VOLVOX

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Classification

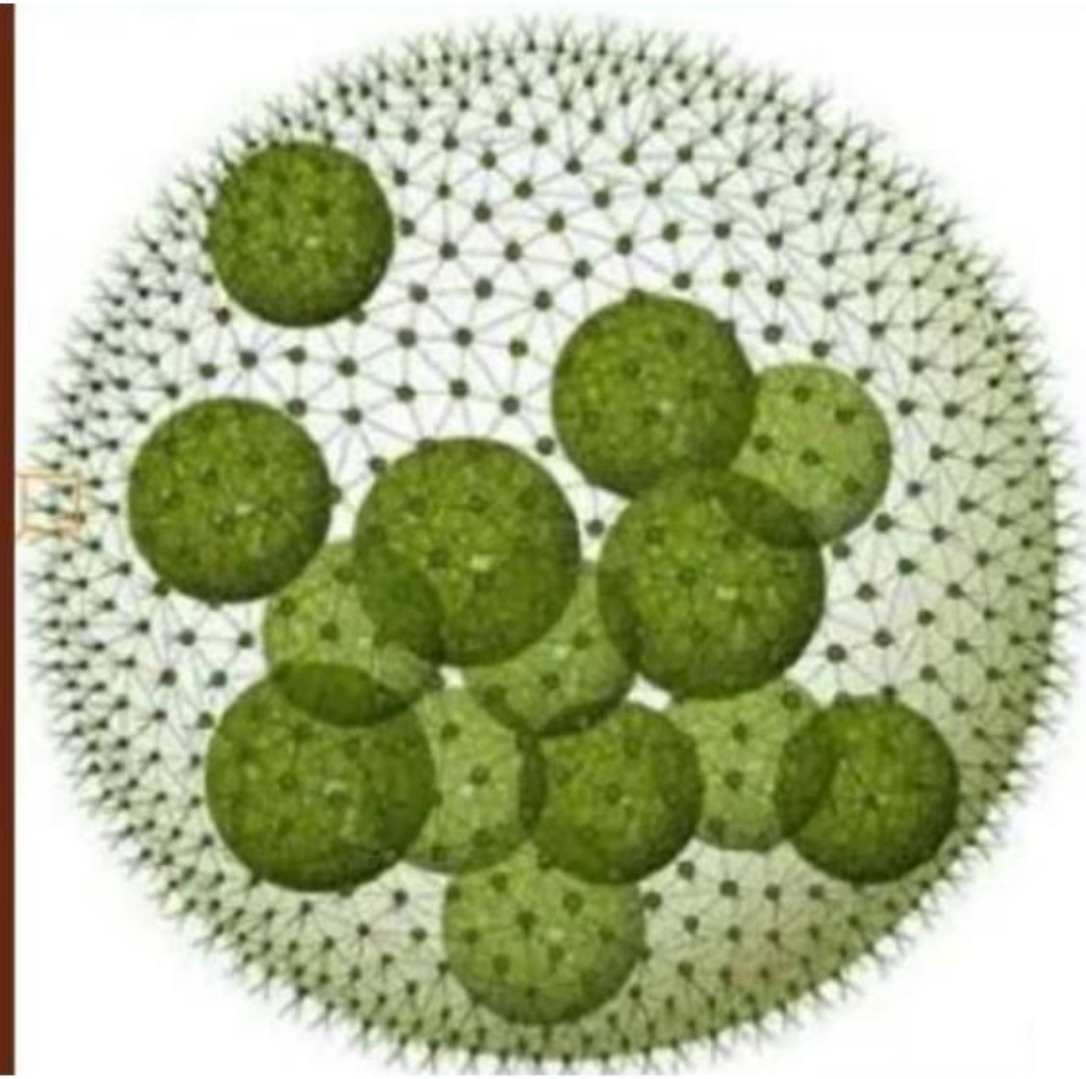
Division **Thallophyta**

Class **Chlorophyceae**

Order **Volvocales**

Family **Volvocaceae**

Genus ***Volvox***

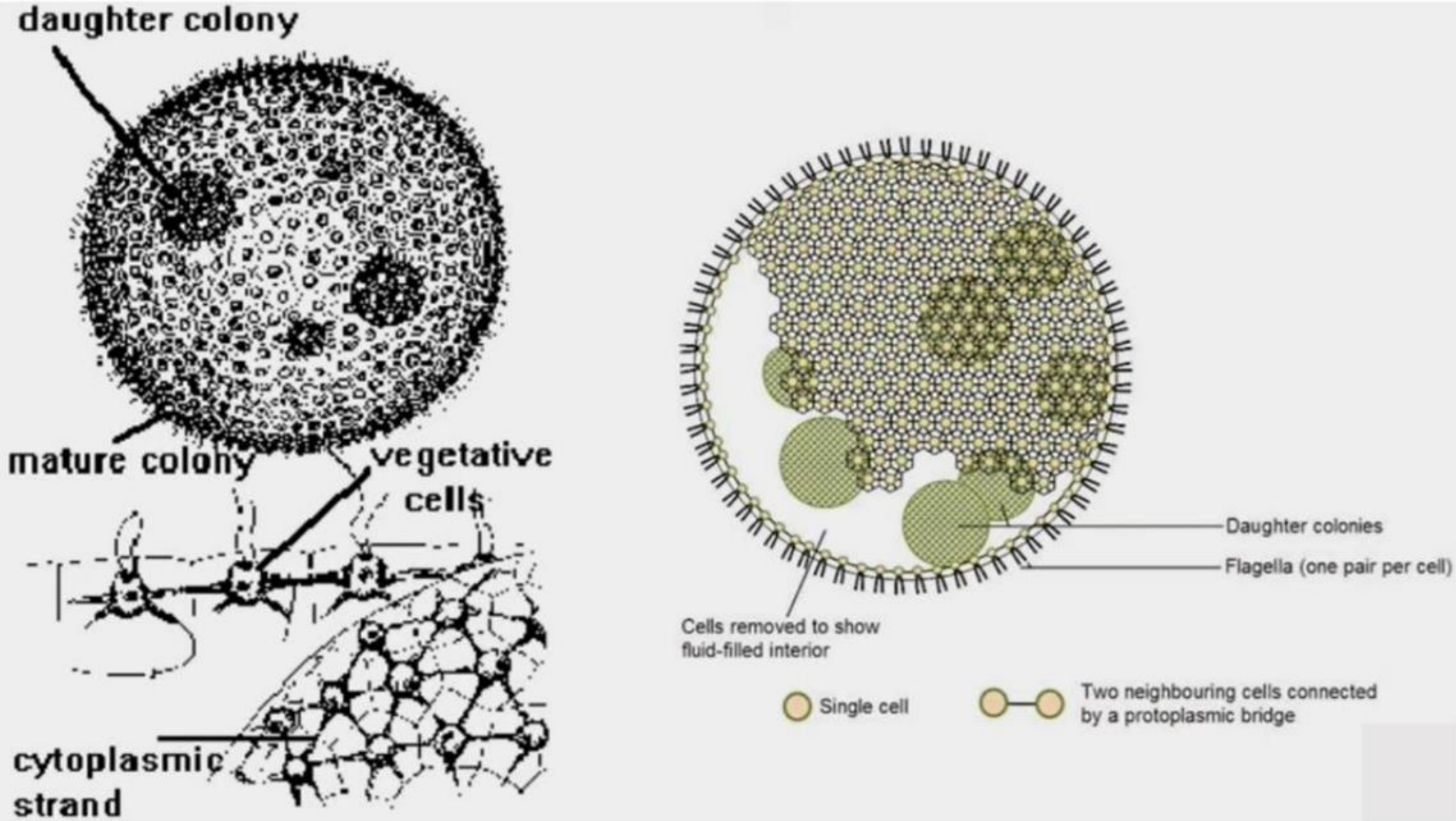


Occurrence of Volvox

- Volvox is a colonial, free floating, ball like , freshwater green algae.
- Volvox grows as planktons on surface of fresh water bodies like temporary and permanent ponds, ditches, lakes and water tanks.
- During rainy season the colour of the pond looks greenish due to the rapid multiplication of Volvox.
- It is also known as rolling ball.
- Volvox is represented by about 20 species.In India 05 sps are common .
- These species are-*Volvox globator; V aureus, V. prolificus, V. africanus and V. rousseletii.*

