

Pollen Study

Pollen

The word "pollen" is Latin and means dust or flower

palalam - Sanskrit means ground seeds

pale – Old Greek for dust

poltos - porridge

pulverize – English for ground

polenta – ground corn grits

Palynology - Hyde and Williams in 1944

Palynos - Greek

Literally 'the science of floating dust particles in the air'

Study of fossil pollen, diatoms, chitinozoans (planktonic animals),
and dinoflagellates

Palynomorph – anything found in organic residue that belongs
to a plant or animal



Applications

Biostratigraphy and geochronology

Palaeoecology and climate change

Taxonomy and evolutionary studies

Forensic palynology

Allergies

Melissopalynology

Archaeological

Pollination Biology



Assyrian “Winged Genie” Pollinating Dates

Assyrian (Nimrud, Iraq), c. 884-60 BCE



In this low-relief carving, a winged figure fertilizes a date tree. To produce an abundant crop, date palms require hand-pollination. The objects held by the figure suggest this process: the bumpy oval resembles the male date flower clusters shaken over female flowers. The bucket recalls the water that is then sprinkled to hold the pollen in place. All these actions are necessary to make date orchards fruitful. The winged figure's horned cap identifies him as a god. In his hands, the gesture of pollination becomes one of divine blessing that recognizes the cyclical nature of seasonal time related to agricultural cycles.



Aristotle – didn't believe plants had separate sexes.

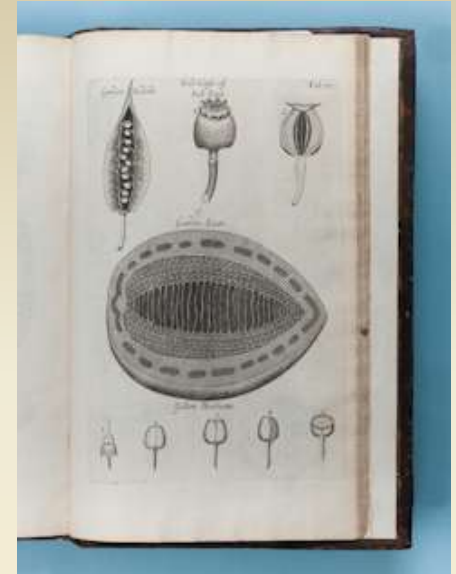
Theophrastus – recognized importance of pollination to date plants, and also to figs.

Nehemiah Grew

1641-1712

Anatomy of Plants - 1682

Contains the first microscopic description of pollen, identified stamens as male.



Marcello Malpighi

1628 - 1694

Anatome Plantarum (1675-1679)

Noted furrows on pollen grains,
But viewed pollen as a secretion



**Marcello Malpighi
(1628-1694)**



Rudolf Jakob Camerarius 1665-1721

De sexu plantarum epistola (1694)



Experimented with:

Mulberry - female plants not near to male (staminate) plants produced fruit but with no seeds

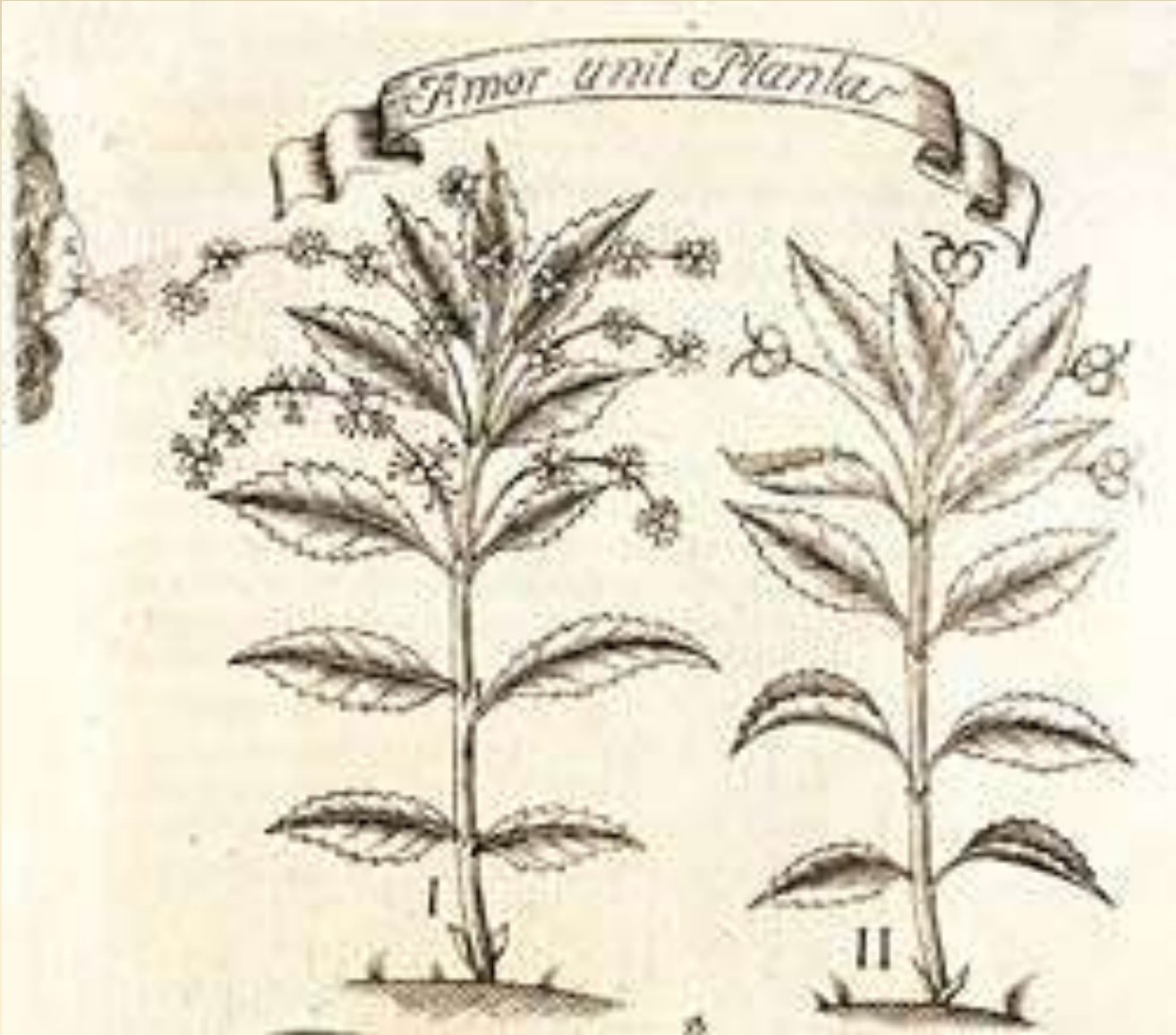
Castor Bean and Corn

cut off the staminate flowers (the "tassels" of maize), and likewise observed that no seeds formed

Linnaeus - Sponsalia Plantarum (The betrothals of Plants) in 1747
 First use of word pollen in scientific sense



**Linnaeus - Sponsalia Plantarum (The betrothels of Plants) in 1747
Wind Pollination**



Josef Gottlieb Kölreuter 1733-1806



- Develop scientific application of sex in plants.
- Performed experiments with the tobacco plant that included artificial fertilization and the production of fertile hybrids between plants of different species.
- Forerunner of Mendel's work.

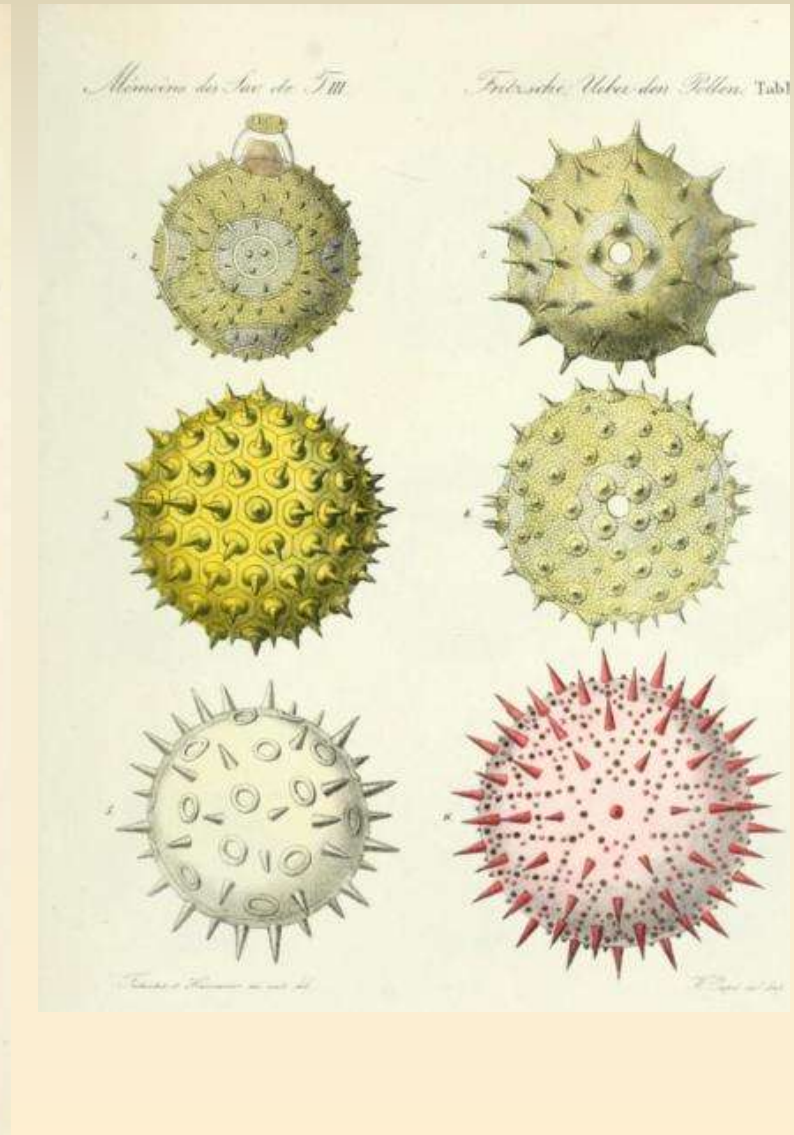
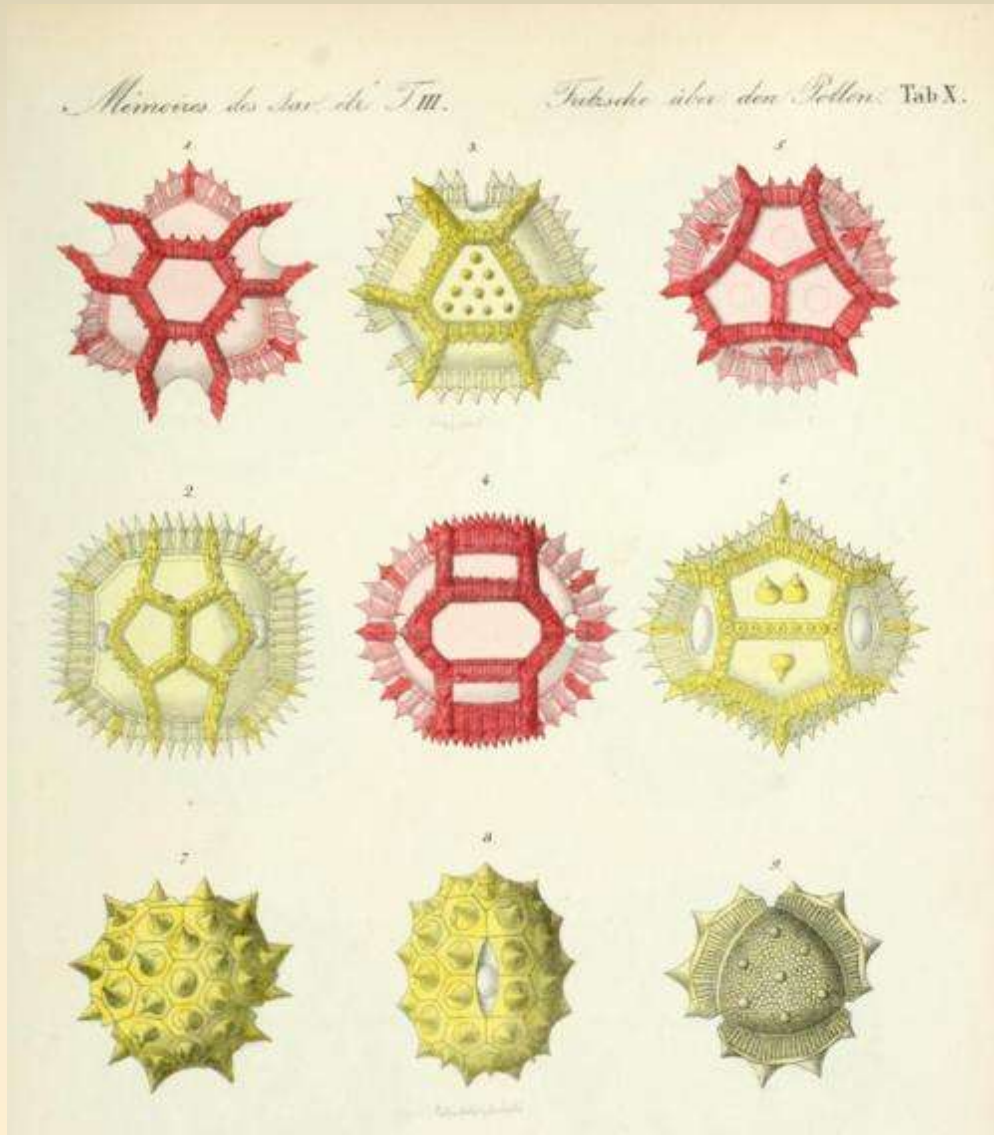
Hugo von Mohl – 1805 – 1872



- Studied fine structure of walls,
- Developed sectioning of pollen.
- Developed classification of pollen based on apertures

1835 *Sur la structure* et les formes du *pollen*. Ann. Sci. Nat. Bot. Ser. 2,3, 148-180, 220-236, 304-346

Pollen from 'Ueber den Pollen' by Julius Fritzsche Published 1837



Pollen analysis was initially confined to Nordic countries because many early publications were in Nordic languages

