

**ENATION THEORY**

**FRANK BOWER**

**ENATION**

# **MICROPHYLL ENATION**



**NON-VASCULAR  
PHOTOSYNTHETIC  
STEM OUTGROWTH**

# **MICROPHYLL ENATION**



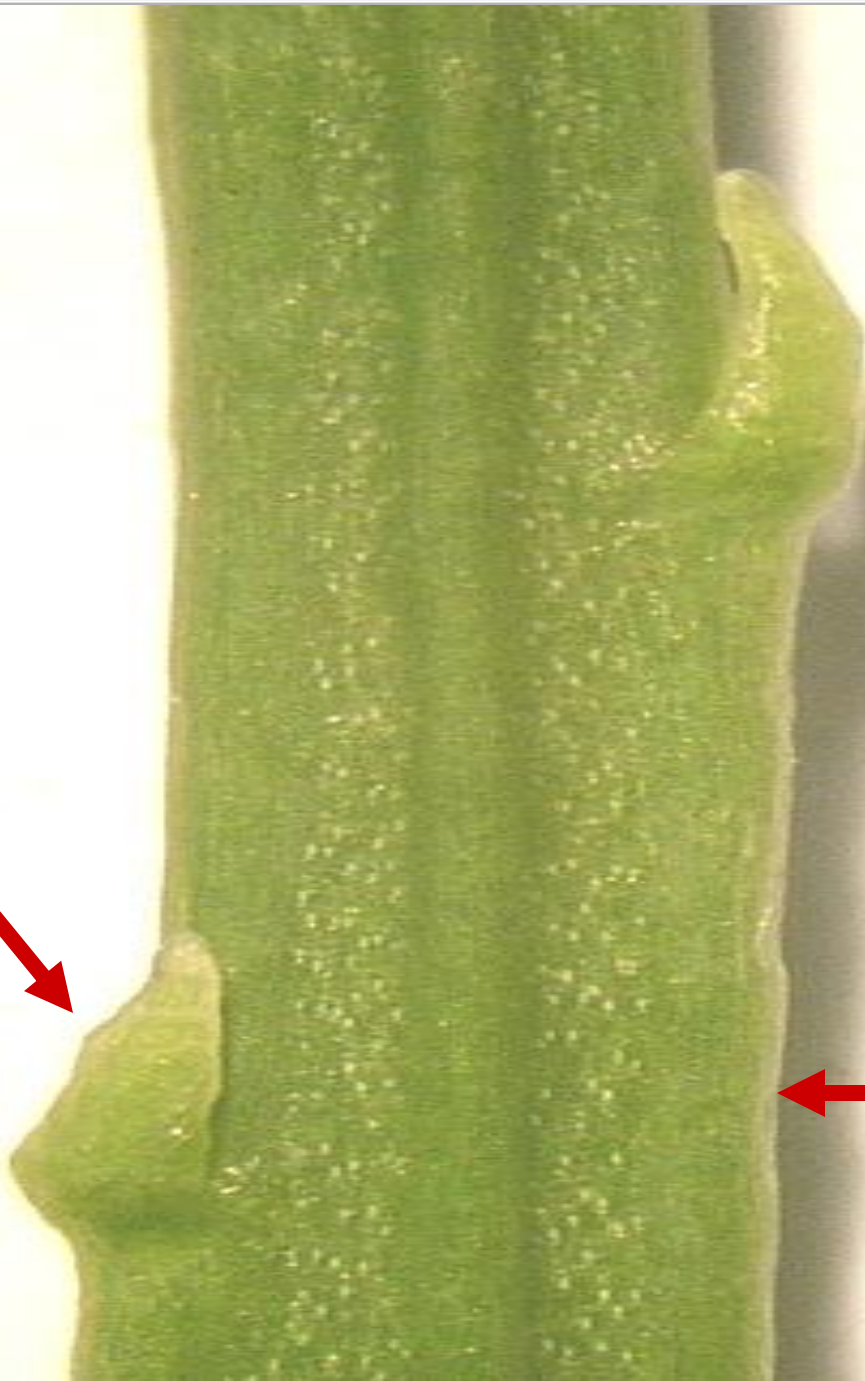
**ENATION**

**NON-VASCULAR**

**NON-VASCULAR**

**ENATION**

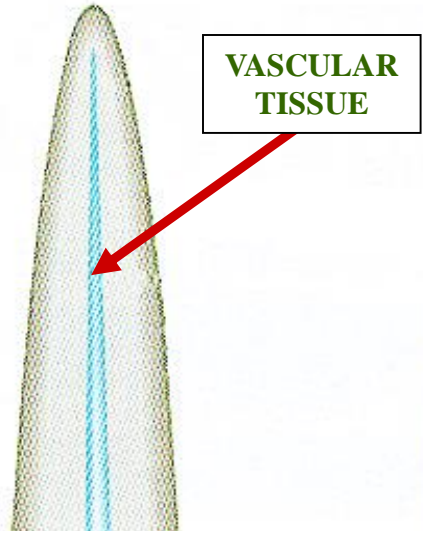
**STEM**





# ENATION THEORY COMPONENTS

# ENATION THEORY COMPONENTS

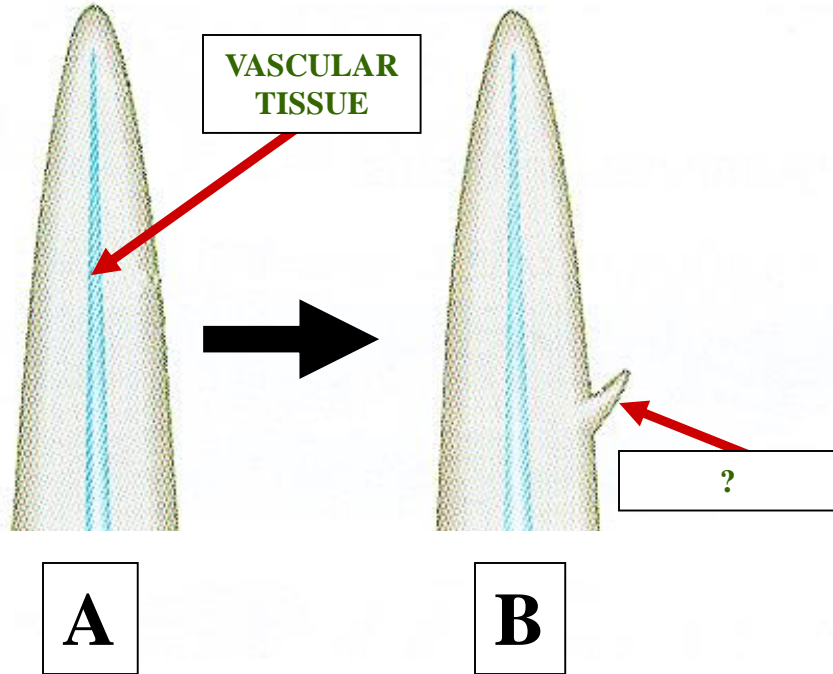


VASCULAR  
TISSUE

A

ENATION ABSENT

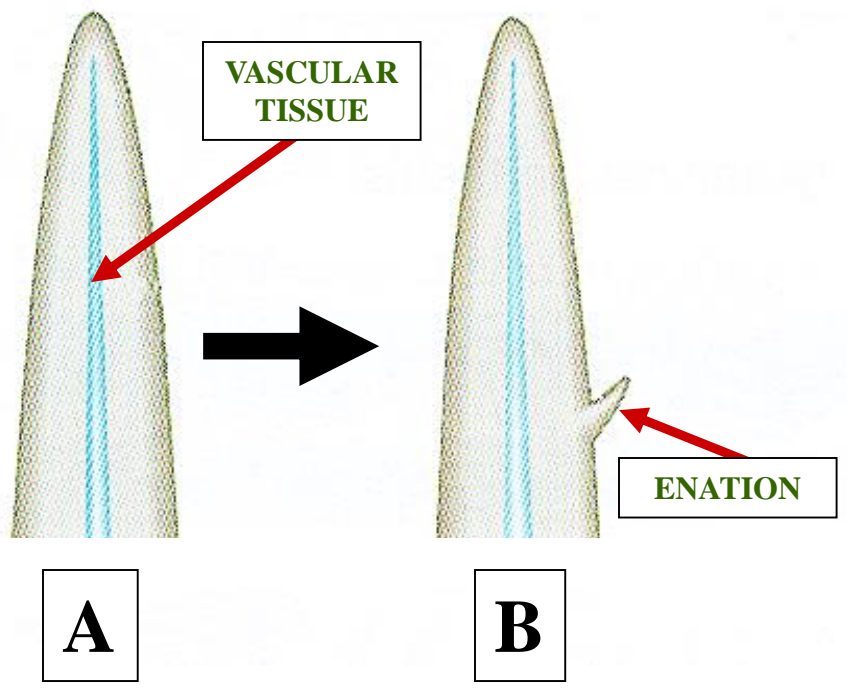
# ENATION THEORY COMPONENTS



ENATION ABSENT

➔ = TIME

# ENATION THEORY COMPONENTS



VASCULAR  
TISSUE

ENATION

A

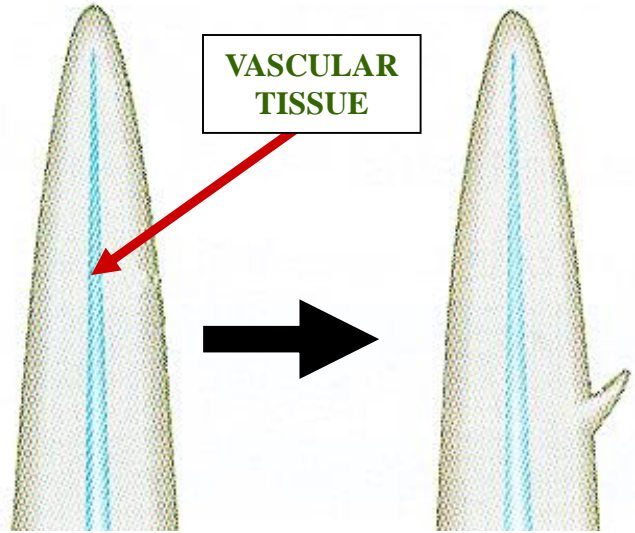
B

ENATION ABSENT

→ = TIME



# ENATION THEORY COMPONENTS



VASCULAR  
TISSUE

A

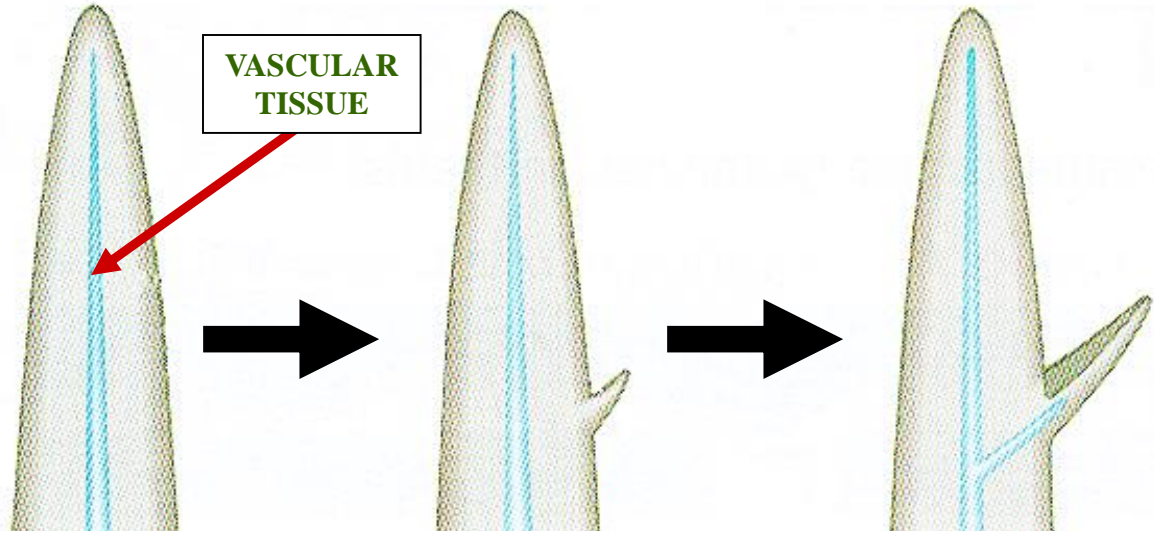
B

ENATION ABSENT

ENATION PRESENT  
INCREASES PSYN  
SURFACE AREA

→ = TIME

# ENATION THEORY COMPONENTS



**A**

**B**

**C**

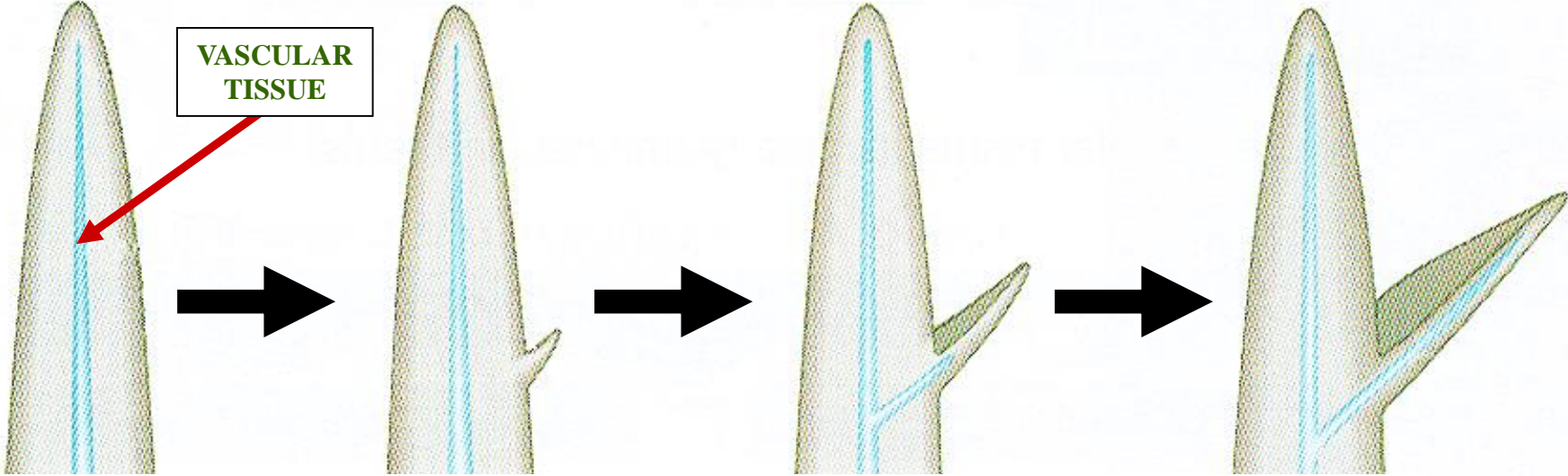
ENATION ABSENT

ENATION PRESENT  
INCREASES PSYN  
SURFACE AREA

ENATION PARTLY  
VASCULARIZED

**→ = TIME**

# ENATION THEORY COMPONENTS



**A**

**B**

**C**

**D**

ENATION ABSENT

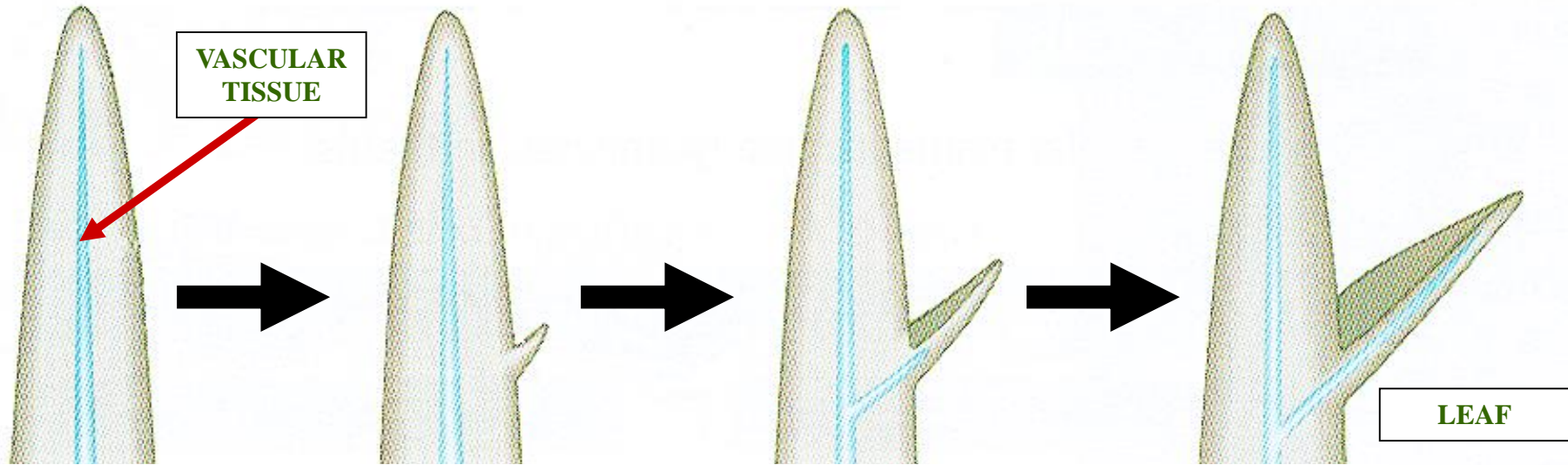
ENATION PRESENT  
INCREASES PSYN  
SURFACE AREA

ENATION PARTLY  
VASCULARIZED

ENATION FULLY  
VASCULARIZED

**→ = TIME**

# ENATION THEORY COMPONENTS



**A**

**B**

**C**

**D**

ENATION ABSENT

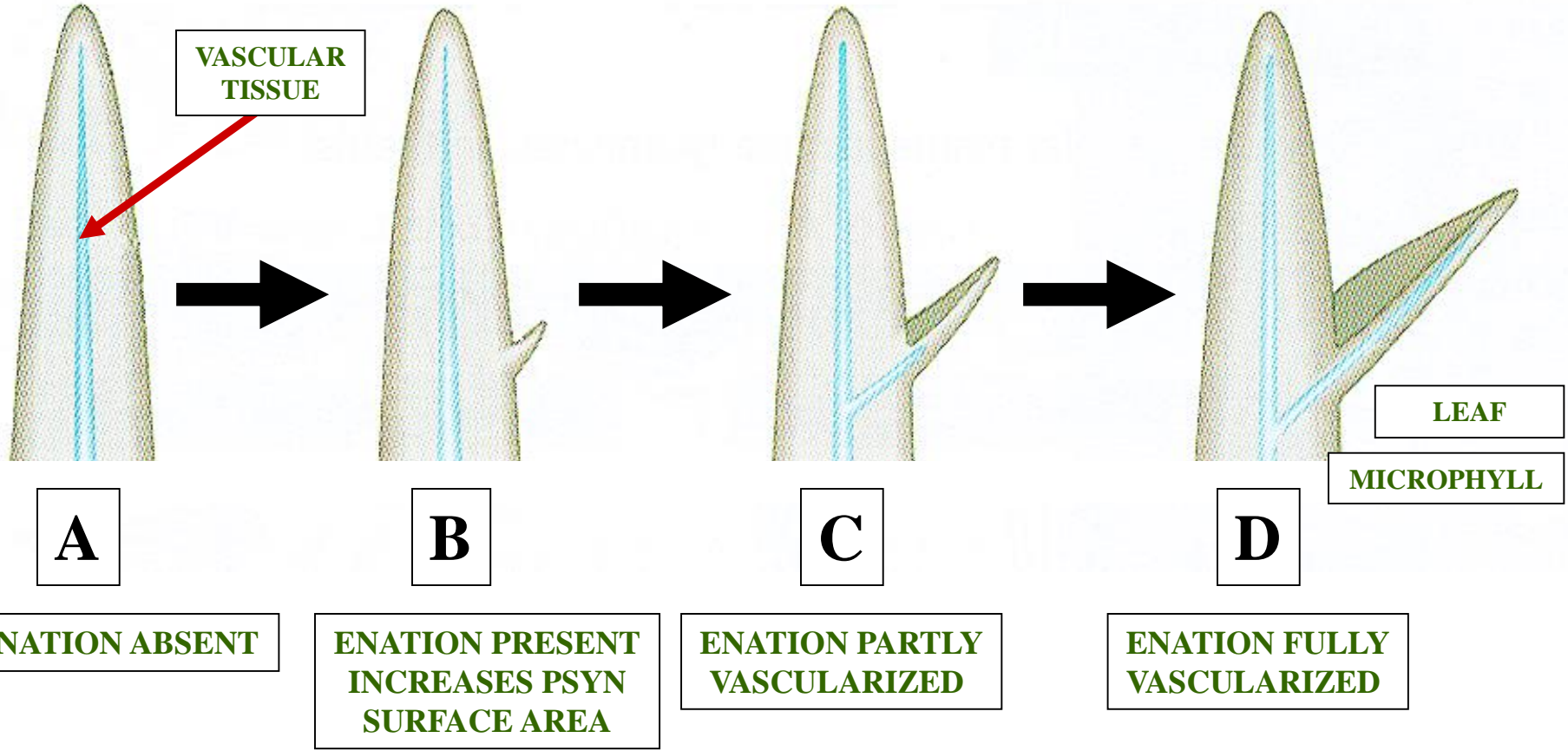
ENATION PRESENT  
INCREASES PSYN  
SURFACE AREA

