

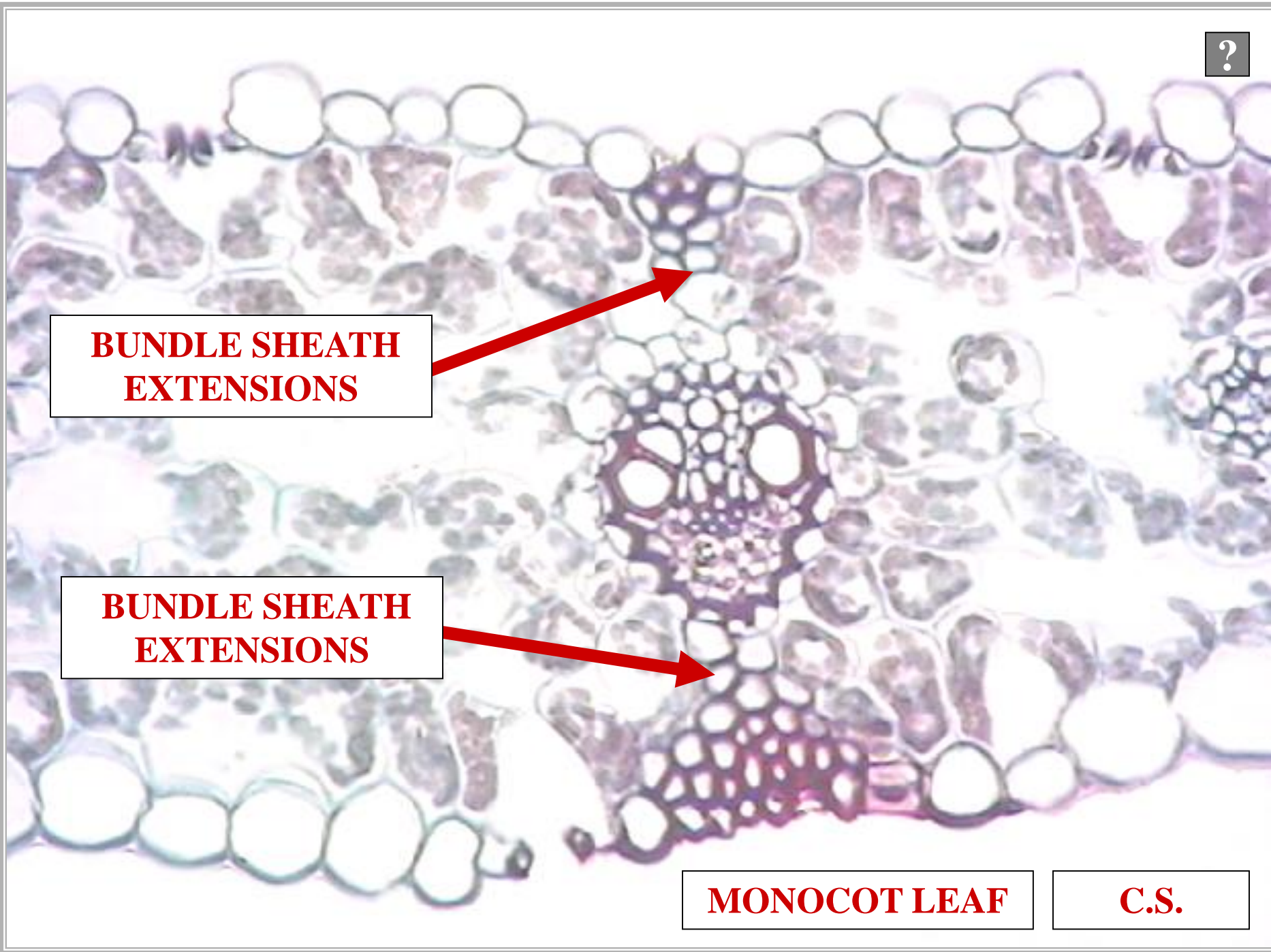
?

**BUNDLE SHEATH  
EXTENSIONS**

**BUNDLE SHEATH  
EXTENSIONS**

**MONOCOT LEAF**

**C.S.**



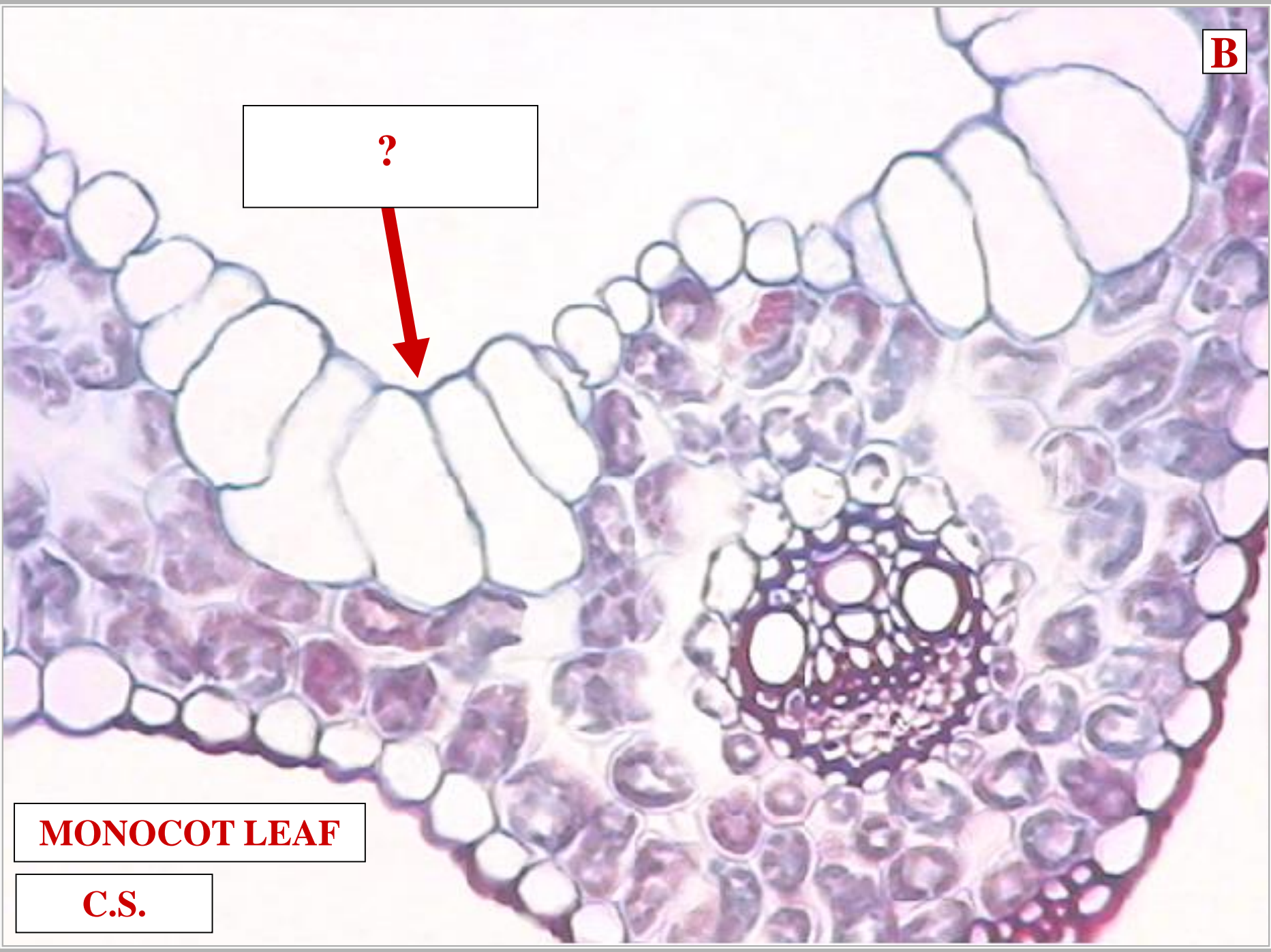
**B**

**?**



**MONOCOT LEAF**

**C.S.**



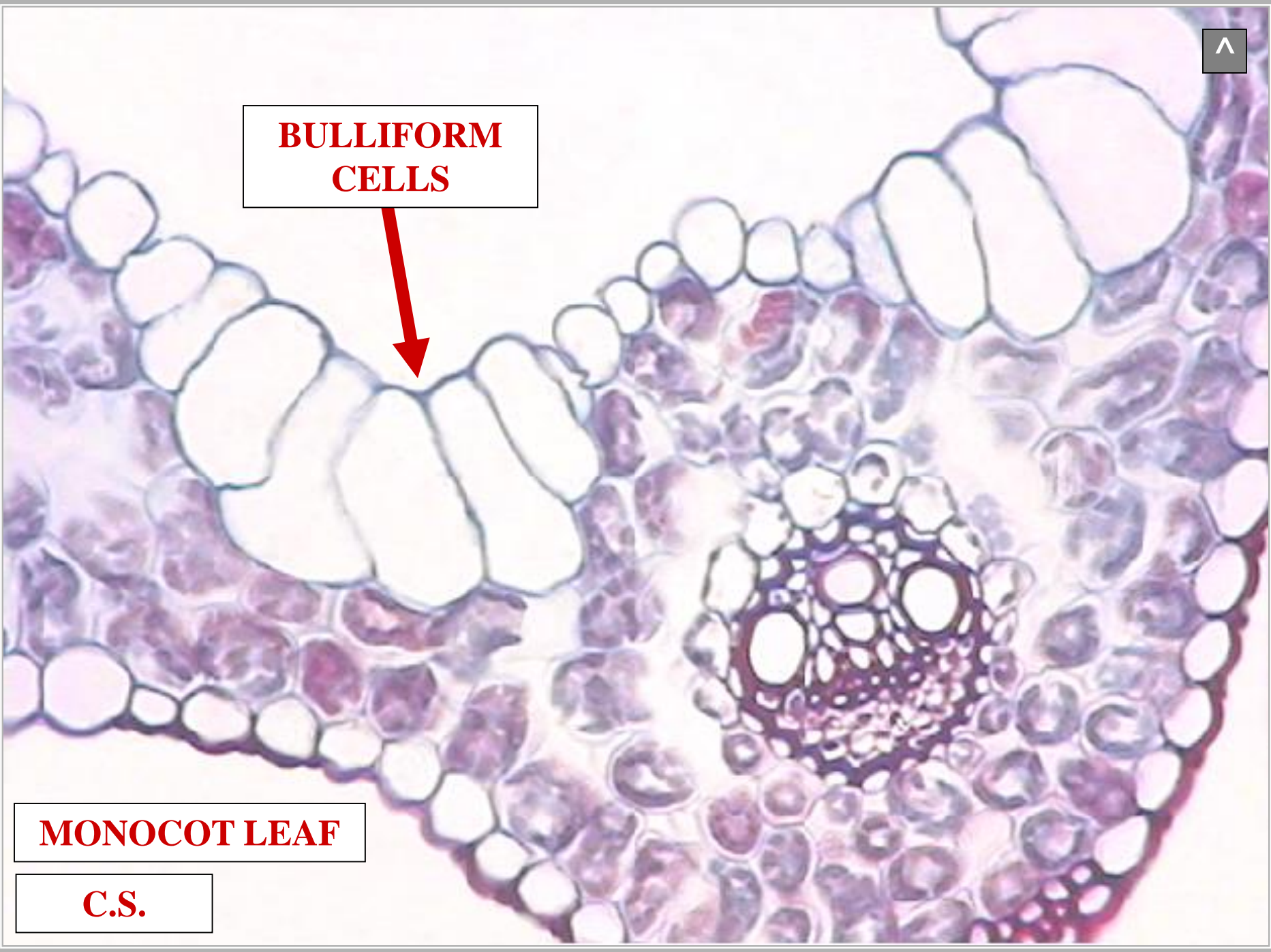


**BULLIFORM  
CELLS**



**MONOCOT LEAF**

**C.S.**





# **MODIFIED LEAVES**



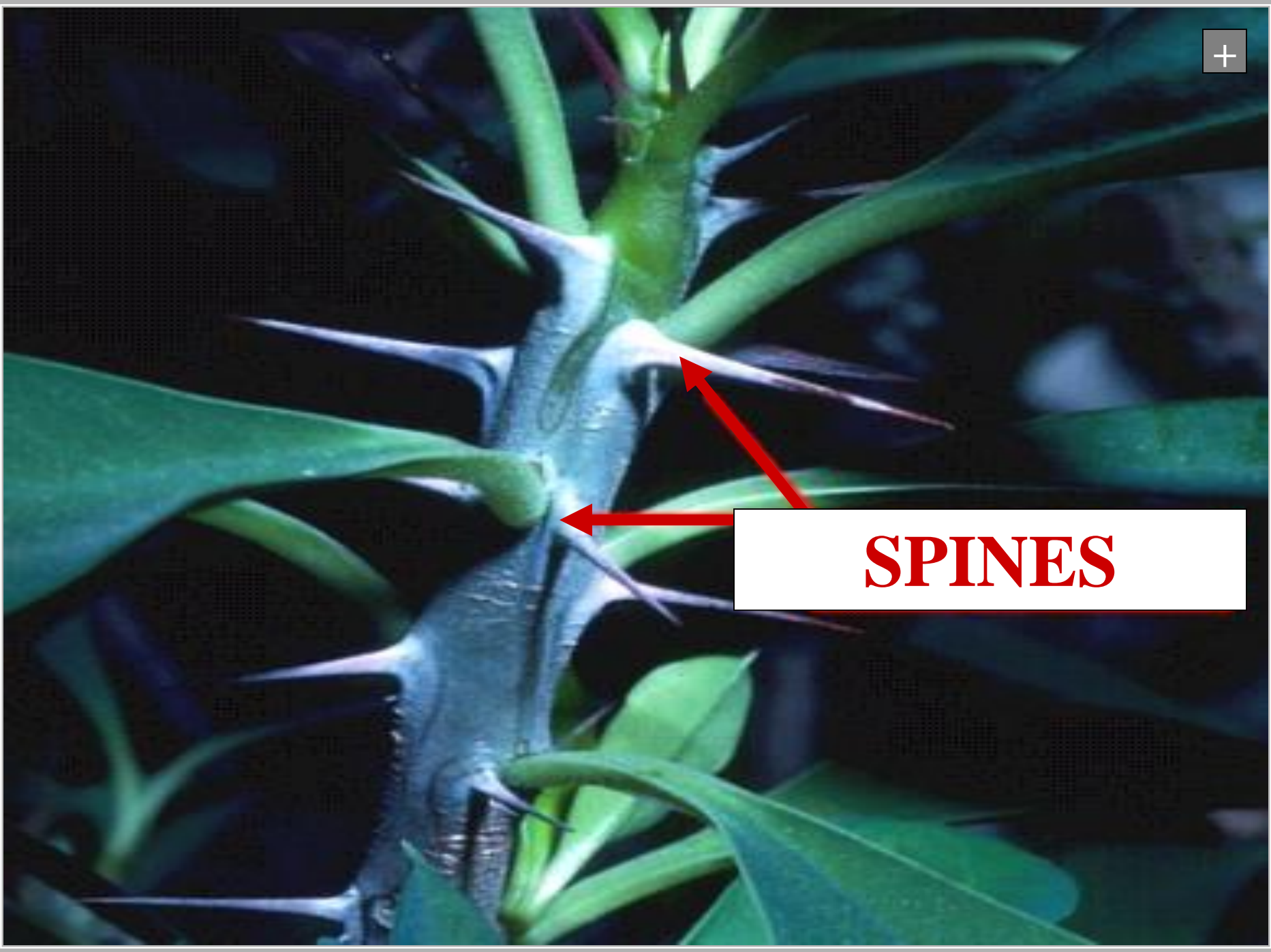
**MODIFIED LEAVES  
PROVIDE  
SPECIAL FUNCTION**



