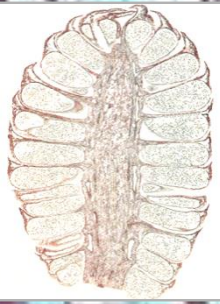


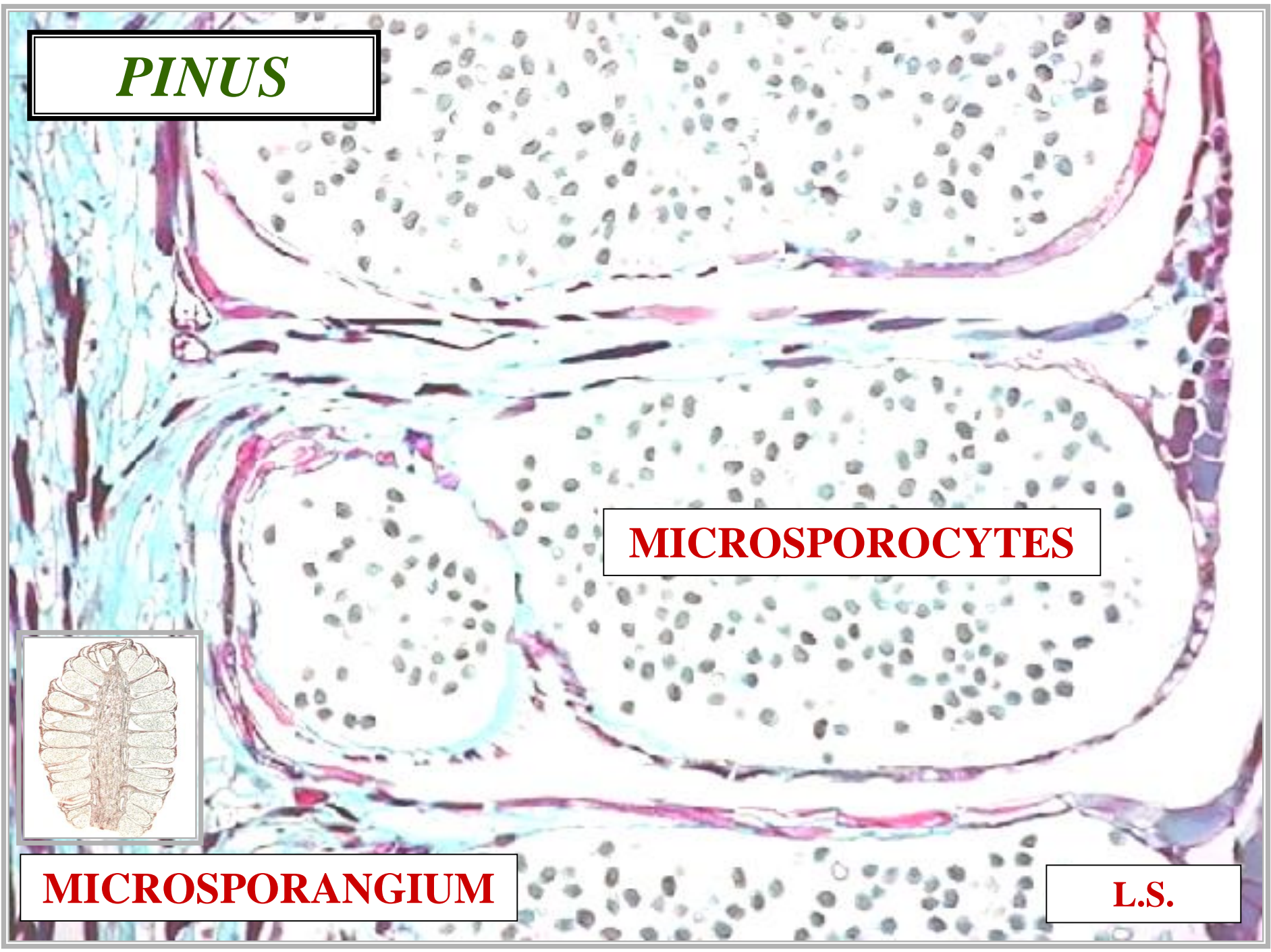
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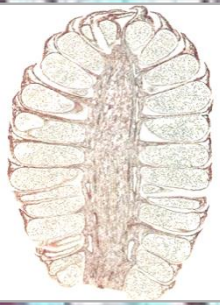
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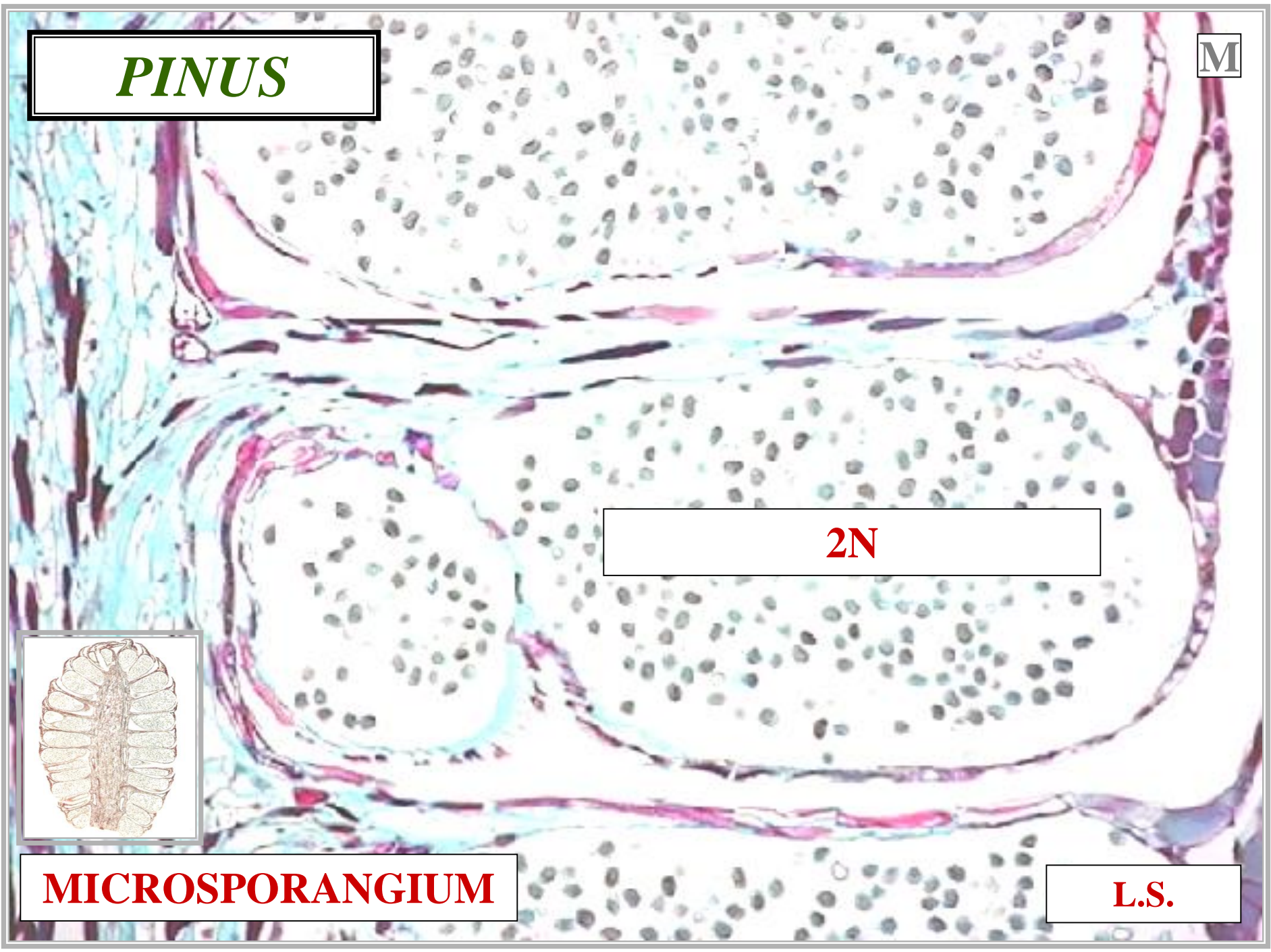
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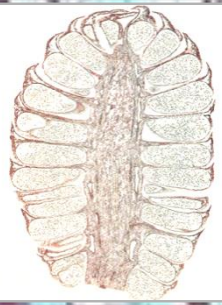
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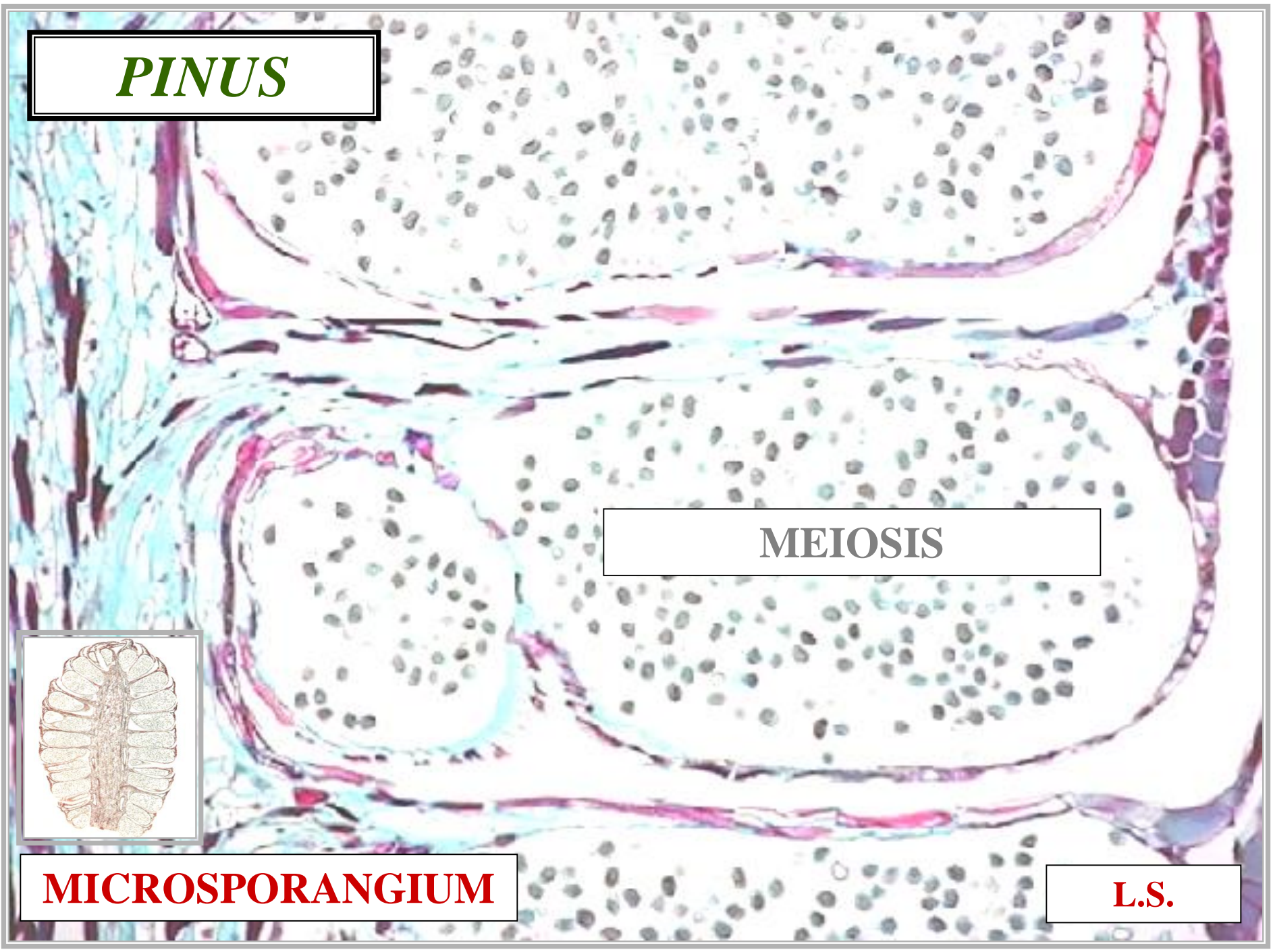
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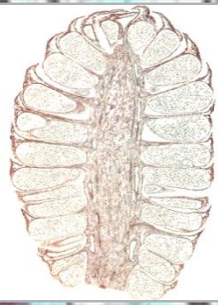
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MICROSPORES



MICROSPORANGIUM

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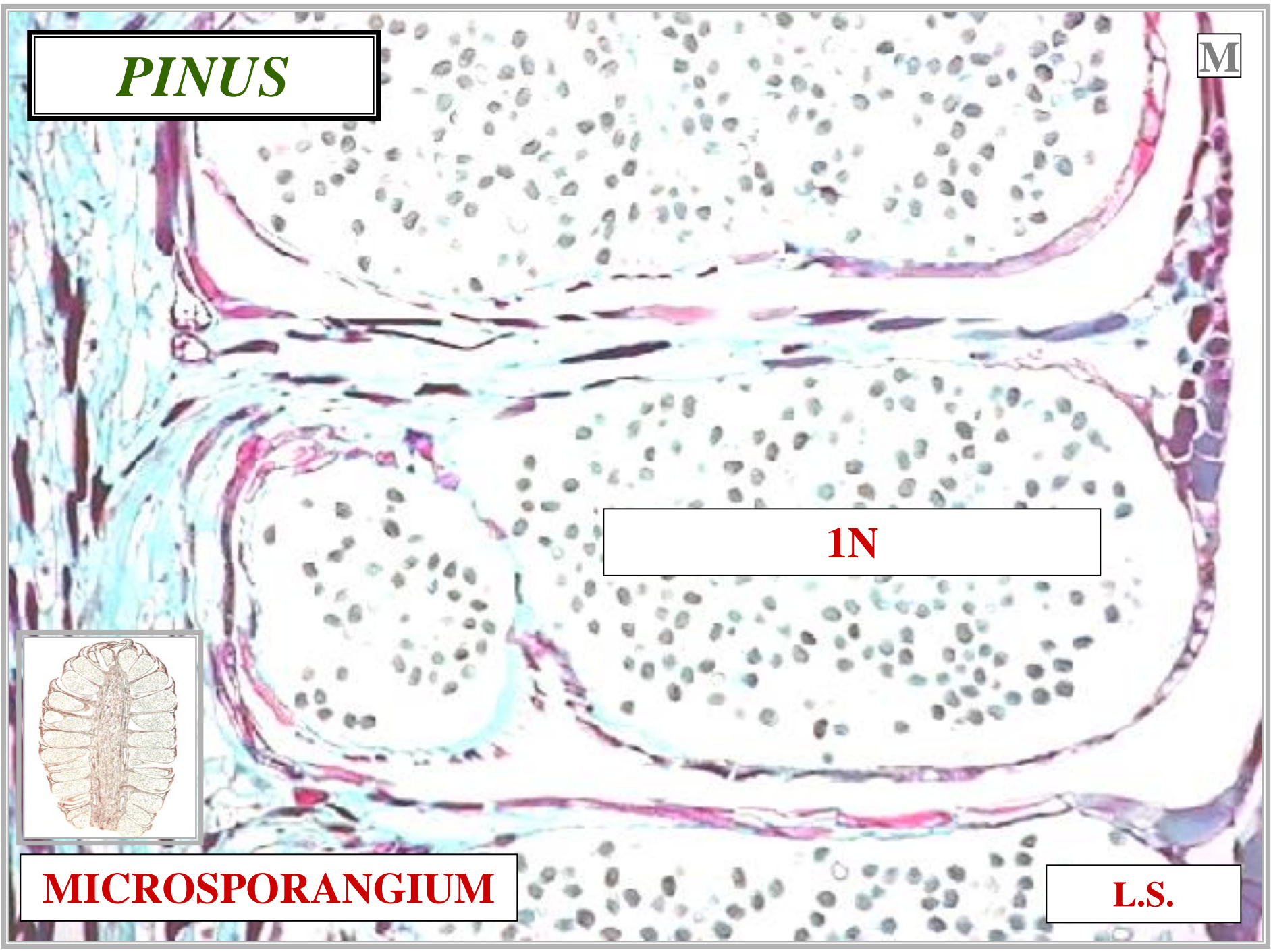
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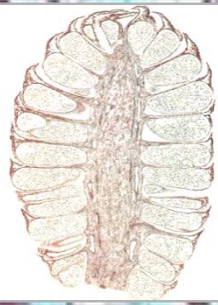
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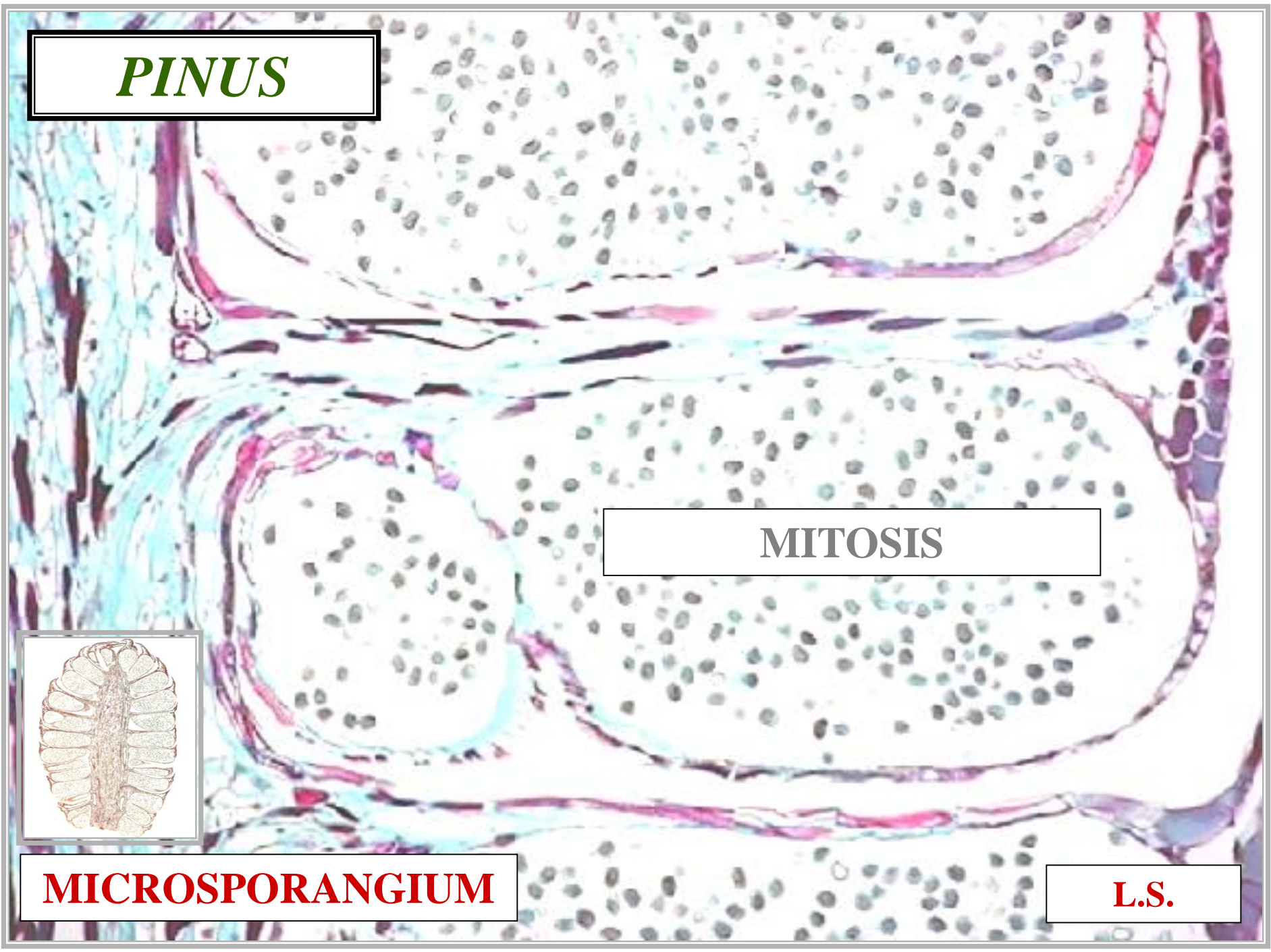
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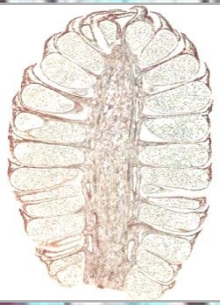
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MICROGAMETOPHYTE



MICROSPORANGIUM

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PINUS



MICROSPORANGIUM

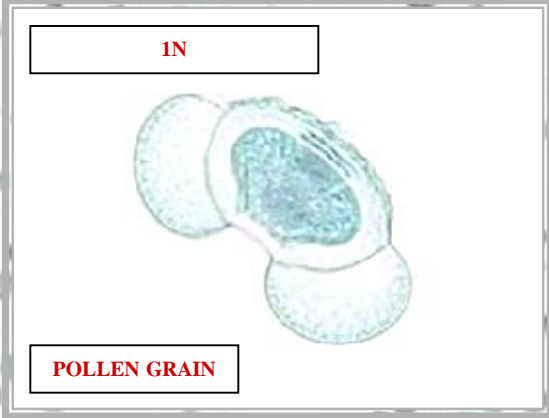
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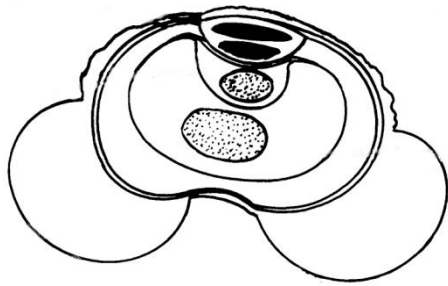
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MICROGAMETOPHYTE



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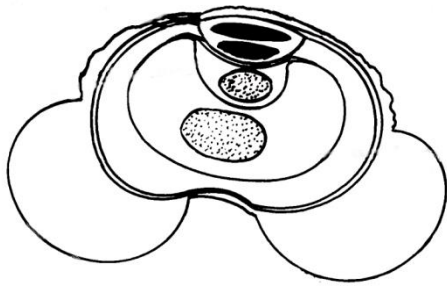
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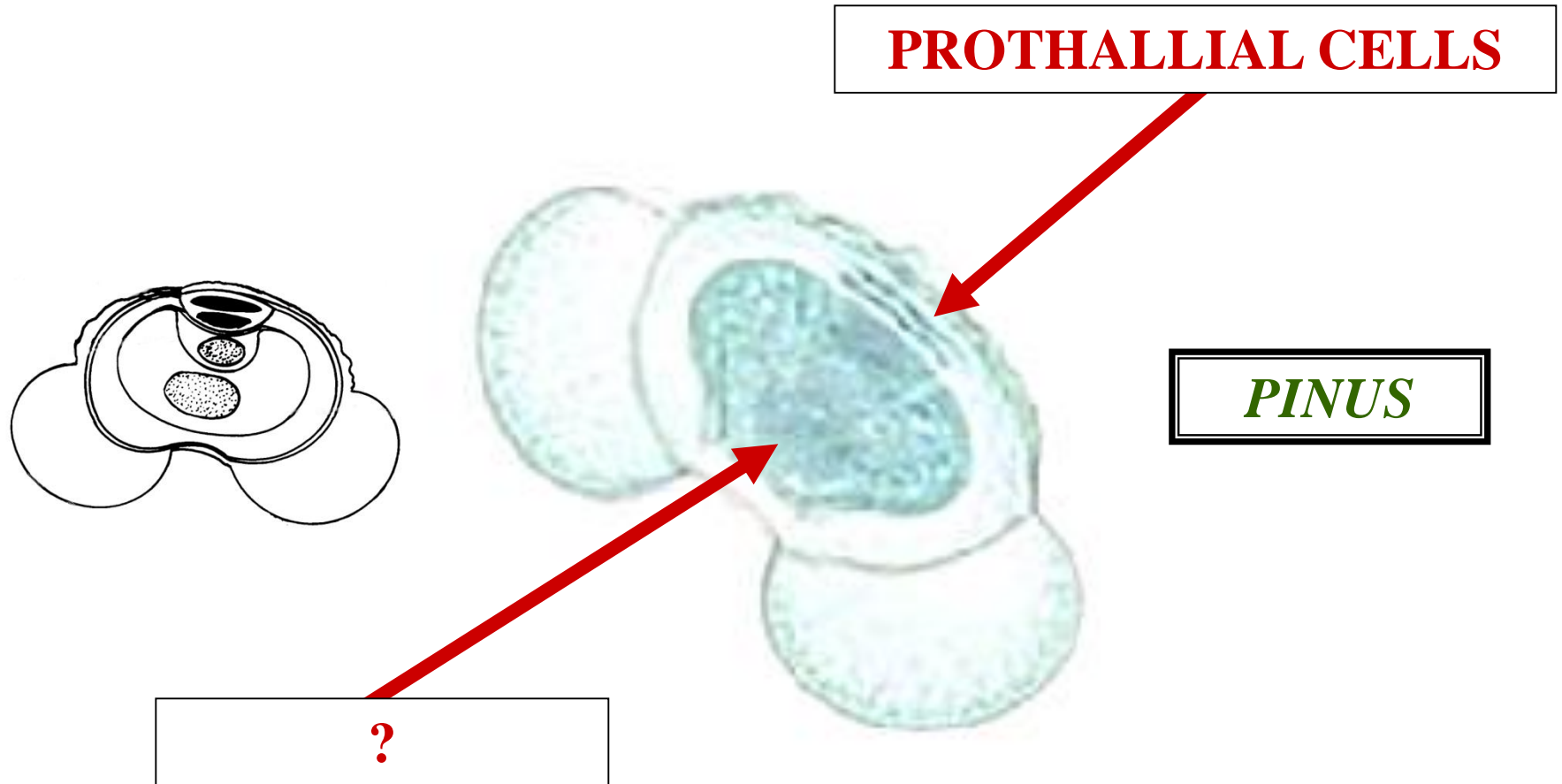
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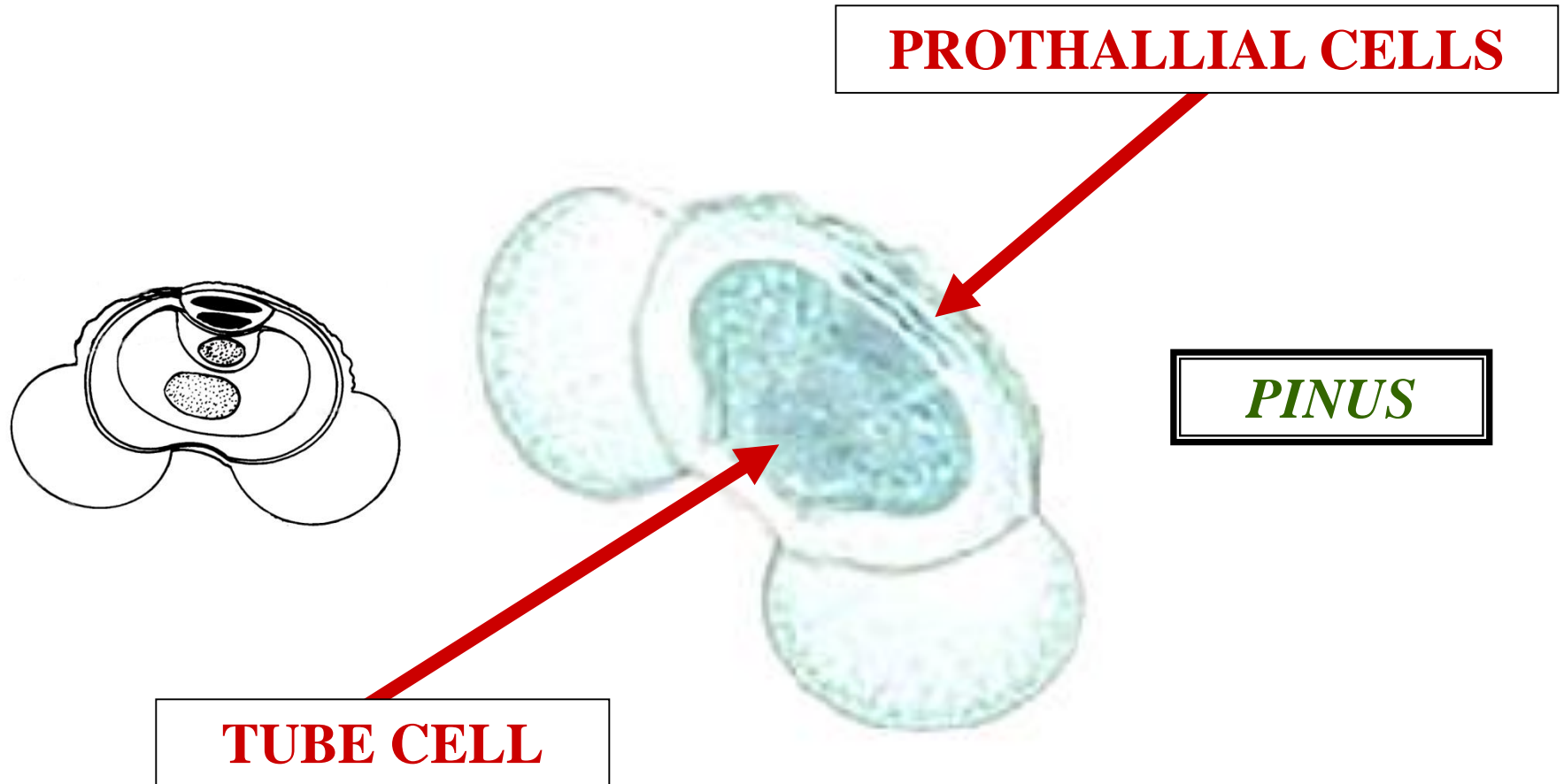
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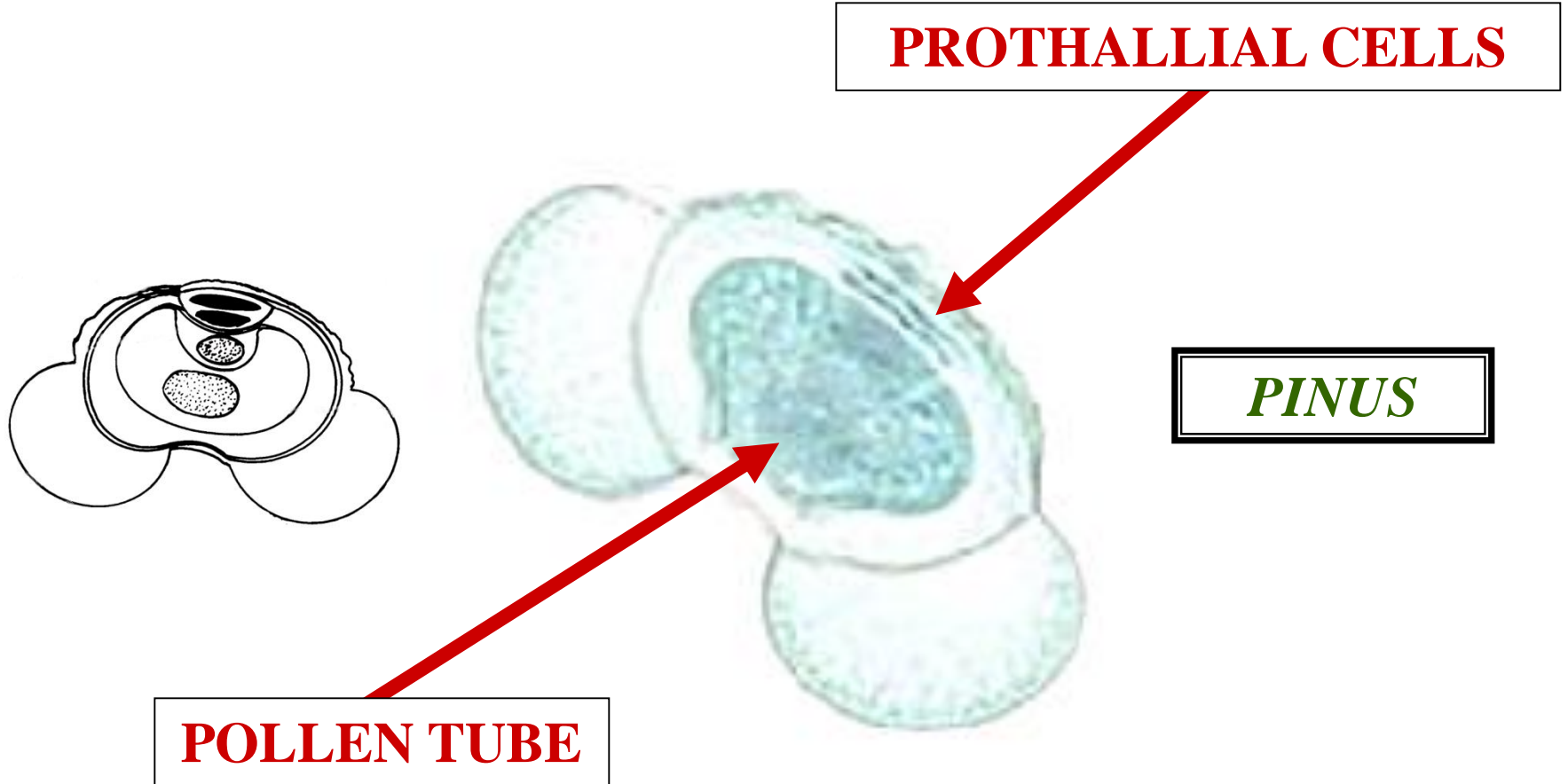
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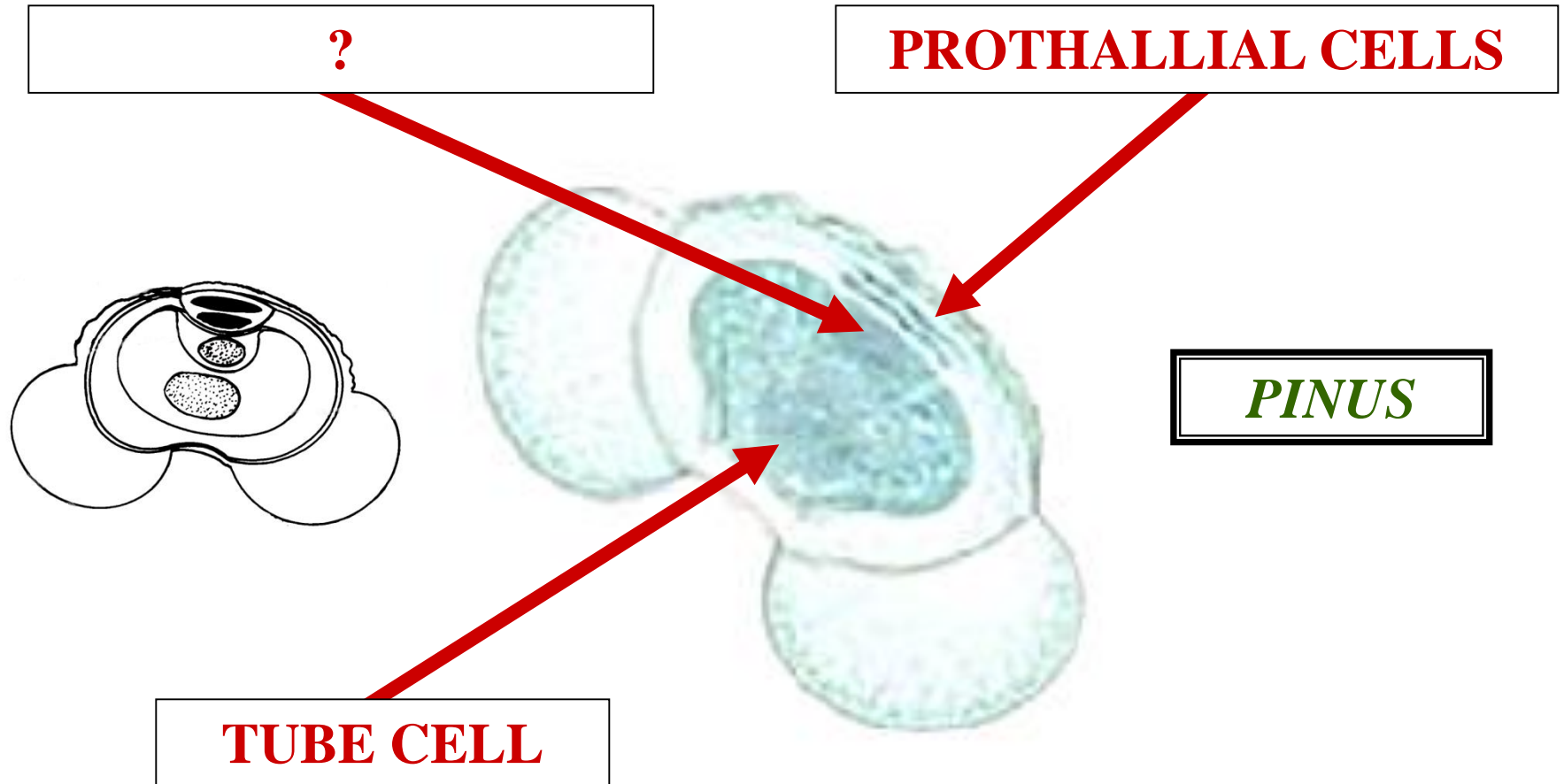
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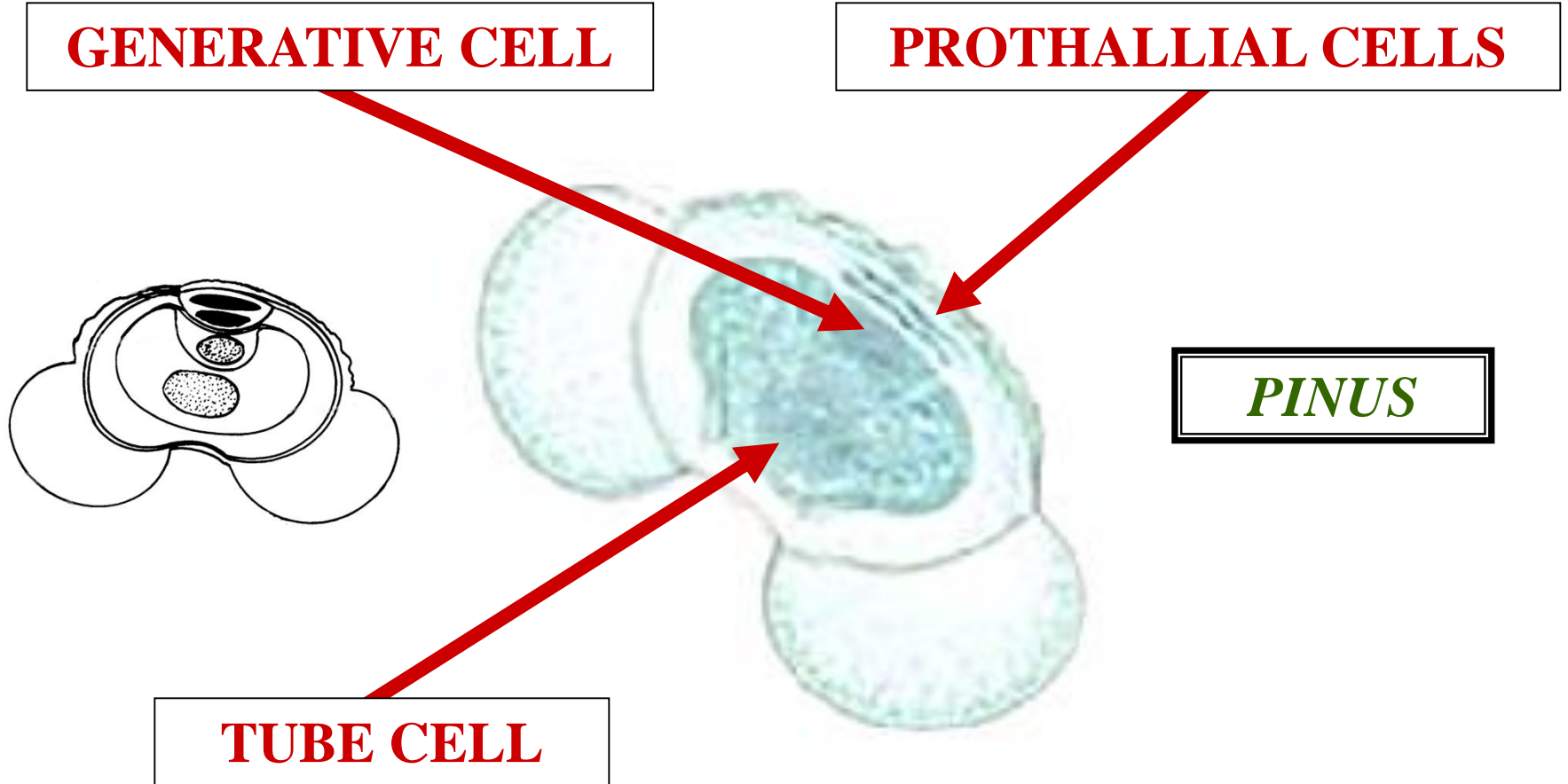
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MICROGAMETOPHYTE



