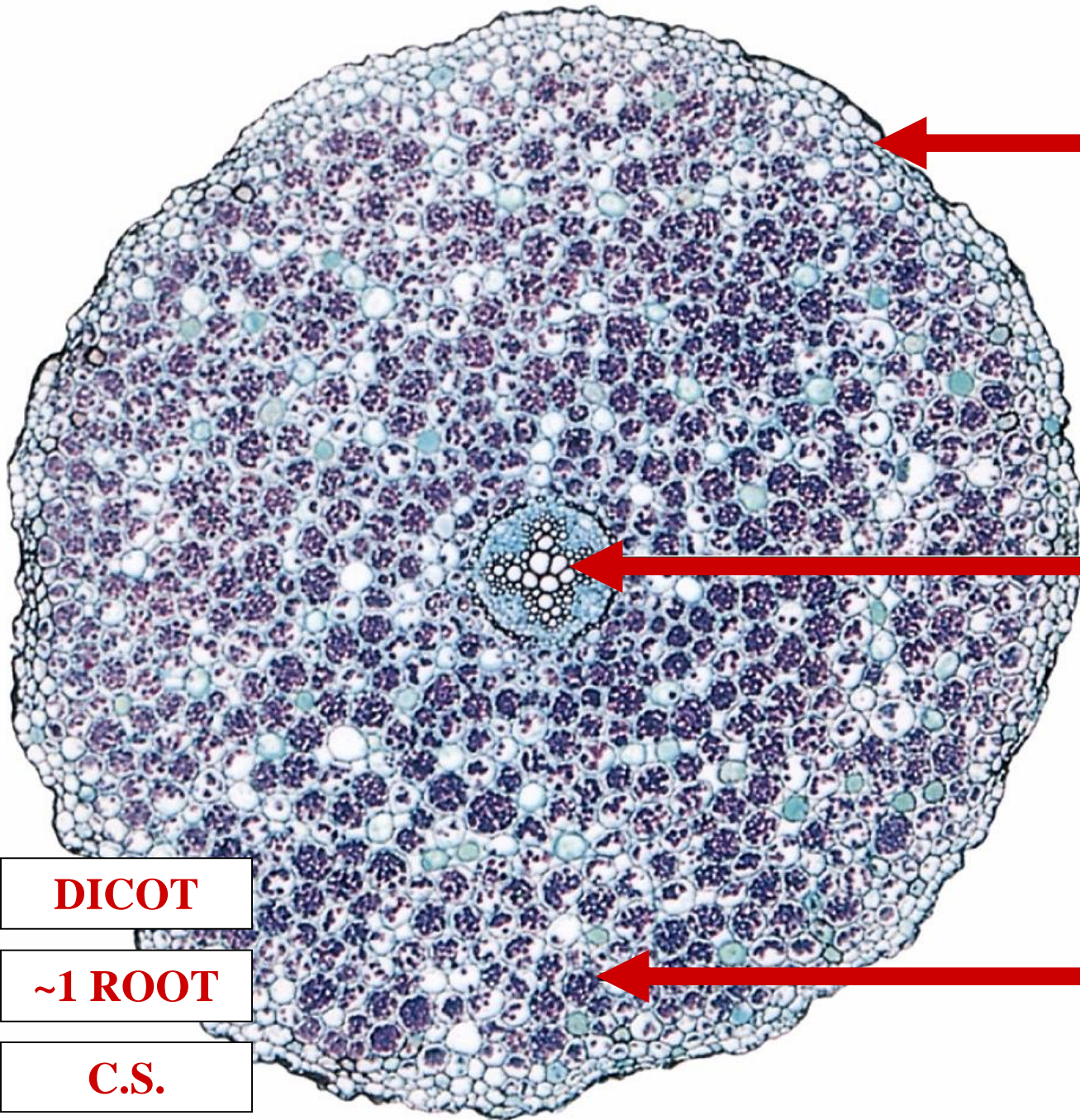




DICOT ROOT PRIMARY GROWTH SUMMARY

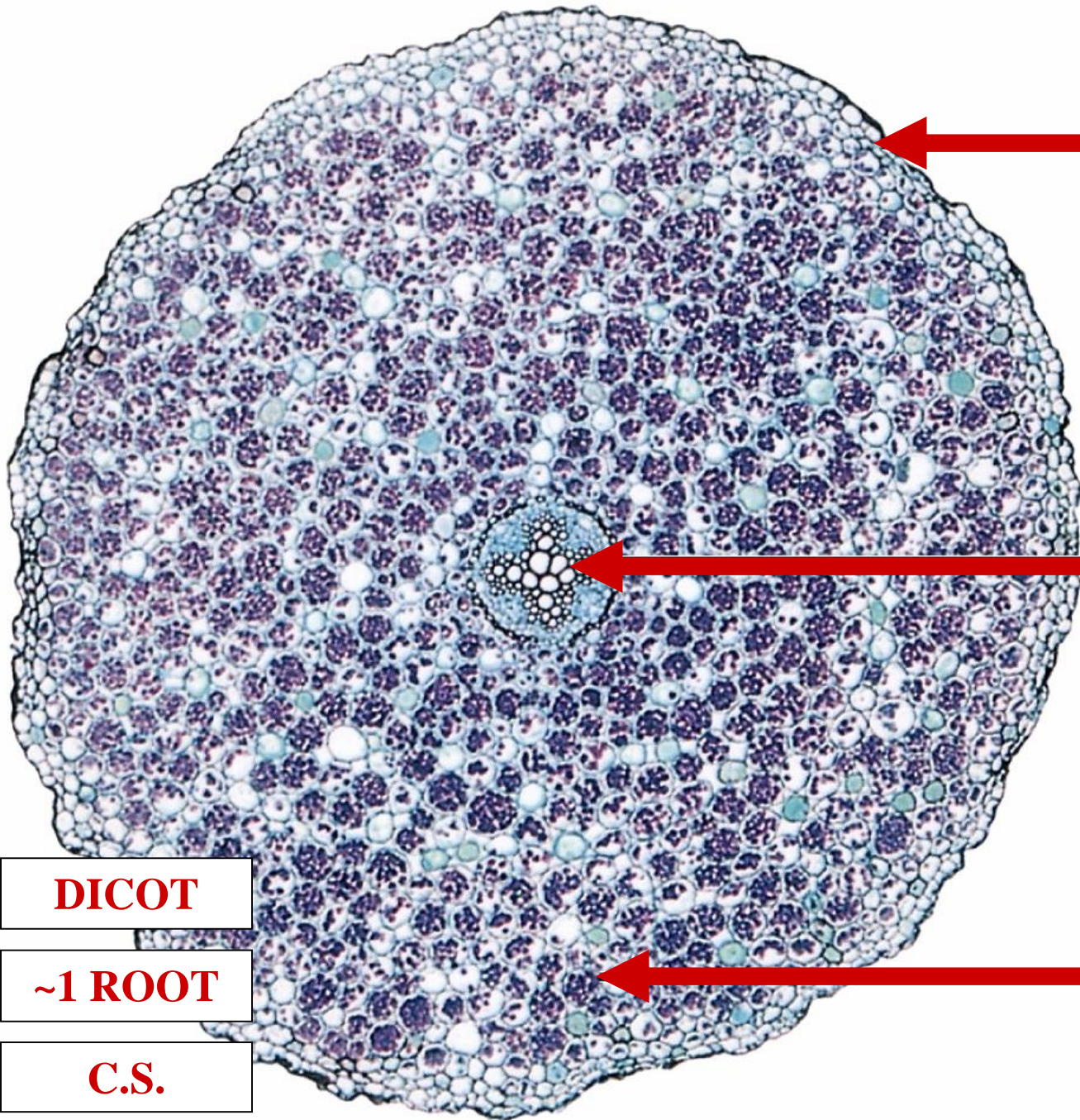


1

DICOT

~1 ROOT

C.S.

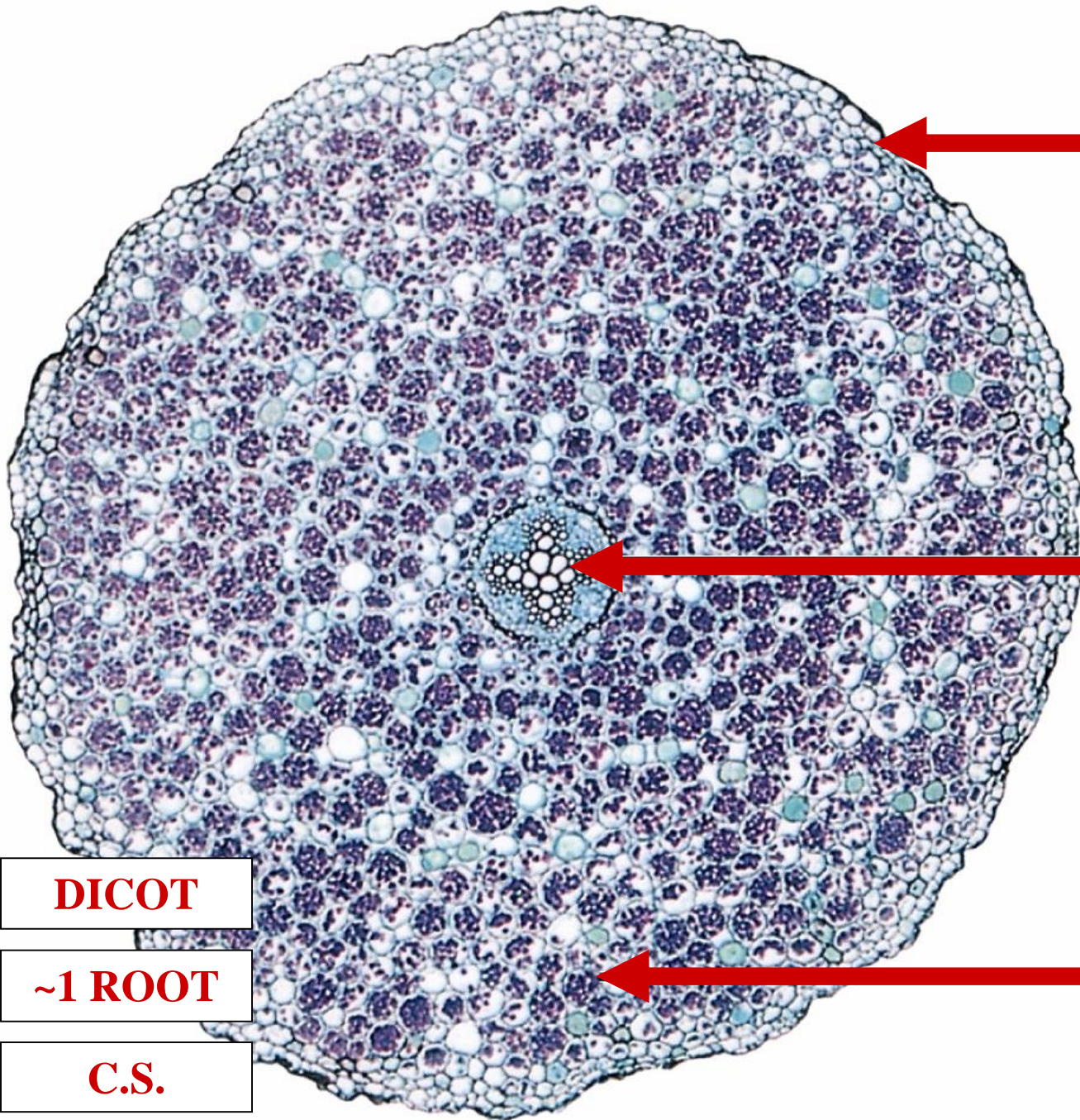


EPIDERMIS

DICOT

~1 ROOT

C.S.



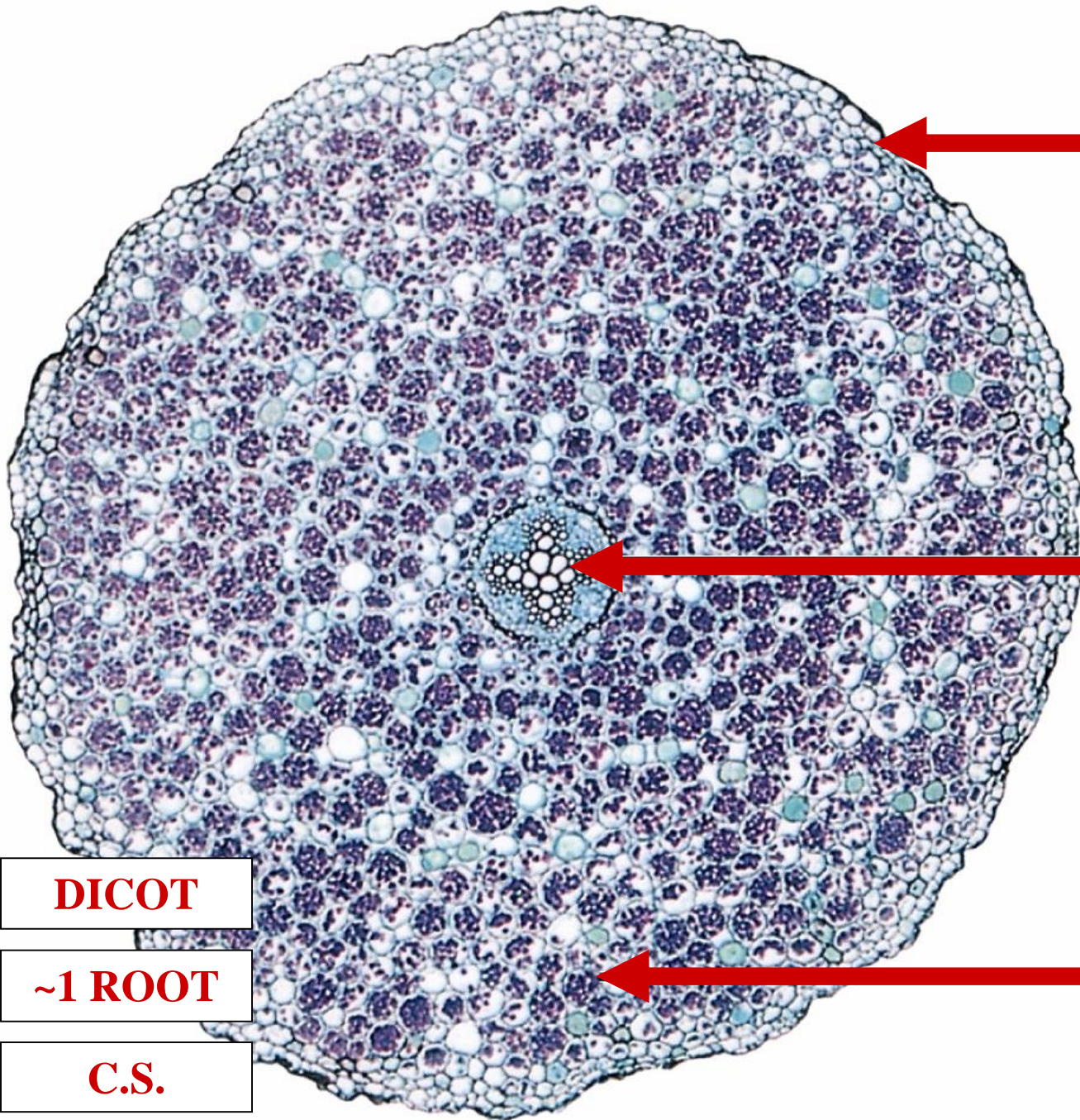
EPIDERMIS

DICOT

~1 ROOT

C.S.

2



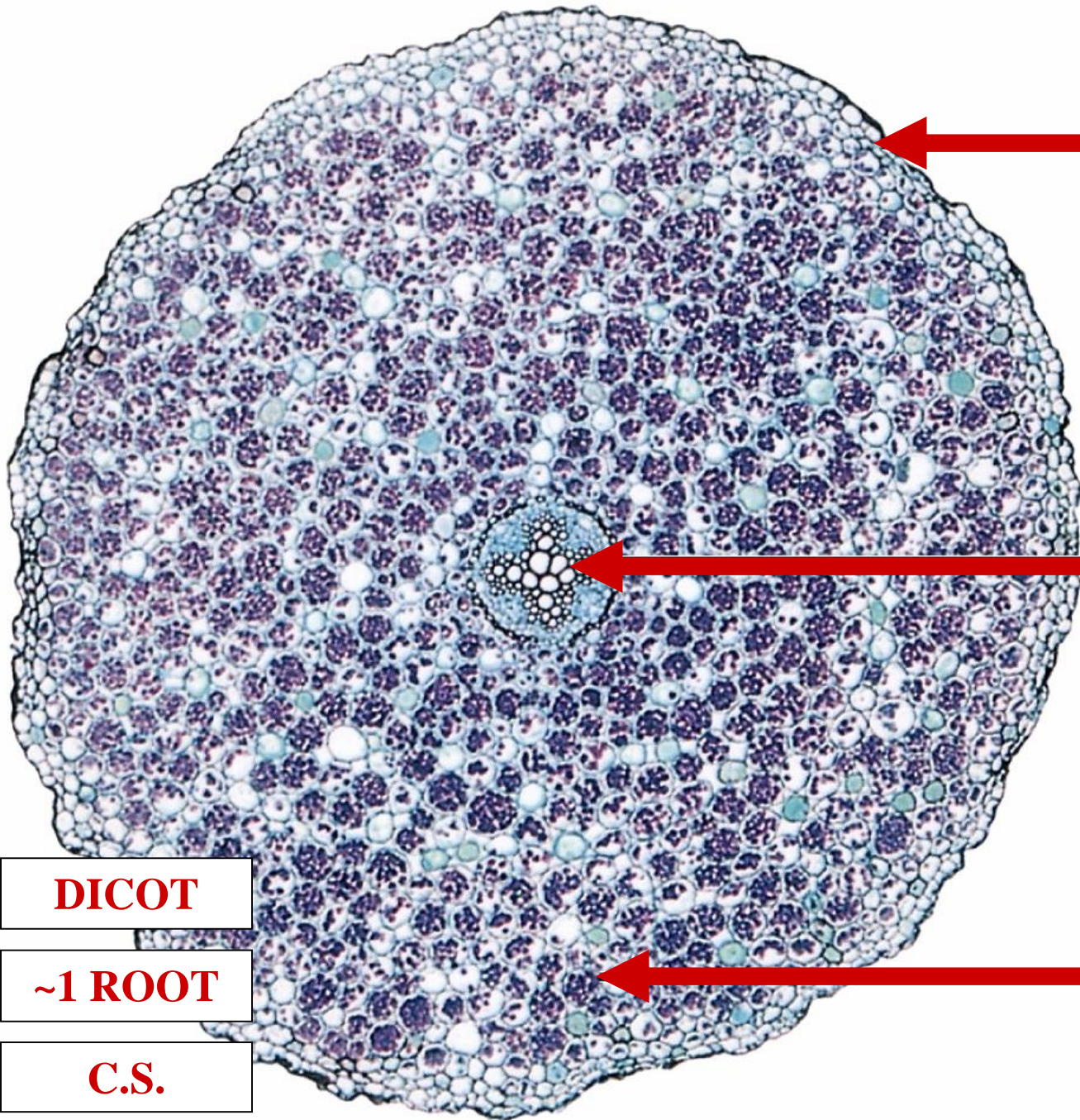
EPIDERMIS

DICOT

~1 ROOT

C.S.

CORTEX



EPIDERMIS

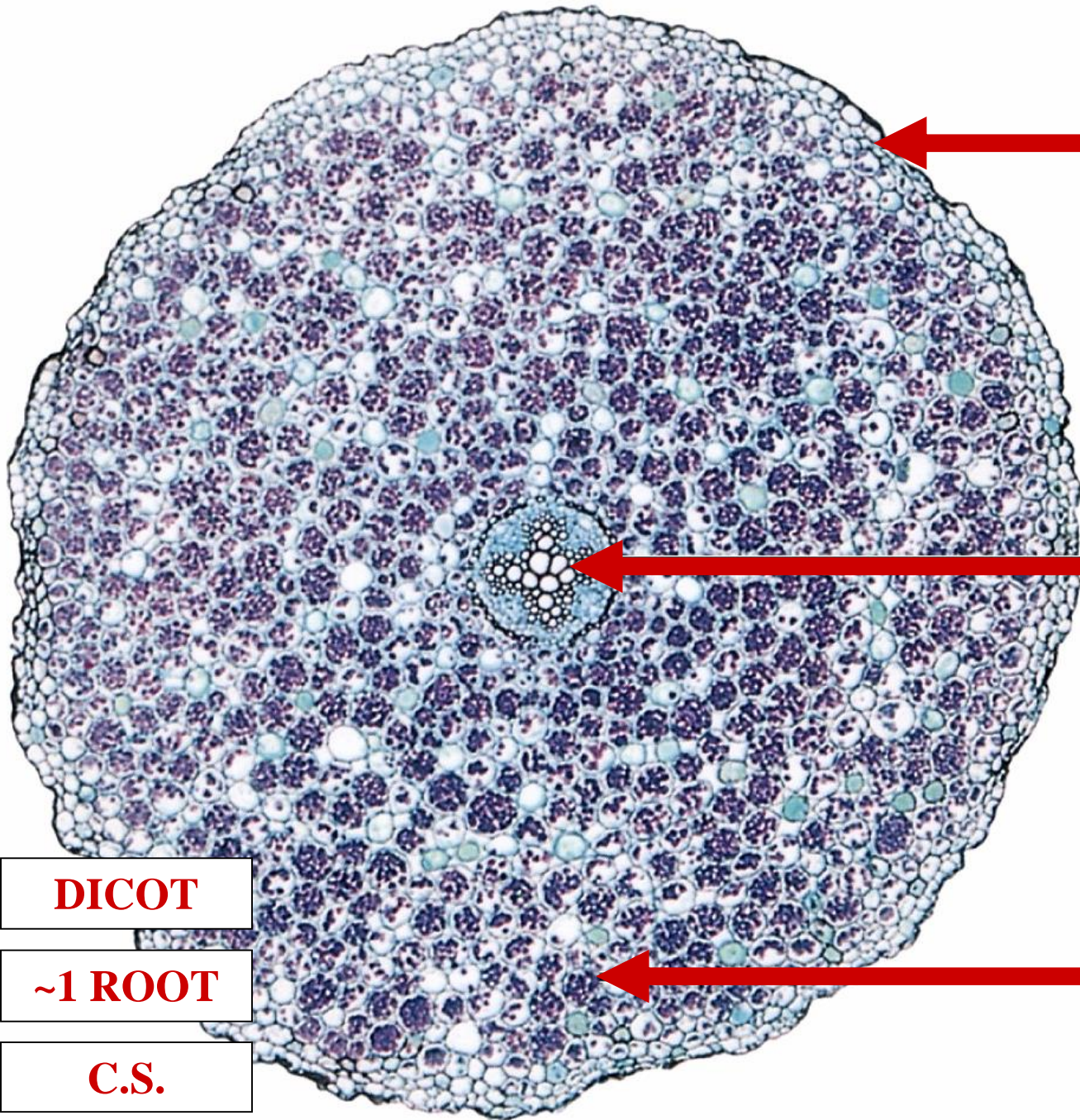
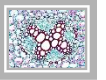
3

DICOT

~1 ROOT

C.S.

CORTEX



EPIDERMIS

VASCULAR STELE

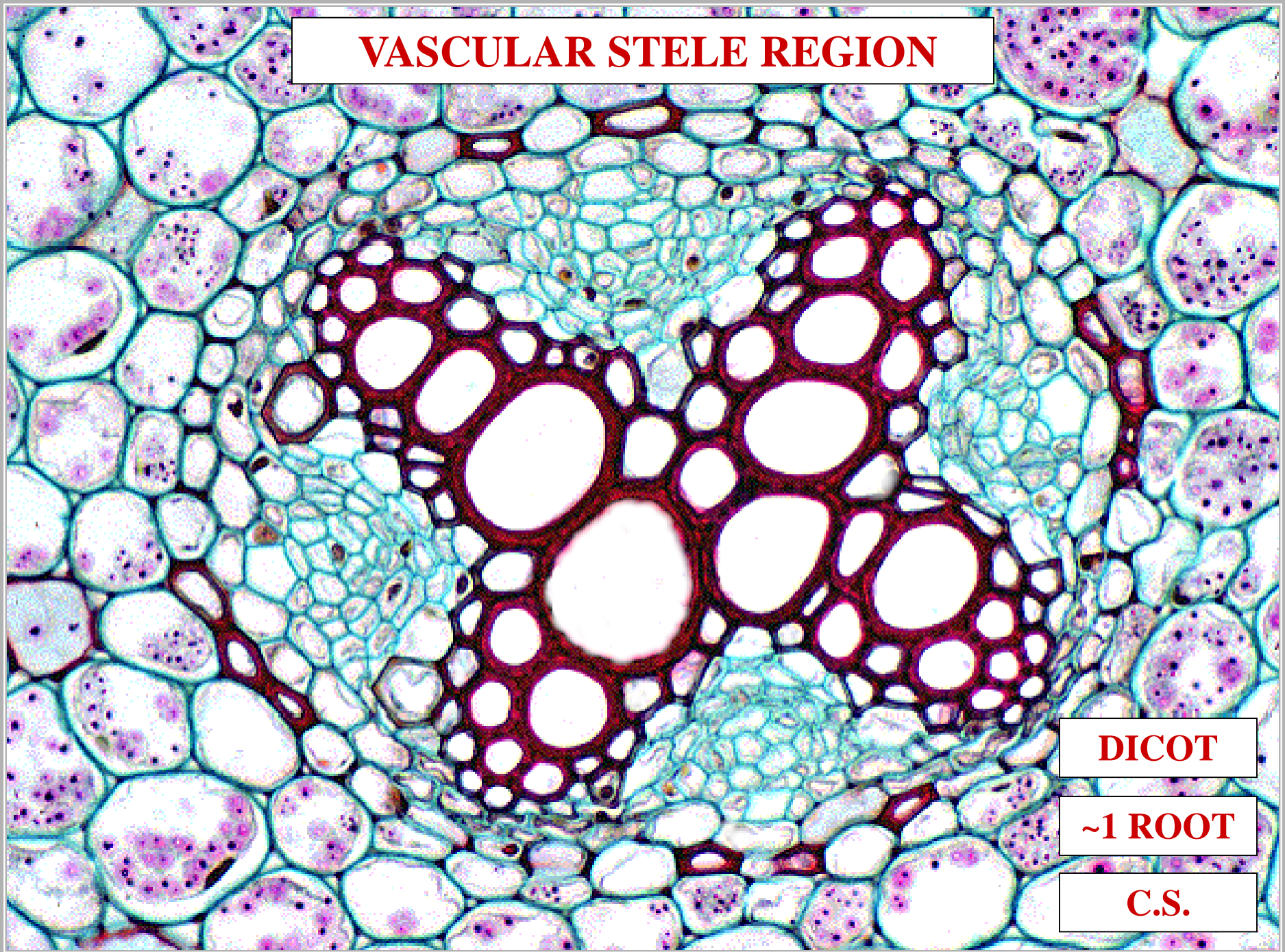
DICOT

~1 ROOT

C.S.

CORTEX

VASCULAR STELE REGION

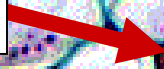


DICOT

~1 ROOT

C.S.

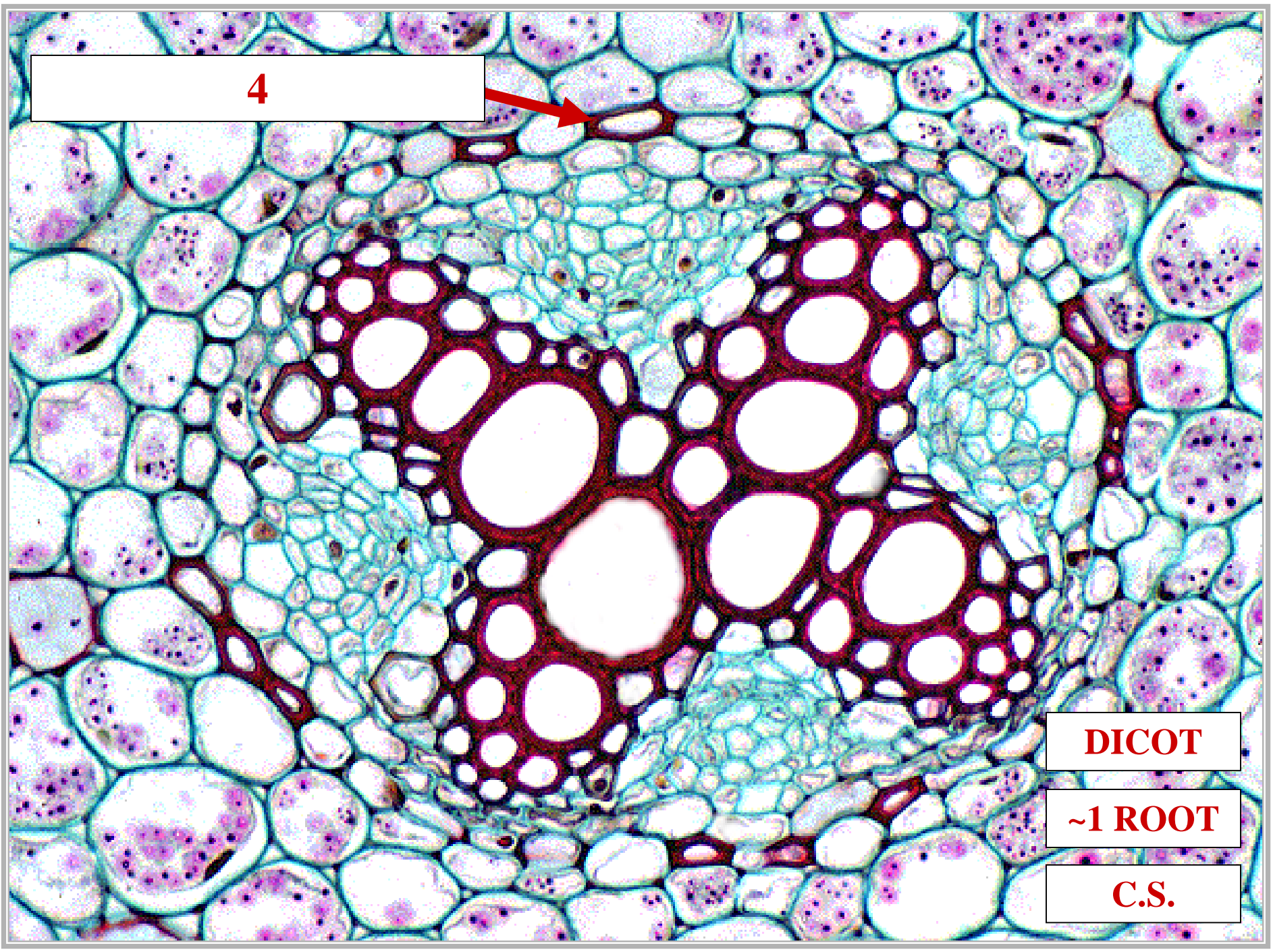
4



DICOT

~1 ROOT

C.S.



