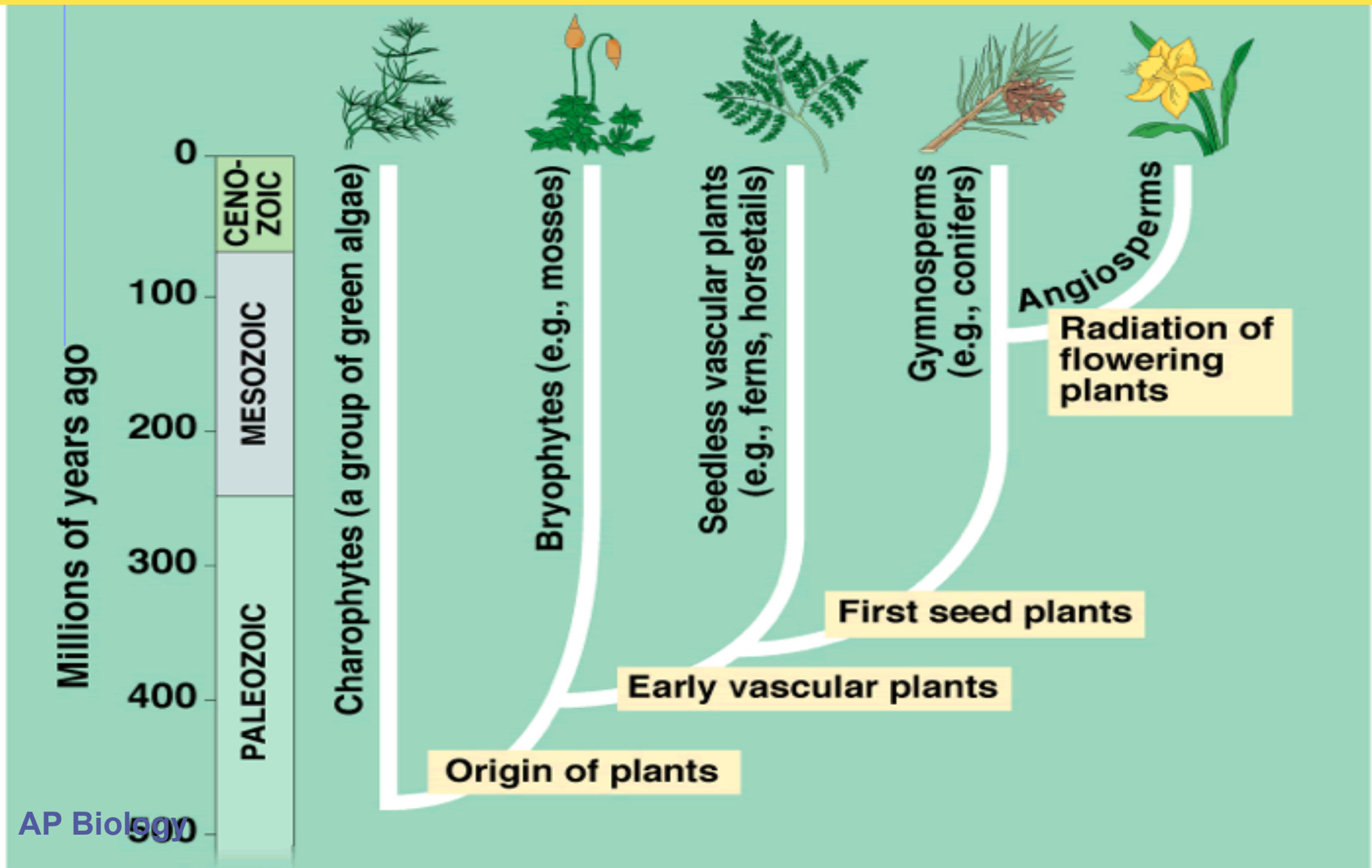


Seed-Producing Plants Evolve from a Subset of Vascular Plants



Seed Plants Evolve 360 m.y.a.



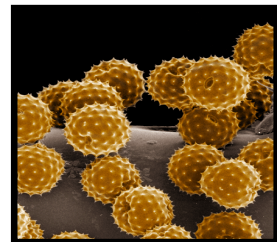
SIX Common Characteristics of Seed Plants

1. Have Vascular Systems (xylem & phloem)
2. Reduced (microscopic) gametophytes
 - Protects egg and embryo now inside sporophyte
 - Sporophyte protects gametophyte against drought & radiation & provides nutrients to the gametophyte
 - Sporophyte dominates the life cycle
 - Conifers and fruit trees you see are diploid not haploid



3. Heterospory

- Both male and female spores (n) are now produced and now form separate male and female gamete-producing gametophytes, which each make either the sperm or the egg. Respectively
 - ◆ Megasporangia on sporophyte produce megaspore that develops into microscopic female gametophyte
 - ◆ Microsporangia on sporophyte produce microspores that develop into microscopic male gametophyte
 - Tiny male & female multicellular gametophytes are kept inside sporophyte and are not released into environment where they would face dehydration, damage by herbivores & UV radiation.



Seed Plants Evolve 360 m.y.a.