Structure of Volvox

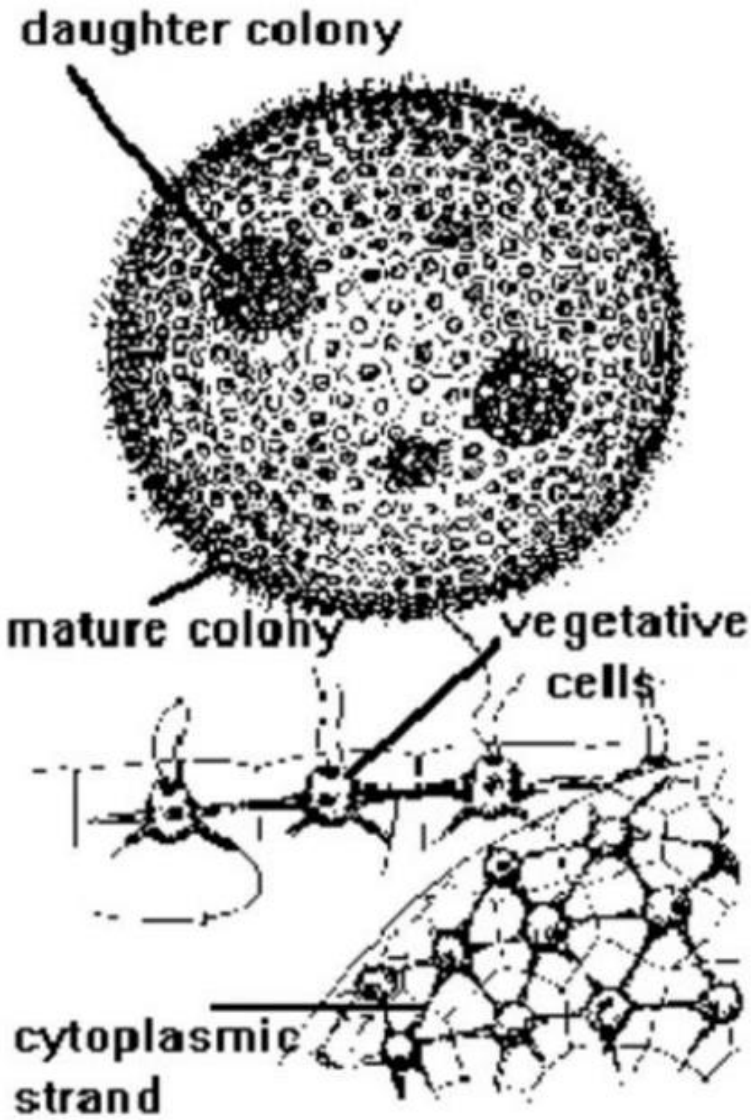
- Volvox is a motile ,colonial alga with definite shape and number of cells.
- This type of colony is called coenobium.
- The colony is hollow, spherical or oval in shape and the size of colony is about the size of a pin-head.
- Depending upon the species of Volvox the cells can be 500-60,000.
- The central part of colony is filled with watery or mucilaginous substance and the cells are arranged in a single layer on periphery of the colony .


daughter colony
mature colony
vegetative cells
cytoplasmic strand
Daughter colonies
Flagella (one pair per cell)
Cells removed to show fluid-filled interior
Single cell
Two neighbouring cells connected by a protoplasmic bridge

- The colony of Volvox shows polarity.
- The cells of anterior end possess bigger eye spots than those of posterior end cells.
- The cells of posterior side become reproductive on maturity.
- The mucilage envelope of colony appears angular due to compression between cells.
- The cells are connected to each other through cytoplasmic strands.
- In some species cytoplasmic connections or strands are absent.

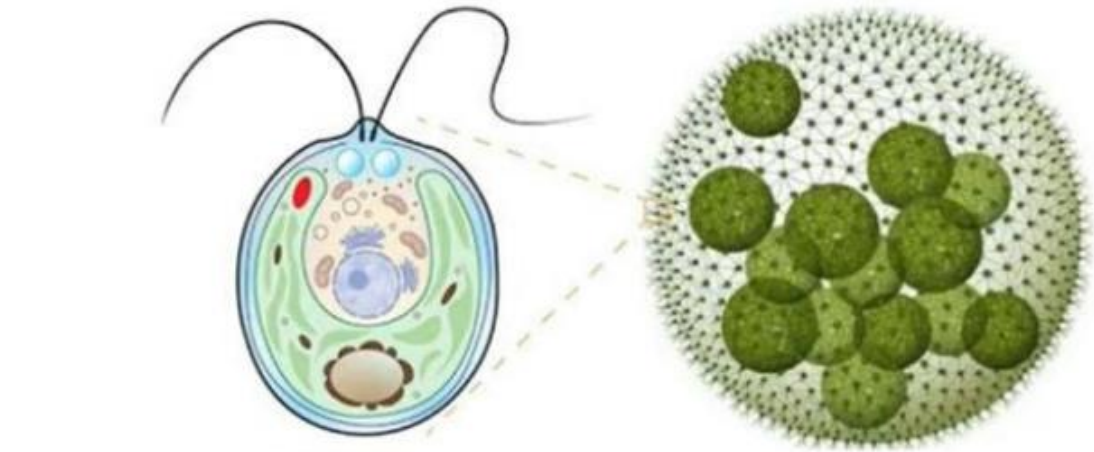
- Cells are usually pyriform with papillate anterior and broad posterior end.
- Every cell in the colony has its own mucilage sheath .
- Each cell in the colony is eukaryotic and *Chlamydomonas* type.
- The cells are biflagellate. Flagella are isoknot and whiplash type .
- Cell wall is made up of cellulose.
- The protoplasm is enclosed within a semipermeable plasma membrane.
- One nucleus, a cup shaped chloroplast with one or more pyrenoids, an eyespot, neuromotor apparatus and 2-6 contractile vacuoles are present in each cell .

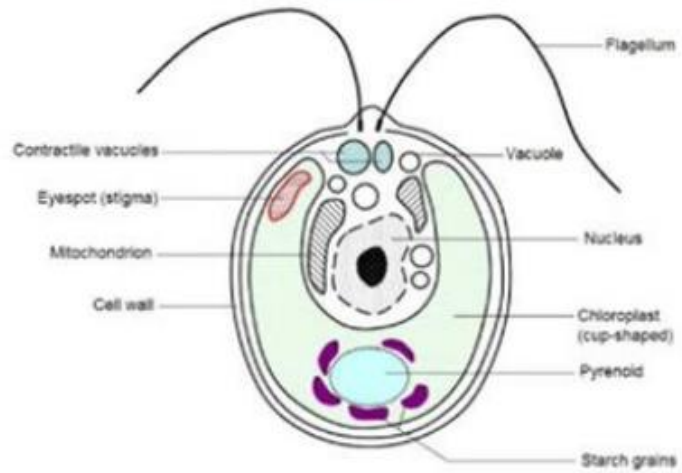
- Chloroplast is present in the posterior part of the cell.
- Eyespot is towards the external face.
- Pyrenoids is made up of protein core and peripheral starch plates.
- Cells of the colony are independent for functions like photosynthesis, respiration and excretion.
- The movement of colony takes place by co-ordinated flagellar movement of all cells.
- Asexual and sexual reproduction is common in the coenobium.



Volvox

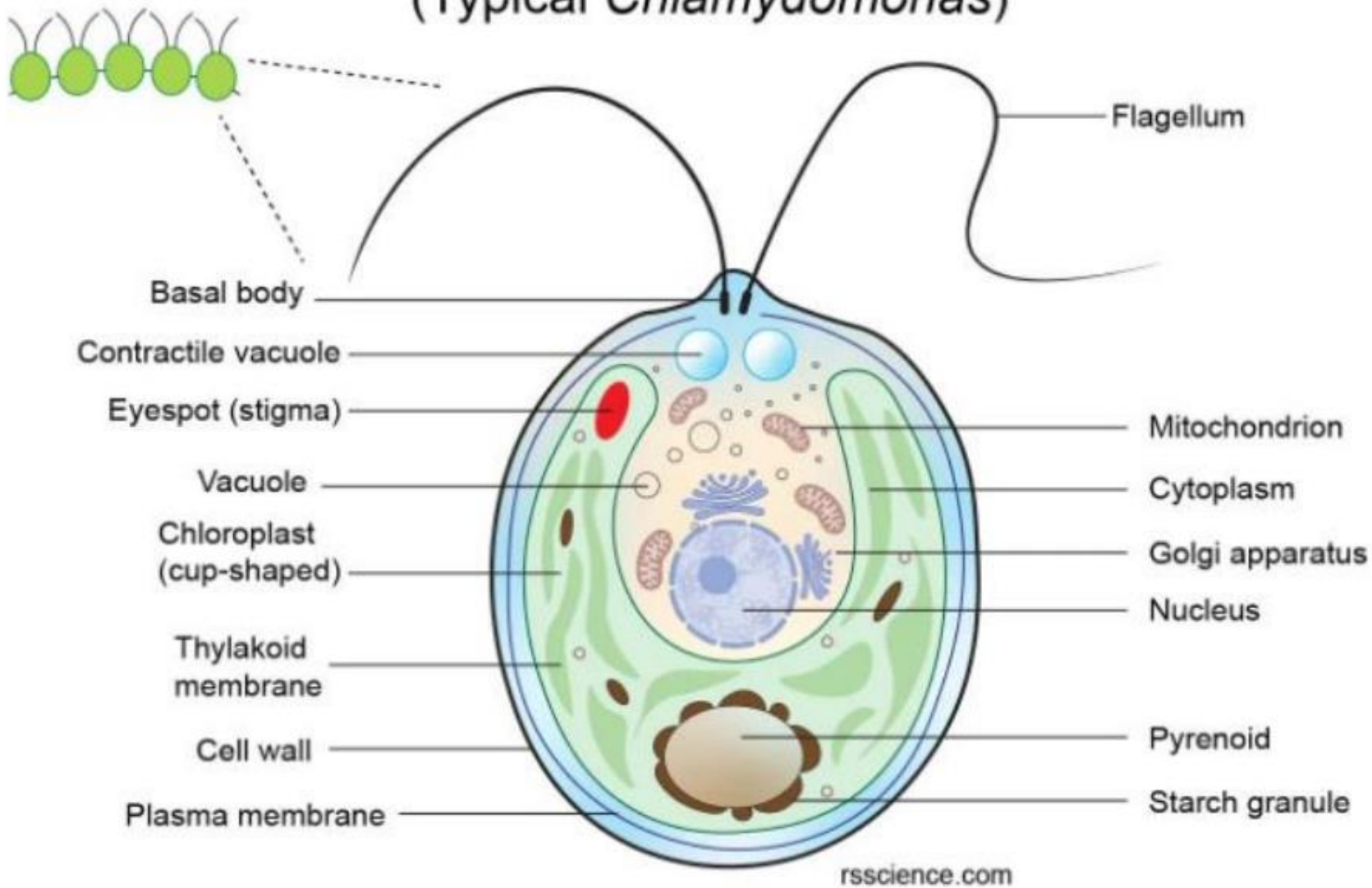
The emerald green algae of the micro world



