EDO UNIVERSITY IYAMHO
Department of Biological Science
PBB 111: Introduction to Plant Biology and Biotechnology

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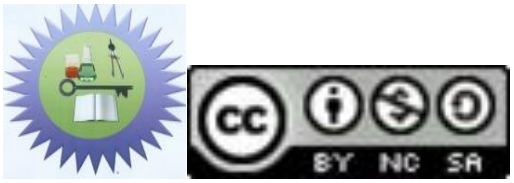
General overview of lecture: This course is intended to give the students a basic knowledge of the concept of Plant Biology and biotechnological applications.

Prerequisites: Students should be familiar with the concepts in basic plant biology, such as diversity and Classification of living organism, habits, and life forms, mode of nutrition, size and shape.

Learning outcomes:
At the end of this lecture, students should be able to:

- Explain the different levels of organization of life
- Recount the roles of different scientists in the discovery of the cell
- Differentiate between prokaryotic and eukaryotic organisms
- State the functions of the different parts of the plant cell
- Explain what biology is, relating it to the environment and things around us.
- Differentiate living from non-living things.
- Distinguish between the various study areas related to biology.
- Explain what biotechnology means
- Discuss the merits and demerits associated with biotechnology
- Relate different organisms with different habitats.
- Differentiate between habitat and plant habit.
- Identify the different plant habits on the field.
- Discuss the different modes of nutrition.



- Understand the Concept of Biodiversity
- Understand the reason for classification of living organism
- Understand the characteristics and the evolutionary relationships among groups of plants.
- Demonstrate hands-on practical on Cladogram construction using specimens of different groups of the plant kingdom

Assignments: We expect to have a minimum of 5 individual homework assignments throughout the course in addition to a term paper write-up and Final Exam.

Grading: We will assign 10% of this class grade to homework, 5% for term paper, 15% for the continuous assessment test and 70% for the final exam.

Textbook: The recommended textbooks for this class are as stated:
Title: Progress in Botany
Authors: U. Luttge, W. Beyschlag, B. Budel, D. Francis
Publisher: Springer-Verlag Berlin Heidelber
ISBN 978-3-540-68420-6

Title: Botany: Plants, People and the Environment
Authors: Linda R. Berg Ph.D
Publisher: Thomson Higher Education
ISBN-13: 978-0-534-46669-5

Main Lecture

What is biology?

Biology is the science that deals with the **study of life**, the **interrelationship between diverse forms of living things** and their **environment.**

- Bios meaning 'life'
- Logos meaning 'study or discourse'

Life represents the presence of the processes that make a thing living. These processes are referred to as the characteristics of living things

Characteristics of living things

1. Nutrition	They take They take in nutrients from organic substances and mineral ions for growth and tissue repair.

2. Excretion	They remove toxic materials, waste products of metabolism and substances in excess by chemical reactions in the cells.
3. Respiration	They exchange gases within their cells and the external environment.
4. Sensitivity	They respond to changes in their environment (response to stimulus).
5. Reproduction	They have the ability to perpetuate life and produce new offspring with same general characters, ensuring continuous survival of species.
6. Growth	They increase in size by increasing cell numbers and cell size from within, using nutrients obtained from food.
7. Movement	They change position, either by moving from place to place or by moving parts of their bodies in response to stimulus.

There are over 100 related study areas and career prospects in biology. Some of which would be briefly defined as we proceed. However, there are two major branches of biology. They are:

i. Plant biology also known as botany (derived from *botane*, which means herb).
ii. Animal biology also known as zoology (derived from *zoon*, which means animal).

For the sake of this course, our focus would be mainly on plant biology. Let's briefly discuss the history and scope of plant biology.

What is plant biology?

Plant biology can be defined as the science that deals with the **study of plants**, **how they interact with other organisms and the environments they live in.**

History of plant biology

- **Refer to assignment 1 and recommended textbook for the history of plant biology**

Scope of plant biology

This science investigates the internal and external structures of plants, their functions in regards to nutrition, how they grow, move and reproduce, their modes of adaptation to different conditions of the environment, their distribution in space and time, their life history, relationships and classification, the laws involved in their evolution from lower and simpler forms to higher and more complex forms, the laws of heredity, the uses of plants and the different methods that can be adopted to improve plants for the use of mankind.

Related study areas

1. Plant Anatomy: The study of microscopic (internal) plant structure (cells and tissues).
2. Plant Morphology: The study of macroscopic (external) plant form (development of leaves, roots and stems).
3. Plant Physiology: The study of functions and vital processes of plants.
4. Plant Cytology: The study of the structure, function and life history of plant cells.
5. Plant Ecology: The study of relationships between plants and the world they live in.
6. Plant Genetics: The study of inheritance and genetic constitution of an organism.

