A SPECIAL TRAINING PROGRAMME FOR SC/ST TEACHERS OF SCHOOLS RUN BY ADI DRAVIDAR WELFARE DIRECTORATE OF TAMILNADU ON SCIENCE AT SECONDARY LEVEL

(28/1/2002 to 6/2/2002)

REPORT

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Mysore 570 006

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PREFACE

The Regional Institute of Education (RIE), Mysore, caters to the needs of the Southern States of Karnataka , Kerala, Andhra Pradesh, Tamilnadu and the Union Territories of Pondicherry and Lakshadweep in the field of School Education. The Institute accordingly conducts a number of Inservice programs at the State, Regional and National levels. The State of Tamilnadu requested the RIE, Mysore, to conduct a special training program in science for the teachers of Secondary Schools run by the Adi Dravidar Welfare Directorate in the State. A ten day training program was hence organised from 28th January 2002 to 6th February 2002 at the RIE, Mysore which was attended by twenty one teachers drawn from the different schools run by the directorate.

The main objectives of the training programme were:

a) to identify the difficult topics in science at the secondary level

b) to identify the " hardspots" in the above topics

c) to empower the teachers with relevant strategies to overcome the hardspots

d) to train the teachers in conducting laboratory work at the secondary level

The present volume contains the details about the training programme.

Mysore
28/2/2002

P.R.Lalitha
Academic Coordinator

LIST OF RESOURCE PERSONS AND THE LECTURES DELIVERED BY THEM

Name	Initials	Topics discussed
Physics Dr S.S. Raghavan Professor	SSR	1. Magnetism 2. Electromagnetism
Dr M.N.Bapat Reader	MNB	1. Waves 2. Sound
Mr N.R.Nagaraja Rao Sr. Lecturer	NRN	1. Reflection at Spherical Surfaces 2. Refraction at Spherical Surfaces
Chemistry Dr B.S.Raghavendra Reader	BSR	1. Atomic Structure & Electronic Configuration 2. Periodic Table 3. General Principles of Metallurgy and extraction of Iron and Aluminium
External Resource Person Dr V. Kesavan Professor (Retd.)	VK	1. Chemical bonding and shapes of Molecules 2. Organic Compounds-Saturated And Unsaturated
Botany Dr G.V.Gopal Reader	GVG	1. Pteridophyte 2. Gnetum
Dr Geetha Nair Sr. Lecturer	GN	1. Chara –Life History & Sex Organs
Zoology Dr L. Srikantappa Professor	LS	1. Genetics – DNA &RNA
Dr S.P. Kulkarni Sr. Lecturer	SPK	1. Nutrition 2. Heart & Circulatory System of Birds 3. Macromolecules – Carbohydrates, Proteins and Lipids

LIST OF RESOURCE PERSONS INVOLVED IN PRACTICALS AND DEMONSTRATIONS

Name	Initials	Practicals&Demonstrations
Physics Dr P.R.Lalitha Reader	PRL	**Demonstrations** 1. Ripple Tank 2. Estimation of the Size of a molecule 3. Preparation of Low Cost Teaching Aids and their use **Practicals** Experiments identified in Physics
Dr R. Narayanan Reader	RN	**Demonstrations** 1. Discharge of Electricity through Gases 2. Spectra **Practicals** Experiments identified in Physics
Chemistry Dr B.S.Raghavendra Reader	BSR	**Practicals** 1. Preparation and Properties of Oxygen, Hydrogen, Chlorine and Ammonia
External Resource Person Dr V. Kesavan Professor (Retd.)	VK	2. Redox Reactions 3. Preparation of Ethylene
Botany Dr G.V.Gopal Reader	GVG	**Practicals** 1. Pteridium - Sex-organs, Prothallus, Sporophytes 2. Gnetum – Sex organs, Sporophyte, Gametophyte 3. Chara – Sex- Organs. Nuclue
Zoology Dr S.P.Kulkarni Sr. Lecturer	SPK	**Practicals** 1. Dissection of Earthworm -Digestive system -Nephridia 2. Mitosis- Study of Various Stages

A SPECIAL TRAINING PROGRAM FOR SC/ST TEACHERS OF SCHOOLS RUN BY ADI DRAVIDAR WELFARE DIRECTORATE OF TAMILNADU ON SCIENCE AT SECONDARY LEVEL

Programme Schedule
28/1/2002 to 6/2/2002

Day and Date	**9-11 am**	**11.15-1.00pm**		**2.00-3.30pm**	**3.45-5.00pm**
Mon 28/1	Registration And Inauguration	Identification of hardspots in Physics & Chemistry		Identification of hardspots in Botany & Zoology	Visit to Labs
Tue 29/1	Physics (SSR)	Chemistry (BSR)		Physics Lab (PRL+RN)	
Wed 30/1	Botany (GVG)	Zoology (SPK)		Botany Lab (GVG)	
Thurs 31/1	Physics (NRN)	Chemistry (BSR+VK)		Chemistry Lab (BSR+VK)	
Fri 1/2	Botany (GVG)	Chemistry (BSR+VK)		Physics Lab (PRL)	
Sat 2/2	Zoology (LS)	Botany (GN)		Zoology Lab (SPK)	
Sun 3/2	Physical Science Project			Life Sciences Project	
Mon 4/2	Zoology (SPK)	Physics (MNB)		Zoology Lab (SPK)	
Tue 5/2	Visit to National History Museum (PRL)			Chemistry Lab (BSR+VK)	
Wed 6/2	Botany Lab (GVG)	Physics Lab (PRL+RN)		Wrap-up Session & Valedictory	

ABOUT THE TRAINING PROGRAMME

ABOUT THE TRAINING PROGRAMME

The training program was conducted in two phases.

Phase I A program was organised for three days from 16th Jan. 2002 to 18th Jan. 2002 to work out the strategies for identifying hardspots in science for teachers and planning the interventions to be adopted to empower them overcome the same. A tentative list of the topics in the areas of Physical Sciences and Life Sciences were identified. It was also proposed that on the first day of the actual training program during Phase II the resource persons would meet the teachers and modify the list based on their needs. It was decided that the program would consist of lectures, laboratory work, individual projects and demonstrations. The resource persons identified a list of demonstrations and laboratory experiments which they felt that the teachers must do in order to teach the content effectively. A tentative schedule of work was also drawn up.

The following resource persons were present:

Physics	Dr. P.R. Lalitha, Reader, Academic Coordinator
	Dr. R.Narayanan, Reader.
	Mr. N.R.Nagaraja Rao, Sr. Lecturer.
Chemistry	Dr. V.Kesavan, Professor (Retd.)
Biology	Dr. G.V.Gopal, Reader.
	Dr. S.P.Kulkarni, Sr. Lecturer.

PhaseII The actual training program was conducted from 28th Jan, 2002 to 6th Feb, 2002, in which twenty one teachers participated. On the first day of the program the difficult topics for teachers were finalised by meeting the teachers in the first two sessions. From the second day onwards lectures and lab sessions were organised in which the teachers actually performed a few experiments and a few experiments were demonstrated. A special feature of the program was that a visit to the Natural History Museum was organised where we demonstrated how such visits could be used to promote better science teaching. Another important aspect of the program was that the preparation and use of low cost teaching aids to teach simple concepts in Physics was demonstrated. Teachers felt that the time was insufficient for them to actually prepare the teaching aids during the training. Handouts on a few topics in biology were given to the teachers. In the Physics lab the teachers performed the experiments with the help of the activity sheets. The importance of accurate measurements was stressed and post- lab discussions were held. Teachers also performed experiments related to the content in Chemistry, Botany and Zoology.

The list of topics dealt with in the different areas are listed below :

Physics :

1. Magnetism and Electromagnetism
2. Reflection and Refraction at Spherical Surfaces
3. Waves and Sound

Chemistry :

1. Atomic Structure and Electronic configuration
2. Periodic Table
3. Chemical Bonding and Shapes of Molecules
4. General Principles of Metallurgy
5. Extraction of Iron and Aluminium
6. Organic Compounds –Saturated and Unsaturated

Botany :

1. Pteridophyte – Pteridium life-history, Antheridium, Archegonium, Sporophyte, Gametophyte.
2. Gnetum - Morphlogical Structure of male and female inflorescences.Sporophyte, Gametophyte.

3. Chara - Life history and Sex organs.

Zoology :

1. Nutrition.
2. Heart-Circulatory System in birds.
3. Macromolecules - (Carbohydrate, Protein, Lipids).
4. Genetics – DNA & RNA.

List of Experiments in Physics :

1. Study of uniform motion – Air Bubble Experiment
2. Study of Motion using tape timer.
3. Galileo's Experiment.
4. Study of the relation between u, v & f for a convex lens.
5. i-d curve for a prism.
6. Measurement of the velocity of sound at room temperature by Resonance Column.
7. Mapping of the magnetic field.
8. Study of Ohm's Law.

