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MEGASPORANGIUM

MICROPYLE

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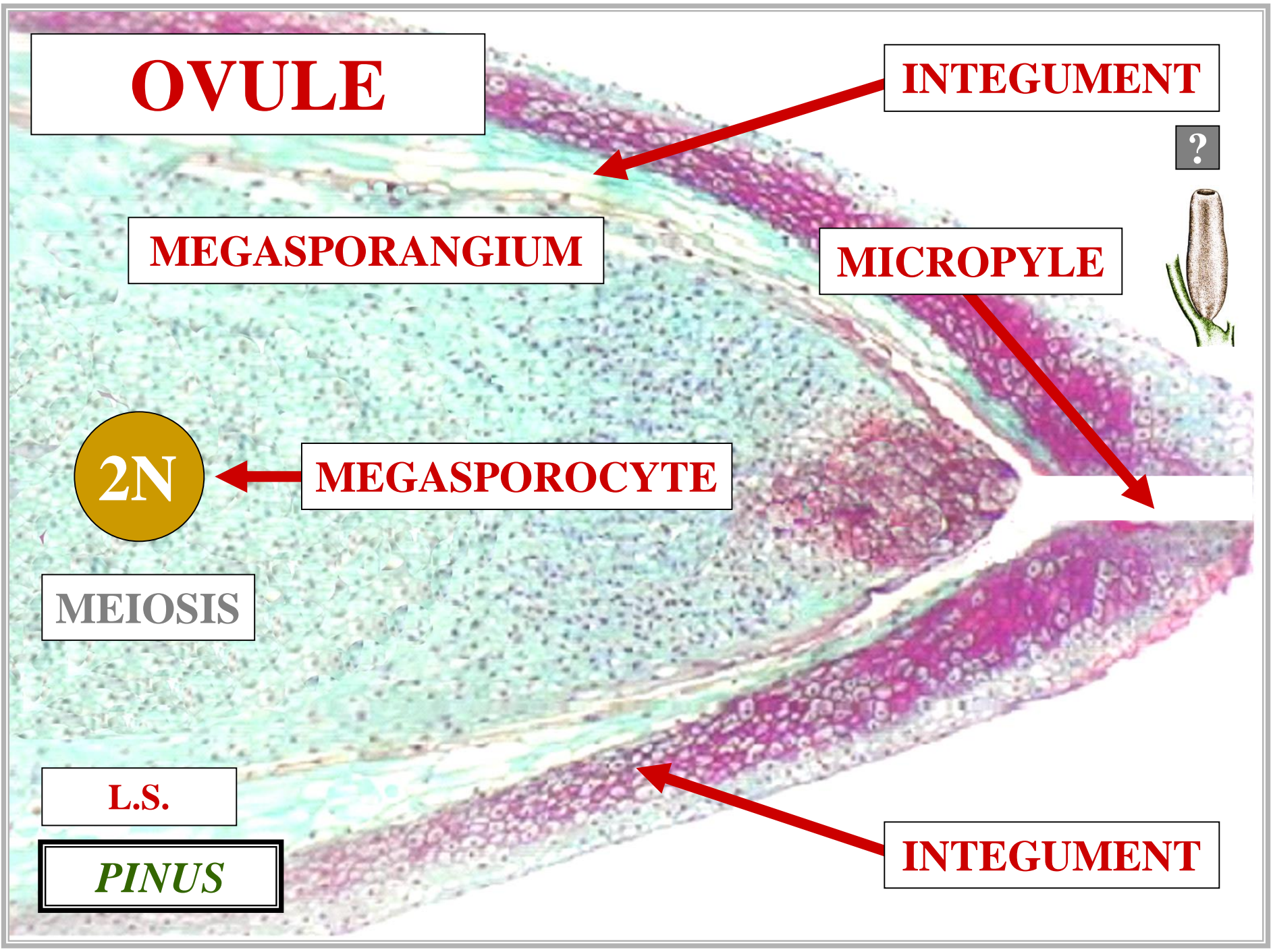
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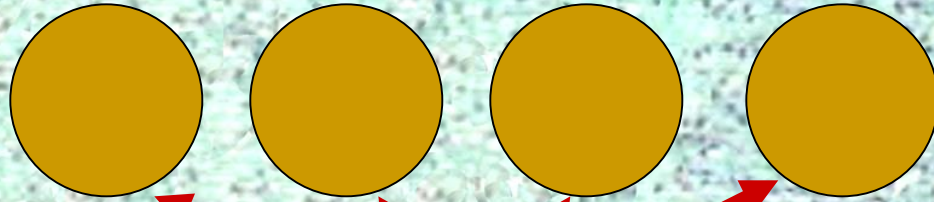
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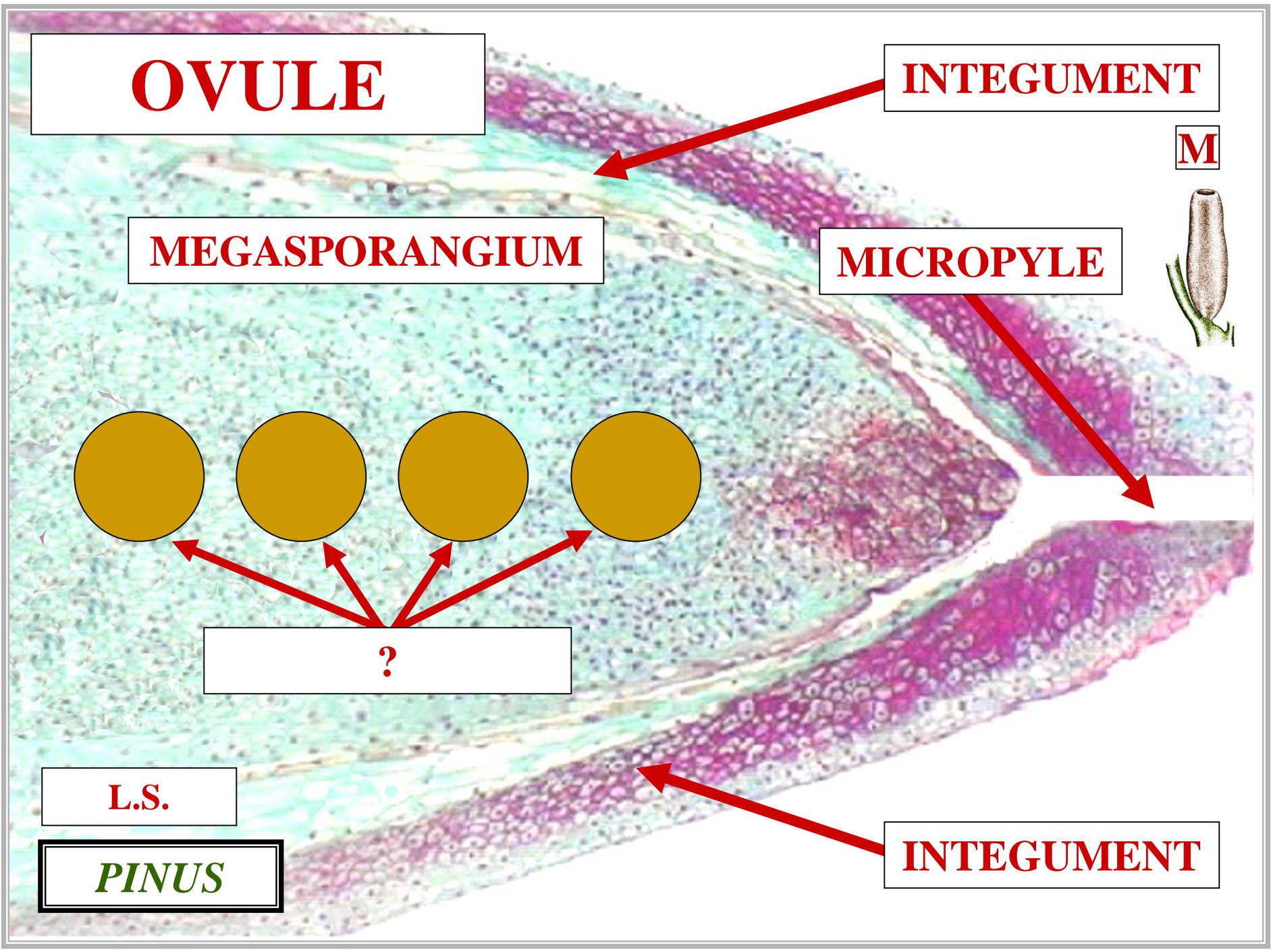


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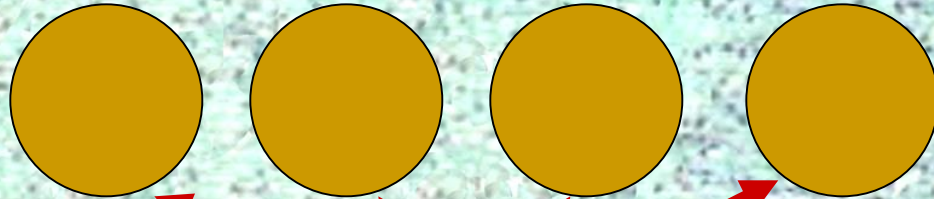
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MICROPYLE

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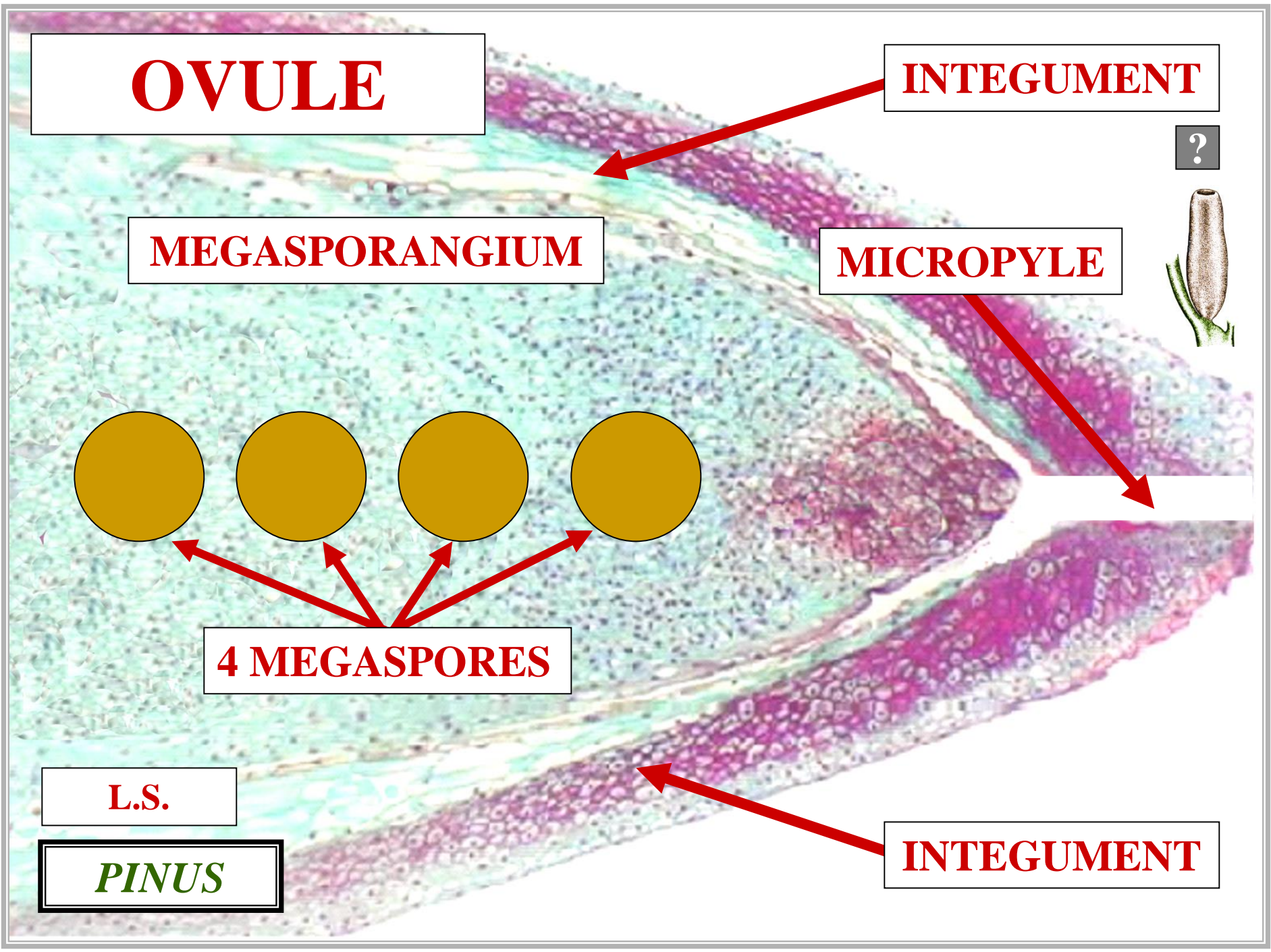


4 MEGASPORES

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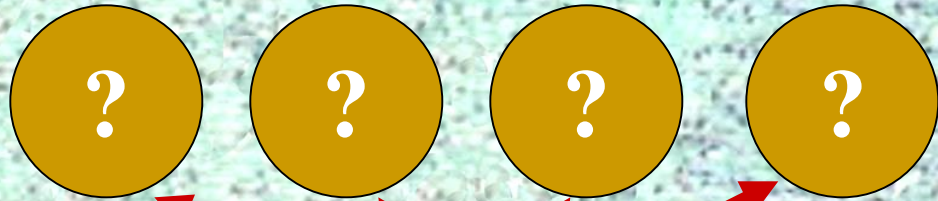
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MICROPYLE

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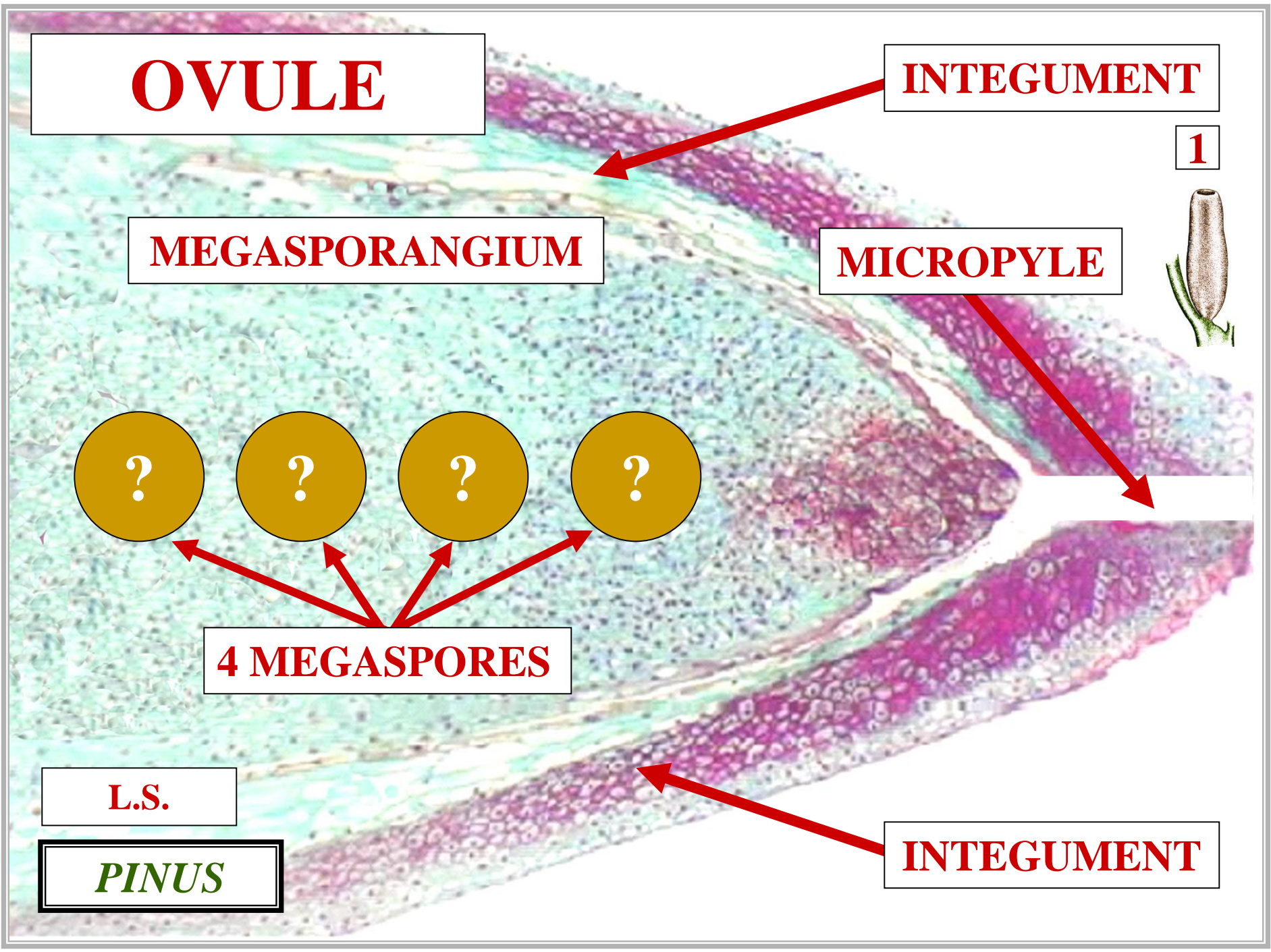


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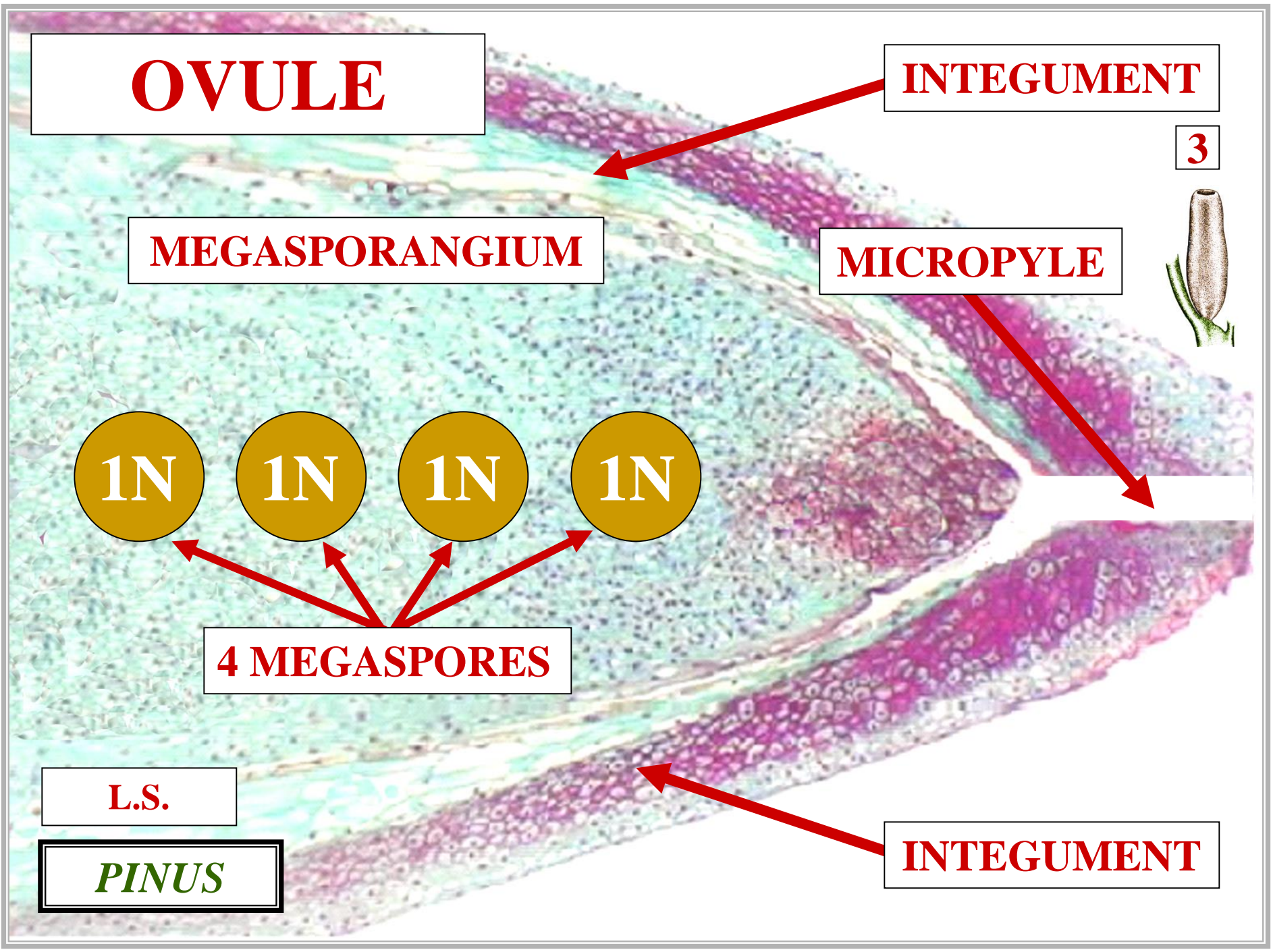


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MEGASPORANGIUM

MICROPYLE

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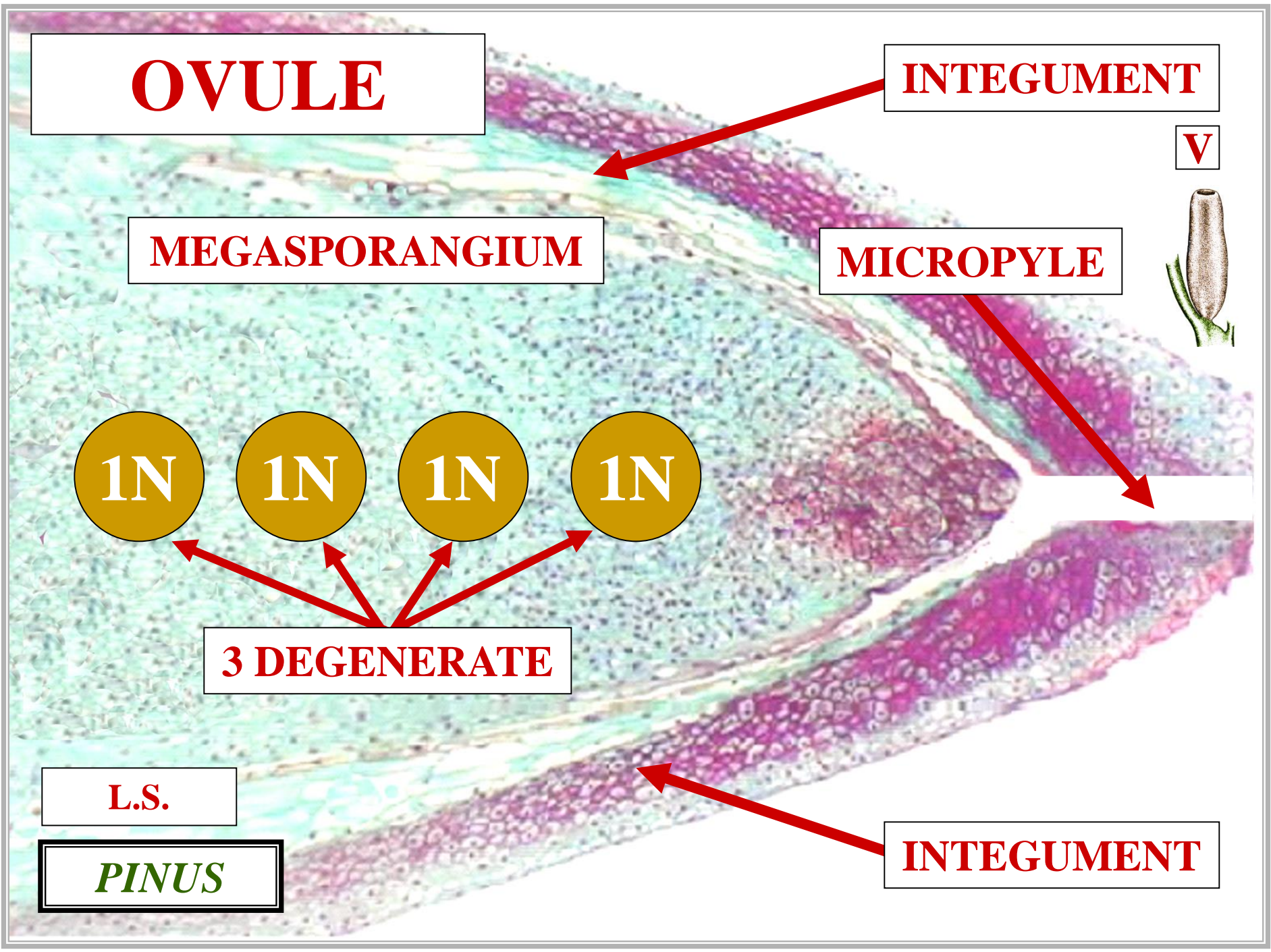


