



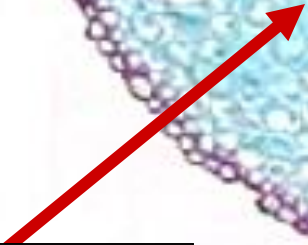
PC

EPIDERMIS



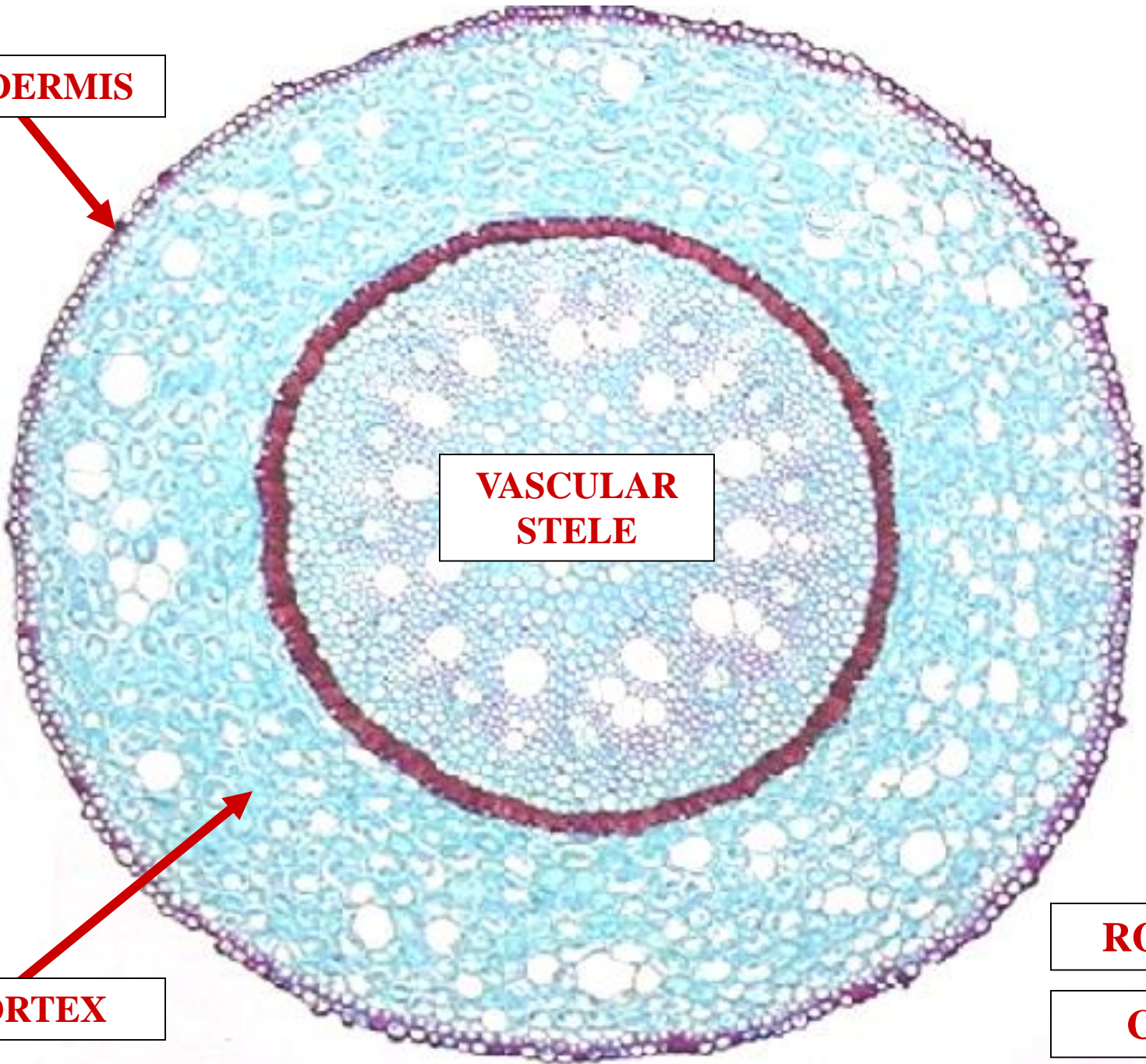
VASCULAR
STELE

CORTEX



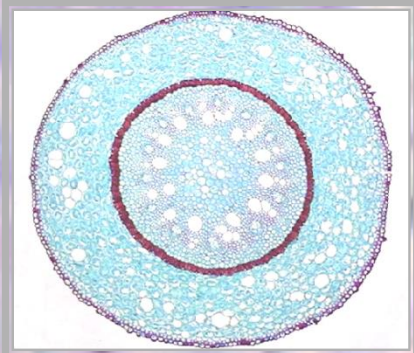
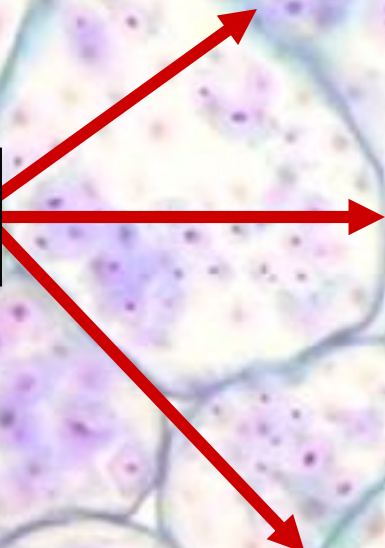
ROOT

C.S.



ST

**PARENCHYMA
CELLS**



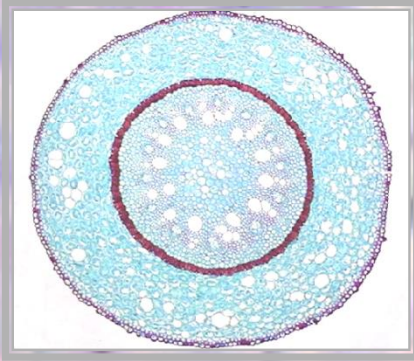
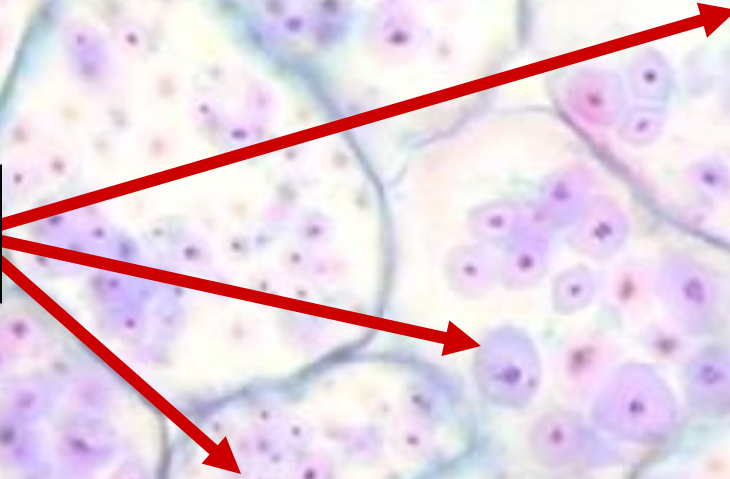
CORTEX

ROOT

C.S.

SG

**STORAGE
FUNCTION**



CORTEX

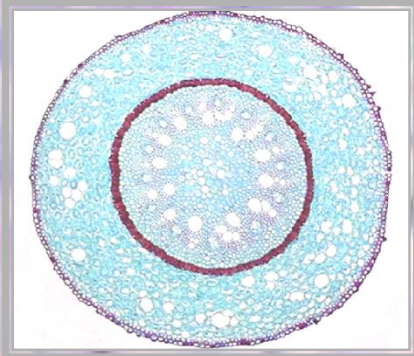
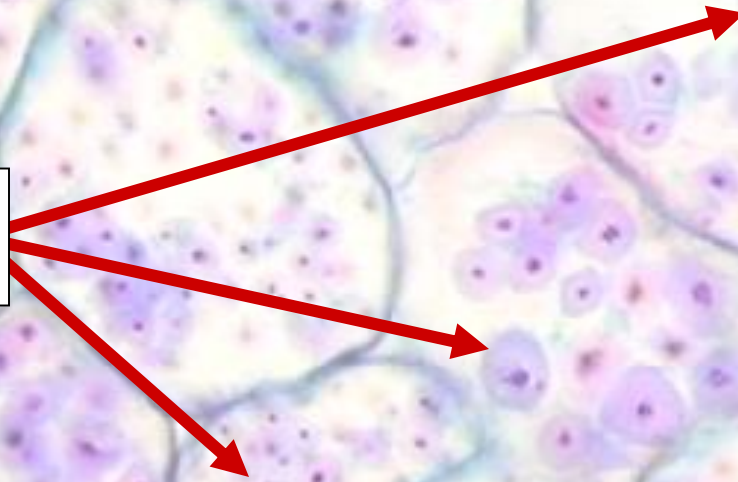
ROOT

C.S.

MW



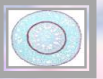
**STARCH
GRAINS**



CORTEX

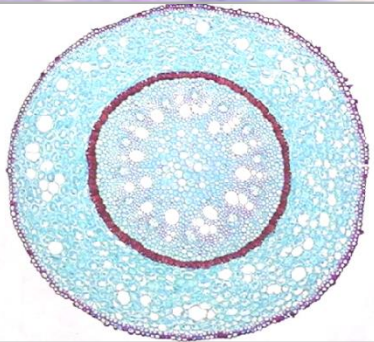
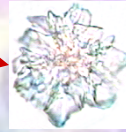
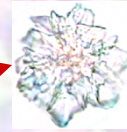
ROOT

C.S.



EN

**METABOLIC
WASTE CRYSTALS**



CORTEX

ROOT

C.S.



EPIDERMIS

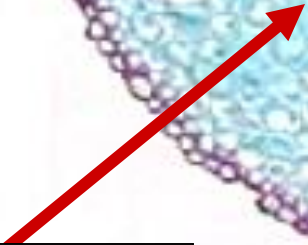


ENDODERMIS



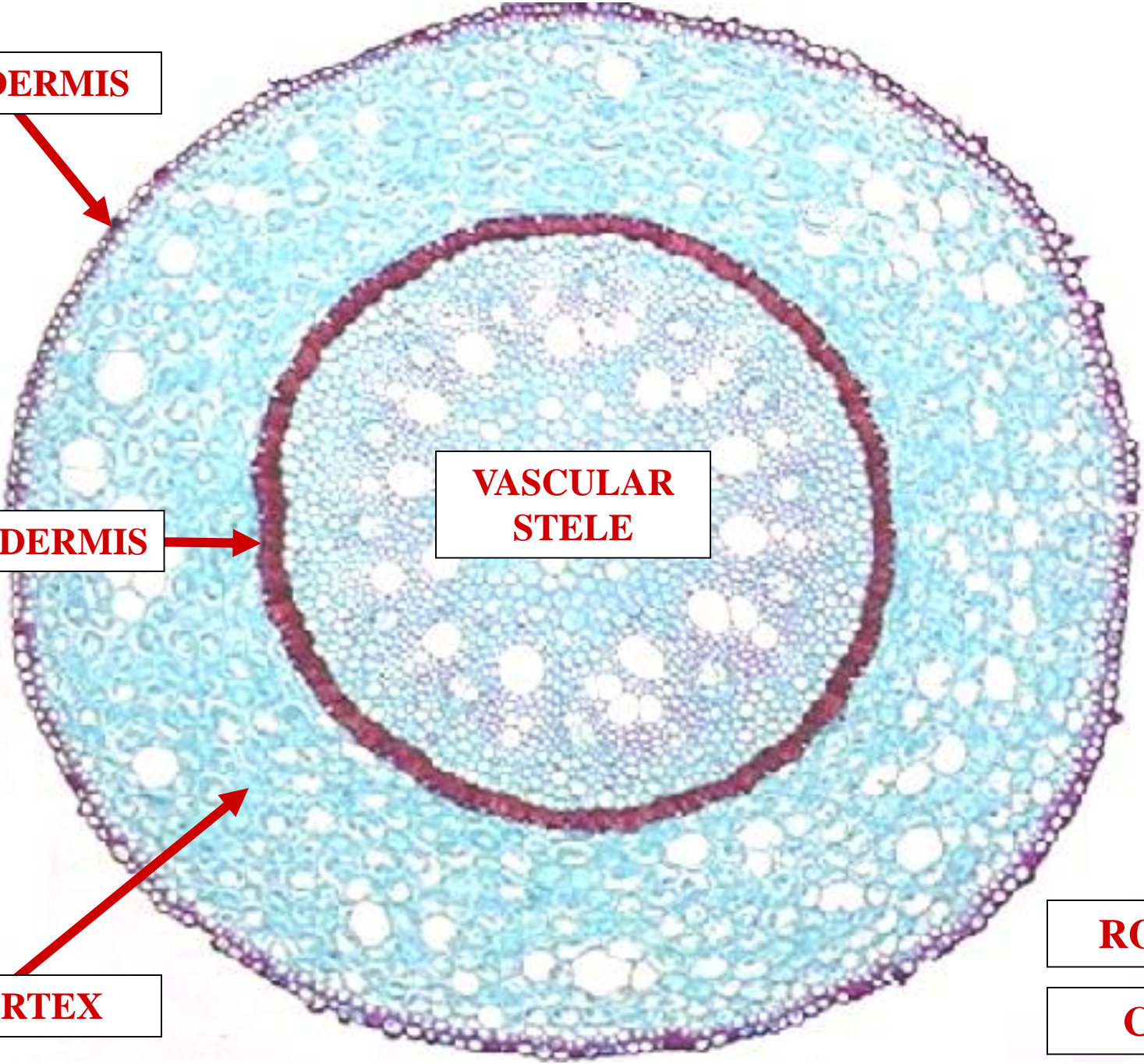
**VASCULAR
STELE**

CORTEX



ROOT

C.S.



**ROOT
CORTEX
ENDODERMIS**

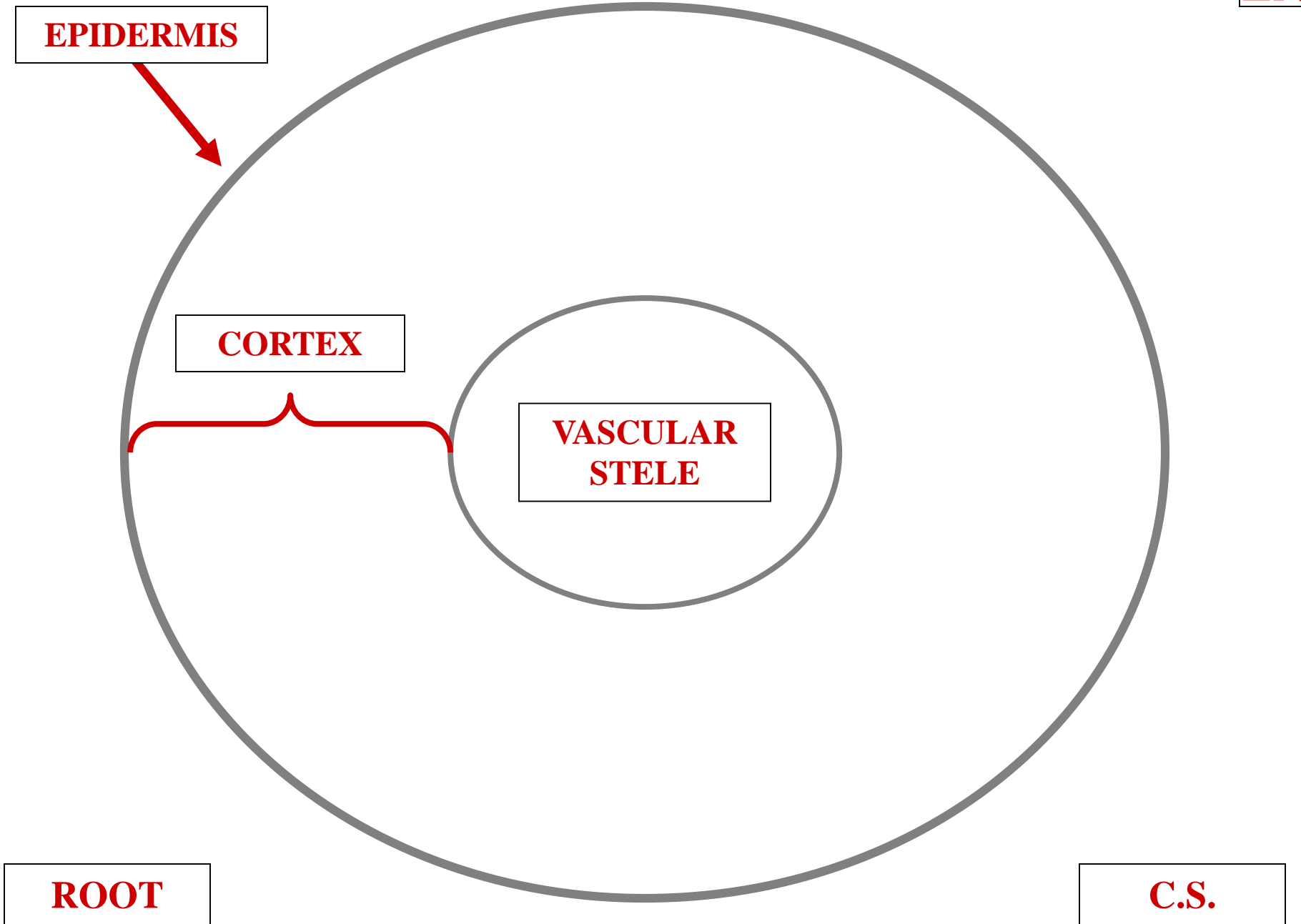
ENDODERMIS

ROOT ANATOMY
ROOT ENDODERMIS



**MODIFIED INNERMOST
CORTEX
CELL LAYER**

ROOT ANATOMY
ROOT ENDODERMIS



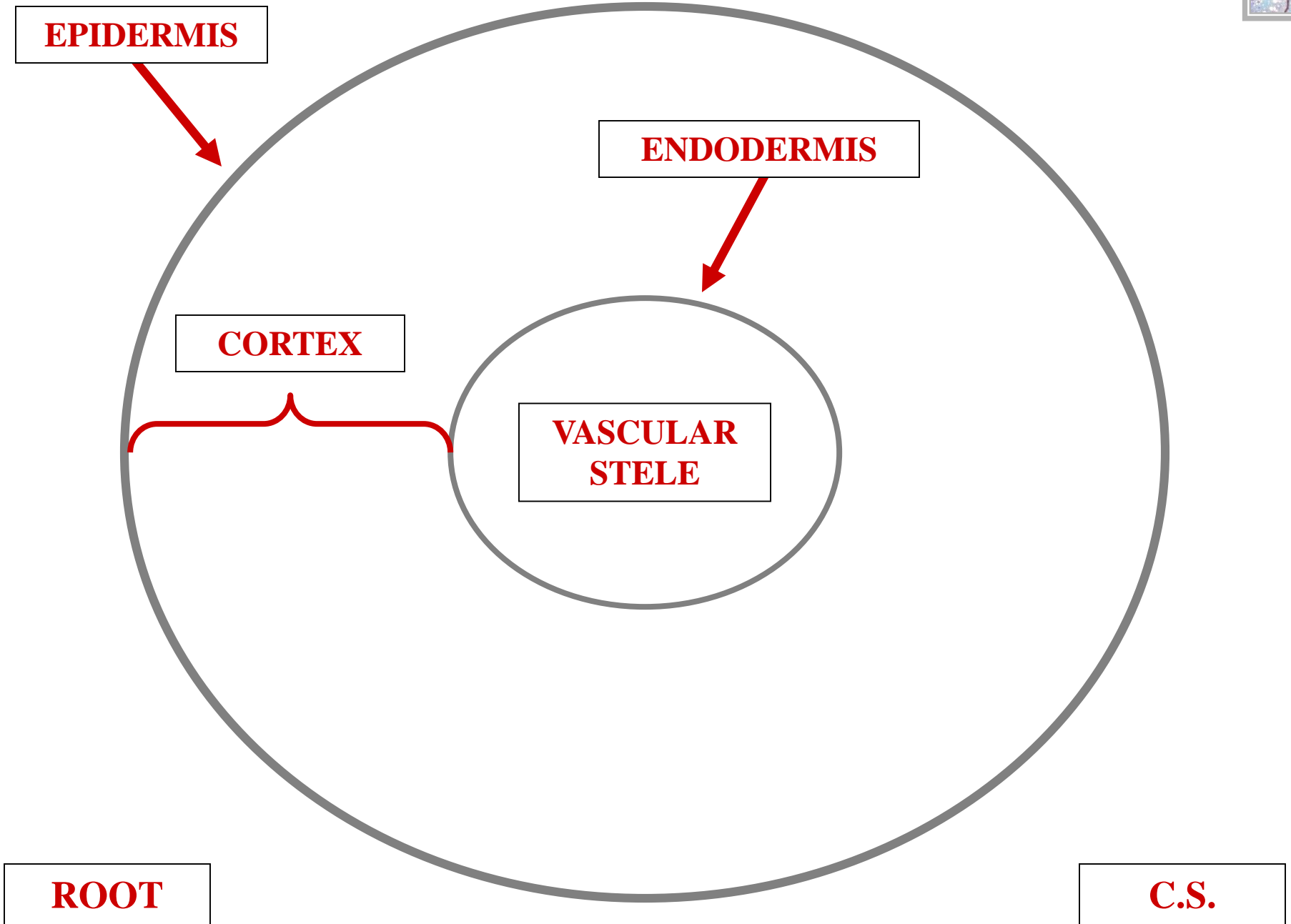
EPIDERMIS

CORTEX

**VASCULAR
STELE**

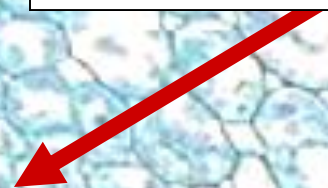
ROOT

C.S.



R

ENDODERMIS

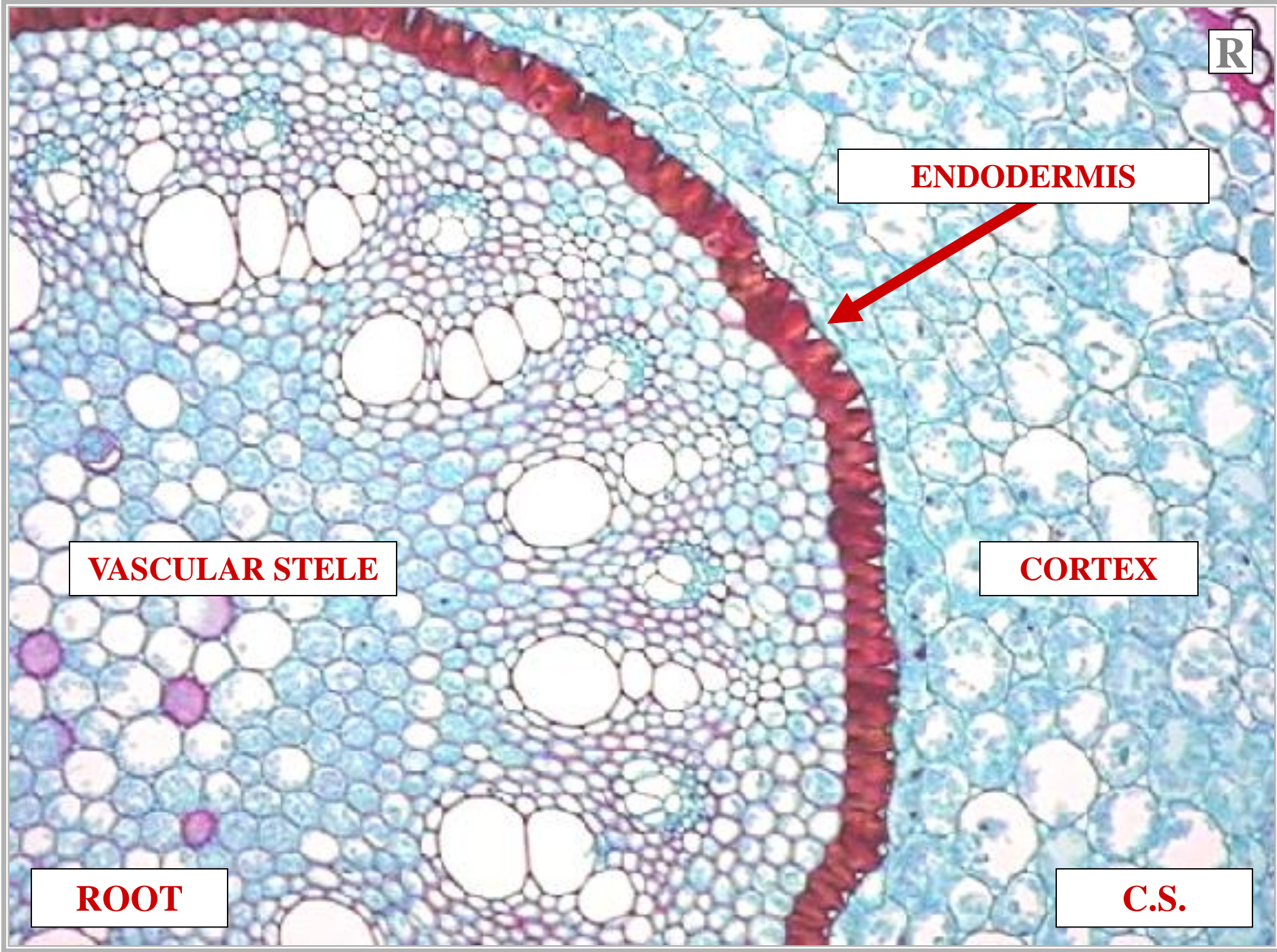


VASCULAR STELE

CORTEX

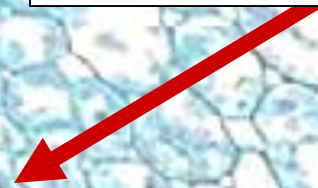
ROOT

C.S.



ENDODERMIS
REDUCES WATER LOSS
FROM STELE → CORTEX

ENDODERMIS

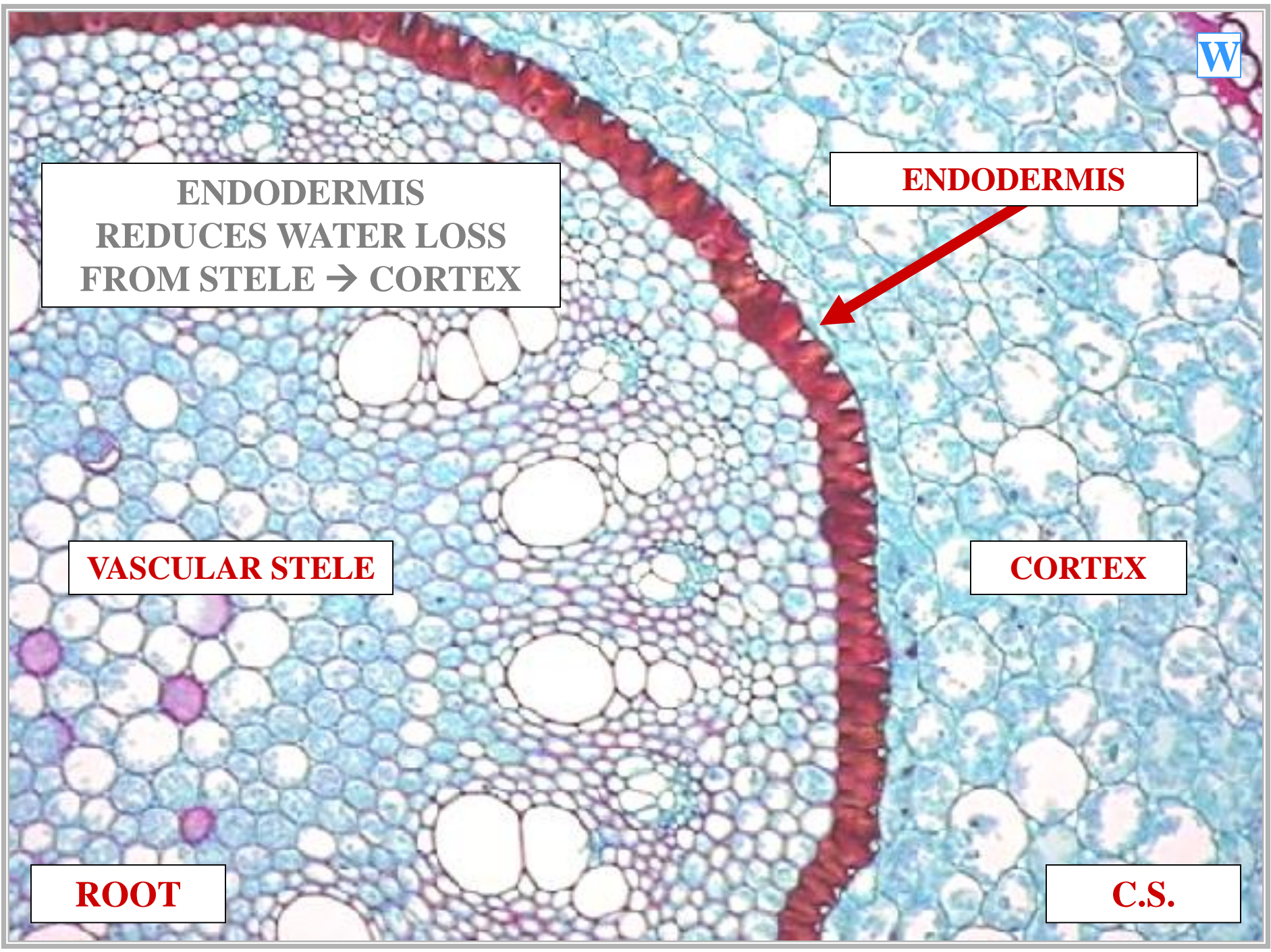


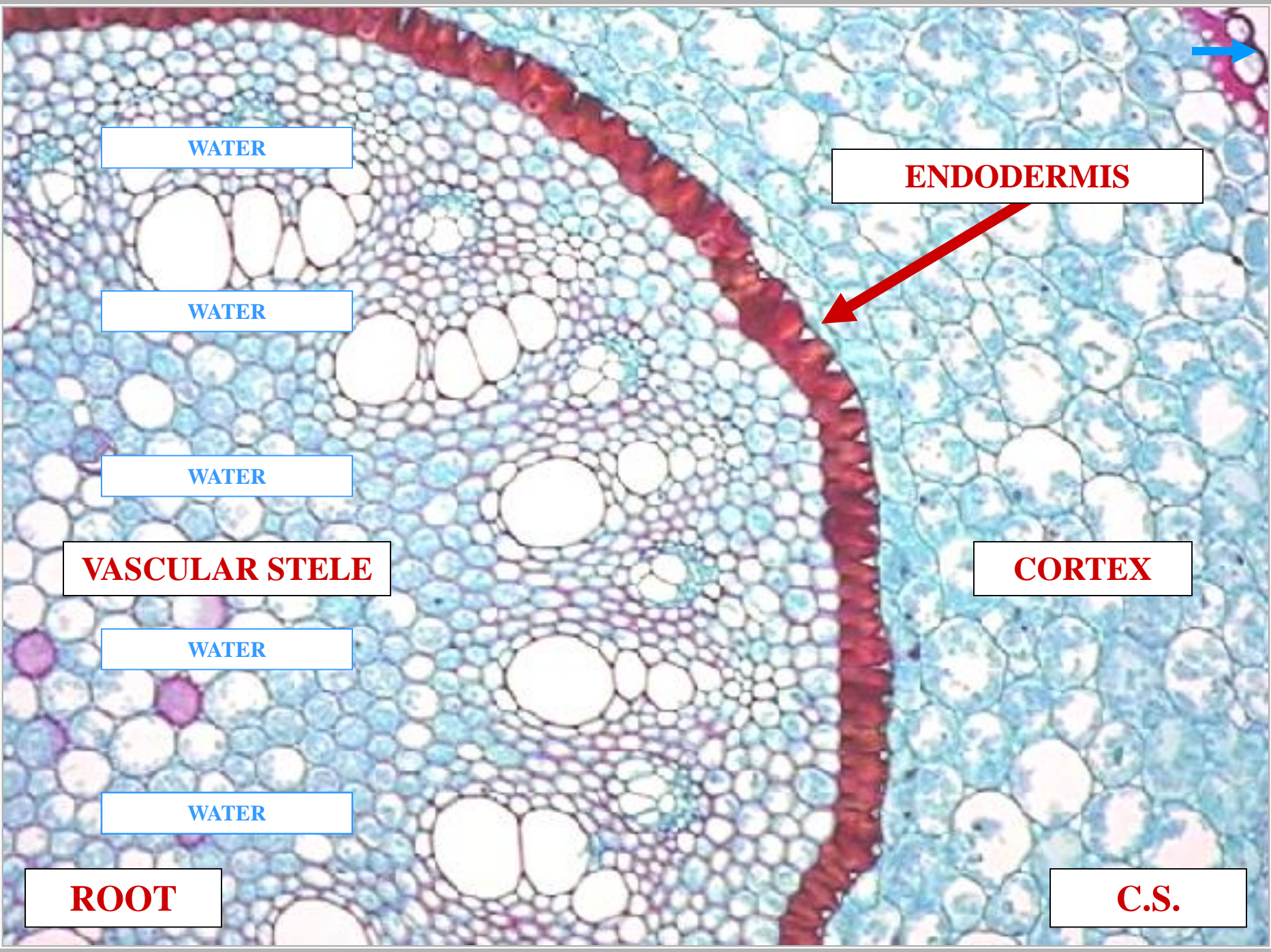
VASCULAR STELE

CORTEX

ROOT

C.S.





WATER

ENDODERMIS

WATER

CORTEX

WATER

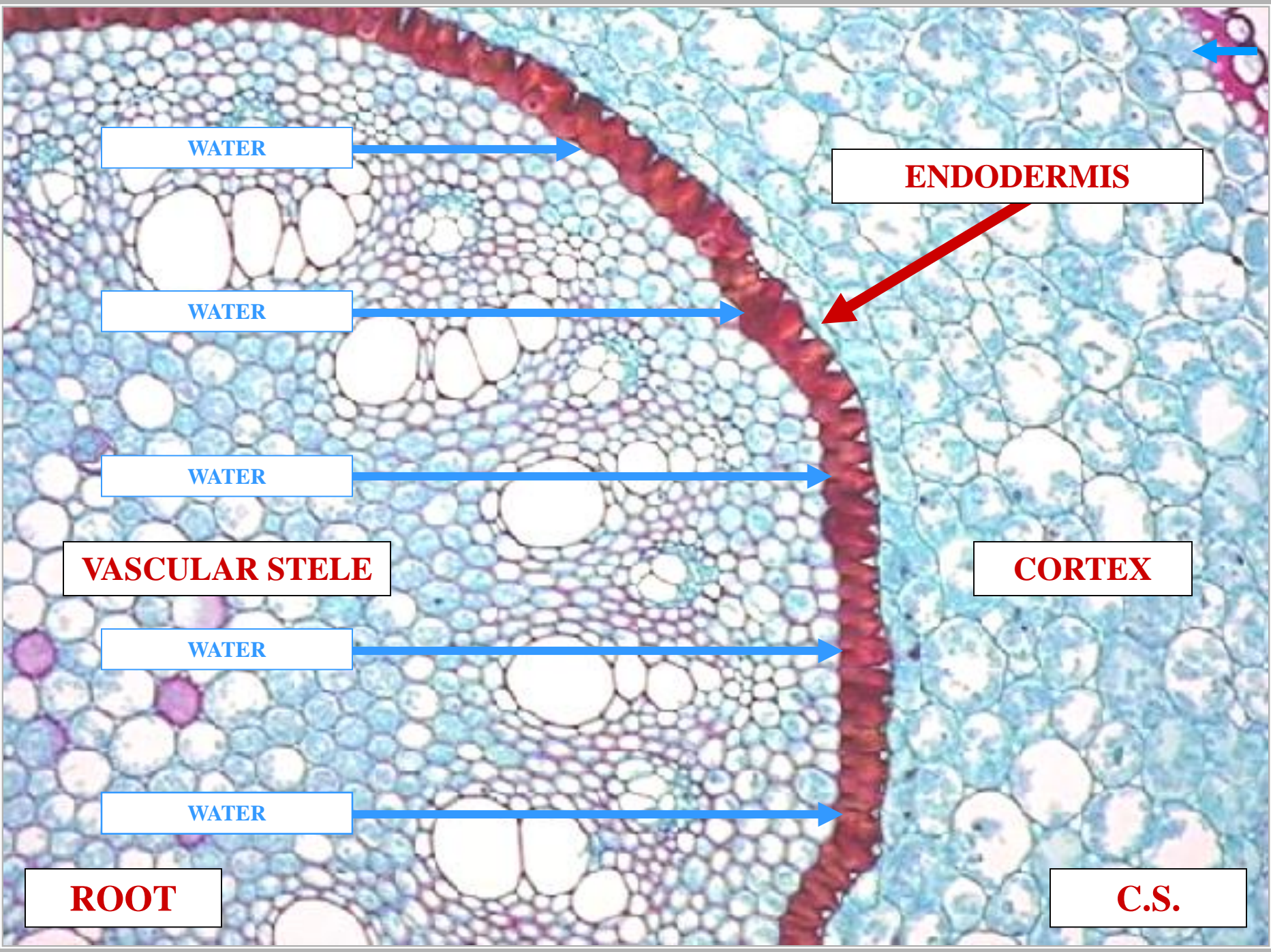
VASCULAR STELE

WATER

WATER

ROOT

C.S.



