



LEAF MORPHOLOGY



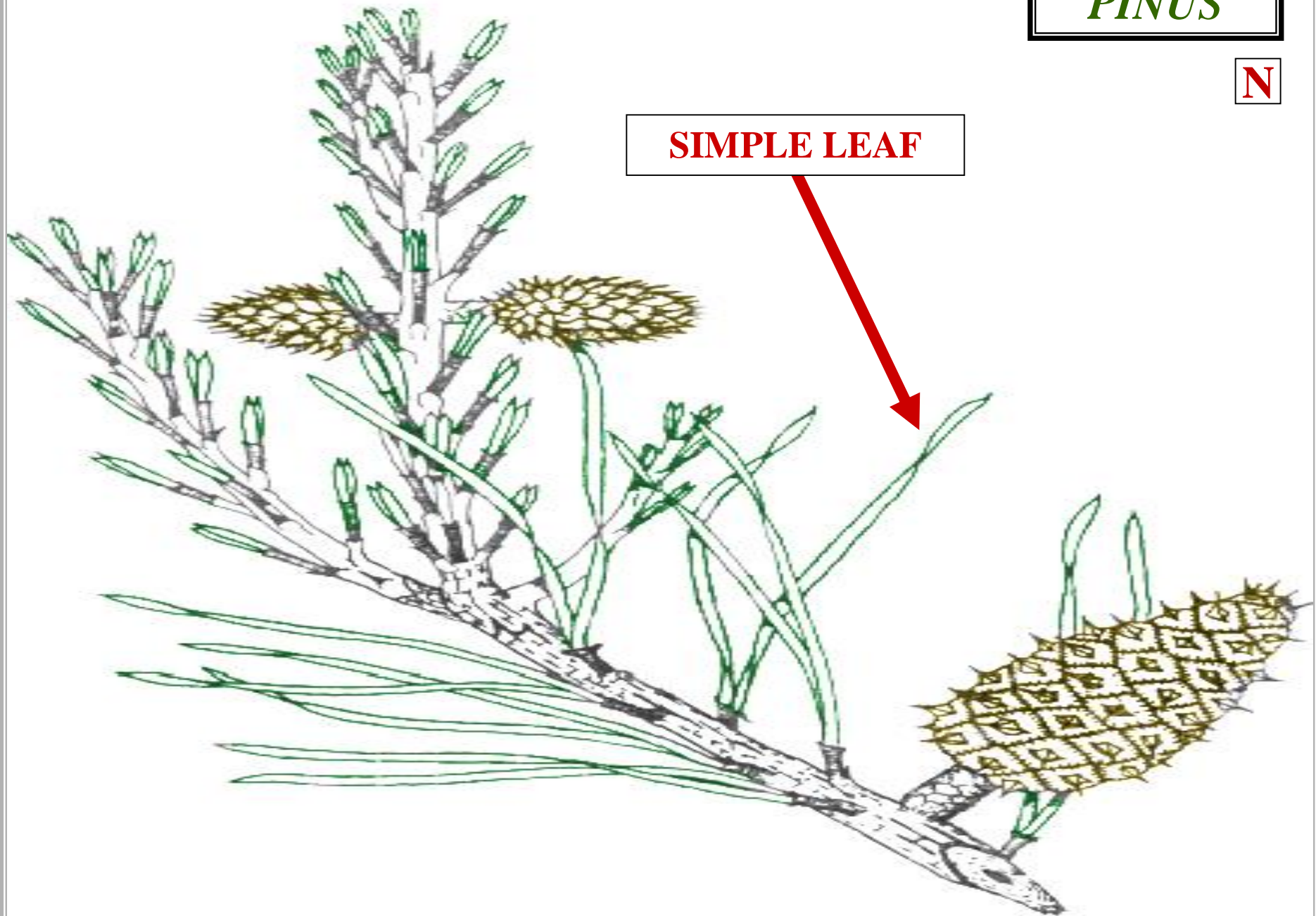
SIMPLE LEAF

PINUS

PINUS

N

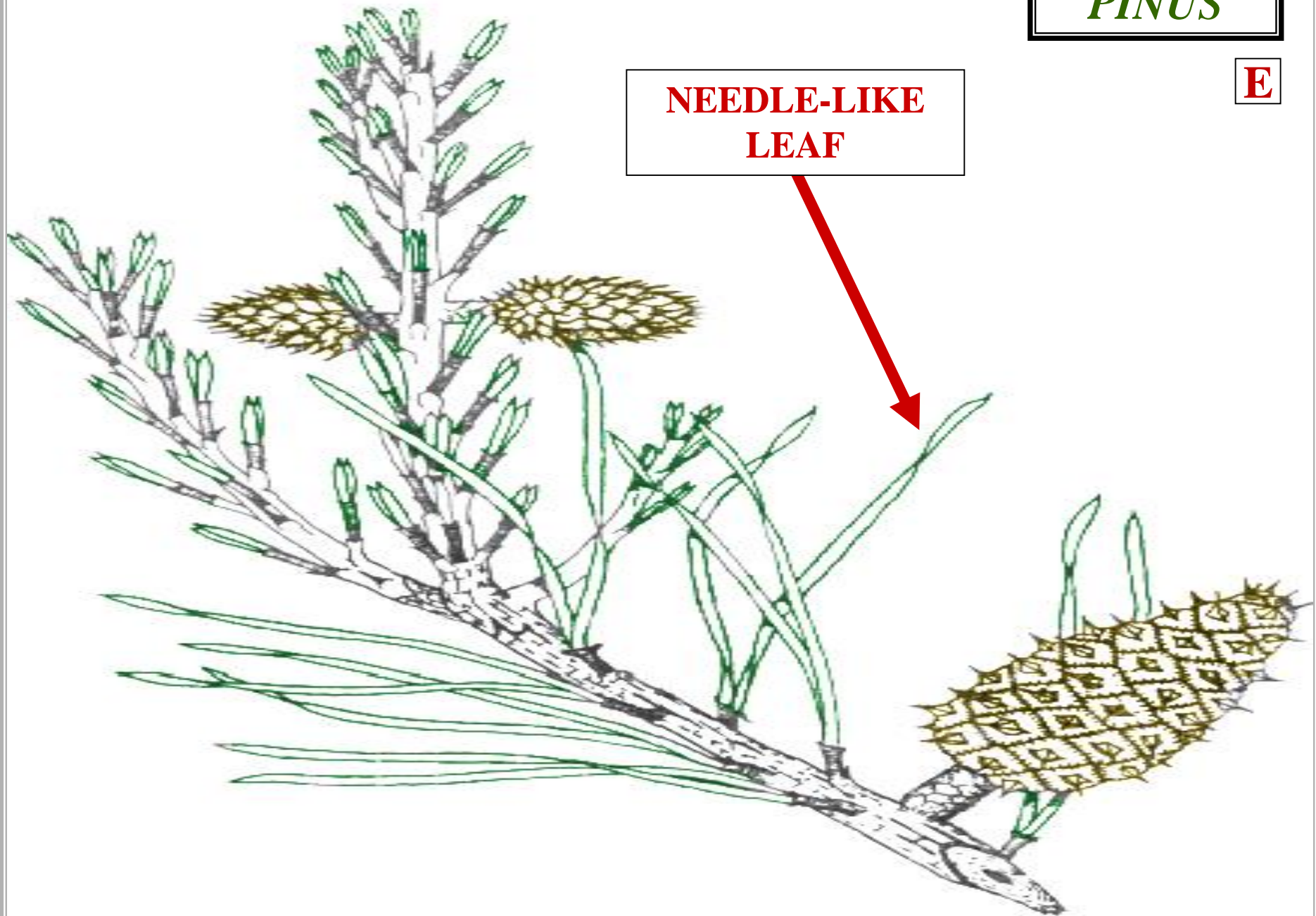
SIMPLE LEAF



PINUS

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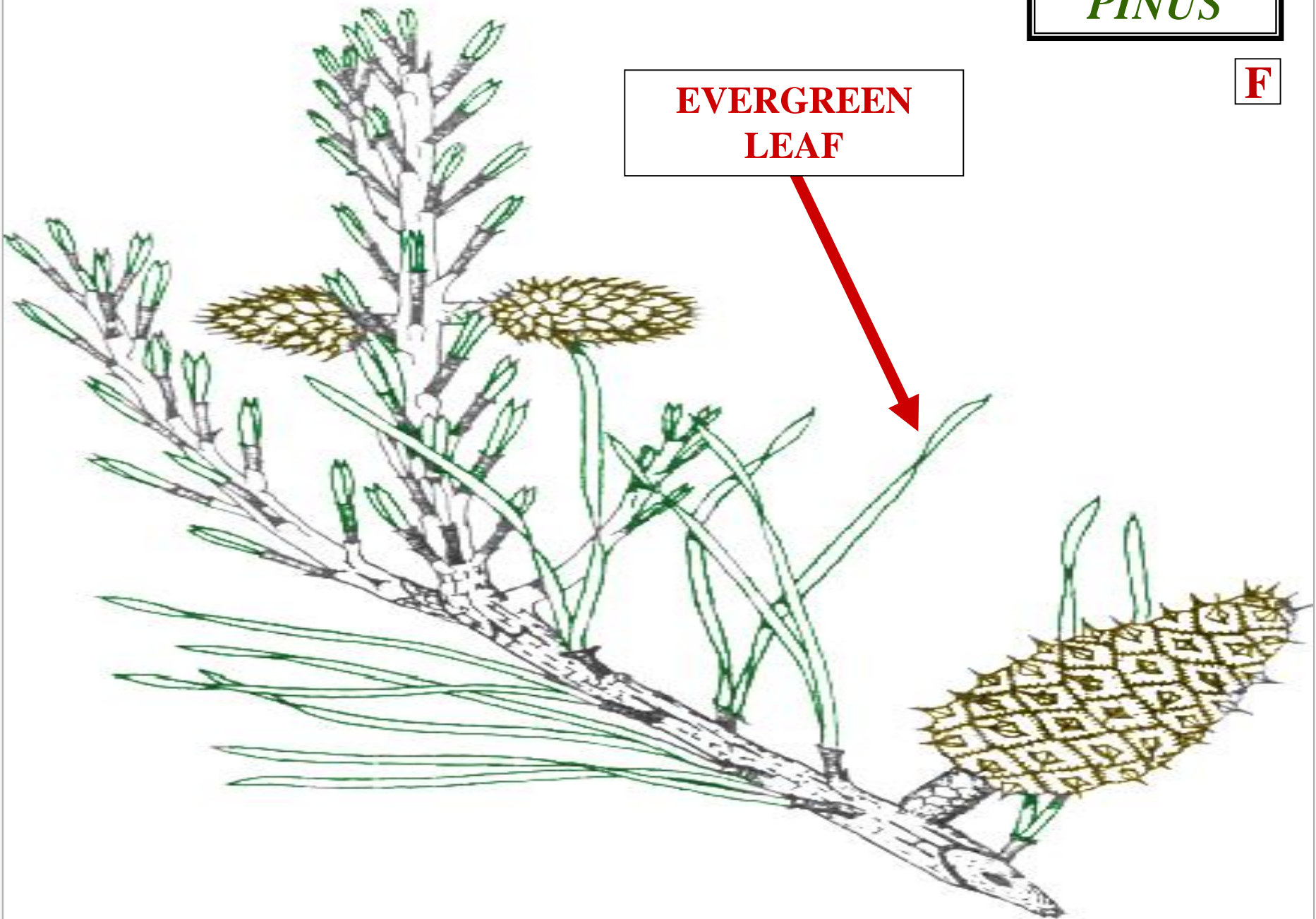
**NEEDLE-LIKE
LEAF**



PINUS

F

**EVERGREEN
LEAF**

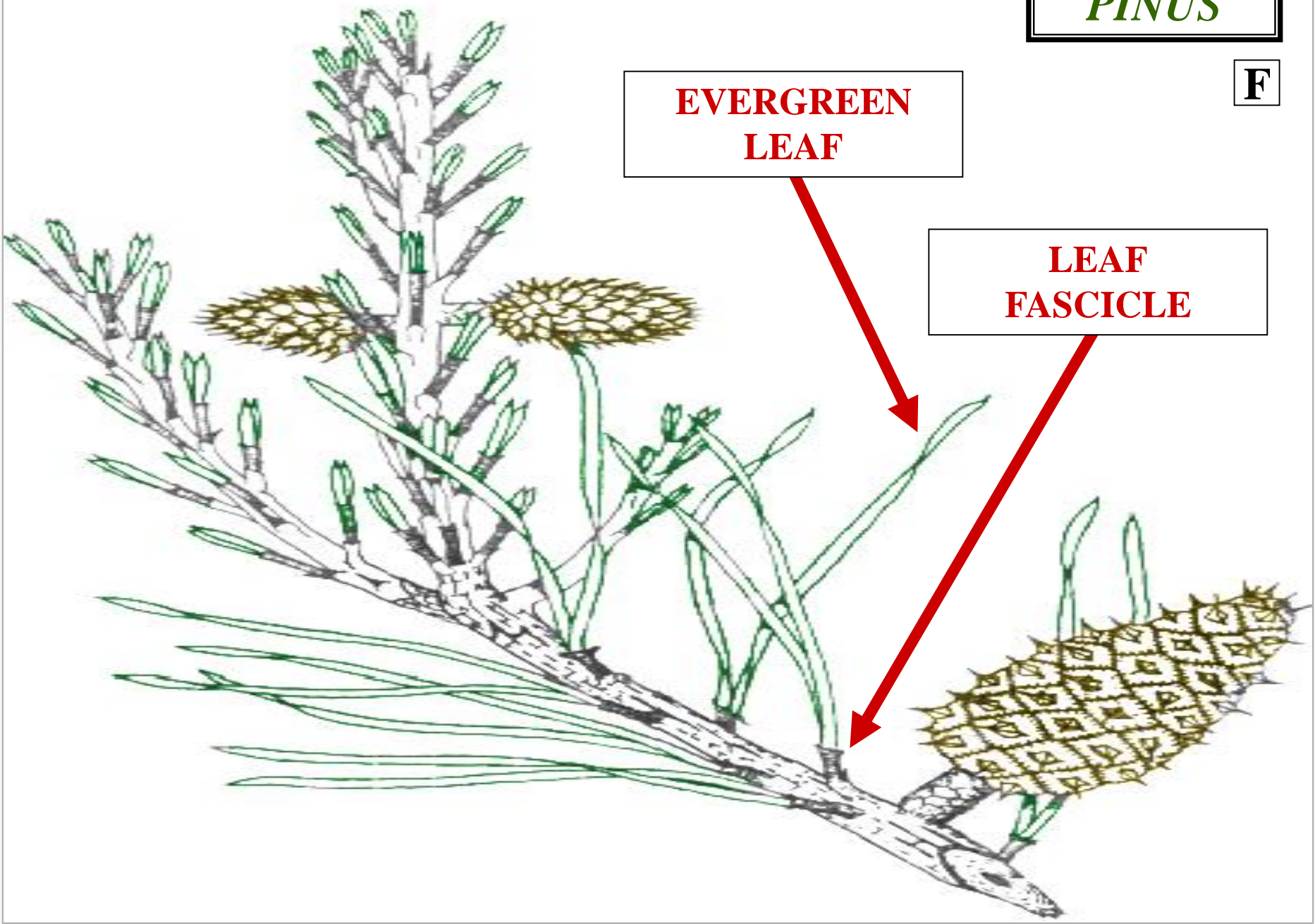


PINUS

F

**EVERGREEN
LEAF**

**LEAF
FASCICLE**



FASCICLE



PINOPHYTA
LEAF FASCICLE

LEAF AGGREGATE

PINOPHYTA
LEAF FASCICLE

PINOPHYTA
LEAF FASCICLE



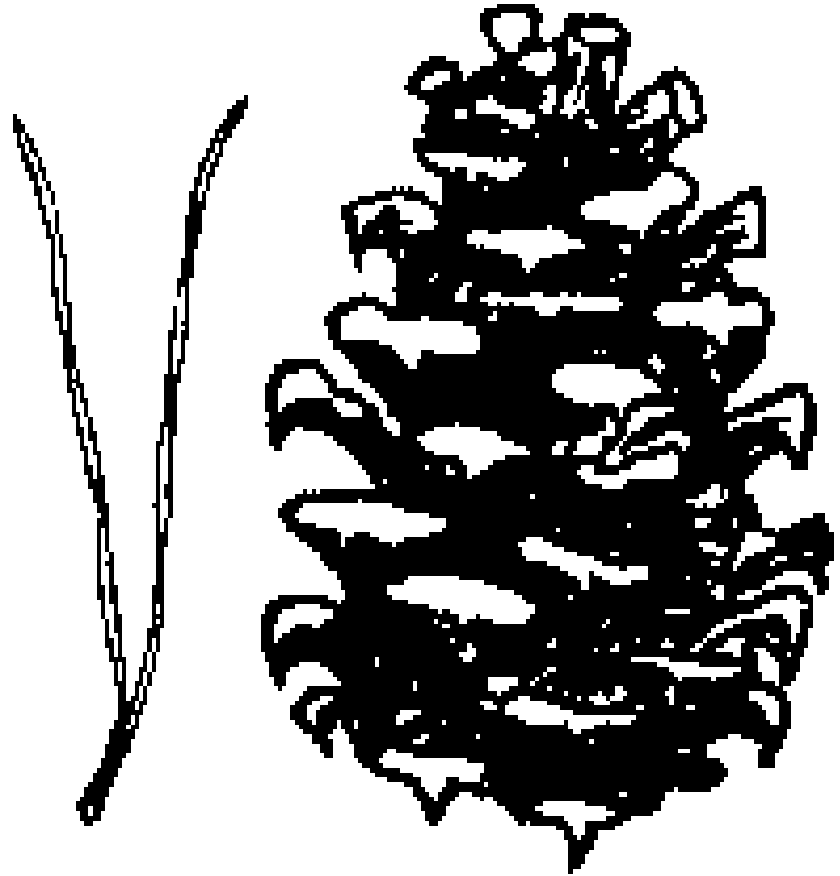
LEAF
NUMBER / FASCICLE
SPECIES SPECIFIC

PINOPHYTA
LEAF FASCICLE



PINUS

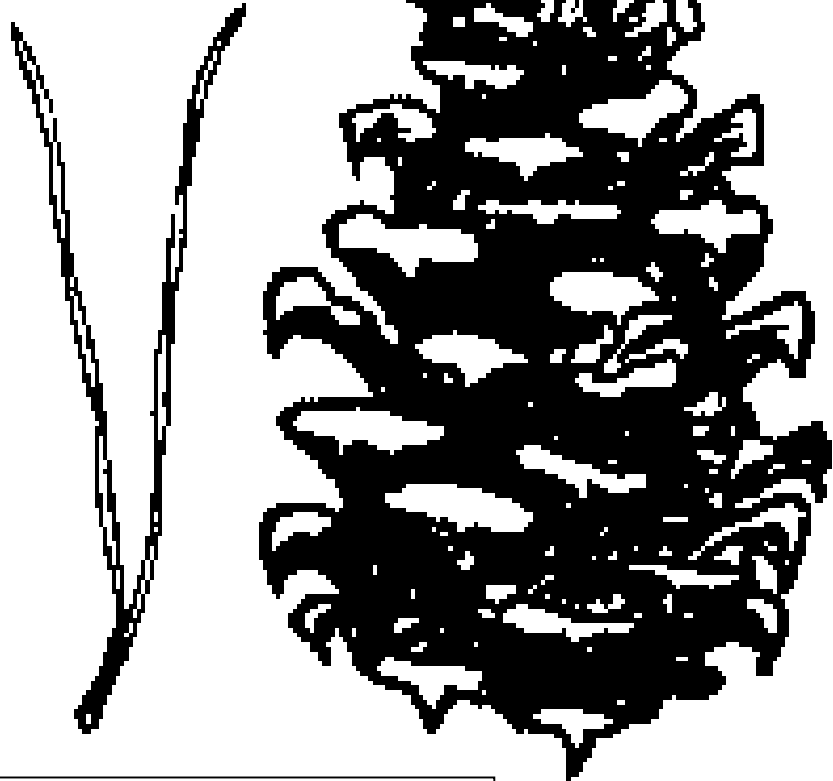
V



PINUS VIRGINIANA

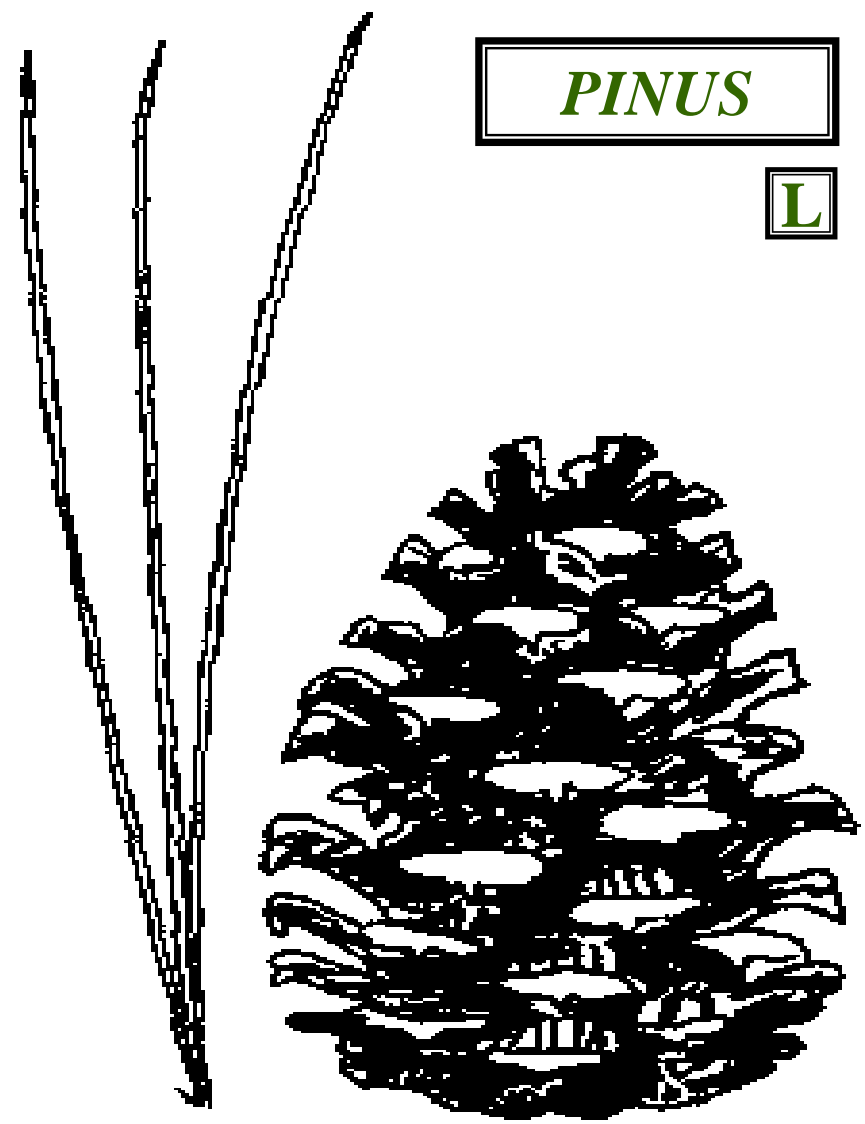


PINUS



2 LEAVES / FASCICLE

VIRGINIA PINE



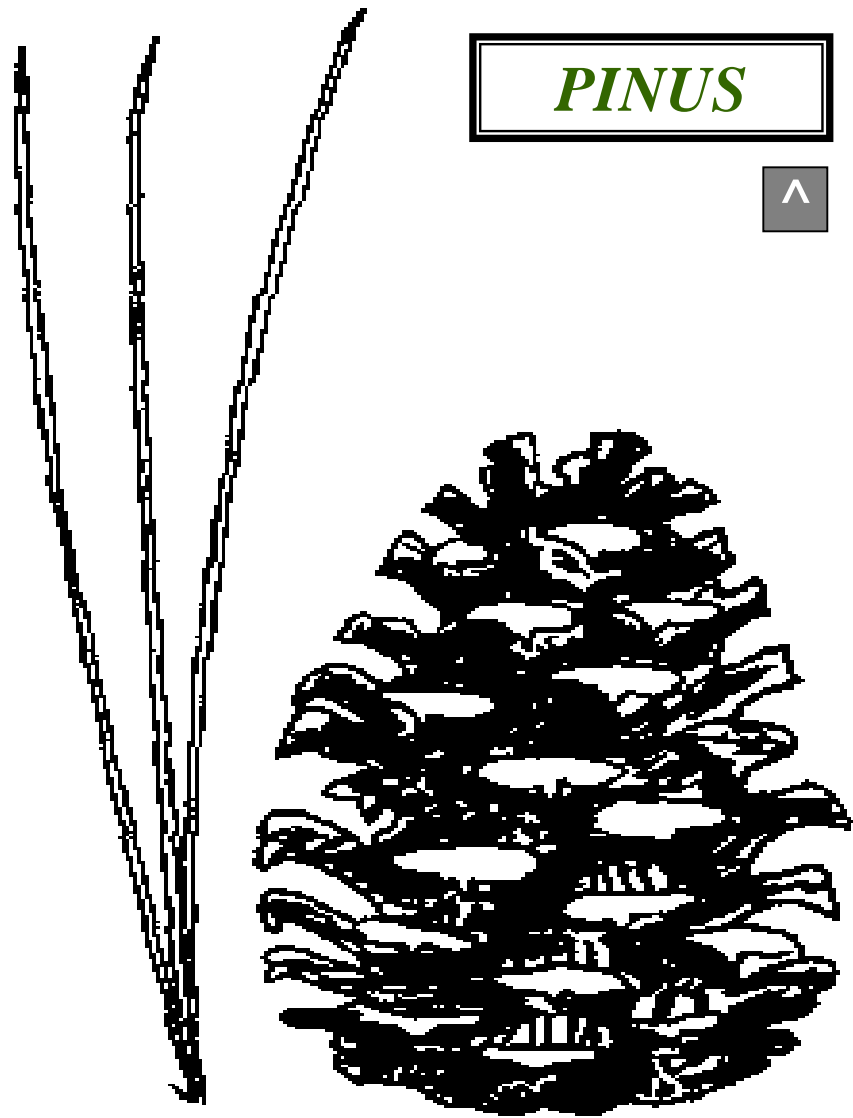
PINUS

L

PINUS TAEDA



PINUS

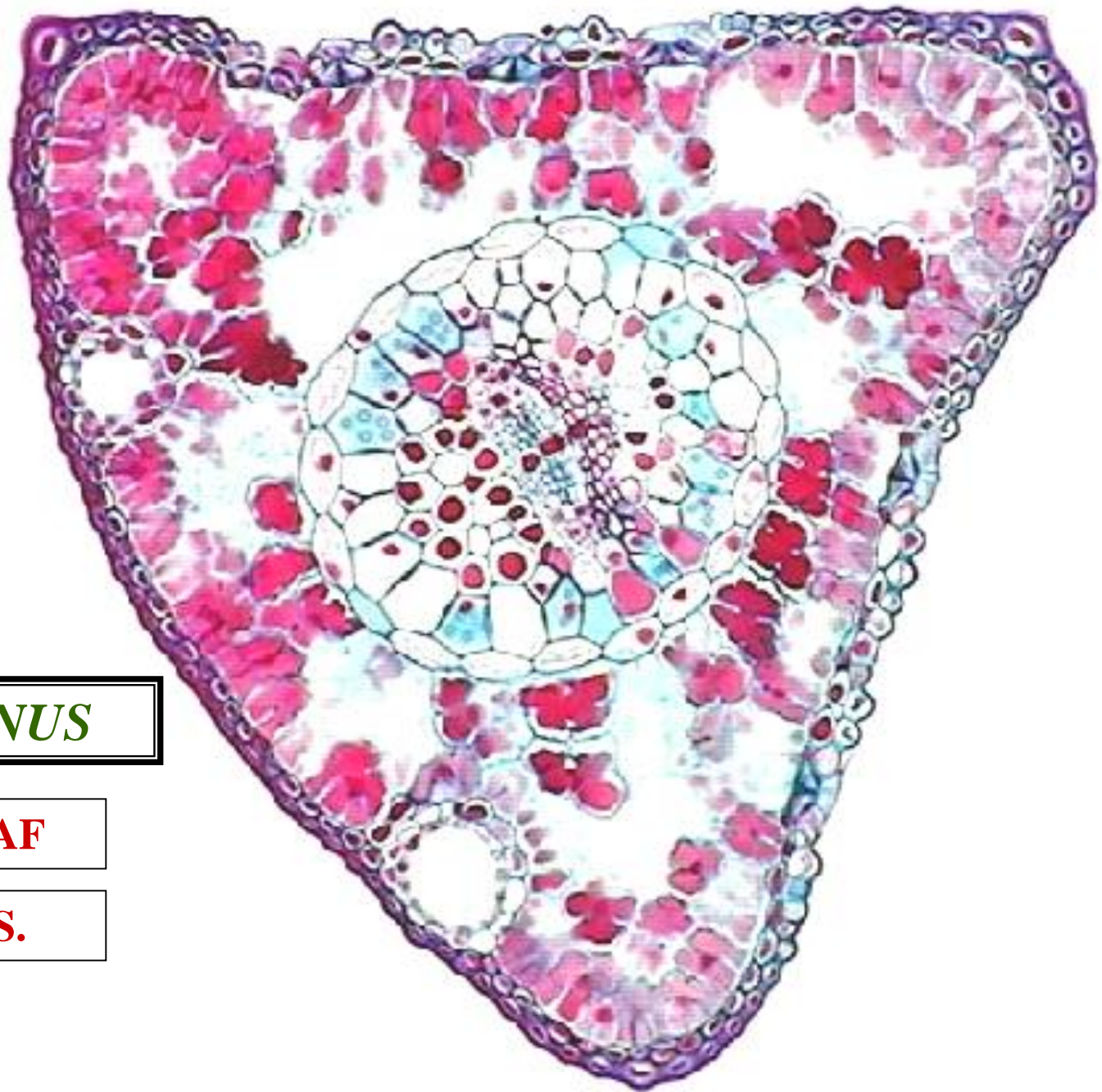


3 LEAVES / FASCICLE

LOBLOLLY PINE



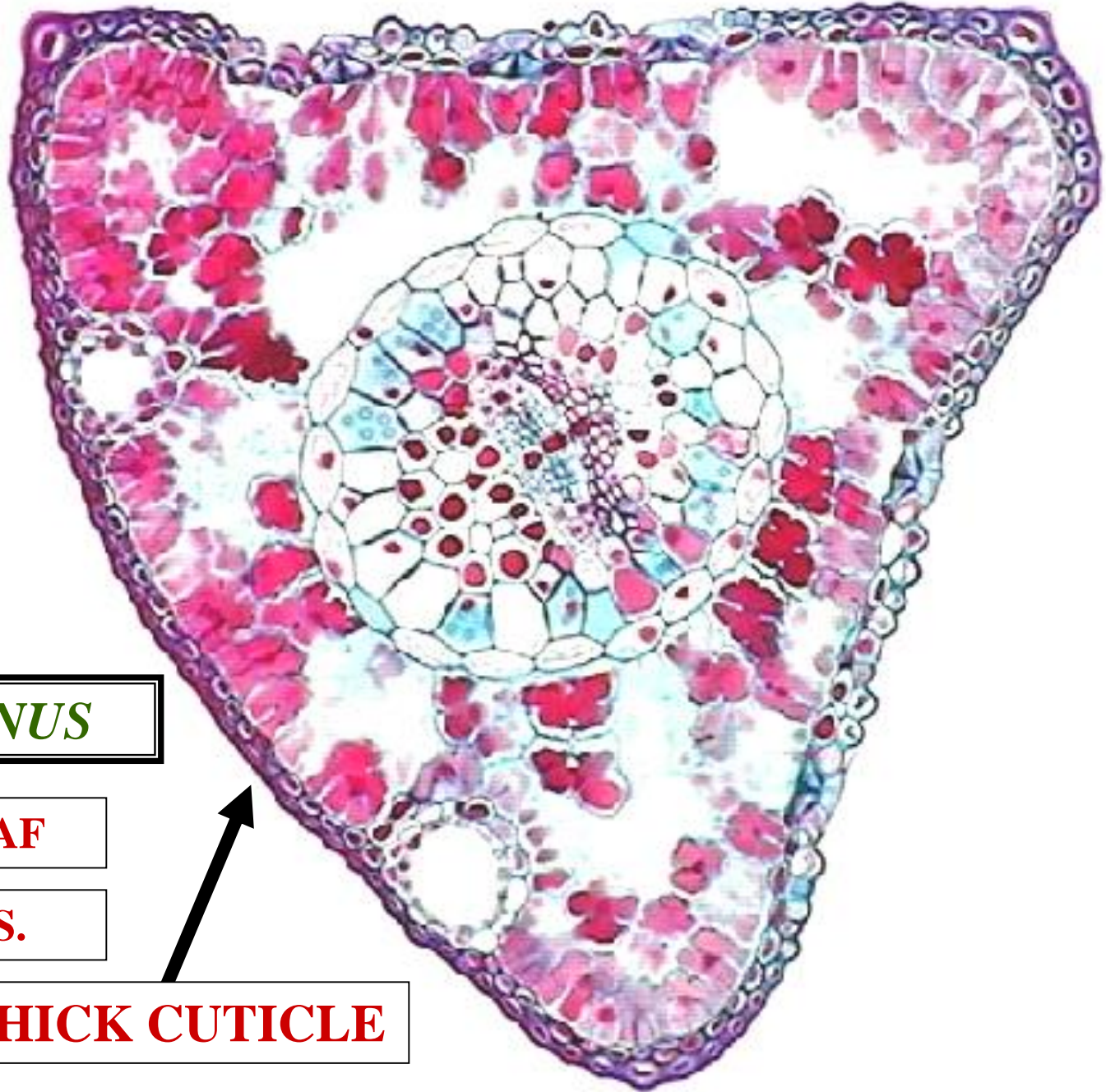
LEAF ANATOMY



PINUS

LEAF

C.S.



