Discipline Courses-I
Semester-I
Paper: Phycology and Microbiology
Unit-I
Lesson: Classifying Plant Diversity- An Introduction
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Chapter: Introduction to Botany

Introduction

Welcome to the fascinating world of plants.

You must be familiar with many plants in your daily lives. Let us look at some images of food plants. Knowing the names of these shall us help to begin our study of botany.

Figure: Different vegetables

- Carrots
- Red Onion
- Cauliflower
- *Solanum melongena* - the egg plant
- Bananas
- Cereal grains
- *Zea mays* – Maize or corn
- *Oryza sativa* – rice
- *Pisum sativum* - the garden pea
- Chillies
- *Piper nigrum* – black pepper
- *Elettaria cardamomum*
- *Coffea arabica* - the coffee plant
- *Theobroma cacao* – the cocoa plant
- Spirulina

Source:http://lettuceeatkale.files.wordpress.com/2009/08/fruit-vegetable-mosaic.jpg,http://cdn5.wn.com/ph/img/71/a9/b5c661c0e81008b58a32910d3273-grande.jpg,http://orgoniteangel.com/uploads/2/8/3/3/2833879/3380272.jpg,http://upload.wikimedia.org/wikipedia/commons/5/5d/Woolworths-cauliflower.jpg,http://farm9.staticflickr.com/8249/8662462333_6719027b14_z.jpg,http://upload.wikimedia.org/wikipedia/commons/8/8a/Banana-Single.jpg,http://upload.wikimedia.org/wikipedia/commons/1/13/Zea_mays_MS_2273.JPG,http://content60.eol.org/content/2012/05/23/21/32430_580_360.jpg,http://upload.wikimedia.org/wikipedia/commons/thumb/b/bc/Doperwt_rijserwt_peulen_Pisum_sativum.jpg/220px-Doperwt_rijserwt_peulen_Pisum_sativum.jpg,http://upload.wikimedia.org/wikipedia/commons/0/04/Chillies_red_and_green.jpg,http://upload.wikimedia.org/wikipedia/commons/f/f1/Black_Pepper_-_Raw.jpeg,http://www.foodpoisonjournal.com/uploads/image/blackpepper%286%29.jpg,http://upload.wikimedia.org/wikipedia/commons/6/6f/Elettaria_cardamomum_capsules.jpg,http://upload.wikimedia.org/wikipedia/commons/5/51/Elettaria_cardamomum_flowers_1.jpg,http://luirig.altervista.org/cpm/albums/bot-hawaii08/03963-Coffea-arabica.jpg,http://upload.wikimedia.org/wikipedia/commons/a/ab/Coffea_arabica_005.JPG,http://upload.wikimedia.org/wikipedia/commons/thumb/7/77/SingleSpirulinaInMicroscope4WEB.jpg/220px-SingleSpirulinaInMicroscope4WEB.jpg,http://upload.wikimedia.org/wikipedia/commons/1/18/Spirulina_powdder_close.jpg

Thus, we can see great diversity in many aspects of plant life by simply observing our daily food. There is beauty in the form of shapes, sizes, and colours amongst the plants.

We also enjoy the beauty of nature when we go out into a garden or park. A visit to a hill station or a wildlife sanctuary brings us into contact with many interesting kinds of plants. This helps us to understand that there is a huge variety in the organization of the myriad forms of plants.

As a beginning to our study of botany, we may look at some images of different plants.

Figure: *Spirogyra* - a simple thallus of a green filamentous alga

- *Volvox* - a colony of a green alga
- *Mucor* – the bread mould, a fungus
- *Funaria* - a group of moss plants ; a bryophyte
- *Athyrium* - a common fern; a pteridophyte
- *Cycas circinalis* - a gymnosperm
- *Pinus roxburghi* - a conifer (gymnosperm)
- *Nepanthes* - the pitcher plant; an insectivorous plant; an angiosperm
- *Rauvolfia serpentine* – an important medicinal plant, an angiosperm
- *Digitalia purpurea* – an important medicinal plant, an angiosperm
- *Nicotiana tabacum* – the tobacco plant, an angiosperm
- Gossypium.- the cotton plant, an angiosperm

Source: http://upload.wikimedia.org/wikipedia/en/7/7d/20090523_213732_Spirogyra.jpg, https://upload.wikimedia.org/wikipedia/commons/e/ee/Mikrofoto.de-volvox-8.jpg, http://cnx.org/content/m44622/latest/Figure_24_01_08.jpg, http://upload.wikimedia.org/wikipedia/commons/0/0b/Funaria.hygrometrica.jpg, http://upload.wikimedia.org/wikipedia/commons/e/eb/Athyrium_filix-femina0.jpg, https://upload.wikimedia.org/wikipedia/commons/d/da/Pinus_roxburghii_foliagecone.jpg, http://upload.wikimedia.org/wikipedia/commons/d/d7/Cycas_circinalis_3.jpg, http://upload.wikimedia.org/wikipedia/commons/8/8b/Rauvolfia_serpentina_002.JPG, http://upload.wikimedia.org/wikipedia/commons/8/8d/04913_Digitalis_purpurea_nevit.jpg,http://upload.wikimedia.org/wikipedia/commons/0/02/Nicotiana_tabacum_Bl%C3%BCten.jpg, http://upload.wikimedia.org/wikipedia/en/archive/2/24/20060404035630!Cotton_Plant.png

From these images, we have had a glimpse into the diversity of plant life. Thus the study of botany helps us to learn about plants or the "gifts of nature to mankind".

