



# CRYPTIC SPECIES

SYMPATRIC POPULATIONS

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MORPHOLOGICALLY IDENTICAL

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BUT REPRODUCTIVELY ISOLATED

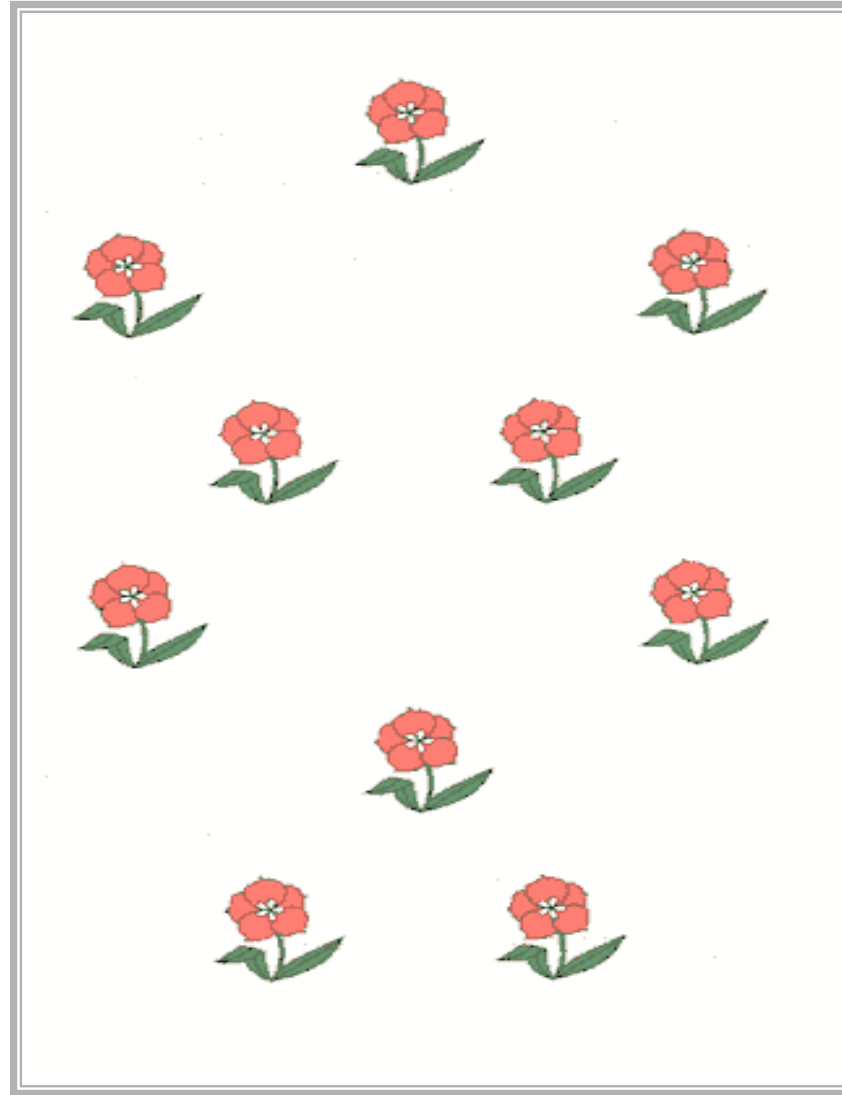
# CRYPTIC SPECIES



# **NON-IDEAL SPECIES**

# **CRYPTIC SPECIES APPLIED**

# CRYPTIC SPECIES

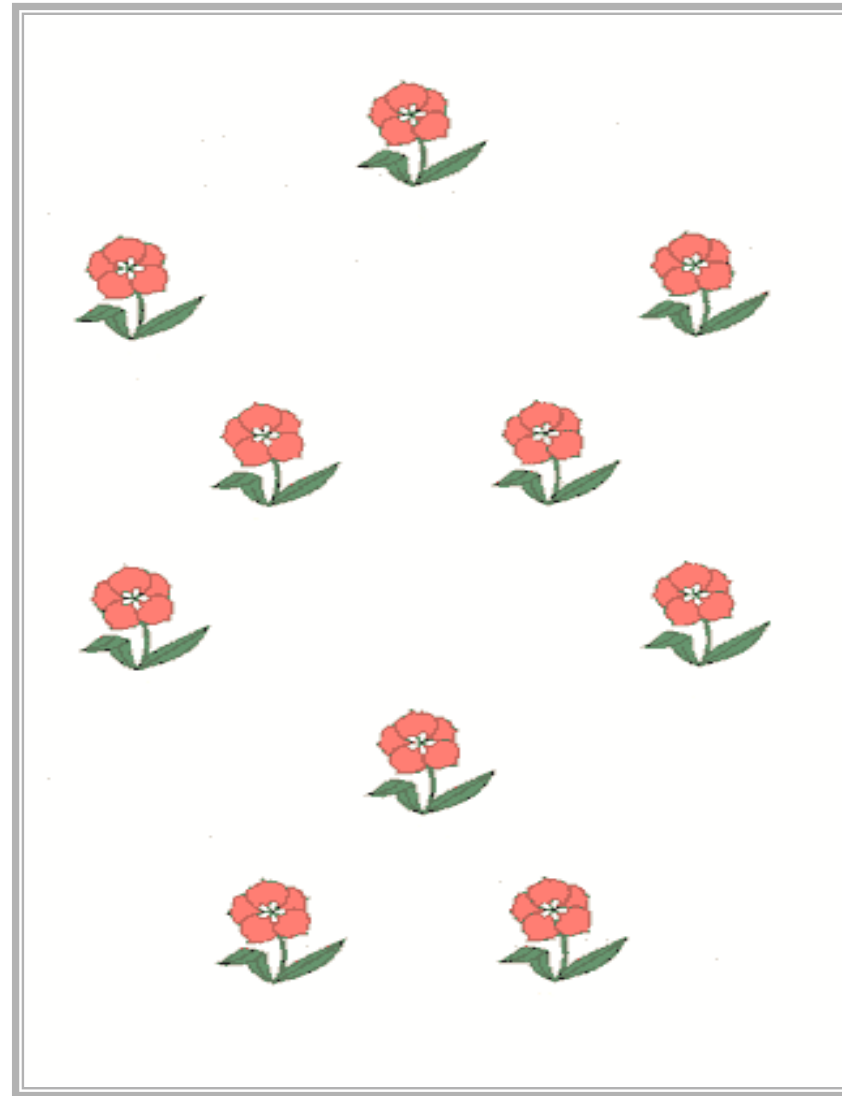


**GEOGRAPHIC  
AREA**

**GEOGRAPHIC  
AREA**

**PARENTAL POPULATION**

# CRYPTIC SPECIES

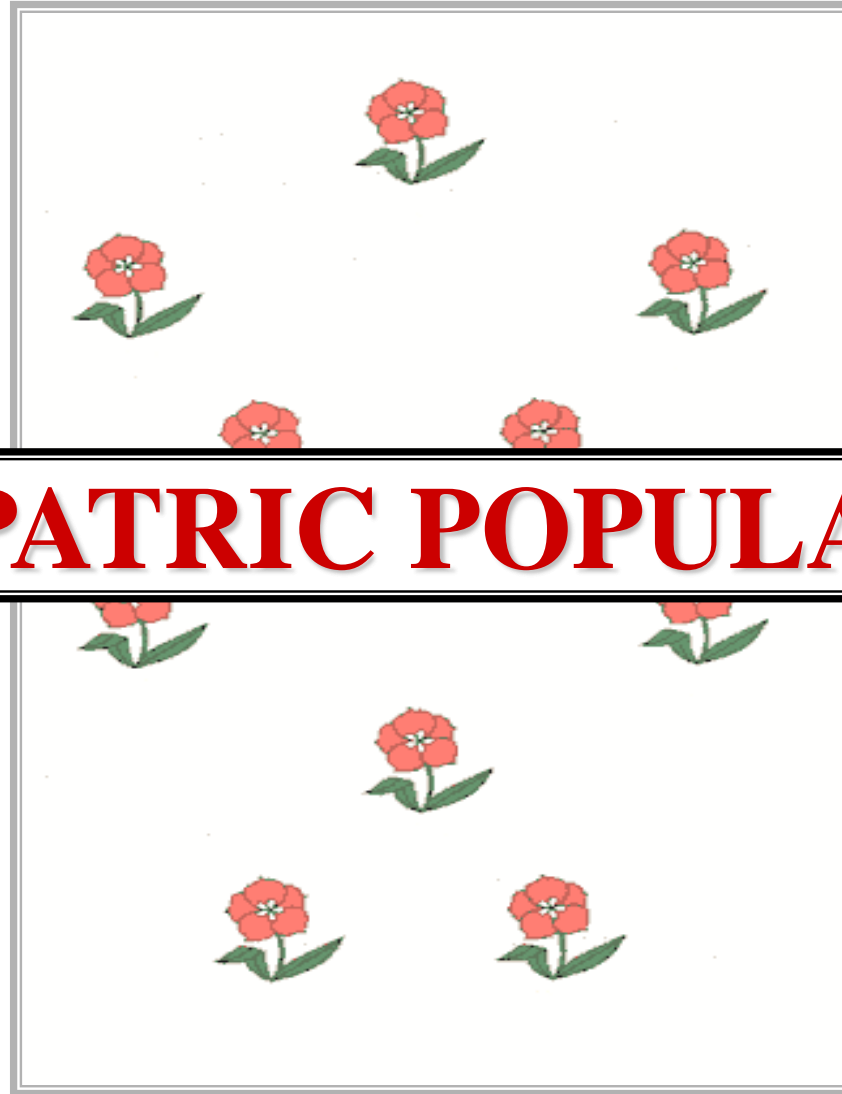


**SAME  
GEOGRAPHIC  
AREA**

**SAME  
GEOGRAPHIC  
AREA**

**PARENTAL POPULATION**

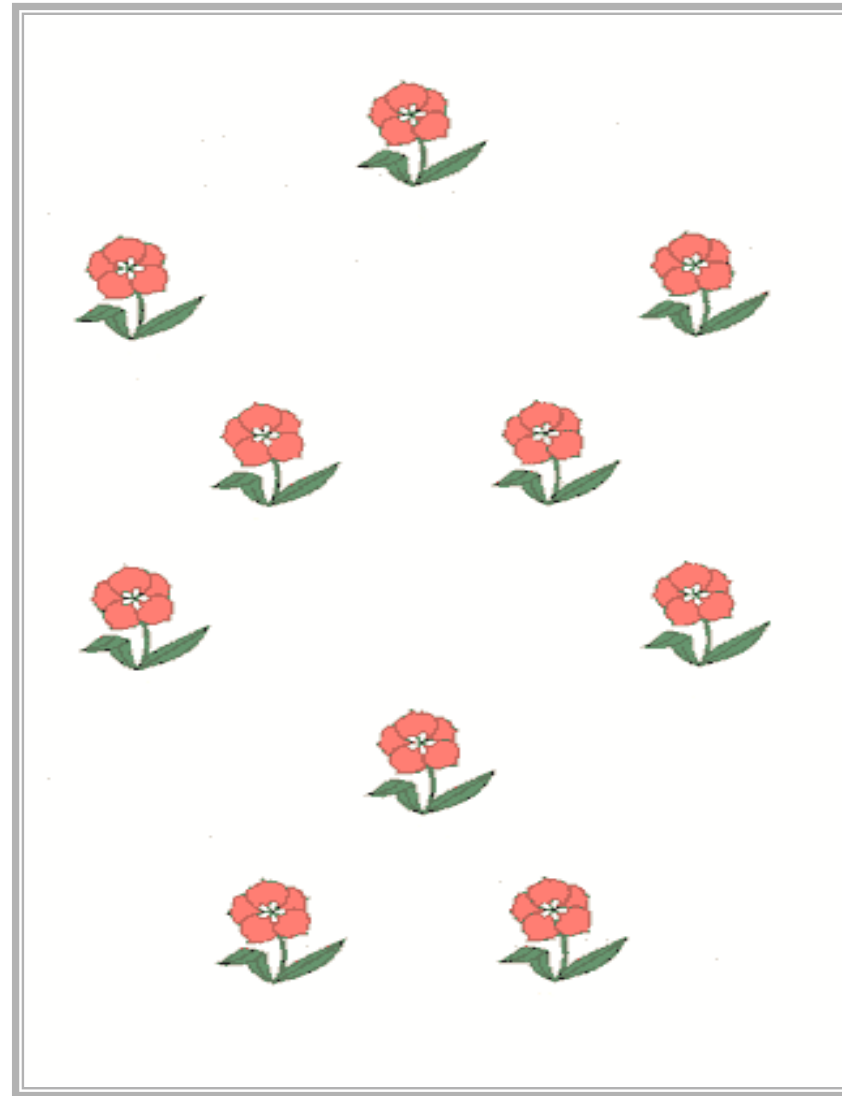
# CRYPTIC SPECIES



**SYMPATRIC POPULATION**

**PARENTAL POPULATION**

# CRYPTIC SPECIES

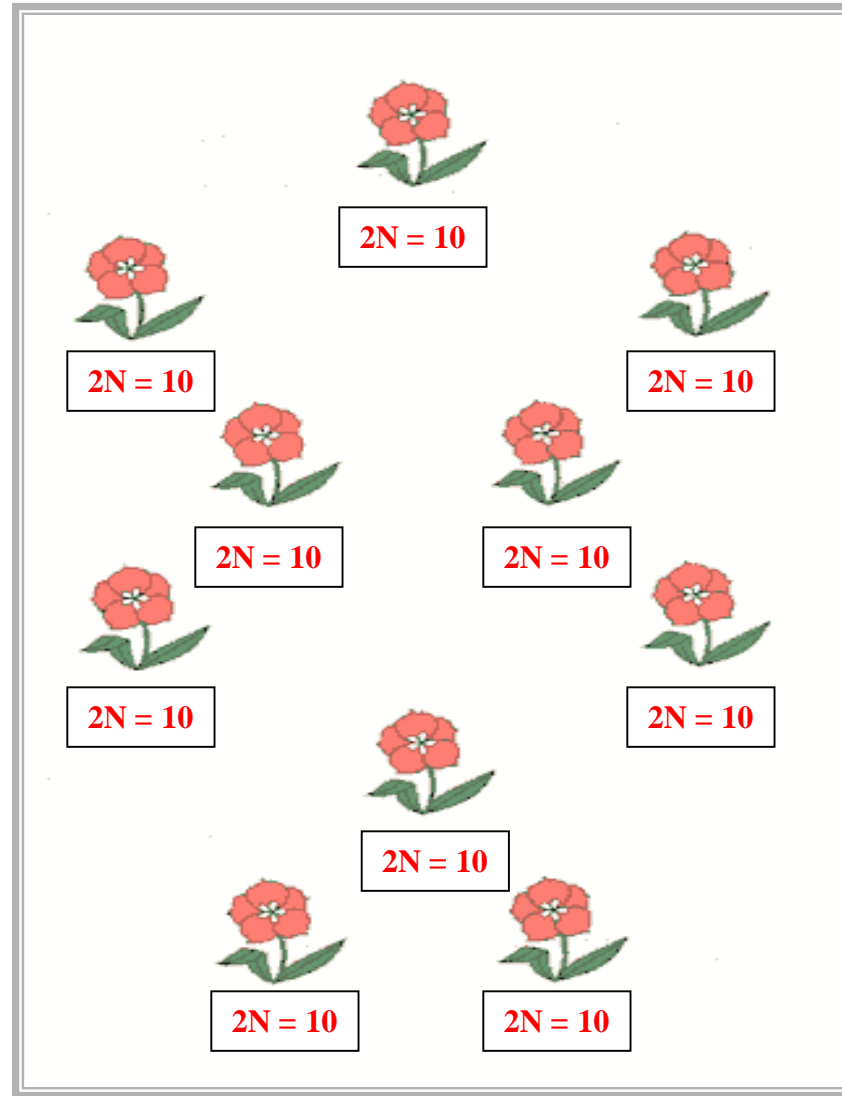


**SAME  
GEOGRAPHIC  
AREA**

**SAME  
GEOGRAPHIC  
AREA**

**PARENTAL POPULATION**

# CRYPTIC SPECIES

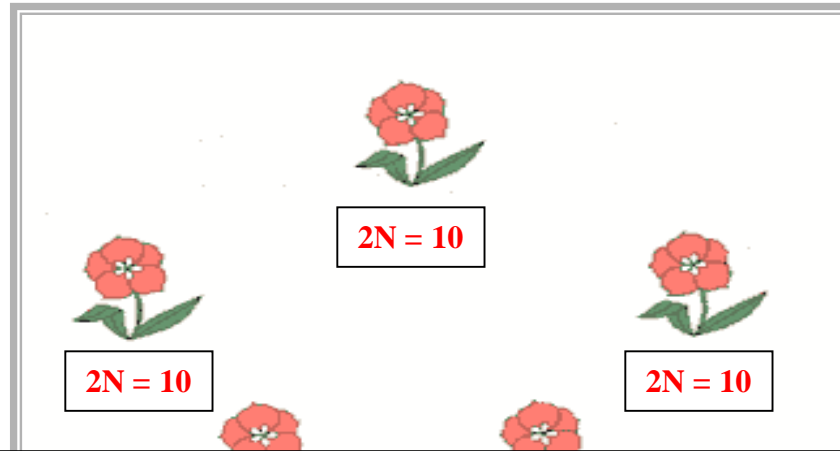


SAME  
GEOGRAPHIC  
AREA

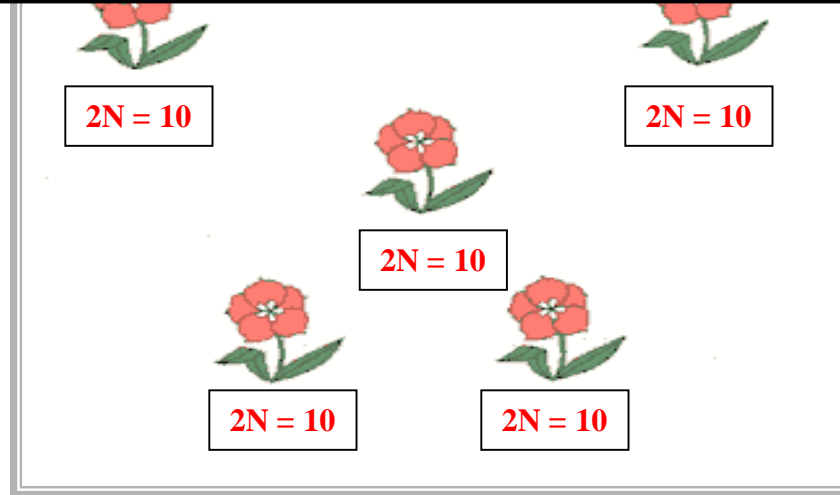
SAME  
GEOGRAPHIC  
AREA

PARENTAL POPULATION

# CRYPTIC SPECIES



**IDENTICAL PLOIDY LEVEL**

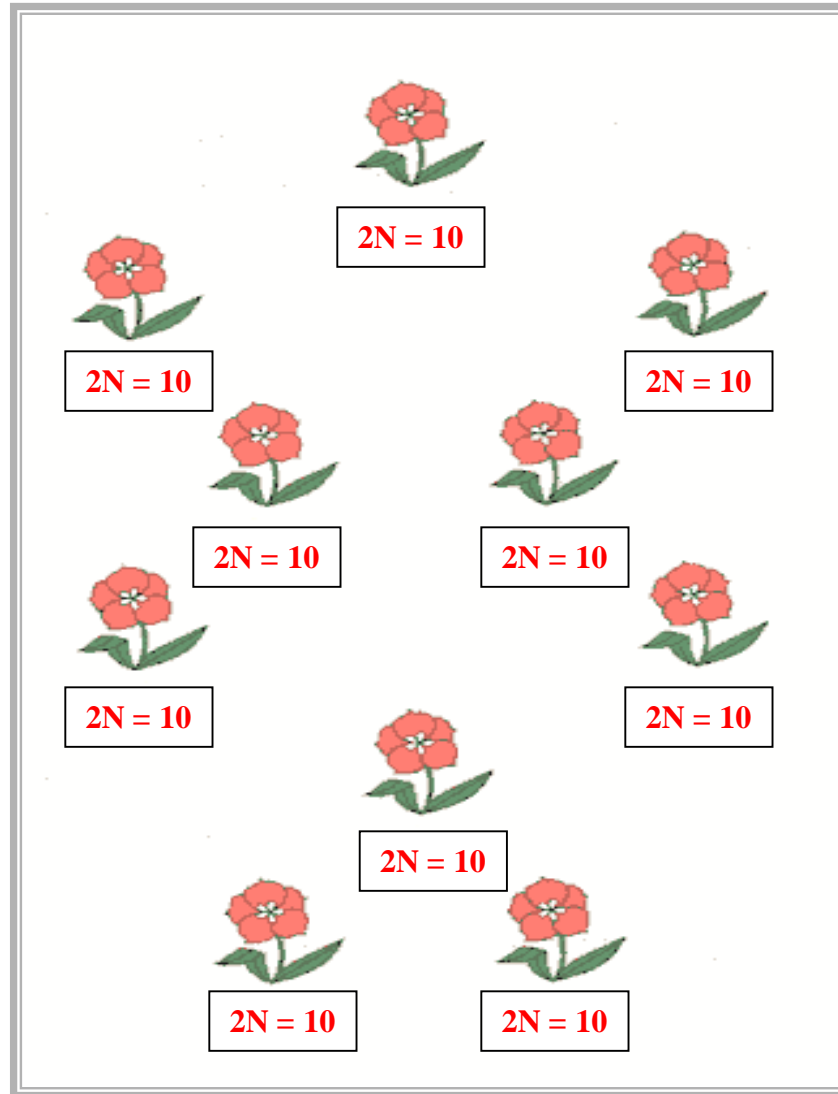


**PARENTAL POPULATION**



# CRYPTIC SPECIES

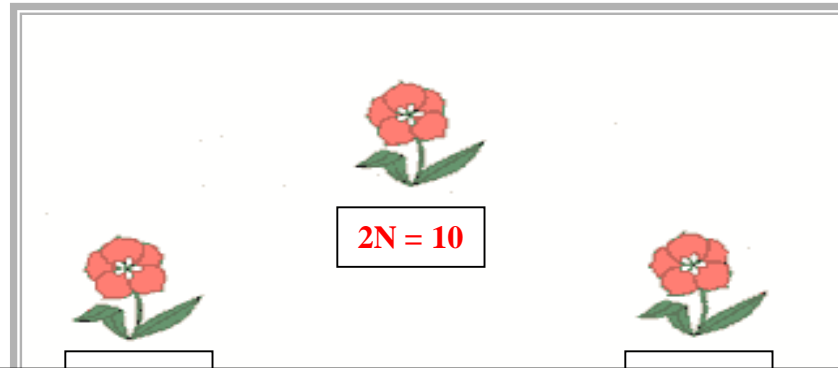
TIME



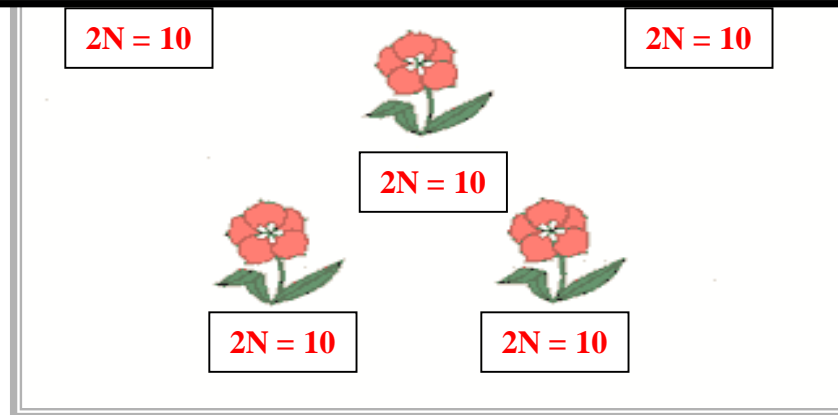
TIME

PARENTAL POPULATION

# CRYPTIC SPECIES

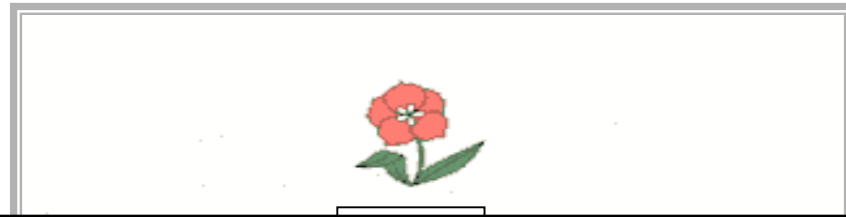


**PLOIDY LEVEL  
CHANGE OCCURS**



**PARENTAL POPULATION**

# CRYPTIC SPECIES



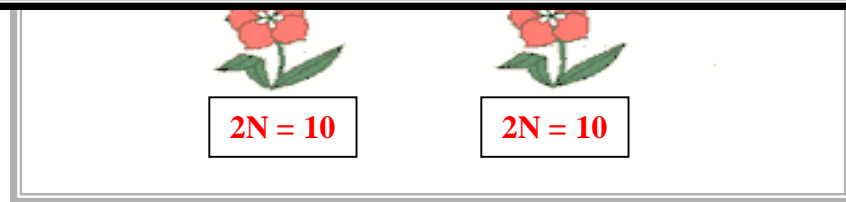
**PLOIDY LEVEL  
CHANGE OCCURS**



$2N = 10$

