AS- 2899
B.Sc. (Hon's) (Third Semester) Examinations, 2013
BIOTECHNOLOGY
(Botany – I Plant Diversity)
Time allowed: Three hours
Maximum marks: 30

MODEL ANSWERS
Section – A

Q1) Multiple choice type questions
Answers:

i) (a)Autotrophic
ii) (a)*Volvox*
iii) (b) Mycelium
iv) (a) Chitin
v) (c) Bryophyte
vi) (c) Bryophyte
vii) (a) Pteridophyte
viii) (d) None of these
ix) (a) Angiosperm
x) (d) None of these

Section – B
(Long answer type questions)

Q2) Describe general characteristics of Algae.
Ans. The term algae was first introduced by *Linnaeus* in 1753. It is an important group of ***Thallophyta*** , the primitive and simplest division of the plant kingdom . The orderly systematic study of algae is called **Phycology** and the scientist is called **Phycologist.**

Important characteristics:
1. Algae are chlorophyll- bearing autotrophic thalloid plant body.
2. Almost all the algae are aquatic.
3. The plant body may be unicellular to large robust multicellular structure.
4. The multicellular complex thalli lack vascular tissue and also show little differentiation of tissues.
5. The sex organs are generally unicellular but, when multicellular all cells are fertile and in most cases the entire structure does not have any protection jacket.
6. The zygote undergoes further development either by mitosis or meiosis, but not through embryo formation.
7. Plants having distinct alternation of generations. Both gametophyte and saprophyte generations- when present in the life cycle are independent.

General characteristics:
Based on habitat the algae may be categorized as:
Aquatic algae, Marine algae. Some algae are found to grow in terrestrial habitats like soil, rocks, logs etc. some algae also occur in uncommon habitat like halophyte algae, thermal algae and symbiotic algae.
Thallus organization: The algal thalli are grouped into the following, based on their organization:

A. **Unicellular algae:** unicellular form of algae is also called acellular algae. The unicells may be:
   a) Motile or b) Non- motile

(a) The motile unicells are either rhizopodial or flagellated. The rhizopodial lack rigid cell wall and have cytoplasmic projections that help in amoeboid movement. The flagellated unicells resemble the motile

gametes and zoospores. The flagella functions as the organ of locomotion. The flagellated unicells are found in many groups of algae, e.g., *Chlamydomonas.*

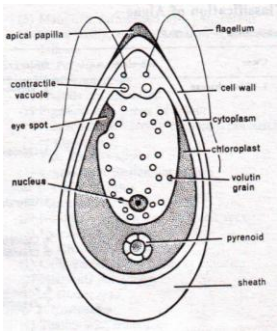
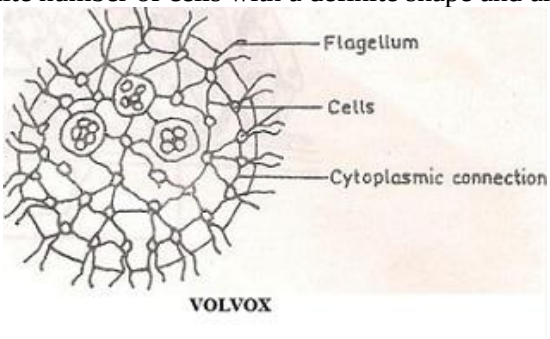


Fig: *Chlamydomonas* - Structure of a single cell.

(b) The non-motile cells may be spiral filament as found *in Spirulina.*

B. Multicellular algae:

Colonial- The cells of these usually remain connected with each other by cytoplasmic threads. Coenobium – When a colony has definite number of cells with a definite shape and arrangement, it is called as coenobium.



1. **Filamentous -** The filamentous plant body is formed through repeated cell divisions in a single plane and in a single direction, where the cells remain firmly attached to each other.

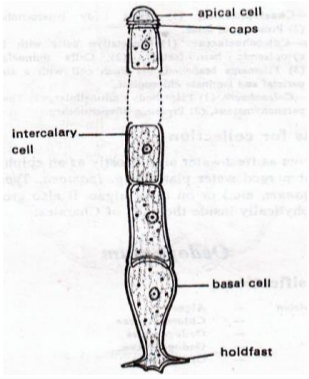


Fig: *Oodogonium* – Structure of filament

2. **Siphonaceous form –** In this form the thallus is aseptate and multinucleate. It may be simple branched (e.g., *Vaucharia*) or may be very elaborate with clear division of labour, differentiated into aerial and subterranean portions.
3. **Heterotrichous form-** two types of habit develop in the algae-
   (a) Prostrate or creeping portion and b) Erect or projecting portion
   This type of habit is known as heterotrichous habit.

