

ORDER MARCHANTIALES

MARCHANTIA

- The best known species of thalloid liverworts are in the genus *Marchantia*
- The thallus which is about 30 cells thick in the centre and 10 cells thick at the margin, forks dichotomously as it grows
- Each branch has a notch at the apex and a central groove that extends back lengthwise behind the notch

MARCHANTIA Cont'd

- The thalli grow as meristematic cells at the notches divide
- Older tissues at the rear decay as new growth is added
- The upper surface of the thallus is divided into diamond-shaped or polygonal segments, the segment lines marking the limits of the chambers below

MARCHANTIA Cont'd

- Each segment has a small bordered pore opening into the interior
- Seen through a microscope, a sectioned liverwort thallus looks a little like a series of covered prickly pear (cactus) gardens sitting on a decorative rock wall
- The ‘rock wall’ which may comprise most of the thallus, consists of parenchyma cells that have few, if any, chloroplasts

MARCHANTIA Cont'd

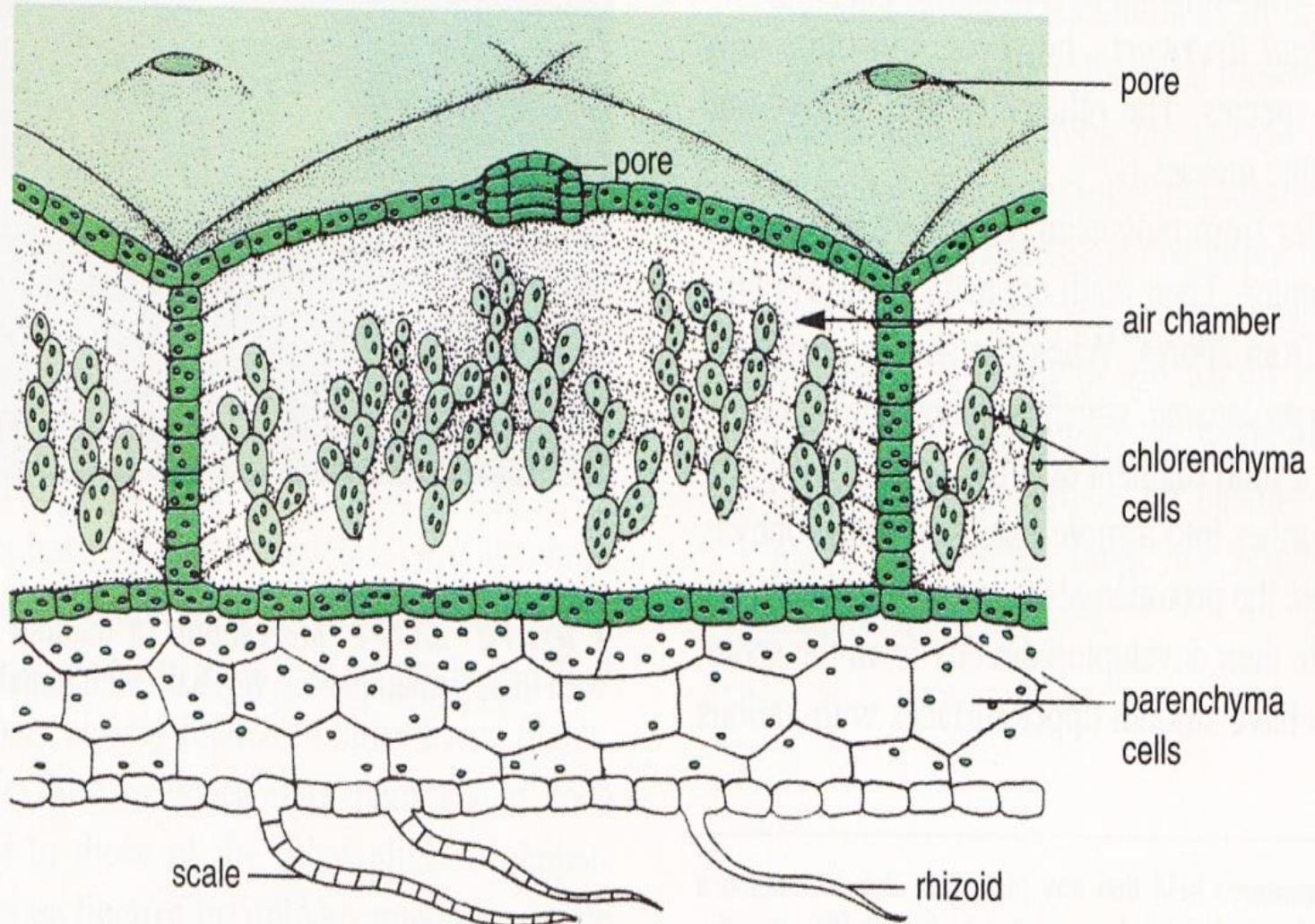
- The tissue apparently stores substances produced in other cells
- The bottom layer of cells is an epidermis from which rhizoids and scales arise
- The 'cactus gardens' consist of upright branching rows of chlorenchyma cells in an air space