# **MODIFIED LEAF TYPES**

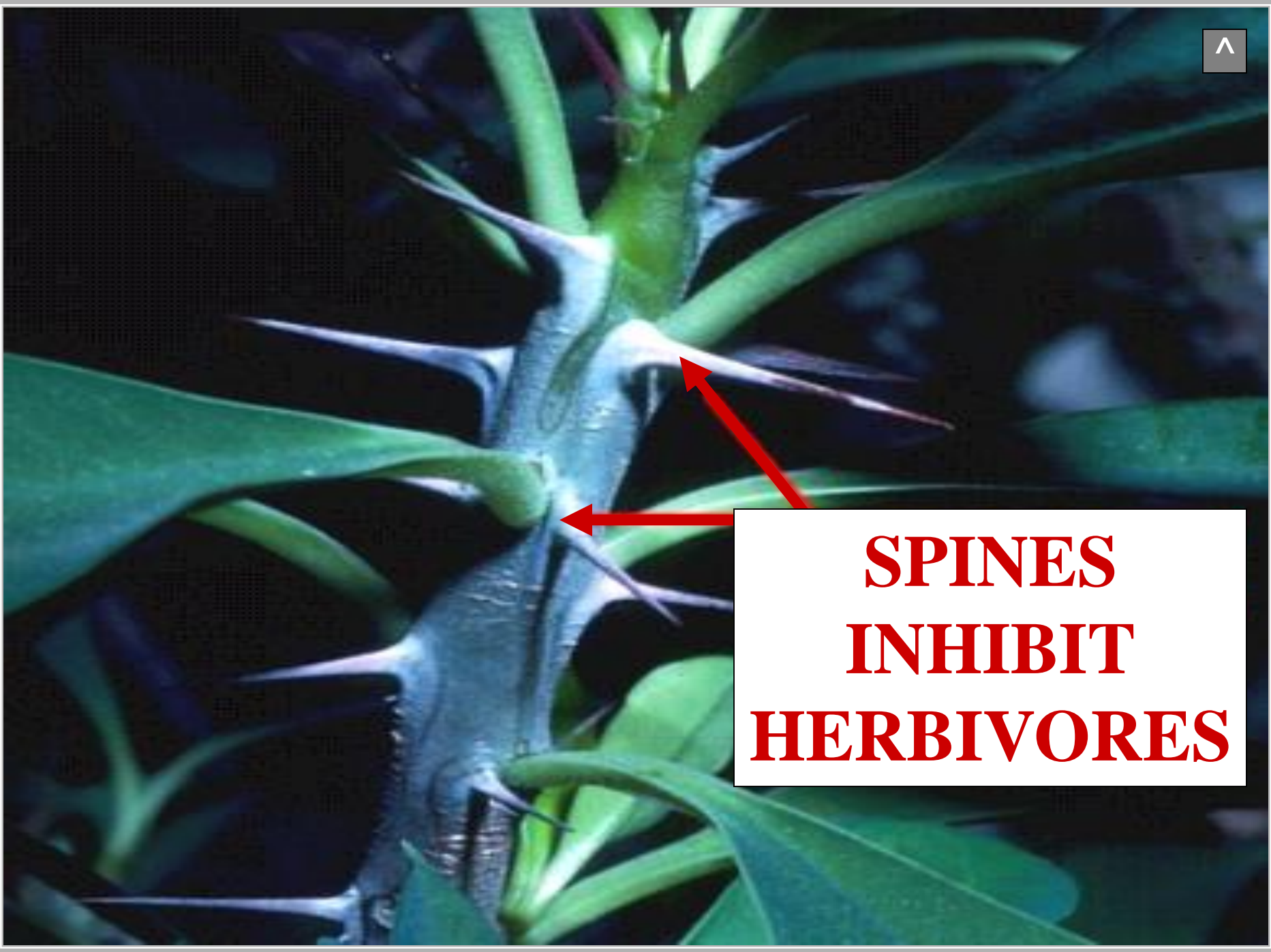


# SPINE



**SPINES**





**SPINES  
INHIBIT  
HERBIVORES**



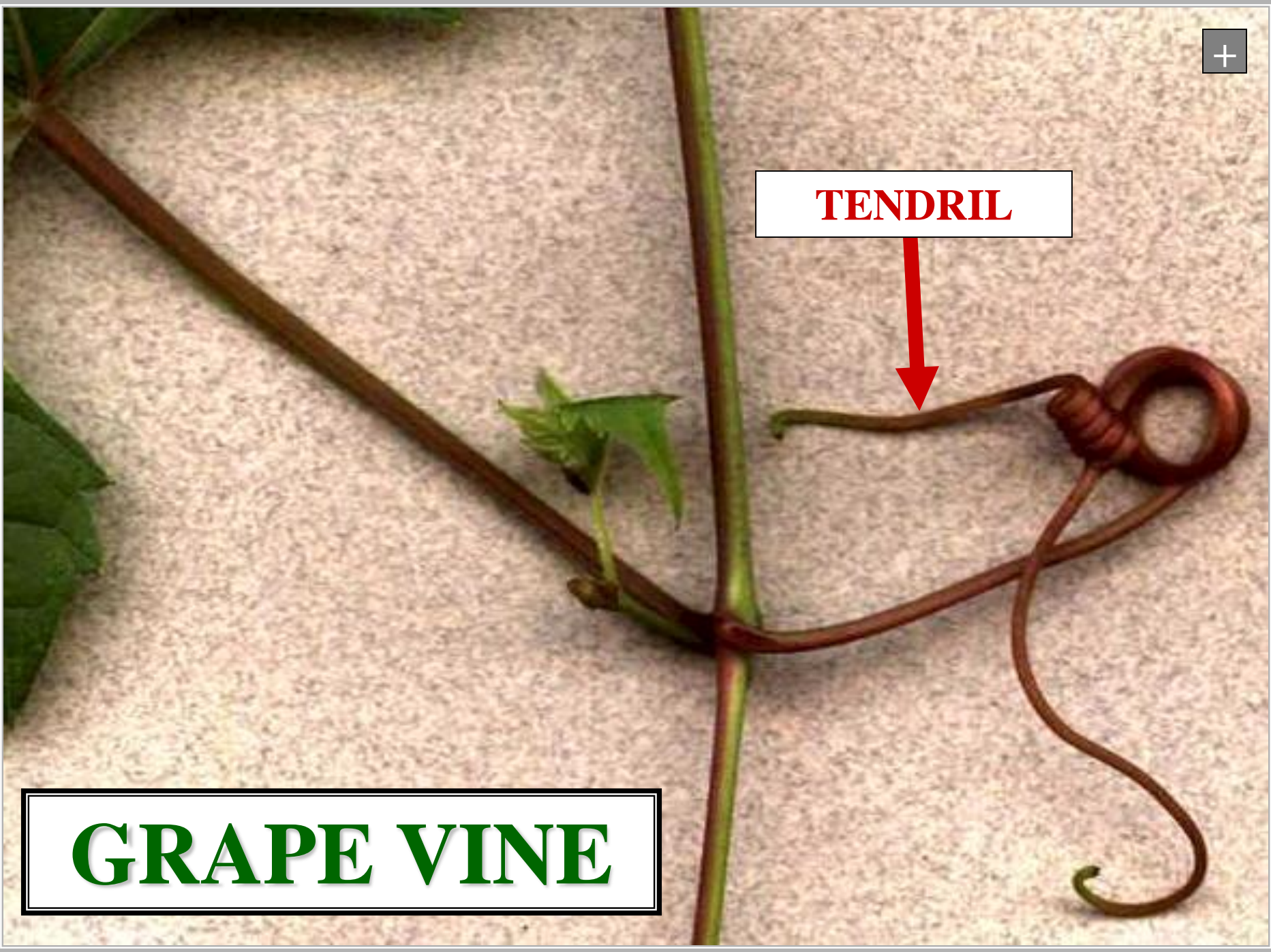
# TENDRIL



**TENDRIL**



**GRAPE VINE**

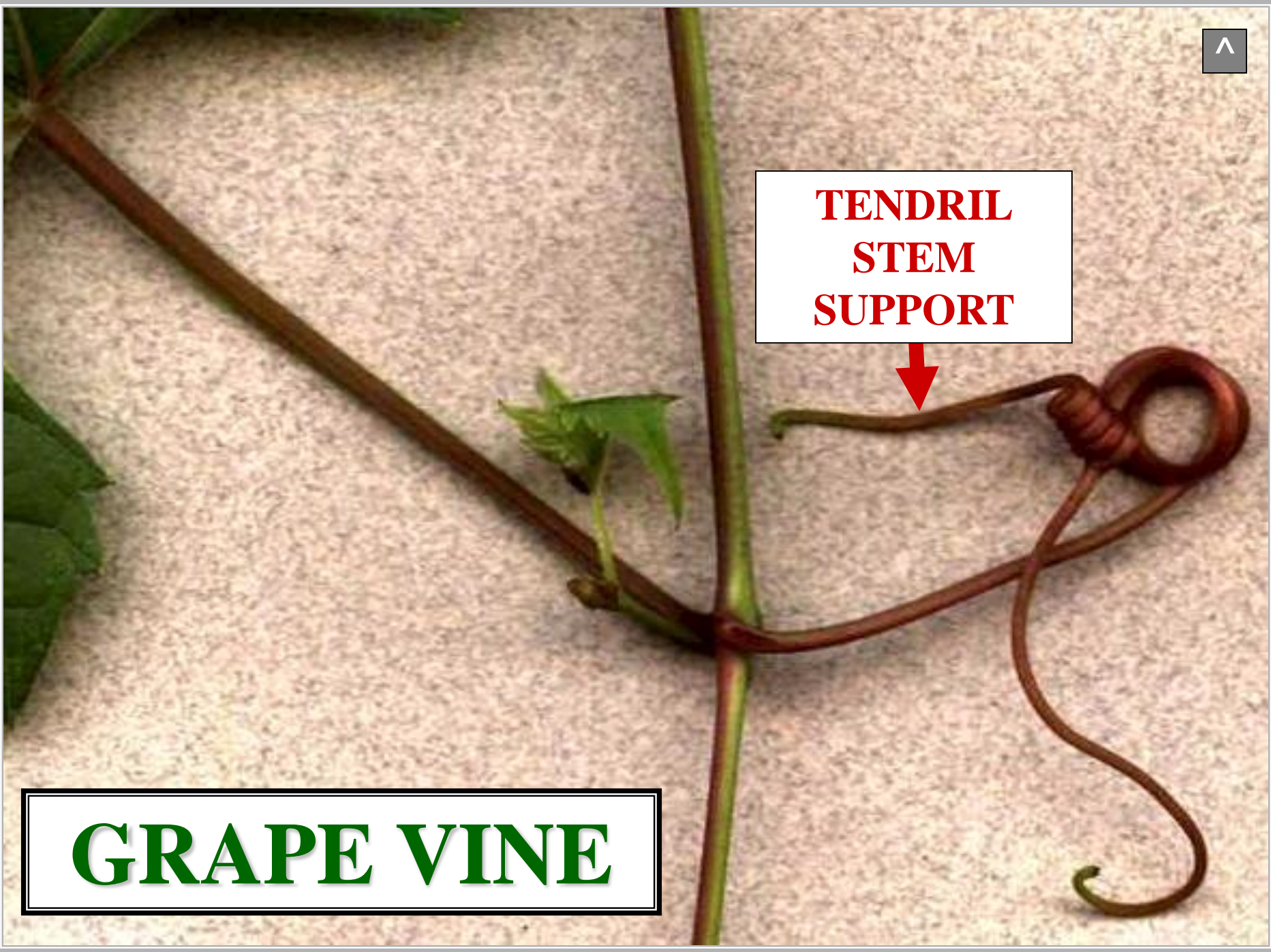




**TENDRIL  
STEM  
SUPPORT**



**GRAPE VINE**





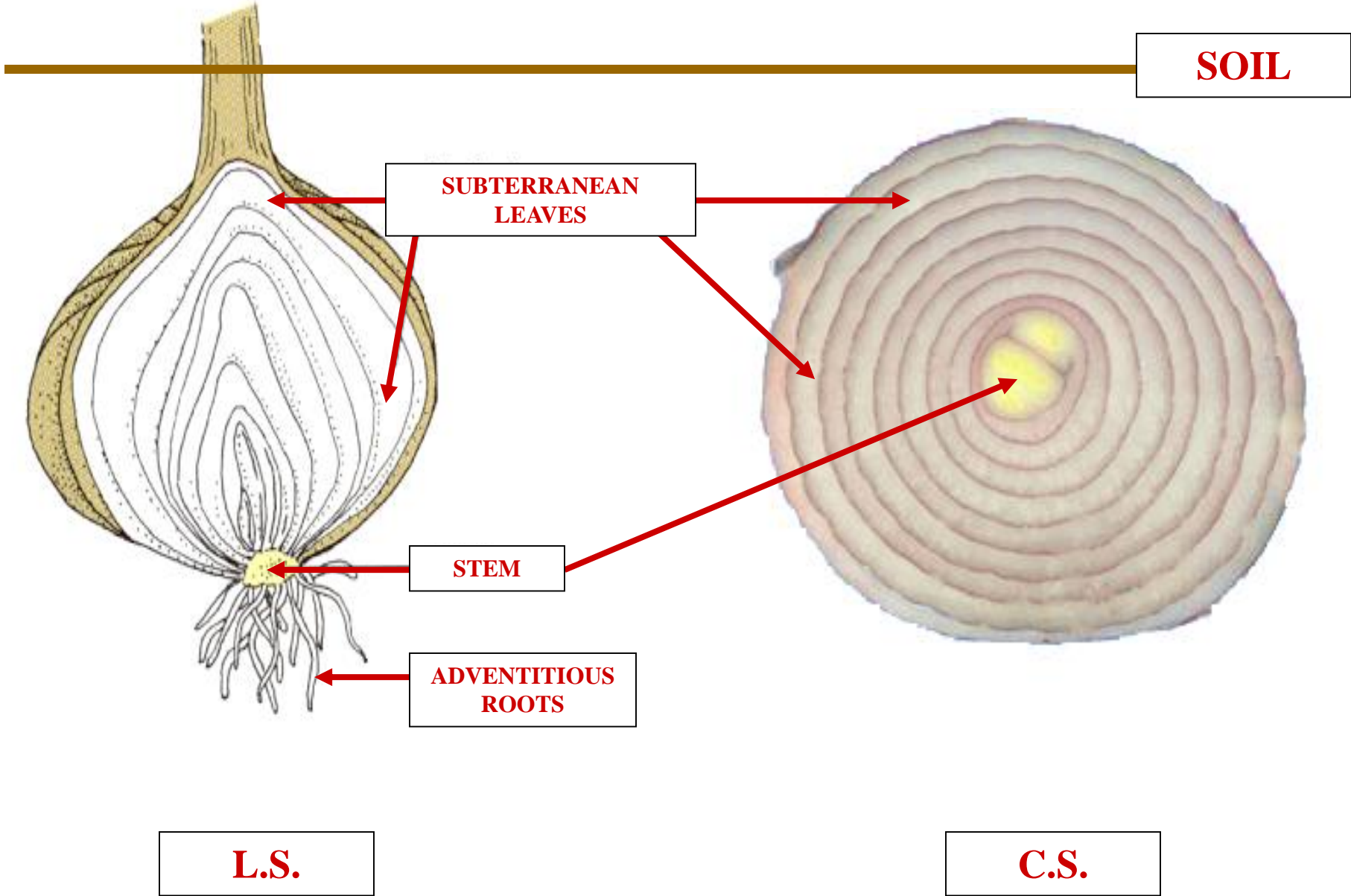
**BULB**

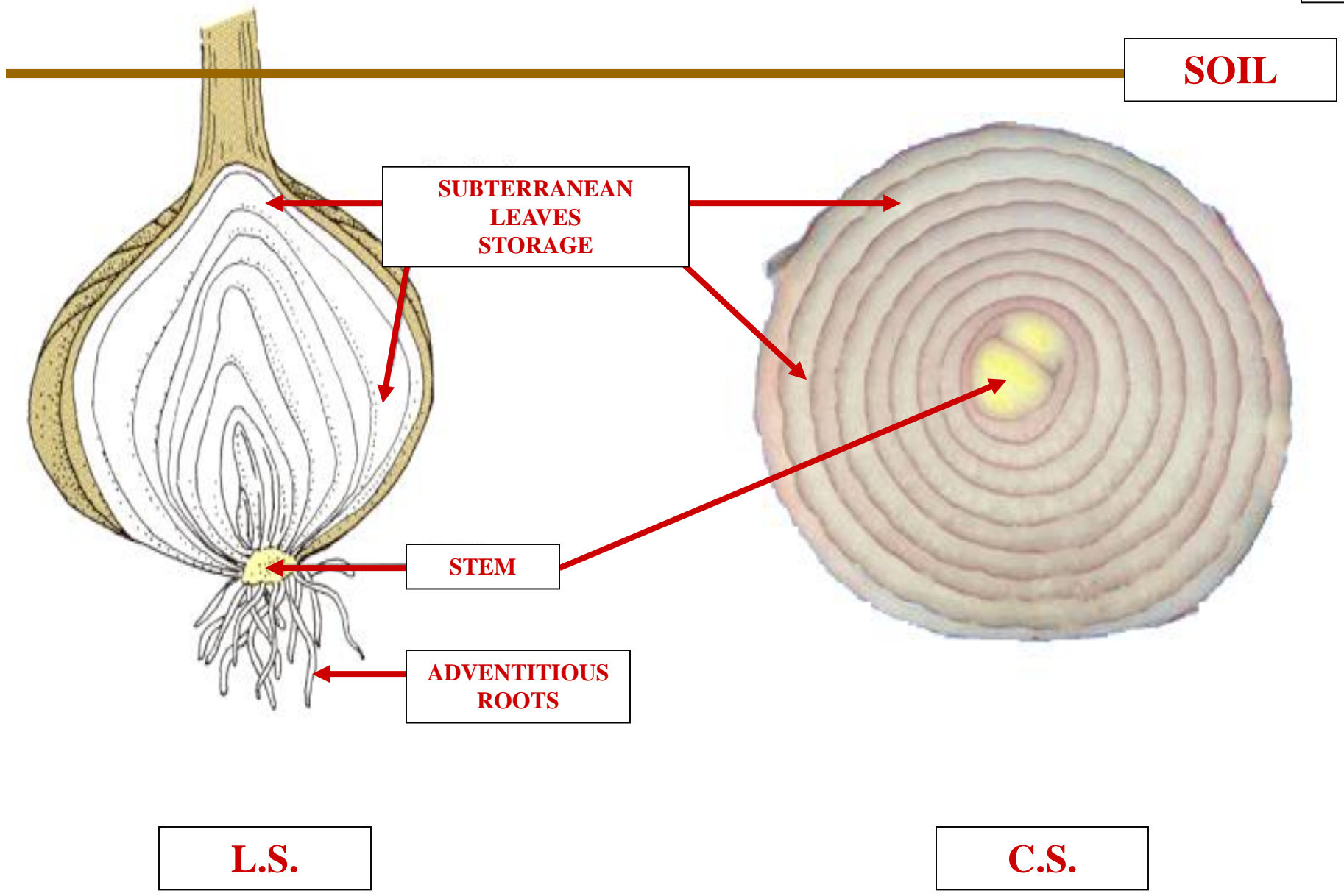


**WILD ONION**

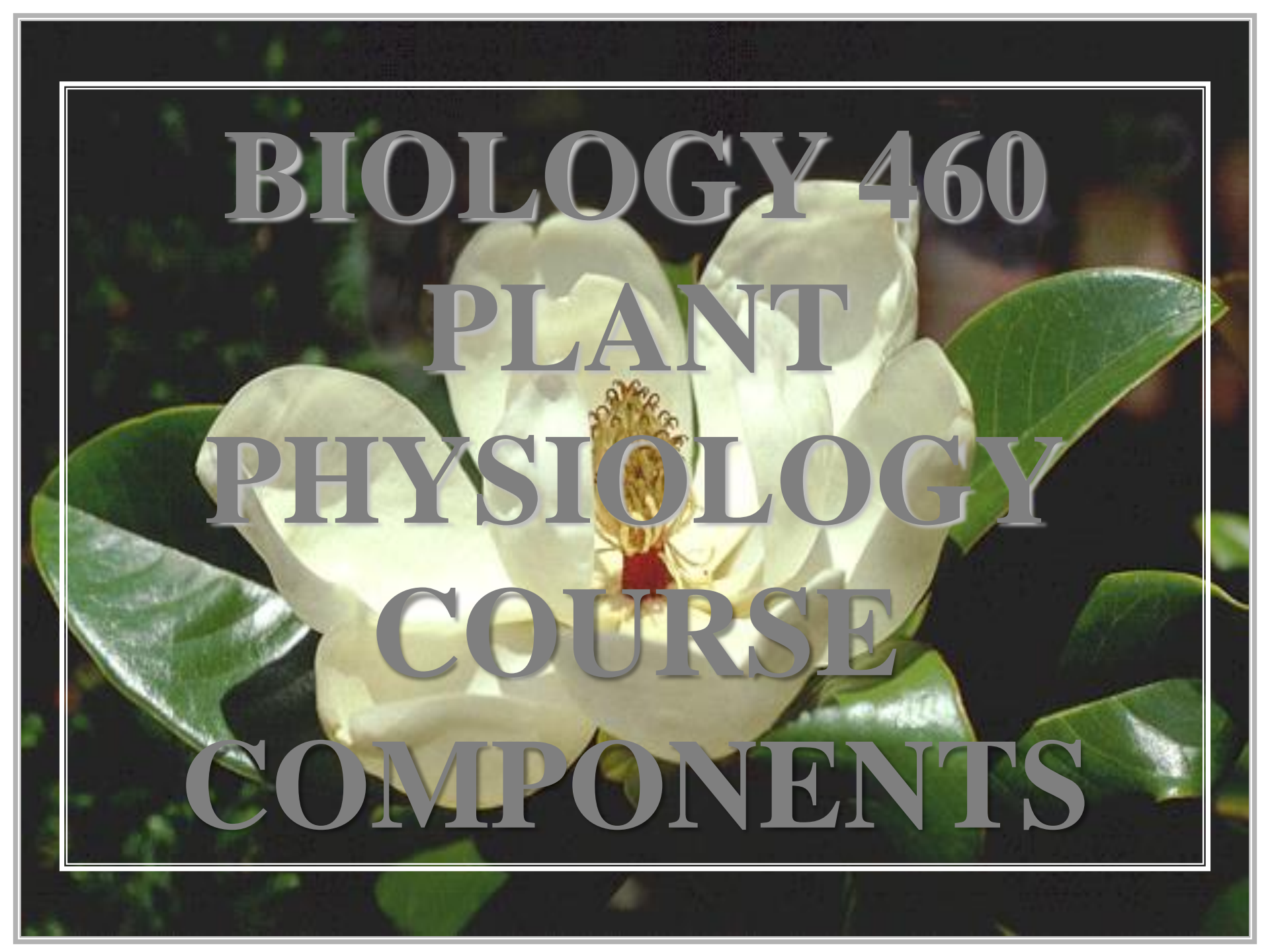


**WILD ONION**










**BIOLOGY 460  
PLANT  
PHYSIOLOGY  
COURSE  
COMPONENTS**



ANGIOSPERM  
MORPHOLOGY  
&  
ANGIOSPERM  
ANATOMY



# ANGIOSPERM CYTOLOGY



# ANGIOSPERM CYTOLOGY

# CYTOLOGY

# **CYTOLOGY**



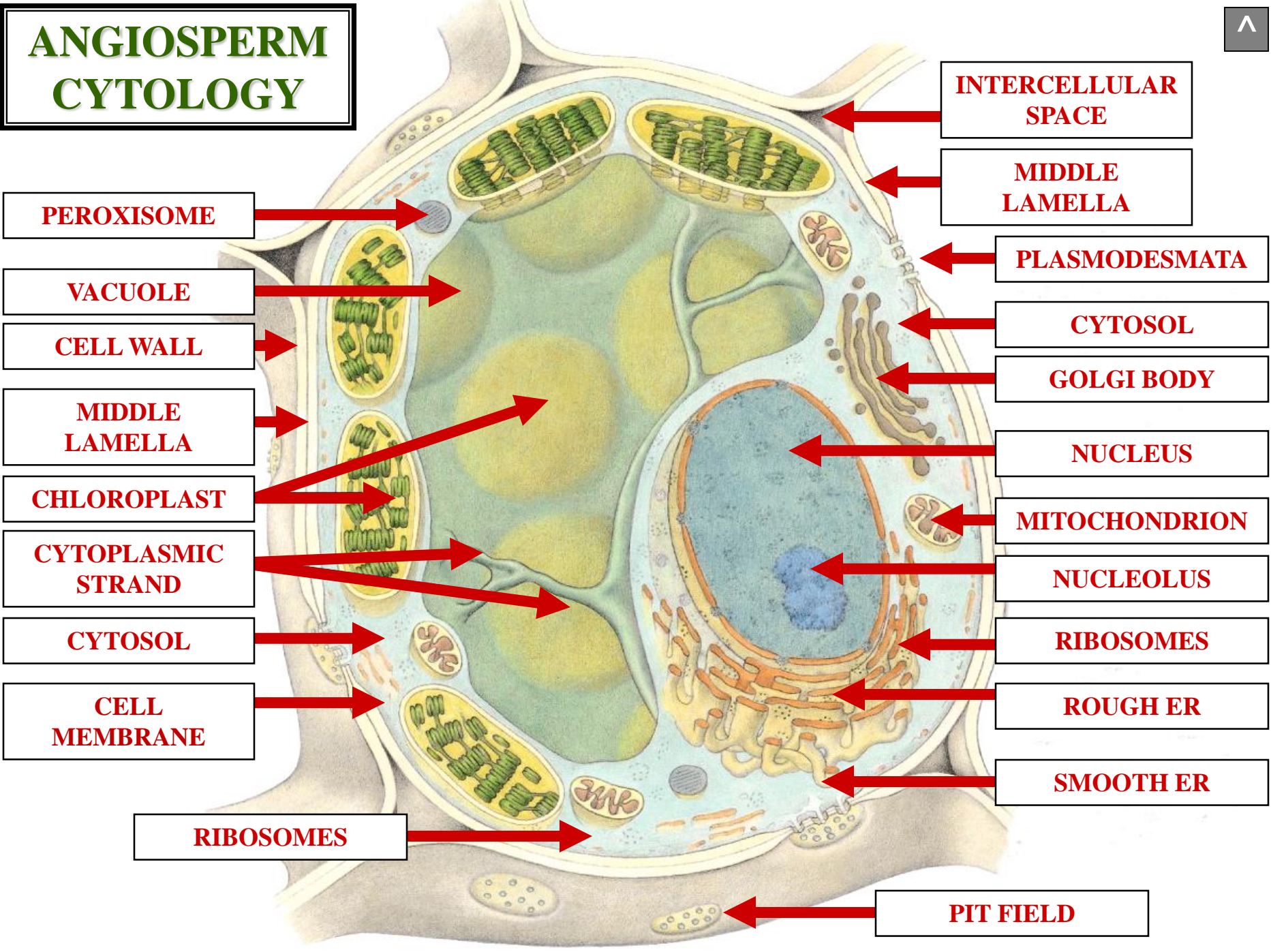
# **CYTOLOGY**

**STUDY CELL STRUCTURE**

**CYTOLOGY**



# ANGIOSPERM CYTOLOGY



**PEROXISOME**

**VACUOLE**

**CELL WALL**

**MIDDLE LAMELLA**

**CHLOROPLAST**

**CYTOPLASMIC