ENATION PARTLY  
VASCULARIZED

ENATION FULLY  
VASCULARIZED

➔ = TIME

# ENATION THEORY COMPONENTS



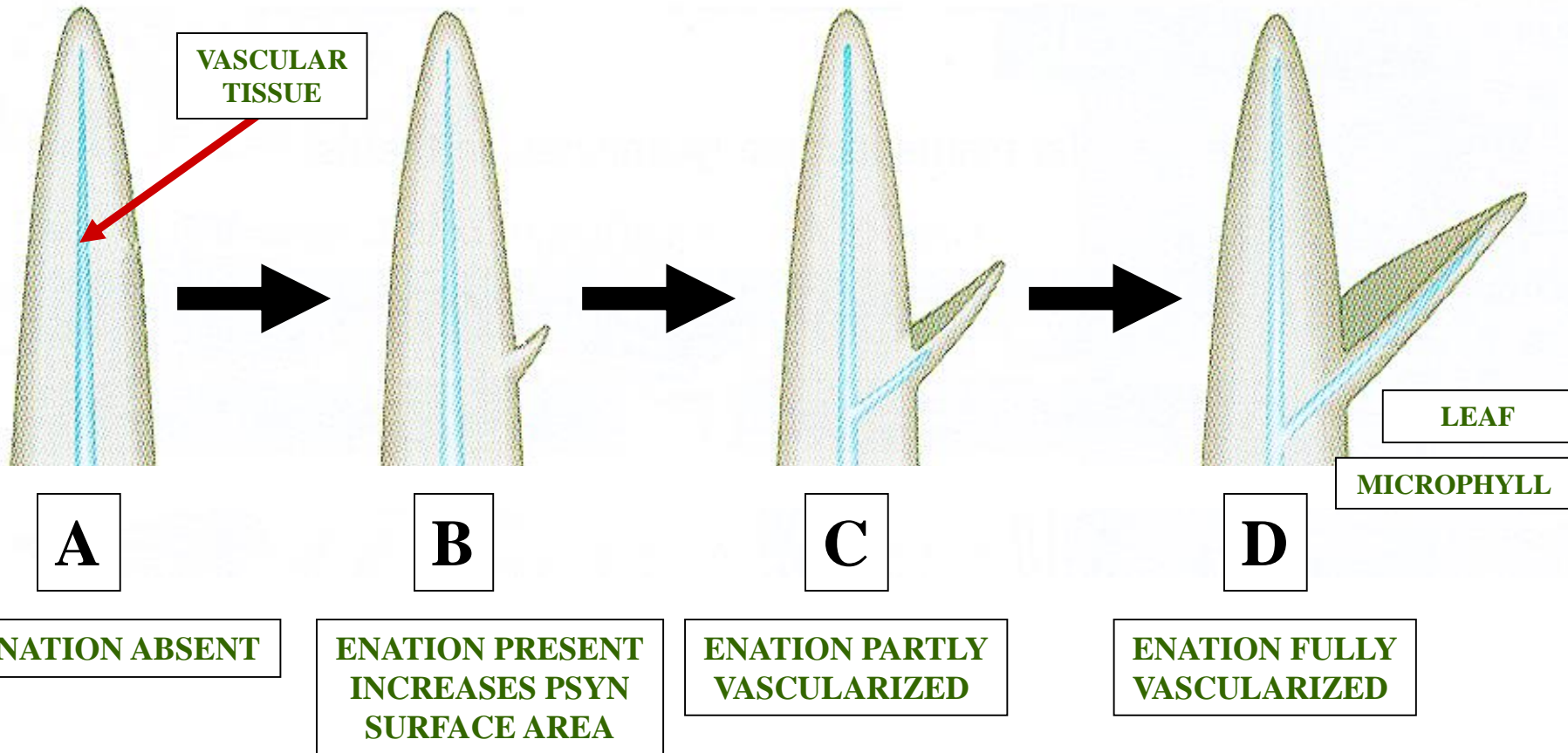
## MICROPHYLL

# ENATION THEORY COMPONENTS

S



L



# ENATION THEORY



**MICROPHYLLS**


**LYCOPHYTES**

**LYCOPODIOPHYTA**



# MEGAPHYLL





**MEGAPHYLLS  
KNOWN TO MOST  
VASCULAR PLANTS**



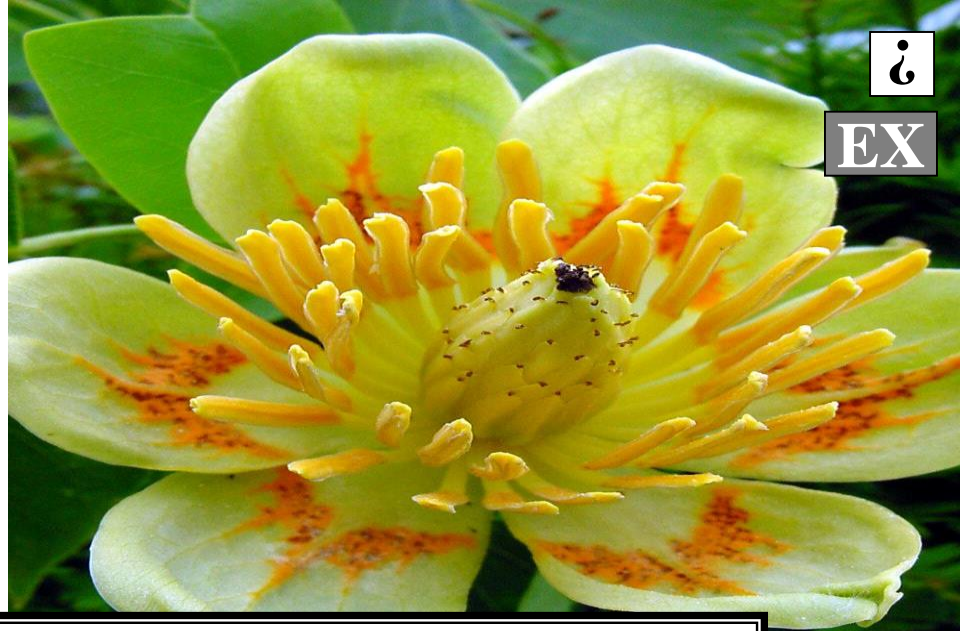
# FERNS





# GYMNOSPERMS





# ANGIOSPERMS





**EXCEPTION**

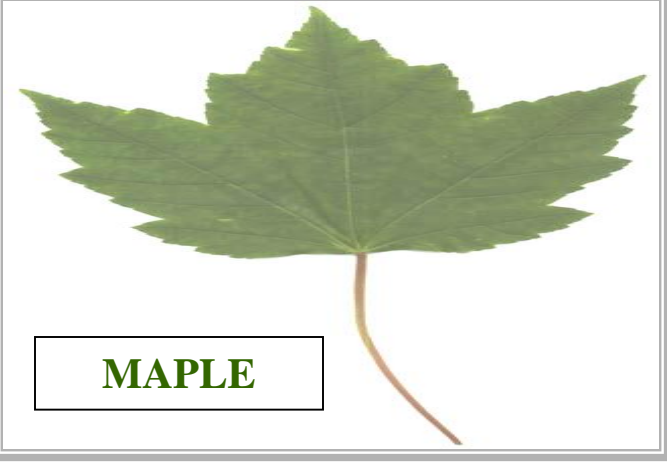
**LYCOPHYTES  
MICROPHYLLS**

**EXCEPTION**



# MEGAPHYLL CHARACTERS

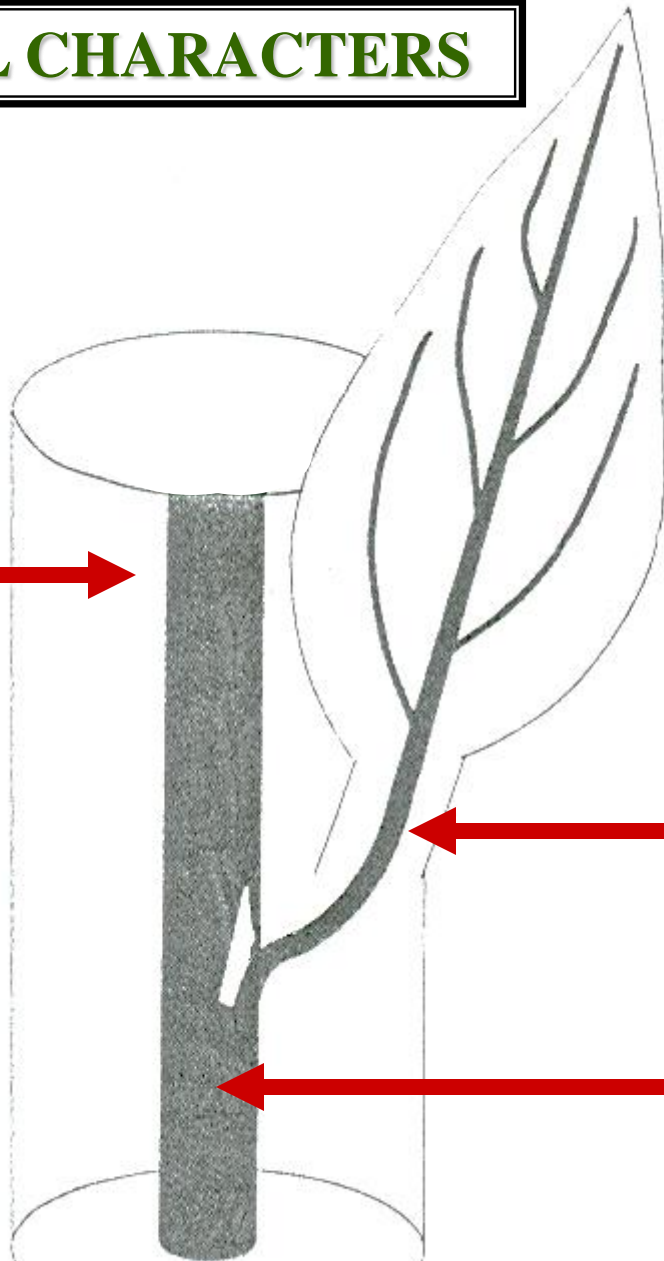
# MEGAPHYLL CHARACTERS



MAPLE

SV

STEM



MEGAPHYLL



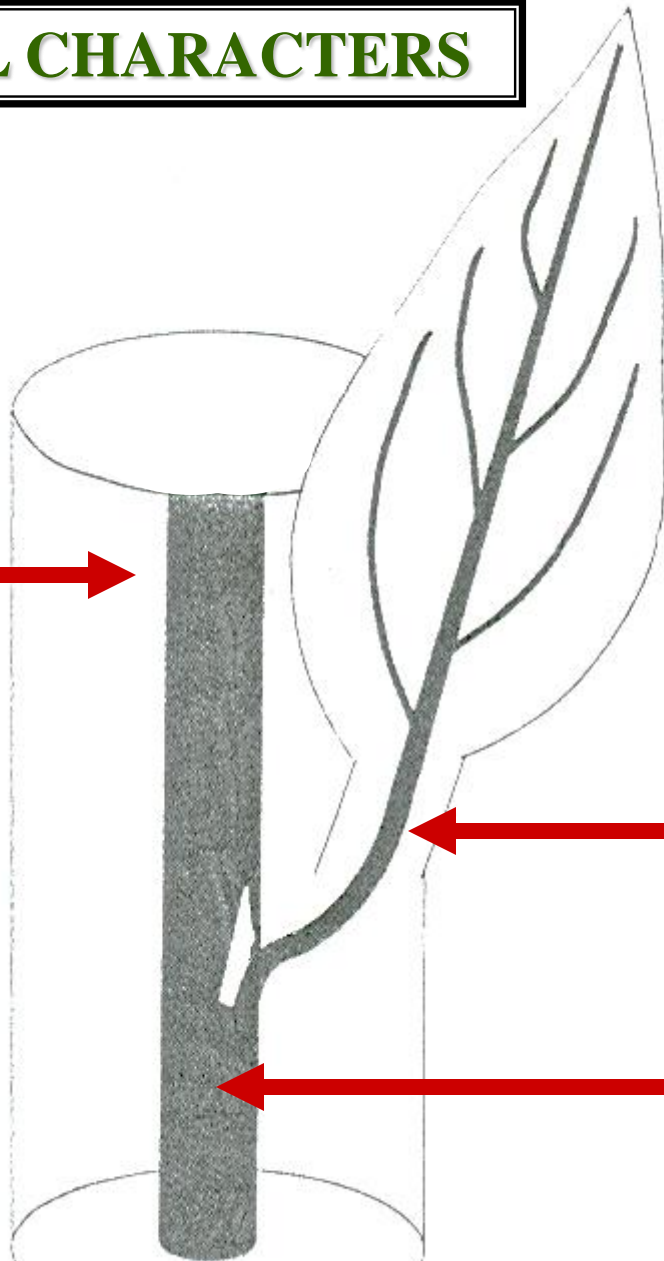
VASCULAR TISSUE



MEGAPHYLL

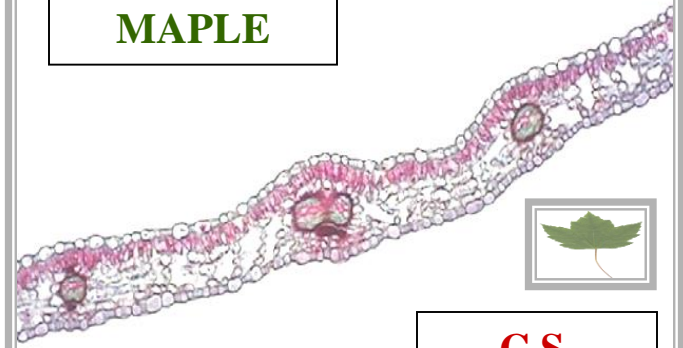
# MEGAPHYLL CHARACTERS

STEM



MEGAPHYLL

MAPLE



C.S.

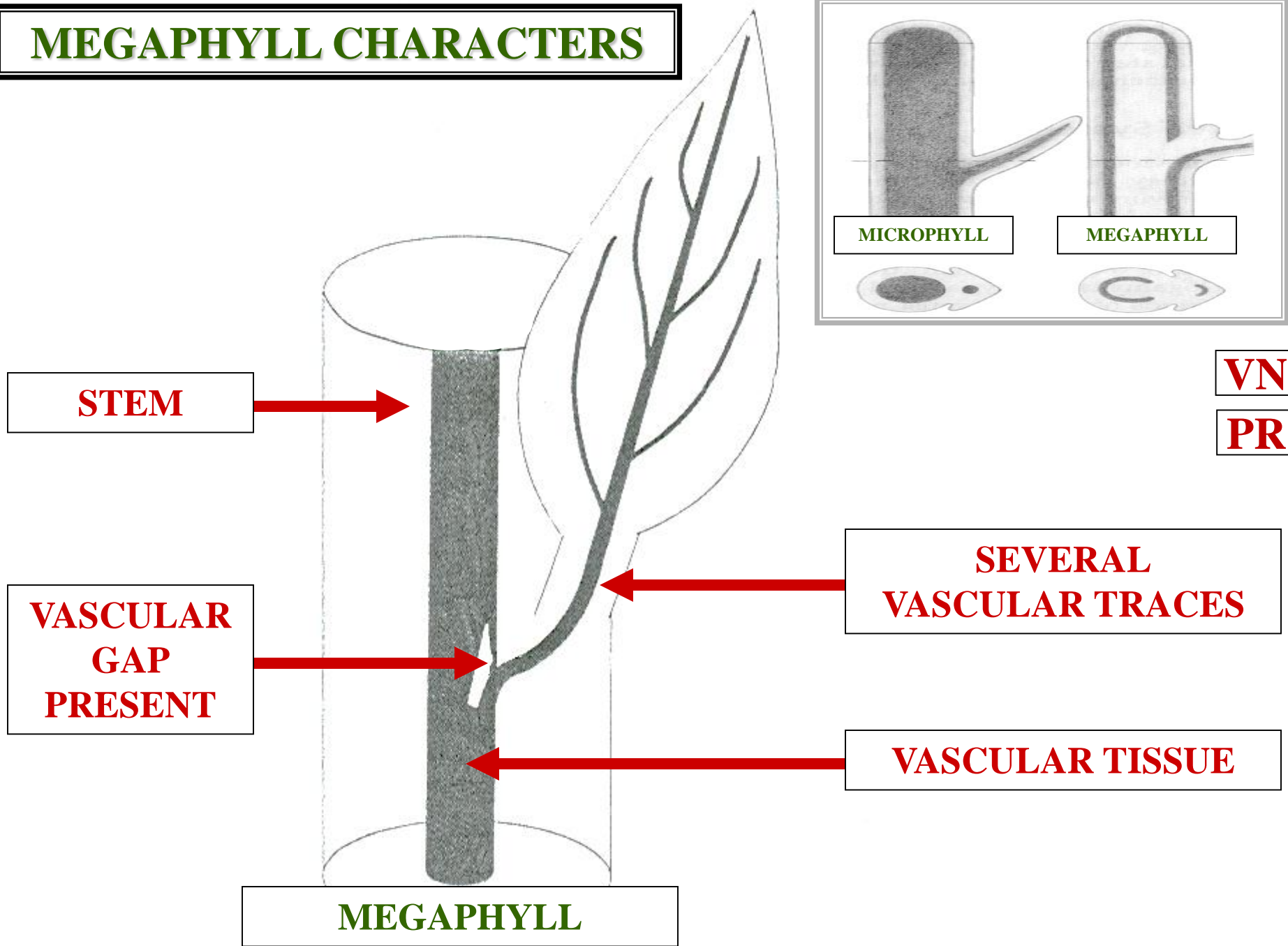
VG

SEVERAL  
VASCULAR TRACES

VASCULAR TISSUE



# MEGAPHYLL CHARACTERS



**STEM**

**VASCULAR  
GAP  
PRESENT**

**MEGAPHYLL**

**MICROPHYLL**

**MEGAPHYLL**

**VN**

**PR**

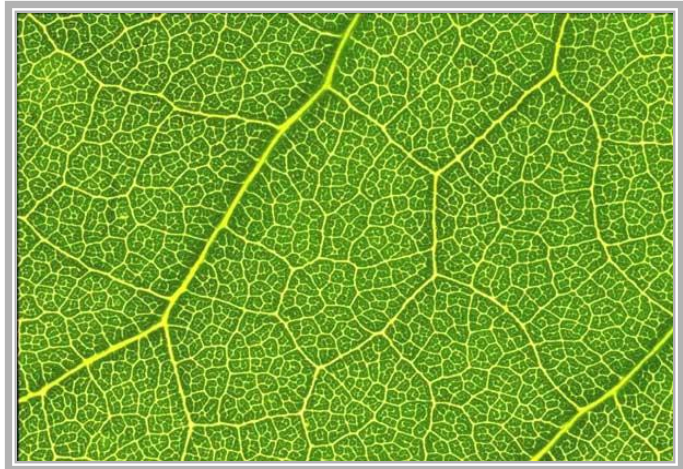
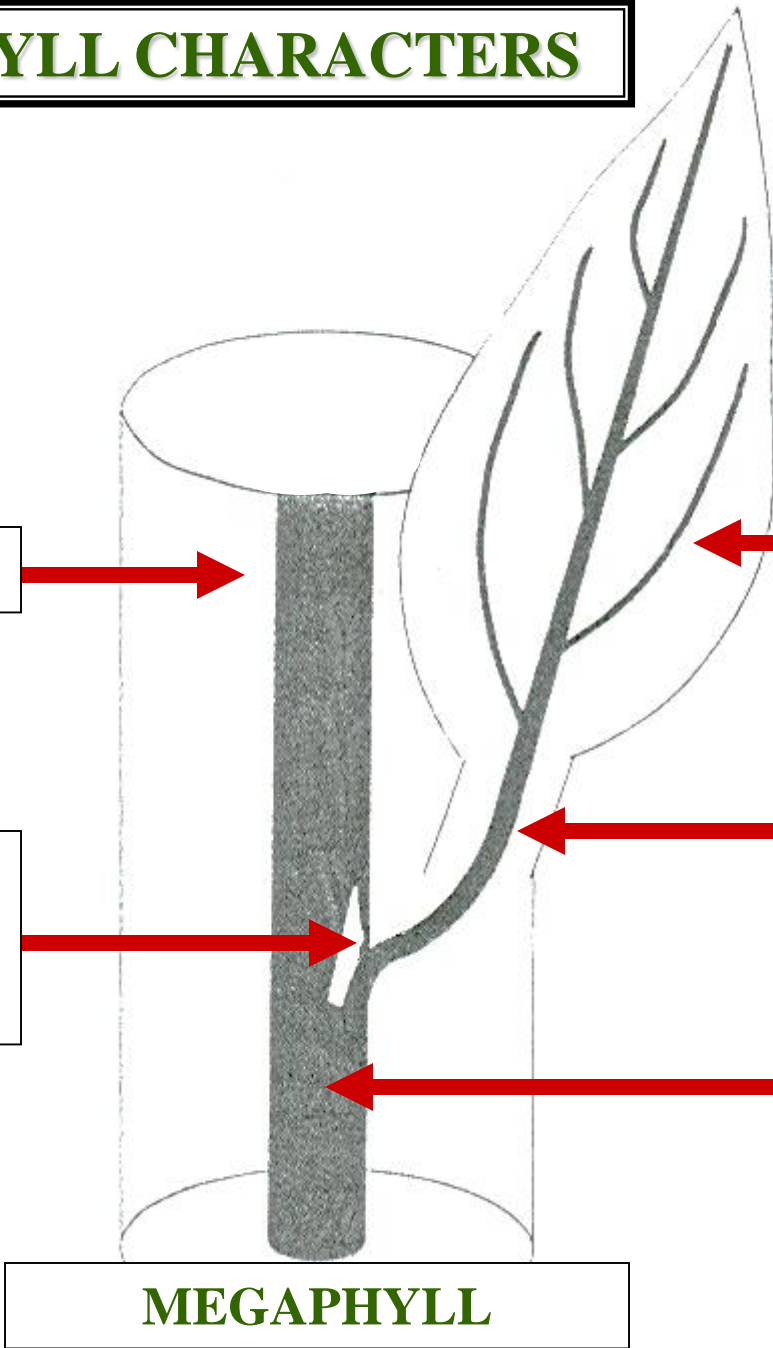
**SEVERAL  
VASCULAR TRACES**

