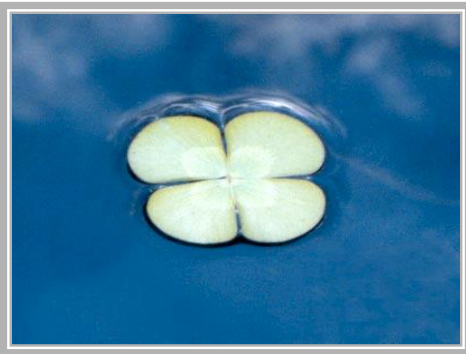


MARSILEA

1

**FROND
PHYLLOTAXY**



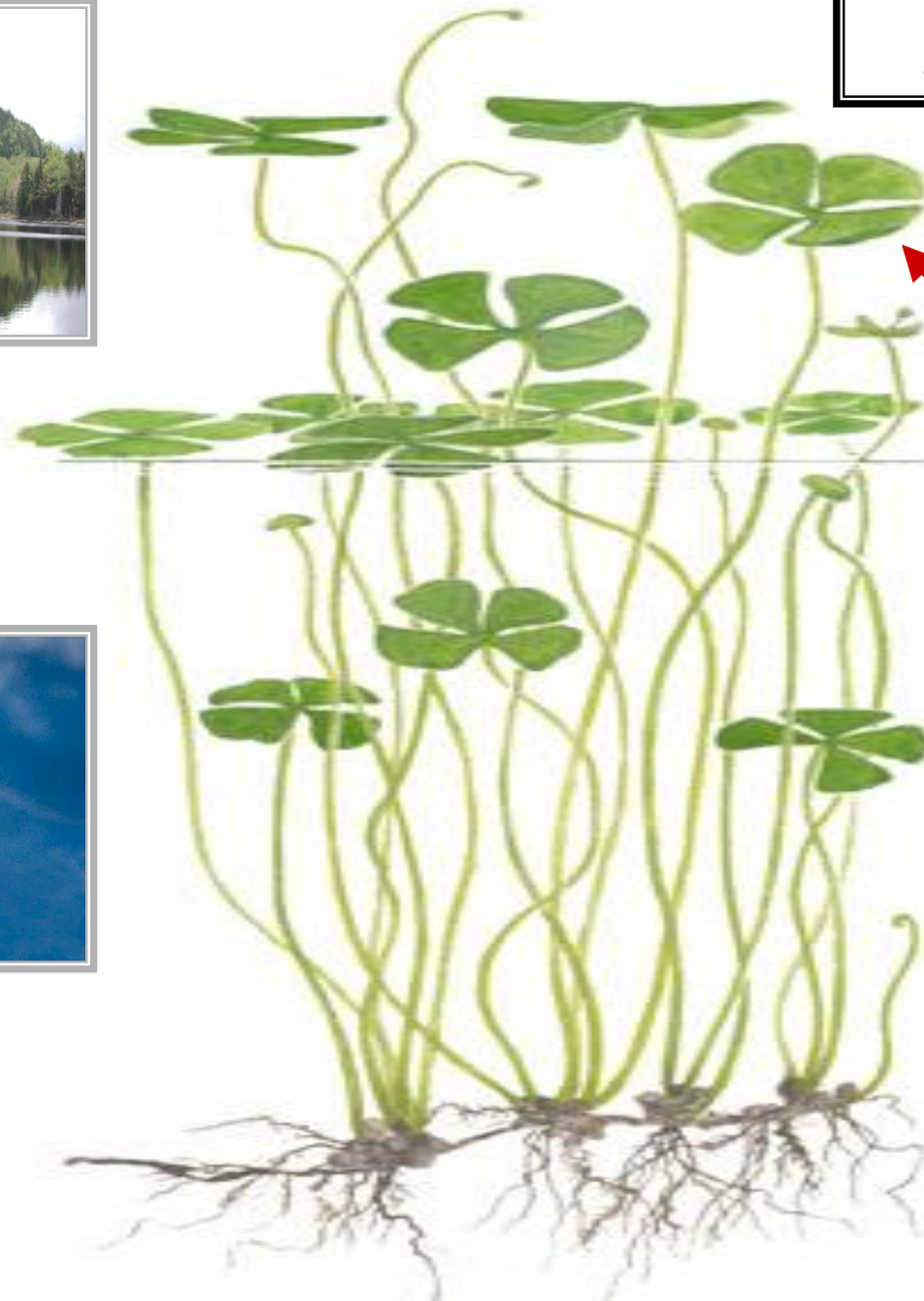
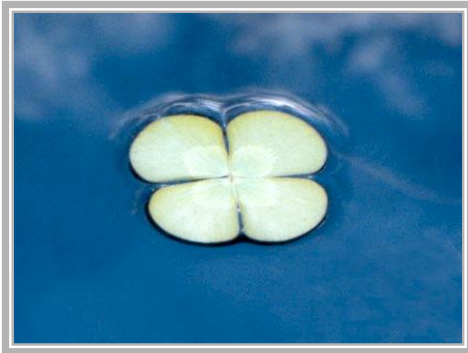


MARSILEA

A

**1 FROND
PER NODE**





MARSILEA

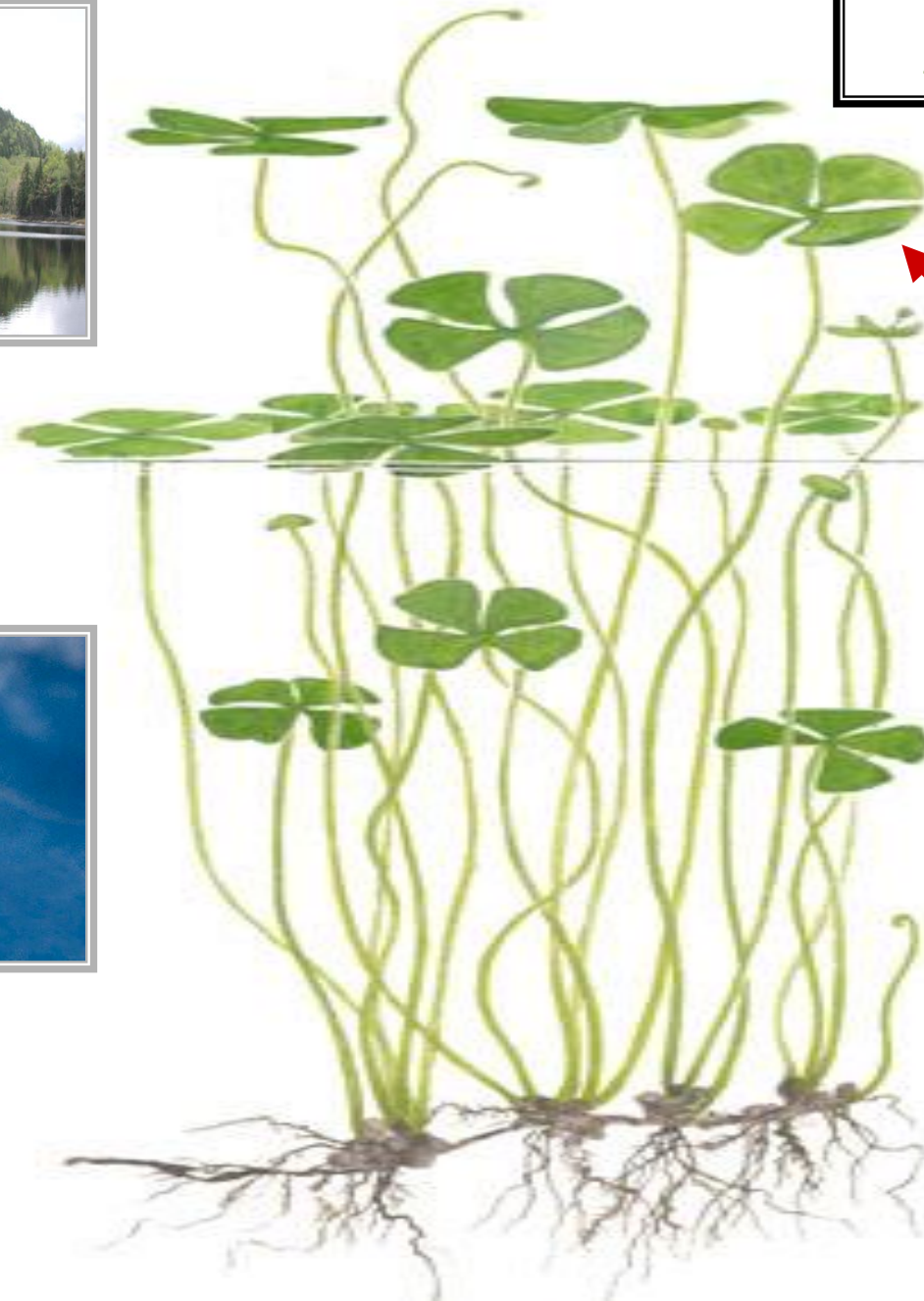
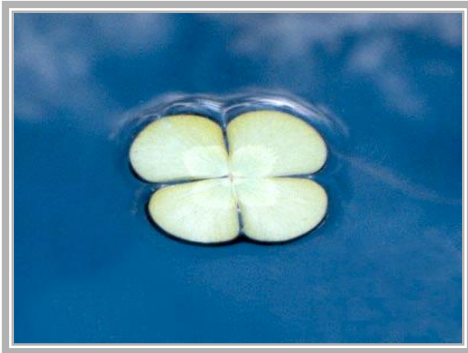


**ALTERNATE
PHYLLOTAXY**





VERNATION



MARSILEA

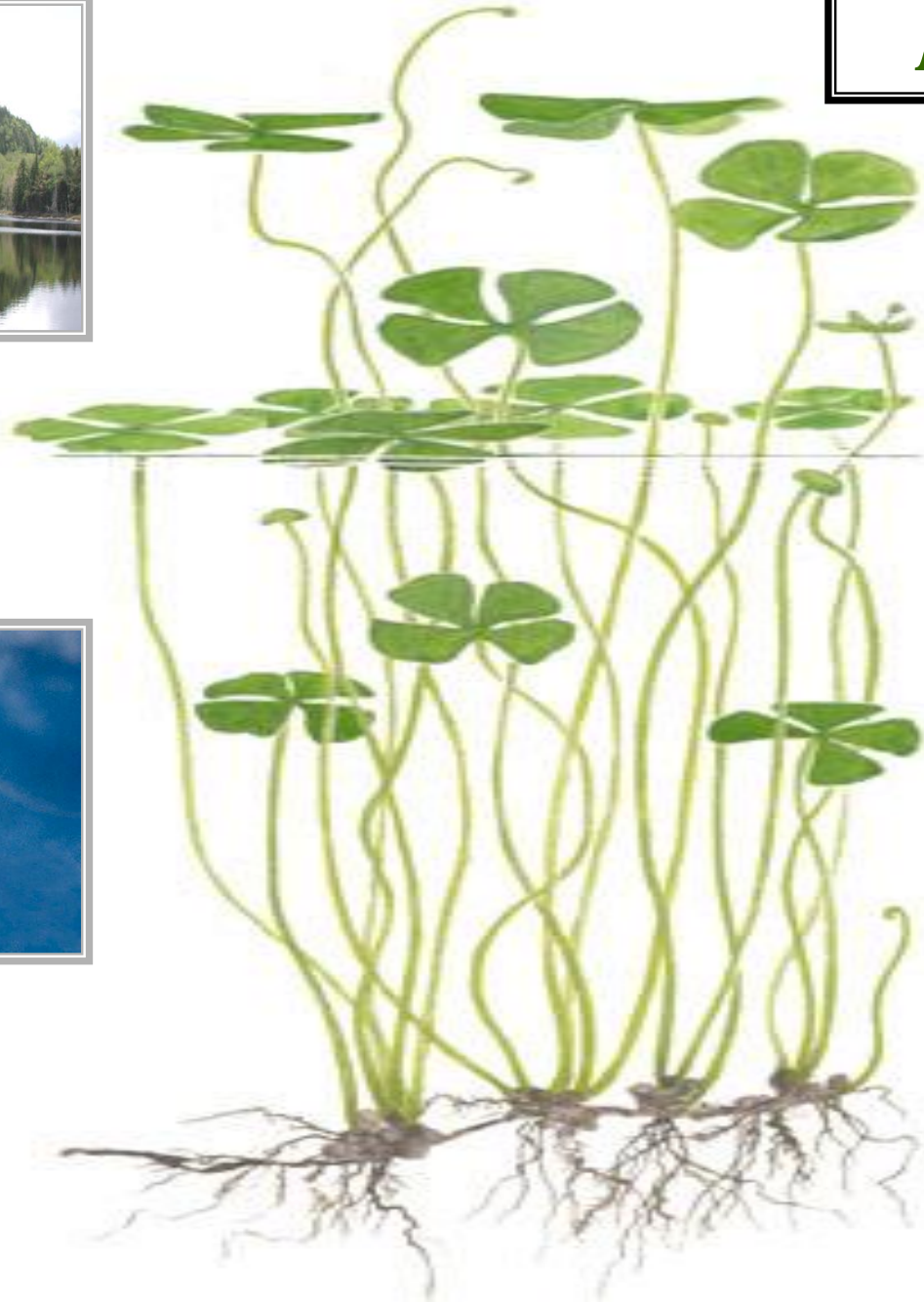
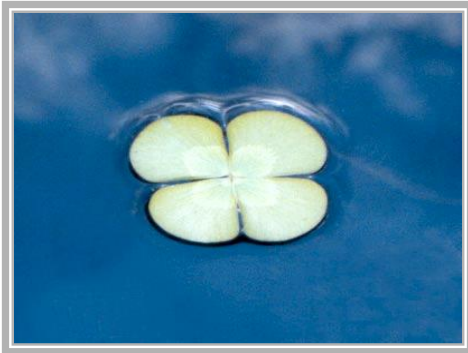
“F”

**FROND
VERNATION**

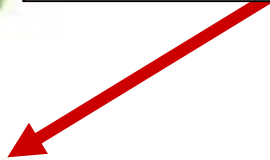




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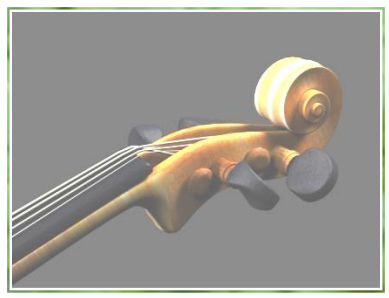


“FIDDLEHEAD”





“FIDDLEHEAD”



CV



“FIDDLEHEAD”

CROZIER





“FIDDLEHEAD”

CROZIER

CIRCINATE VERNATION



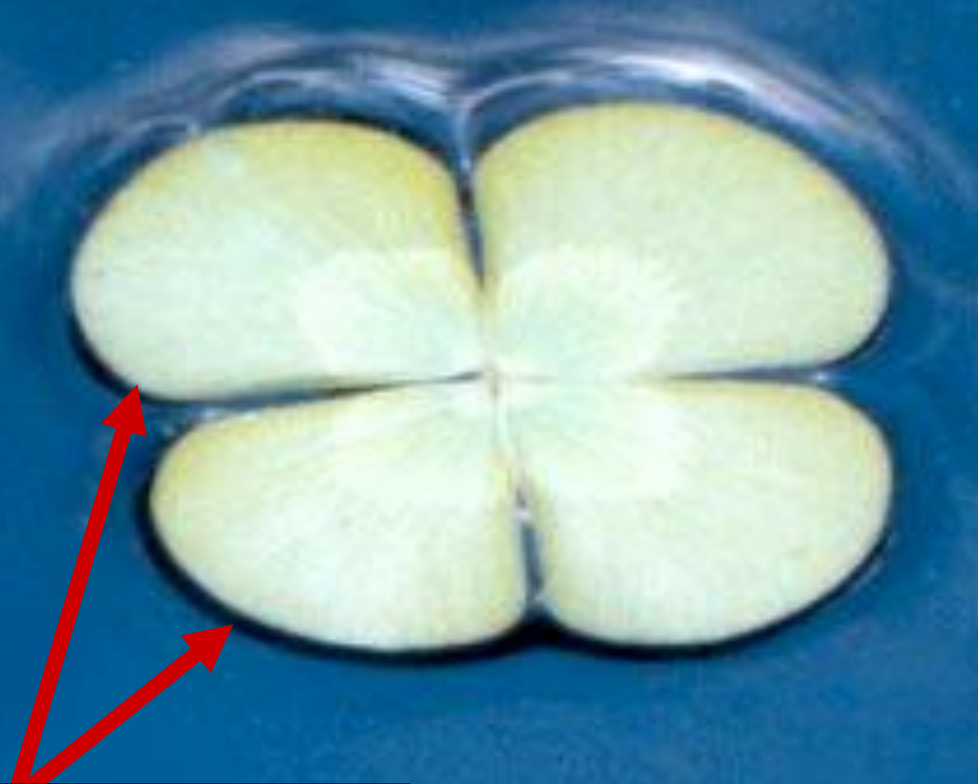


FROND MORPHOLOGY

MARSILEA

P

+



FROND MORPHOLOGY

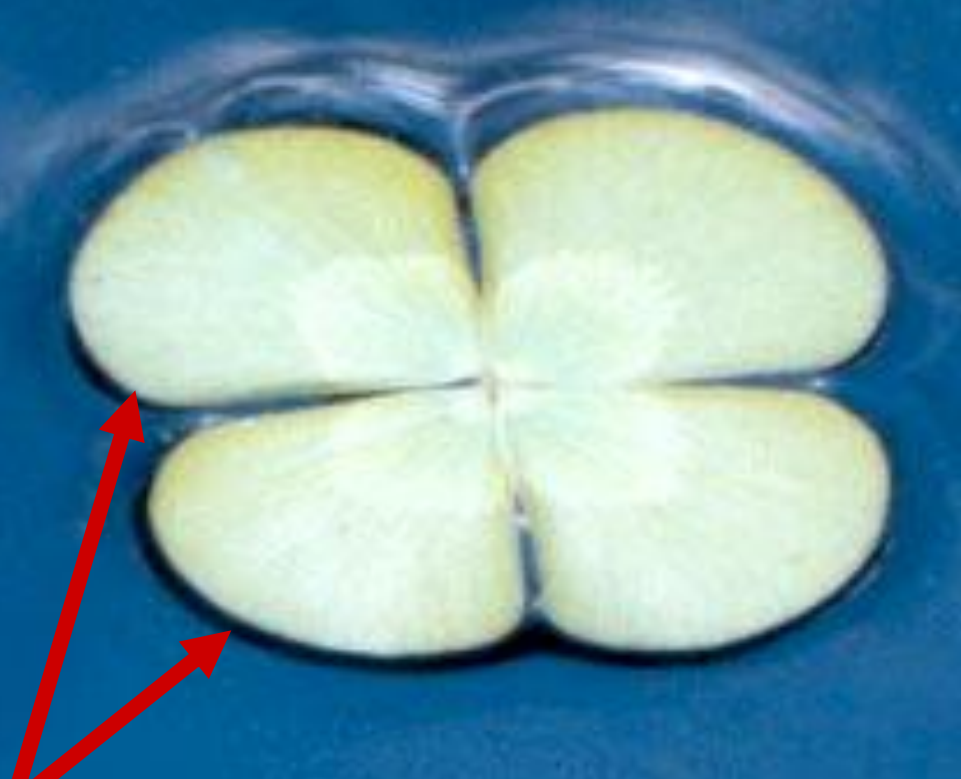
MARSILEA

C



CLOVER-LIKE PINNAE

MARSILEA

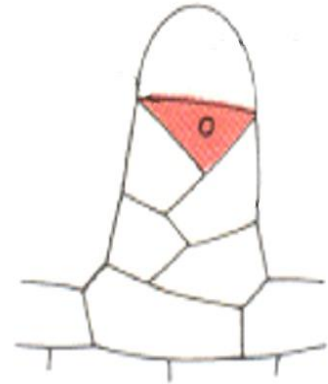
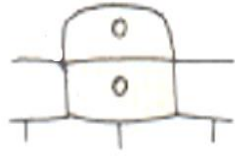
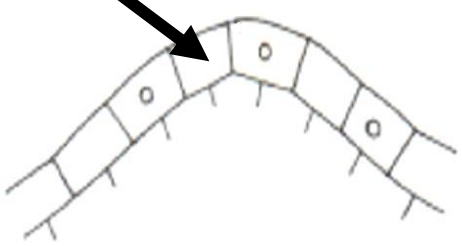


COMPOUND FROND



SPORANGIUM

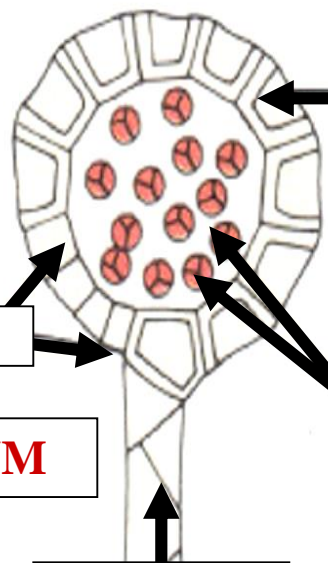
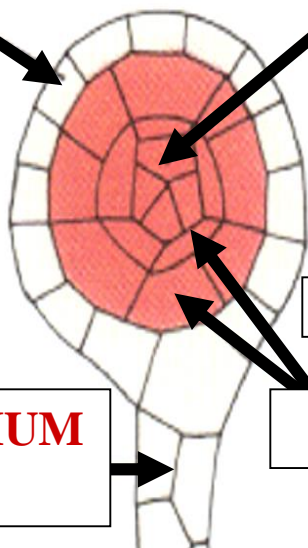
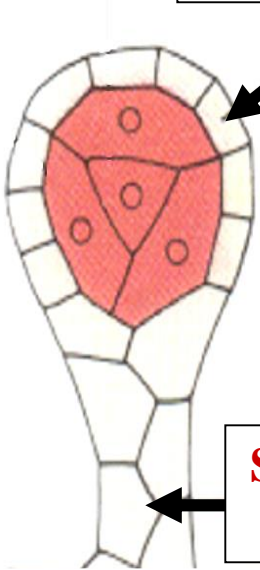
CELL INITIAL



SPORANGIUM WALL

SPOROCYTES

SMALL SIZE



ANNULUS

THIN WALL

FEW SPORES

STOMIUM

TAPETUM

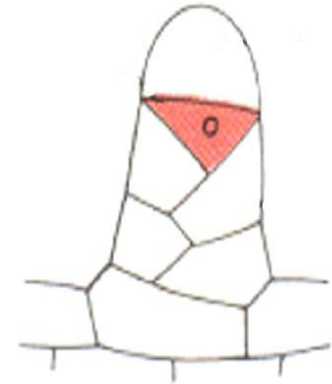
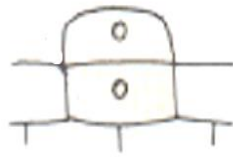
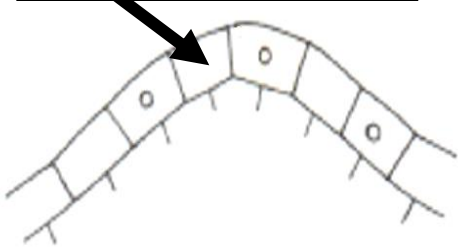
SPORANGIUM STALK

STALK

L.S.