STRAND**

**CYTOSOL**

**CELL MEMBRANE**

**RIBOSOMES**

**INTERCELLULAR SPACE**

**MIDDLE LAMELLA**

**PLASMODESMATA**

**CYTOSOL**

**GOLGI BODY**

**NUCLEUS**

**MITOCHONDRION**

**NUCLEOLUS**

**RIBOSOMES**

**ROUGH ER**

**SMOOTH ER**

**PIT FIELD**



# MIDDLE LAMELLA

**MIDDLE LAMELLA**



# **MIDDLE LAMELLA**

**AREA BETWEEN ADJACENT  
PLANT CELLS**

# **MIDDLE LAMELLA**



**MIDDLE LAMELLA**

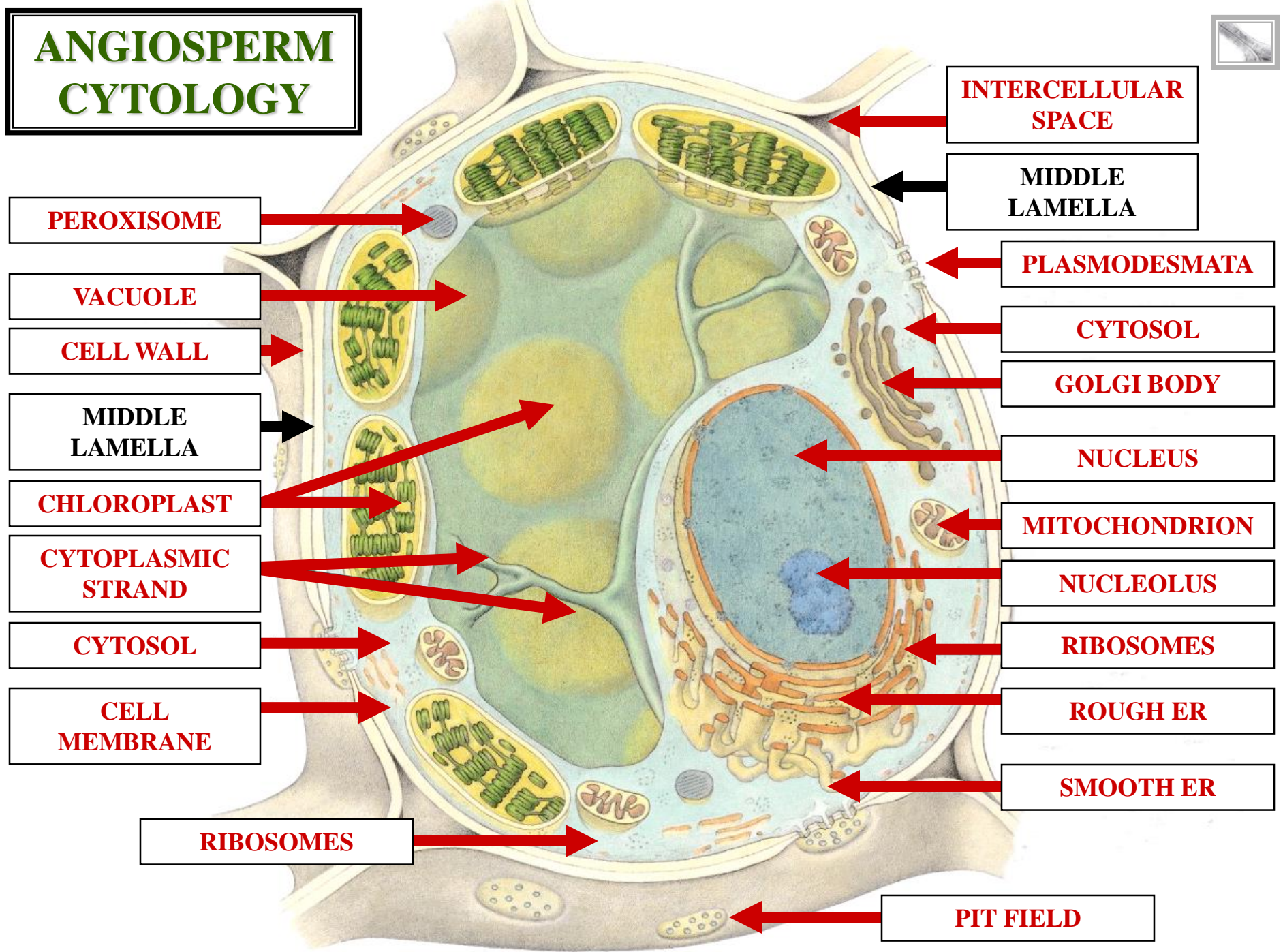
**AREA BETWEEN ADJACENT  
PLANT CELLS**

**---**

**BONDS ADJACENT  
PLANT CELLS**

**MIDDLE LAMELLA**

# ANGIOSPERM CYTOLOGY



**PEROXISOME**

**VACUOLE**

**CELL WALL**

**MIDDLE LAMELLA**

**CHLOROPLAST**

**CYTOPLASMIC STRAND**

**CYTOSOL**

**CELL MEMBRANE**

**RIBOSOMES**

**INTERCELLULAR SPACE**

**MIDDLE LAMELLA**

**PLASMODESMATA**

**CYTOSOL**

**GOLGI BODY**

**NUCLEUS**

**MITOCHONDRION**

**NUCLEOLUS**

**RIBOSOMES**

**ROUGH ER**

**SMOOTH ER**

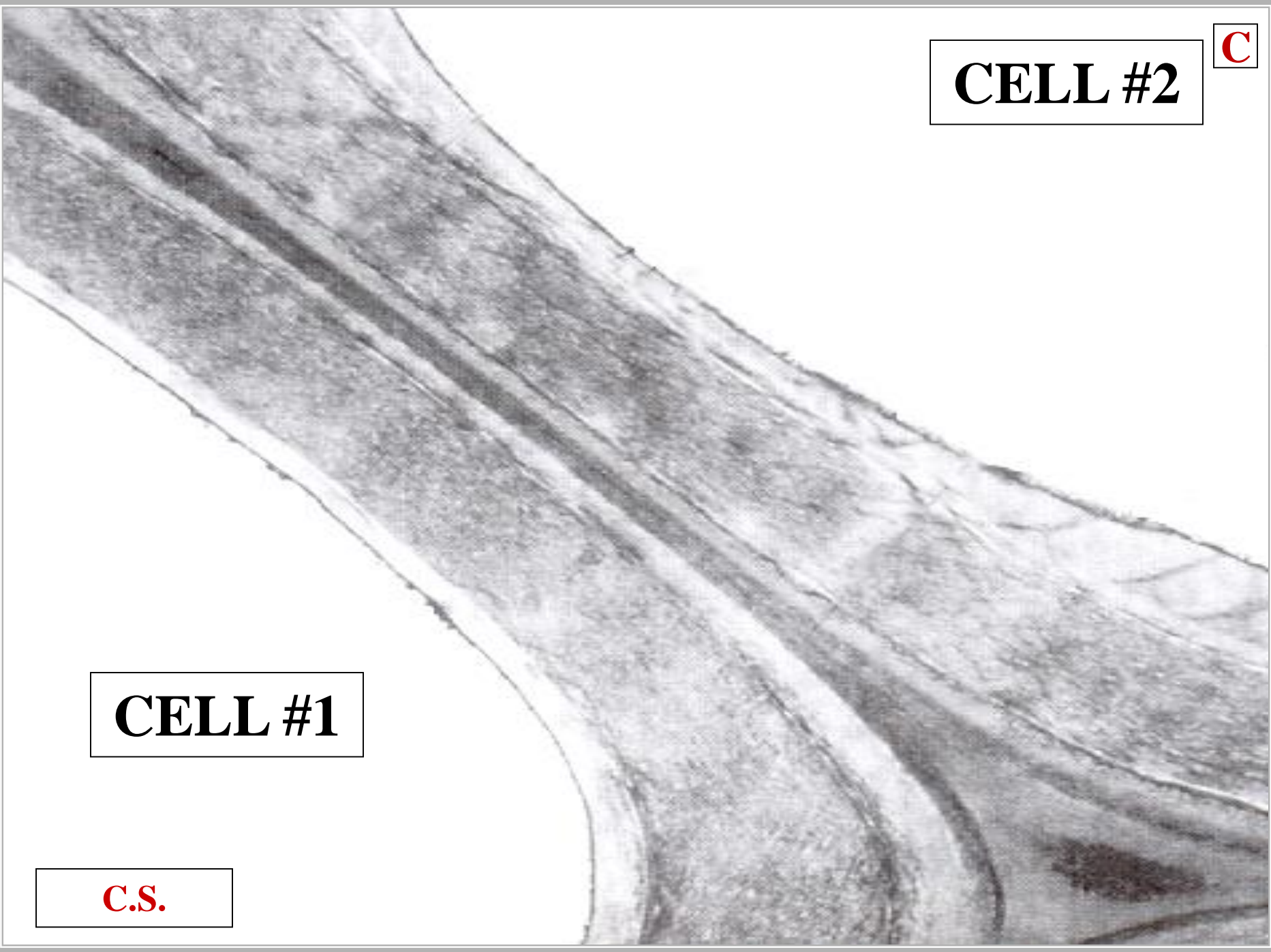
