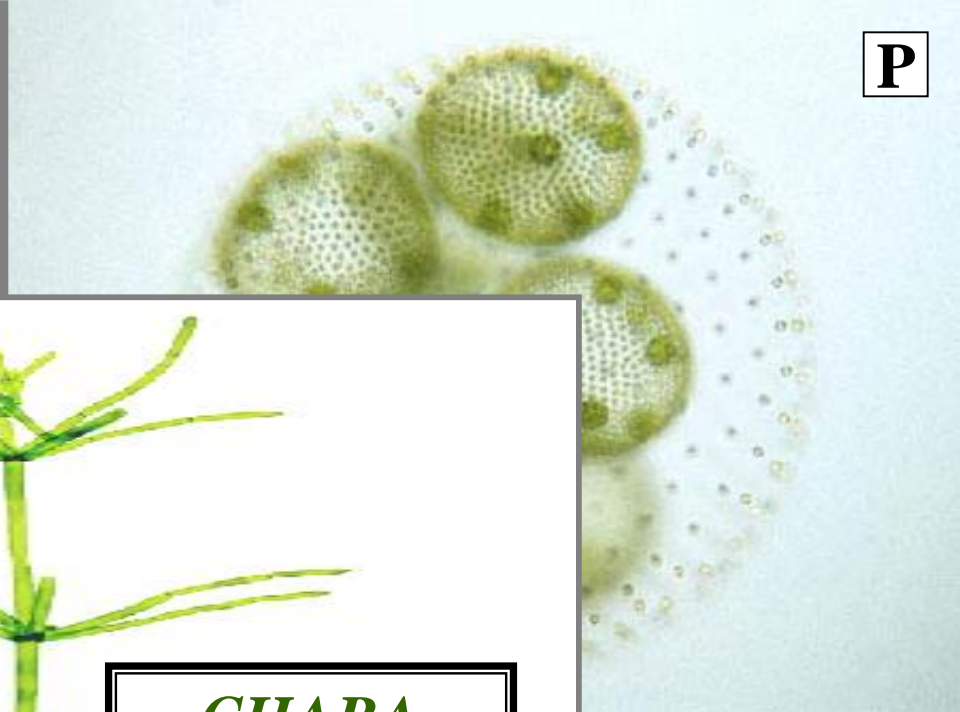
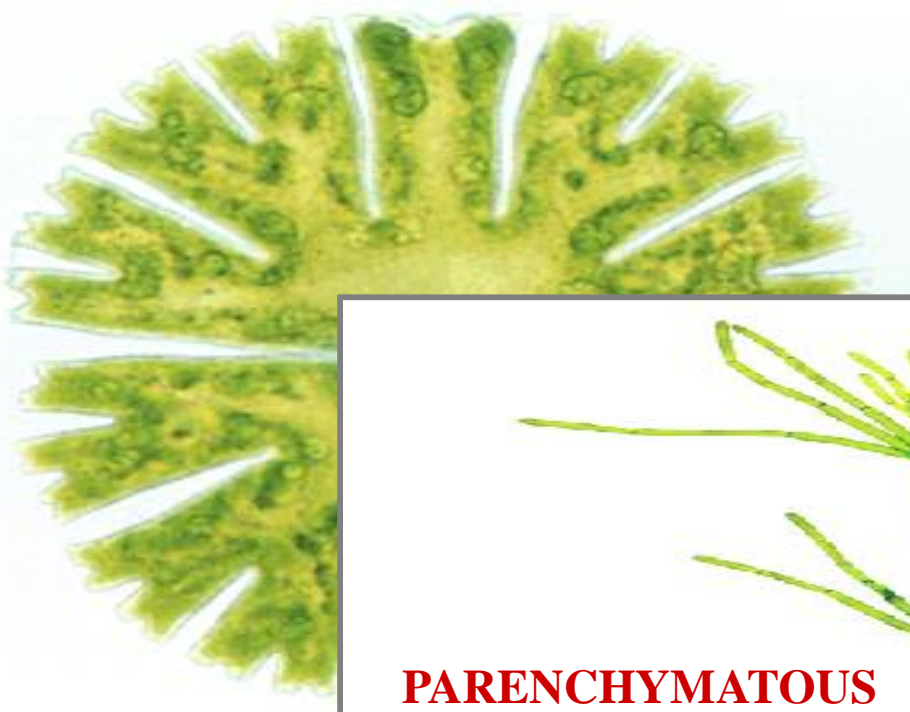
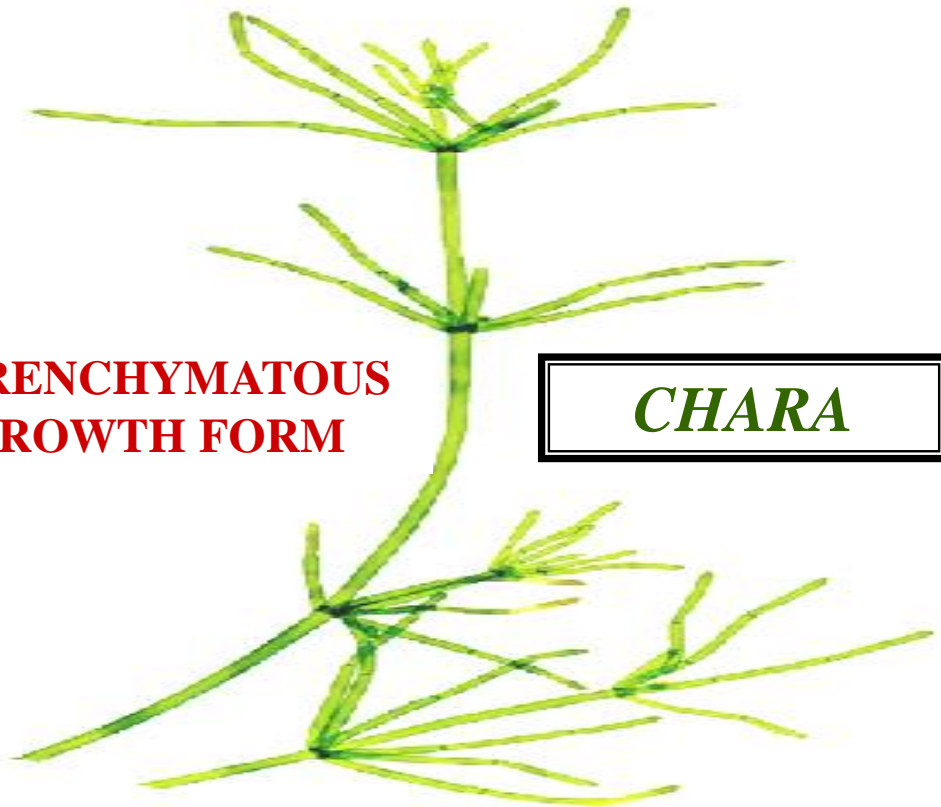


CHAROPHYCEAE GROWTH FORM



**PARENCHYMATOUS
GROWTH FORM**

CHARA



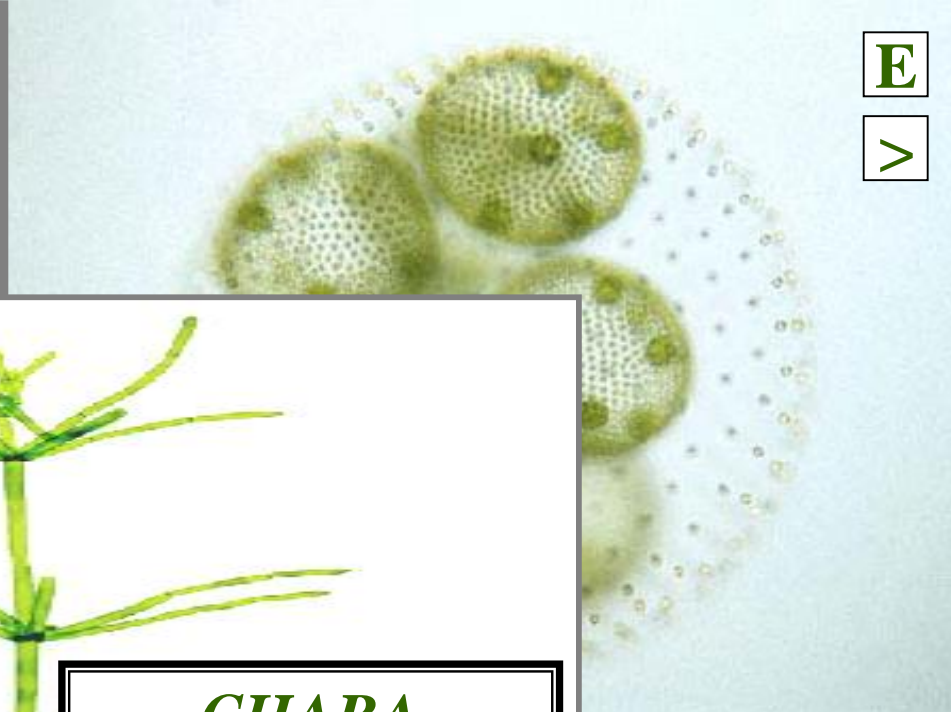
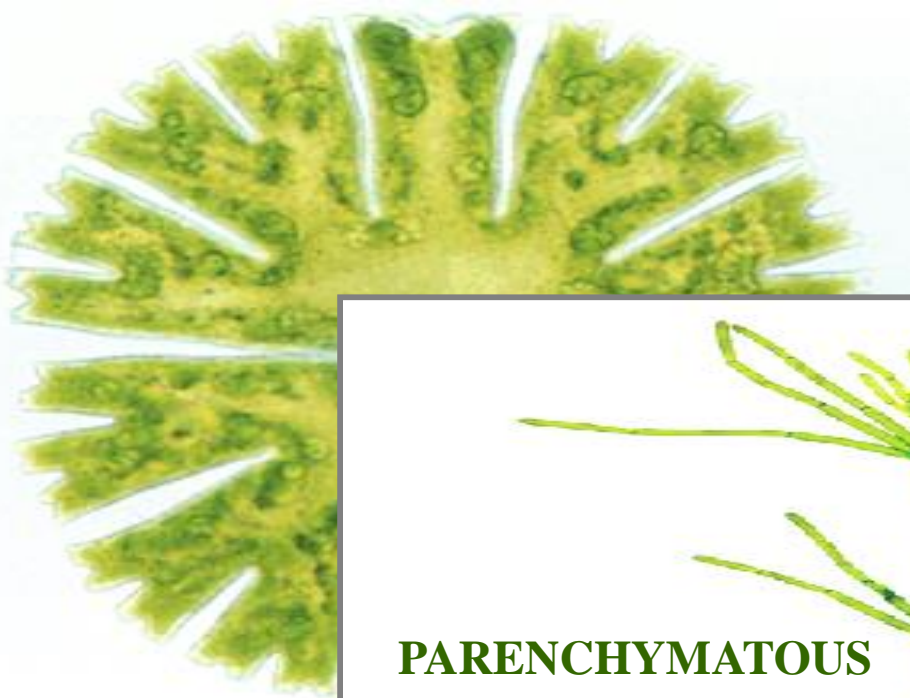
PARENCHYMATOUS