When we study botany, we come to know about the "form", the "structure" and the "function" of these organisms. It also helps us to recognize plants which mankind has domesticated for his survival. Many medicinal properties of plants have played a very important role in curing diseases. Plants have served as important items of trade and commerce since ancient times. This has changed the economy of many countries.

It would also be interesting to know that different plants commonly found in India did not originate in our country (for example maize, potato, tomato, chillies/capsicums) but were 'introduced' from other parts of the world. At the same time plants like rice, mangoes, oranges and many others which have spread out into the world originated in India. These and many more interesting aspects of plants shall make the study of botany a fascinating subject.

Plants and man

Plants have played a very important role in many aspects of human life. From the very beginning of human civilization, man has used different plants for providing him the basic necessities of life (such as food, clothing and shelter) for his survival. The understanding of "nature's gift to mankind" has helped humans to progress culturally, economically, and scientifically. Students of Biology are aware that basic knowledge about the different kinds of organisms has led to modern developments. Thus, today 'molecular biology'/ 'genetic engineering' / 'biotechnology' have become fascinating areas of research in the world of modern biology. It is very important to remember that these advancements have always depended on the "correct understanding" of the organism/s involved in these studies. This brings us to the foundation of the science of classification. We know about the different plants/organisms by classifying them. It is this fundamental science which has helped biology to progress.

In an e-mail sent on June 14, 2013, Professor M. C. Arunan, Homi Bhabha Centre for Science Education, Tata Institute of Fundamental Research, Mumbai (email-<arunan@hbsce.tifr.res.in>) writes:
"Biology faculty members are under constant pressure to innovate in their teaching due to the rapid pace of discovery in the life sciences. They must stay abreast of new biological knowledge and reflect the changing knowledge base in their teaching. Yet the rapid pace of biological discovery affords opportunities to teach with real timely and engaging examples that relate with students' daily lives." Therefore studying botany prepares you to stay abreast with modern developments in life sciences.

It is also necessary to remember that science and technology have played a very important role in the progress of human thought. At the same time, we must appreciate the fact that "basic/fundamental science" is necessary before we can develop and use technology.

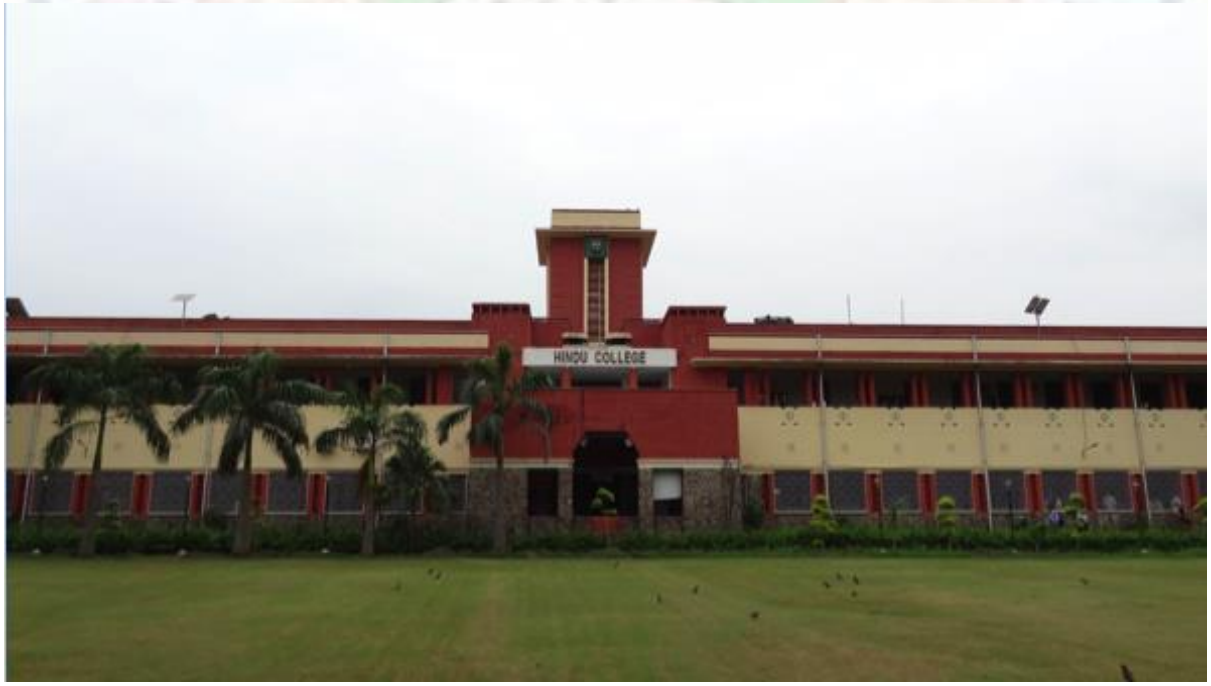
Dr. Siddharatha Mukherjee (Assistant Professor of Medicine, Columbia University, USA, and author of the "Pulitzer Prize-winning book: *The Emperor of All Maladies: A Biography of Cancer*") remarked "Science is among the most profoundly human of our activities" (see The Weekly News magazine – OUTLOOK June 17, 2013).
Therefore basic science helps in laying a strong foundation for understanding "the rapid pace of discovery in the life sciences".