POLLEN GRAIN

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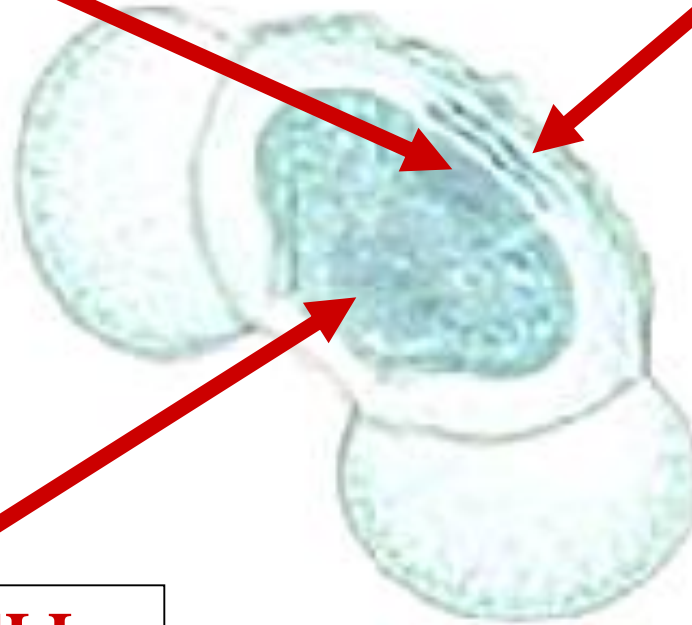
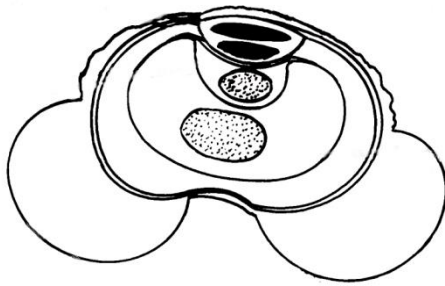


POLLEN GRAIN

MICROGAMETOPHYTE

MITOSIS

PROTHALLIAL CELLS



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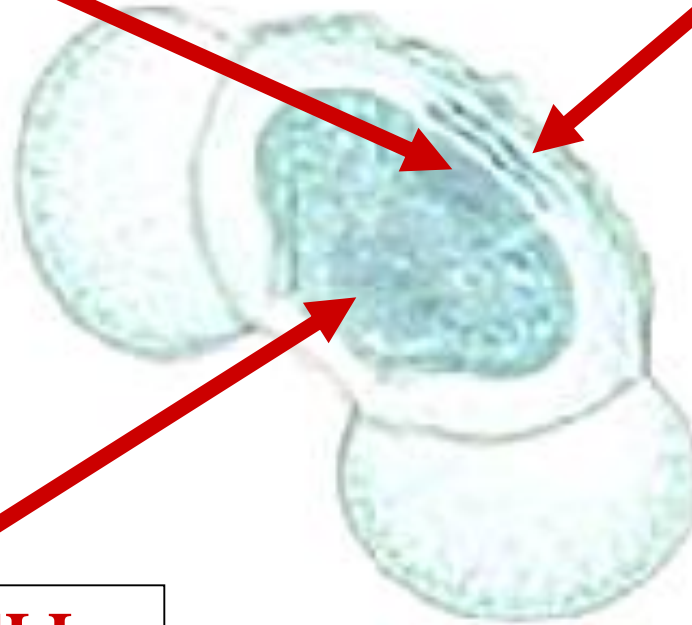
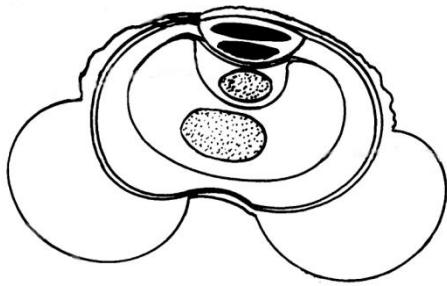
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POLLEN GRAIN

MICROGAMETOPHYTE

STERILE CELL

PROTHALLIAL CELLS



PINUS

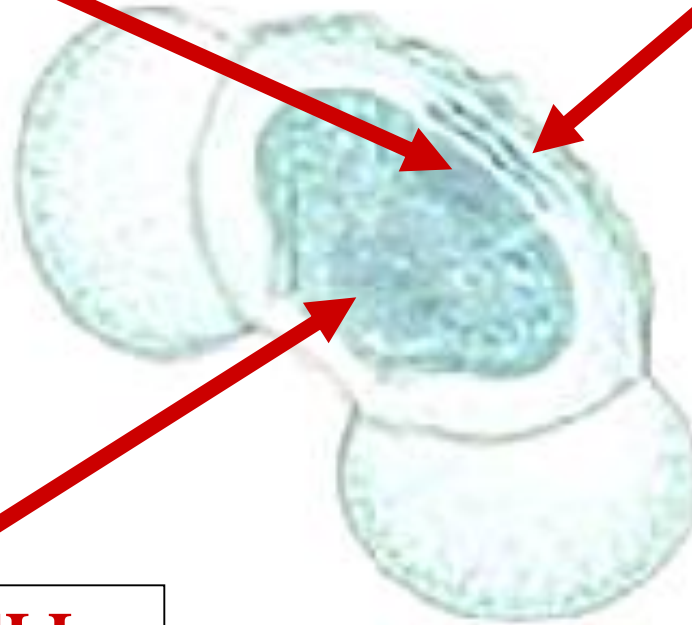
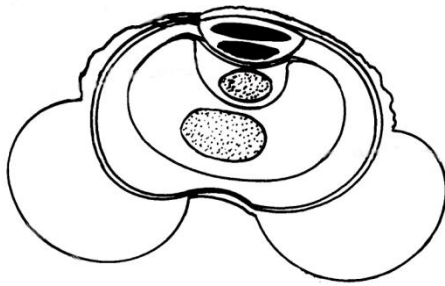
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MICROGAMETOPHYTE

SPERMATOCYTE

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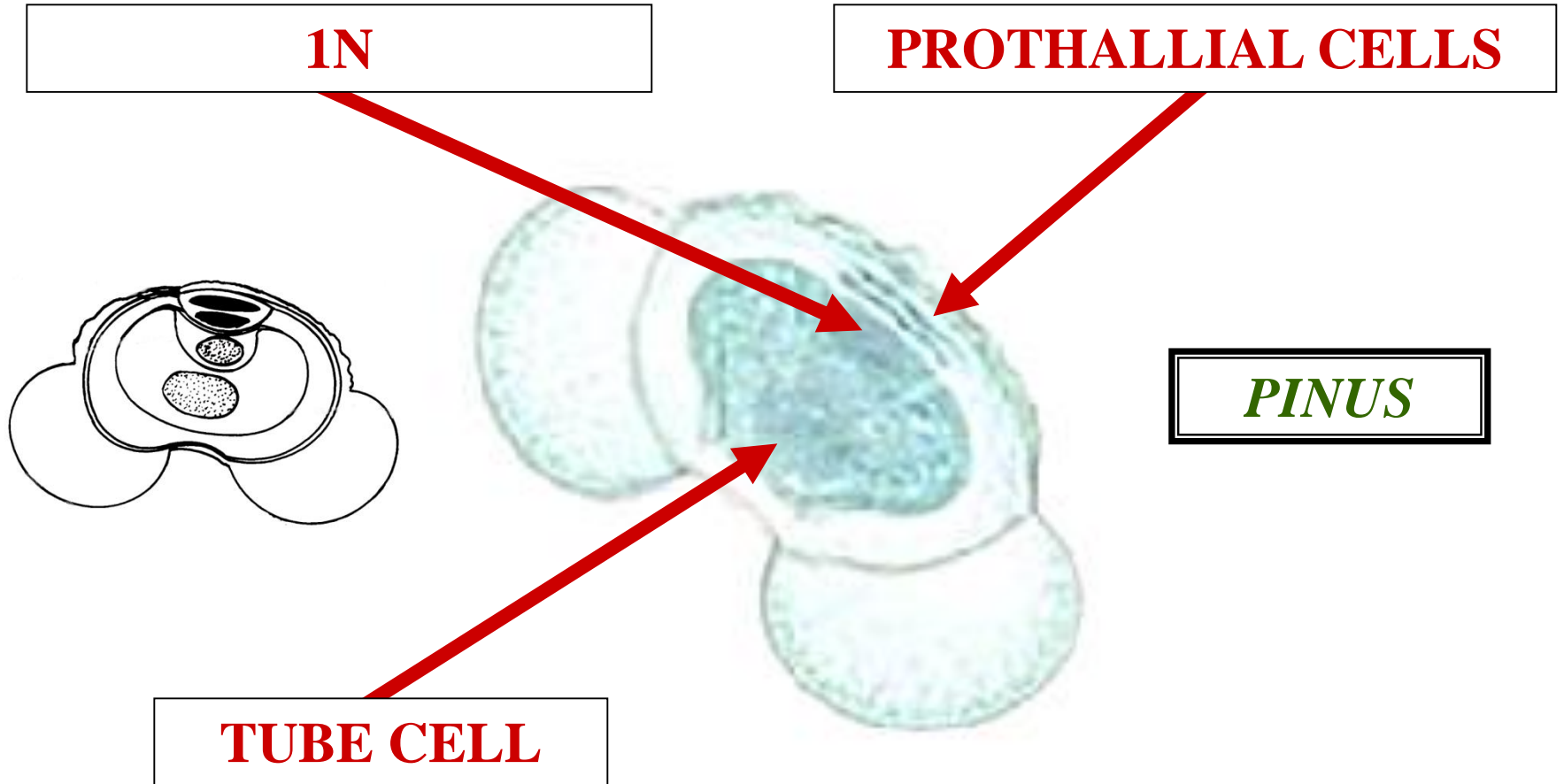


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TUBE CELL

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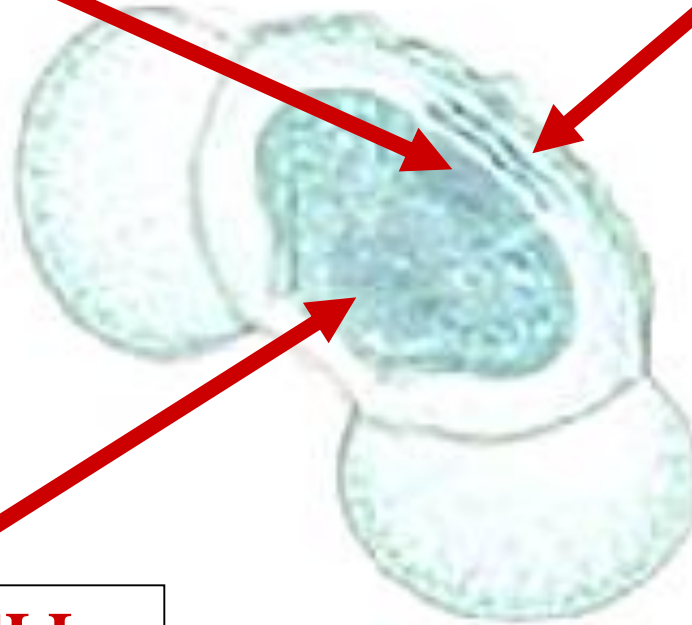
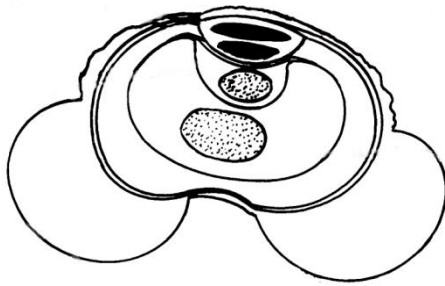


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MICROGAMETOPHYTE

MITOSIS

PROTHALLIAL CELLS



TUBE CELL

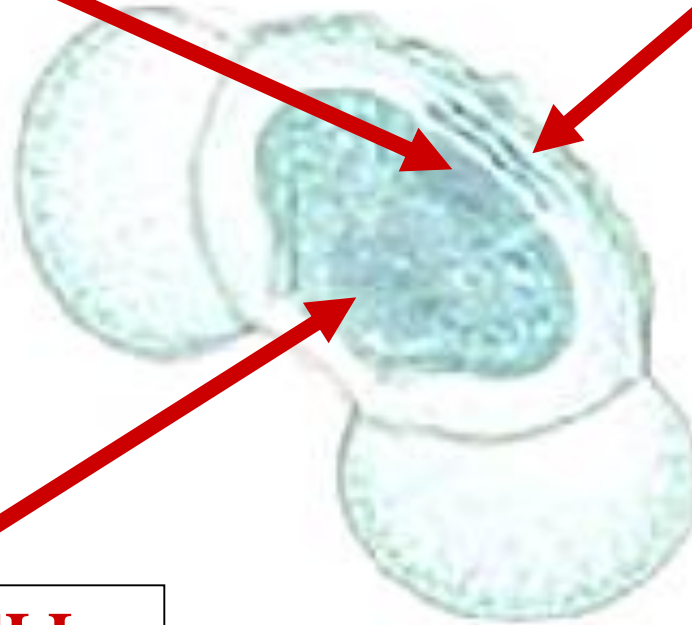
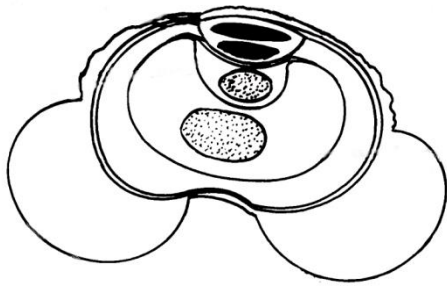
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MICROGAMETOPHYTE

2 SPERM CELLS

PROTHALLIAL CELLS

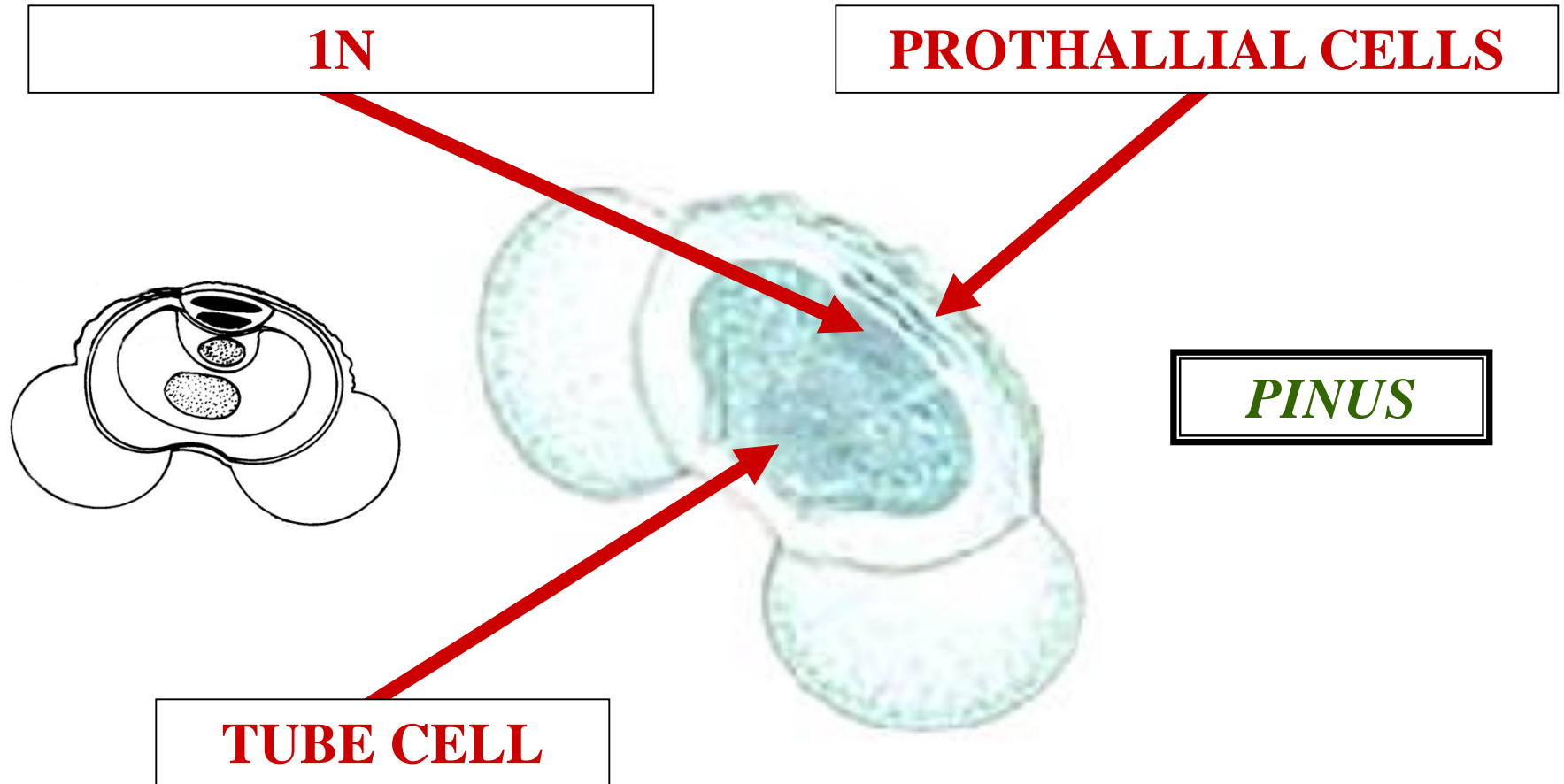


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TUBE CELL

POLLEN GRAIN

MICROGAMETOPHYTE

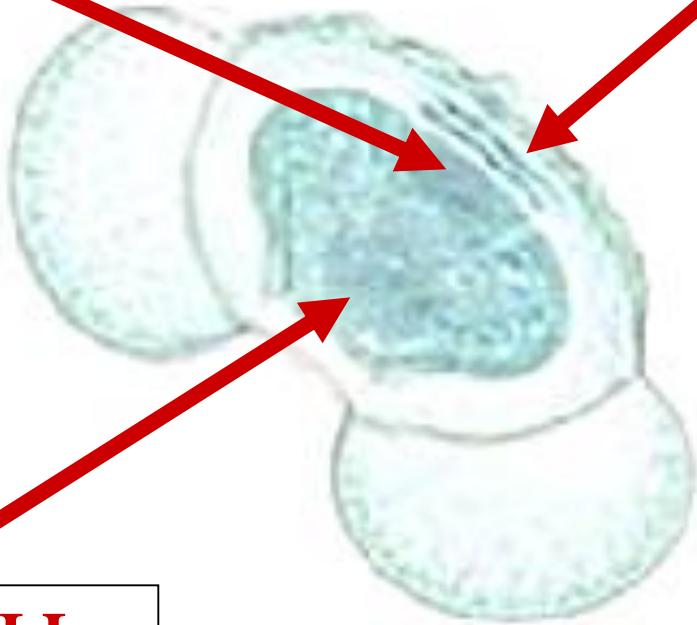
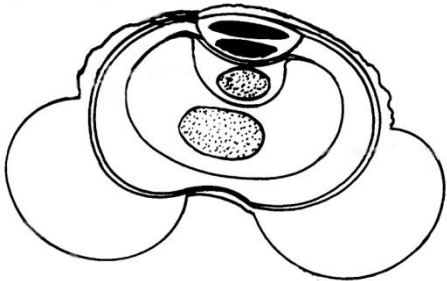


POLLEN GRAIN

MICROGAMETOPHYTE

**2 SPERM CELLS
NON-FLAGELLATED**

PROTHALLIAL CELLS



PINUS

TUBE CELL

POLLEN GRAIN

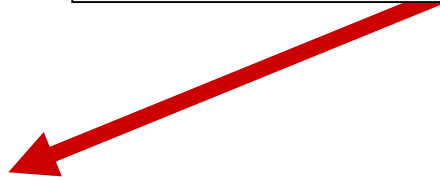
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MATURE SPOROPHYTE



PINUS

MEGASTROBILI



PINUS



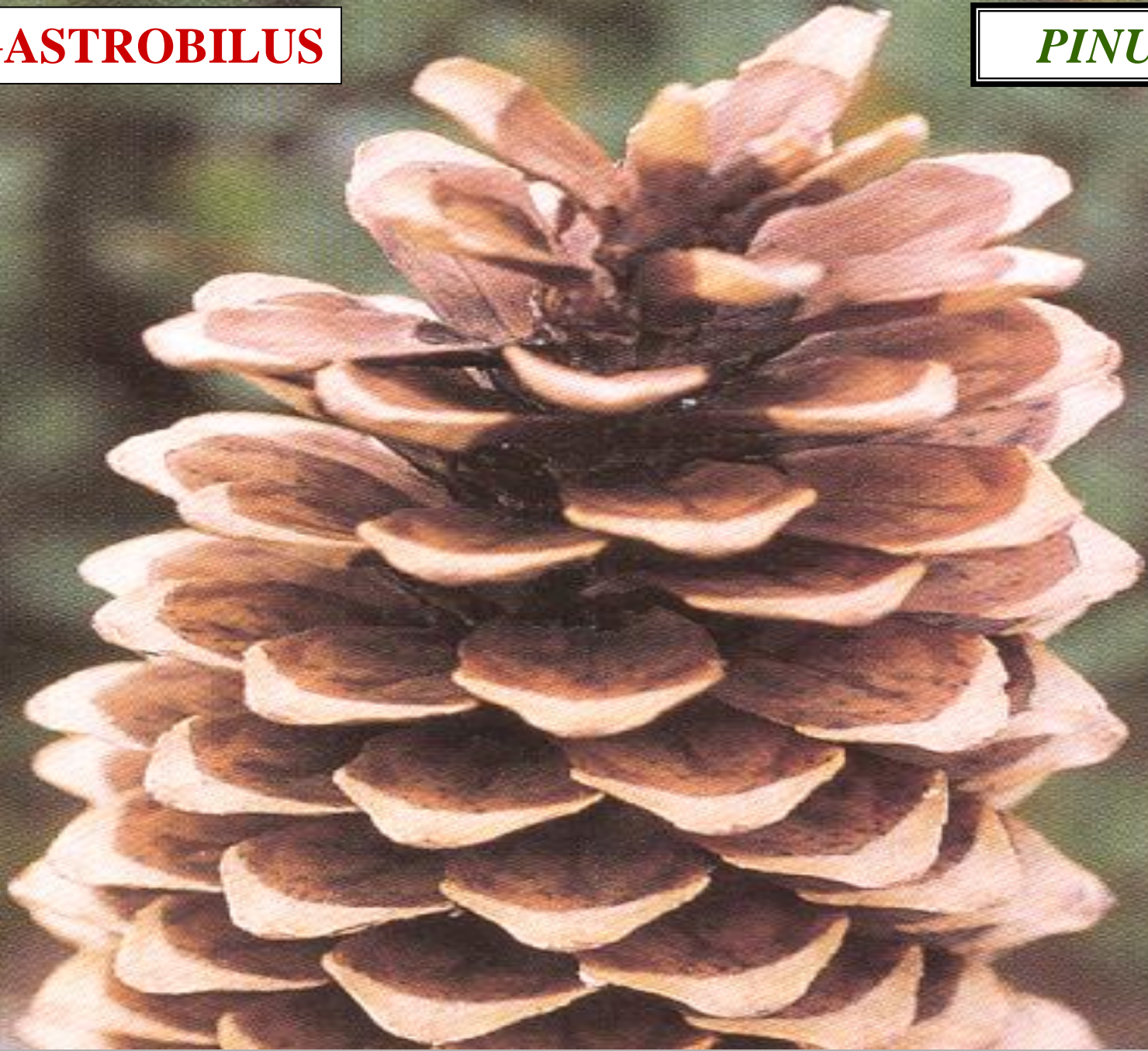
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UPPER BRANCHES**



MEGASTROBILUS

PINUS

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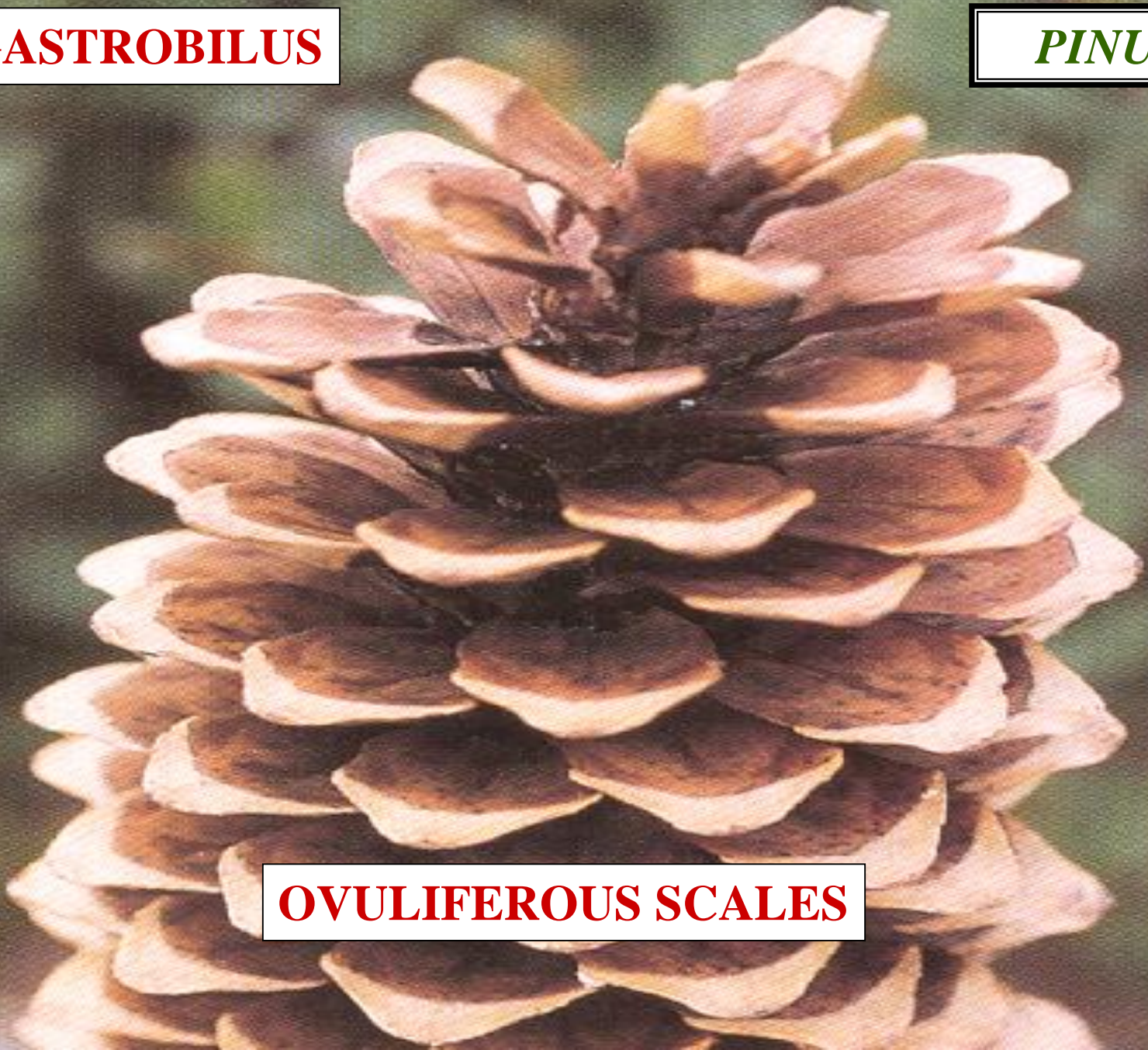
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OVULIFEROUS SCALES