**PIT FIELD**

**CELL #2**

**C**

**CELL #1**

**C.S.**



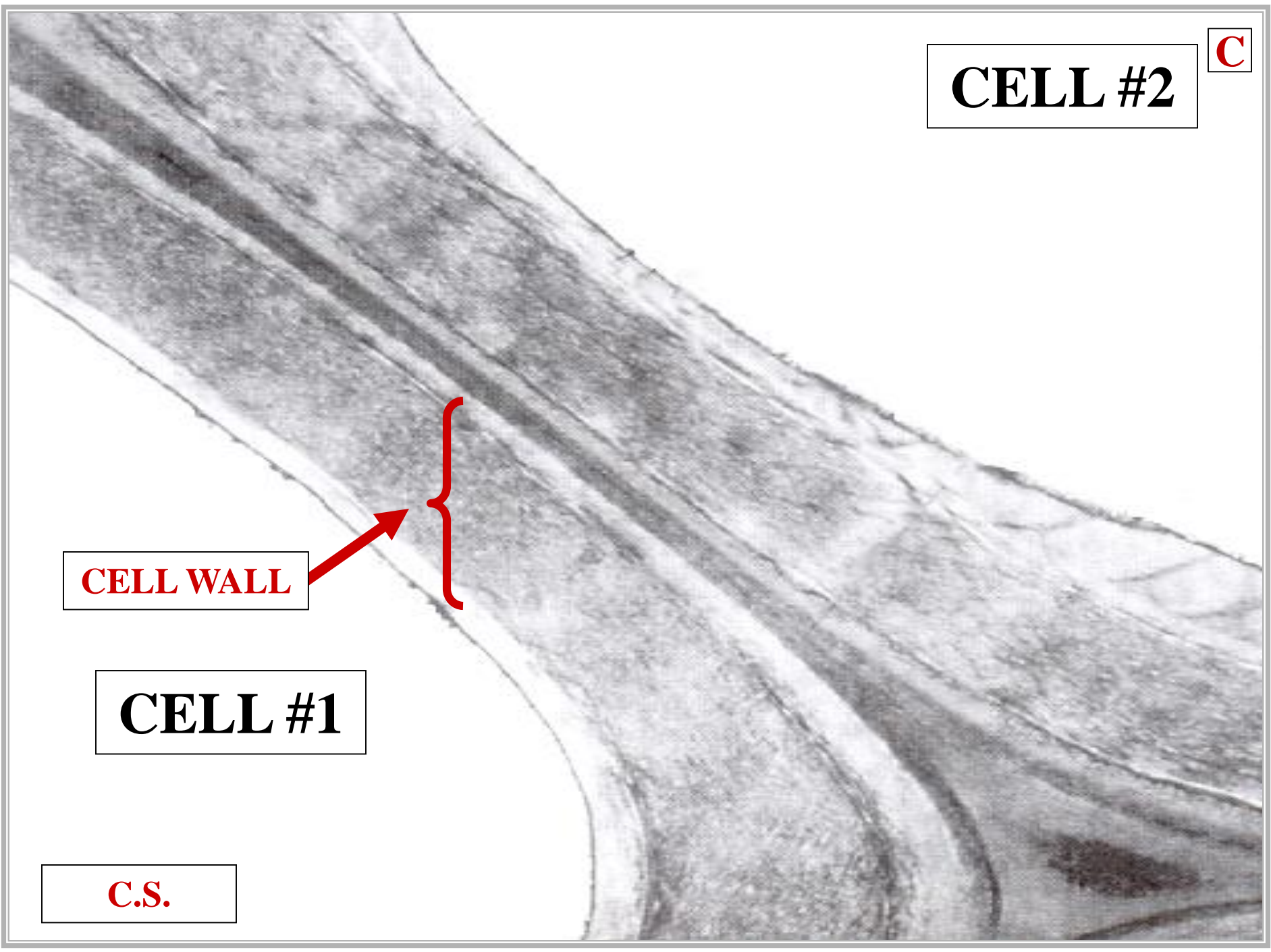
**CELL #2**

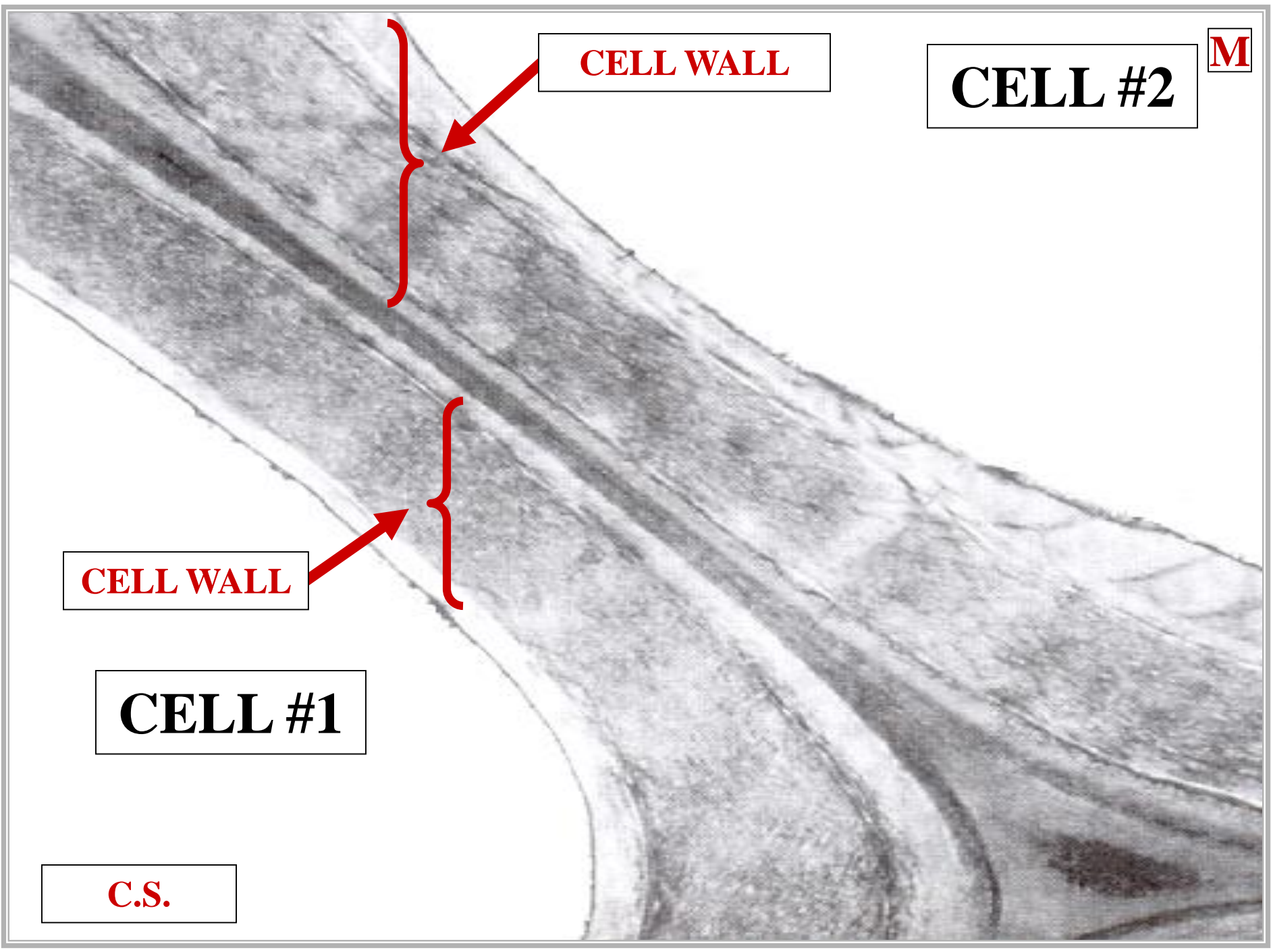
**C**

**CELL WALL**

**CELL #1**

**C.S.**





**CELL WALL**

**CELL #2**

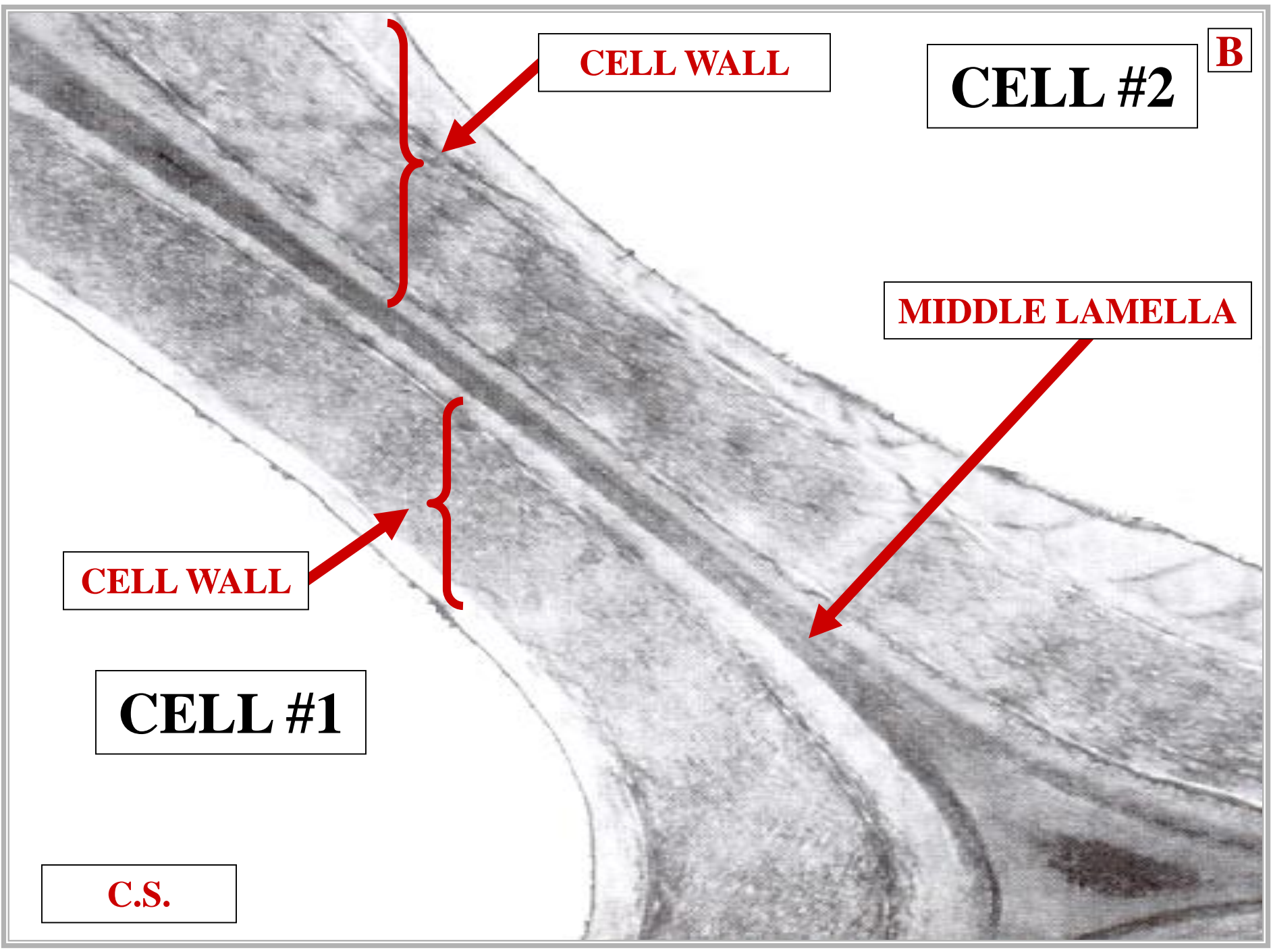
**M**

**CELL WALL**

**CELL #1**

**C.S.**





**CELL WALL**

**CELL #2**

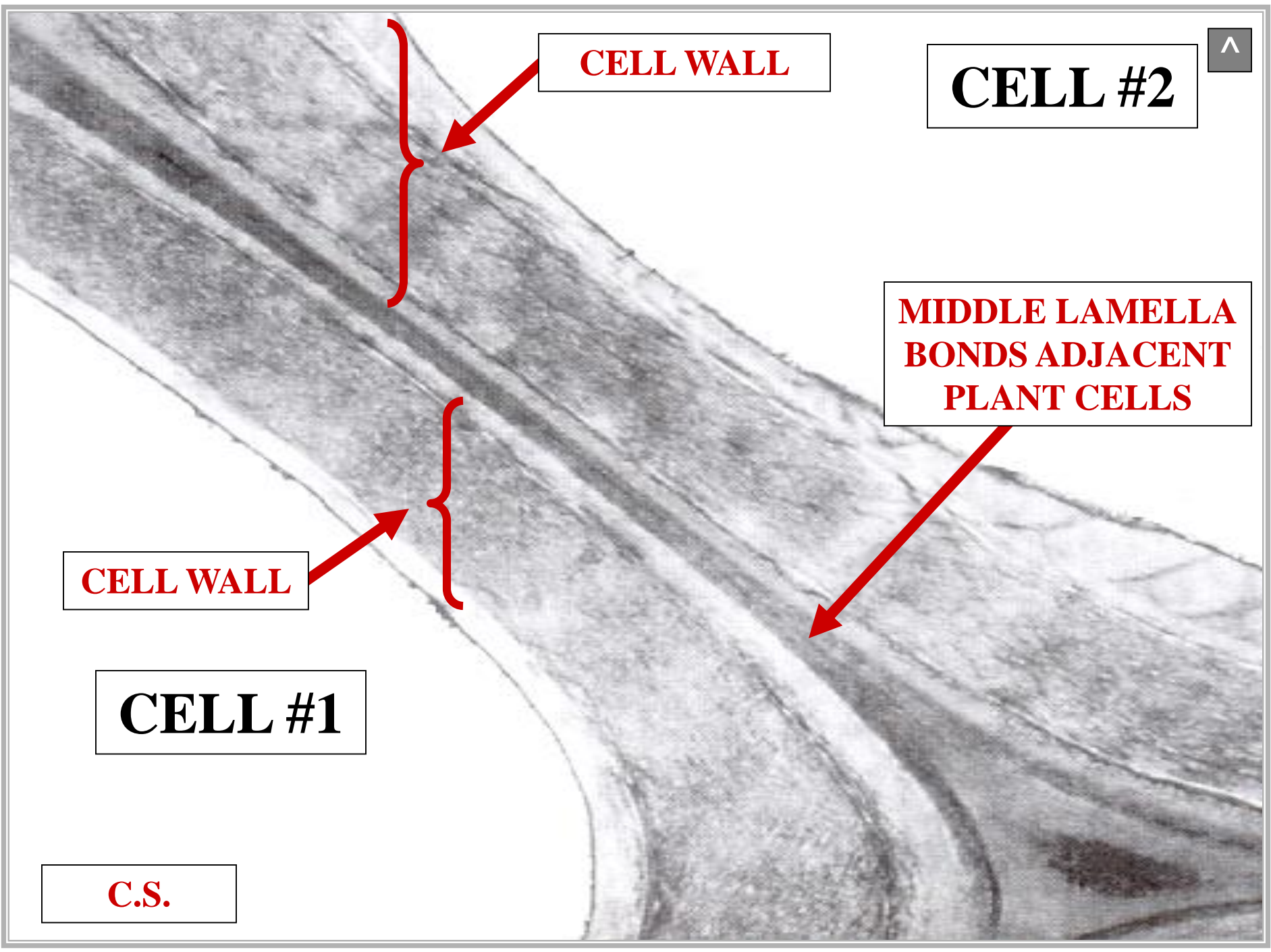
**B**

**MIDDLE LAMELLA**

**CELL WALL**

**CELL #1**

**C.S.**



**CELL WALL**

**CELL #2**

**MIDDLE LAMELLA  
BONDS ADJACENT  
PLANT CELLS**

**CELL WALL**

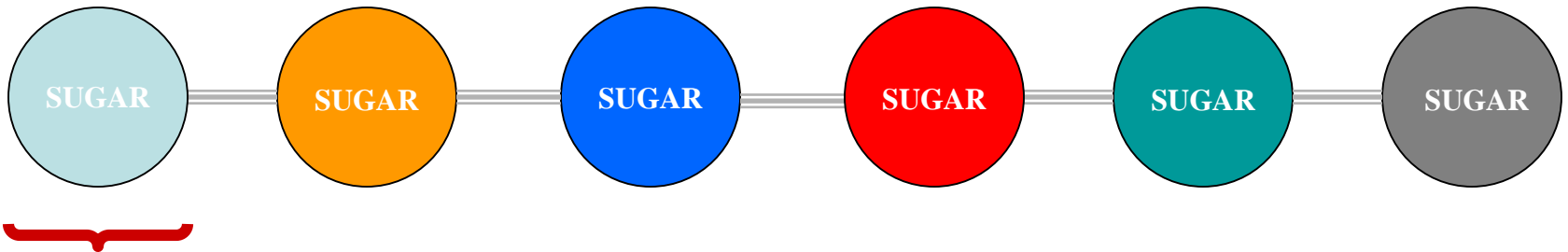
**CELL #1**

**C.S.**



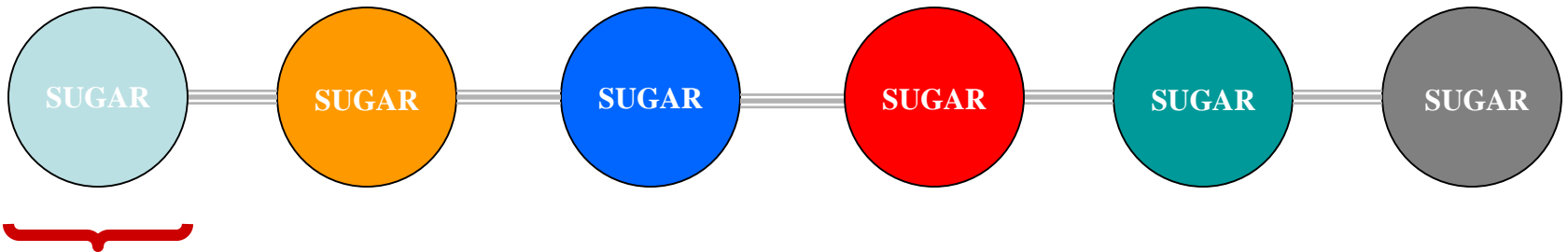
# MIDDLE LAMELLA COMPOSITION

# MIDDLE LAMELLA COMPOSITION



**MONOSACCHARIDE** == = **BOND**

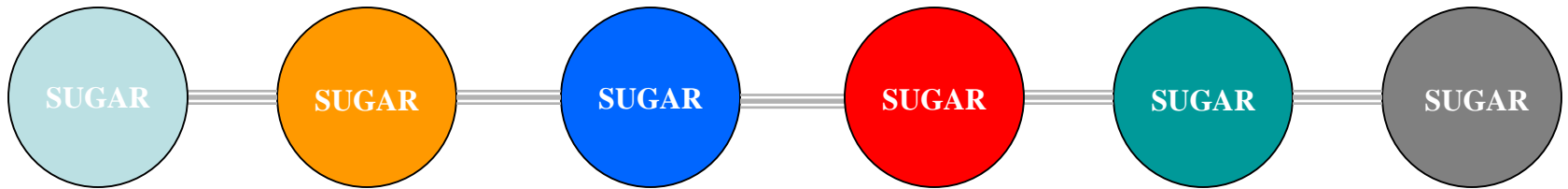
# MIDDLE LAMELLA COMPOSITION



**MONOSACCHARIDE**  $\equiv$  **BOND**

?