$2N = 10$

**VIA ANAPHASE-II  
NON-DISJUNCTION**



$2N = 10$

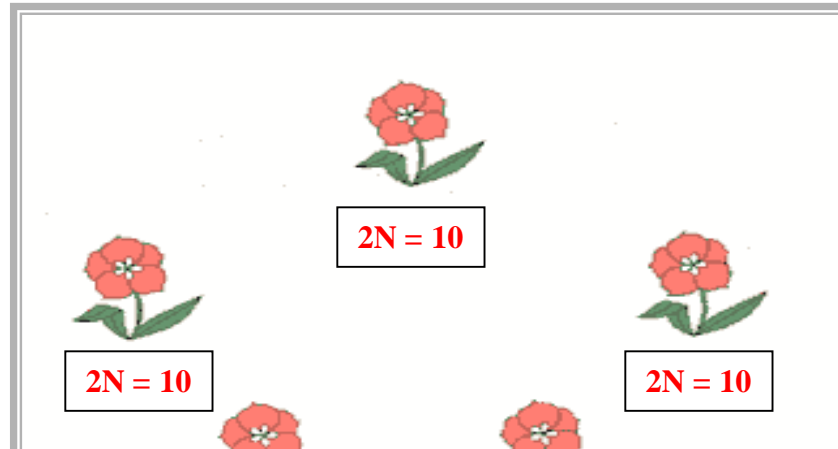
$2N = 10$

**PARENTAL POPULATION**

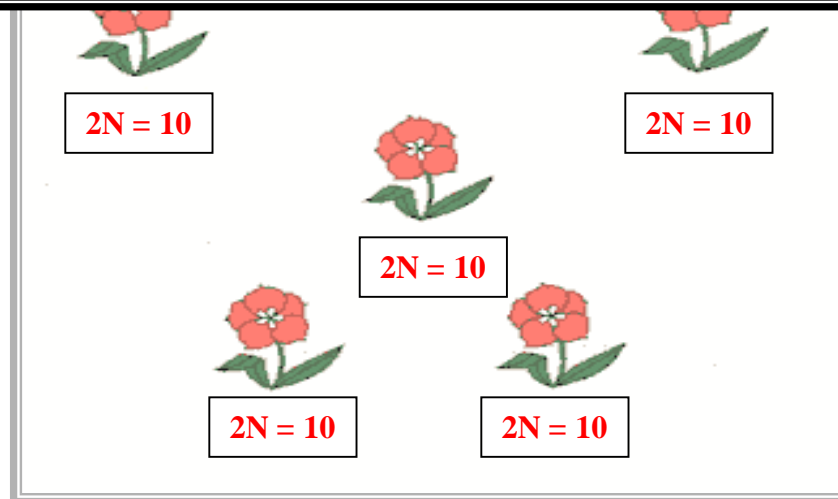
# CRYPTIC SPECIES

10

20

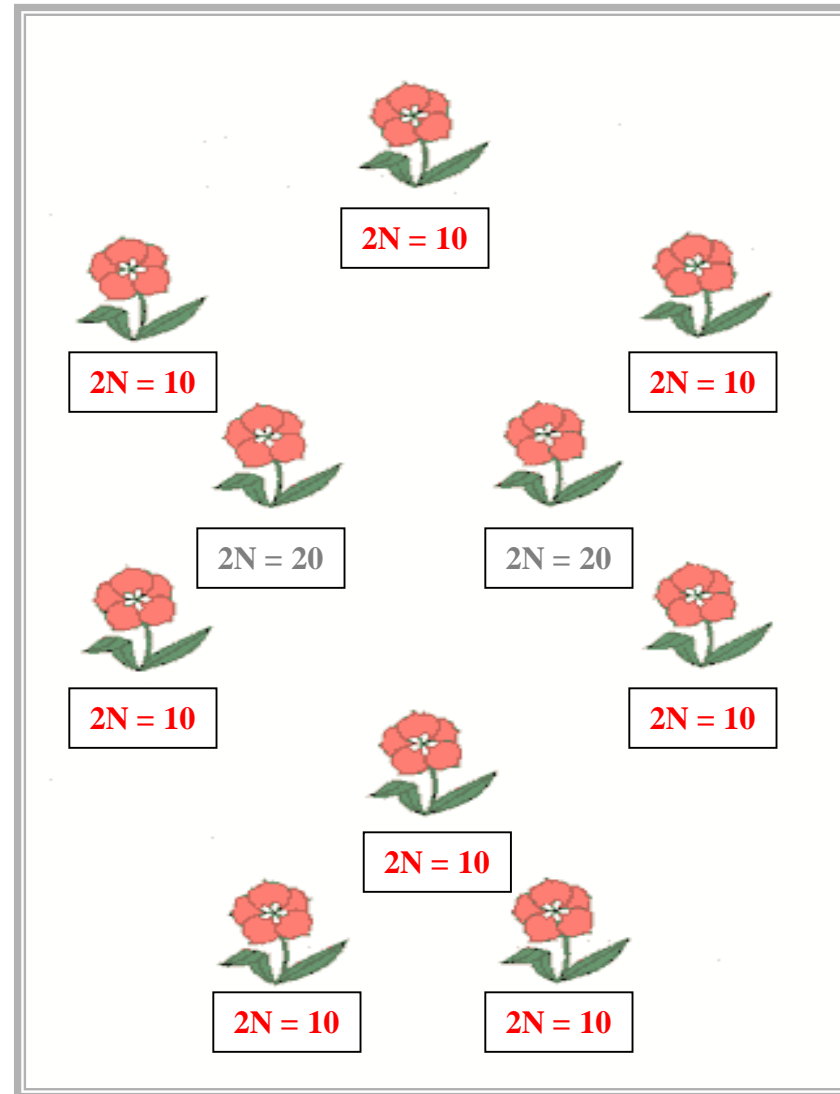


**CYTOTYPES ARISE**



**CYTOTYPES**

# CRYPTIC SPECIES

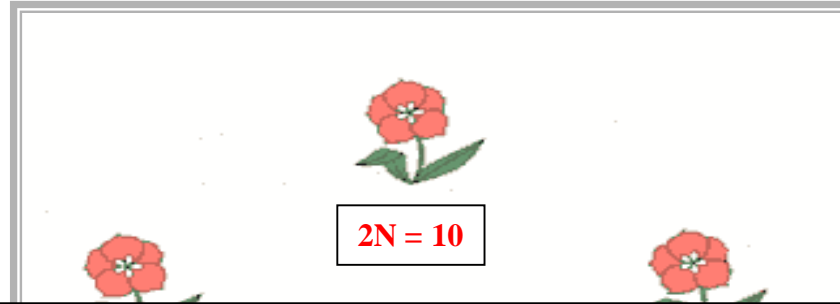


**SAME  
GEOGRAPHIC  
AREA**

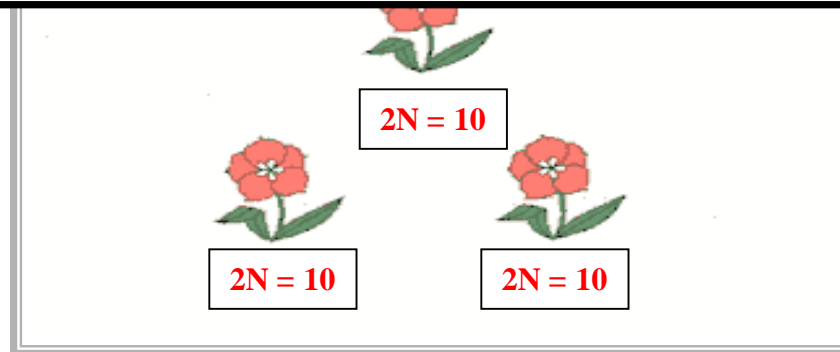
**SAME  
GEOGRAPHIC  
AREA**

**CYTOTYPES**

# CRYPTIC SPECIES

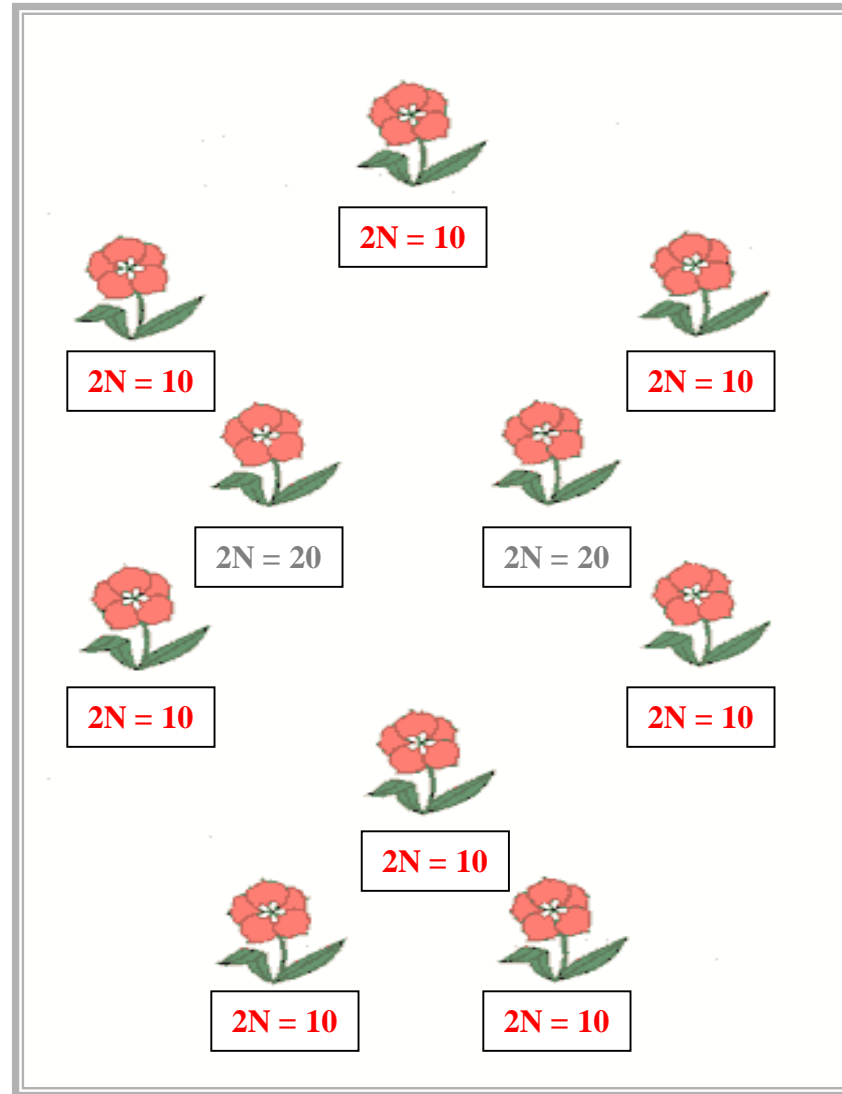


**CYTOTYPES  
MORPHOLOGICALLY  
IDENTICAL**



**CYTOTYPES**

# CRYPTIC SPECIES

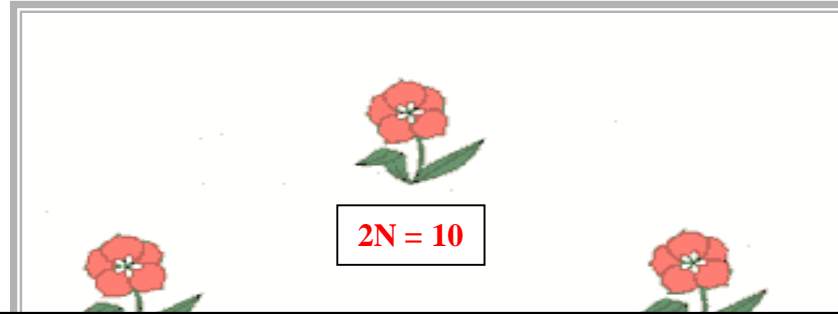


**SAME  
GEOGRAPHIC  
AREA**

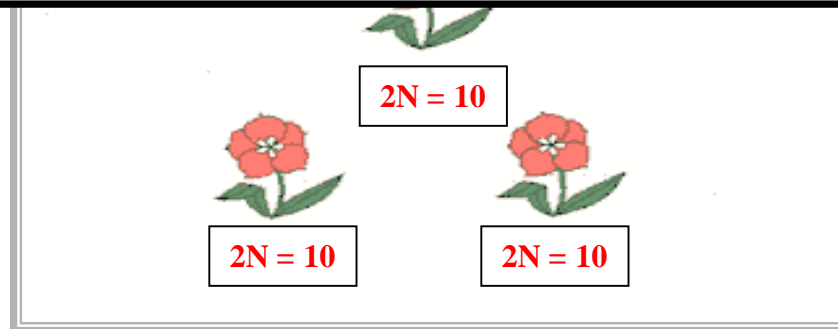
**SAME  
GEOGRAPHIC  
AREA**

## CYTOTYPES

# CRYPTIC SPECIES



**CYTOTYPES  
REPRODUCTIVELY  
ISOLATED**

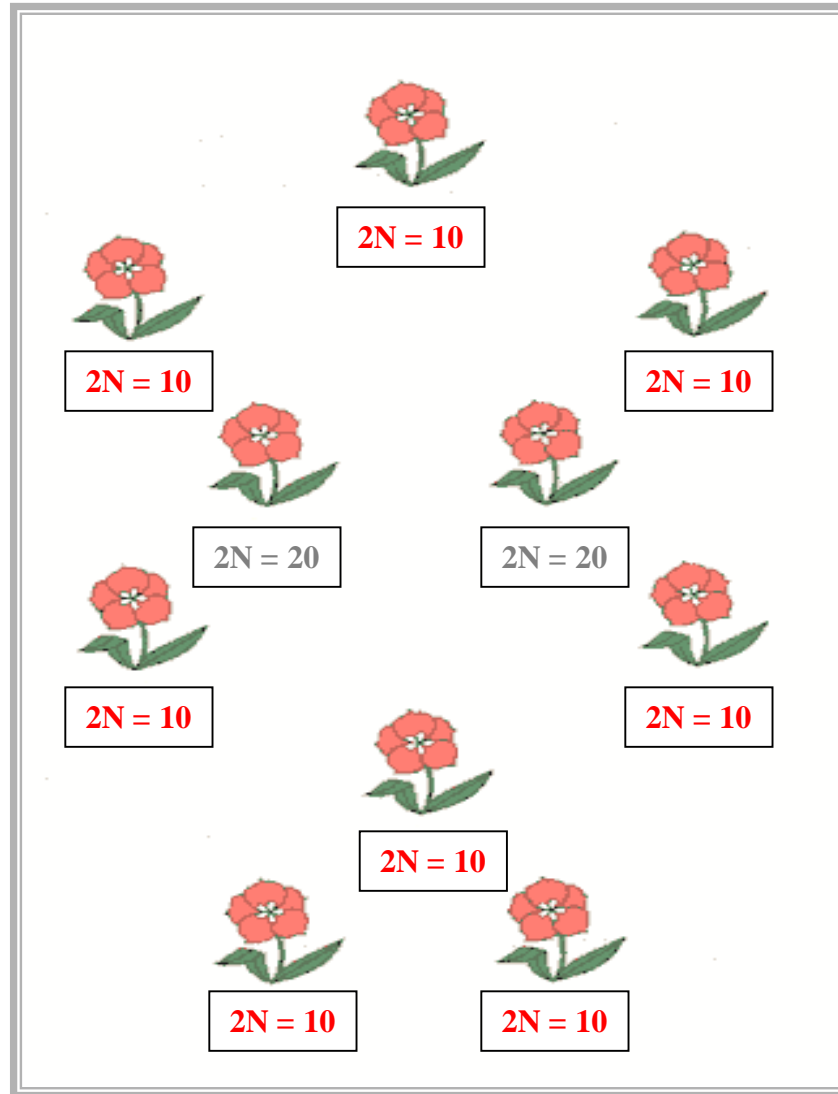


**CYTOTYPES**



# CRYPTIC SPECIES

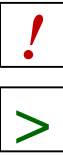
**TIME**



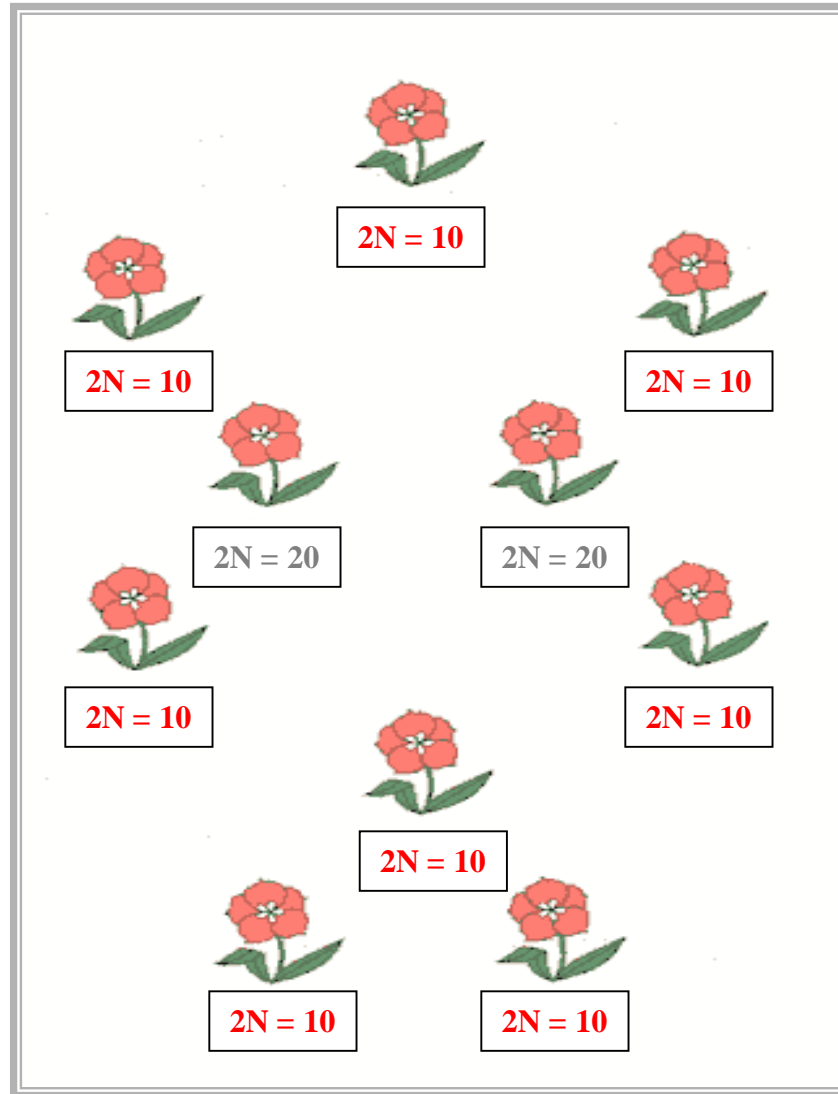
**TIME**

**CYTOTYPES REPRODUCTIVELY ISOLATED**

# CRYPTIC SPECIES



**CYTOTYPES  
UNDERGO  
SEPARATE  
MUTATIONS  
&  
SELECTION**



**CYTOTYPES  
UNDERGO  
SEPARATE  
MUTATIONS  
&  
SELECTION**

**CYTOTYPES REPRODUCTIVELY ISOLATED**

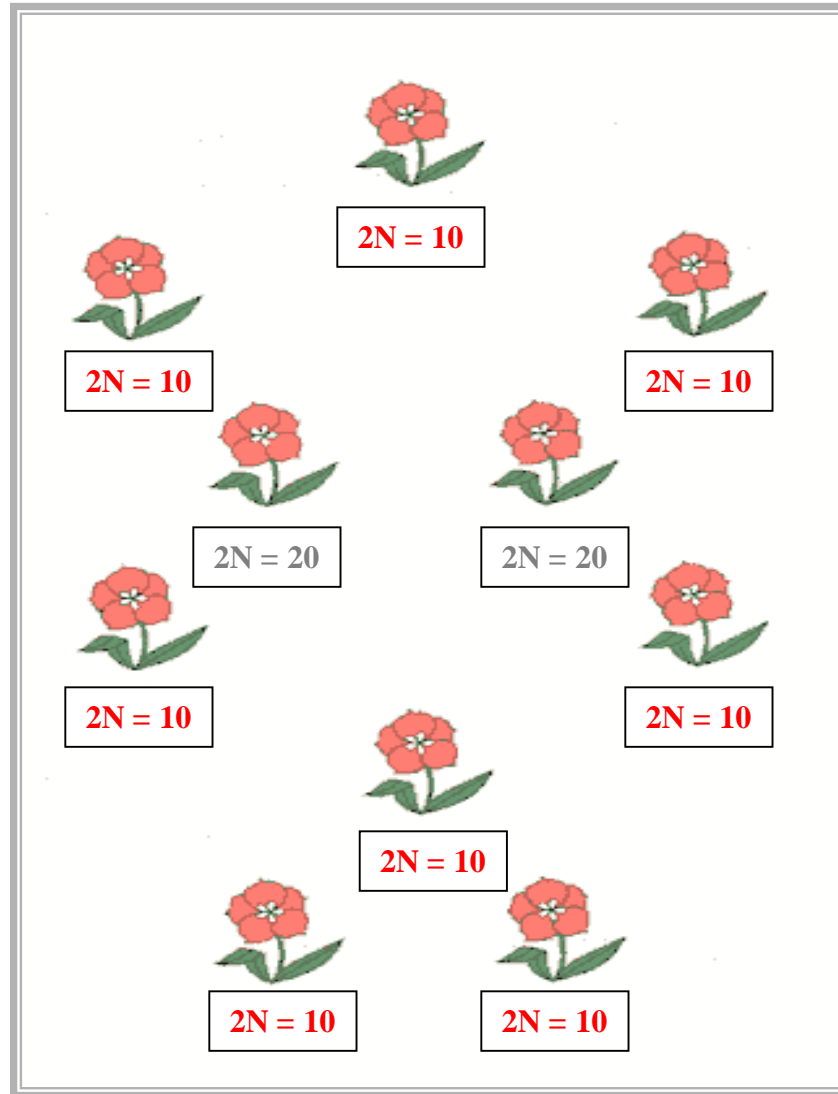
# SYMPATRIC SPECIATION

**!!!NOTE: CHANGES!!!**

# SYMPATRIC SPECIATION

# CRYPTIC SPECIES

**TIME**



**TIME**

**CYTOTYPES MORPHOLOGICALLY IDENTICAL**

# CRYPTIC SPECIES



2N = 10

**CYTOTYPES  
*DO NOT* EVOLVE  
MORPHOLOGICAL  