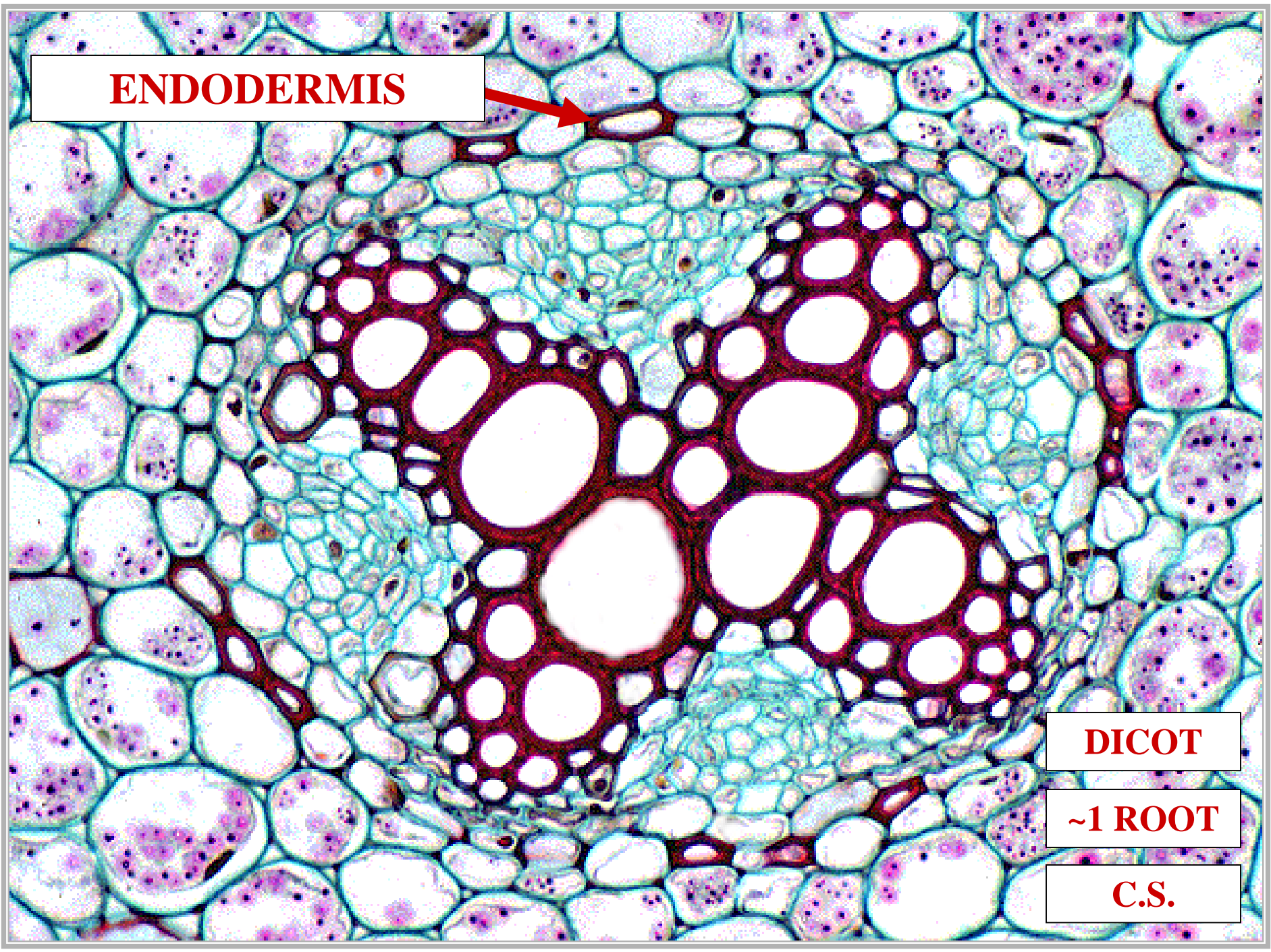
ENDODERMIS



DICOT

~1 ROOT

C.S.



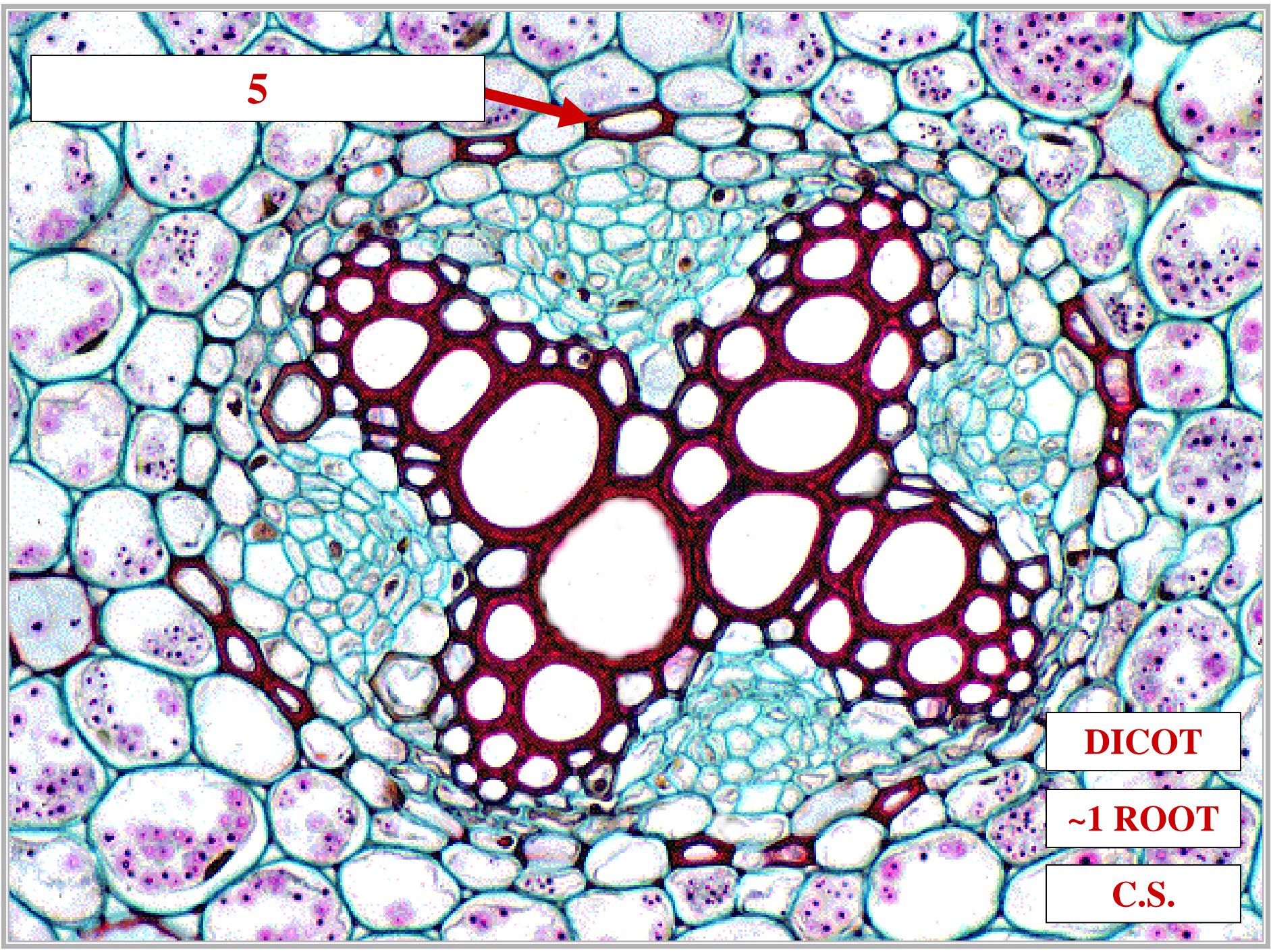
5



DICOT

~1 ROOT

C.S.



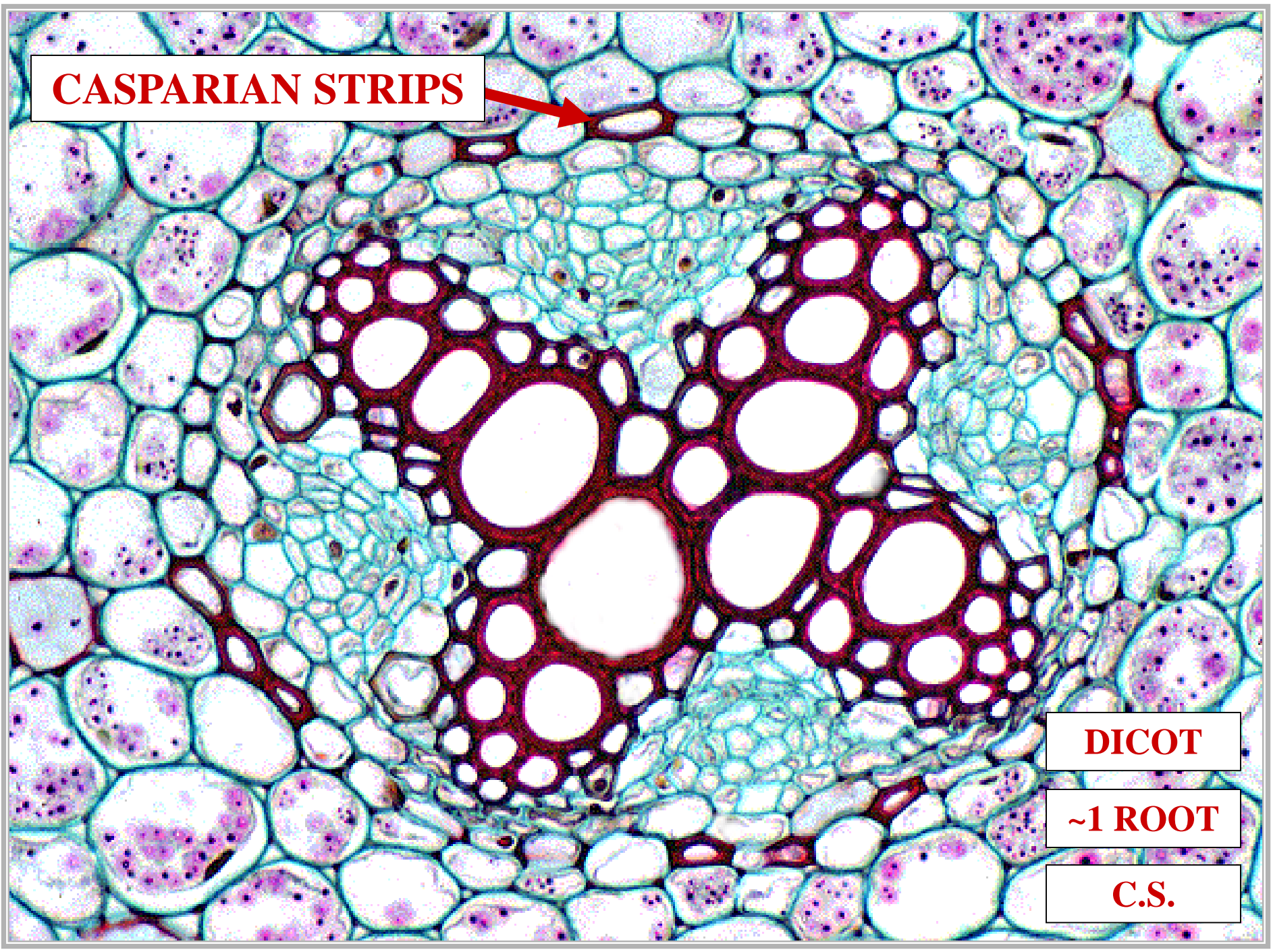
CASPARIAN STRIPS



DICOT

~1 ROOT

C.S.



ENDODERMIS

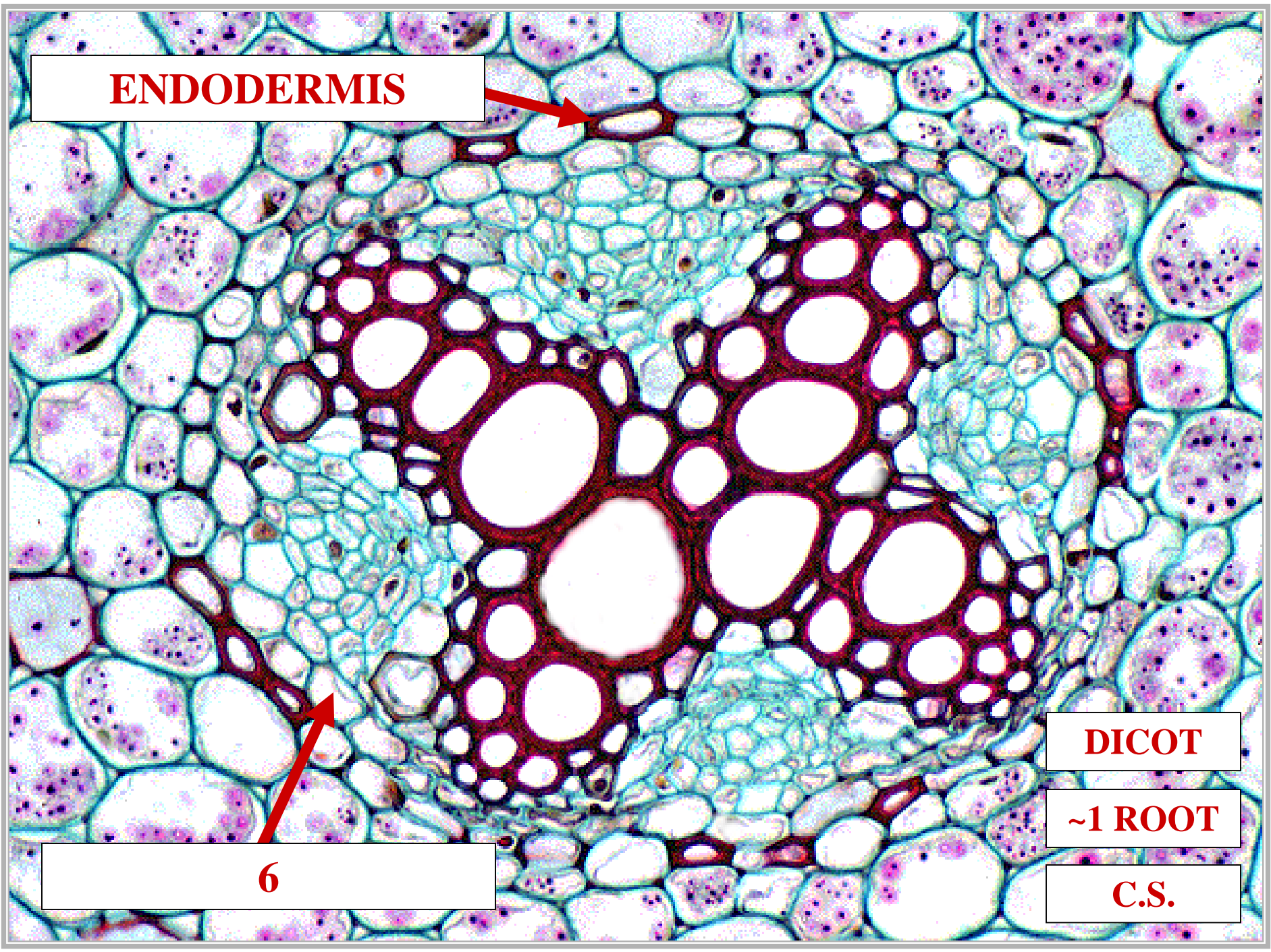


6

DICOT

~1 ROOT

C.S.



ENDODERMIS



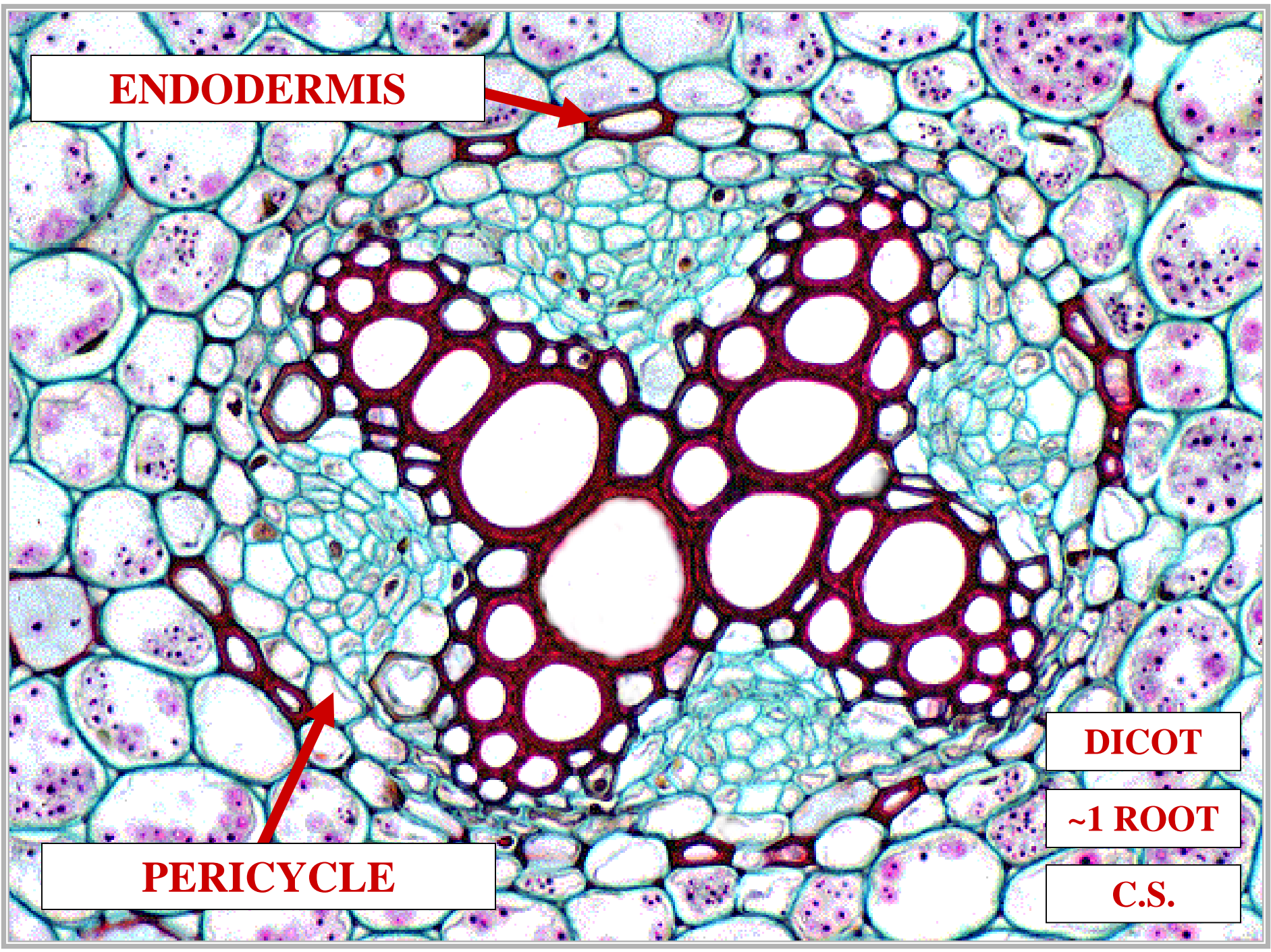
PERICYCLE



DICOT

~1 ROOT

C.S.



ENDODERMIS

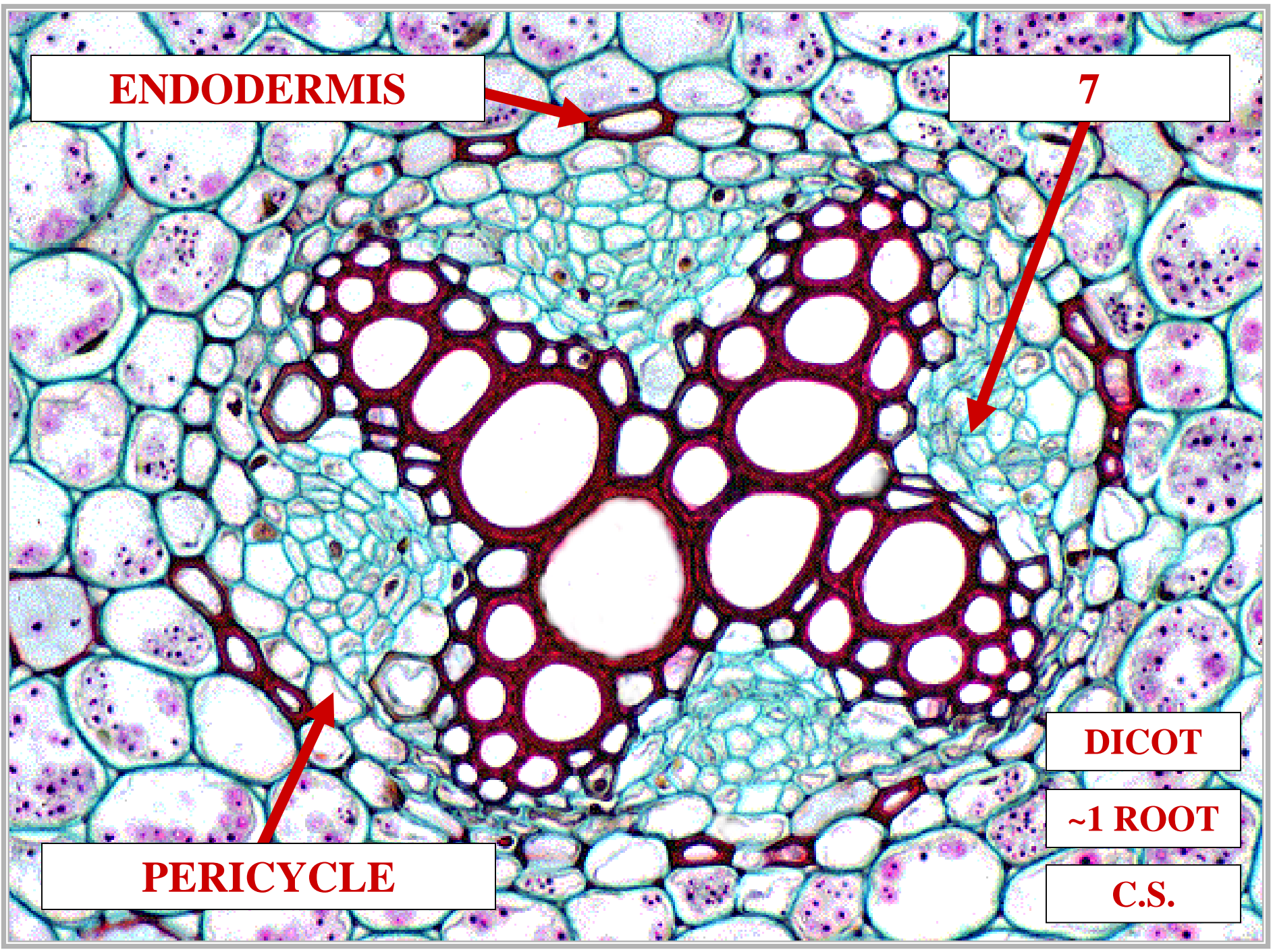
7

DICOT

~1 ROOT

PERICYCLE

C.S.



ENDODERMIS

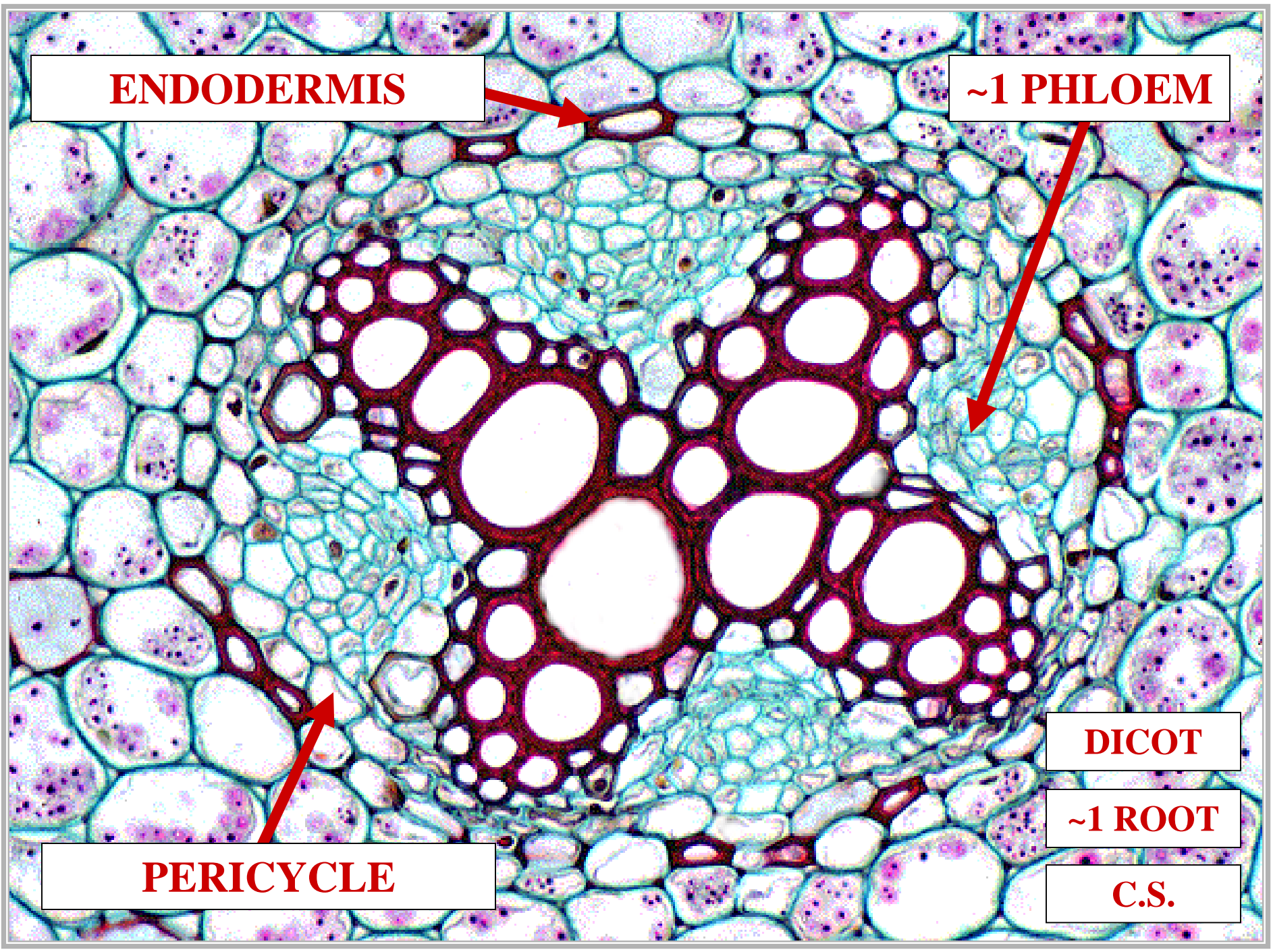
~1 PHLOEM

PERICYCLE

DICOT

~1 ROOT

C.S.