WATER

WATER

WATER

VASCULAR STELE

WATER

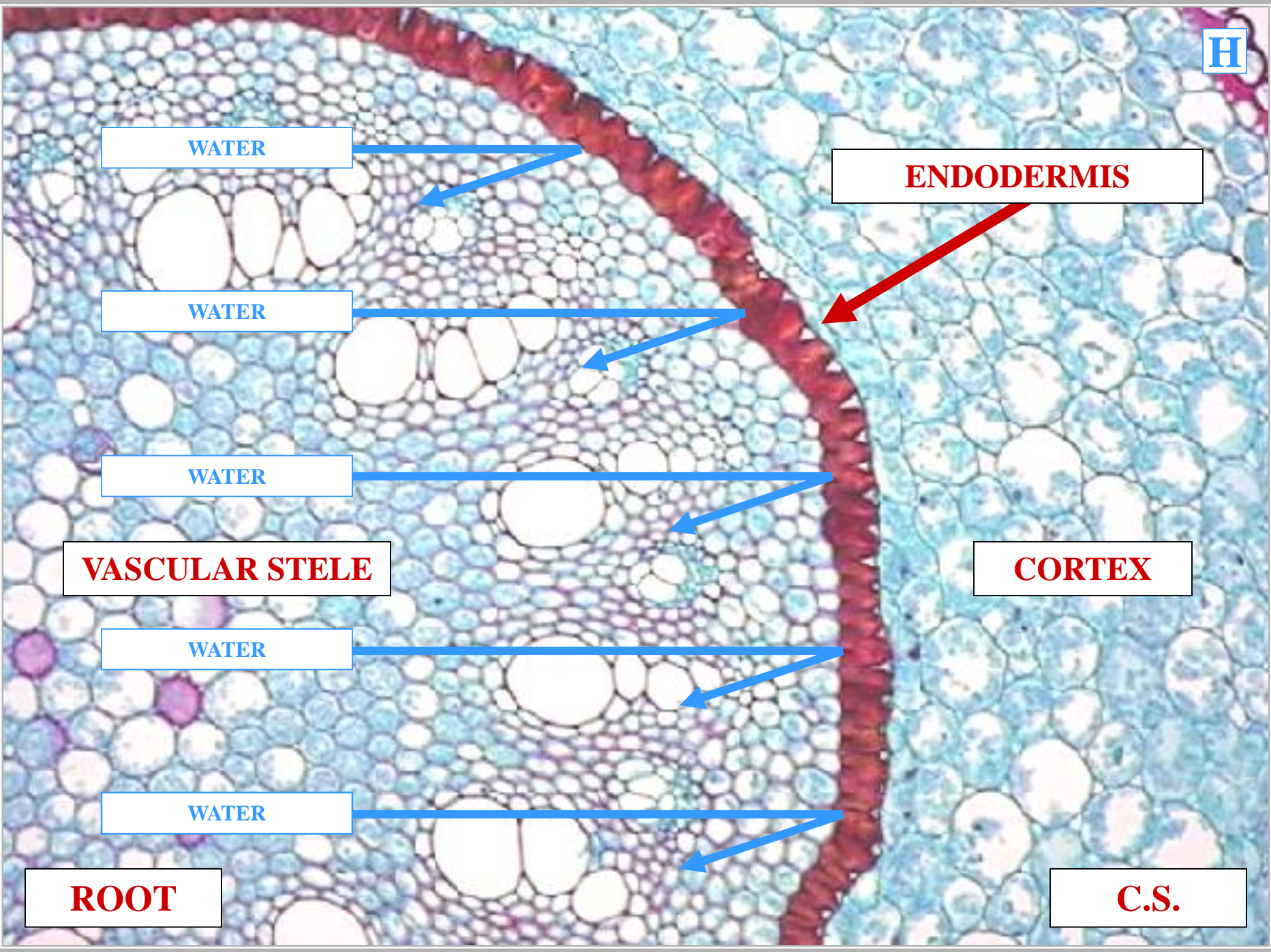
WATER

ENDODERMIS

CORTEX

ROOT

C.S.



WATER

WATER

WATER

VASCULAR STELE

WATER

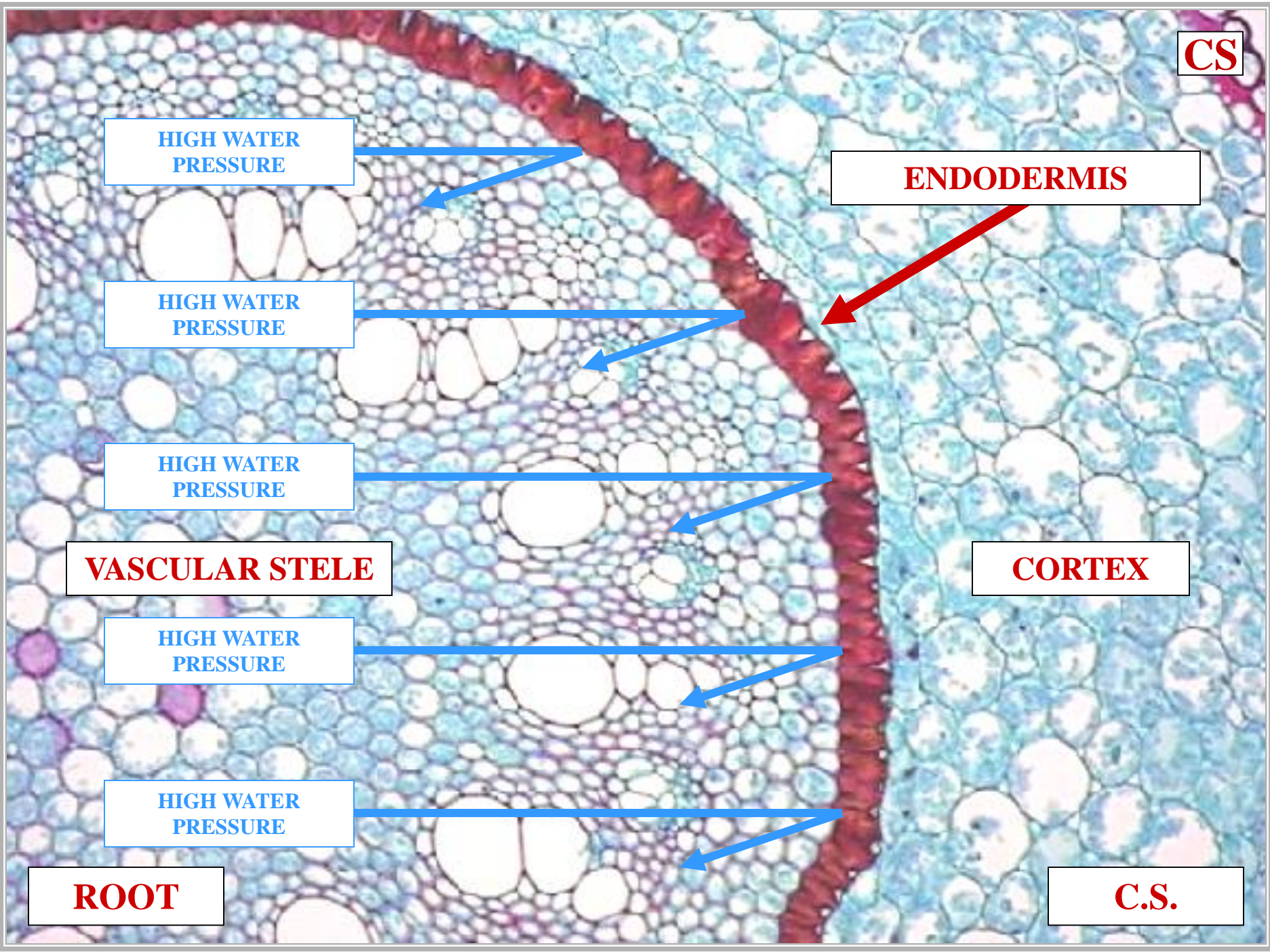
WATER

ENDODERMIS

CORTEX

ROOT

C.S.



CS

HIGH WATER PRESSURE

ENDODERMIS

HIGH WATER PRESSURE

HIGH WATER PRESSURE

VASCULAR STELE

CORTEX

HIGH WATER PRESSURE

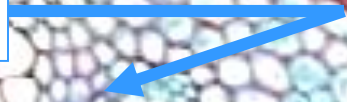
HIGH WATER PRESSURE

ROOT

C.S.



HIGH WATER PRESSURE



ENDODERMIS

CASPARIAN STRIPS



HIGH WATER PRESSURE

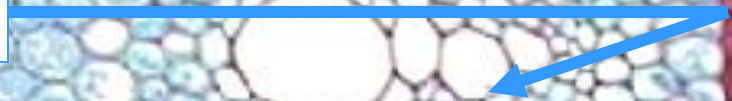


HIGH WATER PRESSURE



VASCULAR STELE

HIGH WATER PRESSURE



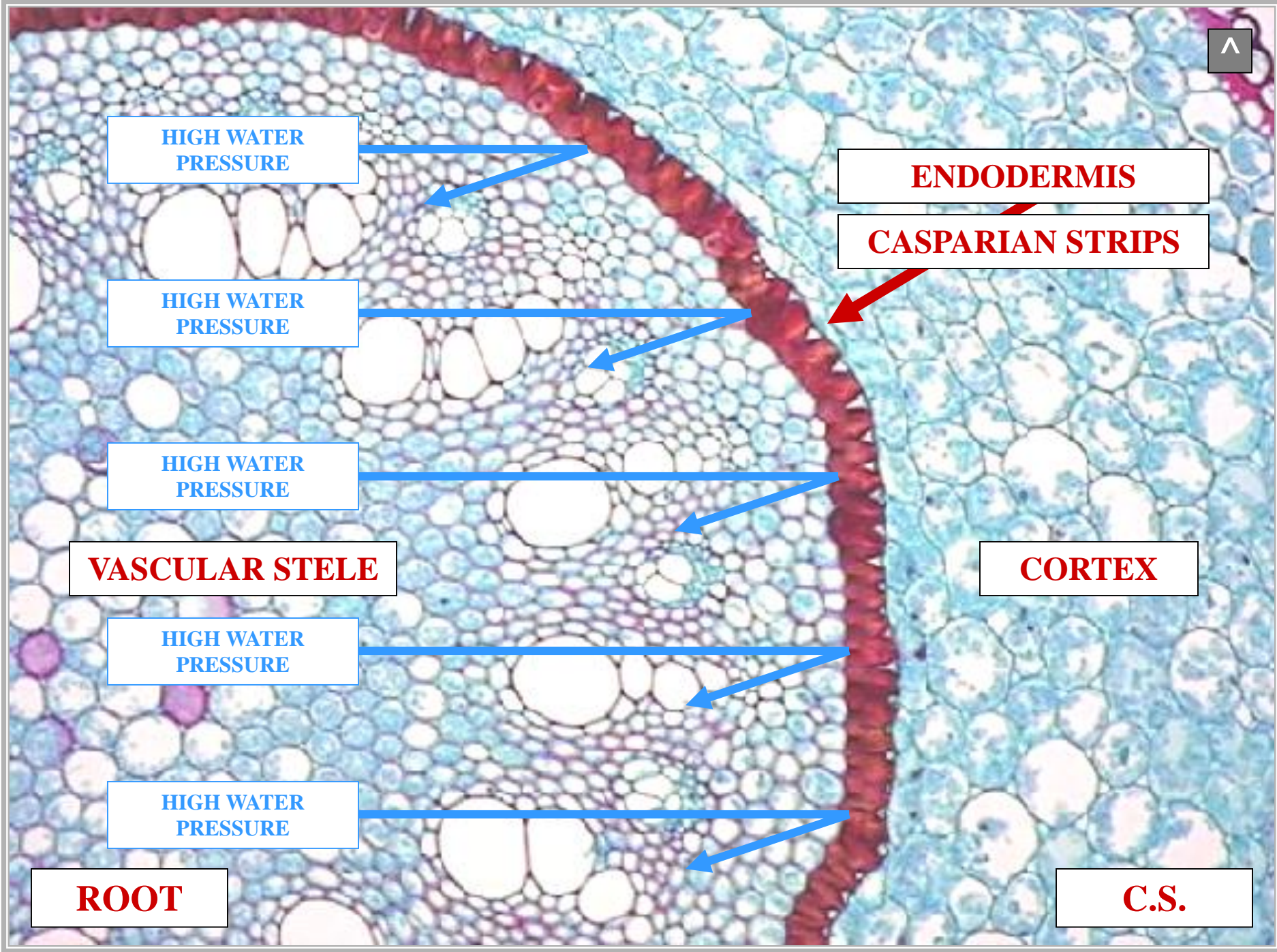
CORTEX

HIGH WATER PRESSURE



ROOT

C.S.



**ROOT
CORTEX
ENDODERMIS
CASPARIAN
STRIPS**

CASPARIAN STRIP

**ROOT ENDODERMIS
CASPARIAN STRIP**



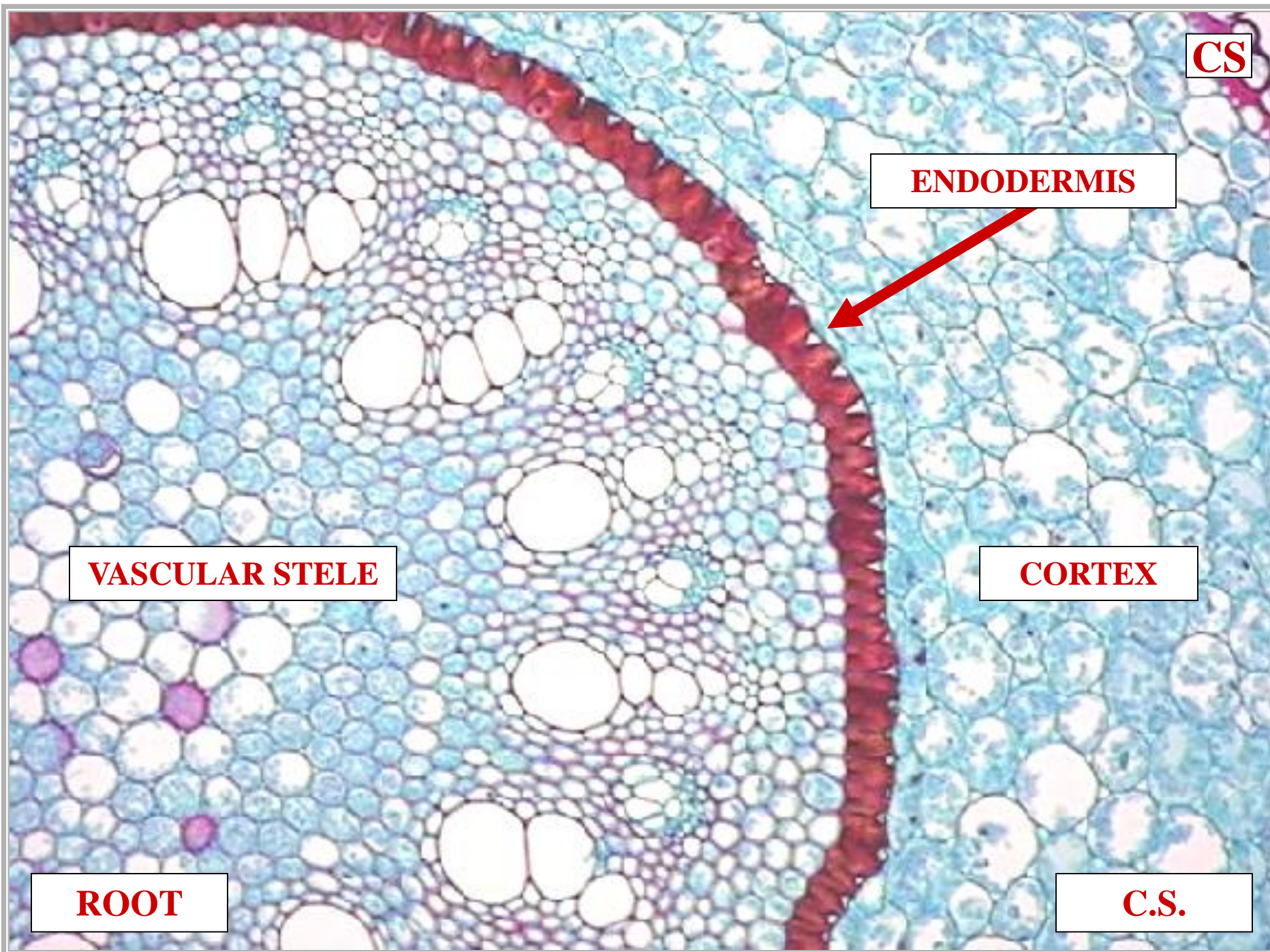
**PERIPHERAL
SUBERIN STRIP ALONG**

**ROOT ENDODERMIS
CASPARIAN STRIP**

ROOT ENDODERMIS
CASPARIAN STRIP
PERIPHERAL
SUBERIN STRIP ALONG

ANTICLINAL WALLS
AND
PERICLINAL WALLS
ROOT ENDODERMIS
CASPARIAN STRIP





CS

ENDODERMIS

VASCULAR STELE

CORTEX

ROOT

C.S.



ENDODERMIS

CASPARIAN STRIPS

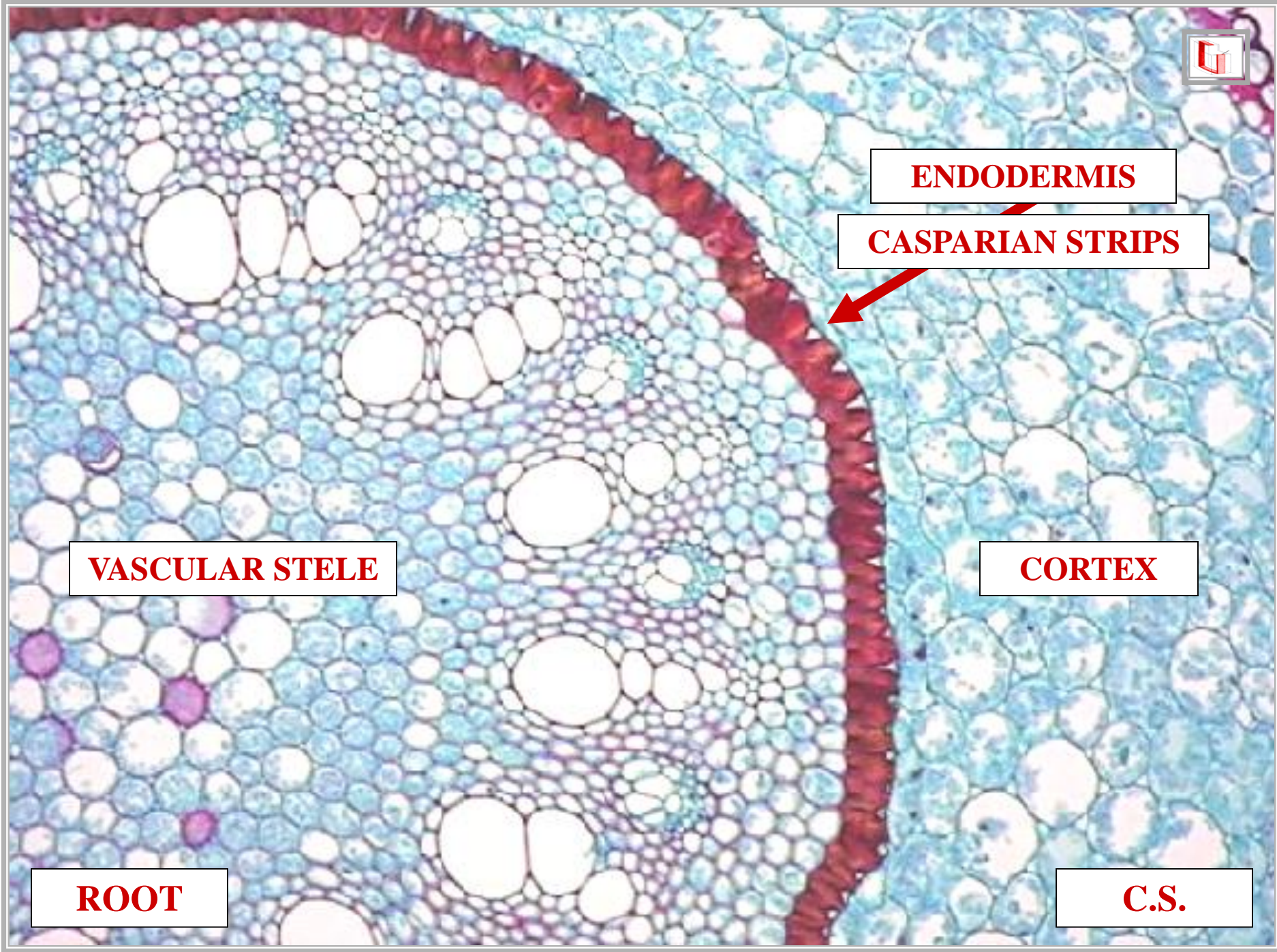


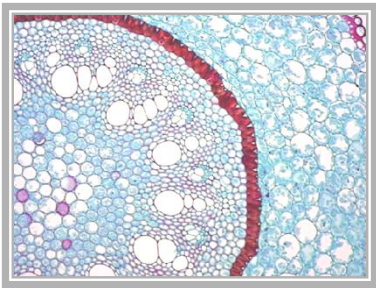
VASCULAR STELE

CORTEX

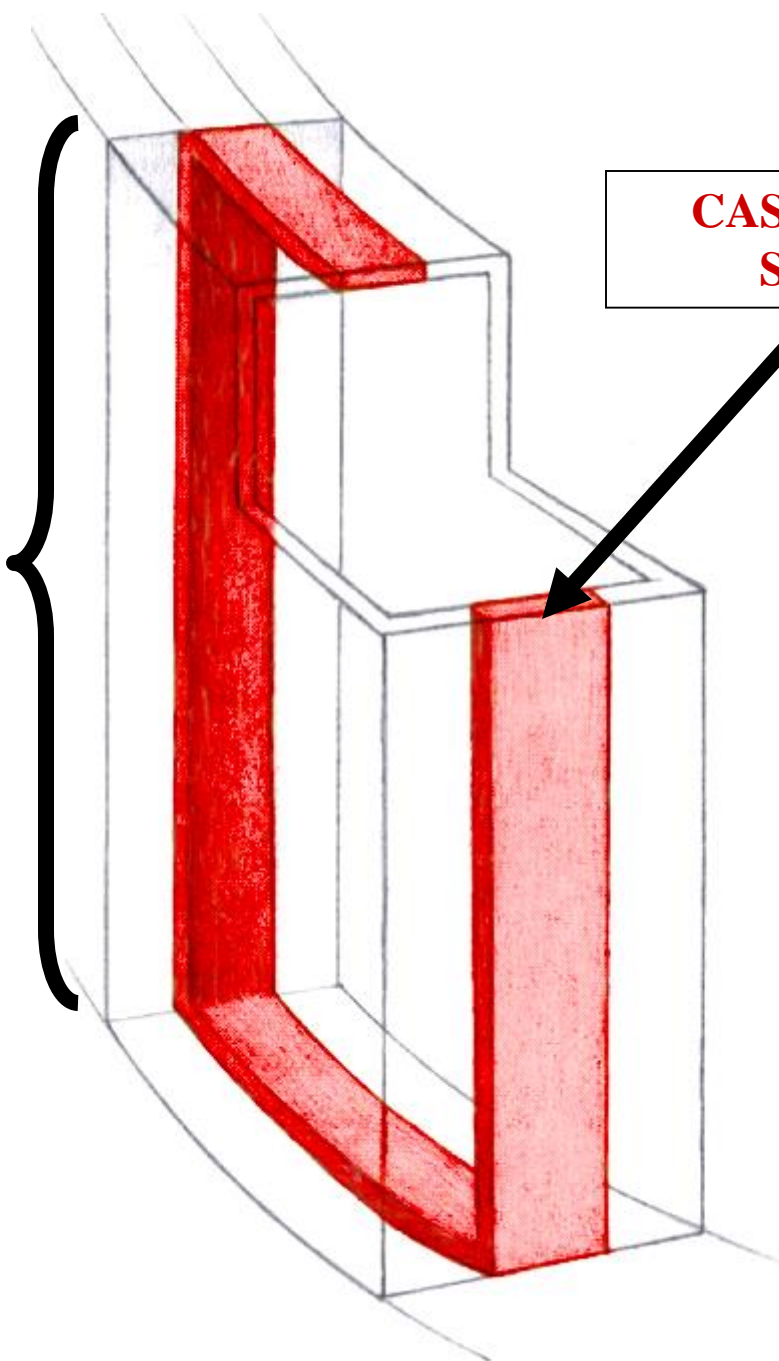
ROOT

C.S.





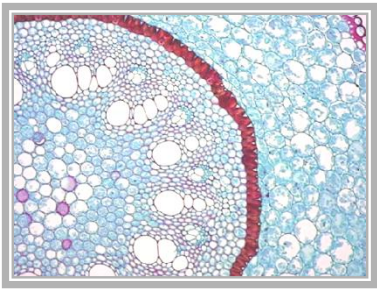
**ENDODERMIS
CELL**



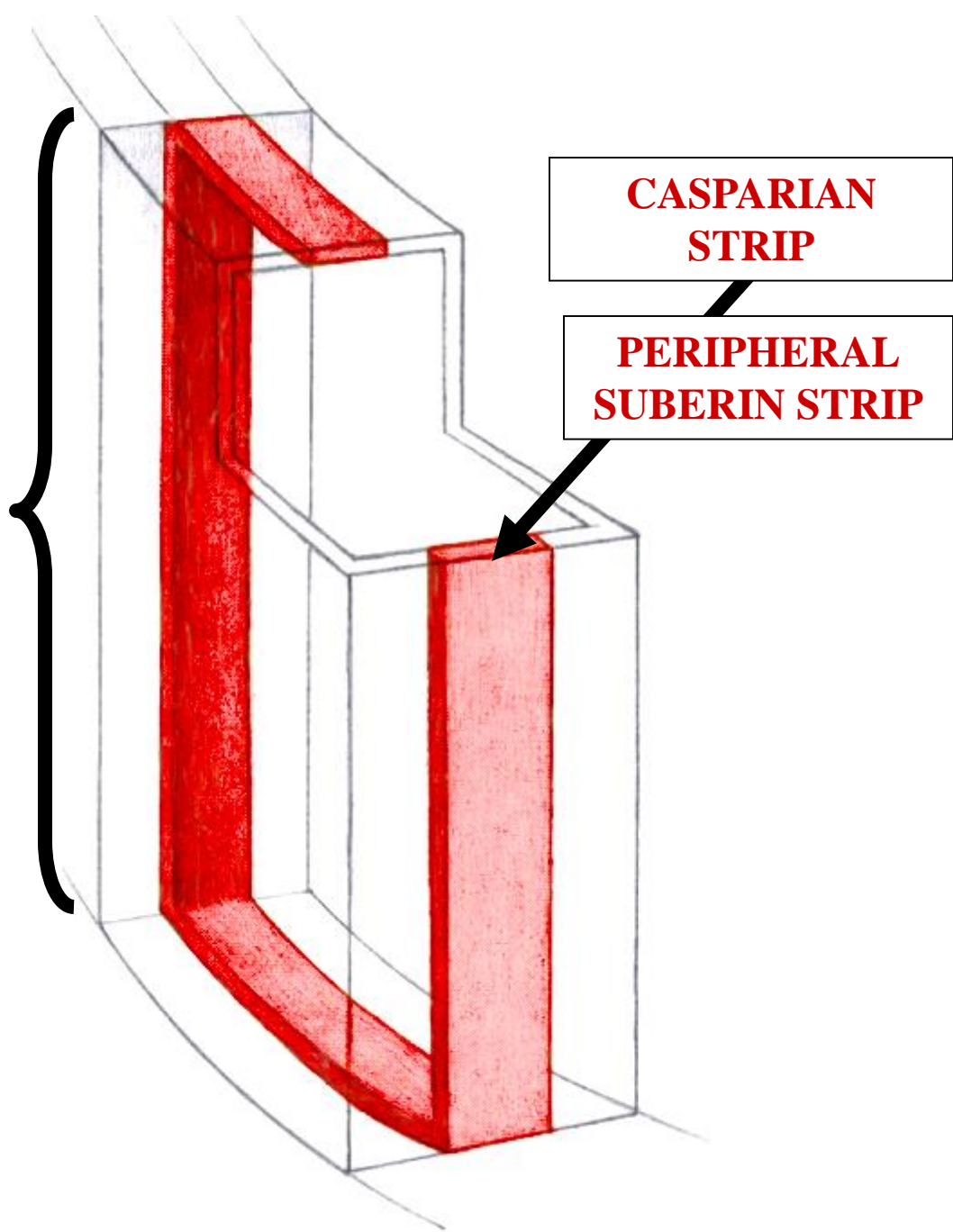
**CASPARIAN
STRIP**

ROOT

L.S.

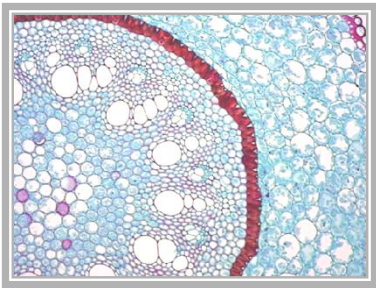


**ENDODERMIS
CELL**

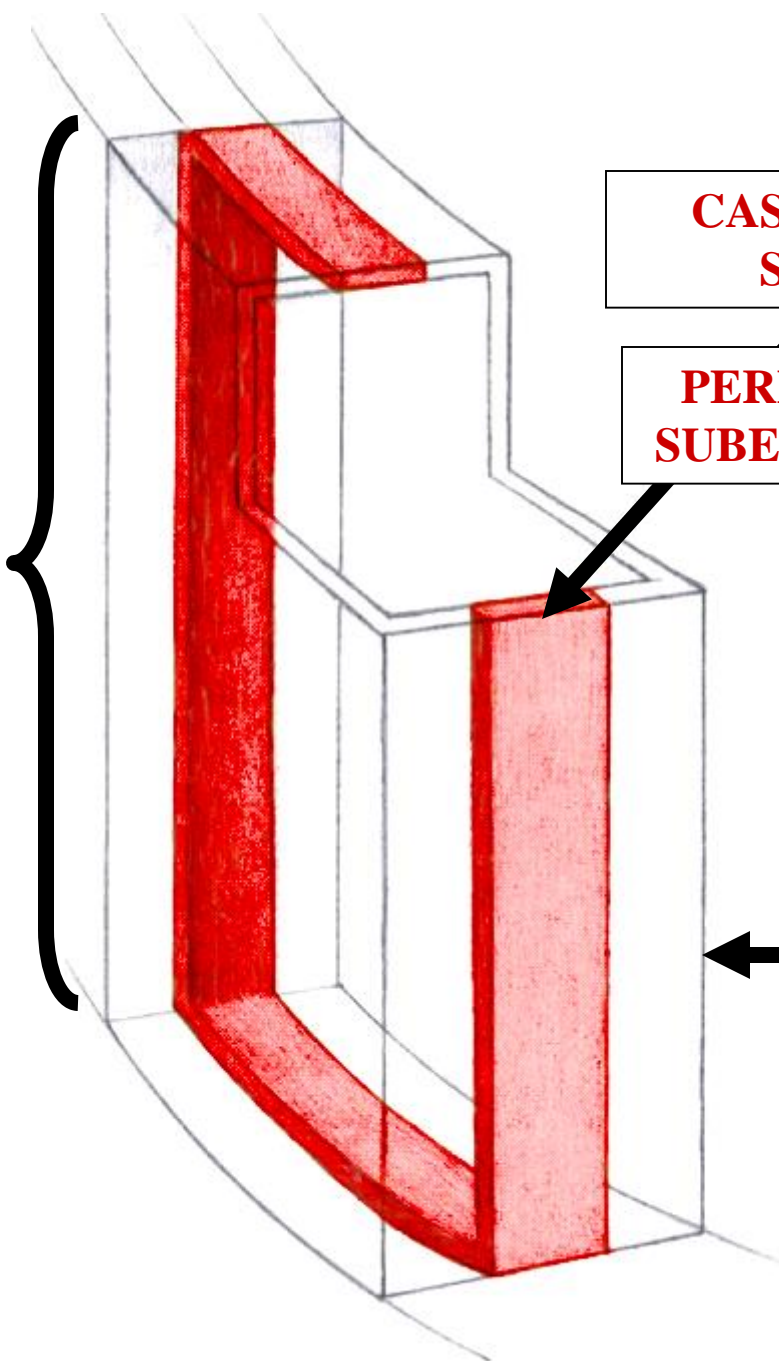


ROOT

L.S.



**ENDODERMIS
CELL**



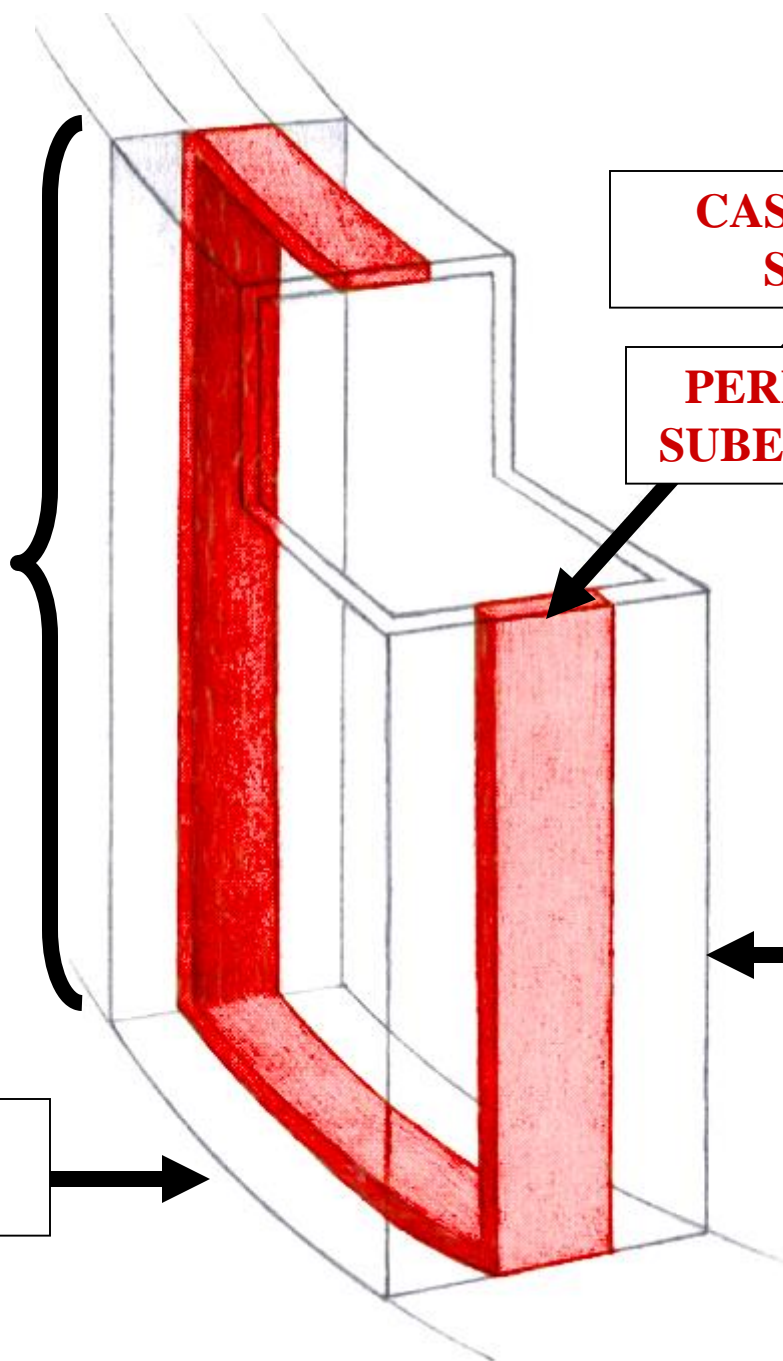
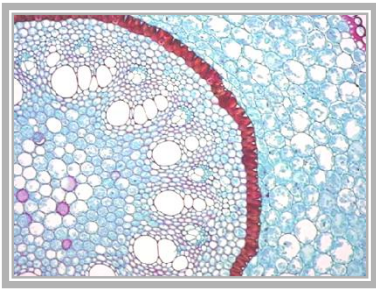
**CASPIAN
STRIP**

**PERIPHERAL
SUBERIN STRIP**

**ANTICLINAL
CELL WALL**

ROOT

L.S.



**ENDODERMIS
CELL**

**CASPARIAN
STRIP**

**PERIPHERAL
SUBERIN STRIP**

**ANTICLINAL
CELL WALL**

**PERICLINAL
CELL WALL**

ROOT

L.S.