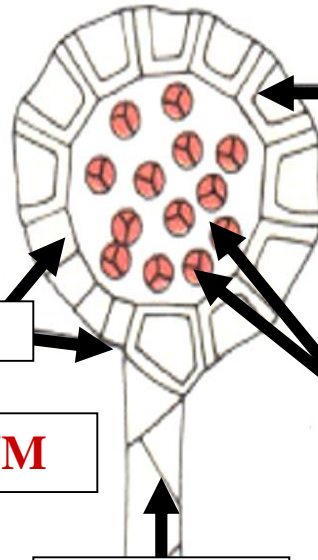
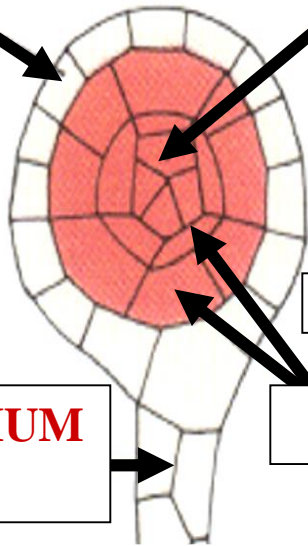
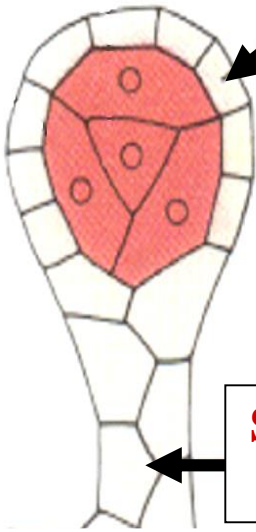
CELL INITIAL



SPORANGIUM WALL

SPOROCYTES

SMALL SIZE



ANNULUS

THIN WALL

STOMIUM

FEW SPORES

SPORANGIUM STALK

TAPETUM

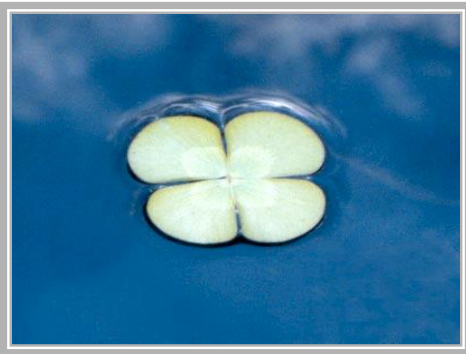
STALK

LEPTOSPORANGIUM

L.S.



SPORANGIUM POSITION



MARSILEA

F

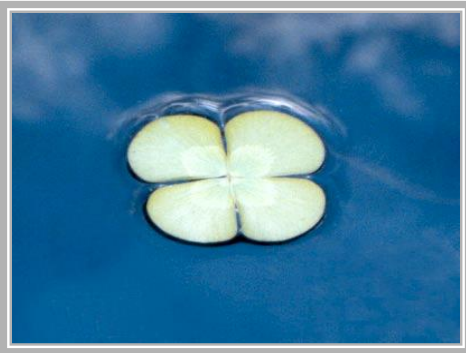


**MODIFIED
PINNA
BEARS
SPORANGIA**



MARSILEA

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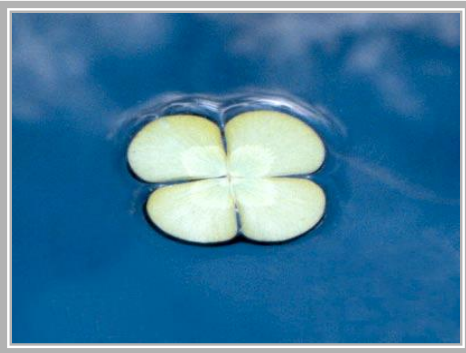


FOLIAR



MARSILEA

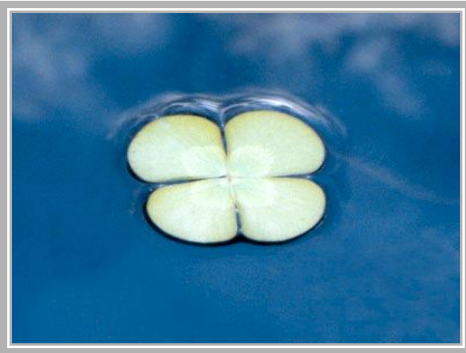
S



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MARSILEA



SPOROCARP

SPOROCARP

SPOROCARP

**MARSILEALES
SPOROCARP**

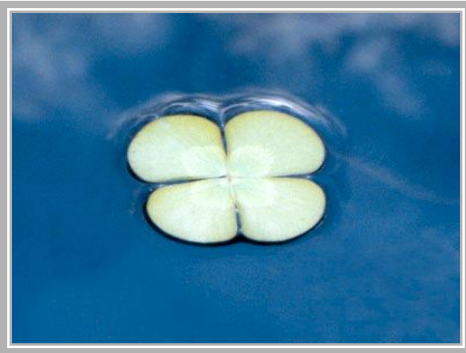
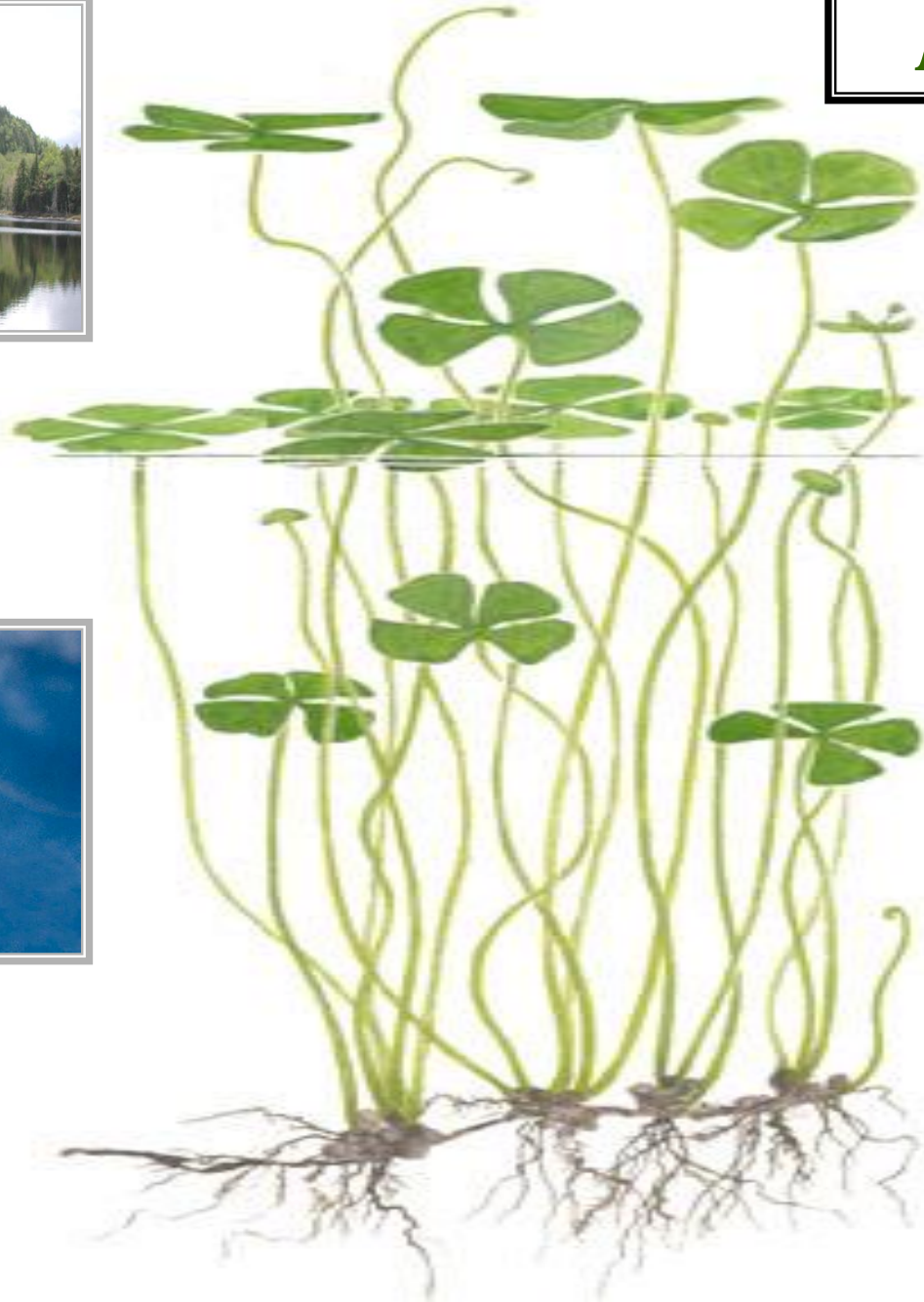


MODIFIED PINNA

**MARSILEALES
SPOROCARP**



MARSILEA



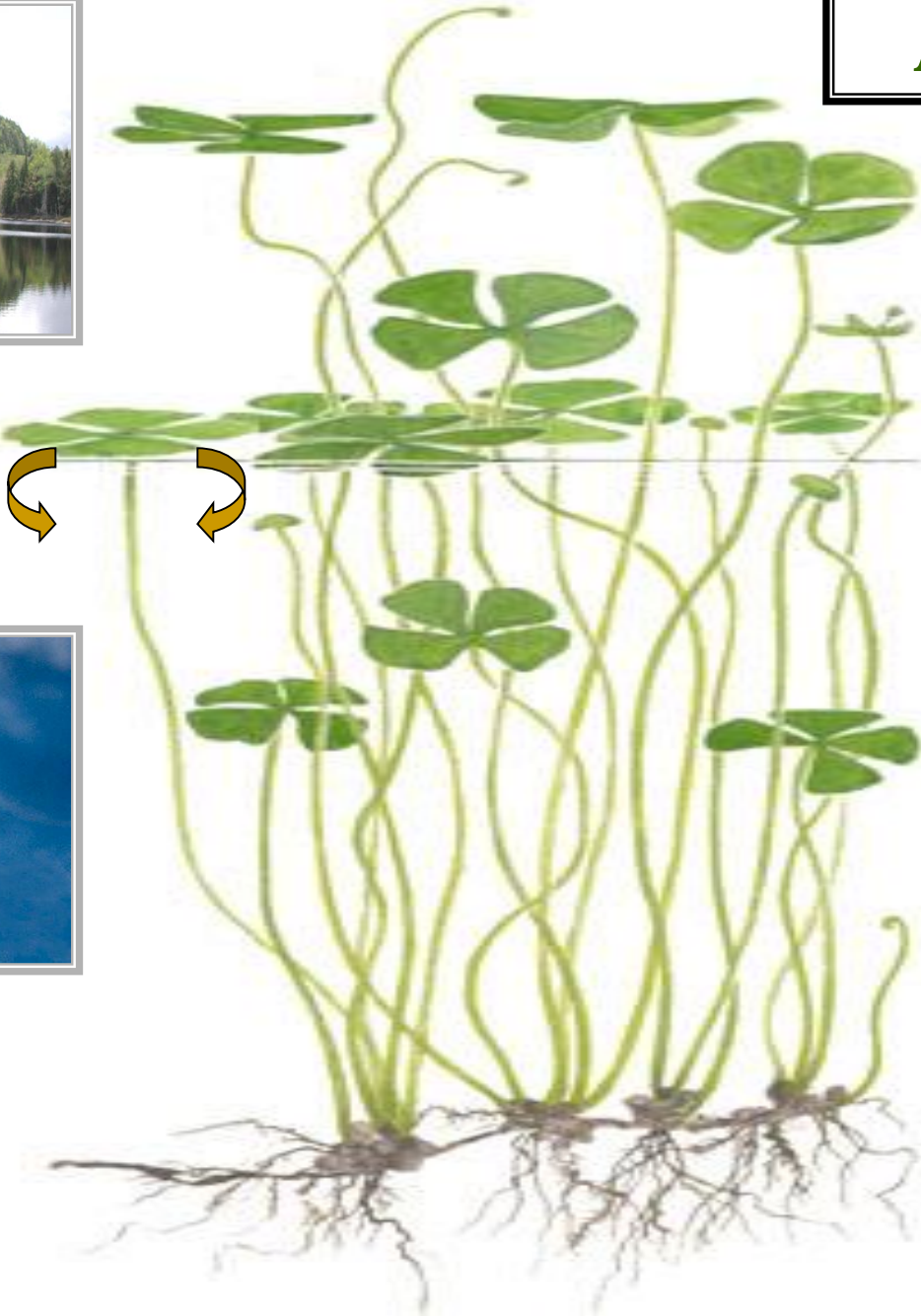
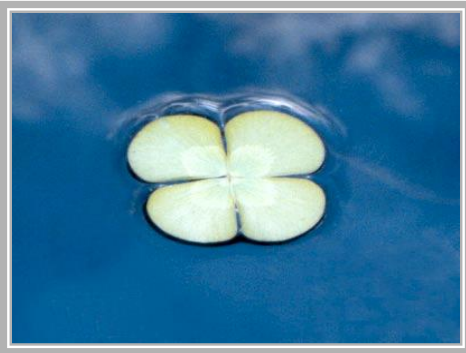
**SPOROCARP
MODIFIED
PINNA**



MARSILEA

EN

ENROLLED



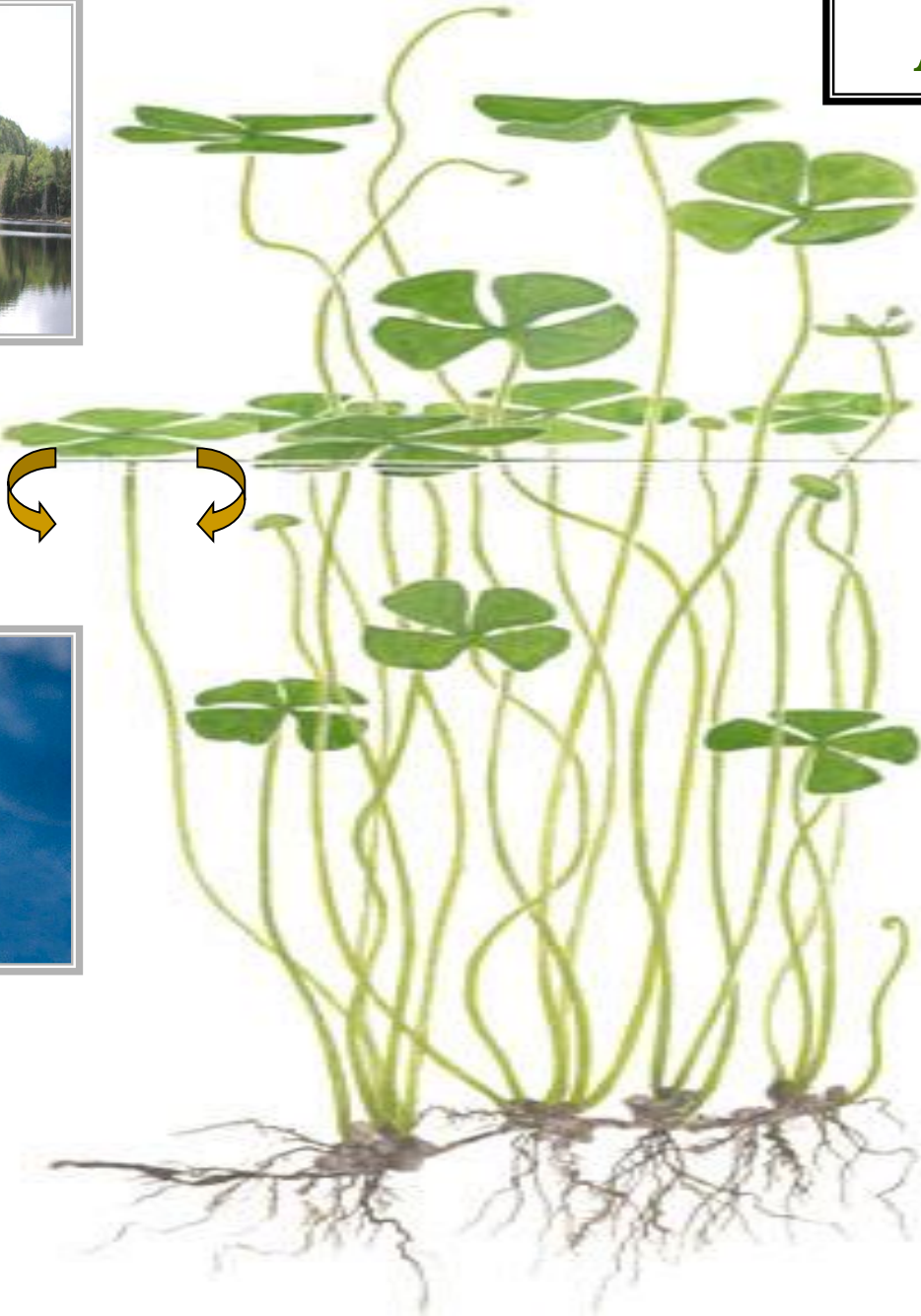
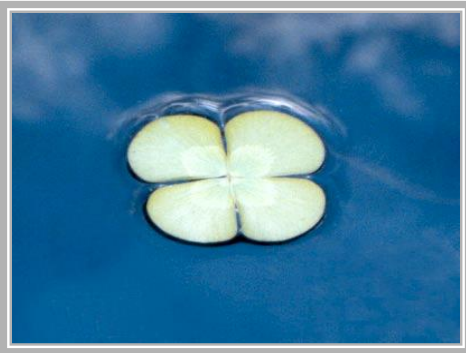
**SPOROCARP
MODIFIED
PINNA**



MARSILEA

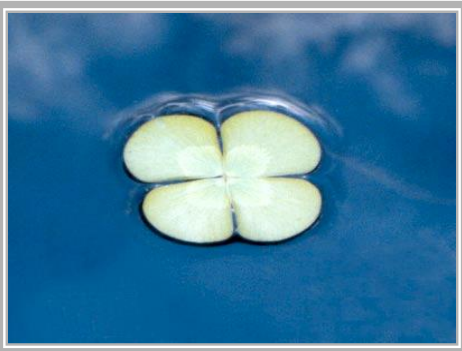


ENROLLED



**SPOROCARP
ENCLOSED
SPORANGIA**

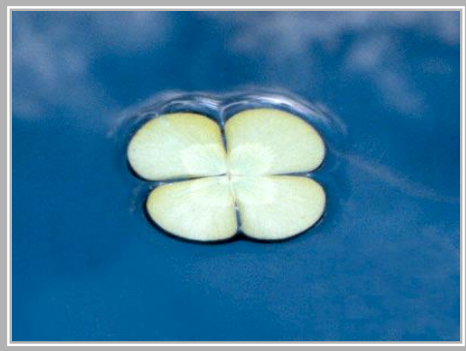
MARSILEA



**SPOROCARP
DROUGHT
RESISTANT**



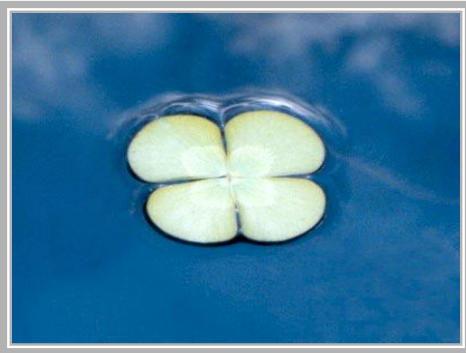
MARSILEA



**SPOROCARP
"GERMINATES"**



MARSILEA



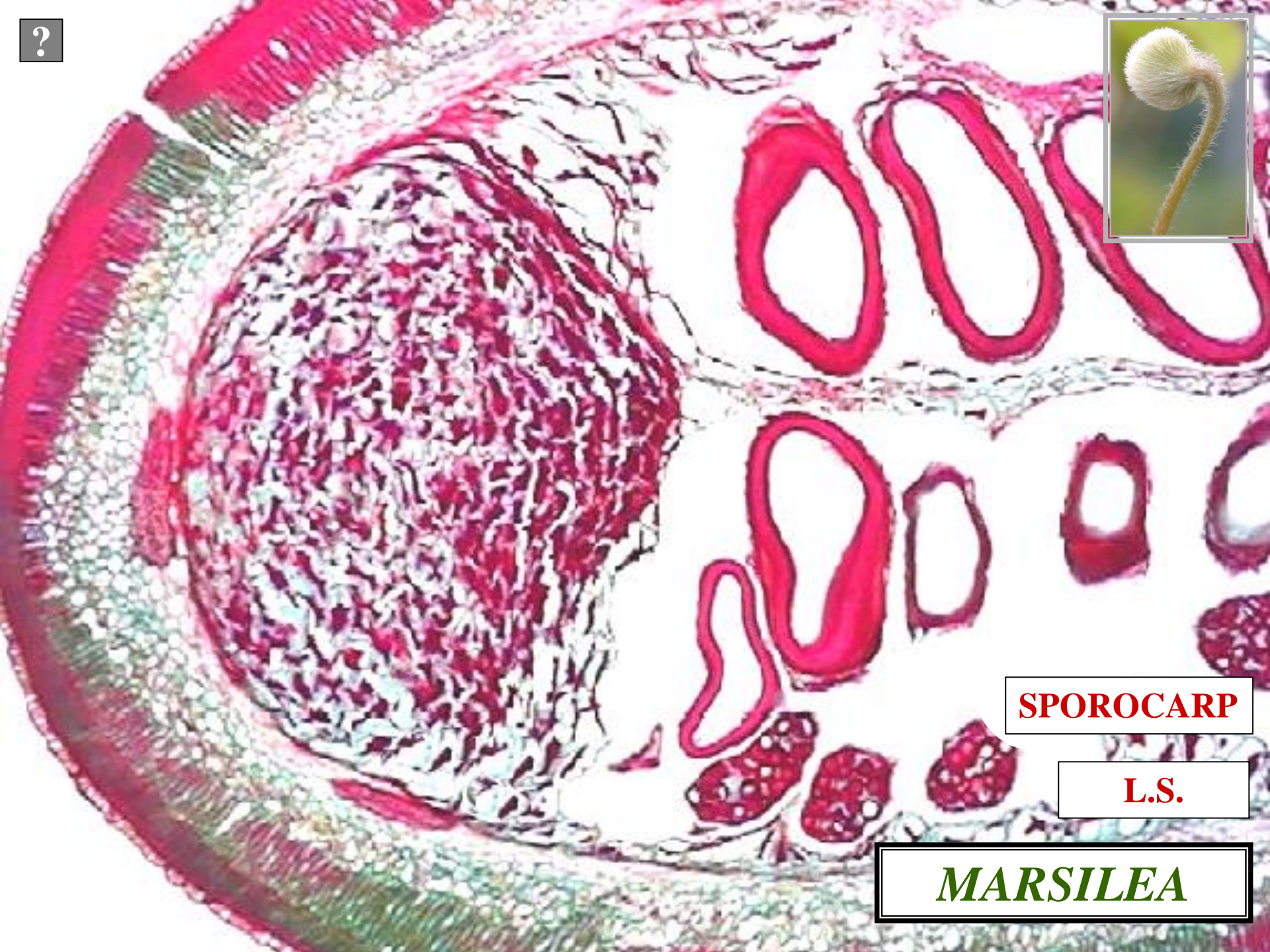
SPORANGIA
EMERGE

**SPOROCARP
“GERMINATES”**



SPOROCARP STRUCTURE

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SPOROCARP

L.S.

MARSILEA

P

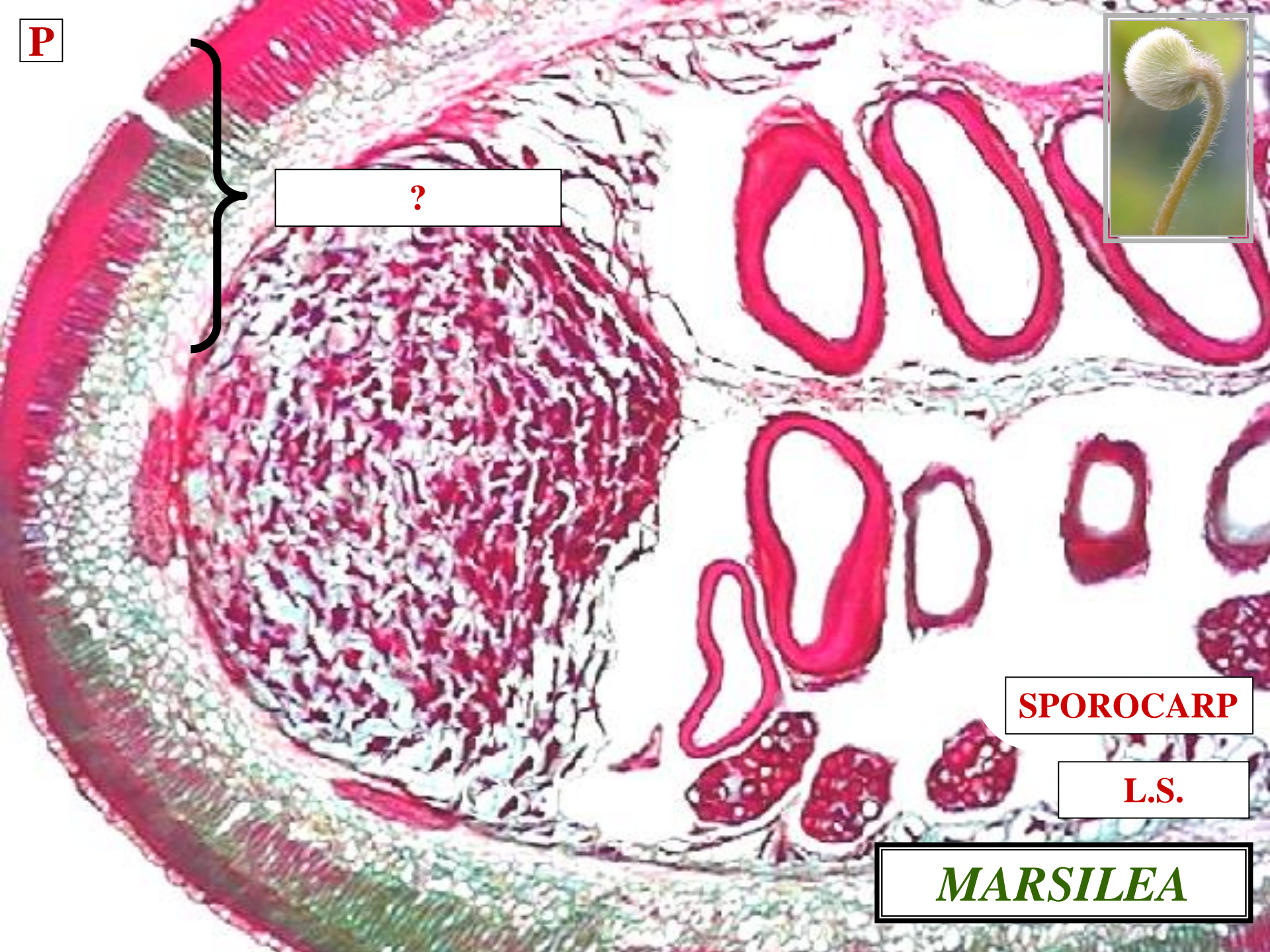


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SPOROCARP

L.S.

