



**SPERM**

F

+



**PTERIDOPHYTES**



S

**BI-FLAGELLATED  
OR  
MULTI-FLAGELLATED  
SPERM**

**PTERIDOPHYTES**

F

+



**SPERMATOPHYTES**

A close-up photograph of a large, white magnolia flower with a prominent yellow stamen and a red pistil, surrounded by green leaves. The flower is the central focus of the slide.

**MULTI-FLAGELLATED  
OR  
NON-FLAGELLATED  
SPERM**

**SPERMATOPHYTES**



# SYNGAMY



# PTERIDOPHYTES

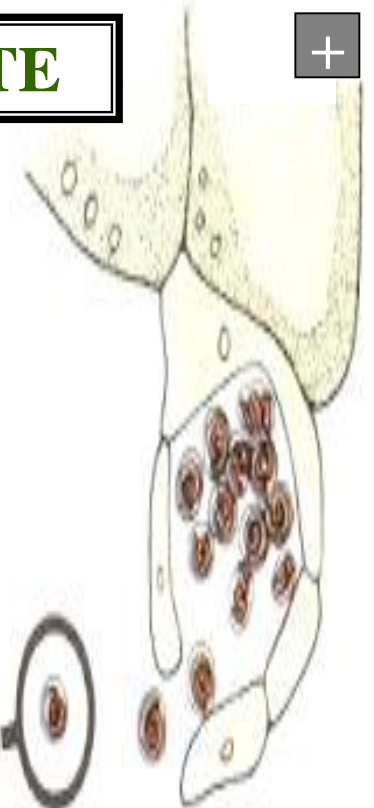
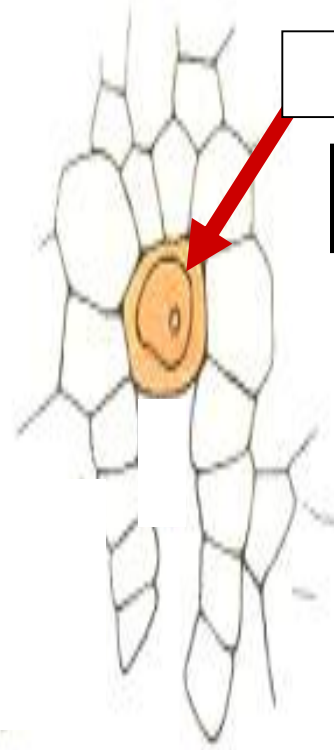
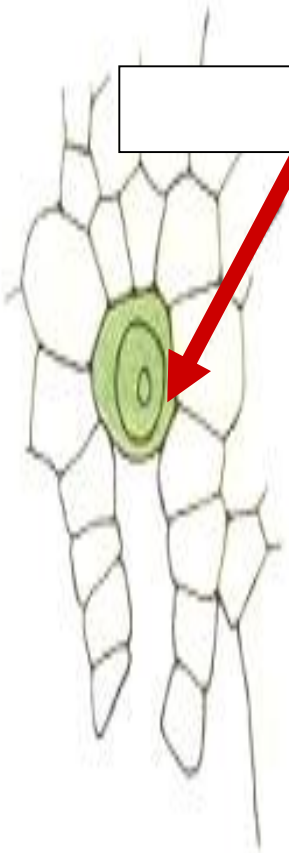
**ARCHEGONIUM**

**EGG**

**ANTHERIDIUM**

**PTERIDOPHYTE**

+



**FLAGELLATED  
SPERM**



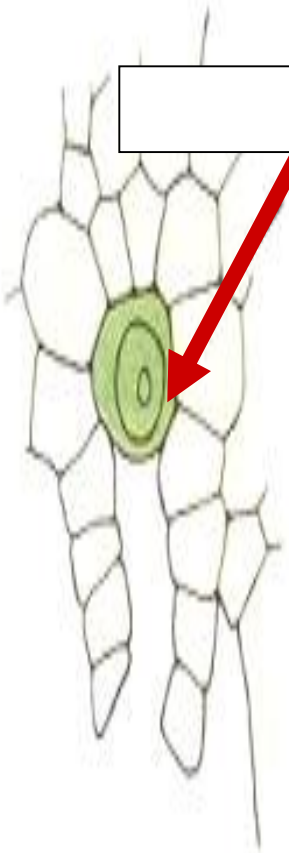
**ARCHEGONIUM**

**EGG**

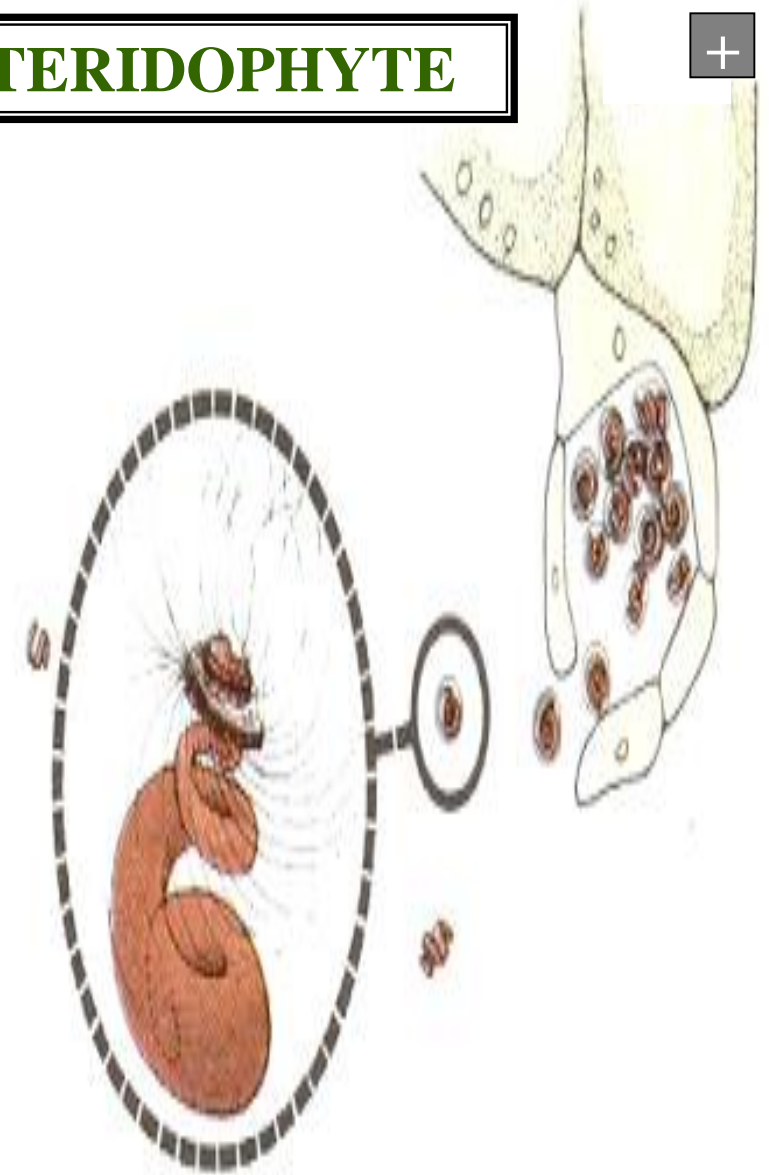
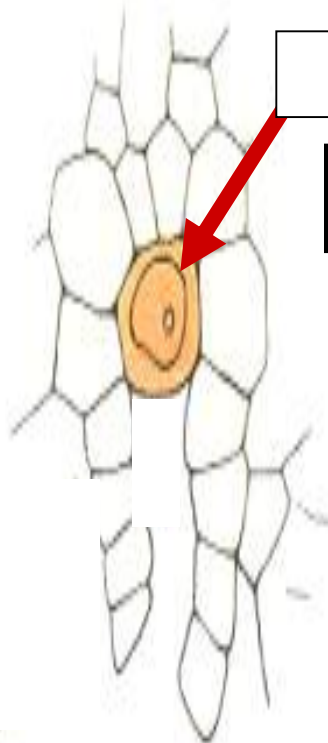
**ANTHERIDIUM**

**PTERIDOPHYTE**

+



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[Empty label box]

**FLAGELLATED  
SPERM**

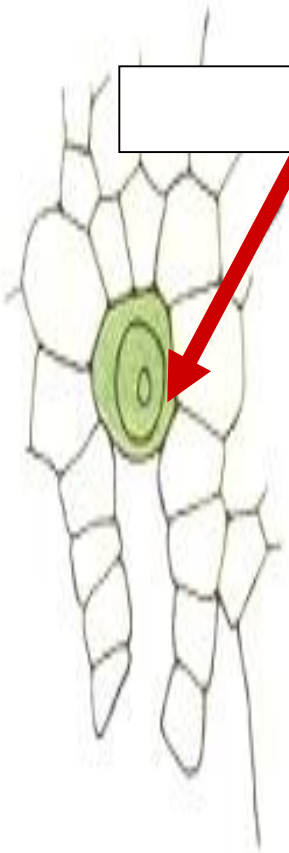
**ARCHEGONIUM**

**EGG**

**ANTHERIDIUM**

**PTERIDOPHYTE**

**S**



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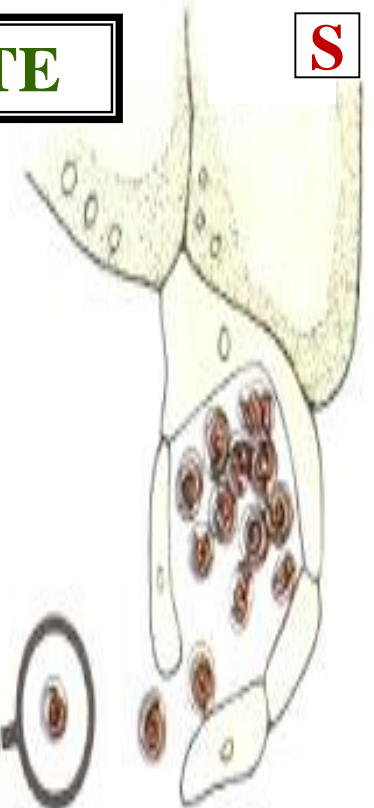


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**FLAGELLATED  
SPERM**



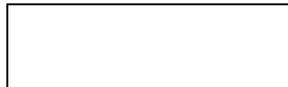
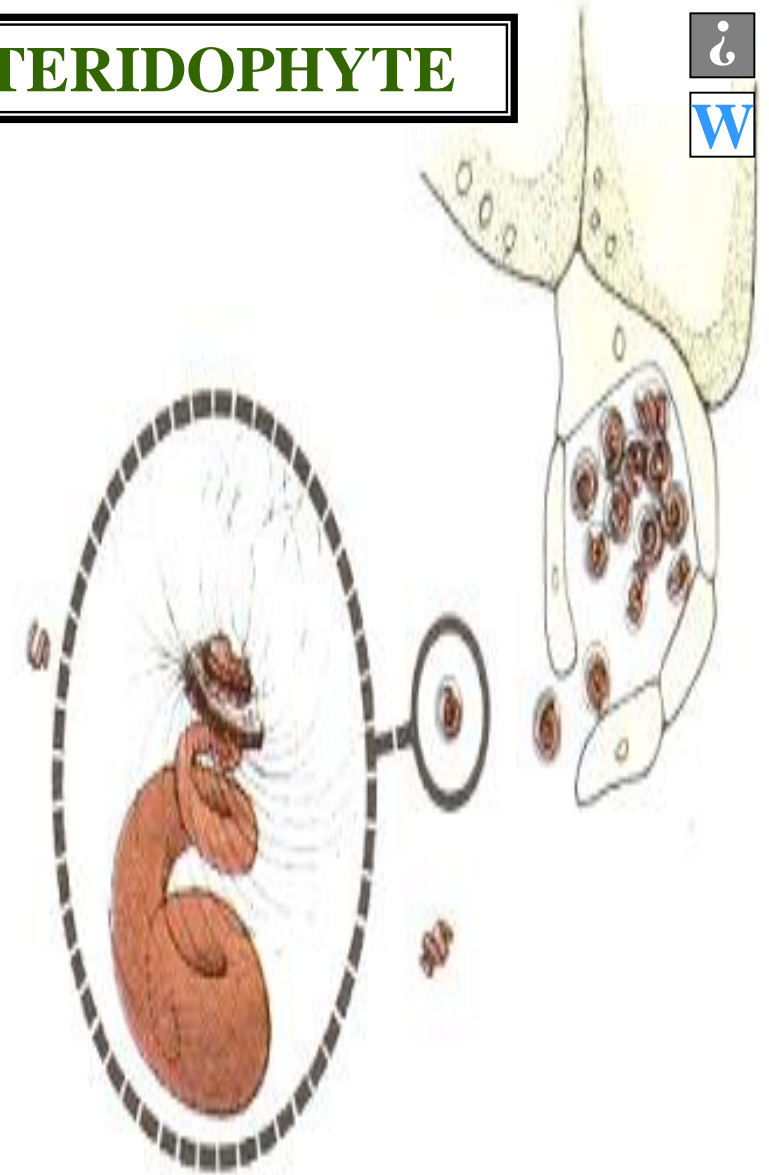
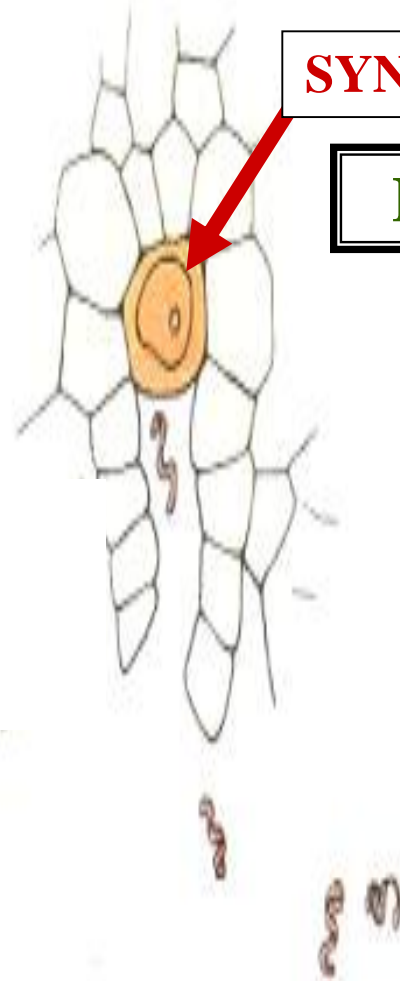
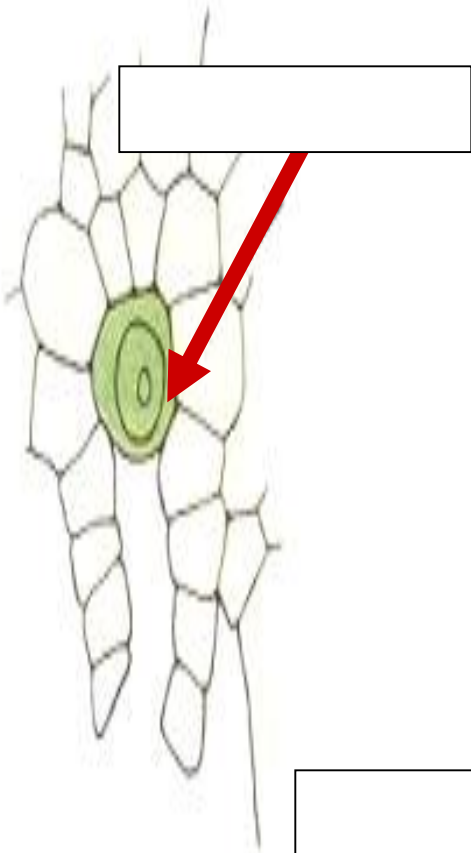
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**ARCHEGONIUM**

**SYNGAMY**

**ANTHERIDIUM**

**PTERIDOPHYTE**



**FLAGELLATED  
SPERM**



**ARCHEGONIUM**

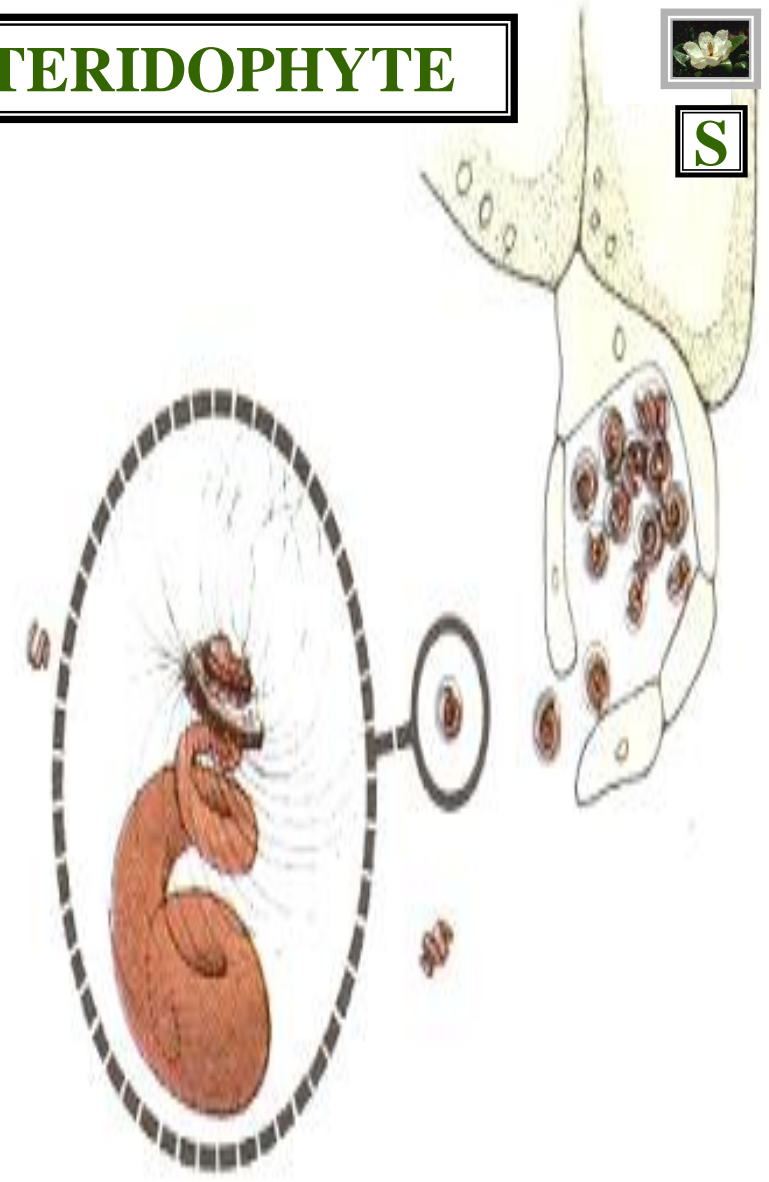
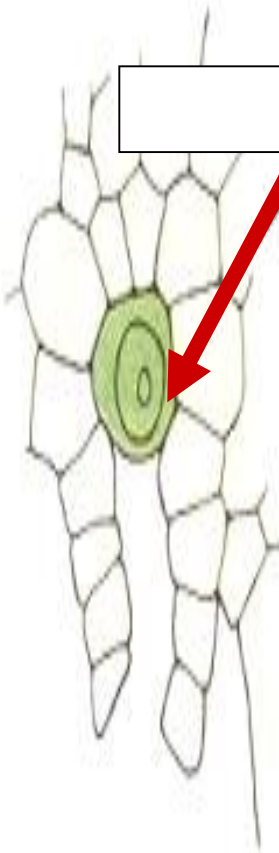
**SYNGAMY**

**ANTHERIDIUM**

**PTERIDOPHYTE**

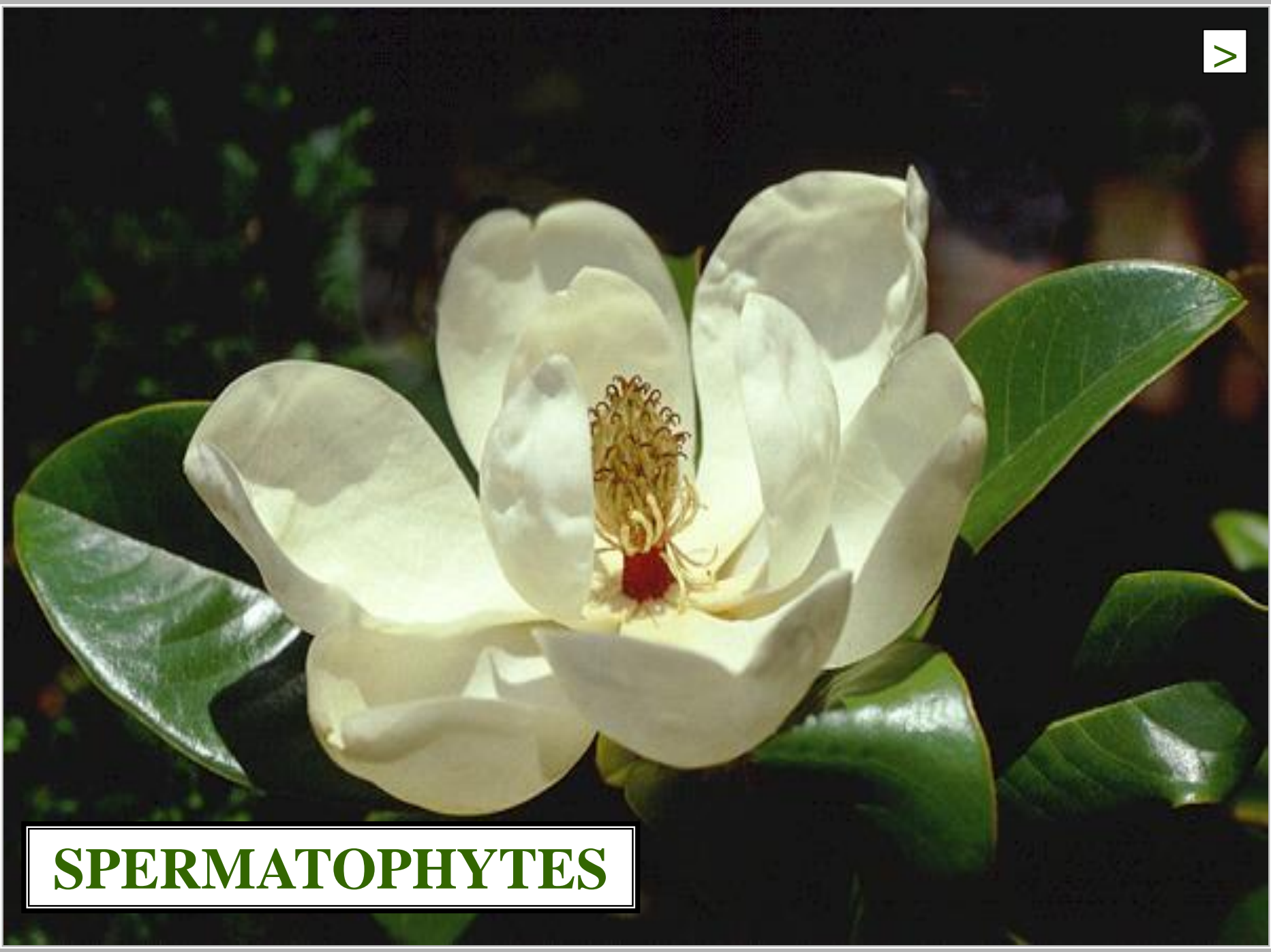


**S**



**WATER**

**FLAGELLATED  
SPERM**



**SPERMATOPHYTES**



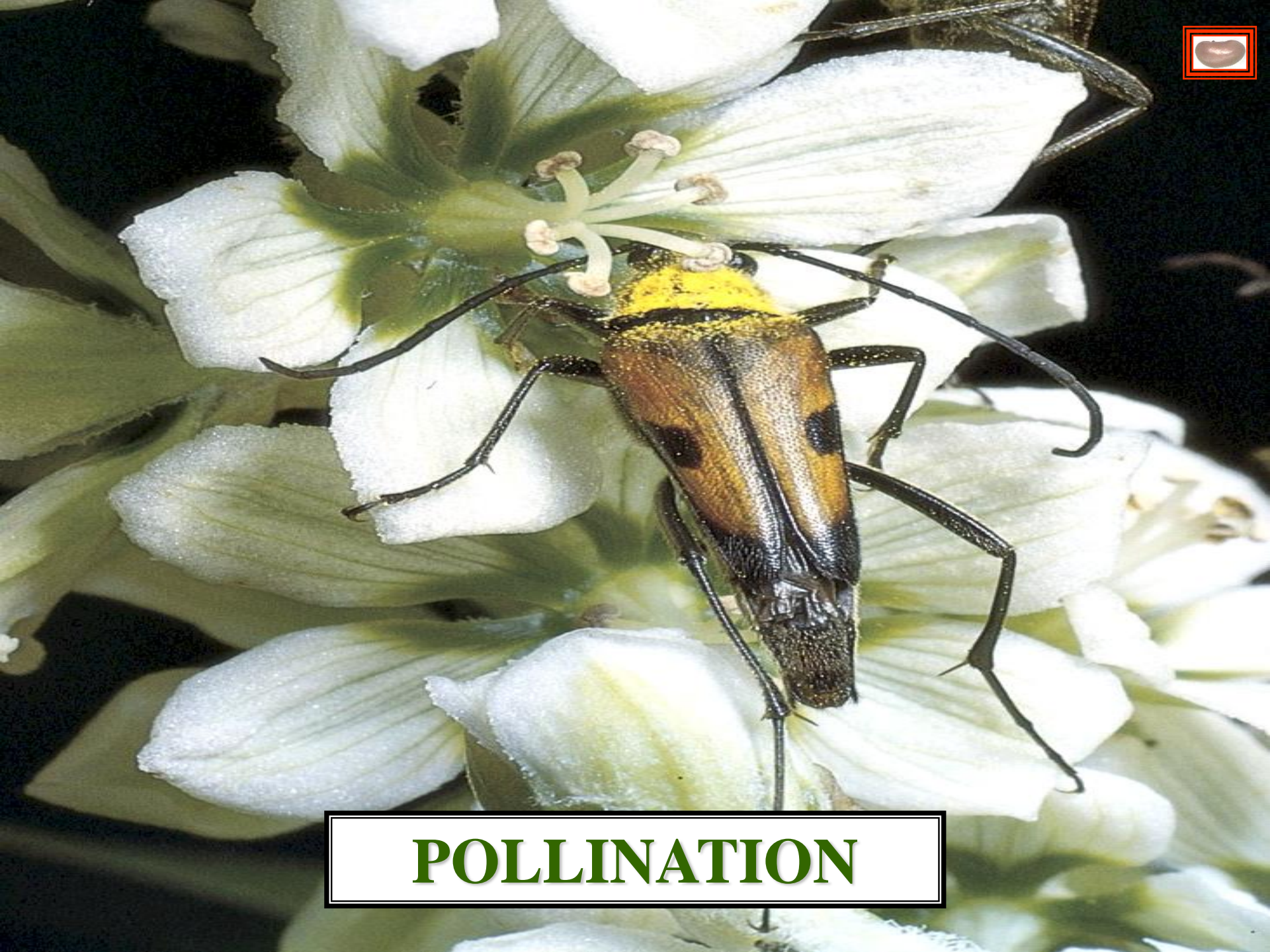
**SPERMATOPHYTES  
SYNGAMY  
DOES NOT REQUIRE  
WATER**