**VASCULAR TISSUE**

# MEGAPHYLL CHARACTERS

**STEM**

**VASCULAR  
GAP  
PRESENT**



**VENATION PRESENT**

**SEVERAL  
VASCULAR TRACES**

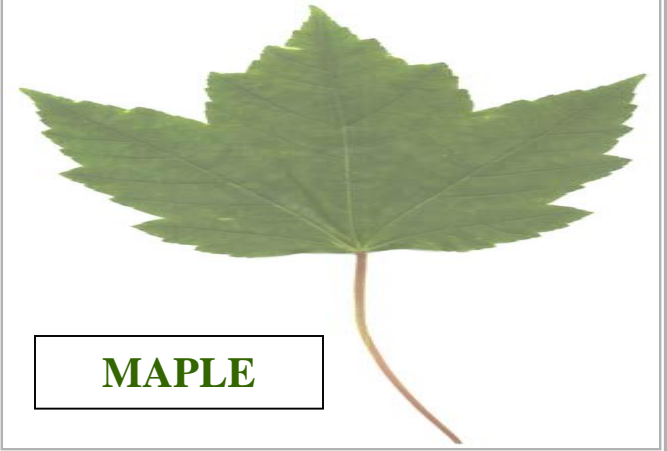
**VASCULAR TISSUE**



**S**

**MEGAPHYLL**

# MEGAPHYLL CHARACTERS



MAPLE

STEM



VENATION PRESENT



VASCULAR GAP PRESENT



SEVERAL VASCULAR TRACES



VASCULAR TISSUE

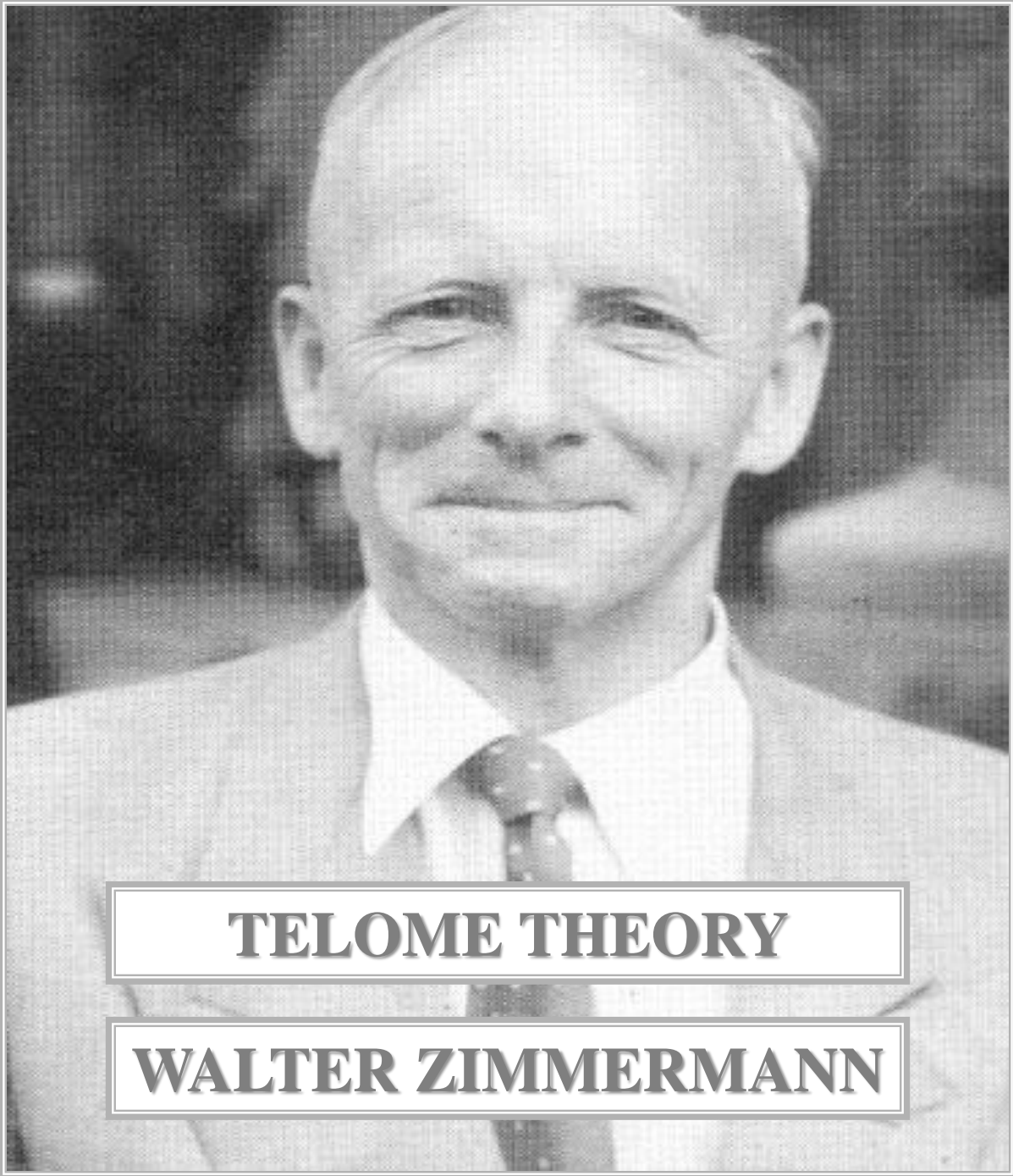


MEGAPHYLL





**MEGAPHYLL**  
**EVOLUTION**  
**TELOME THEORY**



**TELOME THEORY**

**WALTER ZIMMERMANN**

**TELOMIE**

**MEGAPHYLL  
TELOME**



**DICHOTOMOUSLY  
BRANCHED  
STEM**

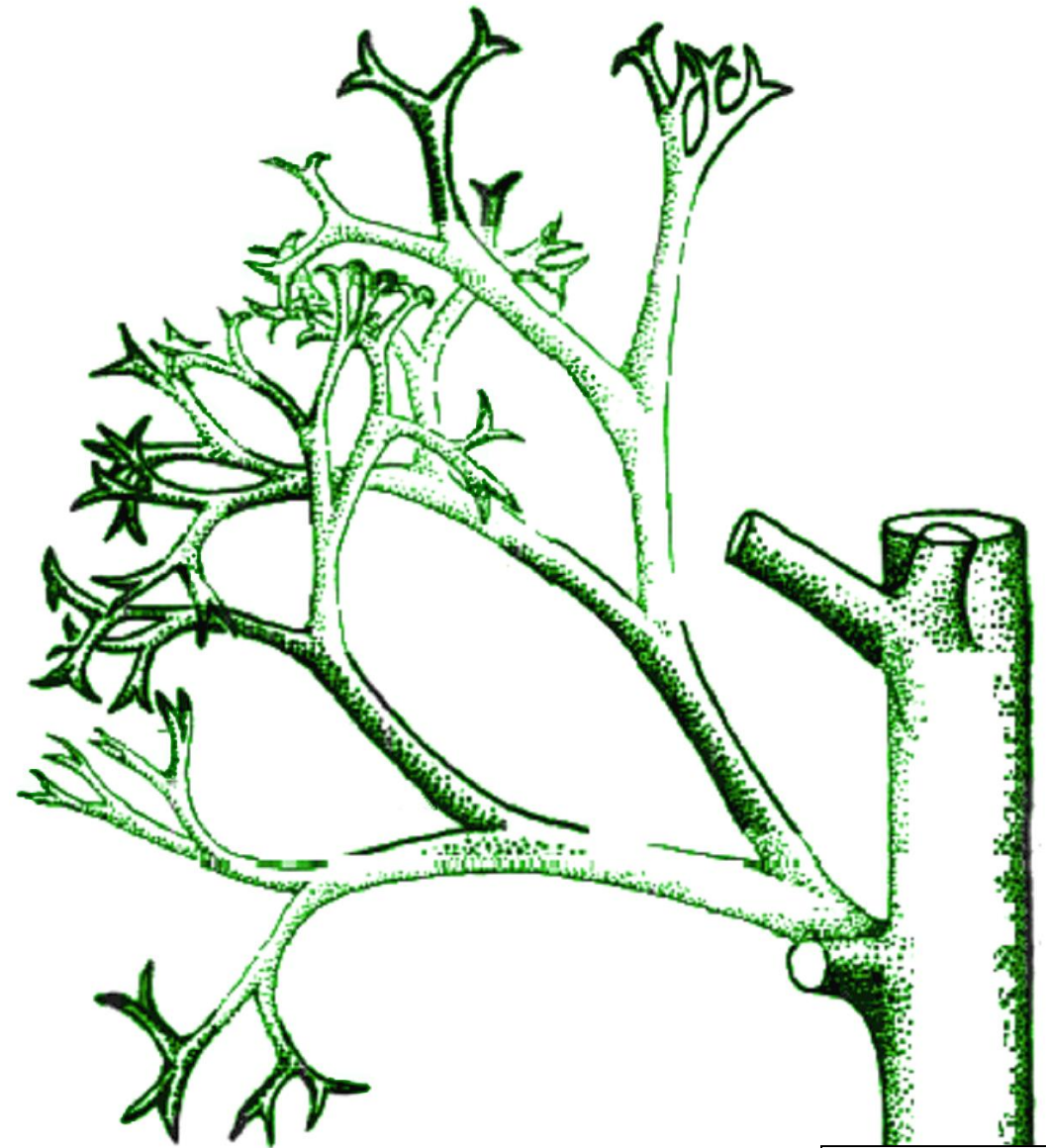
**MEGAPHYLL  
TELOME**



DICHOTOMOUSLY  
BRANCHED  
STEM

**TELOME**

DICHOTOMOUSLY  
BRANCHED  
STEM



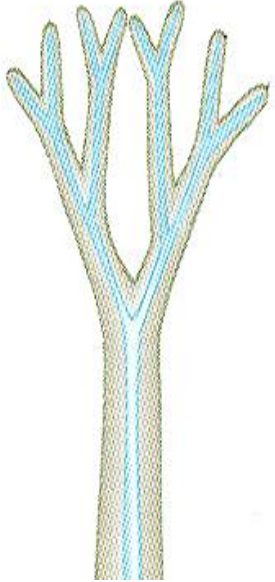
**STEM**





# TELOMERE THEORY COMPONENTS

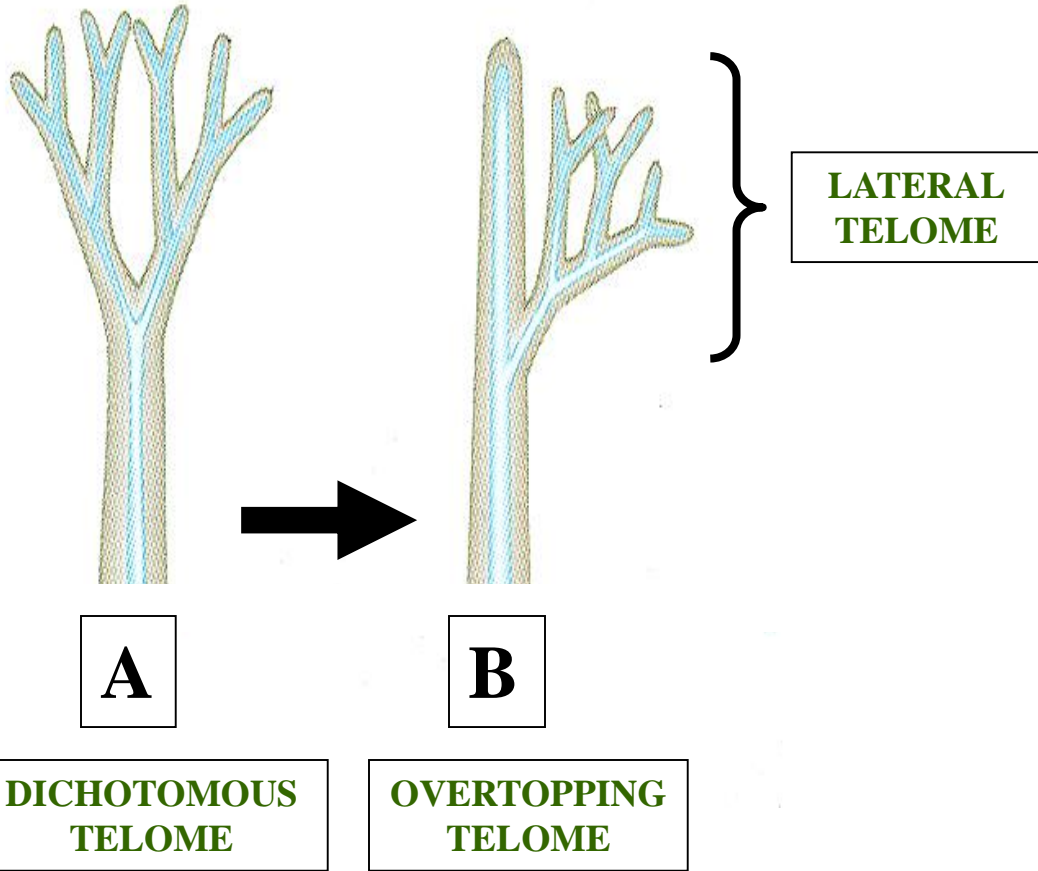
# TELOME THEORY COMPONENTS



**A**

**DICHOTOMOUS  
TELOME**

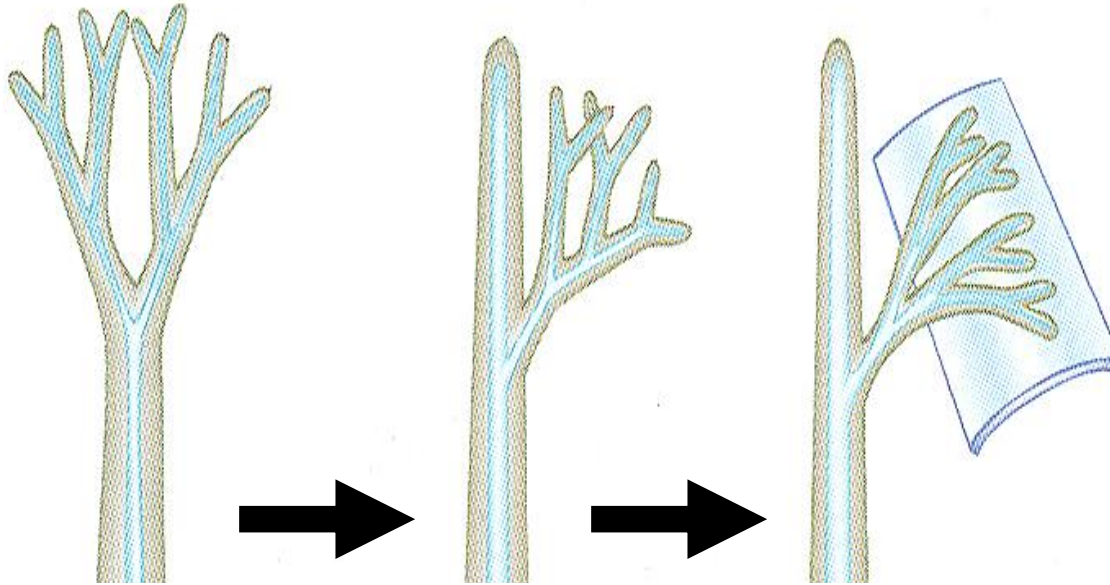
# TELOME THEORY COMPONENTS



**→ = TIME**

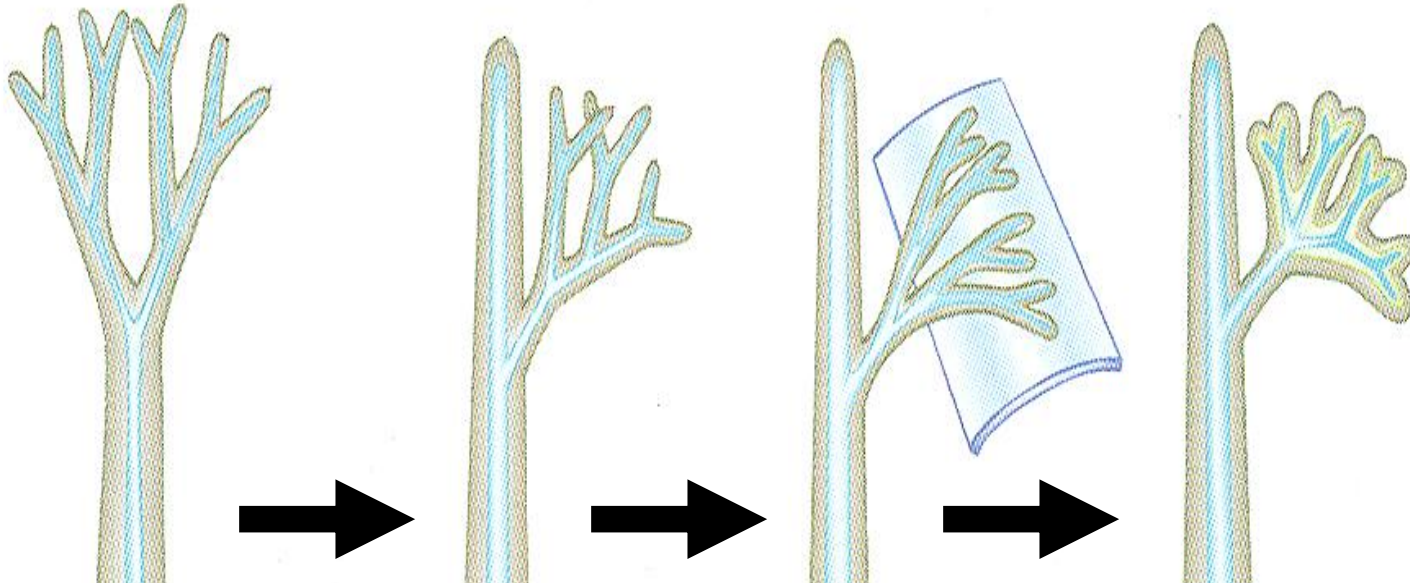
# TELOME THEORY

## COMPONENTS

**A****B****C****DICHOTOMOUS  
TELOME****OVERTOPPING  
TELOME****PLANATION  
TELOME****→ = TIME**

# TELOME THEORY

## COMPONENTS



**A**

**B**

**C**

**D**

**DICHOTOMOUS  
TELOME**

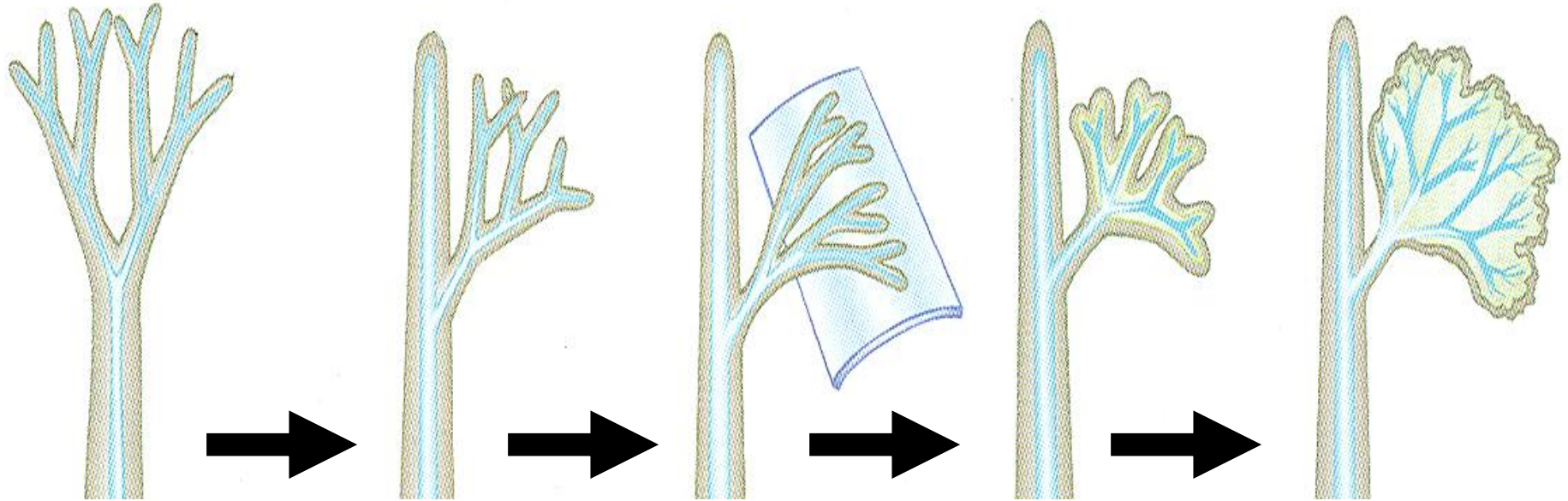
**OVERTOPPING  
TELOME**

**PLANATION  
TELOME**

**WEBBING  
TELOME**

**→ = TIME**

# TELOME THEORY COMPONENTS



**A**

**B**

**C**

**D**

**E**

**DICHOTOMOUS  
TELOME**

**OVERTOPPING  
TELOME**

**PLANATION  
TELOME**

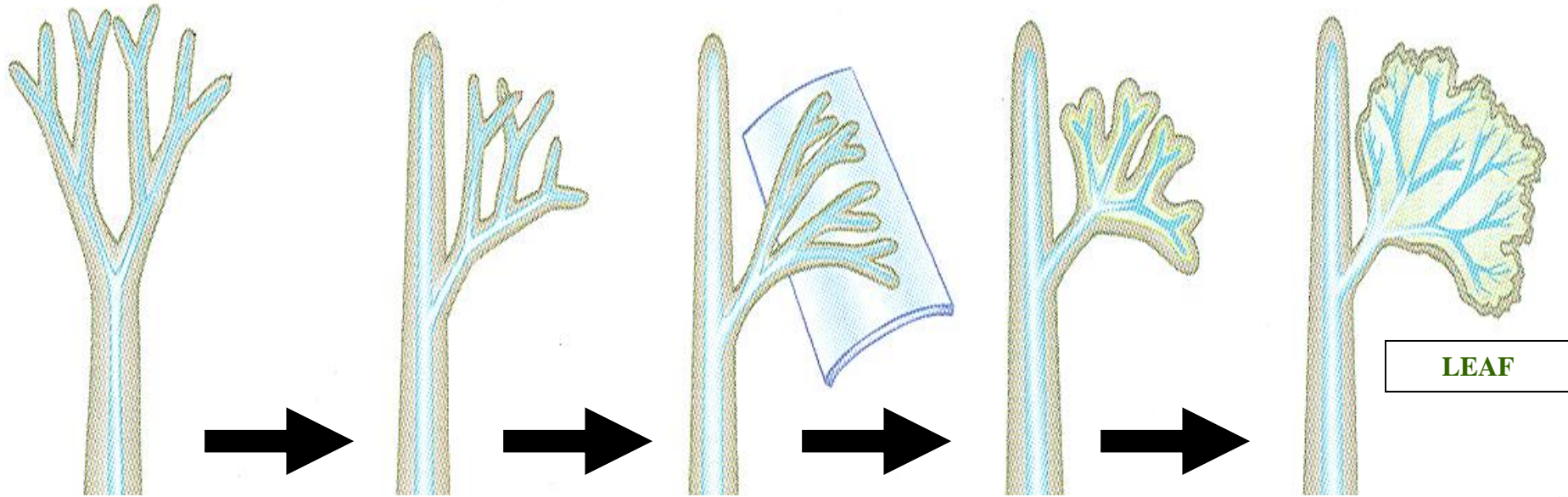
**WEBBING  
TELOME**

**FUSION  
TELOME**

**→ = TIME**

# TELOME THEORY

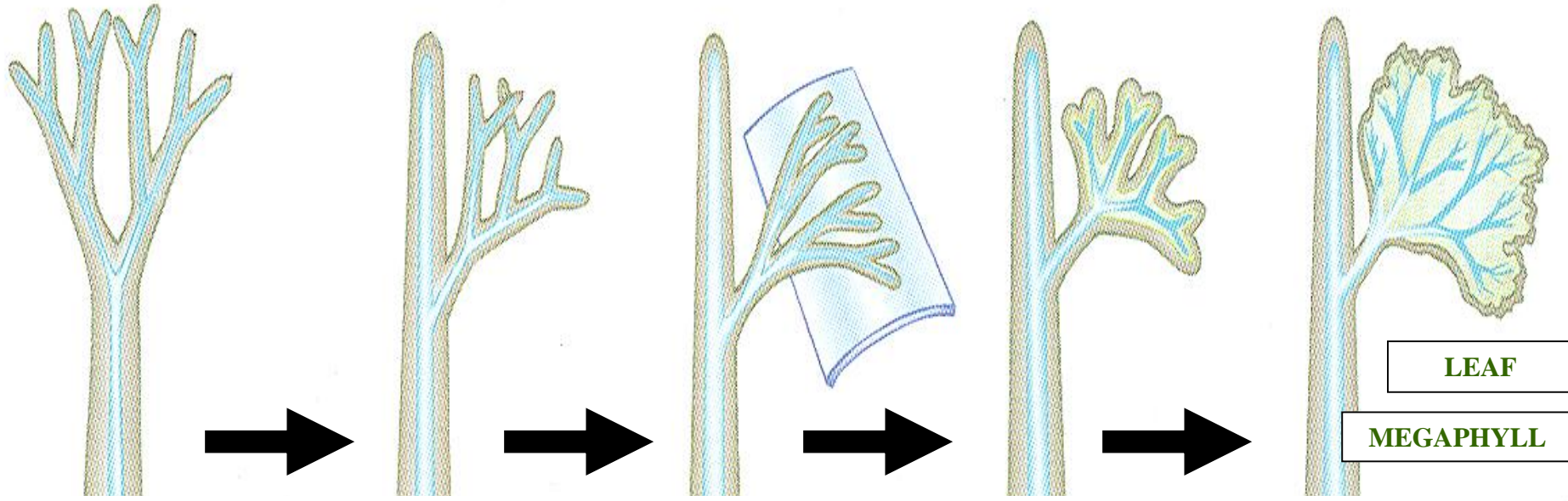
## COMPONENTS

**A****B****C****D****E****DICHOTOMOUS  
TELOME****OVERTOPPING  
TELOME****PLANATION  
TELOME****WEBBING  
TELOME****FUSION  