SUBERIN

ROOT ENDODERMIS
CASPARIAN STRIP
SUBERIN



FAT-LIKE SUBSTANCE

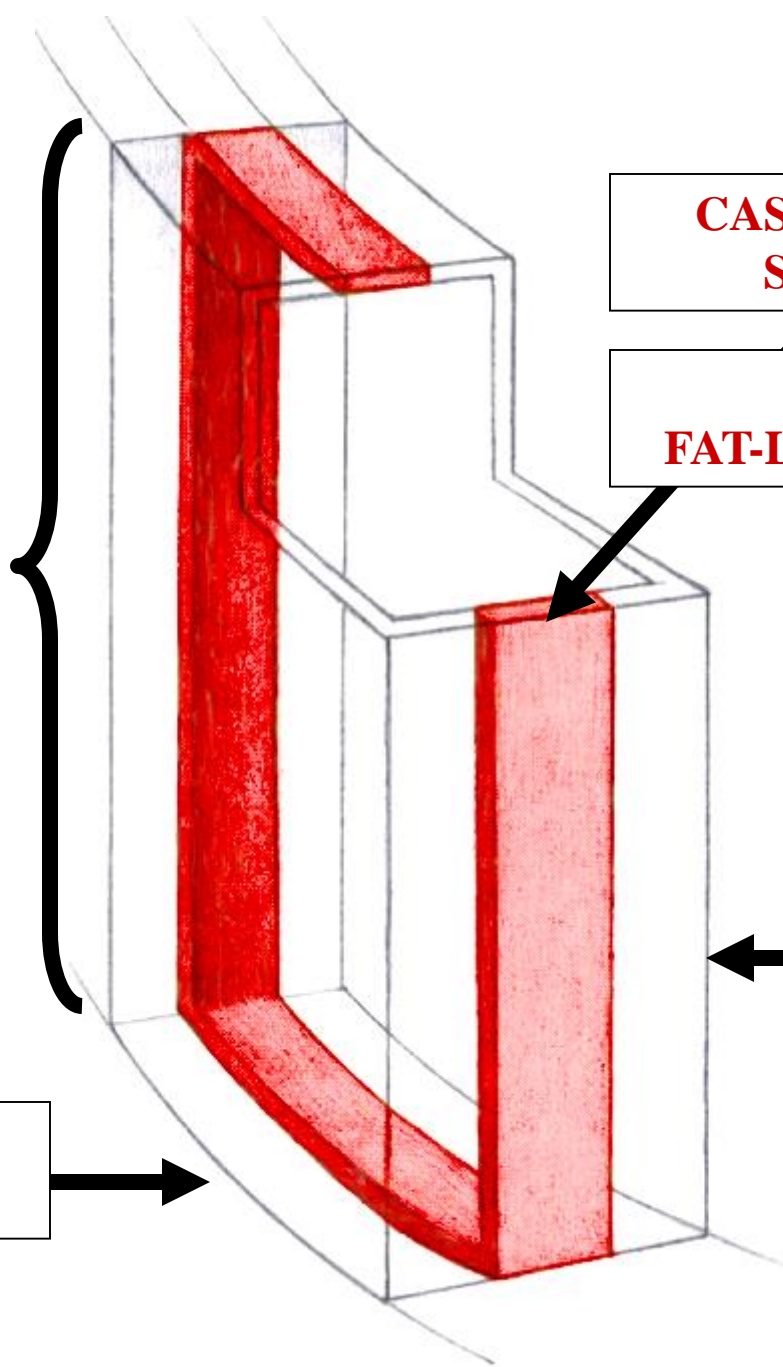
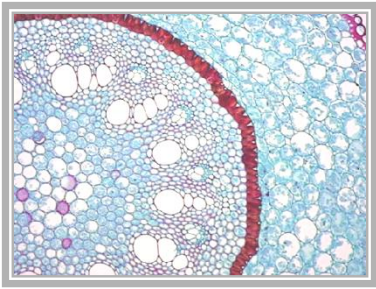
ROOT ENDODERMIS
CASPARIAN STRIP
SUBERIN



**ROOT ENDODERMIS
CASPARIAN STRIP
SUBERIN**

**FAT-LIKE SUBSTANCE
HYDROPHOBIC**

**ROOT ENDODERMIS
CASPARIAN STRIP
SUBERIN**



**ENDODERMIS
CELL**

**CASPARIAN
STRIP**

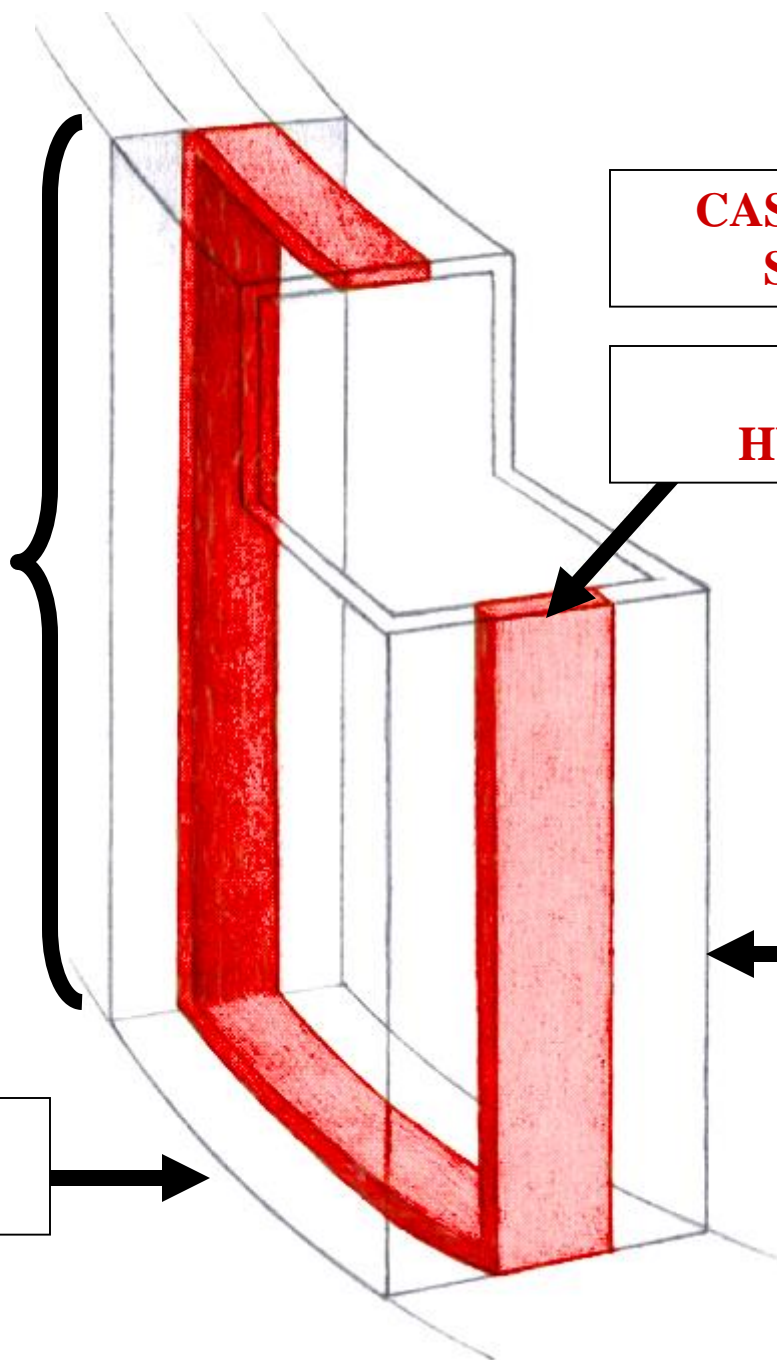
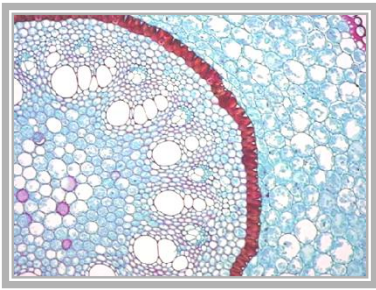
**SUBERIN
FAT-LIKE SUBSTANCE**

**ANTICLINAL
CELL WALL**

**PERICLINAL
CELL WALL**

ROOT

L.S.



**ENDODERMIS
CELL**

**CASPARIAN
STRIP**

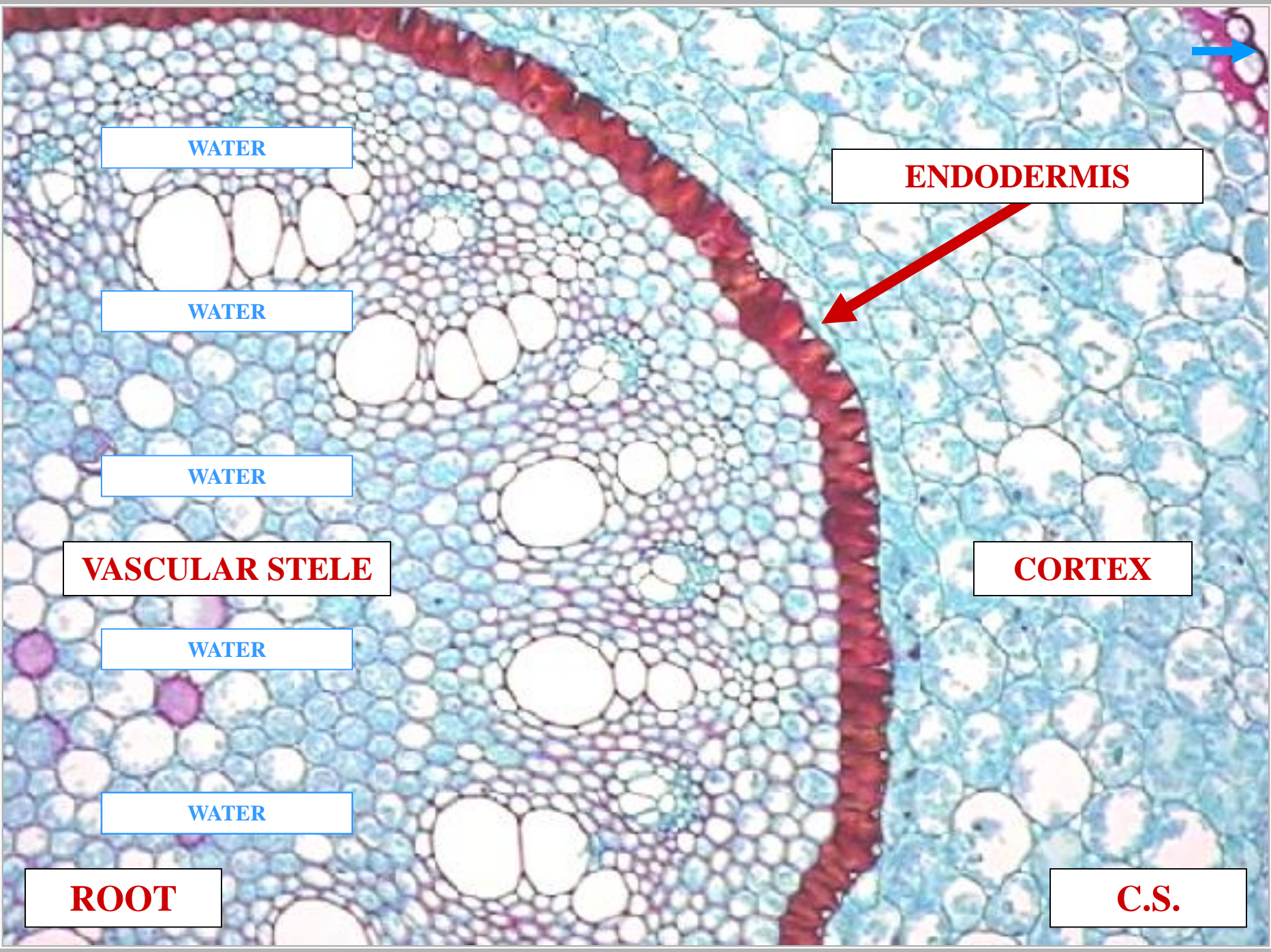
**SUBERIN
HYDROPHOBIC**

**ANTICLINAL
CELL WALL**

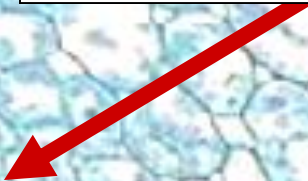
**PERICLINAL
CELL WALL**

ROOT

L.S.



ENDODERMIS



CORTEX

VASCULAR STELE

C.S.

WATER

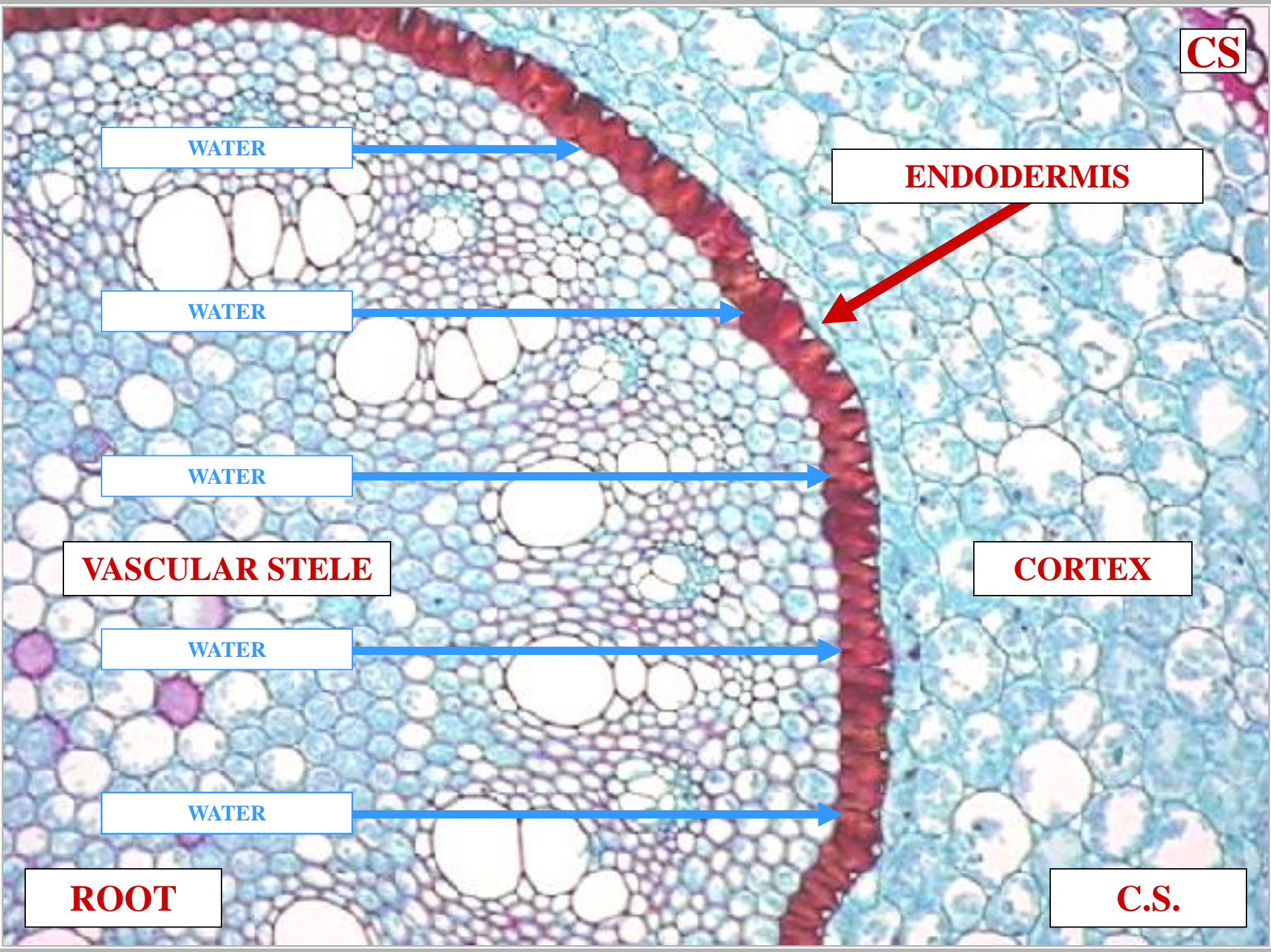
WATER

WATER

WATER

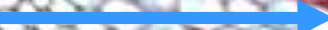
WATER

ROOT

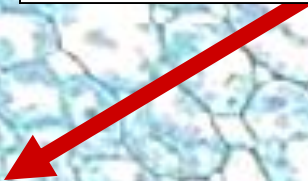


C.S.

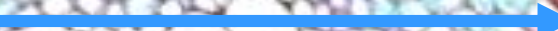
WATER



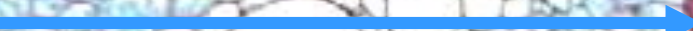
ENDODERMIS



WATER



WATER



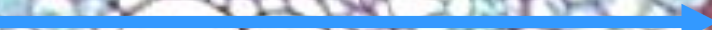
VASCULAR STELE

CORTEX

WATER



WATER

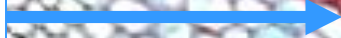


ROOT

C.S.

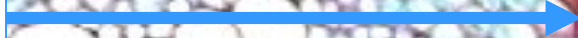
S

WATER



ENDODERMIS

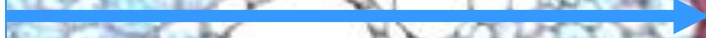
WATER



CASPARIAN STRIPS



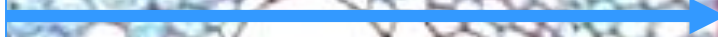
WATER



VASCULAR STELE

CORTEX

WATER

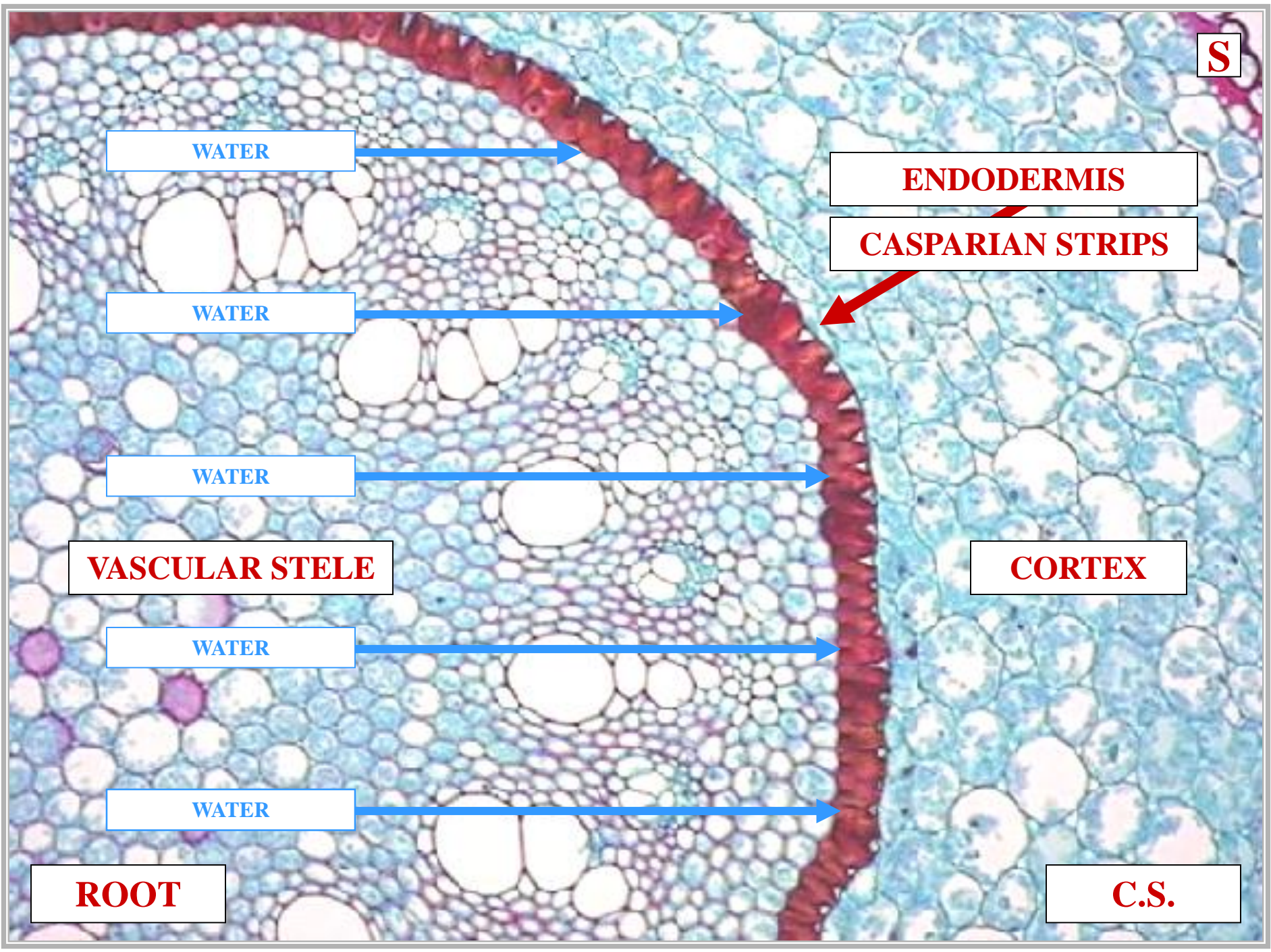


WATER



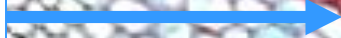
ROOT

C.S.



H

WATER

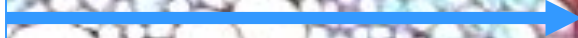


ENDODERMIS

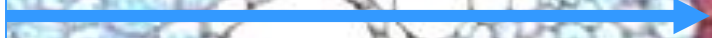
SUBERIN



WATER



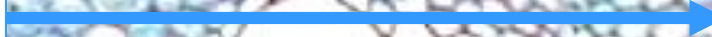
WATER



VASCULAR STELE

CORTEX

WATER

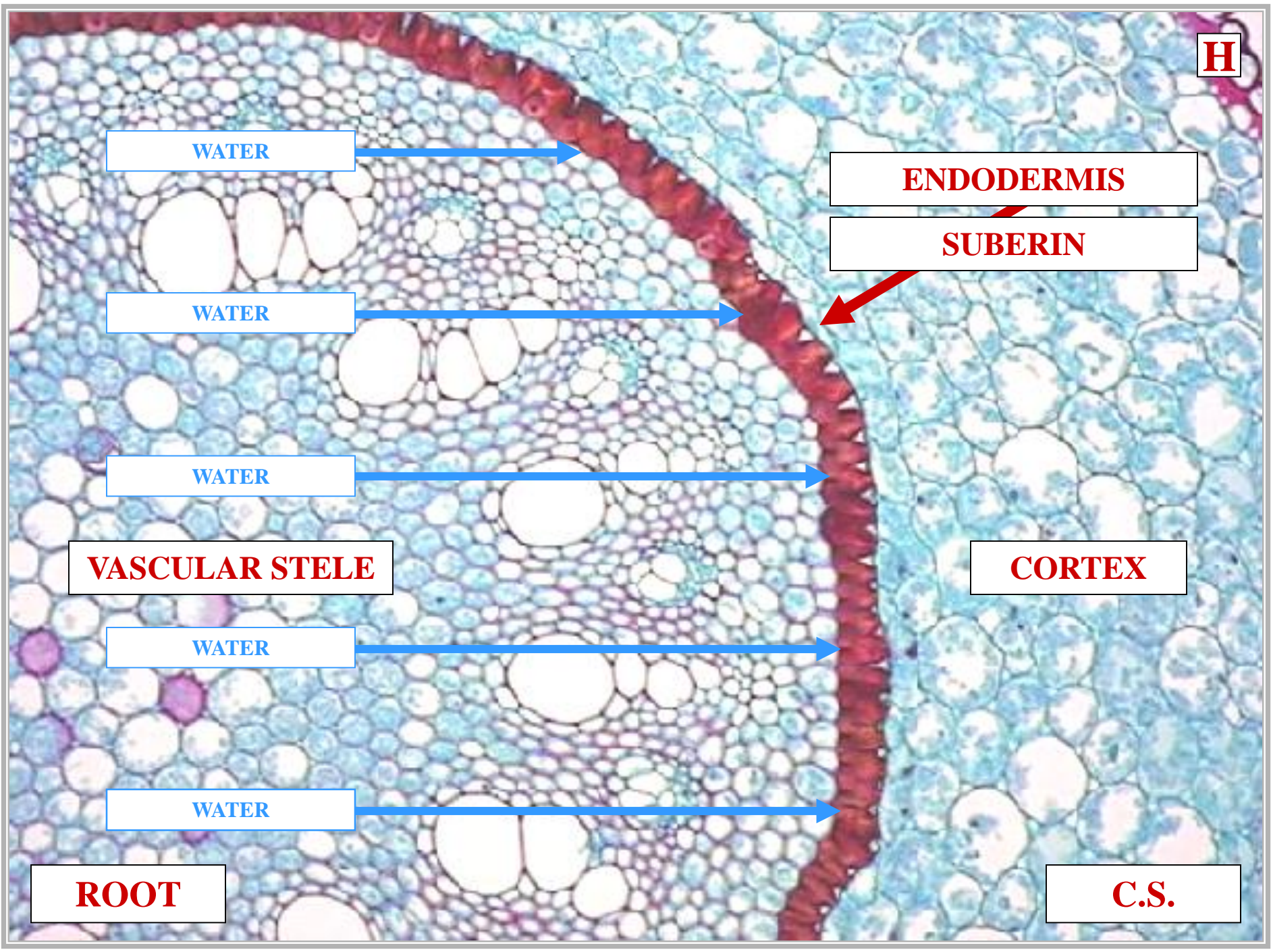


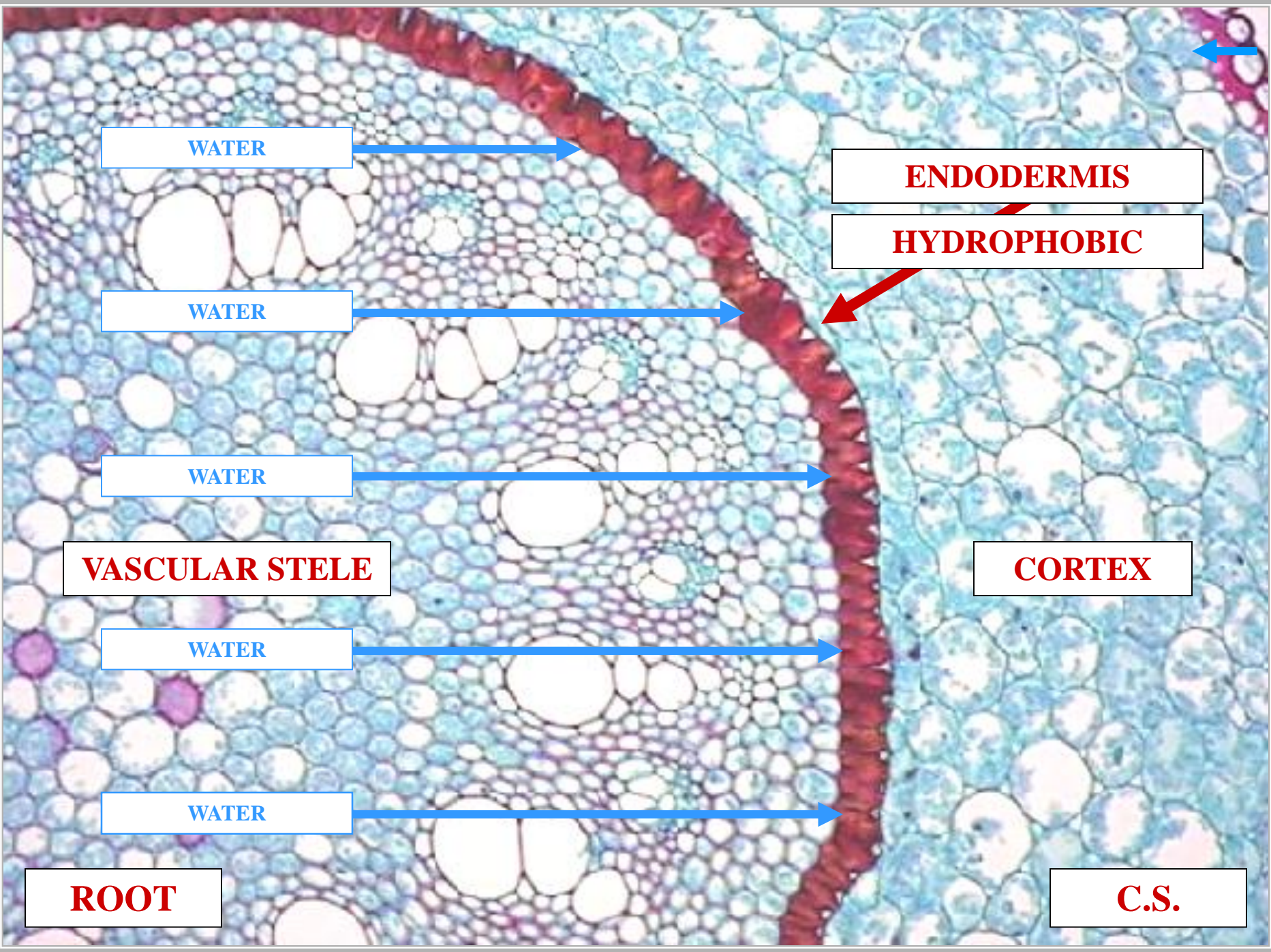
WATER



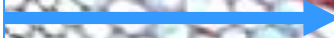
ROOT

C.S.





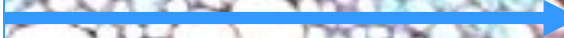
WATER



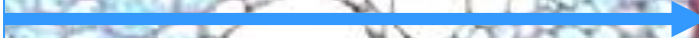
ENDODERMIS

HYDROPHOBIC

WATER



WATER



VASCULAR STELE

CORTEX

WATER



WATER



ROOT

C.S.

H

WATER

WATER

WATER

VASCULAR STELE

WATER

WATER

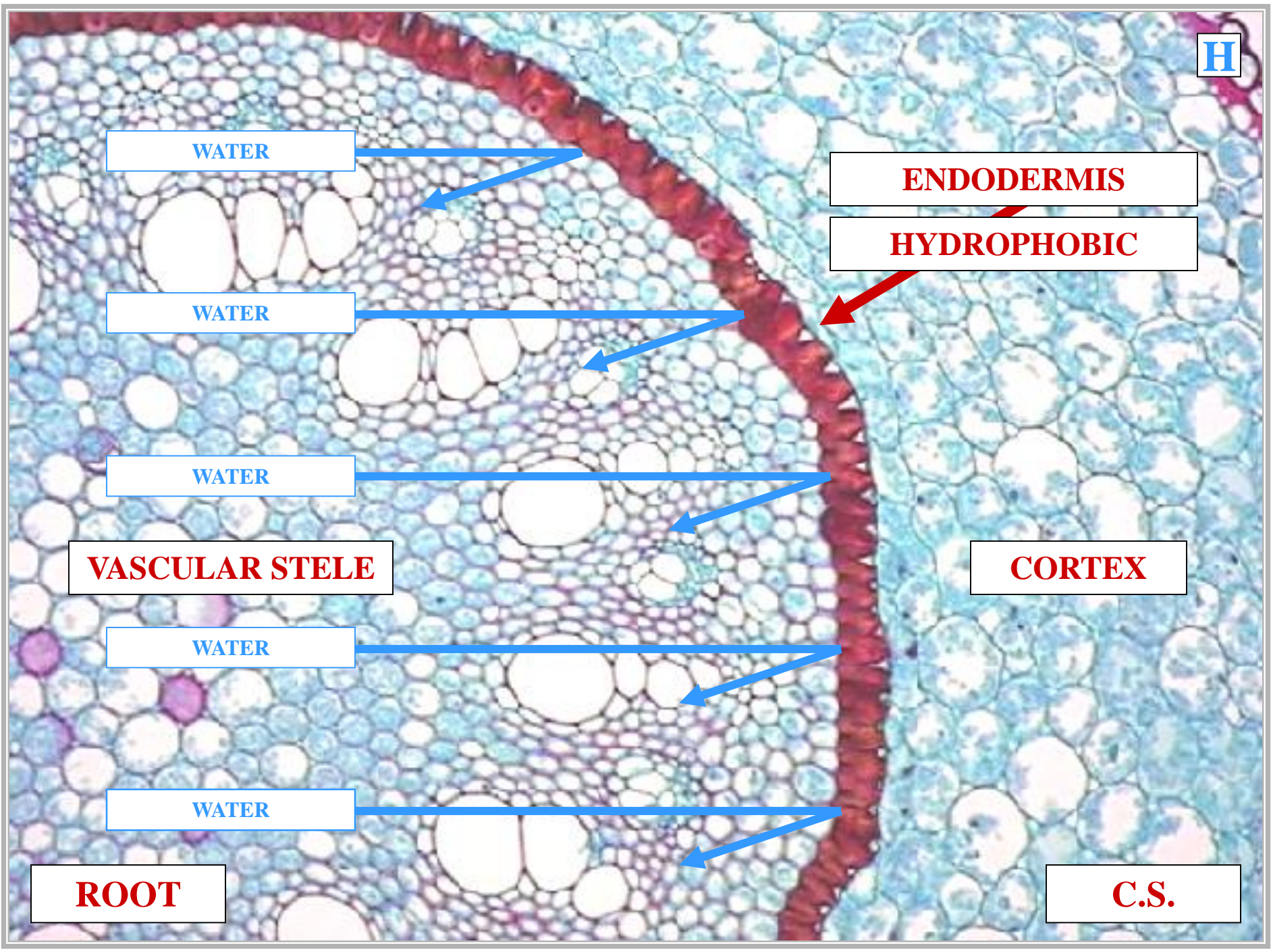
ENDODERMIS

HYDROPHOBIC

CORTEX

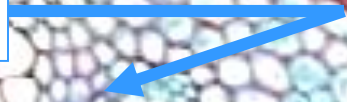
ROOT

C.S.





HIGH WATER PRESSURE

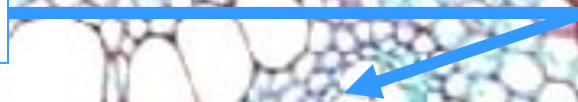


ENDODERMIS

HYDROPHOBIC



HIGH WATER PRESSURE



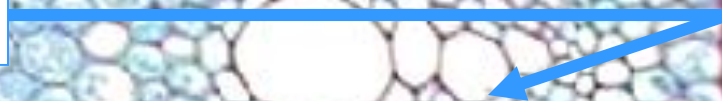
HIGH WATER PRESSURE



VASCULAR STELE

CORTEX

HIGH WATER PRESSURE

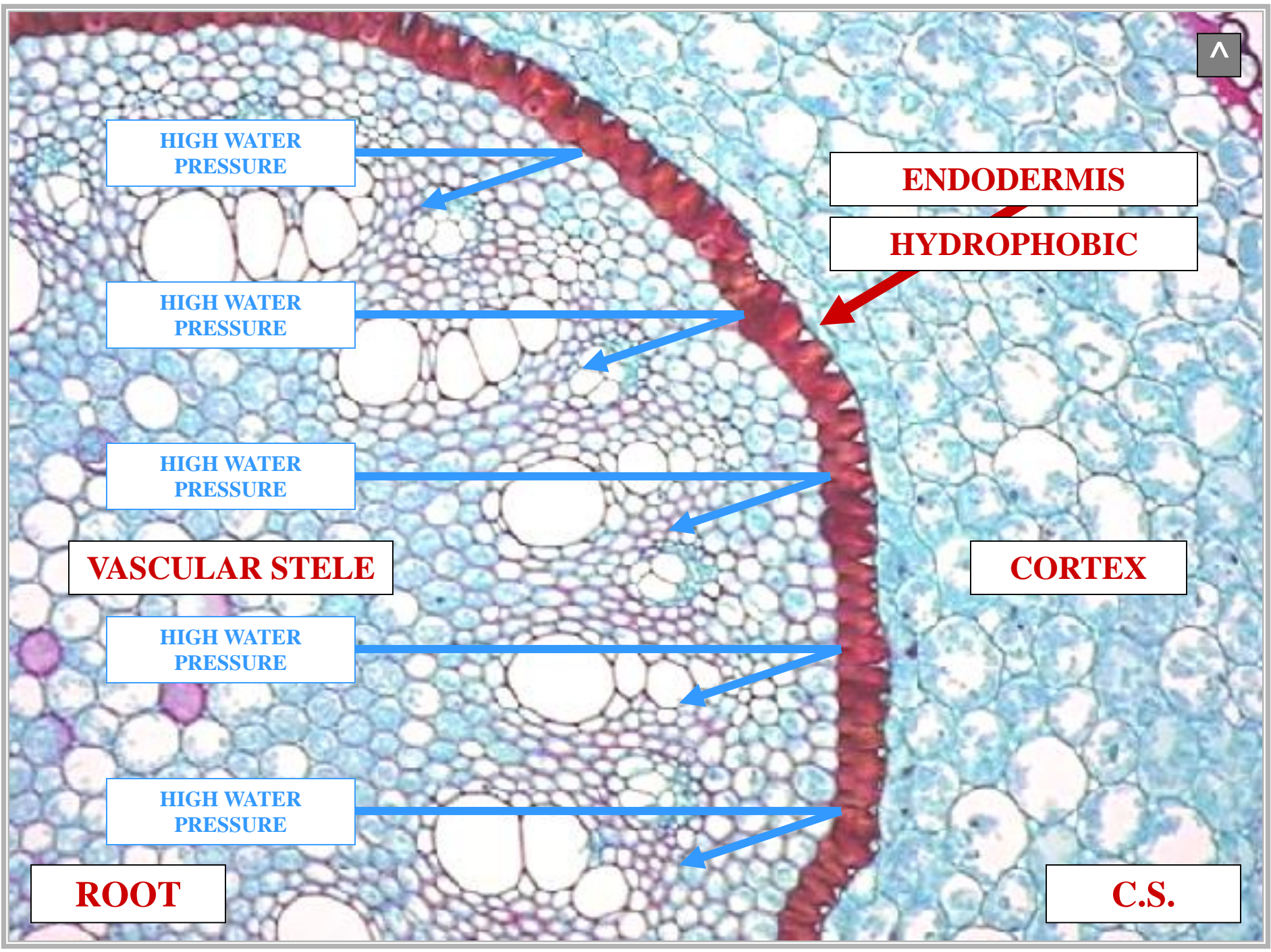


HIGH WATER PRESSURE



ROOT

C.S.





ROOT

VASCULAR TISSUE



VS

**ROOT
VASCULAR TISSUE
PRIMARY
MERISTEM**

ROOT

L.S

VASCULAR STELE

?