PARENCHYMATOUS GROWTH FORM



**MULTICELLULAR
3D PLANT THALLUS**

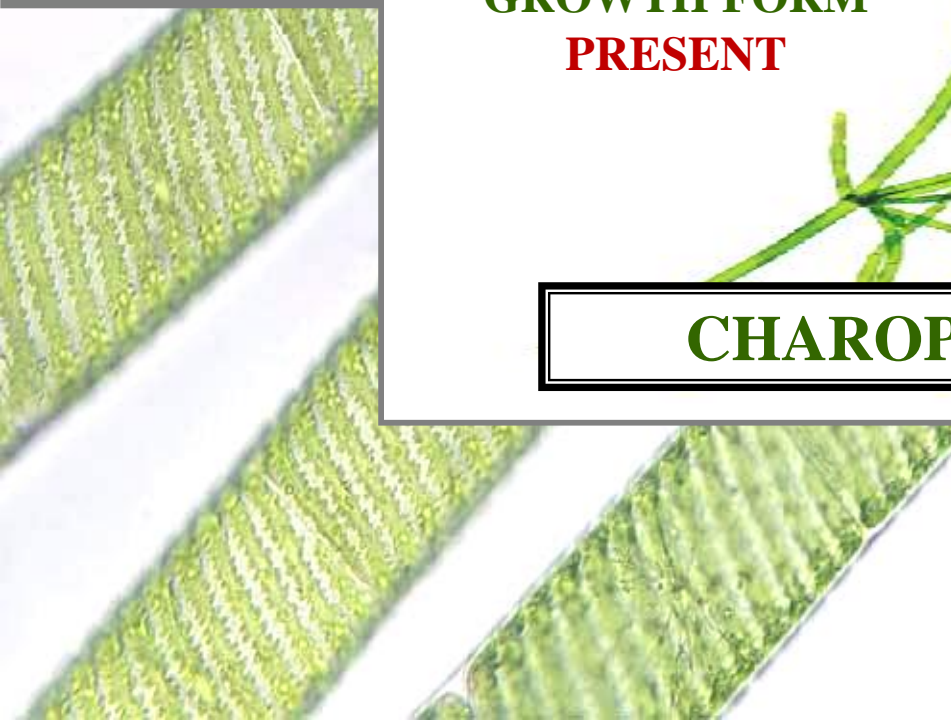
**PARENCHYMATOUS
GROWTH FORM**



**PARENCHYMATOUS
GROWTH FORM
PRESENT**

CHARA

CHAROPHYCEAE





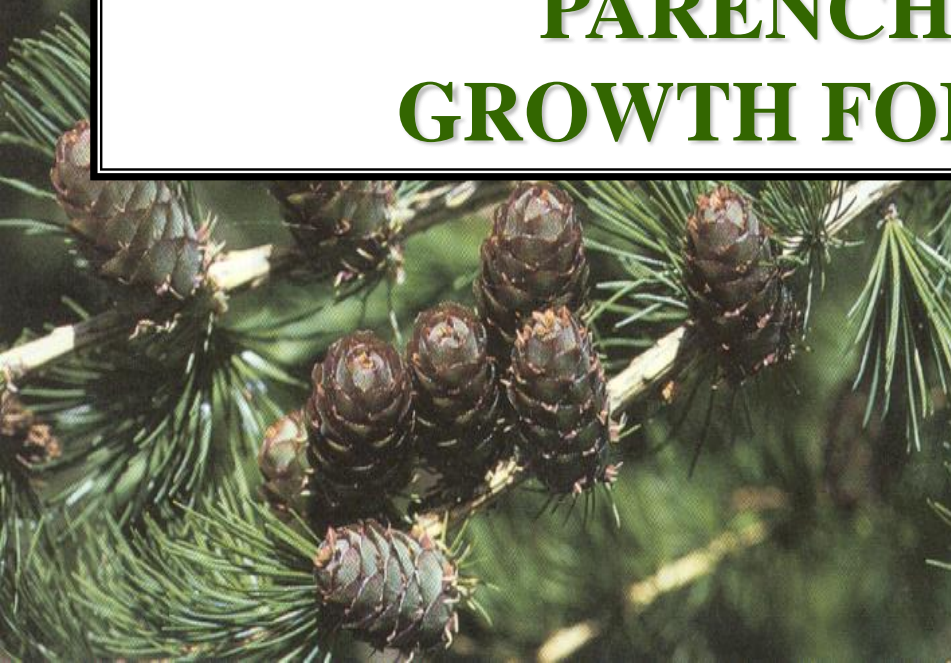
VP

+

EMBRYOPHYTES

PARENCHYMATOUS

GROWTH FORM: **PRESENT**



VASCULAR PLANT EVOLUTION

VASCULAR PLANT EVOLUTION

CYANOPHYTA

ENDOSYMBIOTIC
THEORY

CHLOROPHYTA

PHYCOPLAST ABSENT
PHRAGMOPLAST ABSENT
FLAGELLA APICAL

ULVOPHYCEAE

PHYCOPLAST PRESENT
PHRAGMOPLAST ABSENT
FLAGELLA APICAL

CHLOROPHYCEAE

PHYCOPLAST ABSENT
PHRAGMOPLAST PRESENT
FLAGELLA SUBAPICAL

CHAROPHYCEAE

PARENCHYMATOUS
GROWTH FORM
IDENTICAL WITH
EMBRYOPHYTES

EMBRYOPHYTES



CHLOROPHYTA

CHLOROPLASTS



1 CHLOROPLAST/CELL

MICRASTERIAS



1 CHLOROPLAST/CELL

VOLVOX



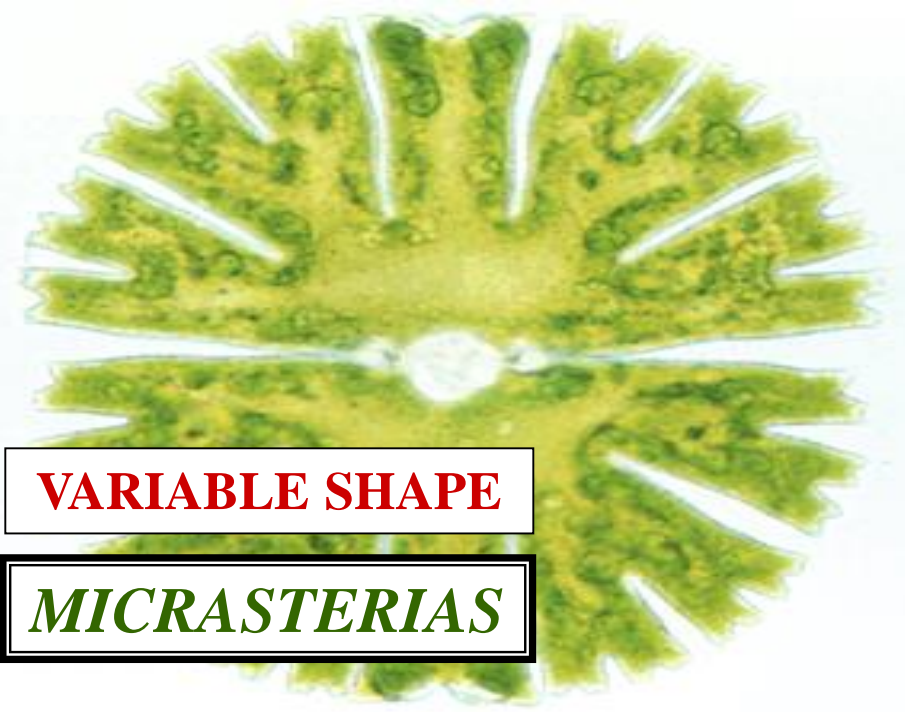
1 CHLOROPLAST/CELL

SPIROGYRA



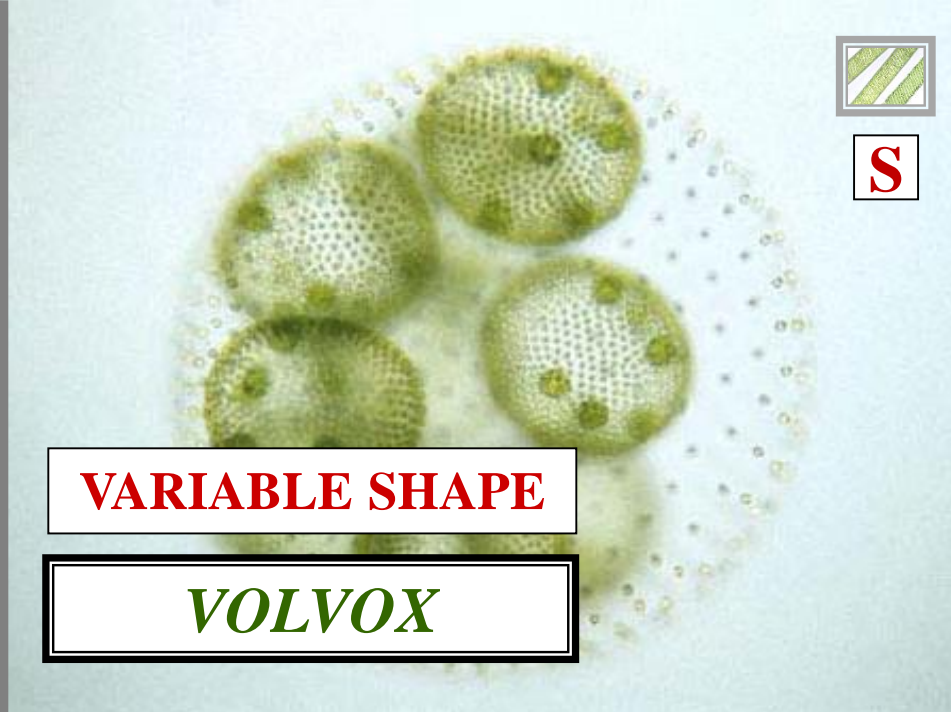
1 CHLOROPLAST/CELL

ULVA



VARIABLE SHAPE

MICRASTERIAS



VARIABLE SHAPE

VOLVOX



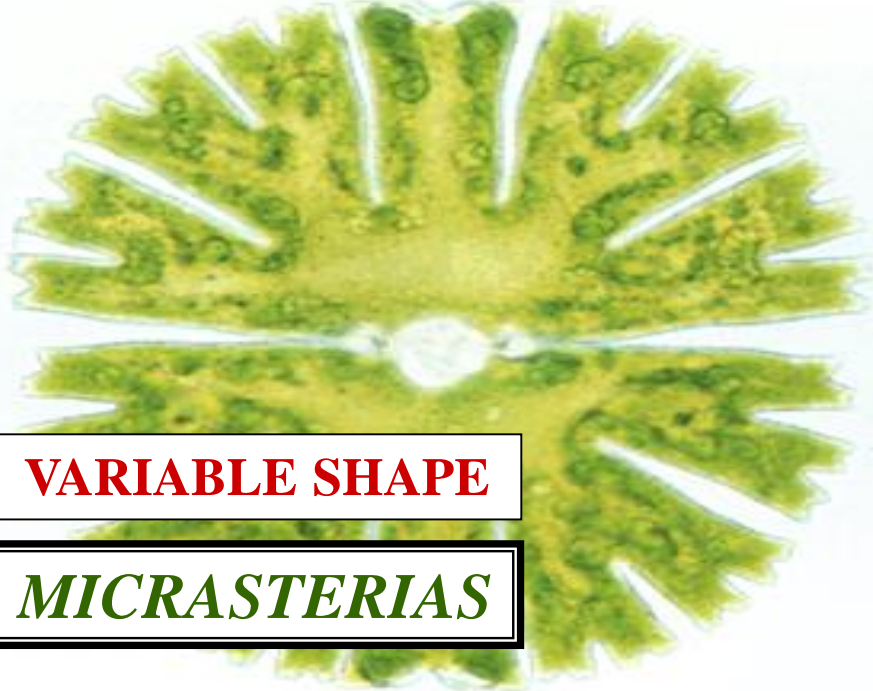
VARIABLE SHAPE

SPIROGYRA



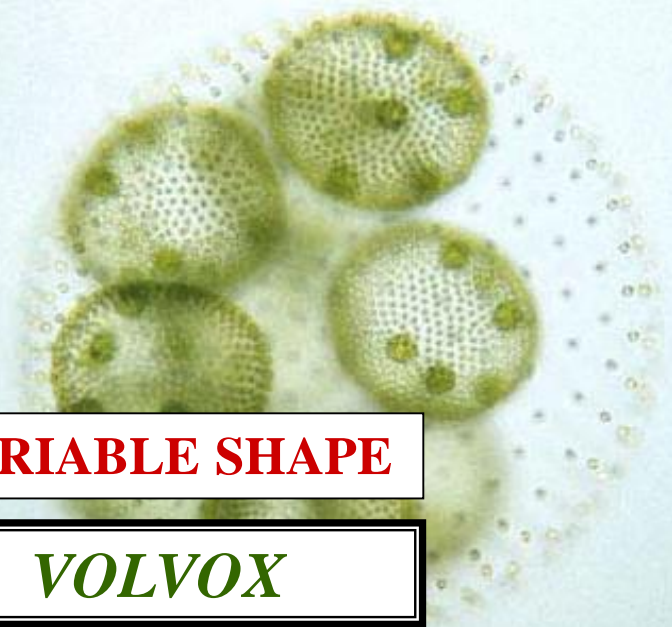
VARIABLE SHAPE

ULVA



VARIABLE SHAPE

MICRASTERIAS



VARIABLE SHAPE

VOLVOX



SPIRAL SHAPE

SPIROGYRA

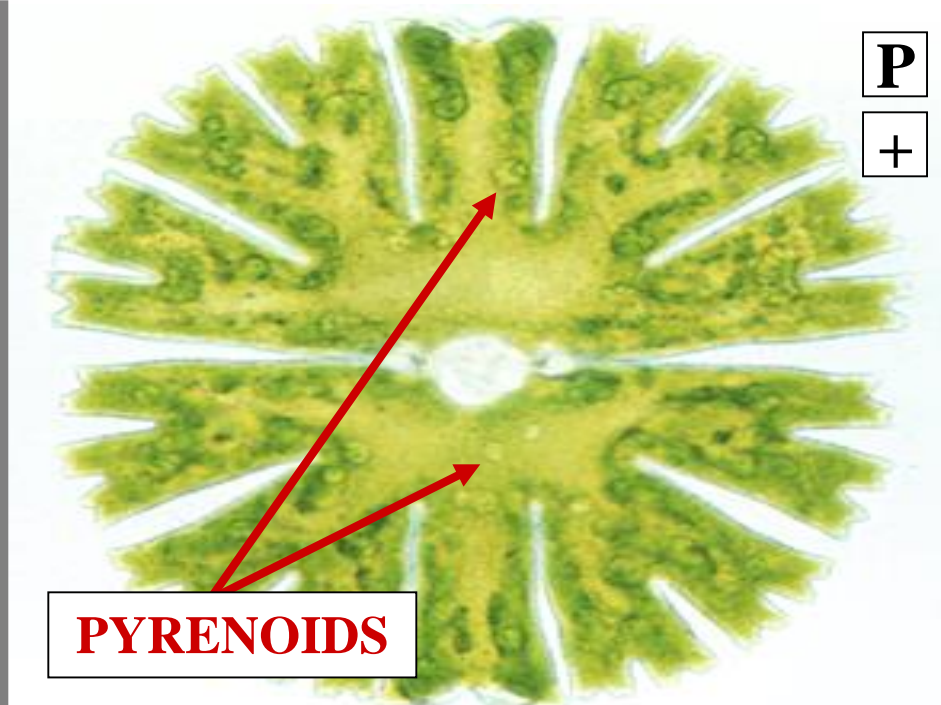


VARIABLE SHAPE

ULVA



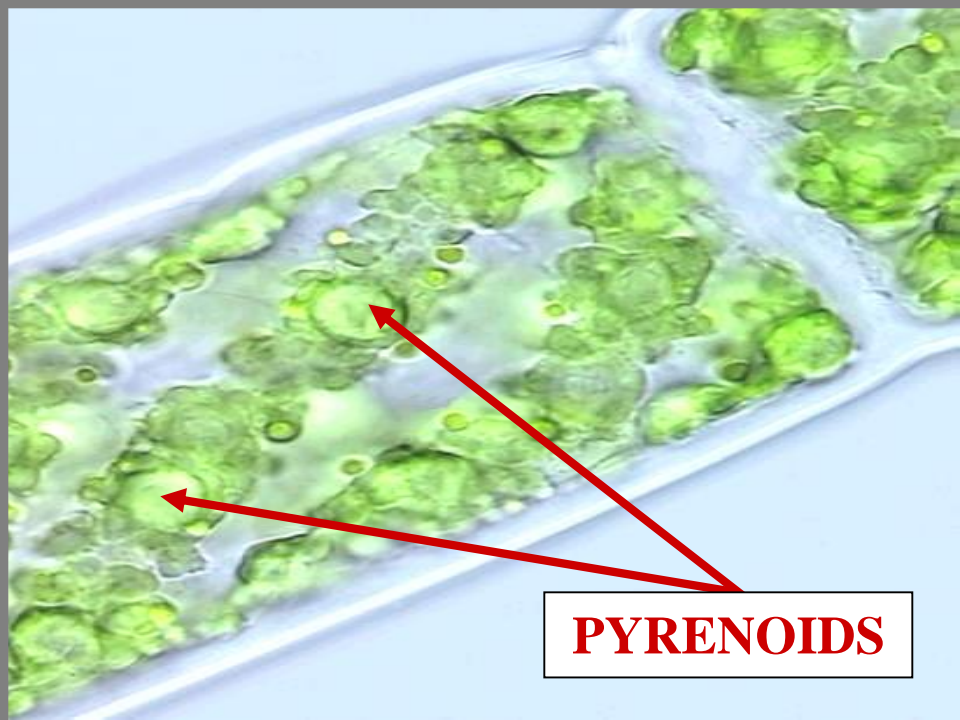
MICRASTERIAS



PYRENOIDS



SPIROGYRA



PYRENOIDS

PYRENOID



PYRENOID

**COVERTS GLUCOSE
TO STARCH**

PYRENOID

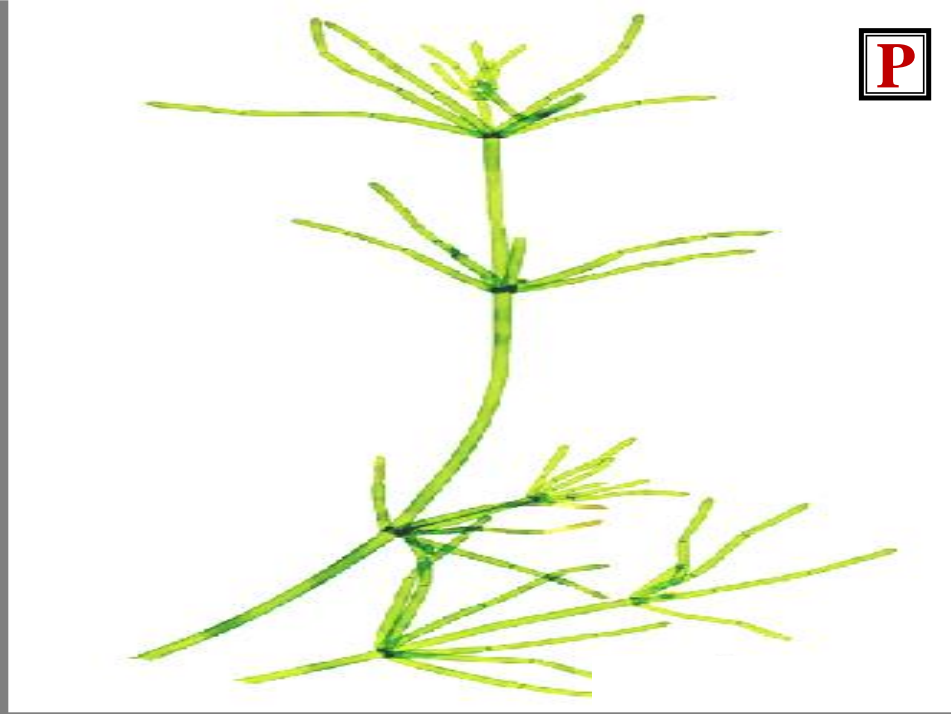
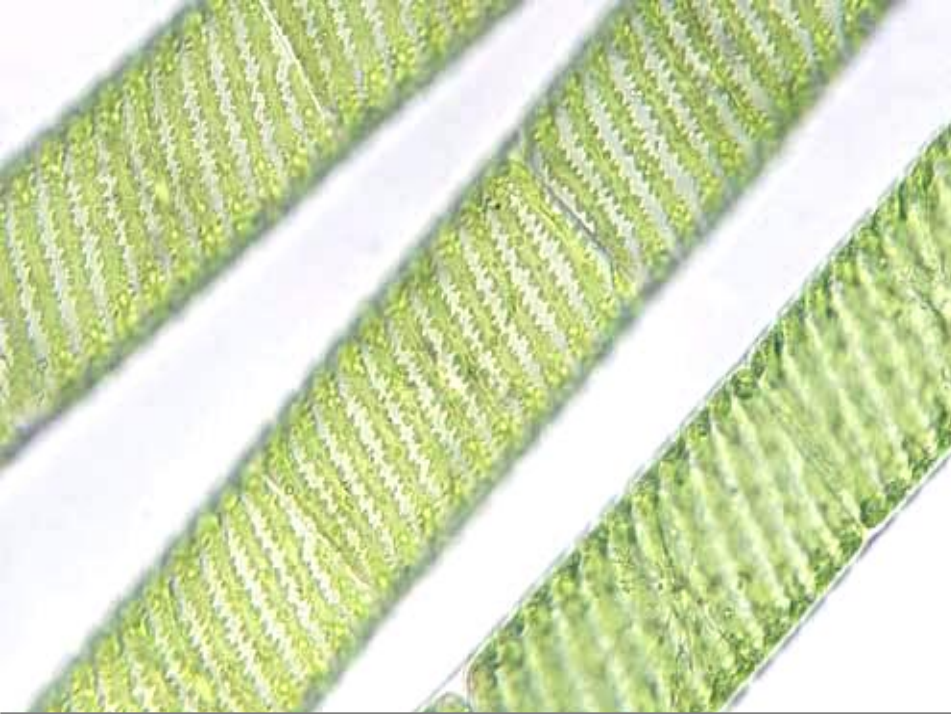


PYRENOID

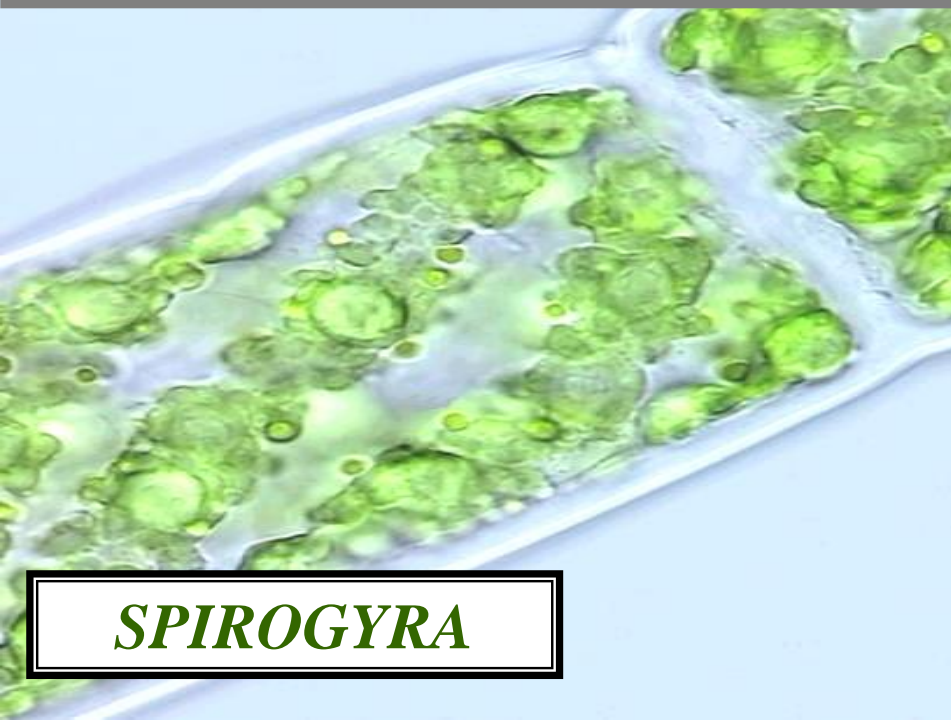
**COVERTS GLUCOSE
TO STARCH**

PRESENT OR ABSENT

PYRENOID

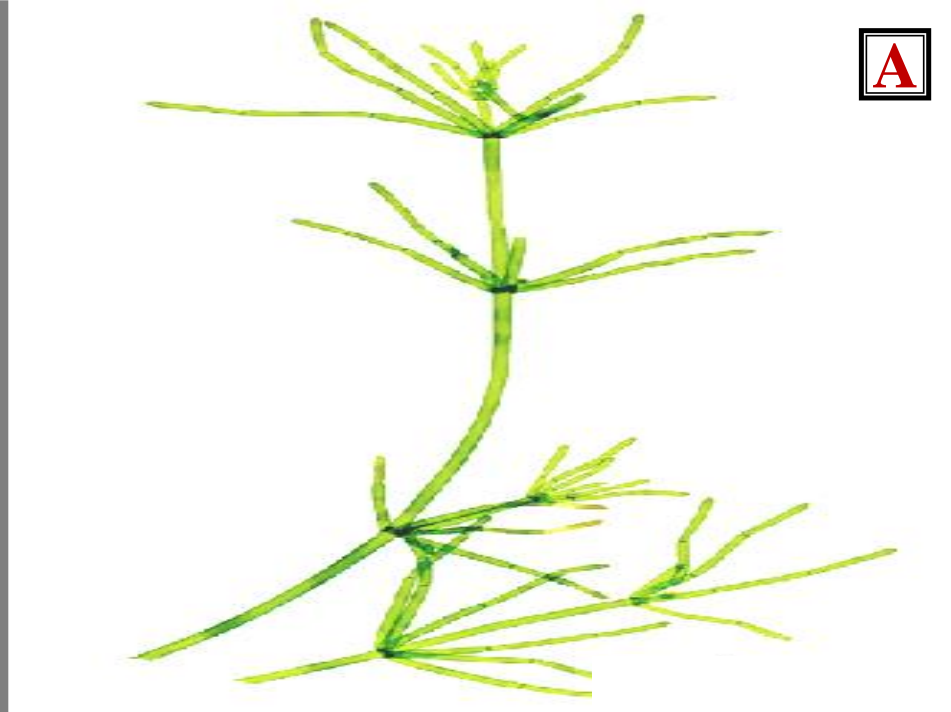
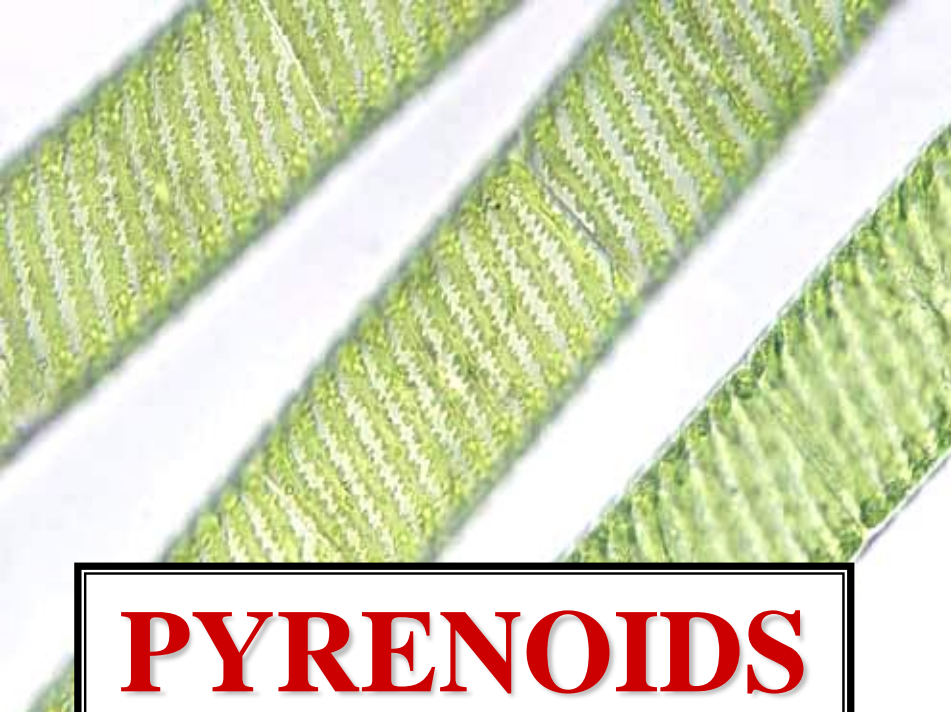


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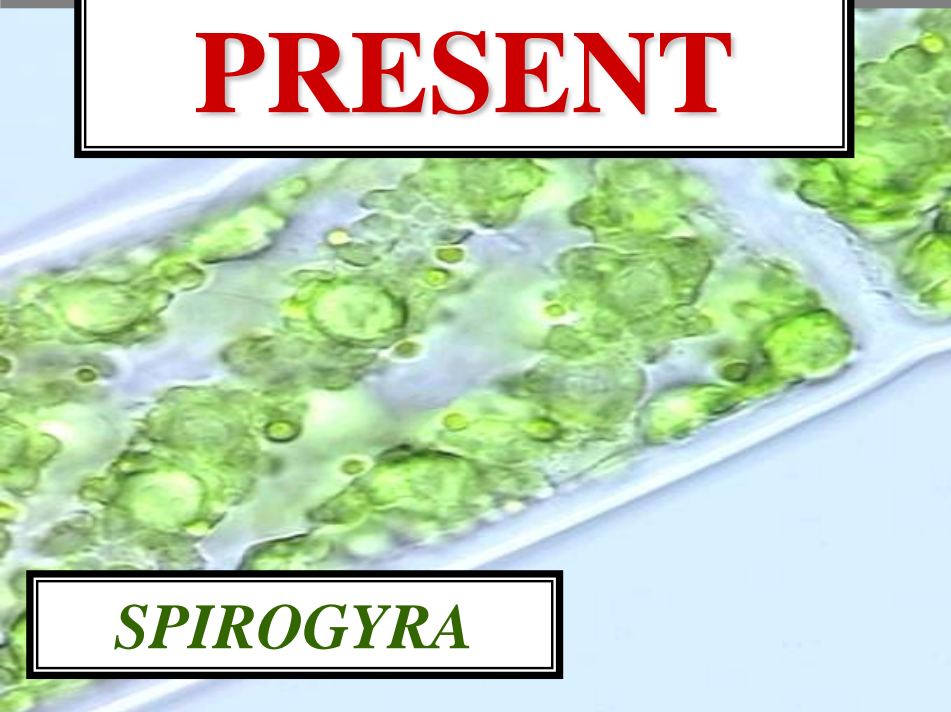


SPIROGYRA

CHARA



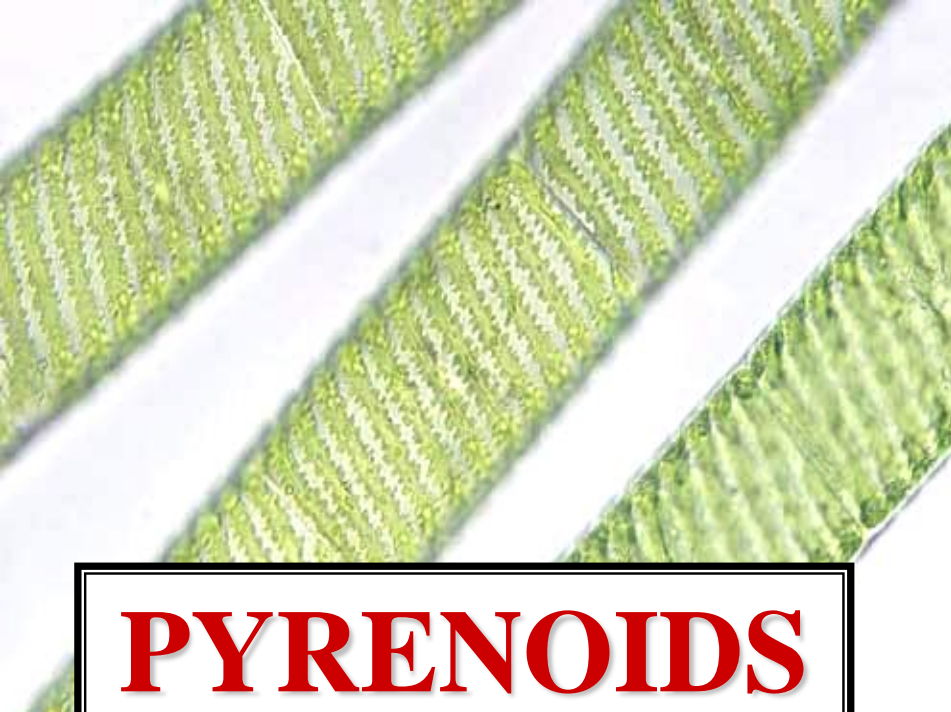
**PYRENOIDS
PRESENT**



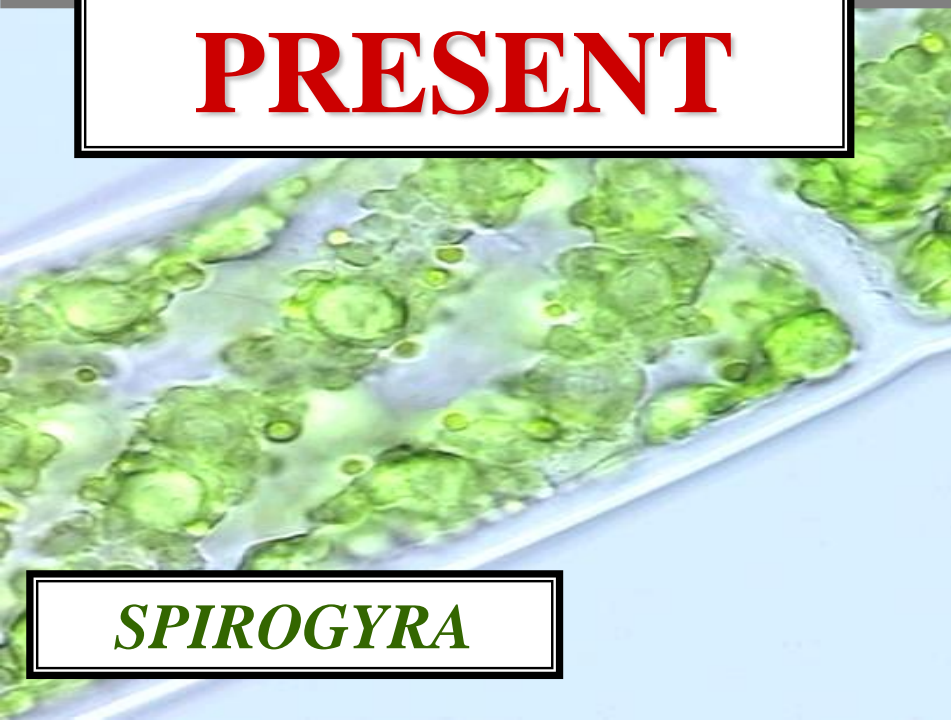
SPIROGYRA



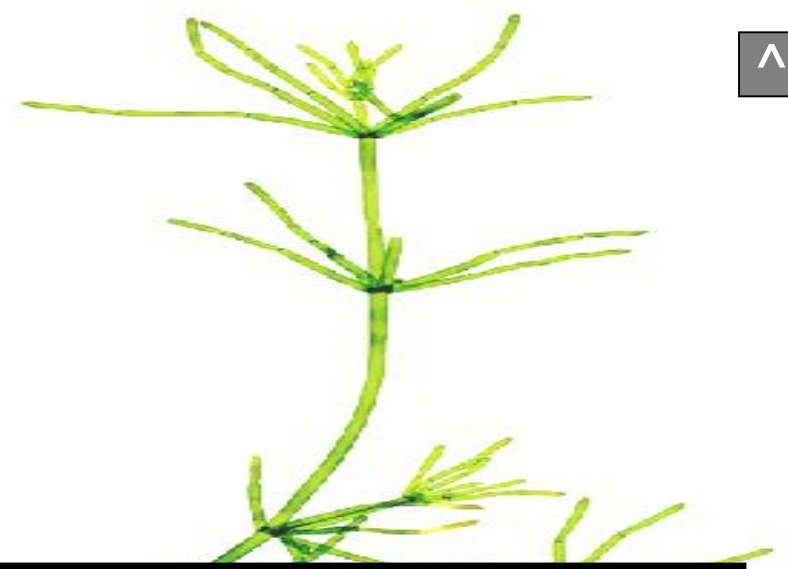
CHARA



**PYRENOIDS
PRESENT**



SPIROGYRA



**PYRENOIDS
ABSENT**



CHARA





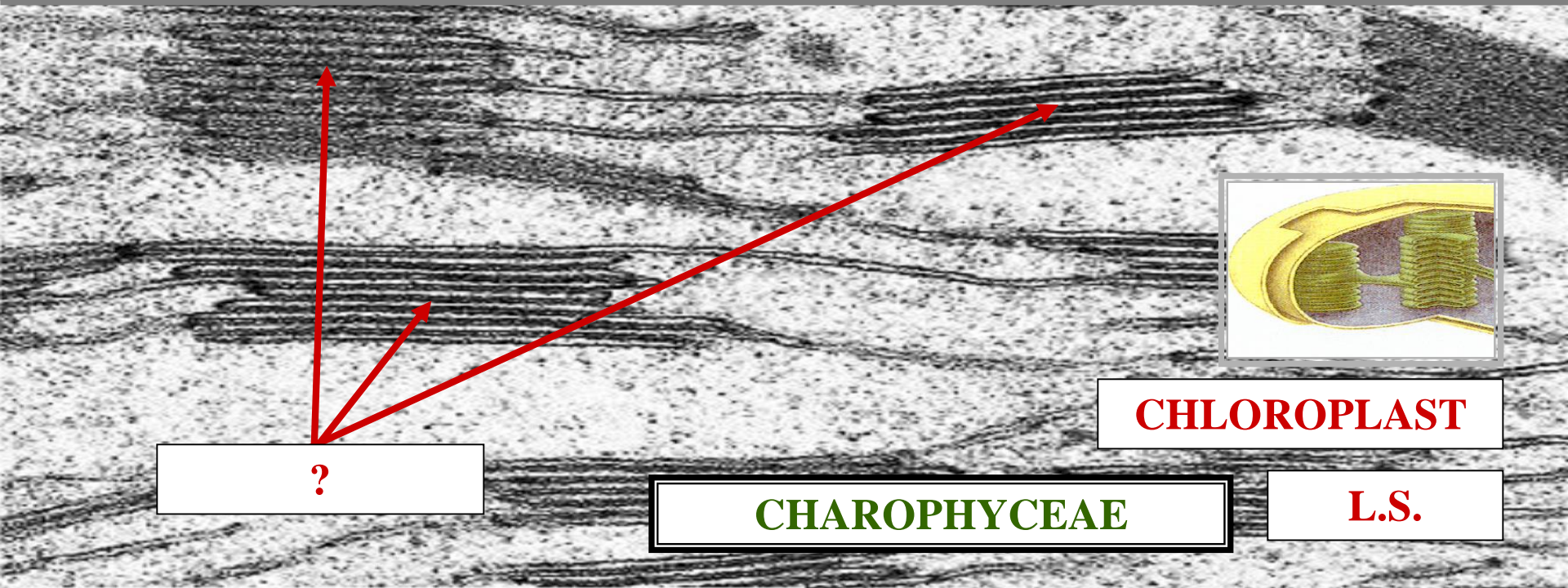
CHAROPHYCEAE

CHLOROPLASTS

CHARA



COLEOCHAETE

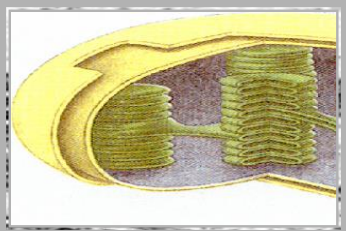


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CHAROPHYCEAE

CHLOROPLAST

L.S.



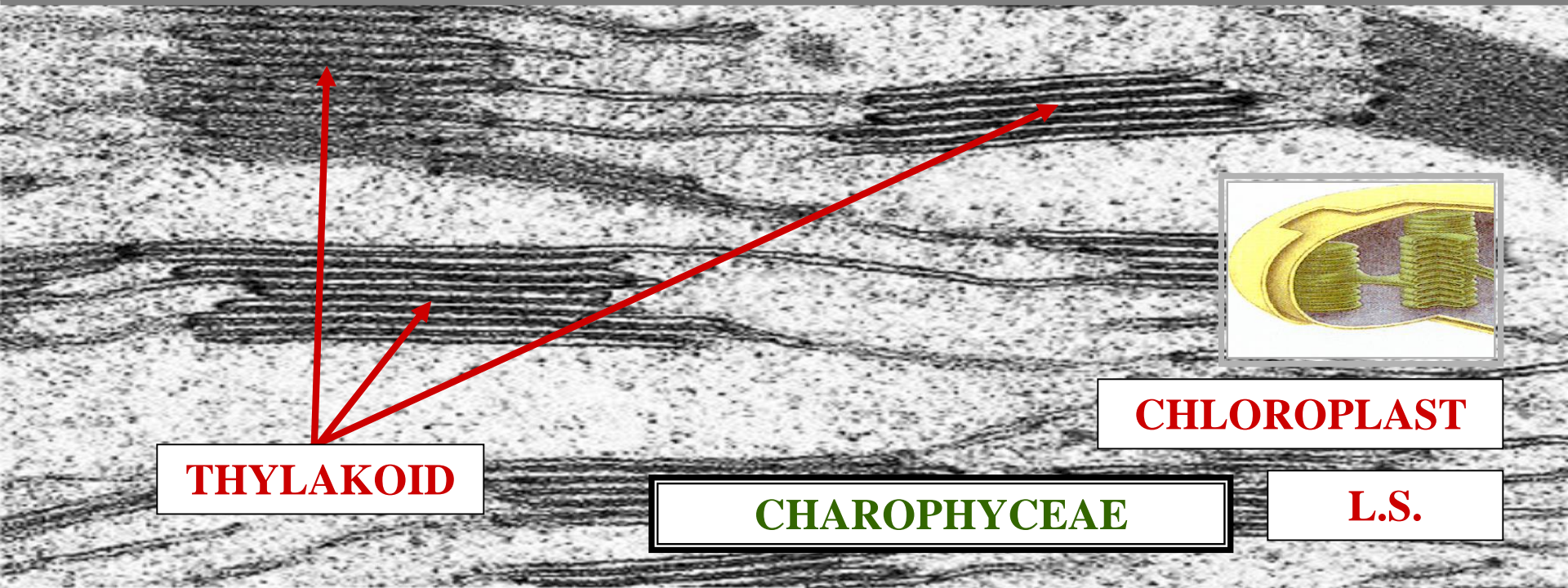
CHARA



?