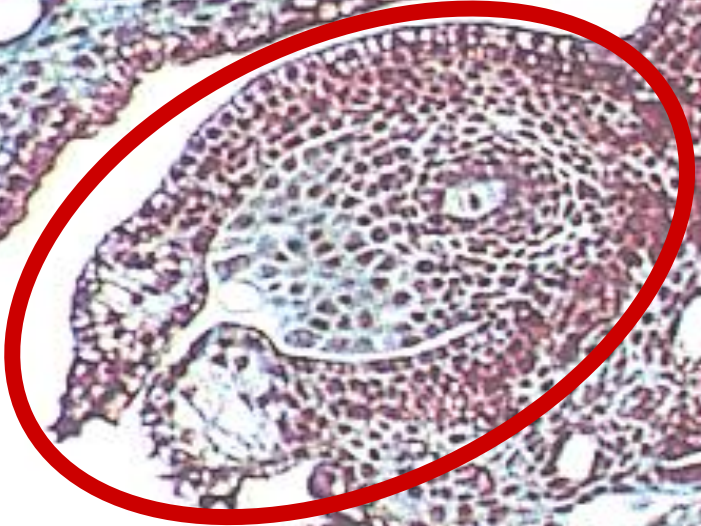


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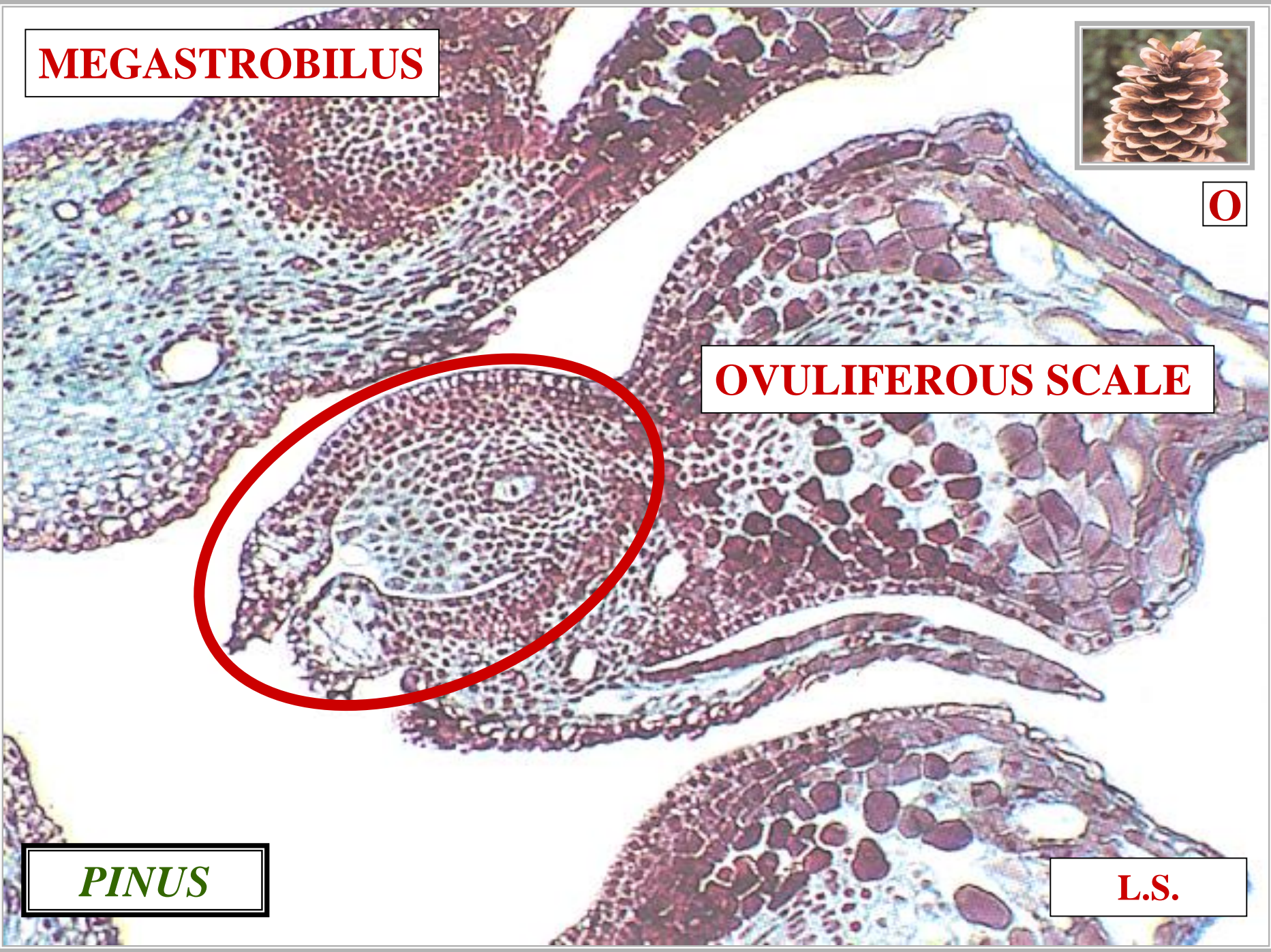
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OVULIFEROUS SCALE



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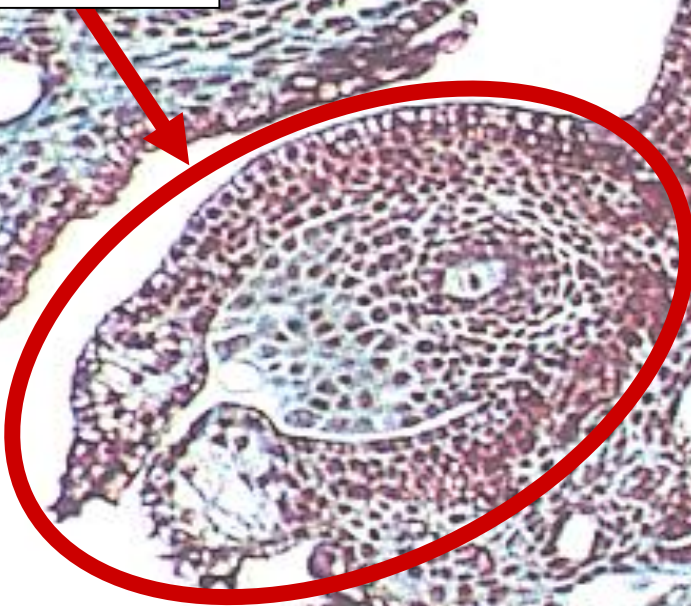
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MEGASTROBILUS



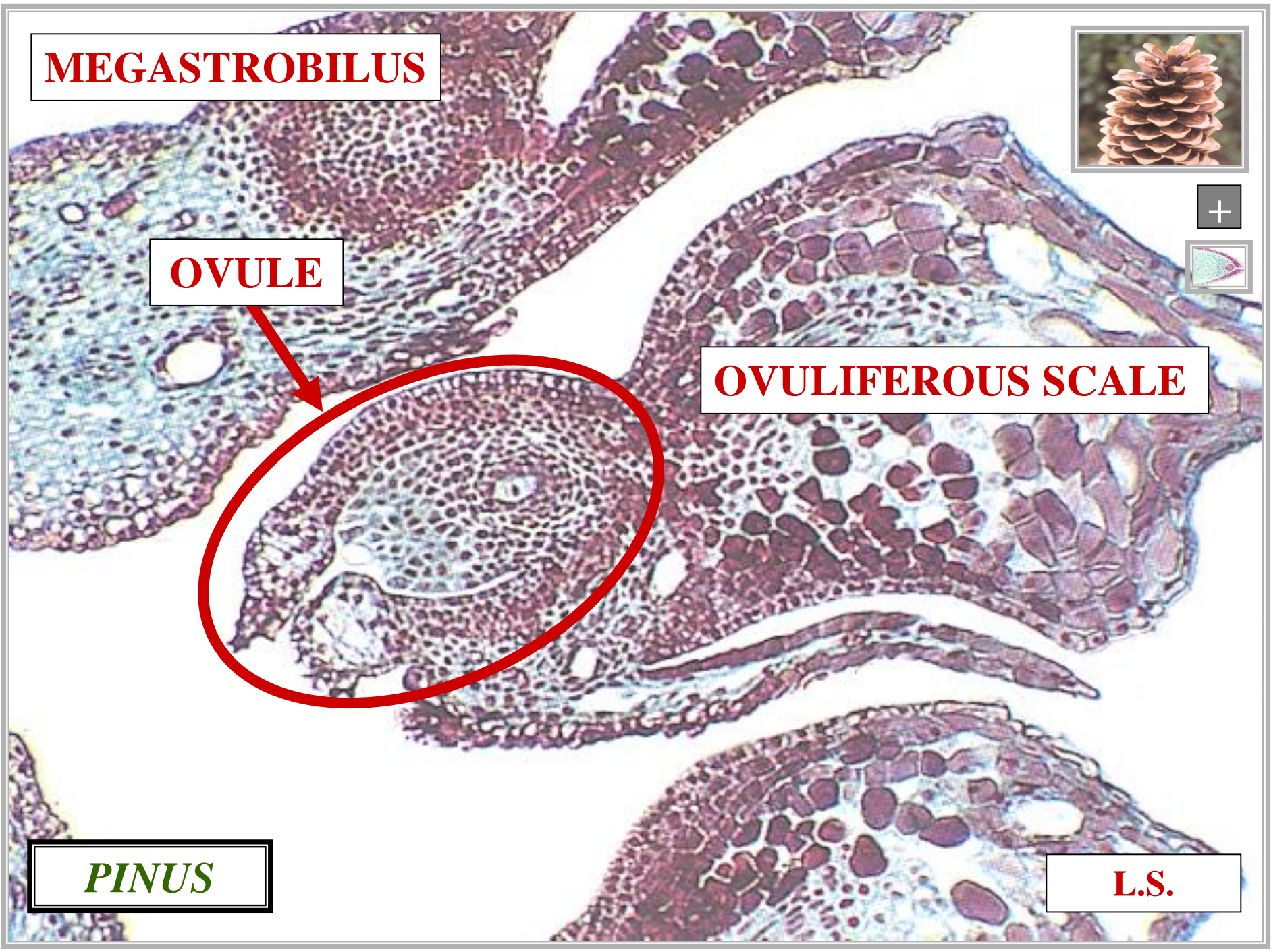
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OVULIFEROUS SCALE

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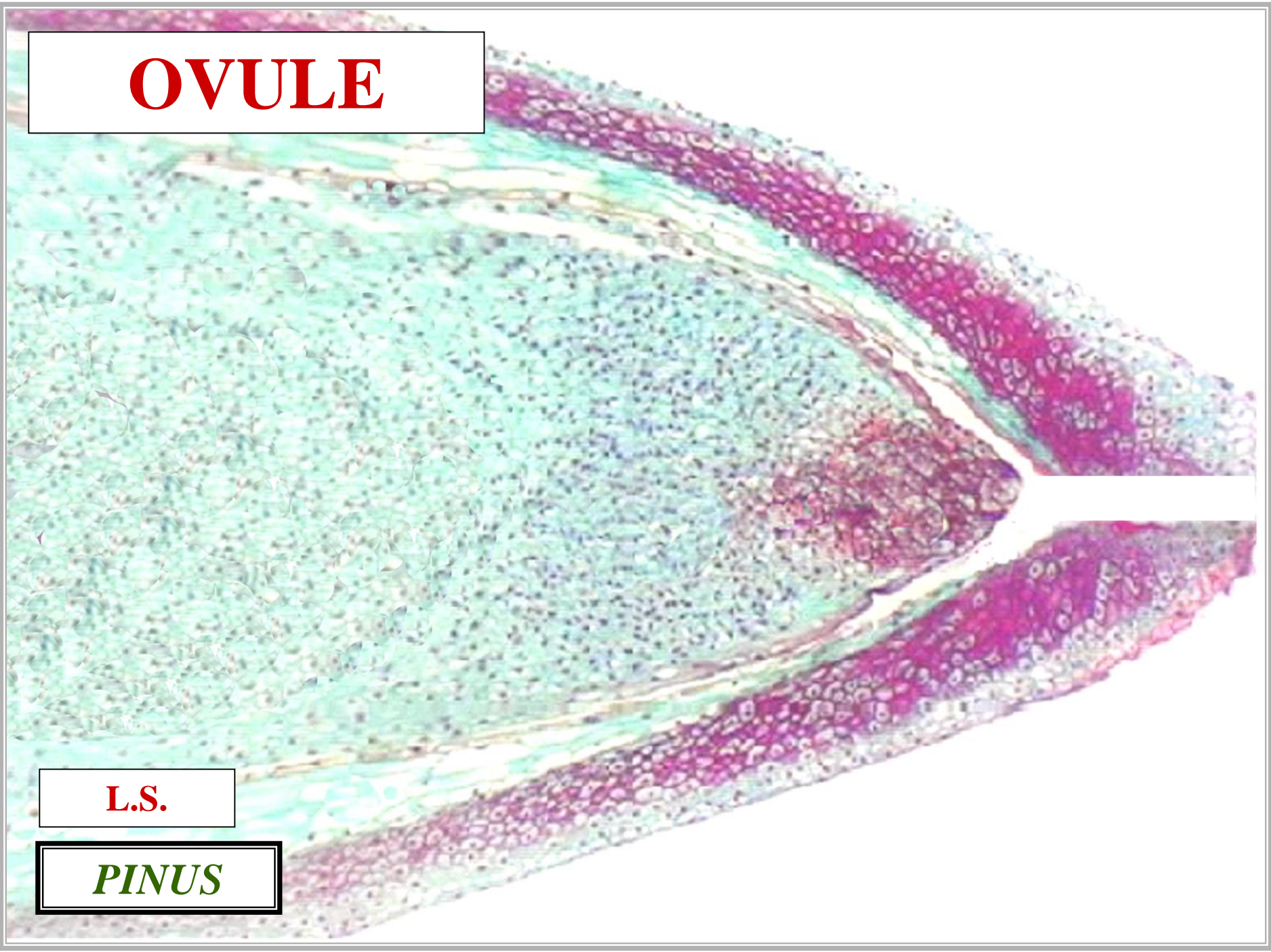
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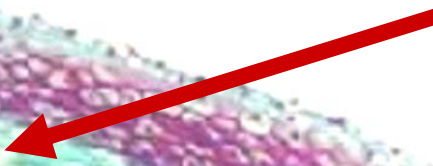
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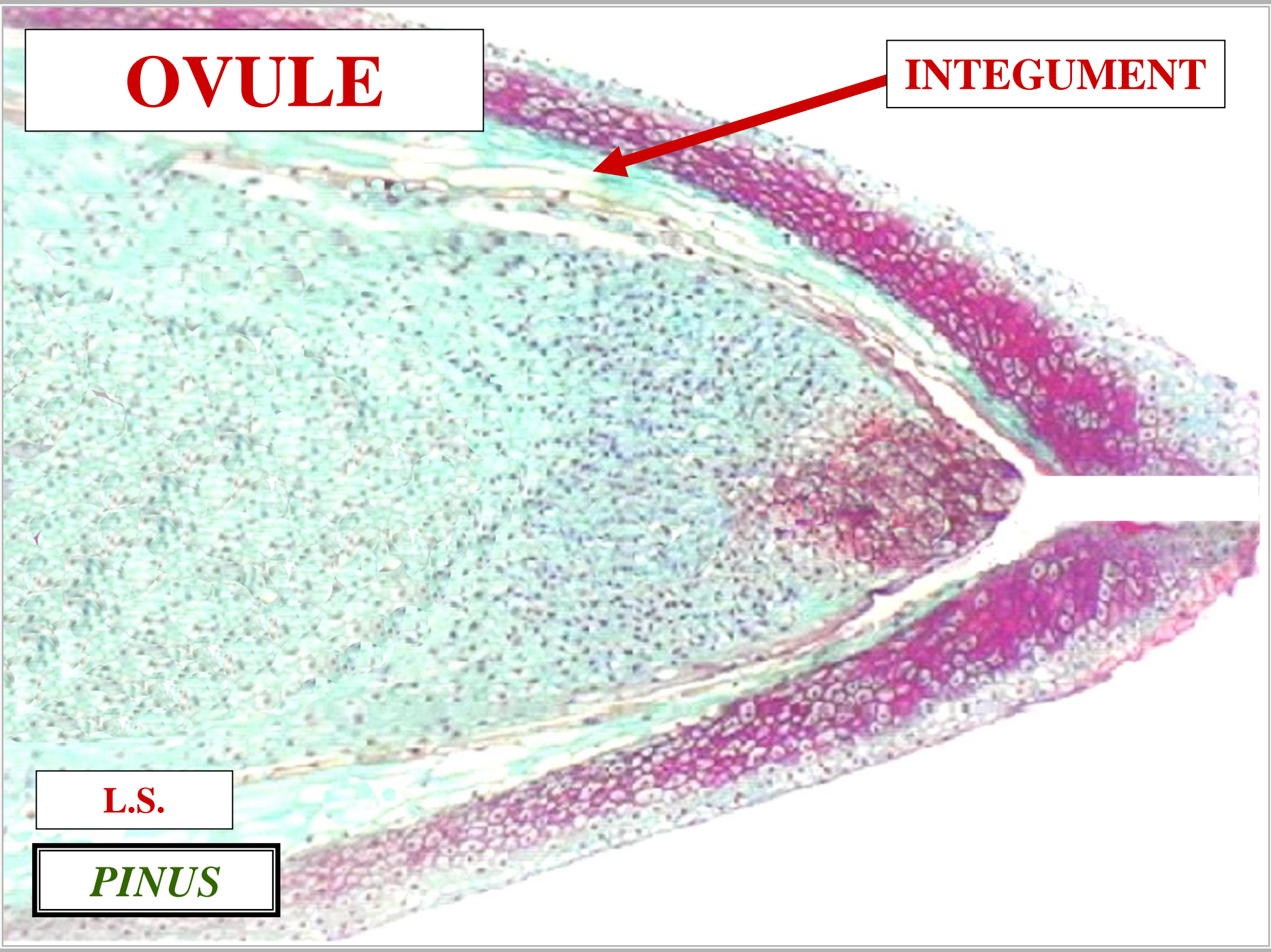
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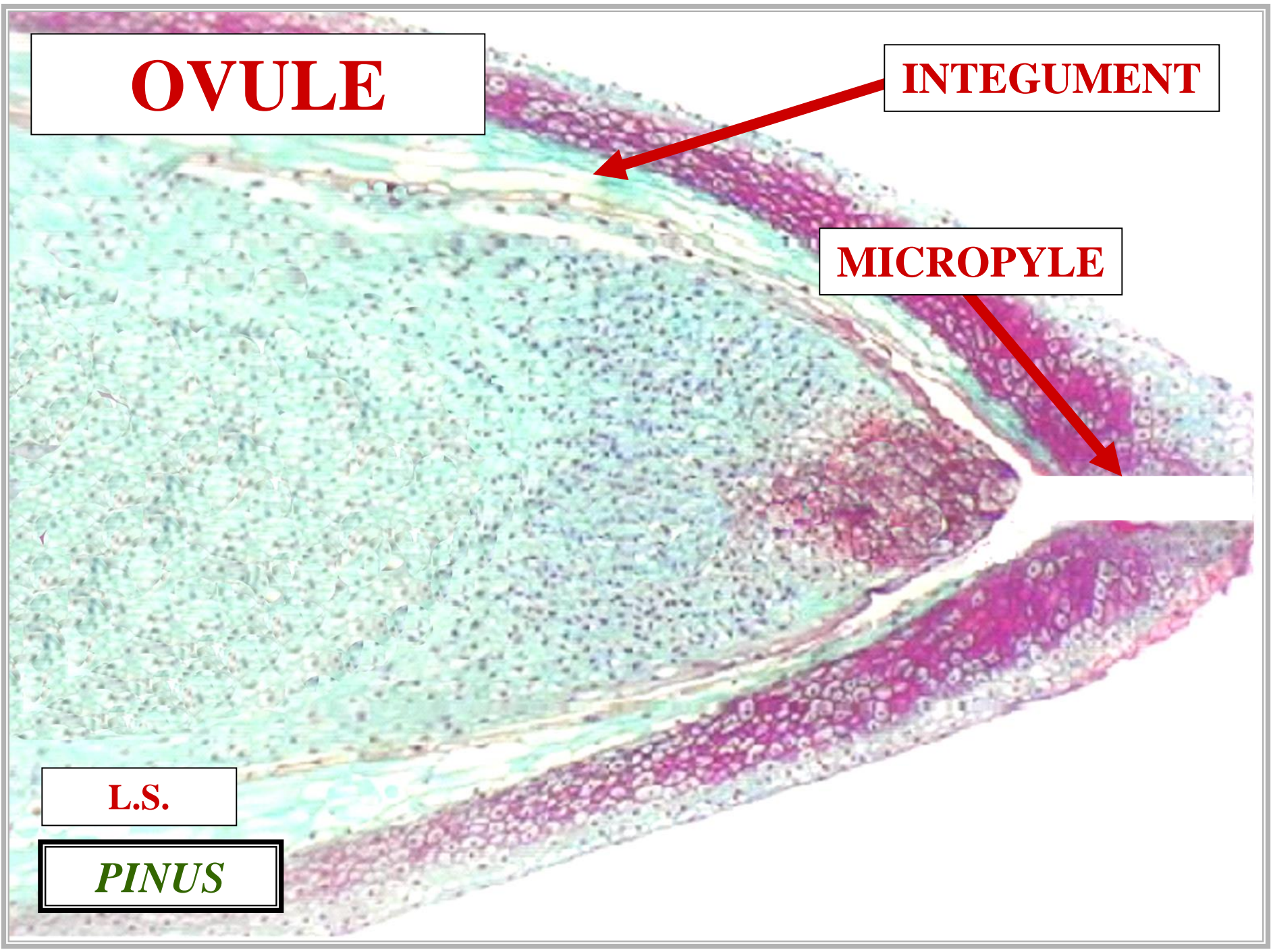
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MICROPYLE

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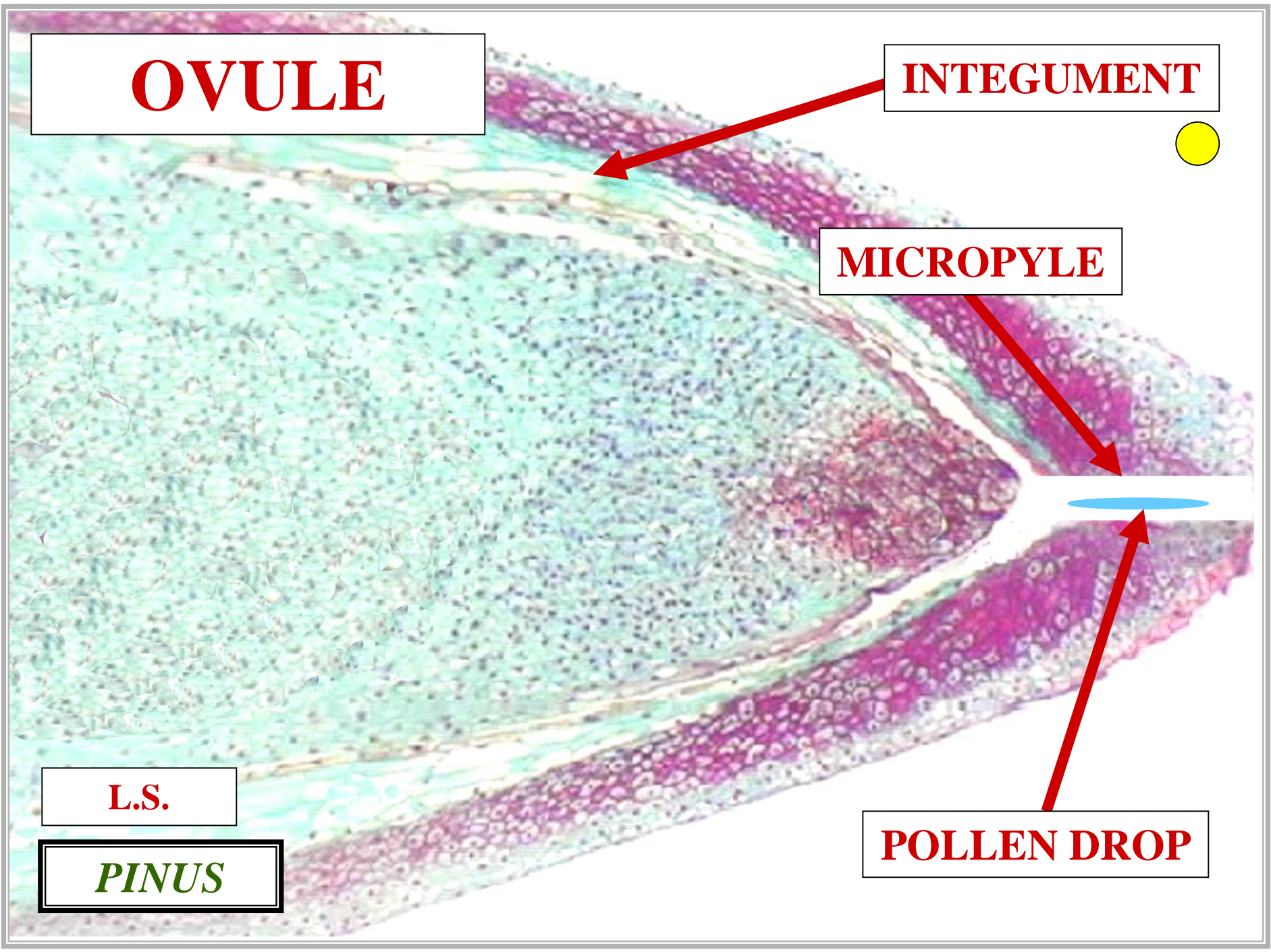
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POLLEN DROP



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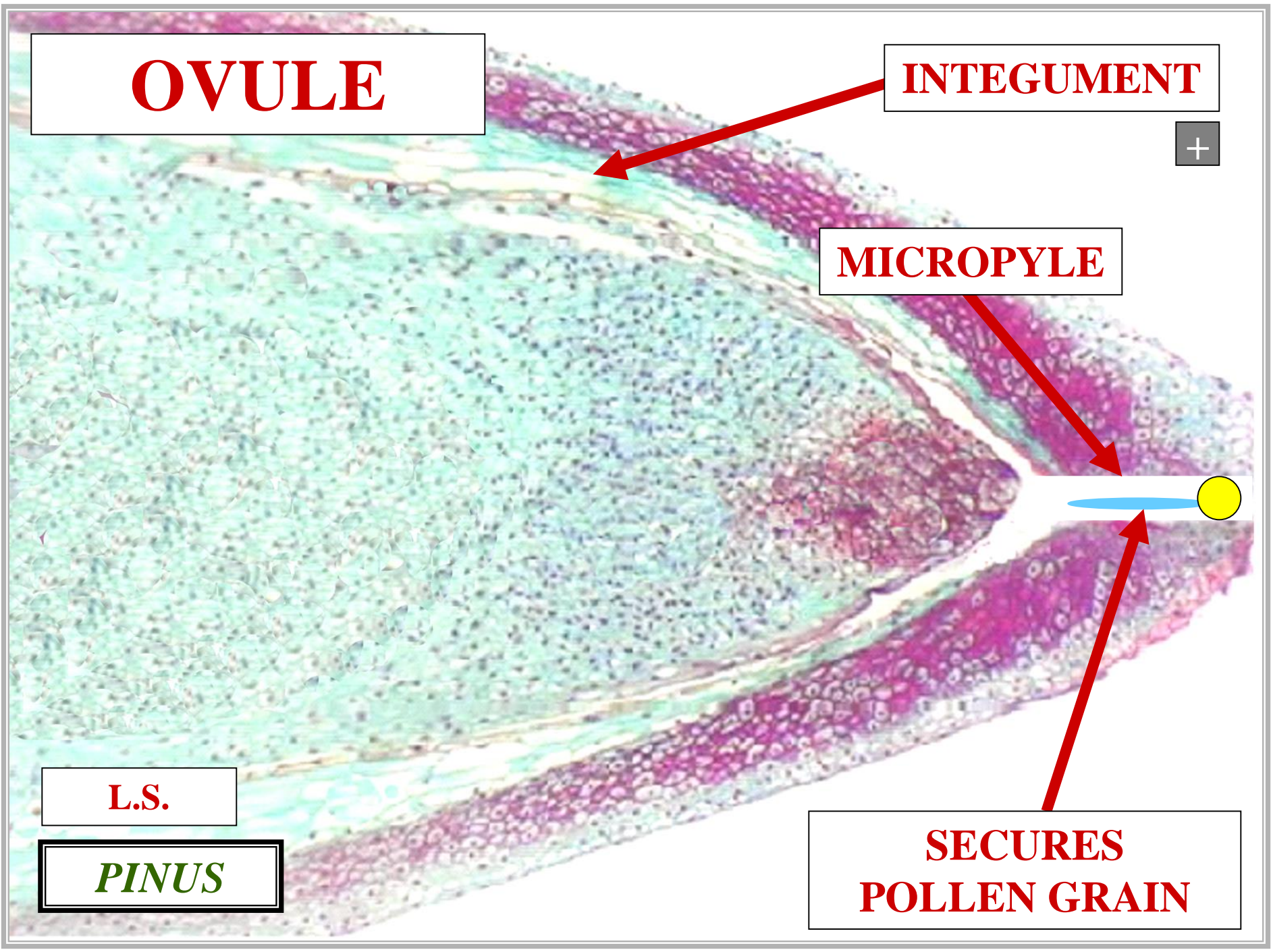


MICROPYLE

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**SECURES
POLLEN GRAIN**



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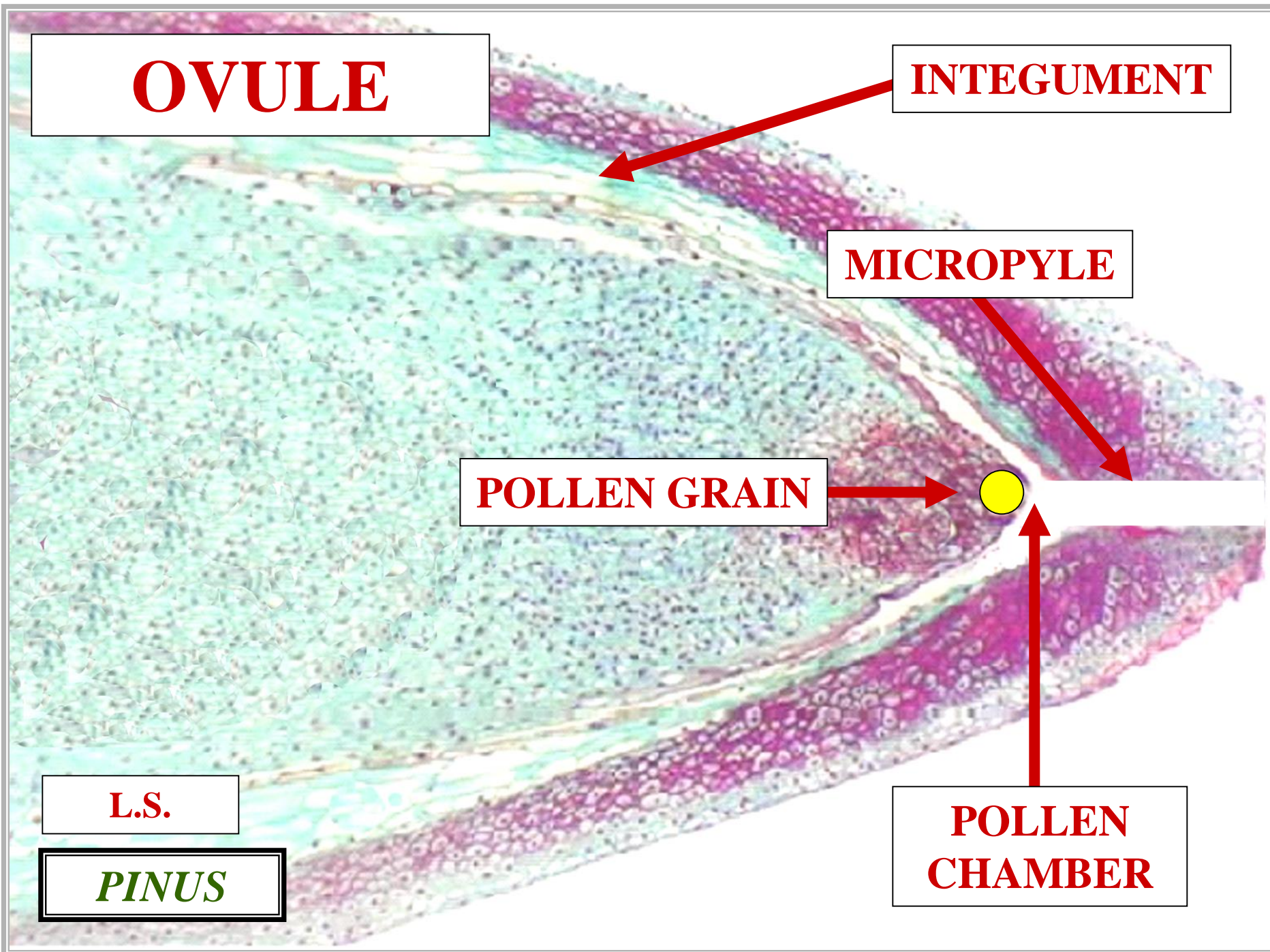
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MICROPYLE