ENDODERMIS

~1 PHLOEM

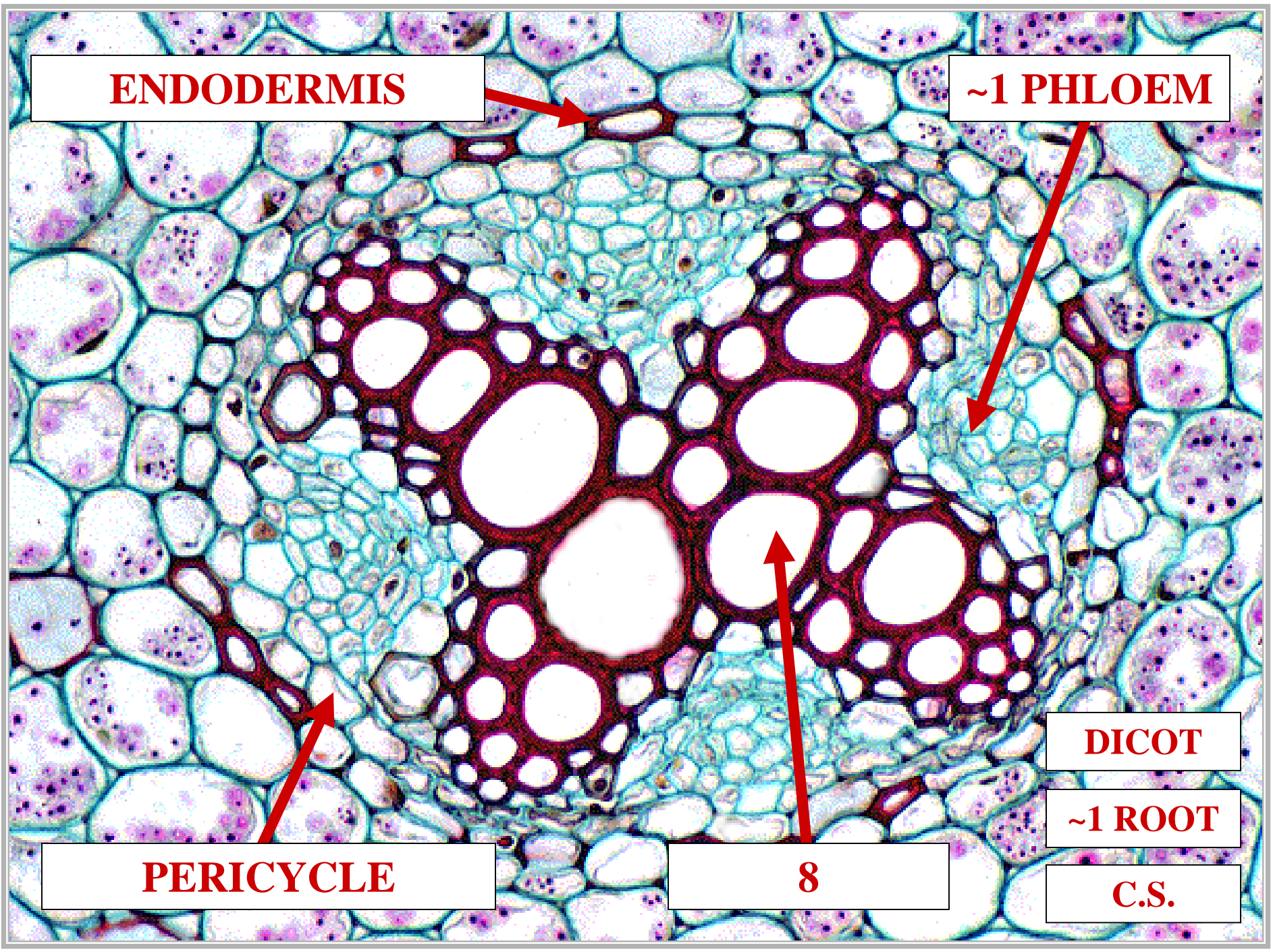
PERICYCLE

8

DICOT

~1 ROOT

C.S.



ENDODERMIS

~1 PHLOEM

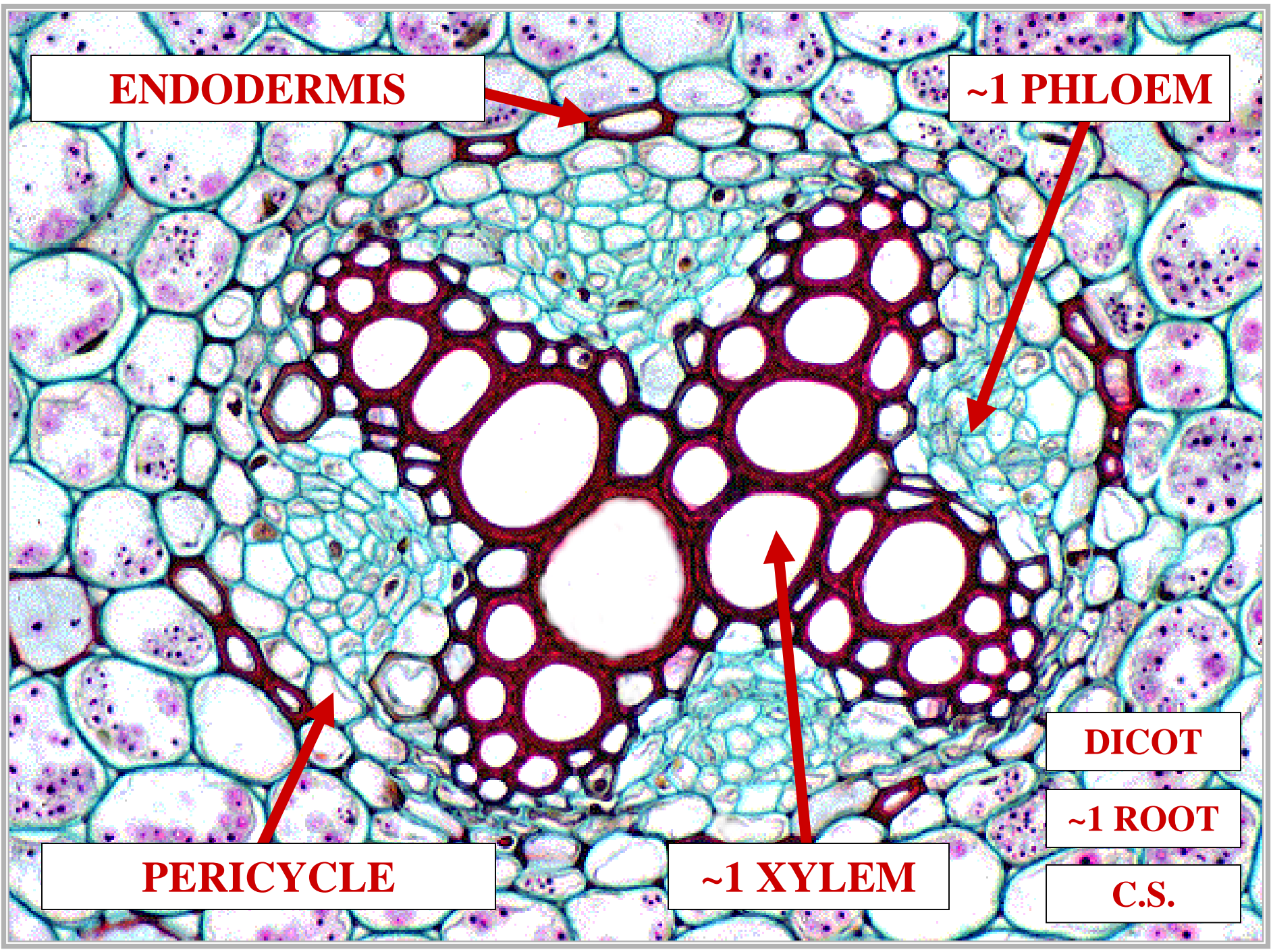
PERICYCLE

~1 XYLEM

DICOT

~1 ROOT

C.S.



ENDODERMIS

~1 PHLOEM

9

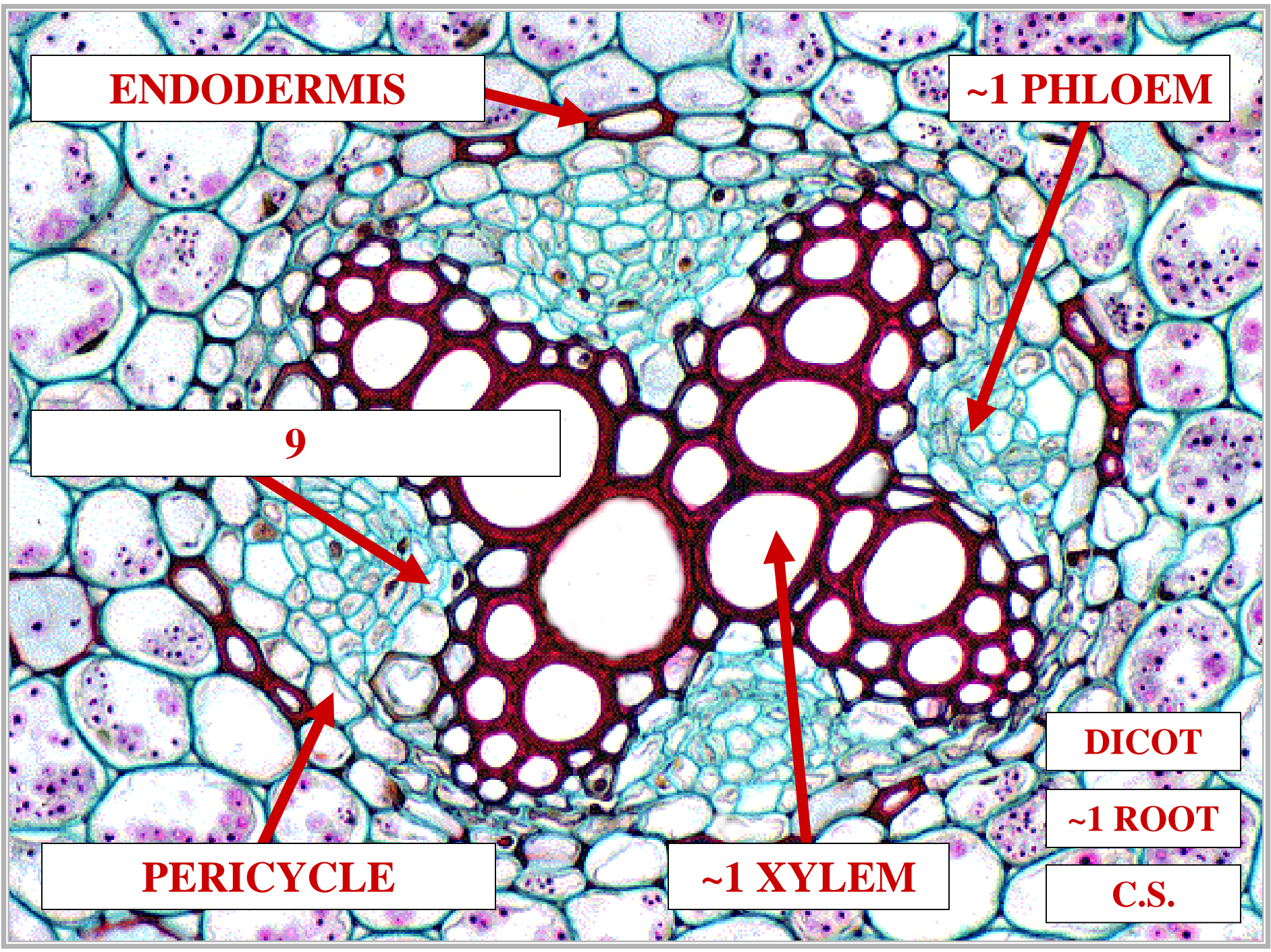
PERICYCLE

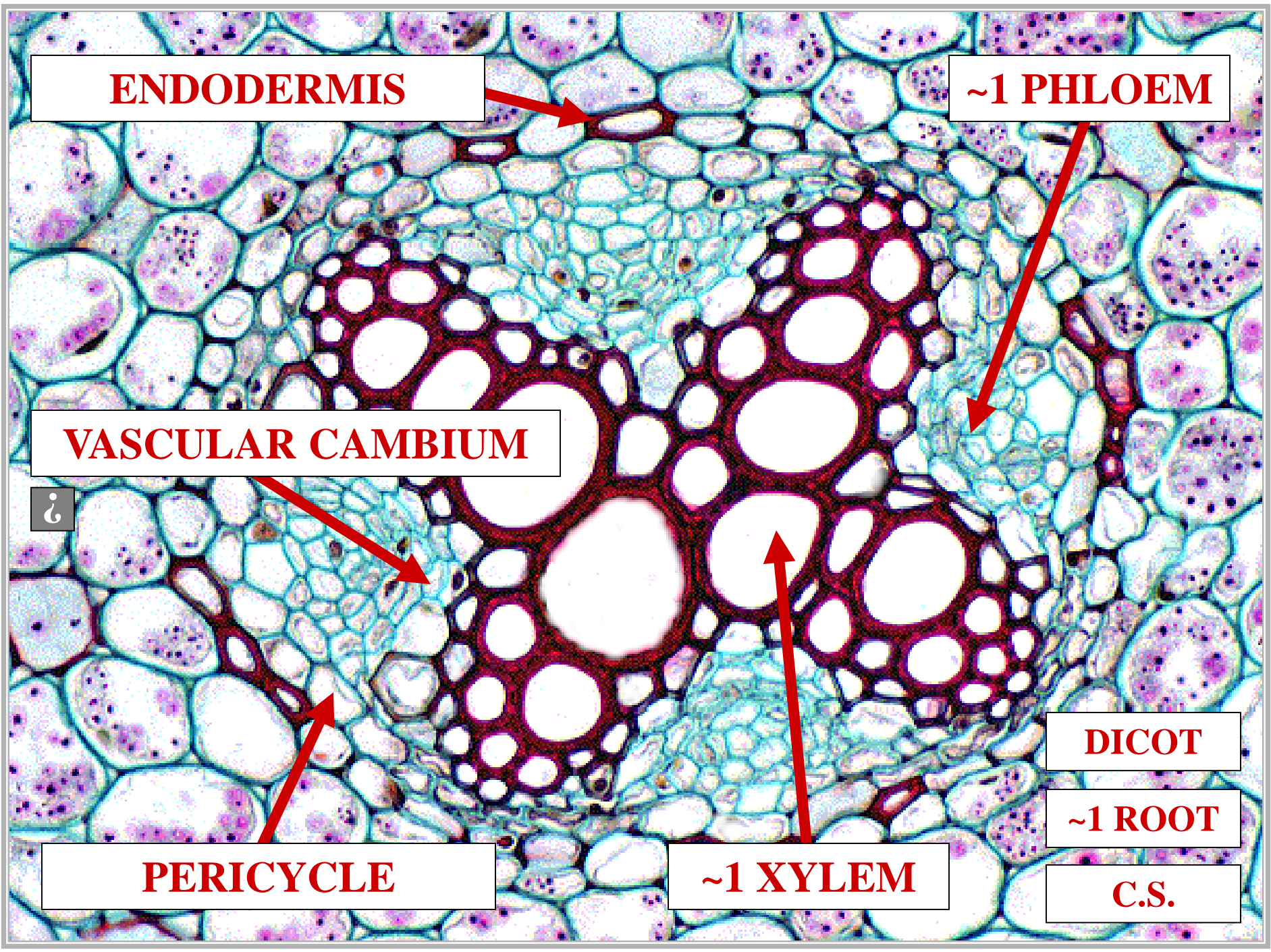
~1 XYLEM

DICOT

~1 ROOT

C.S.





ENDODERMIS

~1 PHLOEM

VASCULAR CAMBIUM

?

DICOT

~1 ROOT

PERICYCLE

~1 XYLEM

C.S.

ENDODERMIS

~1 PHLOEM

~2 GROWTH PRESENT

+

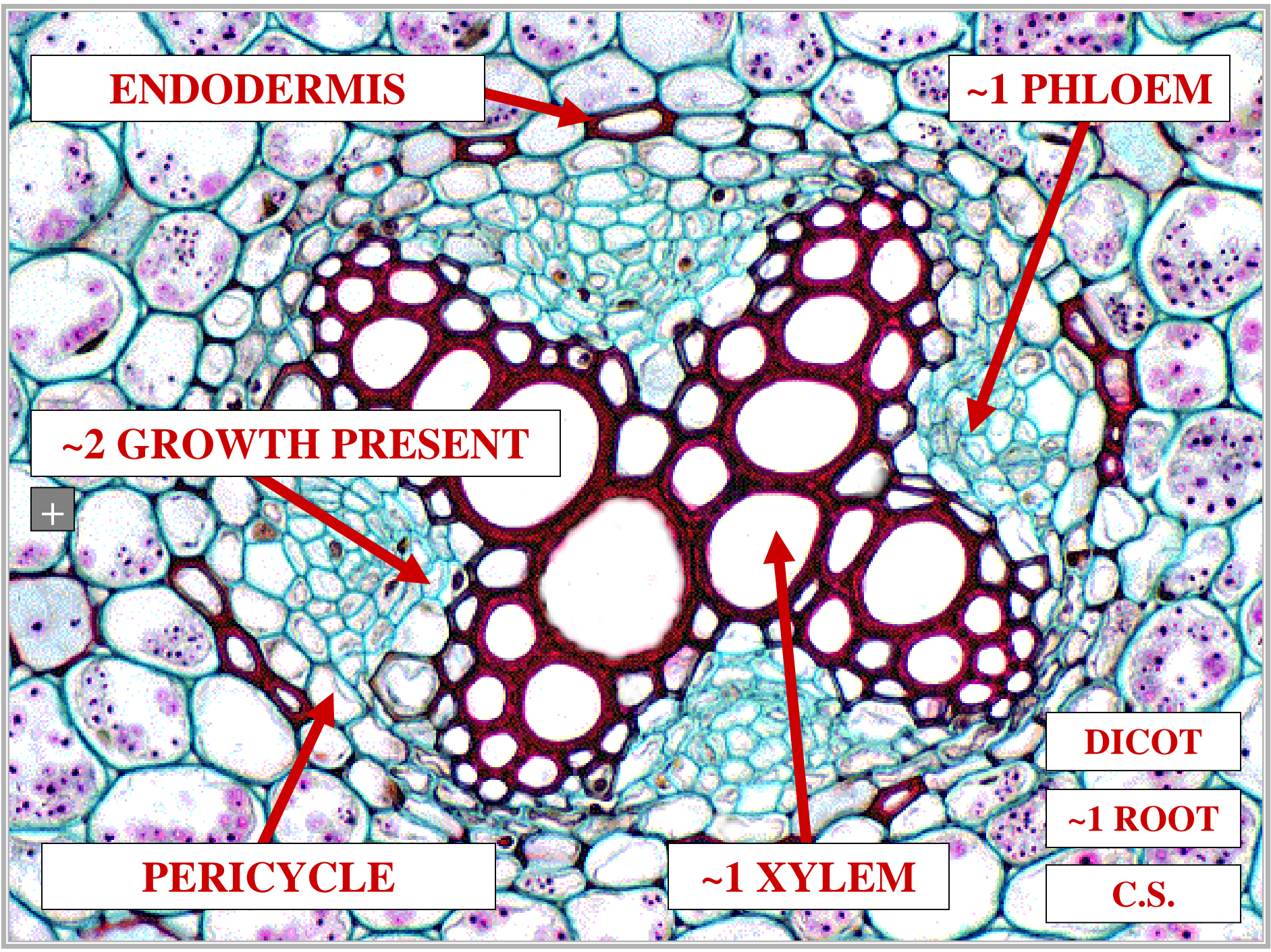
PERICYCLE

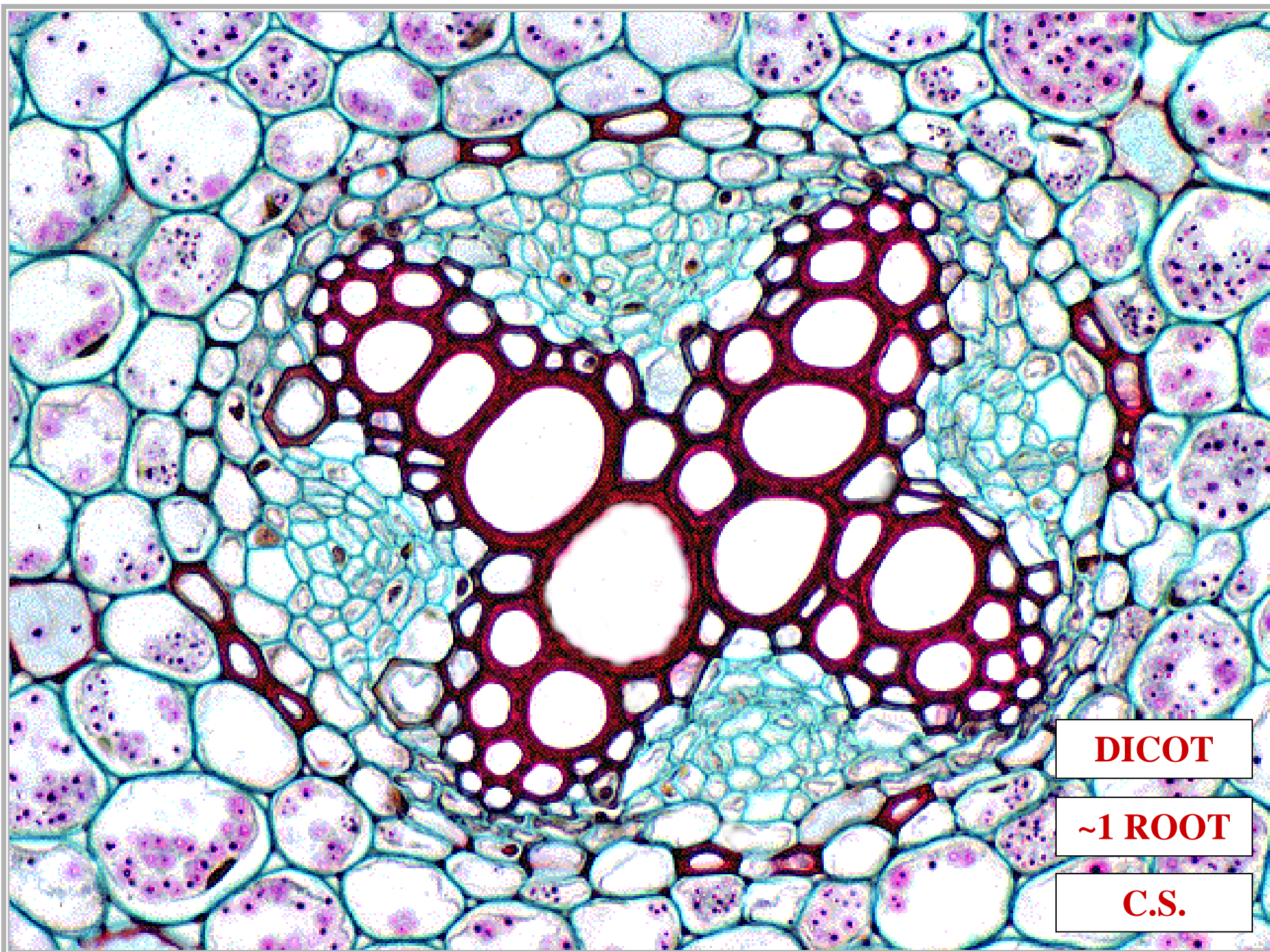
~1 XYLEM

DICOT

~1 ROOT

C.S.

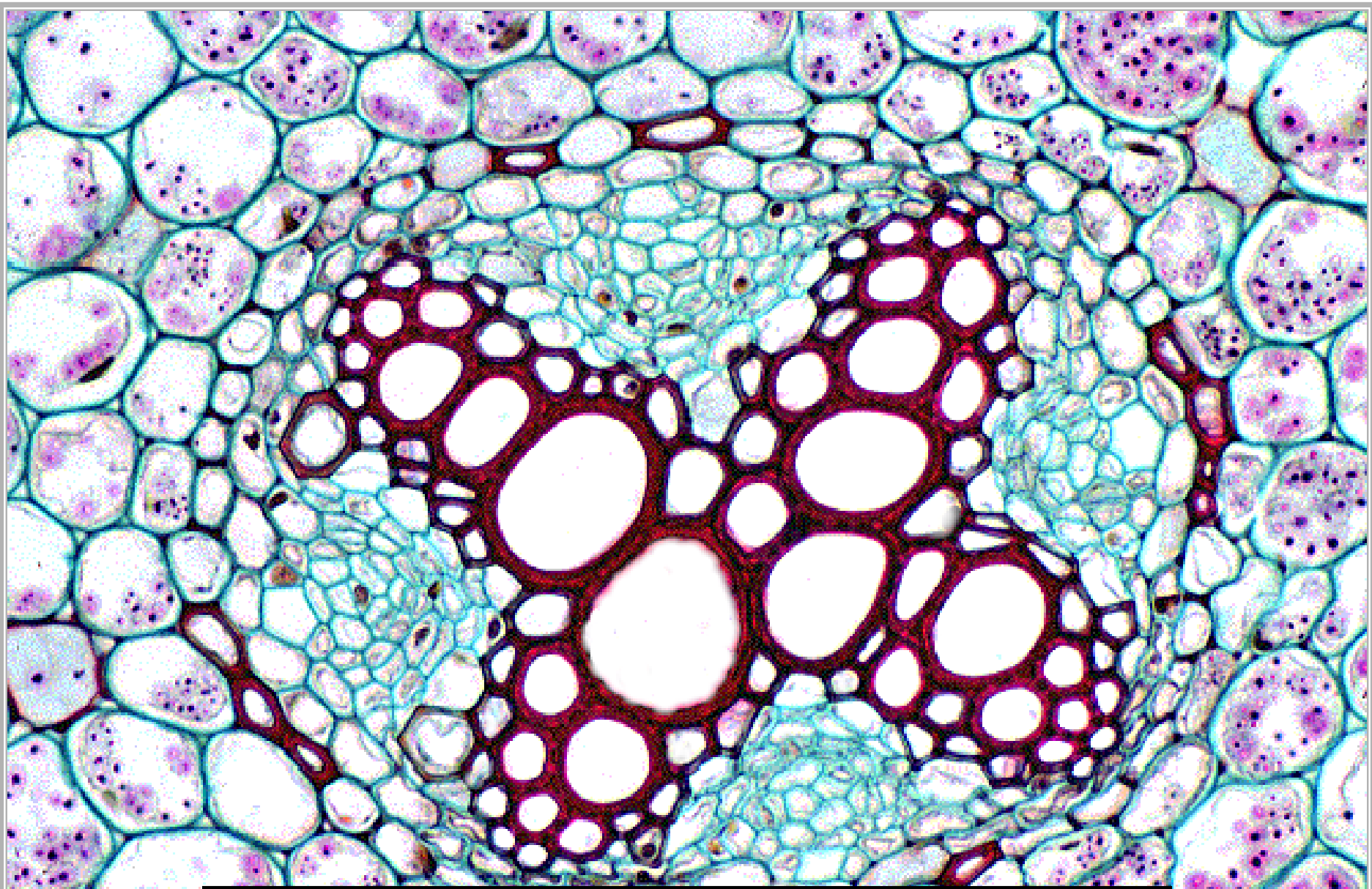




DICOT

~1 ROOT

C.S.



PROTOSTELE

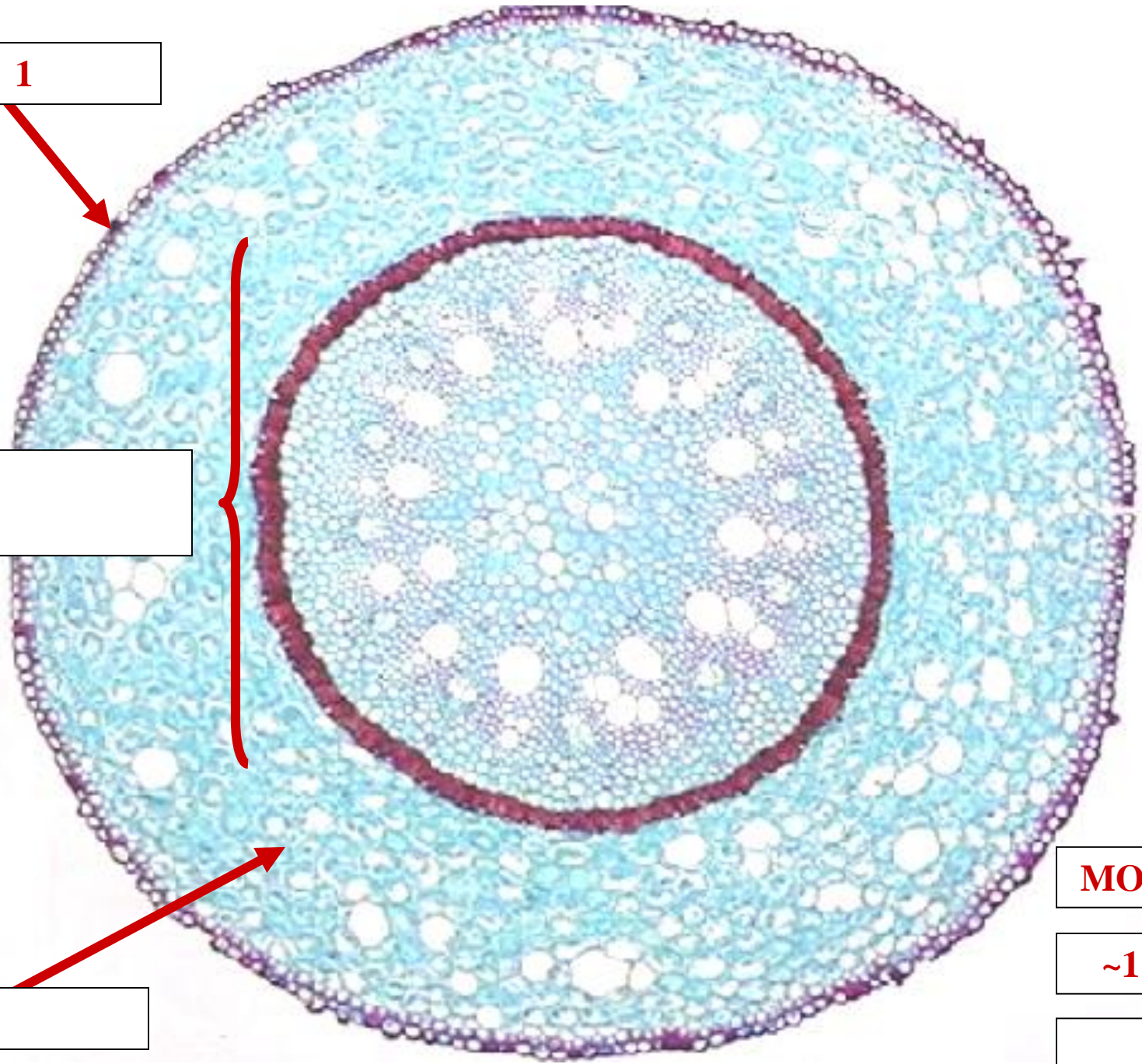
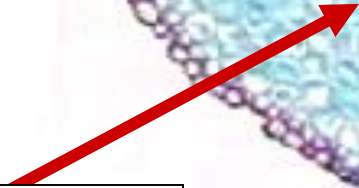
A light micrograph of a plant stem cross-section. The vascular bundles are arranged in a ring, with each bundle containing a central protoxylem lacuna. The bundles are arranged in a pattern where the angle between adjacent bundles is approximately 180 degrees, characteristic of an actinostele. The surrounding tissue consists of cortical cells and pith cells, some of which contain purple-stained inclusions. A small grey square with a white upward-pointing arrow is located in the top right corner.