# MIDDLE LAMELLA COMPOSITION



**MONOSACCHARIDE** == = **BOND**

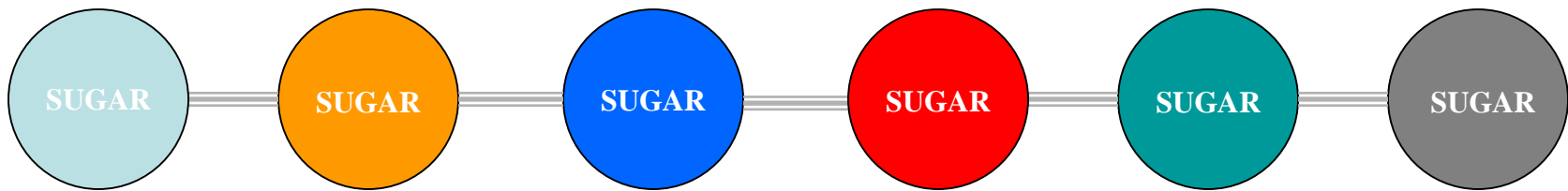
**POLYSACCHARIDE**



M

+

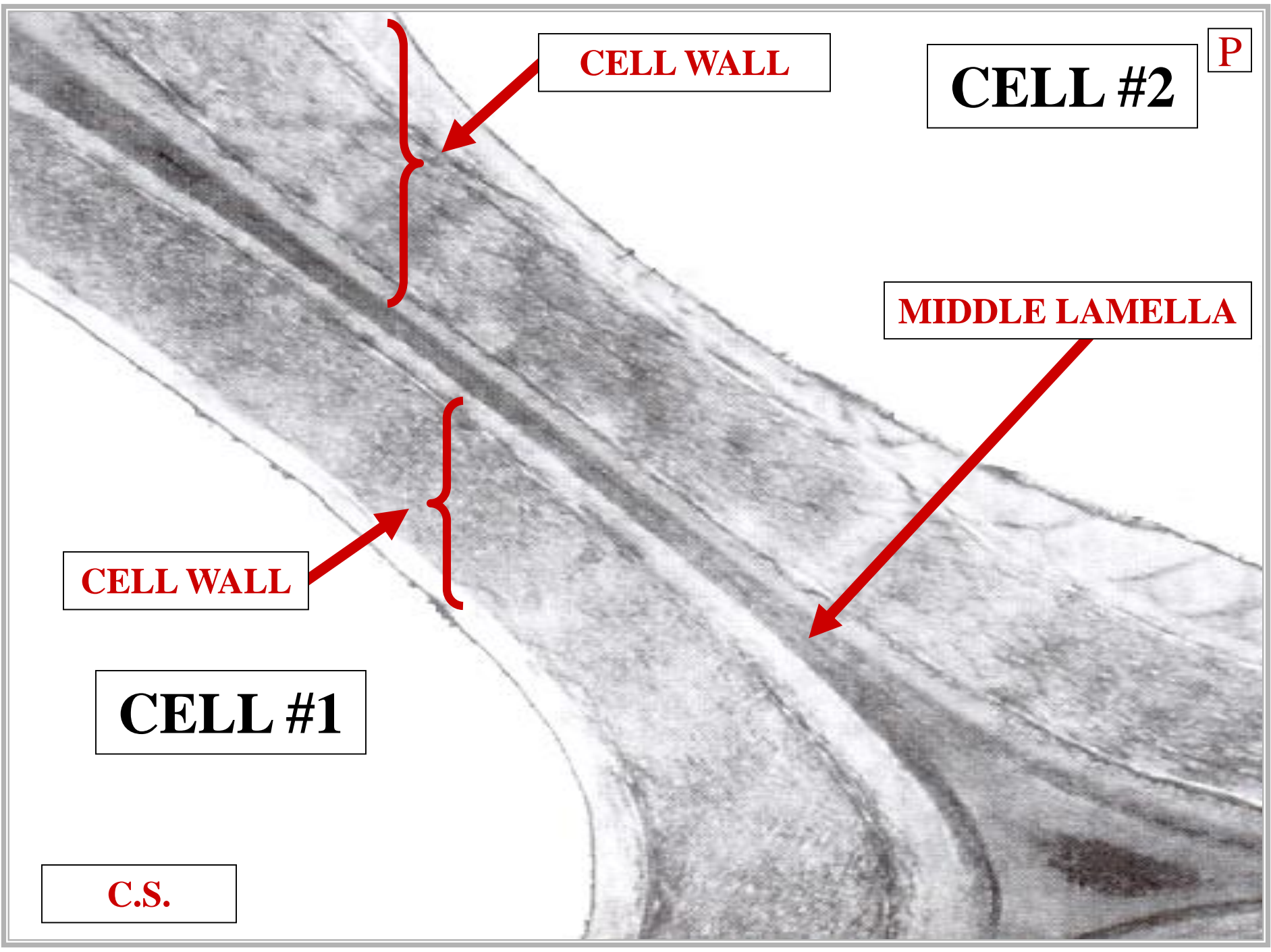
# MIDDLE LAMELLA COMPOSITION



**MONOSACCHARIDE** == = **BOND**



**POLYSACCHARIDE = PECTIN**



**CELL WALL**

**CELL #2**

**P**

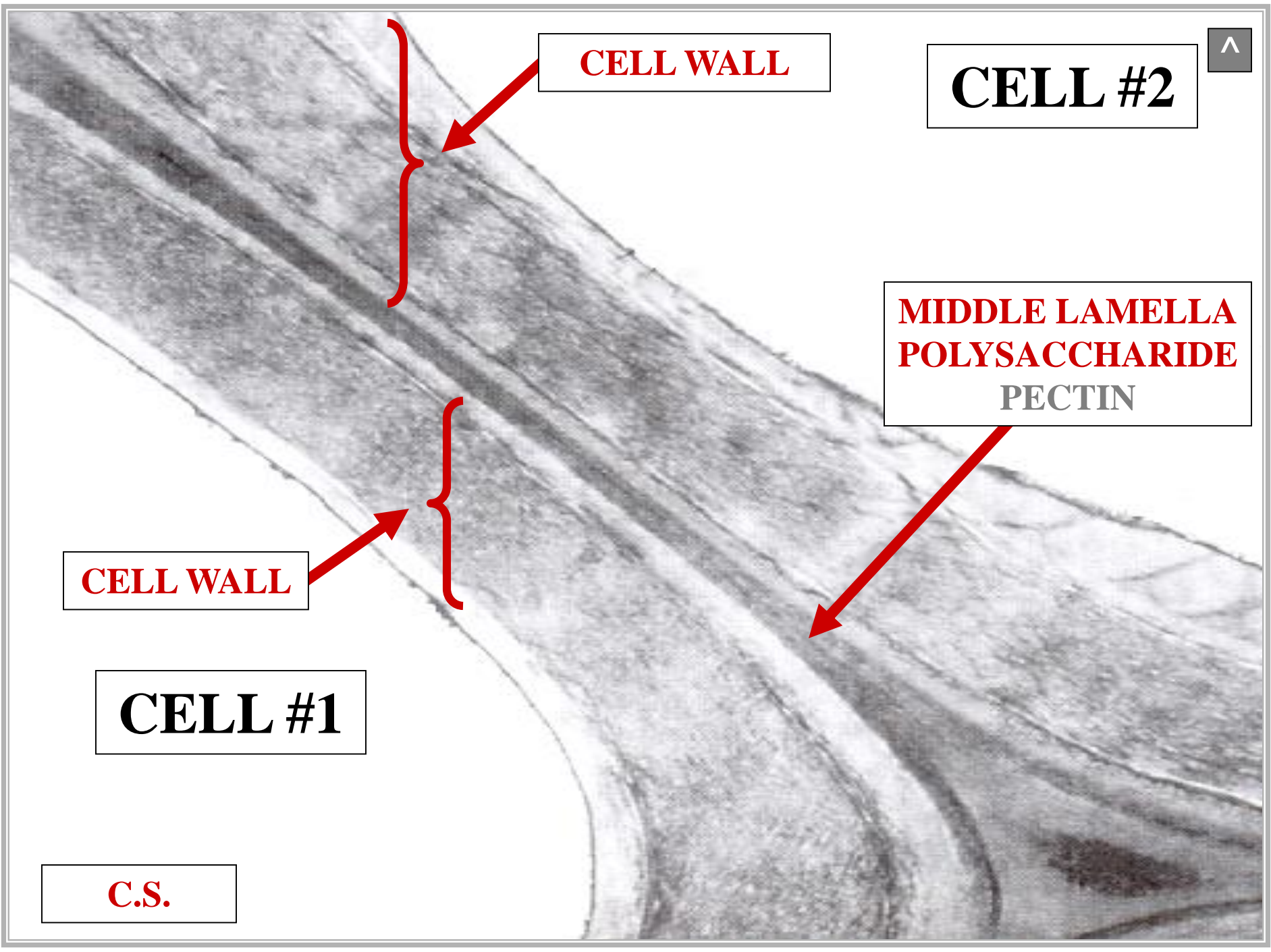
**MIDDLE LAMELLA**

**CELL WALL**

**CELL #1**

**C.S.**





**CELL WALL**

**CELL #2**

**MIDDLE LAMELLA  
POLYSACCHARIDE  
PECTIN**

**CELL WALL**

**CELL #1**

**C.S.**



# CELL WALL

**CELL WALL**



**CELL WALL**

**NON-LIVING RIGID LAYER**

**CELL WALL**



# **CELL WALL**

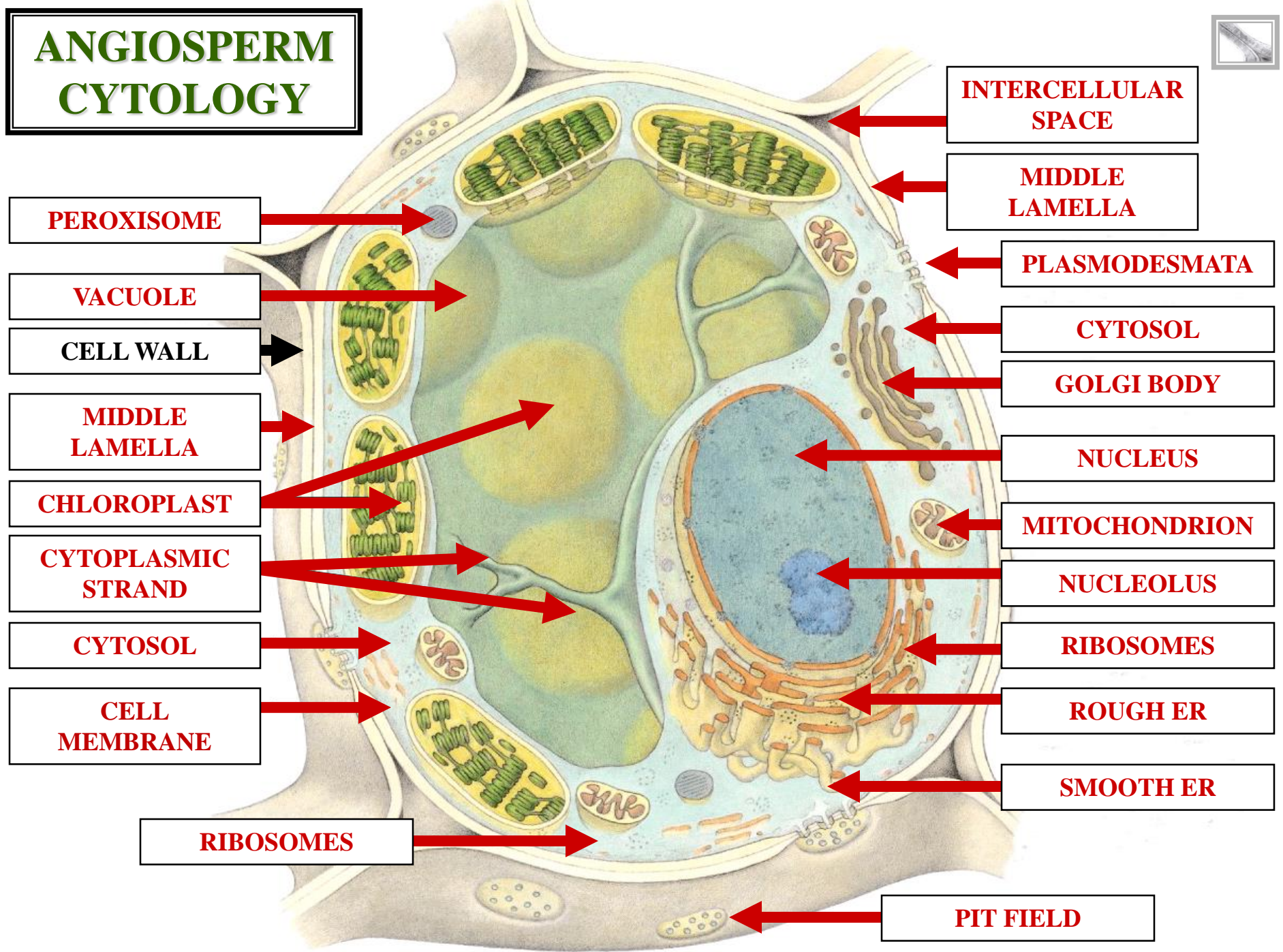
**NON-LIVING RIGID LAYER**

**---**

**SUPPORTS & PROTECTS  
CELL**

**CELL WALL**

# ANGIOSPERM CYTOLOGY



**PEROXISOME**

**VACUOLE**

**CELL WALL**

**MIDDLE LAMELLA**

**CHLOROPLAST**

**CYTOPLASMIC STRAND**

**CYTOSOL**

**CELL MEMBRANE**

**RIBOSOMES**

**INTERCELLULAR SPACE**

**MIDDLE LAMELLA**

**PLASMODESMATA**

**CYTOSOL**

**GOLGI BODY**

**NUCLEUS**

**MITOCHONDRION**

**NUCLEOLUS**

**RIBOSOMES**

**ROUGH ER**

**SMOOTH ER**

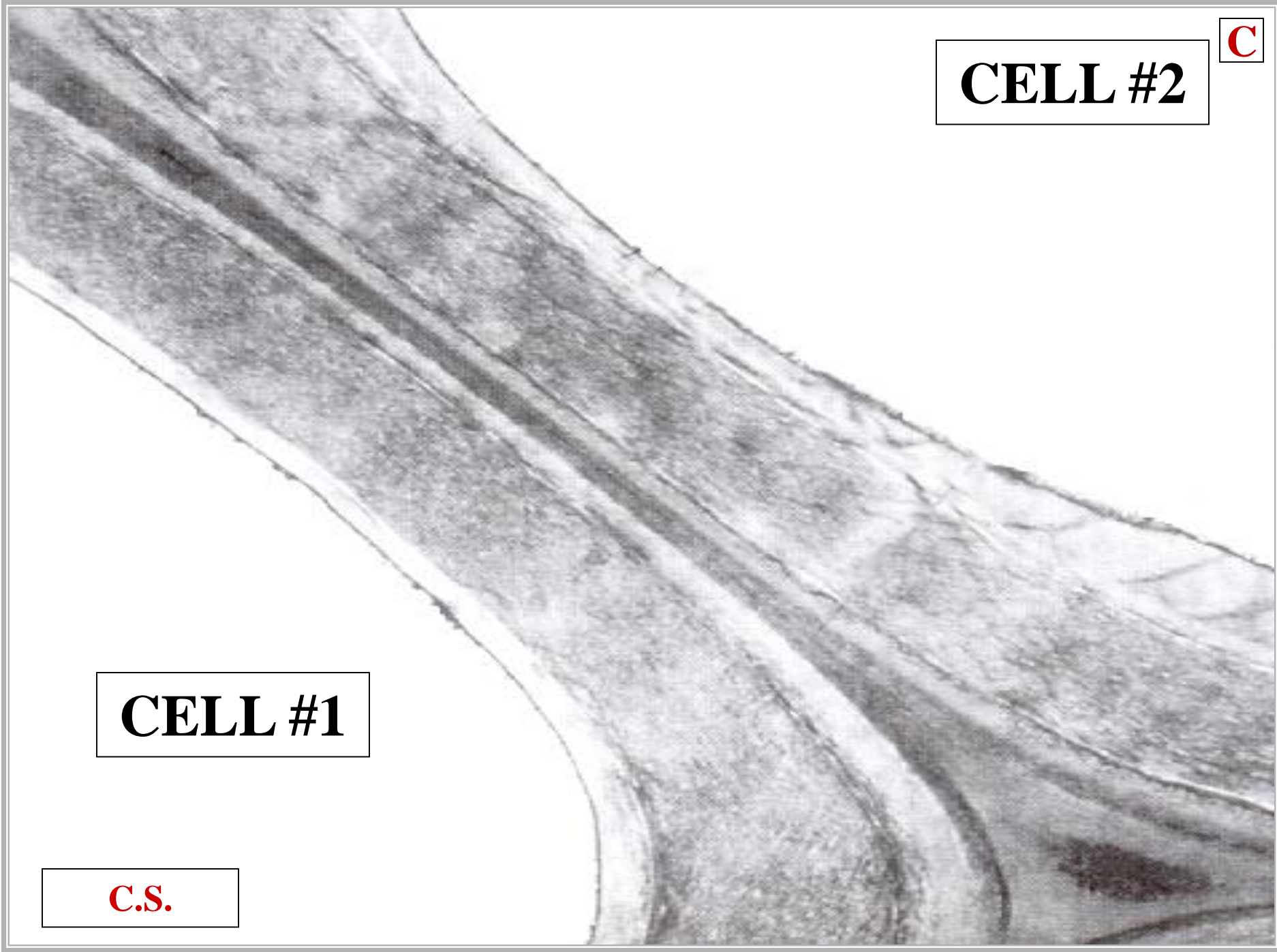
**PIT FIELD**

**CELL #2**

**C**

**CELL #1**

**C.S.**



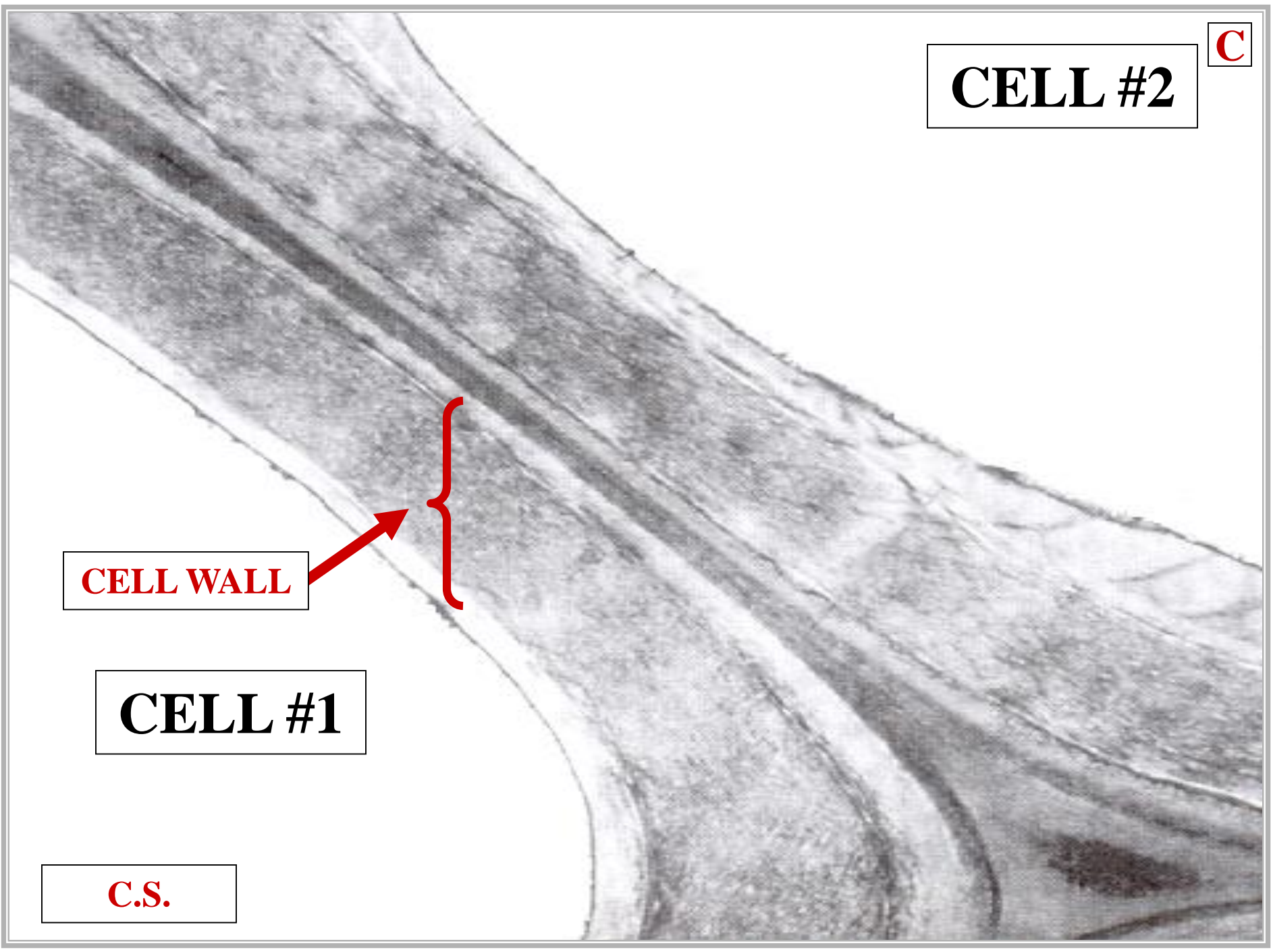
**CELL #2**

**C**

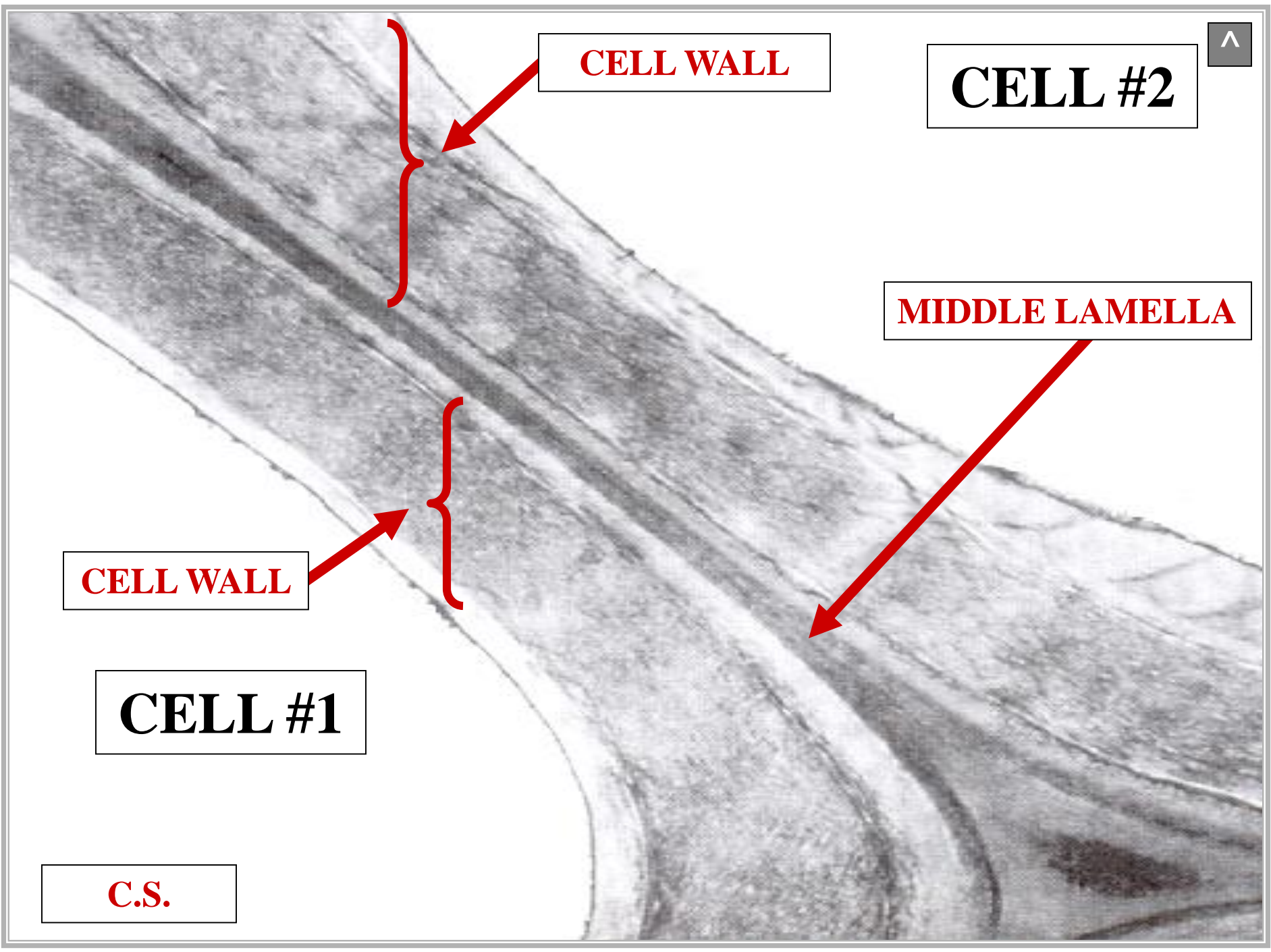
**CELL WALL**

**CELL #1**

**C.S.**







**CELL WALL**

**CELL #2**



**MIDDLE LAMELLA**

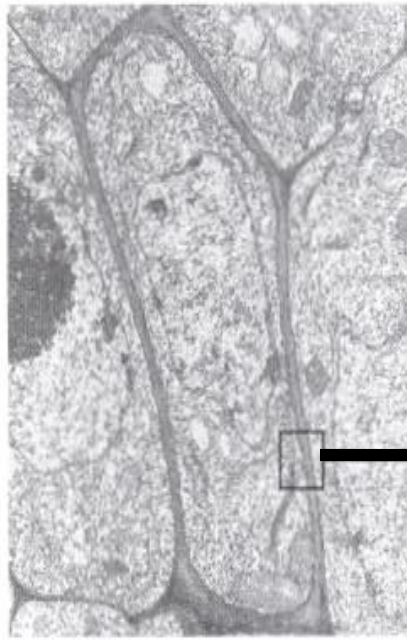
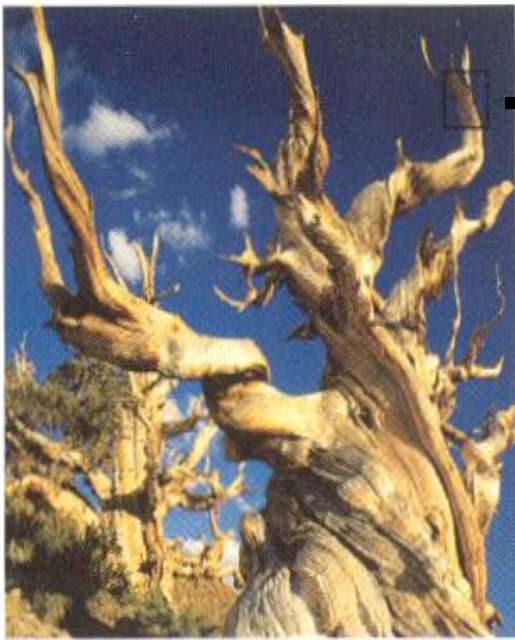
**CELL WALL**

**CELL #1**

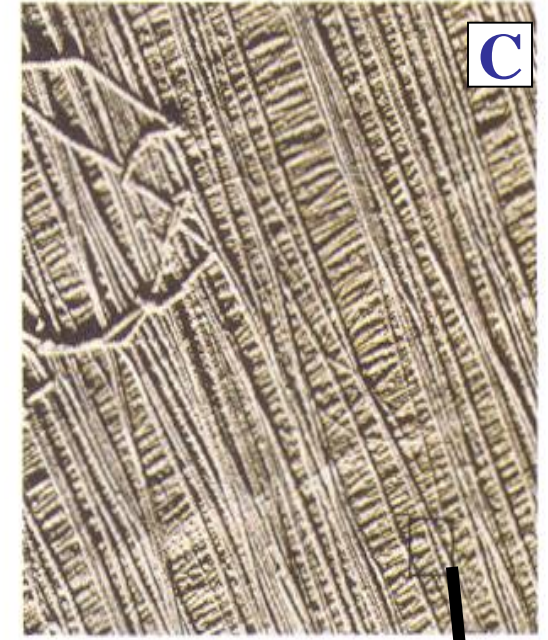
**C.S.**



# CELL WALL COMPOSITION

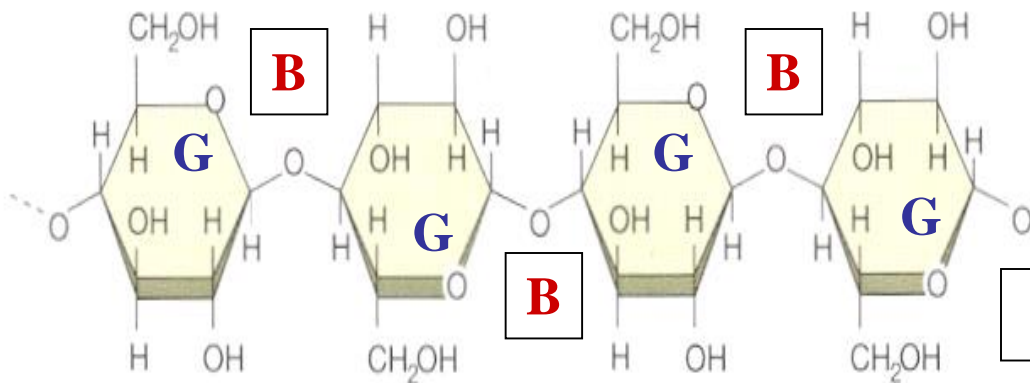
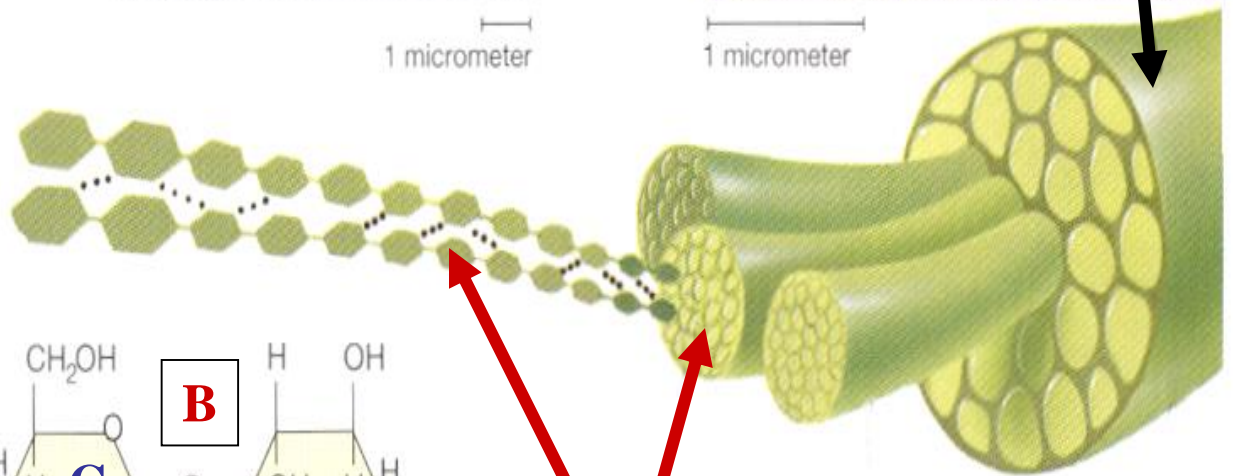


1 micrometer



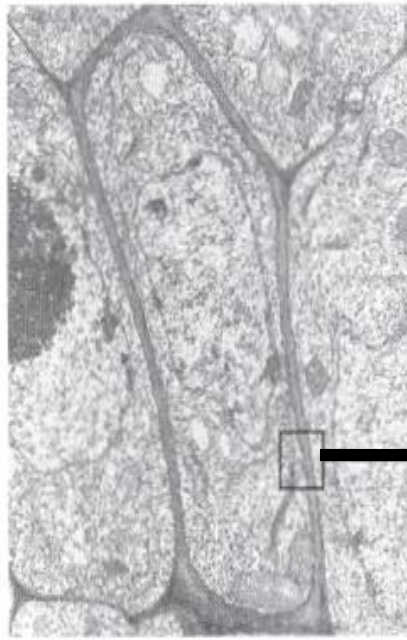
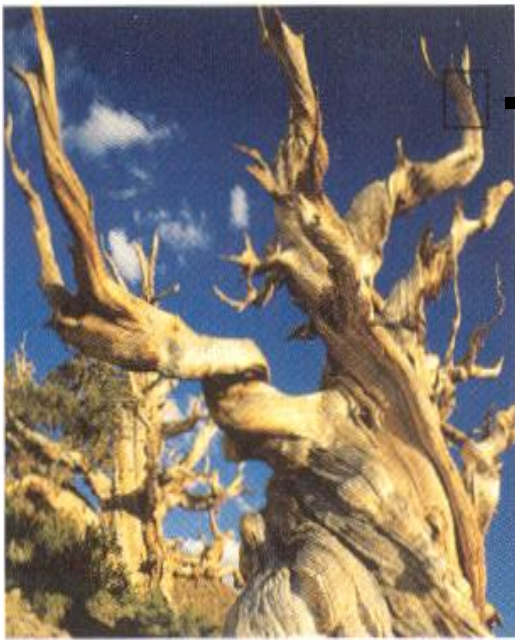
1 micrometer

# ANGIOSPERM CELL WALL



?