TELOME****LEAF****→ = TIME**

# TELOME THEORY

## COMPONENTS

TT  
+



**A**

**B**

**C**

**D**

**E**

DICHOTOMOUS  
TELOME

OVERTOPPING  
TELOME

PLANATION  
TELOME

WEBBING  
TELOME

FUSION  
TELOME

LEAF

MEGAPHYLL

# MEGAPHYLL



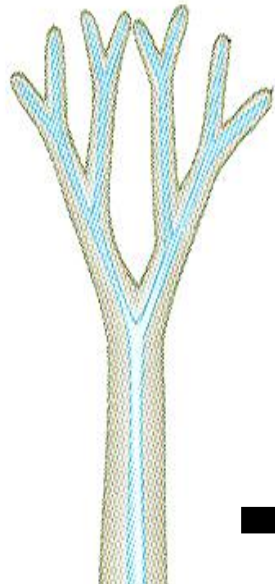
# TELOME THEORY

## COMPONENTS

S

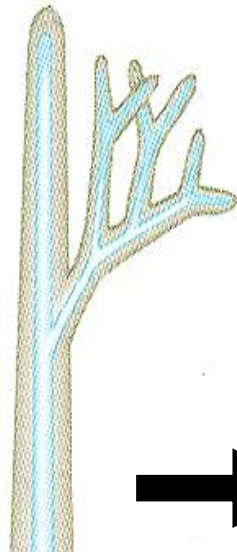
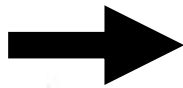


F



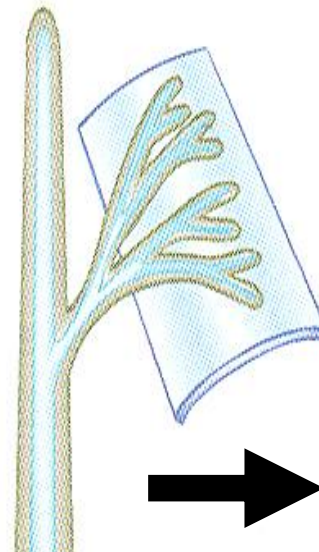
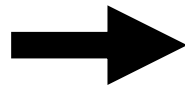
A

DICHOTOMOUS  
TELOME



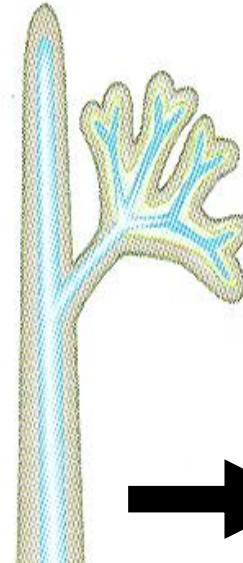
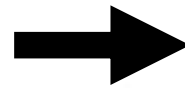
B

OVERTOPPING  
TELOME



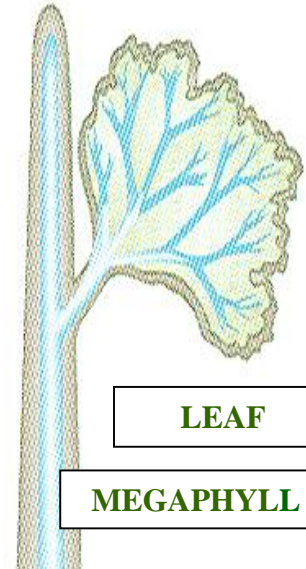
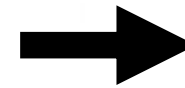
C

PLANATION  
TELOME



D

WEBBING  
TELOME

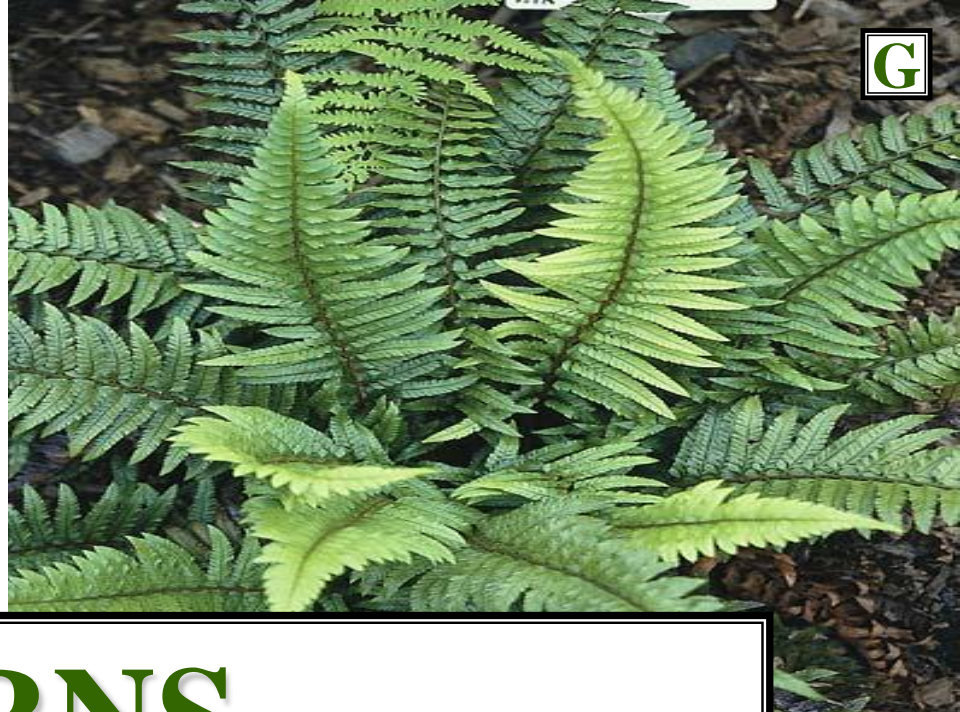


E

FUSION  
TELOME

LEAF  
MEGAPHYLL

# TELOME THEORY



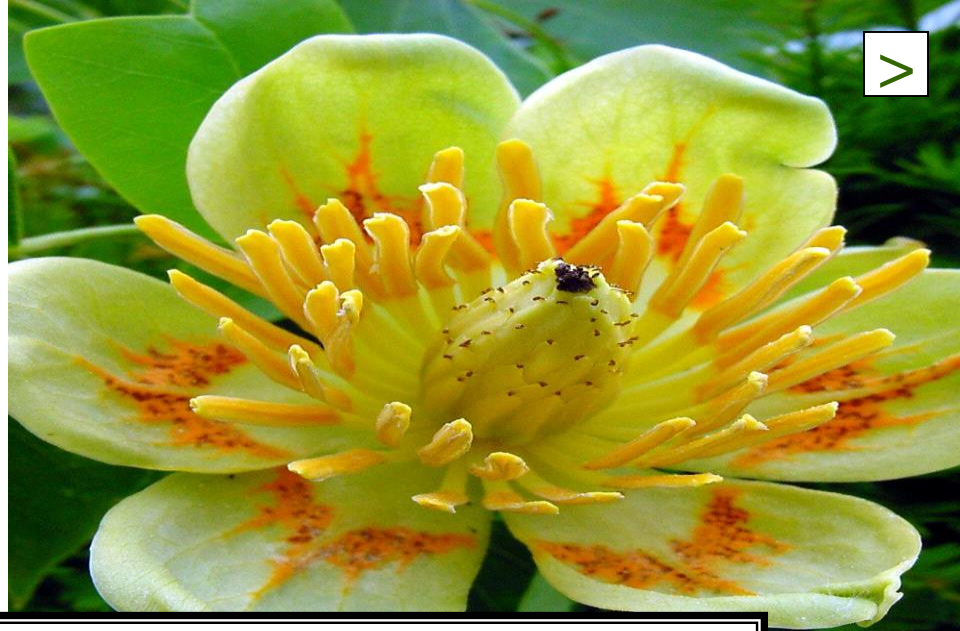
# FERNS





# GYMNOSPERMS





# ANGIOSPERMS





**MICROPHYLL**

**&**

**MEGAPHYLL**

**MISNOMERS**

**SIZE NOT DIAGNOSTIC**



**MICROPHYLL**

**&**

**MEGAPHYLL**

**DIAGNOSTIC**

**ANATOMICALLY**

# LEAF PHYLLOTAXY

# PHYLLOTAXY



# PHYLLOTAXY

## LEAF ARRANGEMENT UPON STEM

# PHYLLOTAXY

**NODE**

**PHYLLOTAXY  
NODE**



**LEAF**

**ORIGIN POINT  
UPON STEM**

**PHYLLOTAXY  
NODE**

N

[ ]



[ ]

STEM

LEAF

[ ]



[ ]

[ ]



**A**

[Blank box]



**NODE**

**STEM**

**LEAF**

[Blank box]



[Blank box]



**NODE**



**AXILLARY BUD**

**PHYLLLOTAXY**  
**AXILLARY BUD**



**STEM NODE**  
**LOCATION**

**PHYLLLOTAXY**  
**AXILLARY BUD**

**A**

[Blank box]



**NODE**

**STEM**

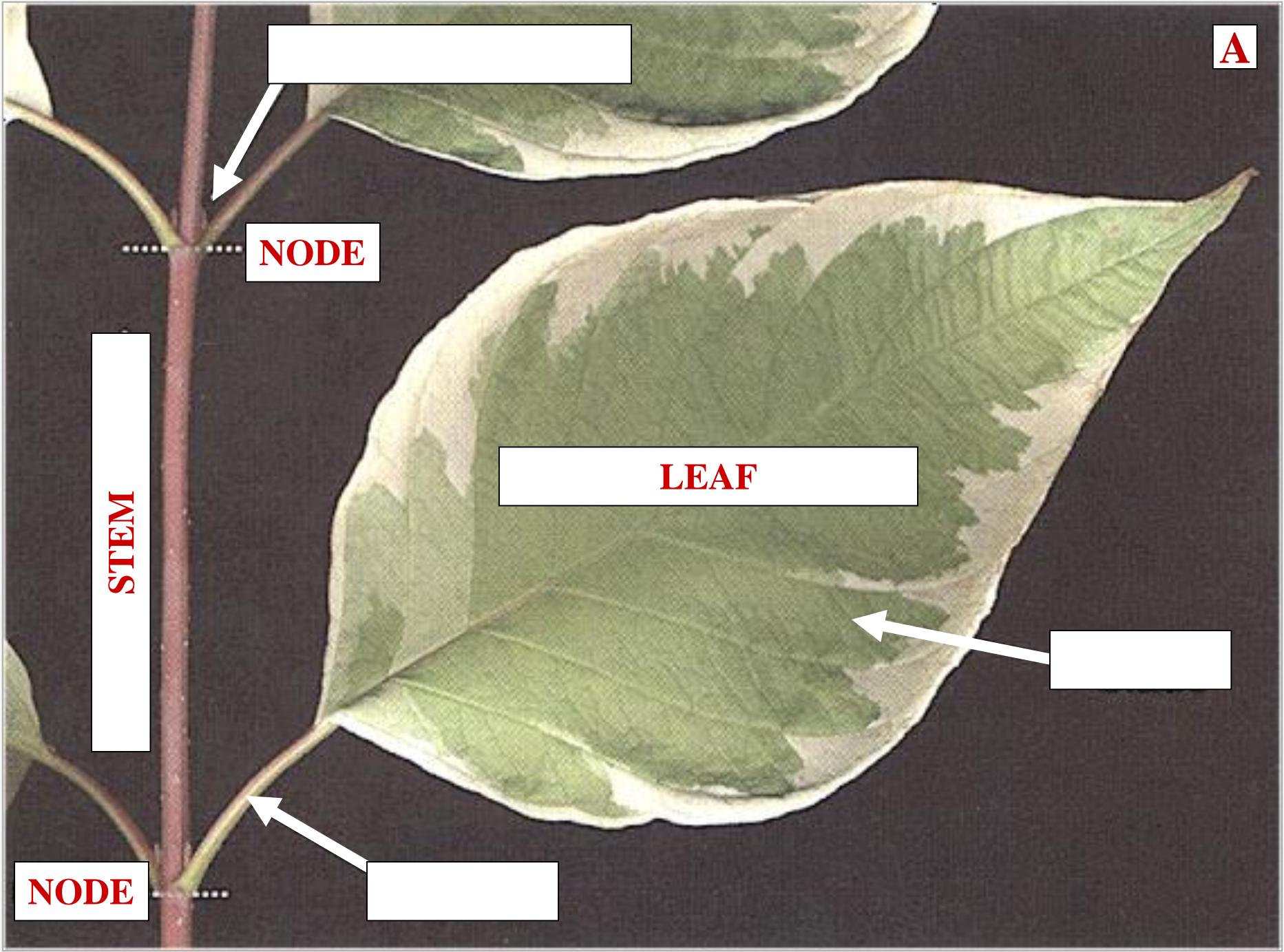
**LEAF**

[Blank box]



**NODE**

[Blank box]





**AXILLARY BUD**



**NODE**



**STEM**



**LEAF**



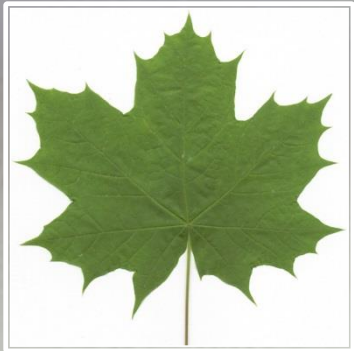
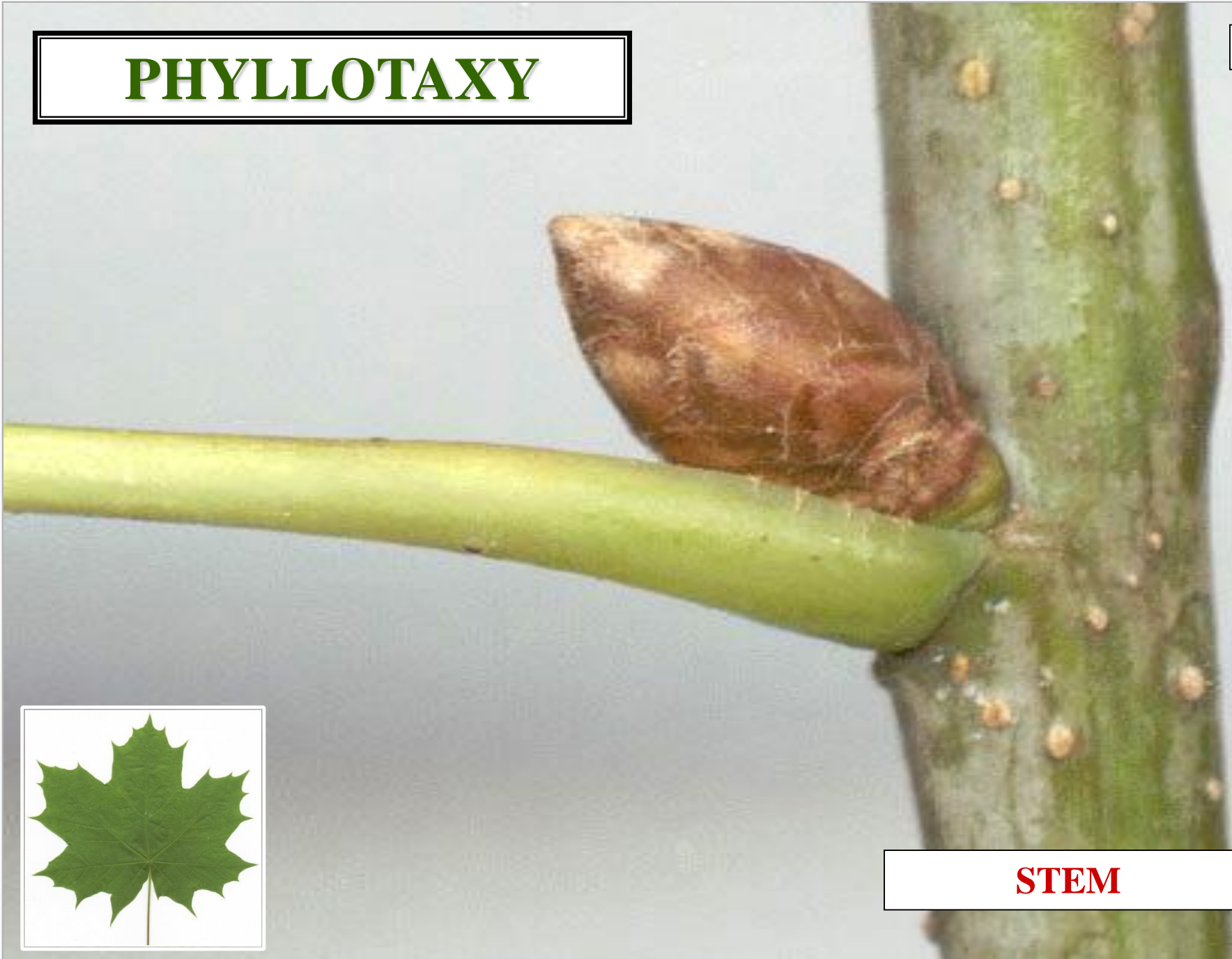
**NODE**





