



**VASCULAR
RAY SYSTEM**



PERMITS LATERAL TRANSPORT



DICOT ~2 STEM



**XYLEM
RAY SYSTEM
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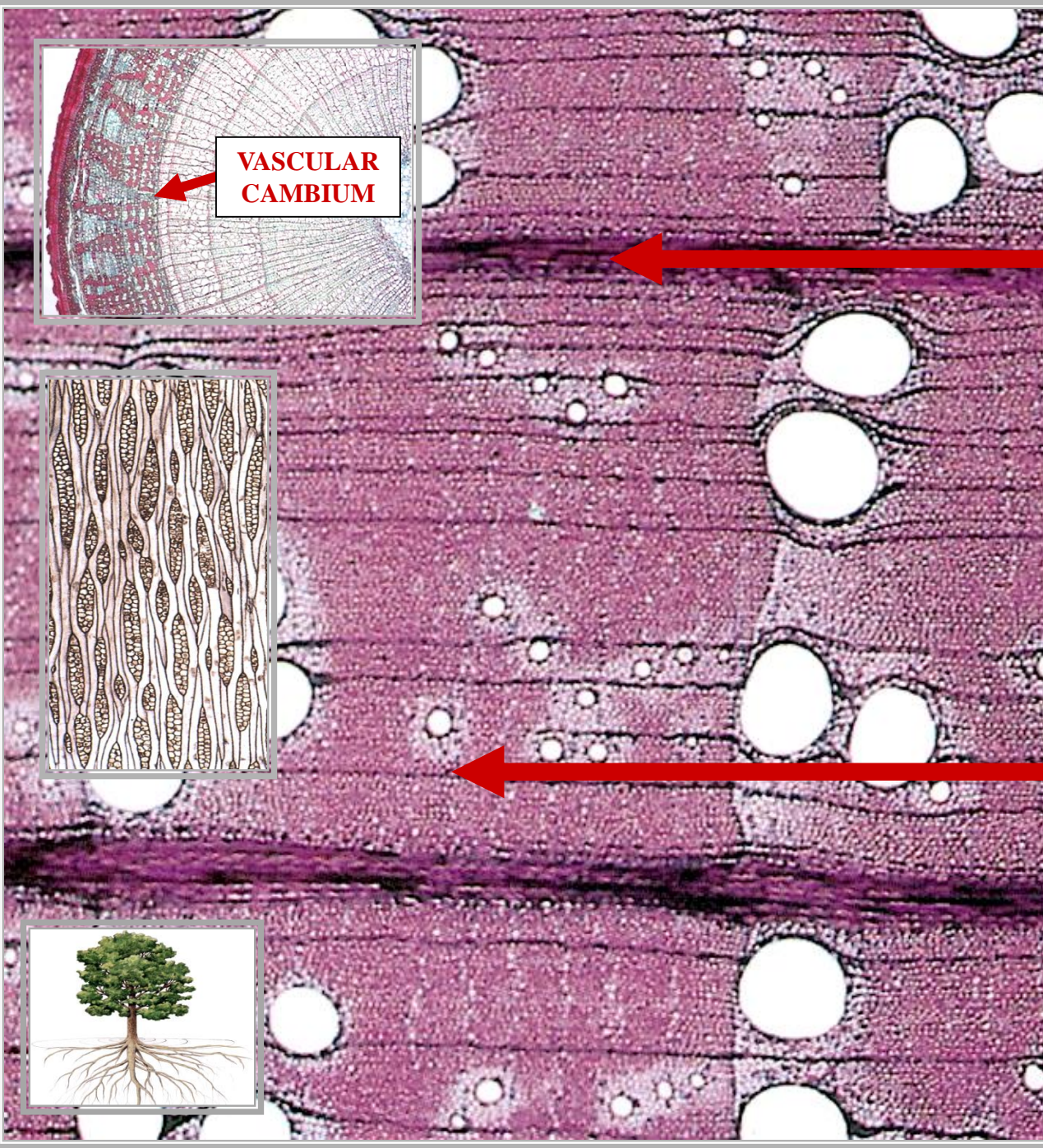
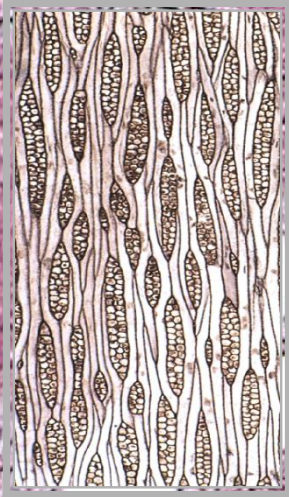
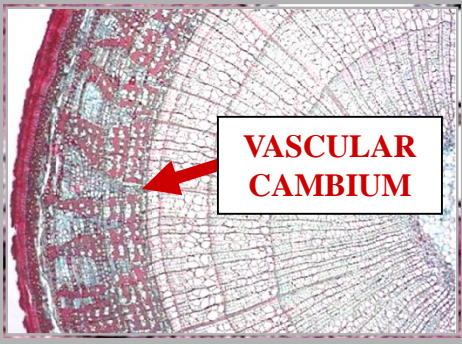
PC

**VASCULAR
CAMBIUM**

**XYLEM RAY
SYSTEM**

**XYLEM RAY
SYSTEM**

C.S.



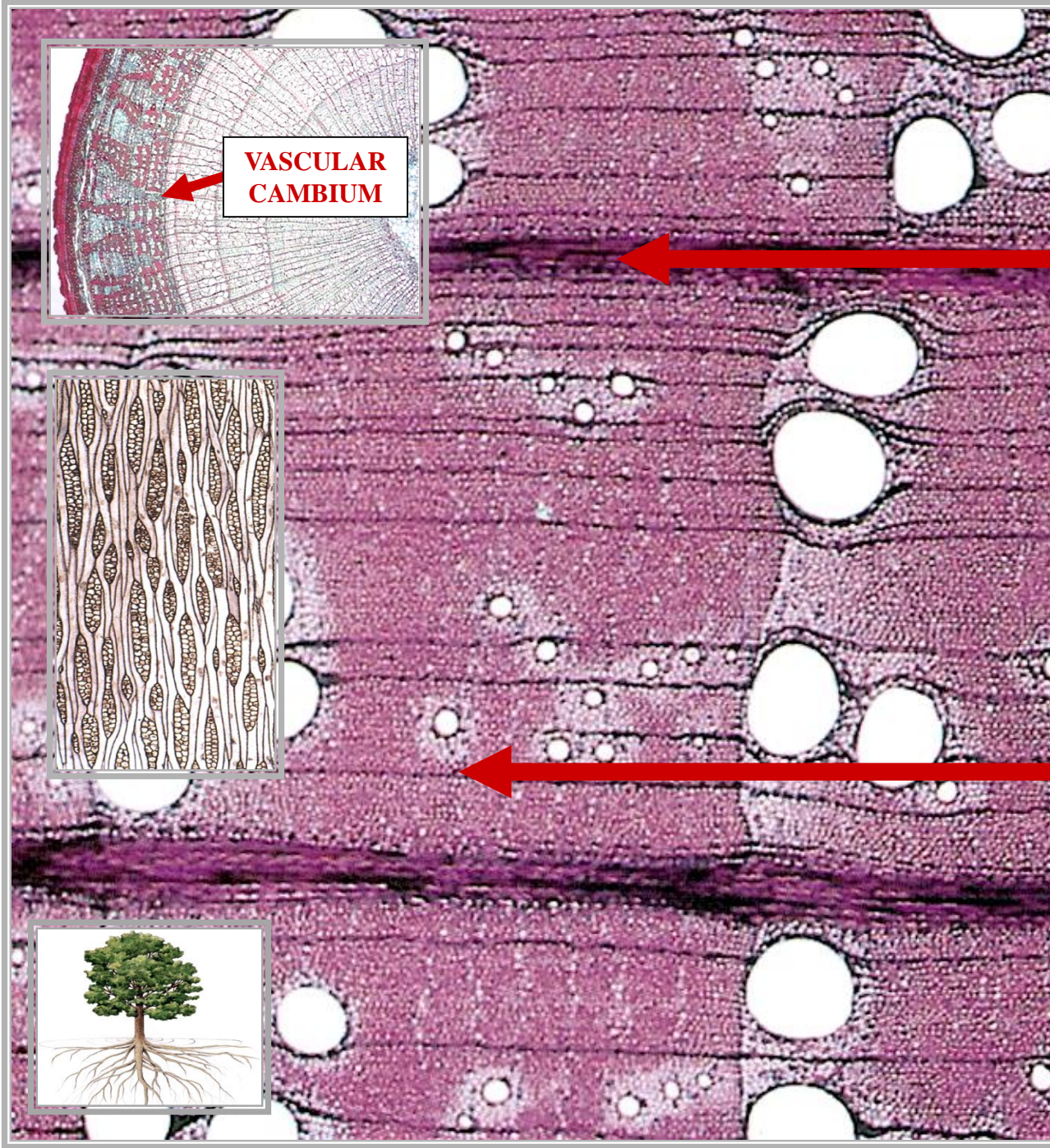
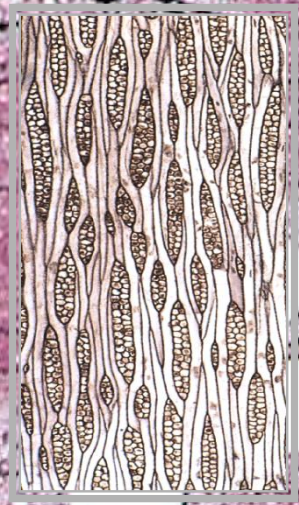
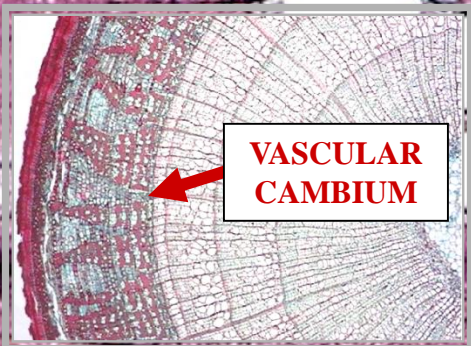
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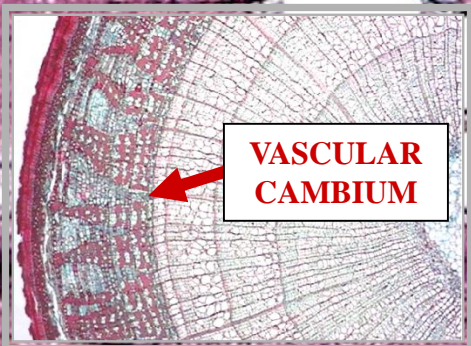
**VASCULAR
CAMBIUM**

**PARENCHYMA
CELLS**

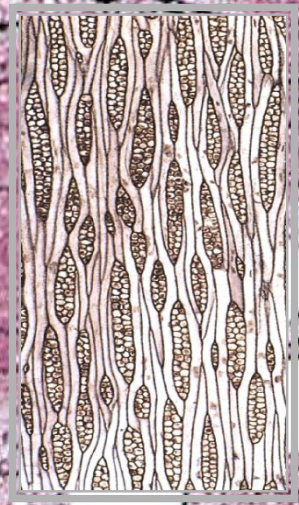
**PARENCHYMA
CELLS**

C.S.





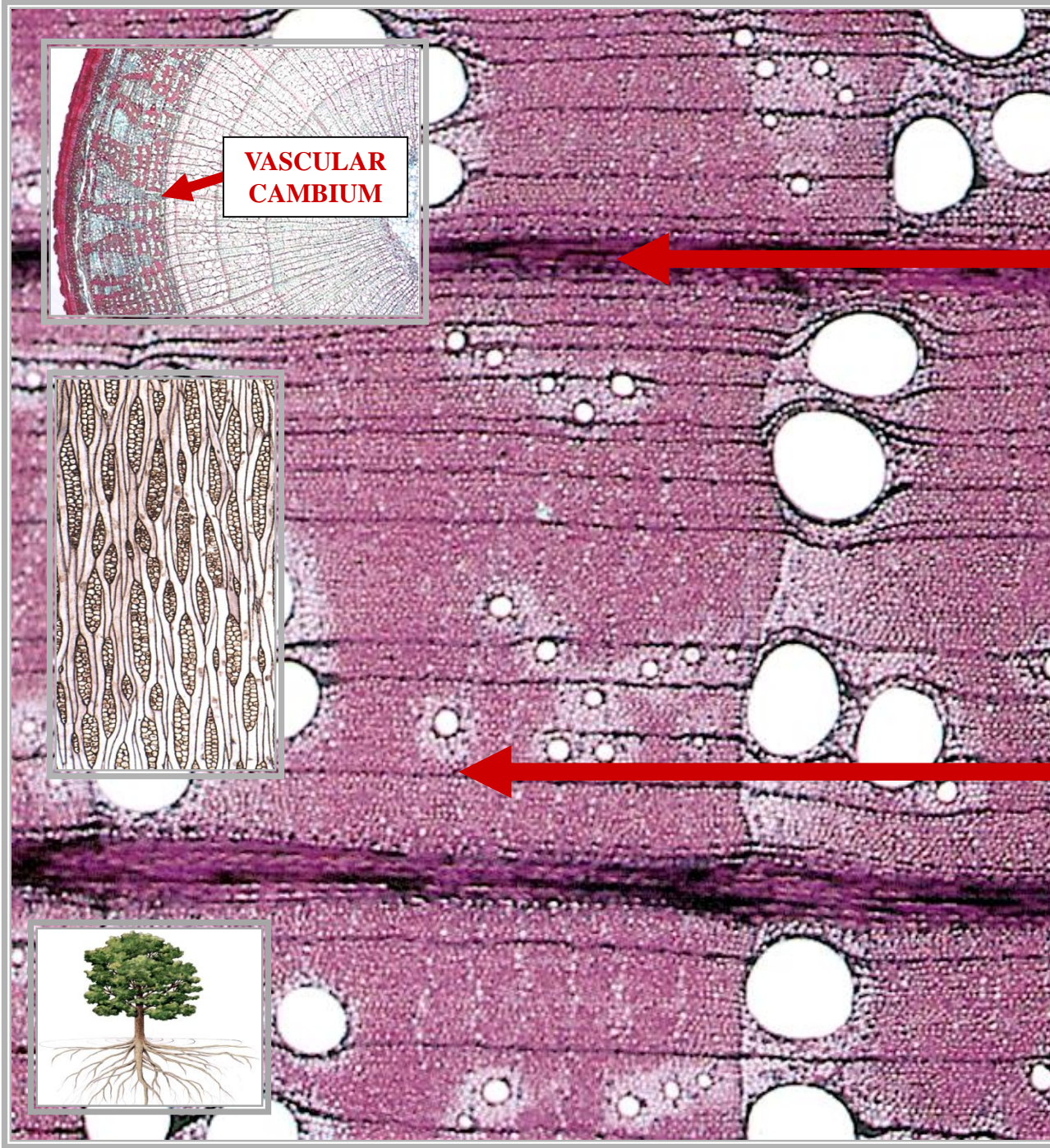
XYLEM RAY



XYLEM RAY



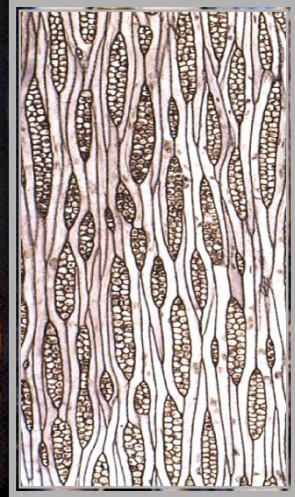
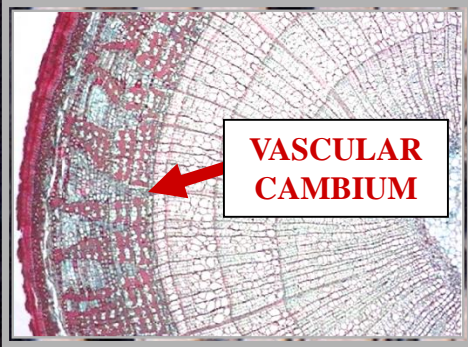
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**PHLOEM
RAY SYSTEM
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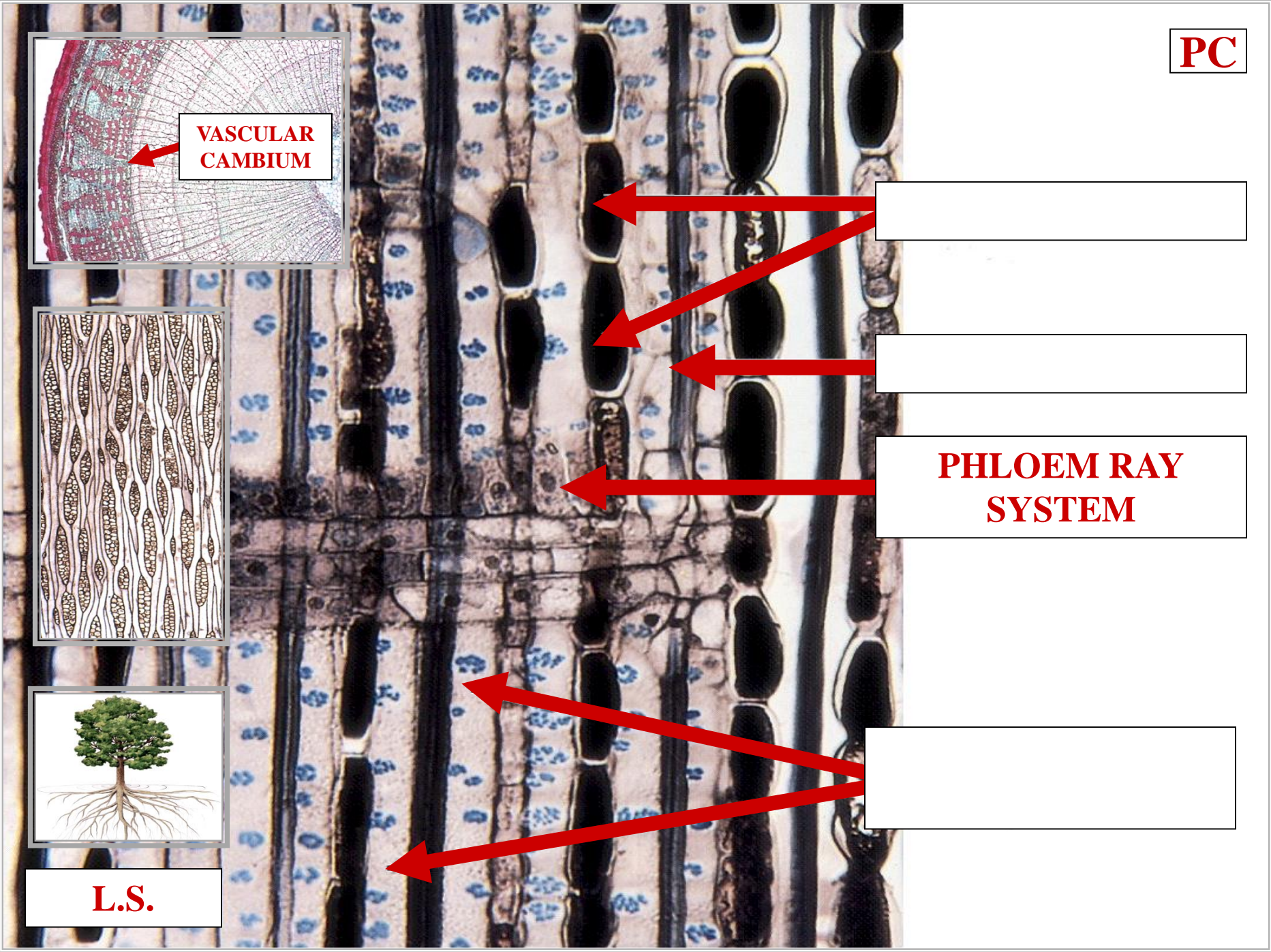
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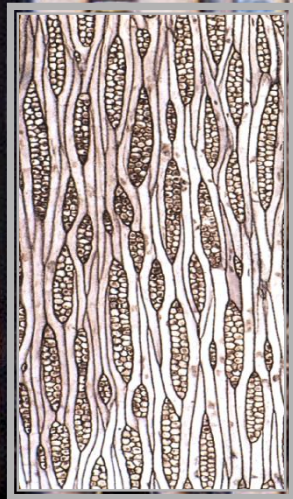
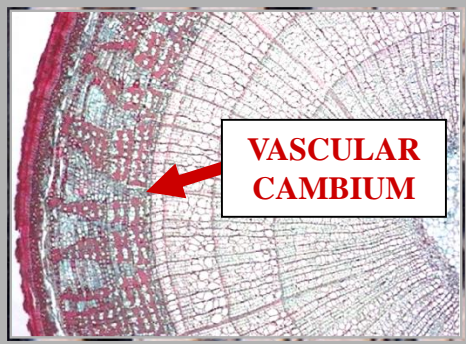
PHLOEM RAY SYSTEM



L.S.



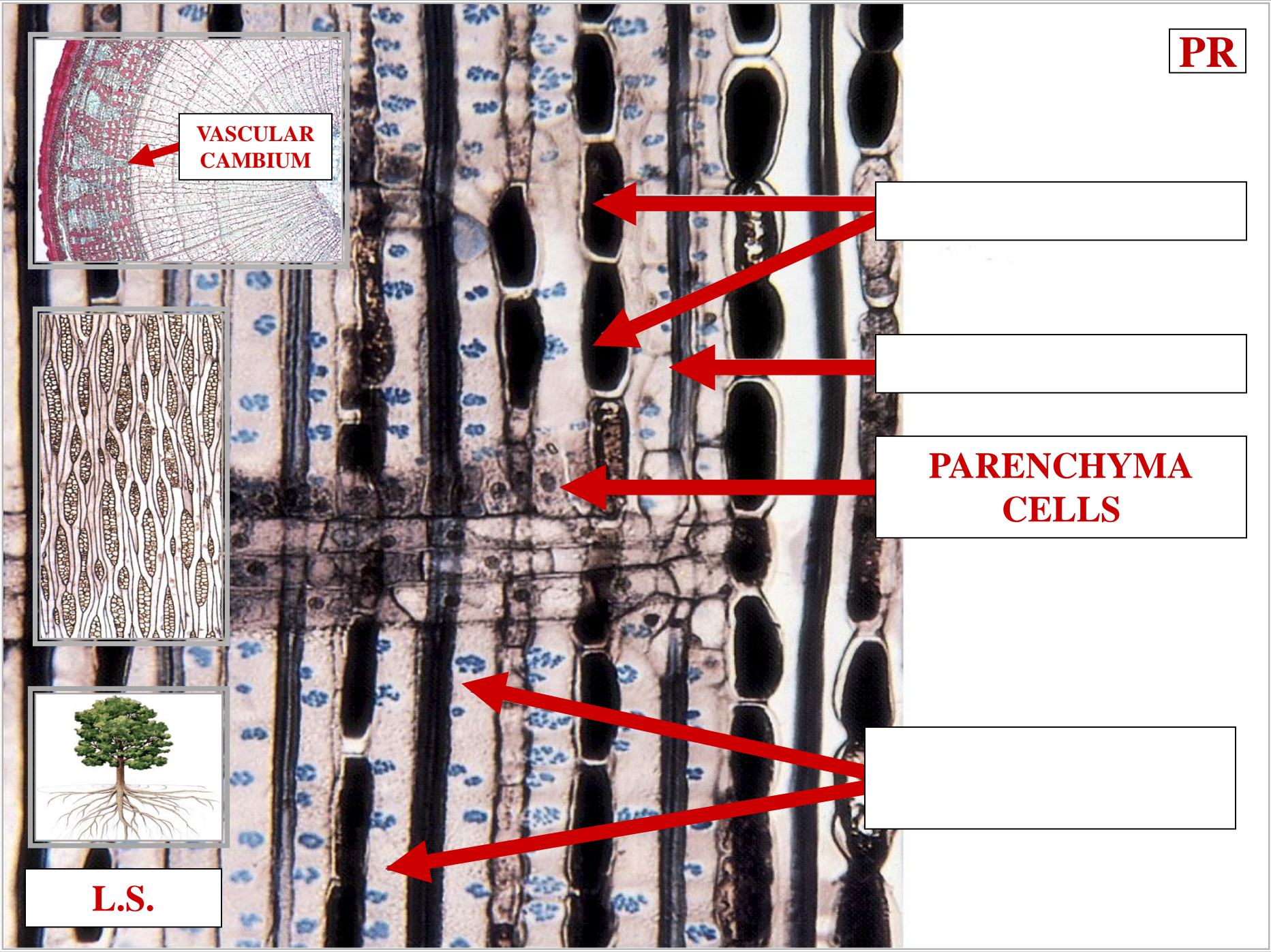
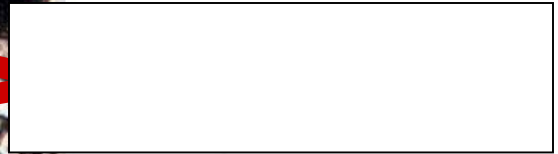
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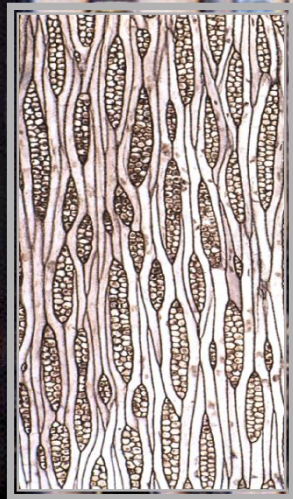
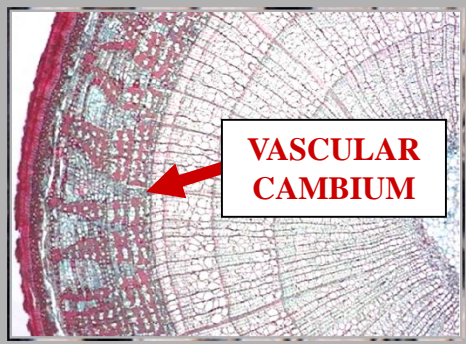


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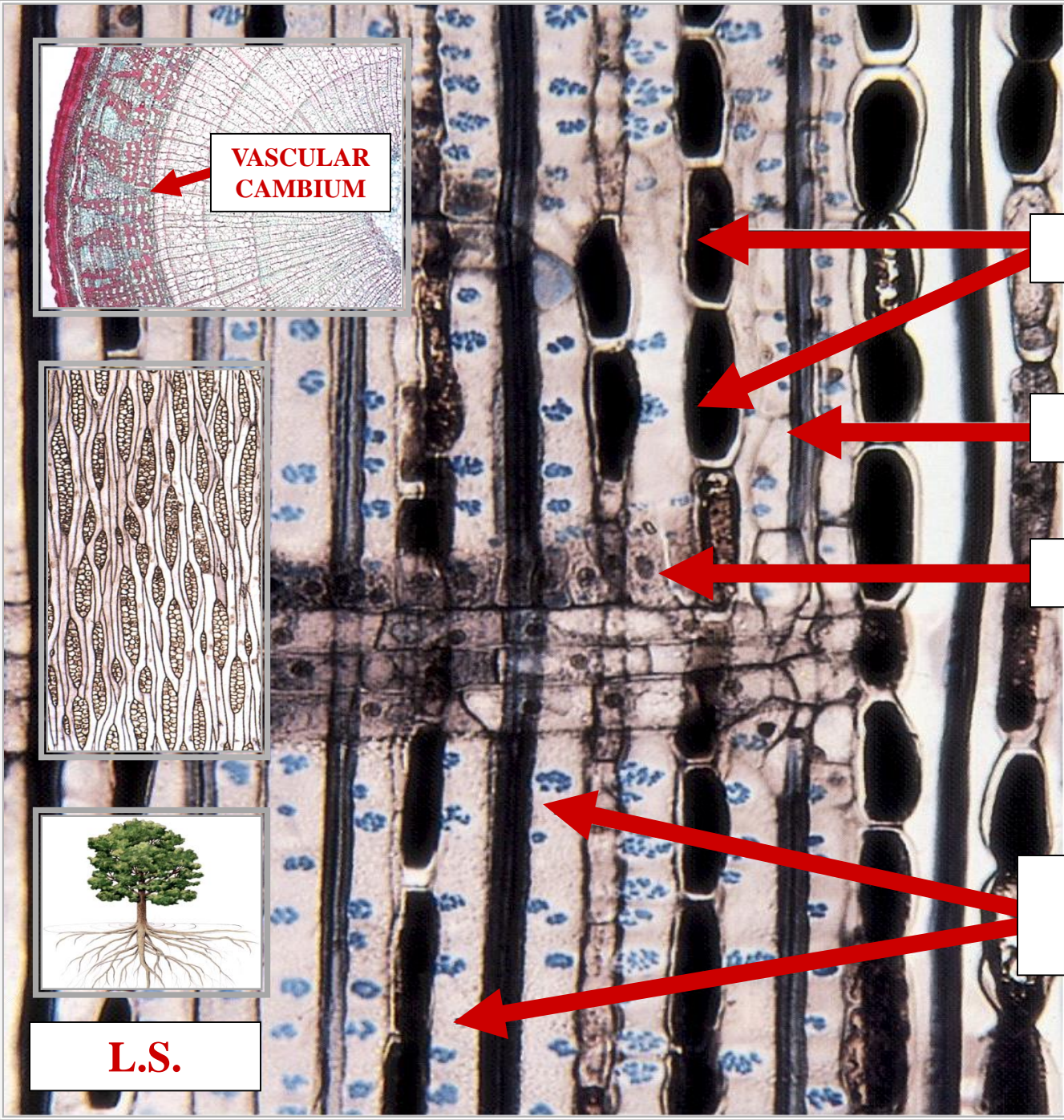


PARENCHYMA CELLS





L.S.