MARSILEA



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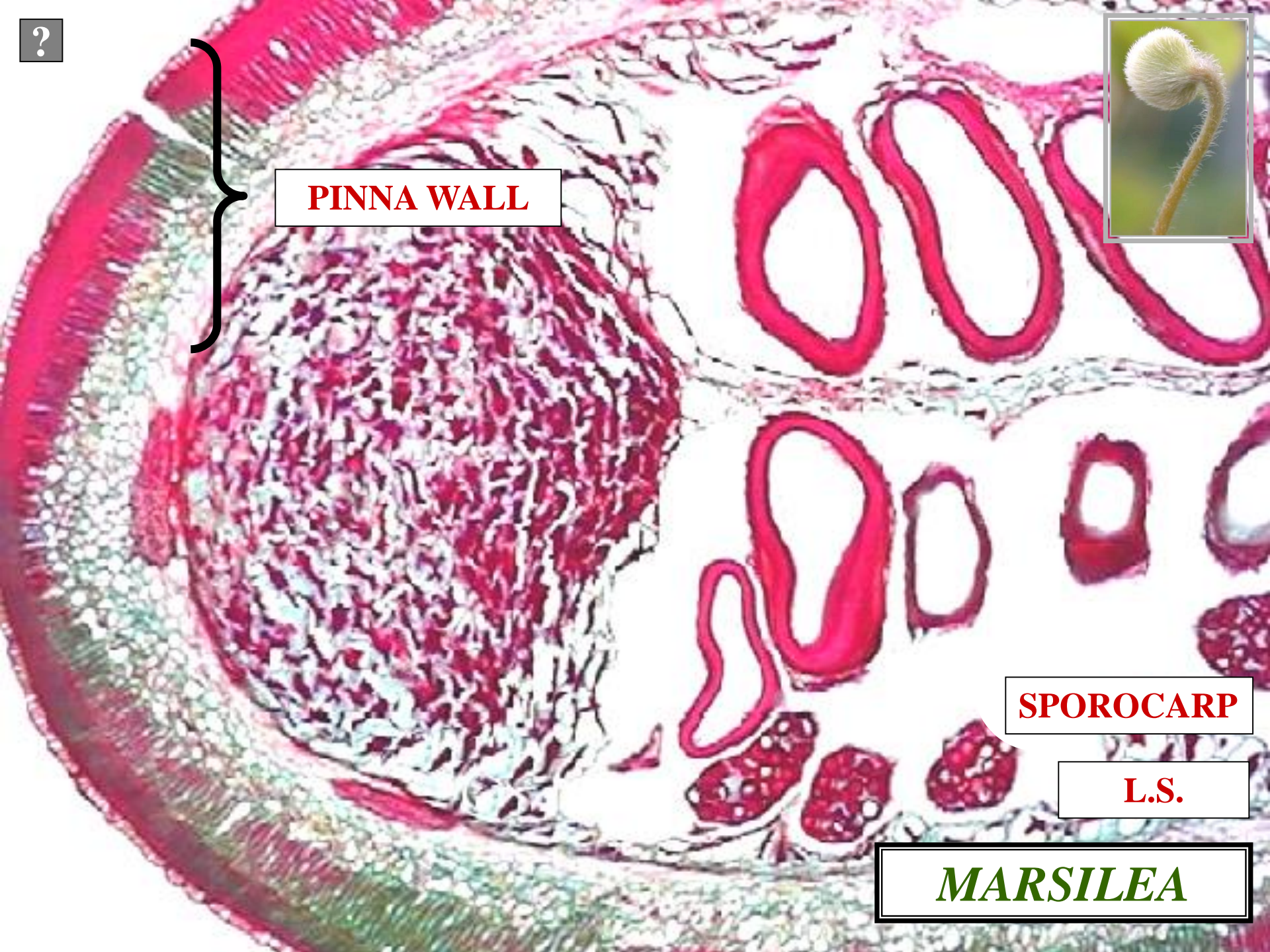


PINNA WALL

SPOROCARP

L.S.

MARSILEA



G



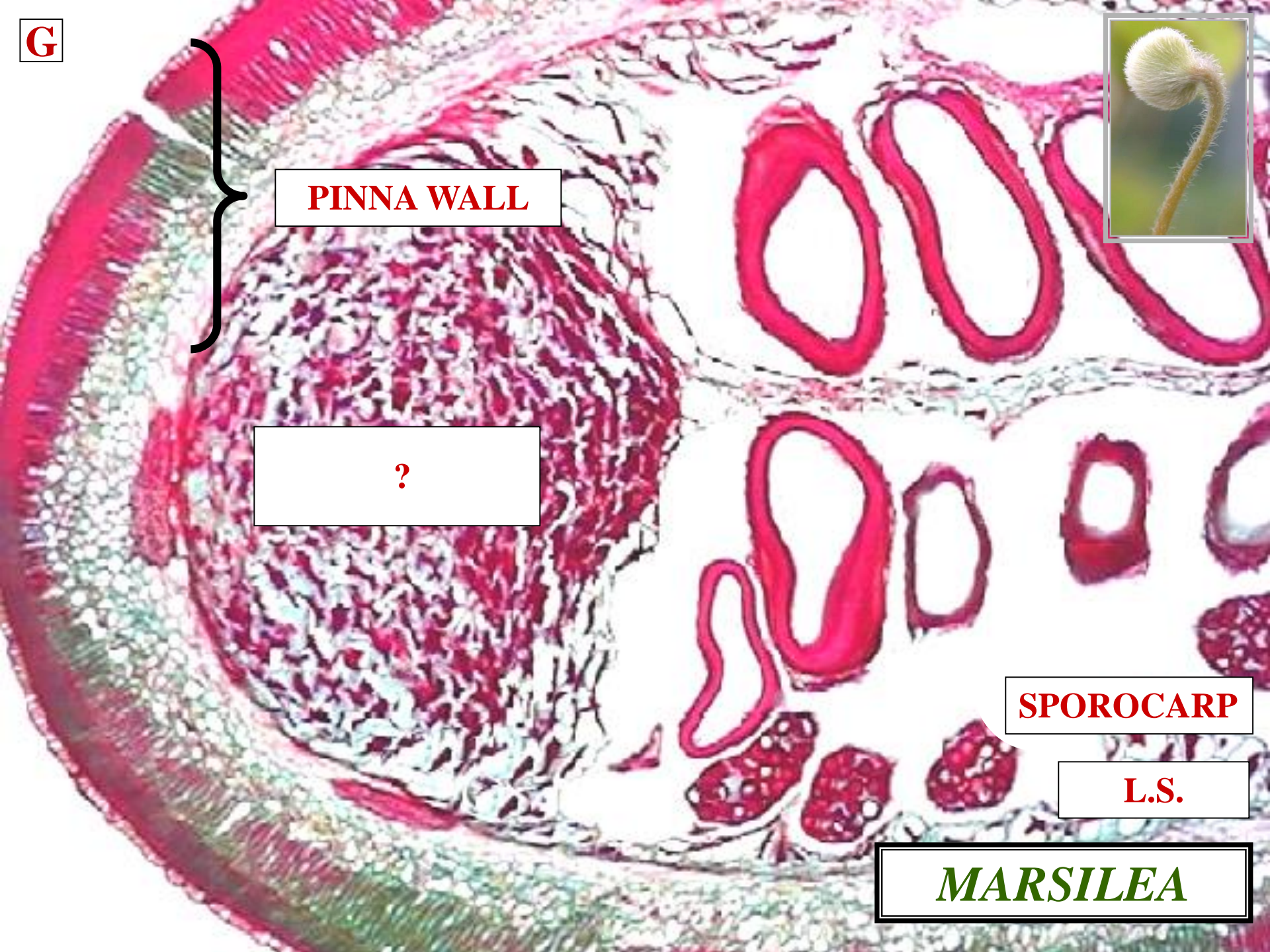
PINNA WALL

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SPOROCARP

L.S.

MARSILEA



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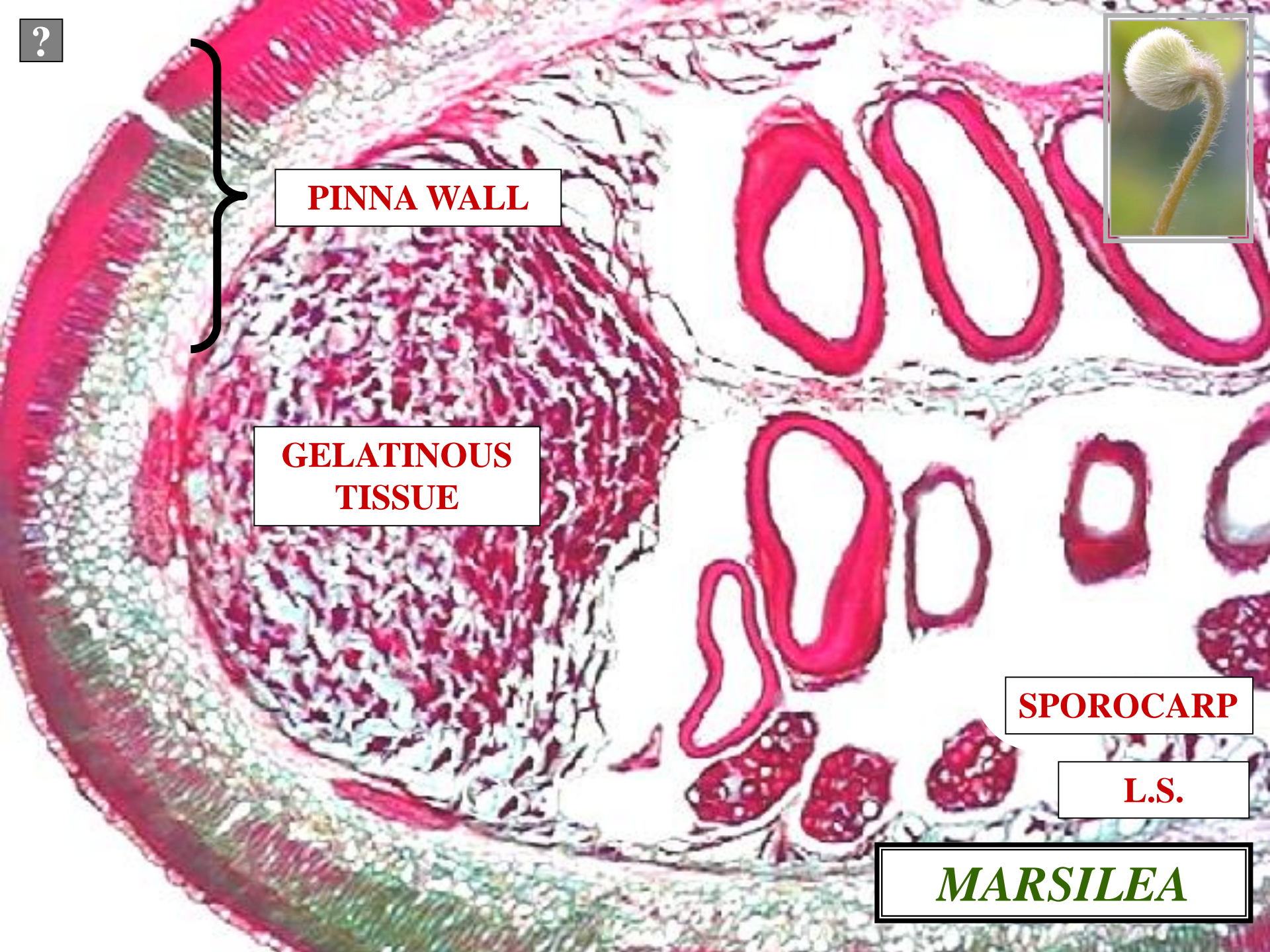
PINNA WALL

GELATINOUS TISSUE

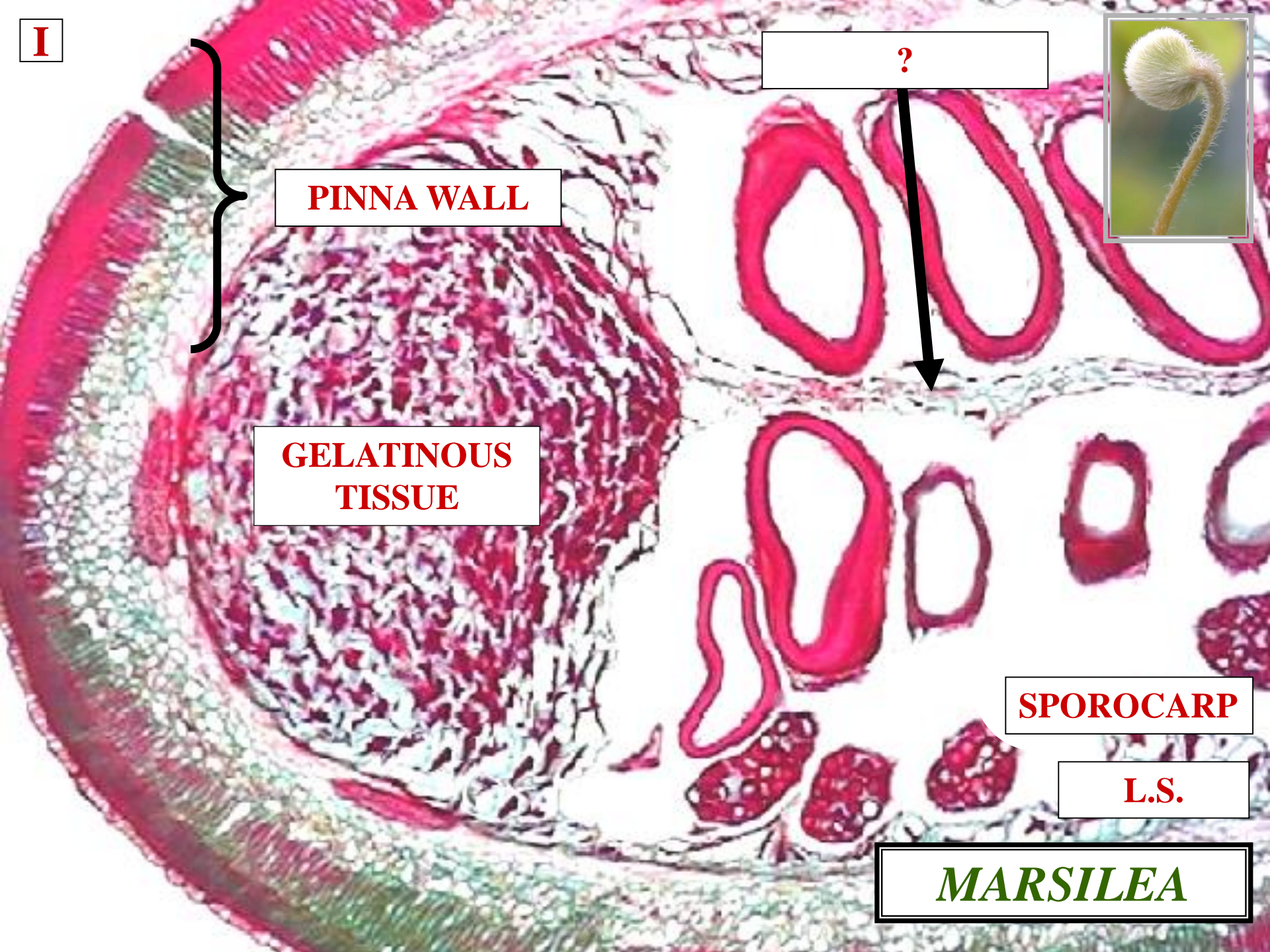
SPOROCARP

L.S.

MARSILEA



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PINNA WALL

GELATINOUS TISSUE

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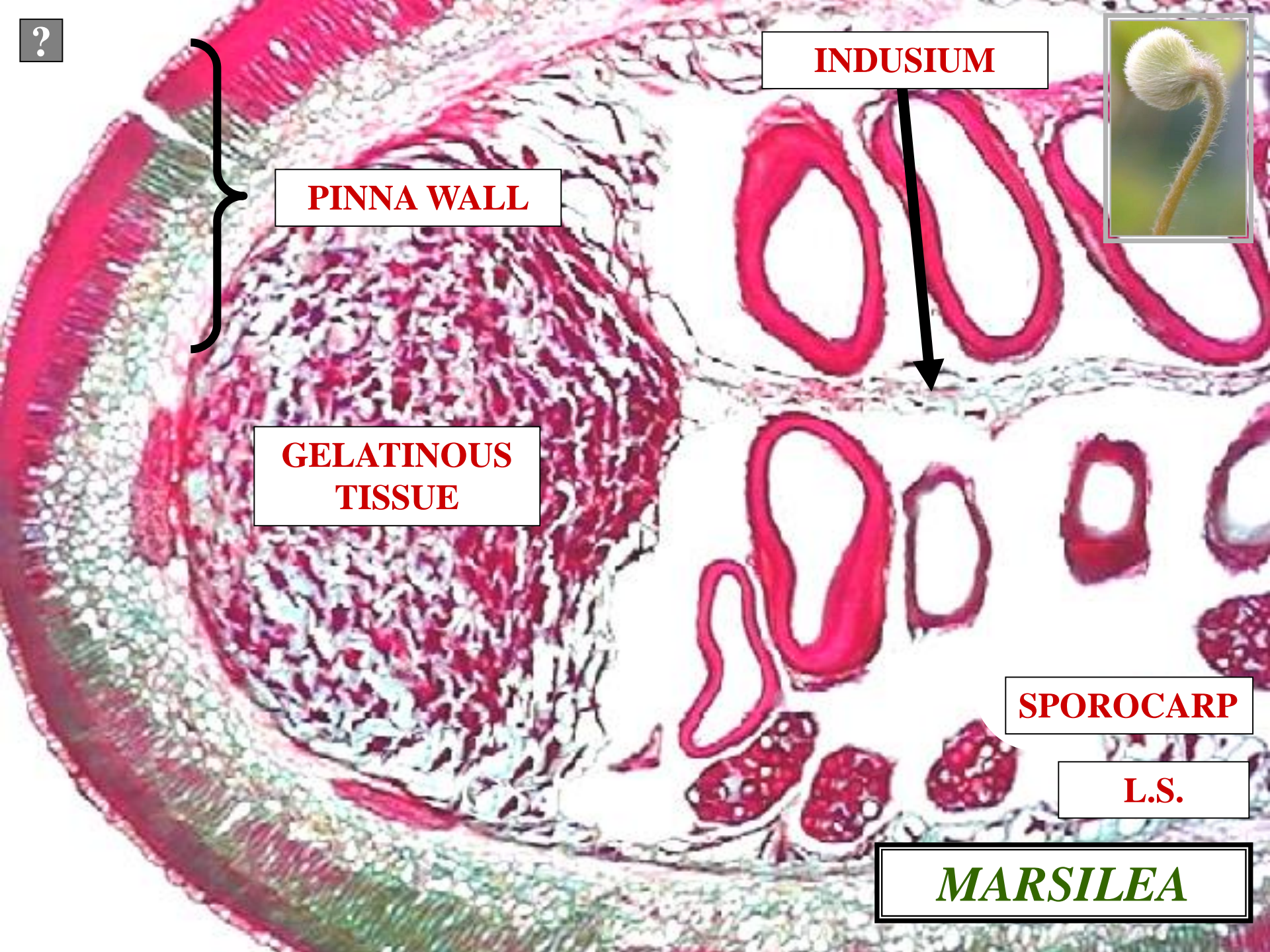
SPOROCARP

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MARSILEA



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INDUSIUM



PINNA WALL

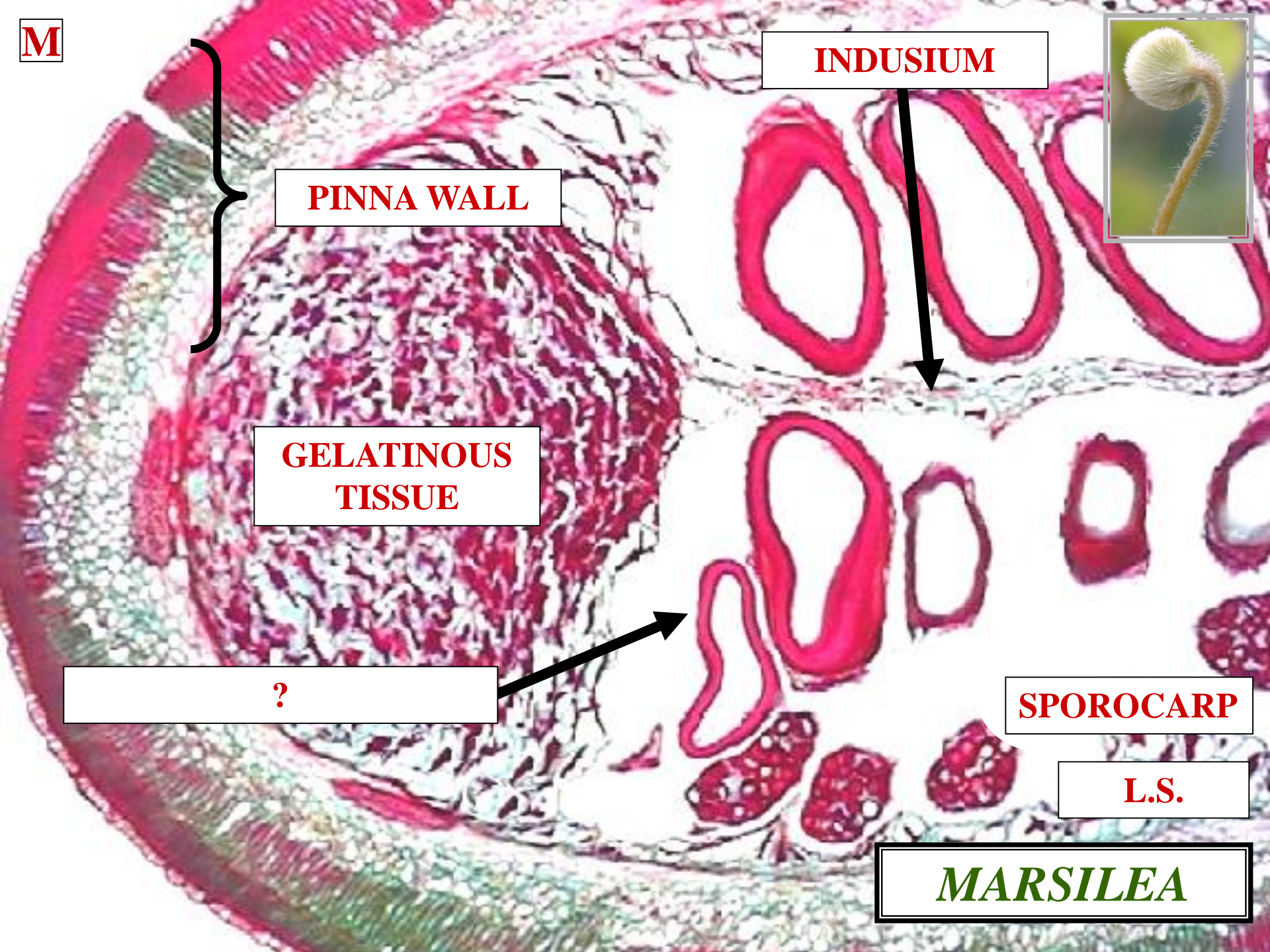
**GELATINOUS
TISSUE**

SPOROCARP

L.S.

