Chara

Occurrence of Chara:

Chara is represented by about 188 species, out of which 30 species are found in India. It is commonly known as “stonewort”. The plant body of Chara is encrusted with calcium and magnesium carbonate especially on the plants growing in heavy water.

Thus the plants become strengthened and called stoneworts. Generally they grow in fresh water of ponds, lakes, tanks etc. in submerged condition. Some species like C. tragilis grows in hot spring, whereas C. baltica grows in brackish water.

Plant Body of Chara::

Chara is a macroscopic, multicellular, profusely branched thalloid plant body, generally attains a height of about 20-30 cm (rarely about 1 meter). It is differentiated into rhizoid and main axis (Fig. 3.91 A).

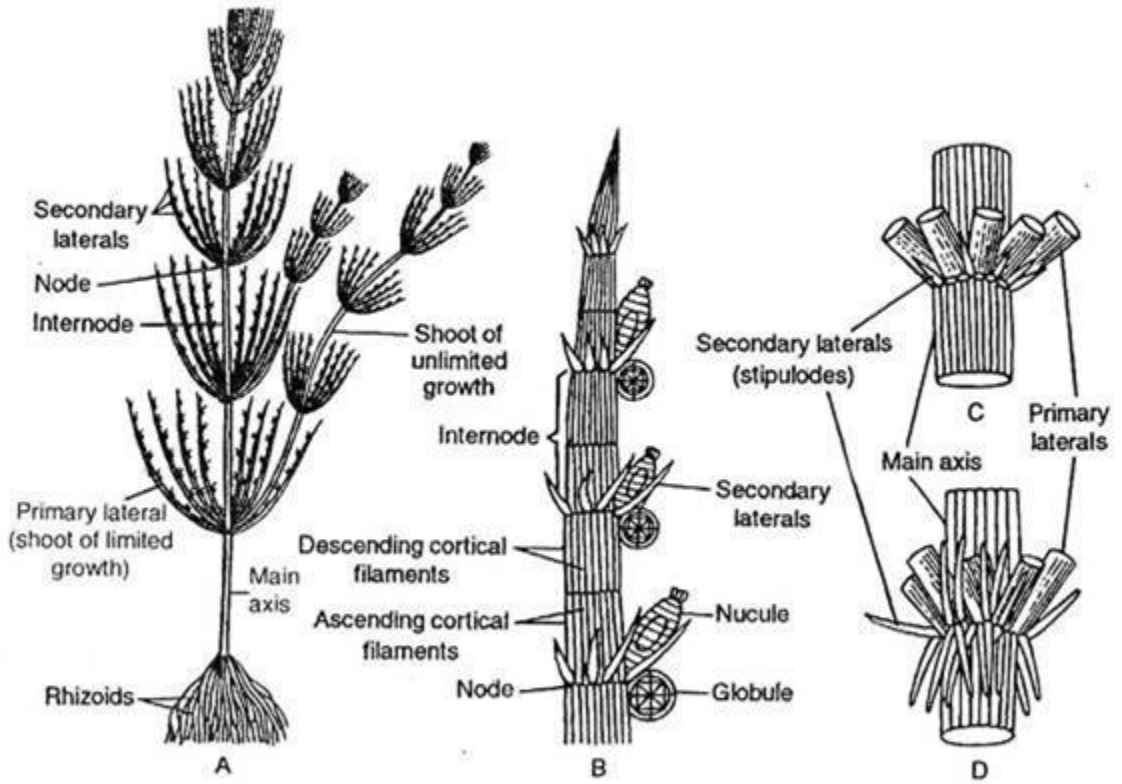

Fig. 3.91 : *Chara* sp. : A. External morphology, B. Shoot (branch) of limited growth or primary lateral, C-D. Appendages on node (C. Haplostephanous and D. Diplostephanous type)

A. Rhizoid:
The rhizoids are thread-like, white, multicellular, uniseriate and branched. It is an elongated branched structure having oblique septa. They are developed either from the base of the plant body or from peripheral cells of lower nodes of the main axis.