4. Ovules

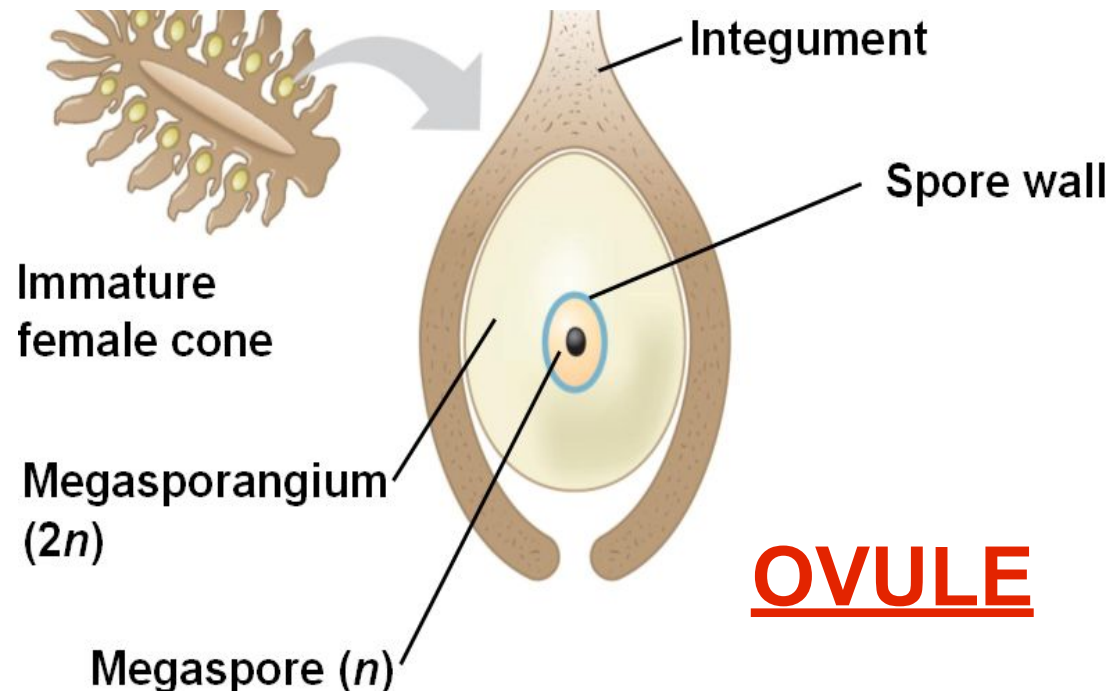
Inside ovule, the megasporangium ($2n$) produces the the megaspore (n) by meiosis. The haploid megaspore is retained within the sporophyte (*spore protected from dehydration & UV compared by not being released into the environment*)

- ◆ **Integument** = Layer of sporophyte tissue that envelops and protect **megasporangium**

Ovule =

Megasporangium, megaspore and integuments

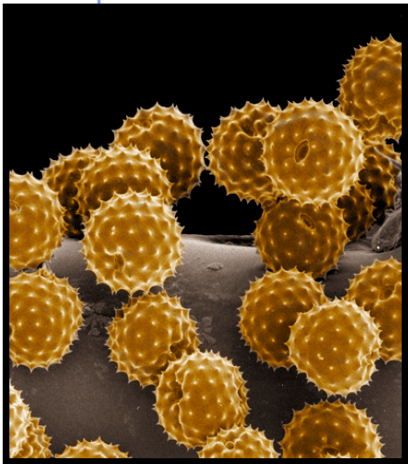
- ◆ Female microscopic multicellular gametophyte develops from megaspore produces one or more **eggs**