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PHLOEM RAY

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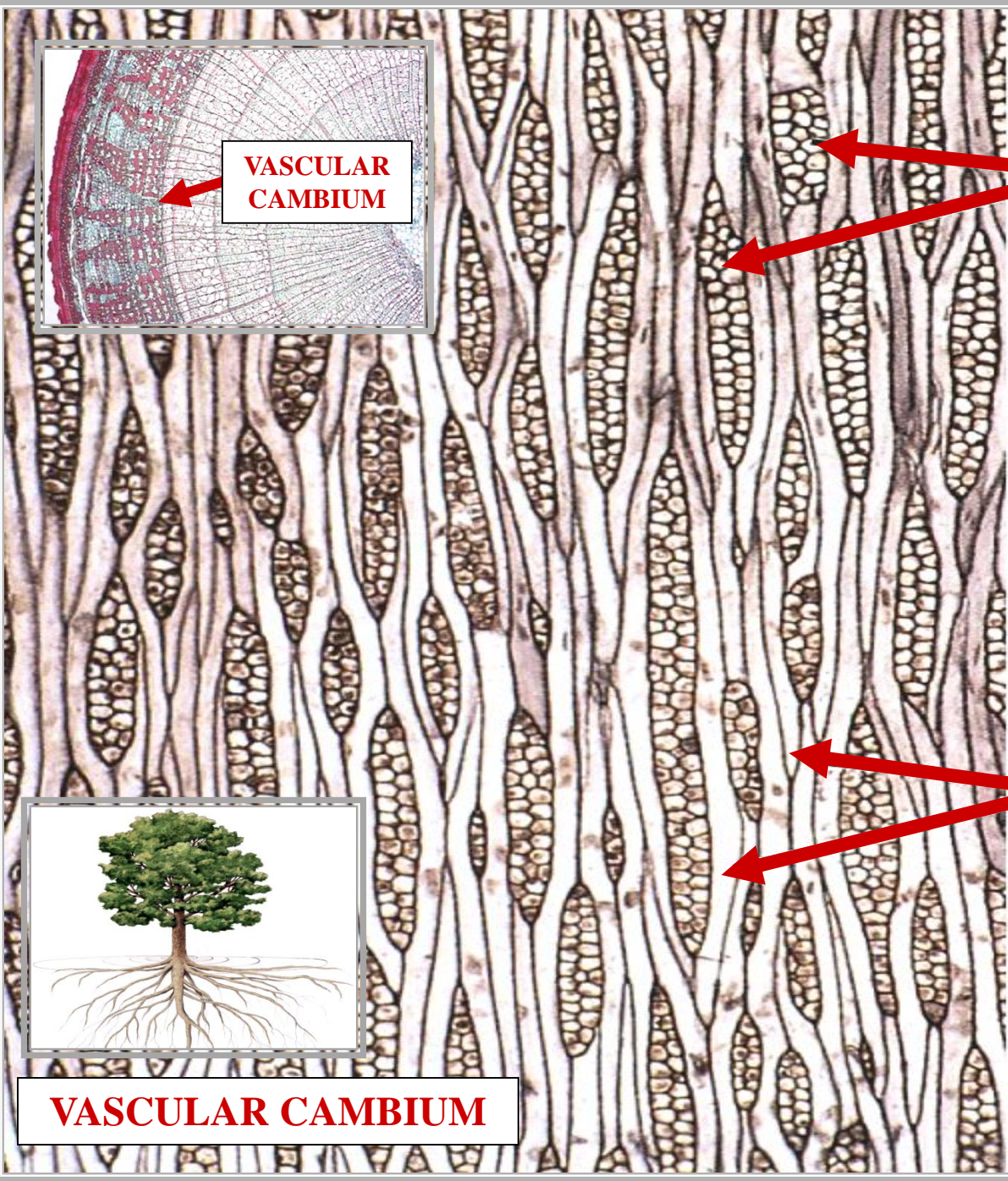
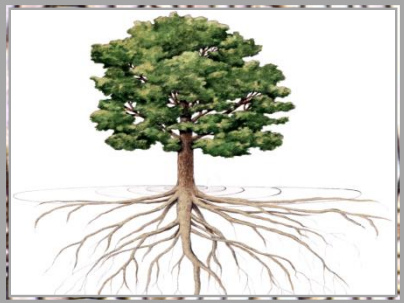
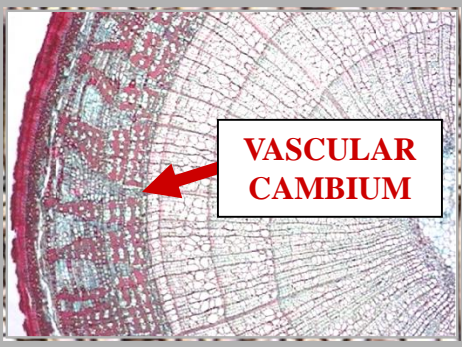
VASCULAR CAMBIUM INITIALS SUMMARY

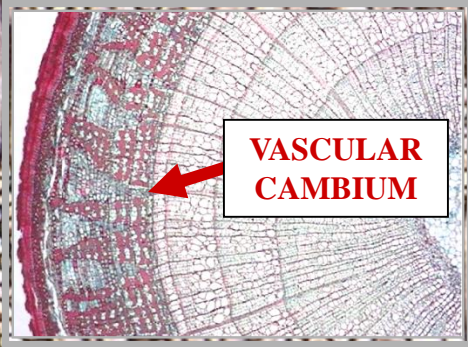
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**RAY
INITIALS**

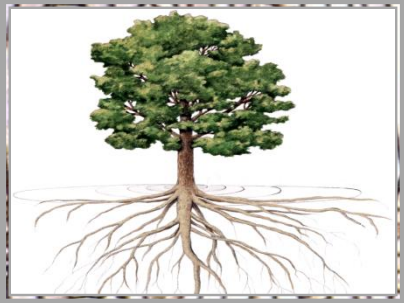
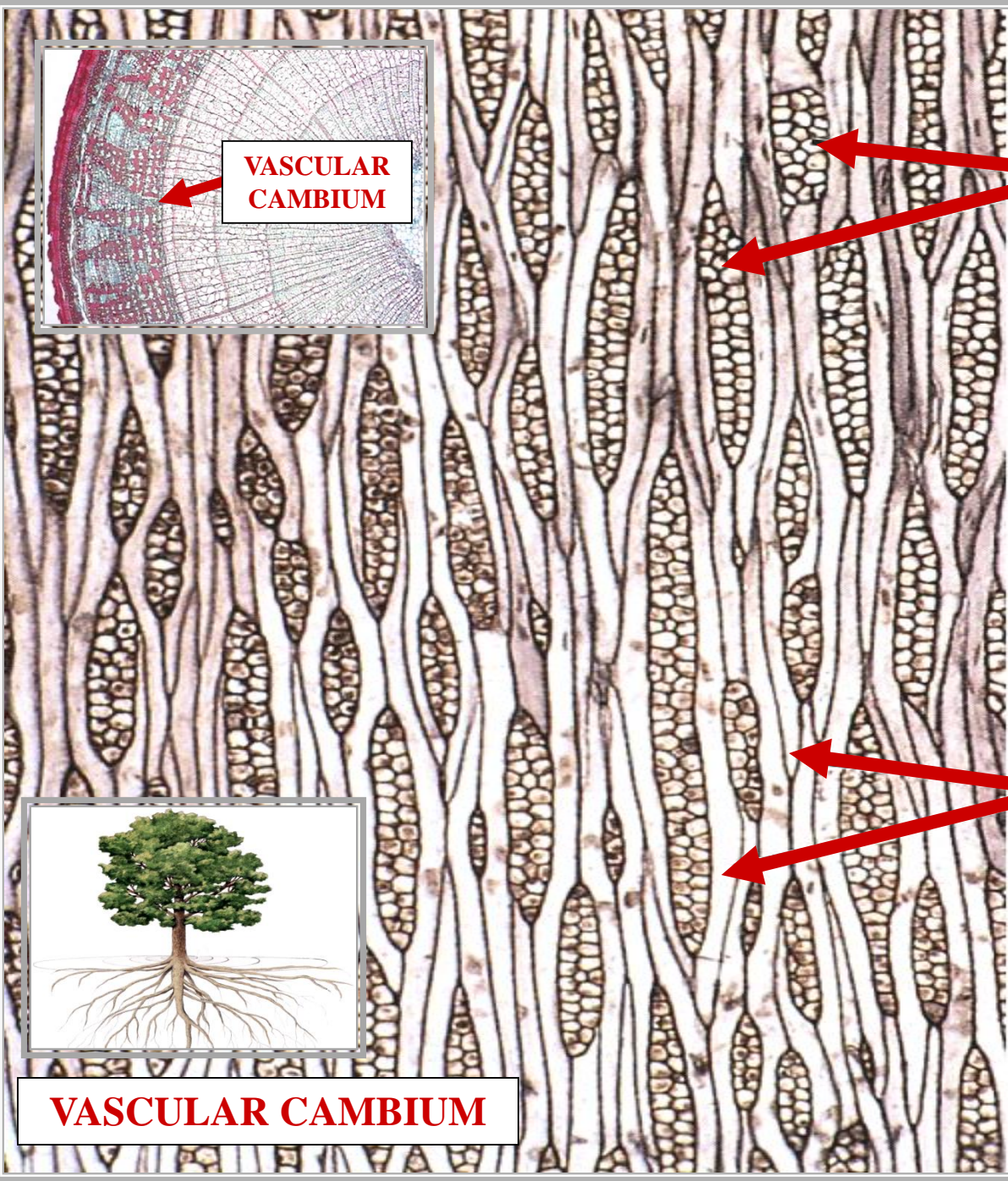
DICOT ~2 STEM

L.S.





LATERAL ORIENTATION



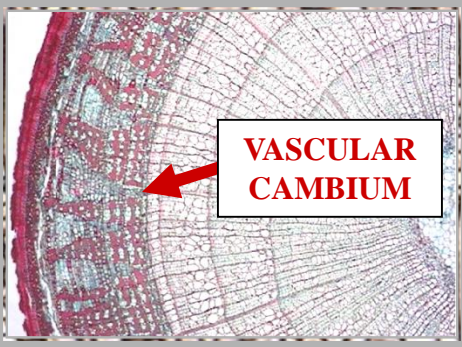
VASCULAR CAMBIUM

DICOT ~2 STEM

L.S.

RS

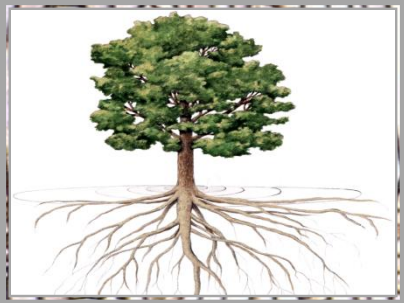
MITOSIS



VASCULAR CAMBIUM



DICOT ~2 STEM

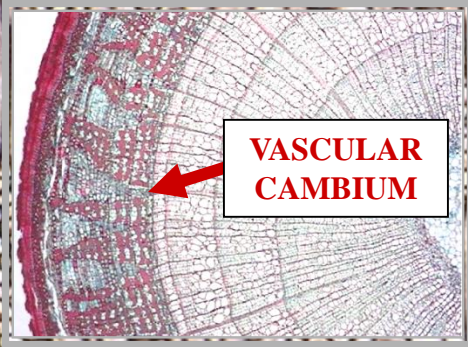


VASCULAR CAMBIUM

L.S.

LT

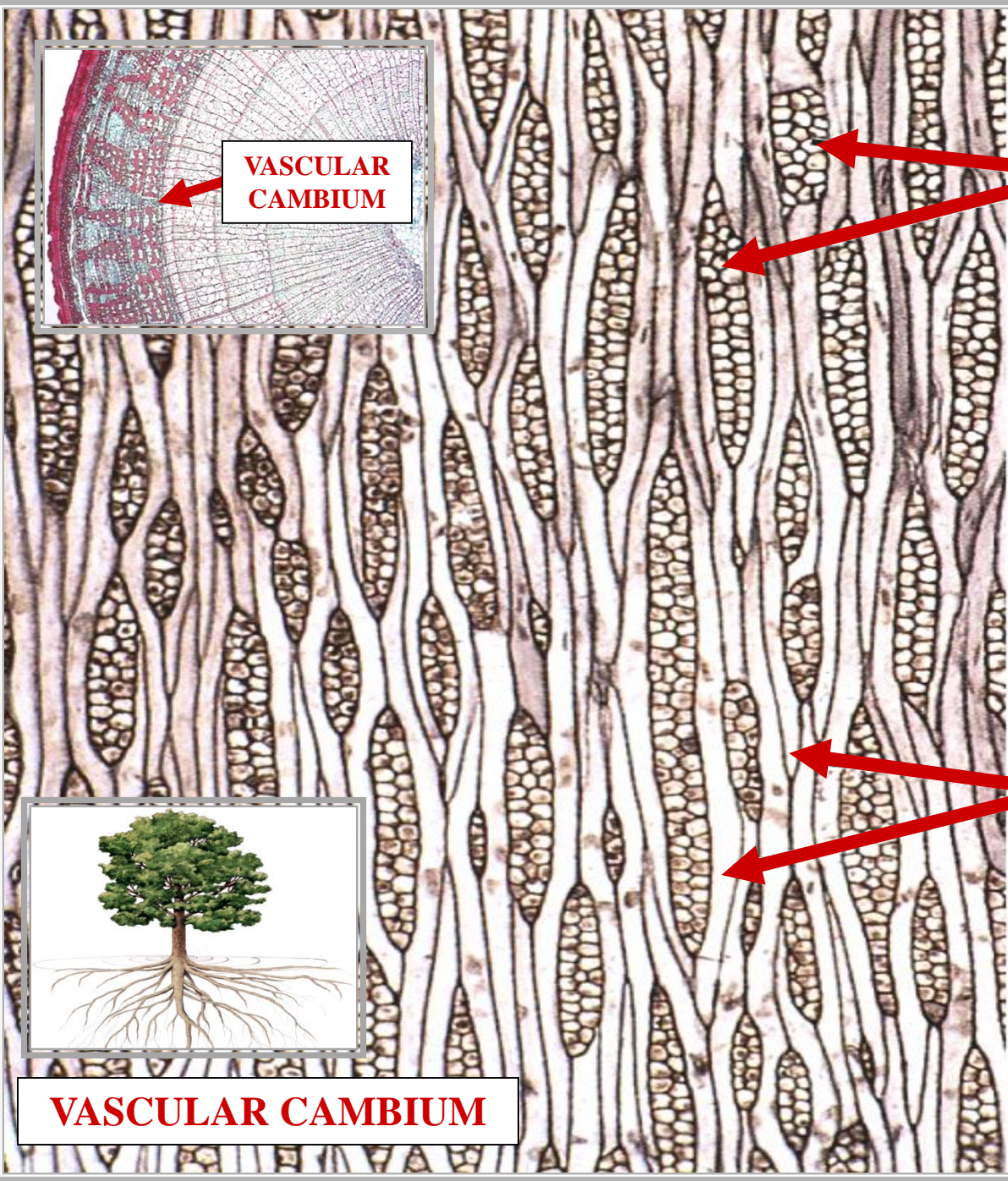
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RAY SYSTEM**

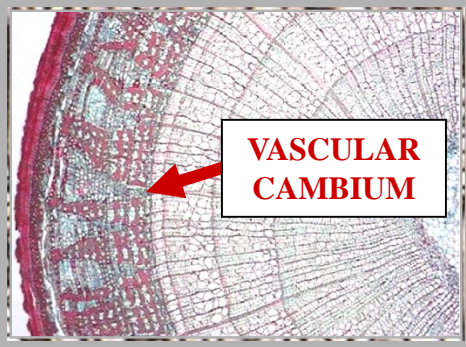


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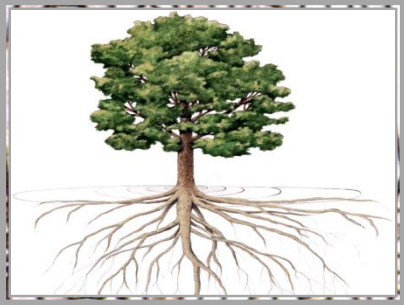
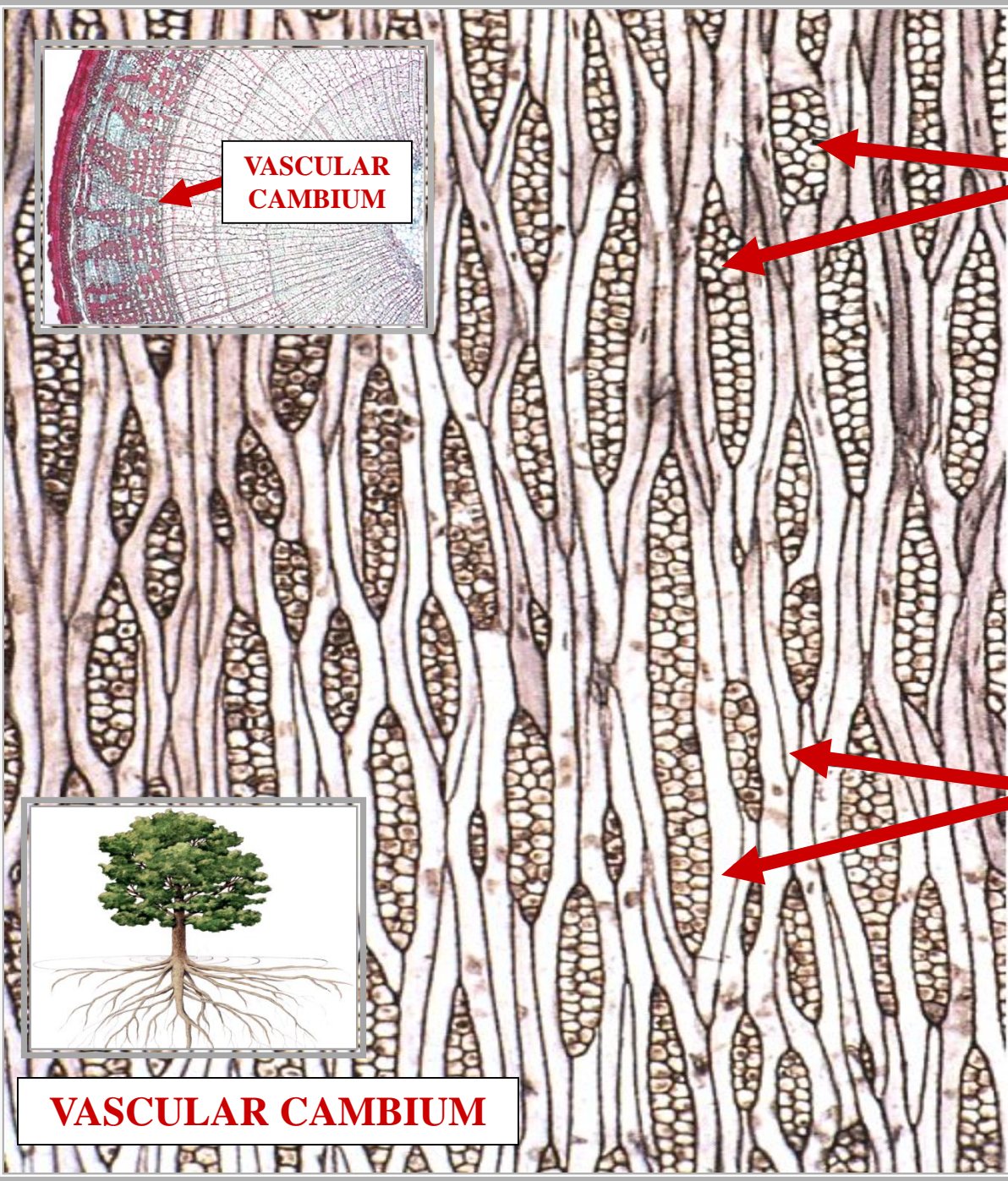


L.S.





**PERMITS
LATERAL
TRANSPORT**

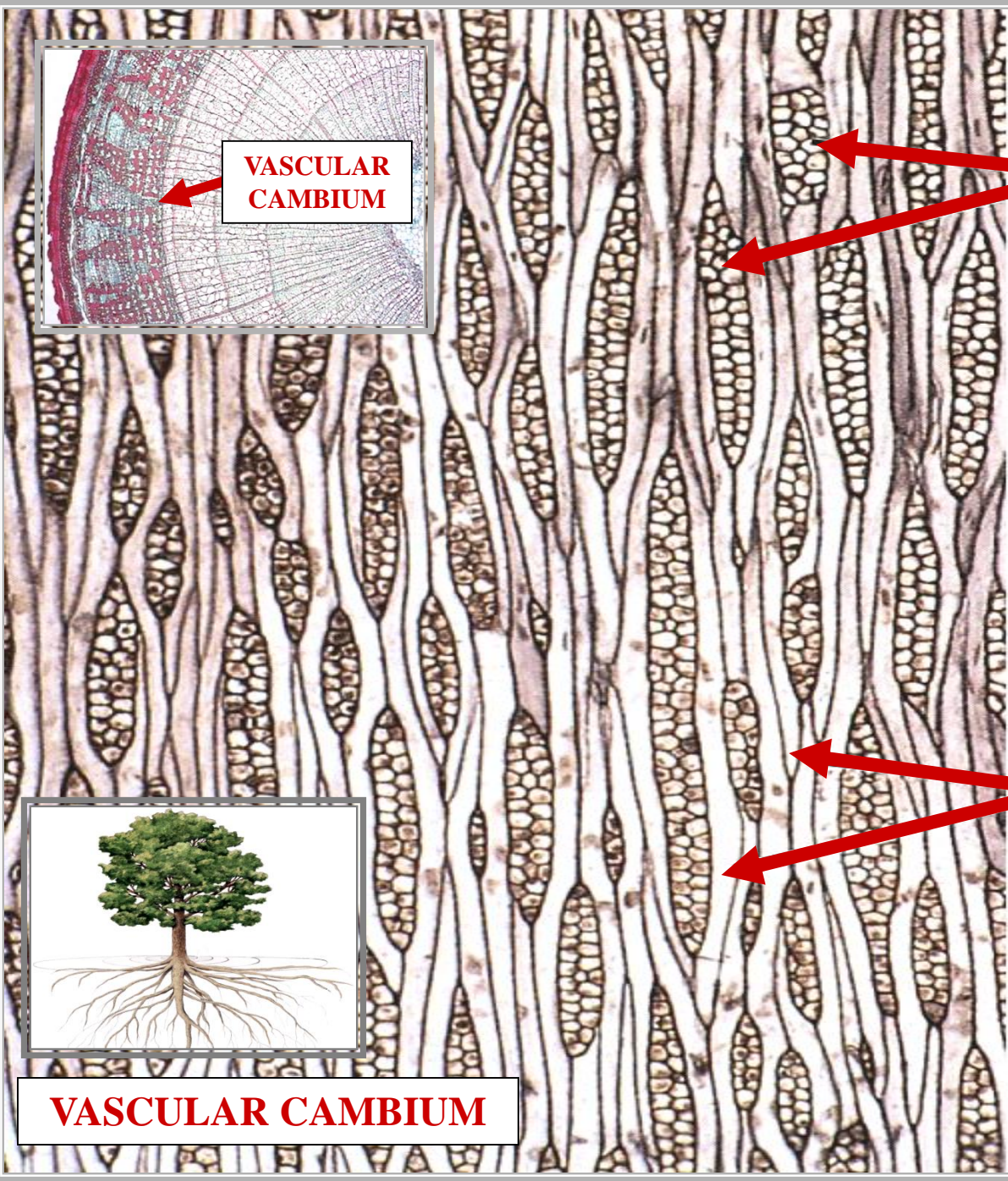
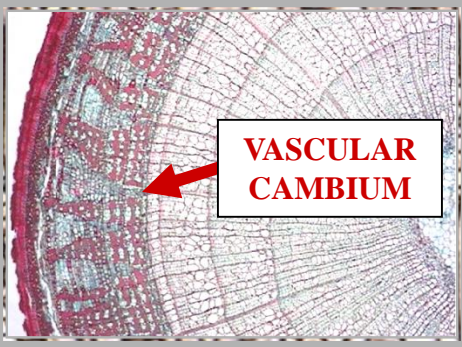


VASCULAR CAMBIUM

DICOT ~2 STEM

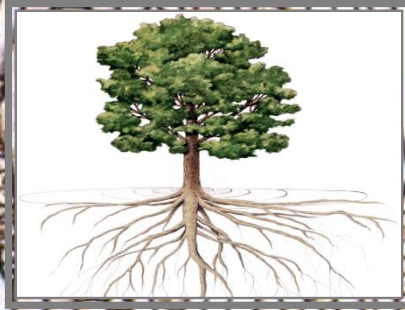
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VO



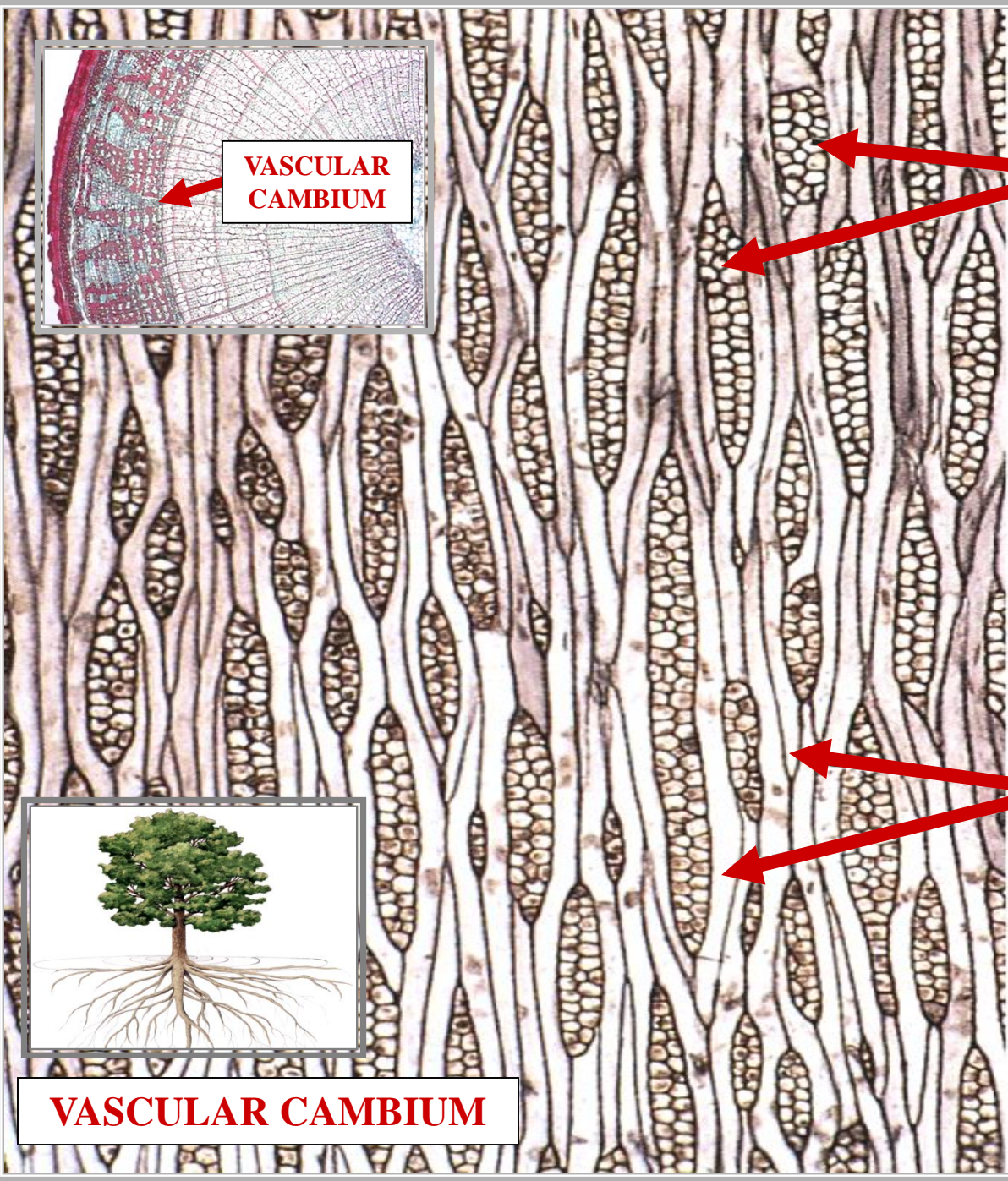
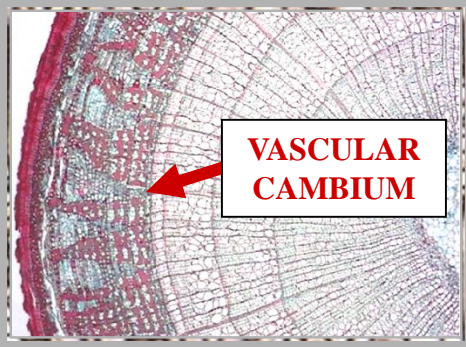
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INITIALS**

DICOT ~2 STEM

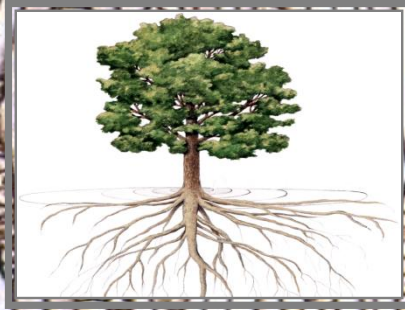


VASCULAR CAMBIUM

L.S.