CHANGES**



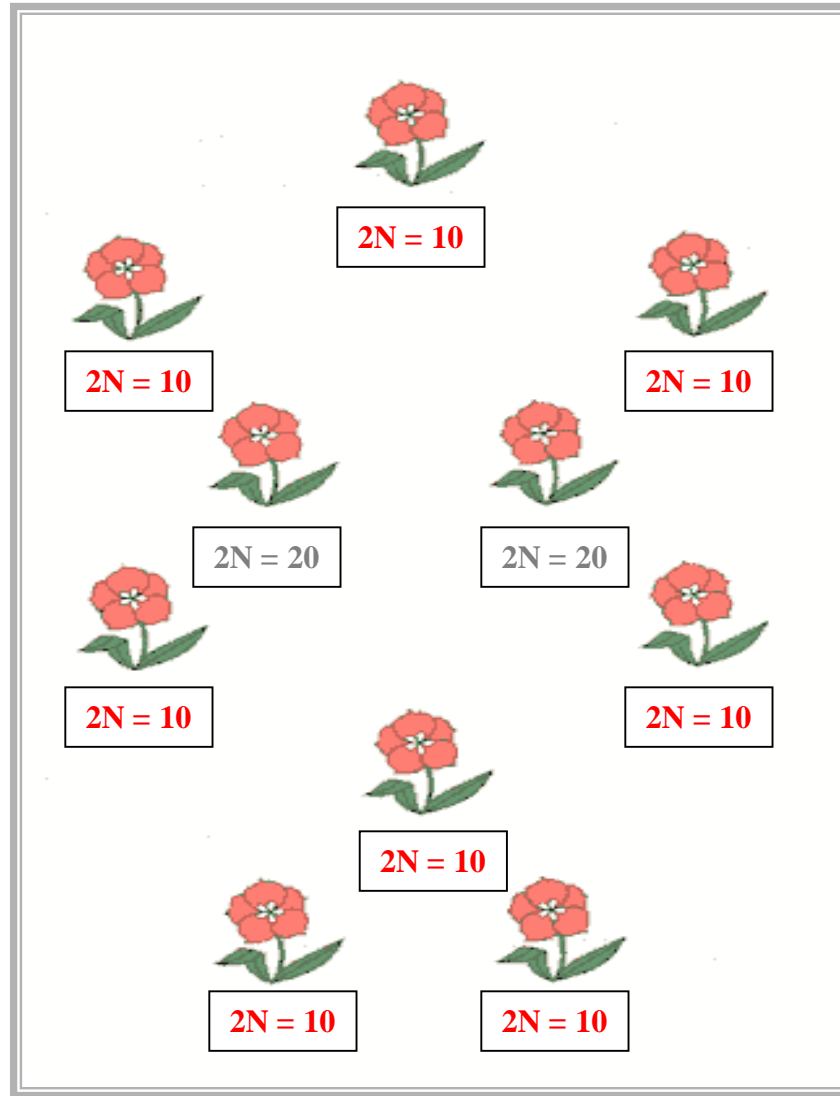
2N = 10



2N = 10

**CYTOTYPES MORPHOLOGICALLY IDENTICAL**

# CRYPTIC SPECIES



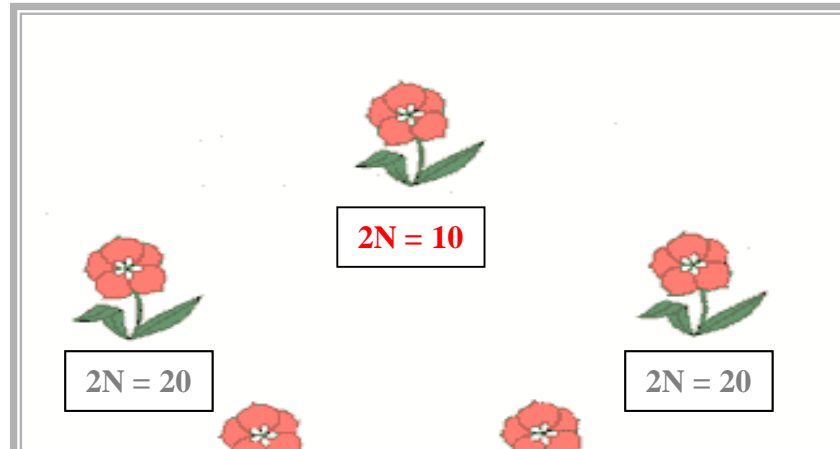
**SAME  
GEOGRAPHIC  
AREA**

**SAME  
GEOGRAPHIC  
AREA**

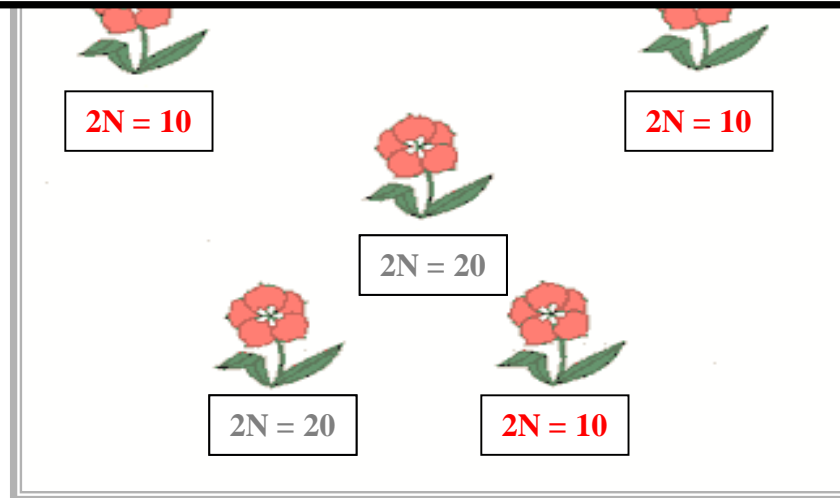
**CYTOTYPES MORPHOLOGICALLY IDENTICAL**

**NON-IDEAL  
SPECIES  
CRYPTIC SPECIES  
OUTCOME**

# CRYPTIC SPECIES



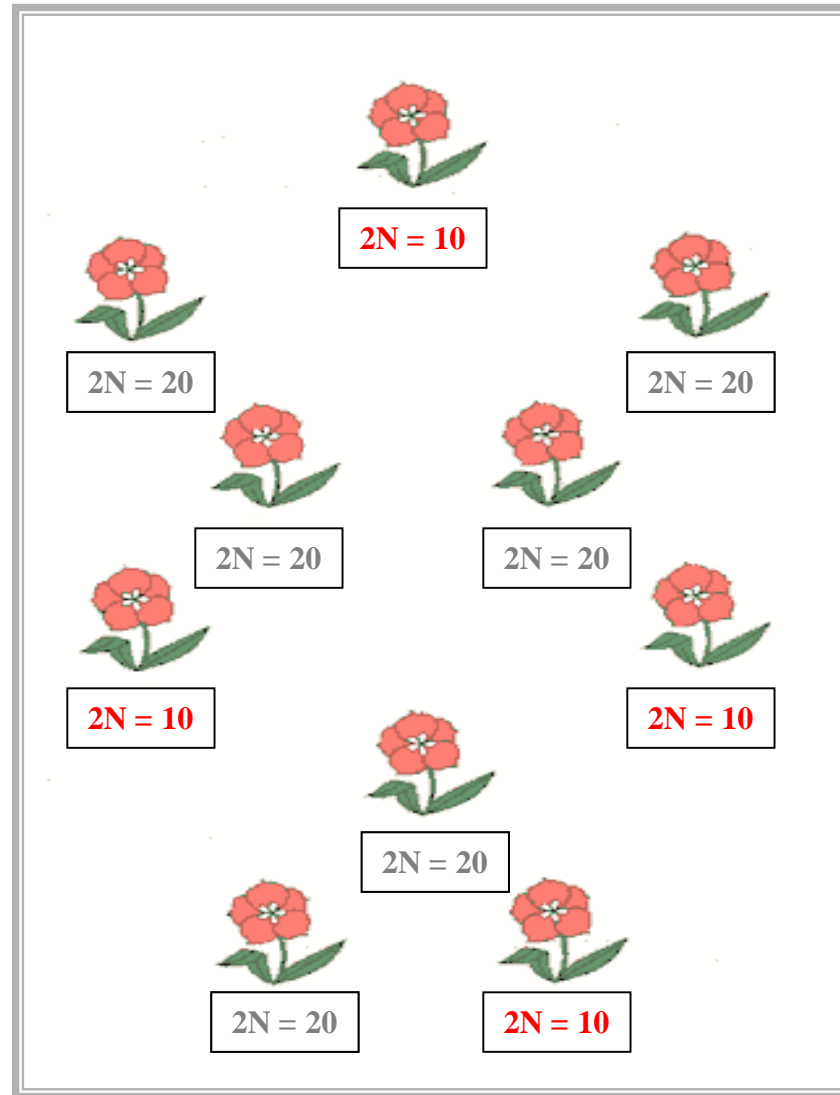
## SYMPATRIC POPULATIONS



# CRYPTIC SPECIES



# CRYPTIC SPECIES

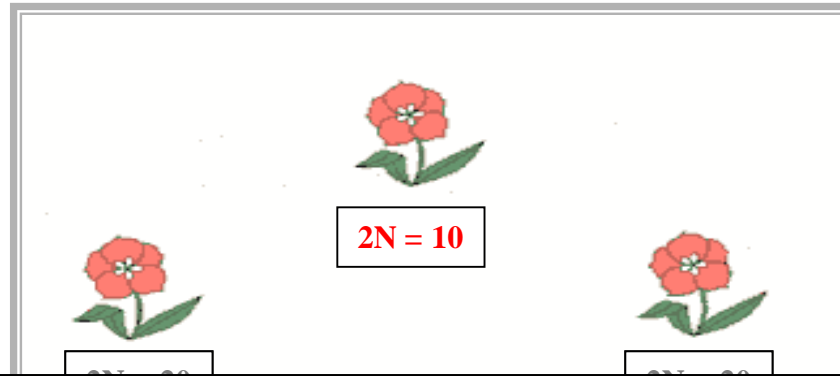


**SAME  
GEOGRAPHIC  
AREA**

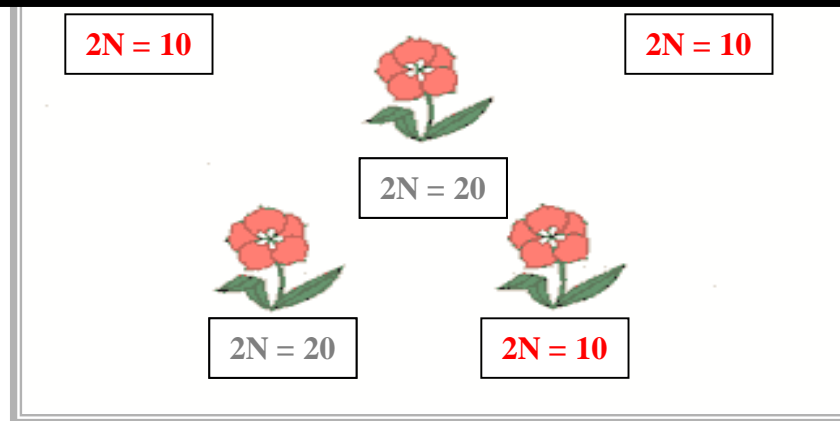
**SAME  
GEOGRAPHIC  
AREA**

# CRYPTIC SPECIES

# CRYPTIC SPECIES

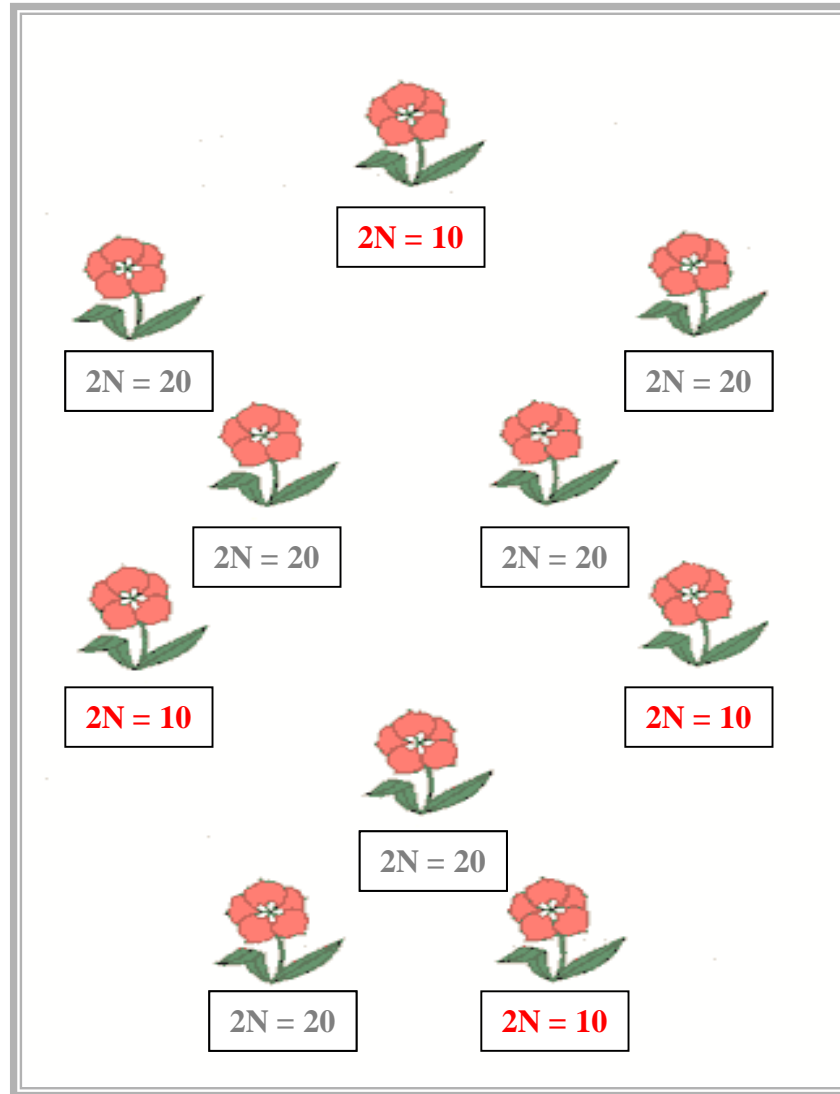


**MORPHOLOGICALLY  
IDENTICAL**



# CRYPTIC SPECIES

# CRYPTIC SPECIES

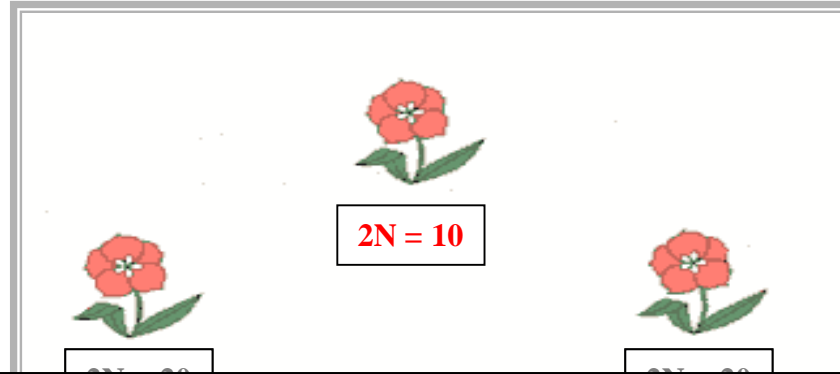


**SAME  
GEOGRAPHIC  
AREA**

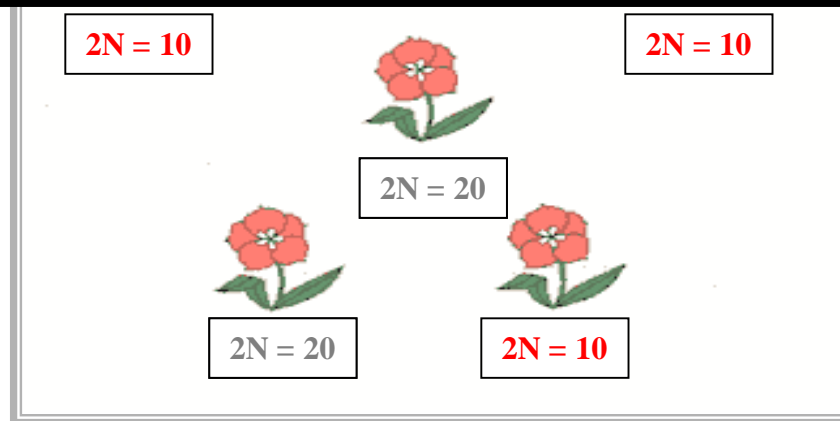
**SAME  
GEOGRAPHIC  
AREA**

# CRYPTIC SPECIES

# CRYPTIC SPECIES

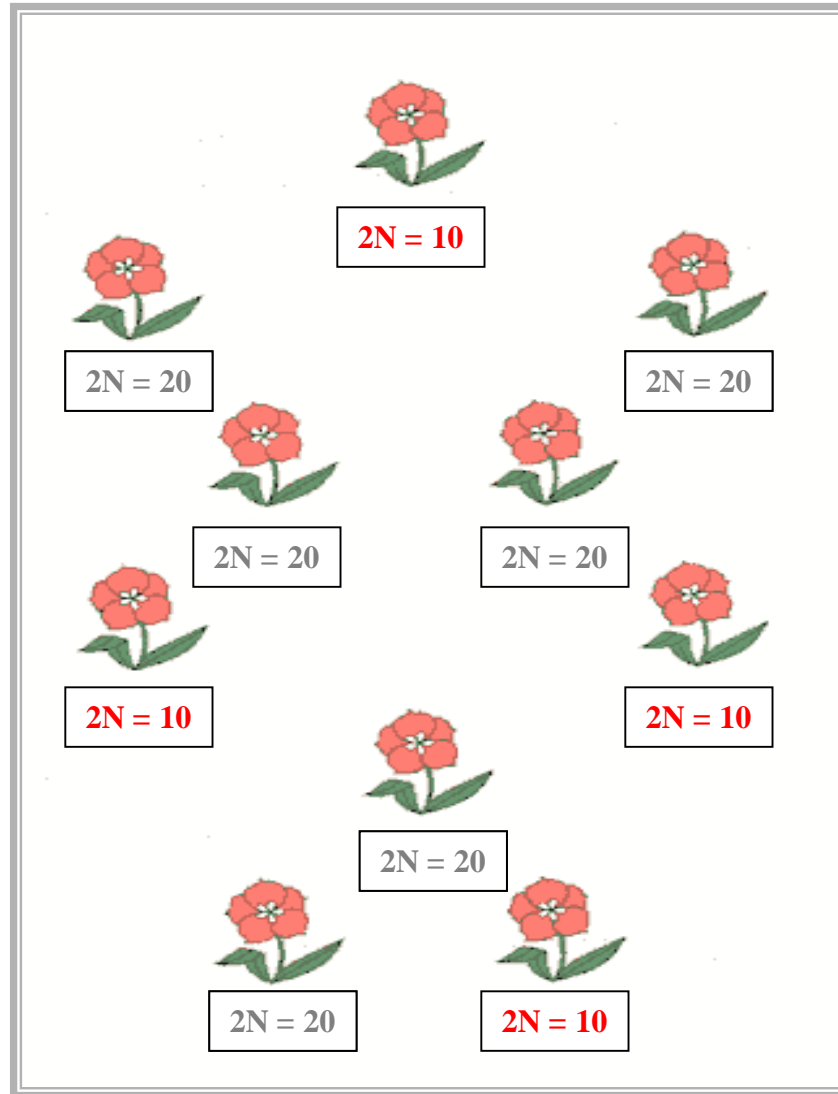


**REPRODUCTIVELY  
ISOLATED**



# CRYPTIC SPECIES

# CRYPTIC SPECIES

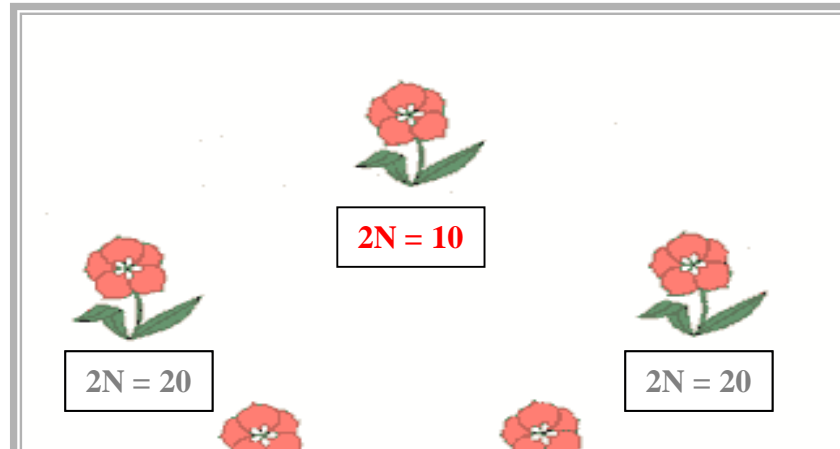


**SAME  
GEOGRAPHIC  
AREA**

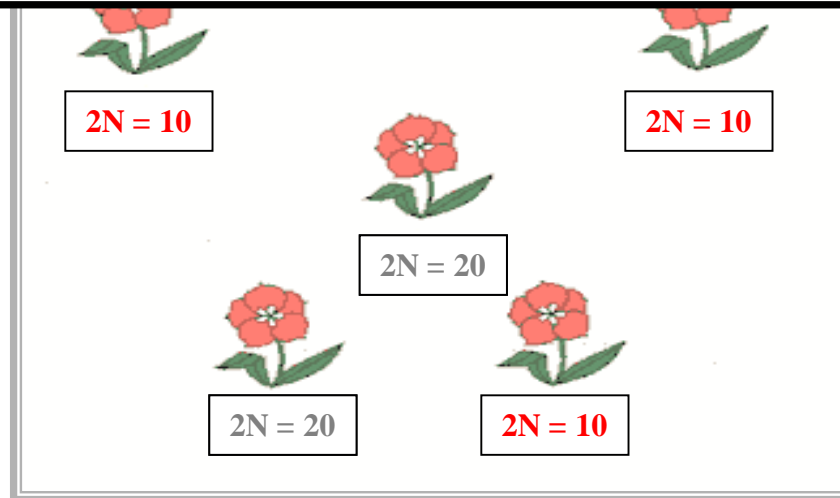
**SAME  
GEOGRAPHIC  
AREA**

# CRYPTIC SPECIES

# CRYPTIC SPECIES



# CRYPTIC SPECIES



# CRYPTIC SPECIES

# CRYPTIC SPECIES TAXONOMIC QUESTIONS

**QUESTION**

**HOW MANY SPECIES  
SHOULD BE  
RECOGNIZED?**

**QUESTION**

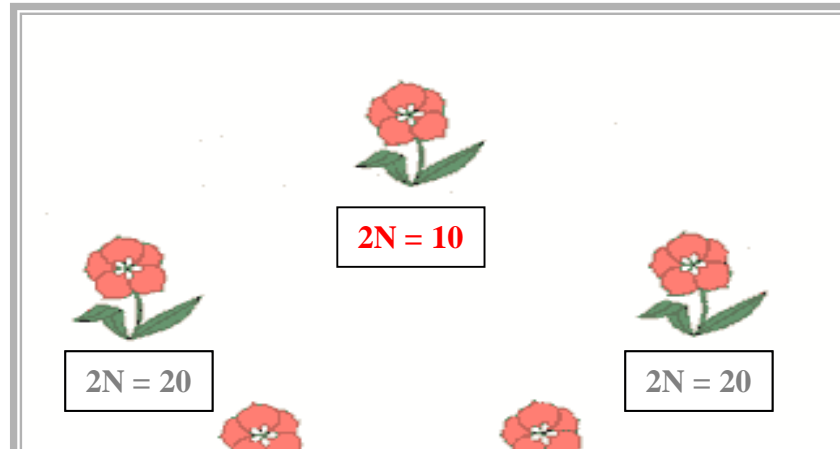