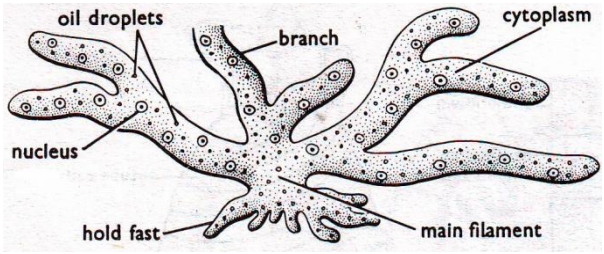


Fig : *Vaucheria* – thallus structure **Fig :** *Ectocarpus:* Heterotrichous filament

Nutrition

Algae are autotrophic in their mode of nutrition. They are able to manufacture their own food by photosynthesis on account of the presence of chlorophyll.

Reproduction

The members of algae reproduce by all the three means:

- Vegetative, asexual and sexual reproduction.

1. Vegetative reproduction

In this type, any vegetative part of the thallus develops into new individual. It does not involve any spore formation and there is no alternation of generations. It is the most common method of reproduction in algae. The vegetative reproduction is of following types-

Cell division or fission, Fragmentation, Hormogonia, etc.

2. Asexual reproduction

Asexual reproduction involves the formation of certain type of spores- either nacked or newly walled. Each and every spore germinates into a new plant. In this method there is no alteration of generations. The asexual spores may be of different types:

Zoospores: these are motile naked spores provided with two, four or many flagella and called as bi-, quadric- or multiflagellate zoospores, respectively. Biflagellate zoospores are found in *Chlamydomonas,* Ulothrix and multiflagellate zoospores are found in *Oedogonium* . But the multinucleate and multiflagellate zoospores as found in *Vaucheria* are called **synzoospores.**

3. Sexual reproduction

During sexual reproduction gametes used to form zygote. Depending on the structure, physiological behavior and complexity of sex organs, sexual reproductions are of the following types:

a) Autogamy- In this process the fusing gametes are developed from the same mother cell and after fusion they form zygote. e.g., Diatom.

b) Hologamy- In some unicellular member the vegetative cells of different strains (- and +) behave as gametes and after fusion they form zygote. e.g., *Chlamydomonas*.

c) Isogamy- It is the process of union between two gametes which are morphologically and physiologically similar- after fusion they form zygote. The gametes are called isogametes. e.g., *Chlamydomonas eugametos* .

d) Anisogamy- In this process the uniting gametes are morphologically and physiologically different. The smaller and more active one is the microgamete (male), whereas the larger and less active one is the macrogamete (female). E.g., *Chlamydomonas braunii*.

e) Oogamy- It is an advanced process where fertilization takes place between a small motile male gamete with a large non-motile female gamete. e.g., *Oedogonium , Vaucheria.*

Q3) Describe the structure of *Volvox*.

Answer: Classification:

Division	- Chlorophyta
Class	- Chlorophyceae
Order	- Volvocales
Family	- Volvocaceae
Genus	- *Volvox*

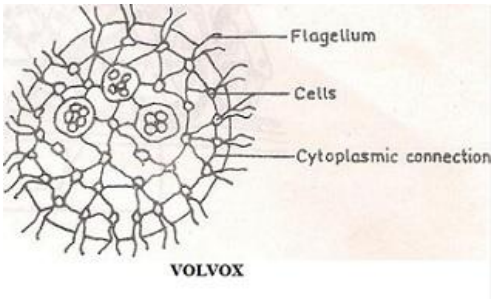
Occurrence: *Volvox* is a green, flagellate colonial alga of worldwide distribution comprising twenty species. It occurs in temporary and permanent fresh water of ponds, pools and ditches.

