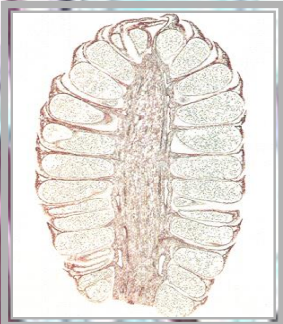


L.S.

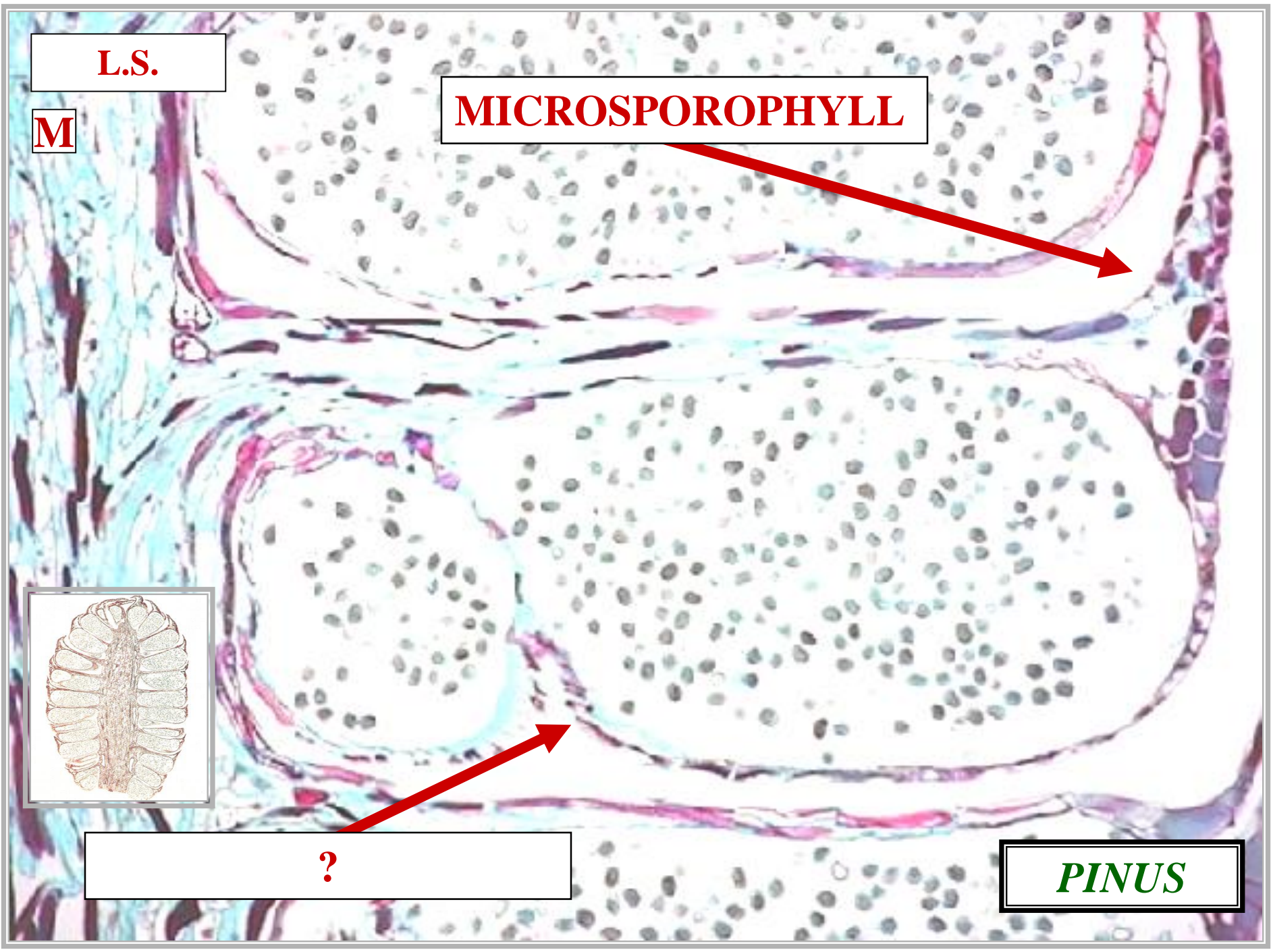
MICROSPOROPHYLL

M



?

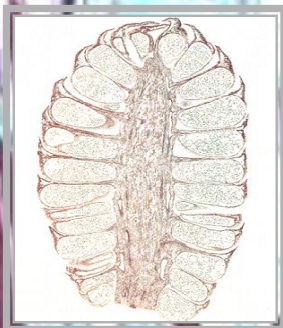
*PINUS*



L.S.

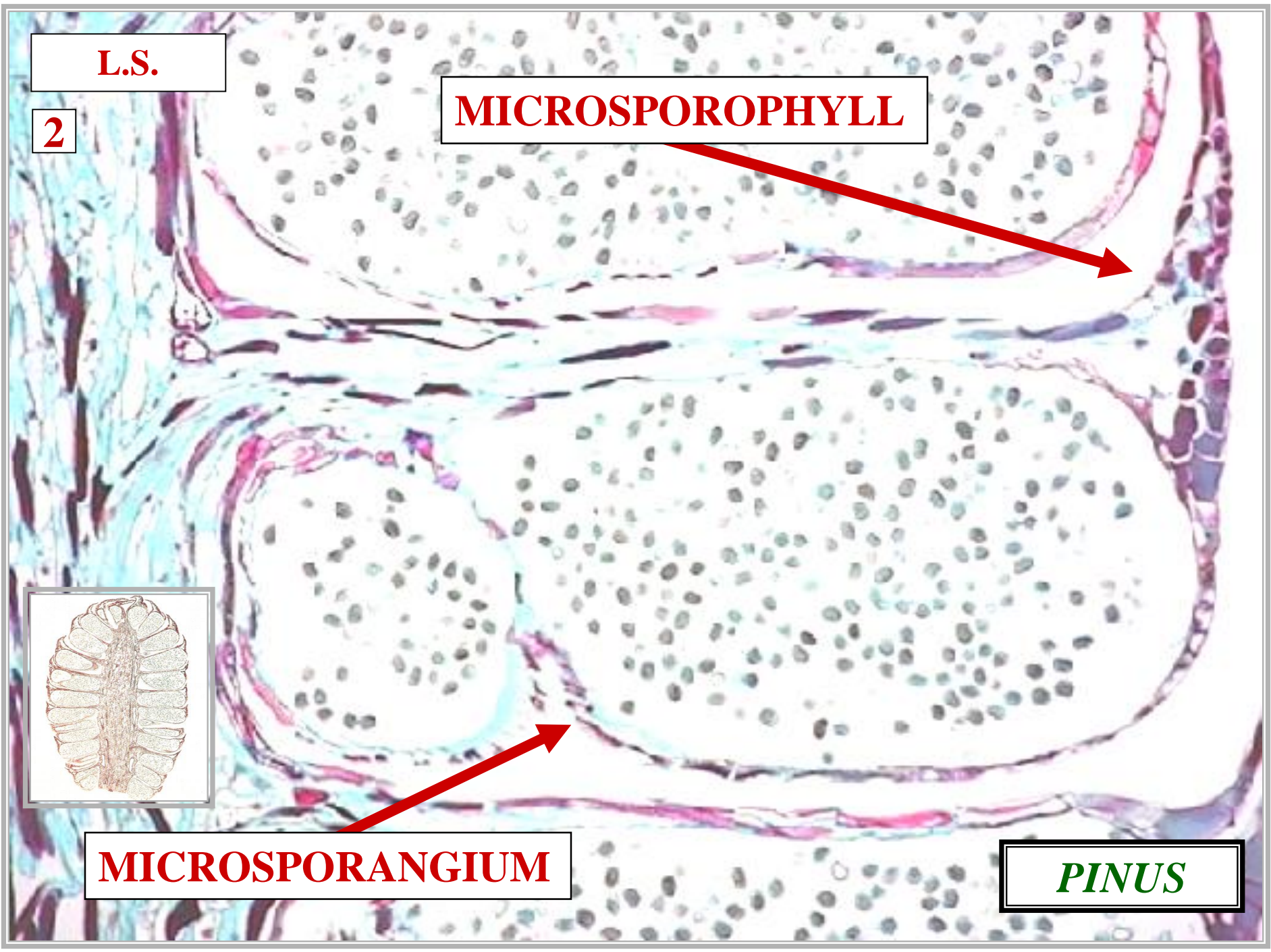
MICROSPOROPHYLL

2



MICROSPORANGIUM

*PINUS*





**L.S.**

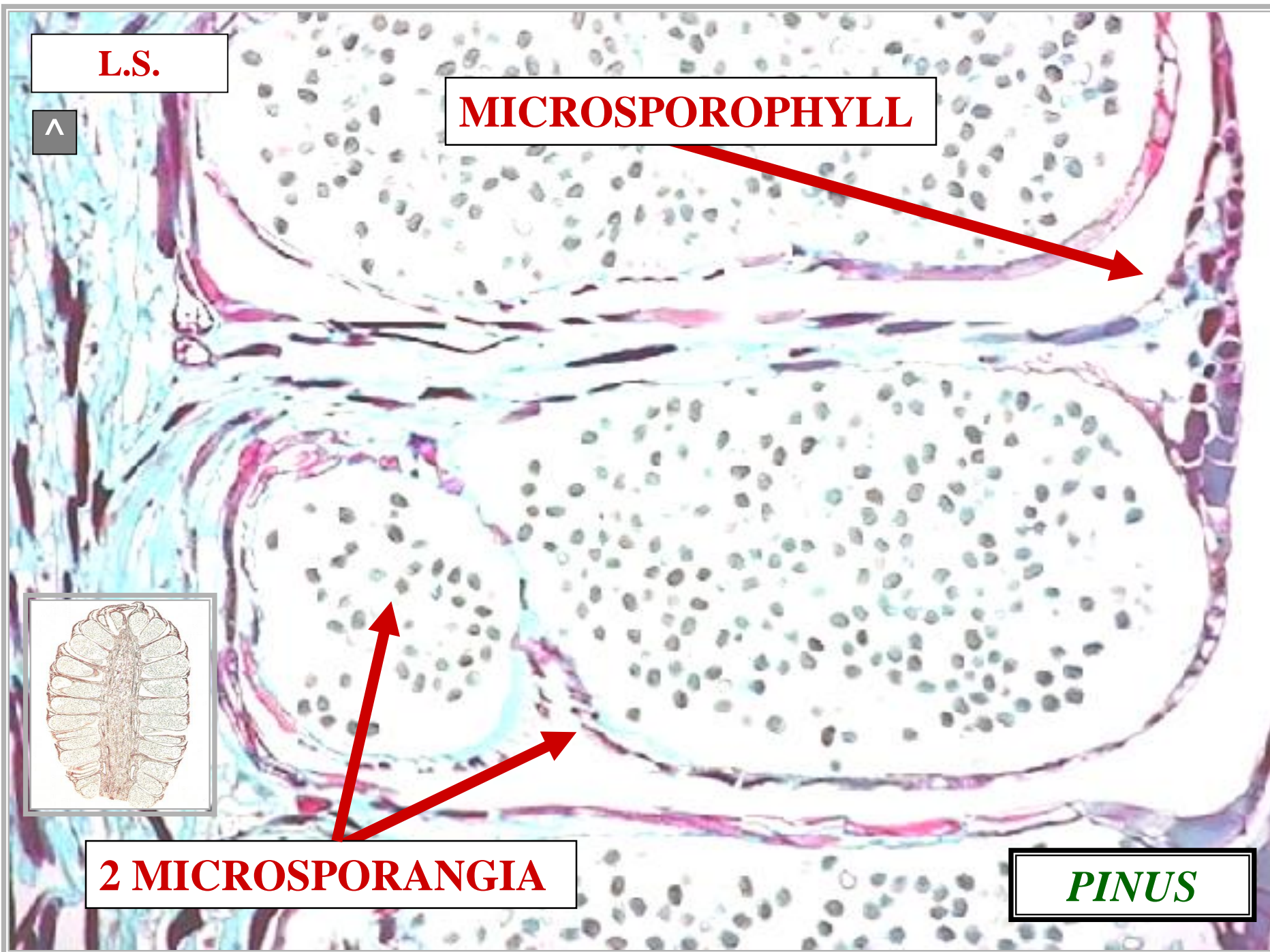
**MICROSPOROPHYLL**

^



**2 MICROSPORANGIA**

***PINUS***



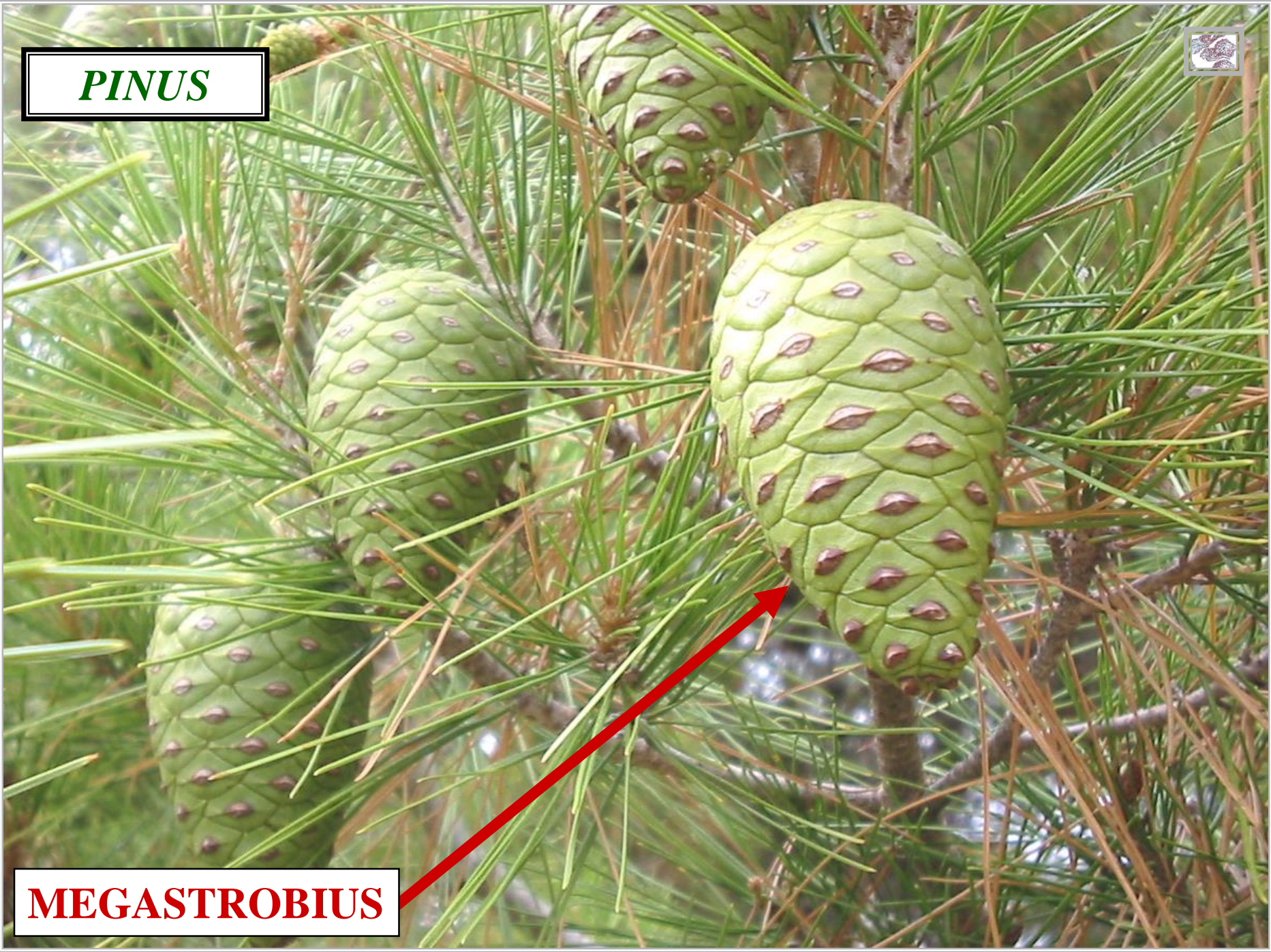


# MEGASTROBILUS





*PINUS*



**MEGASTROBIUS**



**MEGASTROBILUS**



?



*PINUS*

**L.S.**



**MEGASTROBILUS**

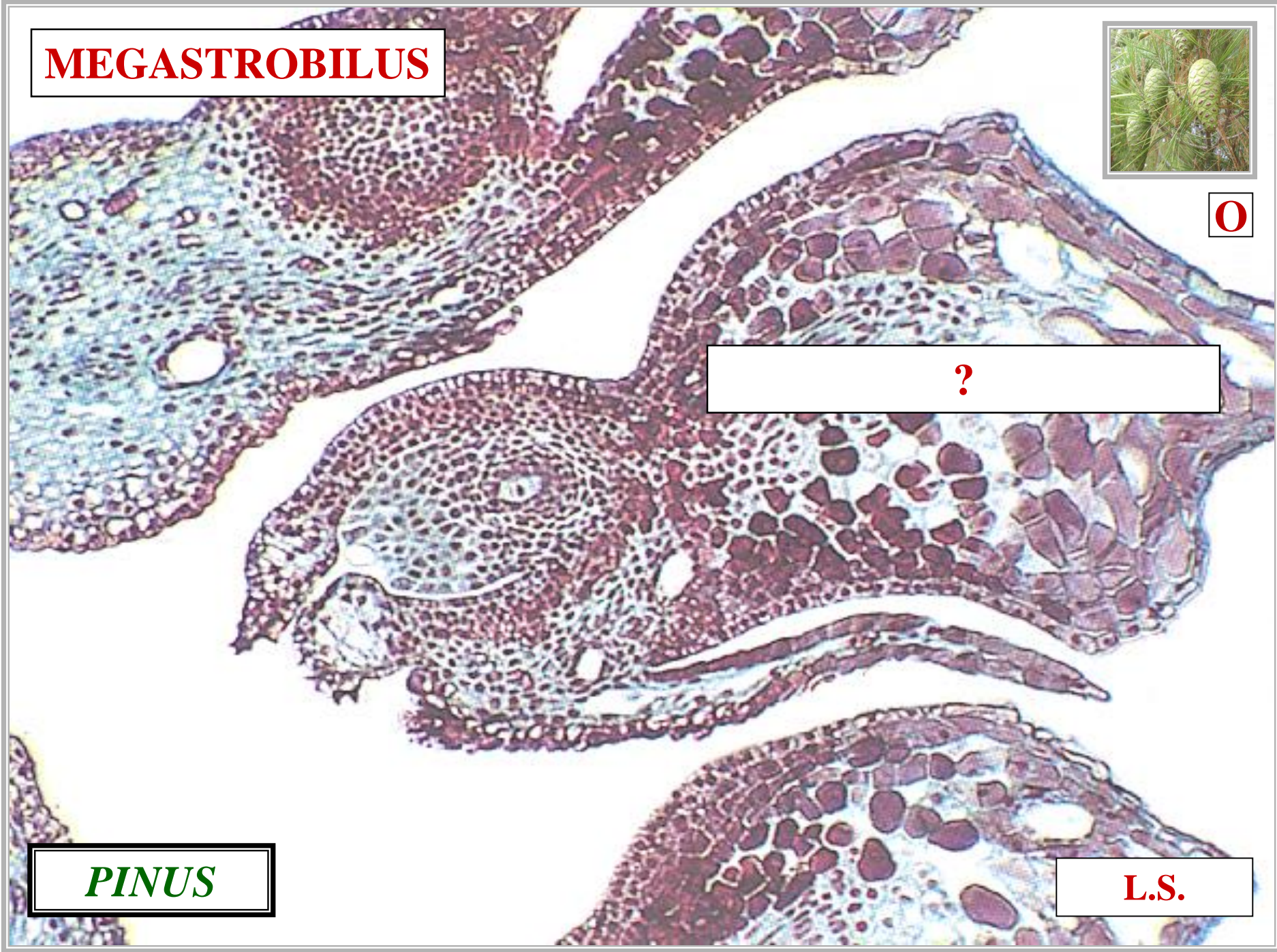


**O**

**?**

***PINUS***

**L.S.**





**MEGASTROBILUS**

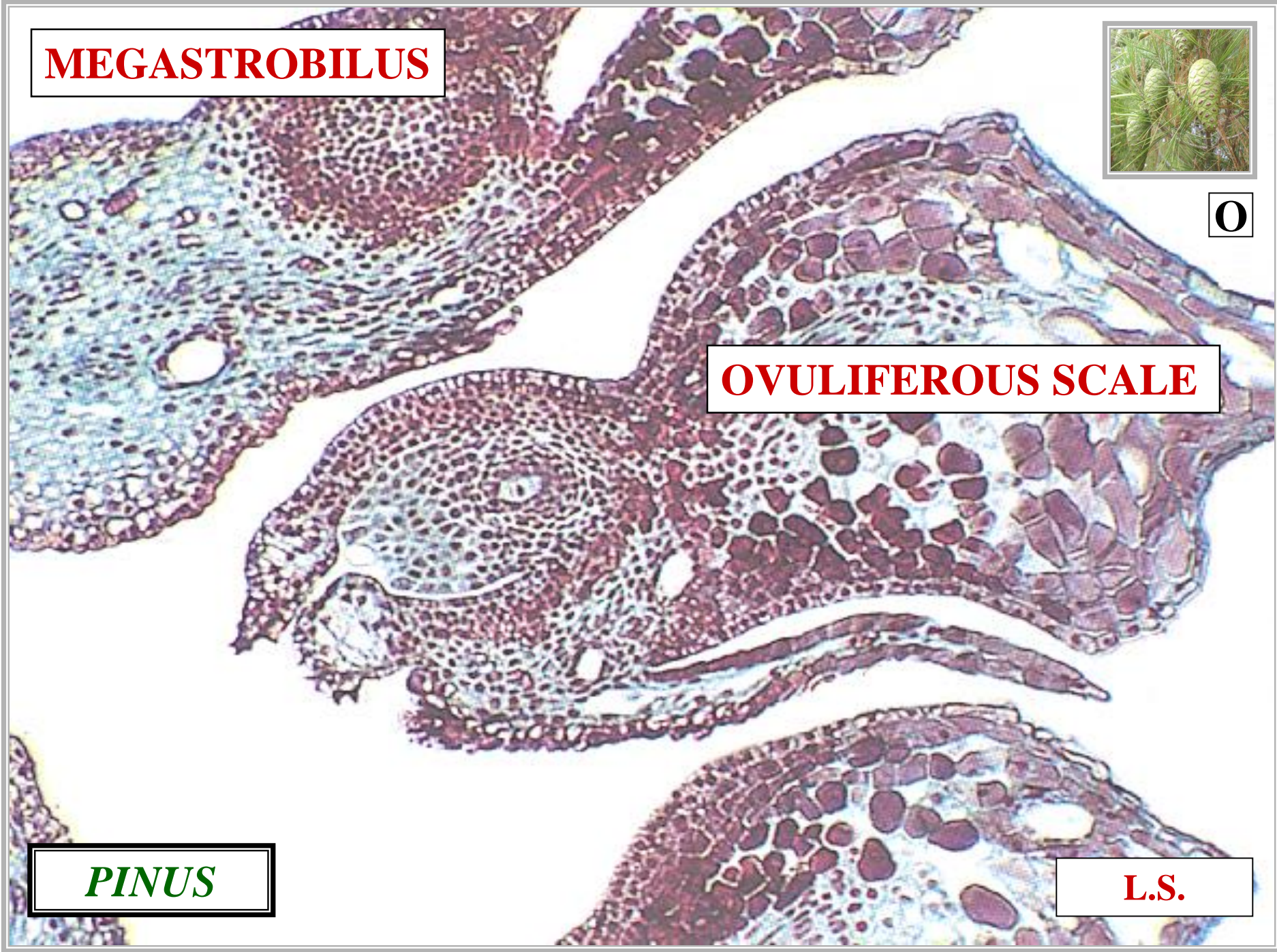


**O**

**OVULIFEROUS SCALE**

***PINUS***

**L.S.**





# **OVULIFEROUS SCALES**



**PINOPHYTA**  
**OVULIFEROUS SCALES**

**OVULE BEARING**  
**BRANCHES**

**PINOPHYTA**  
**OVULIFEROUS SCLALES**



**MEGASTROBILUS**



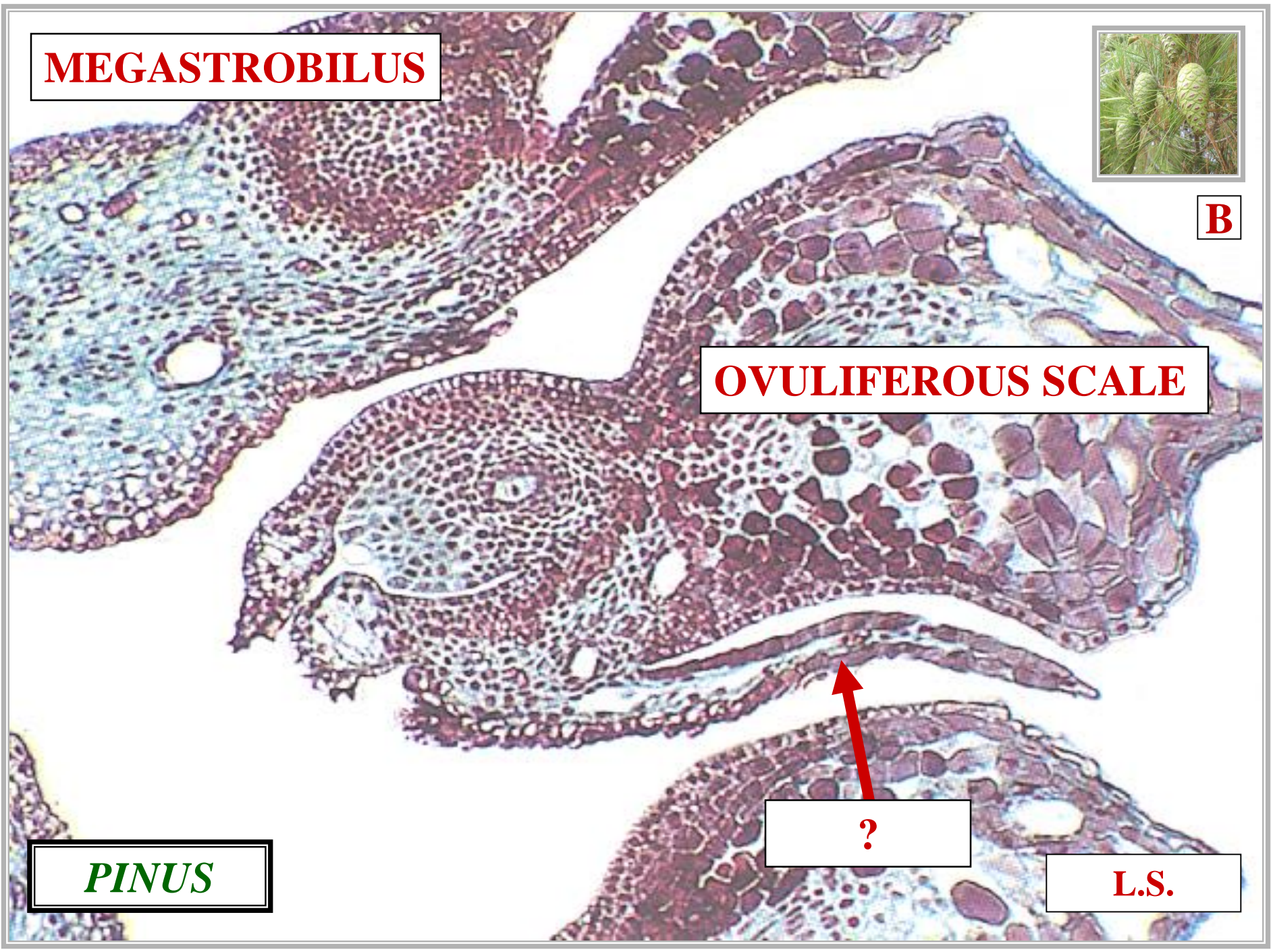
**B**

**OVULIFEROUS SCALE**

**?**

***PINUS***

**L.S.**





**MEGASTROBILUS**



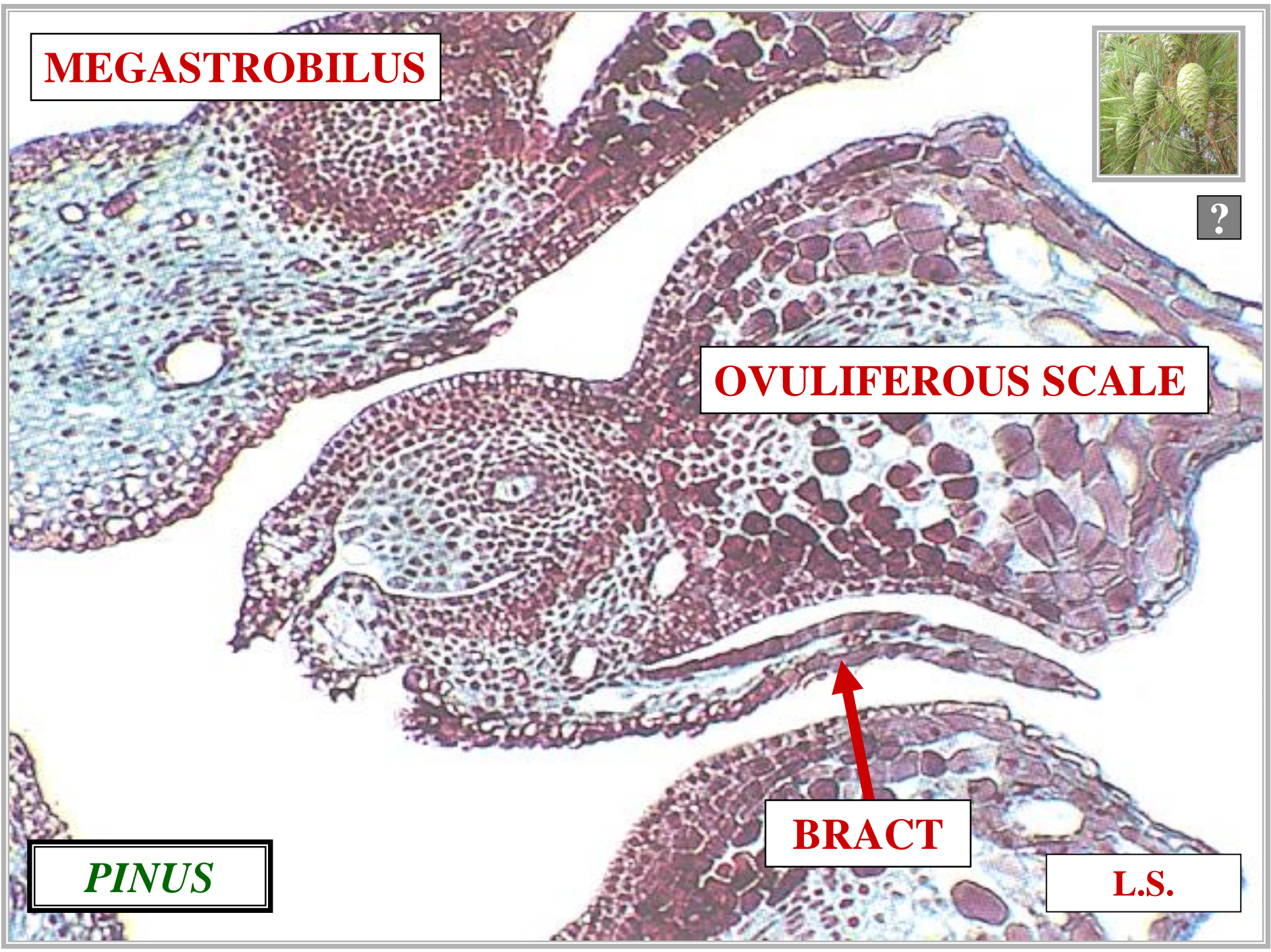
?