MARSILEA

M



INDUSIUM

PINNA WALL

**GELATINOUS
TISSUE**

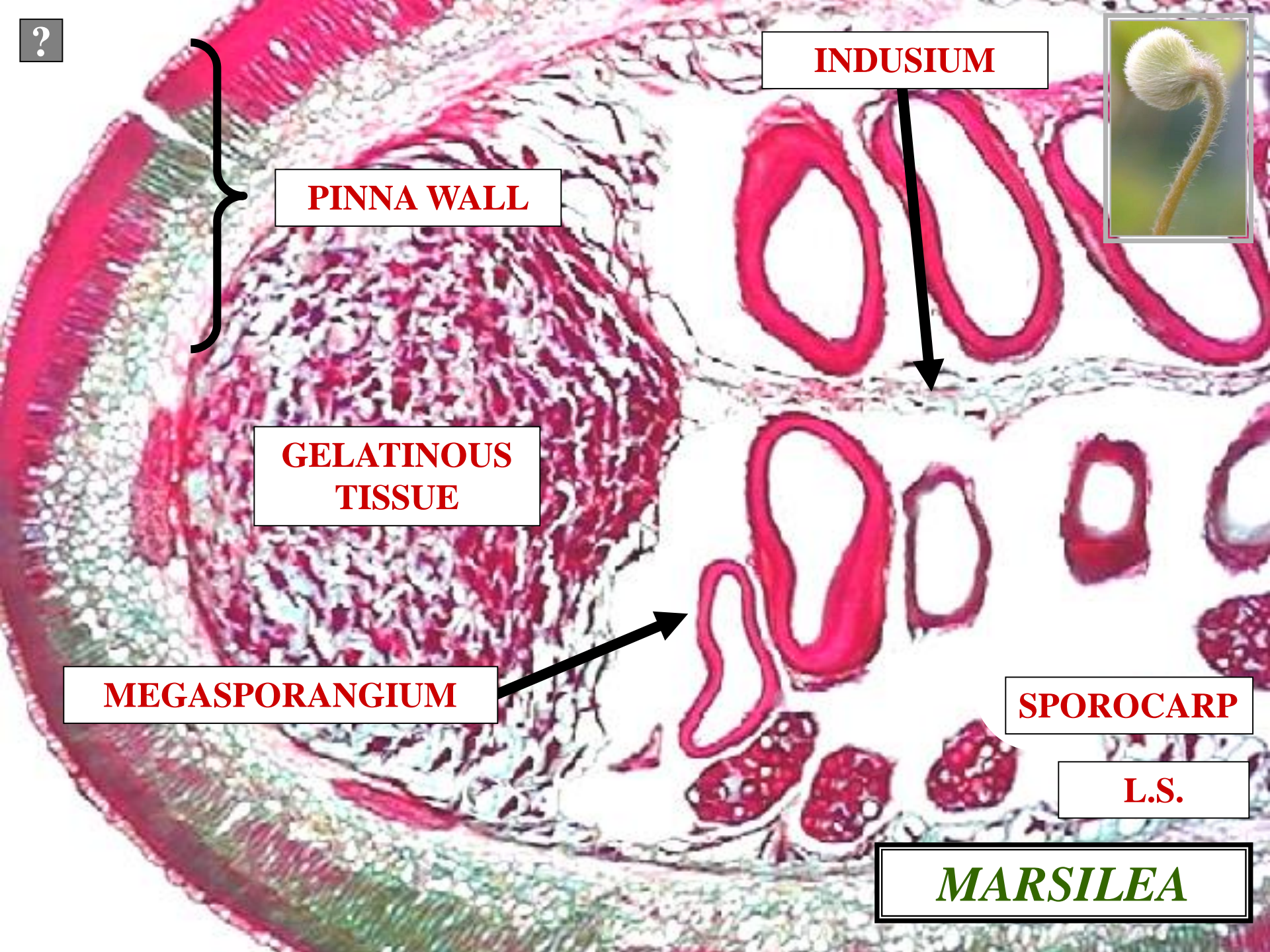
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SPOROCARP

L.S.

MARSILEA

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INDUSIUM

PINNA WALL

**GELATINOUS
TISSUE**

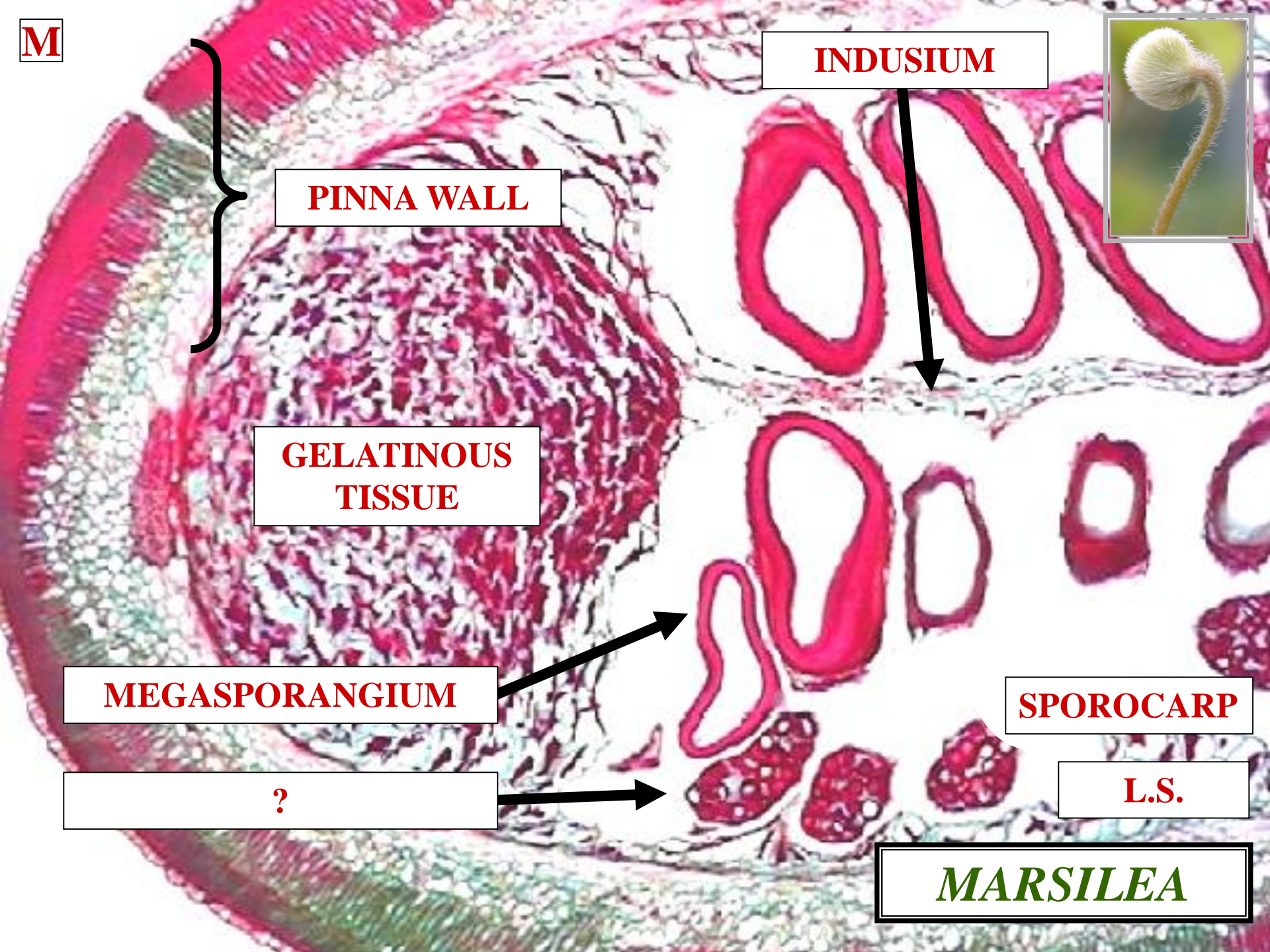
MEGASPORANGIUM

SPOROCARP

L.S.

MARSILEA

M



INDUSIUM

PINNA WALL

**GELATINOUS
TISSUE**

MEGASPORANGIUM

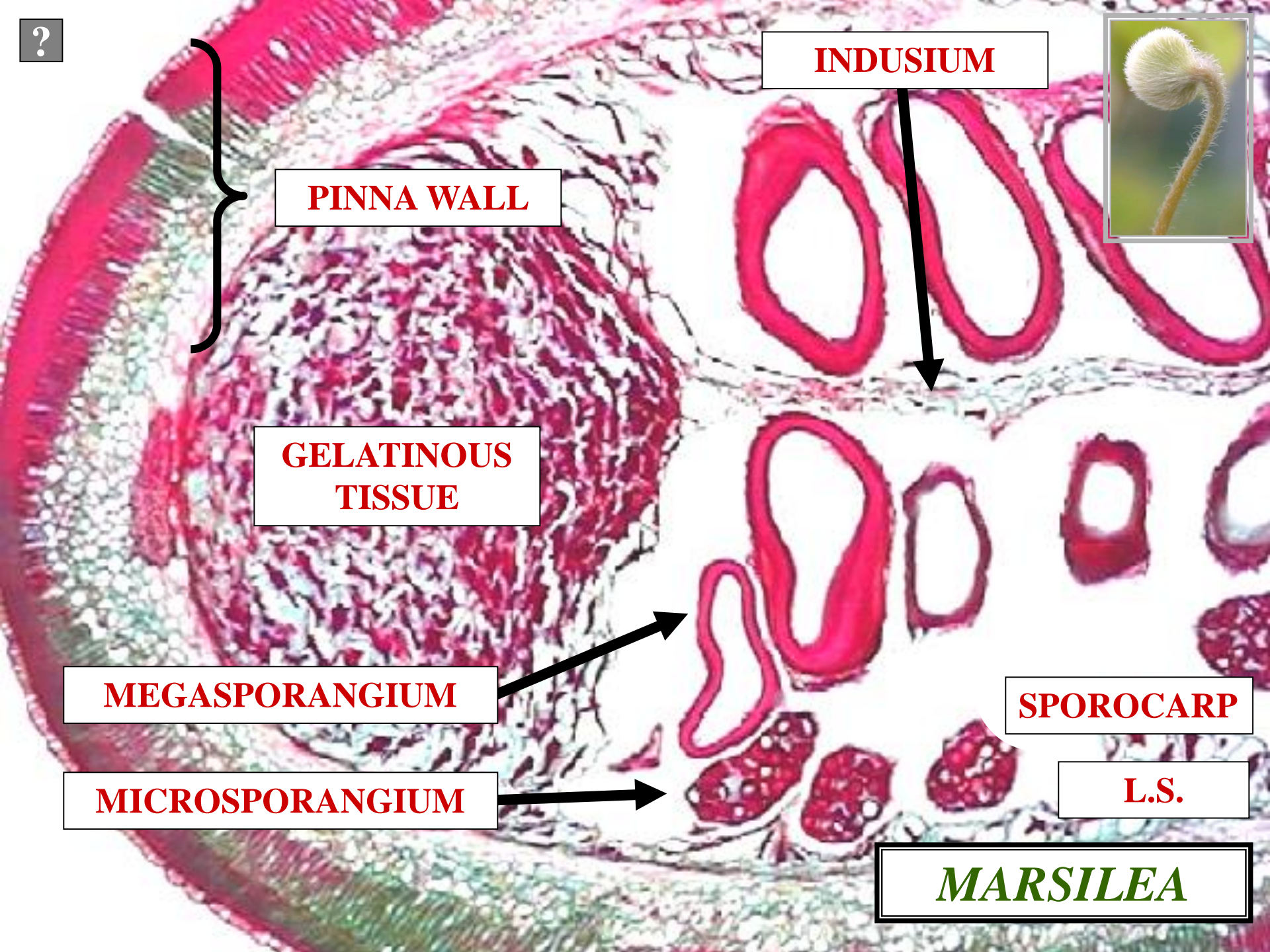
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SPOROCARP

L.S.

MARSILEA

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INDUSIUM



PINNA WALL

**GELATINOUS
TISSUE**

MEGASPORANGIUM

MICROSPORANGIUM

SPOROCARP

L.S.

MARSILEA

P



INDUSIUM

PINNA WALL

GELATINOUS TISSUE

MEGASPORANGIUM

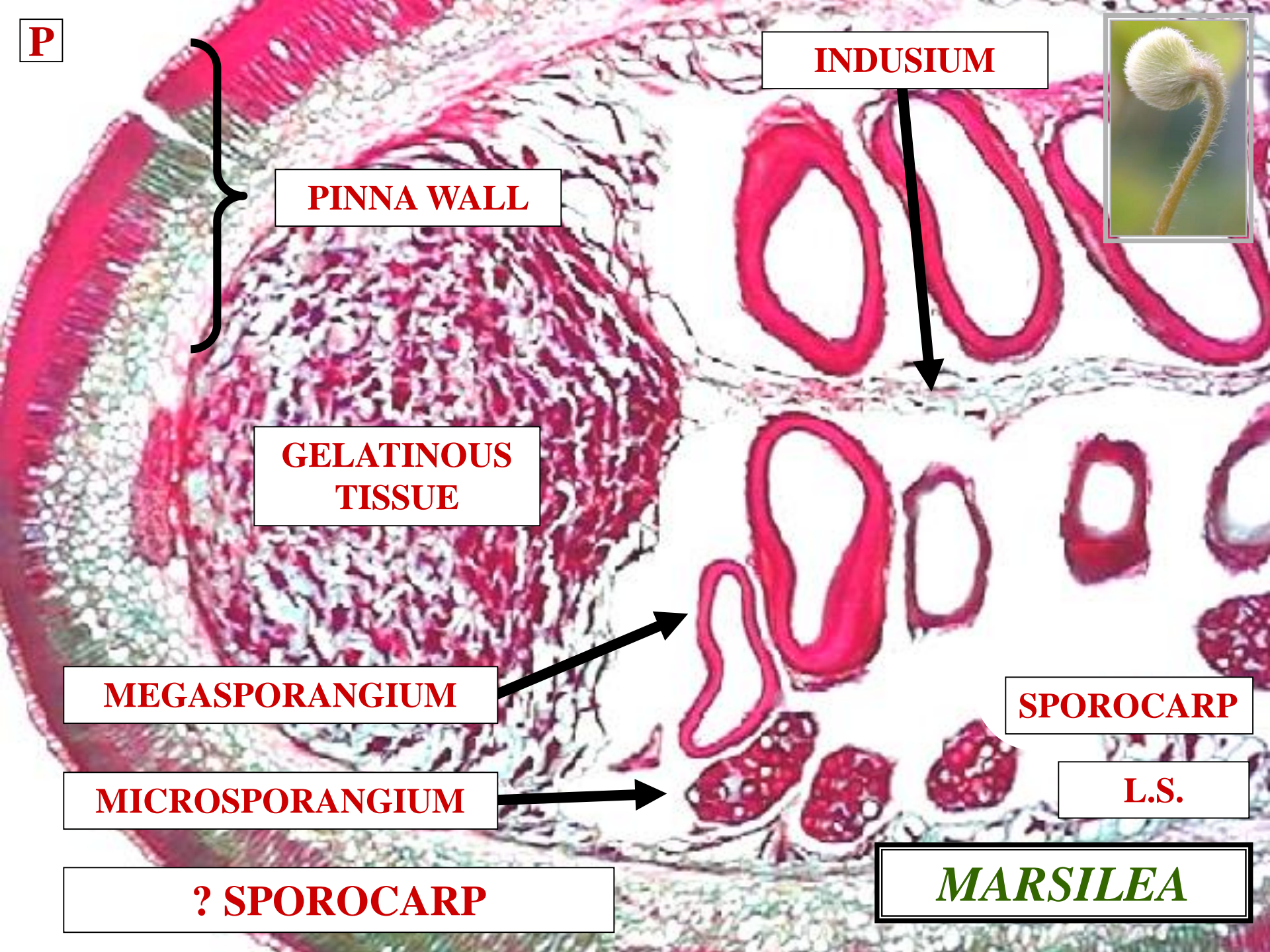
MICROSPORANGIUM

? SPOROCARP

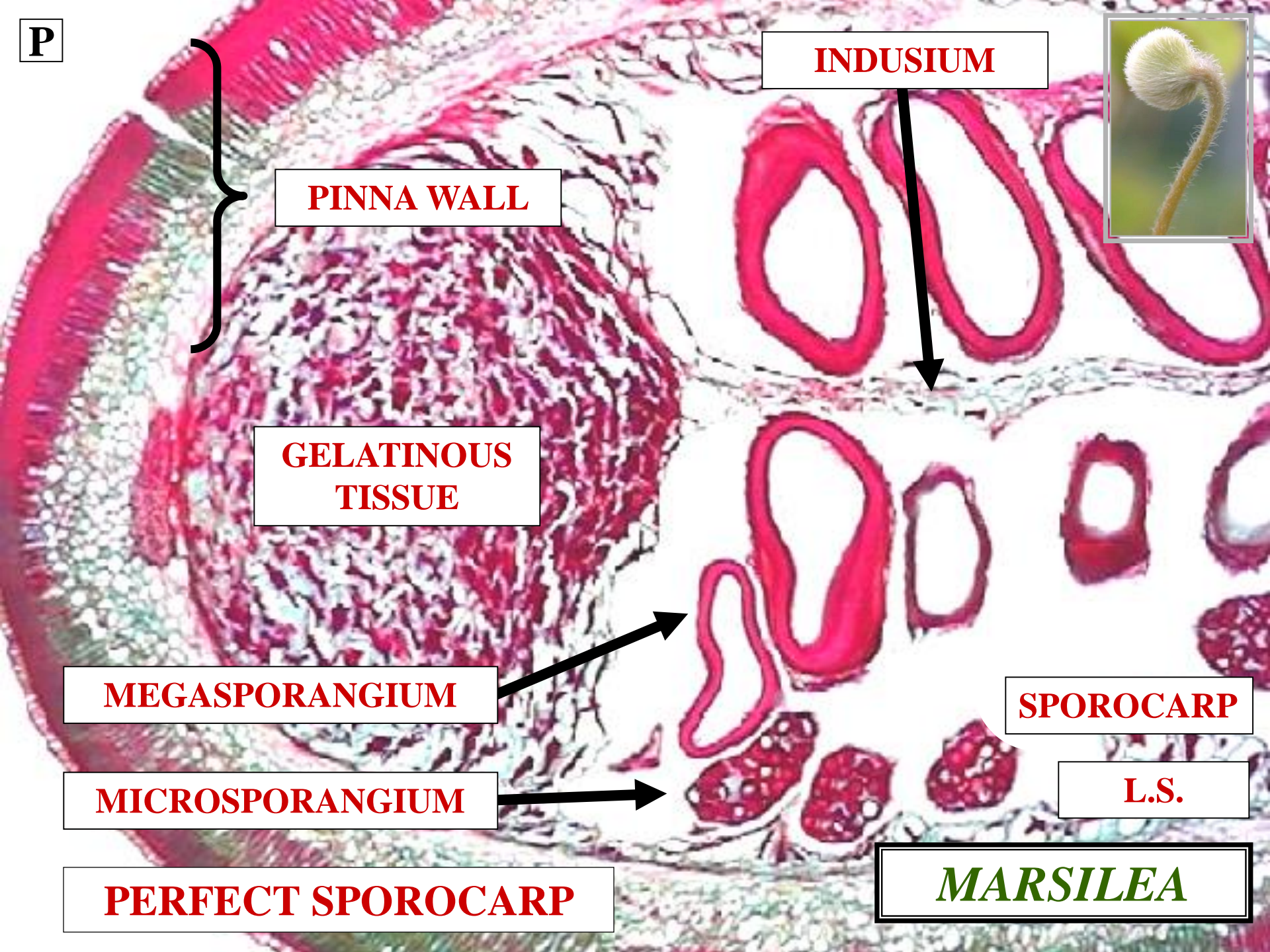
SPOROCARP

L.S.

MARSILEA



P



INDUSIUM

PINNA WALL

GELATINOUS TISSUE

MEGASPORANGIUM

MICROSPORANGIUM

PERFECT SPOROCCARP

SPOROCCARP

L.S.

MARSILEA

**PERFECT
SPOROCARP**

MARSILEALES
PERFECT SPOROCARP
MICROSPORANGIA
&
MEGASPORANGIA
PRESENT

MARSILEALES
PERFECT SPOROCARP





S



INDUSIUM

PINNA WALL

GELATINOUS TISSUE

MEGASPORANGIUM

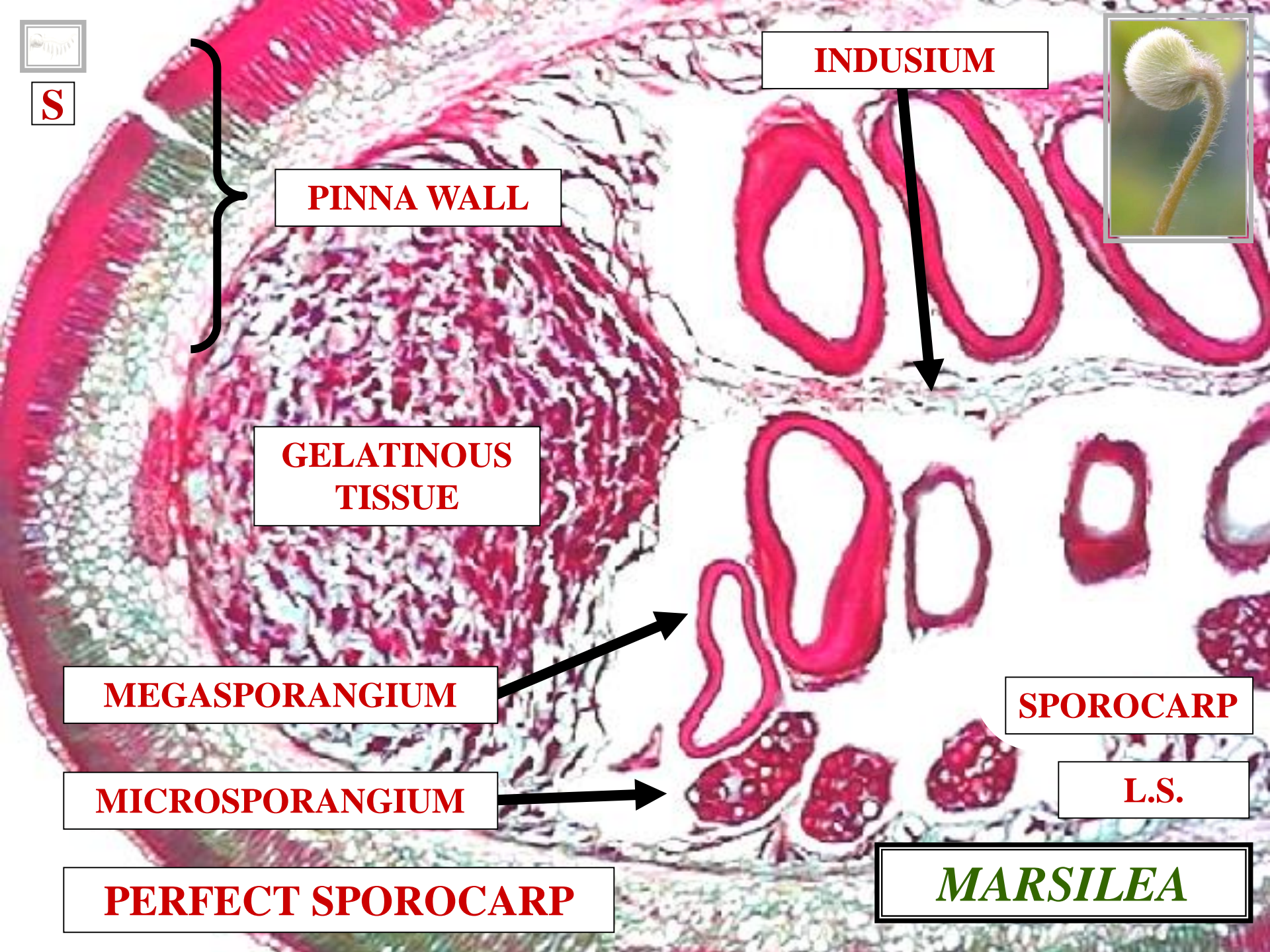
MICROSPORANGIUM

PERFECT SPOROCCARP

SPOROCCARP

L.S.