**ANSWER**  
**DEPENDS**  
**ON**  
**BOTANIST**  
**ANSWER**

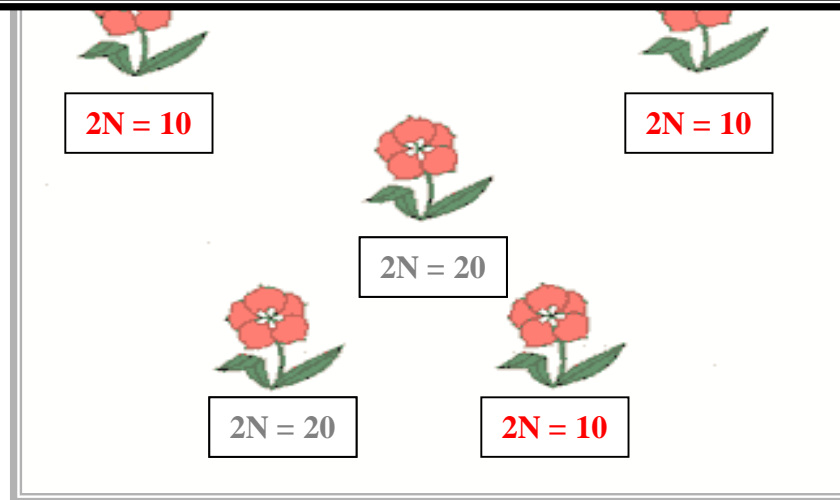


# **BIOLOGICAL SPECIES CONCEPT**

# CRYPTIC SPECIES



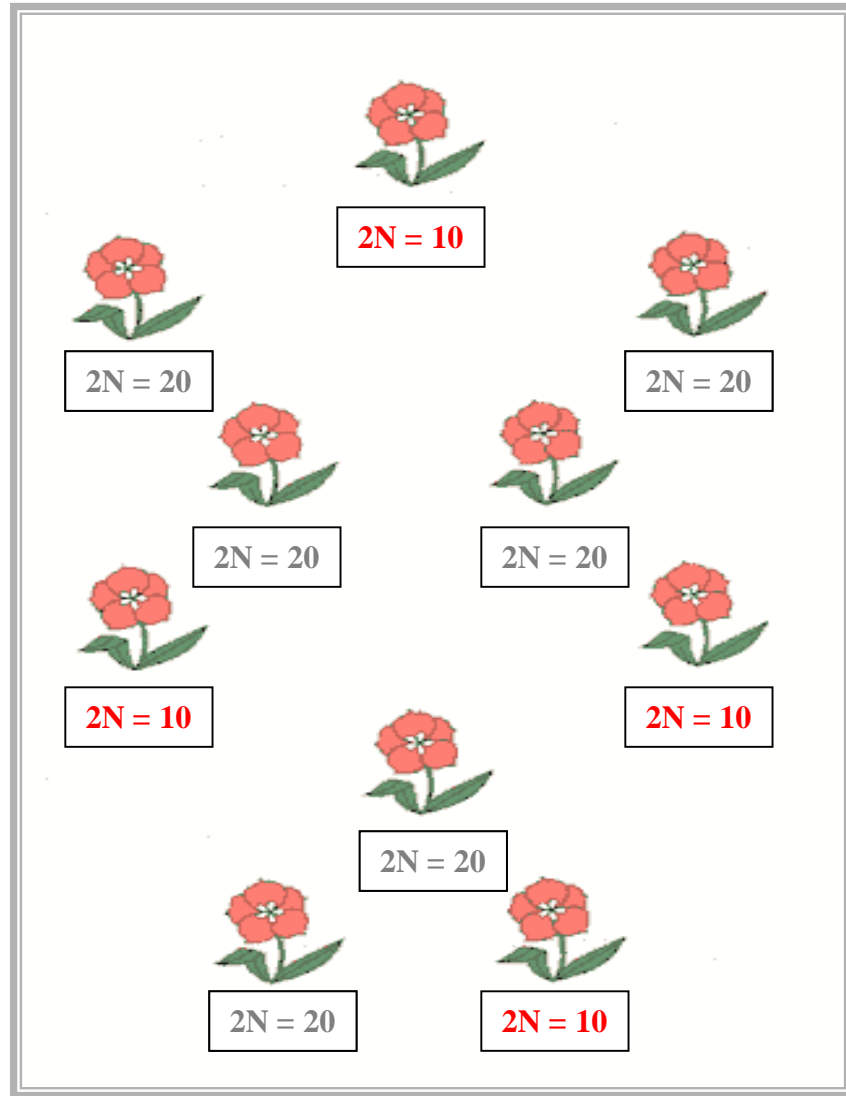
**ABILITY TO INTERBREED**



# CRYPTIC SPECIES

# CRYPTIC SPECIES

**SAME  
GEOGRAPHIC  
AREA**



**SAME  
GEOGRAPHIC  
AREA**

# CRYPTIC SPECIES

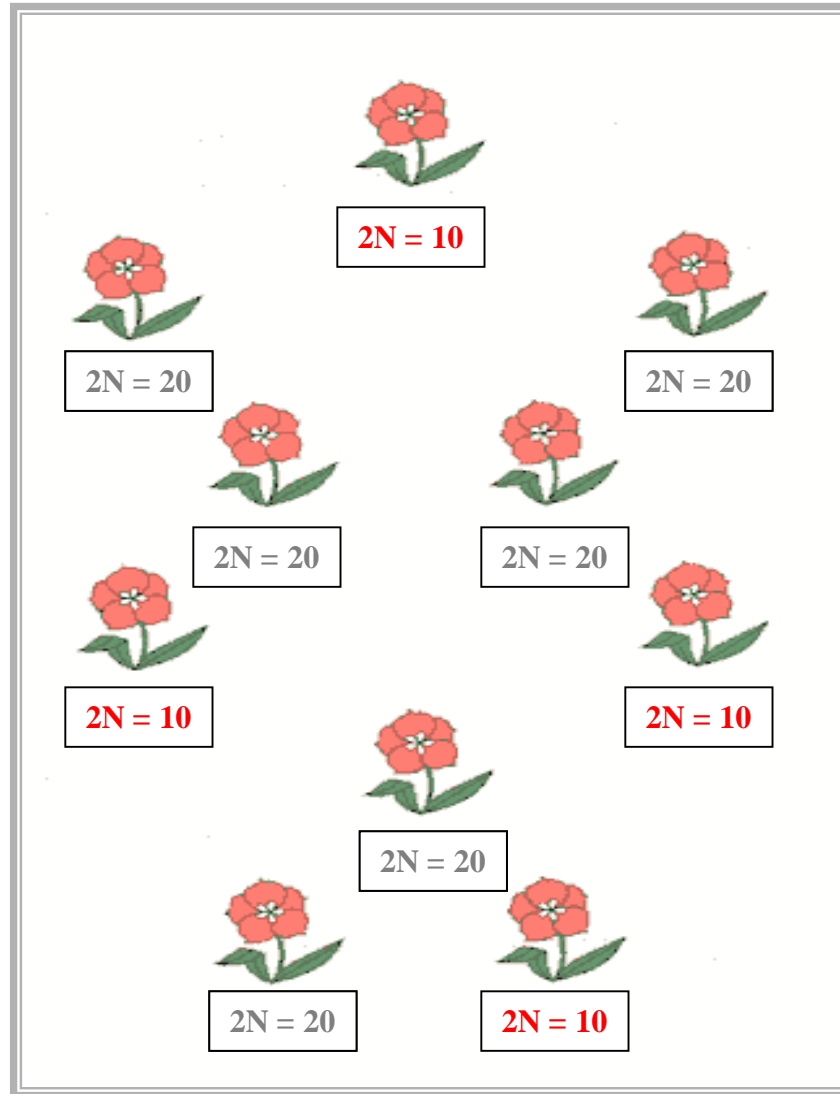


**QUESTION**

**HOW MANY SPECIES  
SHOULD BE  
RECOGNIZED?**

**QUESTION**

# CRYPTIC SPECIES

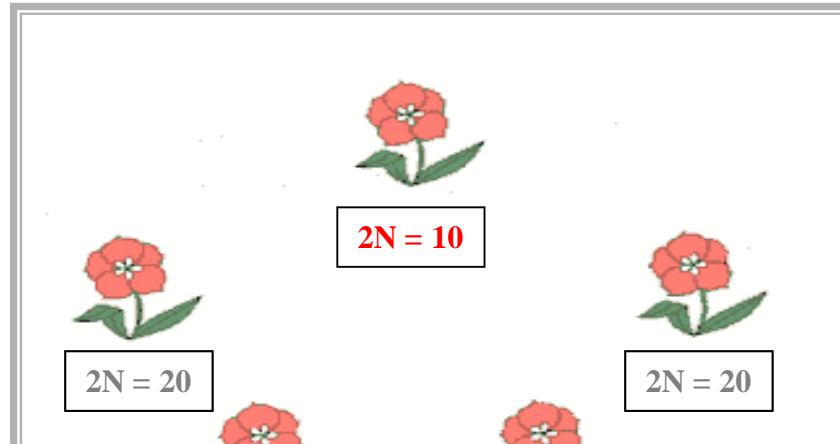


**SAME  
GEOGRAPHIC  
AREA**

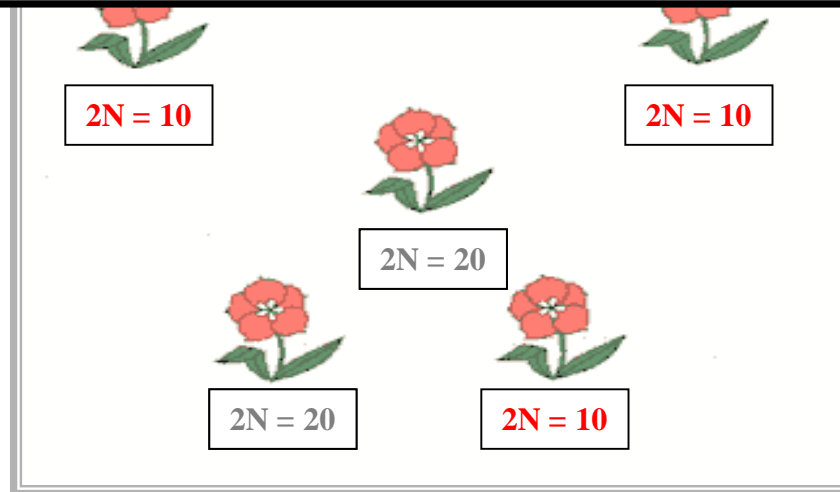
**SAME  
GEOGRAPHIC  
AREA**

# CRYPTIC SPECIES

# CRYPTIC SPECIES



**2 SPECIES**



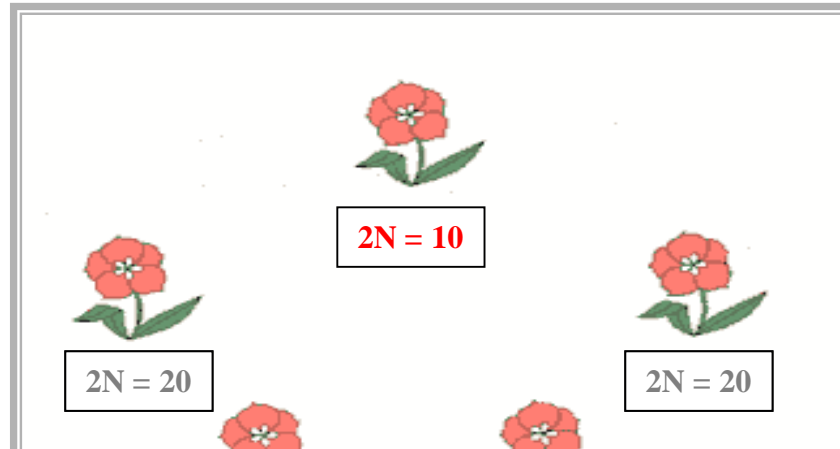
# CRYPTIC SPECIES



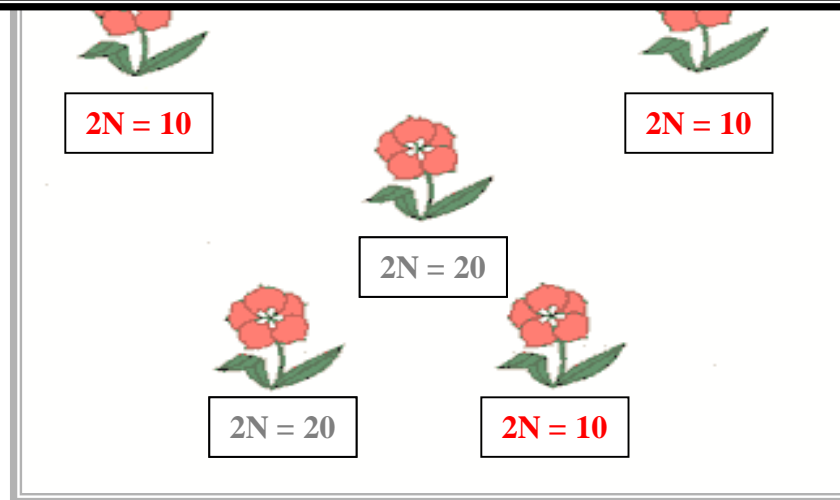
# **MORPHOLOGICAL SPECIES CONCEPT**



# CRYPTIC SPECIES



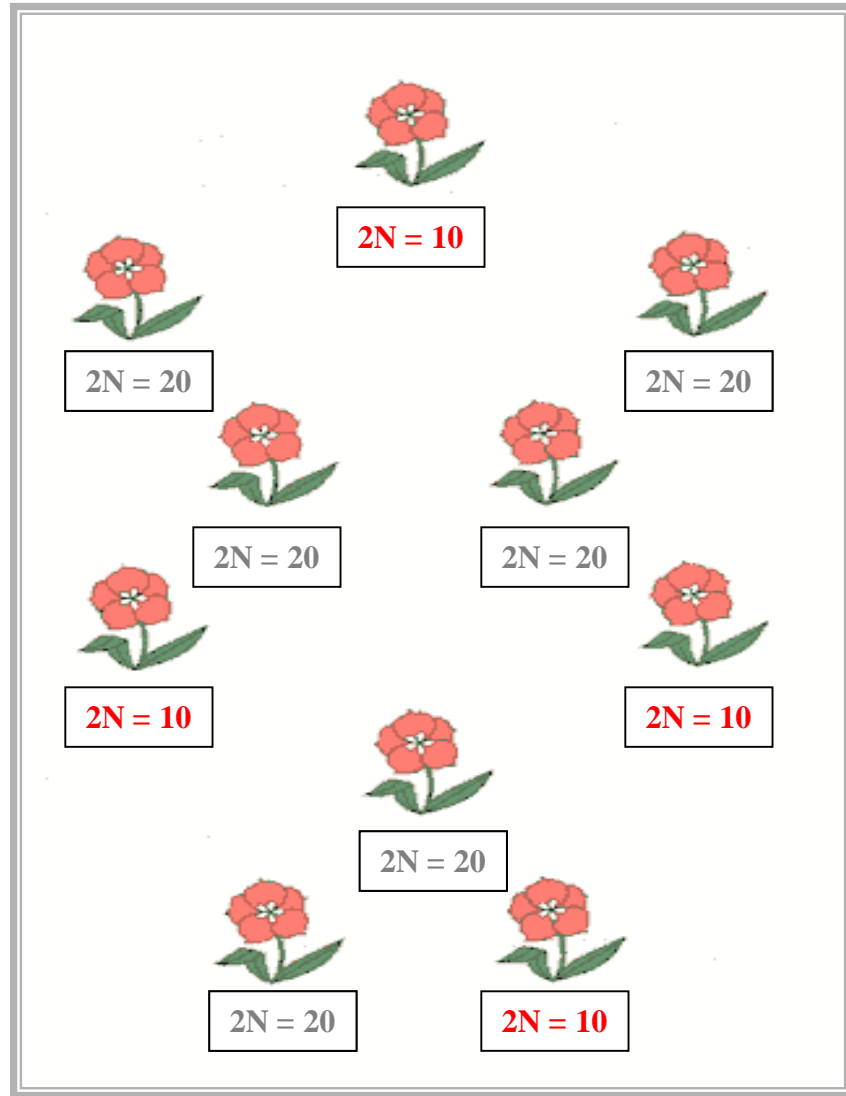
**STRUCTURALLY SIMILAR**



# CRYPTIC SPECIES

# CRYPTIC SPECIES

SAME  
GEOGRAPHIC  
AREA



SAME  
GEOGRAPHIC  
AREA

# CRYPTIC SPECIES

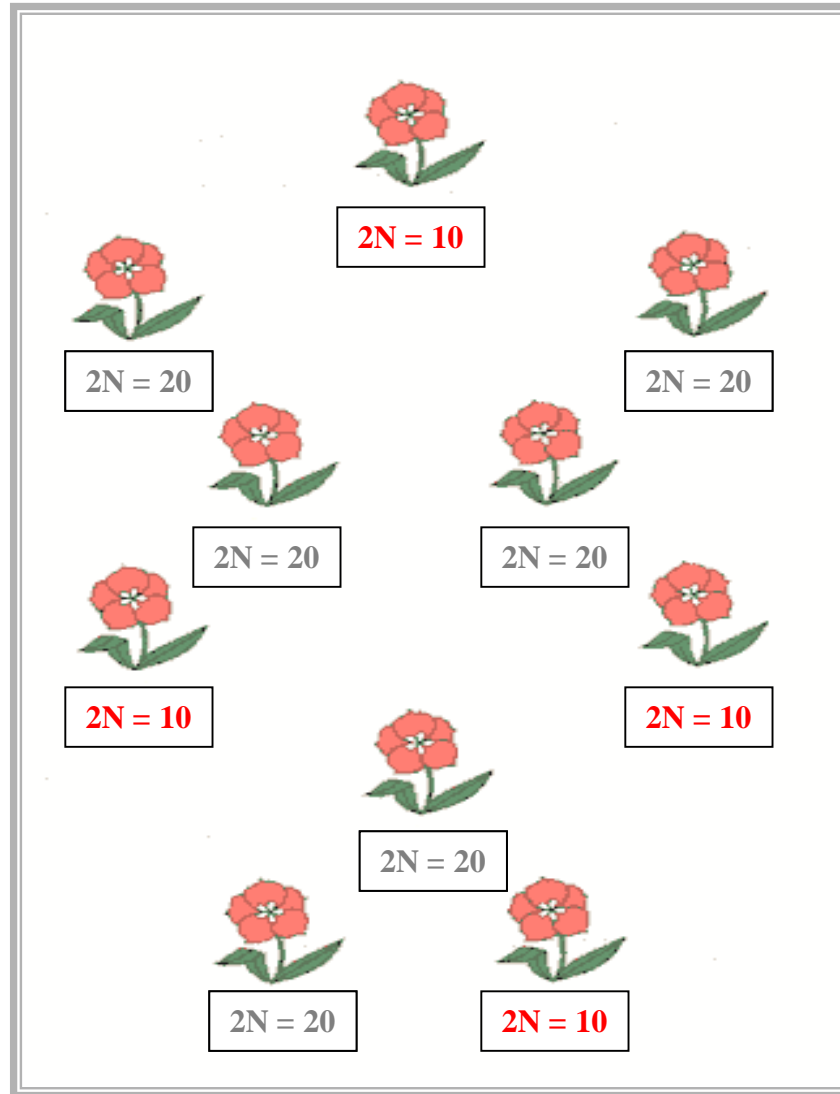


**QUESTION**

**HOW MANY SPECIES  
SHOULD BE  
RECOGNIZED?**

**QUESTION**

# CRYPTIC SPECIES



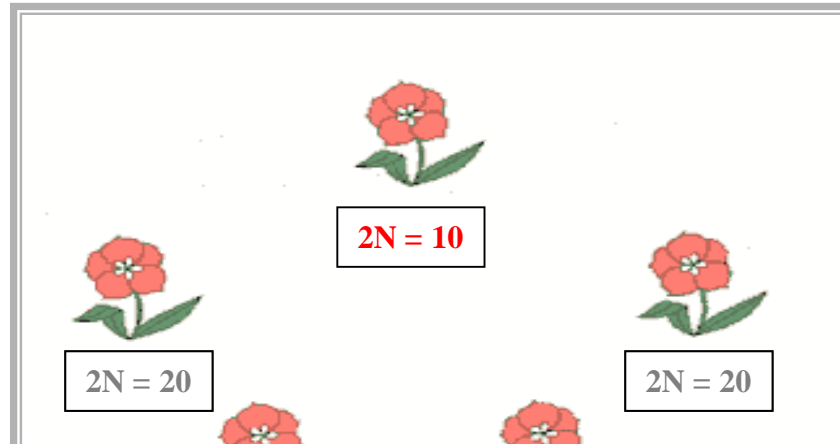
**SAME  
GEOGRAPHIC  
AREA**

**SAME  
GEOGRAPHIC  
AREA**

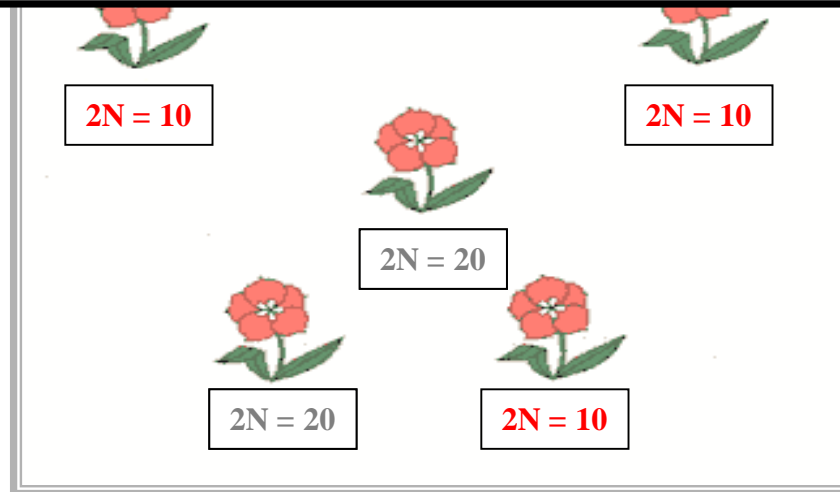
# CRYPTIC SPECIES



# CRYPTIC SPECIES



**1 SPECIES**



# CRYPTIC SPECIES

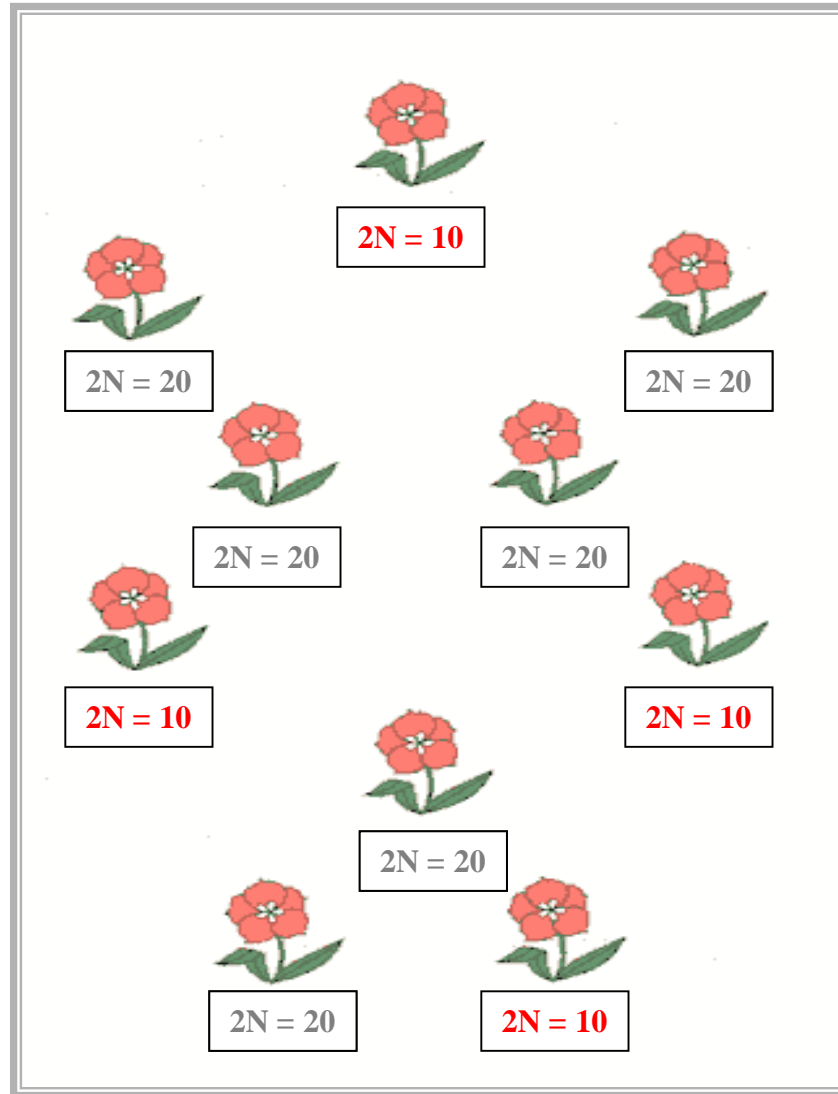


**QUESTION**

**WHICH SPECIES  
CONCEPT IS MORE  
PRACTICAL?**

**QUESTION**

# CRYPTIC SPECIES



**SAME  
GEOGRAPHIC  
AREA**