**OVULIFEROUS SCALE**

**BRACT**

***PINUS***

**L.S.**





**MEGASTROBILUS**



**O**

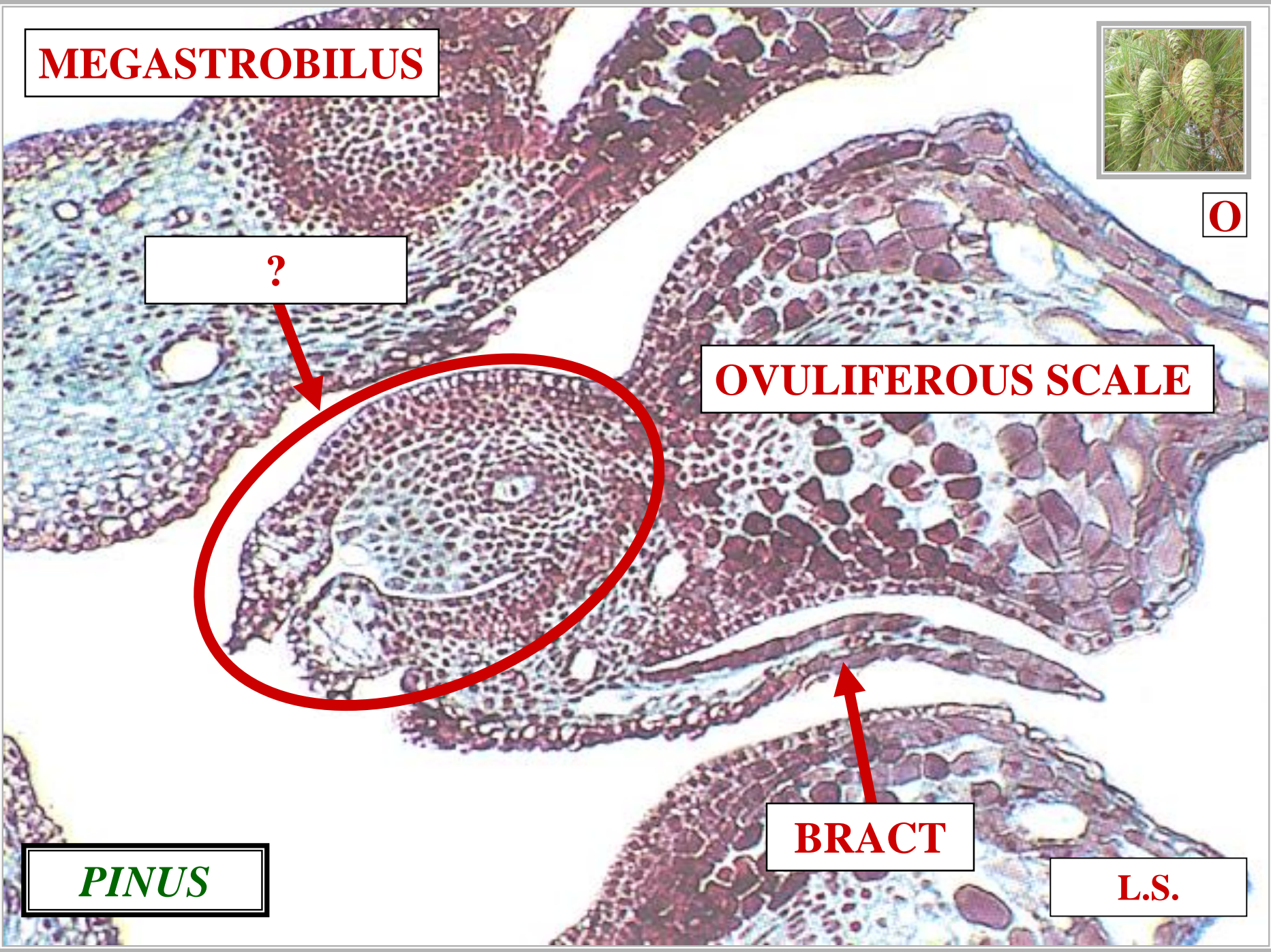
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**OVULIFEROUS SCALE**

**BRACT**

***PINUS***

**L.S.**





**MEGASTROBILUS**



**2**

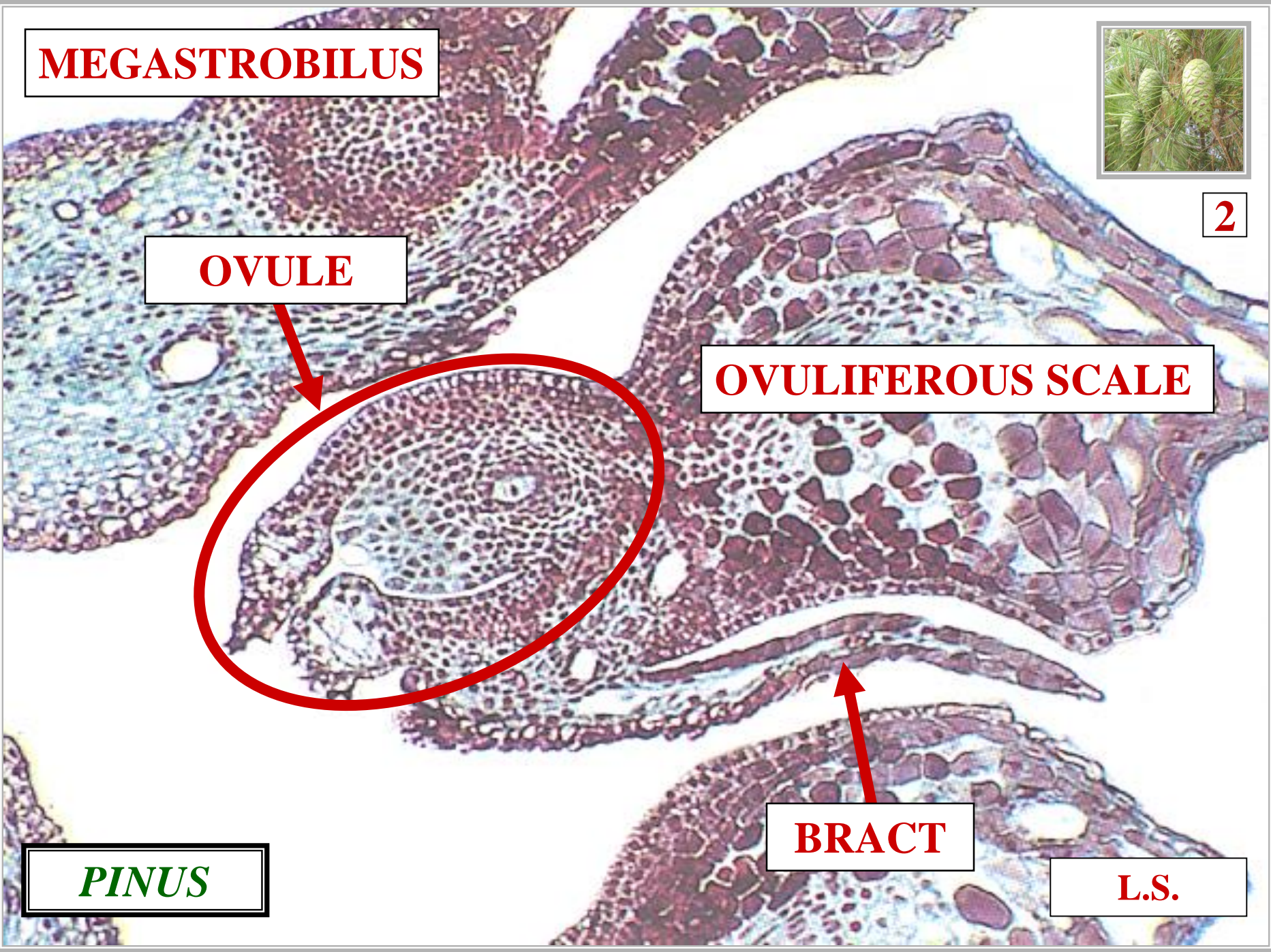
**OVULE**

**OVULIFEROUS SCALE**

**BRACT**

***PINUS***

**L.S.**

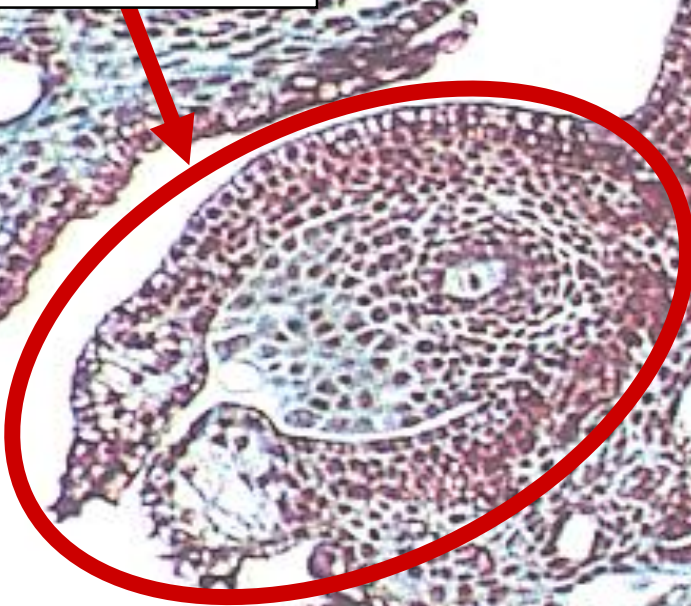




**MEGASTROBILUS**



**2 OVULES**



**OVULIFEROUS SCALE**

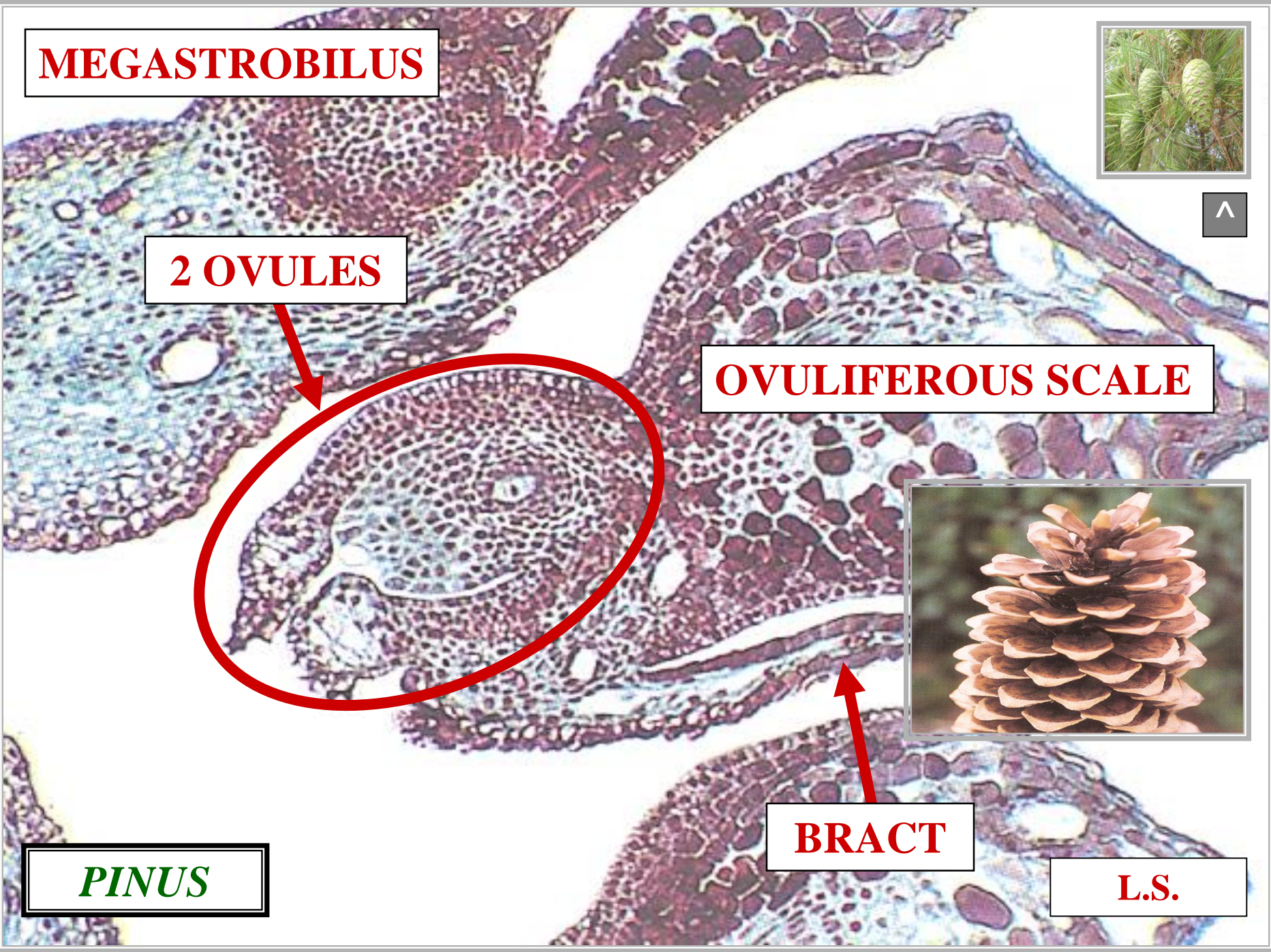


**BRACT**



***PINUS***

**L.S.**





# STROBILI POSITION



*PINUS*

**M**



# MEGASTROBILI



*PINUS*

**M**





# MEGASTROBILI



# MICROSTROBILI

# *PINUS*



**MEGASTROBILI**

*PINUS*



**ENSURES  
CROSS  
POLLINATION**

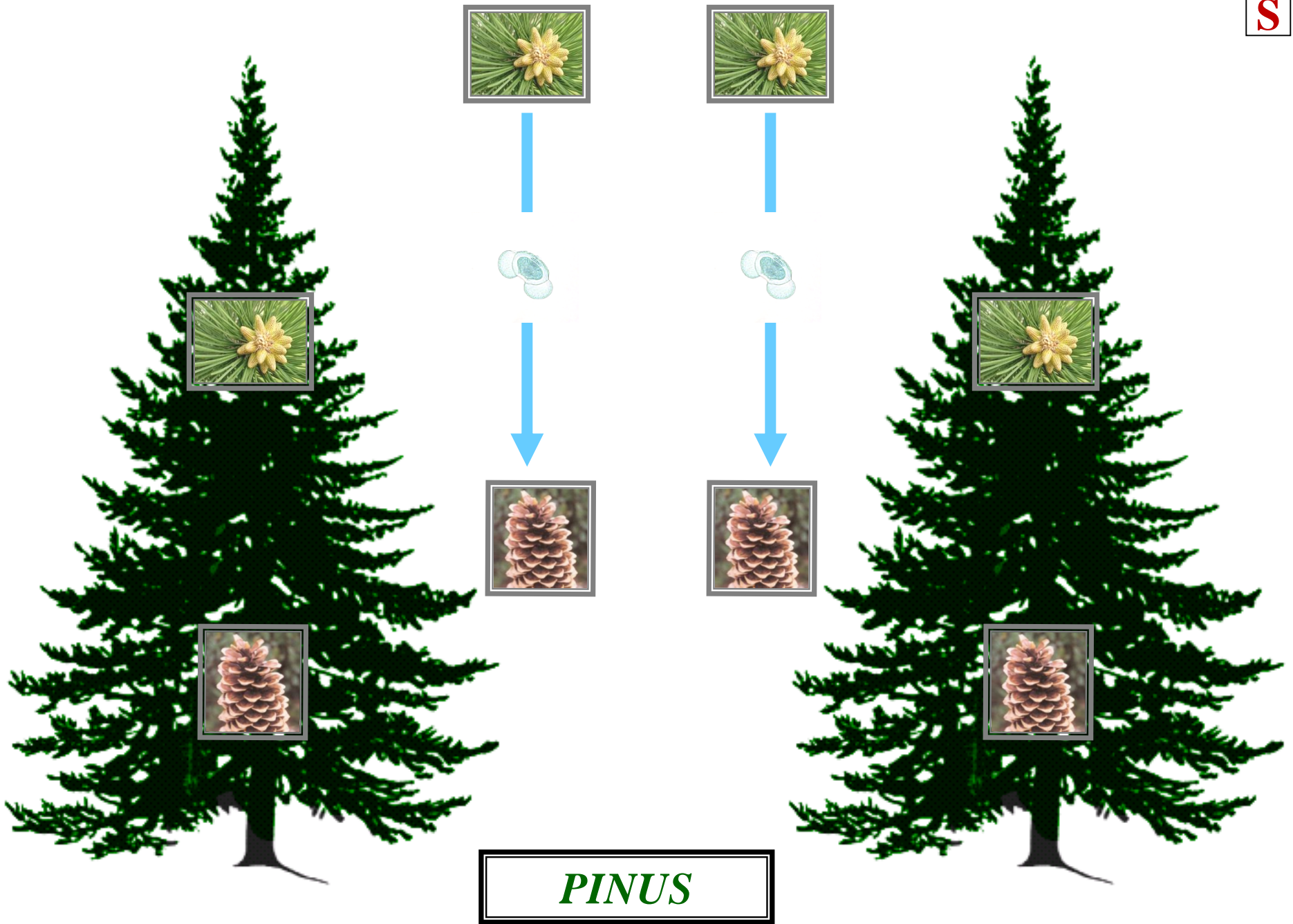
**MICROSTROBILI**







*PINUS*



*PINUS*



# SELF POLLINATION



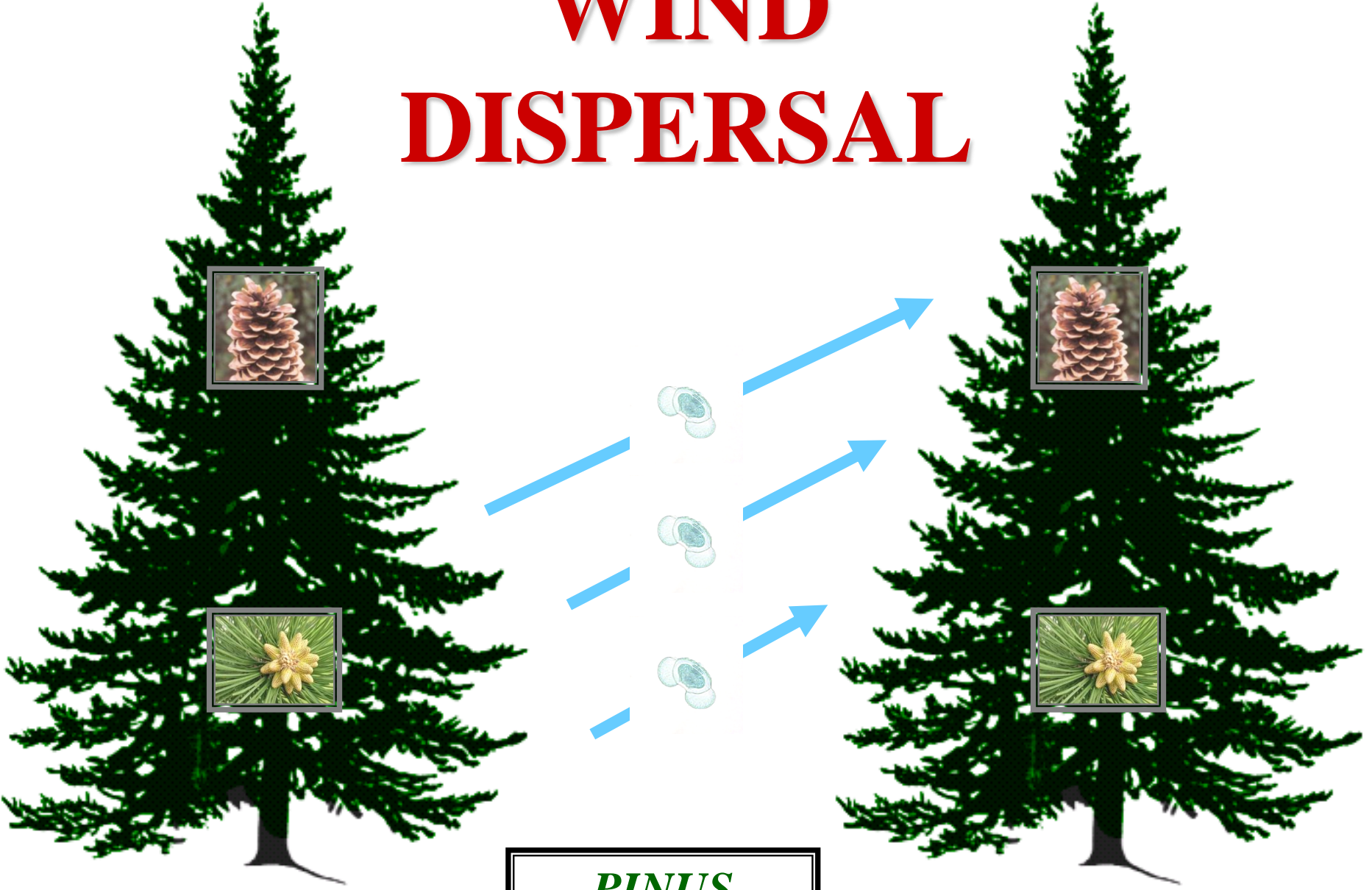
*PINUS*



*PINUS*



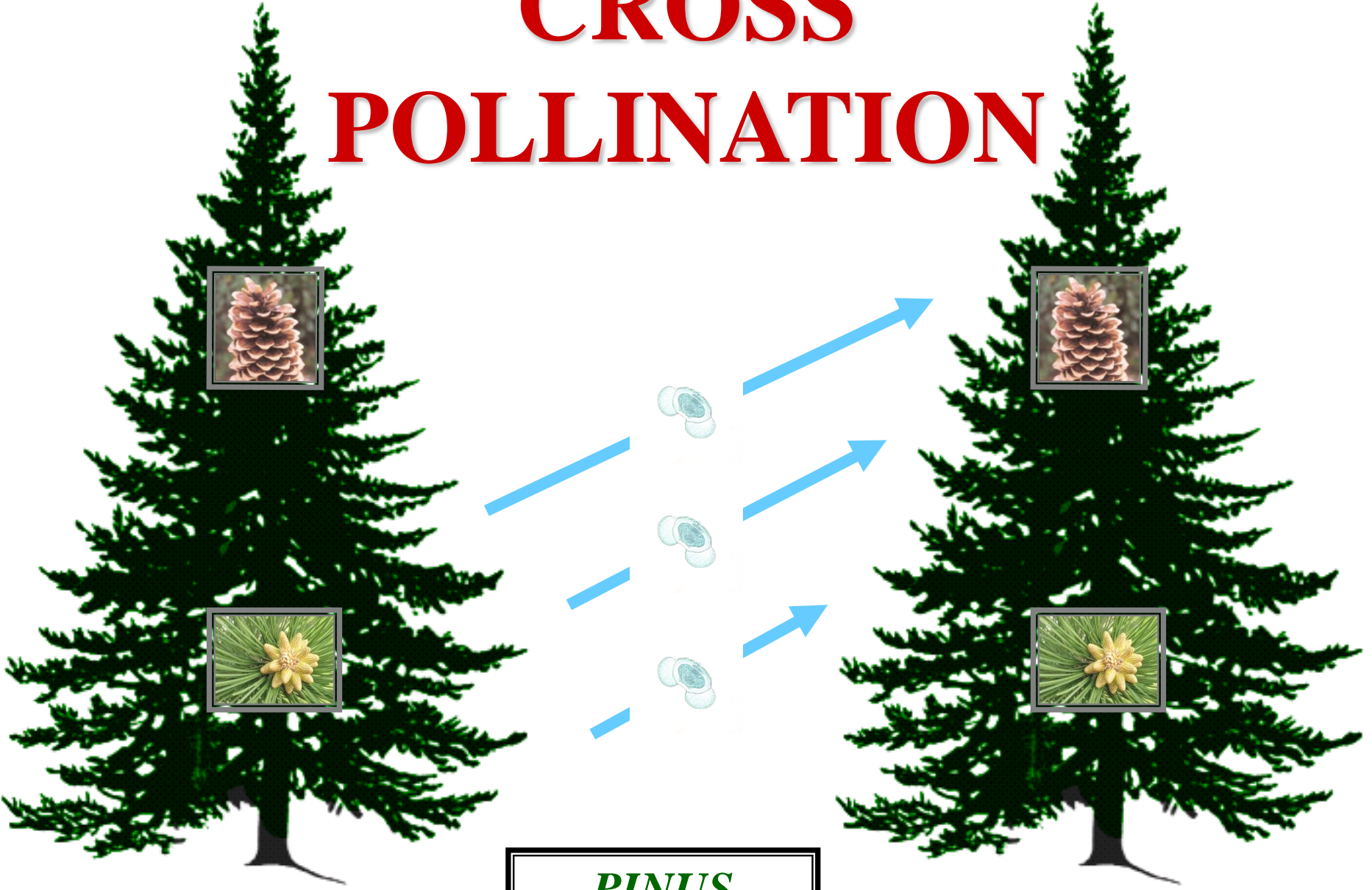
# WIND DISPERSAL



*PINUS*



# CROSS POLLINATION



*PINUS*





# CROSS POLLINATION



ENSURES  
GENETIC  
DIVERSITY

A large rectangular frame with a thin grey border contains the text 'ENSURES GENETIC DIVERSITY' in red, bold, serif font. The frame is set against a background of two green pine trees. Inside the frame, several blue arrows point from the left tree to the right tree, and several light blue pollen grains are shown in flight between the trees, illustrating the process of cross-pollination.