The teachers worked on different projects related to the topics discussed during the course. The participants of the program felt that they were empowered to deal with the hardspots identified. They expressed their heartfelt thanks for having had an opportunity to do the experiments in the laboratory.

APPENDICES

Adiantum

(Maiden-Hair Fern)

Systematic Position : (According to Reimers, 1954)

Division	:	**Pteropsida**
Sub-division	:	**Leptosporangiatae**
Order	:	**Filicales**
Family	:	**Adiantaceae**
Genus	:	**Adiatum**

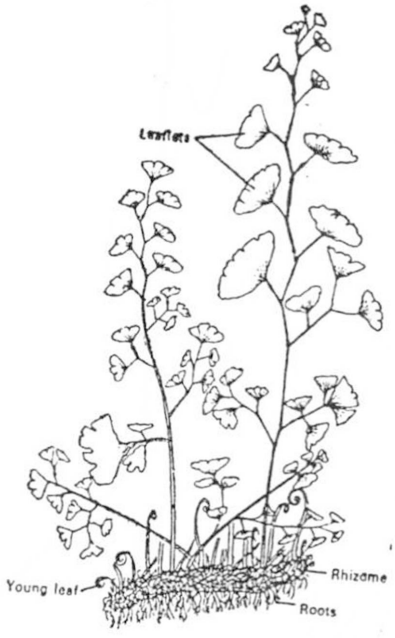
Distribution and Habitat : This well known fern is represented by about 200 species which occur abundantly in tropical and sub-tropical regions of the world. It is commonly called 'Maiden Hair Fern' because in young conditions its entire body (roots, rhizome, petiole) is covered by maiden (young unmarried woman) like hairs called ramenta.

It is a terrestrial fern and occurs in the moist shady places, especially in all warmer parts of the globe. It may grow successfully on old walls and crevices of rocks which remain persistently moist. Because of its **ornamental** beauty Adiantum is also cultivated commonly in gardens. Nayar (1961) has worked on the morphology of 24 Indian species of this genus. Common Indian Species are *Adiantum capillus-veneris, A.Caudatum, A. edgeworthii, A. incisum, A. lumutatum and A. pedatum etc.*

SPOROPHYTE

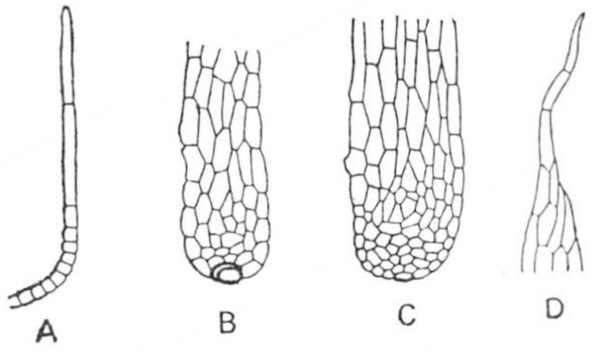
External Features: The sporophytic plant body is divisible into roots, rhizome and well developed leaves.

The primary root is ephemeral and all the well branched black coloured roots are adventitious. The roots arise generally in clusters from the lower side of rhizome.



Adiantum capillus-veneris showing external features

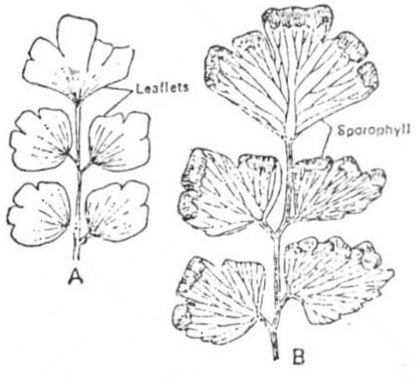
The rhizome is hard, brown, generally prostrate but sometimes erect, creeping on or in the ground, well branched and covered with many multicellular hairs. From the rhizome arise roots towards lower side and leaves towards upper side. In general, the rhizome is creeping (e.g. A capillus-veneris, A. pectinatum) but it may be semi-erect. (e.g. A pedatum) or erect (e.g. A Caudatum). According to Nayar (1961) the rhizome is covered by many paleae which may be ovate or lanceolate in shape, in different species. In earliest stages the paleae develop as unicellular structures which later on become multicellular (5-12 cells) by transverse divisions. The upper cells of paleae are much longer than that of their lower basal cells. The basal cells later on divide longitudinally and thus the basal region becomes flat and multiseriate.



Adiantum capillus-veneris. Showing the structure of Paleae

The leaves are very large, compound, petiolate, dichotomously branched and arranged spirally on the rhizome. They are circinately coiled when young. Paleae or hair-like structures are present on the young parts of the leaf. Each leaf contains many leaflets or pinnae which are stalked, deltoid in shape and contain **dichotomously branched veins** (Fig. 11.33 A). The rachis and the petiole of leaf are very hard in almost all Indian species.

The leaves may be unipinnately compound (e.g. A caudatum) or bi or multipinnately compound (e.g. *A. capillus-veneris, A pedatum, etc).* The rachis is being terminated in a pinna. There exists a difference of shape and size of the terminal pinna with that of others.



Adiantum capillus-veneris A- Sterile leaflets;
B – Ventral side of fertile leaflets

The margins of the fertile leaflets remain folded (Fig.11.33 B) towards the lower side to form the **false indusium.** The fertile portion of each leaflet contains many sporangia which remains filled with spores. Because the spotangia in *Adiantum* are covered by sharply reflexed leaf lobes, **Copeland (1947)** has been of the view that *Adiantum* must have been derived from a progenitor which had marginal sori. Bower (1928), however, has mentioned that because of such condition *Adiantum* resembles more with such groups that never had laminae having truly marginal sori.

From the excised shoot apices of *Adiantum* and some other vascular plants *Wetmore (1950, 54)* has been able to grow normal plants. For such experiments he used agar medium supplemented with 2% sucrose or dextrose. By varying the sugar concentration the shape of the leaf can be modified in this genus.

Anatomy

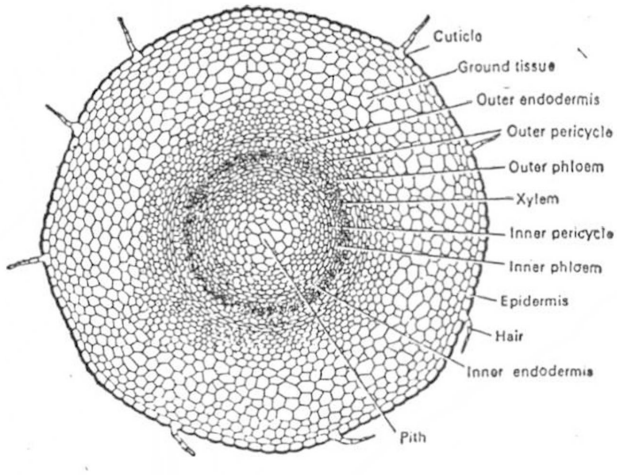
A. Rhizome: The rhizome is internally differentiated into an outermost layer of **epidermis,** a few layered **hypodermis,** a complex type of **stele** which remain embedded in a well developed ground tissue.

The **epidermis** is the outermost layer consisting of thin walled or thick-walled cells. It is generally lined externally by a thick cuticle. From some of the epidermal cells arise multicellular hairs.

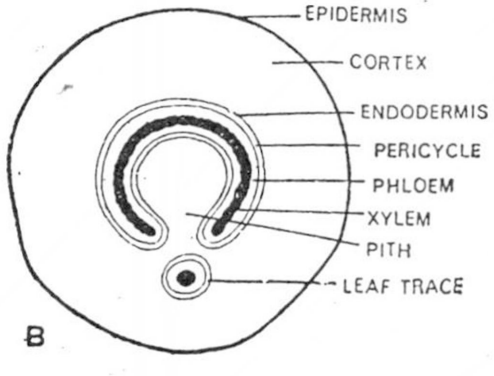
Just inner to the epidermis is present a few celled thick region of **sclerenchymatous hypoderis** (e.g. *A. caudatum and A. pedatum).* In younger rhizome, however, the hypodermis may be absent. Thus the entire **ground tissue** is either wholly parenchymatous, or it is partly parenchymatous and partly scelerenchymatous.