**SAME  
GEOGRAPHIC  
AREA**

**CRYPTIC SPECIES**

**ANSWER**

**MORPHOLOGICAL**

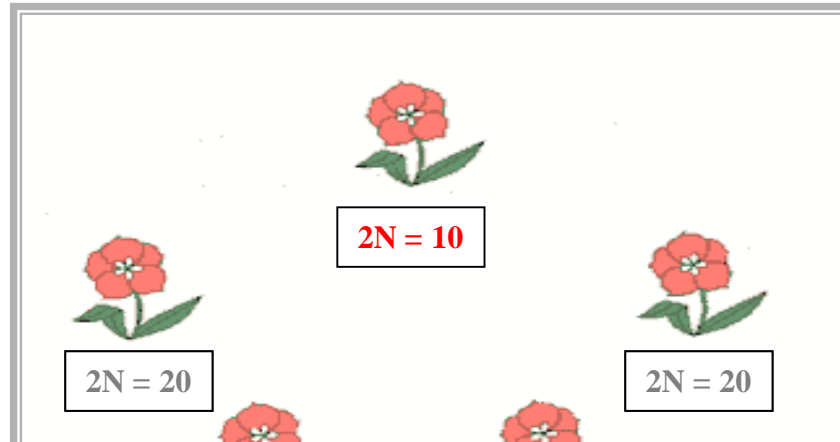
**SPECIES**

**CONCEPT**

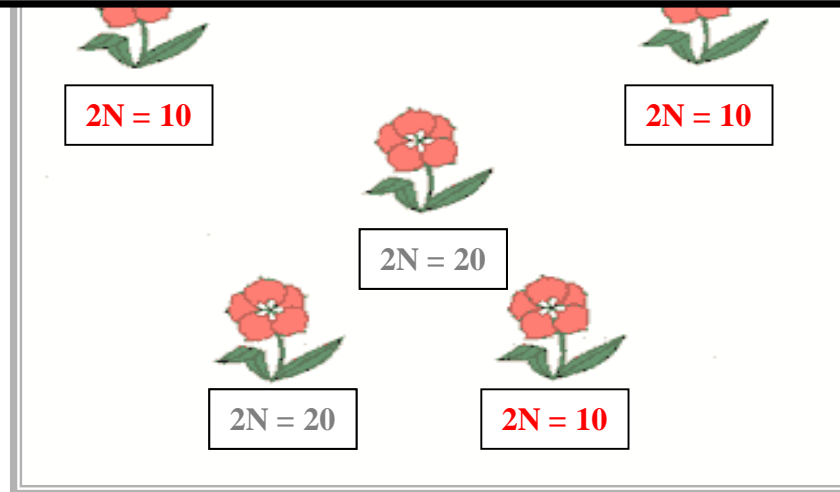
**ANSWER**



# CRYPTIC SPECIES



**1 SPECIES**



# CRYPTIC SPECIES

**BOTANY**

**SPECIES CONCEPT**

**VS**

**ZOOLOGY**

**SPECIES CONCEPT**



# ZOOLOGY

# SPECIES CONCEPT

**B**

**ZOOLOGISTS PREFER**

A photograph of a herd of bison in a grassy field. Two bison are in the foreground, facing each other, with several others in the background. The scene is lit with warm, golden light, suggesting late afternoon or early morning.

# **BIOLOGICAL SPECIES CONCEPT**



# **BOTANY**

# **SPECIES CONCEPT**



**BOTANIST PREFER**



**MORPHOLOGICAL SPECIES CONCEPT**





# TRACHEOPHYTE CHARACTERS



# TRACHEOPHYTE ANATOMY

# VASCULAR TISSUE

# **VASCULAR TISSUE**



**VASCULAR TISSUE**

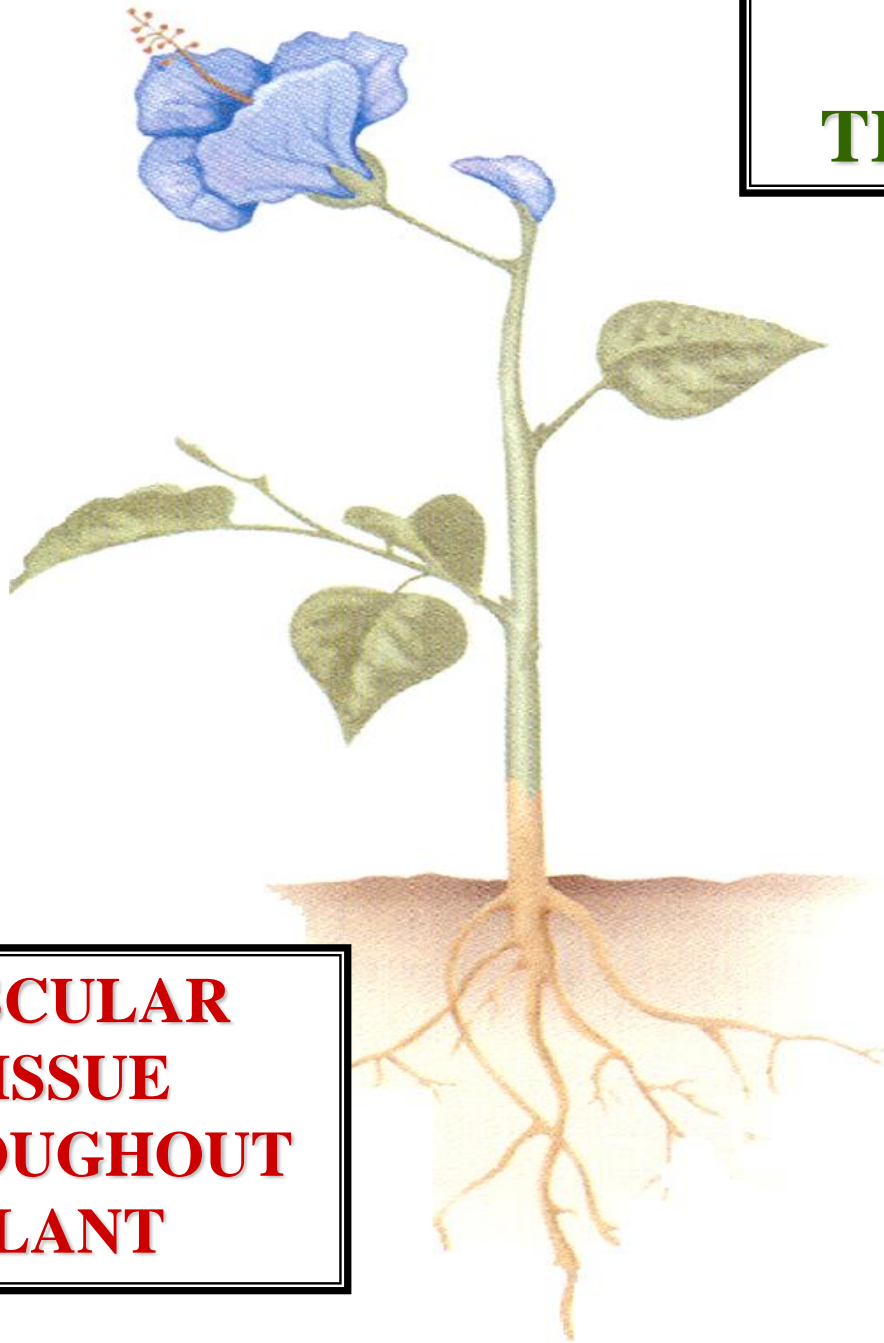
**CONDUCTING TISSUE**

**VASCULAR TISSUE**

# TYPICAL TRACHEOPHYTE

L

**VASCULAR  
TISSUE  
THROUGHOUT  
PLANT**

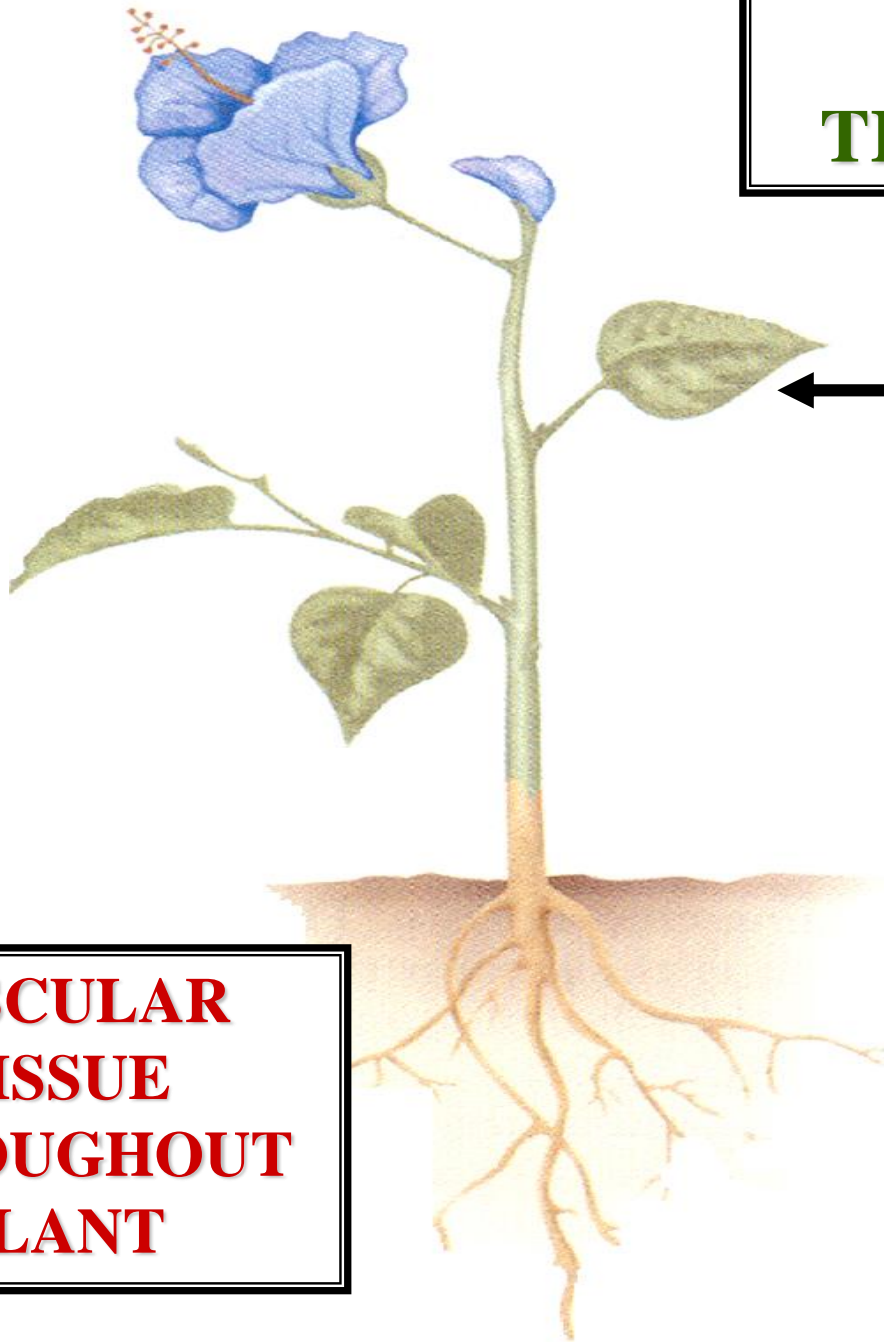


**TYPICAL  
TRACHEOPHYTE**

**S**

**LEAF**

**VASCULAR  
TISSUE  
THROUGHOUT  
PLANT**



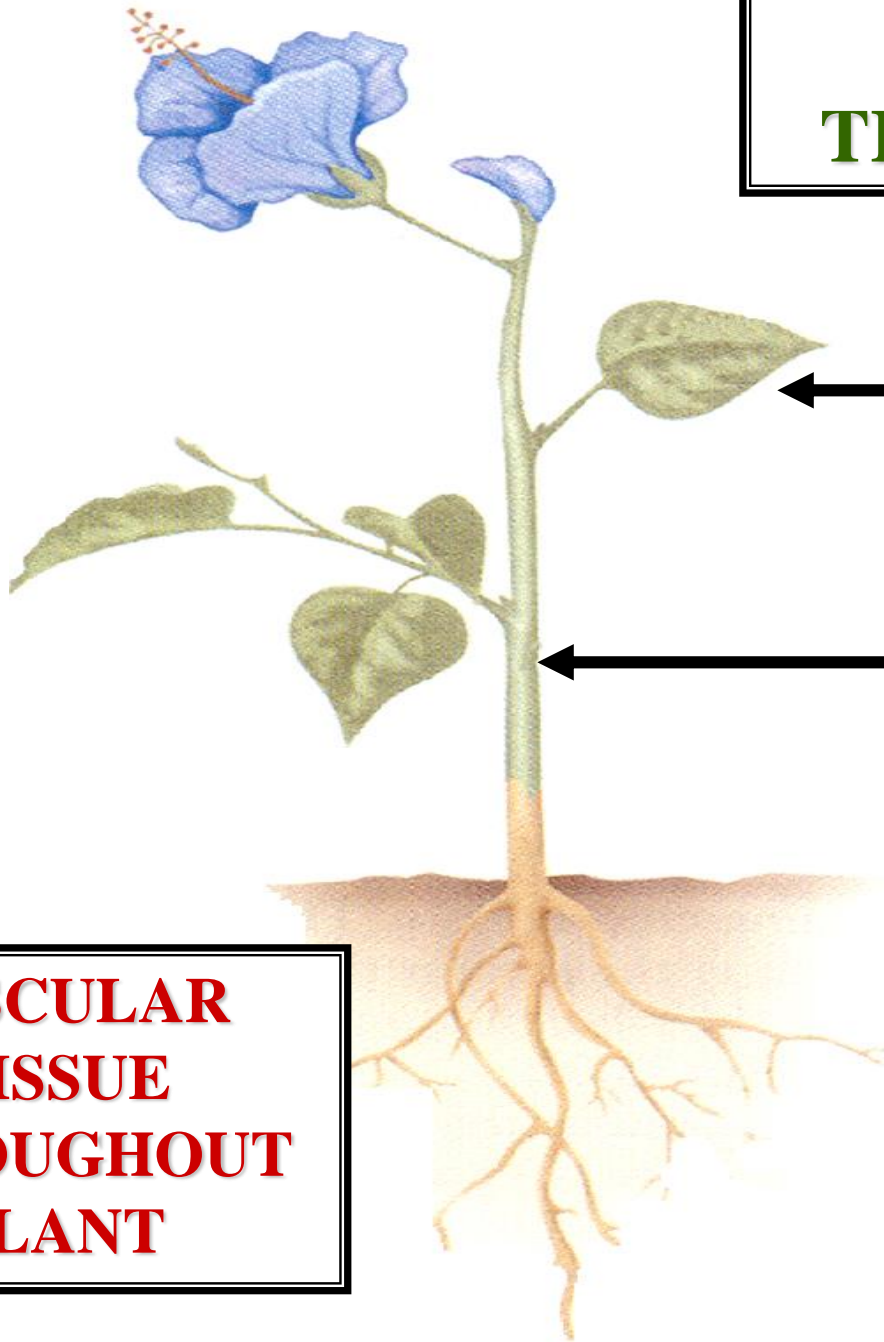
# TYPICAL TRACHEOPHYTE

R

← **LEAF**

← **STEM**

**VASCULAR  
TISSUE  
THROUGHOUT  
PLANT**





# TYPICAL TRACHEOPHYTE

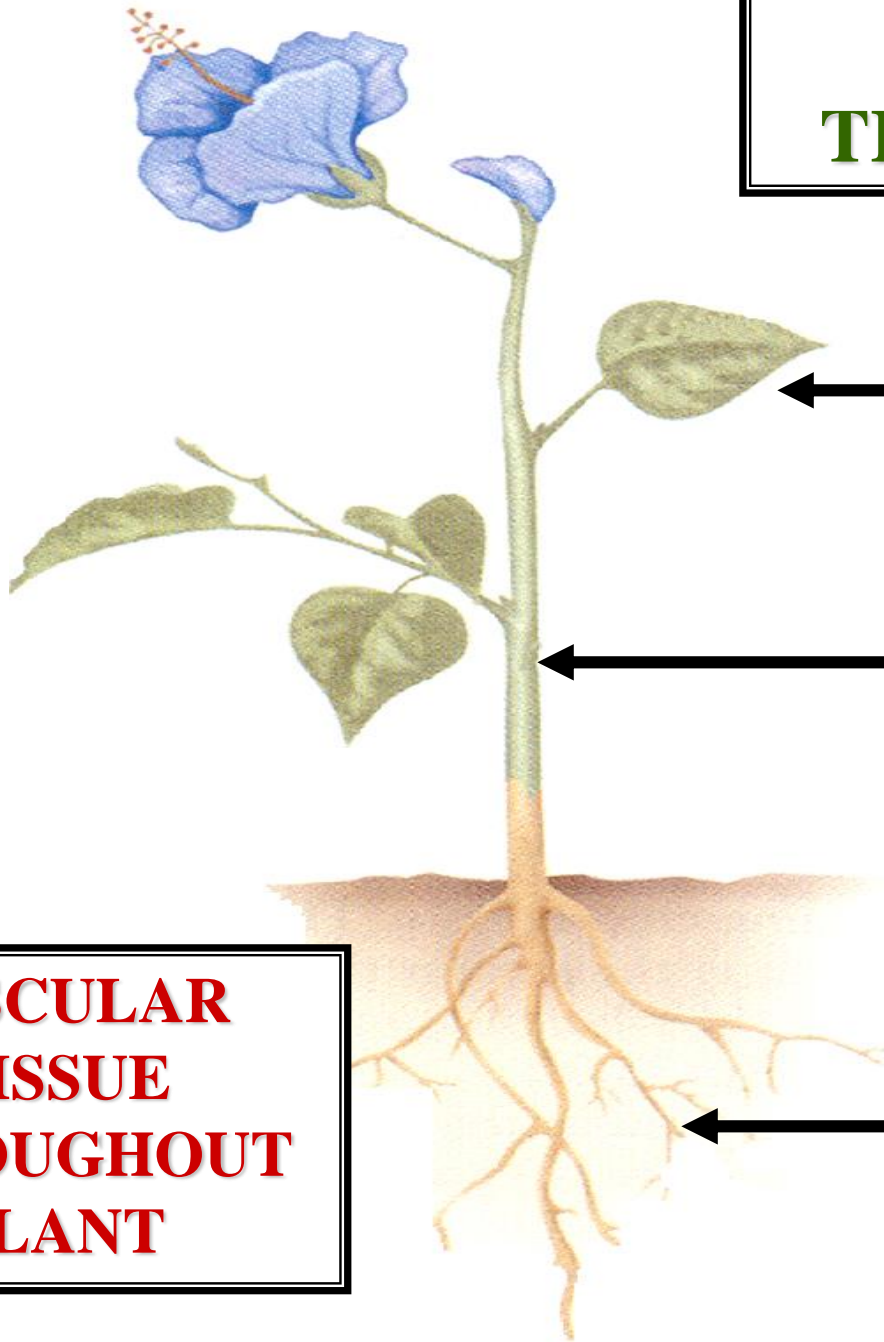


**LEAF**

**STEM**

**ROOT**

**VASCULAR  
TISSUE  
THROUGHOUT  
PLANT**

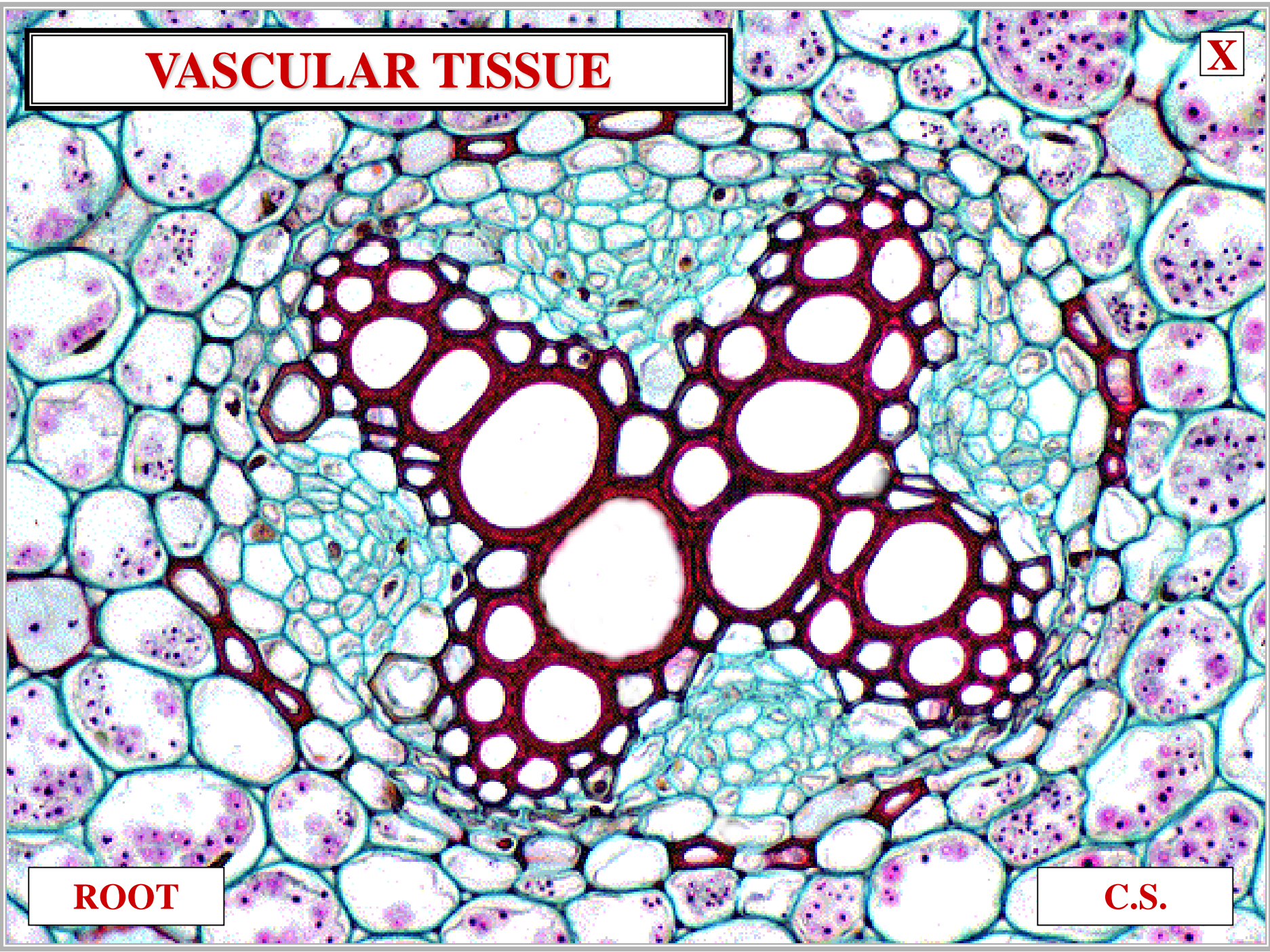


# VASCULAR TISSUE

X

ROOT

C.S.