MARCHANTIA Cont'd

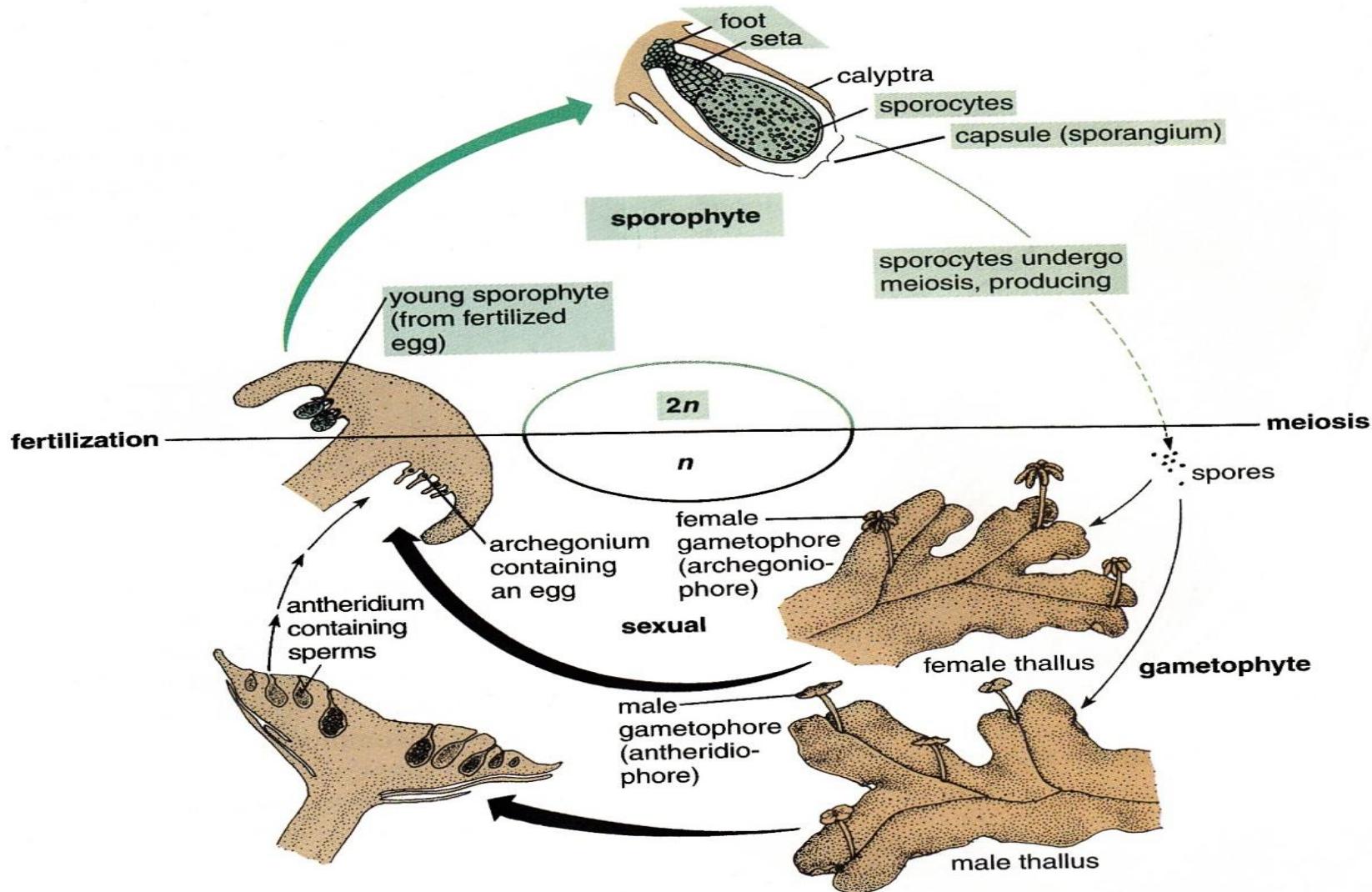
- Vertical walls enclose the individual ‘gardens’ which are covered by a slightly dome-shaped layer of epidermal cells
- The conspicuous pore, which remains open at all times, is located in the centre of each ‘roof’ and looks something like a short, suspended, open-ended barrel