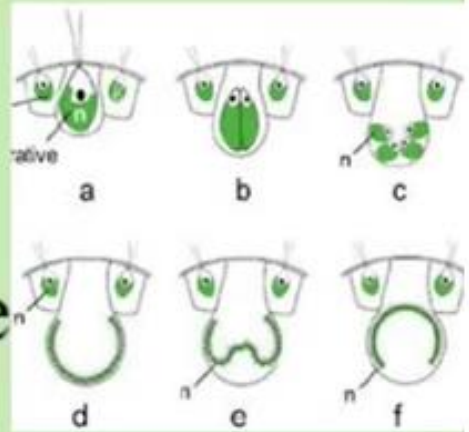


The Structure of Volvox Cell

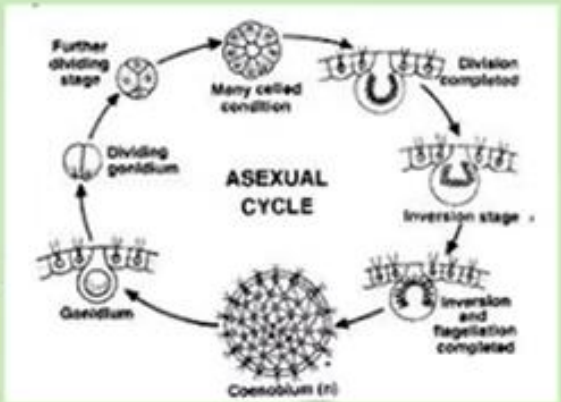
(Typical *Chlamydomonas*)



- Volvox reproduce asexually and sexually.
- Asexual reproduction takes place in favourable conditions *ie* during spring and summer seasons.
- Sexual reproduction starts towards the end of summer season.
- It is for the reason that all the colonies in a collection of time are either asexual or sexual.

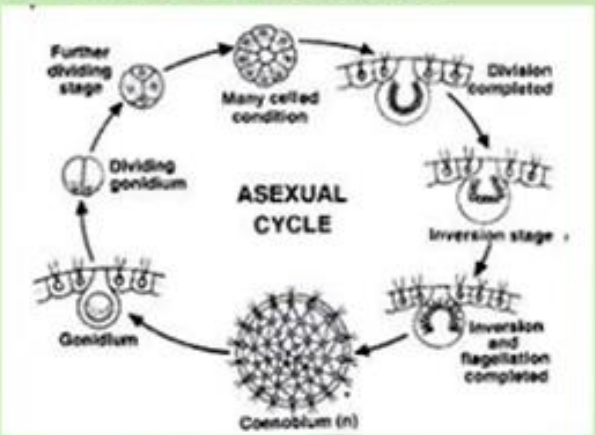


- Asexual reproduction takes place in the begining of growing season.
- During asexual reproduction some cells of the posterior part of colony store food and become enlarge .
- These cells are reproductive cells and called gonidia (Singular - gonidium).
- These cells enlarge up to ten times and become rounded.
- They lose eyespot and flagella.
- Pyrenoids increases in number and cytoplasm become dense.
- Nucleus is suspended in the centre.
- The gonidia are pushed towards hollow gelatinous cavity of the colony along with its gelatinous sheath.



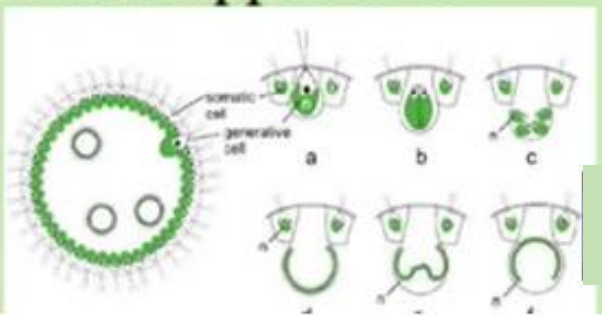
The protoplasm of this gonidium divides and forms daughter colonies.

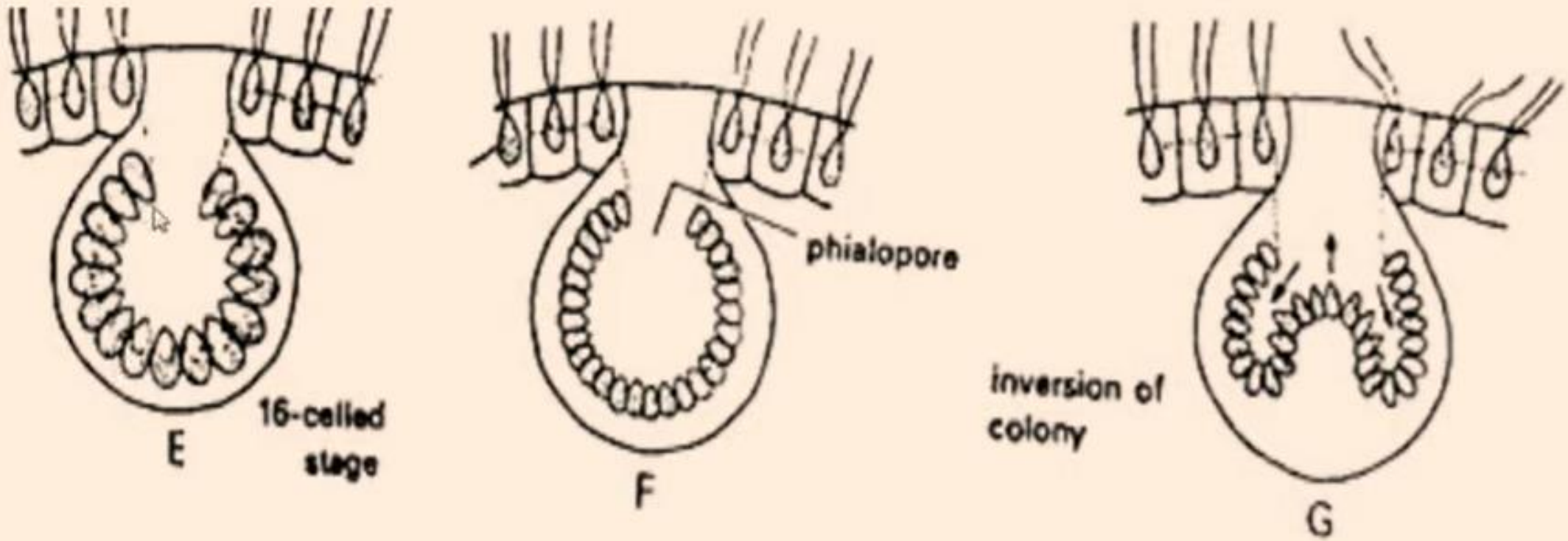
- The first division of the gonidium is longitudinal *i.e.* anterior to posterior plane of the coenobium.
- Second division is also longitudinal but at the right angle of first division.
- Now each cell again divides lengthwise and forms 8 cells.
- These 8 cells are arranged in curved plate-like structure.
- This 8 celled stage is called plakea stage.



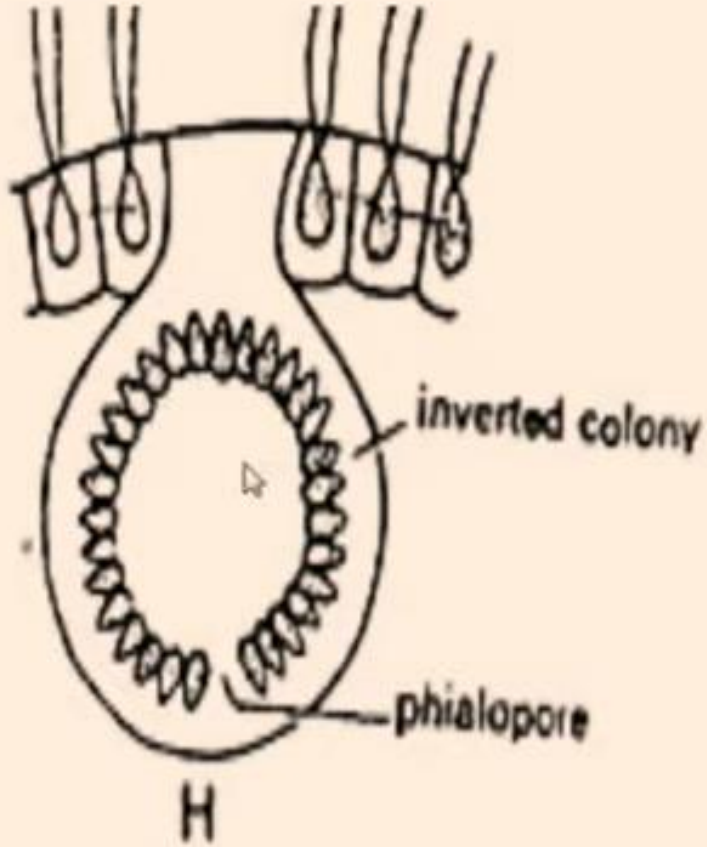
- Each of these 8 cells divides by longitudinal division forming 16 cells arranged in the form of a hollow-sphere .
- The sphere is open on anterior side by a small opening called phialopore.