*PINUS*

# POLLINATION



# **GYMNOSPERM POLLINATION**

**GYMNOSPERM  
POLLINATION**



**POLLEN GRAIN  
DISSEMINATION TO  
MEGASPORANGIUM**

**GYMNOSPERM  
POLLINATION**



**GYMNOSPERM  
POLLINATION**

POLLINATION

ELIMINATES

WATER DEPENDENT

SYNGAMY

**GYMNOSPERM  
POLLINATION**



*PINUS*

**M**





**MICROSTROBILI**

*PINUS*

**M**





**MICROSPORANGIA**

*PINUS*

**D**

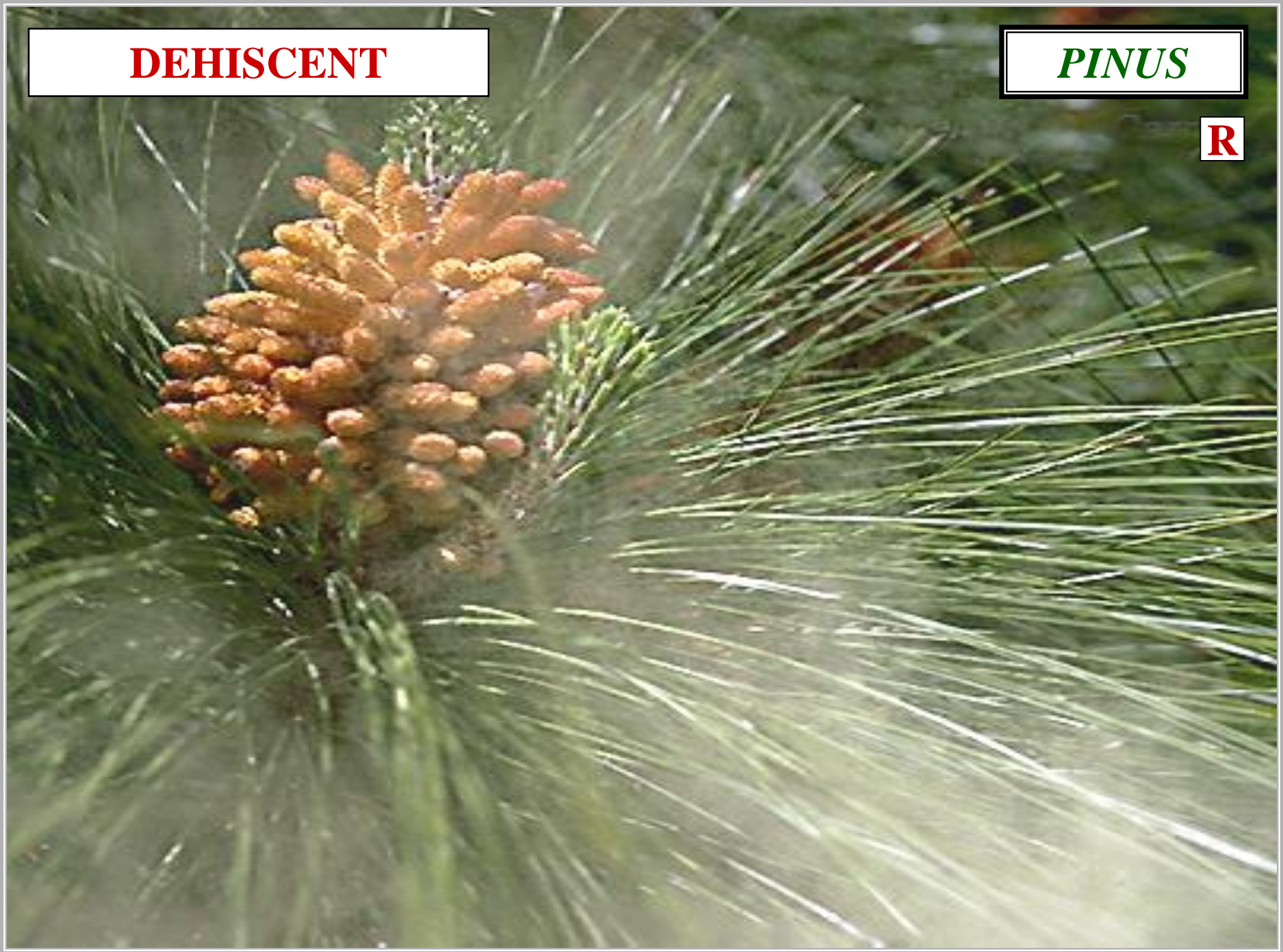




**DEHISCENT**

*PINUS*

**R**





**MICROSPORANGIA**

*PINUS*

**P**

**MICROGAMETOPHYTES  
ARE RELEASED**



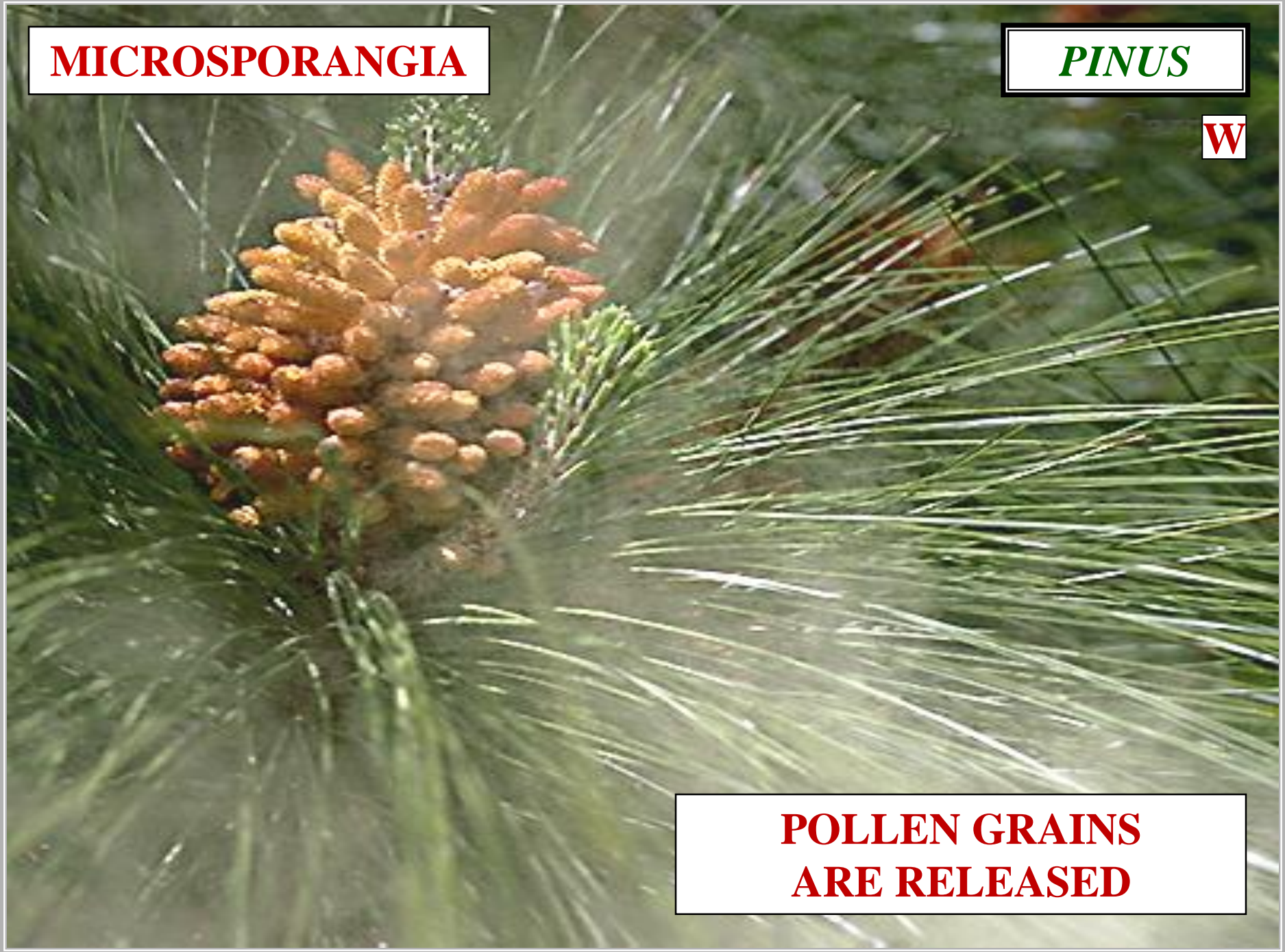


**MICROSPORANGIA**

*PINUS*

**W**

**POLLEN GRAINS  
ARE RELEASED**





**MICROSPORANGIA**

***PINUS***



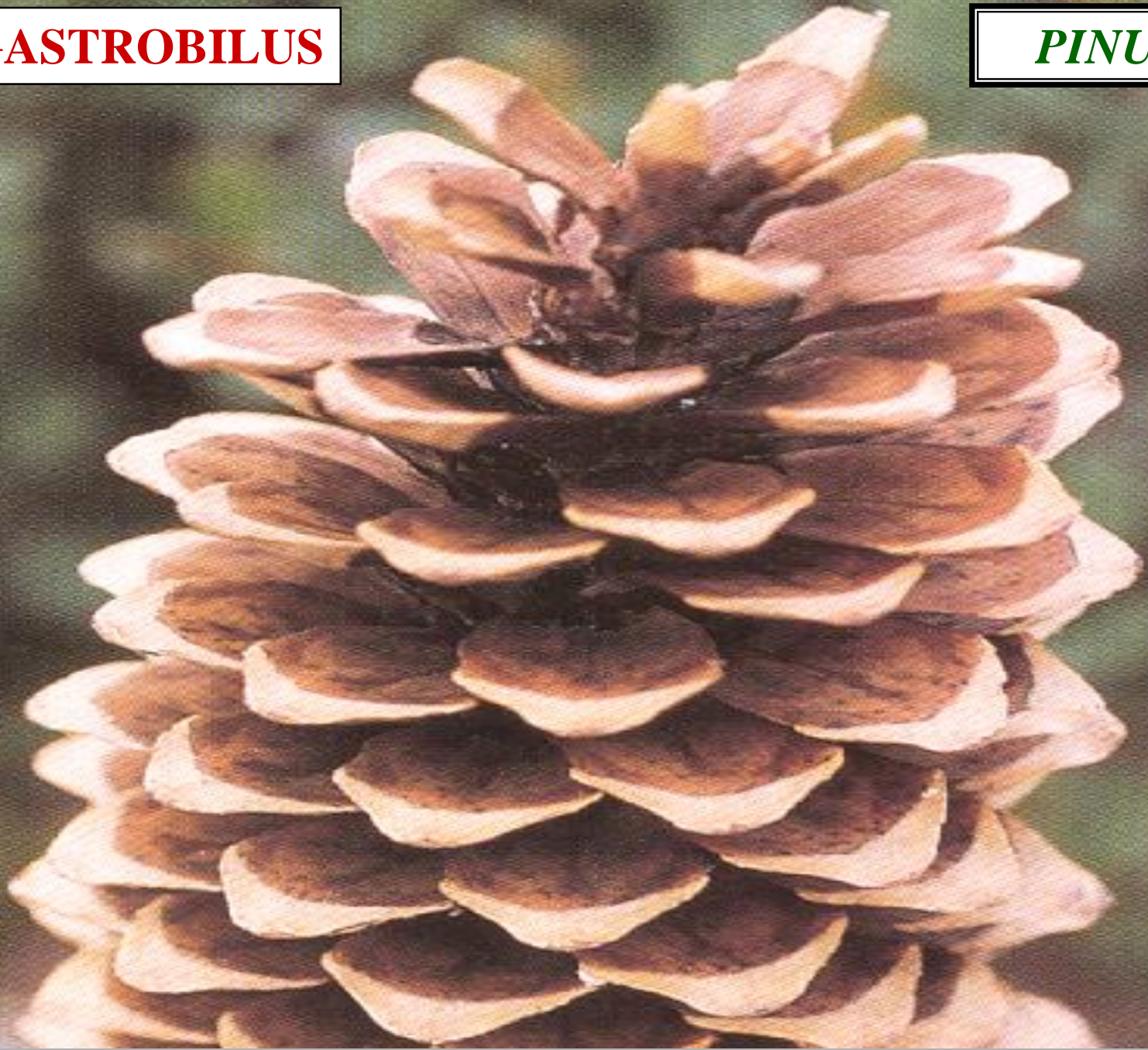
**ANEMOPHILOUS  
WIND POLLINATION**



**MEGASTROBILUS**

*PINUS*

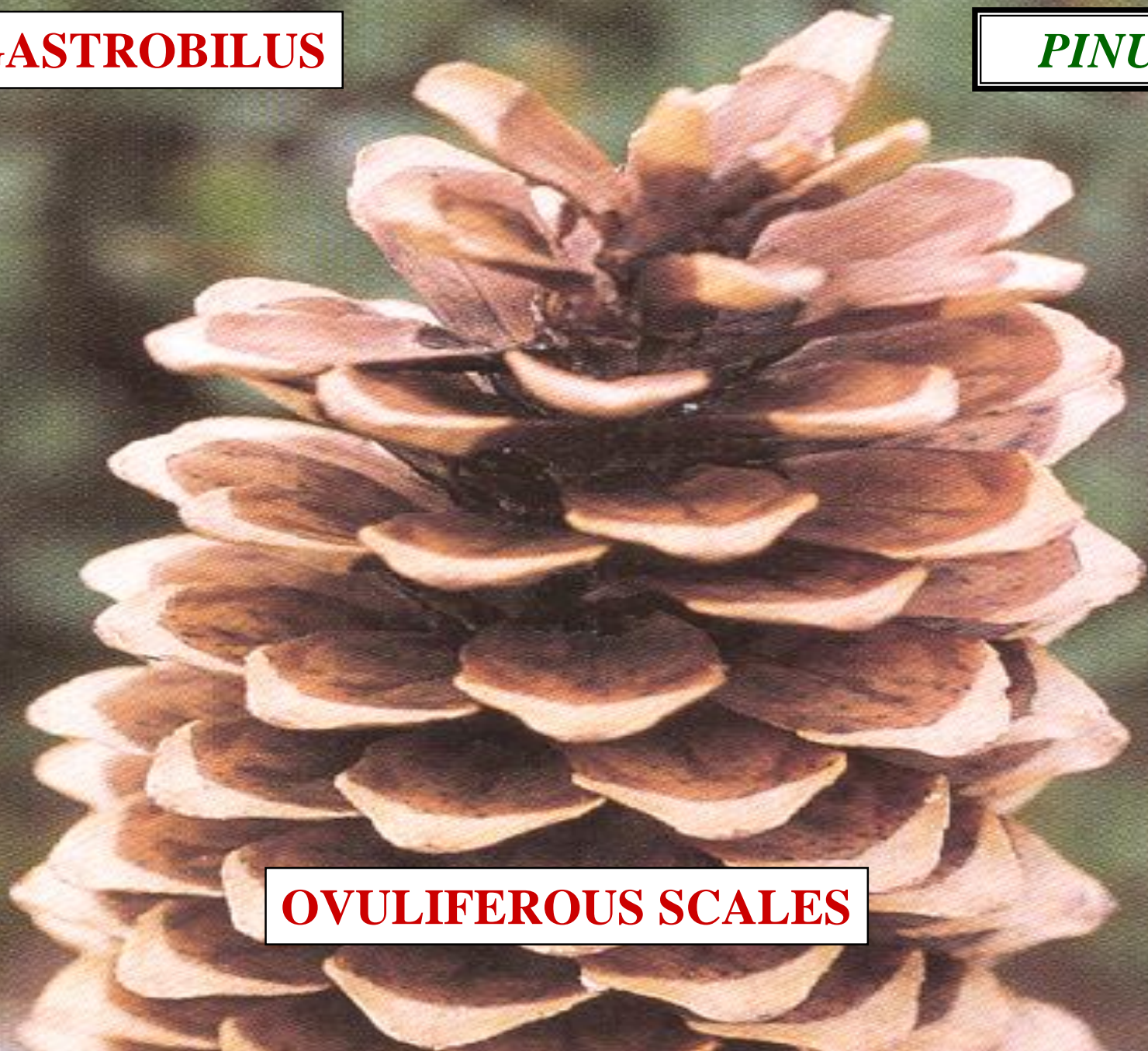
**O**





**MEGASTROBILUS**

*PINUS*



**OVULIFEROUS SCALES**



# MEGASTROBILUS



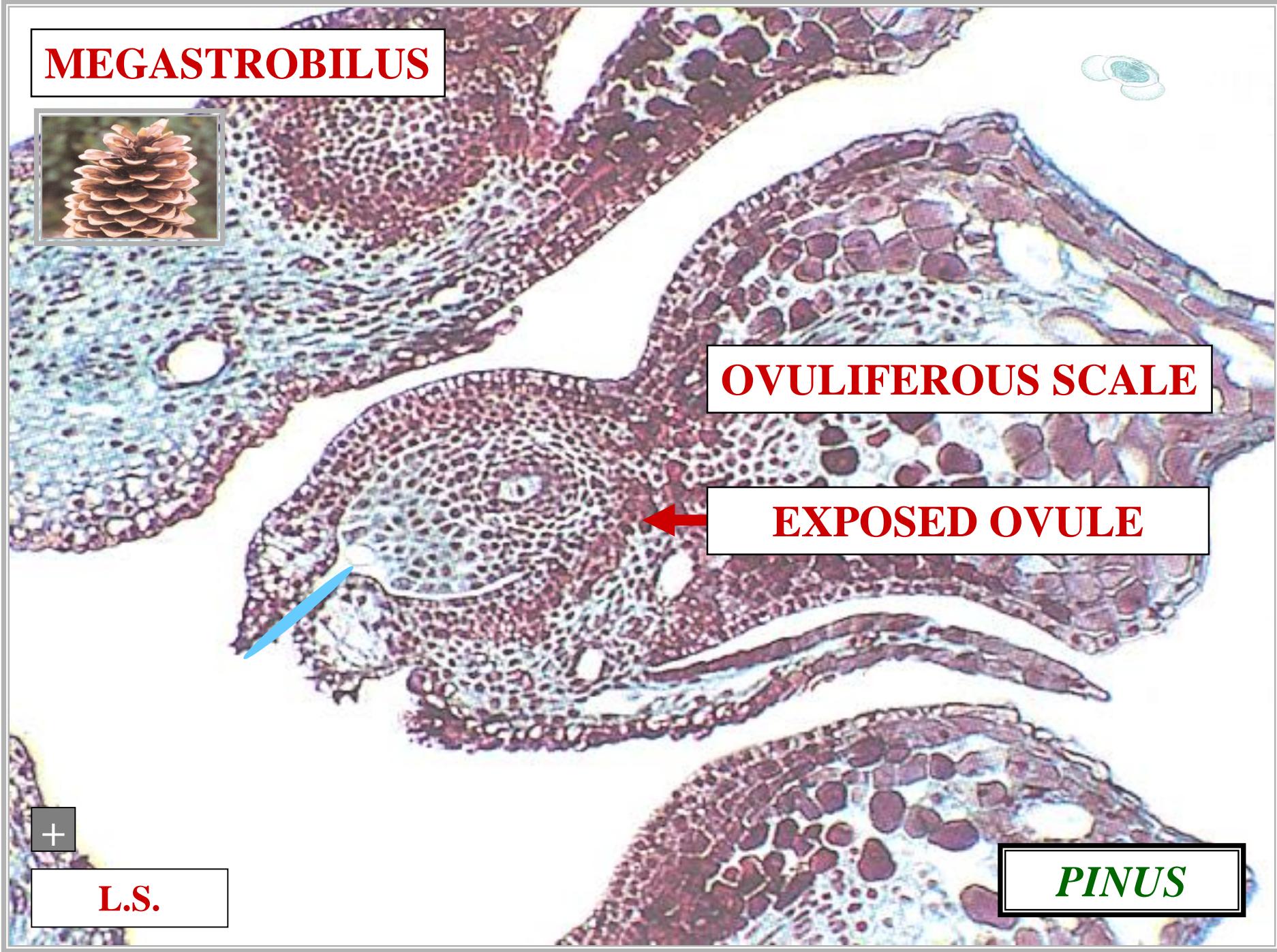
**OVULIFEROUS SCALE**

**EXPOSED OVULE**

+

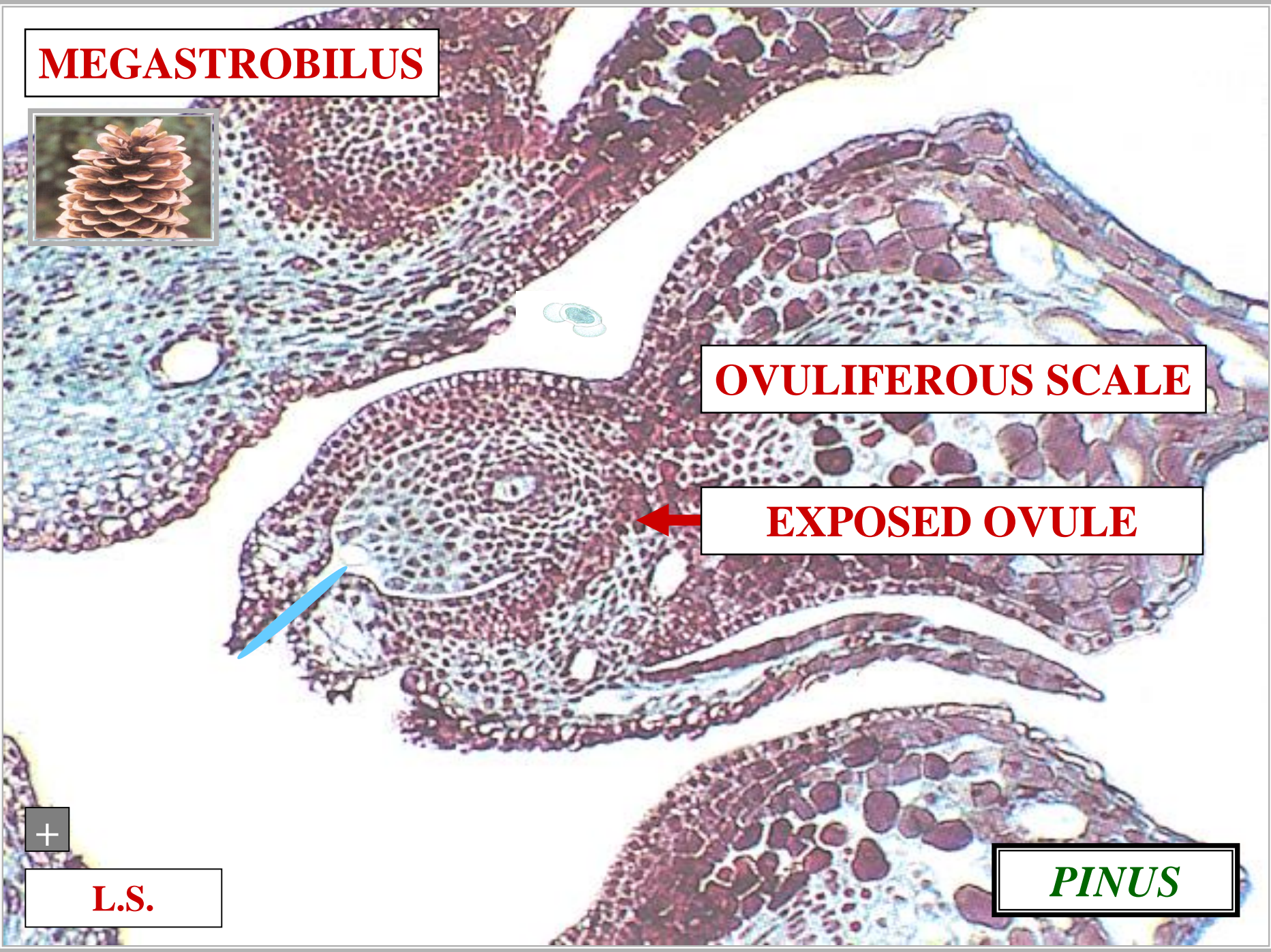
**L.S.**

***PINUS***





# MEGASTROBILUS



**OVULIFEROUS SCALE**

**EXPOSED OVULE**

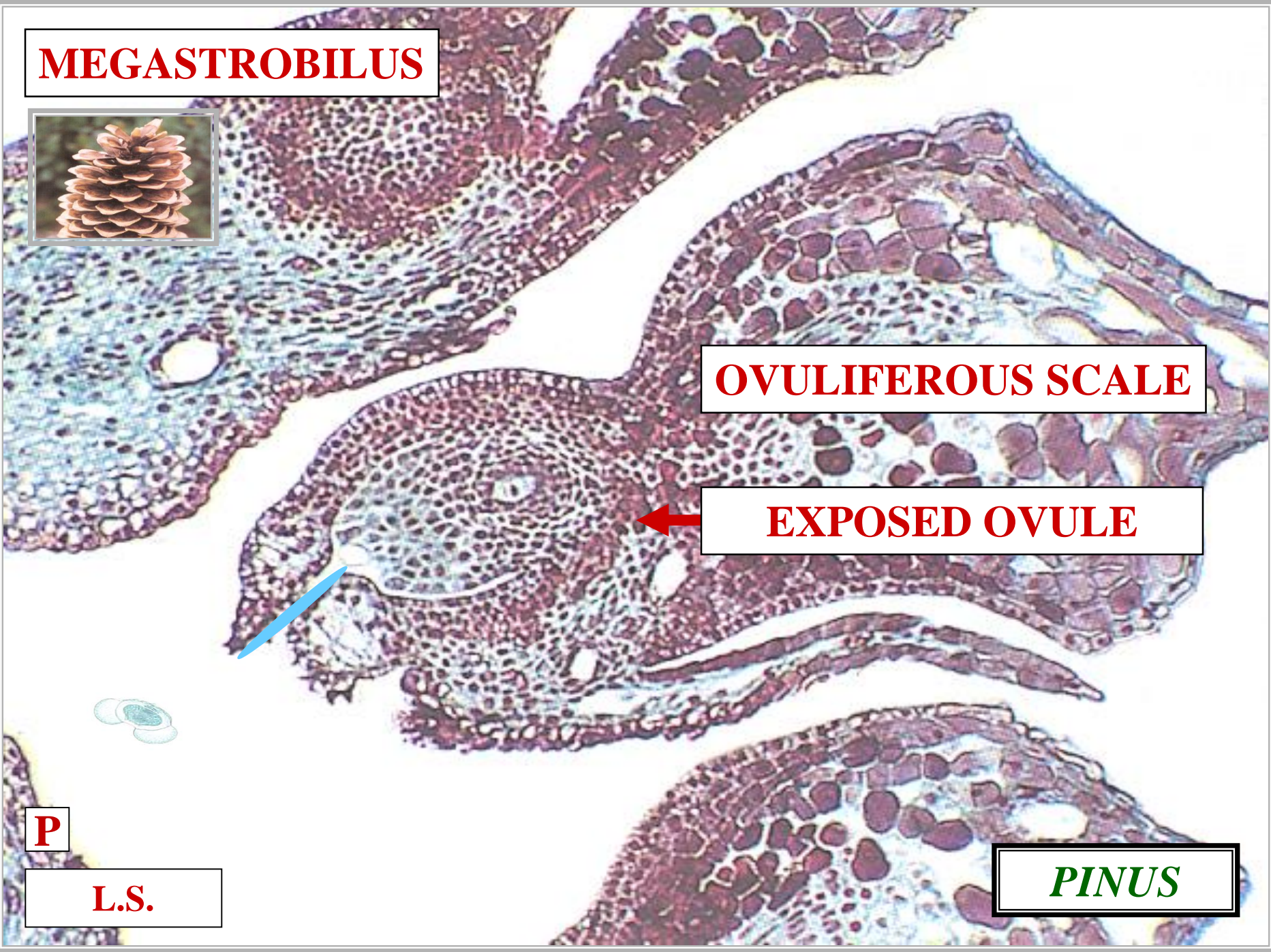
+

**L.S.**

***PINUS***



# MEGASTROBILUS



**OVULIFEROUS SCALE**

**EXPOSED OVULE**

**P**

**L.S.**

***PINUS***



# MEGASTROBILUS



**OVULIFEROUS SCALE**

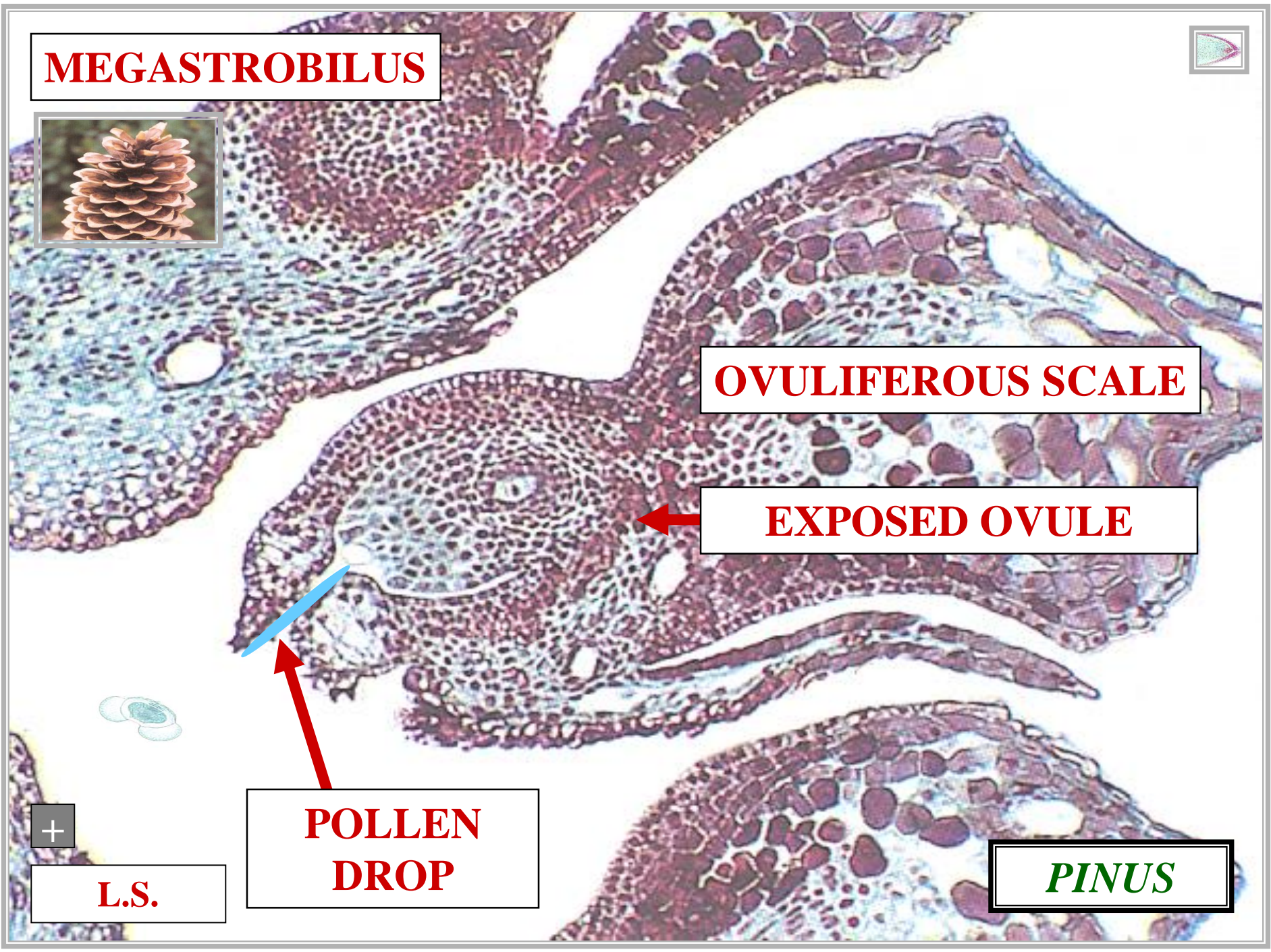
**EXPOSED OVULE**

**POLLEN  
DROP**

***PINUS***

**L.S.**

+





**OVULE**

**INTEGUMENT**

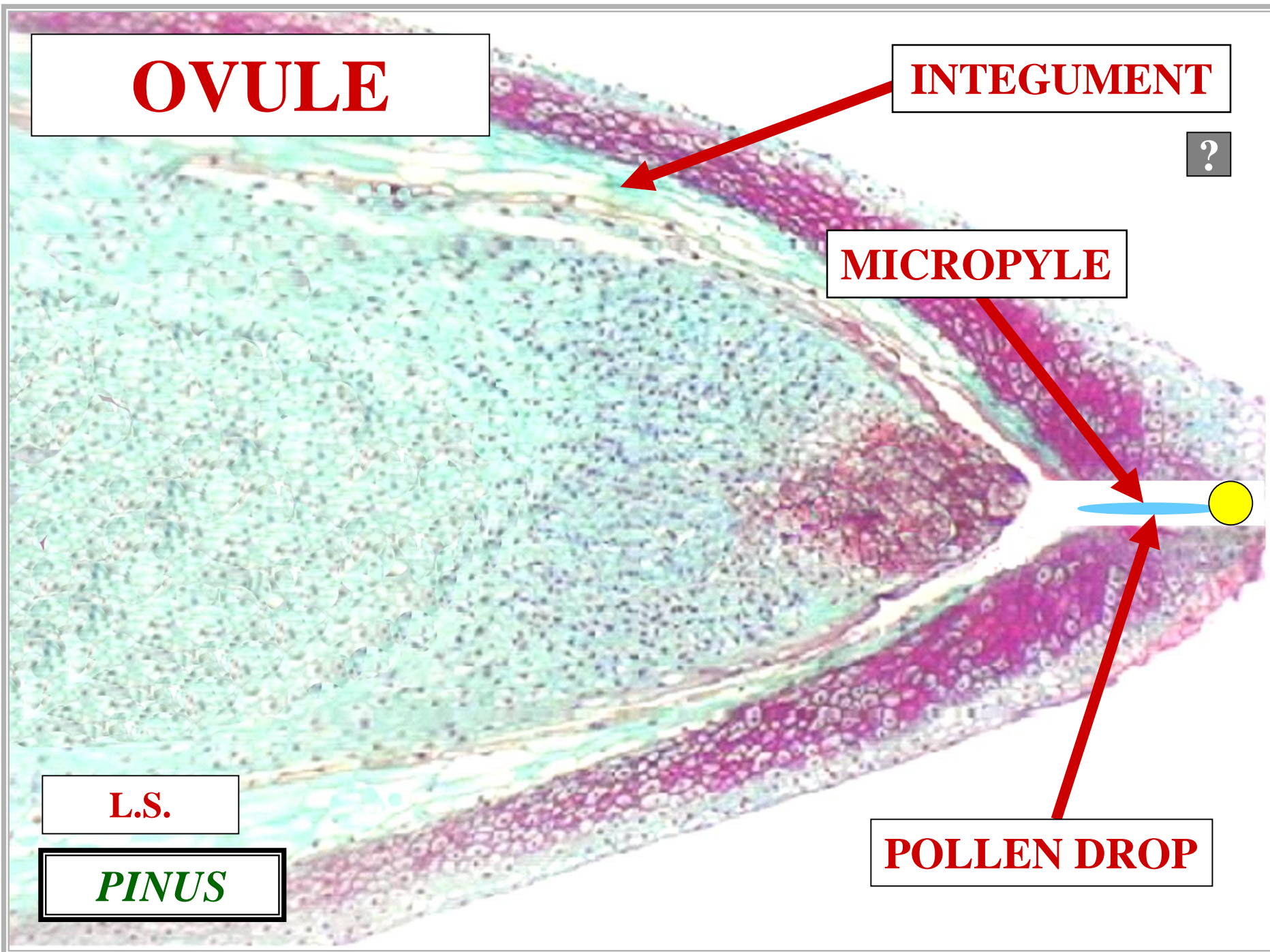
?