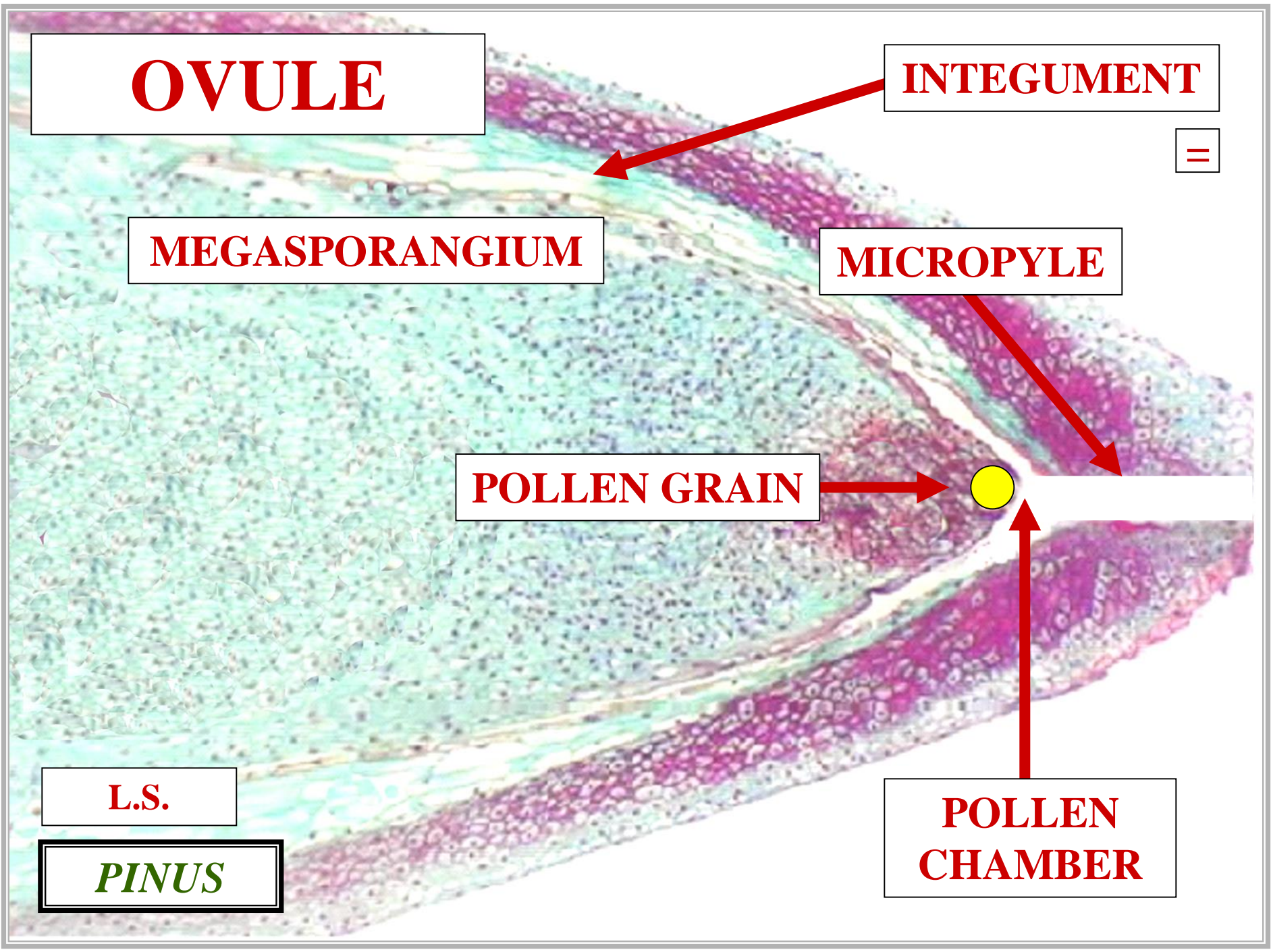
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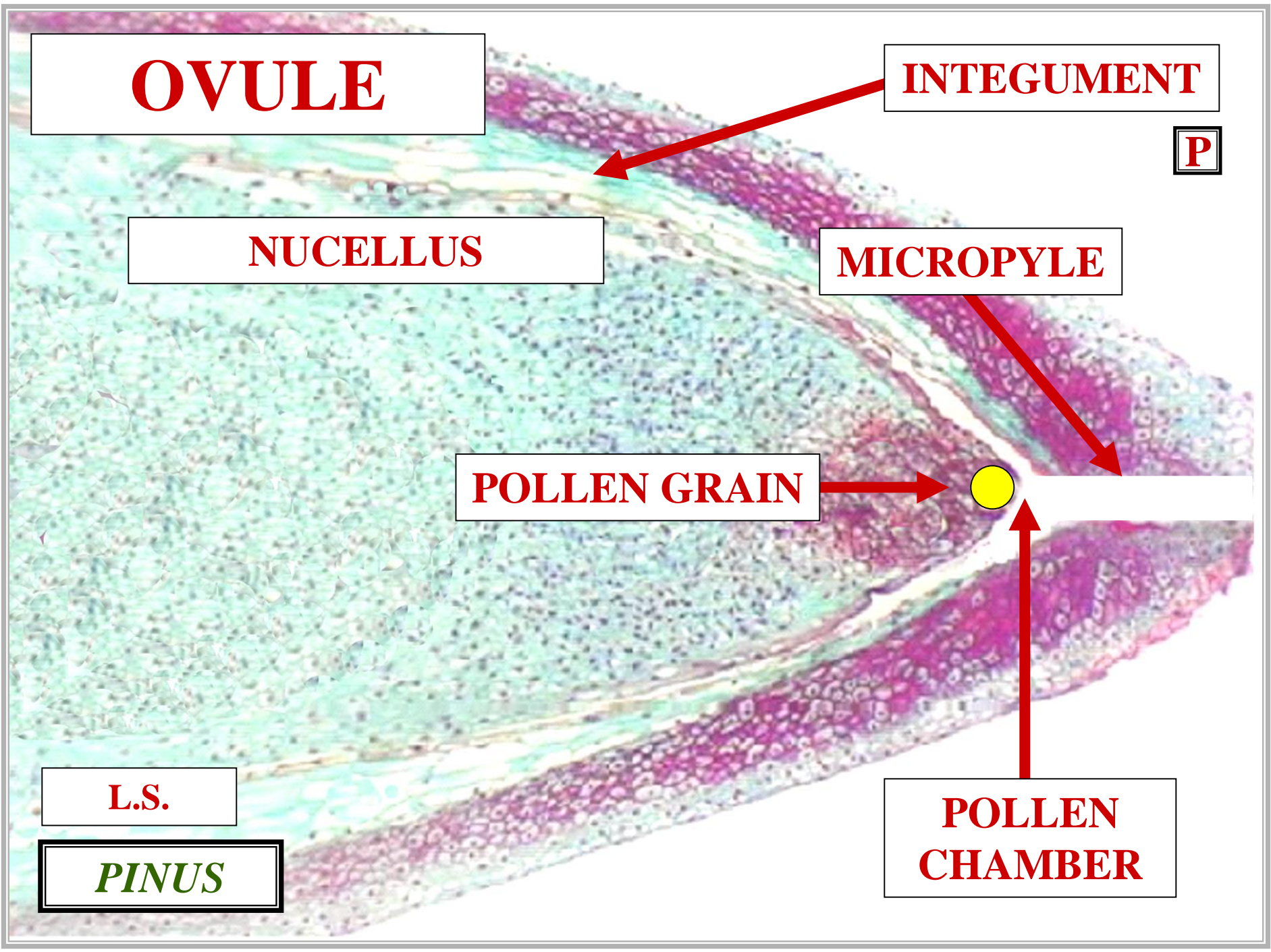
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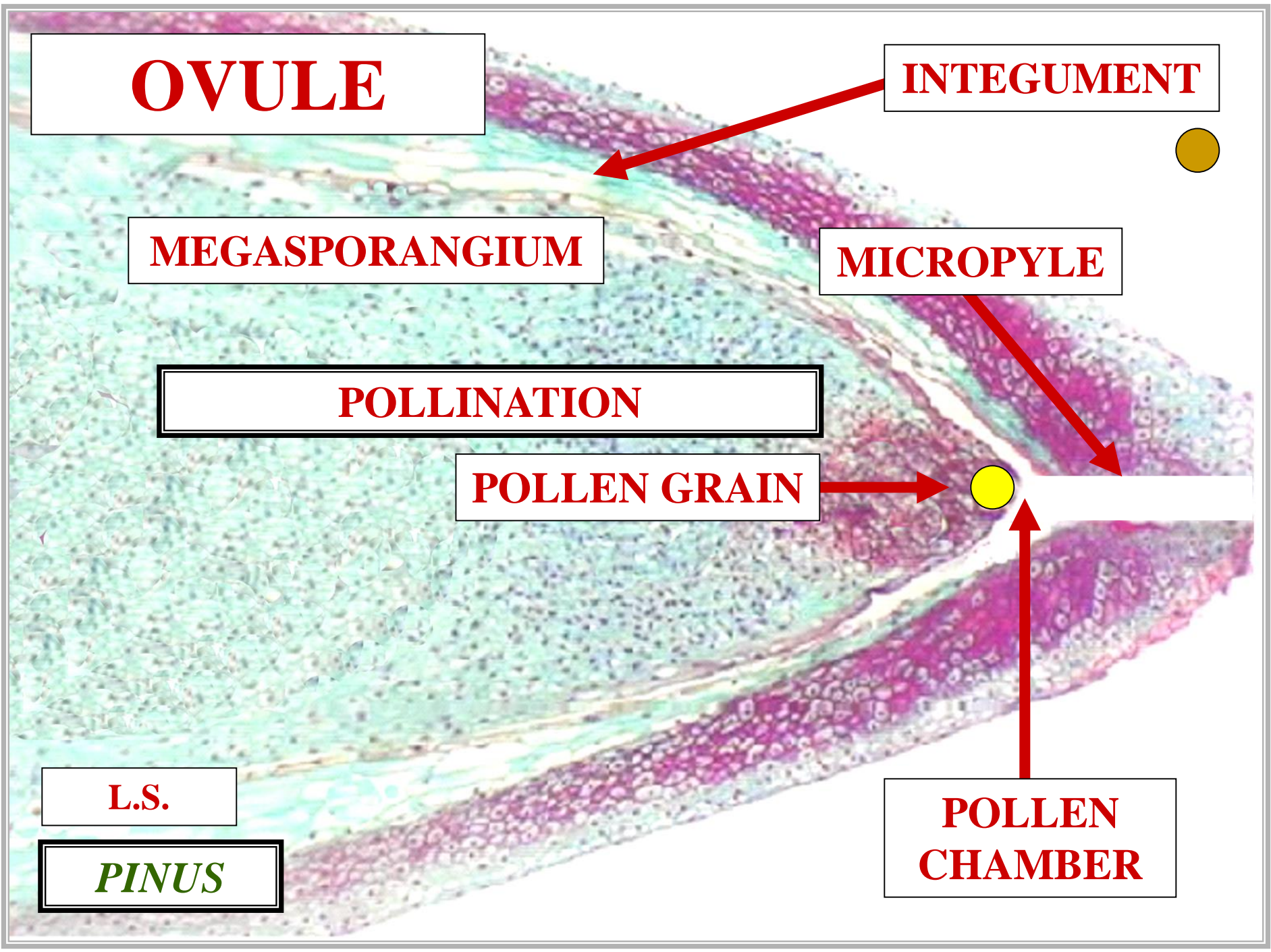
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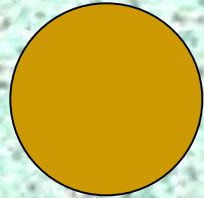


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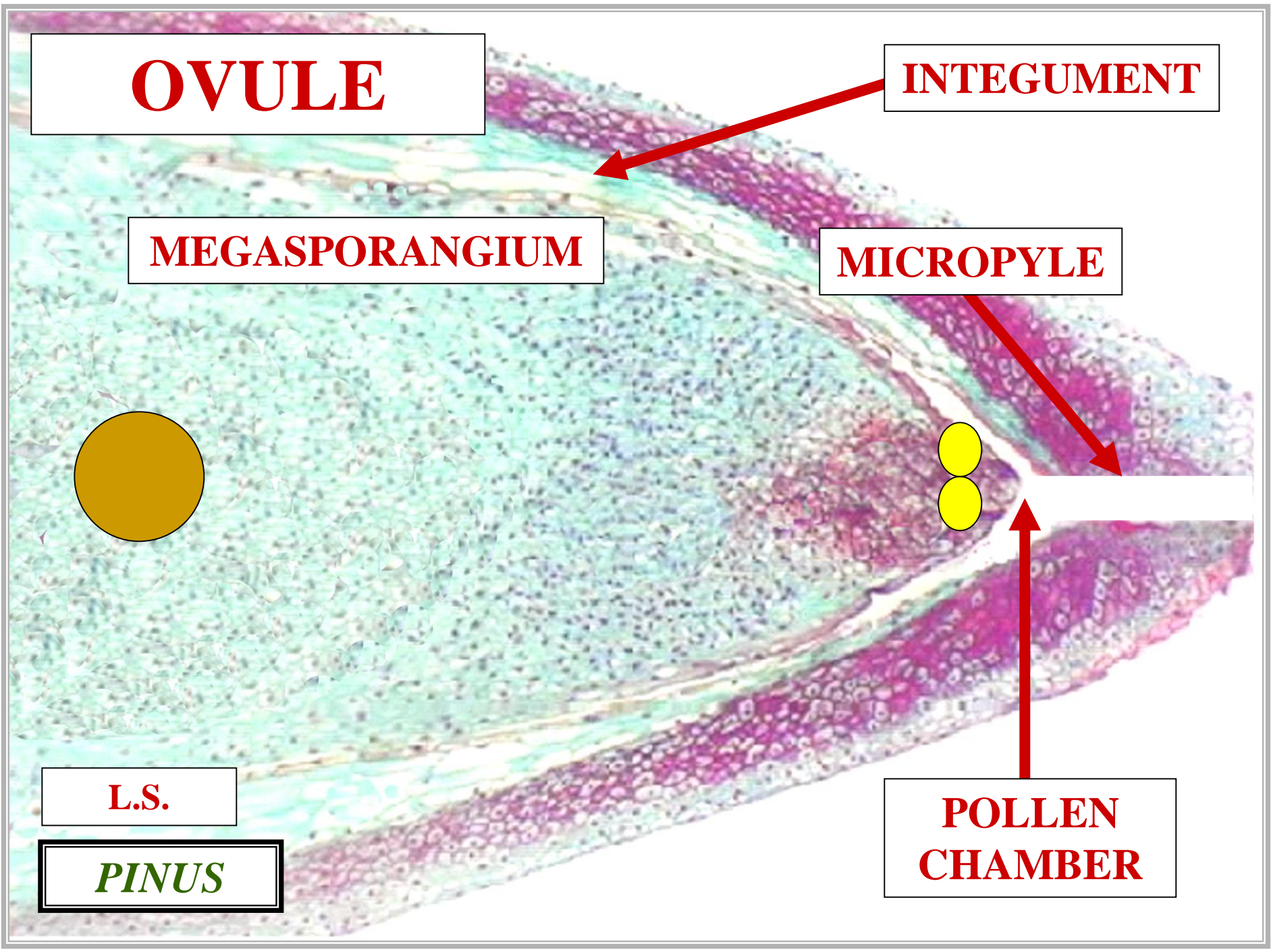
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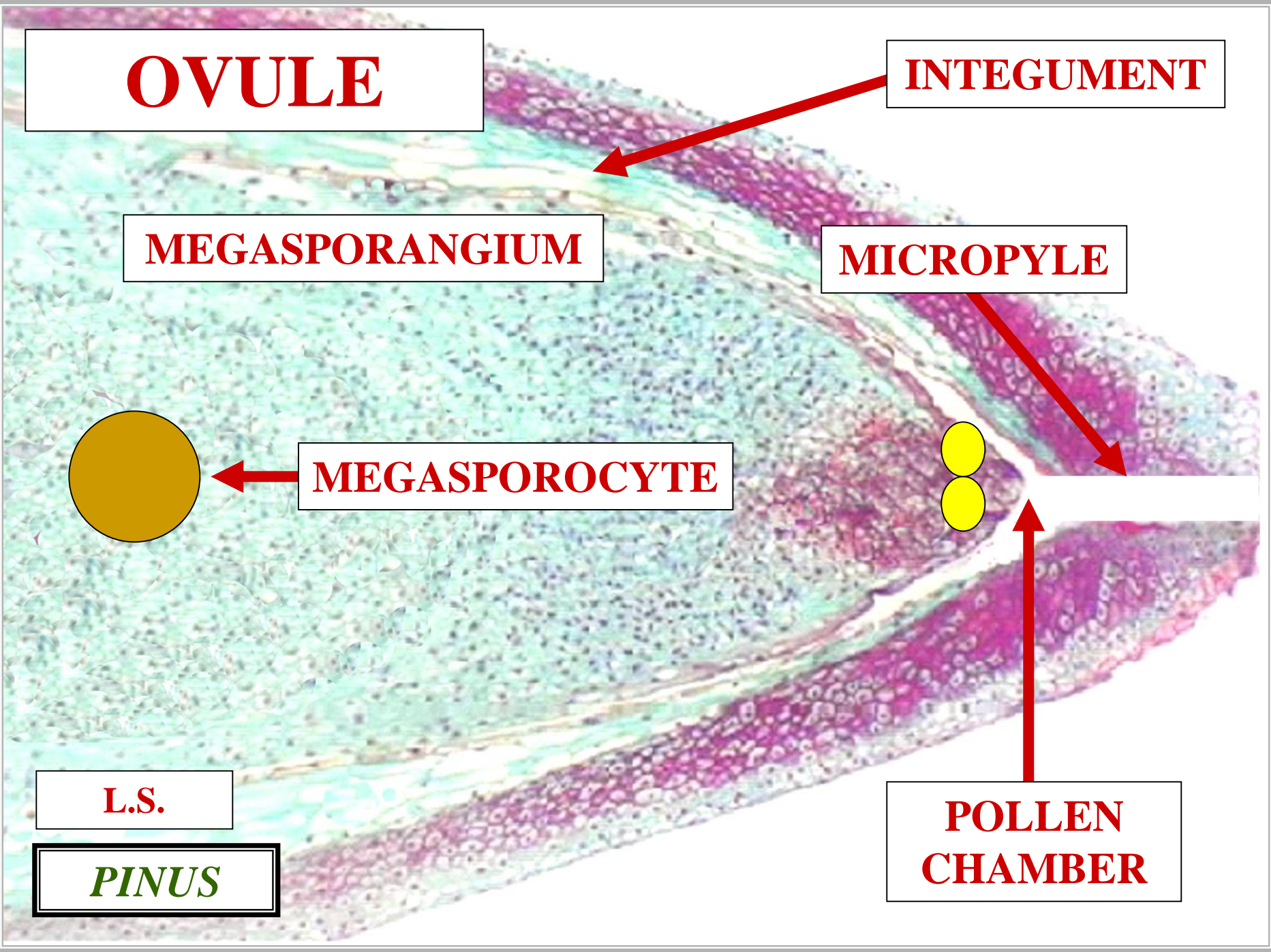
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CHAMBER**

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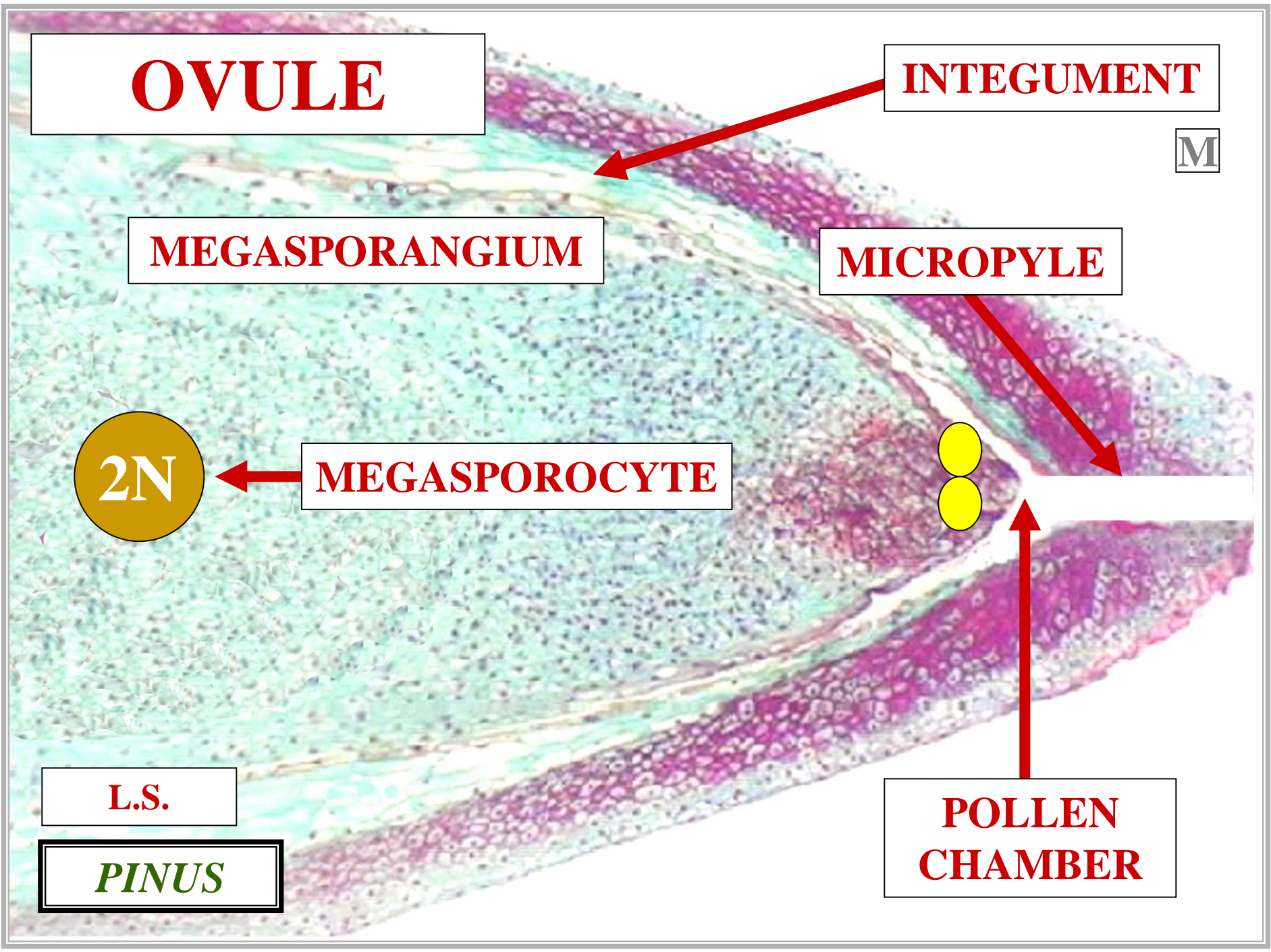
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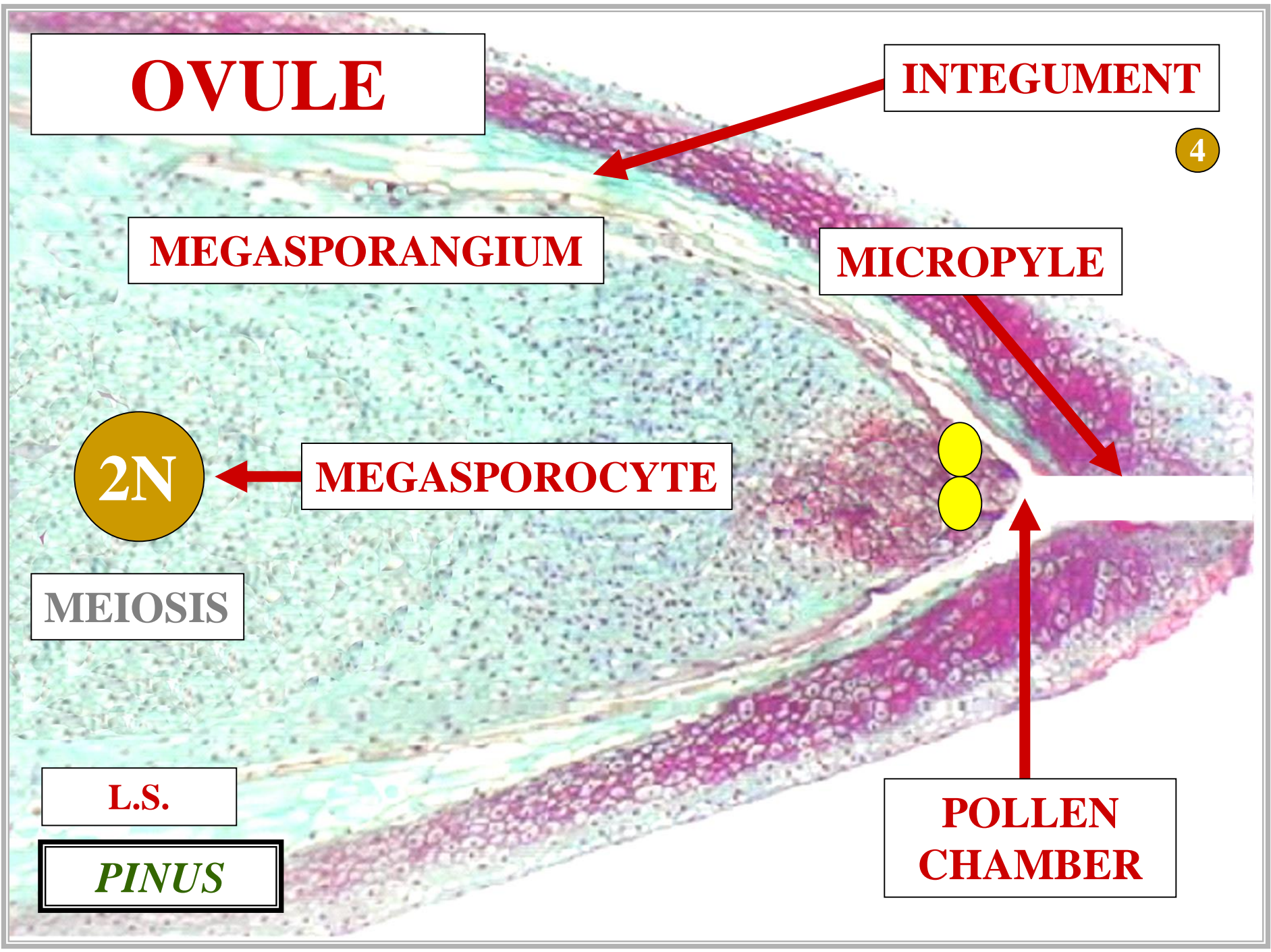
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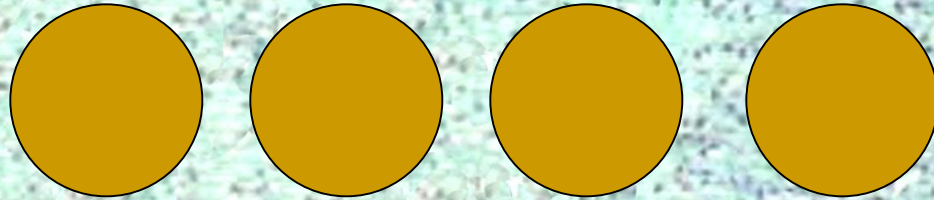


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MEGASPORANGIUM

MICROPYLE



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**POLLEN
CHAMBER**

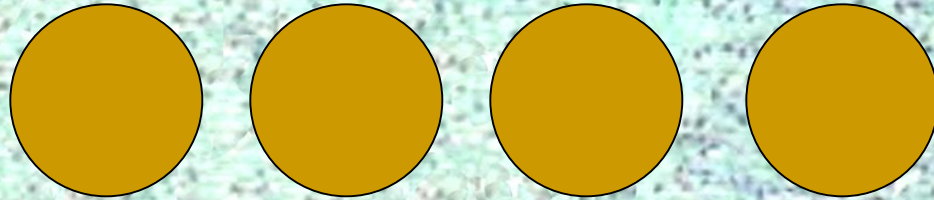
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MEGASPORANGIUM

MICROPYLE



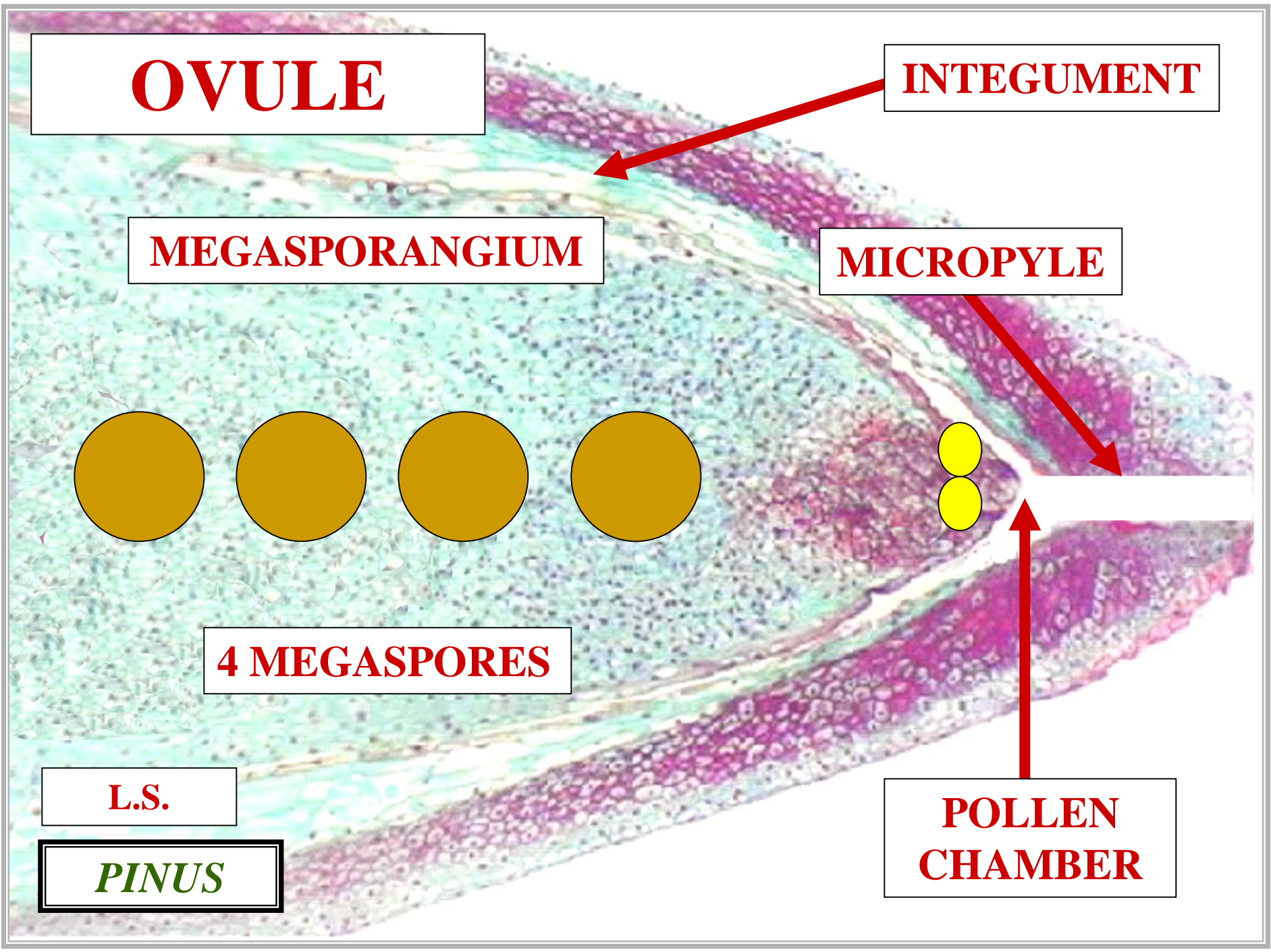
4 MEGASPORES



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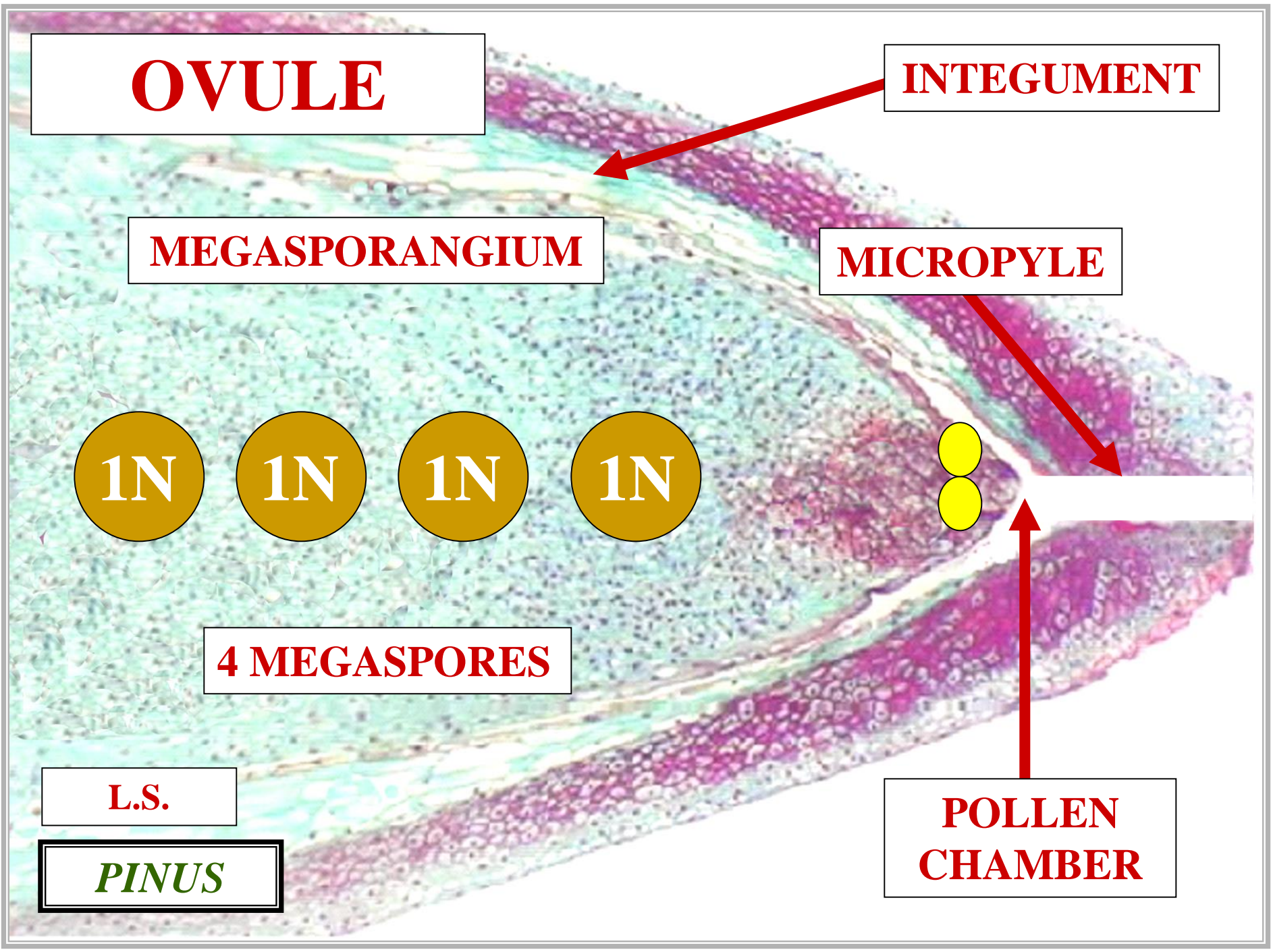
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4 MEGASPORES