B. Main Axis:
It is an erect, long, branched epigeal portion of the plant body, which is differentiated into internodes and nodes.

(i) Internodes:
Generally it consists of two types of cells: i. axial cell or internodal cell, and ii. cortical cells.

i. Axial Cell:
It consists of an elongated central cylindrical cell (Fig. 3.94):
ii. Cortical Cells:
These are elongated but much smaller in diameter than axial cell and ensheathed or corticated as a layer on the outer surface of axial cell (Fig. 3.94). They originate from the node. After originating from the node, 50% of the cortical cells grow upward as the ascending filaments and the rest 50% grow downward as the descending filaments (Fig. 3.91 B).

The ascending filaments cover the lower half and descending filaments cover the upper half of the axial cell. Cortication is not common in all the species.

Depending on the presence or absence of cortex, the species of Chara are divided into two types: Corticate (e.g., C. fragilis, C, zeylanica, C. hatei etc) and Ecorticate (e.g., C. corallina, C. suc- cinata, C. wallichii, C. braunii etc.).

(ii) Node:
The node consists of two cells surrounded by 6-20 peripheral cells (Fig. 3.91 C, D). Three types of appendages are developed from each node.

These are:
1. Branches of unlimited growth,

2. Branches of limited growth, and

3. Stipulodes.

1. Branches (Shoots) of Unlimited Growth:
They are also called axillary branches or long laterals (Fig. 3.91 A) and are developed from the older nodes. These branches are also differentiated into nodes and internodes like the main axis. Each node bears branchlets like the main axis.

2. Branches (Shoots) of Limited Growth:
They are also called primary laterals, branchlets or leaves (Fig. 3.91 B). About 6-16 branchlets develop in whorls around the node of main axis or branch of unlimited growth. It is also divided into 5-15 nodes and internodes. Each node develops some unicellular, hair-like secondary laterals. Sex organs are developed on lower nodes of each branchlet.

3. Stipulodes:
These are unicellular outgrowths developed from lower nodes of branchlets i.e., branches of limited growth. The number of stipufode at each node may be equal to the number of branchlets which is called unistipulate (C. nuda, C. brouni, C. coralline) or if double it is called bistipulate (C. contraria, C. tomentosa, C. baltica):

Depending on the arrangement of stipulodes species of Chara are divided into haplostephanous (i.e., stipules are arranged in single row) e.g., C. braunii, and diplostephanous (i.e., stipules are arranged in two rows) e.g., C. delica- tula (Fig. 3.91 C, D).

Cell Structure of Chara:

The nodal cells are short, uninucleate, with dense and granular cytoplasm and many discoid chloroplasts without pyrenoids. Small vacuoles may be present in the cytoplasm.

The internodal cells are long, with a large central vacuole, many nuclei and many discoid chloroplasts in the cytoplasm. The cytoplasm is differentiated into outer ectoplasm and inner endoplasm. The endoplasm shows streaming movement.

Growth:
Growth of Chara takes place by a dome- shaped apical cell. The cell undergoes repeated transverse divisions and form a row of three cells (Fig. 3.92A-B). The upper one remains as apical cell, middle biconcave one forms the nodal initial and the lower one forms the internodal initial.

The nodal cell undergoes repeated vertical divisions and ultimately forms two central cells surrounded by 6-20 peripheral cells. Branches of limited growth are developed from the peripheral cells arranged in single row. The internodal initial does not divide further and elongates much more to form long internode (Fig. 3.92).