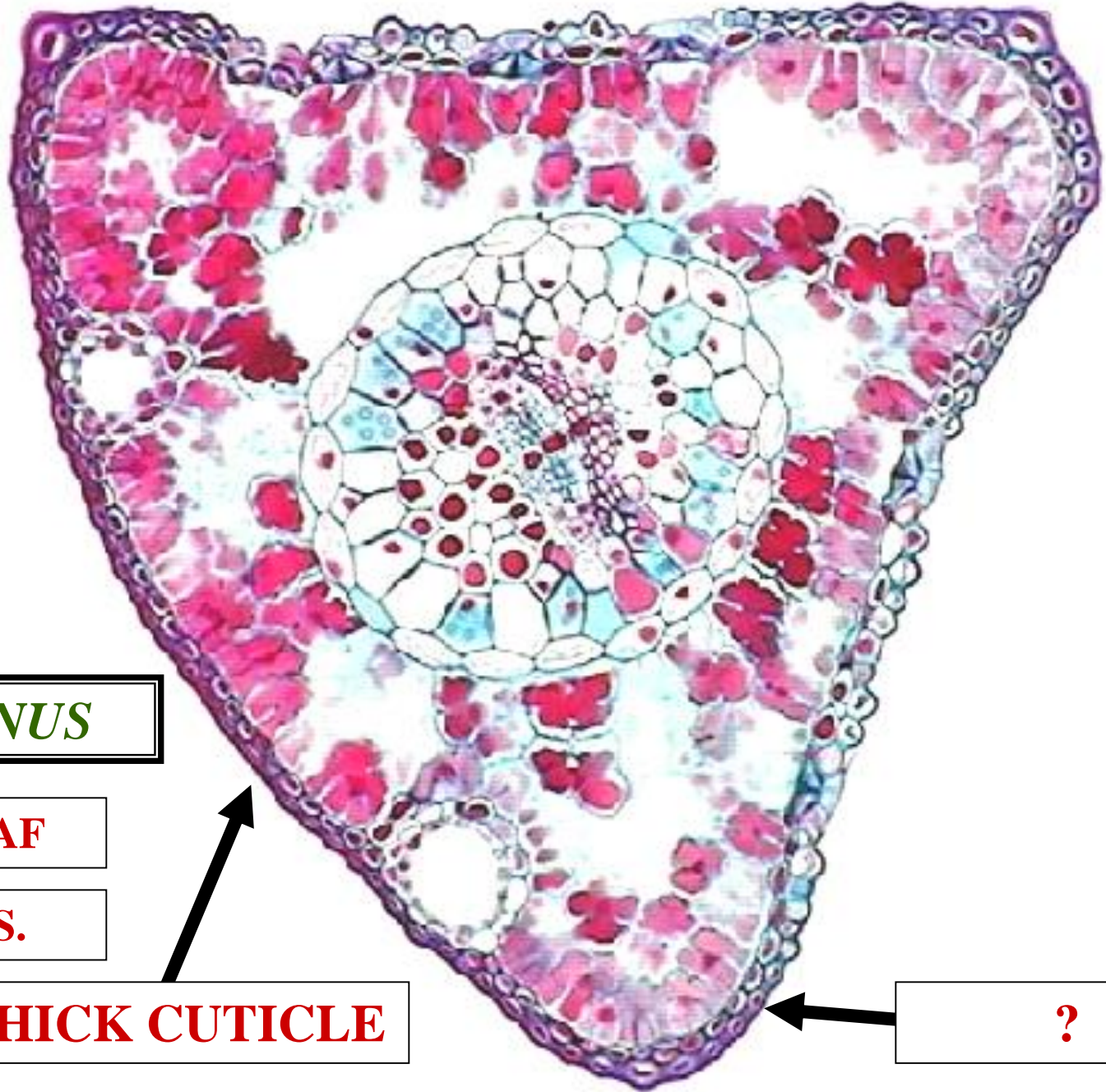
PINUS

LEAF

C.S.

THICK CUTICLE





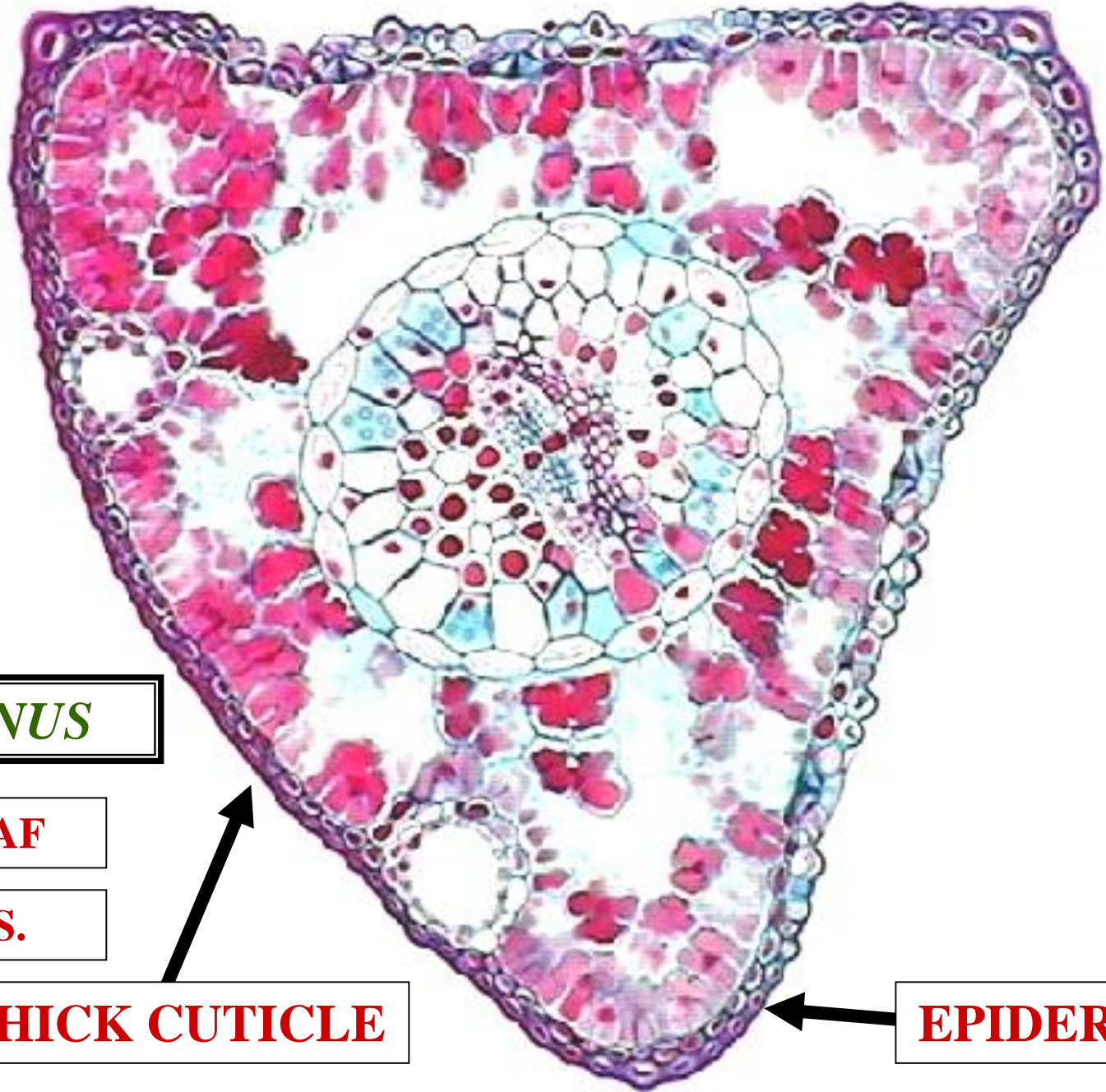
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LEAF

C.S.

THICK CUTICLE

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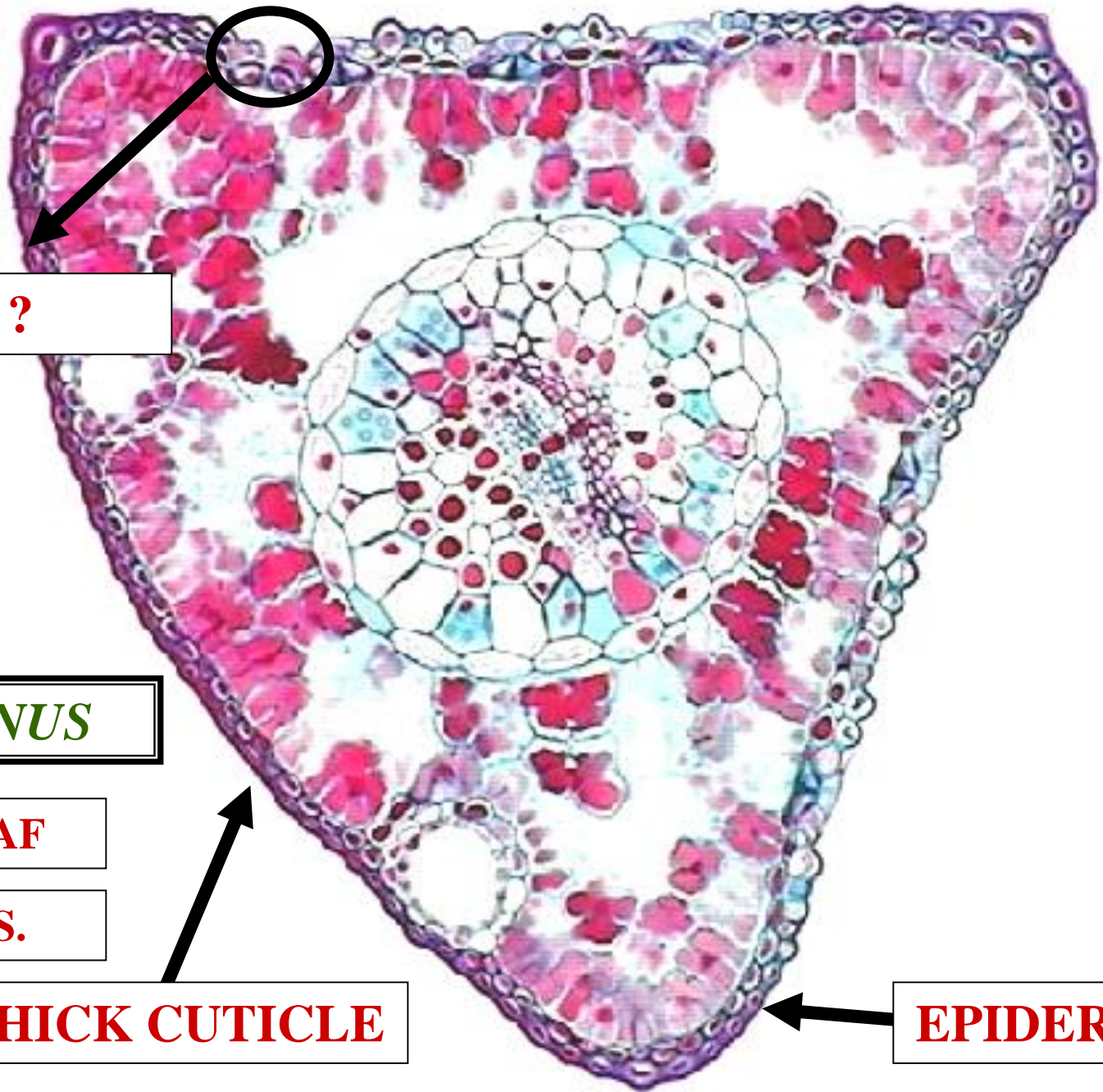
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LEAF

C.S.

THICK CUTICLE

EPIDERMIS



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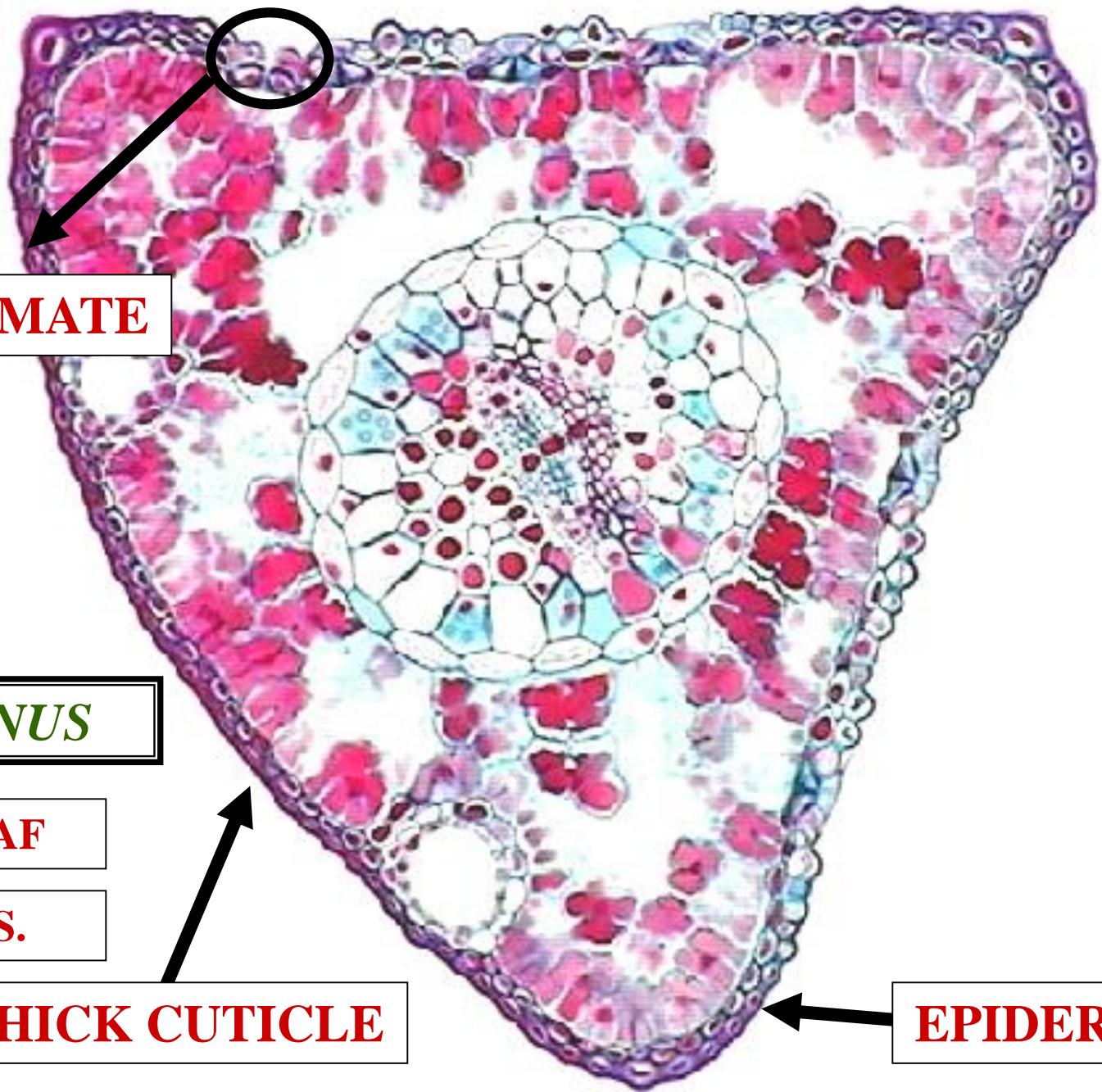
PINUS

LEAF

C.S.

THICK CUTICLE

EPIDERMIS



STOMATE

PINUS

LEAF

C.S.

THICK CUTICLE

EPIDERMIS

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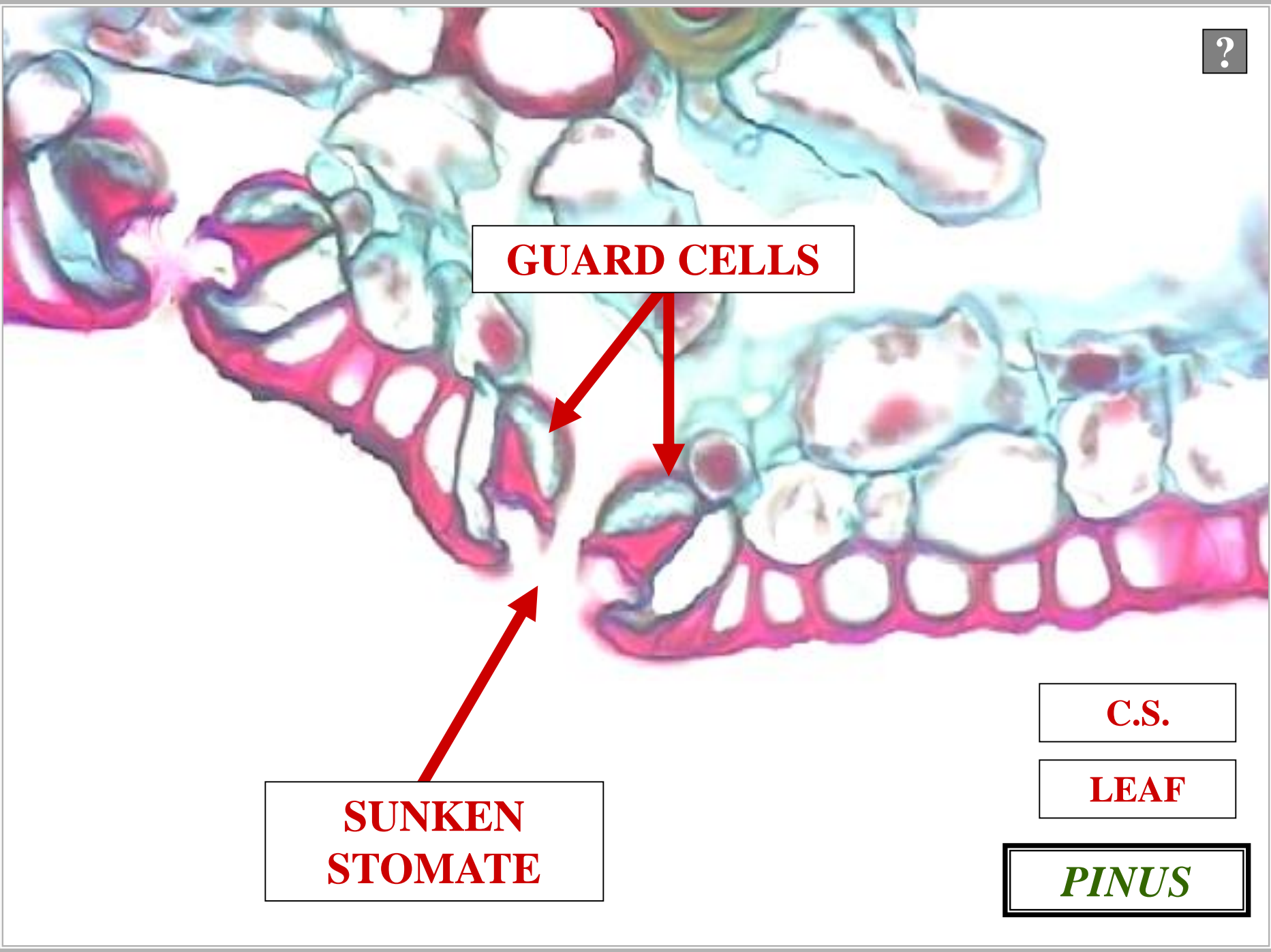
GUARD CELLS

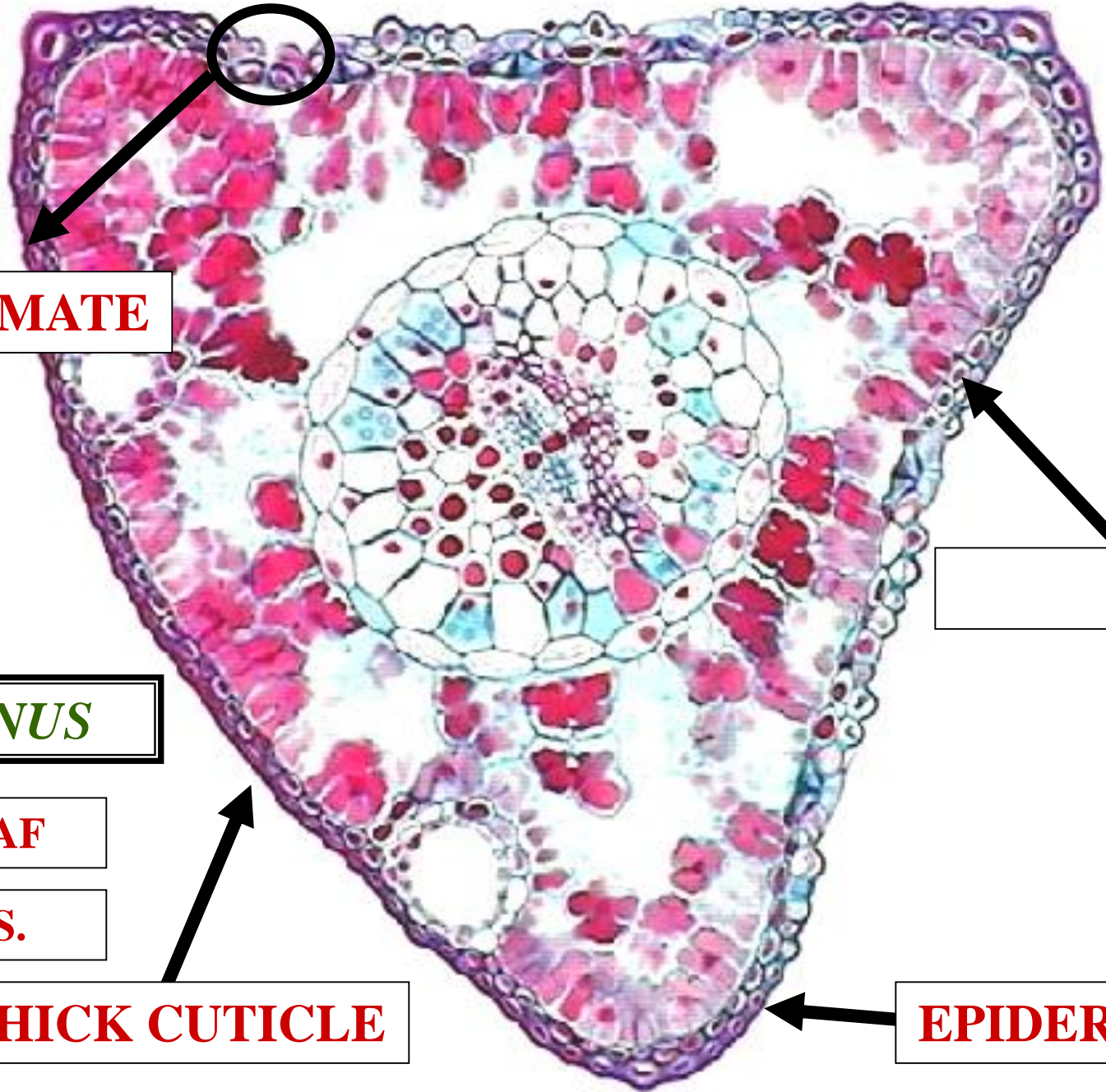
**SUNKEN
STOMATE**

C.S.

LEAF

PINUS





STOMATE

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PINUS

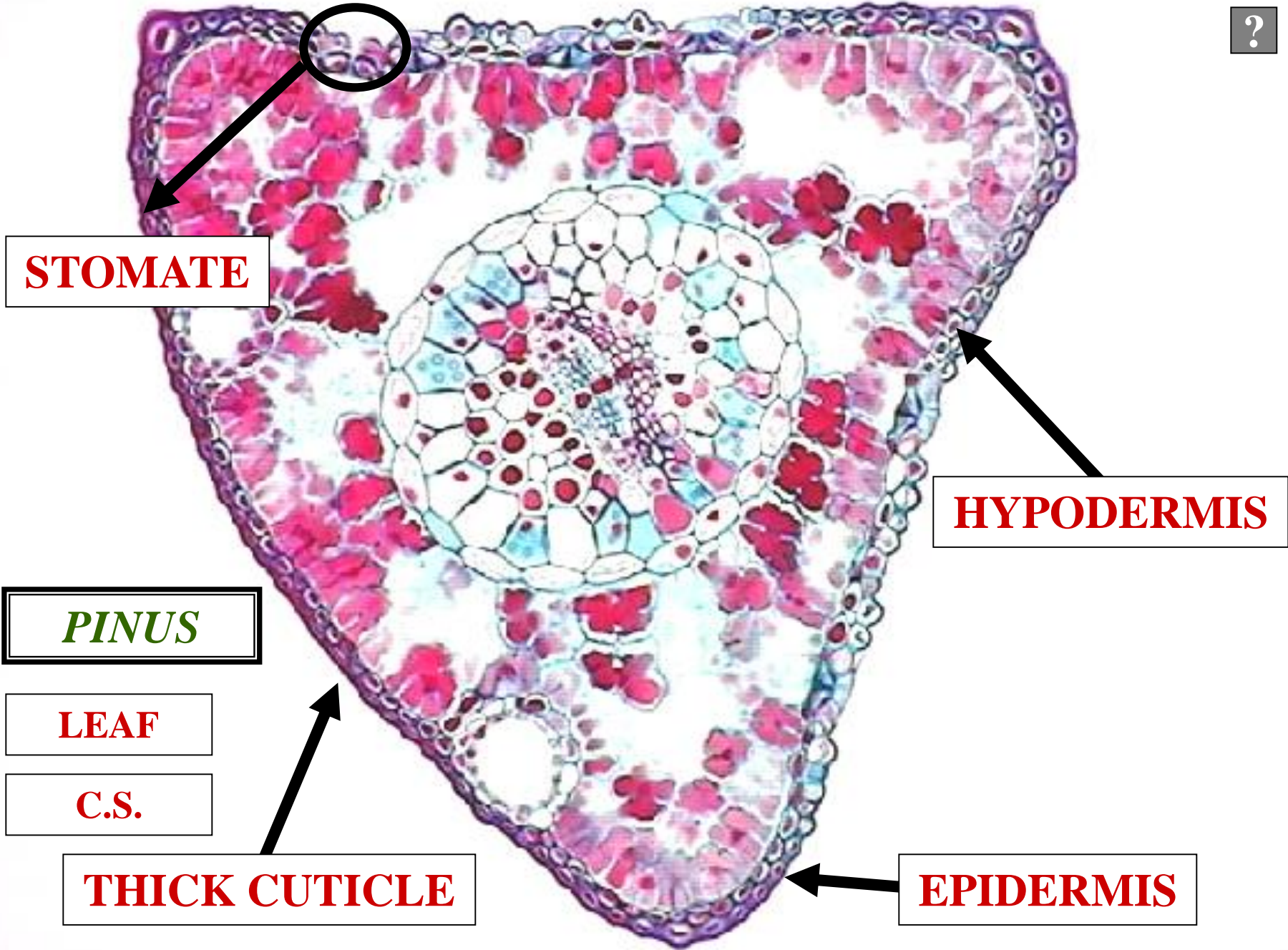
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C.S.