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CHAMBER**



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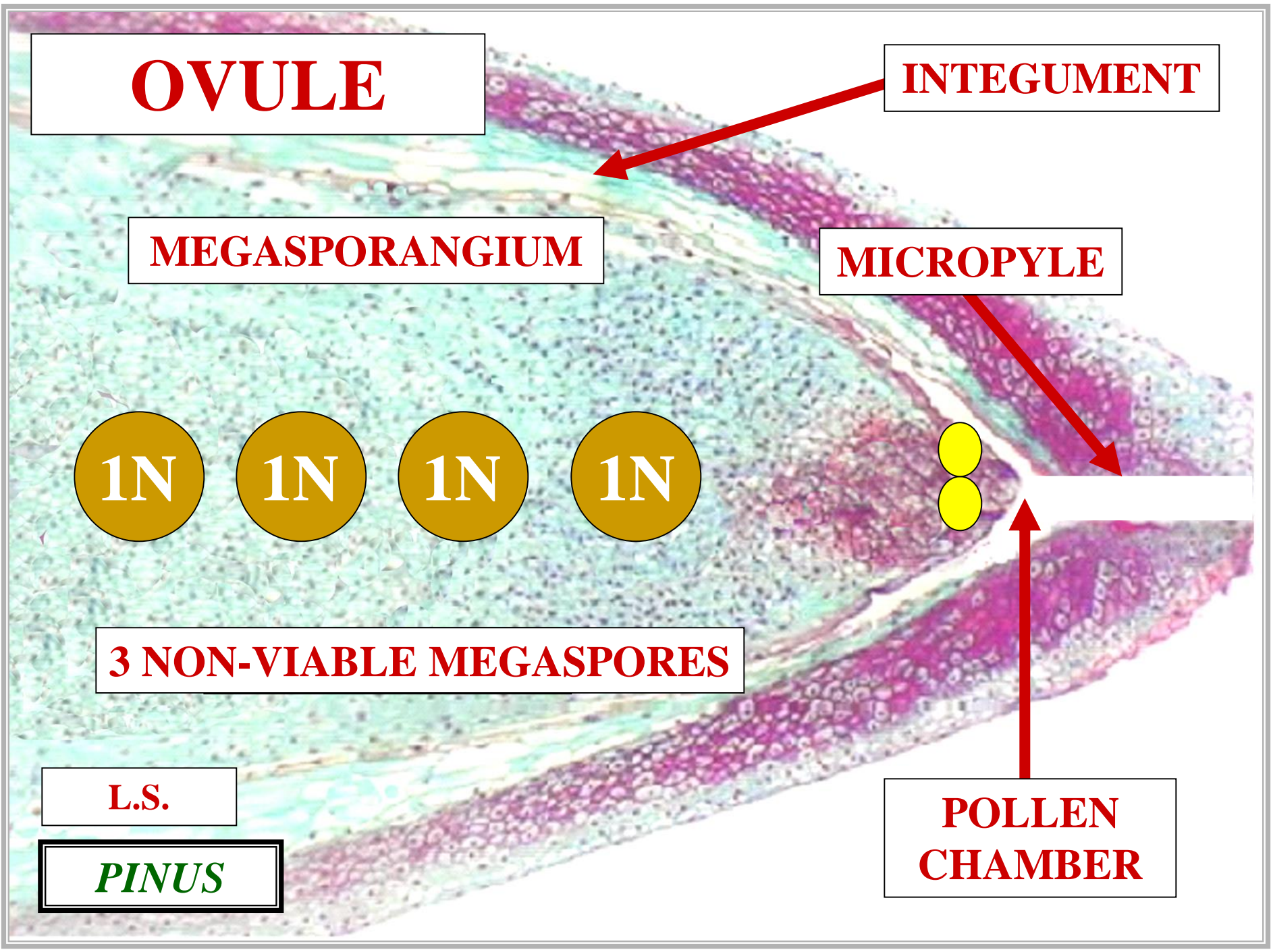
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MEGASPORANGIUM

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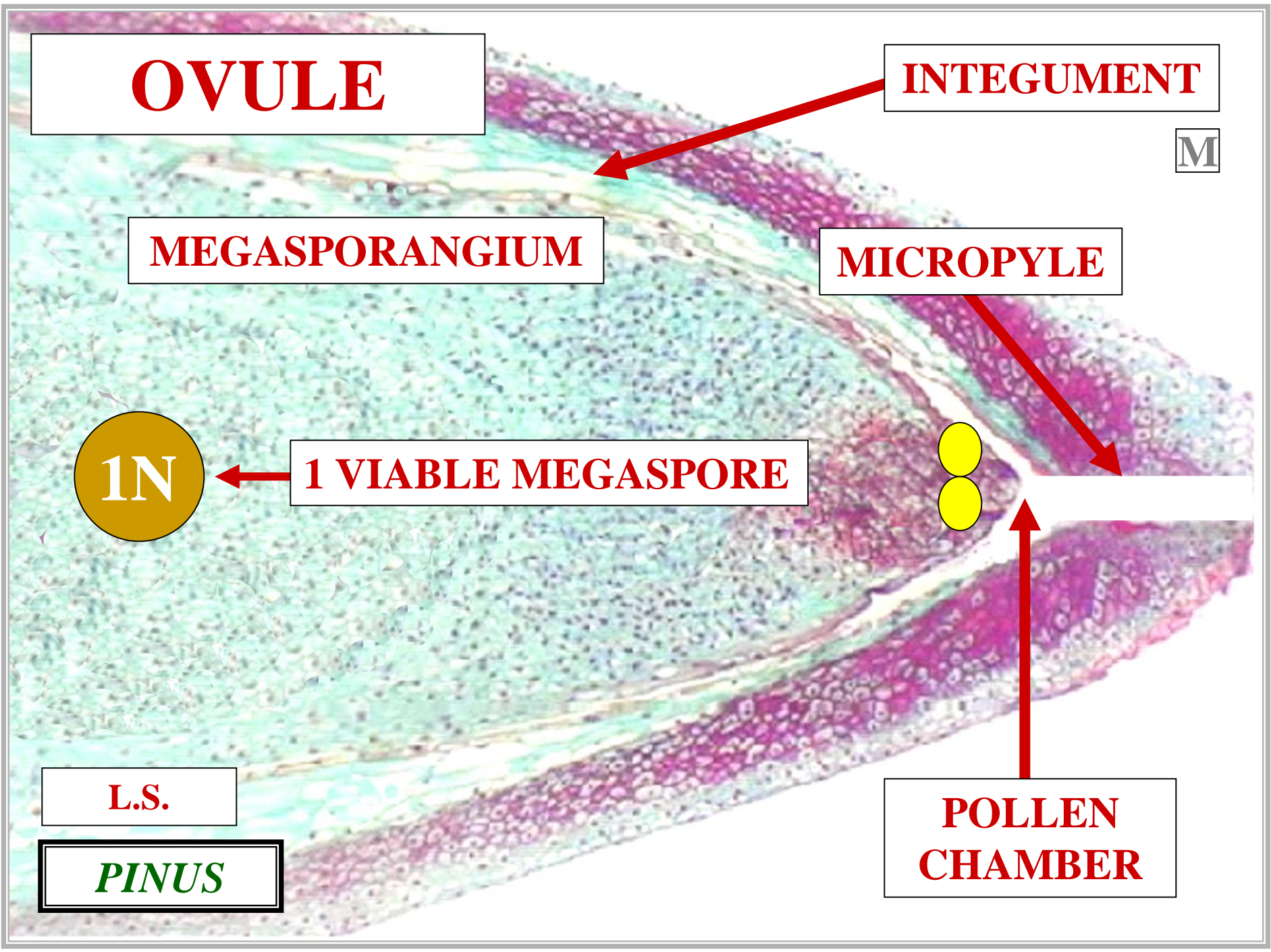
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1 VIABLE MEGASPORE

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**POLLEN
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MEGASPORANGIUM

MICROPYLE

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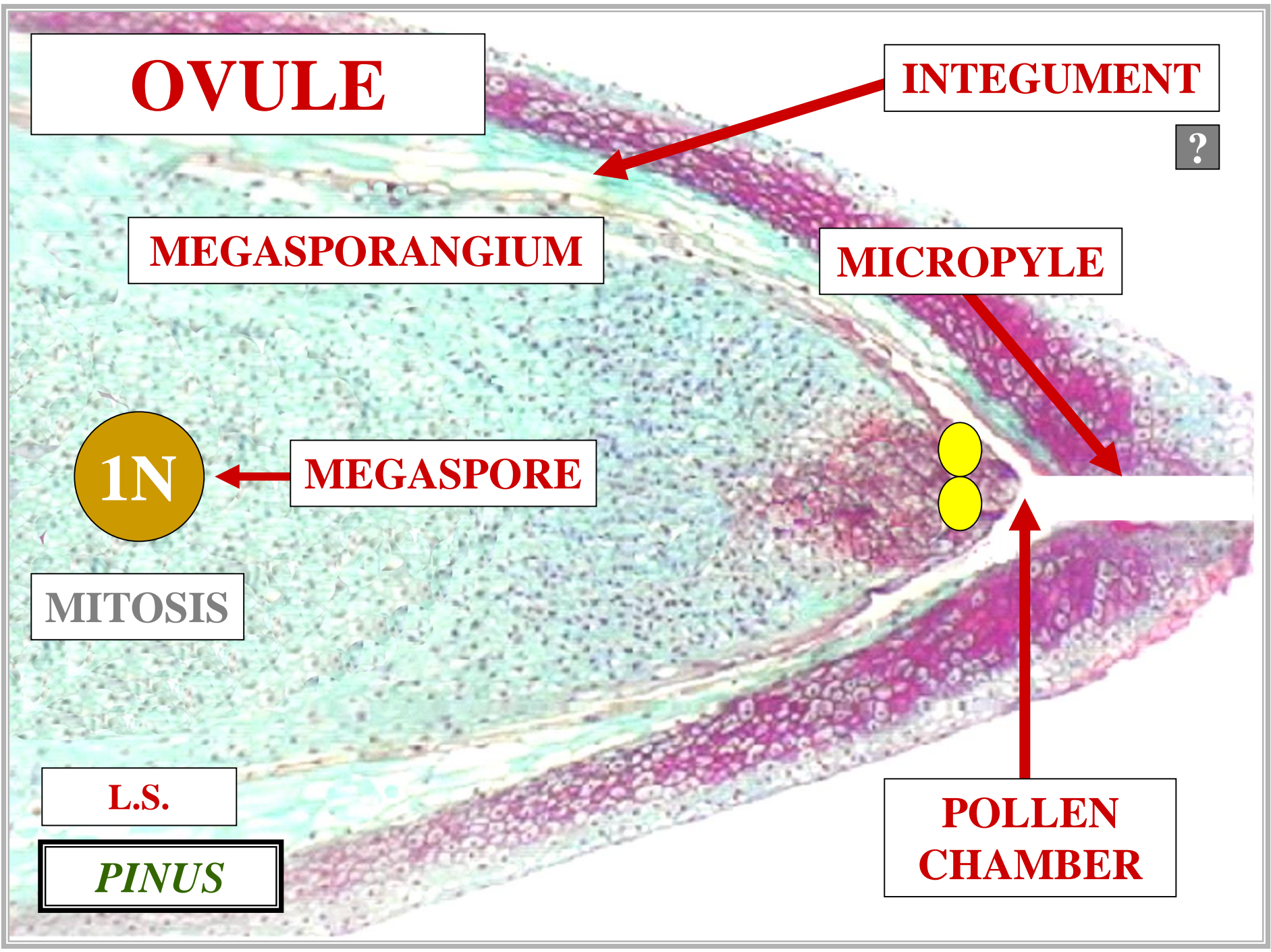
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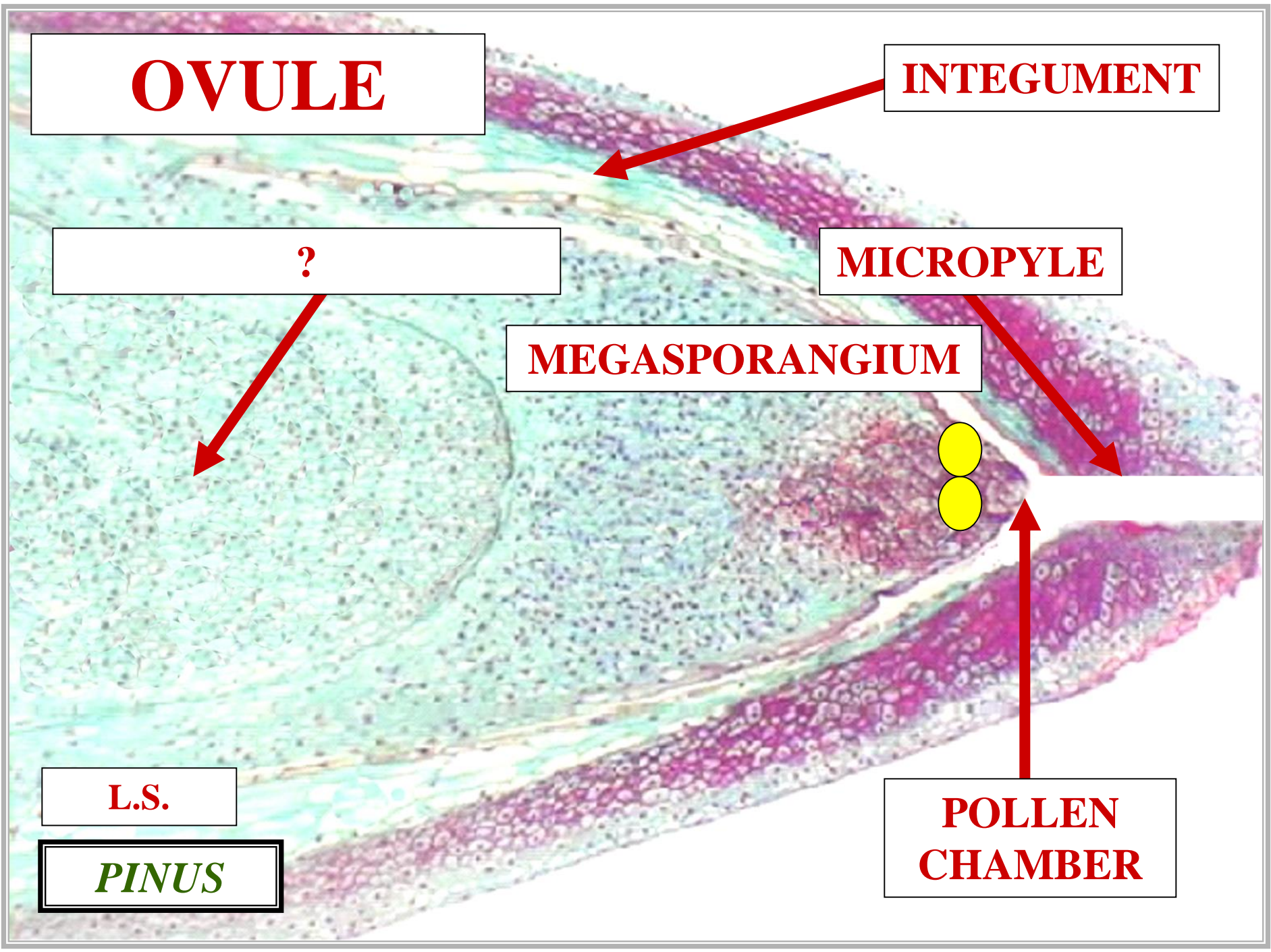
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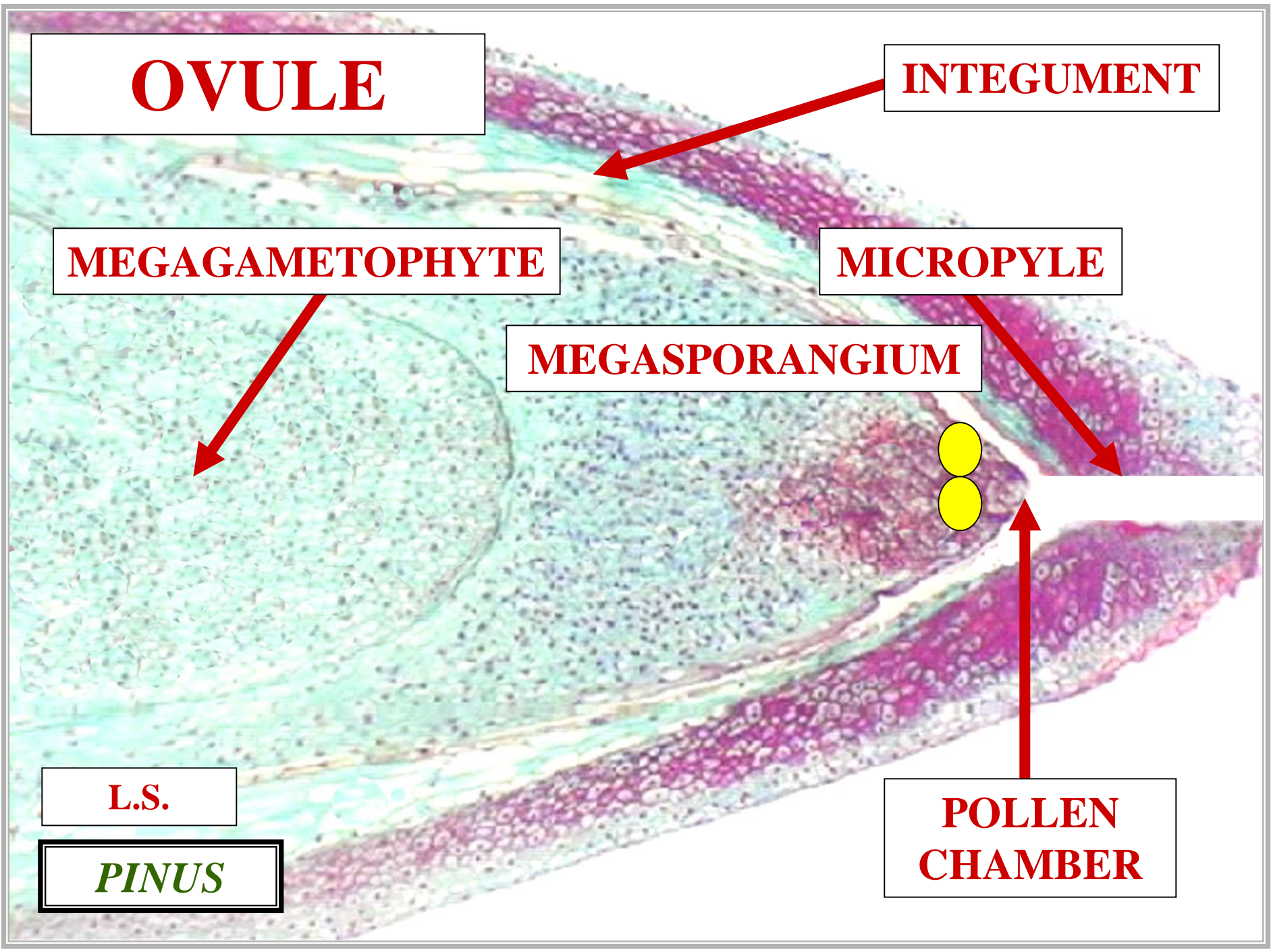
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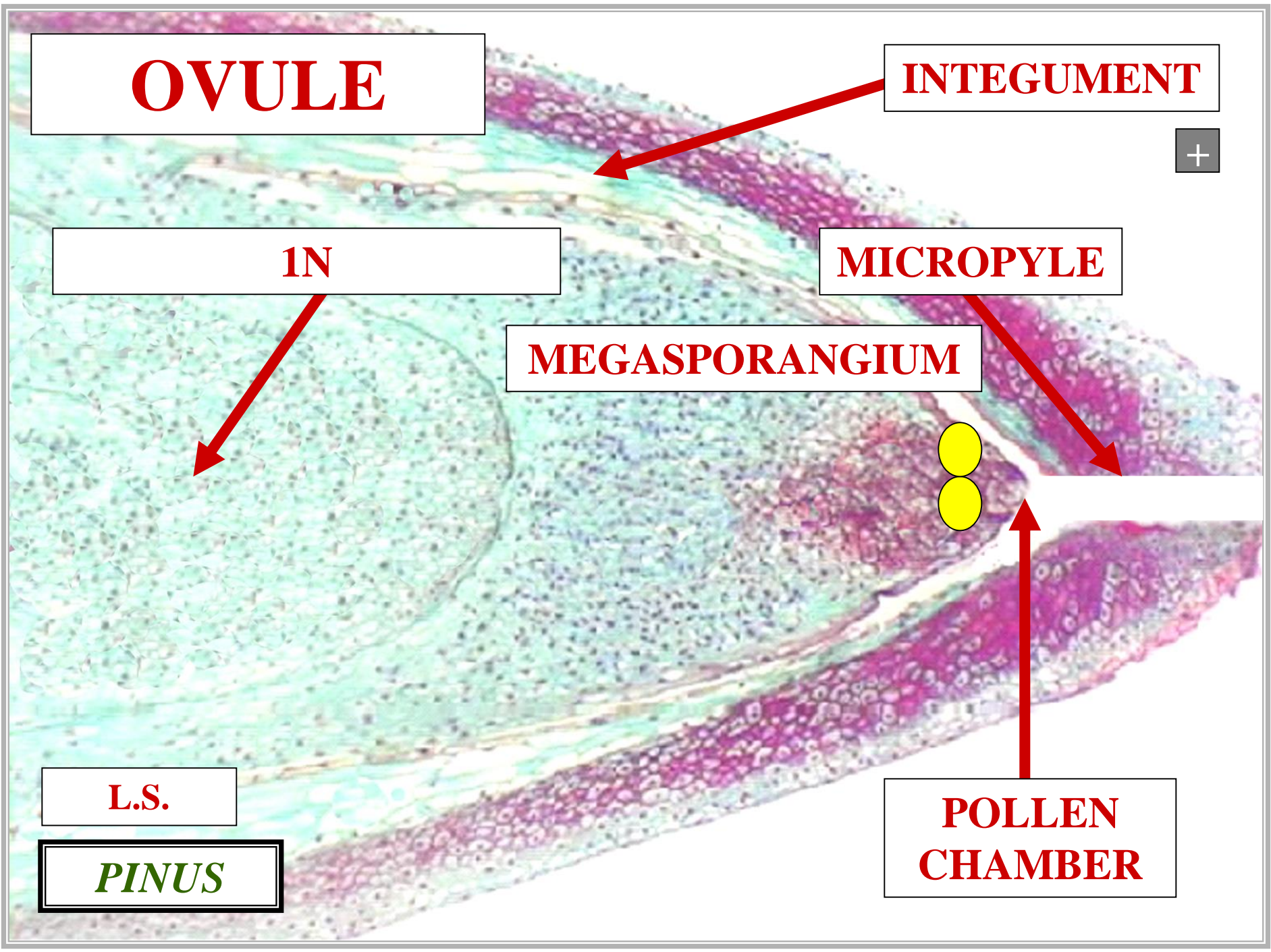
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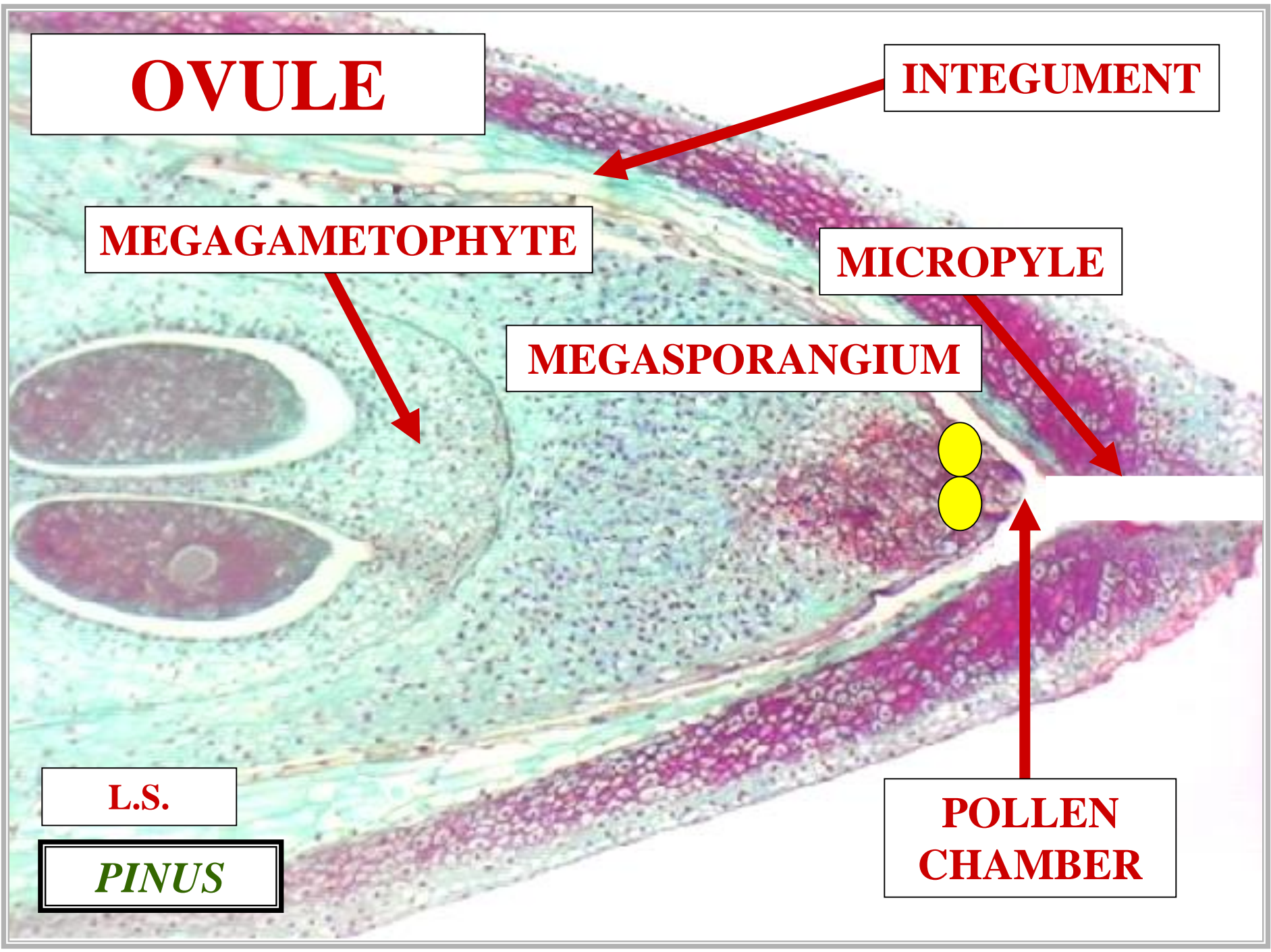
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MICROPYLE