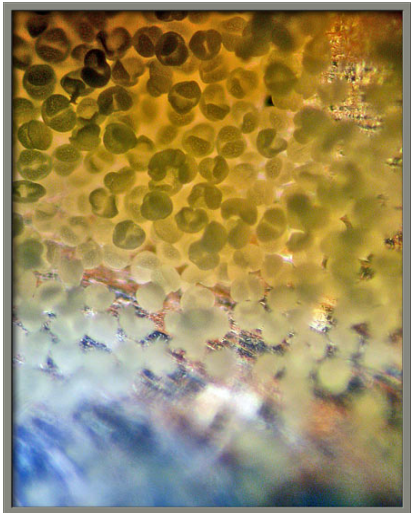
Seed Plants

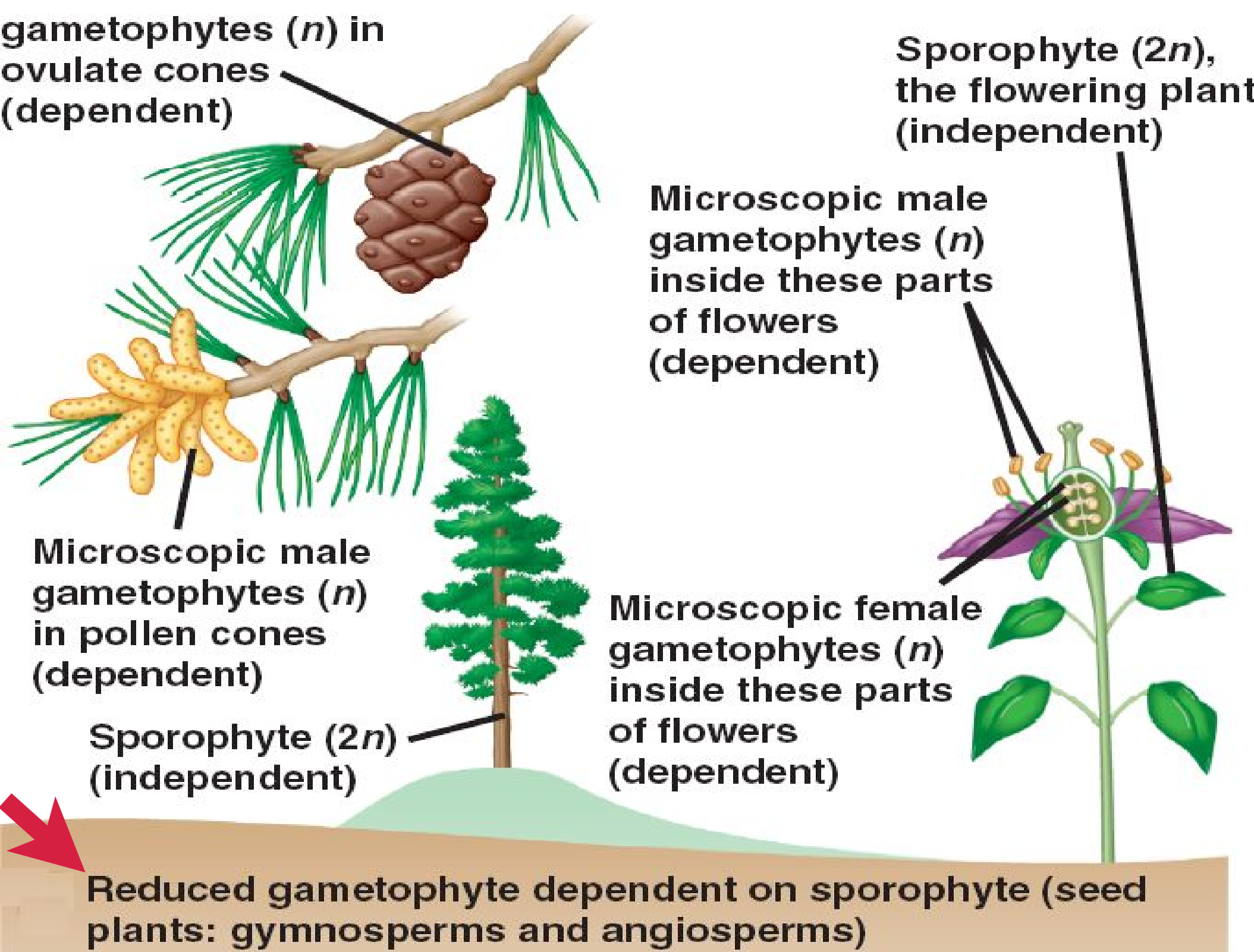
5. Pollen production

- Microsporangia ($2n$) of sporophyte ($2n$) make Microspores (n) via meiosis, which develop into **POLLEN GRAINS**

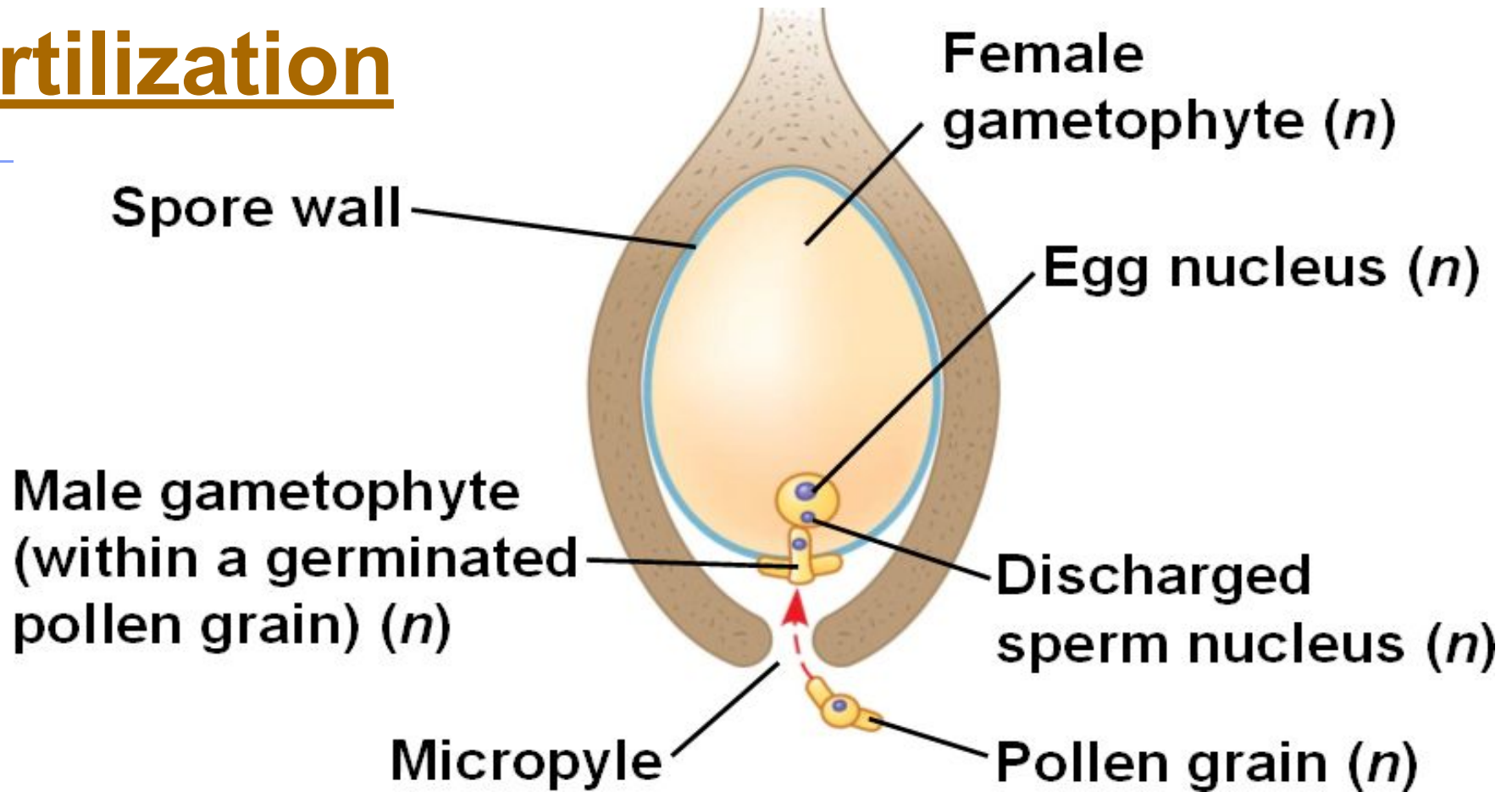


- ◆ **Pollen** contains the male gametophyte inside pollen wall. The male gametophyte will make non-flagellated, non-swimming **sperm** by mitosis.
 - *Walls of pollen grains contain sporopollenin which protects against dehydration & UV radiation*
- ◆ The process of transferring pollen to ovule (where egg forms) is called **POLLINATION**
 - **Pollen grain** lands near ovule and germinates (grows), produces a **pollen tube**
 - Pollen tube **releases sperm** into the female gametophyte inside the sporophyte's ovule
 - Sperm **fertilizes the egg** produced by the female gametophyte inside sporophyte's ovule





Fertilization



- Sperm of MOST seed producing plants (most gymnosperms and all angiosperm) is non-flagellated and non-motile
 - ◆ Pollen grain can be carried (by air or animals) far distances to ovule
 - Sperm do not need to swim through water to egg like in seedless plants