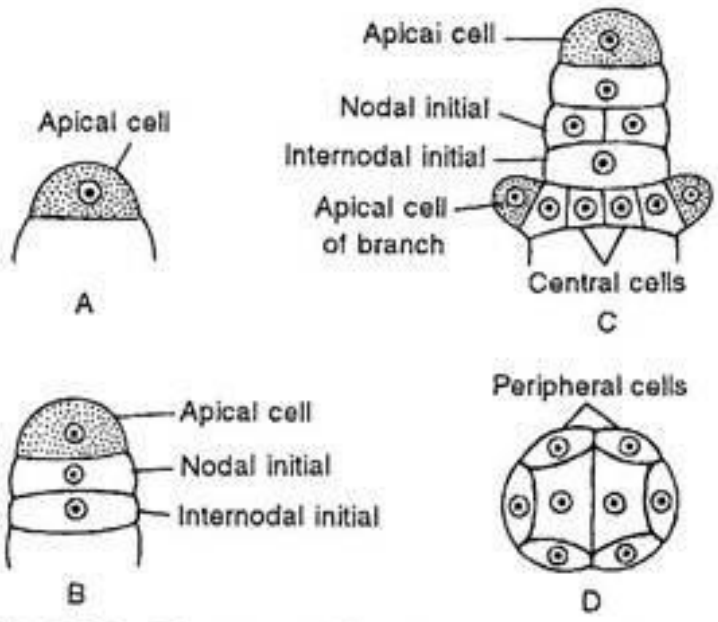

Fig. 3.92 : *Chara* sp. : A-C. Stages of growth, and D. T.S. of node

Important Features of Chara:

1. The plant body shows very much complexity in their structure.

2. They remain attached with the substratum by rhizoids.

3. The main axis is differentiated into nodes and internodes. Each node bears a number of branches of limited growth and sometimes single branches of unlimited growth.

4. The branches of limited, growth are also differentiated into nodes and internodes. Each node bears both the sex organs (Nucule i.e., female and globule i.e., male) and secondary laterals. Nucule is situated above the globule.

5. Reproduction is of two types: Vegetative and Sexual.

6. Vegetative reproduction takes place by means of specialised star-like, tuber-like and protonema-like structures.

7. Sexual reproduction is of oogamous type. The nucule is oval-shaped and very much protected, which contains one egg and globule is round and develops many antherozoids. Zygote is produced after sexual reproduction. It shows very much elaborate post-fertilisation changes.

8. During germination, zygote undergoes meiosis and gradually it forms the plant body of Chara.

Reproduction in Chara:

Chara reproduces by both vegetative and sexual means. Asexual reproduction is absent.

Vegetative Reproduction:

The vegetative reproduction takes place by the formation of following structures:

1. Bulbils:

These are small oval or spherical bodies developed on stem or root nodes. Bulbils are formed on root of C. aspera and stem of C. baltica. After detachment, they germinate and develop new plants (Fig. 3.93A, B).

2. Amorphous Bulbils:

These are small cells developed and aggregated at the node, called amorphous bulbils. They are found in C. fragilis, C. baltica etc. On being detached from the mother plant, they germinate and develop into new plants (Fig. 3.93C).

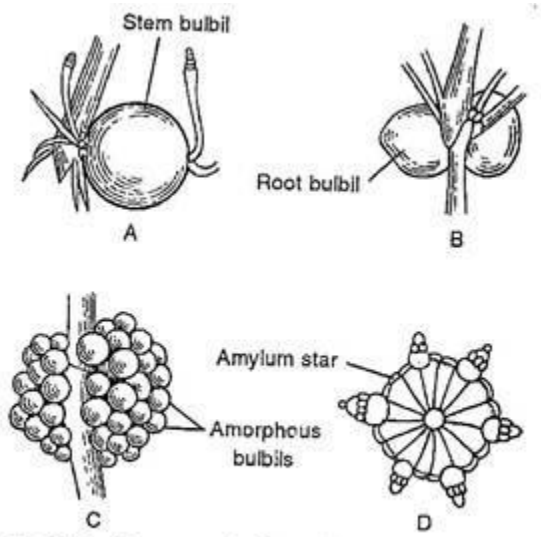

Fig. 3.93 : *Chara* sp. : A. Stem bulbil, B. Root bulbil, C. Amorphous bulbil, and D. Amylum star

3. Amylum Stars:
These are multicellular aggregations of cells, looking like stars and the cells are densely filled with amylum starch; thus they are called amylum stars. The amylum stars are developed at the nodal cells of the basal region e.g., C. stelligera (Fig. 3.93D).