THICK CUTICLE

EPIDERMIS

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STOMATE

HYPODERMIS

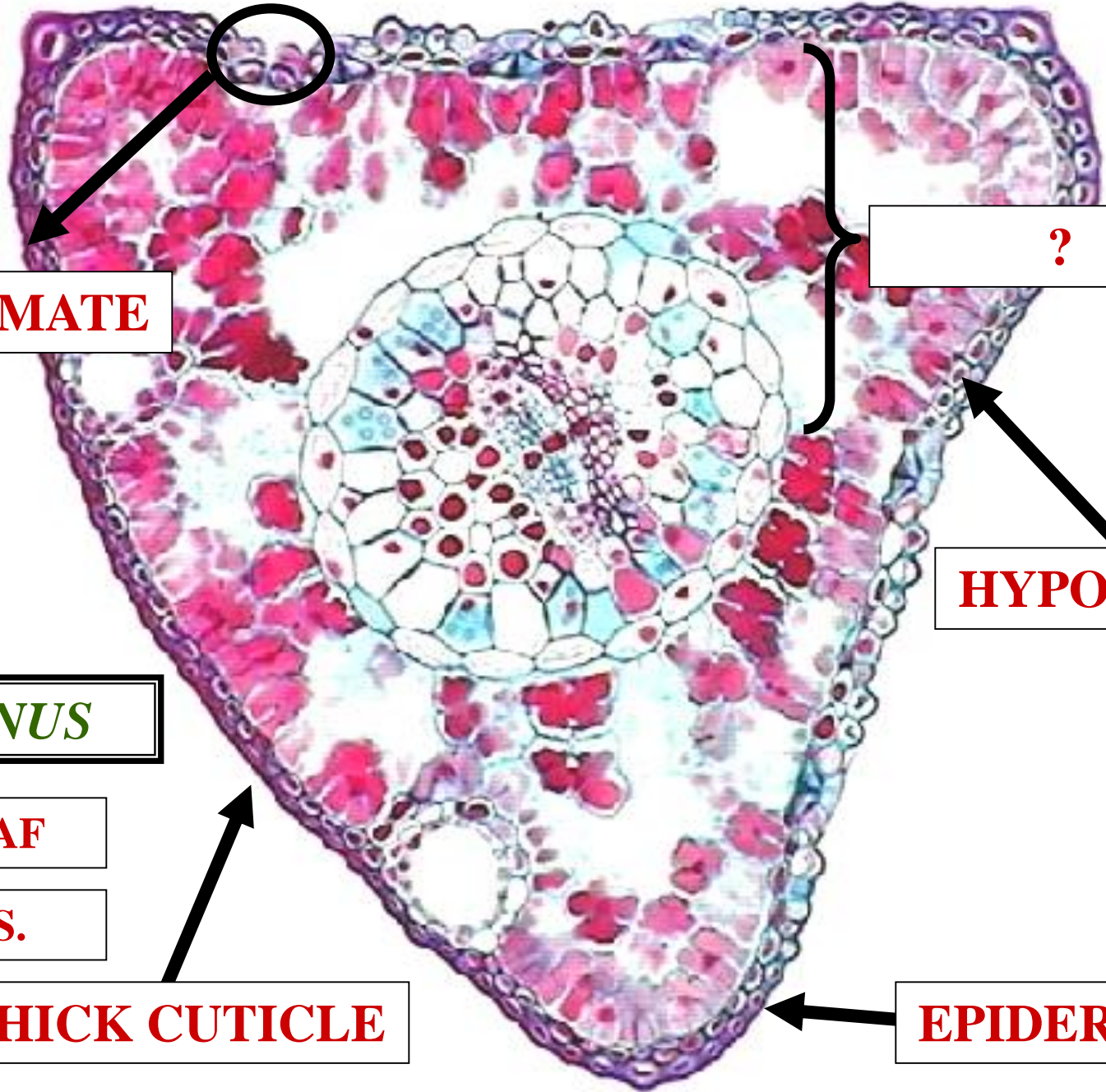
PINUS

LEAF

C.S.

THICK CUTICLE

EPIDERMIS



STOMATE

?

HYPODERMIS

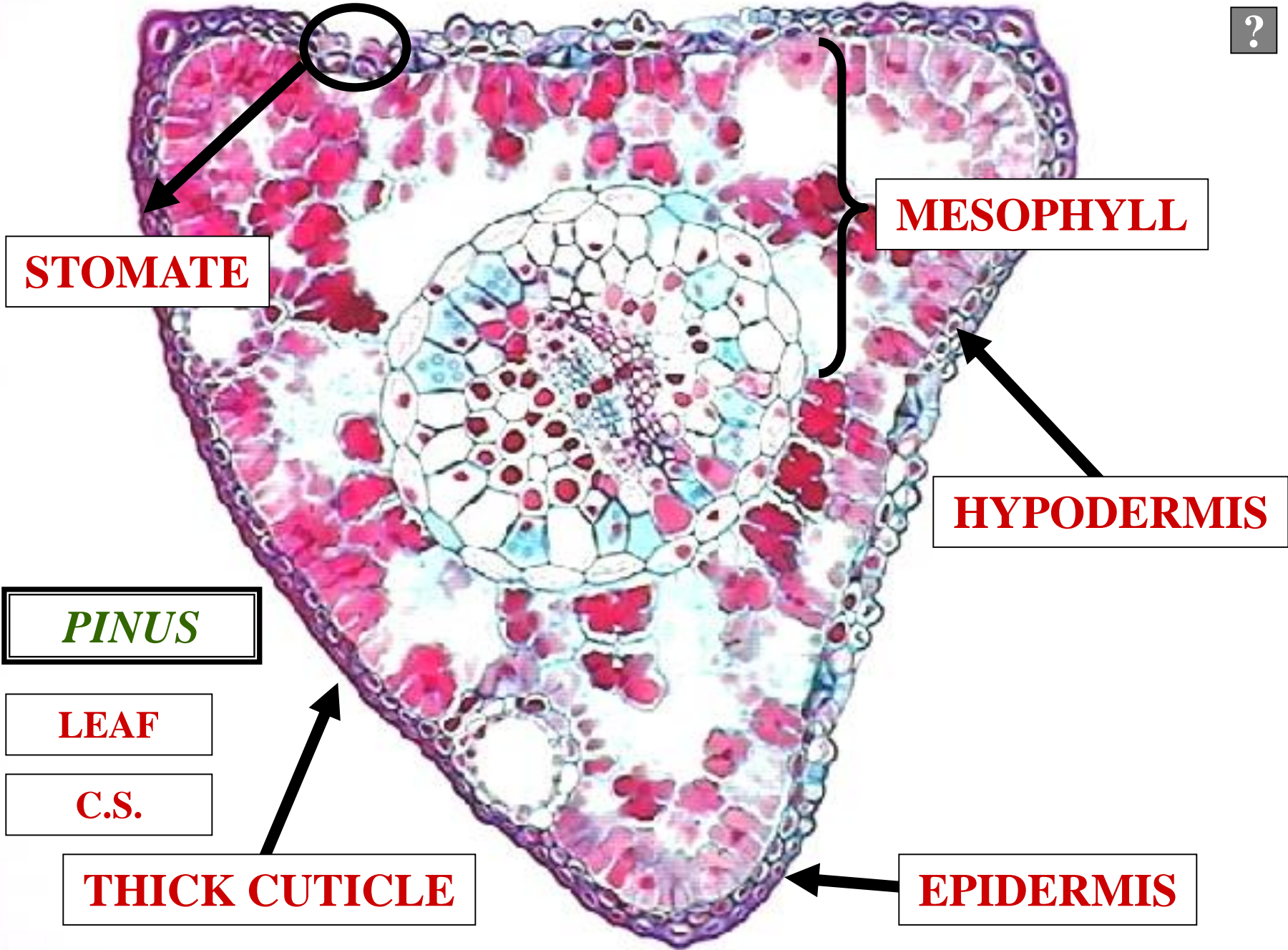
PINUS

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C.S.

THICK CUTICLE

EPIDERMIS



STOMATE

MESOPHYLL

HYPODERMIS

PINUS

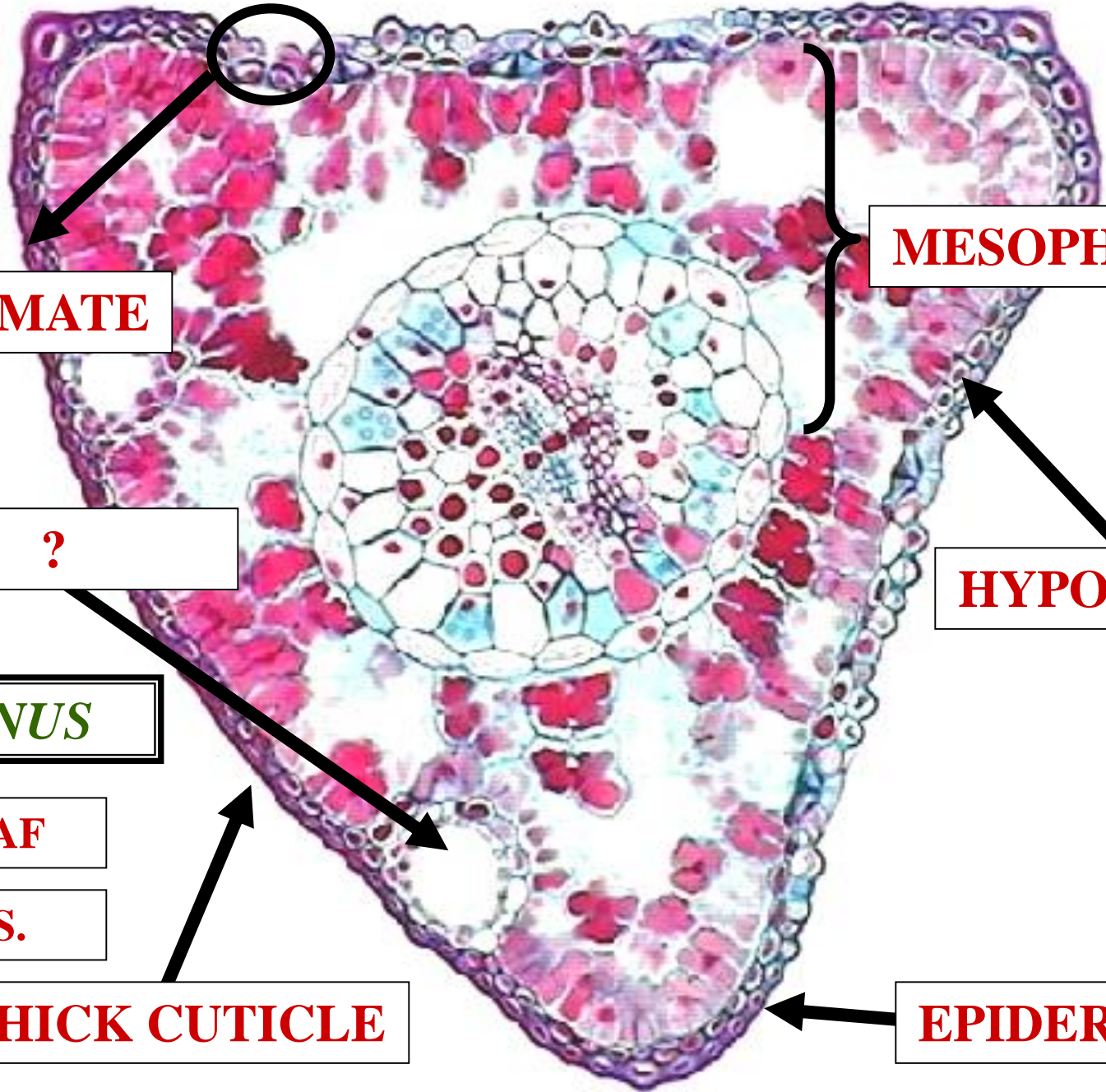
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THICK CUTICLE

EPIDERMIS

R



STOMATE

MESOPHYLL

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HYPODERMIS

PINUS

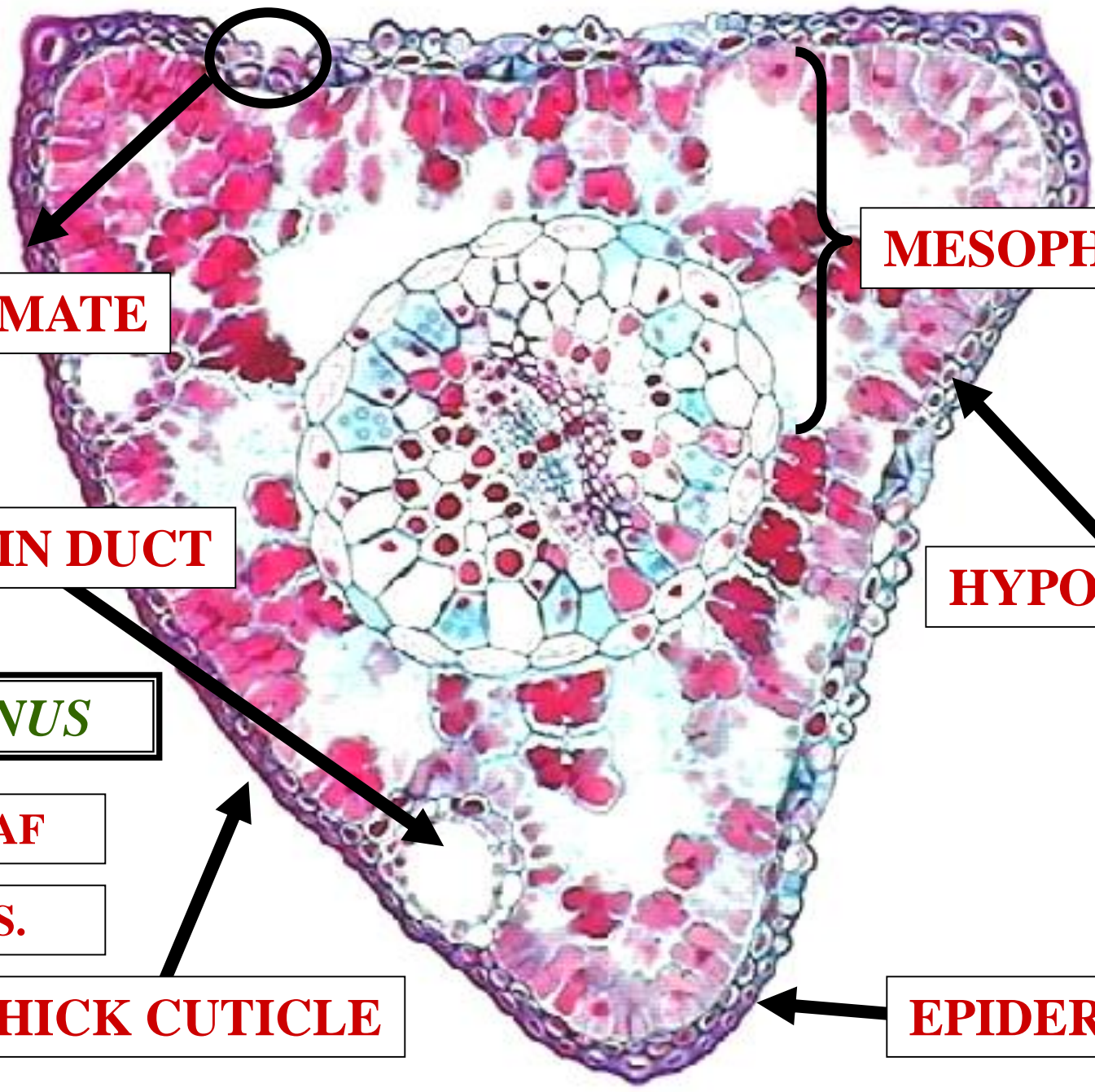
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C.S.

THICK CUTICLE

EPIDERMIS

VC



STOMATE

MESOPHYLL

RESIN DUCT

HYPODERMIS

PINUS

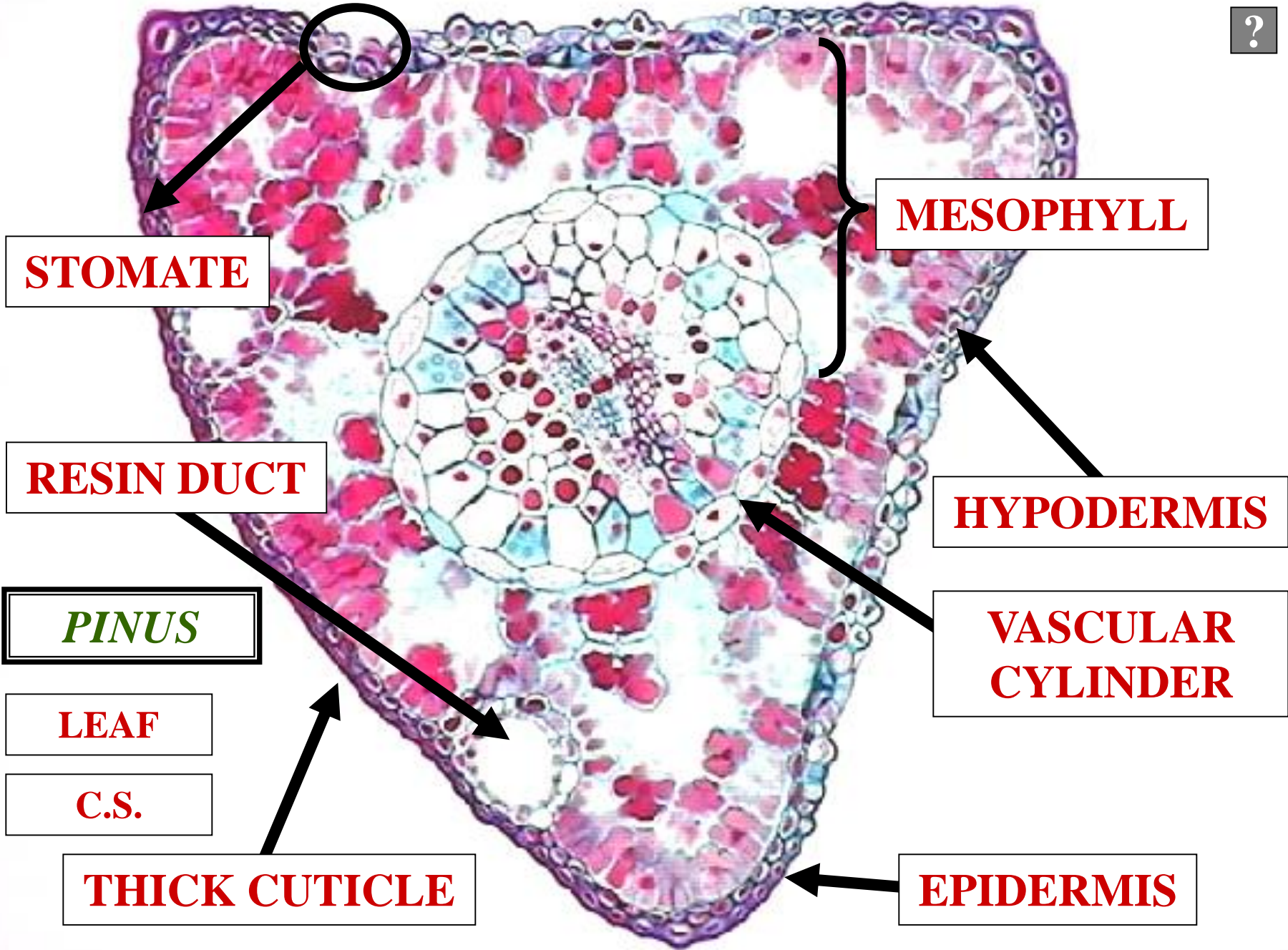
LEAF

C.S.

THICK CUTICLE

EPIDERMIS

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STOMATE

RESIN DUCT

PINUS

LEAF

C.S.

THICK CUTICLE

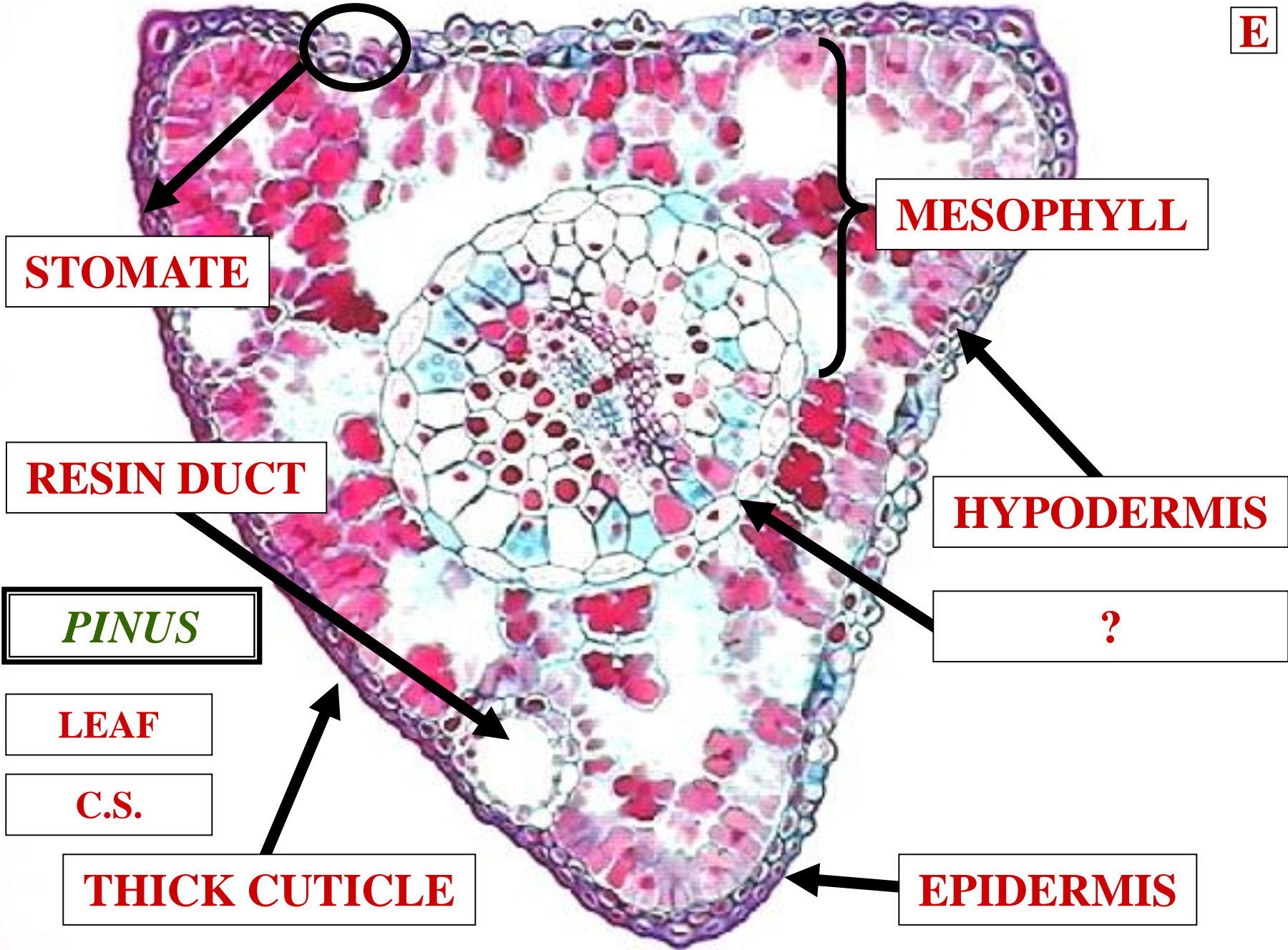
MESOPHYLL

HYPODERMIS

VASCULAR CYLINDER

EPIDERMIS

E



STOMATE

RESIN DUCT

PINUS

LEAF

C.S.

THICK CUTICLE

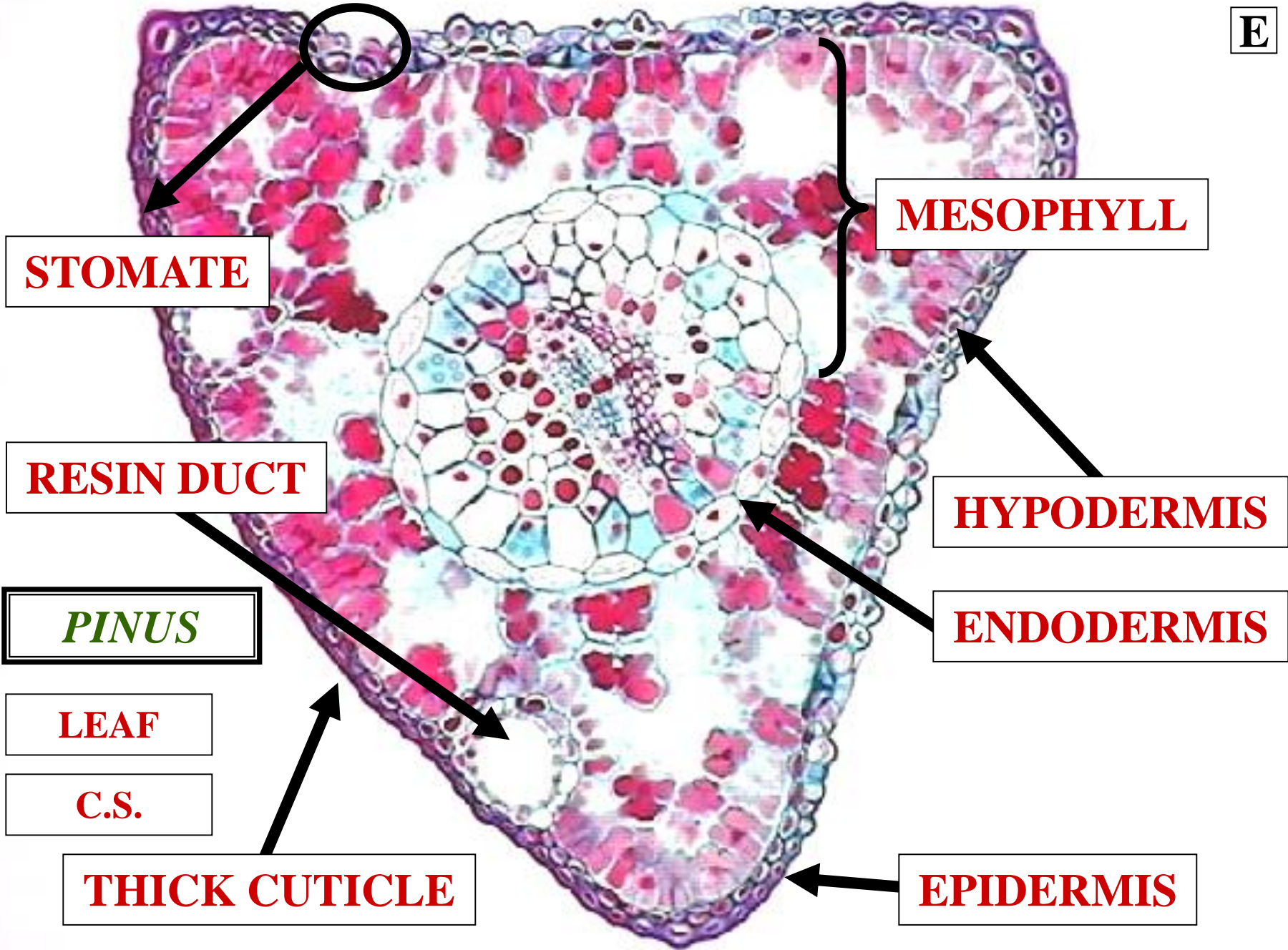
MESOPHYLL

HYPODERMIS

?

EPIDERMIS

E



STOMATE

RESIN DUCT

PINUS

LEAF

C.S.