PROTOSTELE / ACTINOSTELE



MONOCOT ROOT PRIMARY GROWTH SUMMARY

1

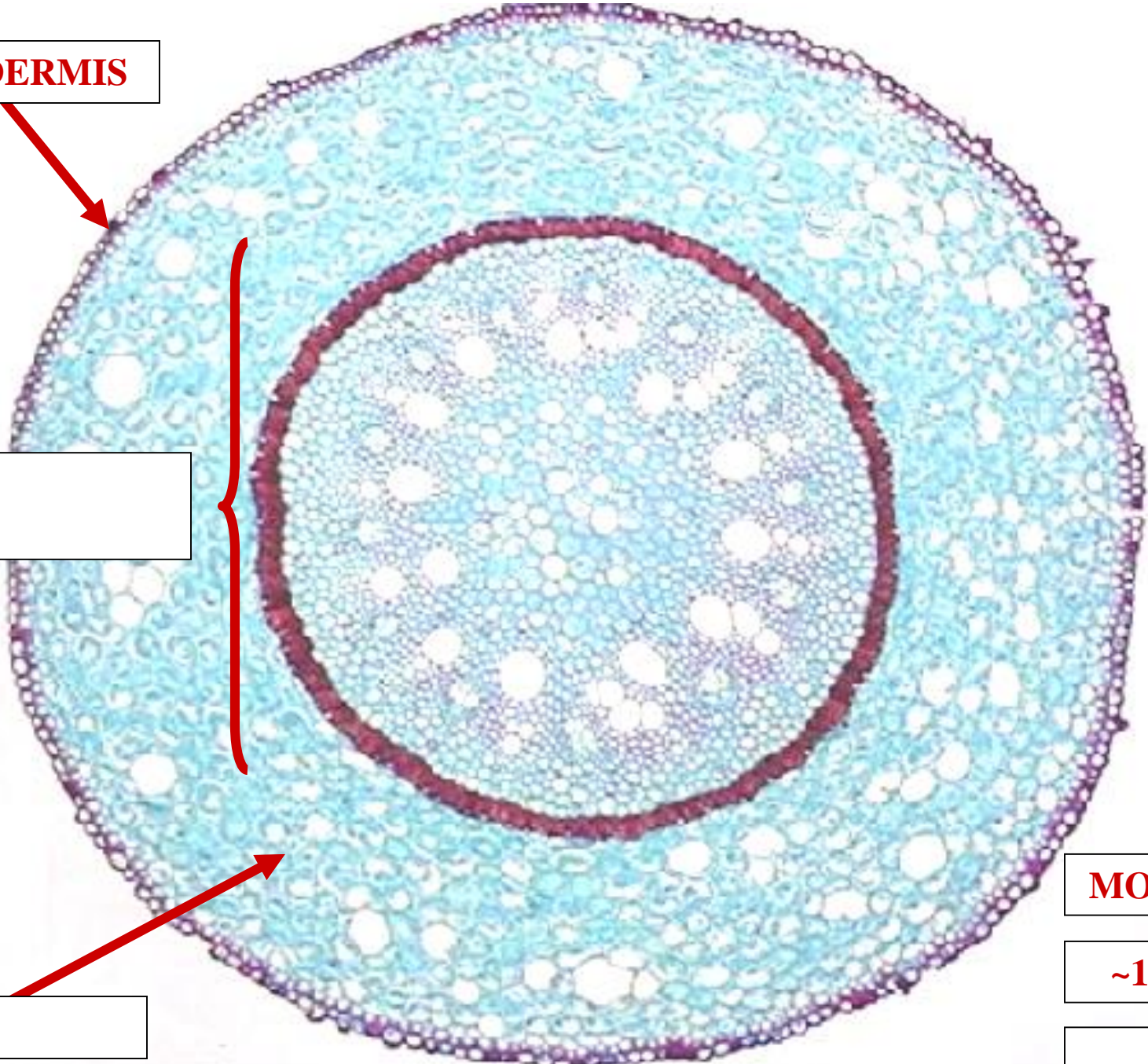
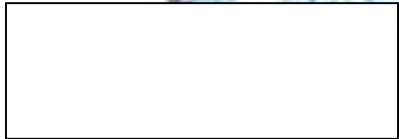


MONOCOT

~1 ROOT

C.S.

EPIDERMIS



MONOCOT

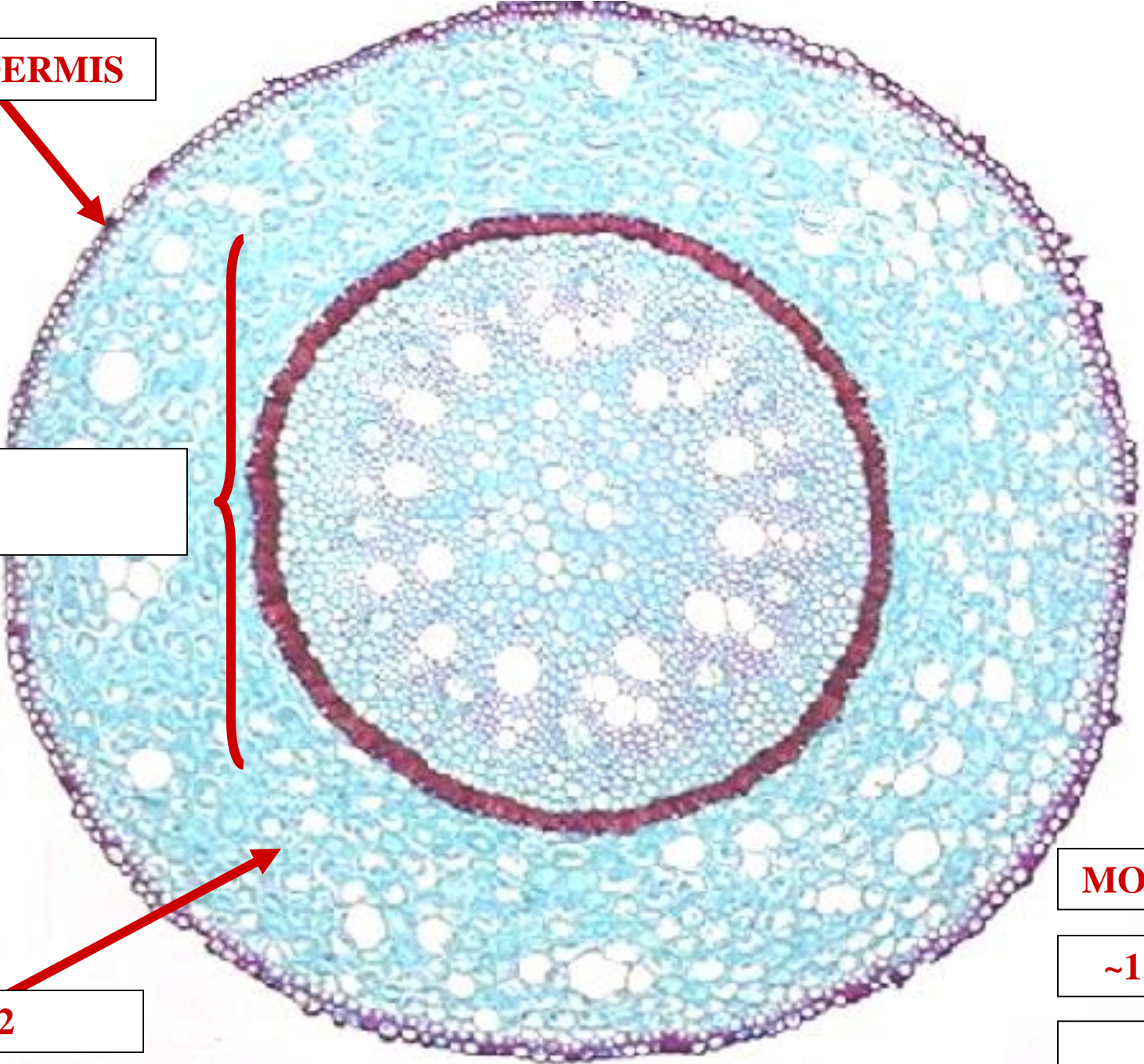
~1 ROOT

C.S.

EPIDERMIS



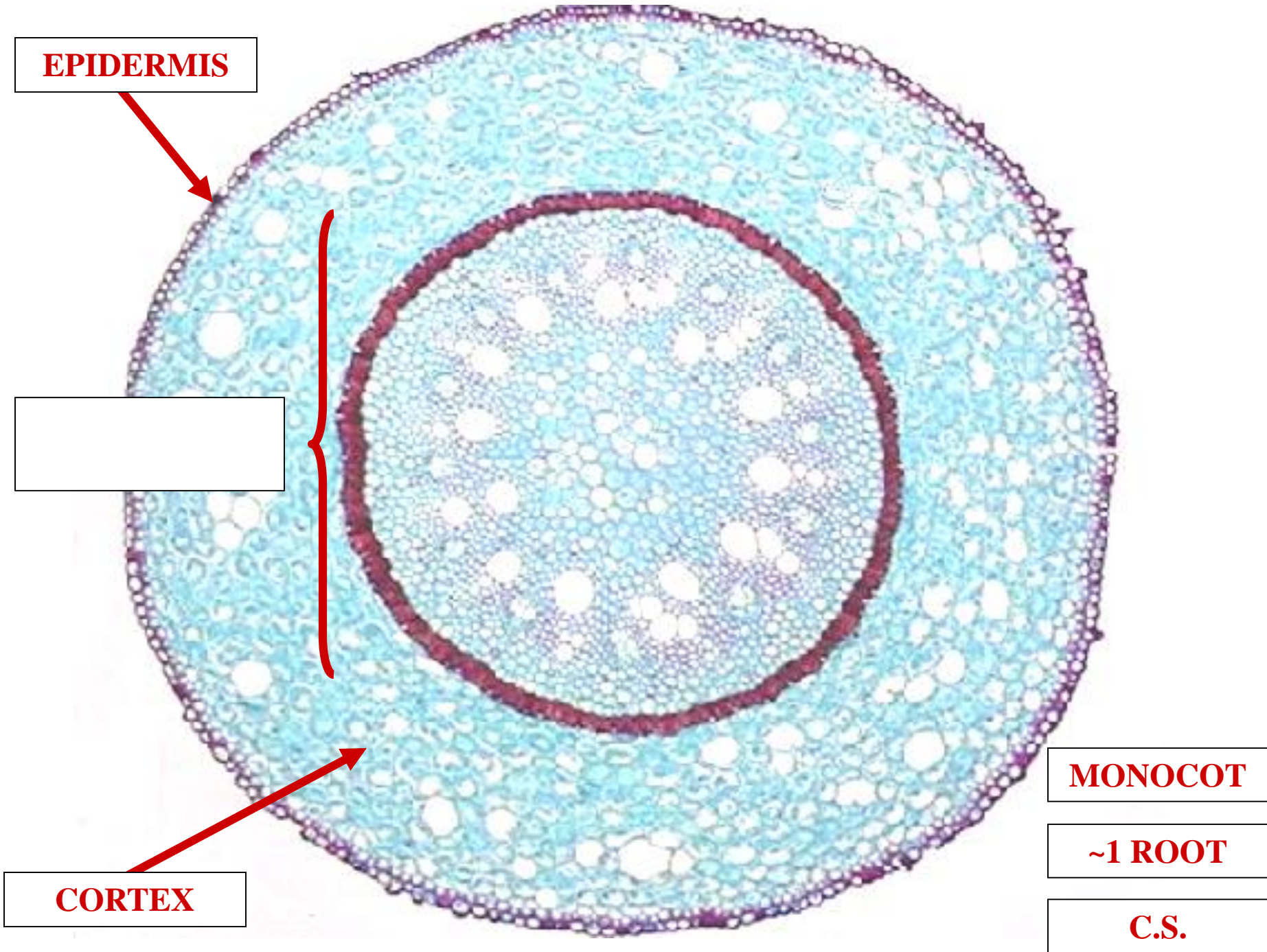
2



MONOCOT

~1 ROOT

C.S.



EPIDERMIS

[Empty box]

CORTEX

MONOCOT

~1 ROOT

C.S.



EPIDERMIS



3



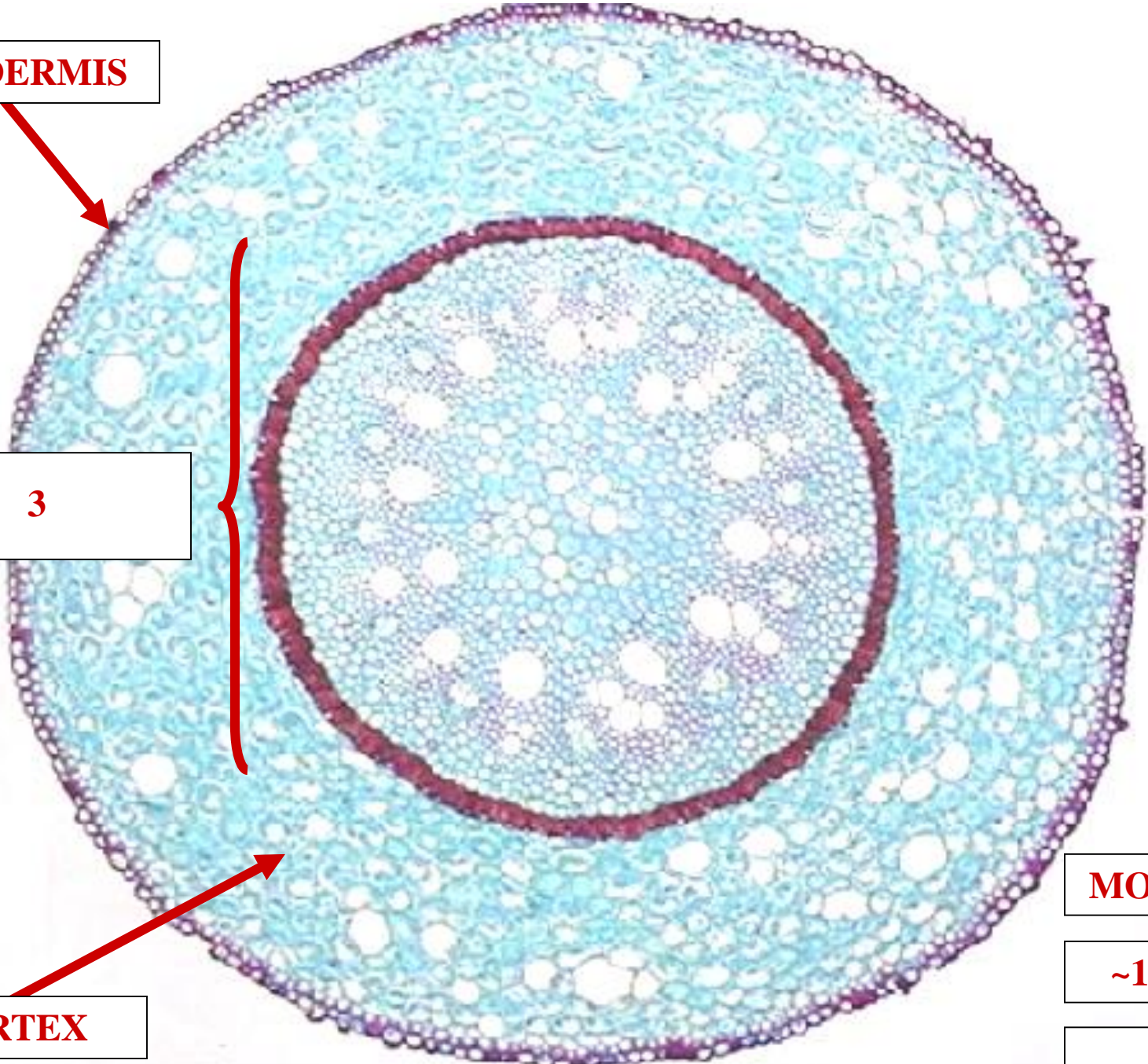
CORTEX



MONOCOT

~1 ROOT

C.S.





EPIDERMIS



**VASCULAR
STELE**



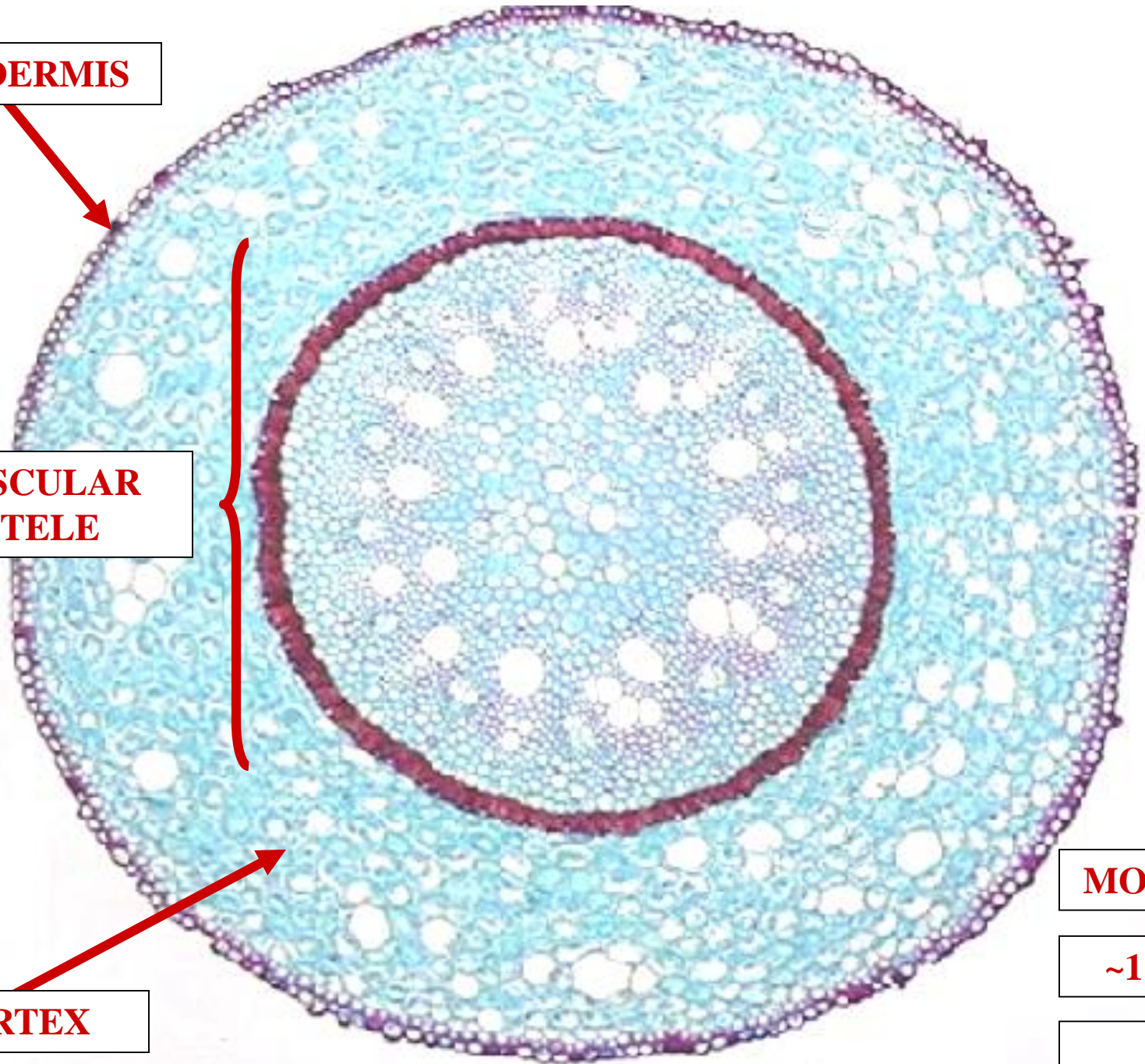
CORTEX



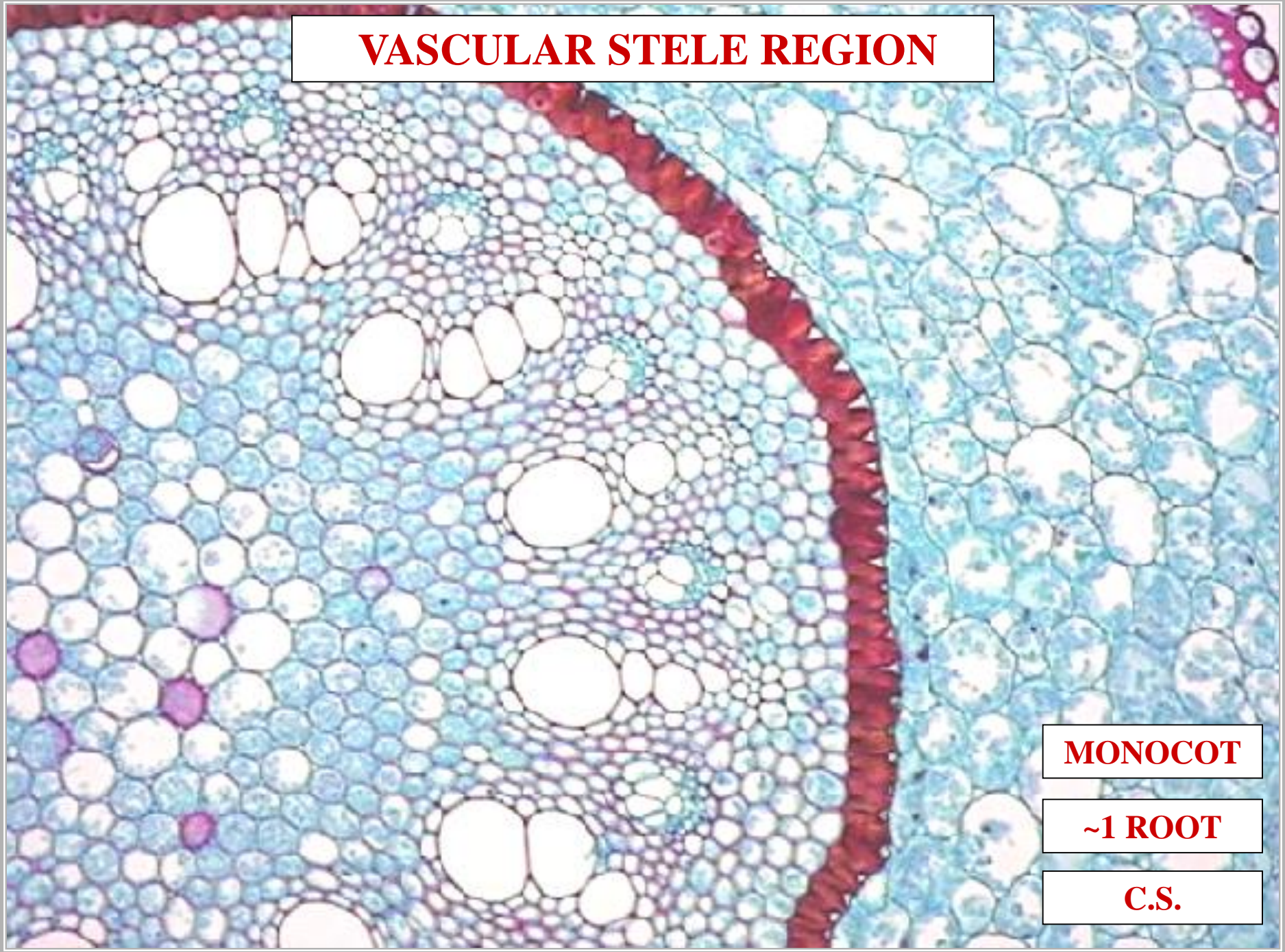
MONOCOT

~1 ROOT

C.S.



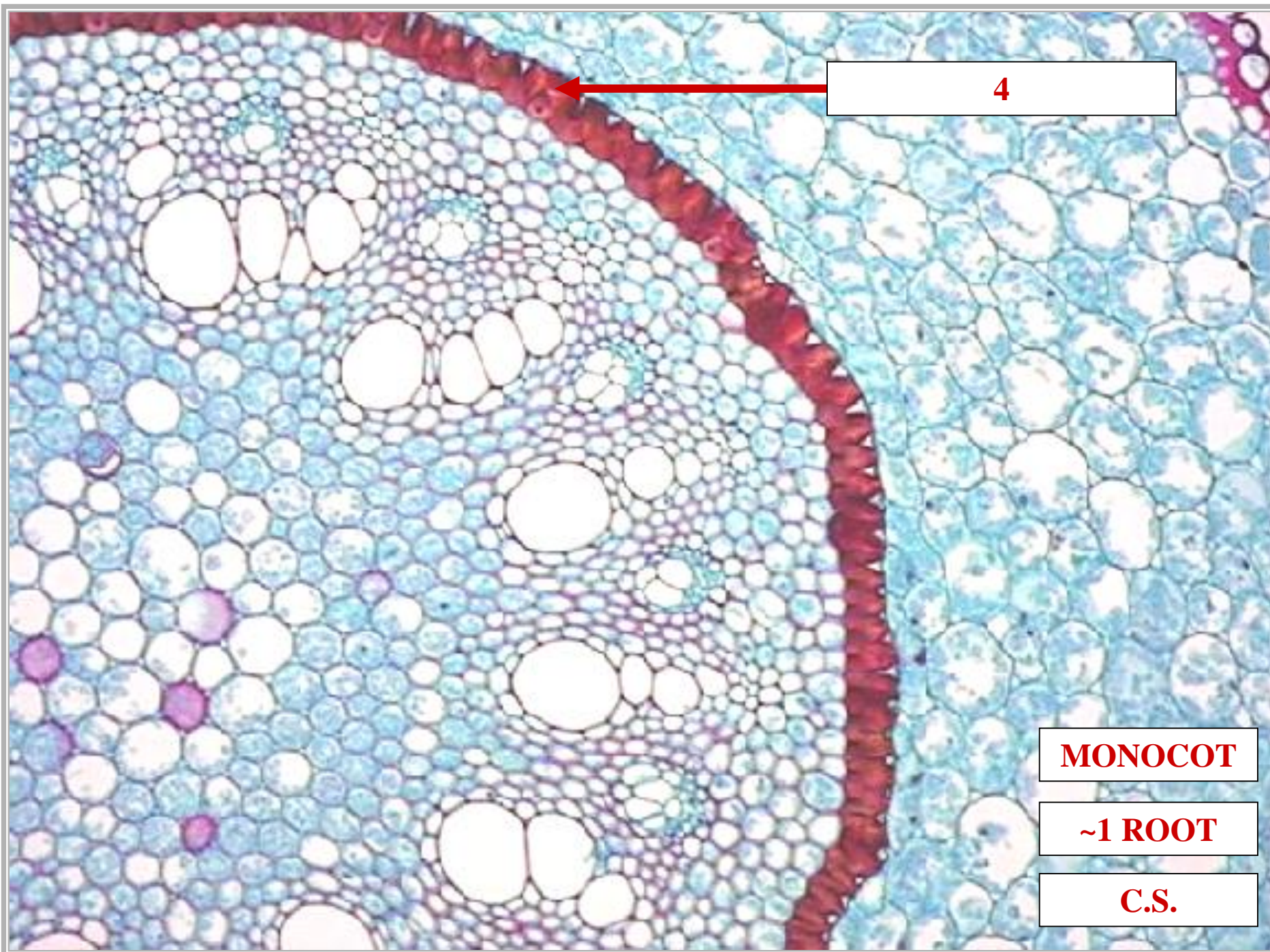
VASCULAR STELE REGION



MONOCOT

~1 ROOT

C.S.

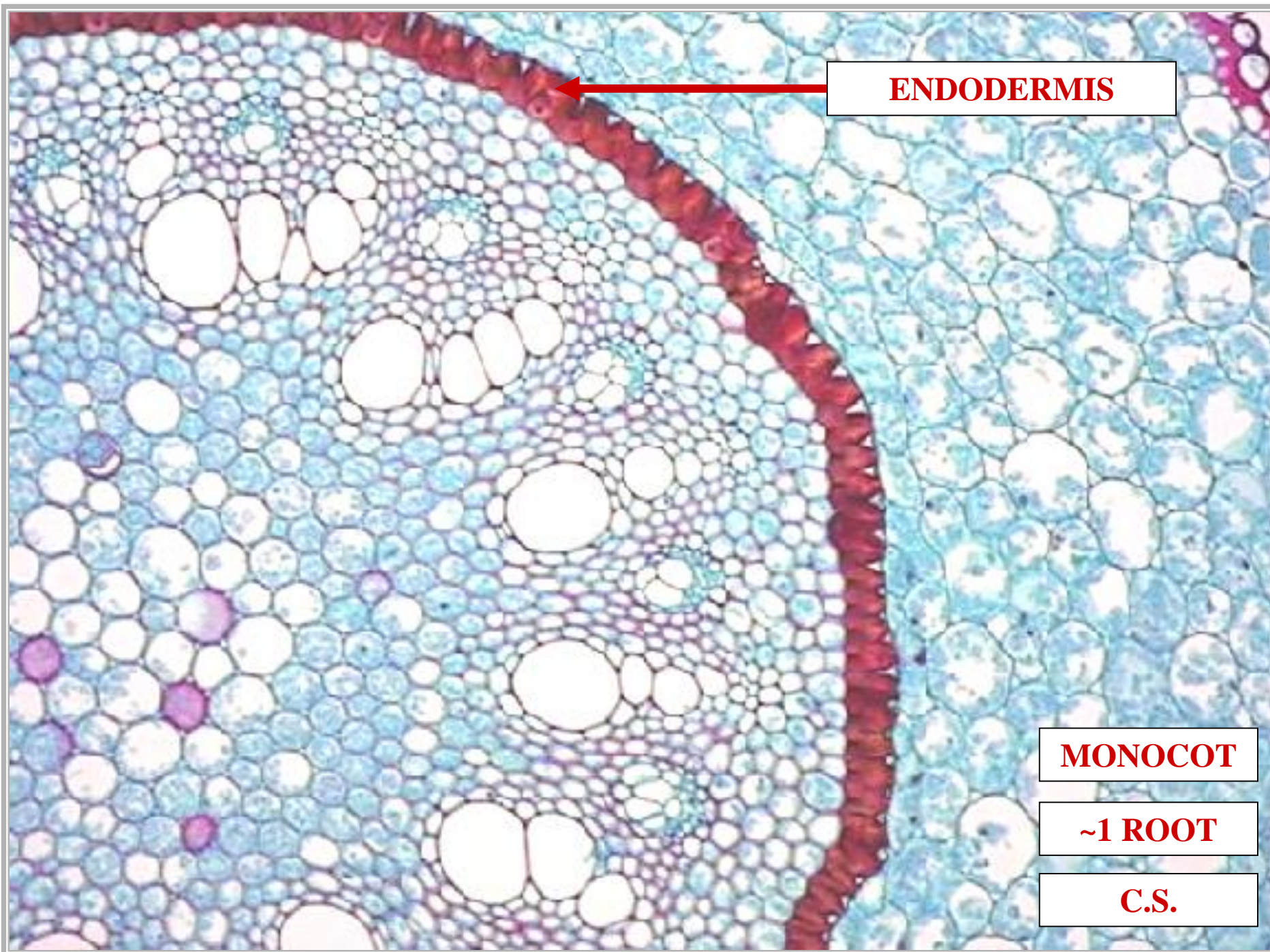


4

MONOCOT

~1 ROOT

C.S.