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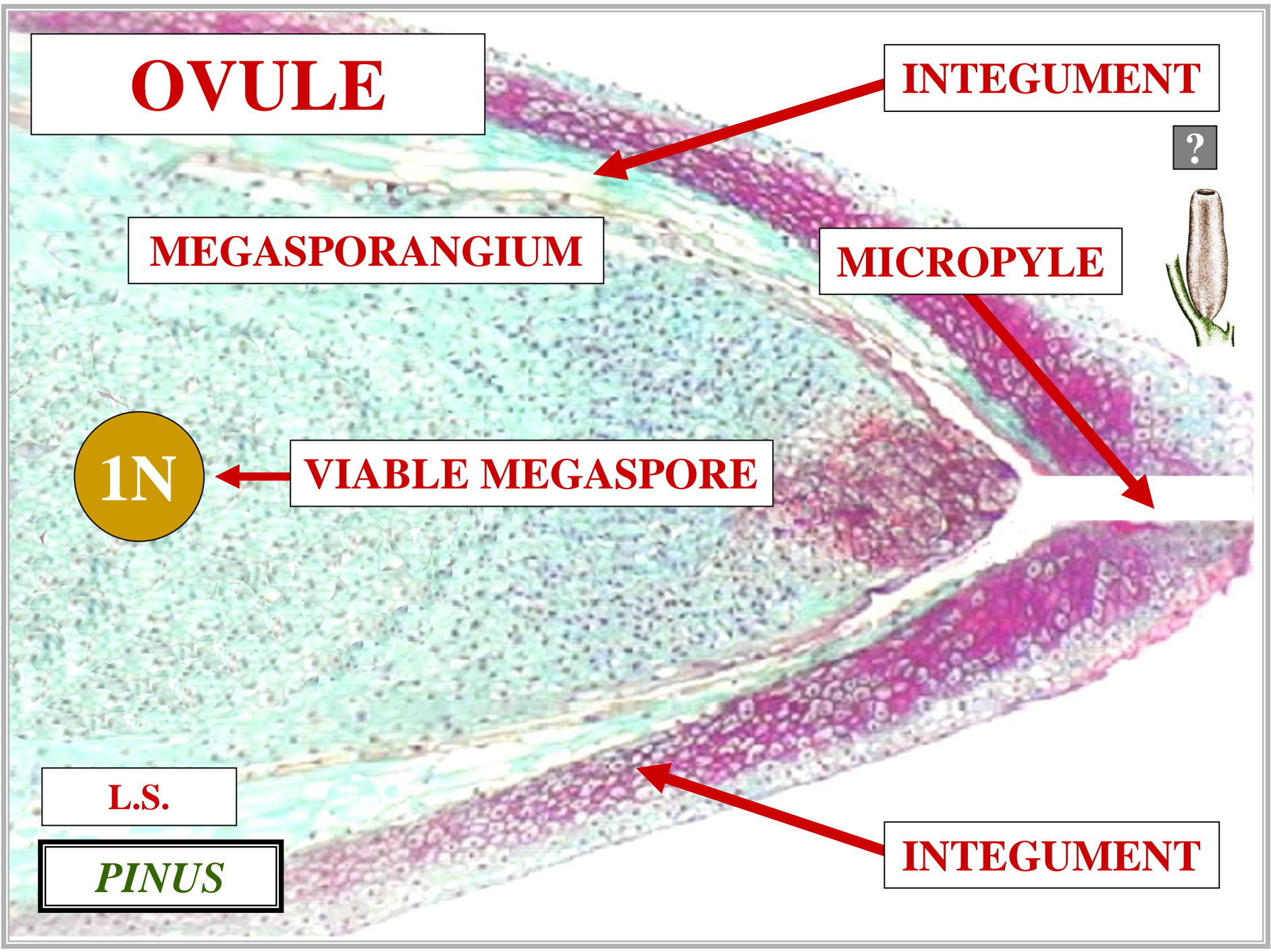
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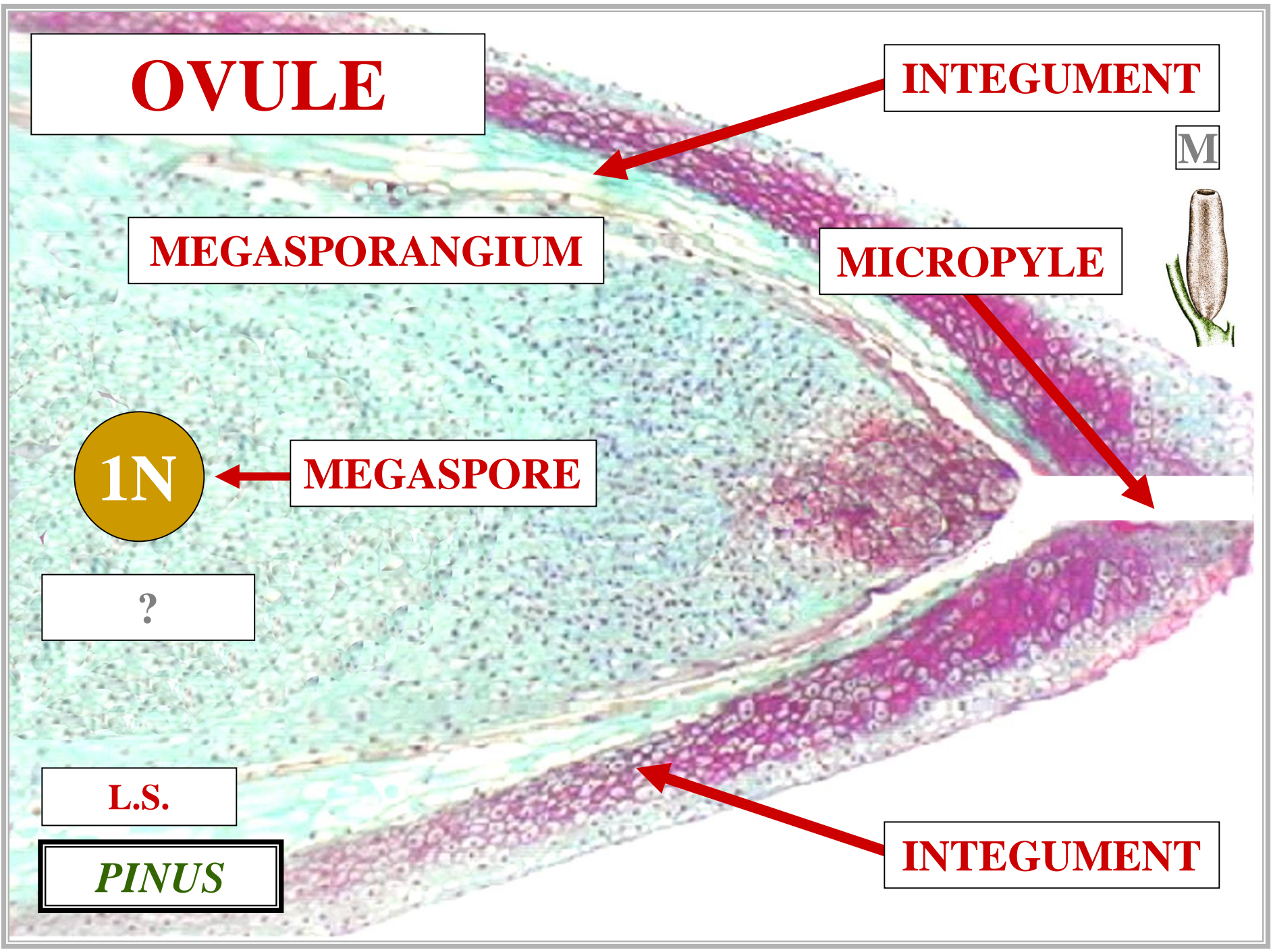
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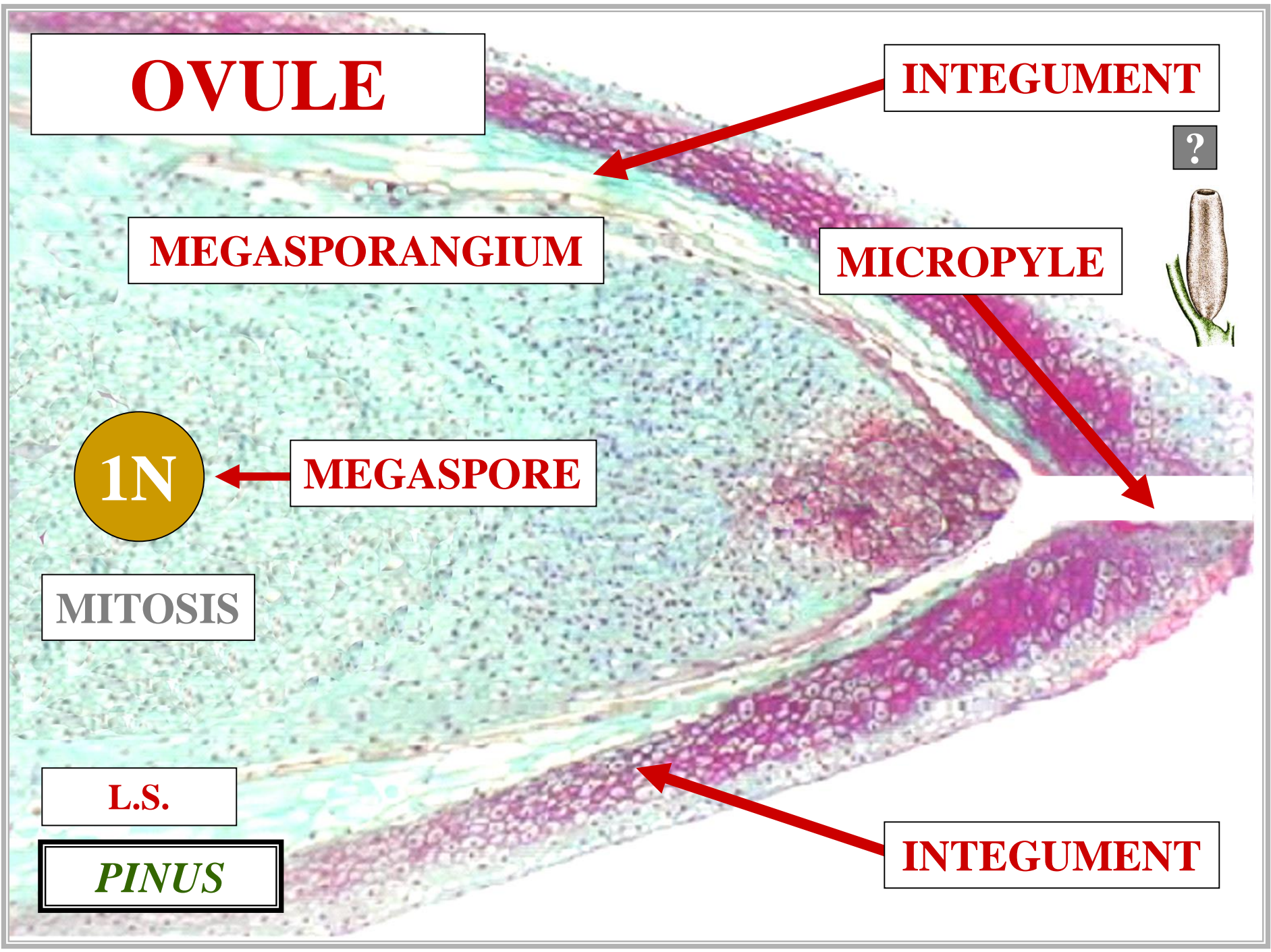
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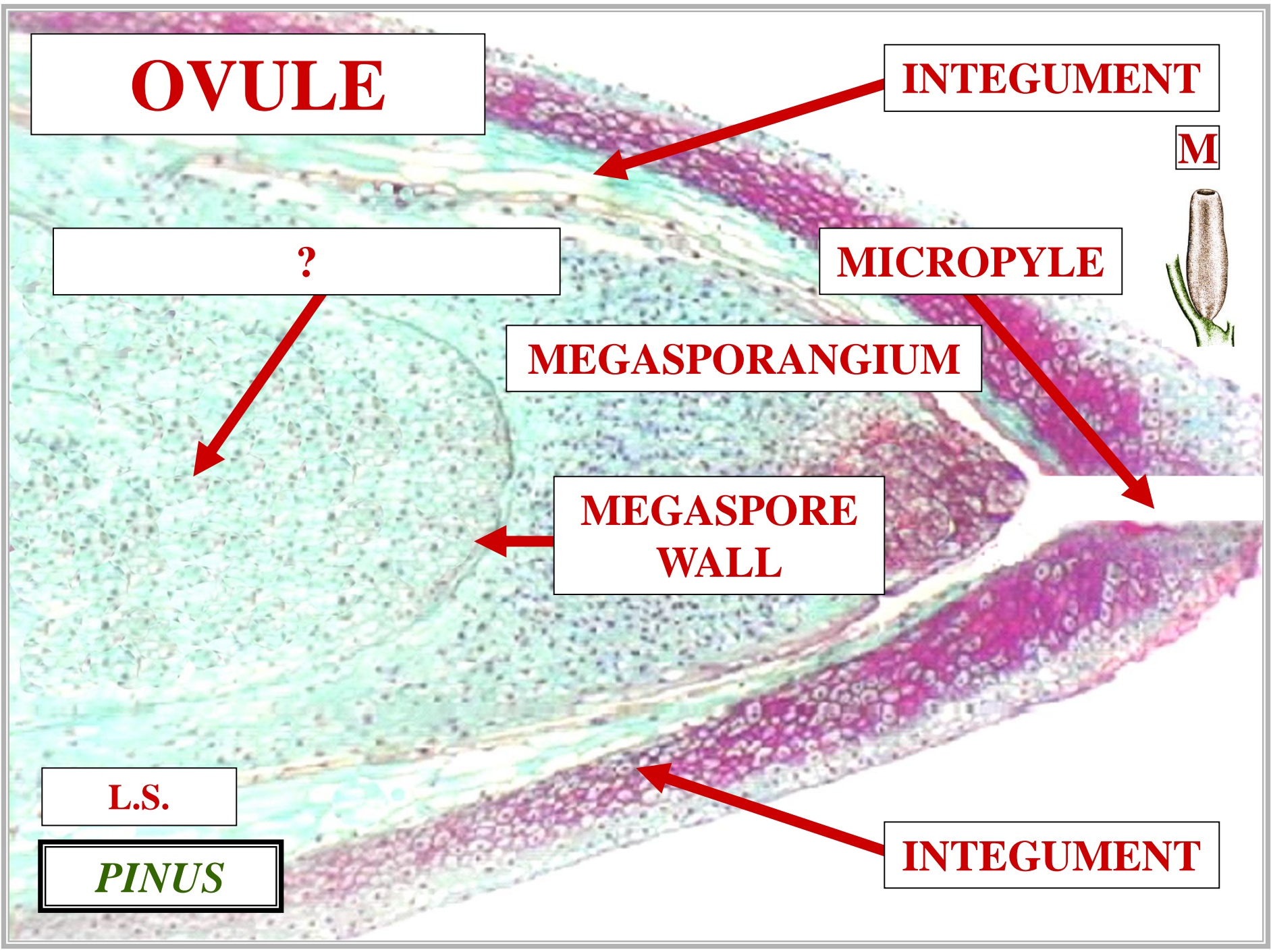
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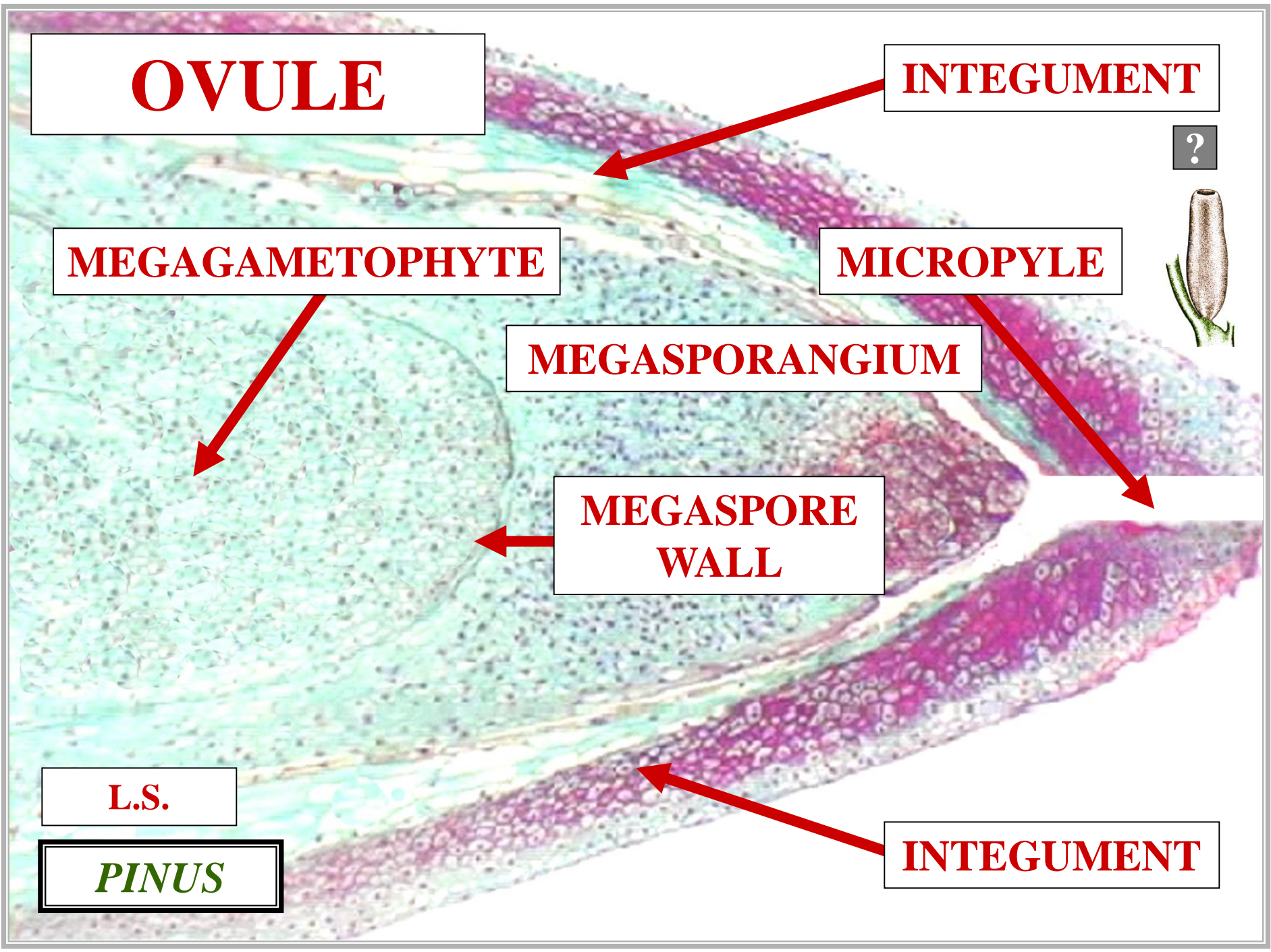
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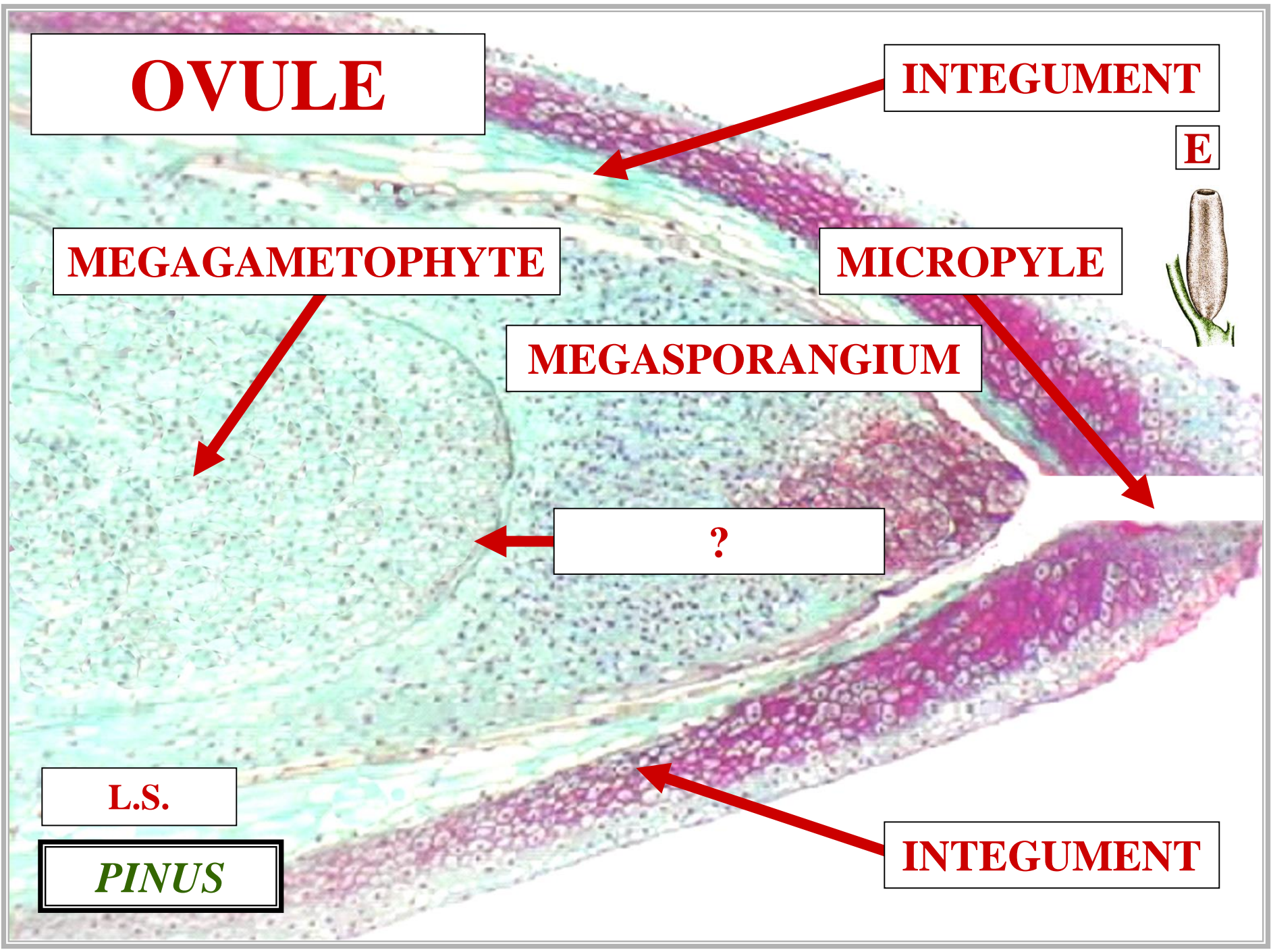
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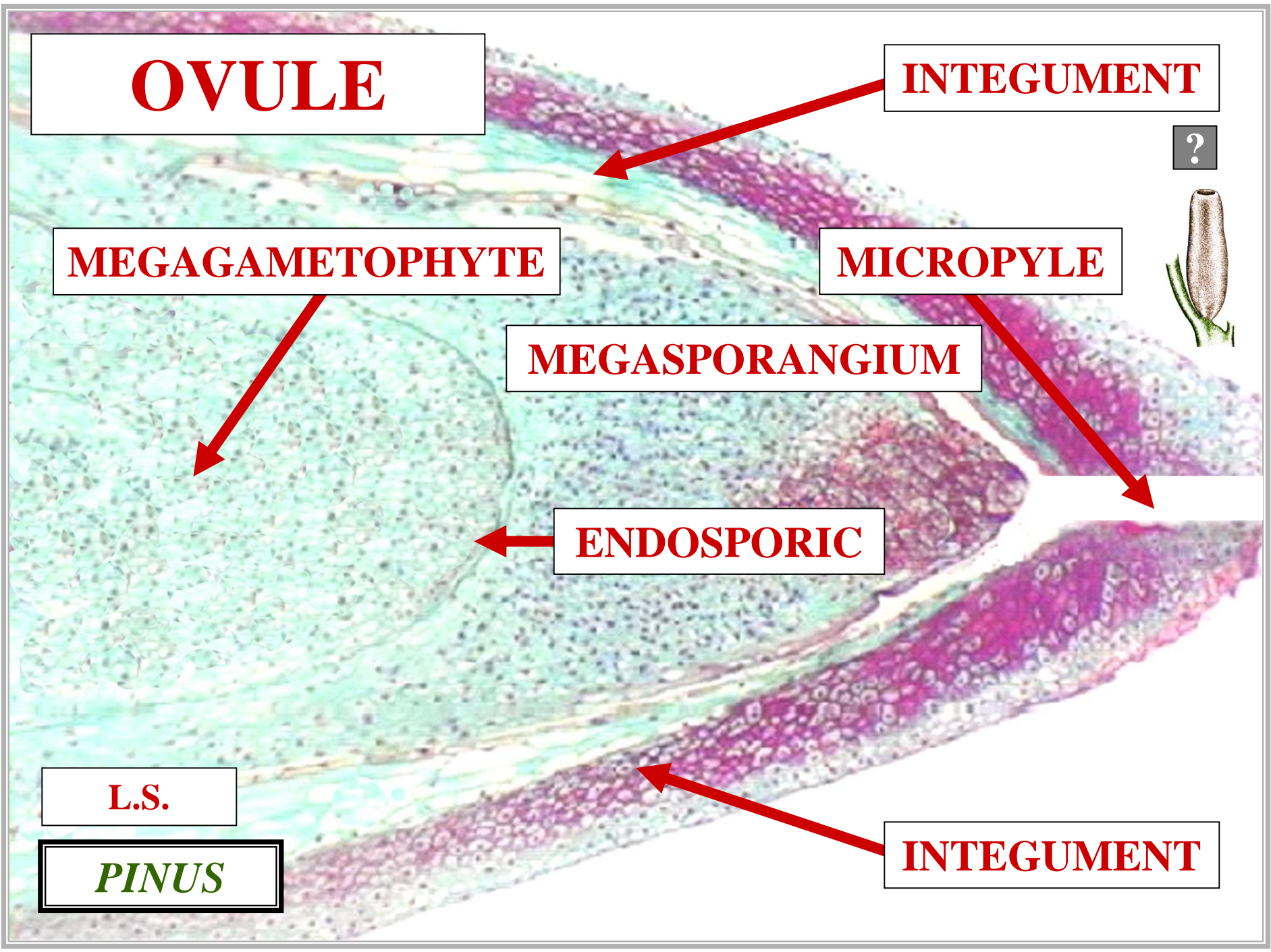
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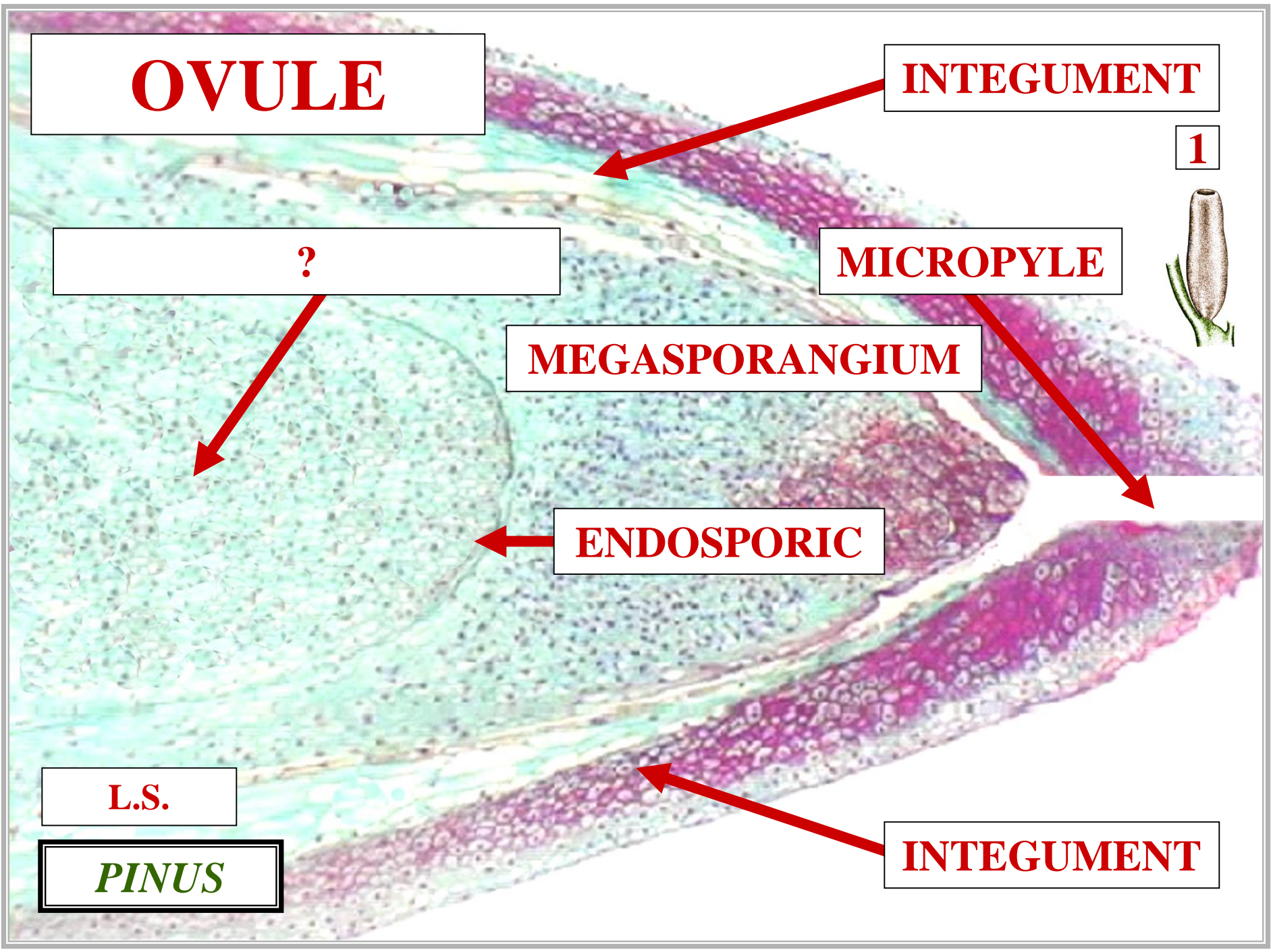
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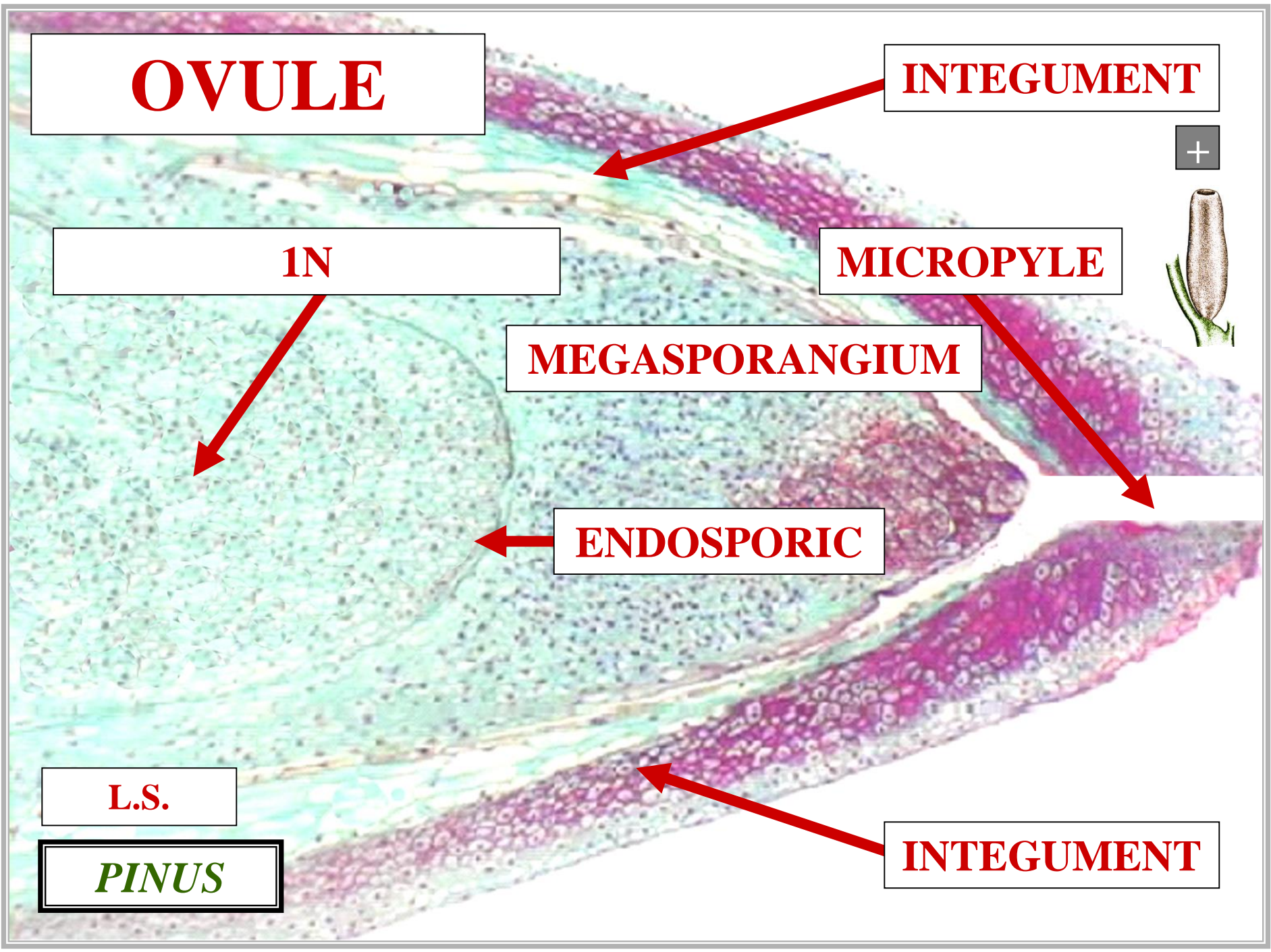
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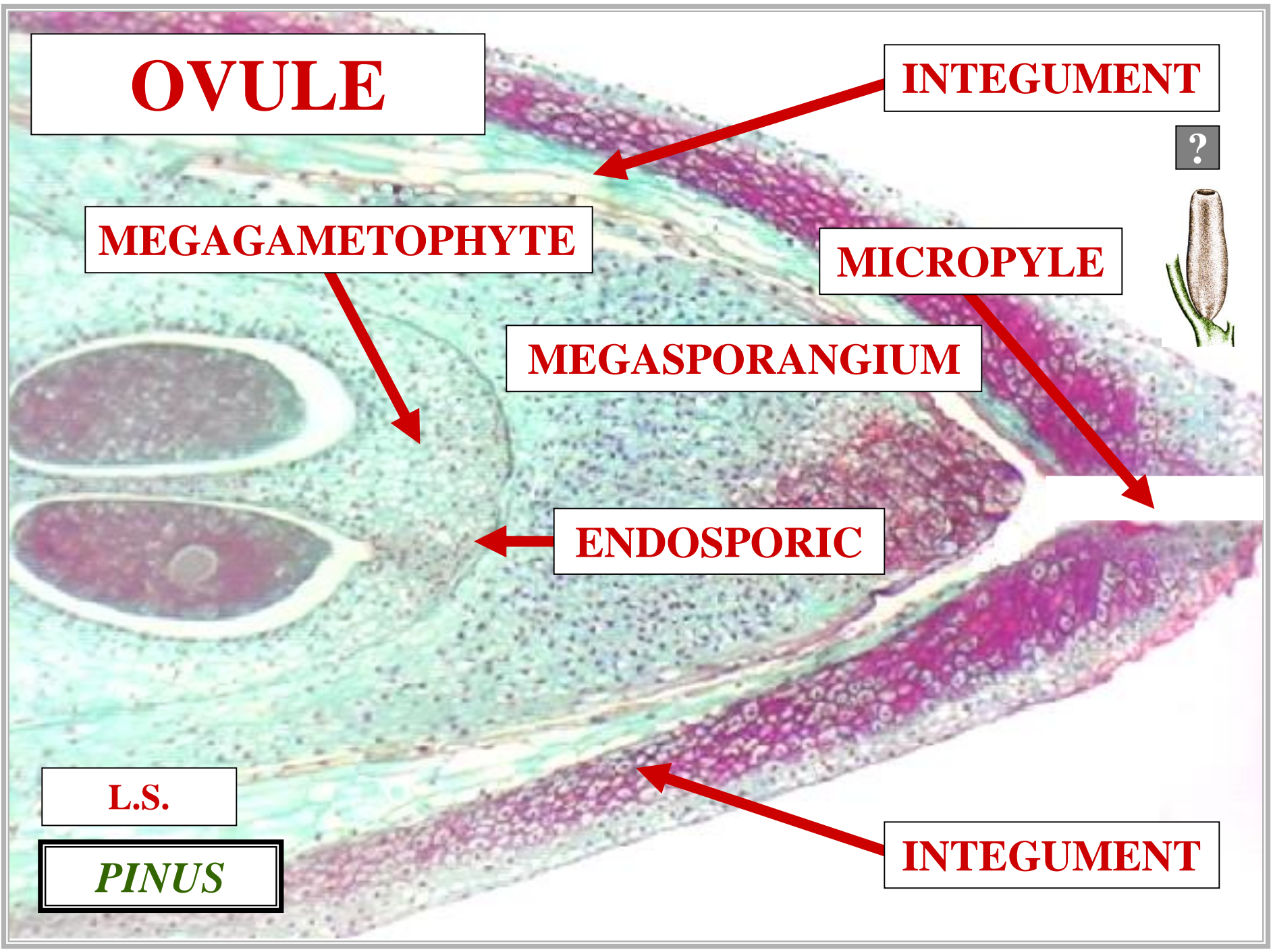
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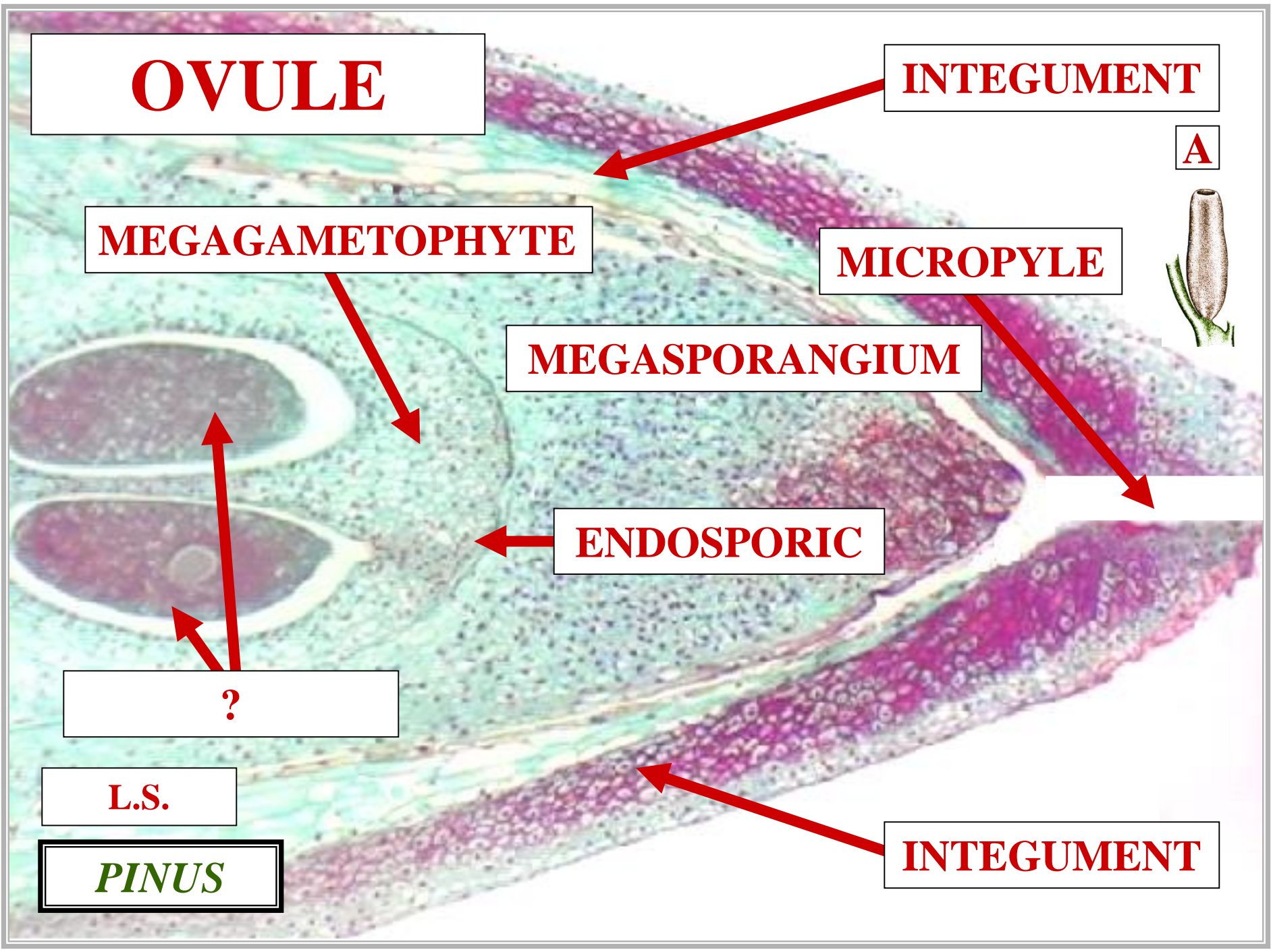
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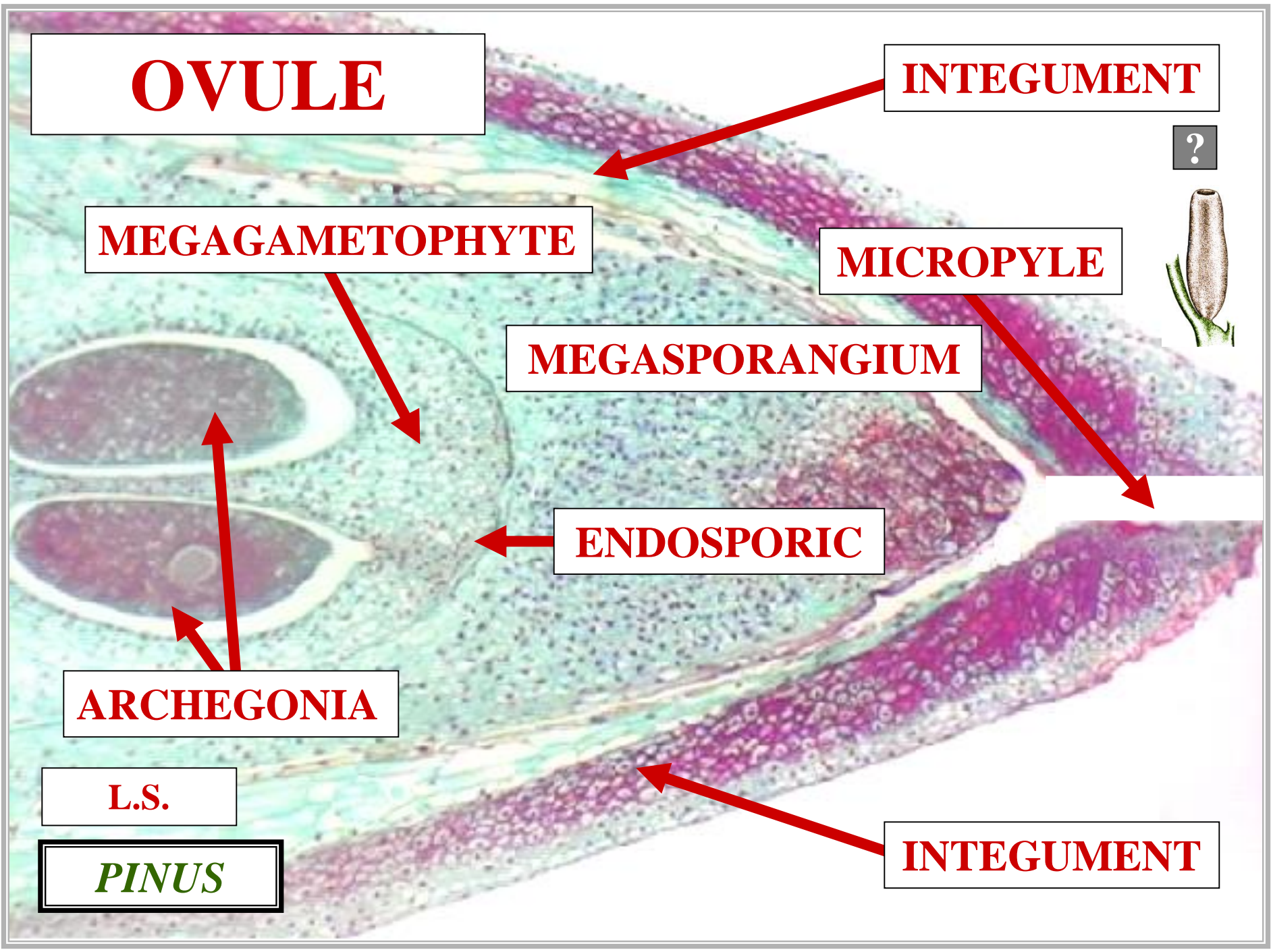
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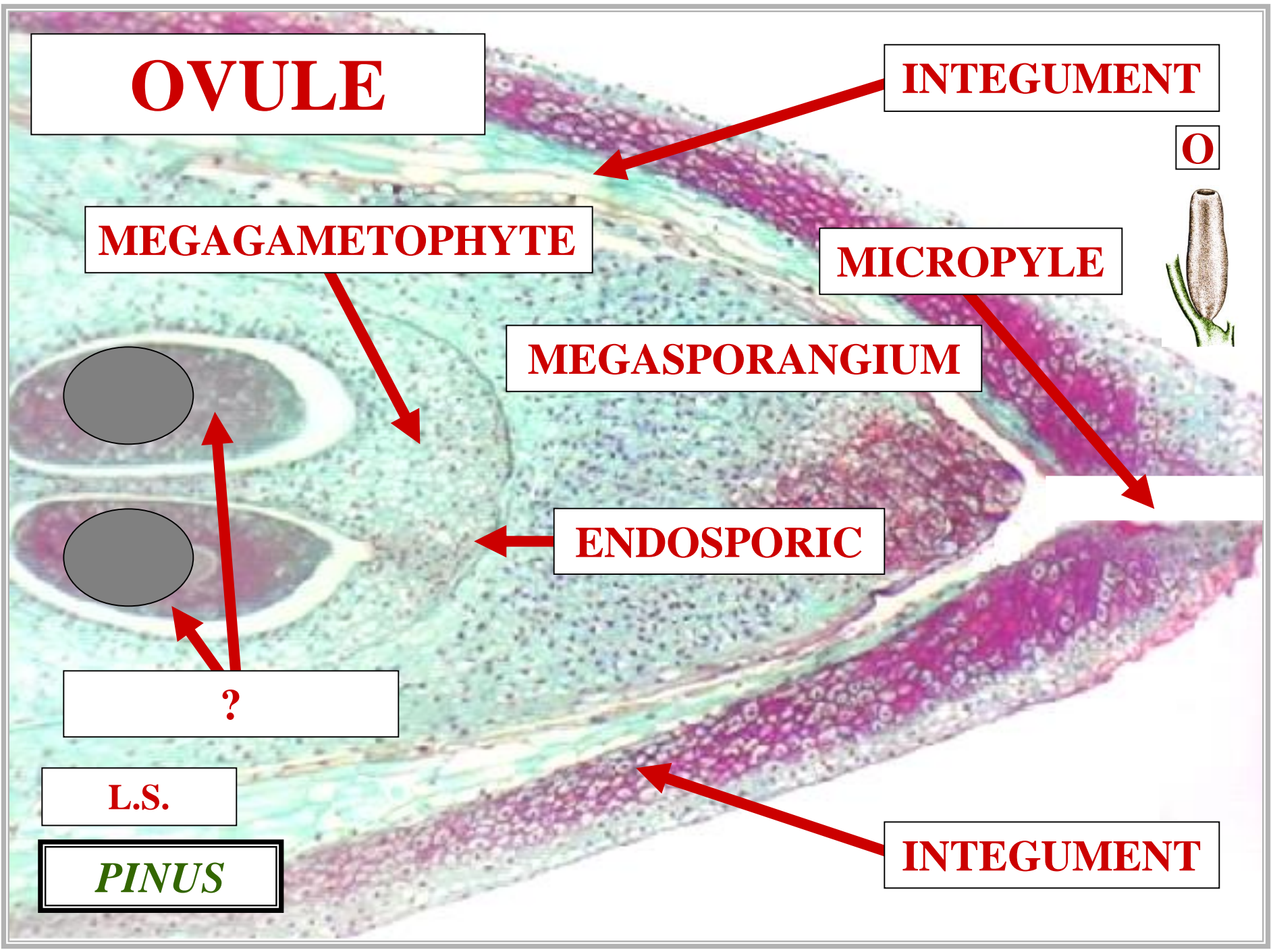
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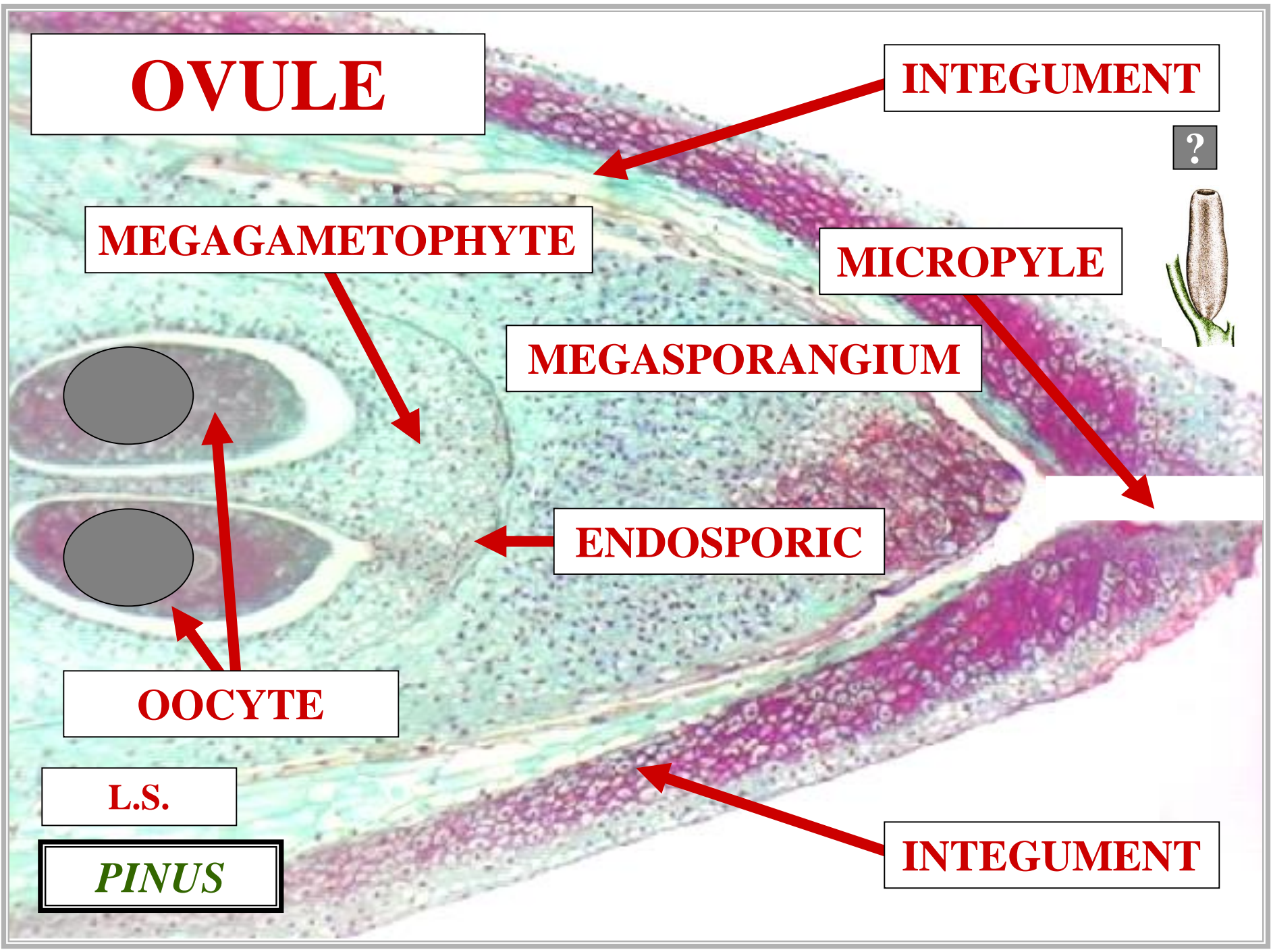
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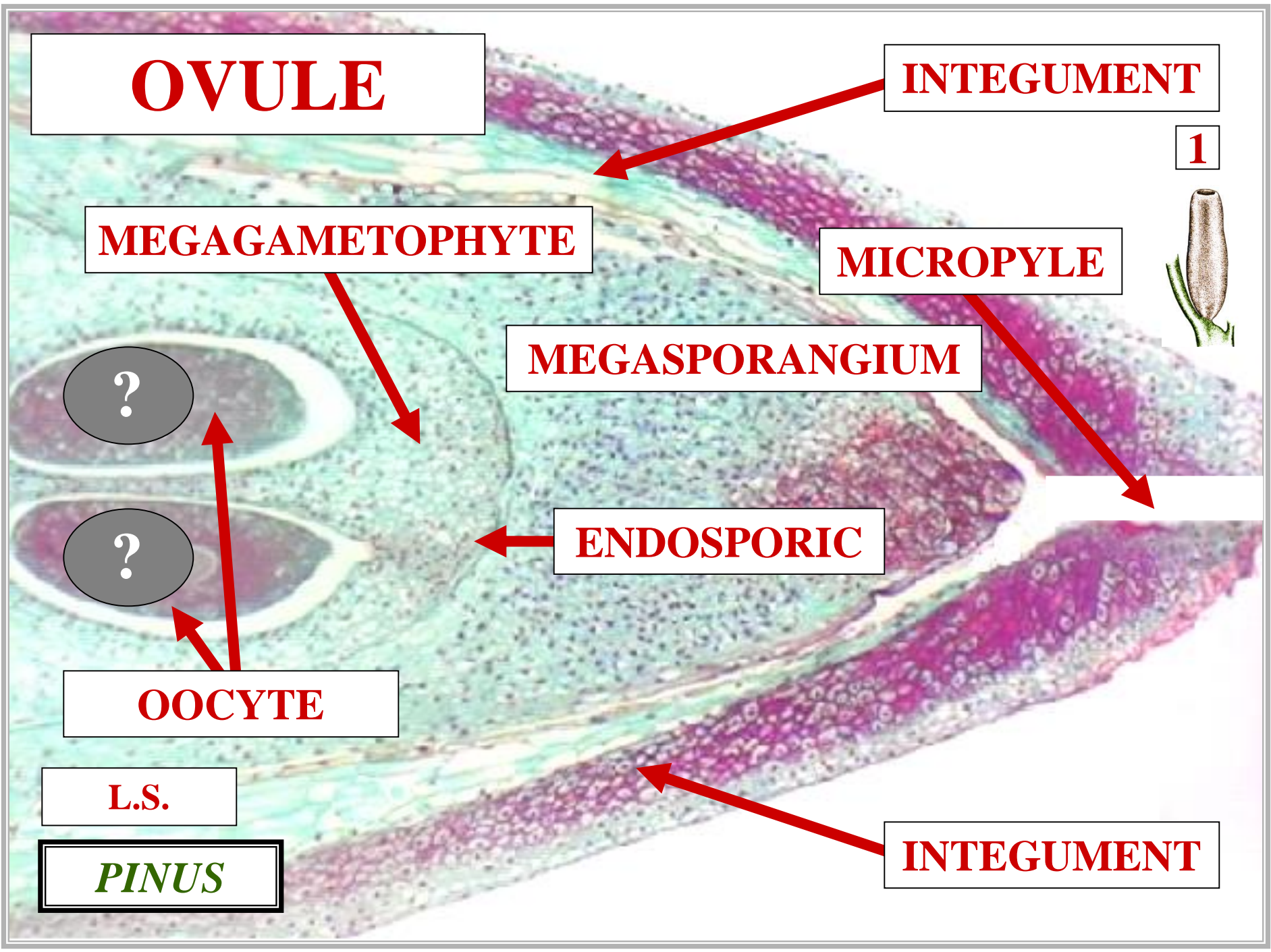
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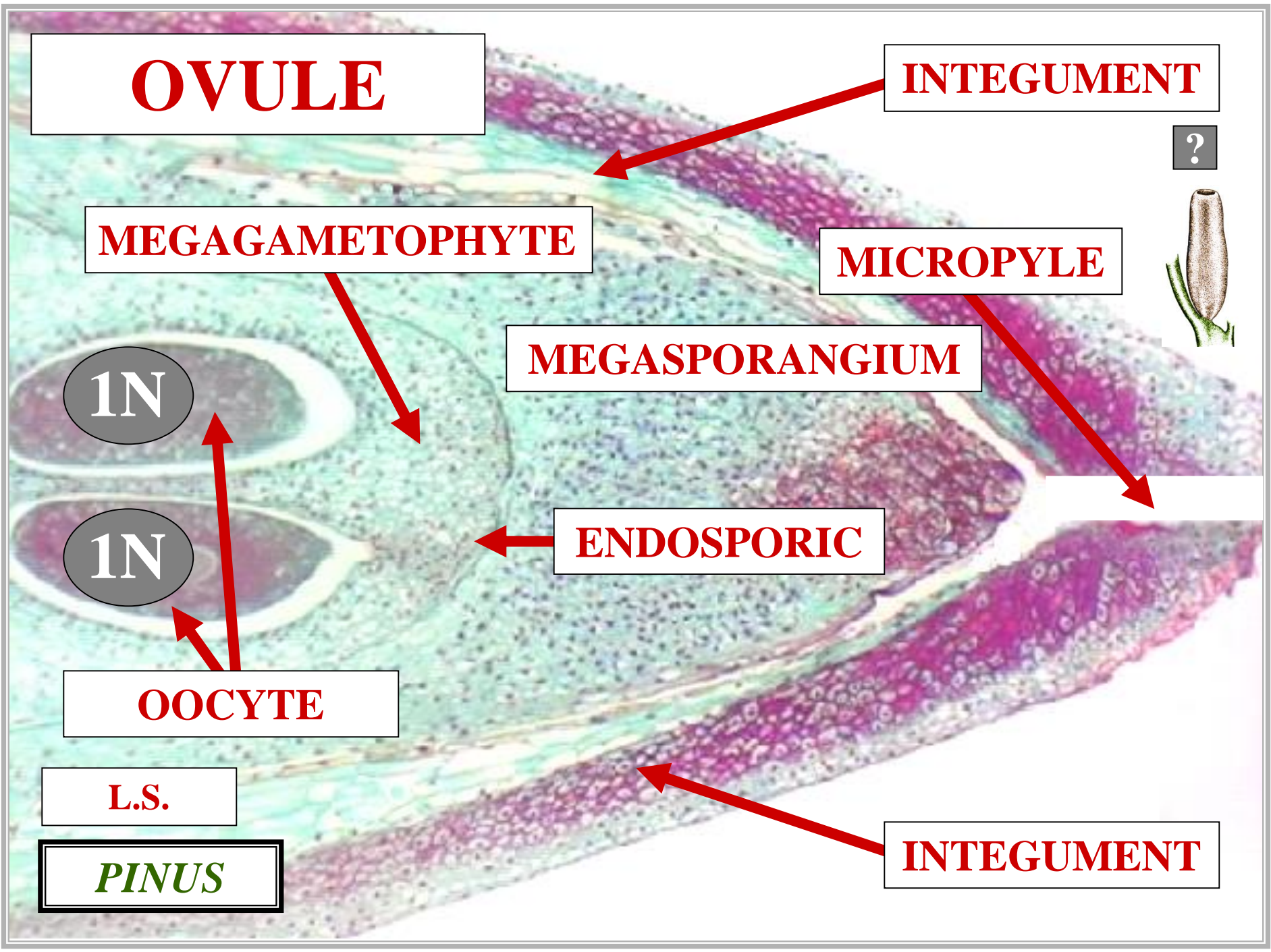
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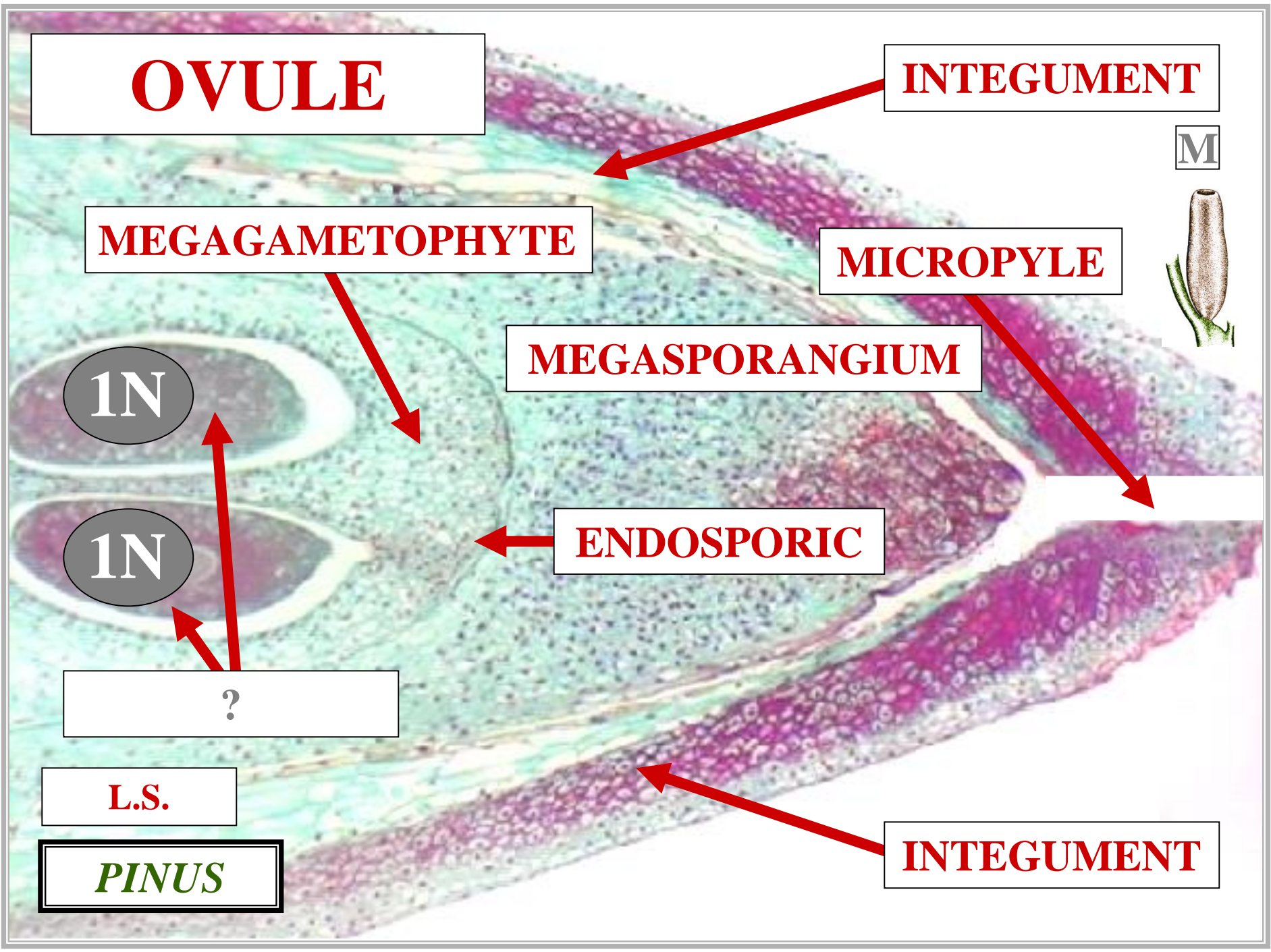
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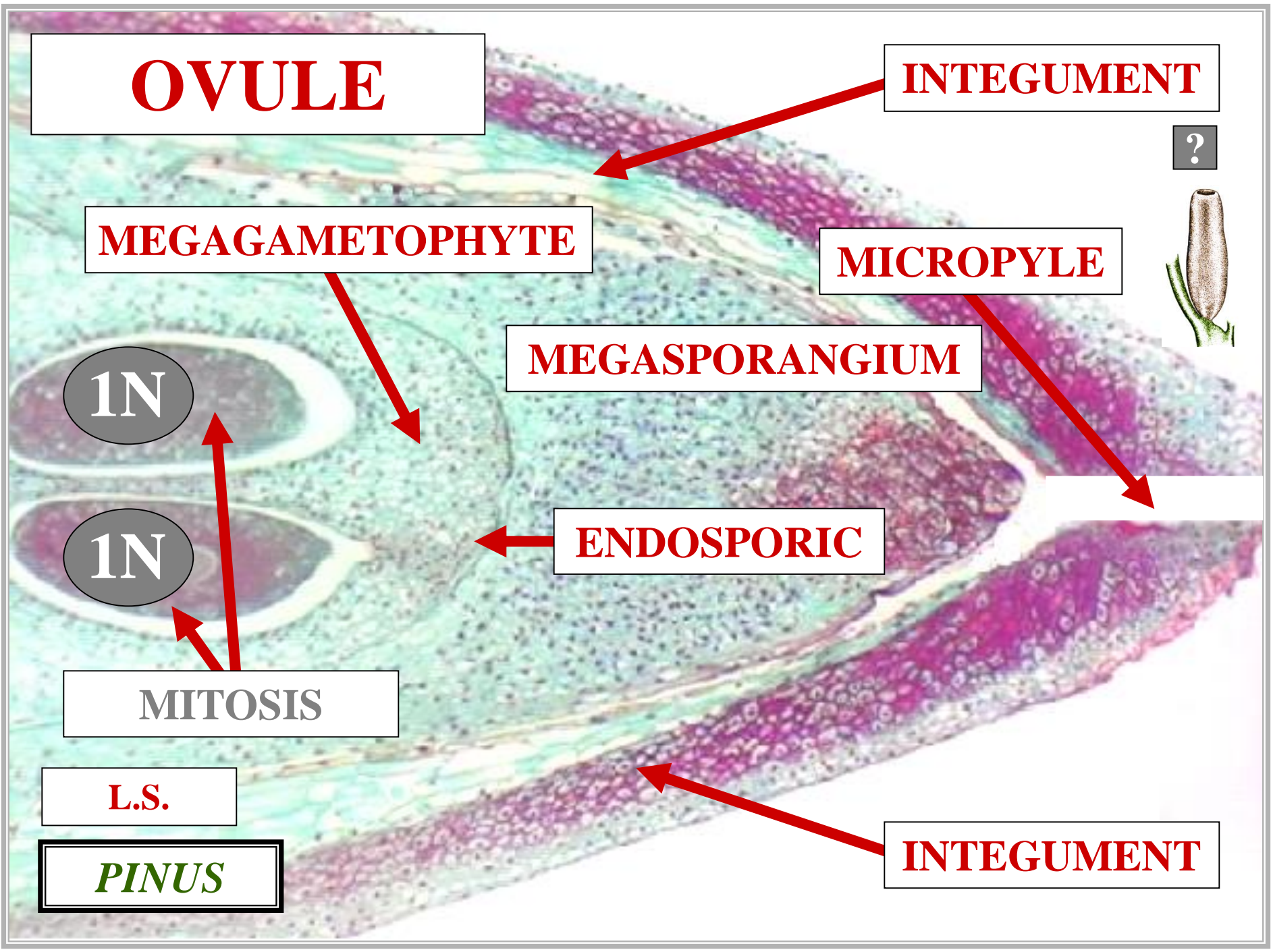
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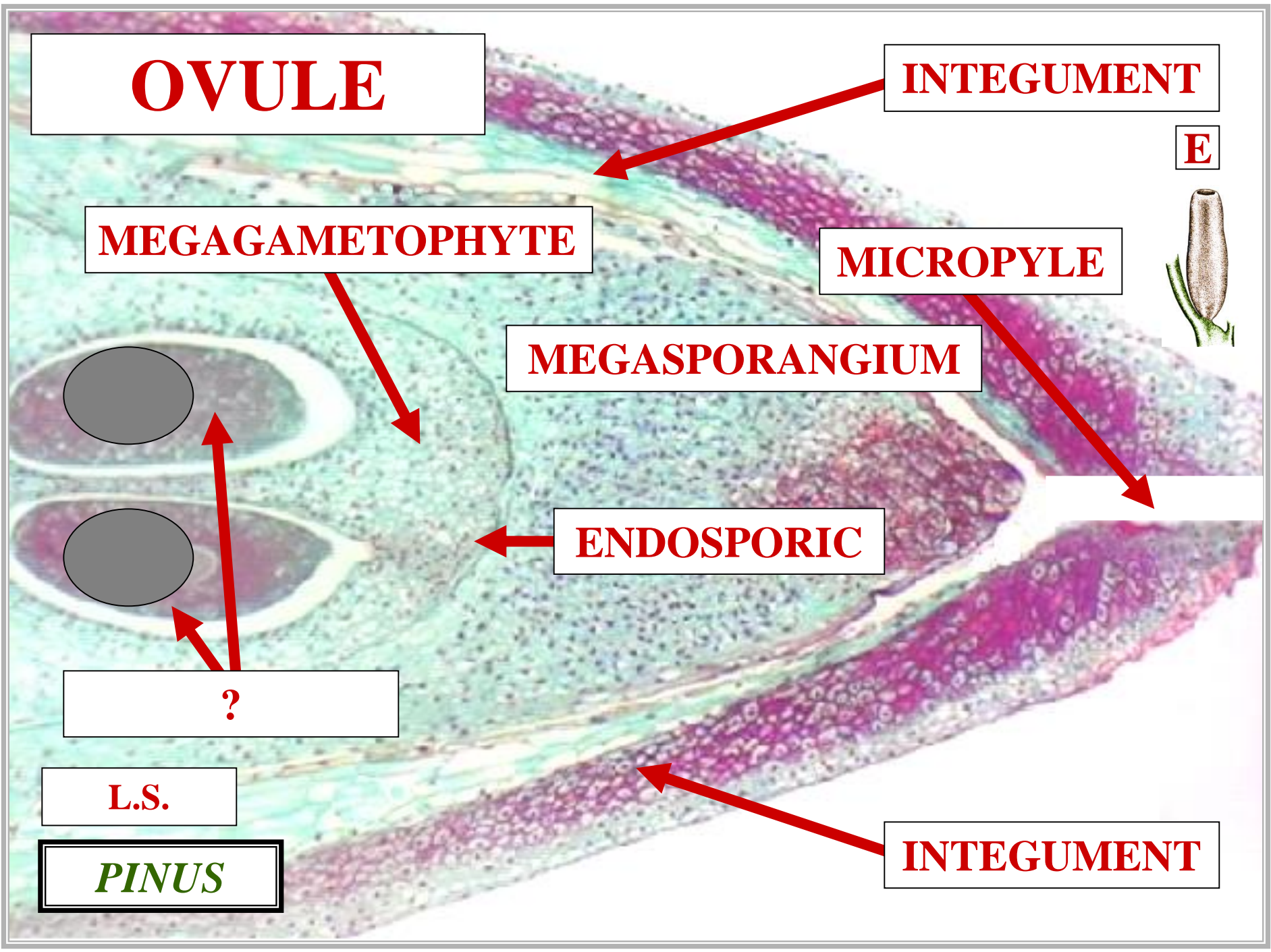
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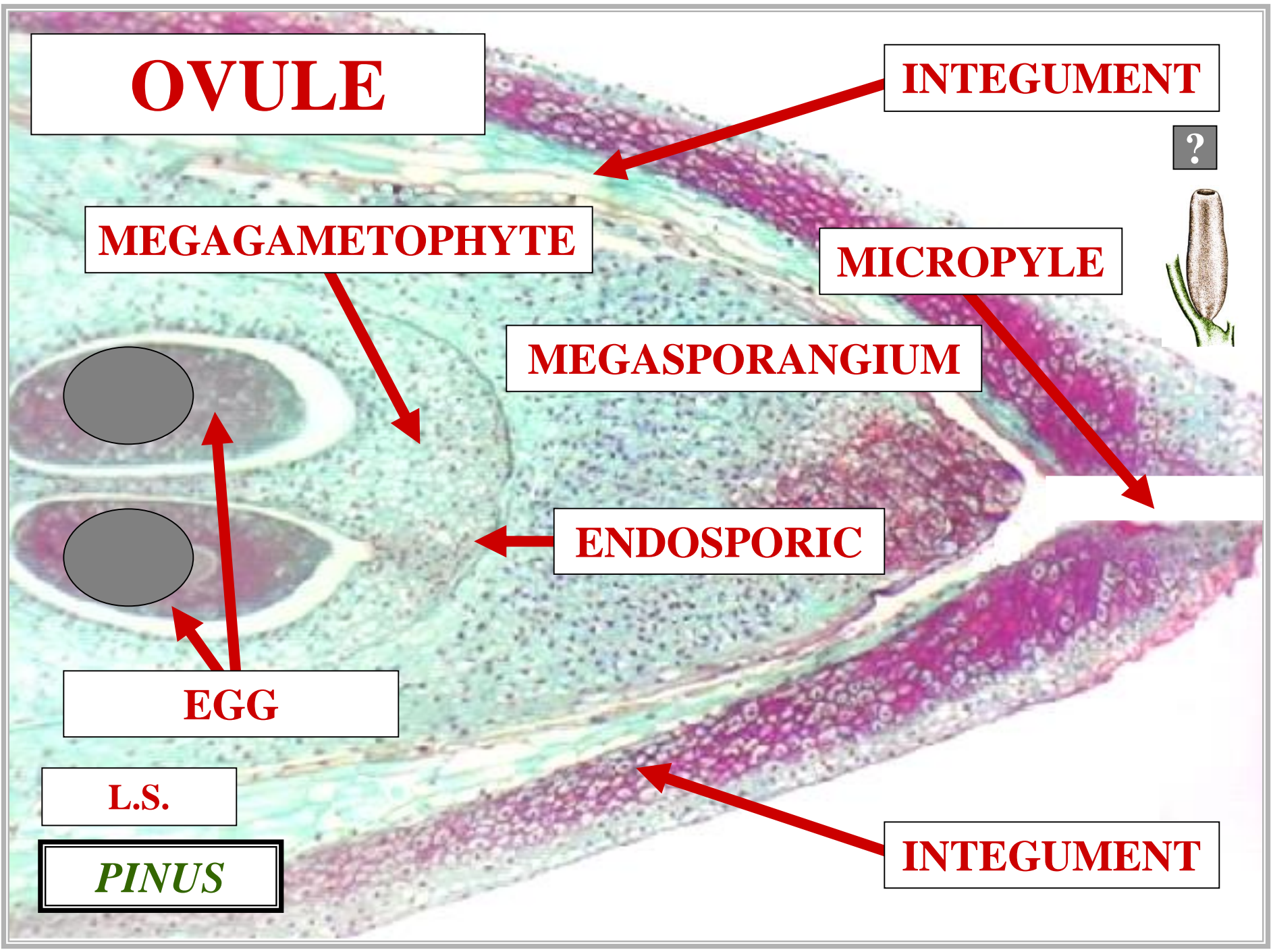
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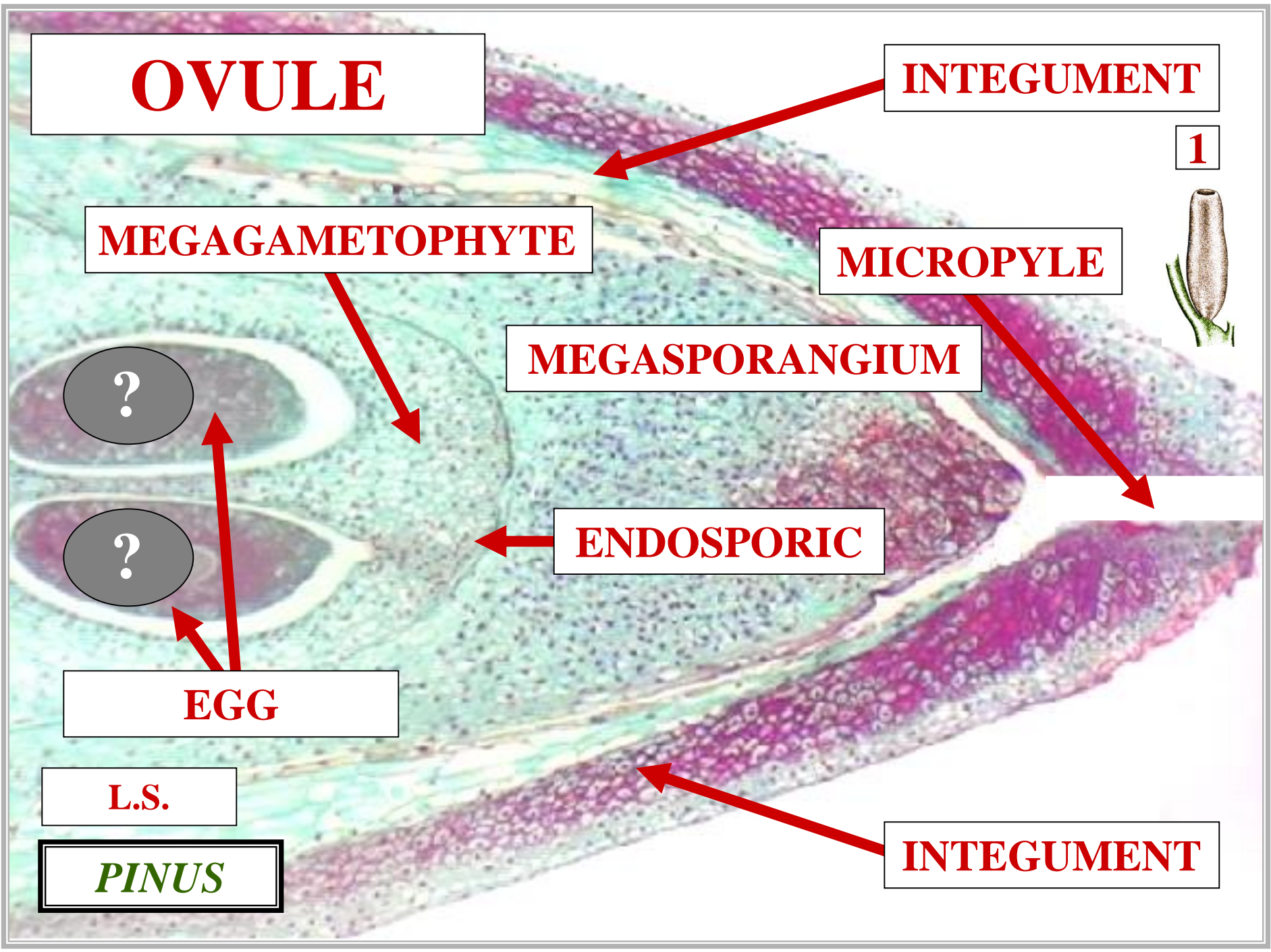
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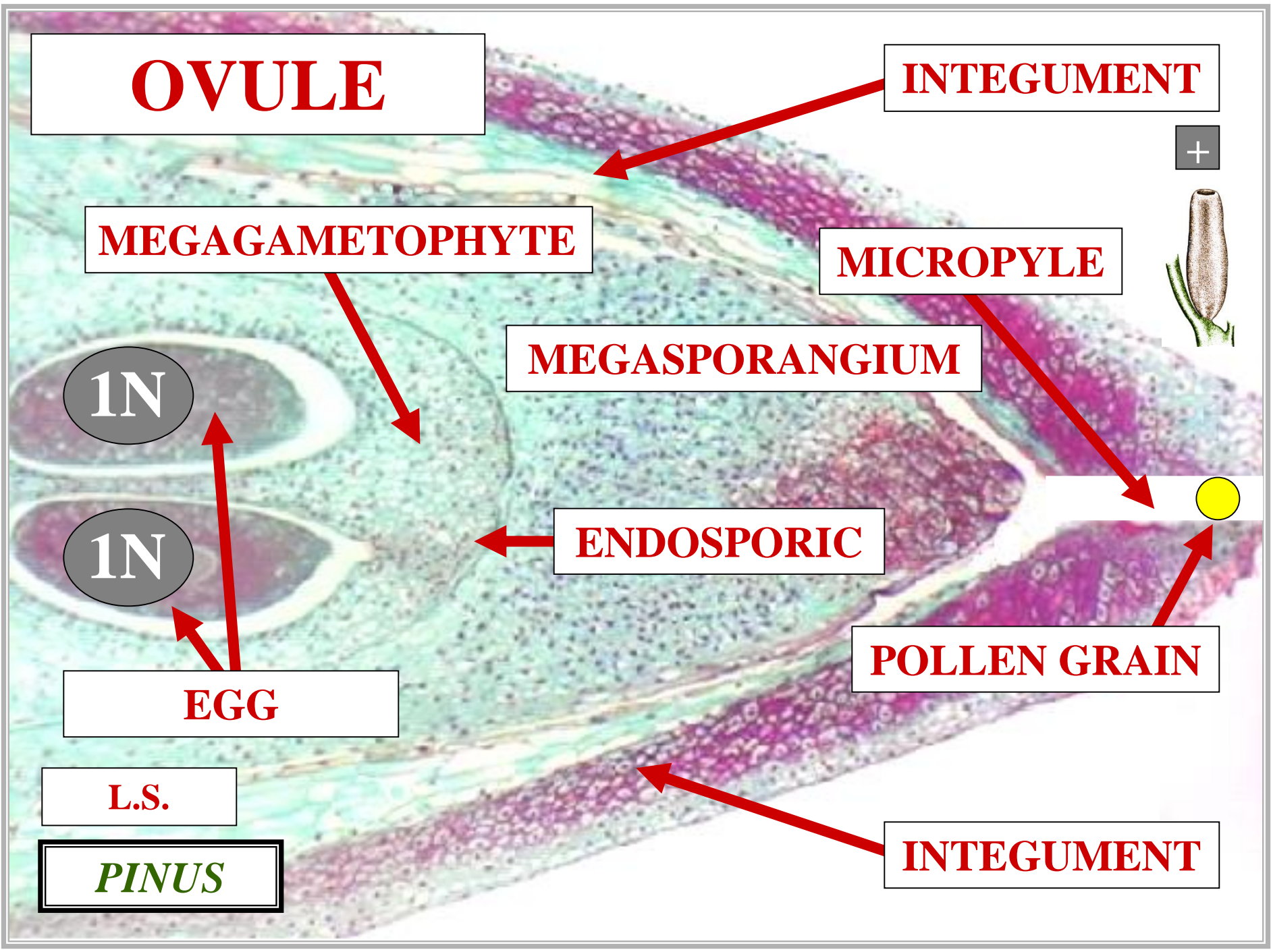
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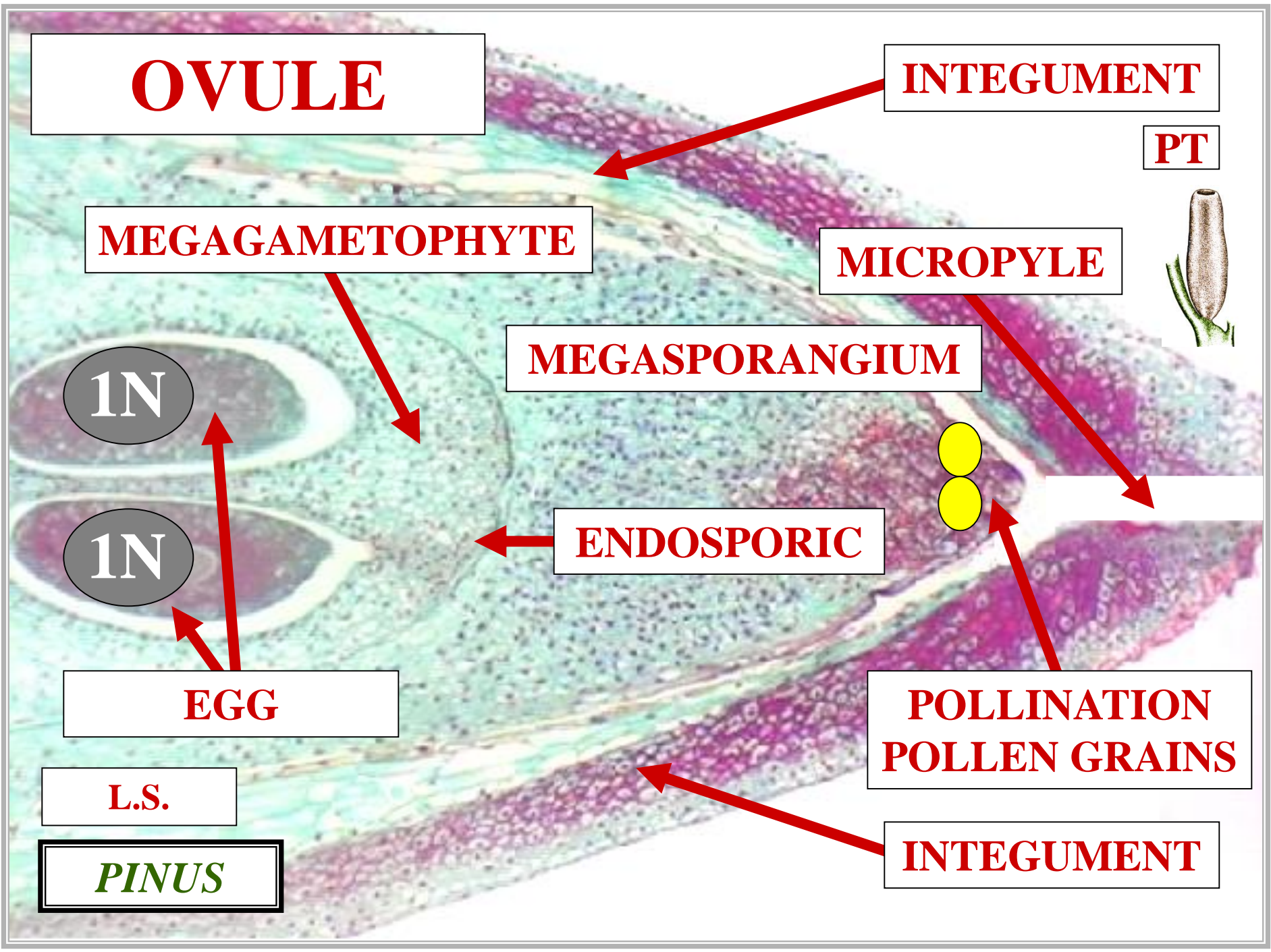
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POLLINATION
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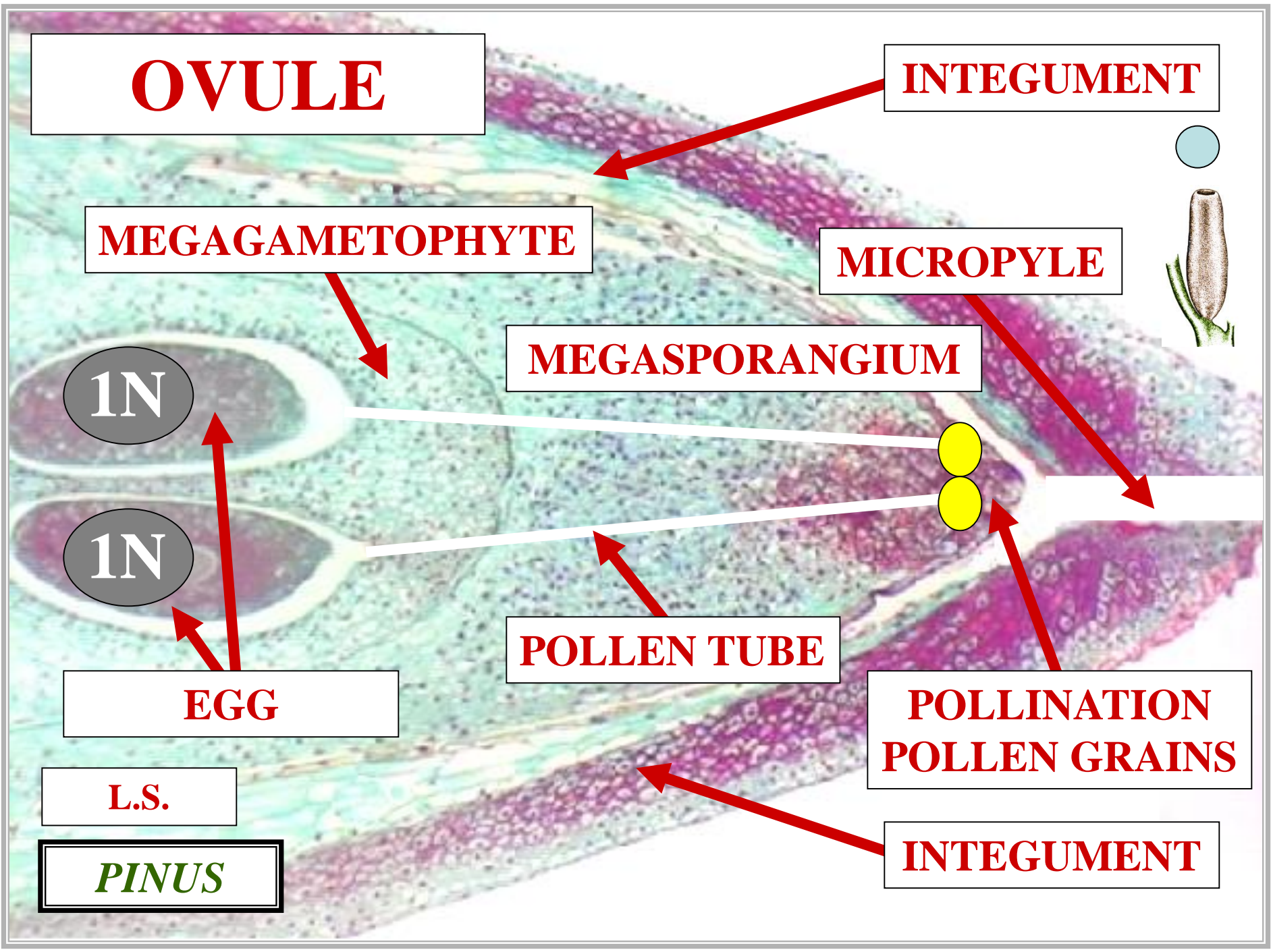
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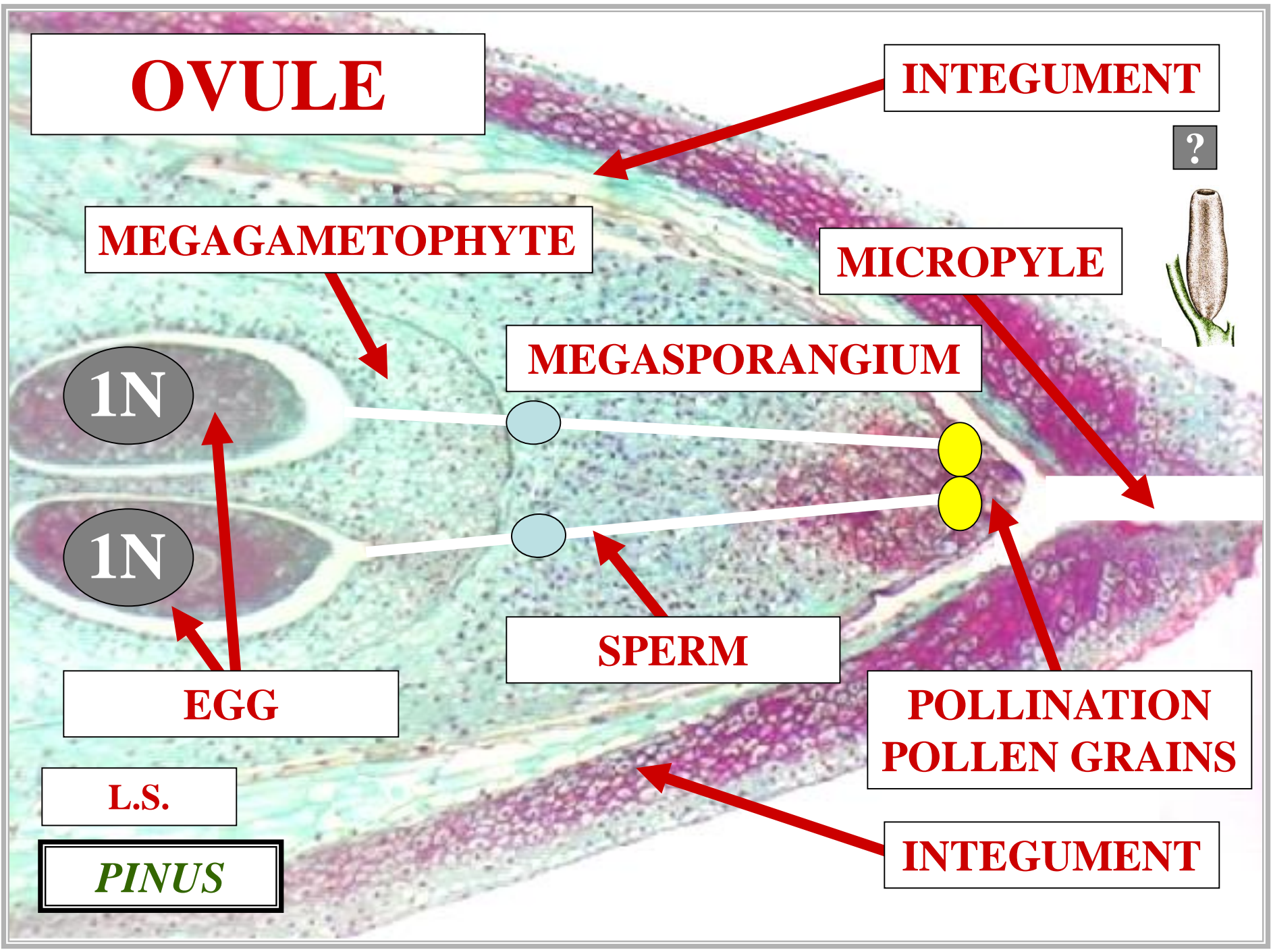
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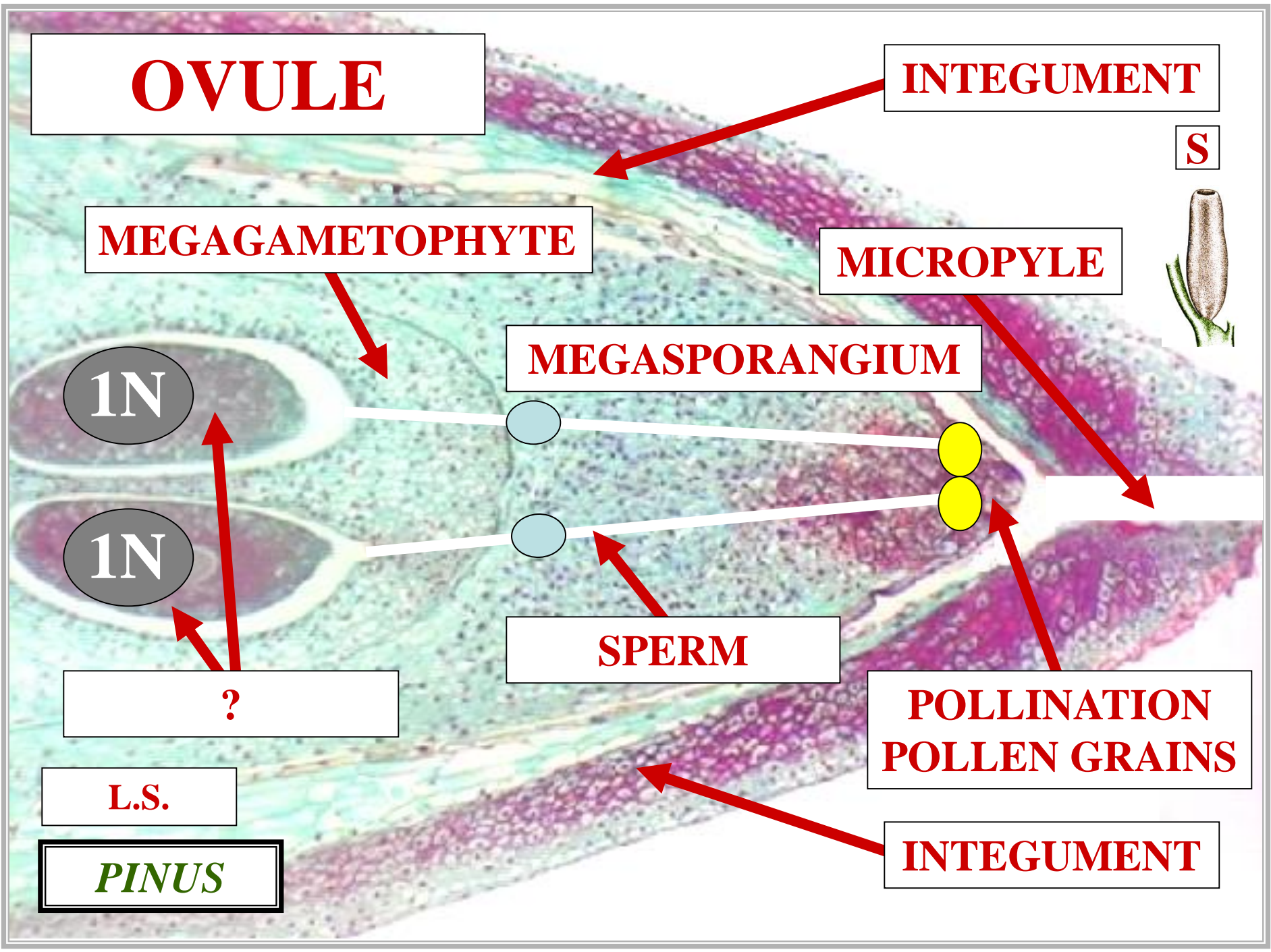
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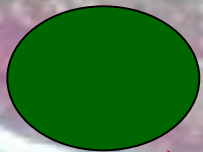
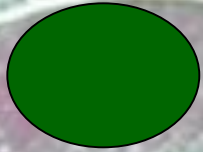
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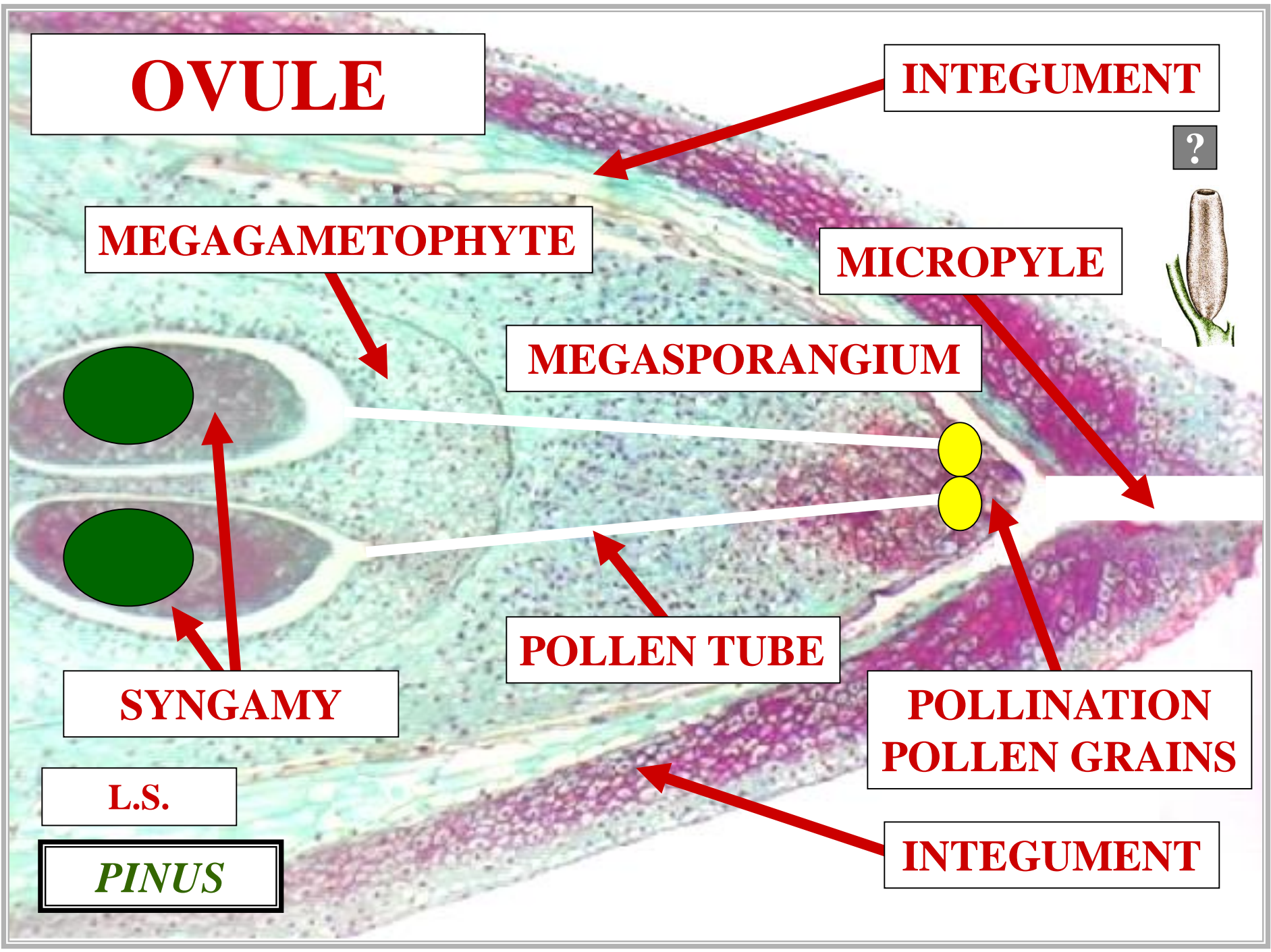
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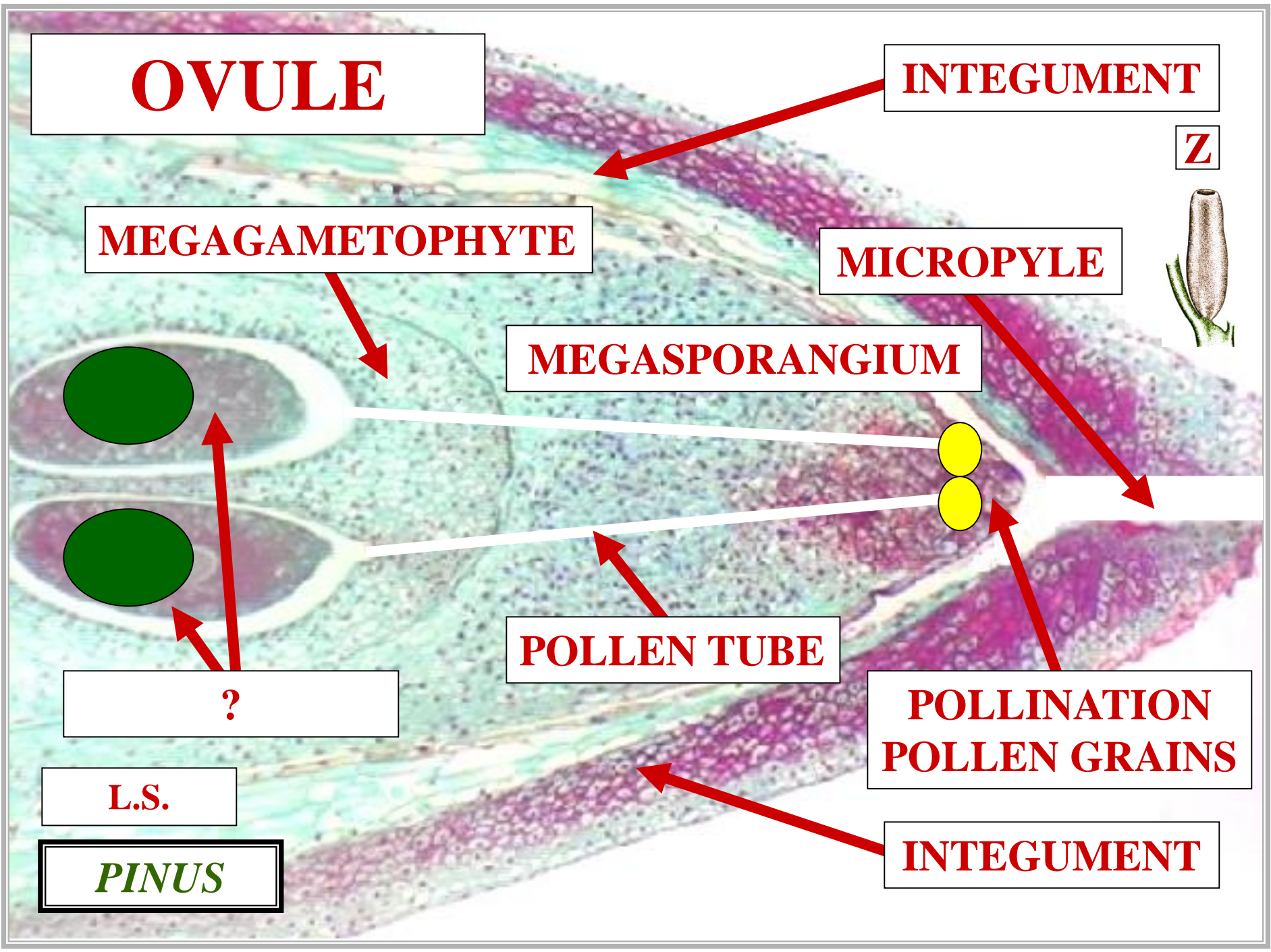
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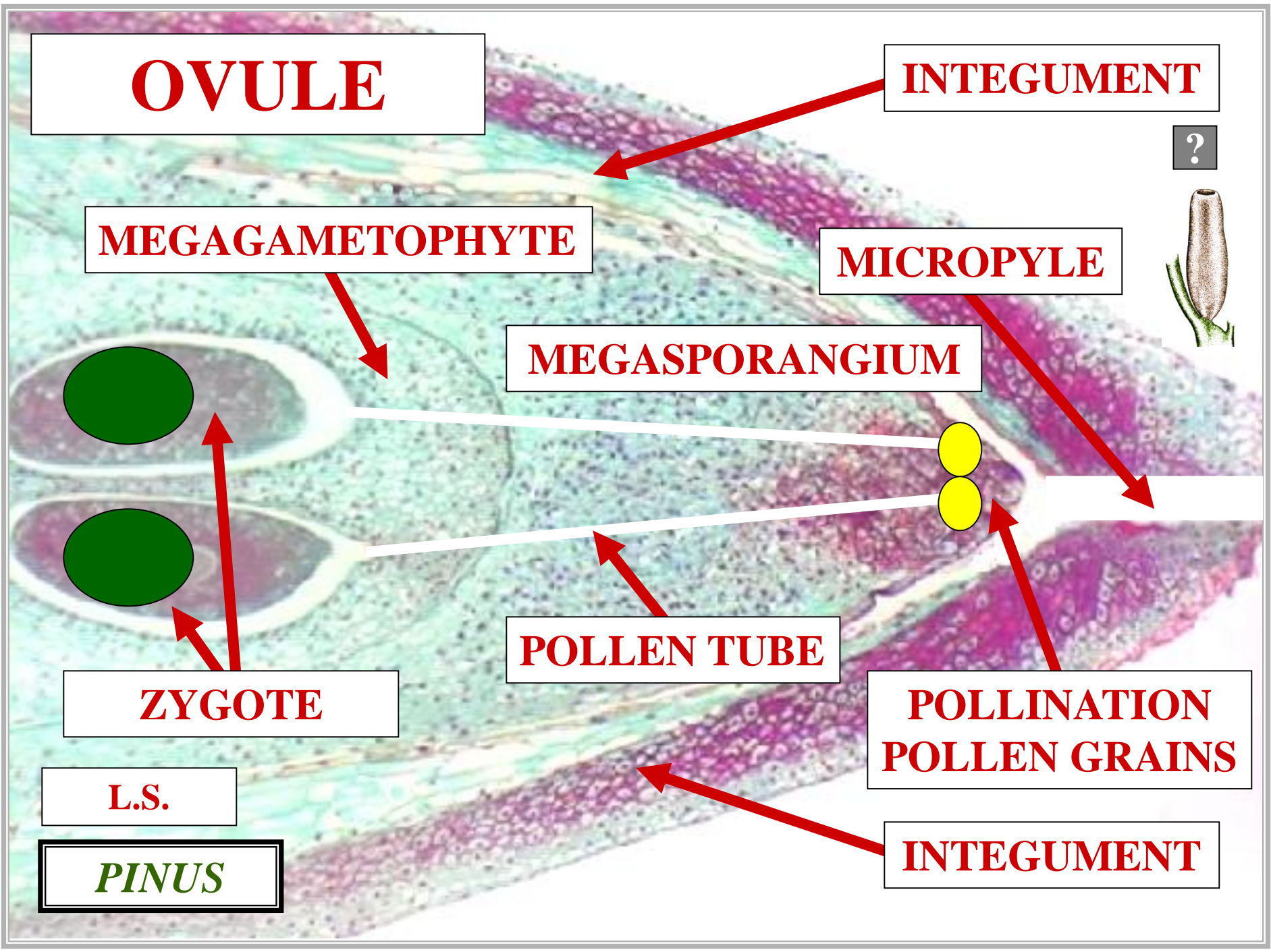
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**POLLINATION
POLLEN GRAINS**