MARCHANTIA Cont'd

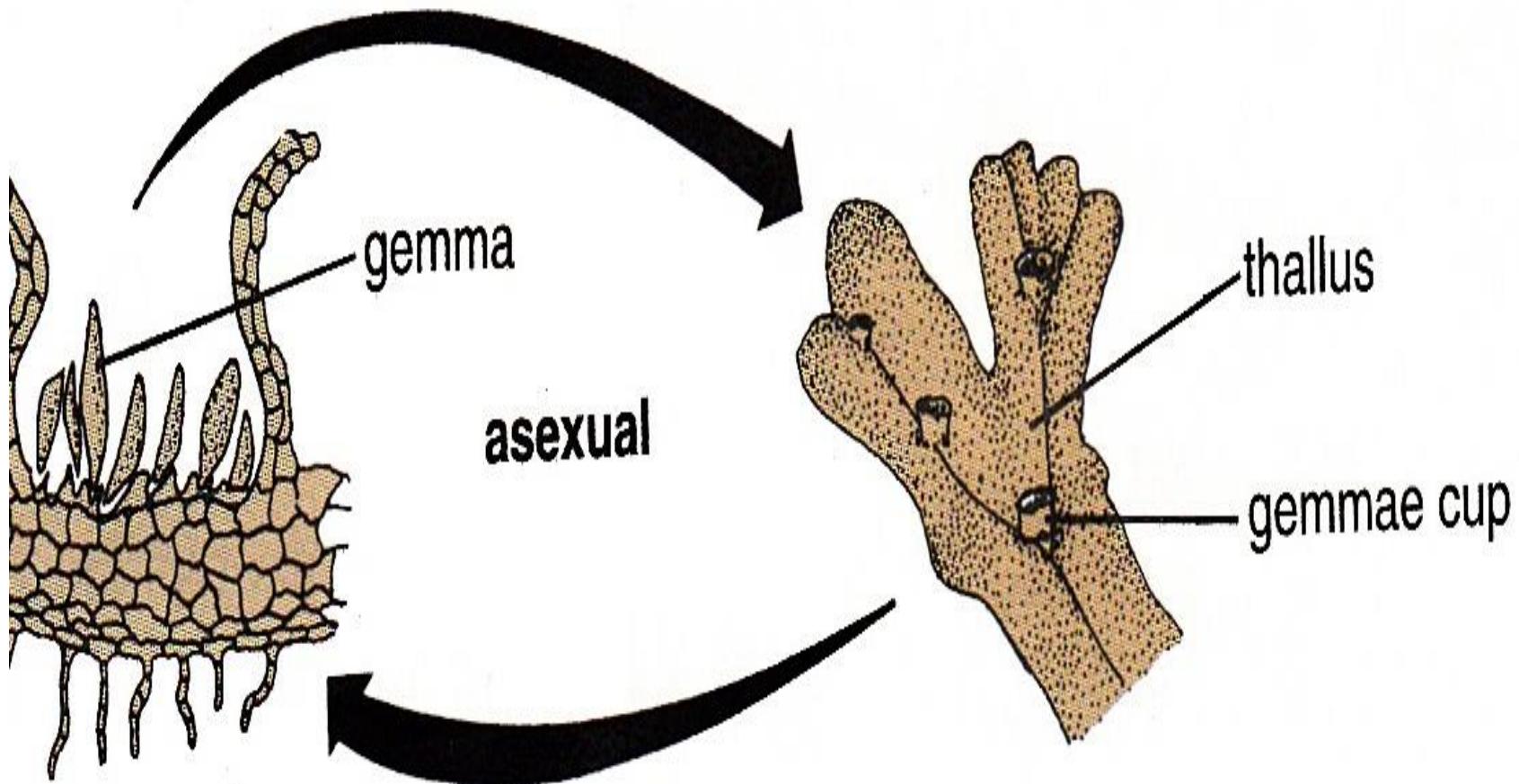
- The pore, like the stoma of a higher plant, allows aeration of the thallus with the minimum dehydration, but is incapable of significant change in its aperture