**VERTICAL
ORIENTATION**

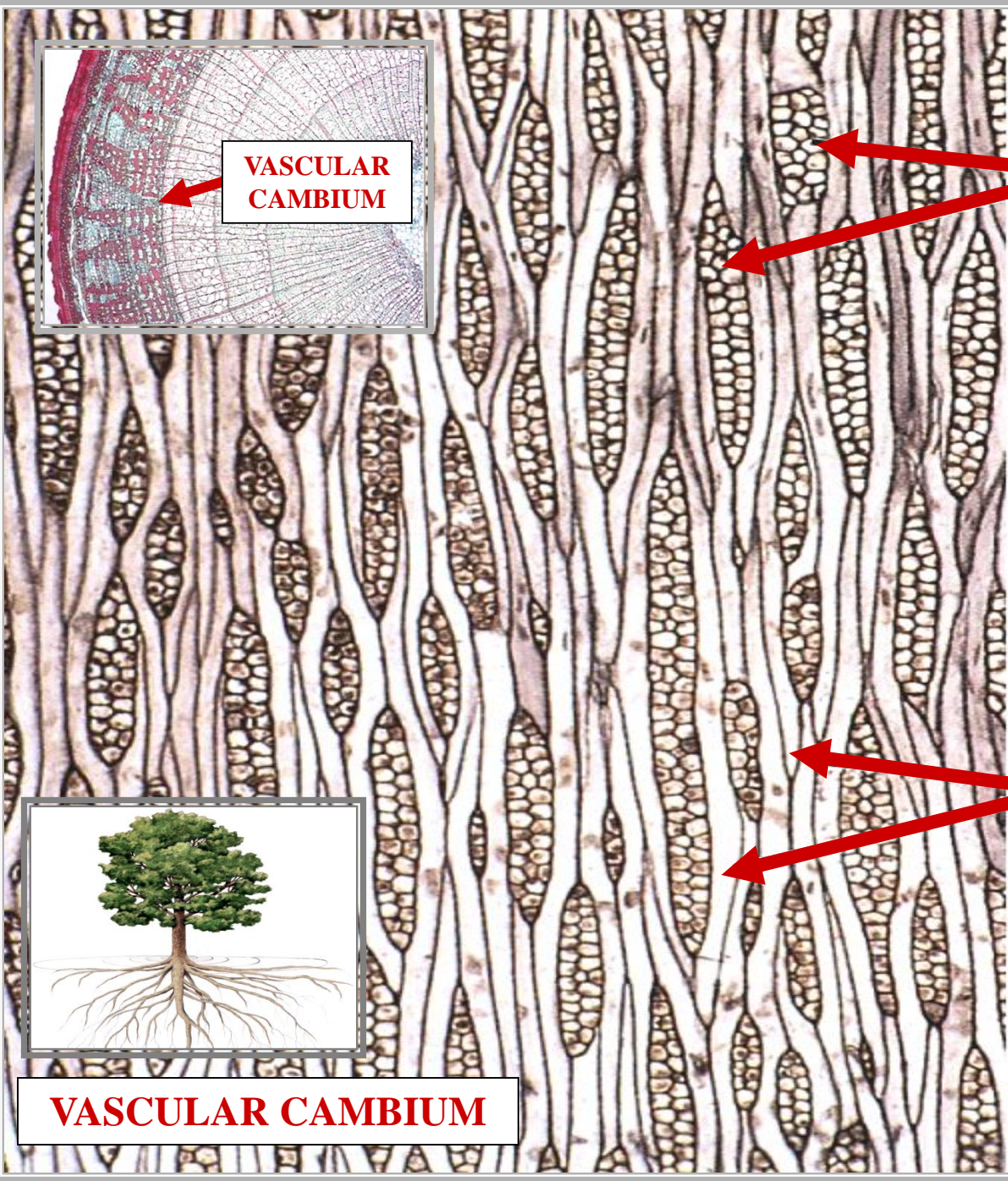
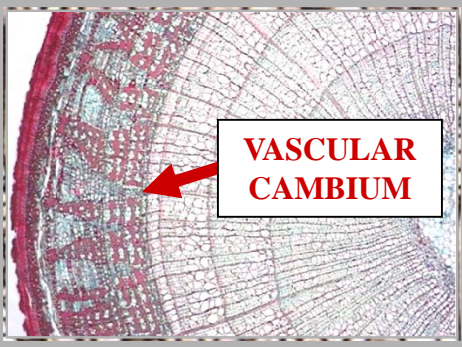


VASCULAR CAMBIUM

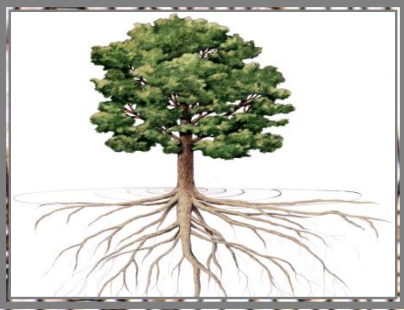
DICOT ~2 STEM

L.S.

AS



MITOSIS

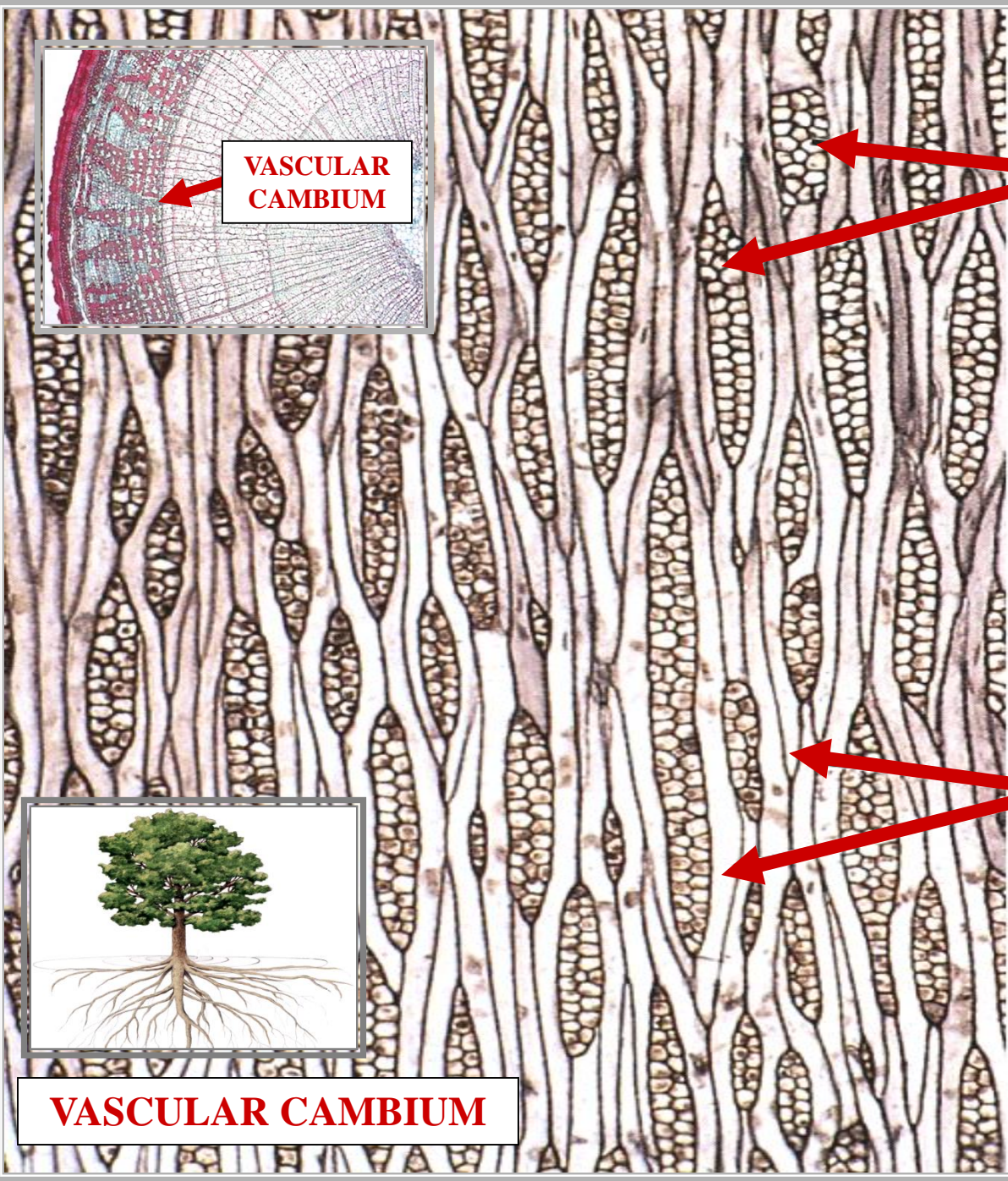
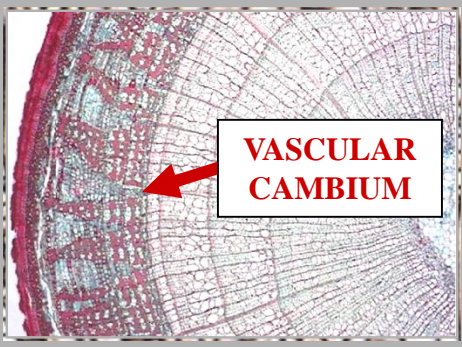


VASCULAR CAMBIUM

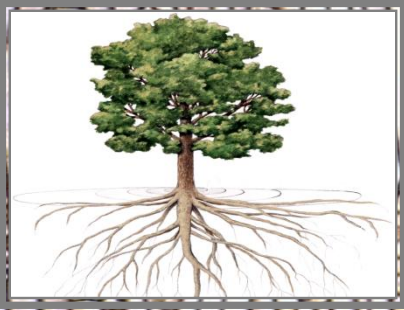
DICOT ~2 STEM

L.S.

VT



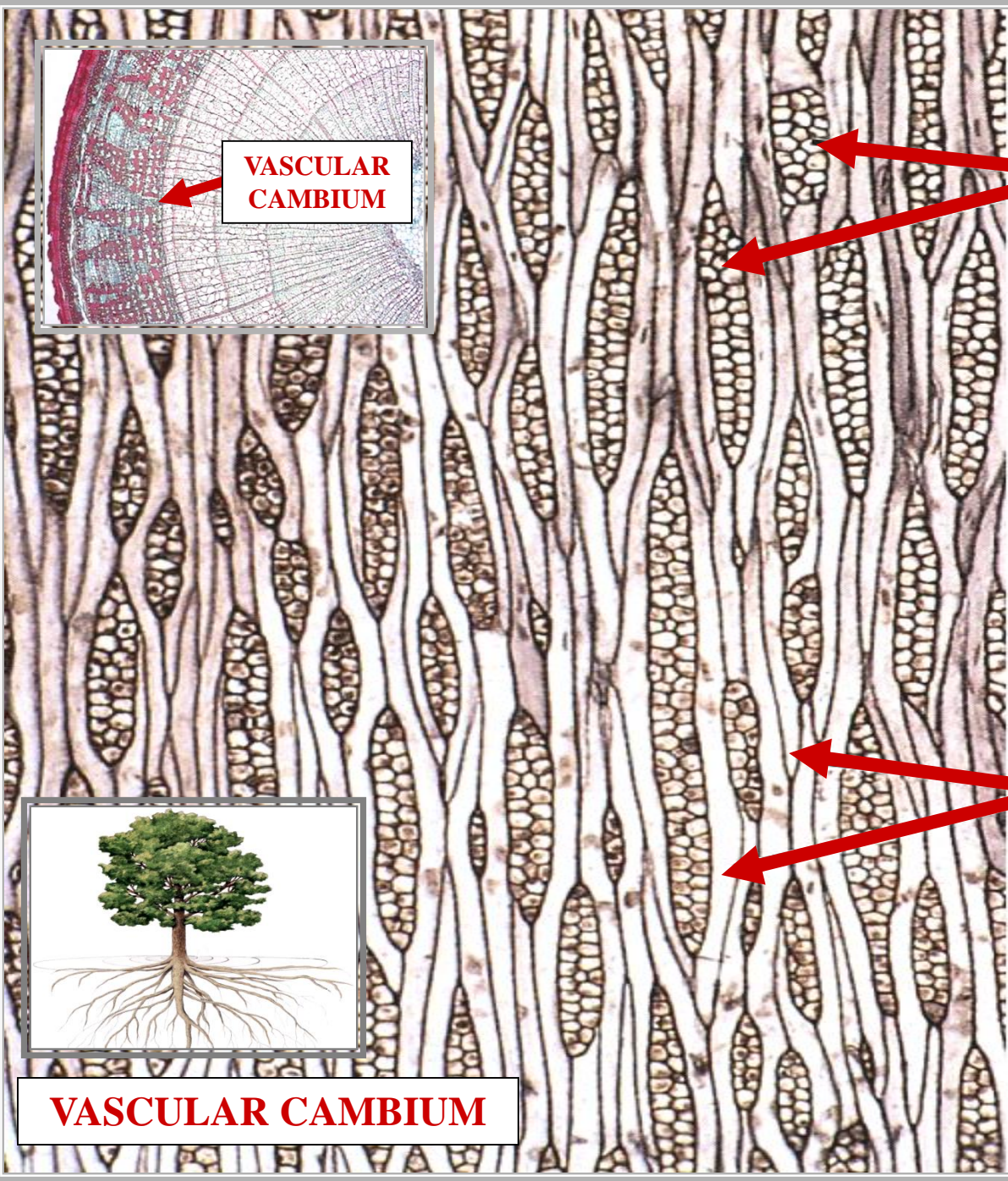
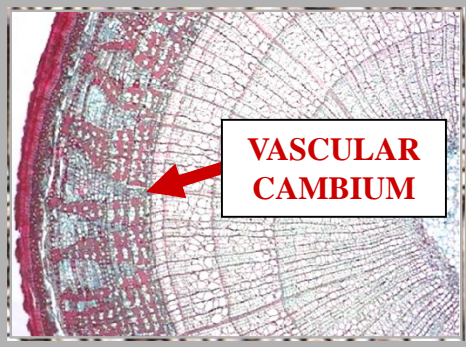
**DERIVE
AXIAL SYSTEM**



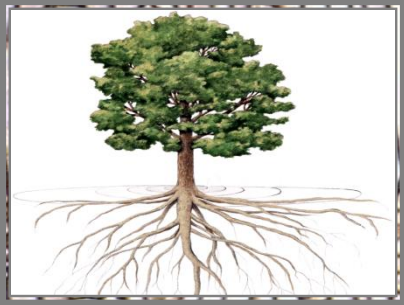
VASCULAR CAMBIUM

DICOT ~2 STEM

L.S.



**PERMITS
VERTICAL
TRANSPORT**



VASCULAR CAMBIUM

DICOT ~2 STEM

L.S.

VASCULAR CAMBIUM TYPES

VASCULAR CAMBIUM TYPES

STORIED VASCULAR CAMBIUM

VASCULAR CAMBIUM TYPES

VASCULAR CAMBIUM TYPES

STORIED VASCULAR CAMBIUM

NON-STORIED VASCULAR CAMBIUM

VASCULAR CAMBIUM TYPES

**STORIED
VASCULAR
CAMBIUM**

VASCULAR CAMBIUM



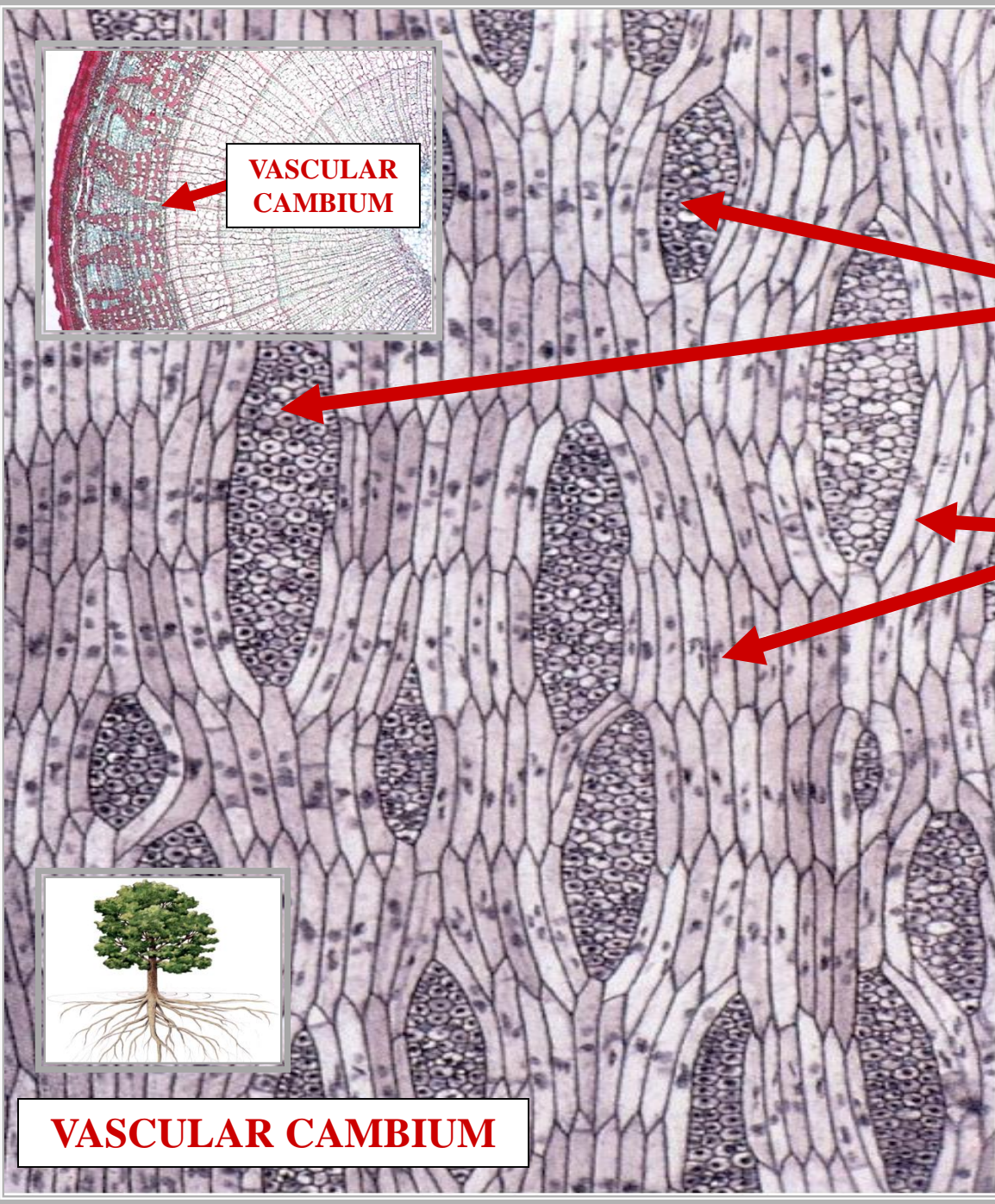
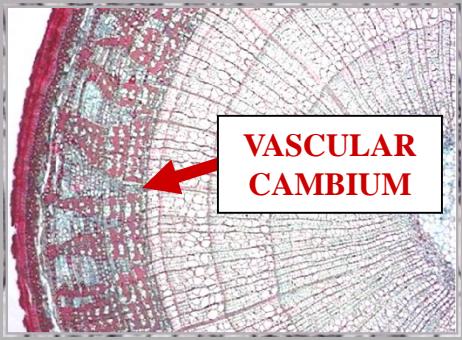
STORIED VASCULAR CAMBIUM

FUSIFORM INITIALS STRATIFIED

INITIALS DO NOT OVERLAP

VASCULAR CAMBIUM

STORIED VASCULAR CAMBIUM



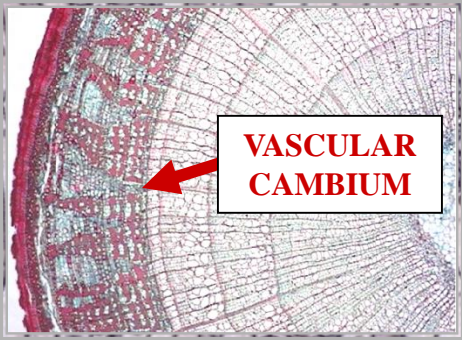
**RAY
INITIALS**

**FUSIFORM
INITIALS
DO NOT
OVERLAP**



VASCULAR CAMBIUM

L.S.



**RAY
INITIALS**

**FUSIFORM
INITIALS
DO NOT
OVERLAP**



L.S.

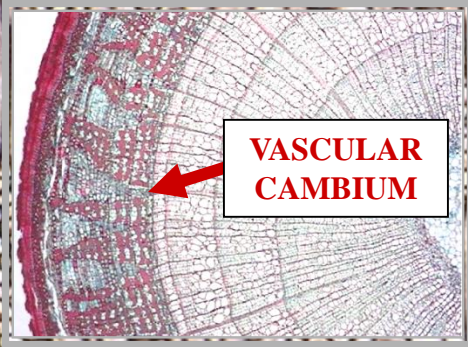
**NON-STORIED
VASCULAR
CAMBIUM**

**VASCULAR CAMBIUM
NON-STORIED**

**VASCULAR CAMBIUM
FUSIFORM INITIALS
NON-STRATIFIED**

**INITIALS DO OVER-LAP
VASCULAR CAMBIUM
NON-STORIED
VASCULAR CAMBIUM**

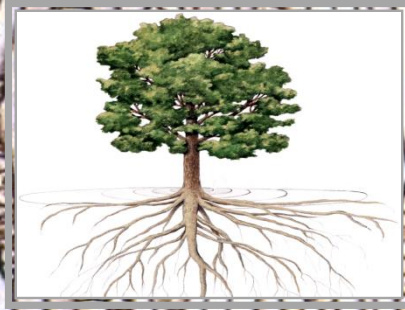




**VASCULAR
CAMBIUM**

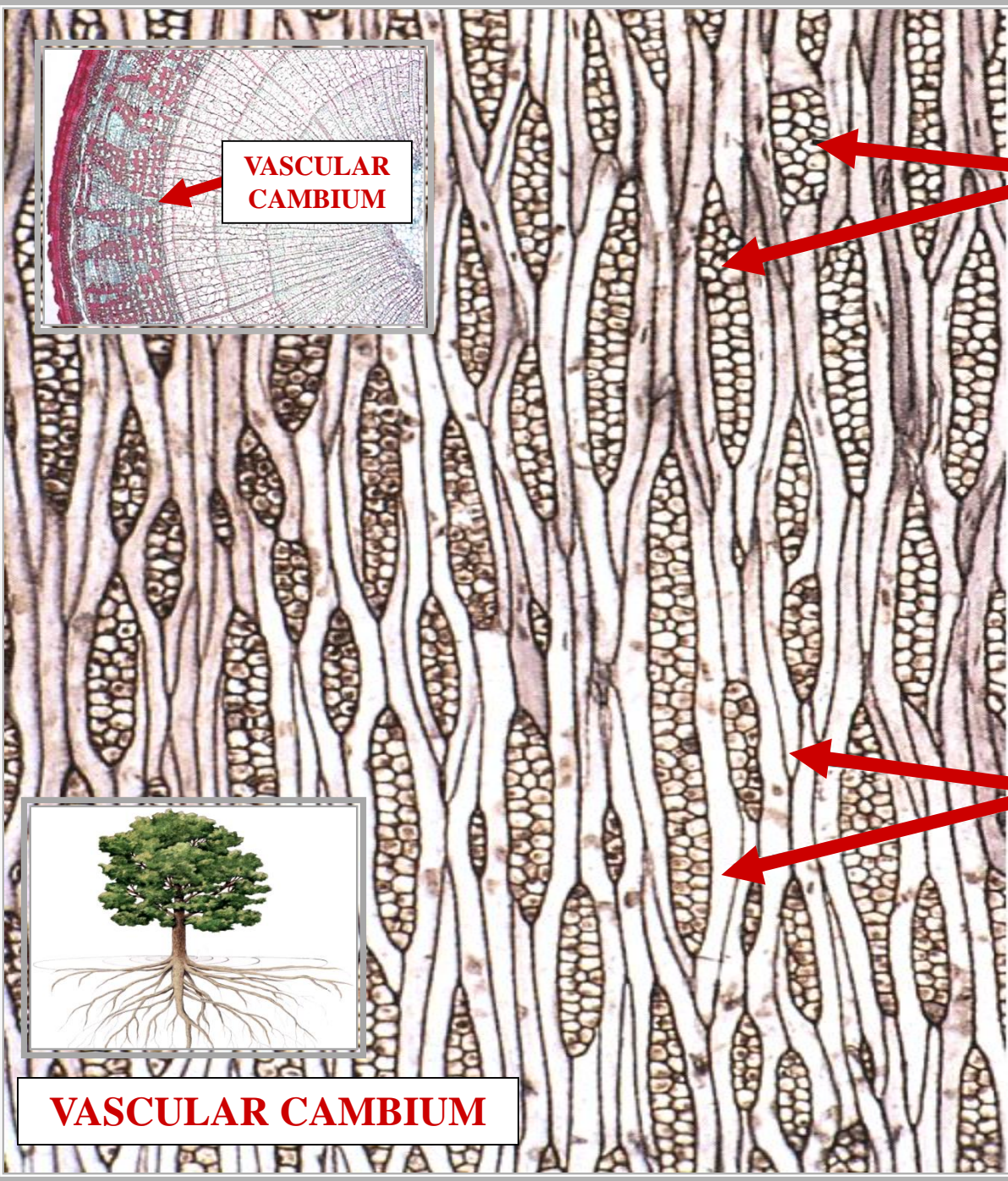
**RAY
INITIALS**

**FUSIFORM
INITIALS
DO OVERLAP**



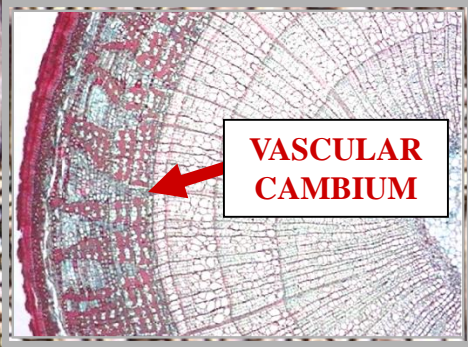
VASCULAR CAMBIUM

L.S.



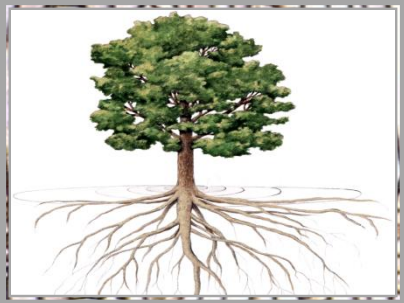
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S



RAY INITIALS

FUSIFORM INITIALS DO OVERLAP



L.S.



**STORIED
VASCULAR CAMBIUM
VS
NON-STORIED
VASCULAR CAMBIUM
SUMMARY**

**FUSIFORM
INITIALS
DO NOT
OVERLAP**

?

**FUSIFORM
INITIALS
DO
OVERLAP**

?

S



**FUSIFORM
INITIALS
DO NOT
OVERLAP**

This micrograph shows a cross-section of wood tissue. The vascular cambium is visible as a distinct, dark, storied band. The fusiform initials are arranged in a regular, non-overlapping pattern, forming a clear boundary between the xylem and phloem.

STORIED VASCULAR CAMBIUM



**FUSIFORM
INITIALS
DO
OVERLAP**

This micrograph shows a cross-section of wood tissue. The vascular cambium is visible as a dark band. The fusiform initials are arranged in an overlapping pattern, which is characteristic of a non-storied vascular cambium.

?



**FUSIFORM
INITIALS
DO NOT
OVERLAP**

This micrograph shows a cross-section of a stem with a storied vascular cambium. The cambium is a distinct, dark-stained layer of fusiform initials that forms a regular, repeating pattern of vertical bands. These bands are separated by radial files of cells, creating a clear, organized structure. The cambium is located between the xylem and phloem, and its activity results in the formation of secondary xylem and secondary phloem.

STORIED VASCULAR CAMBIUM



**FUSIFORM
INITIALS
DO
OVERLAP**

This micrograph shows a cross-section of a stem with a non-storied vascular cambium. The cambium is a dark-stained layer of fusiform initials that forms a more irregular, overlapping pattern of vertical bands. These bands are separated by radial files of cells, but the overall structure is less organized than the storied cambium. The cambium is located between the xylem and phloem, and its activity results in the formation of secondary xylem and secondary phloem.

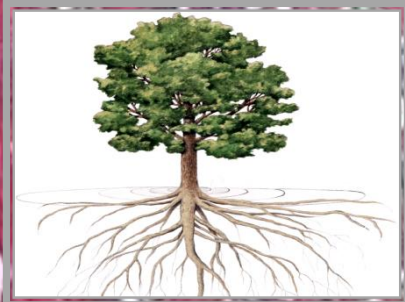
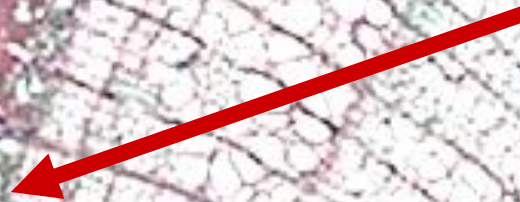
NON-STORIED VASCULAR CAMBIUM



VASCULAR CAMBIUM ACTIVITY



**VASCULAR
CAMBIUM**

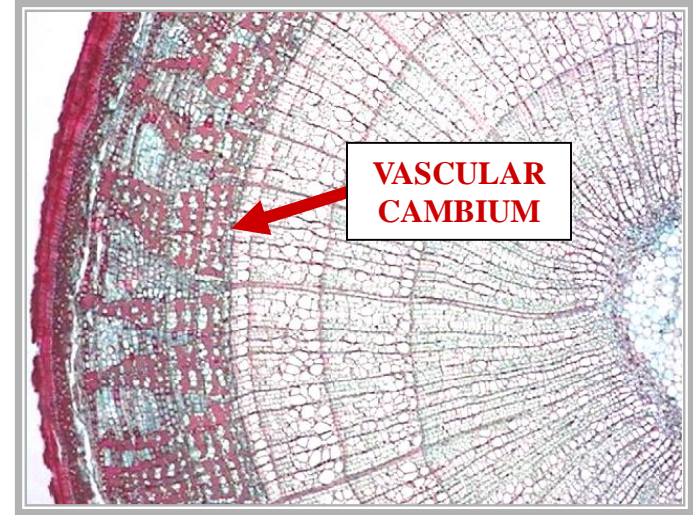


DICOT ~2 STEM

C.S.



CELL



**VASCULAR
CAMBIUM**

PC

**VASCULAR
CAMBIUM**

**VASCULAR
CAMBIUM**

DICOT ~2 STEM

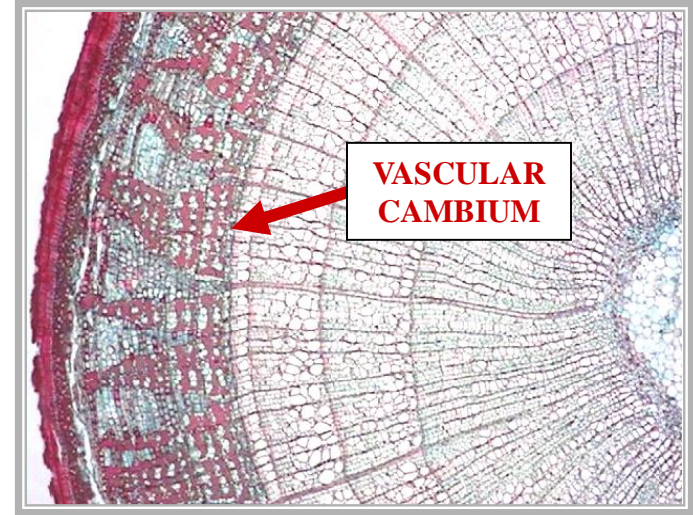
C.S.