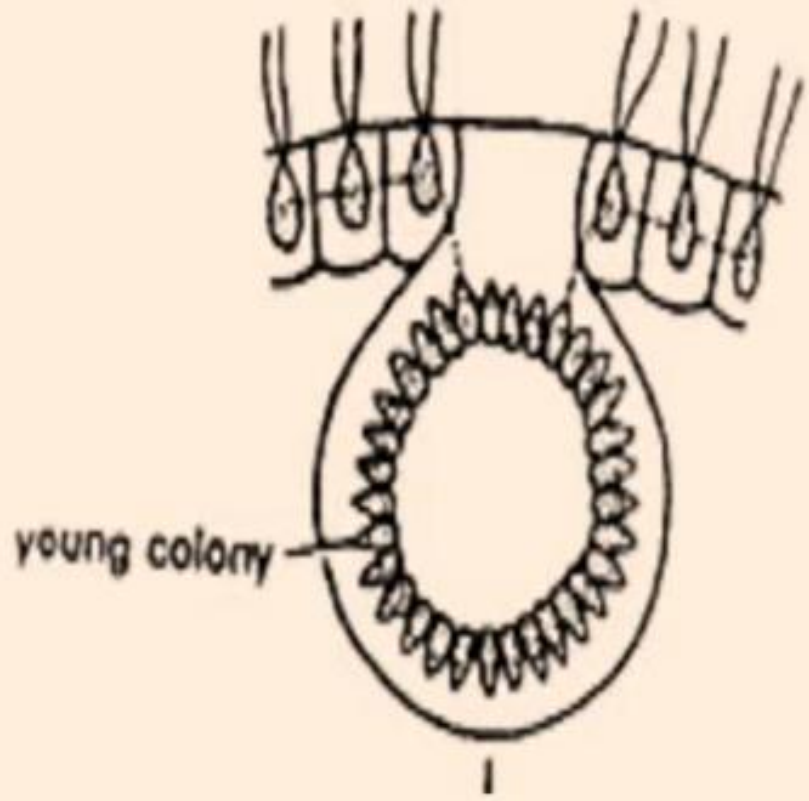
- The cells at this stage continue to divide till the number of cells reaches the characteristic of that species.
- These cells are naked and in close contact with each other.
- The anterior papillate end of cells is directed towards the centre of hollow sphere.
- The next step is called inversion of colony .
- It is necessary process as cells become opposite in direction, their anterior pointed end has to face the periphery of colony.
- The inversion of colony starts with formation of a constriction opposite to phialopore.
- Process of inversion was explained by Pckock(1933).

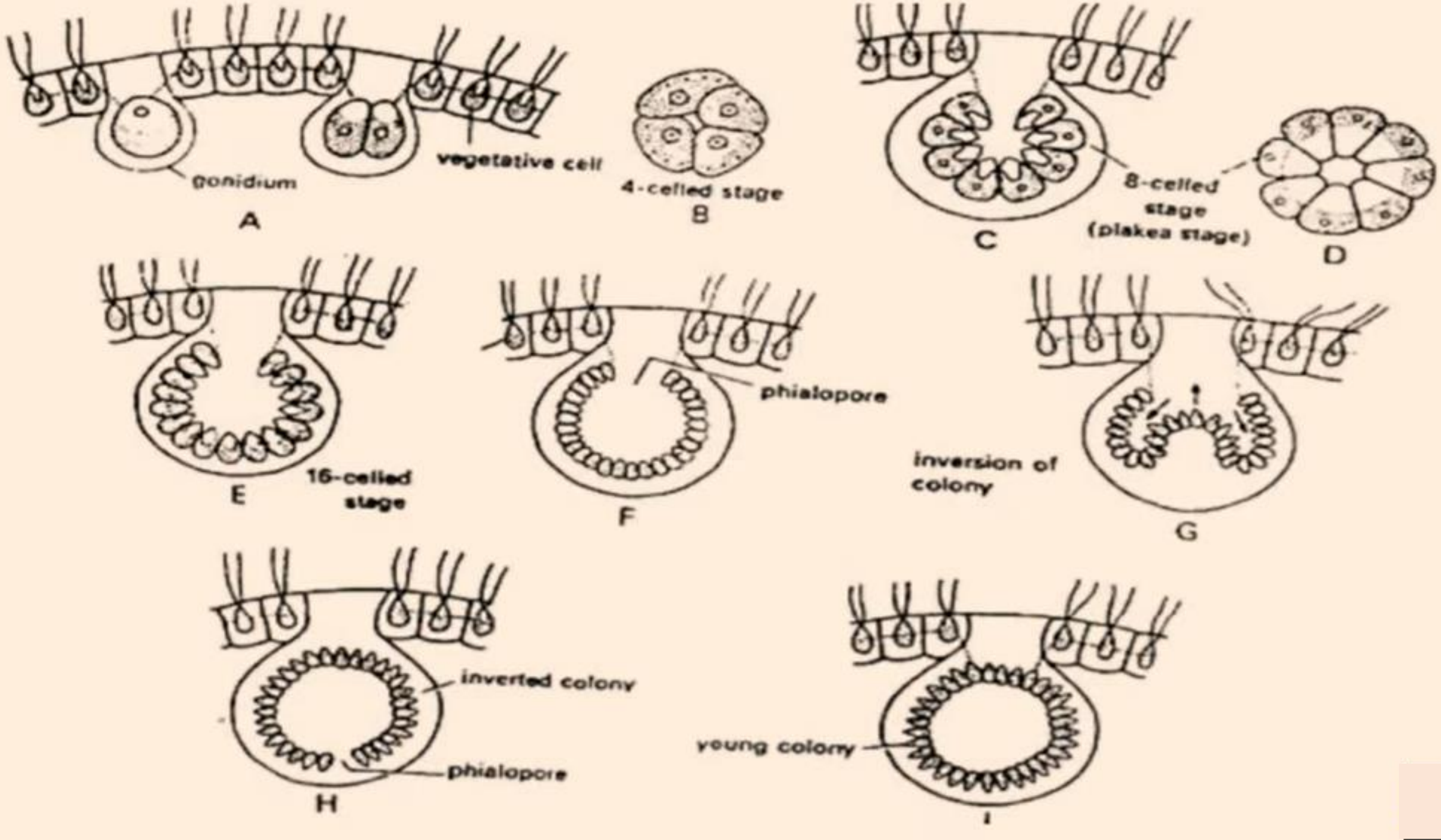



16-celled stage
E
phialopore
F
inversion of colony
G

- The cells of posterior end along with constriction are pushed inside the sphere, till the whole structure comes out of the phialopore.
- This process is called Invagination.
- After inversion, the anterior pointed end of the cell faces periphery.
- The phialopore gets closed, and makes the anterior part of the colony.
- After inversion all the cells secretes cell wall and develop flagella and eyespot.
- Now cells become separated due to development of gelatinous sheath around each cell.
- Process of inversion requires 3 to 5 hours.
- In this way a new daughter colony develop in each gonidium.