MARSILEA



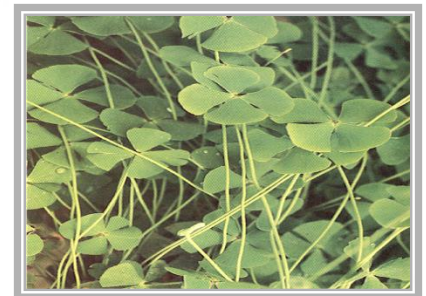
**SPOROCARP
"GERMINATION"**

SOROPHORE

SPOROCARP



LEPTOSPORANGIA



MARSILEA

SOROPHORE



MARSILEALES
SPOROCARP SOROPHORE

DERIVED VIA
GELATINOUS TISSUE

MARSILEALES
SPOROCARP SOROPHORE

MARSILEALES
SPOROCARP SOROPHORE

DERIVED VIA
GELATINOUS TISSUE

BEARS EMERGED
SPORANGIA
MARSILEALES
SPOROCARP SOROPHORE

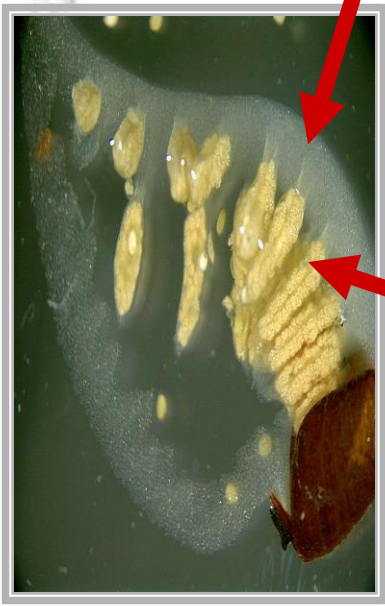


**SPOROCARP
"GERMINATION"**

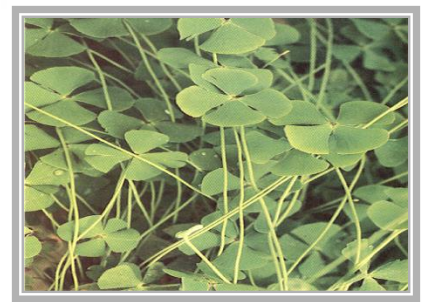


SOROPHORE

SPOROCARP



**EMERGED
SPORANGIA**



MARSILEA





SPORE HABIT

M M

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INDUSIUM

PINNA WALL



GELATINOUS TISSUE

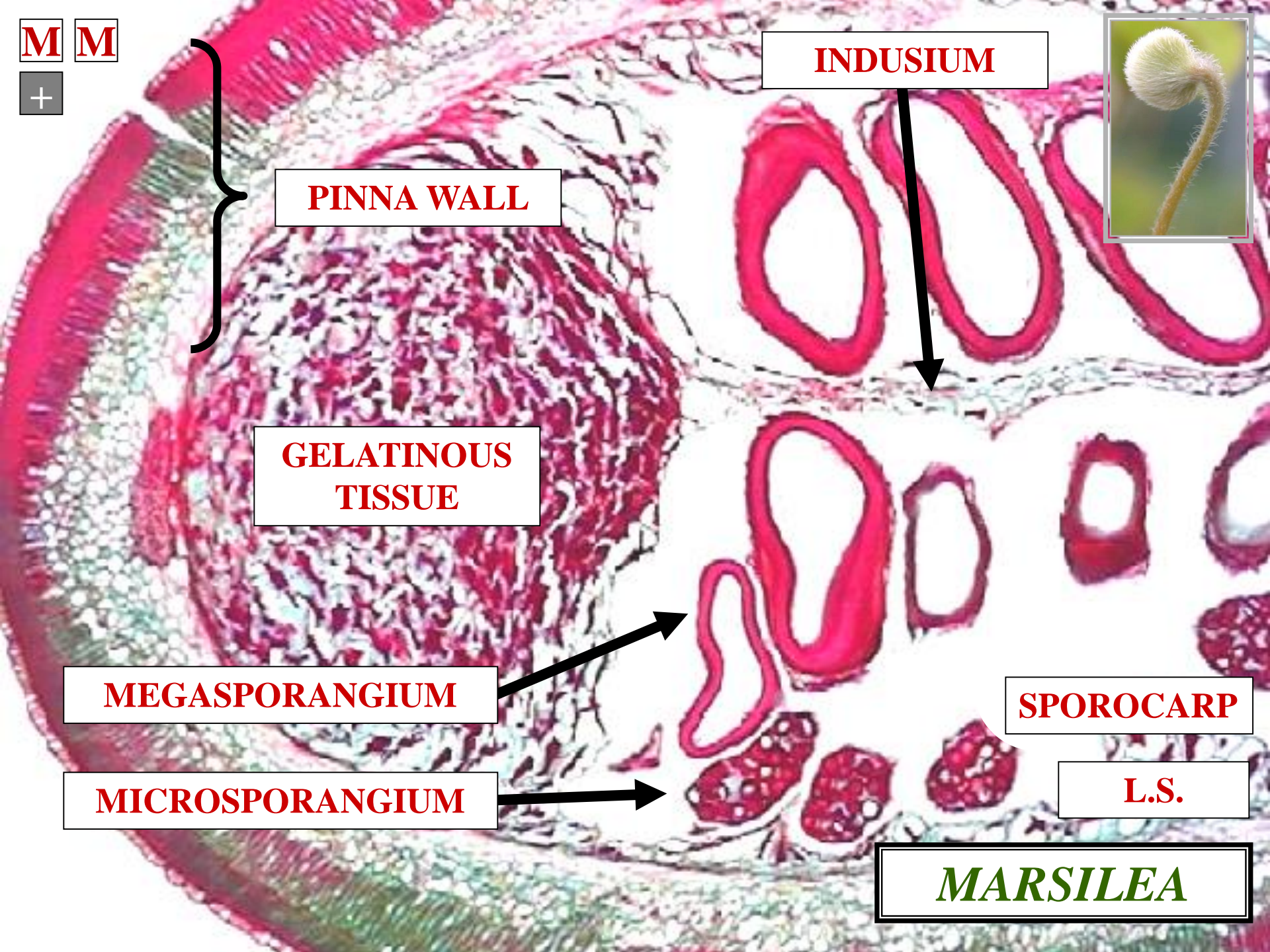
MEGASPORANGIUM

SPOROCARP

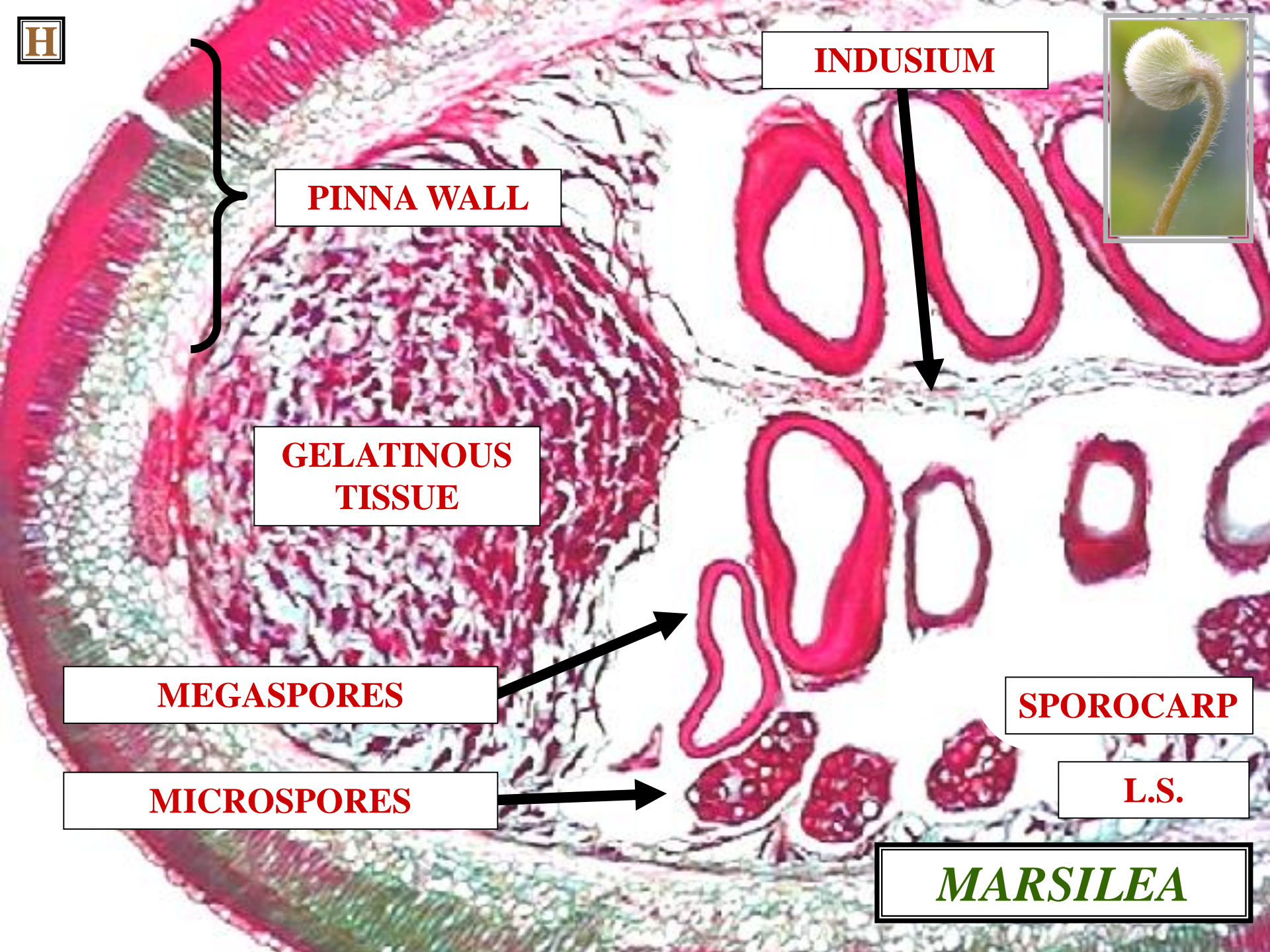
MICROSPORANGIUM

L.S.

MARSILEA



H



INDUSIUM



PINNA WALL

GELATINOUS
TISSUE

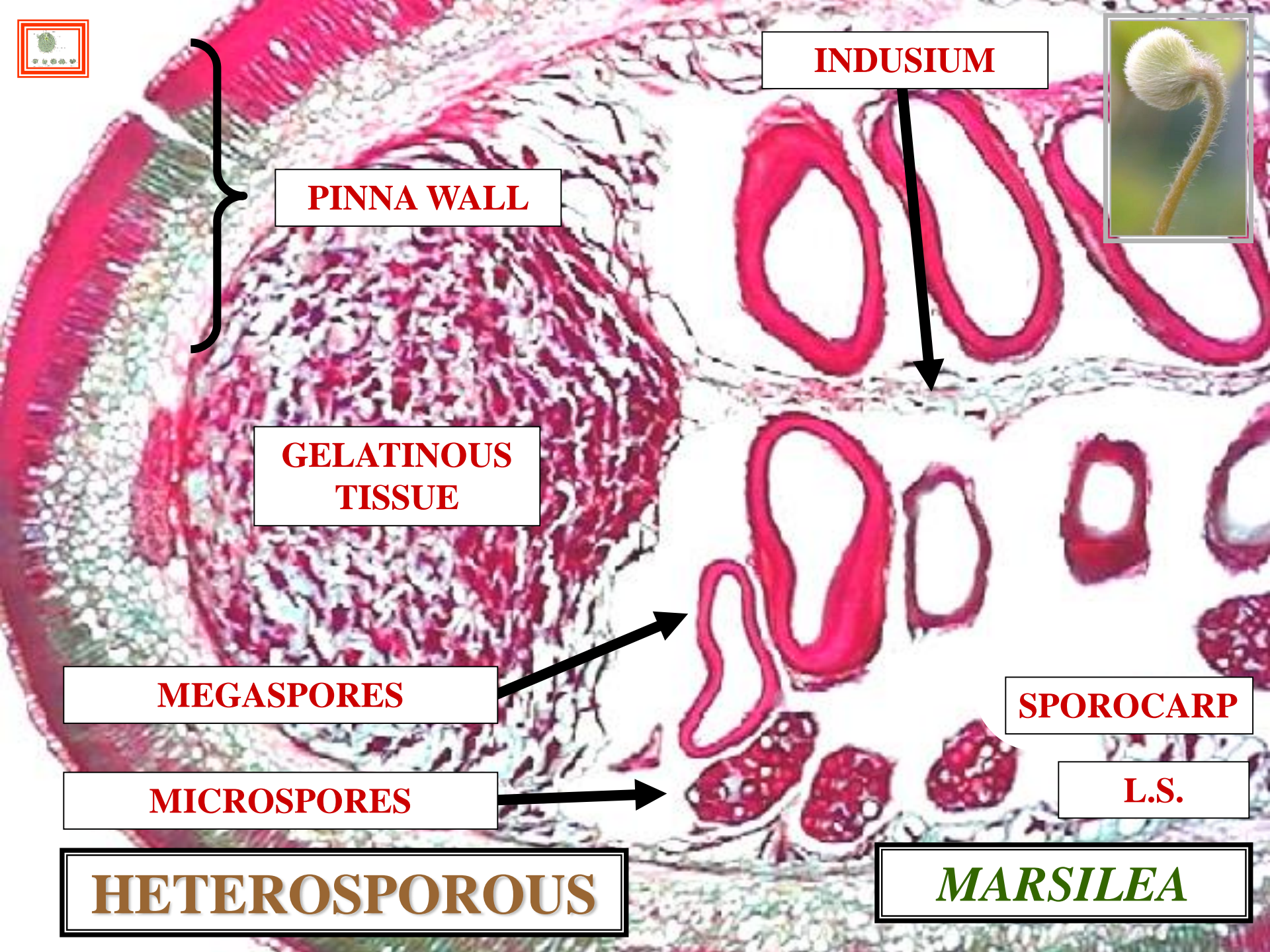
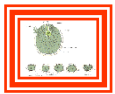
MEGASPORES

MICROSPORES

SPOROCARP

L.S.

MARSILEA



INDUSIUM

PINNA WALL

**GELATINOUS
TISSUE**

MEGASPORES

MICROSPORES

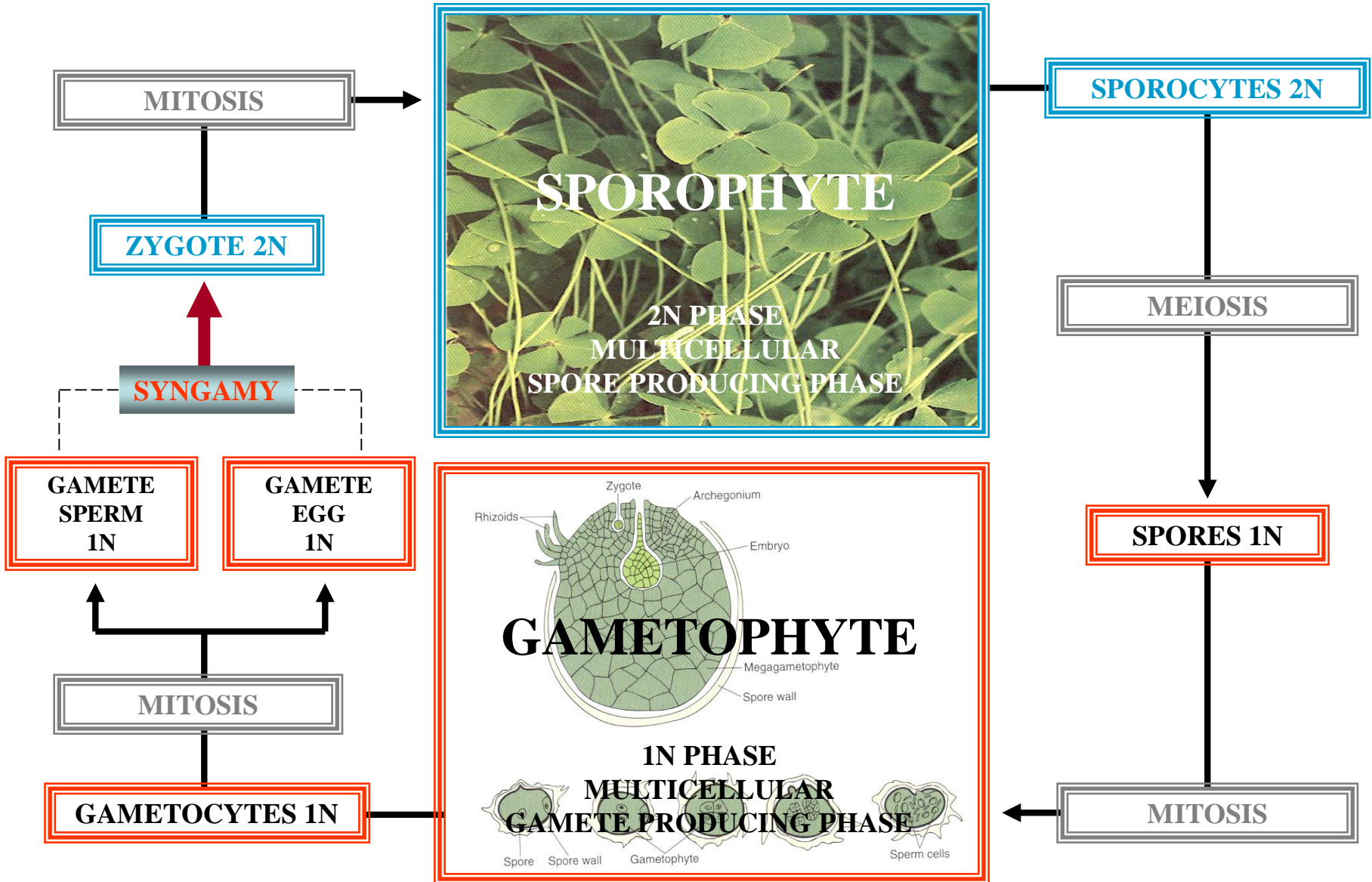
SPOROCARP

L.S.

HETEROSPOROUS

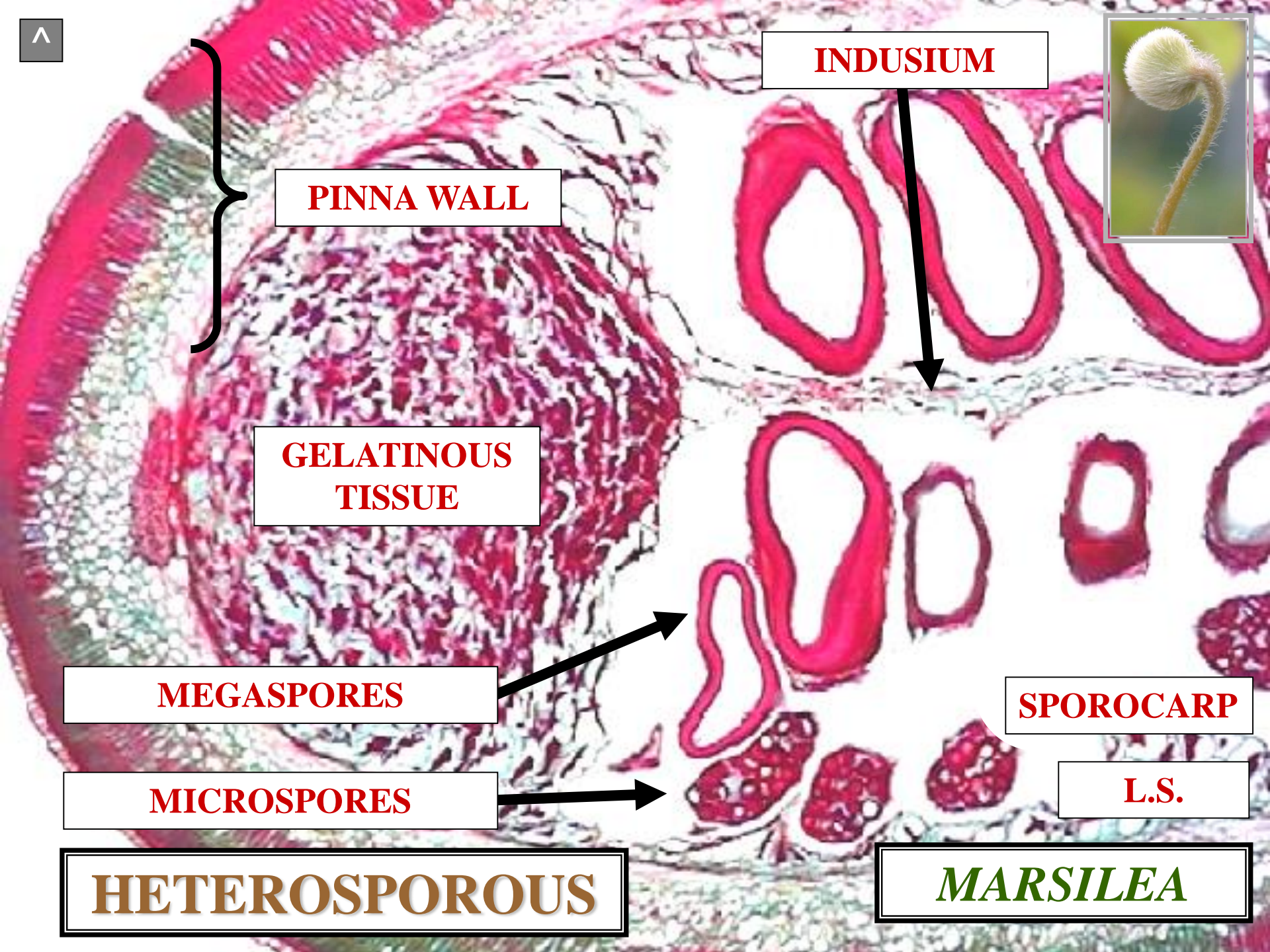
MARSILEA

MARSILEALES LIFE CYCLE





GAMETOPHYTE CHARACTERS



INDUSIUM



PINNA WALL

GELATINOUS TISSUE

MEGASPORES

MICROSPORES

SPOROCARP

L.S.