CELL

**PARENCHYMA
CELL INITIALS**

DICOT ~2 STEM



**VASCULAR
CAMBIUM**

**PARENCHYMA
CELL INITIALS**

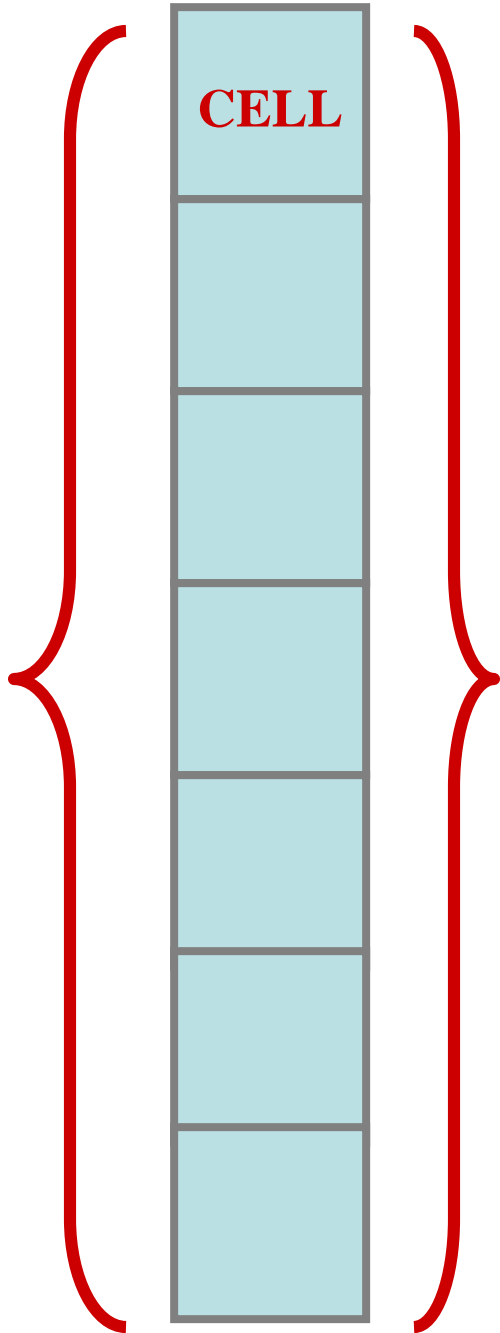
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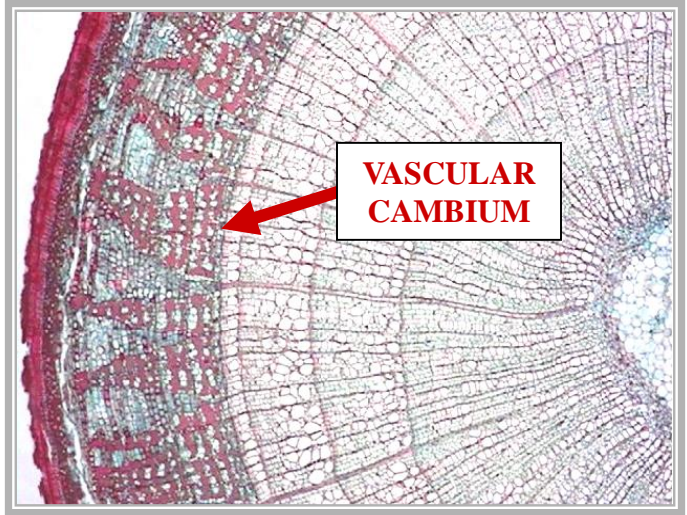


MITOSIS

DICOT ~2 STEM



CELL



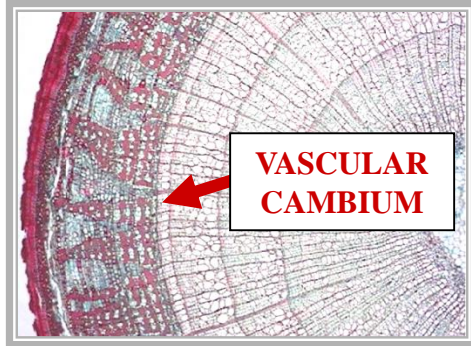
VASCULAR CAMBIUM

MITOSIS

C.S.

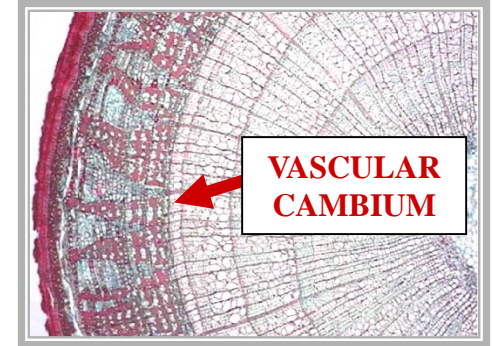


**OUTSIDE
VASCULAR
CAMBIUM**



CELL

**INSIDE
VASCULAR
CAMBIUM**



OUTSIDE

MITOSIS

**DERIVATIVE
PARENCHYMA
CELLS**

DICOT ~2 STEM

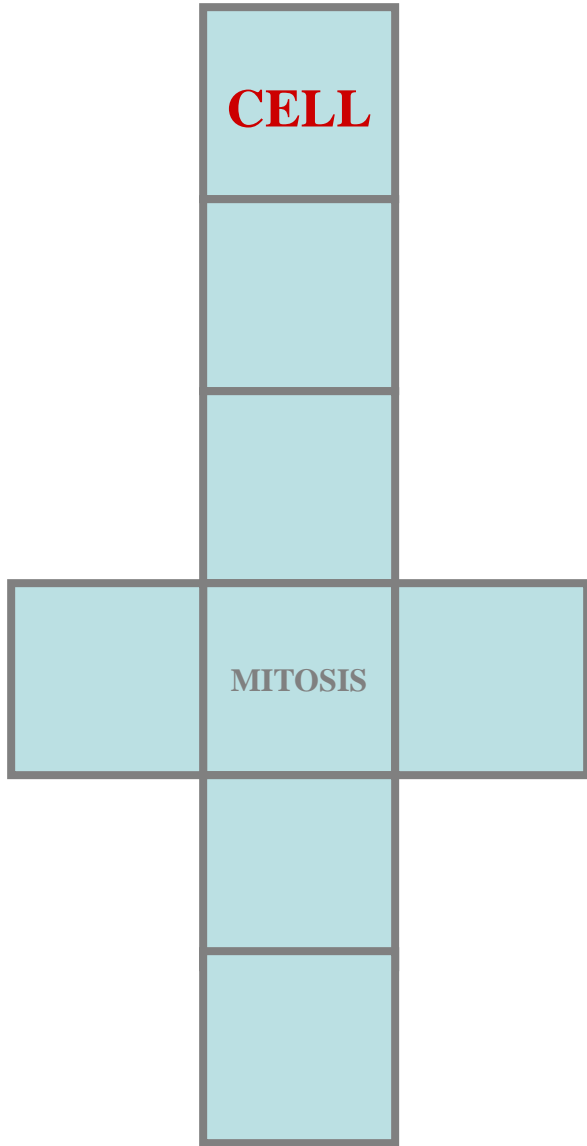
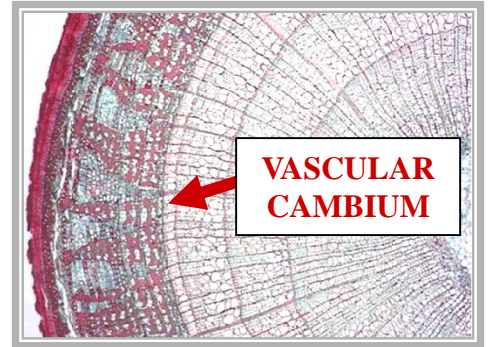
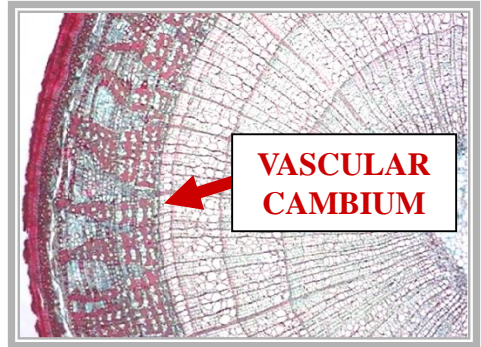
**VASCULAR
CAMBIUM**

C.S.



**OUTSIDE
VASCULAR
CAMBIUM**

**INSIDE
VASCULAR
CAMBIUM**



OUTSIDE

INSIDE

**DERIVATIVE
PARENCHYMA
CELLS**

**DERIVATIVE
PARENCHYMA
CELLS**

DICOT ~2 STEM

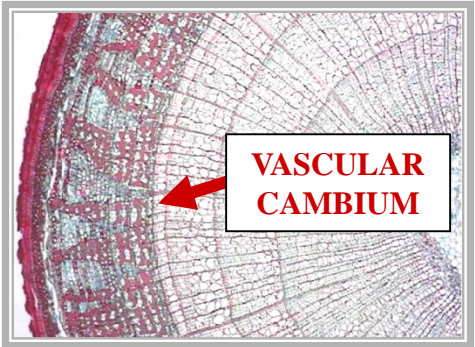
**VASCULAR
CAMBIUM**

C.S.

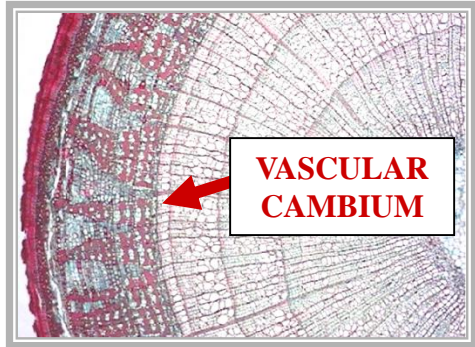
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**OUTSIDE
VASCULAR
CAMBIUM**



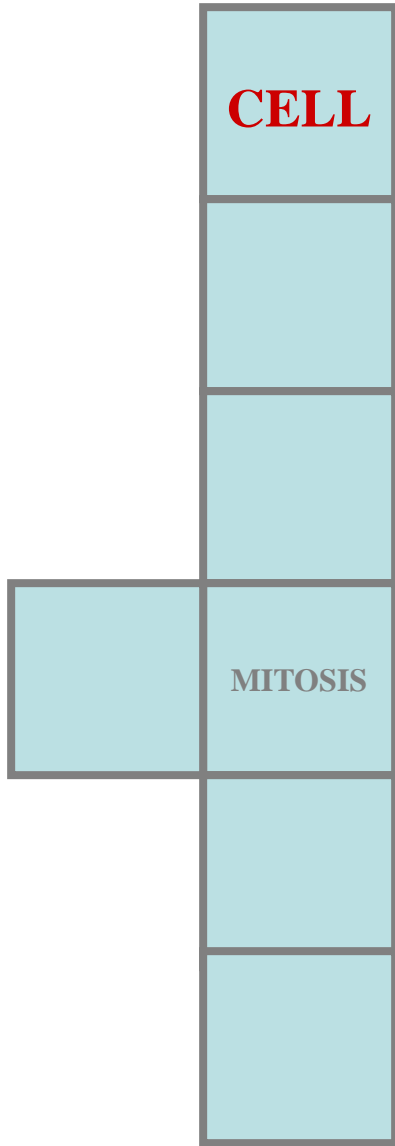
**INSIDE
VASCULAR
CAMBIUM**



OUTSIDE

**DERIVATIVE
PARENCHYMA
CELLS**

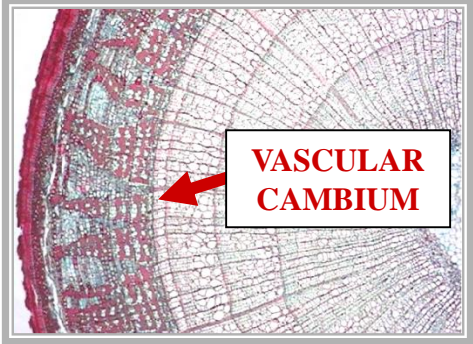
DICOT ~2 STEM



**VASCULAR
CAMBIUM**

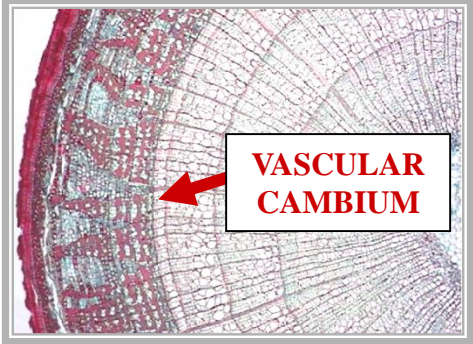
C.S.

**OUTSIDE
VASCULAR
CAMBIUM**



**VASCULAR
CAMBIUM**

**INSIDE
VASCULAR
CAMBIUM**



**VASCULAR
CAMBIUM**

OUTSIDE

DIFFERENTIATE

DICOT ~2 STEM

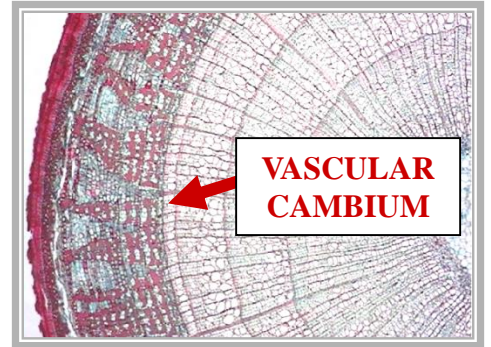
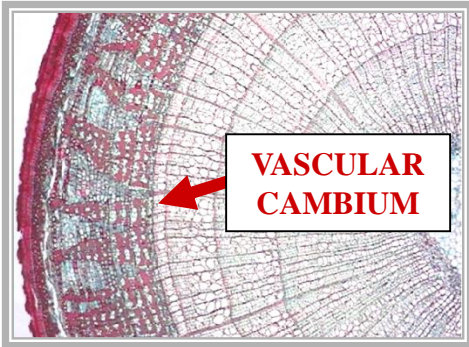


**VASCULAR
CAMBIUM**

C.S.

**OUTSIDE
VASCULAR
CAMBIUM**

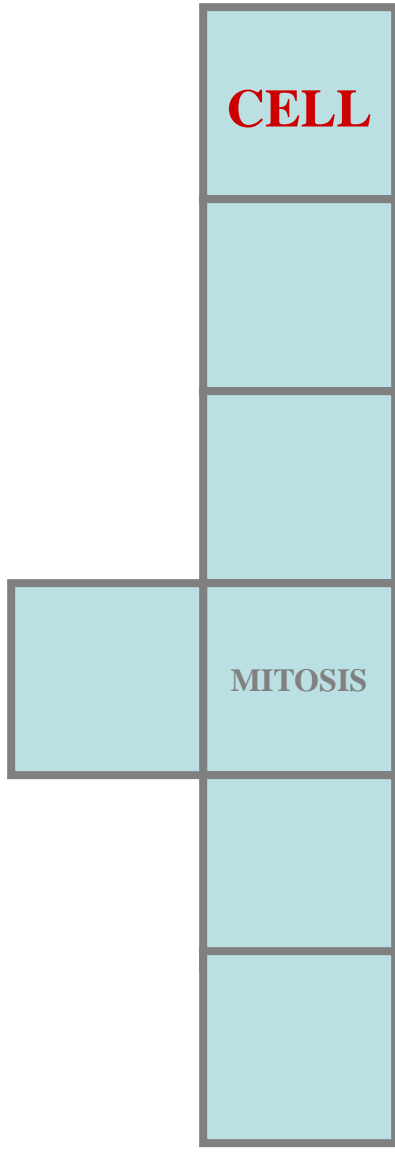
**INSIDE
VASCULAR
CAMBIUM**



OUTSIDE

~2 PHLOEM

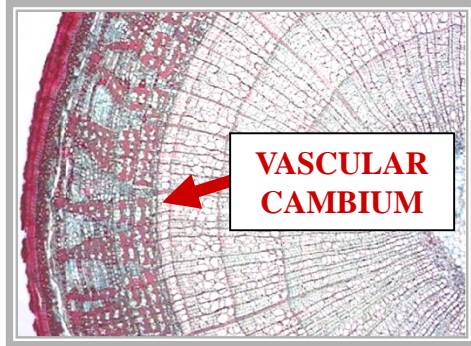
DICOT ~2 STEM



**VASCULAR
CAMBIUM**

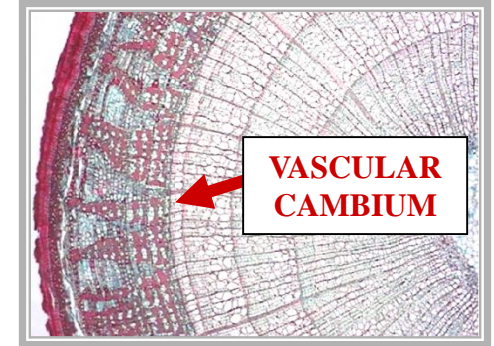
C.S.

**OUTSIDE
VASCULAR
CAMBIUM**



CELL

**INSIDE
VASCULAR
CAMBIUM**



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MITOSIS

OUTSIDE

**~2 PHLOEM
LOW ANNUAL
QUANTITY**

DICOT ~2 STEM

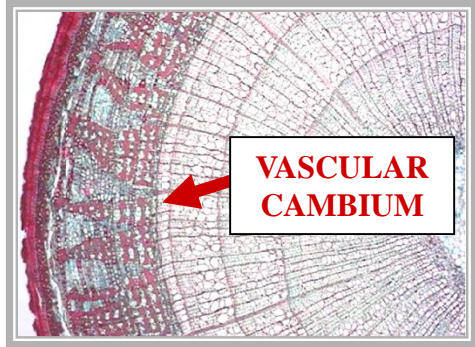
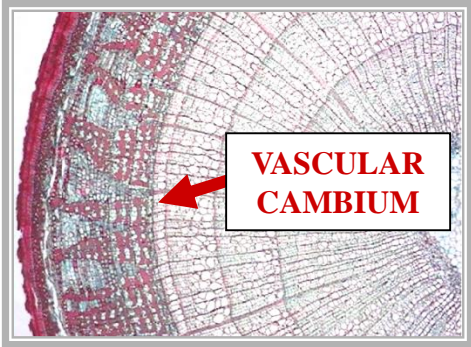
**VASCULAR
CAMBIUM**

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**OUTSIDE
VASCULAR
CAMBIUM**

**INSIDE
VASCULAR
CAMBIUM**



OUTSIDE

INSIDE

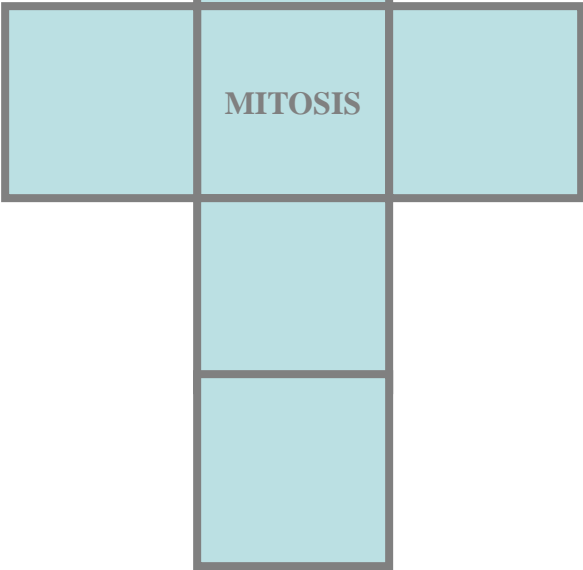
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LOW ANNUAL
QUANTITY**

**DERIVATIVE
PARENCHYMA
CELLS**

DICOT ~2 STEM

**VASCULAR
CAMBIUM**

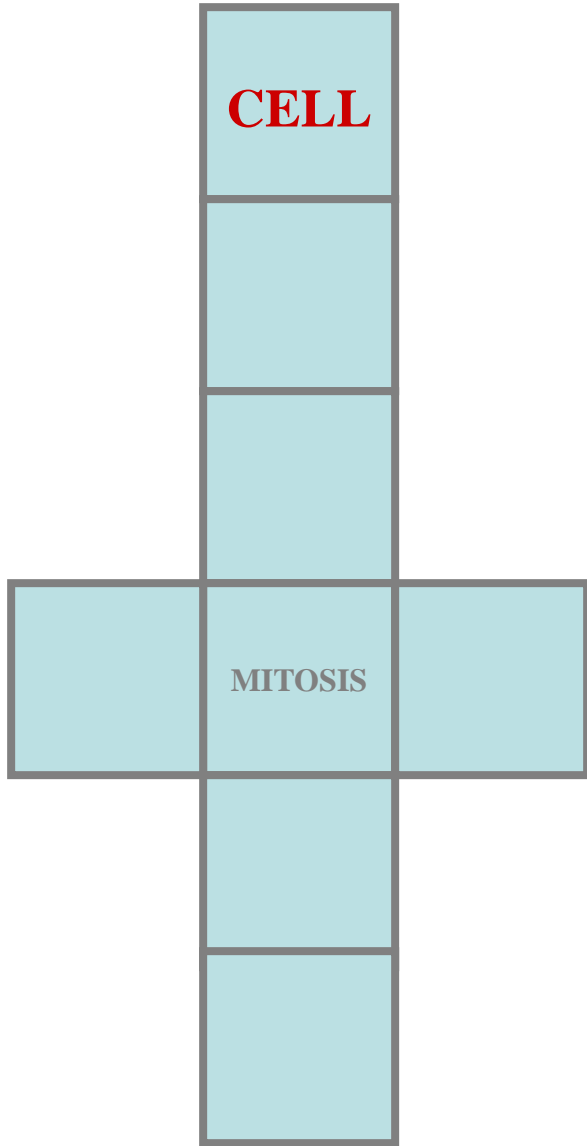
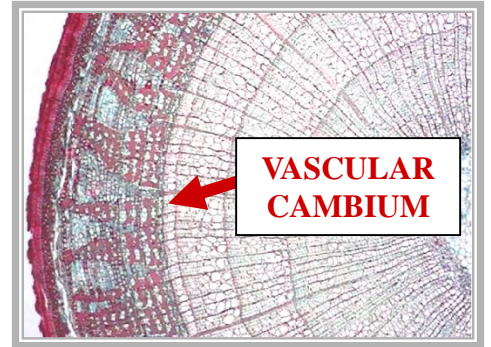
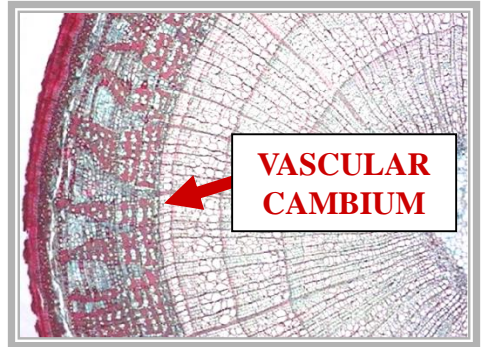
C.S.



2X

**OUTSIDE
VASCULAR
CAMBIUM**

**INSIDE
VASCULAR
CAMBIUM**



OUTSIDE

INSIDE

**~2 PHLOEM
LOW ANNUAL
QUANTITY**

DIFFERENTIATE

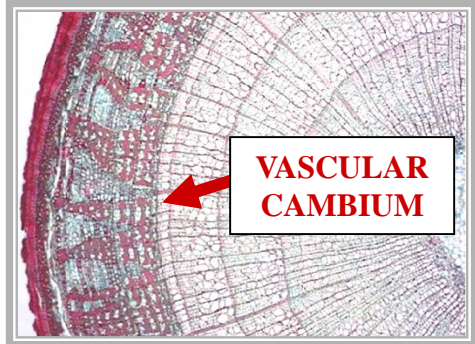
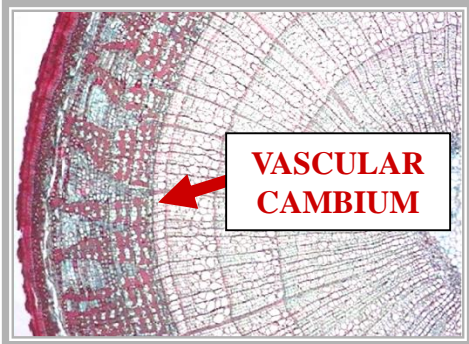
DICOT ~2 STEM

**VASCULAR
CAMBIUM**

C.S.

**OUTSIDE
VASCULAR
CAMBIUM**

**INSIDE
VASCULAR
CAMBIUM**



OUTSIDE

INSIDE

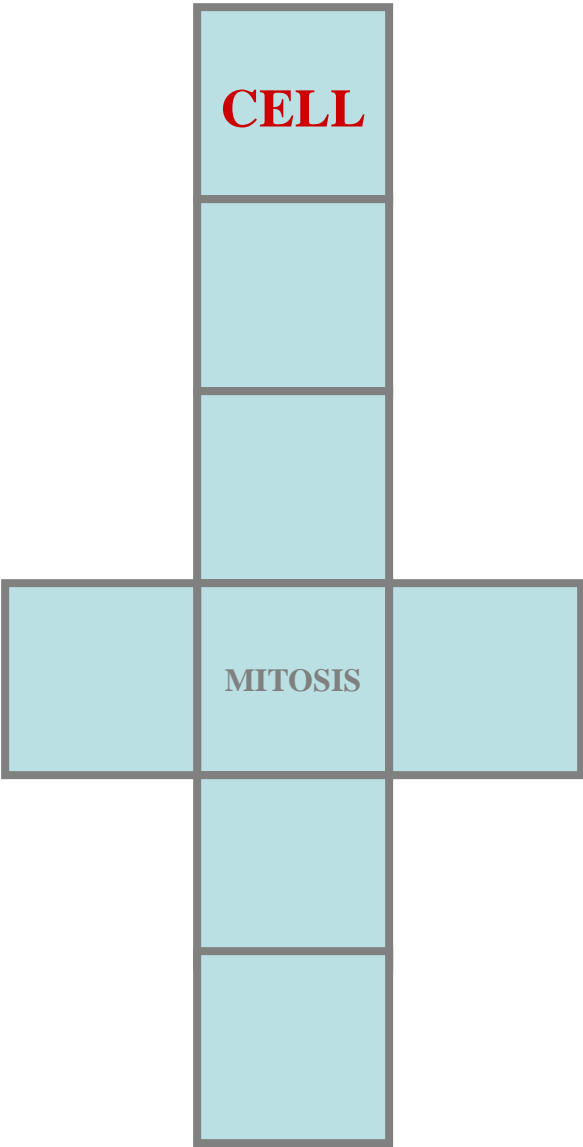
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LOW ANNUAL
QUANTITY**

~2 XYLEM

DICOT ~2 STEM

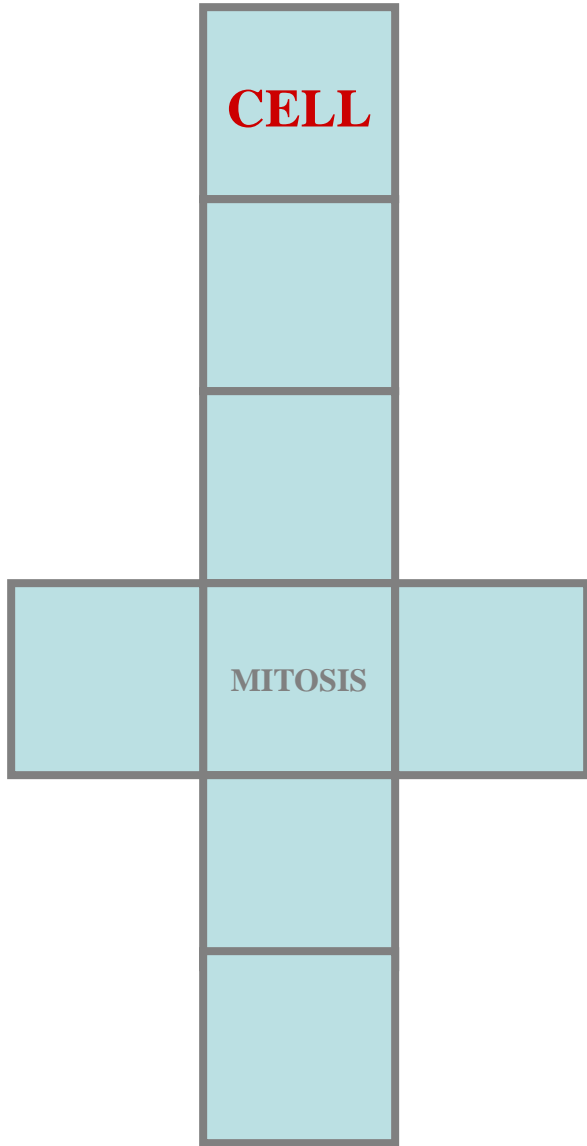
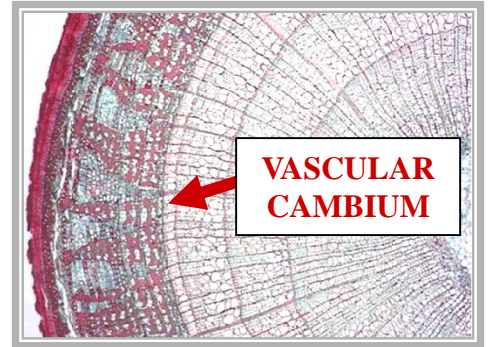
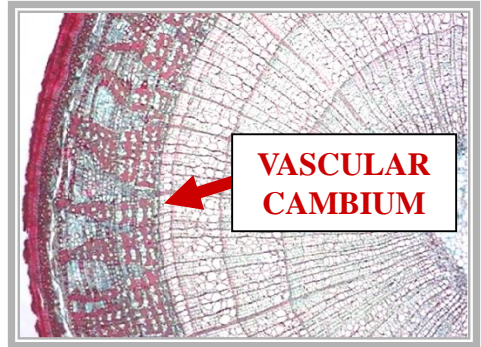
**VASCULAR
CAMBIUM**

C.S.



**OUTSIDE
VASCULAR
CAMBIUM**

**INSIDE
VASCULAR
CAMBIUM**



OUTSIDE

INSIDE

**~2 PHLOEM
LOW ANNUAL
QUANTITY**

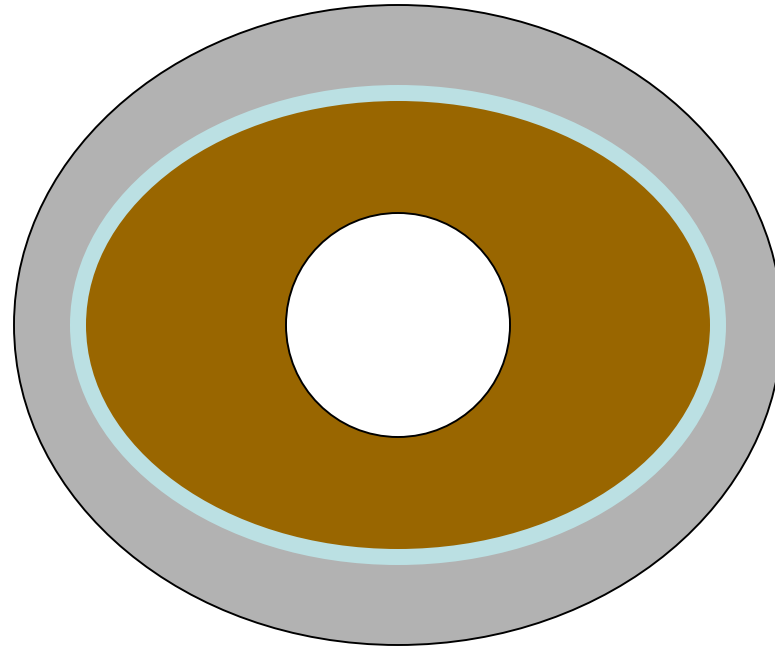
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HIGH ANNUAL
QUANTITY**

DICOT ~2 STEM

**VASCULAR
CAMBIUM**

C.S.