**MICROPYLE**

**L.S.**

***PINUS***

**POLLEN DROP**





**OVULE**

**INTEGUMENT**

**M**

**MICROPYLE**

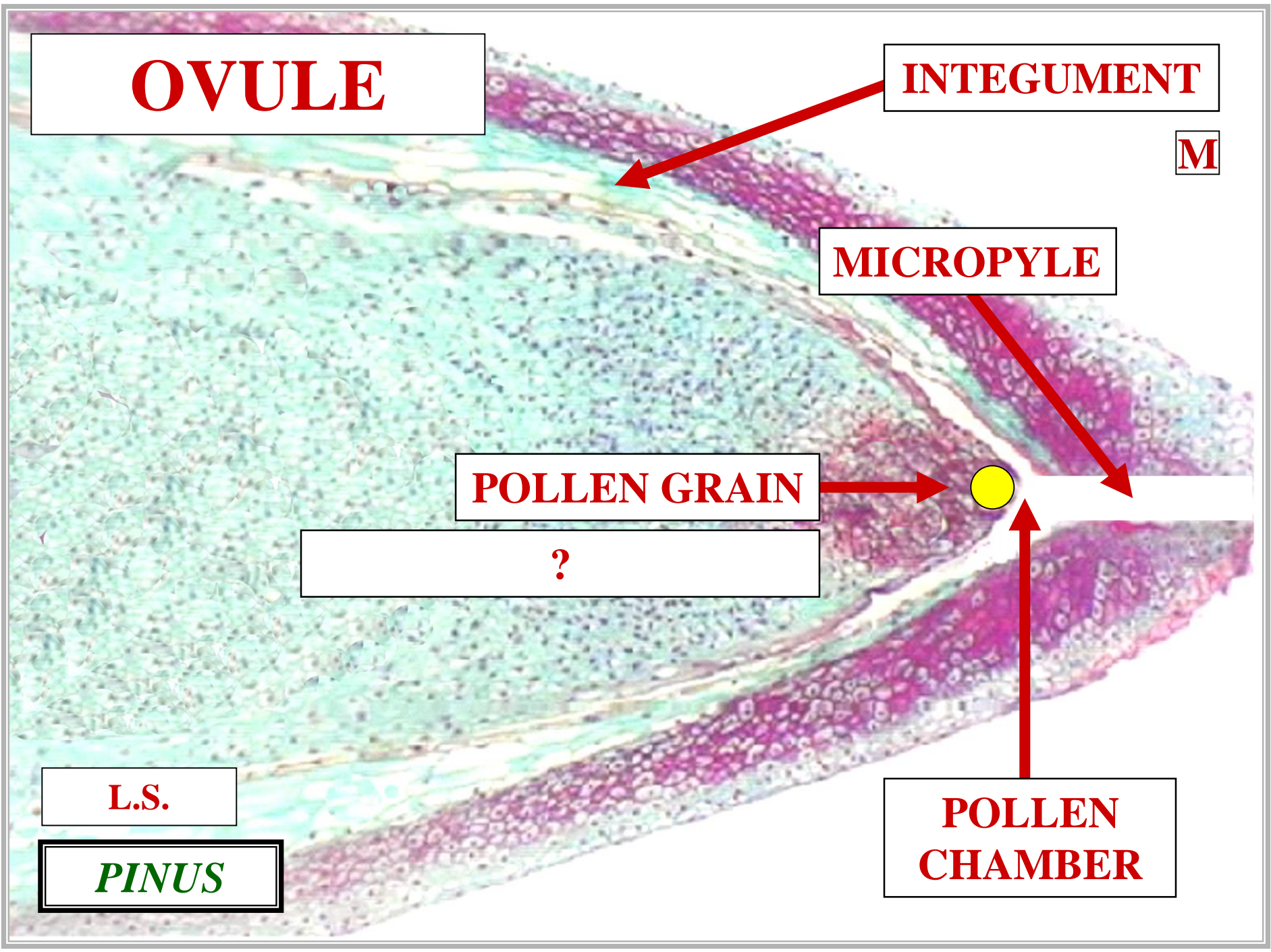
**POLLEN GRAIN**

**?**

**L.S.**

***PINUS***

**POLLEN CHAMBER**





**OVULE**

**INTEGUMENT**

=

**MICROPYLE**

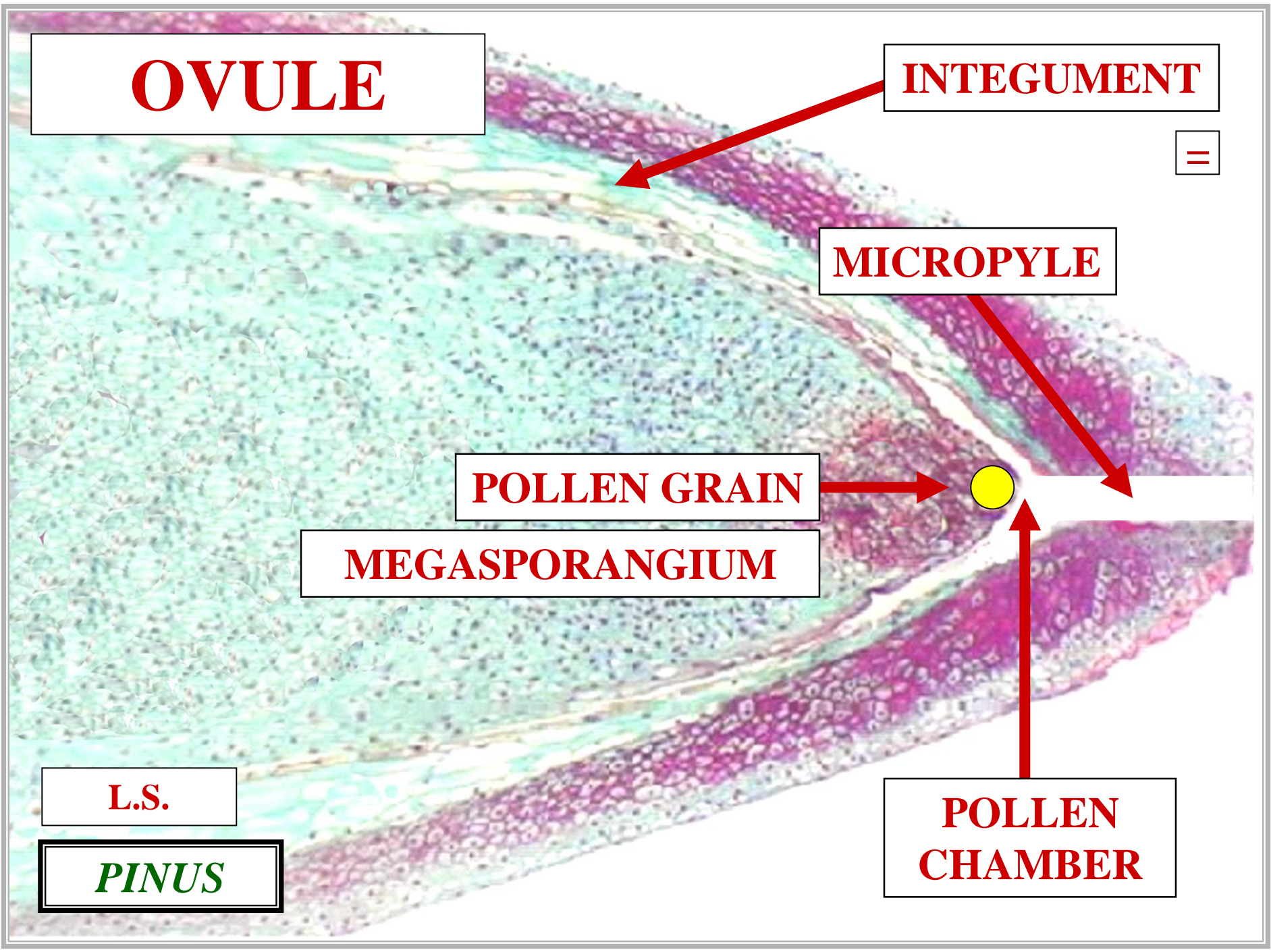
**POLLEN GRAIN**

**MEGASPORANGIUM**

**L.S.**

***PINUS***

**POLLEN CHAMBER**





**OVULE**

**INTEGUMENT**

**?**

**MICROPYLE**

**POLLEN GRAIN**

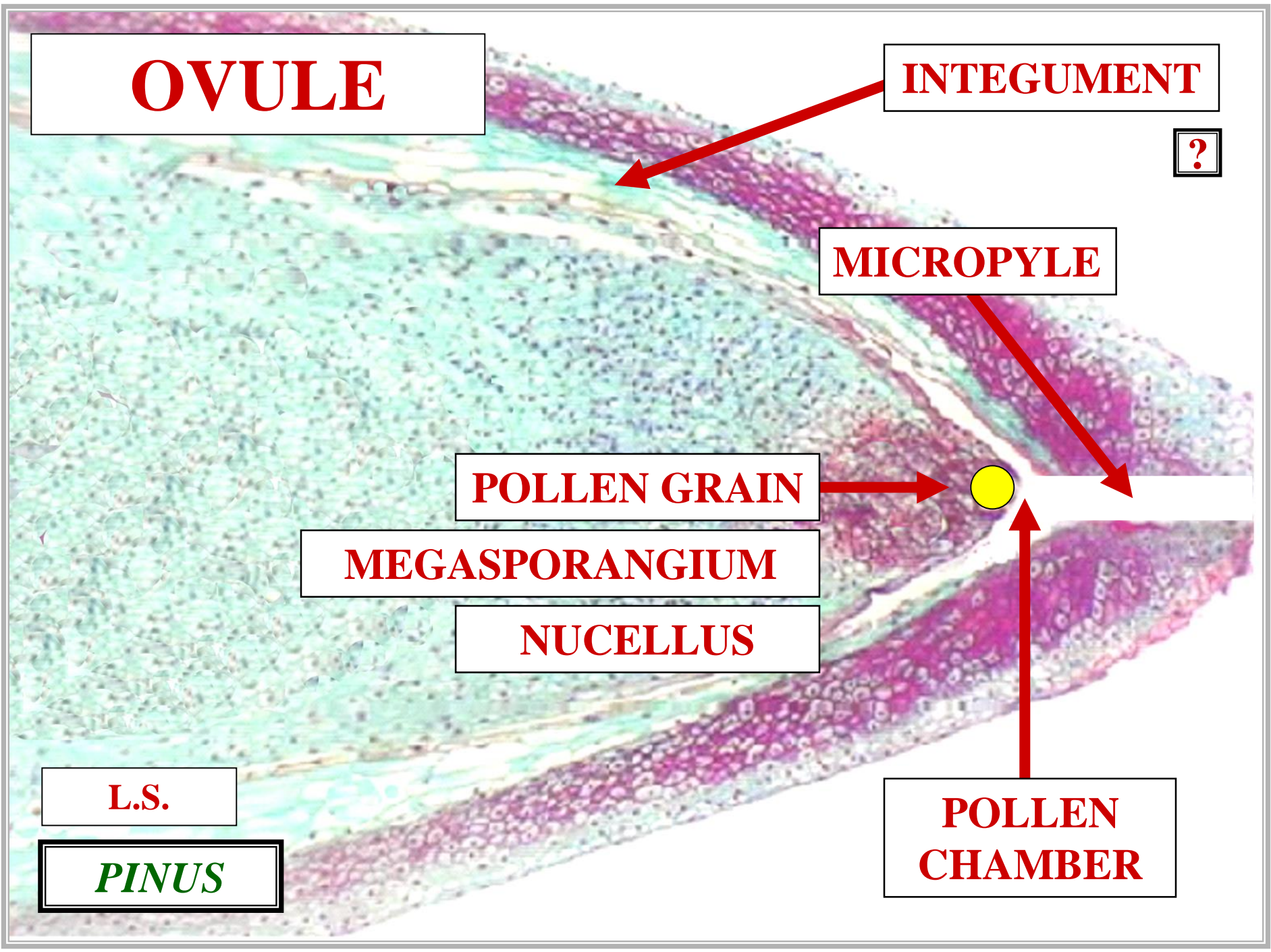
**MEGASPORANGIUM**

**NUCELLUS**

**L.S.**

***PINUS***

**POLLEN CHAMBER**





**OVULE**

**INTEGUMENT**

**P**

**MICROPYLE**

**?**

**POLLEN GRAIN**

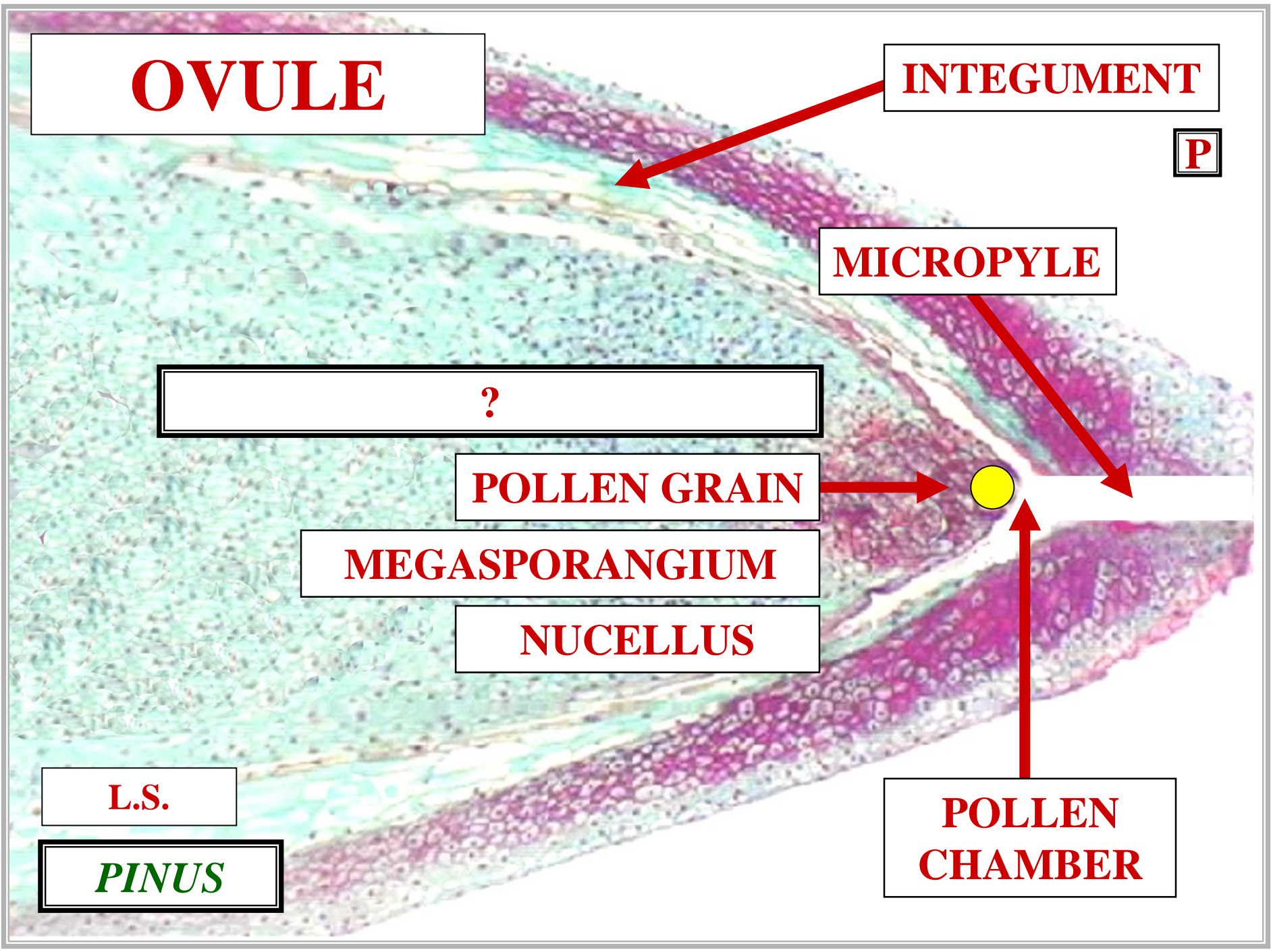
**MEGASPORANGIUM**

**NUCELLUS**

**L.S.**

***PINUS***

**POLLEN CHAMBER**



**OVULE**

**INTEGUMENT**

^



**MICROPYLE**

**POLLINATION**

**POLLEN GRAIN**

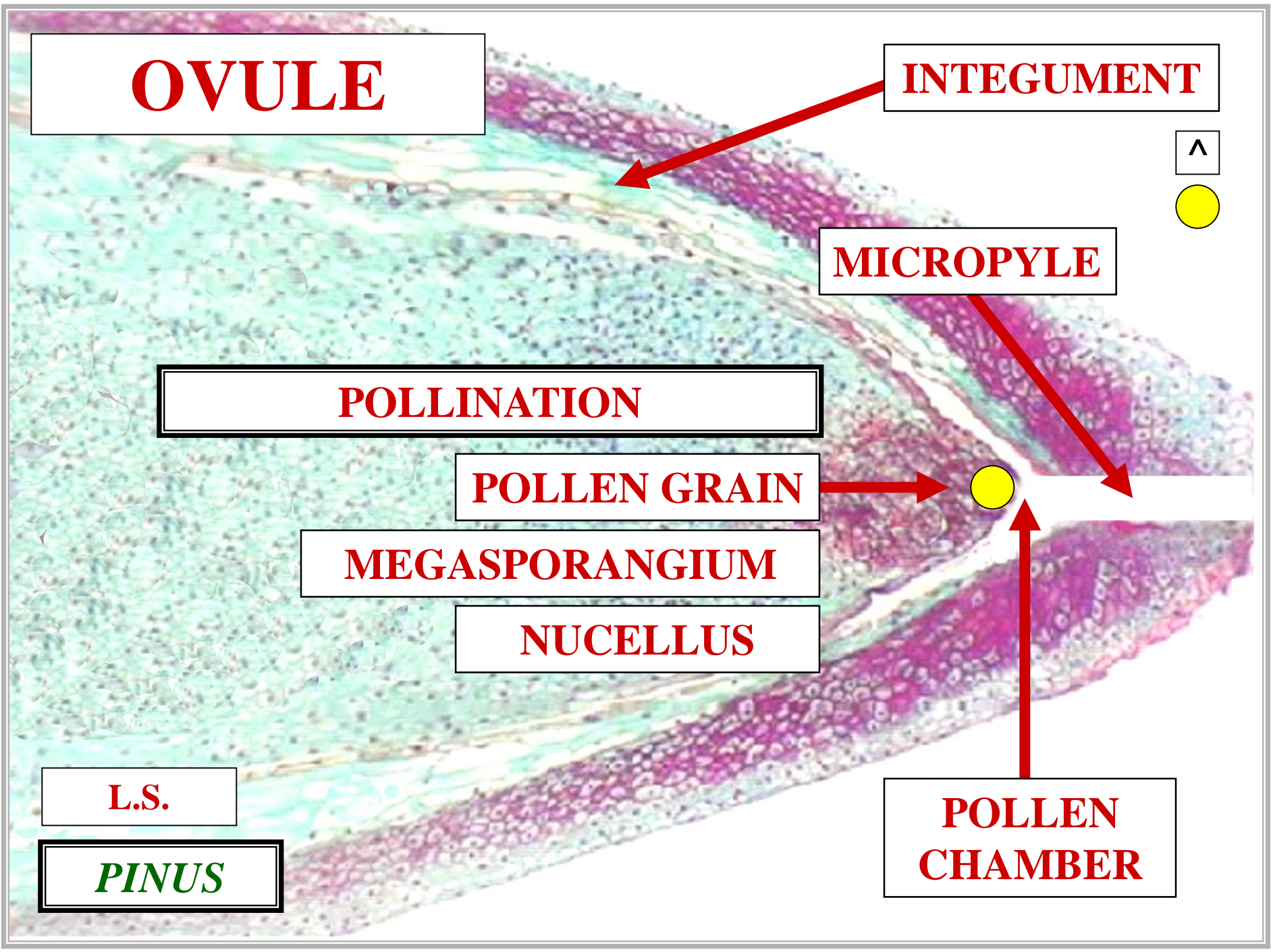
**MEGASPORANGIUM**

**NUCELLUS**

**L.S.**

***PINUS***

**POLLEN CHAMBER**





**OVULE**

**INTEGUMENT**

+

**MEGAGAMETOPHYTE**

**MICROPYLE**

**MEGASPORANGIUM**

**1N**

**ENDOSPORIC**

**1N**

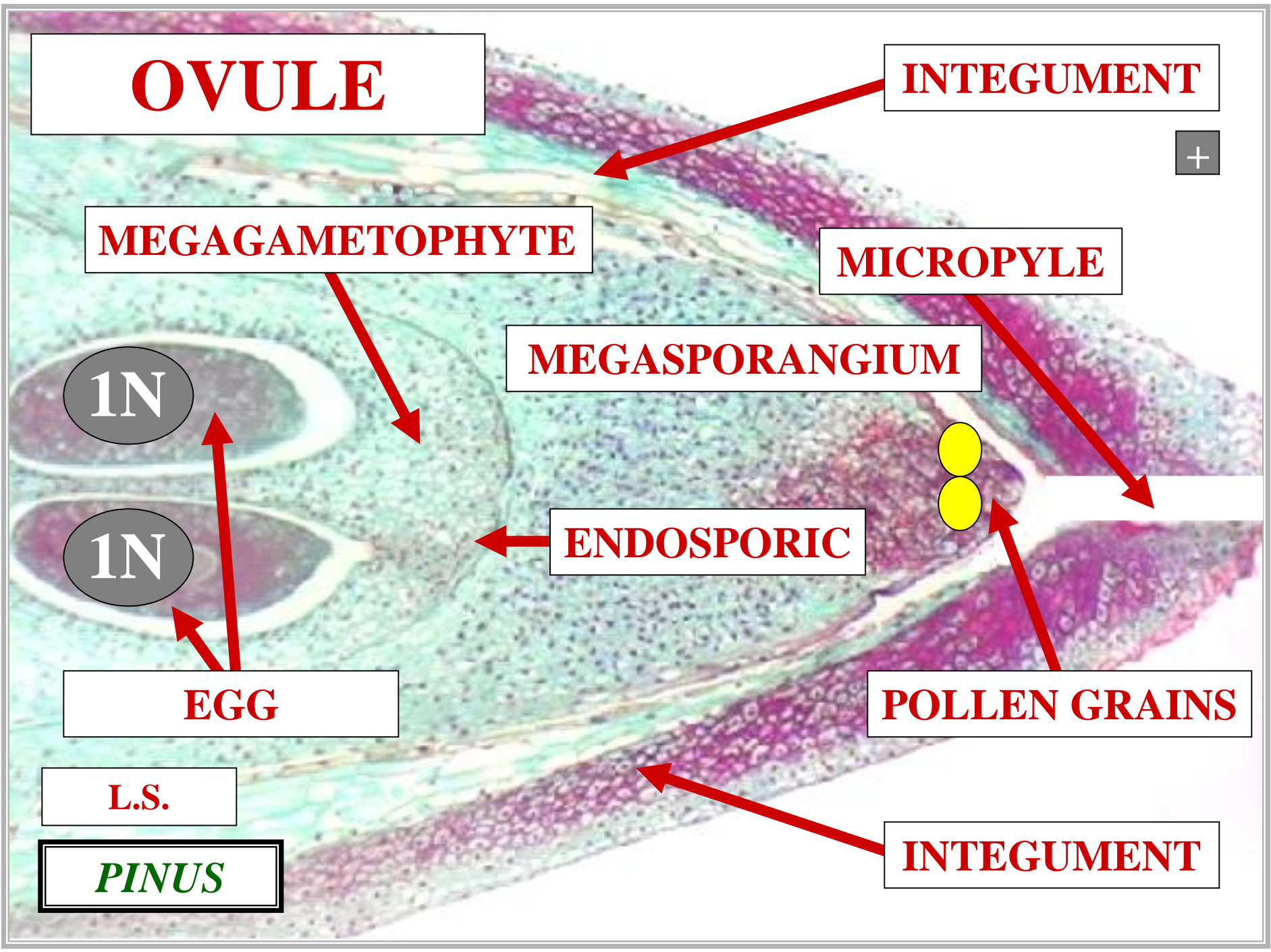
**EGG**

**POLLEN GRAINS**

**L.S.**

**INTEGUMENT**

***PINUS***



**OVULE**

**INTEGUMENT**

**S**

**MEGAGAMETOPHYTE**

**MICROPYLE**

**MEGASPORANGIUM**

**1N**

**1N**

**EGG**

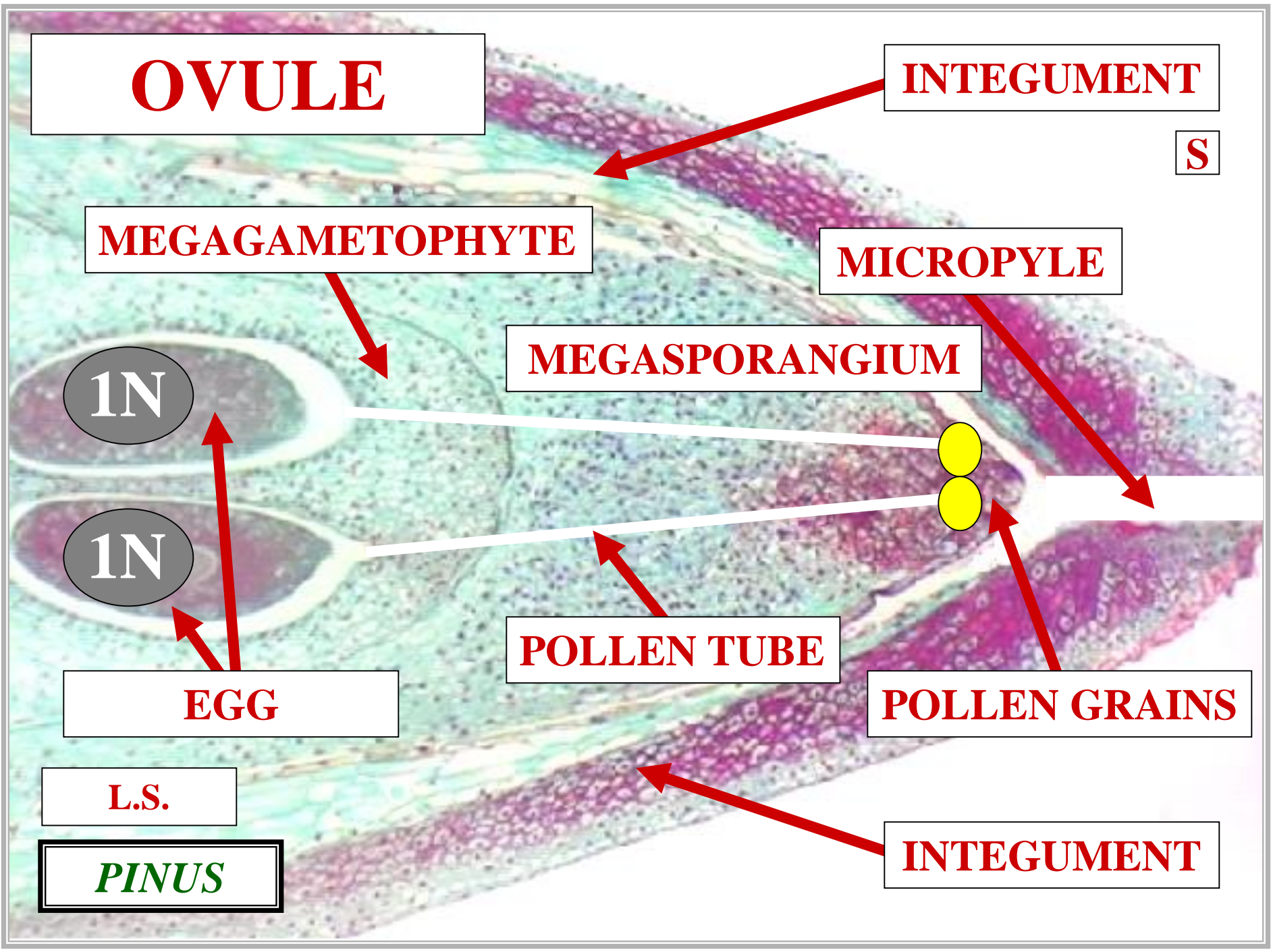