inverted colony
phialopore
H

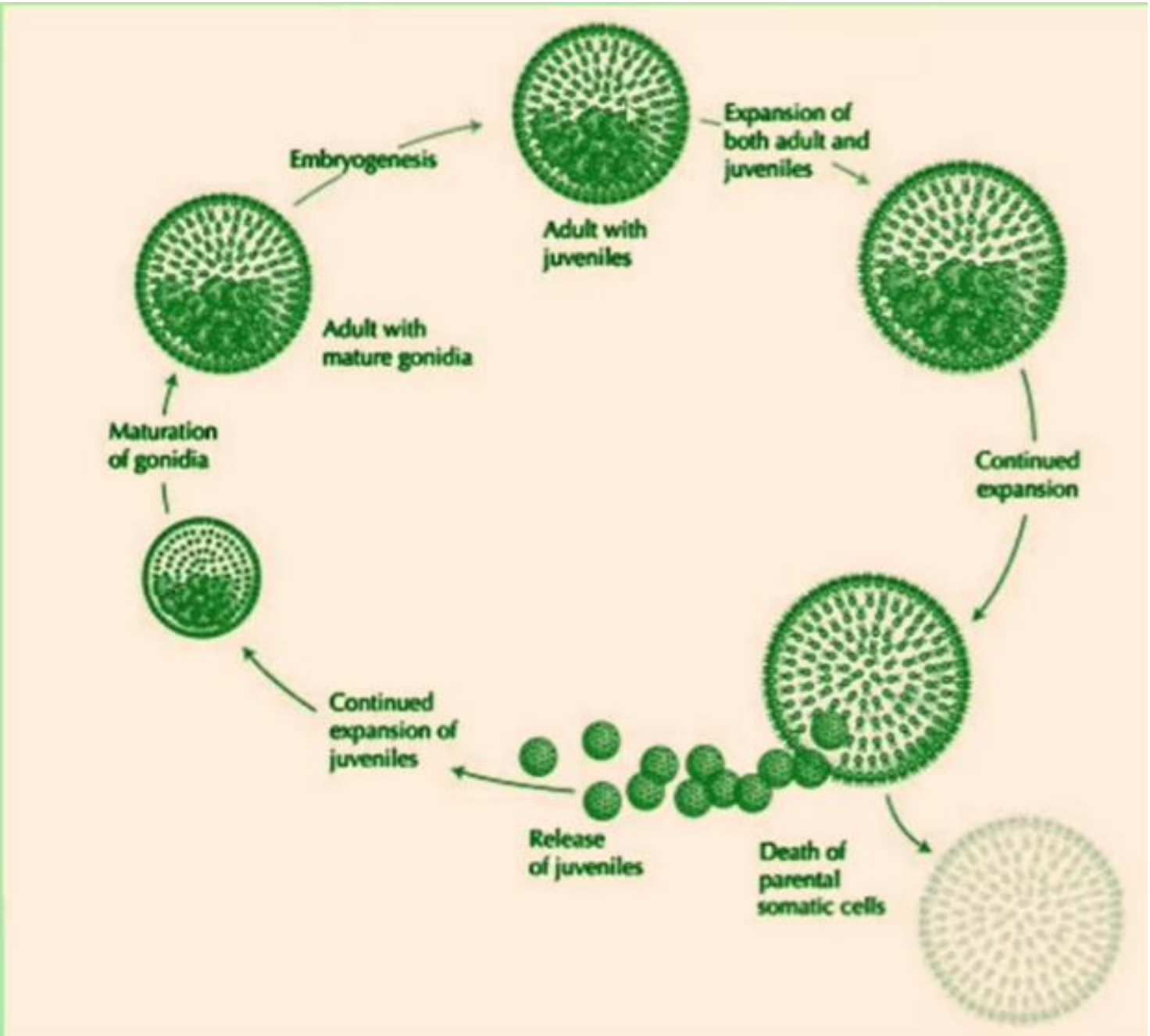

young colony
I

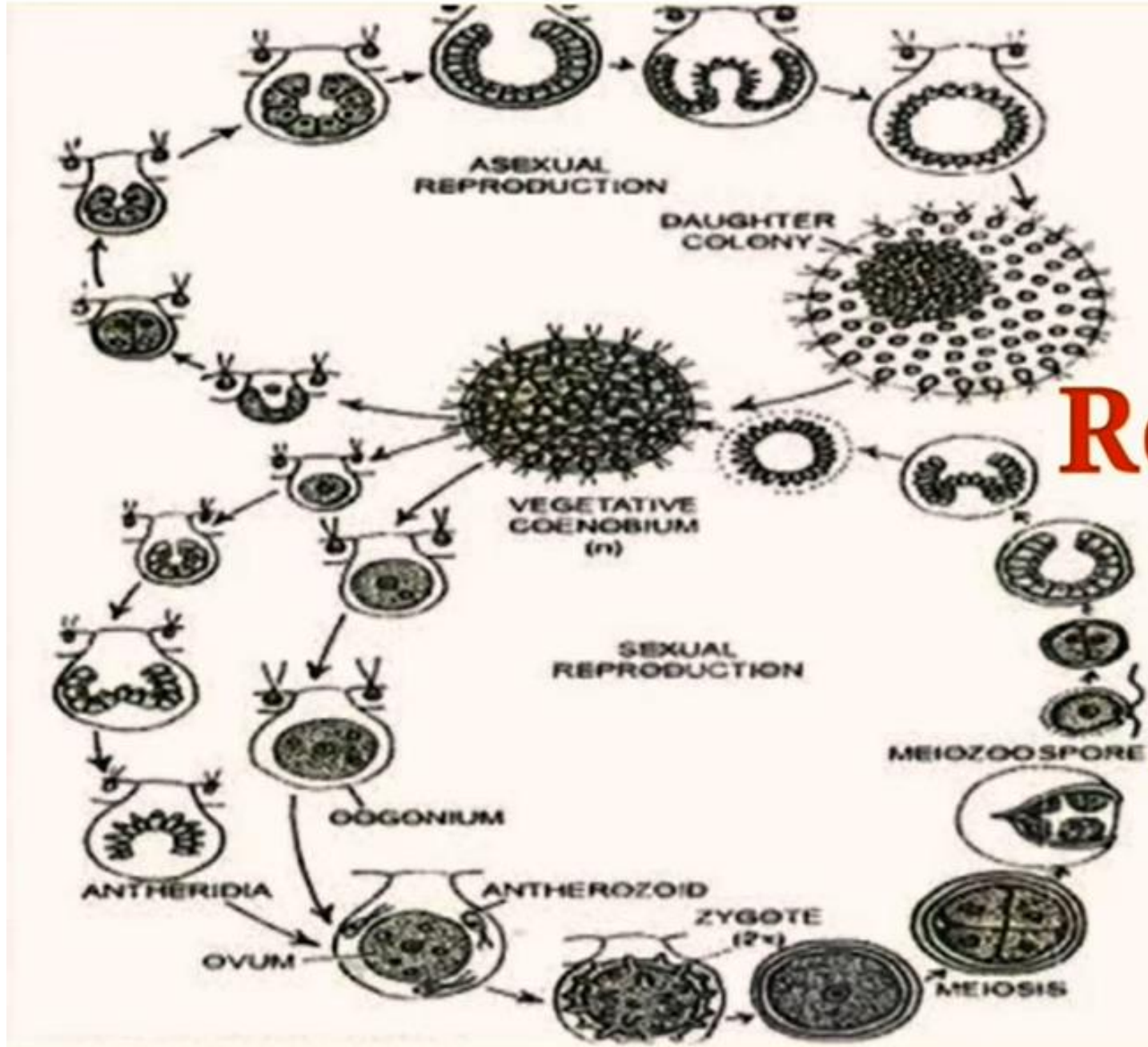

gonidium
vegetative cell
A
4-celled stage
B
8-celled stage (plakea stage)
C
D
E
16-celled stage
phialopore
F
inversion of colony
G
inverted colony
phialopore
H
young colony
I

- The daughter colonies initially remain attached to gelatinized wall of parent colony and later become free in gelatinous matrix of parent colony.
- Many daughter colonies may develop within a parent colony at the same time.

Volvox Coenobium with daughter colonies

- The daughter colonies are released in water after the disintegration of parent colony or through the pores.