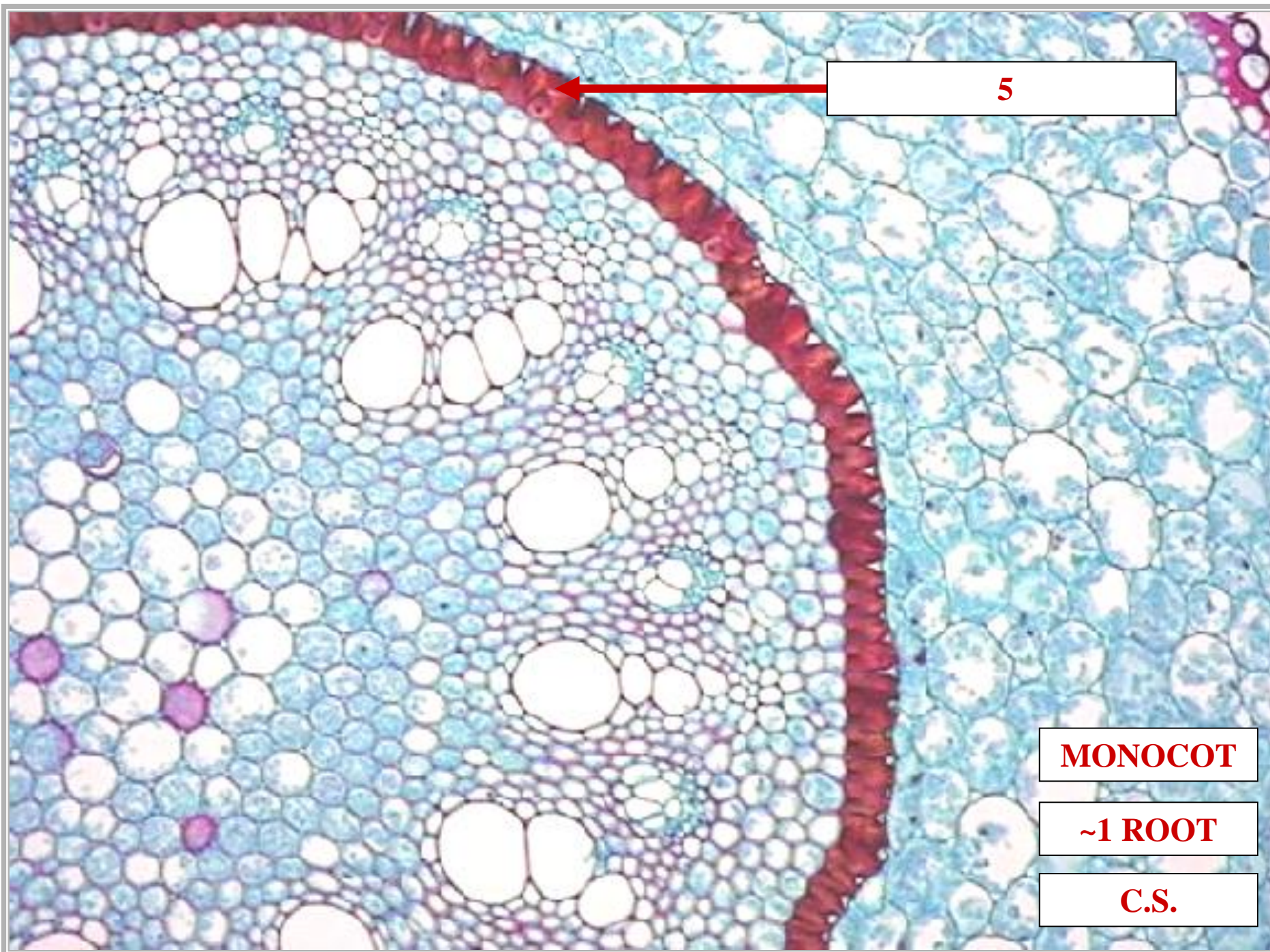


ENDODERMIS

MONOCOT

~1 ROOT

C.S.

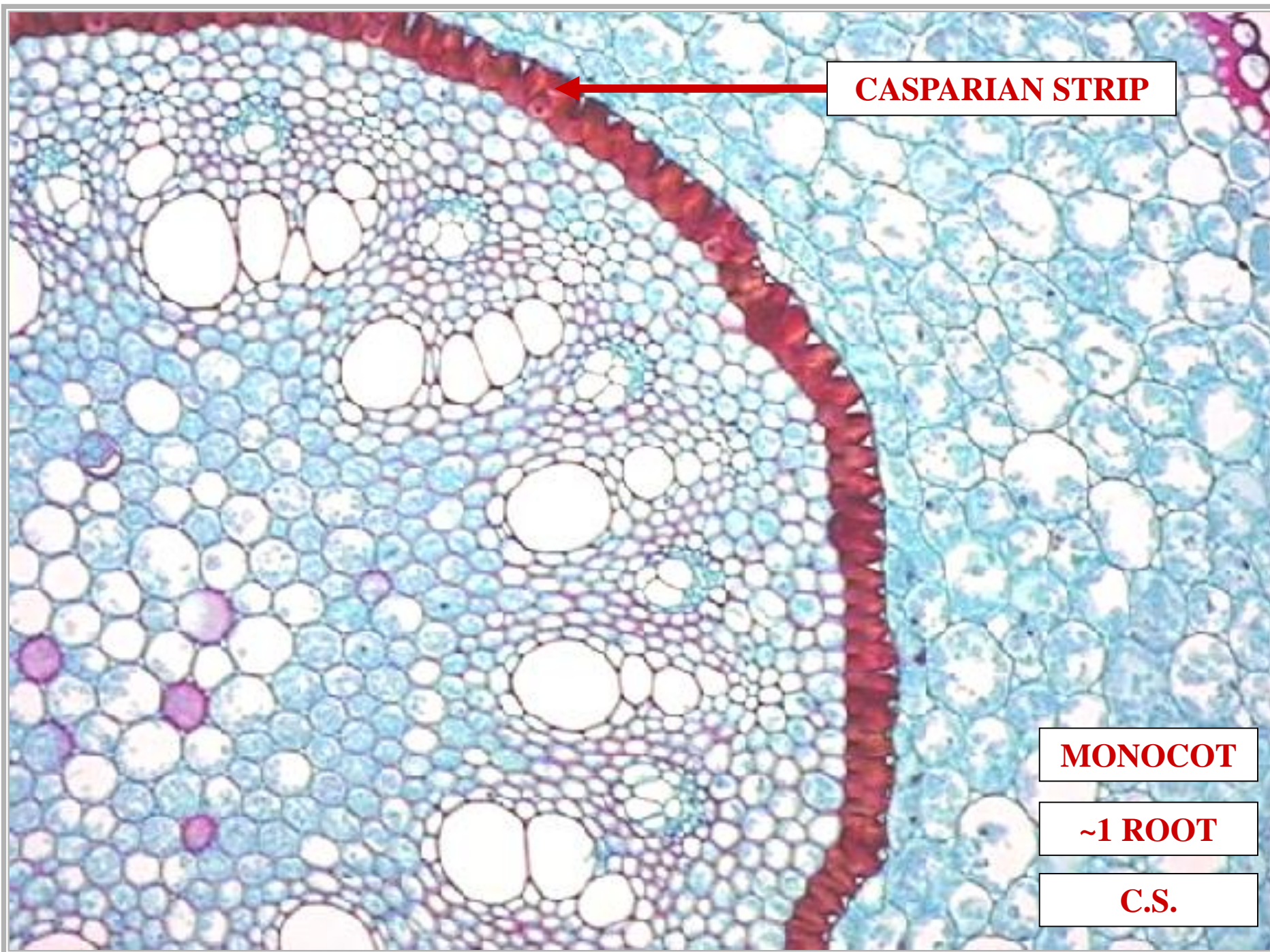


5

MONOCOT

~1 ROOT

C.S.

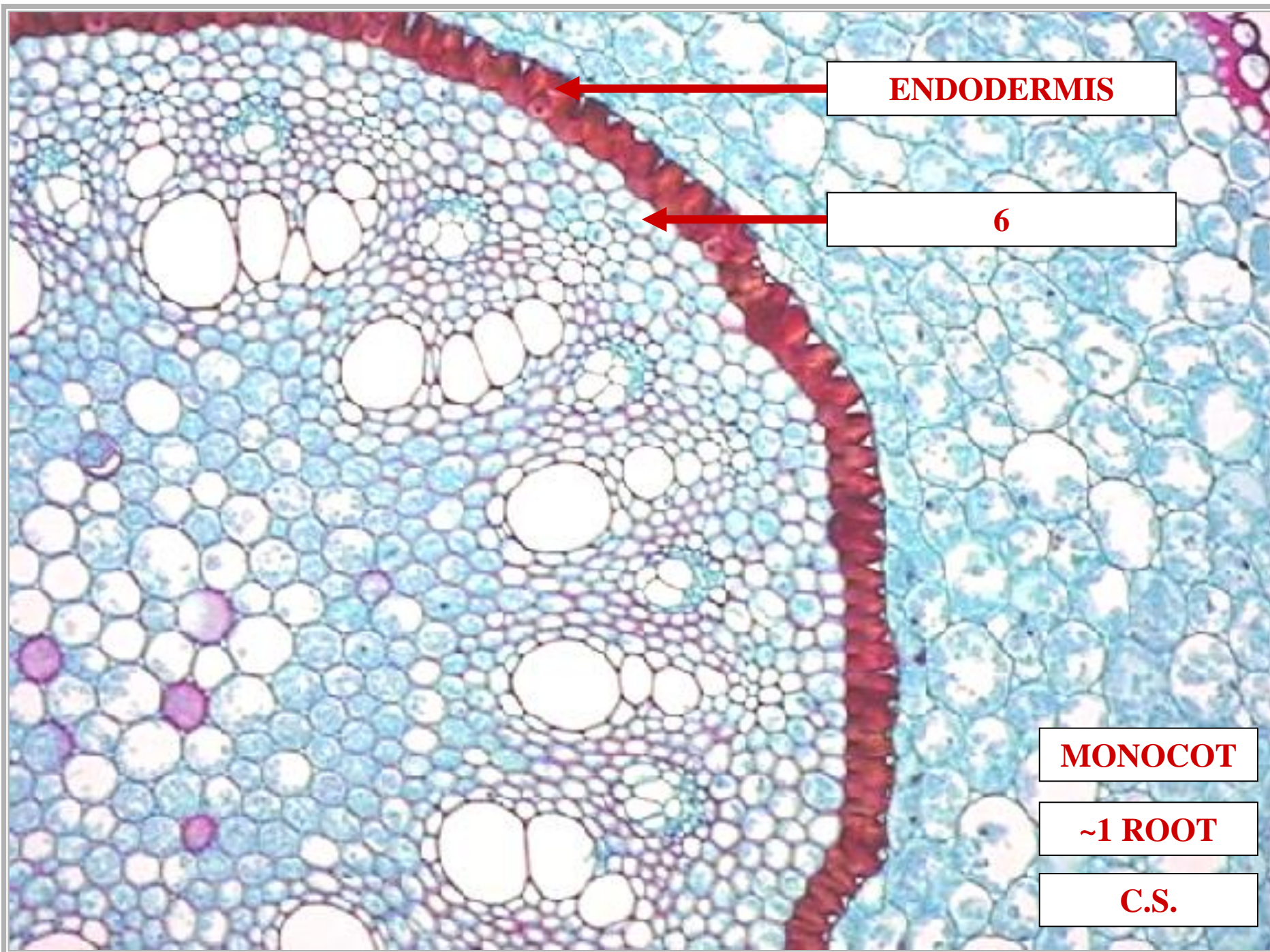


CASPARIAN STRIP

MONOCOT

~1 ROOT

C.S.



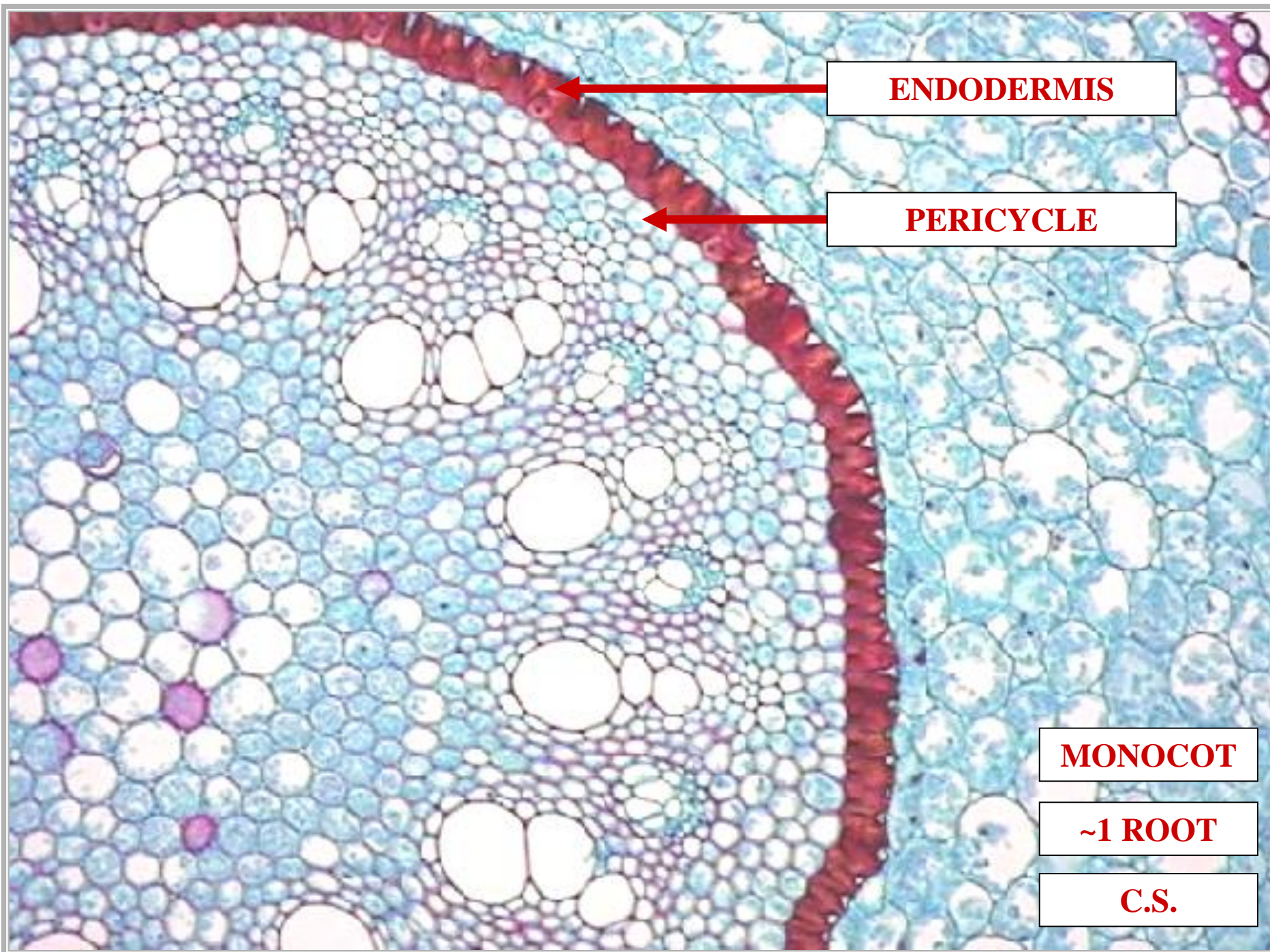
ENDODERMIS

6

MONOCOT

~1 ROOT

C.S.



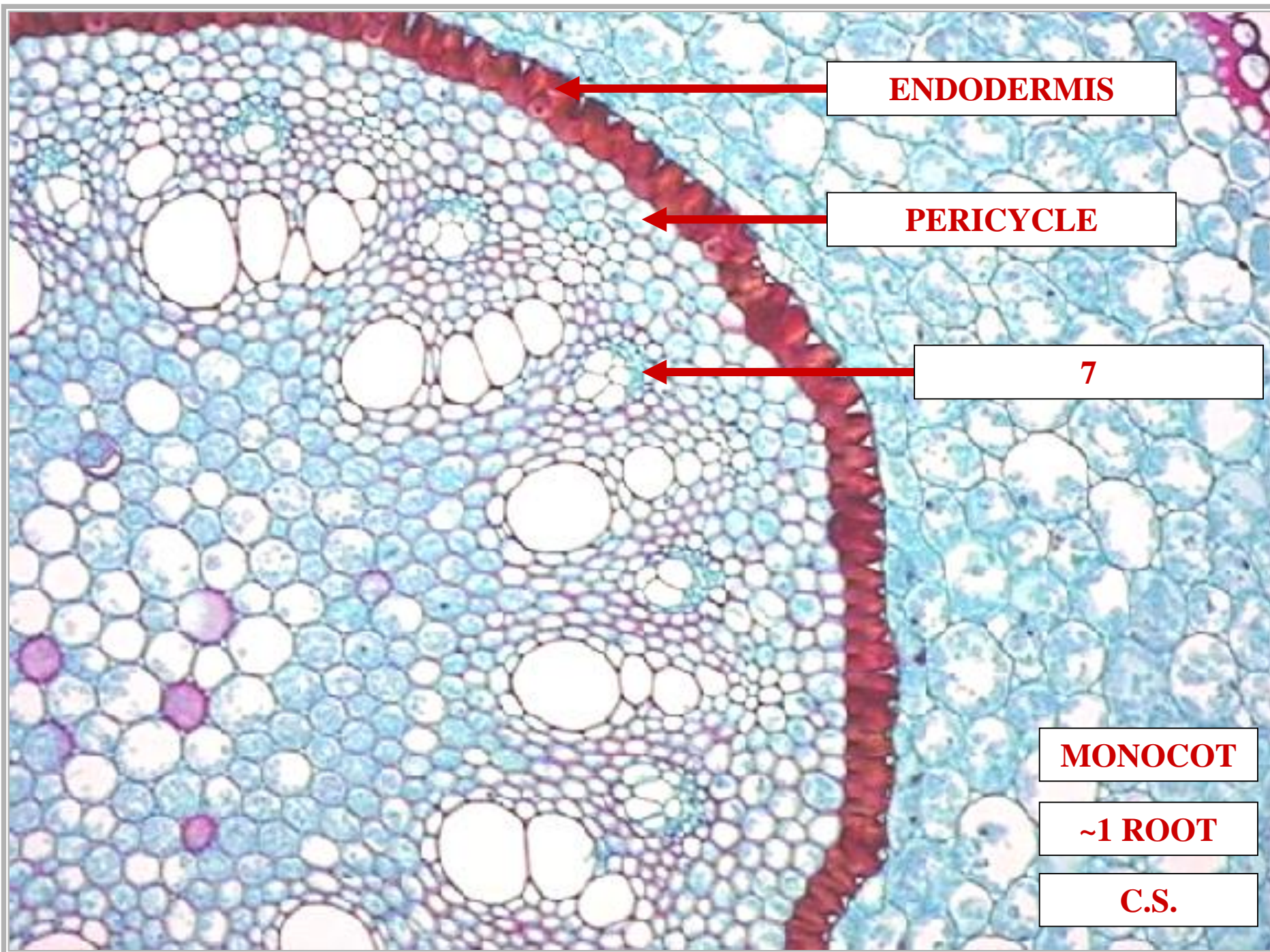
ENDODERMIS

PERICYCLE

MONOCOT

~1 ROOT

C.S.



ENDODERMIS

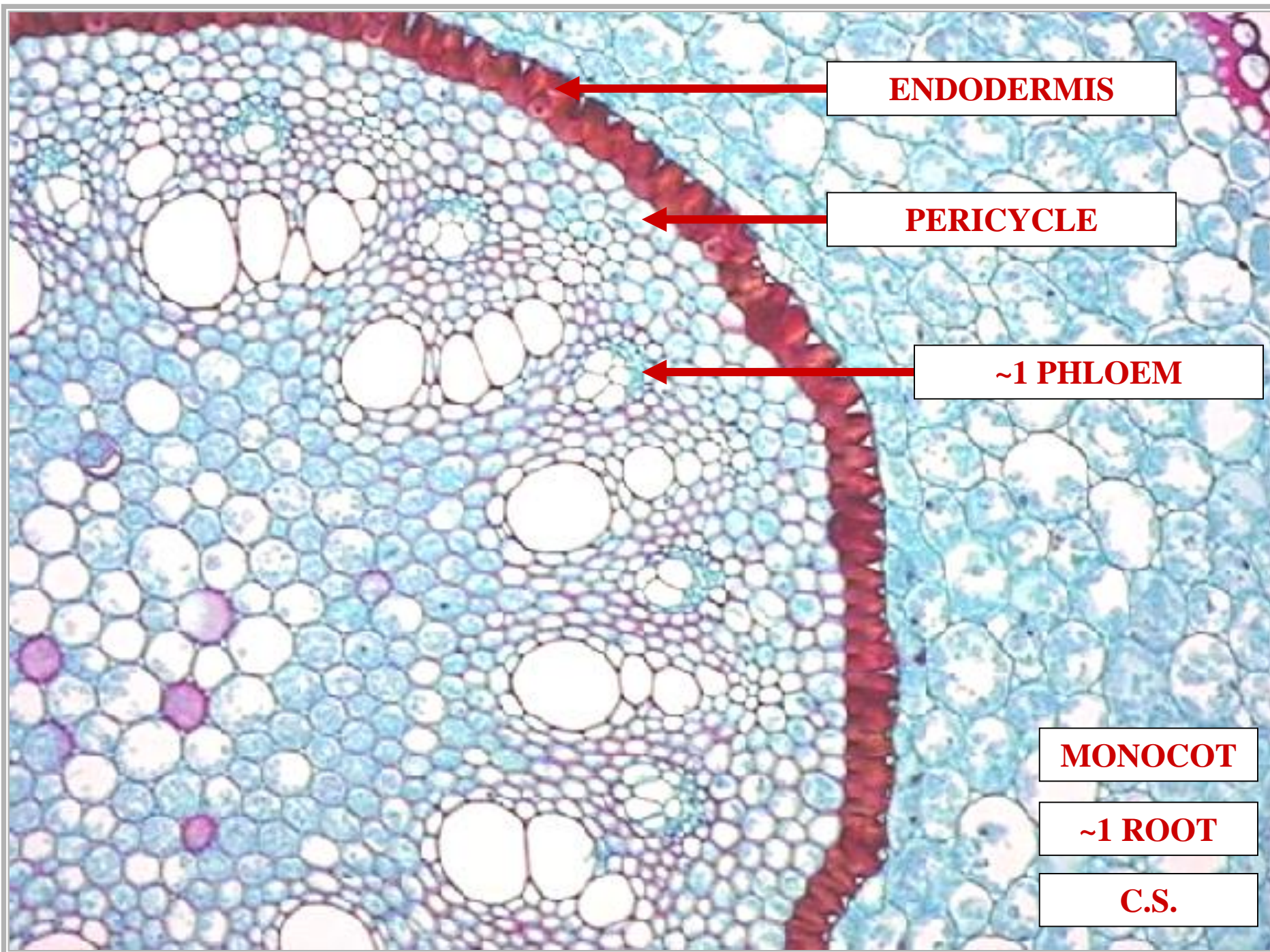
PERICYCLE

7

MONOCOT

~1 ROOT

C.S.



ENDODERMIS

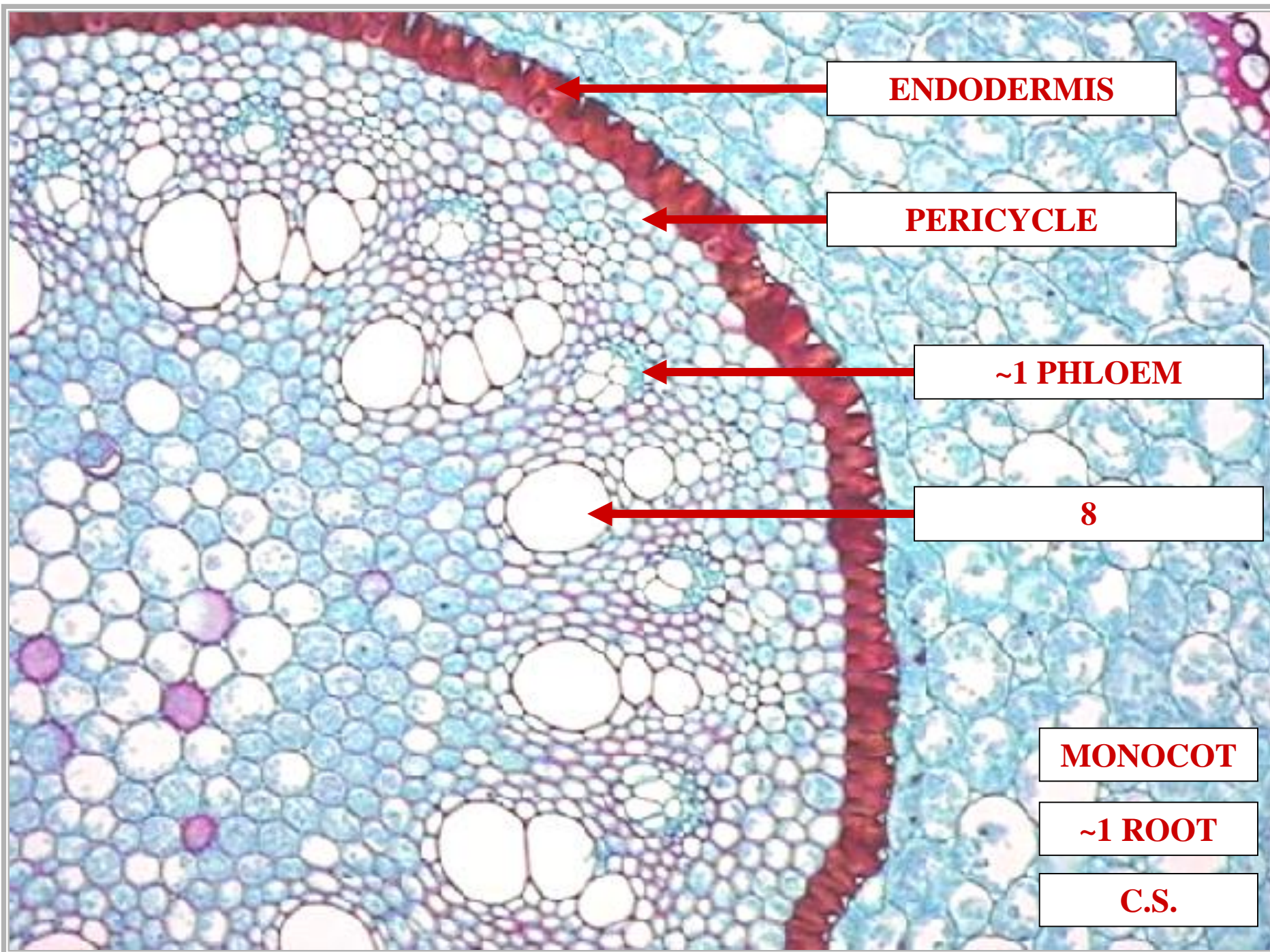
PERICYCLE

~1 PHLOEM

MONOCOT

~1 ROOT

C.S.