The science of classification

Every human being deals with some sort of classification in his/her daily life. For example, students studying science in school usually study three subjects, such as Biology, Chemistry and Physics. This tells us that the different science subjects have been classified according to the specialized areas of their subject matter. Further, students of Biology learn about plants and animals, bacteria and viruses, as well as different aspects of their diversity (appearance or form), organization (structure), and activities (function).Similarly, in Chemistry, students come across "organic chemistry", "inorganic chemistry", "physical chemistry", etc. And this also holds true for Physics. In real terms, we have referred to some kind of classification of science subjects.

There is classification in all spheres of human activity. We know about social classification of human society. There is classification of organizations according to the area of their work. There is also classification within every organization or institution.

In your College, just look around and find out the different areas. You shall recognize the main building. This shall have rooms serving as "classrooms/lecture theatres", or "science laboratories". You would also find a "library", "an auditorium", and "a seminar room". All these spaces refer to the "teaching" area of the college campus. There are areas for administration, recreation, a canteen and other open spaces. In real terms, you have classified the total area of the college campus into different units. This classification is based on the functions/utility of each unit.



Thus, classification is a primary activity of man. All biologists who are concerned with understanding the species must be able to classify organisms. It is therefore necessary to understand this fundamental aspect of the science of classification.

The basic steps in taxonomy

Every biologist knows that classification is one important aspect in the science called taxonomy. In this 'logical science', knowledge about organisms has to be understood in a proper lineal sequence. There are four important steps in this science {(1) characterization, (2) identification, (3) classification, and (4) nomenclature}:

1. The first requirement is to know about the characteristics of the organism. This leads us to describe the features of the organism. It is the first step in our understanding of the biology of the organism. This is referred to as "characterisation" and it serves as the foundation of our knowledge about the organism.
2. The next step is to analyse the characteristics of different organisms in order to differentiate one from the other. Thus by comparing the characters of two/more organisms, we learn whether they are similar or dissimilar. This understanding of the differences between two/more organisms leads to the process known as "identification". It is the second step in our understanding the organisms.
3. When two/more organisms have been identified/differentiated on the basis of their characters, it becomes necessary to group these organisms into different units. Organisms identified as similar on the basis of common characters can be grouped together. Organisms not sharing common characters are grouped into different units. It results in classification or arranging the organisms into different groups. This enables summarisation of knowledge about the organisms.
4. Finally when the different of organisms have been recognised, it becomes necessary to provide each unit a definite scientific name. This aspect of naming organisms or the different units recognised in classification is called nomenclature. Naming the organisms serves a very useful purpose of communicating knowledge.

The concept of classification

Classification serves as a very useful concept in science. It serves as a very important method of organizing knowledge. At the same time, it helps scientists to summarize knowledge in a beautifully concise manner. This in turn serves as a valuable method for "retrieving information". This interesting facet of science is closely intertwined in our lives.

According to A. Tindel Hopwood (1959) "the urge to classify is a fundamental human instinct;....it accompanies us into the world at birth and stays with us to the end" (see Davis & Heywood, 1973 – Principles of Angiosperm Taxonomy; Robert E. Krieger Publishing Company, Huntington, New York).