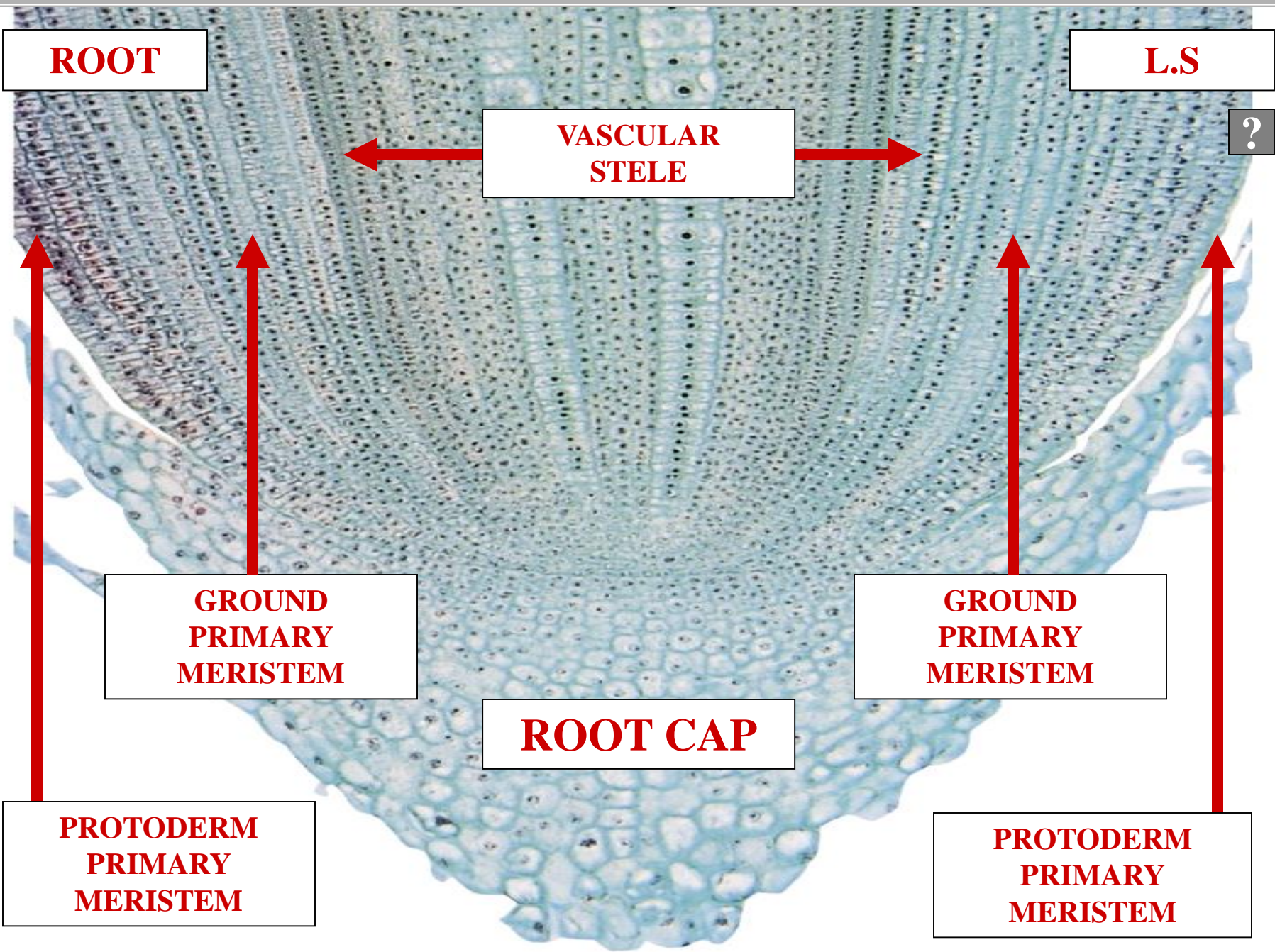
**GROUND
PRIMARY
MERISTEM**

**GROUND
PRIMARY
MERISTEM**

ROOT CAP

**PROTODERM
PRIMARY
MERISTEM**

**PROTODERM
PRIMARY
MERISTEM**



ROOT

L.S

**?
PRIMARY
MERISTEM**

P

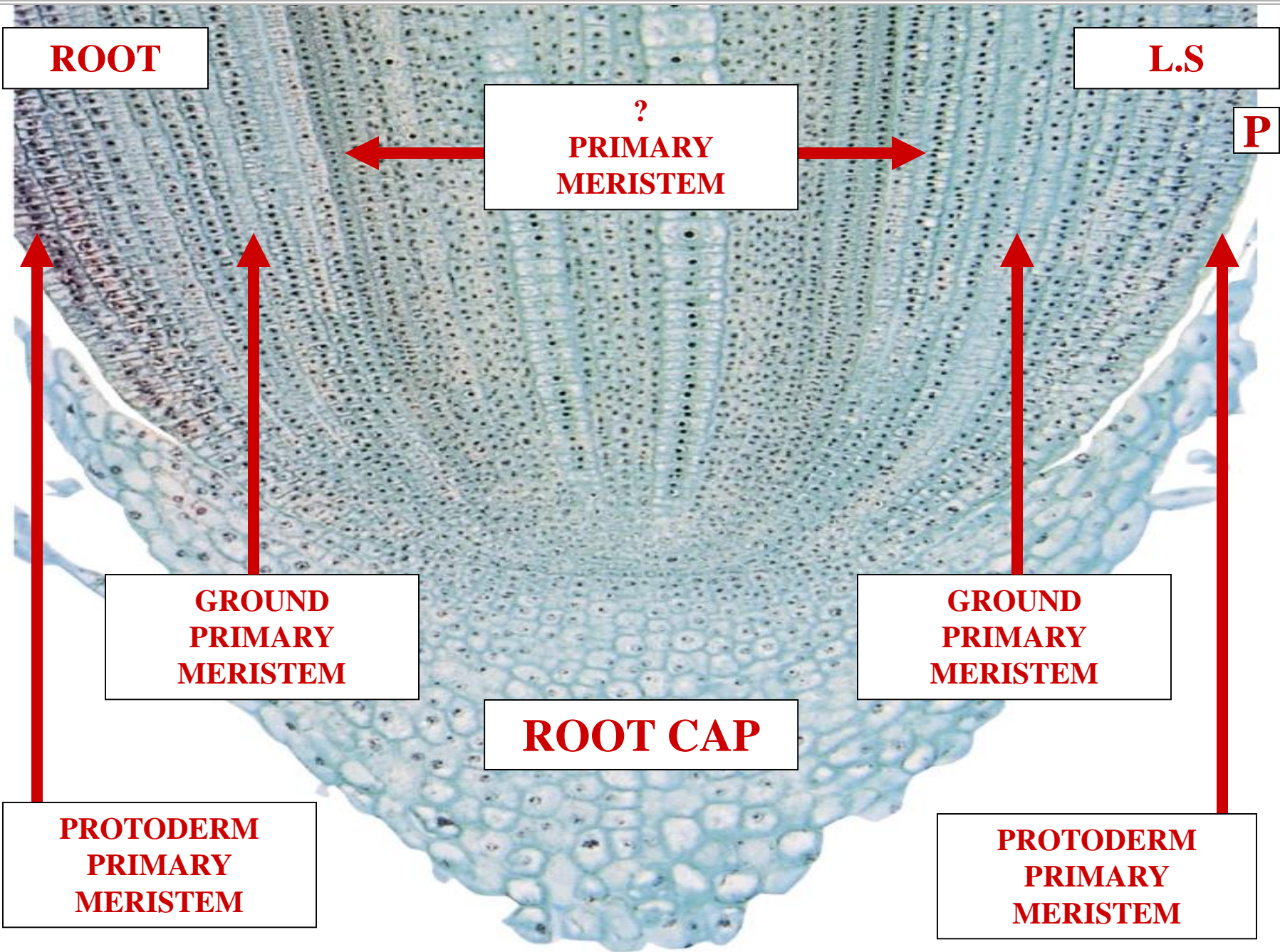
**GROUND
PRIMARY
MERISTEM**

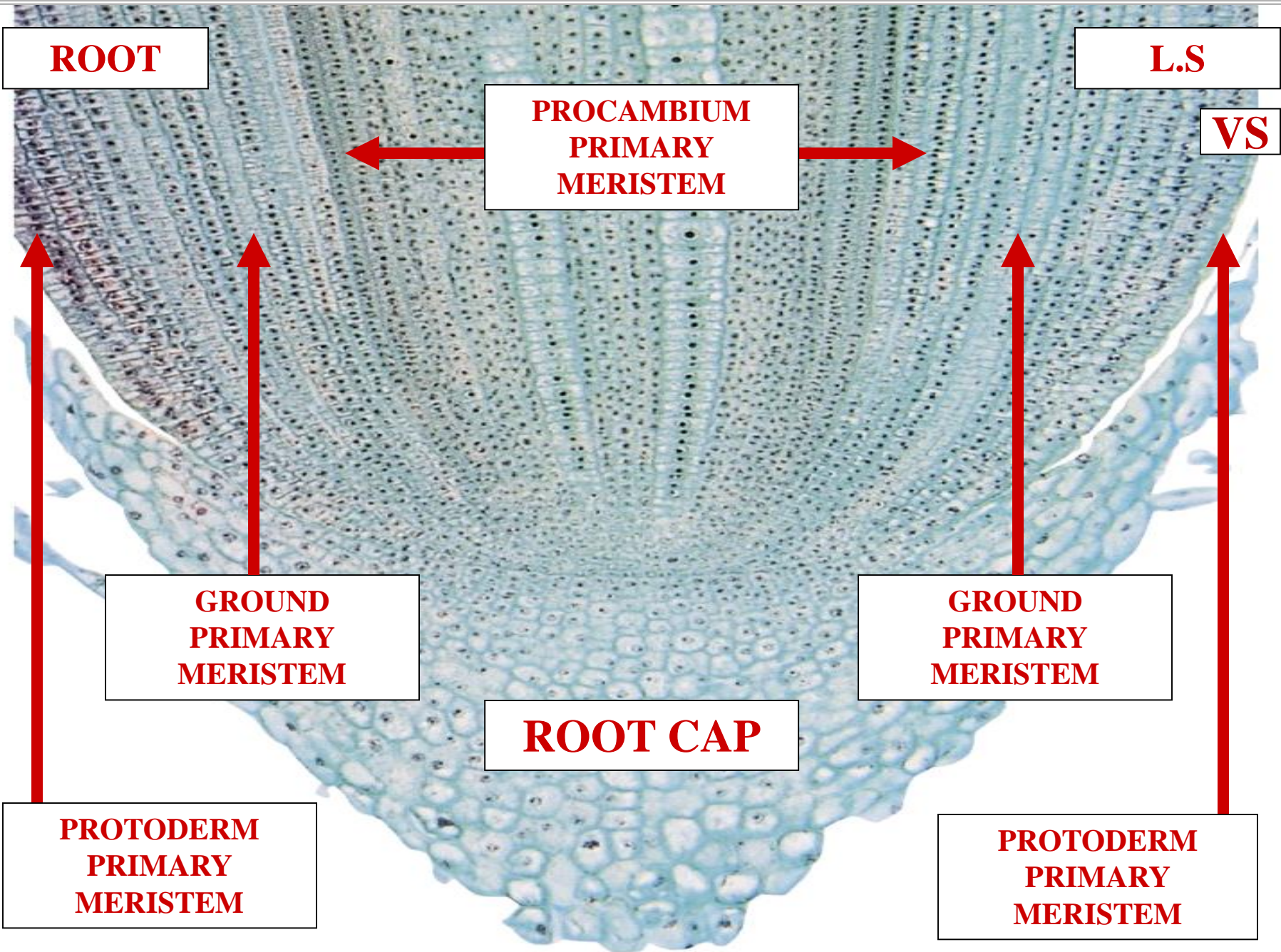
**GROUND
PRIMARY
MERISTEM**

ROOT CAP

**PROTODERM
PRIMARY
MERISTEM**

**PROTODERM
PRIMARY
MERISTEM**





ROOT

L.S

VS

**PROCAMBIUM
PRIMARY
MERISTEM**

**GROUND
PRIMARY
MERISTEM**

**GROUND
PRIMARY
MERISTEM**

ROOT CAP

**PROTODERM
PRIMARY
MERISTEM**

**PROTODERM
PRIMARY
MERISTEM**

ROOT

L.S

VASCULAR STELE



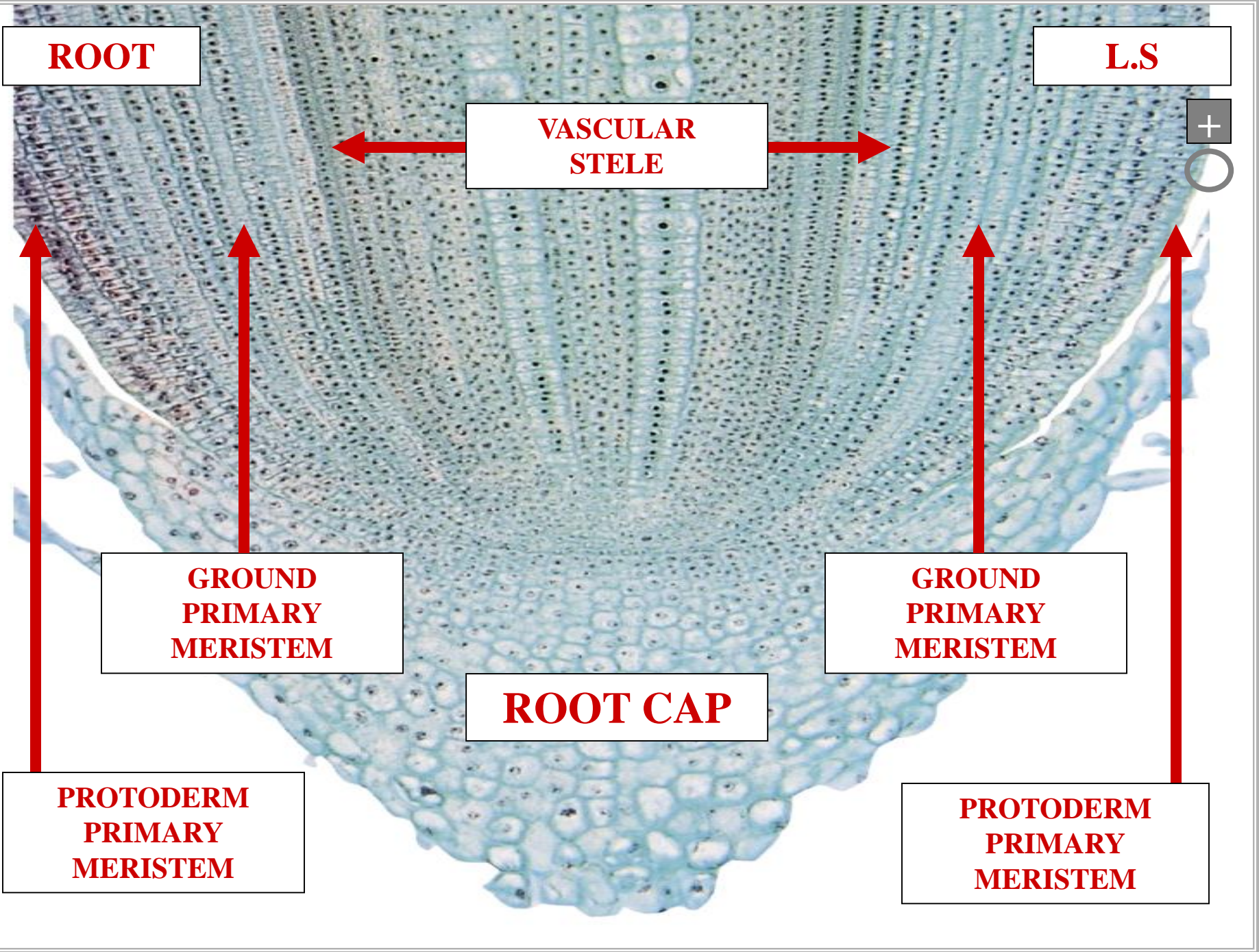
**GROUND
PRIMARY
MERISTEM**

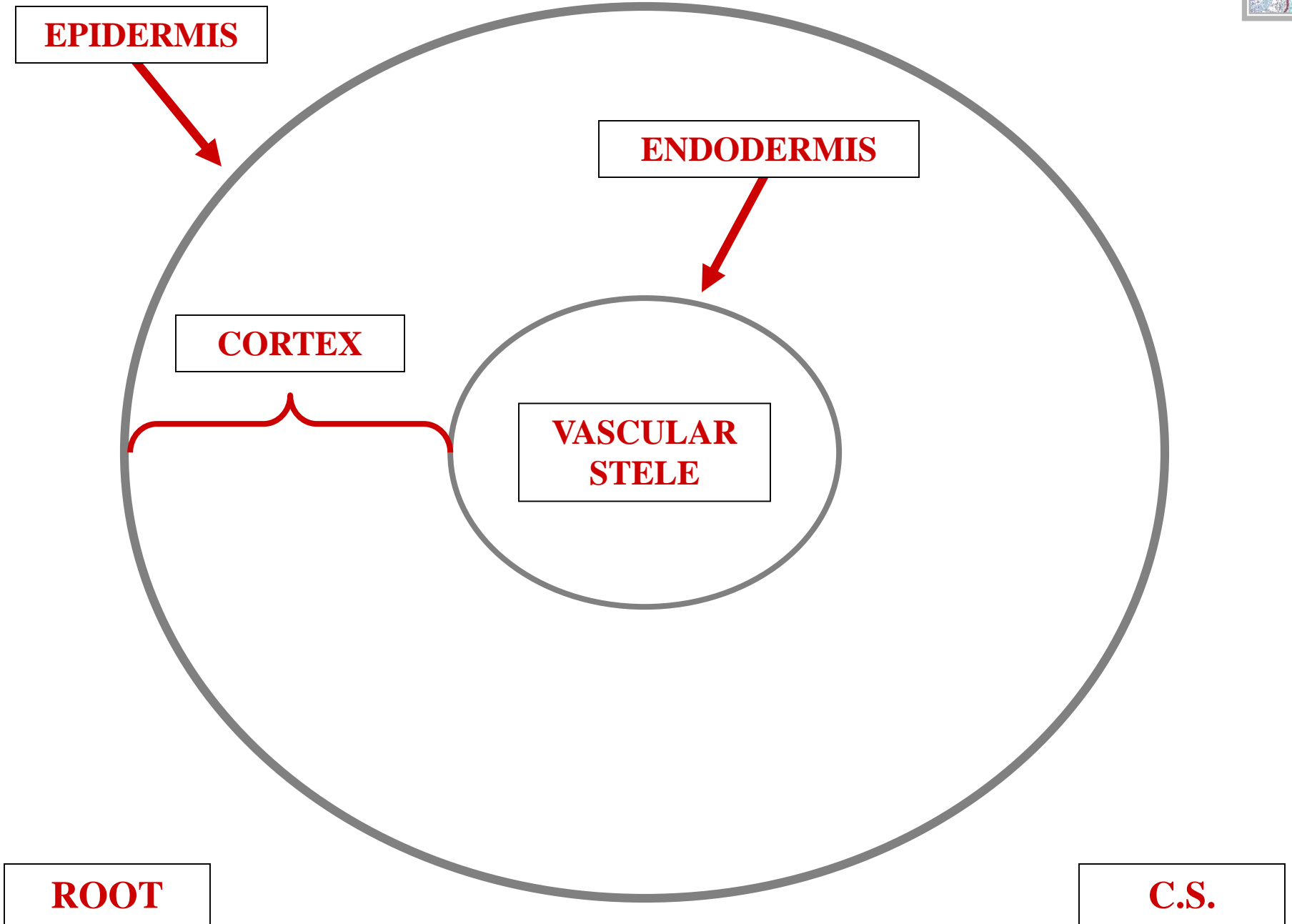
**GROUND
PRIMARY
MERISTEM**

ROOT CAP

**PROTODERM
PRIMARY
MERISTEM**

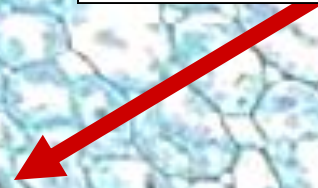
**PROTODERM
PRIMARY
MERISTEM**







ENDODERMIS

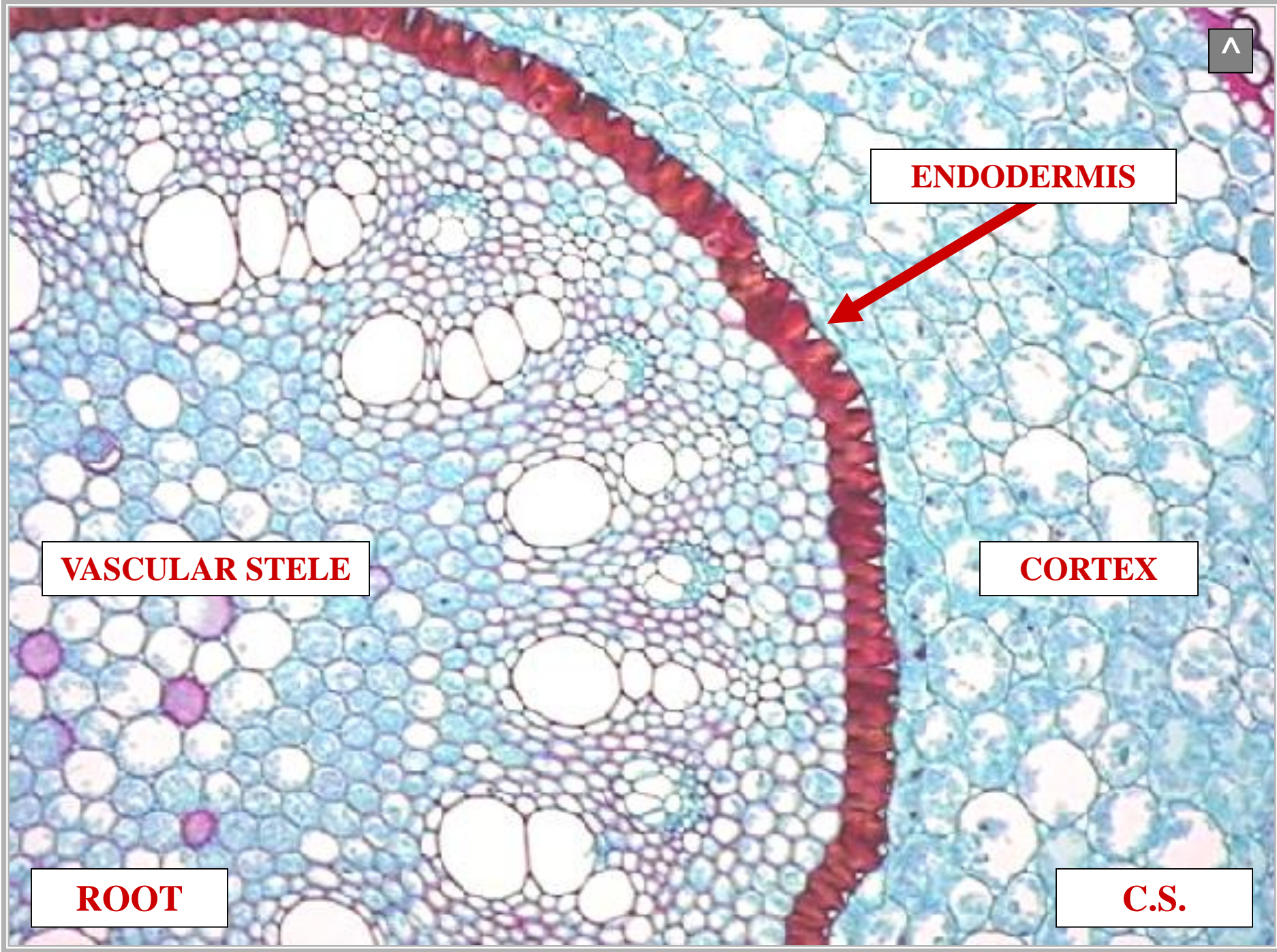


VASCULAR STELE

CORTEX

ROOT

C.S.



ROOT PERICYCLE

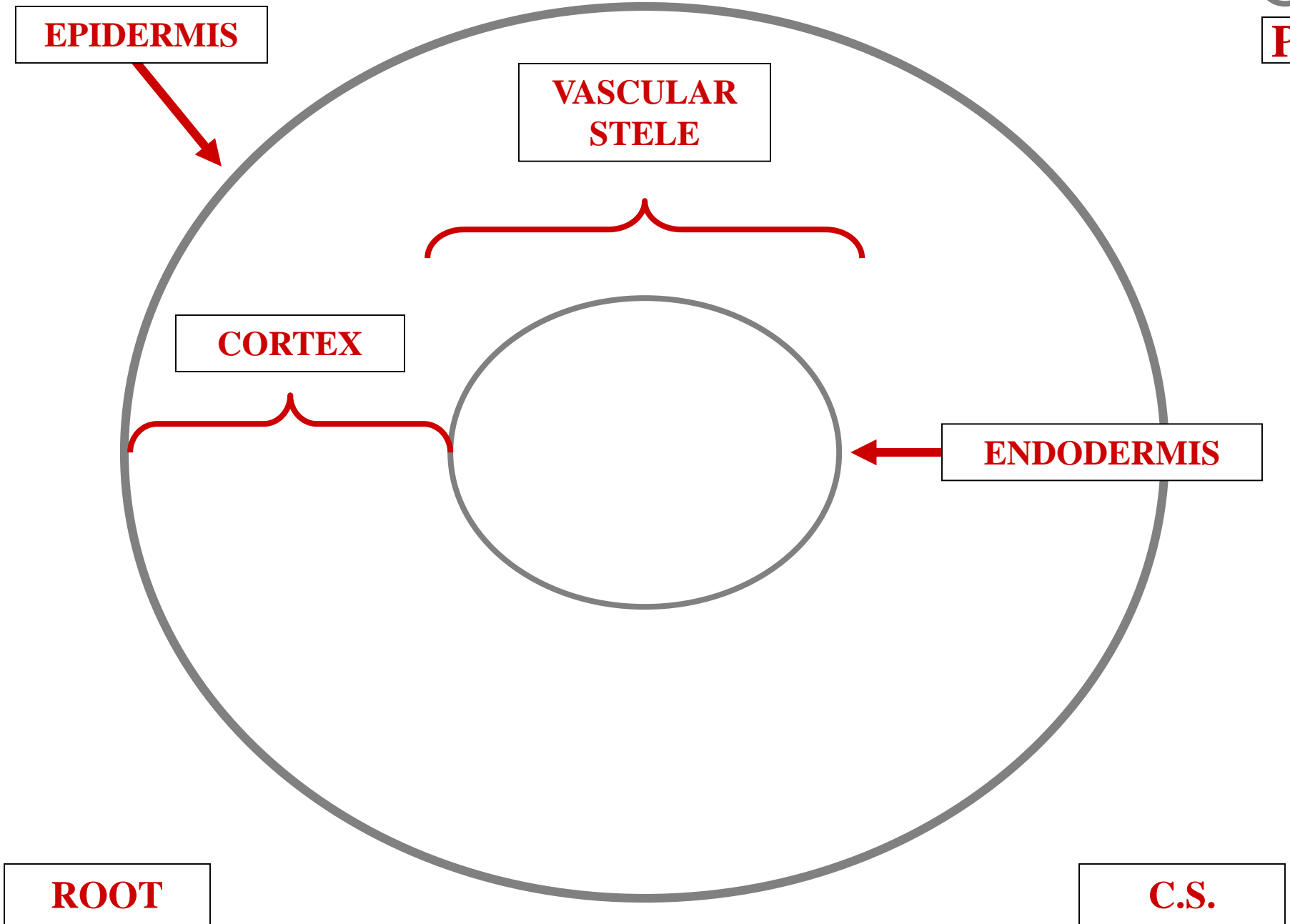
PERICYCLE

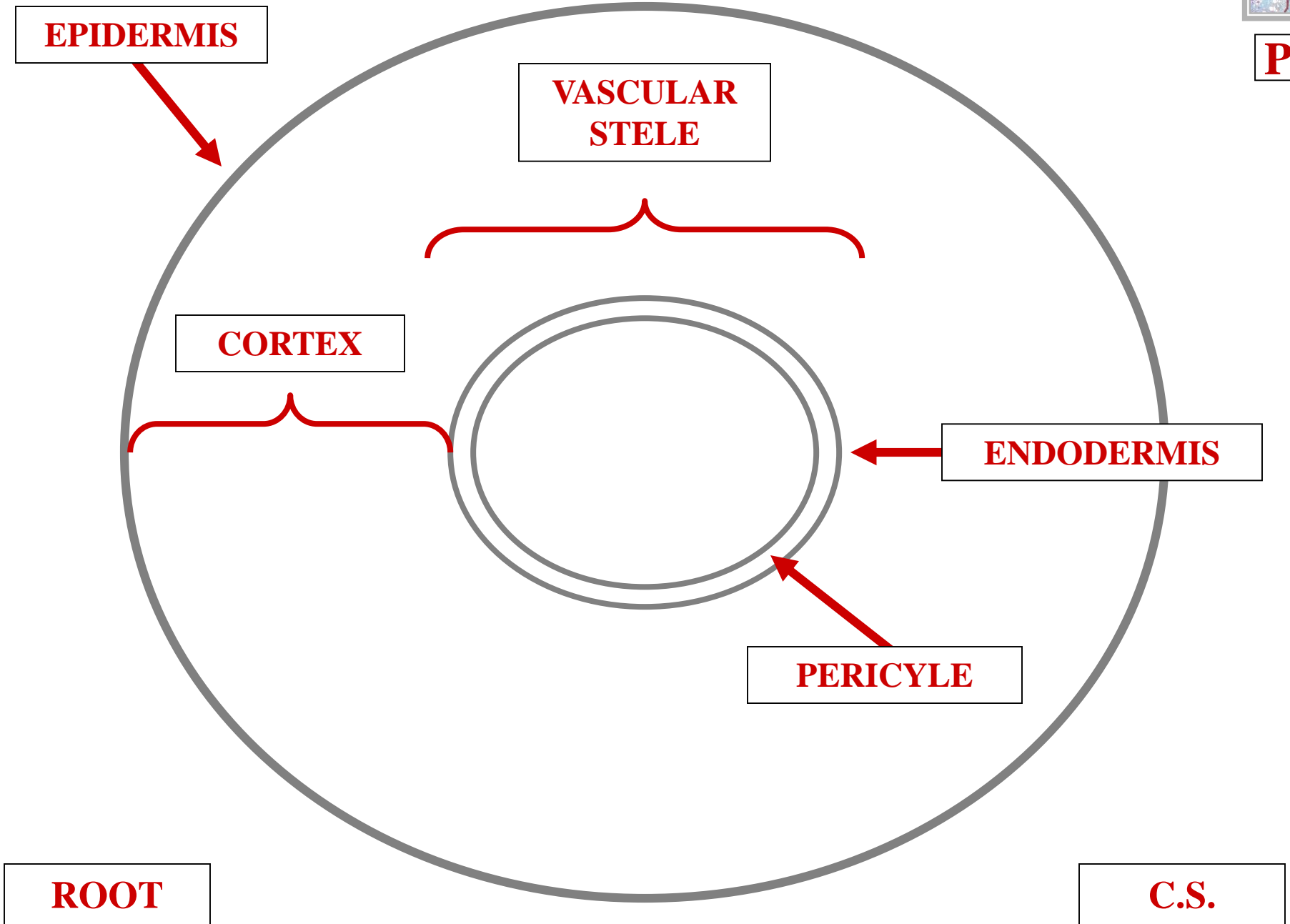


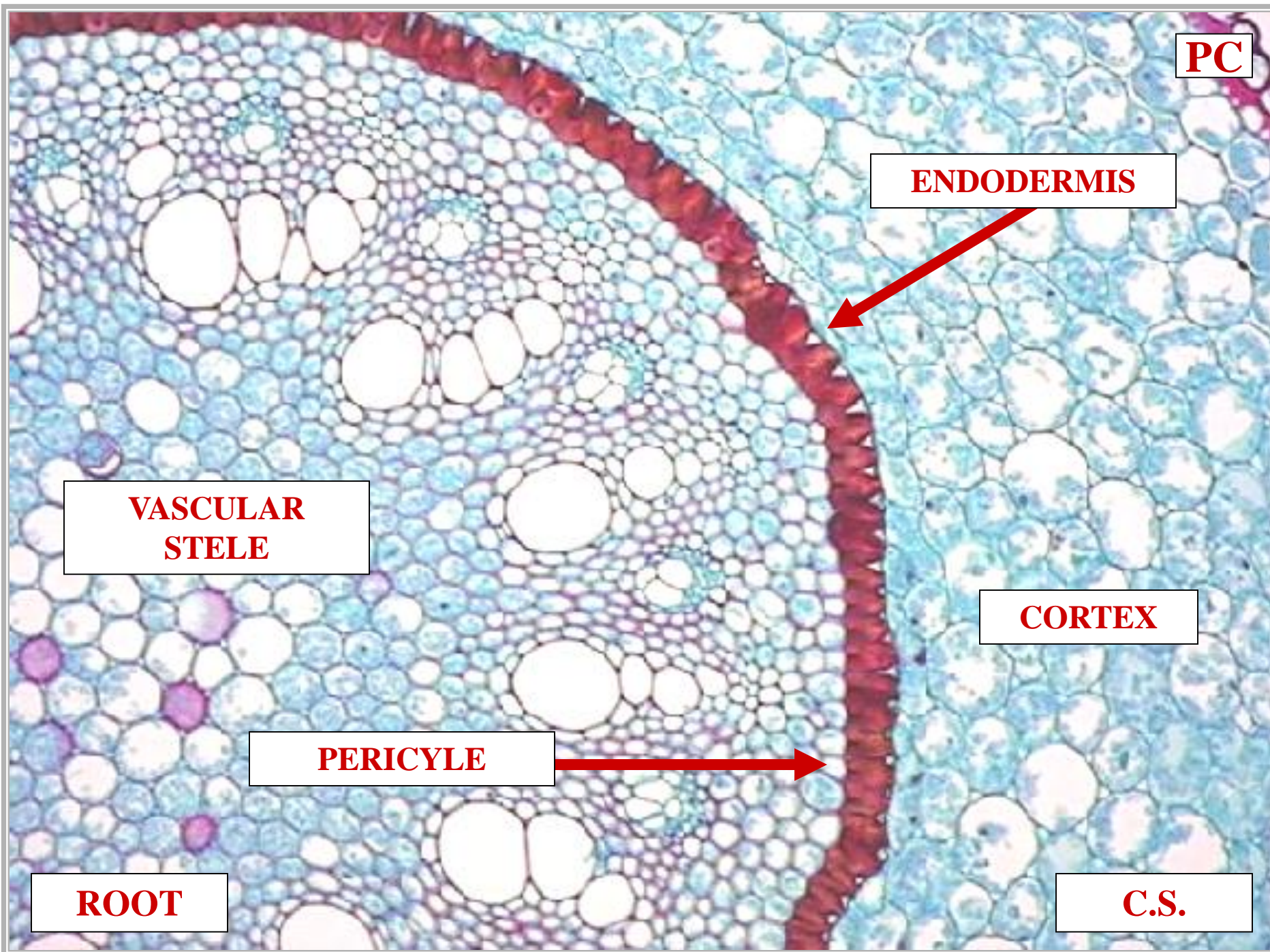
ROOT ANATOMY
PERICYCLE

OUTERMOST
STELE CELL LAYER

ROOT ANATOMY
PERICYCLE







PC

ENDODERMIS

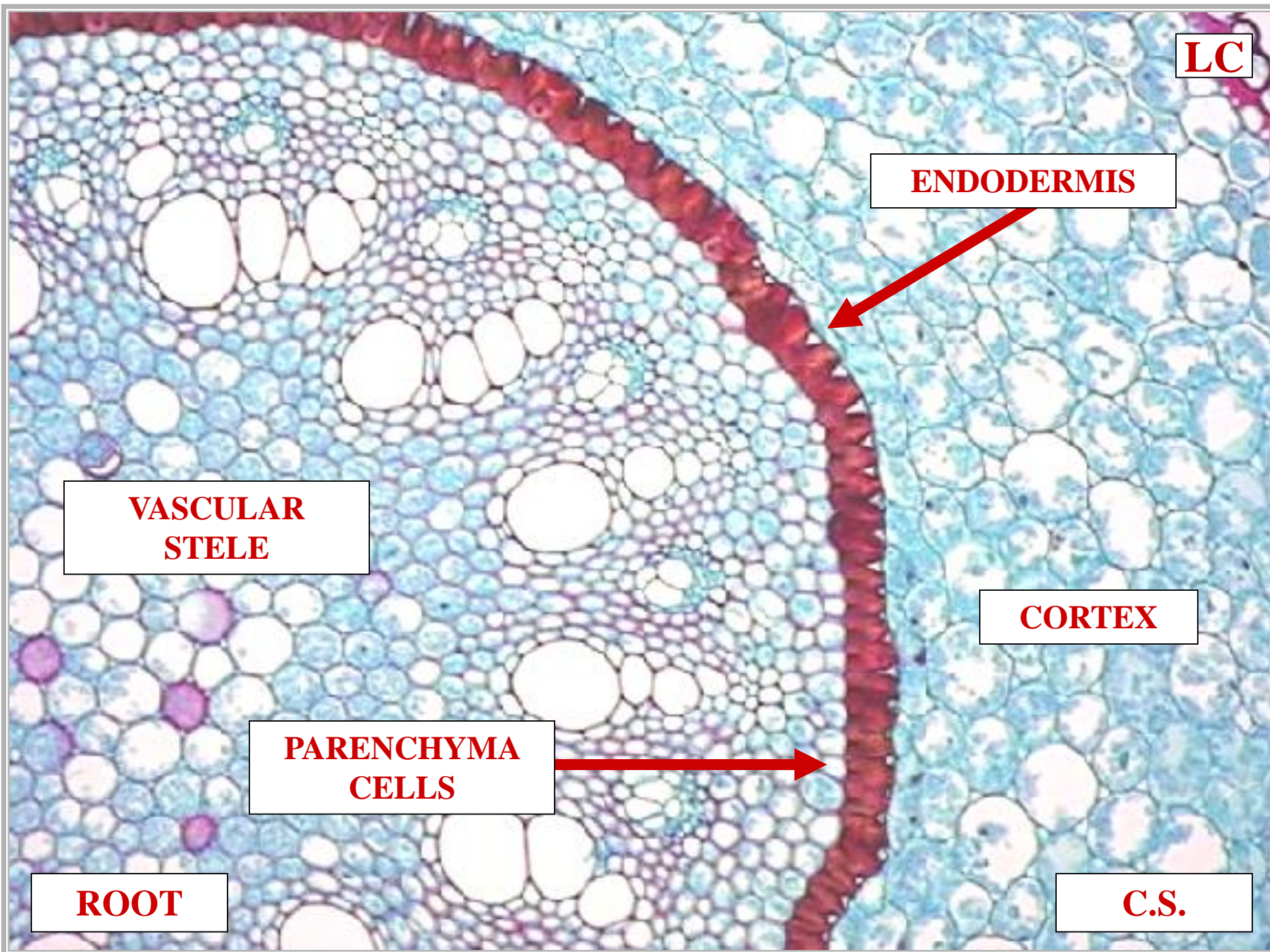
VASCULAR STELE

CORTEX

PERICYCLE

ROOT

C.S.



LC

ENDODERMIS

VASCULAR STELE

CORTEX

PARENCHYMA CELLS

ROOT

C.S.