4. Secondary Protonema:
These are thread like structures developed from primary protonema or from the basal cell of the rhizoid. New plants are also developed from the secondary protonema.

Sexual Reproduction:
Sexual reproduction of Chara is an advanced oogamous type. The sex organs are macroscopic and large. The male sex organ is spherical and yellow to red in colour, called globule. The female sex organ is more or less oval and green in colour, called the nucule or oogonium.

They develop on the nodes of the branch of limited growth (i.e., primary lateral), intermingled with secondary laterals. Nucule is always situated singly above the globule (Fig. 3.91 B, 3.94).

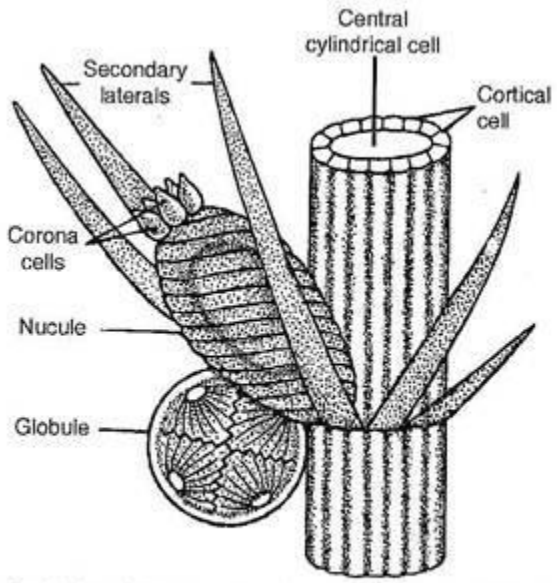

Fig. 3.94 : *Chara* sp. : A portion of the branch of limited growth showing attachment of nucule, globule and secondary laterals at the node

Most of the species are homothallic or monoecious (i.e., male and female sex organs develop on the same plant), but some are heterothallic or dioecious (e.g., C. wallichii).

Structure of Mature Globule:

Mature globules are spherical in shape and yellow to red in colour (Fig. 3.95C). Each globule consists of eight curved plates, situated towards the outer side, which are the shield cells.

From the inner side of the each shield cell, a centrally placed rod shaped structure is developed, called the manubrium. At the distal end of each manubrium one or more globose cells developed are called primary capitula. Each primary capitulum develops two or more secondary capitula.

Finally each secondary capitulum develops 2-4 long antheridial- filaments (Fig. 3.95H, I). Each antheridial filament has 25-250 cells and each cell i.e., antheridium (Fig. 3.95J, K) forms a biflagellate, coiled and uninucleate antherozoid (Fig. 3.95L). Thus a globule can develop as much as 20,000 to 50,000 antherozoids.