In my teaching career (since 1971), I have used a very simple analogy from human life to explain this statement.
The moment a child is delivered/born, s/he lets out a cry. This brings a sense of joy/relief to the doctor attending the delivery because it indicates the birth of a 'healthy child'. The cry indicates that the child has been able to fill up its lungs with air and can start breathing. This can also be interpreted as an understanding that the child has been able to differentiate between the "protected environment inside the mother's womb" from the "exposed environment outside the mother's body". This process of differentiating two situations becomes the starting point in classification. Thus, the first lesson in classification has begun. And this science of classification continues throughout our lives. Finally, when man departs from this world, there is again a definite classification in the manner in which the 'last rites' are performed. These are directly correlated with the religious belief practiced by the individual.
Thus, Tindel Hopwood's statement about classification as a "fundamental human instinct" holds true.
(Visual presentation to engage the attention is necessary. Upload images of new born babies, growing children, adults {example different communities recognized on the basis of their dress}, and even death to indicate the use of classification in human life)

Classification in practice: The Diversity of Organisms

According to Davis & Heywood (1973) "classification is a natural occupation of man". Since the time when human beings adopted the "terrestrial habitat" (thus bringing about a major change from their "arboreal ancestors"), the need to classify organisms became a necessity. Plants which could be used for providing food or other needs had to be differentiated from "other/harmful organisms". This understanding about "food plants" or "medicinal plants", or "harmful plants", etc. paved the way for development of formal/organized plant classification.

In the 18th century, the Swedish Naturalist, Carolus Linneaus, (upload image) suggested that the world around us could be easily divided into three kingdoms: (i) the plant kingdom, (ii) the animal kingdom, and (iii) the minerals. This has been accepted as an

important concept of classification of Nature. A very important outcome of this basic classification is the fact that "living organisms are always correlated to their environment". It has enabled a proper understanding of the "diversity of organisms occurring in nature".

Modern systems of classification

During the 19th and 20th centuries, biologists have used different tools and technologies for understanding this diversity and classifying it. As more knowledge about organisms accumulated, new concepts have been developed in classifying the organisms present on this planet.

Based on the analysis of several characteristics of the organisms, Robert Whittaker (in 1969) suggested that living organisms could be classified into five kingdoms as follows:

1. Kingdom Monera
2. Kingdom Protoctista
3. Kingdom Fungi
4. Kingdom Plantae (= Plant Kingdom according to Linneaus)
5. Kingdom Animalia (= Animal Kingdom according to Linneaus)

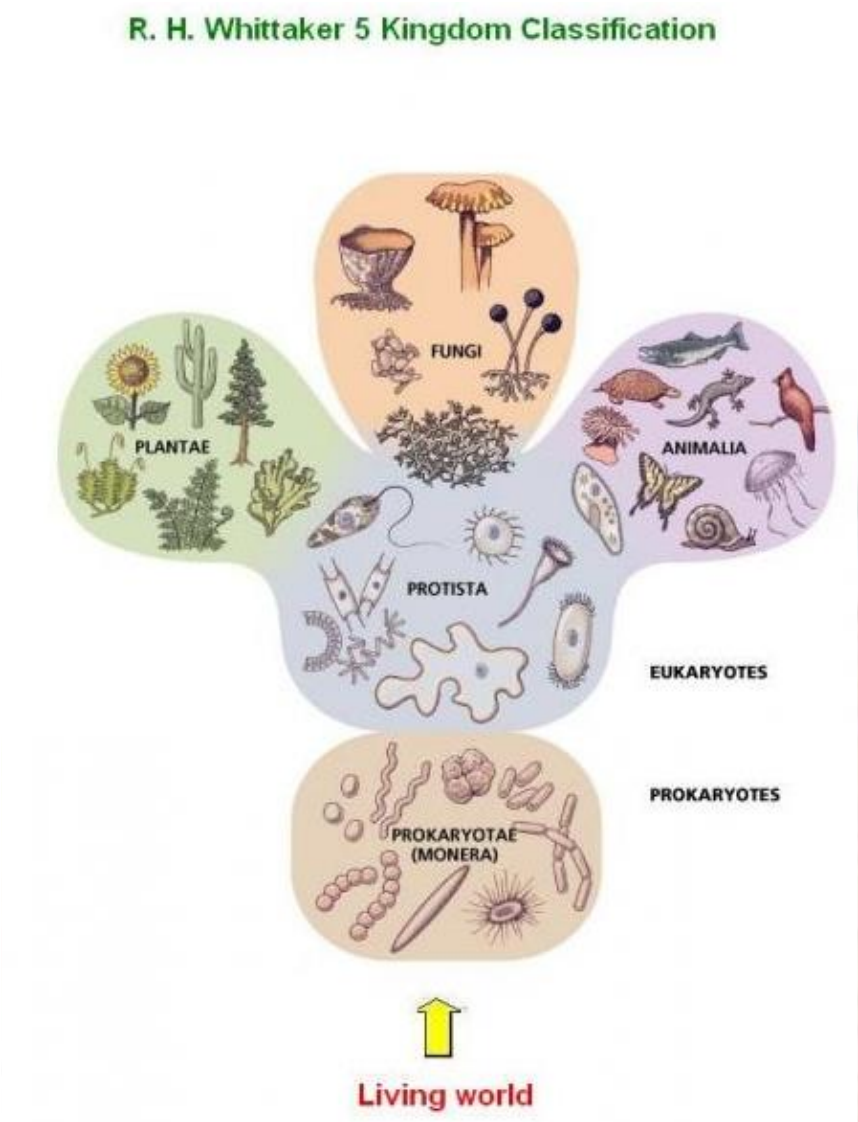


Figure: The five kingdom classification

Source: http://biologmehmet.blogcu.com/ilkin-dunya-ve-yasamin-kokeni/13438014#icerik

This original classification of Whittaker was revised and updated by Lynn Margulis & Karlene Schwartz in the book "Five Kingdoms – second edition, published in 1988 by W. H. Freeman and Company".