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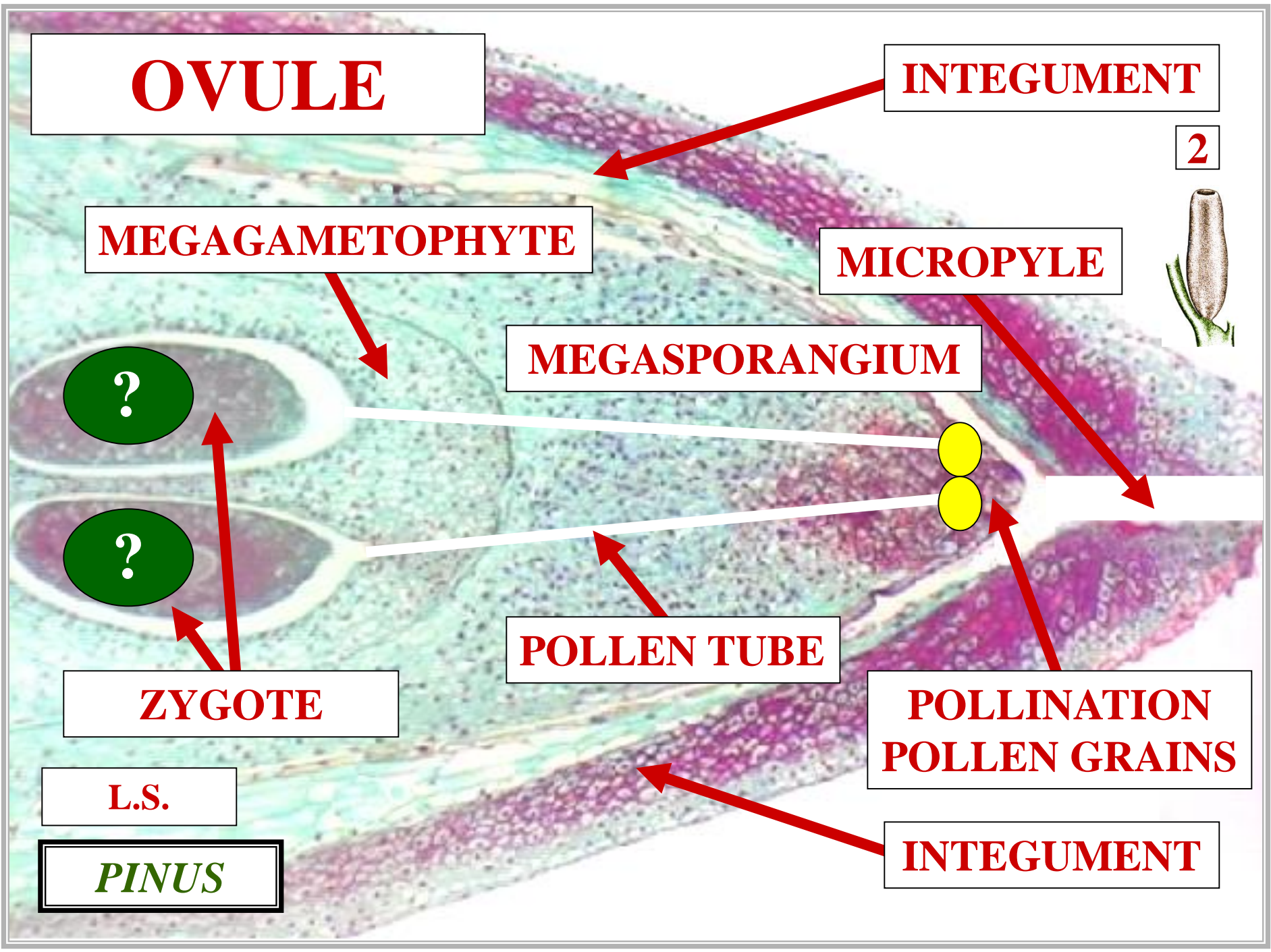
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POLLEN GRAINS**