M

ENDODERMIS

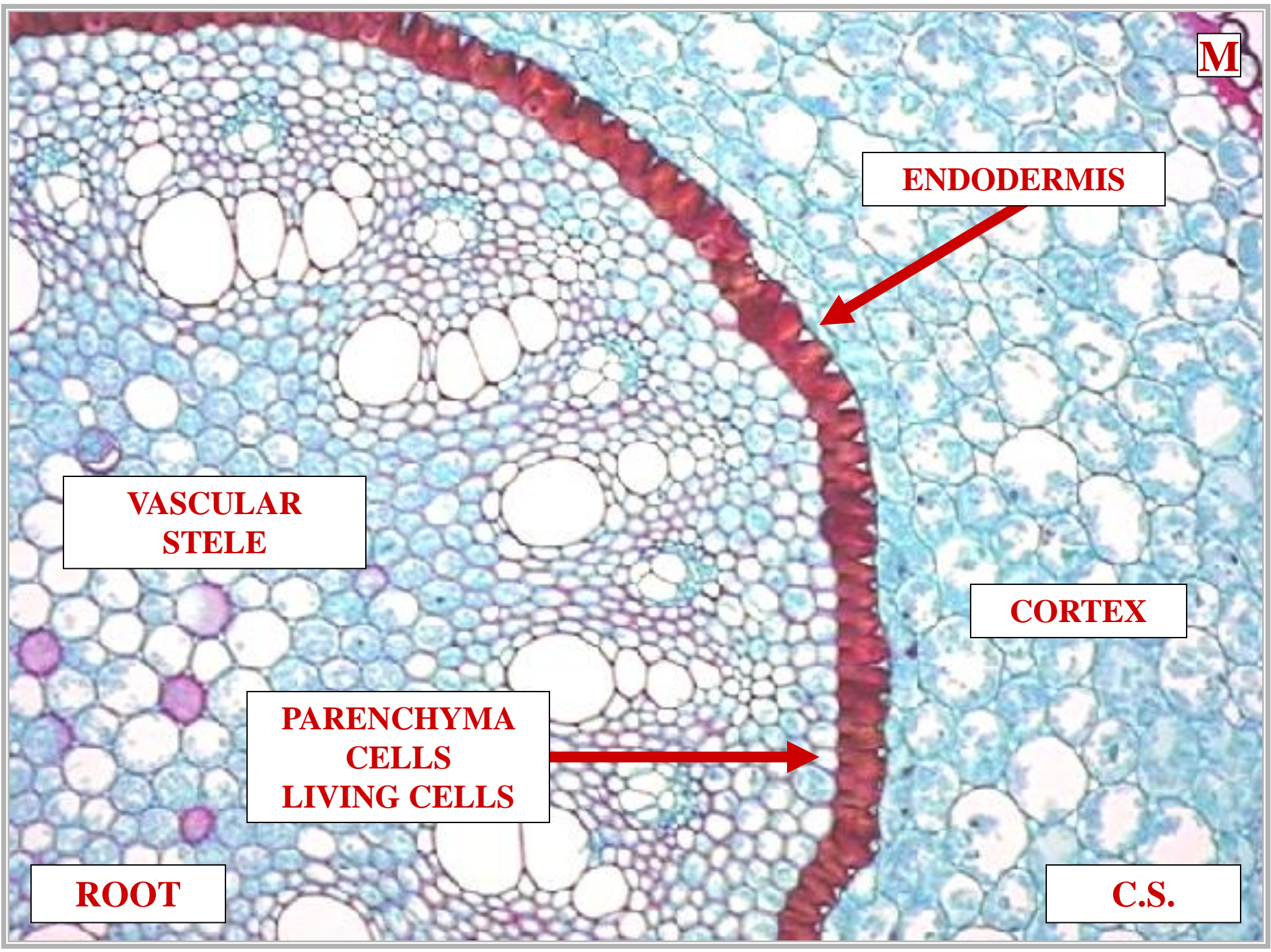
**VASCULAR
STELE**

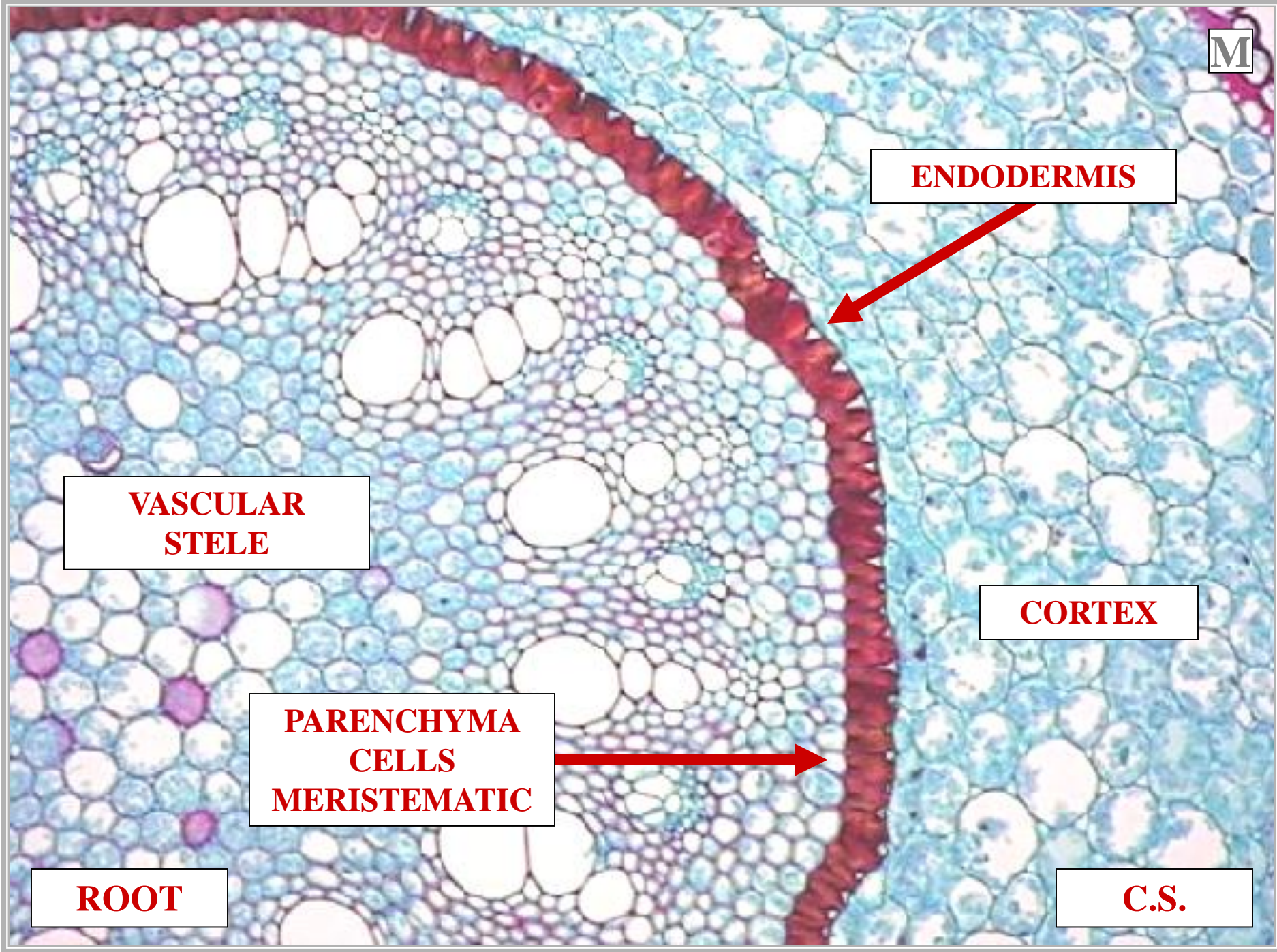
CORTEX

**PARENCHYMA
CELLS
LIVING CELLS**

ROOT

C.S.





ENDODERMIS

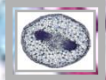
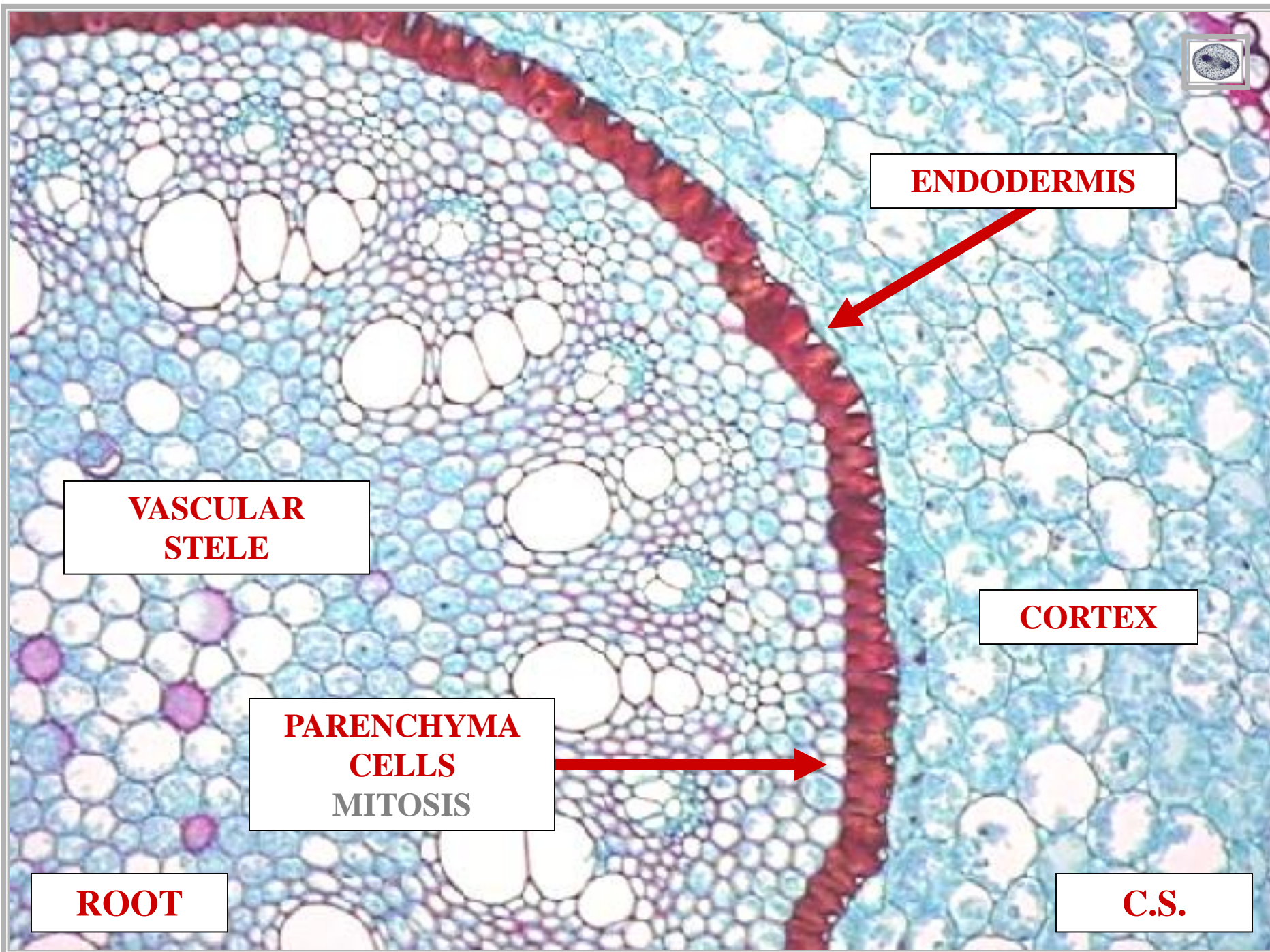
VASCULAR STELE

CORTEX

PARENCHYMA CELLS MERISTEMATIC

ROOT

C.S.



ENDODERMIS

VASCULAR STELE

CORTEX

PARENCHYMA CELLS MITOSIS

ROOT

C.S.

LATERAL ROOT

C.S.

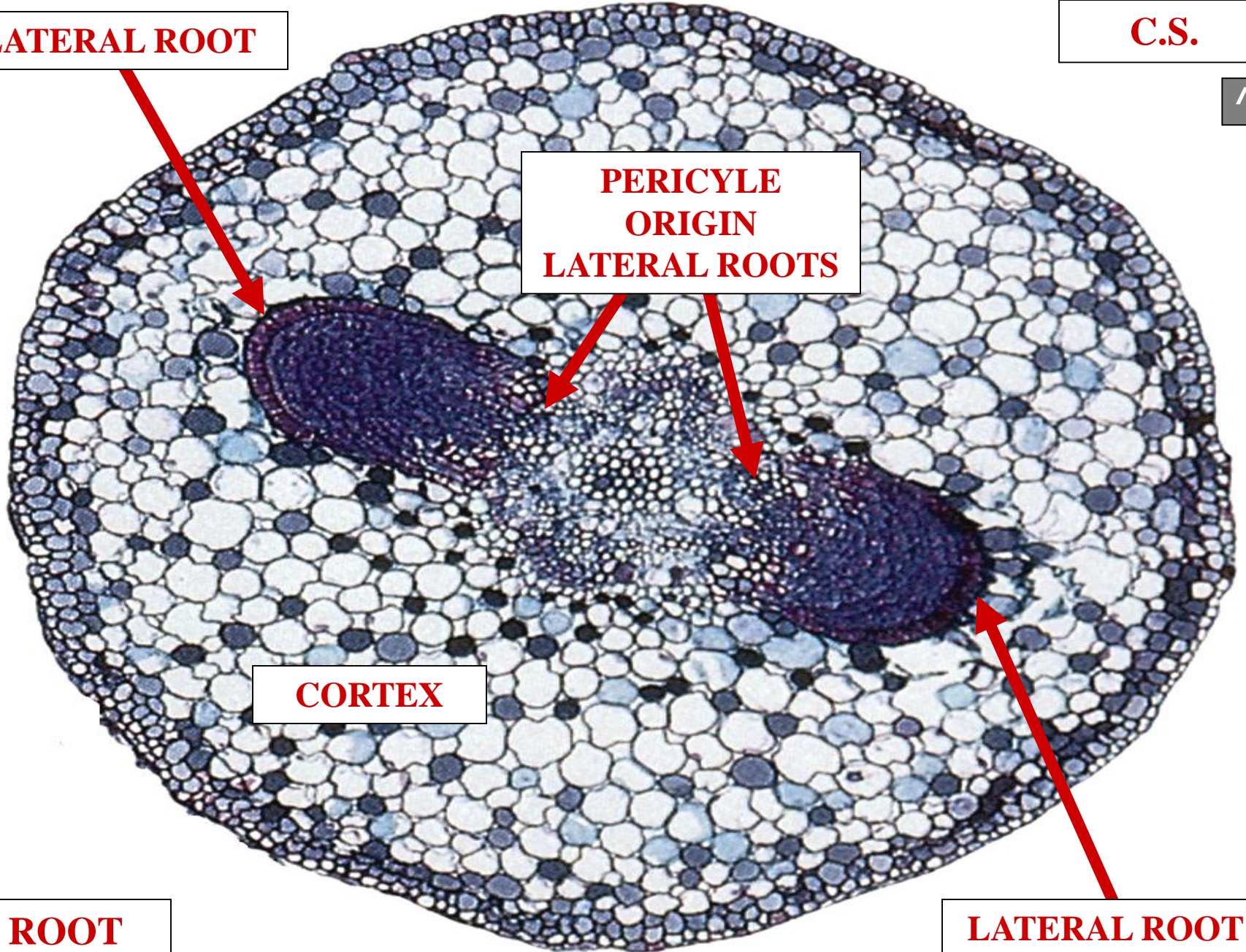


**PERICYLE
ORIGIN
LATERAL ROOTS**

CORTEX

ROOT

LATERAL ROOT



LATERAL ROOTS

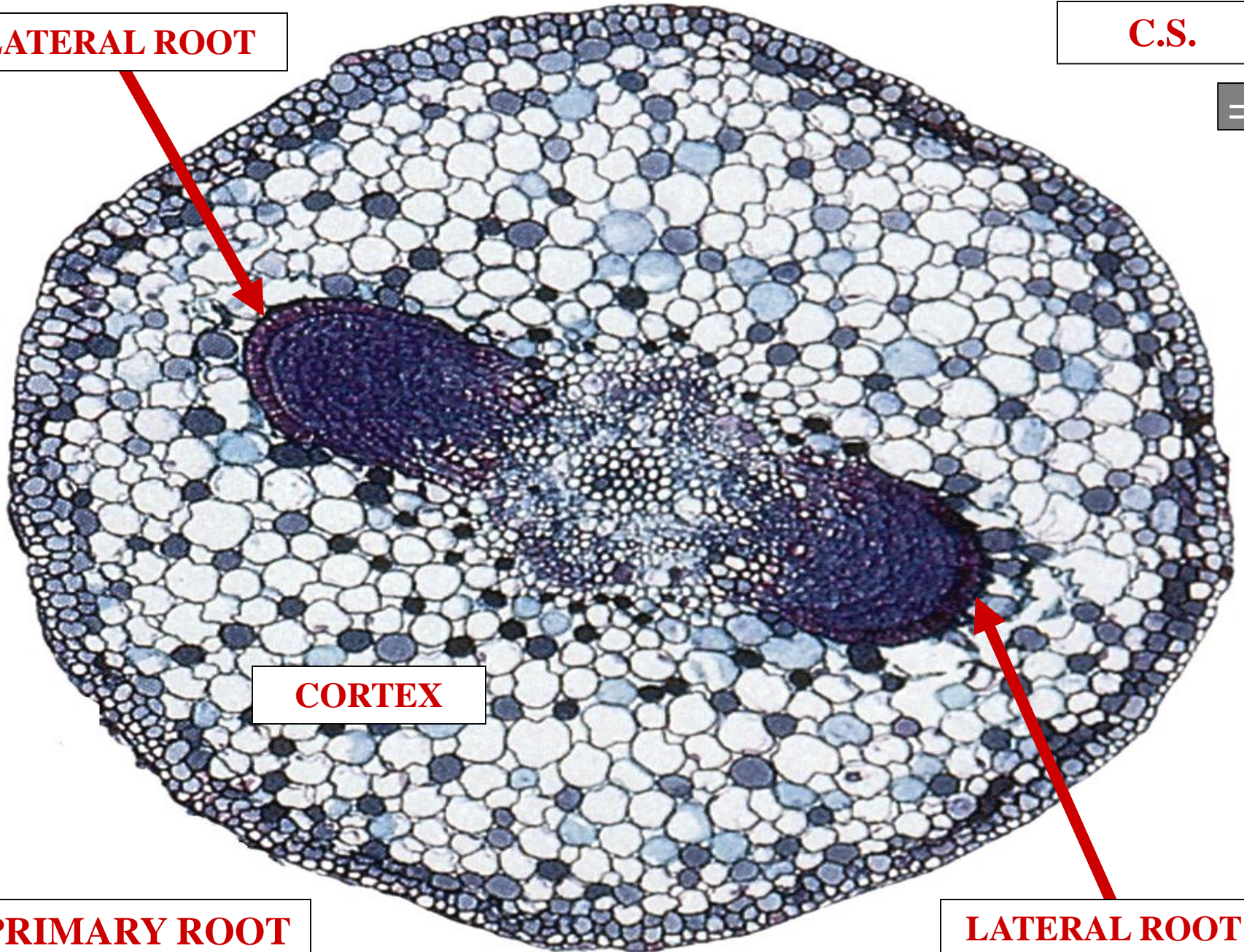


LATERAL ROOT

LATERAL ROOT

C.S.

=



CORTEX

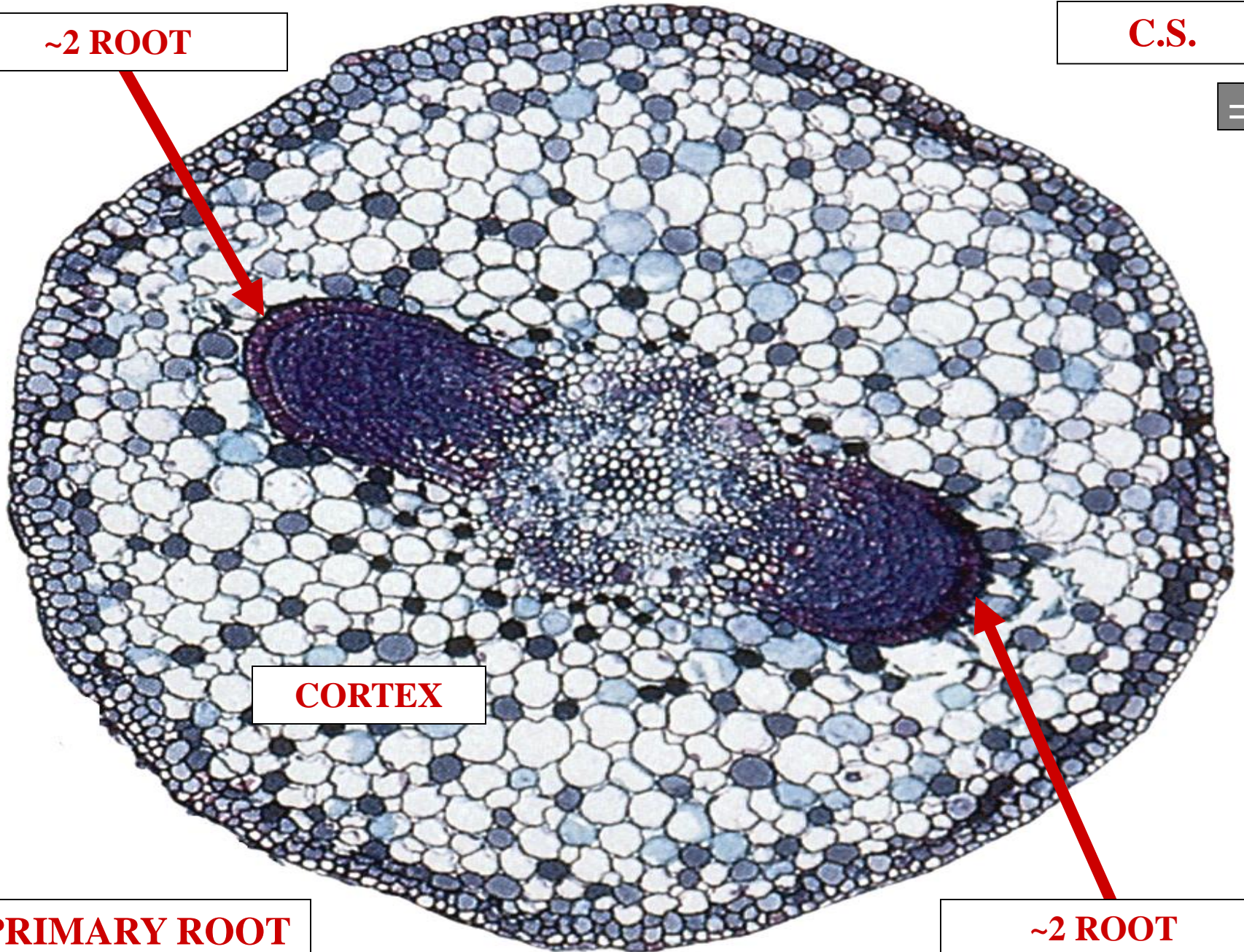
PRIMARY ROOT

LATERAL ROOT

C.S.

=

~2 ROOT



CORTEX

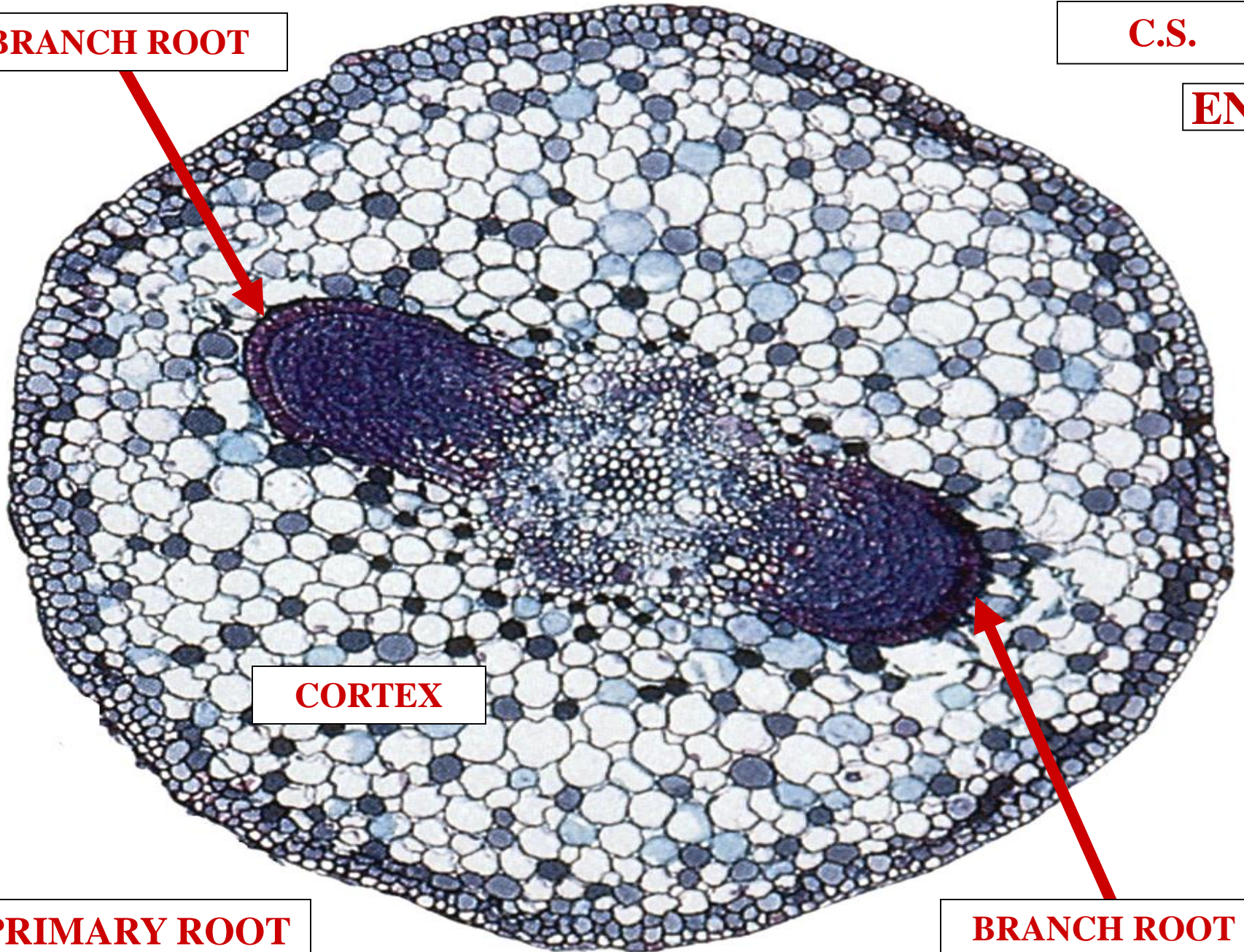
PRIMARY ROOT

~2 ROOT

BRANCH ROOT

C.S.

EN



CORTEX

PRIMARY ROOT

BRANCH ROOT

LATERAL ROOT

C.S.

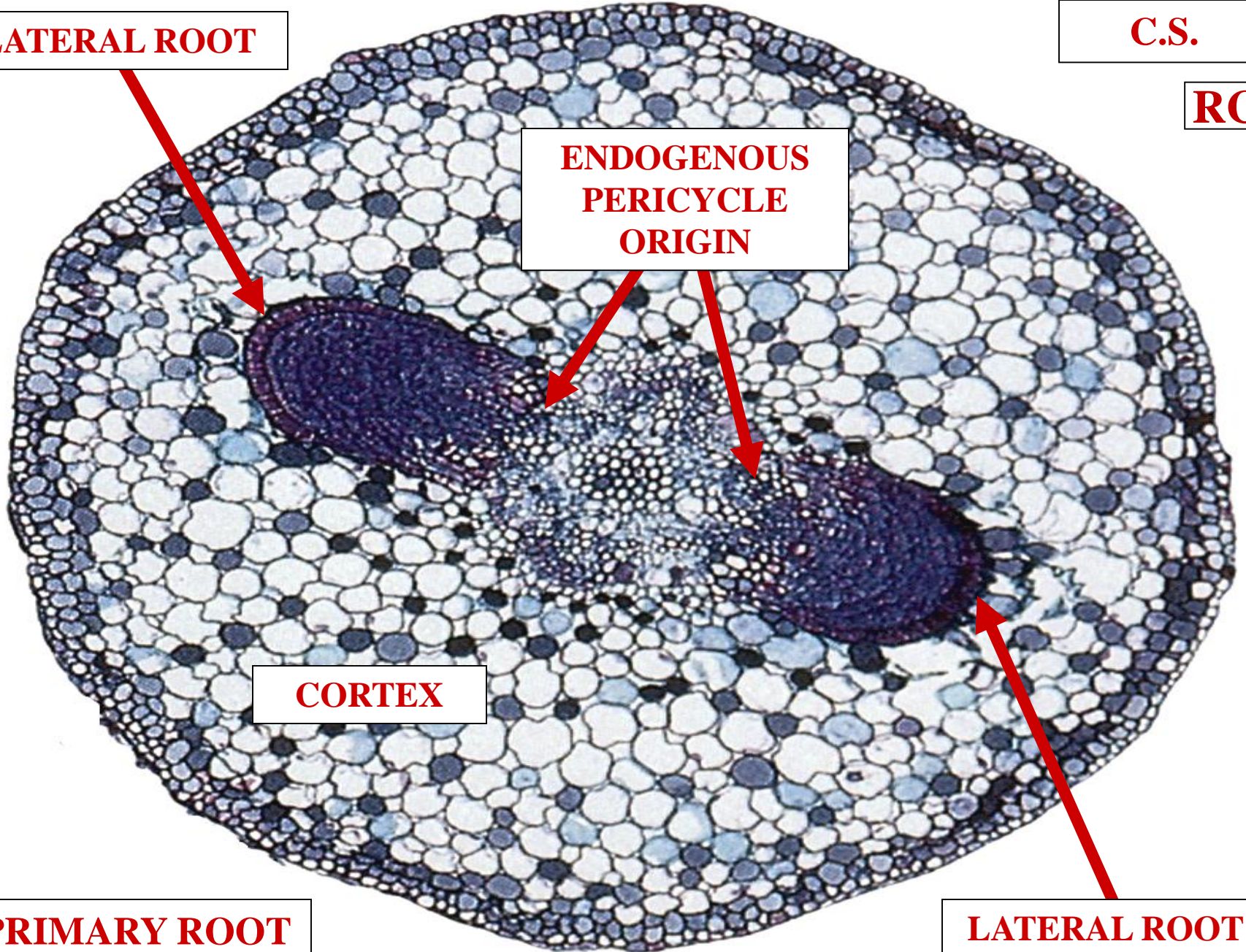
RC

**ENDOGENOUS
PERICYCLE
ORIGIN**

CORTEX

PRIMARY ROOT

LATERAL ROOT



ROOT CAP

C.S.

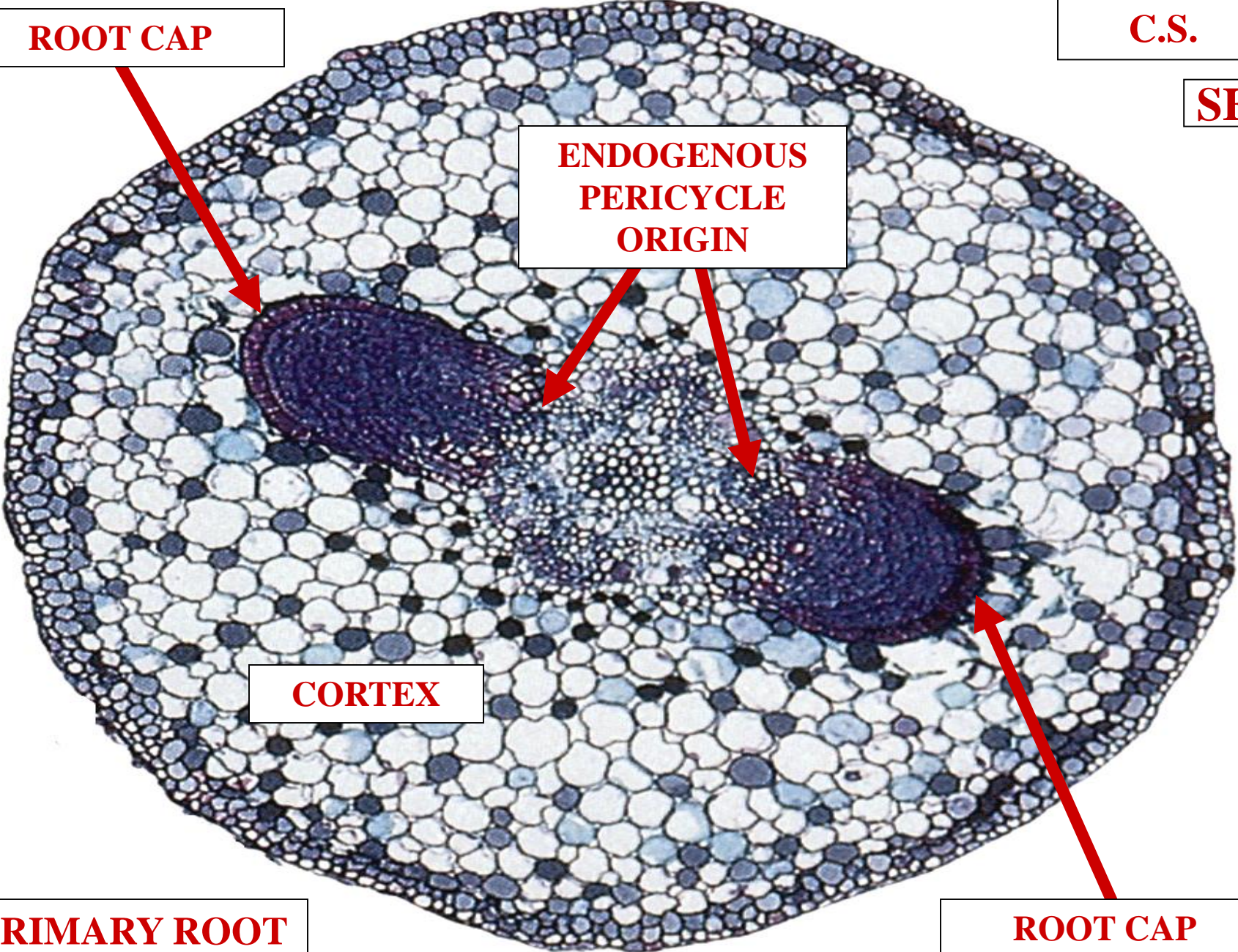
SE

**ENDOGENOUS
PERICYCLE
ORIGIN**

CORTEX

PRIMARY ROOT

ROOT CAP



**SECRETES
ENZYMES**

C.S.

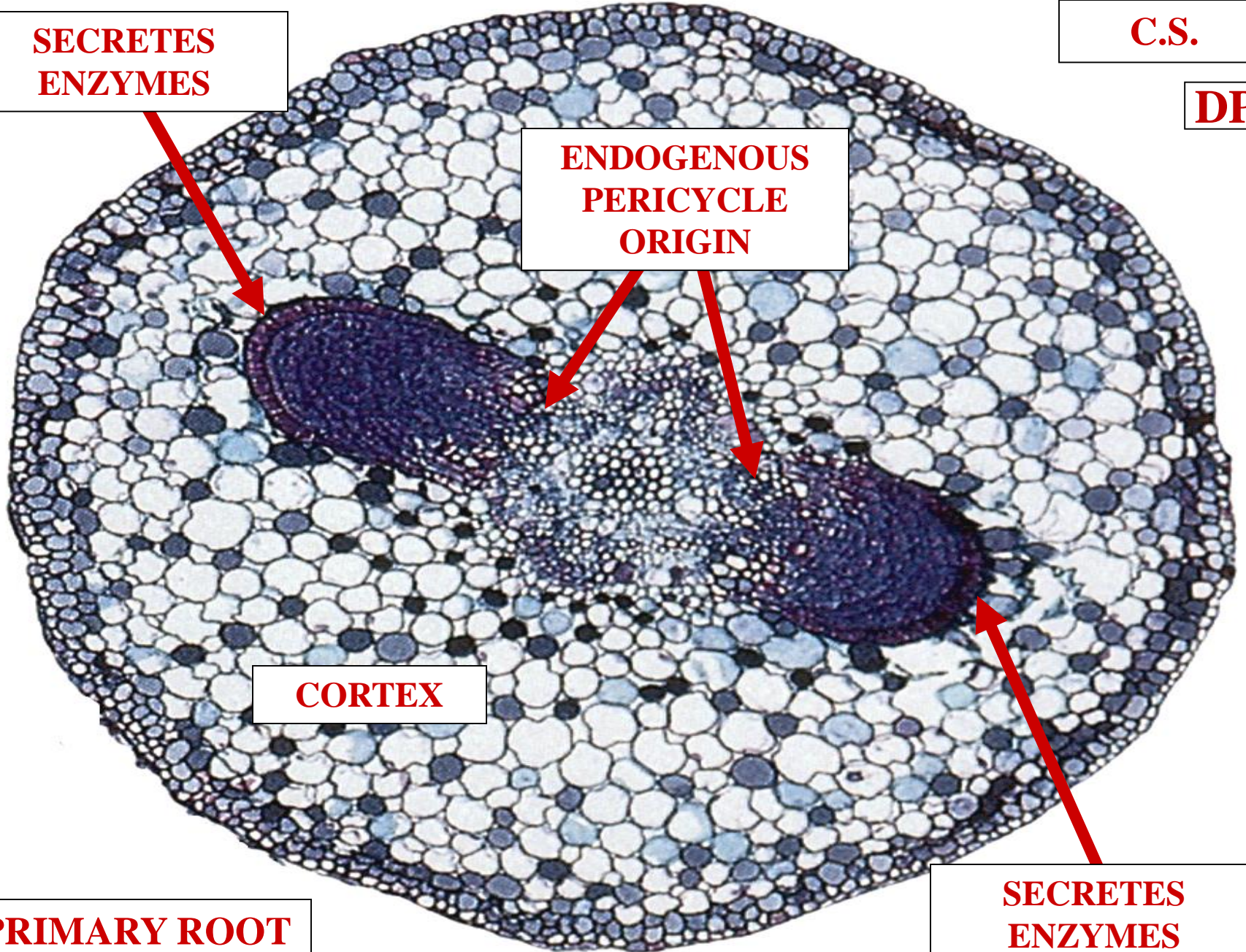
DP

**ENDOGENOUS
PERICYCLE
ORIGIN**

CORTEX

PRIMARY ROOT

**SECRETES
ENZYMES**



C.S.