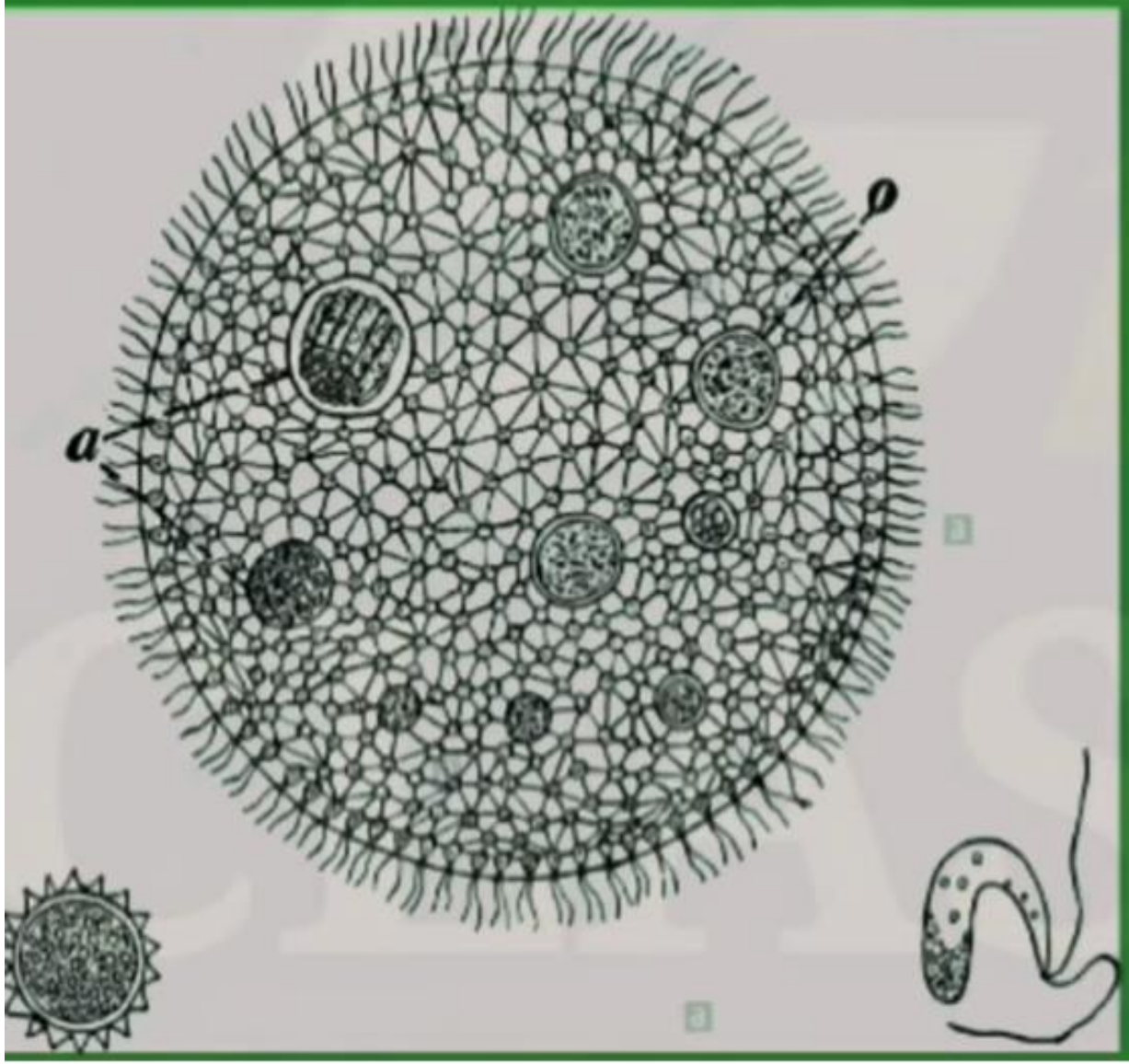


Sexual Reproduction in Volvox

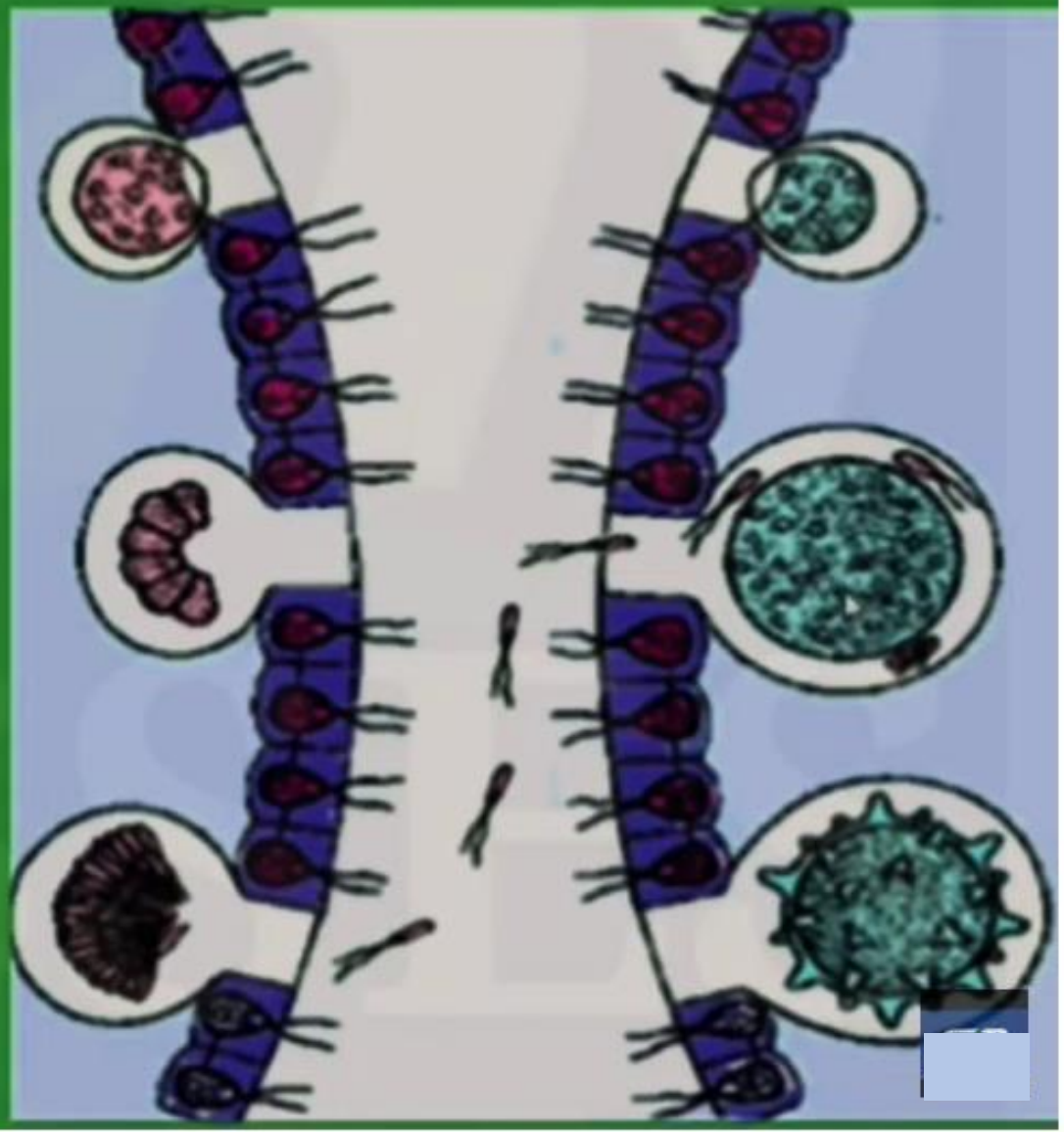
Sexual Reproduction

- Volvox shows advanced oogamous type of sexual reproduction.
- It takes place towards the end of growing season.
- Usually a colony involved in sexual reproduction does not have asexual daughter colonies.
- Some species of Volvox are monoecious *i.e.*, the antheridia and oogonia develop in same colony. E.g., *V. globator*.
- Other Volvox species are dioecious *i.e.*, antheridia and oogonia develop in different colonies.E.g., *V. rousseletii*.

Homothallic species



Heterothallic species



- Monoecious species are usually protandrous *i.e.*, antheridia mature before oogonia but some species are protogynous *i.e.*, oogonia develop before antheridia.
- *V. aureus* is mostly dioecious but sometimes can be monoecious.
- Reproductive cells are located in the posterior part of colony.
- These reproductive cells become enlarge, lose flagella and are called gametangia.
- The male gametangia are called antheridia or androgonidia and female gametangia are called oogonia or gynogonidia.

Development of Antheridium

- The development of antheridium starts with formation of antheridial initial or androgonidial cell in posterior side of the colony.
- The androgonidial cell enlarge, lose flagella, protoplasm becomes dense and nucleus becomes larger.
- The antheridial initial shifts inside towards cavity and remains connected to other vegetative cells through cytoplasmic strands.
- The protoplast of antheridial initial divides, longitudinally to form 16-512 elongated rod shaped cells.

- The cells grouped as a plate like structure or arrange in a hollow sphere.
- At this stage inversion of cells takes place as in asexual reproduction.
- Now each cell metamorphosize into a naked antherozoid or spermatozoid.
- The antherozoid is spindle, elongated or fusiform shaped and have two flagella, two contractile vacuoles, nucleus, cup shape chloroplast, pyrenoid and eye spot.
- It is pale yellow or green in colour.
- The antherozoids are released individually or sometimes in bundles.

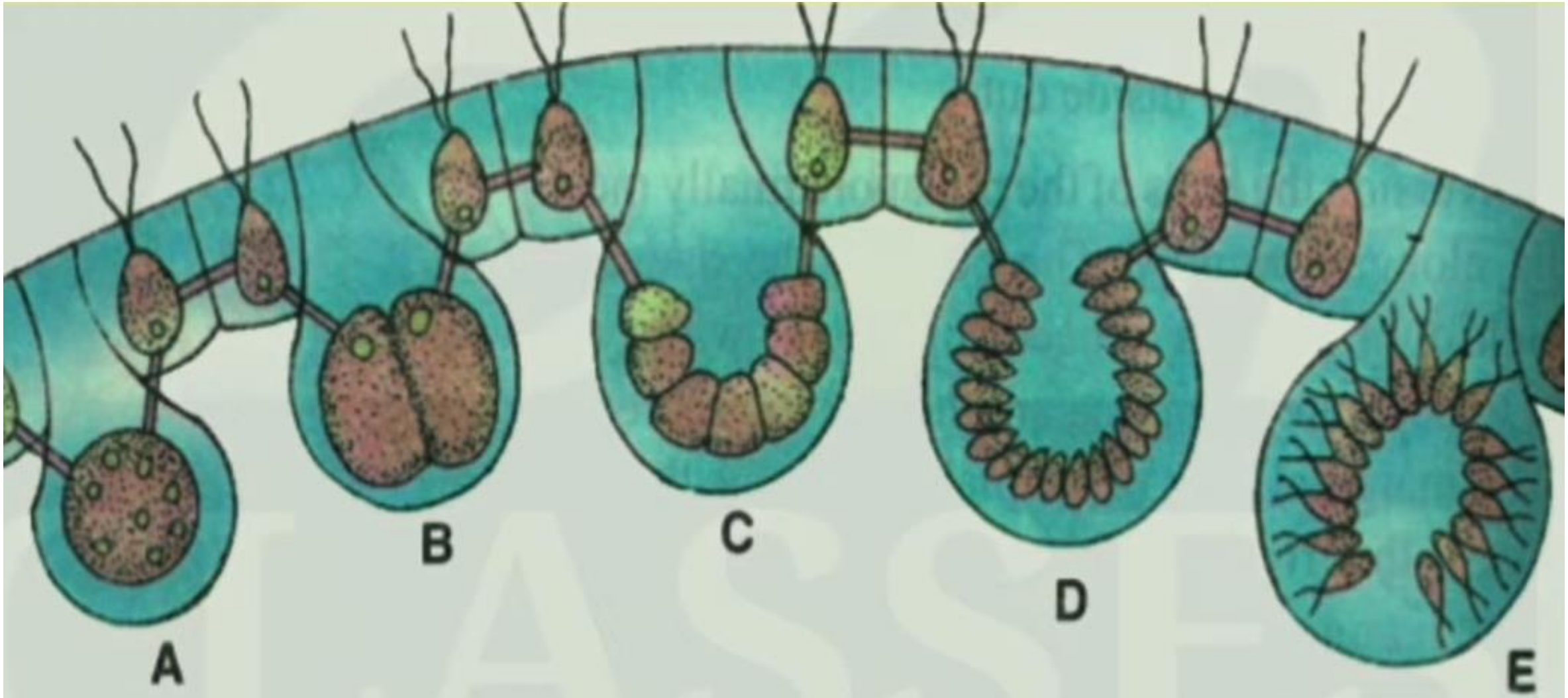
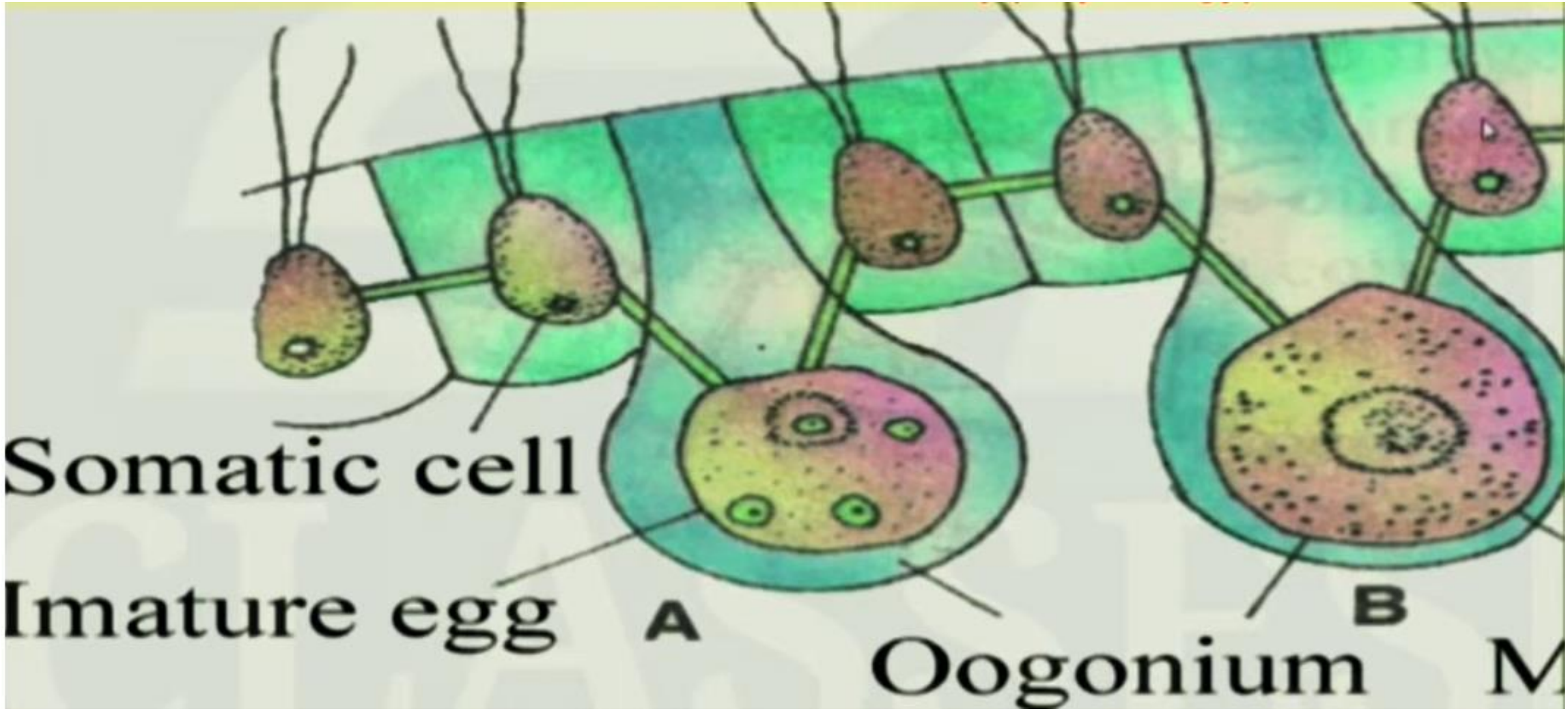