	DISTINGUISHING FEATURE	**PLANTS**	**ANIMALS**
1	Growth	Regions of growth are localized (apical and intercalary). Growth continues until death.	All parts grow simultaneously. Growth ceases before death.
2	Chlorophyll and plastids	Present in all plant cells except fungi and parasites.	Absent in all animal cells.
3	Cell-wall	Present.	Absent.
4	Cellulose	Present in plant cell wall, except fungi.	Absent.
5	Food	Can manufacture own food.	Cannot manufacture own food.
6	Movements	Fixed to support except some lower plants.	Can move freely.
7	Organs	Some are simple or even absent.	Highly developed organ systems.
8	Utilization of Carbon dioxide	Can utilize CO_2 in the atmosphere.	Cannot utilize CO_2 in the atmosphere.
9	Sensory system	They have either no or very basic ability to sense.	They have much more highly developed sensory and nervous system.

7. Molecular biology: The study of the structure and function of biological macromolecules.
8. Biochemistry: The study of chemical aspects of plant life processes and chemical products from plants.
9. Biophysics: The application of physics knowledge to plant life processes.
10. Systematics: The study of evolutionary history and relationships among plants.
11. Taxonomy: The discipline of identifying and naming plants.
12. Plant breeding: The field concerned with development of better types of plants.
13. Plant pathology: The study of diseases of plants.
14. Paleobotany: The study of the biology and evolution of plant fossils.
15. Algology: The study of algae.
16. Mycology: The study of fungi.
17. Lichenology: The study of lichens (dual association of alga and fungus).
18. Horticulture: The science and art of growing and selling medicinal/ornamental plants, vegetables and fruits.
19. Forestry: The science of creating, managing, using, conserving and repairing forests and its resources for man's use.
20. Agronomy: The science and technology of producing plants for food, fuel, fiber and land reclamation.
21. Economic botany: The study of both harmful and beneficial plants.
22. Phytomedicine: The application of scientific knowledge of plants, plant parts and isolated plant chemicals for the prevention and treatment of diseases.
23. Plant conservation: The study of plant decline, its causes and techniques to prevent further loss of plant species.
24. Food science and technology: The study that deals with the development of food from various plants.
25. Systems ecology: The use of mathematical models to demonstrate concepts in nutrient cycling.
26. Pteridology: The study of Pteridophytes (ferns).
27. Bryology: The study of Bryophytes (mosses).
28. Bacteriology: The study of bacteria.
29. Plant biotechnology: The study that deals with the introduction of desirable traits into plants through genetic modification.

Career Prospects for Plant Biologists.

1. **Education**:


They provide knowledge and insight about plants by teaching in schools, museums, botanical gardens, and they help in the development of educational materials and writing of scientific reports or papers.

2. **Research:**

They work with various research institutes in searching for new and better ways to solve the problems and unravel the puzzles associated with plant biology, food production, medicine, environment, etc. Plant biology researchers are very relevant in various industries including food, pharmaceutical, textile, housing and oil and gas industries to mention a few. They work to discover new things and better ways of solving problems.

3. **Production:**

Plant biologists across different areas of specialization are involved in production of useful products of plant origin. For example, drugs, healthy foods, biofuels, improve variety crops and seeds etc.

BIOTECHNOLOGY

Concept of Biotechnology

The term "biotechnology" is derived from two established disciplines – biology and Technology. Biology, as we know, is the study of living organisms while technology is the application of scientific knowledge for practical purposes such as making, modification, usage and knowledge of tools, machines and techniques to solve a problem, improve a preexisting solution to a problem or perform a specific function.

- *Biotechnology is the summation of activities involving technological tools and living organism in such a way that it will enhance the efficiency of the productions for man's benefit.*
- *Biotechnology is the use of living organisms (biology) in whole (e.g. bacteria, fungus) or in part (genetic materials (e.g. chromosome, gene), or biological substances (e.g. enzymes) to perform specific bioprocess tasks (technology).*

The tasks may involve industrial processes (such as manufacturing), bioconversion of wastes (e.g. biofuel production, i.e. conversion of organic waste to gas for use as fuel) or genetic engineering to alter existing forms and function of a living organism in whole or in part. This also conforms to the definition of the United Nations Convention on Biological Diversity that biotechnology as 'any technological application that uses biological systems, living organisms or derivatives thereof to make or modify products or processes for specific use'.