**G = GLUCOSE**  
**B = BETA BOND**



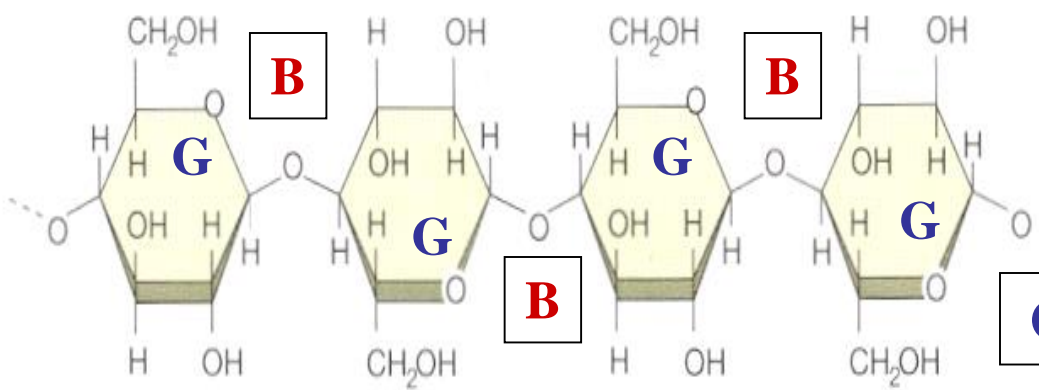
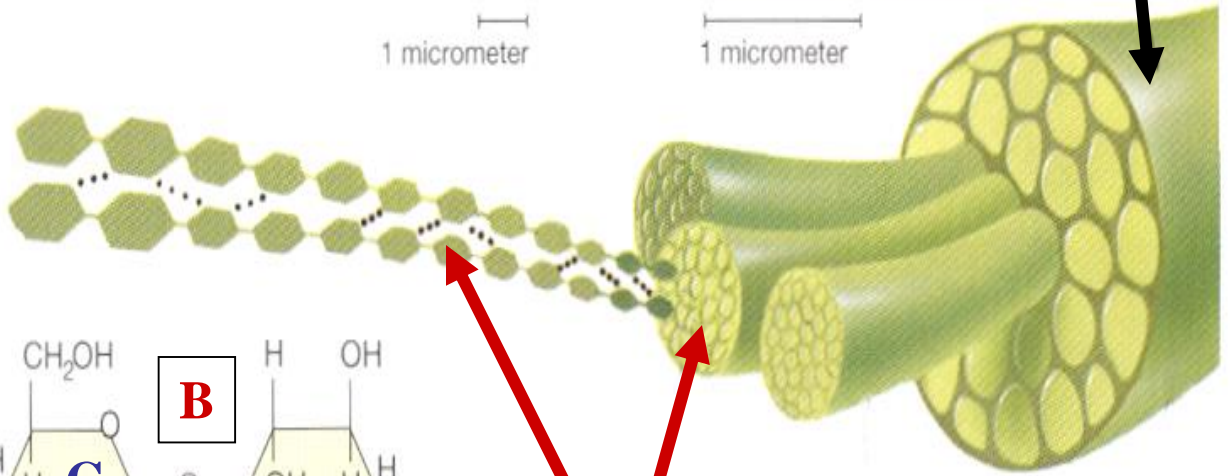
1 micrometer



C

1 micrometer

# ANGIOSPERM CELL WALL



# CELLULOSE

**G = GLUCOSE**  
**B = BETA BOND**

**CELLULOSE**

**CELL WALL  
CELLULOSE**



**C**

**GLUCOSE POLYMER**

**CELL WALL  
CELLULOSE**



**MICELLE**

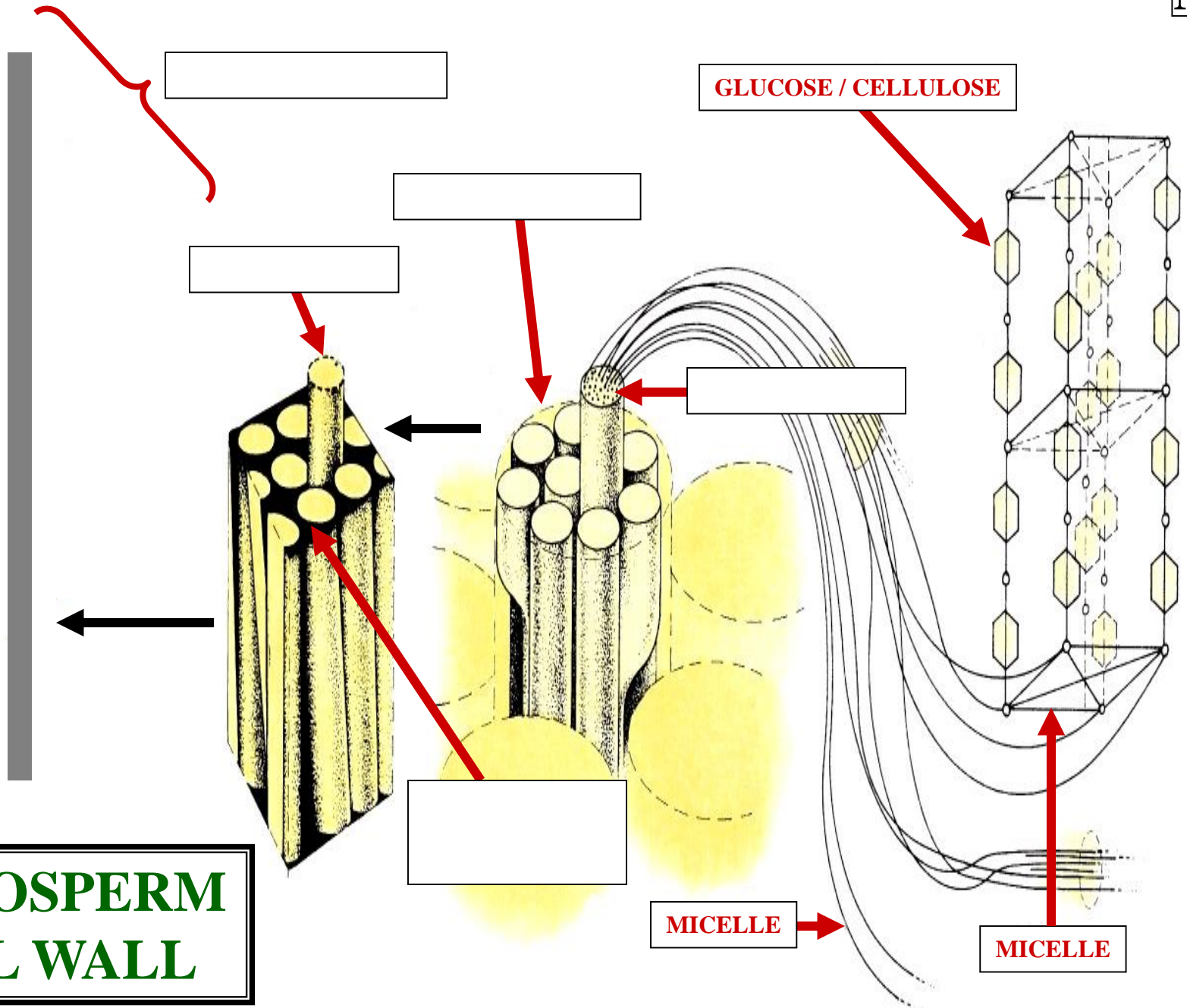




**CELL WALL  
MICELL**

**GLUCOSE  
CELLULOSE  
ASSEMBLAGE**

**CELL WALL  
MICELL**



**ANGIOSPERM  
CELL WALL**

**GLUCOSE / CELLULOSE**

**MICELLE**

**MICELLE**

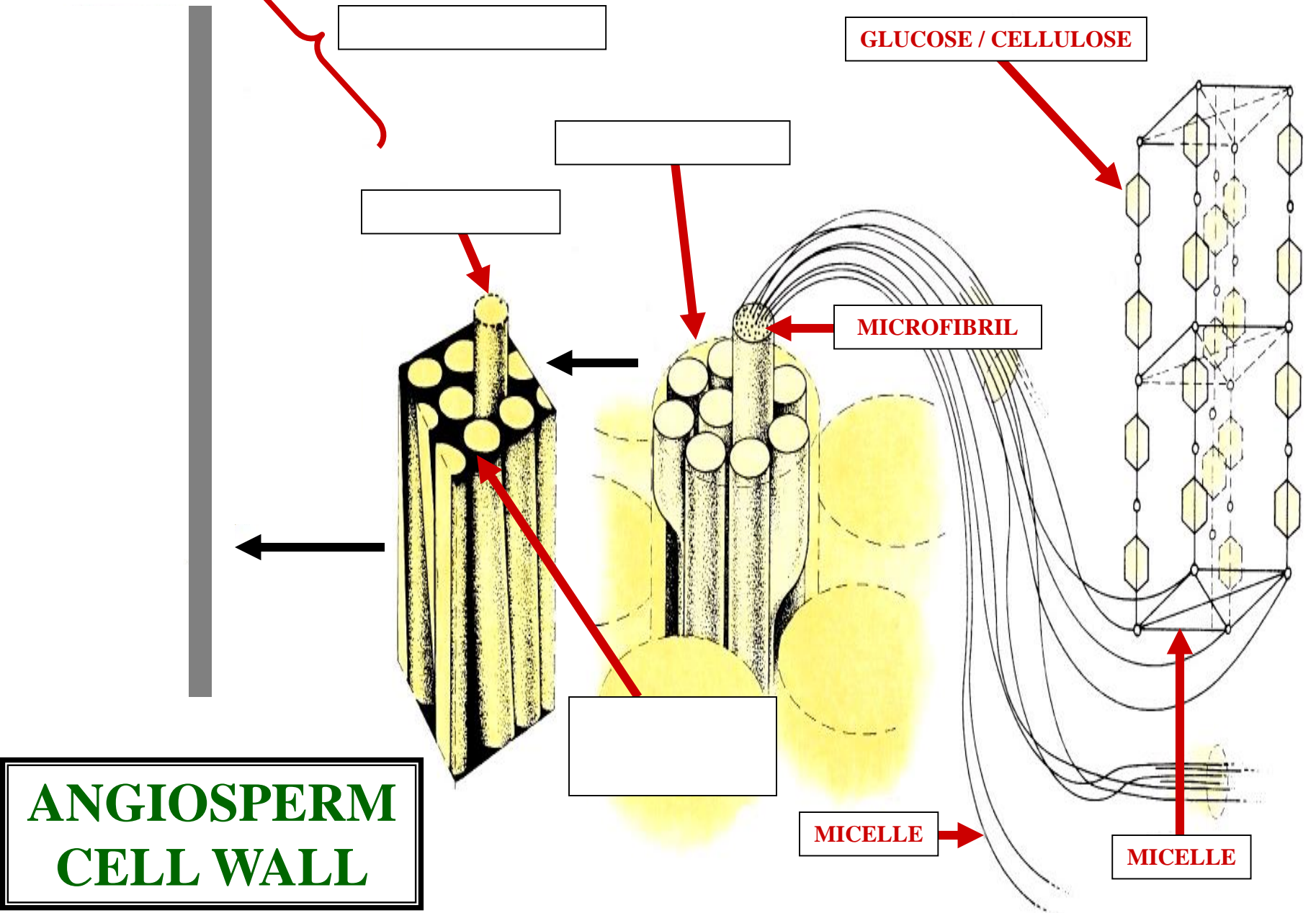
**MICROFIBRIL**



**CELL WALL  
MICROFIBRIL**

**AGGREGATED  
MICELLES**

**CELL WALL  
MICROFIBRIL**



**HEMICELLULOSE**



**CELL WALL  
HEMICELLULOSE**

**FLEXIBLE-GLUE**

**CELL WALL  
HEMICELLULOSE**



**CELL WALL  
HEMICELLULOSE**

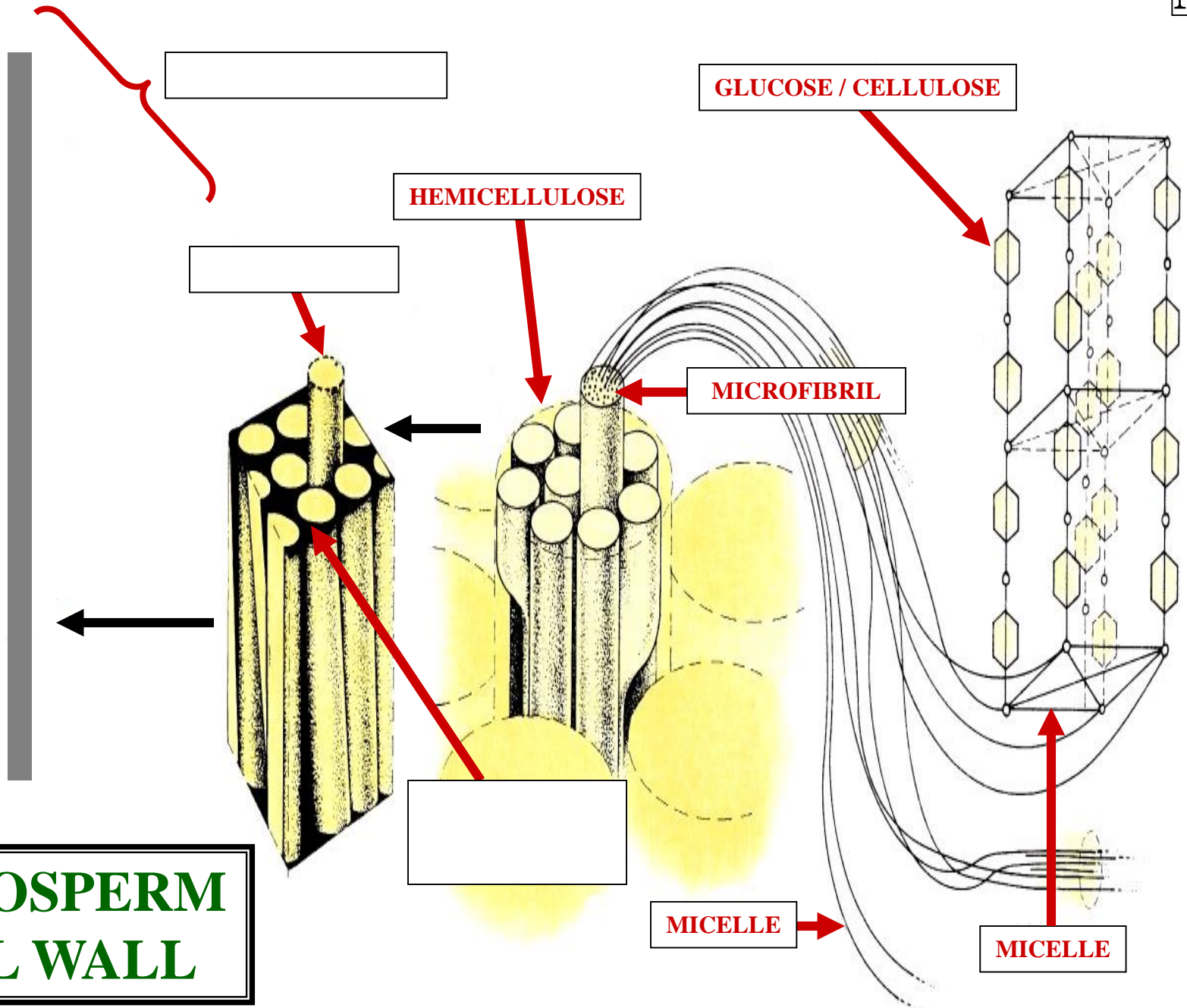
**FLEXIBLE-GLUE**

**---**

**BONDS MICROFIBRILS**

**CELL WALL  
HEMICELLULOSE**





**ANGIOSPERM  
CELL WALL**

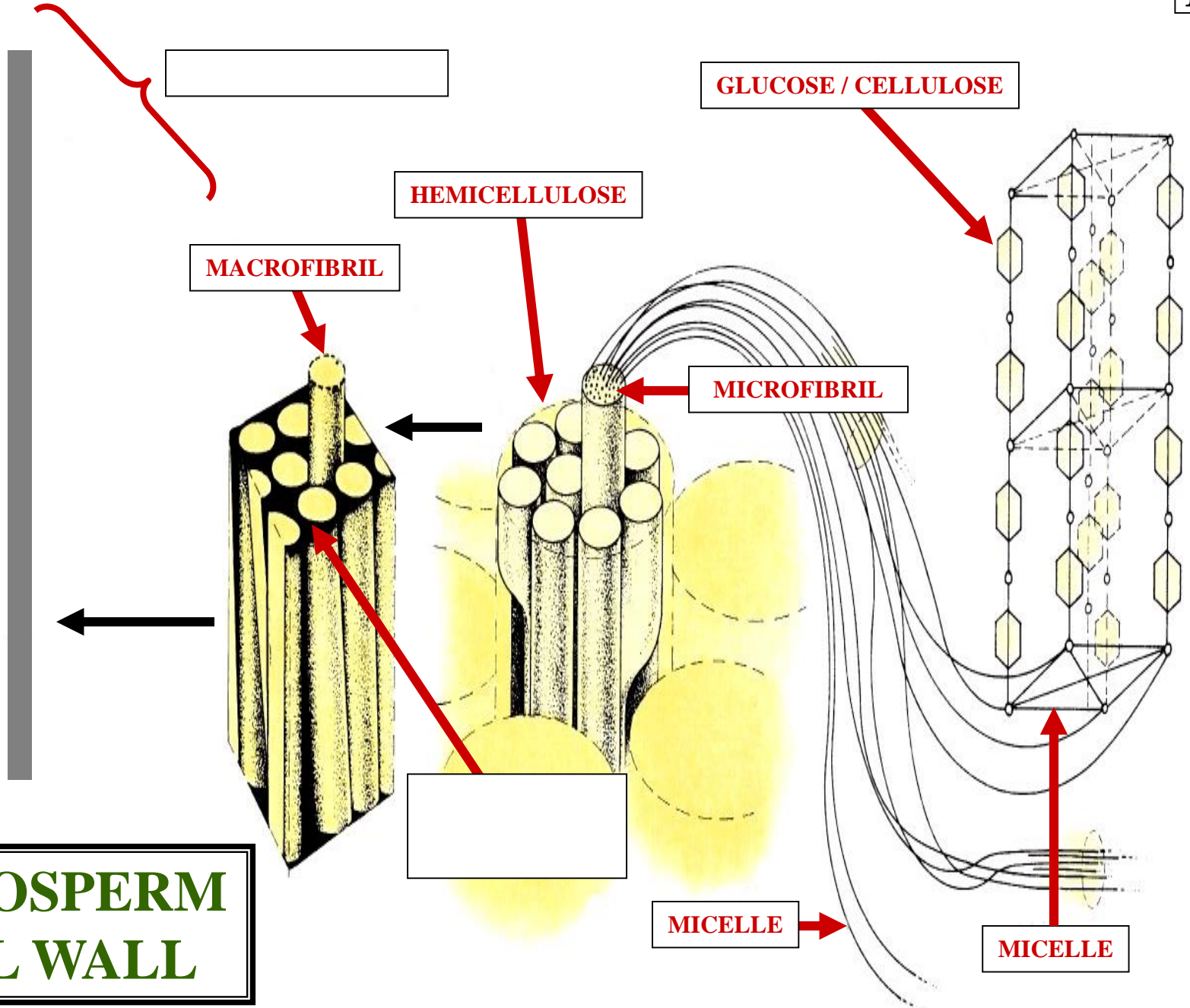
**MACROFIBRIL**



**CELL WALL  
MACROFIBRIL**

**AGGREGATED  
MICROFIBRILS**

**CELL WALL  
MACROFIBRIL**



**ANGIOSPERM  
CELL WALL**

[Empty box]

**GLUCOSE / CELLULOSE**

**HEMICELLULOSE**

**MACROFIBRIL**

**MICROFIBRIL**

[Empty box]