HETEROSPOROUS

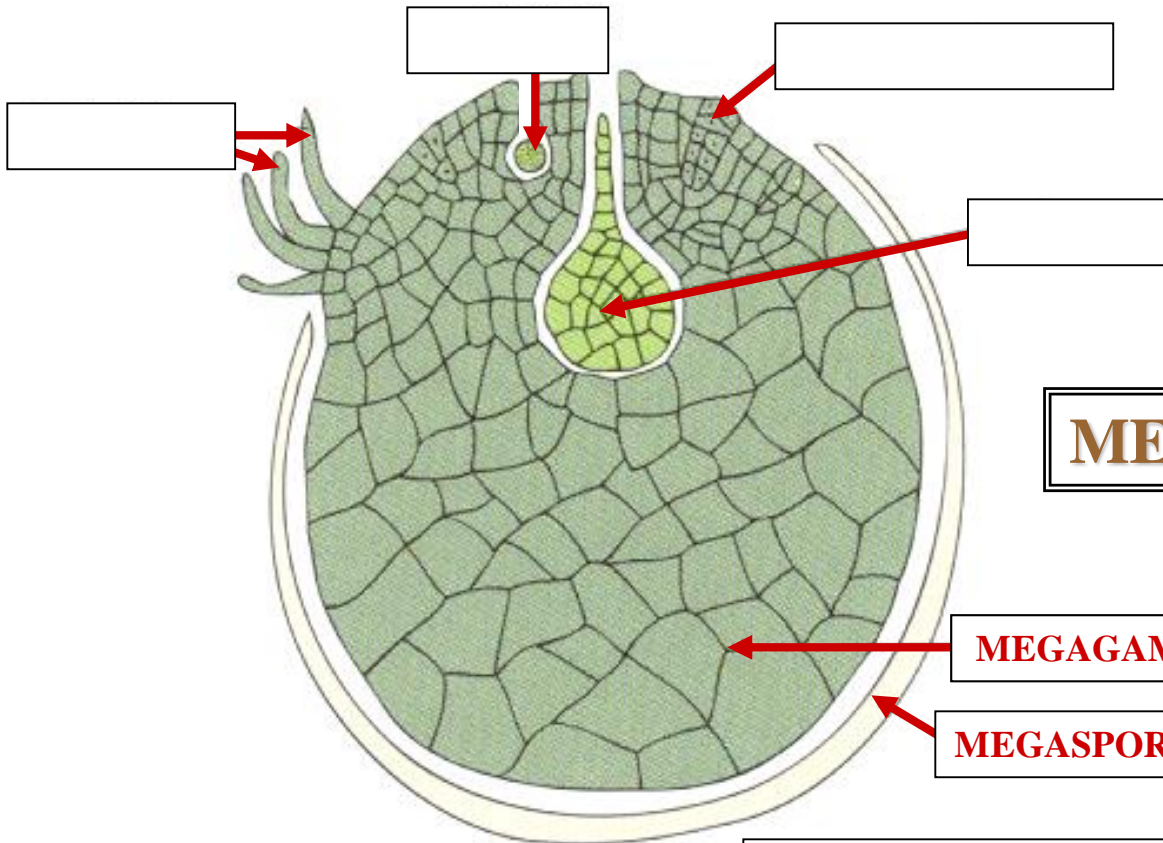
MARSILEA



ENDOSPORIC GAMETOPHYTE

MARSILEA

EN



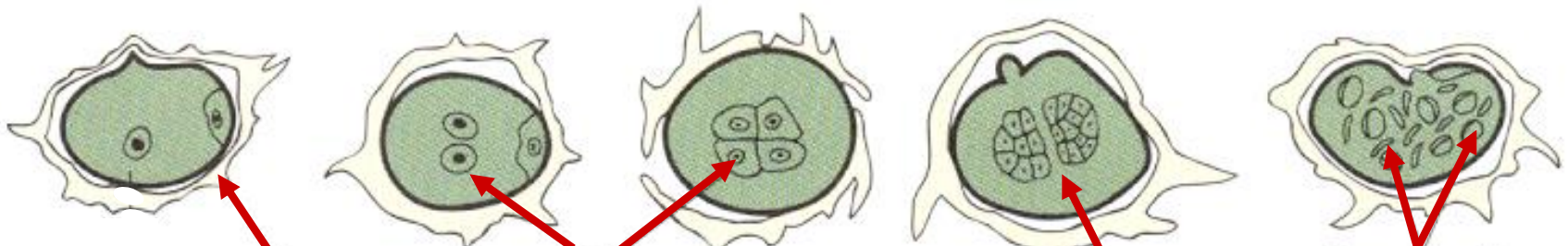
MEGASPORE

MEGAGAMETOPHYTE

MEGASPORE WALL

MICROSPORE

GAMETOPHYTE



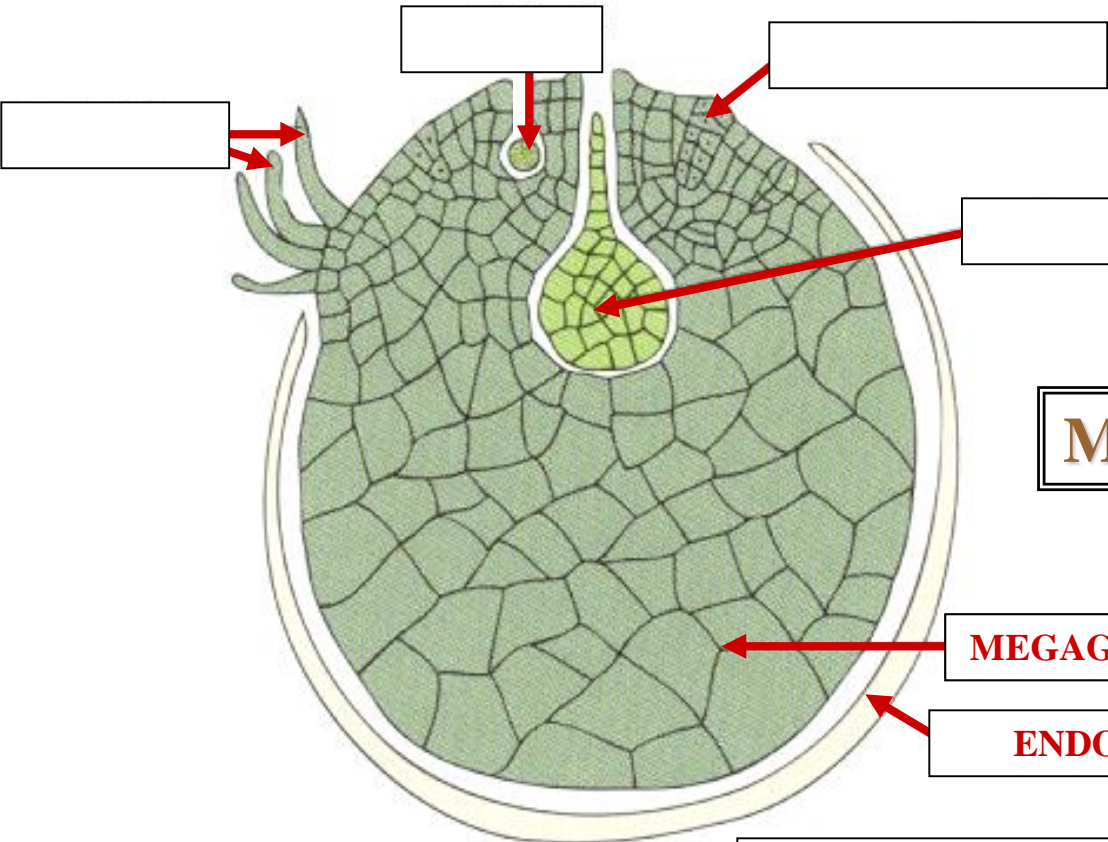
MICROSPORE WALL

MICROGAMETOPHYTE



MARSILEA

W



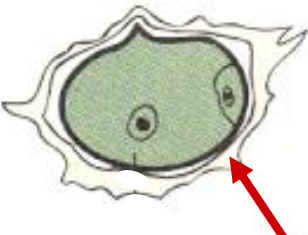
MEGASPORE

MEGAGAMETOPHYTE

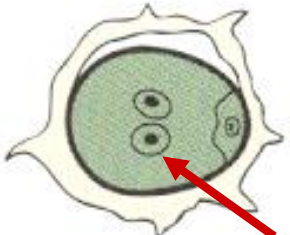
ENDOSPORIC

MICROSPORE

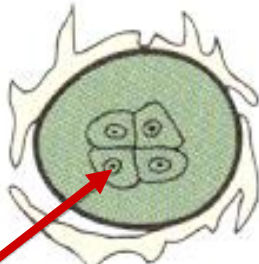
GAMETOPHYTE



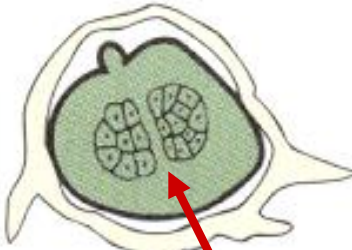
ENDOSPORIC



MICROGAMETOPHYTE



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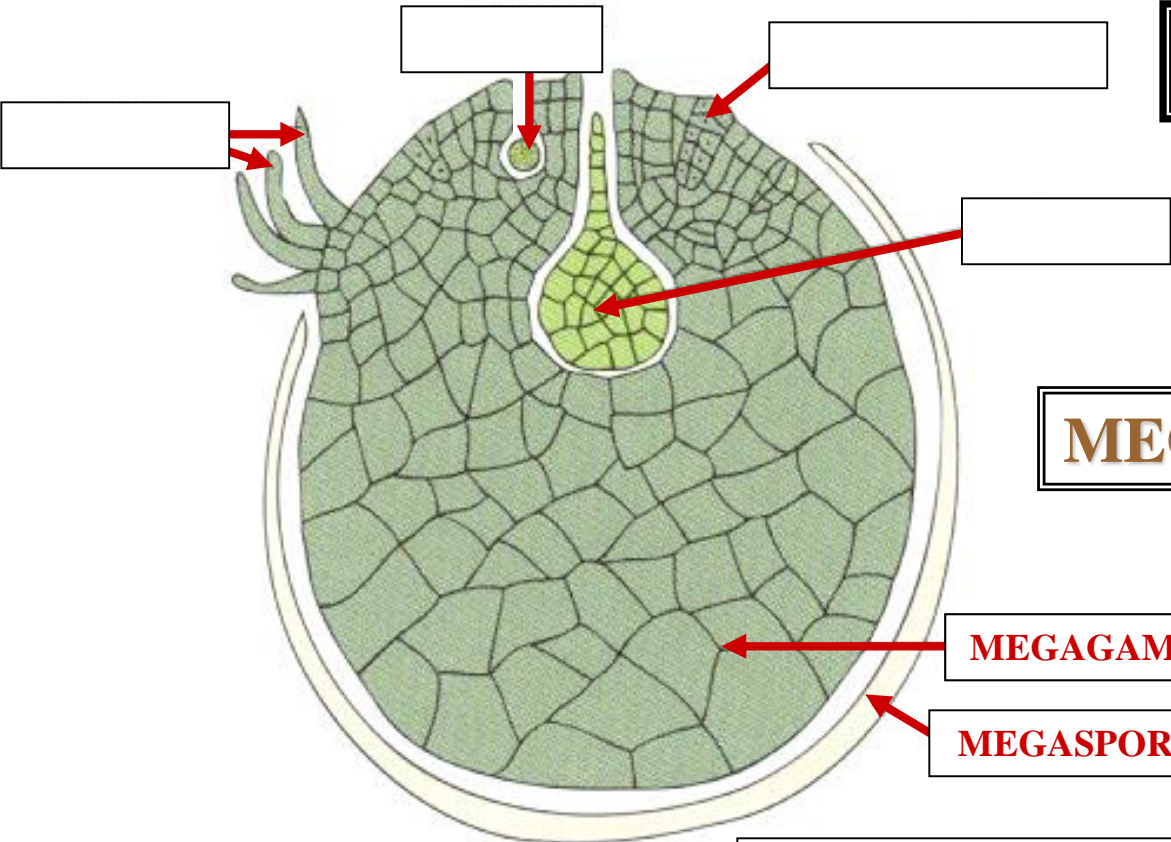


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MARSILEA

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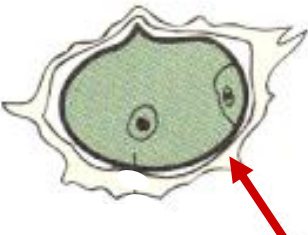
MEGASPORE

MEGAGAMETOPHYTE

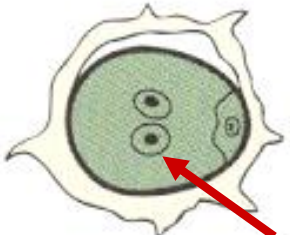
MEGASPORE WALL

MICROSPORE

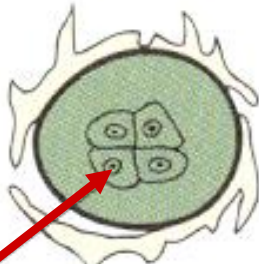
GAMETOPHYTE



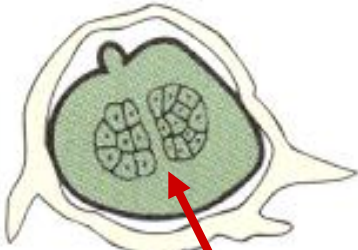
MICROSPORE WALL



MICROGAMETOPHYTE



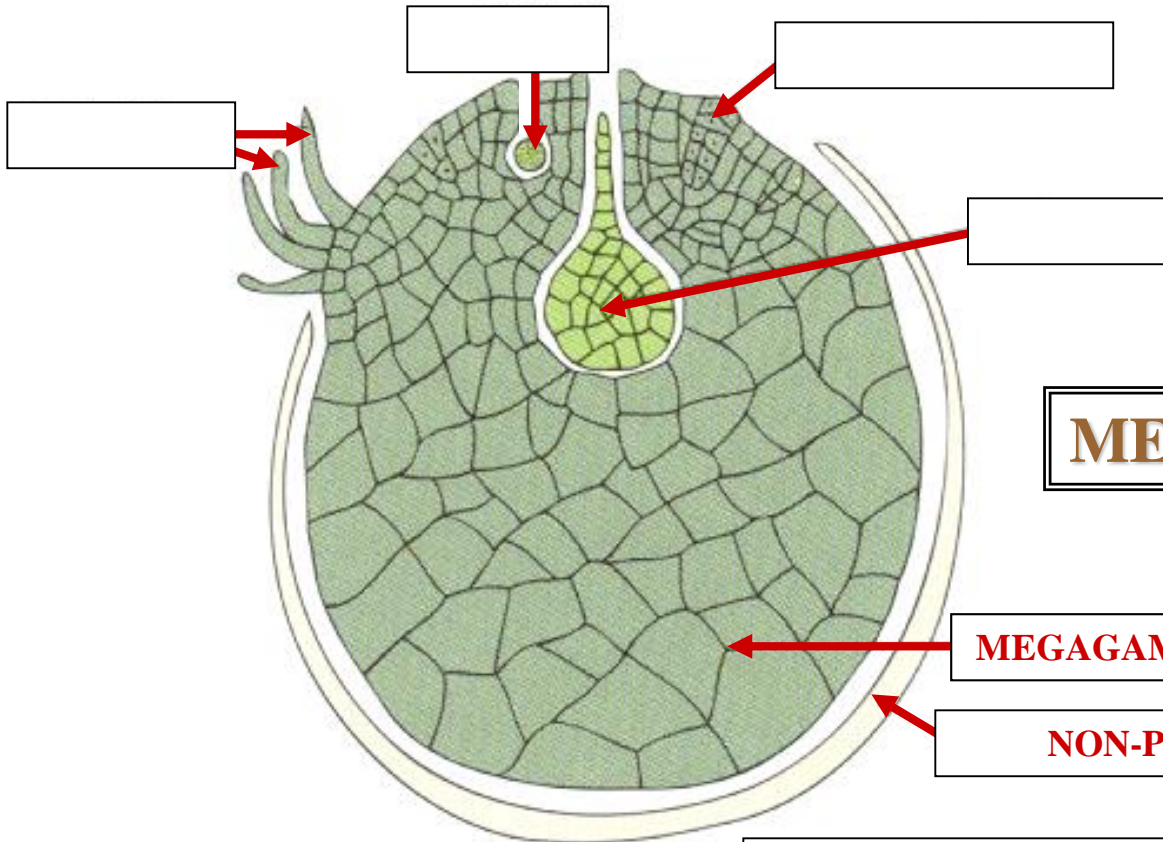
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MARSILEA

W



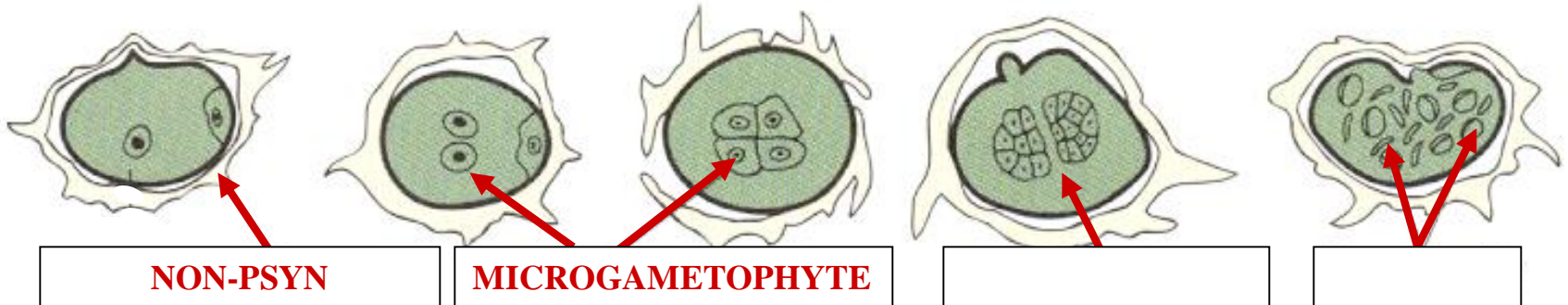
MEGASPORE

MEGAGAMETOPHYTE

NON-PSYN

MICROSPORE

GAMETOPHYTE



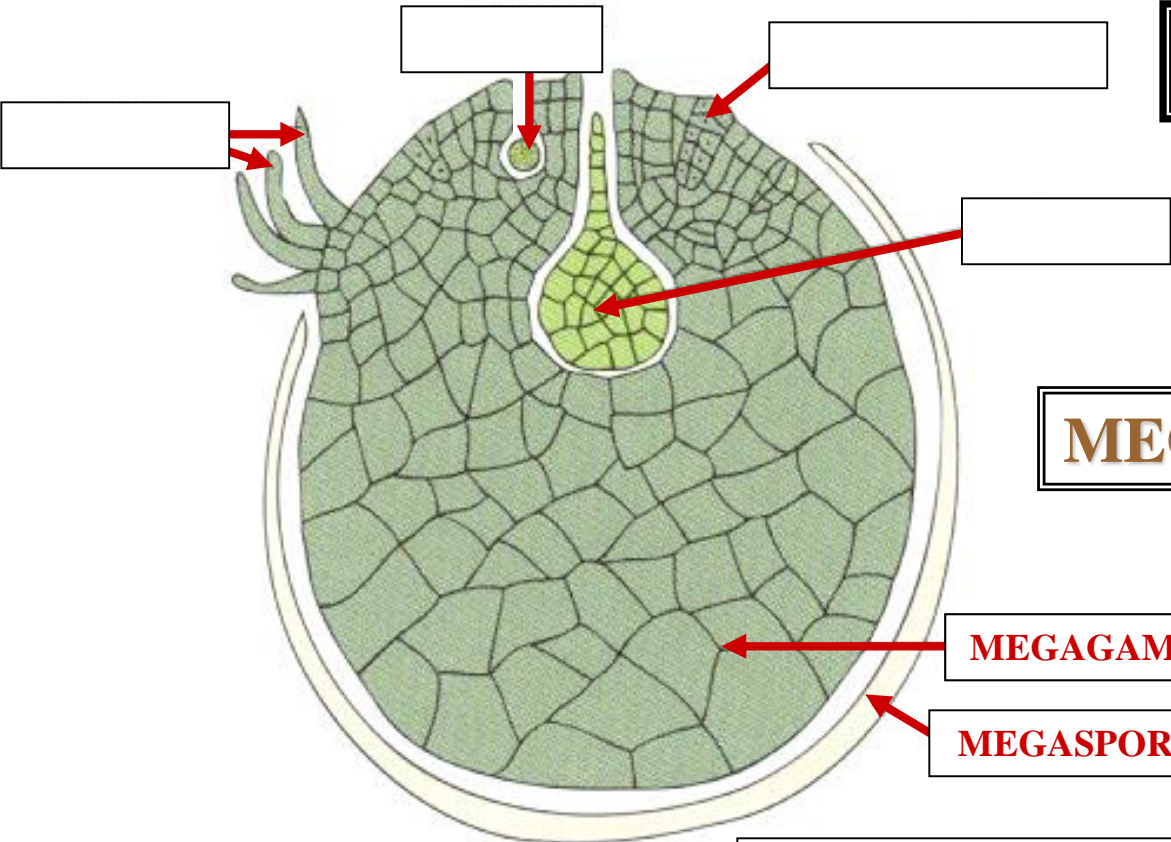
NON-PSYN

MICROGAMETOPHYTE



MARSILEA

M



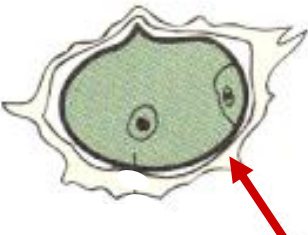
MEGASPORE

MEGAGAMETOPHYTE

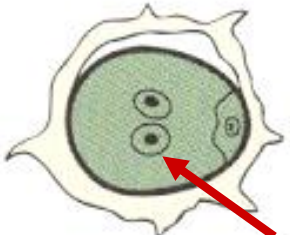
MEGASPORE WALL

MICROSPORE

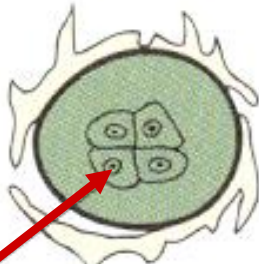
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MICROSPORE WALL



MICROGAMETOPHYTE



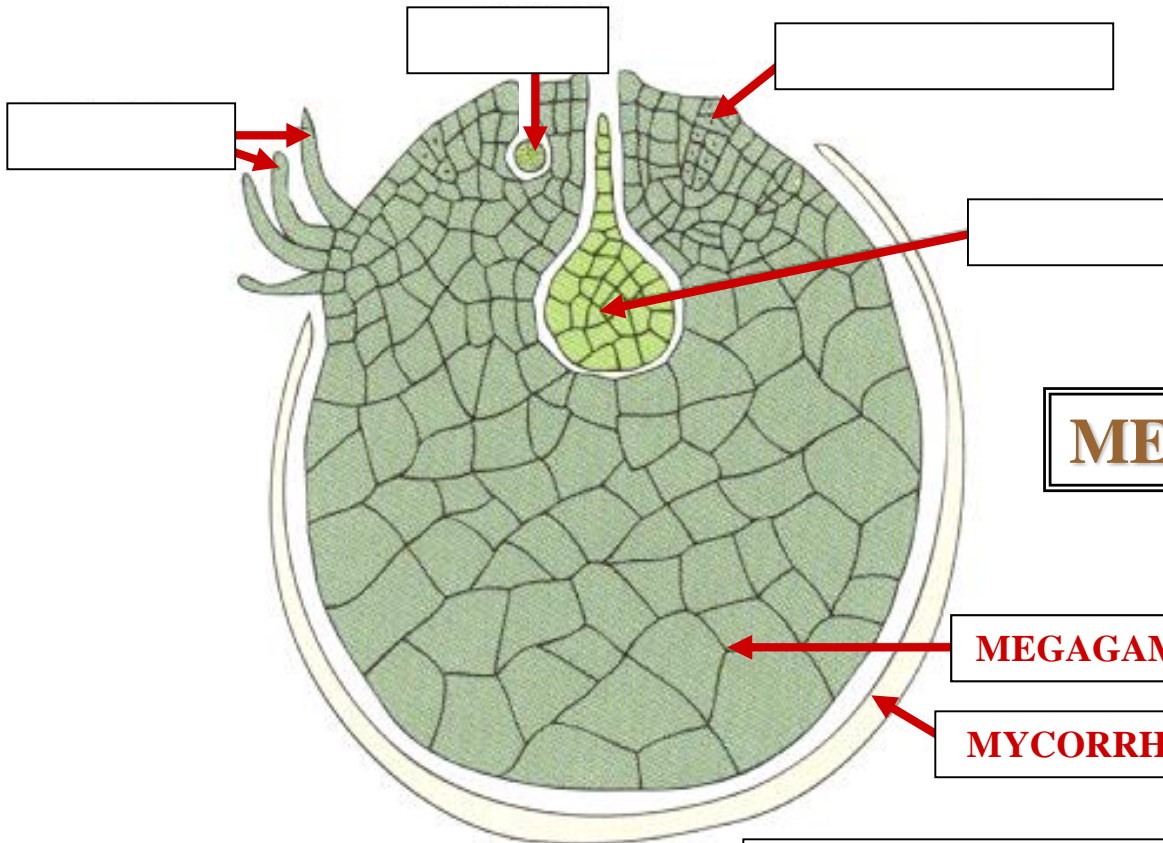
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MARSILEA