Seed Plants

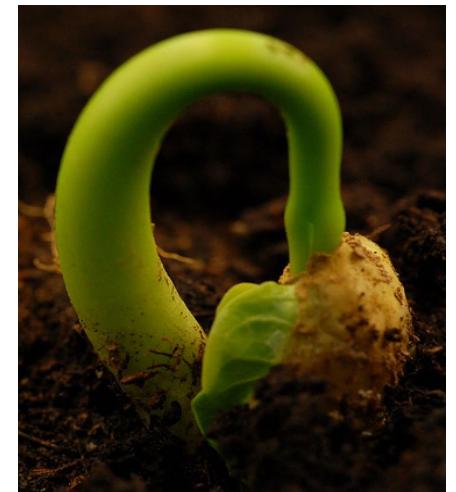
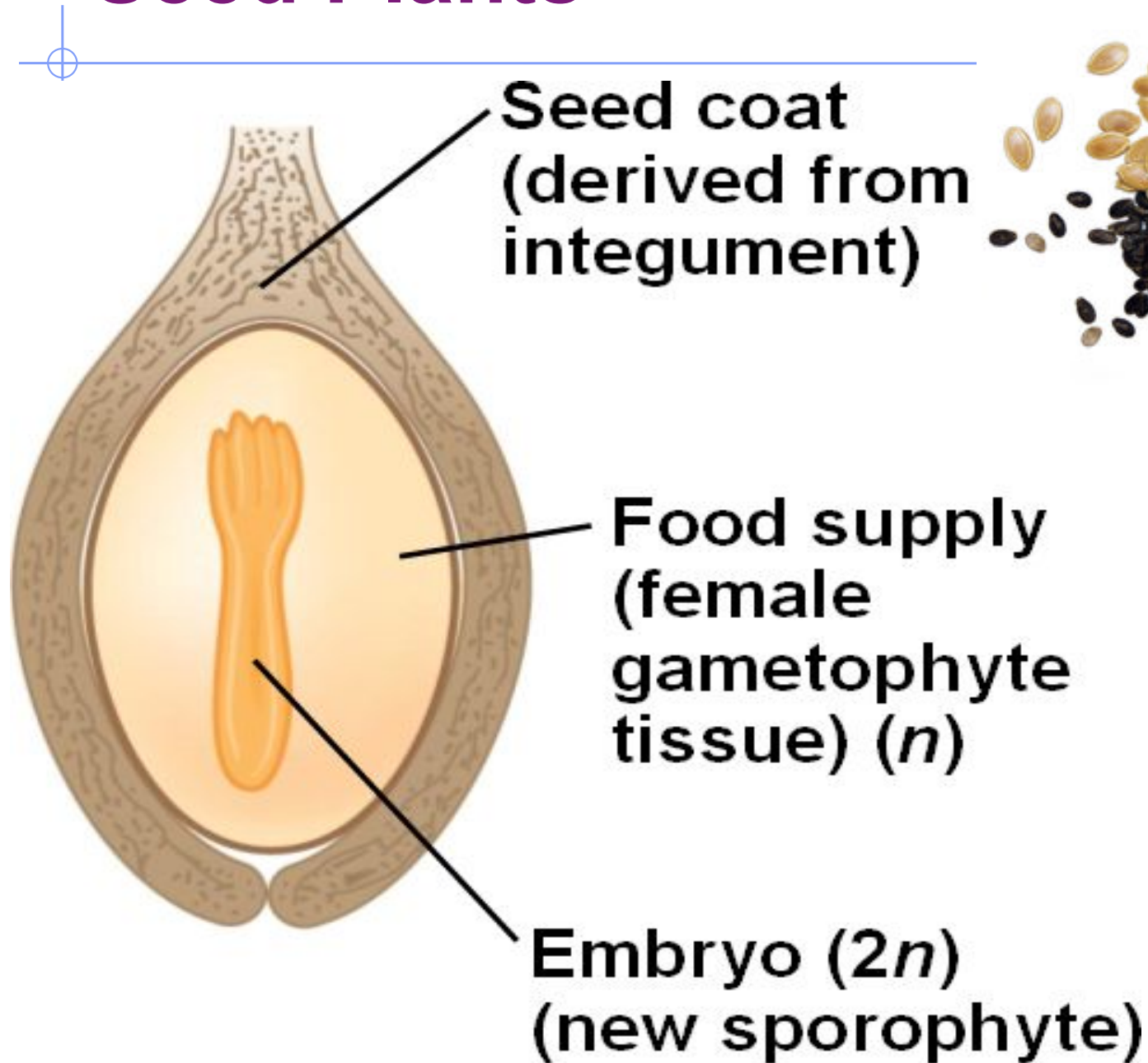
6. Produce Seeds

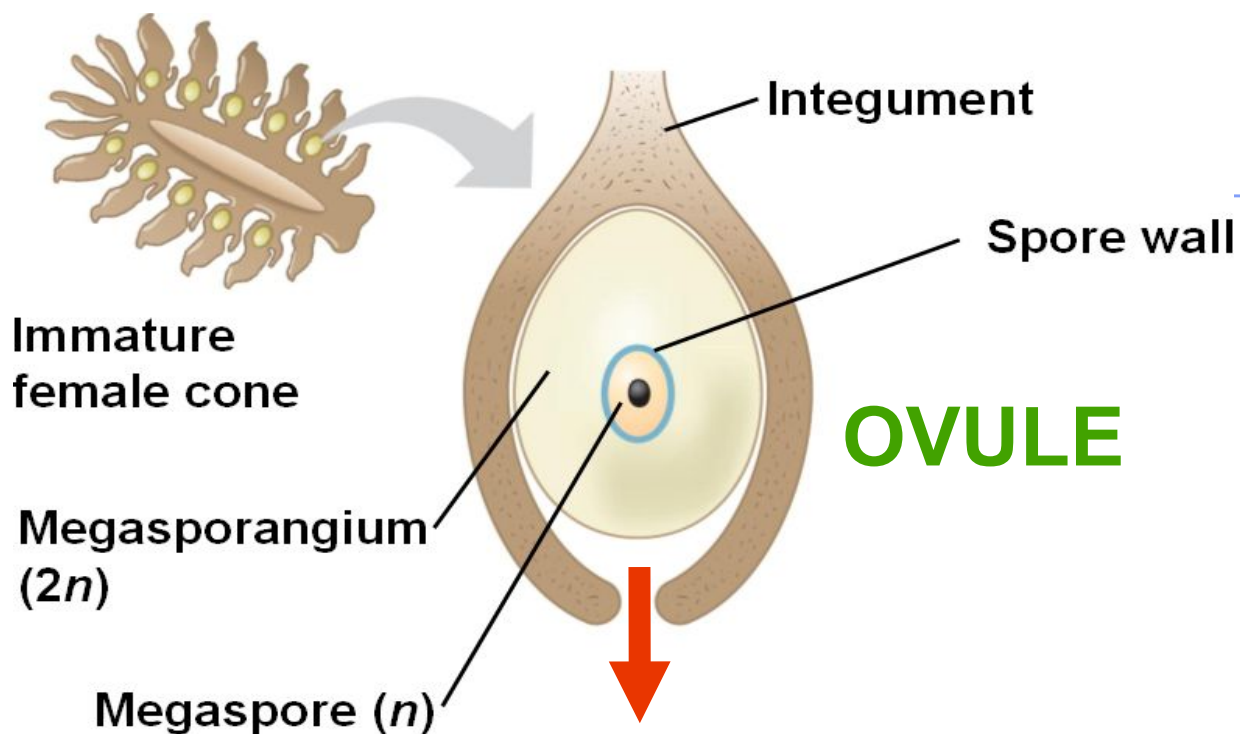
- Once sperm fertilizes egg, zygote undergoes mitosis and forms a sporophyte (2n) embryo
- The whole ovule develops into **SEED!**
 - ◆ **Seed** = Embryo and its food supply surrounded by a protective coat
 - ◆ Contains embryo, food supply, protective coat derived from integument