The stele in *Adiantum* is of complex type and varies in different species. In *A.rubellum **(Fig. 1.34)*** the stellar organization is of **amphiphloic siphonostelic** type. In such types, a well developed **pith** is present in the center, and the xylem remains surrounded on both sides by phloem i.e. **outer phloem** on its outer side and **inner phloem** on the inner side of xylem. Outer phloem remains covered by **outer**

pericycle and **inner endodermis**. This indicates that the vascular cylinder as a whole is uninterrupted. In *A. nobile, A. pectinatum* and *A. pedatum* (Fig.11.35), a **leaf gap** is being traversed by **leaf trace** and thus the vascular cylinder is of **solenostelic type.**



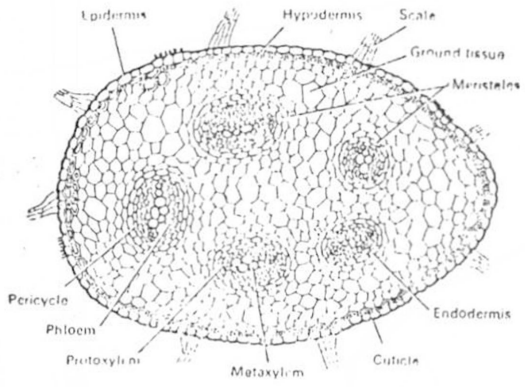
Adiantum rubellum **T.S. rhizome showing amphiphloic siphonostelic condition**



Adiantum **Diagrammatic representation of T.S. rhizome showing solenostelic condition**

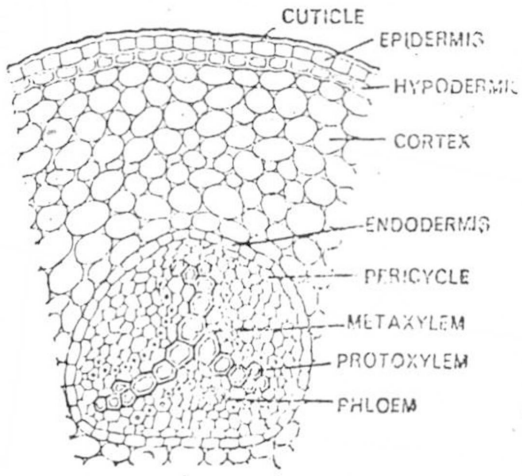
Due to the presence of many leaf gaps the vascular cylinder is being broken into many separate strands in species like *A. capillus-veneris* and *A. caudatum*. Such a vascular cylinder is known as *dictyostele* and each separate strand represents a **meristele** (Fig.11.36).

Each meristele has the general structure of a protostele i.e. xylem remains surrounded by phloem and a layer of pericycle and endodermis, there is no pith.



***Adiantum capillus-veneris* T.S. rhizome showing**
A dictyostelic condition

b) Petiole: The petiole is circular in outline and differentiated internally into **epidermis, hypodermis**, parenchymatous **cortex and stele (Fig.11.37).**



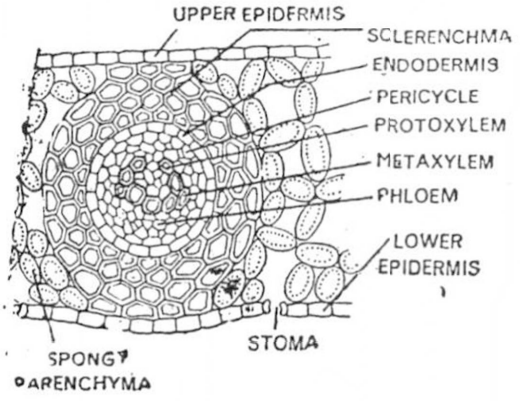
***Adiantum* A part of T.S. petiole**

The epidermis is single layered, devoid of any outgrowth and remain covered externally by **cuticle.**

The epidermis is followed by one to many layered sclerenchymatous **hypodermis.** Inner to the hypodermis is the parenchymatous cortex which forms the ground tissue. Some cells of the cortex remain filled with chloroplast.

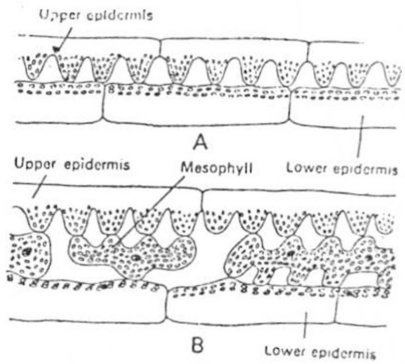
The stele consists of a single layered **endodermis**, one called thick **pericycle, phloem** which surrounds the 'Y' shaped **xylem**. The xylem band is thus thickest in the middle and on all the three ends of 'Y' are present in protoxylem elements. The protoxylem is thus exarch.

c) Leaflet : Each leaflet is bounded on both the sides by a layer of **epidermis**, the cells of which contain chloroplast. The epidermal cells are covered by thin **cuticle**. Throughout the leaf surface the stomata are distributed irregularly in some species but in others the stomata are restricted only on the lower epidermis (Fig. 11.38). In *A. flabellulatum,* however, they are present only near the veins. Ramenta like hairs are present on the epidermis of *A. caudatum.*



***Adiantum,* A part of T.S. leaflet.**

In between the upper and lower layers of epidermis is present an undifferentiated **mesophyll** which consists of only **spongy parenchyma.** The mesophyll is only 1-2 layered in A *capillus-veneris* and A. *pedatum* Fig. 11.39) A compact layer of chlorophyll containing cells is present near the lower epidermal layer.

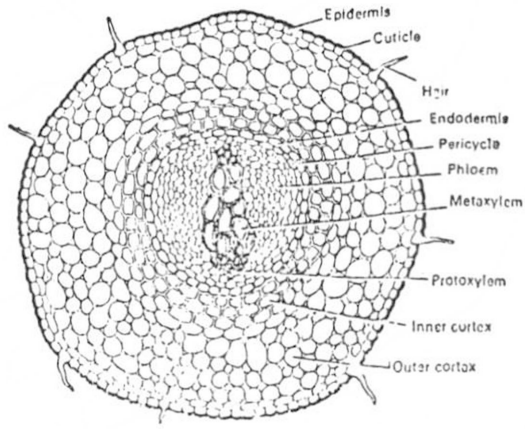


T.S of young leaflets A – Adiantum pedatum showing complete absense of mesophyll tissue; B – Adiantum capillus-veneris showing development of mesophyll tissue

The **vascular bundle** remains surrounded by a thick sclerenchymatous bundle sheath. Each vascular bundle consists of a single layered endodermis, unilayered pericycle and phloem surrounding the xylem. Protoxylem faces towards the upper epidermis.

d) Root : The root is rounded in shape and consists of an outermost layer of **epidermis,** many layered **cortex** and central **stele.**

The **epidermis** is thinwalled and remains surrounded by a cuticular layer. From some of its cells arise unicellular hairs (Fig. 11.40). The epidermal cells are brown coloured. The **cortex** is divisible into outer thin **parenchymatous cortex** and inner thick walled **sclerenchymatous cortex.**

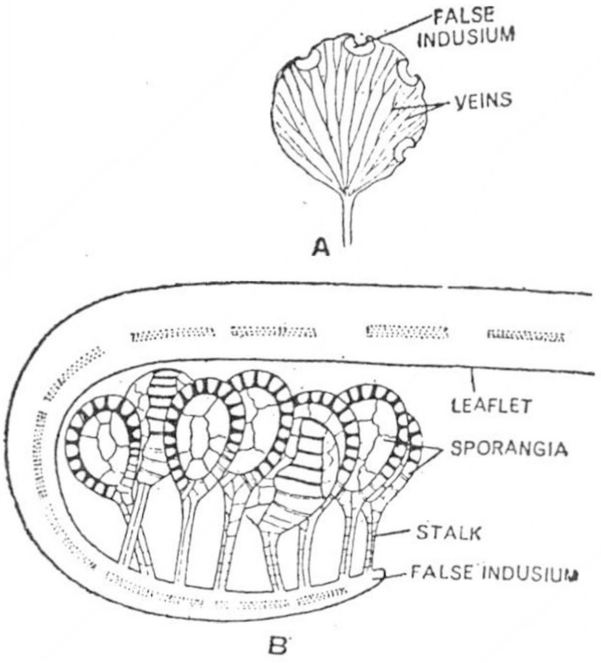


Adiantum capillus-veneris **T.S. Root**

The **stele** is **protostelic, exarch** and **diarch.** It consists of a unilayered **endodermis** having characteristic casparian strips, a layer of **pericycle** and **phloem** surrounding the **xylem.** The phloem is represent in the form of two conspicuous groups present on both the sides of xylem. Metaxylem is present in the center having two protoxylem groups on two opposite ends.