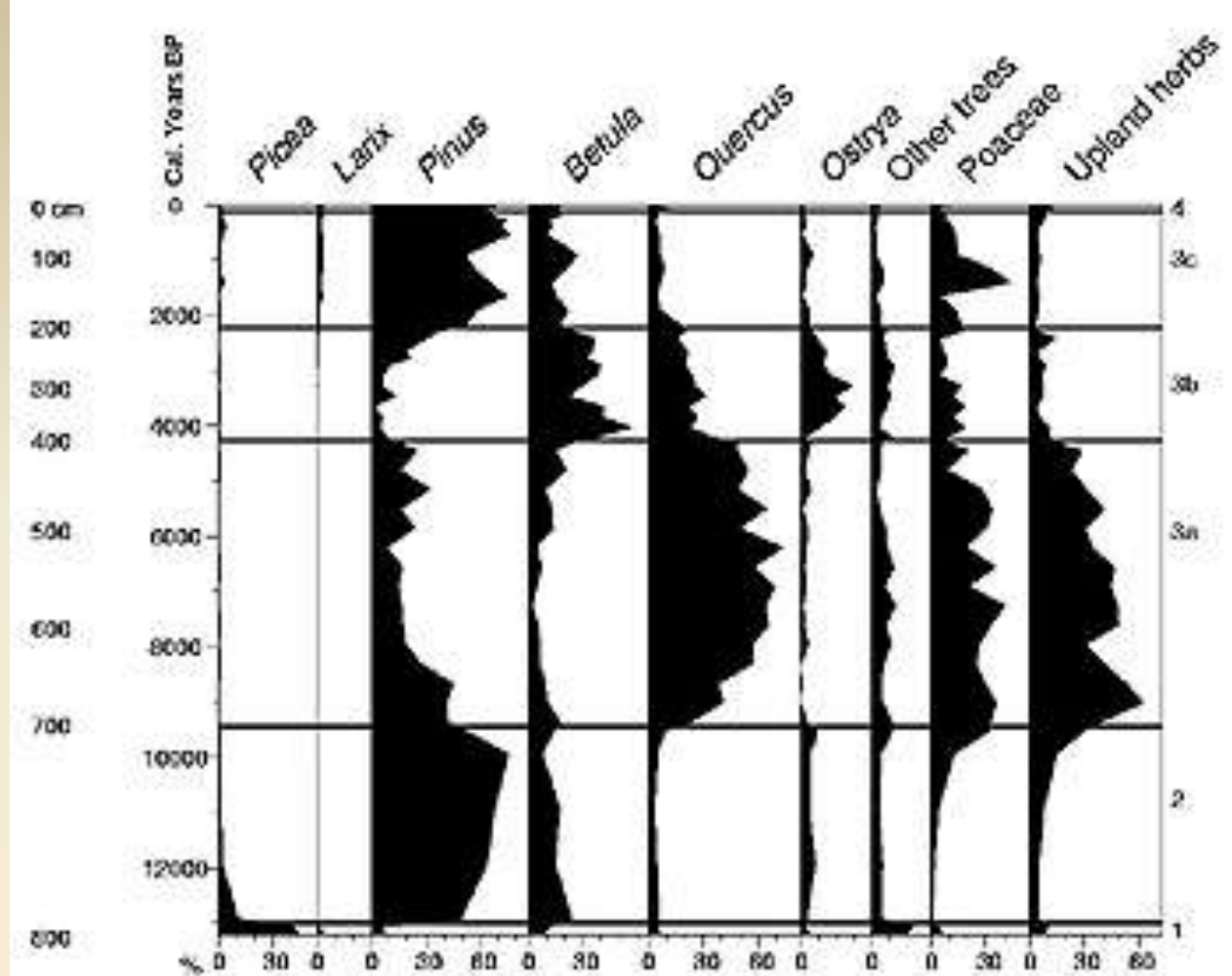
Roger Philip Wodehouse – 1889 -1978 Canadian
1935, 1959. *Pollen grains*.

Gunnar Erdtman - 1897–1973 Swedish
1933 Developed acetolysis technique
1943 *An Introduction to Pollen Analysis*
1952 *Pollen Morphology and Plant Taxonomy. I .
Angiosperms*.
Popularized fossil pollen analysis in the 1920s and
1930s through both his English language
publications and a lecture-collecting tour in North
America

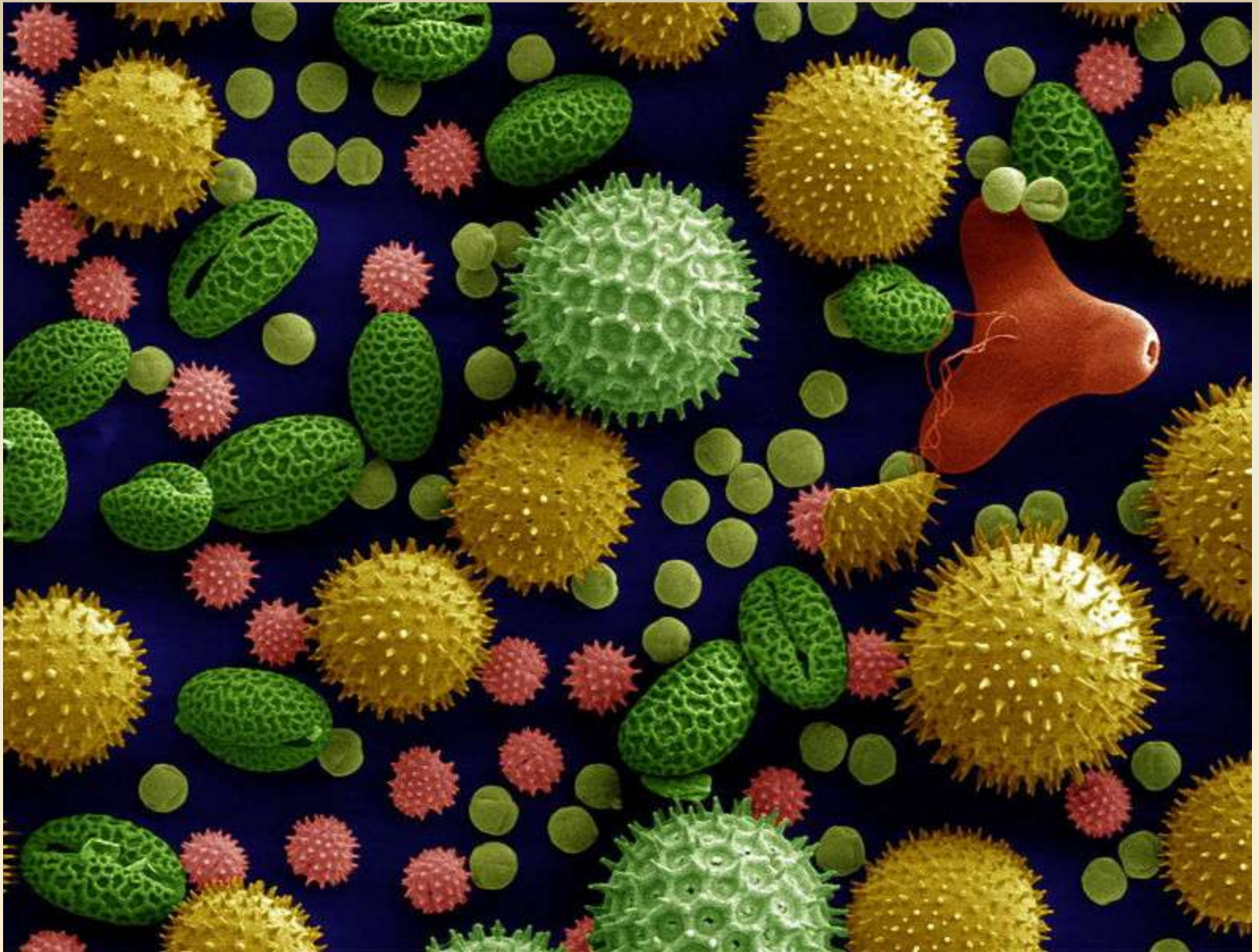
Knut Fægri - 1909 – 2001 Norwegian
Text-Book of Modern Pollen Analysis (4 editions
1950-1989
The Principles of Pollination Ecology (1966, with L.
van der Pijl)

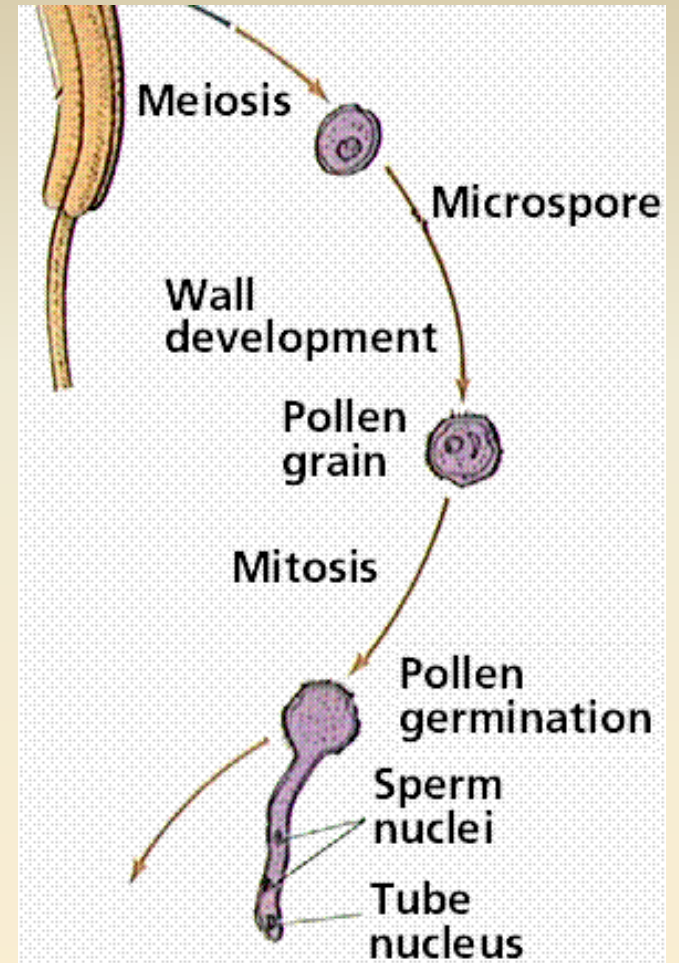
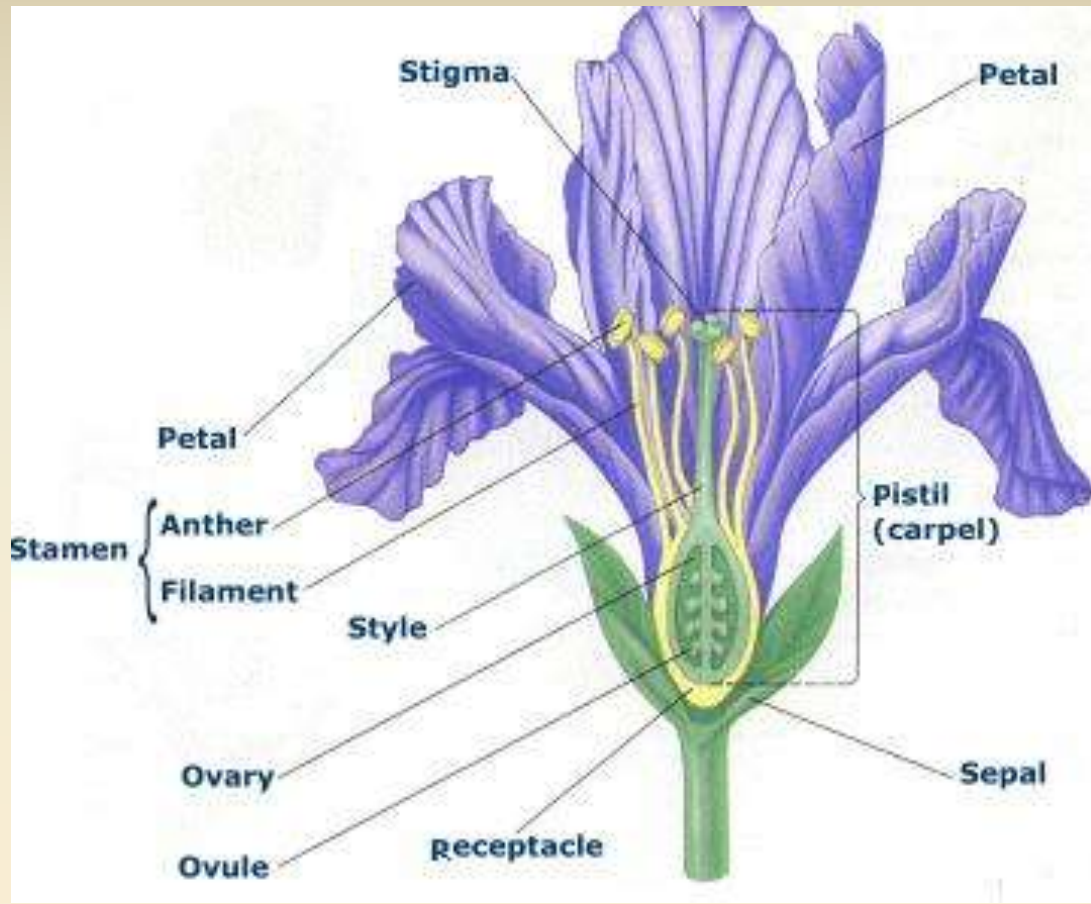