**SPERMATOPHYTES**



**SPERMATOPHYTES  
SYNGAMY  
DOES REQUIRE  
POLLINATION**

**SPERMATOPHYTES**



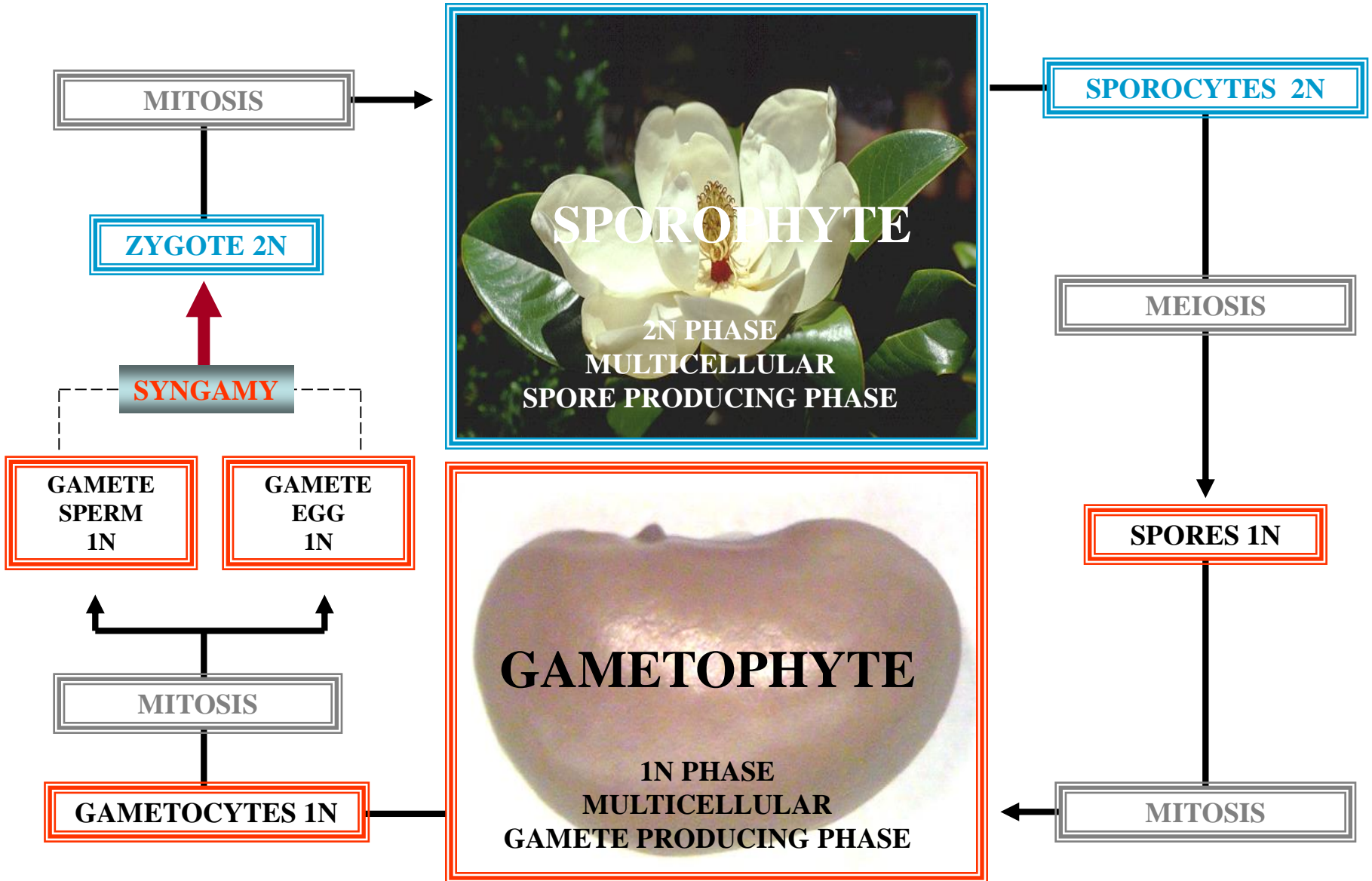
**POLLINATION**



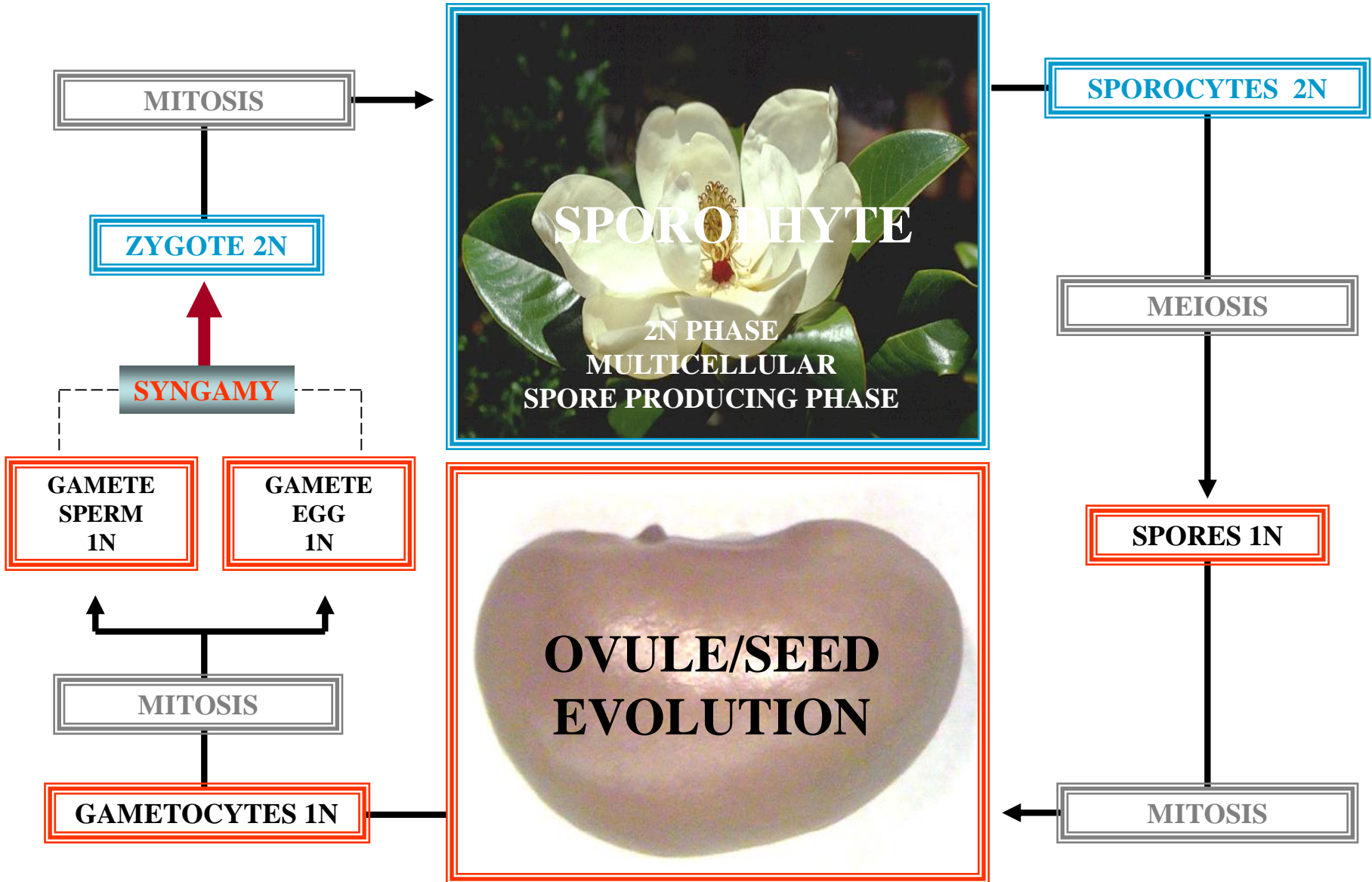
# SPERMATOPHYTE LIFE CYCLE



O



# SPERMATOPHYTE LIFE CYCLE





# OVULE / SEED EVOLUTION



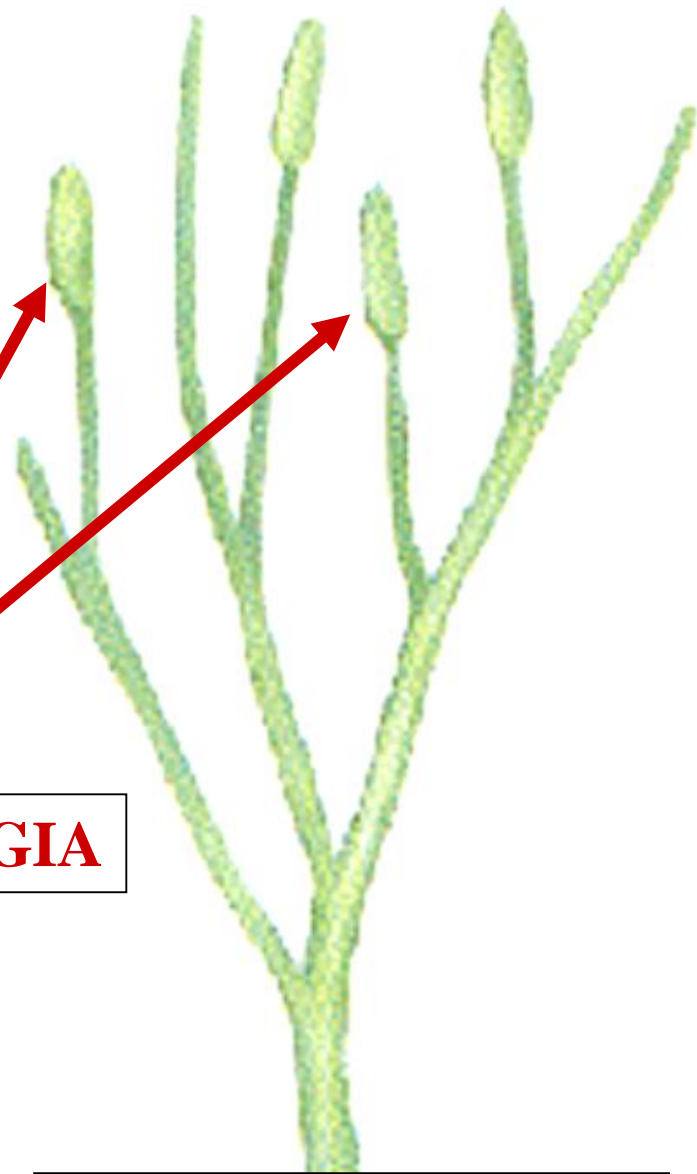
# **HYPOTHETICAL SCENARIO**



# **START HYPOTHETICAL SCENARIO**

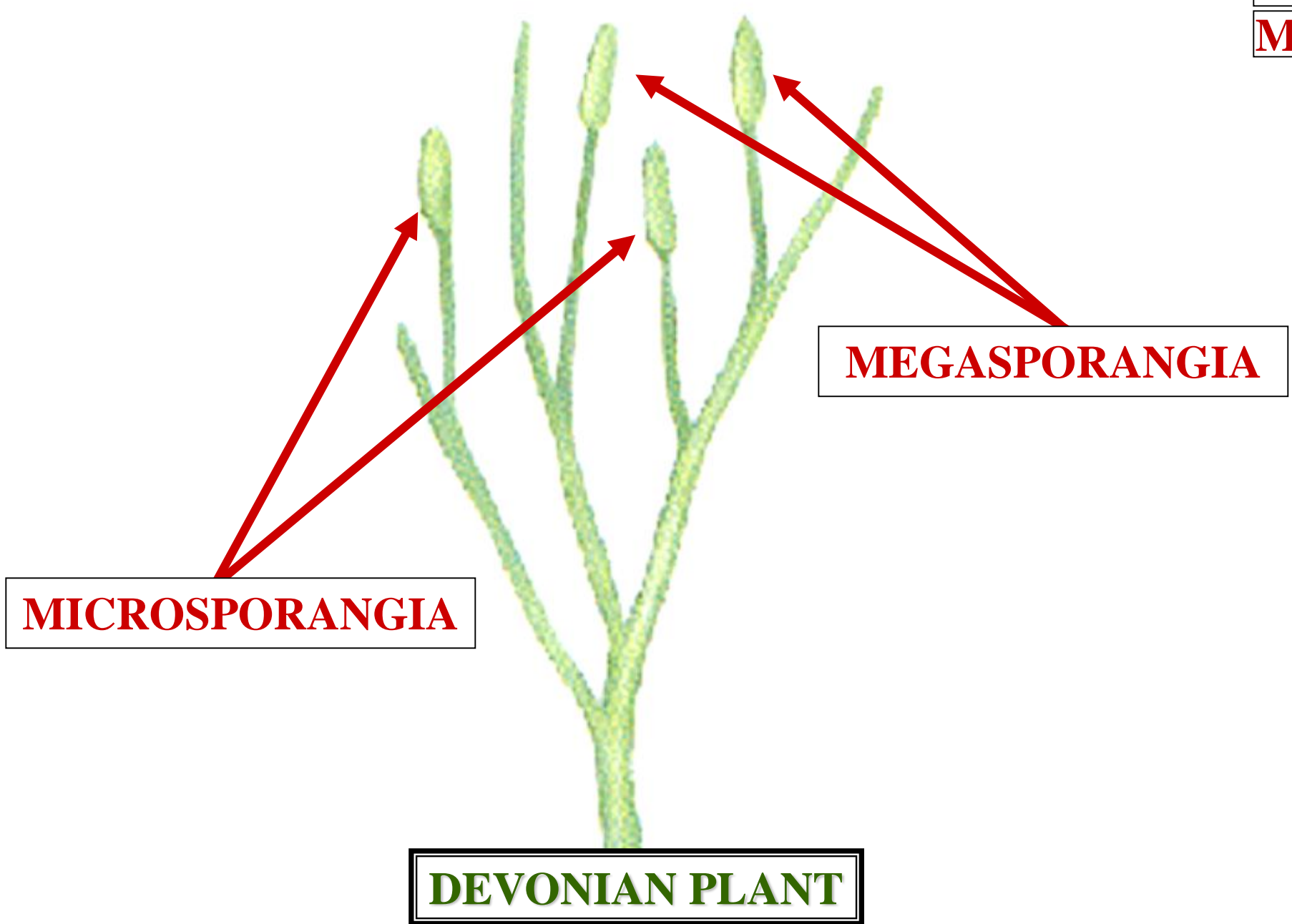


**DEVONIAN PLANT**

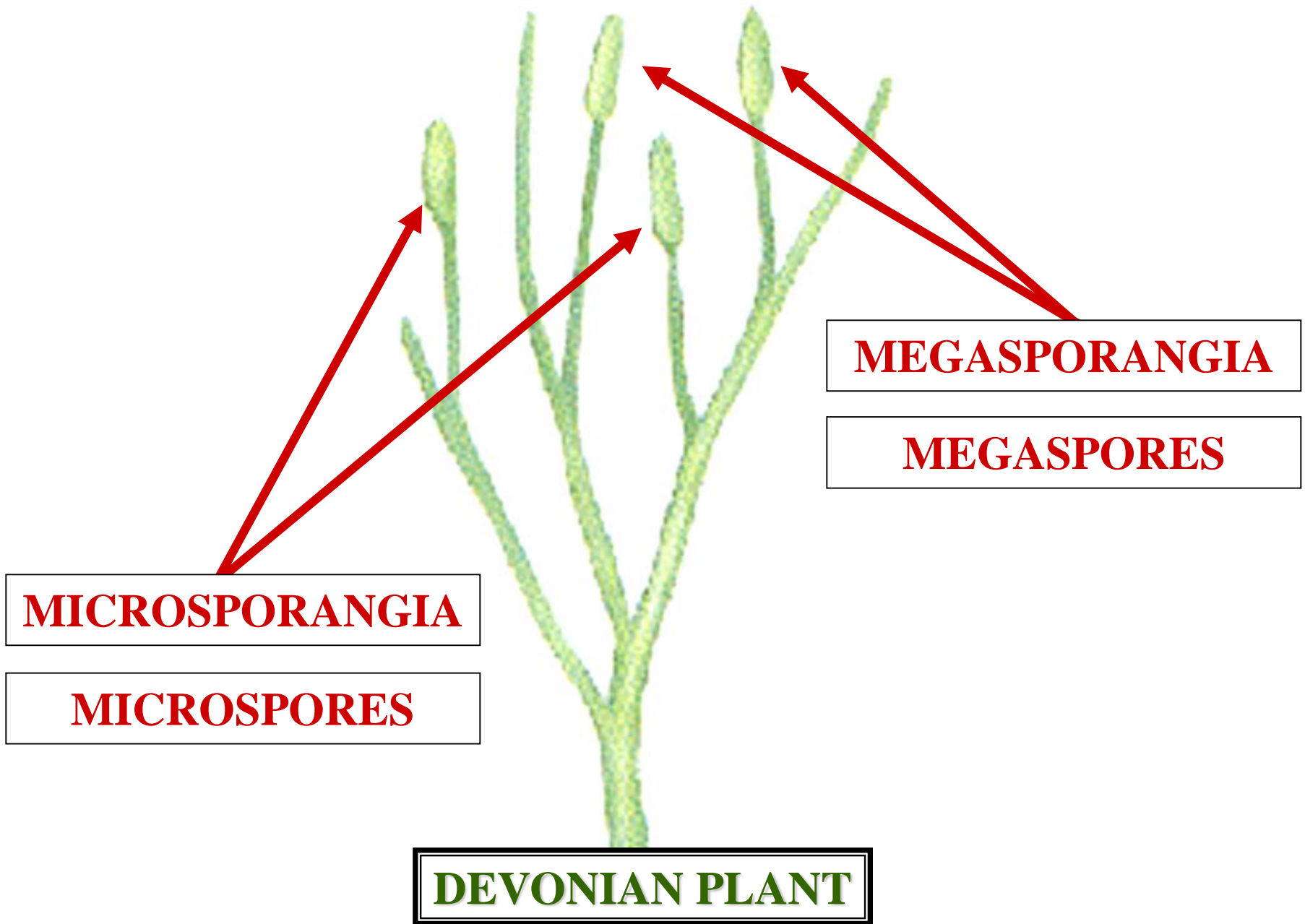


**MICROSPORANGIA**

**DEVONIAN PLANT**







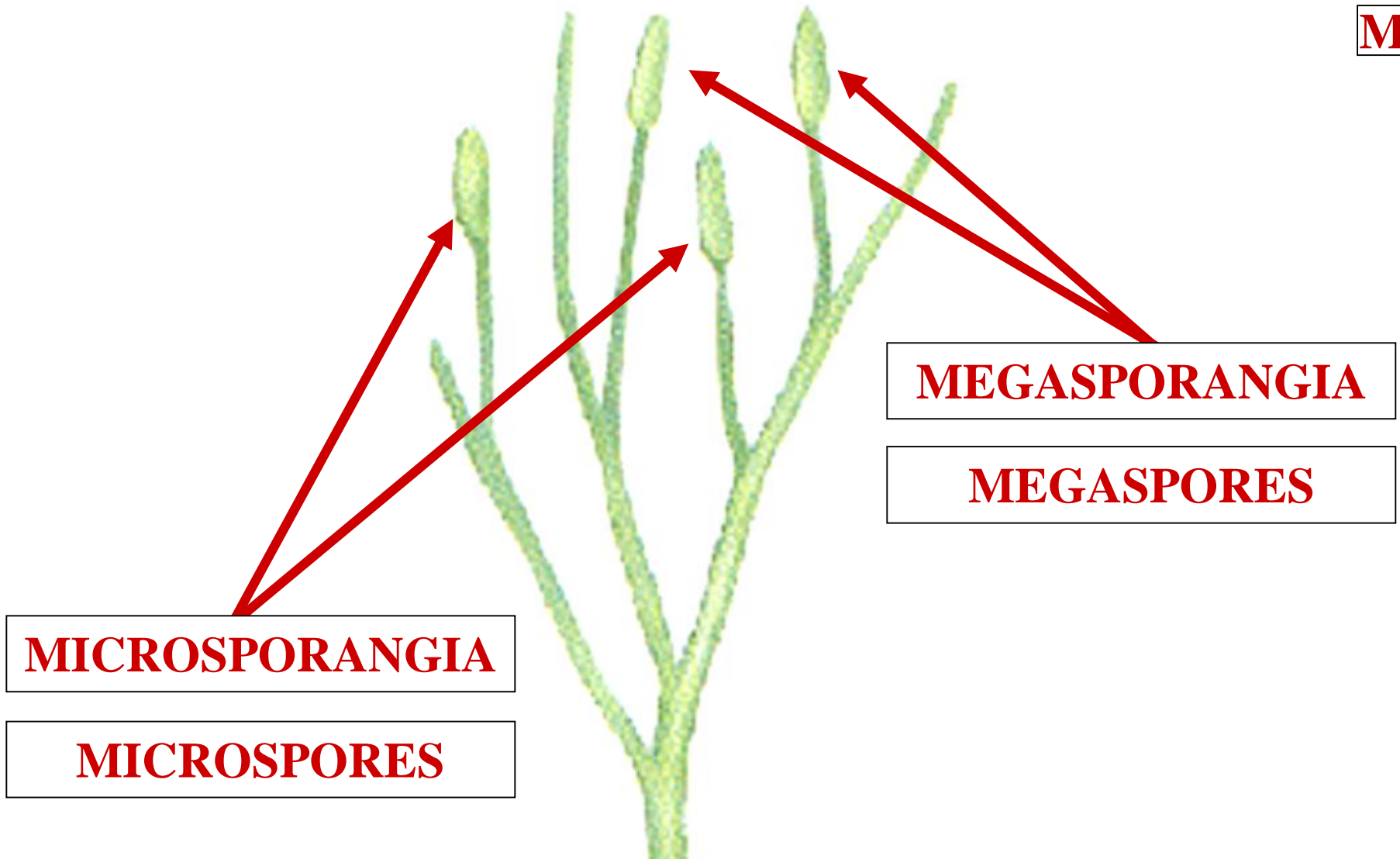
**MICROSPORANGIA**

**MICROSPORES**

**MEGASPORANGIA**

**MEGASPORES**

**DEVONIAN PLANT**



**MICROSPORANGIA**

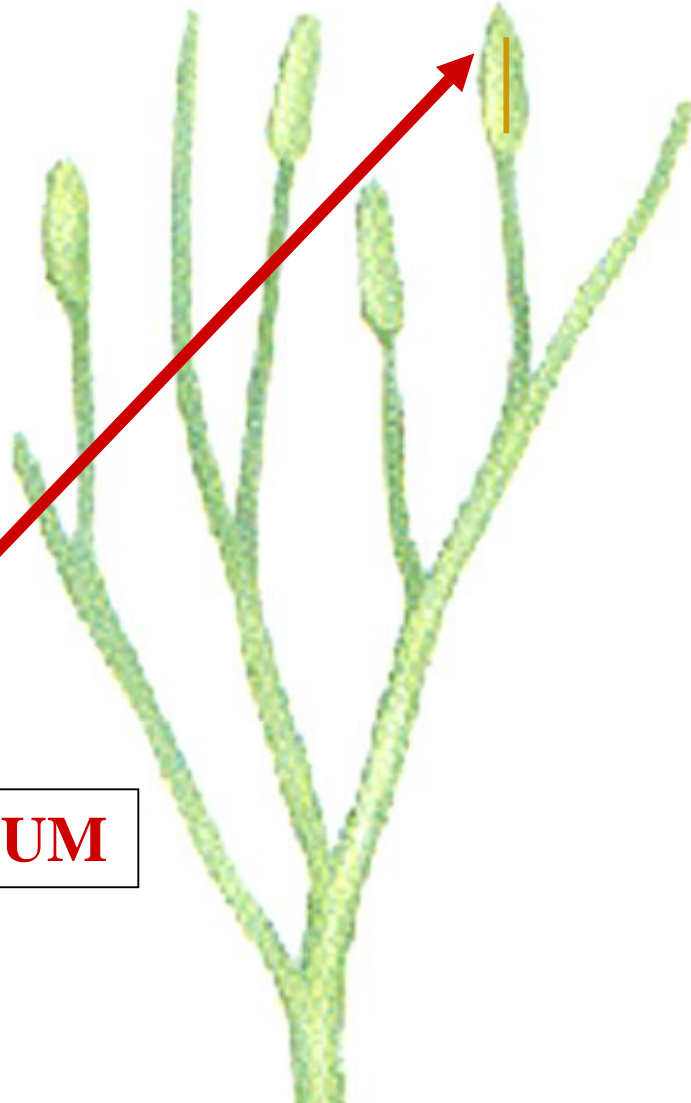
**MICROSPORES**

**MEGASPORANGIA**

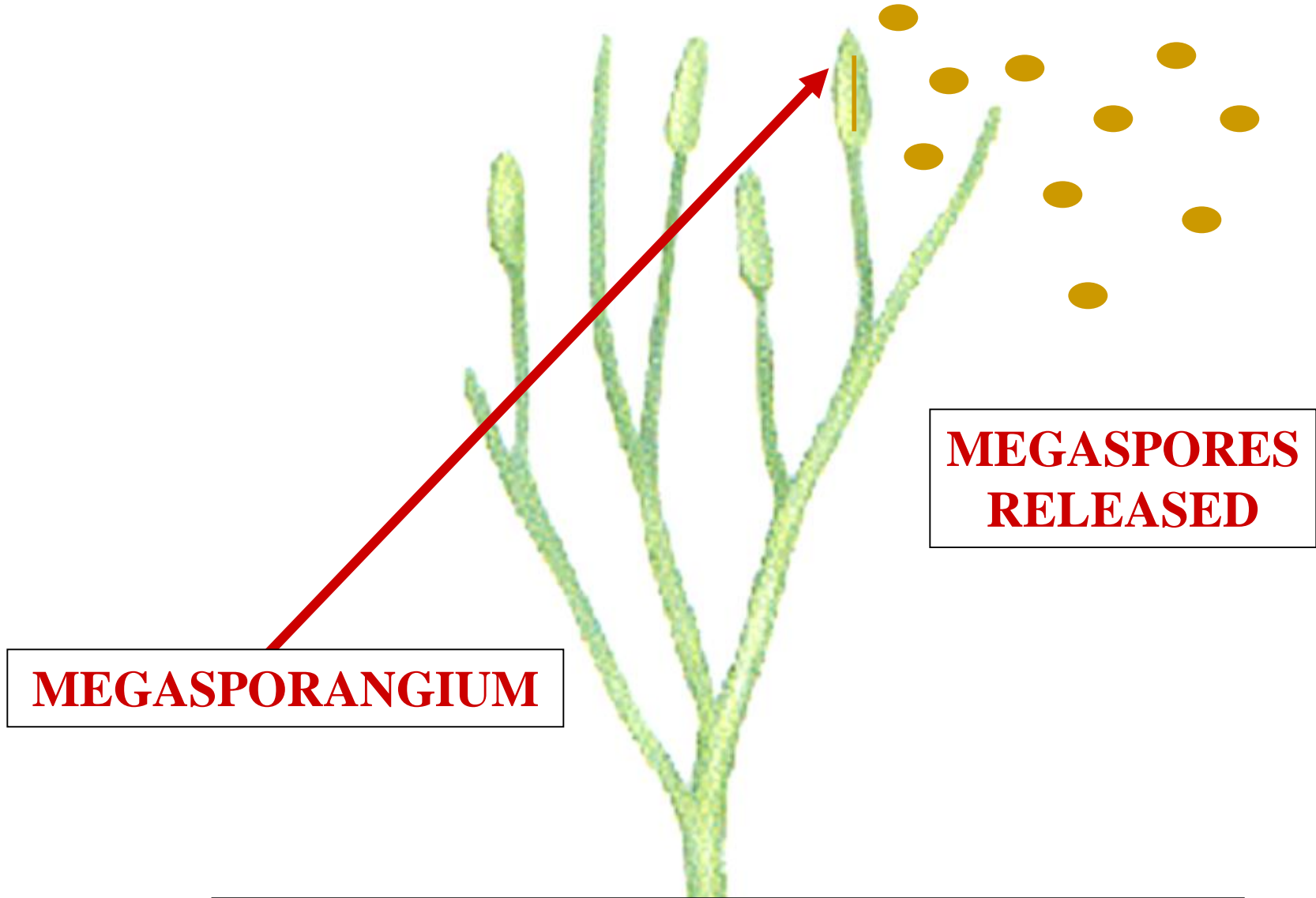