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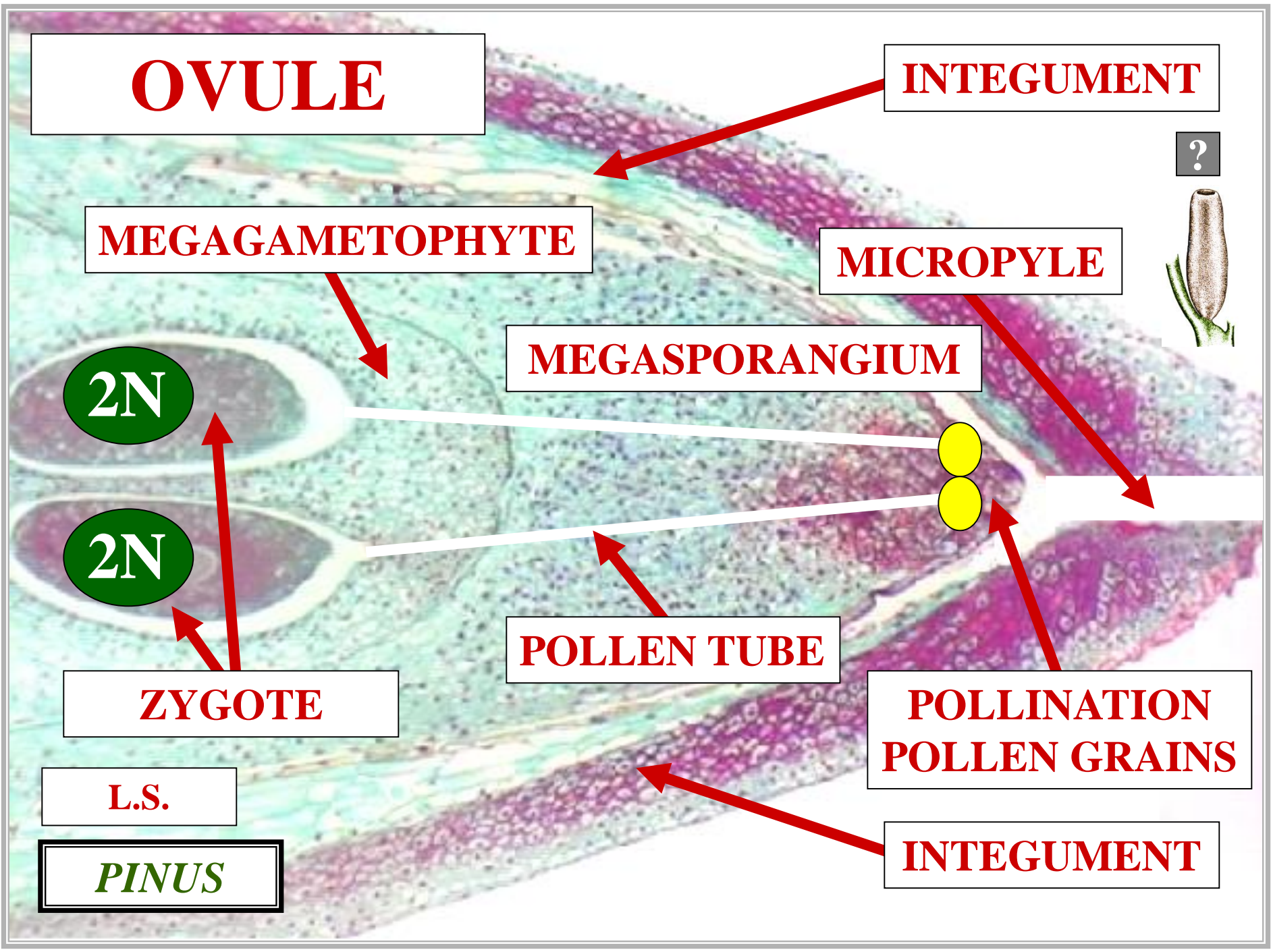
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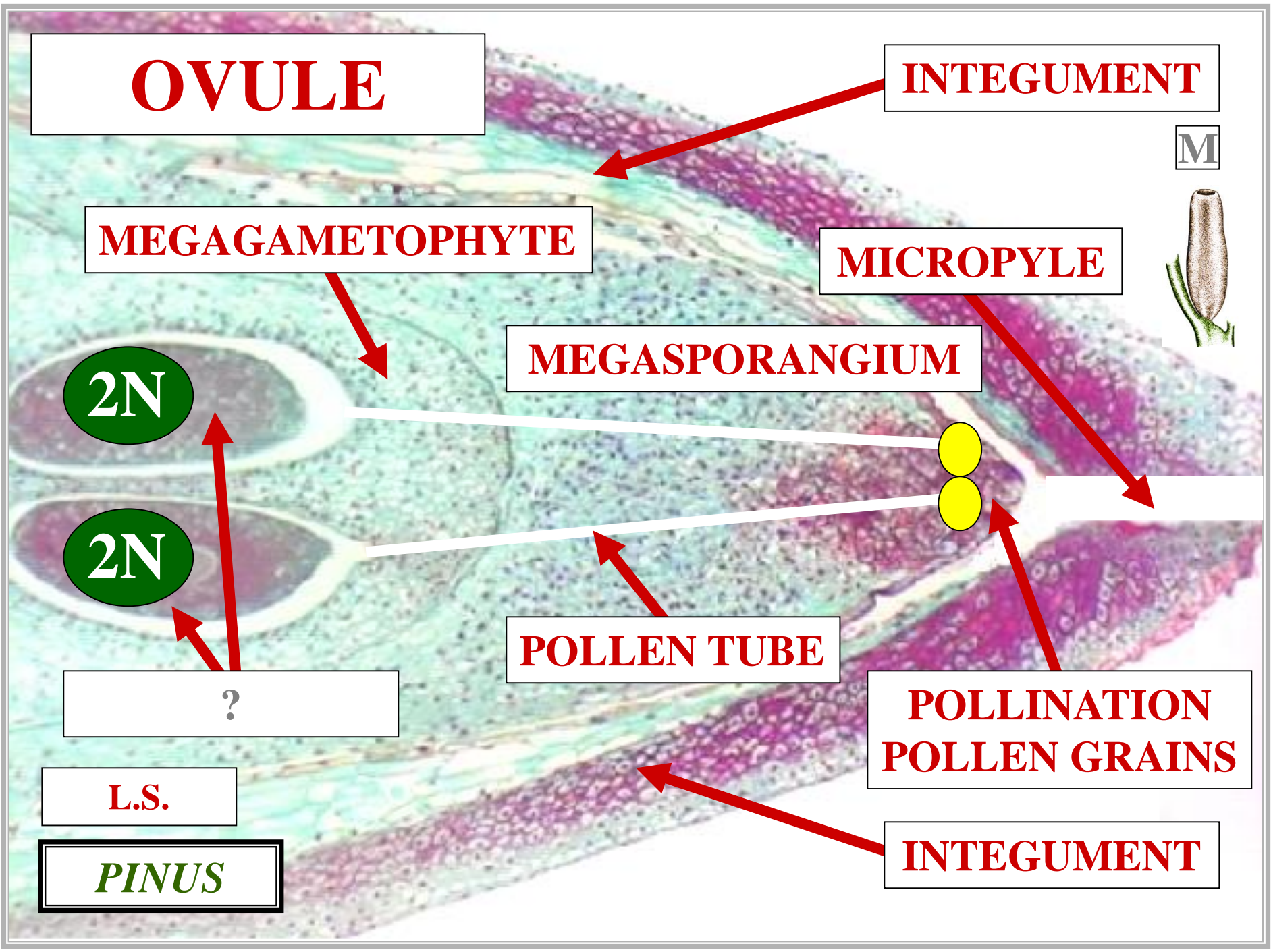
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**POLLINATION
POLLEN GRAINS**