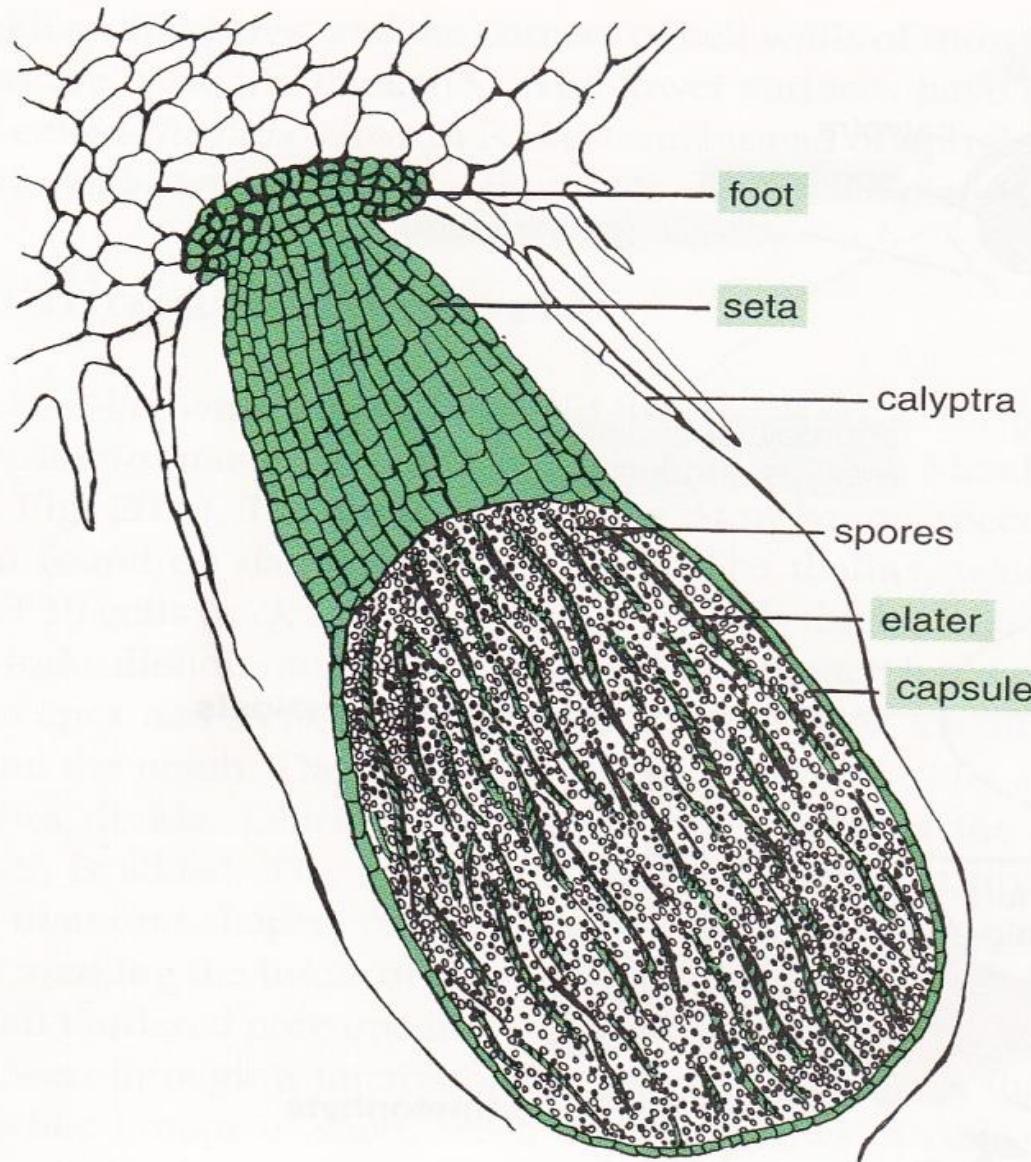


SECTION THROUGH A PORTION OF *MARCHANTIA* THALLUS



LIFE CYCLE OF *MARCHANTIA*





LONGITUDINAL SECTION THROUGH SPOROPHYTE OF *MARCHANTIA*

ASEXUAL REPRODUCTION

- *Marchantia* reproduces asexually by means of **GEMMAE** (sing. **GEMMA**)
- Gemmae are tiny, lens-shaped pieces of tissue that become detached from the thallus
- They are produced on **GEMMAE CUPS** scattered over the upper surface of the liverwort gametophyte

- Raindrops may splash the gemmae as much as 1 meter (3 feet) away
- While gemmae are in the cup, **lunuraric acid** (an endogenous growth regulator found in the liverworts) inhibits their further development, but each is capable of growing into a new thallus as soon as it is out of the cup

ASEXUAL REPRODUCTION *Cont'd*

- In addition, parts of an older thallus may die, isolating patches of active tissue, which may then continue to grow independently
- *Marchantia* is **DIOECIOUS**, i.e. the male and female plants are distinct and separate

SEXUAL REPRODUCTION

- The **gametangia** which are produced on separate male and female gametophytes, are more specialized than those of other liverworts
- Both types of gametangia are formed on **GAMETANGIOPHORES** which are umbrella-like structures borne on slender stalks arising from the central grooves of the thallus

SEXUAL REPRODUCTION *Cont'd*

- The top of the **male gametangiophore**, termed **ANTHERIDIOPHORE**, is disc-like with a scalloped margin, while that of the **female gametangiophore**, termed **ARCHEGONIOPHORE**, looks like the hub and spokes of a wagon wheel

- **ANTHERIDIA**, which are **club-shaped male gametangia** containing numerous sperms are produced in rows just beneath the upper surface of the antheridiophore

SEXUAL REPRODUCTION *Cont'd*

- **ARCHEGONIA**, which are **flask-like female gametangia**, each containing a single egg, are also produced in rows and hang neck downward beneath the spokes of the archegoniophore
- The sperms are extruded in a mucilaginous mass

- Raindrops sometimes splash the released sperms, which have flagella, more than 0.5 meter (1.5 feet) away
- Fertilization may occur before the stalks of the archegoniophores have finished growing
- After fertilization, the **zygote** develops into a **multicellular EMBRYO** (an immature sporophyte)