EN



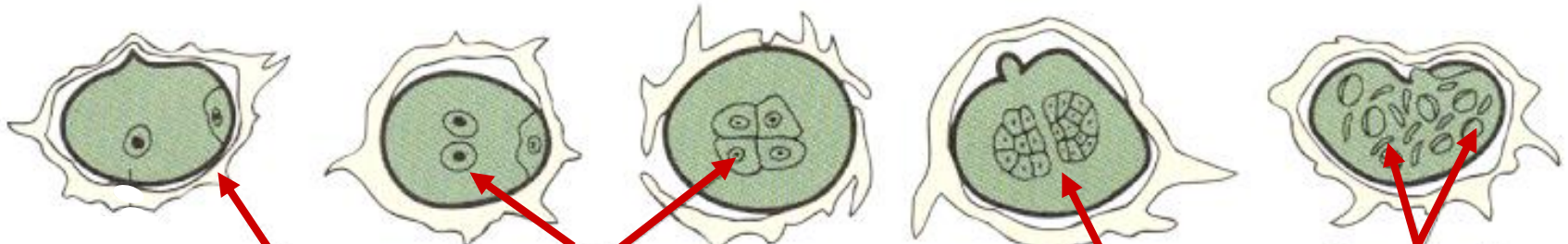
MEGASPORE

MEGAGAMETOPHYTE

MYCORRHIZAE ABSENT

MICROSPORE

GAMETOPHYTE



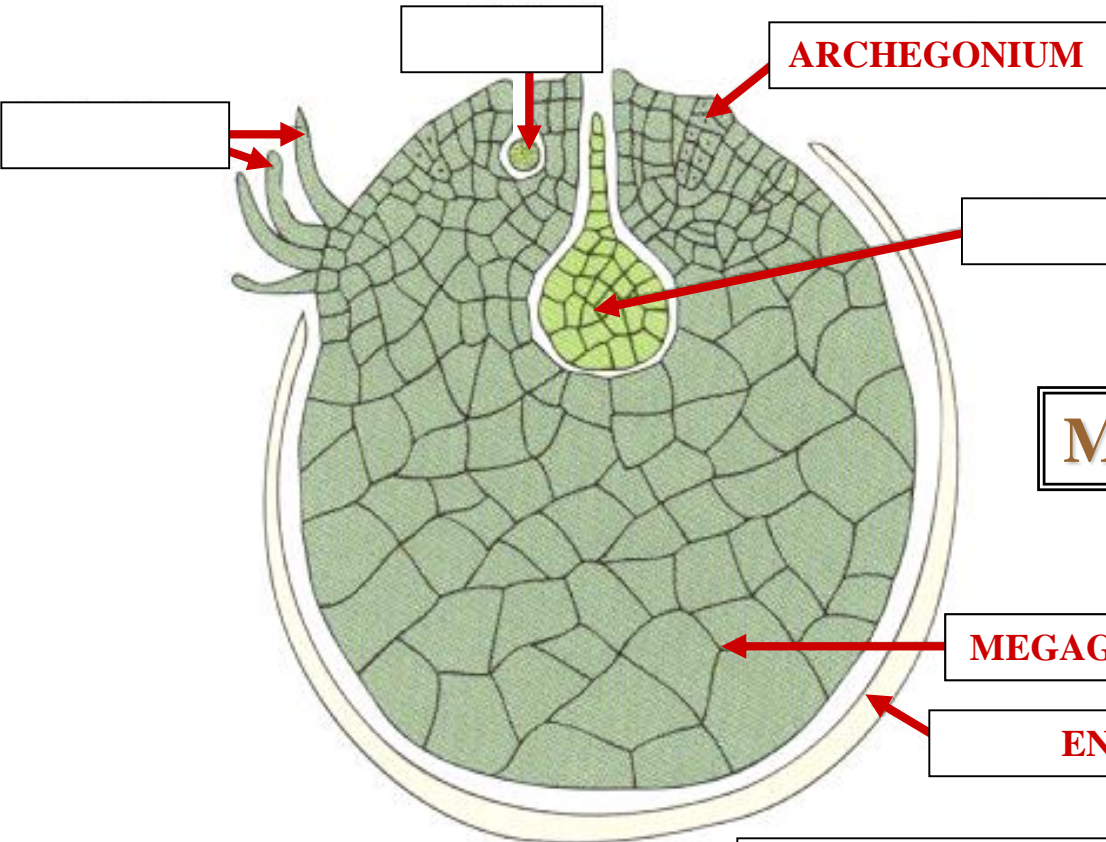
MYCORRHIZAE ABSENT

MICROGAMETOPHYTE



MARSILEA

U



ARCHEGONIUM

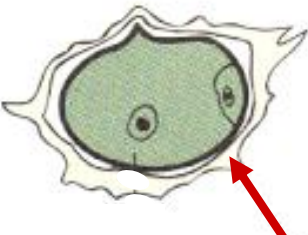
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MEGAGAMETOPHYTE

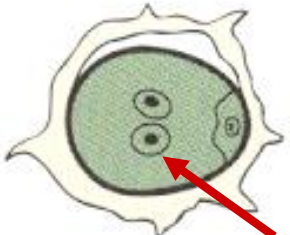
ENDOSPORIC

MICROSPORE

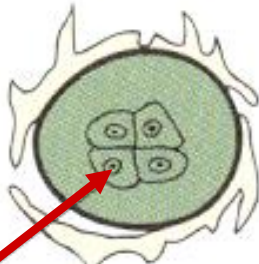
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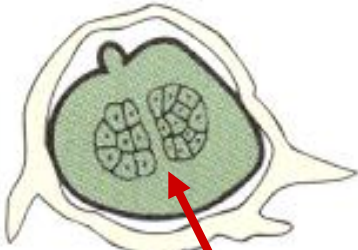
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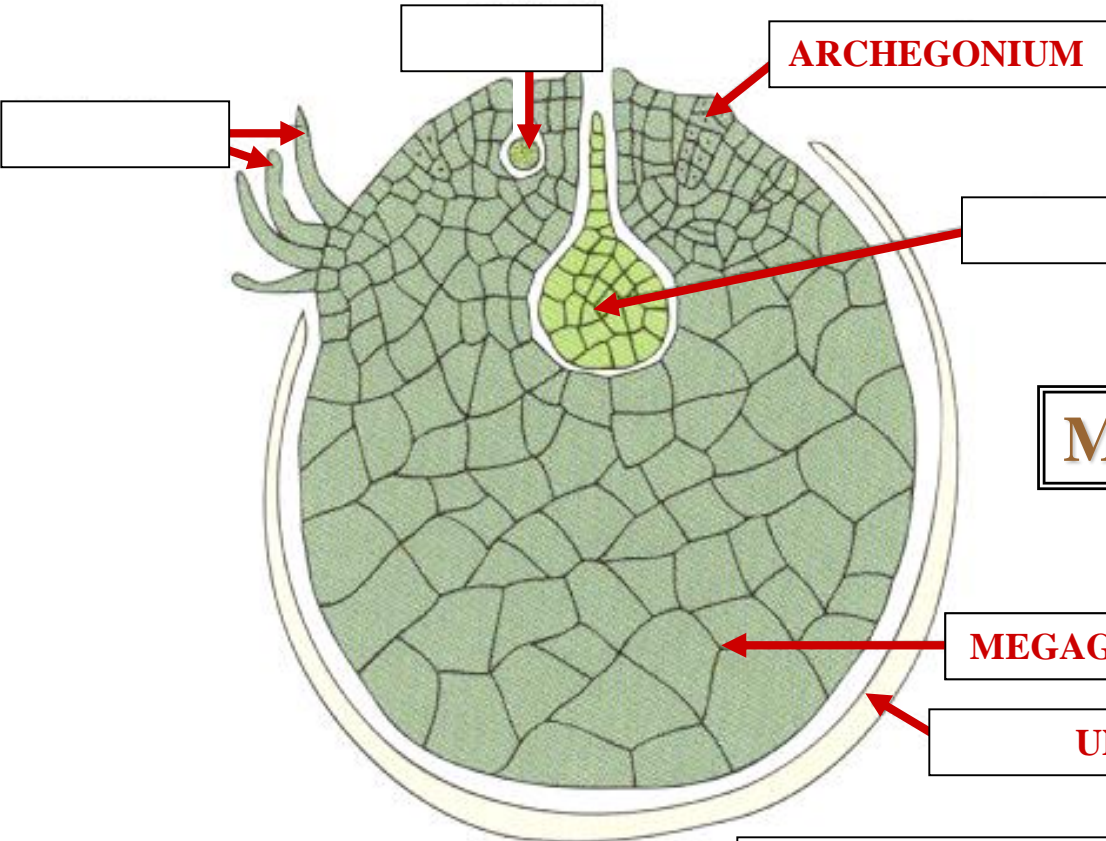
MICROGAMETOPHYTE



ANTHERIDIUM



MARSILEA



ARCHEGONIUM

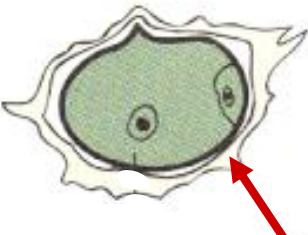
MEGASPORE

MEGAGAMETOPHYTE

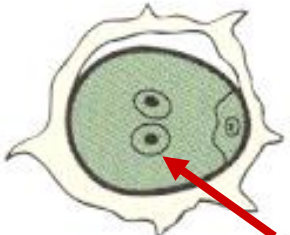
UNISEXUAL

MICROSPORE

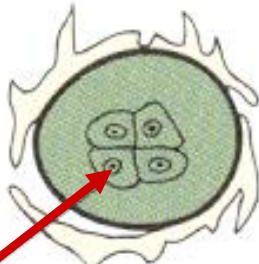
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UNISEXUAL



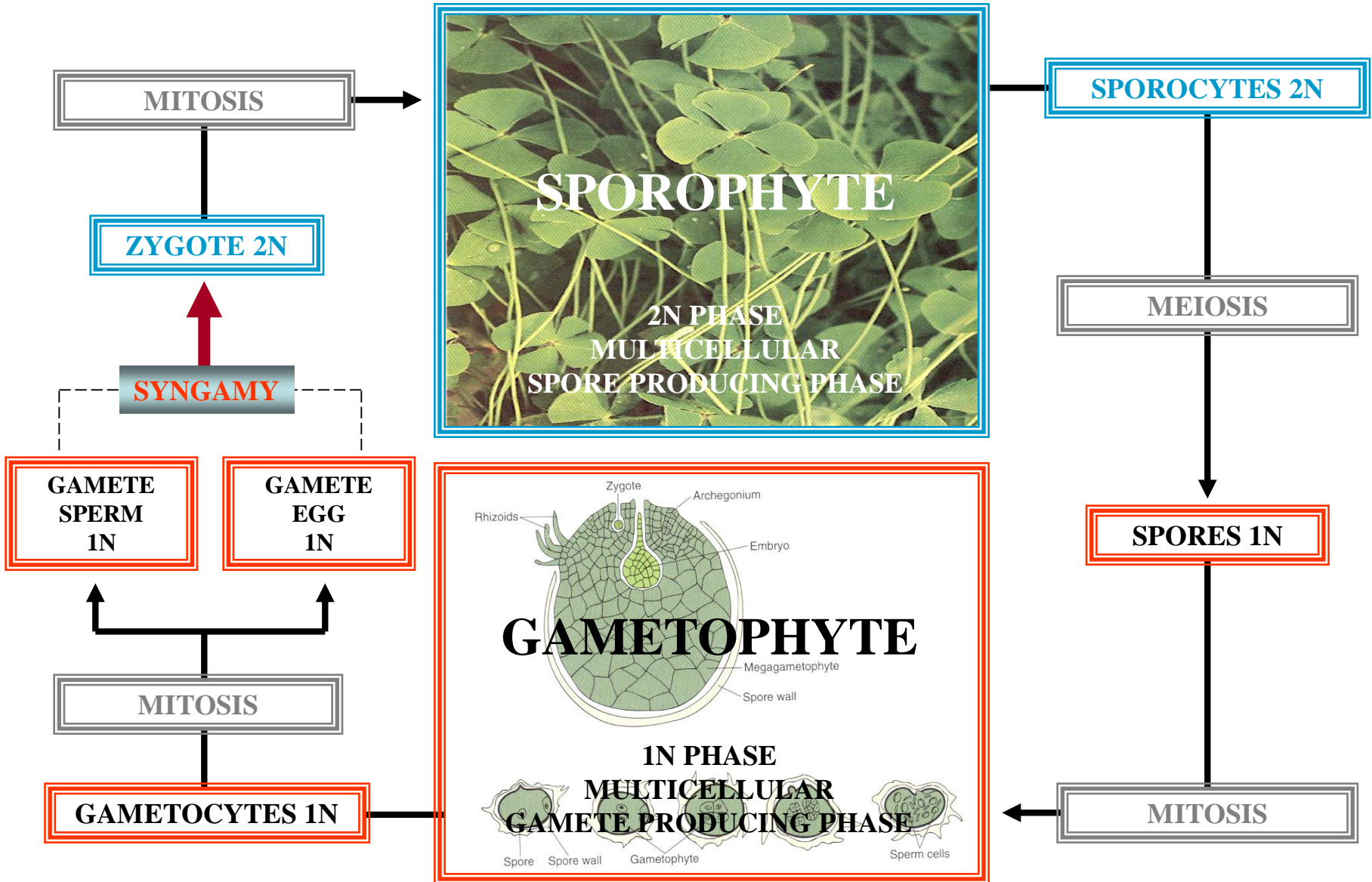
MICROGAMETOPHYTE



ANTHERIDIUM



MARSILEALES LIFE CYCLE





PTERIDOPHYTA CLASSIFICATION

**EXTANT
ORDER**

SALVINIALES

**EXTANT
ORDER**



COMMON NAME



WATER FERNS

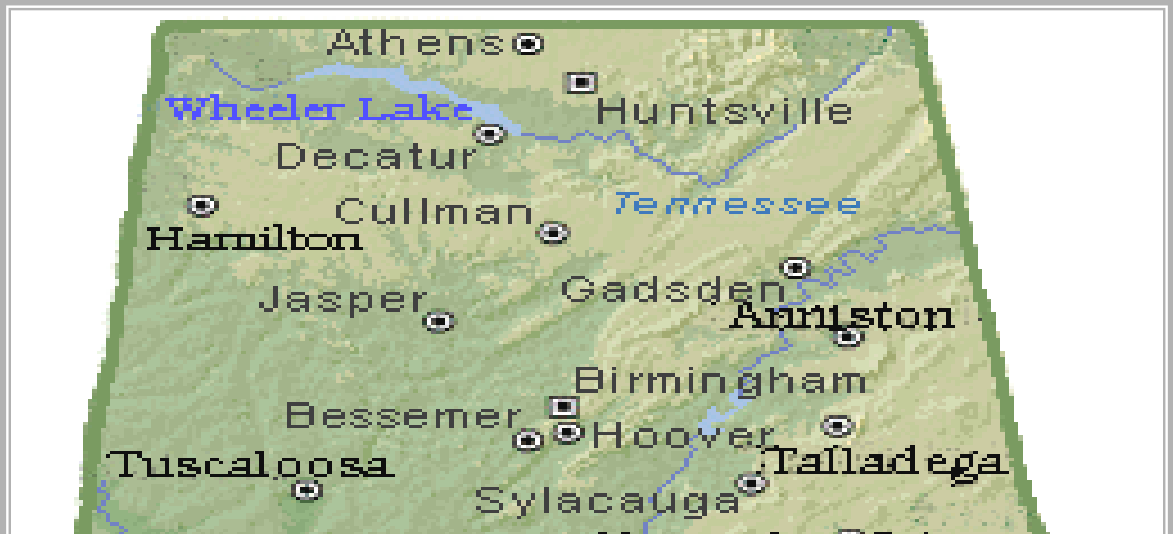


DIVERSITY

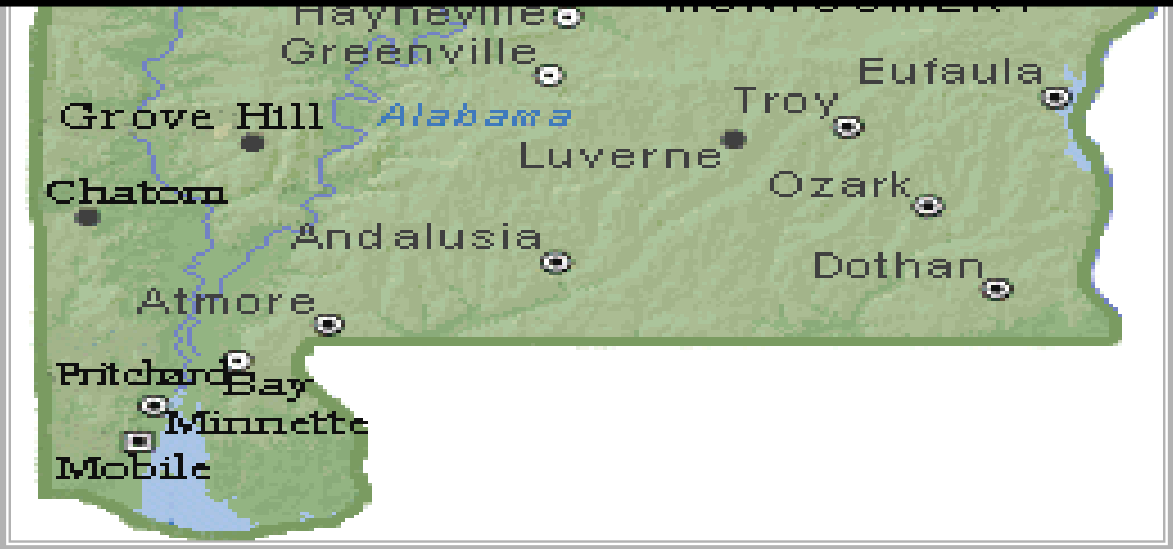


~17 SPECIES

EARTH



2 SPECIES





REPRESENTATIVE GENERA

S

?



?



SALVINIA

A

?