ENDODERMIS

PERICYCLE

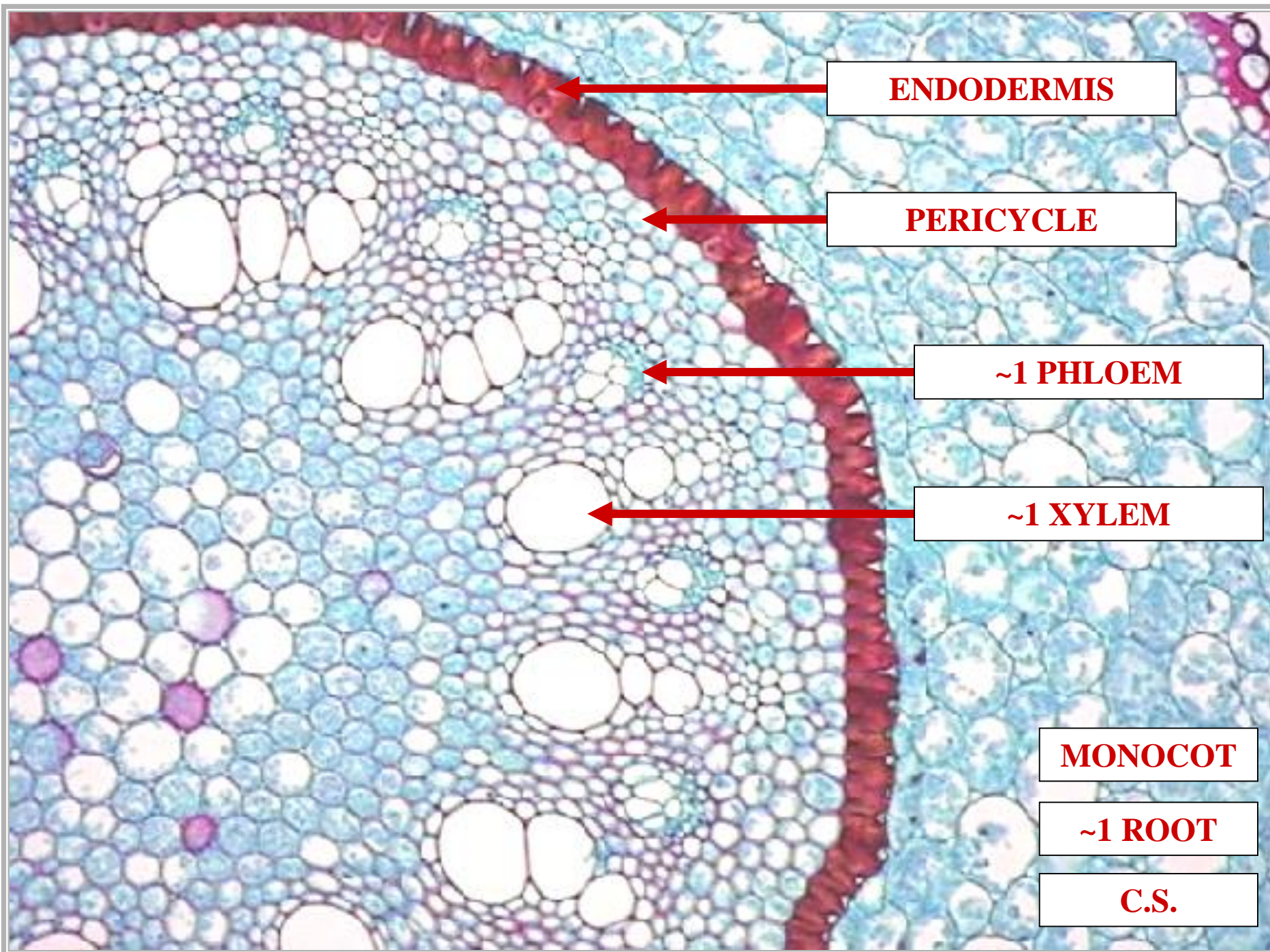
~1 PHLOEM

8

MONOCOT

~1 ROOT

C.S.



ENDODERMIS

PERICYCLE

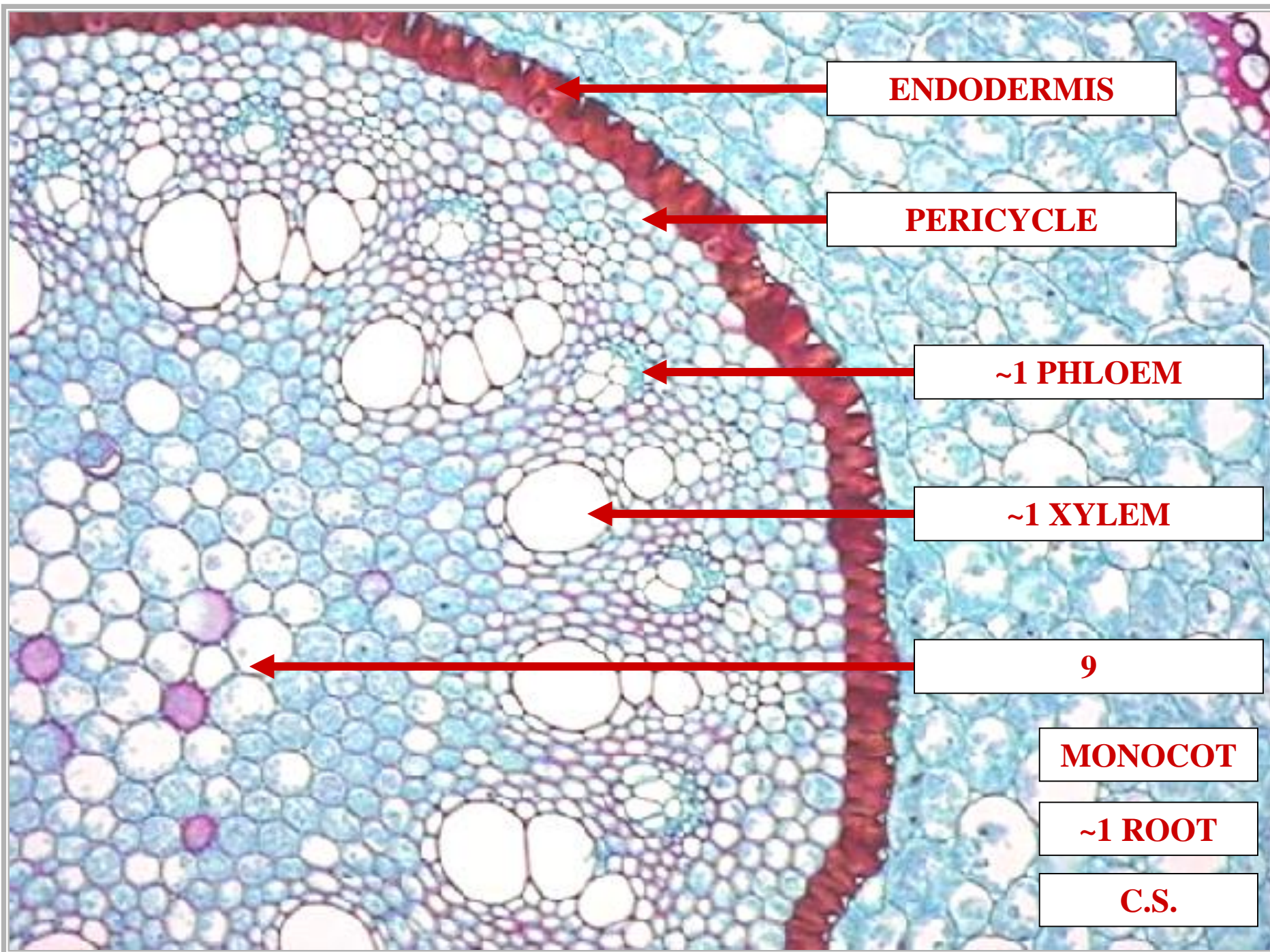
~1 PHLOEM

~1 XYLEM

MONOCOT

~1 ROOT

C.S.



ENDODERMIS

PERICYCLE

~1 PHLOEM

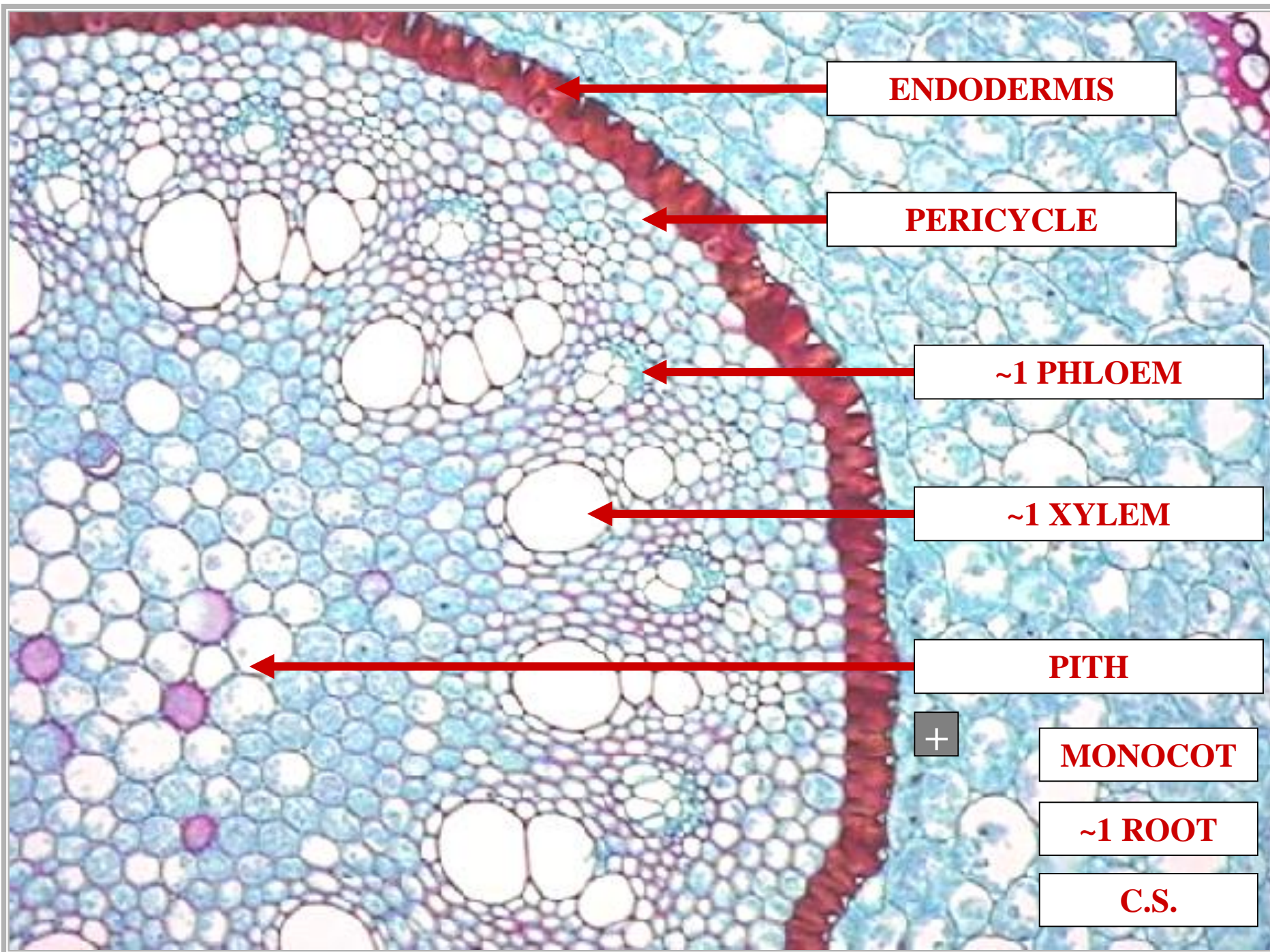
~1 XYLEM

9

MONOCOT

~1 ROOT

C.S.



ENDODERMIS

PERICYCLE

~1 PHLOEM

~1 XYLEM

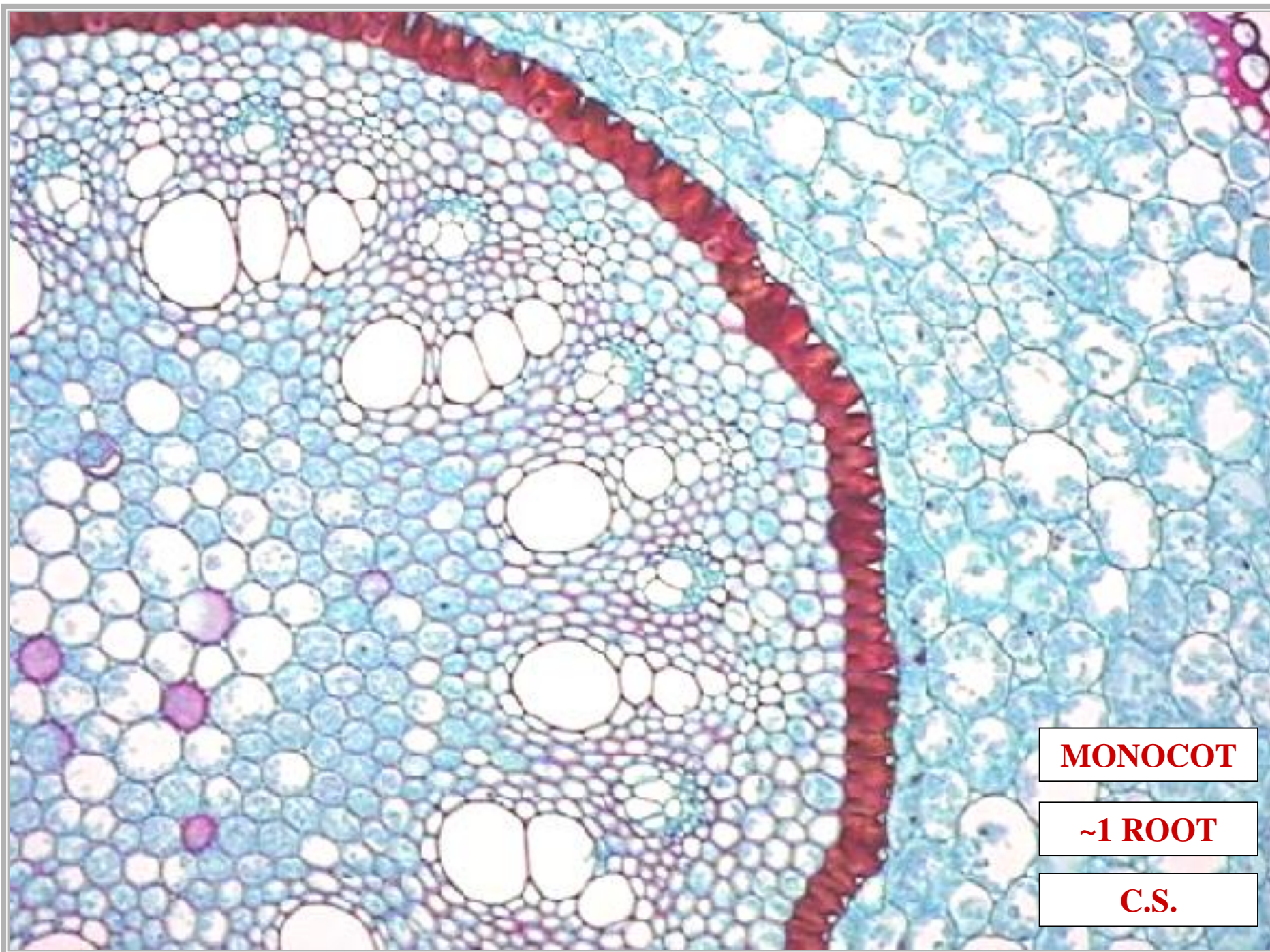
PITH

+

MONOCOT

~1 ROOT

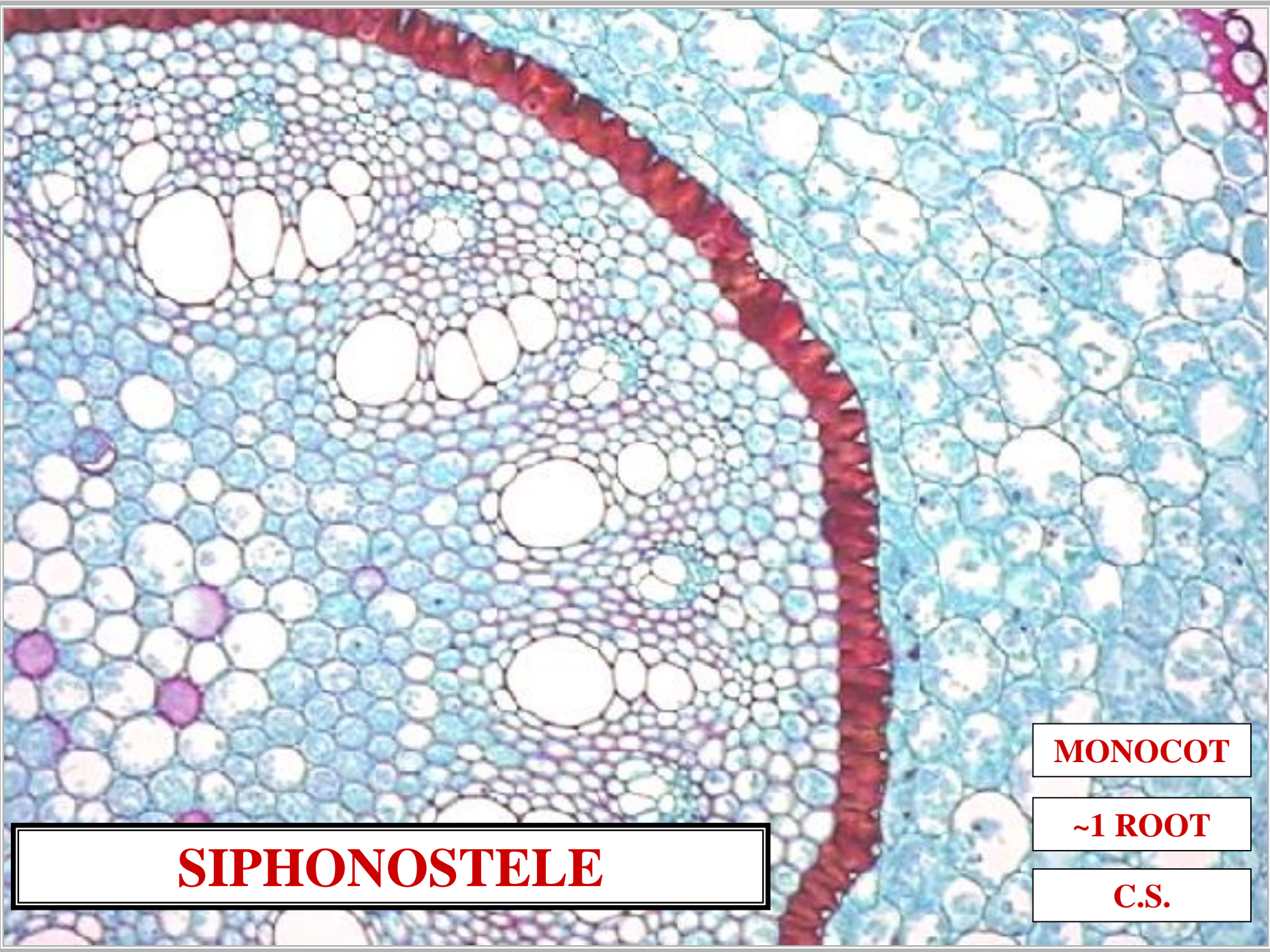
C.S.



MONOCOT

~1 ROOT

C.S.

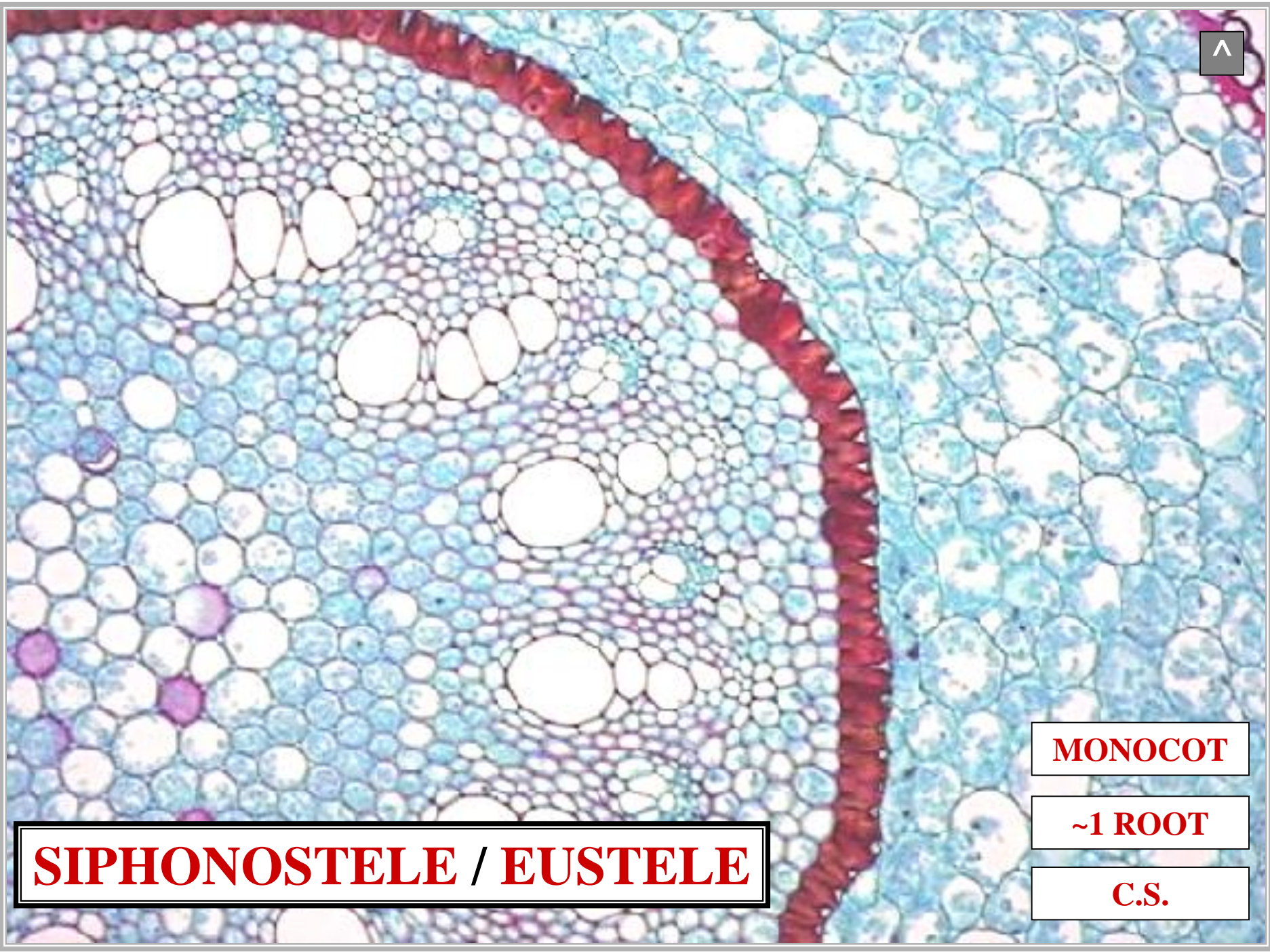


SIPHONOSTELE

MONOCOT

~1 ROOT

C.S.



SIPHONOSTELE / EUSTELE

MONOCOT

~1 ROOT

C.S.