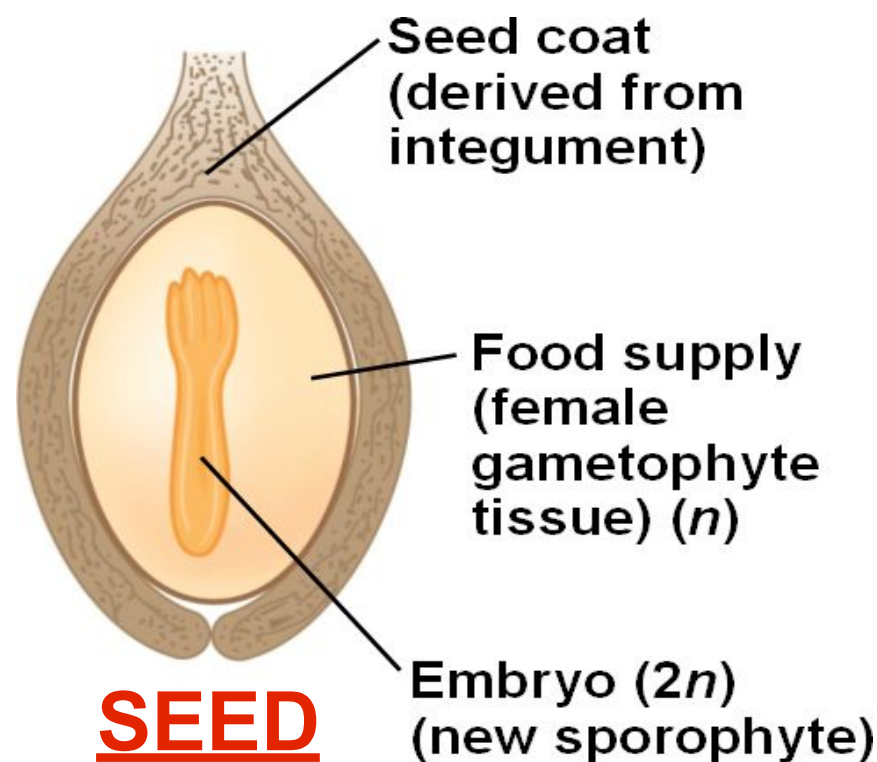
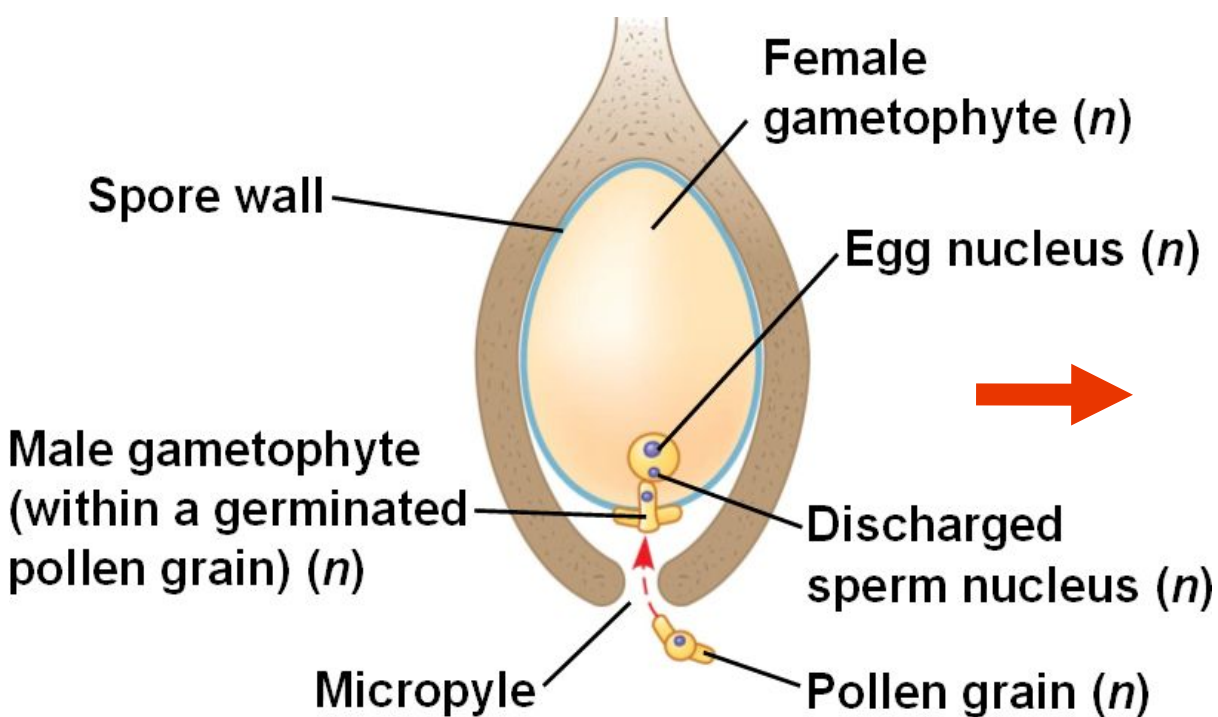
- Extra protection compared to single-celled spore
- Can remain dormant for days, months, years and wait for favorable conditions before germinating
- Can be transported great distances