**MEGASPORES**

**DEVONIAN  
HETEROSPOROUS PLANT**

**MEGASPORANGIUM**



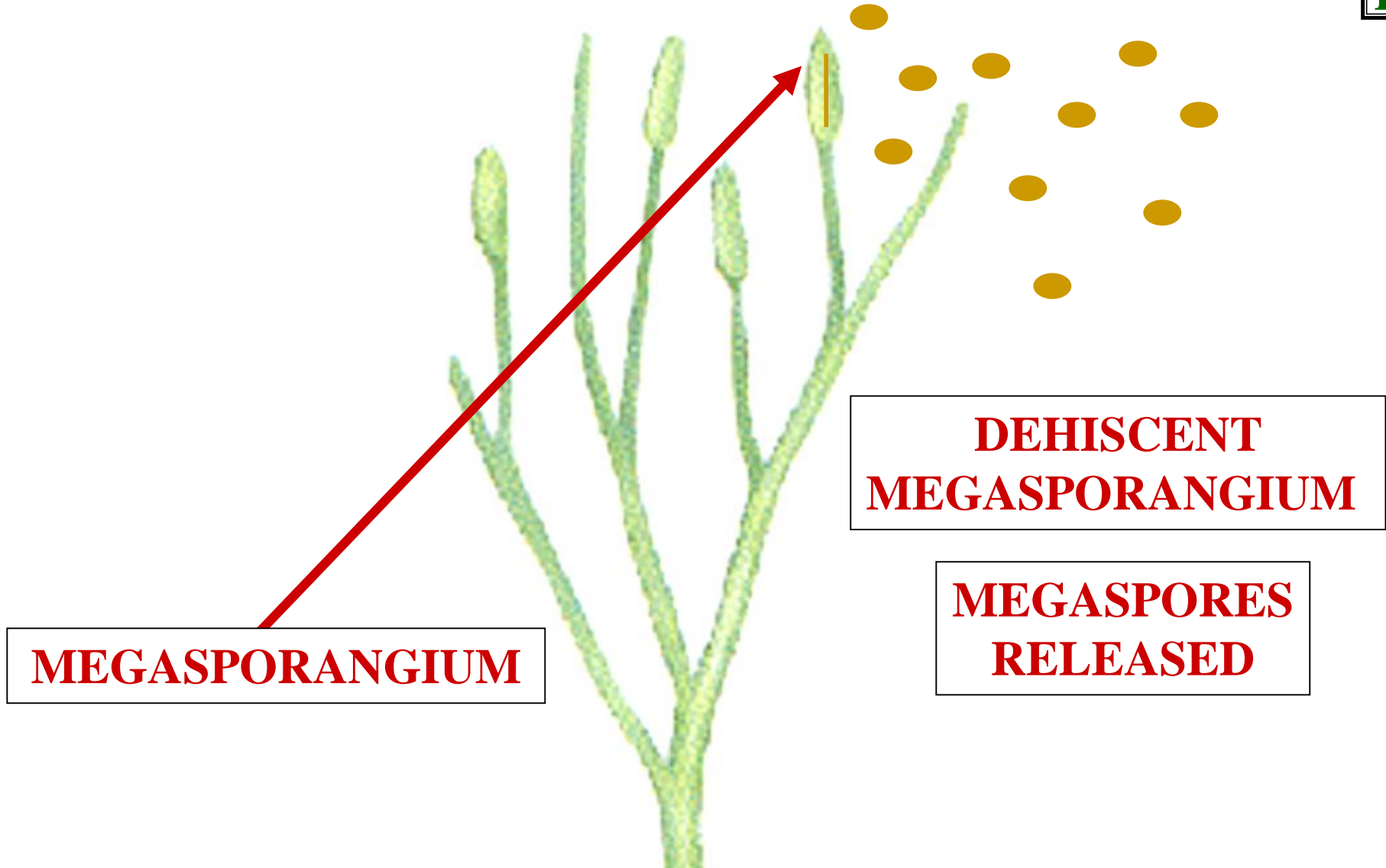
**DEVONIAN  
HETEROSPOROUS PLANT**



**MEGASPORANGIUM**

**MEGASPORES  
RELEASED**

**DEVONIAN  
HETEROSPOROUS PLANT**

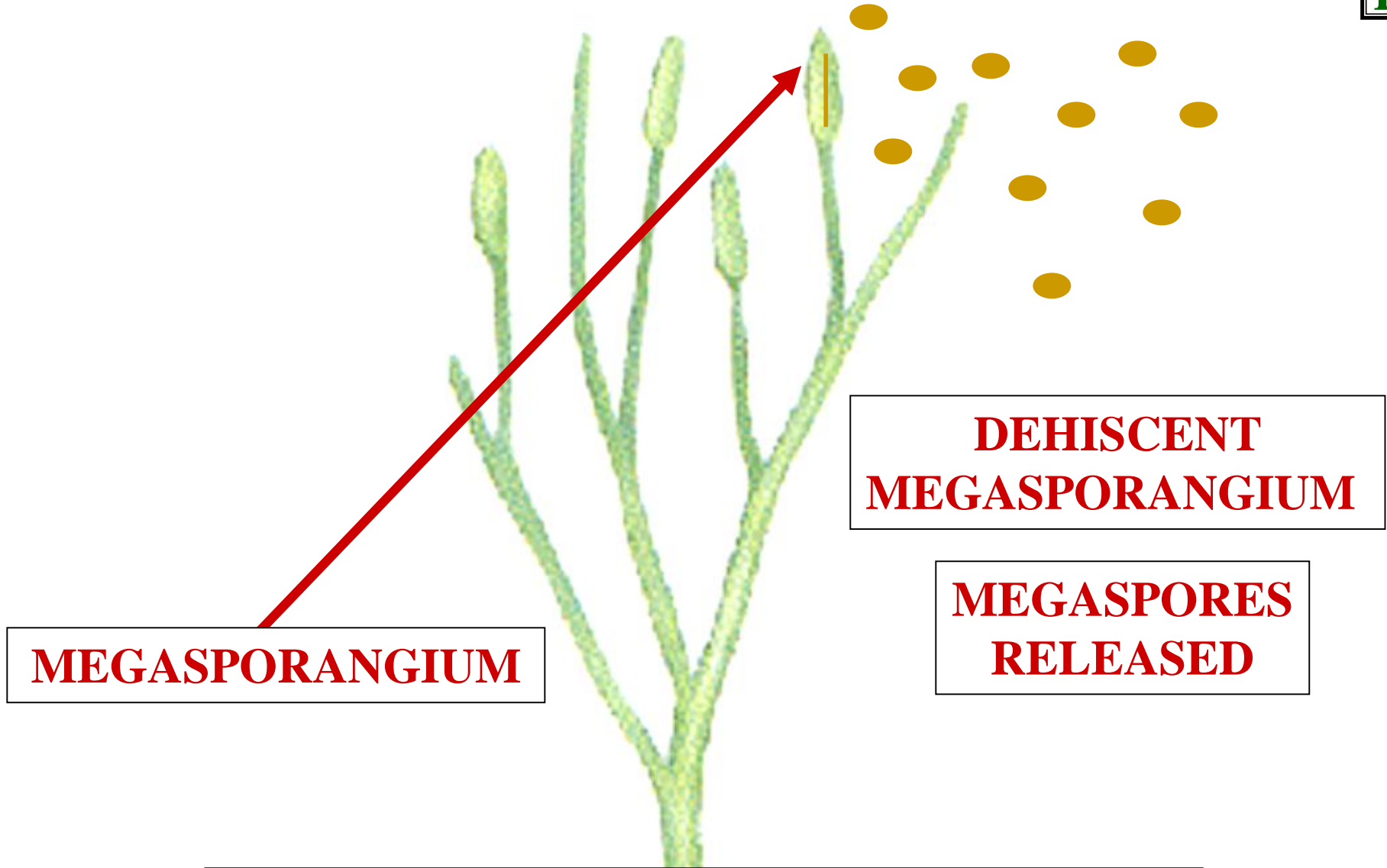


**MEGASPORANGIUM**

**DEHISCENT  
MEGASPORANGIUM**

**MEGASPORES  
RELEASED**

**DEVONIAN  
HETEROSPOROUS PLANT**

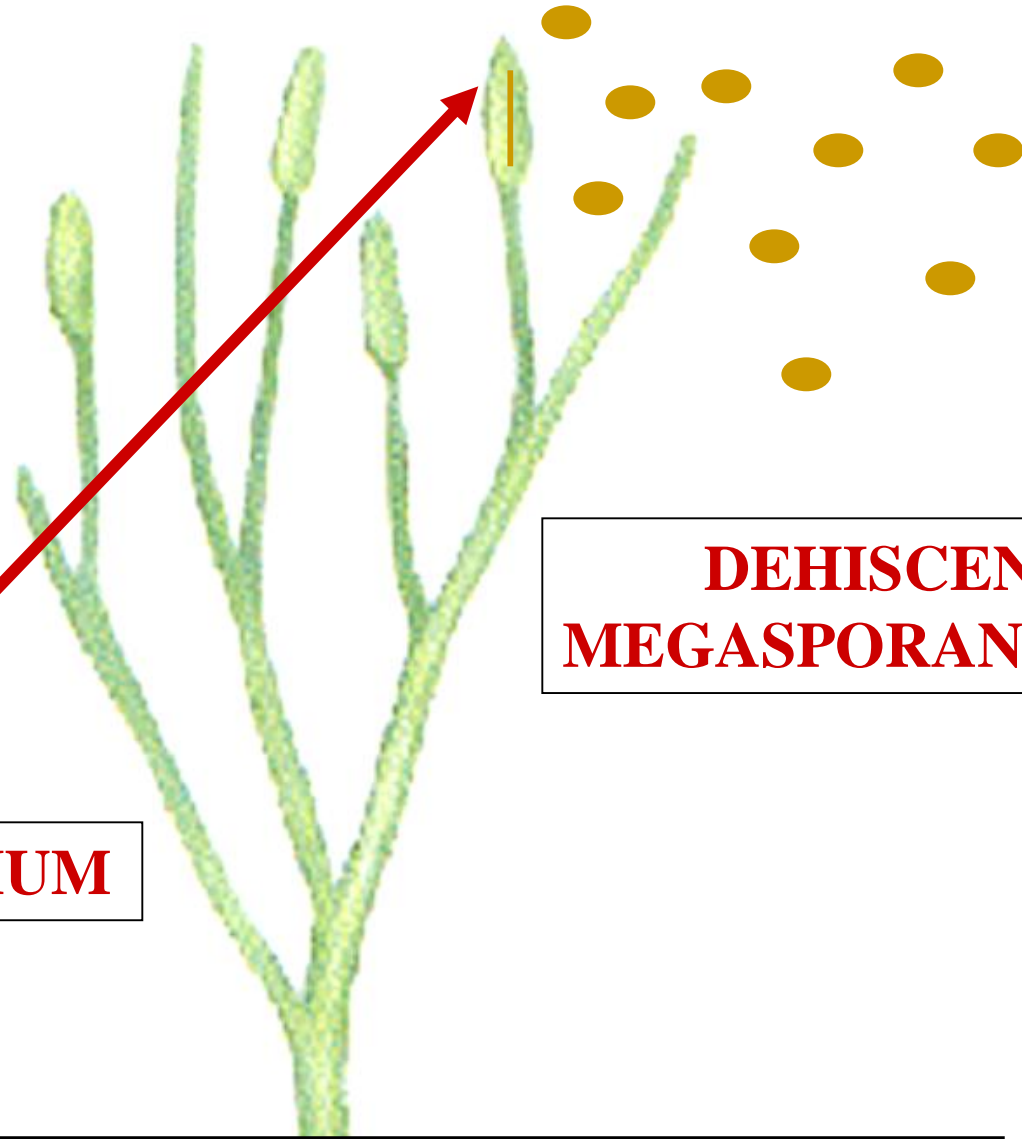


**MEGASPORANGIUM**

**DEHISCENT  
MEGASPORANGIUM**

**MEGASPORES  
RELEASED**

**DEVONIAN  
PTERIDOPHYTE**



**MEGASPORANGIUM**

**DEHISCENT  
MEGASPORANGIUM**

**DEVONIAN  
PROGYMNOSPERM**

?





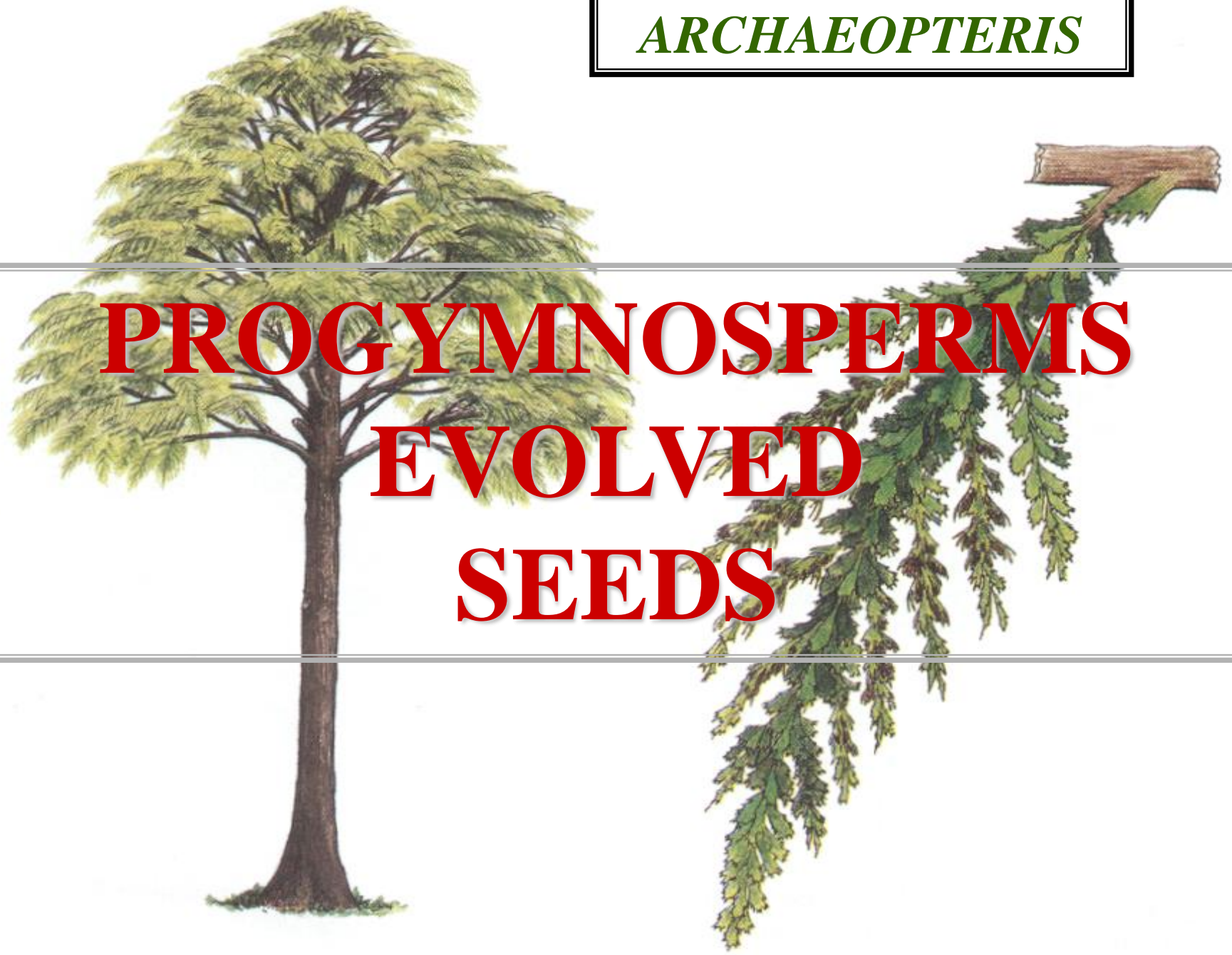


# *ARCHAEOPTERIS*





*ARCHAEOPTERIS*



**PROGYMNOSPERMS  
EVOLVED  
SEEDS**

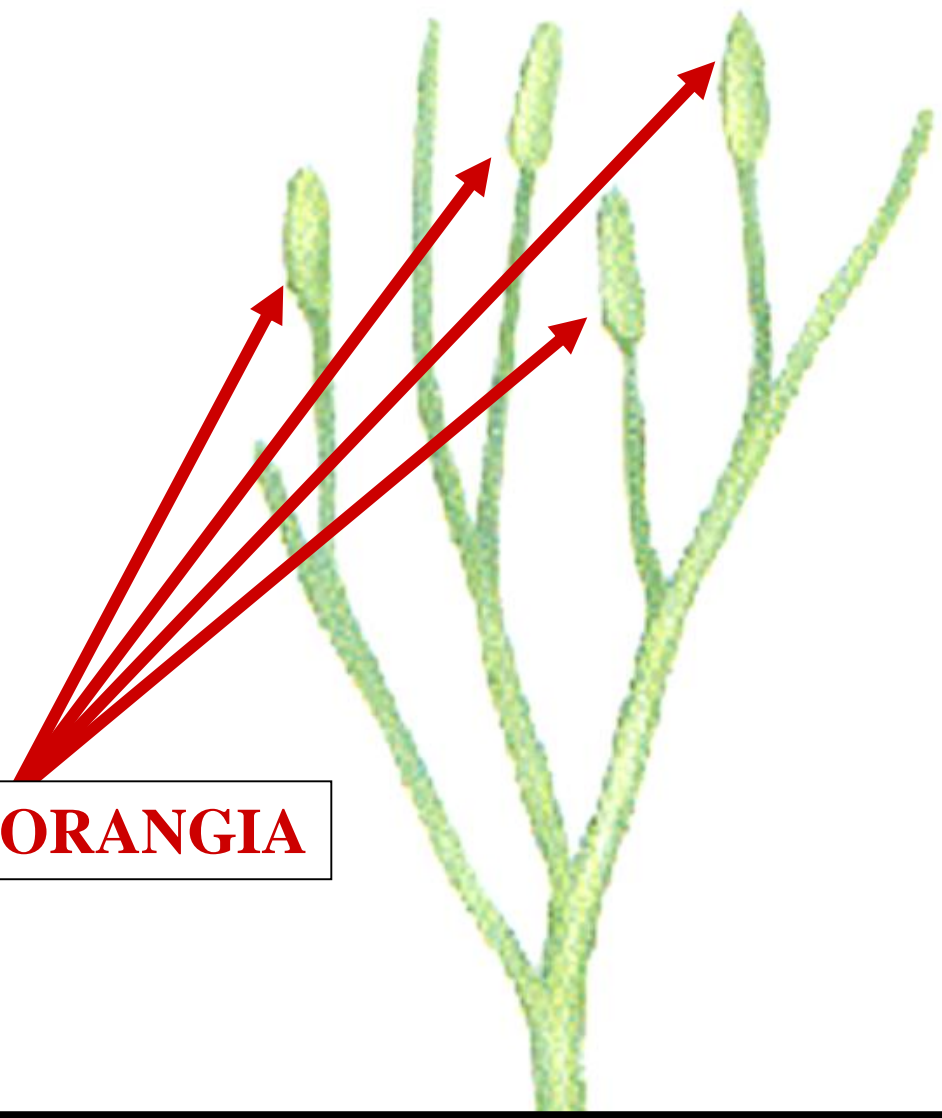
**HYPOTHETICAL  
OVULE / SEED  
EVOLUTION  
EVENTS**