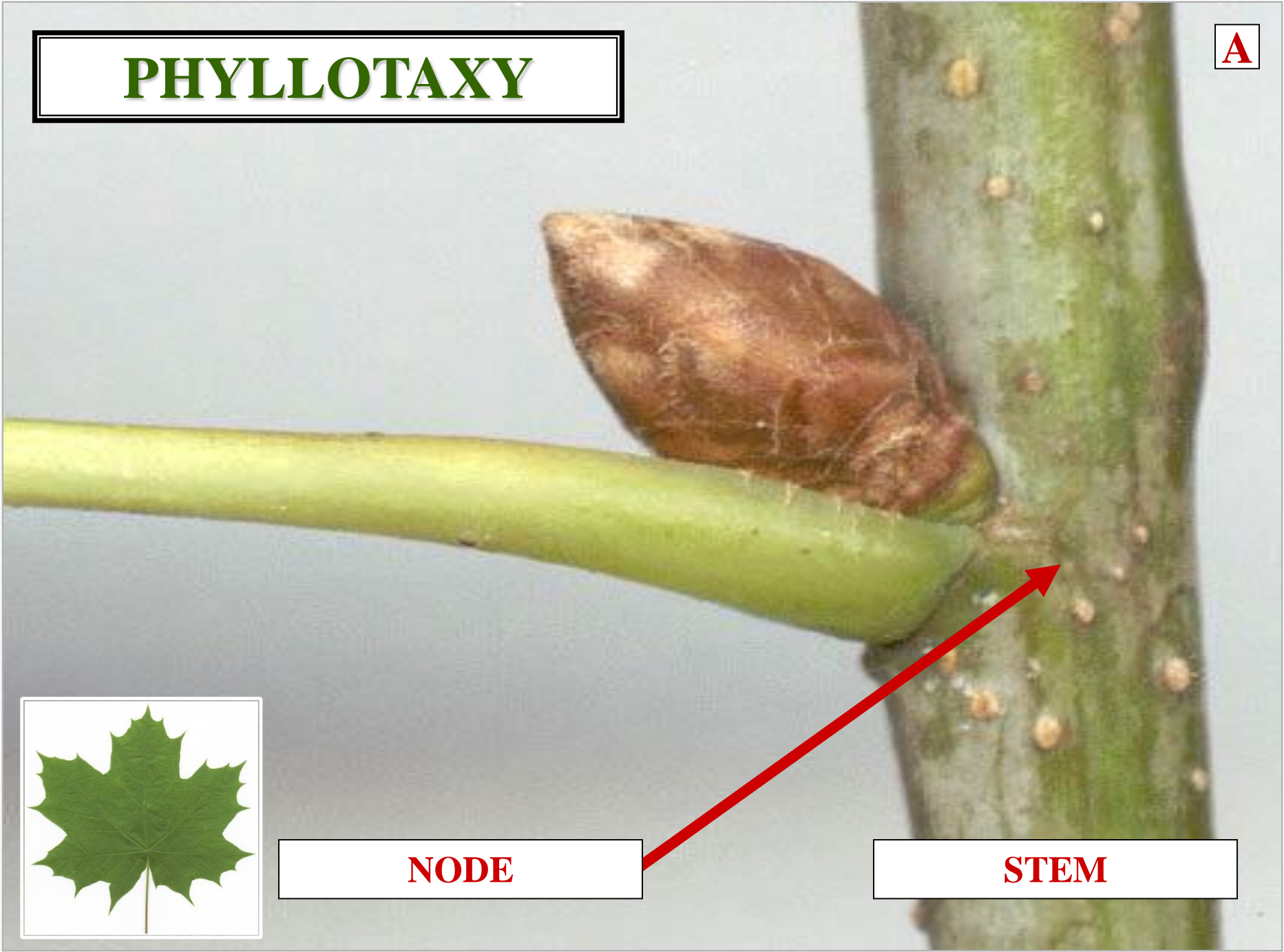
**NODE**  
**AXILLARY BUD**  
**APPLIED**

# PHYLLOTAXY



**STEM**

# PHYLLOTAXY

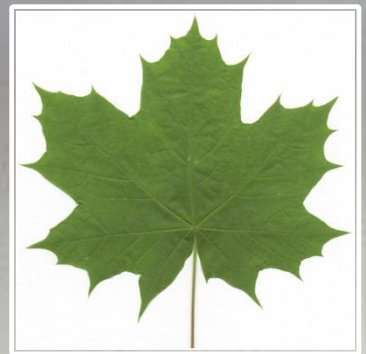
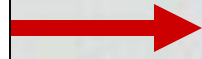


**NODE**

**STEM**

# PHYLLOTAXY

AXILLARY BUD



NODE

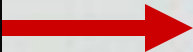


STEM

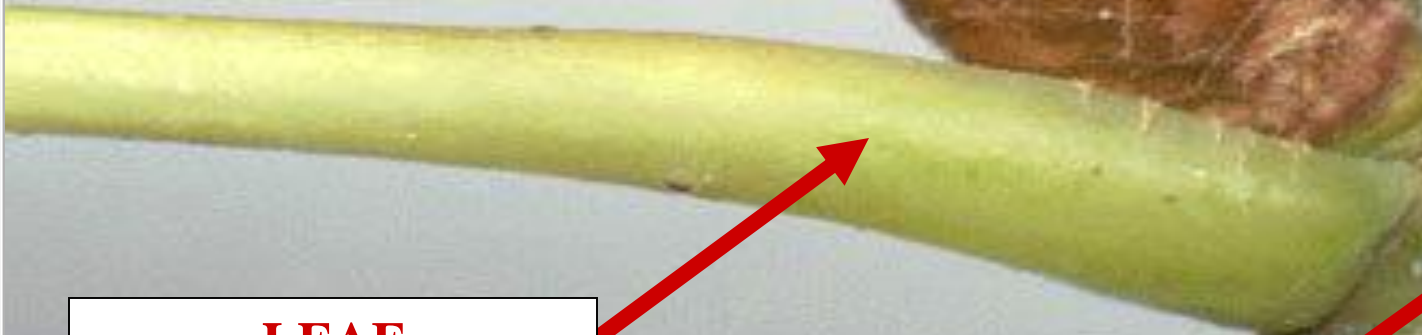


# PHYLLOTAXY

**AXILLARY BUD**



**LEAF**



**NODE**



**STEM**



**LEAF  
PHYLLOTAXY  
TYPES**

# **LEAF PHYLLOTAXY TYPES**

**ALTERNATE**

# **LEAF PHYLLOTAXY TYPES**



# LEAF PHYLLLOTAXY TYPES

ALTERNATE  
OPPOSITE

# LEAF PHYLLLOTAXY TYPES

# LEAF PHYLLLOTAXY

## TYPES

A

ALTERNATE

OPPOSITE

WHORLED

# LEAF PHYLLLOTAXY

## TYPES

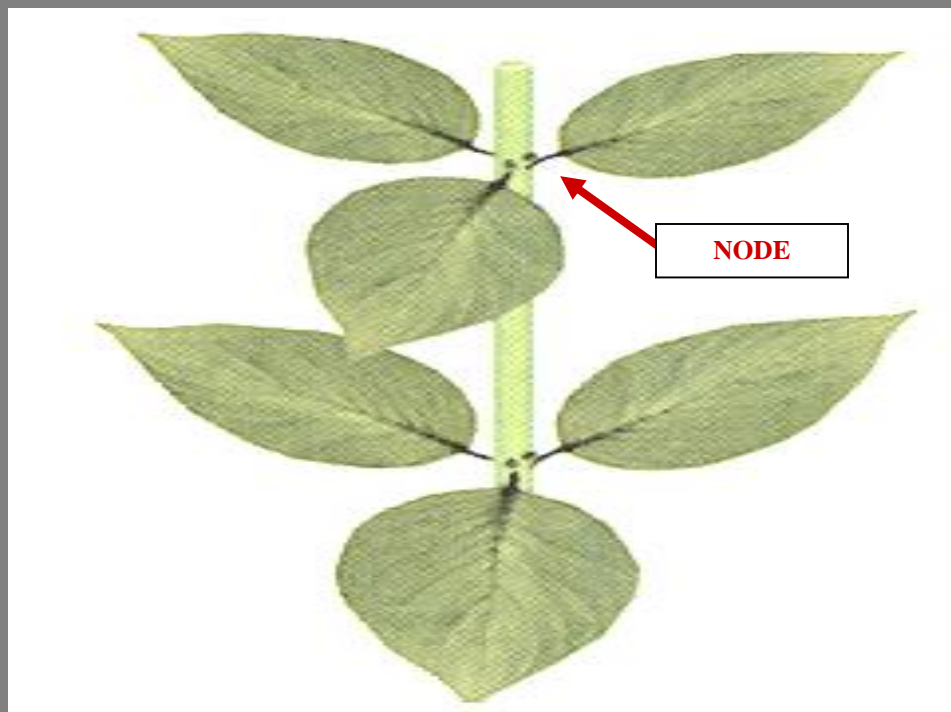
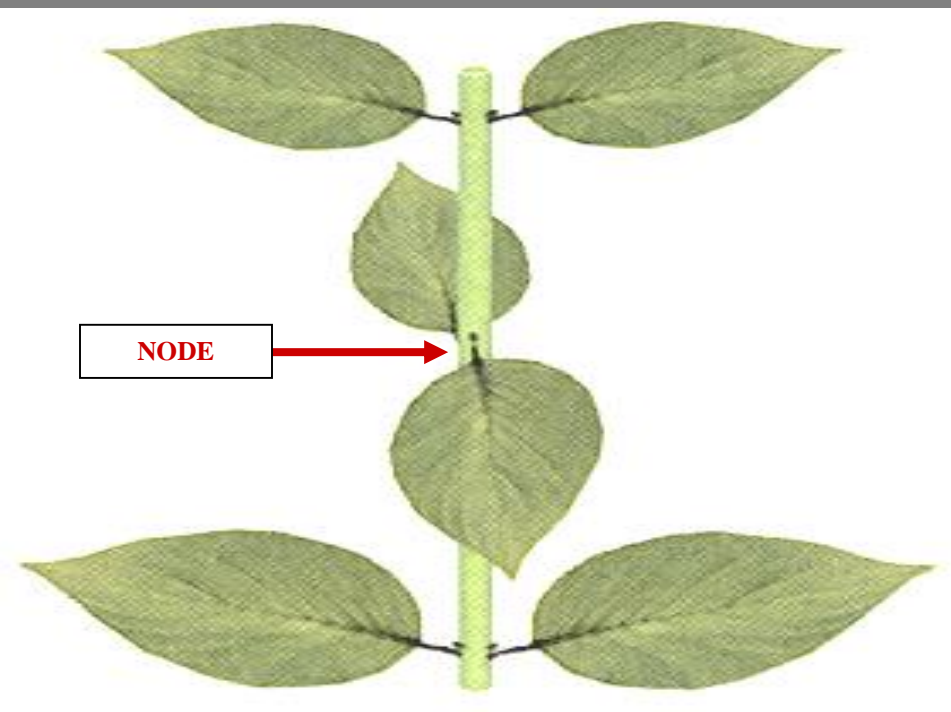
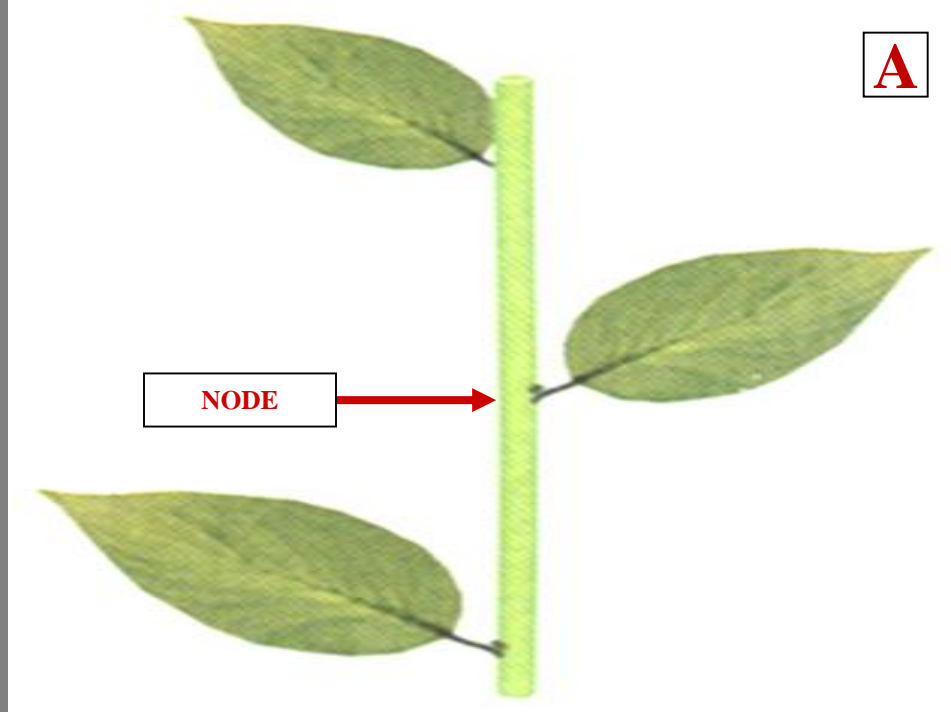
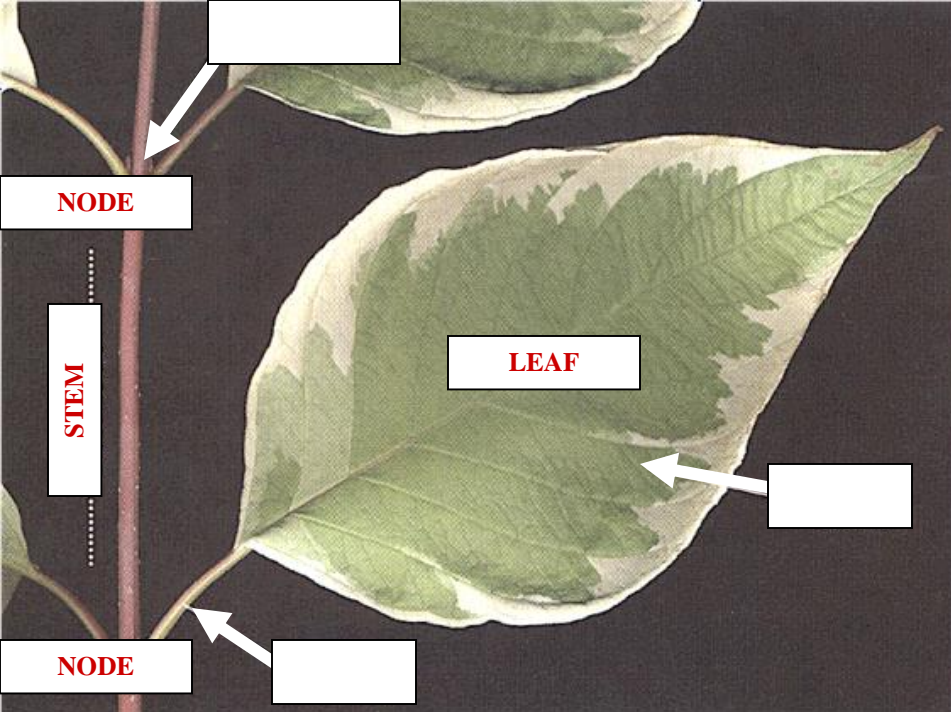
**ALTERNATE  
PHYLLOTAXY**

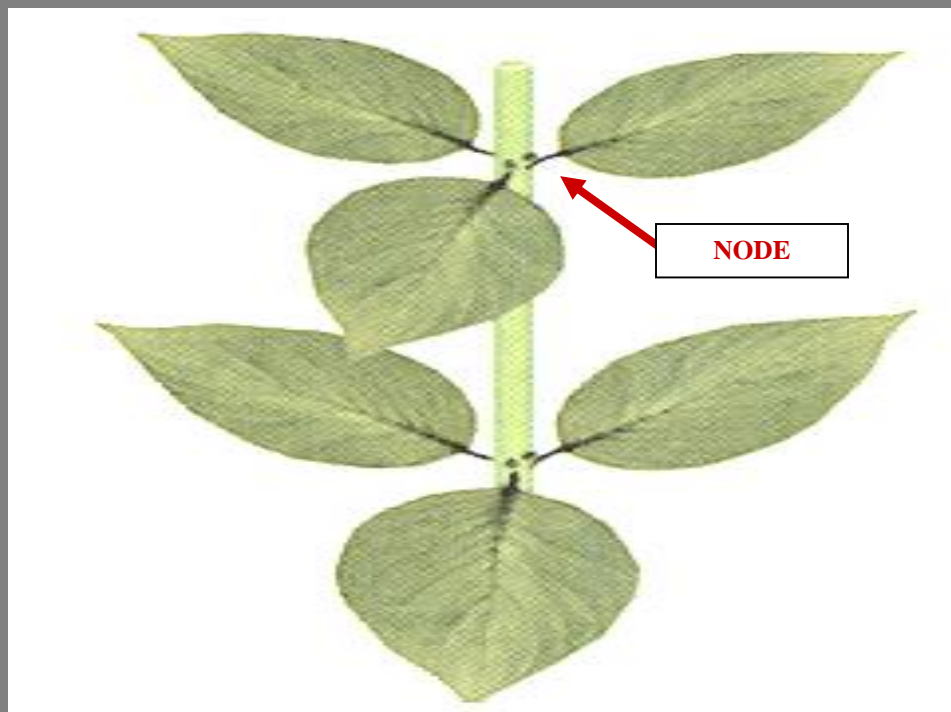
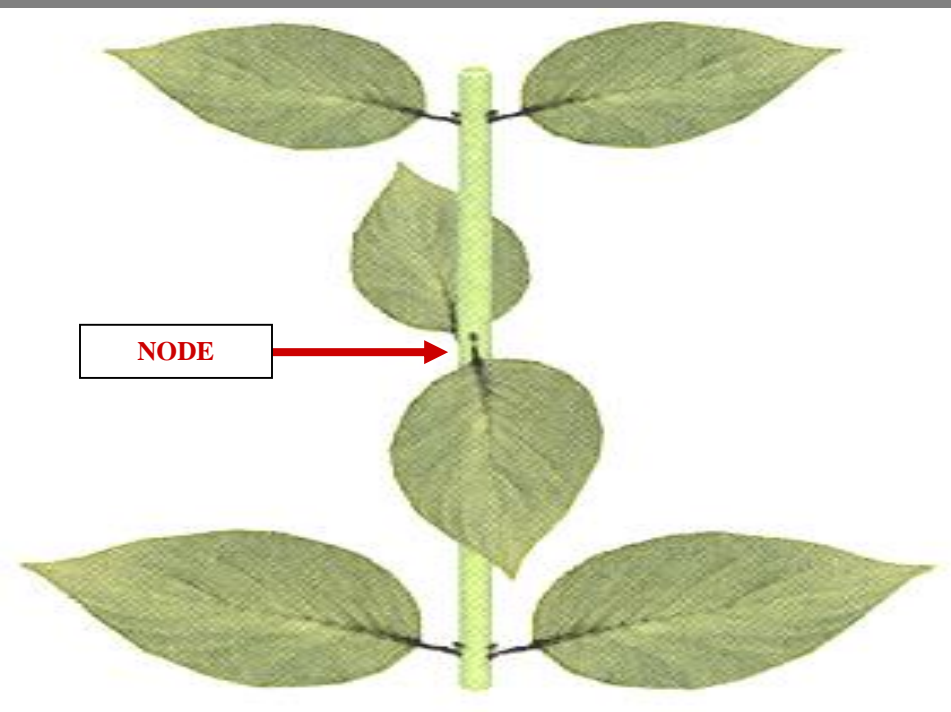
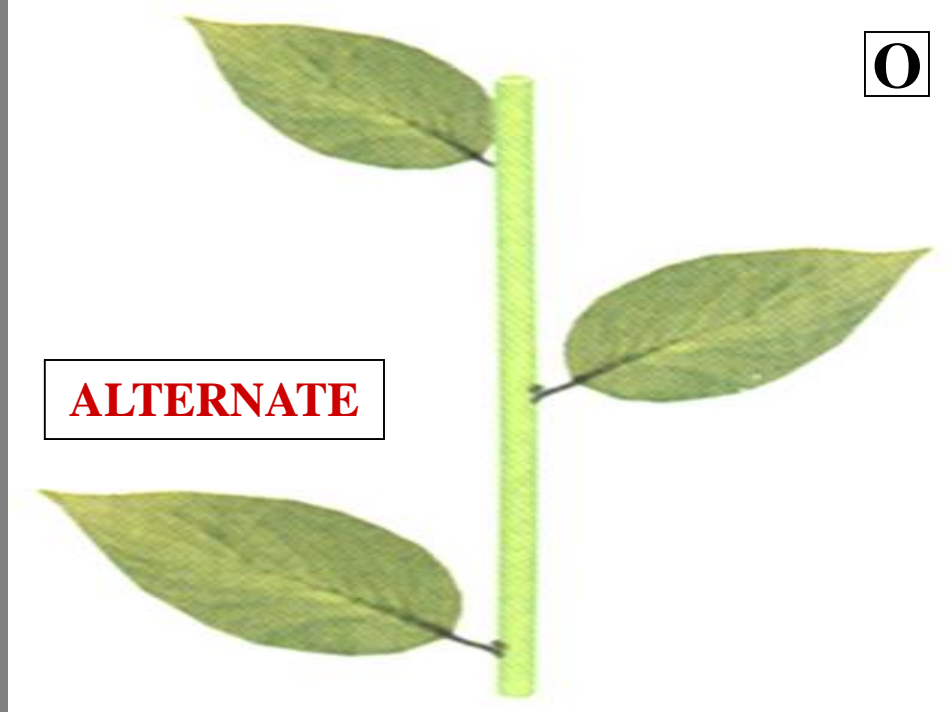
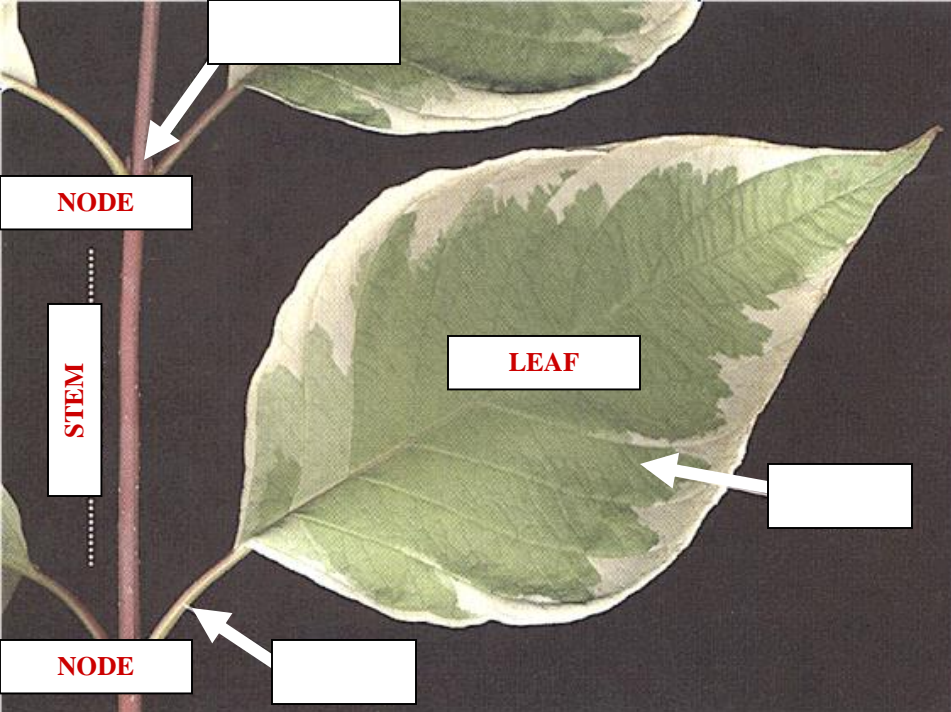