THICK CUTICLE

MESOPHYLL

HYPODERMIS

ENDODERMIS

EPIDERMIS

LEAF
ENDODERMIS

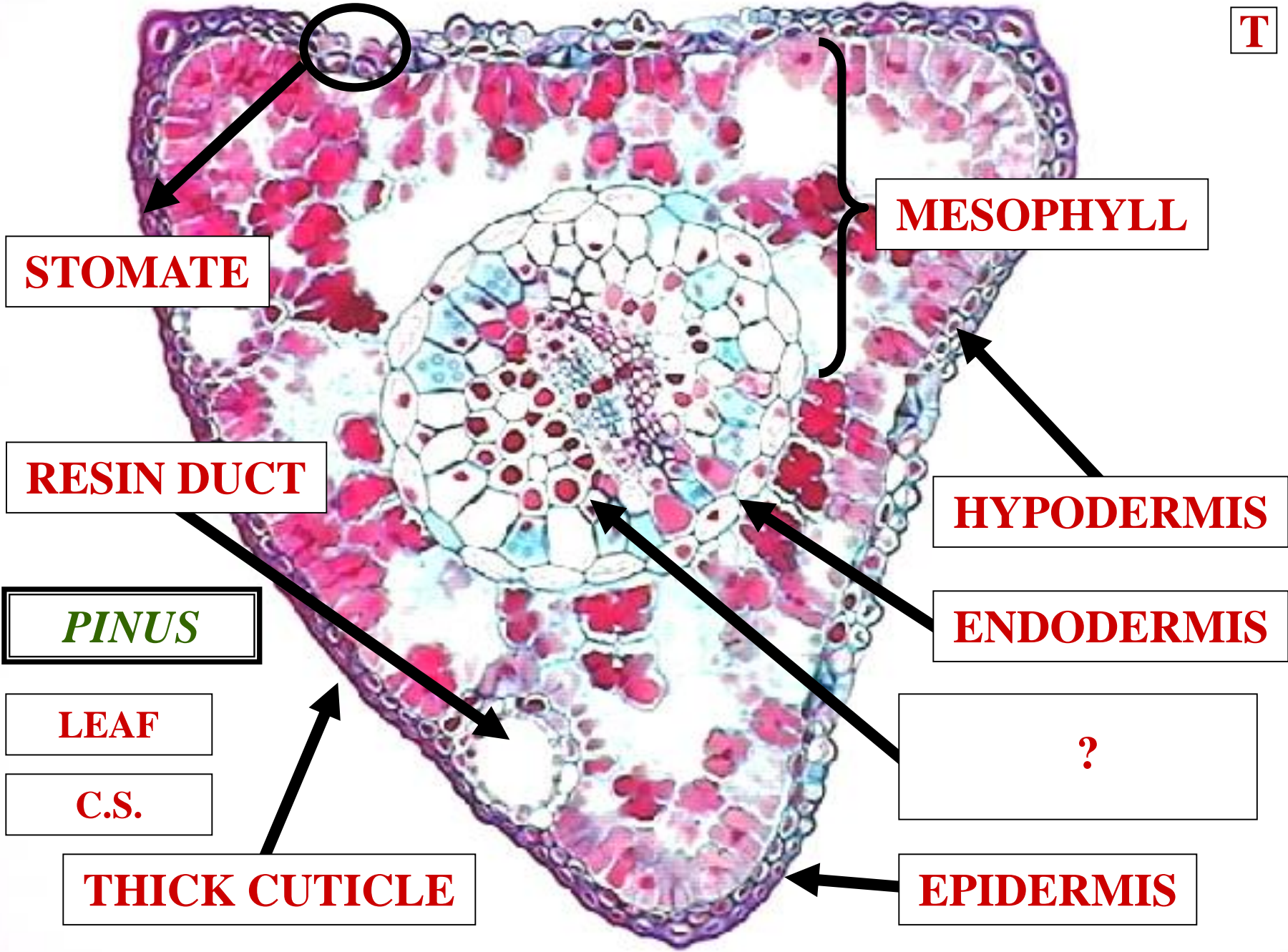
PINOPHYTA
LEAF ENDODERMIS



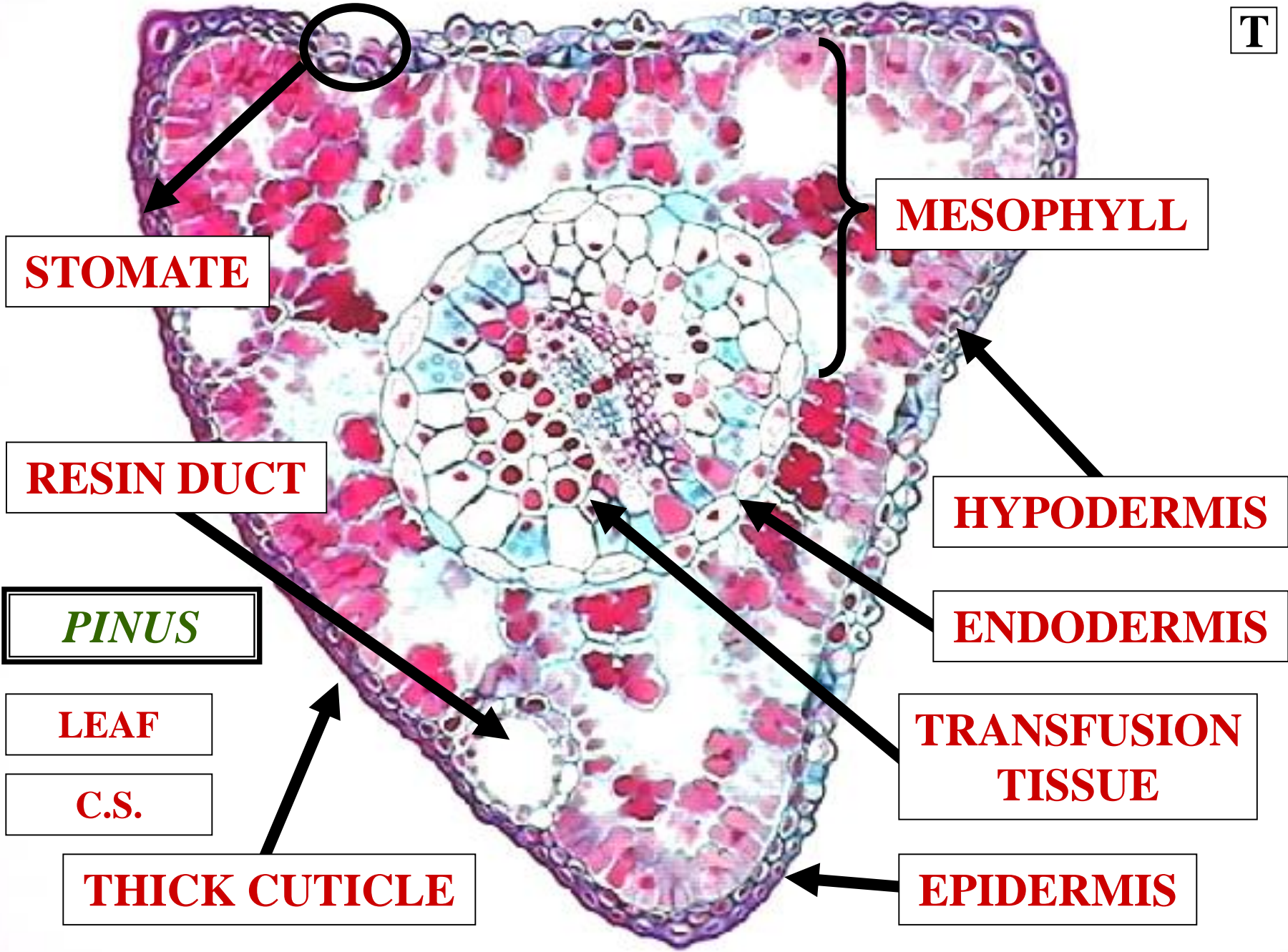
RETAINS WATER
WITHIN
VASCULAR CYLINDER

PINOPHYTA
LEAF ENDODERMIS

T



T



STOMATE

RESIN DUCT

PINUS

LEAF

C.S.

THICK CUTICLE

MESOPHYLL

HYPODERMIS

ENDODERMIS

TRANSFUSION
TISSUE

EPIDERMIS

TRANSFUSION TISSUE

PINOPHYTA



LEAF TRANSFUSION TISSUE

PARENCHYMA CELLS

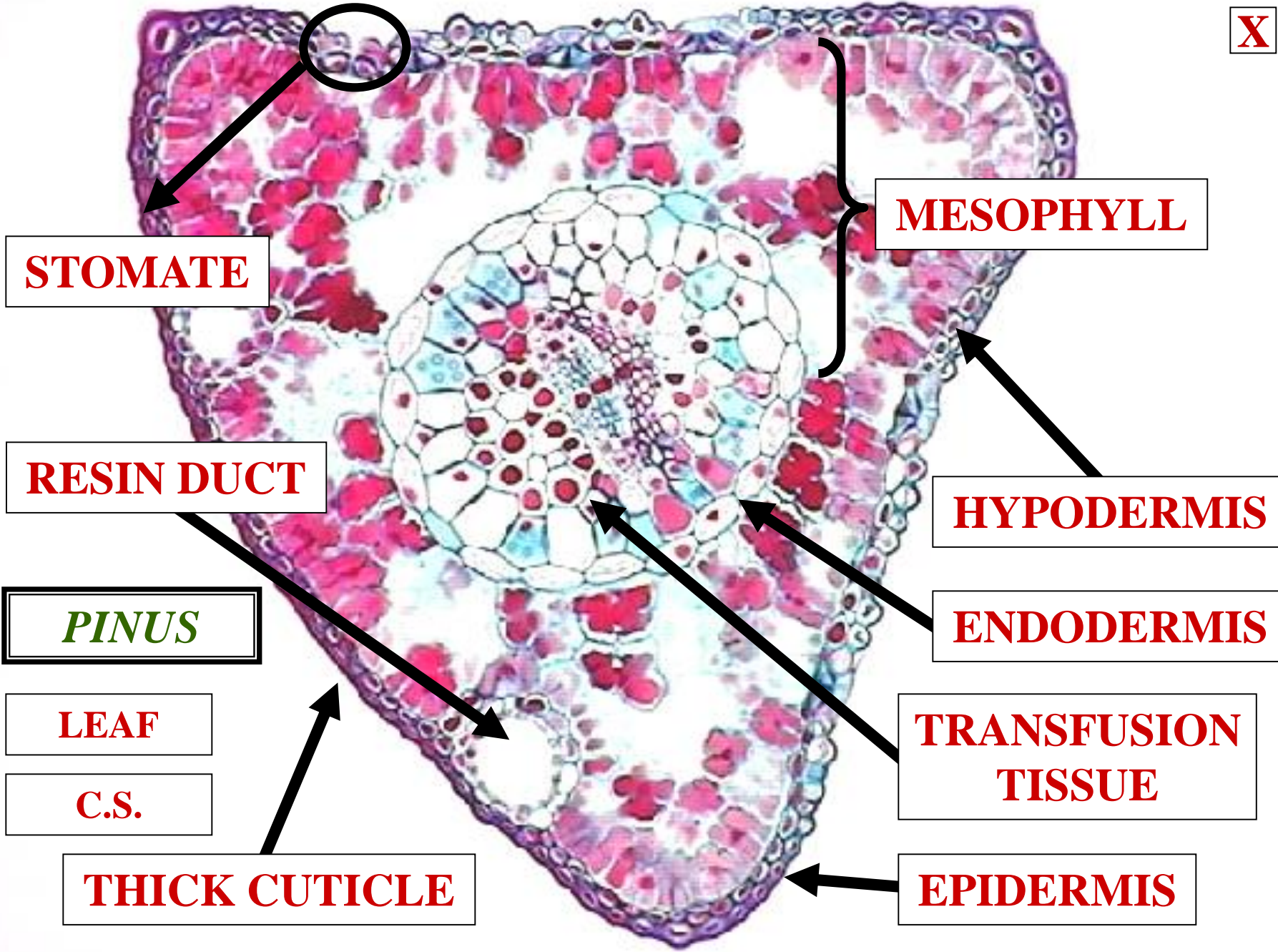
RETAIN WATER

WITHIN

VASCULAR TISSUE

PINOPHYTA

LEAF TRANSFUSION TISSUE



STOMATE

RESIN DUCT

PINUS

LEAF

C.S.

THICK CUTICLE

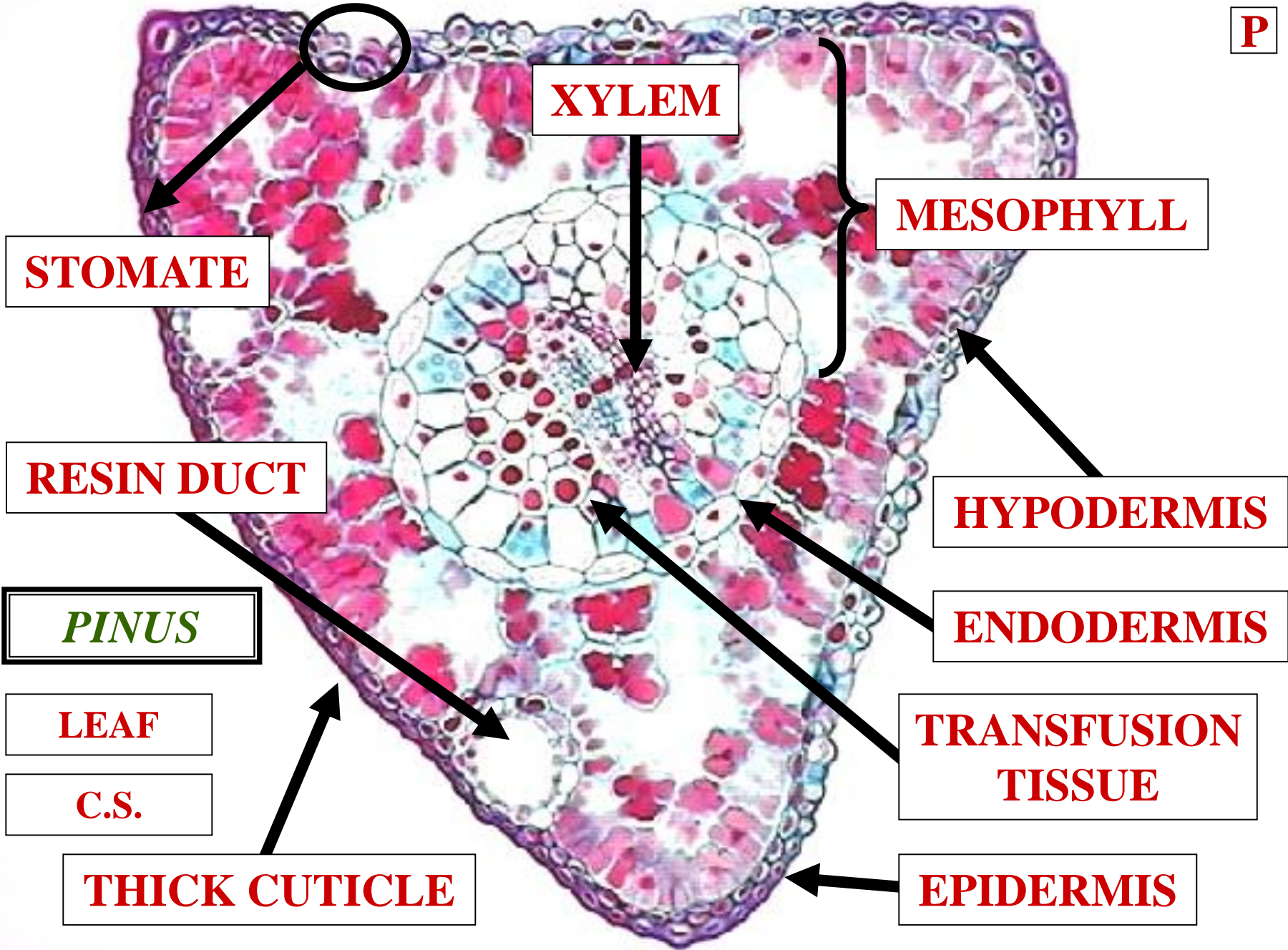
MESOPHYLL

HYPODERMIS

ENDODERMIS

**TRANSFUSION
TISSUE**

EPIDERMIS



XYLEM

MESOPHYLL

STOMATE

RESIN DUCT

HYPODERMIS

PINUS

ENDODERMIS

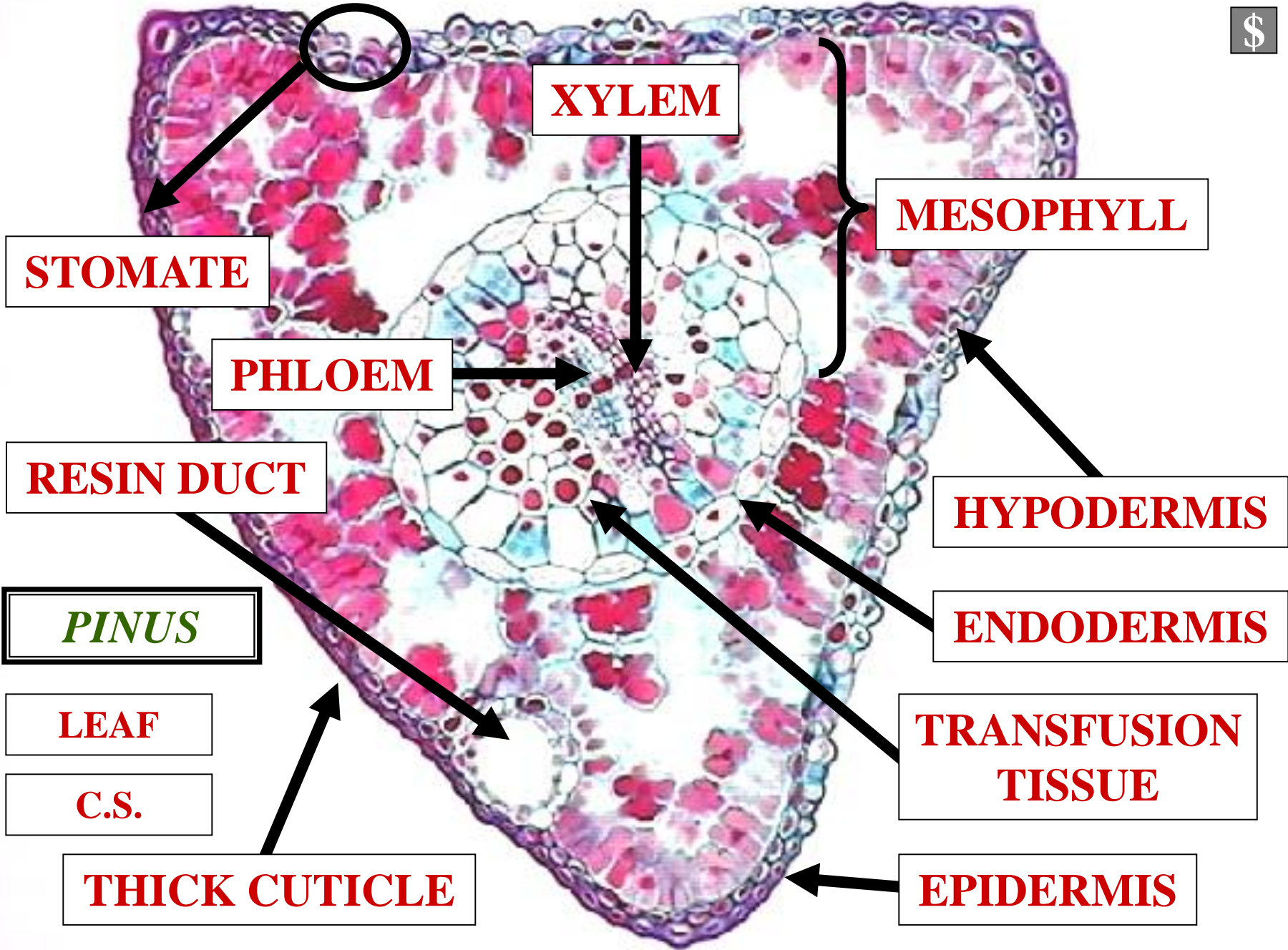
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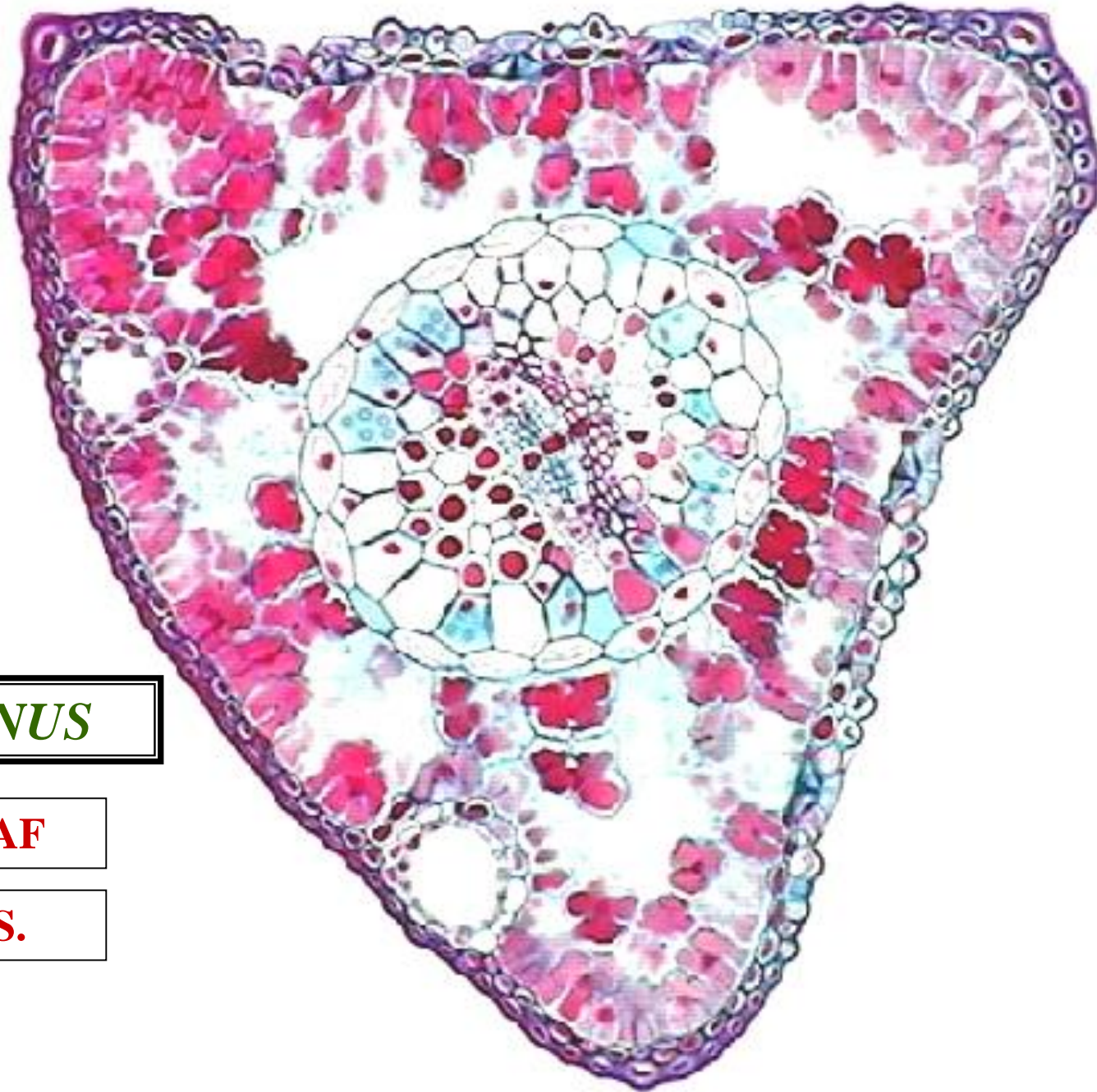
TRANSFUSION TISSUE

C.S.

THICK CUTICLE

EPIDERMIS

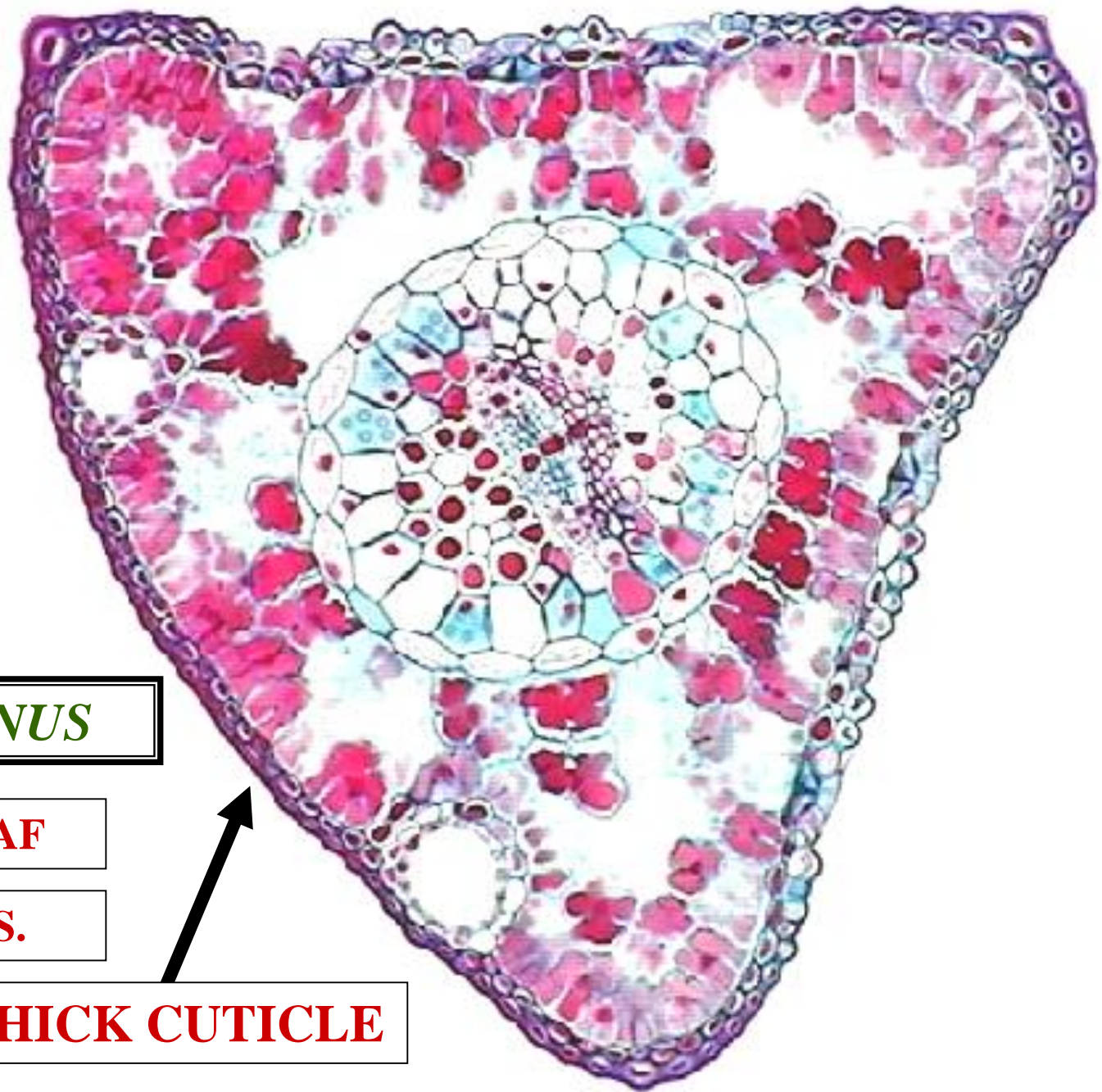




PINUS

LEAF

C.S.



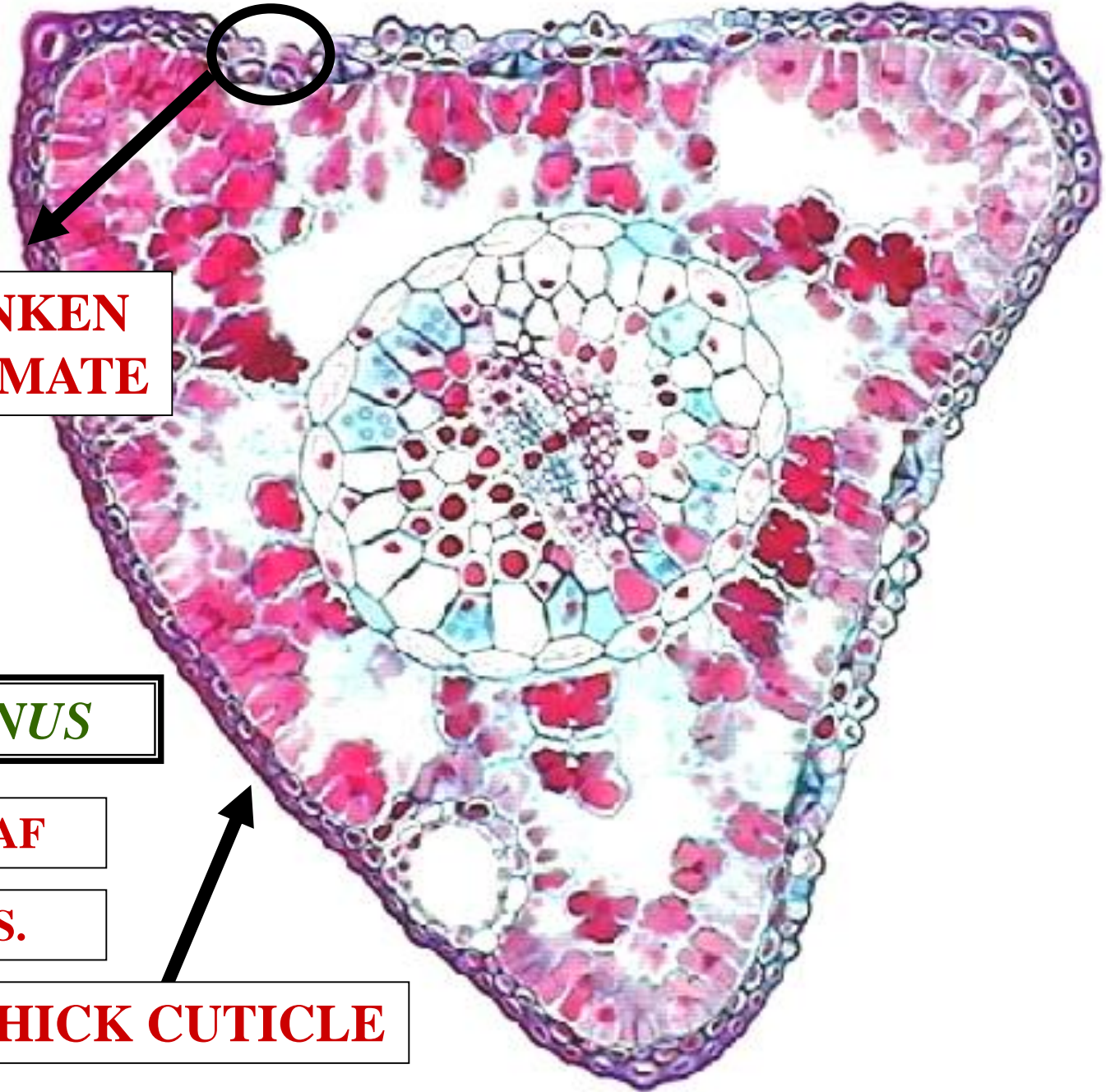
PINUS

LEAF

C.S.