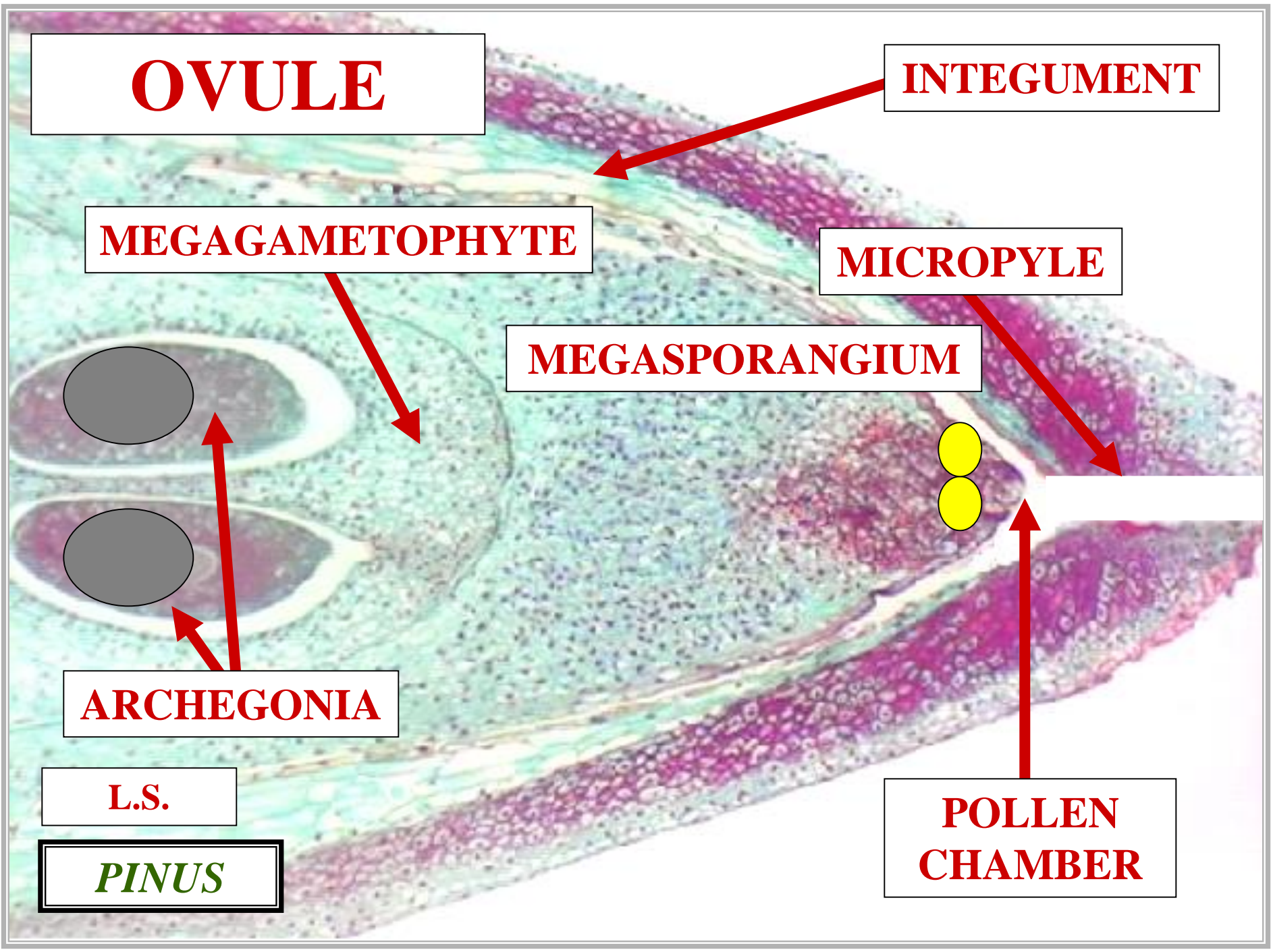
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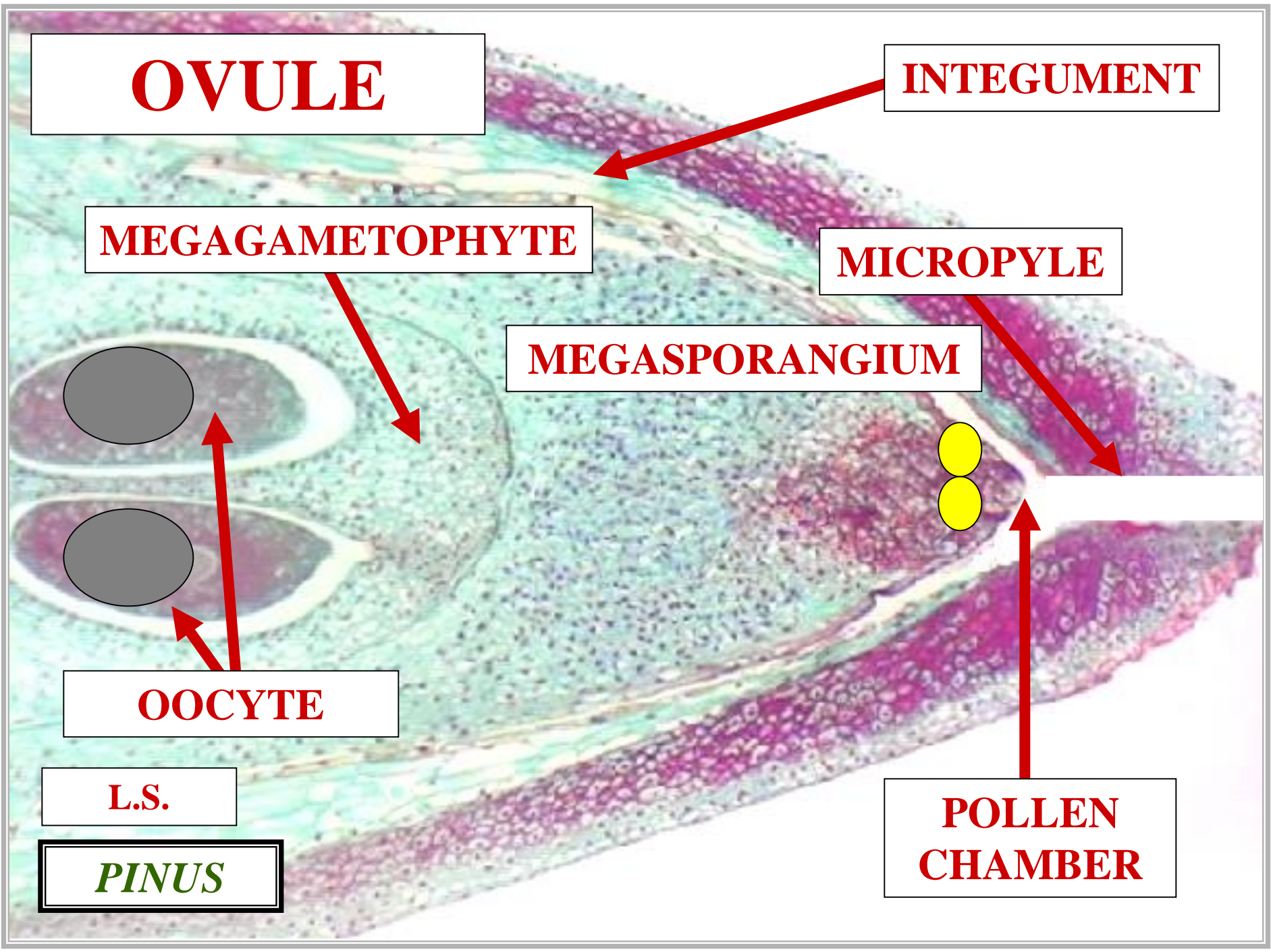
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OOCYTE

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MEGAGAMETOPHYTE

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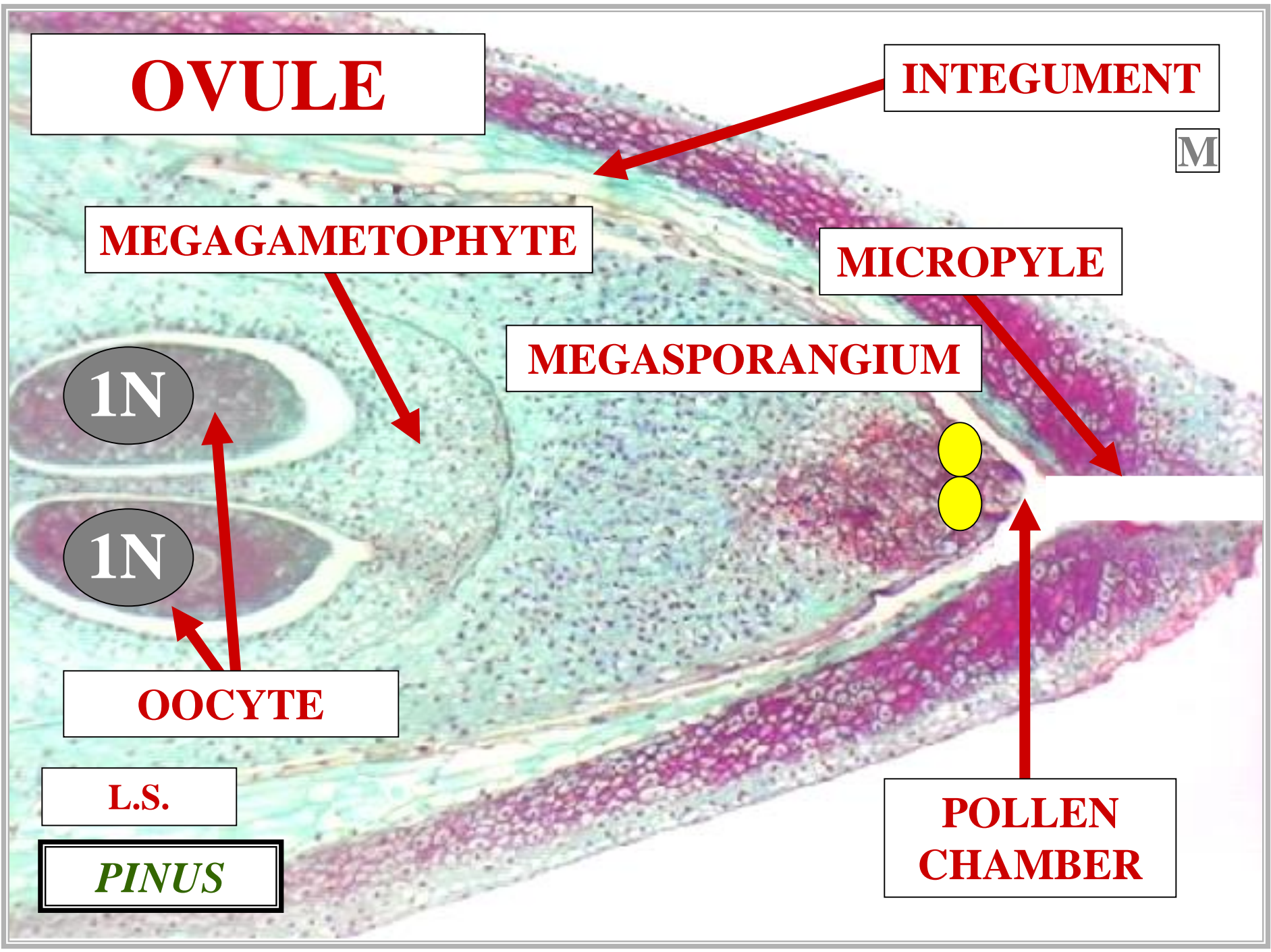
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OOCYTE

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MEGASPORANGIUM

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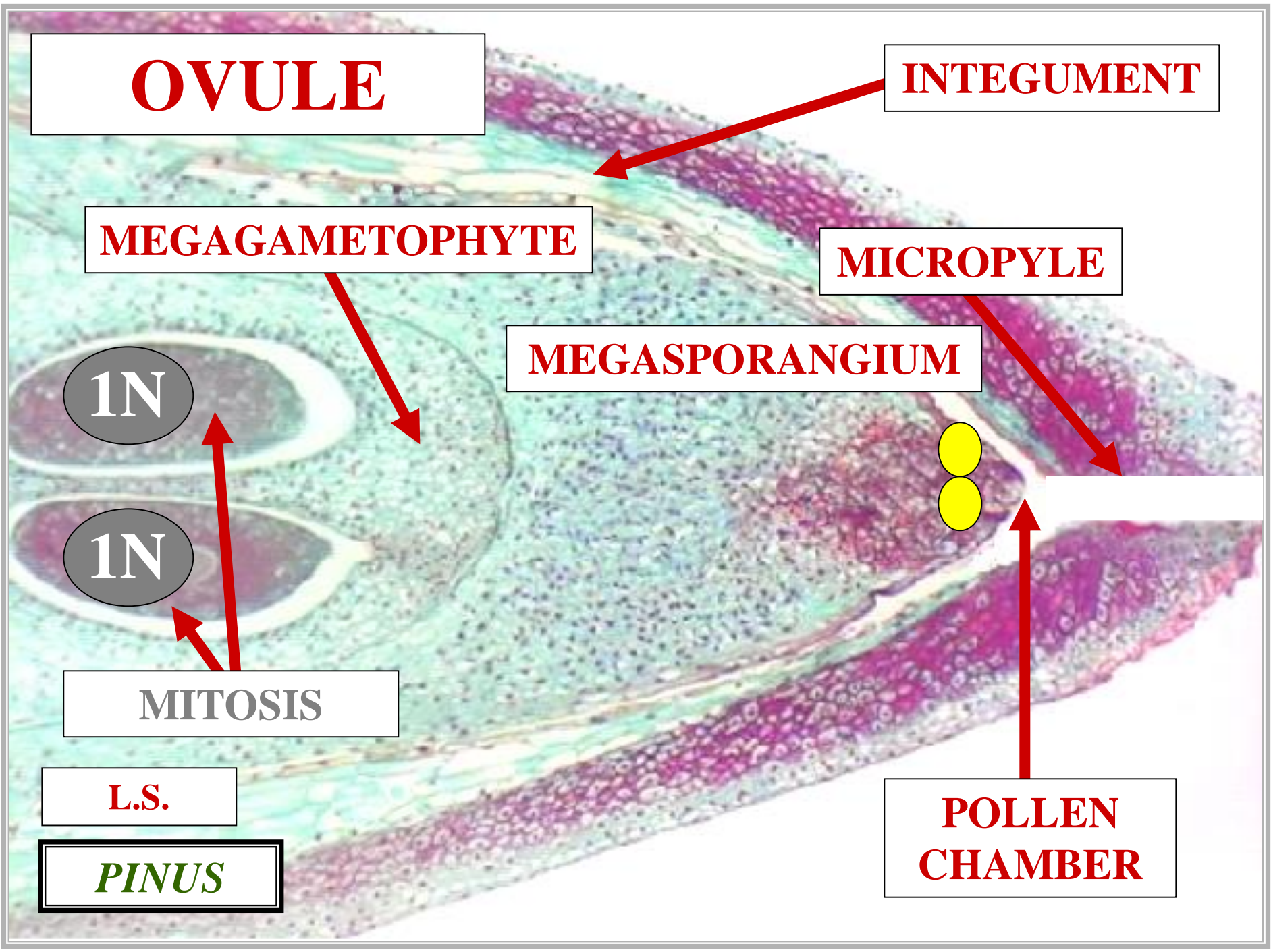
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MITOSIS

L.S.

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**POLLEN
CHAMBER**



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MEGAGAMETOPHYTE

MICROPYLE

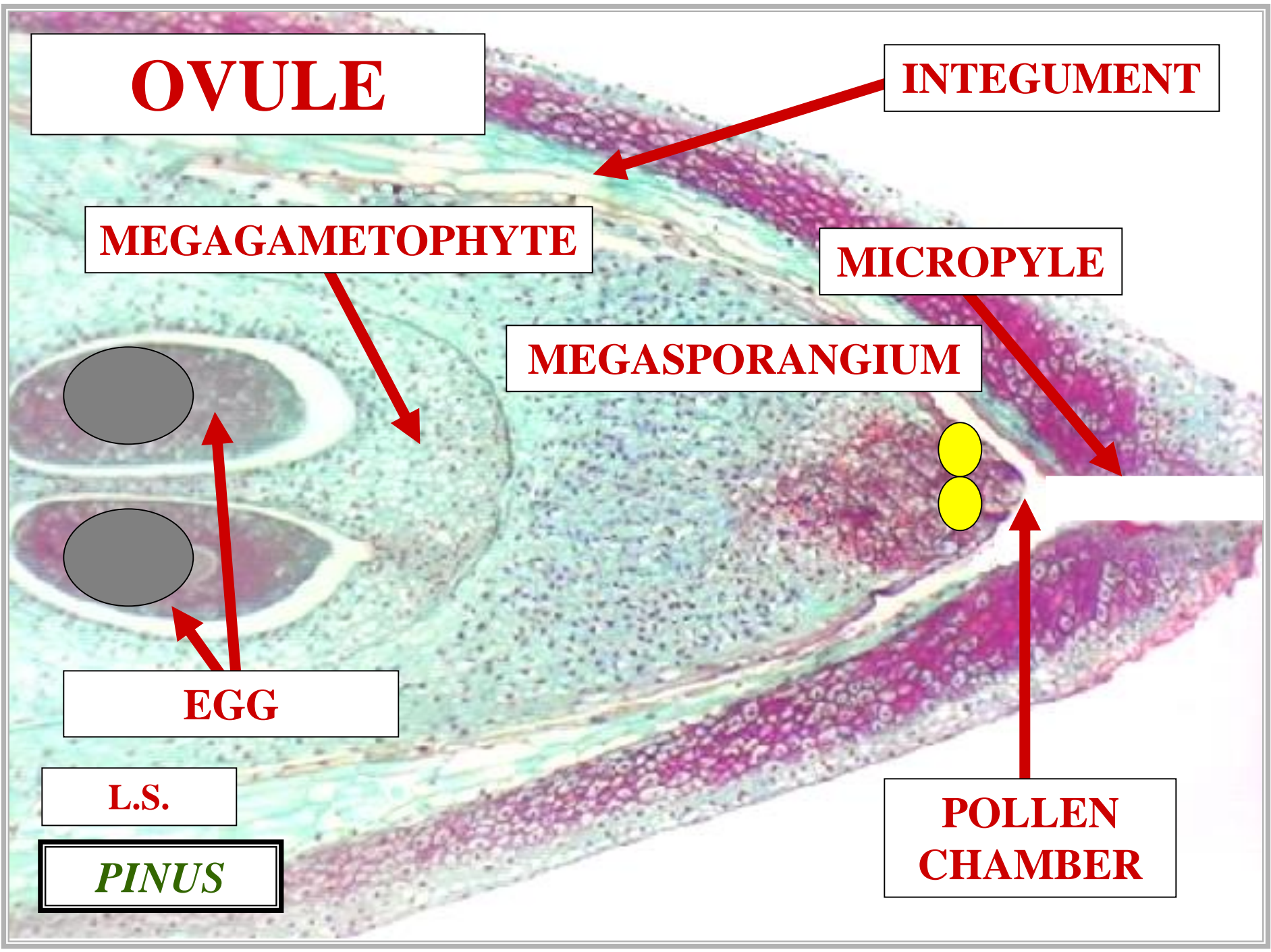
MEGASPORANGIUM

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CHAMBER**



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MICROPYLE

MEGASPORANGIUM

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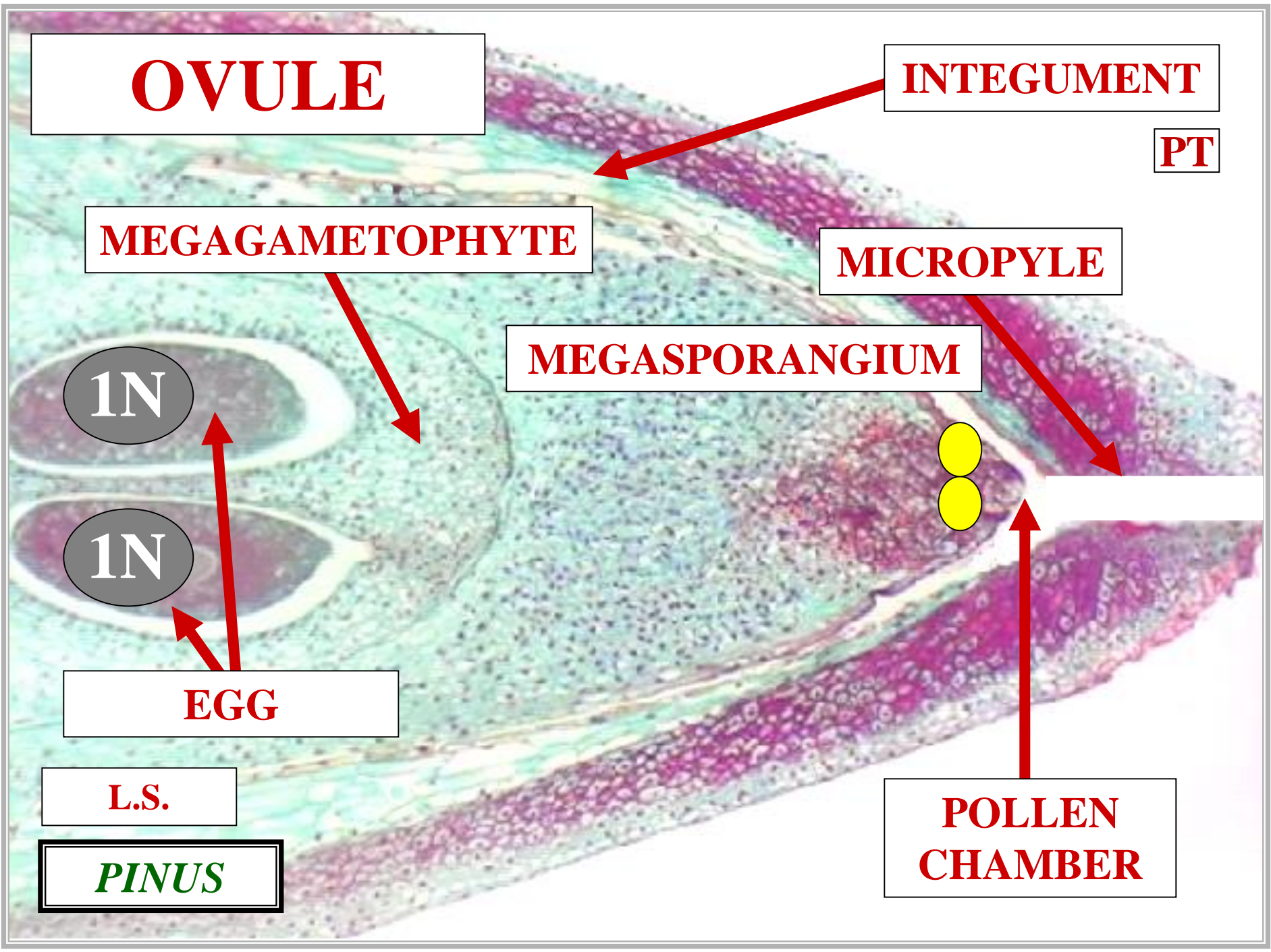
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CHAMBER**



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MICROPYLE

MEGASPORANGIUM

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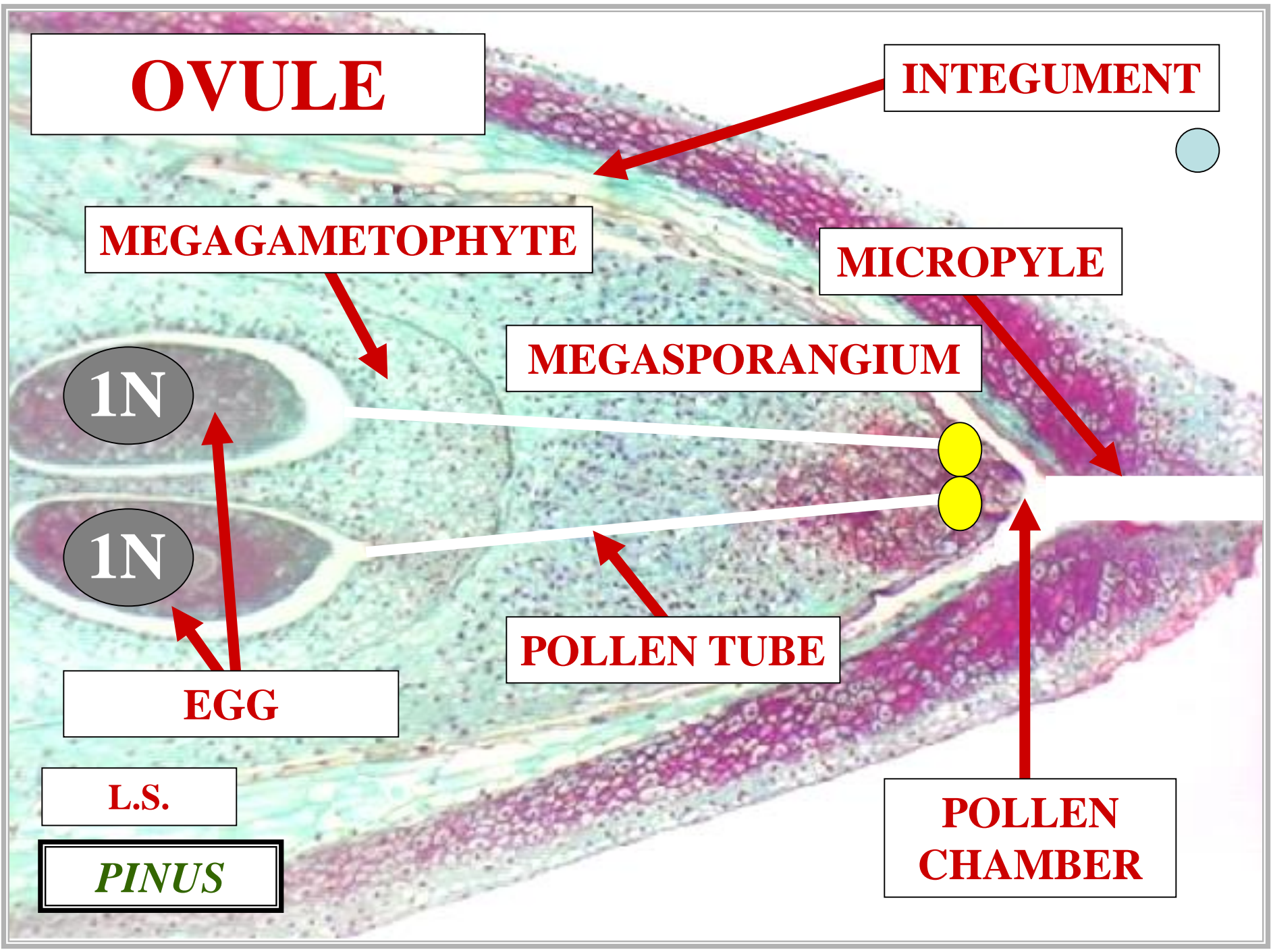
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MEGAGAMETOPHYTE

MICROPYLE

MEGASPORANGIUM

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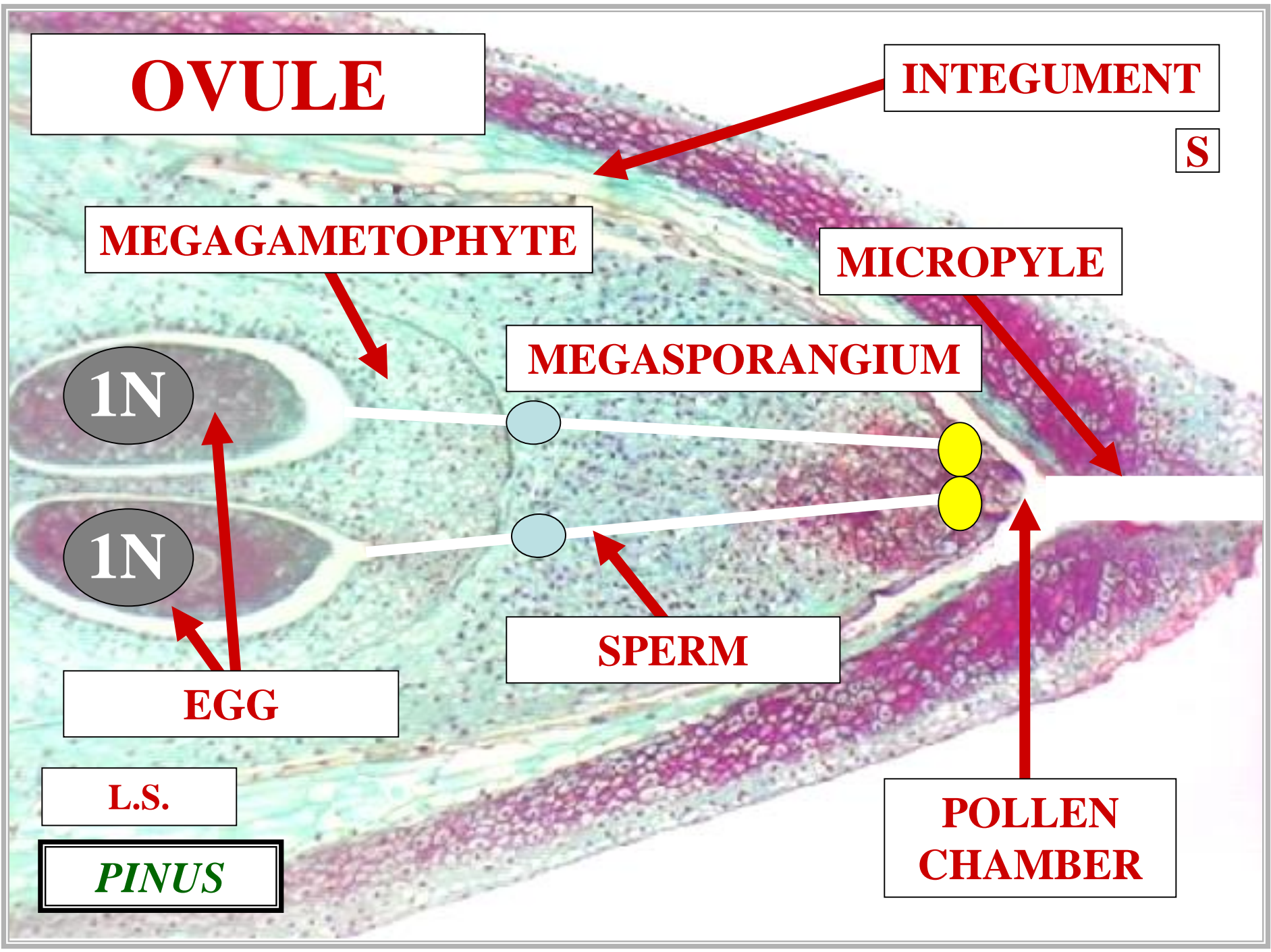
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**POLLEN
CHAMBER**



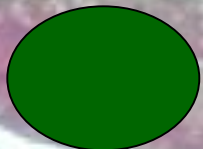
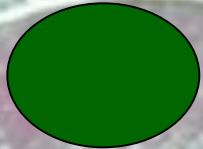
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MEGASPORANGIUM



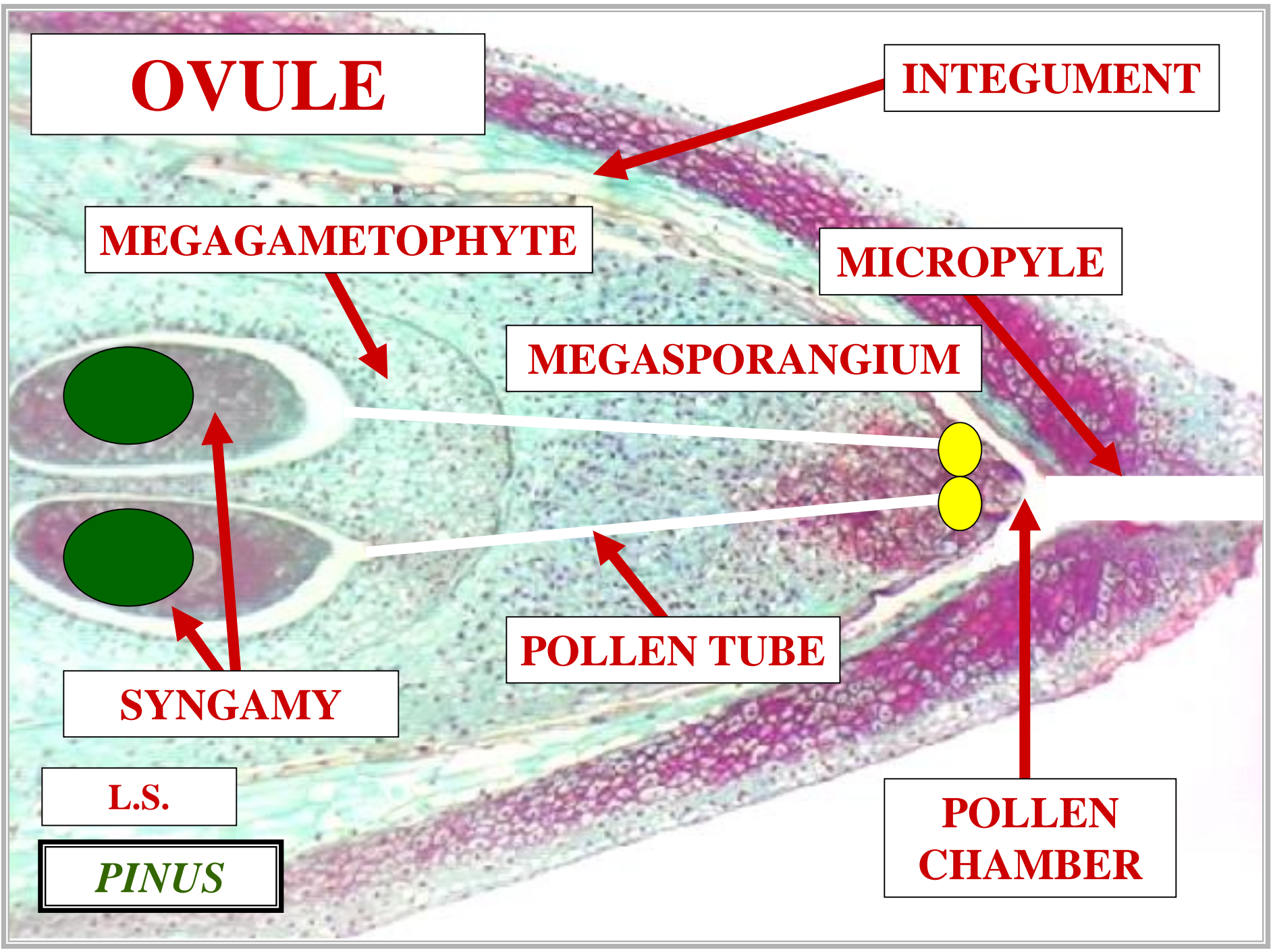
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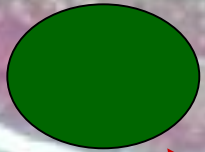
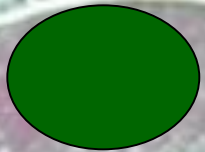
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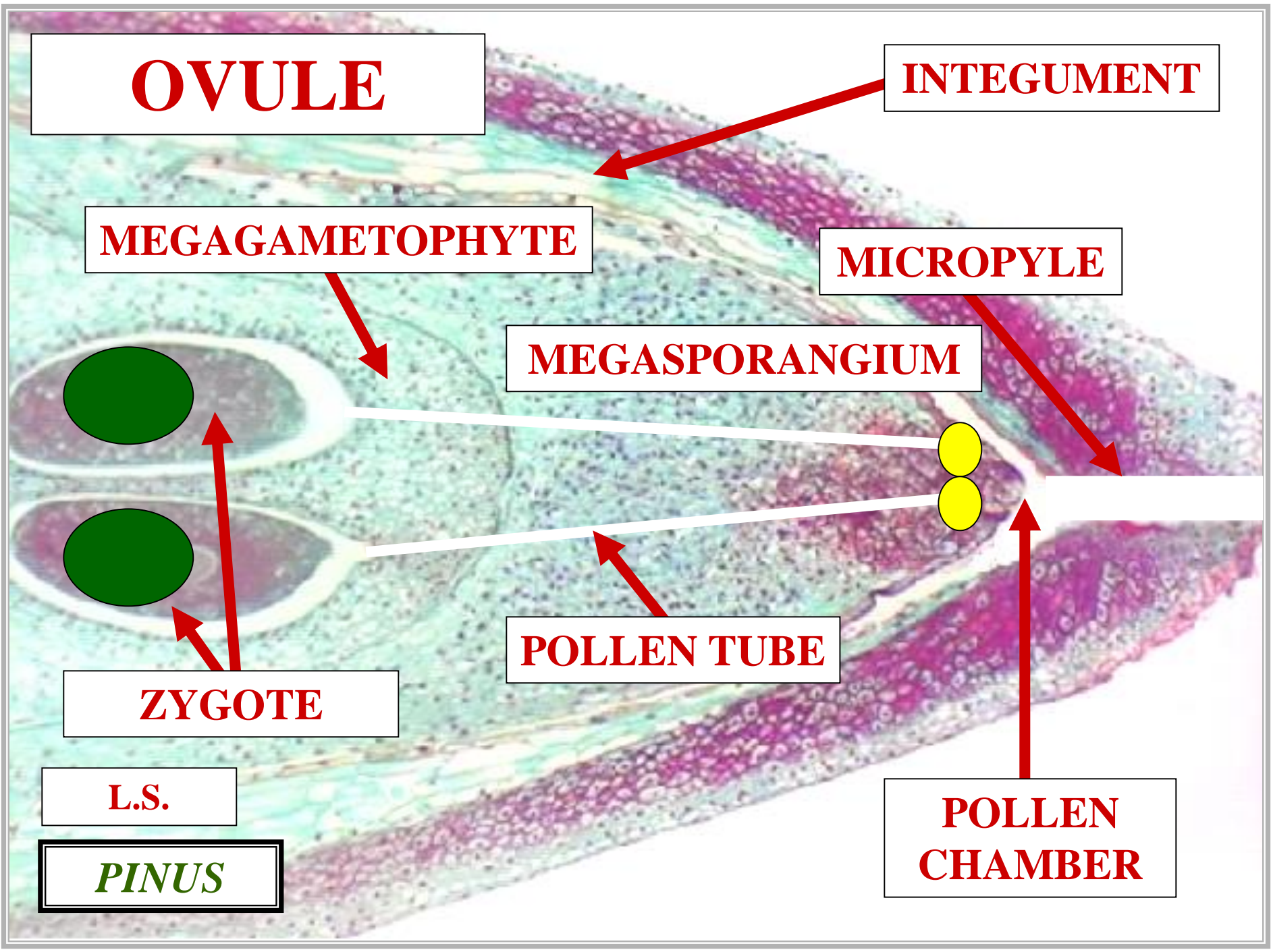
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**POLLEN
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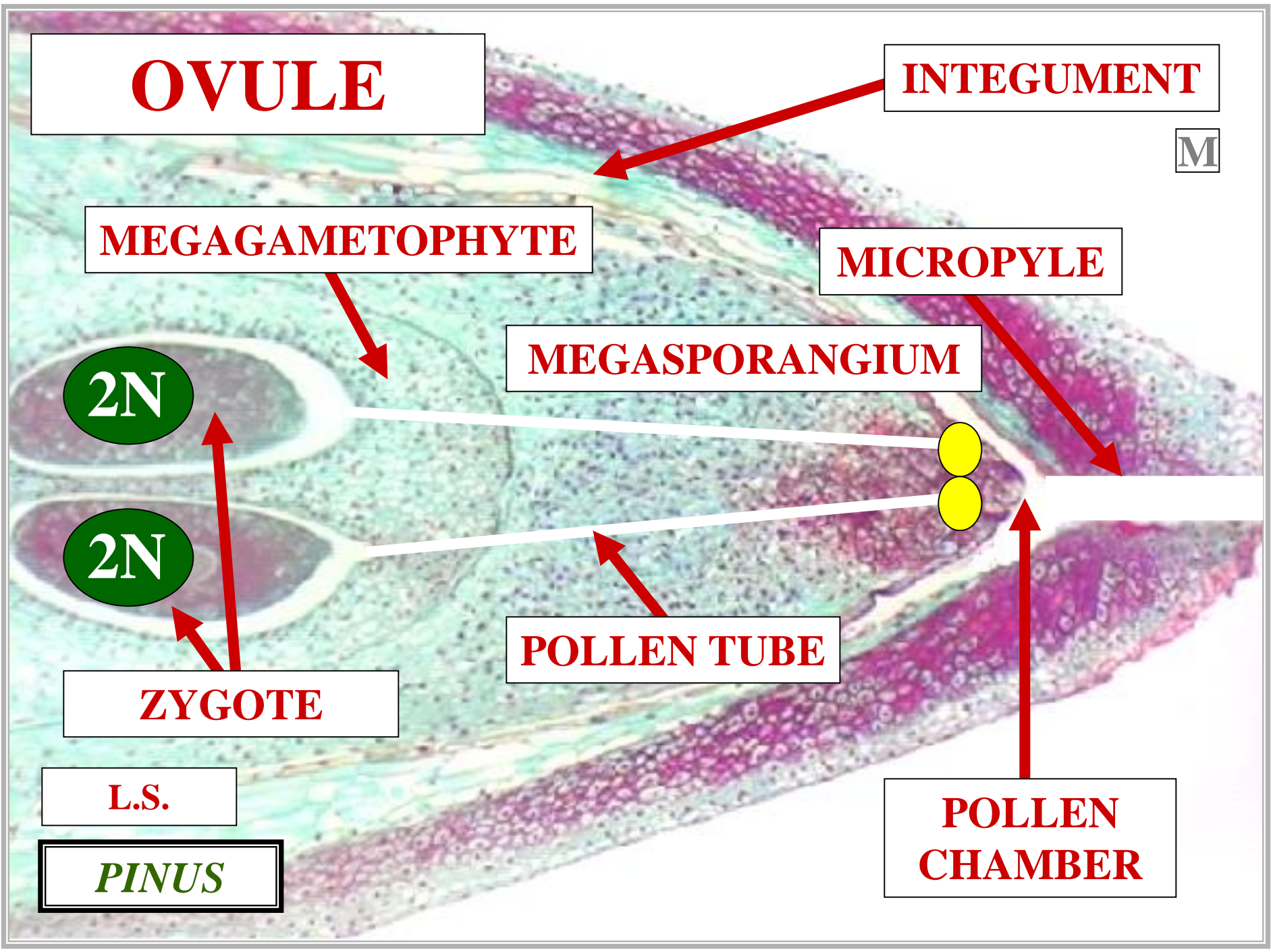
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MICROPYLE