**HYPOTHETICAL  
OVULE / SEED  
EVOLUTION  
EVENT**

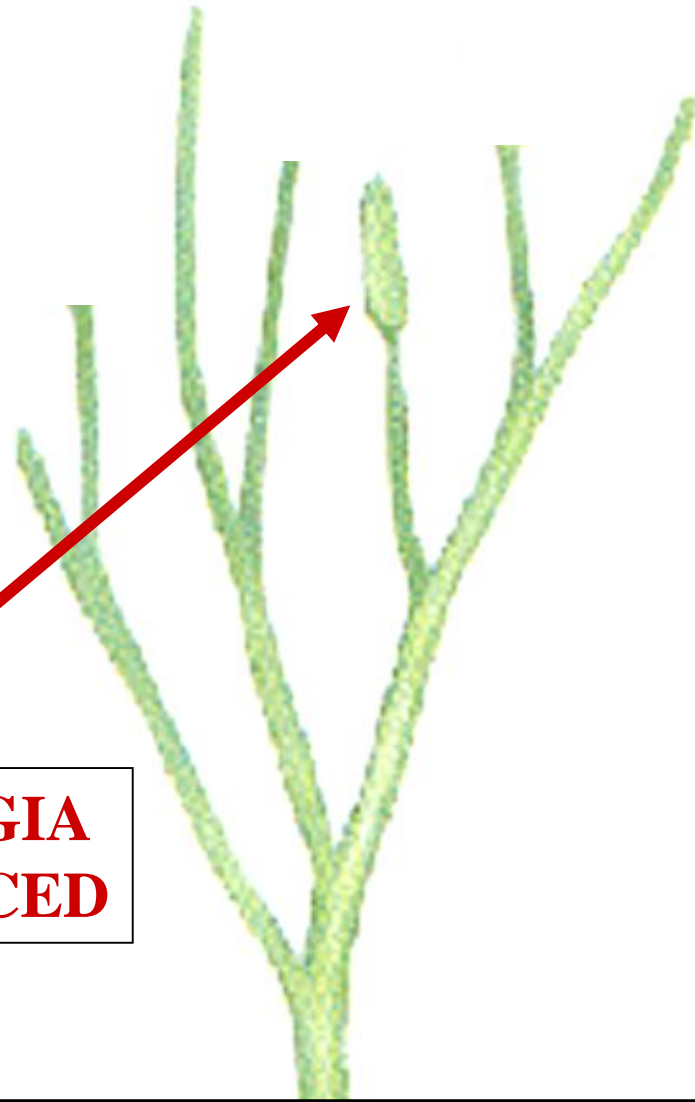
**#1**

**MEGASPORANGIA NO. REDUCED**



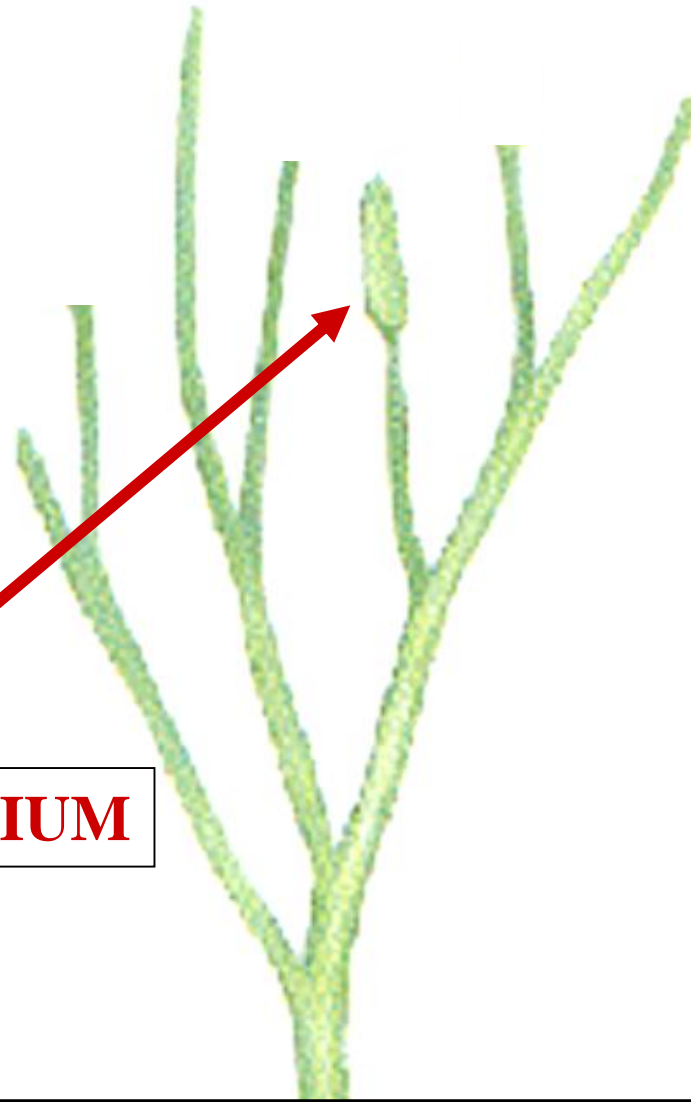
**MEGASPORANGIA**

**DEVONIAN  
HETEROSPOROUS PROGYMNOSPERM**



**MEGASPORANGIA  
NUMBER REDUCED**

**DEVONIAN  
HETEROSPOROUS PROGYMNOSPERM**

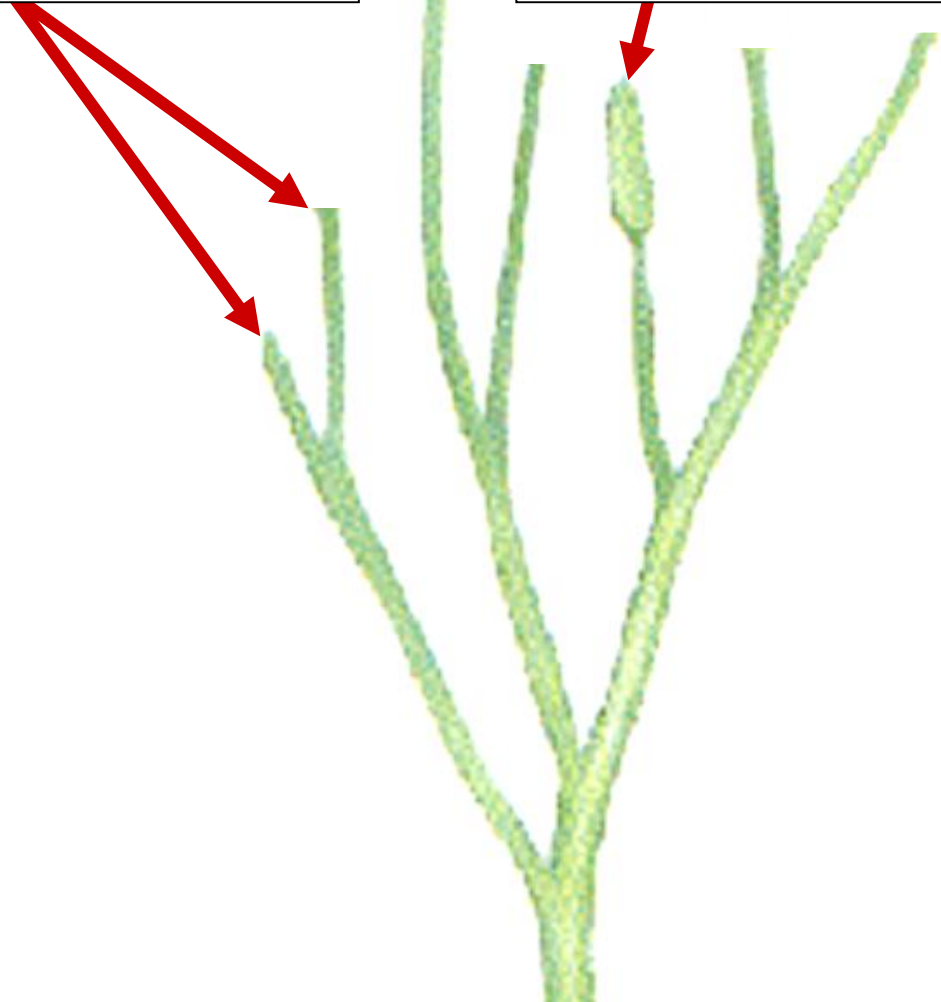


**MEGASPORANGIUM**

**DEVONIAN  
HETEROSPOROUS PROGYMNOSPERM**

**STERILE BRANCHES**

**MEGASPORANGIUM**



**DEVONIAN  
HETEROSPOROUS PROGYMNOSPERM**



**HYPOTHETICAL  
OVULE / SEED  
EVOLUTION  
EVENT**

**#2**

**CUPULE FORMATION**

**CUPULE**

**SEED EVOLUTION**



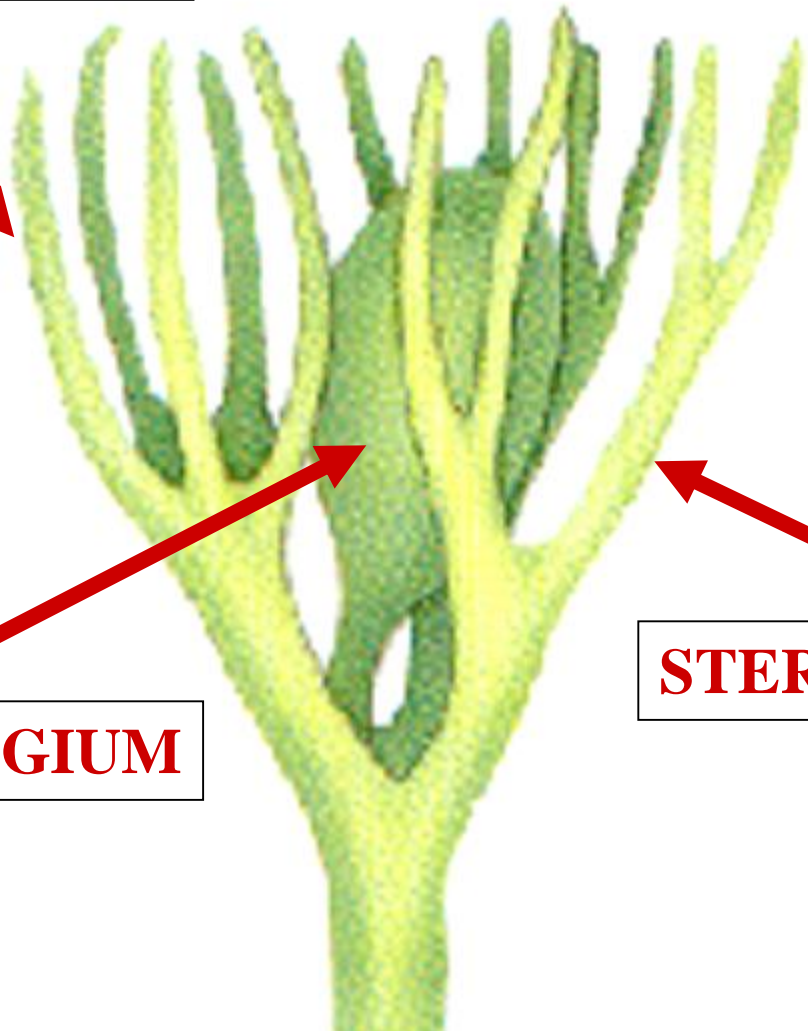
**CUPULE**

**ENVELOPING STERILE  
BRANCHES ABOUT  
MEGASPORANGIUM**

**SEED EVOLUTION**

**CUPULE**

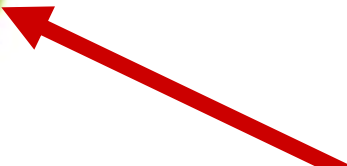
**STERILE BRANCHES**



**MEGASPORANGIUM**



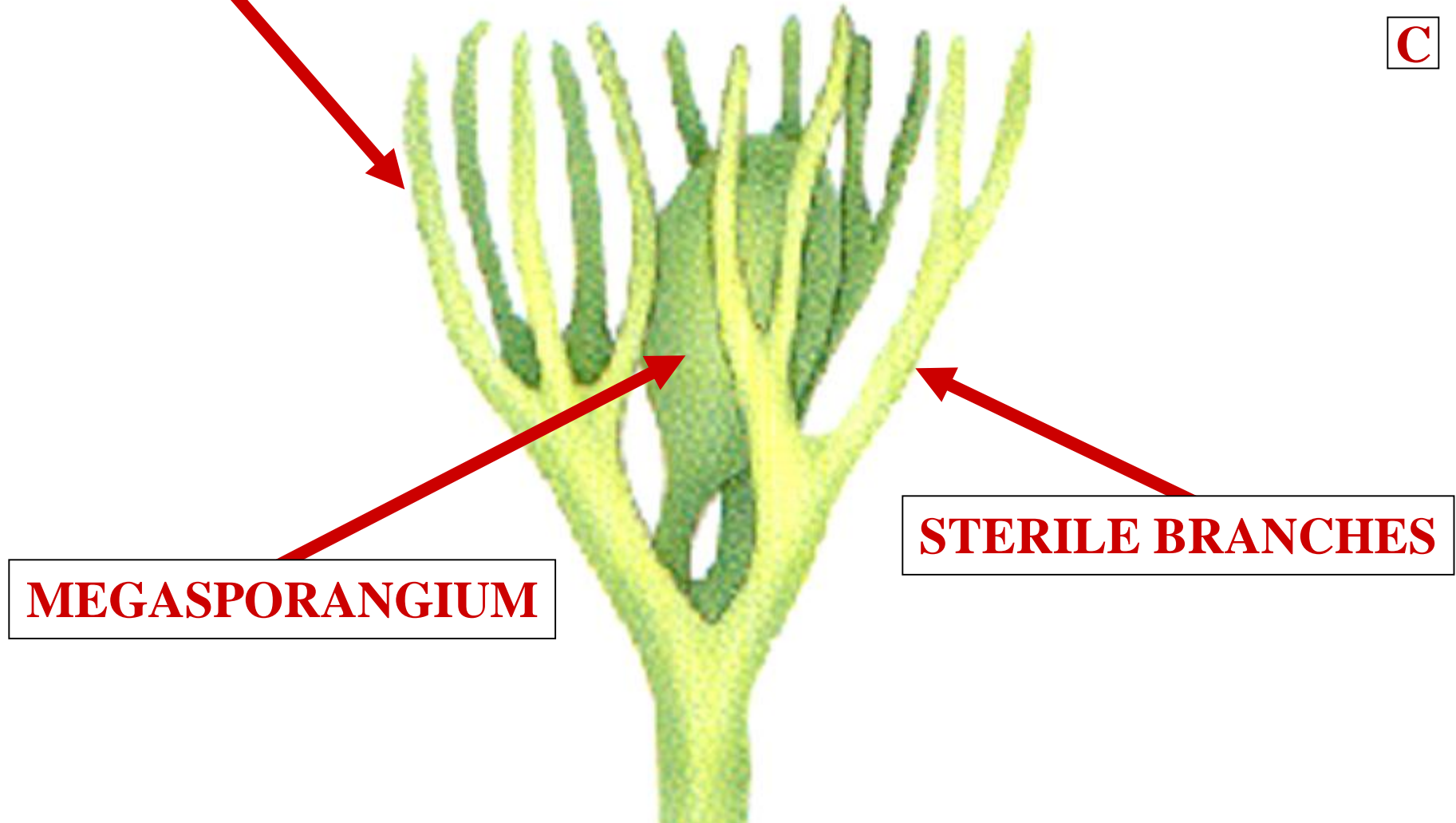
**STERILE BRANCHES**



**DEVONIAN  
HETEROSPOROUS PROGYMNOSPERM**

**STERILE BRANCHES ENVELOPE MEGASPORANGIUM**

**C**

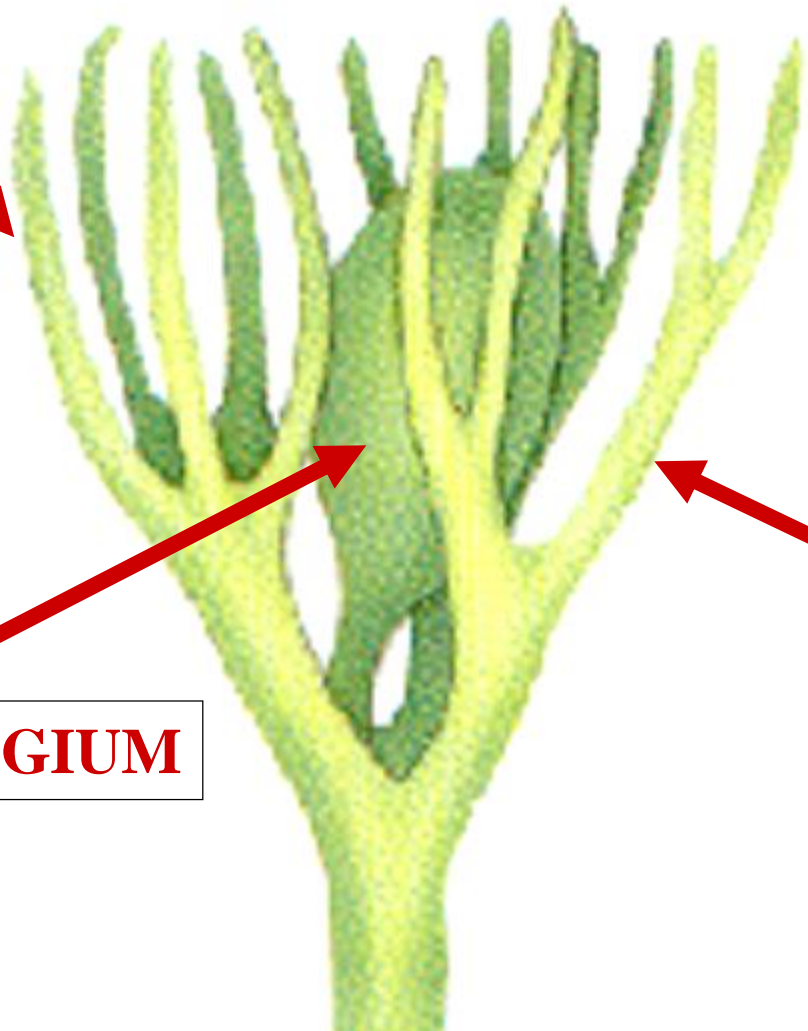


**MEGASPORANGIUM**

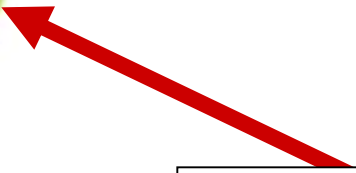
**STERILE BRANCHES**

**DEVONIAN  
HETEROSPOROUS PROGYMNOSPERM**

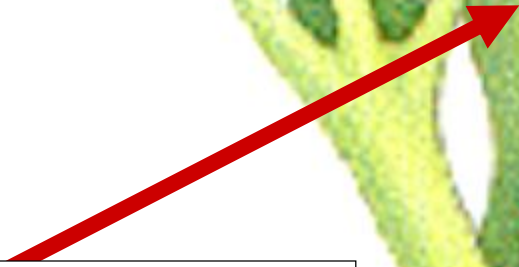
**CUPULE**



**CUPULE**



**MEGASPORANGIUM**



**DEVONIAN  
HETEROSPOROUS PROGYMNOSPERM**

**HYPOTHETICAL  
OVULE / SEED  
EVOLUTION  
EVENT**

**#3**

**INTEGUMENT FORMATION**

**INTEGUMENT**



# SEED EVOLUTION INTEGUMENT

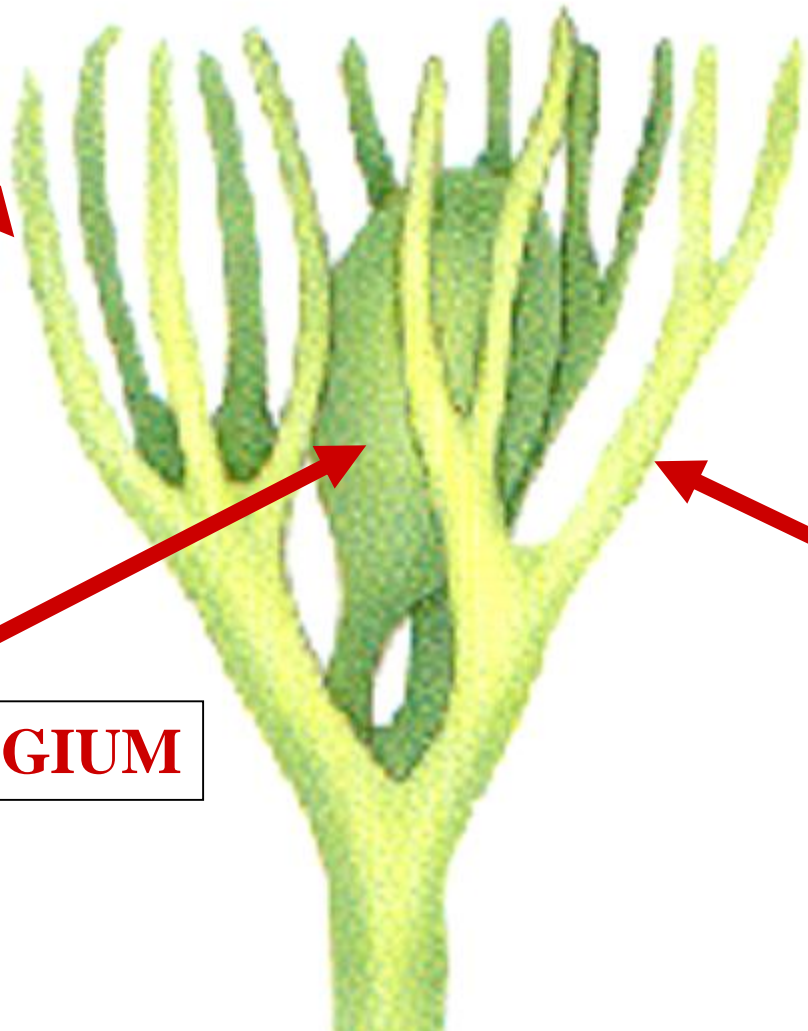


FORMED VIA CUPULE  
FUSION ABOUT  
MEGASPORANGIUM

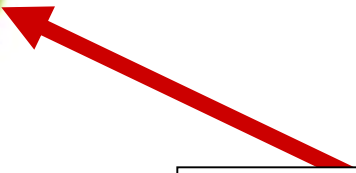
SEED EVOLUTION  
INTEGUMENT



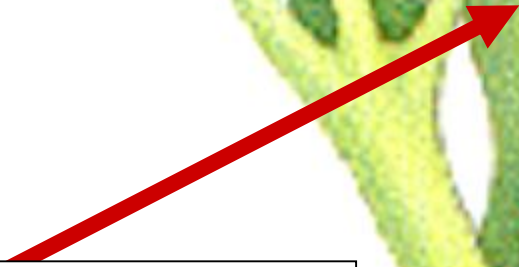
**CUPULE**



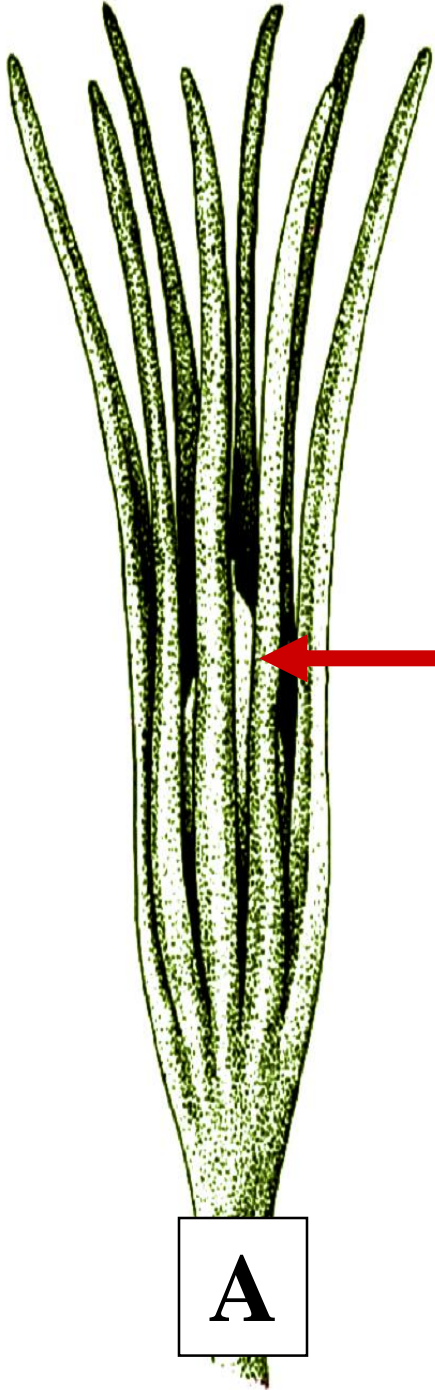
**CUPULE**



**MEGASPORANGIUM**



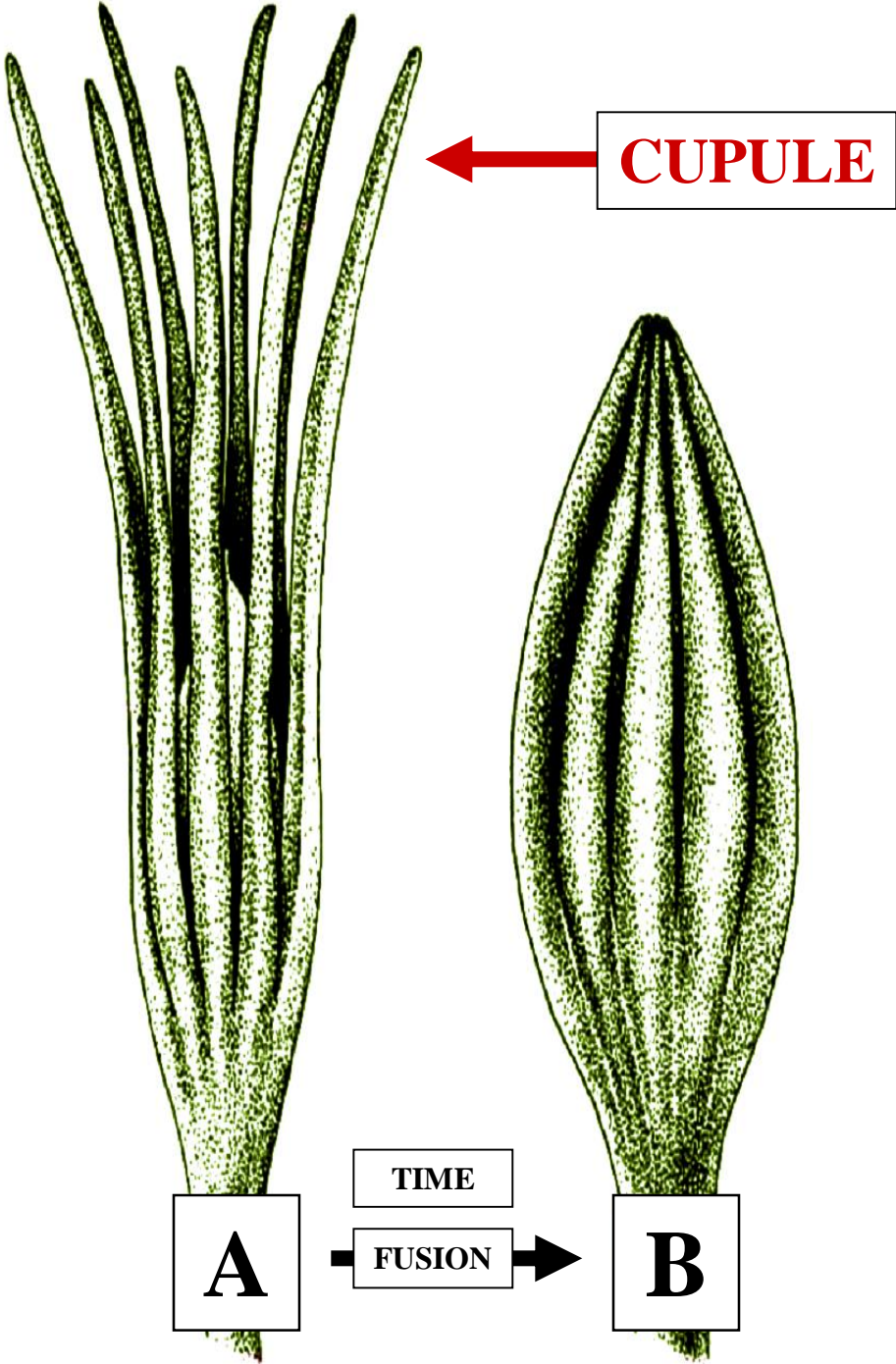
**DEVONIAN  
HETEROSPOROUS PROGYMNOSPERM**