MYCORRHIZAE

MYCORRHIZAE

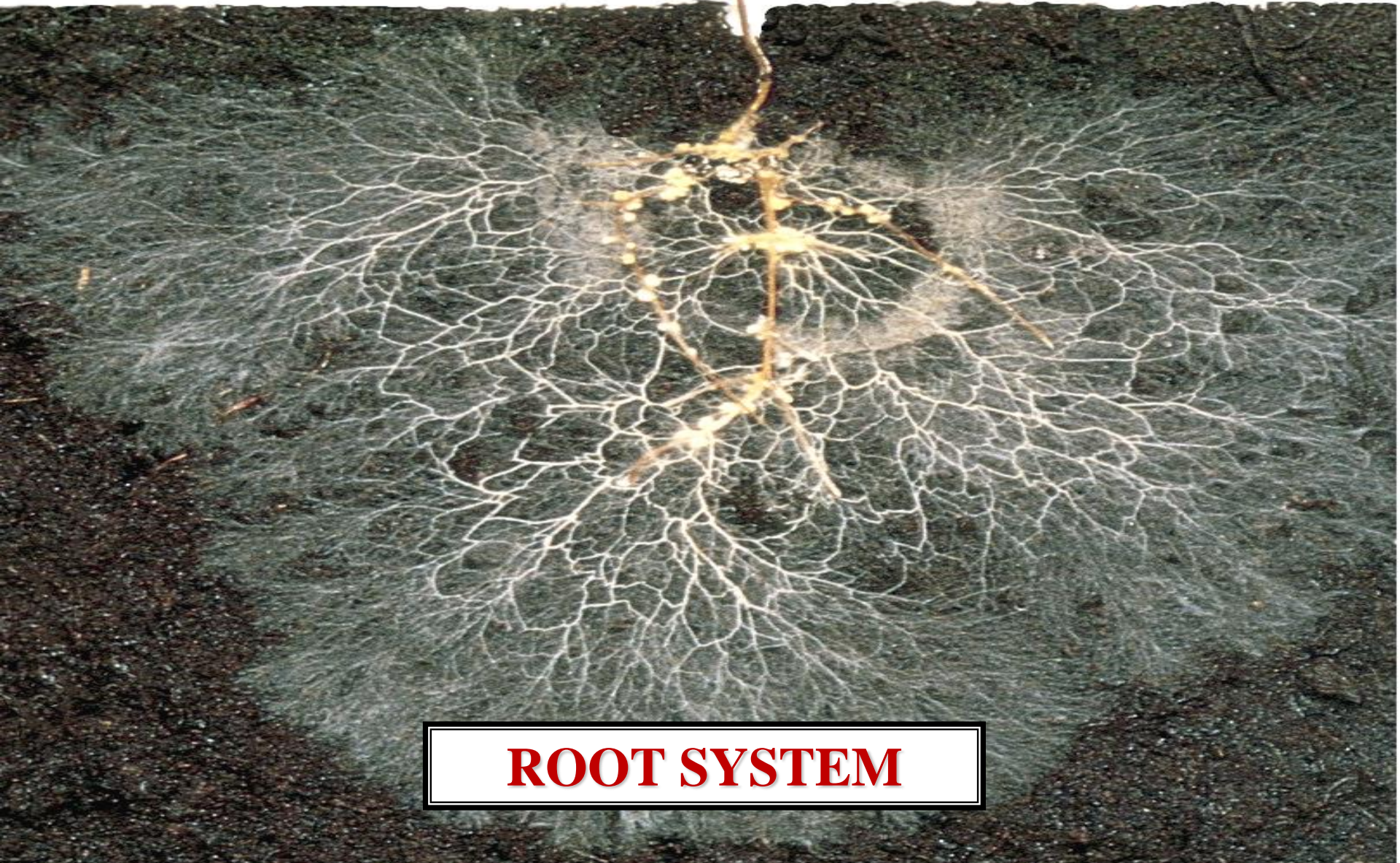


MYCORRHIZAE

FUNGUS-VASCULAR PLANT
ROOT SYMBIOSIS

MYCORRHIZAE

VASCULAR PLANT

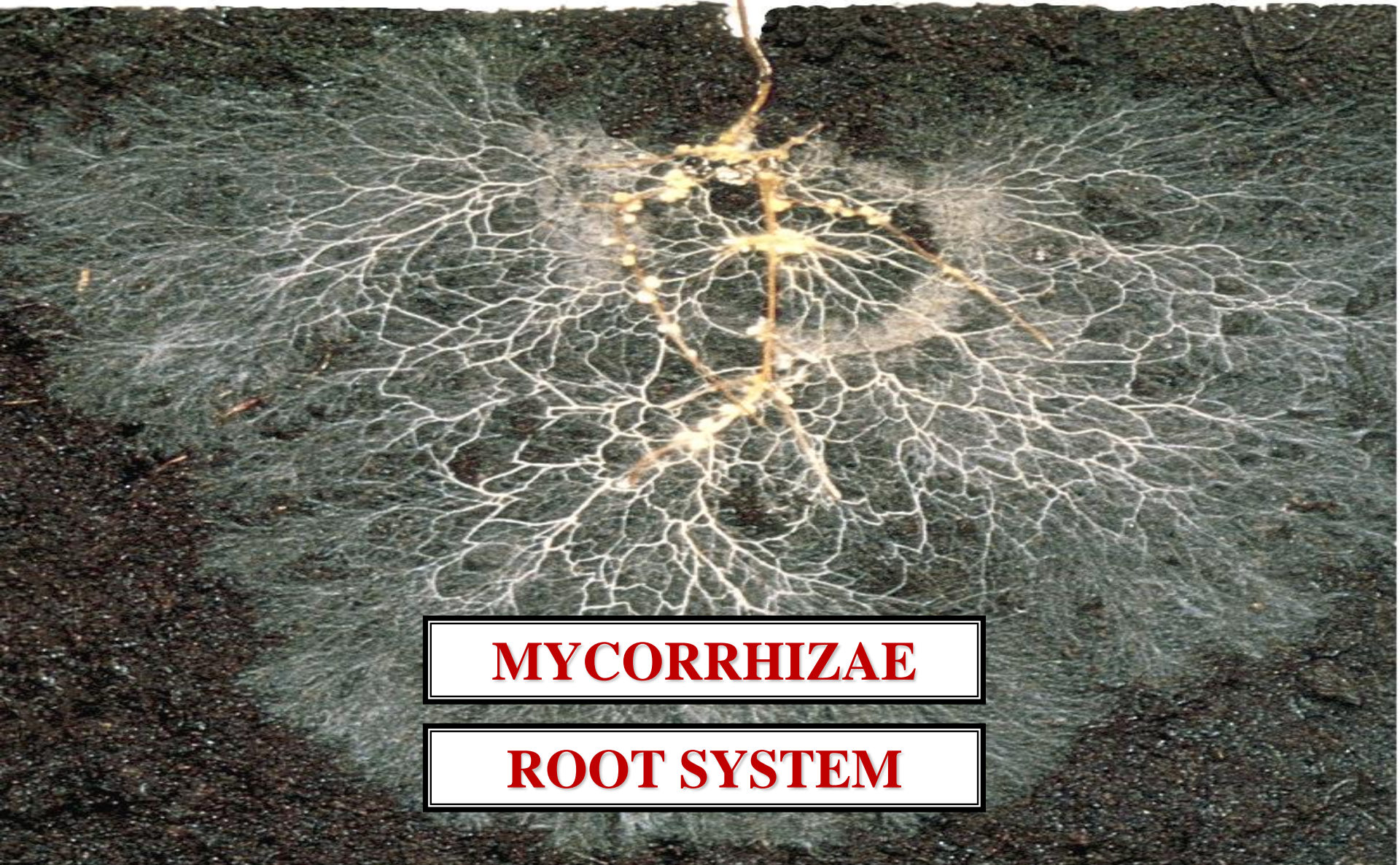


ROOT SYSTEM

VASCULAR PLANT



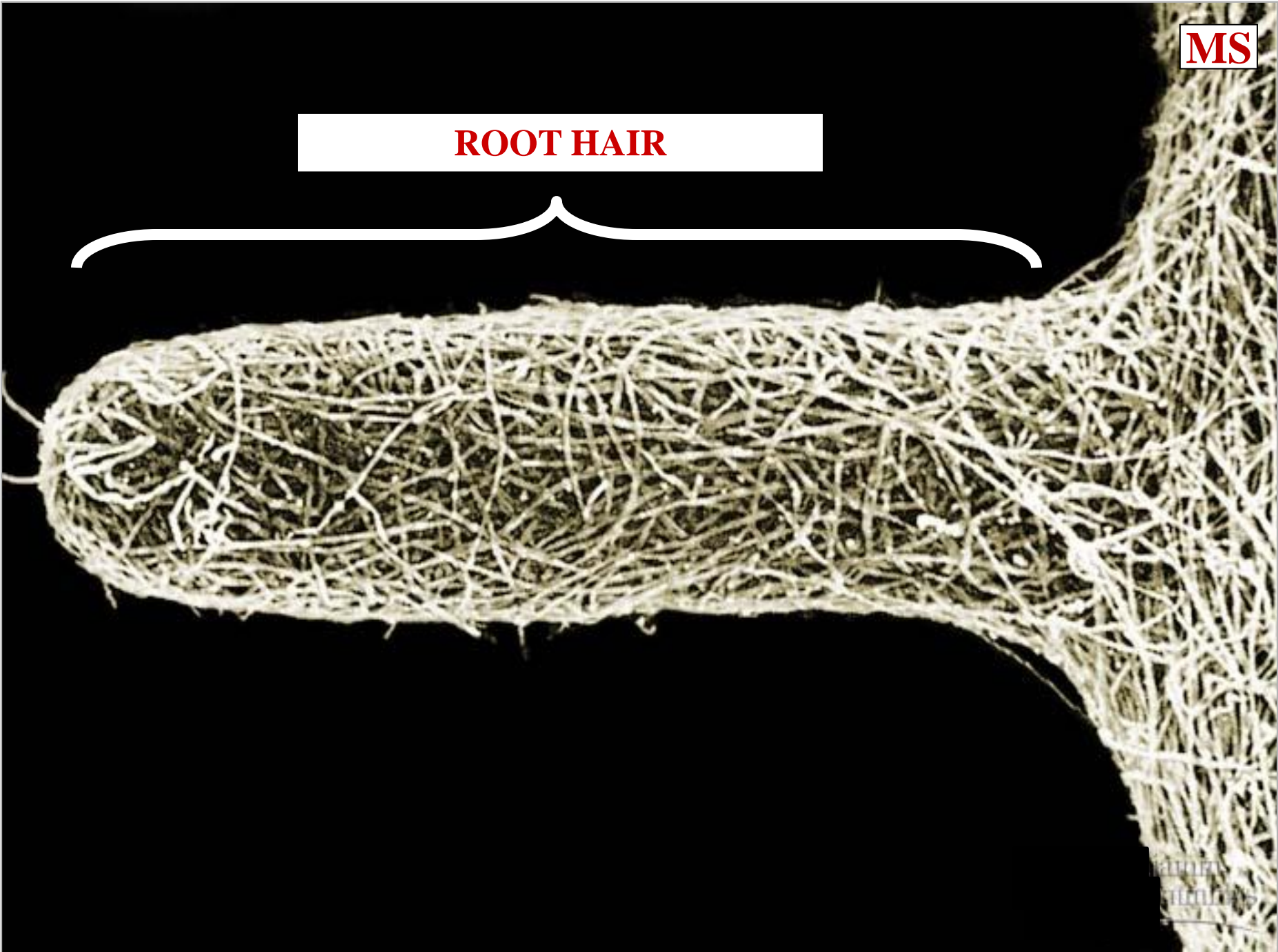
RH



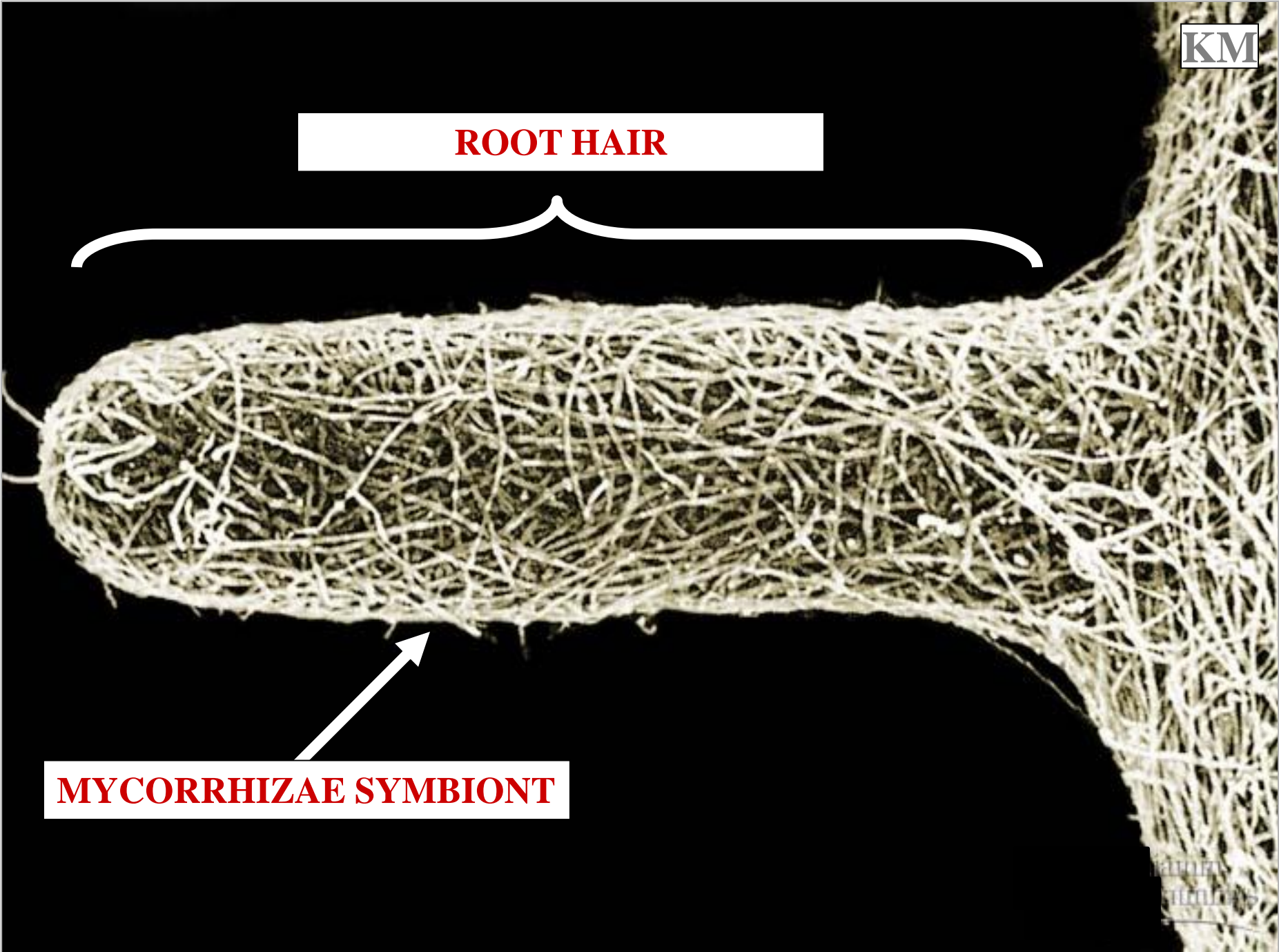
MYCORRHIZAE

ROOT SYSTEM

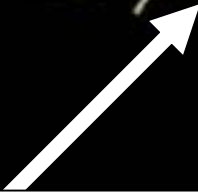
ROOT HAIR



ROOT HAIR



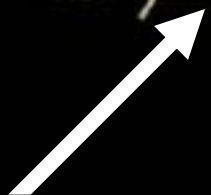
MYCORRHIZAE SYMBIONT



ROOT HAIR



MYCORRHIZAE SYMBIONT



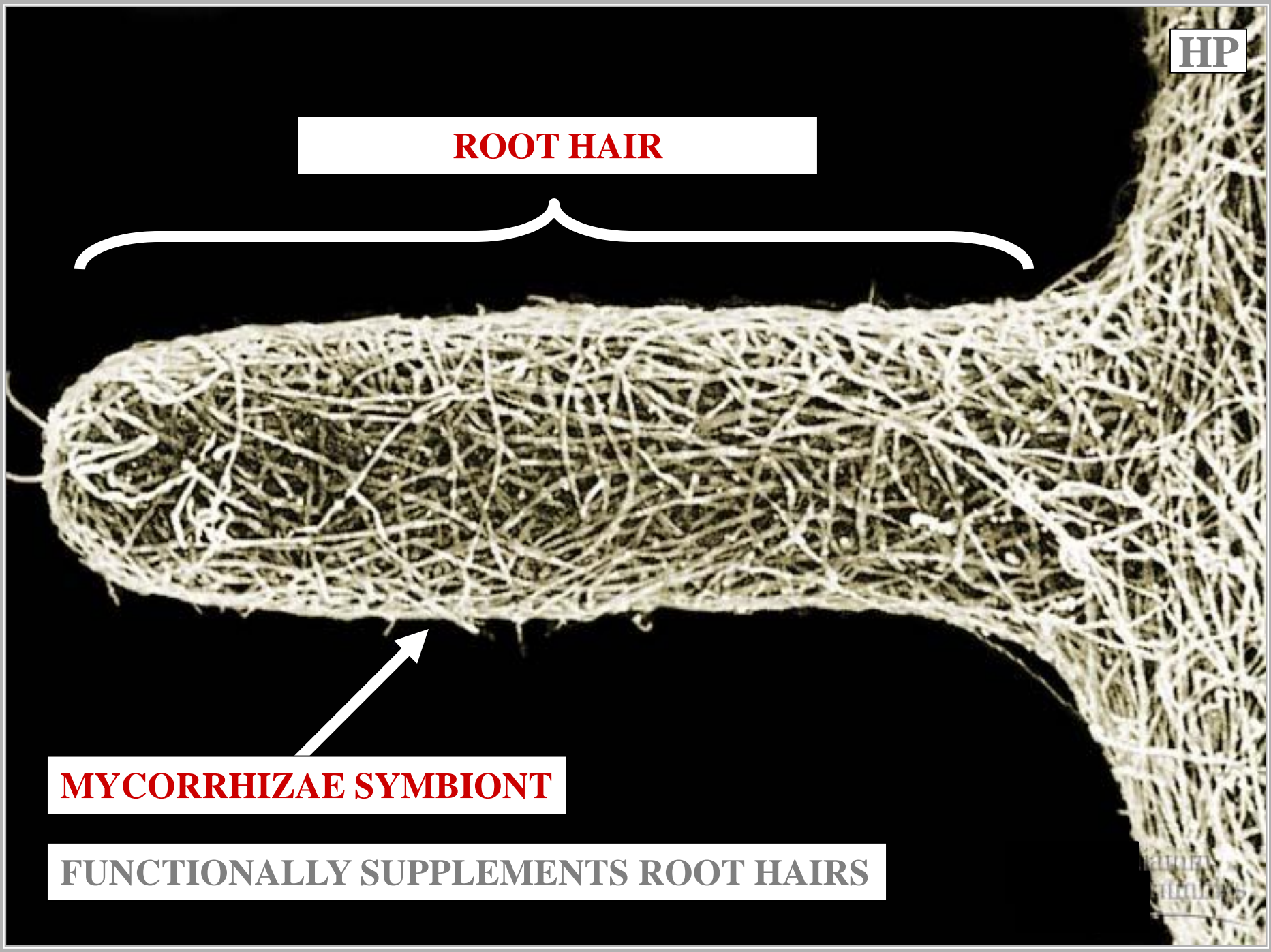
KNOWN MOST VASCULAR PLANTS

HP

ROOT HAIR

MYCORRHIZAE SYMBIONT

FUNCTIONALLY SUPPLEMENTS ROOT HAIRS



A scanning electron micrograph (SEM) of a root tip. The root is a thick, cylindrical structure on the right, tapering to a point on the left. The entire surface of the root is covered in a dense, intricate network of fine, white, thread-like structures. A white bracket above the root points to a specific section of this network. A white arrow points from a text box at the bottom left to the network. A small grey square with a white upward-pointing arrow is in the top right corner.

ROOT HAIR

MYCORRHIZAE SYMBIONT

HYPHAE PASS H₂O & NUTRIENTS FROM SOIL TO PLANT

SYMBIOSIS

SYMBIOSIS

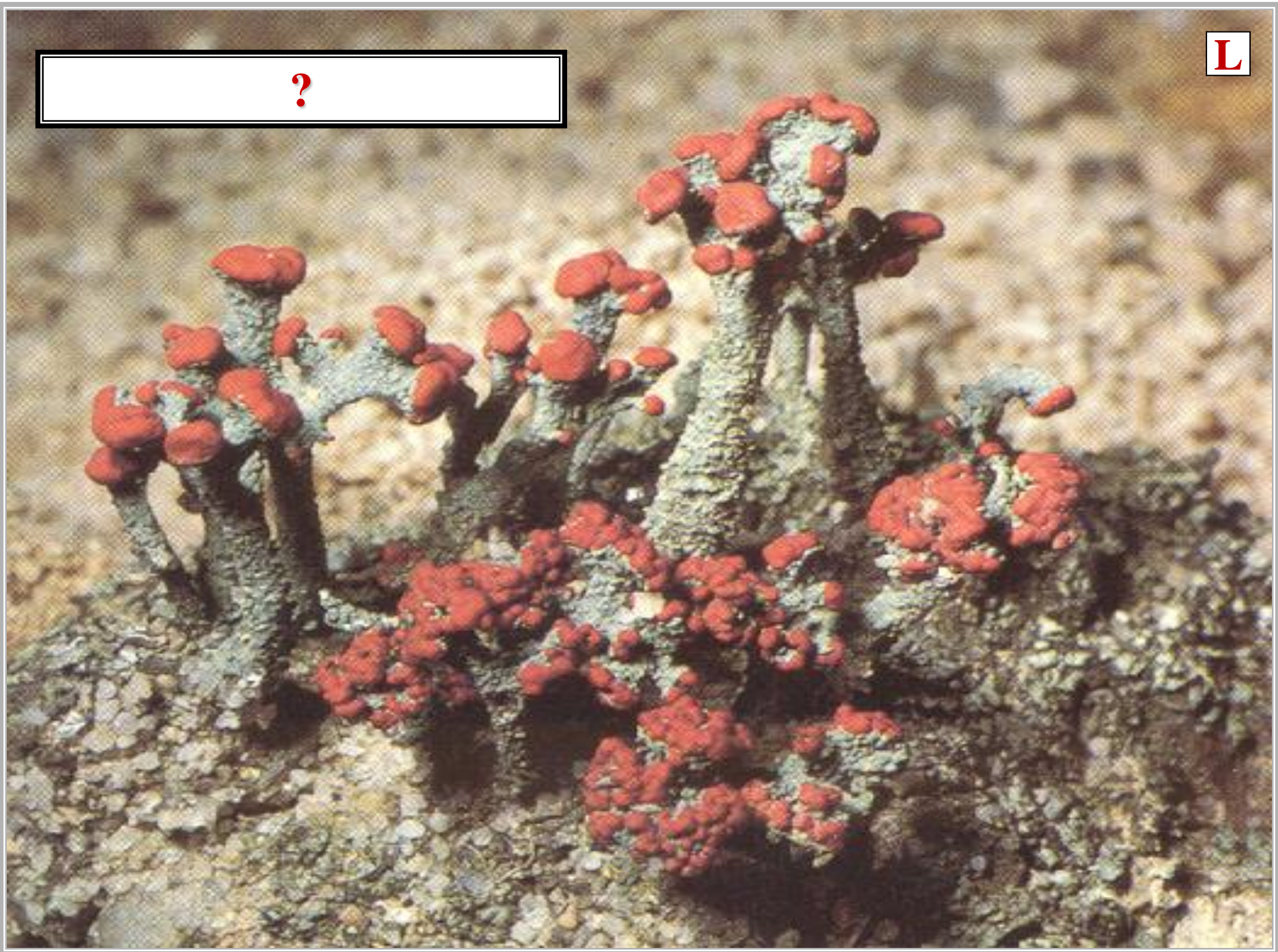


SYMBIOSIS

**TWO DIFFERENT SPECIES
LIVING IN AN
INTRICATE ASSOCIATION**

SYMBIOSIS

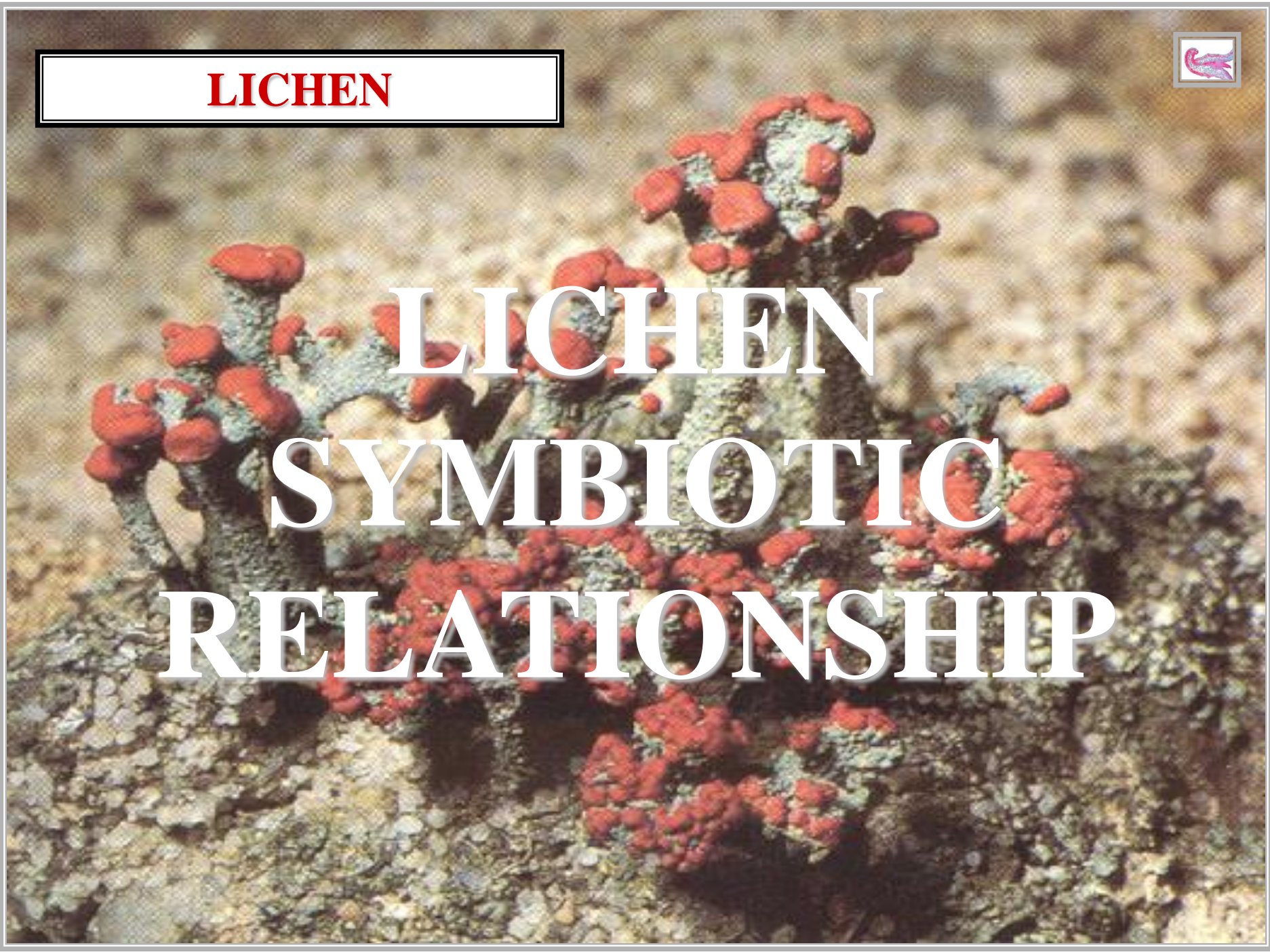
?



LICHEN



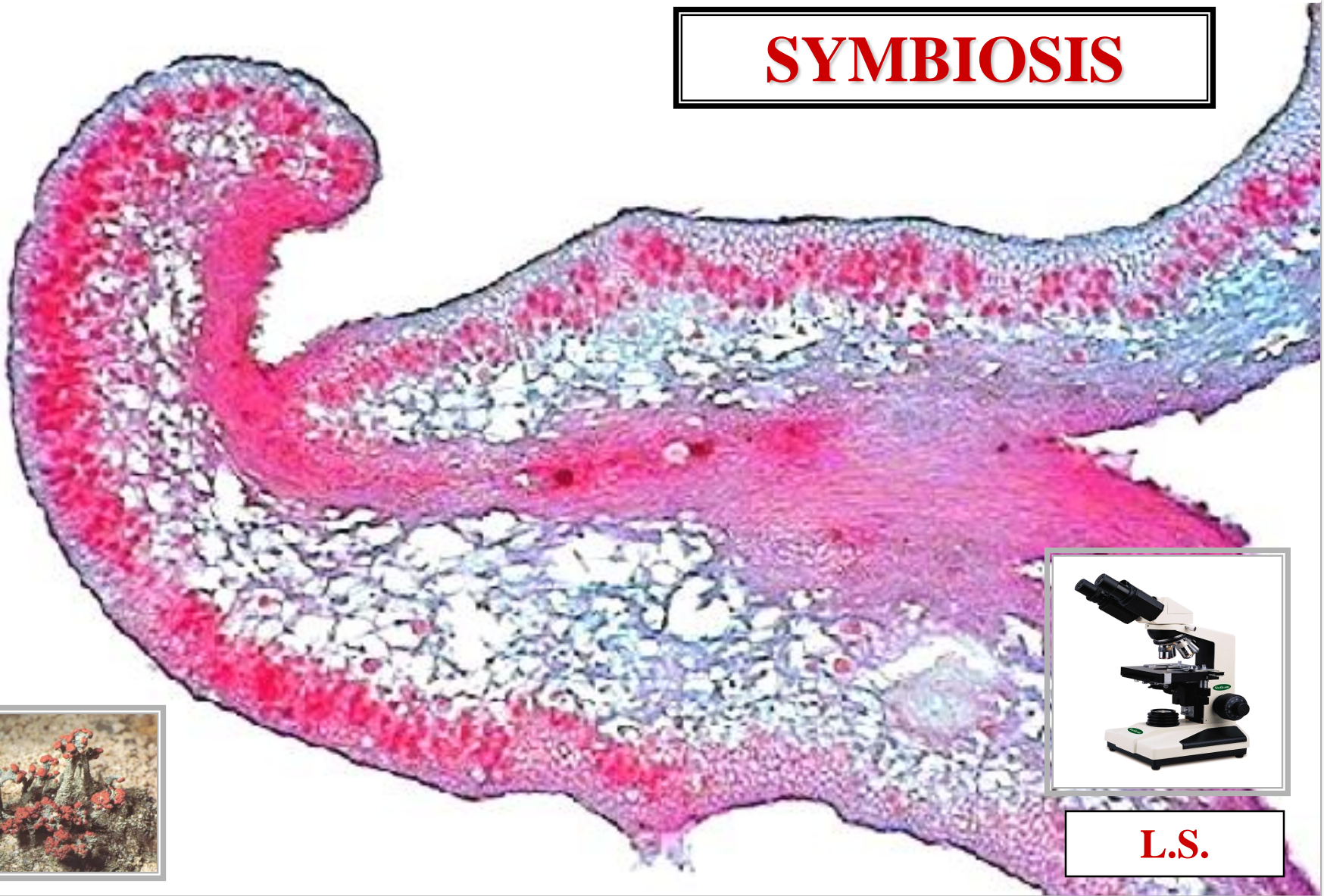
**LICHEN
SYMBIOTIC
RELATIONSHIP**



LICHEN THALLUS



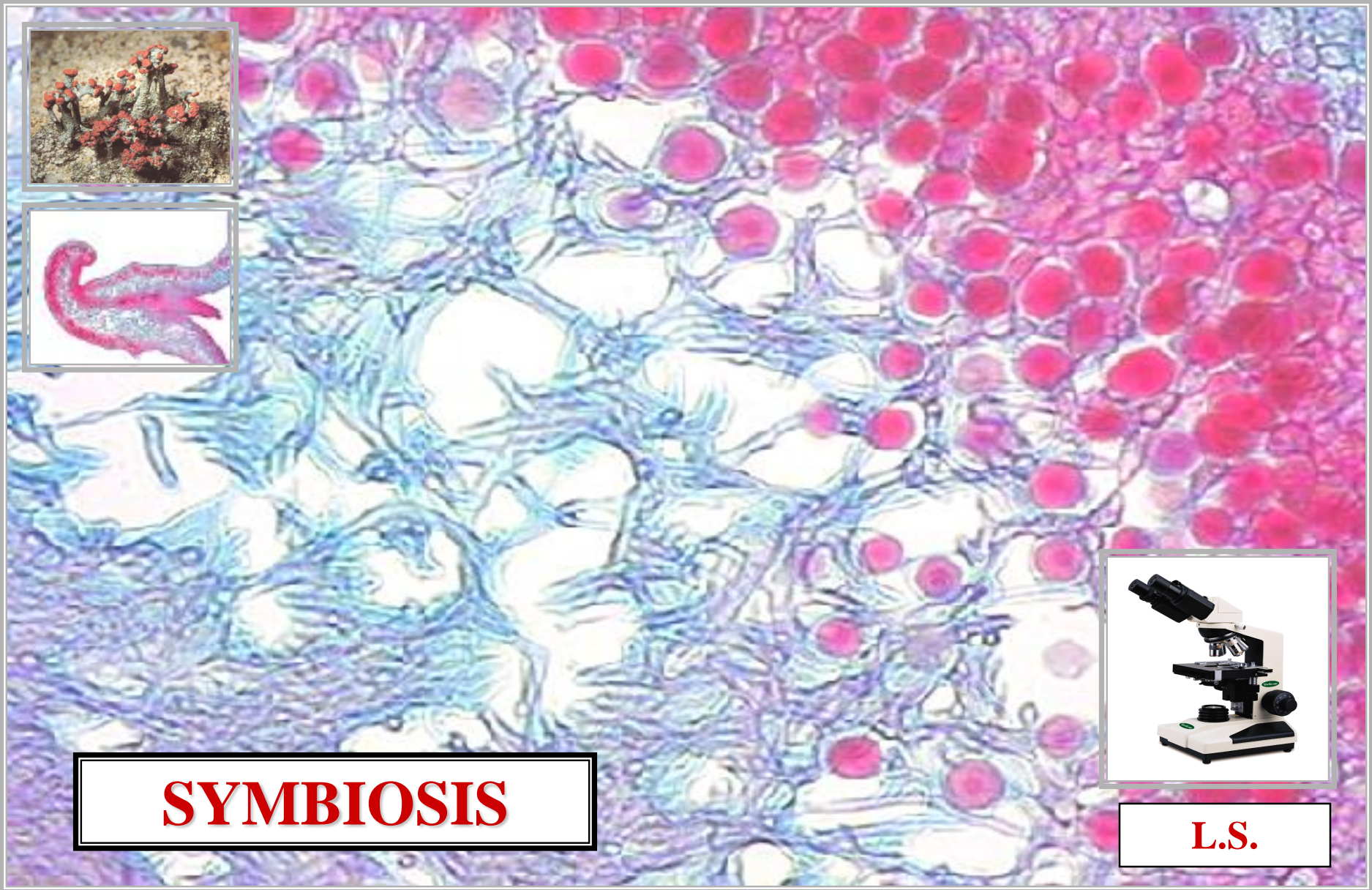
SYMBIOSIS



L.S.

LICHEN THALLUS

FS



SYMBIOSIS



L.S.

LICHEN THALLUS

BS



FUNGUS SYMBIONT

SYMBIOSIS



L.S.

