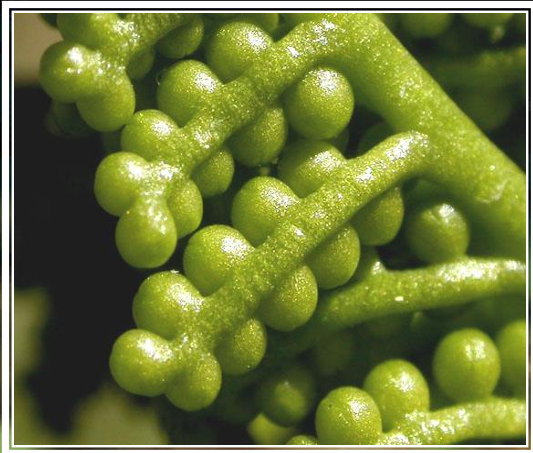




COMMON NAME



GRAPE-FERNS



GRAPE-FERNS

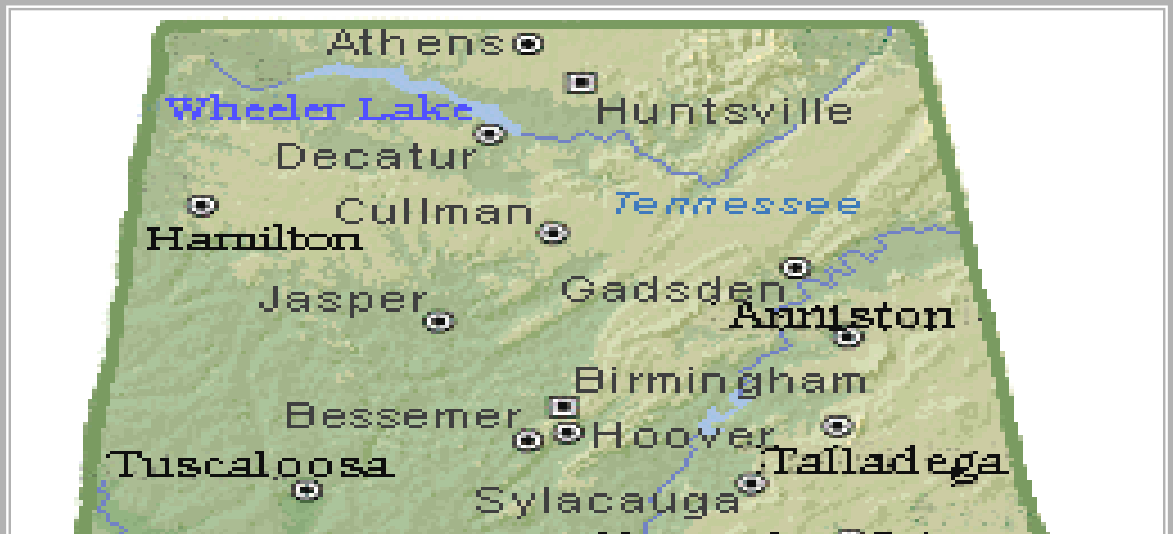


DIVERSITY



~100 SPECIES

EARTH



~7 SPECIES





OPHIOGLOSSALES
MINOR
ALABAMA
COMPONENT
ALABAMA FLORA





REPRESENTATIVE GENERA



OPHIOGLOSSUM



BOTRYCHIUM



HABITAT



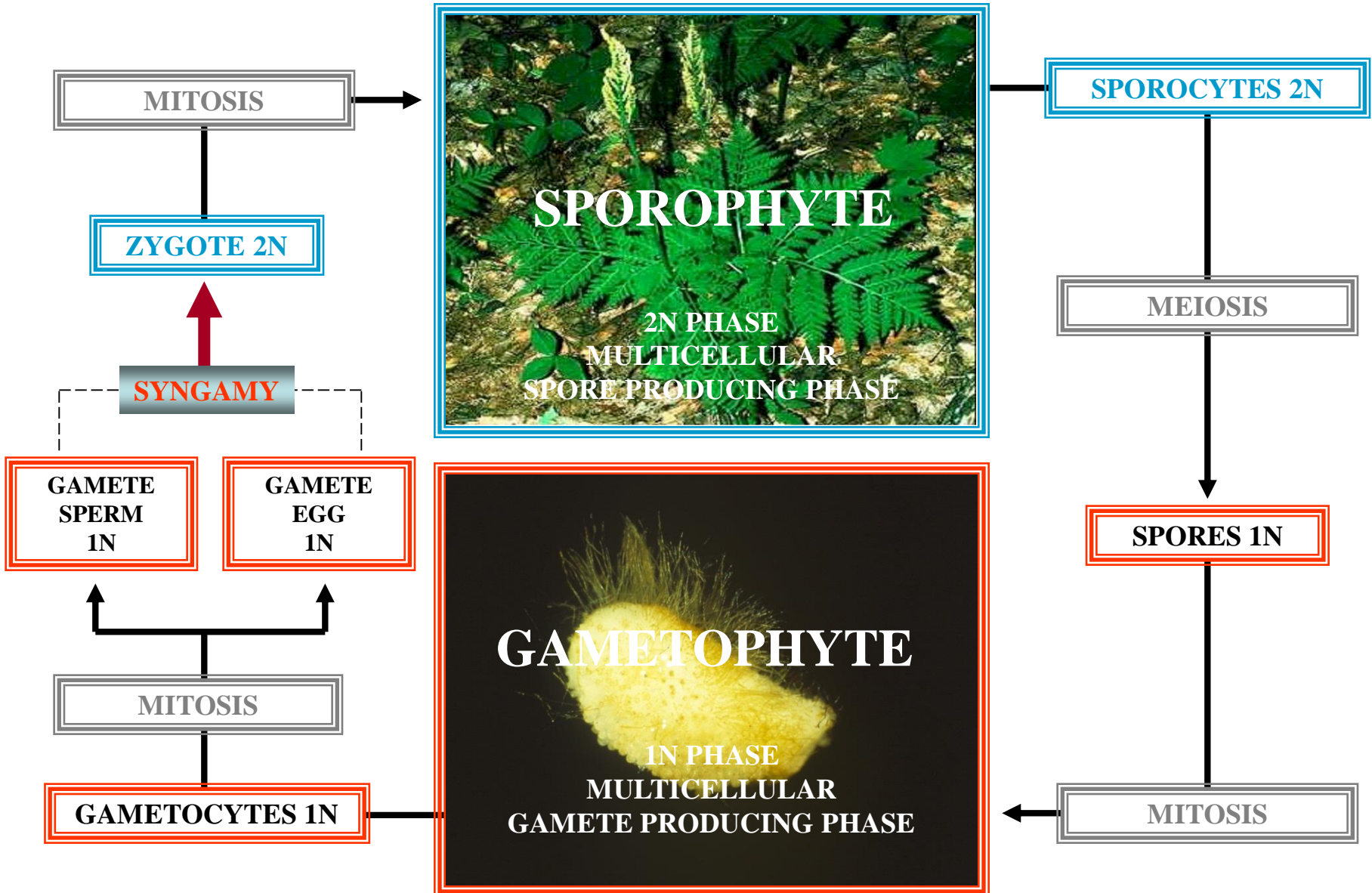
ALABAMA FOREST



GENERAL CHARACTERS

OPHIOGLOSSALES

LIFE CYCLE





SPOROPHYTE CHARACTERS

KARYOTYPE

KARYOTYPE

OPHIOGLOSSOPSIDA KARYOTYPE



CHROMOSOME CHARACTERS

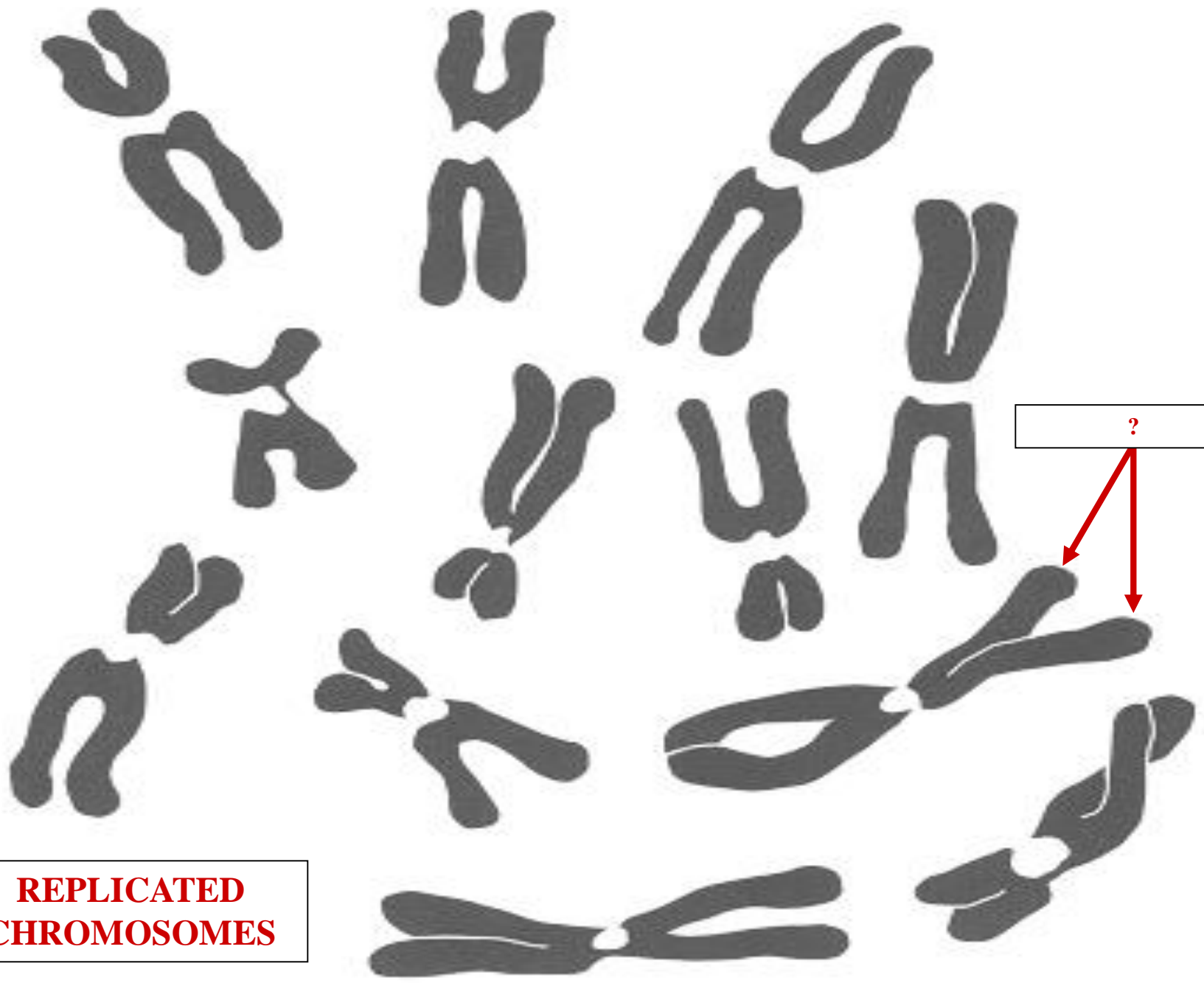
OPHIOGLOSSOPSIDA KARYOTYPE



CHROMOSOMES



**REPLICATED
CHROMOSOMES**



**REPLICATED
CHROMOSOMES**



CHROMATIDS

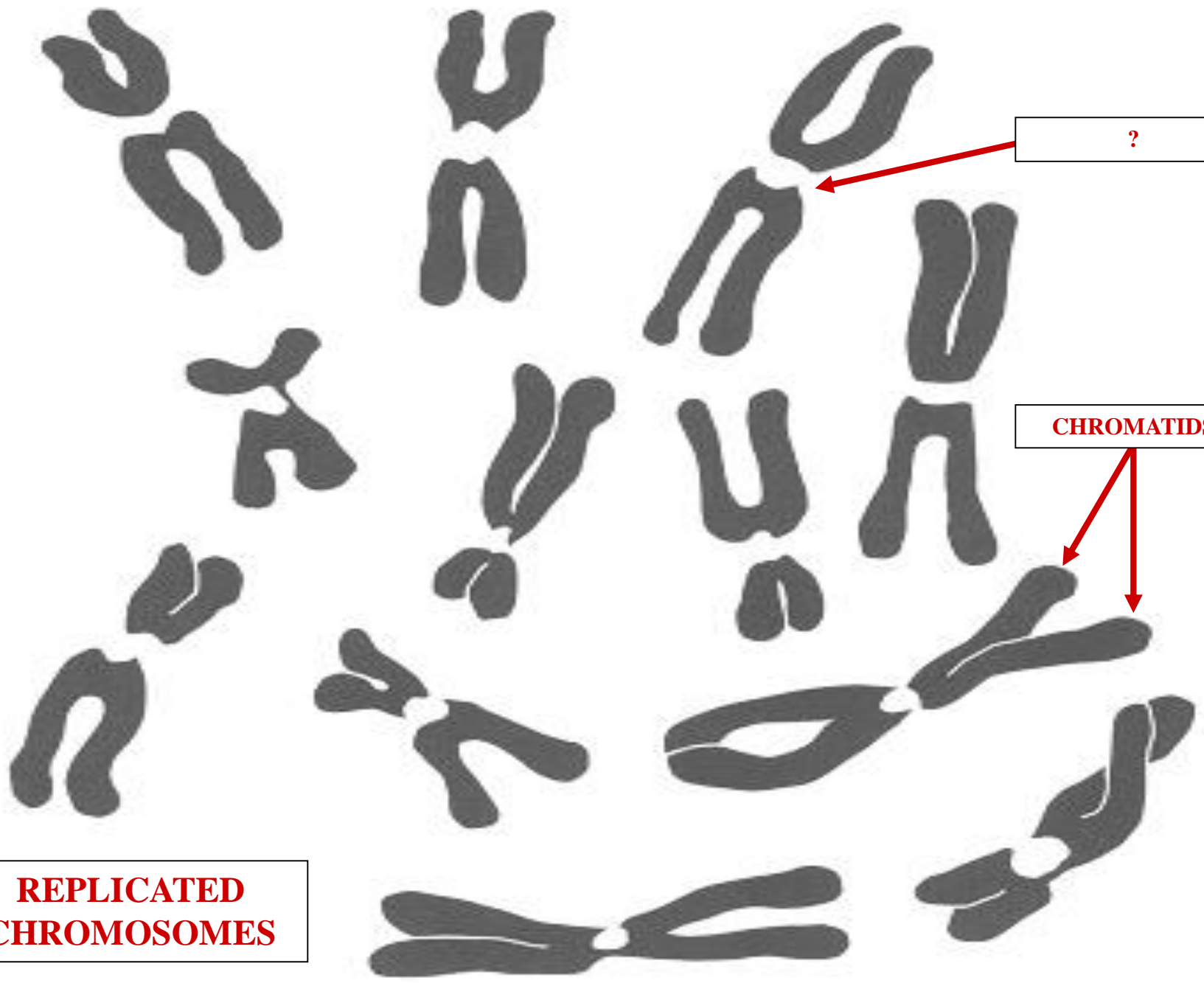


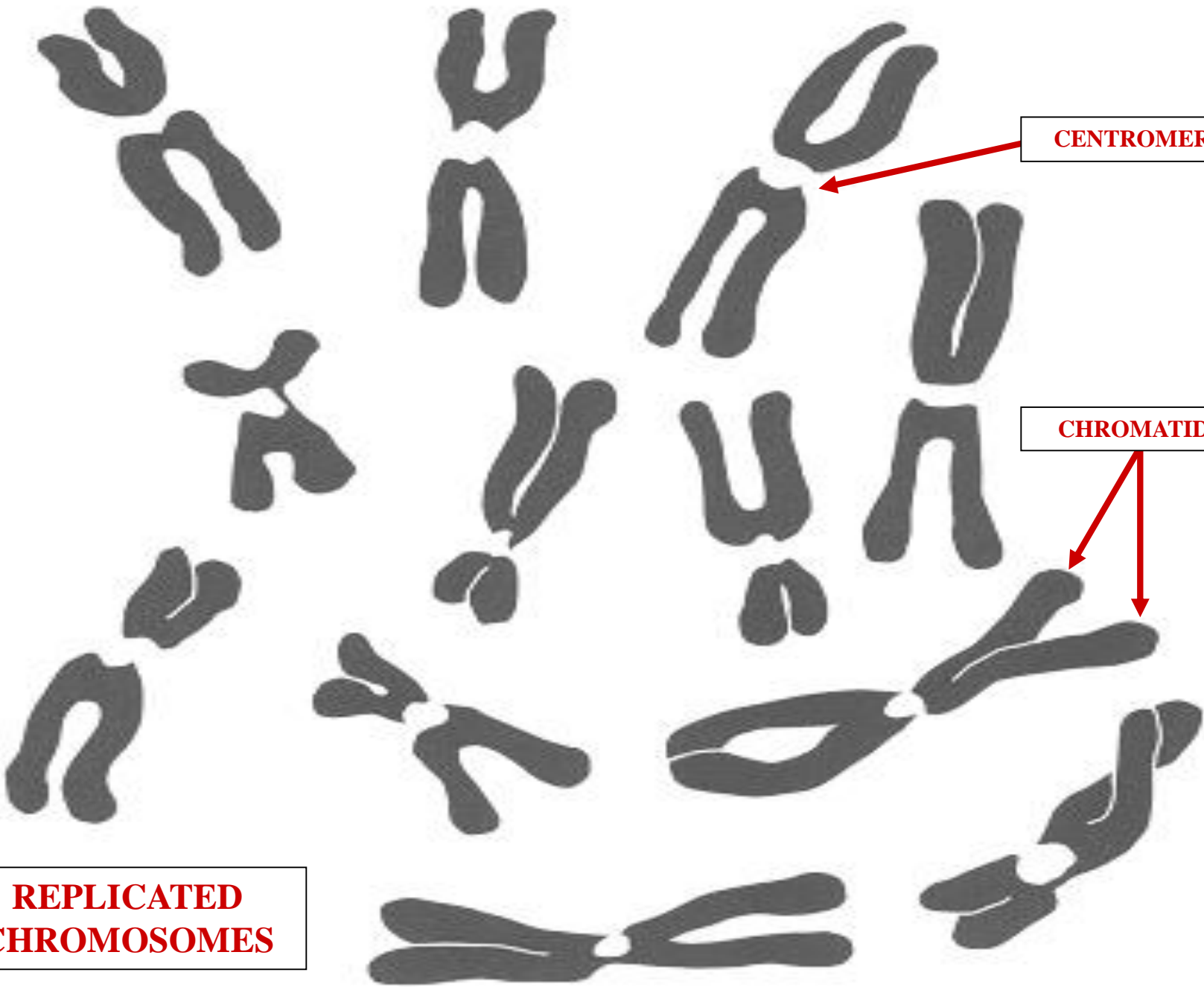
**REPLICATED
CHROMOSOMES**

?