**VASCULAR
CAMBIUM
ACTIVITY
EXAMPLE**

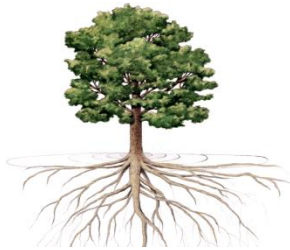
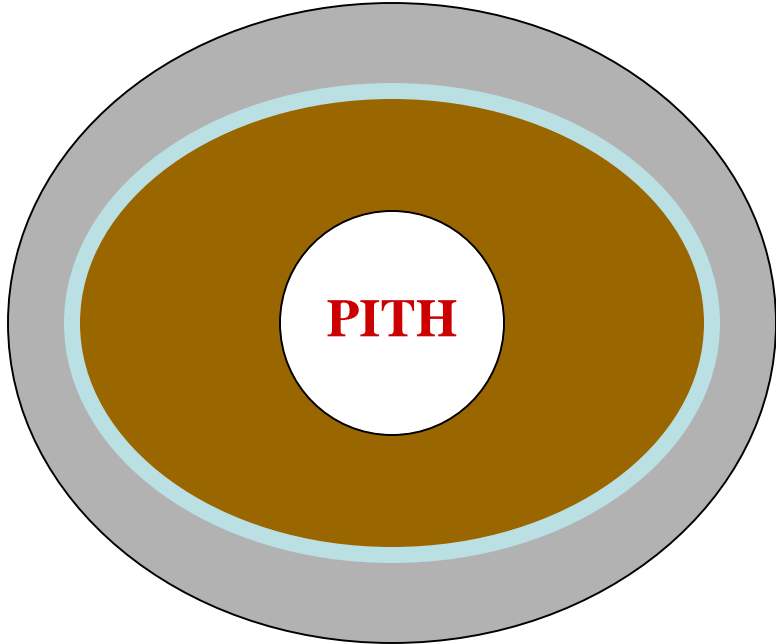


STEM

PRIMARY GROWTH

C.S.

VASCULAR CAMBIUM ACTIVITY



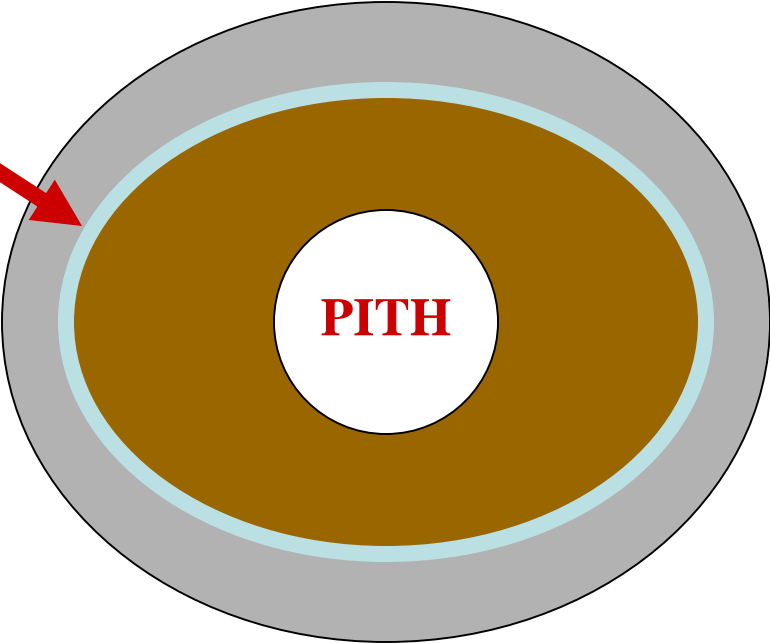
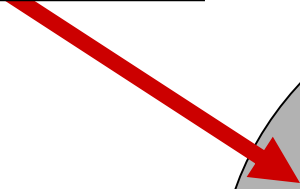
STEM

PRIMARY GROWTH

C.S.

VASCULAR CAMBIUM ACTIVITY

VASCULAR
CAMBIUM



STEM

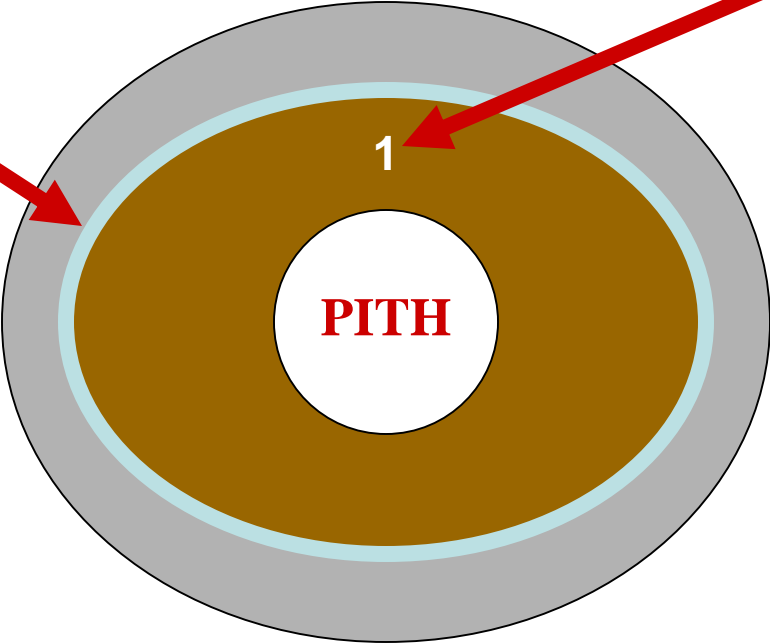
PRIMARY GROWTH

C.S.

VASCULAR CAMBIUM ACTIVITY

VASCULAR CAMBIUM

PRIMARY XYLEM

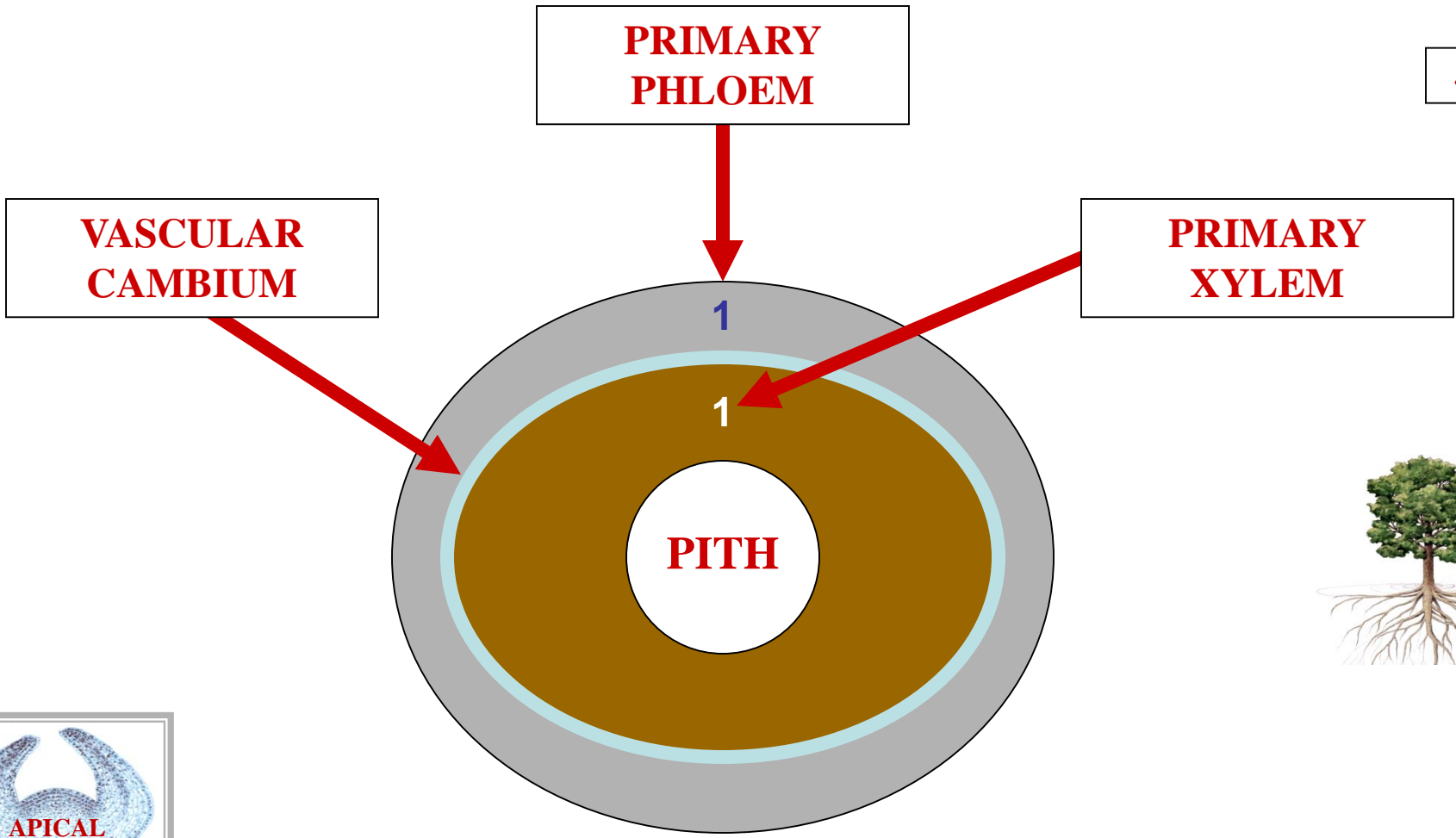


STEM

PRIMARY GROWTH

C.S.

VASCULAR CAMBIUM ACTIVITY

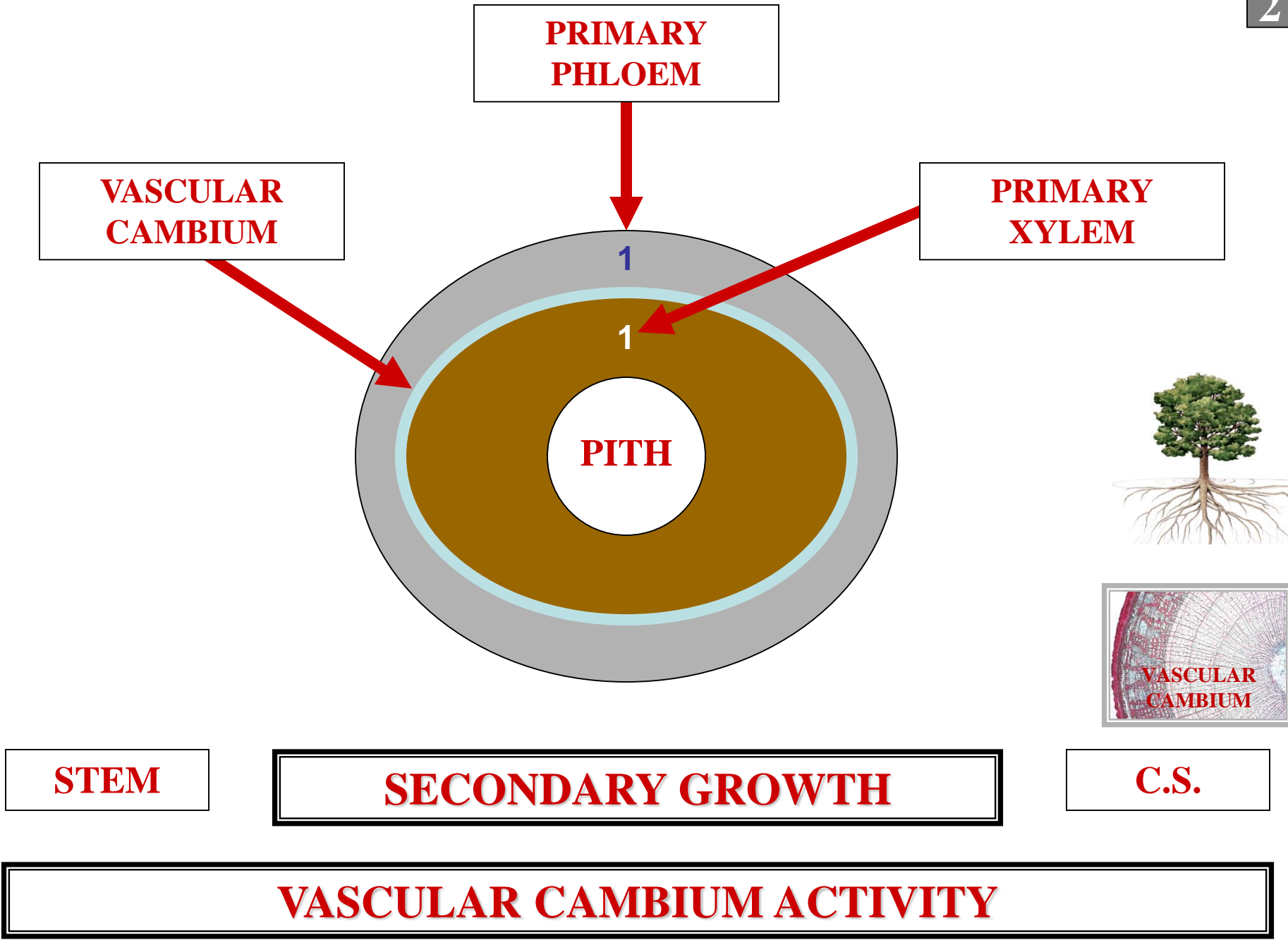


STEM

PRIMARY GROWTH

C.S.

VASCULAR CAMBIUM ACTIVITY

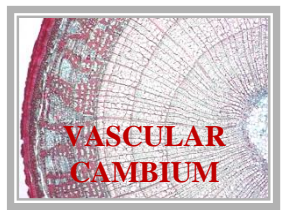


**PRIMARY
PHLOEM**

**VASCULAR
CAMBIUM**

**PRIMARY
XYLEM**

PITH



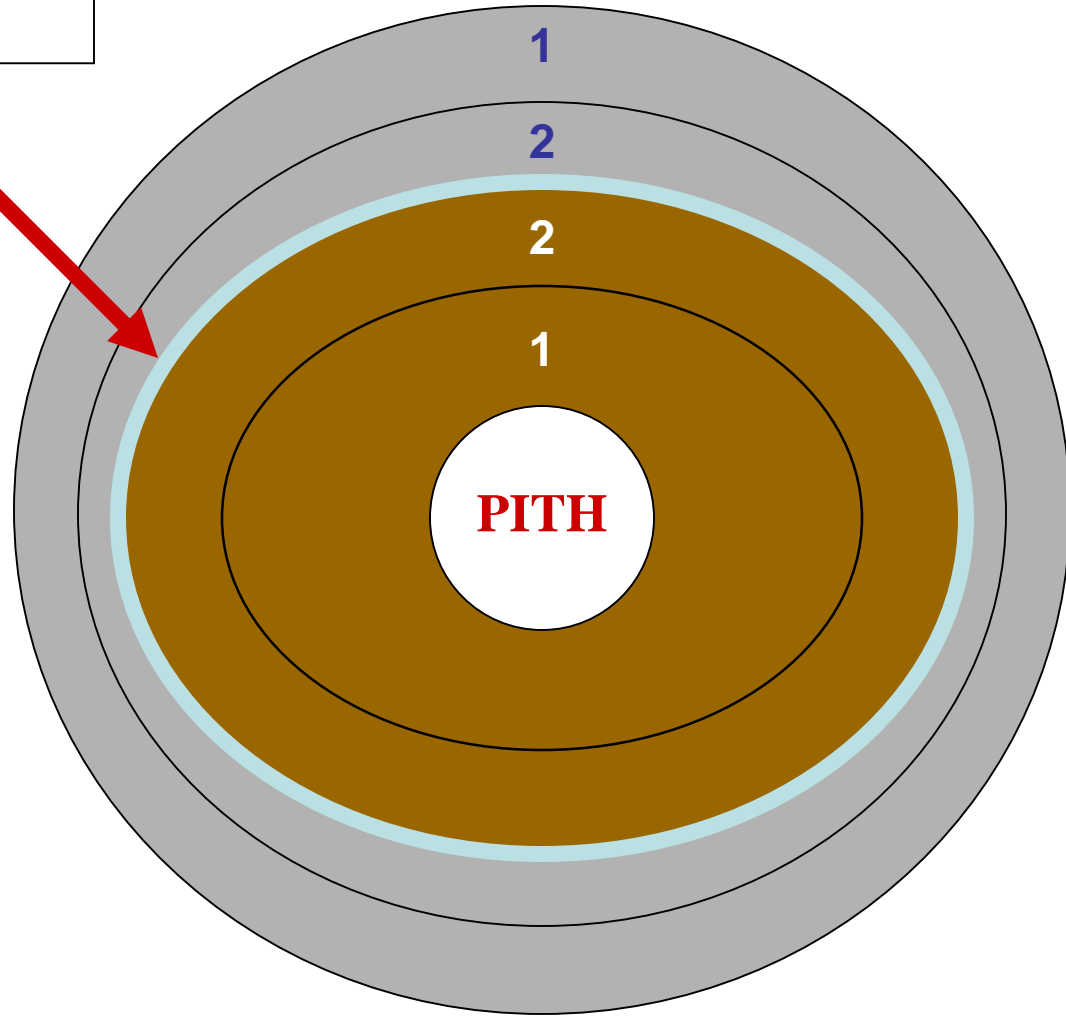
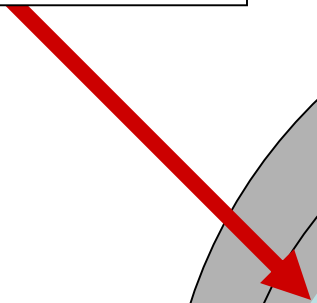
STEM

SECONDARY GROWTH

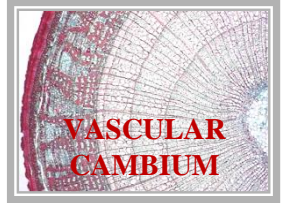
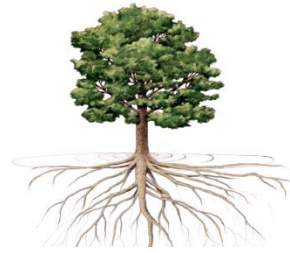
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VASCULAR CAMBIUM ACTIVITY

**VASCULAR
CAMBIUM**



STEM

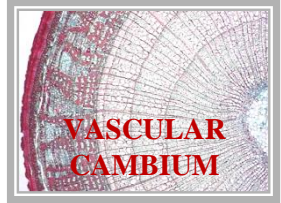
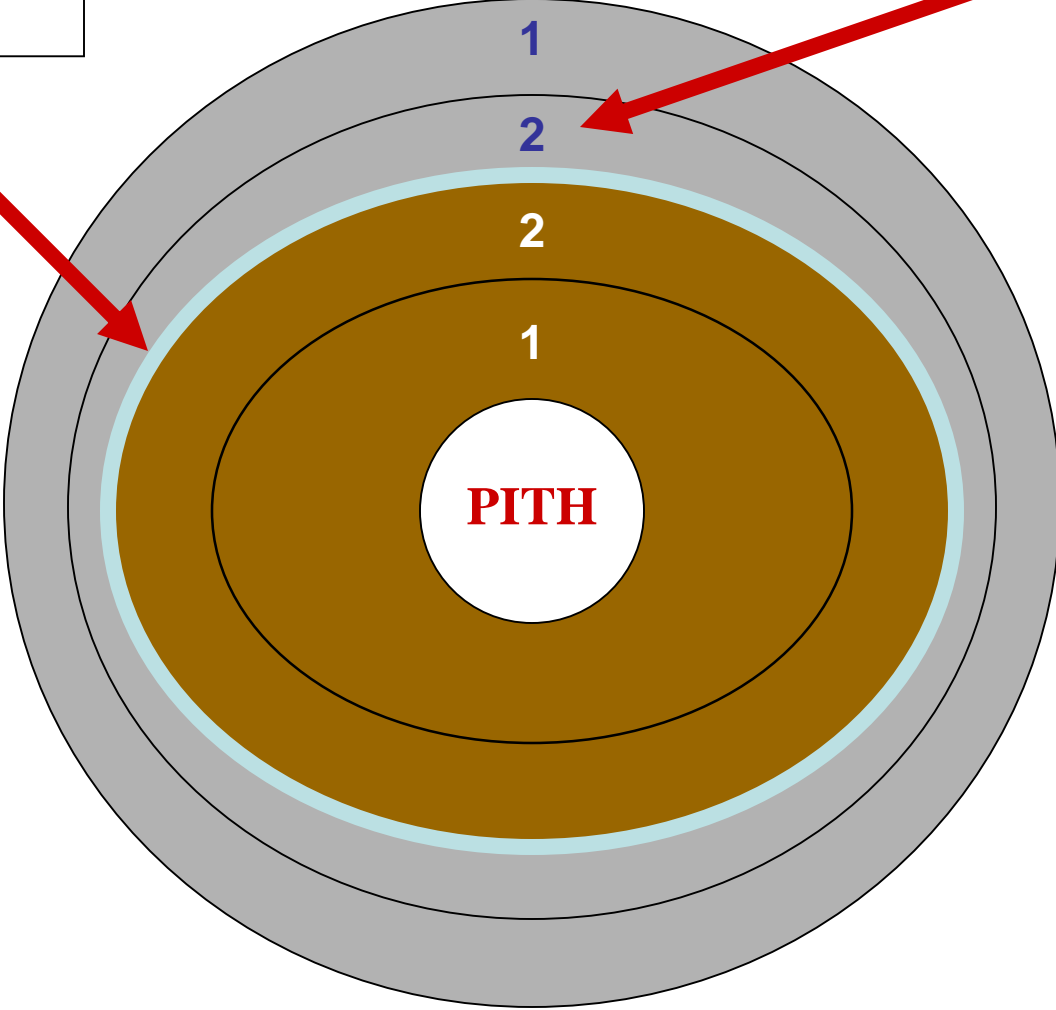


C.S.

VASCULAR CAMBIUM ACTIVITY

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VASCULAR CAMBIUM



STEM

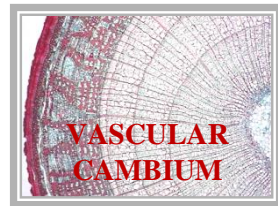
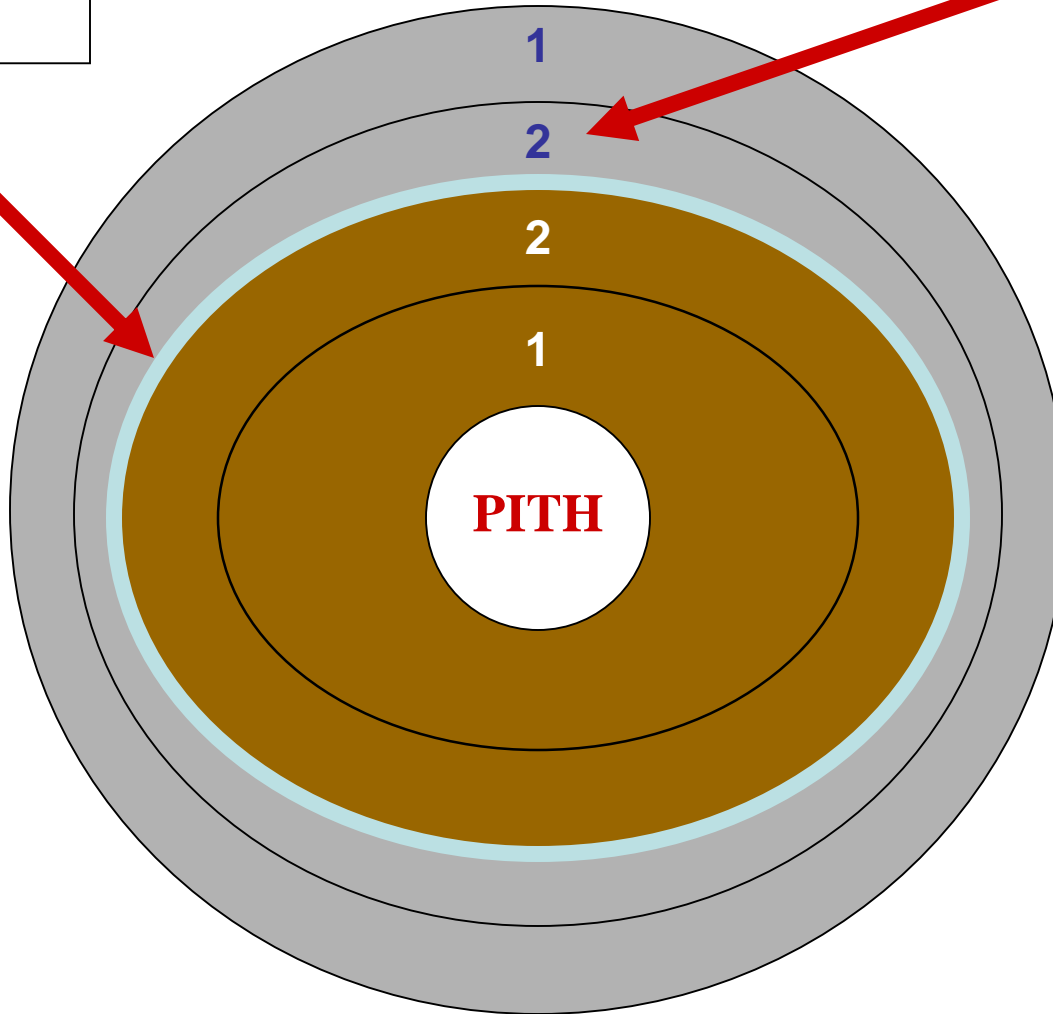
C.S.

VASCULAR CAMBIUM ACTIVITY



SECONDARY PHLOEM

VASCULAR CAMBIUM



STEM

C.S.

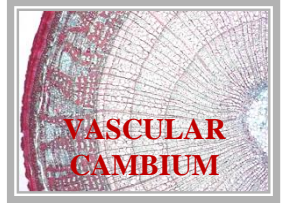
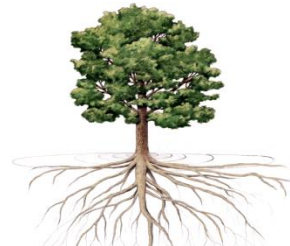
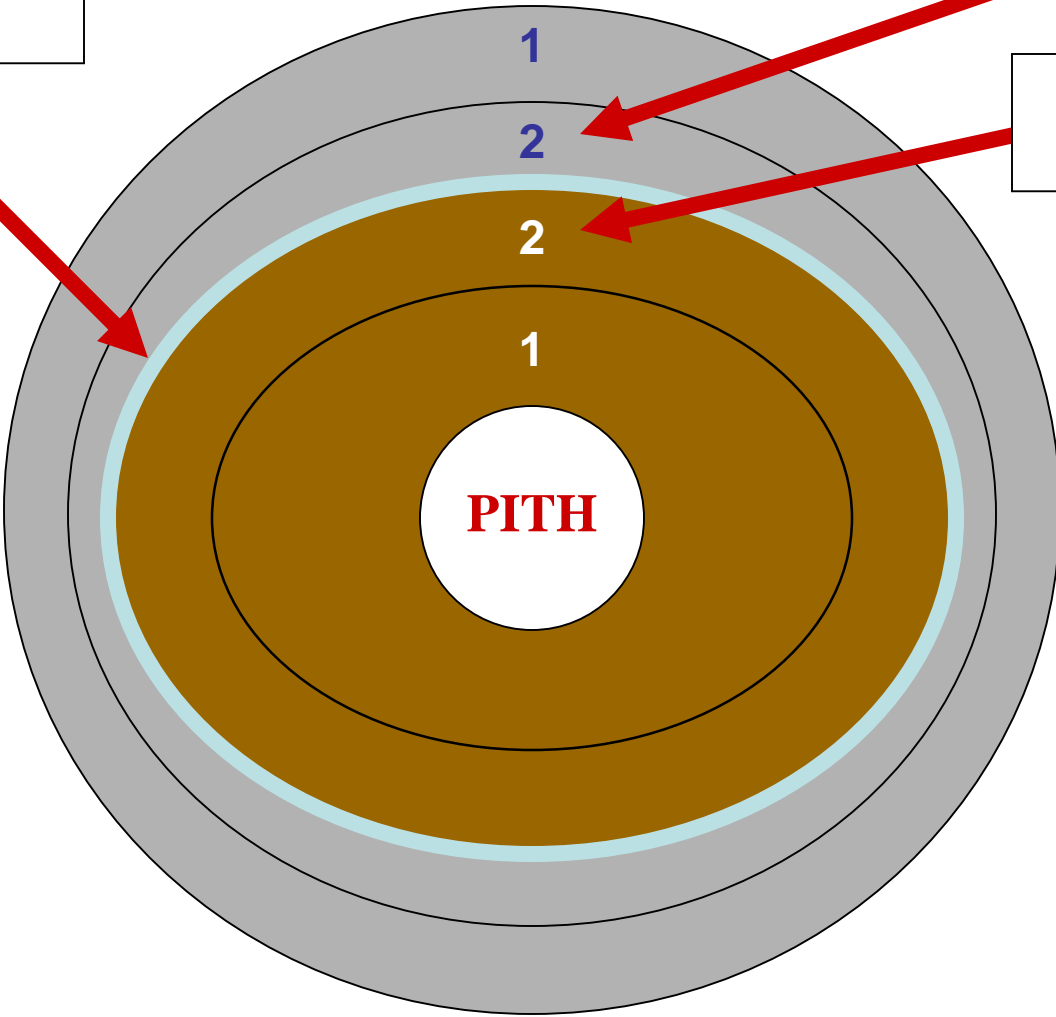
VASCULAR CAMBIUM ACTIVITY

2X

SECONDARY PHLOEM

VASCULAR CAMBIUM

?