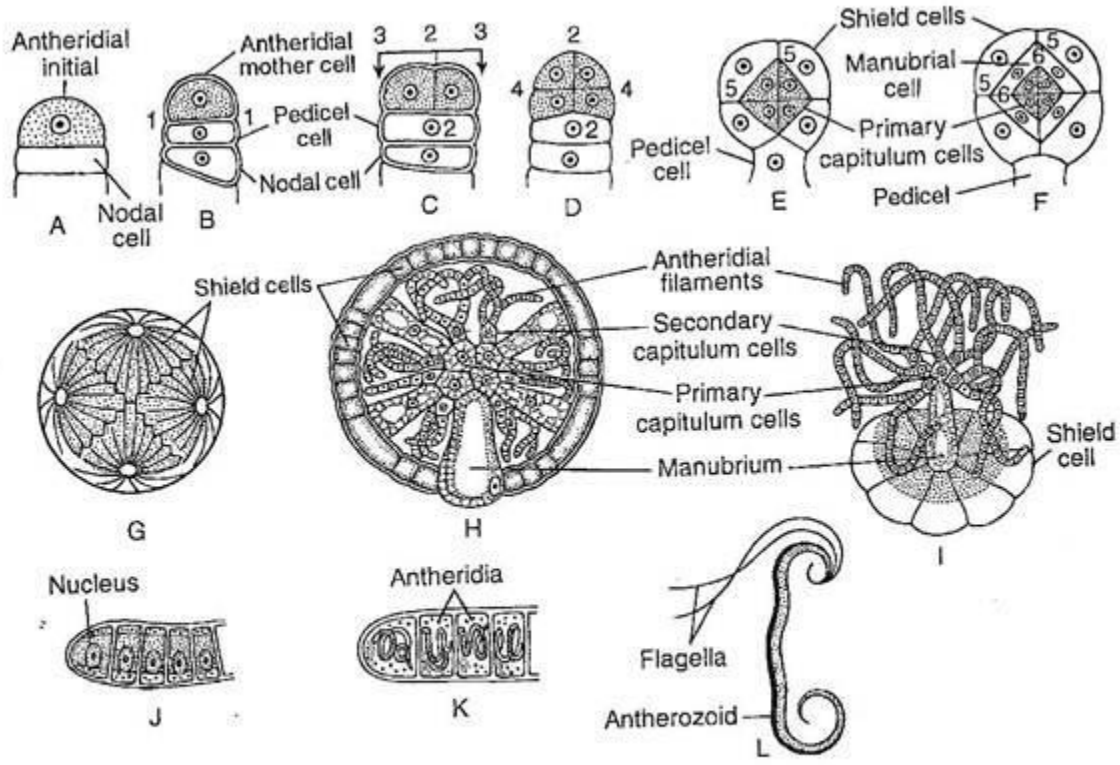

Fig. 3.95 : *Chara* sp. Development of globule. A-F. Stages in the development of globule, G. Mature globule, H. Globule in longitudinal section, I. A shield cells with manubrium, primary and secondary capitulum cells and spermatogenous filaments, J-K. Stages in spermatogenesis, L. An antherozoid

Structure of Mature Nucule or Oogonium:

The nucule of Chara is oval with a short stalk. Like globule it is also developed at the node of primary laterals just above the globule in homothallic species. It consists of centrally placed one central cell, one stalk and one large egg at the top (Fig. 3.96H). The entire structure is covered from the base by five spirally twisted tube cells except at the apex, where they form a crown made up of five corona cells (Fig. 3.94, 3.96H).