THICK CUTICLE





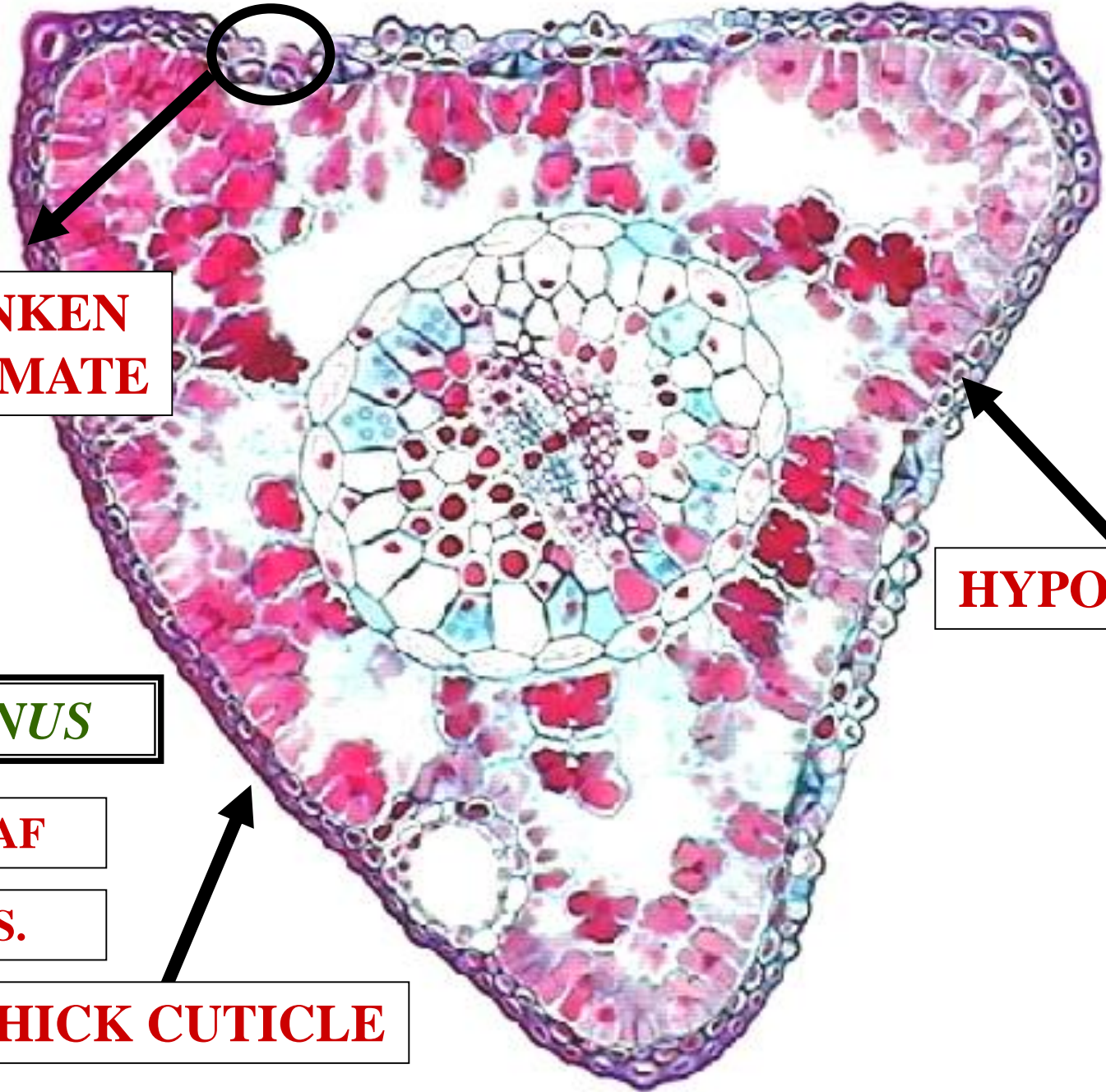
**SUNKEN
STOMATE**

PINUS

LEAF

C.S.

THICK CUTICLE



**SUNKEN
STOMATE**

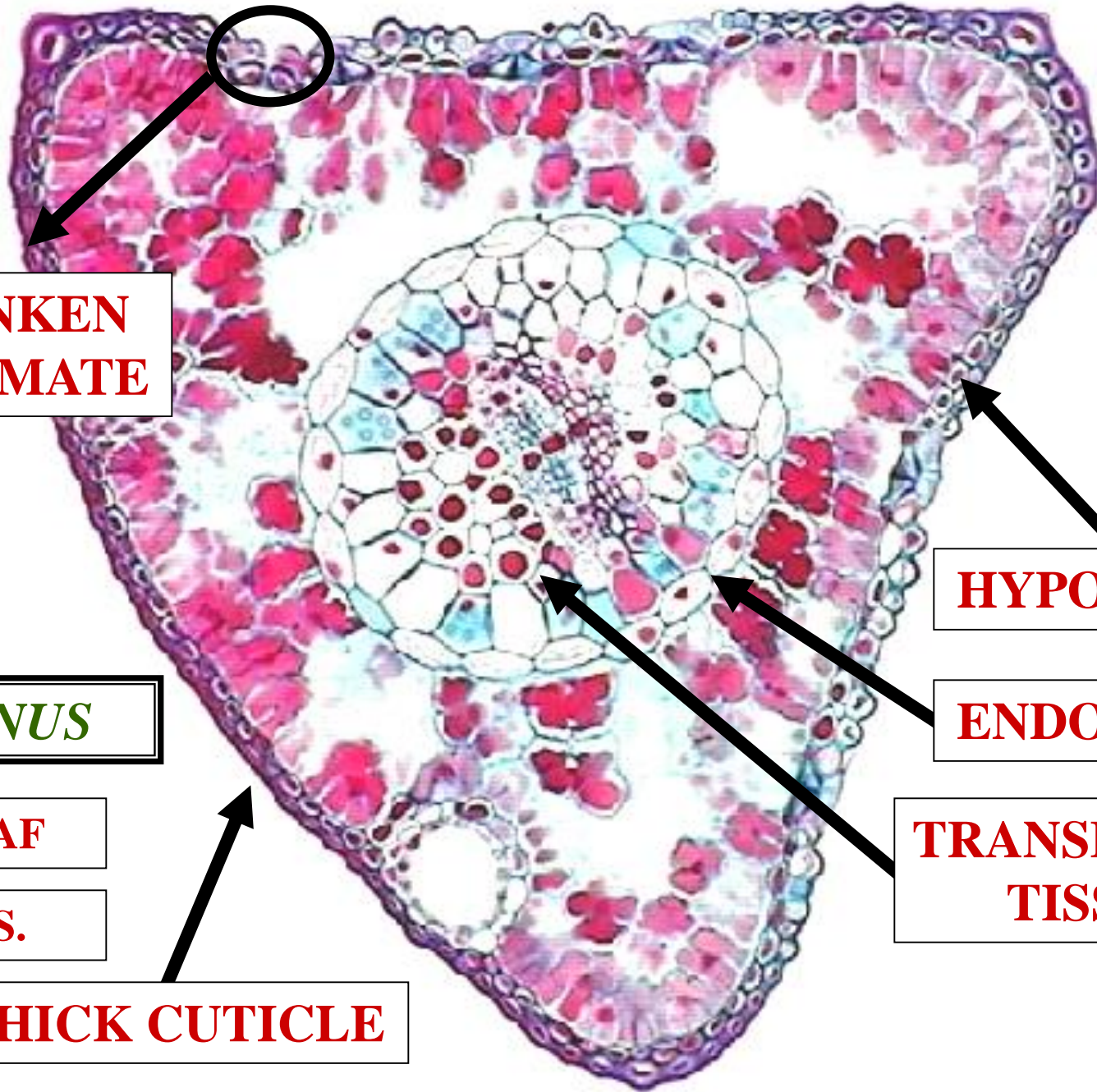
HYPODERMIS

PINUS

LEAF

C.S.

THICK CUTICLE



**SUNKEN
STOMATE**

HYPODERMIS

PINUS

ENDODERMIS

LEAF

**TRANSFUSION
TISSUE**

C.S.

THICK CUTICLE



**LEAF
ADAPTED
XERIC
HABITAT**



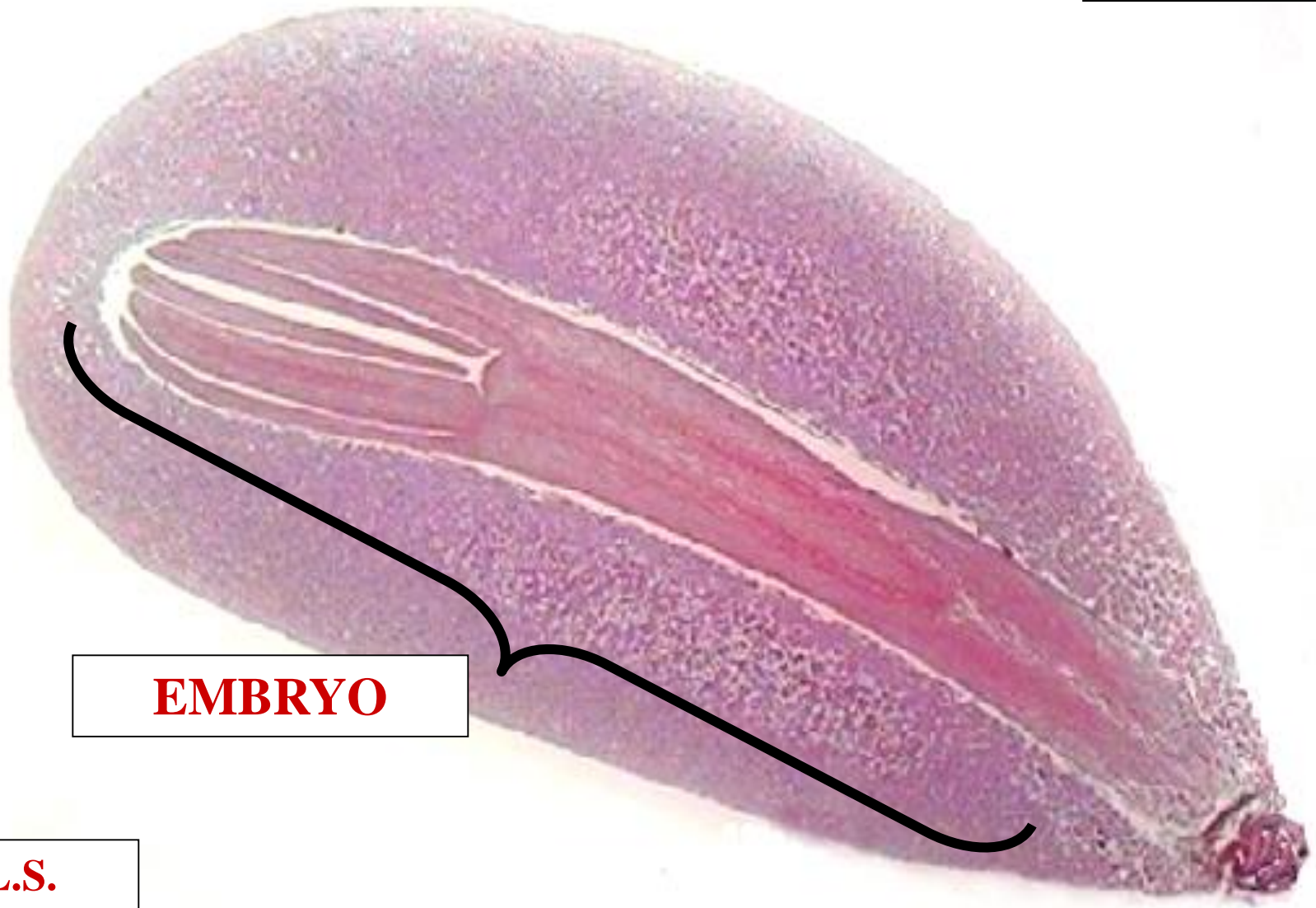
EMBRYO



EMBRYO STRUCTURE

PINUS

?



EMBRYO

L.S.

EMBRYO

PINUS

M

?

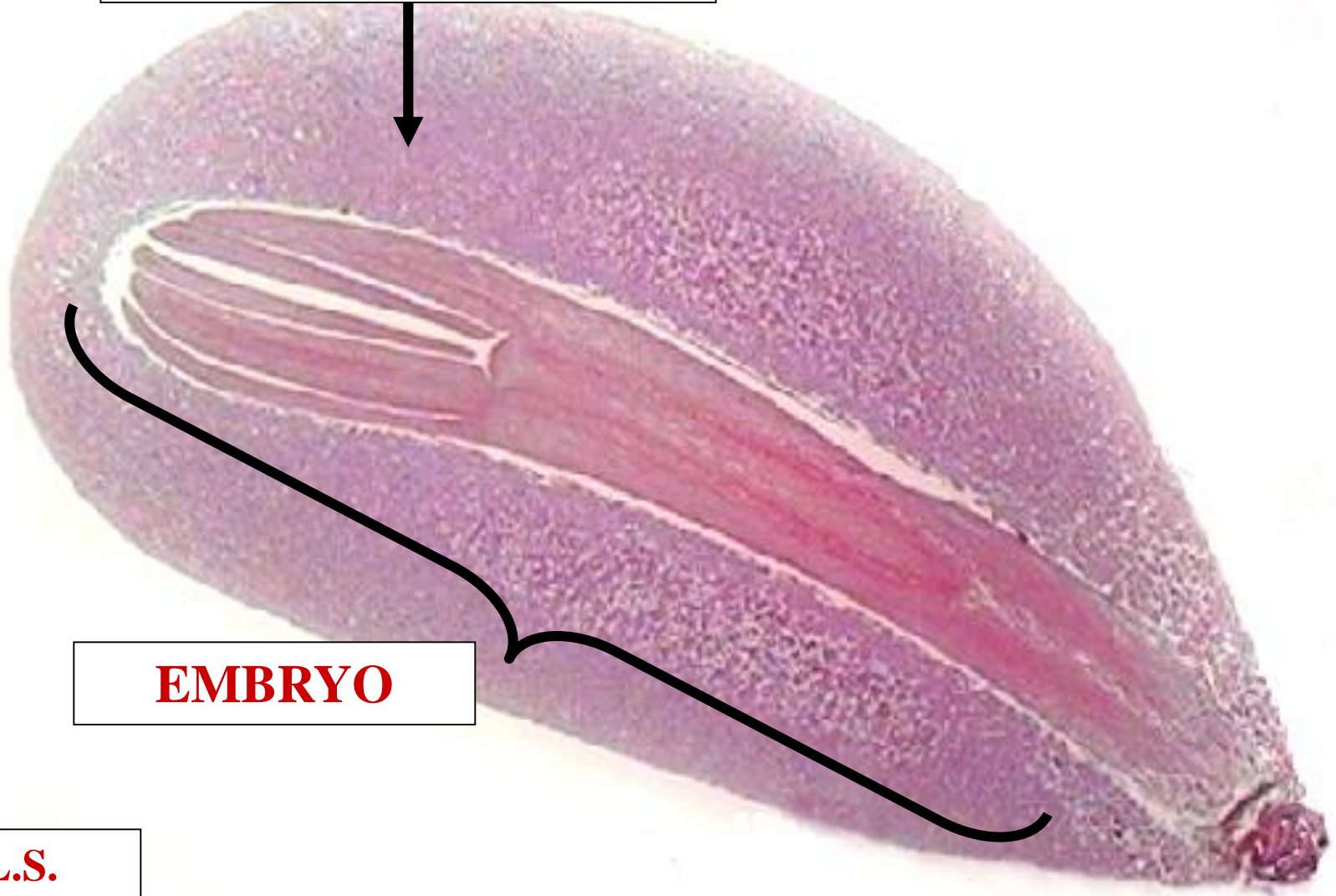


EMBRYO



L.S.

EMBRYO



PINUS

?

MEGAGAMETOPHYTE

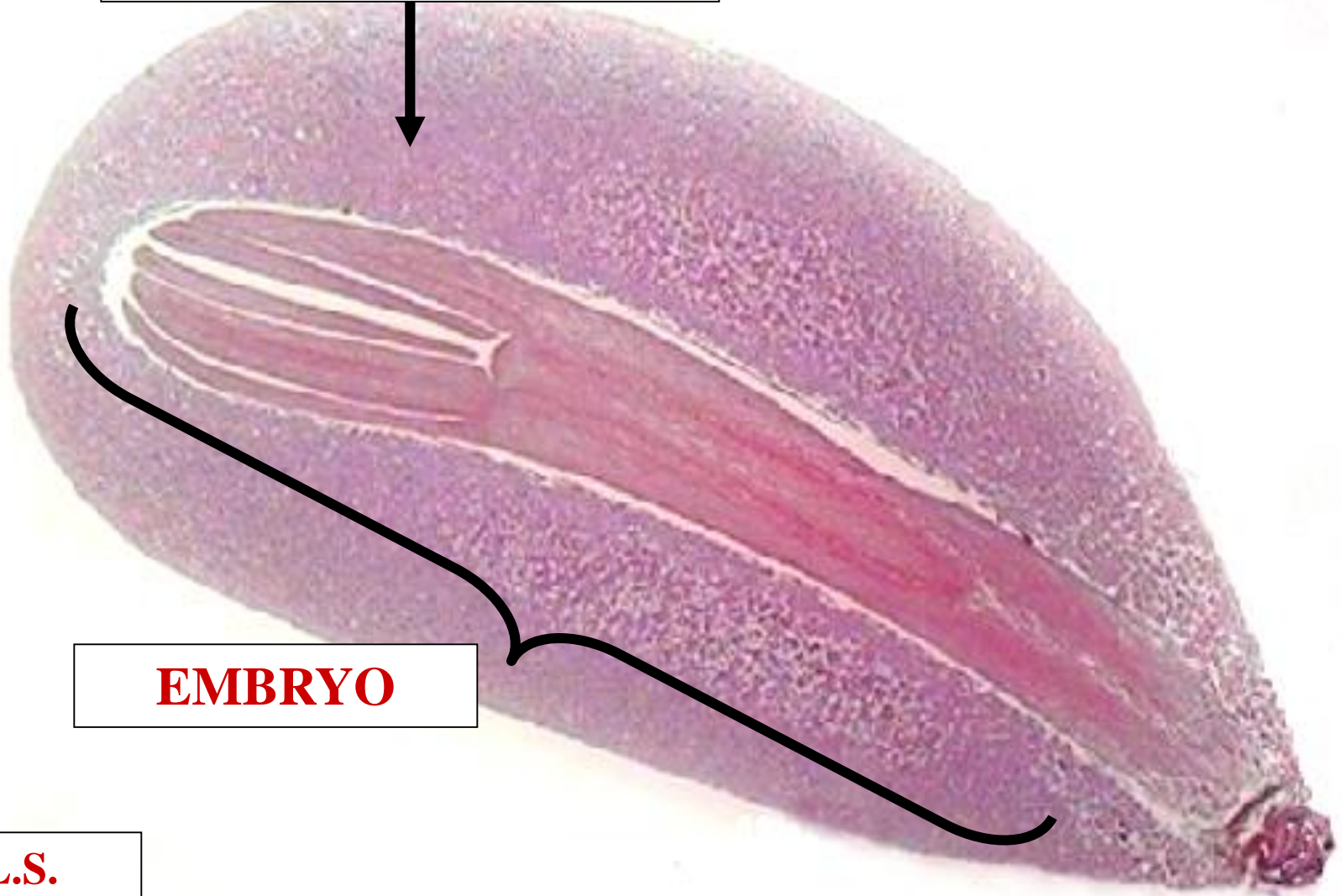


EMBRYO



L.S.

EMBRYO



PINUS

MEGAGAMETOPHYTE

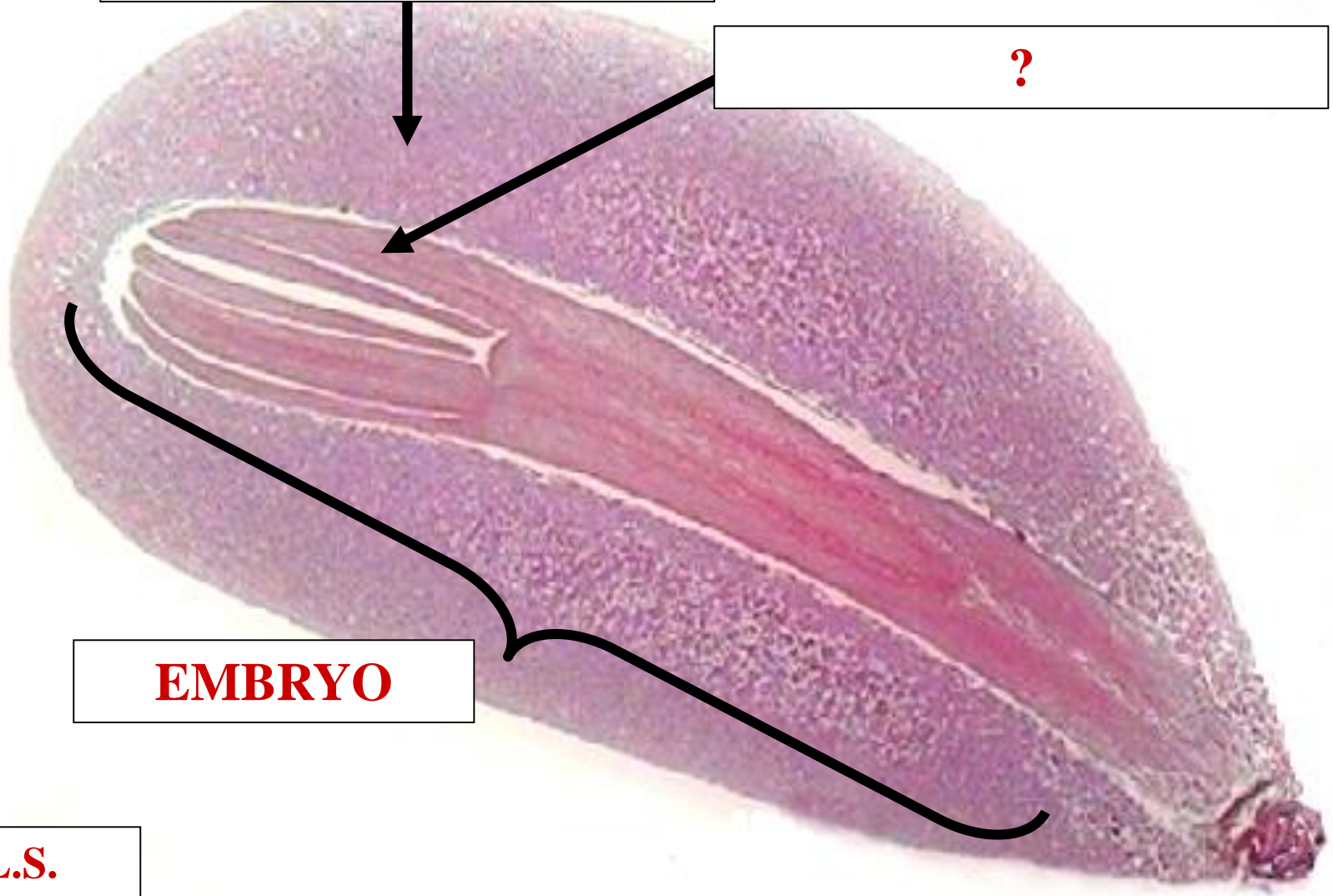
C

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EMBRYO

L.S.

EMBRYO



PINUS

MEGAGAMETOPHTE

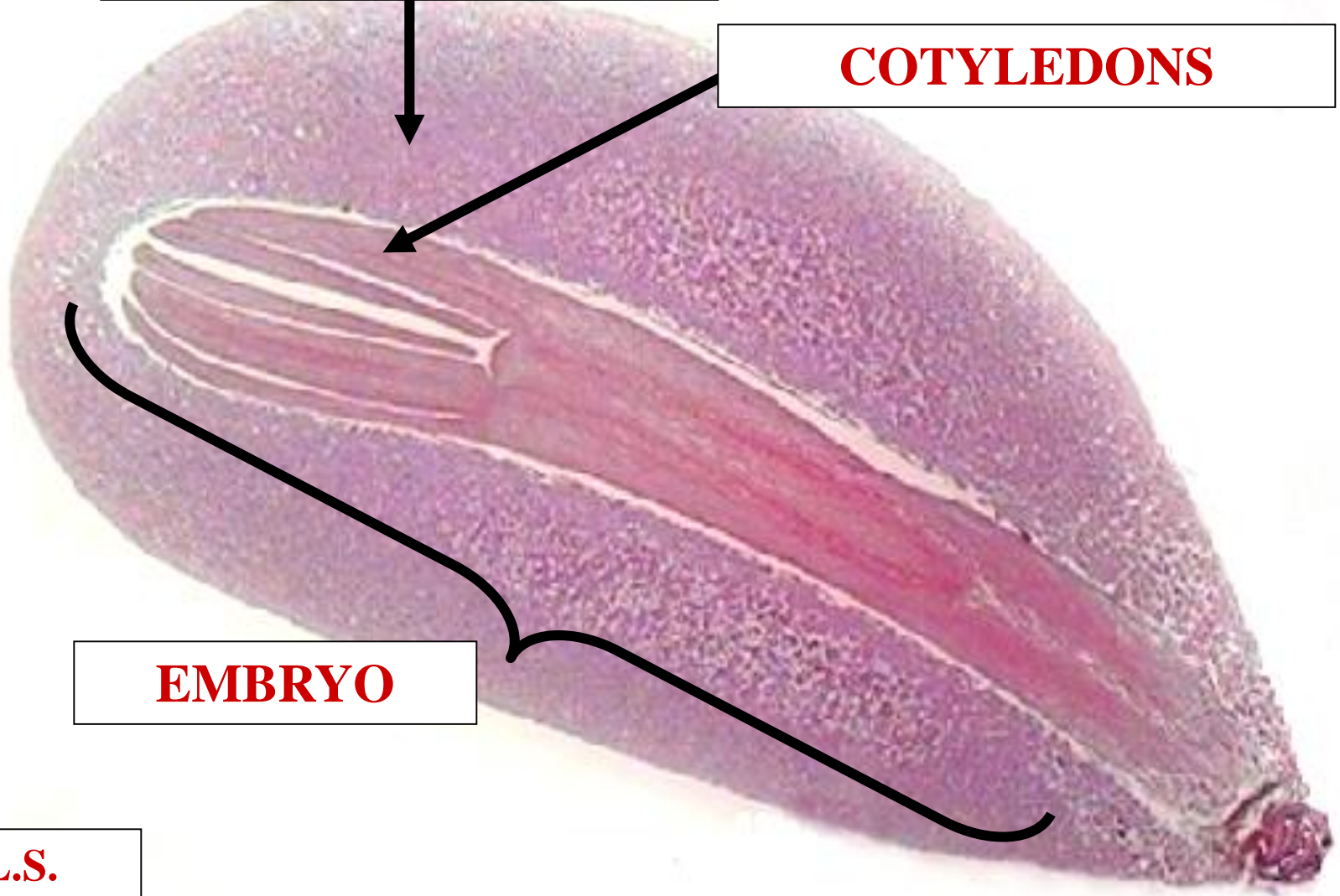
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COTYLEDONS

EMBRYO

L.S.