Spore Producing Structures

a) Morphology : The **spores** are present in the **sporangia**. Many sponrangia are grouped together to form a **sorus.** Because the ultimate vein endings of leaflets do not bear the sporangia, therefore the sori are not marginal in position. The sori are covered and protected by reflexed margins of leaflet which are brown membranous structures called **false indusium.** True indusium is absent. The sporangia develop on the infolded portion of the leaflet (Fig. 11.41A and B). In *A. philippense,* however, the sporangia may develop at the distal ends of all the veins of a leaflet. In each sorus, the sporangia are present in different stages of development. The sporangia bearing leaves are called **sporophylls.**

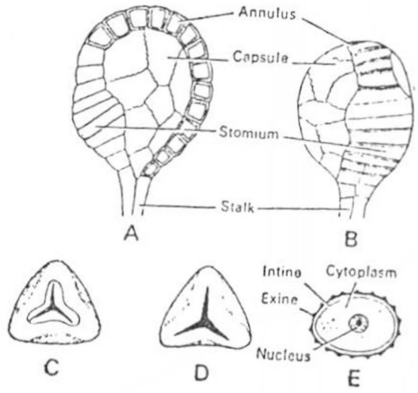


Adiantum A - **Underside of leaflet showing false indusium; B – Leaflet showing sporangia and false indusium in sectional view**

b) **Development of Sporangium:** The development of sporangium is strictly **leptosporangiate type**, and resembles very much with that of Pteridium.

c) **Mature sporangium :** Each mature sporangium (Fig.11.42 A & B) is oblong in shape and remains attached to the indusium with the help of a long multicellular **stalk.** The stalk is about 2 – 3 celled thick and about 4 – cells long. The main body of the sporangium is called **head** or **capsule** which resembles with that of a biconvex lens in shape. Some of the cells of the thinwalled sporangium become thick-walled called **annulus** which is about 1-24 cells long. Few thin walled cells on one side of the annulus form **stomaium** (Fig.11.42 A and B). The stomium remains separated

from annulus by 2 – 6 cells in different species. In the same way, from the stalk also, it (stomium) remains separated by 2- 3 cells. Many **spores** are present in the sporangium *Adiantum* is **homosporous.**



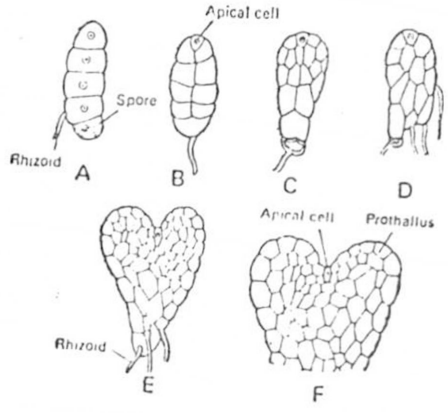
Adiantum **A – A mature sporangium (side view), B – Sporangium showing Front view; C – E – spores in different views**

Gametophyte

a) Spores : The spores (Fig.11.42 C – E) are tetrahedral structures having a triradiate ridge with concave sides. Each spore is a uninucleate structure and remains surrounded by a thin **intine** and a thick yellowish-brown and smooth **exine.** A *caudatum, A. peruvianum* etc. the exine is ornamented (Fig. 11.42). The spore develops into prothallus.

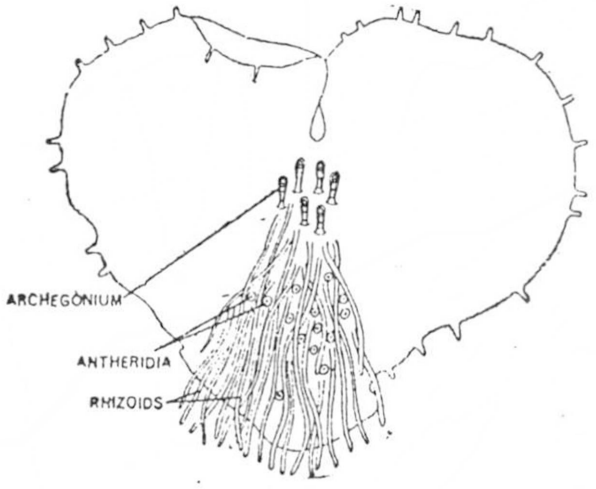
b) Development of spore :

At the time of spore germination the **intine** comes out in the form of germ tube by rupturing the exine at the place of triradiate ridge. With the help of transverse divisions the germ tube becomes a 4 – 5 celled filament (Fig.11.43 A). From one of its cells, generally lowermost, develops a **lateral rhizoid**. This young filament may become green because of the development of the chlroplasts. With the help of two oblique divisions, in the uppermost cell of this filament, develops a three sided **apical cell** (Fig. 11.l43 B). This apical cell is meristematic in nature. With the meristematic activity of the apical cell and many longitudinal divisions in some of the lower cells, the filamentous structure changes into a multicellular spathulate plate. The apical cell becomes narrow or spindle shaped and persists even upto a stage till the prothallus becomes a cordate or heart shaped structure. A deep apical notch develops in the prothallus. This multi-cellular prothallus (Fig.11.43 F) is many celled thick in the middle while only one celled thick on the margins.



Adiantum **Showing spore germination and development of prothallus**

c) **The Mature Prothallus :** The mature prothallus is a thin, green, flat and cordate (heart shaped) body. It is only one celled thick except the region just posterior to the apical notch. On the underside of the posterior older portion develop many unicellular rhizoids. Cells of the prothallus are green because of the presence of many chloroplasts. On the under surface of the prothallus are present sex organs. Antheridia are present projecting on the posterior portion while archegonia are present on the anterior portion (Fig. 11.44).



***Adiantum*, A mature prothallus**

d) **Development of Antheridium:** Similar to Pteridium.

e) **Mature Antheridium :** Similar to *Pteridium*

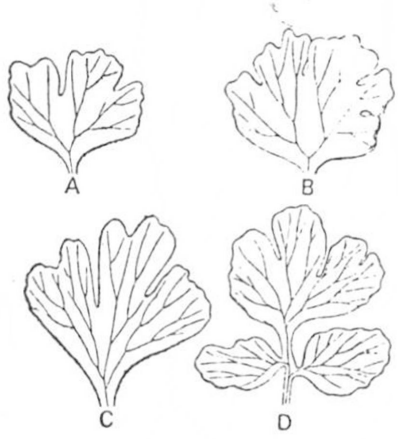
f) **Development and Structure of Archegonium :** Similar to *Pteridium.*

Development of Embryo : Similar to *Pteridium.*

Young Sporophyte

The first organ while arise during the normal embryo development is the **root.** The young **leaves and stem** develop later on. The root penetrates the soil and gets itself established. The lamina of the young leaf is biblobed in the early stages. It

remains traversed by dichotomously branched mid rib. The lamina then becomes three lobed, and later on many lobes develop because of the elongation of the tip of the lamina (Fig. 11.45). Each lobe receives a dichotomously branched vein. In the same fashion many pinnately compound leaves continue to develop and the young sporophyte attains maturity.



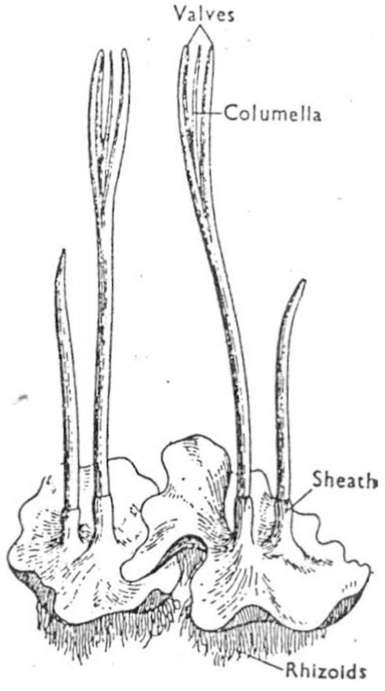
***Adiantum capillus-veneris* showing development of young sporophyte**

PLANT GROUPS

BRYOPHYTA : CLASS ANTHOCEROTAE

The gametophyte

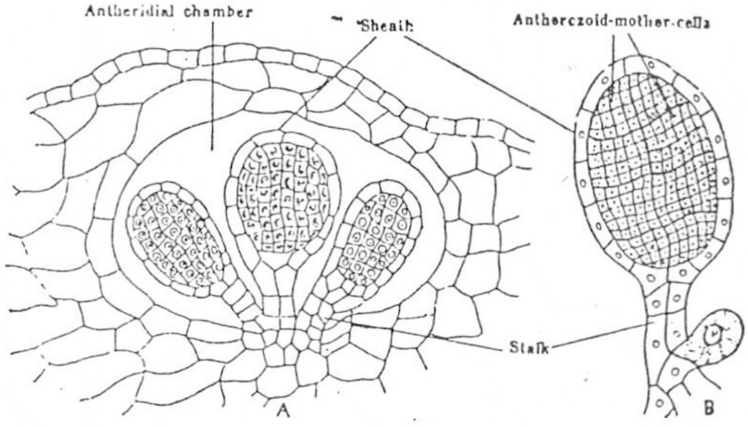
The vegetative body of each plant is a small, dorsiventral and very simple, greasy dark-green gametophytic thallus, which is inconspicuously branched or somewhat lobed, and without any internal differentiation of tissues. There are numerous smooth-walled rhizoids on the under surface of the thallus, the scales being entirely absent. On the ventral side of the thallus, there are numerous large intercellular spaces, each of which opens externally by a narrow slit. These cavities are usually filled up with mucilate and often contain colonies of an endophytic blue-green algae (.e.g. *Nostoc).* Each cell of the thallus usually contains a single large chloroplast with a conspicuous pyrenoid, which is made up of numerous disc- or spindle-shaped bodies destined to be meta-morphozed into small starch grains. Thus, it is evident that simplicity is the most prominent feature of the thallus in comparison with those of *Riccia* and *Marchantia.*



Anthoceros Thallus with sporophytes

Reproduction

Anthoceros reproduces both by vegetative and sexual methods. The vegetative reproduction is usually effected by progressive growth and death of the thallus. Under certain conditions of prolonged desiccation the gametophyte often produces **tubers,** formed due to marginal thickenings. Each tuber is externally protected by a cork layer and under favourable conditions gives rise to a new thallus.