**MICELLE**

**MICELLE**

**PECTIN**



**CELL WALL  
PECTIN**

**FLEXIBLE-GLUE**

**CELL WALL  
PECTIN**

**CELL WALL  
PECTIN**

**FLEXIBLE-GLUE**

**---**

**BONDS MACROFIBRILS**

**CELL WALL  
PECTIN**

**LIGNIN**





**CELL WALL  
LIGNIN**

**RIGID-GLUE**

**CELL WALL  
LIGNIN**

**CELL WALL  
LIGNIN**



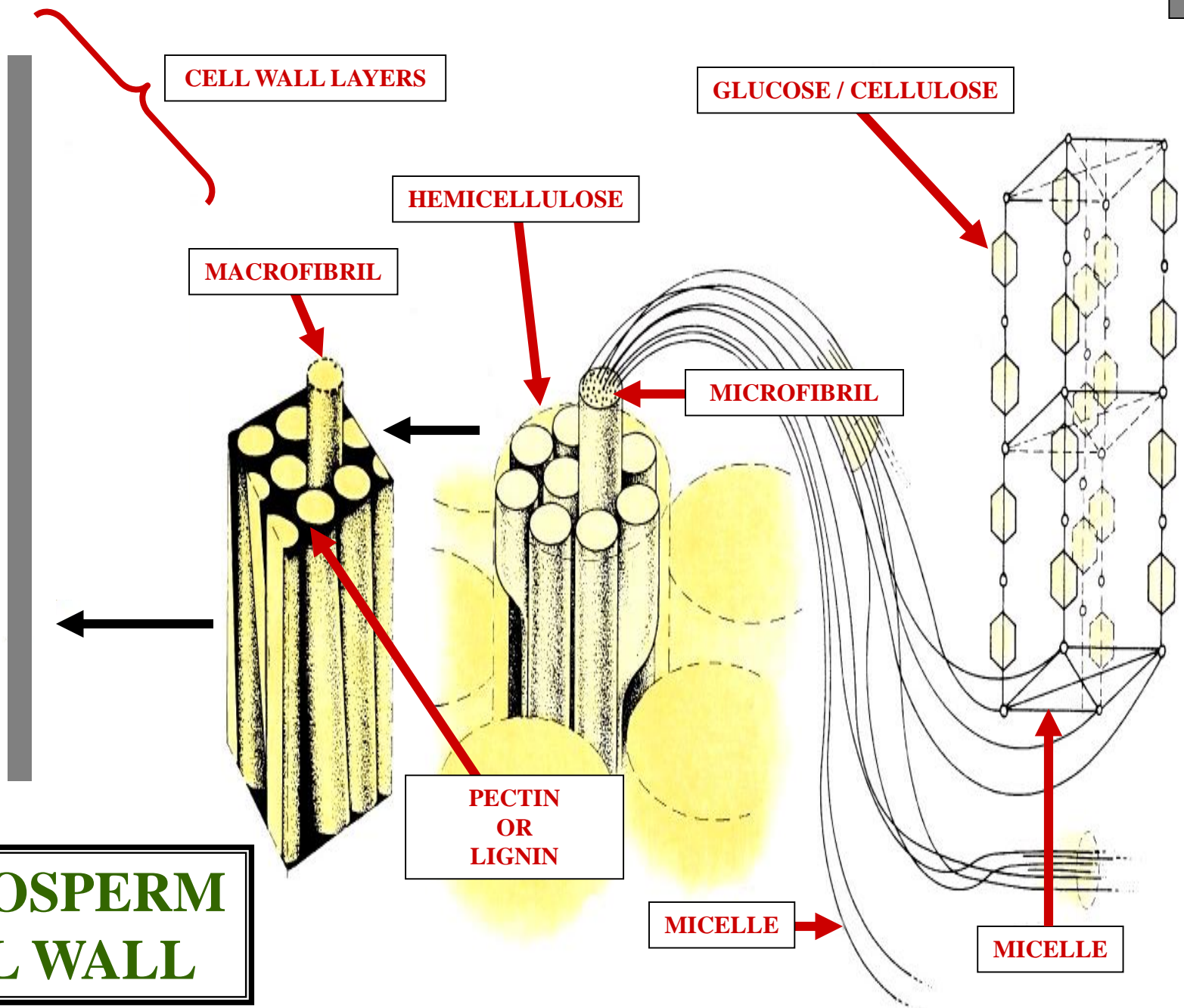
**CW**

**RIGID-GLUE**

**---**

**BONDS MACROFIBRILS**

**CELL WALL  
LIGNIN**



**ANGIOSPERM  
CELL WALL**



# CELL WALL LAYERS

# PRIMARY CELL WALL

# **PRIMARY CELL WALL**



# **PRIMARY CELL WALL**

**DERIVED DURING CELL GROWTH**

# **PRIMARY CELL WALL**



# **PRIMARY CELL WALL**

**DERIVED DURING CELL GROWTH  
HIGH PECTIN CONTENT**

# **PRIMARY CELL WALL**





# **PRIMARY CELL WALL**

**DERIVED DURING CELL GROWTH  
HIGH PECTIN CONTENT  
FLEXIBLE WALL**

# **PRIMARY CELL WALL**



# **PRIMARY CELL WALL**

**DERIVED DURING CELL GROWTH**  
**HIGH PECTIN CONTENT**  
**FLEXIBLE WALL**  
**ALWAYS PRESENT**

# **PRIMARY CELL WALL**

# PRIMARY CELL WALL

P

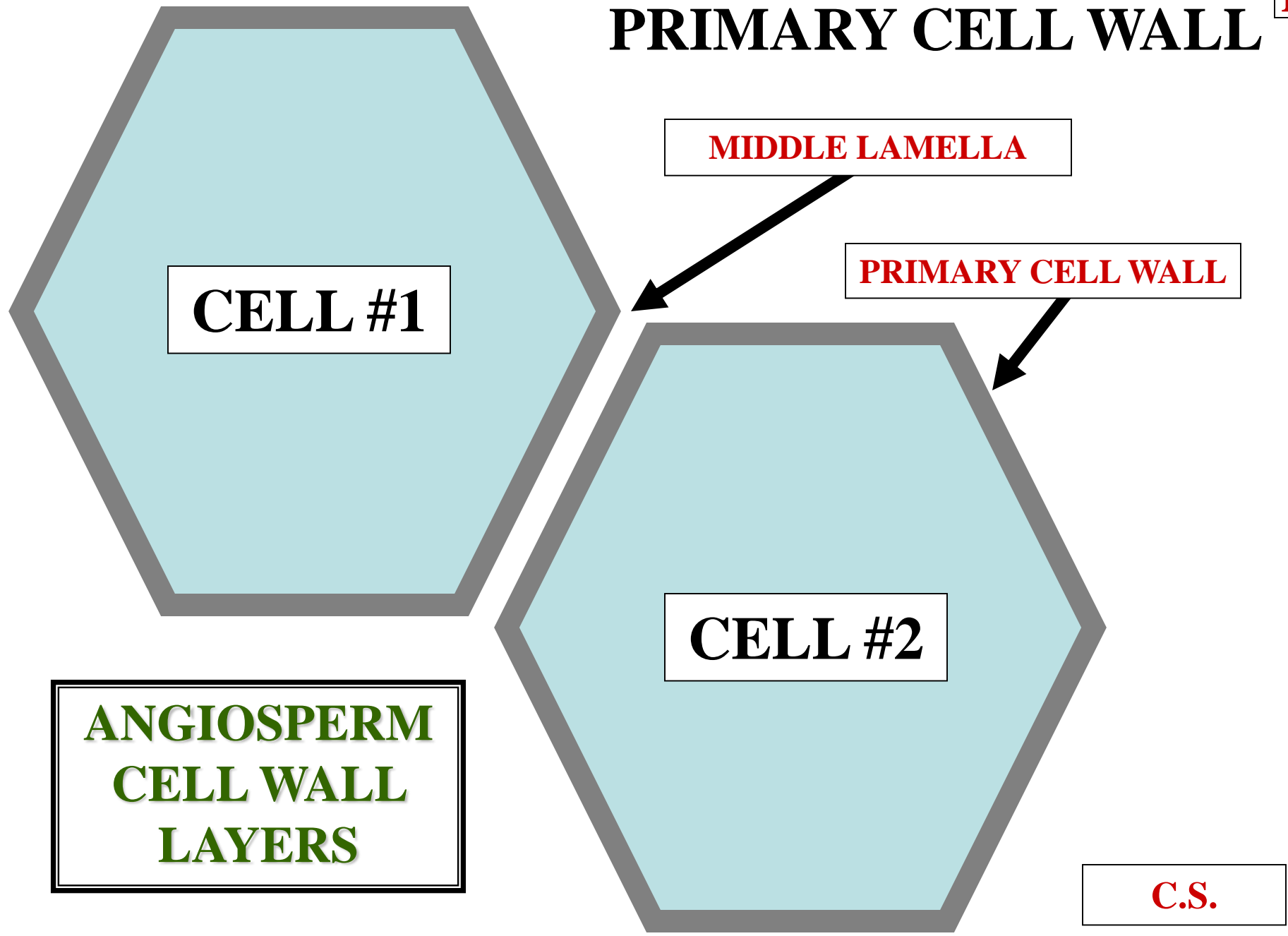
**CELL #1**

**CELL #2**

**ANGIOSPERM  
CELL WALL  
LAYERS**

**C.S.**

# PRIMARY CELL WALL



**CELL #1**

**MIDDLE LAMELLA**

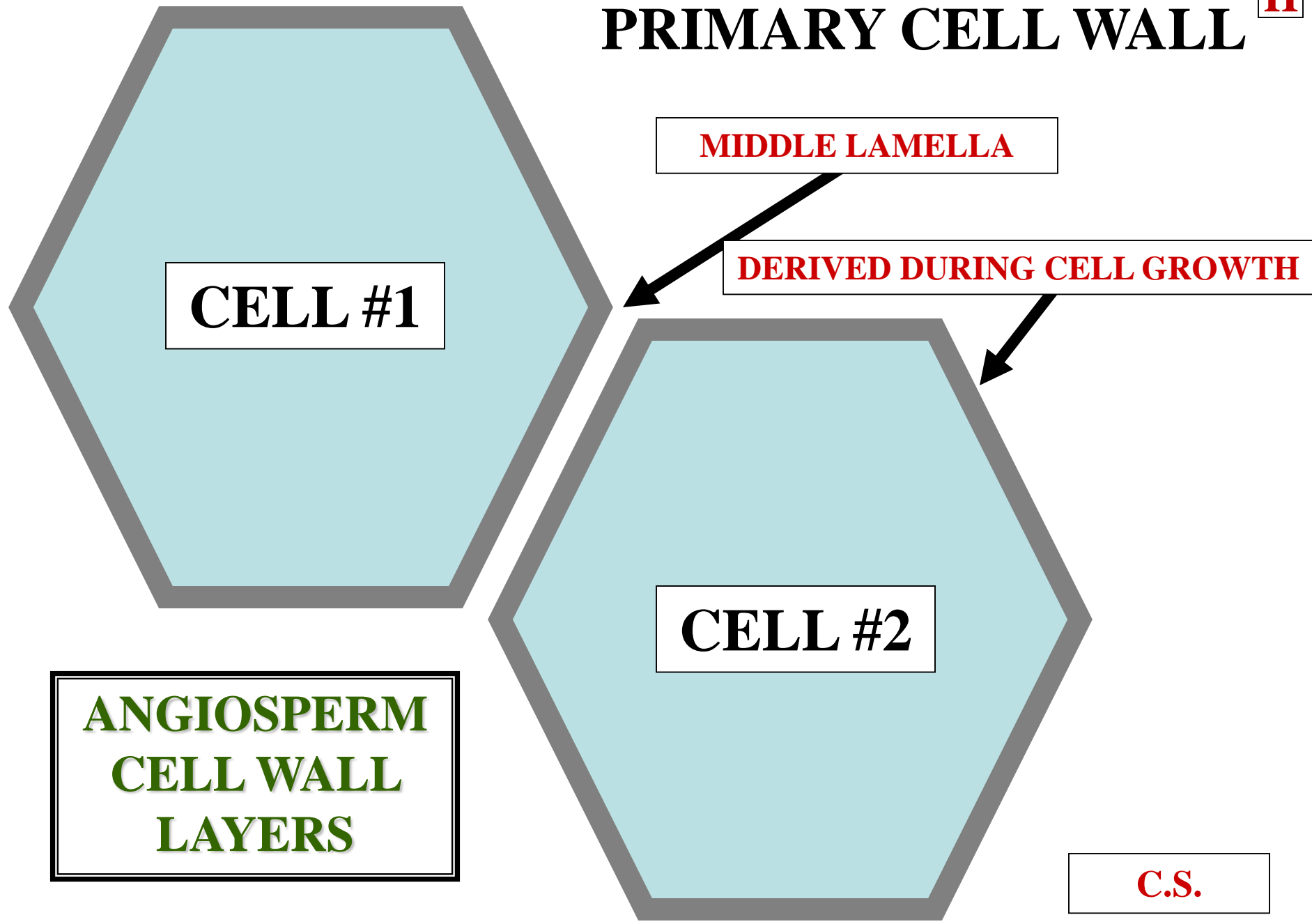
**PRIMARY CELL WALL**

**CELL #2**

**ANGIOSPERM  
CELL WALL  
LAYERS**

**C.S.**

# PRIMARY CELL WALL



**CELL #1**

**MIDDLE LAMELLA**

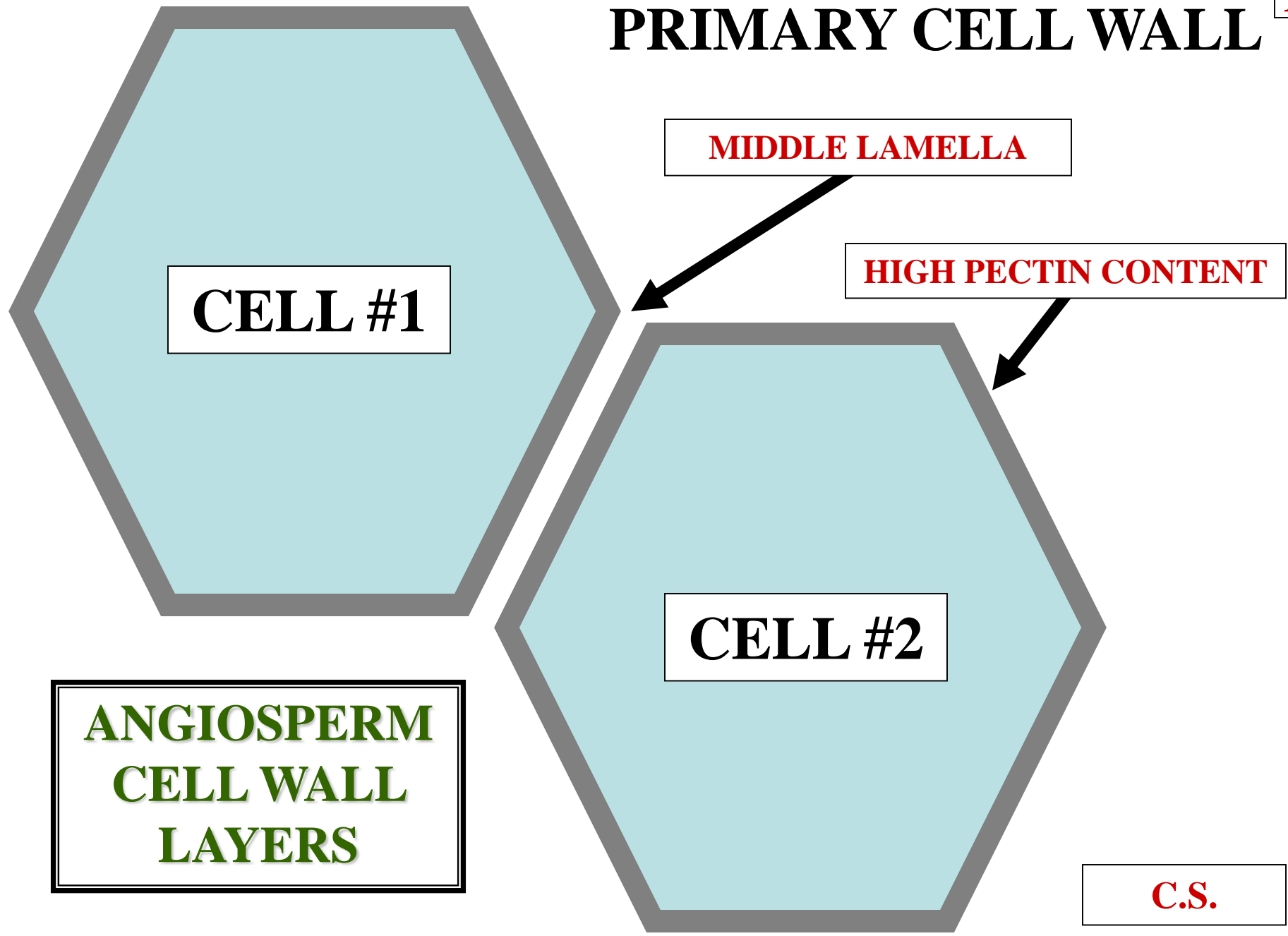
**DERIVED DURING CELL GROWTH**

**CELL #2**

**ANGIOSPERM  
CELL WALL  
LAYERS**

**C.S.**

# PRIMARY CELL WALL



**CELL #1**

**MIDDLE LAMELLA**

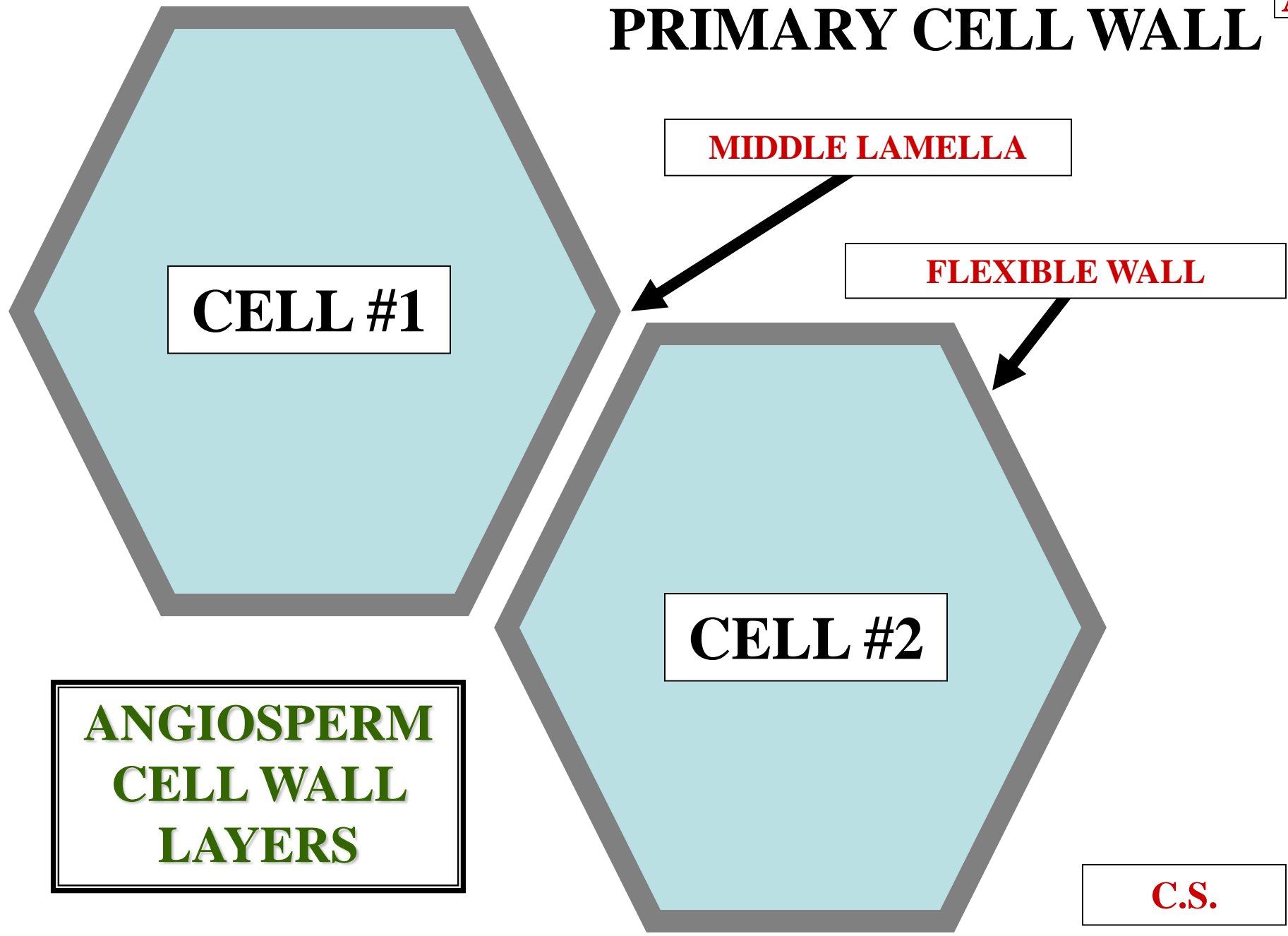
**HIGH PECTIN CONTENT**

**CELL #2**

**ANGIOSPERM  
CELL WALL  
LAYERS**