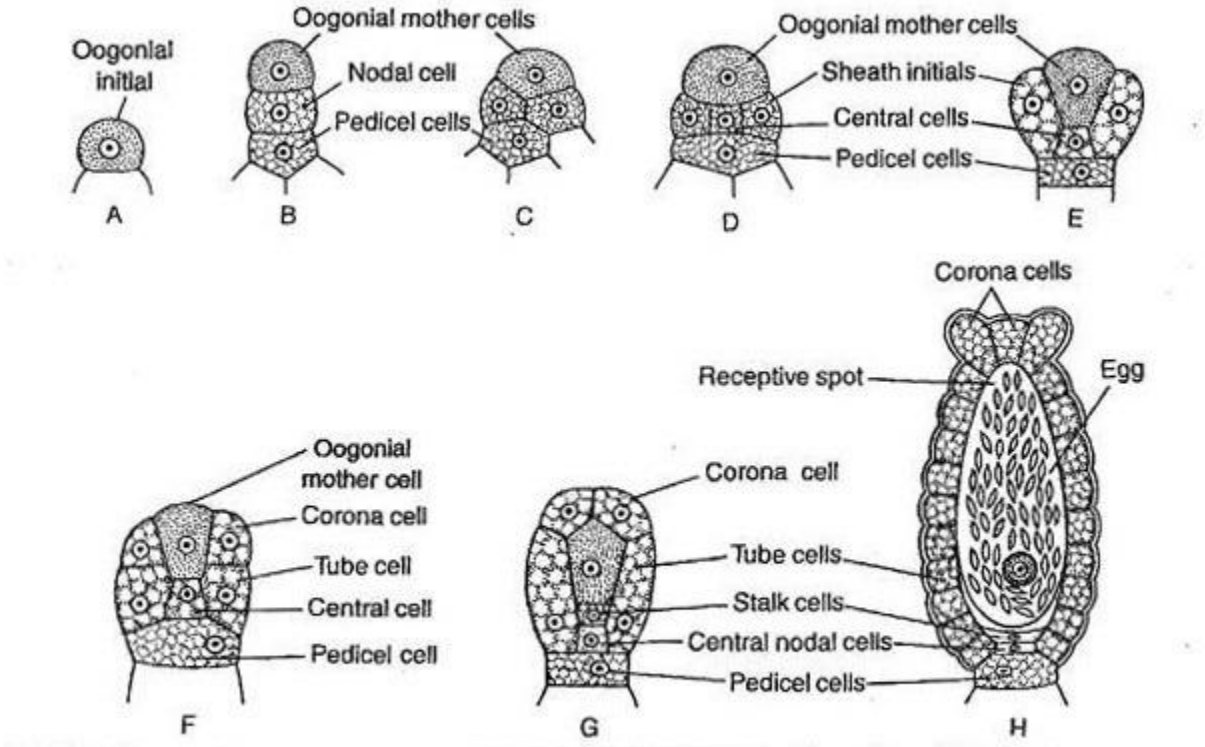

Fig. 3.96 : *Chara* sp. Development of nucule : A-G. Stages in the development of nucule, and H. L.S. of Mature nucule

The jacket of nucule shows similarity with the neck cells of archegonium of Bryophyte.

Development of Sex Organ in Chara:

Development of globule (Fig. 3.95). The globule develops at the node of branches of limited growth. Single peripheral cell of each node functions as the antheridial initial (Fig. 3.95A). The antheridial initial first undergoes transverse division (1-1) to form 2 cells, of which the lower one is the pedicel cell, which forms the stalk.

The upper one is the antheridial mother cell. The antheridial mother cell, then undergoes two vertical divisions right angle to each other (2-2, 3-3) followed by one transverse division (4-4), thus an octant (8 celled stage) is formed.

Each cell of the octant stage then undergoes periclinal division (5-5) to form outer 8 and inner 8 cells. Either the outer or the inner cells then undergo another periclinal division (6-6), thus forming 3 layers of 8 cells each (Fig. 3.95B-F).

The outer 8 cells form the 8 shield cells, the middle 8 cells form the manubrium and the inner 8 cells form primary capitula. The primary capitula further divide and form two or more secondary capitula (Fig. 3.95H, I).

Each secondary capitulum further divides and forms 2-4 antheridial filaments consisting of 25 to 250 anthridial cells or antheridia, formed by repeated mitotic divisions. The protoplast of each antheridium metamorphoses into single biflagellate and coiled antherozoid (Fig. 3.95J, K, L).

Development of nucule (Fig. 3.96). The oogonial initial is developed from the peripheral nodal cell of the primary laterals (Fig. 3.96A). The oogonial initial cell undergoes two transverse divisions thus forming a 3 celled stage. The lowermost is the pedicel cell, middle one is nodal cell and uppermost one represents the oogonial mother cell (Fig. 3.96B). The pedicel cell remains undivided and forms stalk of the nucule.

The middle one undergoes several vertical divisions thus 5 sheath initials are formed which surround a central cell (Fig. 3.96C, D). The oogonial mother cell divides transversely and forms lower stalk cell and upper egg (Fig. 3.96G). The egg elongates further and forms an oval structure. The apical region of the egg develops the receptive spot. Large amount of oil and starch are deposited in the ovum.

The sheath initial elongates further and divides transversely into upper small cells, the corona cells which form a crown-like structure at the top of the oogonium and the lower five cells form the tube cells (Fig. 3.96F, G). The tube cells elongate and become spirally twisted in a clockwise direction outside the oogonium, giving protection to the egg (Fig. 3.94).

Fertilisation:
During fertilisation the tube cells just below the corona get separated slightly and form five narrow slits or openings. The antherozoids get entry through these slits (Fig. 3.96H). Out of many aggregated antherozoids towards the slits, only one comes near the receptive spot of the egg. On contact with the egg, it fuses and forms an oospore (2n).