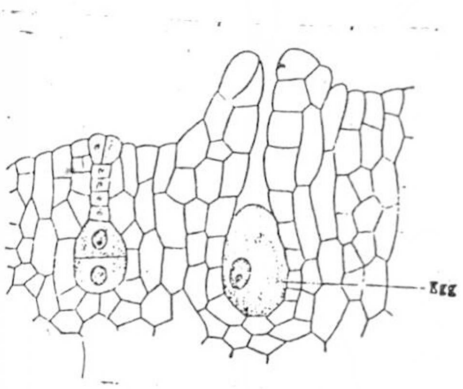


***Anthoceros* - A. Vertical section of a portion of thallus; B . An antheridium (enlarged)**

Anthoceros is chiefly monoecious though in some species the antheridia may attain maturity early (protandrous). It is a note-worthy feature that the sex organs are entirely embedded in the dorsal side of the thallus and not borne on special receptacles, as in *Marchantia.*

Antheridia develop in clusters within closed cavities (**antheridial chambers)** just beneath the upper surface of the thallus. From the floor of each antheridial chamber one to four antheridia develop. The sterile layer, over-roofing each antheridial chamber, may be one or more (usually two) cells in thickness. Each antheridium develops a stalk of several cells in height. Numerous biflagellate antherozoids are produced from each antheridium. When the antheridia attain 0maturity the sterile cell layers, over-roofing each antheridial chamber, disintegrate and the antherozoids are liberated.

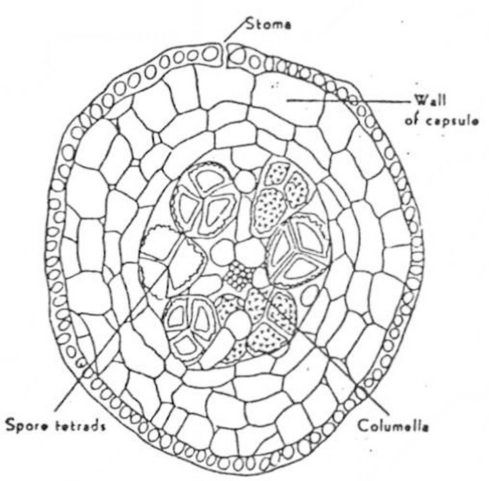
Archegonia develop single and are closely embedded in the thallus. The vegetative cells of the thallus are confluent with a part of the neck and venter of each archegonium, the extreme end of the neck being only protruding. When fully developed, there is a single axial row of cells in each archegonium, consisting of four to six neck canal cells, a ventral canal cell and an egg cell. At maturity, the neck canal cells and the ventral canal cell disorganize and fertilization of the egg is brought about by one of the antherozoids passing down the neck into the venter. After fertilization the fertilized egg secretes a wall around it and forms an oospore. *With fertilization and formation of oospore, the sporophytic or diploid generation begins.*



Anthoceros **Archegonia, young and mature**

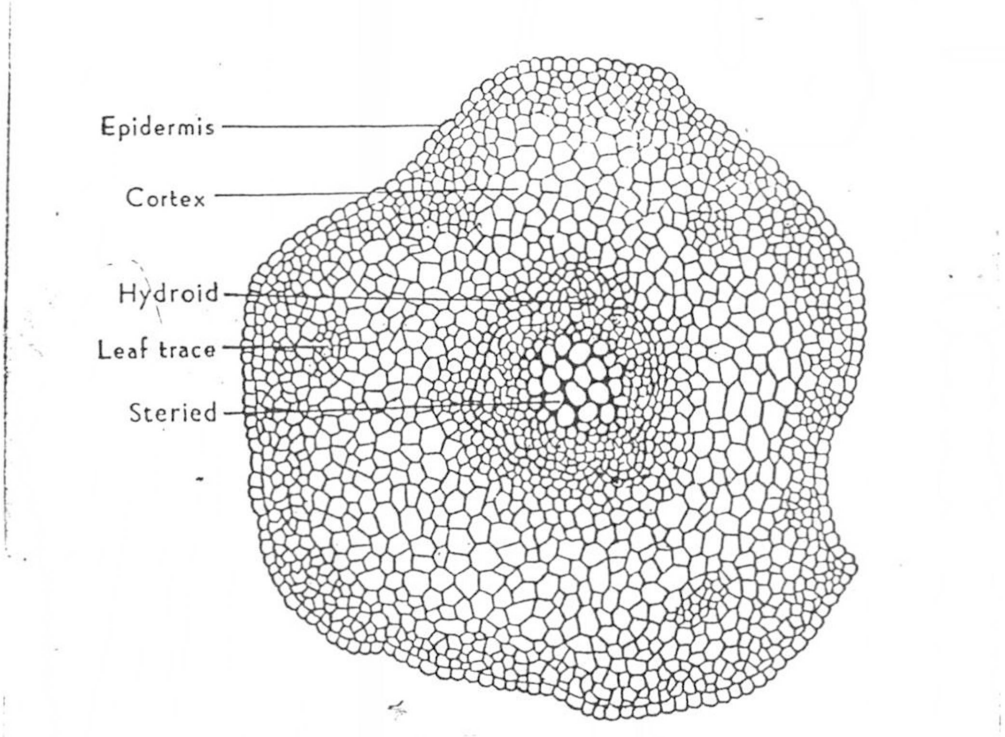
The sporophyte

The oospore, without any period rest, divides and re-divides and forms a sporophyte. The sporophyte is gradually differentiated into a basal foot, and an upper slender cylindrical structure of more or less uniform thickness, the **capsule**. The zygote usually first divides longitudinally and the transversely. This is followed by another longitudinal division of the four daughter cells forming an eight-celled embryo, made up of two tiers of four cells each. The foot develops by division and re-division of the cells of the lower tier. When fully formed, it becomes a massive inverted cap-like structure, by means of which the sporophyte does not only remain anchored to the gametophyte but also absorbs nourishment therefrom. The cells of the upper tier also by repeated divisions from the capsule, which when very young, becomes differentiated into **amphithecium** and **endothecium.** When fully developed, the capsule stands erect on the thallus and attains a height of 2.5 cm or more in some cases.



***Anthoceros* T.S of Capsule**

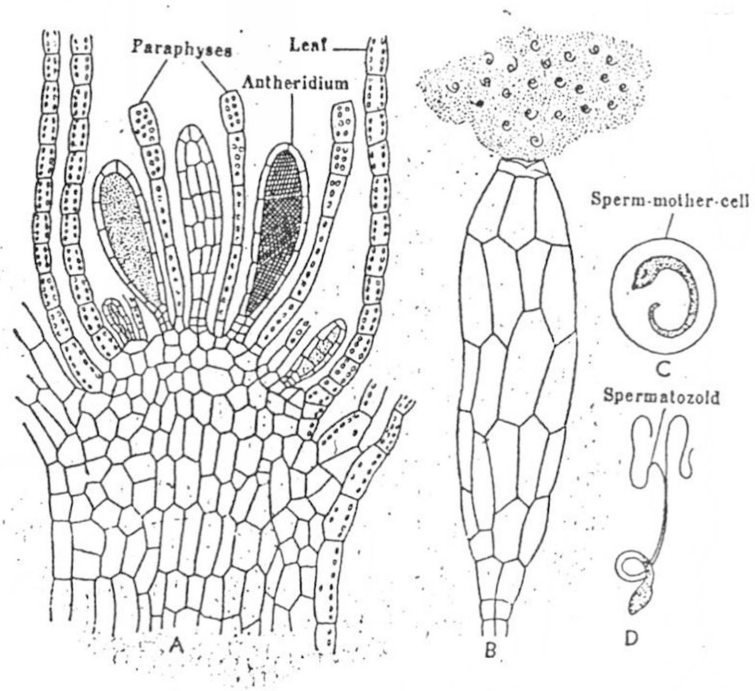
Polytrichum is usually dioecious and the sex organs, antheridia and archegonia, are borne separately at the apices of male and female gametophores respectively, forming the so-called 'inflorescences'. Each inflorescence consists of a group of sex organs which are surrounded by specialized leaves, **perichaetial leaves,** quite different in form and colour from those on the stem.