SEXUAL REPRODUCTION *Cont'd*

- Embryos are diploid, the nuclei of all cells containing $2n$ chromosomes
- A knoblike **FOOT** anchors the **sporophyte (the diploid, spore-producing phase)** in the tissues of the archegoniophore
- The sporophyte hangs suspended by a short, thick stalk called the **SETA**

- The main part of the sporophyte, in which different types of tissue develop, is called a **CAPSULE/SPORANGIUM**
- Liverwort sporophytes typically have no stomata
- **SPORE MOTHER CELLS/SPOROCYTES** in the capsule undergo meiosis, producing haploid spores

SEXUAL REPRODUCTION *Cont'd*

- Other capsule cells do not undergo meiosis but remain, diploid and develop, instead into long, pointed **ELATERS**, which have spiral thickenings and are sensitive to changes in humidity
- Spore dispersal in *Marchantia* takes place as the elaters twist and untwist rapidly

- In the sporophytes of other liverworts, the elaters may aid spore dispersal with a snapping action or by suddenly expanding

ORDER JUNGERMANNIALES (LEAFY LIVERWORTS)

- This is the largest order of liverworts containing about two-thirds of all species in the Hepaticae
- They are often abundant in tropical jungles and in fog belts

VEGETATIVE STRUCTURE

- The gametophytes of these liverworts are leafy, in contrast to thalloid plants; that is, the gametophytes have stem-like and leaf-like organs (that may be held somewhat erect, off the ground)
- A very common widespread genus is *Porella*
- Other examples are *Frullaria*, *Lophocolea*, *Marsupella*

VEGETATIVE STRUCTURE *Cont'd*

- Leafy liverworts always have two rows of partially overlapping leaves whose cells contain distinctive oil bodies
- The leaves consist of a single layer of cells and have no midribs
- Unlike the leaves of mosses, they often have folds and lobes

- In the tropics, the lobes form little water pockets in which tiny animals are always present
- It has been suggested that this water pockets may function like the pitchers of pitcher plants

VEGETATIVE STRUCTURE *Cont'd*

- A third row of underleaves (**AMPHIGASTRIA**) which are smaller than the other leaves and not visible from the top, is often present on the underside of leafy liverworts
- Classification of the leafy liverworts is based largely on the arrangement and lobing of the leaves

VEGETATIVE STRUCTURE *Cont'd*

- When the anterior margins of the leaves lie regularly beneath the posterior of those in front, the arrangement is said to be **SUCCUBOUS** and when the converse occurs, the arrangement is said to be **INCUBOUS**
- A few rhizoids, which anchor the plants, develop from the stem-like axis at the base of the underleaves

SEXUAL REPRODUCTION

- Reproduction is essentially similar to that described for the Marchantiales
- Specialized gametophores are however, never produced
- Both monoecious and dioecious forms occur, sometimes in the same genus

- Archegonia are always restricted to the apices of the stem and its branches
- Because they are apical, they, and ultimately the sporophyte, terminate growth of the main shoot so that vegetative growth is continued by lateral, **sympodial** branching

SEXUAL REPRODUCTION *Cont'd*

- Archegonia are generally enclosed within a cylindrical unistratose chlorophyllose tube, the PERIANTH
- Sporophytes resemble those of *Marchantia*

SEXUAL REPRODUCTION *Cont'd*

- At maturity, the sporophyte capsule may be pushed out from among the leaves as the seta elongates
- The sporangium/capsule usually opens by four longitudinal lines
- When a spore germinates, it produces a PROTONEMA, which consists of a short filament of photosynthetic cells
- The protonema soon develops into a new gametophyte

PORELLA **OCCURRENCE**

- *Porella* is a common **acrogynous**, leafy liverwort
- It grows on moist rocks, tree trunks and old walls and forms a compact greenish patch, practically covering the medium on which it grows

VEGETATIVE STRUCTURE

- The plant body consists of a slender, dorsiventral, prostrate stem and leafy branches
- The lower side of the stem bears several rhizoids, primarily for anchorage
- The leaves are arranged in three rows: two rows of dorsal leaves and a row of ventral, small leaves called **AMPHIGASTRIA**

- The dorsal leaves are unequally bi-lobed and overlapping
- The plant grows by means of an apical tetrahedral cell, which cuts off segments on three sides