A more recent approach, using electron microscopes, application of biochemical techniques, and other tools has helped in understanding classification in a better manner. We now know that there are fundamental differences between prokaryotic and eukaryotic cells. Further, ribosomal RNA sequence studies have established the fact that prokaryotic organisms can be classified into two distinct lineages. These are distinct from the lineages of the eukaryotic organisms.

The American microbiologist and biophysicist (upload image) Carl Richard Woese (1977 – "Phylogenetic structure of the prokaryotic domain: The primary kingdoms" Proceedings of the National Academy of Sciences Volume 74 (11) pages 5088-5090) defined "a new Domain or Kingdom of life" He based this concept on the phylogenetic taxonomy of the "16S ribosomal RNA". This led to the proposal that the organisms of the world can be classified into 3 Domains:

1. Domain Archaea
2. Domain Bacteria
3. Domain Eukarya [This Domain is further classified into 4 Kingdoms: (a) Kingdom Protoctista, (b) Kingdom Fungi, (c) Kingdom Plantae, and (d) Kingdom Animalia]

In both these approaches (the 5 Kingdom or the 3 Domain classifications), the organisms are classified according to an evolutionary sequence. Beginning with simple prokaryotic organisms, biologists attempt to understand the process of evolution. Complexity of the organisms and the elaborate organization of eukaryotic organisms can thus be understood. Therefore in scientific classifications of organisms, biologists perceive an evolutionary sequence. Thus, in the 3 Domain classification, Domain Archaea includes primitive prokaryotic organisms while Domain Bacteria includes the more advanced prokaryotes. All the eukaryotic organisms are classified in the third Domain – Eukarya. Similarly, in the 5 Kingdom classification, the organisms are classified according to the complexity of their structure, indicating a definite sequence. Therefore, scientific classifications of organisms help biologists to understand evolution as it occurs in nature.

Botany as a science

Students of Botany study different kinds of organisms. These include the prokaryotic viruses and bacteria as well as the large group of eukaryotic organisms. Thus, we come across terms such as "algae", "fungi', "bryophytes", "pteridophytes", "gymnosperms" and "angiosperms". Each of these refers to a distinct group of eukaryotic organisms studied by botanists. Each group has been characterized by a defined set of parameters. Of these, the fungi are achlorophyllous while all other groups are chlorophyllous organisms. Interestingly, in both the "5-Kingdom" and the "3-Domain" classifications of organisms, the achlorophyllous fungi are placed in "Kingdom Fungi". The chlorophyllous eukaryotes (except some algae) are classified into "Kingdom Plantae" in both these classifications.

All these groups of organisms classified in Kingdom Plantae, as well as the fungi (Kingdom Fungi) and the viruses & bacteria shall be an integral part of your course. The

system of classification adopted in the course shall help you to understand the concept of evolution also. A brief overview of the course has been provided in the following paragraphs.

Keeping in mind that the prokaryotes originated before the eukaryotes, the course begins with interesting information on the simplest of organisms studied by biologists i.e. the viruses. Interestingly, these do not exhibit any metabolic activity on their own. They can also be stored as "crystals" in the laboratory. However, when these minute structures enter a living cell (of a bacterium, plant or animal), they can reproduce like living organisms and thus behave like "true organisms". They are able to do so by taking over the host cell's genetic mechanism. Viruses were discovered as "disease causing material" and they have a very simple organization. Unlike other organisms, viruses are not made up of cells. A typical virus has two basic parts, a core of nucleic acid and an outer coat of protein. The nucleic acid of a virus can be either DNA or RNA and it is this core which enables the virus to reproduce after it enters a living cell. The study of viruses is called "Virology" and it has provided a large amount of knowledge in understanding molecular biology.

