotic and Eukaryotic cells

There are two general classes of cells: the Prokaryotic cell typical of bacteria and bluegreen algae (cyanobacteria), and the Eukaryotic cell found in all other organisms, plant and animal.

The Prokaryotes, meaning literally "before the nucleus" are the simplest cell known. As a rule, these cells are small in dimension: from 0.1 to 0.25um (micrometers) among the mycoplasmas, the smallest cells known, a few micrometer in length and somewhat less in with among the bacteria, and a bit larger in the blue-green algae. The living portion of the cells of bacteria and blue-greens is limited externally by a plasma membrane, outside of which a more or less rigid cell wall and a jellylike mucilaginous capsule or sheath are present. They contain a

single chromosome comprised of a single large molecule of DNA not located in a membranebound
nucleus, but found in a nucleus region, or nucleoid. The DNA is not complexed with histone proteins, and Prokaryotes lack membranous organelles such as mitochondria, plastids, Golgi apparatus, and endoplasmic reticulum. During cell division, the nucleoid divides without visible chromosomes, never by true chromosomes (mitotic) division.
Then Eukaryotes ("true nucleus") is a far more elaborate structured and partitioned unit than is the prokaryotic cell from which it is presumably developed. An internal division of labour has taken place, accomplished by the use of membranes. The exterior of the cell is bound by a plasma membrane to which in the case of plant cells, an outer wall of cellulose and other materials which have been added. The hereditary material is enclosed in a membrane bound nucleus and is segmented into complex nucleoprotein bodies or chromosomes, the number of which is characteristics for each species.

Taxonomy

Deals with description, identification and naming of plants and classification into different groups according to their resemblance and differences mainly in morphological characteristics.

Units of Classification

Species: group of individuals having very close resemblance with one another, structurally and functionally. They interbreed freely and successfully, have same number of chromosomes in 2n (somatic) and n (gametes) cells.
Genus: collection of species which bear a close resemblance to one another as far as the morphological characteristics of the flora in reproductive plants are concerned.

Nomenclature

The name of a plant has two parts. The first refers to the genus and the second to the species. This method of giving two names to a living organism is called Binomial system of nomenclature.
In this system the two names are latinised. The genus starts with a capital letter. Each is underlined/italised. They ARE not underlined when in italics. There are so many systems of classification that have been used in botany today.

☐ Artificial system

☐ Linnanean system

☐ Natural system

☐ Bentham and Hooker's system

☐ Eengler's system

☐ Phylogenetic system

☐ Hutchinson's system

Reproduction in Cryptogams

☐ Any member of Thallophyta, Bryophyta or Pteridophyta may take to one or more of the three methods of reproduction. i.e. (A) Vegetative (B) Asexual (C) Sexual

☐ Vegetative reproduction is by cell division or fragmentation of part of the plant body.

☐ Asexual reproduction is by fission or through various types of spores which could be zoospores(motile spores) or ordinary non-motile spores (Gonidia)

☐ Sexual reproduction takes place by fusion of two gametes. The two games involved may be similar in shape, size, and behavior (isogamy) or may be slightly different in size and behavior (anisogamy). In advanced members gametes become differentiated into male gametes (antherozoids, spermatozoid or microgametes) and female gametes (mega gametes, egg cell or oosphere or ovum).

The fusion of these male and female gametes under this condition is termed oogamy. In oogamous members, the male reproduction cells are small, motile, ciliated, active and initiative while the female gametes are large, non-motile, non-ciliate, passive and receptive. The oosphere is retained in the oogonium.

Alternation of generation

The life cycle (life history) of many flowerless plants especially the higher algae, bryophytes and the pteridophytes is completed in two alternating stages or generation which differ in morphology (body structure) and mode of reproduction. The sporophyte or saprophytic or asexual generation reproduces by spores while the gametophytes or gametophytic or sexual generation reproduces by gametes. One generation gives rise to the other for the life history to be complete. The sporophyte to the Gametophyte and the Gametophyte to the sporophyte. Therefore, two generations regularly alternate with each other. This phenomenon is termed alternation of generations. In terms of chromosome number, the gametophyte with nchromosome fuse to give a zygote with 2n chromosome (Diploid). The zygote develops into the sporophyte with 2n number of chromosome.

Meiotic division in some cell of the saprophytic takes place to give haploid spores with n chromosomes. This haploid spore gives the gametophyte which is also haploid.