CHROMATIDS

REPLICATED
CHROMOSOMES





CENTROMERE

CHROMATIDS

**REPLICATED
CHROMOSOMES**

HIGHEST KNOWN
VASCULAR PLANT
CHROMOSOME
NUMBER

OPHIOGLOSSUM

$2N = 1260$

OPHIOGLOSSUM



HIGHEST KNOWN VASCULAR PLANT KARYOTYPES

OPHIOGLOSSUM



ROOT



**TRUE ROOTS
PRESENT**

VERTICAL RHIZOME

BOTRYCHIUM



**TRUE ROOTS
PRESENT
REDUCED**

VERTICAL RHIZOME

BOTRYCHIUM

**TRUE ROOT
REDUCED**

A

**MATURATION
REGION**

**ELONGATION
REGION**

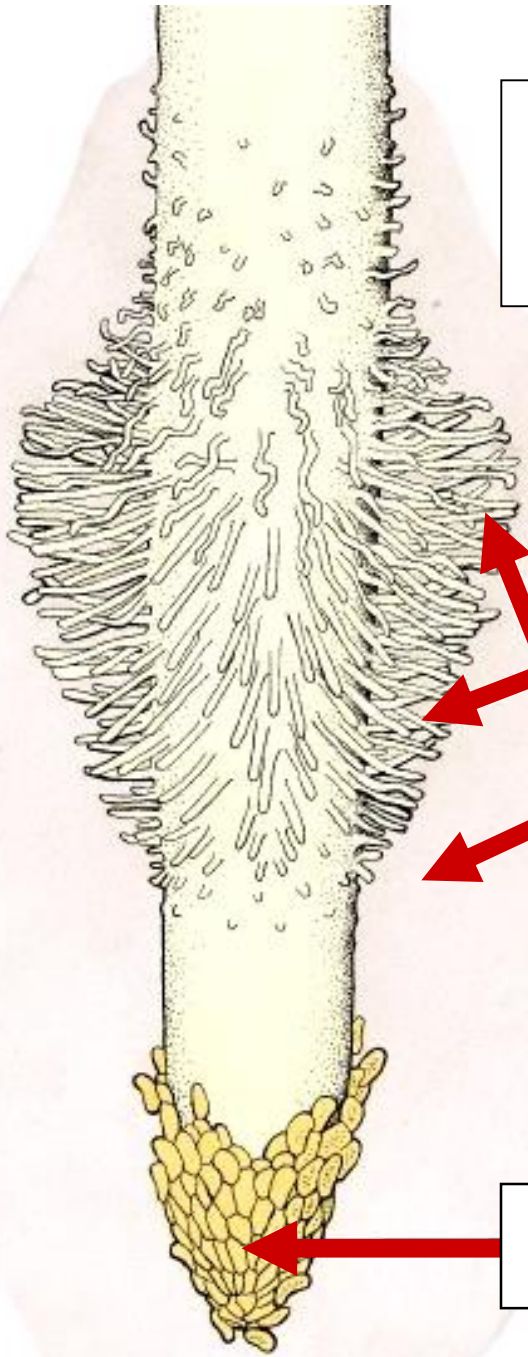
**DIVISION
REGION**

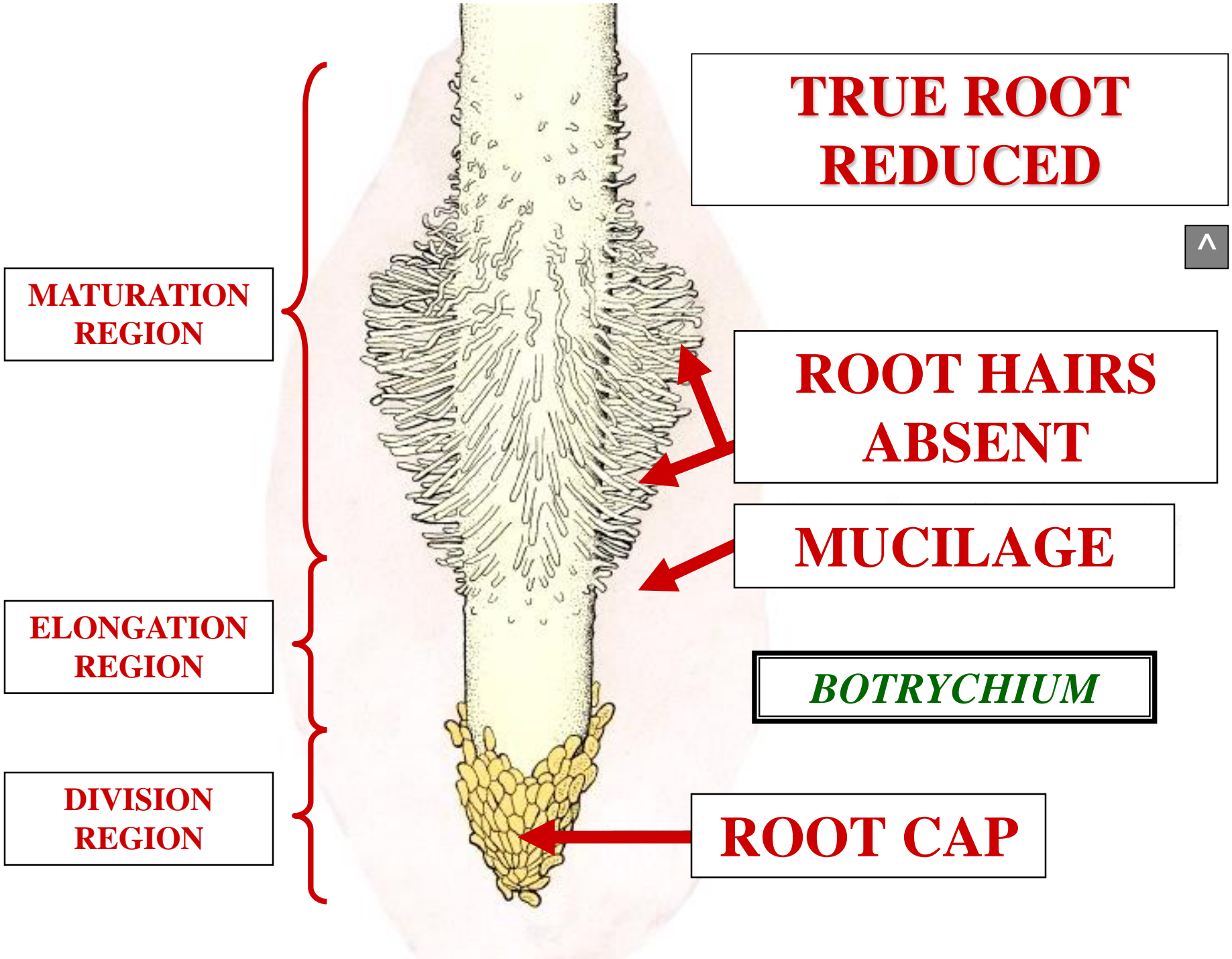
ROOT HAIRS

MUCILAGE

BOTRYCHIUM

ROOT CAP







STEM



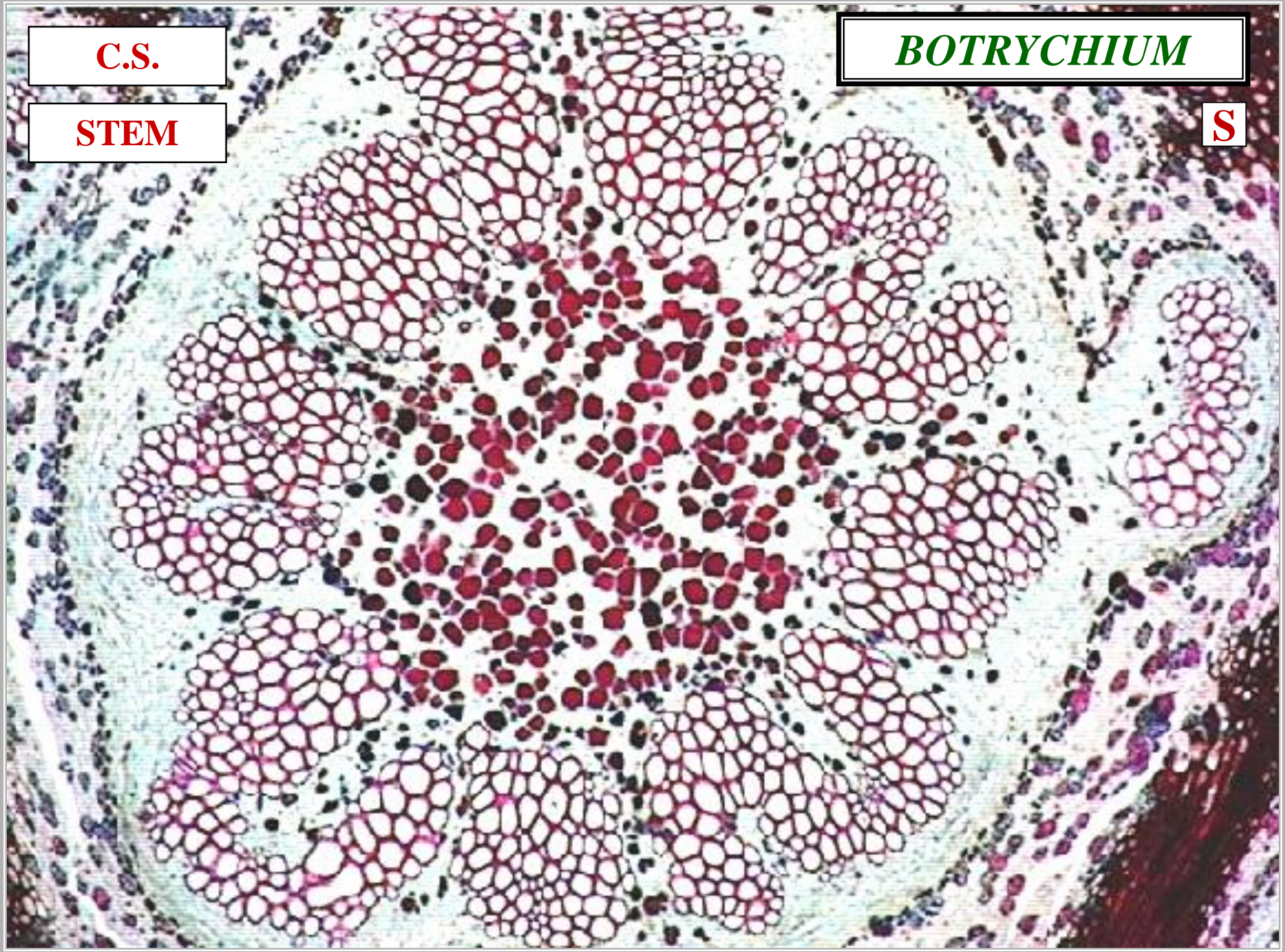
STEM STELE

C.S.

BOTRYCHIUM

STEM

S



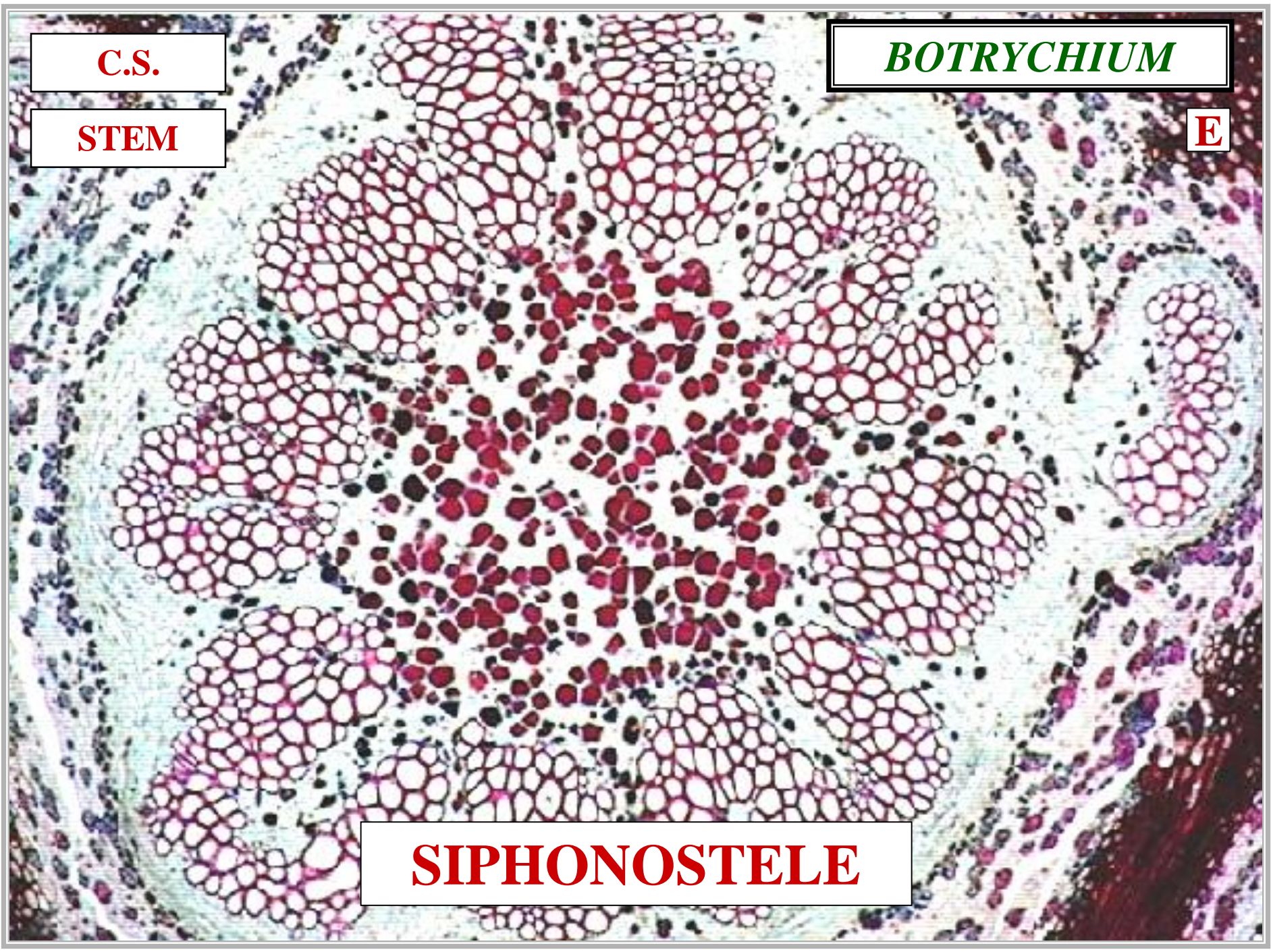
C.S.

BOTRYCHIUM

STEM

E

SIPHONOSTELE



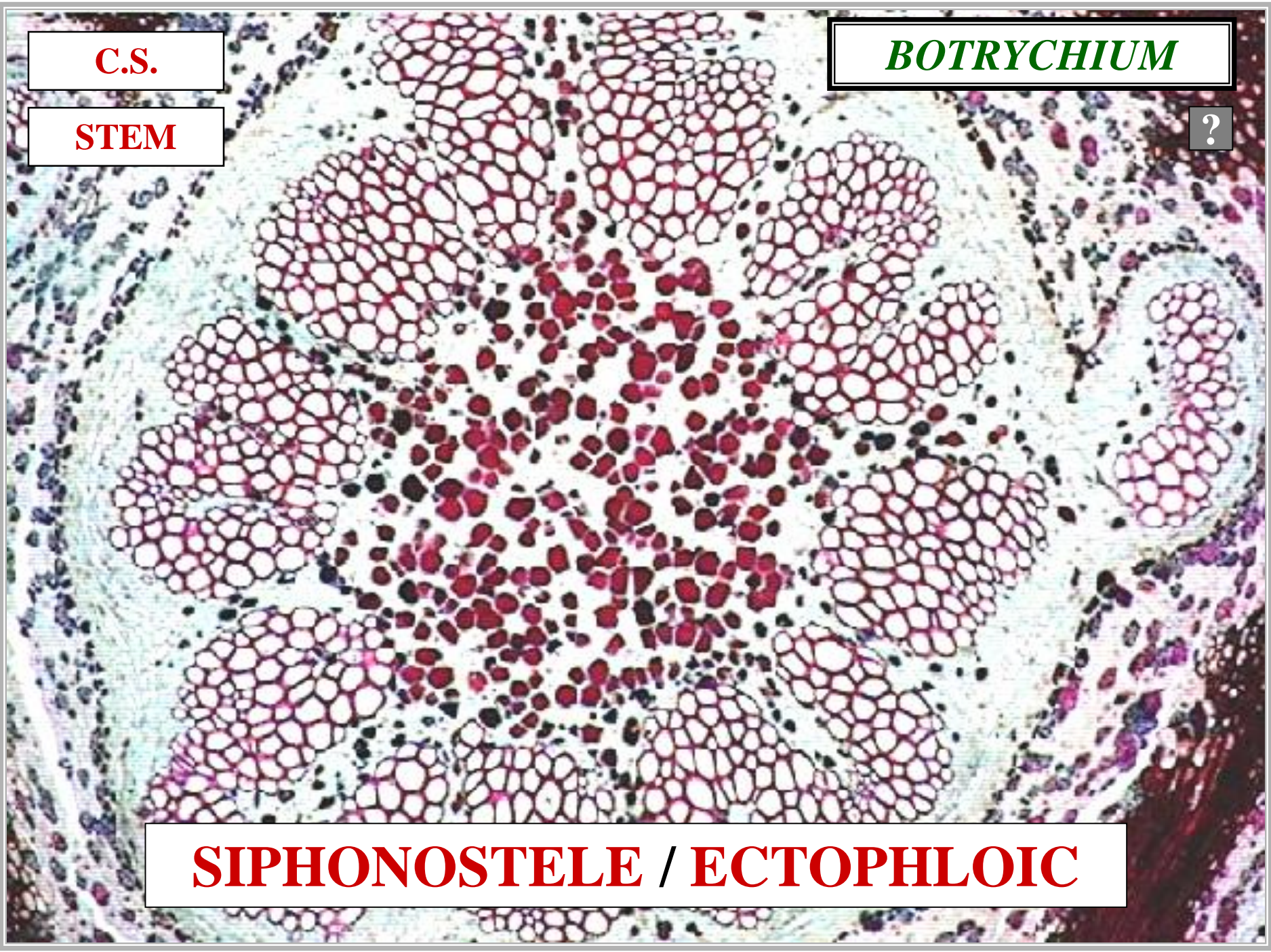
C.S.

BOTRYCHIUM

STEM

?

SIPHONOSTELE / ECTOPHLOIC



C.S.

BOTRYCHIUM

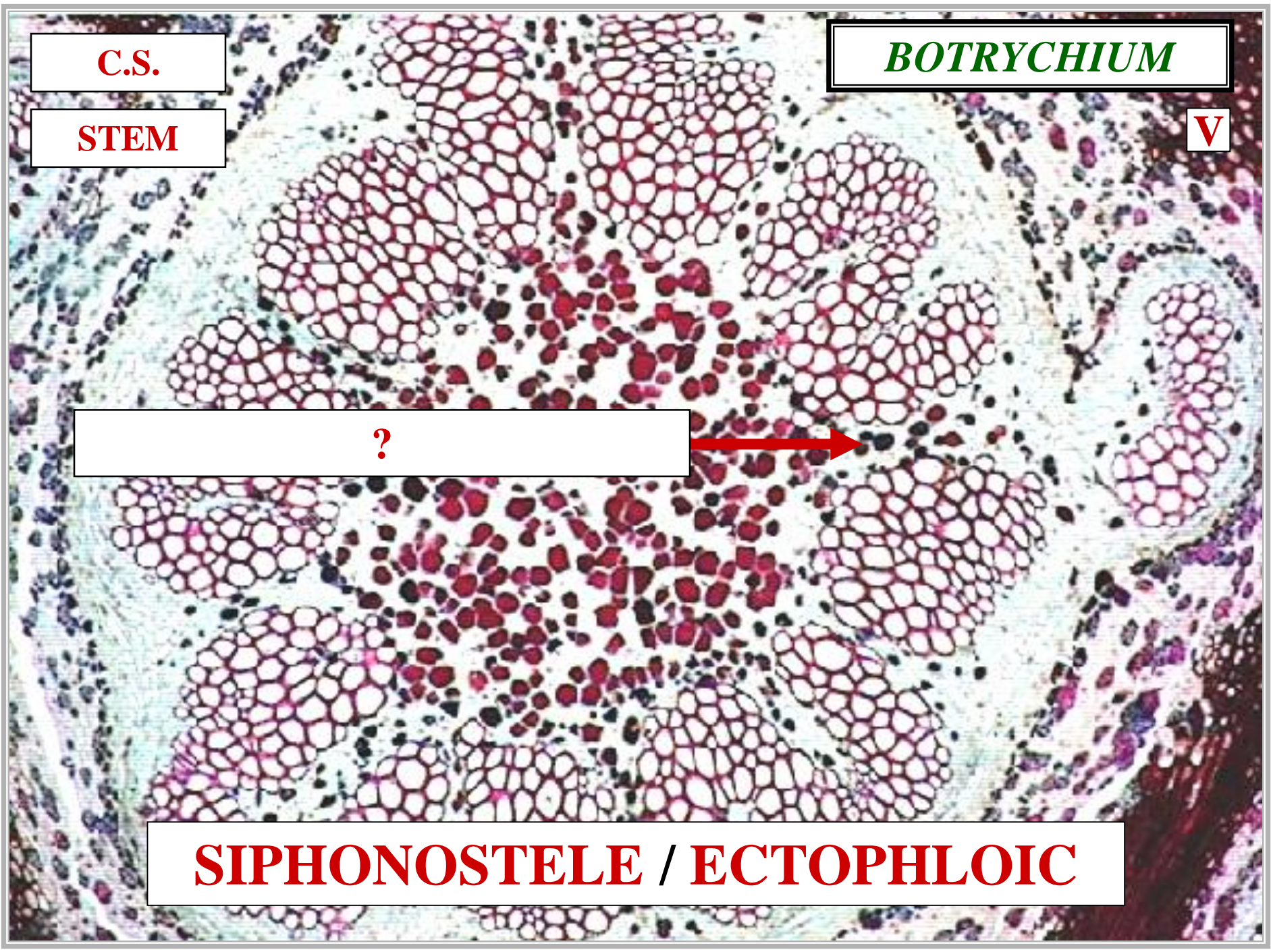
STEM

V

?



SIPHONOSTELE / ECTOPHLOIC



C.S.

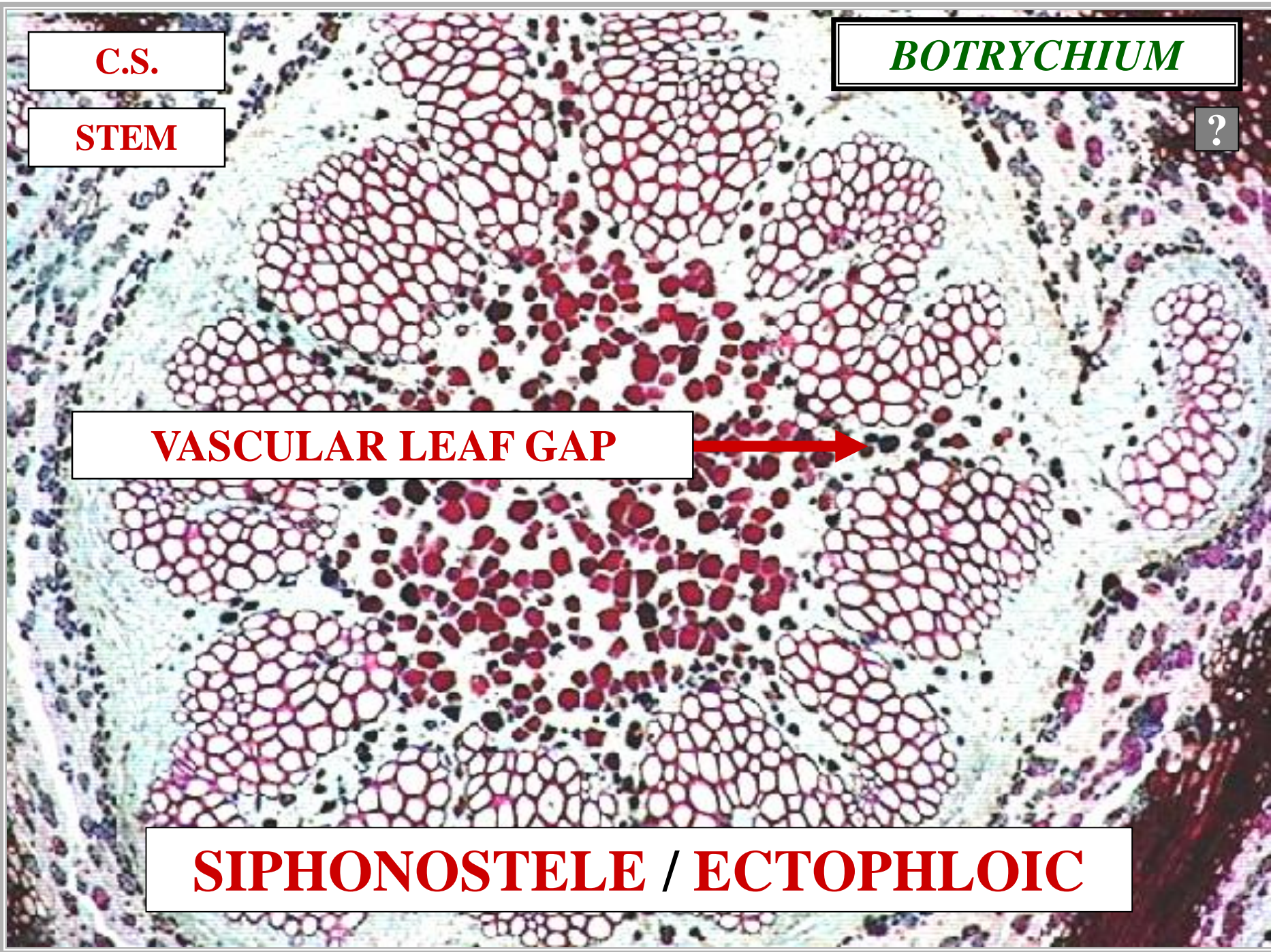
BOTRYCHIUM

STEM

?

VASCULAR LEAF GAP →

SIPHONOSTELE / ECTOPHLOIC



C.S.