Fig : Development of Antherozoids (Sperms)

Development of Oogonium

- The oogonia also develops in posterior side of the colony.
- The oogonial initials enlarge and become flask shaped.
- Its nucleus becomes large, protoplast becomes dense, flagella and eyespot are lost, many pyrenoids appear and this whole cell is known as egg .
- The mature egg or ovum is round or flask shaped structure.
- The egg is uninucleate structure and have a parietal chloroplast.
- It is filled with reserve food material and green in colour.
- The beak of flask shape oogonium functions as receptive spot and opens at the surface of colony.


Somatic cell
Imature egg
A
B
Oogonium
M

Fertilization in Volvox

- After liberation from antheridium, the antherozoids swim freely on surface of water.
- Due to chemotactic response the antherozoids reach the oogonia in groups.
- Many antherozoids enters inside the oogonium through receptive spot but only one fuses with egg .
- First step is plasmogamy (fusion of male and female cytoplasm)and then karyogamy (fusion of male and female nuclei) take place.
- Diploid zygote or oospore forms after fertilization.
- *Mainx* (1928) reported parthenogenesis in volvox, where egg directly develops into a new coenobium.

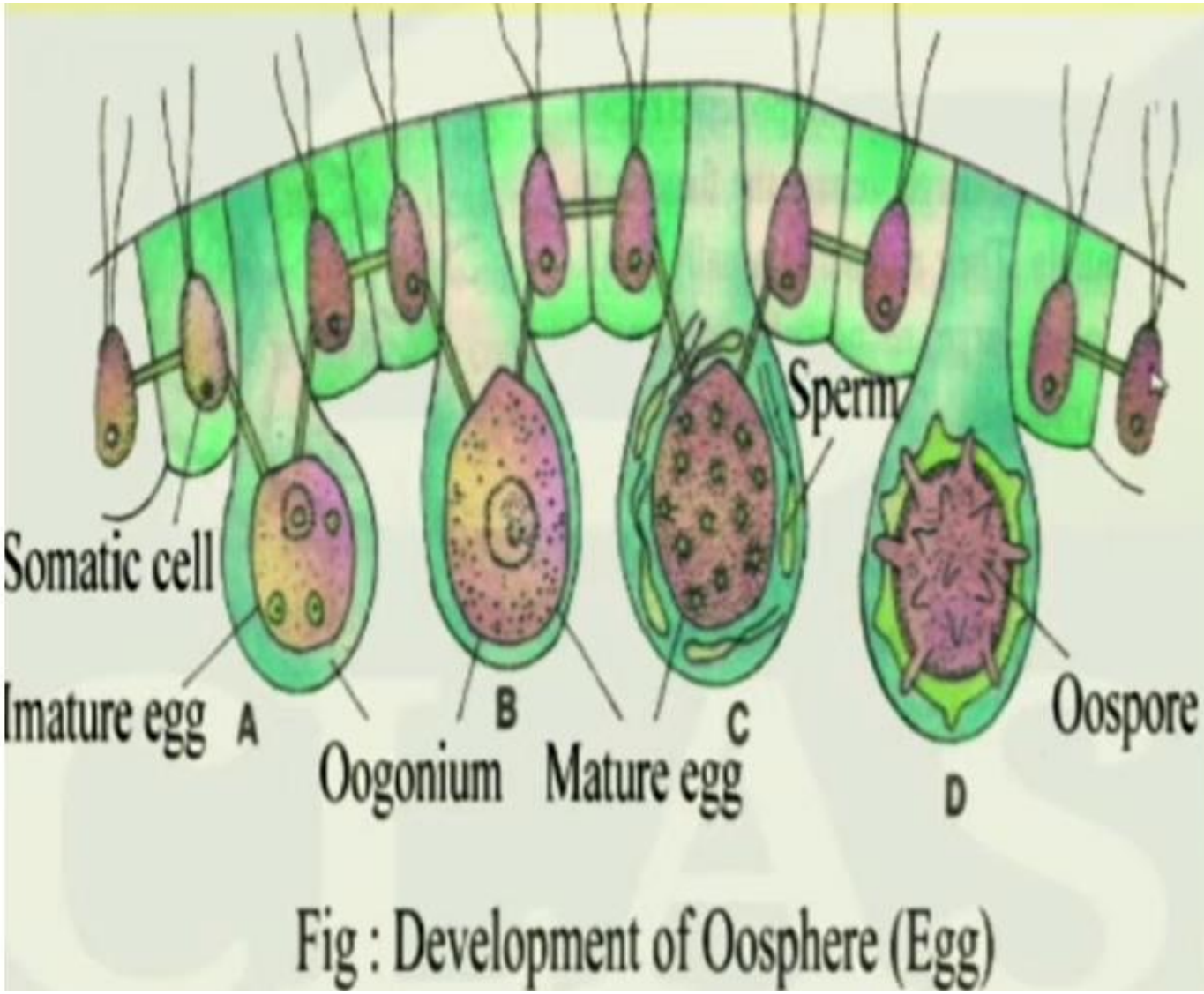
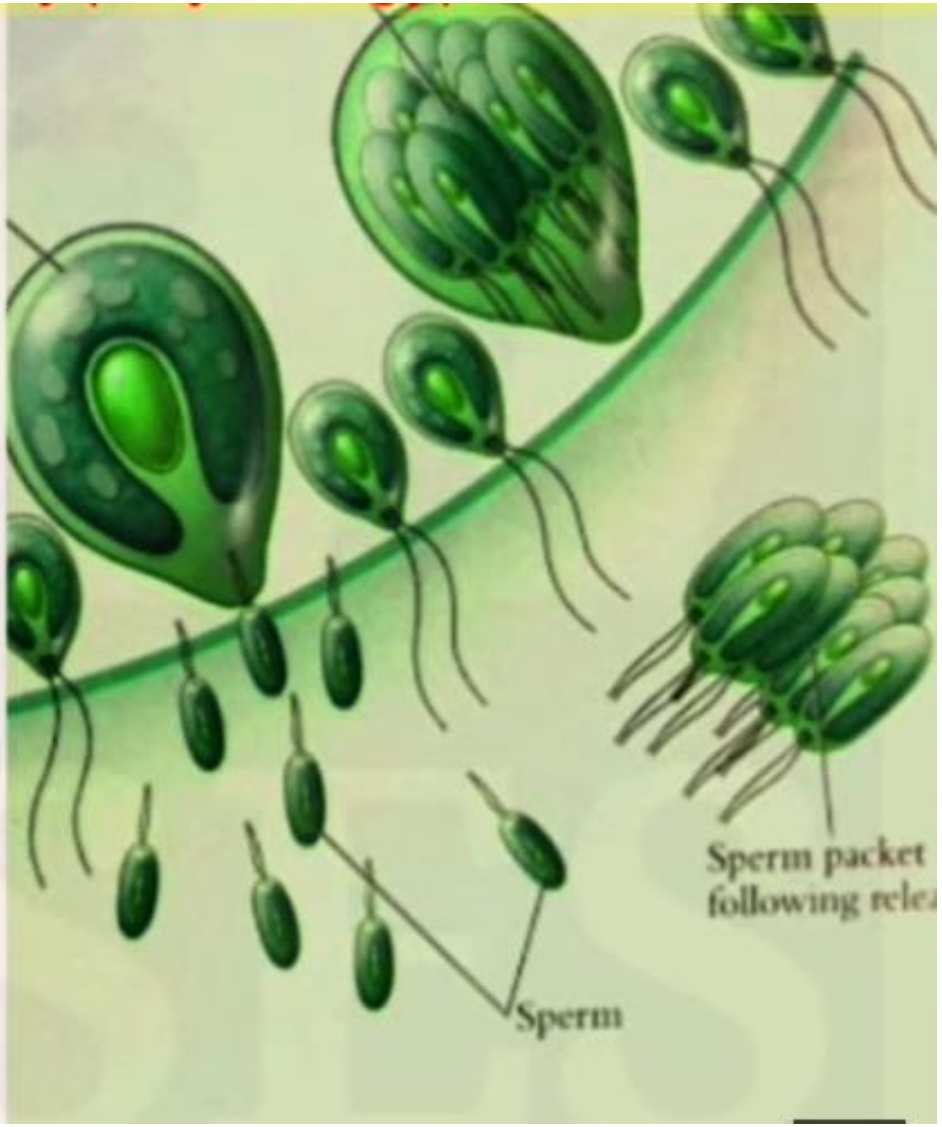