Polytrichum **Transverse section of the stem**

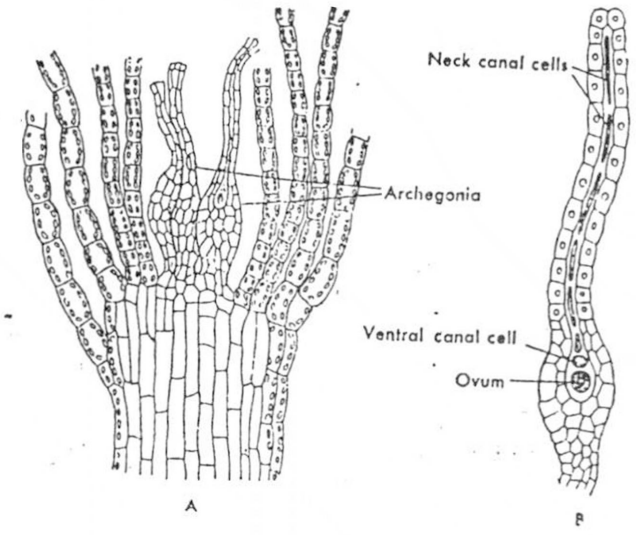
The conspicuous male inflorescence consists of a group of antheridia intermingled with peculiar sterile green hairs (**paraphyses)** and is surrounded by broad, reddish and membraneous perichaetial leaves. The growth of the apical region of the stem is, however, not stopped by the formation of antheridia, and its further growth may be resumed when the formation of antheridia is totally stopped. This inflorescence is regarded as a compound structure, since groups of antheridia develop at the base of each leaf of the inflorescence and it is quite probable that each group represents a condensed branch.

Each **antheridium** is a shortly stalked, club-shaped body containing within it many mother cells of the spermatozoids (**androcyte cells**) and within each of which a biflagellate spermatozoid is developed. When ripe, the antheridium has a yellowish or orange colour and pens at the top (multicellular **opercular cap),** the whole mass of spermatozoids mother cells escape and finally from these mother cells, the spermatozoids are discharged in the surrounding film of water, which wets the surface of the moss bed.



Polytrichum **A. Longitudinal section through the apex of a male plant showing Antheridia and paraphyses; B. A mature antheridium discharging spermatozoids; C. Spermatozoid mother cell; D. A spermatozoid**

The **archegonia,** borne on a separate plant are also in a cluster at the apex of the gametophore and the perichaetial leaves usually remain folded over them. Each archegonium is a flask-shaped body with a very short stalk and consists of two parts: a basal swollen portion, the **venter,** and a comparatively long upper portion, the **neck.** The venter contains a ventral canal cell and a female cell, the **oosphere,** or **ovum** or **egg.** In this case, there is a variable number of *neck* cells.

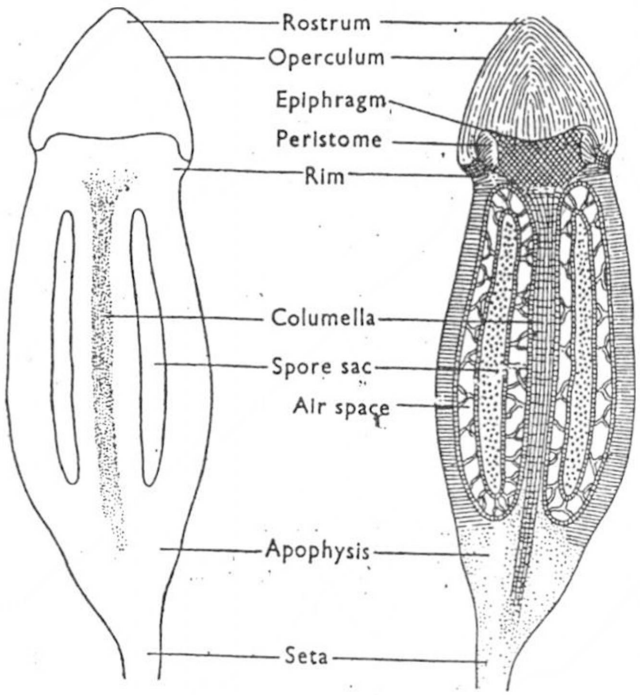


Polytrichum **A. Longitudinal section through the apex of a female plant showing archegonia; B. A mature archegonium**

When an archegonium matures, a passage is established due to the disorganization of the canal cells. This passage becomes filled with a mucilaginous substance containing canesugar. Fertilization takes place in water. Biflagellate spermatozoids, swimming by means of flagella, come in the neighbourhood of archegonium; these being attracted by the canesugar, penetrate the neck, but only one of them fuses with the ovum. The fertilized ovum then surrounds itself with a cell wall and becomes an **oospore.** The ova of several archegonia may be fertilized forming oospores, but the one which is formed first begins to grow on getting food, while the rest dry up, so that only one sporophyte develops over a leafy gametophore. *With fertilization and formation of oospore, the sporophytic or diploid generation beings.*

The sporophyte

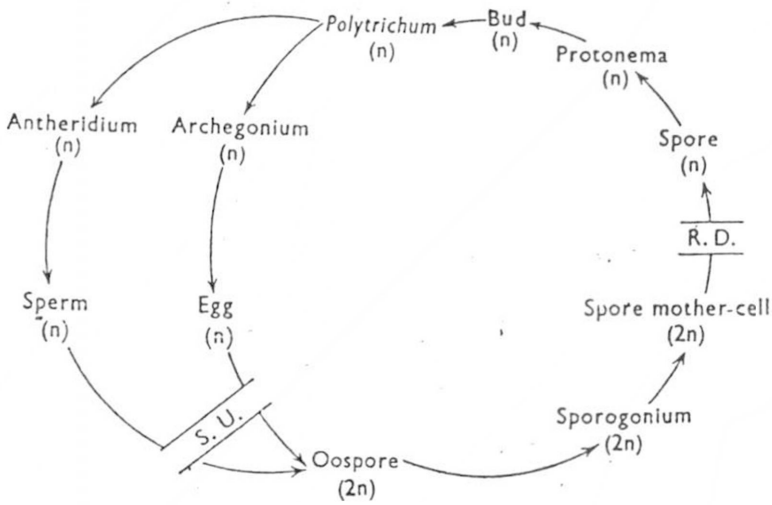
The oospore gradually passes into an embryo, which ultimately gives rise to the **sporogonium**, the sporophytic generation of the moss plant. Due to the rapid growth of the sporogonium, the upper portion of the archegonium-neck becomes torn off, so that it is carried off in the form of a cap, ultimately forming a very large hood-shaped **calyptra** covered with a dense growth of hairs.



Polytrichum **Median longitudinal section of a capsule (diagrammatic)**

The sporogonium consists of three parts : (a) a sac-like upper part, the **capsule**, (b) a slender stalk called **seta**, and (c) a small **foot** by means of which it is attached to the gametophyte. The capsule is at first green in colour owing to the possession of chloroplasts and in its lower portion it bears a few stomata. Within the capsule, the sporogenous tissue develops, from which ultimately **spores** are formed (four spores from each spore mother cell due to reduction division). A large part of the central tissue of the capsule remains sterile forming the so-called **columella** and the conical upper part, the **operculum,** which becomes detached from the lower part as lid in order to allow these spores to escape; the operculum is prolonged into a beak-like **rostrum.** Just beneath the operculum, there is a complicated structure known as **peristome** consisting of 32 to 64 'teeth' in a circle around the mouth of the spore-cavity of the capsule. These are nothing but bundles of thickened fibrous cells, regularly arranged in crescent from resembling the spokes in a wheel and have got a

profound taxonomic importance. These teeth help to scatter the spores. The tip of the columella is expanded into the **epiphragm**, filling the space inside the peristome ring. There are two large intercellular spaces surrounding the sporogenous tissue, one on its outer side and the other between it and the columella, and are traversed by narrow filamentous strands of cells containing chloroplasts. At maturity, the capsule finally becomes horizontal and dorsiventral. *With reduction division and formation of spores, the gametophytic or haploid generation begins.*



Life cycle of *Polytrichum*

The new gametophyte

When the spores mature, they are shed by means of peristome. These may rest for some time but when they germinate, under favourable conditions, they directly give rise to **protonemata.** Lateral buds arise from the protonema and each produces a new moss plant.