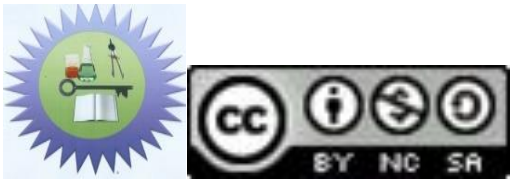
Origin and History of Biotechnology

The word "biotechnology" was first coined by a Hungarian known as Karl Ereky in 1919 to describe a technology based on the use of living organisms either in whole or in part to convert raw materials into more useful product(s). In real sense, however, the history of biotechnology can be divided into three major developmental periods, namely: ancient, classical and modern history. The ancient history dated hundreds of centuries ago suggesting that humans have used organisms for development almost throughout human history. During that period, techniques that today formed the background of biotechnology were developed although the word "biotechnology" was not used to describe any of the techniques. Such technologies included fermentation, which was developed in the ancient Egypt more than 6000 years ago. Fermentation is the use of microorganisms usually bacteria or yeast to breakdown organic compounds, e.g. sugars into simpler substances e.g. carbon dioxide and alcohol. The new fermentation technology was first used to make wine and later dough rise about 4000 years ago giving birth to the world's first bread. It also gave rise to the making of many other food products such as cheese and dairy products. This period ended about 500 – 100 BC when the Chinese developed what were to become the world's first antibiotics and insecticide using moldy curds (solid part of sour milk) and powdered chrysanthemum (a perennial garden plant), respectively. During this period, only whole-organisms were used. The classical history occurred between the 16th and 19th century AD involving the invention, discovery and development of technologies, materials and methods, that will later give rise to the use of animal parts and substances in biotechnology. The first of such materials was the **microscope** invented by **Zaccharias Jenssen** in 1590. This led to the **discovery of the cell** in 1665 by an Englishman, **Robert Hooke** and **one celled microorganisms**, bacteria and protozoa between 1675 and 1683 by **Antone Van Leeuwenhoek**, a tradesman of Delft, Holland. **Cell theory** was however not developed until 1839 when **Theodor Schwann, Matthias Jakob and Rudoff Virchow** propounded that the **cell is the building block of all living things**. In 1796, **Edward Jenner**, an English physician and scientist from Berkeley, Gloucestershire, developed the first successful **vaccine against smallpox**. This was the beginning of biotechnology application to medicine. In 1802, the term "biology" in its modern sense was propounded independently by a German naturalist, Gottfried Reinhold Treviranus (Biologie oder Philosophie der lebenden Natur) and a French soldier and naturalist, Jean-Baptiste de Lamarck (Hydrogéologie) although the word was coined in 1800 by another German physiologist, Karl Friedrich Burdach. The development of biology as a science of study led to series of quick discoveries that culminated in the coining of the word biotechnology in 1919. First was the discovery of proteins (the building block of living organisms) in 1838 by Gerhard Johan Mulder, a Dutch chemist although the word was first used by a Swedish scientist Jöns Jacob Berzelius in 1816. This was followed by the discovery of cell nucleus in 1933 by a Scottish Botanist Robert Brown, although the nucleus had earlier been observed by Thonius Philips van Leeuwenhoek. The two important isolations of *Escherichia coli* and yeast in 1855 by


Theodor Escherich (a German) and Louis Pasteur (a French), respectively confirmed that individual microorganisms were involved with food poisoning and food decay. Gregor Johann Mendel, an Austrian scientist discovered the gene in 1862 and laid the foundation of not only genetics but also genetic engineering, which as we will see in later chapters play great roles in modern biotechnology. The later independent discoveries of the chromatin (1879) and chromosome (1888) by two German scientists Walther Flemming and Heinrich Wilhelm Gottfried von WaldeyerHartz, respectively ended the middle age period in the history of biotechnology. The modern biotechnology started with the coining of the word "biotechnology" in 1919 by Karl Ereky of Hungary in his book Biotechnologie der Fleisch-, Fett- und Milcherzeugung im landwirtschaftlichen Grossbetriebe (Biotechnology of Meat, Fat and Milk Production in an Agricultural Large-Scale Farm), published in Berlin. The new technology spread within a short time to various parts of the world including Great Britain and the United States of America. It encouraged further research on the discovery of microorganisms and their application to new areas in biologically-based industries to create new fermentation products. The research intensification led to the discovery in 1927 by Muller that x-rays cause mutation (a random change in a gene or chromosome resulting in a new trait or characteristic that can be inherited; which could be a source of beneficial, neutral or harmful genetic effect) in organisms. This was a landmark discovery, showing for the first time that changes in the internal (genetic) composition of an organism gives rise to new phenotype (visible characteristics). Further research along this line led to the discovery of penicillin, in 1928 by the Scottish scientist Alexander Fleming and coining of the term "molecular biology" in 1938 by Warren Weaver, an American mathematician. The knowledge of molecular biology (the study of the molecular basis of biology), enhanced the understanding of the interaction between the various systems of a cell, including the interactions between deoxyribonucleic acid (DNA), ribonucleic acid (RNA) and protein biosynthesis quickly gave rise to genetic engineering in 1941. A process of altering the genetic material (DNA and RNA) and other components of the living cells to make them capable of producing new substances and/or performing new functions, genetic engineering involves the understanding of the composition, sequence and functions of genes and their constituents in an organism and the consequence of alteration of all or any of these. The applications of this technology (i.e. alteration of the composition and sequence) of genes to achieve specific functions have giving rise to several emerging issues in modern biotechnology.

Awareness of Biotechnology

Biotechnology offers tremendous opportunities for improving the wellbeing of current and future generations and the environment. However, it also embodies risks and may be misunderstood



unless adequate effort is made to inform the populace of the benefits, demerits and processes of innovations attached to the new technology. This effort requires knowledge of public awareness of the technology, the sources of information to the public and how reliable such sources are. Most of what is known about public awareness of biotechnology in Nigeria is derived from a study carried out by Anyawale and his colleagues covering all parts of the country. The study reported that about two-thirds (63.2%) of Nigerians have heard of the term “biotechnology”.