LICHEN THALLUS

S



BACTERIA SYMBIONT

FUNGUS SYMBIONT

SYMBIOSIS



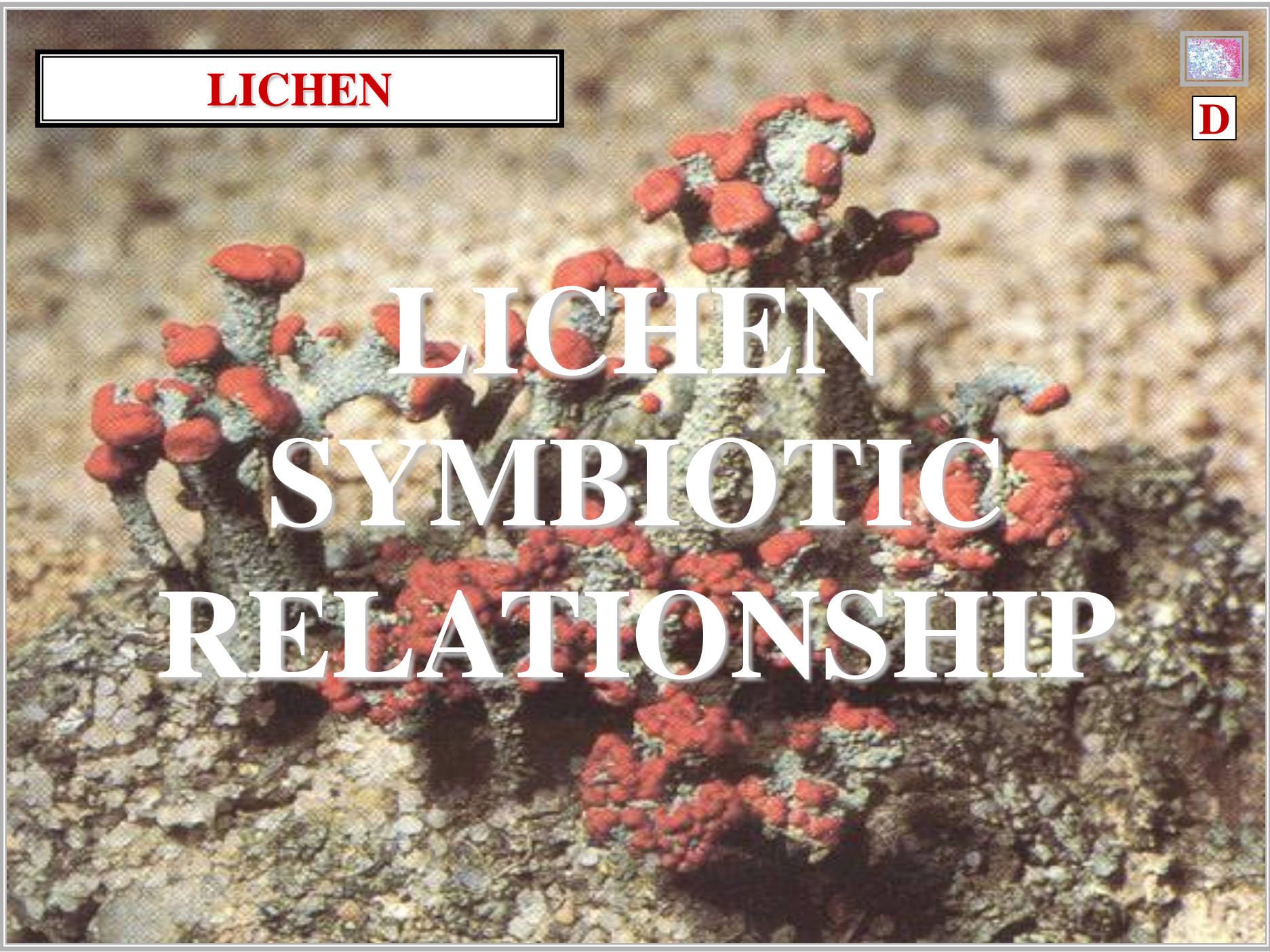
L.S.

LICHEN



D

**LICHEN
SYMBIOTIC
RELATIONSHIP**



LICHEN THALLUS



D



**DIFFERENT
BACTERIA SYMBIONT**

**DIFFERENT
FUNGUS SYMBIONT**

SYMBIOSIS



L.S.



**DIFFERENT
SYMBIONTS
DIFFERENT
LICHEN**



SYMBIOSIS TYPES

SYMBIOSIS TYPES

PARASITISM

SYMBIOSIS TYPES

SYMBIOSIS TYPES

PARASITISM

COMMENSALISM

SYMBIOSIS TYPES

SYMBIOSIS TYPES

PARASITISM

COMMENSALISM

MUTUALISM

SYMBIOSIS TYPES

PARASITISM



SYMBIOSIS
PARASITISM

ONE SPECIES BENEFITS
ONE SPECIES ADVERSELY
AFFECTED

SYMBIOSIS
PARASITISM

A photograph of an Indian Pipe (Monotropa hypopitys) plant in a forest. The plant is white and lacks chlorophyll, growing from a forest floor covered in brown leaves and pine needles. It has several upright stems with clusters of small, bell-shaped flowers. The background is a blurred forest floor with green leaves and brown debris.

INDIAN PIPE

F

SYMBIOSIS

A photograph of an Indian Pipe (Monotropa hypopitys) plant in a forest. The plant is a pale, translucent white color with several upright stems and clusters of small, bell-shaped flowers. The background is a forest floor covered in brown leaves and some green foliage. Several text boxes with labels are overlaid on the image.

INDIAN PIPE

ANGIOSPERM

CL

FLOWER

SYMBIOSIS

INDIAN PIPE

ANGIOSPERM

N



CHLOROPLASTS: ABSENT

SYMBIOSIS

A photograph of an Indian Pipe (Monotropa hypopitys) plant in a forest. The plant is white and lacks chlorophyll, growing from a forest floor covered in brown leaves and pine needles. It has several upright stems with clusters of small, bell-shaped flowers. The background is a blurred forest floor with green leaves and brown debris.

INDIAN PIPE

ANGIOSPERM

P

NON-PSYN PLANT

SYMBIOSIS

A photograph of an Indian Pipe (Monotropa hypopitys) plant. The plant is a pale, translucent white color with several upright stems and clusters of small, bell-shaped flowers. It is growing in a forest setting with a ground covered in brown, fallen leaves and some green foliage. The plant is the central focus of the image.

INDIAN PIPE

ANGIOSPERM

^

C

PARASITISM

SYMBIOSIS

COMMENSALISM



SYMBIOSIS

COMMENSALISM

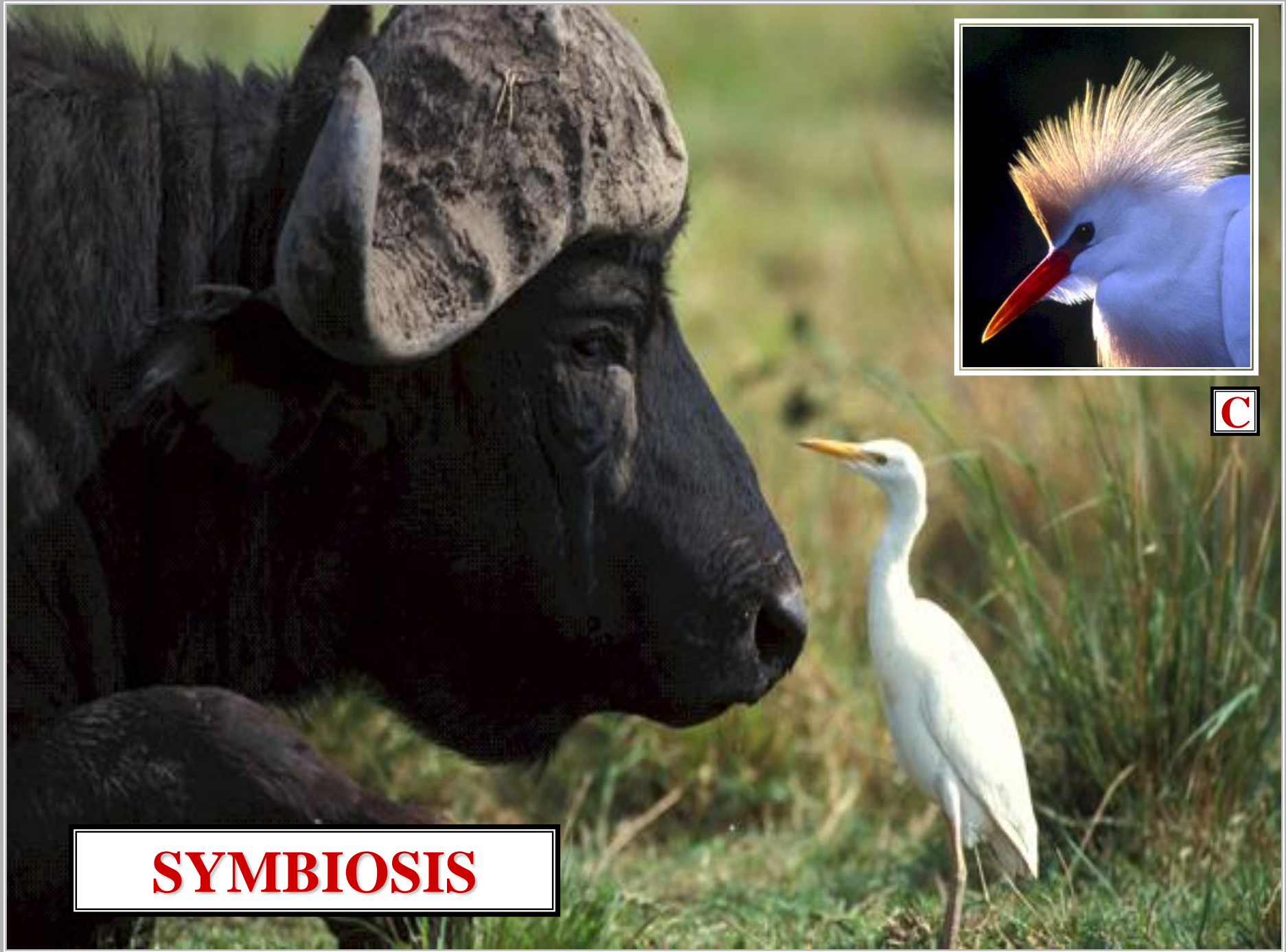
ONE SPECIES BENEFITS
ONE SPECIES UNAFFECTED

SYMBIOSIS

COMMENSALISM

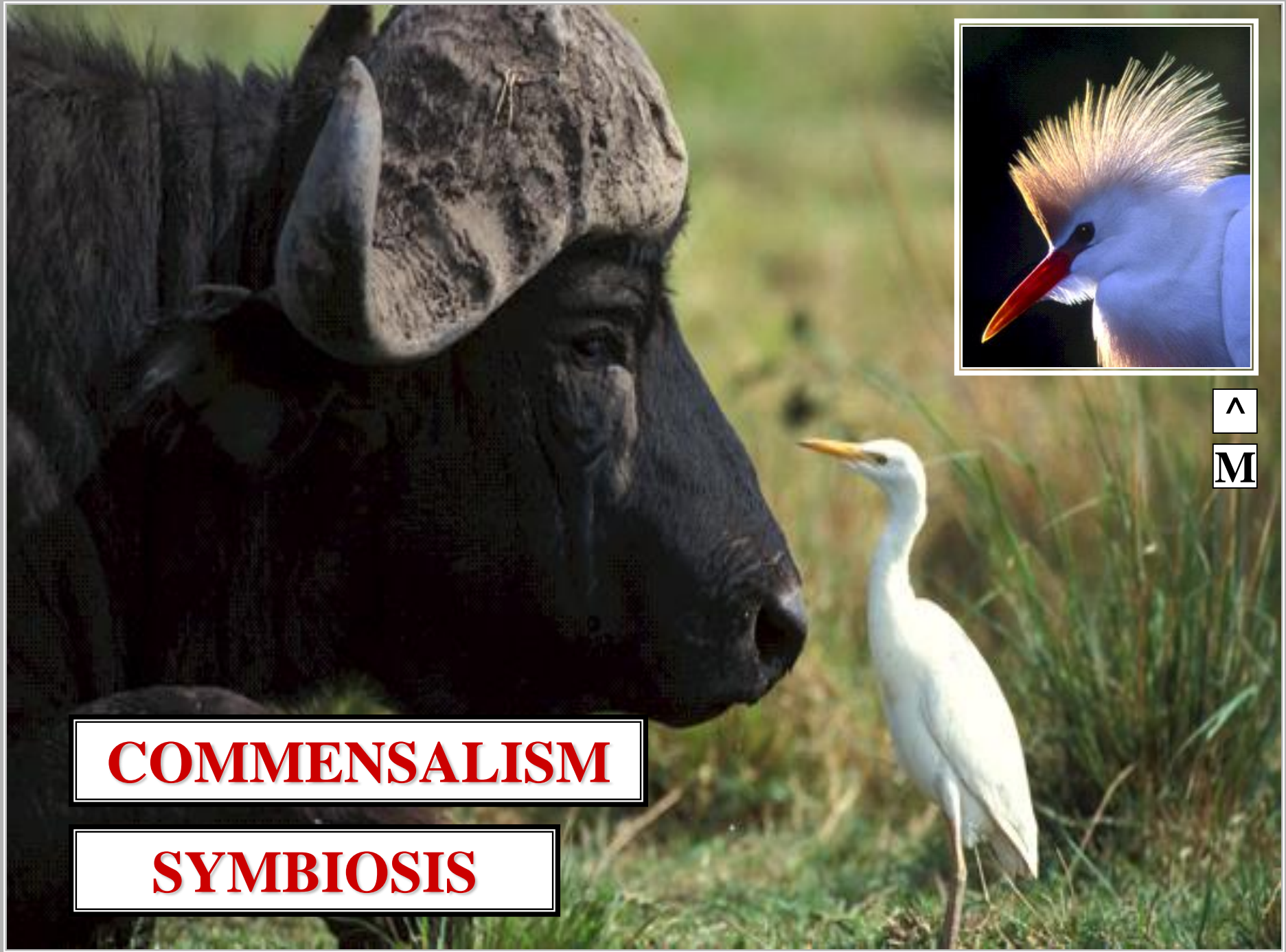
AFRICAN SAVANNA





C

SYMBIOSIS



COMMENSALISM

SYMBIOSIS

MUTUALISM



**SYMBIOSIS
MUTUALISM**

**BOTH SPECIES
BENEFIT**

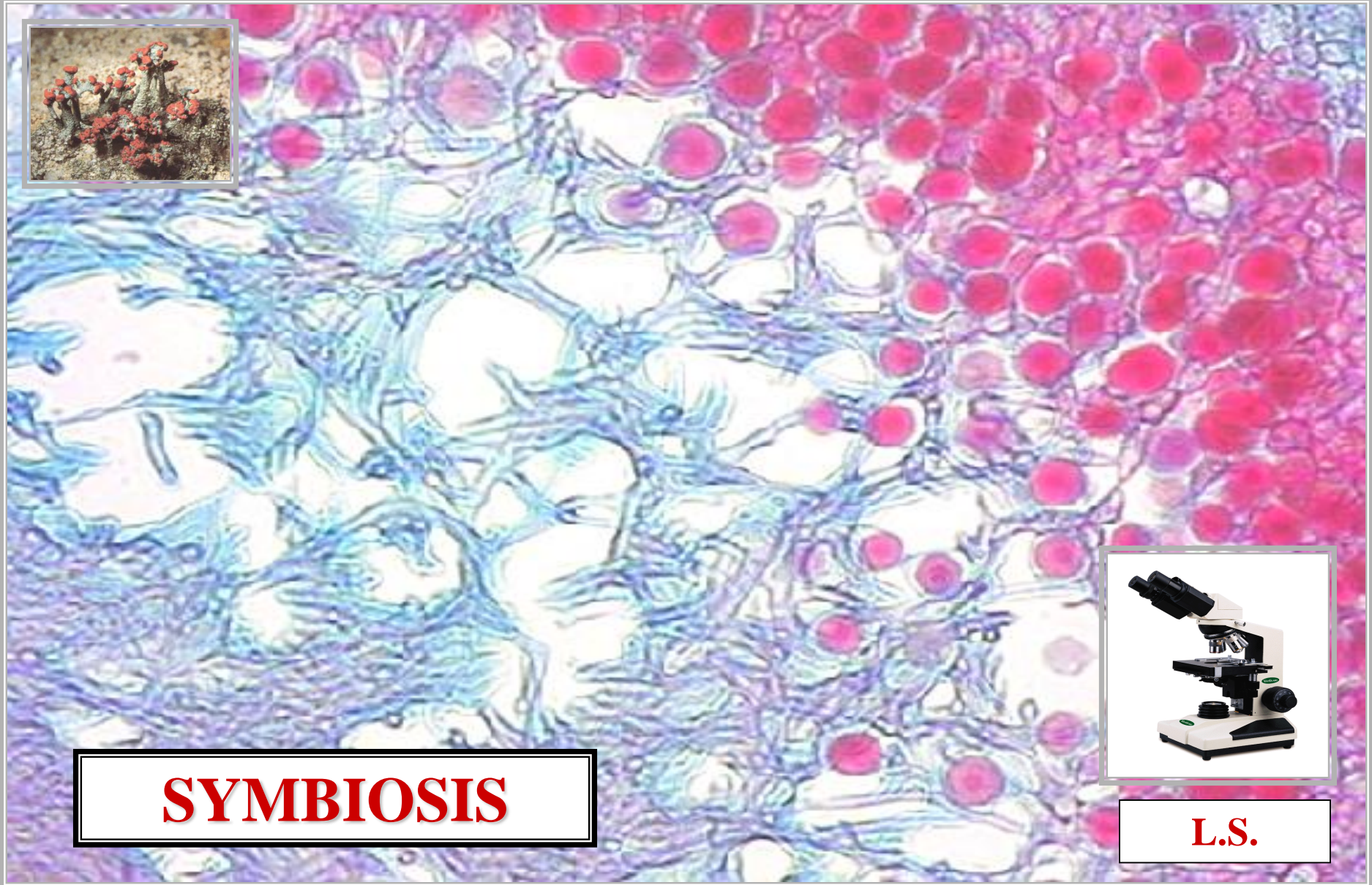
**SYMBIOSIS
MUTUALISM**

LICHEN



LICHEN THALLUS

FS



SYMBIOSIS



L.S.

LICHEN THALLUS

BS



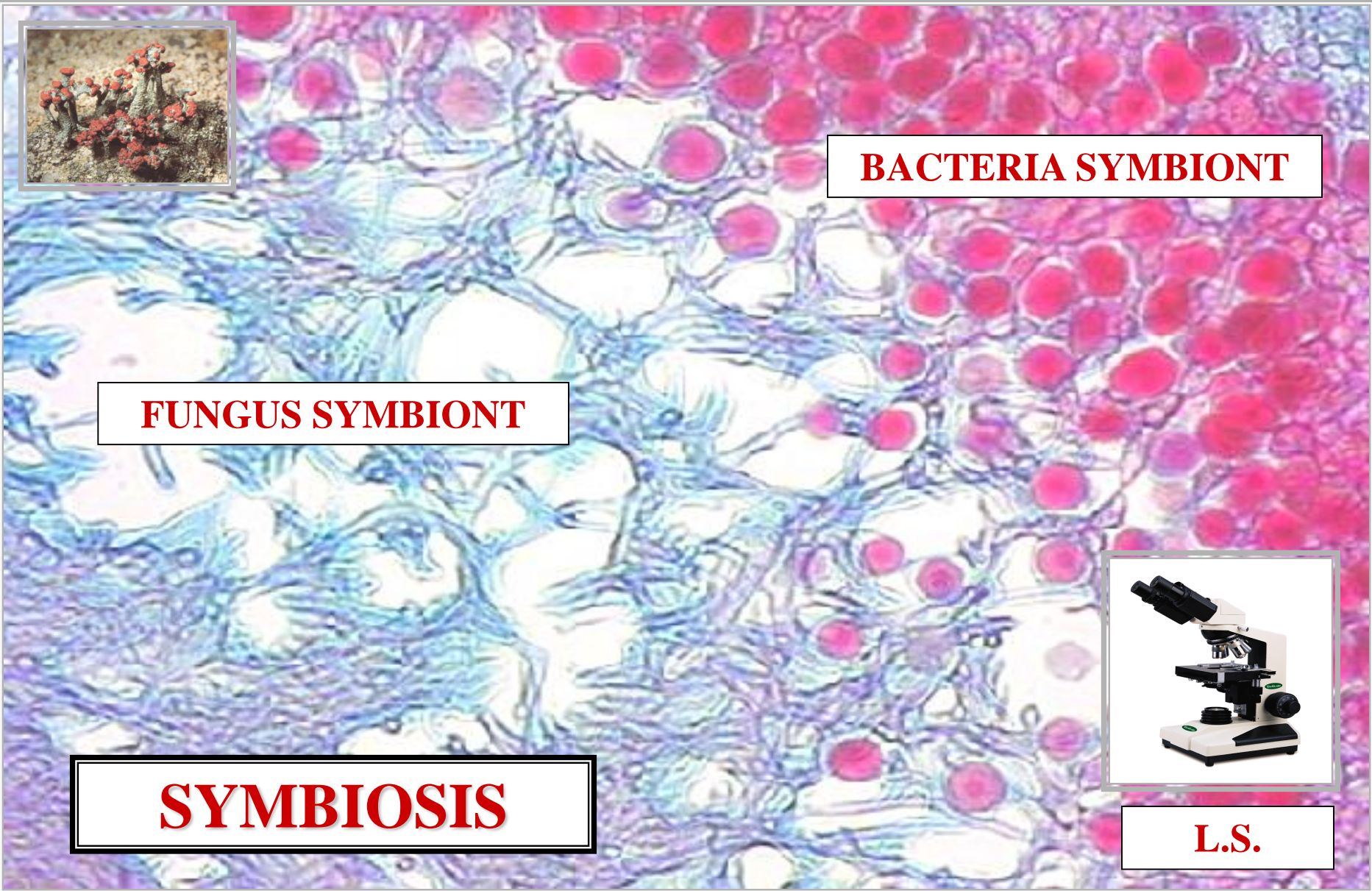
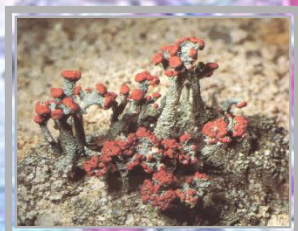
FUNGUS SYMBIONT

SYMBIOSIS



L.S.

LICHEN THALLUS



BACTERIA SYMBIONT

FUNGUS SYMBIONT

SYMBIOSIS



L.S.

LICHEN THALLUS



FUNGUS SYMBIONT

BACTERIA SYMBIONT
PHOTOSYNTHESIS

SYMBIOSIS



L.S.

LICHEN THALLUS



FUNGUS SYMBIONT

BACTERIA SYMBIONT
PHOTOSYNTHESIS
PROVIDES: GLUCOSE

SYMBIOSIS



L.S.

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BACTERIA SYMBIONT
PHOTOSYNTHESIS
PROVIDES: GLUCOSE

FUNGUS SYMBIONT
PROVIDES: GLUCOSE

SYMBIOSIS



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BACTERIA SYMBIONT
PHOTOSYNTHESIS
PROVIDES: SECURITY

FUNGUS SYMBIONT
PROVIDES: SECURITY

SYMBIOSIS



L.S.

LICHEN THALLUS



BACTERIA SYMBIONT
PHOTOSYNTHESIS
PROVIDES: GLUCOSE

FUNGUS SYMBIONT
PROVIDES: SECURITY

MUTUALISM

SYMBIOSIS

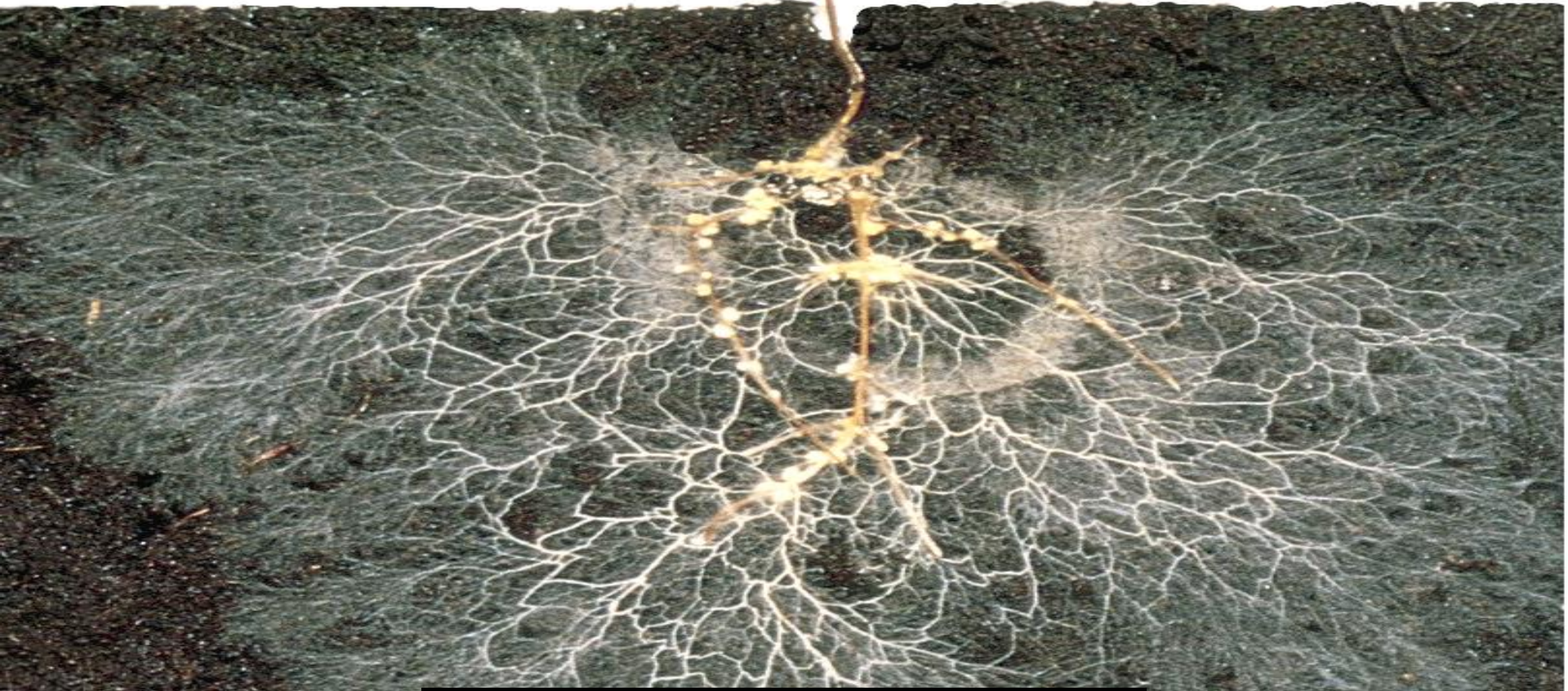


L.S.



**MYCORRHIZAE
MUTUALISTIC
SYMBIOTIC
RELATIONSHIP**

VASCULAR PLANT



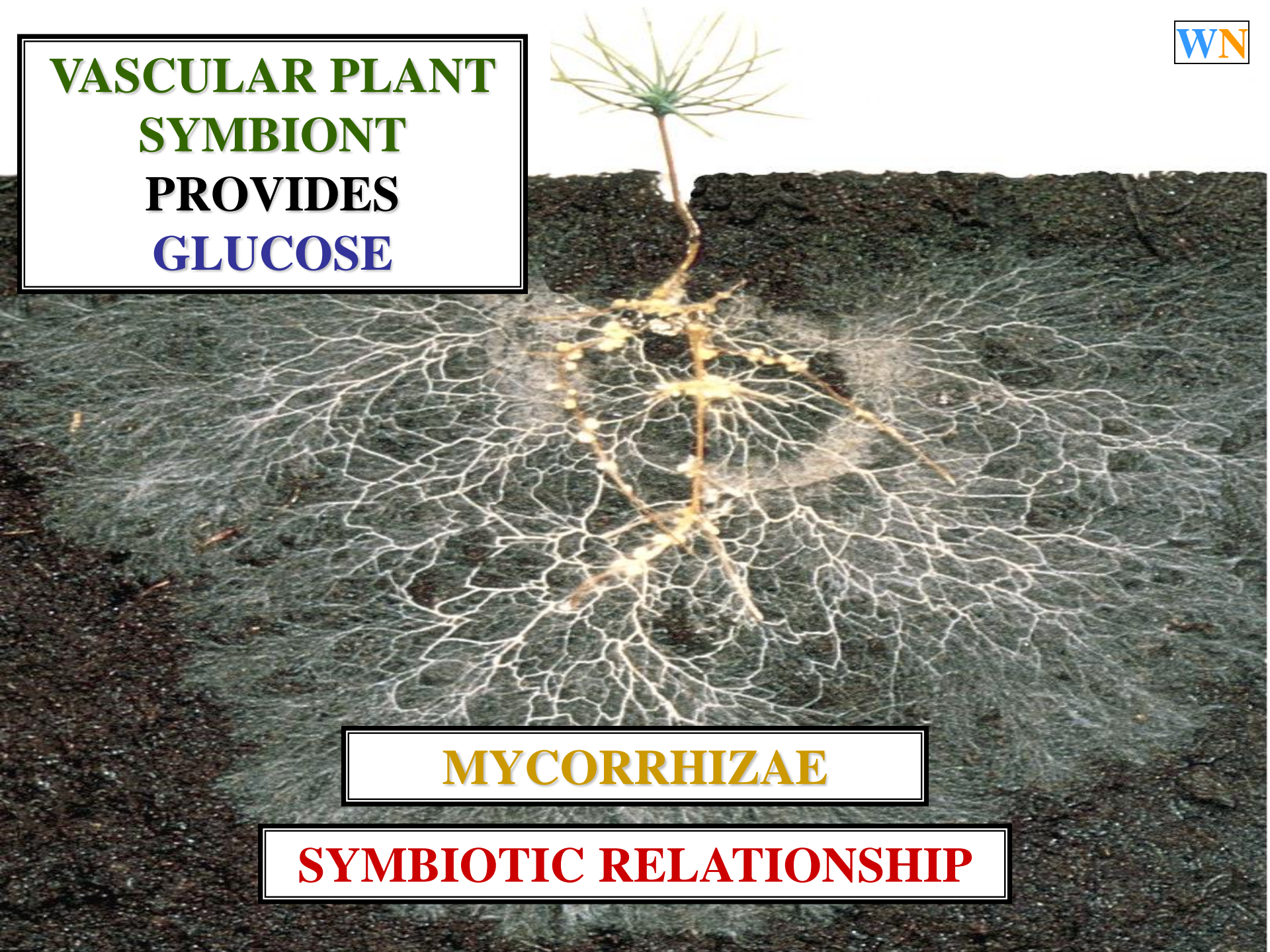
MYCORRHIZAE

SYMBIOTIC RELATIONSHIP

**VASCULAR PLANT
SYMBIONT
PROVIDES
GLUCOSE**

MYCORRHIZAE

SYMBIOTIC RELATIONSHIP



**VASCULAR PLANT
SYMBIONT
PROVIDES
GLUCOSE**

**MYCORRHIZAE
SYMBIONT
PROVIDES
WATER & NUTRIENTS**

SYMBIOTIC RELATIONSHIP