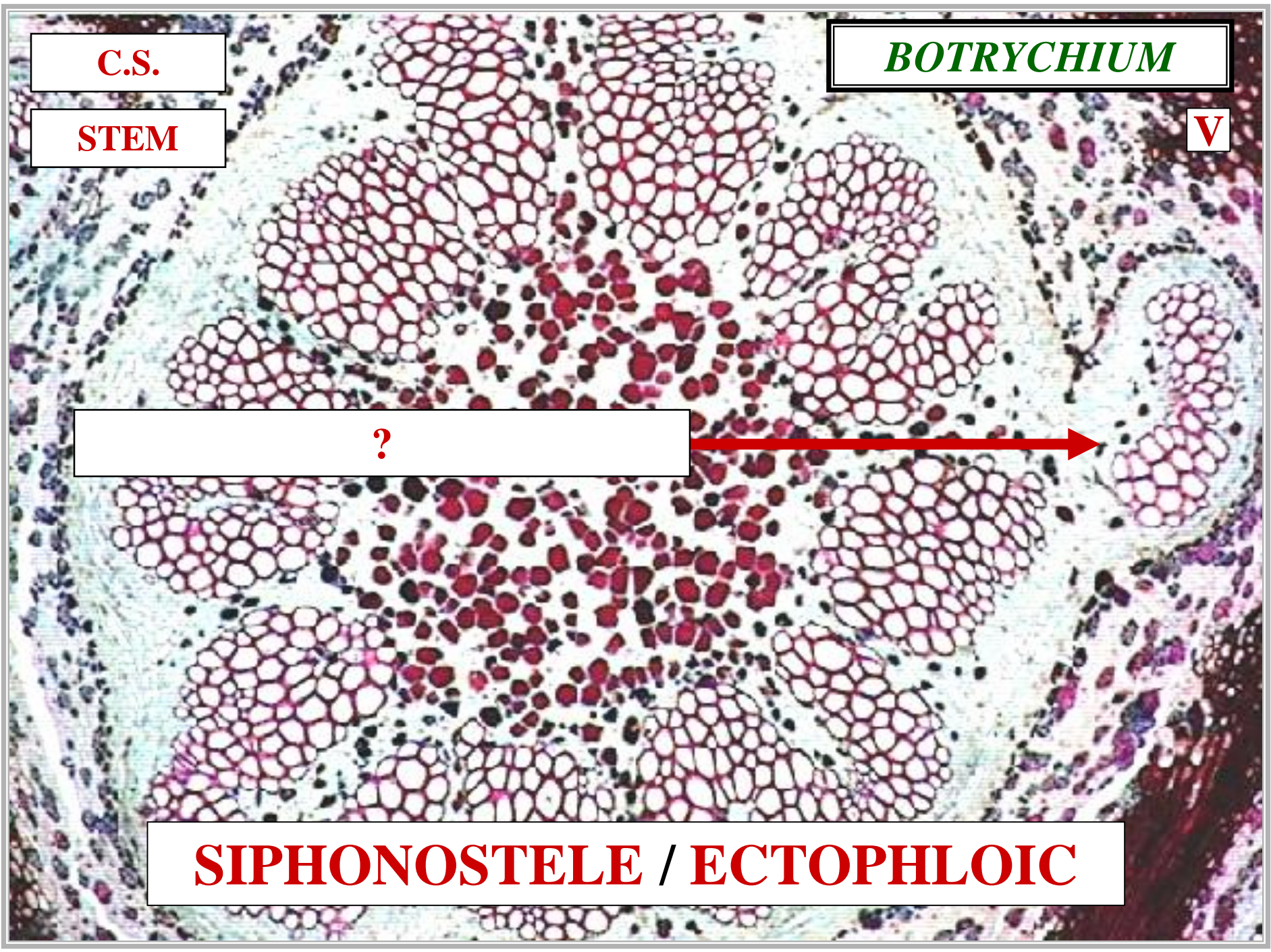
BOTRYCHIUM

STEM

V

?

SIPHONOSTELE / ECTOPHLOIC



C.S.

BOTRYCHIUM

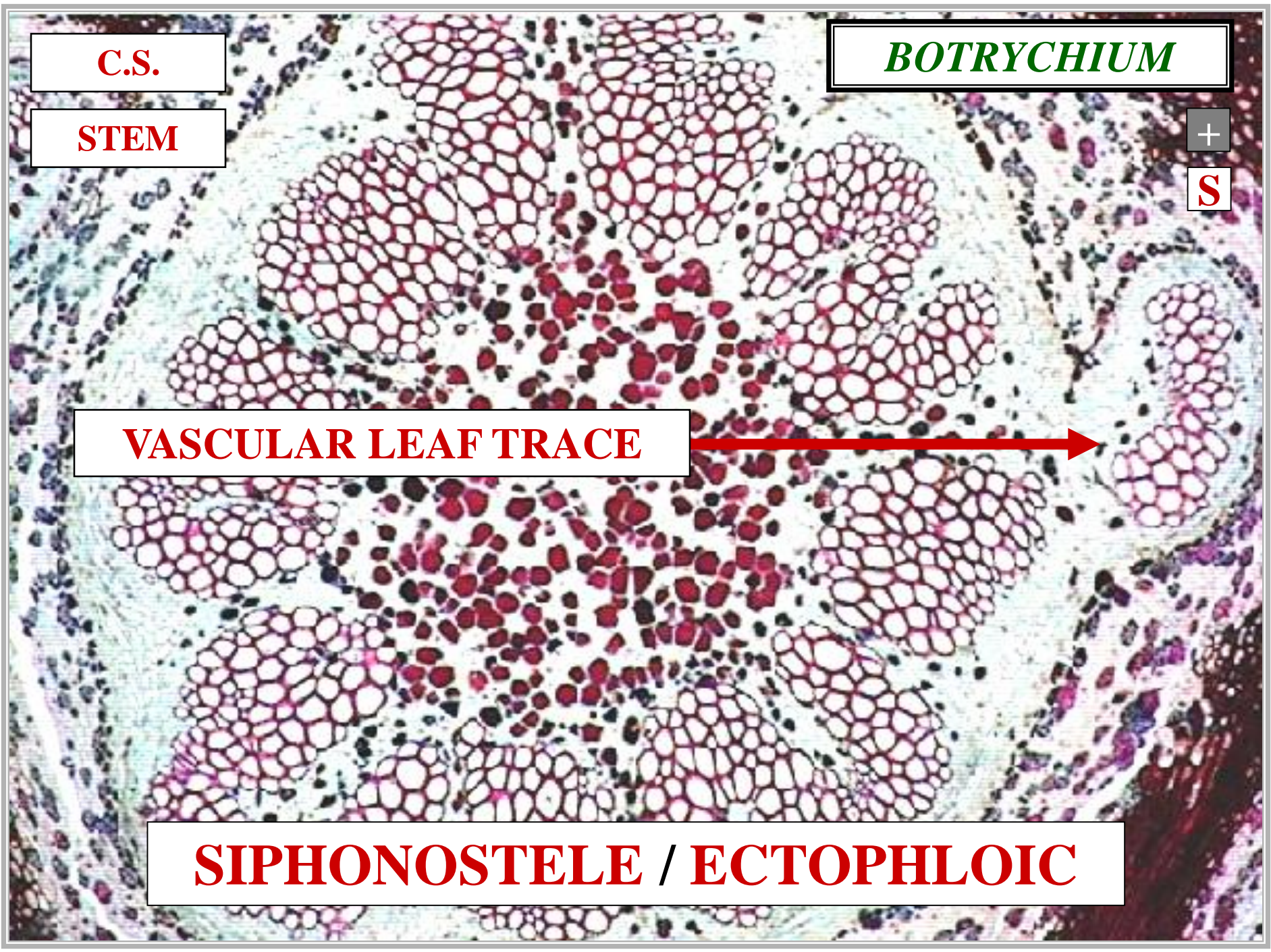
STEM

+

S

VASCULAR LEAF TRACE →

SIPHONOSTELE / ECTOPHLOIC



C.S.

BOTRYCHIUM

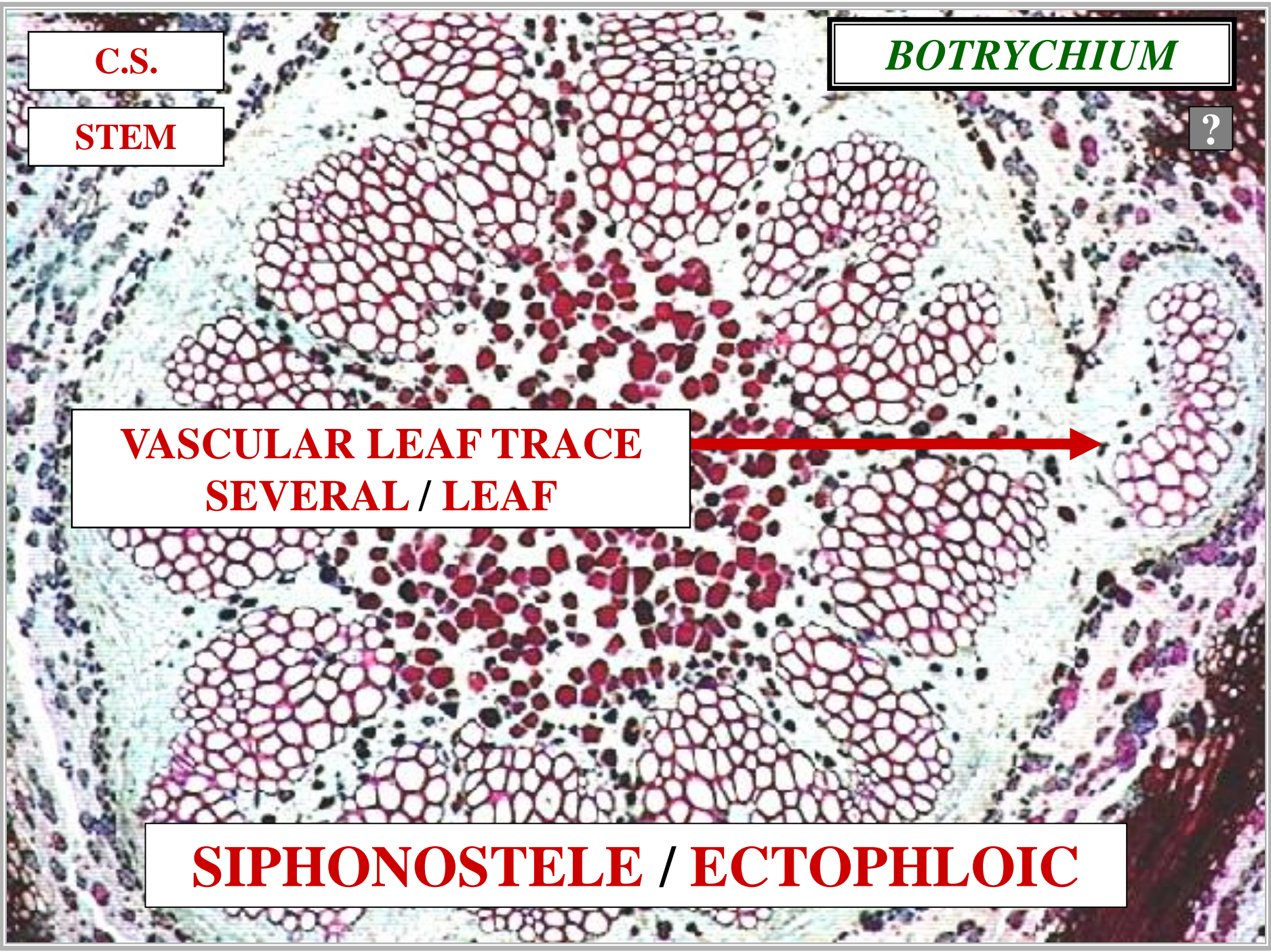
STEM

?

**VASCULAR LEAF TRACE
SEVERAL / LEAF**



SIPHONOSTELE / ECTOPHLOIC



C.S.

BOTRYCHIUM

STEM

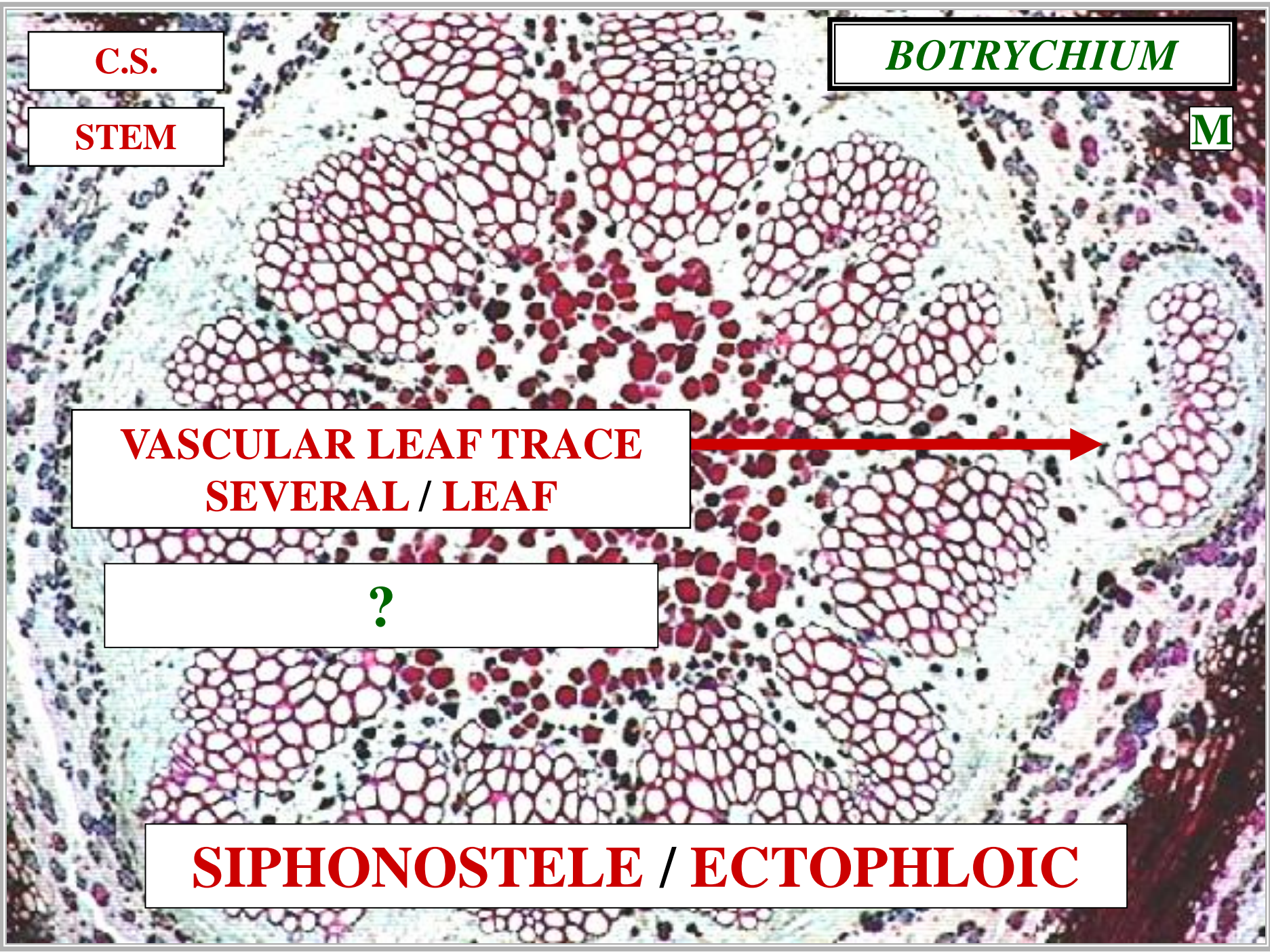
M

**VASCULAR LEAF TRACE
SEVERAL / LEAF**



?

SIPHONOSTELE / ECTOPHLOIC



C.S.

BOTRYCHIUM

STEM

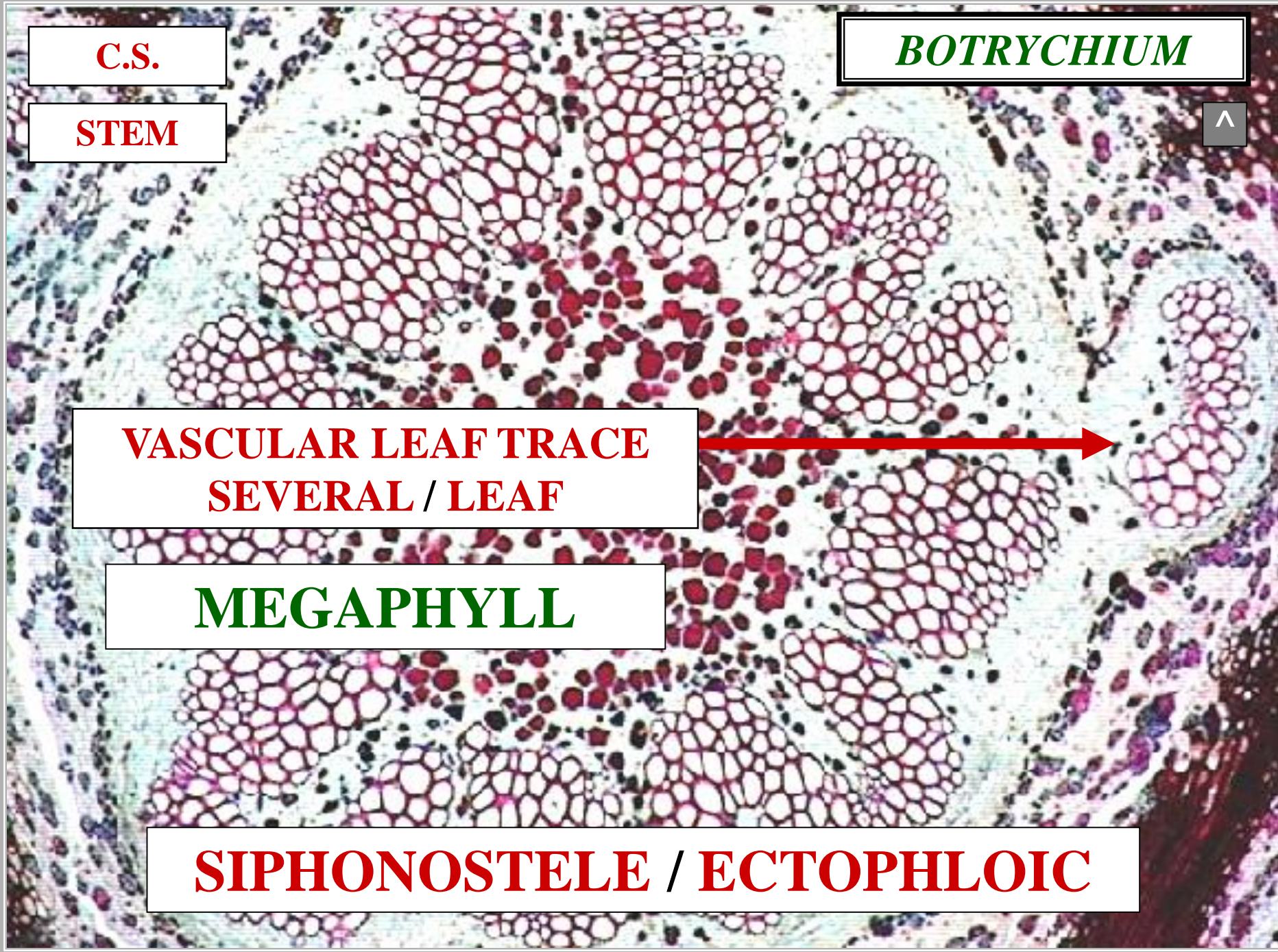


**VASCULAR LEAF TRACE
SEVERAL / LEAF**



MEGAPHYLL

SIPHONOSTELE / ECTOPHLOIC





RHIZOME



ROOTS

VERTICAL RHIZOME

BOTRYCHIUM

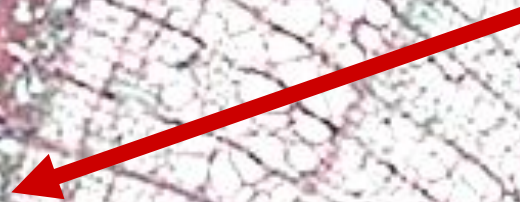


ROOTS

BRANCHING ABSENT

BOTRYCHIUM

?



RHIZOME

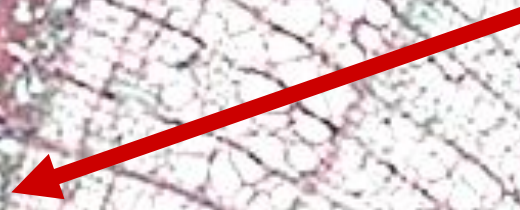
C.S.



BOTRYCHIUM

P

**VASCULAR
CAMBIUM**



RHIZOME

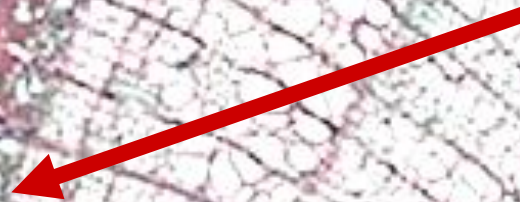
C.S.



BOTRYCHIUM

X

**VASCULAR
CAMBIUM**



~2 PHLOEM

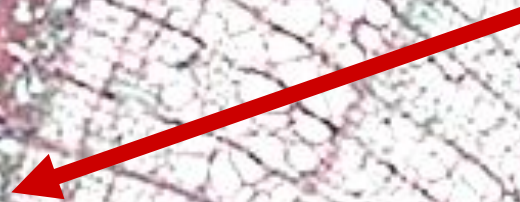
RHIZOME

C.S.



BOTRYCHIUM

**VASCULAR
CAMBIUM**



~2 PHLOEM

~2 XYLEM

RHIZOME

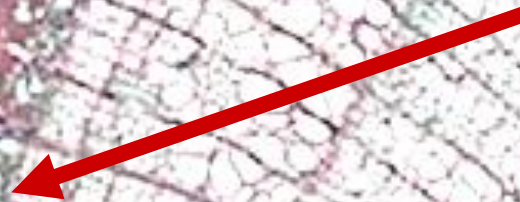
C.S.



BOTRYCHIUM



**VASCULAR
CAMBIUM**



~2 PHLOEM

~2 XYLEM



SECONDARY GROWTH: PRESENT

RHIZOME

C.S.