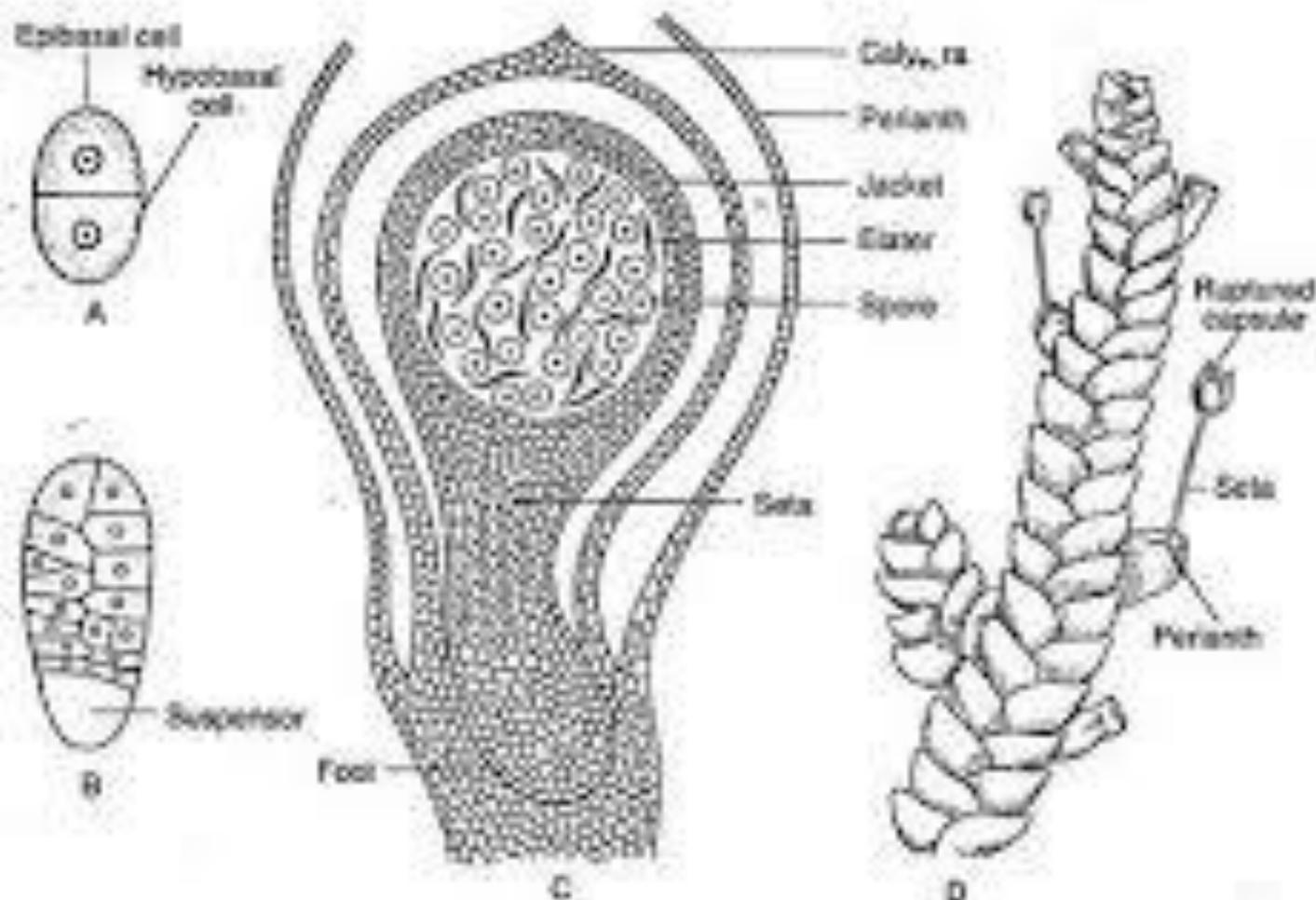


Fig. 6.26 : *Planaria sporophyta*: A. Ovule stage of embryo, B. Young embryo sporophyte, C. L.S. of mature sporophyte, D. Part of female gametophyte showing fully matured sporophytes with ruptured capsules