Amongst the many that have heard of biotechnology, few have detailed knowledge of the processes of the new technology, clearly demonstrating that awareness does not necessarily equate to knowledge. In fact, only few Nigerians have an understanding of the basic procedures involved in biotechnology. A further breakdown of their findings revealed that awareness was more in the southern parts (southwest and southeast) of the country than in the northern parts. Furthermore, it is higher in the southwest than either in the southeast or South-south geopolitical zones of the south. The study suggested that location of institutions such as International Institute for Tropical Agriculture (IITA), Ibadan, National Center of Genetic Resources and Biotechnology (NACGRAB), University of Ibadan, and Obafemi Awolowo University that deal with biotechnology in one form or the other in the southwest may have contributed to the higher level of awareness in the zone.

CONCLUSION

The history of biotechnology could be divided into three major period of ancient, classical and modern history. Ancient history started more than 6000 BC when man first used fermentation to process some of its food materials. During this period, no one knew that technology involved the use of other living organisms in processing foods. This knowledge came in the Middle Ages during the classical history, which started in the 14th century AD. During this period, equipment such as microscopes was discovered and with it came the existence of living organisms that cannot be seen with the unaided eyes. The discovery of these microorganisms, the roles they play in food processing especially fermentation and techniques for manipulating them (ability to alter their populations and transfer them from one medium to another) led to several experiments on how to make them work better and faster to produce food in higher quality and quantity. This gave rise to biotechnology; a term coined in 1919 by a Hungarian agriculturist known as Karl Ereky. The emergence of the term biotechnology did not only herald a new discipline but also a new era in biotechnology. The era of modern biotechnology was born. This saw the development of very complex materials, equipment and methods of manipulating microorganisms, cells and parts of cells in bioprocess production. It also saw a significant diversification of biotechnology methods into many other fields other than food production.

Types of biotechnology

- Microbial Biotechnology
- Agricultural Biotechnology
- Animal Biotechnology
- Forensic Biotechnology
- Environmental Biotechnology
- Aquatic Biotechnology
- Medical Biotechnology
- Regulatory Biotechnology

Microbial Biotechnology

Definition:

Microbial biotechnology is defined as any technological application that uses technological systems, microbial organisms, or derivatives thereof, to make or modify products or processes for specific use.' Manipulation of microorganisms such as yeast and bacteria.

Applications:

- Create better enzymes
- More efficient decontamination processes for industrial waste product removal
- Used to clone and produce large amounts of important proteins used in human medicine

Agricultural Biotechnology

Definition:

Agricultural biotechnology is a range of tools, including traditional breeding techniques that alter living organisms to increase agricultural productivity.

i. Plants more environmentally friendly that yield more per acre (genetically engineered).
ii. Resistance to diseases and insects.
iii. Foods with higher protein or vitamin content.
iv. Drugs developed and grown as plant products.

v. These better plants ultimately reduce production costs to help feed the growing world population.

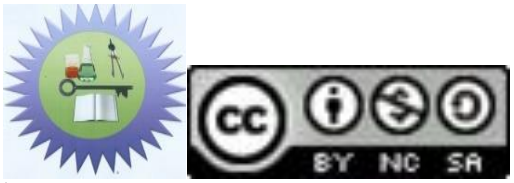
Animal Biotechnology

Definition:

Animal biotechnology is a branch of biotechnology in which molecular biology techniques are used to genetically engineer or modify animals in order to improve their suitability for pharmaceutical, agricultural or industrial applications.

Applications:

- Transgenic animals - way to achieve large scale production of therapeutic proteins from animals for use in humans. Female transgenic animals express therapeutic proteins in milk (contains genes from another source). Example: human genes coding for clotting proteins can be introduced into female goats for production of these proteins in their milk. Animals as a source of medically valuable proteins e.g Antibodies.
- Animals as important models in basic research
- Animal cloning
- Source of transplant organs
- **Aquaculture** – raising fish in controlled conditions for use as food sources. Example finfish and shellfish (50% of all fish consumed by humans).
- **Genetic engineering-** Gene "knockout" experiments - Disrupt a gene in the animal and then look at what functions are affected in the animal as a result of the loss of the gene. This allows researchers to determine the role and function of the gene. Since humans are similar to rats and mice, gene knockout studies in rats and mice can lead to better understanding of gene function in humans.
- Disease-resistant strains of oysters
- Vaccines against viruses that infect salmon and other finfish
- Transgenic salmon that overproduce growth hormone
- **Bio-prospecting**: rich and valuable sources of new genes, proteins and metabolic processes with important applications for human benefits
- Marine plankton and snails found to be rich sources of antitumor and anticancer molecules



▶ Design and testing of drugs and genetic therapies

Forensic Biotechnology

Forensic biotechnology is the application of biotechnology to the legal system. By identifying DNA salvaged from a crime scene (e.g. tissues, hair, blood, etc.), a forensic biotechnologist can place a suspect at the scene of the crime or identify an unknown individual.