BOTRYCHIUM

BOTRYCHIUM

ONLY KNOWN

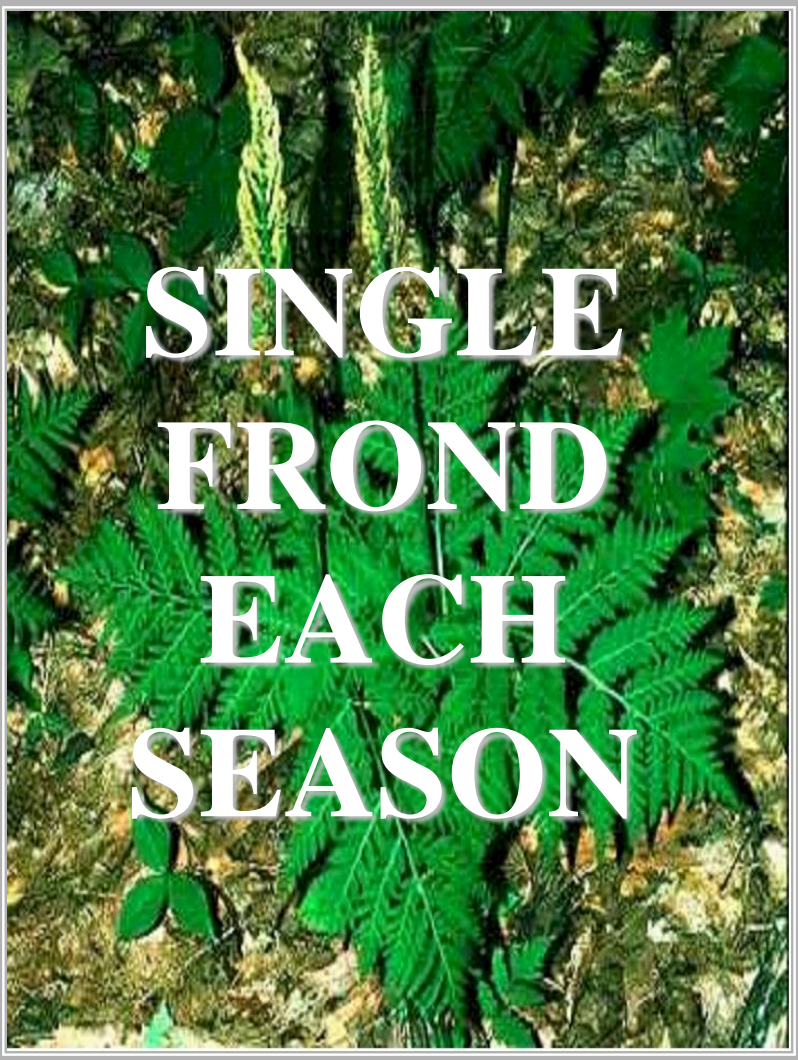
PTERIDOPHYTA

WITH

SECONDARY GROWTH



FROND



SINGLE
FROND
EACH
SEASON

BOTRYCHIUM

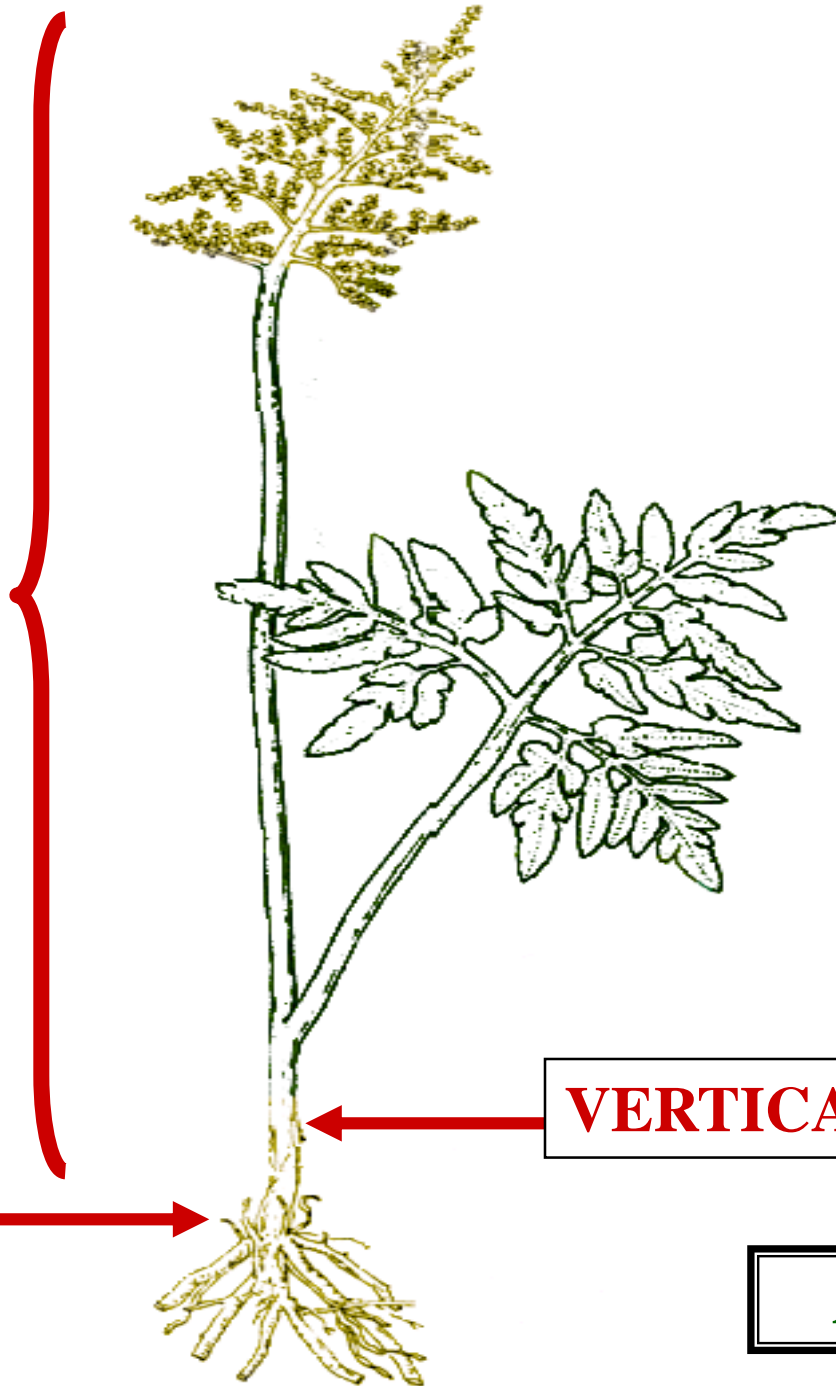


SINGLE
FROND
EACH
SEASON

OPHIOGLOSSUM



**1 FROND
PER
SEASON**



ROOTS

VERTICAL RHIZOME

BOTRYCHIUM

PHYLOTAXY



**1 FROND
PER
SEASON**



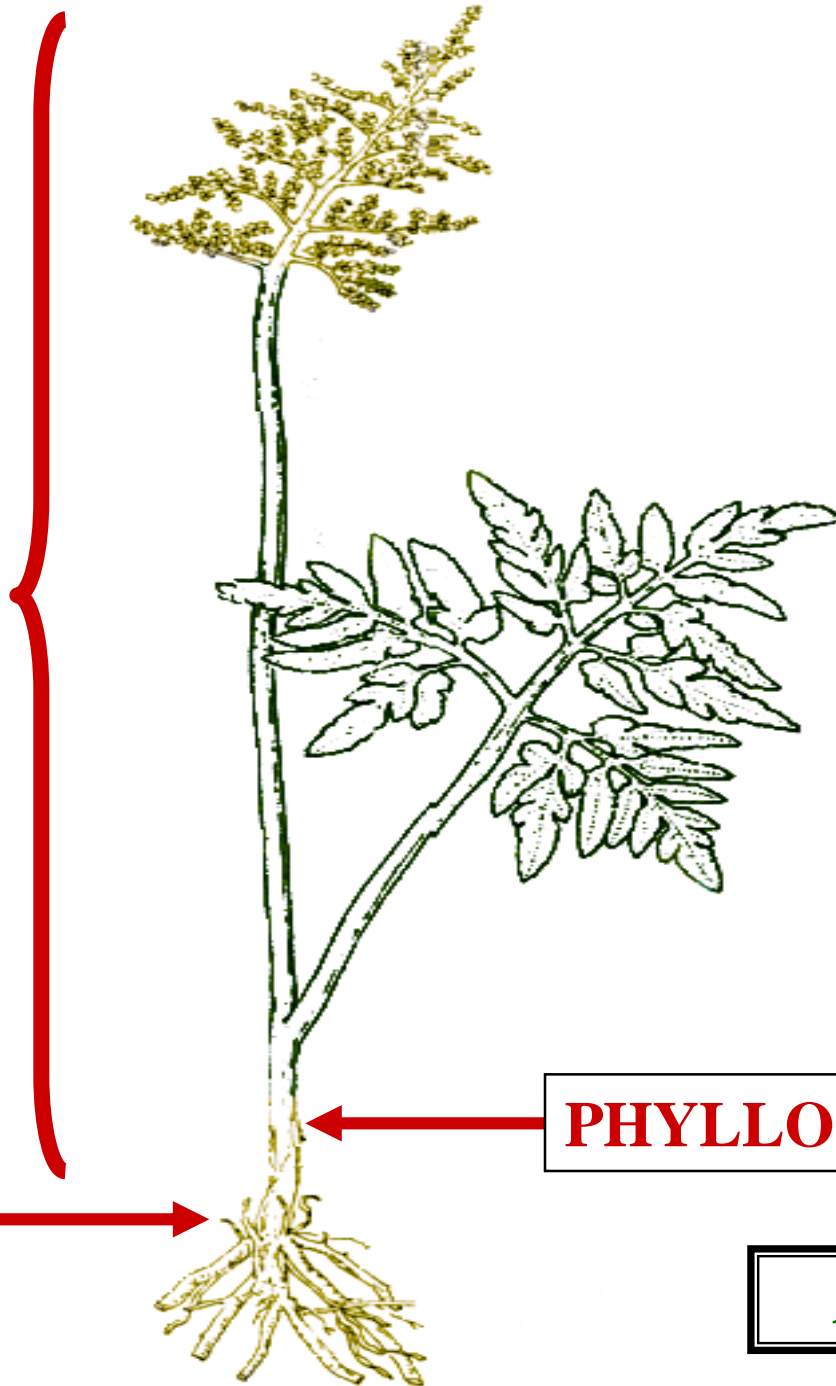
ROOTS

PHYLLOTAXY

BOTRYCHIUM



**1 FROND
PER
NODE**



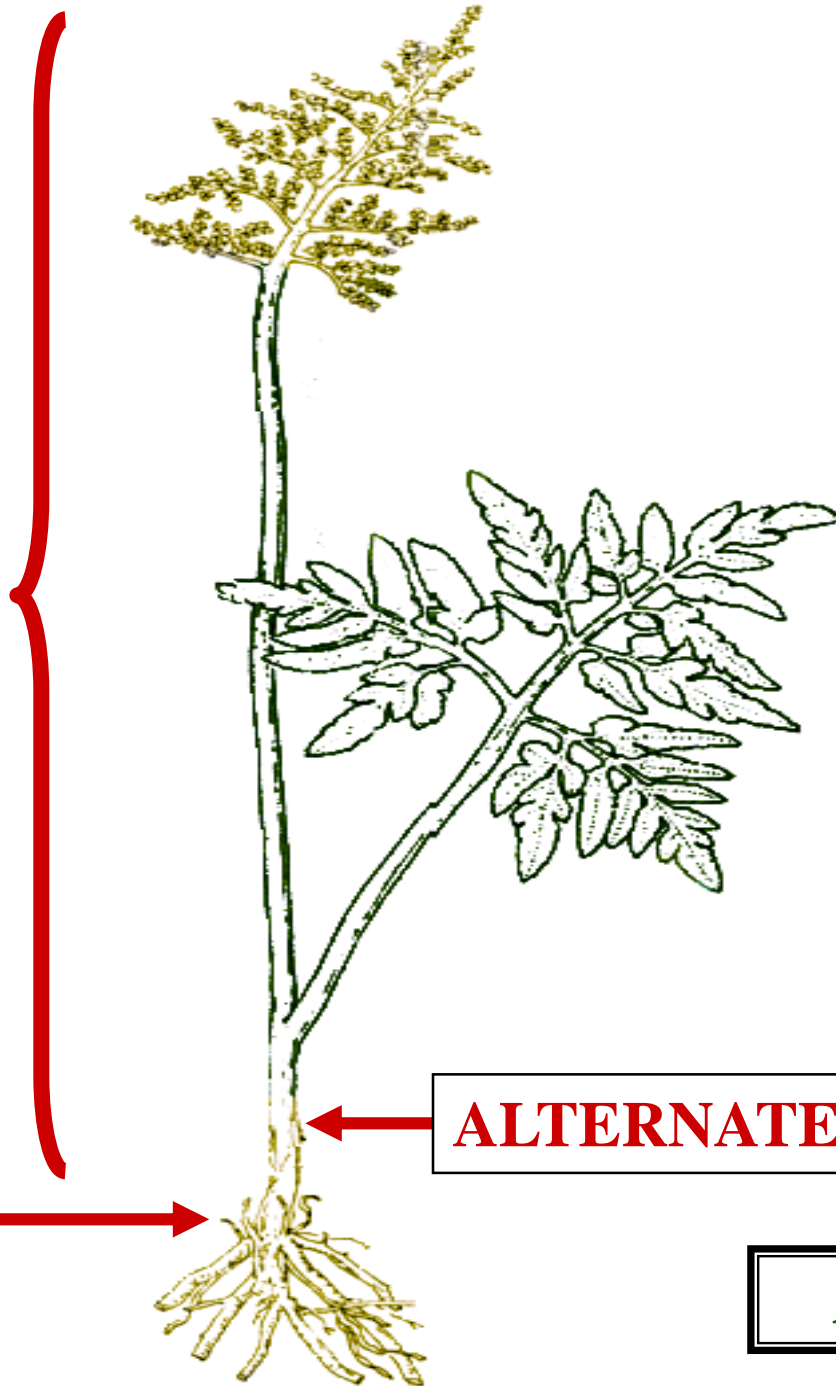
ROOTS

PHYLLOTAXY

BOTRYCHIUM



**1 FROND
PER
NODE**



ROOTS

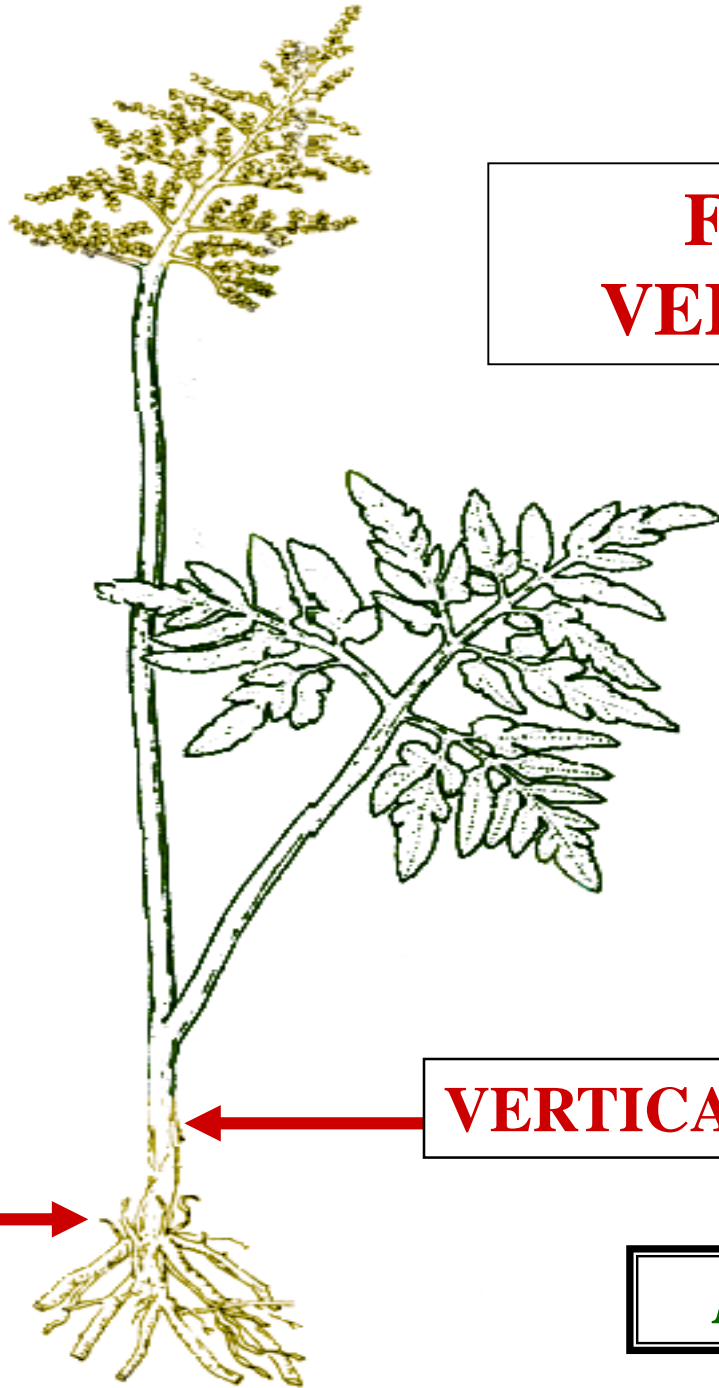
ALTERNATE PHYLLOTAXY

BOTRYCHIUM

FROND VERNATION



**1 FROND
PER
SEASON**



**FROND
VERNATION**

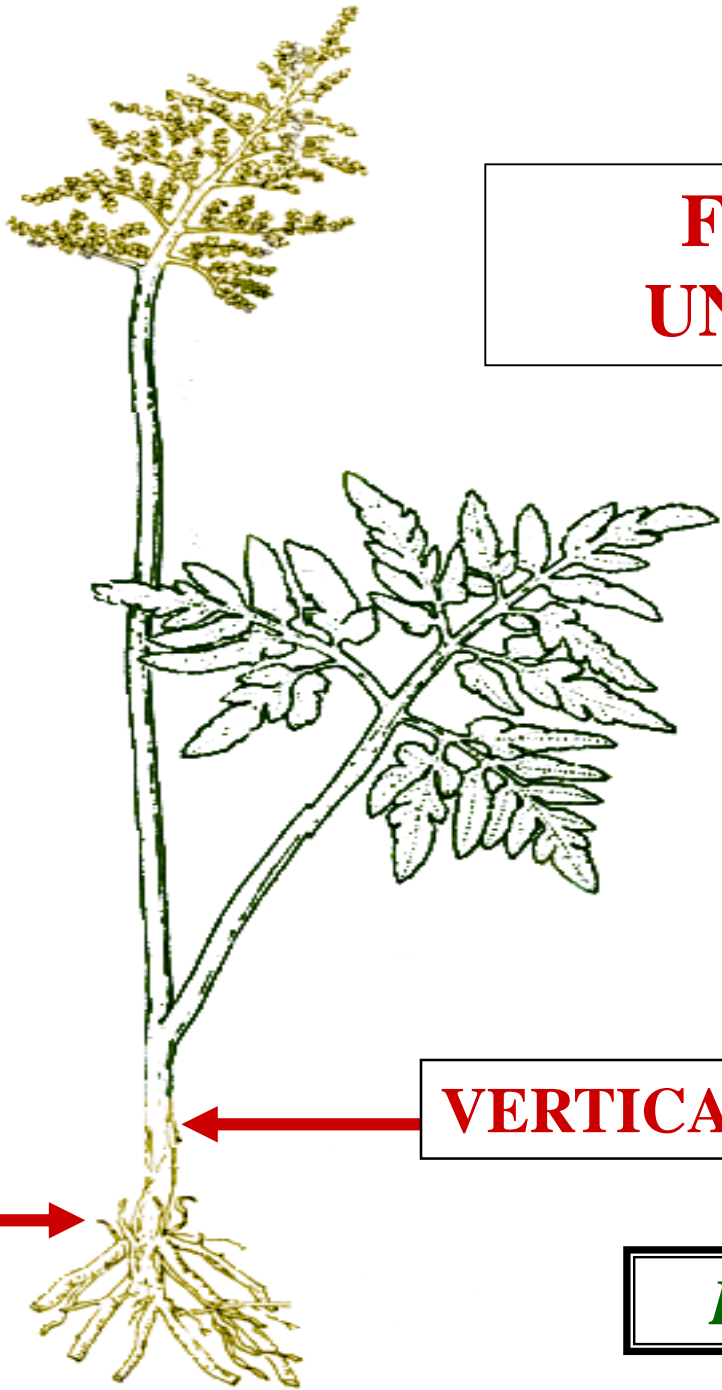
VERTICAL RHIZOME

ROOTS

BOTRYCHIUM



**1 FROND
PER
SEASON**



**FROND
UNFOLDS**

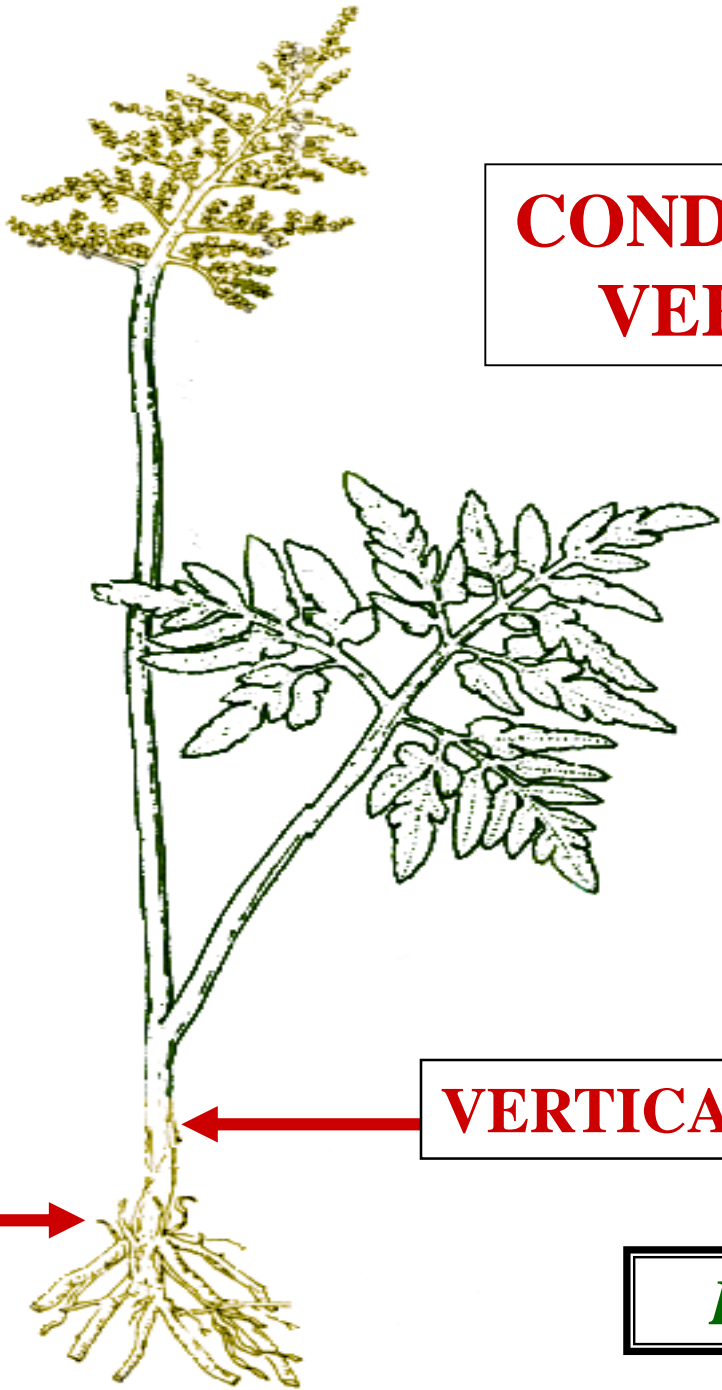
VERTICAL RHIZOME

ROOTS

BOTRYCHIUM



**1 FROND
PER
SEASON**



**CONDUPLICATE
VERNATION**

VERTICAL RHIZOME

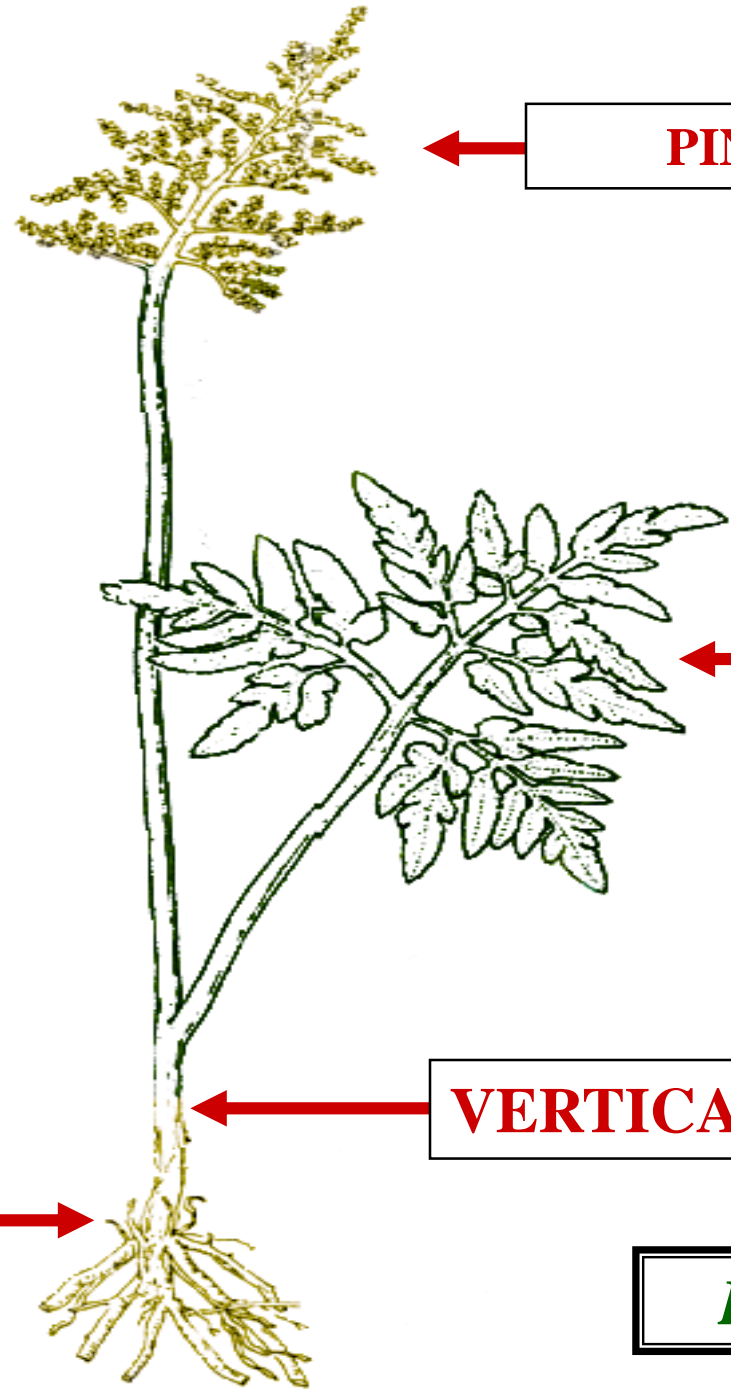
ROOTS

BOTRYCHIUM

FROND MORPHOLOGY