Order Pottiales

The plants are mostly small and the leaves are variable. The mesophyll cells are isodiametric, usually opaque and small. The capsule is borne on a long and thin seta. It is cylindrical and erect. The calyptra is narrow. There are 16 teeth in the peristome.

The Order includes only *one* family : **Pottiaceae**

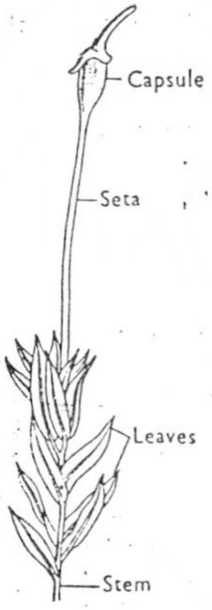
Barbula
(Fam. Pottiaceae)

Barbula is a common moss which grows profusely and gregariously forming dense bright yellowish-green masses in damp places and on brick walls during the rainy season, and usually in association with other mosses. So far four species of *Barbula* have been recorded in India viz. *B. indica, B. comosa, B. Orientalis and B. gungetica.*

The gametophyte

The vegetative body of the gametophyte consists of two portions, viz. a prostrate, green, filamentous portion, called the **protonema** and a differentiated vegetative shoot, the **gametophore.**

The protonema is derived from a spore as a result of germination. When fully developed, it is a much-branched filamentous structure, which is differentiated into an extensive green portion, the **chloronema,** and a pale green slender branched portion that gives rise to rhizoids. Each portion consists of several cells, which are delimited from one another usually by walls. The chloronema is positively phototropic and remains on the surface of the substratum, while the rhizoidal system is negatively phototropic and grows vertically down into the substratum.

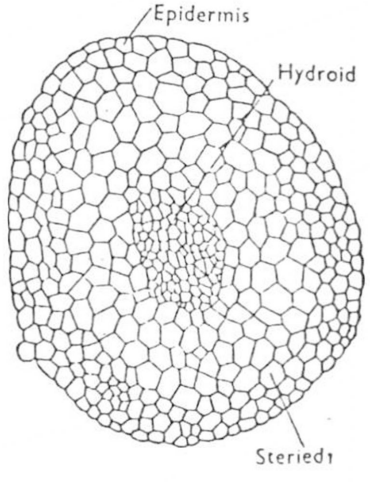


Barbula **A gametophore with an attached sporophyte**

The gametophore takes its origin from the bud developed on the protonema. The bud is a two- or three-celled structure, which enlarges and becomes somewhat pear-shaped. By further divisions an apical cell is ultimately differentiated and from this cell, the gametophore develops. The gametophore, when fully developed is erect and usually consists of a simple axis (stem) bearing numerous spirally-arranged minute leaves and with smooth-walled rhizoids at the base. The rhizoids have oblique

walls and are brown in colour in older portion. The leaves are lanceolate with obtuse apex, margins recurved and minutely sinulate and with a strong midrib projecting beyond the apex of the blade. In younger portion of the gametophores, the leaves show tristichous arrangement, but in the older portion, this arrangement is lost.

A cross-section of the stem shows two distinct portions, namely, a central cylinder made up of thin-walled, narrow, polygonal cells (elongated in longitudinal section) and an outer cortical region with much larger cells with thicker and yellowish-brown cell walls at maturity. When young, the cortical cells contain chloroplasts. An epidermal layer is, however, not clearly differentiated.



***Barbula* T S of stem**

Reproduction

Barbula reproduces both by vegetative and sexual methods.

Vegetative propagation takes place in three ways :

a) By the formation of brute bodies, which arise as axillary multicellular, branched, filamentous bodies from a single or a group of superficial cells of the axis. The apical cells of these branches along with a few other cells, increase in volume, turn dark-green and become filled with dense cytoplasmic matter, and by a series of irregular division develop thick-walled, yellowish-brown multicellular bodies, known as **brute bodies (propagula).** The brute bodies, on germination, produce protonema and rhizoids.

ACTIVITY SHEET I

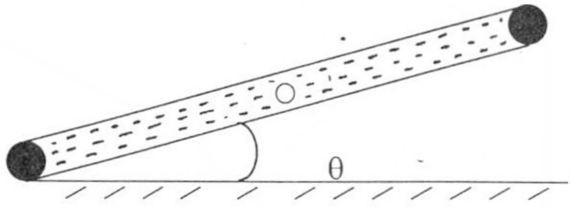
Motion of air bubble

Aim

Study of uniform motion of an air bubble

Materials required

Broken burette sealed at both ends with an air bubble trapped in it, stand, meter scale, protractor, stop watch.



Procedure:

Step I: Mark 10 cm distances along the burette using rubber bands. Keep the burette inclined at a known angle.

Step II: Note the time taken by the bubble to travel a distance of 10 cm. Calculate the speed of the bubble. Repeat your observations for at least four more distances.

Step III: Tabulate your observations and draw a distance time graph. Calculate the speed from the graph and compare it with the calculated values.

Step IV: Repeat the experiment by changing the inclination of the burette (for at least five inclinations).

Tabular Column

	Constant inclination			Constant distance		
Sl.No.	Distance (cm)	Time (s)	Speed (cm/s)	Inclination θ	Time (s)	Speed (cm/s)

Answer the following questions:

1. Identify the forces acting on the bubble.
2. What happens to the speed of the bubble when the
   a. inclination changes
   b. distance changes for a particular inclination ?
3. What is the nature of the distance time graph ?
4. What type of motion is the bubble executing ?

ACTIVITY SHEET II

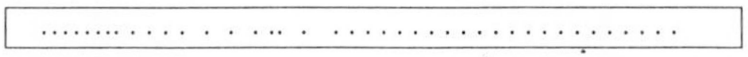
Tape Timer

Aim

Study of motion using a tape timer

Materials required

Tape, Tape timer, cellotape, meter scale.



Procedure

Step I: Attach the tape to a moving cart and draw it using a tape timer.

Step II: Spread the tape on a table and fix it with cellotape at both ends.

Step III: Count ten dots and assume it to denote an interval of time. Repeat this until you have at least eight to ten such intervals marked along the tape.

Step IV: Measure the distance covered by the cart from the starting point to the end of each interval using the meter scale and tabulate the same.

Step V: Draw a graph between distance and time. Calculate the speed.

Tabular Column

Sl..No.	Time interval (s)	Distance (cm)	Speed (cm /s)

Answer the following questions:

1. What is the nature of the graph ?
2. How do the speeds in the different time intervals compare ?
3. What type of motion is the cart executing?
5. What quantities do you have to plot on the X- and Y- axes to get a straight line graph ?
6. How can you find out the instantaneous velocity from the graph ?

ACTIVITY SHEET III

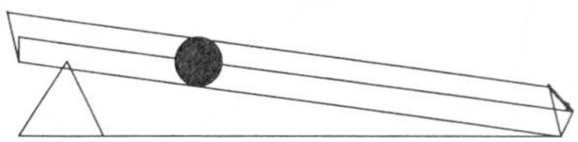
Galileo's Experiment

Aim

Study of motion of a steel ball in a grooved track

Materials required

Smooth metal ball, 3m long grooved track, stop watch, scale and iron stand.



Procedure

Step I : Keep the grooved track horizontally on the table. Place the steel ball in the groove and observe whether the ball moves. What should you do to make the ball move ?

Step II : At one end raise the track by using a stand. Now observe that the track is no longer horizontal but inclined. Keep the ball once again on the track and observe its motion.

Step III: Mark off distances 1m, 1.3m, 1.5m, 1.7m, 1.9m, 2.1m, etc., along the track. Keep the ball and note the time taken to travel these distances and tabulate.

Step IV: Repeat the experiment for different inclinations.

Step V: Draw a graph between distance s and time t. Also draw the $s\text{-}t^2$ graph .

Tabular Column

Distance moved (m)	Time Taken (s)				Mean Time T (s)	T^2 (s^2)
	1	2	3	4		

Answer the following questions:

1. Identify the forces acting on the system.
2. What do you observe from the table ?
3. What is the nature of the s-t graph ?
4. Interpret the s-t^2 graph.
5. What is the relation between inclination and acceleration ?

ACTIVITY SHEET IV

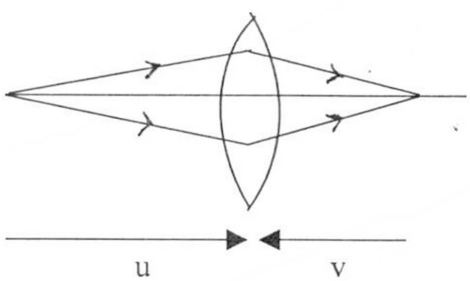
Convex lens

Aim

Study the relation between u, v and f, for a convex lens

Materials required

Convex lens, lens stand, scale, source of light, object, screen.



Procedure

Step I: Find the approximate focal length of the given lens by focussing a distant object.