COLEOCHAETE



THYLAKOID

CHAROPHYCEAE

CHLOROPLAST

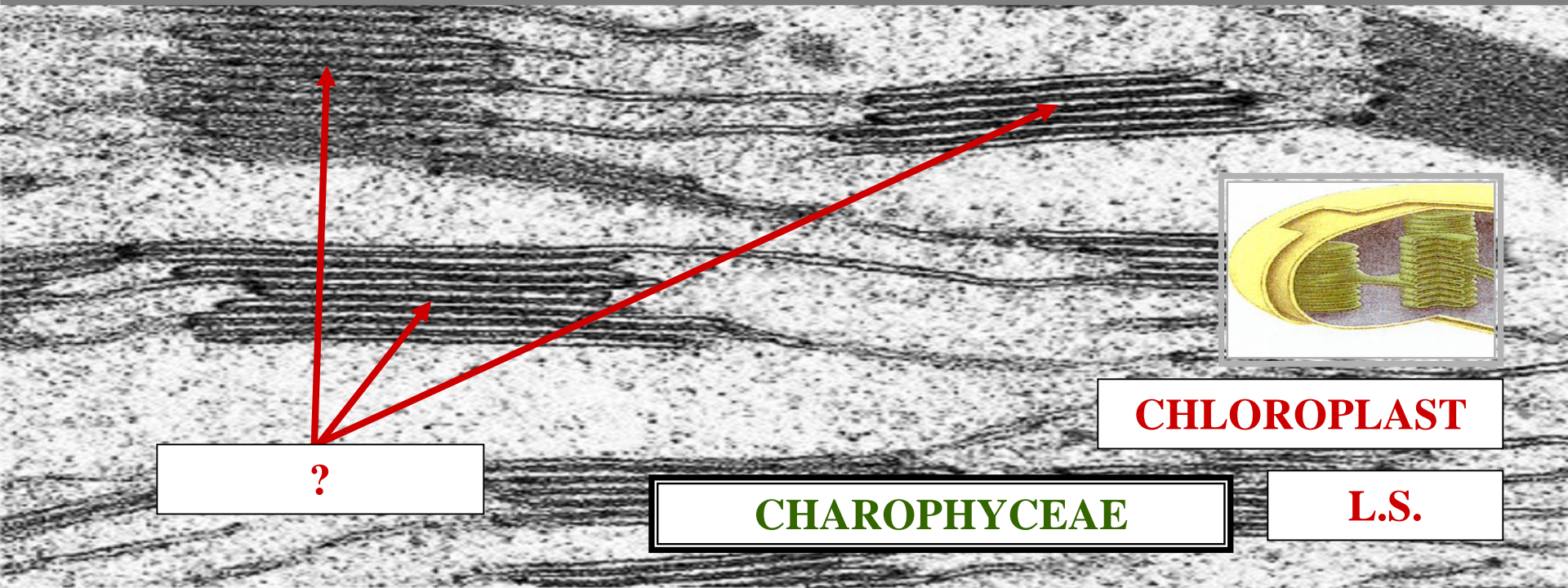
L.S.

G

CHARA



COLEOCHAETE



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CHAROPHYCEAE

CHLOROPLAST

L.S.

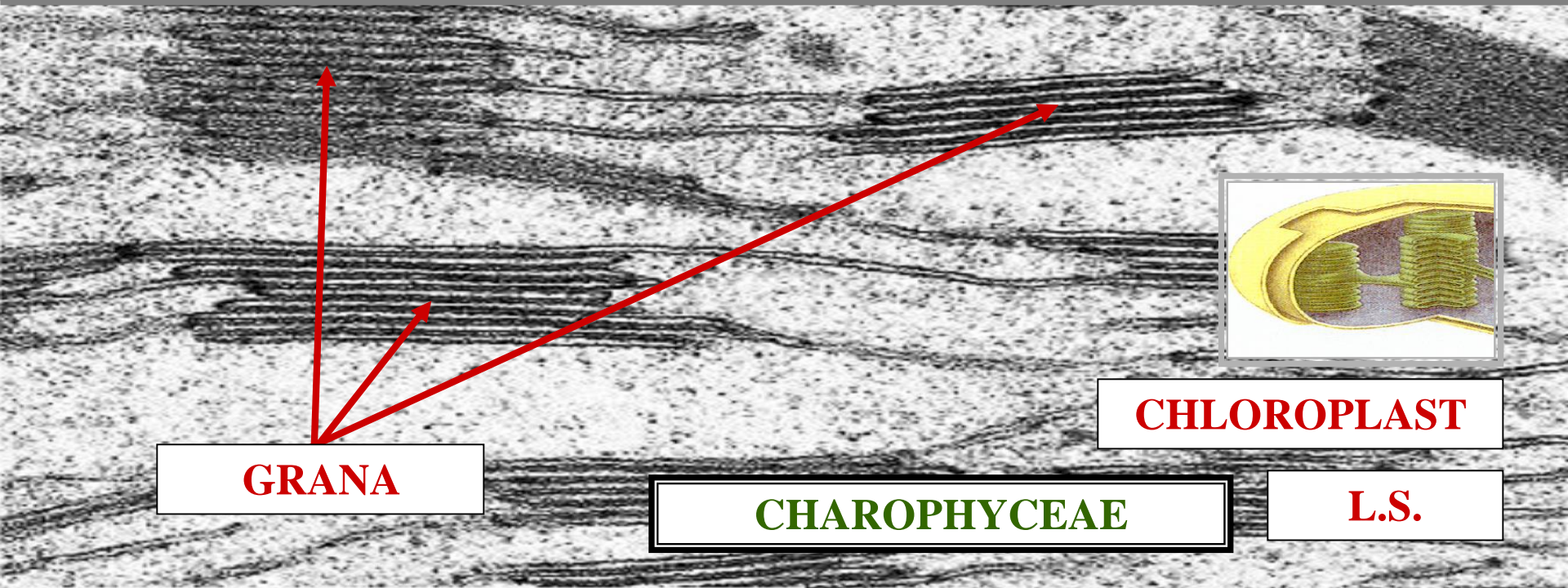
CHARA



G

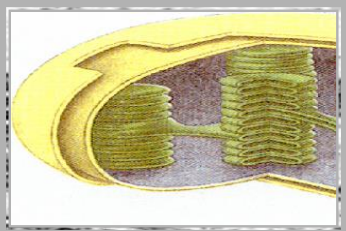


COLEOCHAETE



GRANA

CHAROPHYCEAE



CHLOROPLAST

L.S.

GRANA

GRANA



**STACKED
THYLAKOID VESICLES**

GRANA

GRANA



STACKED

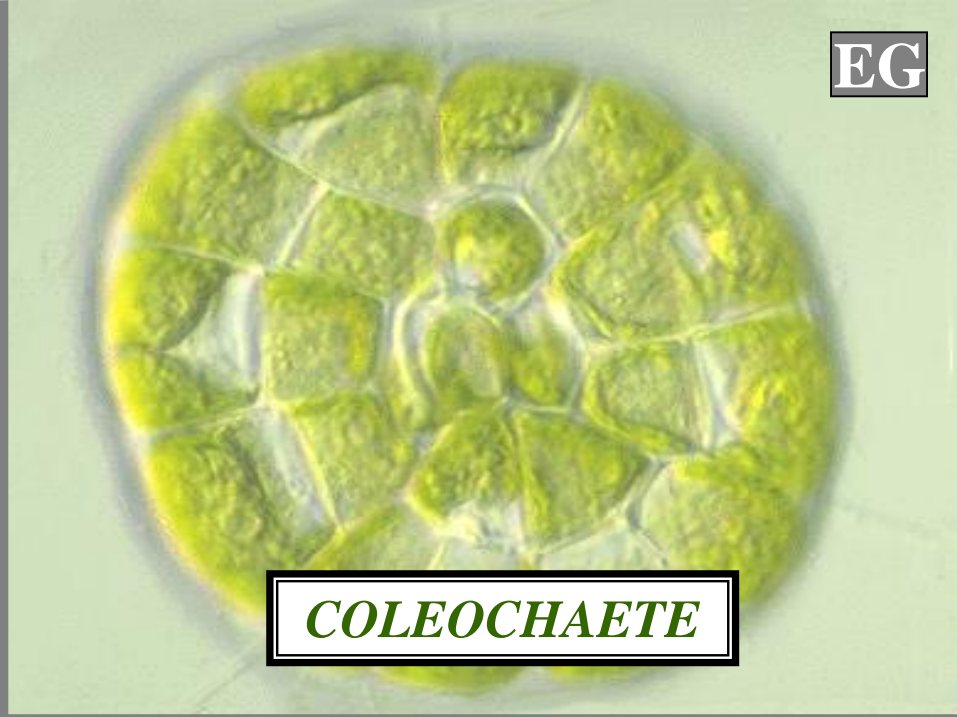
THYLAKOID VESICLES

RESTRICTED

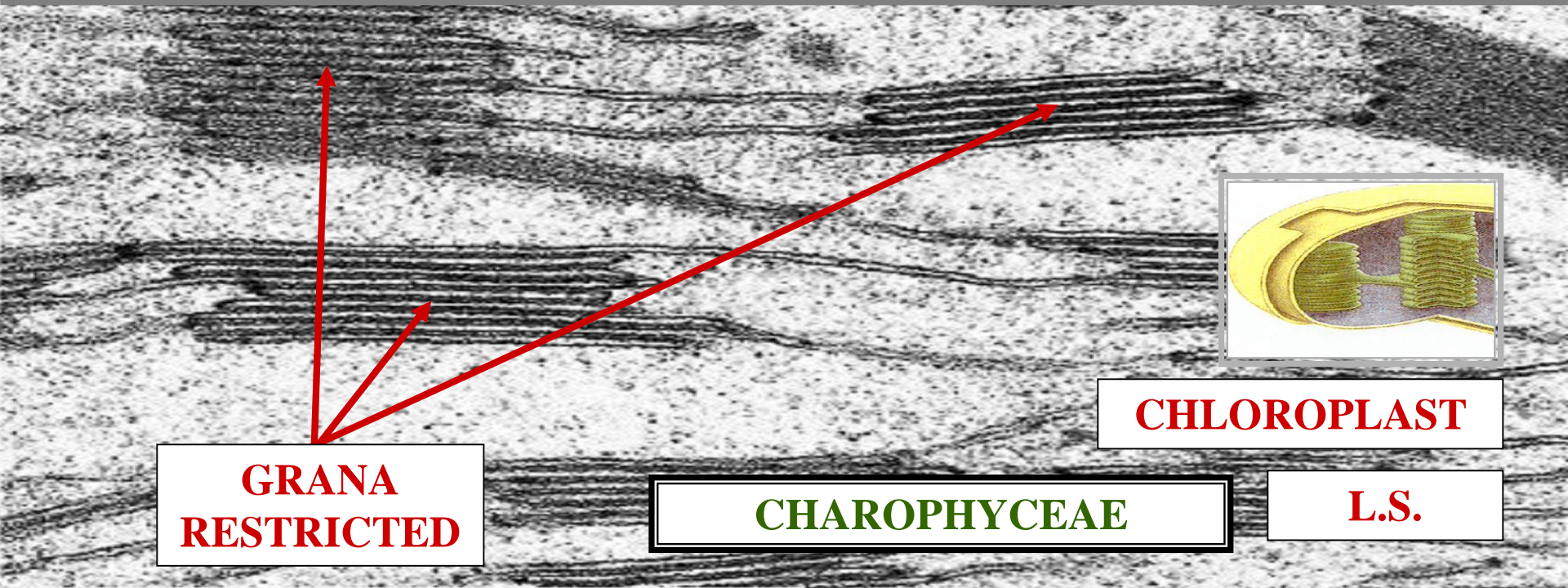
CHAROPHYCEAE

GRANA

CHARA

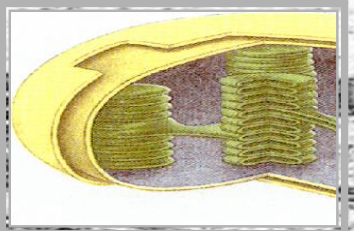


COLEOCHAETE



**GRANA
RESTRICTED**

CHAROPHYCEAE



CHLOROPLAST

L.S.

CHAROPHYCEAE

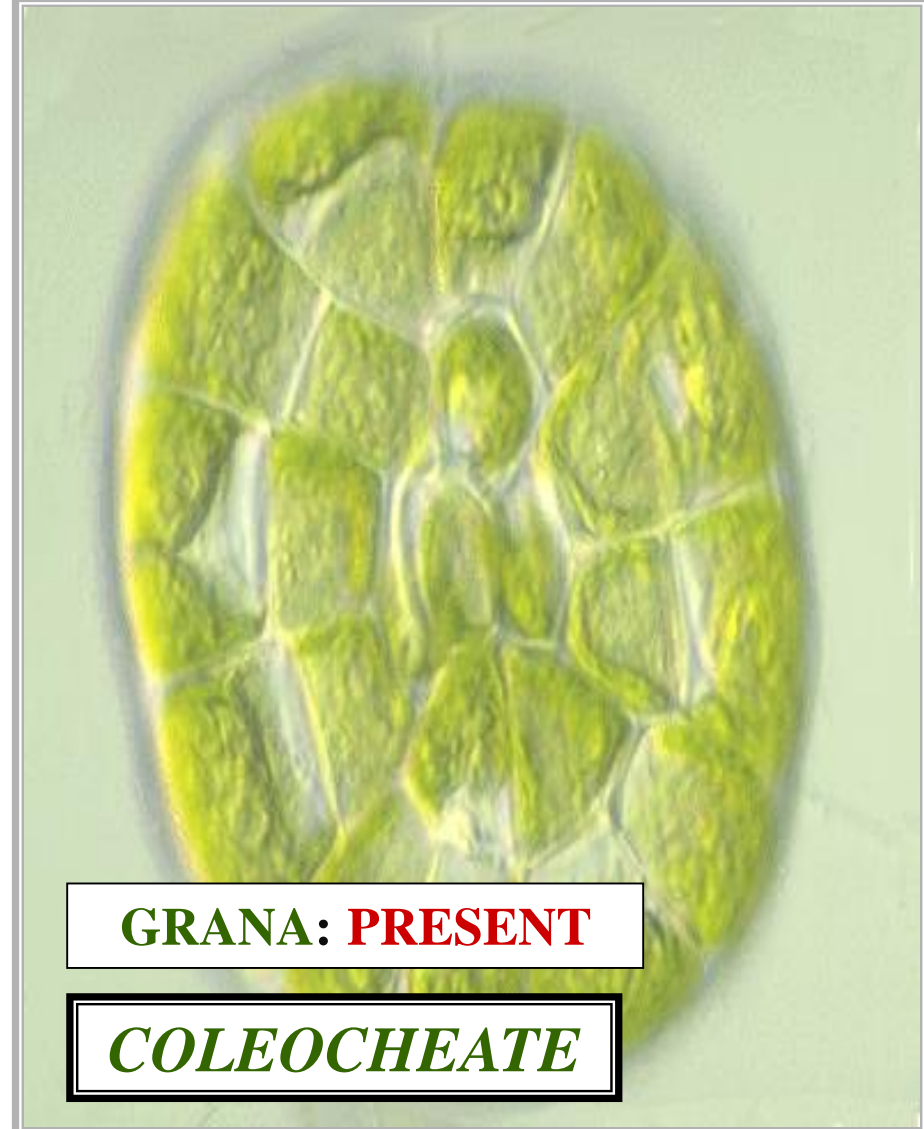
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GRANA: PRESENT

CHARA



GRANA: PRESENT

COLEOCHEATE

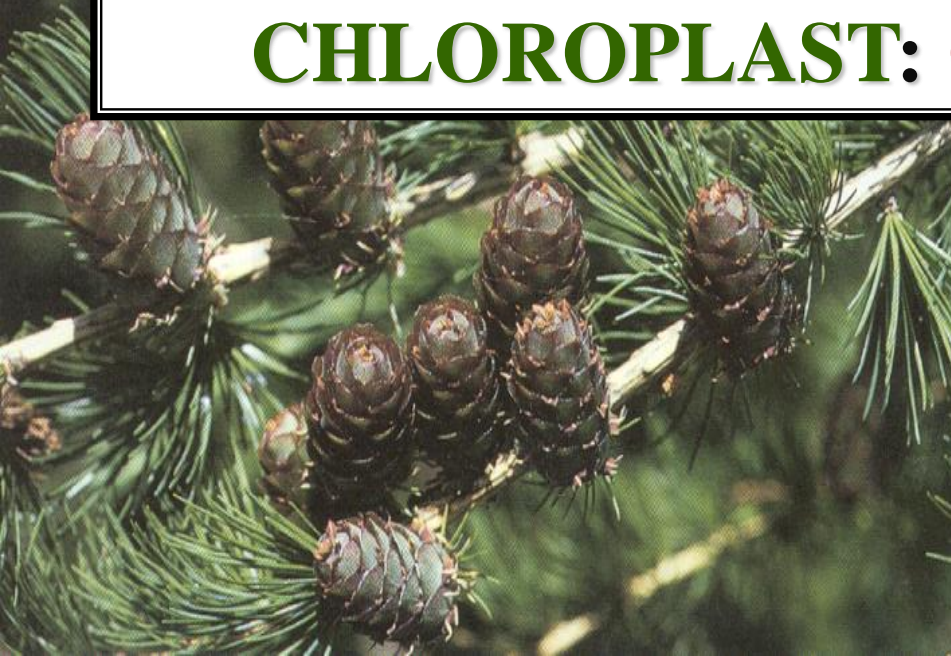


VP

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EMBRYOPHYTES

CHLOROPLAST: **GRANA PRESENT**



VASCULAR PLANT EVOLUTION

VASCULAR PLANT EVOLUTION

CYANOPHYTA

ENDOSYMBIOTIC
THEORY

CHLOROPHYTA

PHYCOPLAST ABSENT
PHRAGMOPLAST ABSENT
FLAGELLA APICAL

ULVOPHYCEAE

PHYCOPLAST PRESENT
PHRAGMOPLAST ABSENT
FLAGELLA APICAL

CHLOROPHYCEAE

PHYCOPLAST ABSENT
PHRAGMOPLAST PRESENT
FLAGELLA SUBAPICAL

CHAROPHYCEAE

CHLOROPLAST GRANA
IDENTICAL WITH
EMBRYOPHYTES

EMBRYOPHYTES





CHLOROPHYTA

KARYOKINESIS

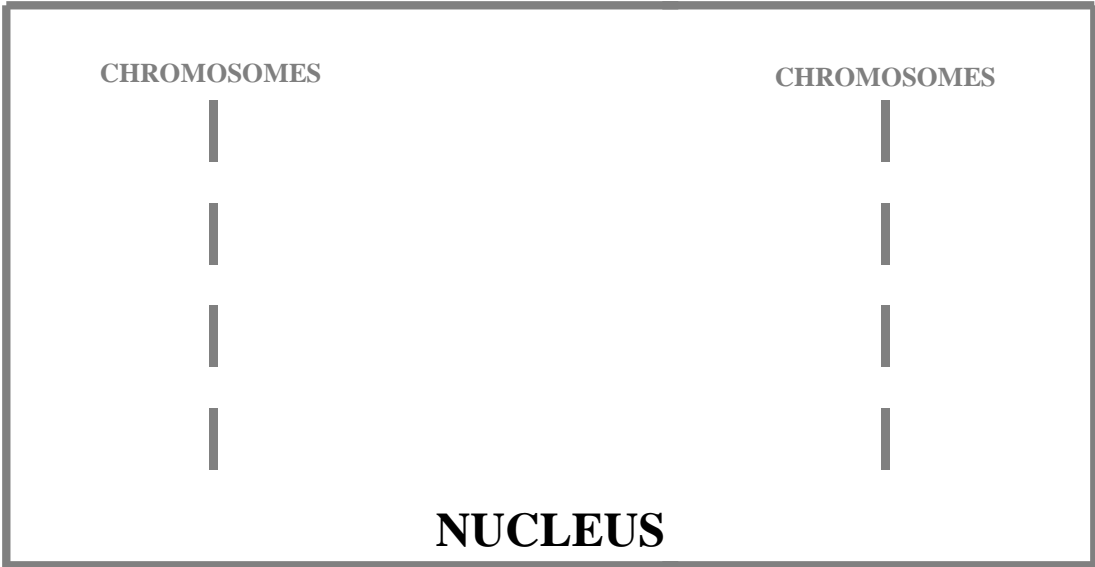





CHLOROPHYCEAE

KARYOKINESIS

CHLOROPHYCEAE

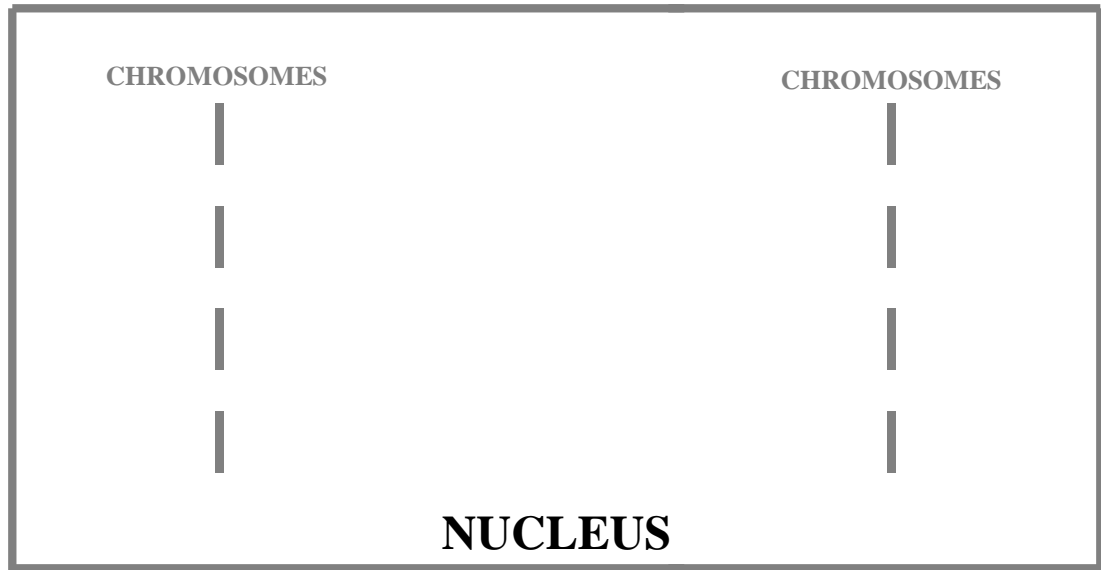
KARYOKINESIS



-  = CELL MEMBRANE
-  = NUCLEAR MEMBRANE
-  = MICROTUBULE

CHLOROPHYCEAE

KARYOKINESIS

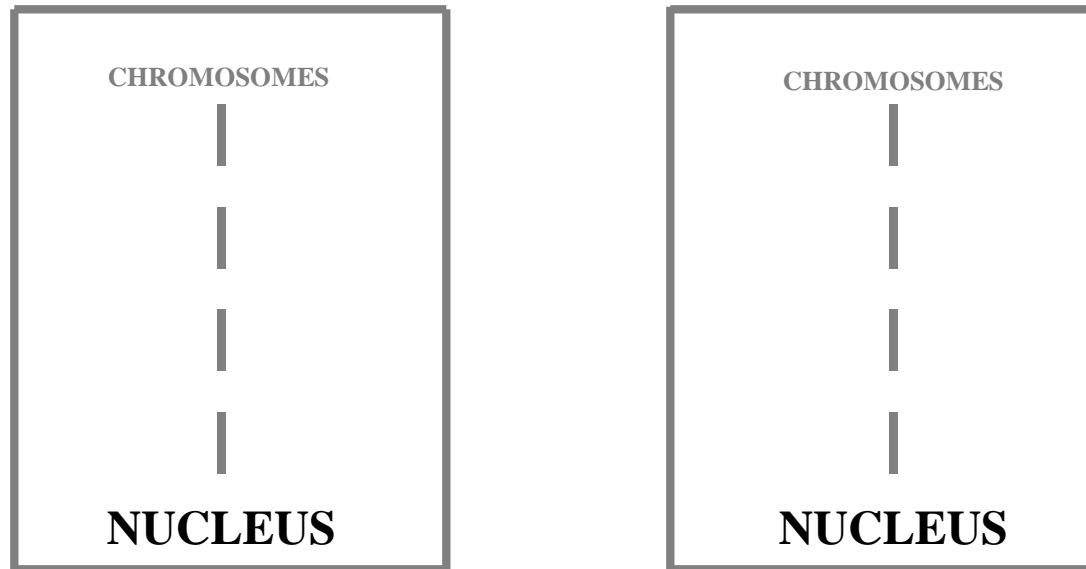


PERSISTENT NUCLEAR MEMBRANE

-  = CELL MEMBRANE
-  = NUCLEAR MEMBRANE
-  = MICROTUBULE

CHLOROPHYCEAE

KARYOKINESIS

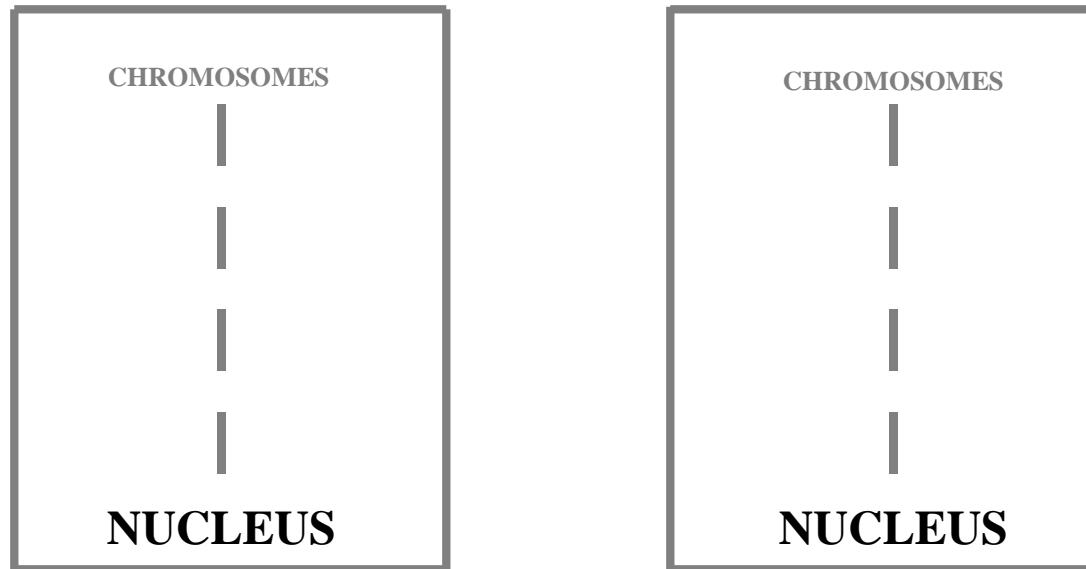


PERSISTENT NUCLEAR MEMBRANE

-  = CELL MEMBRANE
-  = NUCLEAR MEMBRANE
-  = MICROTUBULE

CHLOROPHYCEAE

KARYOKINESIS



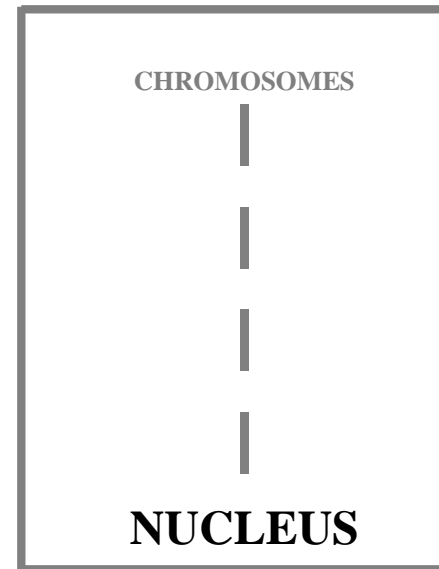
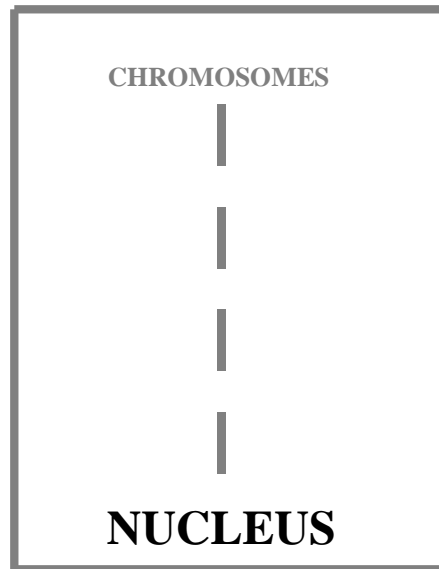
PERSISTENT NUCLEAR MEMBRANE
KARYOKINESIS SPINDLE ABSENT