EMBRYO



PINUS

S

MEGAGAMETOPHYTE

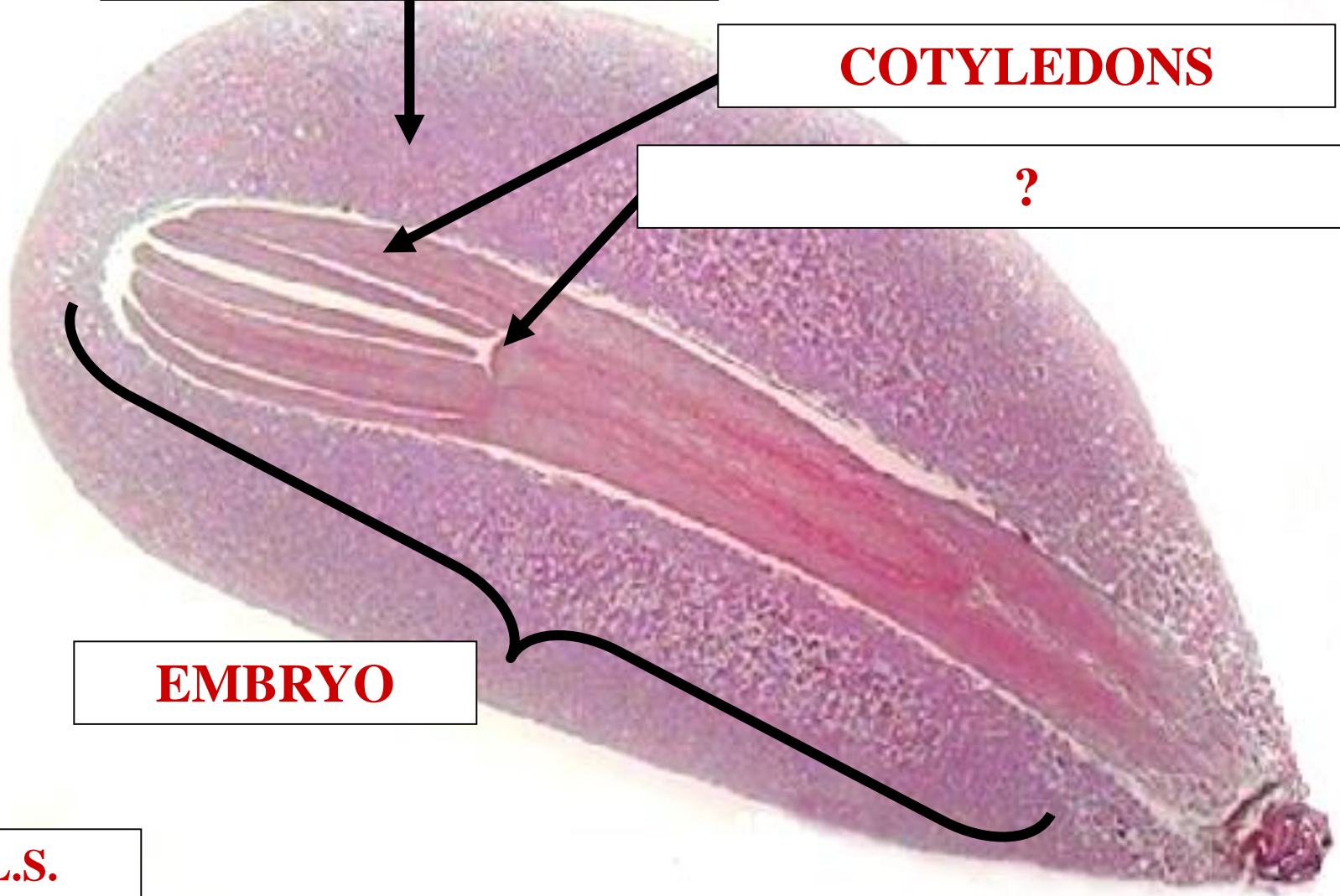
COTYLEDONS

?

EMBRYO

L.S.

EMBRYO



PINUS

?

MEGAGAMETOPHYTE

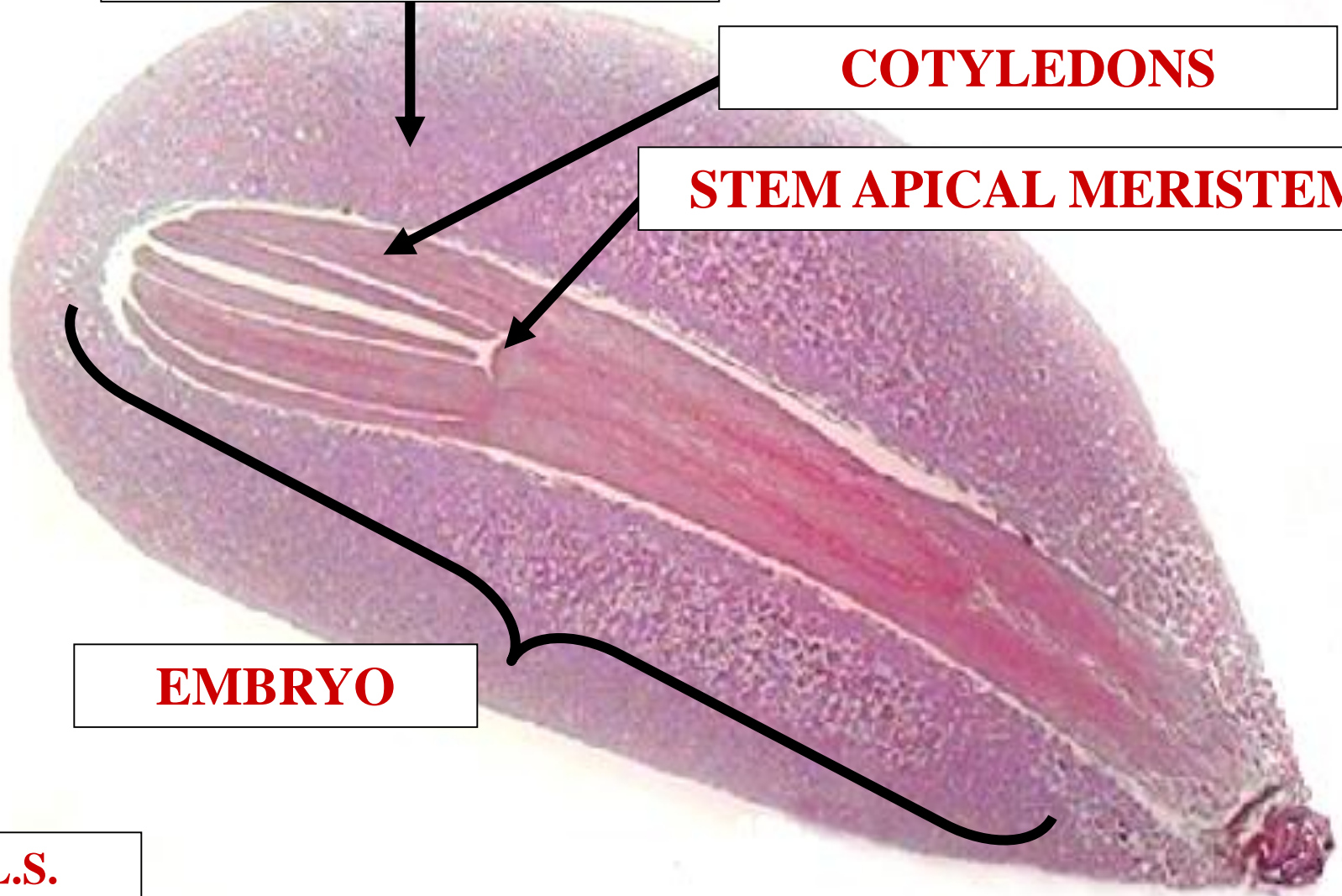
COTYLEDONS

STEM APICAL MERISTEM

EMBRYO

L.S.

EMBRYO



PINUS

MEGAGAMETOPHYTE

H

COTYLEDONS

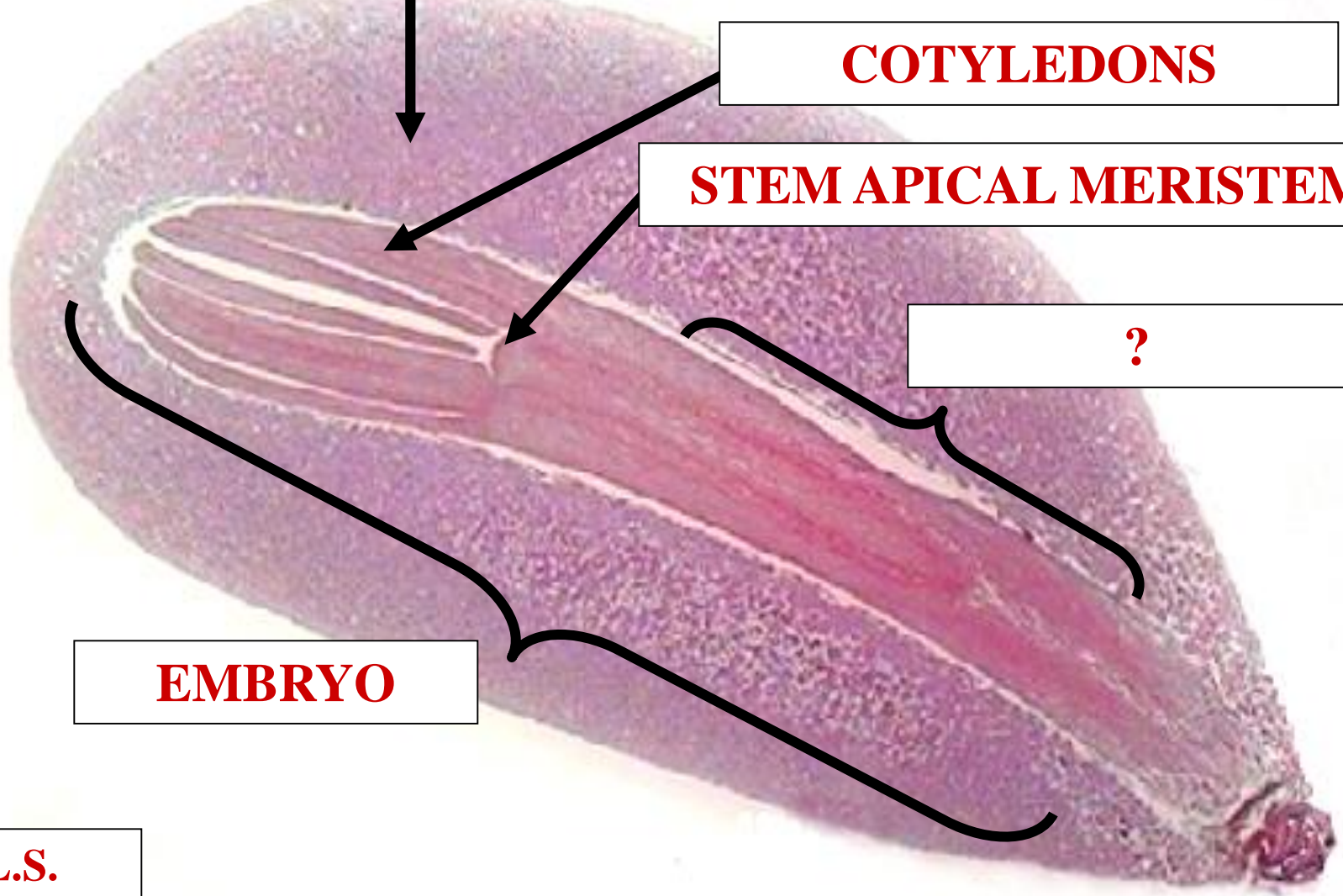
STEM APICAL MERISTEM

?

EMBRYO

L.S.

EMBRYO



PINUS

?

MEGAGAMETOPHYTE

COTYLEDONS

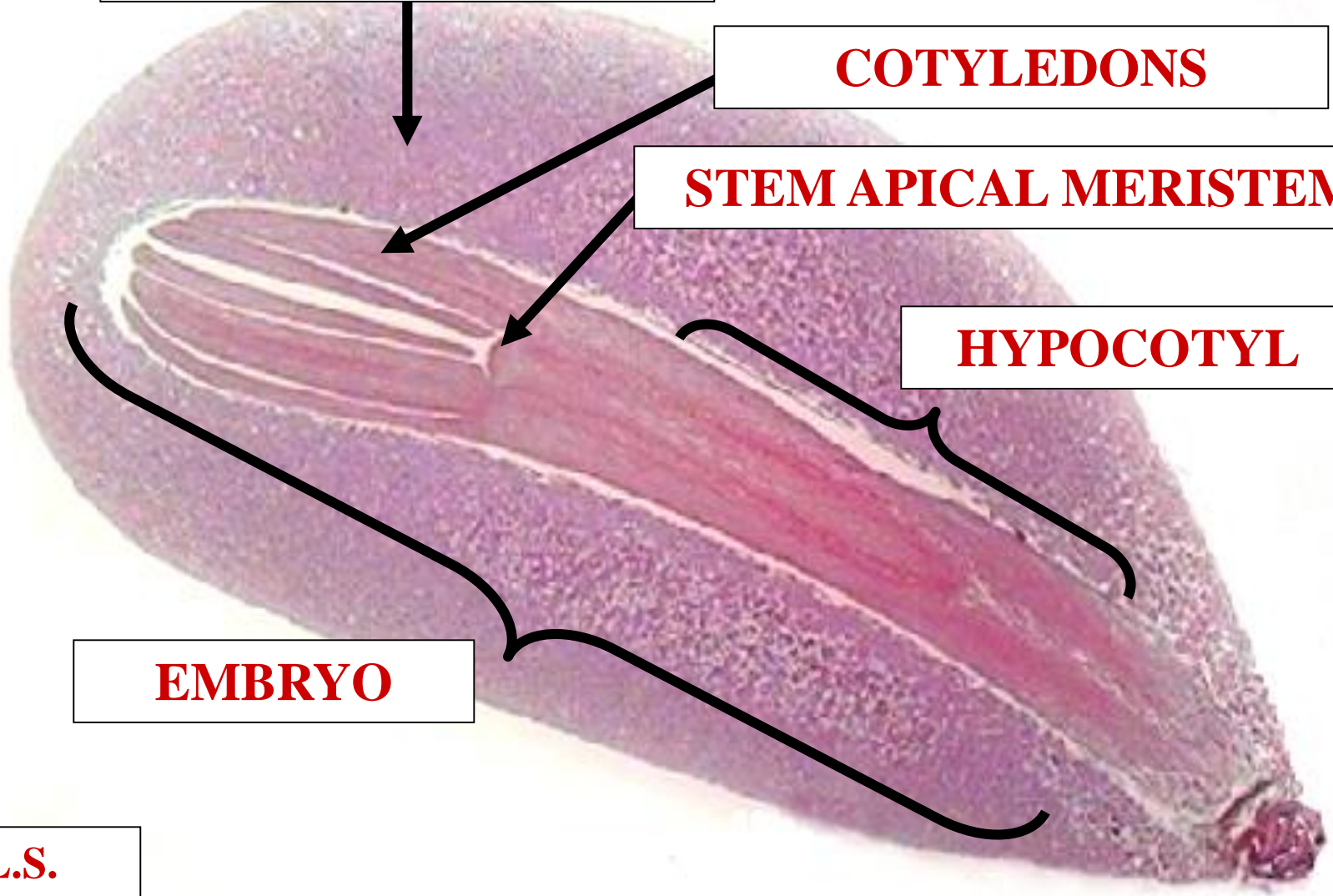
STEM APICAL MERISTEM

HYPOCOTYL

EMBRYO

L.S.

EMBRYO



PINUS

R

MEGAGAMETOPHYTE

COTYLEDONS

STEM APICAL MERISTEM

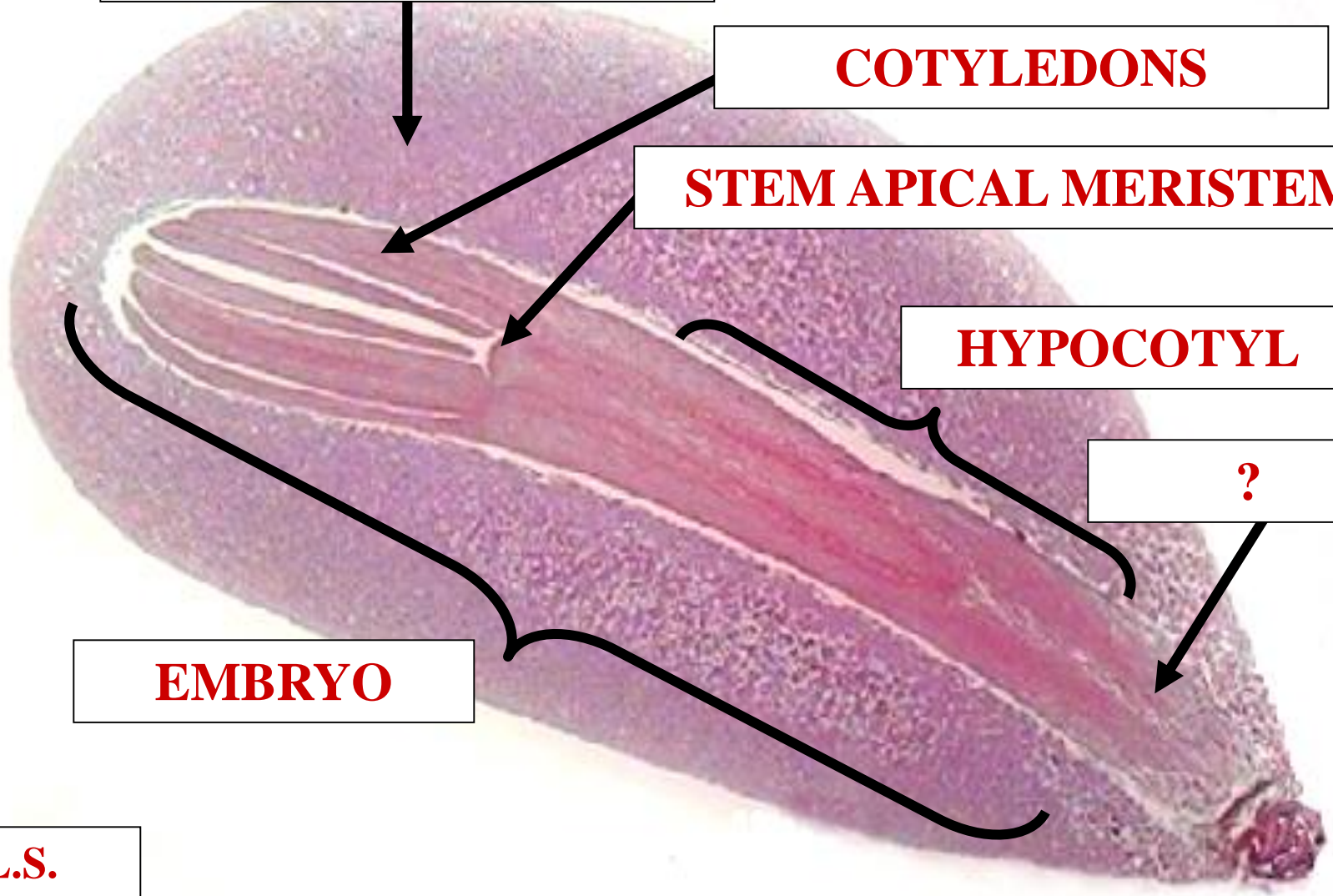
HYPOCOTYL

?

EMBRYO

L.S.

EMBRYO



PINUS

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MEGAGAMETOPHYTE

COTYLEDONS

STEM APICAL MERISTEM

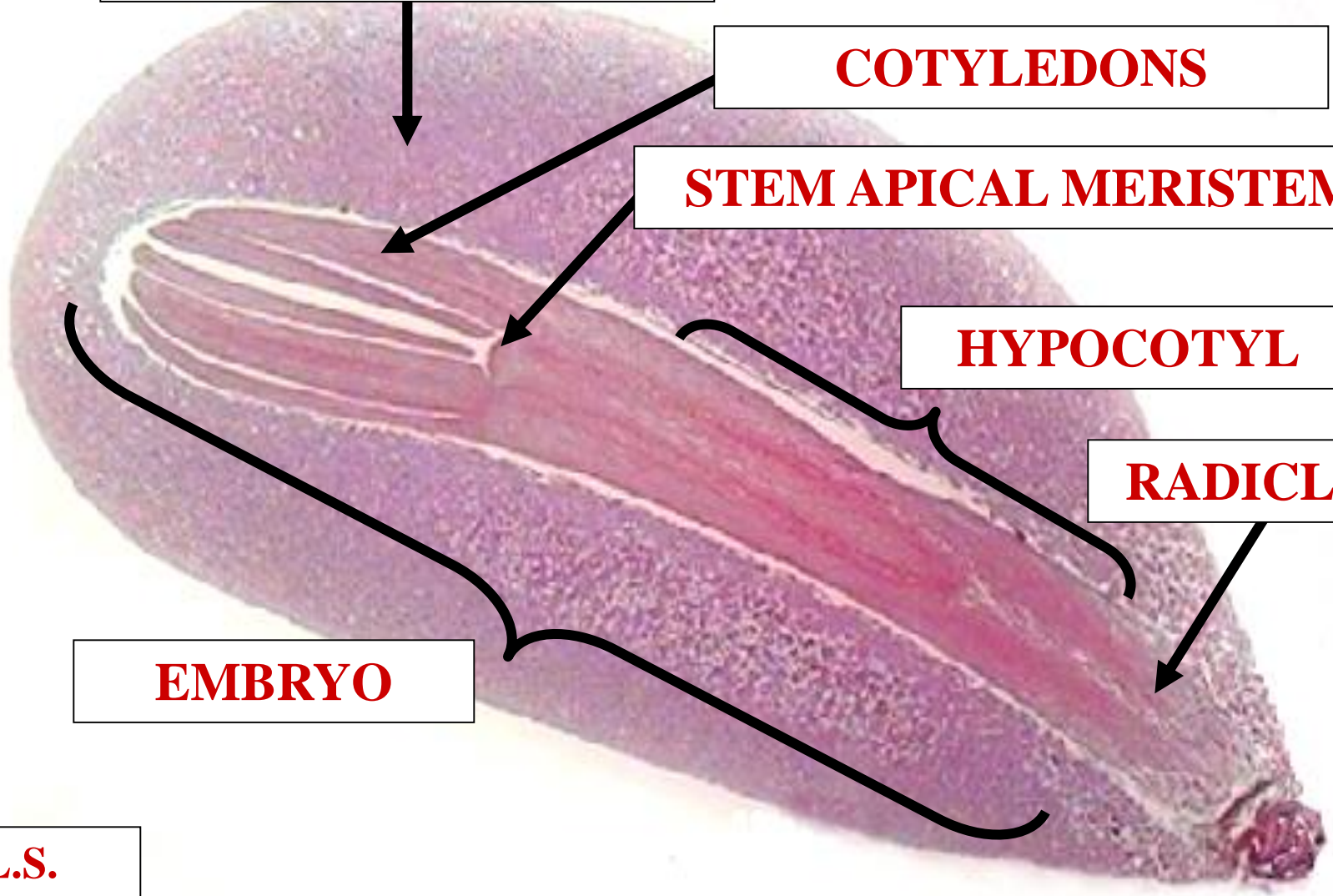
HYPOCOTYL

RADICLE

EMBRYO

L.S.

EMBRYO



PINUS

R

MEGAGAMETOPHYTE

COTYLEDONS

STEM APICAL MERISTEM

HYPOCOTYL

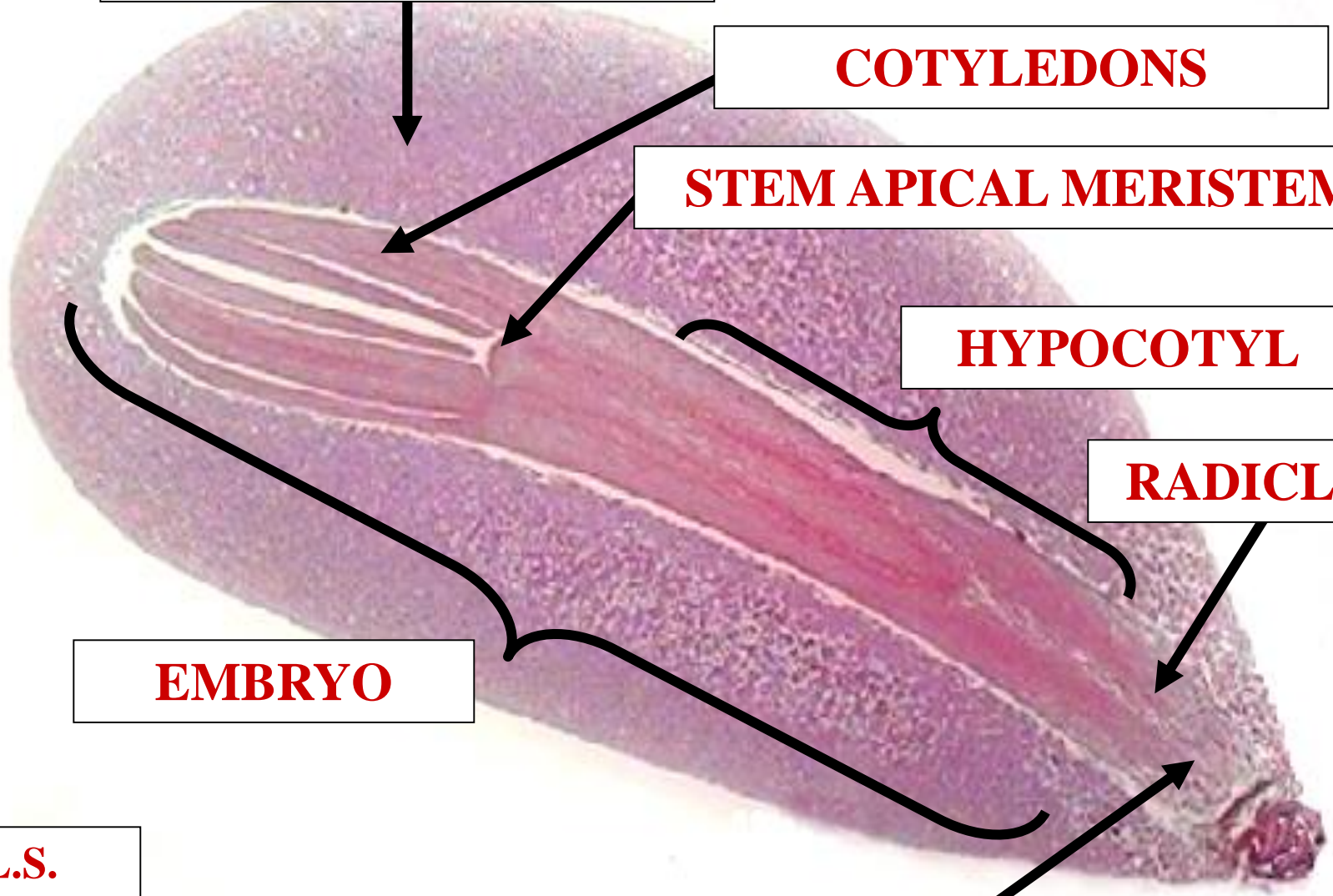
RADICLE

EMBRYO

L.S.

EMBRYO

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PINUS

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MEGAGAMETOPHYTE

COTYLEDONS

STEM APICAL MERISTEM

HYPOCOTYL

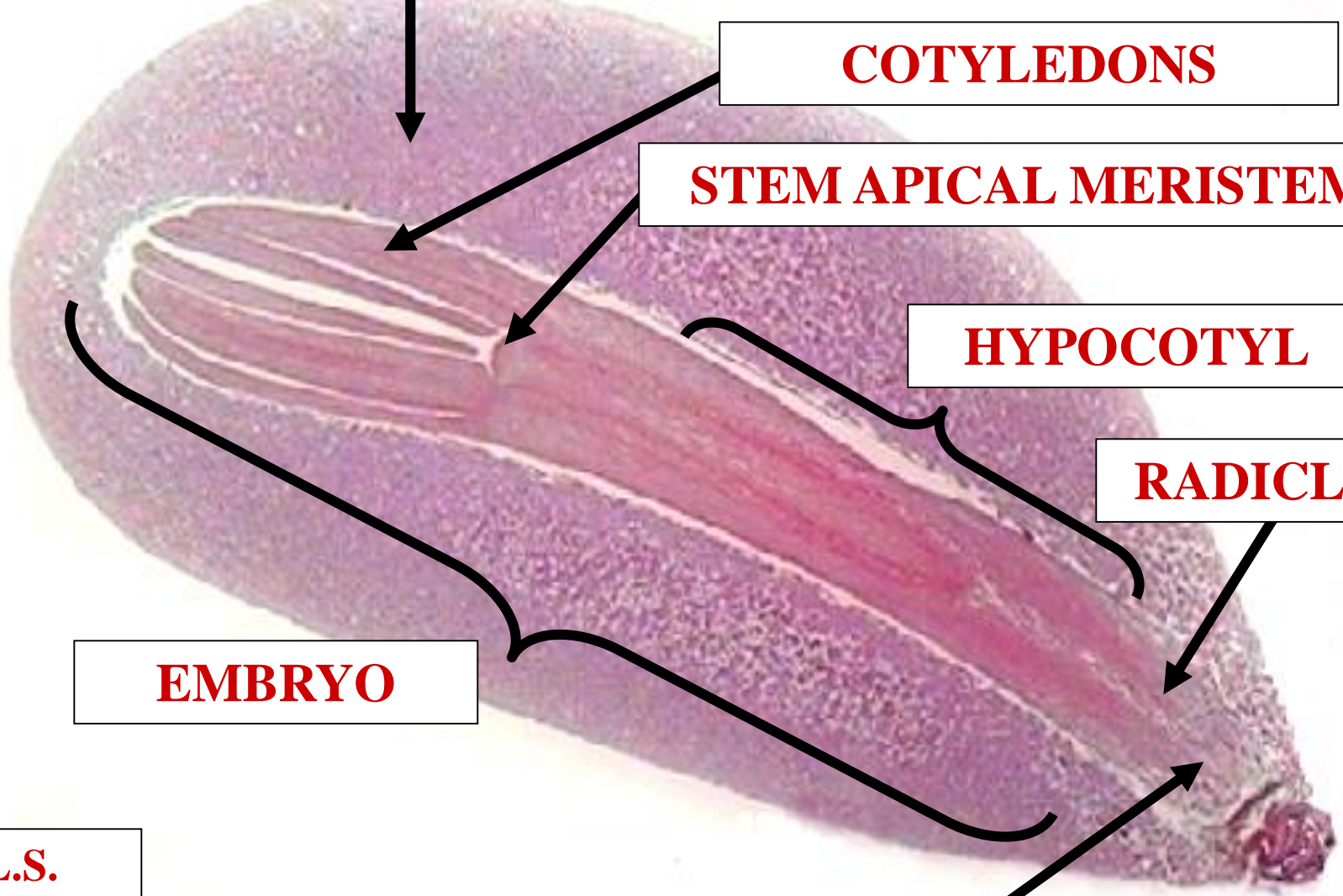
RADICLE

EMBRYO

L.S.