**PINNAE
PRESENT**



PINNA

PINNA

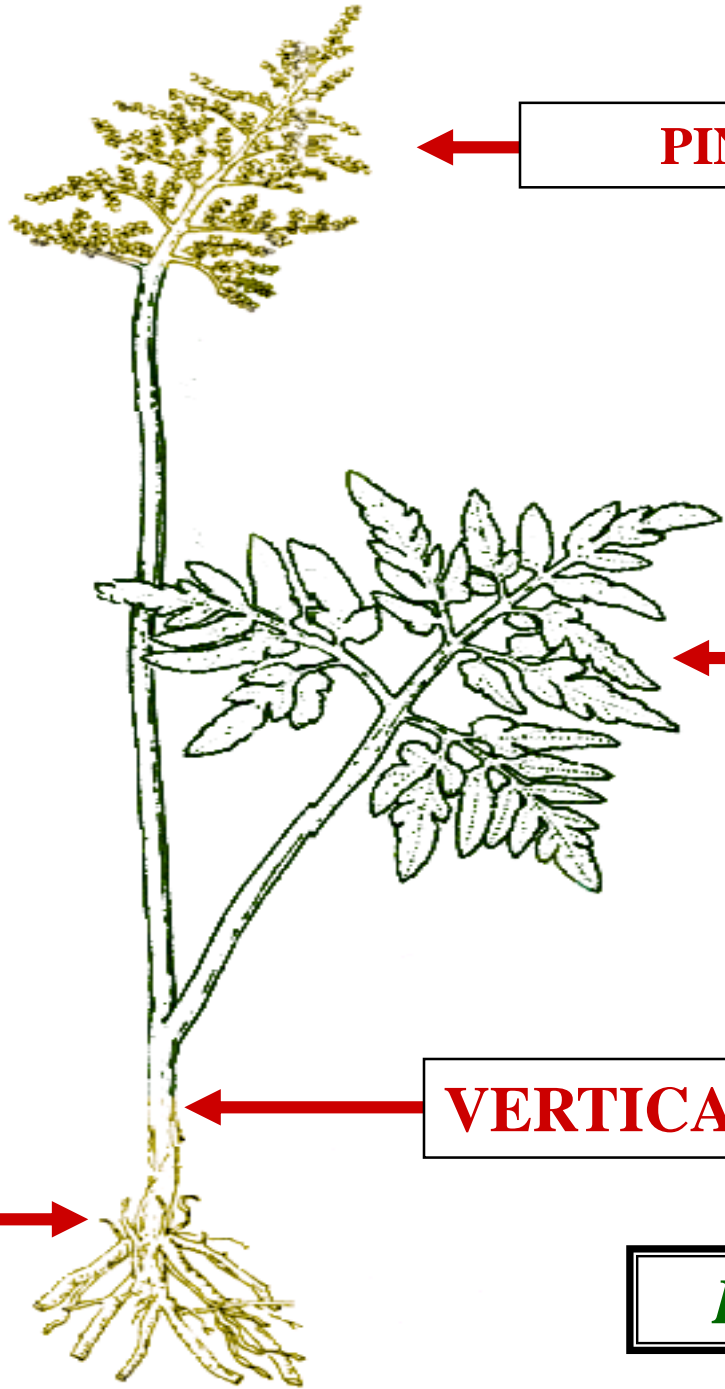
VERTICAL RHIZOME

ROOTS

BOTRYCHIUM



**COMPOUND
FROND**



PINNA

PINNA

VERTICAL RHIZOME

ROOTS

BOTRYCHIUM



**COMPOUND
FROND**



PINNA

**NON-FERTILE
PINNA**

VERTICAL RHIZOME

ROOTS

BOTRYCHIUM



**COMPOUND
FROND**



PINNA

PSYN

VERTICAL RHIZOME

ROOTS

BOTRYCHIUM



**COMPOUND
FROND**



**FERTILE
PINNA**

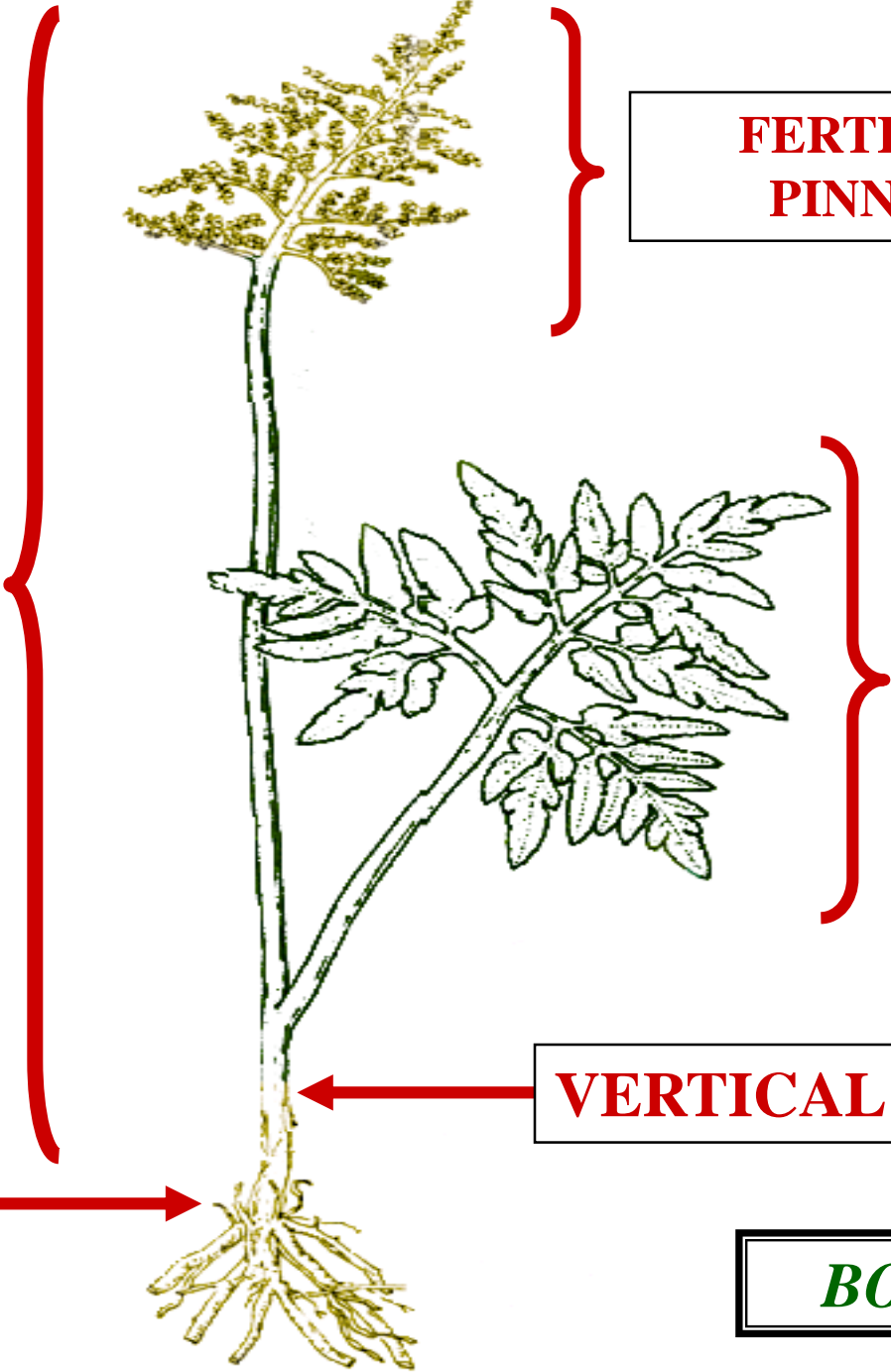


**NON-FERTILE
PINNA**

VERTICAL RHIZOME

ROOTS

BOTRYCHIUM





**COMPOUND
FROND**



NON-PSYN

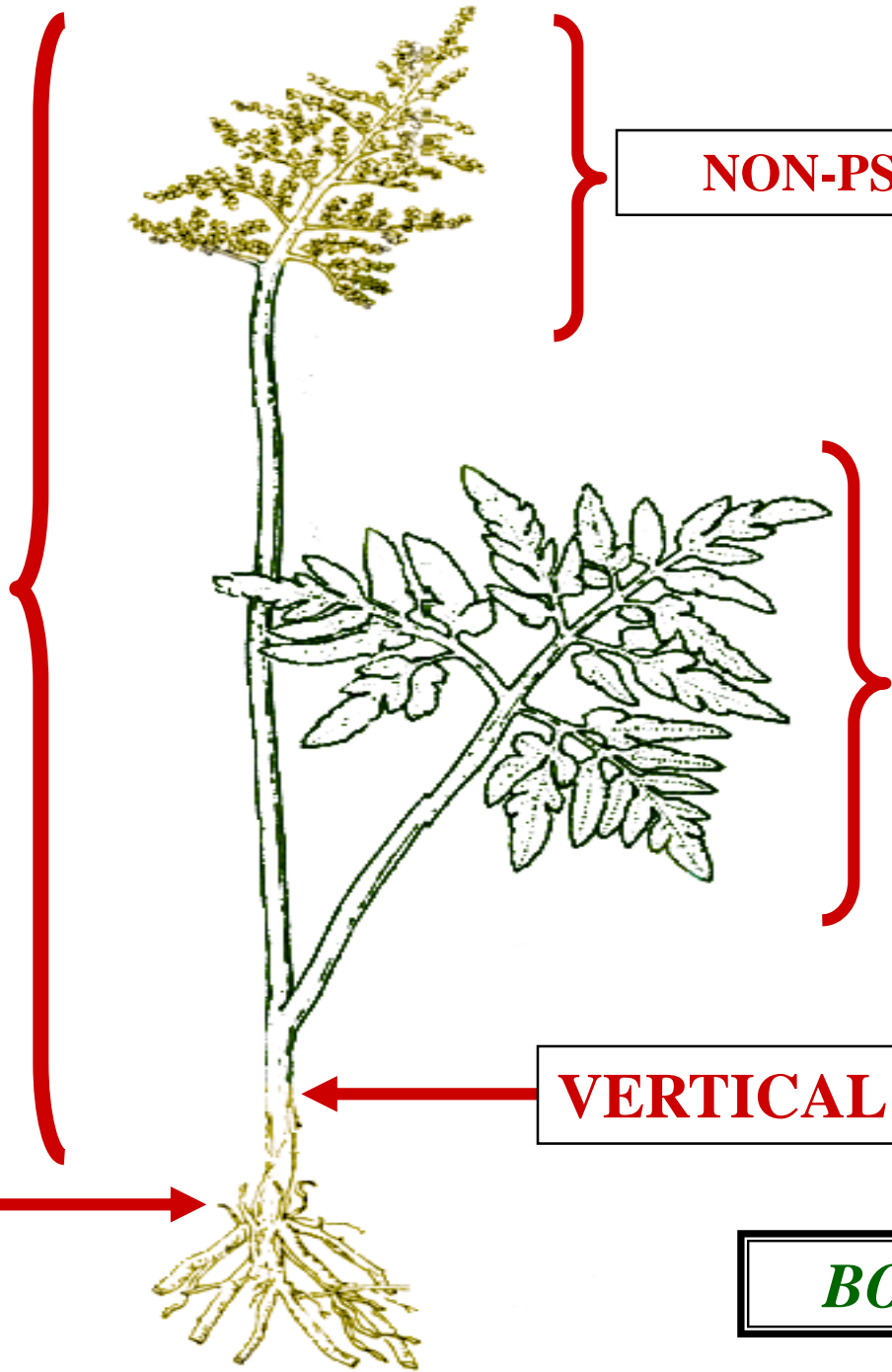


**NON-FERTILE
PINNA**

VERTICAL RHIZOME

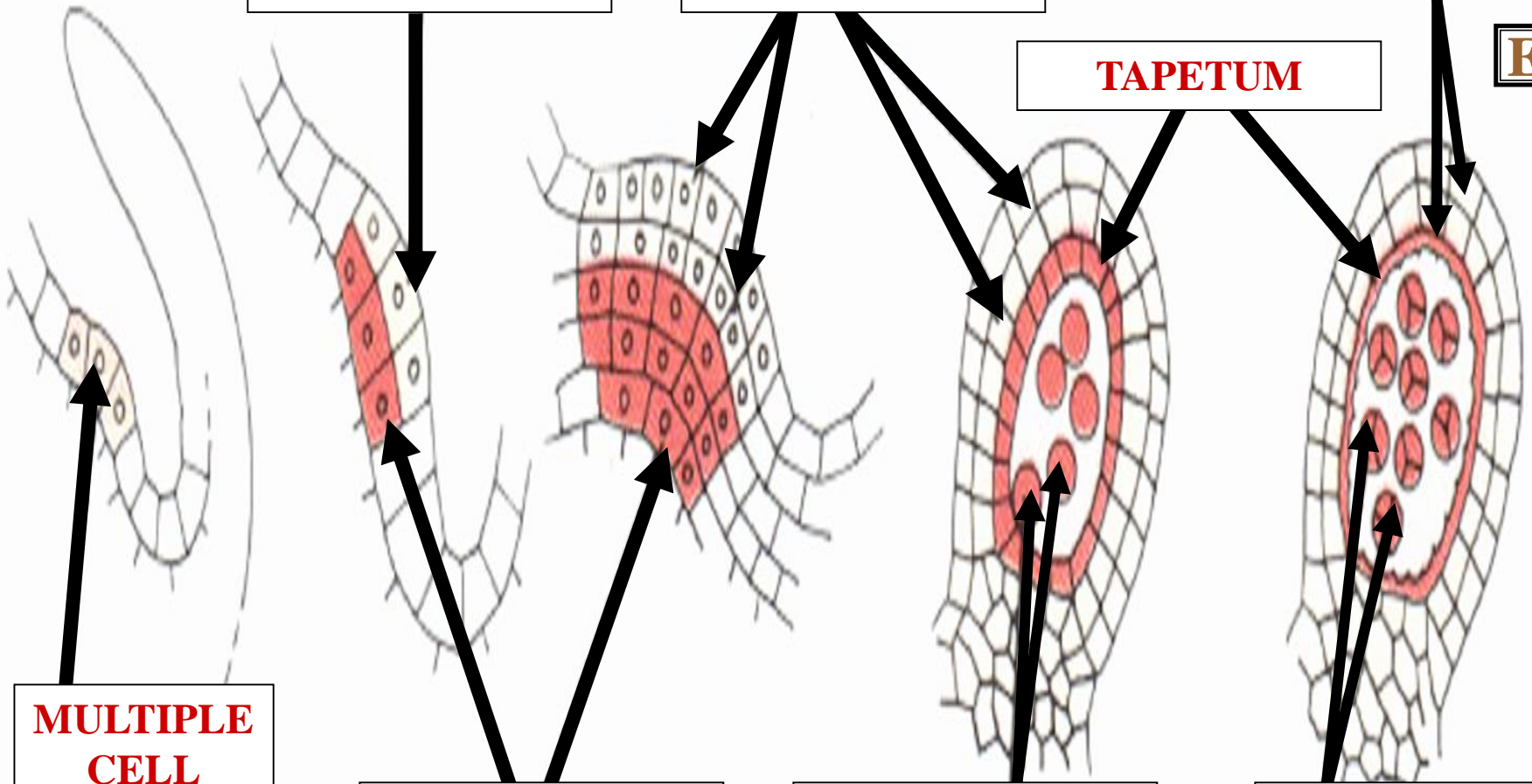
ROOTS

BOTRYCHIUM





SPORANGIUM



E

**MULTIPLE
CELL
INITIALS**

WALL CELLS

WALL CELLS

LARGE SIZE

THICK WALL

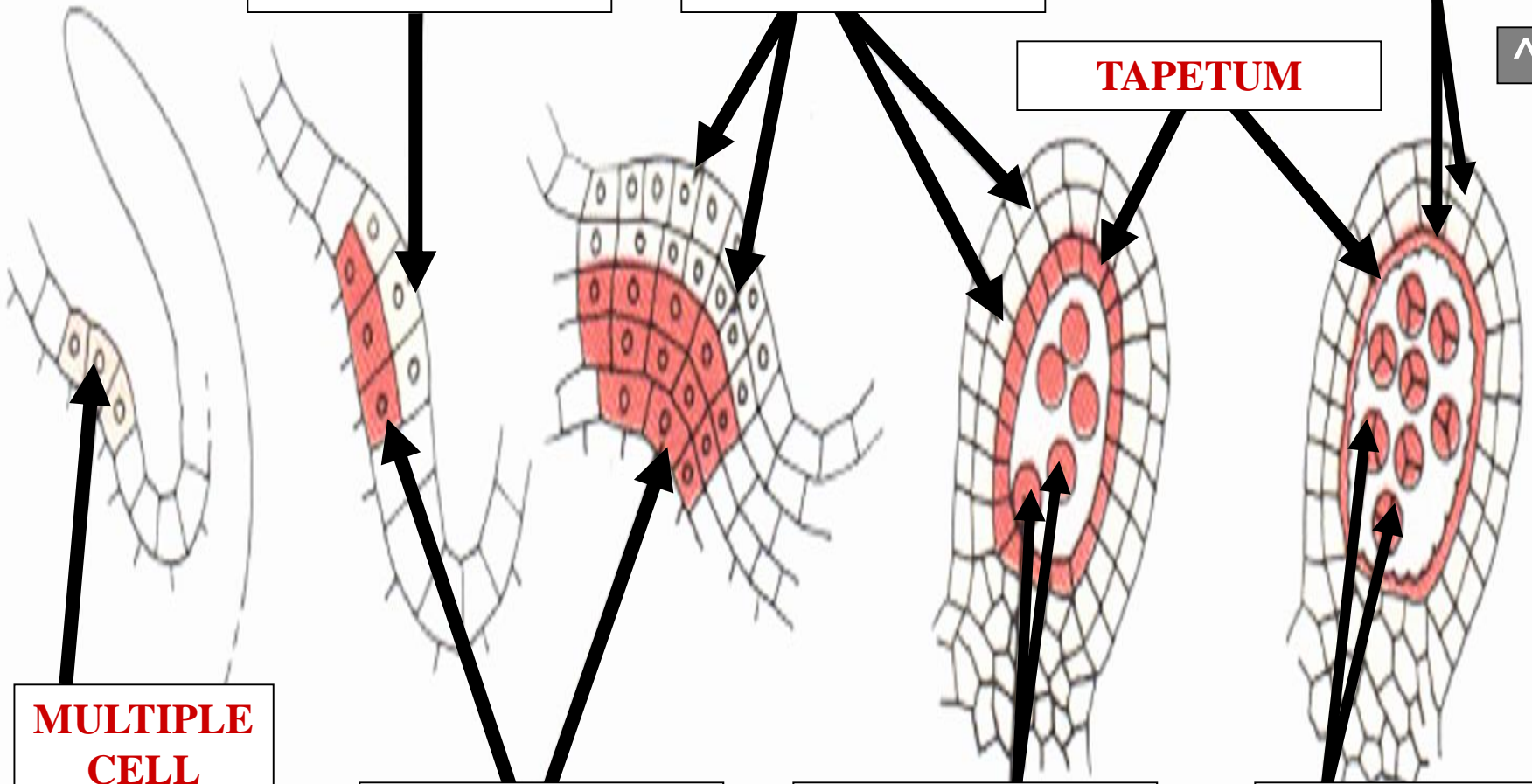
TAPETUM

SPOROCYTES

SPOROCYTES

**NUMEROUS
SPORES**

L.S.



WALL CELLS

WALL CELLS

LARGE SIZE

THICK WALL

TAPETUM



**MULTIPLE
CELL
INITIALS**

SPOROCYTES

SPOROCYTES

**NUMEROUS
SPORES**

EUSPORANGIUM

L.S.