— = CELL MEMBRANE
— = NUCLEAR MEMBRANE
— = MICROTUBULE

CHLOROPHYCEAE



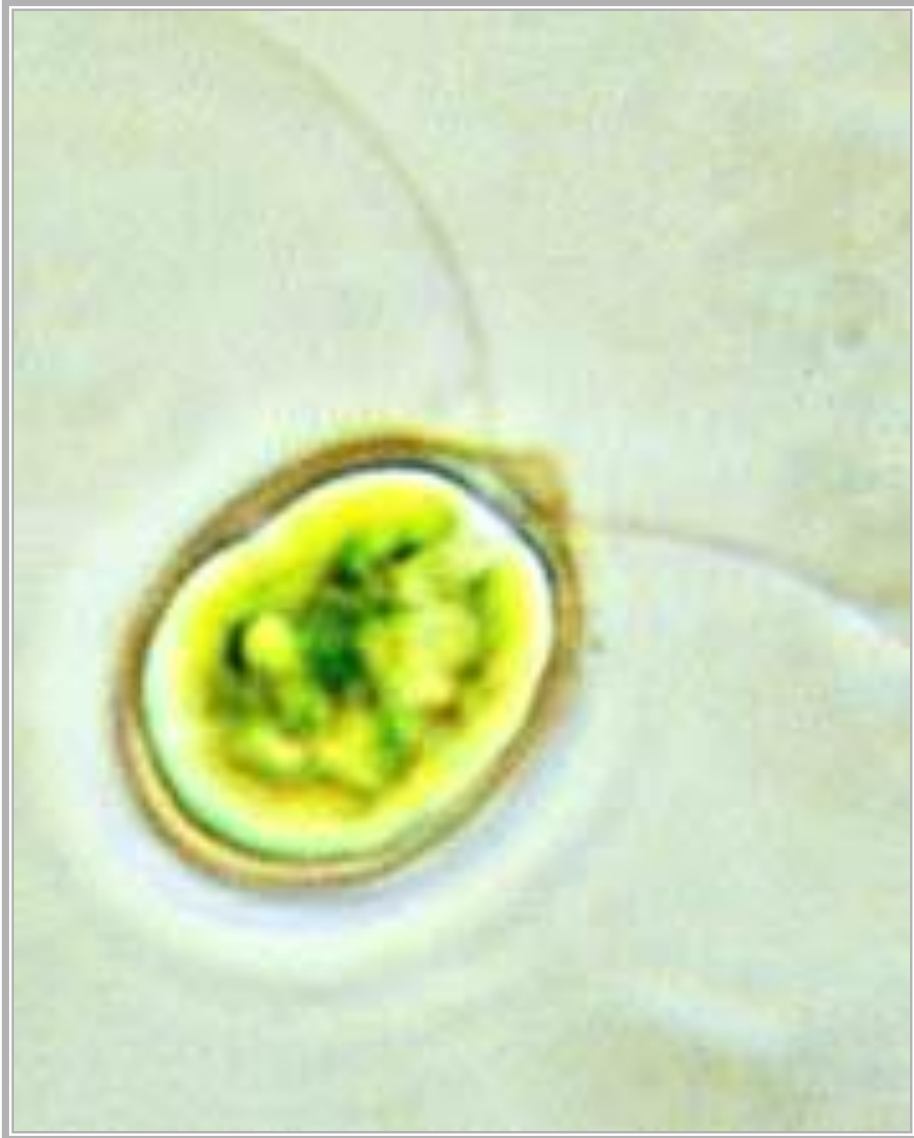
KARYOKINESIS



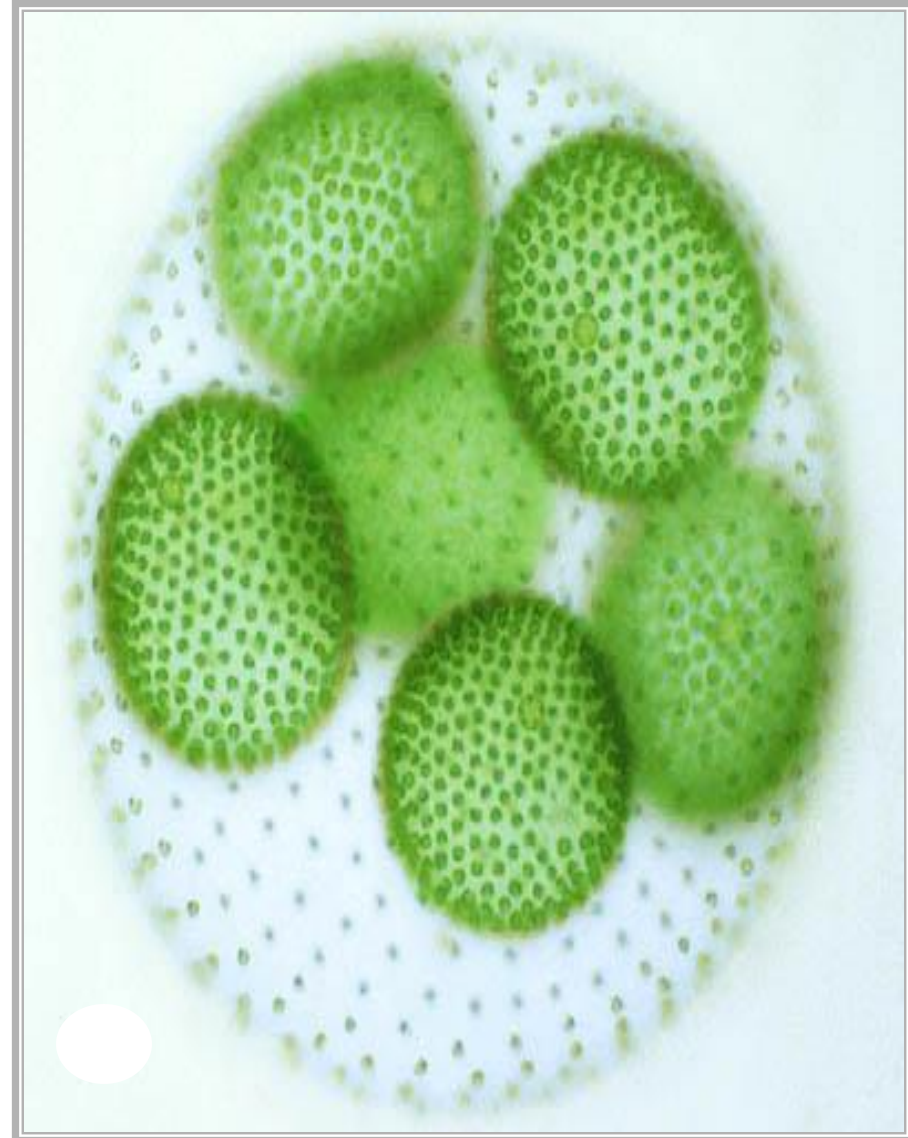
PERSISTENT NUCLEAR MEMBRANE
KARYOKINESIS SPINDLE ABSENT
DAUGHTER NUCLEI CLOSE

 = CELL MEMBRANE
 = NUCLEAR MEMBRANE
 = MICROTUBULE

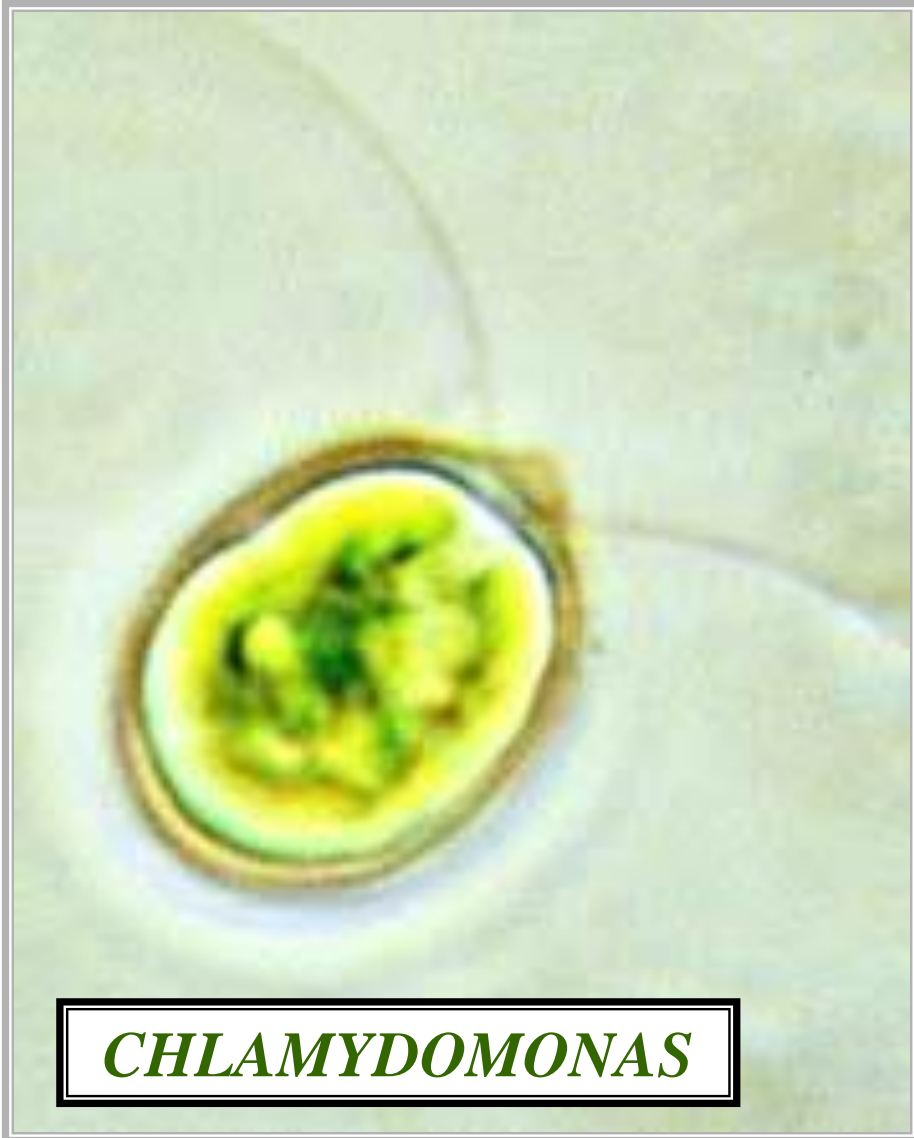
CHLOROPHYCEAE



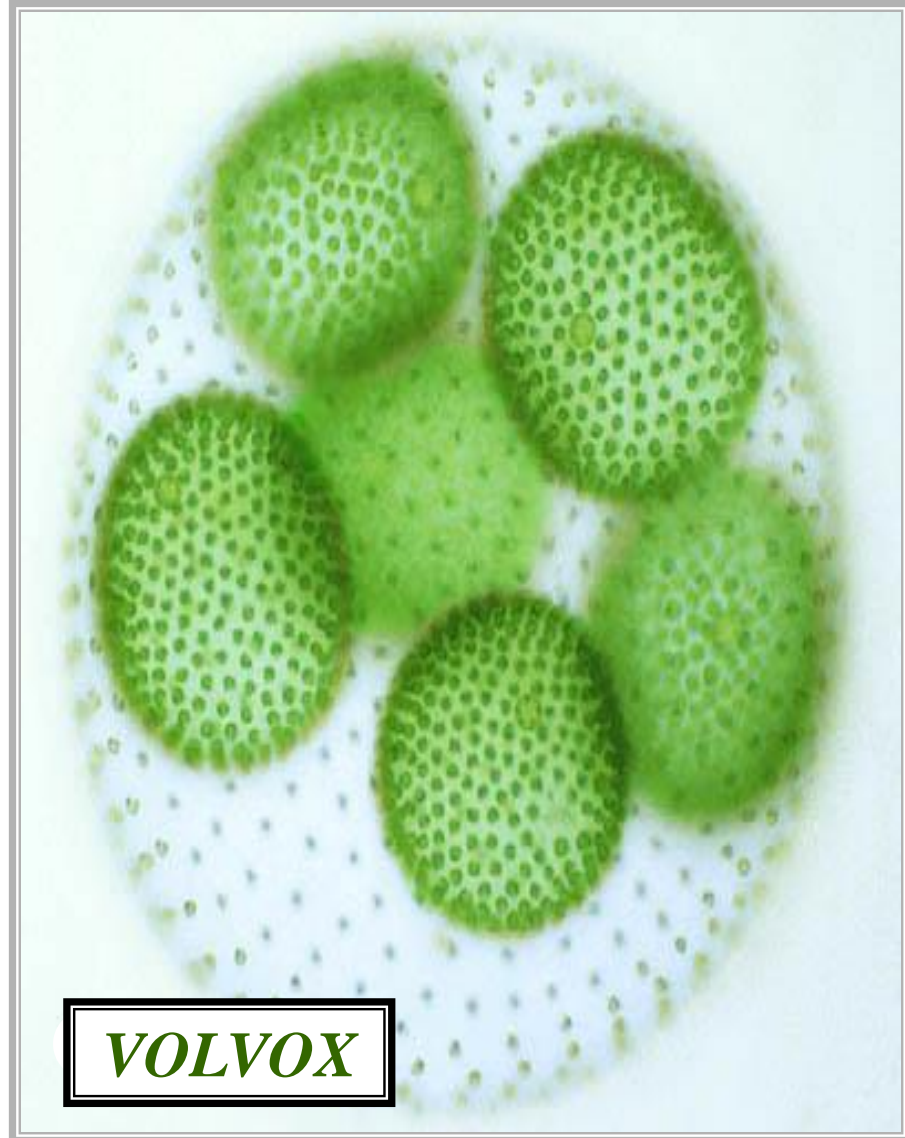
CHLOROPHYCEAE



CHLOROPHYCEAE



CHLAMYDOMONAS



VOLVOX



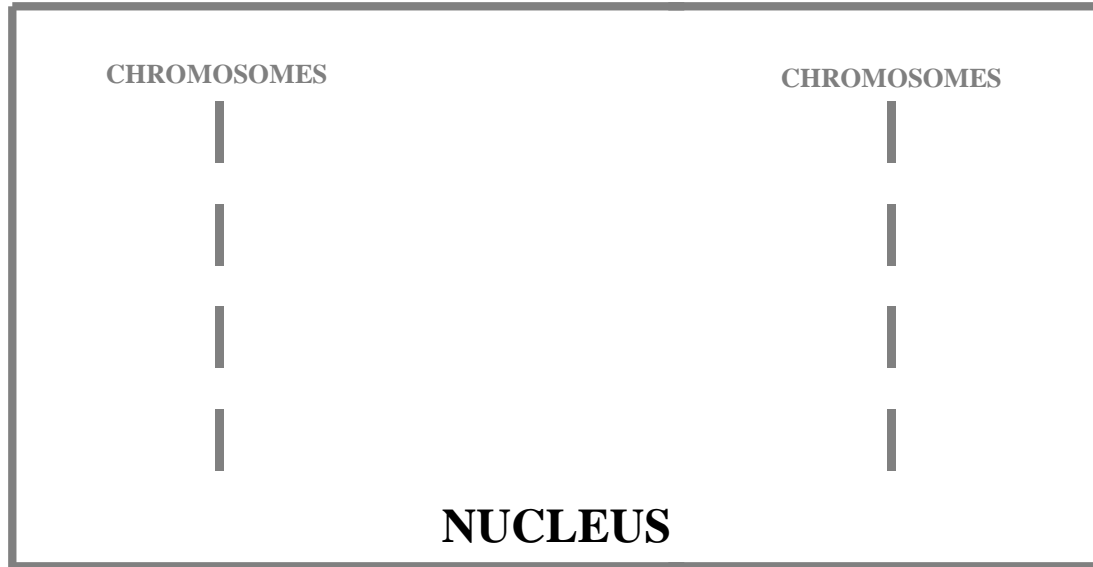
ULVOPHYCEAE

KARYOKINESIS

ULVOPHYCEAE

KARYOKINESIS

CELL CYTOSOL

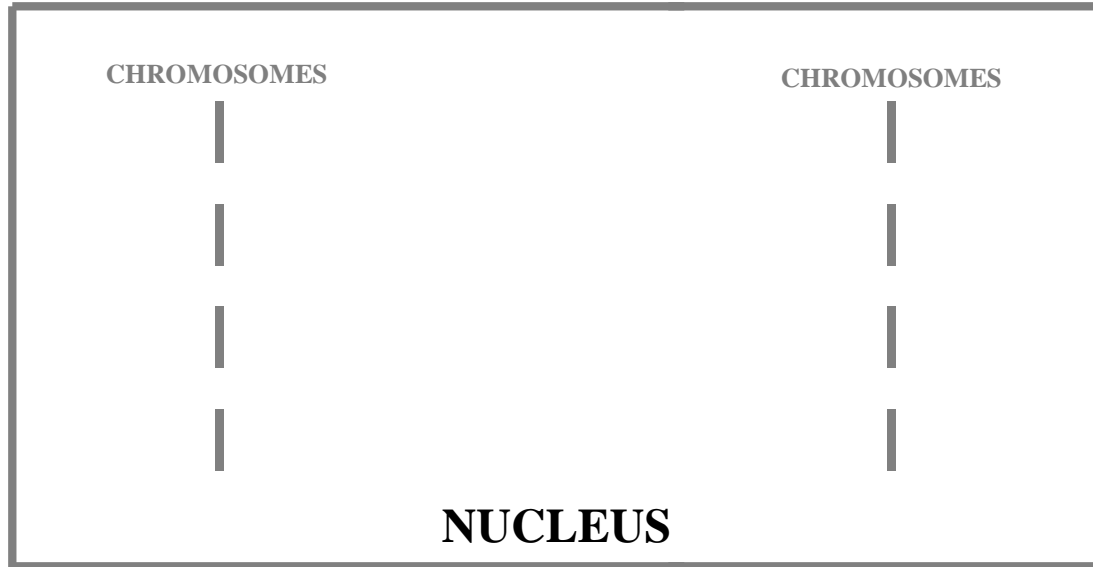


-  = CELL MEMBRANE
-  = NUCLEAR MEMBRANE
-  = MICROTUBULE

ULVOPHYCEAE

KARYOKINESIS

CELL CYTOSOL



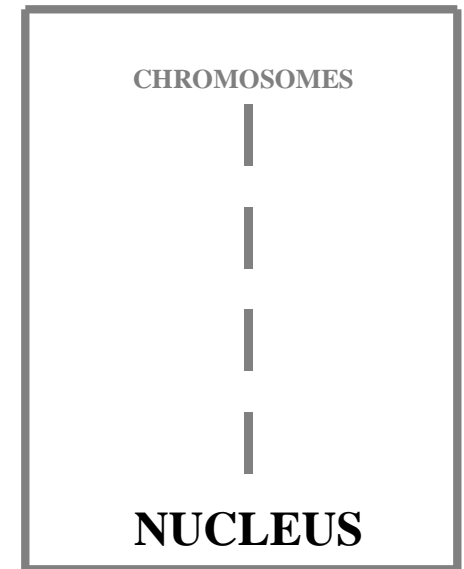
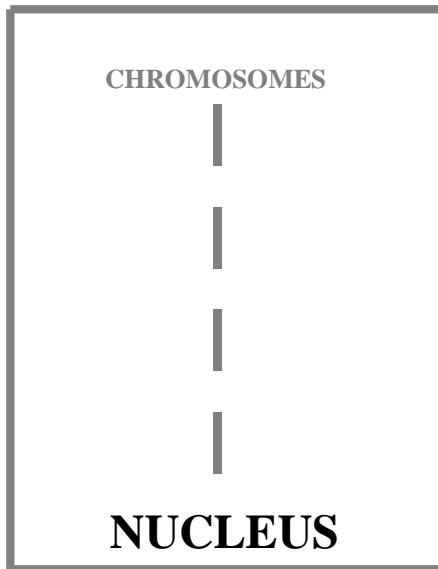
PERSISTENT NUCLEAR MEMBRANE

-  = CELL MEMBRANE
-  = NUCLEAR MEMBRANE
-  = MICROTUBULE

ULVOPHYCEAE

KARYOKINESIS

CELL CYTOSOL



PERSISTENT NUCLEAR MEMBRANE

-  = CELL MEMBRANE
-  = NUCLEAR MEMBRANE
-  = MICROTUBULE

ULVOPHYCEAE

KARYOKINESIS

CELL CYTOSOL



PERSISTENT NUCLEAR MEMBRANE
KARYOKINESIS SPINDLE PRESENT

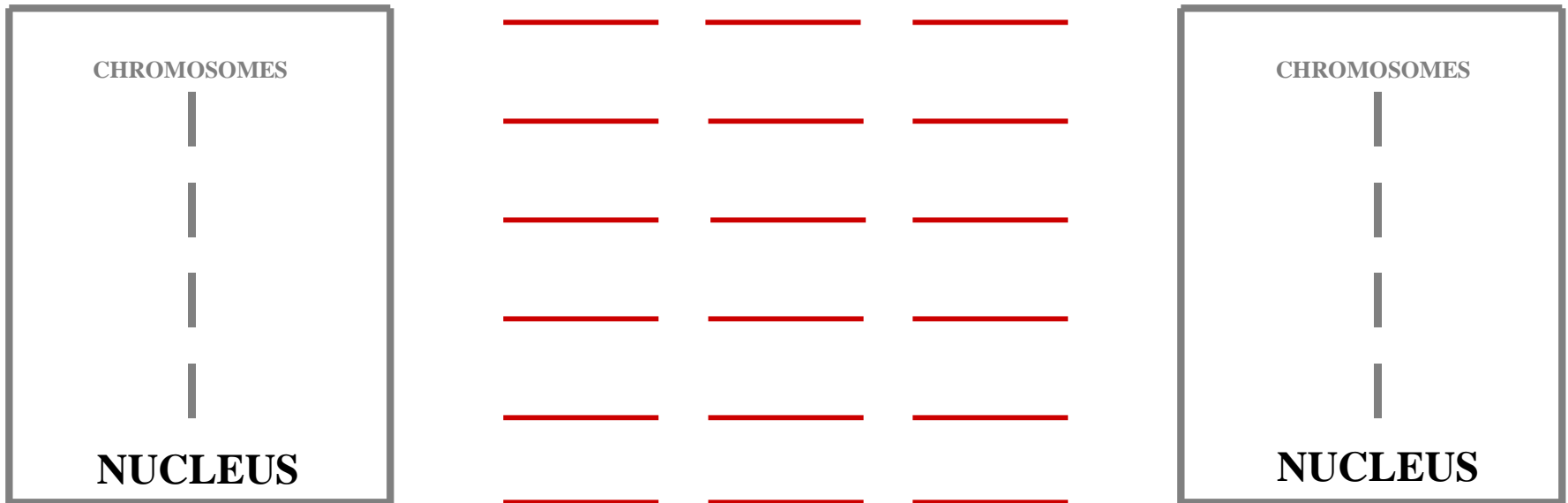
 = CELL MEMBRANE
 = NUCLEAR MEMBRANE
 = MICROTUBULE