Besides the viruses, the other important prokaryotes are the bacteria. These are very simple and constitute a distinct group of "organisms". They are the most abundant organisms on the earth, and there are both "good" as well as "bad" bacteria. These simple prokaryotes can occur in various forms. They do not have any "membrane bound organelles" such as a nucleus, mitochondria or chloroplasts. Some bacteria can live in the soil and/or water and play a very important role in the environment. Many bacteria are necessary for the food industry. Different kinds of bacteria help in making "curd" or "yoghurt" from milk. Others are required for processing cheese or alcoholic beverages. A large number of bacteria exist in sewage-treatment plants for purifying waste and thus help in recycling of water. Bacteria are also known to cause diseases in humans and other animals. They may produce "toxins" when they grow in improperly stored food, thus causing "food- poisoning". The study of bacteria is called "Bacteriology" and it has led to the understanding of numerous biological processes. The recent progress in biotechnology and/or genetic engineering has been possible due to the knowledge about bacteria.

After having been introduced to the "simple" prokaryotes, it becomes easy to understand the "more complex" eukaryotes. This enables us to understand "how evolution" occurs in nature.

The organisms which can be truly called "plants" are all eukaryotic. They also have the very important pigment, "chlorophyll" in their cells. Algae are amongst the first group of

plants which botanists study. This is a very diverse group ranging from microscopic single cells (measuring 0.6 – 0.8 µm) to simple filaments as well as various patterns of thallus organization. The largest alga may grow to a length of 60 meters and weigh about 300 kilograms. Besides, this vast diversity in the size of a single alga, we also come across many beautiful colours in the different algae. Thus, depending in the type of pigments in the cell, the algae are commonly classified as "green algae", "blue-green algae", "red algae", "brown algae" and other colour combinations. Interestingly, all algae always have "chlorophyll a" as the important pigment for photosynthesis. In addition to this, we study a large number of characters of this diverse group called algae. It is important to know that many aspects of photosynthesis were understood by studying the green alga *Chlorella*. The study of algae is called "Phycology" or "Algalogy".

Interestingly, the "blue-green algae" are prokaryotic organisms, but they are classified as "algae" on the basis of their thallus structure and habitat features. Their prokaryotic cell organization probably indicates their antiquity in evolutionary terms. At the same time, their reproductive behavior compares better with the bacteria. Therefore, these organisms are also called "cyanobacteria".

We always welcome a change from routine because it provides us an opportunity to analyze and appreciate new avenues/approaches. In this context, the classification of organisms also brings a new understanding of nature. Although, the "Fungi" are routinely studied as an integral part of courses in Botany/Plant Sciences, these organisms are not "true plants". The fungi are eukaryotic organisms which do not have chlorophyll, the pigment essential for photosynthesis. Besides this important difference, there are several other features which distinguish the fungi from the "true plants". In all the modern systems of classification of organisms, the fungi are classified in a separate unit called "Kingdom Fungi". Thus it is a distinct from the "Plant Kingdom".

Figure: Kingdom fungi is a diverse assemblage of achlorophyllous eukaryotic organisms some of which are visually appealing.

Source: https://upload.wikimedia.org/wikipedia/commons/d/da/Fungi_Diversity.jpg

There are many fascinating aspects of fungi which concern mankind. For example, we all appreciate the aroma of freshly baked bread and know that this is due to a fungus called "baker's yeast". Some fungi (example mushrooms) are edible. Similarly, many fungi living in the soil play a very important role in decomposing dead organic matter. Fungi such as *Penicillium* produce antibiotics which have been used for curing diseases. Some fungi infect our important crops causing huge damage to food and other useful plant products. They also bring about "fungal" infections in man and other animals. All these aspects of fungi, including the diversity of their structure and functions are studied as a part of the botany course. The study of fungi is called "Mycology" and there are many fascinating aspects of this science. Thus, by including the study of fungi in a botany

course, biologists have brought about a useful change to help us understand the organisms in a more meaningful manner.

The prokaryotic viruses and bacteria as well as the eukaryotic algae and fungi occur in diverse habitats. The viruses can be stored as crystals and also reproduce within living cells. The bacteria and fungi show a similar distribution and ecology, while the algae are largely aquatic. Of these, it is the algae which are chlorophyllous, and therefore of great interest to botanists. Thus after having studied the algae, botanists focus their attention on the other groups of chlorophyllous eukaryotes, especially plants occurring on land.

The "Bryophytes" which are often called "the amphibians of the plant kingdom" are recognized as the "first land plants". They are therefore important for understanding the origin and evolution of land plants. These organisms have many important features, thus making their study an interesting aspect of botany. One significant character of bryophytes concerns the organization of the female sex organ. This is called an "archegonium". (A similar female sex organ also develops in the other land plants such as the "Pteridophytes", and the "Gymnosperms".) Interestingly, the term "Cryptogams" was used for classifying the algae, bryophytes and pteridophytes because the sex organs of these plants were "hidden" inside the plant body and could not be observed easily. Another important feature of the bryophytes is the absence of "vascular tissues (xylem and phloem)" in the plant body. The common "liverworts" and "mosses" belong to two distinct units classified as bryophytes, and the study of these plants is called "Bryology".