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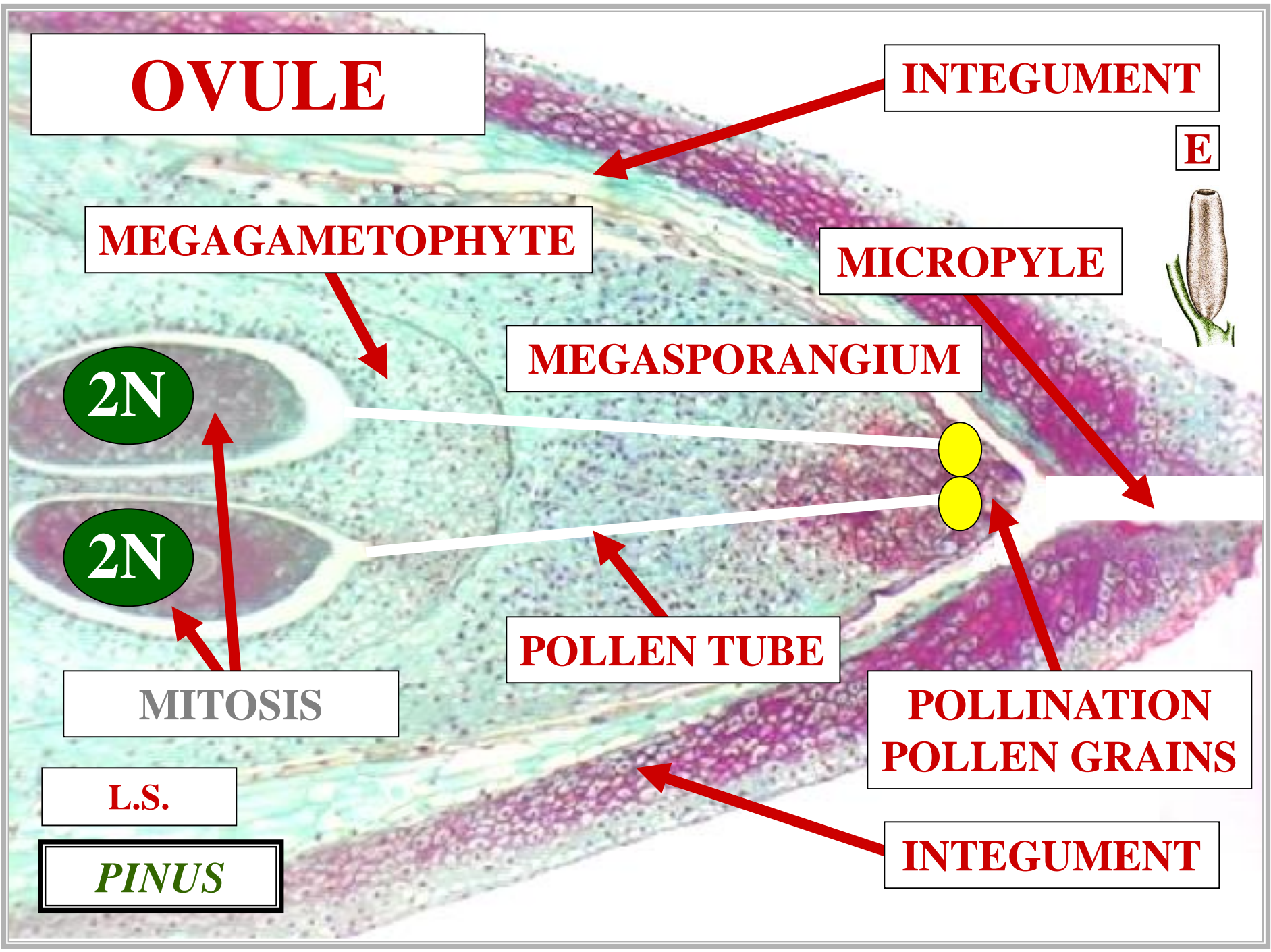
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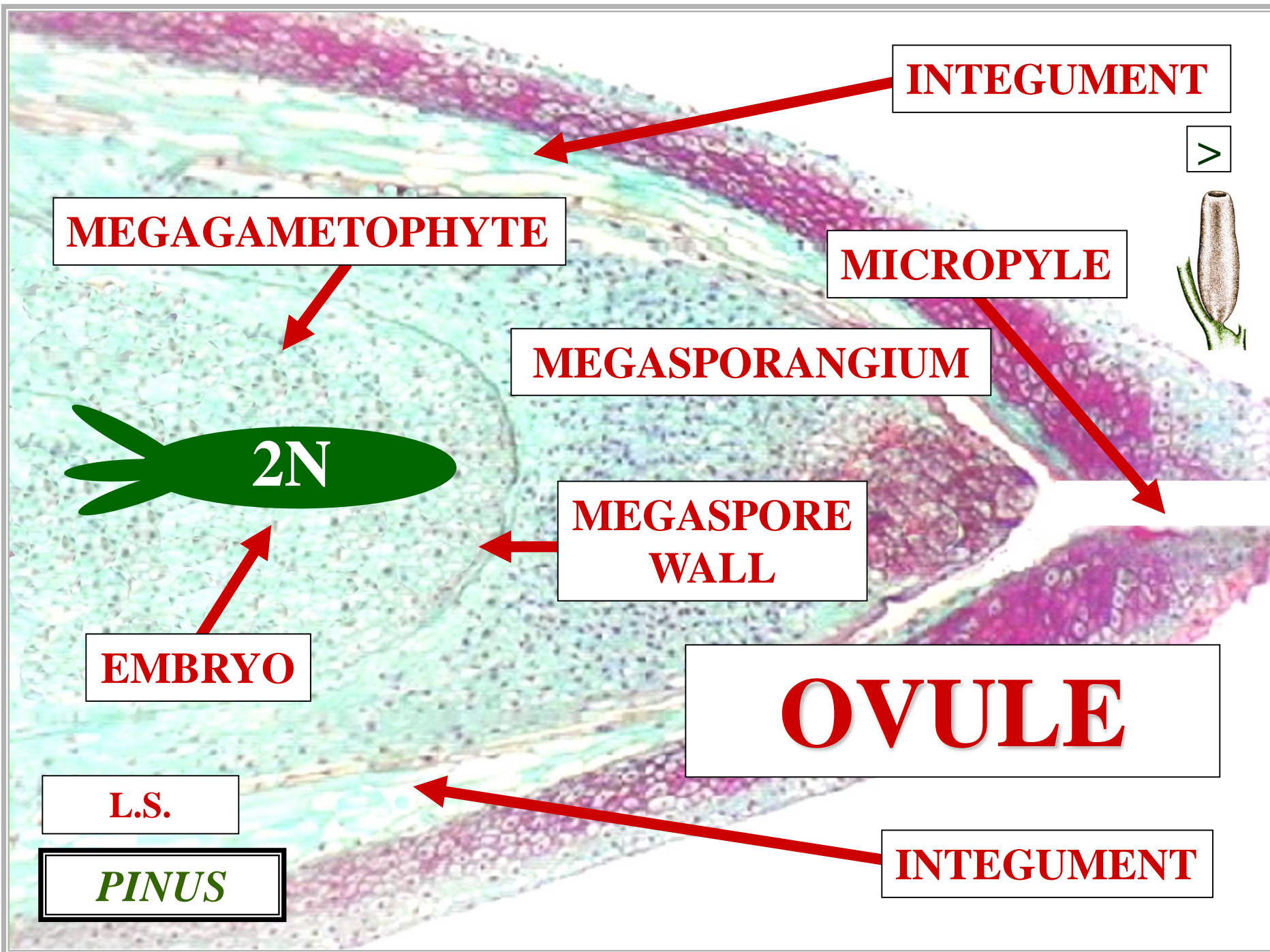
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MEGAGAMETOPHYTE