**POLLEN TUBE**

**POLLEN GRAINS**

**L.S.**

***PINUS***

**INTEGUMENT**





**OVULE**

**INTEGUMENT**

**S**

**MEGAGAMETOPHYTE**

**MICROPYLE**

**MEGASPORANGIUM**

**1N**

**1N**

**EGG**

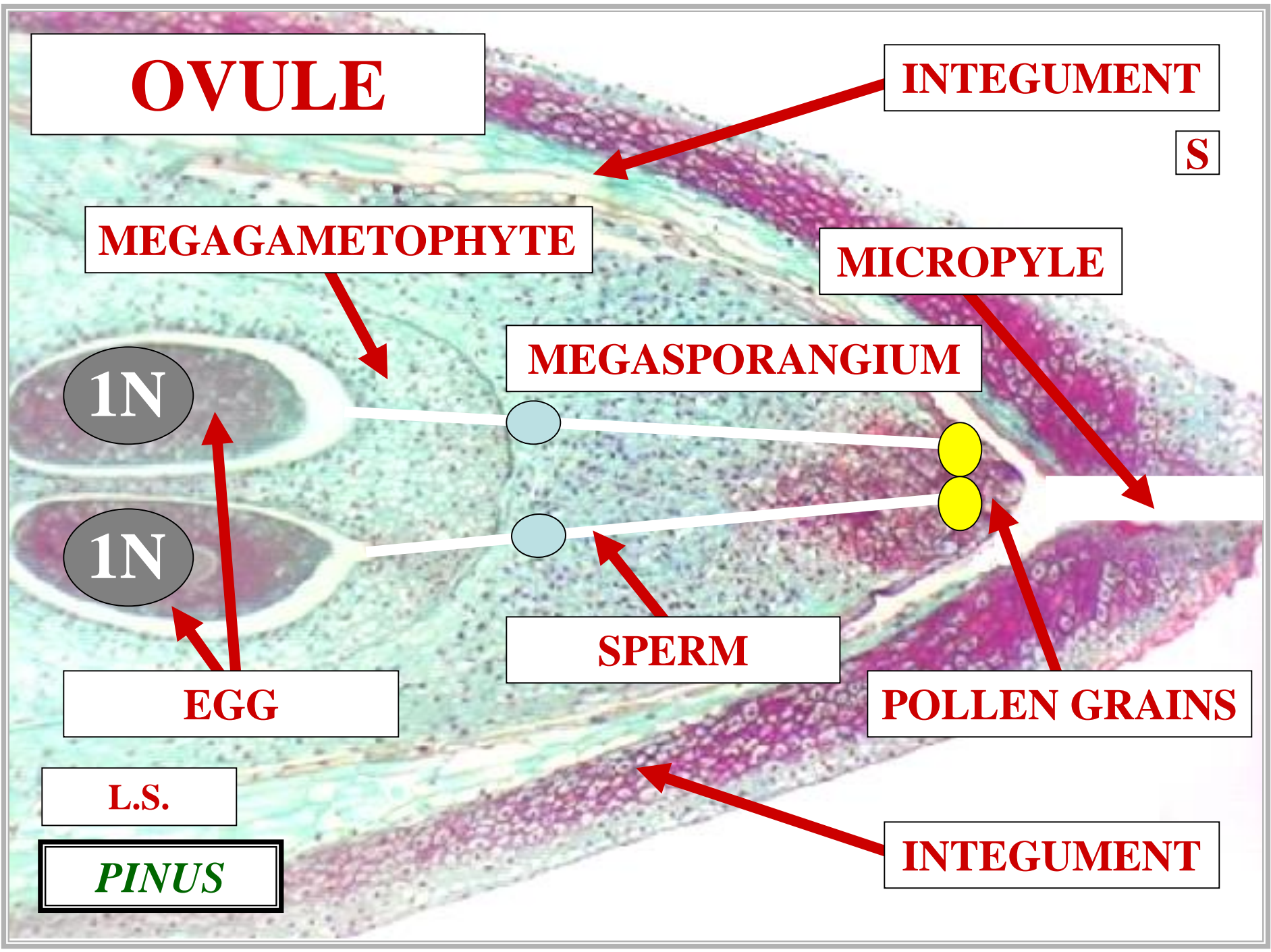
**SPERM**

**POLLEN GRAINS**

**L.S.**

***PINUS***

**INTEGUMENT**



**OVULE**

**INTEGUMENT**



**MEGAGAMETOPHYTE**

**MICROPYLE**

**MEGASPORANGIUM**

**2N**

**2N**

**POLLEN TUBE**

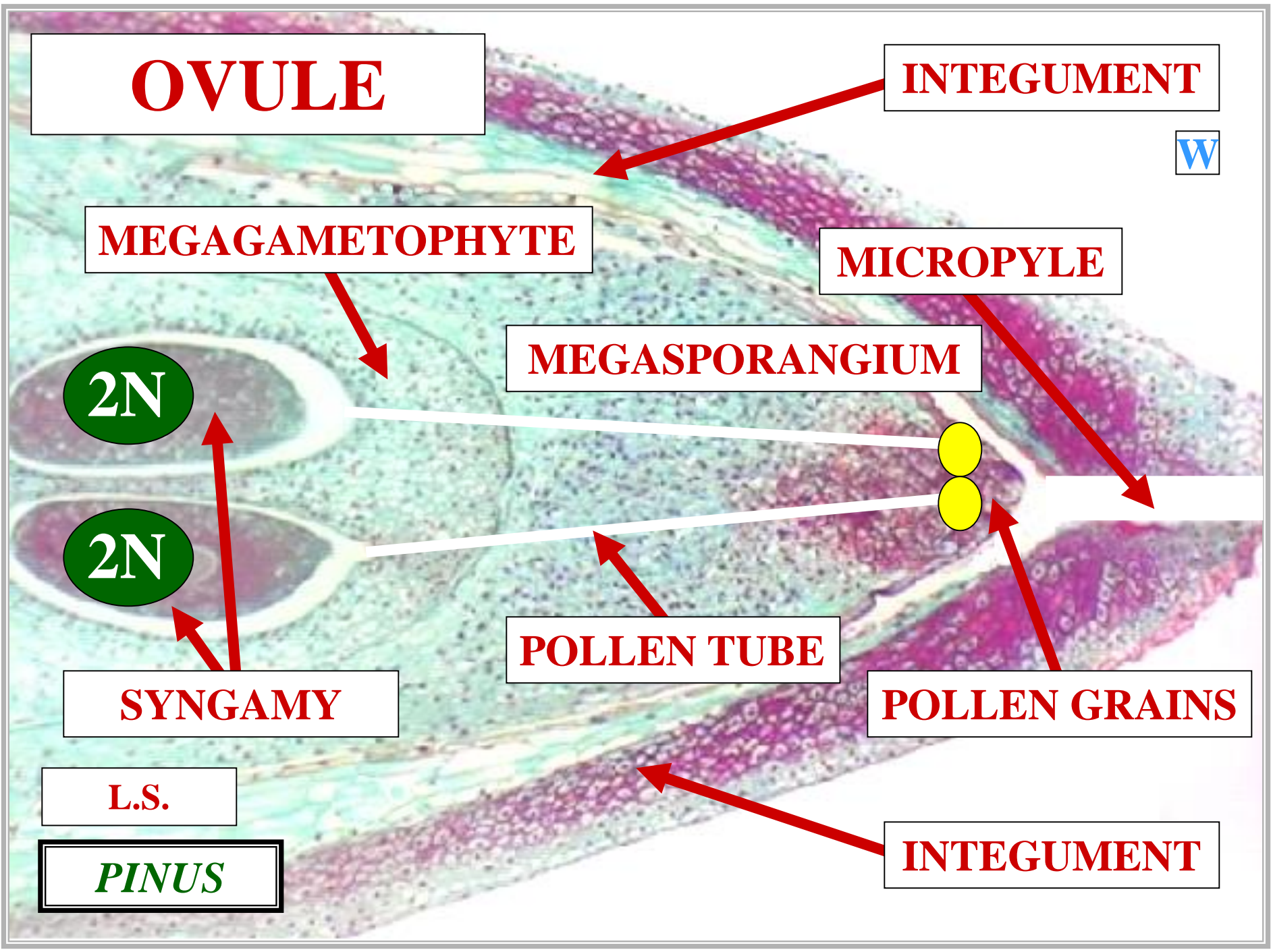
**SYNGAMY**

**POLLEN GRAINS**

**L.S.**

***PINUS***

**INTEGUMENT**





**OVULE**

**INTEGUMENT**



**MEGAGAMETOPHYTE**

**MICROPYLE**

**MEGASPORANGIUM**

**2N**

**2N**

**POLLEN TUBE**

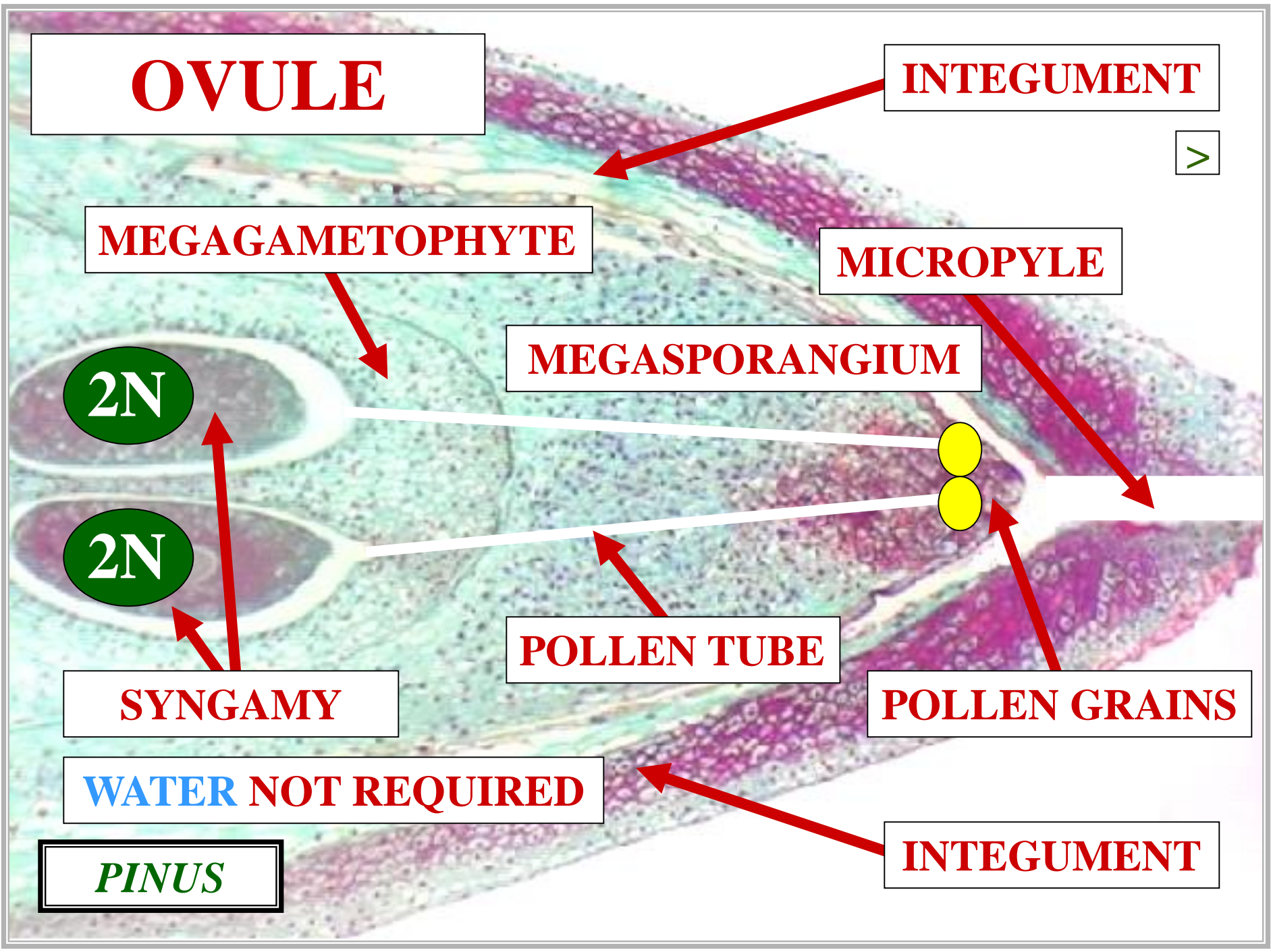
**SYNGAMY**

**POLLEN GRAINS**

**WATER NOT REQUIRED**

**INTEGUMENT**

***PINUS***







**POLLINATION**

**ADAPTATION**

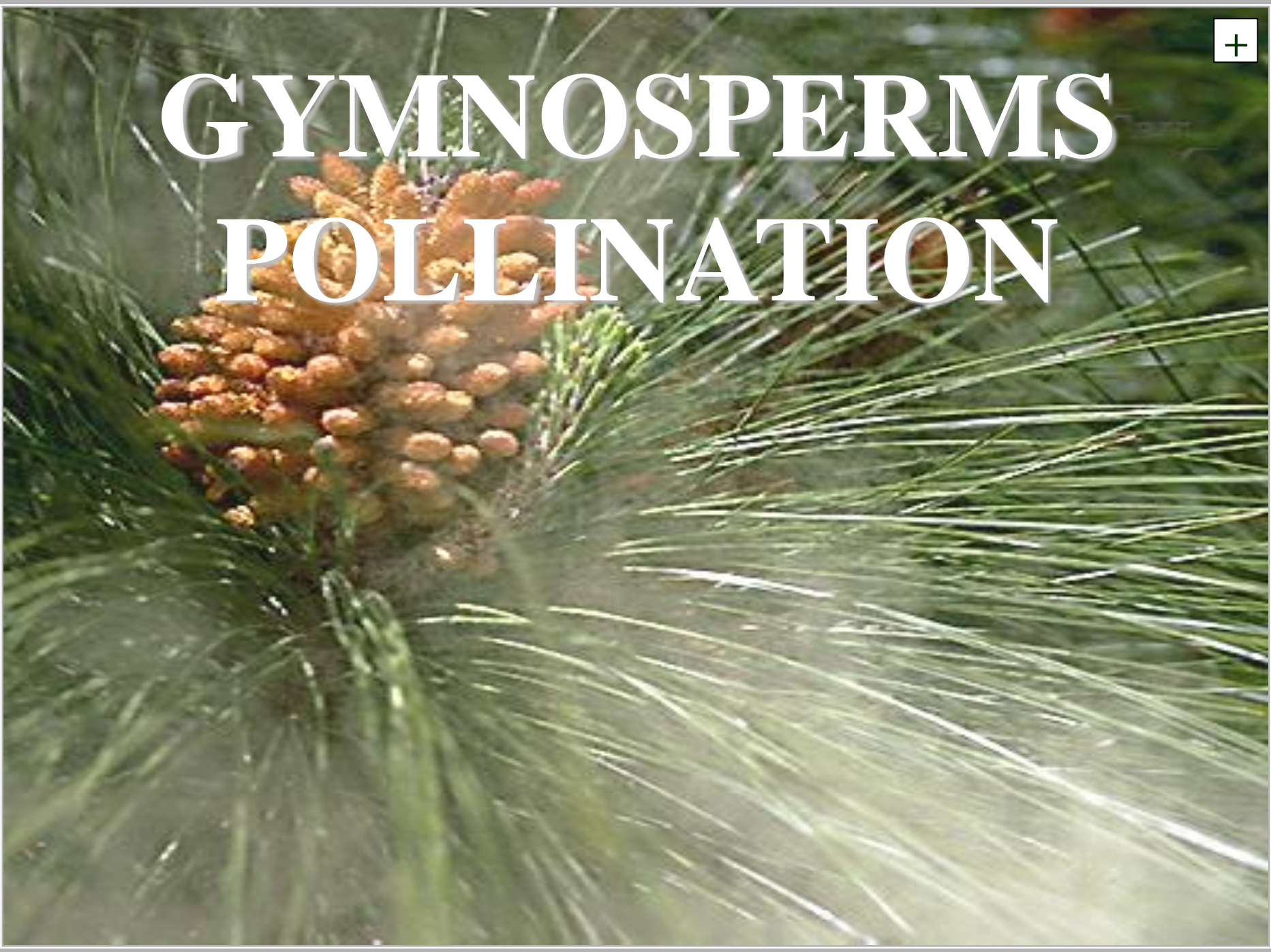
**ZERIC**

**HABITAT**





# GYMNOSPERMS POLLINATION







**GYMNOSPERMS  
POLLINATION  
POLLEN GRAIN  
DESTINATION**







**GYMNOSPERMS**

**POLLINATION**

**POLLEN GRAIN**

**DESTINATION**

**OVULE**

**MEGASPORANGIUM**



**SEED**





# SEED DISPERSAL



**SEED**

**INTEGUMENT WING**

**WIND DISPERSAL**

***PINUS***

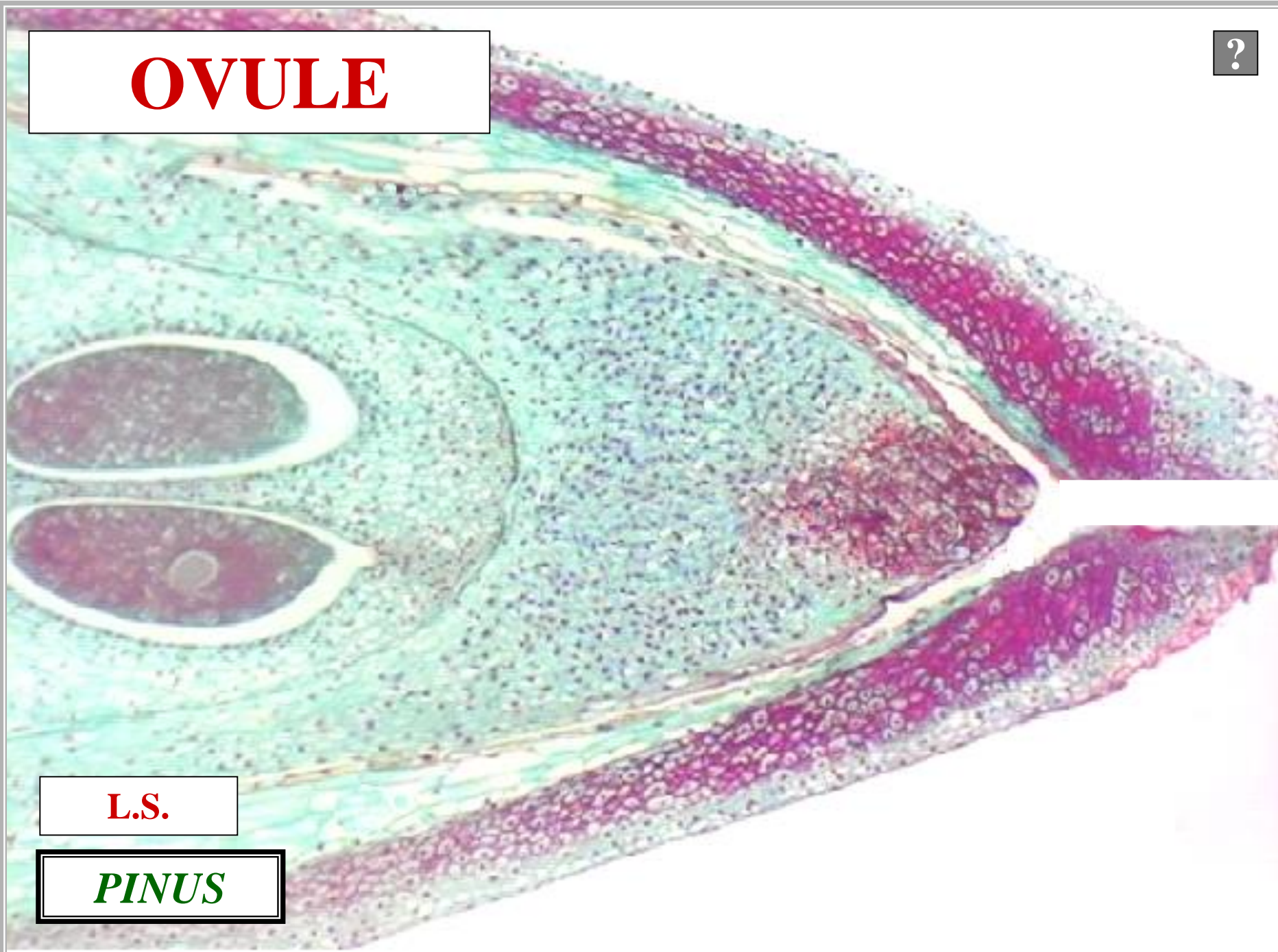


# SEED ANATOMY



# OVULE

?



L.S.