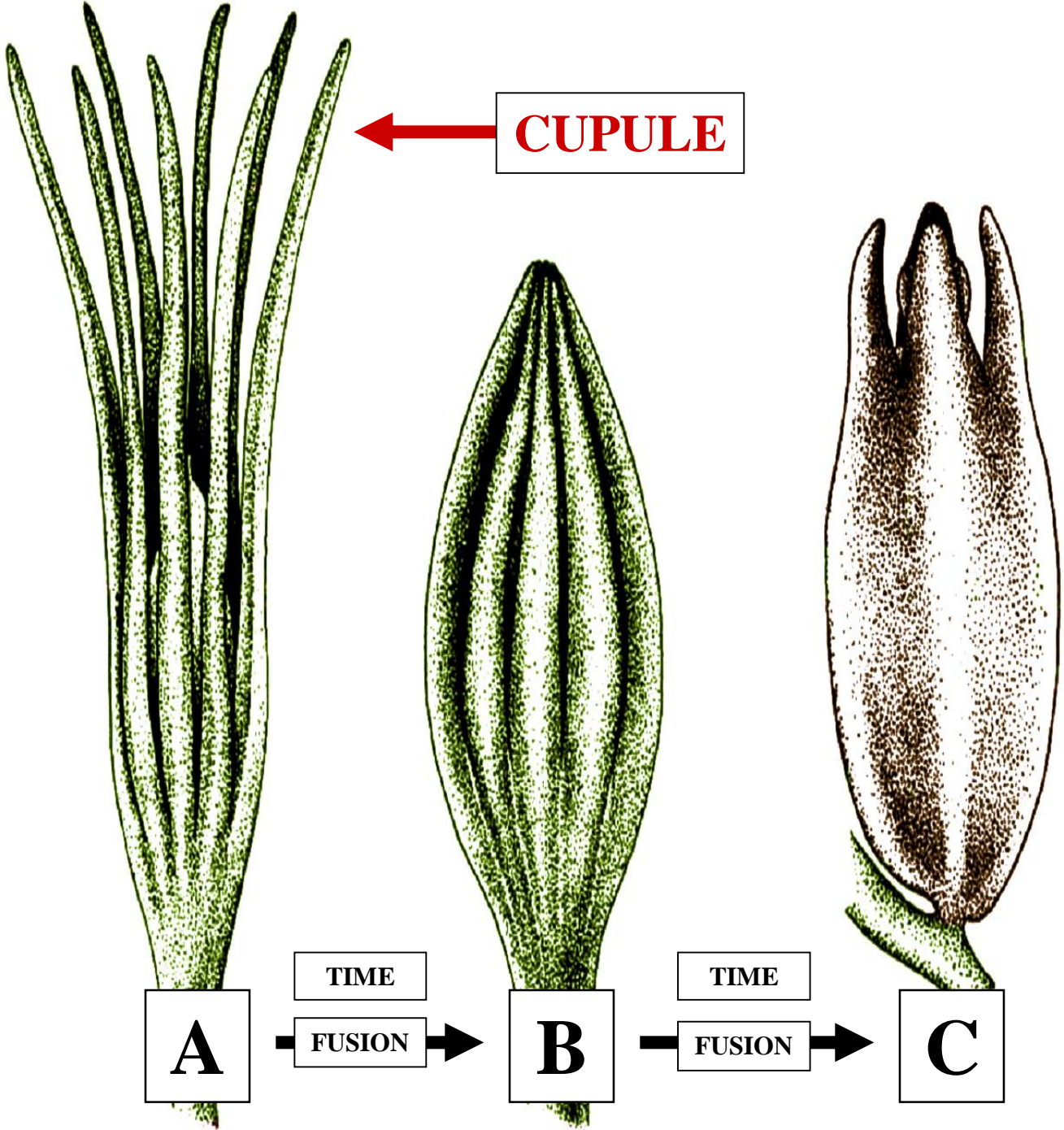


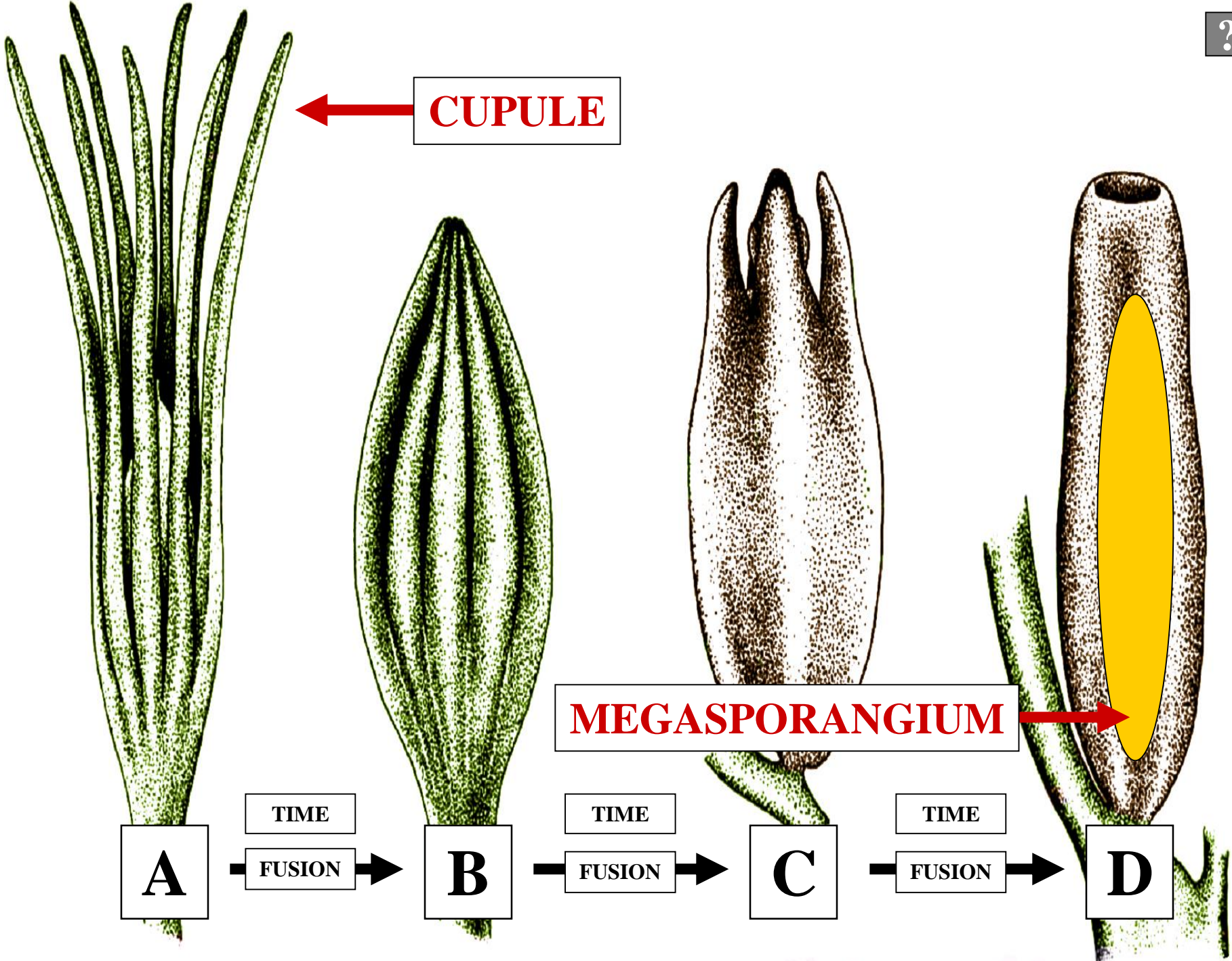
**CUPULE**

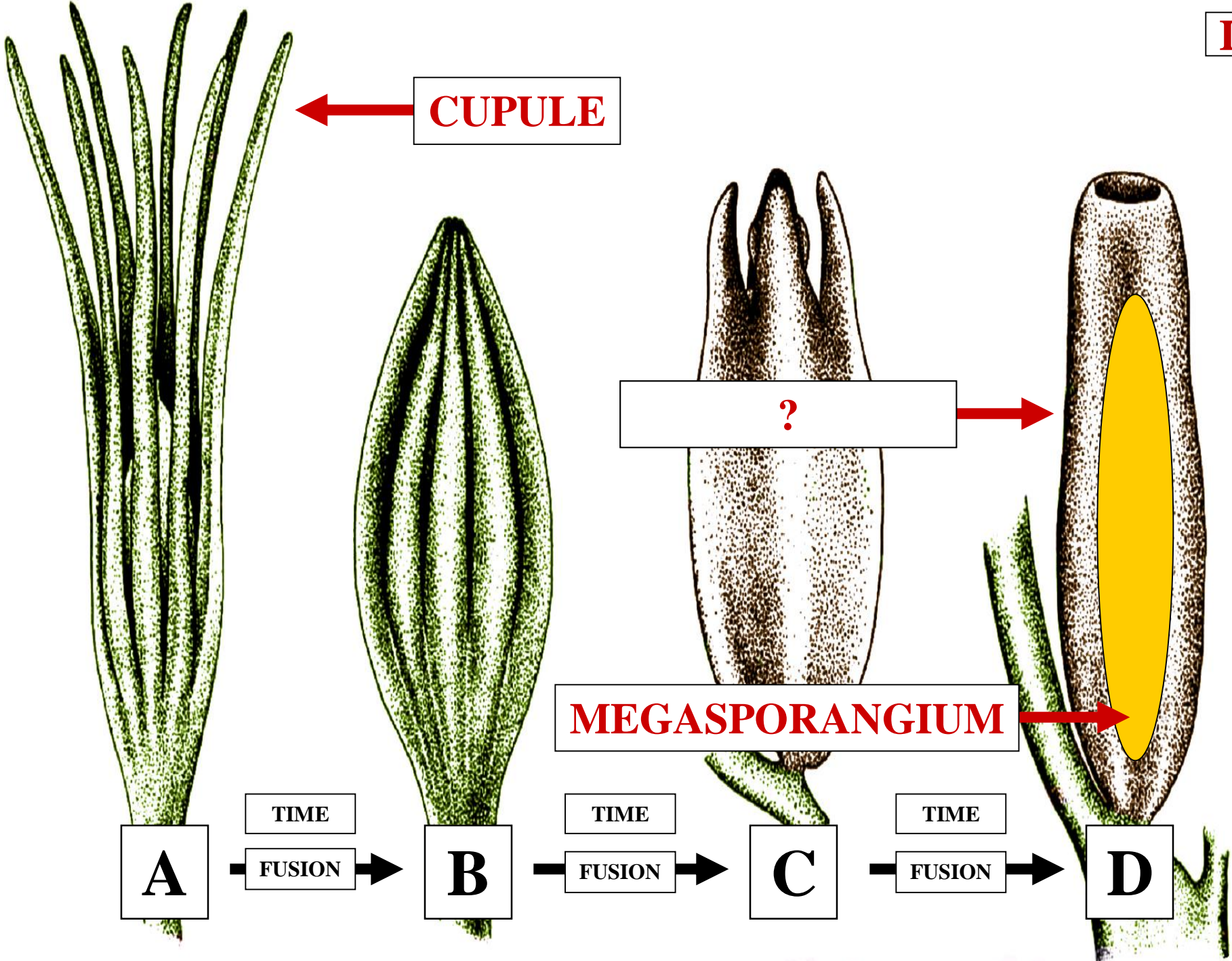
**MEGASPORANGIUM**

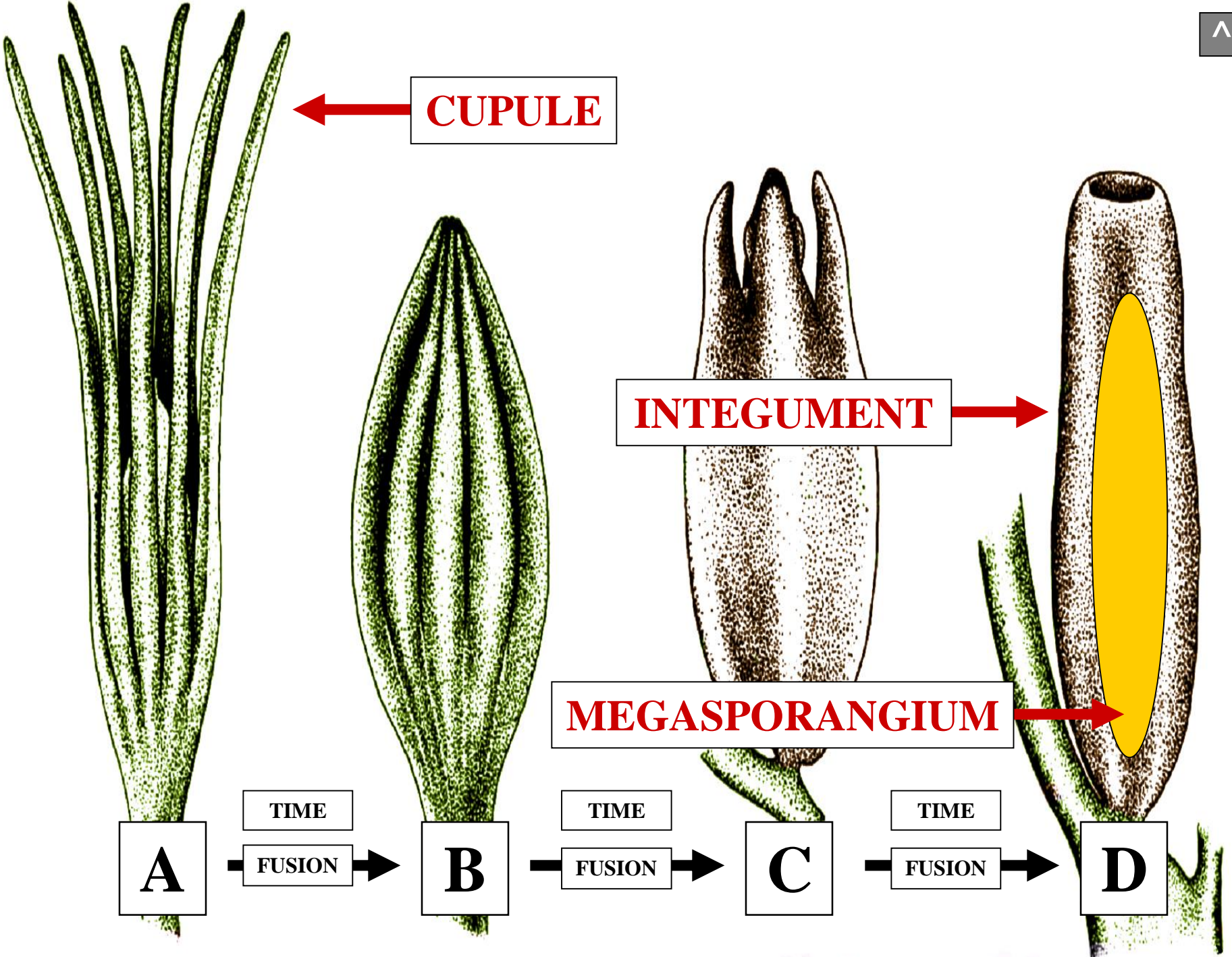
**A**











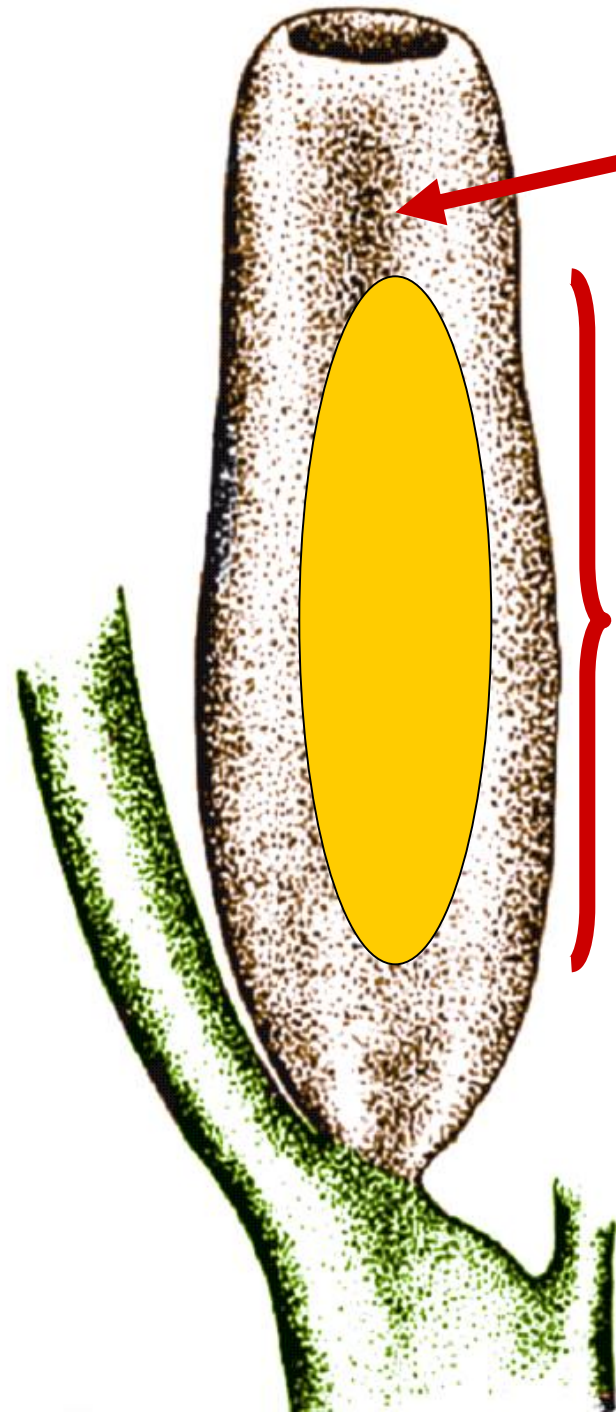




**END  
HYPOTHETICAL  
SCENARIO**

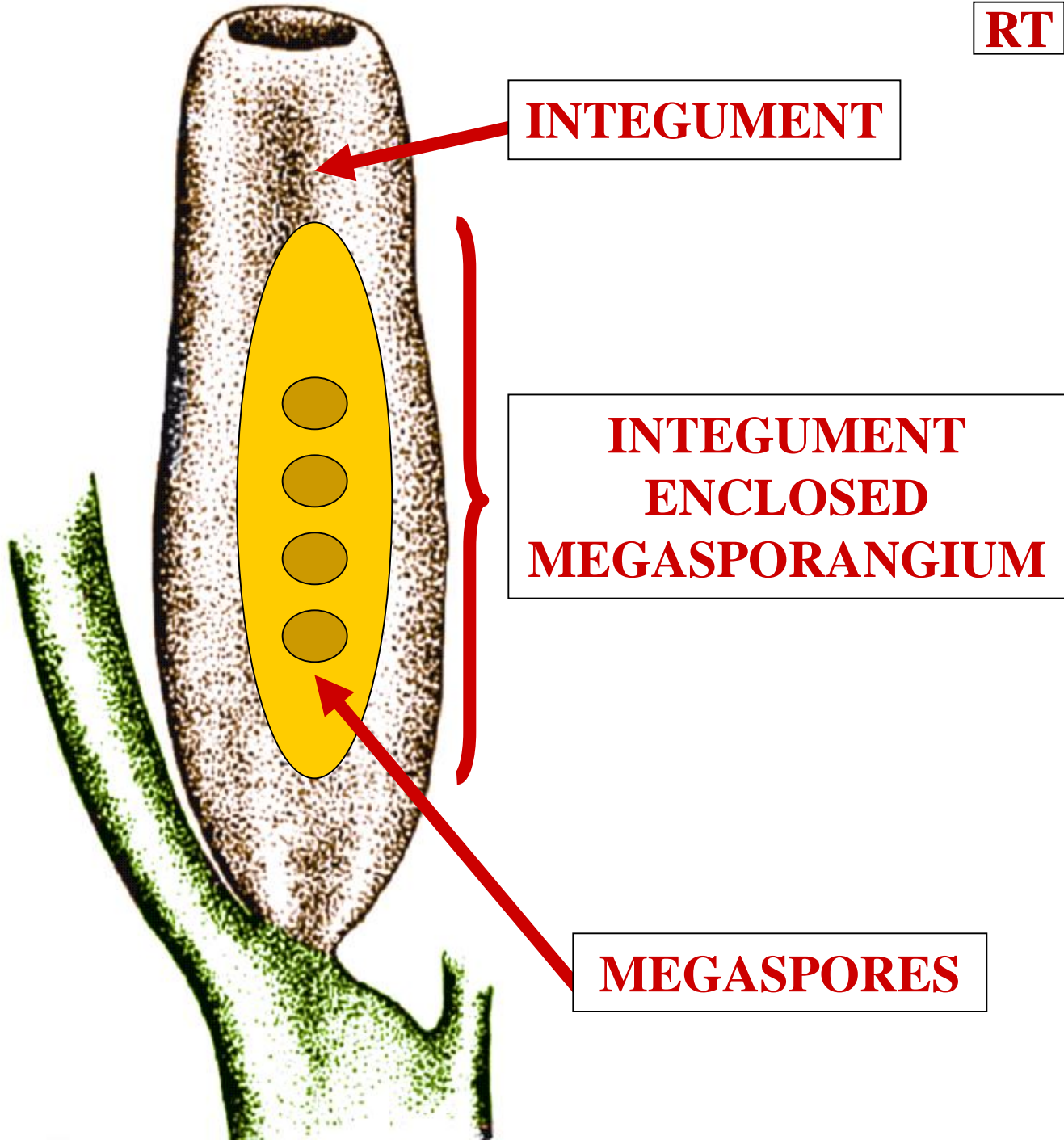


**M**



**INTEGUMENT**

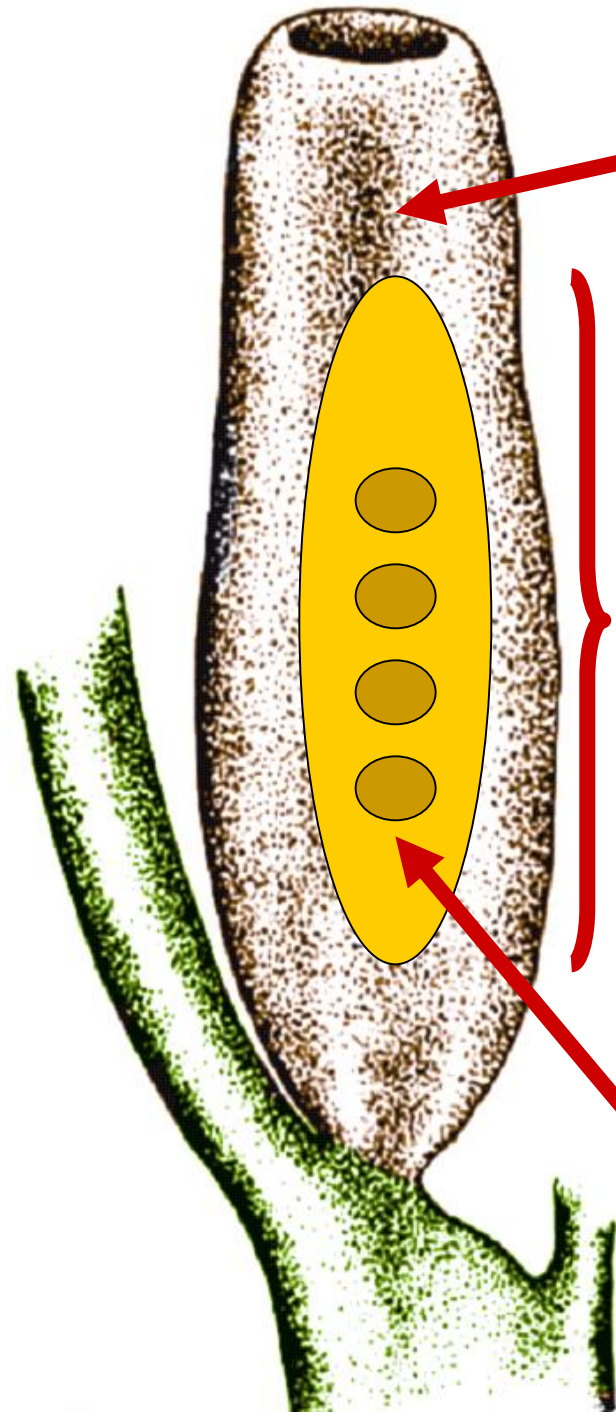
**INTEGUMENT  
ENCLOSED  
MEGASPORANGIUM**



**INTEGUMENT**

**INTEGUMENT  
ENCLOSED  
MEGASPORANGIUM**

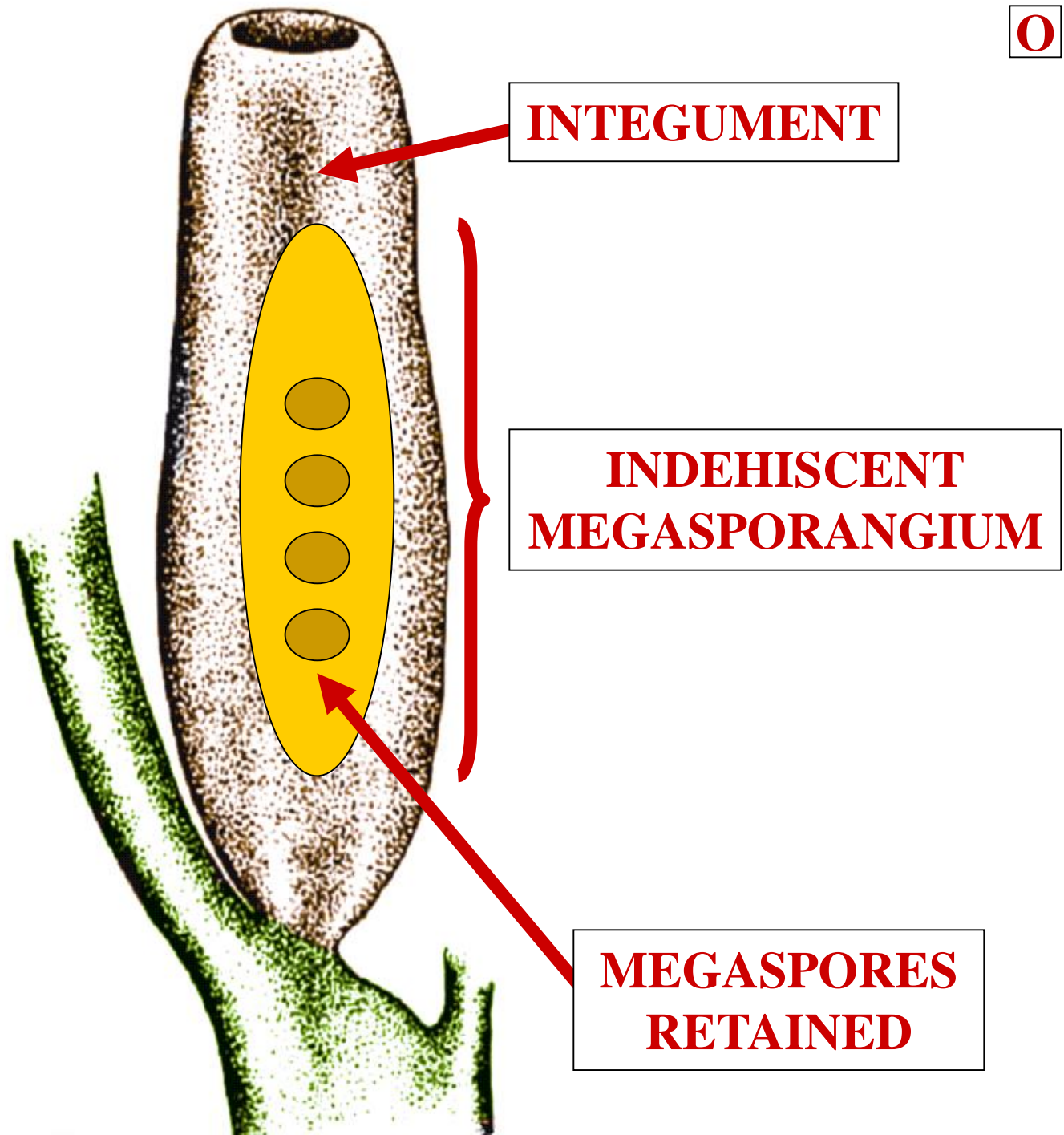
**MEGASPORES**



**INTEGUMENT**

**INTEGUMENT  
ENCLOSED  
MEGASPORANGIUM**

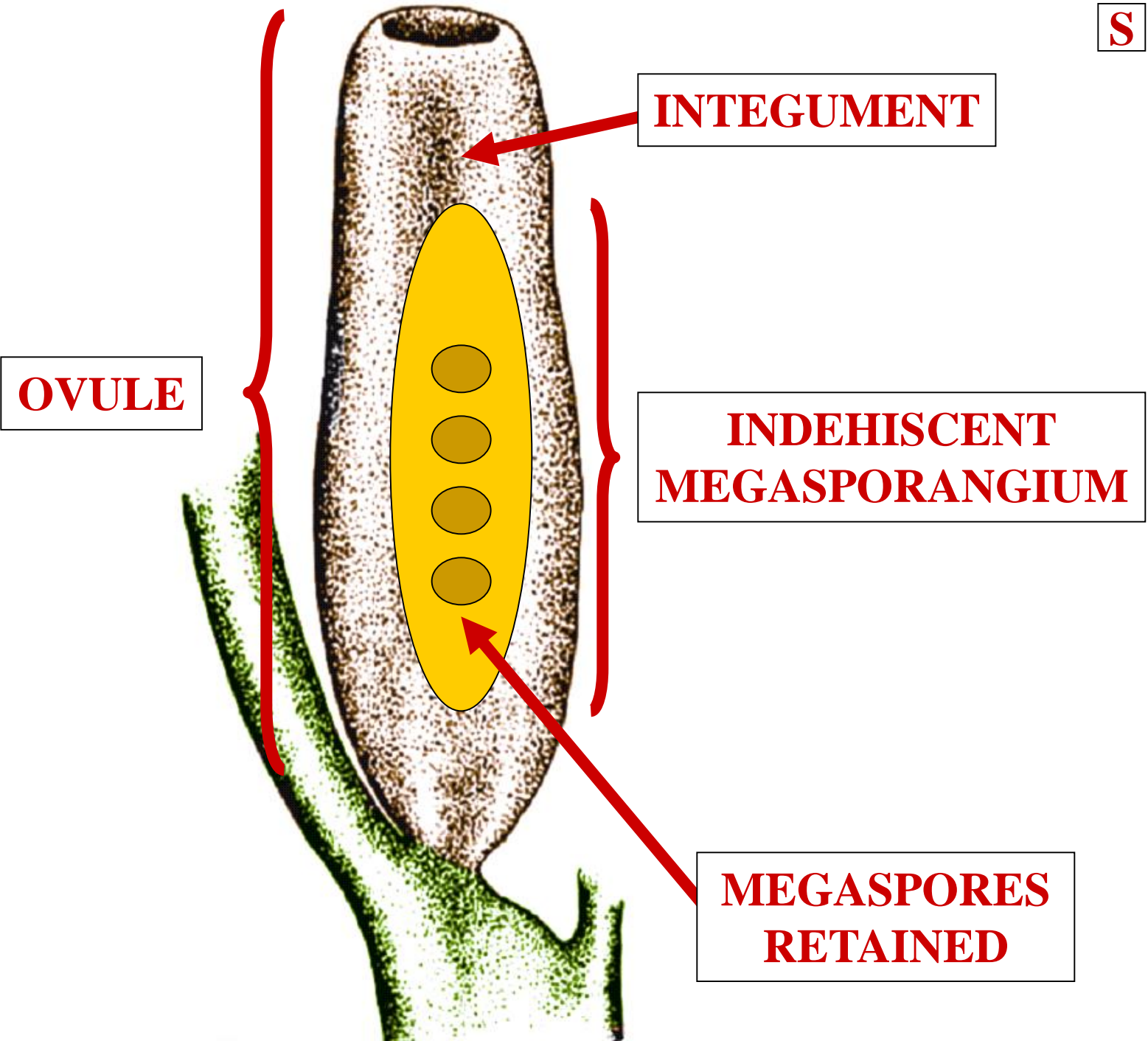
**MEGASPORES  
RETAINED**



**INTEGUMENT**

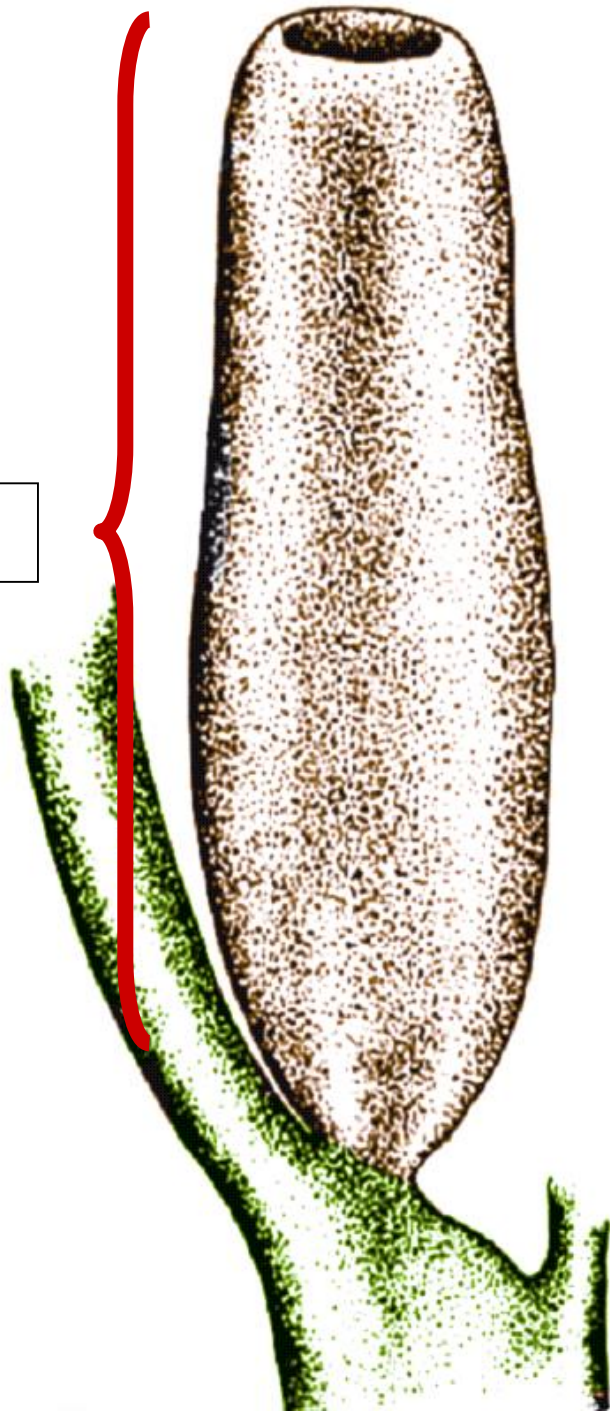
**INDEHISCENT  
MEGASPORANGIUM**

**MEGASPORES  
RETAINED**





**SEED**



SEED



?