SPORANGIUM POSITION



**COMPOUND
FROND**



**FERTILE
PINNA**

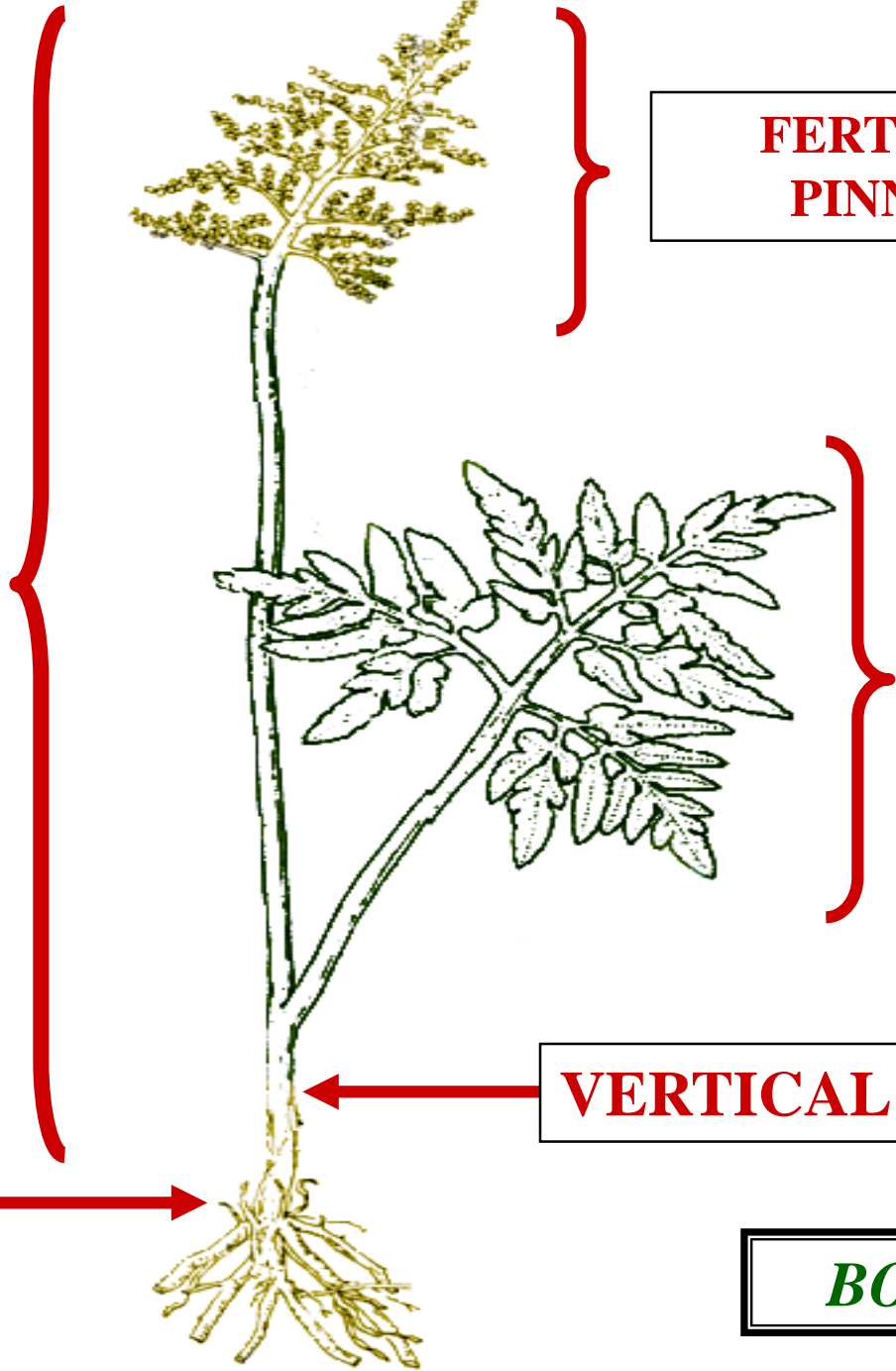


**NON-FERTILE
PINNA**

VERTICAL RHIZOME

ROOTS

BOTRYCHIUM



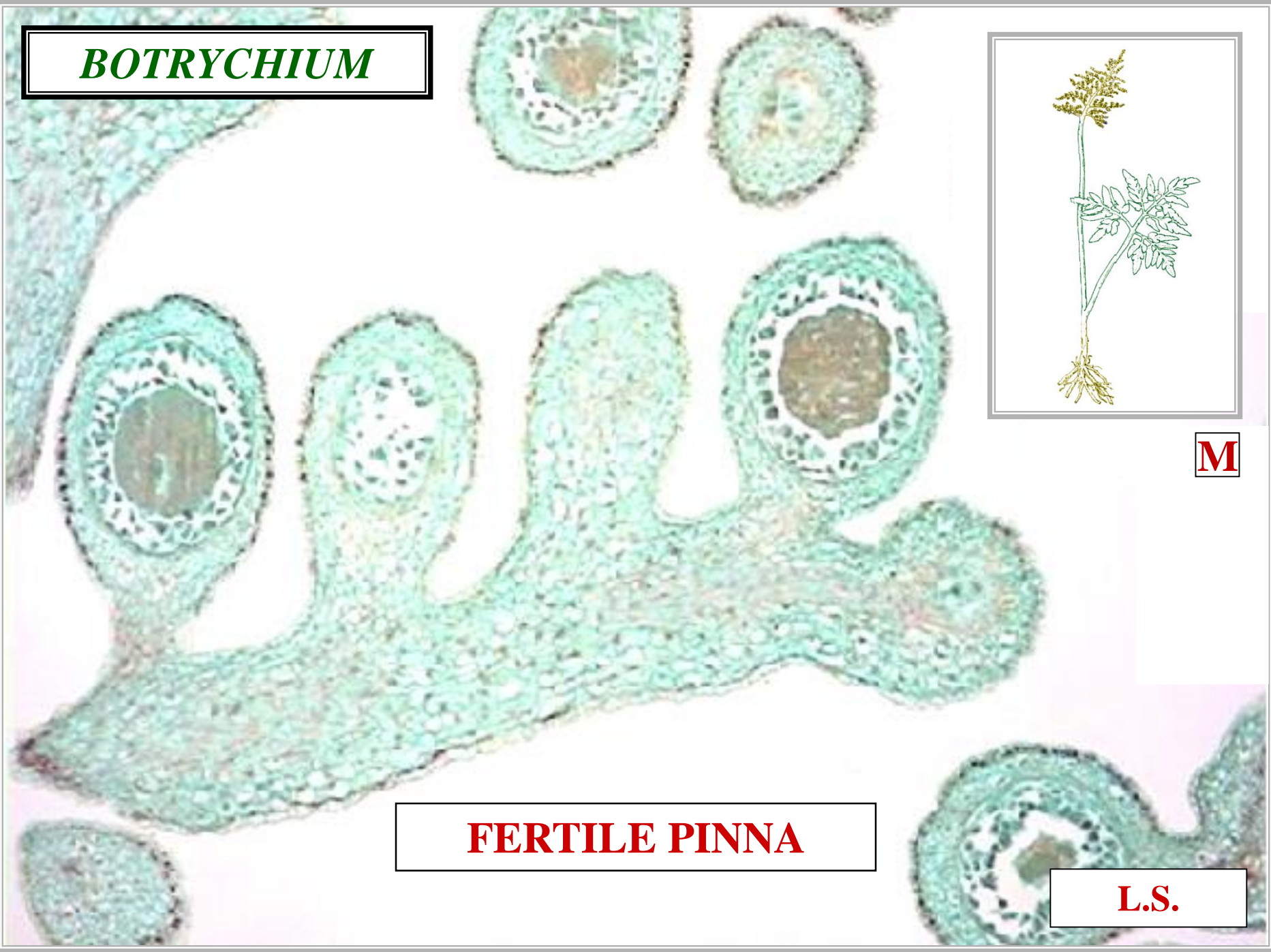
BOTRYCHIUM



M

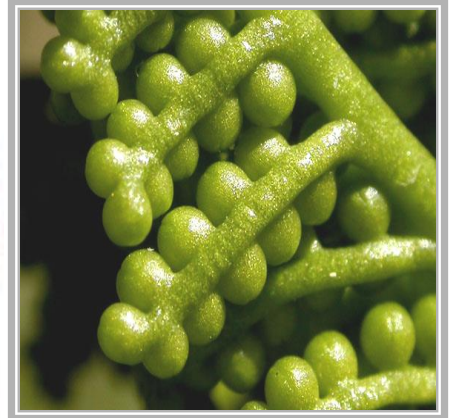
FERTILE PINNA

L.S.

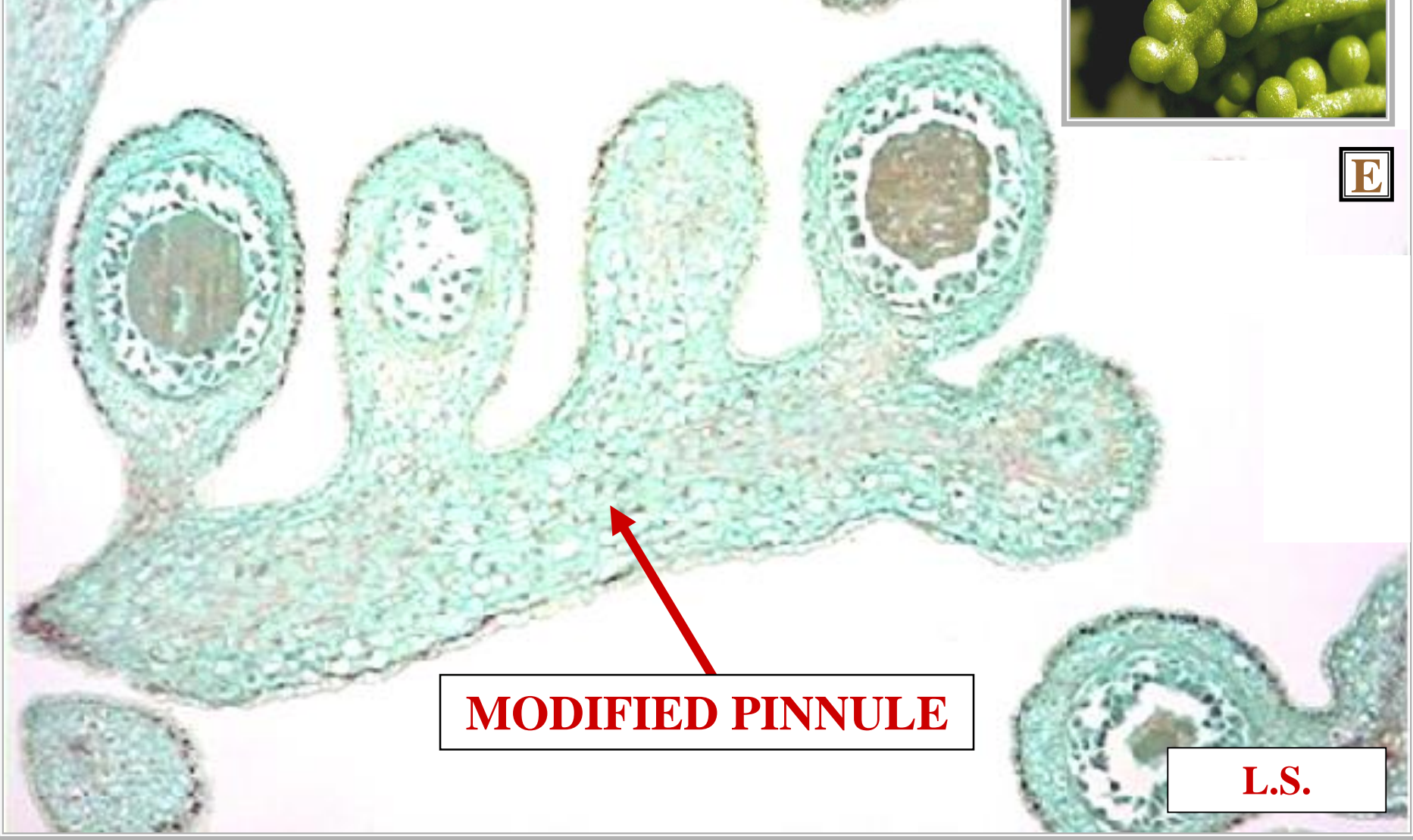


BOTRYCHIUM

FERTILE PINNA



E



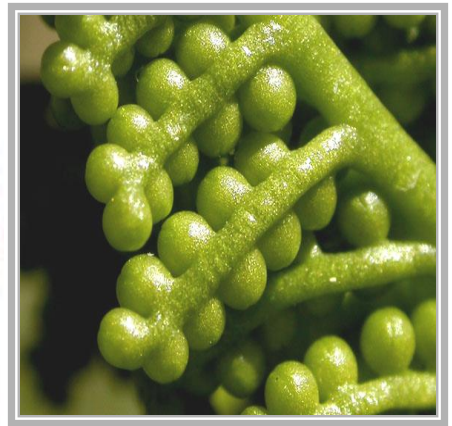
MODIFIED PINNULE

L.S.

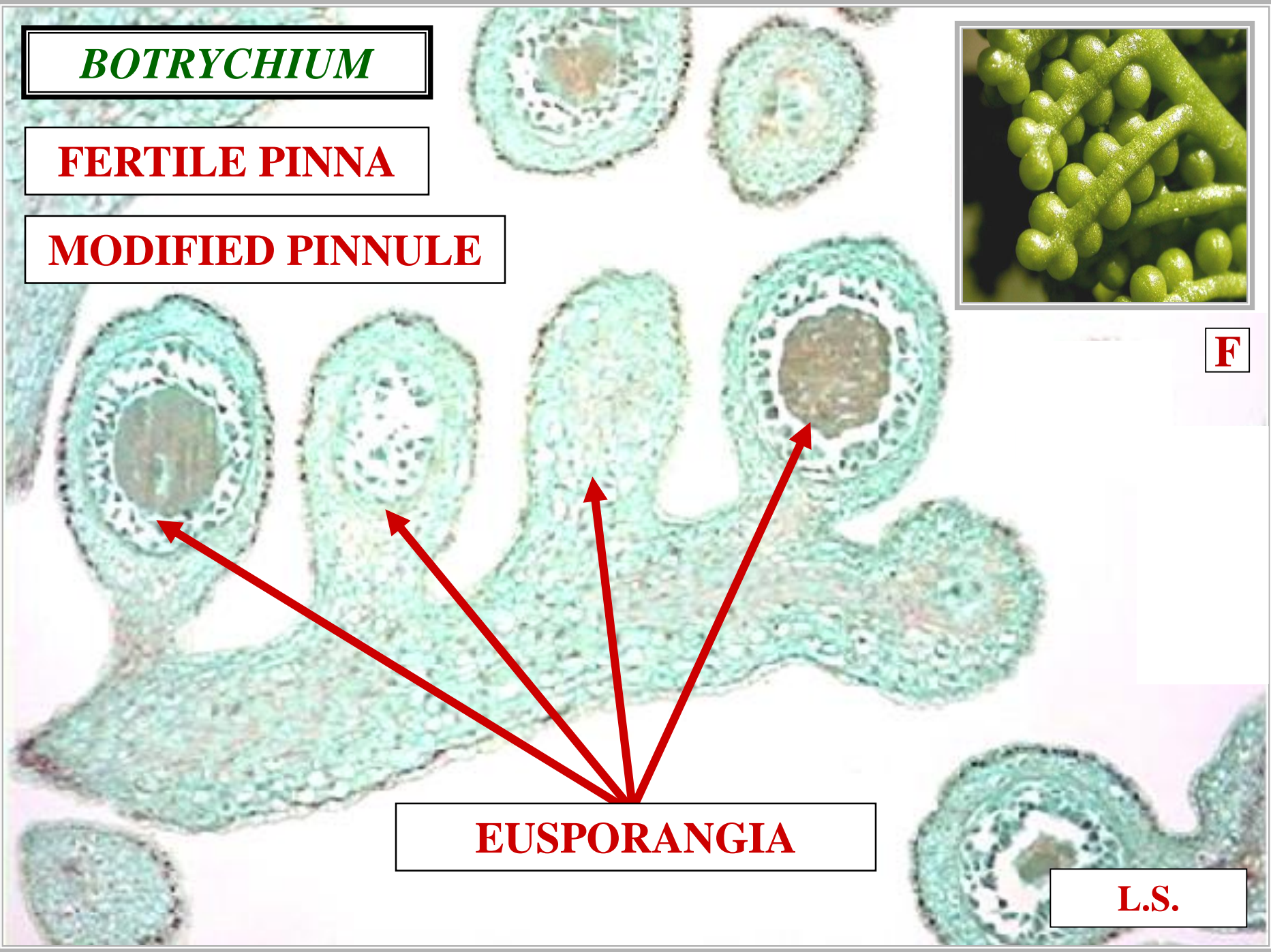
BOTRYCHIUM

FERTILE PINNA

MODIFIED PINNULE



F



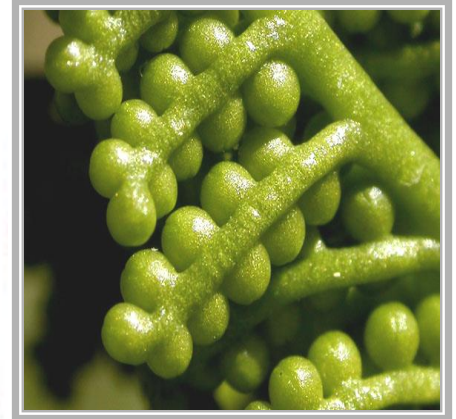
EUSPORANGIA

L.S.

BOTRYCHIUM

FERTILE PINNA

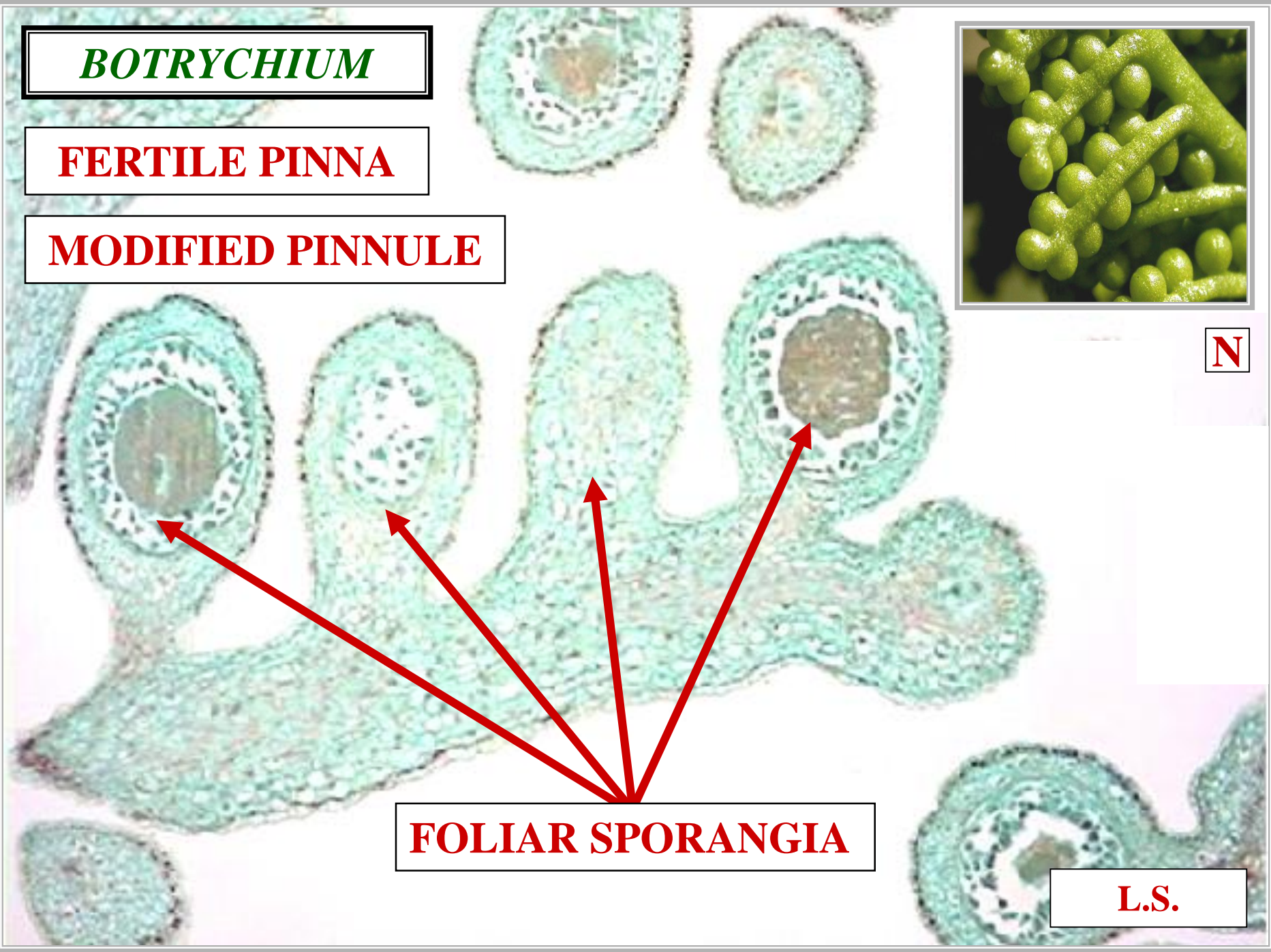
MODIFIED PINNULE



N

FOLIAR SPORANGIA

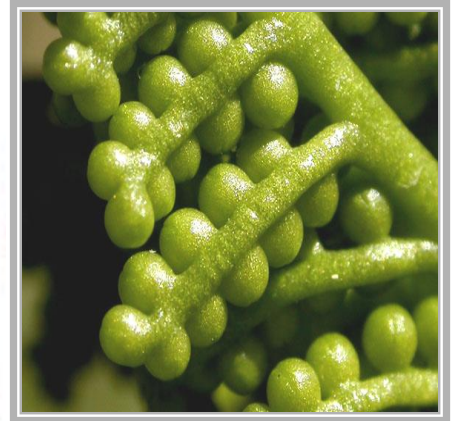
L.S.