Size, Form and Structure of Coenobium:

The *Volvox* coenobium is the largest and most highly differentiated of all the free swimming colonial forms. The coenobia look like minute green balls just the size of a small pin head varying from 0.5 to 2.0 mm in diameter.In form, the coenobium is a sphere of extracellular mucilage with a firm bounding layer. The numerous cells of the colony are embedded in the gelatinous matrix and are arranged in a single peripheral layer. The *Volvox* coenobium is thus a hollow sphere with the interior showing no cellular organization. Depending upon the species the number of cells in the colony varies between 500 or 1000 and 50,000. Each cell has its own gelatinous sheath or mucilaginous envelope and thus is separated from its neighbors by a considerable expanse of the gelatinous material. This shows that *Volvox* is not an individual but an association of a number of adjacent cells. The protoplasmic fibrils connect the cells through the mucilage which extends in a wedge-shaped mass towards the interior. The coenobium is filled with watery mucilage.

Cell Structure:

Each cell is provided with two flagella at its anterior end. There are two contractile vacuoles near the base of the flagella. The green chloroplast is cup-shaped with usually one pyrenoid. The reddish brown eye spot is located in the anterior region of the chloroplast immediately beneath the double chloroplast envelope.The protoplast is stellate with a number of coarse unbranched processes traversing the mucilaginous portion of the cell wall. There are several contractile vacuoles distributed irregularly near the surface of the protoplast. The chloroplast is a curved plate with one or more pyrenoids.



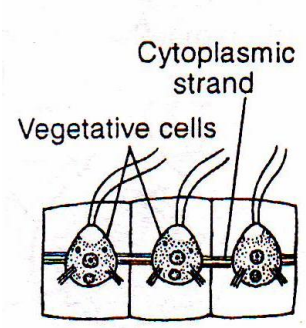


Fig: Cell structure of *Volvox.*

Q4) Describe the general characteristics of fungi.

Fungi are the members of *Thallophyta* of plant kingdom. According to modern scientists, term fungus is used for all those micro-organisms which are nucleated, spore bearing and achlorophyllous.

Habitat: Fungi are usually growing on dead organic matter which forms substratum for fungi. Fungi are worldwide in distribution.

Structure: Fungi are the organisms with simple eukaryotic structure. The plant body is made up of filaments. These filaments are known as hyphae. These hyphae are found as a network. The network of this hypha is called as mycelium. The hyphae of some fungi do not have septa and are called aseptate fungi whereas hyphae with septa are called septate fungi. Non septate hyphae are unicellular and multinucleated. This type of hyphae is called coenocytic.

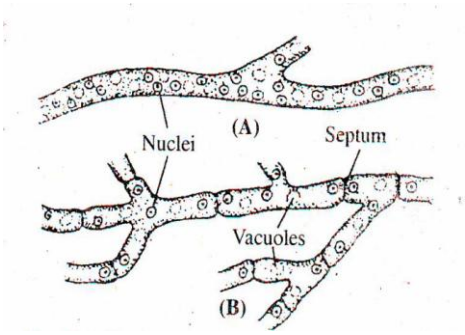


Fig: Hyphae (A) - Aseptate, (B) - Septate

The cells of septate hyphae contain one, two or more nuclei. The transverse wall of septate fungi has a minute pore through which protoplasm of all the cells is connected together.

Each cell of fungi is covered by a cell wall which is composed of fungal cellulose or chitin.

Nutrition in fungi: The fungi are chlorophyll- less plants and cannot synthesize their own food hence they are heterotrophic in nutrition and they obtain their food by a special method. They possess a special filament called **haustoria** which secrete digestive enzymes.

The fungi which obtain their food from dead organic material are called Saprophytes whereas fungi obtaining their food from living plants and animals are called Parasites – The living beings on which the fungi parasitise are called hosts. Some species of fungi grow in the association of other plants and are mutually beneficial. This association is called the symbiosis.

1. **Parasitic fungi-** the fungi which obtain their food from living host where they grow are called parasitic fungi. The parasitic fungi may be of following kinds:

a) Obligate parasites: parasites which grow and survive only on or in the living host. They take their food from the host through special knob on finger like structures called *haustoria.*

Obligate parasites fungi which grow superficially on the surface of host are called as **ectoparasites.** Their mycelium is confined to upper surface of vegetative parts.

Some parasitic fungi enter the host tissues, are called as endoparasites. Their mycelium may be present between host cells or within the host cells.

b) Facultative saprophytes: some fungi which are usually parasitic, but after the death of host are able to absorb their food from the decaying body of the host.