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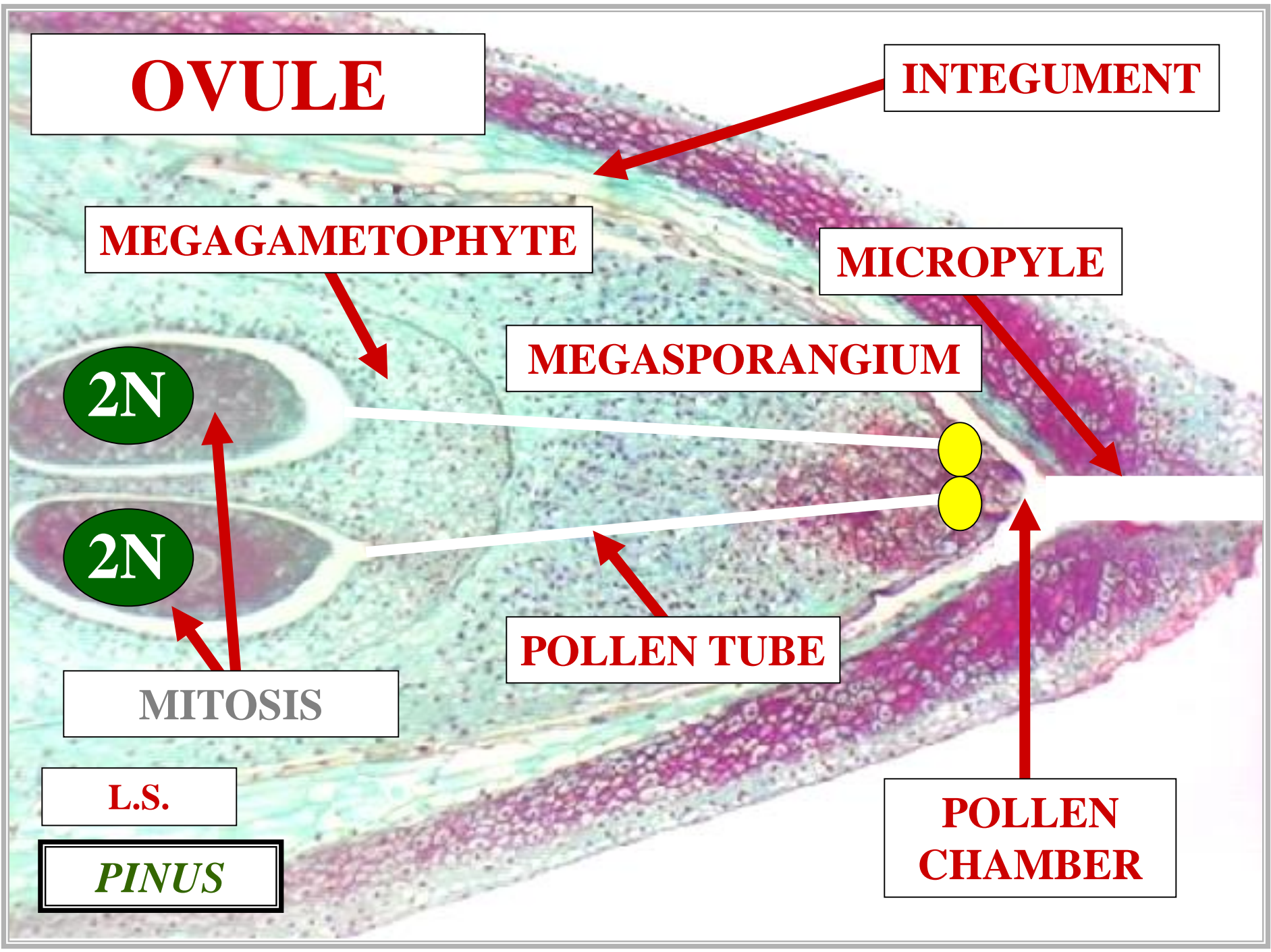
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**POLLEN
CHAMBER**



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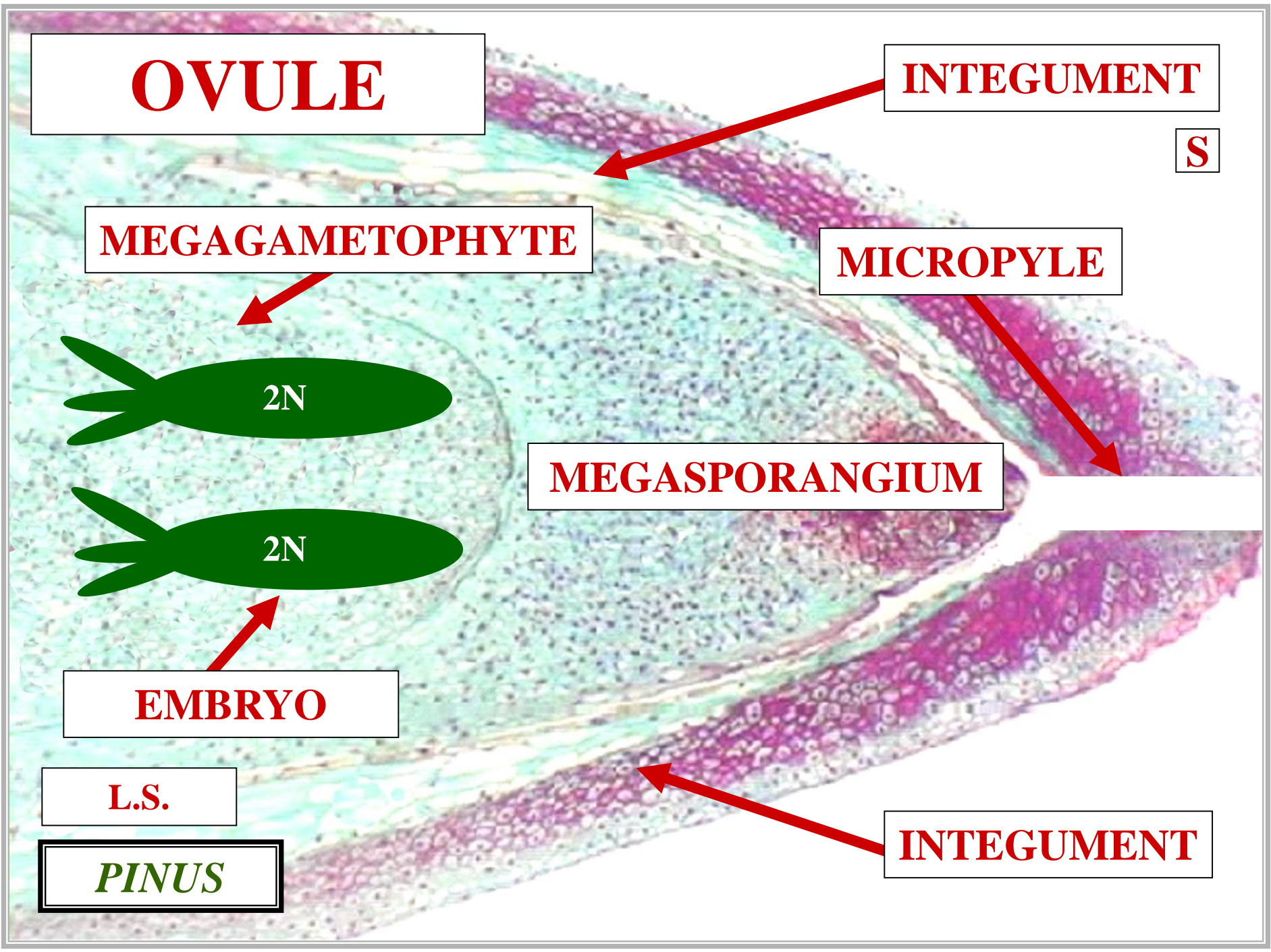
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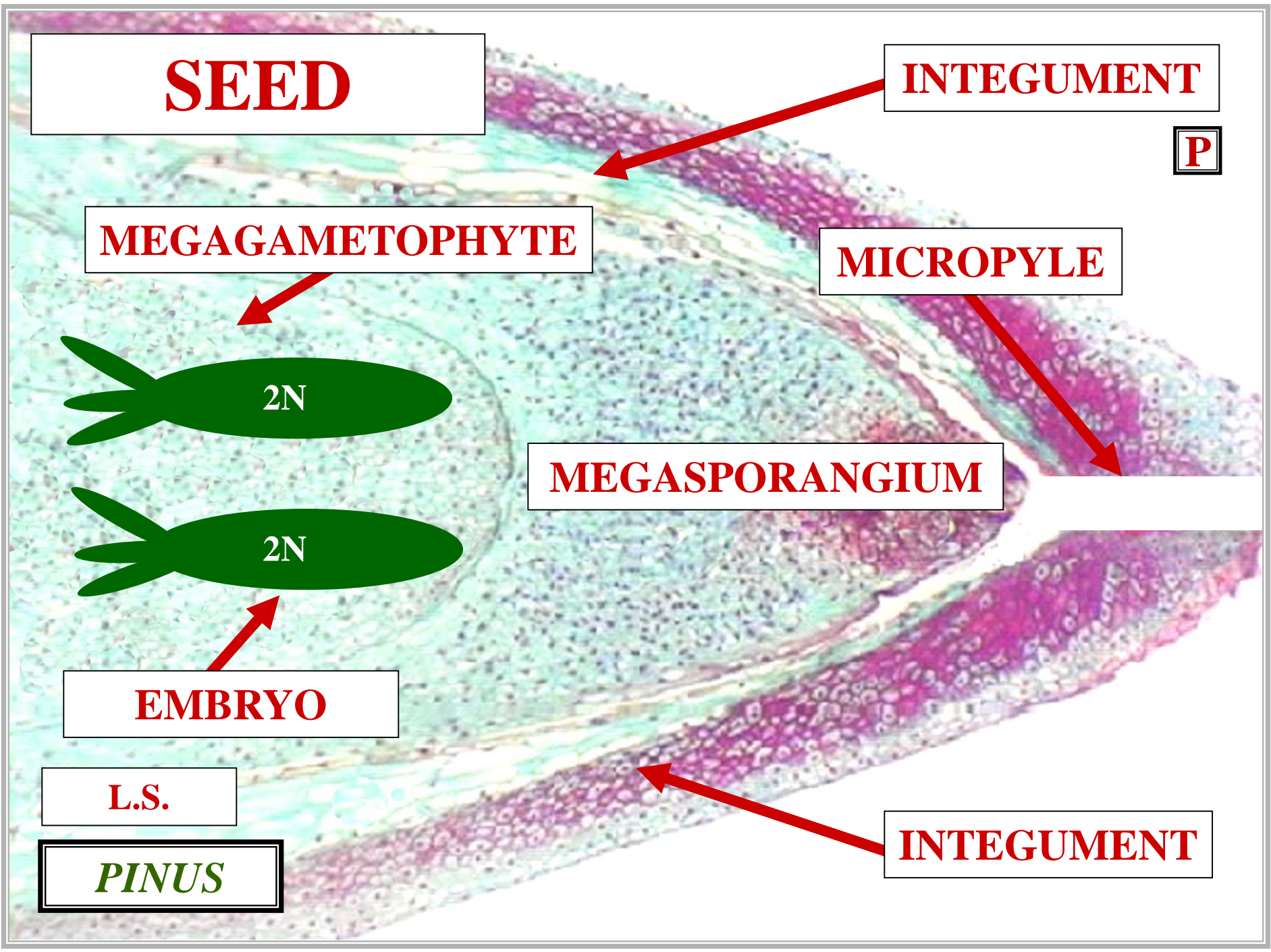
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SEED

INTEGUMENT

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MICROPYLE

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MEGASPORANGIUM

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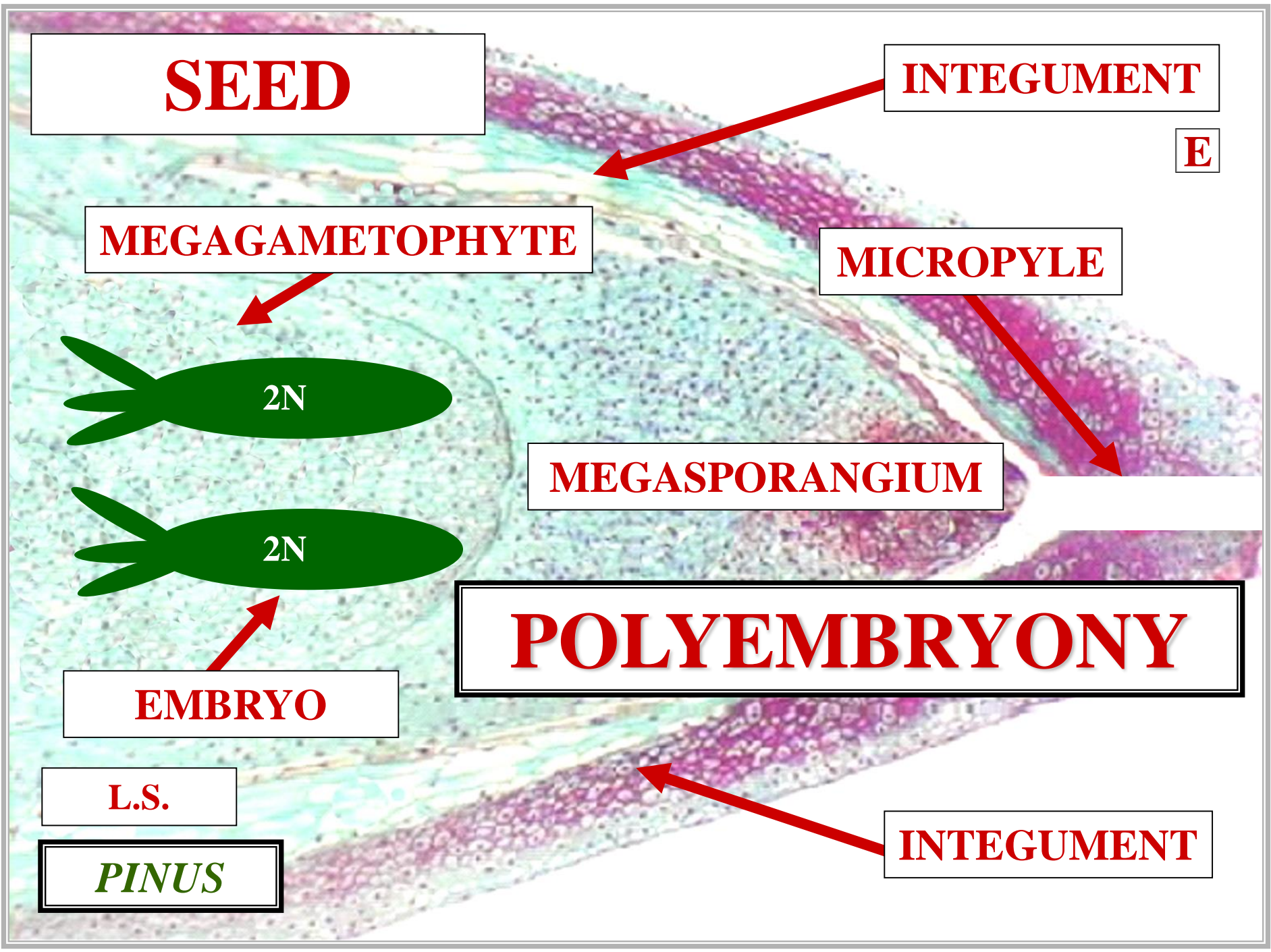
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INTEGUMENT

PINUS



SEED

INTEGUMENT

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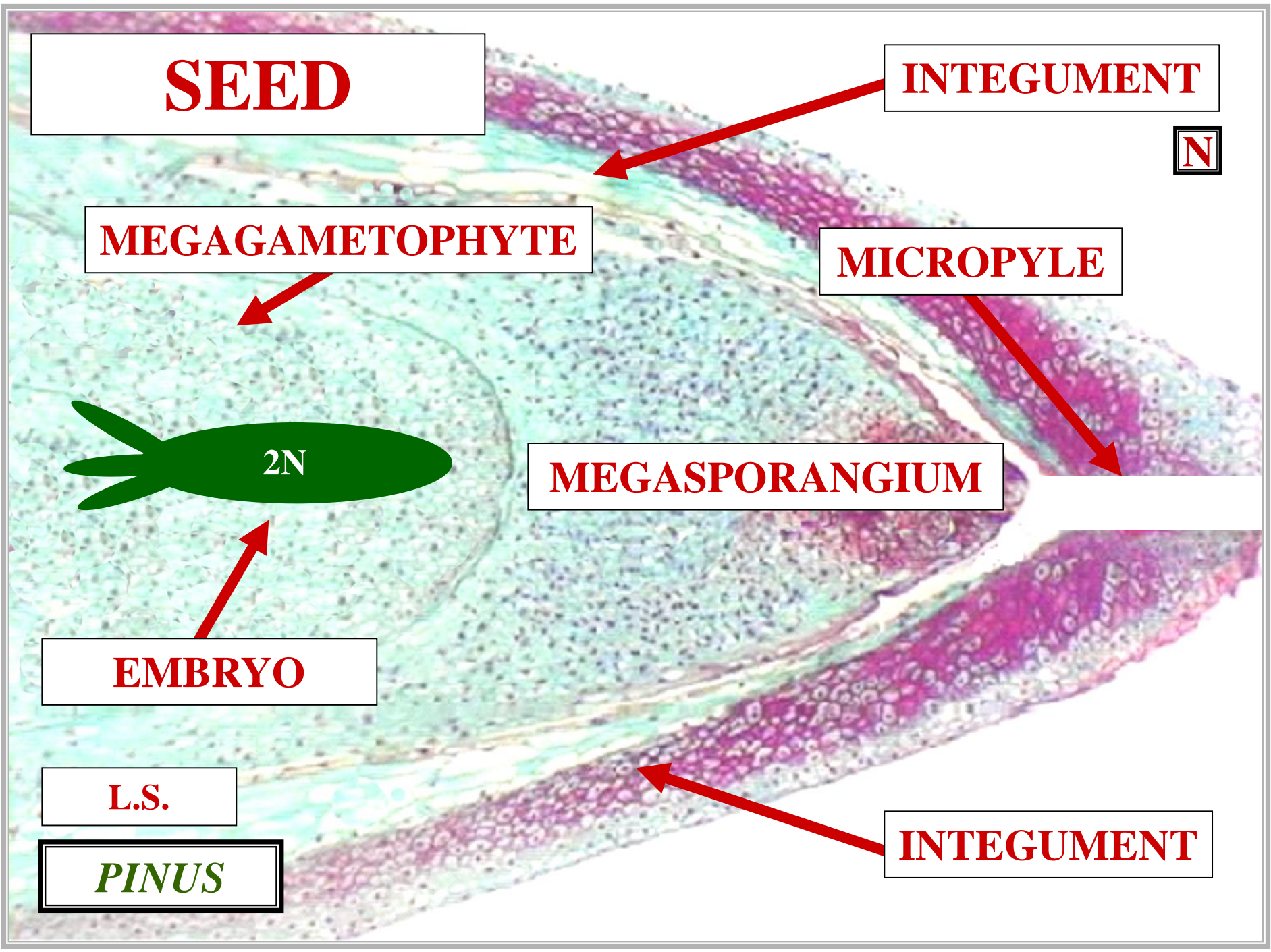
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EMBRYO

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PINUS

INTEGUMENT



SEED

INTEGUMENT



MEGAGAMETOPHYTE

MICROPYLE



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MEGASPORANGIUM

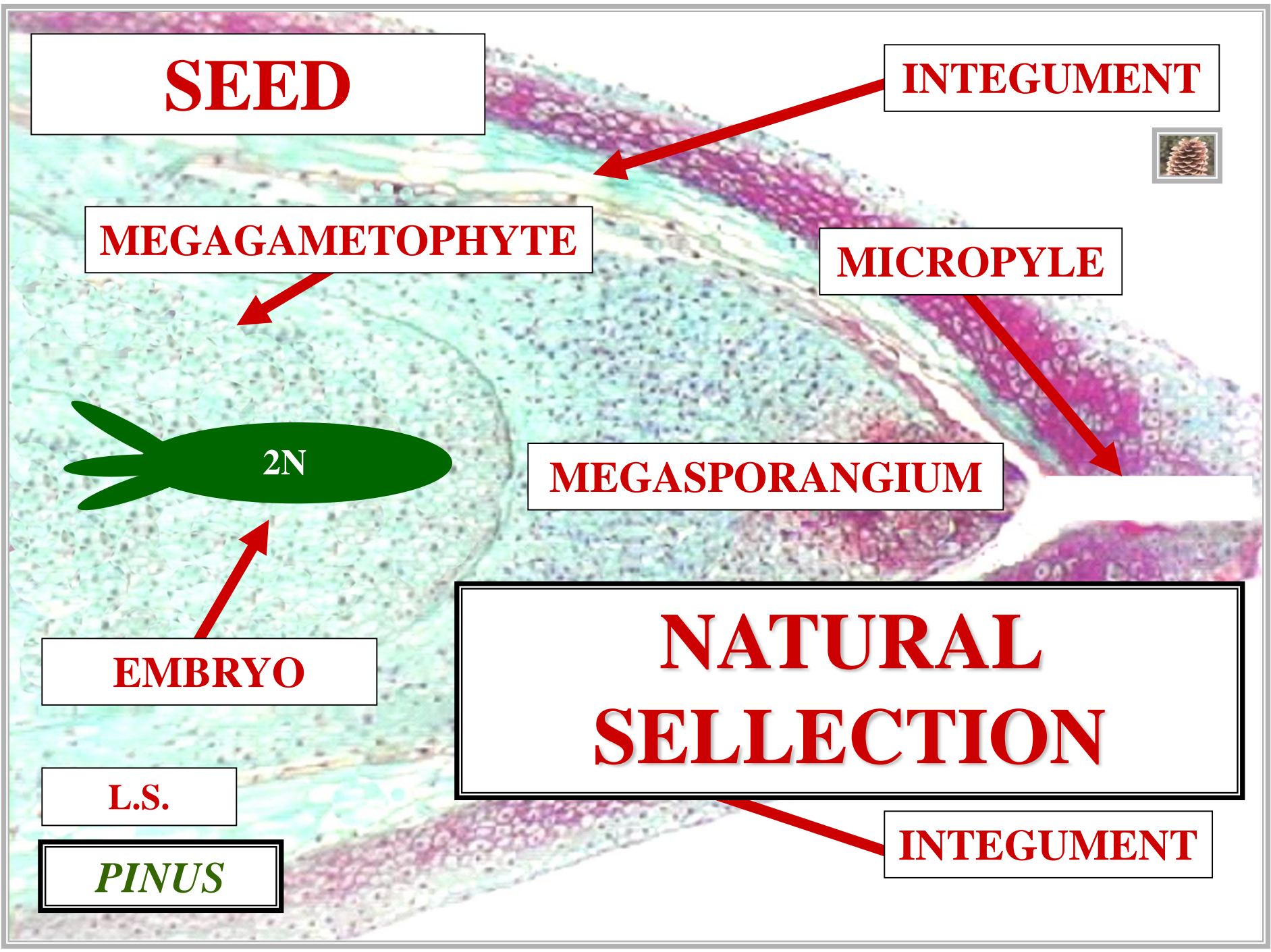
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**NATURAL
SELECTION**

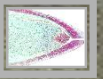
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PINUS

INTEGUMENT



MEGASTROBILUS



OVULIFEROUS SCALES

SEED WIND DISPERSAL



PINUS

SEED

INTEGUMENT

G
+

MEGAGAMETOPHYTE

MICROPYLE

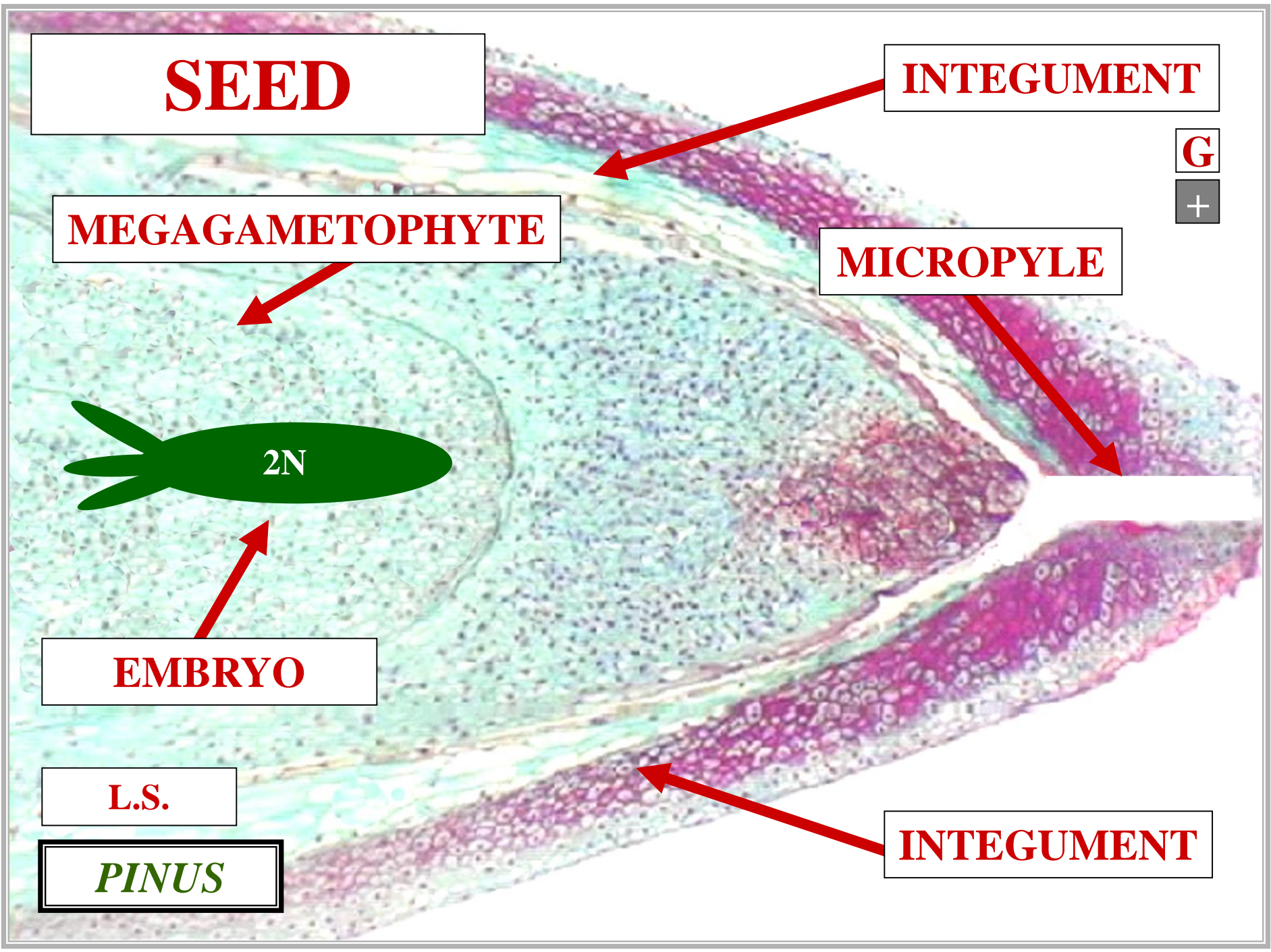
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INTEGUMENT