EMBRYO

ROOT APICAL MERISTEM



PINUS

S

MEGAGAMETOPHYTE

COTYLEDONS

STEM APICAL MERISTEM

HYPOCOTYL

RADICLE

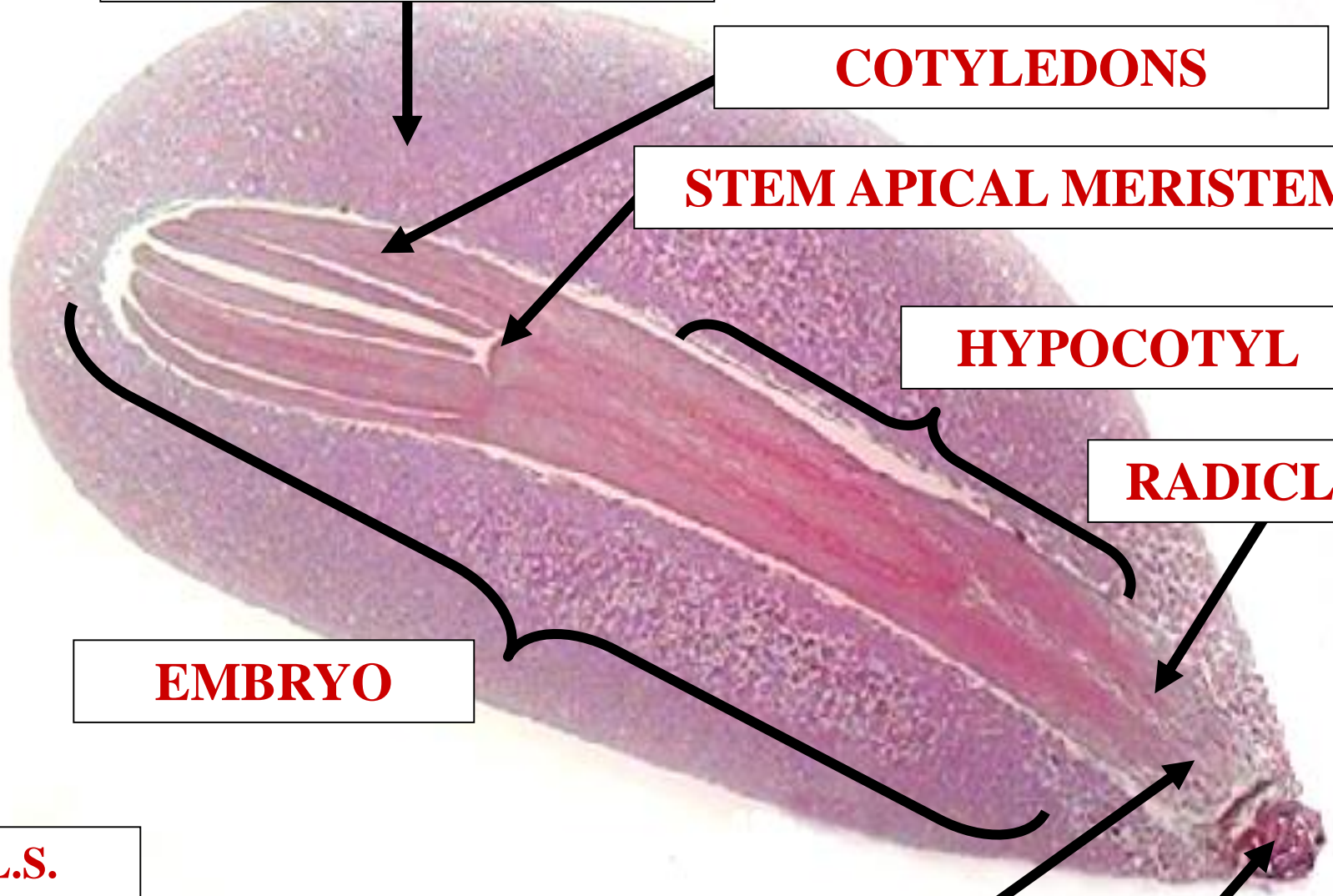
EMBRYO

L.S.

EMBRYO

ROOT APICAL MERISTEM

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PINUS

MEGAGAMETOPHYTE

COTYLEDONS



STEM APICAL MERISTEM

HYPOCOTYL

RADICLE

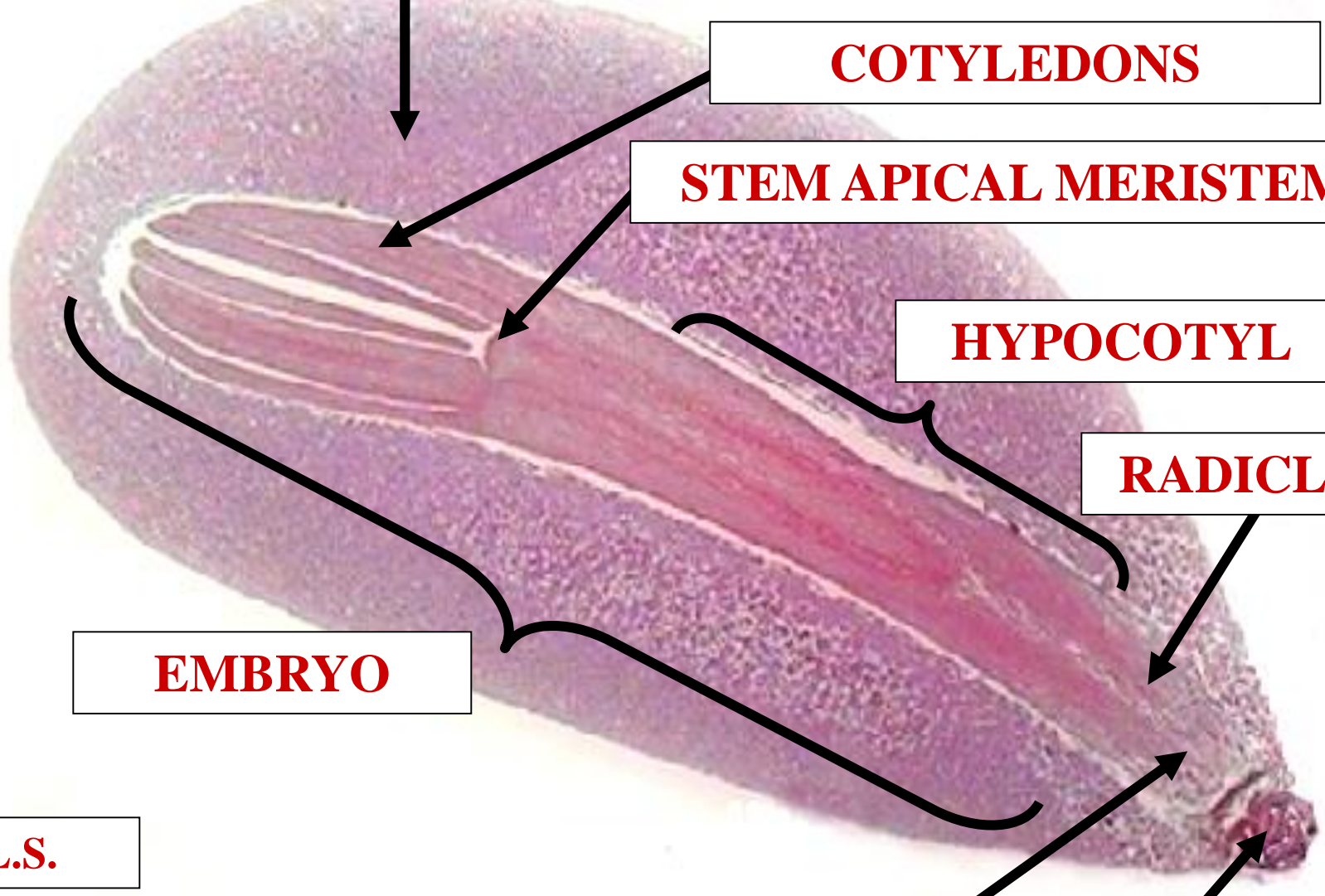
EMBRYO

L.S.

EMBRYO

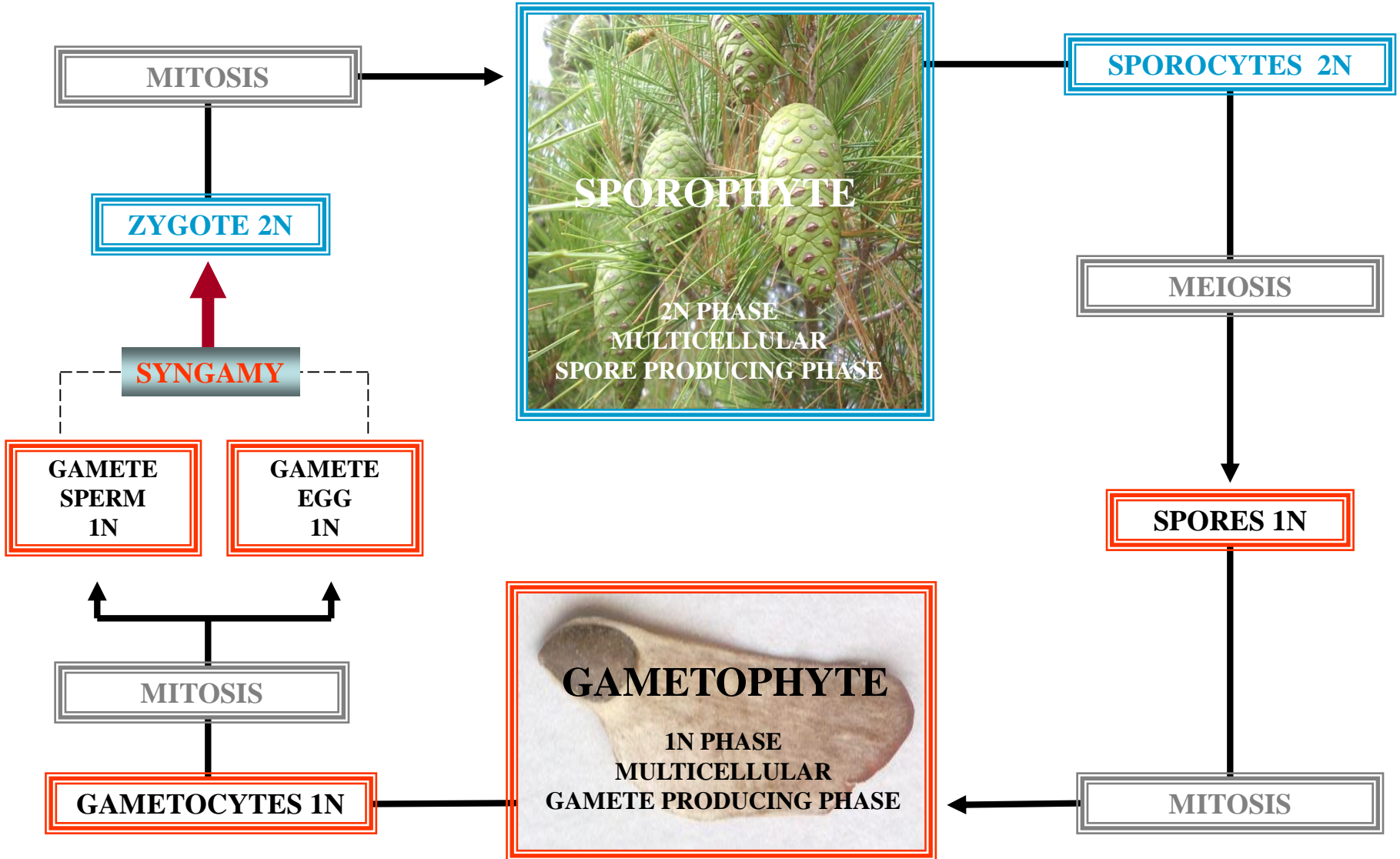
ROOT APICAL MERISTEM

SUSPENSOR





PINOPHYTA LIFE CYCLE





GAMETOPHYTE CHARACTERS



MICROGAMETOPHYTE

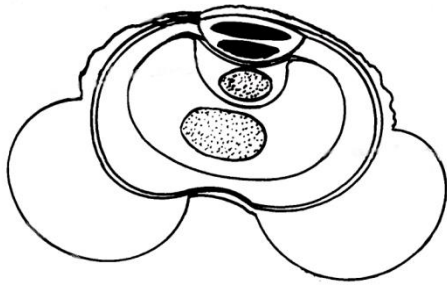


POLLEN GRAIN



POLLEN GRAIN STRUCTURE

MICROGAMETOPHYTE

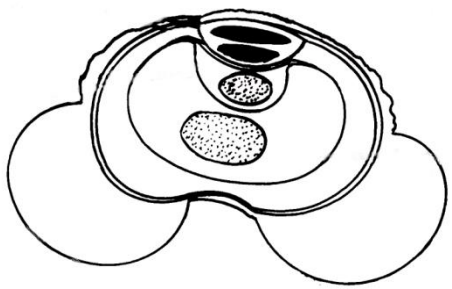


PINUS

POLLEN GRAIN

MICROGAMETOPHYTE

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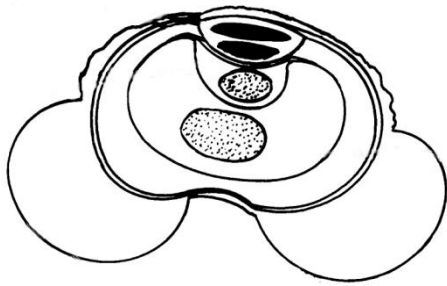


PINUS

POLLEN GRAIN

MICROGAMETOPHYTE

PROTHALLIAL CELLS



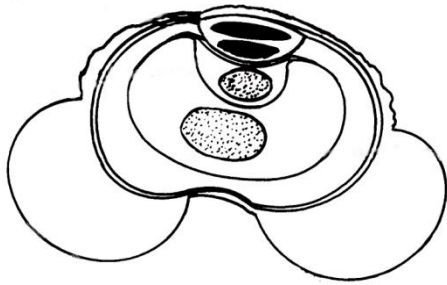
PINUS

POLLEN GRAIN

MICROGAMETOPHYTE

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PROTHALLIAL CELLS



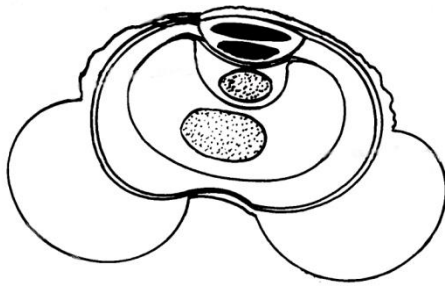
PINUS

POLLEN GRAIN

MICROGAMETOPHYTE

GENERATIVE CELL

PROTHALLIAL CELLS



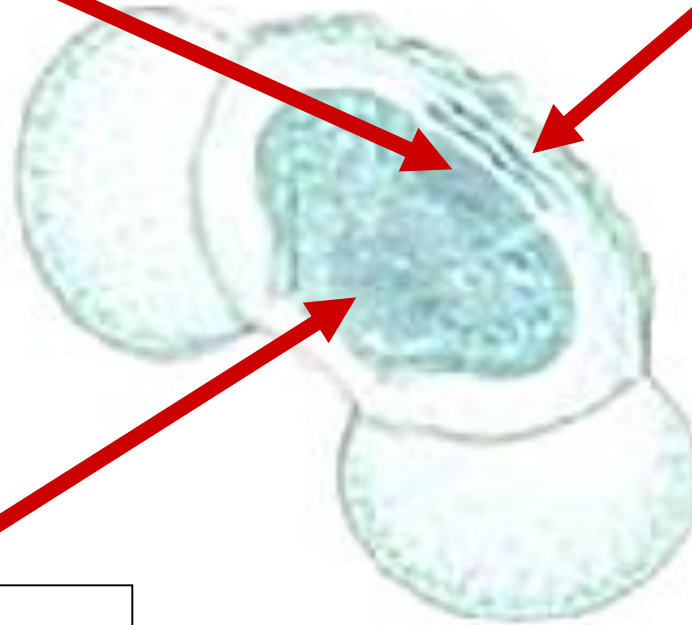
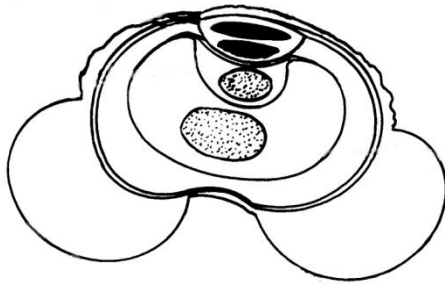
PINUS

POLLEN GRAIN

MICROGAMETOPHYTE

GENERATIVE CELL

PROTHALLIAL CELLS



PINUS

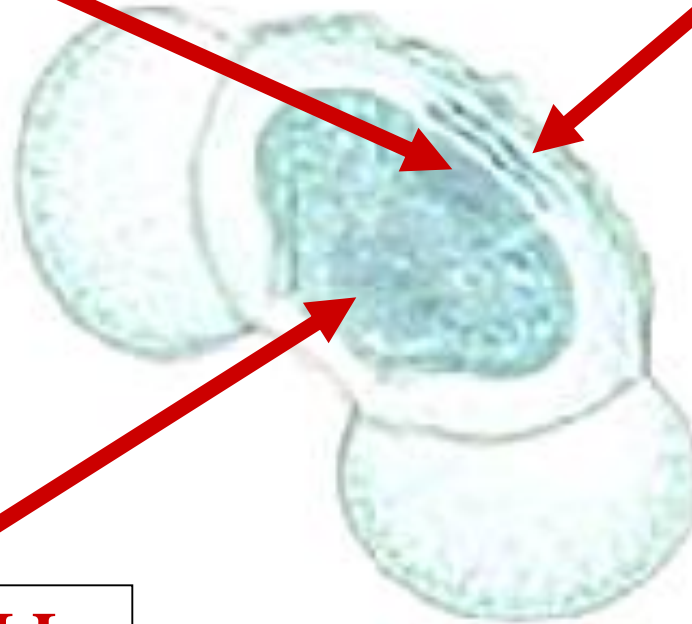
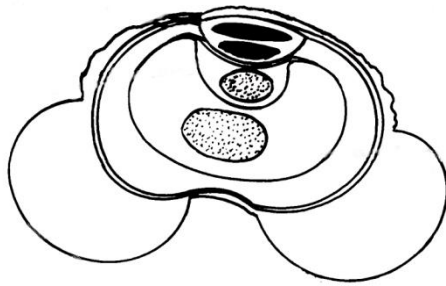
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POLLEN GRAIN