STEM

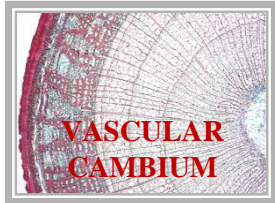
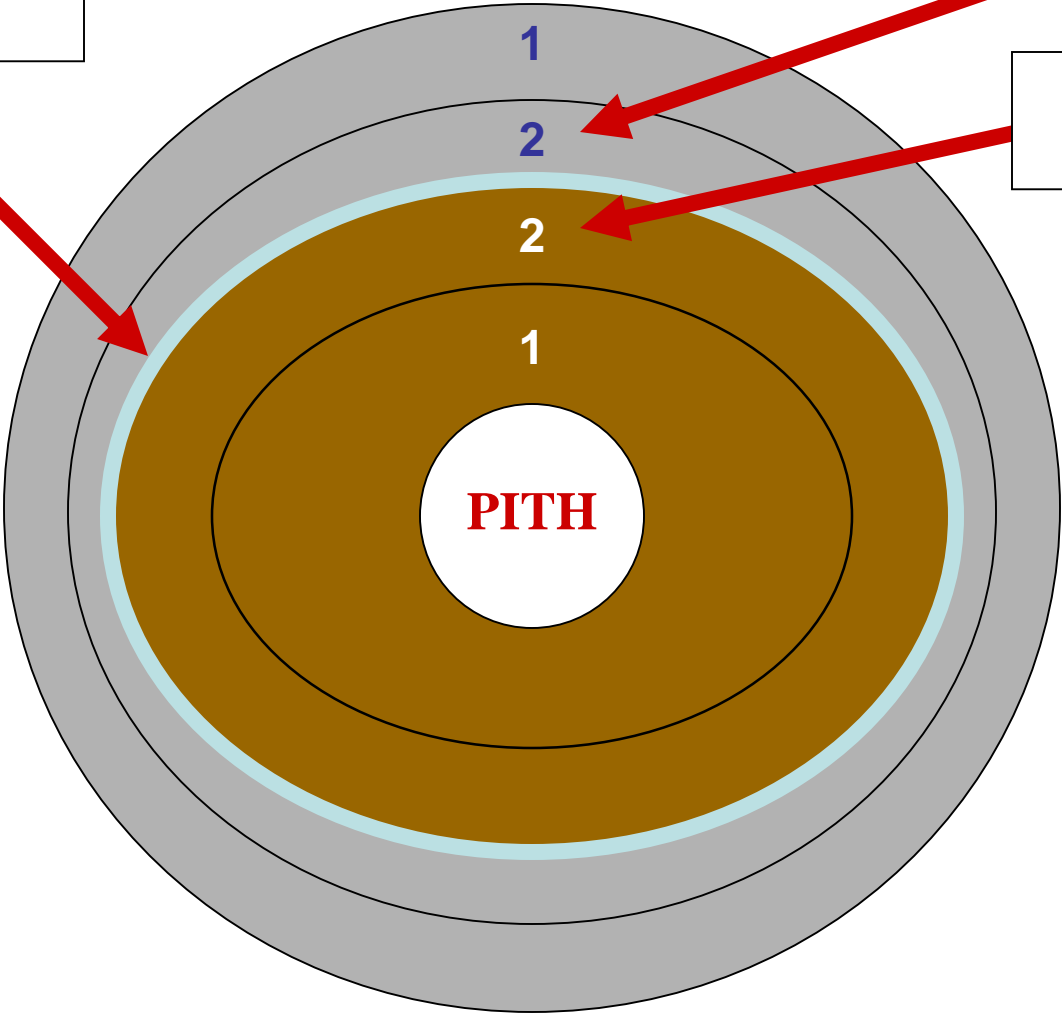
C.S.

VASCULAR CAMBIUM ACTIVITY

VASCULAR CAMBIUM

SECONDARY PHLOEM

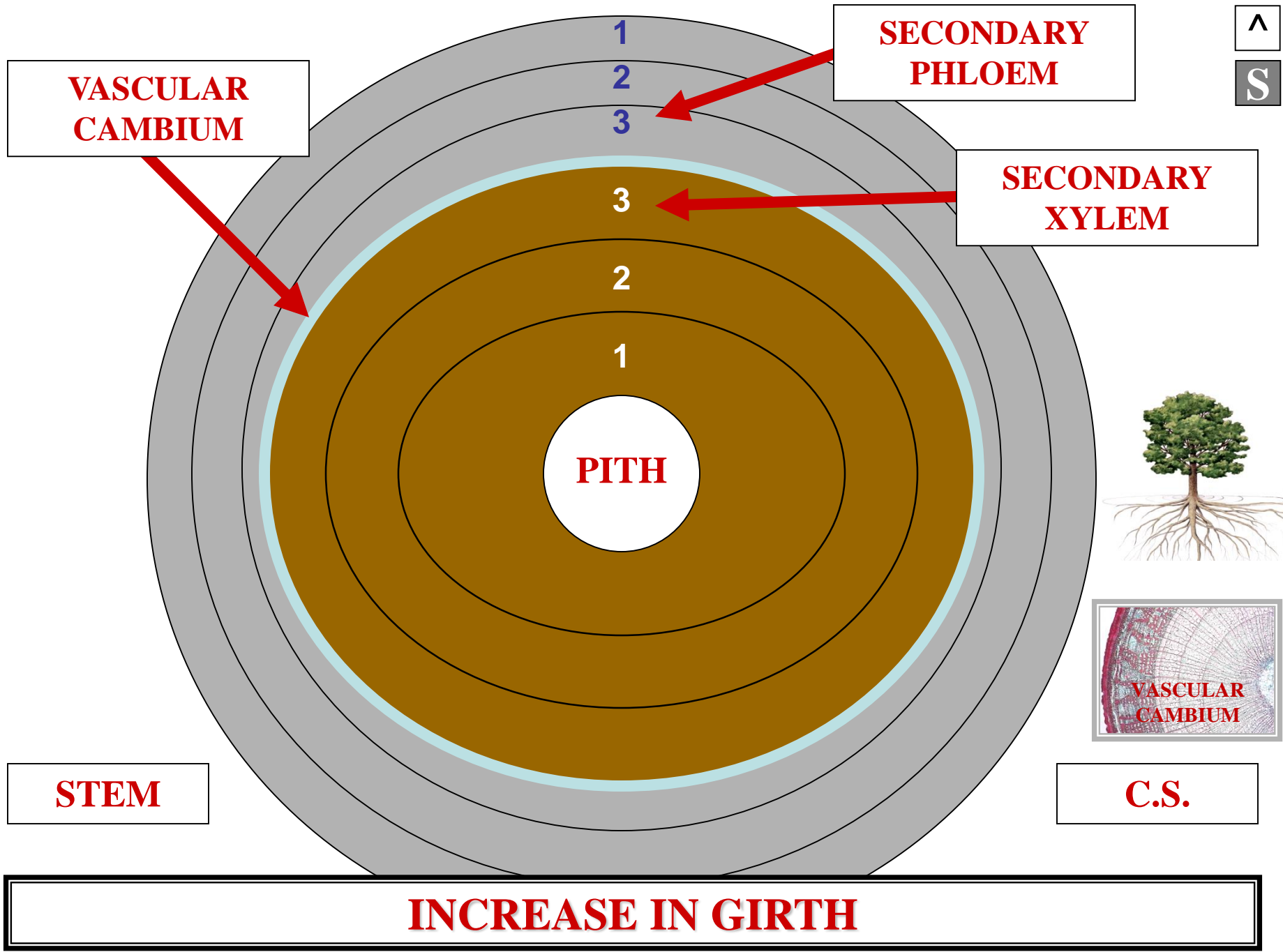
SECONDARY XYLEM



STEM

C.S.

VASCULAR CAMBIUM ACTIVITY

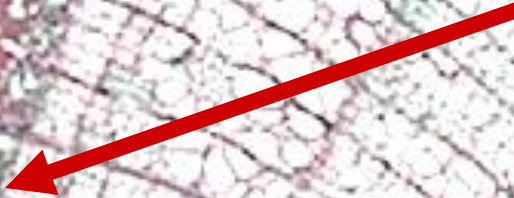




VASCULAR CAMBIUM ACTIVITY SUMMARY

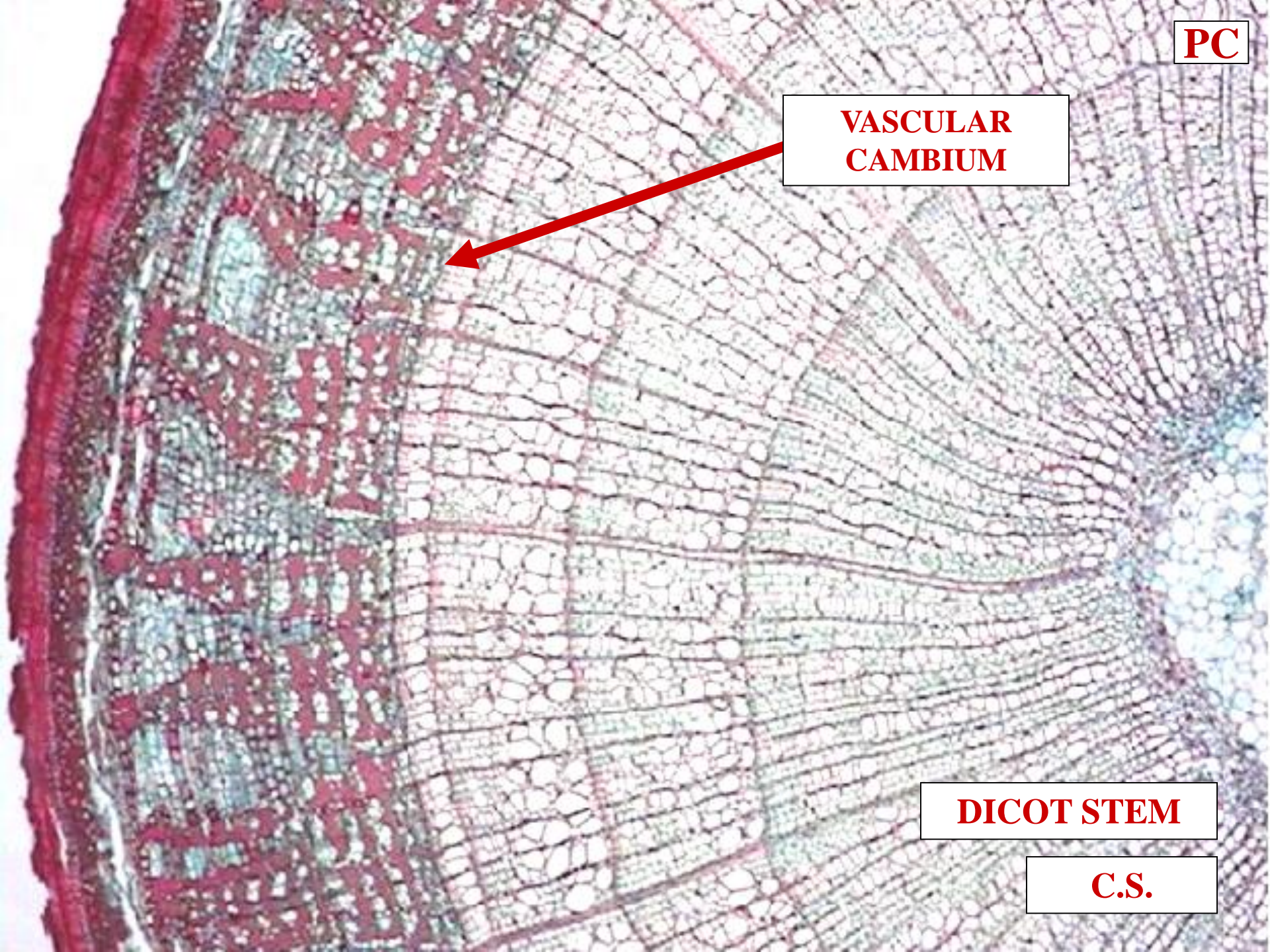
PC

**VASCULAR
CAMBIUM**

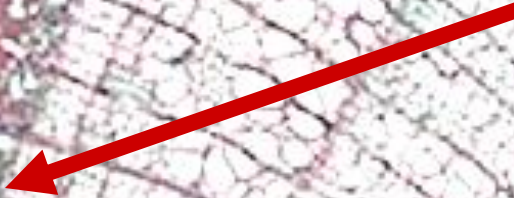


DICOT STEM

C.S.

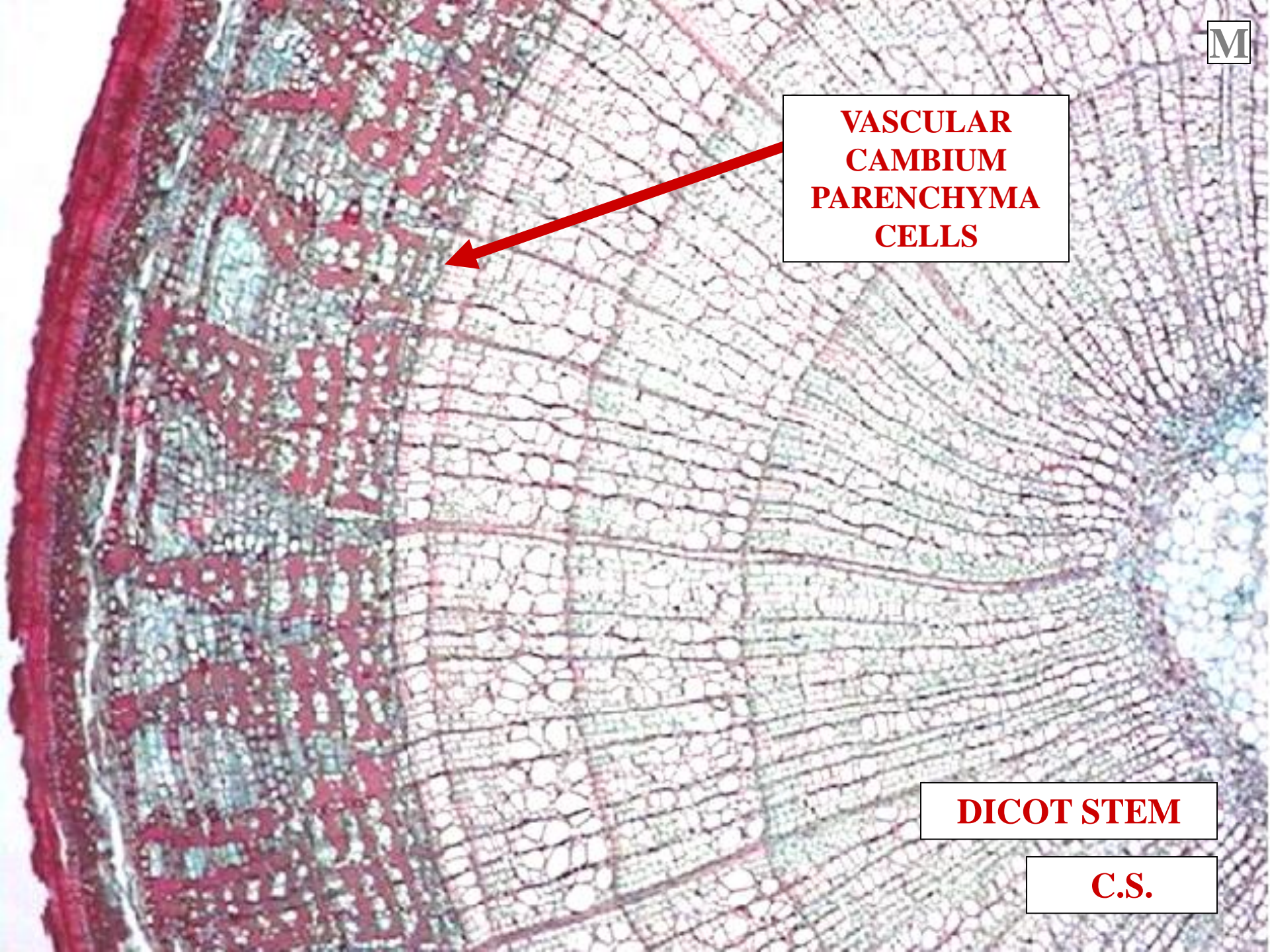


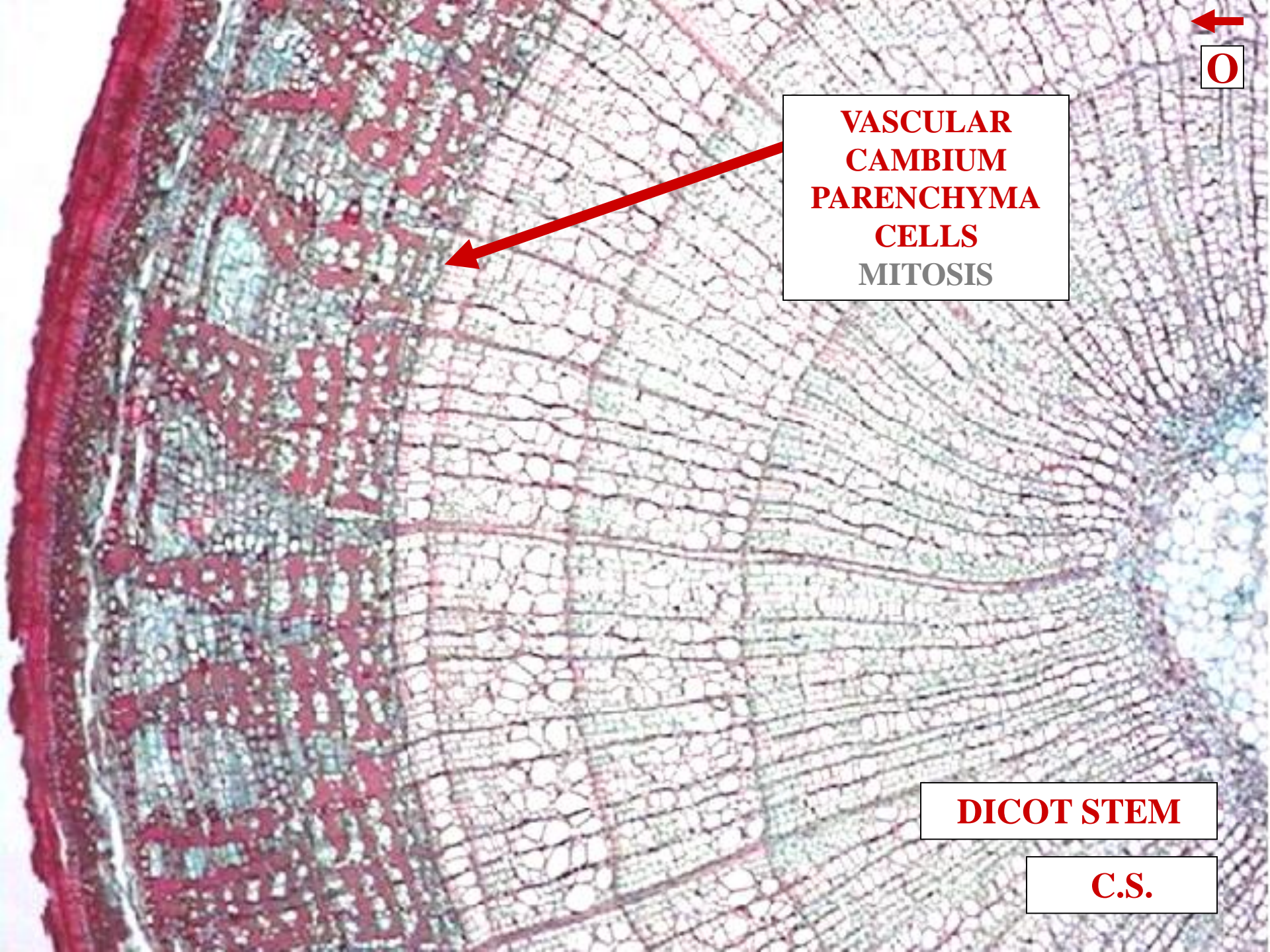
**VASCULAR
CAMBIUM
PARENCHYMA
CELLS**



DICOT STEM

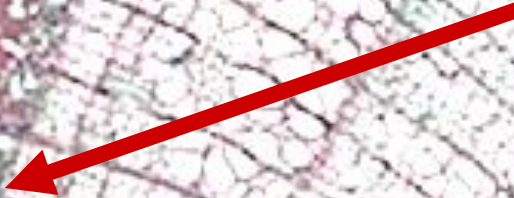
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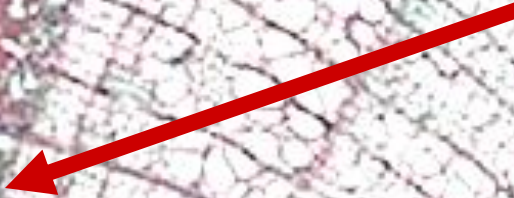
**VASCULAR
CAMBIUM
PARENCHYMA
CELLS
MITOSIS**



DICOT STEM

C.S.

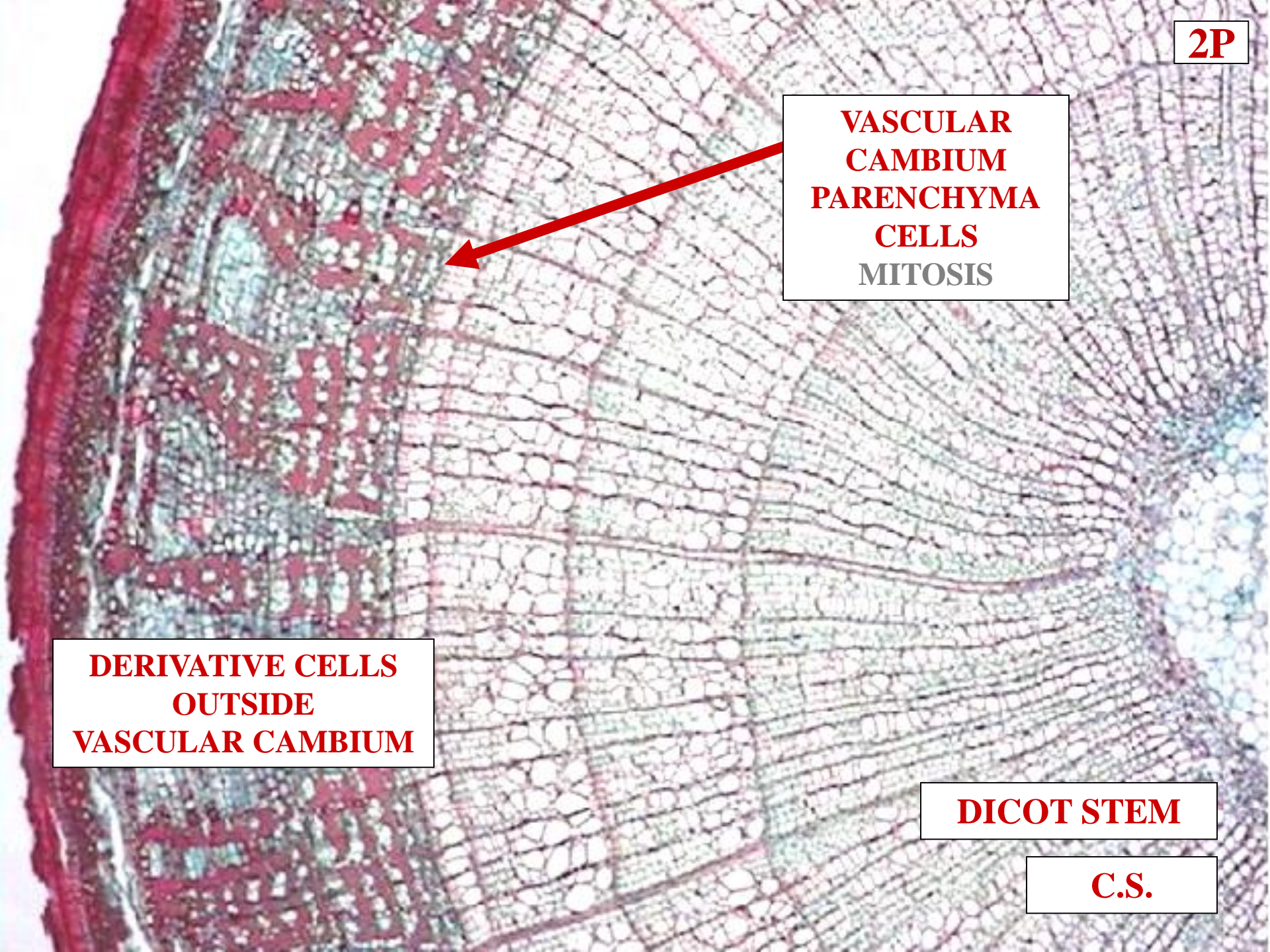
**VASCULAR
CAMBIUM
PARENCHYMA
CELLS
MITOSIS**



**DERIVATIVE CELLS
OUTSIDE
VASCULAR CAMBIUM**

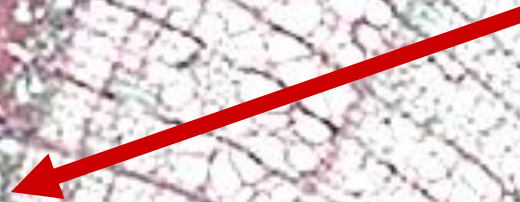
DICOT STEM

C.S.



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**VASCULAR
CAMBIUM
PARENCHYMA
CELLS
MITOSIS**

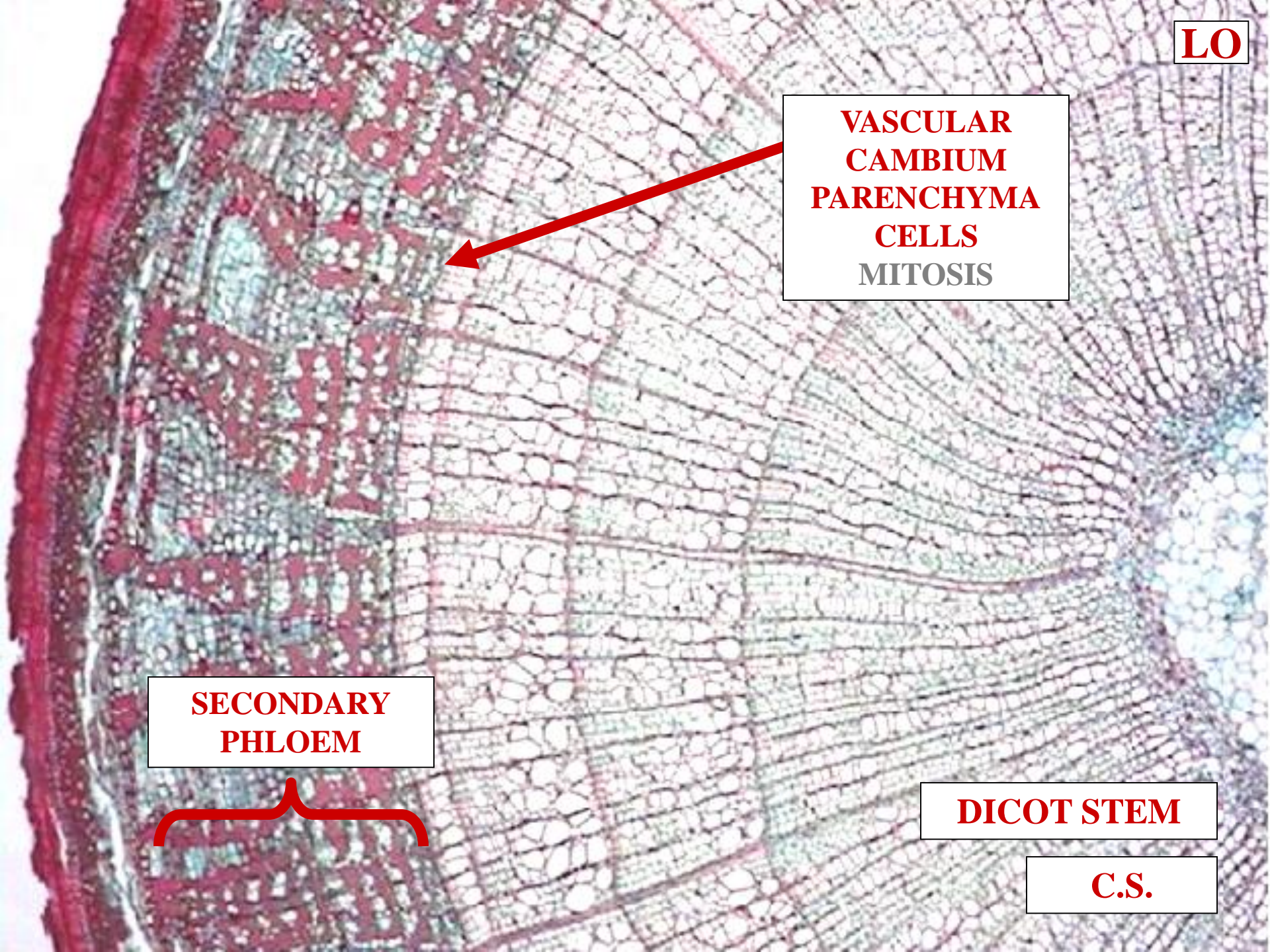


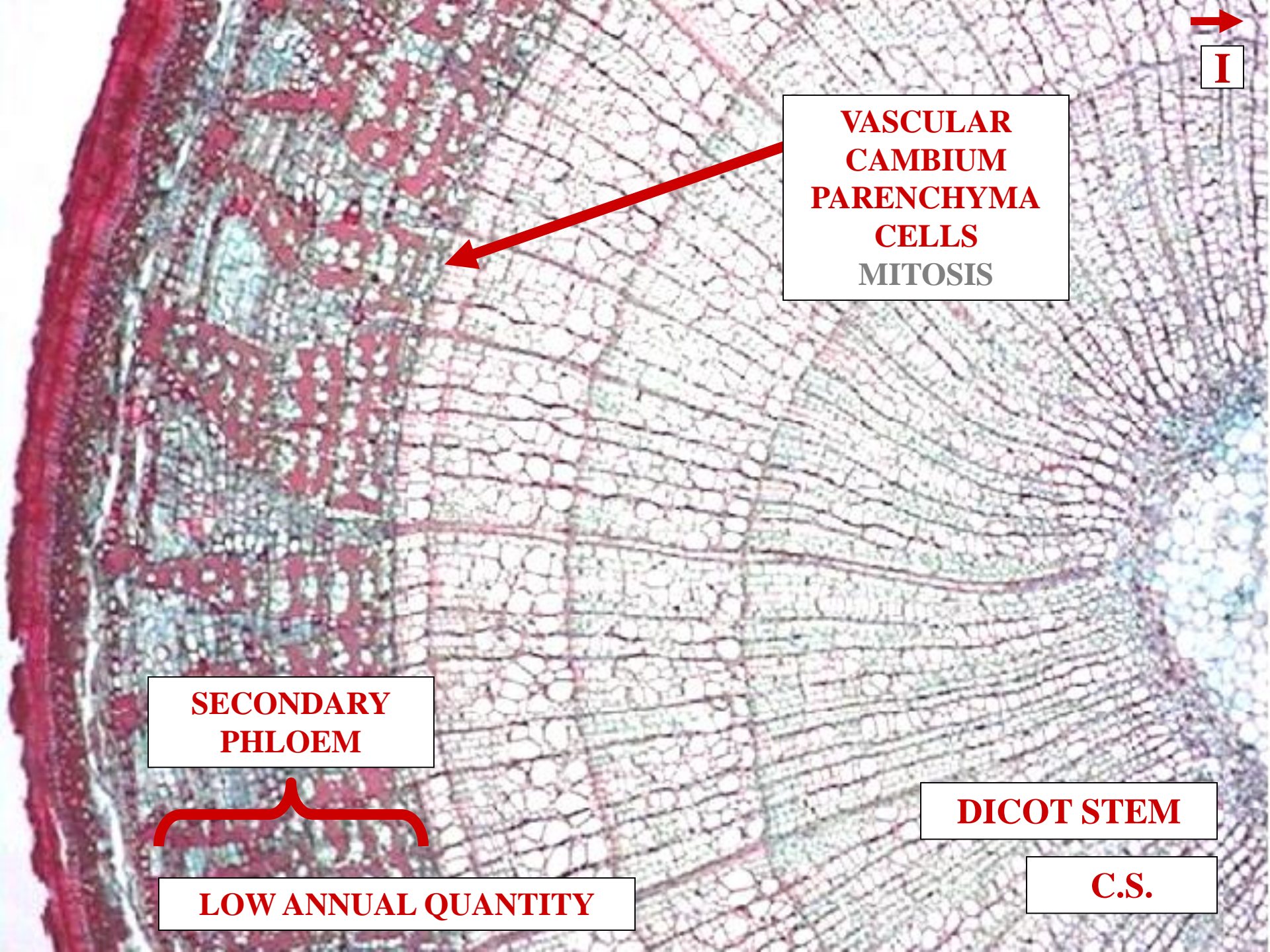
**SECONDARY
PHLOEM**



DICOT STEM

C.S.