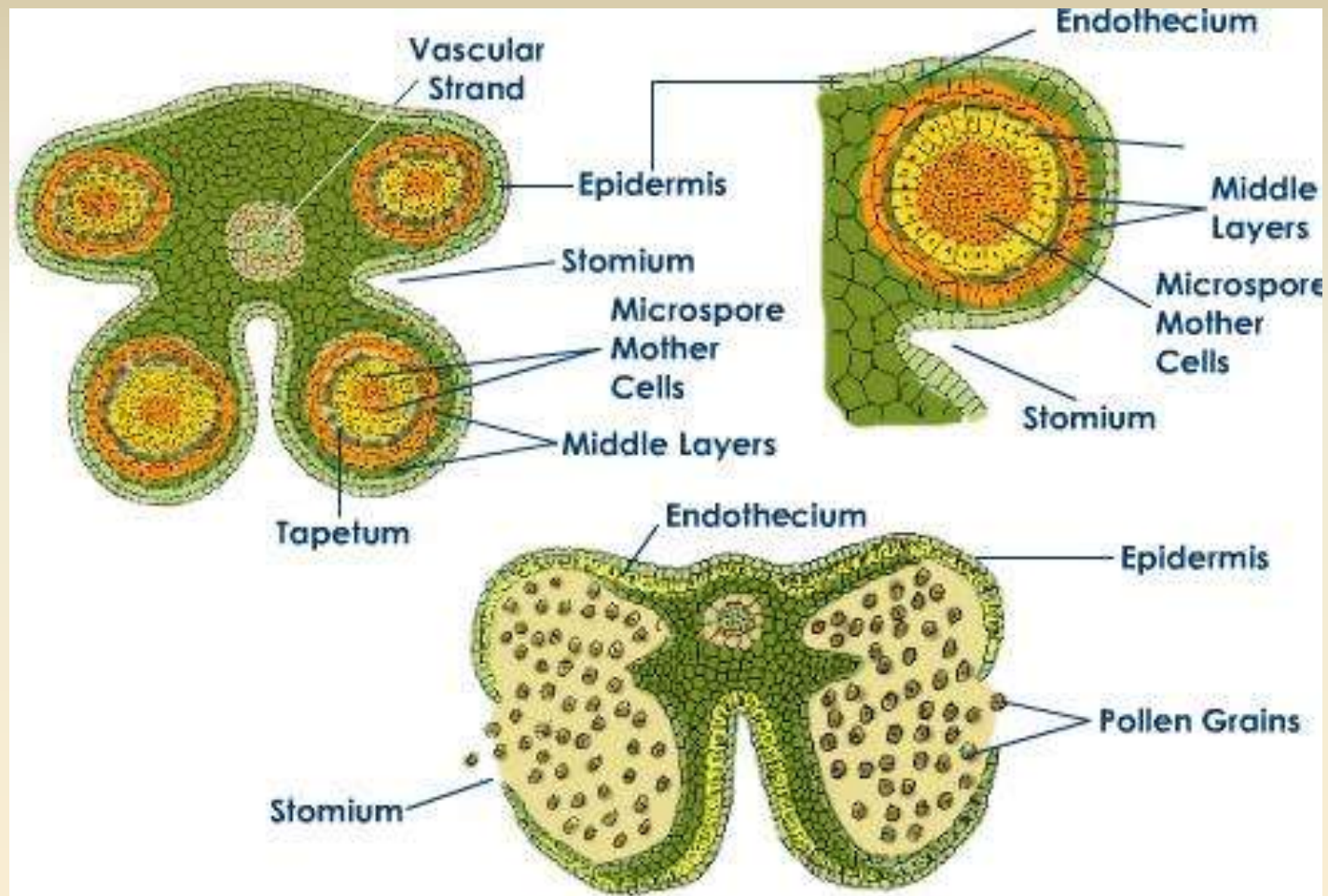
Erdtman 1931



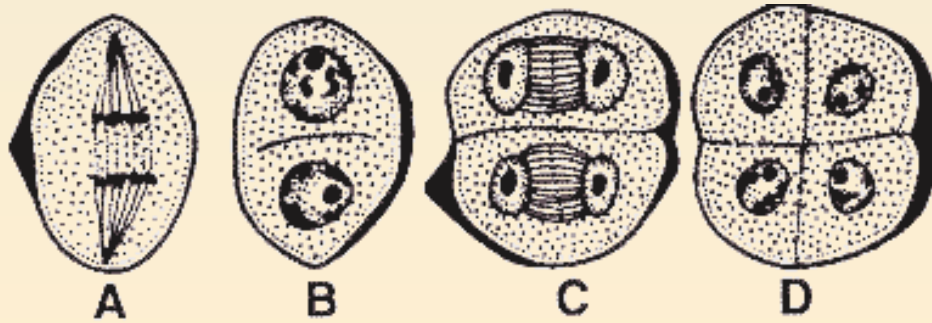
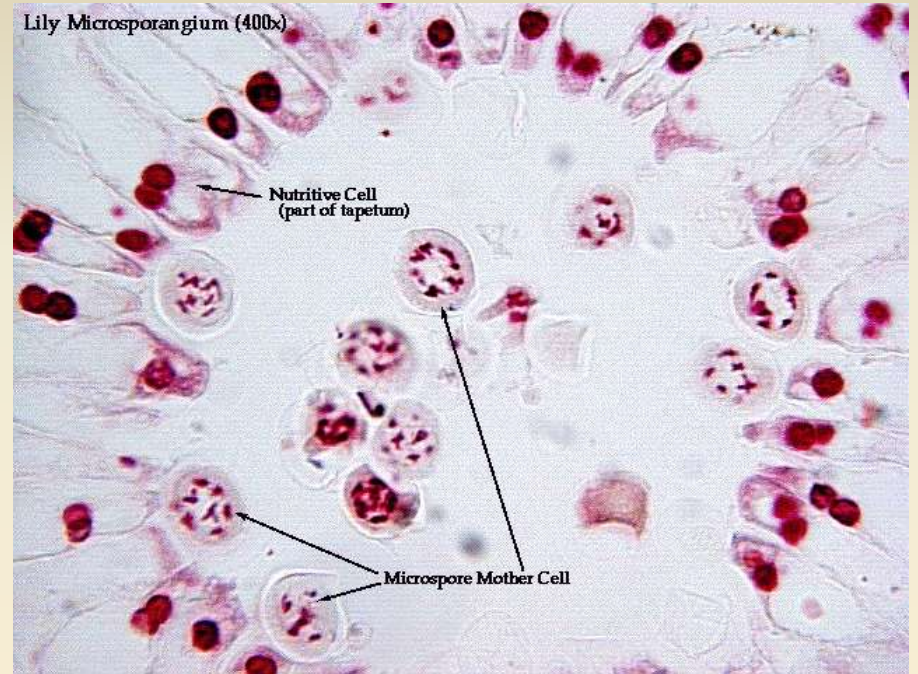
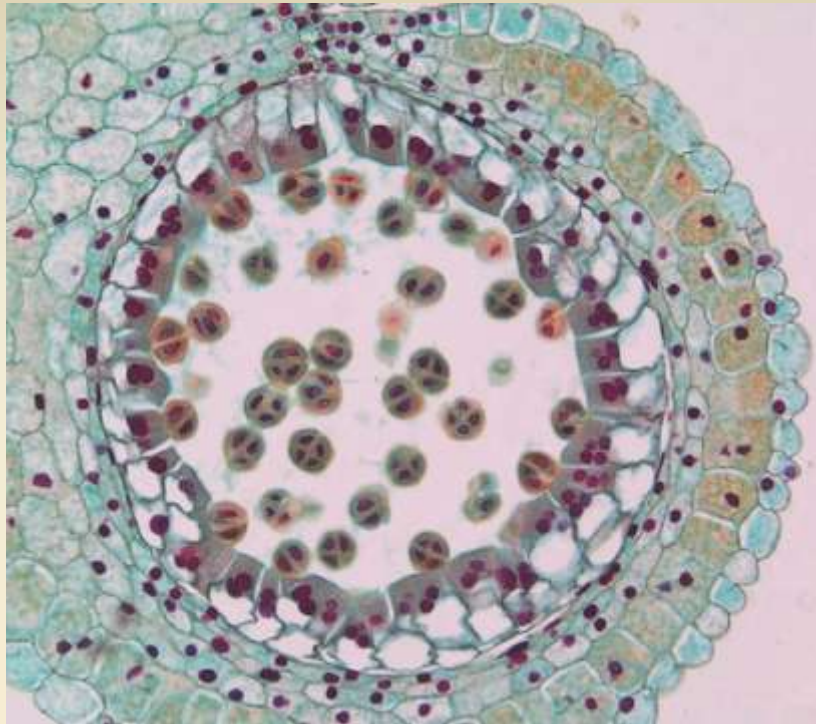
Bog D Pond pollen diagram, located about 70 m south of Erdtman's Muskeg core, redrawn from McAndrews (1966). Pollen sum is tree pollen. Sediment is gyttja with a buried soil at the base. Four 14C dates and the surface provide a chronology. The Poaceae peak in Zone 3c is from wild rice.







Pollen Mother Cells



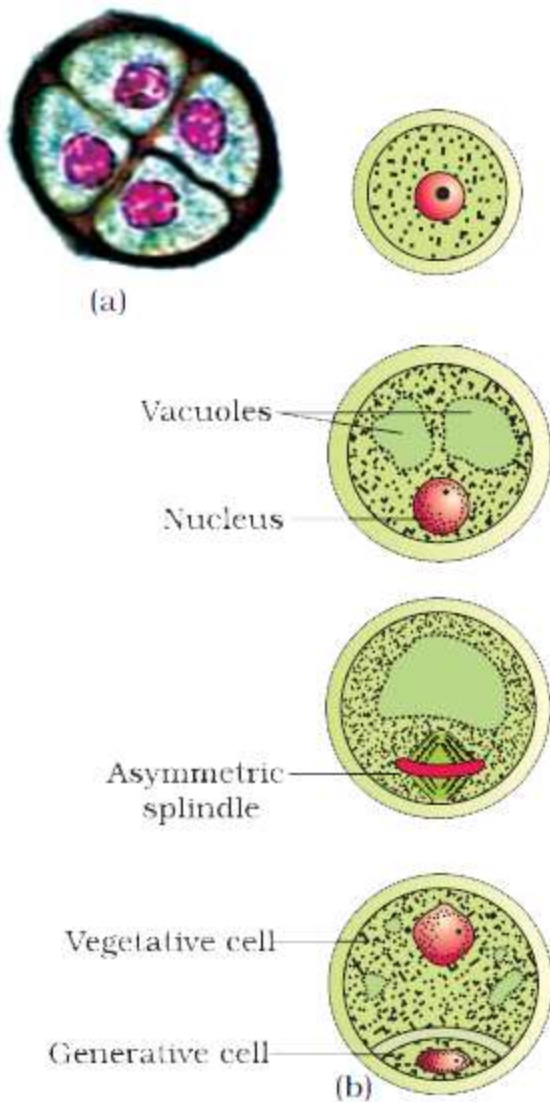
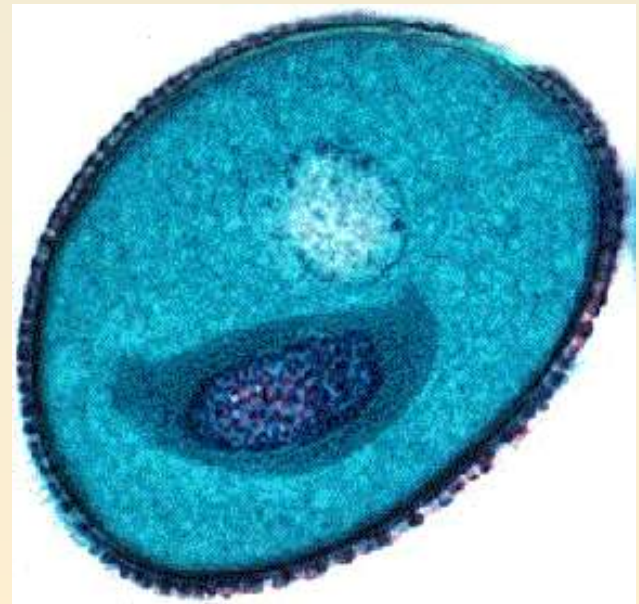
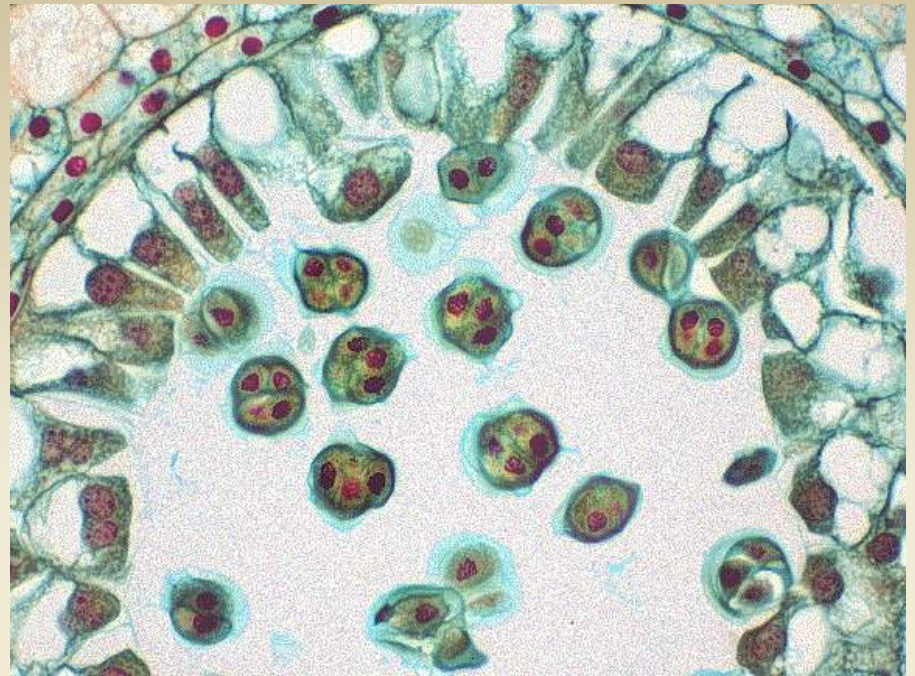
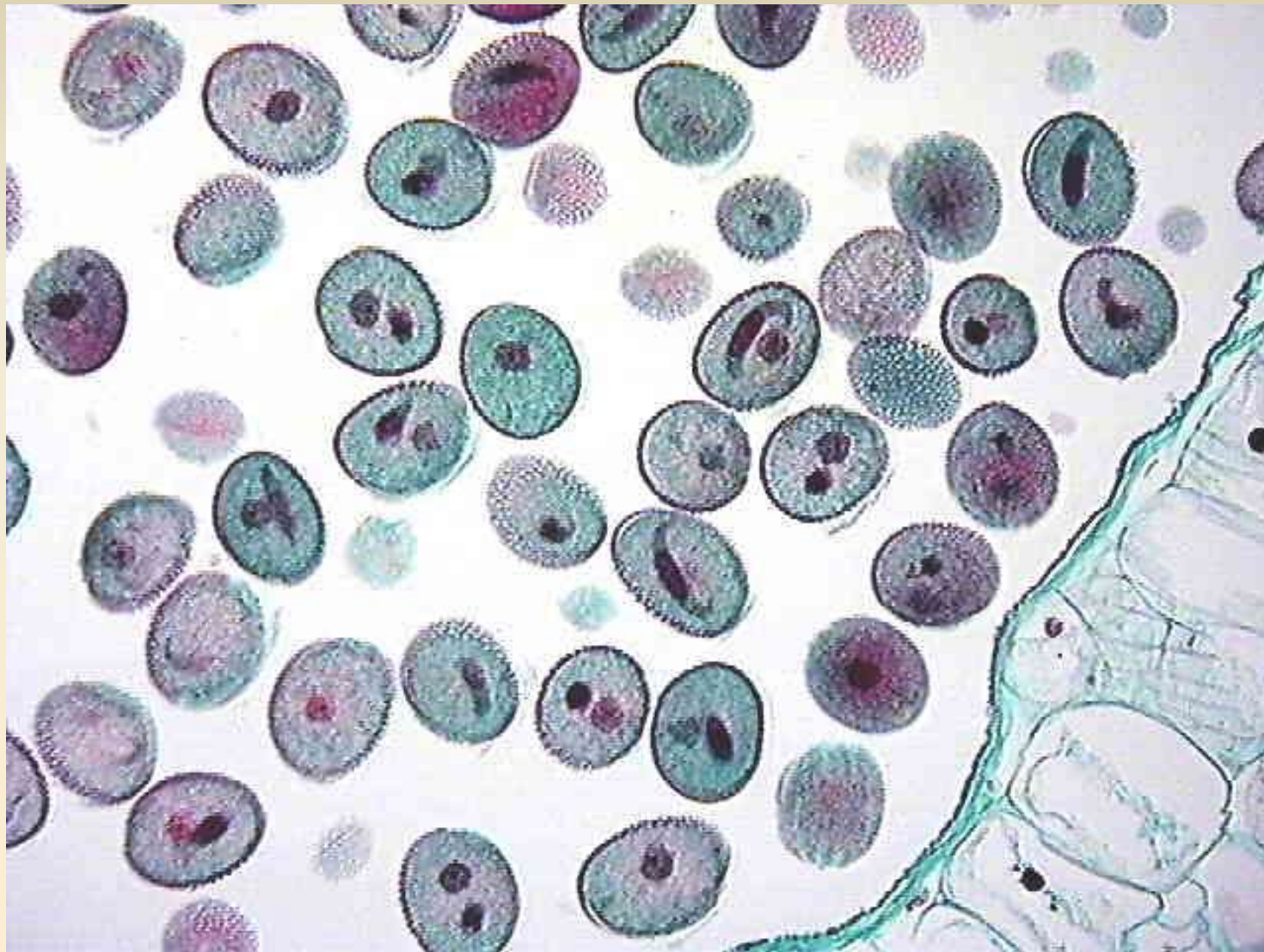