Seed Plants





Seed Formation



Types of Seed-producing plants:

■ Gymnosperms (305 mya)

◆ Plants with 'naked' seeds not enclosed in ovaries

- Evolved as moist Carboniferous period became the Permian period with much drier climates

- ◆ Reptiles replaced amphibians
- ◆ Gymnosperms are also better suited to dry climates than mosses and ferns

◆ Key adaptations:

1. SEEDS + POLLEN
2. Some had needle shaped leaves with SMALL SURFACE AREAS
3. Some had TICKER CUTICLES
(waxy hydrophobic covering on leaves)

■ Angiosperms (140 mya)

◆ Flowering Plants

- Plants with seeds enclosed in ovaries for extra protection & help getting dispersed



Gymnosperms - “Naked Seeds”

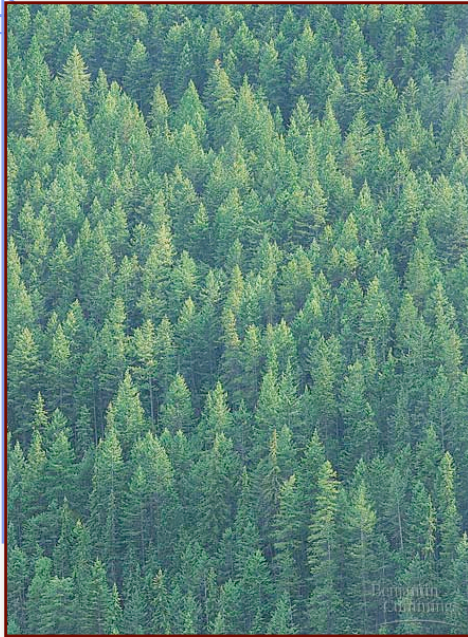
- **Key reproductive adaptations of Seed plants**
 1. Sporophytes dominates life cycle, protecting haploid spores, gametophytes, and then gametes.
 2. Seeds are resistant to UV damage/dehydration and act to disperse the sporophyte embryo of the life cycle
 3. Pollen act the airborne agents bringing male gametes to the egg over long distances & in even dry conditions.



Cone-bearing Gymnosperms = Conifers

- **Ex; Pine, fir, redwood, spruce**
 - ◆ **Pine tree = Sporophyte ($2n$)**
 - Sporangia = spore (n) producing organs located on scale-like structures packed densely in cones where meiosis takes place

Gymnosperm: conifers

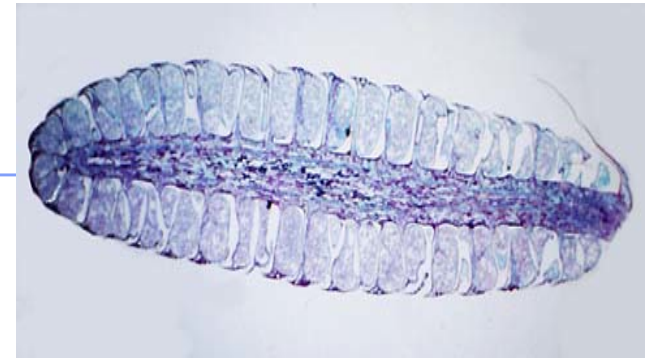


Gymnosperms

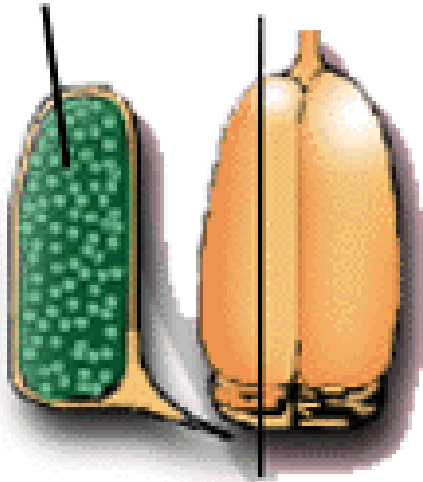
- **ALL GYMNOSPERMS ARE HETEROSPOROUS**

- 1. Small pollen cones of sporophyte ($2n$), microsporocytes, undergo meiosis producing haploid microspores

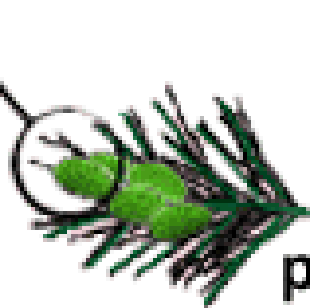
These microspores develop into a male gametophyte enclosed in a pollen wall = POLLEN GRAIN



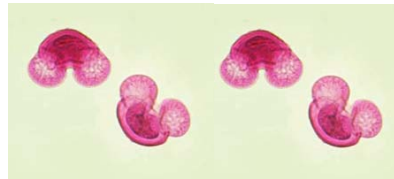
microspore
mother cells



microsporophyll
with
microsporangia



pollen bearing
cone



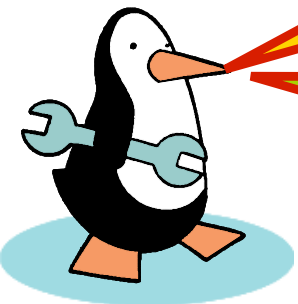
Pollen Grains contain the male gametophyte (n) which will produce the sperm by mitosis

- Pollen eliminated the requirement for water for fertilization

- ◆ spread through wind in gymnosperms (*rarely animals*)

Where can conifers live?