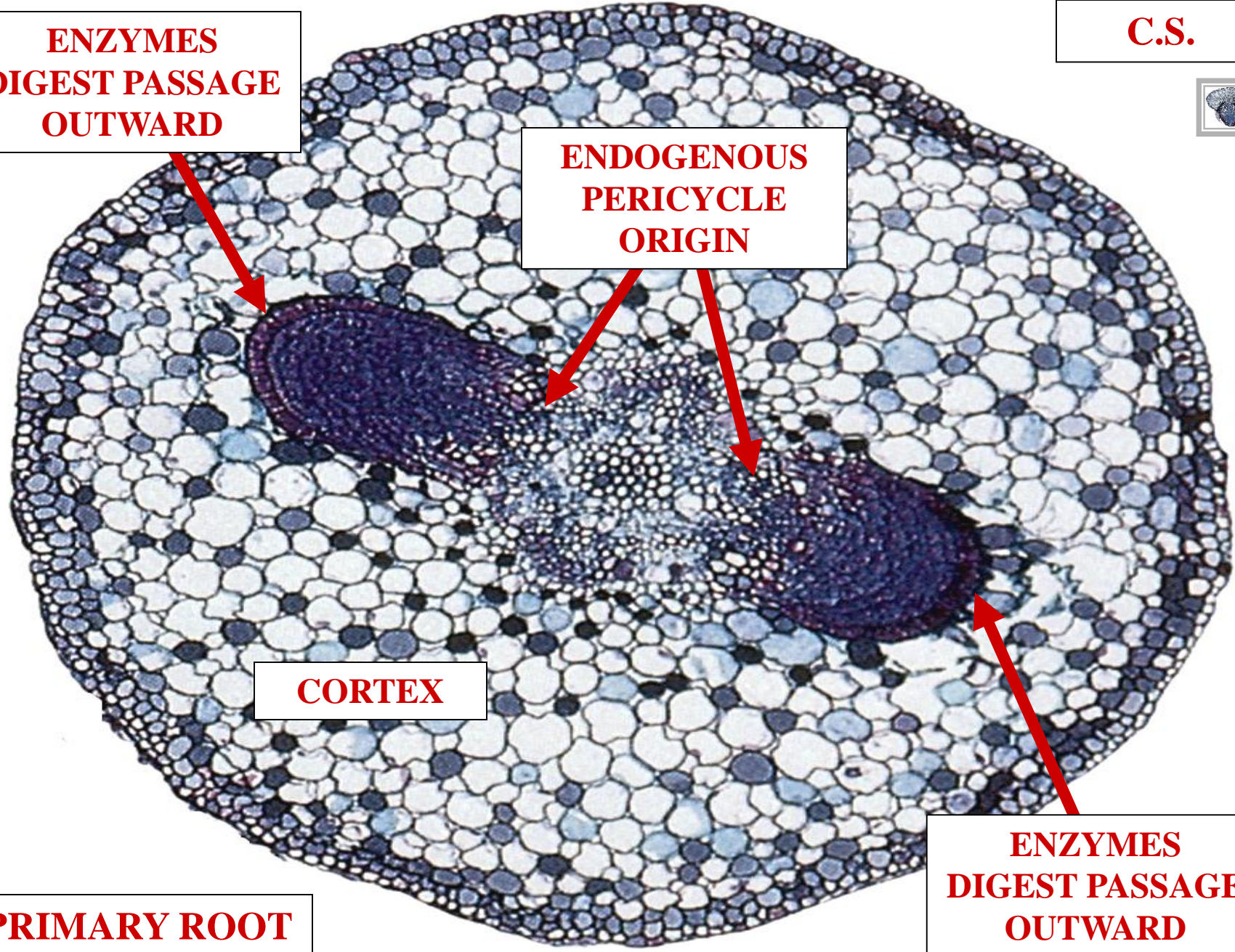
**ENZYMES
DIGEST PASSAGE
OUTWARD**

**ENDOGENOUS
PERICYCLE
ORIGIN**

CORTEX

**ENZYMES
DIGEST PASSAGE
OUTWARD**

PRIMARY ROOT



PRIMARY ROOT

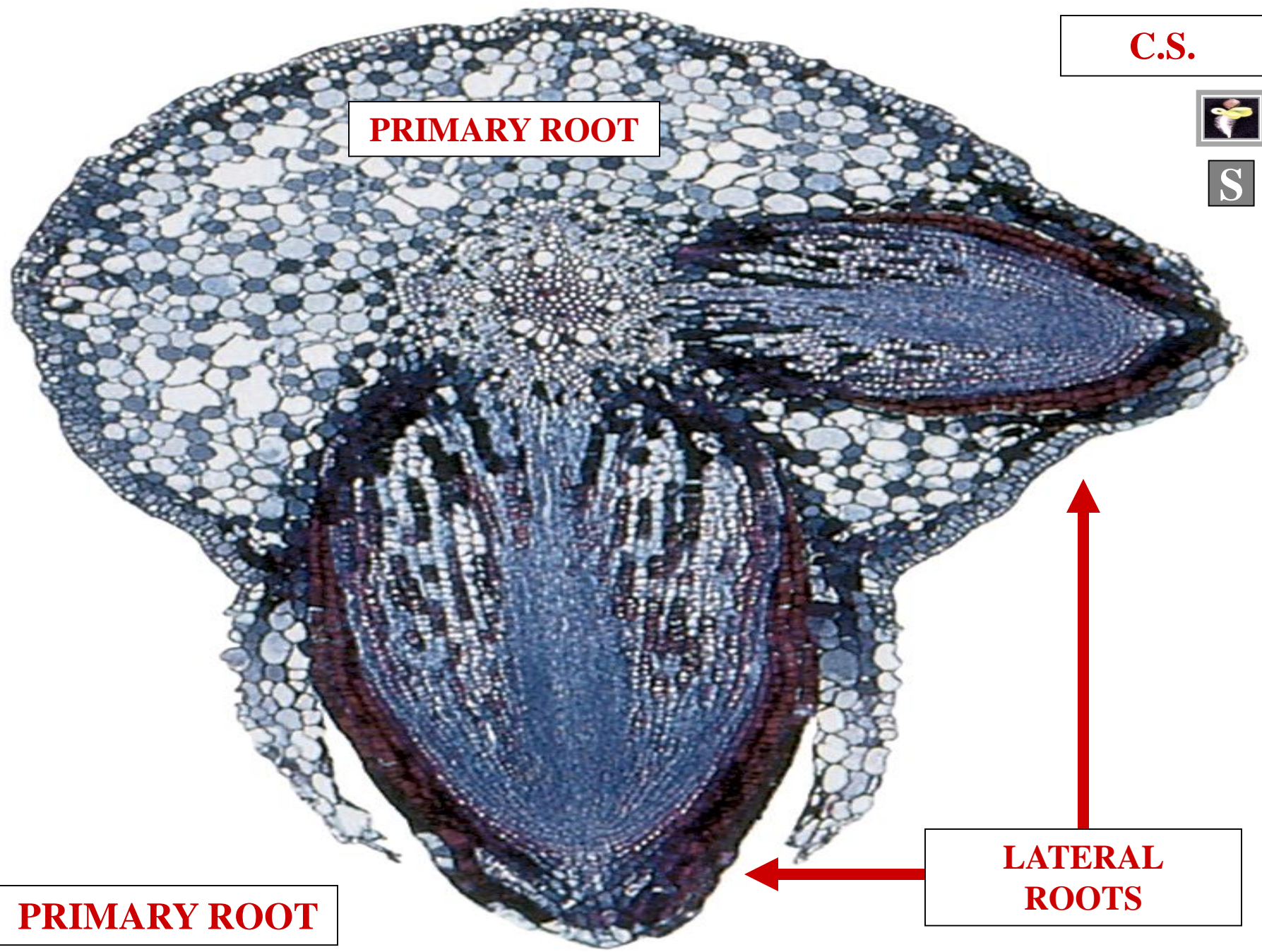
C.S.

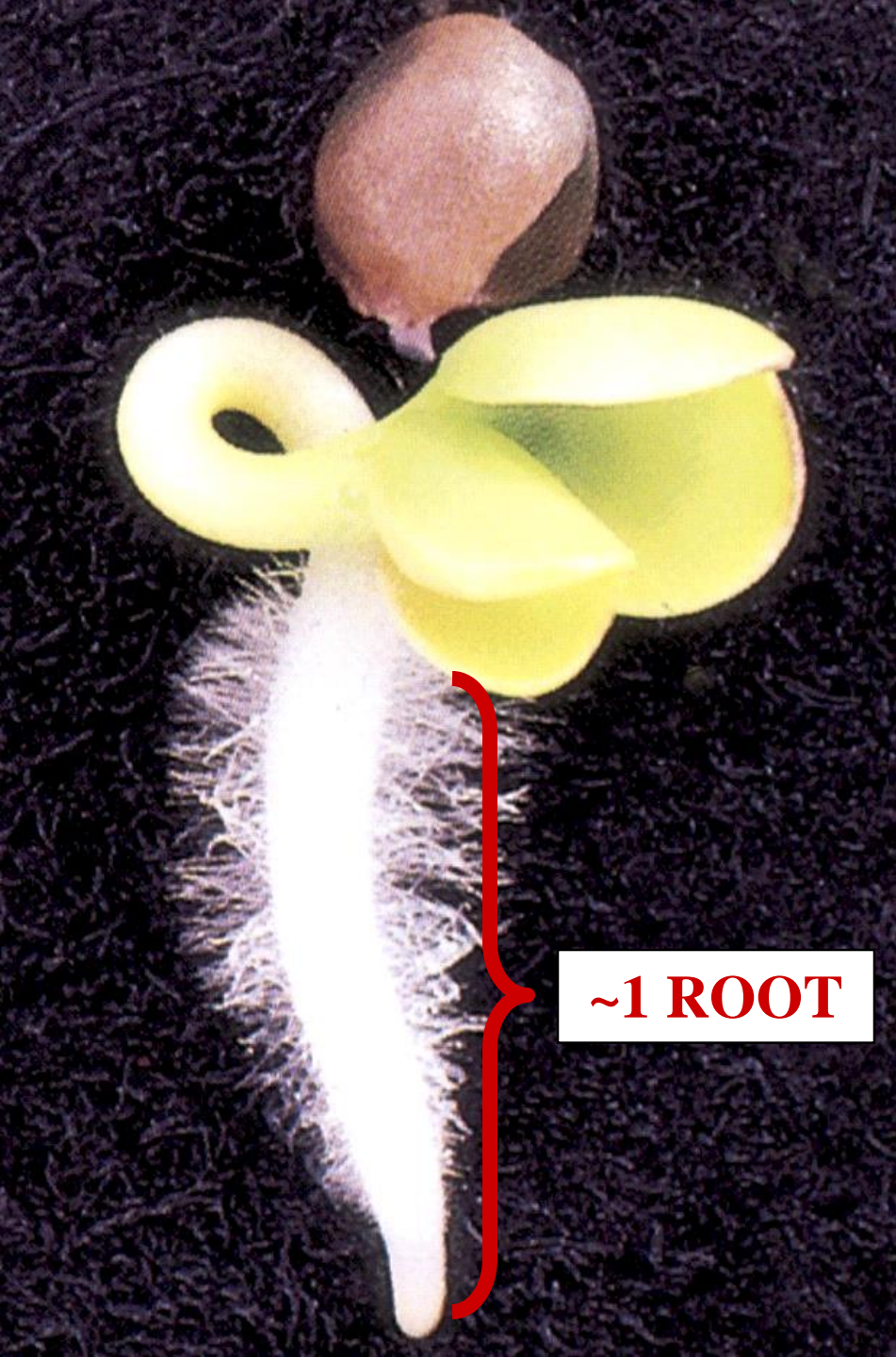


S

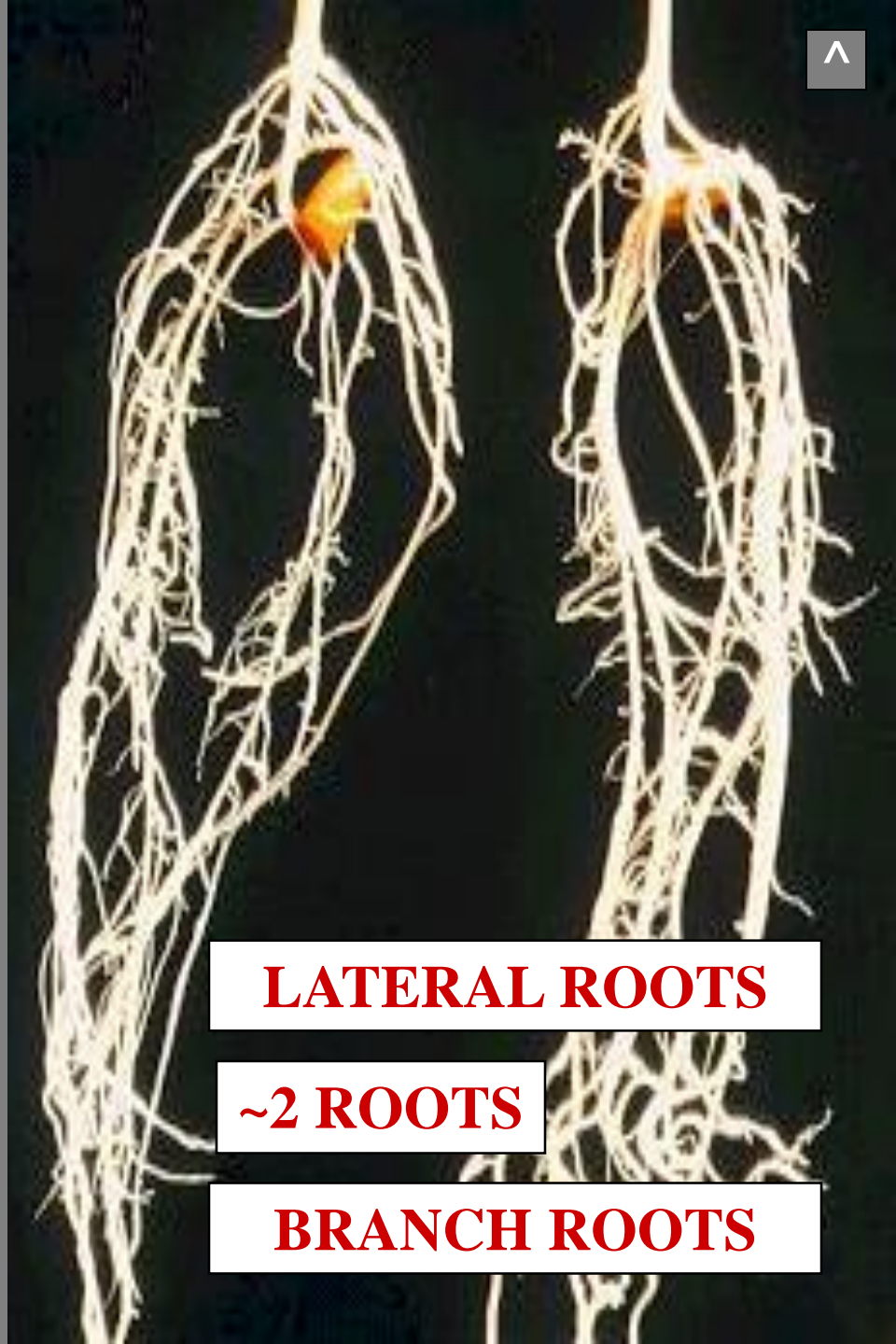
PRIMARY ROOT

LATERAL ROOTS





~1 ROOT



LATERAL ROOTS

~2 ROOTS

BRANCH ROOTS

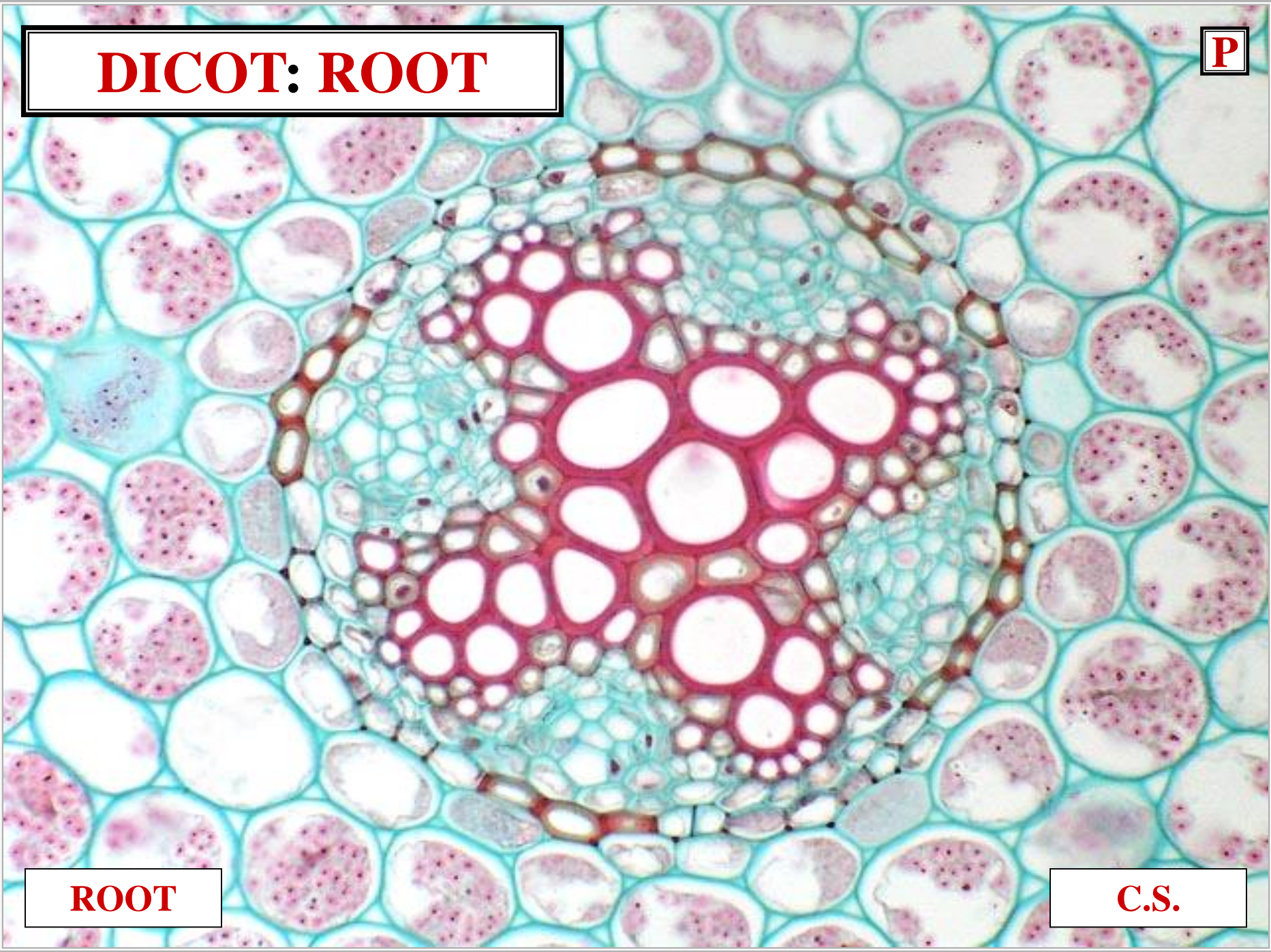




DICOT ROOT STELE

DICOT: ROOT

P



ROOT

C.S.

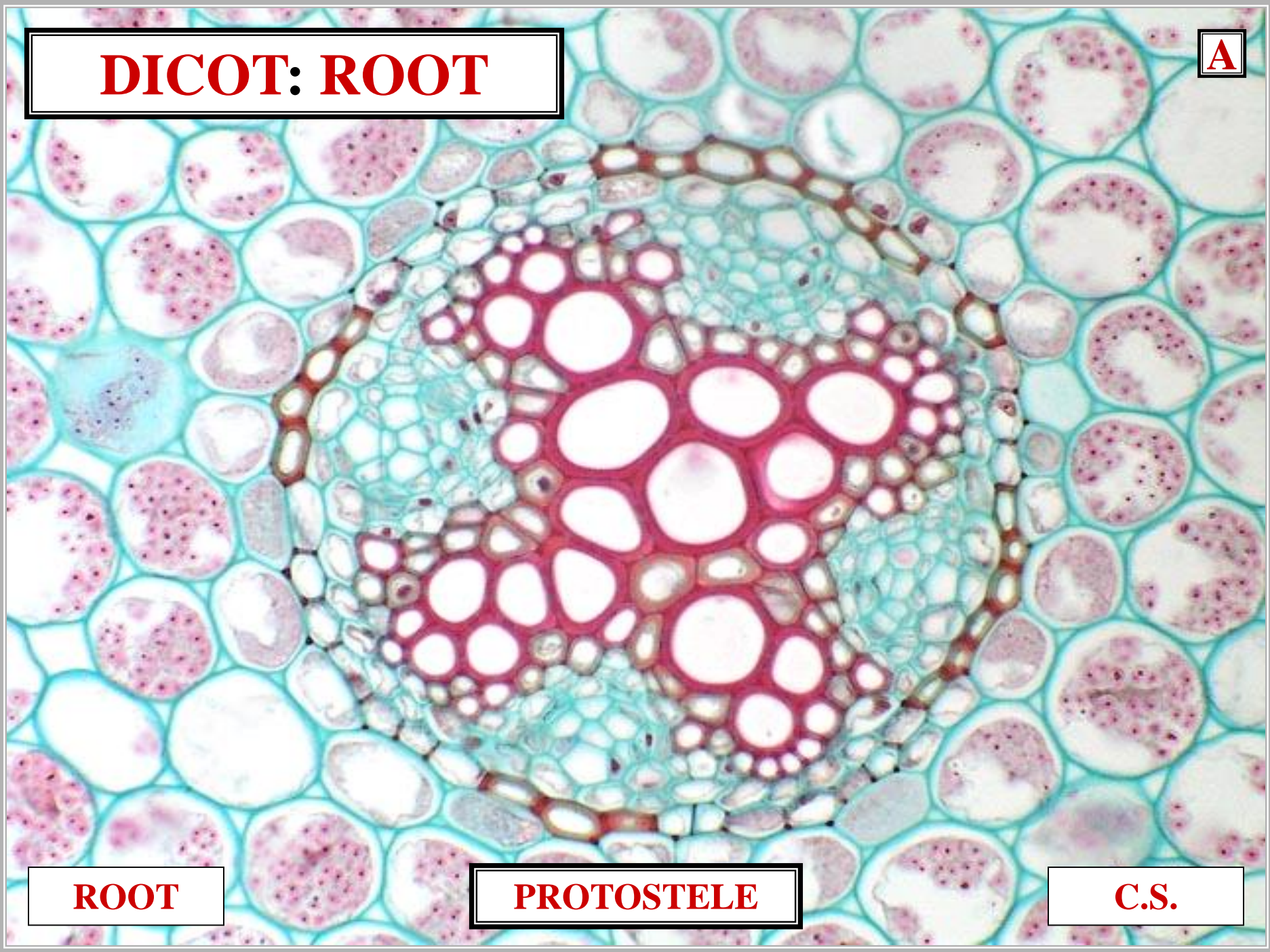
DICOT: ROOT

A

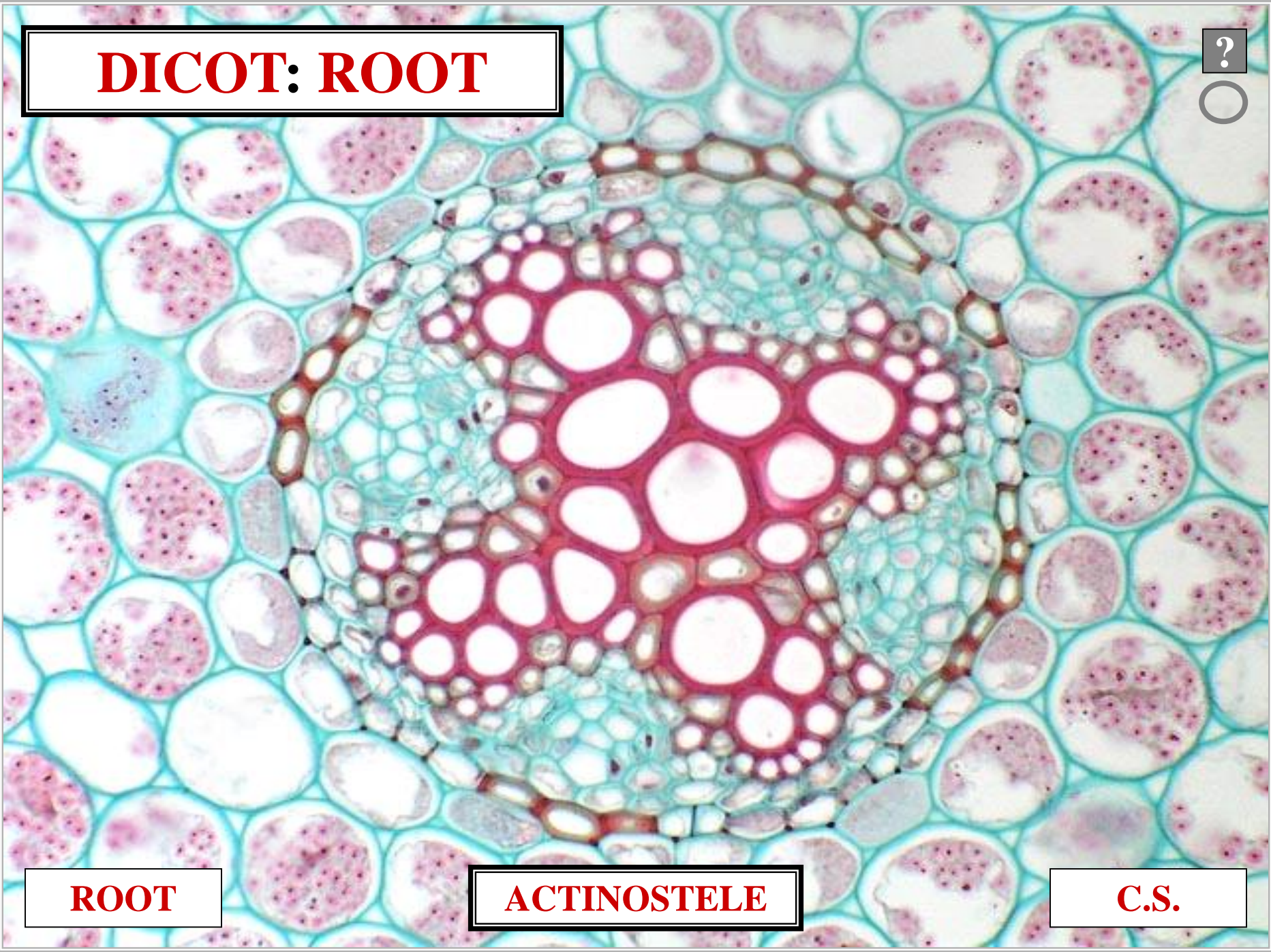
ROOT

PROTOSTELE

C.S.



DICOT: ROOT



ROOT

ACTINOSTELE

C.S.

~P

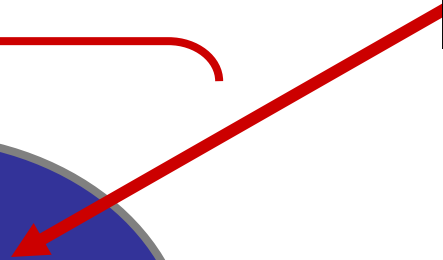
EPIDERMIS



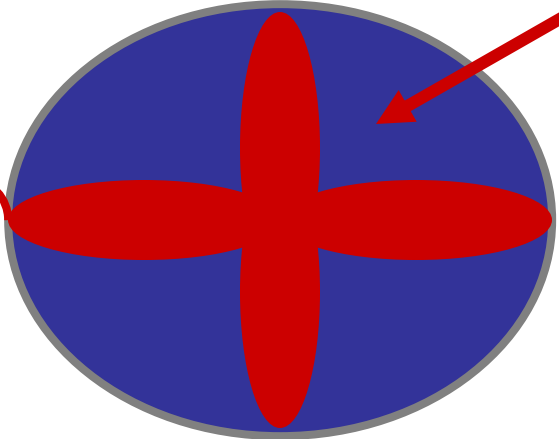
VASCULAR STELE



?



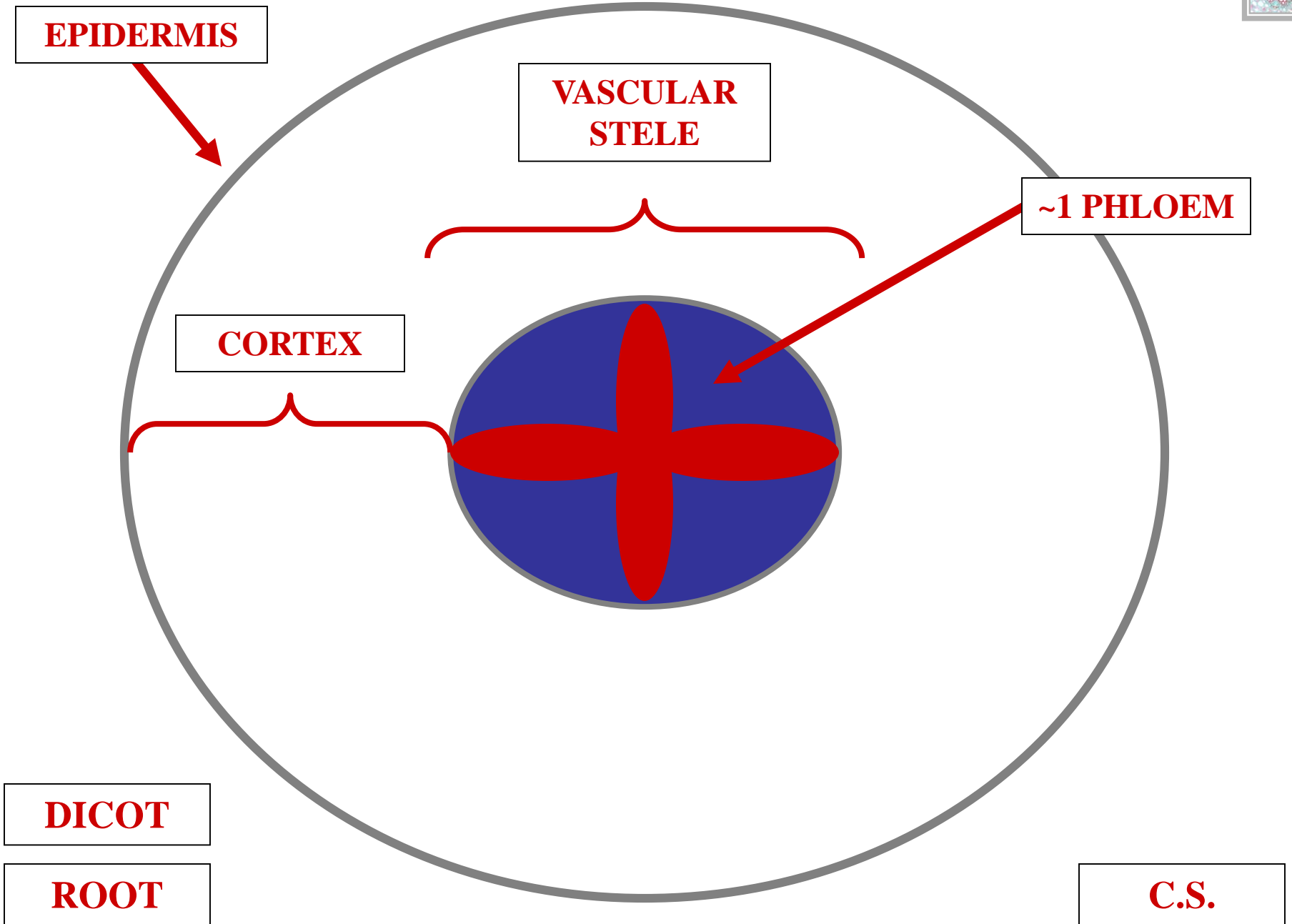
CORTEX



DICOT

ROOT

C.S.



EPIDERMIS

**VASCULAR
STELE**

~1 PHLOEM

CORTEX

DICOT

ROOT

C.S.

DICOT: ROOT

?

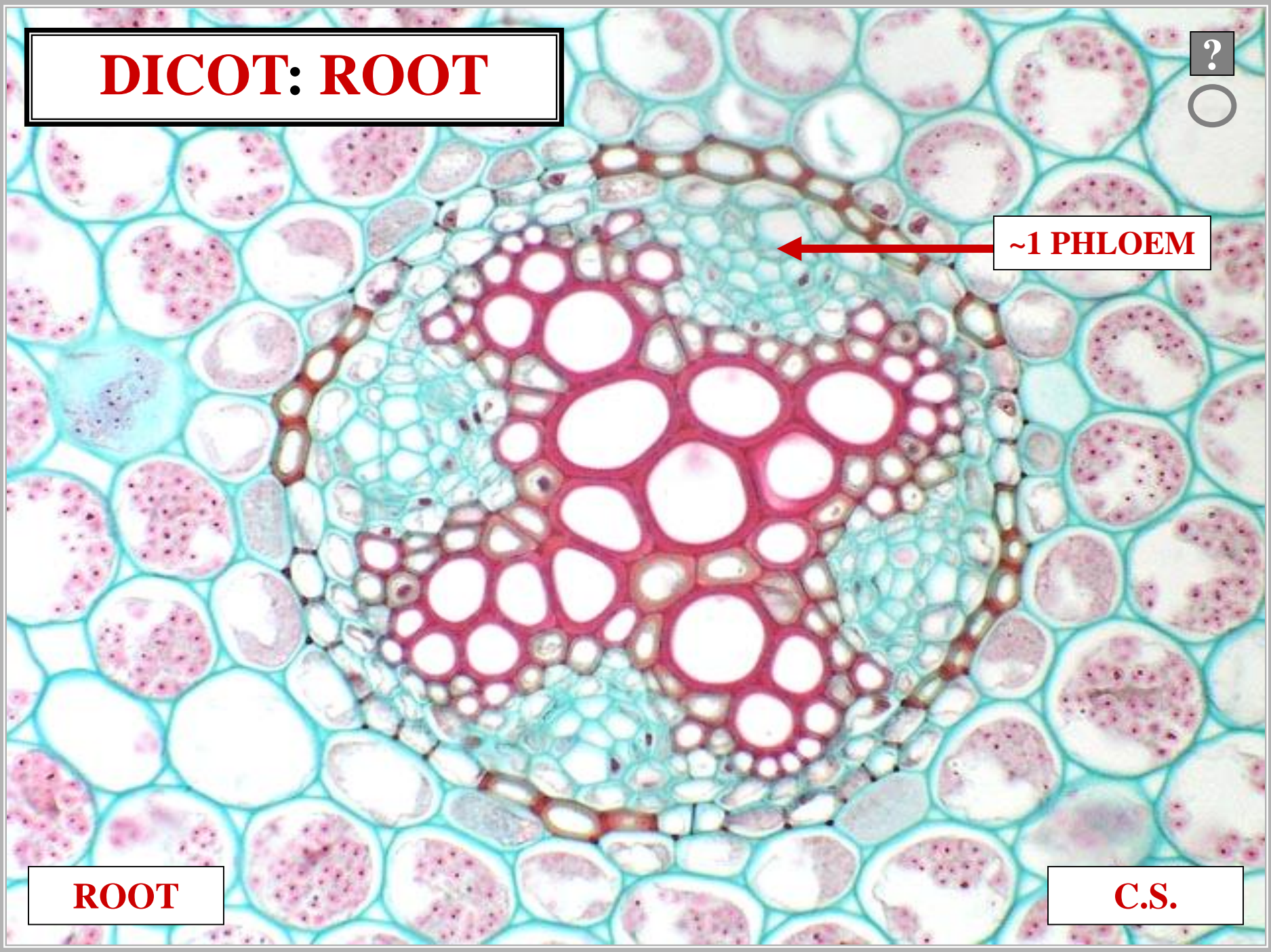


~1 PHLOEM

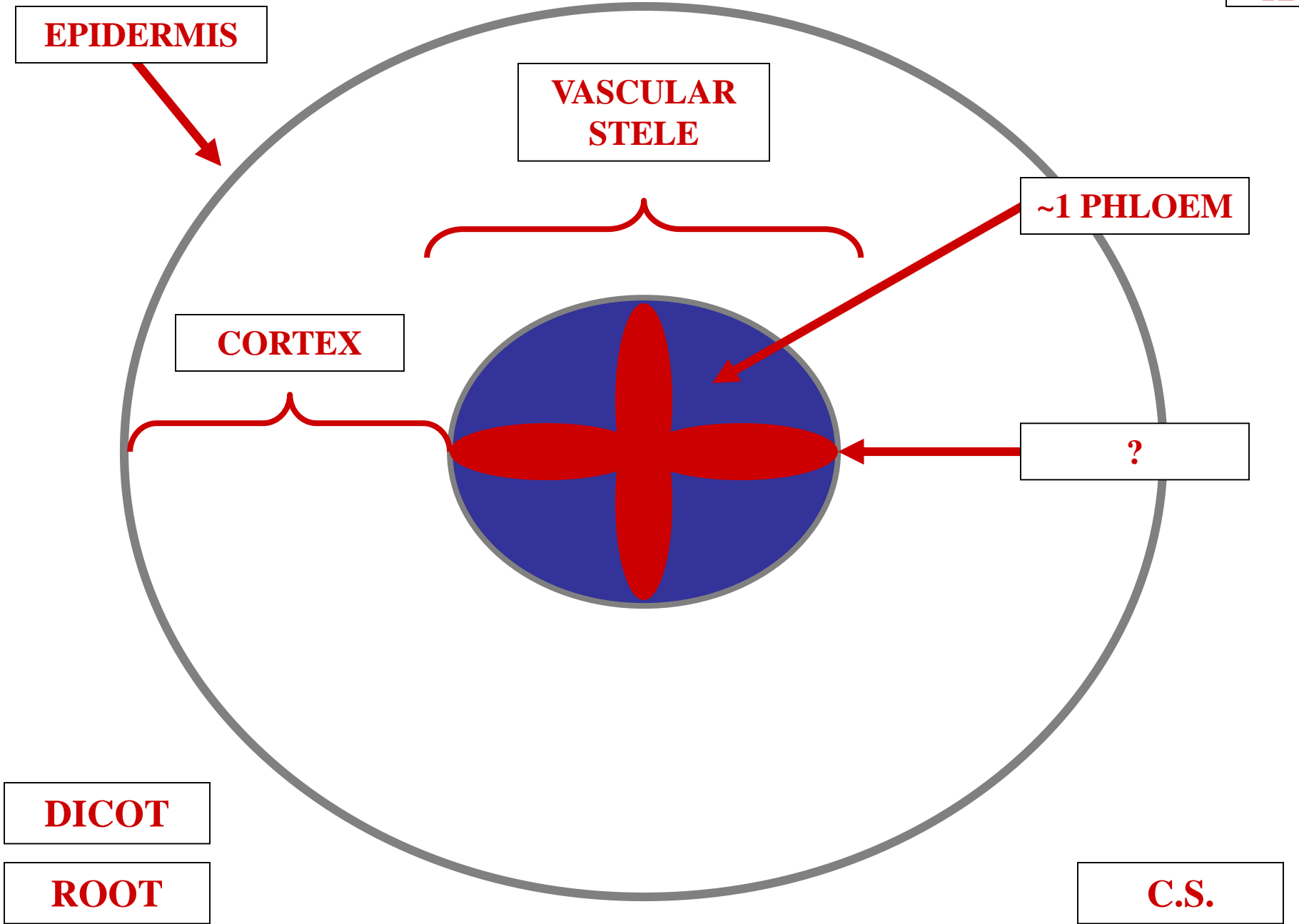


ROOT

C.S.