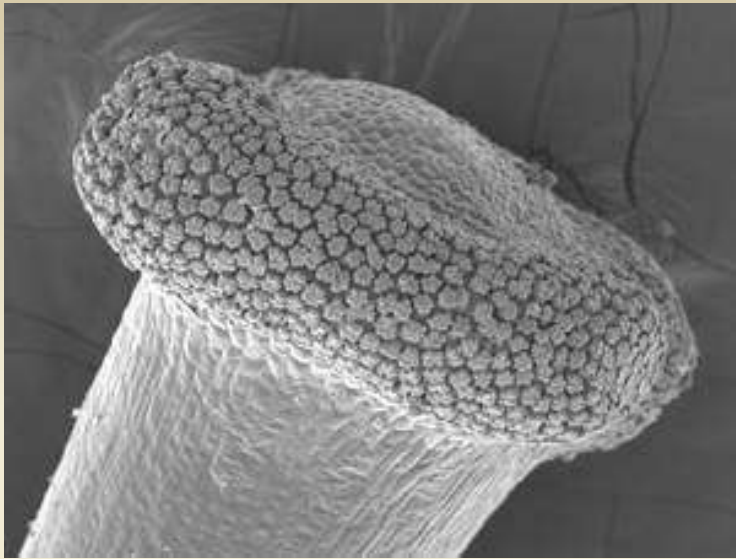
Figure 2.5 (a) Enlarged view of a pollen grain tetrad; (b) stages of a microspore maturing into a pollen grain



Lilium - Binucleate Mature Pollen



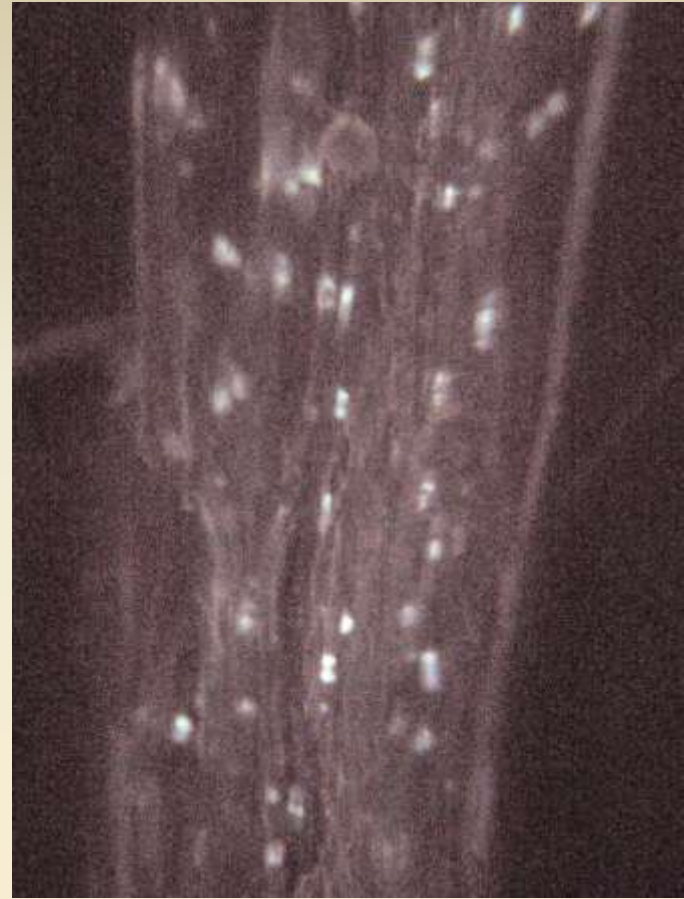
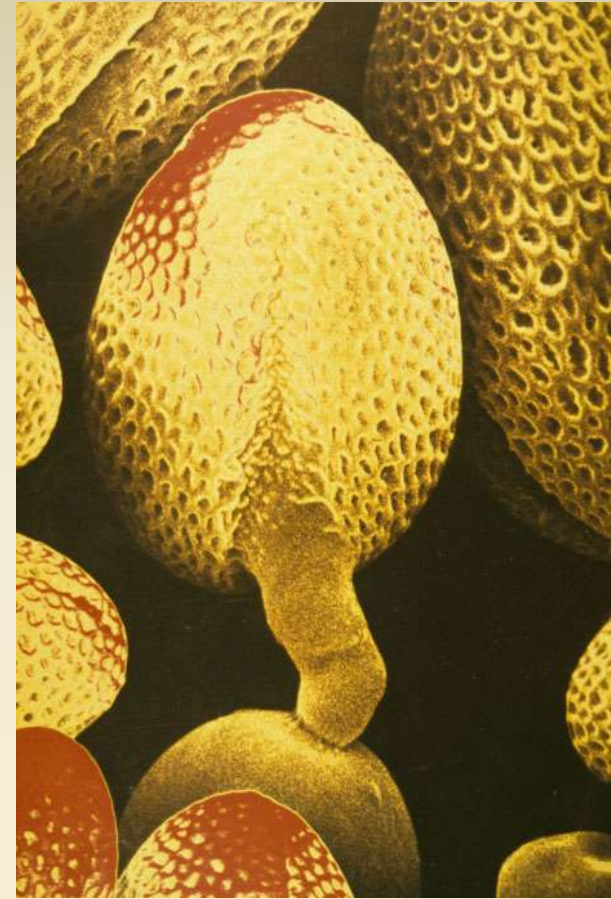




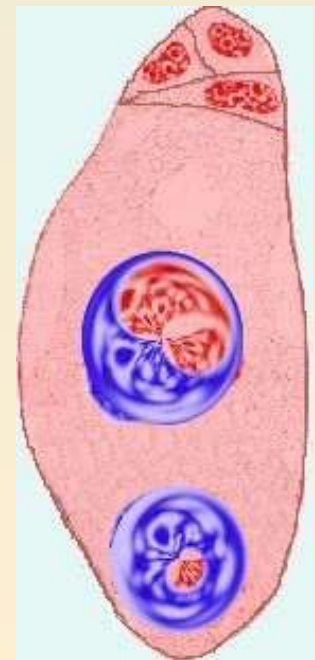
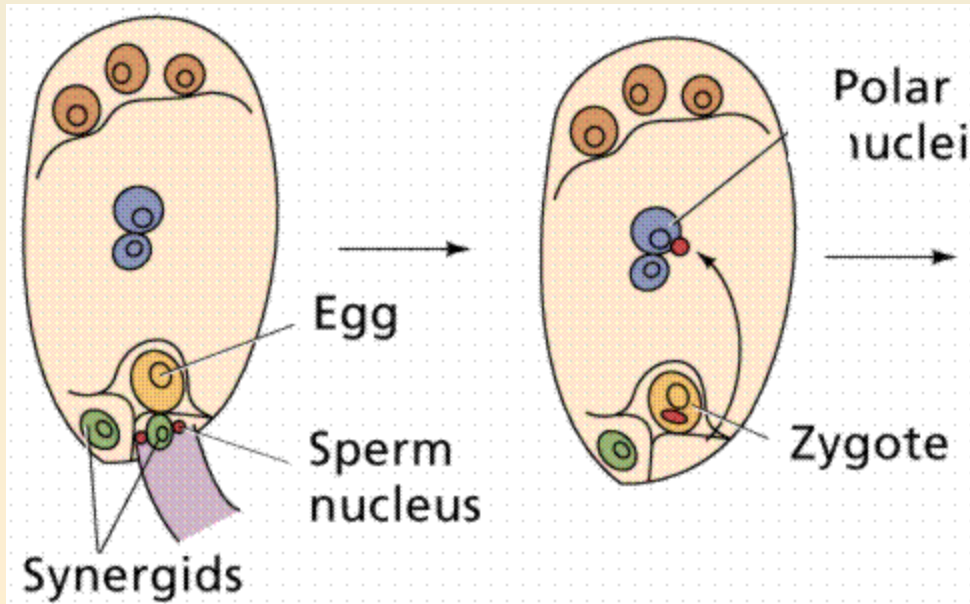
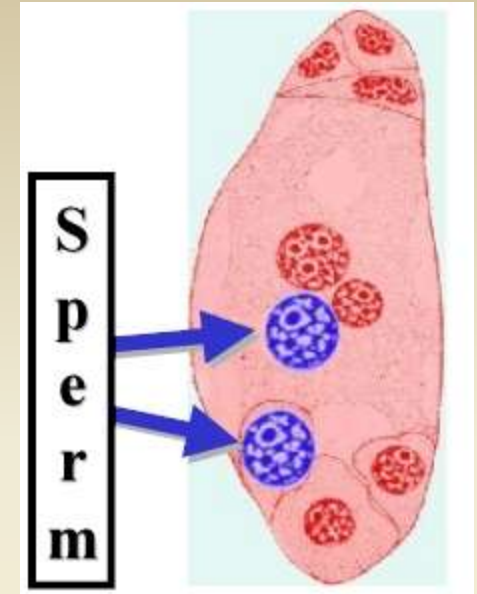
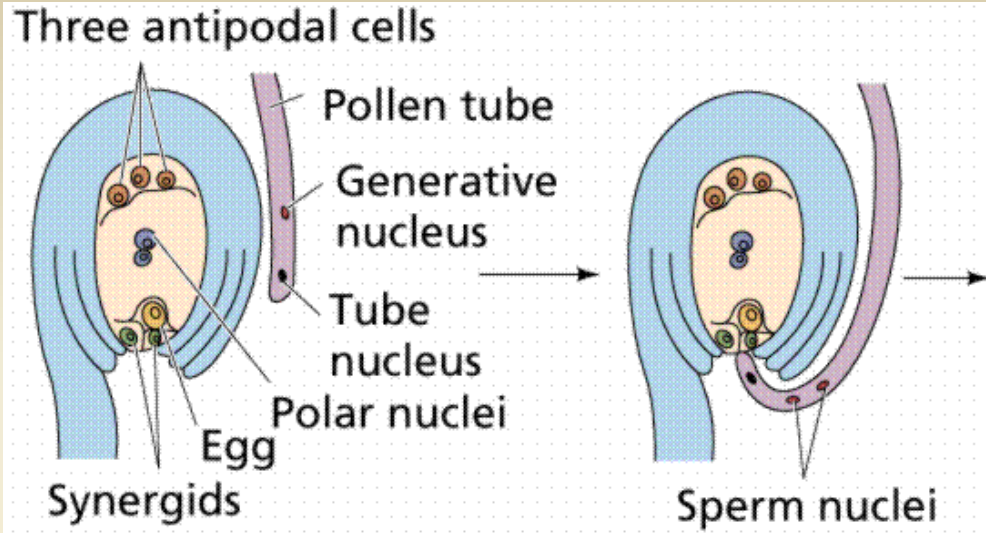
HV spot WD det HFW magpressure 2 mm
10.00 kV 2.5 15.3 mm LFD 4.83 mm 62 x 24 Pa Amaryllis pistil