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**VASCULAR
CAMBIUM
PARENCHYMA
CELLS
MITOSIS**

**SECONDARY
PHLOEM**



LOW ANNUAL QUANTITY

DICOT STEM

C.S.

2X

**VASCULAR
CAMBIUM
PARENCHYMA
CELLS
MITOSIS**

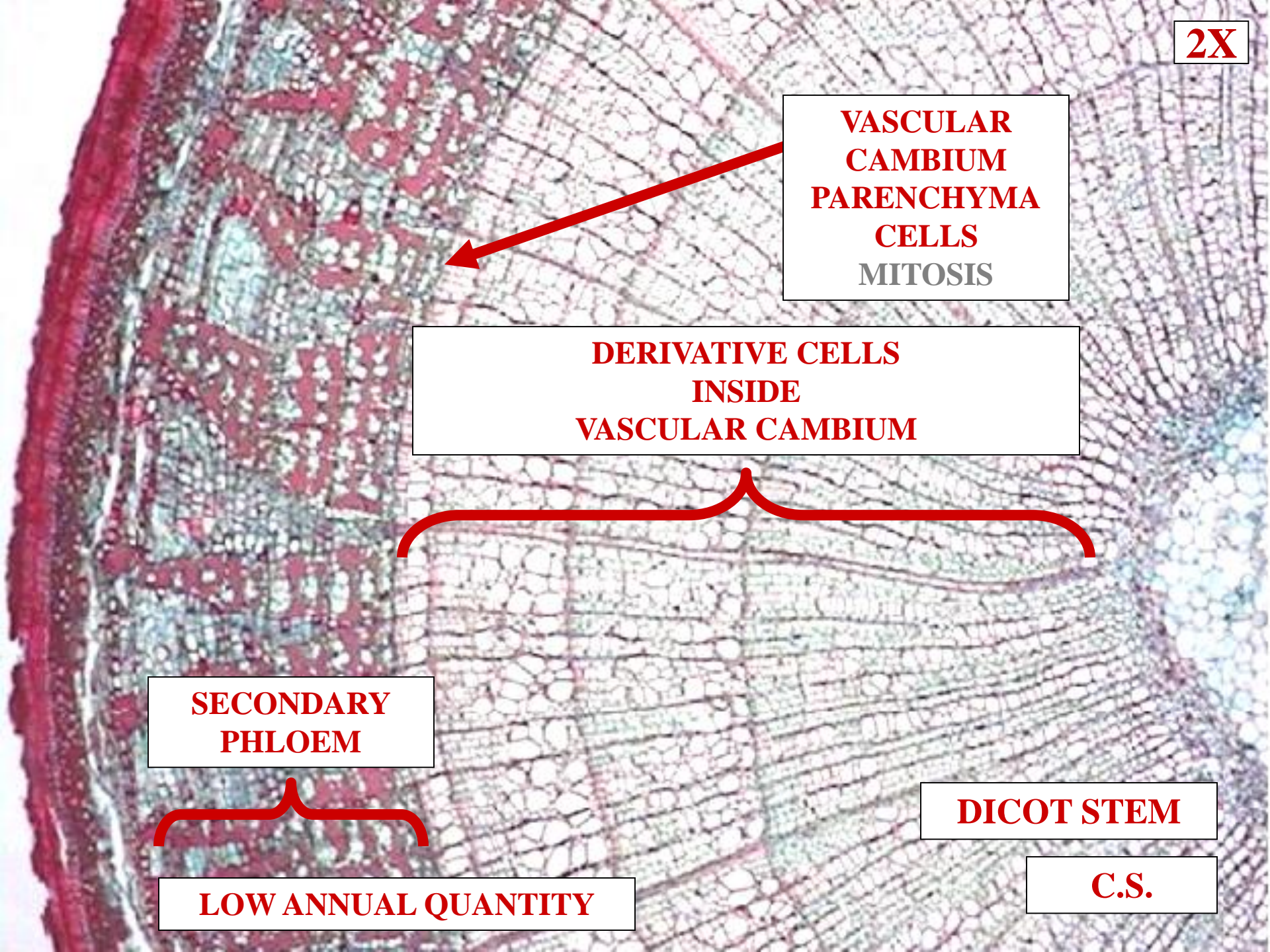
**DERIVATIVE CELLS
INSIDE
VASCULAR CAMBIUM**

**SECONDARY
PHLOEM**

DICOT STEM

LOW ANNUAL QUANTITY

C.S.



HI

**VASCULAR
CAMBIUM
PARENCHYMA
CELLS
MITOSIS**

**SECONDARY
XYLEM**



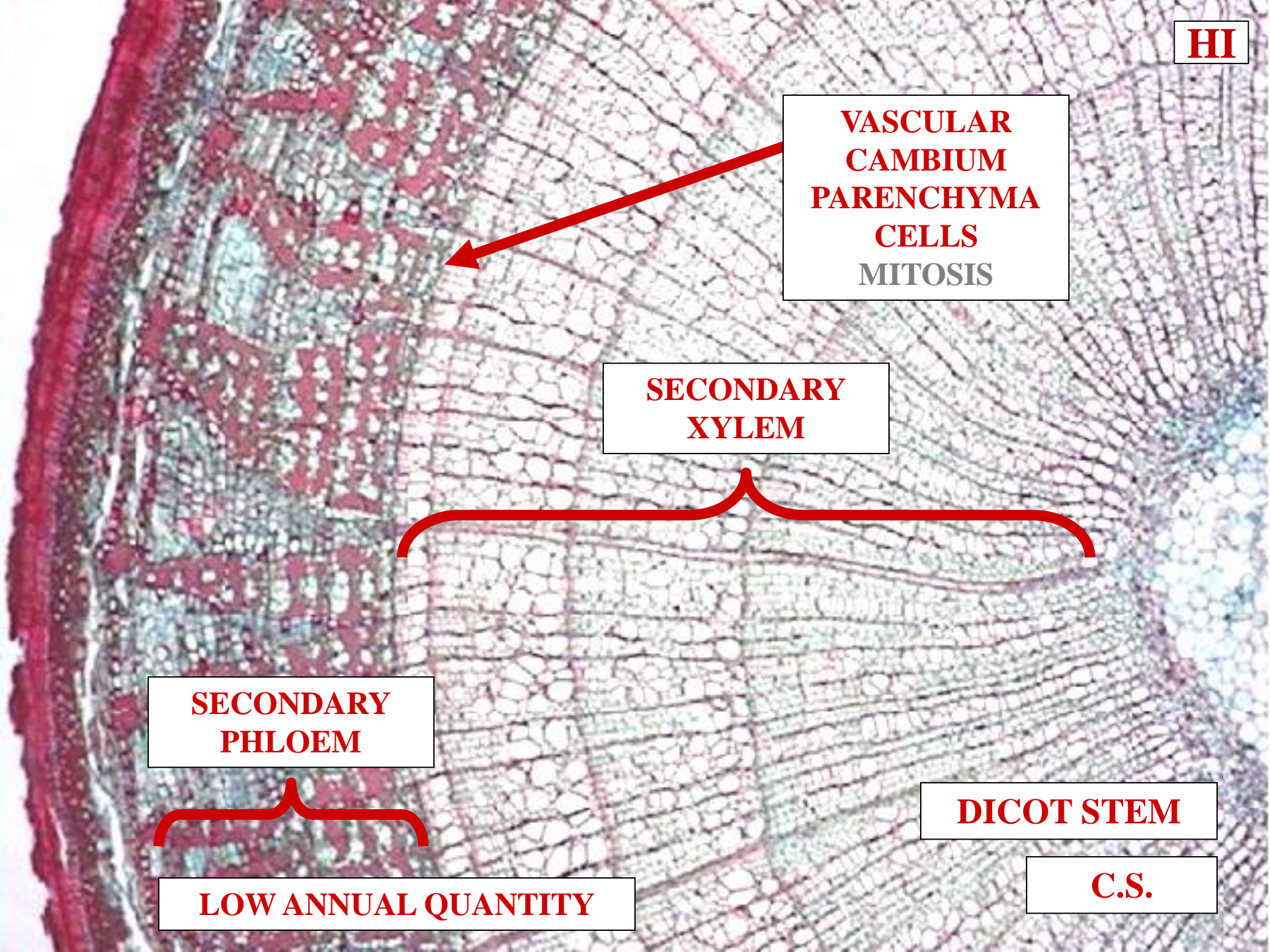
**SECONDARY
PHLOEM**



LOW ANNUAL QUANTITY

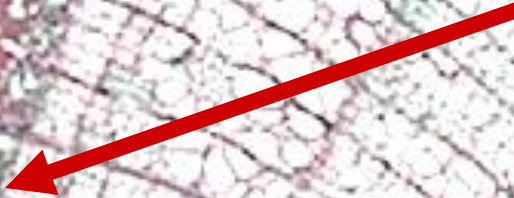
DICOT STEM

C.S.





**VASCULAR
CAMBIUM
PARENCHYMA
CELLS
MITOSIS**



**SECONDARY
XYLEM**



HIGH ANNUAL QUANTITY

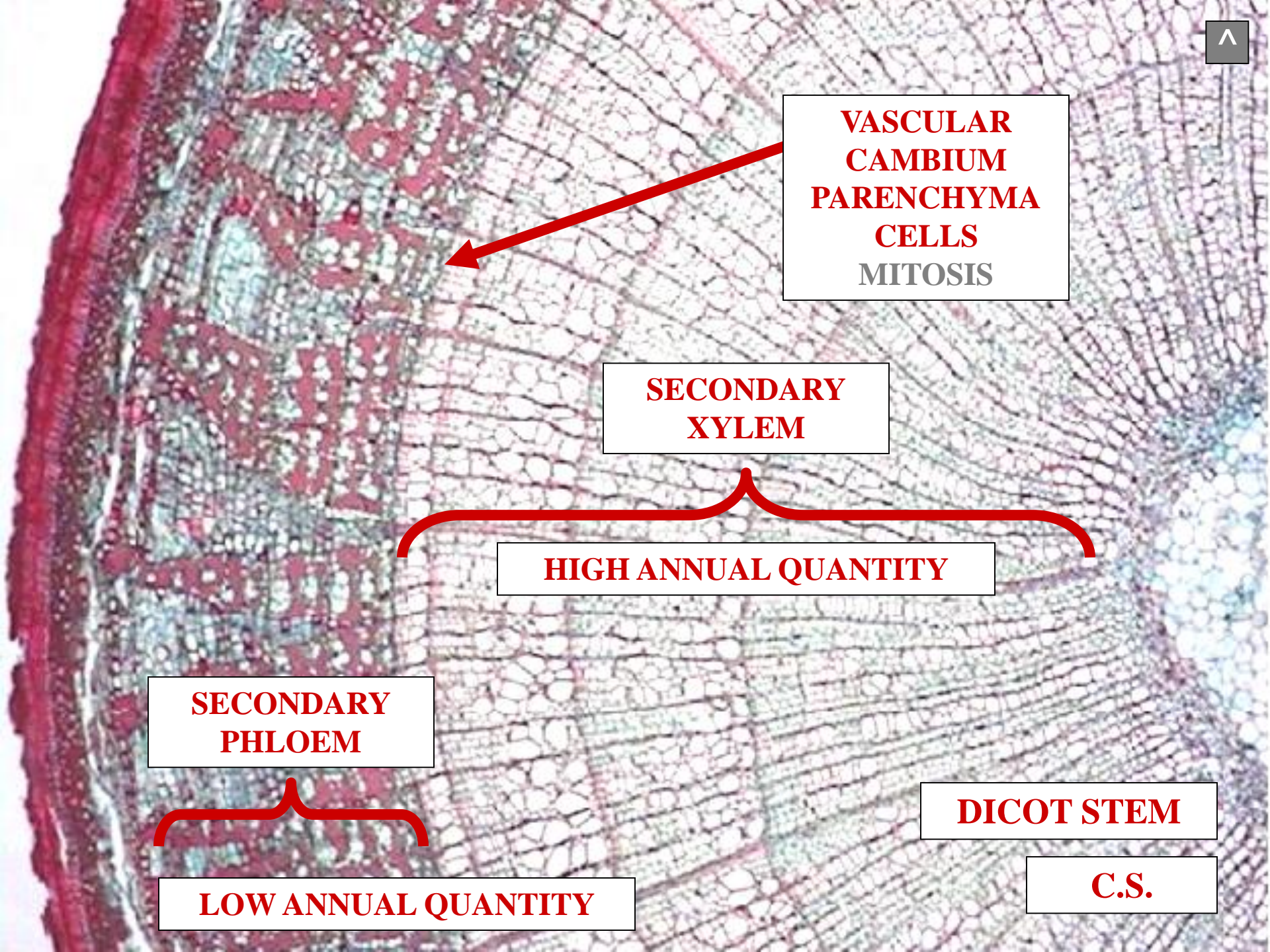
**SECONDARY
PHLOEM**



LOW ANNUAL QUANTITY

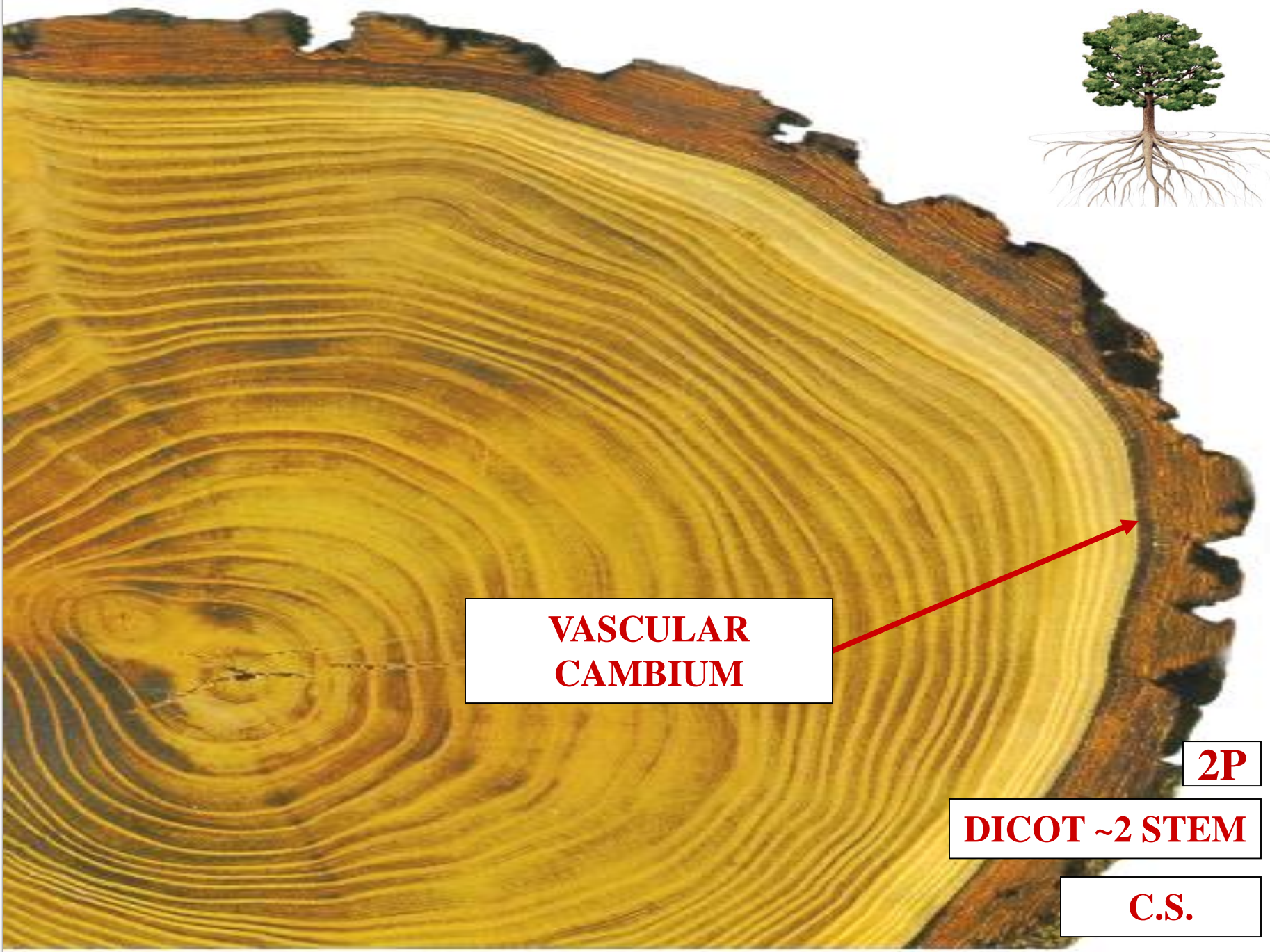
DICOT STEM

C.S.





SECONDARY XYLEM TISSUE

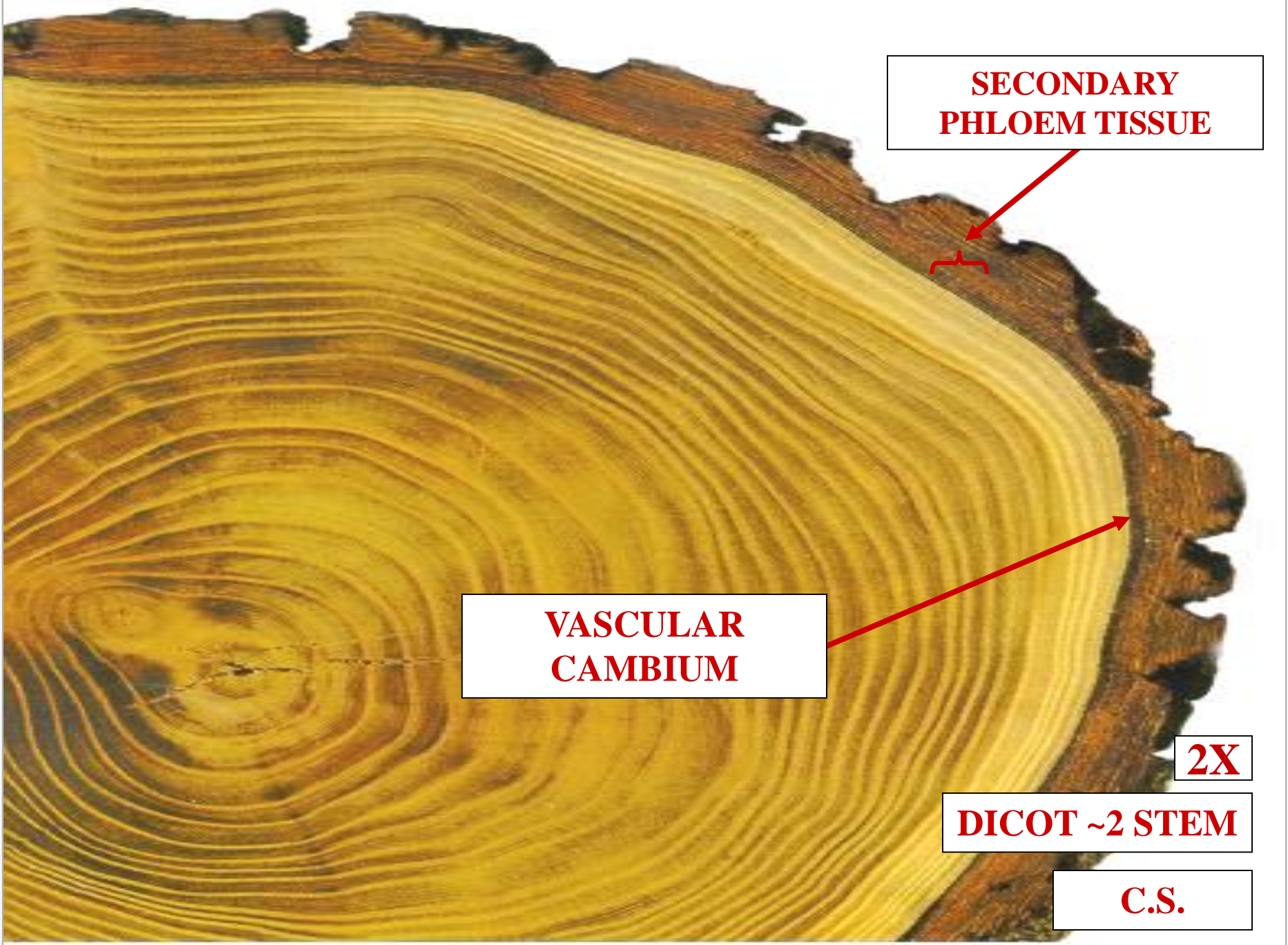


**VASCULAR
CAMBIUM**

2P

DICOT ~2 STEM

C.S.



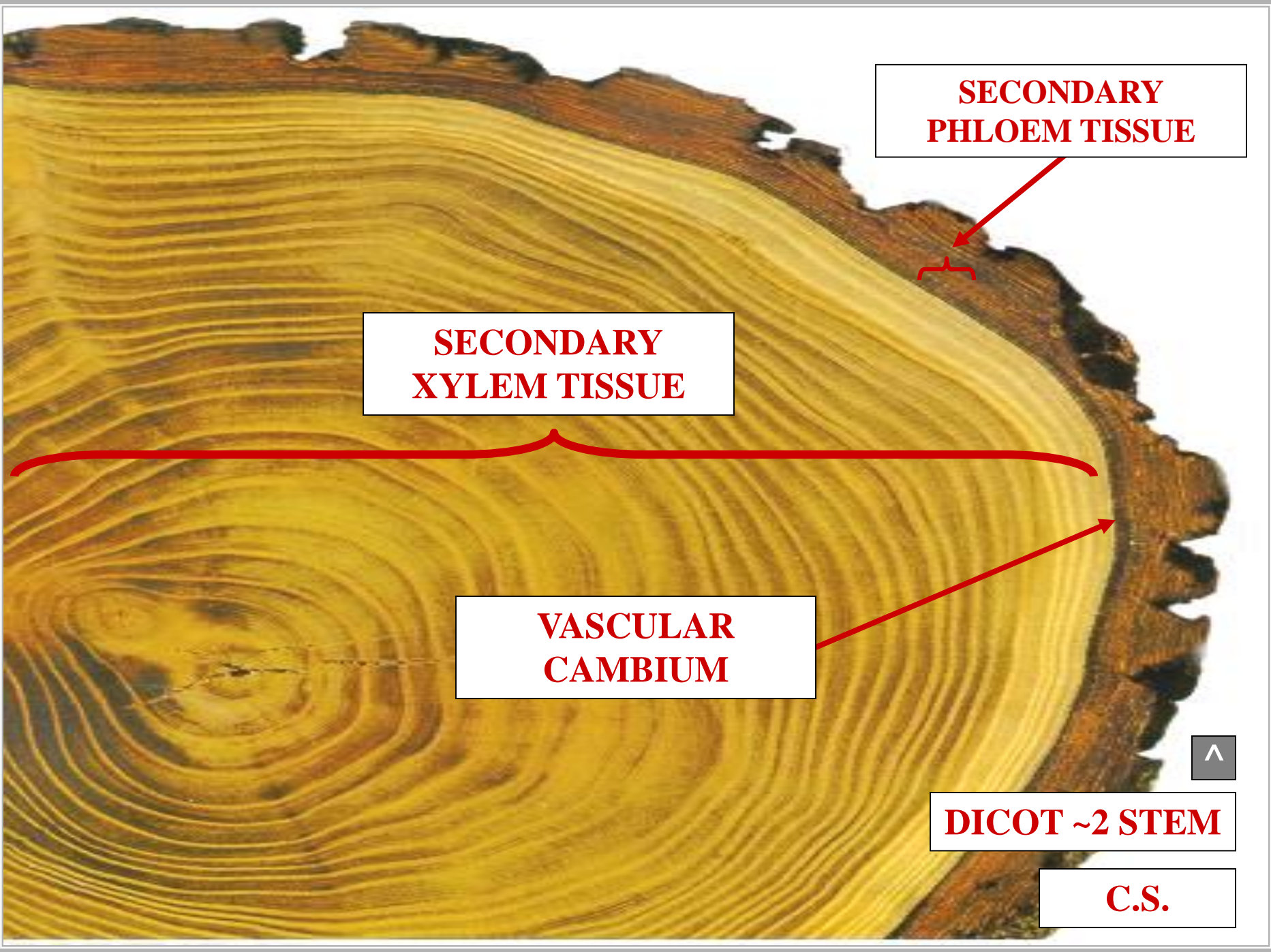
**SECONDARY
PHLOEM TISSUE**

**VASCULAR
CAMBIUM**

2X

DICOT ~2 STEM

C.S.



**SECONDARY
PHLOEM TISSUE**

**SECONDARY
XYLEM TISSUE**

**VASCULAR
CAMBIUM**

DICOT ~2 STEM

C.S.



SECONDARY XYLEM CELL TYPES

**SECONDARY
XYLEM TISSUE
CELL TYPES**

FIBERS

**SECONDARY
XYLEM TISSUE
CELL TYPES**

**SECONDARY
XYLEM TISSUE
CELL TYPES**

FIBERS

TRACHEIDS

**SECONDARY
XYLEM TISSUE
CELL TYPES**

**SECONDARY
XYLEM TISSUE
CELL TYPES**

FIBERS

TRACHEIDS

VESSEL MEMBERS

**SECONDARY
XYLEM TISSUE
CELL TYPES**

**SECONDARY
XYLEM TISSUE
CELL TYPES**

FIBERS

TRACHEIDS

VESSEL MEMBERS

PARENCHYMA

**SECONDARY
XYLEM TISSUE
CELL TYPES**



**SECONDARY
XYLEM
CELL TYPES
APPLIED**

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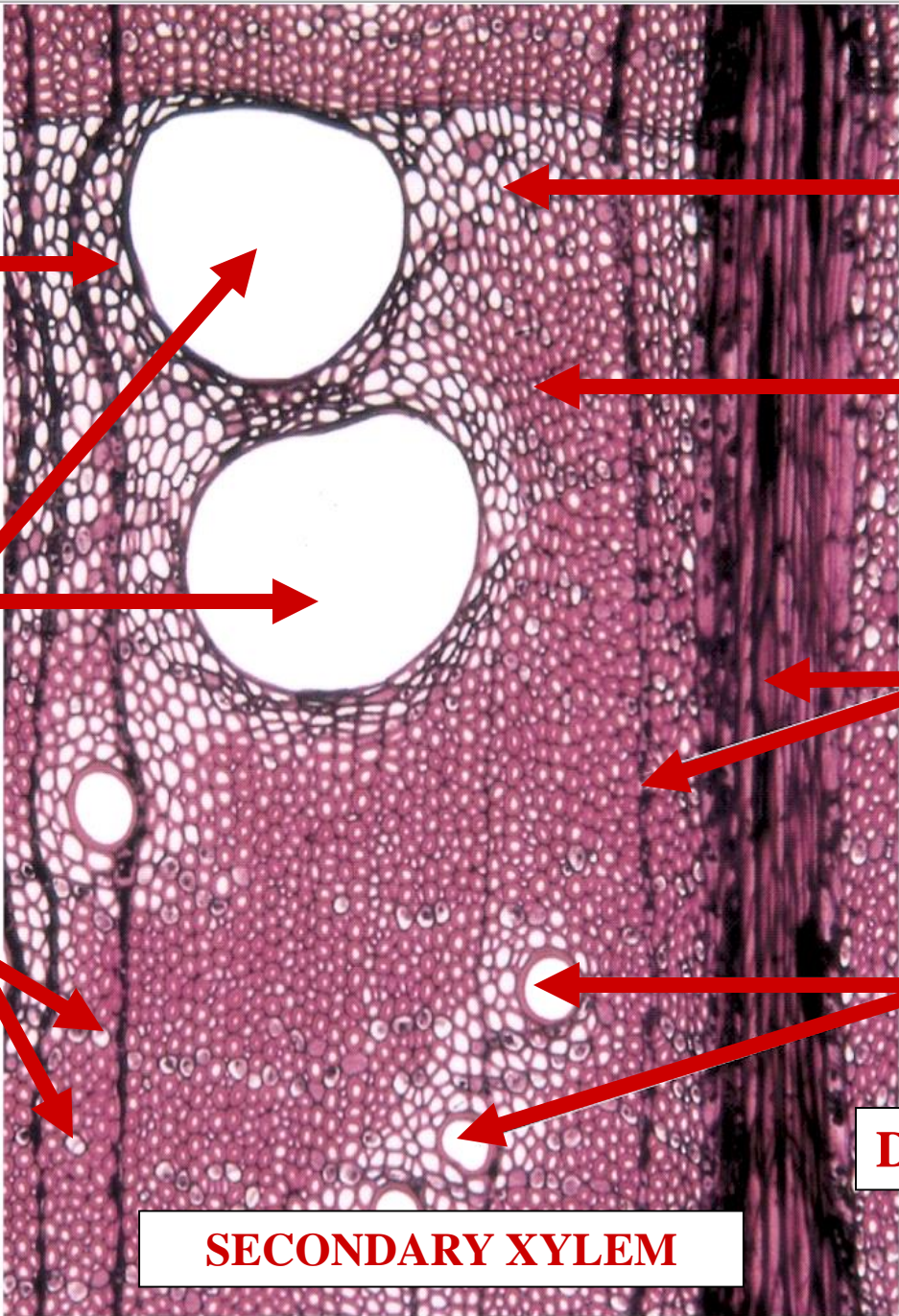
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SECONDARY XYLEM

DICOT ~2 STEM

C.S.