BOTRYCHIUM

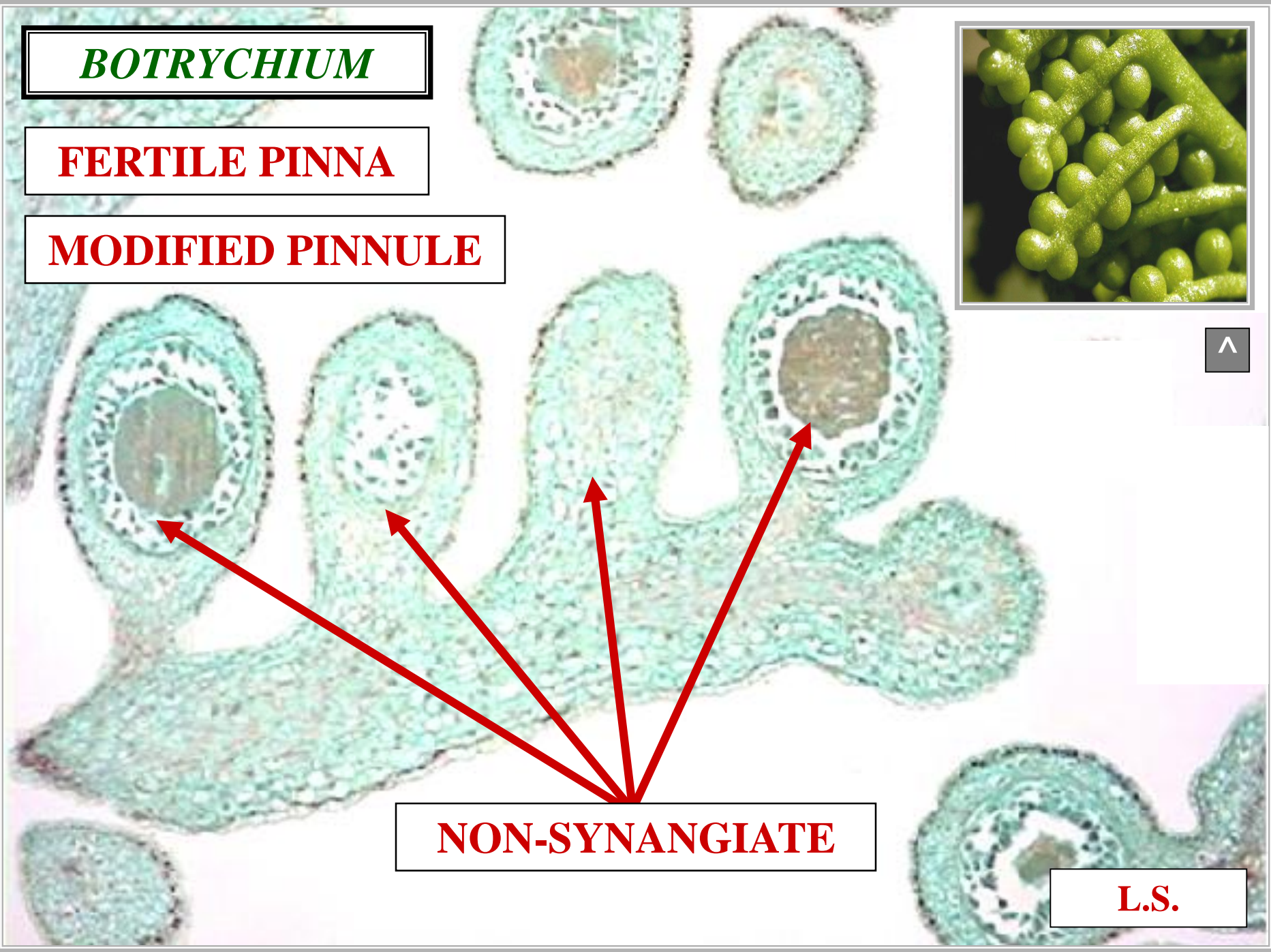
FERTILE PINNA

MODIFIED PINNULE



NON-SYNGIATE

L.S.





SPORE HABIT

BOTRYCHIUM

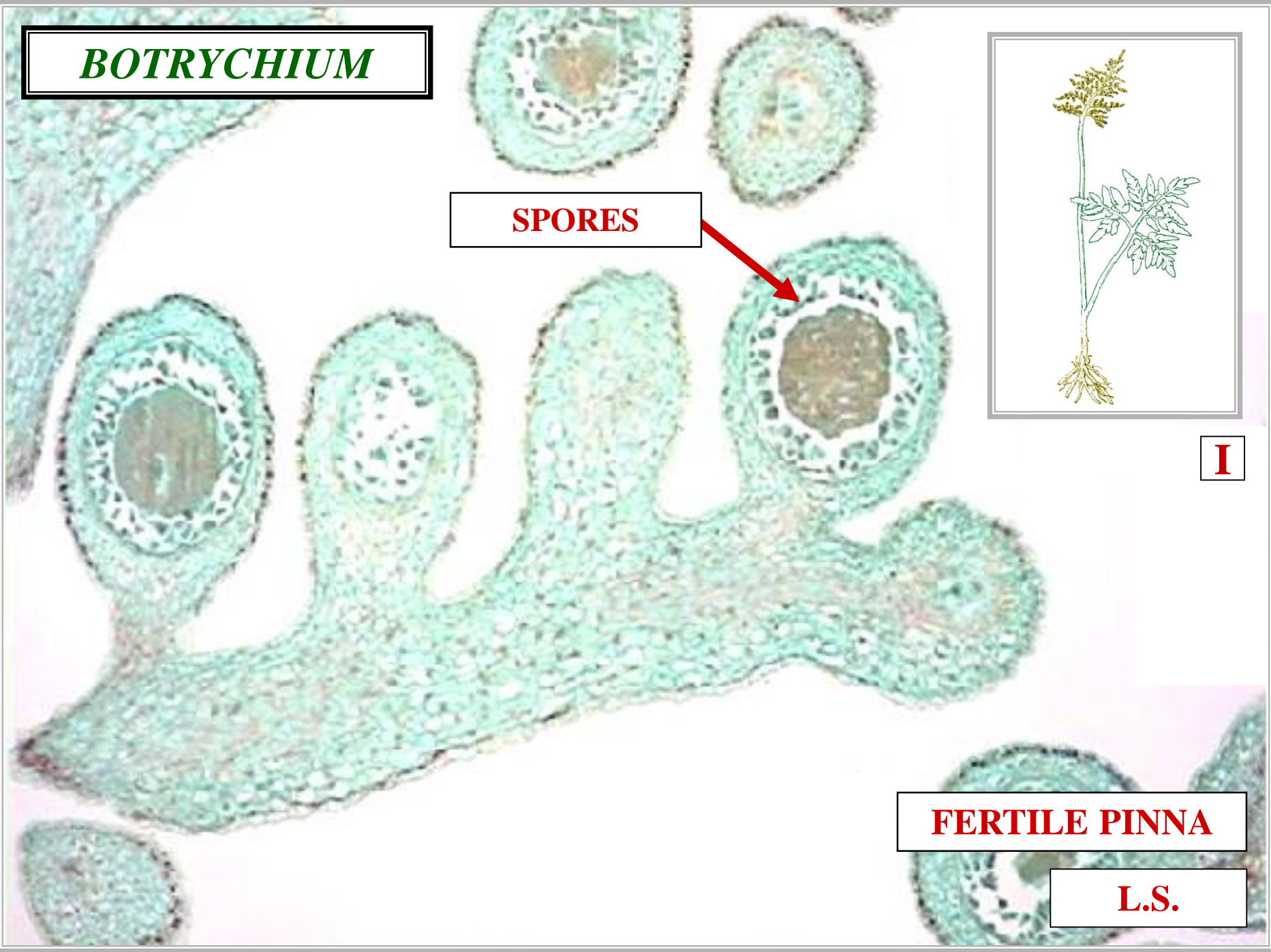
SPORES



I

FERTILE PINNA

L.S.



BOTRYCHIUM

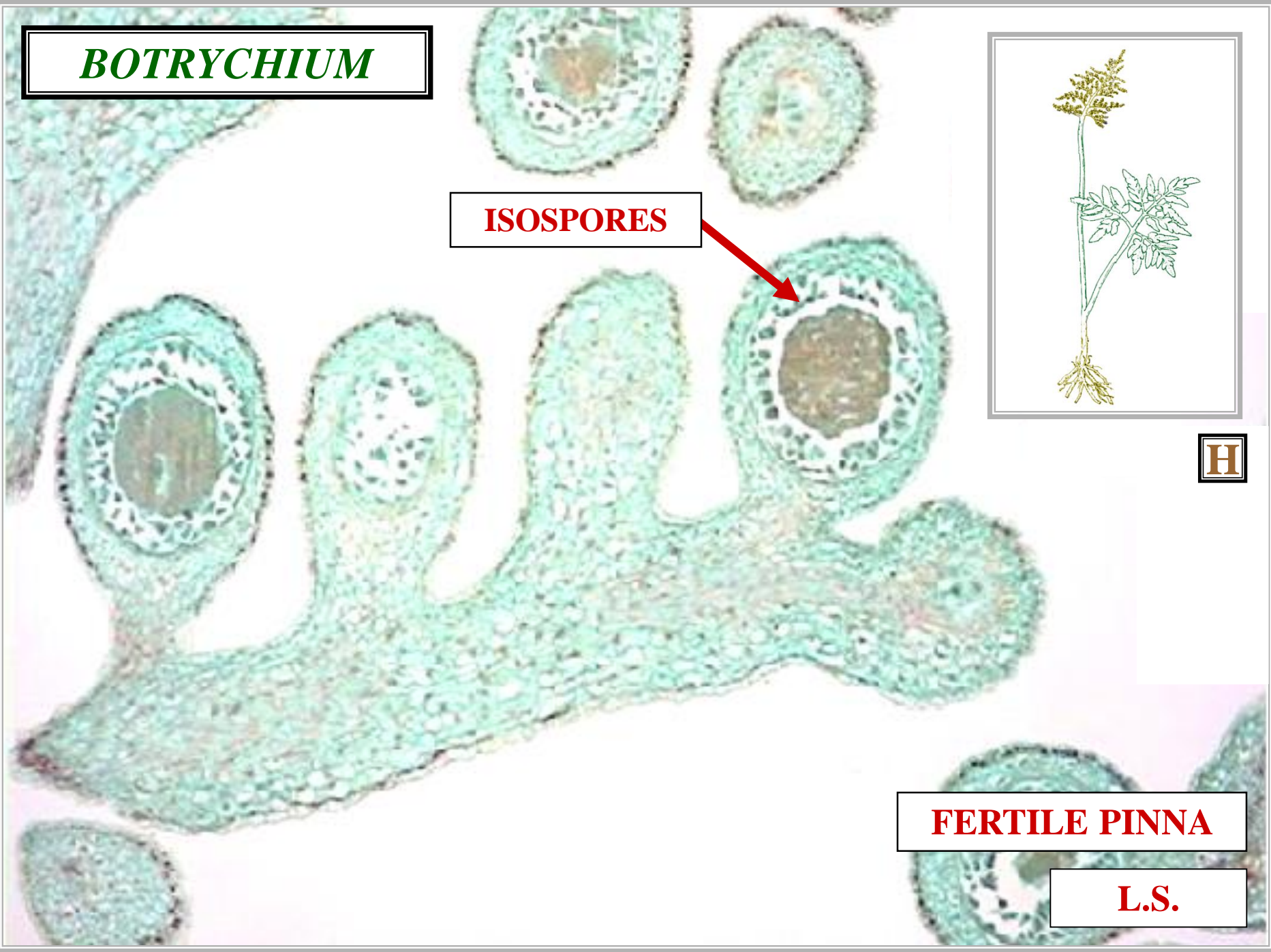
ISOSPORES



H

FERTILE PINNA

L.S.



BOTRYCHIUM

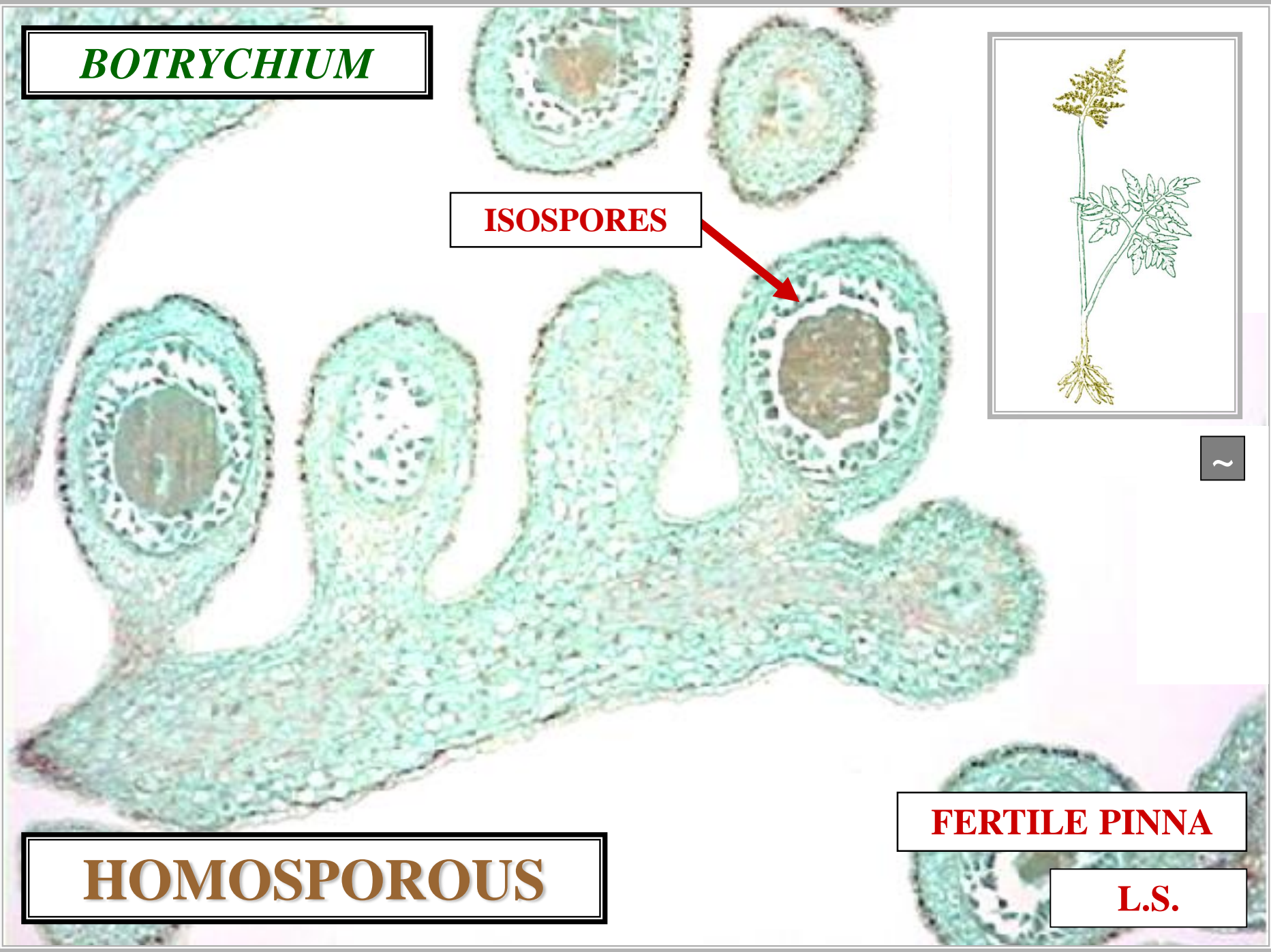
ISOSPORES



FERTILE PINNA

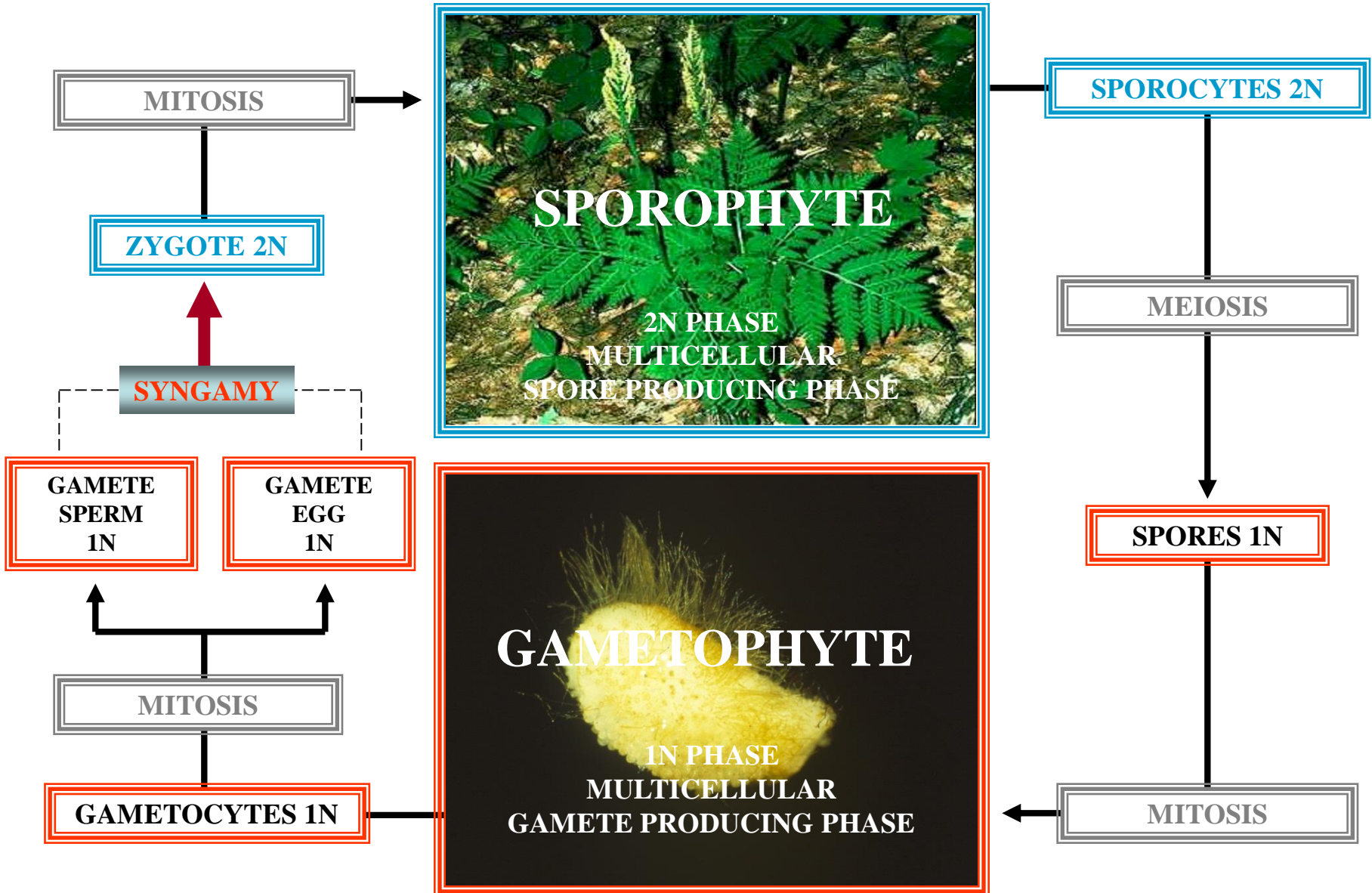
HOMOSPOROUS

L.S.



OPHIOGLOSSALES

LIFE CYCLE



GAMETOPHYTE CHARACTERS

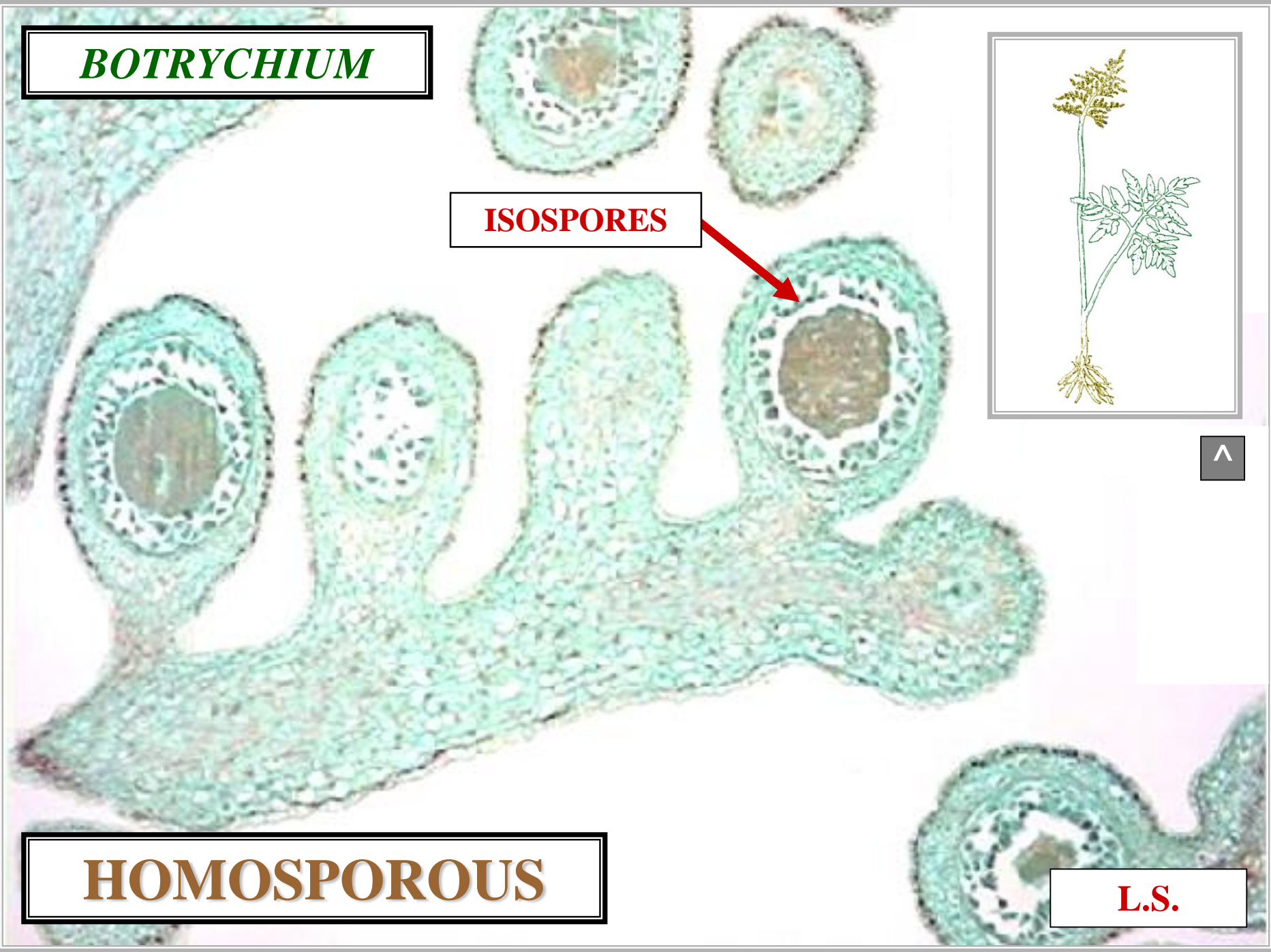
BOTRYCHIUM

ISOSPORES



HOMOSPOROUS

L.S.