ULVOPHYCEAE



KARYOKINESIS

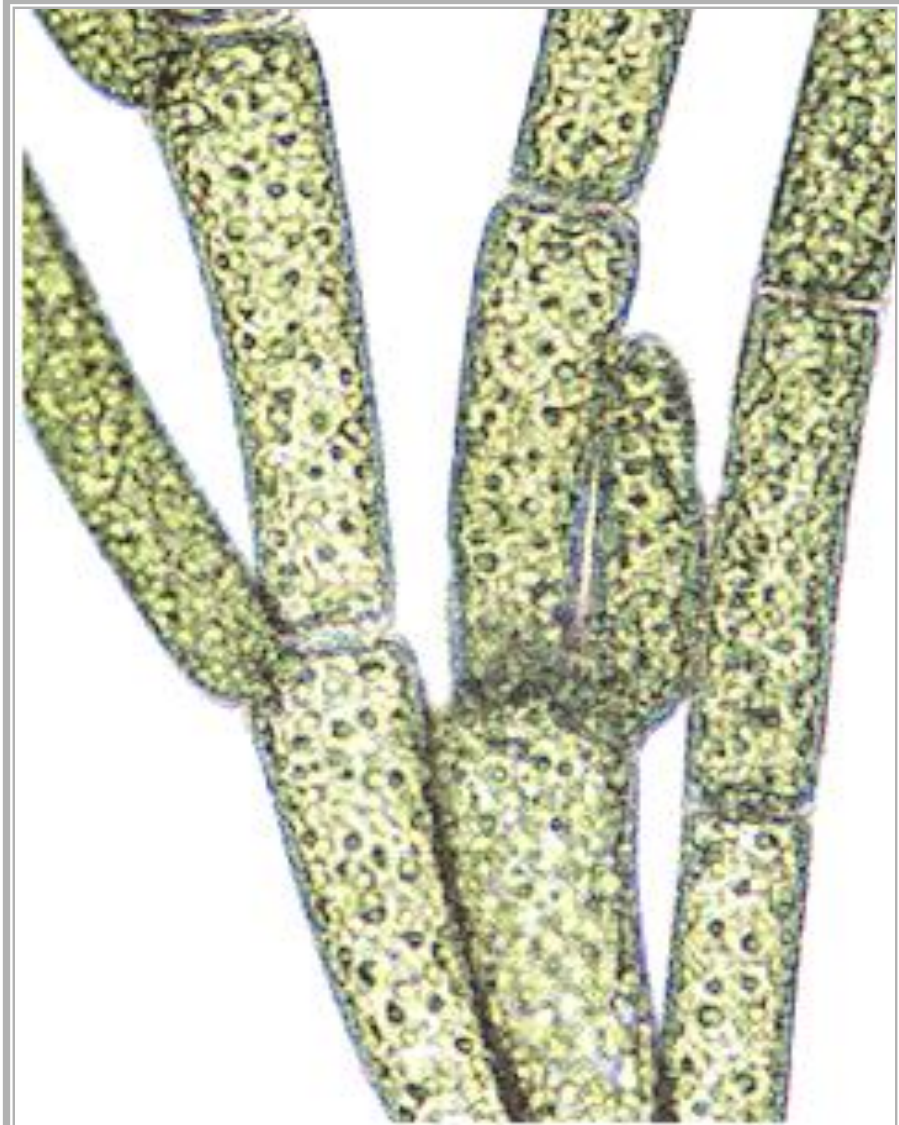
CELL CYTOSOL



PERSISTENT NUCLEAR MEMBRANE
KARYOKINESIS SPINDLE PRESENT
DAUGHTER NUCLEI SEPARATED

 = CELL MEMBRANE
 = NUCLEAR MEMBRANE
 = MICROTUBULE

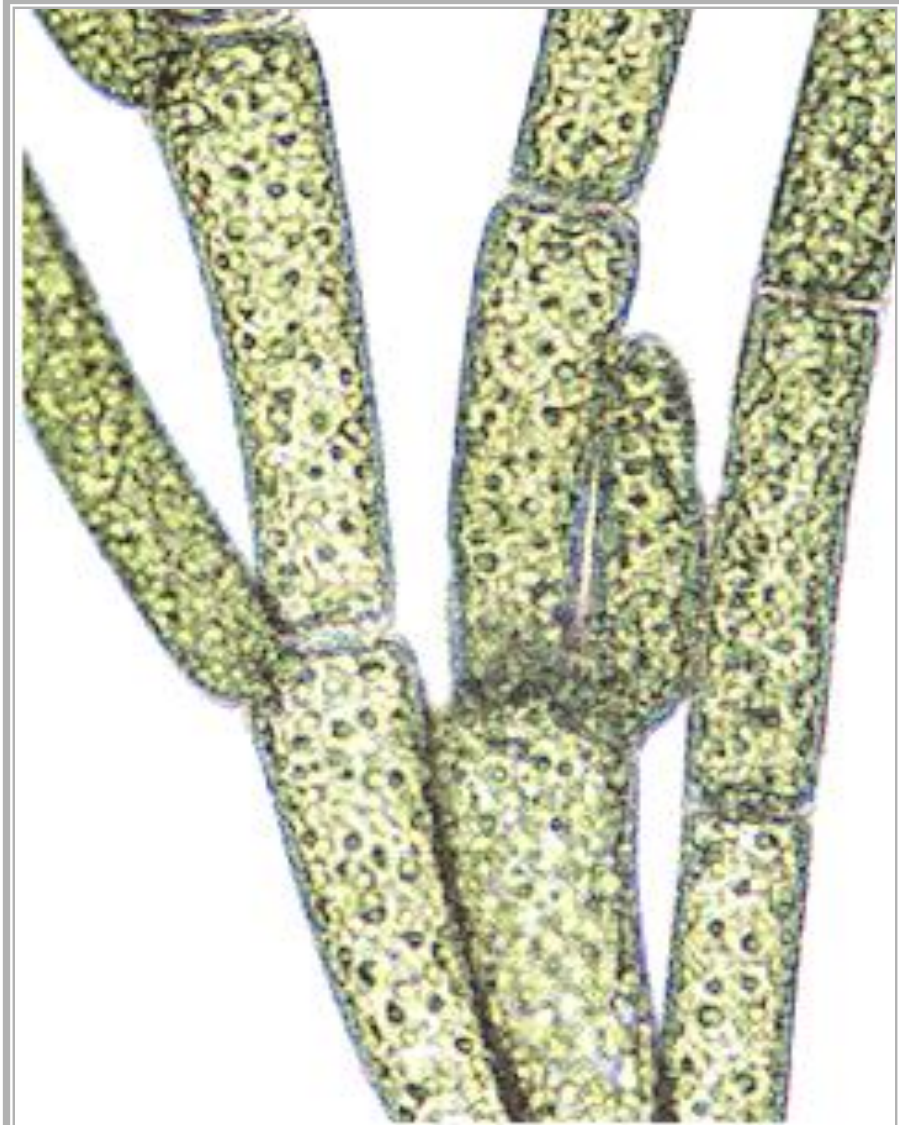
ULVOPHYCEAE



ULVOPHYCEAE



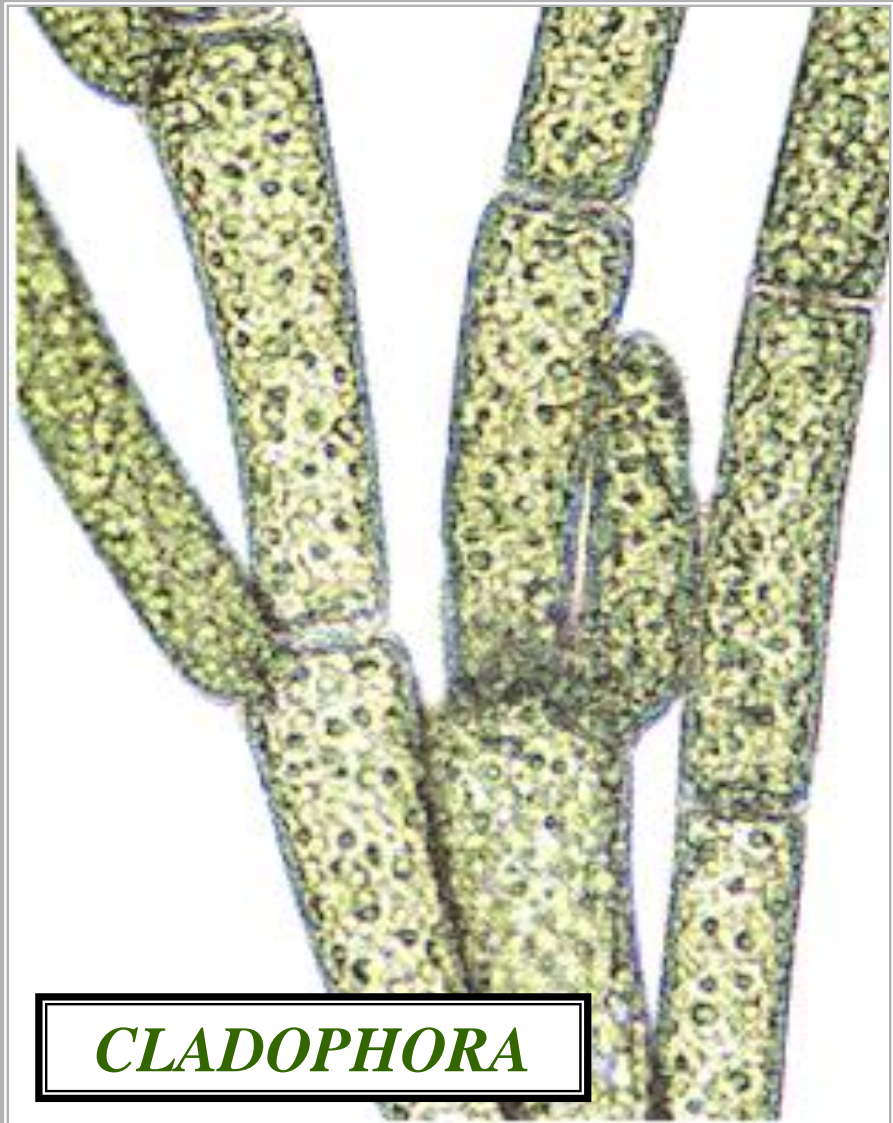
ULVA



ULVOPHYCEAE



ULVA



CLADOPHORA



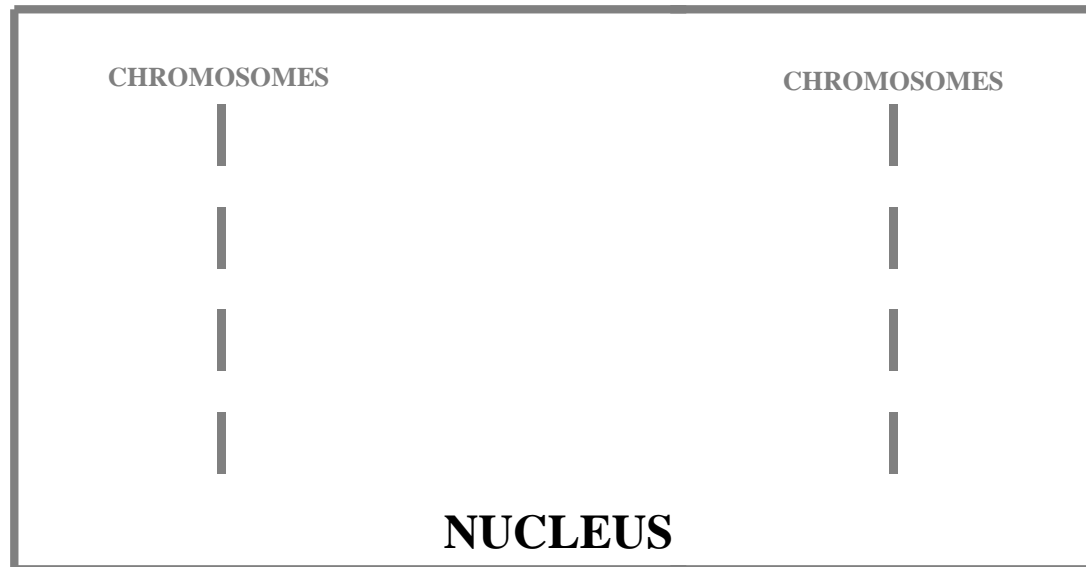
CHAROPHYCEAE

KARYOKINESIS

CHAROPHYCEAE

KARYOKINESIS

CELL CYTOSOL

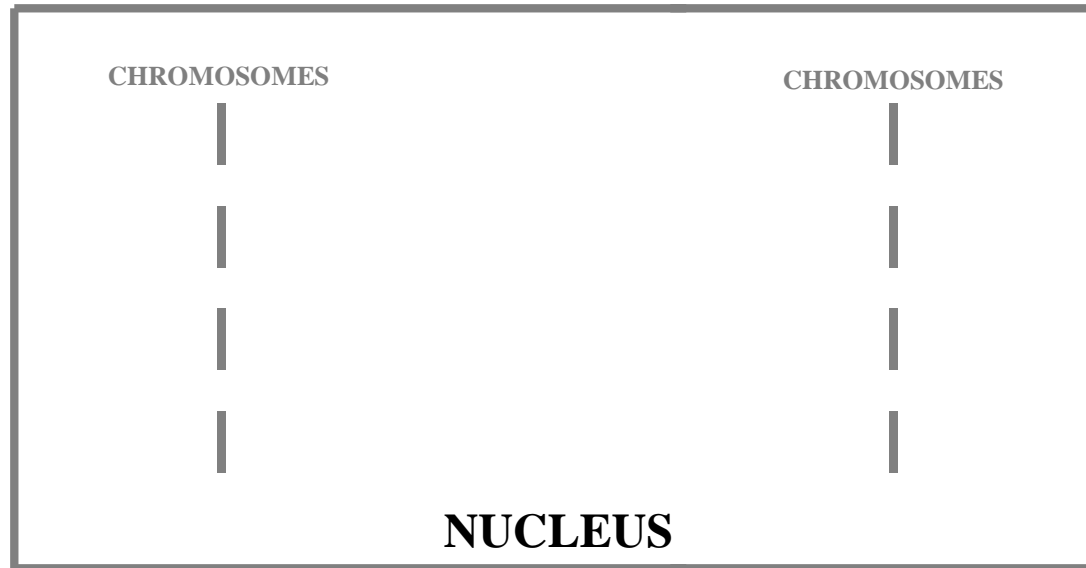


-  = CELL MEMBRANE
-  = NUCLEAR MEMBRANE
-  = MICROTUBULE

CHAROPHYCEAE

KARYOKINESIS

CELL CYTOSOL



NON-PERSISTENT NUCLEAR MEMBRANE

-  = CELL MEMBRANE
-  = NUCLEAR MEMBRANE
-  = MICROTUBULE

CHAROPHYCEAE

KARYOKINESIS

CELL CYTOSOL

CHROMOSOMES



CHROMOSOMES



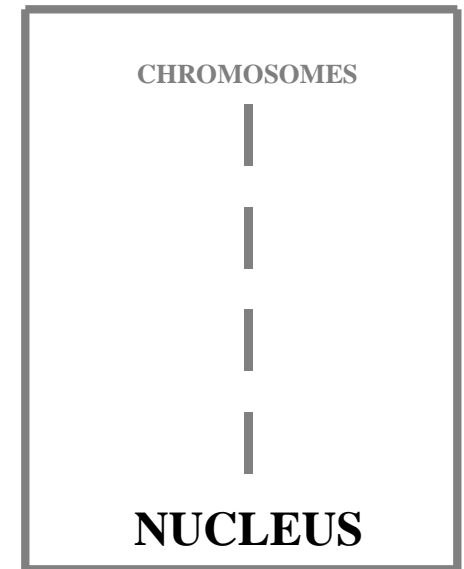
NON-PERSISTENT NUCLEAR MEMBRANE

-  = CELL MEMBRANE
-  = NUCLEAR MEMBRANE
-  = MICROTUBULE

CHAROPHYCEAE

KARYOKINESIS

CELL CYTOSOL



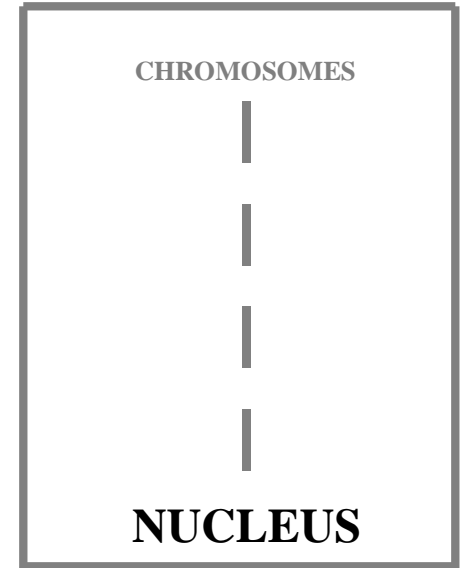
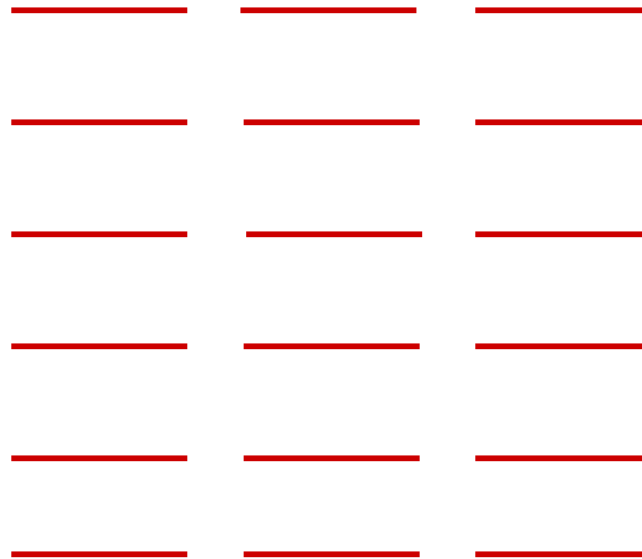
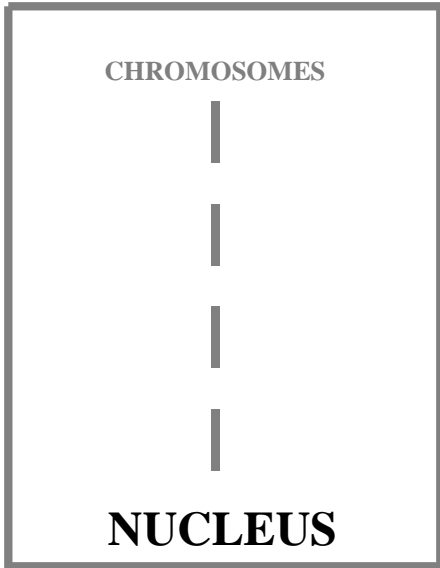
NON-PERSISTENT NUCLEAR MEMBRANE

-  = CELL MEMBRANE
-  = NUCLEAR MEMBRANE
-  = MICROTUBULE

CHAROPHYCEAE

KARYOKINESIS

CELL CYTOSOL



NON-PERSISTENT NUCLEAR MEMBRANE
KARYOKINESIS SPINDLE PRESENT

-  = CELL MEMBRANE
-  = NUCLEAR MEMBRANE
-  = MICROTUBULE

CHAROPHYCEAE




KARYOKINESIS

CELL CYTOSOL



NON-PERSISTENT NUCLEAR MEMBRANE
KARYOKINESIS SPINDLE PRESENT
DAUGHTER NUCLEI SEPARATED

 = CELL MEMBRANE
 = NUCLEAR MEMBRANE
 = MICROTUBULE

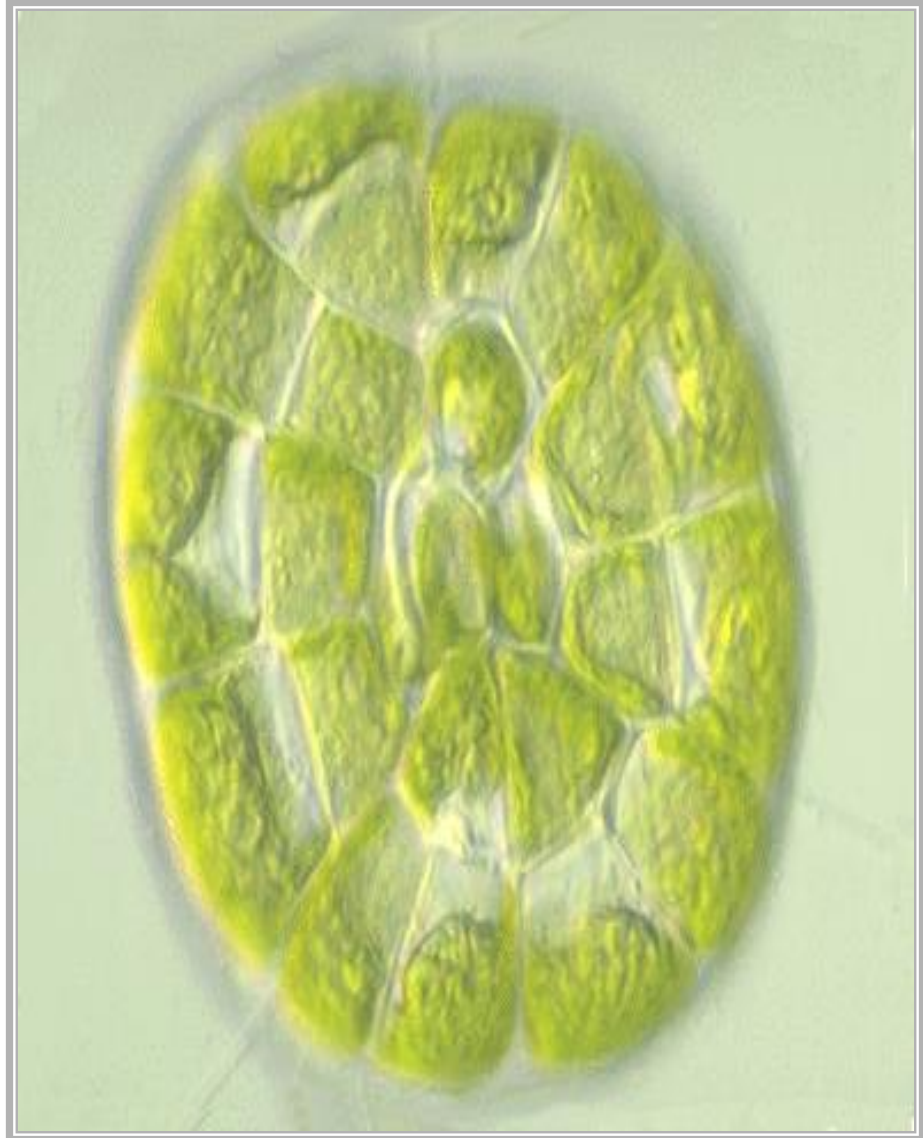
CHAROPHYCEAE



CHAROPHYCEAE



CHARA



CHAROPHYCEAE

E

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CHARA



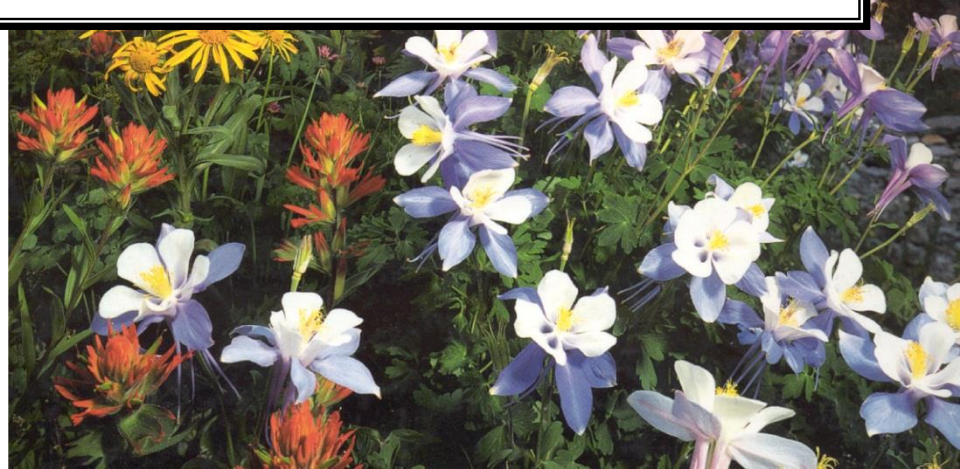
COLEOCHEATE



EMBRYOPHYTES

KARYOKINESIS:

NON-PERSISTANT NUCLEAR MEMBRANE

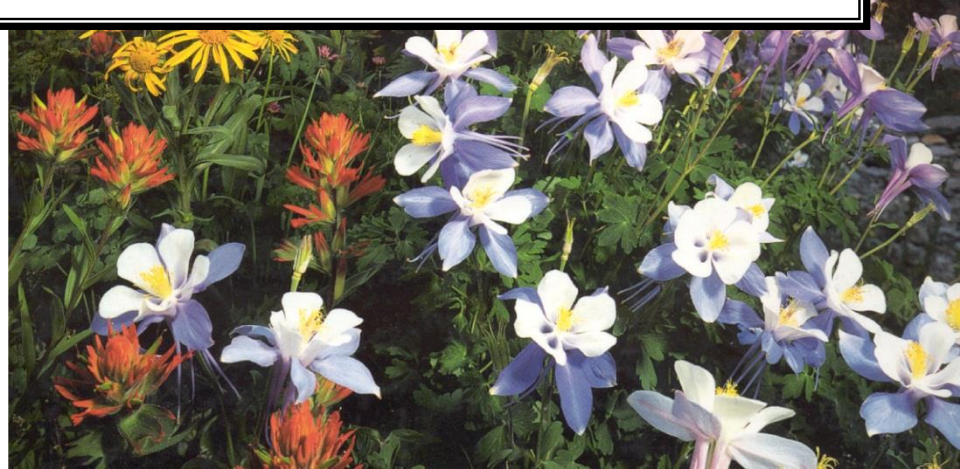




EMBRYOPHYTES

KARYOKINESIS:

KARYOKINESIS SPINDLE PRESENT

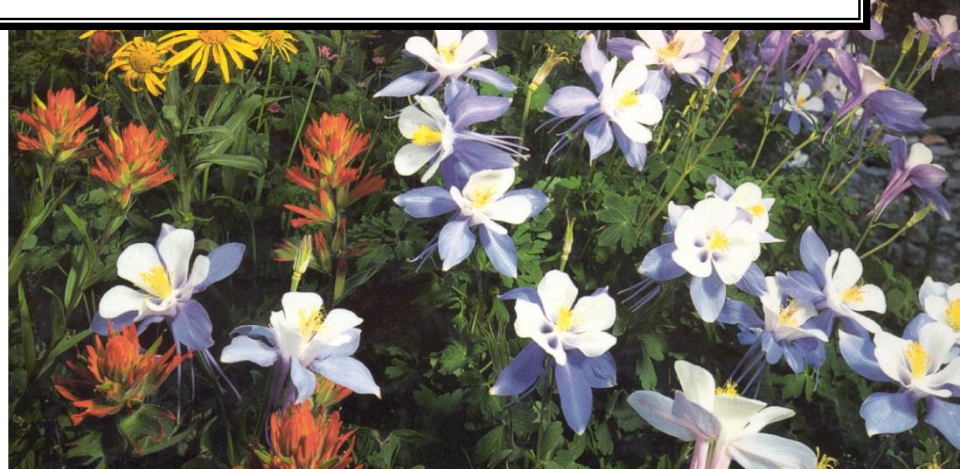
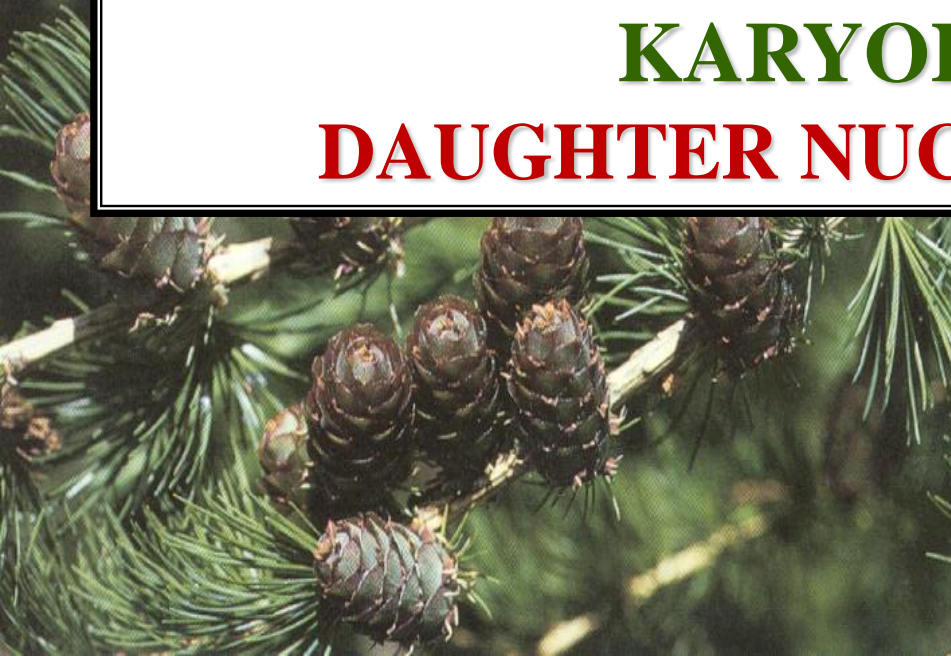