**SEED**



**SPERMATOPHYTE**

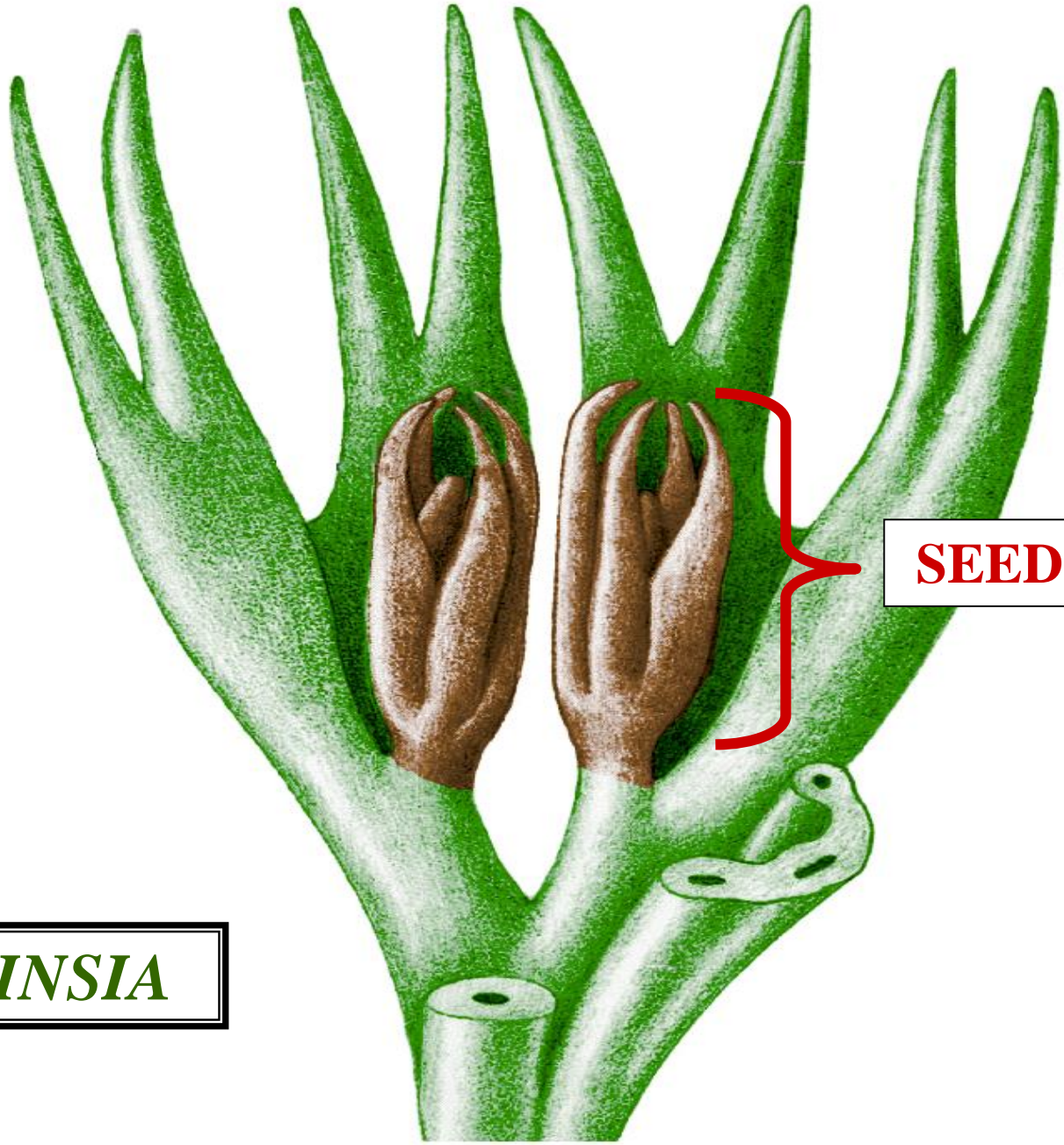


**E**

**SEED**



**SPERMATOPHYTE / GYMNOSPERM**

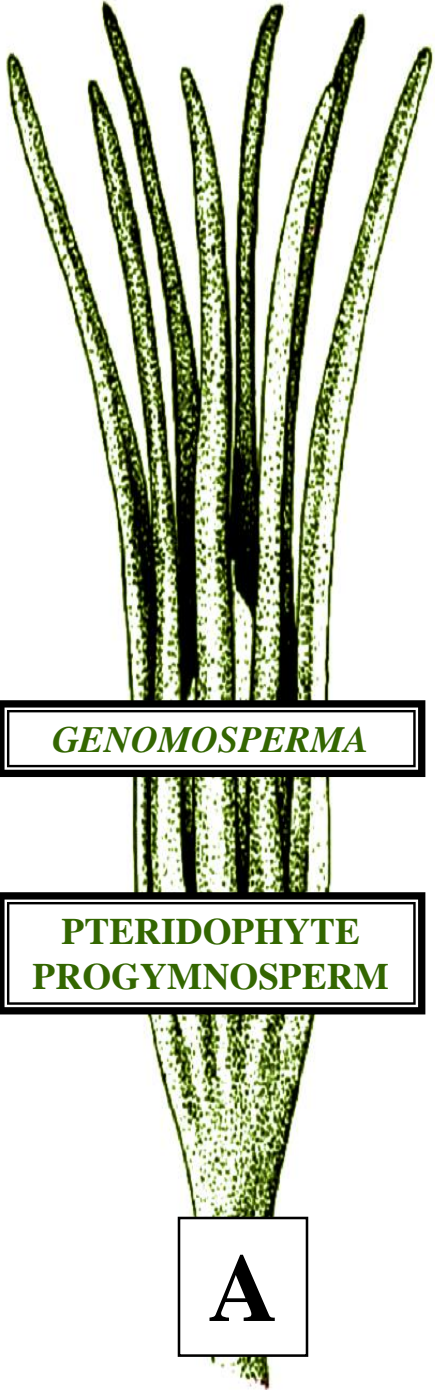


**SEED**

***ELKINSIA***



# FOSSIL EVIDENCE

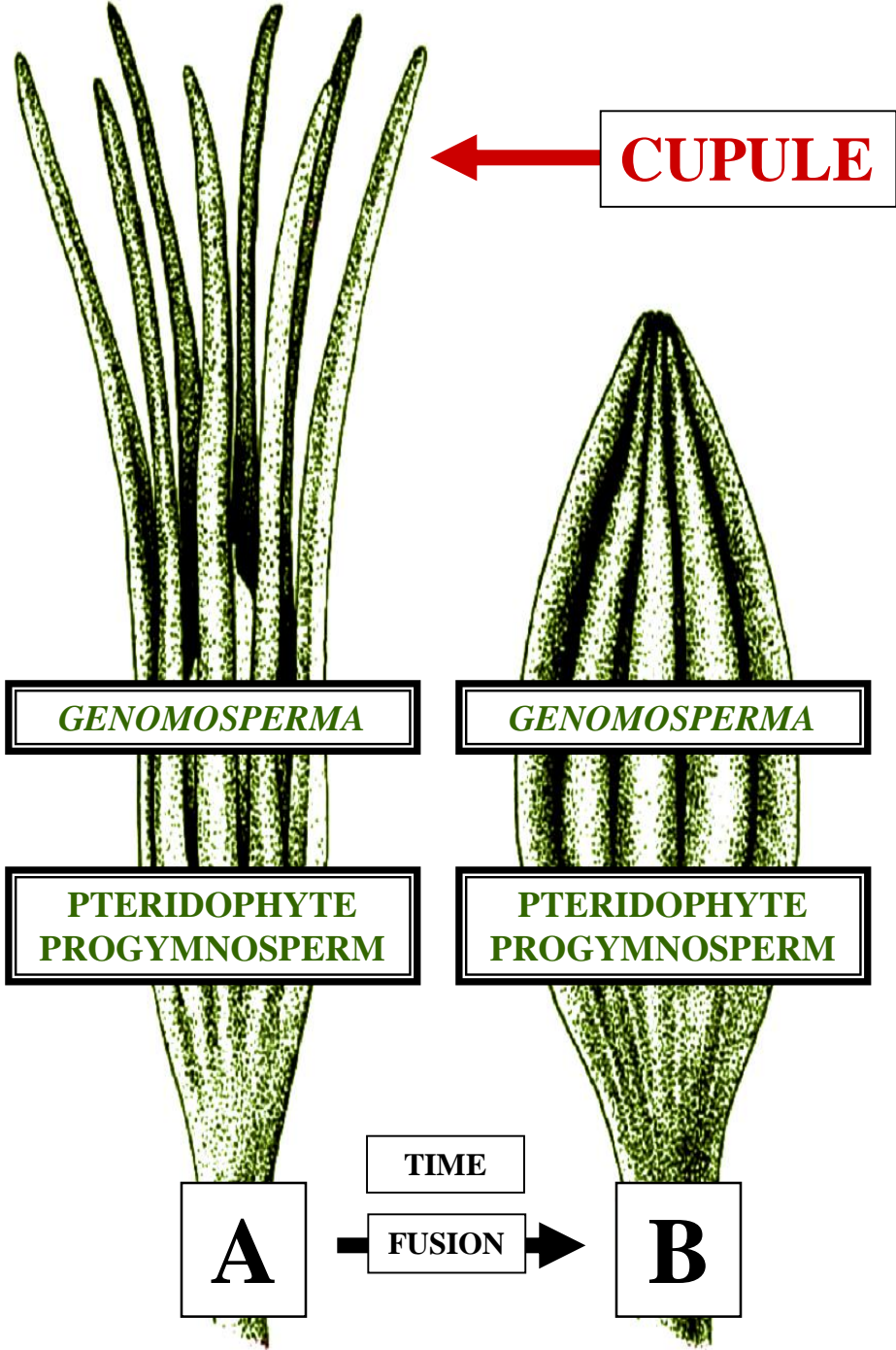


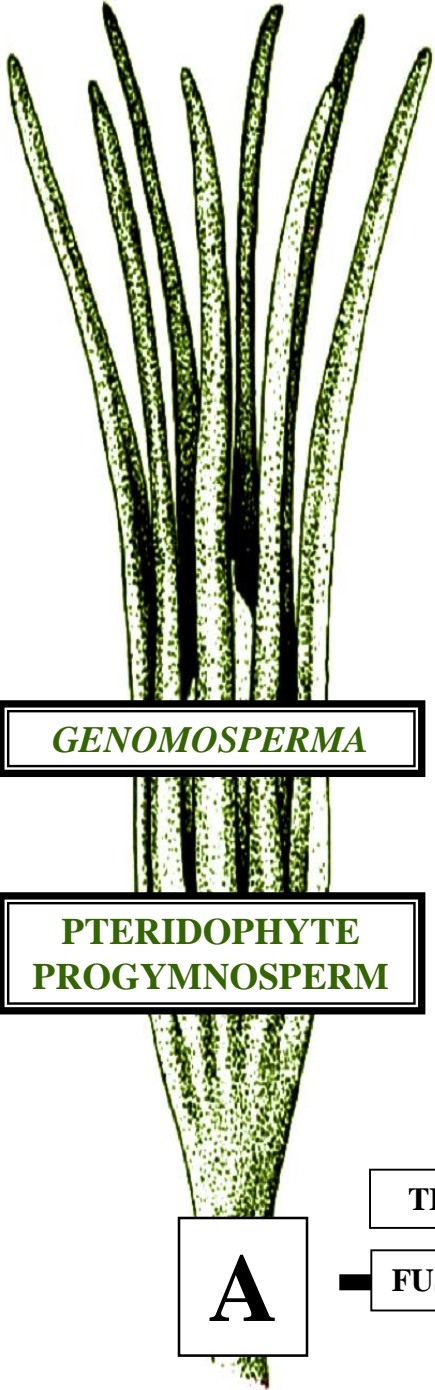
**CUPULE**

*GENOMOSPERMA*

**PTERIDOPHYTE  
PROGYMNOSPERM**

**A**

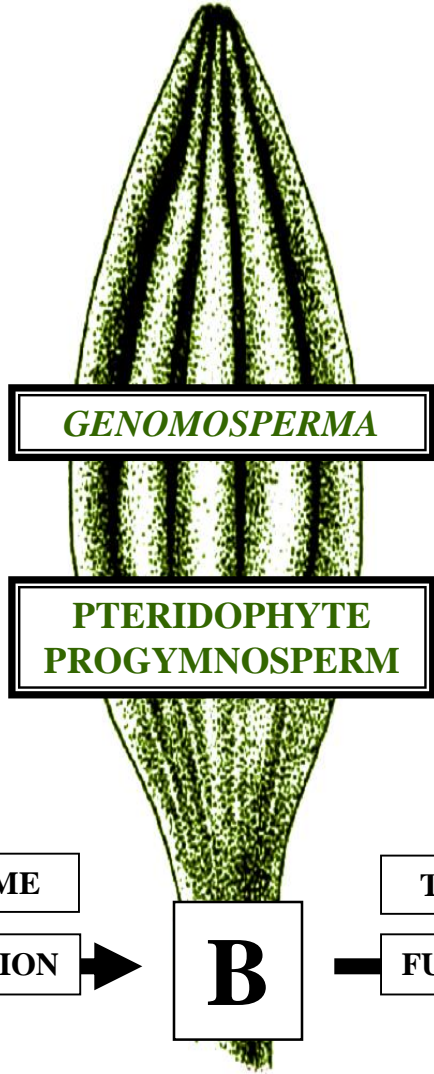




*GENOMOSPERMA*

**PTERIDOPHYTE  
PROGYMNOSPERM**

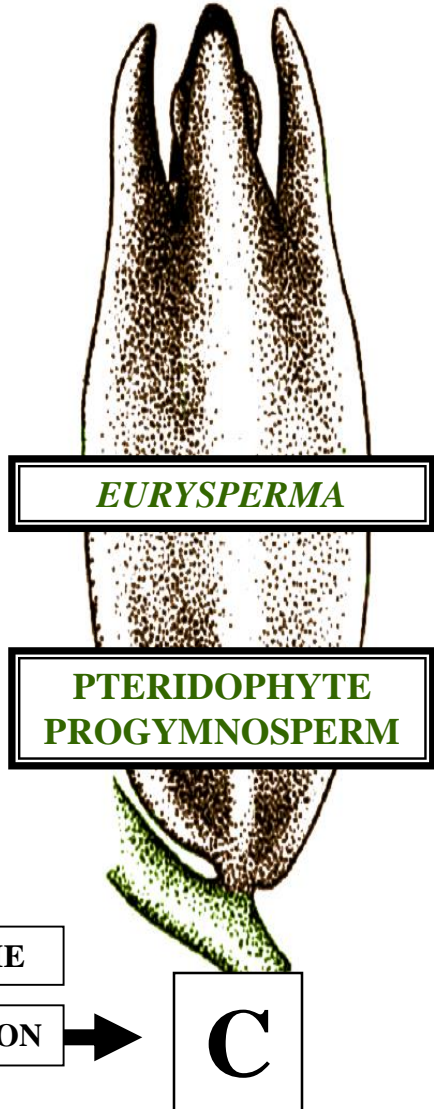
**A**



*GENOMOSPERMA*

**PTERIDOPHYTE  
PROGYMNOSPERM**

**B**



*EURYSPERMA*

**PTERIDOPHYTE  
PROGYMNOSPERM**

**C**

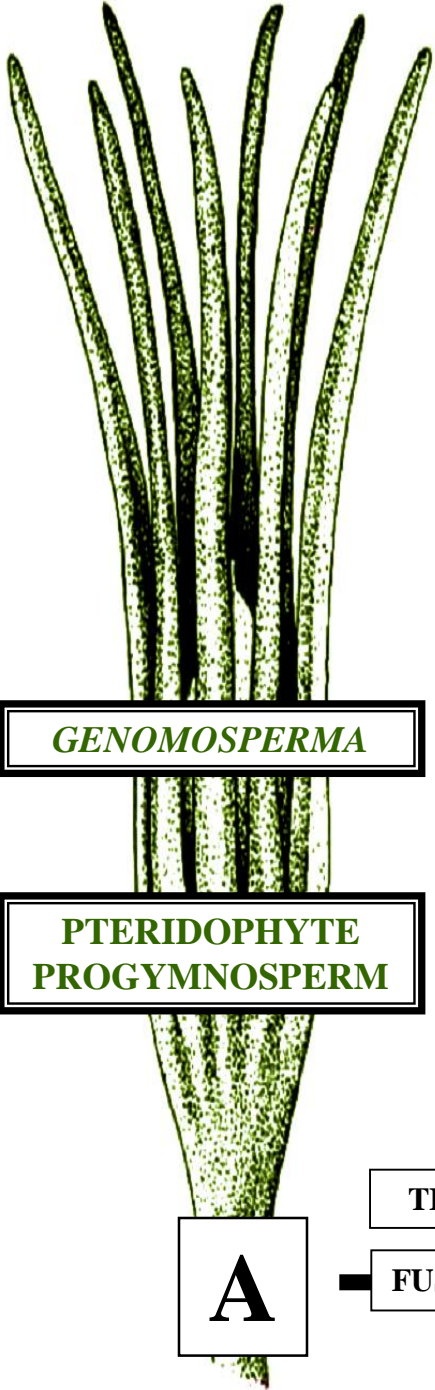
TIME

FUSION

TIME

FUSION

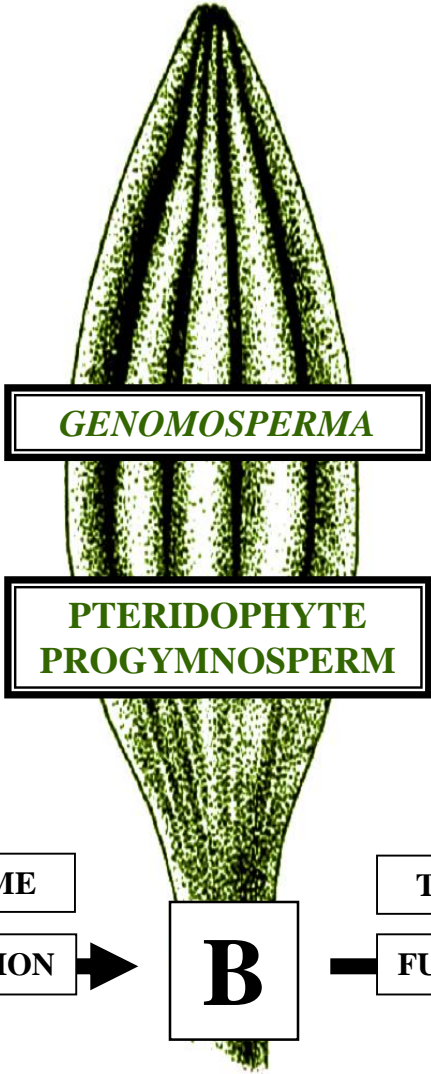
**CUPULE**



*GENOMOSPERMA*

*PTERIDOPHYTE  
PROGYMNOSPERM*

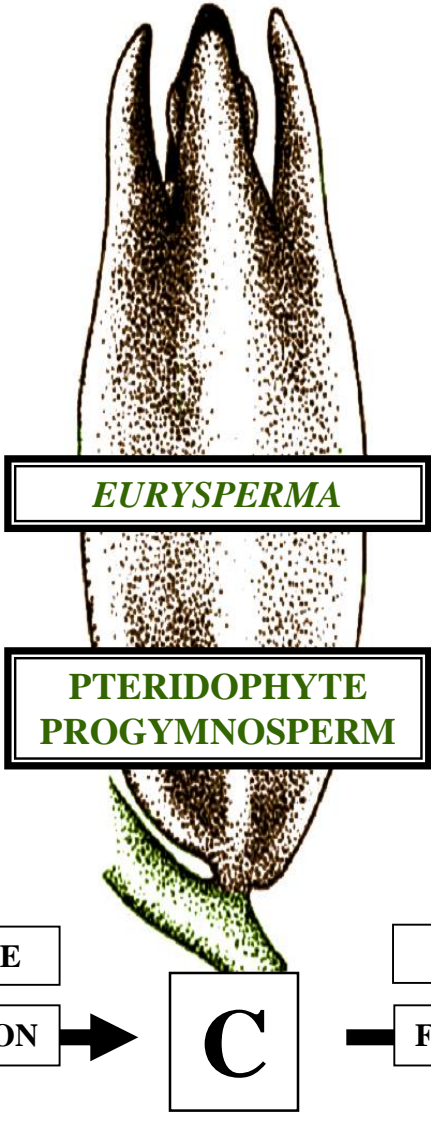
**A**



*GENOMOSPERMA*

*PTERIDOPHYTE  
PROGYMNOSPERM*

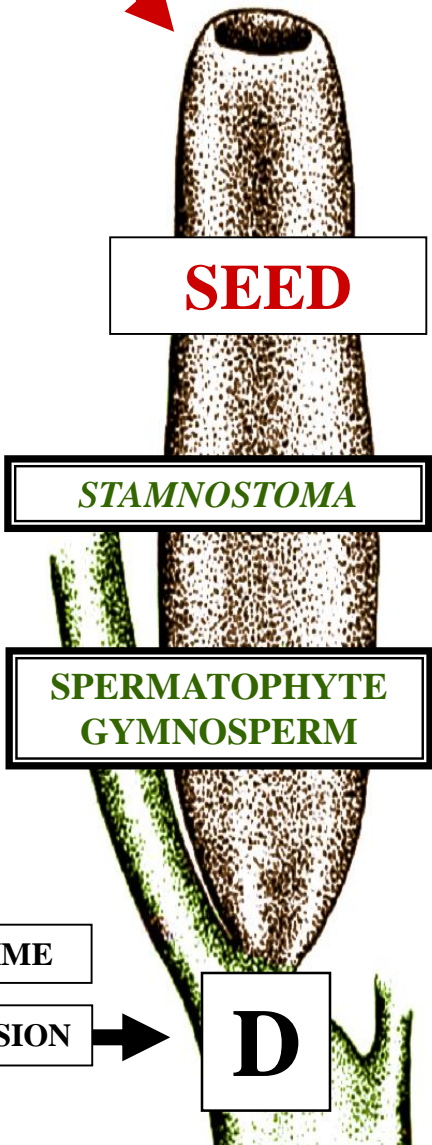
**B**



*EURYSPERMA*

*PTERIDOPHYTE  
PROGYMNOSPERM*

**C**



*STAMNOSTOMA*

*SPERMATOPHYTE  
GYMNOSPERM*

**D**

TIME  
FUSION

TIME  
FUSION

TIME  
FUSION

**CUPULE**

**INTEGUMENT**

**SEED**



# DEFINITION OVULE/SEED

**OVULE**

**SEED EVOLUTION  
OVULE**



**IMMATURE SEED**

**SEED EVOLUTION  
OVULE**

**SEED EVOLUTION  
OVULE**

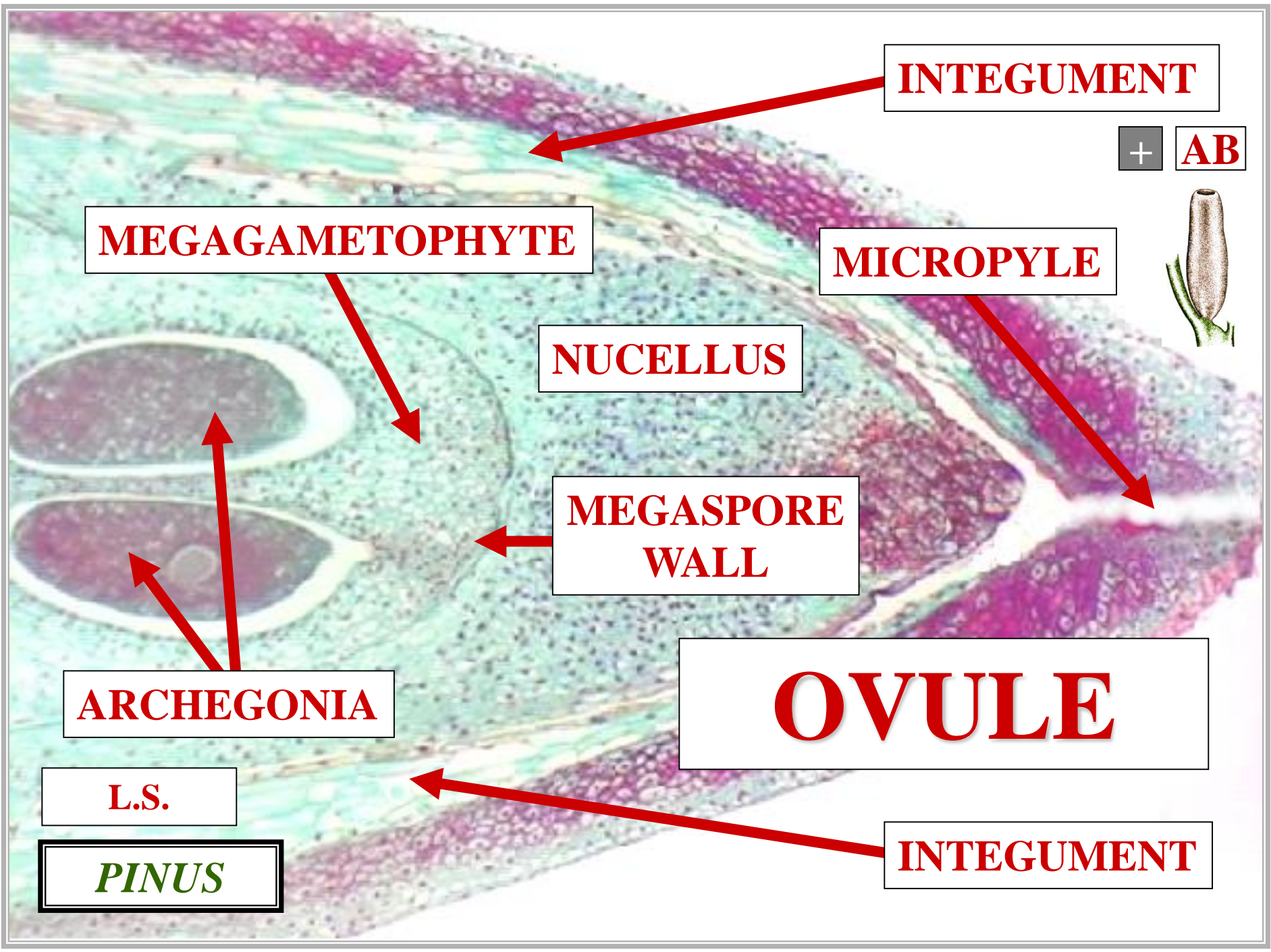


**IMMATURE SEED**

**---**

**EMBRYO LACKING**

**SEED EVOLUTION  
OVULE**



**INTEGUMENT**

**+** **AB**



**MEGAGAMETOPHYTE**

**MICROPYLE**

**NUCELLUS**

**MEGASPORE WALL**

**ARCHEGONIA**

**OVULE**

**L.S.**

***PINUS***

**INTEGUMENT**

**EMBRYO: ABSENT**

**INTEGUMENT**

**^** **S**

**MEGAGAMETOPHYTE**

**MICROPYLE**



**NUCELLUS**

**MEGASPORE WALL**

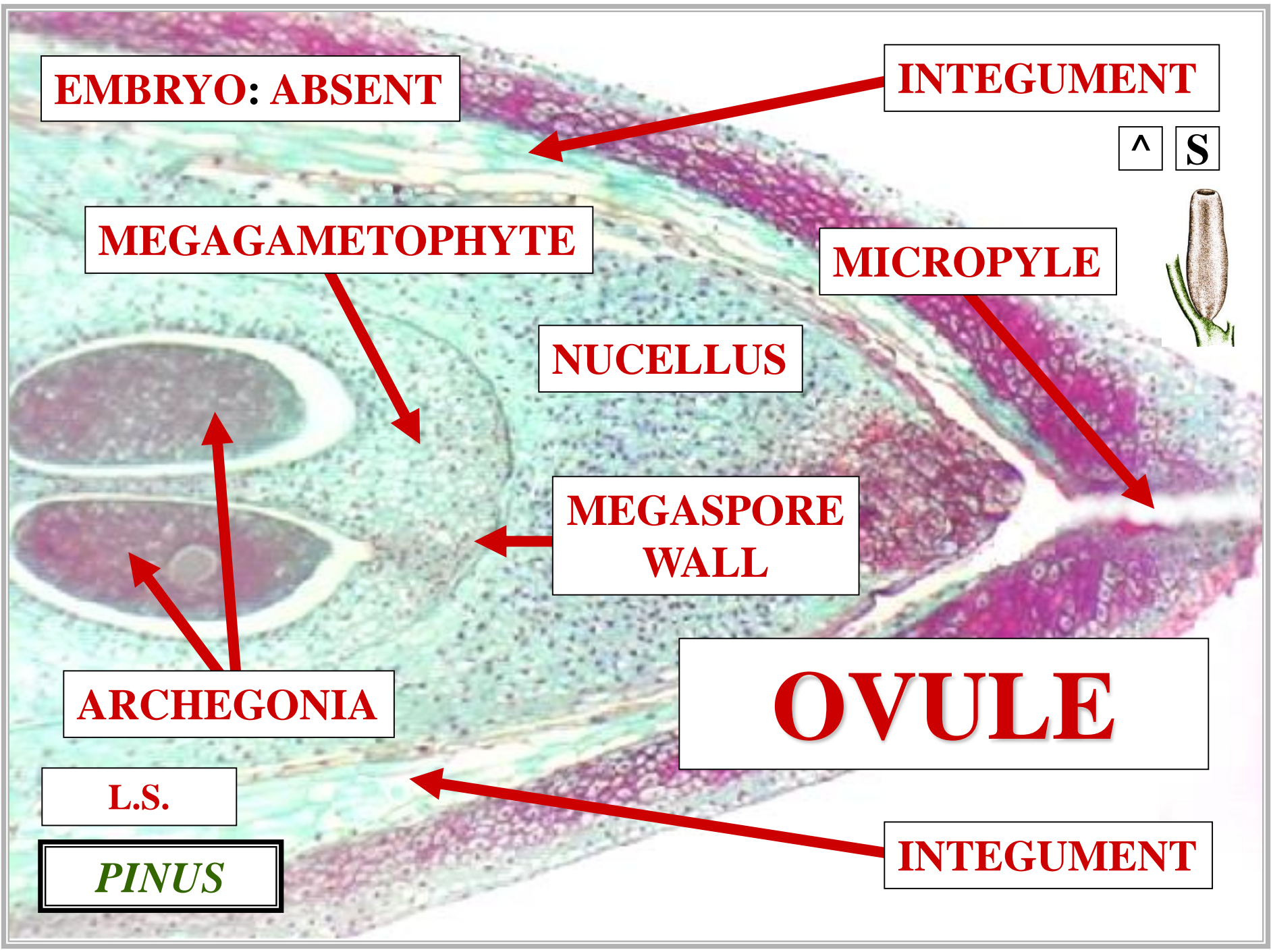
**OVULE**

**ARCHEGONIA**

**L.S.**

***PINUS***

**INTEGUMENT**



**SEED**

**SEED EVOLUTION**  
**SEED**



**MATURE OVULE**

**SEED EVOLUTION**  
**SEED**



**SEED EVOLUTION**



**SEED**

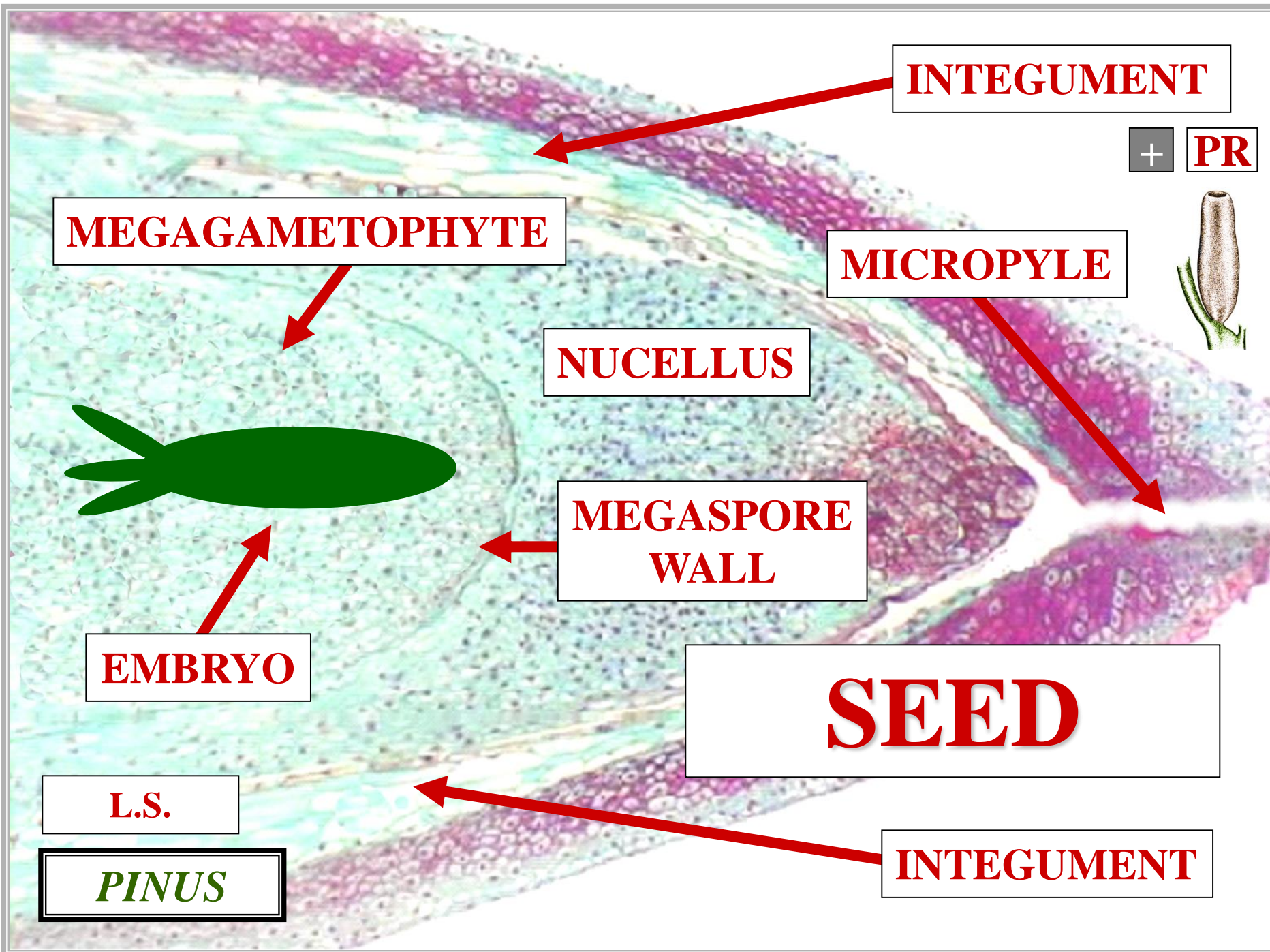
**MATURE OVULE**

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**EMBRYO PRESENT**

**SEED EVOLUTION**

**SEED**



**INTEGUMENT**

**+** **PR**



**MEGAGAMETOPHYTE**

**MICROPYLE**

**NUCELLUS**

**MEGASPORE WALL**

**SEED**

**EMBRYO**

**L.S.**

***PINUS***

**INTEGUMENT**

**EMBRYO: PRESENT**

**INTEGUMENT**

**MEGAGAMETOPHYTE**

**MICROPYLE**

**NUCELLUS**

**MEGASPORE WALL**

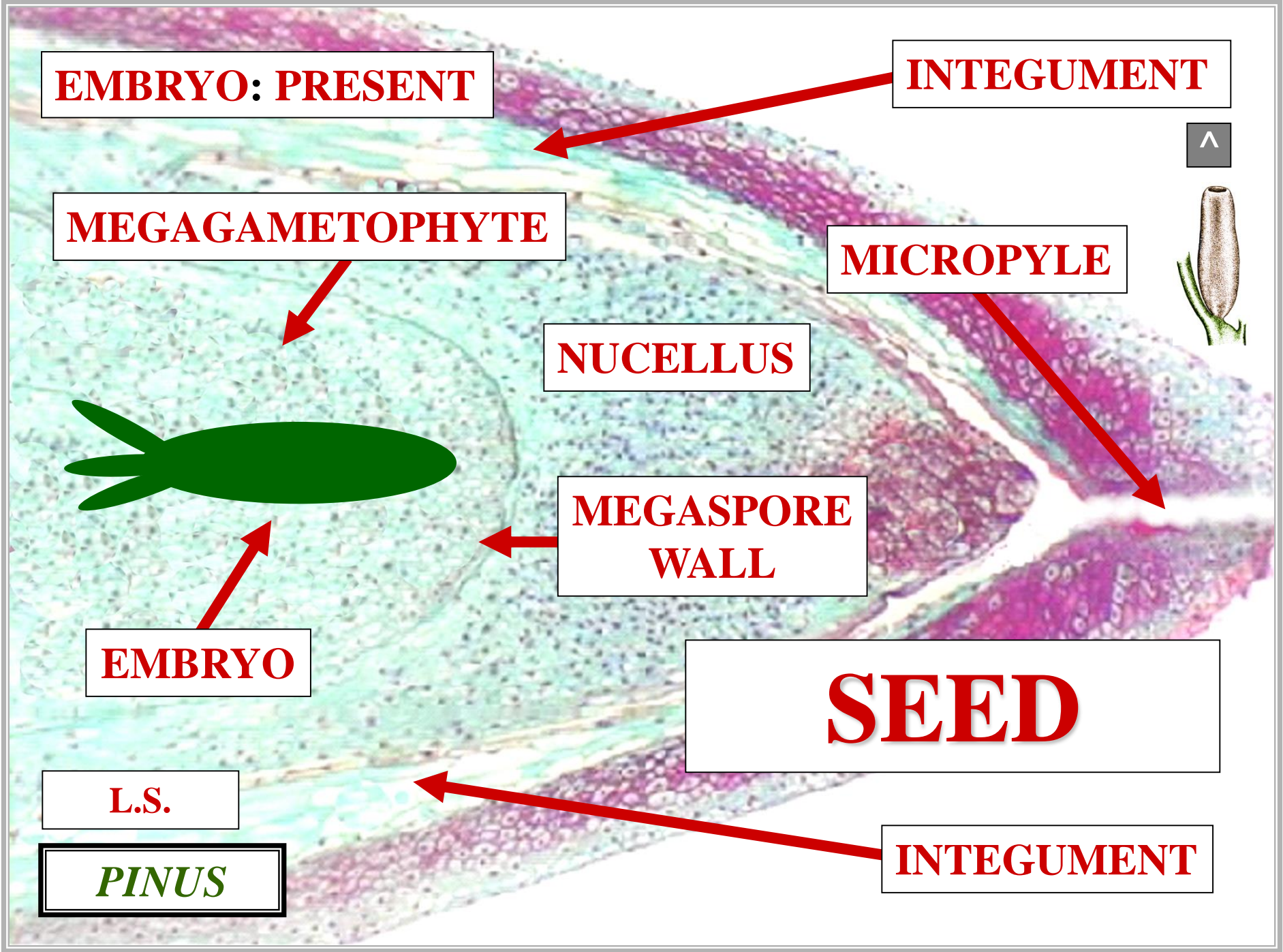
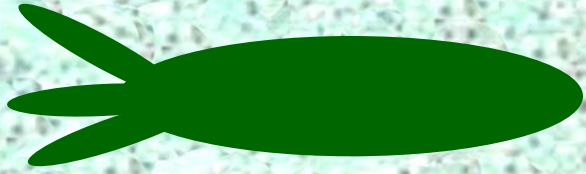
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**SEED**