Forensic biotechnology is also used in:

- ▶ paternity cases
- ▶ identification of human remains
- ▶ tracking and confirmation of the spread of diseases
- ▶ Identifying and monitoring endangered species, through DNA fingerprinting**.**

Environmental Biotechnology

In line with this, the International Society for Environmental Biotechnology defined environmental biotechnology as "the development, use and regulation of biological systems for remediation of contaminated environments (land, air and water) and for environmental-friendly processes (green manufacturing technologies and sustainable development)." This simply means that environmental biotechnology is the optimal use of nature in a cyclic manner that sustains the environment for future generations.

Bioremediation: The use of biotechnology to process and degrade a variety of natural and manmade substances. Particularly those that contribute to environmental pollution. For example, stimulated growth of bacteria that degrade components in crude oil. This method has been used in

- 1989 Exxon Valdez oil spill in Alaska
- 2010 Deep Water Horizon spill (promoted research into natural oil-degrading organisms and enzymes)

Medical Biotechnology

Medical biotechnology is the use of living cells and cell materials to research and produce pharmaceutical and diagnostic products that help treat and prevent human diseases.

Involved with the whole spectrum of human medicine

- Preventive medicine (vaccines)
- Diagnosis of health and illness
- Treatment of human diseases
- Human Genome Project (Gene therapy): Research on the function of human genes and controlling factors that regulate genes.
- Stem cell technologies: Stem cells are immature cells grown in lab and then treated with different chemicals to allow them to develop into specific kinds of tissues needed for transplant. Stem cells are currently used for diabetes and spinal cord injuries.

Regulatory Biotechnology

Quality Assurance (QA): This involves all activities involved in regulating the final quality of a product.

Quality Control (QC): Part of QA process that involves lab testing and monitoring of processes and applications to ensure consistent product standards.

Together QA and QC ensure that biotechnology products meet strict standards for purity and performance.

- **Why should you care about a product undergoing intense regulations as a consumer?**

LEVELS OF ORGANIZATION OF LIFE

- Atoms are fundamental units of all substances, living or non-living.
- Molecules are atoms joined together by chemical bond.
- Cells are the smallest unit of life.
- Tissues are organized array of cells and substances that interact in a collective.
- Organs are structural unit of interacting tissues.
- The organ system is a set of interacting organs.

- An organism is a life form- living entity made up of one or more cells.
- Multi-celled organisms are individuals that consists of more than one cell.
- Population is a group of single-celled or multi-celled individuals of a species in a given area.
- A community includes all populations of all species in a specified area.
- An ecosystem is a community interacting with its physical environment through the transfer of energy and materials. E.g., sunlight and water sustain the natural community in Obudu cattle ranch.
- Biosphere is the sum of all ecosystems and regions of the earth crust, water and atmosphere in which organisms live in.

Contributors to the discovery of the cell

Antony van Leeuwenhoek (1674) Soon after Hooke published his results, Anton Van Leeuwenhoek succeeded in developing much more powerful microscopes, some capable of magnifications up to 300x. Leeuwenhoek was able to inspect water samples of pond water and made the first observations of human blood cells, and of sperm cells. By the early 1800s after several studies on organisms and their internal components enough data was gathered to safely make the conclusion that all **organisms consist of cells.** He became the father of Microbiology.

- **Nehemiah Grew** (1682), discovered that cells in the forms of cavities with cellulose walls were in different plants. He wrote **The Anatomy of Plants**.
- **H. J. Dutrochet** (1824), expressed the idea of individuality of cells i.e., cells were not just spaces between a network of fibres, but these were separate and separable units.
- **Robert Brown** (1833) named the cell nucleus.
- **Robert Remak** (1855) discovered cell division and confirmed the existence of plasma membrane.

THE CELL THEORY

The cell theory is a widely accepted explanation of the relationship between cells and living things. This theory was proposed by **Matthias Schleiden** and **Theodore Schwann** in 1839. They describe that all organisms are composed of similar units of organization, called cells. In 1838 Schleiden found that all plant cells have basically similar structure. Schwann (1839) observed that animal cells differ from plant cells in lacking cell wall but are otherwise similar amongst

themselves. He declared that all animals and plants are made up of cells. Schleiden (1838) summarized his observations into three conclusions about cells:

i. The cell is the unit of structure, physiology, and organization in living things.

ii. The cell retains a dual existence as a distinct entity and a building block in the construction of organisms.

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

Rudolph Virchow (1858) states that "Omnis cellula e cellula“, meaning that the new cells arise from pre-existing cells only.

The main features of cell theory now are:

- ❑ All living organism are composed of cells. Therefore cell is structural unit of living organisms.
- ❑ All cells arise from the pre-existing cells of similar type. Thus cell is a unit of heredity.
- ❑ All cells are basically alike in chemical composition and metabolic activities.
- ❑ The function of an organism as a whole is the result of the activities and interactions of its cells.