EMBRYOPHYTES

KARYOKINESIS:

DAUGHTER NUCLEI SEPARATED



VASCULAR PLANT EVOLUTION

VASCULAR PLANT EVOLUTION

CYANOPHYTA

ENDOSYMBIOTIC
THEORY

CHLOROPHYTA

PHYCOPLAST ABSENT
PHRAGMOPLAST ABSENT
FLAGELLA APICAL

ULVOPHYCEAE

PHYCOPLAST PRESENT
PHRAGMOPLAST ABSENT
FLAGELLA APICAL

CHLOROPHYCEAE

PHYCOPLAST ABSENT
PHRAGMOPLAST PRESENT
FLAGELLA SUBAPICAL

CHAROPHYCEAE

KARYOKINESIS
IDENTICAL WITH
EMBRYOPHYTES

EMBRYOPHYTES





CHLOROPHYTA

CYTOKINESIS

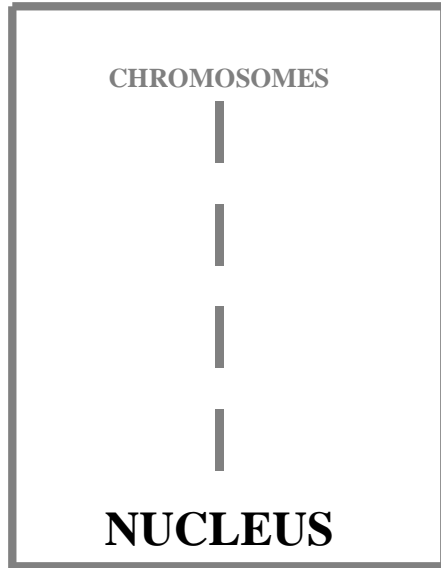


CHLOROPHYCEAE CYTOKINESIS

CHLOROPHYCEAE

CYTOKINESIS

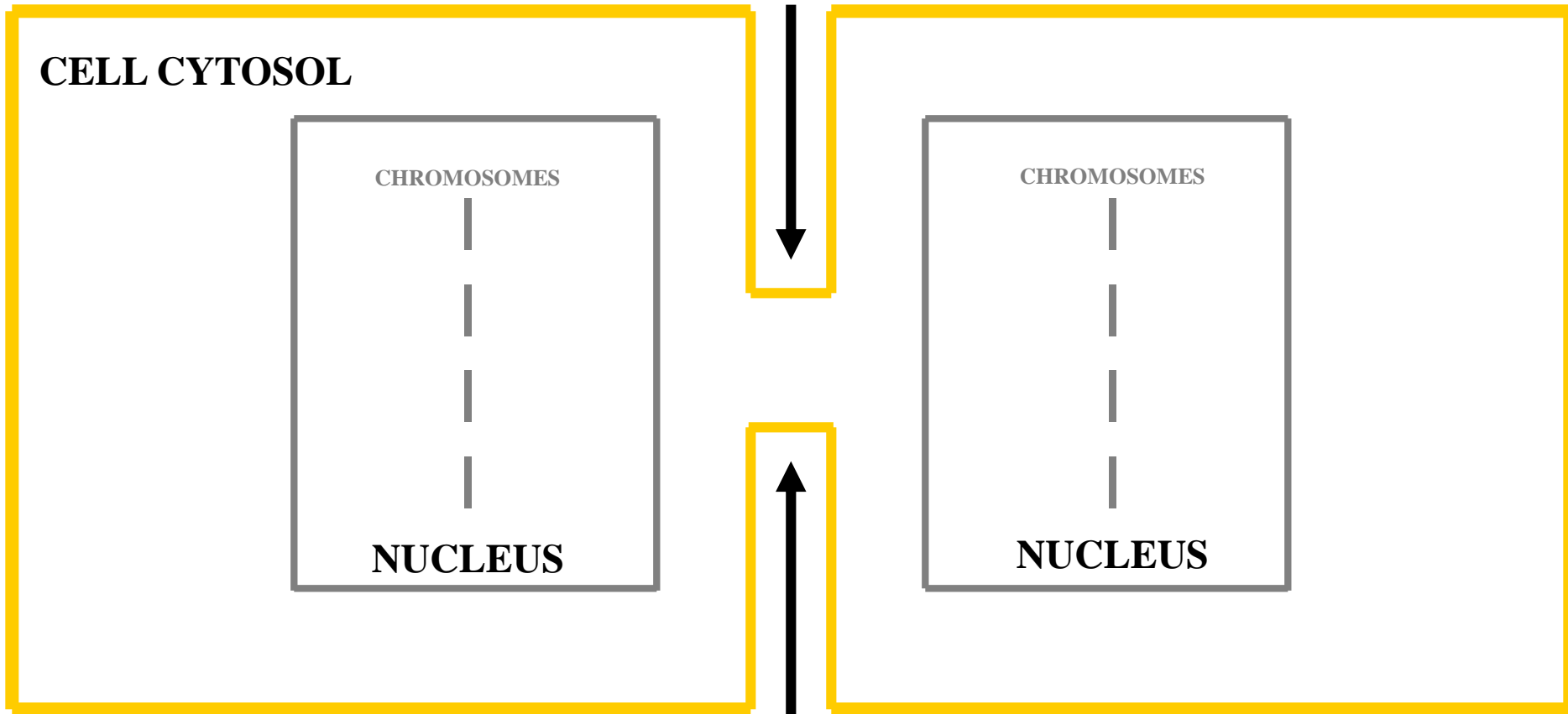
CELL CYTOSOL



-  = CELL MEMBRANE
-  = NUCLEAR MEMBRANE
-  = MICROTUBULE

CHLOROPHYCEAE

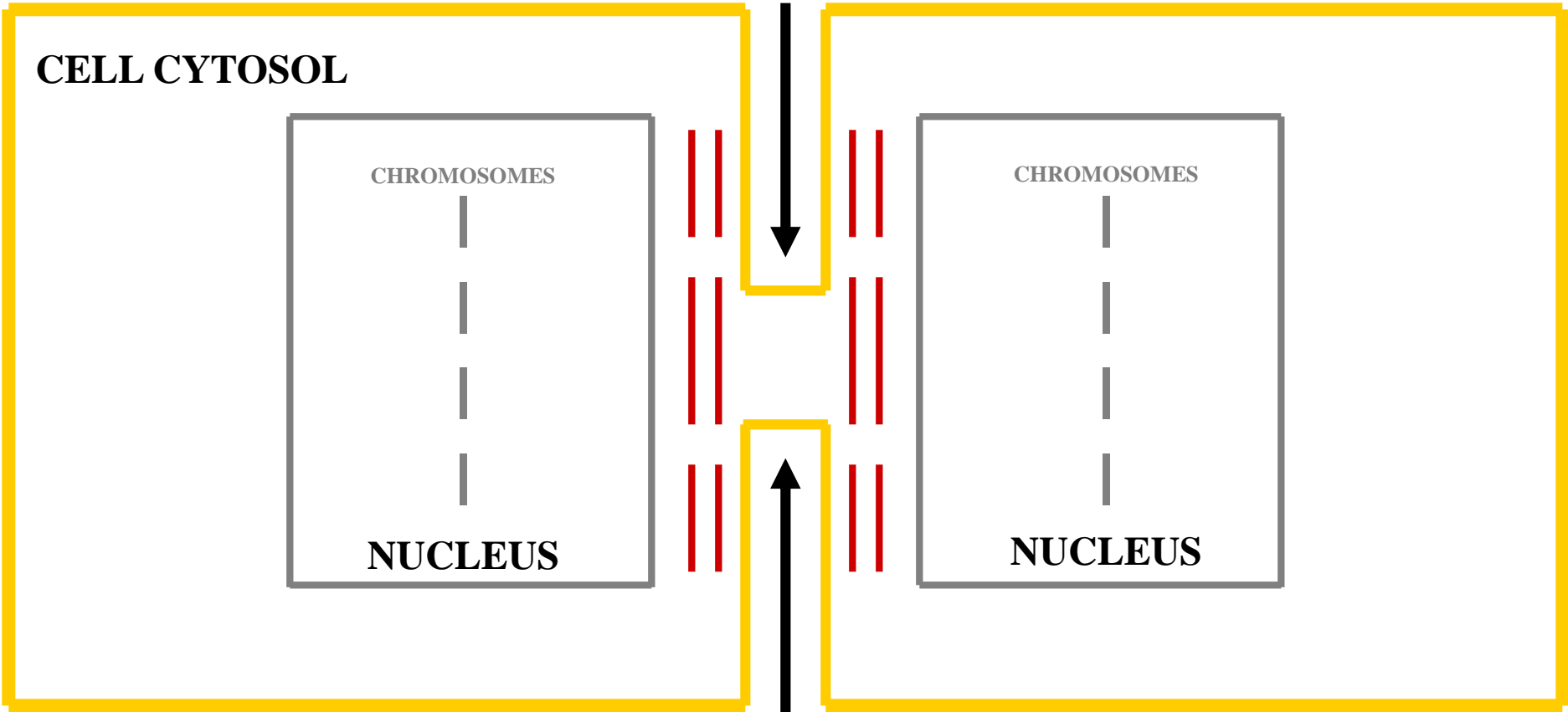
CYTOKINESIS



- = **CELL MEMBRANE**
- = **NUCLEAR MEMBRANE**
- = **MICROTUBULE**

CHLOROPHYCEAE

CYTOKINESIS



CELL CYTOSOL

CHROMOSOMES

NUCLEUS

CHROMOSOMES

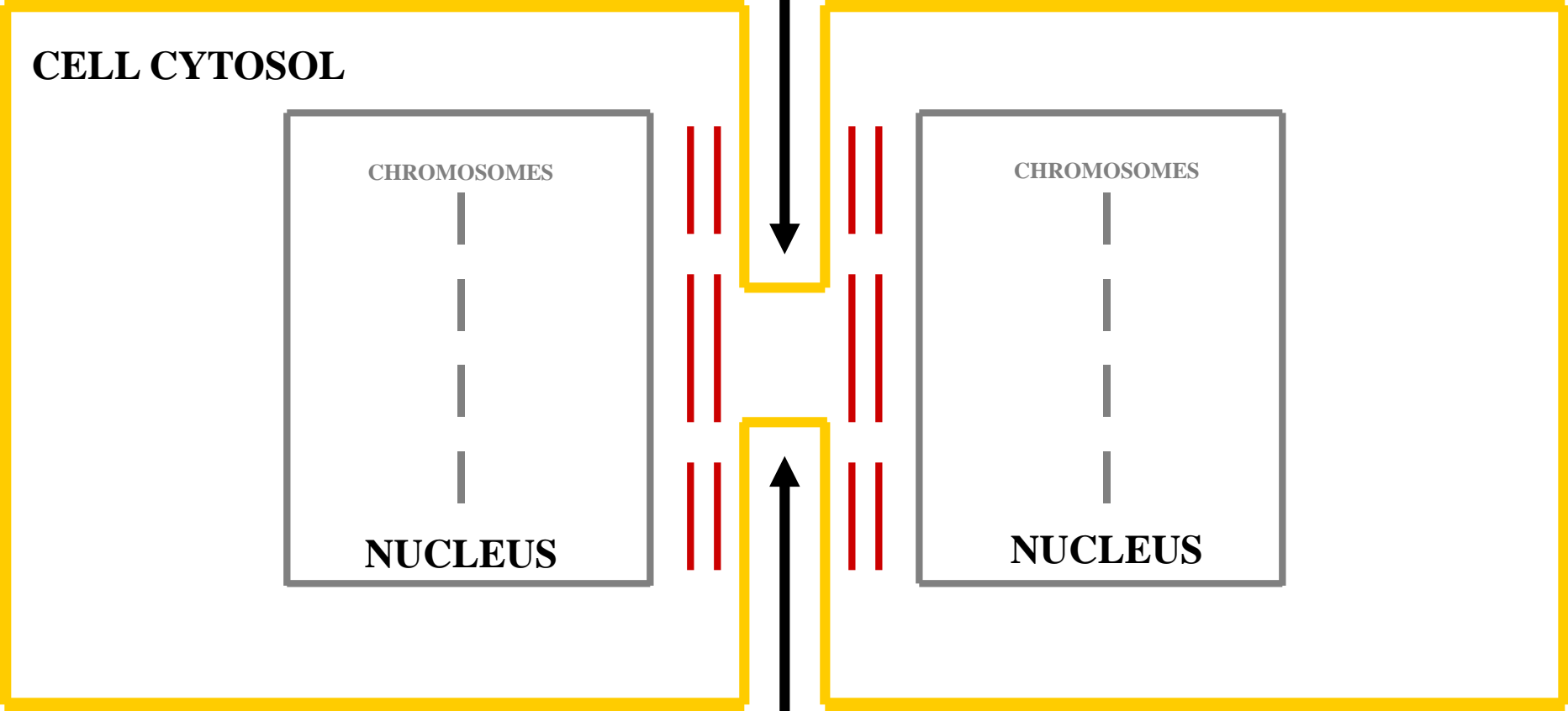
NUCLEUS

FURROWING
CYTOKINESIS SPINDLE PRESENT

-  = CELL MEMBRANE
-  = NUCLEAR MEMBRANE
-  = MICROTUBULE

CHLOROPHYCEAE

CYTOKINESIS



FURROWING
CYTOKINESIS SPINDLE PRESENT
PHYCOPLAST SPINDLE

— = CELL MEMBRANE
— = NUCLEAR MEMBRANE
— = MICROTUBULE

PHYCOPLAST

PHYCOPLAST



CYTOKINESIS SPINDLE

PHYCOPLAST

PHYCOPLAST



CYTOKINESIS SPINDLE

MICROTUBULES ALIGNED

PARALLEL

TO CELL DIVISION

PHYCOPLAST

PHYCOPLAST

CYTOKINESIS SPINDLE

MICROTUBULES ALIGNED

PARALLEL

TO CELL DIVISION

GUIDES FURROWING

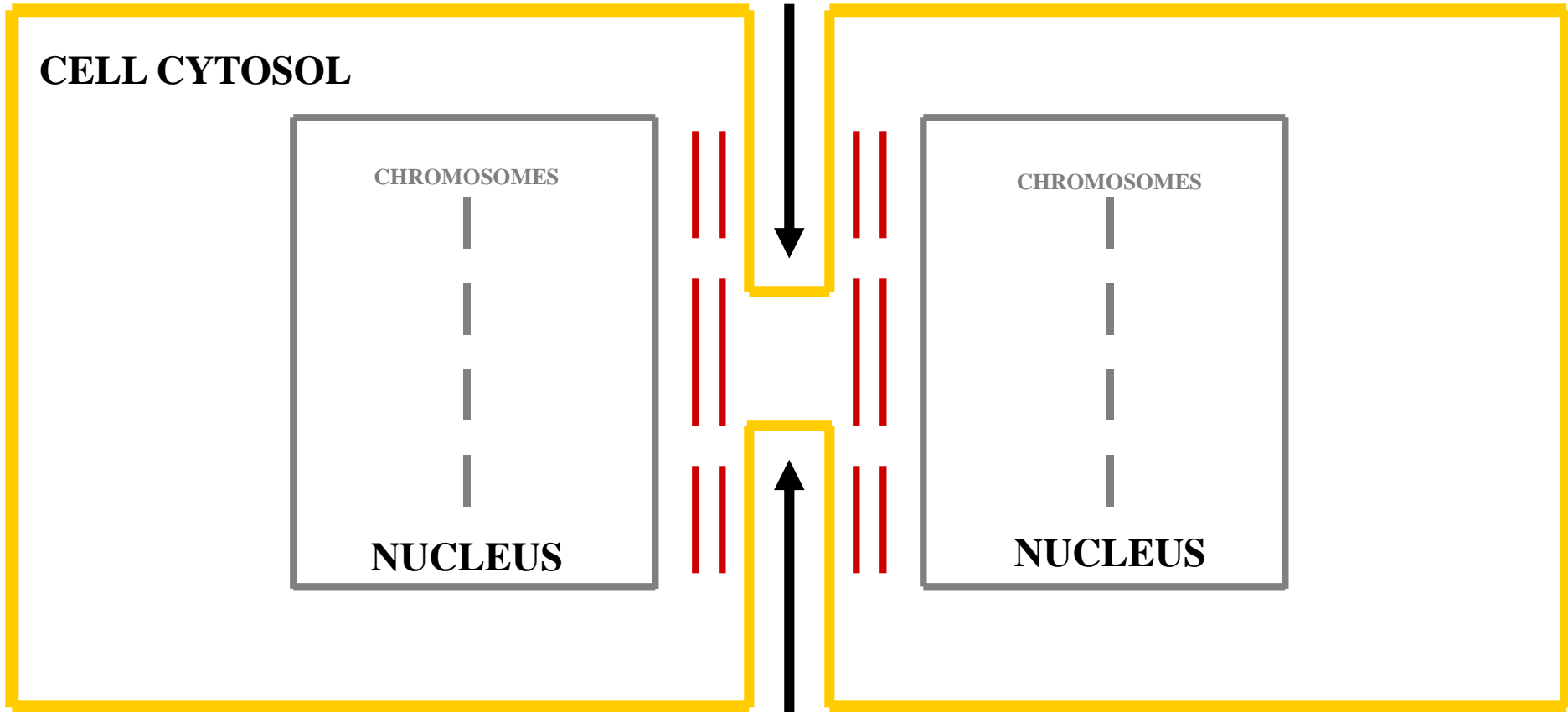
PHYCOPLAST



CHLOROPHYCEAE



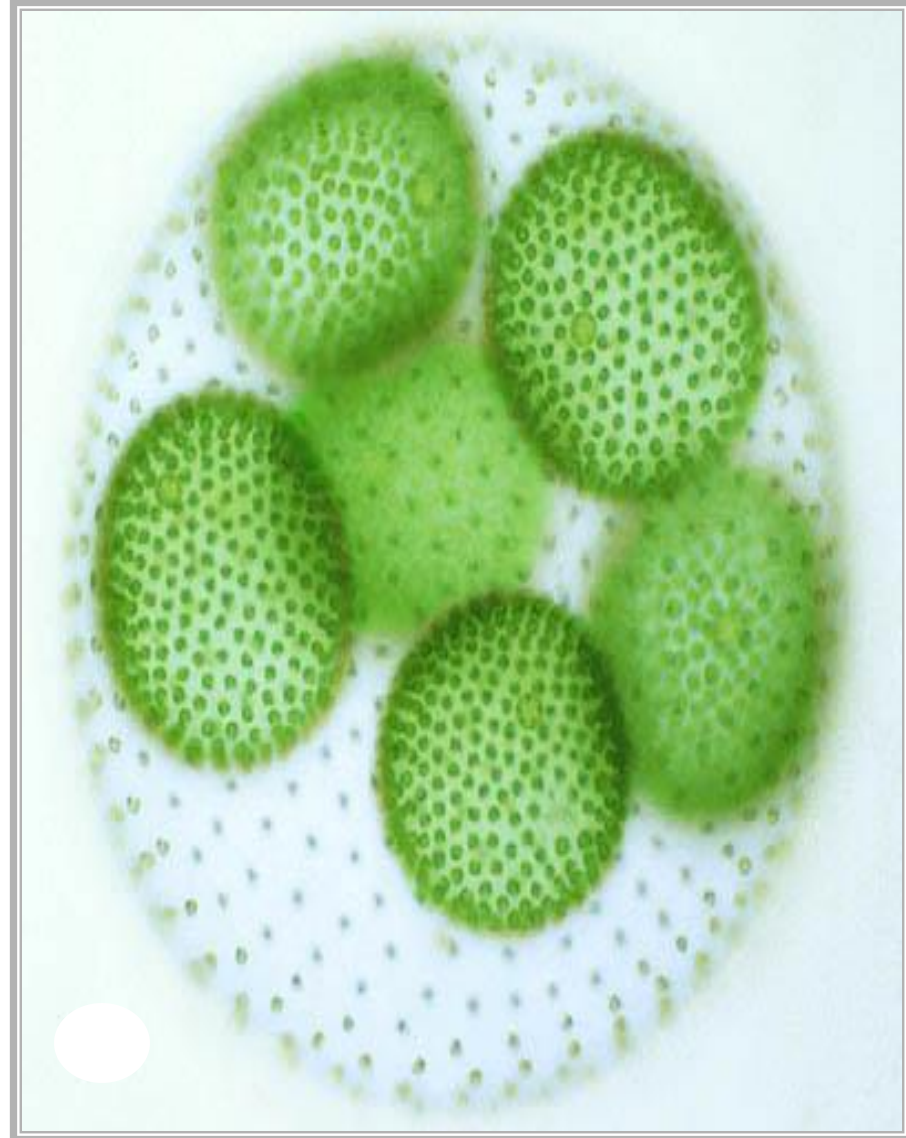
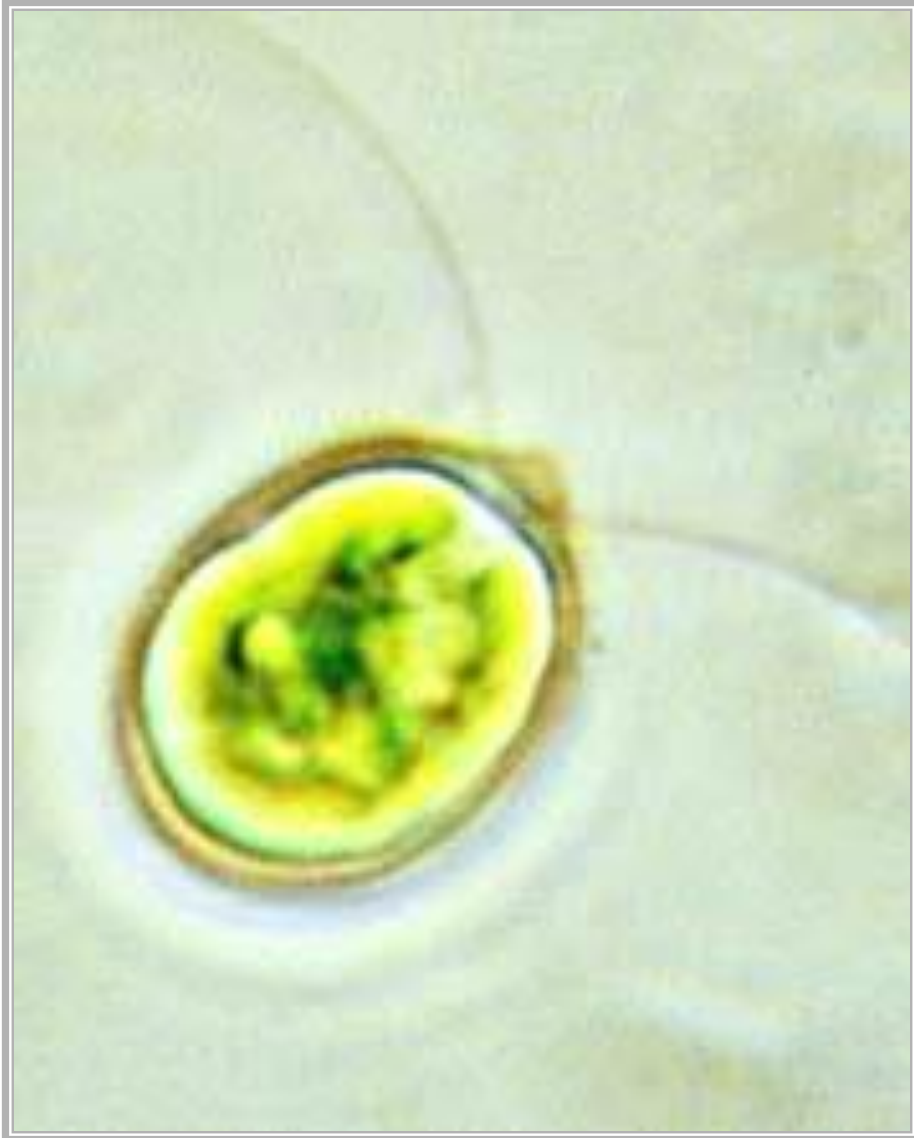
CYTOKINESIS