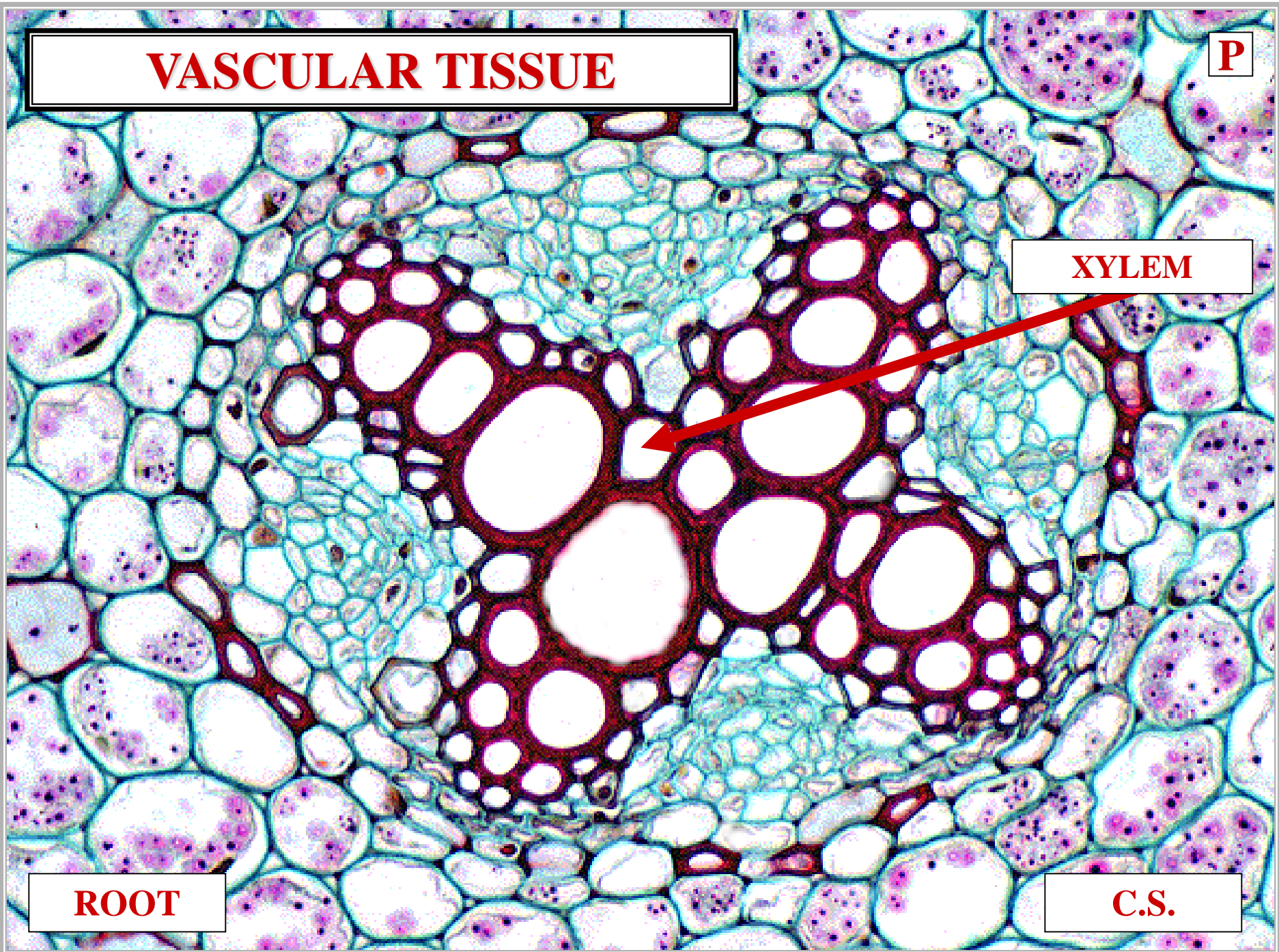
# VASCULAR TISSUE

P

XYLEM

ROOT

C.S.



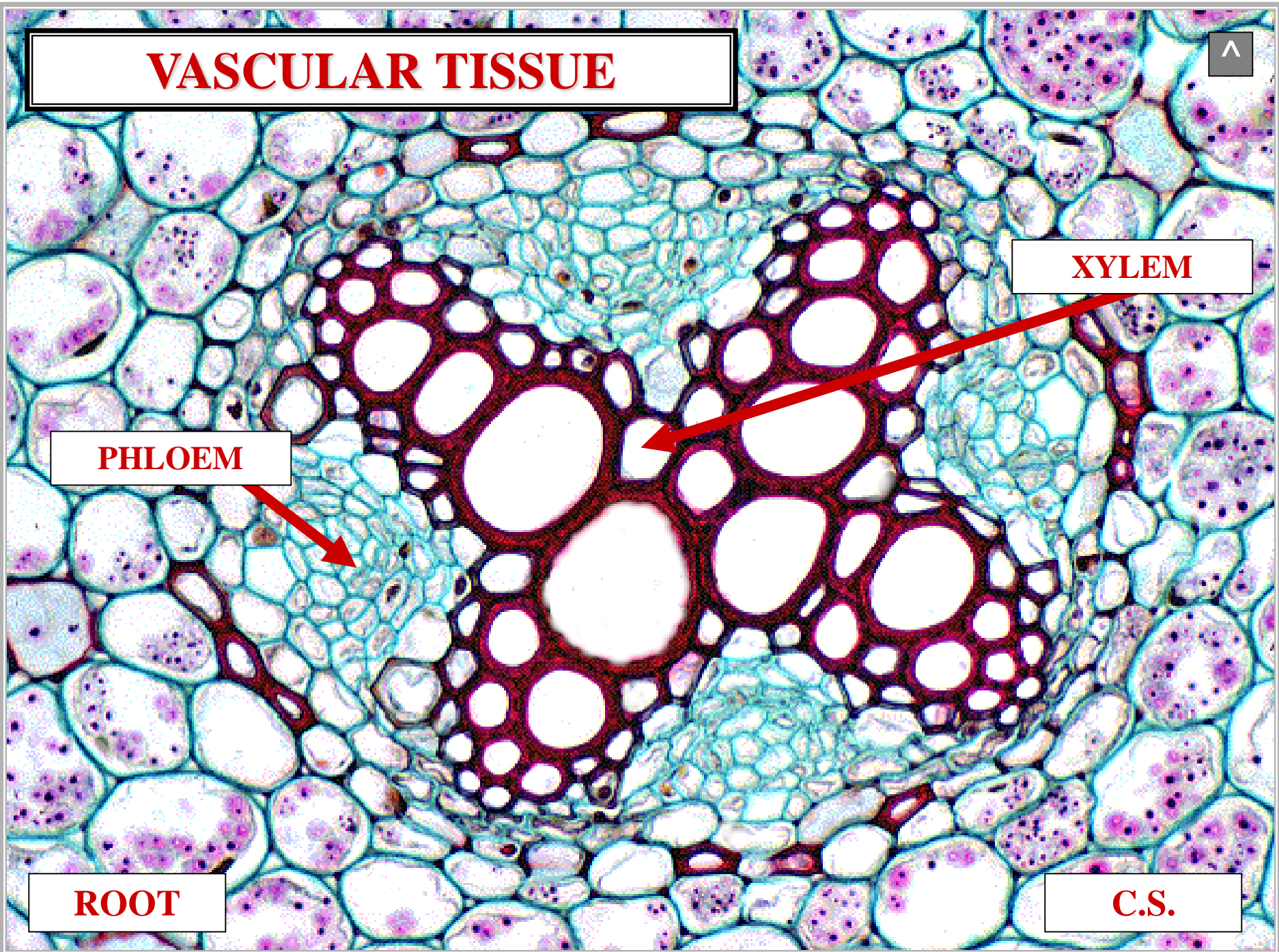
# VASCULAR TISSUE

XYLEM

PHLOEM

ROOT

C.S.



**XYLEM**

**VASCULAR TISSUE**

# **XYLEM TISSUE**

# VASCULAR TISSUE

## XYLEM



CONDUCTS WATER

# VASCULAR TISSUE

## XYLEM

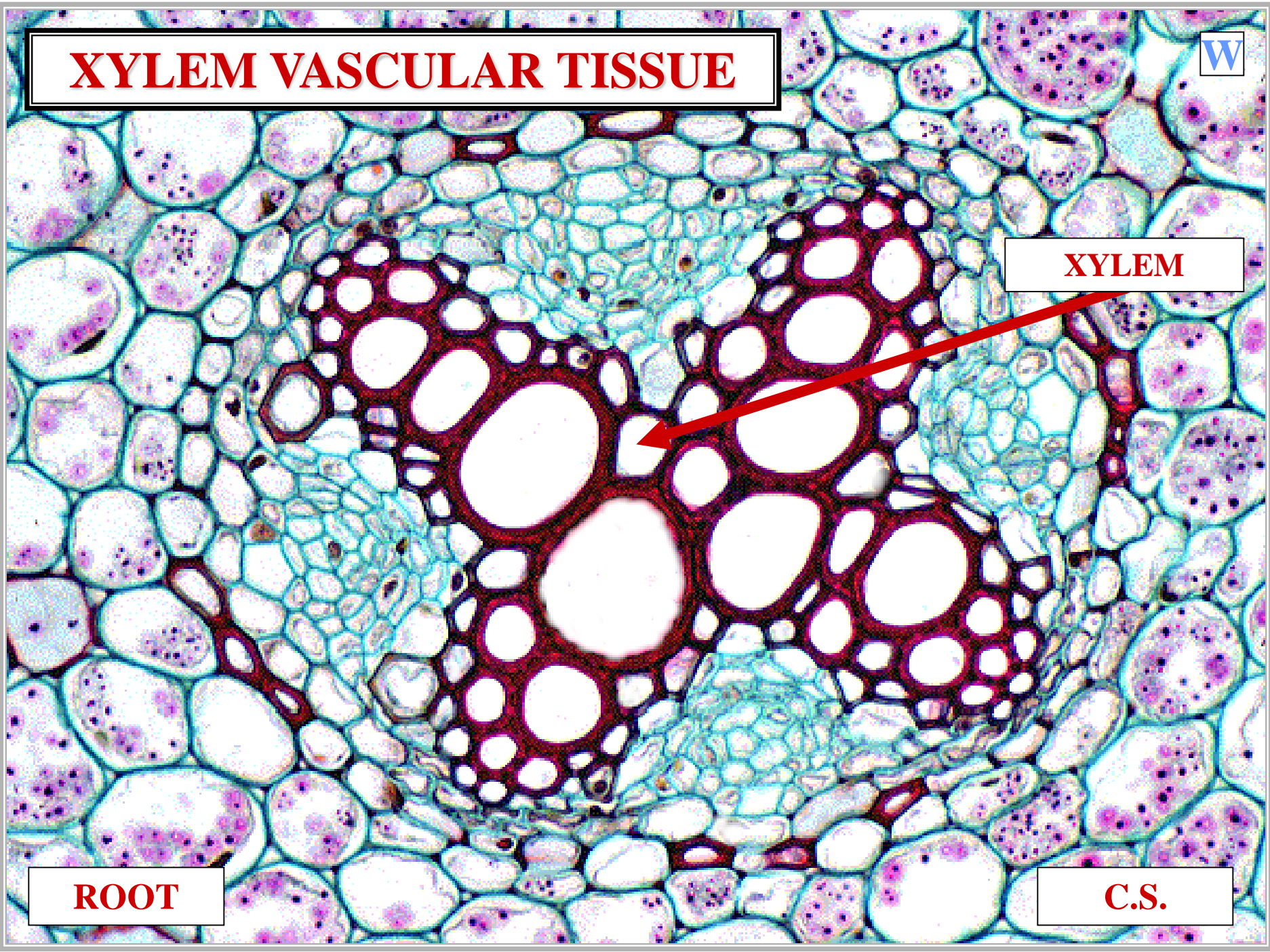
# XYLEM VASCULAR TISSUE

W

XYLEM

ROOT

C.S.





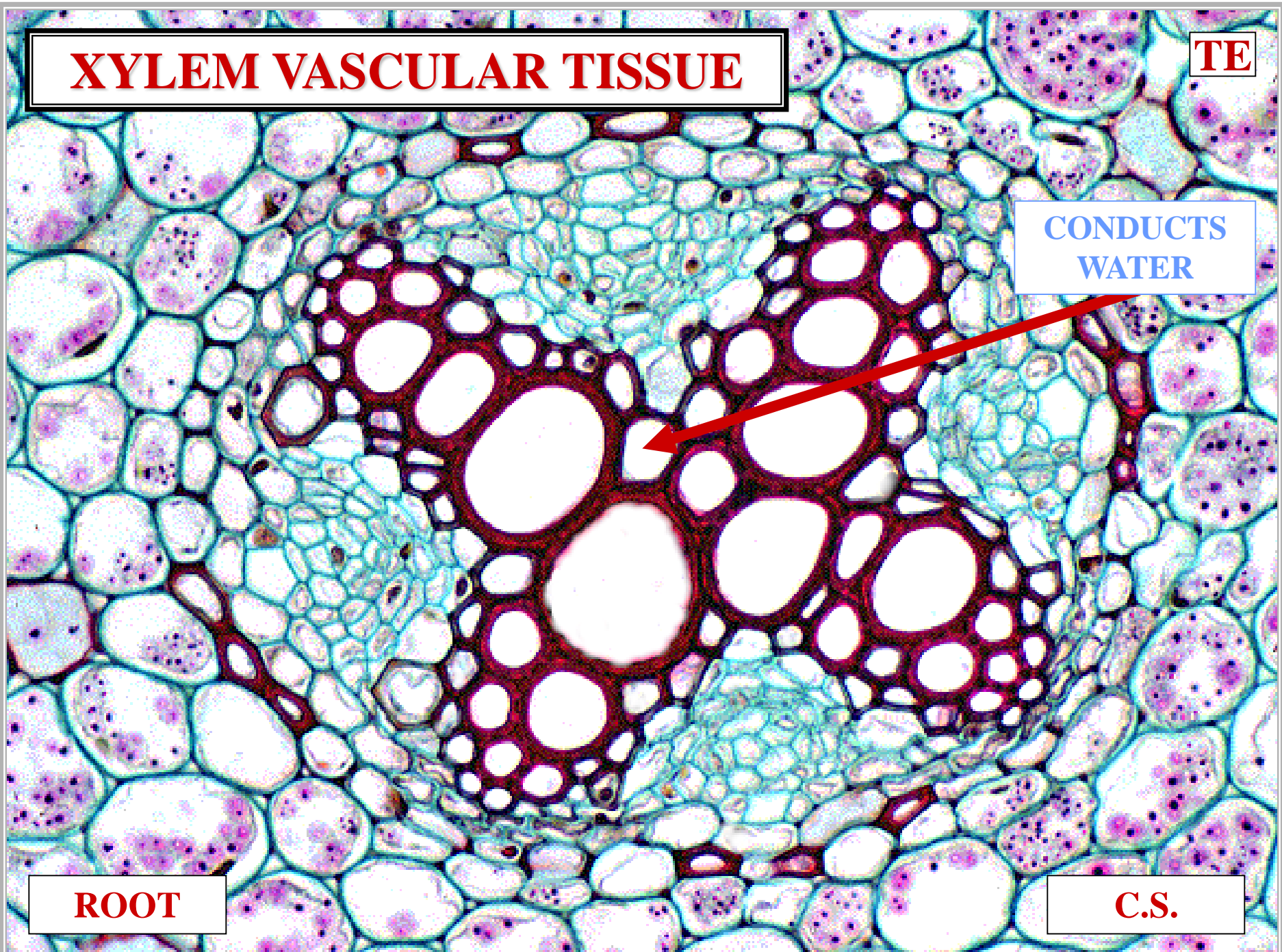
# XYLEM VASCULAR TISSUE

TE

CONDUCTS  
WATER

ROOT

C.S.

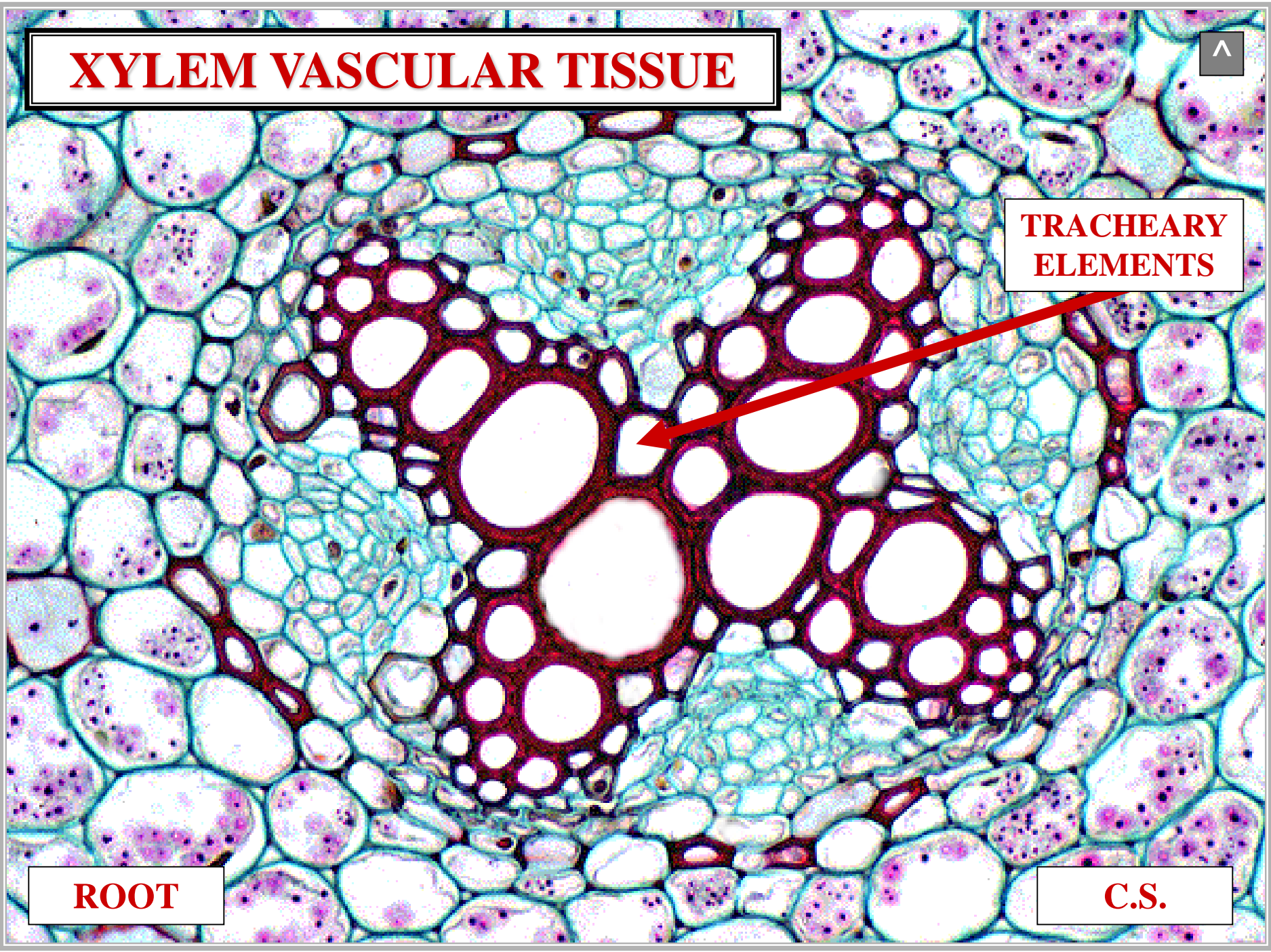


# XYLEM VASCULAR TISSUE

TRACHEARY  
ELEMENTS

ROOT

C.S.