**Embed: Bryophyte Life Cycle
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Source: http://www.docstoc.com/docs/80368271/Bryophyte-Life-Cycle

The more evolved land plants show the development of "vascular tissues" and therefore they are also called the "Vascular Plants". There are three important groups of these vascular plants – the "Pteridophytes", the "Gymnosperms" and the "Angiosperms". Of these, the pteridophytes were also "cryptogamous" and therefore referred to as "Vascular Cryptogams". At the same time, the pteridophytes are also called "seedless vascular plants" because unlike the gymnosperms and angiosperms, they do not produce any seeds. Thus in terms of their appearance/structure, they are totally different from the first land plants (the bryophytes) and also differ from the higher land plants (the gymnosperms and the angiosperms). The most common members of this interesting group of plants are the numerous ferns. There are also other fossil as well as living pteridophytes, the study of which has provided significant insights into the process of evolution. In these plants, there are two distinct phases/generations in the life cycle. The dominant phase is called the sporophyte and it shows the presence of vascular tissues. This phase reproduces asexually by developing spores. This sporophyte always alternates with the "thallus-like gametophyte" which reproduces sexually. The two phases of the life cycle show a "regular alternation of generations". The study of pteridophytes is called "Pteridology".

You may have seen the interesting film "Jurassic Park" and would probably know that the term "Jurassic" refers to a period in the evolutionary/geological development of the earth. Scientists have calculated that this period existed from about 200 to 145 million years ago. Botanists have found that the gymnosperms were relatively diverse in this period. Amongst these ancient vascular plants, the cycads grew abundantly during the Jurassic period. Therefore this period is also called the "Age of Cycads". Interestingly, the cycads which survive today have not changed at all. They still have the same characteristic features by which they were identified millions of years ago. Because of this unchanged appearance, the cycads are often referred to as "living fossils". Besides, the cycads, the gymnosperms also include the numerous kinds of conifers (which are abundant in different parts of the world today), as well as the unique "Maiden-hair tree" (*Gingko biloba*) and the bizarre *Welwitschia* (which is found only in the deserts of southwest Africa). *Gnetum* and *Ephedra* are the other gymnosperms generally studied by botanists. A large number of economically important substances are obtained from the gymnosperms. The large trees of many conifers show secondary growth leading to the formation of secondary xylem. This constitutes the bulk of all the wood we see around us, and it is important for making paper. Besides wood and pulp (used for making paper), gymnosperms also produce resin from which turpentine is made. This is an important raw material for the paint and varnish industry. The seeds of the "chilgoza pine" are consumed as a 'dry fruit or pine nut'.

Finally, we arrive at the very top of the evolutionary tree when we study the angiosperms. This dominant group of land plants is commonly referred to as "the flowering plants" because of the organization of their reproductive organs as "flowers". Most of the discussions about structure, anatomy, embryology, genetics, physiology, ecology, and economic aspects of plants which we read in botany textbooks, are based to a large extent, on the study of the angiosperms.

Thus by understanding classification, students of botany are able to know about the different kinds of organisms and their characteristic features, as well as appreciate the concept of evolution.

Glossary

We also come across several other terms for different "units of classification" in text books of botany. Each term has a meaning and expresses an understanding of some characters of the organisms. Some of these commonly used terms are defined here.

- **"Thallophyta/Thallophytes"** – organisms without highly differentiated tissues, such as vascular tissues, or distinct organs such as roots, stems, etc. The plant body is made up one/many cells. These can be chlorophyllous (example algae) or achlorophyllous (example fungi).
- **"Embryophytes"** – eukaryotic plants in which the zygote develops into a multi-cellular embryo which then grows into an adult plant. The bryophytes, pteridophytes, gymnosperms, and angiosperms are all embryophytes. The formation of a "pollen tube" after pollination is observed in the gymnosperms and the angiosperms. Hence these units have also been classified in a larger unit called "Embryophyta siphonogama" {indicating two features simultaneously, i.e. formation of an embryo as well as the formation of a pollen tube (siphon)}. Since no "pollen tube" is formed in bryophytes and pteridophytes, these units are classified together in "Embryophyta asiphonogama" (a = without + siphonogama = having a pollen tube) to differentiate the four units showing embryo formation in their life cycle.
- **"Cryptogams"** – a term used by Carolus Linneaus when he classified the plants into 24 classes. These are organisms in which the sex organs are "hidden" in the plant body and are not observed easily. For example, in the algae, fungi, bryophytes and pteridophytes, the sex organs are formed inside the thallus.
- **"Vascular Cryptogams"** or **"Higher Cryptogams"** – plants having vascular tissues (xylem and phloem for conduction of water and other materials) as well as "hidden" sex organs. The pteridophytes are referred to as vascular cryptogams because they usually have an elaborate sporophyte and a generally reduced

gametophyte. The sporophyte (having vascular tissues) reproduces asexually by producing spores in sporangia while the gametophytes (without vascular tissues) reproduce sexually. The gametes are formed in the "hidden" sex organs on the gametophyte.