Exceptions to the Cell Theory

- **Virus-** Protoplasm and nucleus absent. DNA and RNA is the genetic material.
- **Bacteria and Blue Green Algae**:- Nuclear membrane is absent, thus the nuclear content is in direct contact with the cytoplasm. No true cells.
- **Some mould fungi**:- Body is made-up of undivided mass of protoplasm in which several nuclei are scattered.

The Plant Cell

All plants are made up of one or more units called cells. The cell brings structural and functional stability to plants.

Plants are of two types:-

Multicellular plants:- Most plants consists of many cells. All the function of life are carried out by one or other group of cells. e.g. Spirogyra.

Unicellular plants:- Many plants consist of single cell. In these plants all the vital functions are carried out by the single cell. This type is also known as acellular. e.g. Chlamydomonas.

In multicellular living things, a collection of cells working together to perform similar functions is called a tissue; various tissues that perform coordinated functions form organs; and organs that work together to perform general processes form body systems. The plant cell is a basic structural and functional unit of plants.

Cell size

Cell size varies widely in various plants. The size varies from micron to millimeter (a micron is a one thousandth part of a millimeter).

The smallest cells are found in bacteria- the cell of ***Mycoplasma laidlawii*** with a diameter of about 0.1 - 0.15 micron is considered to be the smallest.

In plants the longest cells are fibres producing e.g. Jute, Cotton, ramie, which are about 55 cm long. A single celled alga ***Acetabularia*** measures about 10 cm in height.

Cell shape

- The shape of the cells varies with their position in plants. It can be polygonal, spherical, elliptical, spindle-shaped, cuboidal, plate-like or irregular.
- In multicellular plants cell shape also depends on their location and nature of function. The cell shapes are influenced by the surface tension and viscosity of the protoplasm, pressure exerted by the surrounding cells and the rigidity of cell membrane.

Cell types

Two types of living cells were recognized in plants by **Dougherty (1957).** This division is based on internal complexity or morphology.

- **Prokaryotic cell** (pro = primitive, karyon = nucleus) : This type of cells have:-

a) A organized nucleus is absent in the protoplasm, i.e., the nucleus is without nuclear membrane, nuclear reticulum, nucleoplasm and nucleolus. The nuclear material is not bounded by nuclear membrane , the nuclear materials remain diffused with cytoplasm.

b) Only monera i.e. Blue green algae (Cyanobacteria) and Bacteria are prokaryotic cell known as prokaryotes.

c) The genetic material contain DNA, histone absent.

- **Eukaryotic cell** (eu = true, karyon = nucleus): This type of cells have:-

a) A true nucleus with a definite nuclear membrane by which nuclear material is bounded. Nucleoli present. Distinct organelles, the small structures that each perform a specific set of functions, are present within eukaryotes.

b) The majority of plants are composed of eukaryotic cells.

c) The genetic material contains DNA complex with histone proteins to form well-organized chromosomes.

Comparison of prokaryotic and eukaryotic cells

Feature	**Prokaryotic Cells** **Bacteria and Cyanobacteria**	**Eukaryotic Cells** **Algae, Fungi, Plants**
Cell size and cell organization	1-10 mm: unicellular	5-100 mm: multicellular
Organelles	Few or none	Nucleus, mitochondria, chloroplasts, endoplasmic reticulum, Golgi apparatus
DNA	Circular (or linear) DNA organized in a nucleoid	Linear DNA molecules organized in chromosomes bounded in a nucleus
Synthesis of RNA and proteins	RNA and proteins synthesis occur in same place	RNA synthesis occur in nucleus and proteins synthesis in the cytoplasm
Chromosome	Single	Multiple
Ribosomes	70s (50s+20s)	80s (60s+40s)
Metabolic activity	Photosynthetic and respiratory enzymes are found on plasma membrane	Photosynthetic and respiratory enzymes are found on chloroplast and mitochondria respectively
Cell division	Amitosis, spindle apparatus absent during cell division; replicated DNA pulled by attachment to plasma membrane	Mitosis, meiosis, spindle apparatus present and chromosomes pulled by it
Metabolic activity	Anaerobic (respiration in absence of oxygen) or aerobic	Aerobic (in presence of oxygen)

Cytoskeleton	Not present	Present

PLANT CELL STRUCTURE DIVERSITY OF HABITATS OF LIVING ORGANISMS

A habitat is an ecological or environmental area that is inhabited by a particular species of animal, plant or other type of organism.

- Terrestrial habitat
- Aquatic habitat- freshwater, marine
- Microhabitats

DIVERSITY OF HABITS OF PLANTS

Habit is the biological form and pattern of growth characteristic of a living organism.

Plant habit denotes the height attained by any given plant due to the nature of the stem and the life span of the plant.

Four major habits of plants:

1) Tree: A tree is a plant with a single large woody strong stem or trunk with high woody branches. Example Iroko (*Chlorophora excelsa*).
2) Shrubs: These are woody plants whose branches remain close to the ground. Shrubs have many woody stems of about the same size with none standing out as a main trunk. Examples: Tecoma (*Tecoma stans*) and Allamanda (*Allamanda cathartica*).
3) Herbs (Annuals, Biennials and Perennials): These are soft or weak-stemmed small plants.