2. **Saprophytic fungi**: These fungi obtain their food from dead organic matter. They may be:

a) Obligate saprophytes: these fungi always take their food from decaying organic matter.

b) Facultative parasites: these fungi usually saprophytes but can live parasitically under some conditions. e.g. *Fusarium, Pythium, Alternaria*.

c) Symbiotic fungi: it is a special type of association in which both the partners are mutually benefitted. Some members of fungi live symbiotically with other plants.

Mechanism of nutrition:

To absorb nutrients and other materials, either the entire mycelium is responsible or special structures are formed for this purpose. The mycelium may ramify in the intercellular space between the host cells or penetrate into the host cells. The former are called intercellular hyphae and the latter intracellular hyphae. In many fungi, the intercellular hyphae send special sac like structures called haustoria to suck nutrients.

Reproduction in fungi:

Fungi can reproduce by following three methods:

1. Vegetative reproduction
2. Asexual reproduction
3. Sexual reproduction

1. **Vegetative reproduction**: it may takes place by any of the following methods:

Budding, Fission, Fragmentation

2. **Asexual reproduction** : It may takes place by any of the following methods:

By conidia, zoospores, aplanospores, sporangiospores, oidia , chlamydospores, Ascospores, basidiospores, binucleate spores, etc.

3. Sexual reproduction:

Sexual reproduction occurs by formation of gametes (n). Fungi are less developed organisms, in which sexual reproduction may be of isogamous or anisogamous or oogamous type. It generally involves three stages:

a) Plasmogamy- in this stage gametes of opposite sex come closer to each other and fusion of protoplast of two gametes takes place , as a result of which two haploid nuclei come closer to each other.
b) Karyogamy- In this haploid stage, nuclei of the gametes fused to form diploid gametes.
c) Meiosis- In this stage diploid zygote divides by meiosis cell division to form haploid cells, which develop to form new fungal hyphae. In lower fungi, the fungal cells themselves act as gametes, but in higher forms distinct reproductive structures antheridium (male) and oogonium (female) are produced.

Types of asexual reproduction-

Planogametic copulation, Gametangial contact, Gametangial copulation, Spermatization, Somatogamy.

Q5) Describe the external and internal structure of *Riccia.*

Ans. **Classification:**

Class - Hepaticopsida
Order - Marchantiales
Family - Ricciaceae
Genus - *Riccia*

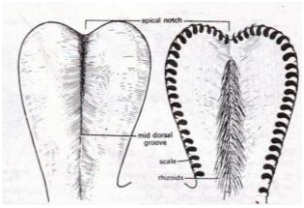
Distribution and Habitat:

The different species of *Riccia* prefer to grow on damp soil, moist and shady rocks and other similar terrestrial habitats.

External structure:

The gametophytic plant body of *Riccia* is a dichotomously branched dorsiventral prostrate thallus. In terrestrial habits, the plants usually occur in a rosette form due to the presence of a number of dichotomies that grow together from one place. These rosettes are upto 15 cm in diameter. Each dichotomy is a linear to wedge shaped structure where the medium region is thickened with a conspicuous longitudinal groove on the dorsal side ending in a notch the growing plant is located at the tip of the notch. Transverse row of scales are present on the ventral surface. The scales are one cell in thickness that are more crowded near the apex and overlap the growing point, often pigmented violet. In the mature portion of the thallus, each scale is split into two to form two rows of scales along the two margins. The thallus also bears numerous rhizoids in the ventral surface which are unicellular, elongated, tubular and hair like structure. Rhizoids serve the purpose of anchorage to the substratum and absorption of water and nutrients from soil. There are two types of rhizoids: Some with smooth walls and others tuberculated with internal peg-like or plate like projections of the wall. Rhizoids are devoid of protoplasm at maturity and are absent in aquatic forms.

Fig**:** Rosette



A B

Fig: (A) Dorsal and (B) ventral view of thallus

Internal structures:

The thallus of *Riccia* shows an internal differentiation of tissues. A vertical transverse section (V.T.S.) of the thallus shows two distinct regions (a) the ventral storage region and (b) the dorsal assimilatory (photosynthetic) region.