MICROGAMETOPHYTE

GENERATIVE CELL

PROTHALLIAL CELLS

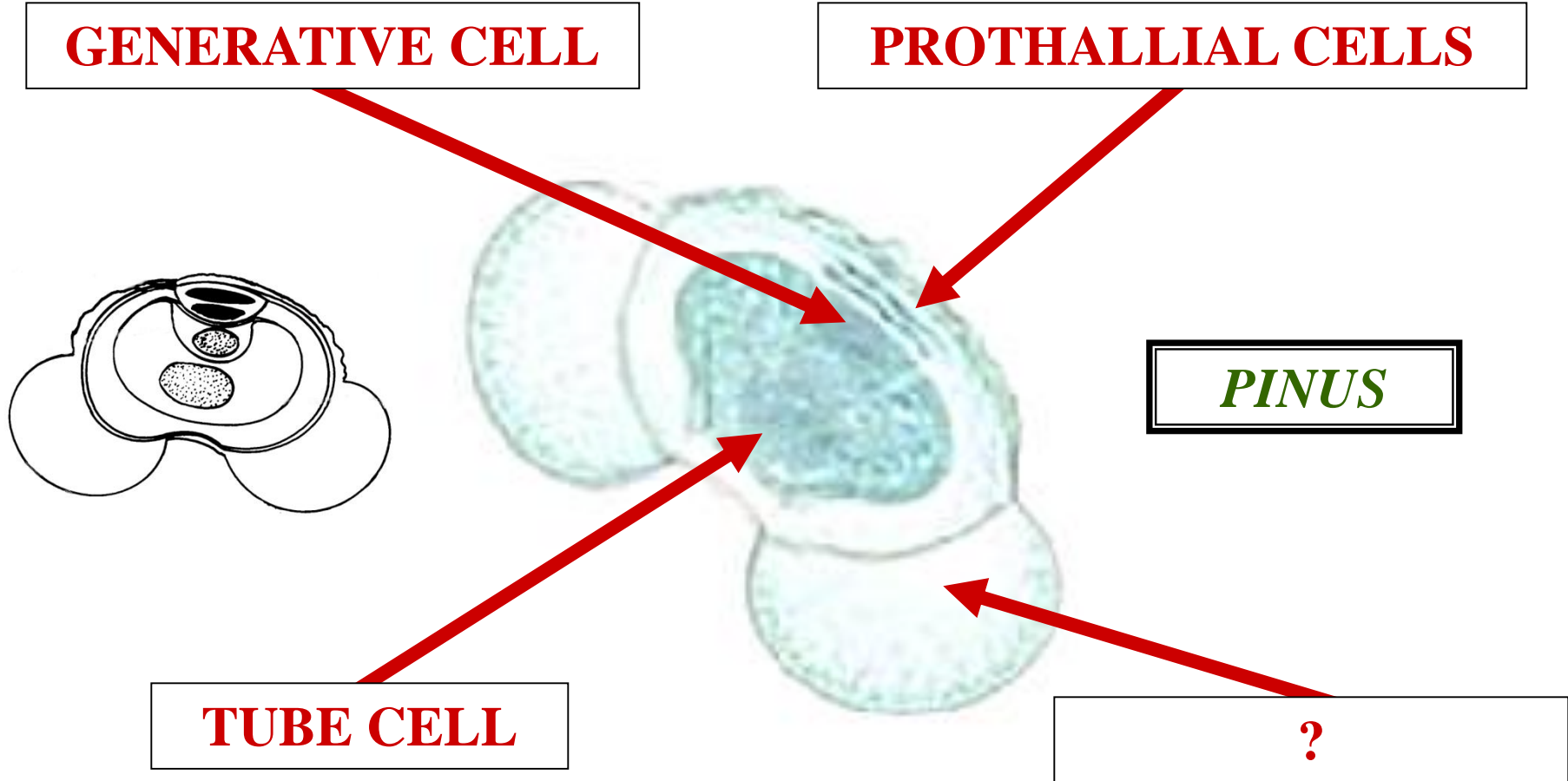


PINUS

TUBE CELL

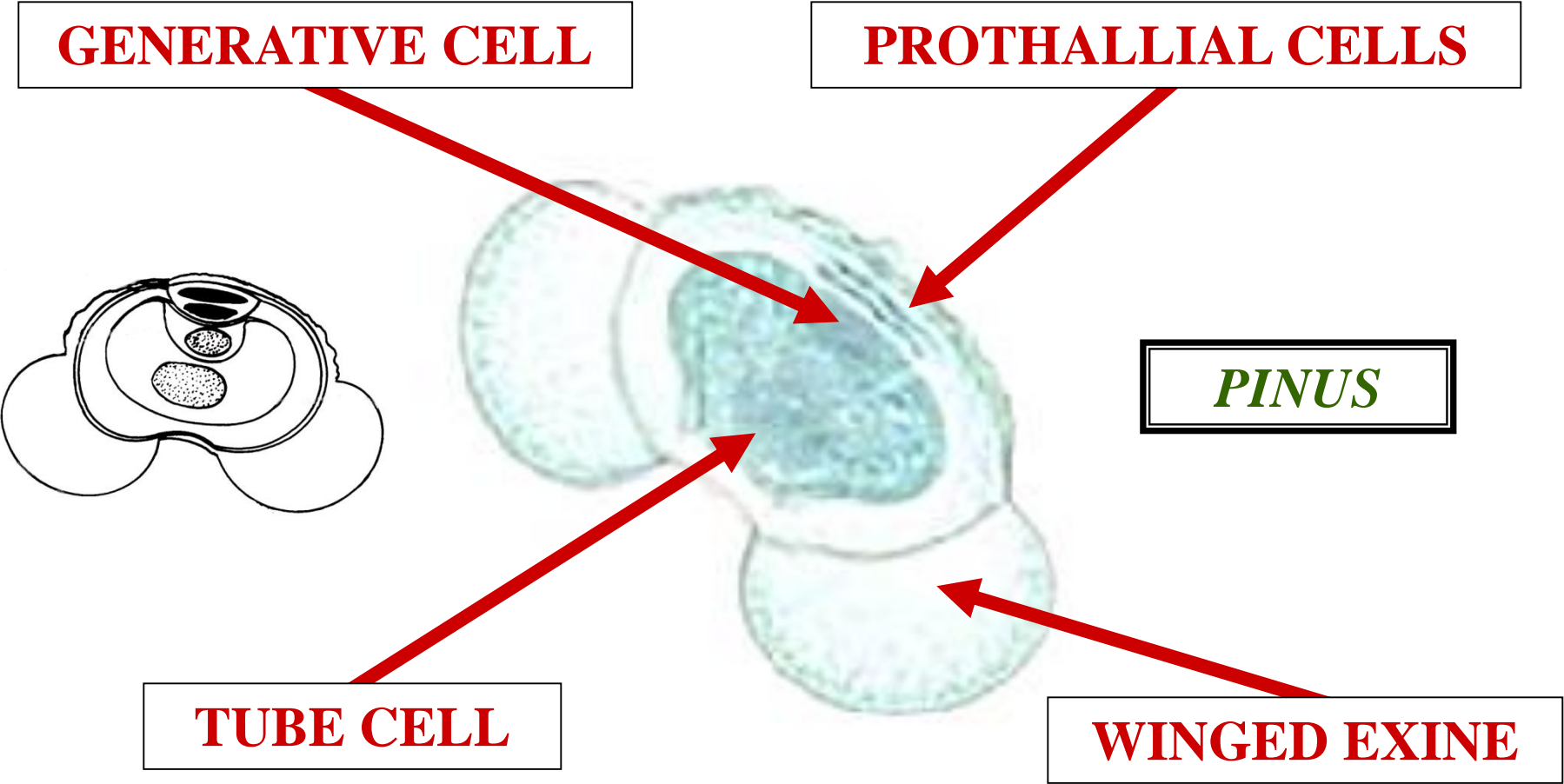
POLLEN GRAIN

MICROGAMETOPHYTE



POLLEN GRAIN

MICROGAMETOPHYTE



POLLEN GRAIN



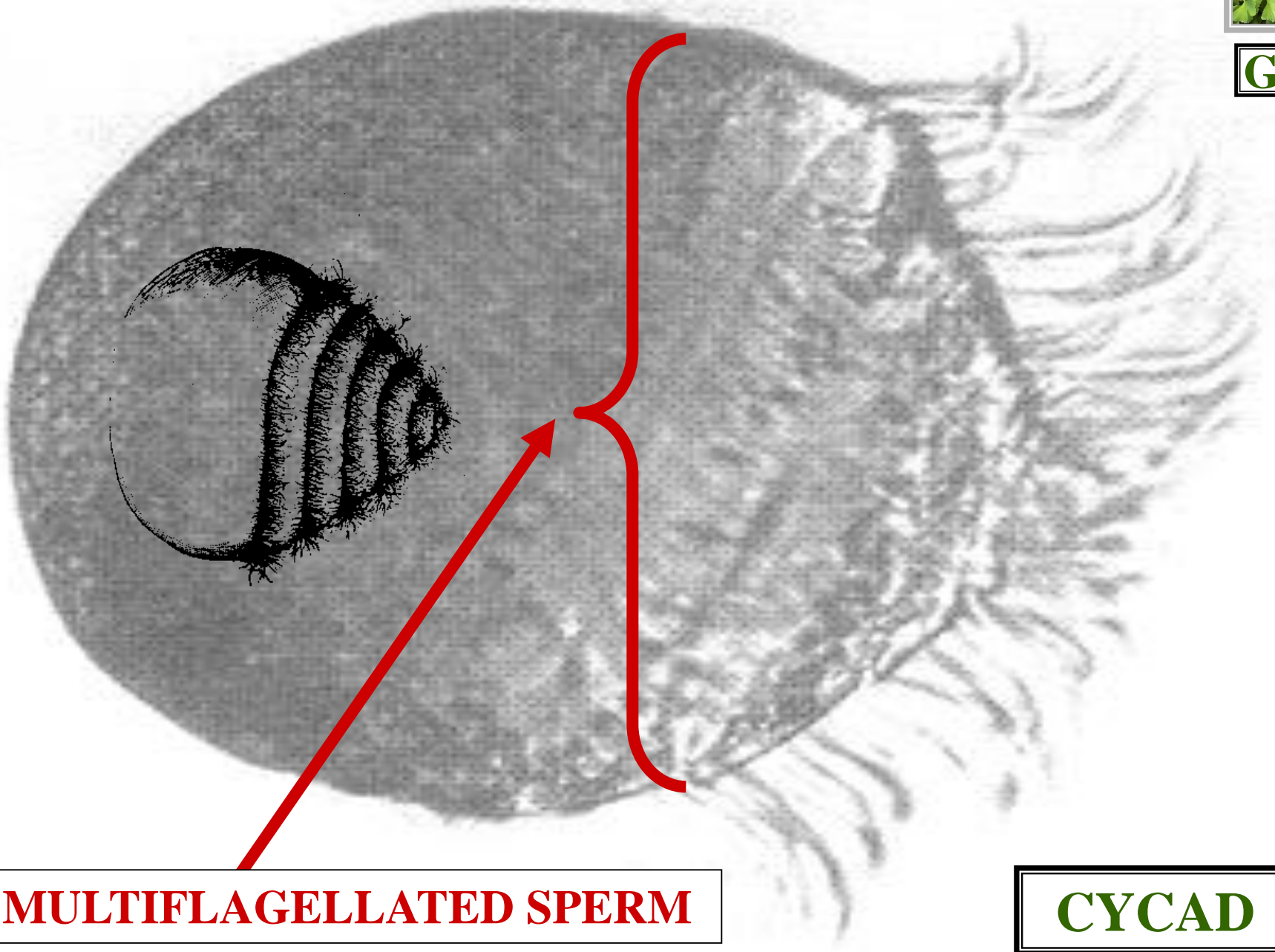
SPERM

CYCAD





G

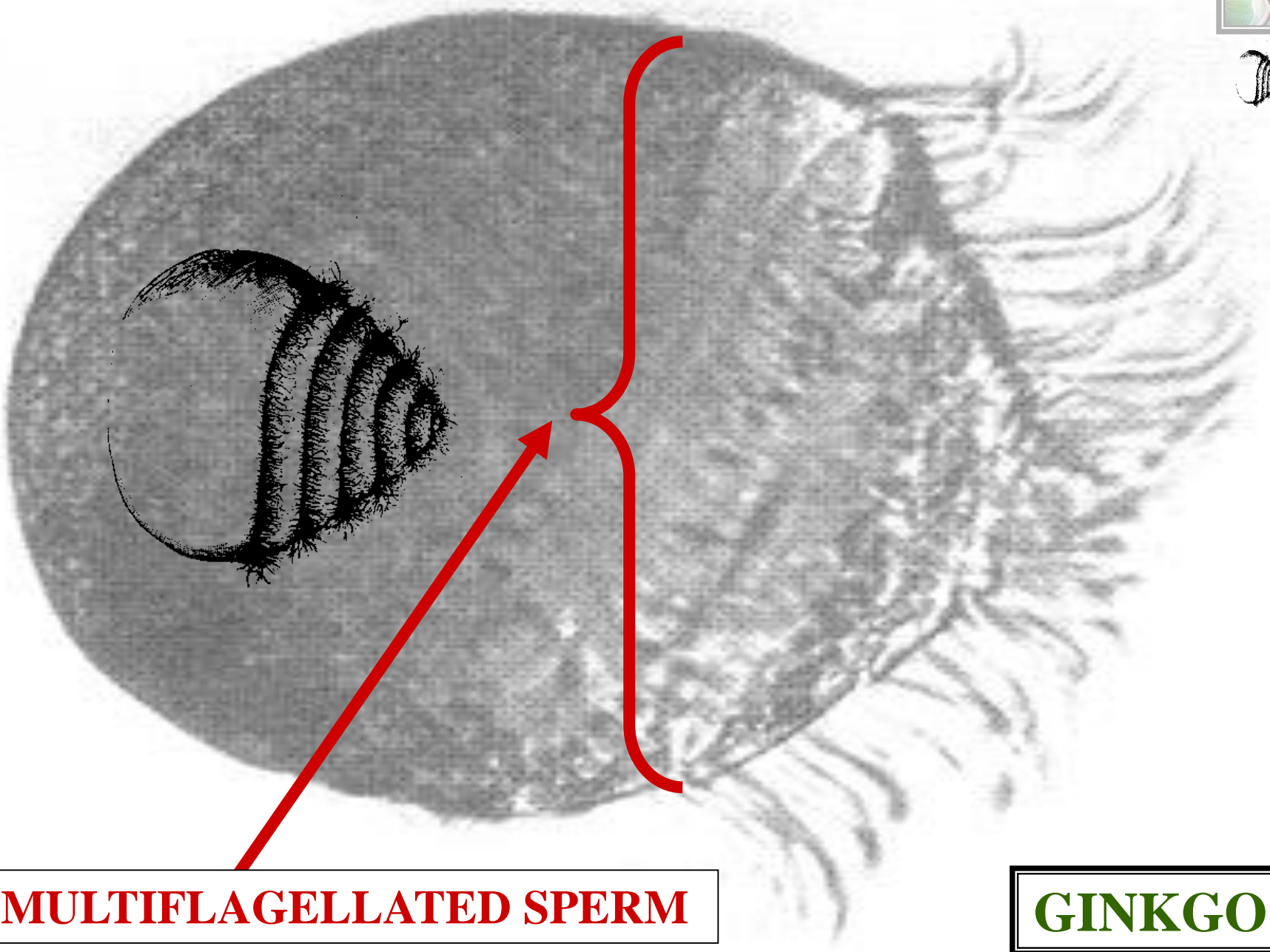


MULTIFLAGELLATED SPERM

CYCAD

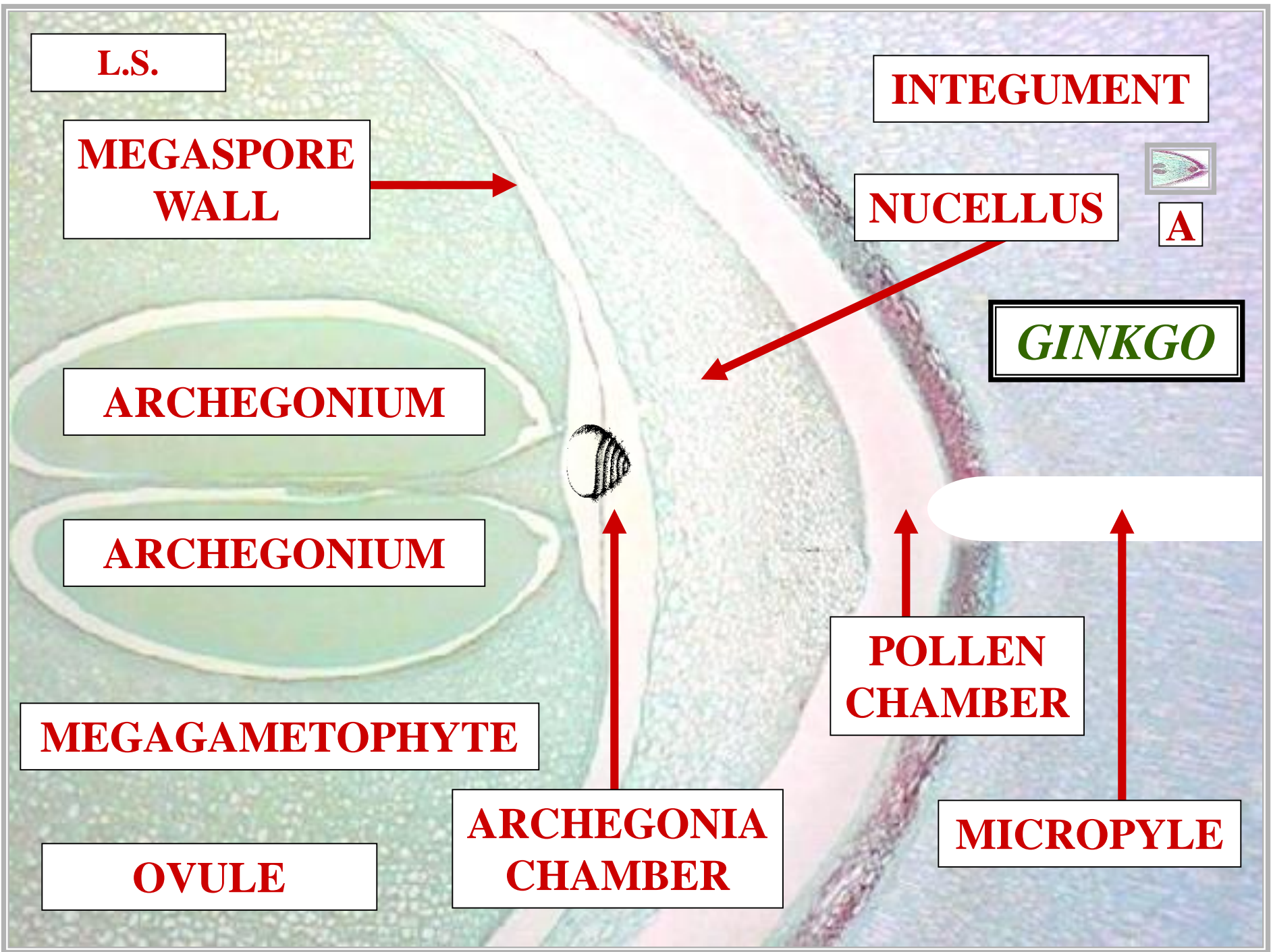
GINKGO





MULTIFLAGELLATED SPERM

GINKGO

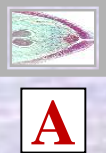


L.S.

INTEGUMENT

MEGASPORE WALL

NUCELLUS



GINKGO

ARCHEGONIUM

ARCHEGONIUM

MEGAGAMETOPHYTE

POLLEN CHAMBER

OVULE

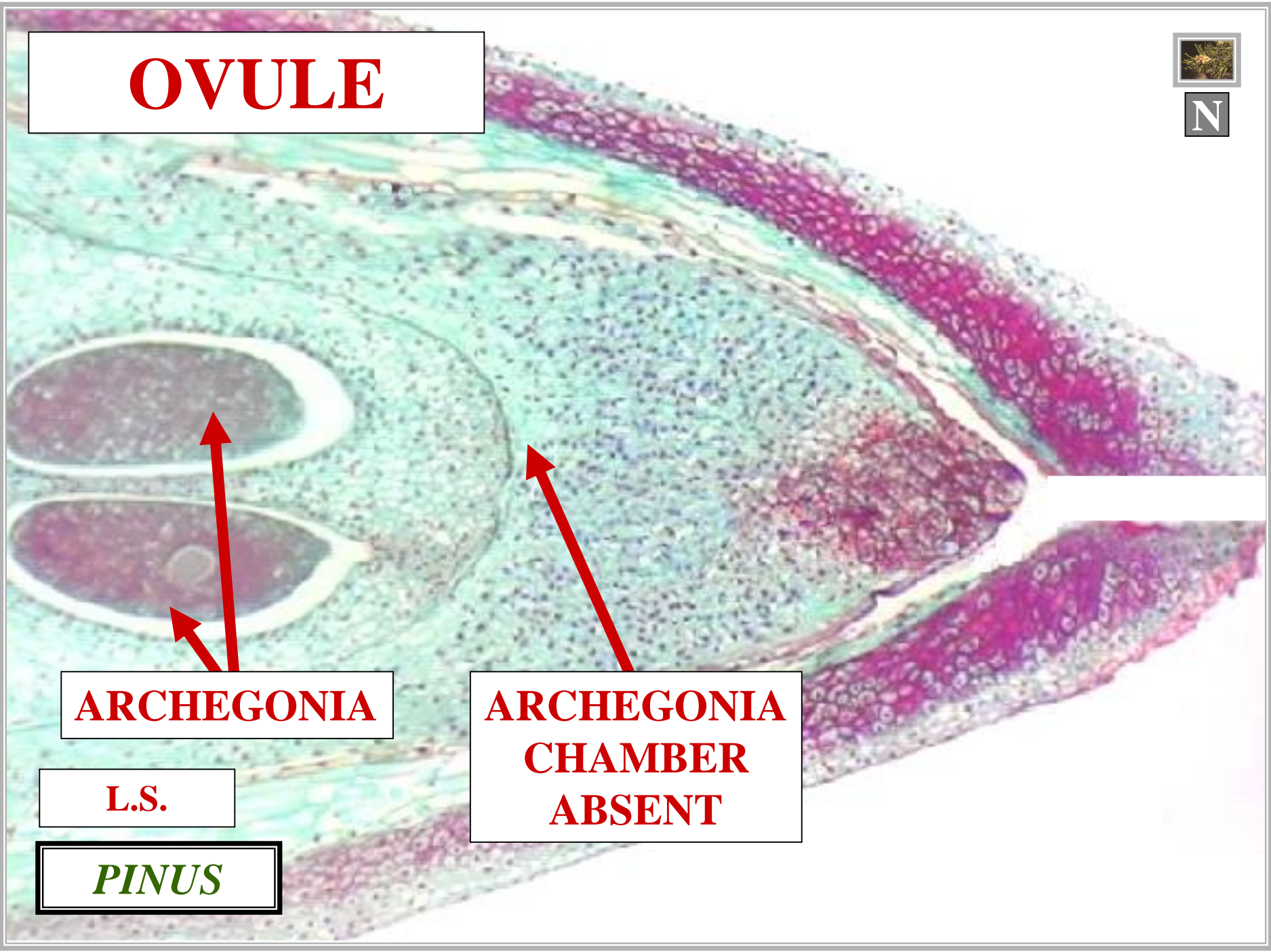
ARCHEGONIA CHAMBER

MICROPYLE

OVULE



N



ARCHEGONIA

L.S.

PINUS

ARCHEGONIA
CHAMBER
ABSENT

A close-up photograph of a pine branch with several long, thin, green needles. A small, brown, textured pine cone is visible in the center of the branch. The background is dark and out of focus.

PINOPHYTA
SPERM
NON-FLAGELLATED



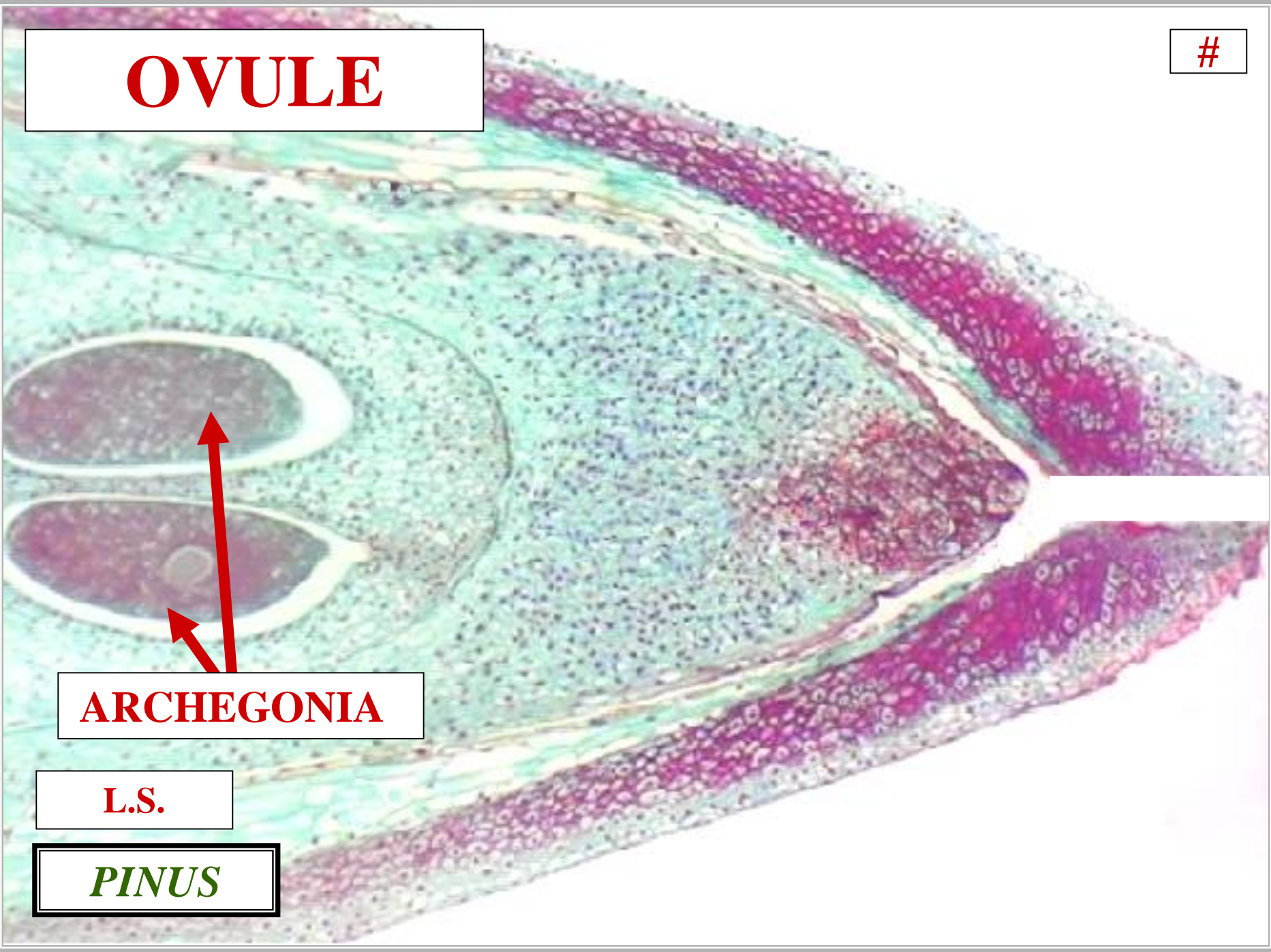
MEGAGAMETOPHYTE



ARCHEGONIA

OVULE

#



ARCHEGONIA

L.S.

PINUS

OVULE

?



A longitudinal section of a Pinus ovule. The image shows a large, central nucellus containing two archegonia. Each archegonium consists of a large, oval-shaped egg cell and a smaller, circular cell. The nucellus is surrounded by a thick, multi-layered integument. The outermost layer is the epidermis, followed by a thick, multi-layered cuticle. The nucellus is embedded in the nucellar tissue. The integument is highly vascularized, with numerous xylem and phloem vessels. The nucellus is surrounded by a thick, multi-layered integument. The outermost layer is the epidermis, followed by a thick, multi-layered cuticle. The nucellus is embedded in the nucellar tissue. The integument is highly vascularized, with numerous xylem and phloem vessels.

2 ARCHEGONIA

L.S.

PINUS

OVULE

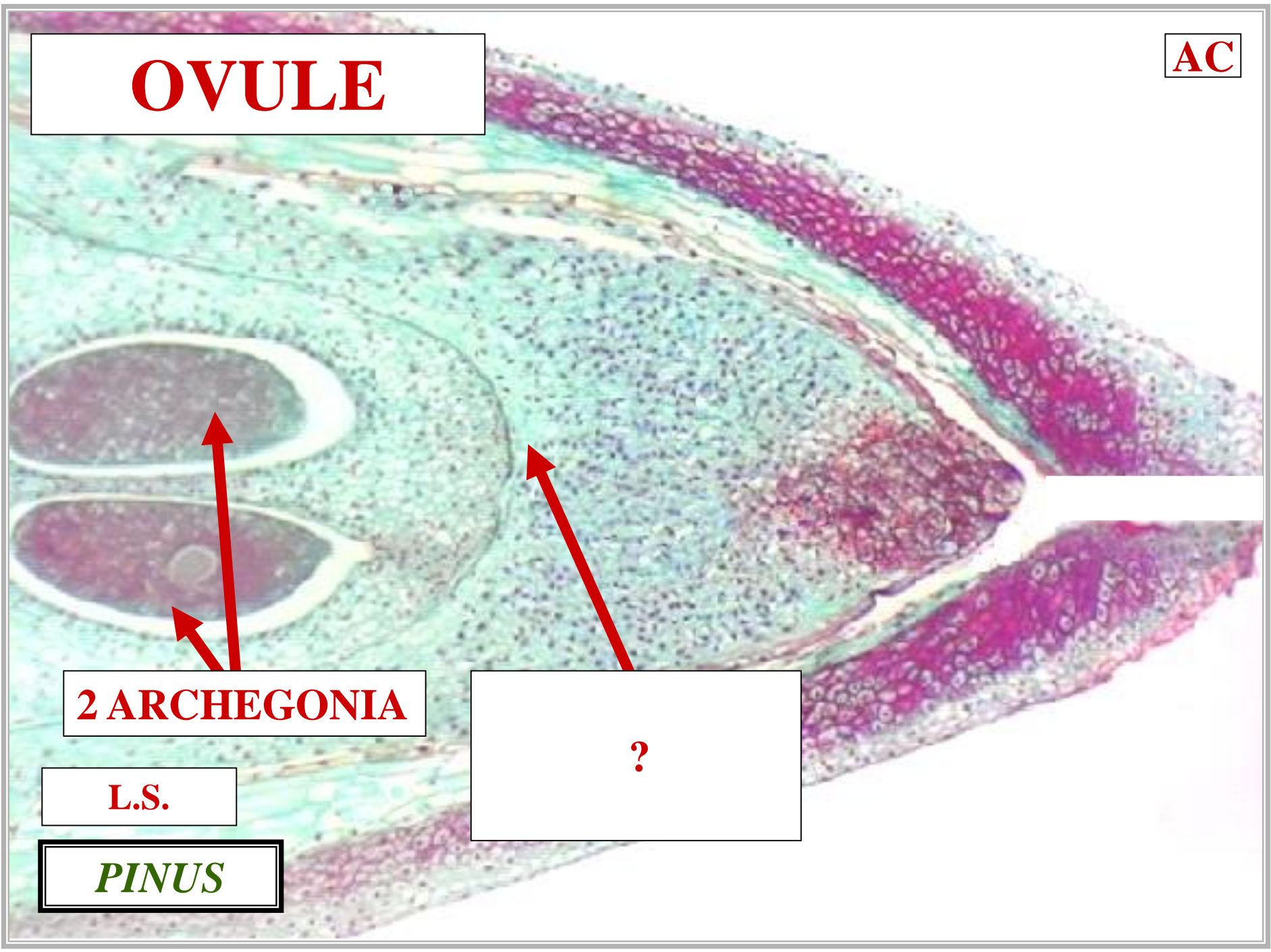
AC

2 ARCHEGONIA

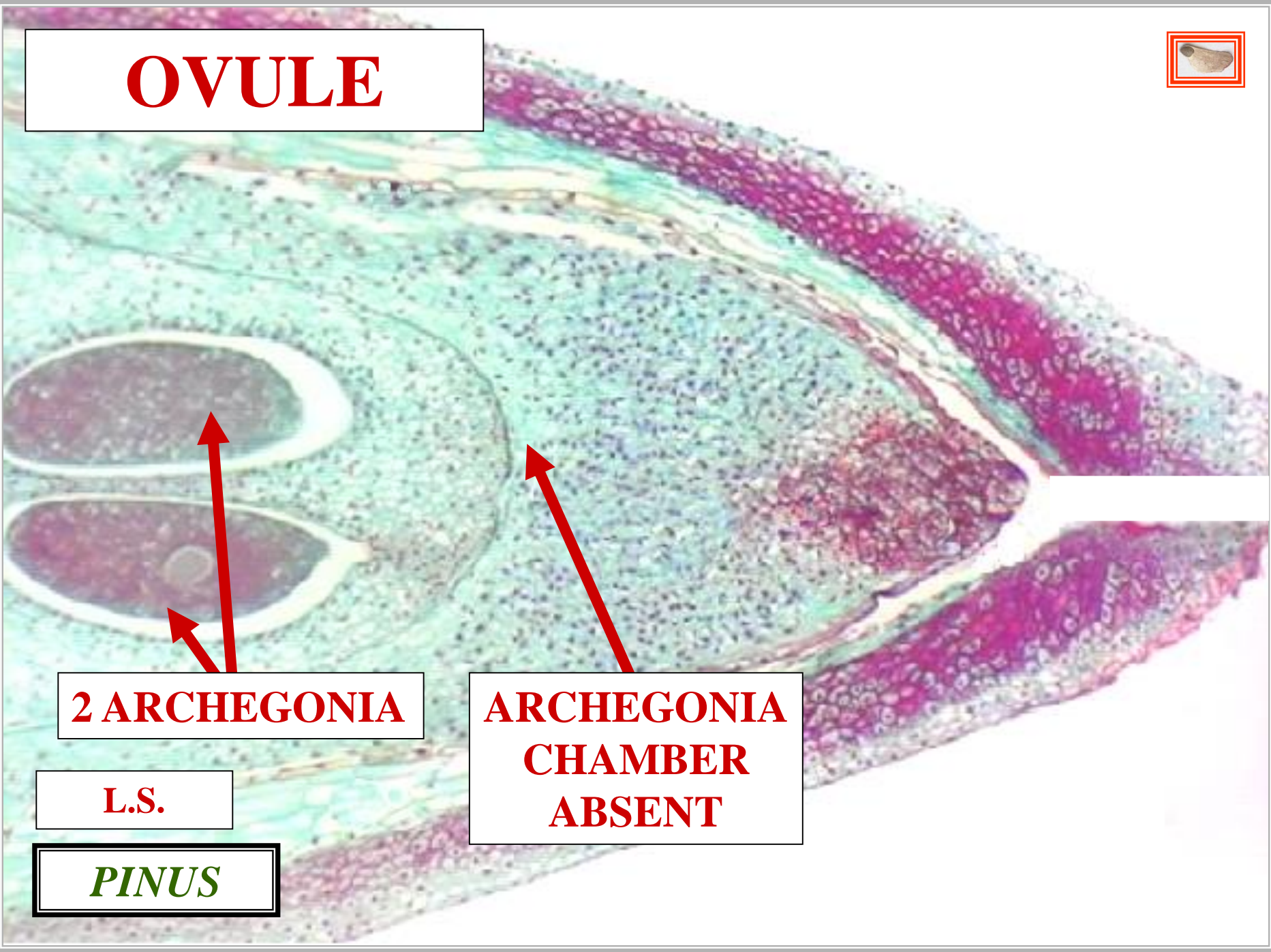
L.S.

PINUS

?



OVULE



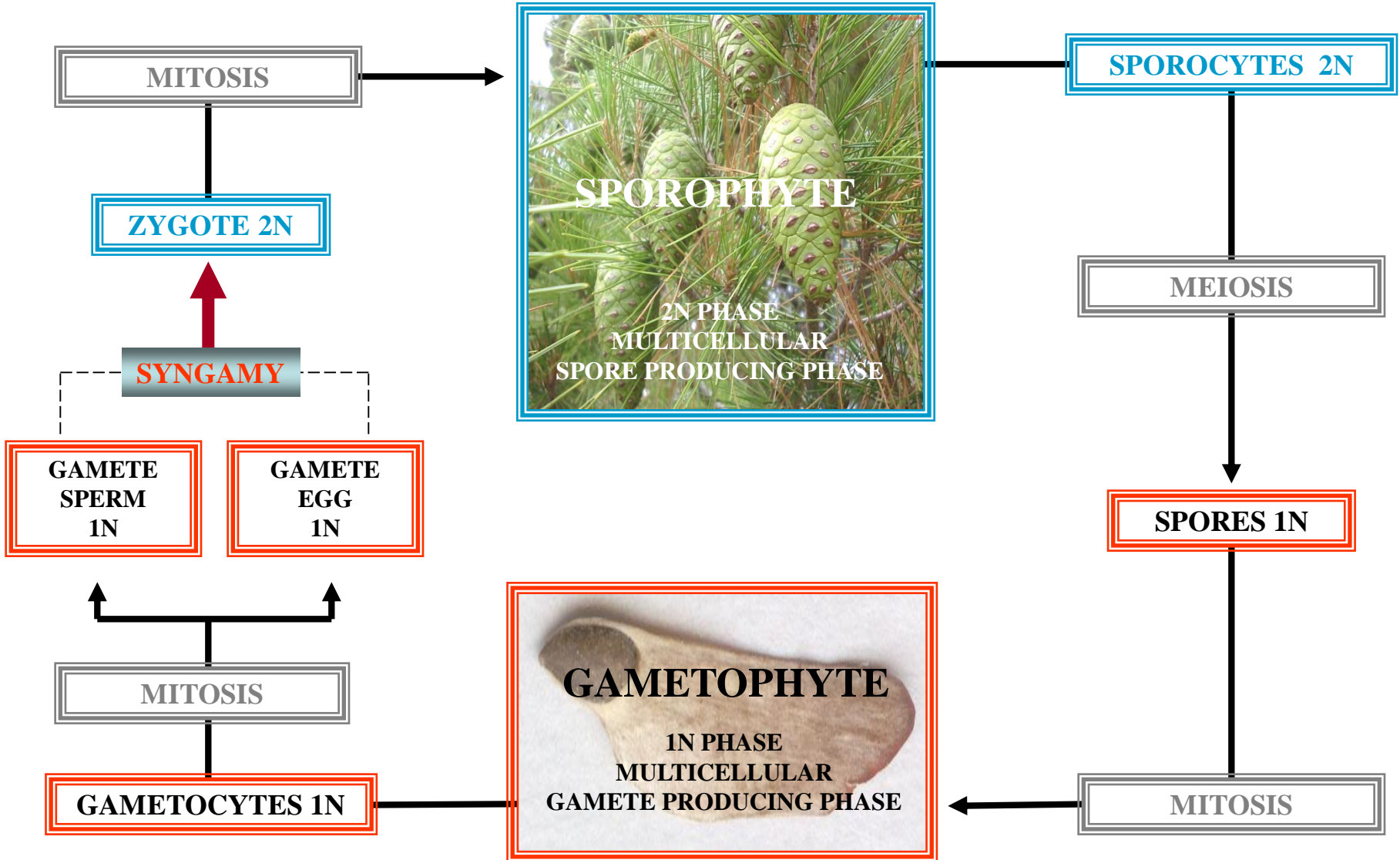
2 ARCHEGONIA

**ARCHEGONIA
CHAMBER
ABSENT**

L.S.

PINUS

PINOPHYTA LIFE CYCLE





REPRODUCTION



SEX CONDITION

PINUS

M



MEGASTROBILI



PINUS

M



MEGASTROBILI



MICROSTROBILI

PINUS

M



MEGASPORANGIA



MICROSTROBILI

PINUS

M



MEGASPORANGIA



MICROSPORANGIA

PINUS



MEGASPORANGIA

PINUS



MONOECIOUS



MICROSPORANGIA





MICROSTROBILUS