# **ALTERNATE PHYLLOTAXY**

**ONE  
LEAF PER NODE**

**ALTERNATE PHYLLOTAXY**





# **OPPOSITE PHYLLLOTAXY**

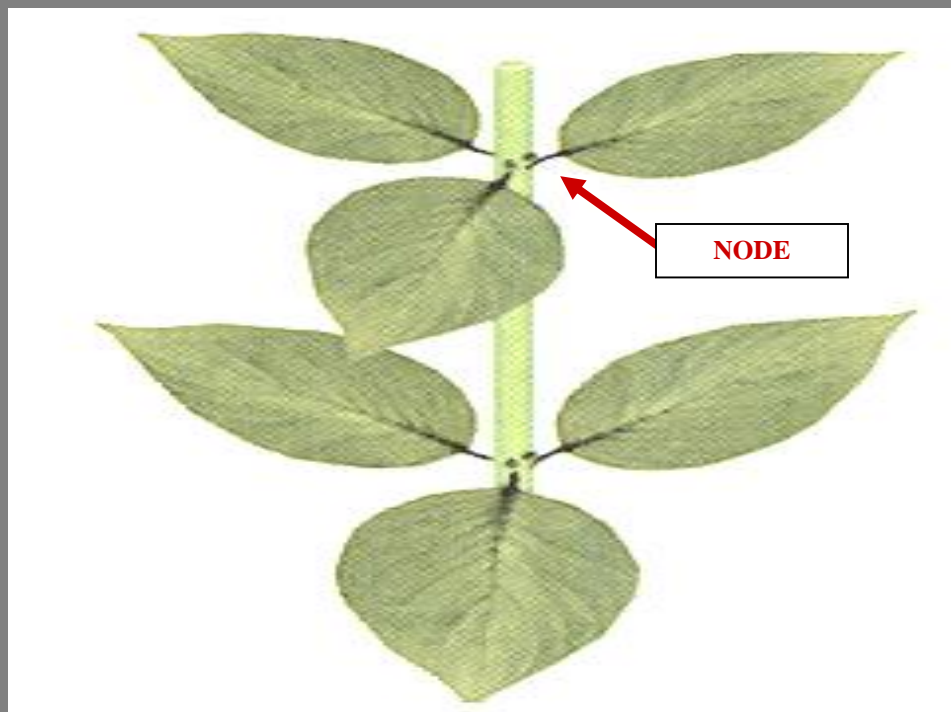
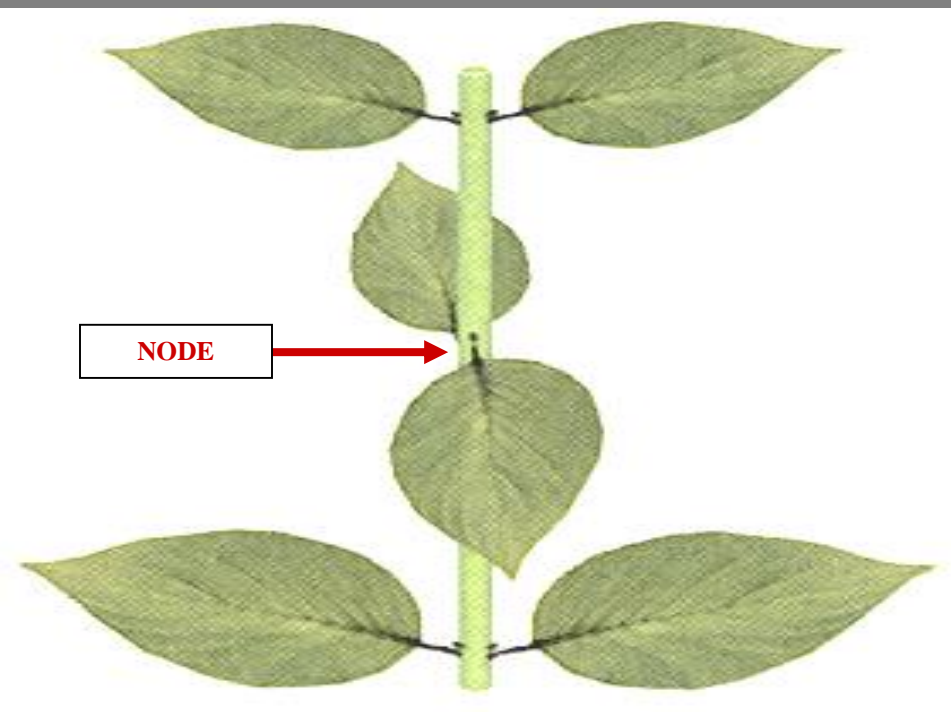
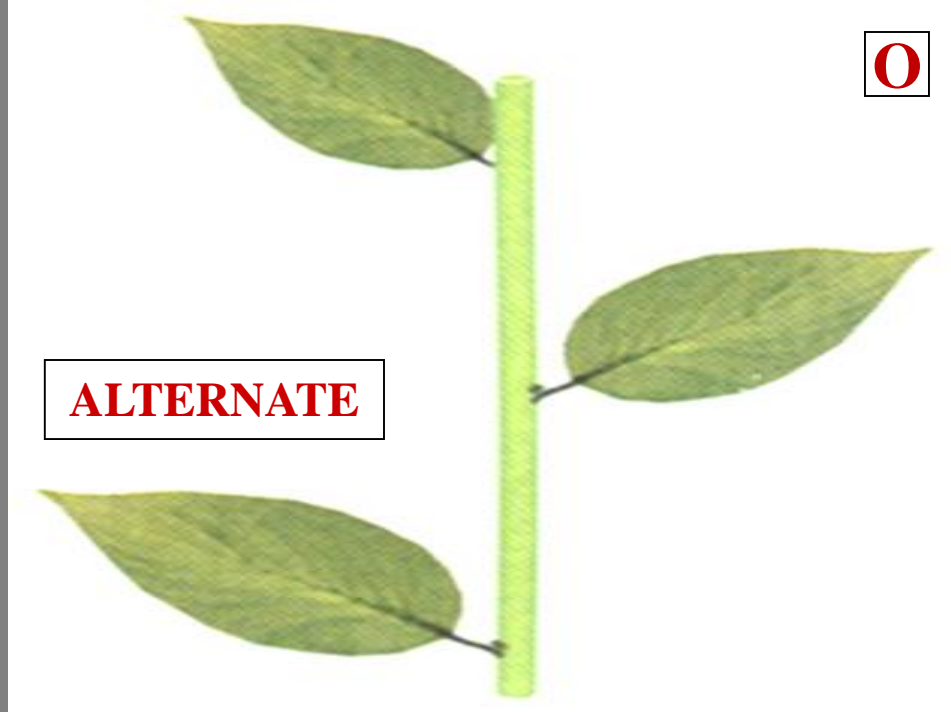
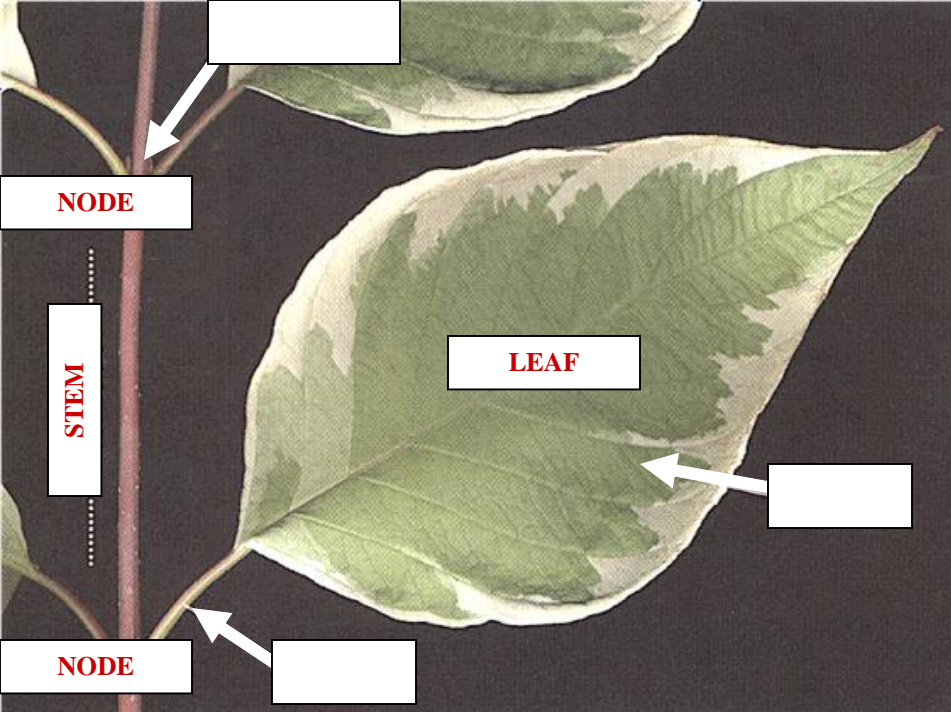


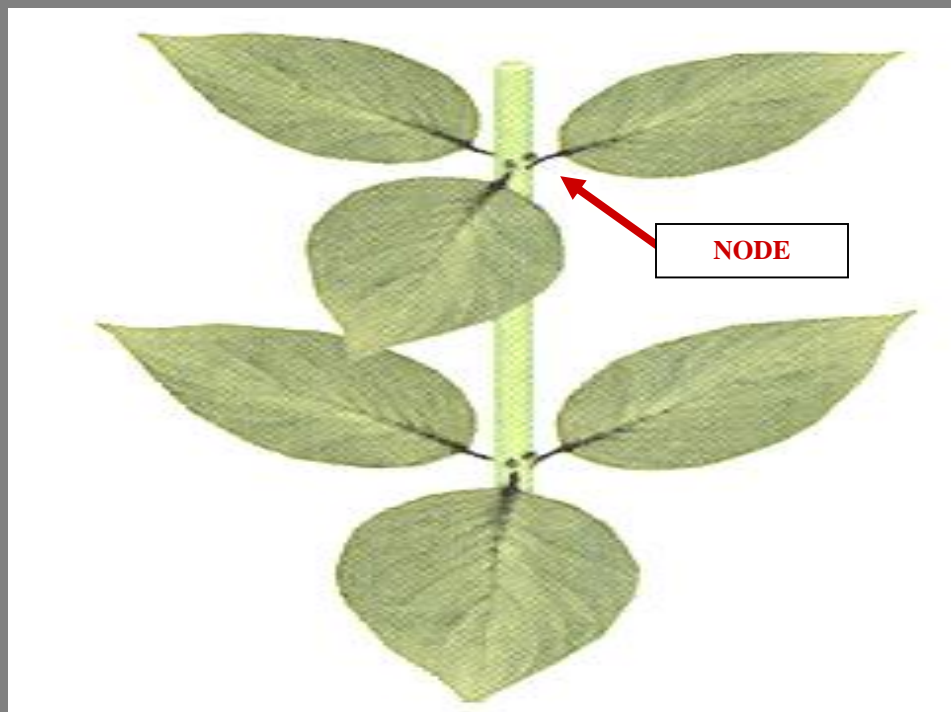
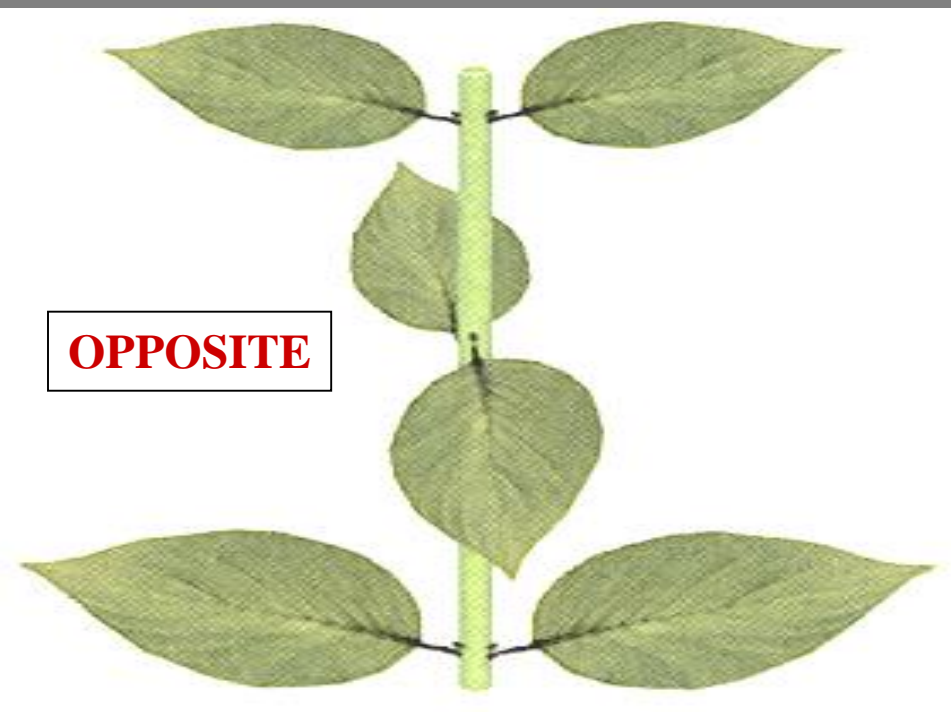
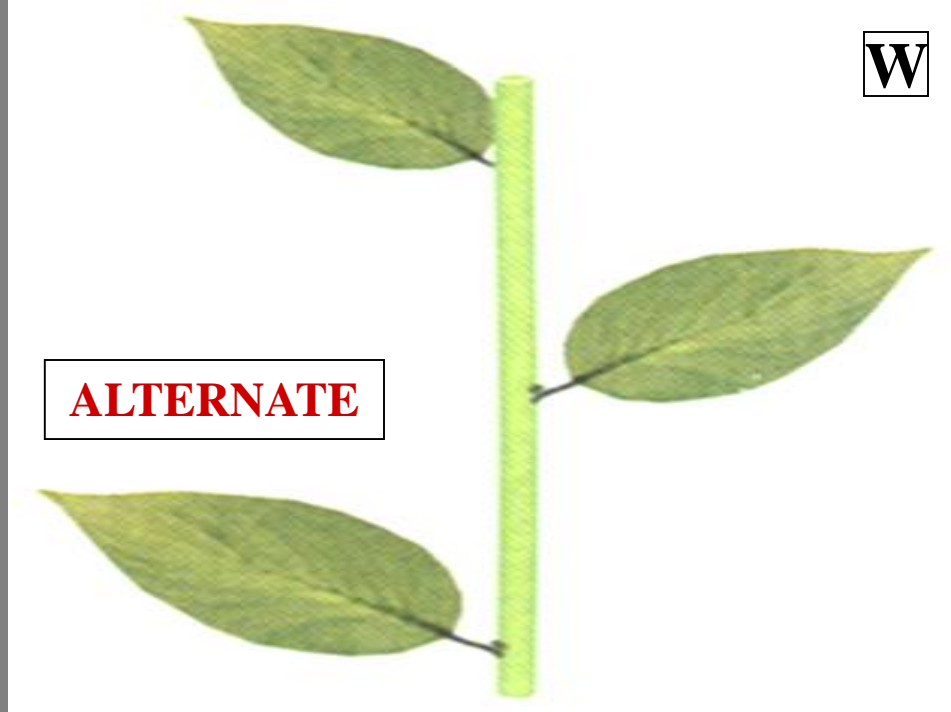
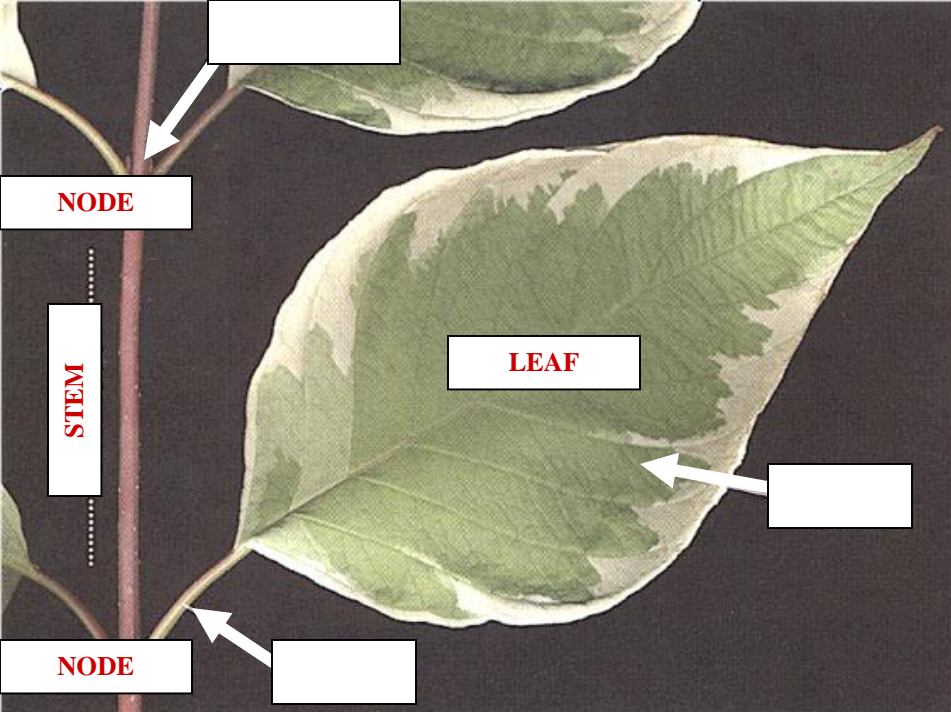
# **OPPOSITE PHYLLLOTAXY**