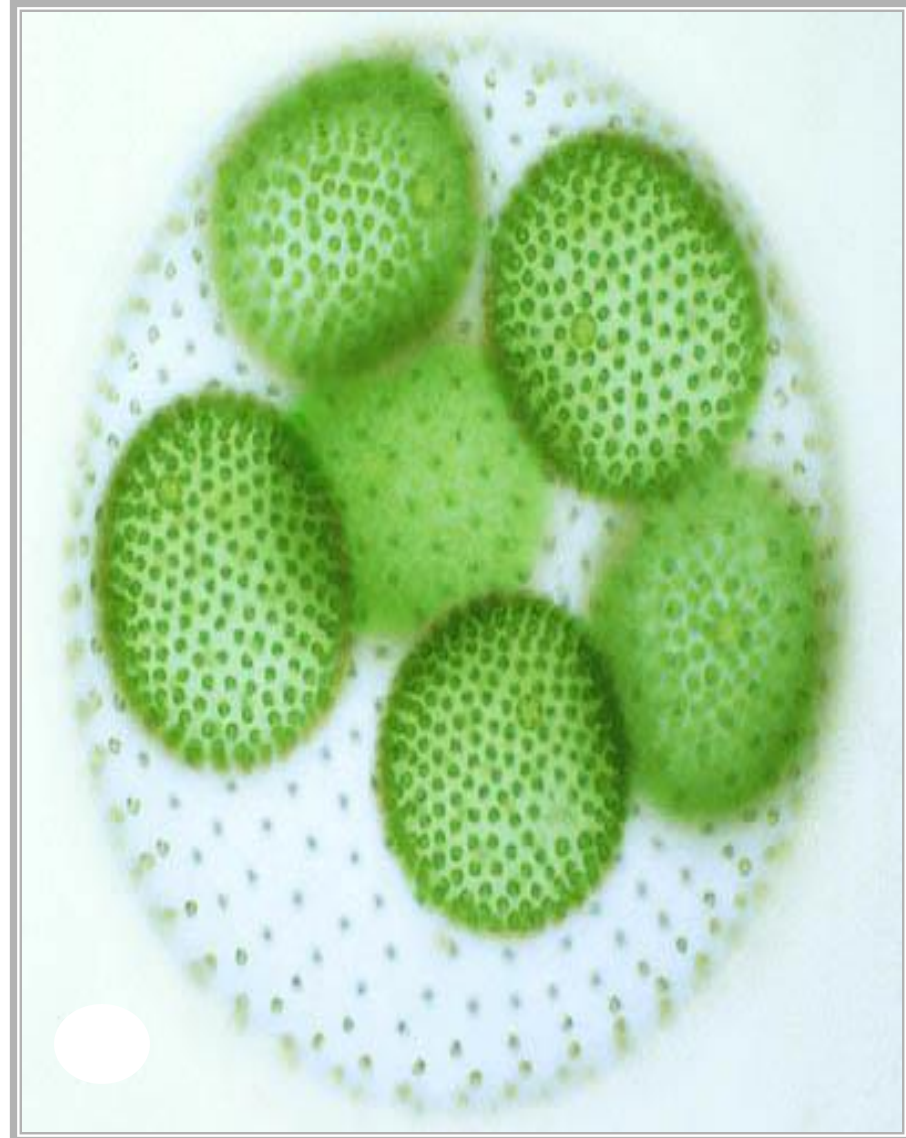
FURROWING
PHYCOPLAST SPINDLE
PARALLEL MICROTUBULES

 = CELL MEMBRANE
 = NUCLEAR MEMBRANE
 = MICROTUBULE

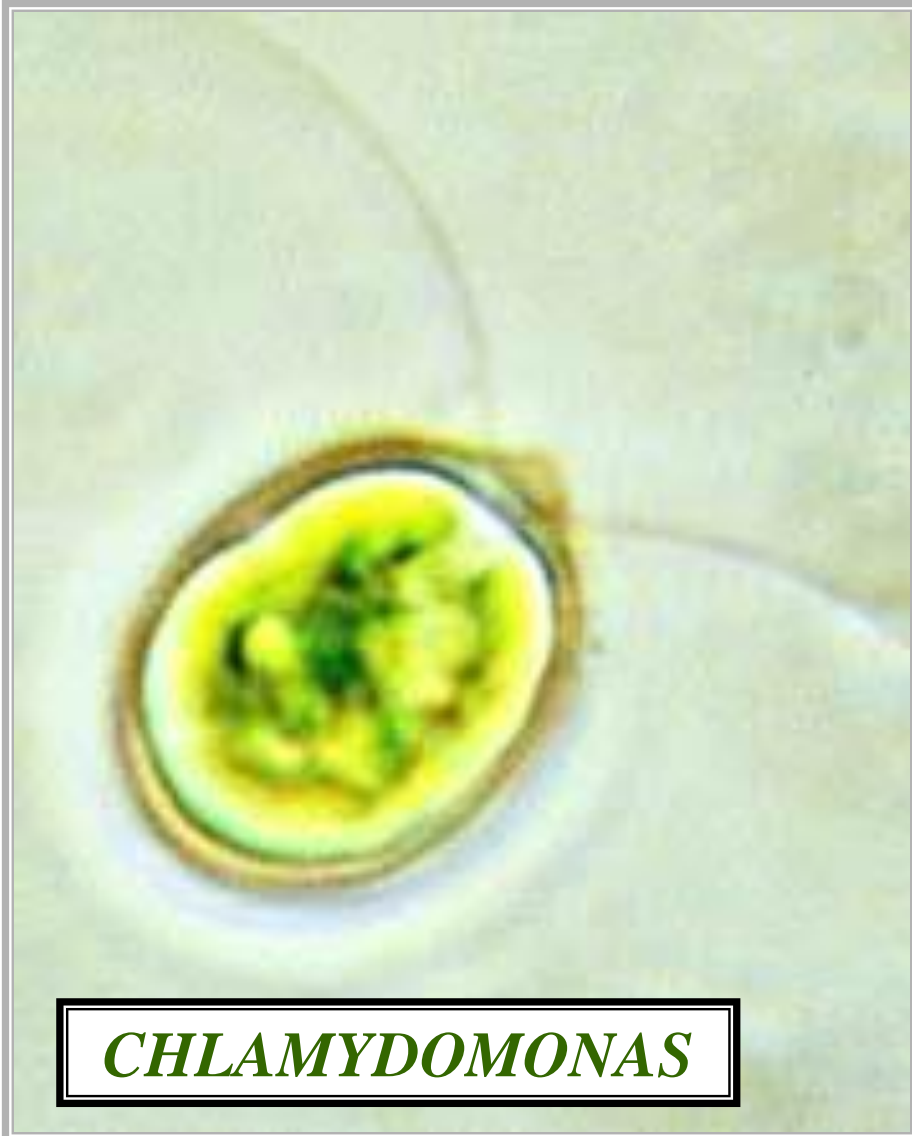
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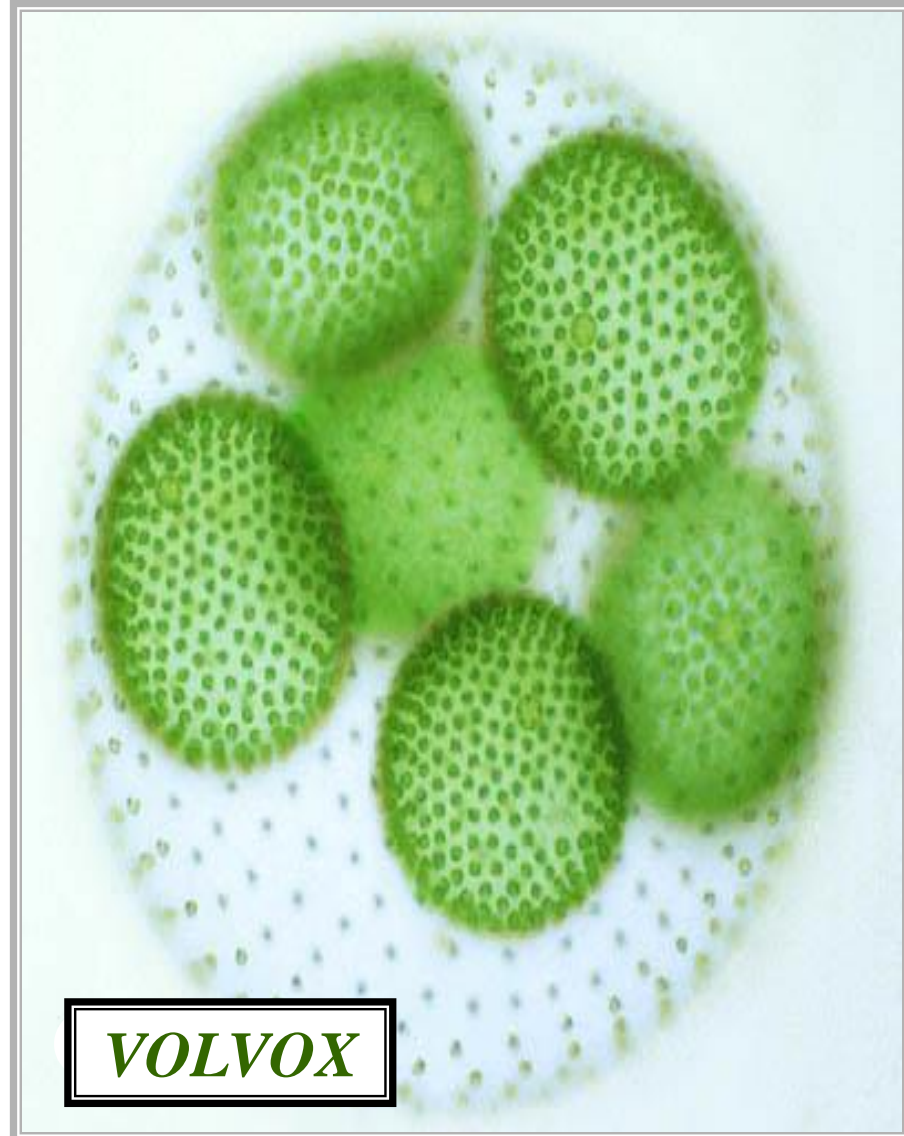
CHLOROPHYCEAE



CHLOROPHYCEAE



CHLAMYDOMONAS



VOLVOX

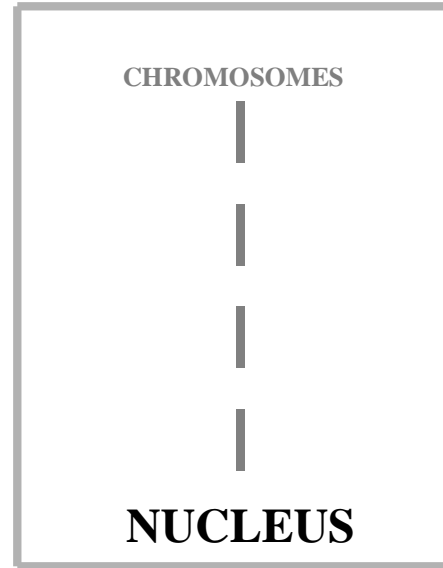
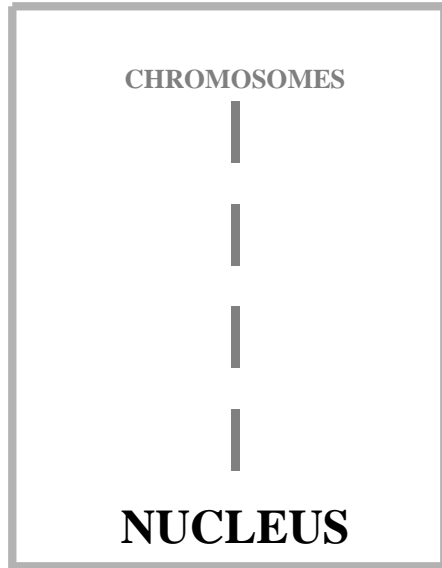


ULVOPHYCEAE CYTOKINESIS

ULVOPHYCEAE

CYTOKINESIS

CELL CYTOSOL

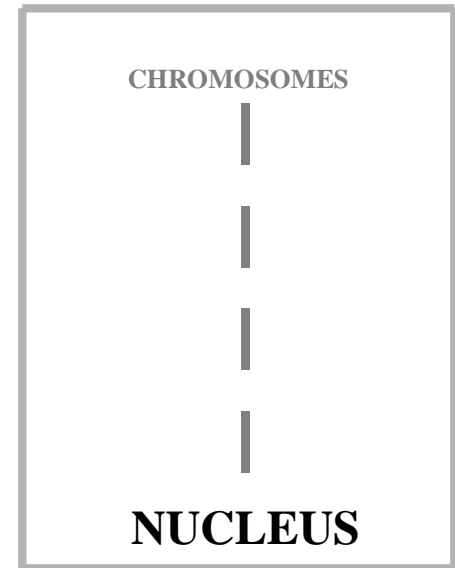
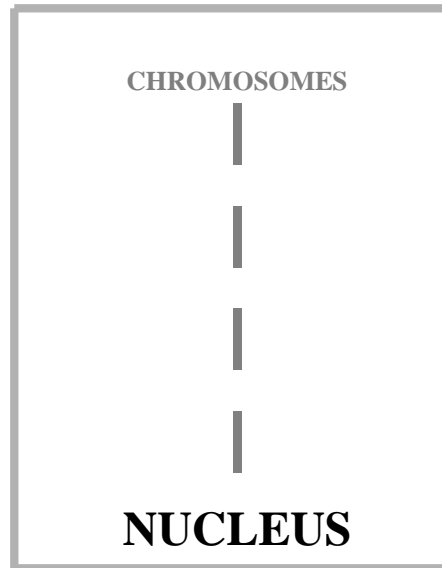


-  = CELL MEMBRANE
-  = NUCLEAR MEMBRANE
-  = MICROTUBULE


ULVOPHYCEAE

CYTOKINESIS

CELL CYTOSOL



FURROWING

-  = CELL MEMBRANE
-  = NUCLEAR MEMBRANE
-  = MICROTUBULE

ULVOPHYCEAE



CYTOKINESIS

CELL CYTOSOL

CHROMOSOMES

NUCLEUS

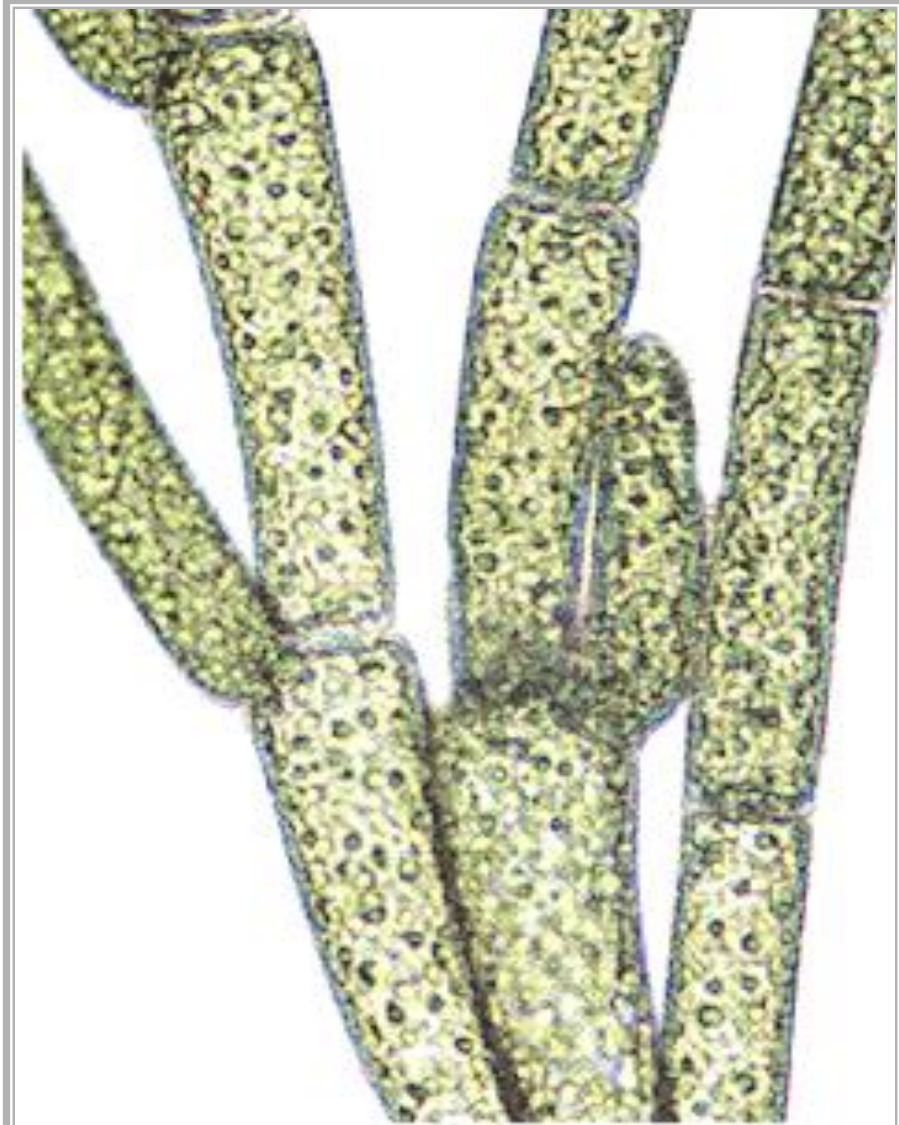
CHROMOSOMES

NUCLEUS

FURROWING
CYTOKINESIS SPINDLE ABSENT

-  = CELL MEMBRANE
-  = NUCLEAR MEMBRANE
-  = MICROTUBULE

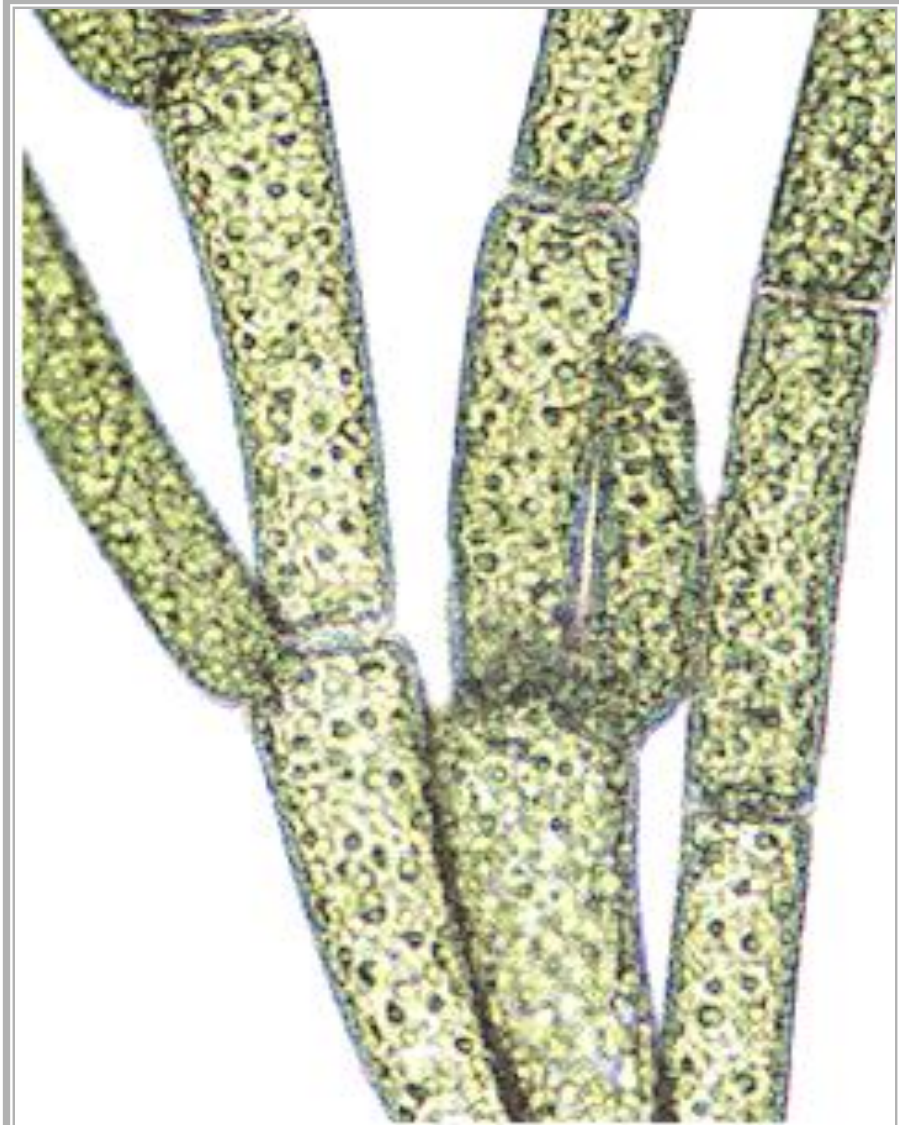
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ULVOPHYCEAE



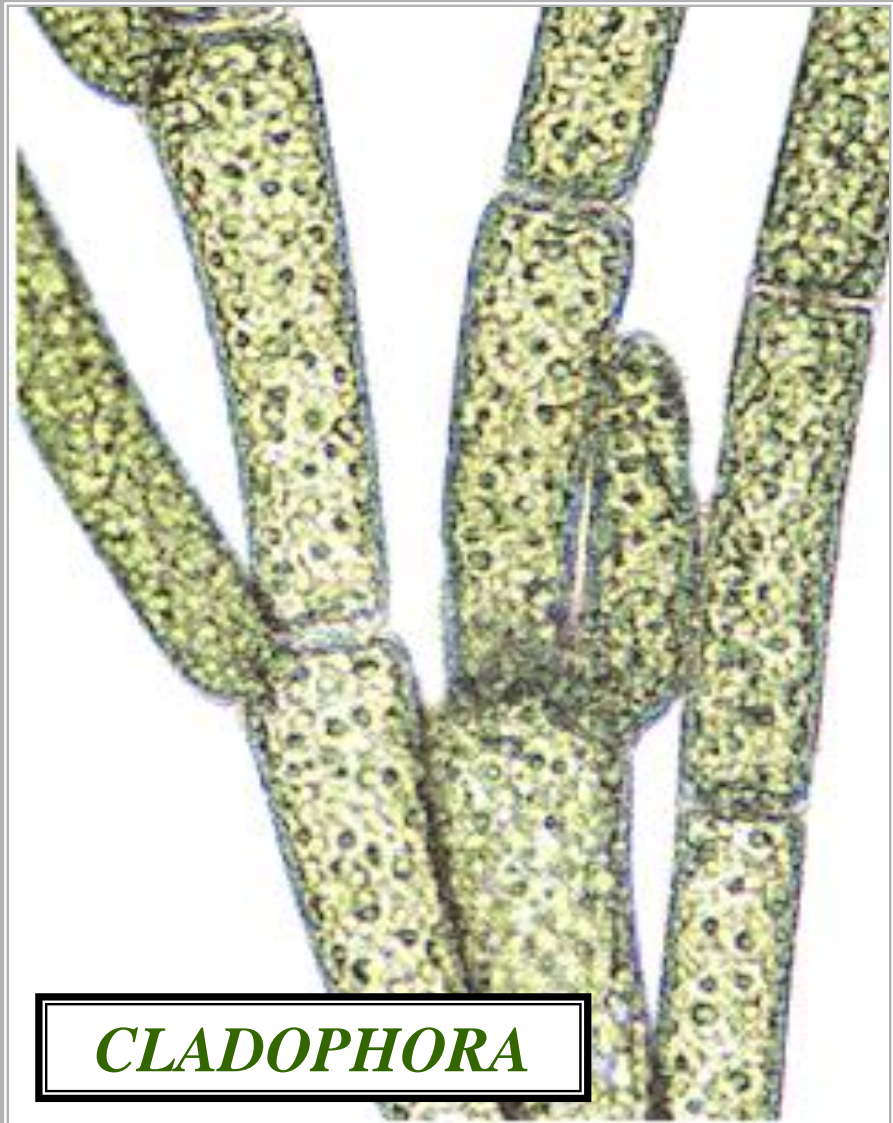
ULVA



ULVOPHYCEAE



ULVA



CLADOPHORA



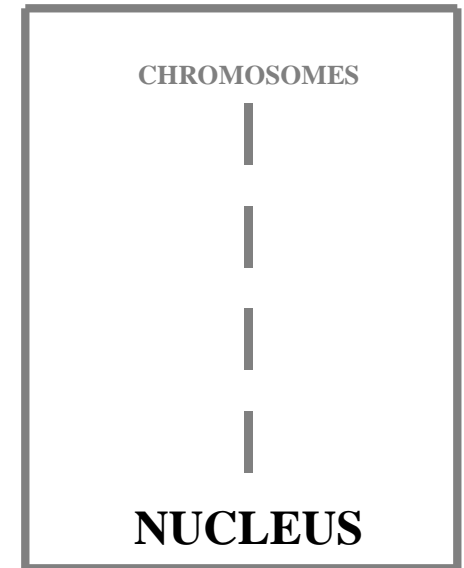
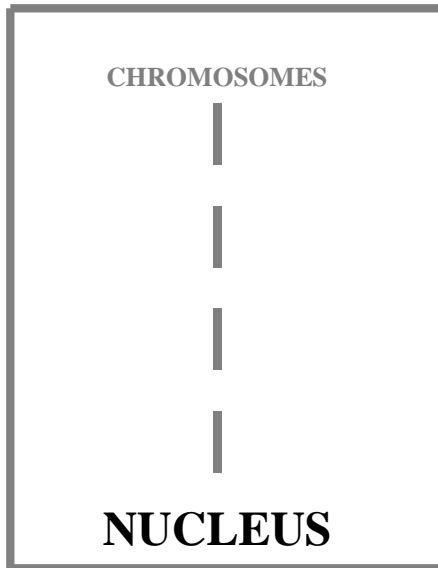
CHAROPHYCEAE CYTOKINESIS