   Herbaceous Annuals- complete their life cycle within one growing season. Examples: Rice (*Oryza sativa*), coco-yam (*Colocasia esculenta*) and maize (*Zea mays*).

   Herbaceous Biennials- complete their life cycle in two years or growing seasons. Examples: onion (*Allium cepa*) and carrot (*Daucus carota*).

   Herbaceous Perennials- develop new shoot during every favourable growth period and retain dormant underground parts during unfavourable periods. Examples: alligator pepper (*Aframomom melegueta*), African never die or sensitive plant (*Mimosa pudica*) and ginger plant (*Zingiber officinale*).

4) Climbers (Woody-stem climbers and Soft-stemmed climbers): These are plants with woody or fleshy stems and climb on other plants.

Woody-stem climbers- Also known as **Lianes** and are able to climb to the top of very tall forest trees because of their woody stems. Example: *Hiptage benghalensis*

Soft-stemmed climbers- Possess modified parts (twinning, slender leafless tendrils) which enables them to hold on to their support. Example: Morning glory weed (*Ipomoea involucrata*)

Possess strong, sharp often hooked thorny leaf parts which enables them to hold on to their support. Example: Rose plant (*Rosa indica*).

Possess roots, stems or leaves that are modified into climbing structures. Examples: Root- Betel pepper (*Piper betle*), Stem- Wild yam (*Dioscorea bulbifera*), Leaf- Glory lily (*Gloriosa superba*)

MODE OF NUTRITION OF LIVING ORGANISMS

All living organisms depend on external sources of energy to be able to fuel the chemical activities that enable them move, grow and carry out all life's activities.

1. AUTOTROPHIC NUTRITION: here, organisms manufacture their own food. These organisms are known as primary producers. All green plants fall under this category. They are also known as autotrophs.

2. HETEROTROPHIC NUTRITION: Organisms depend on autotrophs for food. They are briefly explained below.

a. Saprobiontic nutrition-- This occurs in organisms which feed on dead and/or decaying organic matter. Fungi and most bacteria are saprobionts. These organisms secrete digestive enzymes on their food, breaking it down to soluble materials which are absorbed.

b. Holozoic nutrition- Organisms take solid organic materials into their systems (ingestion). The solid food is digested, absorbed and utilized by tissues and finally egested.

- Herbivores- these are organisms that feed on plants. E.g. Domestic goat (*Capra hircus*).
- Carnivores- these are organisms that feed on animals. E.g. Lion (*Panthera leo*).

- Omnivores- these are organisms that feed on plants and animals. E.g. Man (*Homo sapiens*).

c. Symbiotic nutrition- organisms live together and derive nourishment

- Parasitic nutrition- One organism (parasite) lives in another (host), benefiting from it and harming it.
- Mutualism- Both organisms benefit.
- Commensalism - One organism benefits while the other does not and is not harmed.

BIODIVERSITY

Biodiversity is the total variation within and among species of all living organisms and their habitats. It is the occurrence of diverse or varied forms of living beings which differ from one another in external appearance, size, colour, pattern, internal structure, nutrition, behaviour, habitat, etc.

Benefits of Biodiversity

Biodiversity plays an important role in the way ecosystems function and in the services they provide. The following is a list of some of the benefits, or services, of biodiversity:

1. Provisioning services such as food, clean water, timber, fiber and genetic resources
2. Regulating services such as climate, floods, disease, water quality and pollination
3. Cultural services such as recreational, aesthetic and spiritual benefits
4. Supporting services such as soil formation and nutrient cycling

Types of Biodiversity

Biodiversity includes three main types: diversity within species (genetic diversity), between species (species diversity) and between ecosystems (ecosystem diversity).

Taxonomy

Taxonomy is the science of identifying, naming and classifying organisms into groups. It has three (3) sub branches:

Nomenclature – naming of organisms.

Classification involves the identification and assigning of organisms to taxonomic groups based on similar characteristics.

Identification is a process of assigning an entity to a group that has already been established

Taxonomic Rank

In biological classification, organisms are put into different ranks according to their similarities and differences. These ranks are known as taxonomic rank. it is the relative level of a group of organisms (a taxon) in a taxonomic hierarchy. Examples of taxonomic ranks are: Kingdom, Phylum, Class, Order, Family, Genus, and Species.

Nomenclature (binomial nomenclature)

Nomenclature is concerned with the assignment of names to taxonomic groups in agreement with published rules. Binomial nomenclature is a system of naming organism, where the first word beginning with a capital is the genus of the organism and the second word beginning with lower-case letter is the species of the organism. The International Code of Nomenclature for algae, fungi and plants (ICN) regulates the naming of plants species.

Classification of living things

Classification is the process of arranging organisms into groups based on the shared observable characteristics. It is the ordered grouping of organisms according to their similarities and differences.

Why is classification importance?