GERMINATION

INTEGUMENT

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MEGAGAMETOPHYTE

MICROPYLE



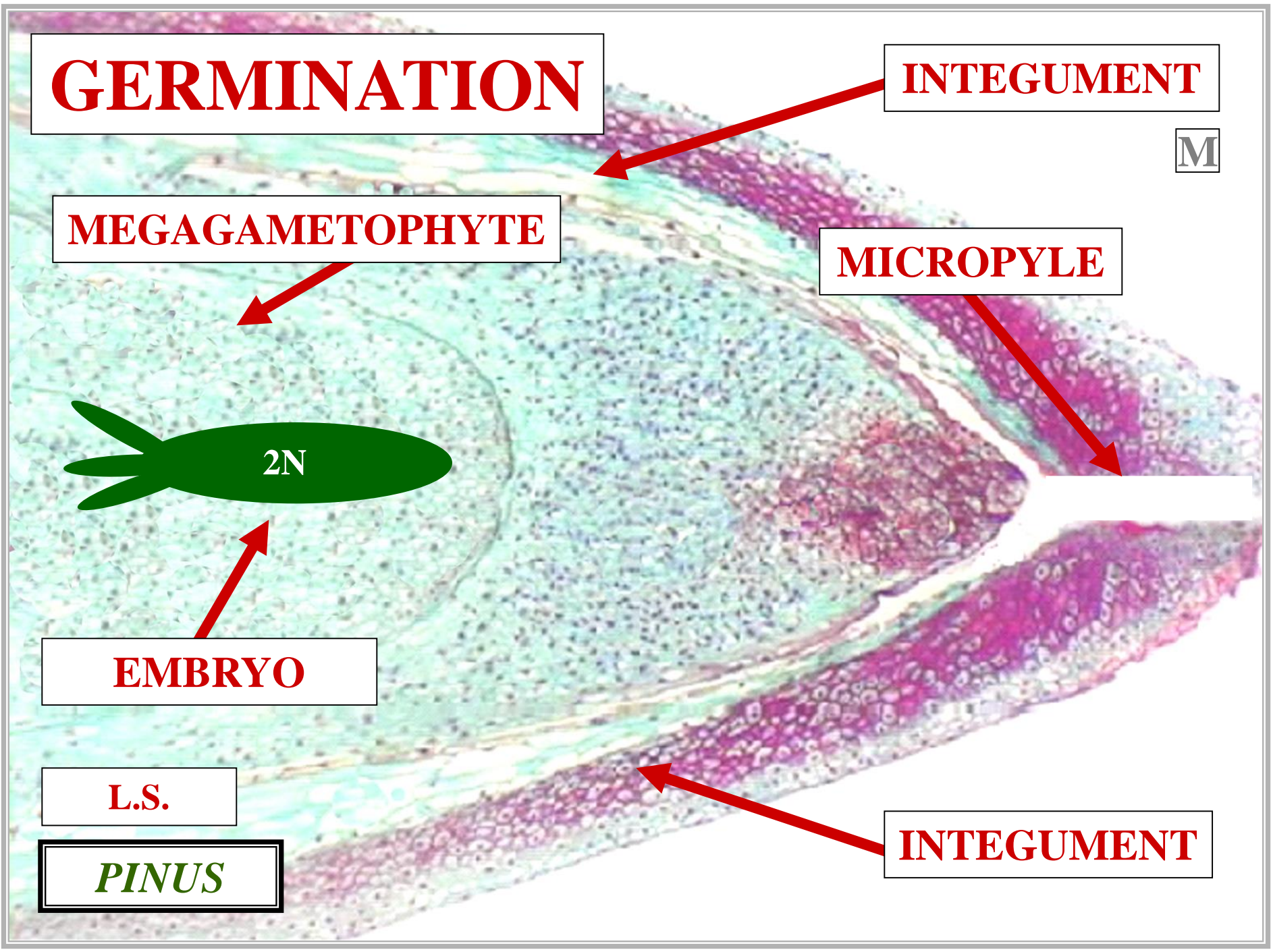
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EMBRYO

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GERMINATION

INTEGUMENT

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MICROPYLE

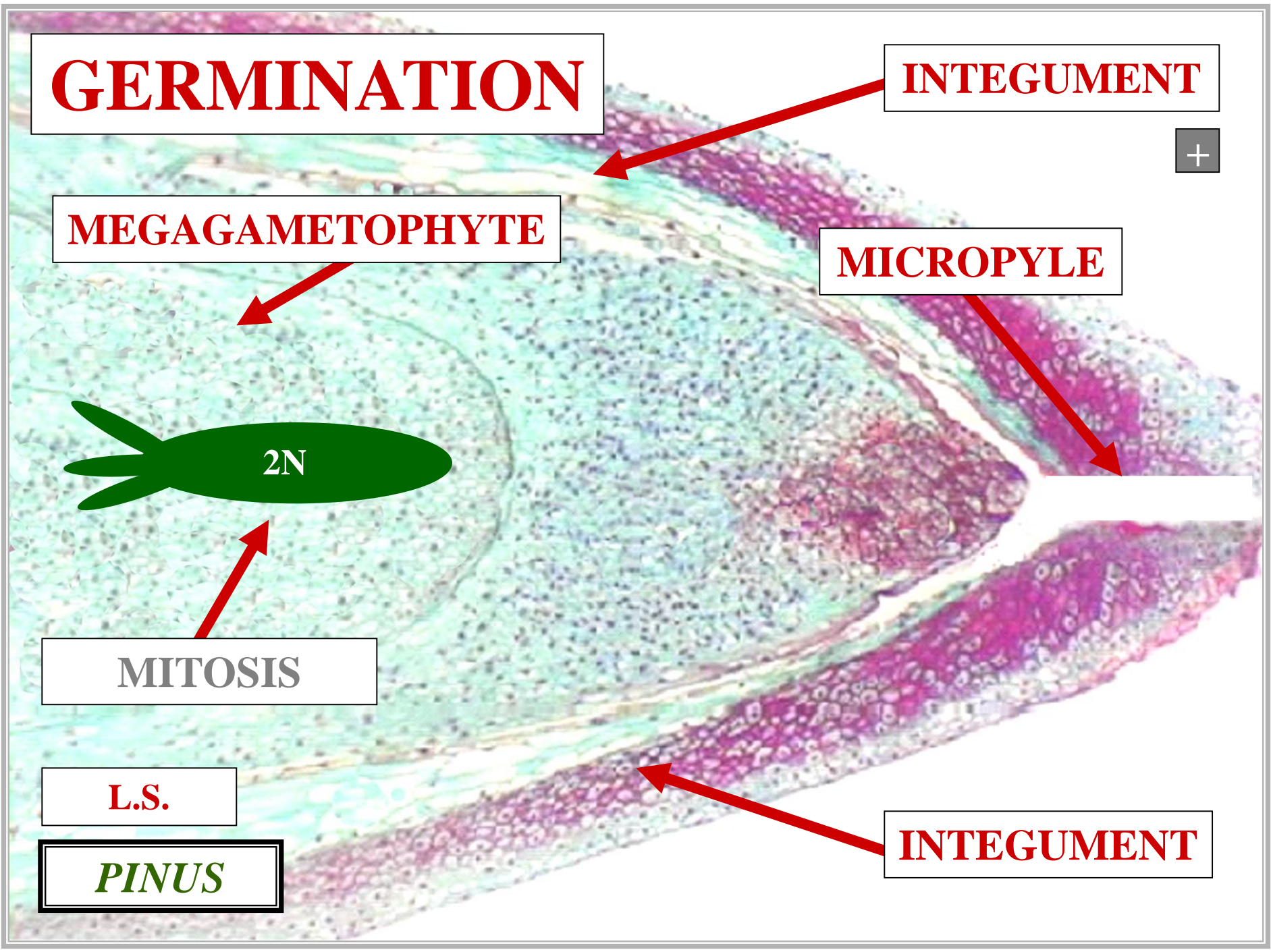
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MITOSIS

L.S.

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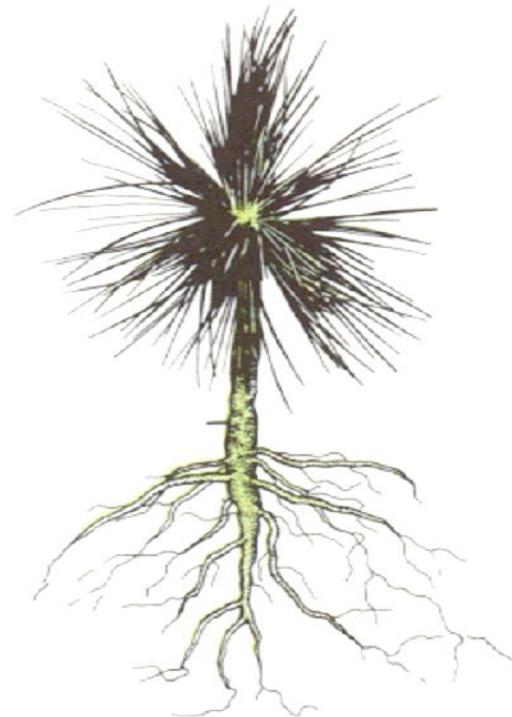
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PINUS

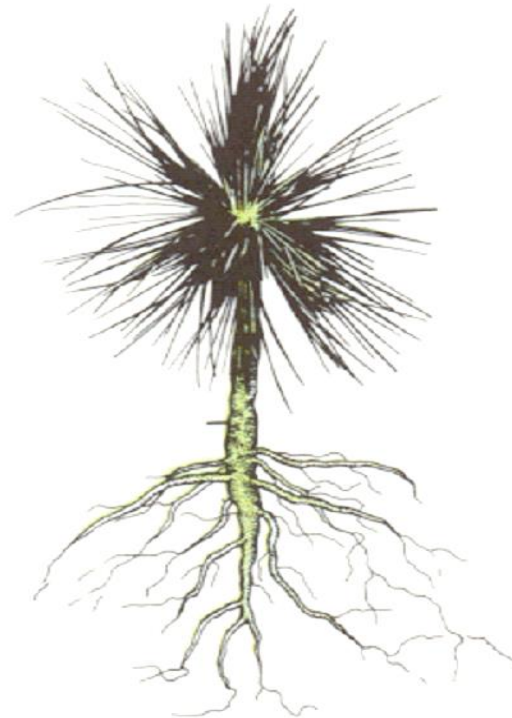
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YOUNG SPOROPHYTE



PINUS

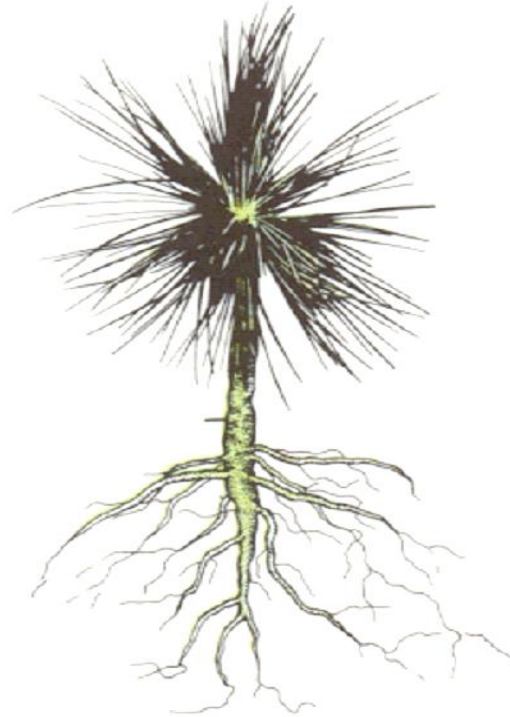
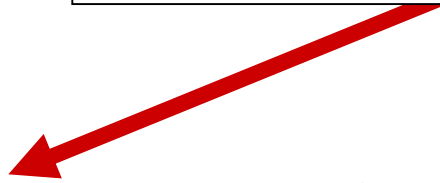
MITOSIS



PINUS



MATURE SPOROPHYTE



PINUS





FOSSIL RECORD



~230

MILLION YEARS



?



P

TRIASSIC



JURASSIC



CRETACEOUS



PERMIAN



TRIASSIC



JURASSIC



CRETACEOUS

PINOPHYTA EVOLVE

PERMIAN

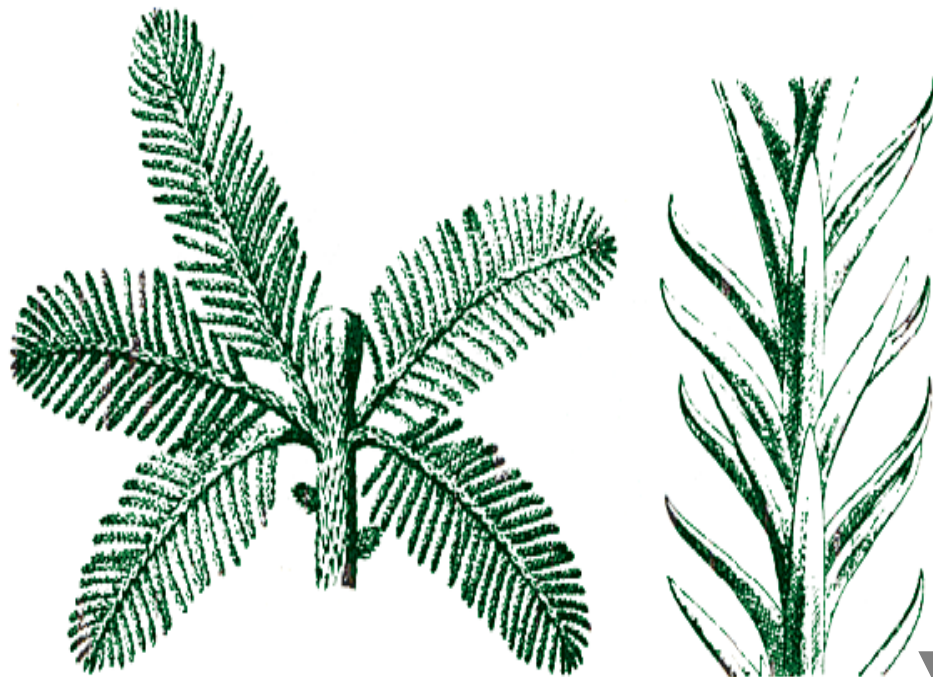
TRIASSIC

JURASSIC

CRETACEOUS

UTRECHTIA

PERMIAN



ARAUCARIA





~50

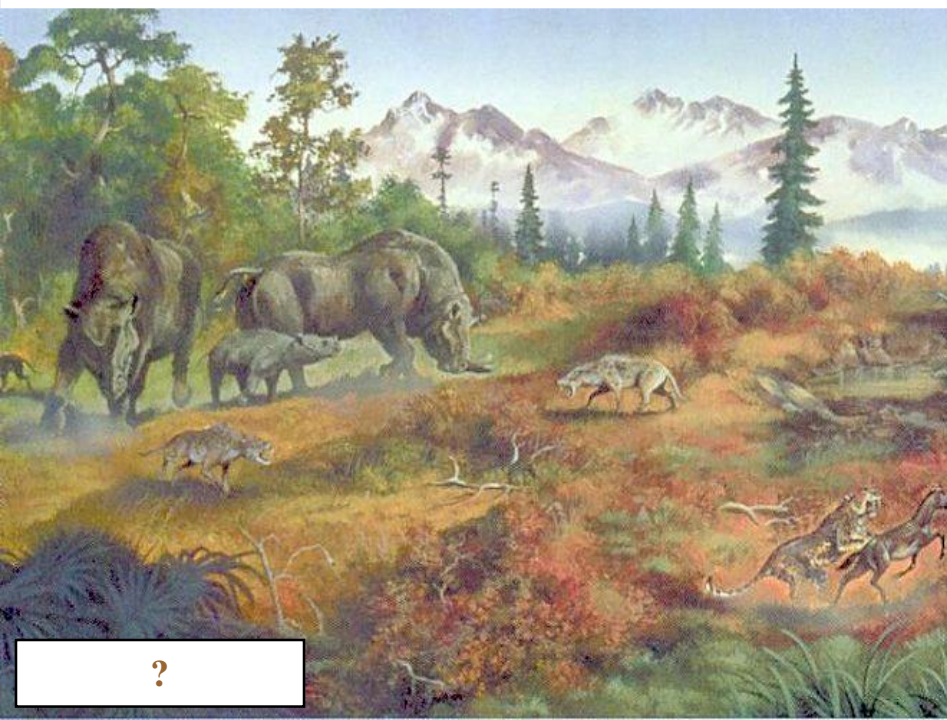
MILLION YEARS



JURASSIC



CRETACEOUS



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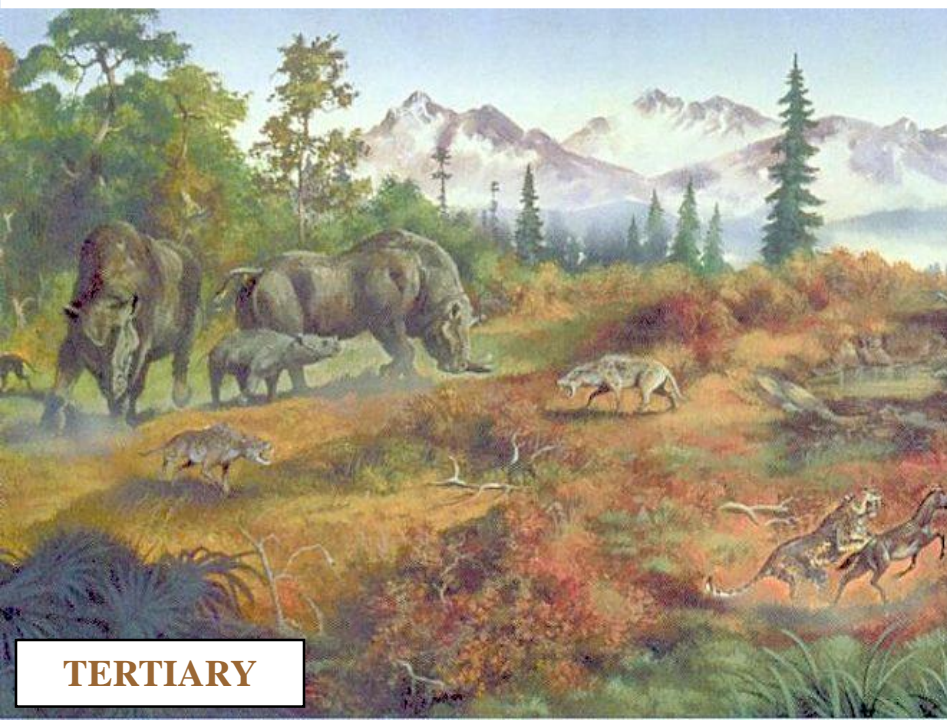
QUATERNARY



JURASSIC



CRETACEOUS



TERTIARY



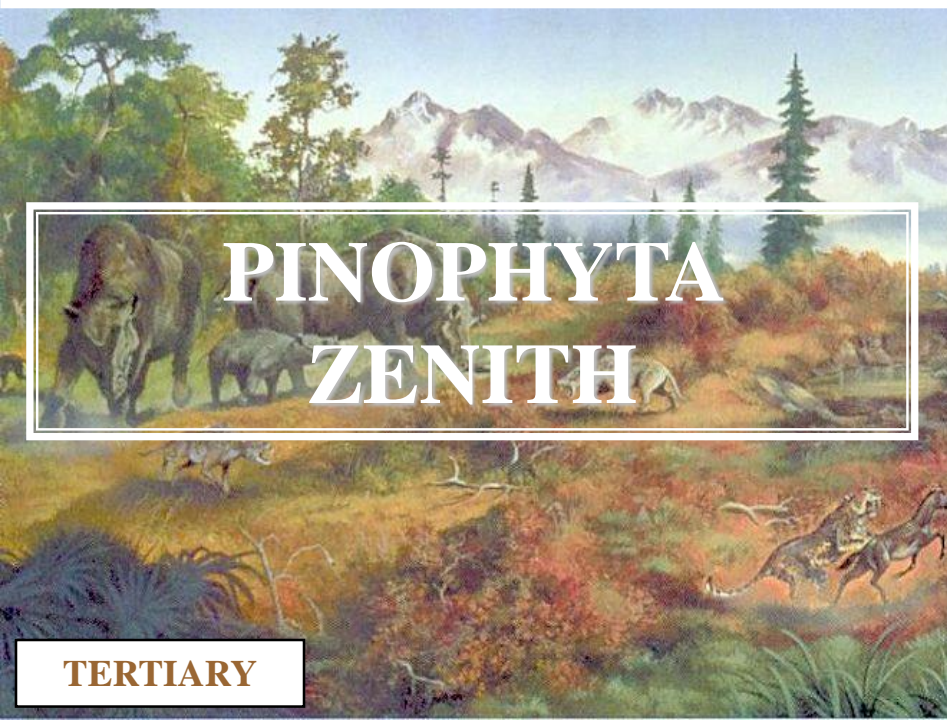
QUATERNARY



JURASSIC



CRETACEOUS



**PINOPHYTA
ZENITH**

TERTIARY



QUATERNARY

PHYLOGENETIC RELATIONSHIP



PTERIDOSPERMOPHYTA

MANOXYLIC WOOD

PYCNOXYLIC WOOD

CYCADOPHYTA

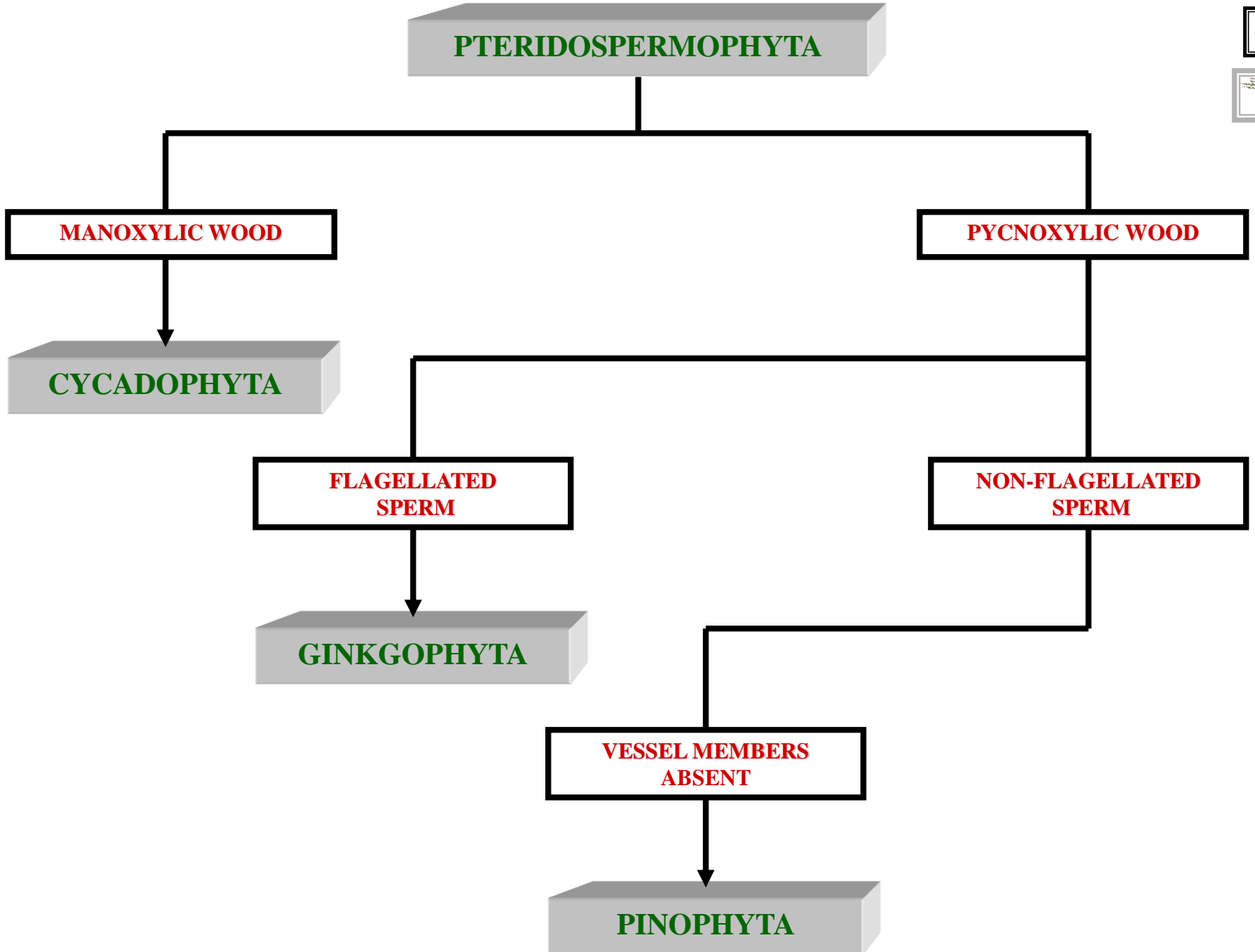
**FLAGELLATED
SPERM**

**NON-FLAGELLATED
SPERM**

GINKGOPHYTA

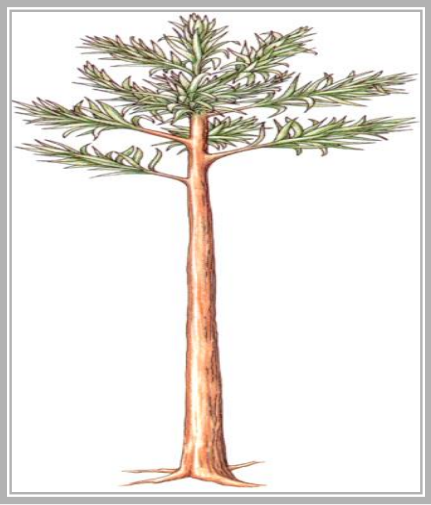
**VESSEL MEMBERS
ABSENT**

PINOPHYTA





PINOPHYTA EVOLUTION



LYGINOPTERIS

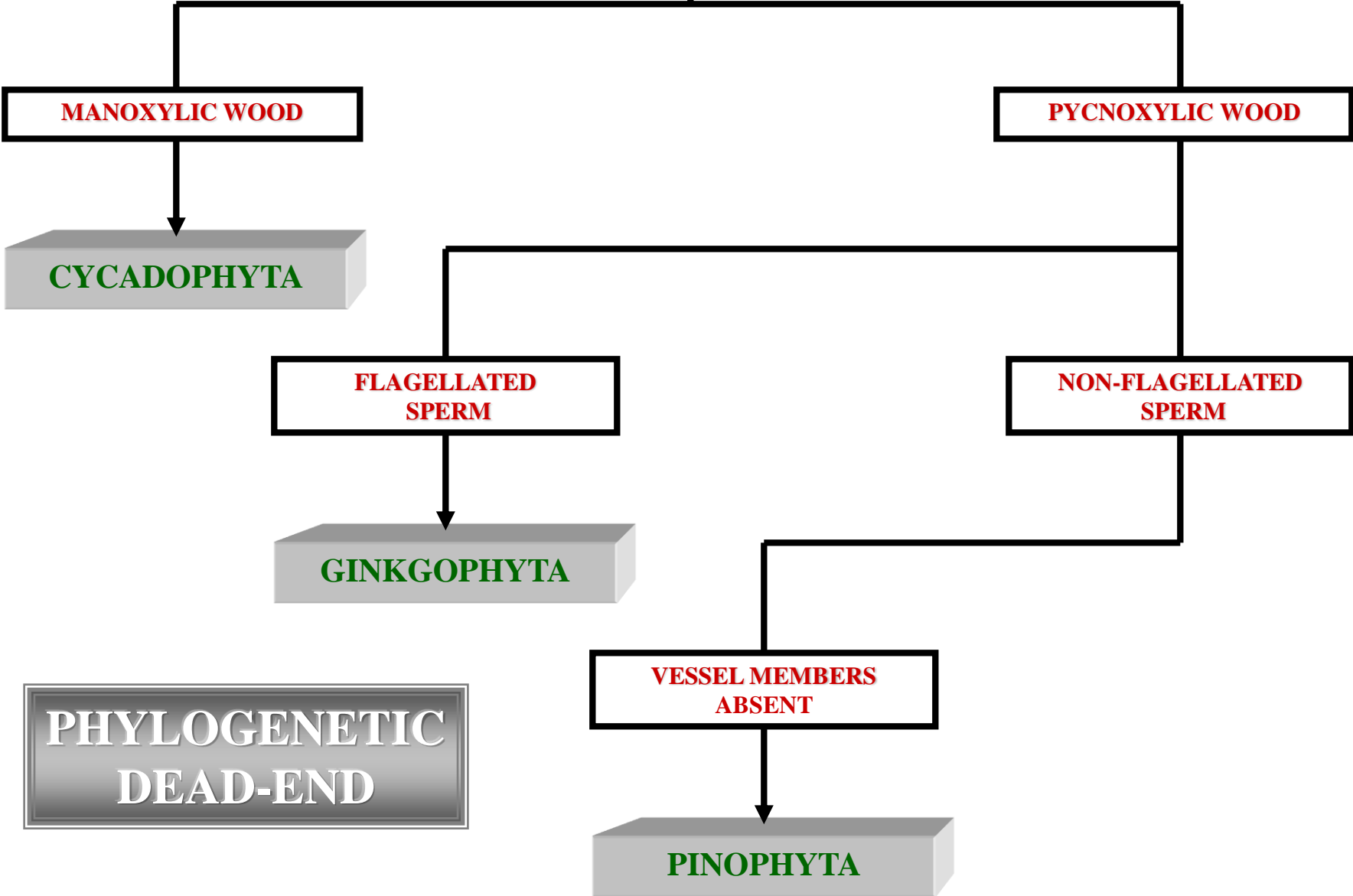
CORDAITES

PINOPHYTA

PTERIDOSPERM

PTERIDOSPERM

PTERIDOSPERMOPHYTA



**PHYLOGENETIC
DEAD-END**



VASCULAR PLANT EVOLUTION



**~200
MILLION YEARS**



GNETOPHYTA EVOLVE



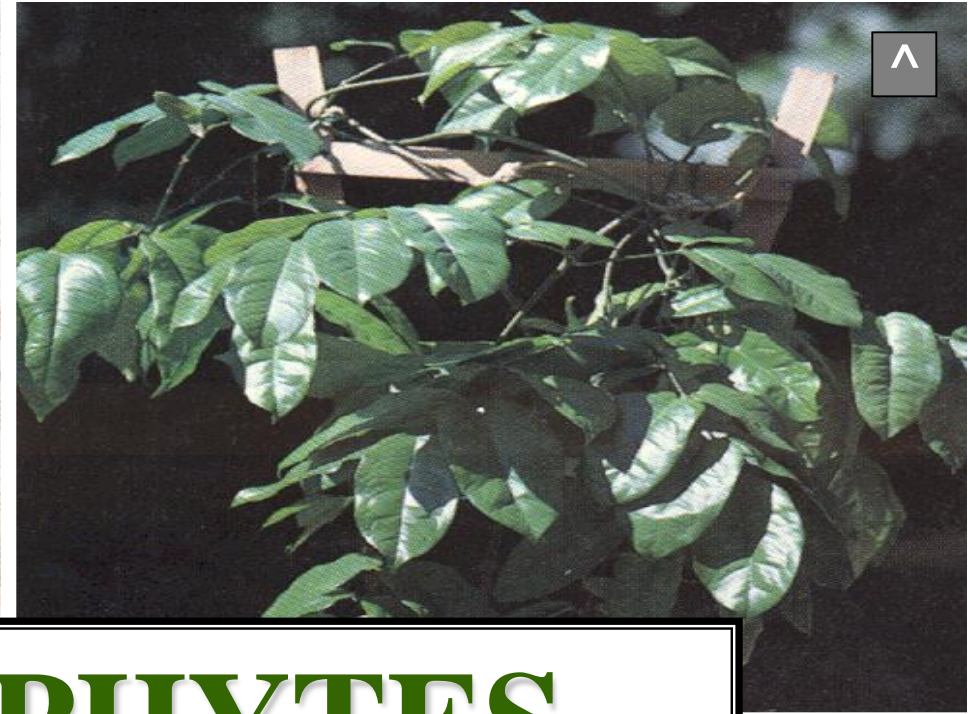


**EXTANT
PHYLUM**

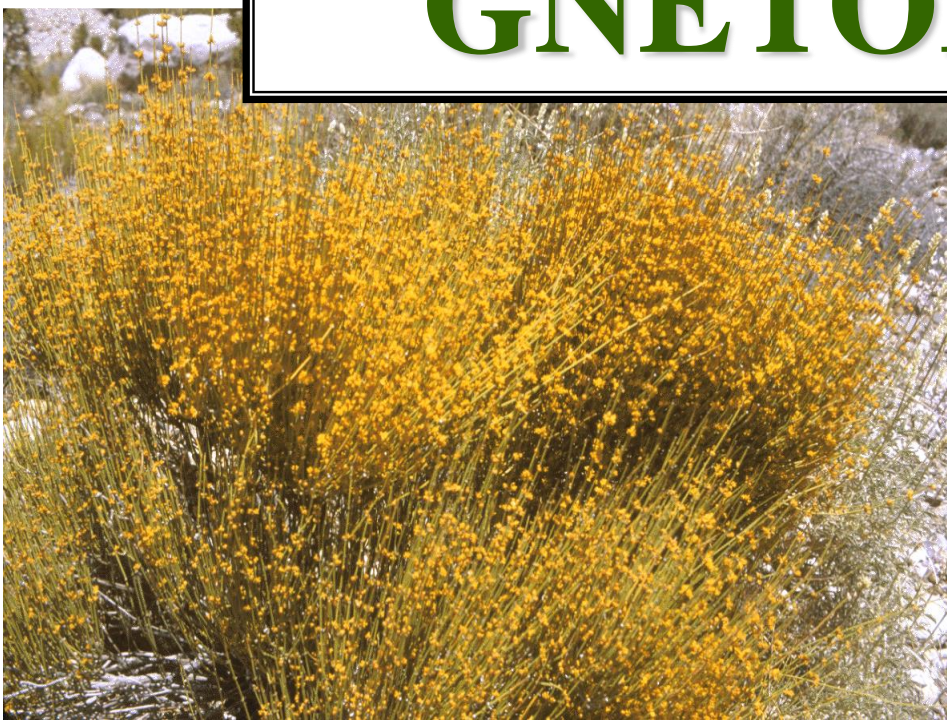
**PHYLUM
GNETOPHYTA**

**EXTANT
PHYLUM**

COMMON NAME



GNETOPHYTES





DIVERSITY