*PINUS*





**OVULE**

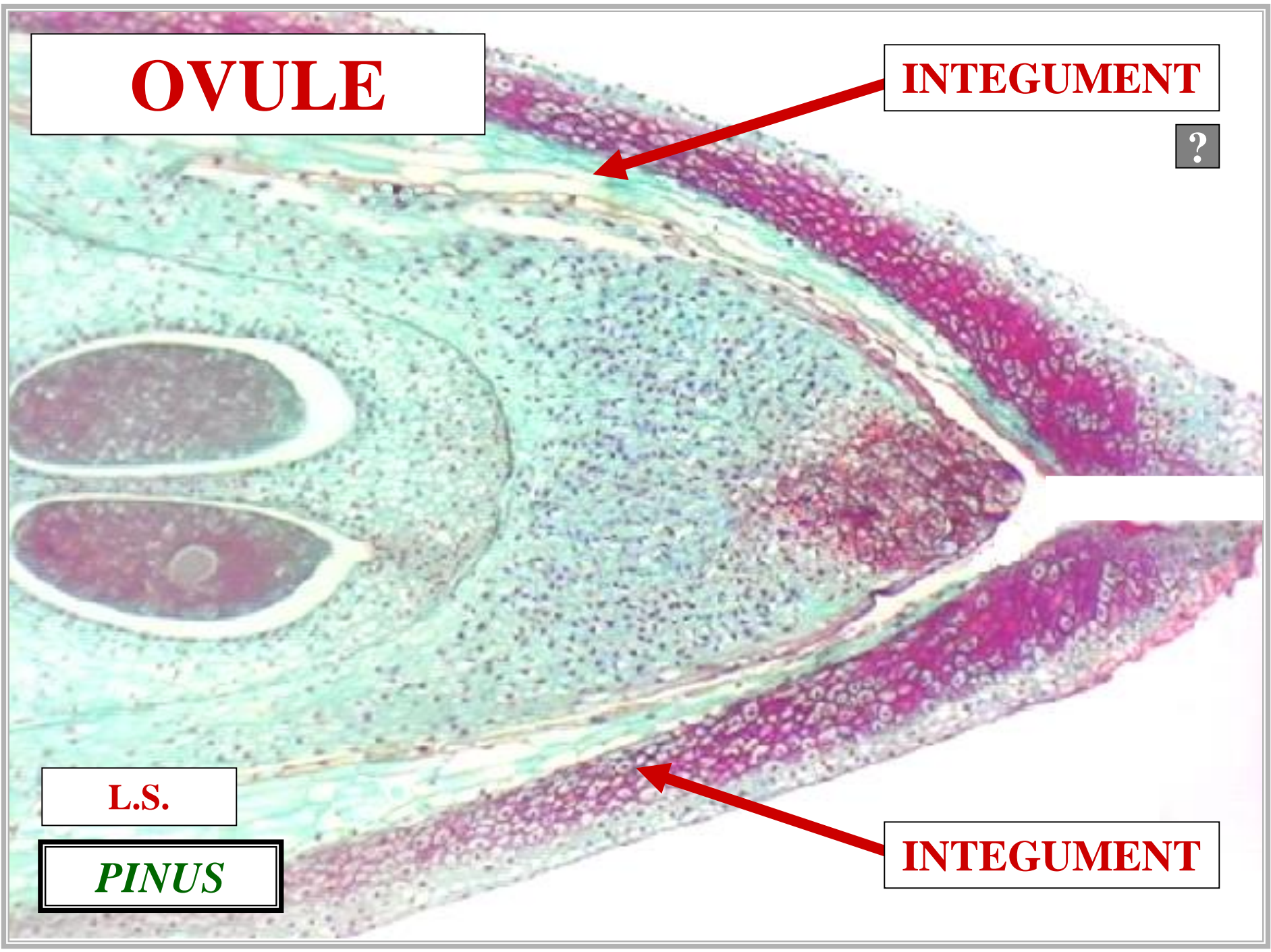
**INTEGUMENT**

?

**L.S.**

***PINUS***

**INTEGUMENT**



**OVULE**

**INTEGUMENT**

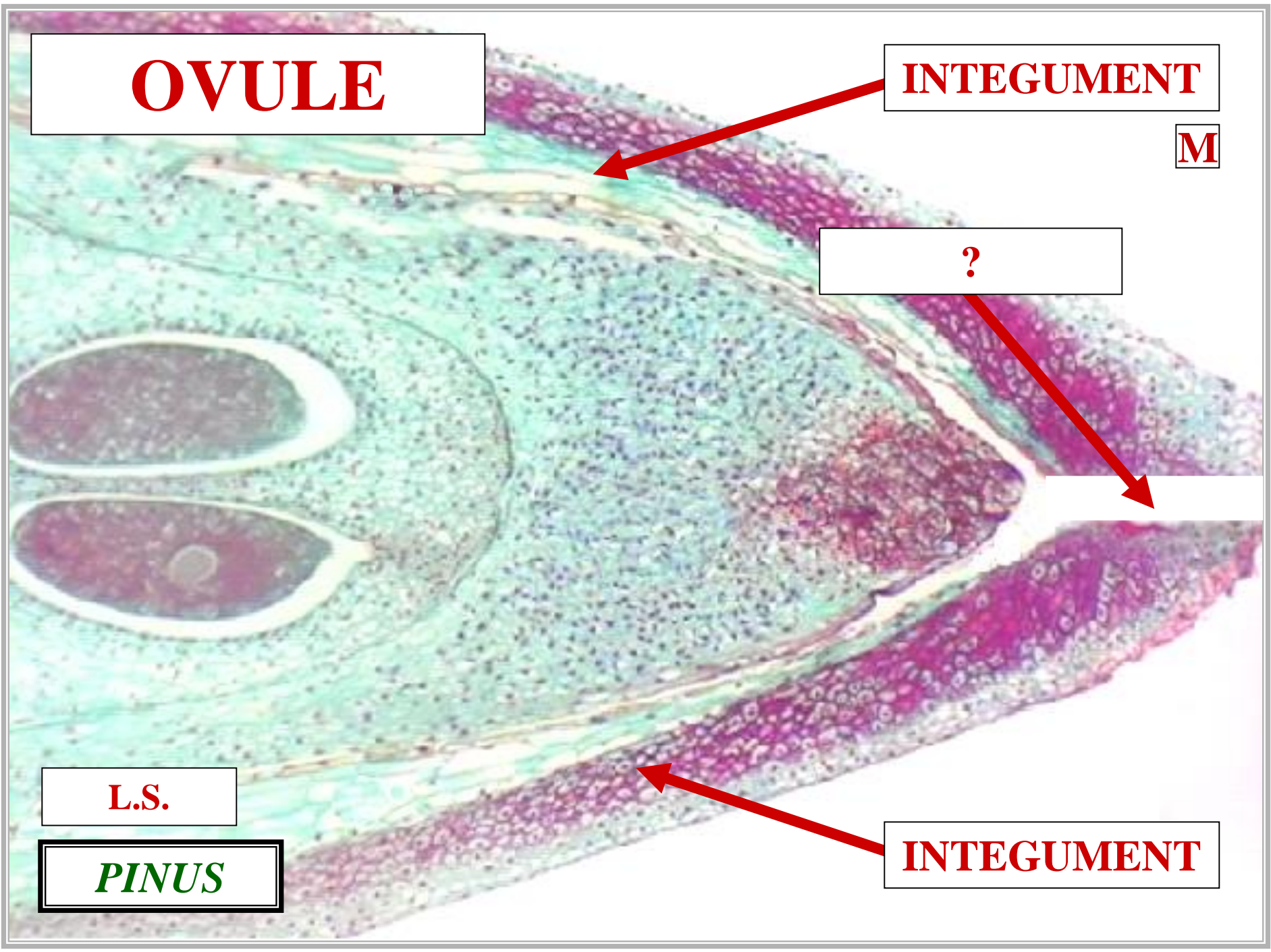
**M**

**?**

**L.S.**

***PINUS***

**INTEGUMENT**





**OVULE**

**INTEGUMENT**

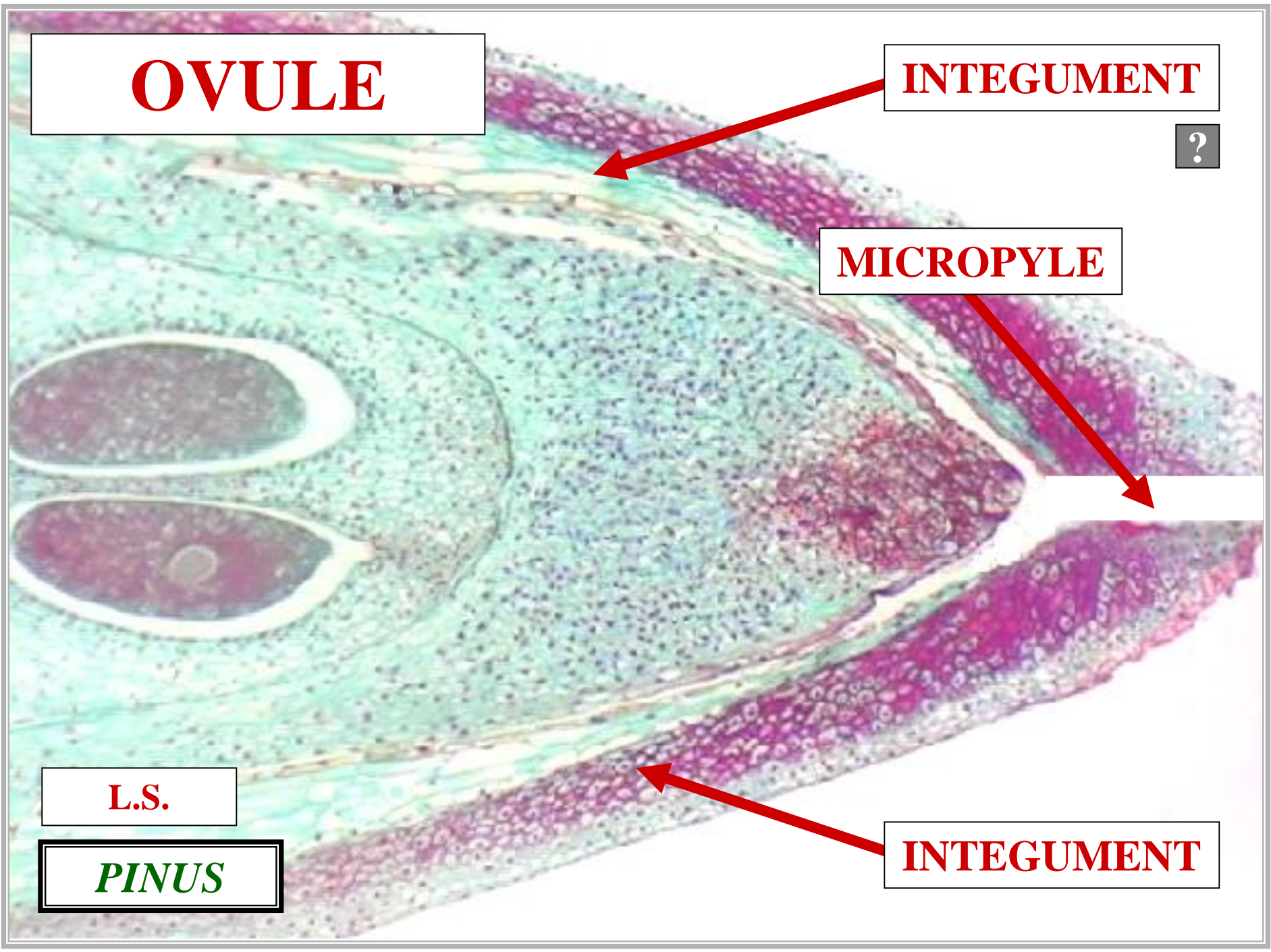
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**MICROPYLE**

**L.S.**

***PINUS***

**INTEGUMENT**



**OVULE**

**INTEGUMENT**

**P**

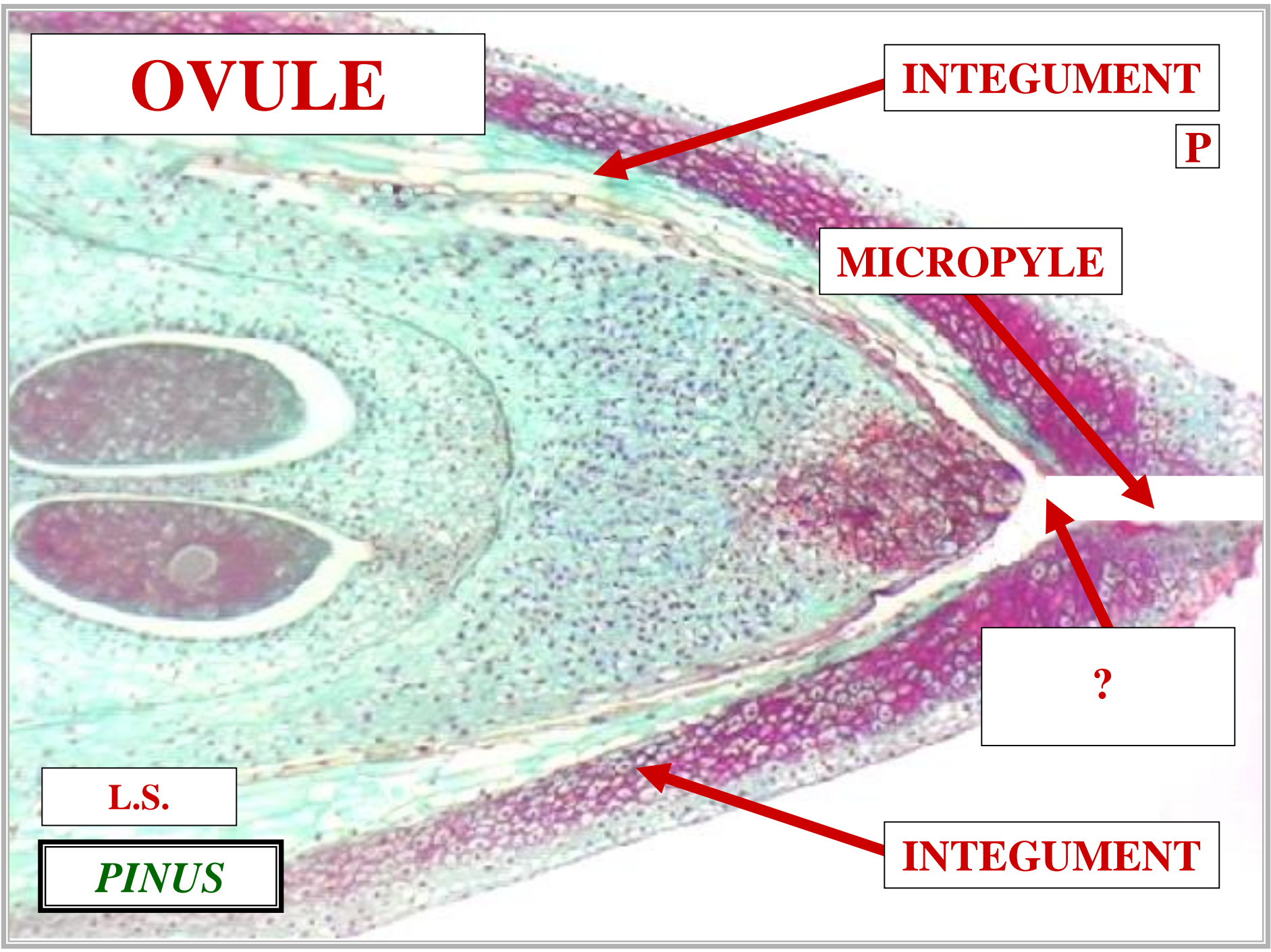
**MICROPYLE**

**?**

**L.S.**

***PINUS***

**INTEGUMENT**





**OVULE**

**INTEGUMENT**

?

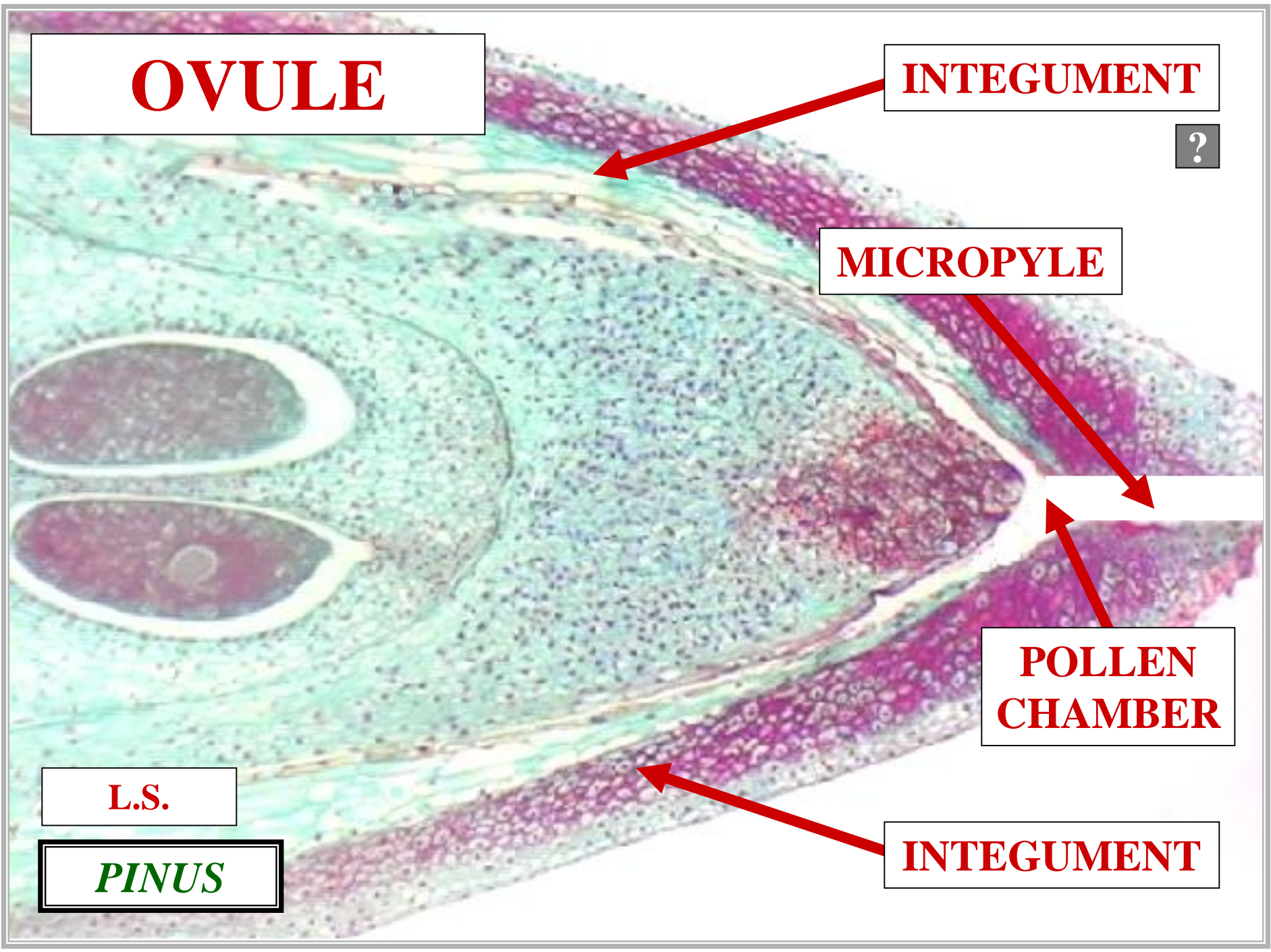
**MICROPYLE**

**POLLEN  
CHAMBER**

**L.S.**

***PINUS***

**INTEGUMENT**



**OVULE**

**INTEGUMENT**

**M**

**MICROPYLE**

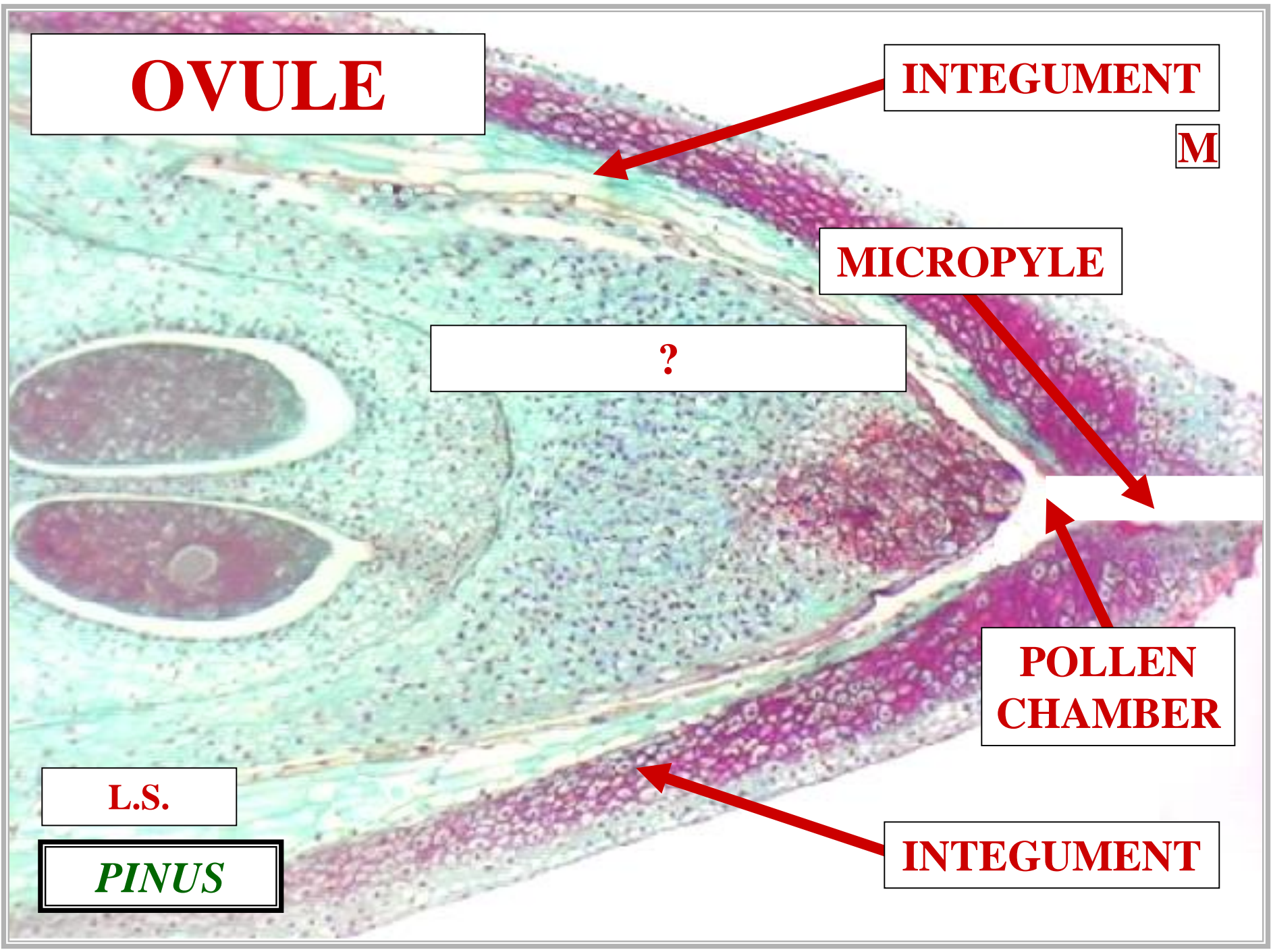
**?**

**POLLEN  
CHAMBER**

**L.S.**

***PINUS***

**INTEGUMENT**





**OVULE**

**INTEGUMENT**

**=**

**MICROPYLE**

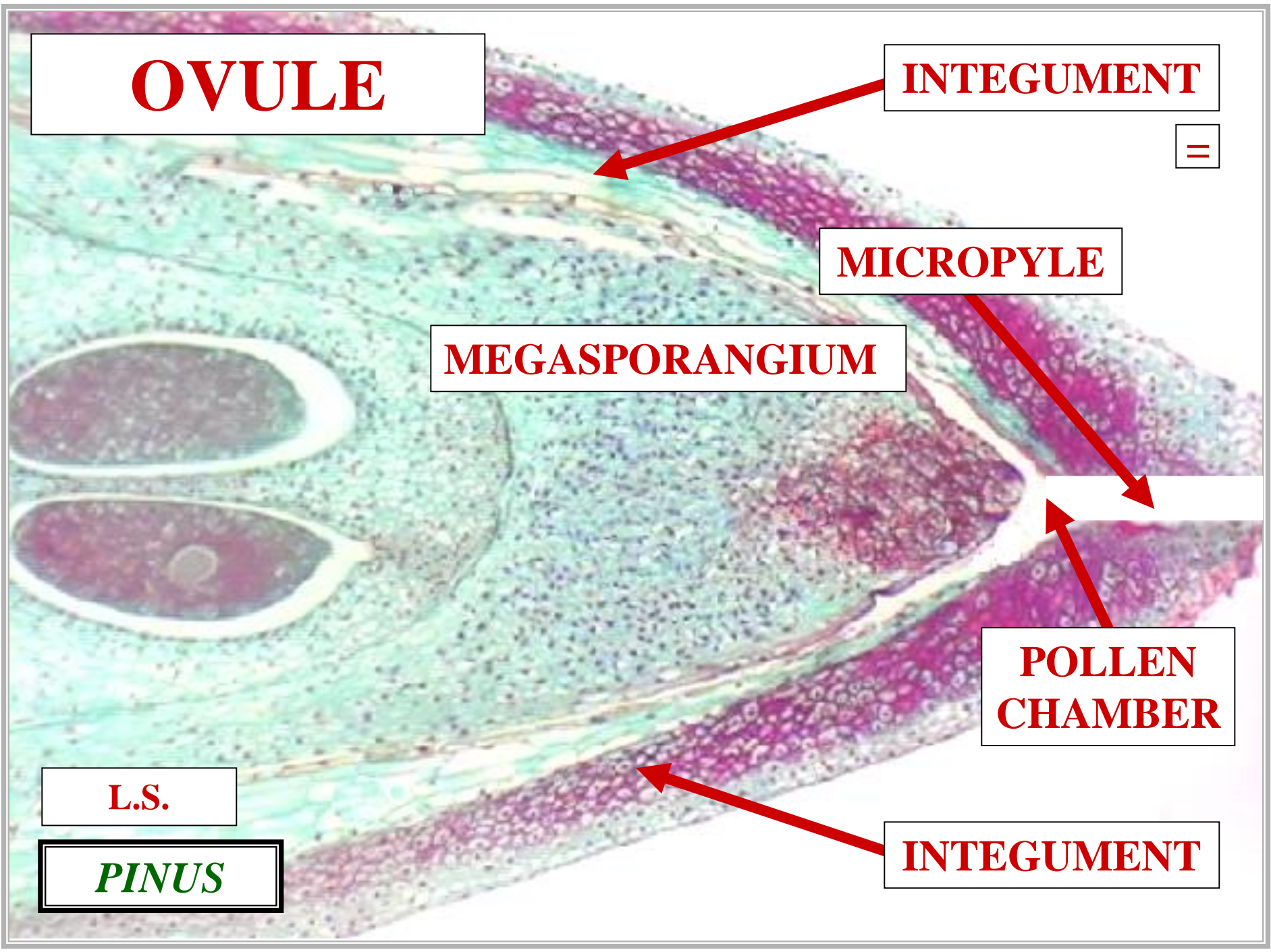
**MEGASPORANGIUM**

**POLLEN  
CHAMBER**

**L.S.**

***PINUS***

**INTEGUMENT**



**OVULE**

**INTEGUMENT**

?