**L.S.**

**INTEGUMENT**

***PINUS***





# OVULE / SEED ANATOMY

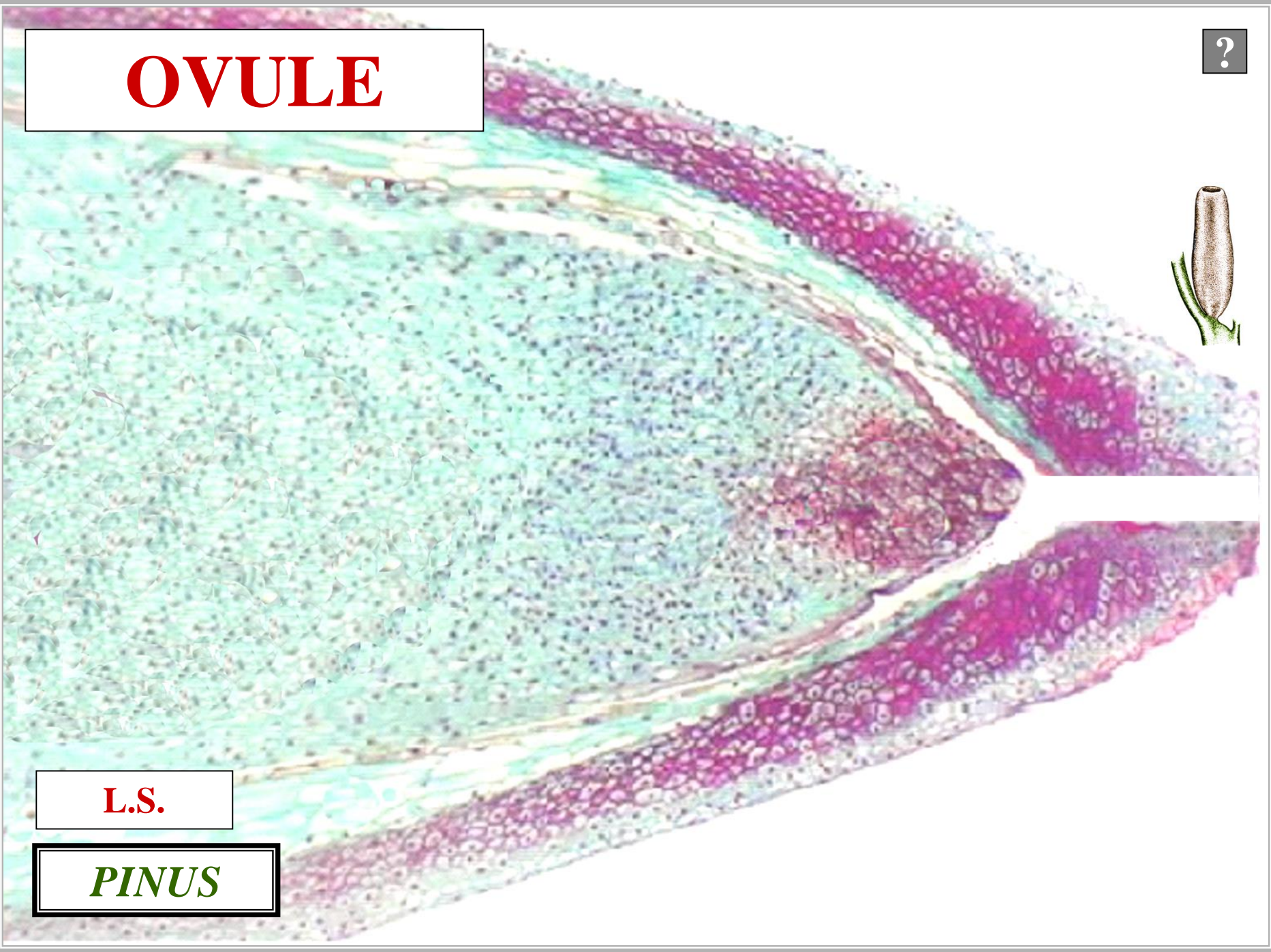
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**OVULE**

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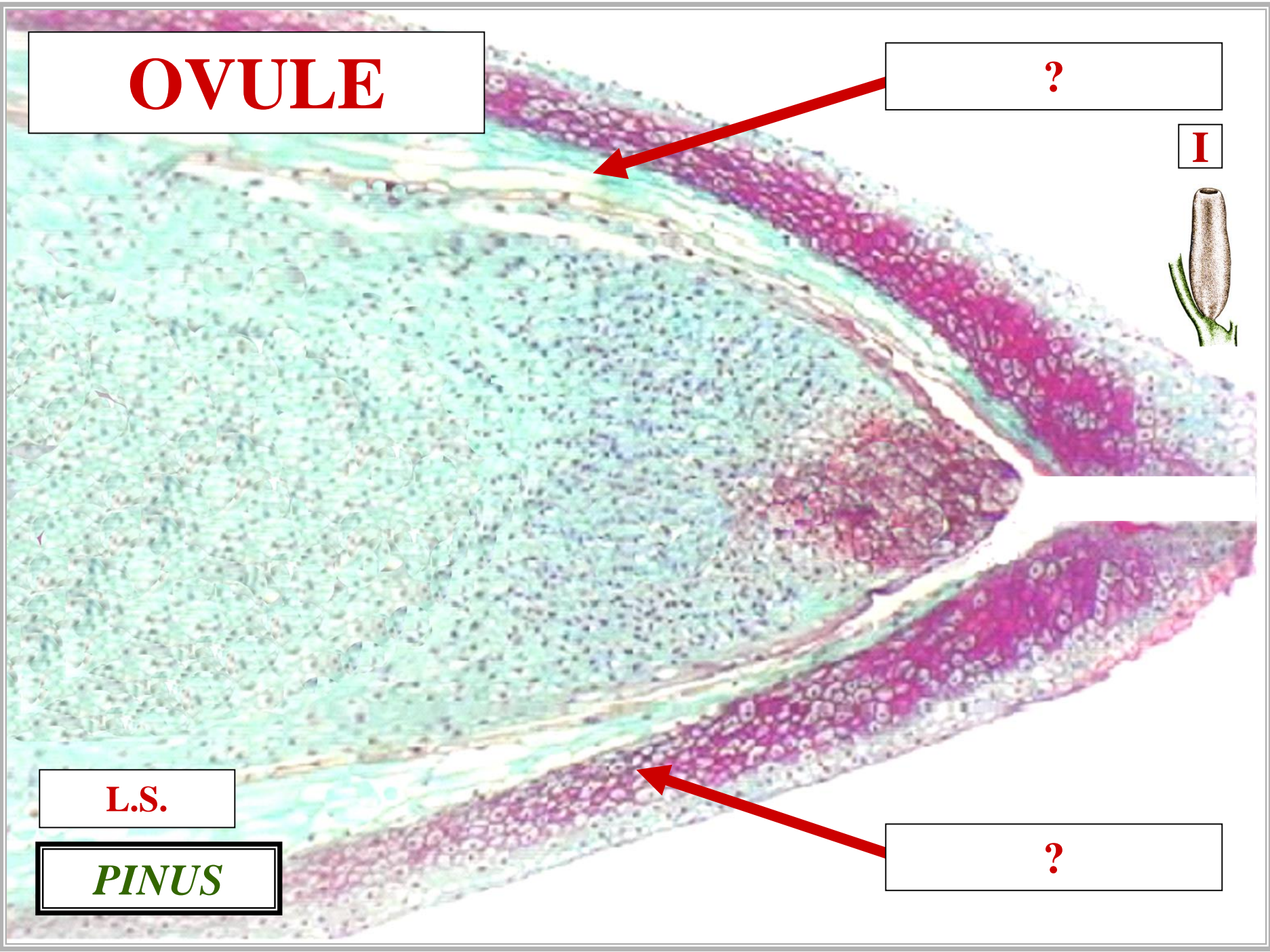
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**OVULE**

**INTEGUMENT**

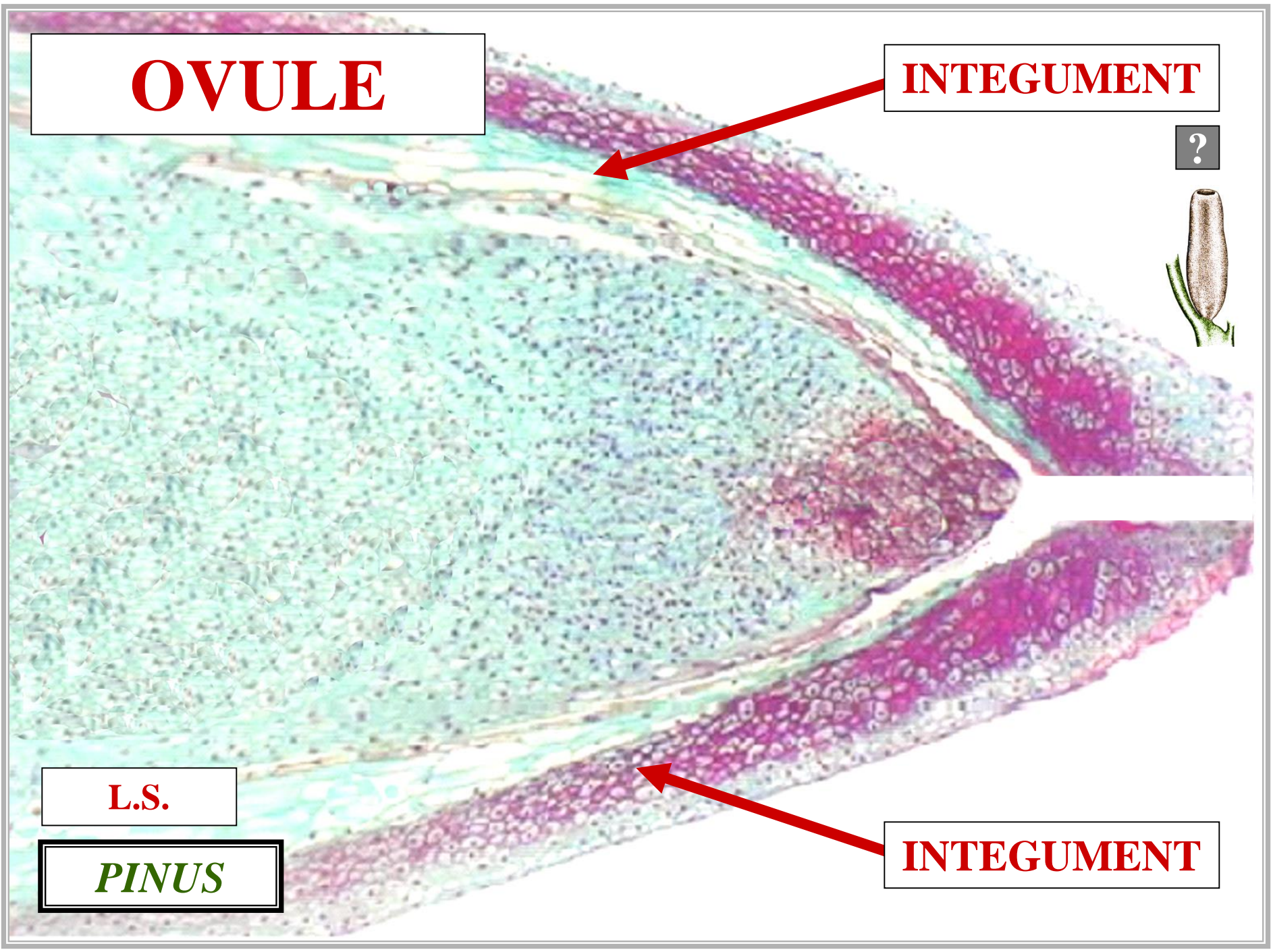
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**INTEGUMENT**



**OVULE**

**INTEGUMENT**

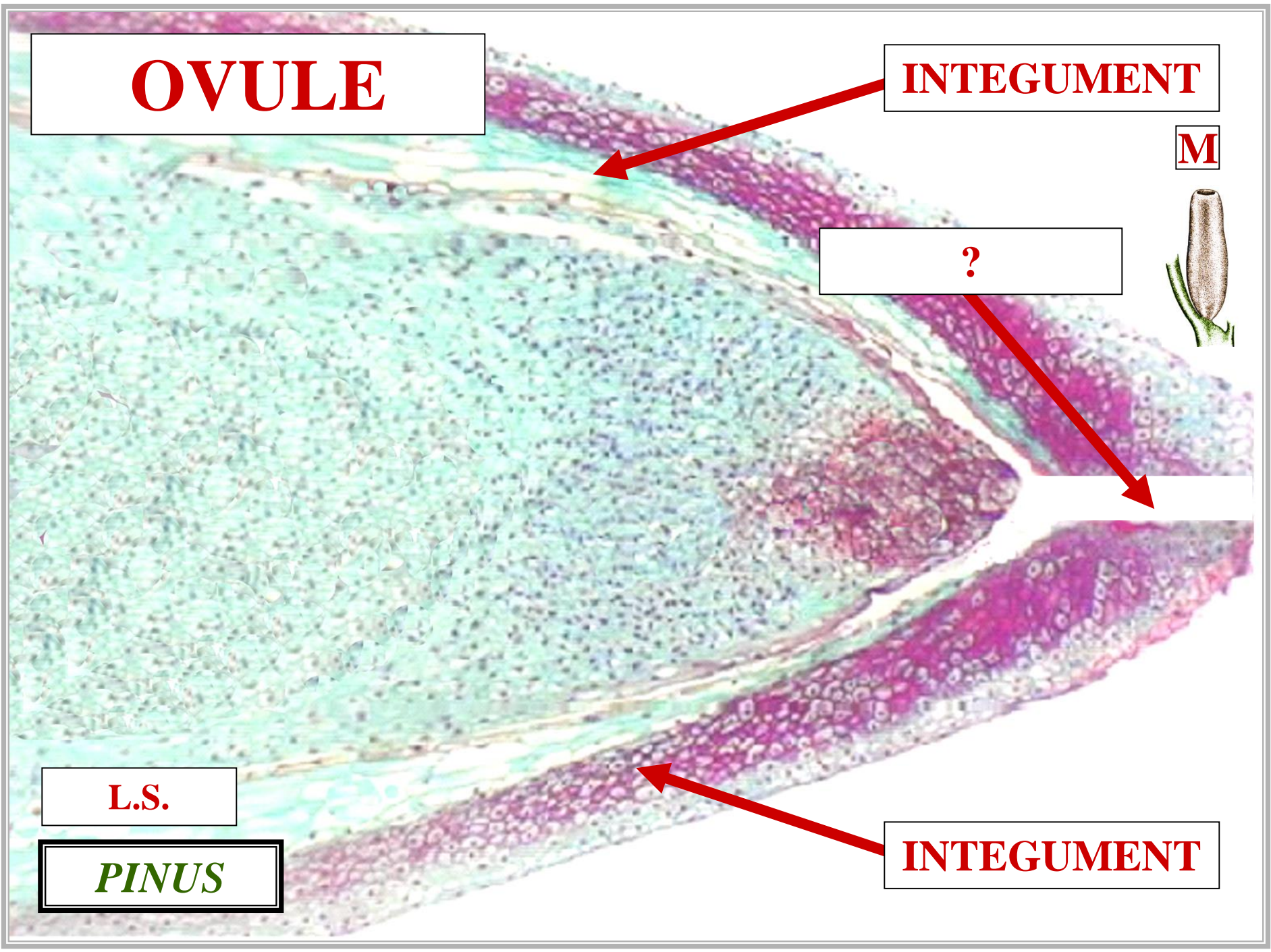
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***PINUS***

**INTEGUMENT**





**OVULE**

**INTEGUMENT**

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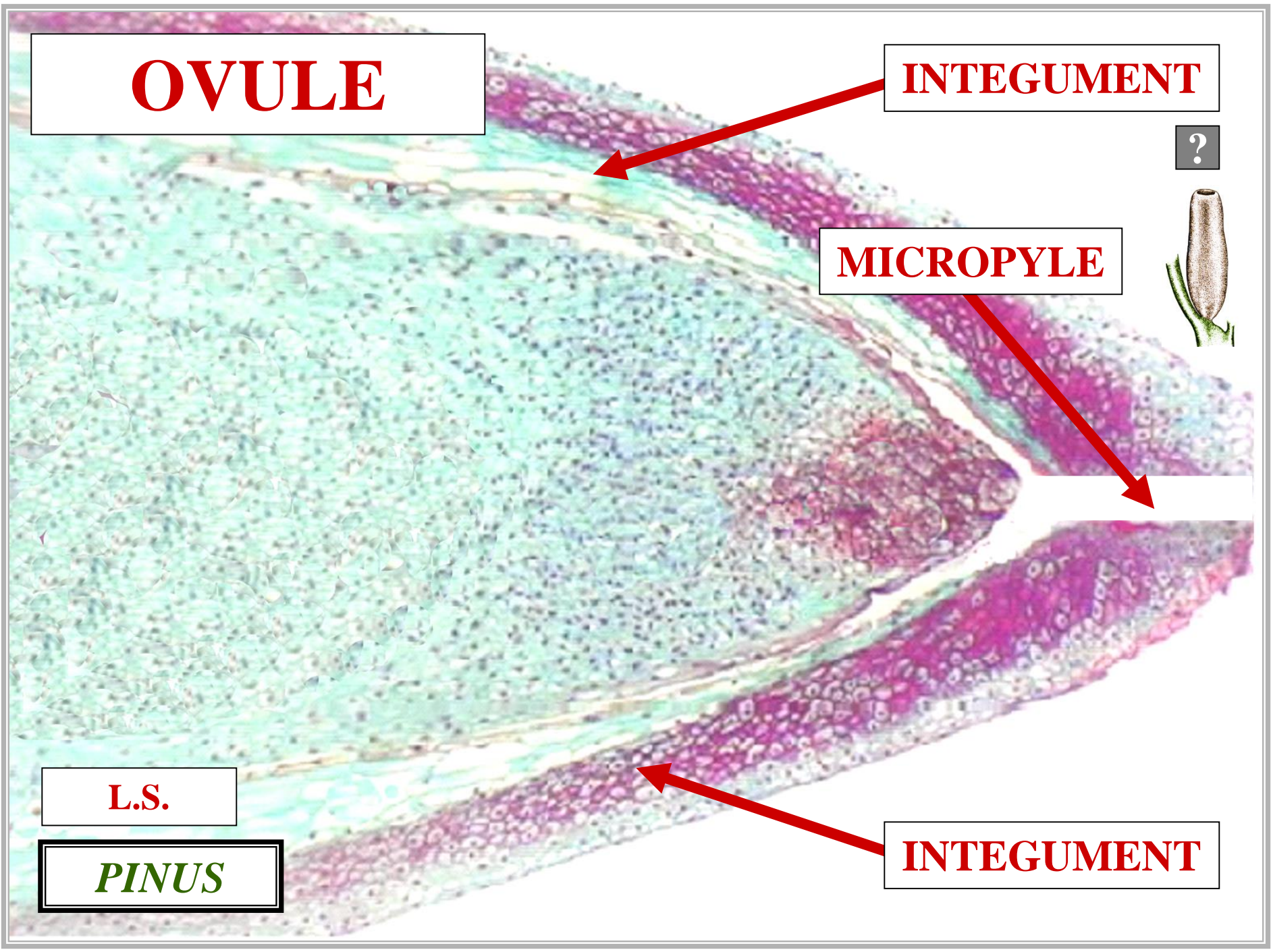
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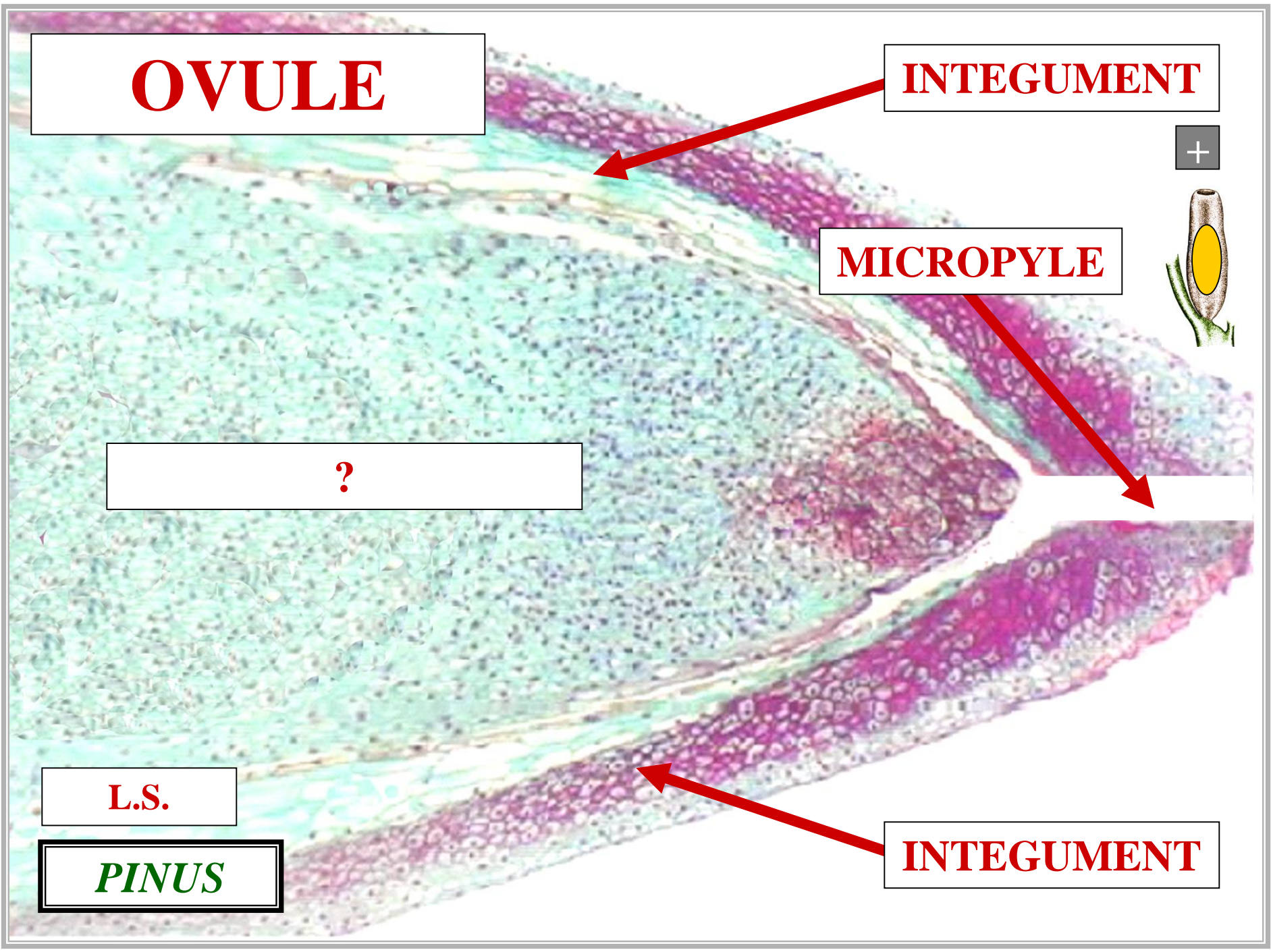
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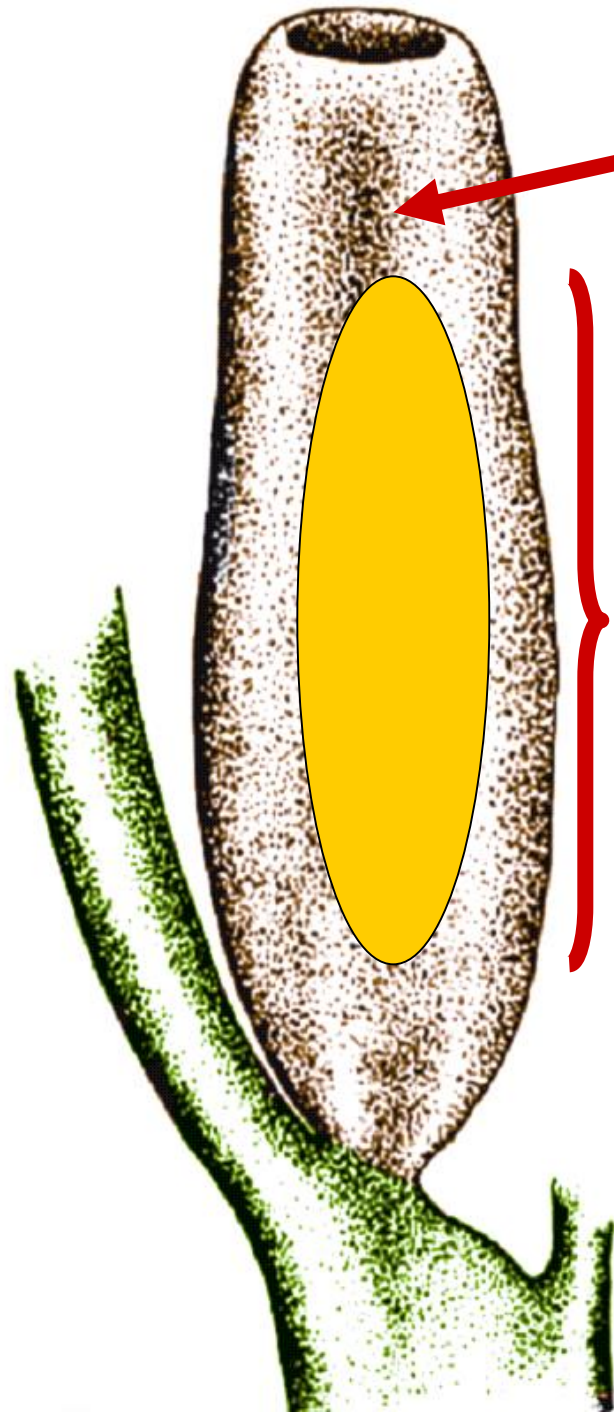
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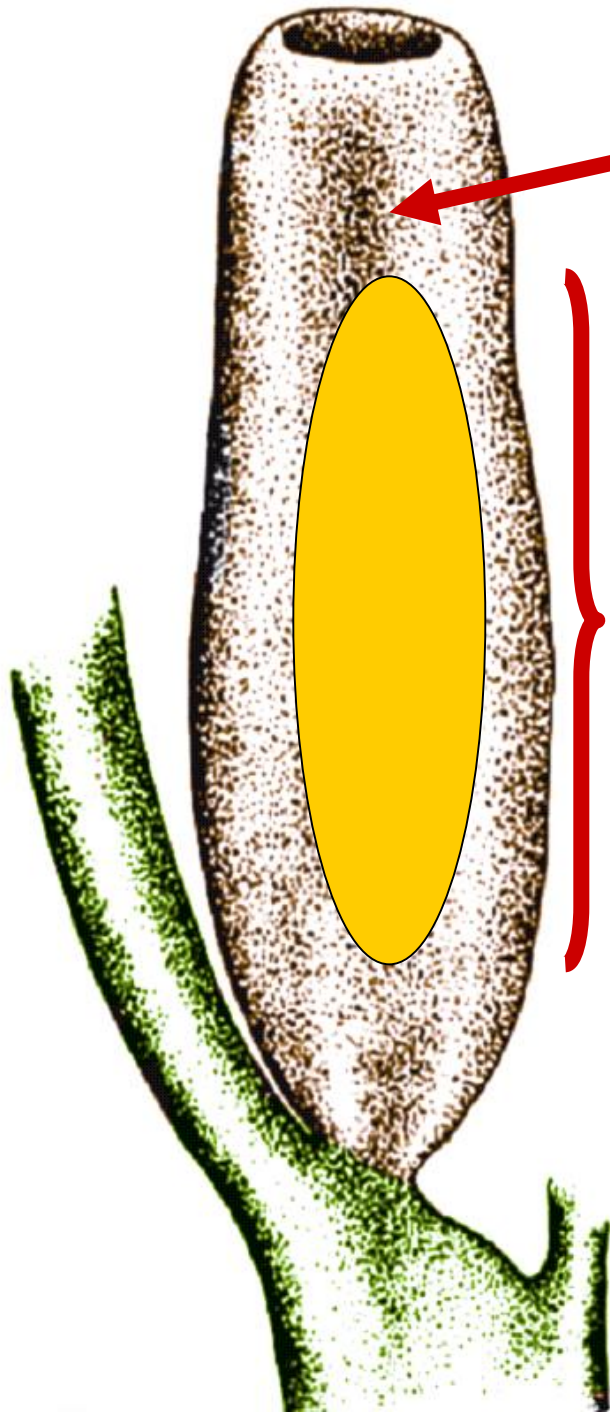
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**INTEGUMENT**