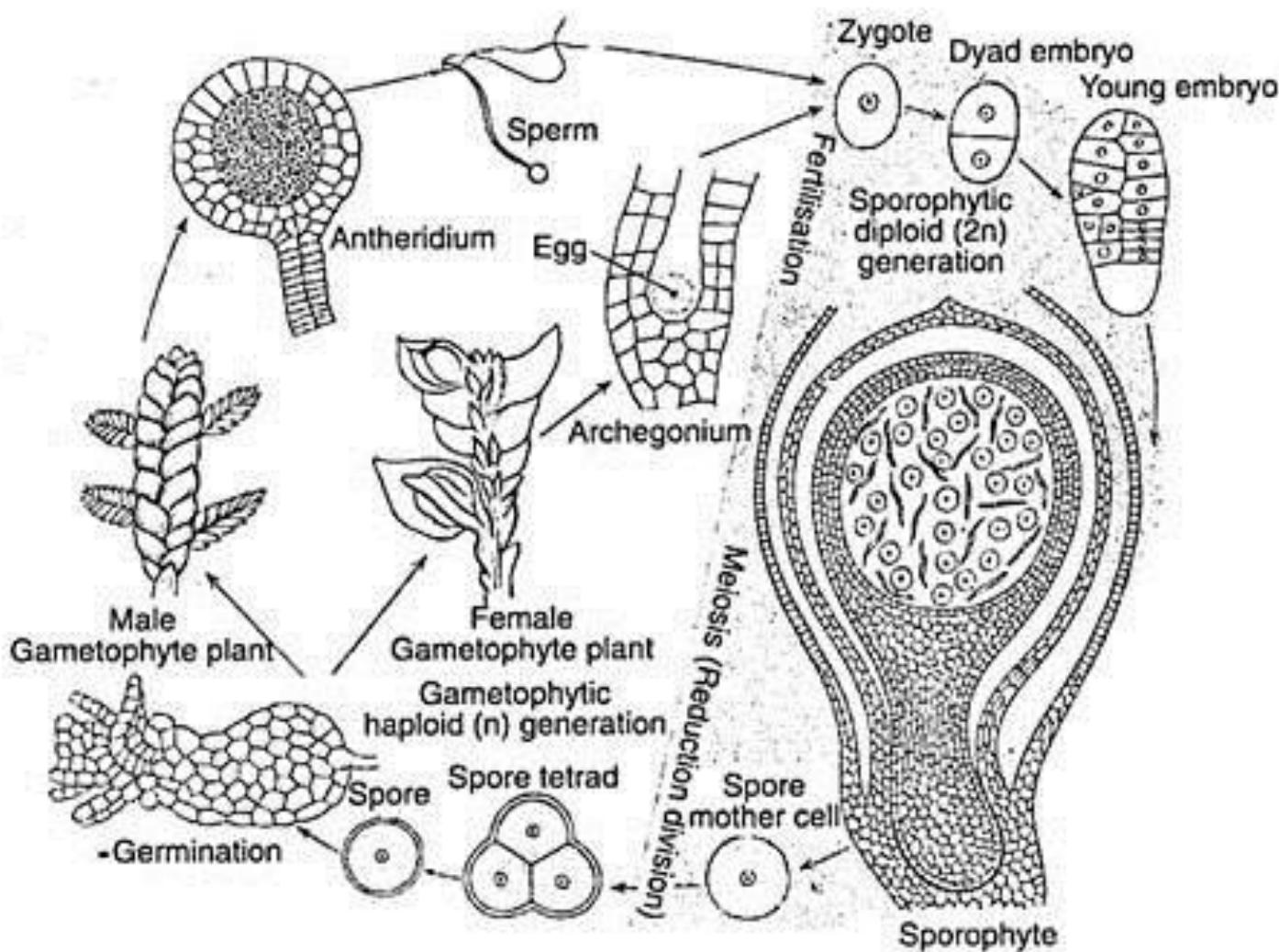


Fig. 6.28 : Life cycle of *Porella* showing alternation of generations

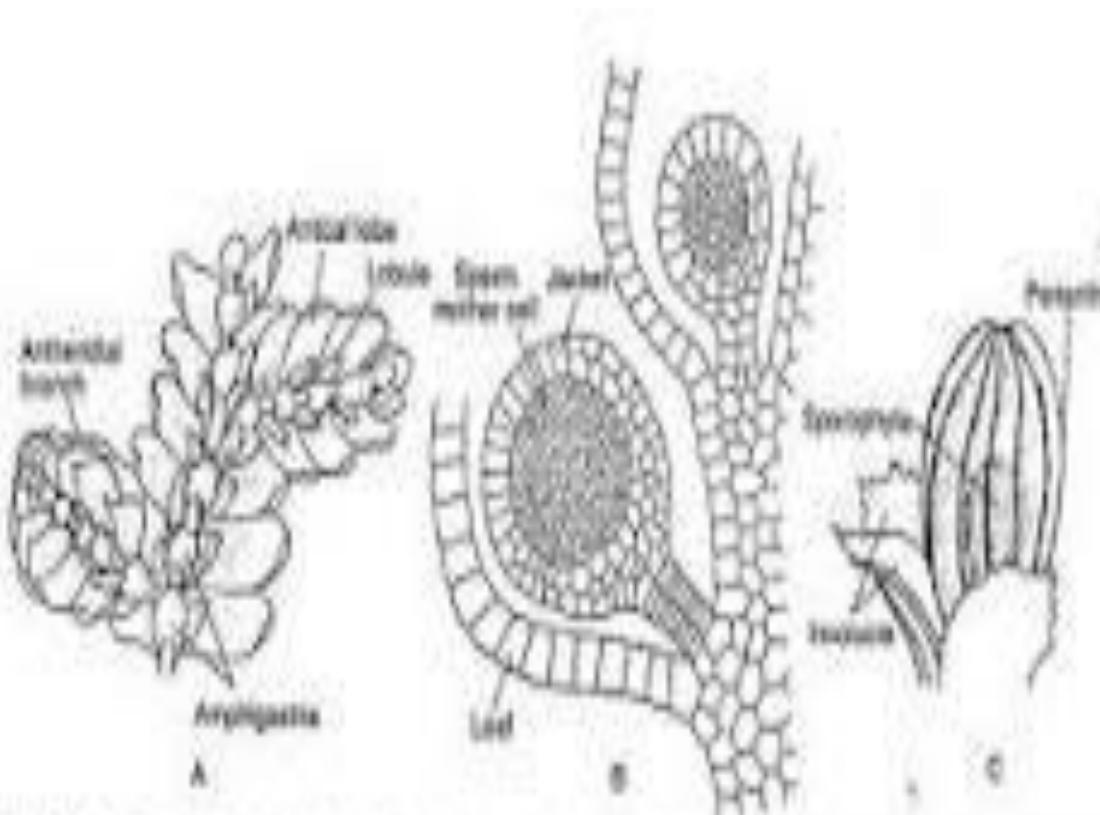


Fig. 4.23 : *Fucus pyrophylla*: A, Part of male plant (lateral view) showing rhizoidal branches and details of leaves. B, L.S. of antheridial shoot showing antheridia in leaf axile. C, An archegonial branch from a female plant showing involure and perianth with the young sporangia inside (after Kudryavtsev).

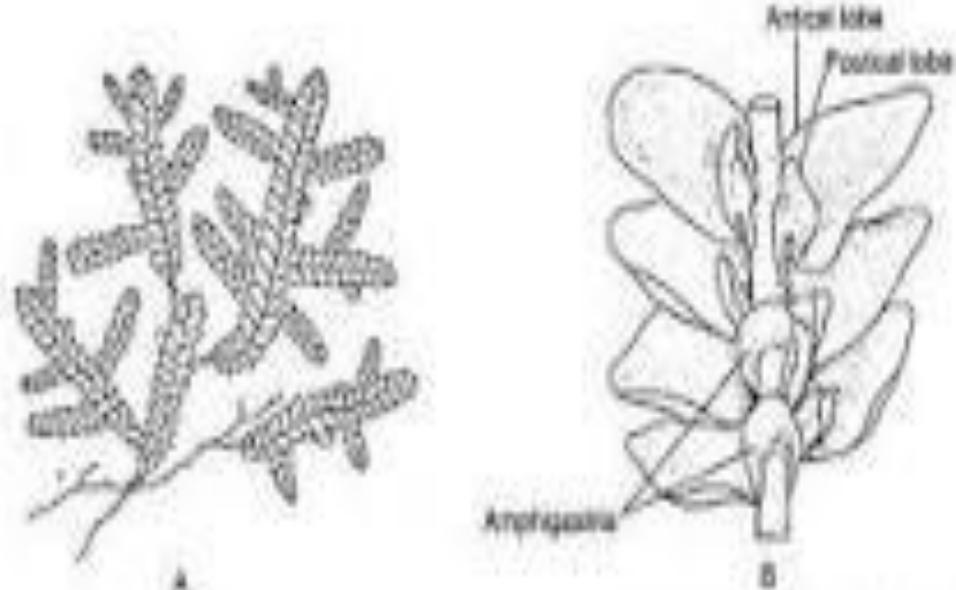


Fig. 6.21 : A. *Porella polyphylla* gametophyte plant bearing several sporophytes (dorsal view); B. A part of gametophyte shoot (magnified ventral view, top amphigonium removed)

REPRODUCTION

- **VEGETATIVE REPRODUCTION** may take place by the breaking off of the branches, or by the formation of unicellular or multicellular gemmae on the margin or at the apex of the leaf

SEXUAL REPRODUCTION

- *Porella* is dioecious
- The male plants are usually smaller and produce special short and lateral antheridial branches
- These bear antheridia, each in the axil of a leaf (or bract)
- Paraphyses may be present

SEXUAL REPRODUCTION *Cont'd*

- Each antheridium is a globular body surrounded by a wall (jacket) and provided with a long, multicellular stalk
- It is packed with antherozoid mother cells (androcytes), each giving rise to a minute biciliate antherozoid