Storage region:
The ventral region of the thallus is formed of a compact colorless parenchymatous tissue, often contains starch. This region serves as the storage region of the thallus. The scales and rhizoids develop from the basal part of this tissue.
Assimilatory region:
This region is composed of vertical rows of green, chlorophyllous cells that are separated by vertical air canals. Usually each air canal is very narrow and surrounded by four vertical rows of cells. However, in a few species (e.g., *R. vesiculosa*) the canals may be wider and surrounded by 8 rows of cells. The canals are open on the dorsal surface so that the top of the thallus is porous, but does not show any organized air pores like *Marchantia*. The outer most cell is in each vertical row is larger and colorless which forms an interrupted, one cell thick epidermis.
Apical growth:
The growth in length of the thallus takes place by means of 3-5 apical cells (initials). They are situated in the apical notch (growing point) and are more or less triangular in outline. Some of the median cells fails to divide or spilt vertically. As a result two separate growing point are formed, so that the thallus becomes dichotomous.

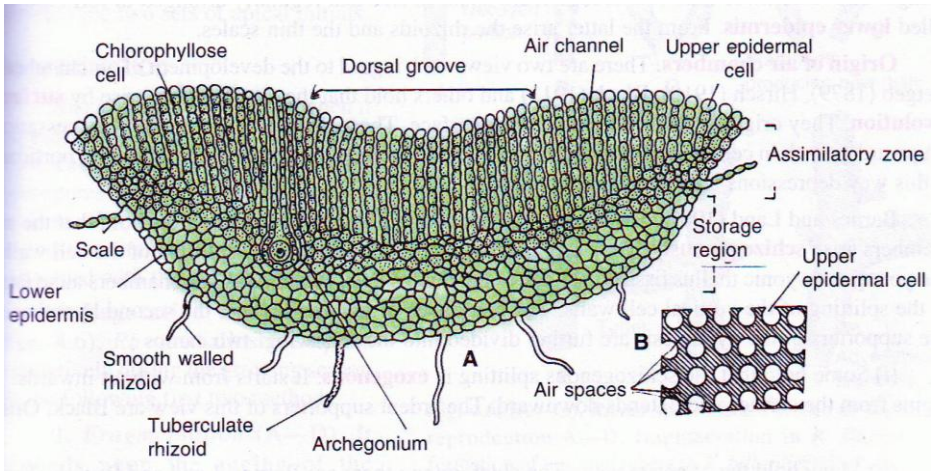


Fig: Internal structure of *Riccia* thallus.

Q. 6) Describe the external structure of *Riccia* and *Marchantia.*
Ans: ***Riccia***
Classification:
Class - Hepaticopsida
Order - Marchantiales
Family - Ricciaceae
Genus - *Riccia*
Distribution and Habitat:
The different species of *Riccia* prefer to grow on damp soil, moist and shady rocks.
External structure:
The gametophytic plant body of *Riccia* is a dichotomously branched dorsiventral prostrate thallus. In terrestrial habits, the plants usually occur in a rosette form due to the presence of a number of dichotomies that grow together from one place. These rosette are upto 15 cm in diameter. Each dichotomy is a linear to wedge shaped structure where the medium region is thickened with a conspicuous longitudinal groove on the dorsal side ending in a notch the growing plant is located at the tip of the notch. Transverse row of scales are present on the ventral surface. The scales are one cell in thickness that are more crowded near the apex and overlap the growing point, often pigmented violet. In the mature portion of the thallus, each scale is split into two to form two rows of scales along the two margins.

The thallus also bears numerous rhizoids in the ventral surface which are unicellular, elongated, tubular and hair like structure. Rhizoids serve the purpose of anchorage to the substratum and absorption of water and nutrients from soil. There are two types of rhizoids: some with smooth walls and others tuberculate with internal peg-like or plate like projections of the wall. Rhizoids are devoid of protoplasm at maturity and are absent in aquatic forms.

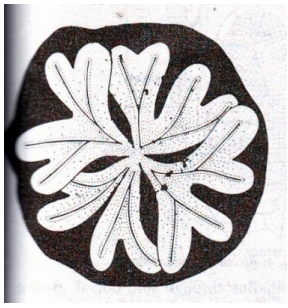
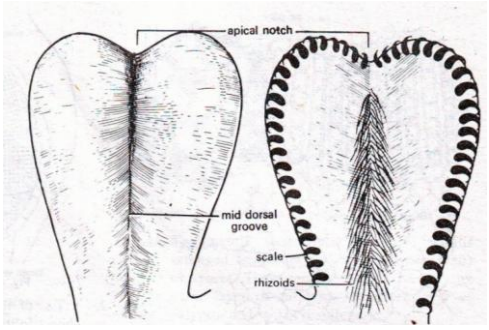


Fig**:** Rosette



A B

Fig: (A) Dorsal and (B) ventral view of thallus.