**TWO  
LEAVES PER NODE**

**OPPOSITE PHYLLLOTAXY**







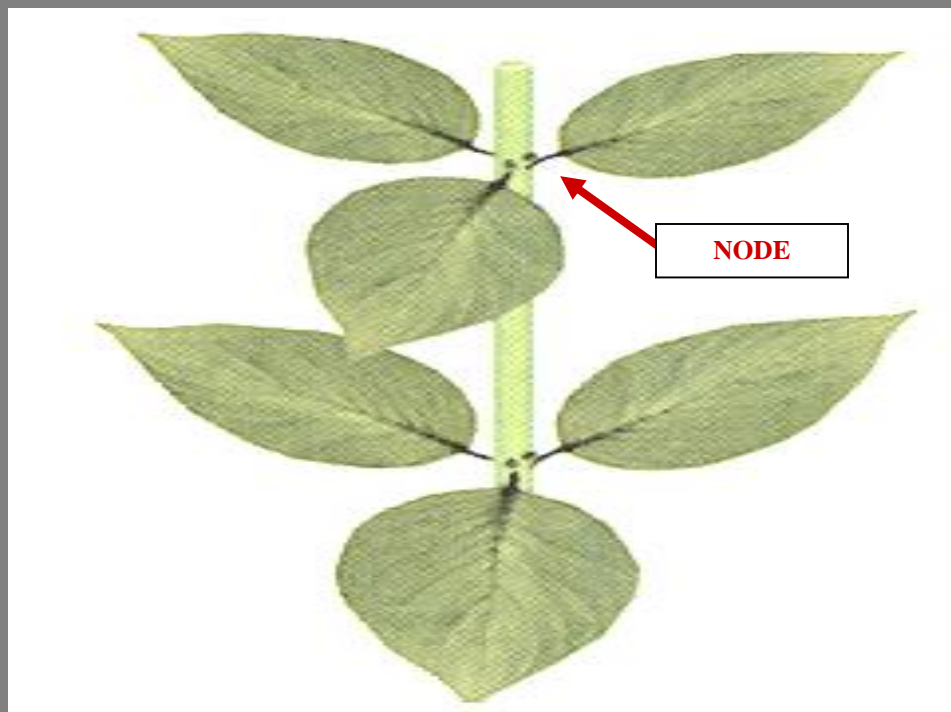
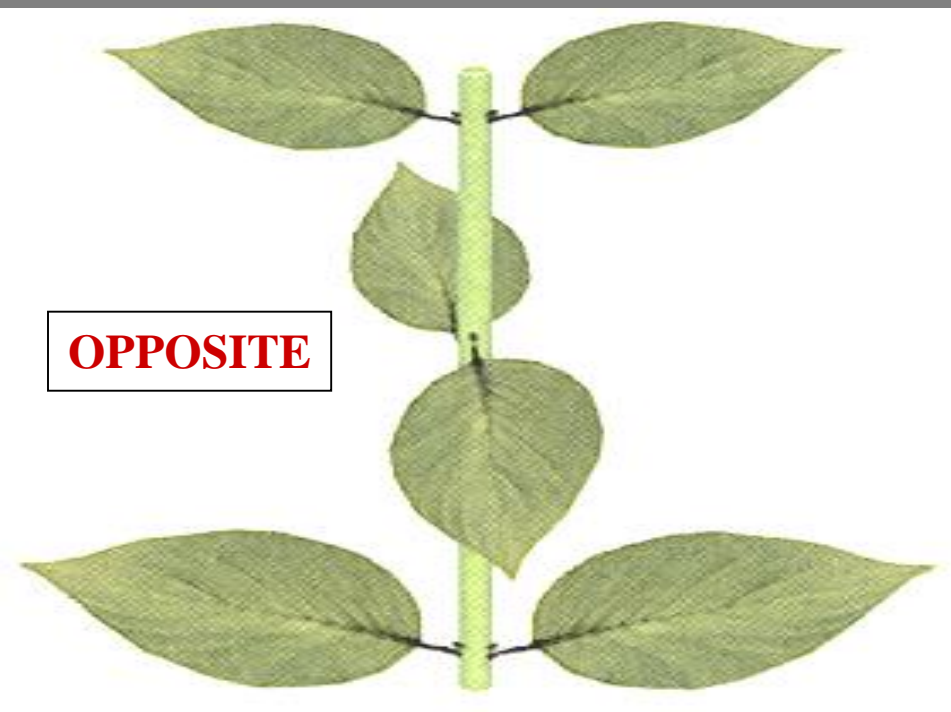
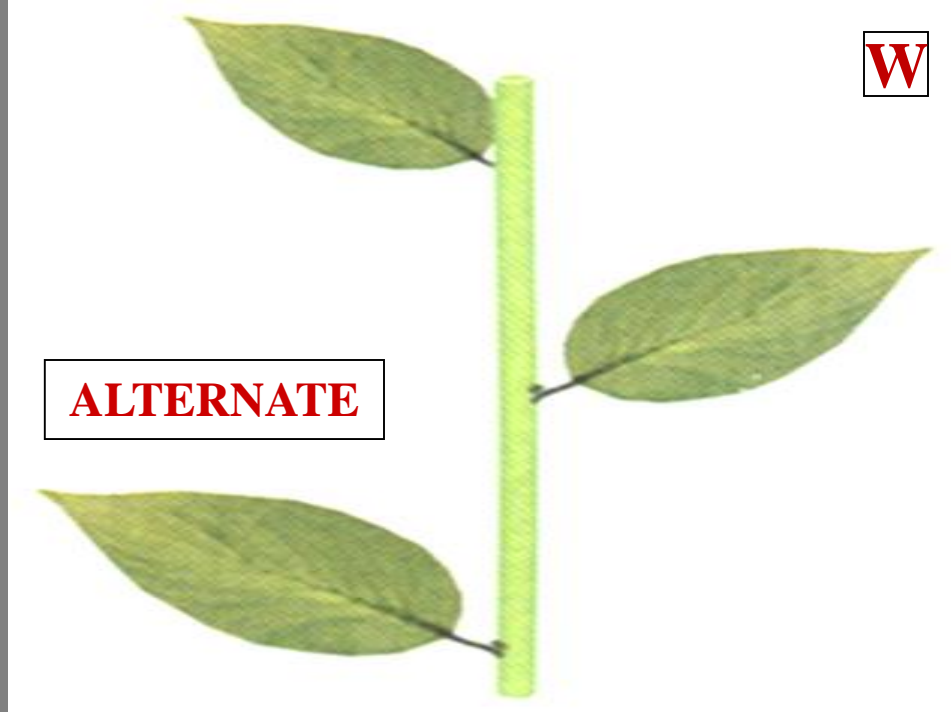
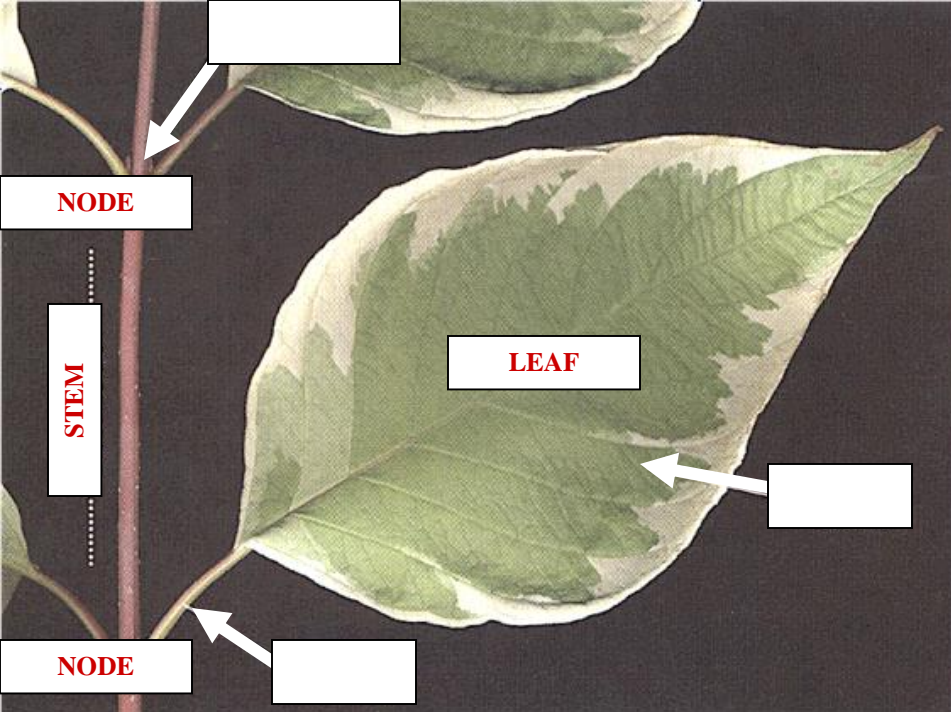
# **WHORLED PHYLLOTAXY**

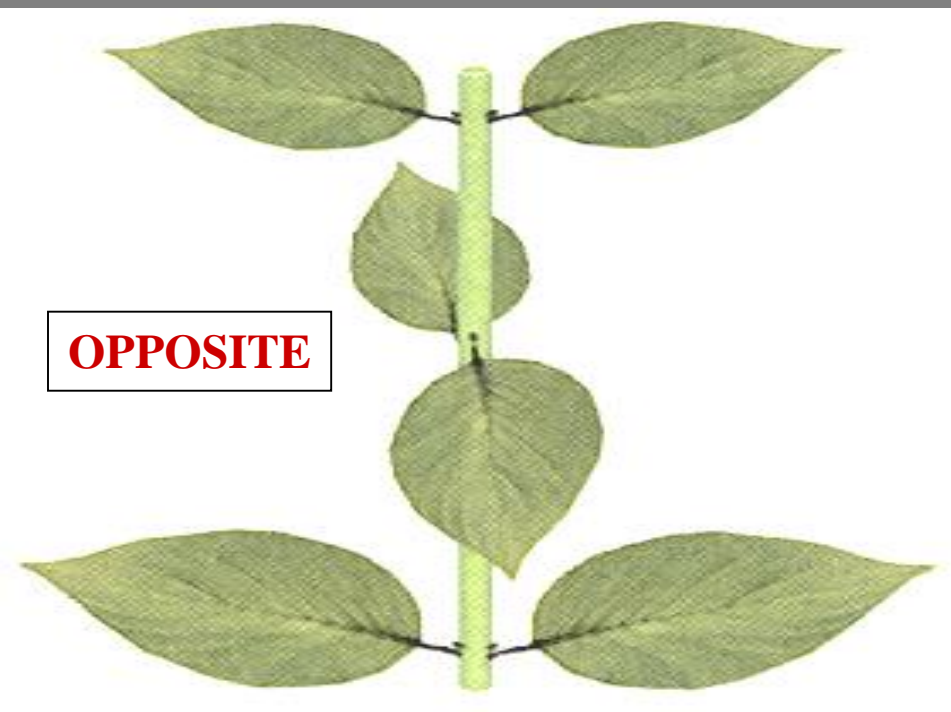
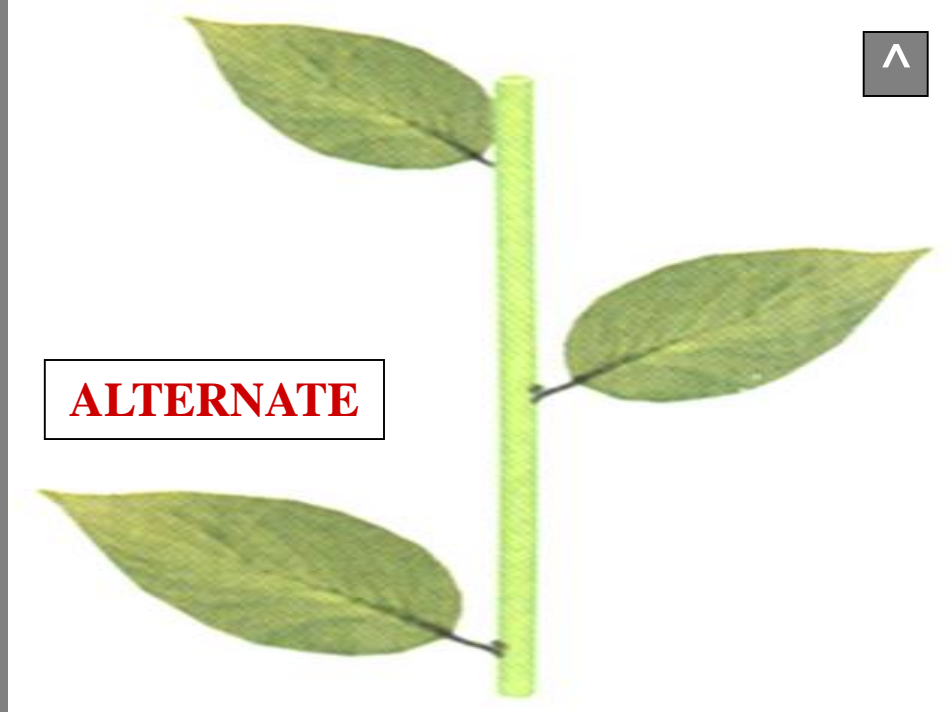
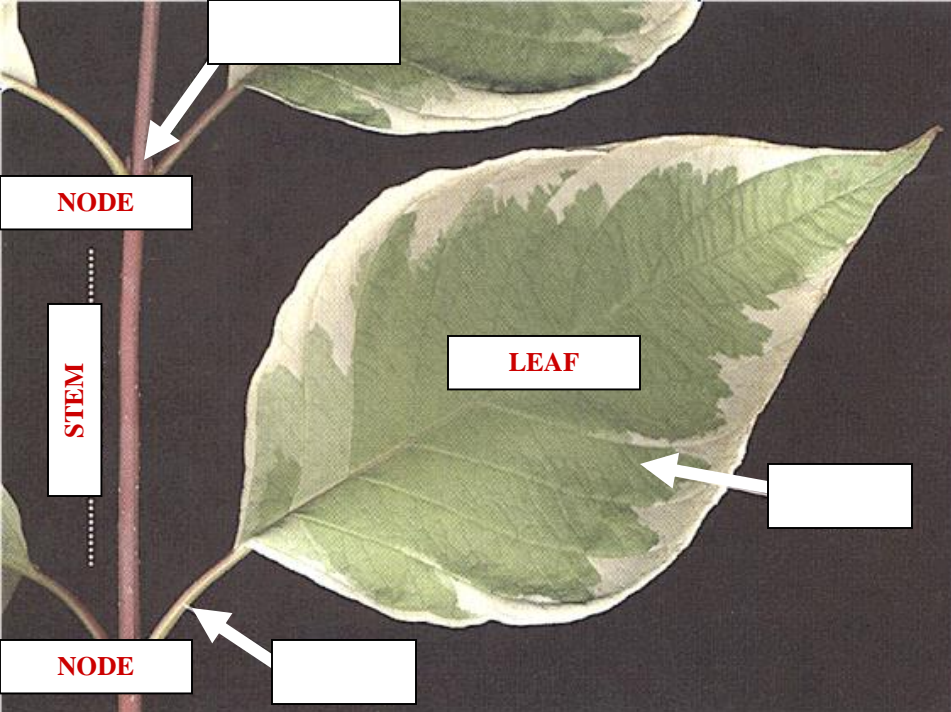


# WHORLED PHYLLOTAXY

THREE  
OR MORE  
LEAVES PER NODE

WHORLED PHYLLOTAXY







**LEAF  
MORPHOLOGY  
&  
LEAF  
ANATOMY**



# DICOT LEAF MORPHOLOGY



# DICOT LEAF MORPHOLOGY TYPES

**DICOT LEAF  
MORPHOLOGY  
TYPES**

**SIMPLE LEAF**

**DICOT LEAF  
MORPHOLOGY  
TYPES**



# **DICOT LEAF MORPHOLOGY TYPES**

**SIMPLE LEAF**

**COMPOUND LEAF**

# **DICOT LEAF MORPHOLOGY TYPES**

# **SIMPLE DICOT LEAF**

**SIMPLE  
DICOT LEAF**

**DICOT LEAF**  
**SIMPLE LEAF**



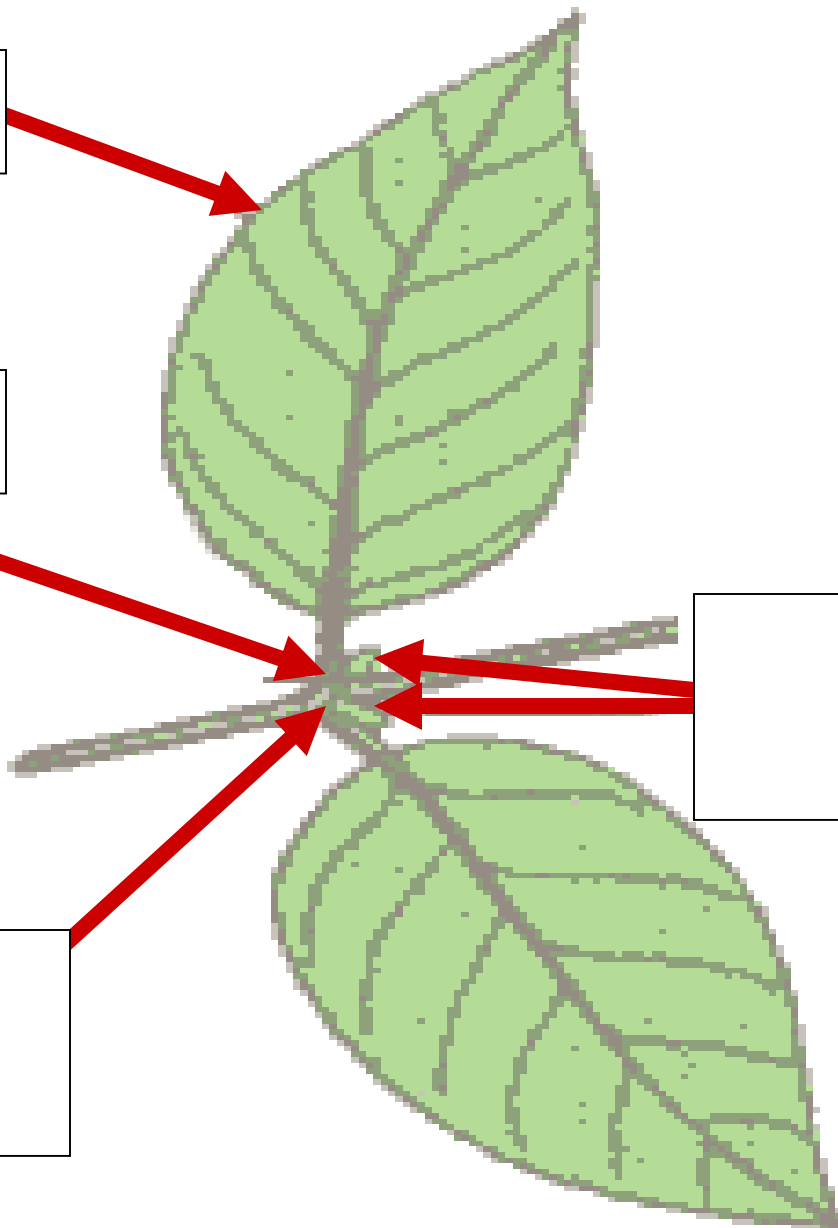
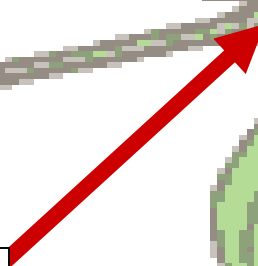
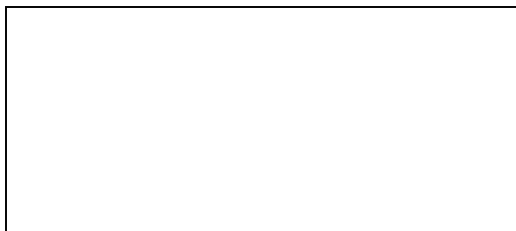
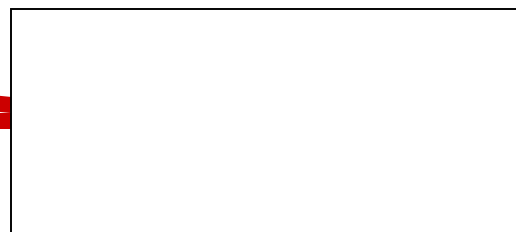
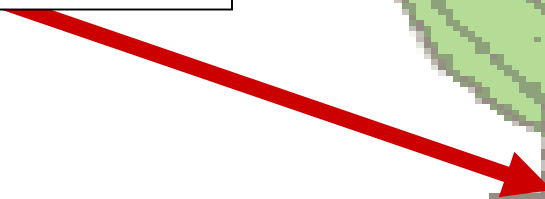
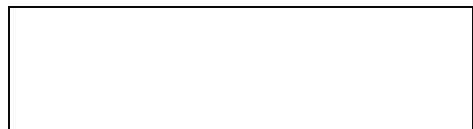
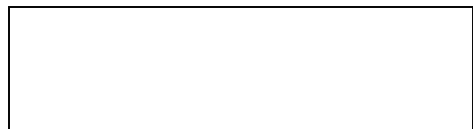
**LEAFLETS ABSENT**

**DICOT LEAF**  
**SIMPLE LEAF**

# **SIMPLE LEAF**

**LL**

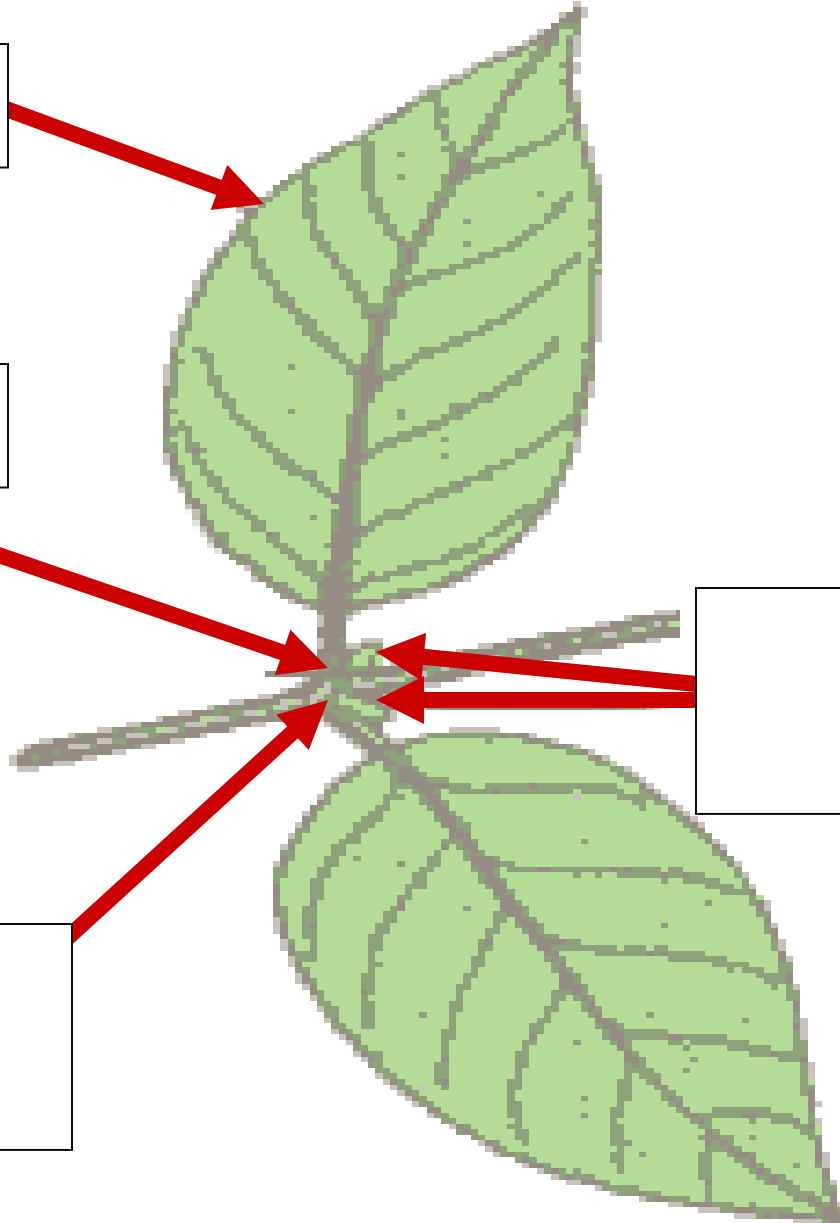
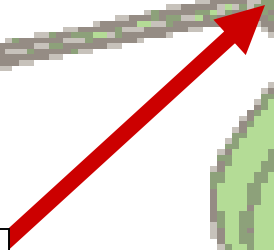
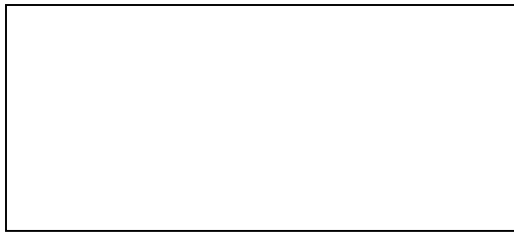
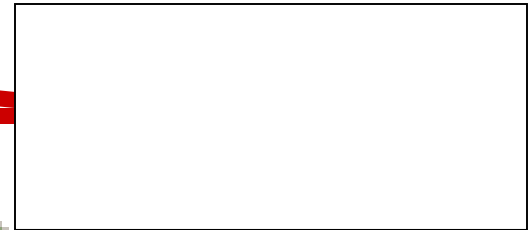
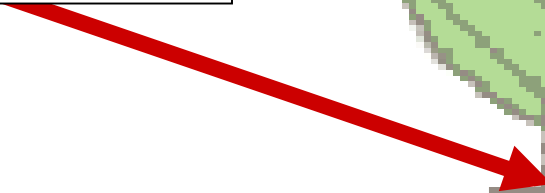
**AB**