MICROPYLE



MEGASPORANGIUM



MEGASPORE WALL

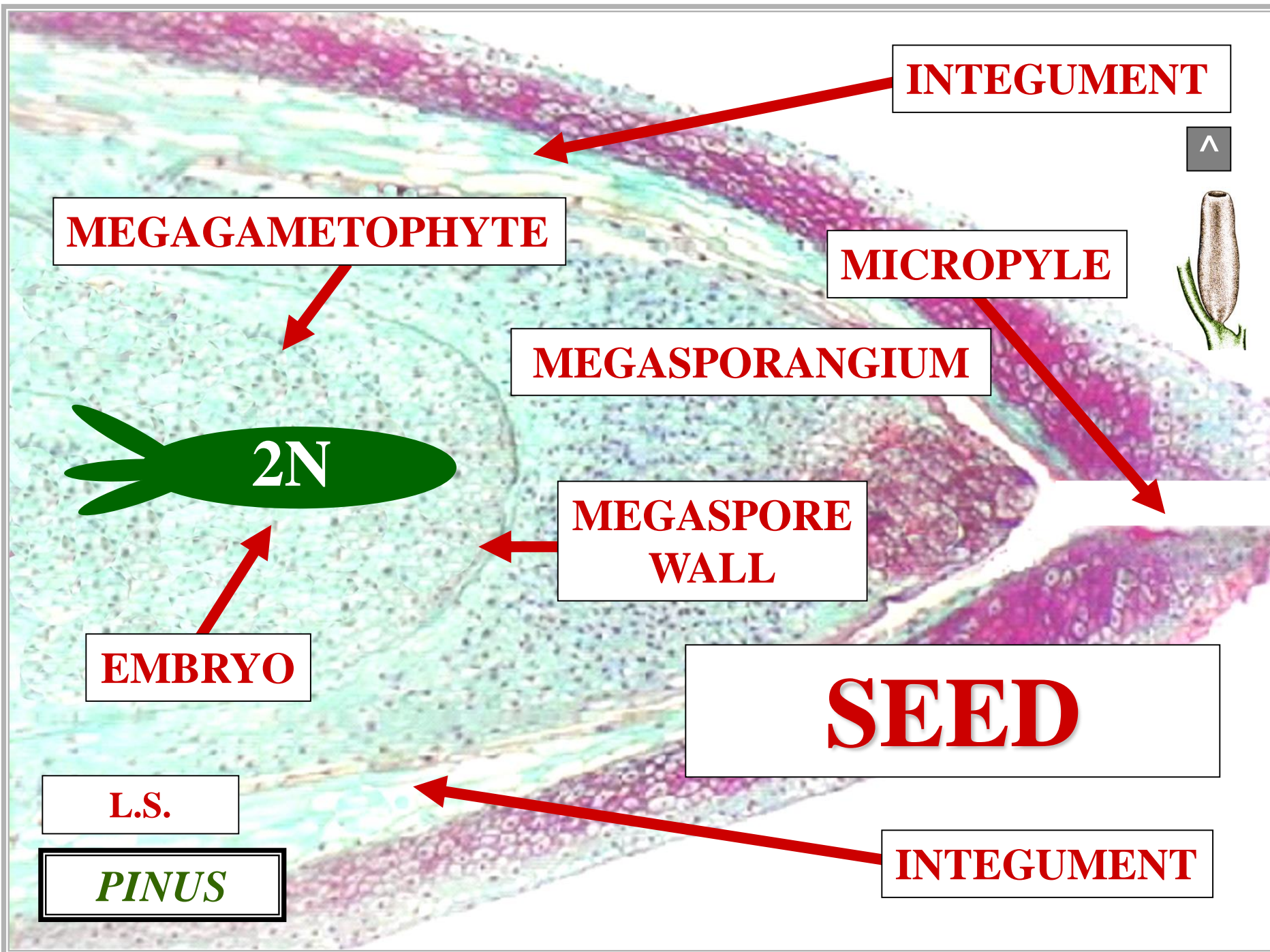
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MEGAGAMETOPHYTE

MICROPYLE

MEGASPORANGIUM

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MEGASPORE WALL

EMBRYO

SEED

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PINUS

INTEGUMENT



**SEED
ENHANCES
EMBRYO
SURVIVAL**



**SEED
PROVIDES
EMBRYO
PROTECTION**



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MEGAGAMETOPHYTE

MICROPYLE

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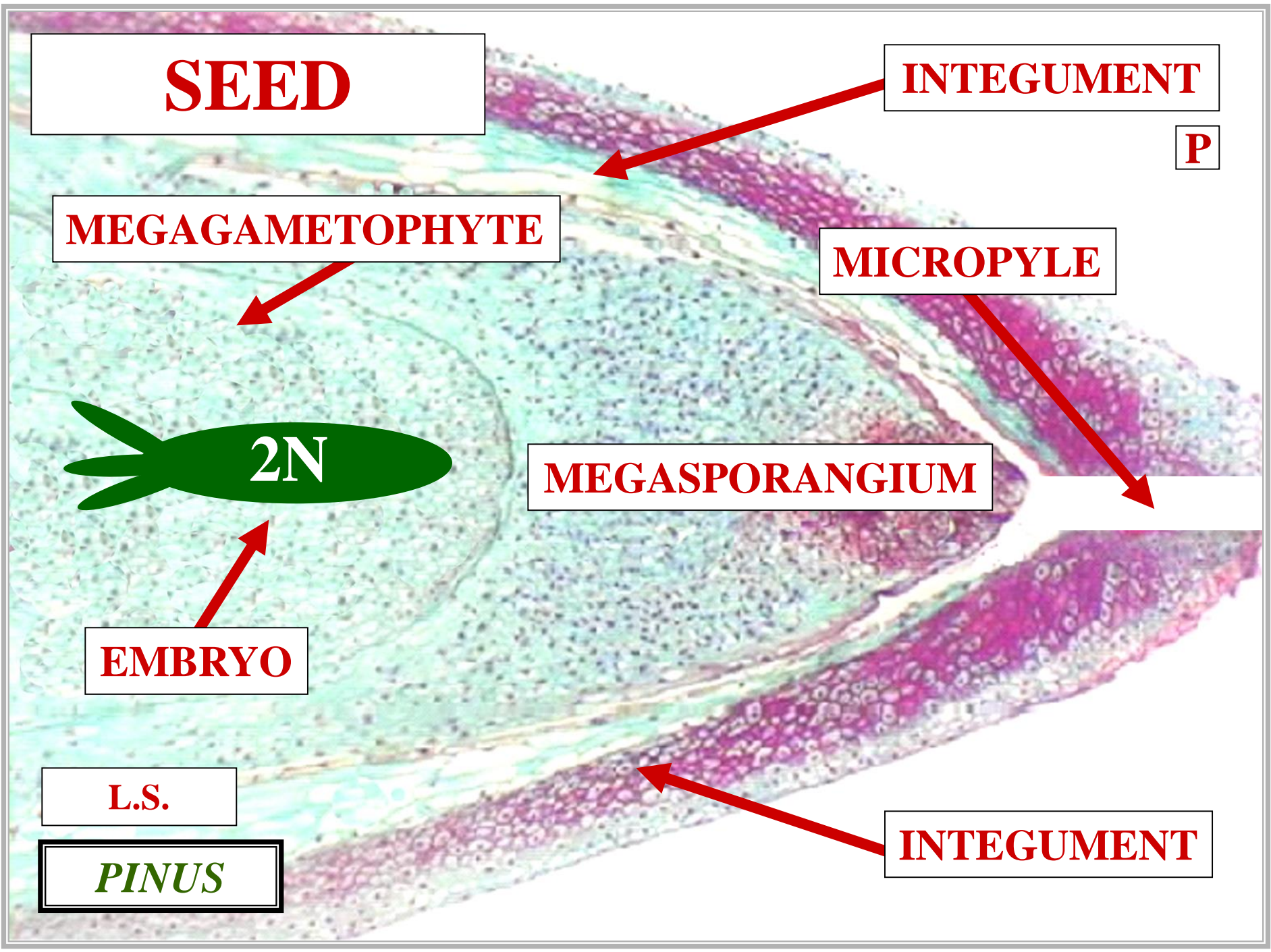
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SEED