***Marchantia*:**

Classification

Class - Hepaticopsida

Order - Marchantiales

Family - Marchantiaceae

Genus - *Marchantia*

Distribution and habitat:

Marchantia is cosmopolitan in distribution. It prefers to grow on moist, cool and shady environment. Usually it is found on the surface of damp soil, in the sides of streams, springs and swamps.

External structure:

The gametophyte of *Marchantia* is a dichotomously branched, prostrate, dorsiventral thallus. The dorsal surface of the thallus shows many regular, rhomboidal or polygonal areas. Each area has a pore at the center. A distinct median groove (mid rib) is present on the upper (dorsal) surface in each branch of the thallus with a corresponding ridge on the ventral surface. The branches grow indefinitely by means of a growing point situated in the terminal groove (apical notch).

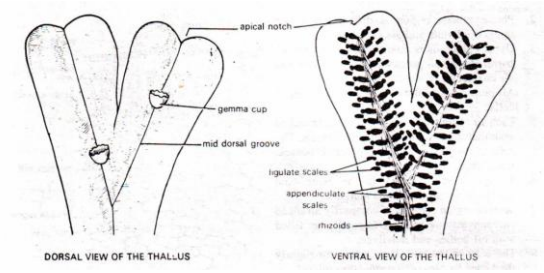


Fig: *Marchantia*- External features.

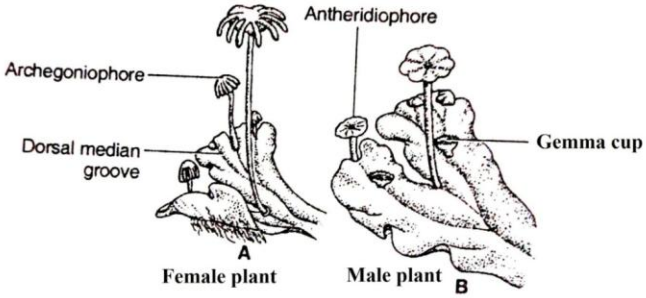


Fig: Plant body of *Marchantia*

The ventral surface of the thallus bears 3-4 rows of scales and rhizoids on both sides of the midrib. The scales are membranes, one layered thick, usually violet in color due to the presence of anthocyanin pigments, morphologically, the scales are of two types- appendiculate and ligulat. The appendiculate scales situated near the midrib are larger and more elaborate by the presence of an apical sub-rounded appendage. The ligulate scales on the other hand, are relatively small, situated towards the margin ,which do not have appendage. These scales protect the growing point of the thallus from desiccation. Besides

the scales, the ventral surface of the thallus bears rhizoids between the scales. They are usually unicellular, colorless and are of two types viz., smooth walled and tuberculate as in *Riccia*. The rhizoids perform the function of anchorage to the substratum as well as absorption of water and nutrients from soil.

Q7) Describe the external structure of *Rhynia*.

Ans. Classification

Division- Psilophyta
Class - Psilophytopsida
Order - Psilophytales
Family - Rhyniaceae
Genus - *Rhynia*

Till now only two species of Rhynia named as *Rhyniamajor* and *R. gwynne-vaughani* have been described by Kidston and Lang (1917, 1921) from the Old Red Sandstone Beds of Middle Devonian period of Paleozoic era. Kidston and Lang (1921) thought and supported by evidences that in those times the plants grew in swampy marshes near the volcanoes.

Structure of *Rhynia*:

Both the species of *Rhynia* were herbaceous plants. Comparatively the *Rhynia* major was larger in size. *R. gwynne vaughani* was a smaller herbaceous plant, possible about 18 cm in height and 1.0 – 2.0 mm in diameter. The height of *Rhynia major* is relatively high and is about 50 cm and their diameter was 1.5- 6 mm. The plant body of both species consisted of dichotomously branched horizontal rhizome and the erect, aerial dichotomously branched stem. The aerial branches were leafless shoots. The plants were rootless. Instead of the roots the unicellular rhizoids were present in patches on the underside of the rhizome. The aerial branches were naked, leafless, cylindrical, dichotomously forked and tapering at the apices. The terminal, elongated sporangia were found on the tapering vegetative apices.