Fig : Development of Oosphere (Egg)

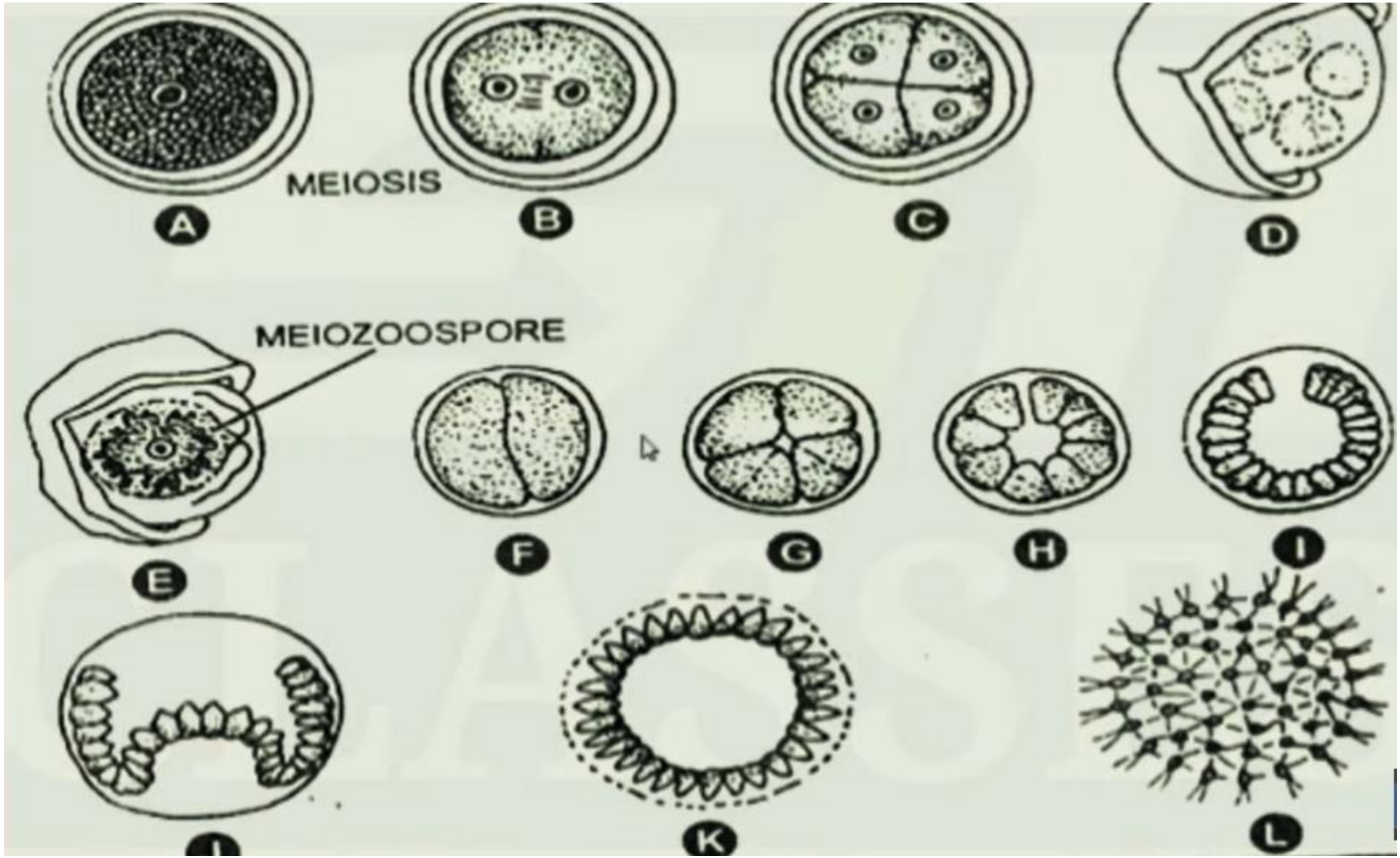


- The diploid zygote secretes a three layered thick wall which may be smooth or spiny.
- Three layers of the wall are exospore, mesospore and endospore.
- The outer exospore is generally thick.
- It may be smooth in *V. aureus* or spiny e.g., *V. globator* .
- The middle mesospore and inner endospore are thin and smooth.
- The walls contain pigment haematochrome which imparts red orange colour to the zygote.
- The zygotes retain in the coenobium for some time and after that liberated by the disintegration of parent colony.
- After liberation it settle down at the bottom of the pool and remain viable for several years.

Germination of Oospore

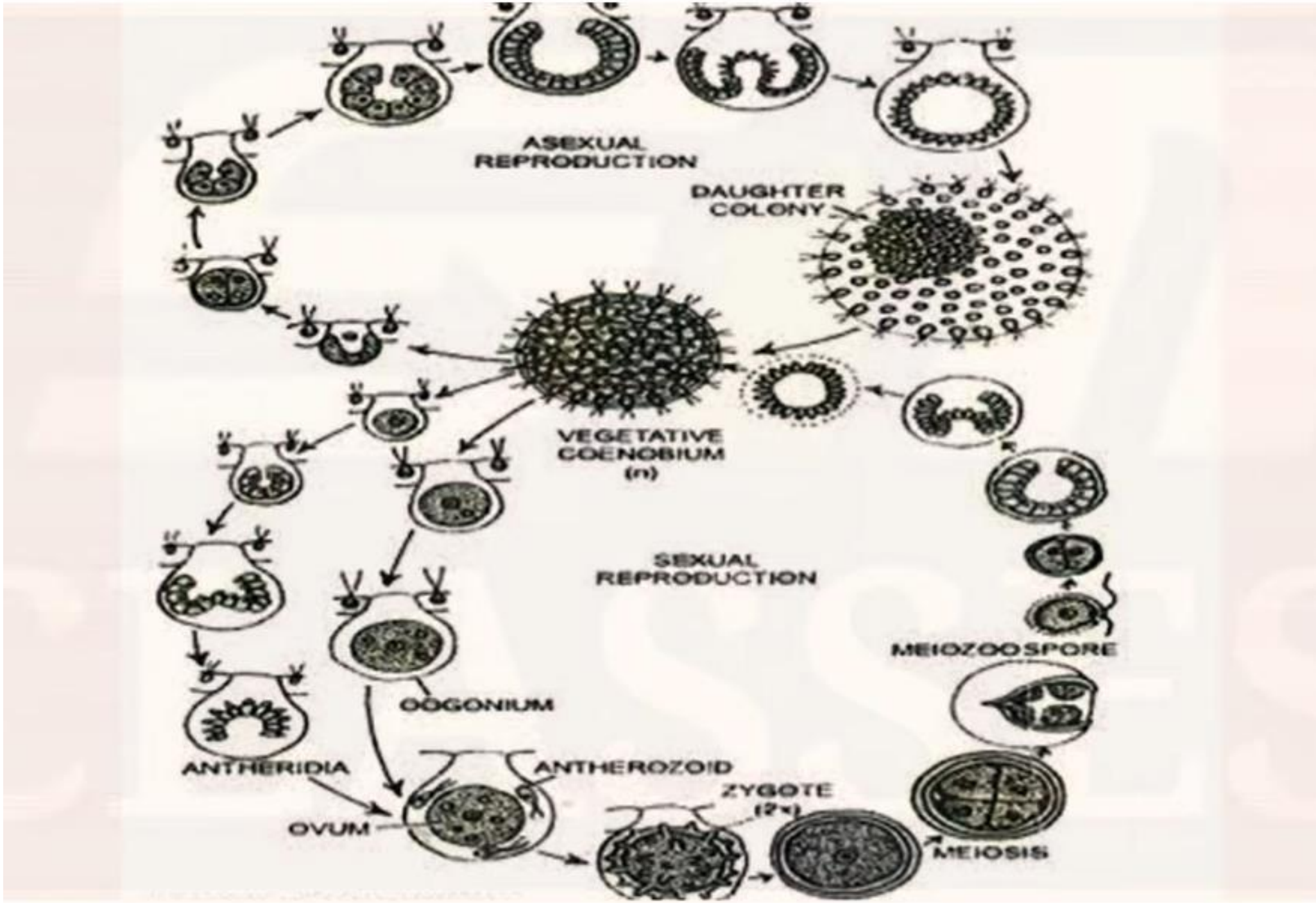
- The dormant oospore germinates on the onset of favourable climatic conditions.
- The outer two layers of zygote burst and the inner layer comes out as vesicle.
- The diploid nucleus of zygote undergoes meiotic division and forms four haploid cells.
- The four haploid cells migrate into the vesicle .
- The development of new colony from zygote differs in different species of *Volvox*.

- In *V. rousseletii* the zygote forms a single biflagellate zoospore, the protoplast of zoospore divide and divides to form a colony.
- In all above methods , the cells divides and divides and then undergo inversion to make a mature coenobium.


MEIOSIS
A
B
C
D
MEIOZOOSPORE
E
F
G
H
I
J
K
L

Alternation of Generation

- The life cycle of Volvox is **haplontic.**
- The dominant stage is free-living haploid (n) gametophyte .
- The haploid gametophyte produce haploid gametes which fertilize to make diploid zygote (2n)
- The sporophyte stage is represented only by the diploid zygote (2n).
- Zygote divides by meiosis to make haploid cells (n) which mature into haploid Volvox colony.


ASEXUAL
REPRODUCTION
DAUGHTER
COLONY
VEGETATIVE
COENOBIUM
(n)
SEXUAL
REPRODUCTION
MEIOZOOSPORE
OOGONIUM
ANTHERIDIA
ANTHEROZOID
ZYGOTE
(2n)
OVUM
MEIOSIS

THANK YOU