**C.S.**

# PRIMARY CELL WALL



**CELL #1**

**MIDDLE LAMELLA**

**FLEXIBLE WALL**

**CELL #2**

**ANGIOSPERM  
CELL WALL  
LAYERS**

**C.S.**

# PRIMARY CELL WALL

S

1

CELL #1

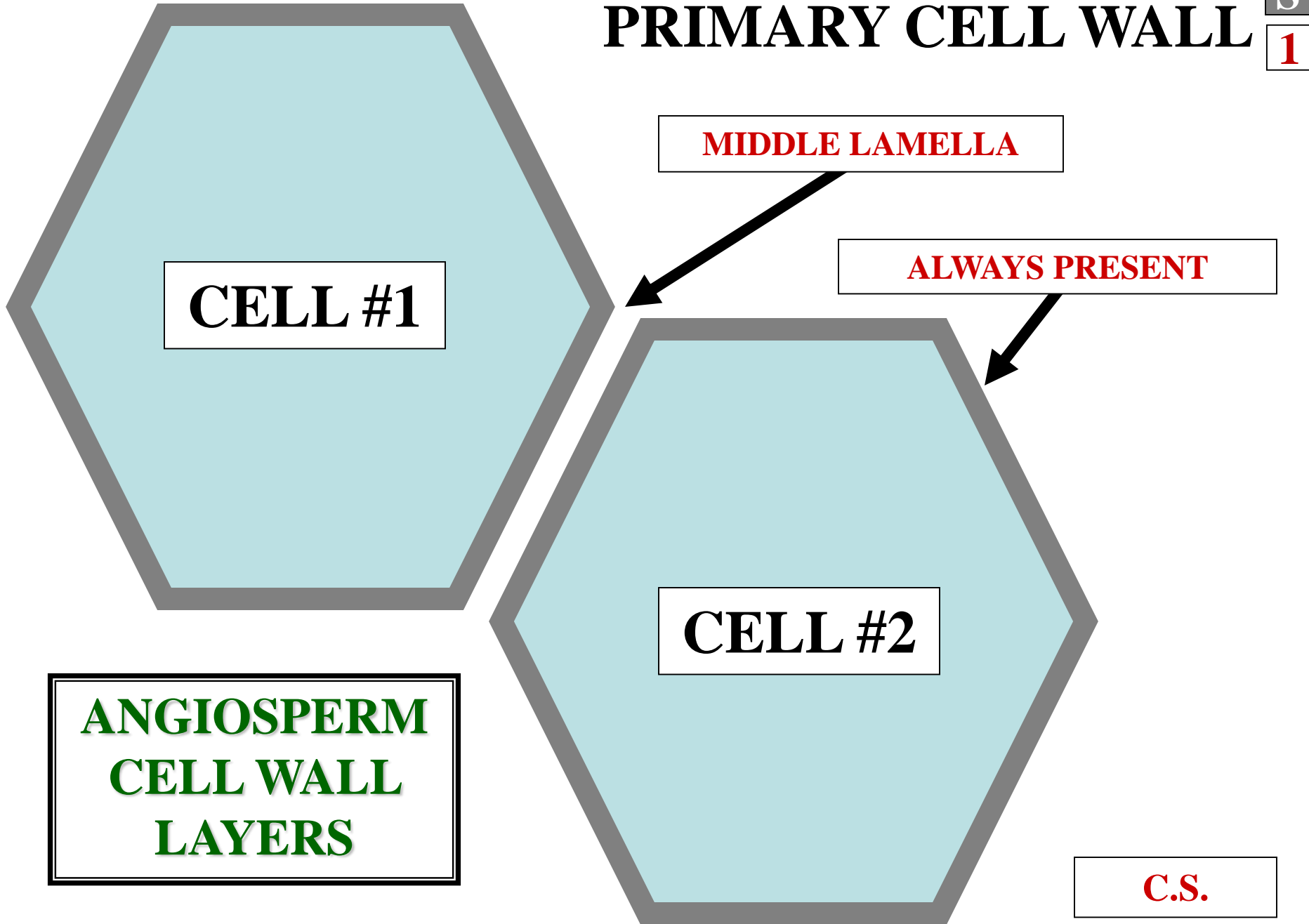
MIDDLE LAMELLA

ALWAYS PRESENT

CELL #2

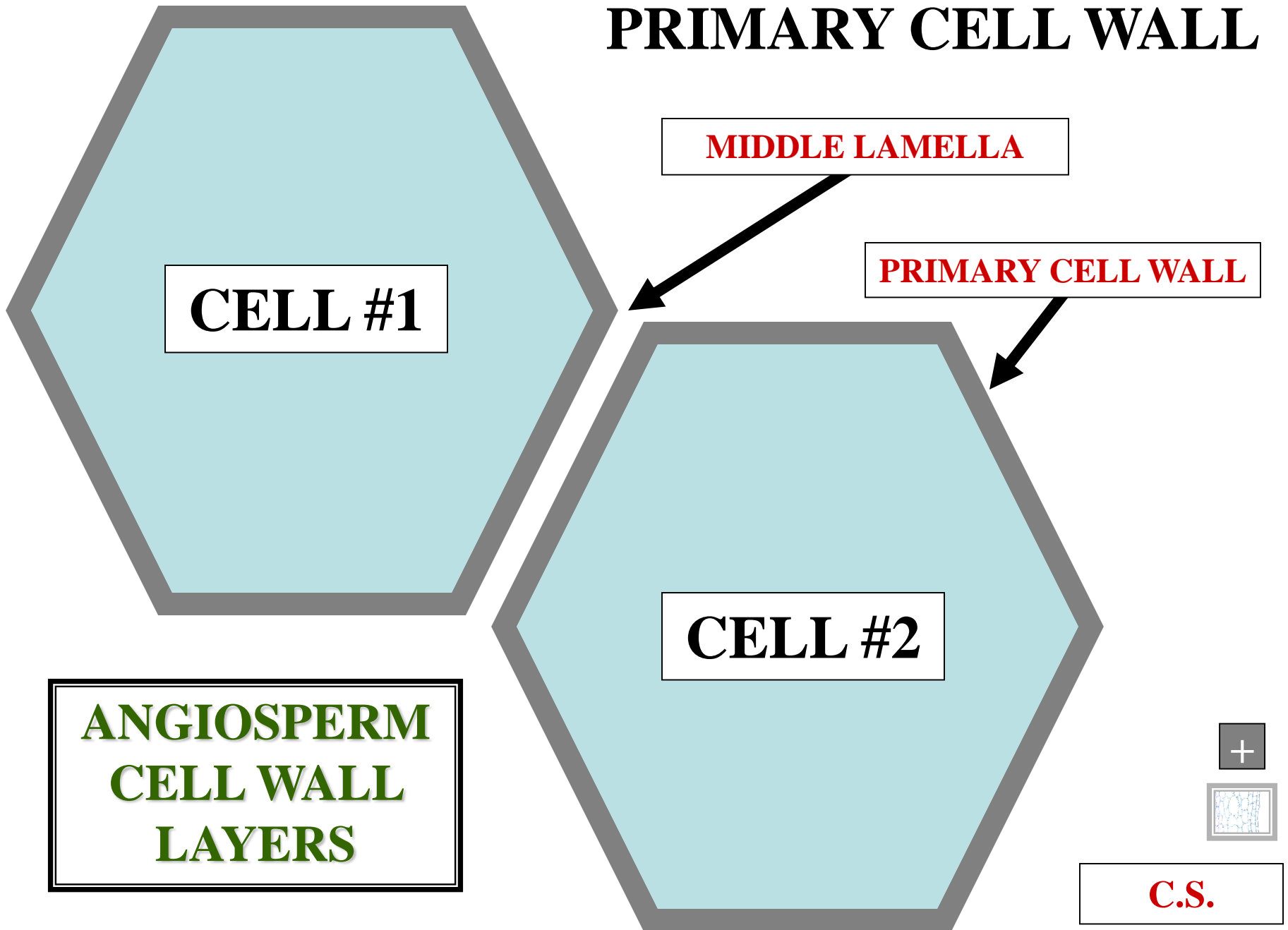
ANGIOSPERM  
CELL WALL  
LAYERS

C.S.





# PRIMARY CELL WALL



**CELL #1**

**MIDDLE LAMELLA**

**PRIMARY CELL WALL**

**CELL #2**

**ANGIOSPERM  
CELL WALL  
LAYERS**

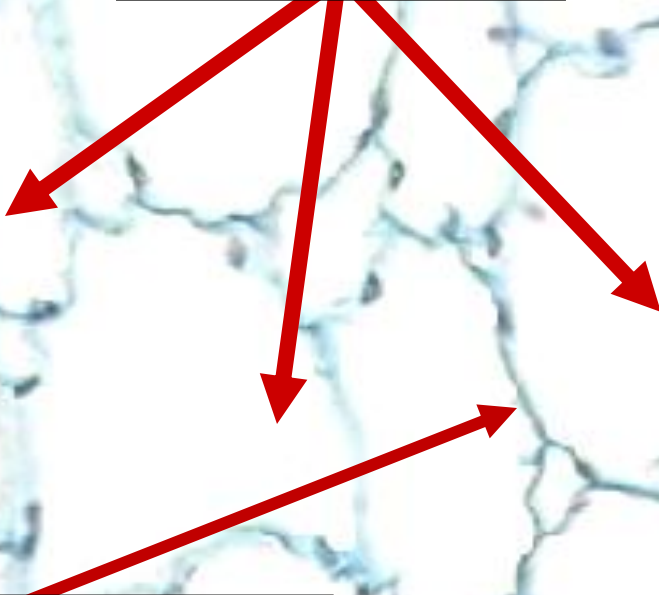
**C.S.**



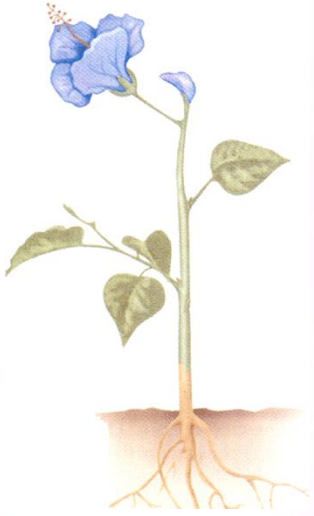
**C.S.**

**STEM**

**PARENCHYMA  
CELLS**



**PRIMARY CELL WALL**



# SECONDARY CELL WALL

# **SECONDARY CELL WALL**

# SECONDARY CELL WALL



DERIVED AFTER CELL GROWTH

# SECONDARY CELL WALL

# SECONDARY CELL WALL



DERIVED AFTER CELL GROWTH  
DEPOSITED INWARD OF ~1 WALL

# SECONDARY CELL WALL

# SECONDARY CELL WALL



DERIVED AFTER CELL GROWTH  
DEPOSITED INWARD OF ~1 WALL  
HIGH LIGNIN CONTENT

# SECONDARY CELL WALL



# SECONDARY CELL WALL

DERIVED AFTER CELL GROWTH  
DEPOSITED INWARD OF ~1 WALL  
HIGH LIGNIN CONTENT  
RIGID WALL

# SECONDARY CELL WALL



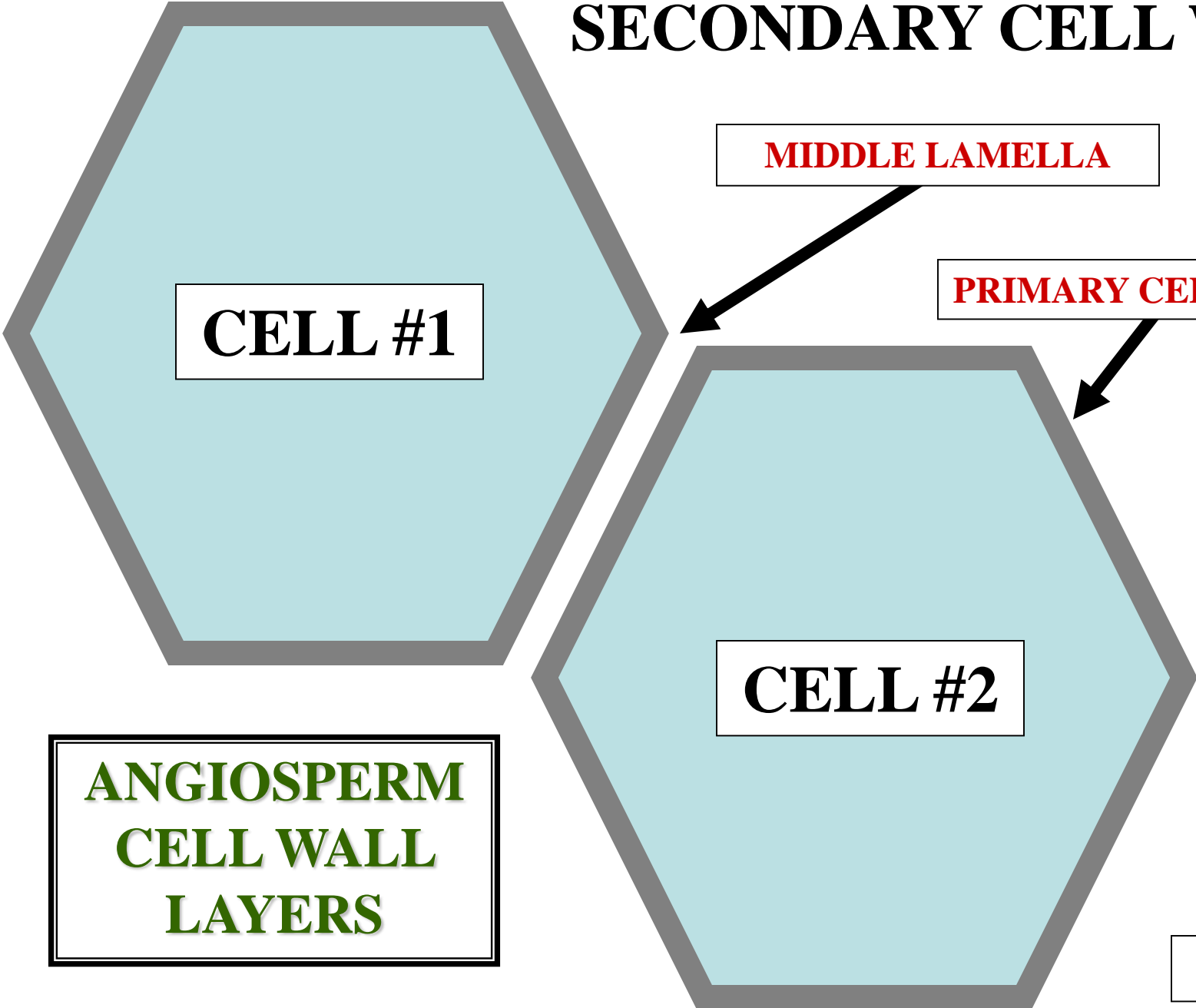


# **SECONDARY CELL WALL**

**DERIVED AFTER CELL GROWTH  
DEPOSITED INWARD OF ~1 WALL  
HIGH LIGNIN CONTENT  
RIGID WALL  
PRESENT OR ABSENT**

# **SECONDARY CELL WALL**

# SECONDARY CELL WALL



**CELL #1**

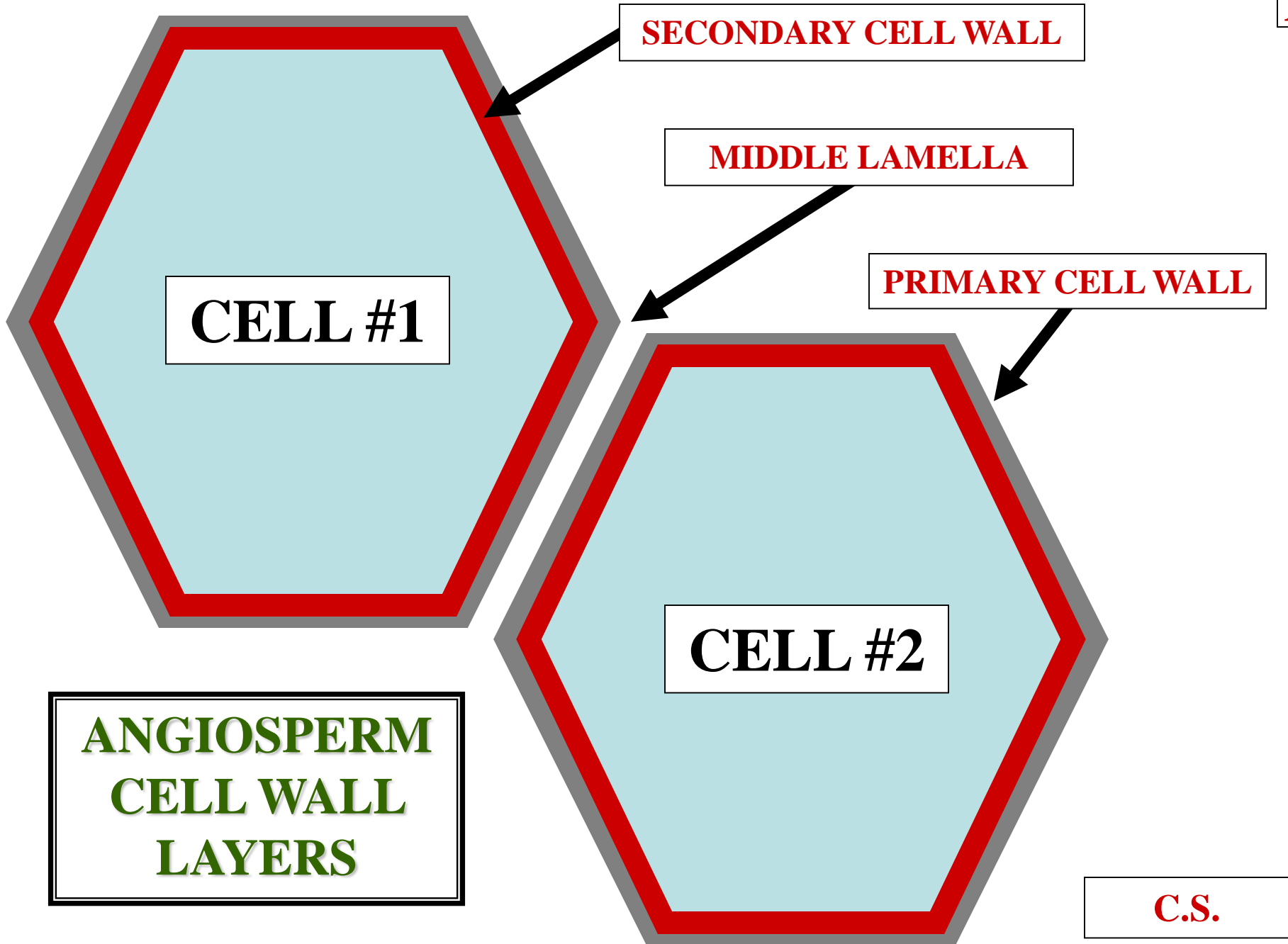
**MIDDLE LAMELLA**

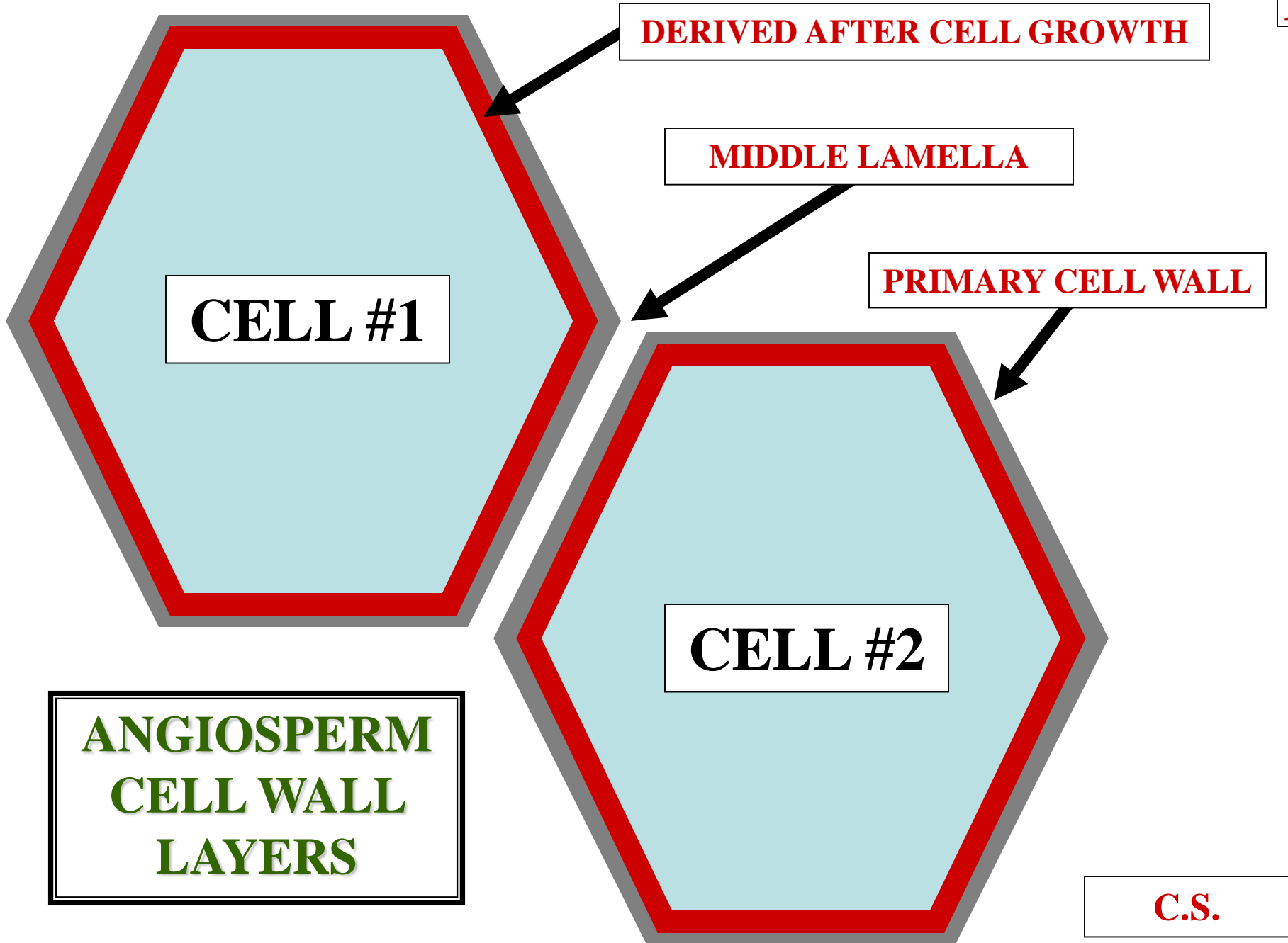
**PRIMARY CELL WALL**

**CELL #2**

**ANGIOSPERM  
CELL WALL  
LAYERS**

**C.S.**





DERIVED AFTER CELL GROWTH

MIDDLE LAMELLA

PRIMARY CELL WALL

CELL #1

CELL #2

ANGIOSPERM  
CELL WALL  
LAYERS

C.S.