Oospore:

It is hard, spherical to ellipsoidal in shape and of various colours like light yellow, brown, red or black. It is surrounded by four layered walls, of which the outer two are coloured and inner two are colourless.

Germination:

During germination the nucleus of oospore migrates towards the upper region (Fig. 3.97B). The nucleus then undergoes meiotic division to form 4 haploid nuclei (Fig. 3.97C). The oospore then divides into two unequal cells of which the upper lenticular cell contains one nucleus and lower large basal cell contains three nuclei (Fig. 3.97D). The nuclei of the basal cell gradually degenerate.

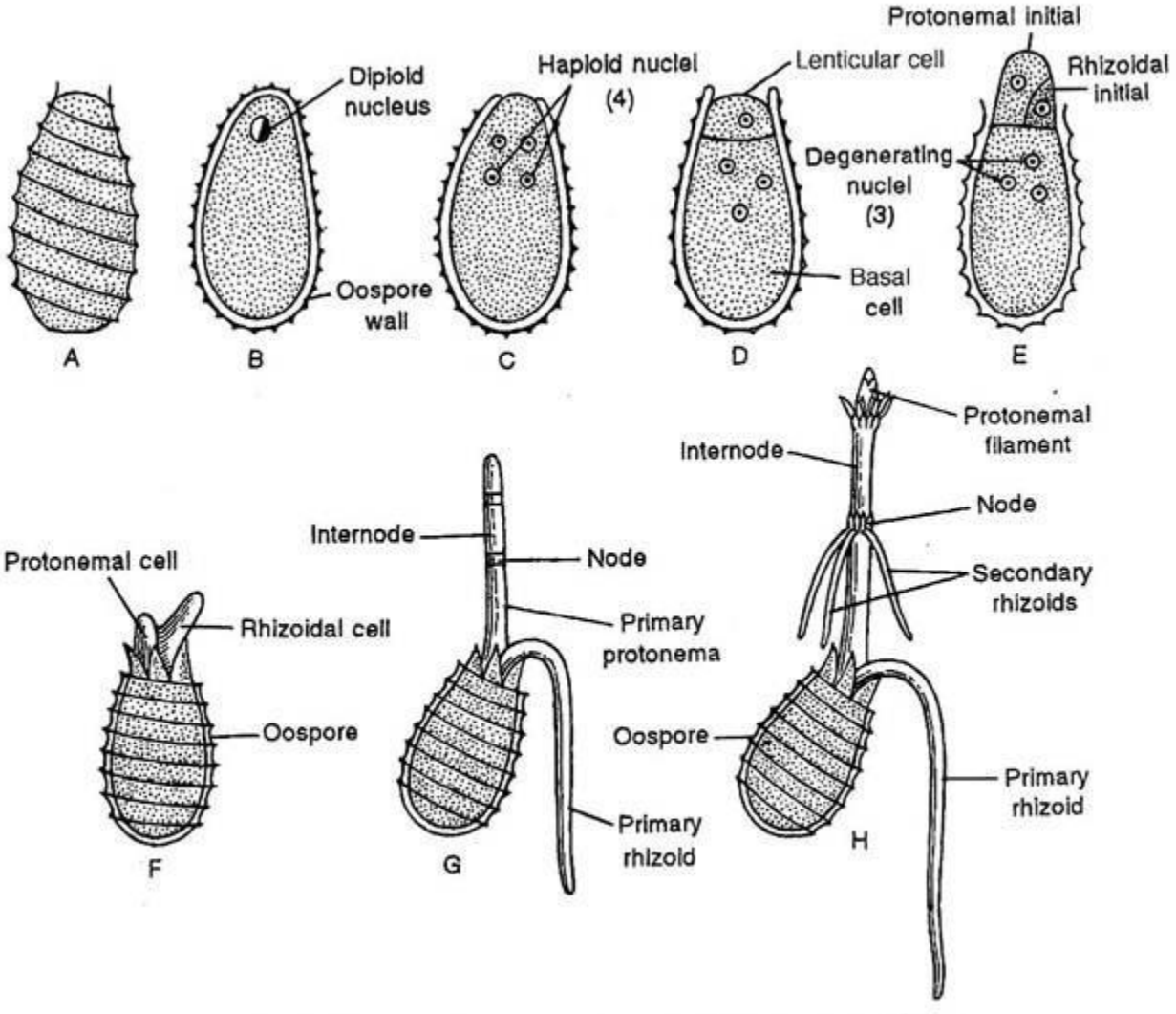