Step II: Place the convex lens in front of an illuminated object at a distance greater than 2f . Catch the clear image of the object on a screen.

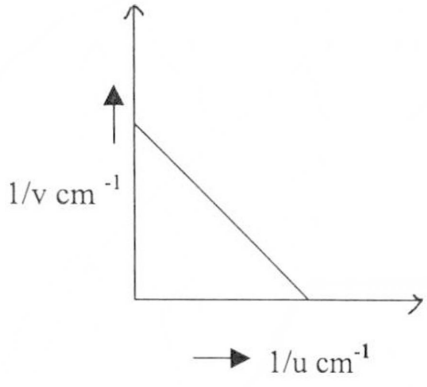
Step III: Measure the distance 'u' between the object and the lens and the distance 'v' between the image and the lens and tabulate.

Step IV: Repeat the experiment by moving the lens each time by 2 cm toward the object.

Step V: Draw the u-v graph and the 1/u – 1/v graph. Compute the focal length from the graph.

Tabular Column

Sl, No.	Object distance U cm	Image distance v cm	1/u cm^{-1}	1/ v cm^{-1}



Answer the following questions

1. How does the image distance vary with the object distance ?
2. Are the values of 'u' and 'v' interchangeable, when you move the object from 2f to f.
3. What type of image is obtained if the object is placed nearer to the lens than the focus?
4. What is the nature of the u-v graph ?
5. What do the intercepts on the X- and Y- axes denote ?
6. Compare the value of the focal length obtained with the value obtained approximately and account for any differences obtained.

ACTIVITY SHEET V

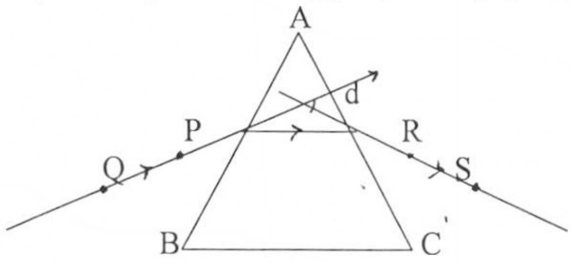
Prism

Aim

To draw the i-d curve for the prism and calculate the refractive index

Materials required

Prism, drawing board, pins, drawing pins, white paper, protractor, pencil.



Procedure

Step I : Fix the sheet of white paper on the drawing board with drawing pins.

Step II : Place the prism on the sheet and trace its boundary ABC with the pencil.

Step III: Remove the prism and draw the normal to one of the faces. Fix the angle of incidence to be 30^0.

Step IV: Replace the prism and fix the pins P&Q along the line marked to represent the angle of incidence 30^0.

Step V: Looking through the other side fix two more pins R&S such that they are in line with the images of the pins P&Q fixed on the other side of the prism.

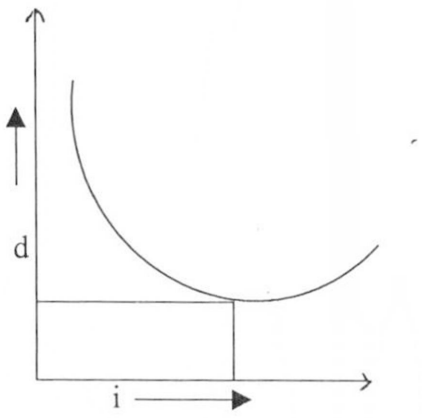
Step VI: Mark the position of the pins. Remove the prism. Join the marks and extend the line to meet the prism.

Step VII: Trace the refracted ray through the prism . Extend the incident and the emergent rays such that they meet each other. Measure the angle of deviation 'd'.

Step VIII: Repeat the experiment for different angles of incidence and tabulate. Draw the i-d graph.

Tabular Column

Sl.No.	Angle of incidence	Angle of deviation



Answer the following questions

1. What is the nature of the i-d graph ?
2. When do you say that the angle of deviation is a minimum ?
3. What is the angle of minimum deviation obtained in your experiment ?
4. What is the maximum value of 'i' you can use in this experiment ? Assuming the value of the angle of the prism to be 60^0 find the value of the refractive index of the material of the prism.

ACTIVITY SHEET VI

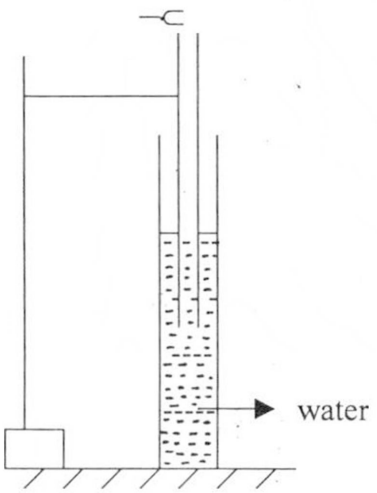
Resonance Column

Aim

Determine the velocity of sound at room temperature

Materials required

Jar of water, tuning forks, scale, stand, rubber pad.



Procedure

Step I: Place the jar filled with water on a stool.

Step II: Insert the tube open at both ends into the jar and fix it to a stand so that it can be moved up and down conveniently.

Step III: Place the tuning fork after striking it against the pad as shown in the figure and adjust the position of the tube to hear maximum sound.

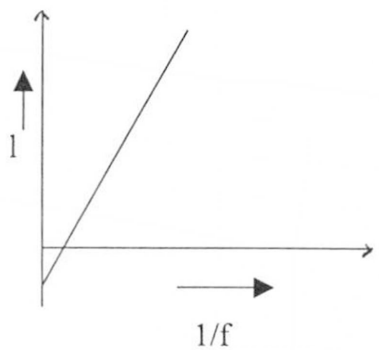
Step IV: Measure the length of the tube above the surface of water in the jar at resonance and tabulate.

Step V: Repeat the experiment for all the tuning forks given.

Step VI: Draw a graph between 1/f and l and calculate the velocity of sound at room temperature using the relation $v = 331\sqrt{T/K/273}\ ms^{-1}$

Tabular Column

Frequency of fork	Resonance length 'l' cm	1/f



Answer the following questions

1. What is resonance?
2. What is the nature of the graph?
3. Why do you get an intercept on the Y- axis and what does this indicate?
4. Suppose you do not have the apparatus we have provided you how would you perform this experiment in your school given only the tuning forks?
5. How will you ensure that the length you have measured is not a harmonic?
6. Why is a node formed at the surface of water? Give reasons

ACTIVITY SHEET VII

Magnetic Field

Aim

To map the magnetic field and locate the null points

Materials required

Drawing board, drawing pins , bar magnet, compass needle, scale.

Procedure

Step I: Fix the sheet of white paper to the drawing board with the drawing pins.

Step II: Trace the magnetic meridian by keeping the compass needle on the board and noting the north- south direction. Keep all other magnets far away.

Step III: Place the bar magnet along the magnetic meridian with its north pole pointing north.

Step IV: Using the compass needle trace the lines of force by joining the points obtained. Do not forget to mark the direction of the field lines. Locate the null points.

Answer the following questions

1. How do the field lines appear as you move away from the magnet ?
2. Will the pattern be the same if you keep the bar magnet with its south pole facing north ?
3. What happens to the field at the null points ?
4. Why do field lines never cross?

ACTIVITY SHEET VIII

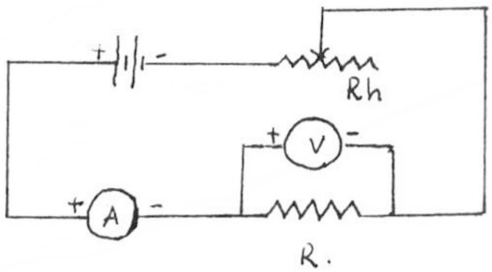
Ohm's Law

Aim

To study the relation between V, I and R in a simple electric circuit

Materials Required

Ammeter, Voltmeter, Plug key, Battery eliminator, connecting wires, resistance box 1Ω - 3Ω, Rheostat.



Procedure

Step I: Connect the circuit as shown in the figure.

Step II : Keeping the resistance constant for different currents through the circuit note down the voltage across the resistance and tabulate.

Step III: Repeat the experiment by now maintaining the voltage a constant and varying the resistances. Note down the values of the resistance and the current in the circuit.

Step IV: Draw a graph between voltage and current for constant resistance. Also draw a graph between current and reciprocal of resistance for constant voltage in the circuit.

Tabular Column

Sl. No.	Constant resistance		Constant Voltage	
	I Amp	V volts	Resistance Ω	I Amp

Answer the following questions

1. How does the voltage vary with the current for constant resistance ?
2. How does the current vary with resistance for constant voltage ?
3. What is the nature of the graphs obtained in the two cases ?
4. Why is an ammeter connected in series and a voltmeter in parallel in an electric circuit ?
5. Give analogies to illustrate the term potential difference.

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