**PREVENTS
PHYSICAL
DAMAGE**

MEGAGAMETOPHYTE

MICROPYLE

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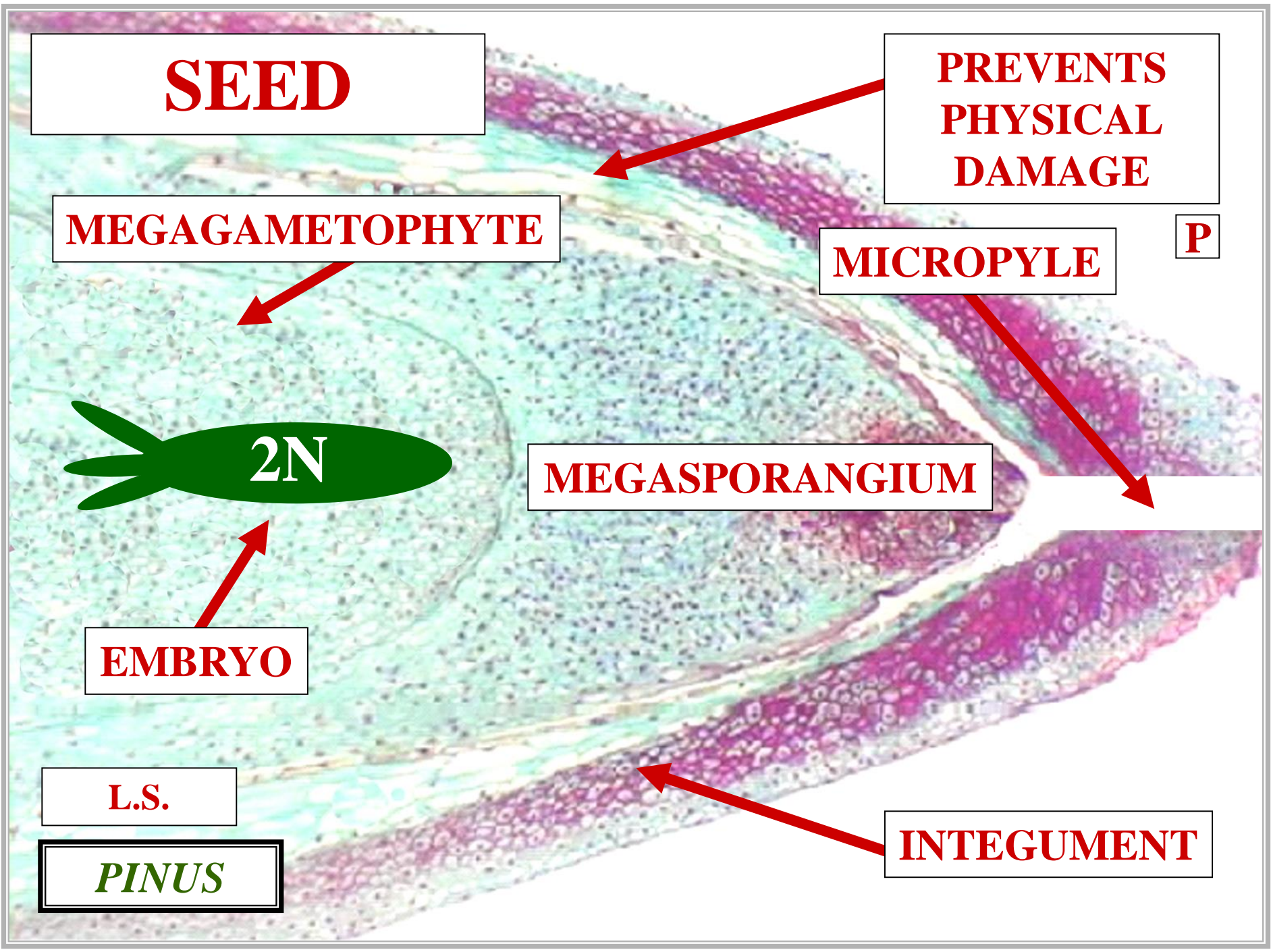
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**PREVENTS
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DAMAGE**

MEGAGAMETOPHYTE

MICROPYLE



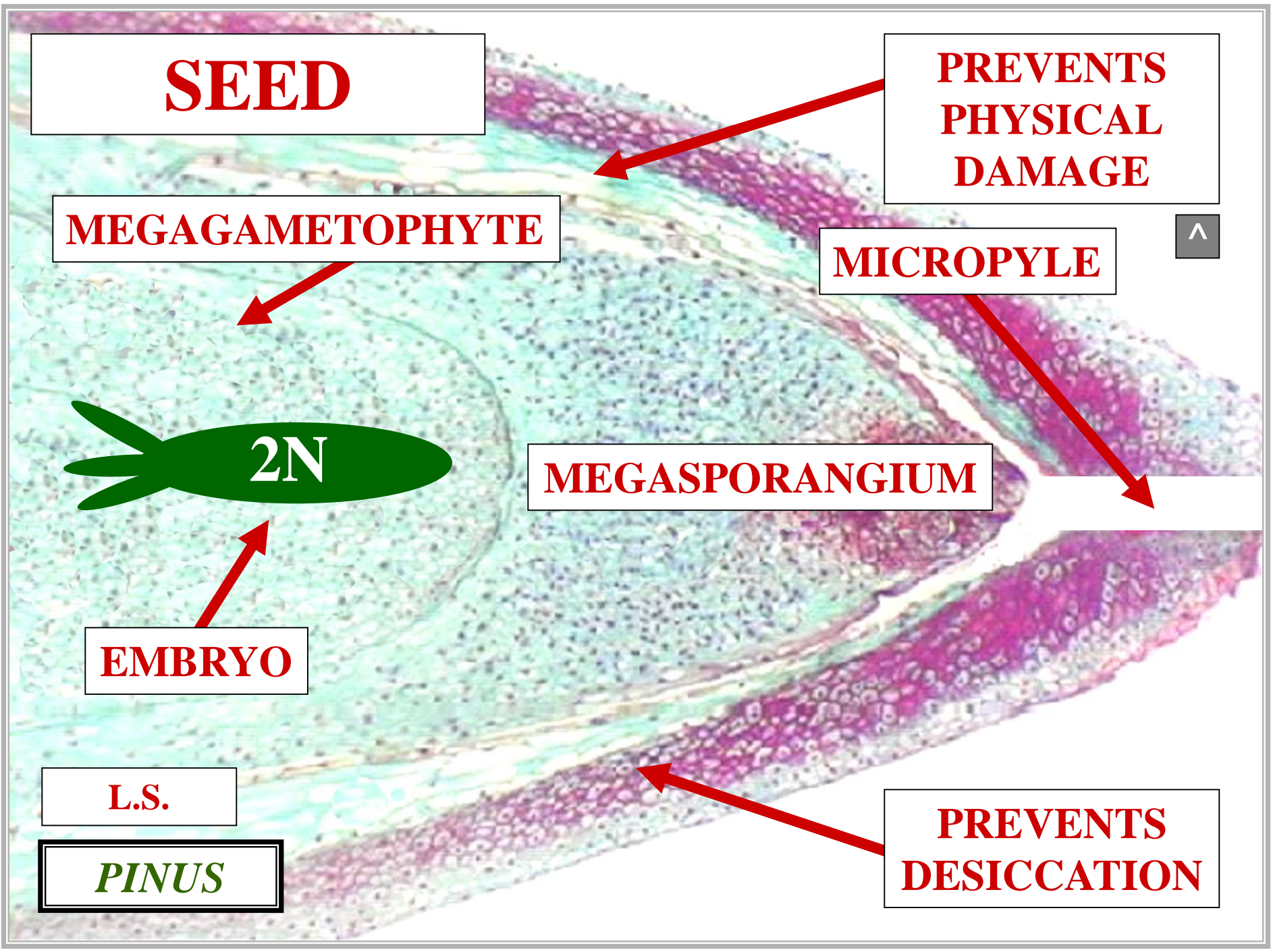
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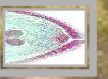




**SEED
PROVIDES
EMBRYO
NUTRITION**



GYMNOSPERMS



GYMNOSPERMS

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**INHIBITS
PHYSICAL
DAMAGE**

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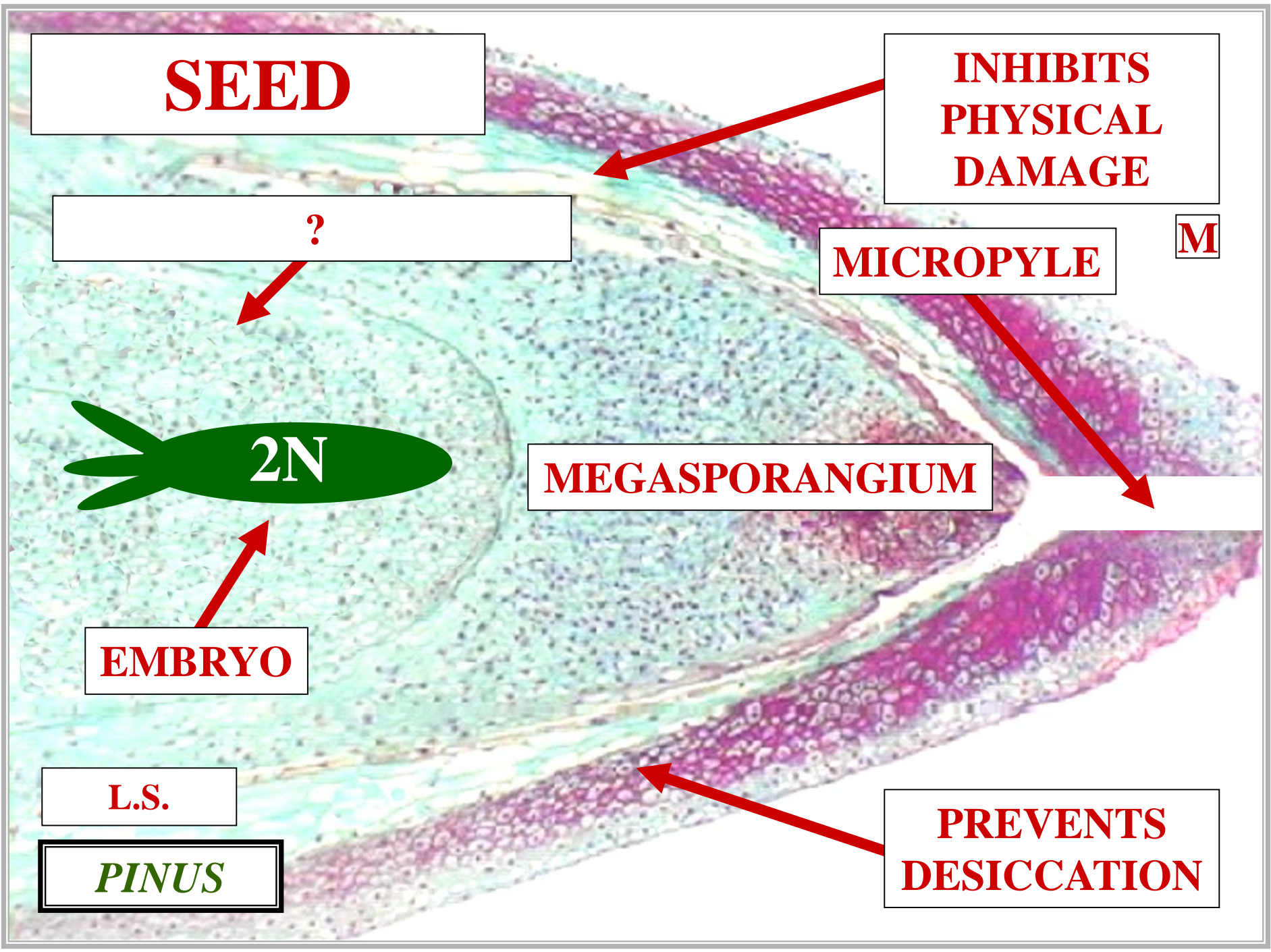
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**PREVENTS
DESICCATION**



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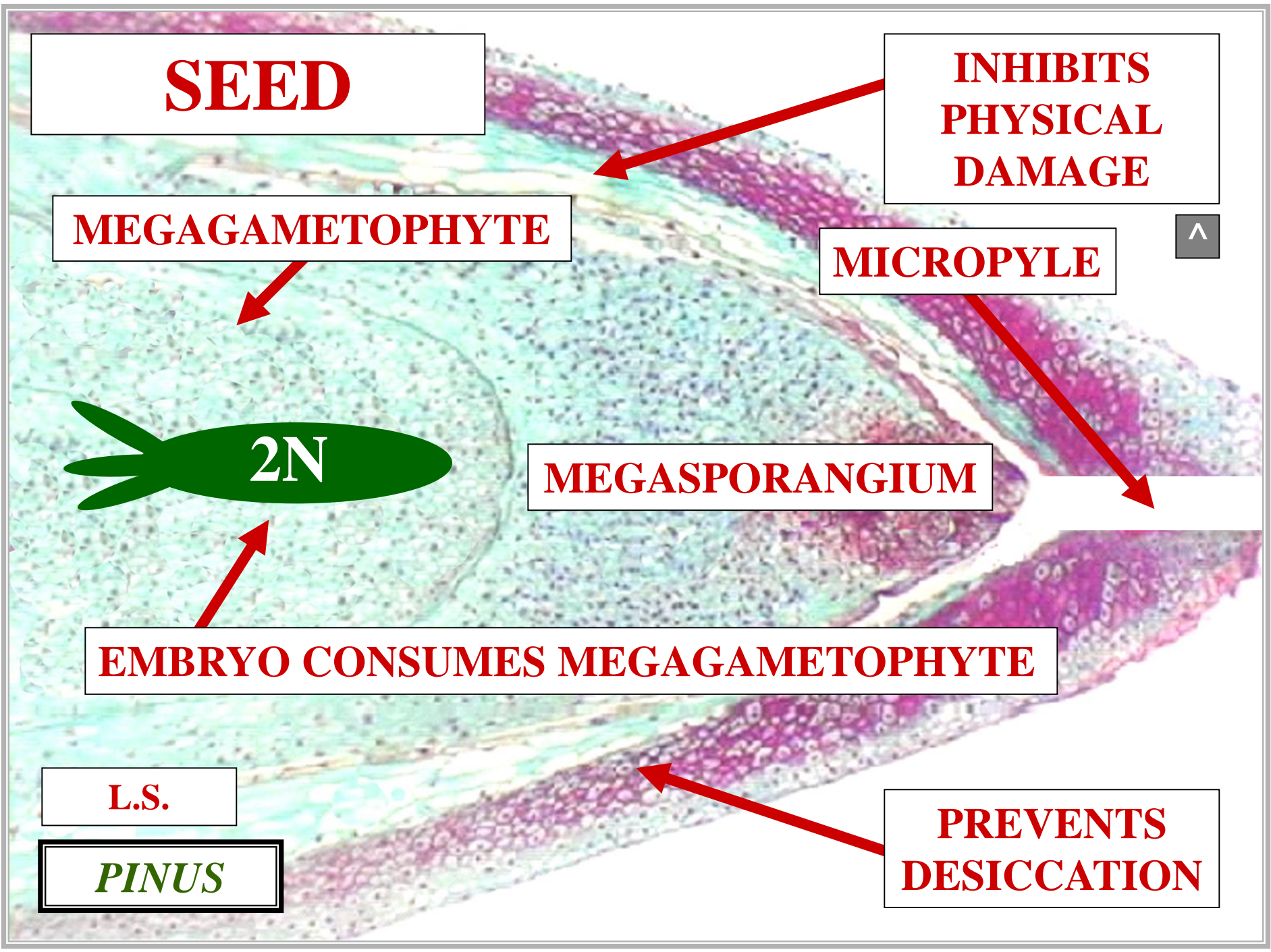
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**PREVENTS
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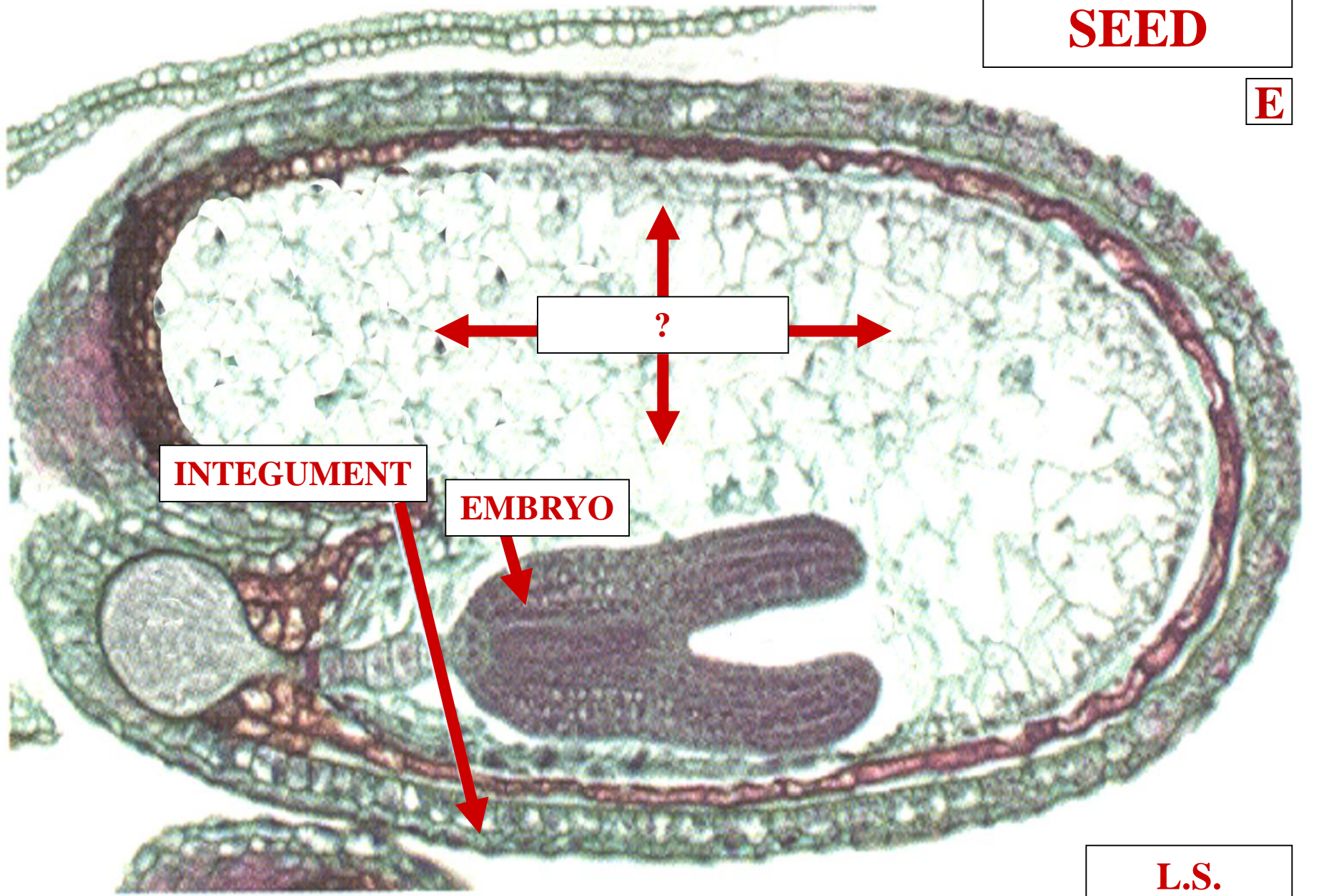
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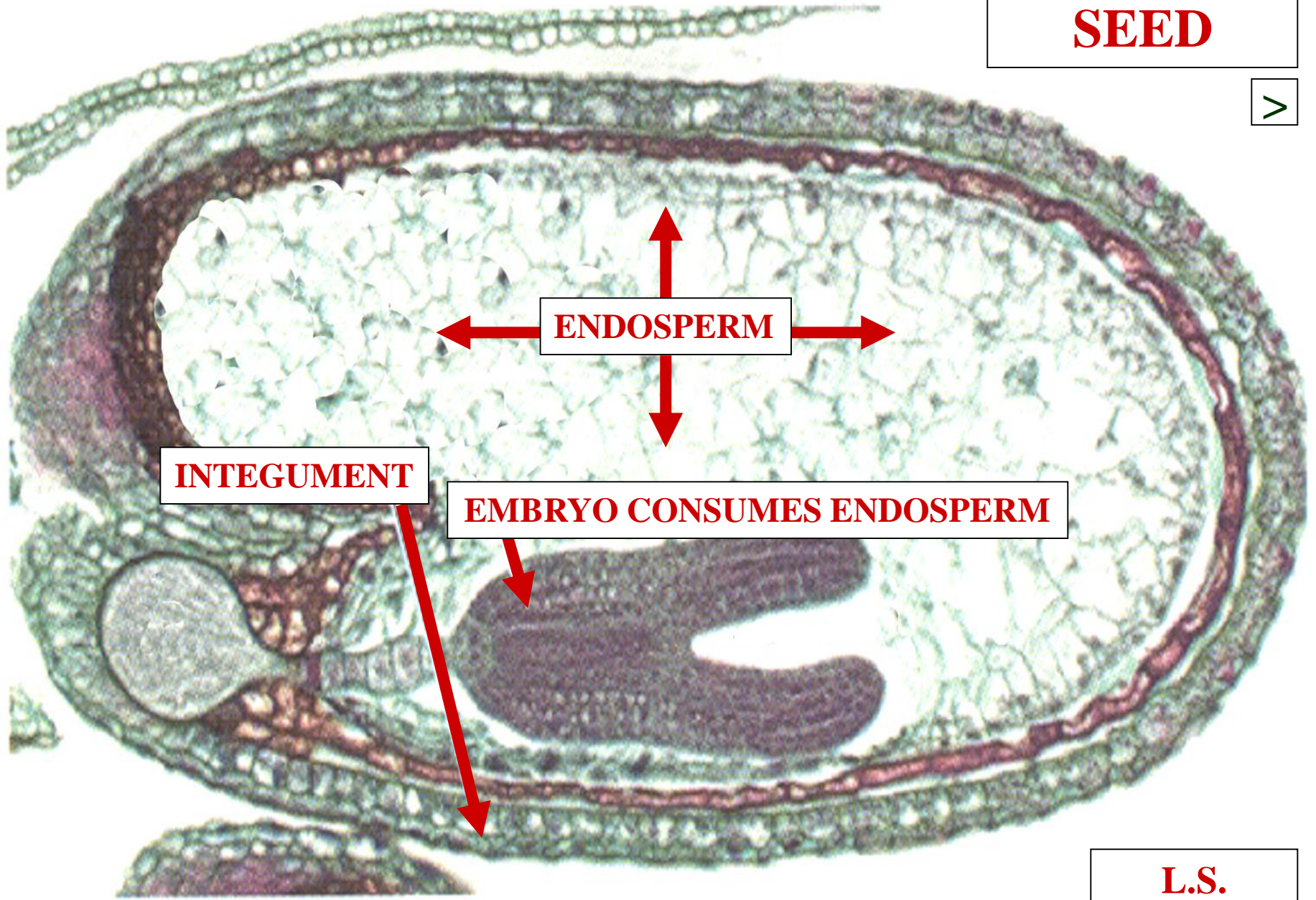