Fig. 3.97 : *Chara* sp. : A-H. Succesive stages in oospore germination

The lenticular cell projects out by rupturing the oospore wall and divides mitotically by an oblique longitudinal septum to form a larger protonemal initial and a small rhizoidal initial (Fig. 3.97E). Both the initials grow in opposite direction.

The protonemal initial is differentiated into nodes and internodes and form the upper part of the plant body, whereas the rhizoidal initial forms rhizoids (Fig. 3.97F, G, H). Secondary rhizoids may develop from the lower node of protonemal filament (Fig 3.97G)

Life Cycle of Chara:

Fig. 3.98 depicts the life cycle of Chara.

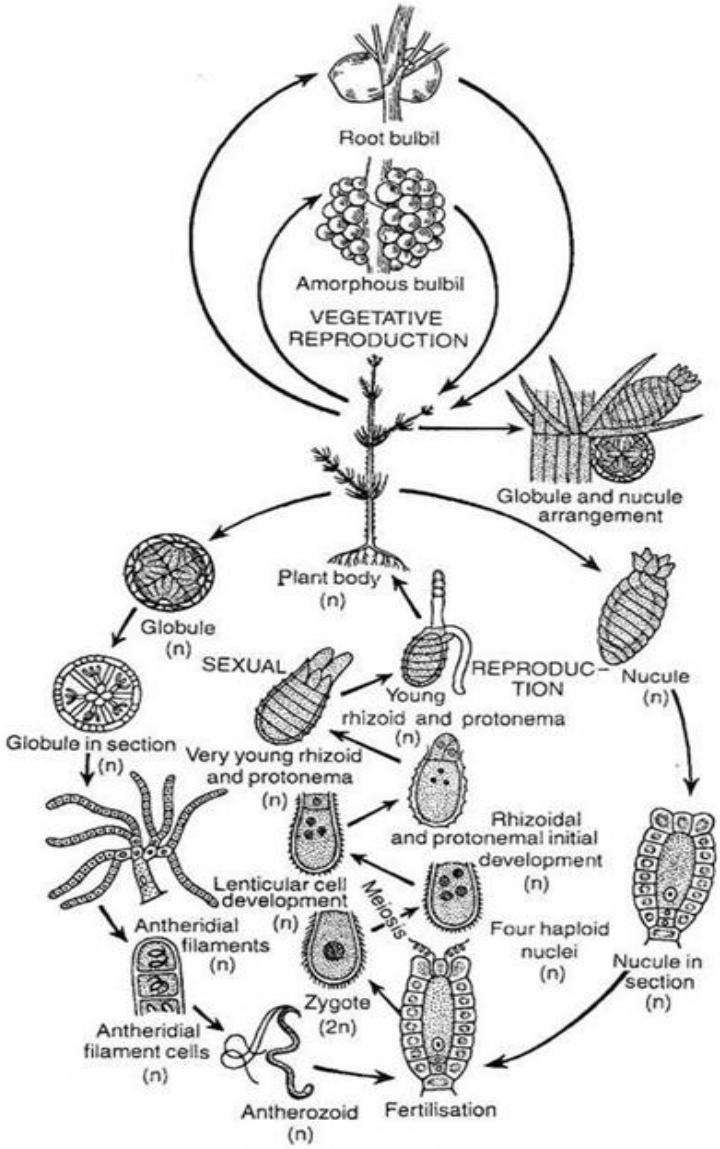

Fig. 3.98 : Life cycle of *Chara* sp.