**INTEGUMENT  
ENCLOSED  
MEGASPORANGIUM**

**OVULE**

**INTEGUMENT**

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**MICROPYLE**

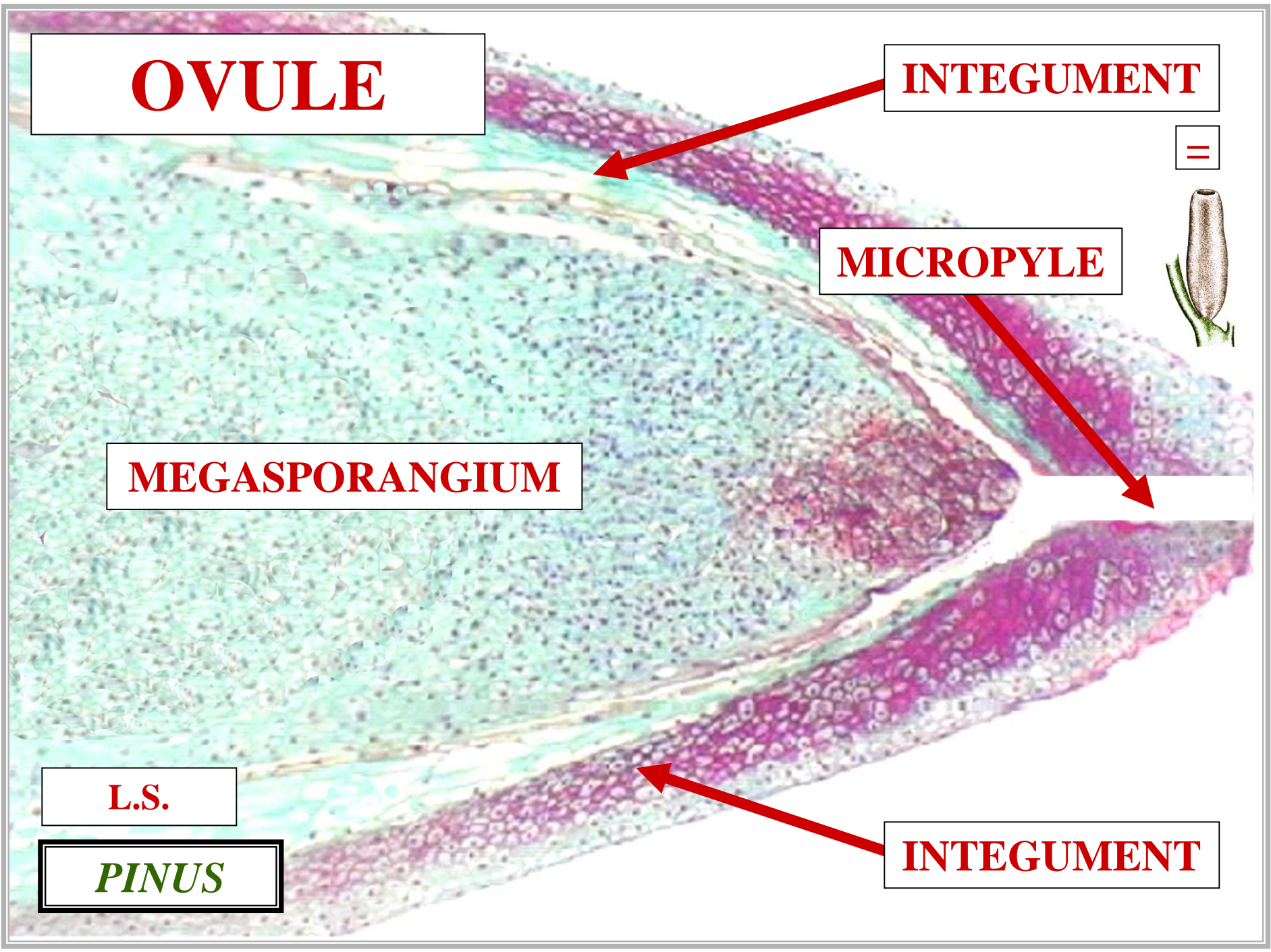


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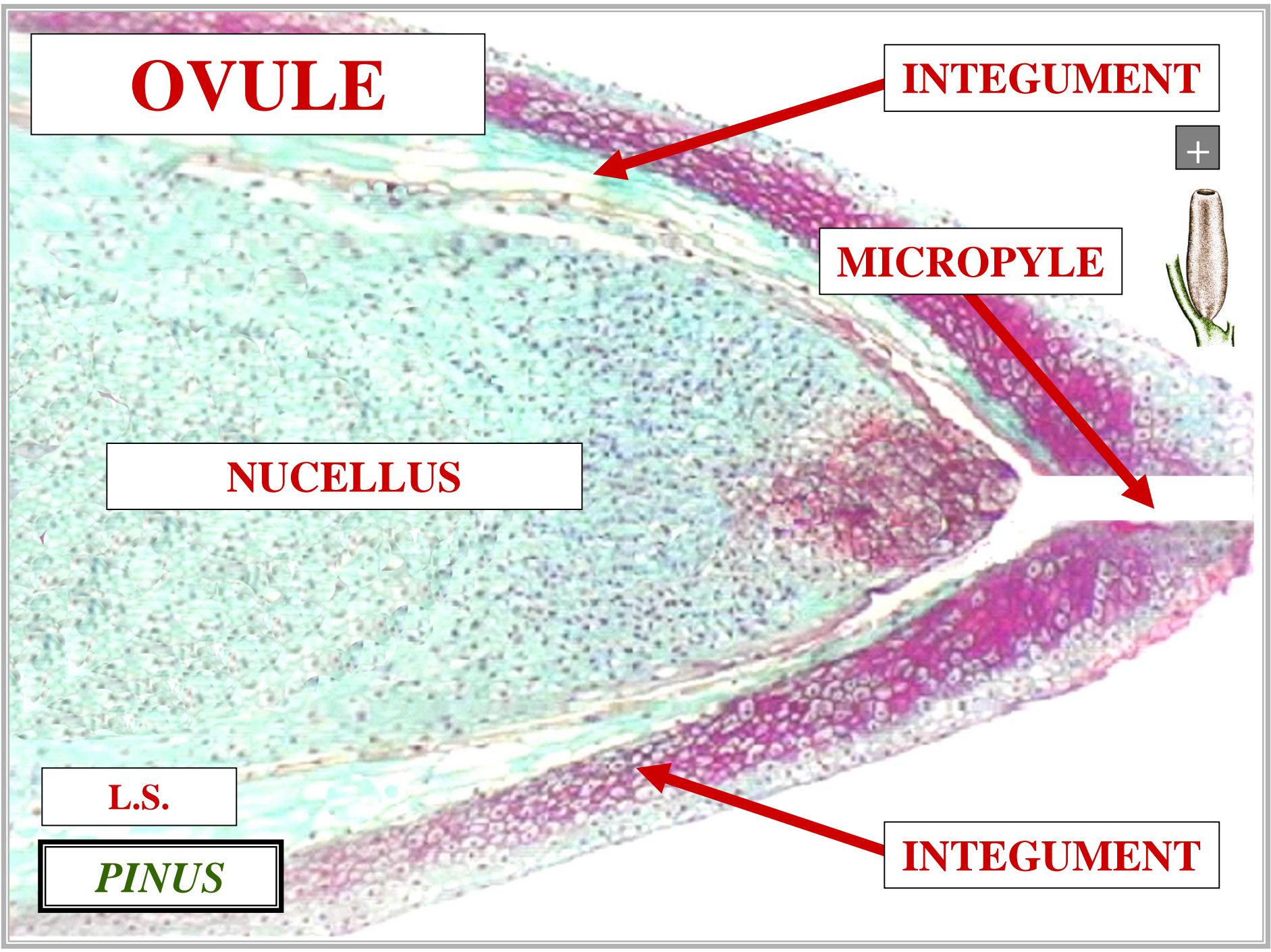
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***PINUS***

**INTEGUMENT**



**OVULE**

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**MICROPYLE**

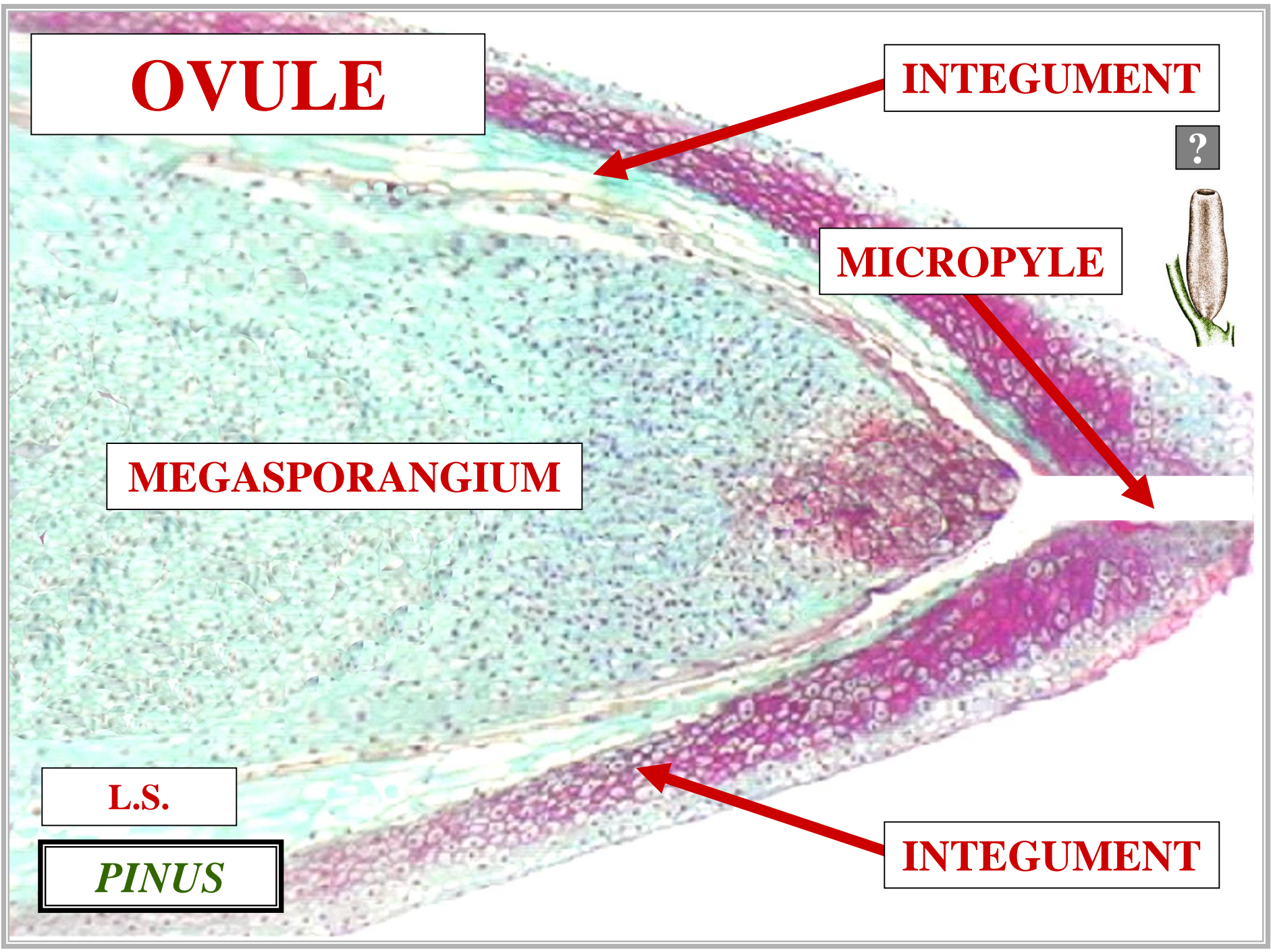


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**OVULE**

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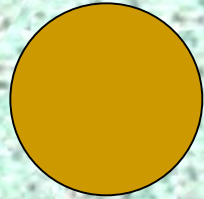
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**MICROPYLE**

**M**



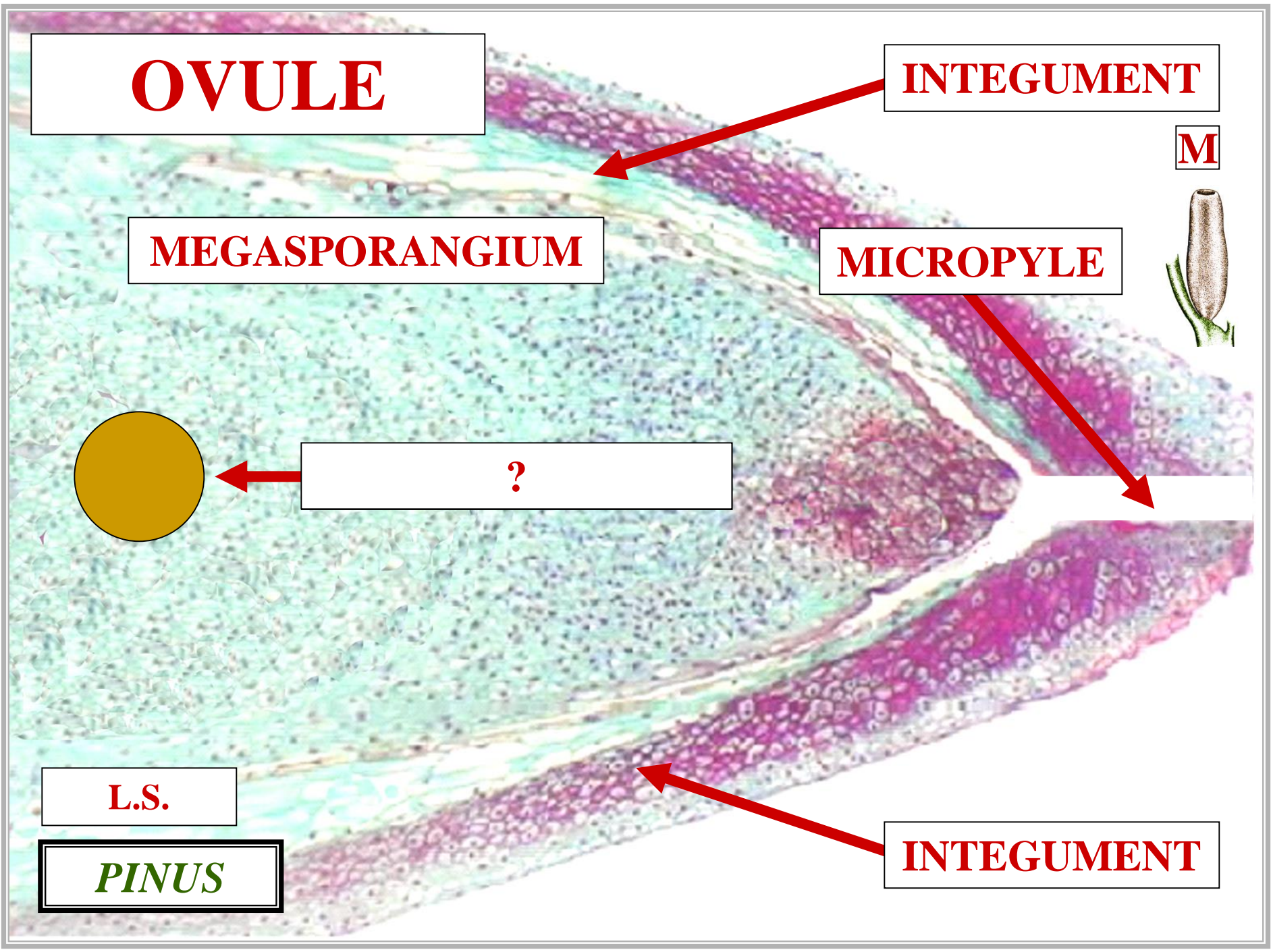
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**INTEGUMENT**





**OVULE**

**INTEGUMENT**

**MEGASPORANGIUM**

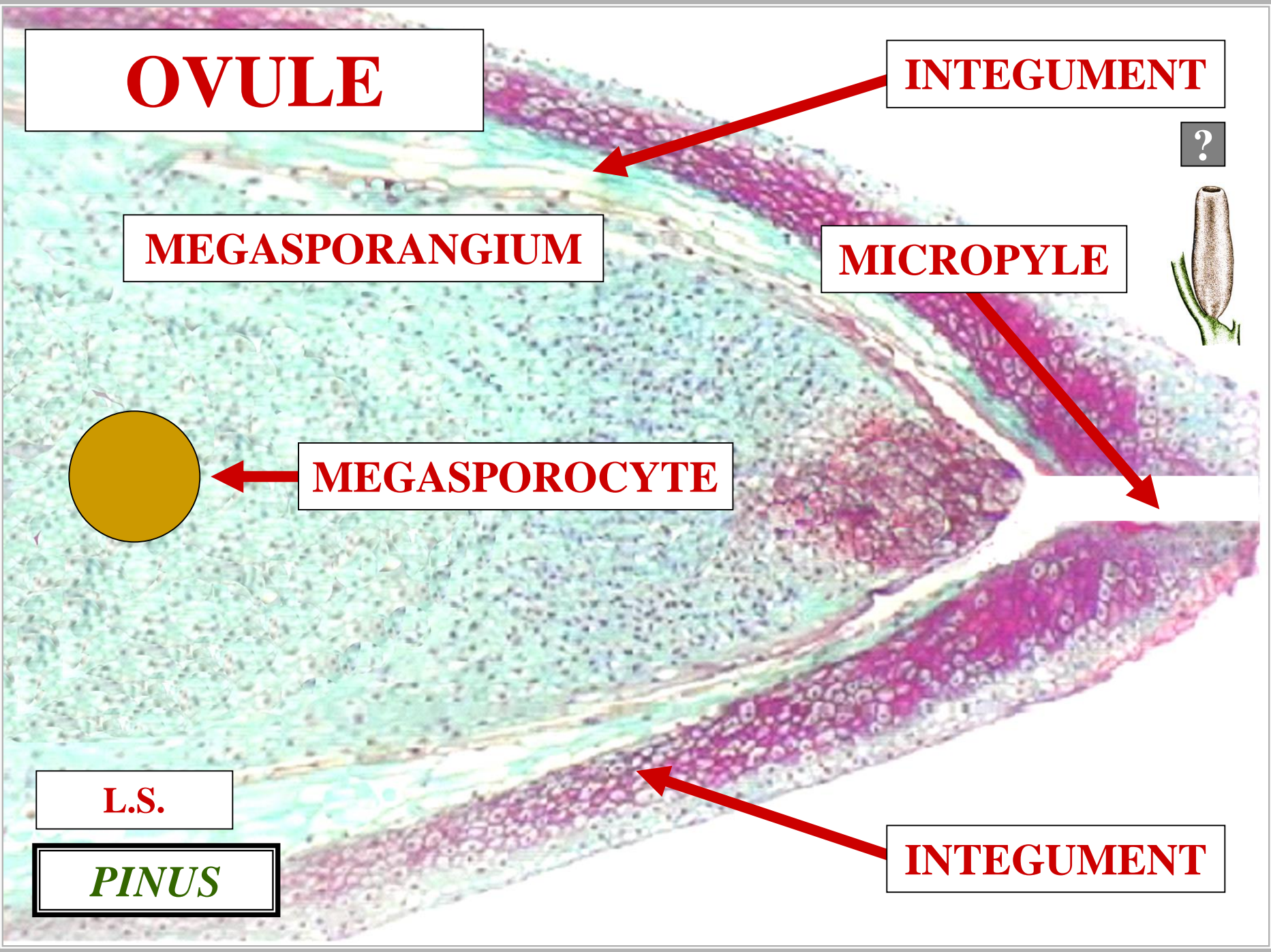
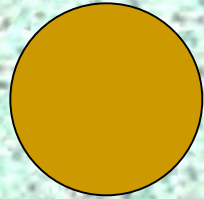
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**MEGASPOROCYTE**

**L.S.**

***PINUS***

**INTEGUMENT**



**OVULE**

**INTEGUMENT**

**MEGASPORANGIUM**

**MICROPYLE**

**2**



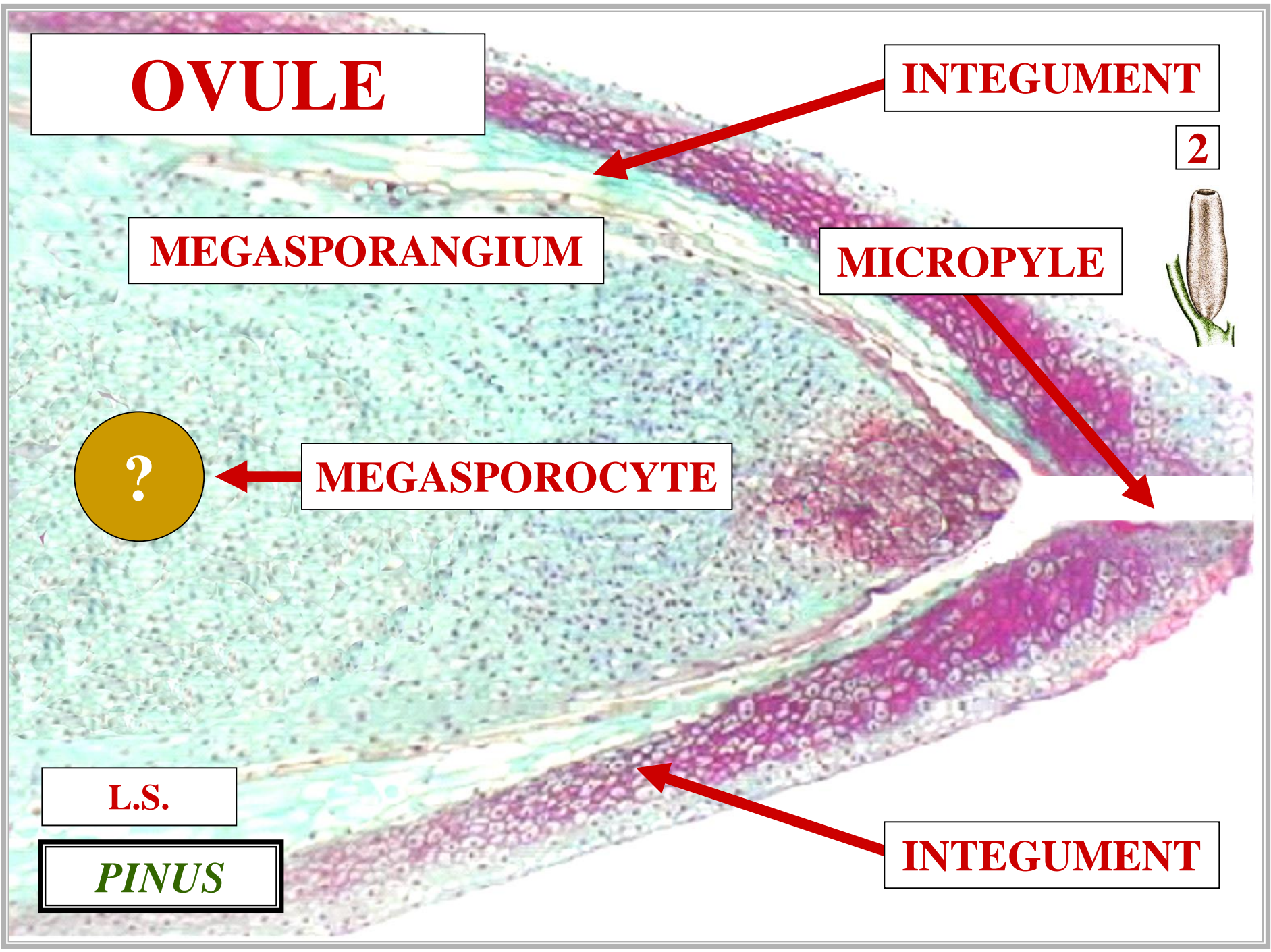
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**L.S.**

***PINUS***

**INTEGUMENT**



**OVULE**

**INTEGUMENT**

**MEGASPORANGIUM**

**MICROPYLE**

**2N**

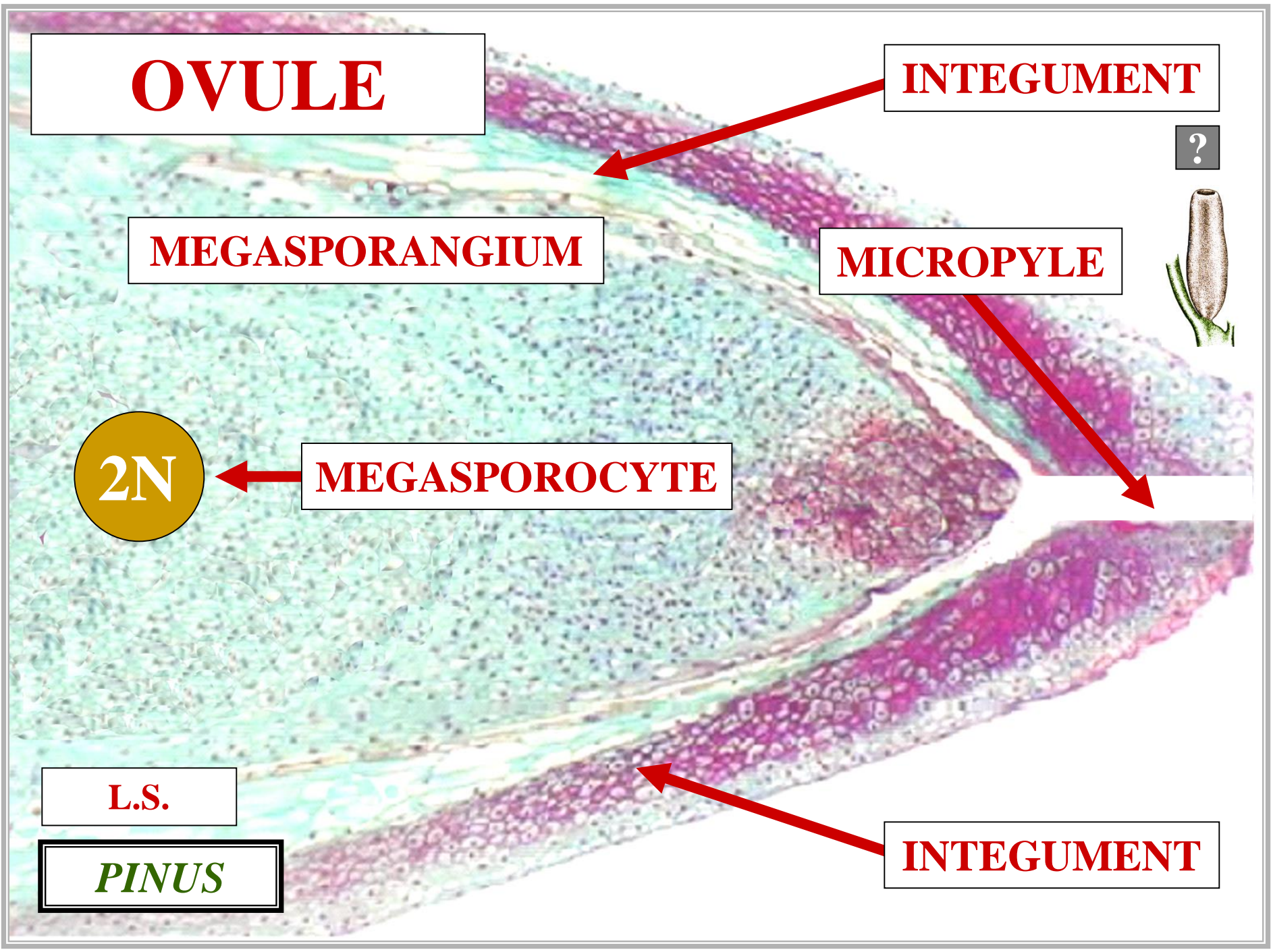
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**L.S.**

***PINUS***

**INTEGUMENT**

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**OVULE**

**INTEGUMENT**

**MEGASPORANGIUM**

**MICROPYLE**

**M**



**MEGASPOROCYTE**

**2N**

**?**

**L.S.**

***PINUS***

**INTEGUMENT**