Able to live in drier environments

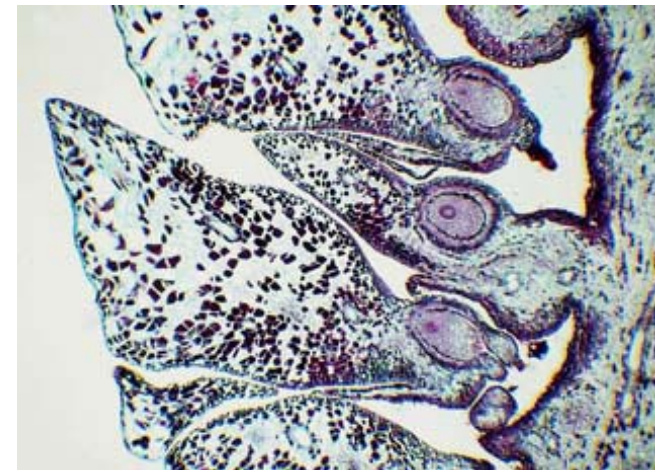
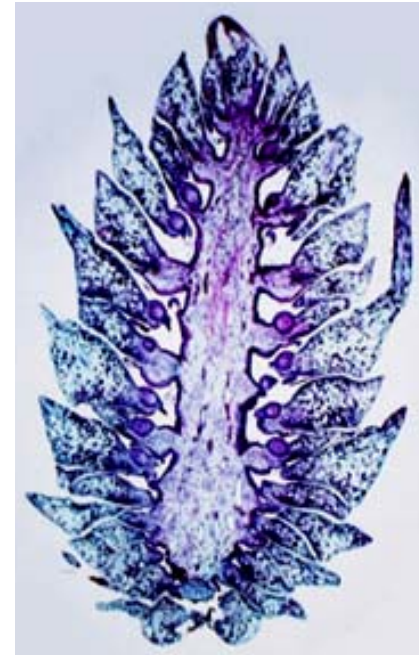
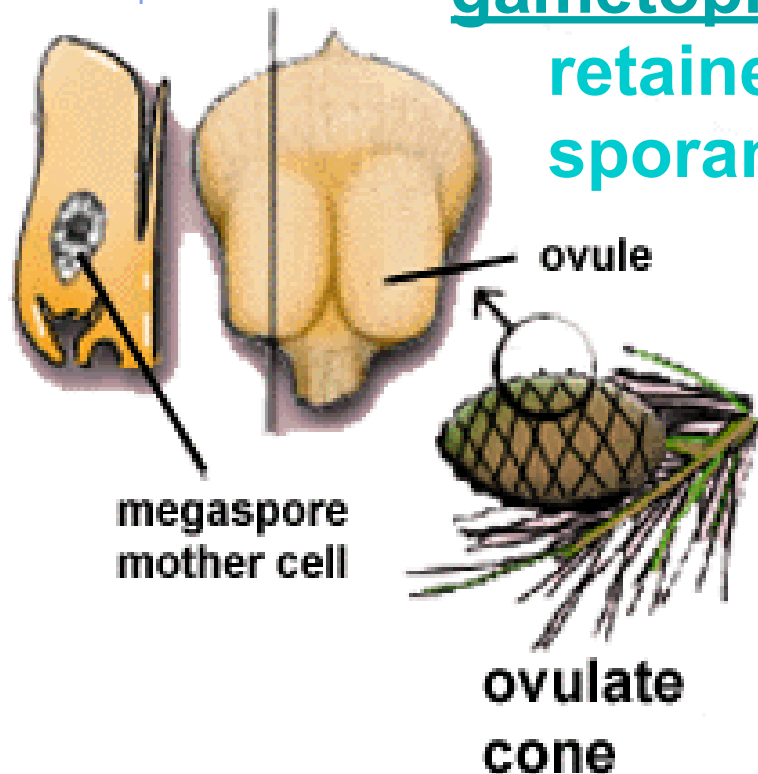


Gymnosperms

- 2. In Ovulate cones, megasporocytes undergo meiosis producing haploid megaspores (n) inside ovules (2n)

Megaspores develop into a female gametophyte (n) and are retained inside the sporangia of sporophyte.

the female gametophyte makes two female gametes form = 2 EGGS



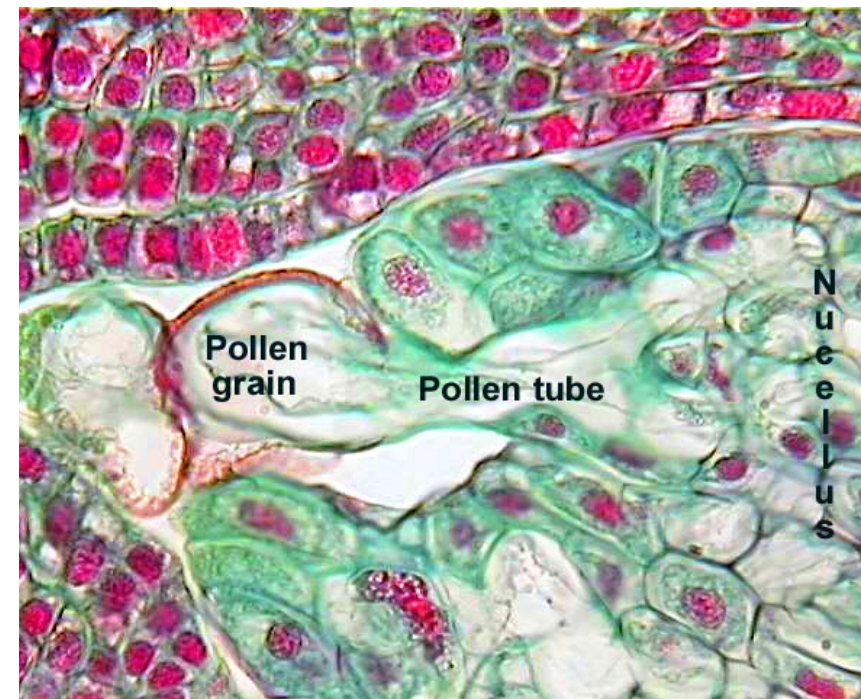
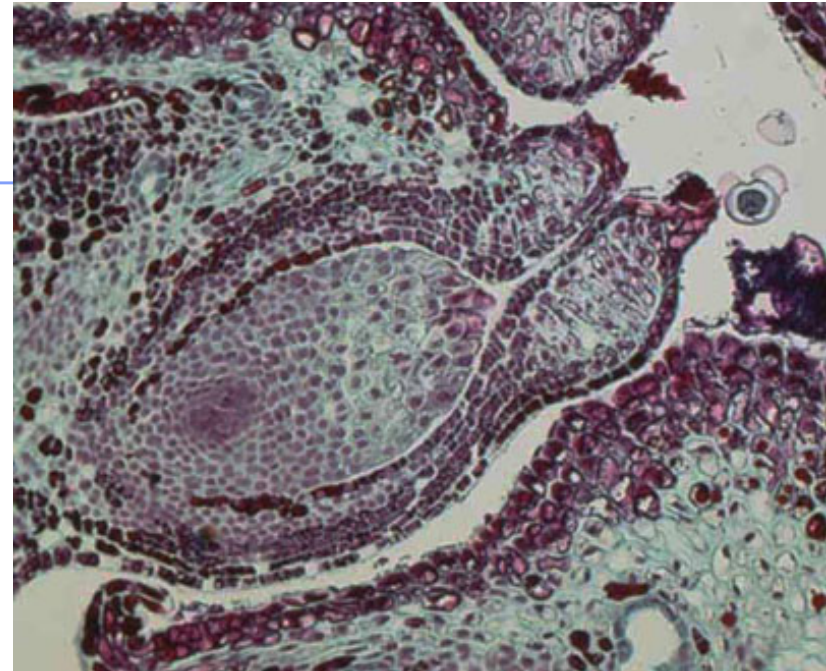
Gymnosperms