CHAROPHYCEAE



CYTOKINESIS

CELL CYTOSOL

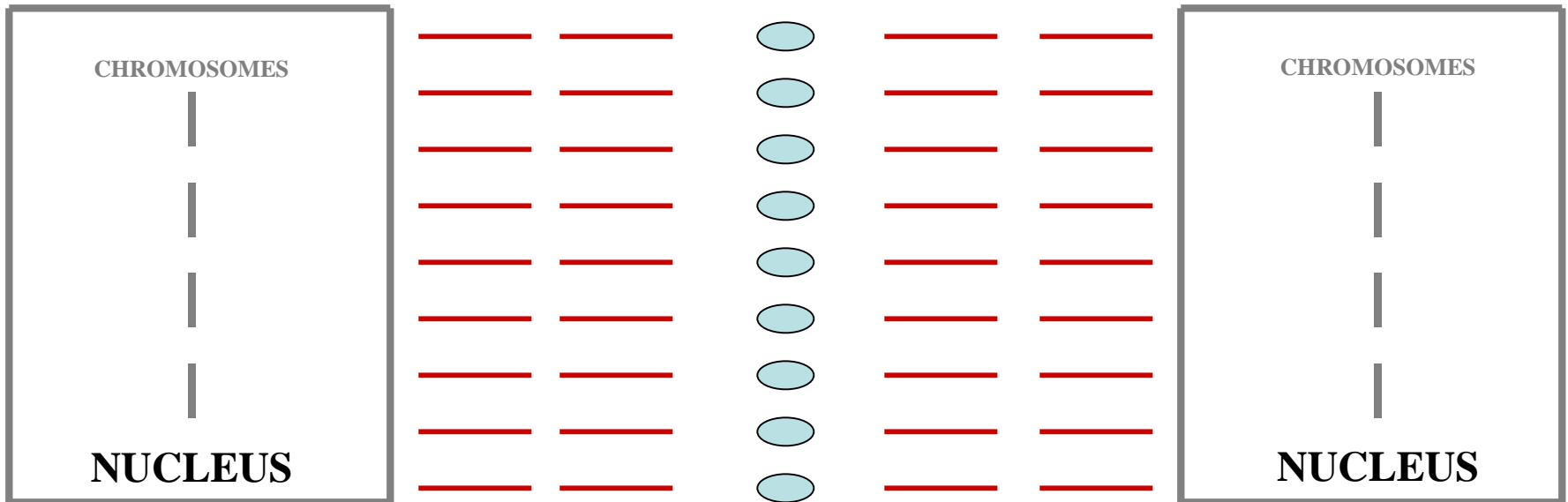


-  = CELL MEMBRANE
-  = NUCLEAR MEMBRANE
-  = MICROTUBULE

CHAROPHYCEAE

CYTOKINESIS

CELL CYTOSOL



 = GOLGI VESICLES

 = CELL MEMBRANE

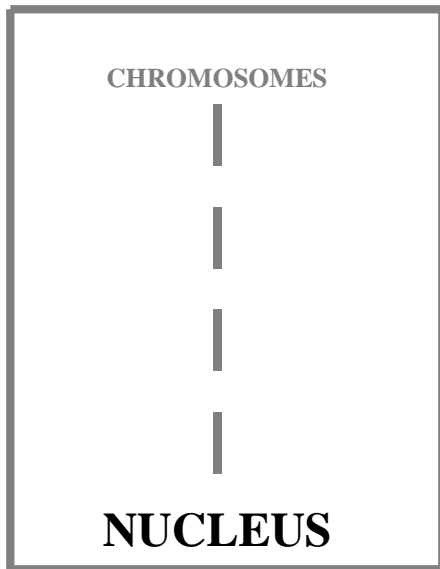
 = NUCLEAR MEMBRANE

 = MICROTUBULE

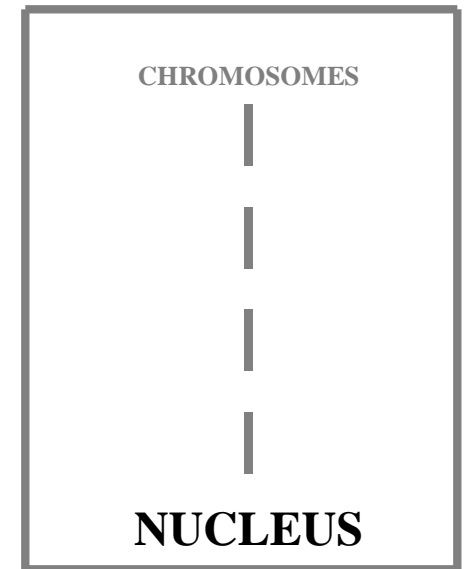
CHAROPHYCEAE

CYTOKINESIS

CELL CYTOSOL



CELL PLATE

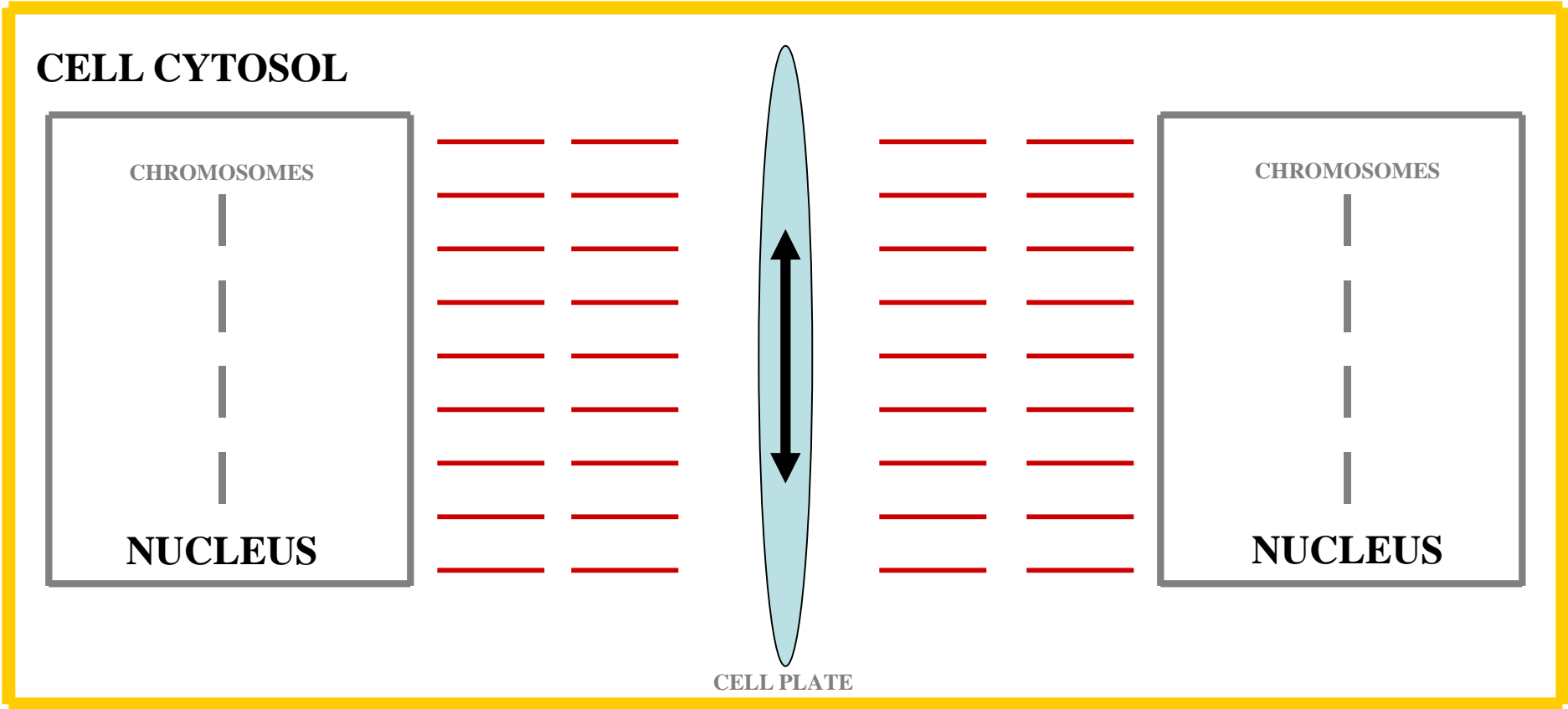


CELL PLATE

-  = CELL MEMBRANE
-  = NUCLEAR MEMBRANE
-  = MICROTUBULE

CHAROPHYCEAE

CYTOKINESIS

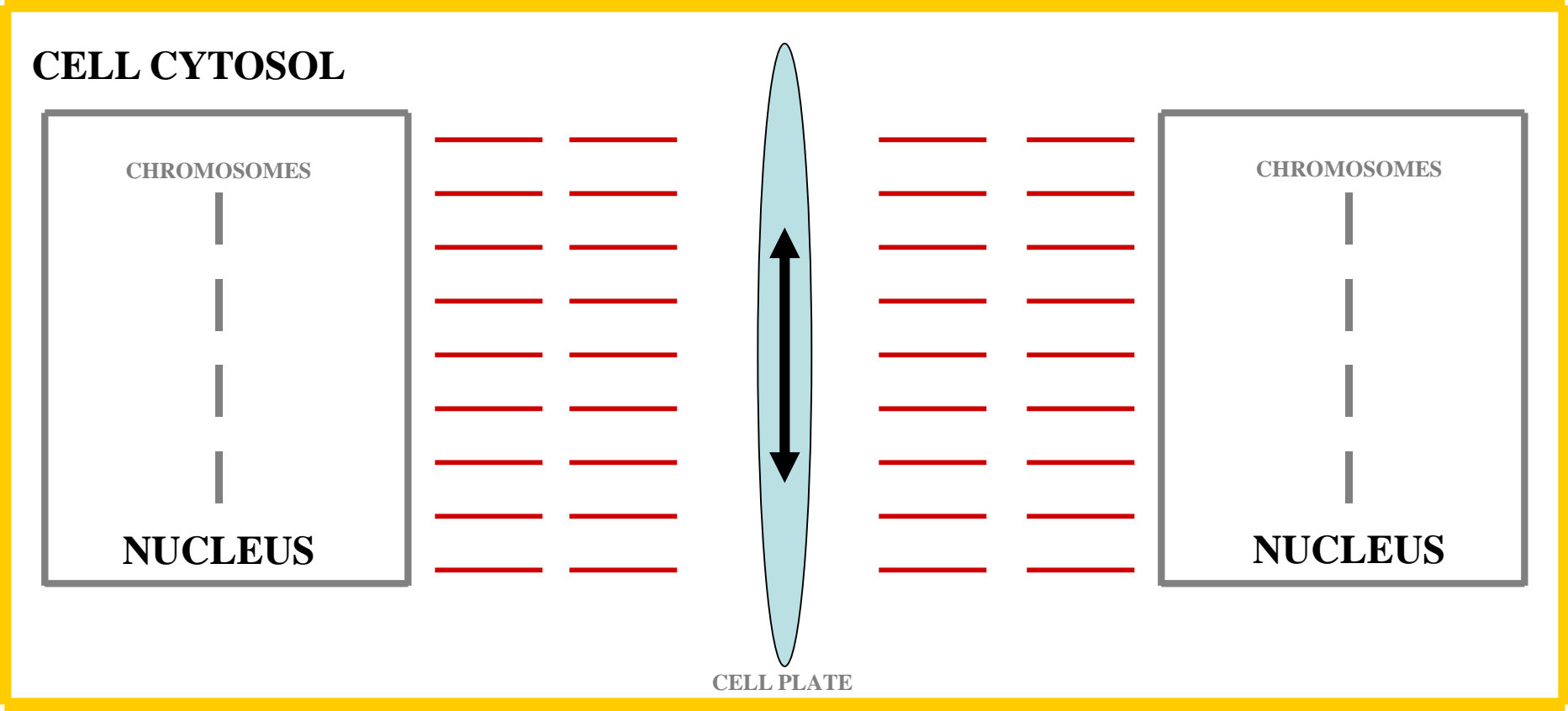


CELL PLATE
CYTOKINESIS SPINDLE PRESENT

-  = CELL MEMBRANE
-  = NUCLEAR MEMBRANE
-  = MICROTUBULE

CHAROPHYCEAE

CYTOKINESIS



CELL PLATE
 CYTOKINESIS SPINDLE PRESENT
 PHRAGMOPLAST SPINDLE

 = CELL MEMBRANE
 = NUCLEAR MEMBRANE
 = MICROTUBULE

PHRAGMOPLAST

PHRAGMOPLAST



CYTOKINESIS SPINDLE

PHRAGMOPLAST

PHRAGMOPLAST



CYTOKINESIS SPINDLE

MICROTUBULES ALIGNED
PERPENDICULAR
TO CELL DIVISION

PHRAGMOPLAST

PHRAGMOPLAST



CYTOKINESIS SPINDLE

**MICROTUBULES ALIGNED
PERPENDICULAR
TO CELL DIVISION**

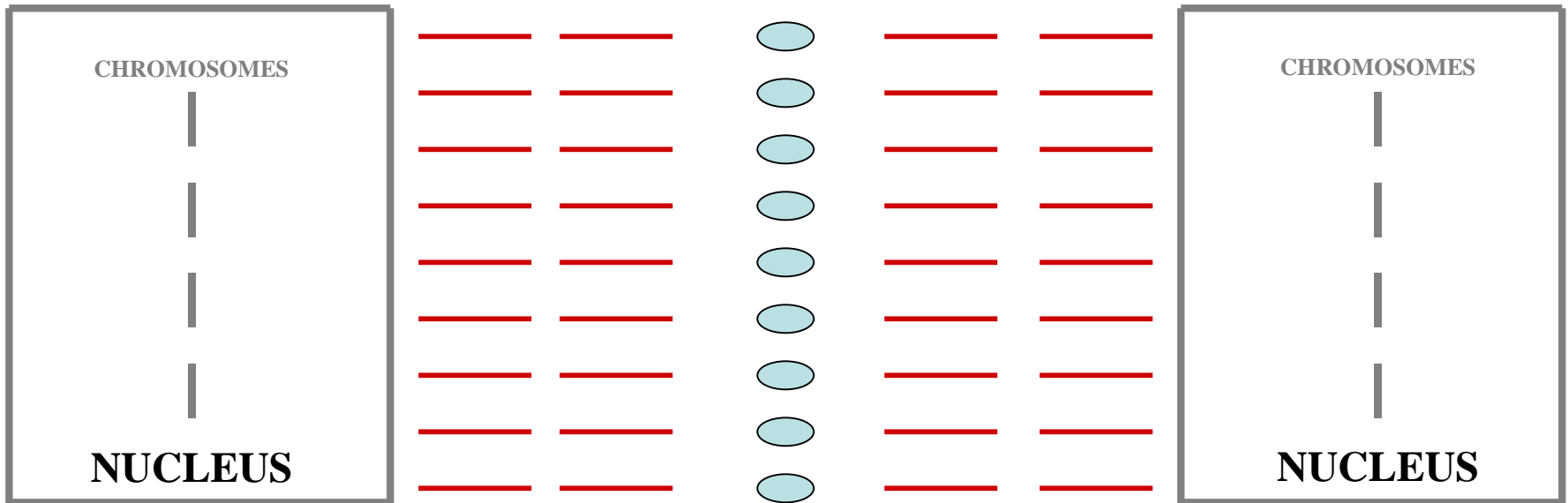
**ALIGNS GOLGI VESICLES
PHRAGMOPLAST**

CHAROPHYCEAE



CYTOKINESIS

CELL CYTOSOL



 = GOLGI VESICLES

CELL PLATE

PHRAGMOPLAST SPINDLE

PERPENDICULAR MICROTUBULES

 = CELL MEMBRANE

 = NUCLEAR MEMBRANE

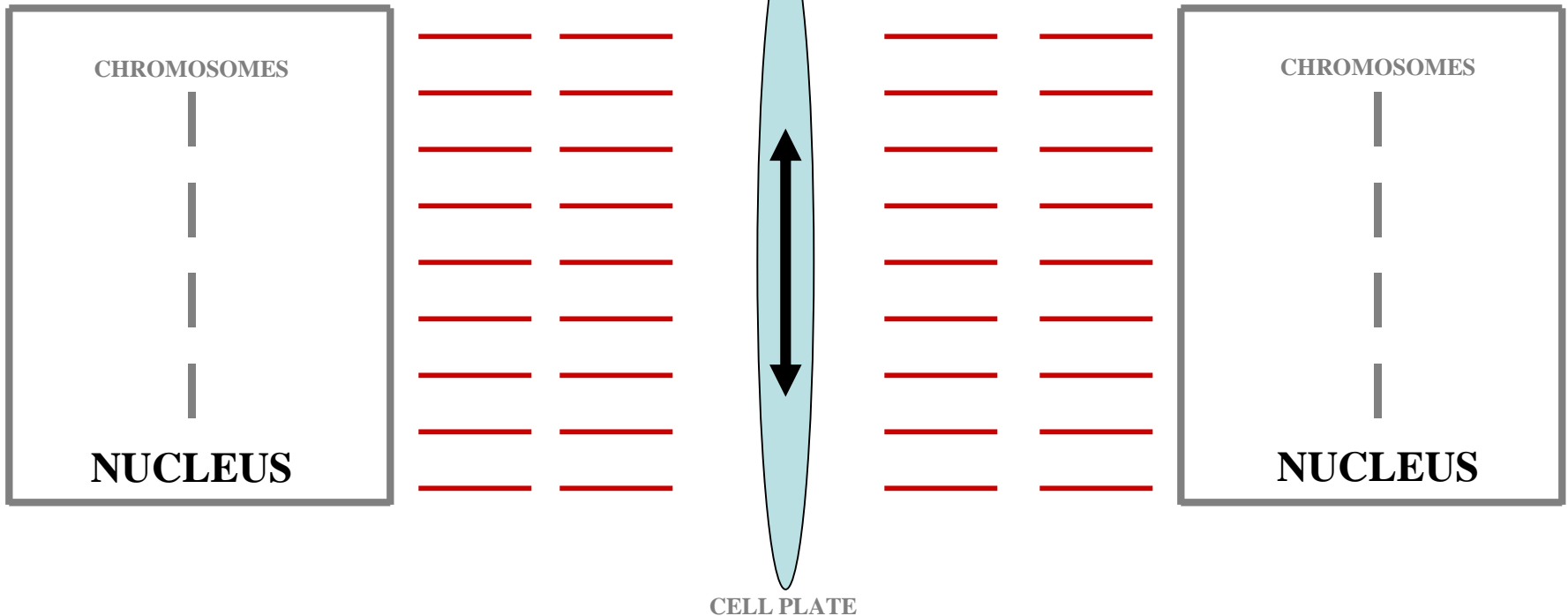
 = MICROTUBULE

CHAROPHYCEAE



CYTOKINESIS

CELL CYTOSOL



CELL PLATE

PHRAGMOPLAST SPINDLE

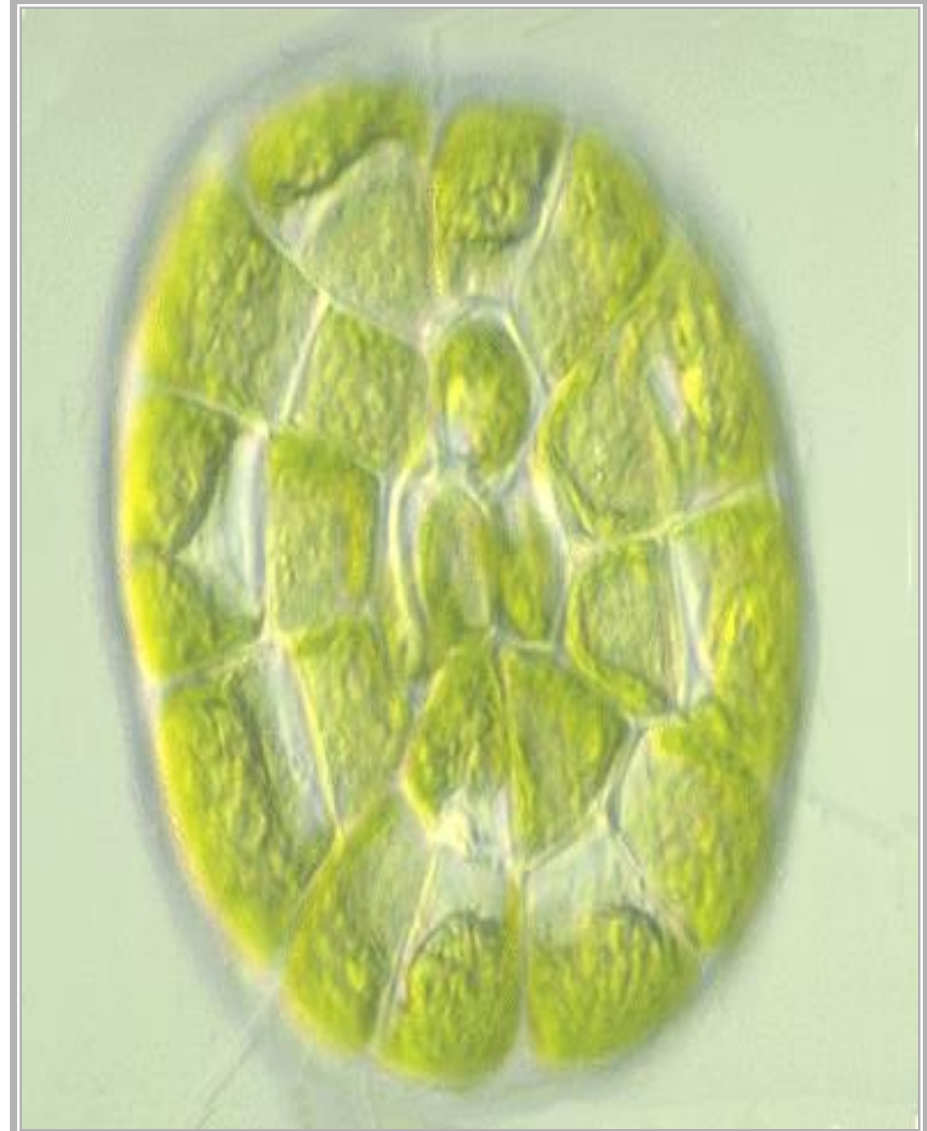
PERPENDICULAR MICROTUBULES

 = CELL MEMBRANE

 = NUCLEAR MEMBRANE

 = MICROTUBULE

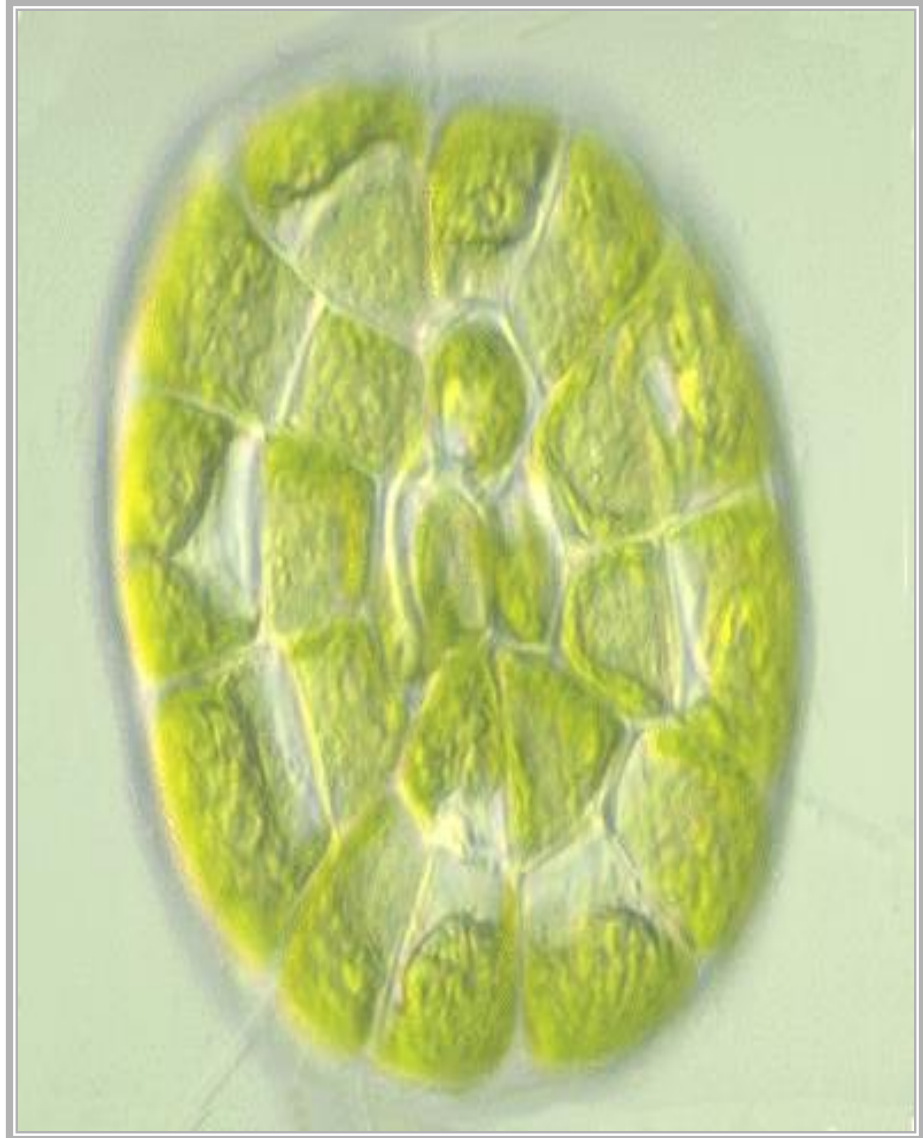
CHAROPHYCEAE



CHAROPHYCEAE



CHARA



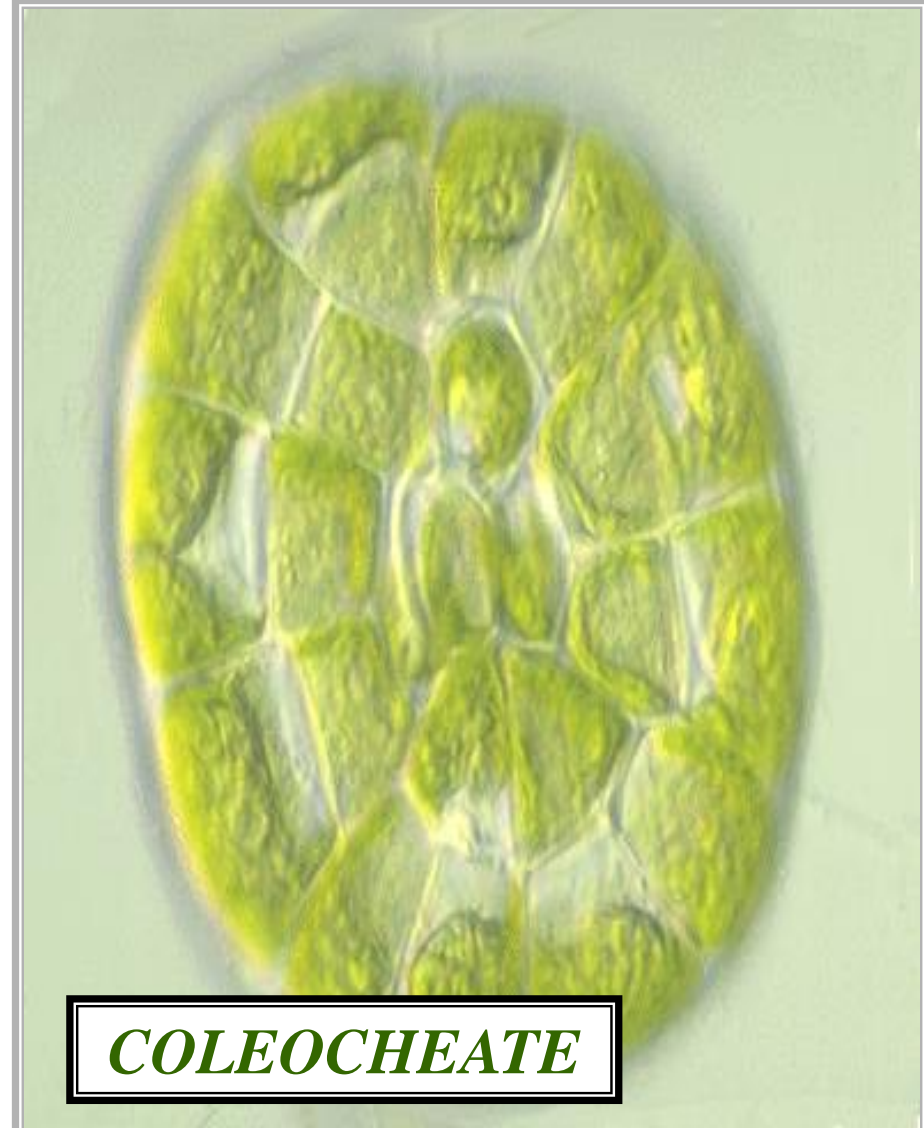
CHAROPHYCEAE

E

>



CHARA



COLEOCHEATE



EMBRYOPHYTES

**CYTOKINESIS:
CELL PLATE FORMATION**