**MICROPYLE**

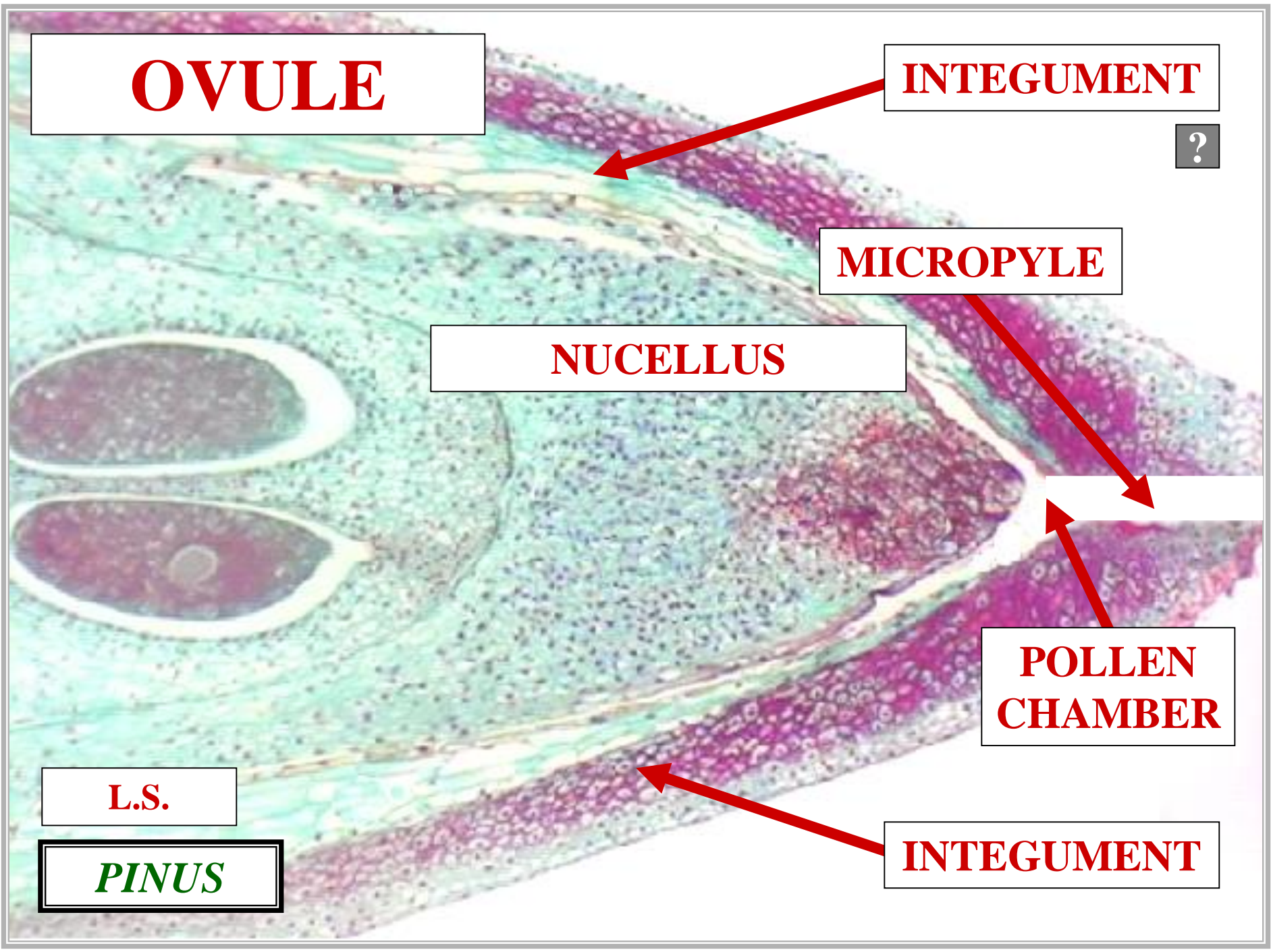
**NUCELLUS**

**POLLEN  
CHAMBER**

**L.S.**

***PINUS***

**INTEGUMENT**





**OVULE**

**INTEGUMENT**

**M**

**?**

**MICROPYLE**

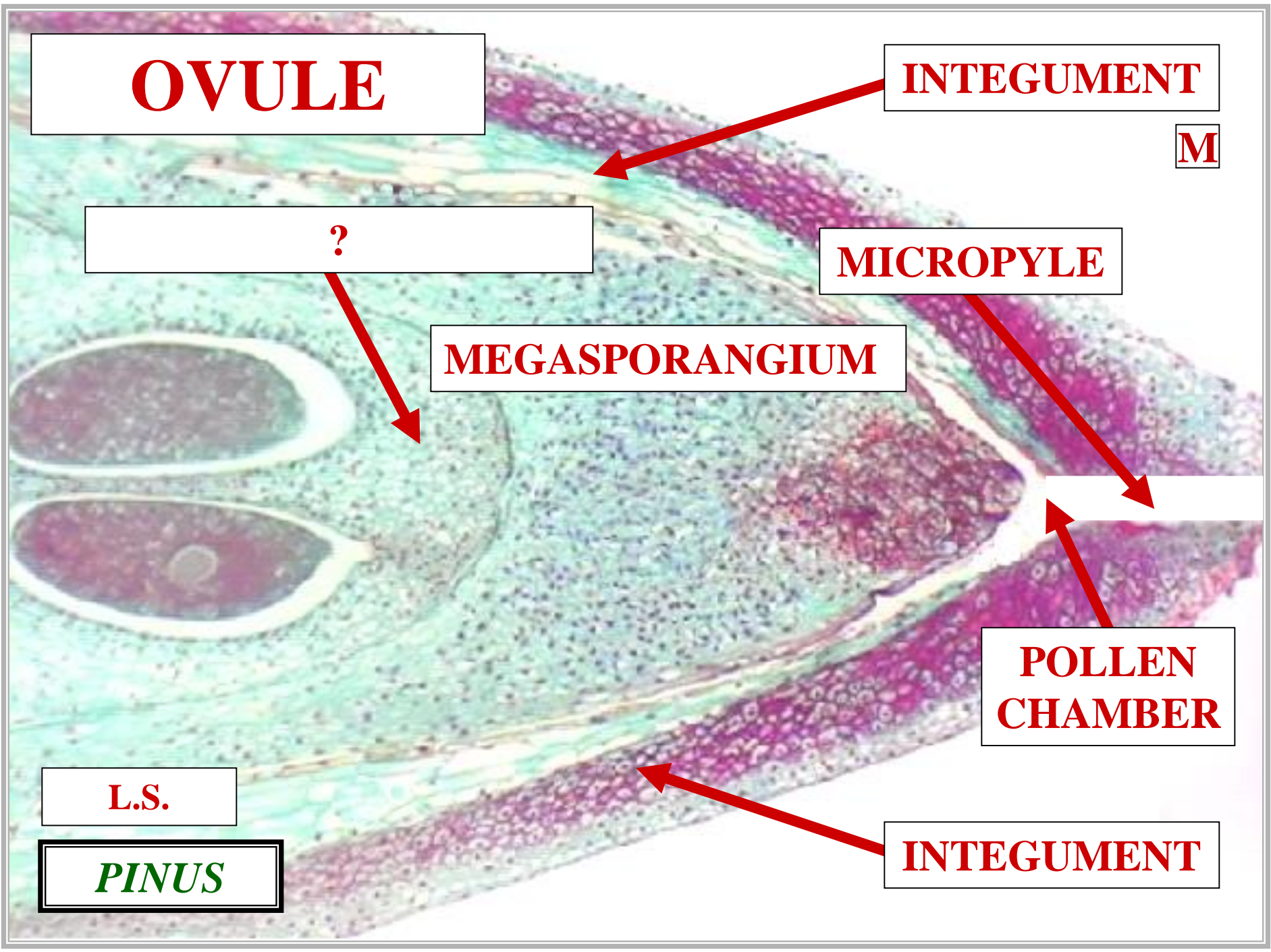
**MEGASPORANGIUM**

**POLLEN  
CHAMBER**

**L.S.**

***PINUS***

**INTEGUMENT**



**OVULE**

**INTEGUMENT**

?

**MEGAGAMETOPHYTE**

**MICROPYLE**

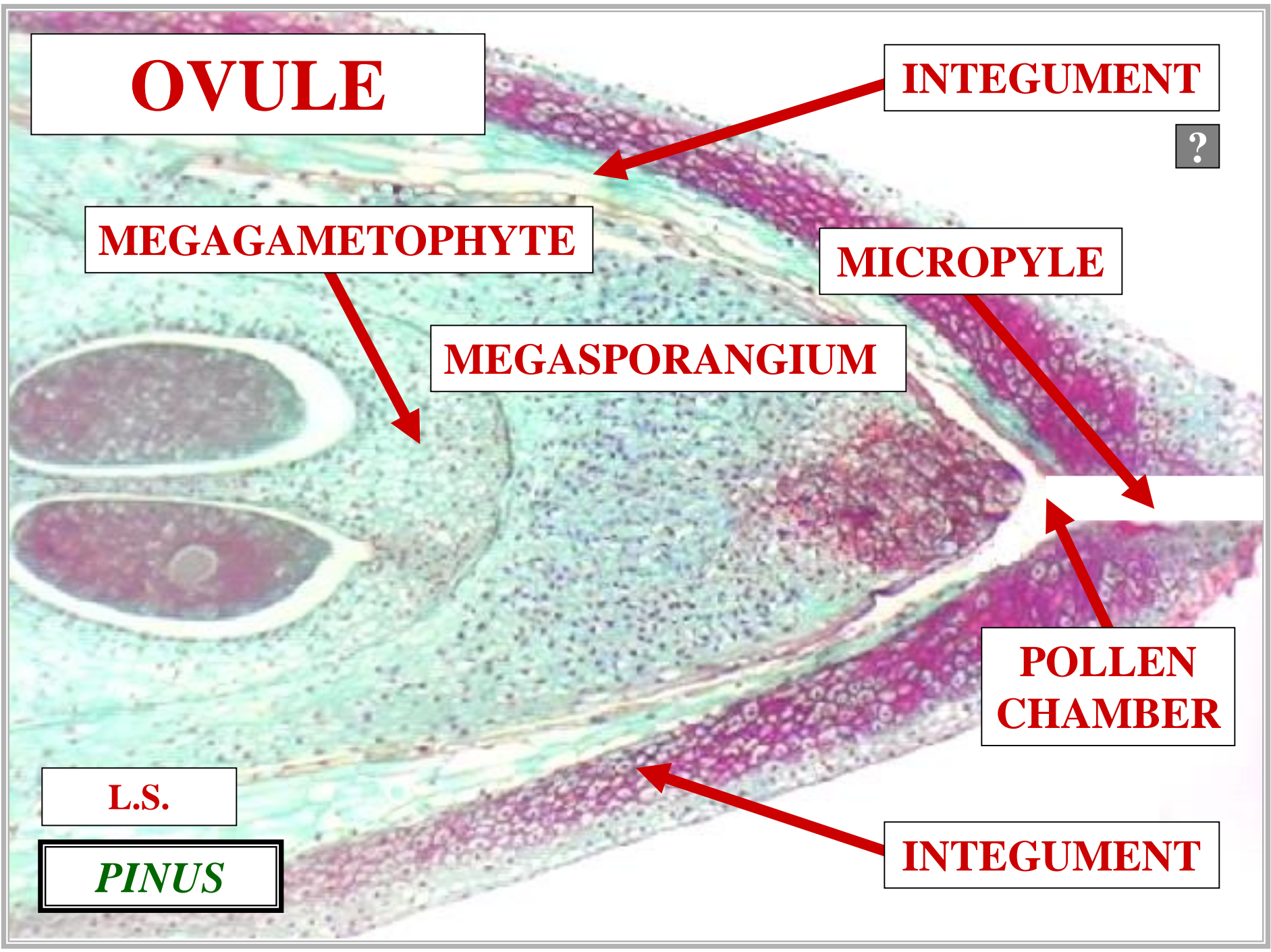
**MEGASPORANGIUM**

**POLLEN  
CHAMBER**

**L.S.**

***PINUS***

**INTEGUMENT**





**OVULE**

**INTEGUMENT**

**M**

**MEGAGAMETOPHYTE**

**MICROPYLE**

**MEGASPORANGIUM**

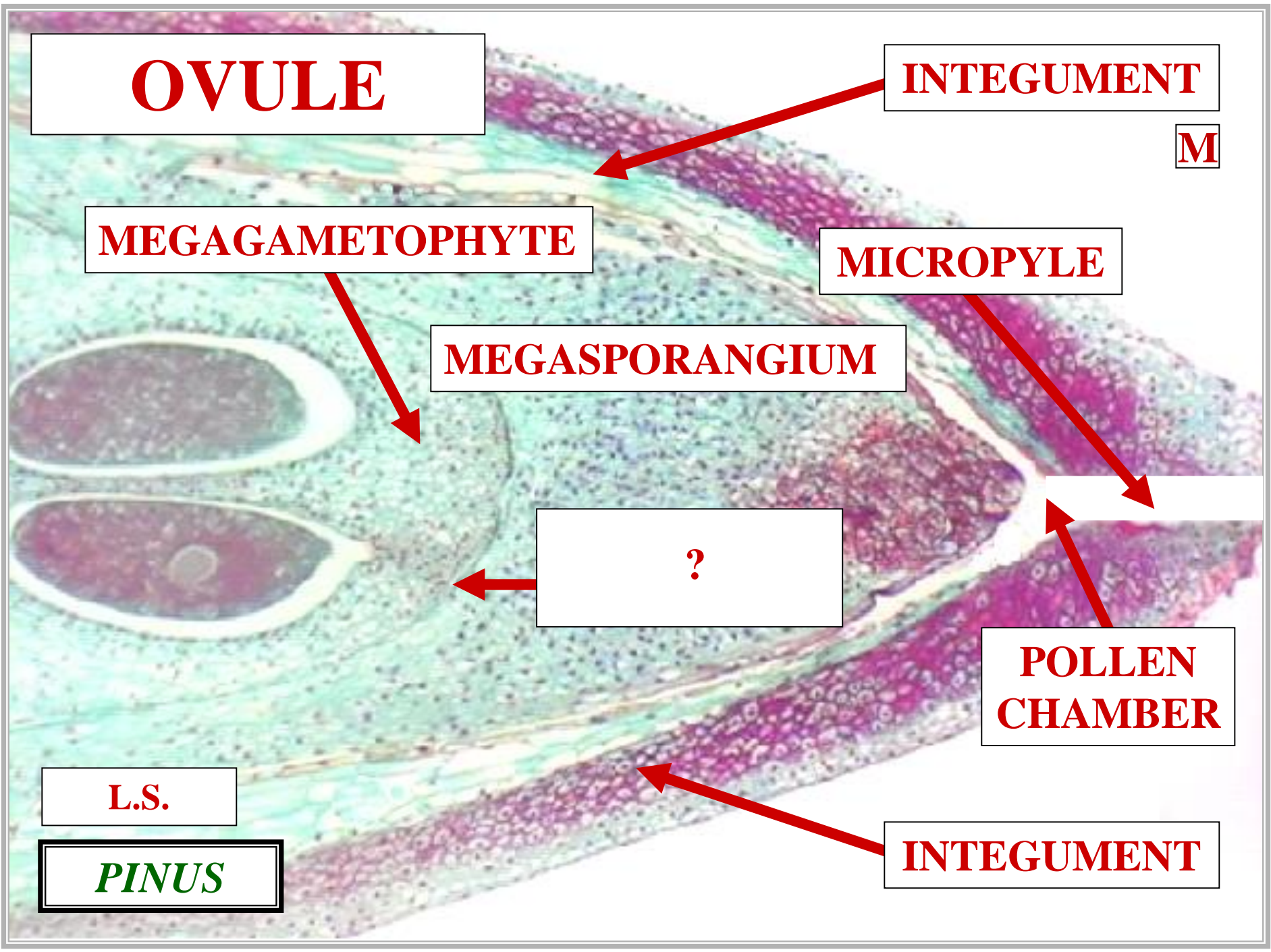
**?**

**POLLEN  
CHAMBER**

**L.S.**

***PINUS***

**INTEGUMENT**



**OVULE**

**INTEGUMENT**

?

**MEGAGAMETOPHYTE**

**MICROPYLE**

**MEGASPORANGIUM**

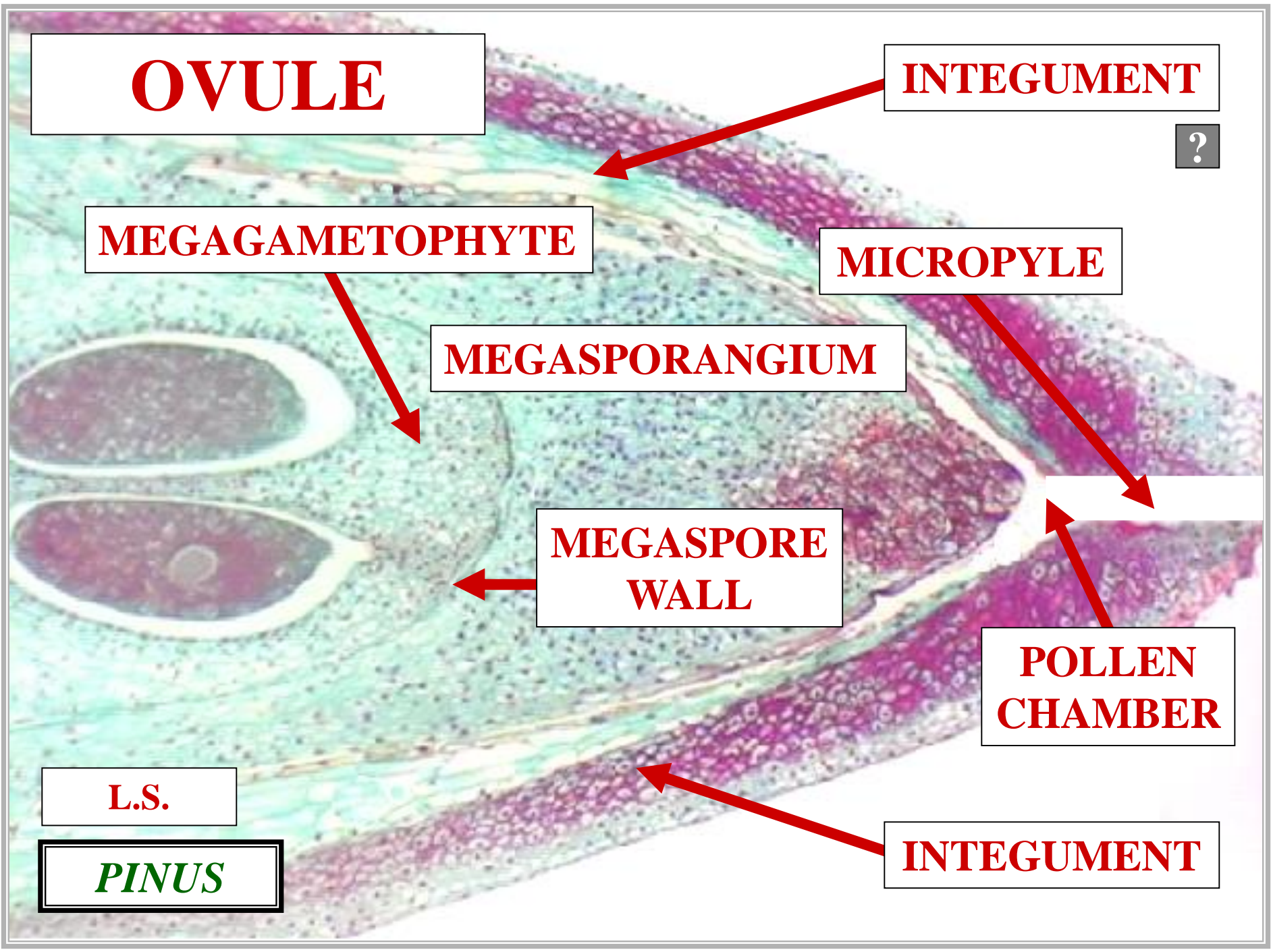
**MEGASPORE  
WALL**

**POLLEN  
CHAMBER**

**L.S.**

***PINUS***

**INTEGUMENT**





**OVULE**

**INTEGUMENT**

**A**

**MEGAGAMETOPHYTE**

**MICROPYLE**

**MEGASPORANGIUM**

**MEGASPORE  
WALL**

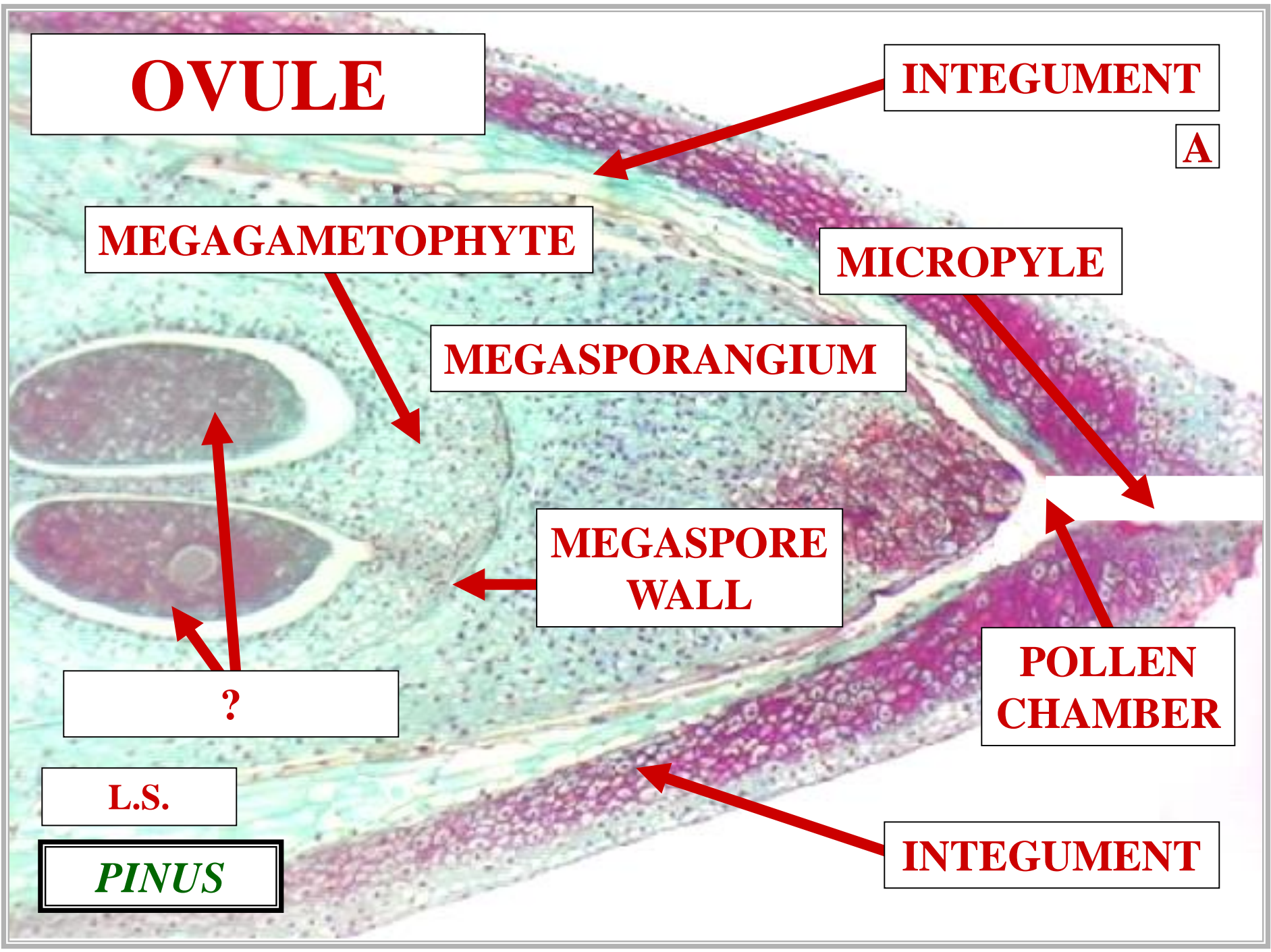
**POLLEN  
CHAMBER**

**?**

**L.S.**

***PINUS***

**INTEGUMENT**



**OVULE**

**INTEGUMENT**

**MEGAGAMETOPHYTE**

**MICROPYLE**

**MEGASPORANGIUM**

**MEGASPORE  
WALL**

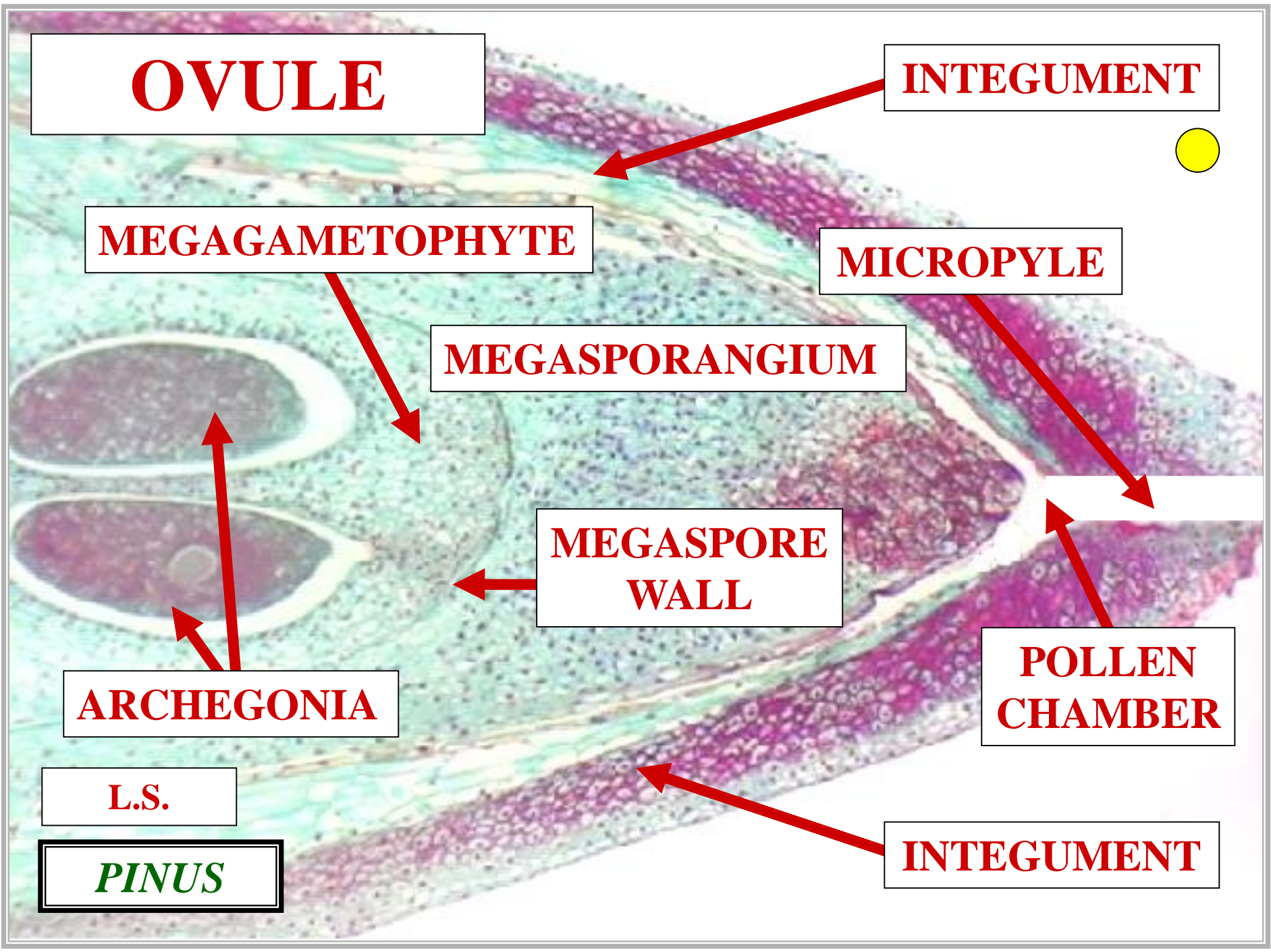
**ARCHEGONIA**

**POLLEN  
CHAMBER**

**L.S.**

**INTEGUMENT**

***PINUS***





**OVULE**

**INTEGUMENT**

**PT**

**MEGAGAMETOPHYTE**

**MICROPYLE**

**MEGASPORANGIUM**

**1N**

**1N**

**ENDOSPORIC**

**EGG**

**POLLEN GRAINS**

**L.S.**

***PINUS***

**● = POLLEN GRAIN**

**INTEGUMENT**

**OVULE**

**INTEGUMENT**

**MEGAGAMETOPHYTE**

**MICROPYLE**

**MEGASPORANGIUM**

**1N**

**1N**

**EGG**

**POLLEN TUBE**

**POLLEN GRAINS**

**L.S.**

***PINUS***

**● = POLLEN GRAIN**

**INTEGUMENT**



**OVULE**

**INTEGUMENT**

**S**

**MEGAGAMETOPHYTE**

**MICROPYLE**

**MEGASPORANGIUM**

**1N**

**1N**

**SPERM**

**EGG**

**POLLEN GRAINS**

**L.S.**

***PINUS***

**● = POLLEN GRAIN**

**INTEGUMENT**

**OVULE**

**INTEGUMENT**

?