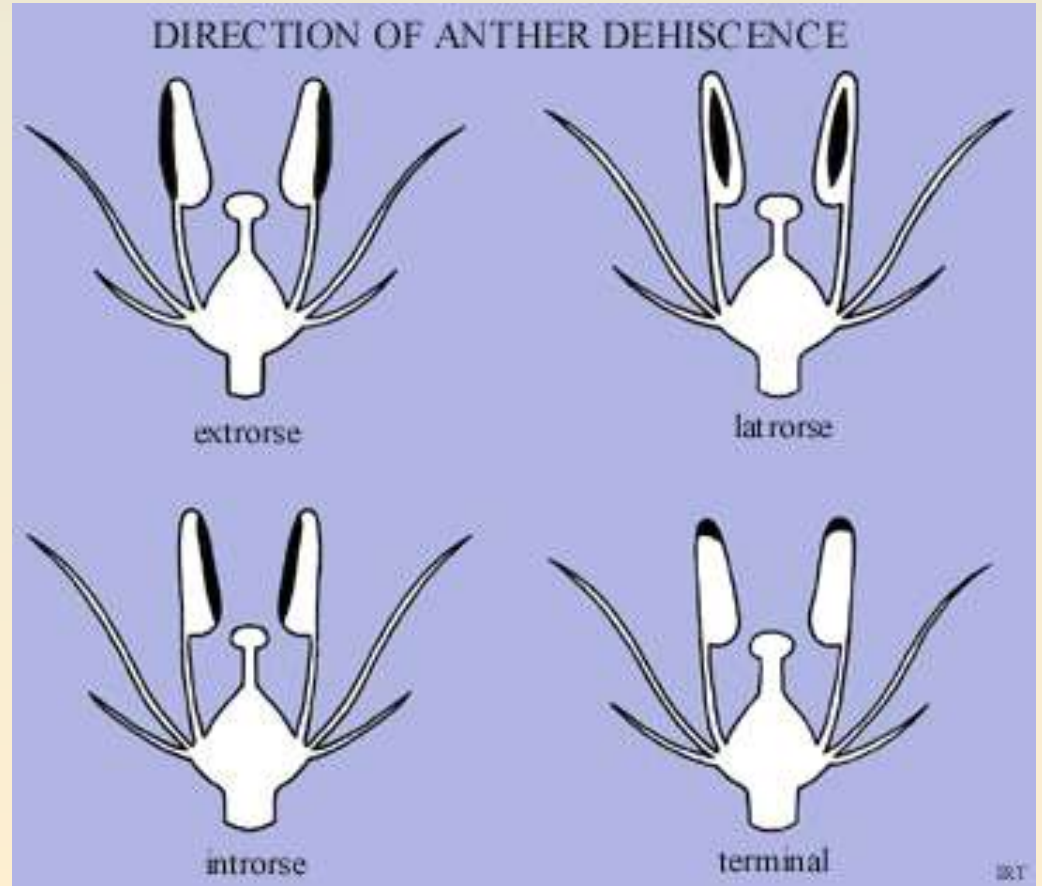
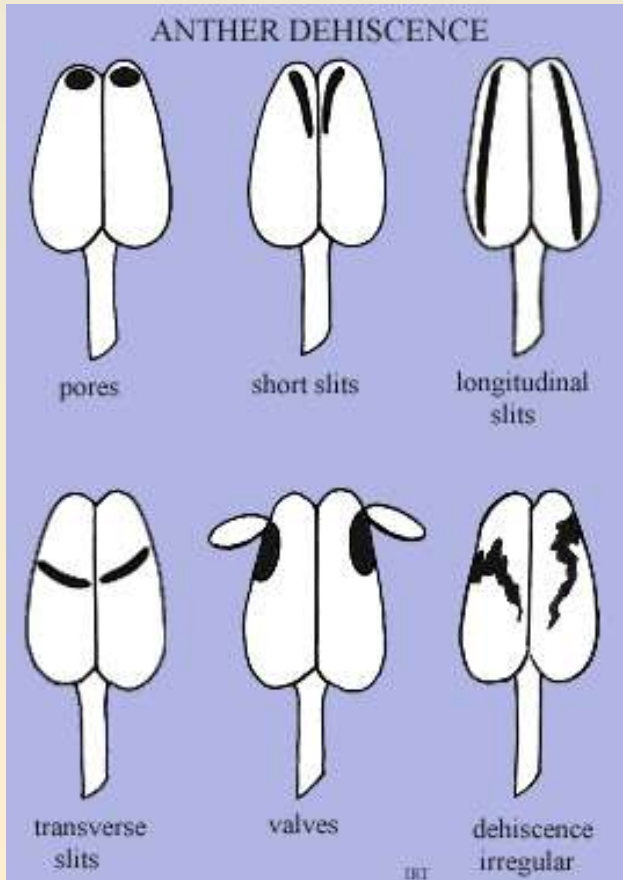
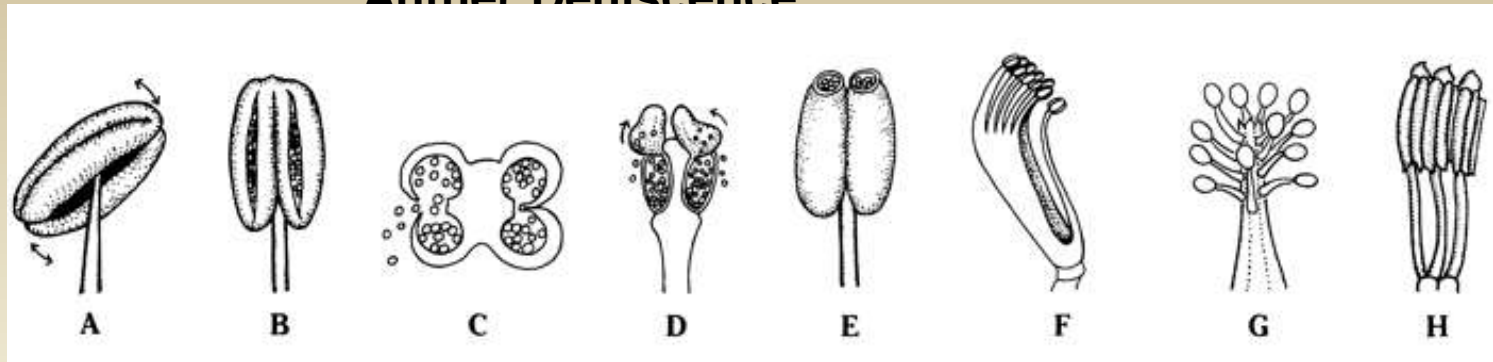
Pollen tube growth



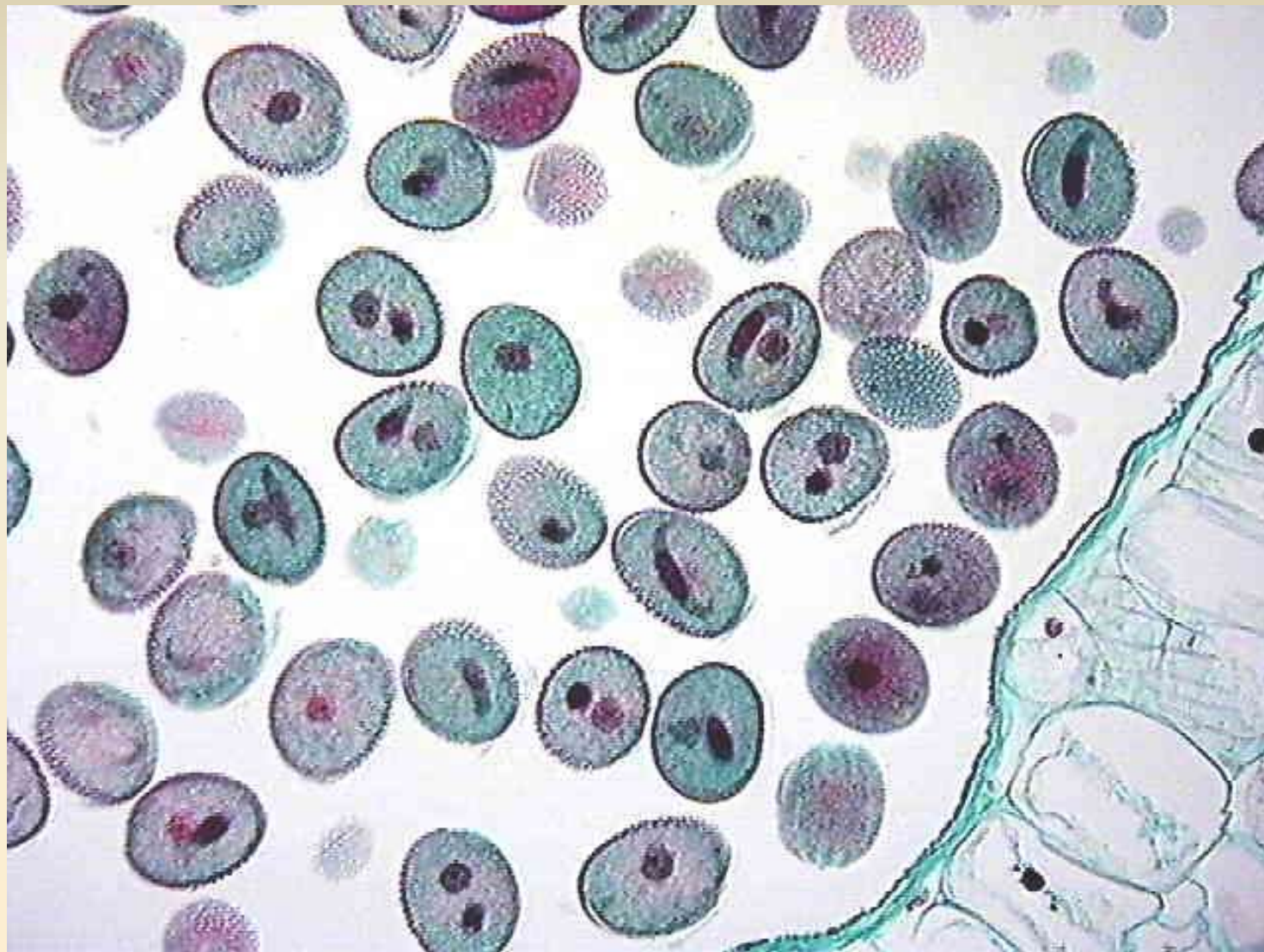
Double Fertilization



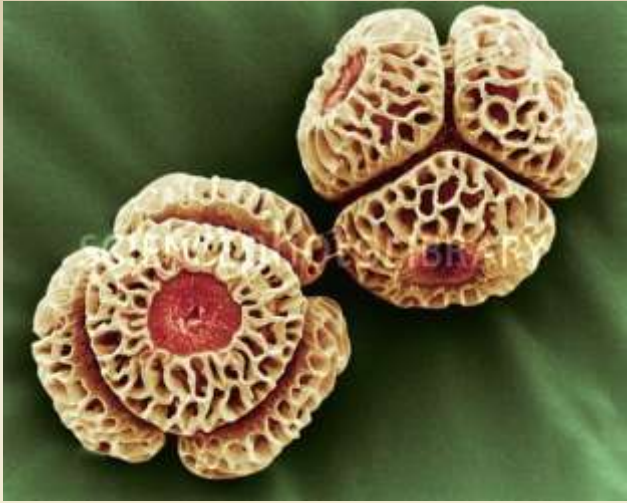
Anther Dehiscence



Lilium - Binucleate Mature Pollen

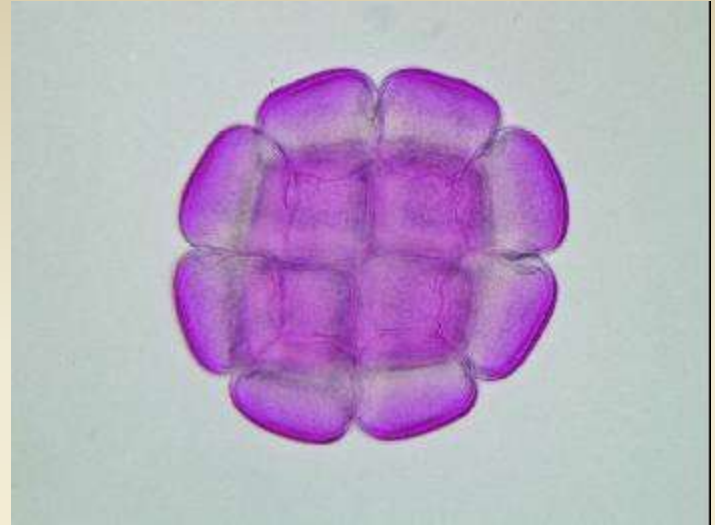


Tetrads



Drimys

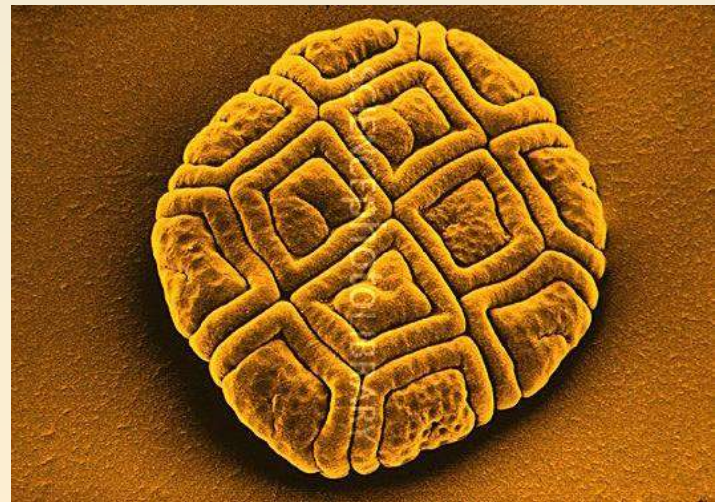
Polyads



Albizia



Drosera



Acacia

Dyads

Podostemaceae

Tetradas

Annonaceae

Apocynaceae

Begoniaceae

Datisceae

Droseraceae

Empetraceae

Epacridaceae

Ericaceae

Gentianaceae

Goodeniaceae

Guttiferae

Hydrostachyaceae

Malvaceae

Nepenthaceae

Onagraceae

Pyrolaceae

Schisandraceae

Winteraceae

Polyads and Tetrads

Mimosae (Fabaceae)