- Each archegonium has a short multicellular stalk, a venter with an egg cell and an egg nucleus, a ventral canal cell, a long neck with 6-8 neck canal cells, and a wall

SEXUAL REPRODUCTION *Cont'd*

- The neck is nearly as broad as the Venter
- Fertilization takes place in the usual way
- The anterozoids, when liberated, swim in water to the archegonium
- They enter through the apical opening and finally, one of them fuses with the egg nucleus
- The fertilized egg forms a zygote

SPOROPHYTE

- The zygote secretes a wall round itself and soon grows in size
- It divides and redivides and soon gives rise to a sporophyte
- This consists of a foot, seta and capsule
- The capsule is globose and surrounded by a wall (jacket), 2 or 4 layers thick
- It encloses short, slender, spirally thickened elaters and many spores

SPOROPHYTE Cont'd

- The sporophyte is surrounded by a calyptra, perianth and involucre
- The calyptra is the envelope developed from the venter
- The other two envelopes are formed by united leaves (or bracts)
- When mature, the capsule dehisces by four valves, and the spores are liberated

GERMINATION OF THE SPORE

- Under favourable conditions, the spore germinates and gives rise to a small, multicellular body, the PROTONEEMA
- Soon its apical cell becomes active and produces the shoot and leaves of a new *Porella* plant