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EMBRYO CONSUMES ENDOSPERM

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**SPERMATOPHYTE
SEED
ENHANCES
EMBRYO
SURVIVAL**



SPERMATOPHYTE FOSSIL RECORD



~360

MILLION YEARS

~385 MILLION YEARS AGO

S

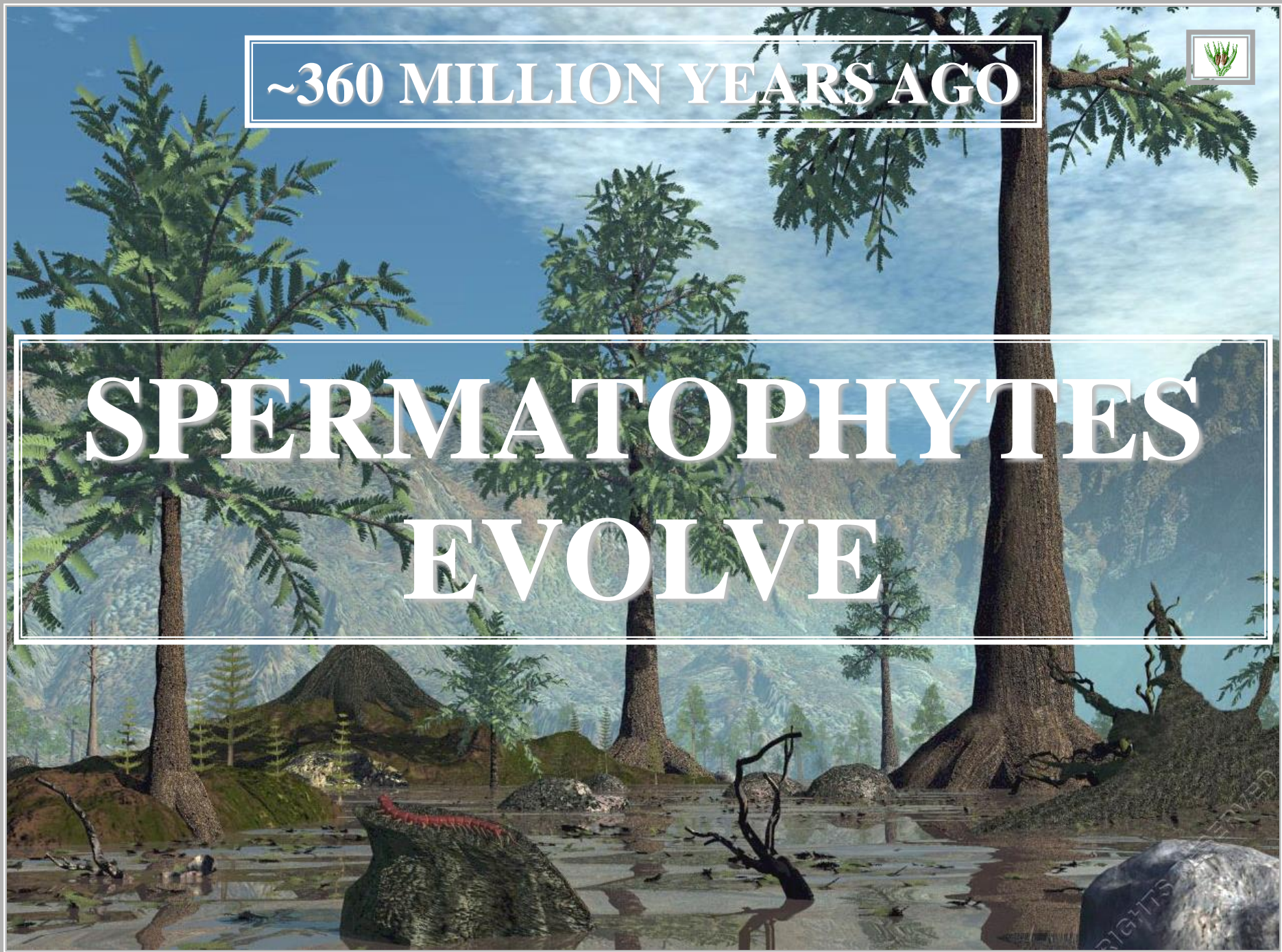
DEVONIAN

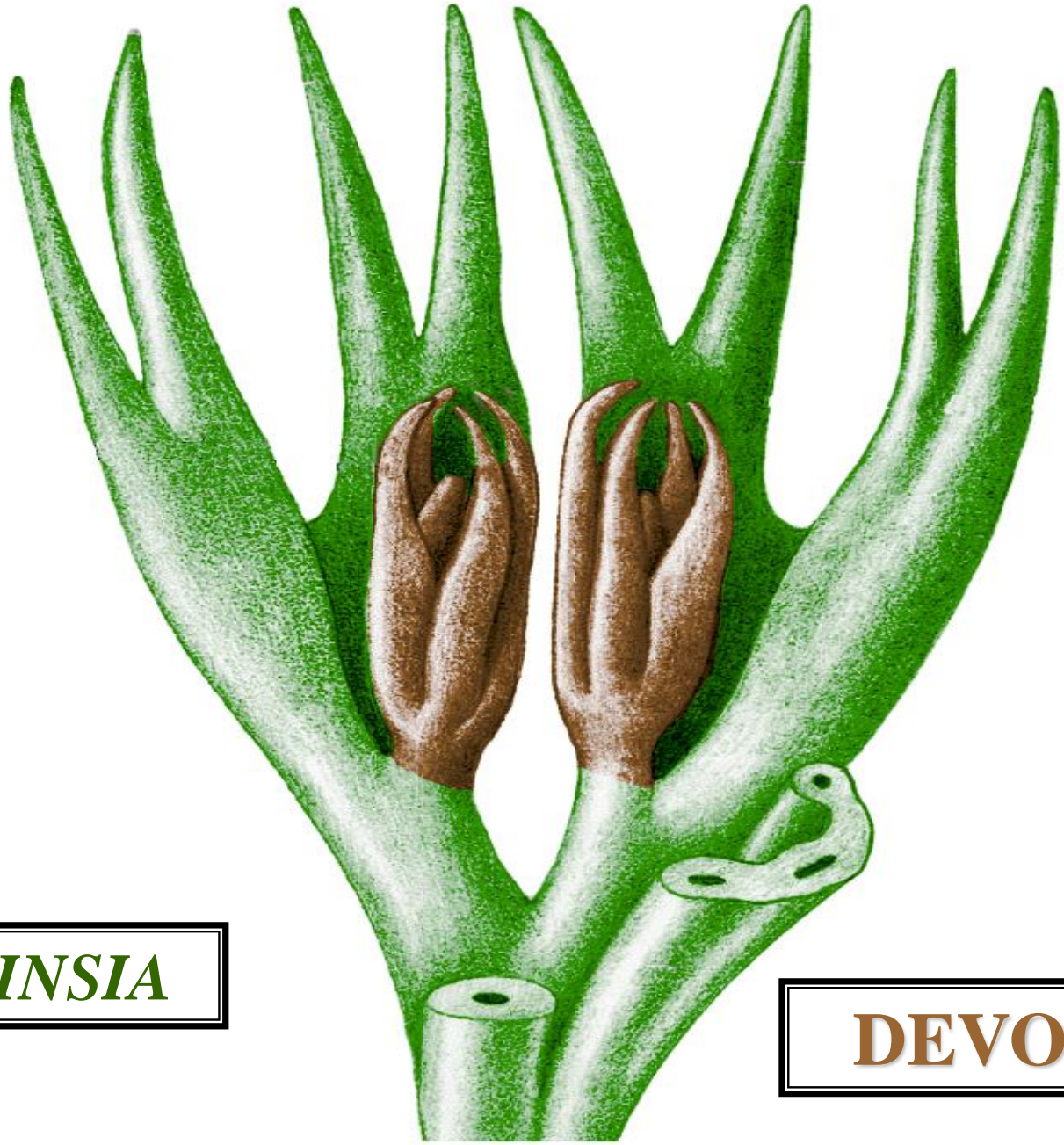


~360 MILLION YEARS AGO



SPERMATOPHYTES EVOLVE





ELKINSIA

DEVONIAN



OLDEST KNOWN SPERMATOPHYTE

ELKINSIA

DEVONIAN



~260

MILLION YEARS

~260 MILLION YEARS AGO

PERMIAN

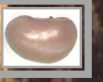


A vibrant, detailed illustration of a prehistoric landscape. In the foreground, a waterfall cascades over rocks into a stream. The ground is covered with various types of ferns and other ancient plants. In the middle ground, several dinosaurs are visible, including a large, scaly dinosaur near the waterfall and a smaller, more agile dinosaur further back. The background features rolling hills and mountains under a clear blue sky with a few clouds. The overall scene is bright and colorful, capturing the essence of a lush, ancient world.

~260 MILLION YEARS AGO

**SPERMATOPHYTES
DISPLACED
PTERIDOPHYTES**

PRESENT



**SPERMATOPHYTES
DOMINATE PLANTS
EXTANT
FLORA**

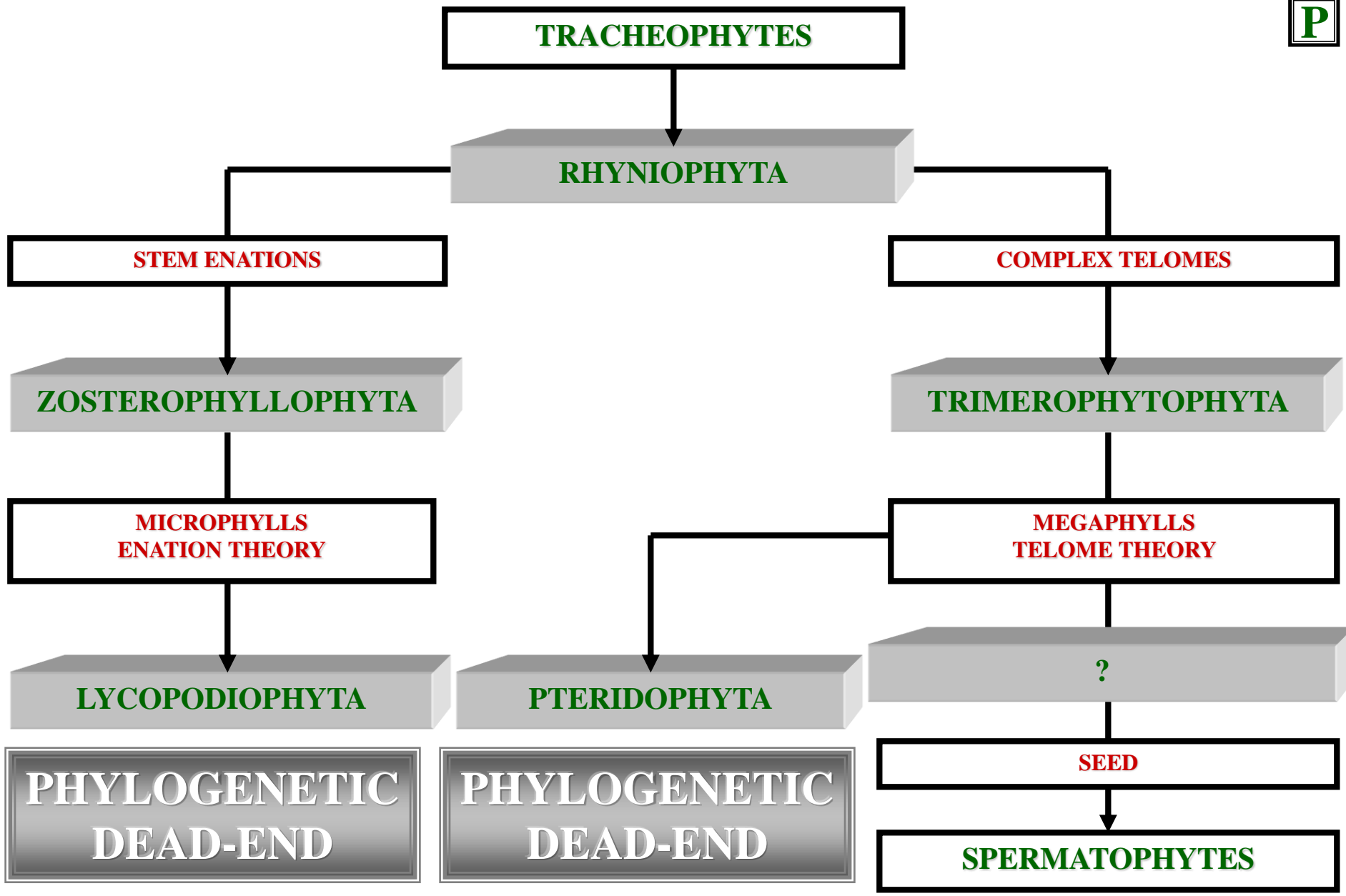


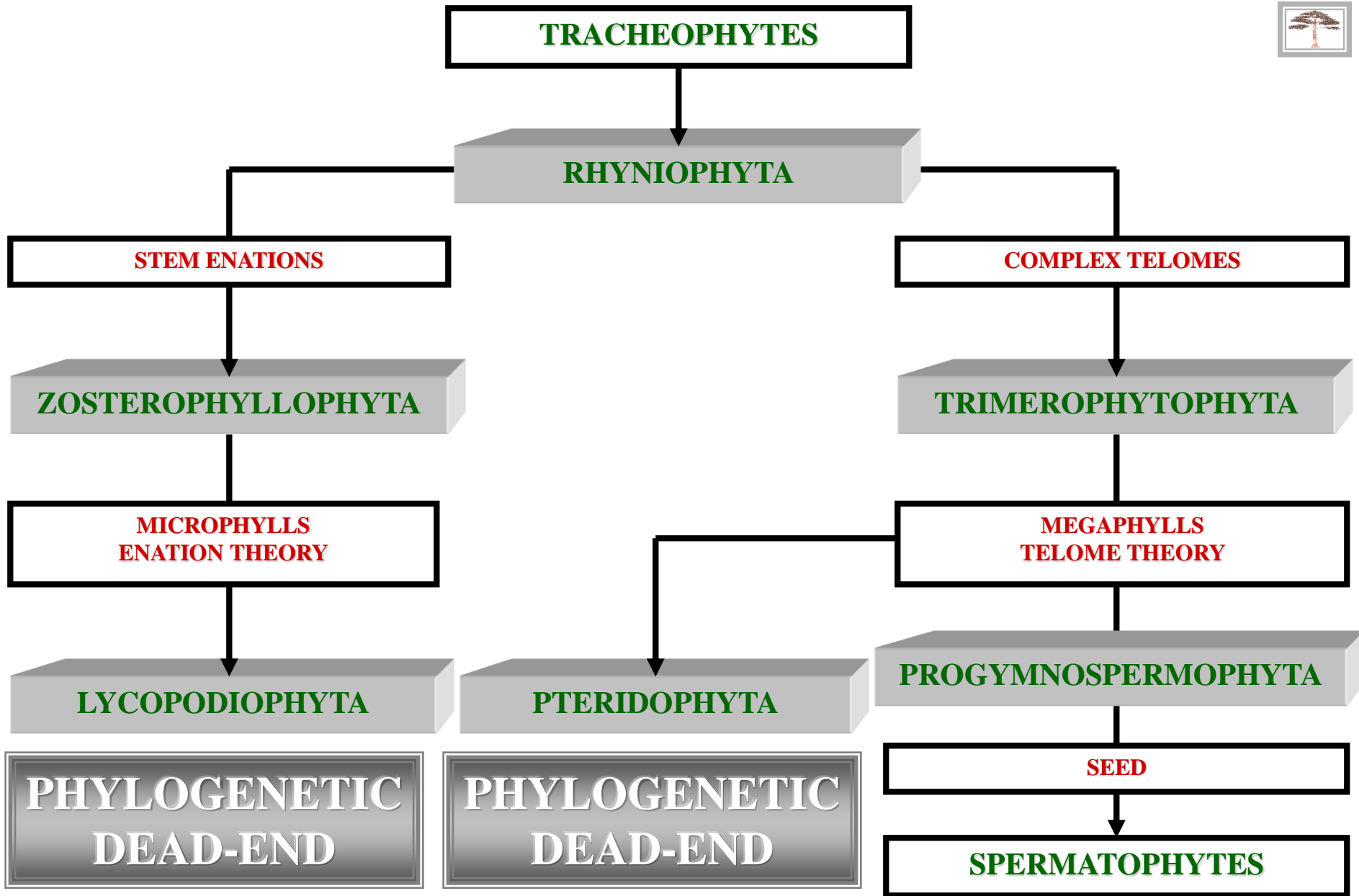
SEED EVOLUTION



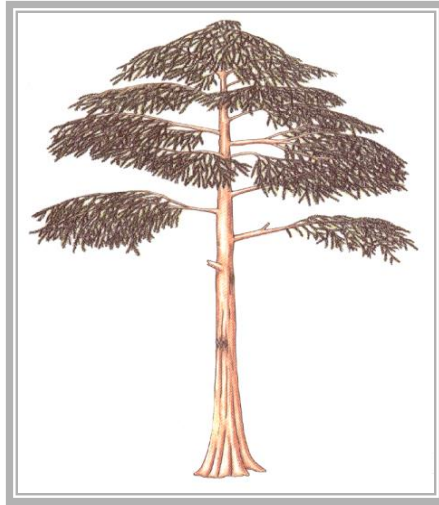
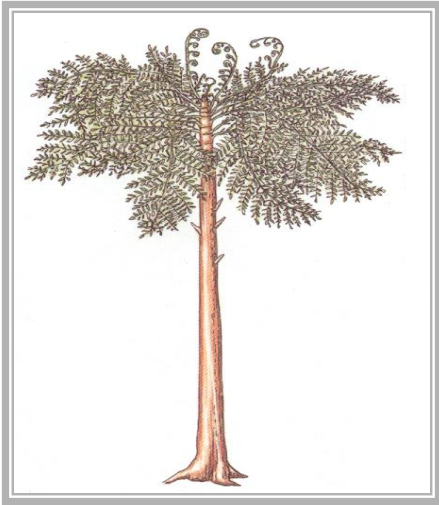
**SEED
KEY TO
SPERMATOPHYTES
DOMINANCE
OVER
PTERIDOPHYTES**

PHYLOGENETIC RELATIONSHIP





SPERMATOPHYTE EVOLUTION



LYGINOPTERIS

ARCHEOPTERIS

SPERMATOPHYTE

PROGYMNOSPERM

PROGYMNOSPERM

GYMNOSPERMS

PTERIDOPHYTE

PTERIDOPHYTE

GYMNOSPERMS

GYMNO

GYMNOSPERM
GYMNO



EXPOSED

GYMNOSPERM
GYMNO

GYMNOSPERM
GYMNO



OVULE EXPOSED

GYMNOSPERM
GYMNO

GYMNOSPERM

“GYMNO”



**OVULE EXPOSED
DURING
POLLINATION**

GYMNOSPERM

“GYMNO”

SPERM

GYMNOSPERM
“SPERM”



OVULE / SEED

GYMNOSPERM
“SPERM”



**GYMNOSPERM
OVULE / SEED
EXPOSED
DURING
POLLINATION**



COMMON NAME



NON-FLOWERING SEED PLANTS





DIVERSITY



~800 SPECIES

EARTH



**GYMNOSPERMS
MINOR
COMPONENT
EXTANT FLORA**

EARTH

DISTRIBUTION

T

TROPICAL

EARTH



TEMPERATE

EARTH



DOMINATELY TEMPERATE

EARTH



GENERAL CHARACTERS

GYMNOSPERM LIFE CYCLE





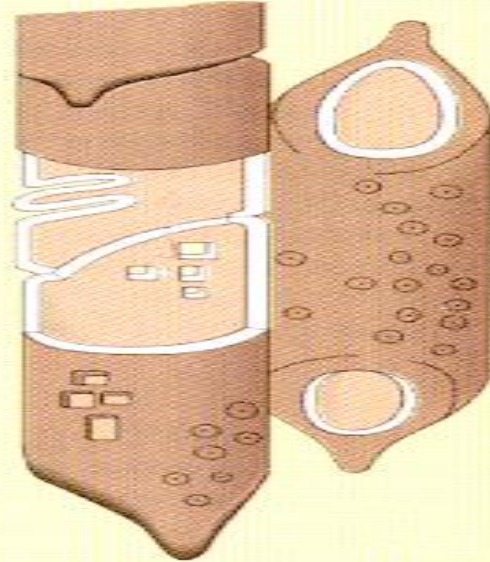
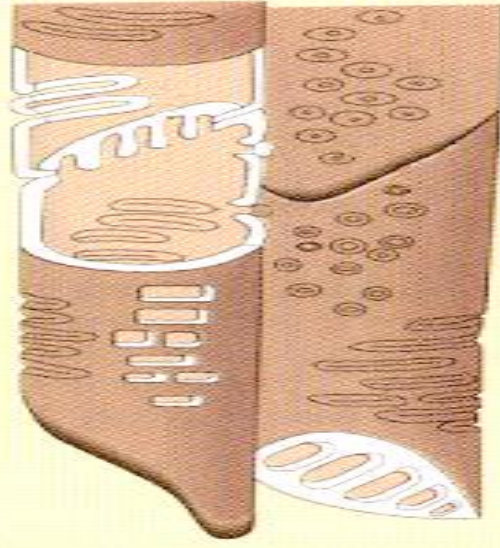
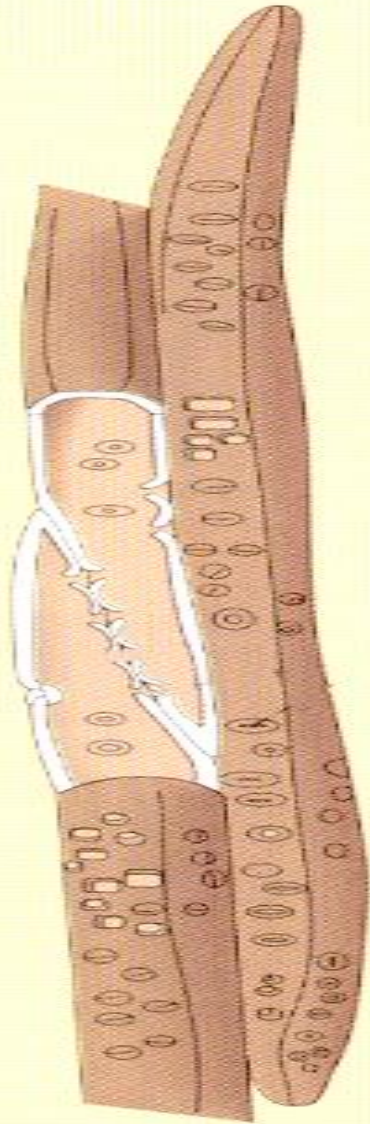
SPOROPHYTE CHARACTERS



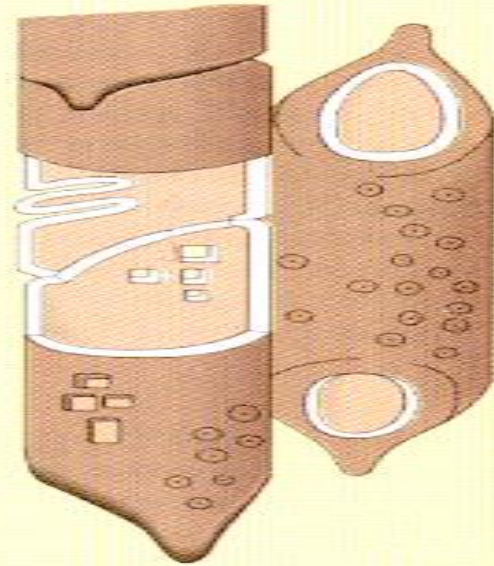
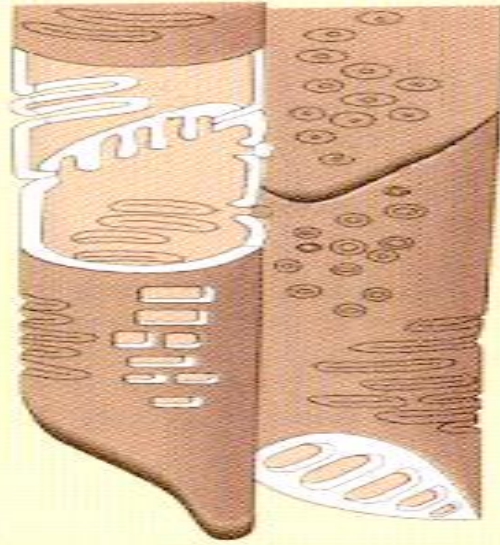
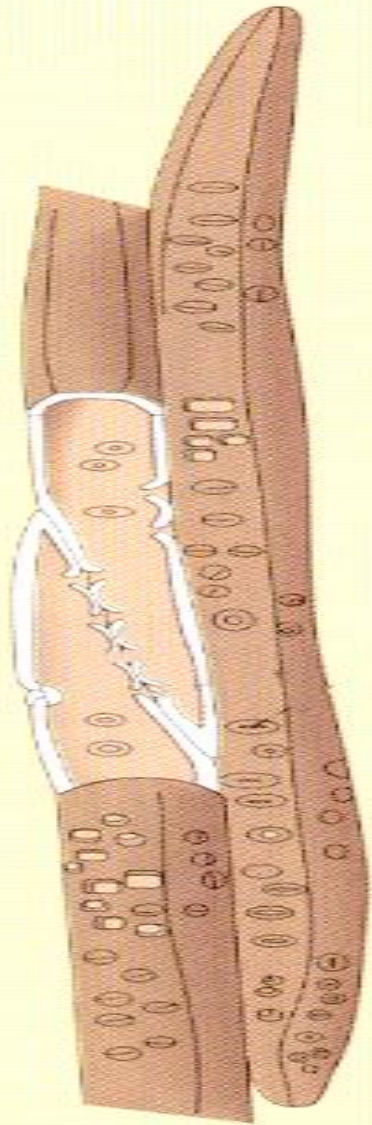
VASCULAR TISSUE



XYLEM



XYLEM CELLS



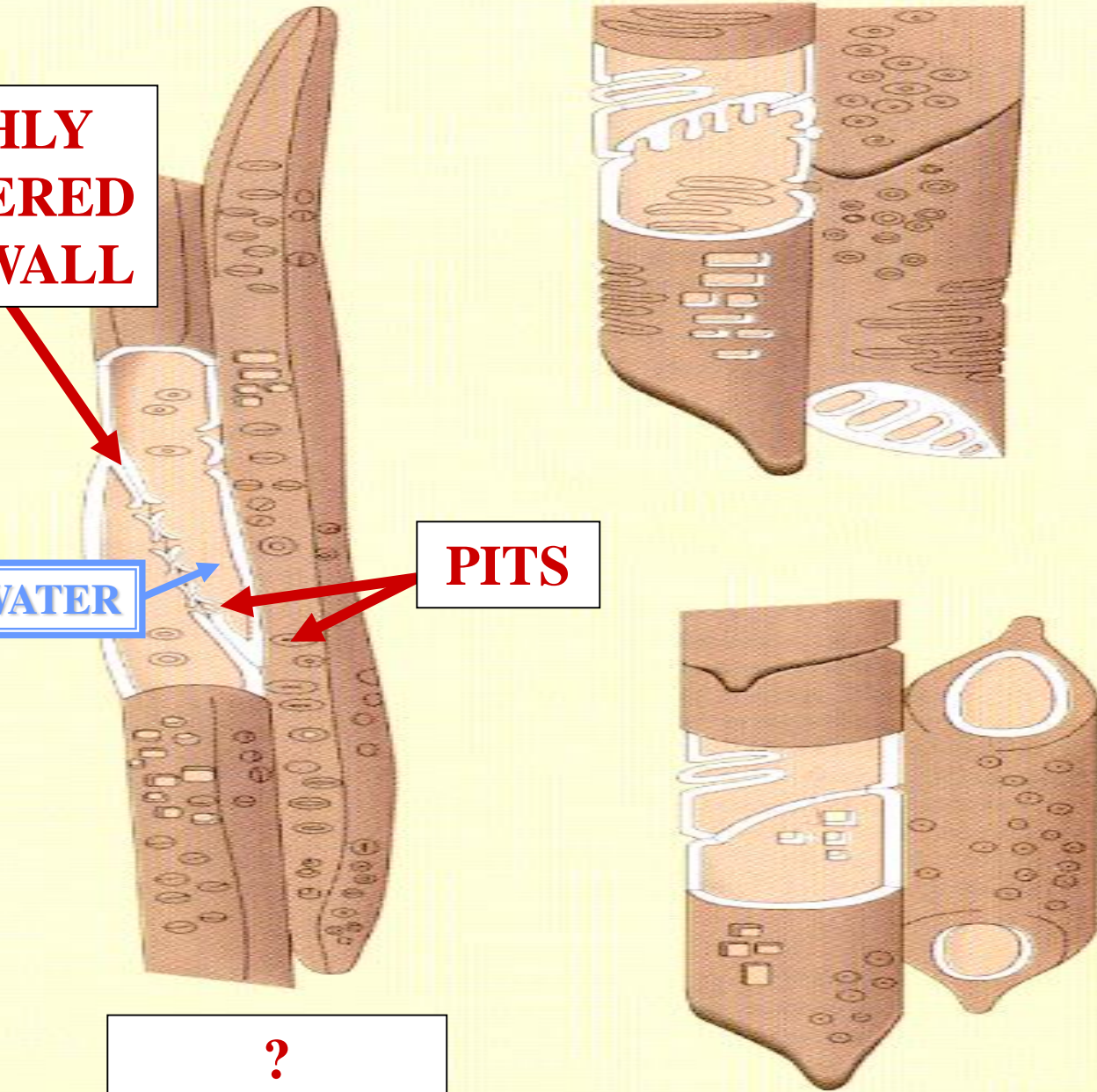
TRACHEARY ELEMENTS

**HIGHLY
TAPPED
END WALL**

WATER

PITS

?



**HIGHLY
TAPPED
END WALL**

WATER

PITS

TRACHEID