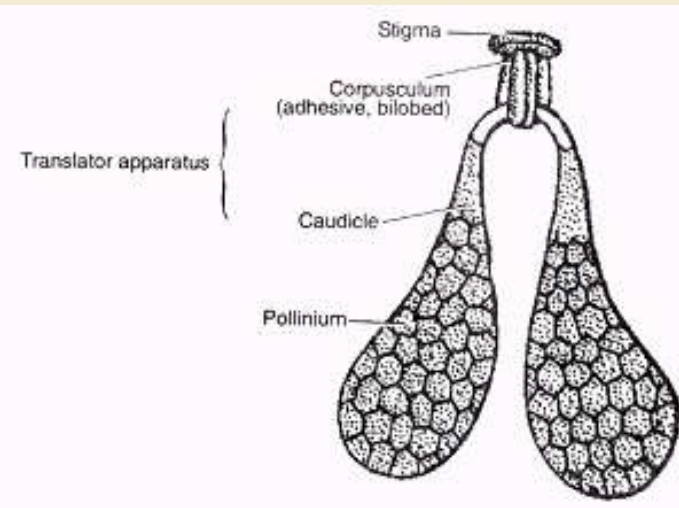
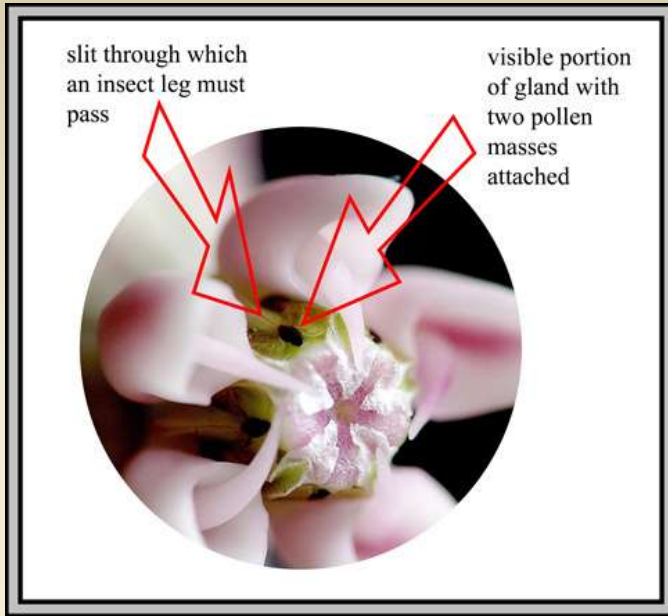
Pollinia

Asclepiadaceae

Orchidaceae

Ascepiadaceae – Milkweed Pollinia

Orchid Pollinia



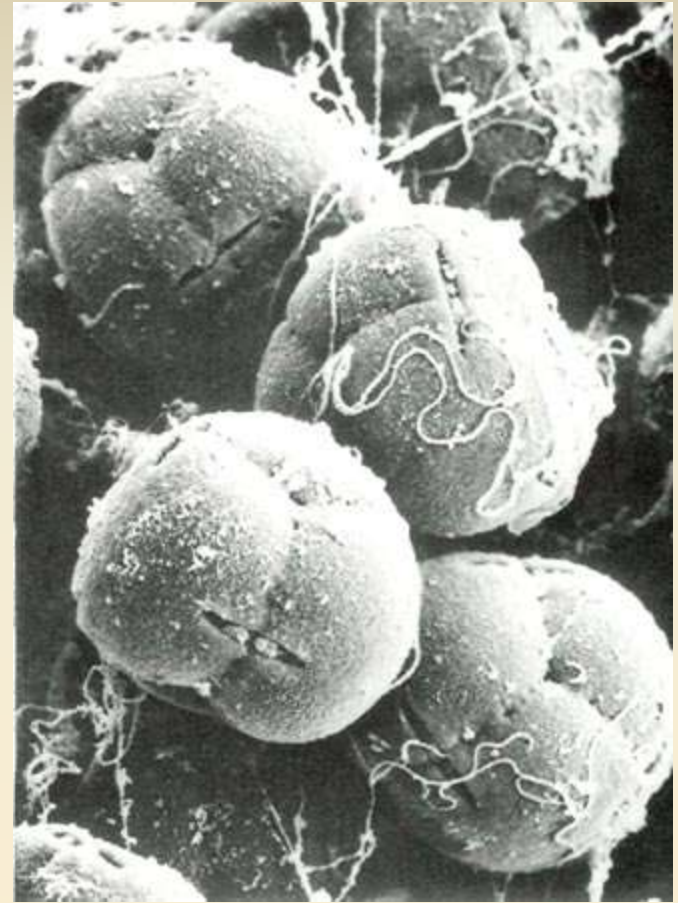
Pollen Size



Cucurbita sp.

Myosotis sp.

Viscin Threads

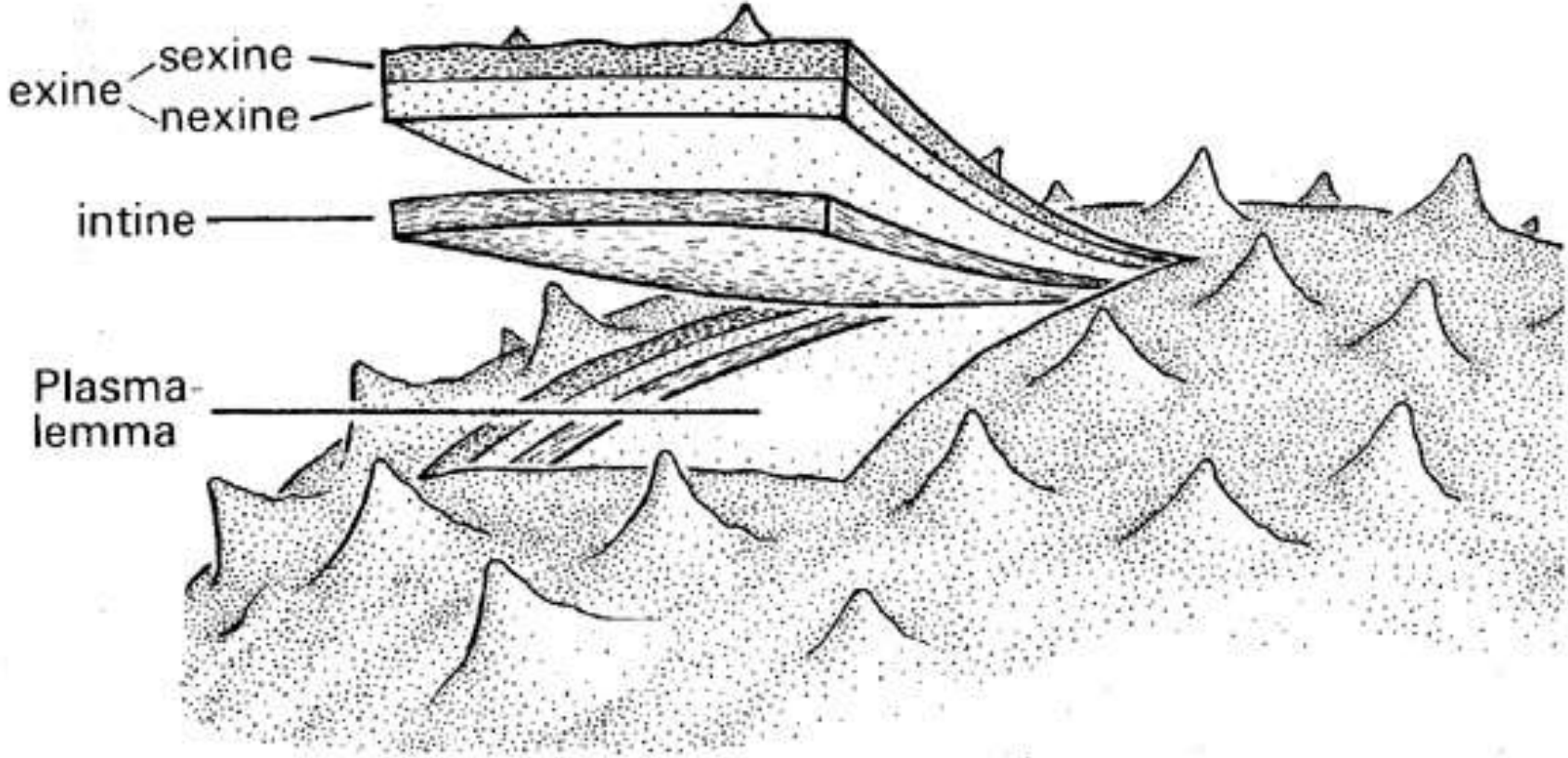


Rhododendron

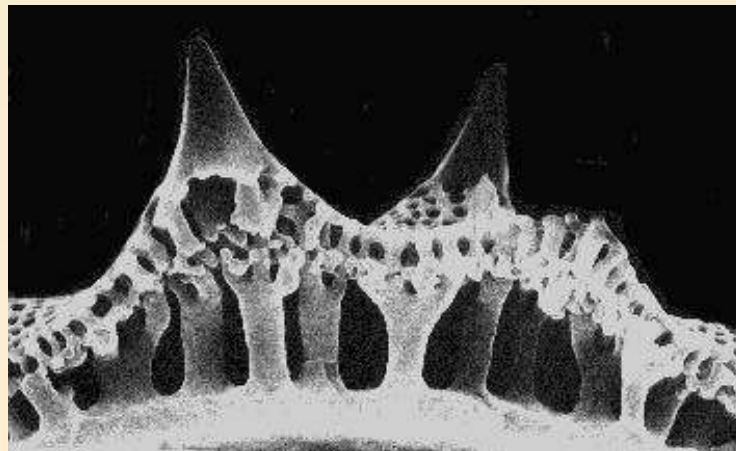
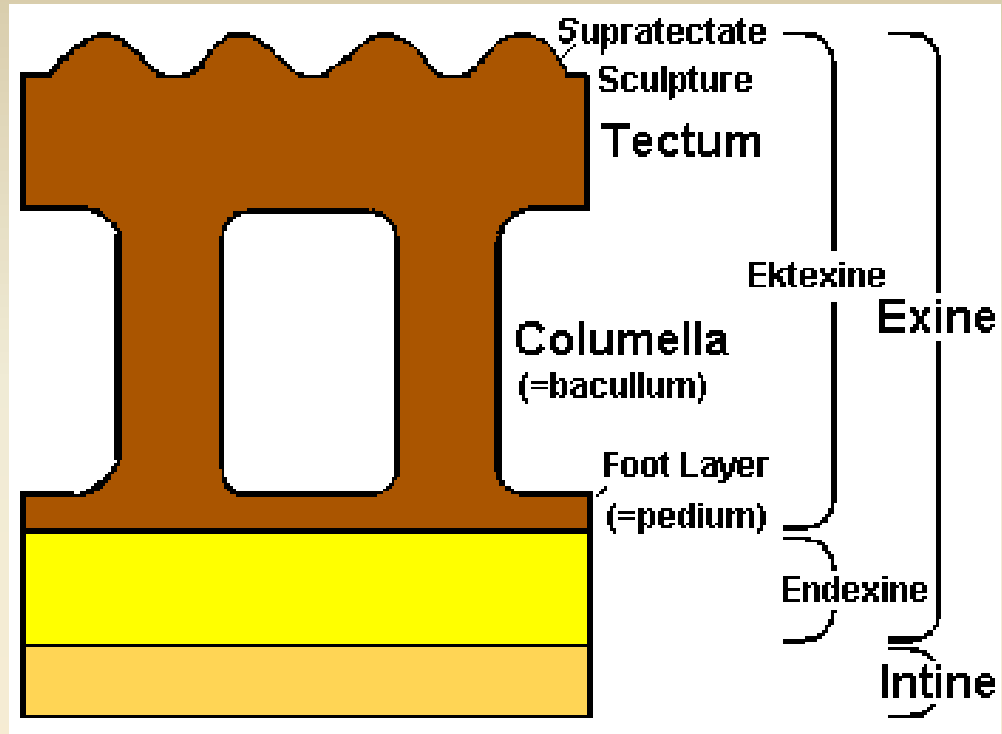