EXOSPORIC GAMETOPHYTE

BOTRYCHIUM

GAMETOPHYTE

S



EXOSPORIC

BOTRYCHIUM

GAMETOPHYTE

N



SUBTERRANEAN

BOTRYCHIUM

GAMETOPHYTE

M



NON-PSYN

BOTRYCHIUM

GAMETOPHYTE

B



MYCORRHIZAE ABUNDANT

BOTRYCHIUM

GAMETOPHYTE

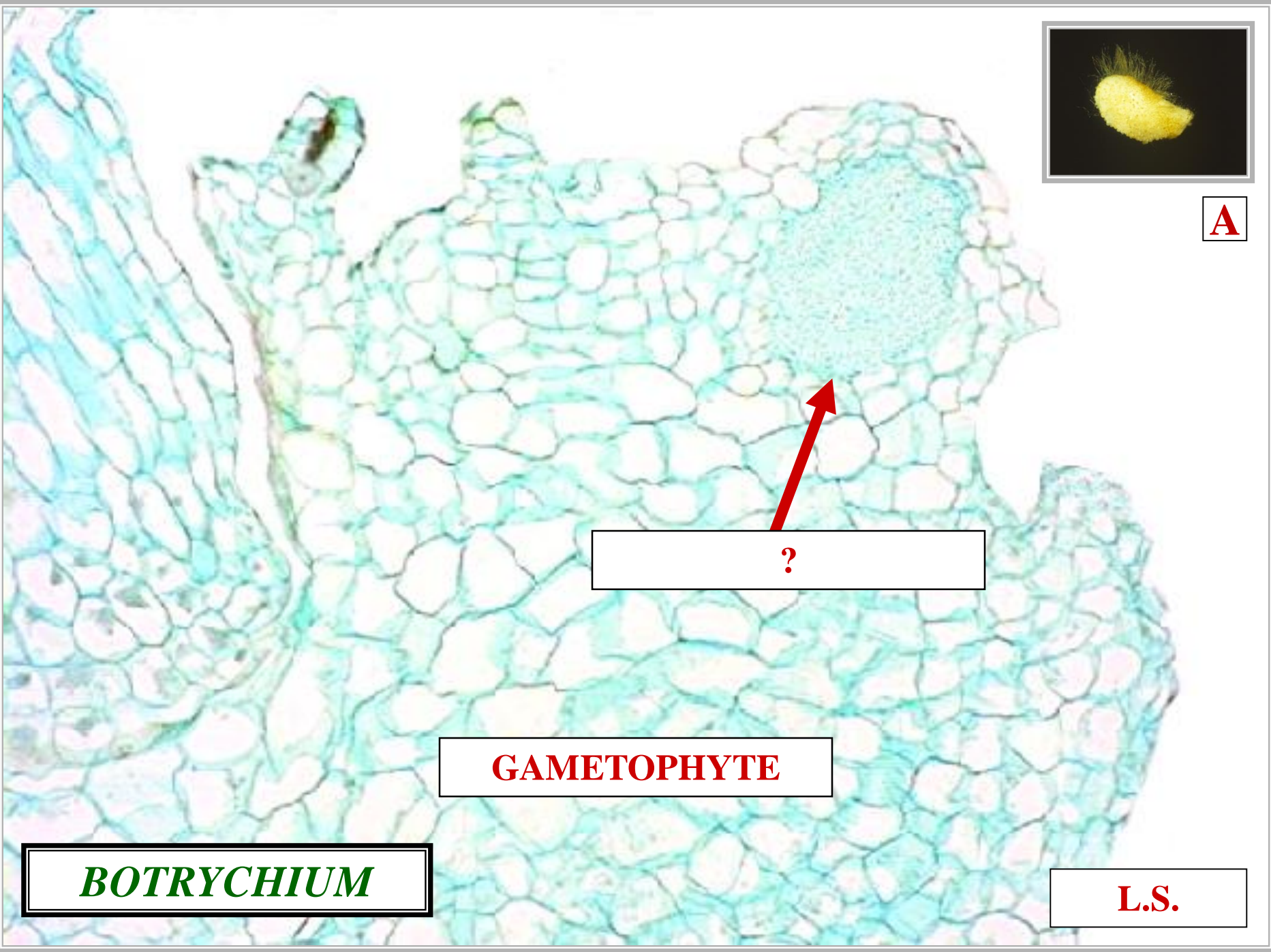
?



BISXEUAL



A



?

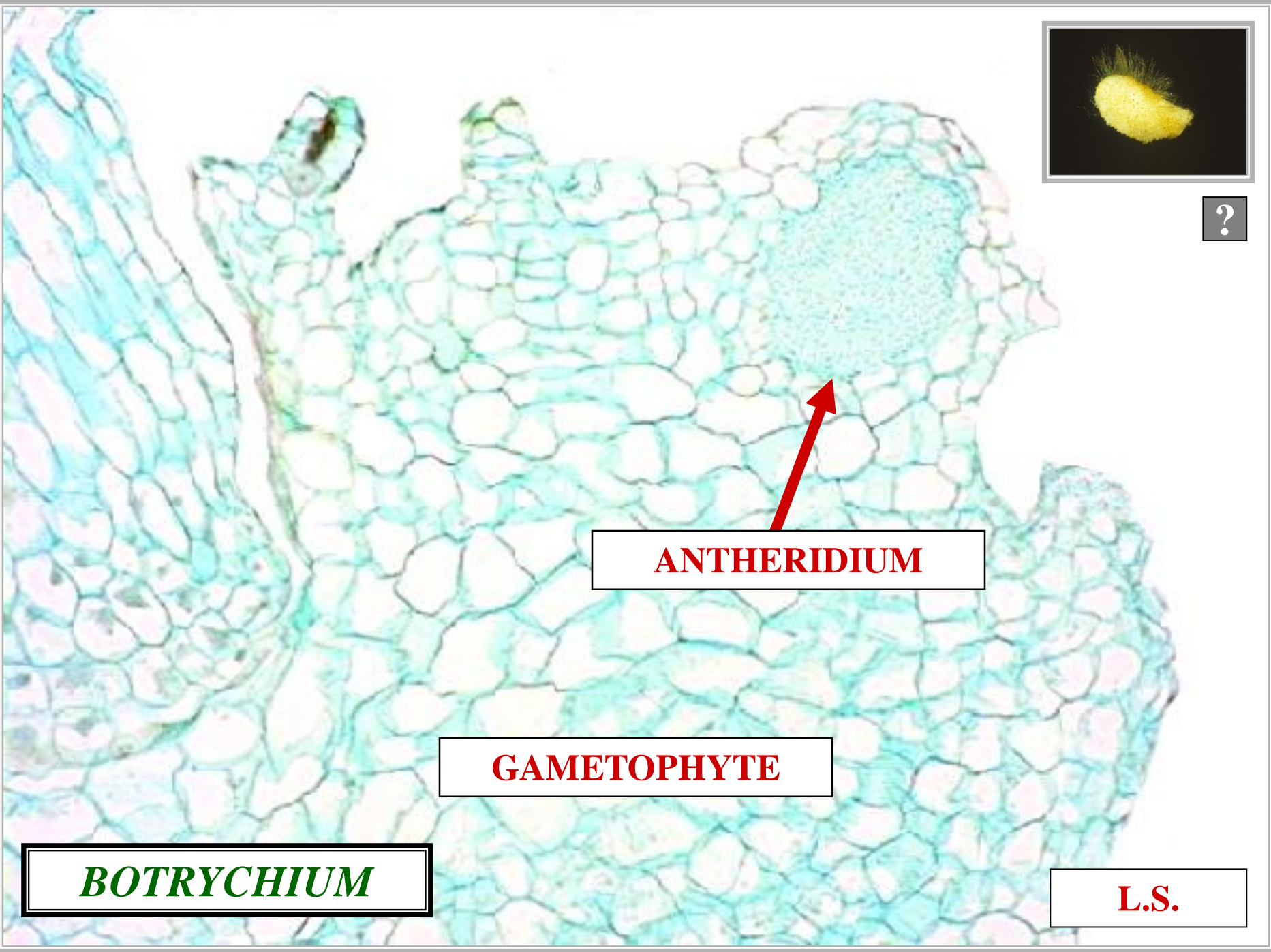
GAMETOPHYTE

BOTRYCHIUM

L.S.



?



ANTHERIDIUM

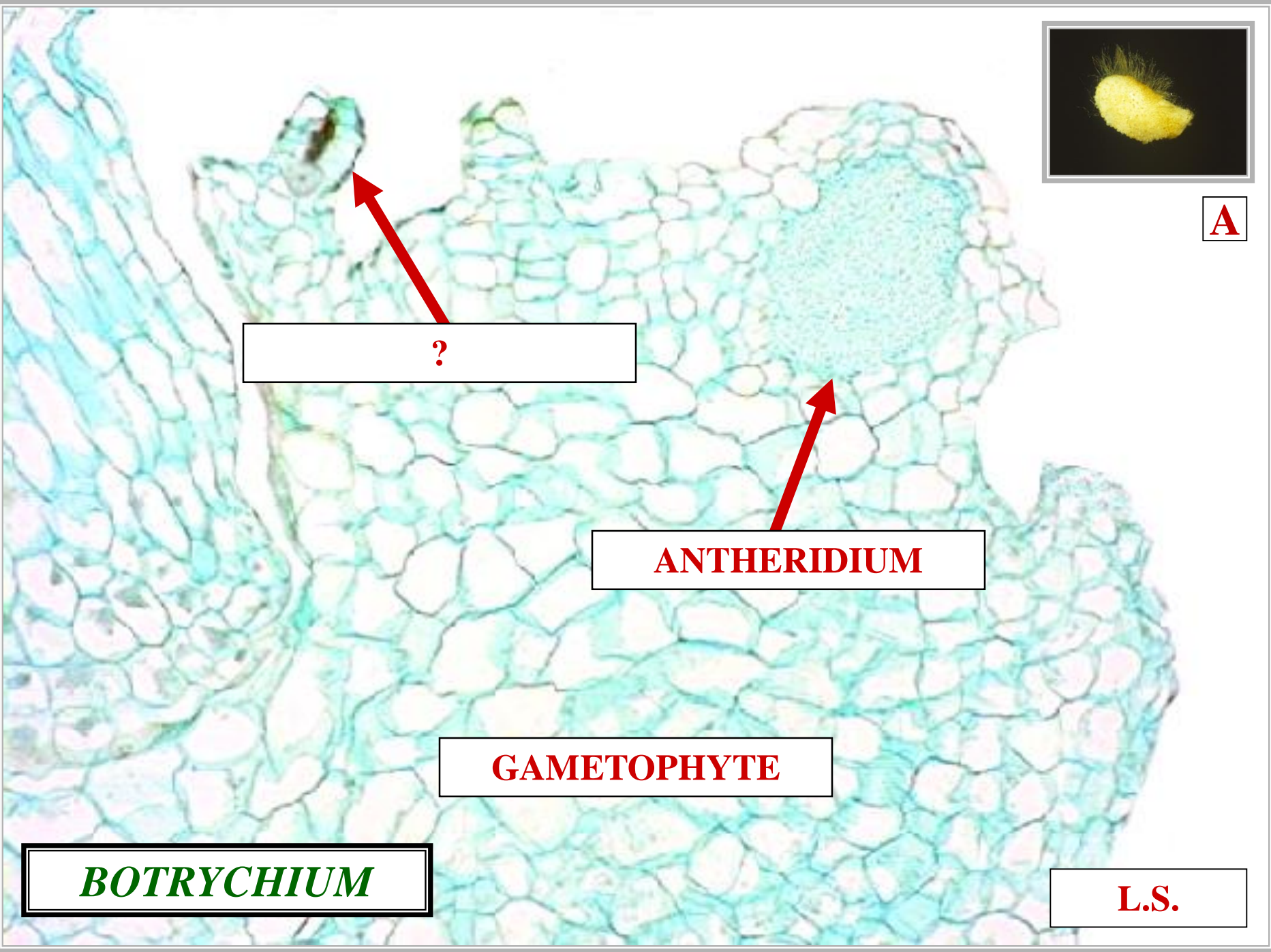
GAMETOPHYTE

BOTRYCHIUM

L.S.



A



?

ANTHERIDIUM

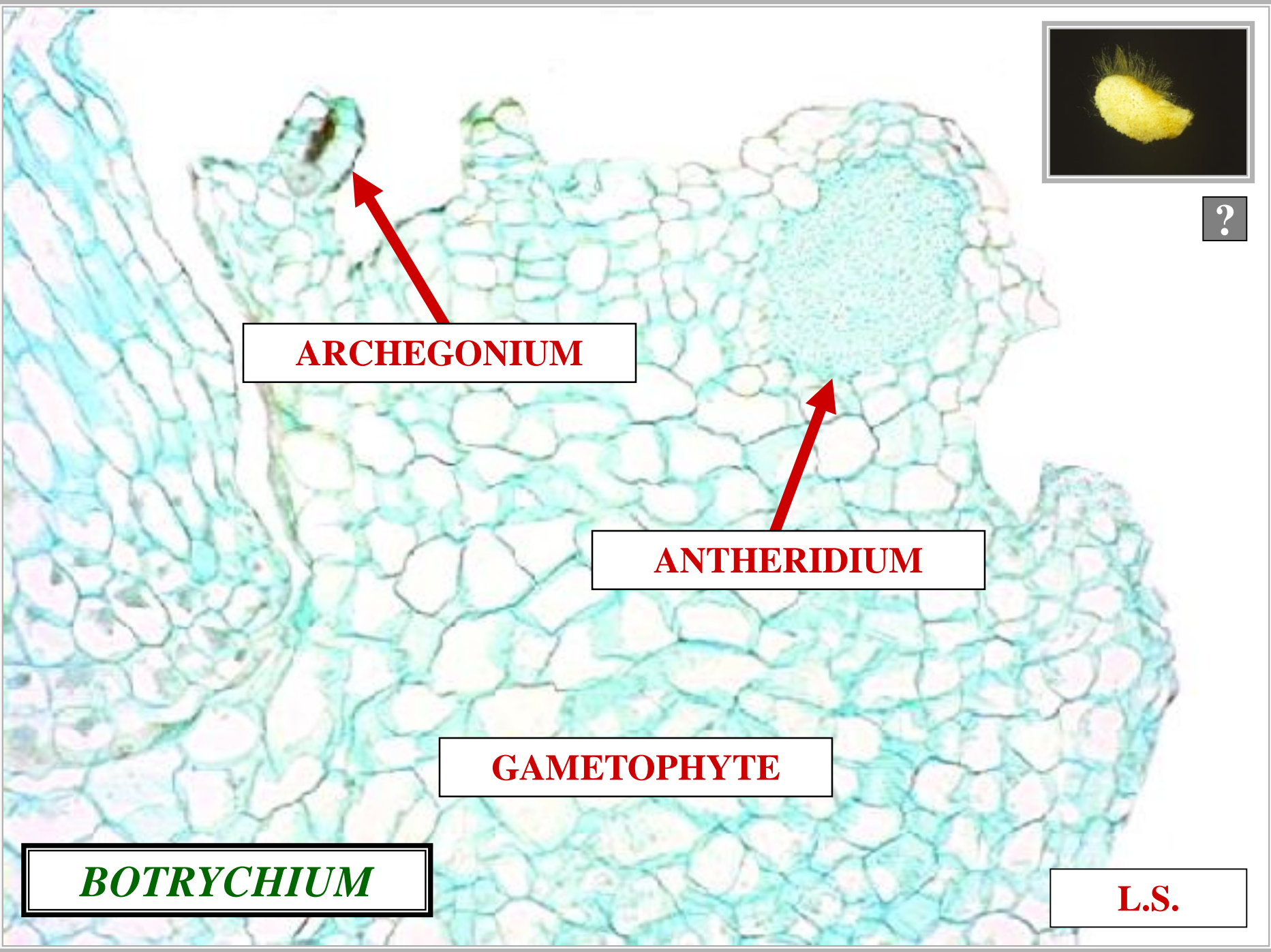
GAMETOPHYTE

BOTRYCHIUM

L.S.



?



ARCHEGONIUM

ANTHERIDIUM

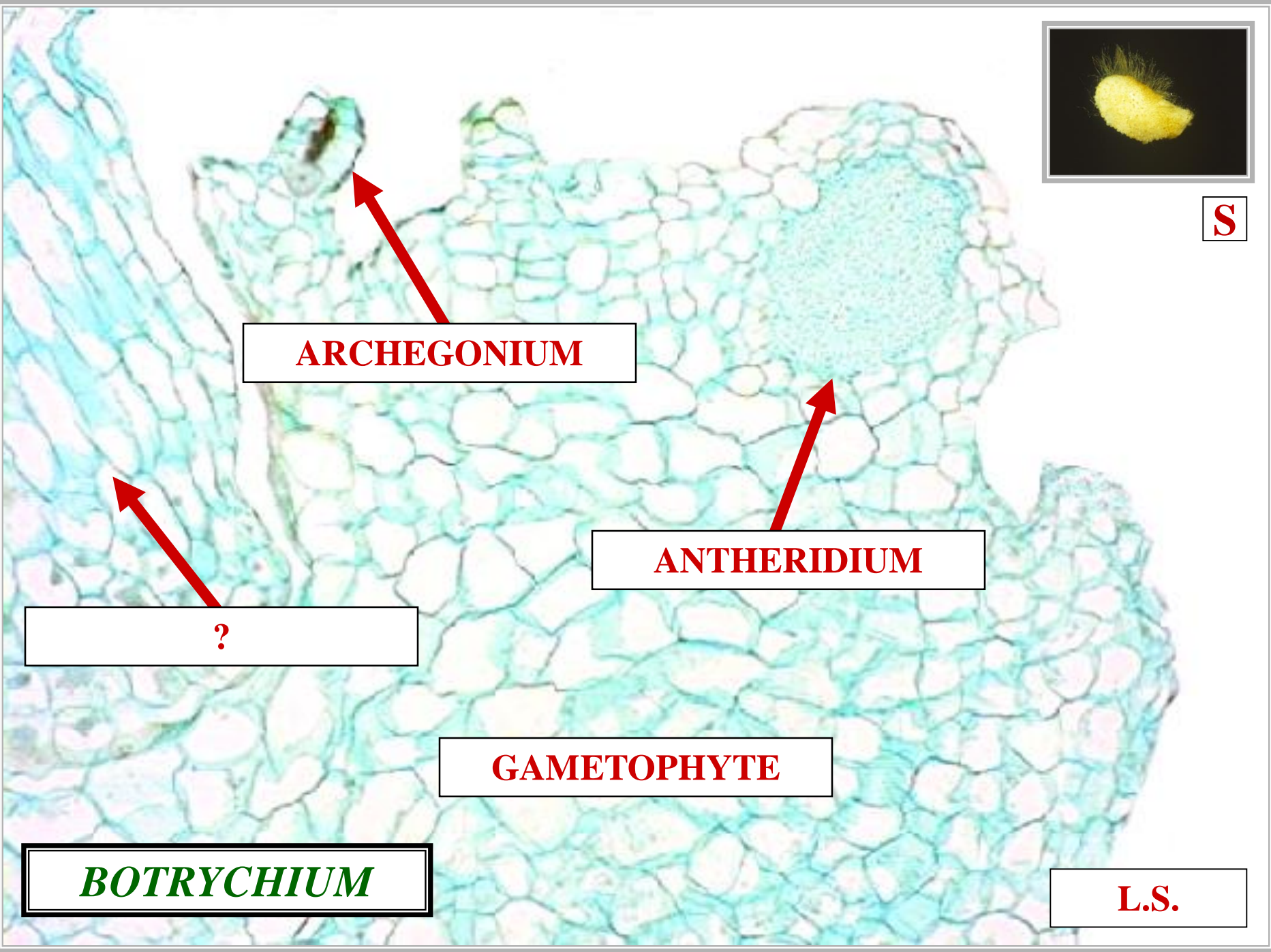
GAMETOPHYTE

BOTRYCHIUM

L.S.



S



ARCHEGONIUM

ANTHERIDIUM

?

GAMETOPHYTE

BOTRYCHIUM

L.S.



ARCHEGONIUM

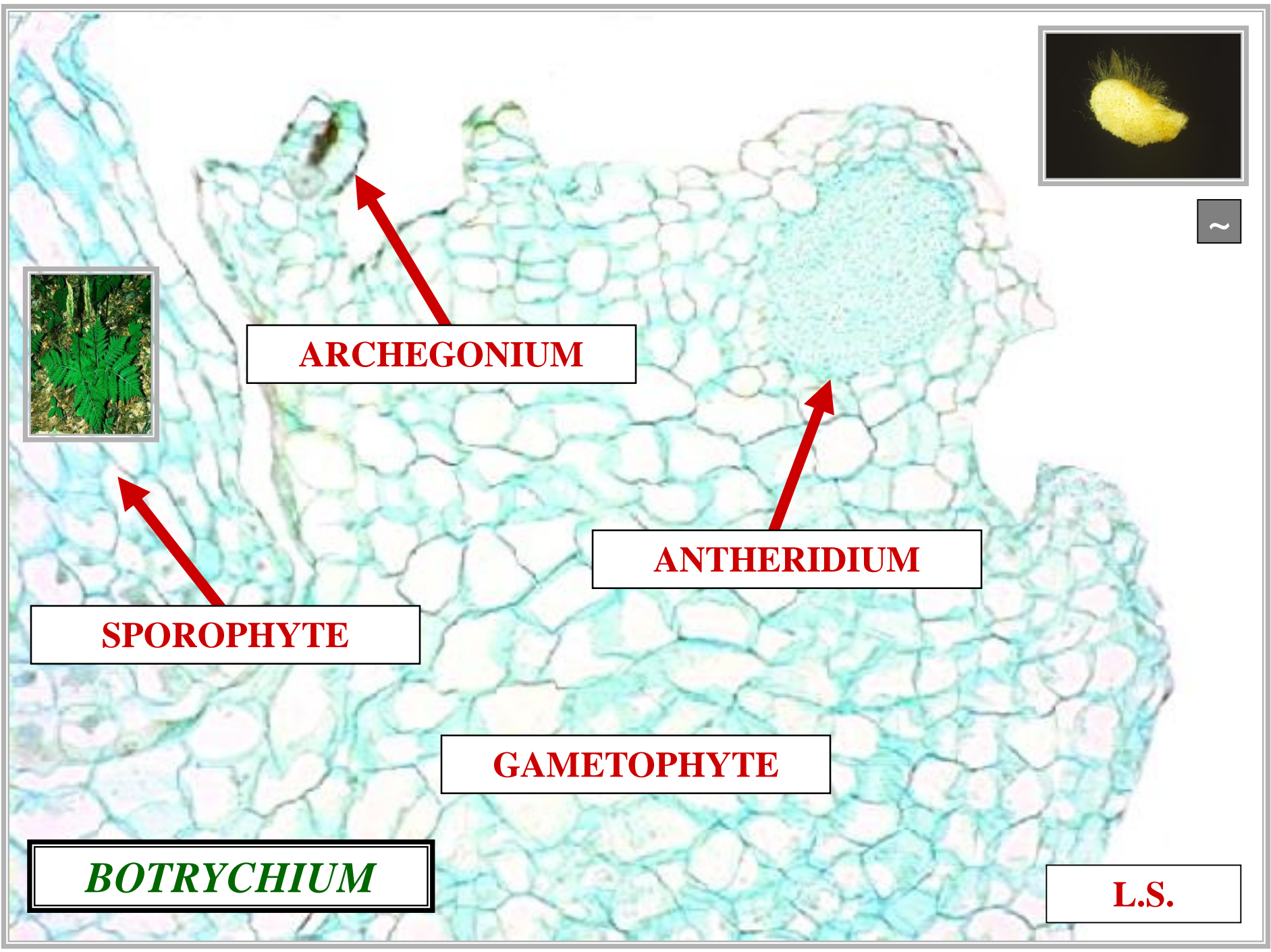
ANTHERIDIUM

SPOROPHYTE

GAMETOPHYTE

BOTRYCHIUM

L.S.



OPHIOGLOSSALES

LIFE CYCLE