~X



EPIDERMIS

VASCULAR STELE

~1 PHLOEM

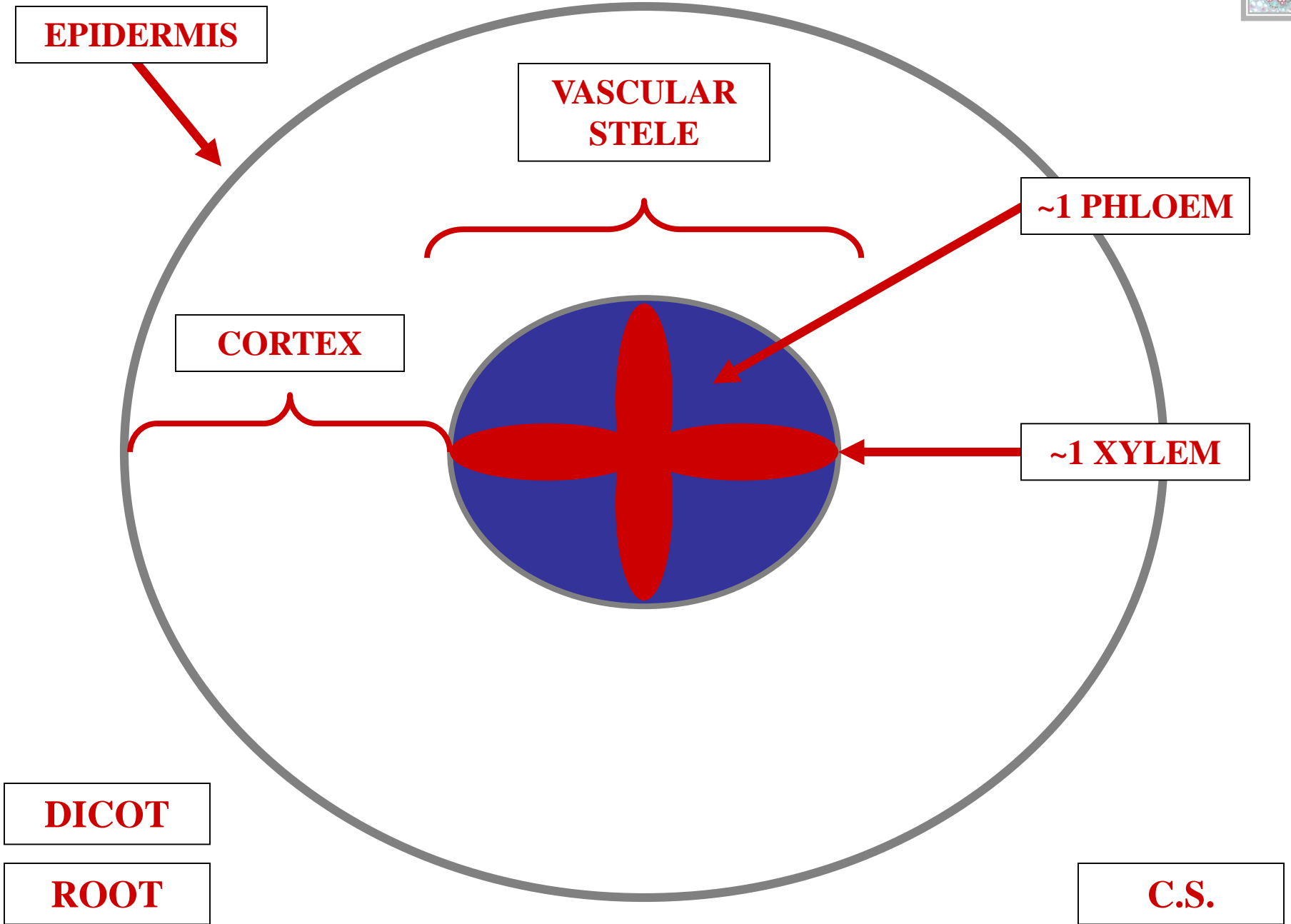
CORTEX

?

DICOT

ROOT

C.S.



DICOT: ROOT

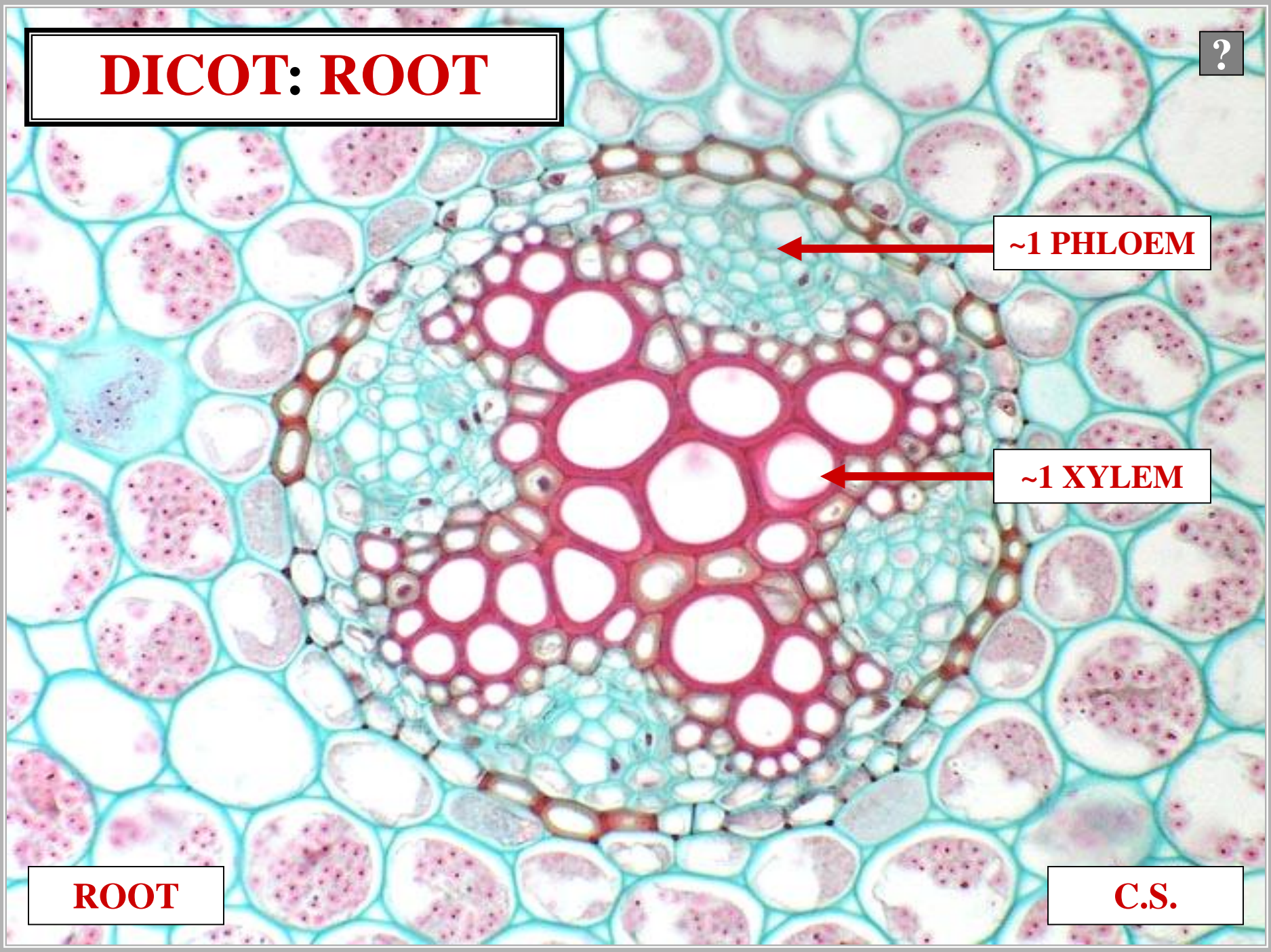
?

~1 PHLOEM

~1 XYLEM

ROOT

C.S.



VC

EPIDERMIS

VASCULAR
STELE

~1 PHLOEM

CORTEX

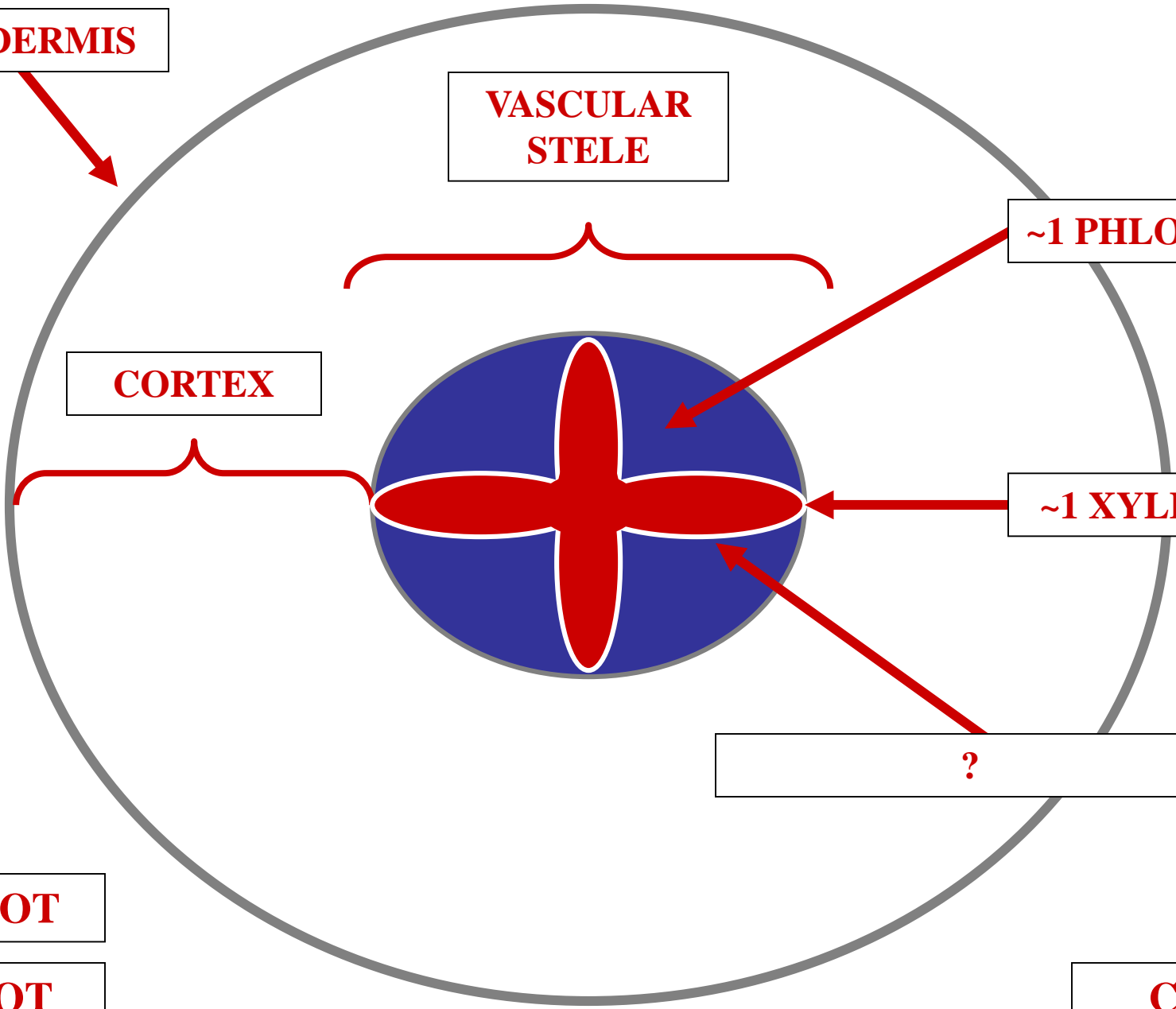
~1 XYLEM

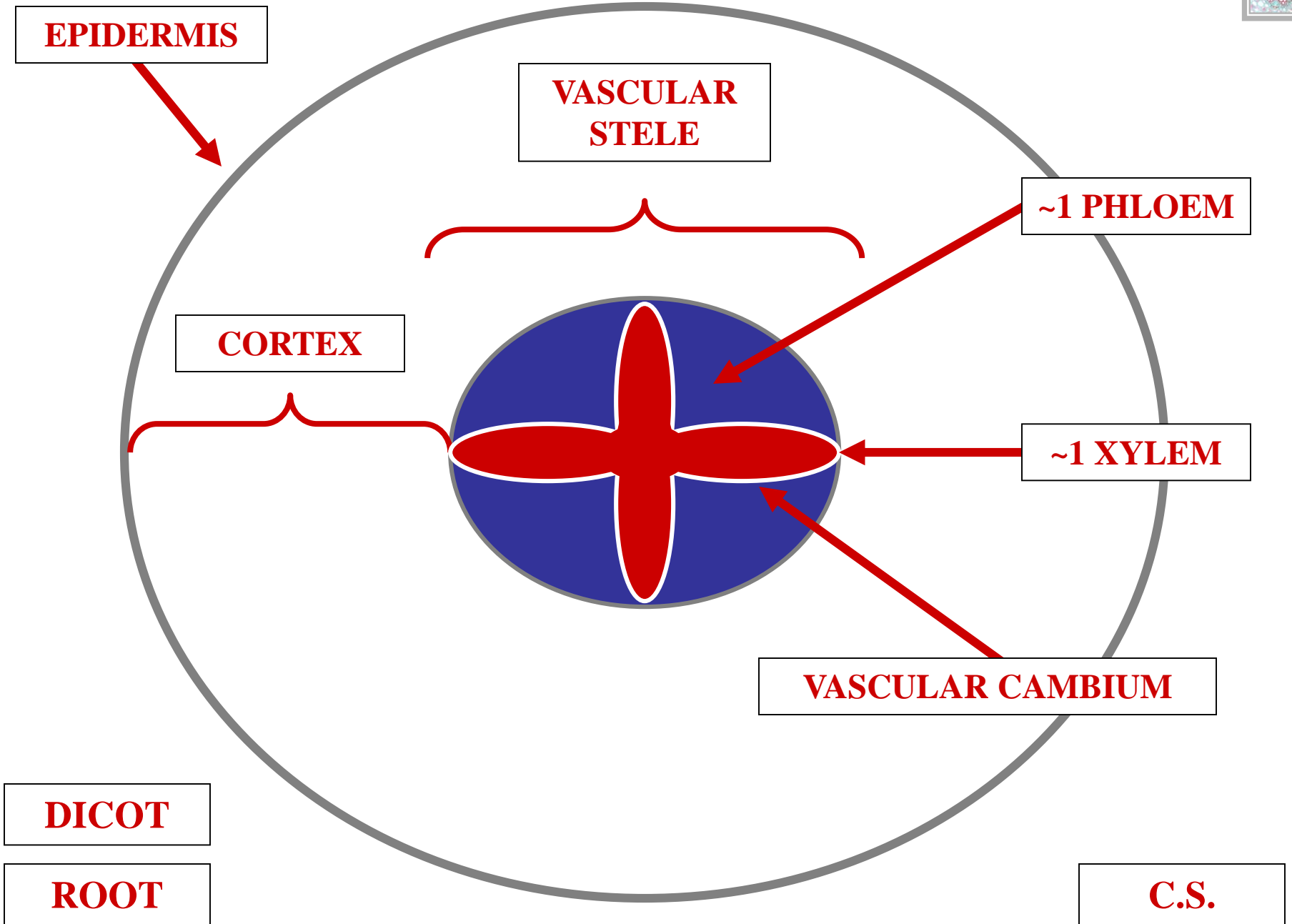
?

DICOT

ROOT

C.S.





DICOT: ROOT

ROOT

C.S.

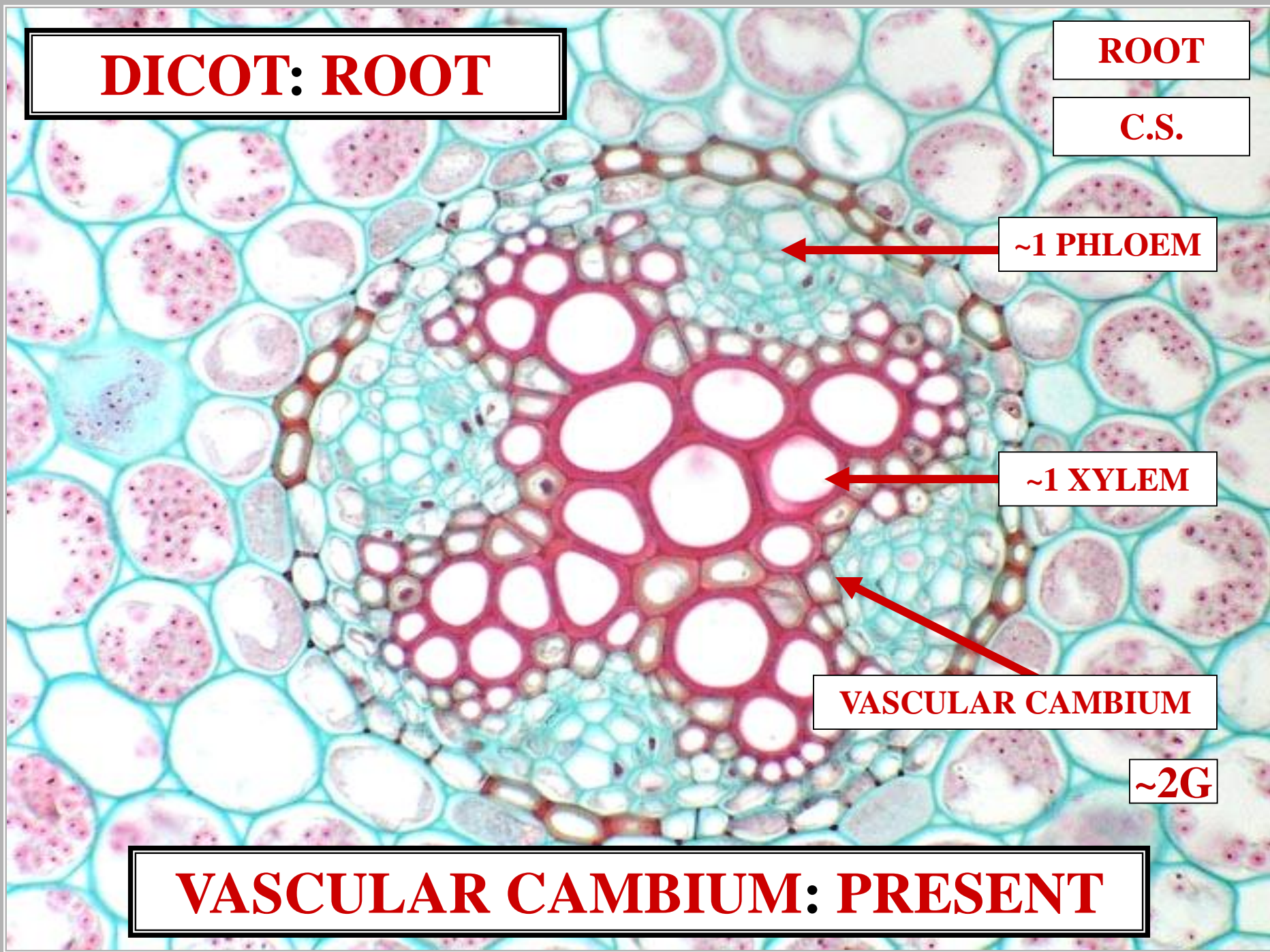
~1 PHLOEM

~1 XYLEM

VASCULAR CAMBIUM

~2G

VASCULAR CAMBIUM: PRESENT



DICOT: ROOT



ROOT

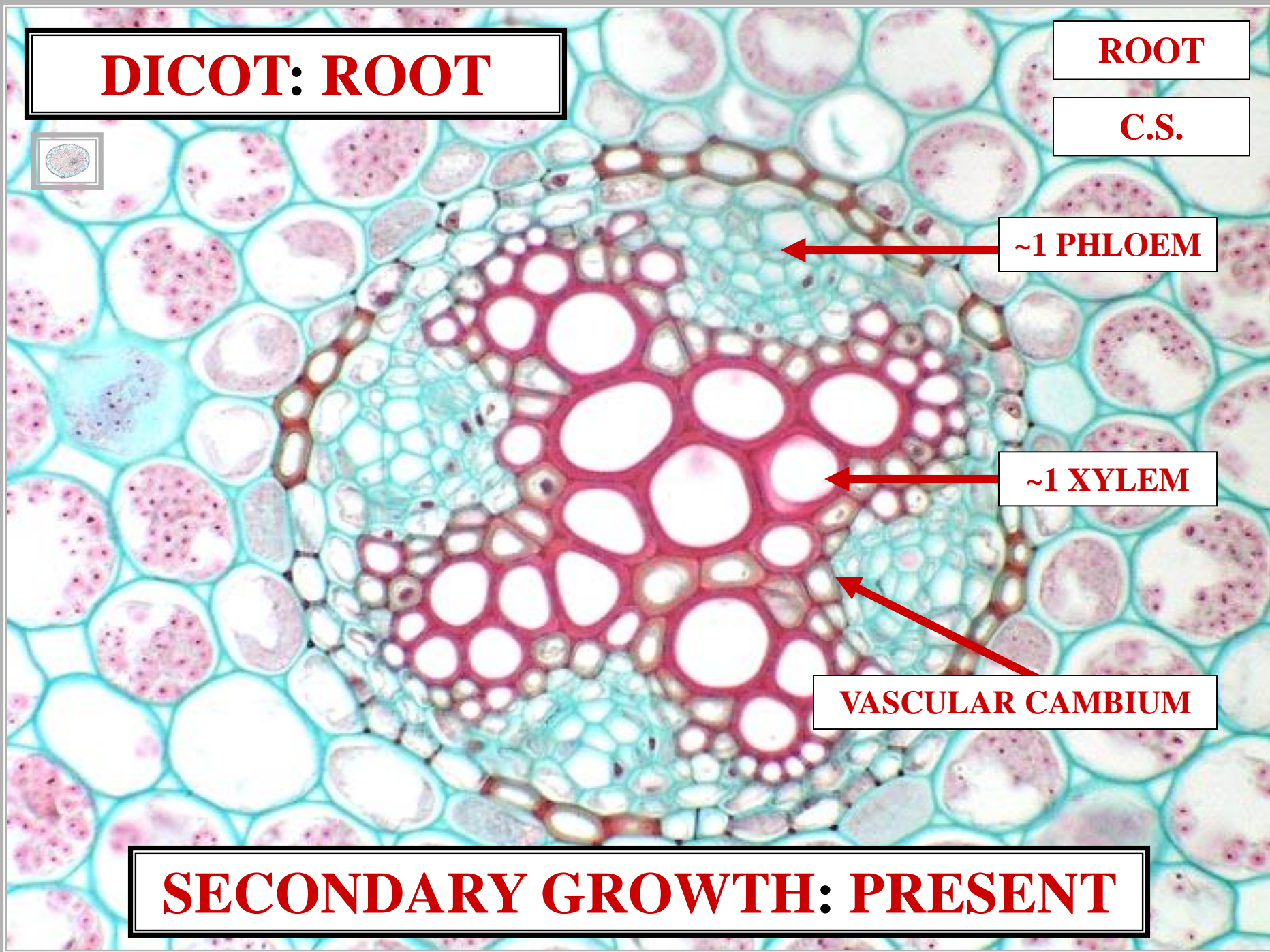
C.S.

~1 PHLOEM

~1 XYLEM

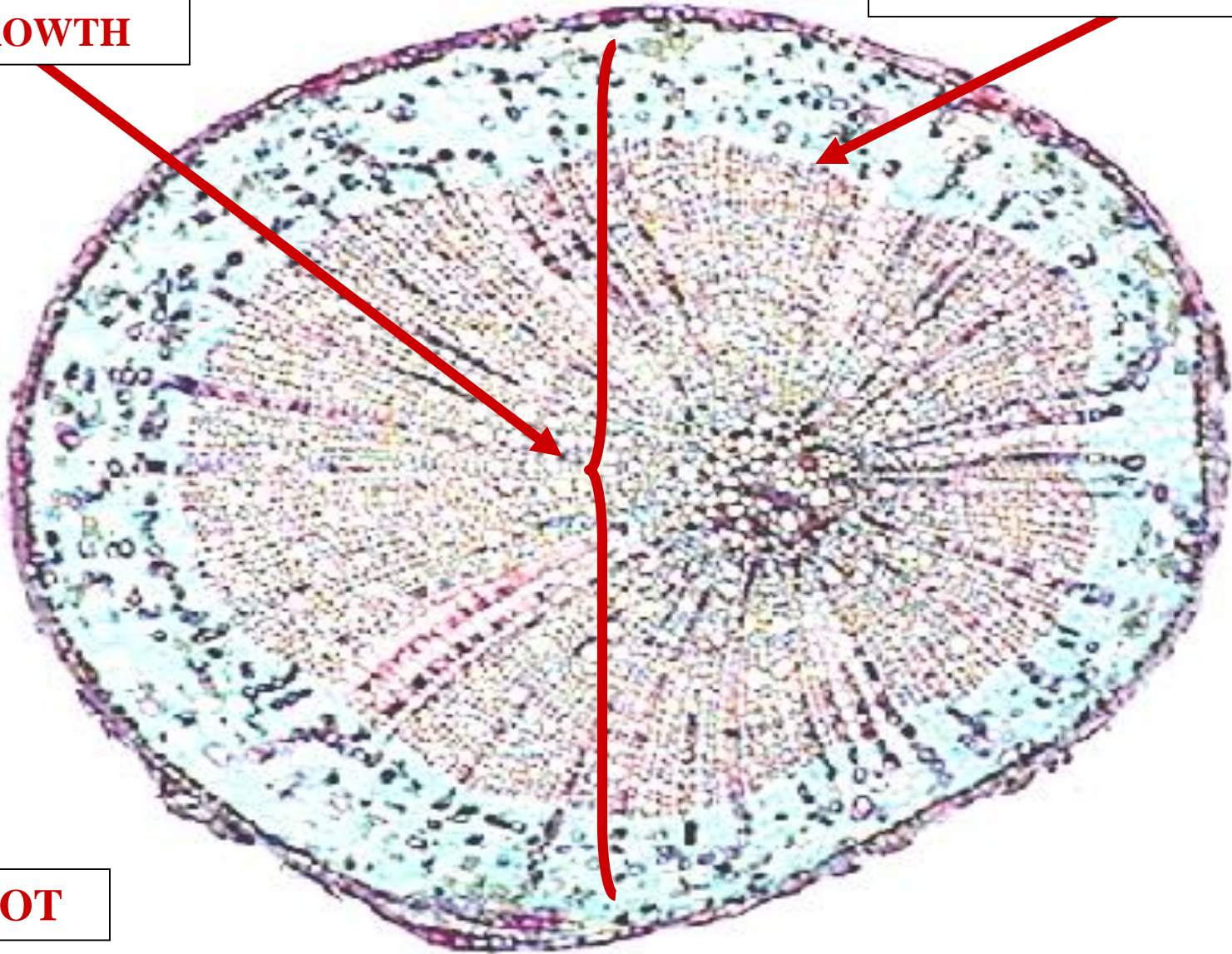
VASCULAR CAMBIUM

SECONDARY GROWTH: PRESENT



**SECONDARY
GROWTH**

VASCULAR CAMBIUM



DICOT

ROOT

C.S.



MONOCOT ROOT STELE

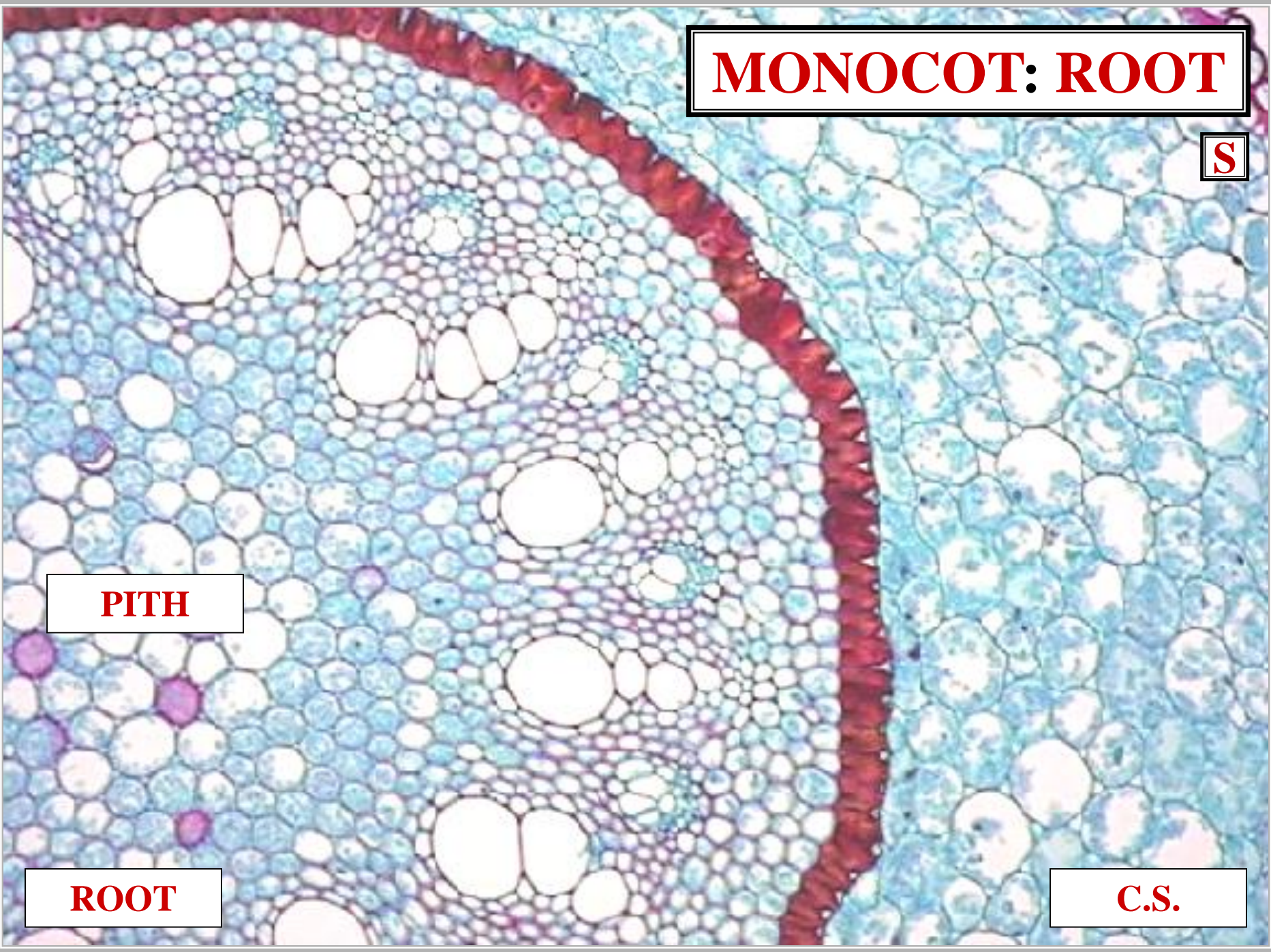
MONOCOT: ROOT

S

PITH

ROOT

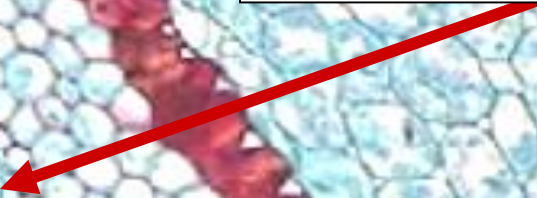
C.S.



MONOCOT: ROOT

VASCULAR BUNDLE

E

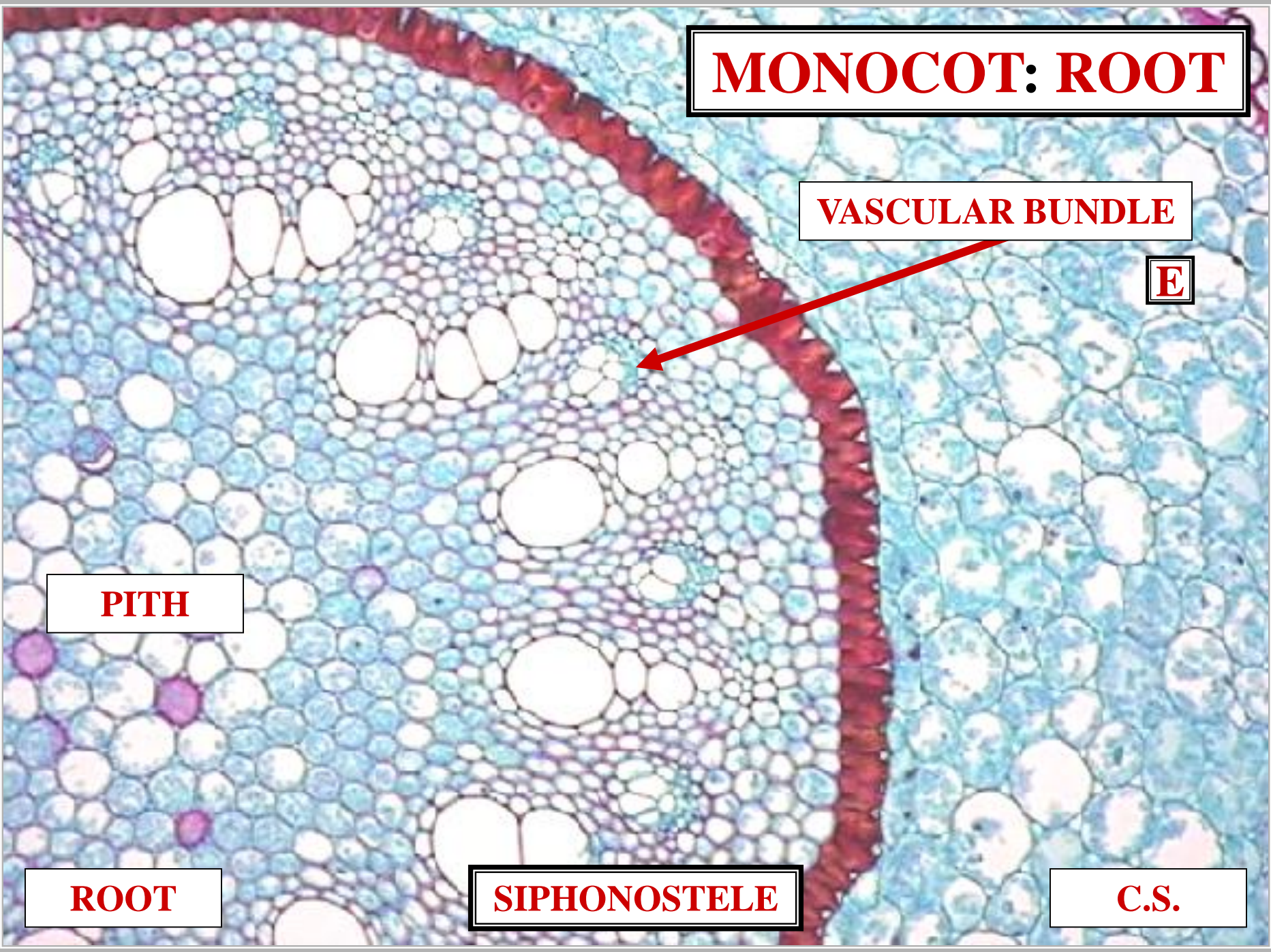


PITH

ROOT

SIPHONOSTELE

C.S.



MONOCOT: ROOT

VASCULAR BUNDLE

?

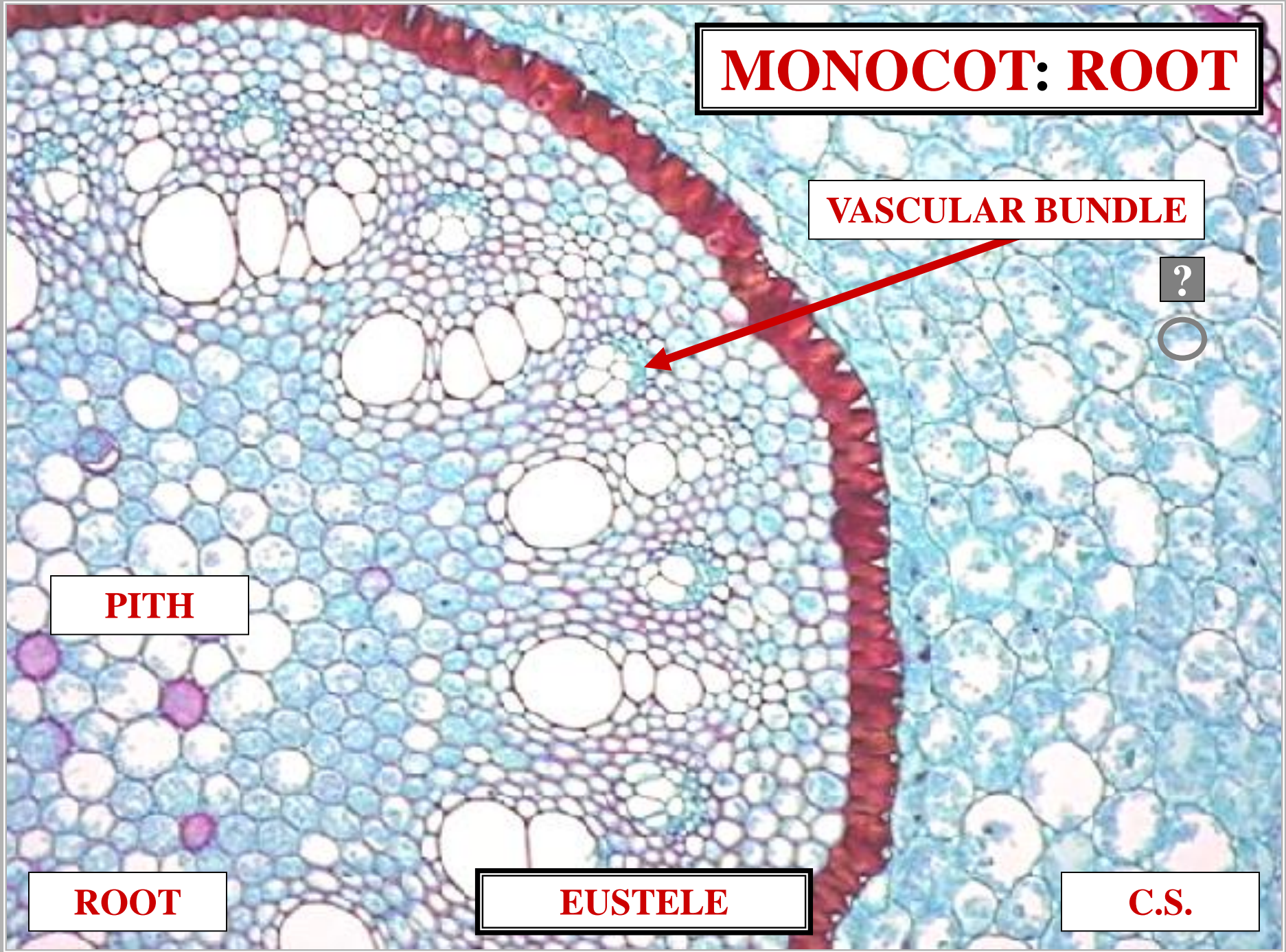


PITH

ROOT

EUSTELE

C.S.