Oenothera

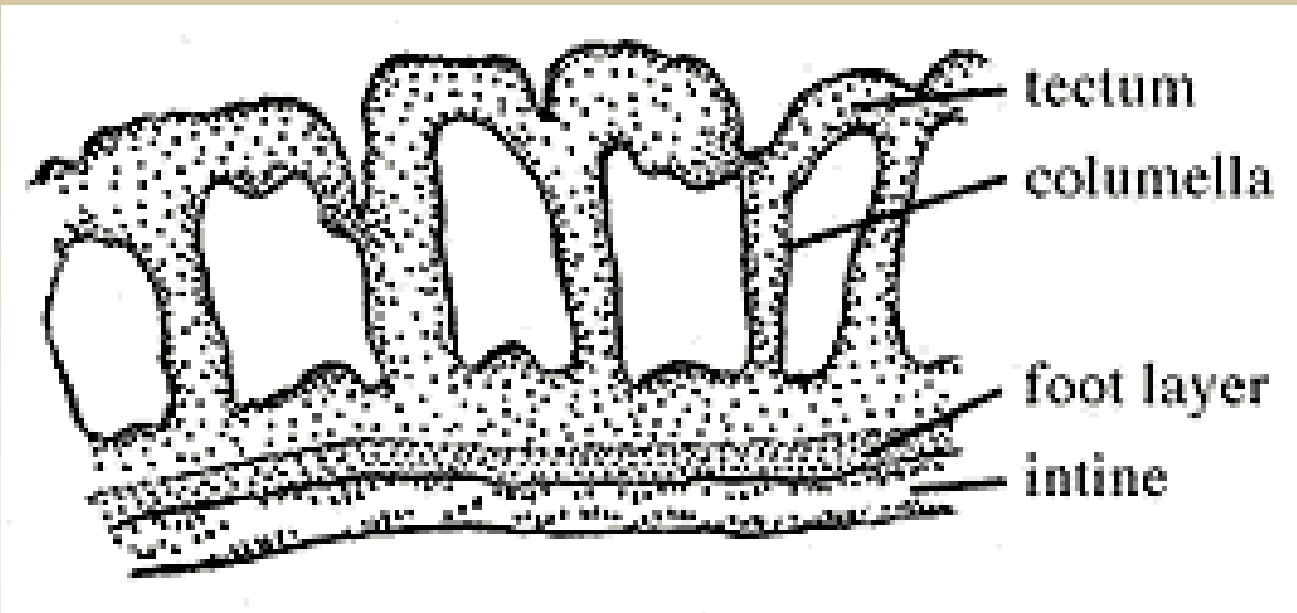
Pollen Wall



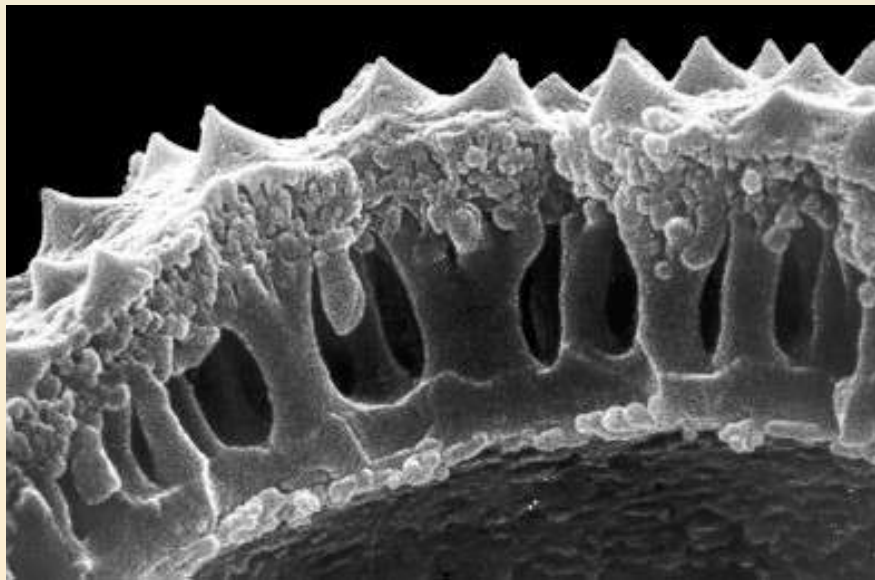
Pollen Wall



Anthemis
Exine
Skvarla

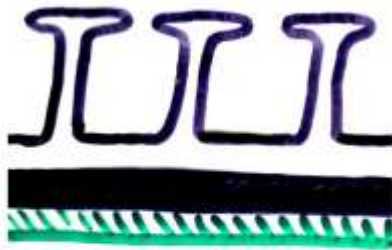


Tectate-collumellate wall (exine) typical of angiosperm pollen.

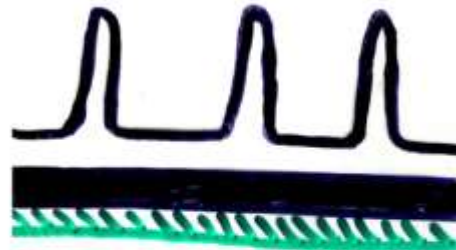


Artemisia

Pollen Walls



Tectate
Angiosperms only



Columellate
Angiosperms only



spongy endexine
Gymnosperms



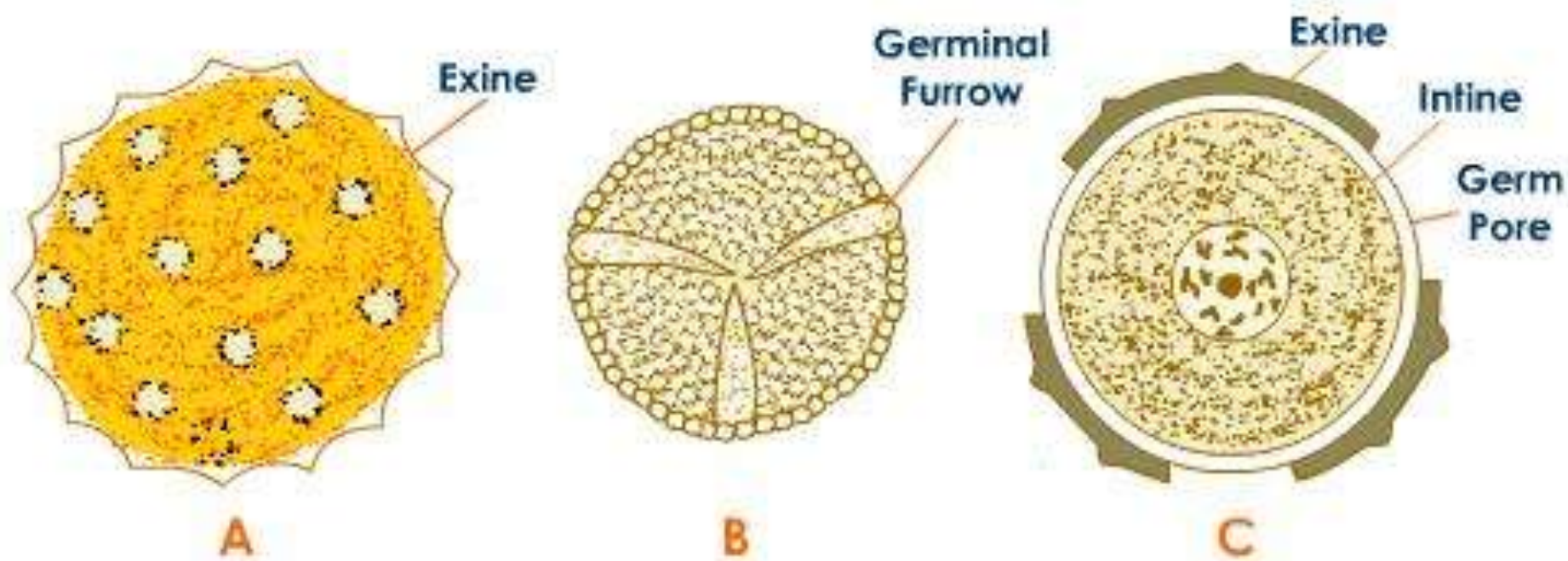
endexine not spongy
Angiosperms



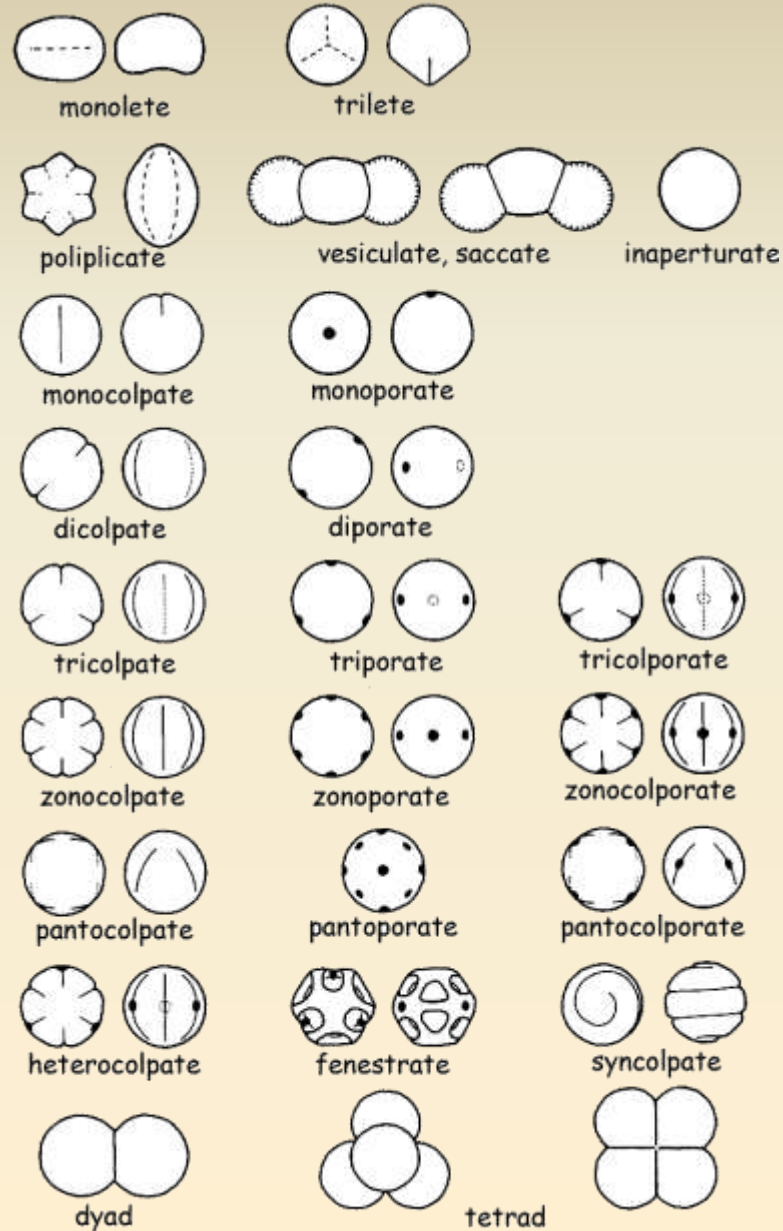
Monosulcate
Gymnosperms &
some angiosperms

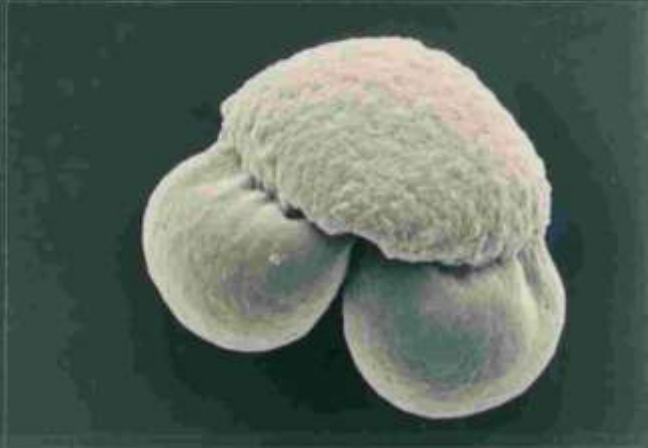
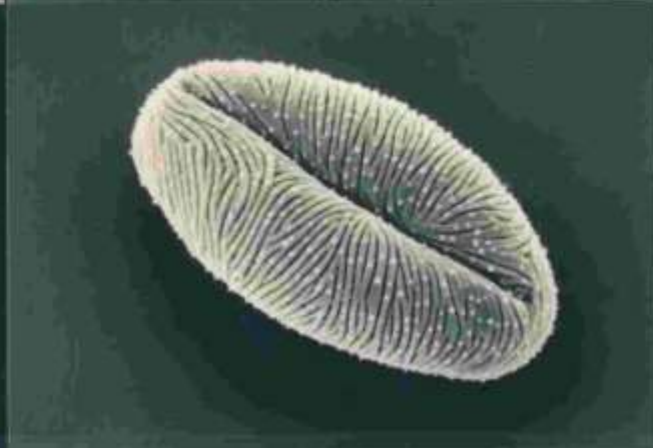
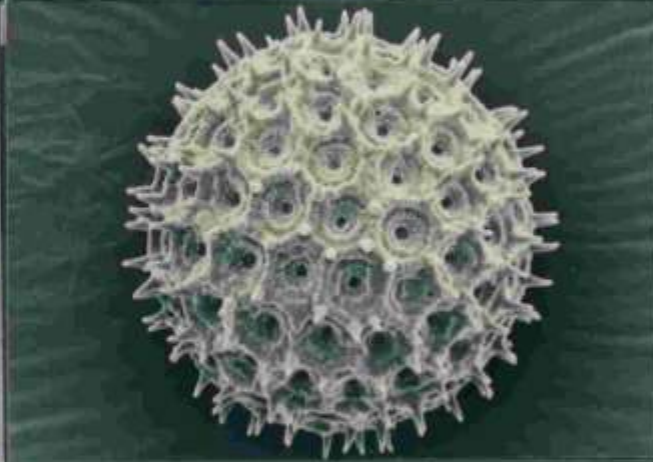
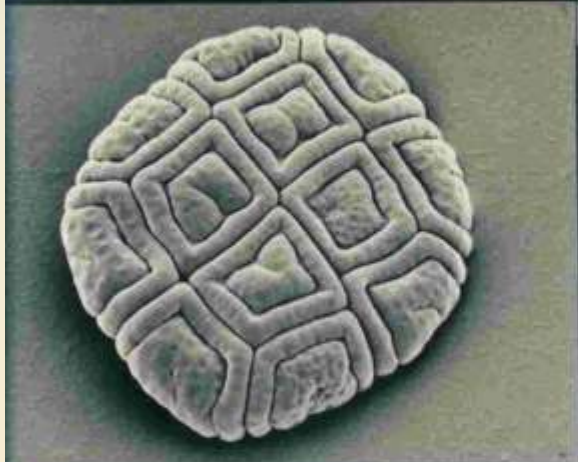
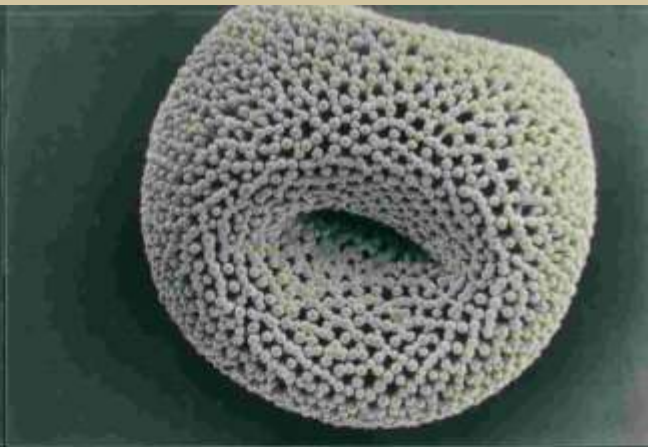
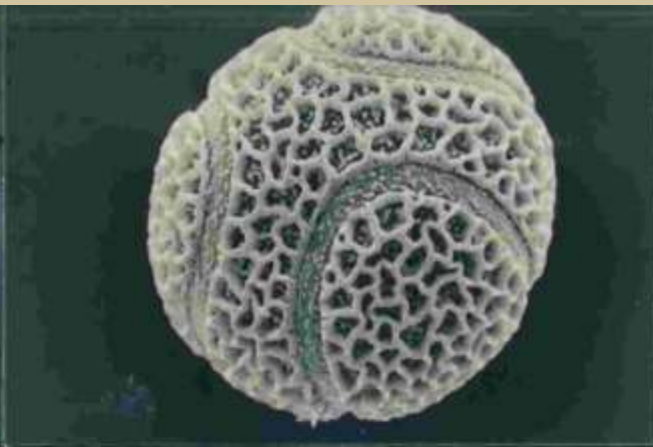