AZOLLA



HABITAT

ALABAMA LAKE OR ALABAMA POND



AQUATIC HABITAT

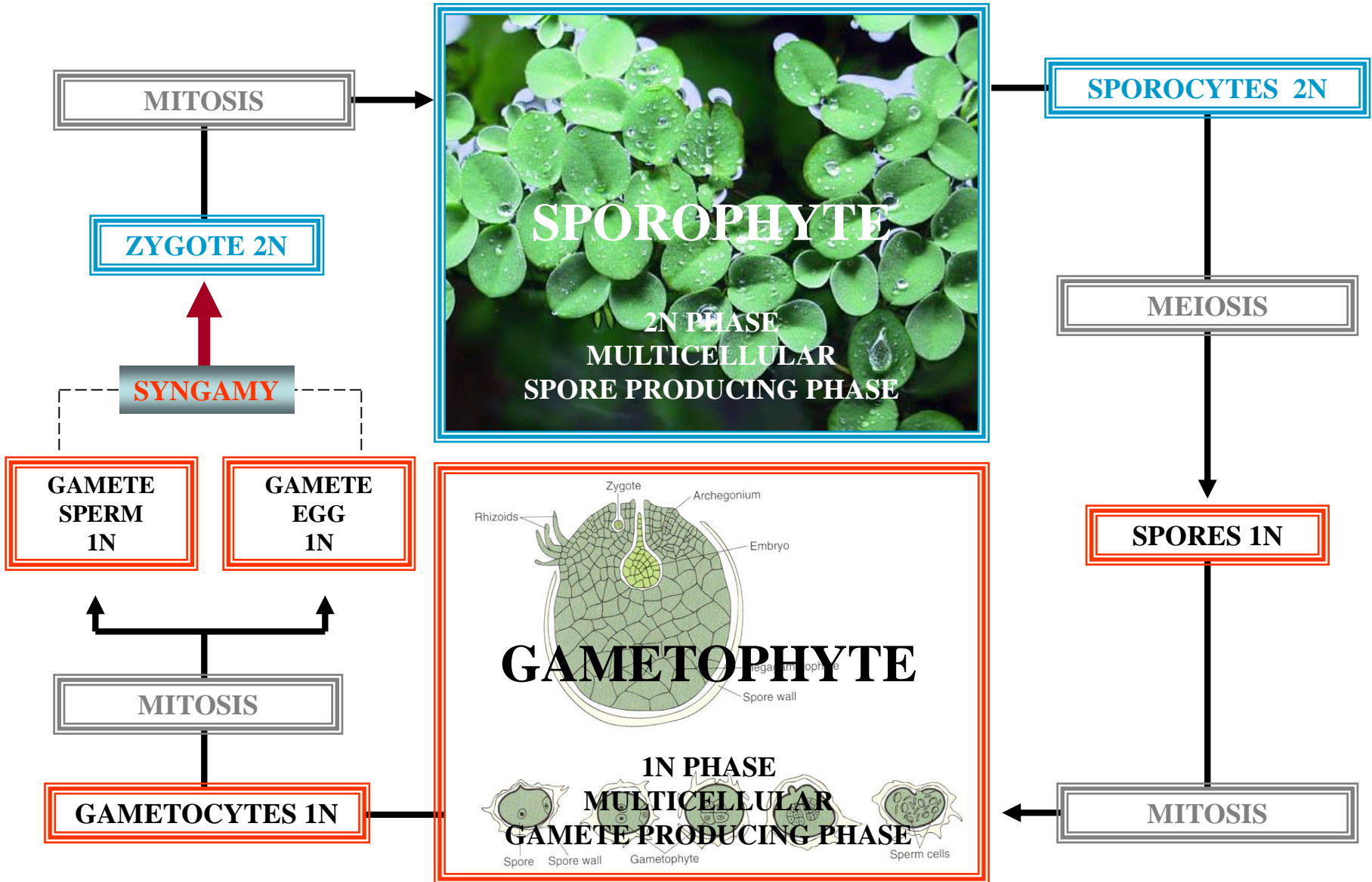


GENERAL CHARACTERS



SALVINIALES

LIFE CYCLE





SPOROPHYTE CHARACTERS

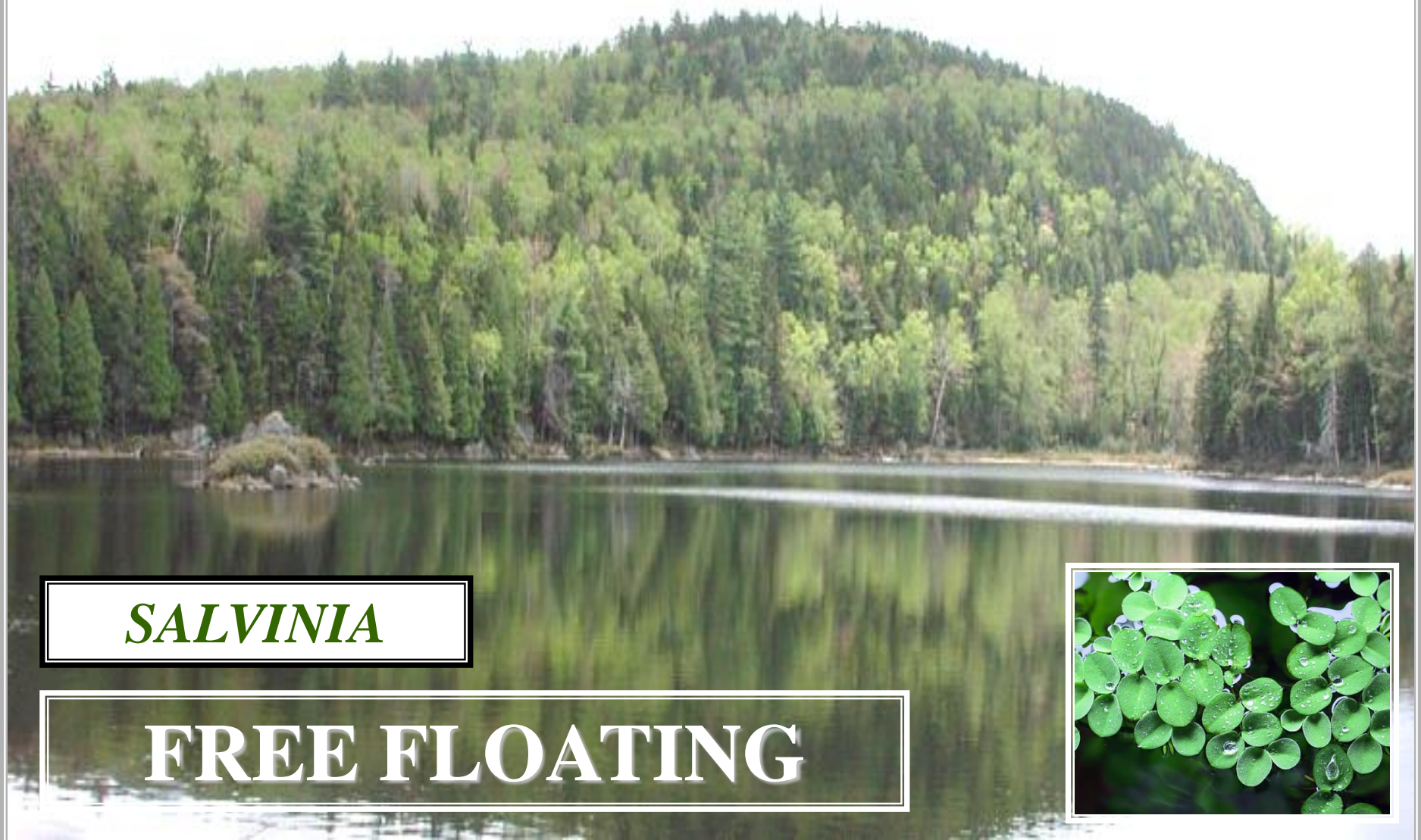


GROWTH HABIT

ALABAMA LAKE OR ALABAMA POND

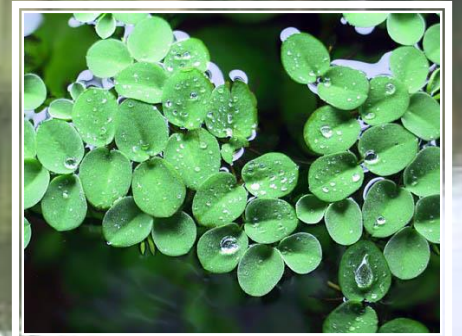
A

+



SALVINIA

FREE FLOATING





ALABAMA LAKE OR ALABAMA POND

AZOLLA

FREE FLOATING





MORPHOLOGY



**TYPICAL
FERN
MORPHOLOGY**



**TYPICAL
FERN
MORPHOLOGY**



SALVINIA



AZOLLA



**TYPICAL
FERN
MORPHOLOGY**

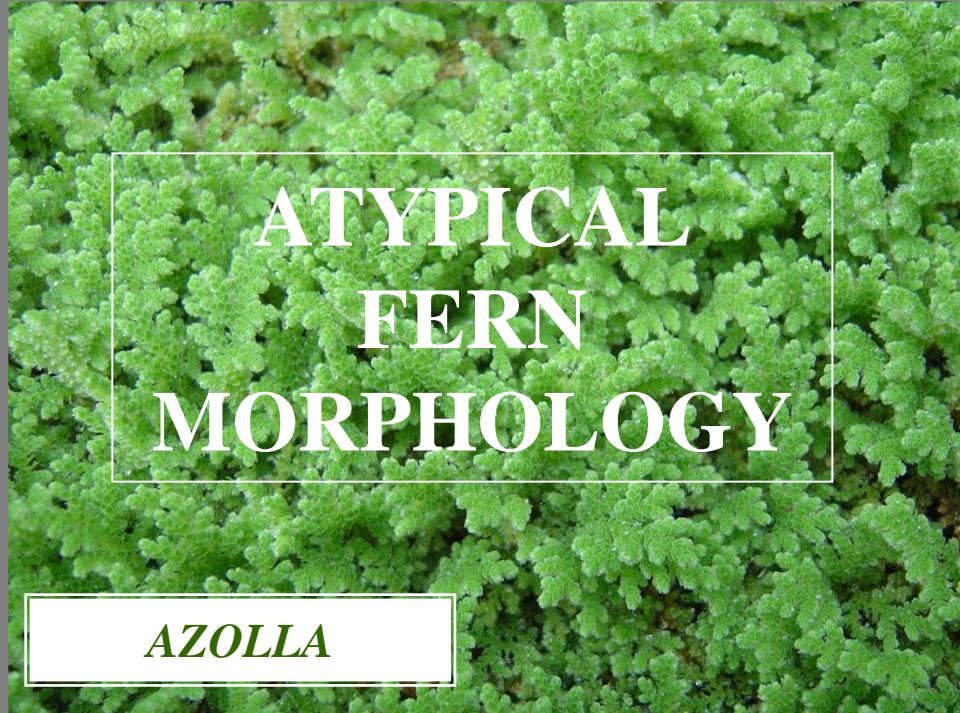


**TYPICAL
FERN
MORPHOLOGY**



**ATYPICAL
FERN
MORPHOLOGY**

SALVINIA



**ATYPICAL
FERN
MORPHOLOGY**

AZOLLA



**TYPICAL
FERN
MORPHOLOGY**



**TYPICAL
FERN
MORPHOLOGY**



**MORPHOLOGY
NOT
FERN-LIKE**

SALVINIA



**MORPHOLOGY
NOT
FERN-LIKE**

AZOLLA



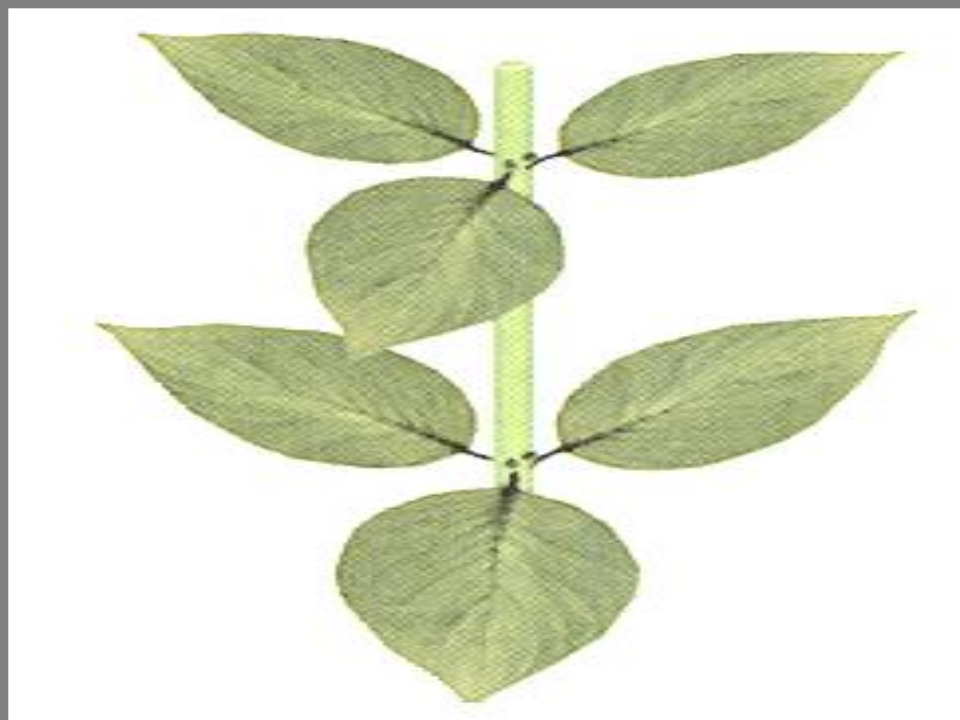
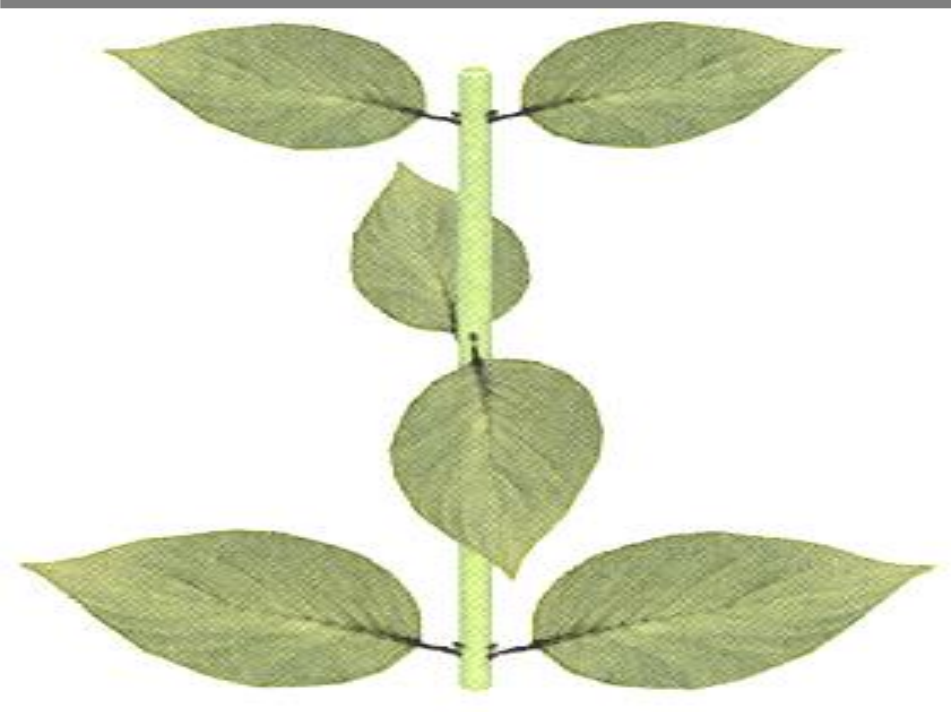
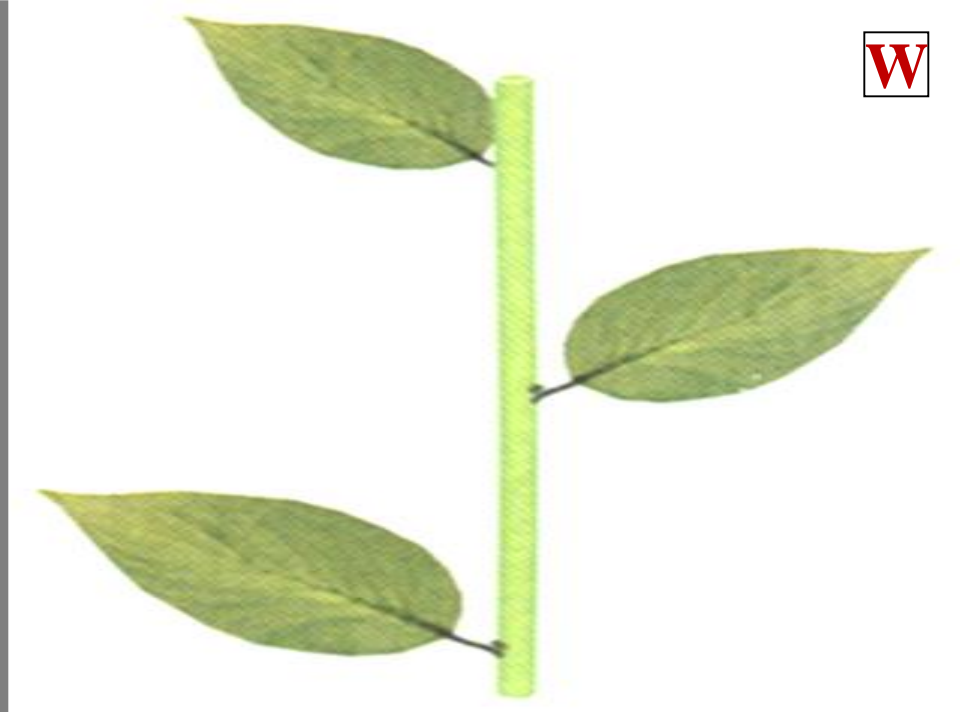
FROND



PHYLLOTAXY

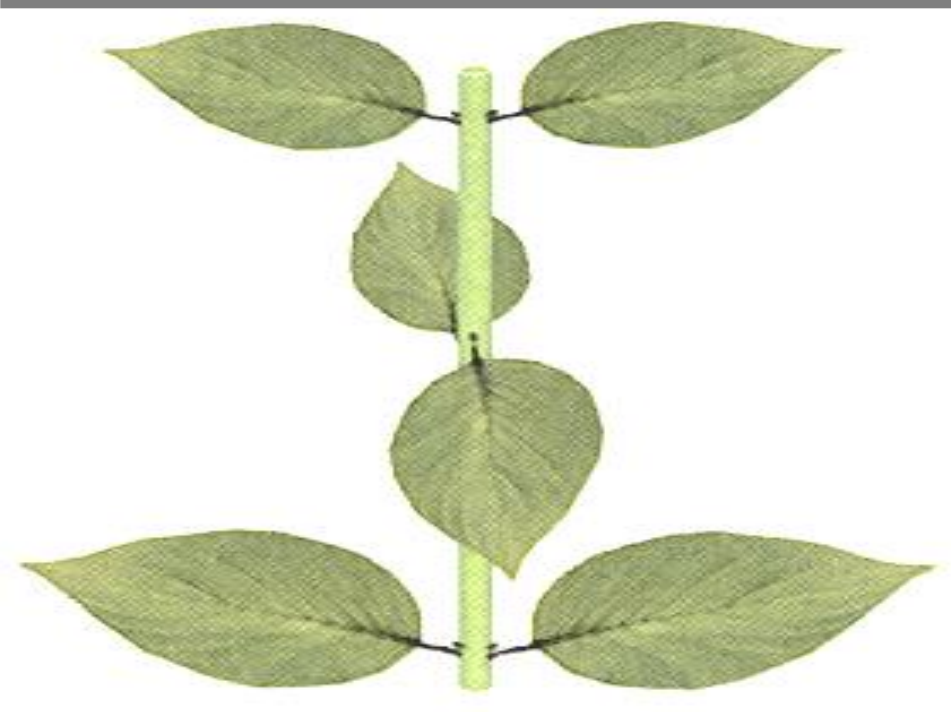
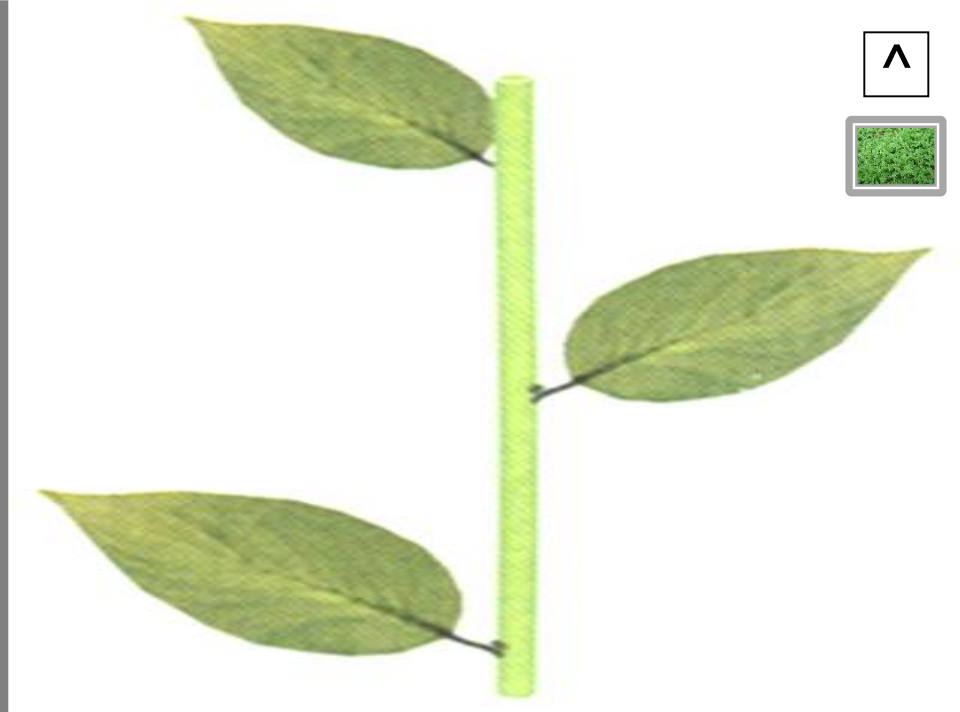


SALVINIA

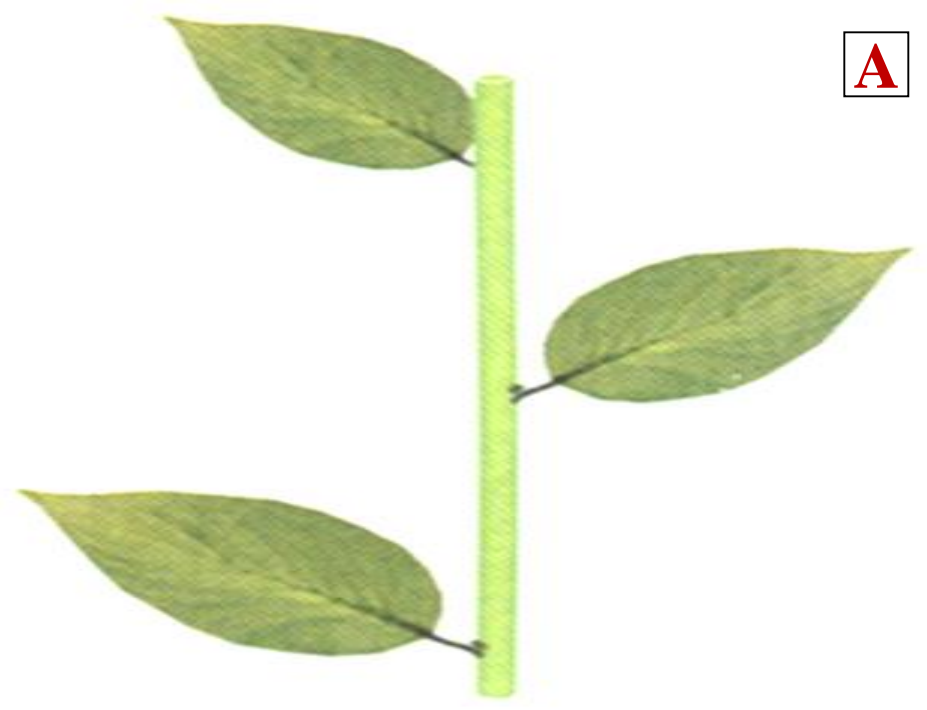




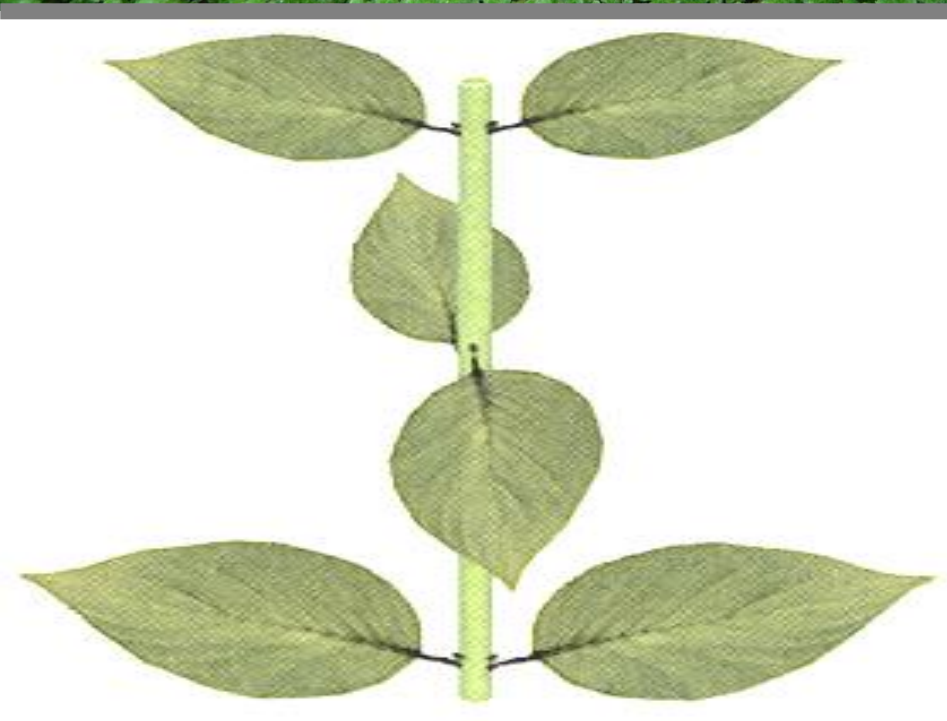
SALVINIA



WHORLED



A

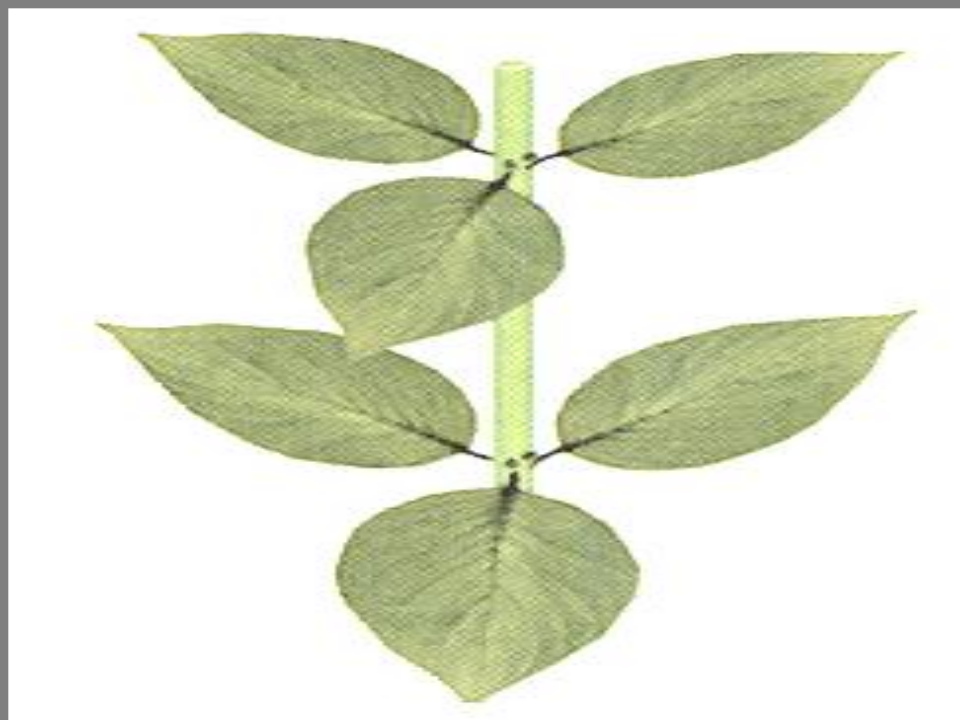
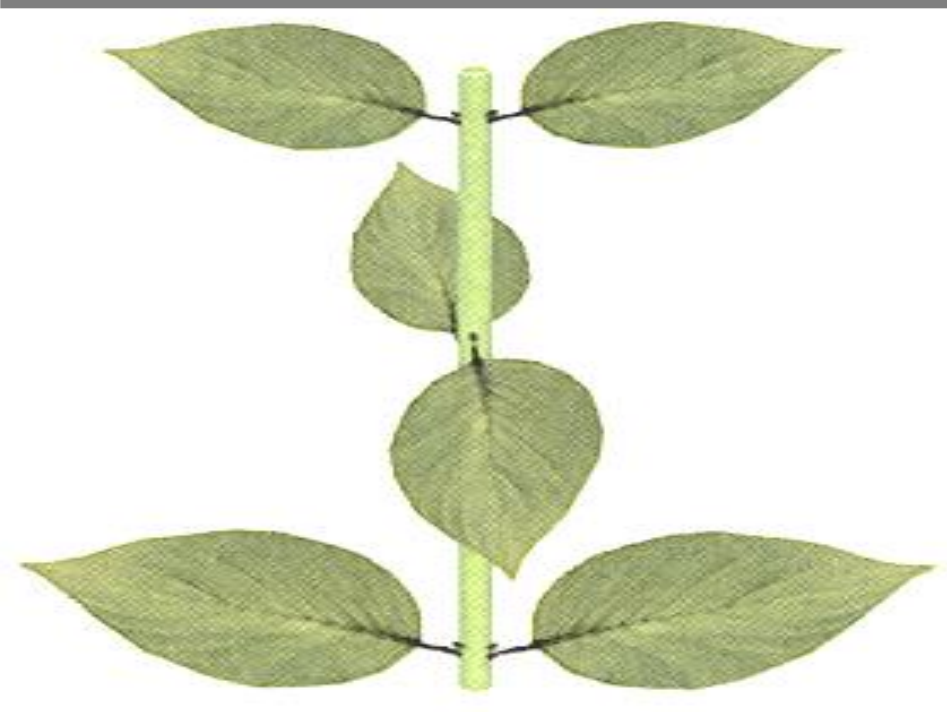




AZOLLA



ALTERNATE





FROND MORPHOLOGY