~P

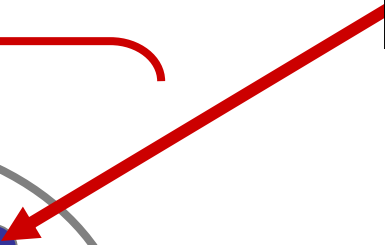
EPIDERMIS



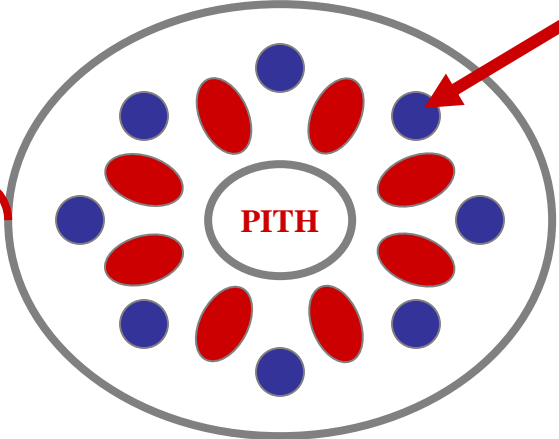
VASCULAR STELE



?



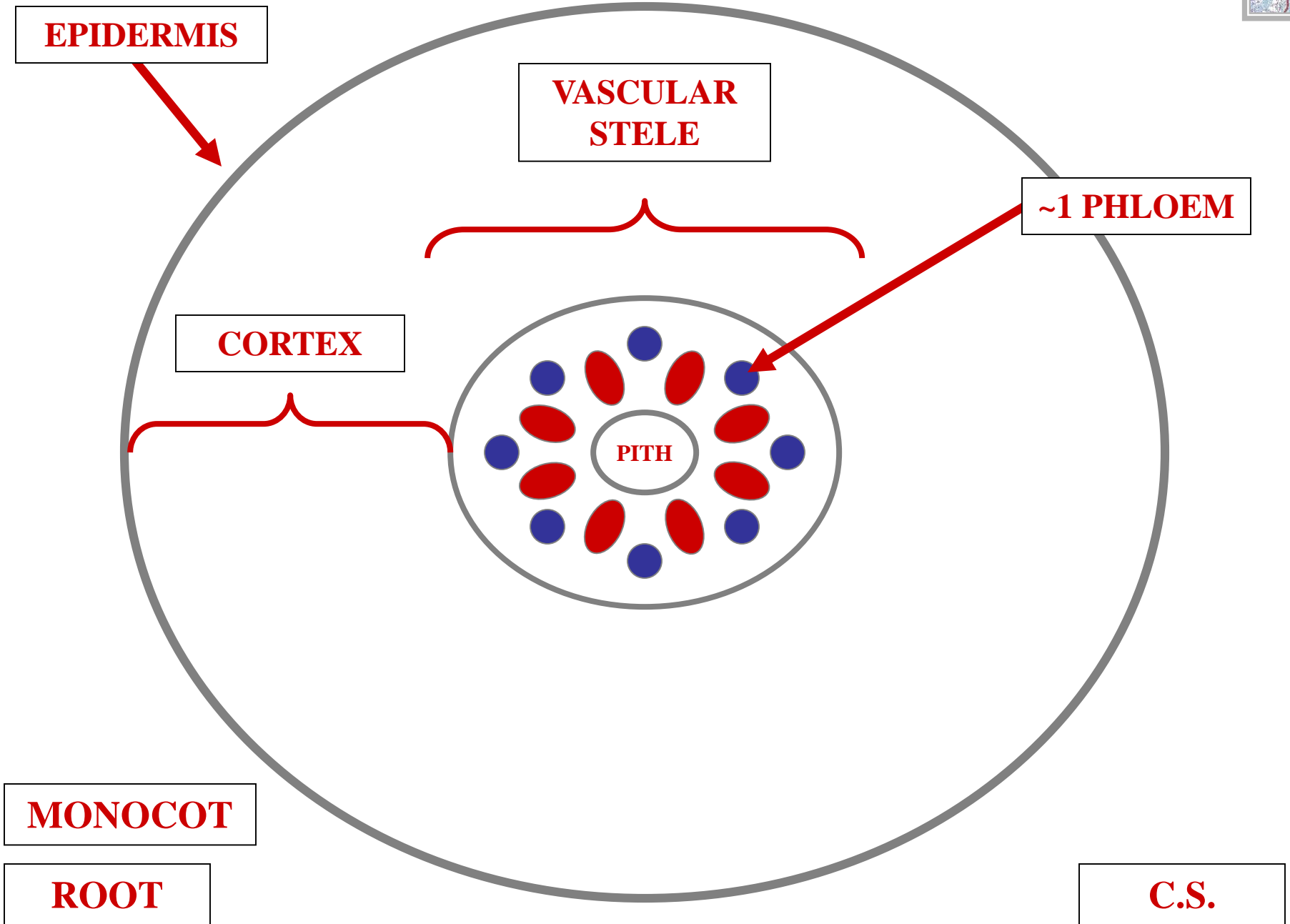
CORTEX



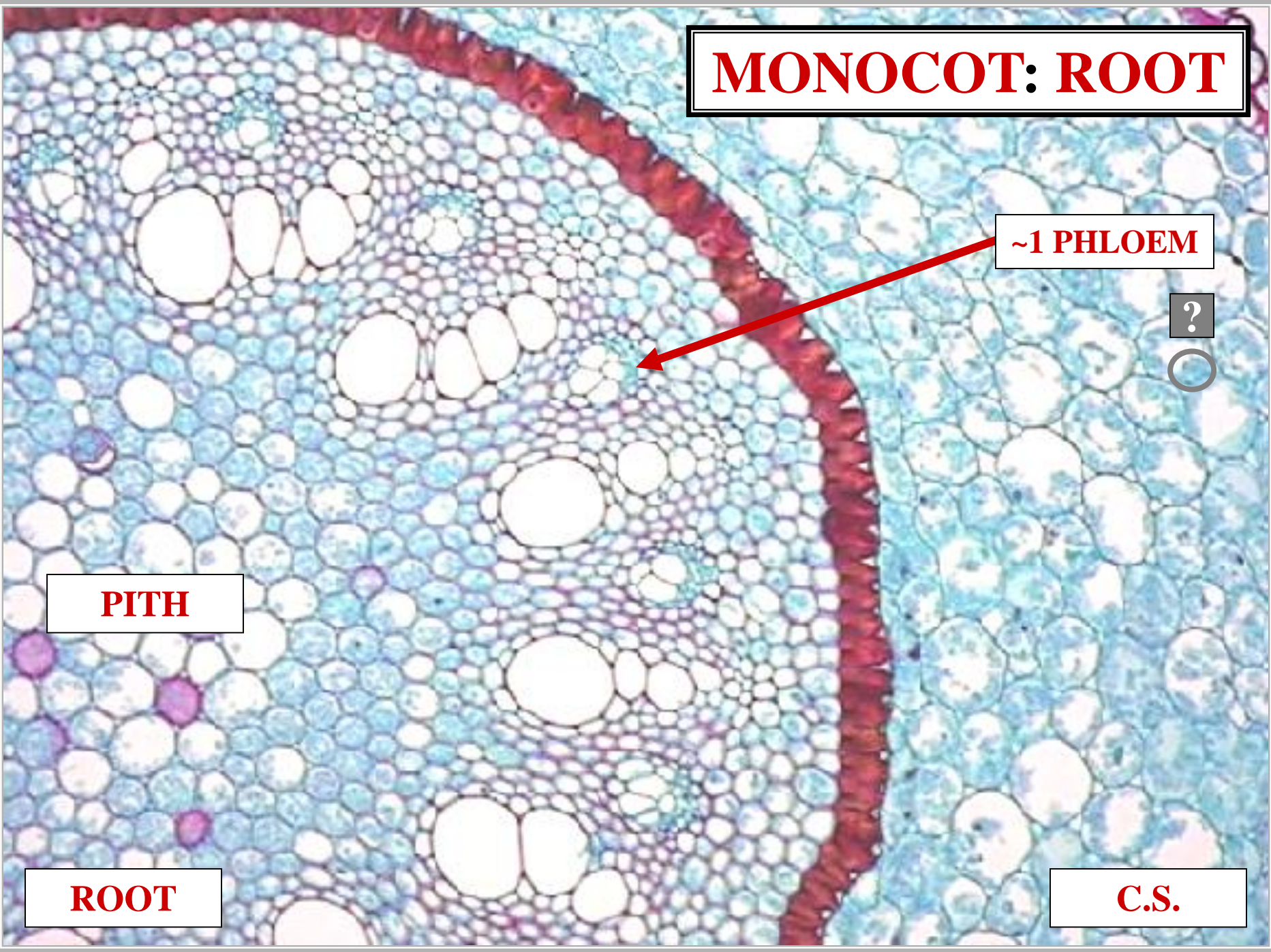
MONOCOT

ROOT

C.S.



MONOCOT: ROOT



~1 PHLOEM

?

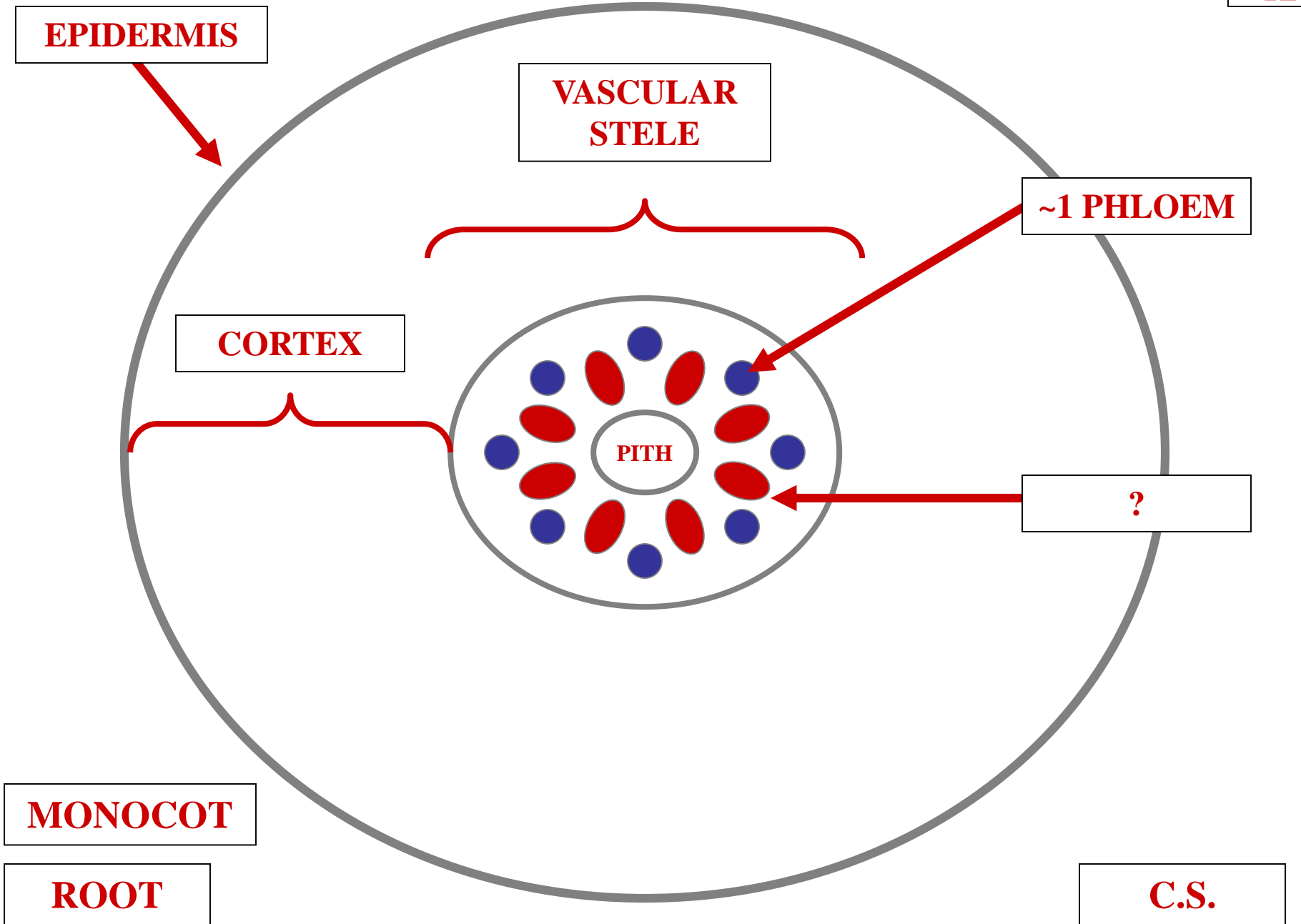


PITH

ROOT

C.S.

~X



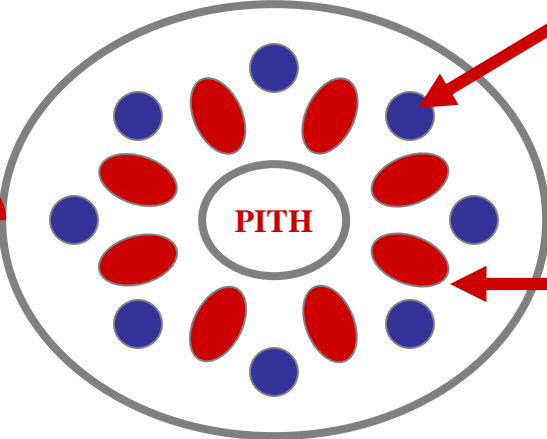
EPIDERMIS

VASCULAR STELE

~1 PHLOEM

CORTEX

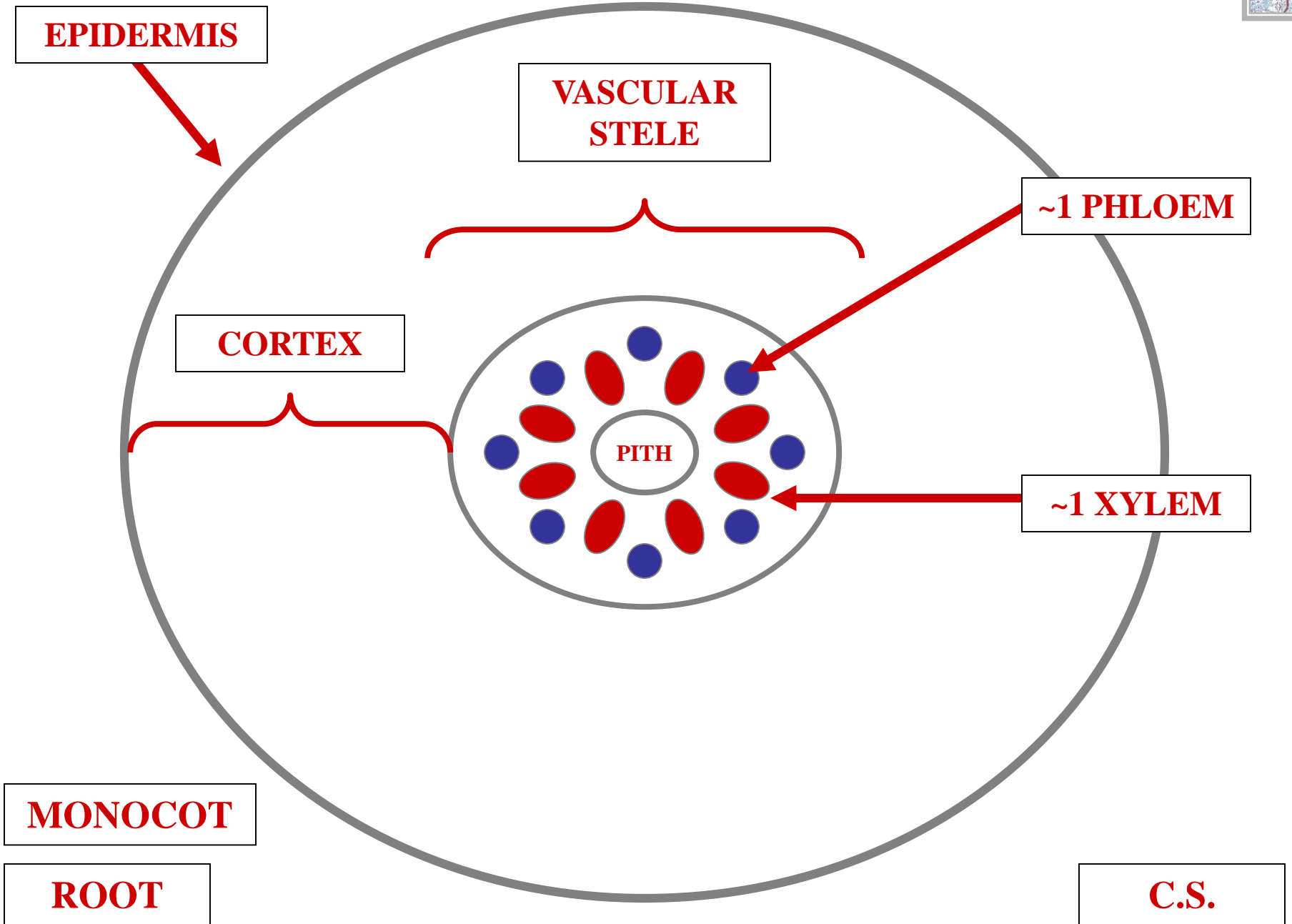
?



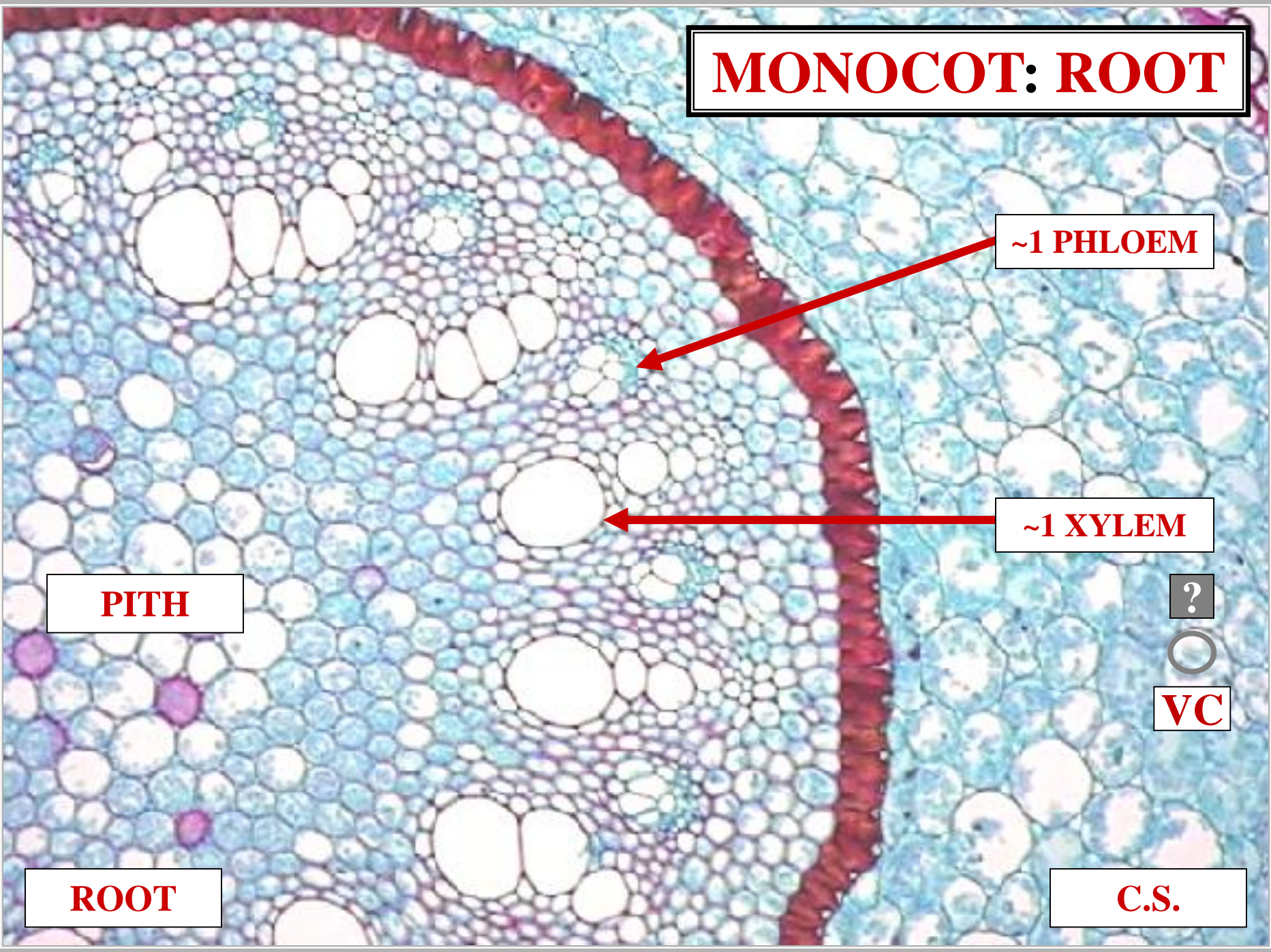
MONOCOT

ROOT

C.S.



MONOCOT: ROOT



~1 PHLOEM

~1 XYLEM

?

○

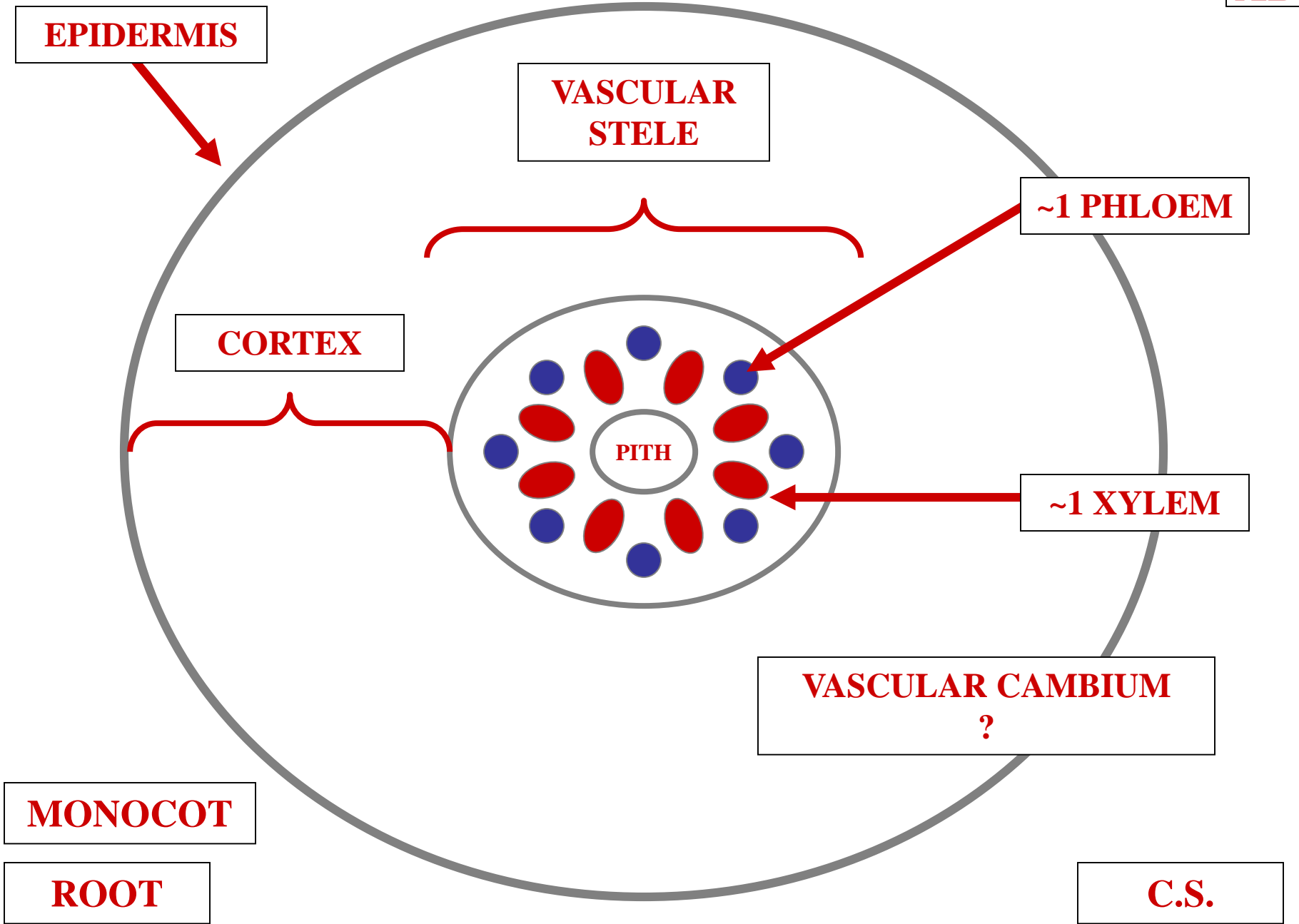
VC

PITH

ROOT

C.S.

AB



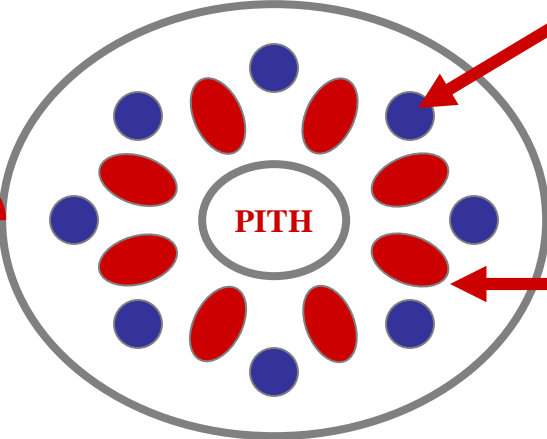
EPIDERMIS

VASCULAR STELE

~1 PHLOEM

CORTEX

~1 XYLEM



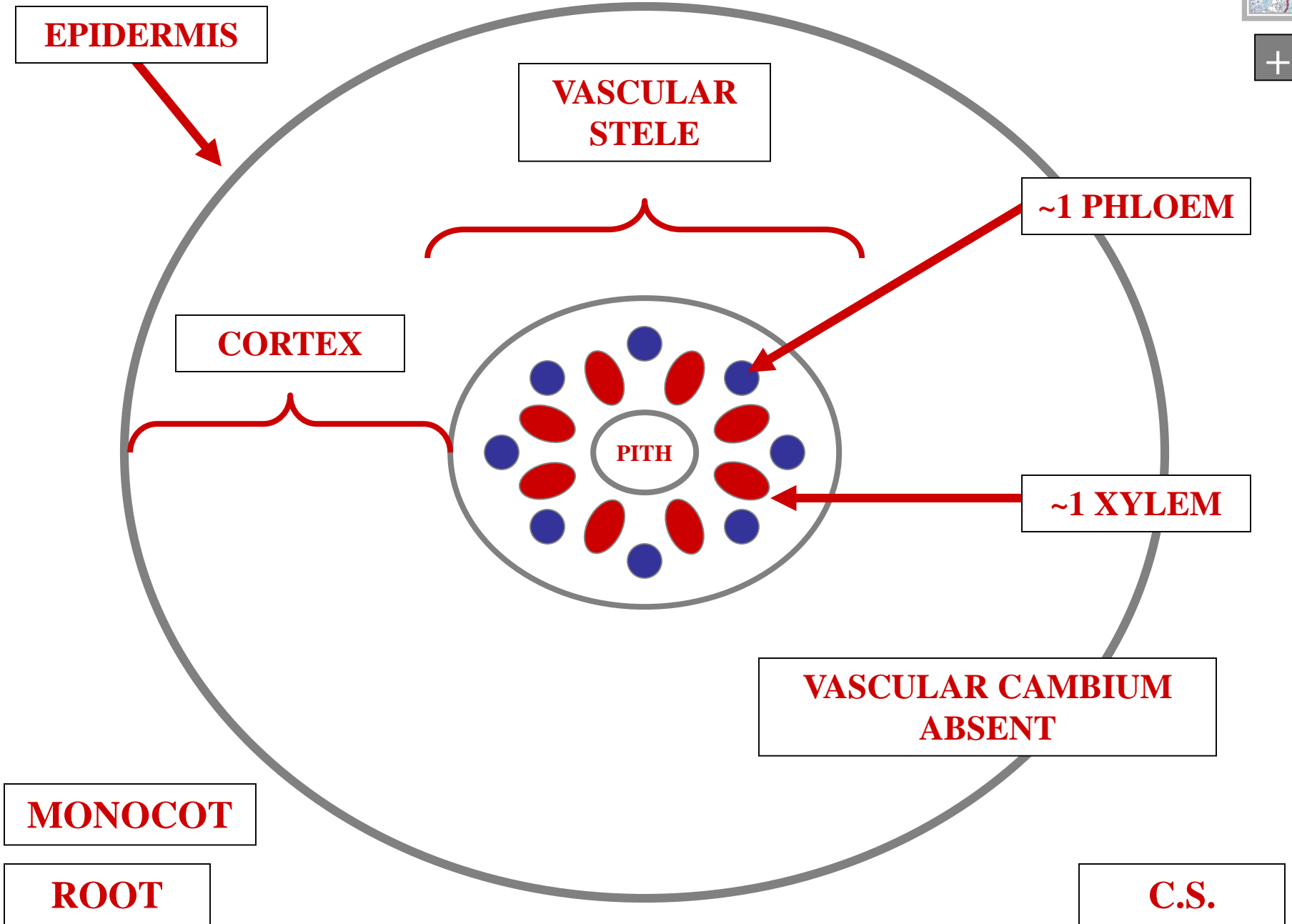
PITH

VASCULAR CAMBIUM ?

MONOCOT

ROOT

C.S.



ROOT

C.S.

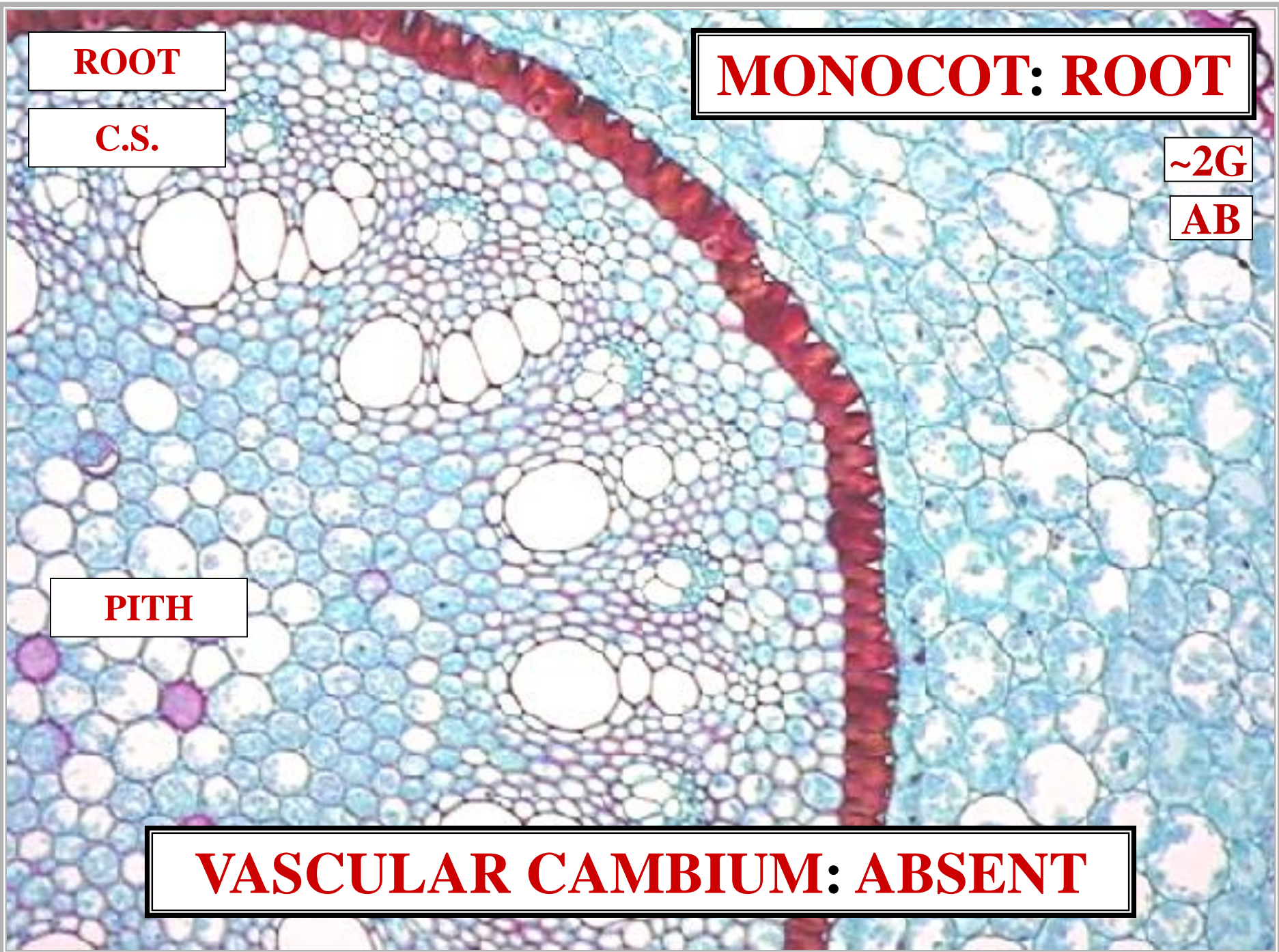
MONOCOT: ROOT

~2G

AB

PITH

VASCULAR CAMBIUM: ABSENT



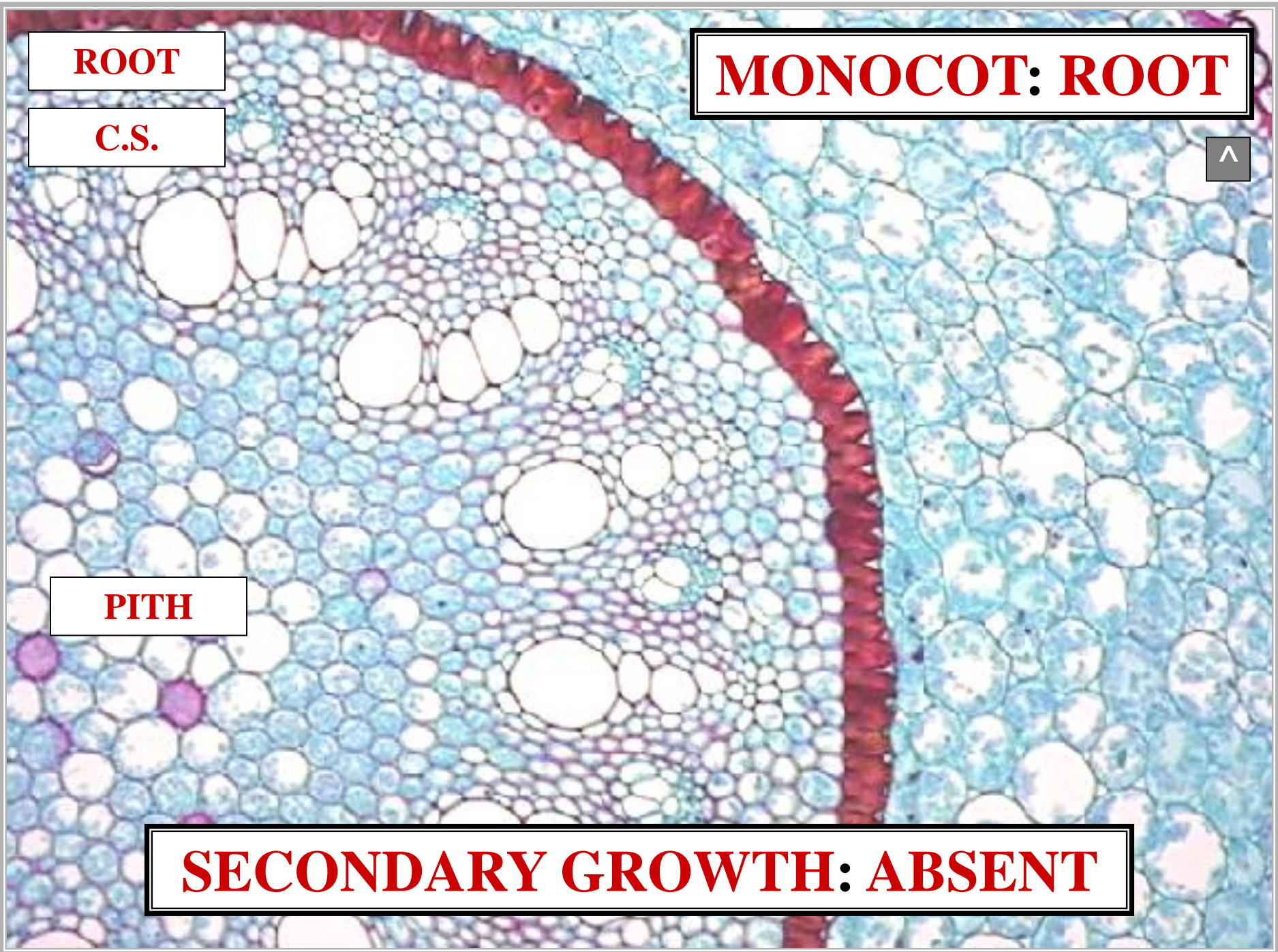
ROOT

C.S.

MONOCOT: ROOT

PITH

SECONDARY GROWTH: ABSENT





ROOT PRIMARY GROWTH SUMMARY