- **"Archegoniatae"** – plants in which the female sex organ is called an "archegonium". This is a multi-celled structure more elaborate in its organisation when compared to the single-celled female sex organ (called oogonium) of the algae. The bryophytes, pteridophytes and gymnosperms are generally grouped as archegoniates.
- **"Vascular Plants"** – Highly differentiated plants having well-defined vascular tissues such as xylem and phloem. There are three well-known groups of vascular plants: the pteridophytes, the gymnosperms, and the angiosperms.
- **"Phanerogams"** – Highly differentiated plants bearing well-defined flowers, i.e. the angiosperms.
- **"Spermatophytes"** – Highly differentiated plants producing "seeds". The gymnosperms and angiosperms are both "seed-bearing" vascular plants.

Summary

(i) In this lesson, we have been able to start the "learning process" and know about some fundamental aspects of botany.

(ii) An attempt has been made to identify some commonly used food plants.

(iii) A brief survey has enabled us to know about the diversity of organisms studied by botanists.

(iv) Knowledge about the form, the structure and the functions of plants provides us with a strong foundation for understanding modern aspects of life sciences. This leads us to know about molecular biology, biotechnology, and genetic engineering.

(v) Modern developments in botany are based on a proper understanding of the organisms.

(vi) This requires an insight into the fundamental aspects of the science of classification.

(vii) The concept of classification is very important in everyday life of humans. It helps us to organise our knowledge in a logical manner. This enables easy retrieval of information.

(viii) The study of the characteristics of the organism provides the 'data base' for understanding botany.

(ix) Classification of organisms has been carried out by man from very ancient times.

(x) Different systems of classification have been proposed by many botanists. The Swedish Naturalist, Carlous Linneaus recognised the 'Plant Kingdom' as a distinct unit of classification.

(xi) In recent times, Whittaker classified the organisms into 5 Kingdoms.

(xii) The American microbiologist, Carl Woese, recognised a "new domain" amongst organisms and proposed a modern "3 Domain" classification of organisms.

(xiii) The majority of organisms studied by botanists are eukaryotic. The achlorophyllous (eukaryotic) fungi are also studied by students of botany. Besides the eukaryotes, botanists begin their learning by studying the prokaryotic organisms, namely viruses and bacteria. The classification of these organisms indicates an evolutionary sequence.

(xiv) Many scientific terms have been used in botanical classification. Some of the more common terms have been defined/explained.

Exercise

1. Know the plants in your kitchen.
   (a) Make a list of all the plants and plant products available in your kitchen at home.
   (b) Attempt to know some basic characters of each item in your lists. This shall enable you to classify these plants.
   (c) Try to classify the plants into distinct categories such as 'vegetables', 'fruits', 'cereals', 'pulses', 'spices', etc.
   (d) You may also classify these plants on the nature of the part of the plant used.

2. Know the plants in your neighbourhood/your college campus.
   (a) Observe the plants in your neighbourhood or your college campus.
   (b) List some basic characters of each plant.
   (c) Consult your teachers to identify these plants.

3. Differentiate the following statements as TRUE/FALSE
   i. Plants are the "gifts of nature to mankind".
   ii. Rice and mangoes originated in India.
   iii. Classification of organisms is based on the study of their form, structure, and functions.
   iv. Caroleus Linneaus proposed the 3 Domain classification.
   v. Algae are achlorophyllous organisms.
   vi. Pteridophytes have a gametophyte in the form of a thallus.

vii. All embryophytes develop vascular tissues.
viii. A pollen tube is formed in all embryophytes.
ix. Gymnosperms and angiosperms are called "seed-bearing plants".
x. Students of botany study only the eukaryotic chlorophyllous organisms.

4. Select the correct answer in the following MCQ's:
   i. The following cultivated plants originated in India:
      A. Potato
      B. Maize
      C. Rice
      D. Tomato
   ii. Plants which cannot be classified in Embryophyta are:
      A. Algae
      B. Bryophytes
      C. Gymnosperms
      D. Pteridophytes
   iii. Which of the following groups can be classified as "Vascular Cyrptogams"
      A. Bryophytes
      B. Pteridophytes
      C. Gymnosperms
      D. Angiosperms
   iv. The plants which do not produce seeds are:
      A. Cryptogams
      B. Phanerogams
      C. Spermatophytes
      D. Angiosperms
   v. Pteridophytes cannot be classified as:
      A. Vascular plants
      B. Cryptogams
      C. Thallophytes
      D. Embryophytes
5. List the 4 steps in taxonomy in the proper sequence.
6. Name the 5 Kingdoms into which organisms can be classified. Name the author who proposed this classification.
7. Who proposed the 3 Domain classification?

References/Further Reading

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