Pollination = when pollen grains reach the ovule where the egg is.

Pollen grains germinate forming pollen tube which grows into the Megasporangium.

It is actually during this time that the megasporocyte undergoes meiosis to form the gametophyte which produces two eggs.

The pollen tube discharges two sperm cells that fertilize the eggs to form zygotes.



Gymnosperms

It may take 3 years for male and female gametophytes to be made and for their gametes to form fertilized ovules.

Fertilized zygotes undergo mitosis and form embryos.

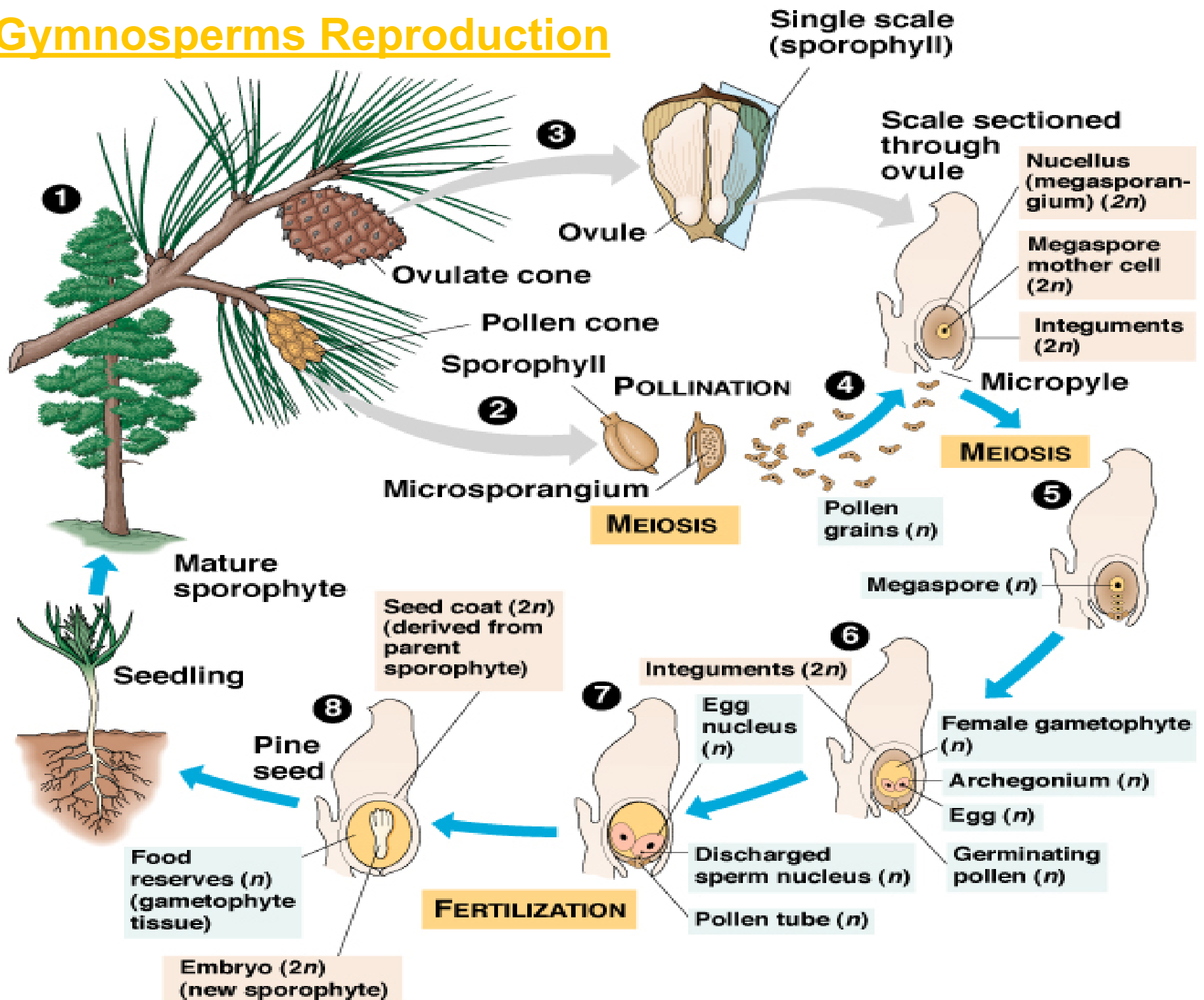
Embryos are packaged into SEEDS.

Then the scales of each ovulate (“female”) cone separate and the seeds are dispersed by the wind.

A seed that lands in a favorable environment, germinates and emerges as a pine seedling.



Gymnosperms Reproduction



Cones & naked seeds