Classification is very important for the following four reasons.

1. It aids memory
2. Perception power:
3. Explains relationship
4. Stable scientific names

Systems of classification:

There are three basic systems of classification of plants. They include: Artificial Classification, Natural Classification and Phylogenetic Classification.

According to the different systems of classification, living organisms have been grouped based on the following

-3 domains concept

-5 kingdom concept
-Angiosperm phylogeny group

The Three Domains Concept

The domain is the broadest category, while species is the most specific category available. The taxon Domain was only introduced in 1990 by Carl Woese. The three domains are organized based on the difference between eukaryotes and prokaryotes. They include: Archea (Archeabacteria) Eubacteria, and Eukaryote

The Five Taxonomic Kingdoms of the living world

R. H Whittaker, 1969, proposed the five kingdom classification. The groups includes Kingdom monera or prokaryotae, Protista or protoctista, fungi, plantae, and animalia

Monera- also known as the kingdom bacteria. the Monera kingdom is made up of bacteria. Their cells do not contain a nucleus. Some bacteria are autotrophs, some are heterotrophs.

Protists (Protista)- the protists are made up of organisms that cannot easily fit into the plant, animal, or fungi kingdoms. They are one celled organisms with a nucleus or simple multicelled organisms. Some protists are autotrophs, some are heterotrophs. The animal-like protists are called protozoa. The plant-like ones are called algae while the fungus-like ones are the water molds e.g Euglena and Amoeba

Fungi- Consist of multicellular eukaryotic organisms with cell walls made of chitin. the fungi kingdom is made up of molds, yeasts, and mushrooms. Fungi are heterotrophs because they must absorb their food. Yeasts are one celled, while molds and yeasts are eukaryotes. Their cells have a nucleus, a cell wall, and no chlorophyll. Most fungi are decomposers, they break down dead organisms.

Plants- the plant kingdom is made up of plants. Plants are autotrophs, they make their own food. Plants are eukaryotes; they are made up of many cells. Bryophytes, Pteridophytes and Seed Plant (Tracheophytes) makes up the plantae group:

Bryophytes:

These are simple terrestrial plants that lack vascular tissues. They include the following divisions: liverworts (Hepaticae) examples *Marchantia polymorpha*, *Riccia discolor*,

Ricciocarpus natans, Hornworts (Anthocerotae) examples *Anthoceros punctatus* and the mosses (Musci) examples: *Funaria hygrometrica, Polytrichum commune, Barbula indica*.

Pteridophytes (Seedless plants)

The pteridophytes are ferns and their related seedless vascular plants. They have xylem (for transporting water and dissolved minerals) and phloem (for transporting photosynthetic products) but do not produce seeds. Example of fern include: *Lycopodium* sp., *Selaginella* sp. *Equisetum,* (horsetail fern), *Nephrolepis biserrata, Pteris togoensis, Diplazium sammatii* and *Pteridium aquilinum*.

Seed Plant (Tracheophytes)

The common feature in these plants is the possession of seeds, which by definition is the ripened fertilized ovule. The seed plants are divided into the angiosperms or flowering plants with enclosed seeds) and gymnosperm (Plants with exposed seeds).

Gymnosperm

These are the cone-bearing trees or woody plants, which do not differ greatly in their structure from the woody angiosperms. Gymnosperms do not produce flowers but as seed plants that bear seeds on scale-like leaves, which are arraigned spirally to form cones. The seeds are termed naked seeds because they are exposed to air on the surface of cone scales. They are made up of four divisions:

Angiosperm

These are the most successful of all plants that dominate all of major terrestrial habitats. The term angiosperm literally means enclosed seed, because they produce seed that are enclosed within a protective covering.

Gymnosperms are seed plants but there are major characteristics, which differentiates them from angiosperm.

Differences between Gymnosperm and Angiosperm

Gymnosperms	**Angiosperm**
The pollen grains are conveyed directly to the exposed ovules	the pollen grain is transferred on to the stigma where it germinates and the pollen tube grows through a considerable length until it penetrate the ovular tissue
They bear naked seed borne exposed on the	The seed of the angiosperm is borne within

surface of cone scales	fruit tissues that develop from ovary.
There is no double fertilization in gymnosperm	Double fertilization is a major feature in angiosperm
The xylem of gymnosperms is composed of tracheid and wood parenchyma but lack vessels, hence the are soft wood	The xylem of angiosperms has vessels and so the plants are hardwoods. Hence, they are hard wood.
All gymnosperm are woody plants	Angiosperms may be woody or herbaceous

Animals (Animalia): the animal kingdom is made up of animals. Animals are heterotrophs- they must obtain food by eating it. Animals are eukaryotes. The 35 phyla are divided into two groups: vertebrates and invertebrates.

The concept of Angiosperm Phylogeny Group

The Angiosperm Phylogeny Group, or APG, refers to an informal international group of systematic botanists who collaborate to establish a consensus on the taxonomy of flowering plants (angiosperms) that reflects new knowledge about plant relationships discovered through phylogenetic studies.