Bryophytes (Bryophyta)

The Bryophytes comprise land inhabiting autotrophic plants which prefer moist and shady places. Vascular tissues are absent. True roots are absent. They have root-like structures called the Rhizoids which help in anchorage and absorption of water and nutrients from the soil. Bryophytes show an advance over most algae by the development of archegonia, multicellular antheridia and a distinct alternation of generation. The sporophyte is dependent on the gametophyte in the Bryophytes. The gametophytic plant body is either thalloid (flattened) as in the liverwort or a leaf shoot (Axial) as in the mosses. The Gametophytes predominates in the Bryophyta.

THE PTERIDOPHYTES

The pteridophytes are seedless vascular plants. They differ from the bryophytes in three key respects.

i. The sporophytes does not remain attached to (a much reduced) gametophyte

ii. It has true vascular tissues

iii. It is larger, long lived phase of the life cycle

Most pteridophytes live in wet humid places, and their gametophytes lack vascular tissues. Good examples are the lycopodium, sellaginella, Fern (Dryopteris)

ANGIOSPERM MORPHOLOGY

Angiosperms are flowering and seed-bearing plants. They are higher plants with well developed root and vascular tissues. Angiosperms are the most successful and most abundant group of plants. They provide most of man’s food and raw materials. Over 250,000 species have been reported.

Factors responsible for the success of Angiosperm

a) Variability in structure
b) Genetic flexibility
c) Efficient pollination and fertilization mechanisms
d) Production of large number of seeds
e) Fast rate of growth
f) Short life cycle
g) Self fertility/bisexuality etc.

The angiosperms dominate the vegetation of West Africa and they are grouped into two classes namely monocotyledons and dicotyledons.

There is great variation among plants and they are grouped or classified based on the similarities and differences that exist among them. This process of grouping plants is known as classification. To classify plants, it is essential to have good knowledge of the variation in the features of the plants hence the need to study plant morphology.

The word Morphology was derived from two Latin words Morphe= form and Logos= study. Plant morphology deals with the study of forms and features of different plant organs such as roots, stems, leaves, flowers, fruits and seeds.

Binomial system of nomenclature

The first of the two names is the generic name, while the second name is the specific name. The first letter of the generic name is written in capital letter, while the specific name is written in small letter all through. The two names should be underlined separately or italicized when in prints.

Plants are also known by their common and vernacular names which may vary in different localities, cultures and tribes.

DESCRIPTION OF PLANTS

Plants can be described or classified based on criteria such as size, habit, habitat, life span, behavior etc.

Description based on size

Plants can be described as tree, shrub or herb based on their size.

Trees are plants with single hard or woody trunk that carry branches well above the ground. E.g. *Mangifera indica*, *Khaya senegalensis*, *Delonix regia*, *Terminalia catapa* etc.

Shrubs are plants or small trees with two or more woody trunks that developed from a single rootstock e.g. *Hibiscus* sp, *Ixora* sp, *Acalypha* sp etc.

Herbs are small plants with soft, fleshy stem e.g. *Talinum triangulae*, *Ageratum conyzoides*, *Lactuca sativa* etc.

Description based on duration of life

Based on life span, plants can be described as annuals, biennials and perennials.

Annuals are plants that complete their life cycle in one season i.e. one year e.g. *Oryza sativa*, *Zea mays*.

Biennials are plants that complete their life cycle in two seasons i.e. two years e.g. *Allium cepa*, *Manihot esculenta*.

Perennials are plants that live for more than two years e.g. *Triplochyton scleroxylum*, *Milesia excels*, *Hildergadia barterii* etc.

Description based on habitat

Plants are also described based on their habitats. Many plants have also developed features that adapt them to their specific habitats.

Mesophytes or land plants are plants growing in regions with average temperatures and moisture

e.g. *Tithonia diversifolia*, *Euphorbia heterophylla* etc.
Xerophytes are plants growing in the desert or dry places e.g. *Cactus* sp., *Euphorbia* sp., *Aloe* sp,.
Hygrophytes are plants growing in moist aand shady places e.g. Ferns, some grasses
Hydrophytes are plants growing in aquatic places e.g. water lettuce (Pistia), water hyacinth (*Eichhornia* sp), water lily,
Halophytes are plants growing in saline soil or water e.g. *Rhizophora* sp., *Kandelia* sp., Mangrove plants etc.