S

**MEGAGAMETOPHYTE**

**MICROPYLE**

**MEGASPORANGIUM**

**2N**

**2N**

**POLLEN TUBE**

**SYNGAMY**

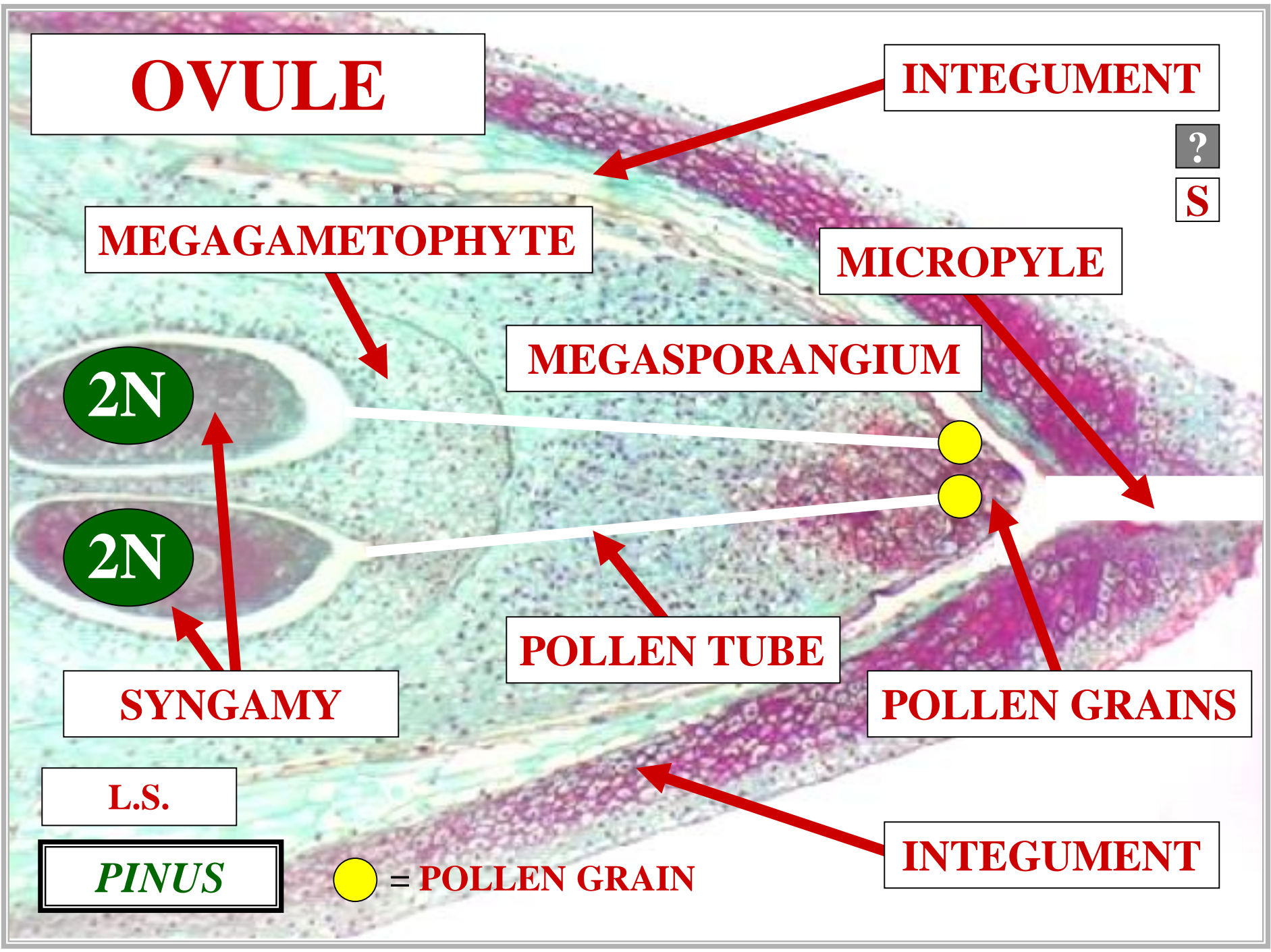
**POLLEN GRAINS**

**L.S.**

***PINUS***

**● = POLLEN GRAIN**

**INTEGUMENT**





?

INTEGUMENT

S

MEGAGAMETOPHYTE

MICROPYLE

2N

MEGASPORANGIUM

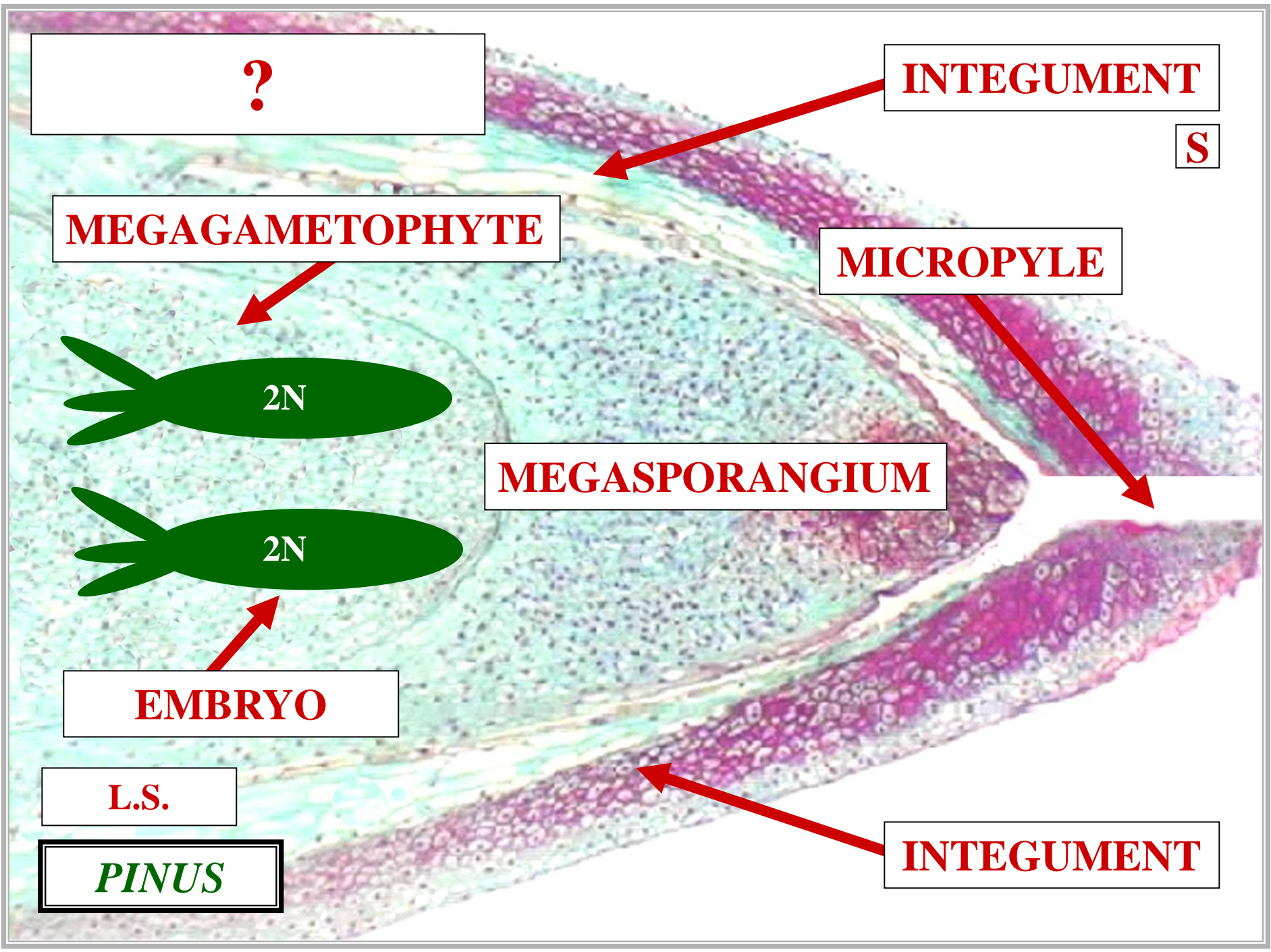
2N

EMBRYO

L.S.

*PINUS*

INTEGUMENT



**SEED**

**INTEGUMENT**

**P**

**MEGAGAMETOPHYTE**

**MICROPYLE**

**2N**

**MEGASPORANGIUM**

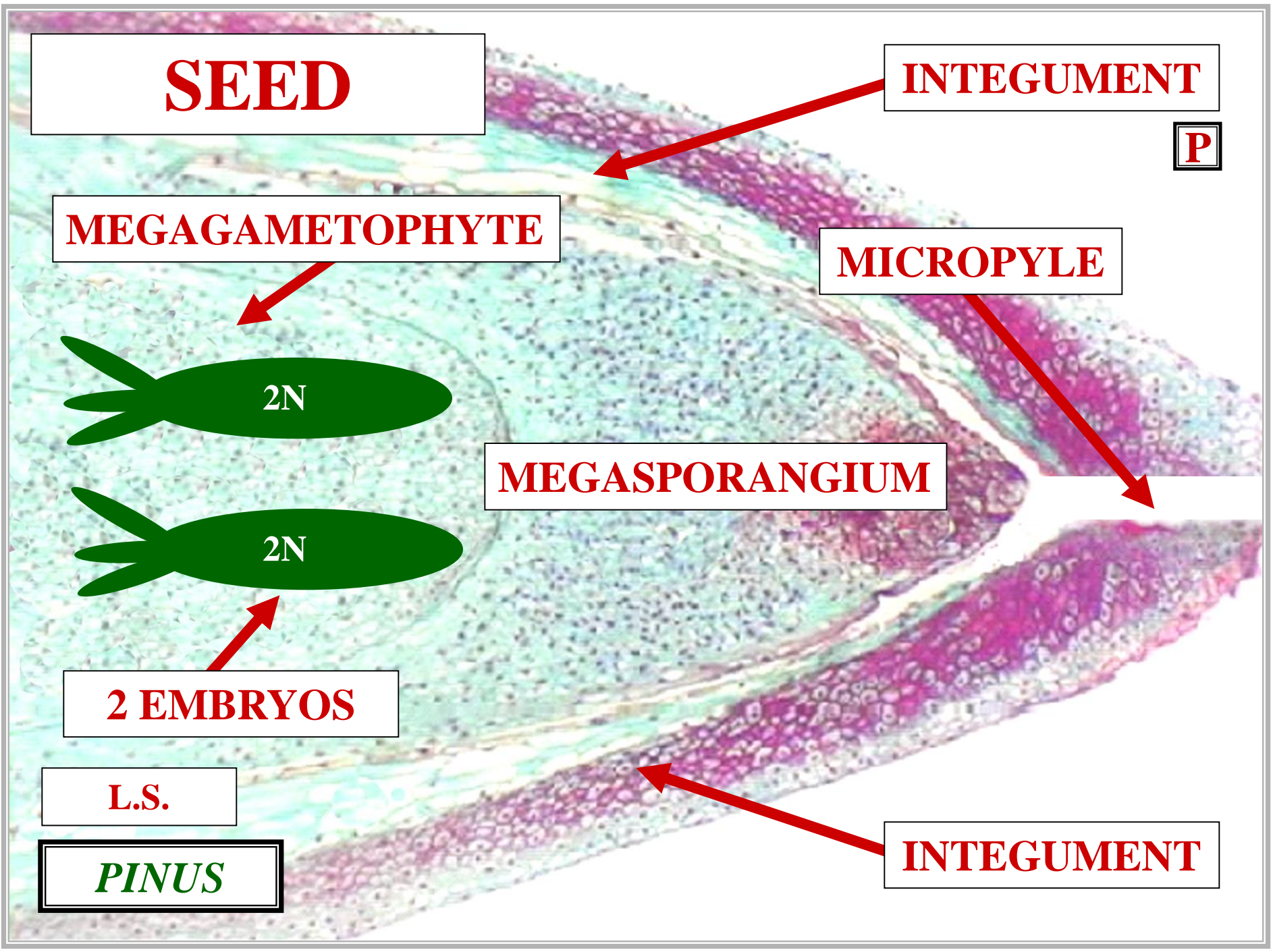
**2N**

**2 EMBRYOS**

**L.S.**

***PINUS***

**INTEGUMENT**





**SEED**

**INTEGUMENT**

**P**

**MEGAGAMETOPHYTE**

**MICROPYLE**

**2N**

**MEGASPORANGIUM**

**2N**

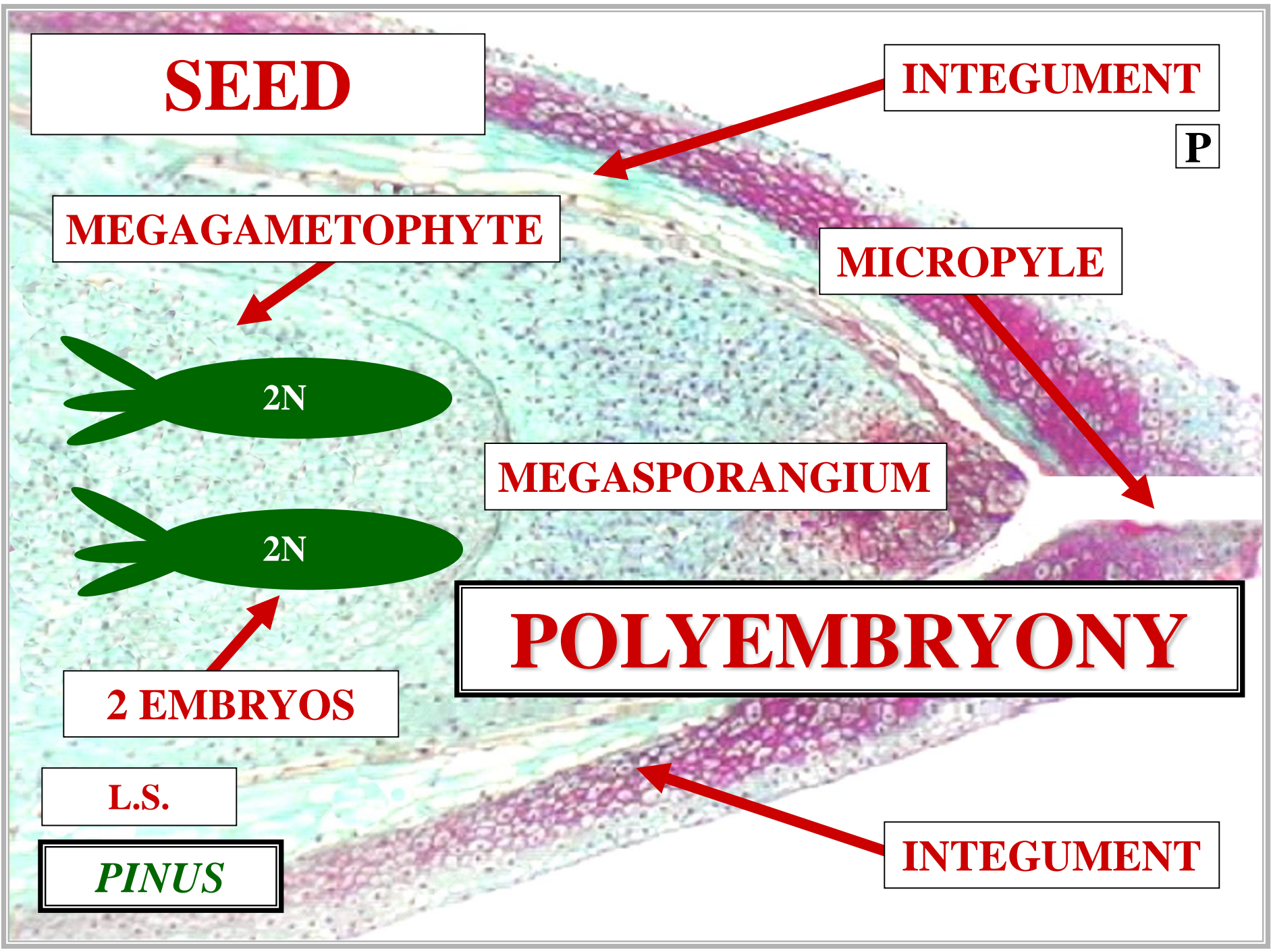
**POLYEMBRYONY**

**2 EMBRYOS**

**L.S.**

***PINUS***

**INTEGUMENT**



**POLYEMBRYONY**





**GYMNOSPERM  
POLYEMBRYONY**

**1+ EMBRYO/SEED**

**GYMNOSPERM  
POLYEMBRYONY**

**SEED**

**INTEGUMENT**

**NS**

**MEGAGAMETOPHYTE**

**MICROPYLE**

**2N**

**MEGASPORANGIUM**

**2N**

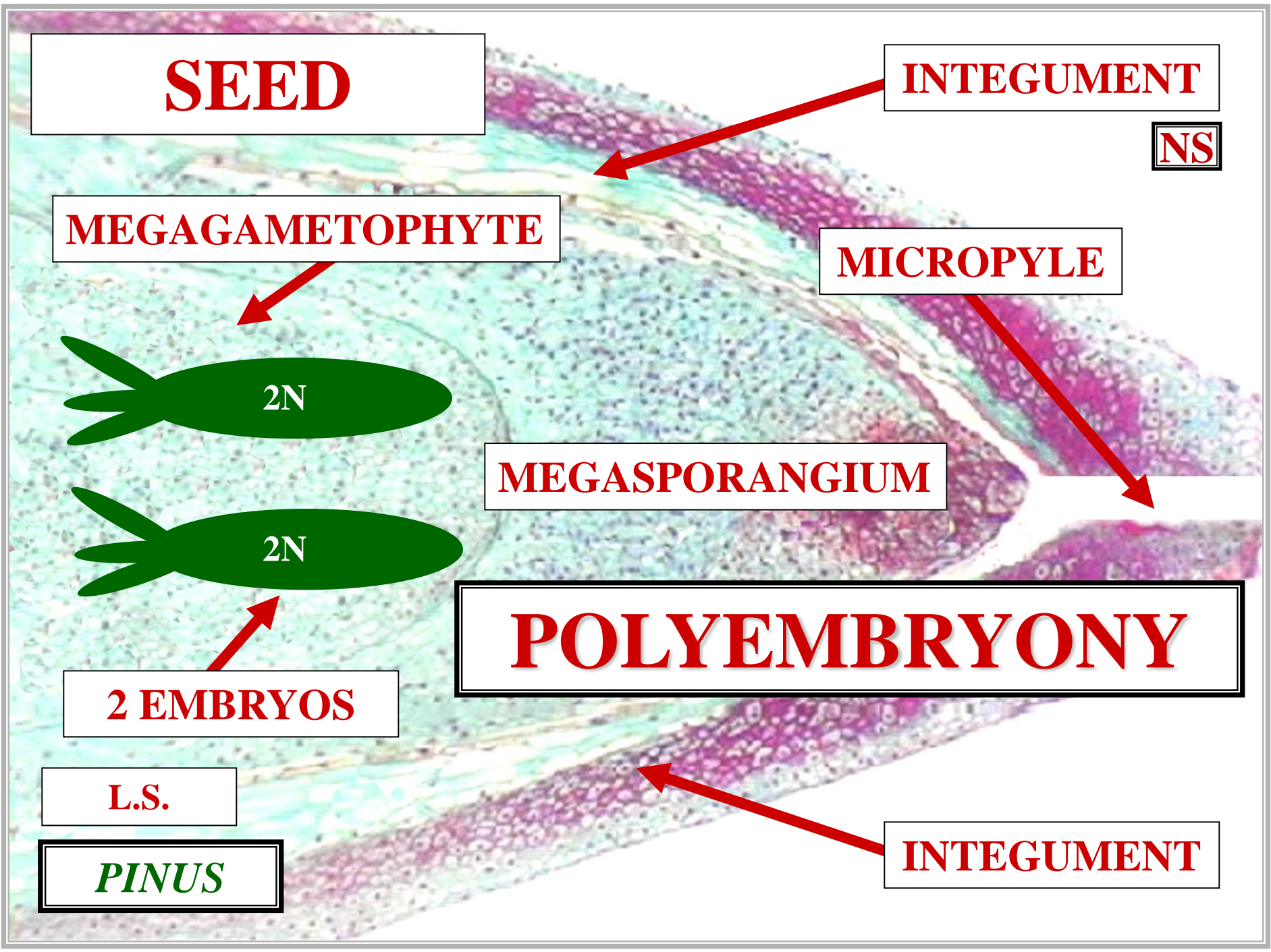
**POLYEMBRYONY**

**2 EMBRYOS**

**L.S.**

***PINUS***

**INTEGUMENT**





**SEED**

**INTEGUMENT**

**MEGAGAMETOPHYTE**

**MICROPYLE**

2N

2N

2N

**MEGASPORANGIUM**

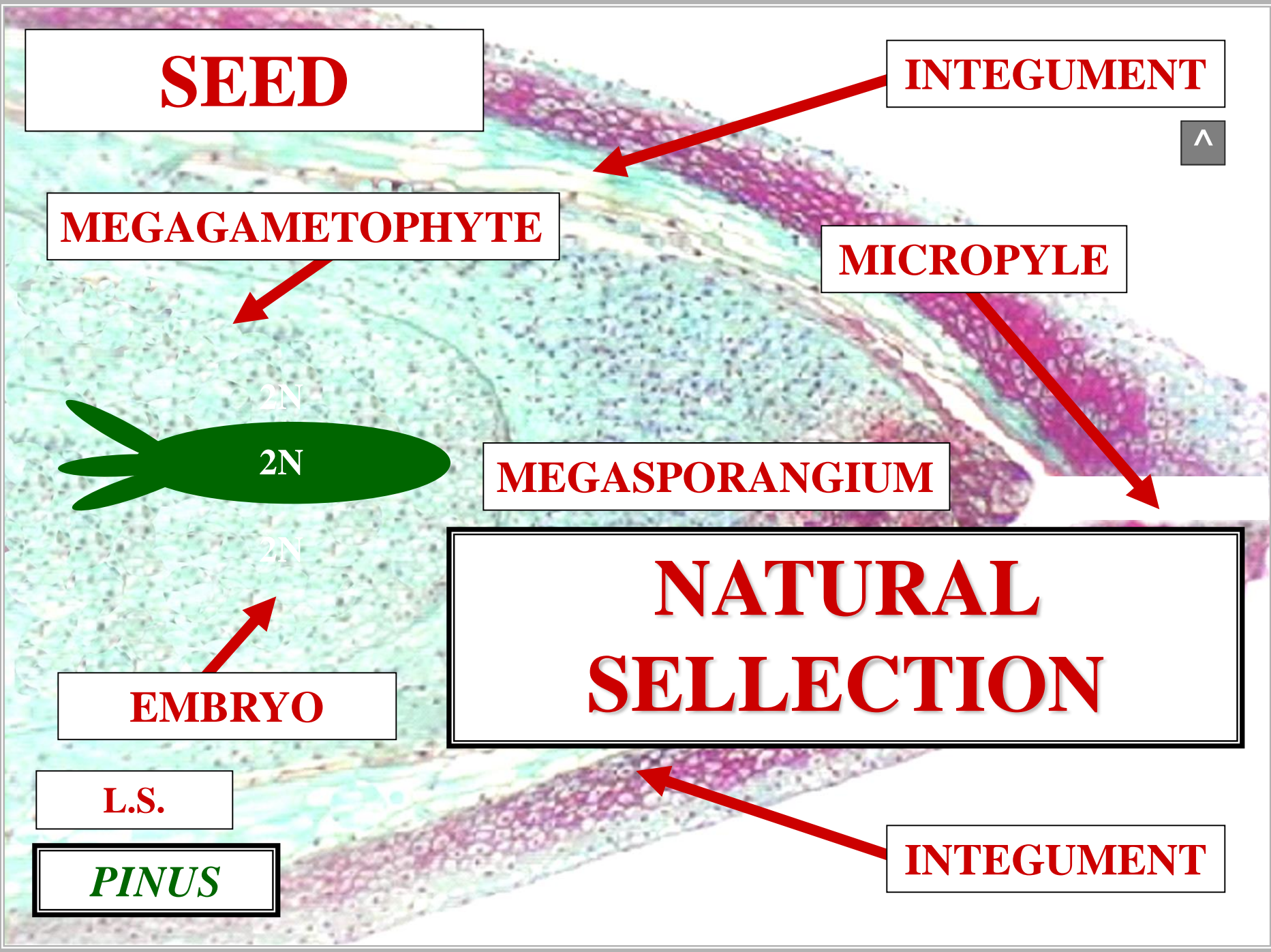
**NATURAL  
SELECTION**

**EMBRYO**

**L.S.**

***PINUS***

**INTEGUMENT**





# SEED DISPERSAL



**MEGASTROBILUS**



**W**

**SEEDS**



***PINUS***



# SEED DISPERSAL



**SEED**

**INTEGUMENT WING**

**WIND DISPERSAL**

***PINUS***

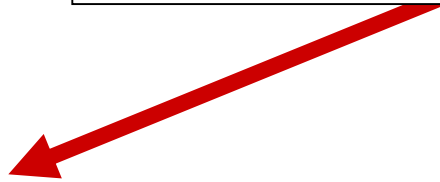




***PINUS***  
**LIFE CYCLE**

***PINUS***

**MATURE SPOROPHYTE**

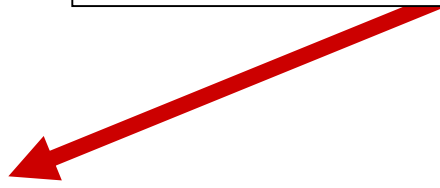




# *PINUS*

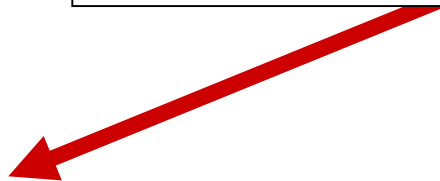


$2N$



*PINUS*

**MICROSTROBILI**

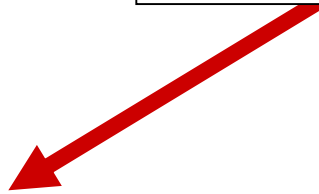




# *PINUS*



**MICROSTROBILI  
LOWER BRANCHES**





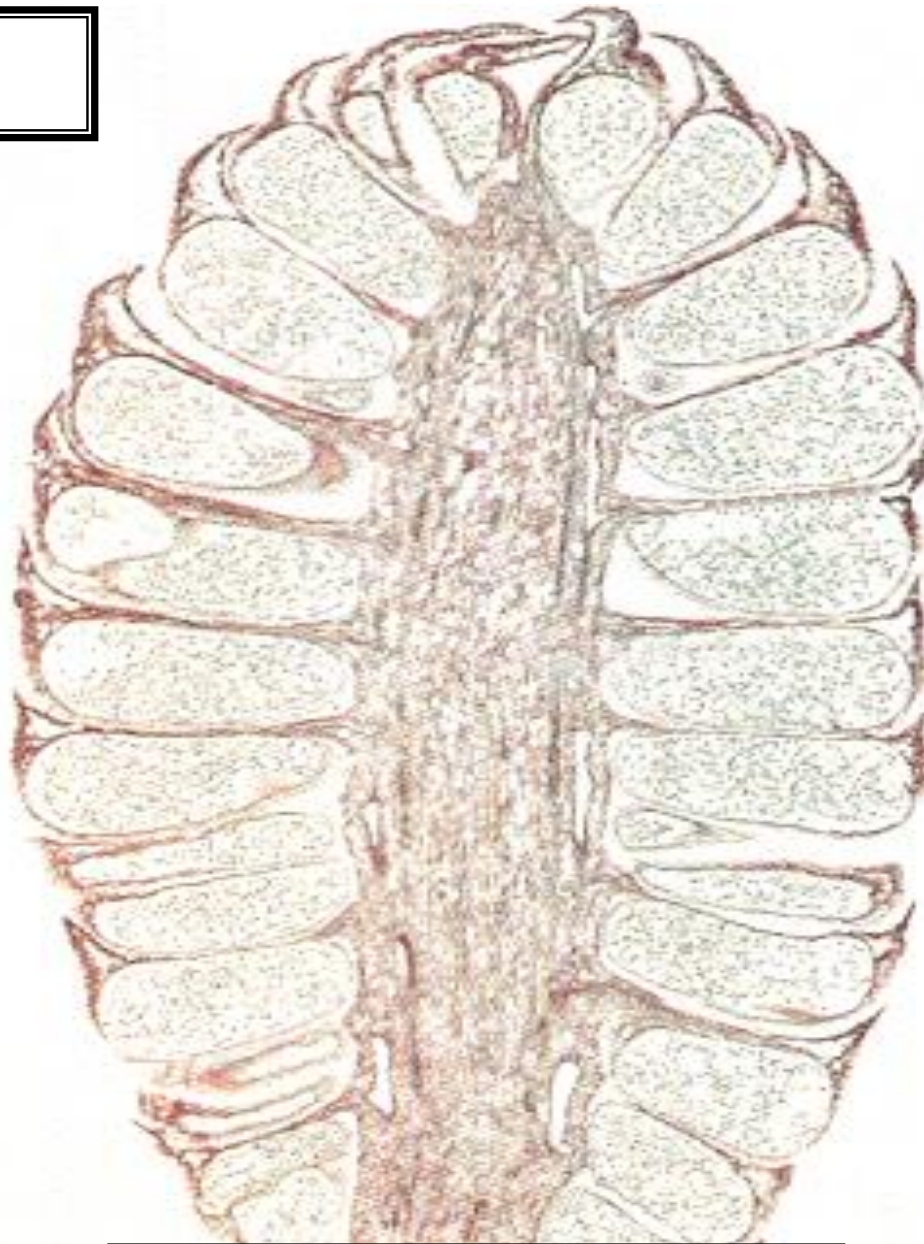
**MICROSTROBILI**



***PINUS***



***PINUS***



**MICROSTROBILUS**

**L.S.**

***PINUS***

**M**



**MICROSTROBILUS**

**L.S.**