# TRACHEARY ELEMENTS

# **TRACHEARY ELEMENTS**



**XYLEM**

**TRACHEARY ELEMENTS**

**WATER**

**CONDUCTING**

**CELLS**

**XYLEM**

**TRACHEARY ELEMENTS**



**TE**

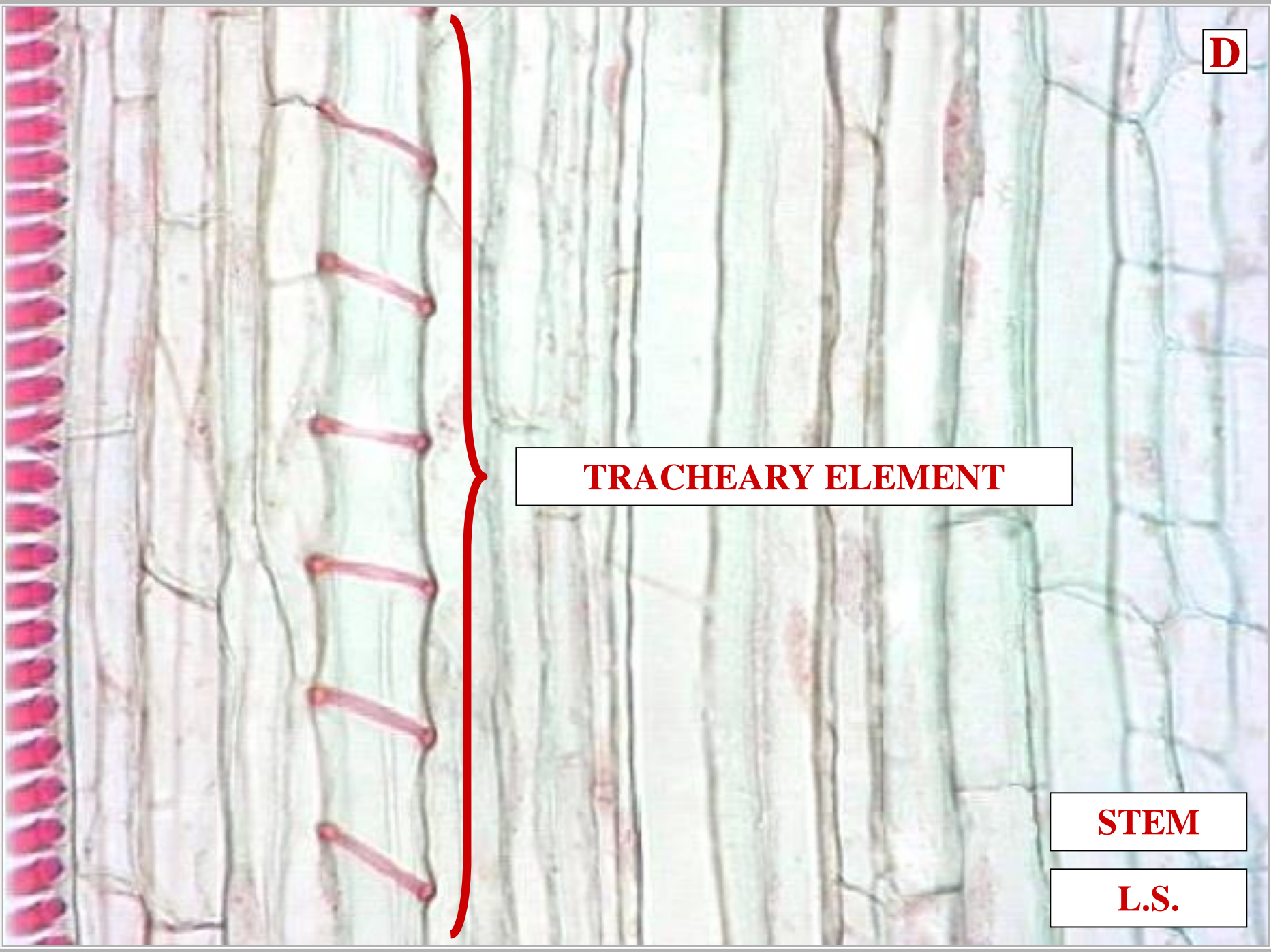
# TRACHEARY ELEMENT CHARACTERS

**D**

**TRACHEARY ELEMENT**

**STEM**

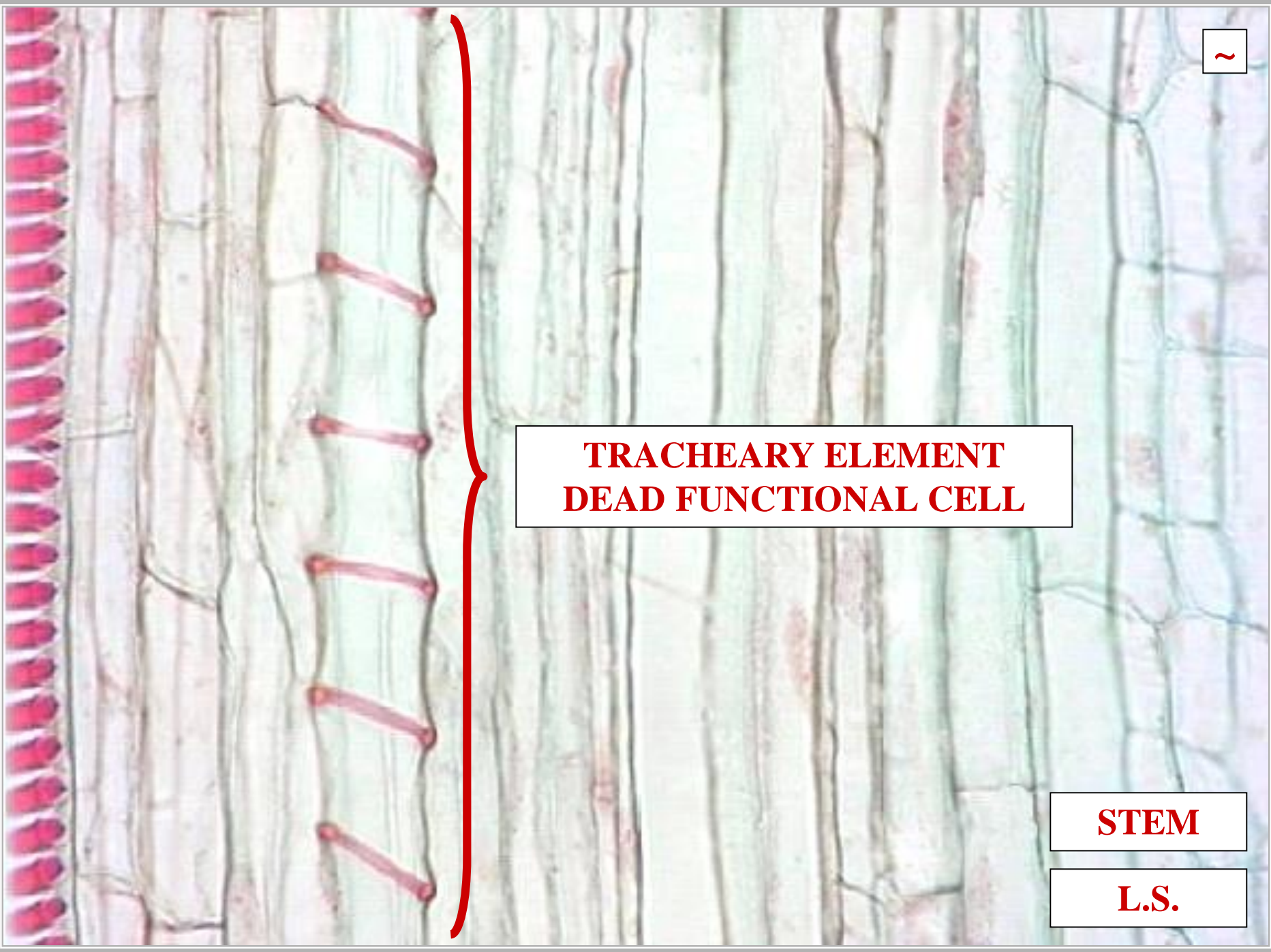
**L.S.**



**TRACHEARY ELEMENT  
DEAD FUNCTIONAL CELL**

**STEM**

**L.S.**



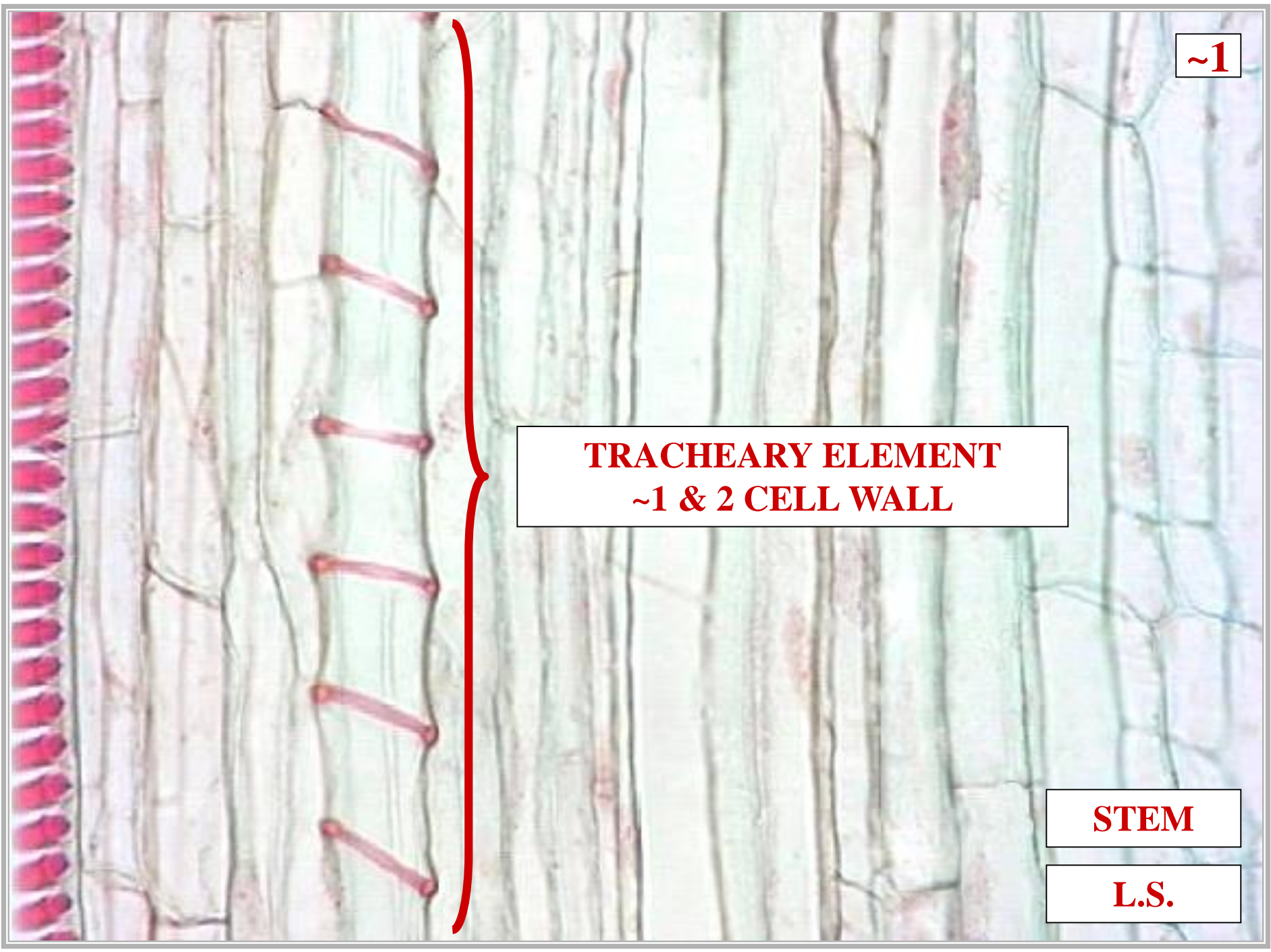


~1

**TRACHEARY ELEMENT  
~1 & 2 CELL WALL**

**STEM**

**L.S.**

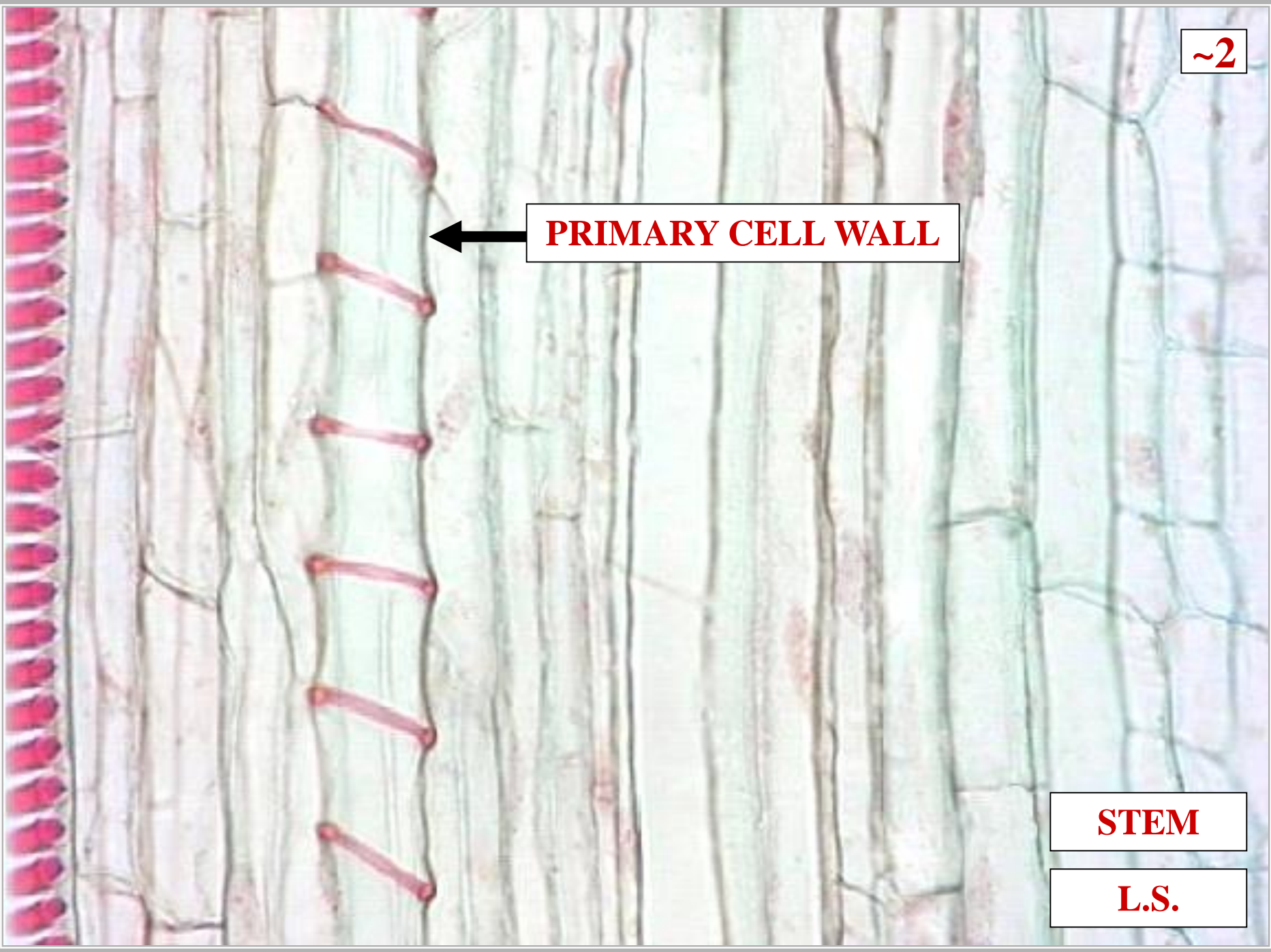


**PRIMARY CELL WALL**



**STEM**

**L.S.**



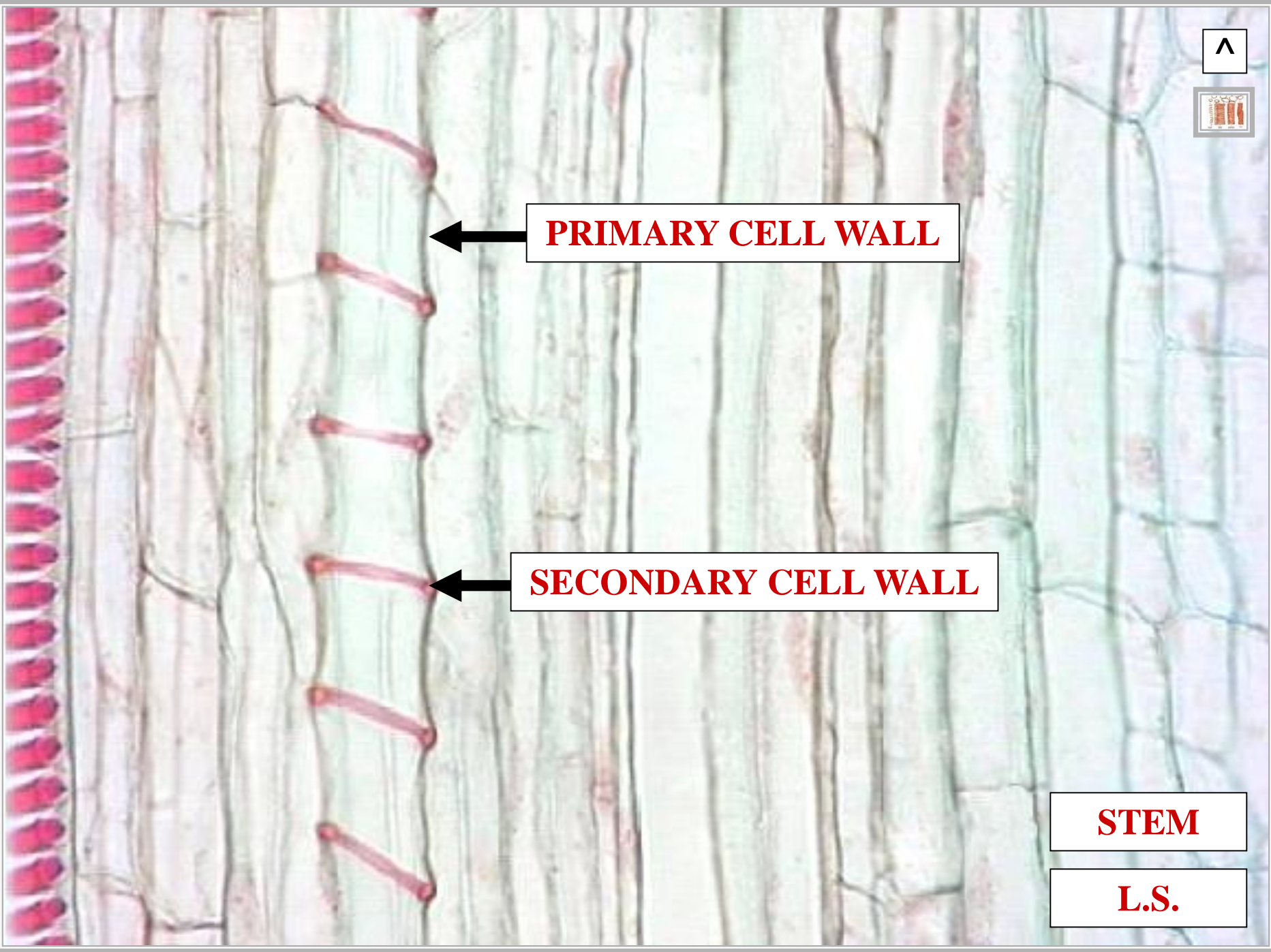


**PRIMARY CELL WALL**

**SECONDARY CELL WALL**

**STEM**

**L.S.**

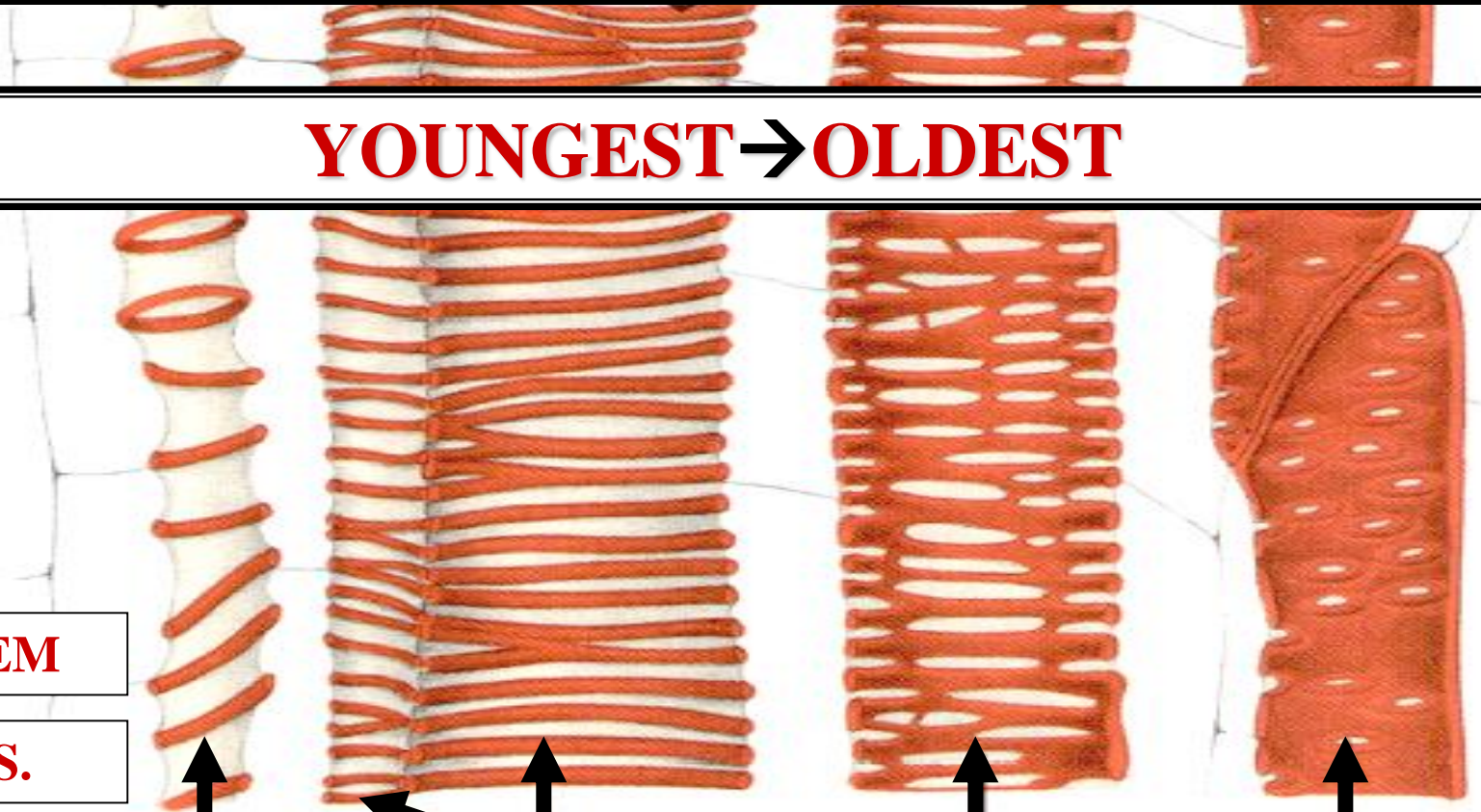




**XYLEM  
SECONDARY  
CELL WALL  
---  
MATURATION  
PATTERN**

# XYLEM SECONDARY CELL WALL MATURATION PATTERN

YOUNGEST → OLDEST



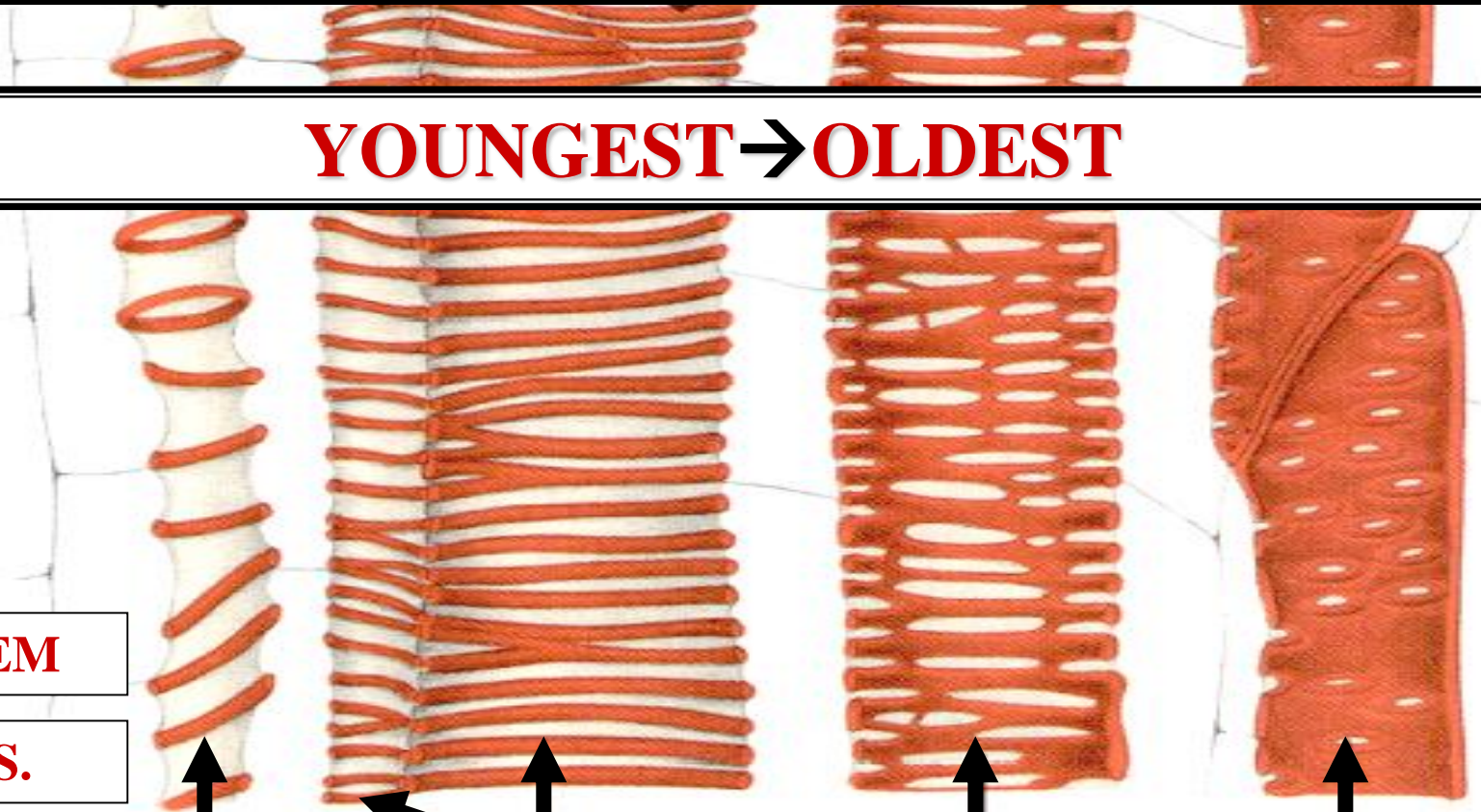
STEM

L.S.