Description based on nature of stem

Plants can be described as erect or scandent based on the nature of their stems.
Erect plants are those with strong stem that can stand on their own without any support.
Scandent plants are those having weak, long stem with diffuse branches which cannot carry the plant upright.
Scandent plants are called climbers if they attach themselves to other plants or objects by some means. Examples are rootlet climbers e.g. *Piper guinense* , hook climber e.g. *Bougainvillea*, tendril climber e.g. *Gloriosa superb*, *Passiflora edulis* and stem climbers or twinners e.g. *Dioscorea* sp., *Vigna* sp.
Lianes or lianas are very thick and woody perennial climbers usually found in the forest. They climb round their supports e.g. *Entada gigas*. Other scandent plants are scramblers and stranglers. Scramblers do not attach to their support but simply lean against nearby plants and spread over them e.g. *Combretum* sp while stranglers start their life from seed which grow on the host or near the host.

Description based on behavior of plants

The following plant types exist in this description
Plant parasites: these are plants living on other living plants. They could be total parasites e.g. Cuscuta or partial parasites eg. Mistletoe.
Epiphytes: these are plants that grow on other plants but they produce their food by themselves. They only attach themselves to the external part of the host e.g. Orchids
Saprophytes: these are plants that grow on dead plants or decaying organic matter e.g. Monotropa
Carnivorous plants capture insects and feed on them e.g. *Bladder wort*, Venus fly-trap, *Butter wort*, Pitcher plant etc
Symbionts are two organisms living together as if they are part of the same plant and the two organism benefit from the relationship. The relationship is called symbiosis e.g. Lichen which is the association of fungi and blue green algae which is seen as green patches on tree trunks and old walls.

THE ROOT SYSTEM

The root is the organ of the plant found in the ground that develops from the embryonic radical
REGIONS OF THE ROOT
A typical root is made up of 3 regions that contain cells that are engaged in different cellular activities and the root cap.
The three regions are for cell divisions, cell elongation and cell maturation.
The root cap protects the root apex as it penetrates the soil. The cells of the root cap is regenerated as it is been worn off in the process of soil penetration.
REGION OF CELL DIVISION
This is the apex of the root containing meristematic cells that undergo repeated divisions. Cells

produced in this region are directed downwards towards the root cap and upwards towards the region of cell elongation.

REGION OF CELL ELONGATION

The cells in this region undergo rapid elongation and enlargement and are responsible for the growth in length of the root

REGIONS OF CELL MATURATION

Cells in this region undergo maturation and differentiation into various kinds of tissues. Roots hairs are produced in this region for absorption of water and mineral salts from the soil.

FUNCTIONS OF THE ROOT

☐ Absorption of water and mineral salts from the soil

☐ Anchorage of the plant to the soil

☐ Conduction of the absorbed water upwards to the stem

☐ Storage of food in some plant species

TYPES OF ROOT

There are two main forms of root, namely the Tap root system and Fibrous root system. In the tap root system, there is a main or primary root or tap root from which smaller branch roots or lateral roots or secondary roots develop. The secondary roots can also produce smaller branch roots called rootlets or tertiary roots. This type of root system is found in the dicotyledonous plants e.g. *Amaranthus* sp, *Chocorus* sp.

THE STEM

The stem is the ascending portion of the axis of the plant, developing directly from the plumule and bears the leaves, branches and flowers. On the stem are nodes and internodes. Leaves and branches develop from the nodes. Stems are usually terminated by either vegetative of floral bud. When the stem or branch ends in a vegetative bud, it continues to grow upwards or sideways. Growth of stem ceases when it is terminated by a floral bud. Buds occurring in the axil of leaves are termed axillary buds.

Functions of stem

☐ The stem bear the leaves and flowers and spread them out on all sides for proper functioning i.e. light reception and pollinator attraction.

☐ Stem conducts water and mineral salts from the root to the leaves

☐ Conduction of prepared food from the leaves to other parts of the plant

☐ Storage of water and food in some species

☐ Young green stems perform photosynthesis to compliment the leaves

☐ Stem is used to for vegetative propagation in some plants species

☐ Some stems especially the underground stems are useful for perennation

Types of stem

Stem could be either aerial or underground. Aerial stems are those existing above the ground, while underground stems remain under the ground, producing aerial shoots when the conditions are favorable. Underground stems are useful for food storage and perennation.