**SIMPLE  
LEAF**

**LEAFLETS  
ABSENT**

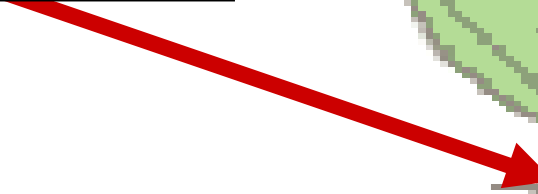
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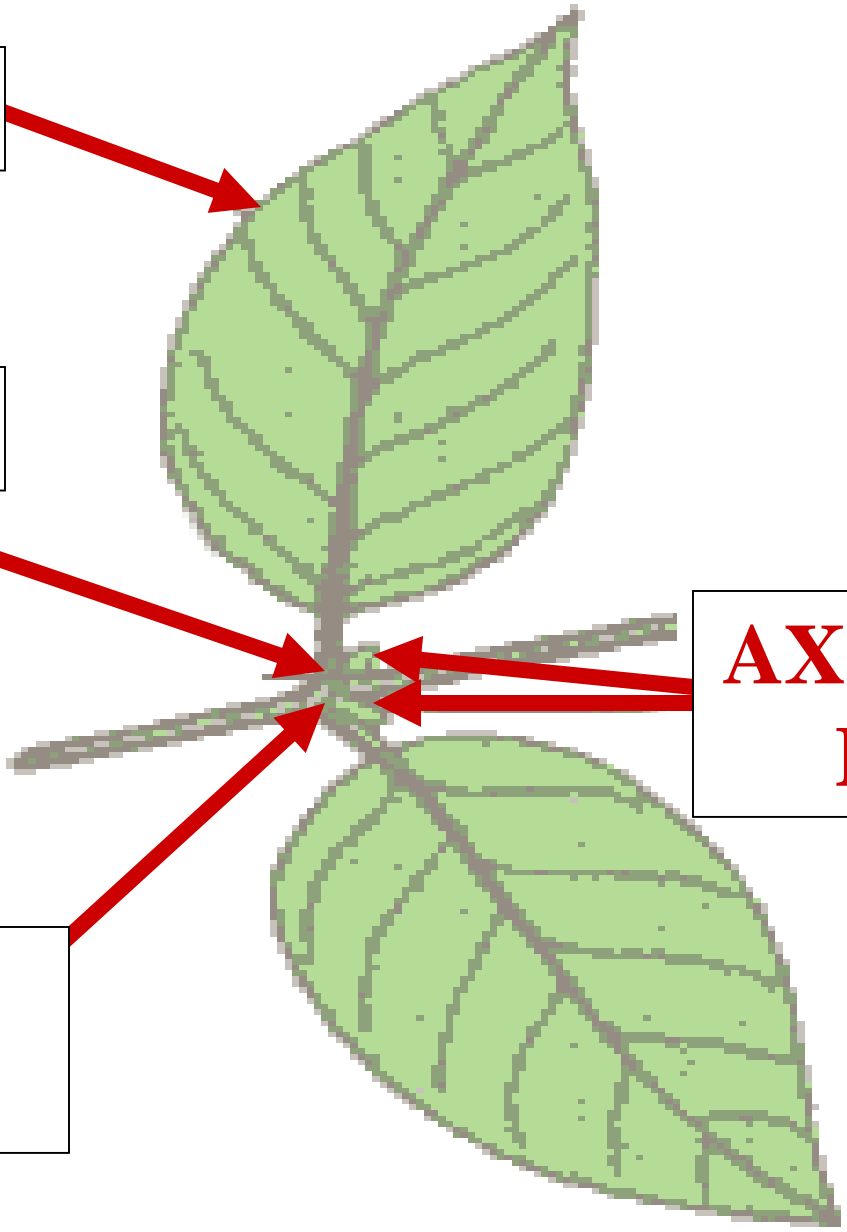
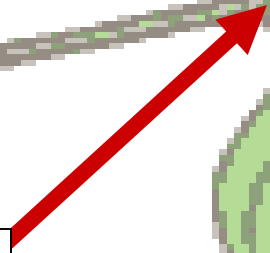


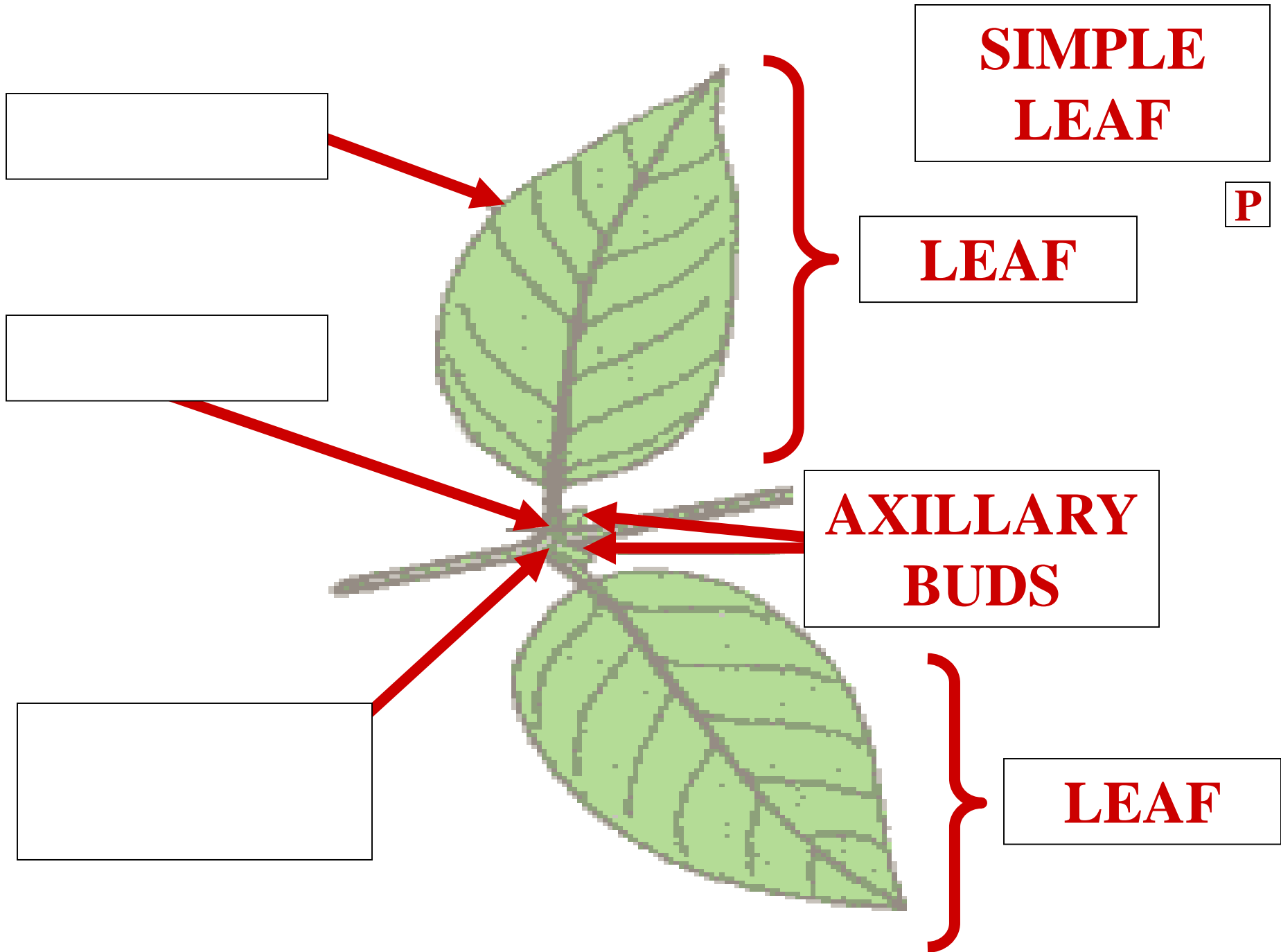
**SIMPLE  
LEAF**

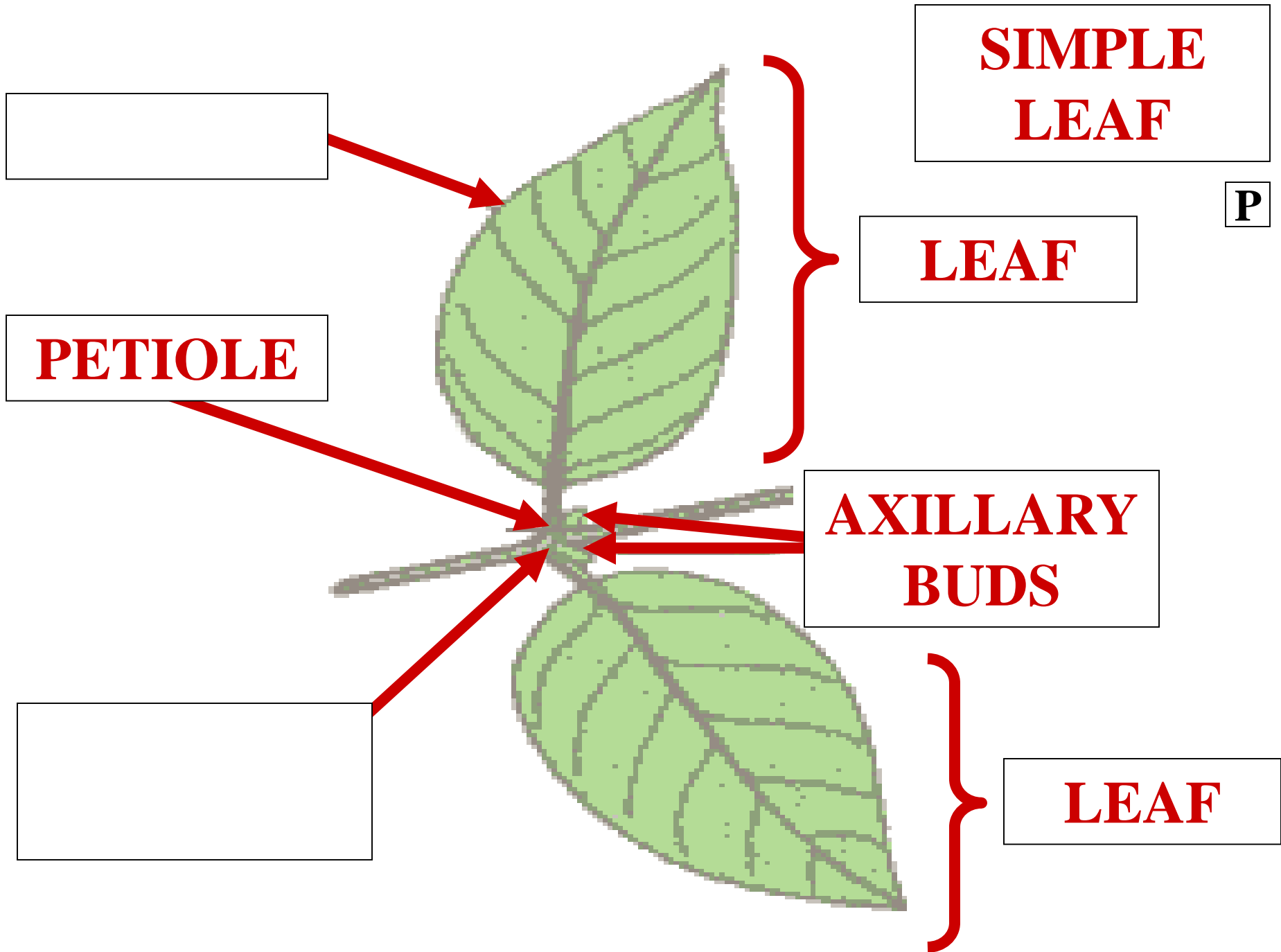
**LF**



**AXILLARY  
BUDS**







**PETIOLE**

# DICOT LEAF PETIOLE



LEAF STALK

# DICOT LEAF PETIOLE

**SIMPLE  
LEAF**

**S**

**LEAF**

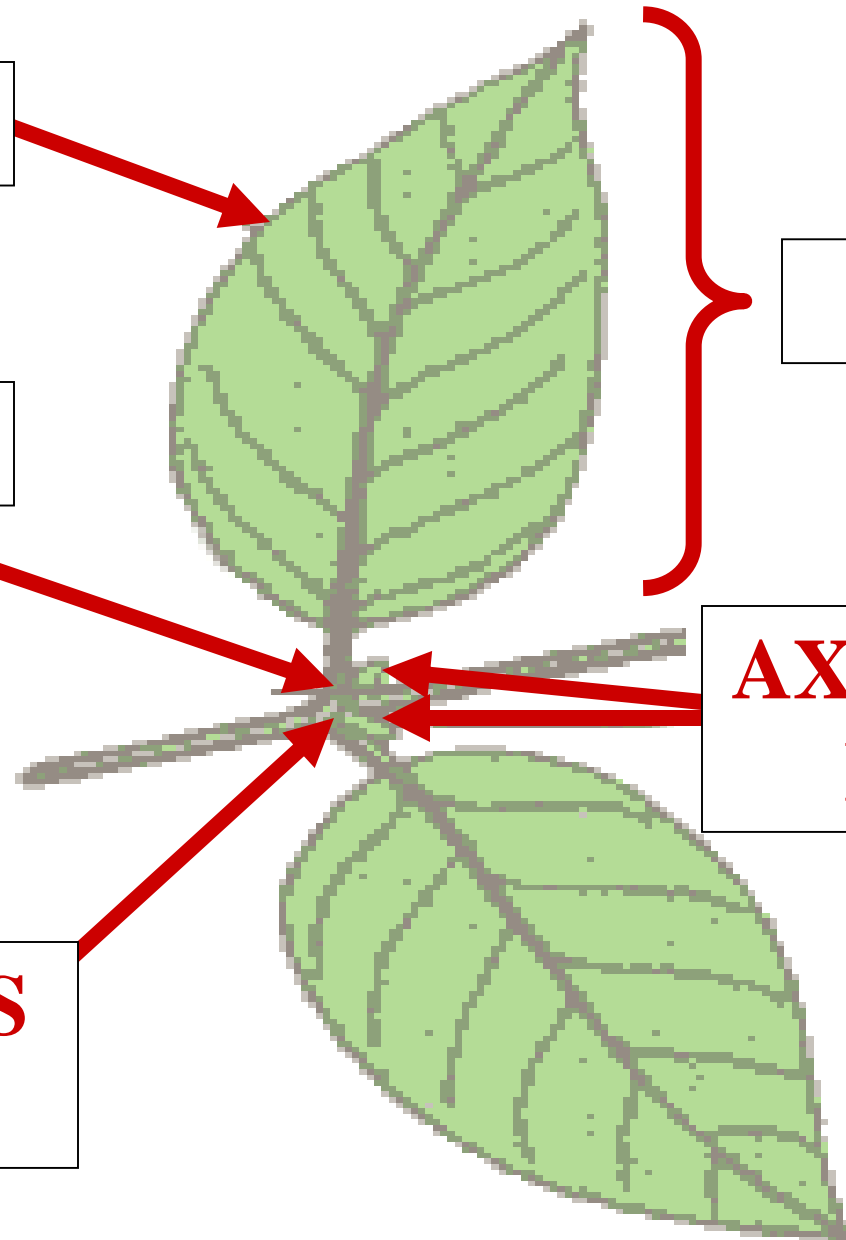
**AXILLARY  
BUDS**

**LEAF**

**PETIOLE**



**STIPULES  
ABSENT**



**STIPULE**

**DICOT LEAF  
STIPULE**



**LEAF-LIKE APPENDAGE  
AT PETIOLE BASE**

**DICOT LEAF  
STIPULE**



# **DICOT LEAF STIPULE**



**LEAF-LIKE APPENDAGE  
AT PETIOLE BASE**

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**PRESENT OR ABSENT**

# **DICOT LEAF STIPULE**

[ ]

**SIMPLE  
LEAF**

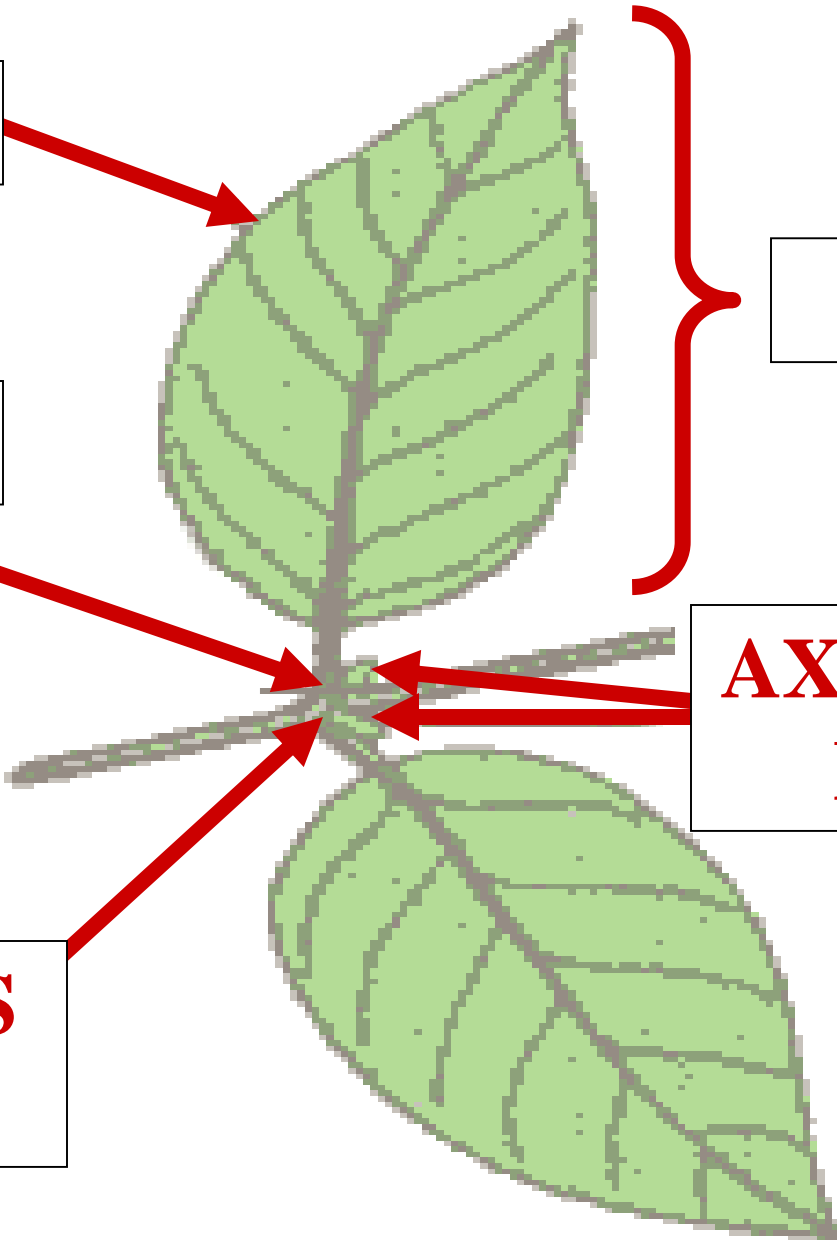
**L**

**LEAF**

**PETIOLE**



**STIPULES  
ABSENT**



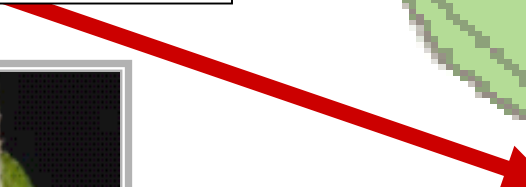
**AXILLARY  
BUDS**

**LEAF**

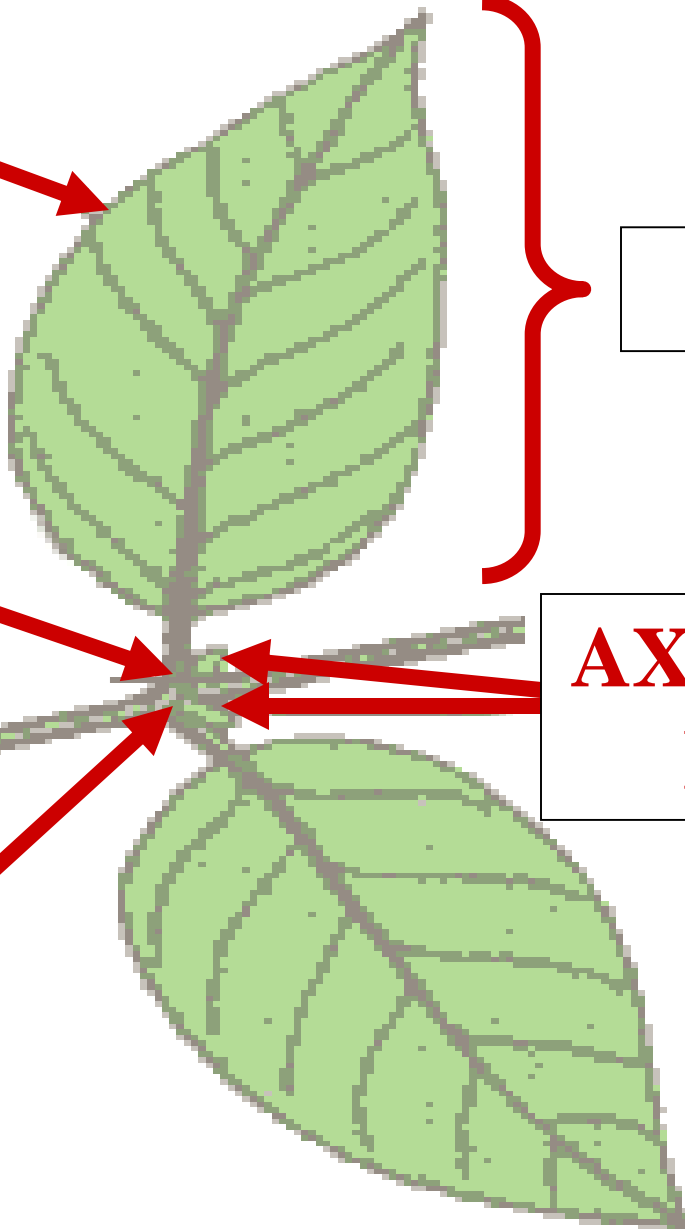
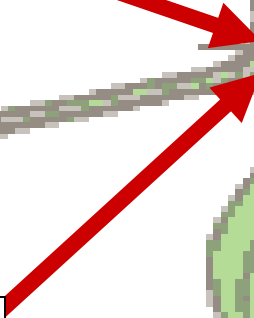
**LAMINA**



**PETIOLE**



**STIPULES  
ABSENT**



**SIMPLE  
LEAF**

**LEAF**

**L**

**AXILLARY  
BUDS**



**LEAF**



**LAMINA**