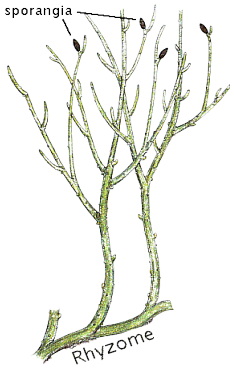


Fig: External structure of *Rhynia*

Q8) Describe Bentham and Hooker system of classification.

Bentham and Hooker System of Classification

Benthom, and Hooker: George Bentham (1800-1884) and Sir Joseph Hooker (1817-1911), two great English systematists adopted a very comprehensive system of classification in their "Genera plantarum" is virtually an extension of the work of de Jussuieu and de Candolle. They discussed dicotyledons first, then gymnosperms and lastly monocotyledons. According to the system of classification, the plant kingdom comprises about 97, 205 species of seeded plants, in 202 orders including 2 anomalous orders of dicots and 3 orders of gymnosperms and grouped in to cohorts (orders, as now understood). The dicotyledons, gymnosperms and monocotyledons comprised 165, 3 and 34 orders respectively. They divided dicotyledons in to 3 divisions, 14 series which were further divided into cohorts and orders. They started with the family Ranunculaceae (with free sepals and petals and indefinite number of free stamens and carpels, and ended in Labiatae excluding incompletae and Ordines anomaly. They divided

monocoyledos in to 7 series which were directly divided in to orders without the interpolation of cohorts. The Bentham Hooker's system of classification of phanerogams or seed plant may be summarized as follows:

BENTHAM & HOOKER CLASSIFICATION

Group 1: DICOTYLEDONS – 2 cotyledons, exogenous growth.
Division1: *POLYPETALAE* – petals are separate. It has 3 series and 8 order

Series 1: THALAMIFLORAE – Stamens all attached to receptacle.
It includes 6 cohorts and 34 orders (1-34)
1. Cohorts – Ranales - Gynoecium apocarpous.
6. Cohorts - Malvales - Seplas valvate.

Series 2: DISCIFLORAE – Ovary superior, immersed in disk of flower.
It has 4 cohorts and 21 (35-57) orders + 2 anomalies orders
7. Cohorts – Geraniales - Ovule pendulous, raphe ventral.
10. Cohorts – Sapindales - Ovule ascending, raphe ventral to reverse.

Series 3: CALYCIFLORAE – Stamens fused to Calyx of flower
It includes 5 cohorts and 27 (58-84) orders
11. Cohorts – Rosales - Ovaries separate, rarely united.
15. Umbellales - Ovary syncarpous; 1 ovule per locule

Division 2: *GAMOPETALAE* – petals fused
It includes 3 series, 10 cohorts and 45 (85-93) orders.
Series 1: INFERAE – Ovary inferior; stamen no. = petal no.
Coherate 1 Rubiales – Stamens epipetalous; locules 2 - many; ovules 1- many.
Coherate 3 Campanulales – Stamens free; locules 2-6; ovules many.

Series 2: HETEROMERAE – Ovary superior; **stamens opposite petals or double the petal no**.
Coherates are 3 and orders are 12(94-105).
a) Ericales – Stamens double petal no.; Ovary 2-many locules
b) Ebenales – Stamens opposite petals; Few large seeds.

Series 3: BICARPELLATAE – Ovary superior, with 2 carpels.
It includes 4 coherate and 24(106-129) orders
1. Gentianales – Corolla regular; leaves opposite.
2. Lamiales – Corolla irregular to oblique; 1-2 ovules.

Division 3*: MONOCHLAMYDEAE – only 1 kind of perianth (not petals + sepals)*
It is divided into 8 series and 36 orders (130 -166)
1) Curved embryos/ Curvembryeae [The curved embryos & seeds make these part of the Caryophyllids]
7) Ordines anomalus (→ Paleoherbs/Rosids)

Group 2: Gymnospermae: Naked seeded plants**,**
It include 3 orders and Gnetaceae, Coniferae and Cycadaceae

Group 3: MONOCOTYLEDONS – 1 cotyledon, Endogenous growth.
It includes 7 series 34 orders (167-200)
Series 1) Microspermes
7) Glumiflorae