T

2

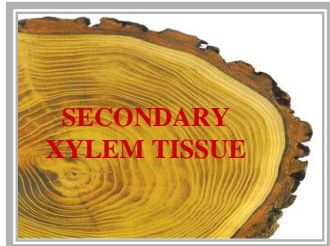
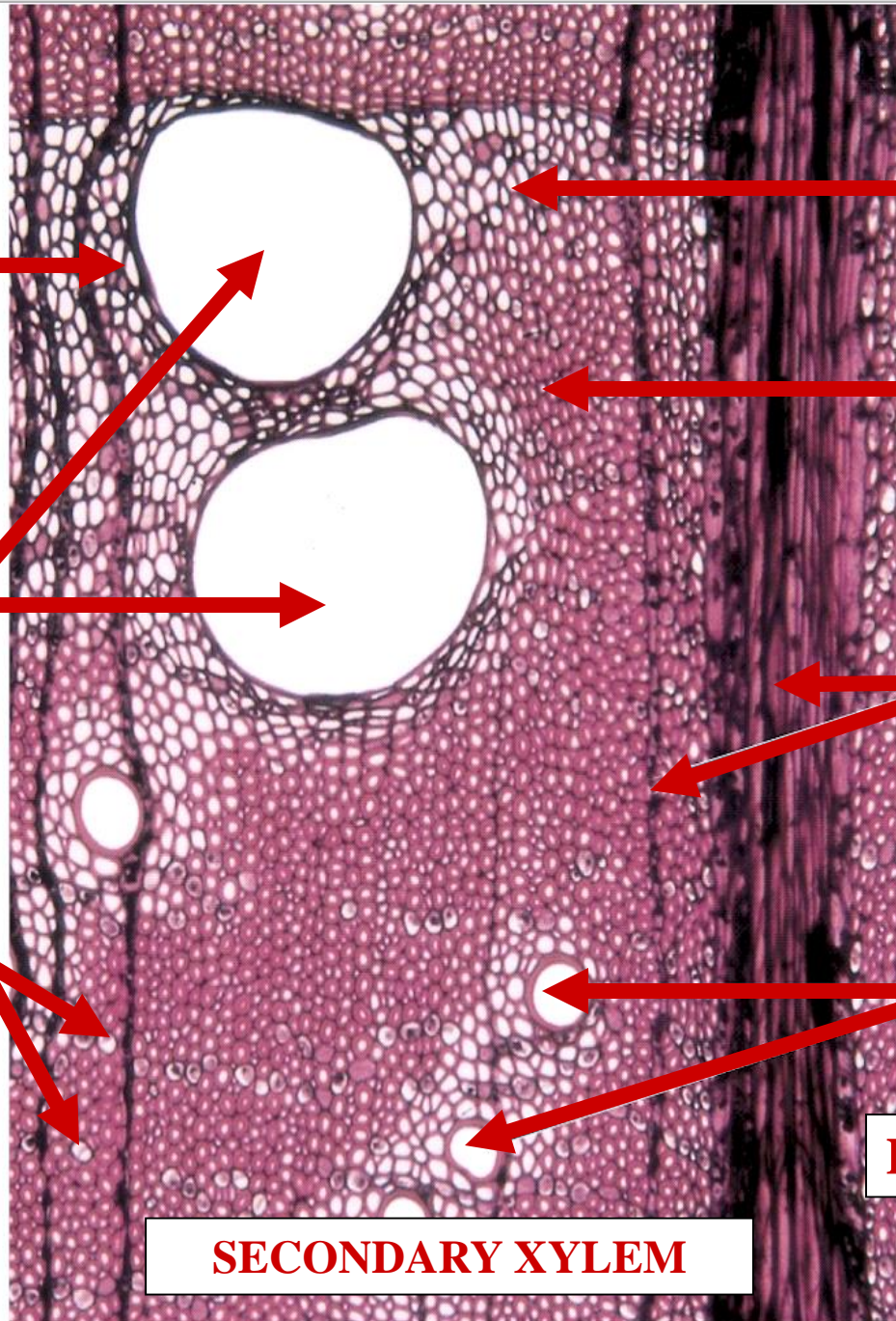
FIBERS

DICOT ~2 STEM

C.S.

SECONDARY XYLEM

SECONDARY XYLEM TISSUE



VM

TRACHEIDS

FIBERS

3

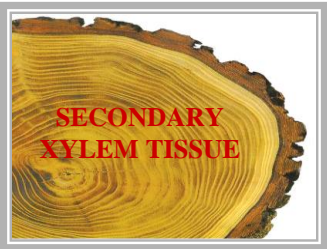
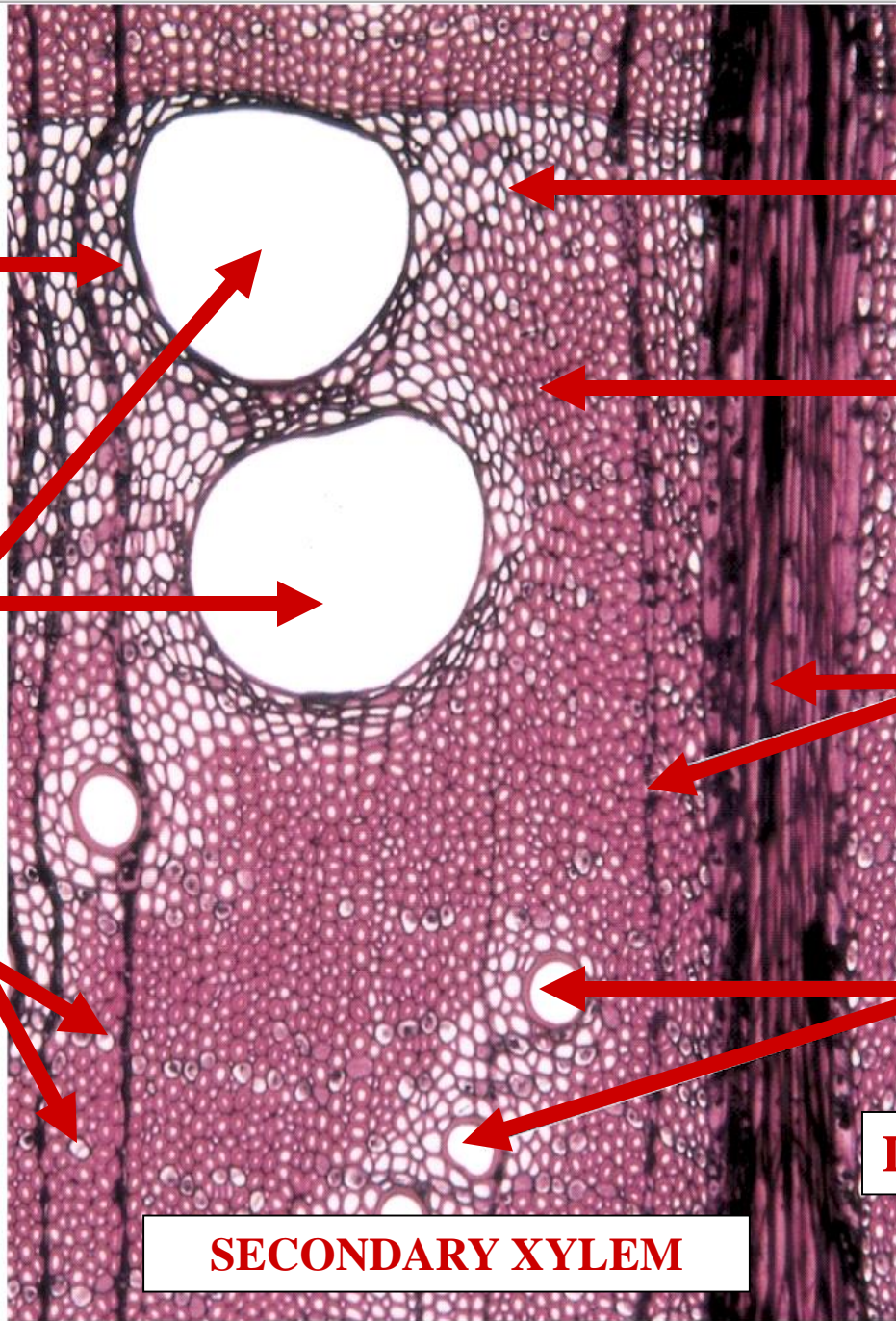
3

DICOT ~2 STEM

C.S.

SECONDARY XYLEM

SECONDARY XYLEM TISSUE



PC

TRACHEIDS

FIBERS

4

VESSEL MEMBERS

DICOT ~2 STEM

C.S.

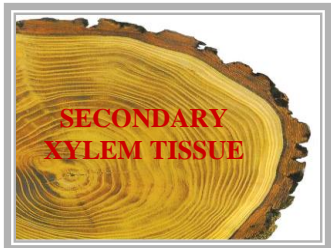
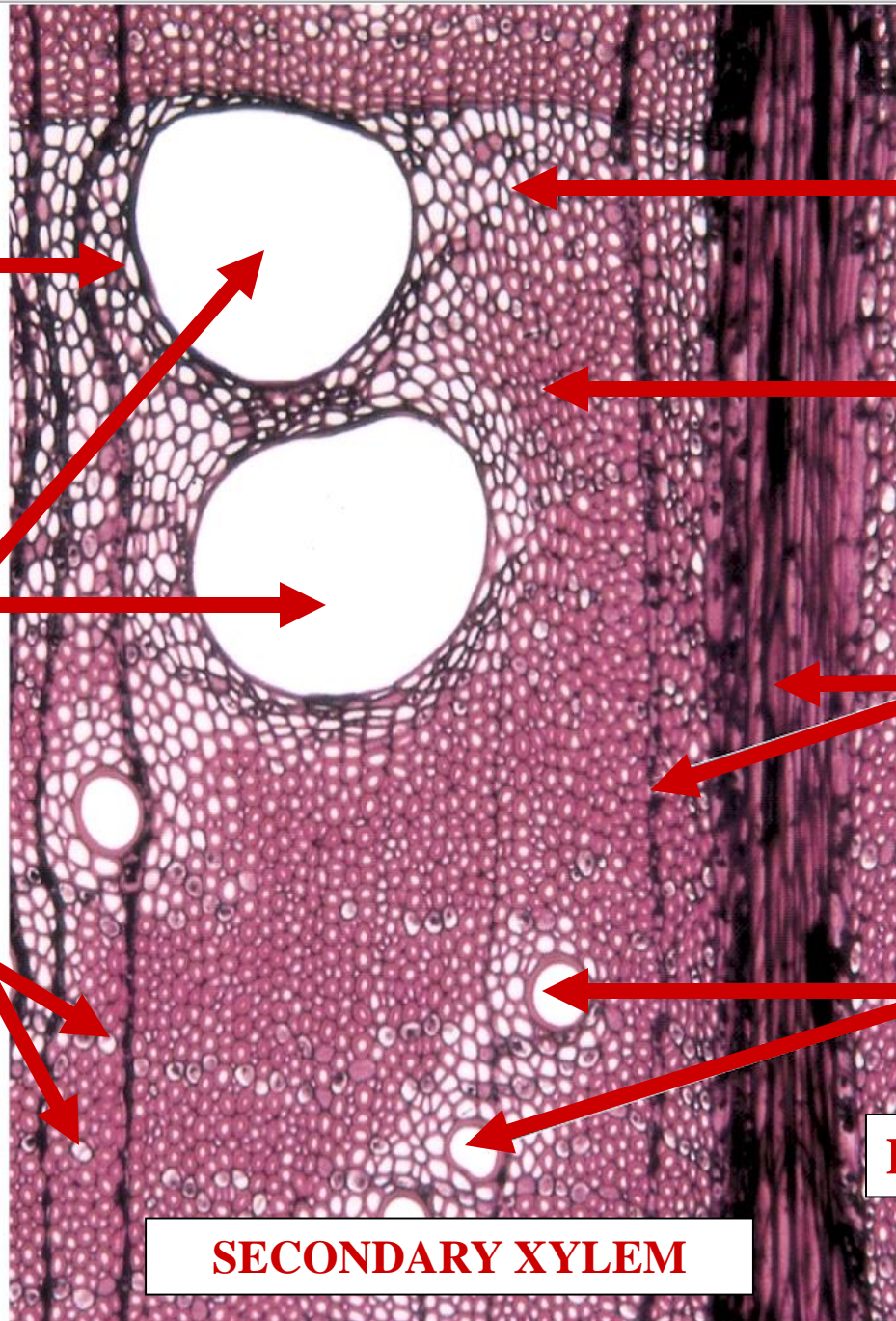
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VESSEL MEMBERS

4

SECONDARY XYLEM

SECONDARY XYLEM TISSUE

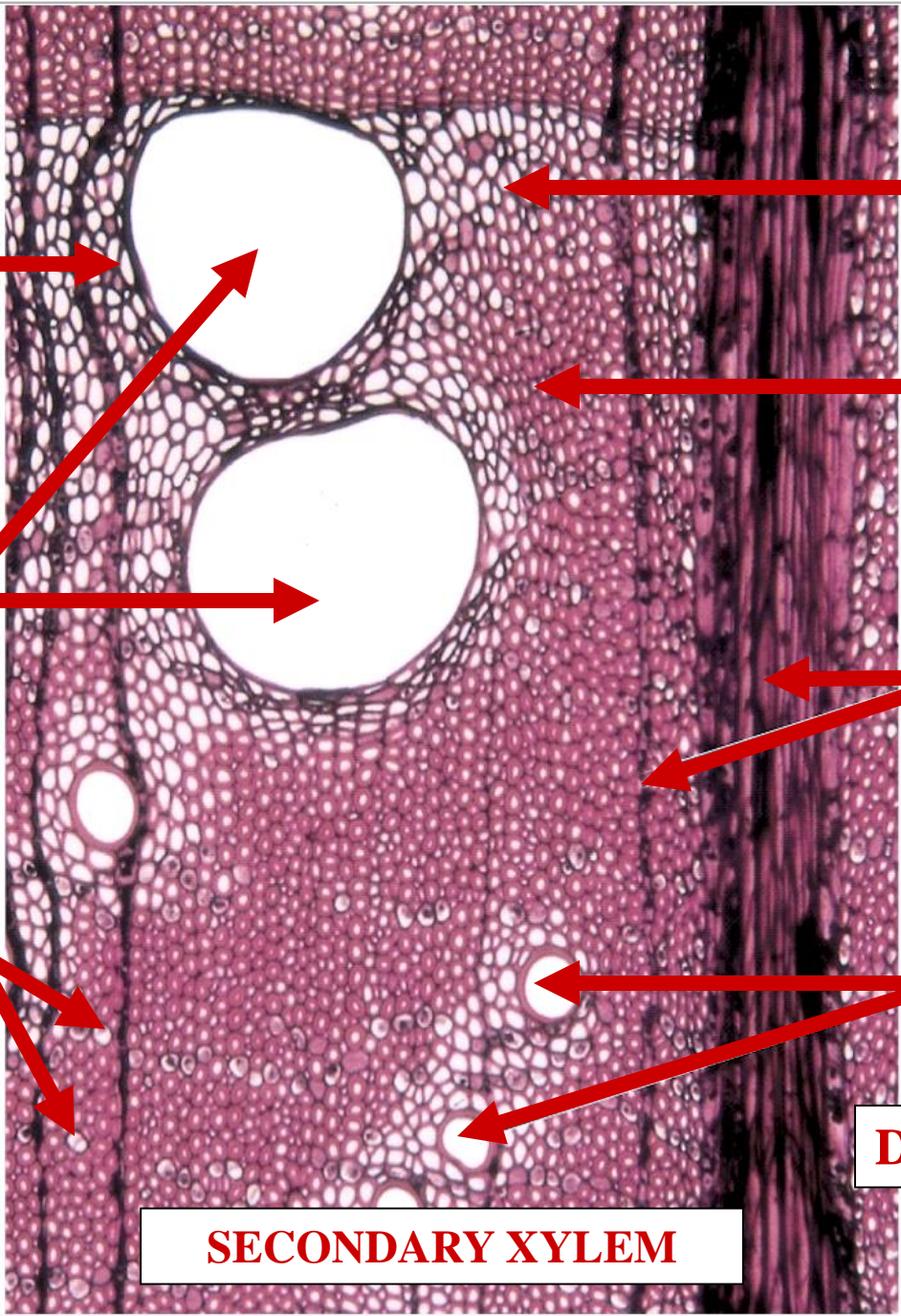
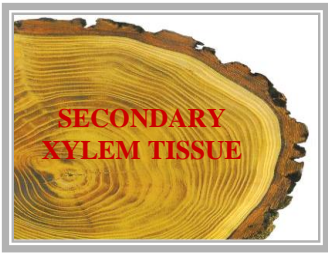




PARENCHYMA CELL

VESSEL MEMBERS

PARENCHYMA CELLS



TRACHEIDS

FIBERS

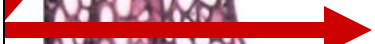
PARENCHYMA CELL

VESSEL MEMBERS

DICOT ~2 STEM

C.S.

SECONDARY XYLEM



**SECONDARY
XYLEM
PARENCHYMA
CELL TYPES**

**SECONDARY XYLEM
PARENCHYMA
CELL TYPES**

AXIAL PARENCHYMA

**SECONDARY XYLEM
PARENCHYMA
CELL TYPES**

**SECONDARY XYLEM
PARENCHYMA
CELL TYPES**



**AXIAL PARENCHYMA
RAY PARENCHYMA**

**SECONDARY XYLEM
PARENCHYMA
CELL TYPES**

**SECONDARY
XYLEM TISSUE
AXIAL
PARENCHYMA**

**AXIAL
PARENCHYMA**

SECONDARY XYLEM TISSUE AXIAL PARENCHYMA



VERTICAL ORIENTATION

**SECONDARY XYLEM TISSUE
AXIAL PARENCHYMA**

SECONDARY XYLEM TISSUE AXIAL PARENCHYMA

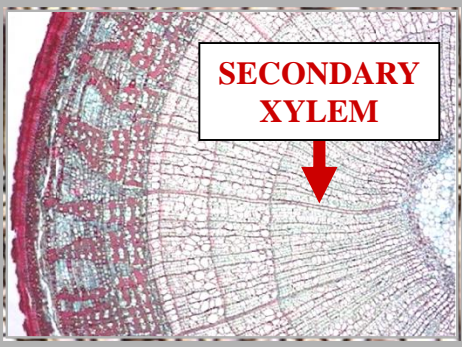


VERTICAL ORIENTATION

FUSIFORM INITIAL DERIVED

SECONDARY XYLEM TISSUE AXIAL PARENCHYMA

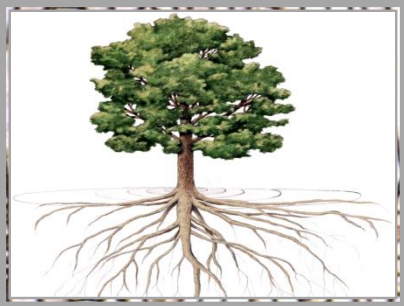
VO



SECONDARY XYLEM

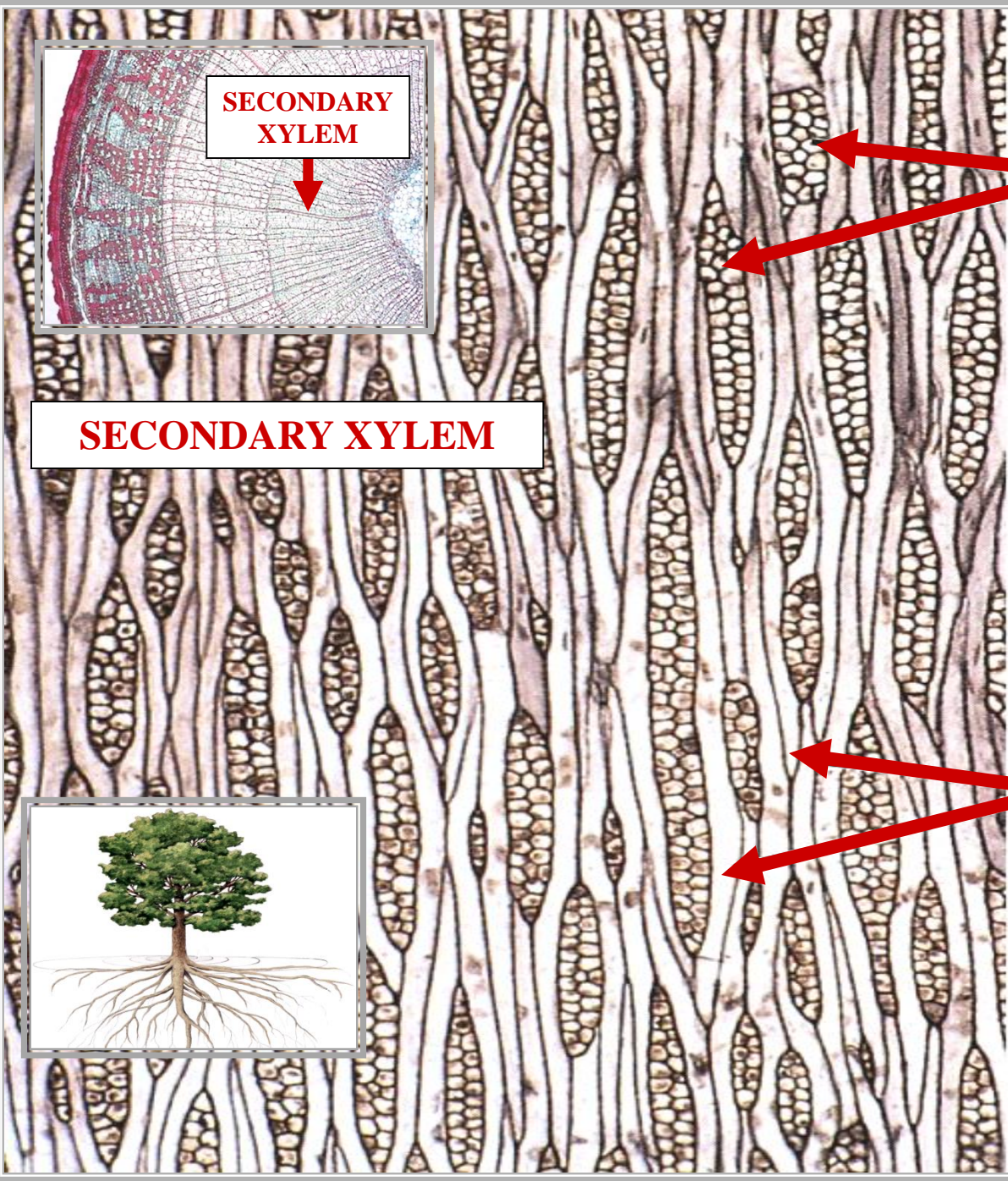


**AXIAL
PARENCHYMA**

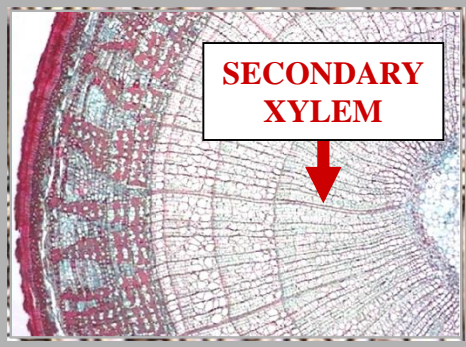


DICOT ~2 STEM

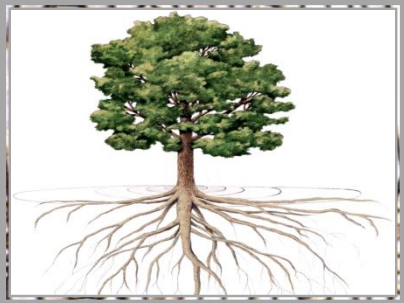
L.S.



VC **FI**



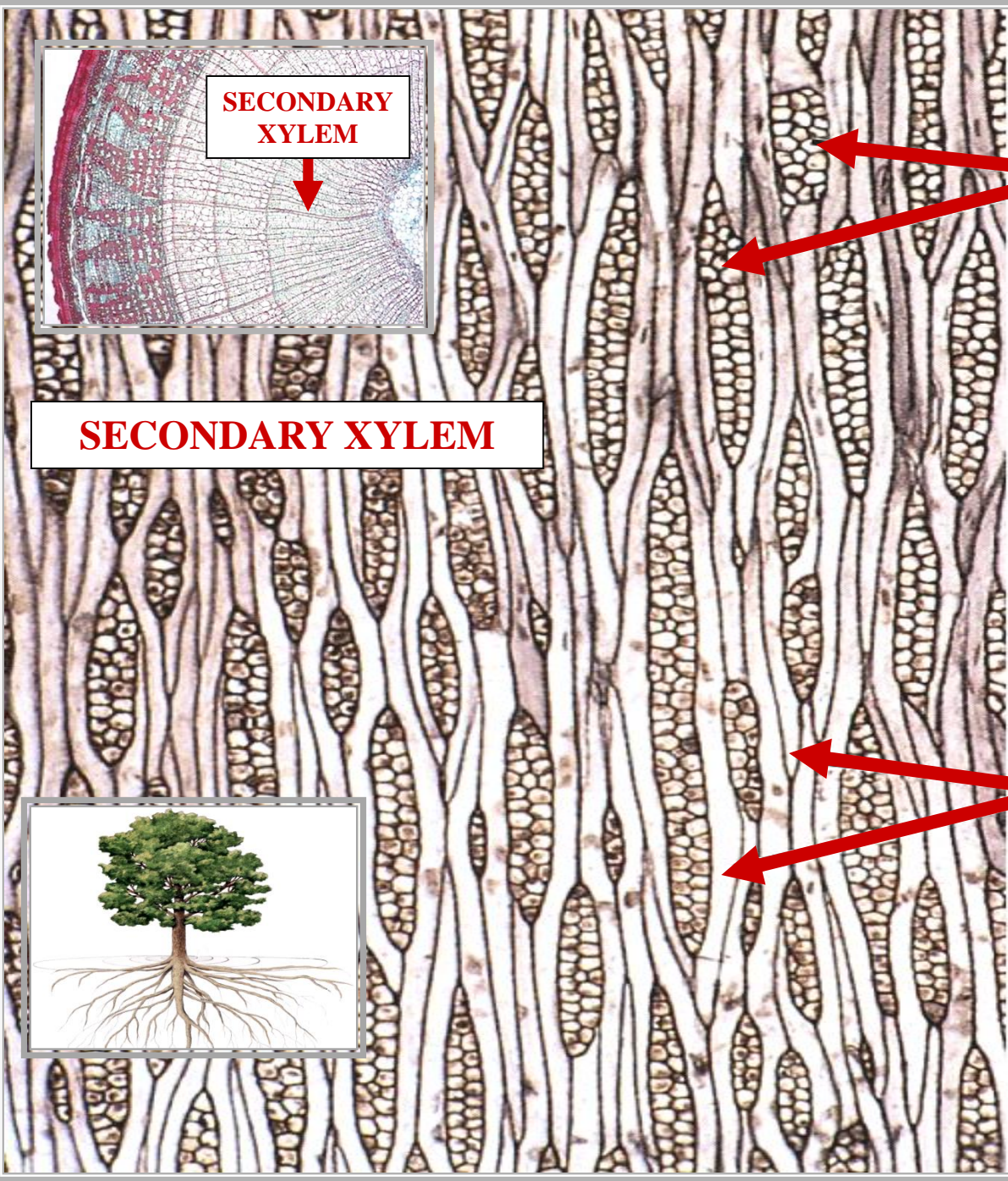
SECONDARY XYLEM



**VERTICAL
ORIENTATION**

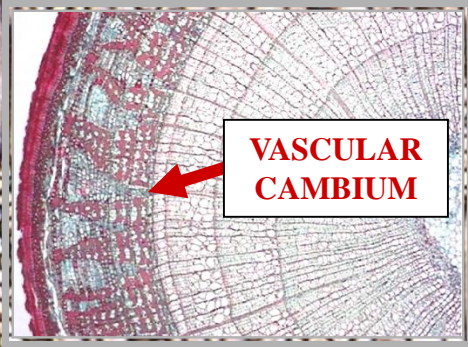
DICOT ~2 STEM

L.S.



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AP



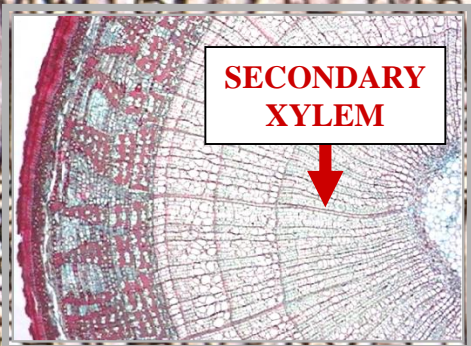
SECONDARY XYLEM



FUSIFORM
INITIAL
DERIVED

DICOT ~2 STEM

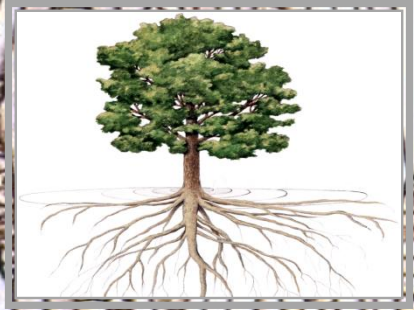
L.S.



SECONDARY XYLEM



SECONDARY XYLEM



AXIAL PARENCHYMA

DICOT ~2 STEM

L.S.