# XYLEM SECONDARY CELL WALL MATURATION PATTERN

YOUNGEST → OLDEST



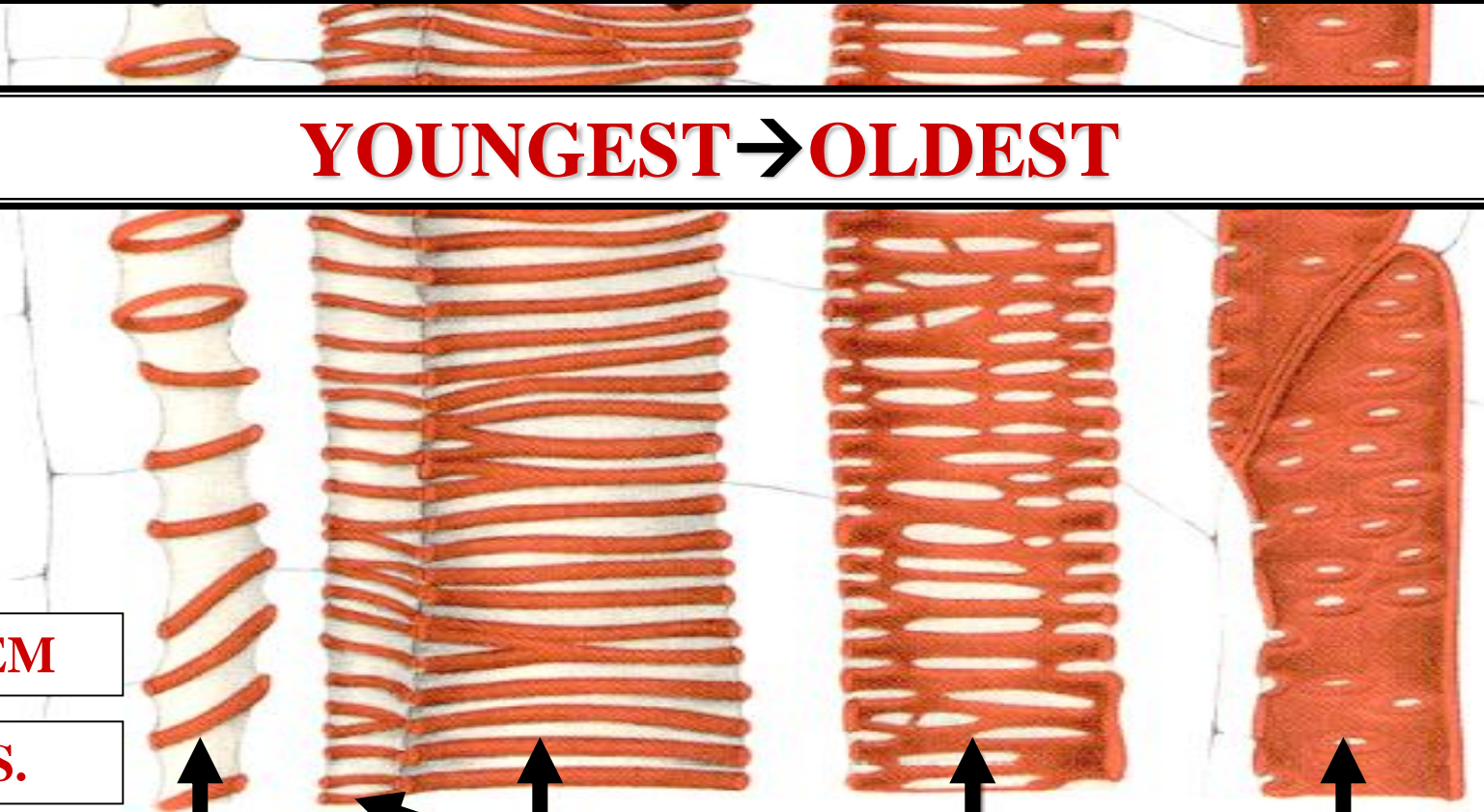
STEM

L.S.

ANNULAR

# XYLEM SECONDARY CELL WALL MATURATION PATTERN

YOUNGEST → OLDEST



STEM

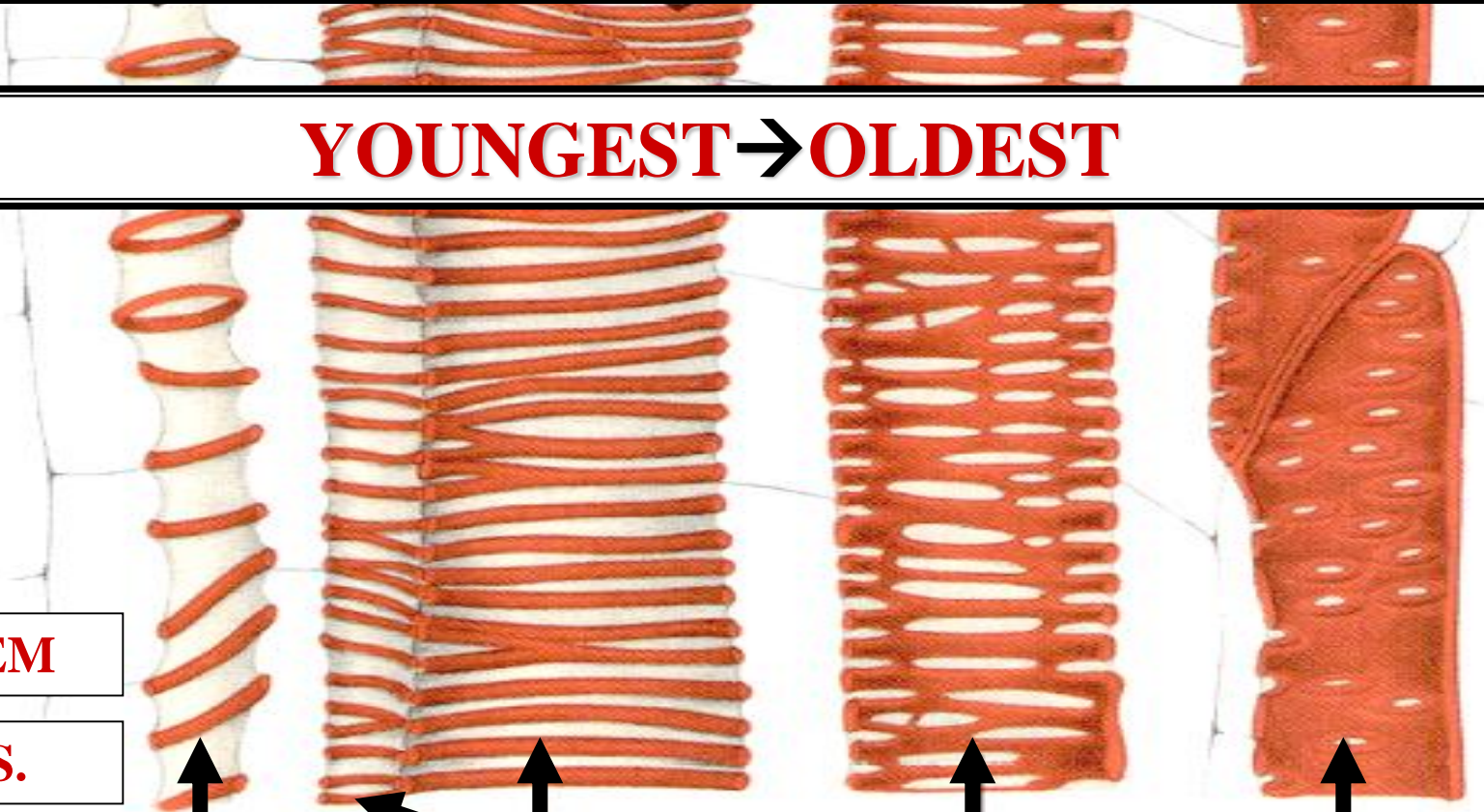
L.S.

ANNULAR

HELICAL

# XYLEM SECONDARY CELL WALL MATURATION PATTERN

YOUNGEST → OLDEST



STEM

L.S.

ANNULAR

HELICAL

SCALARIFORM





# XYLEM SECONDARY CELL WALL MATURATION PATTERN

**YOUNGEST → OLDEST**

**STEM**

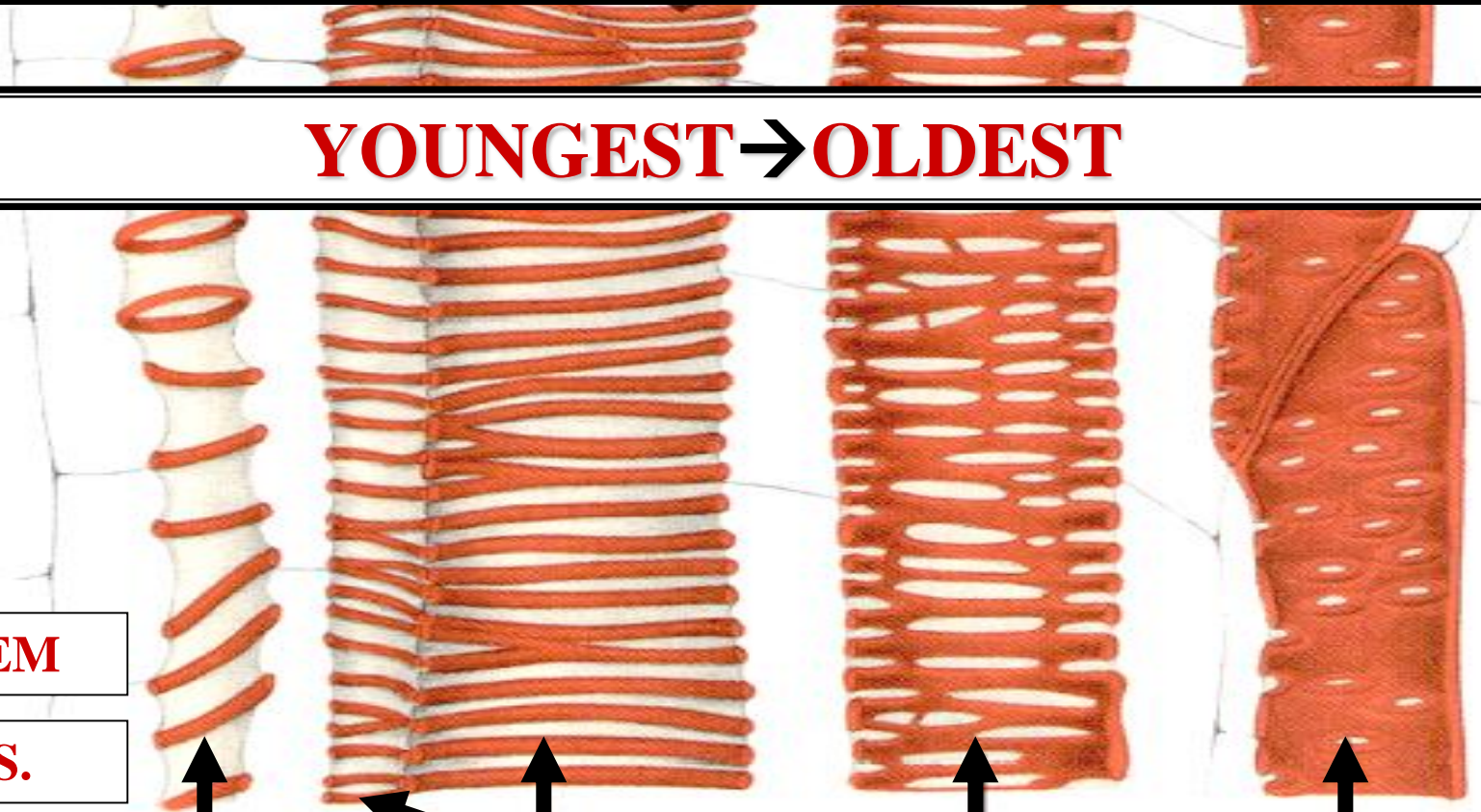
**L.S.**

**ANNULAR**

**HELICAL**

**SCALARIFORM**

**PITTED**



# TRACHEARY ELEMENT TYPES

# **TRACHEARY ELEMENT TYPES**

**TRACHEIDS**

# **TRACHEARY ELEMENT TYPES**

# **TRACHEARY ELEMENT**

## **TYPES**

**T**

**TRACHEIDS**

**VESSEL MEMBERS**

# **TRACHEARY ELEMENT**

## **TYPES**

**TRACHEID**

# **TRACHEARY ELEMENT**

## **TRACHEID**



**KNOWN MOST VASCULAR PLANTS**

# **TRACHEARY ELEMENT**

## **TRACHEID**

# **TRACHEARY ELEMENT**

## **TRACHEID**



**KNOWN MOST VASCULAR PLANTS**  
**DERIVATION: TRACHEOPHYTES**

**TRACHEARY ELEMENT**  
**TRACHEID**

**TRACHEARY ELEMENT**



**TRACHEID**

**KNOWN MOST VASCULAR PLANTS**

**DERIVATION: TRACHEOPHYTES**

**---**

**END WALL HIGHLY TAPPED**

**TRACHEARY ELEMENT**

**TRACHEID**



# TRACHEARY ELEMENT



## TRACHEID

KNOWN MOST VASCULAR PLANTS

DERIVATION: TRACHEOPHYTES

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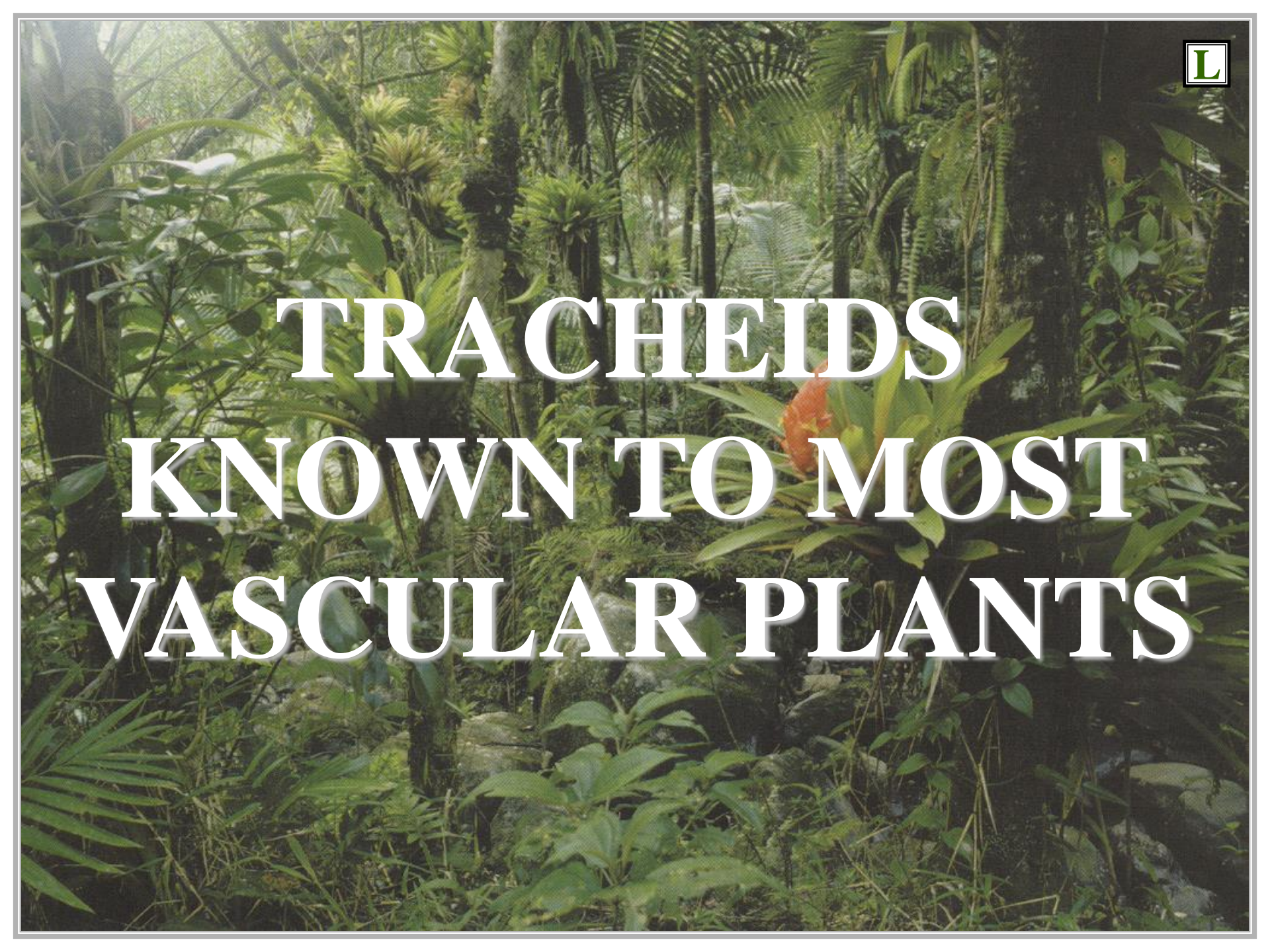
END WALL HIGHLY TAPPED

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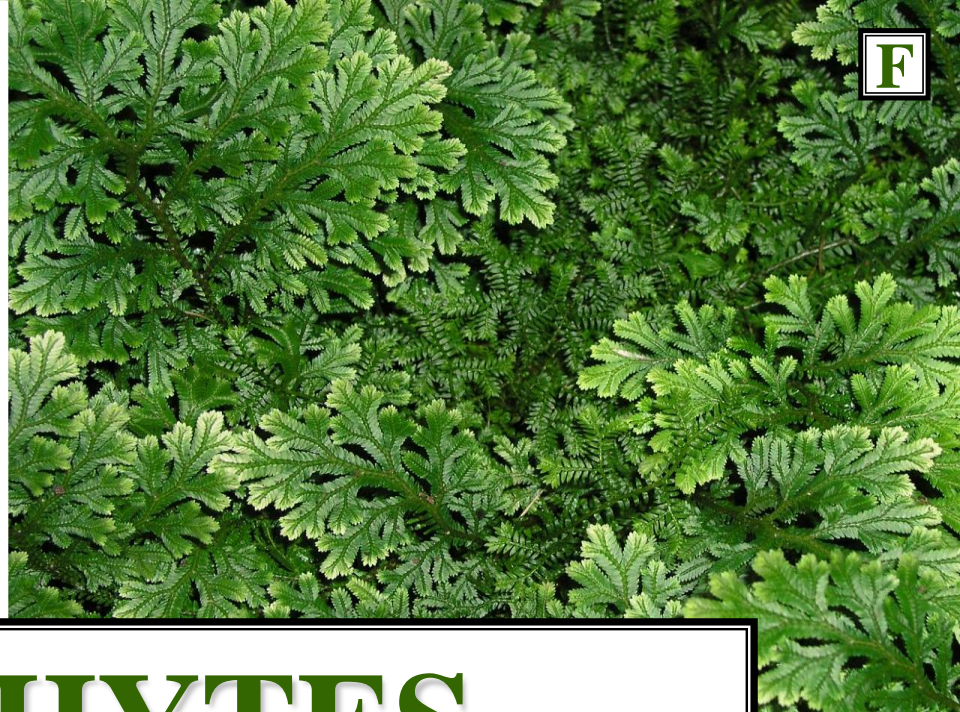
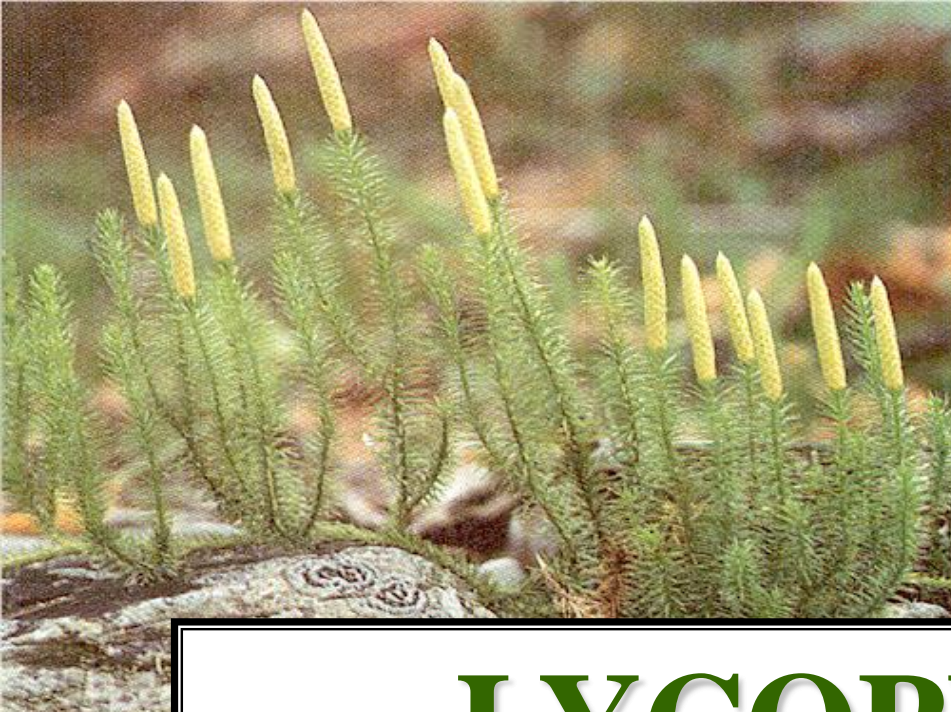
END WALL PITTED

# TRACHEARY ELEMENT

## TRACHEID

A lush tropical forest scene with dense green foliage and a prominent orange flower. The text is overlaid in the center.

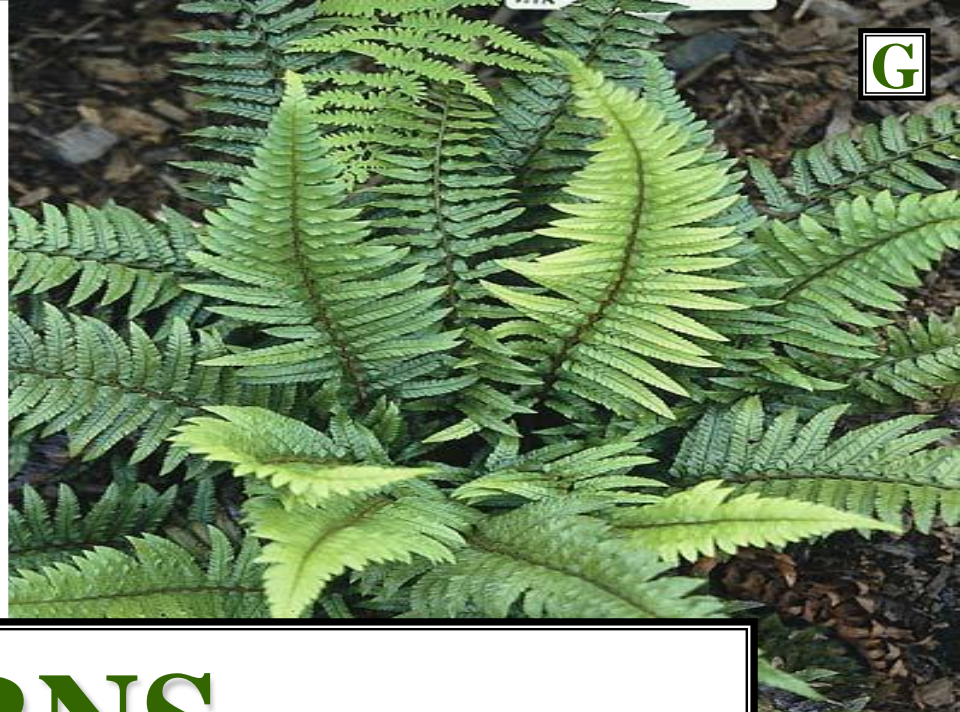
**TRACHEIDS  
KNOWN TO MOST  
VASCULAR PLANTS**



F

# LYCOPHYTES





# FERNS