Trisulcate (tricolpate)
Angiosperms only

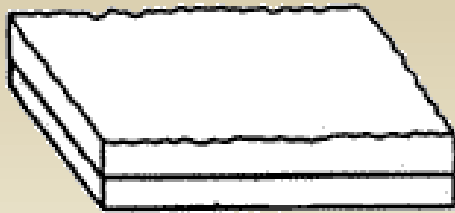


Entire spectrum of possible pollen types

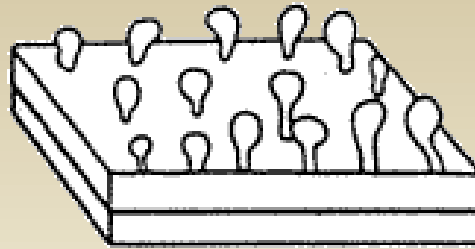




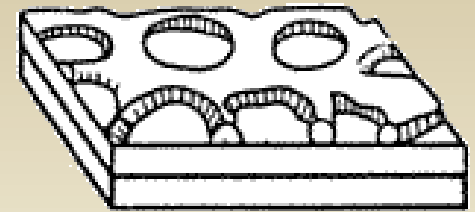
Exine Ornamentation



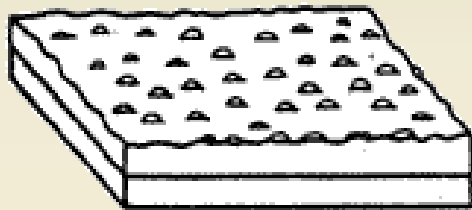
psilate



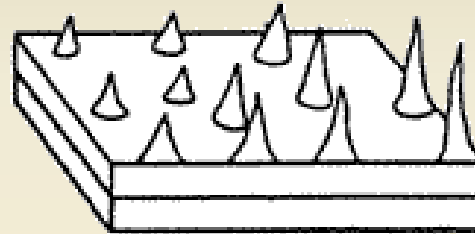
clavate



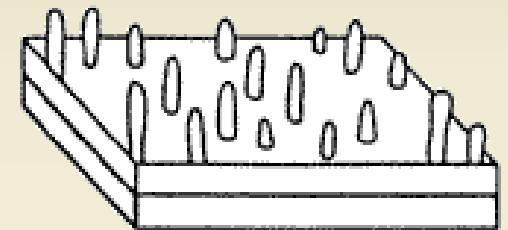
reticulate



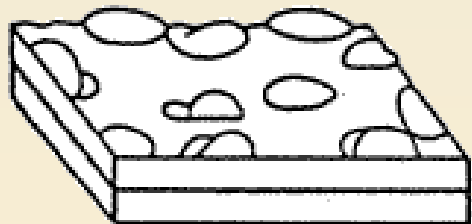
scabrate



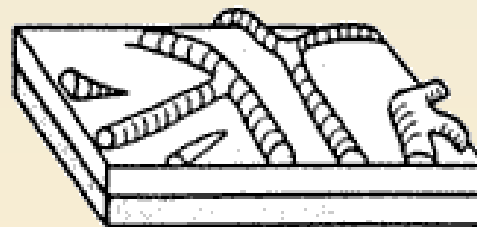
echinate



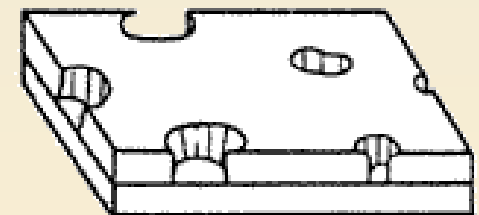
baculate



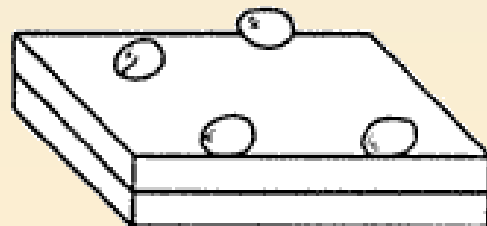
verrucate



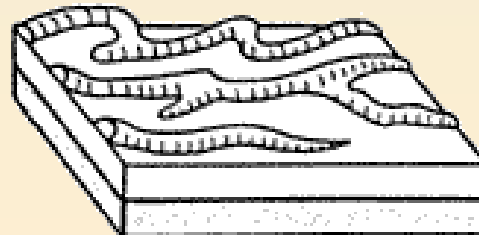
rugulate



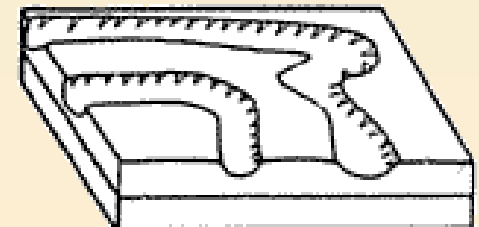
foveolate



gemmate

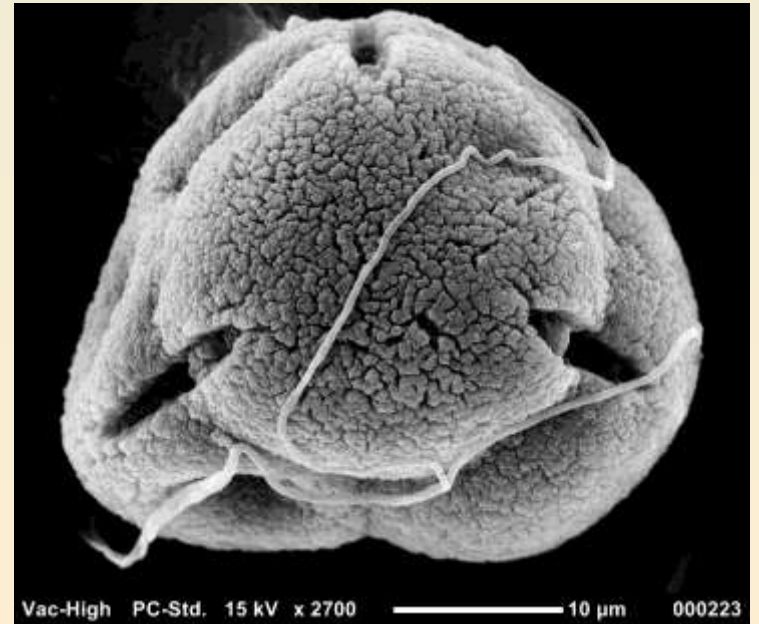
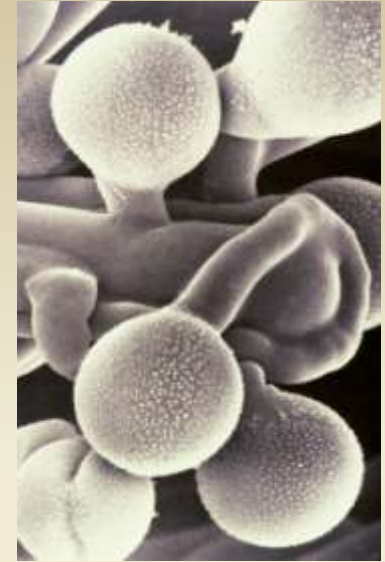
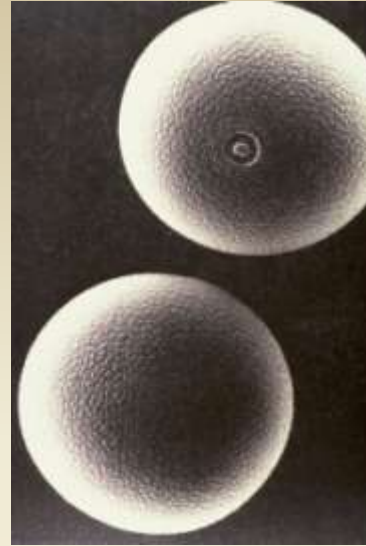
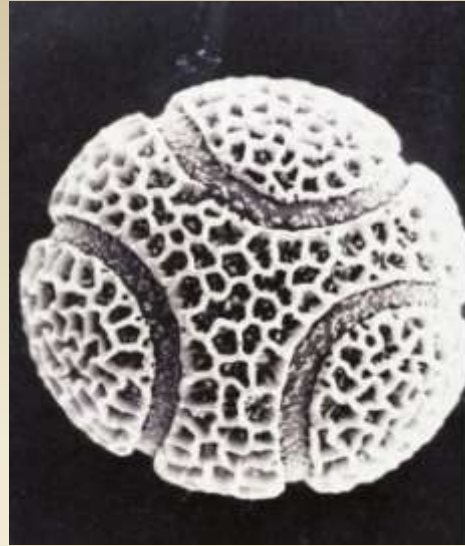


striate

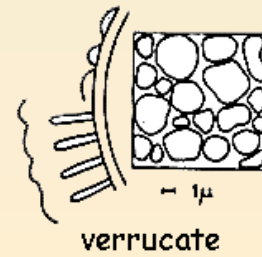
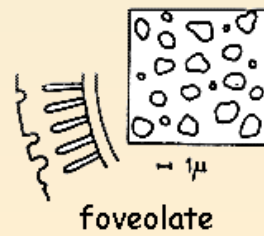
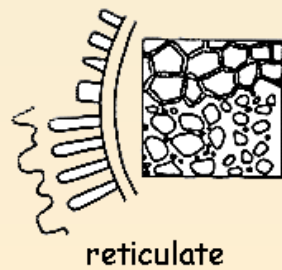
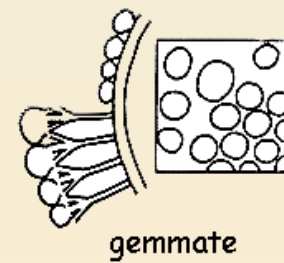
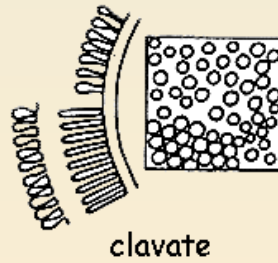
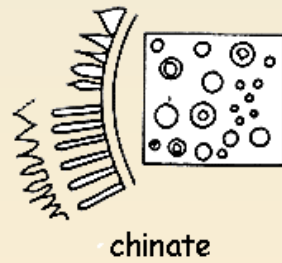
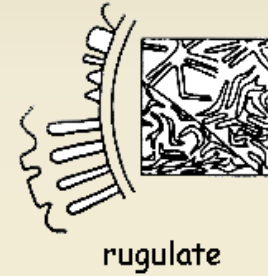
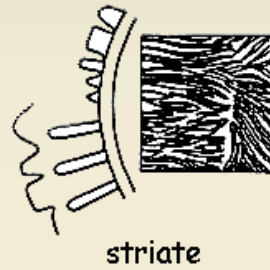
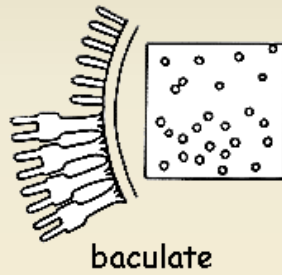
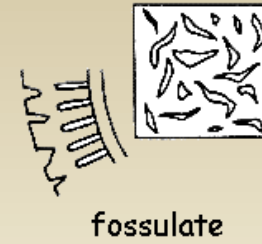
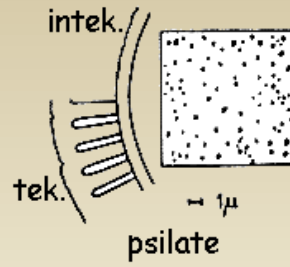
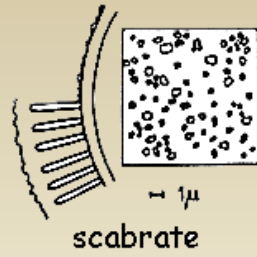


frustillate

Pollen



Different forms of the exine surface





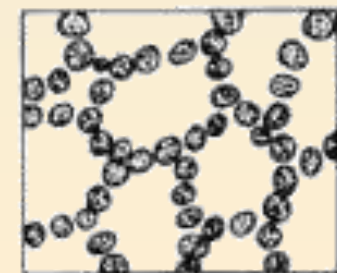
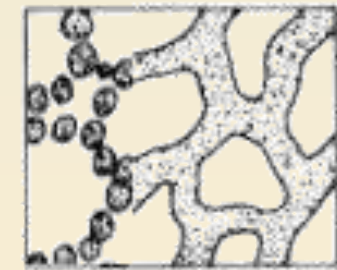
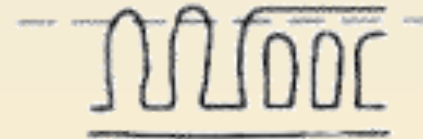
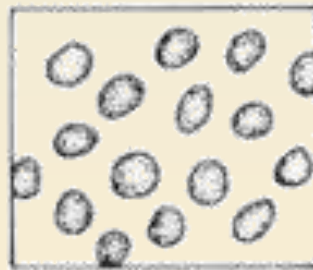
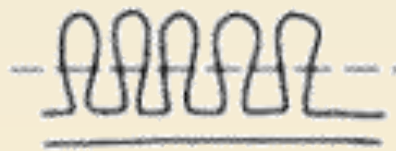
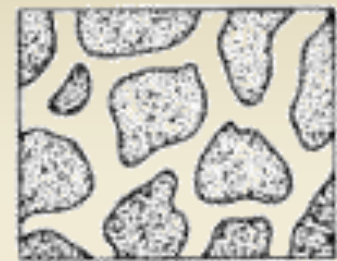
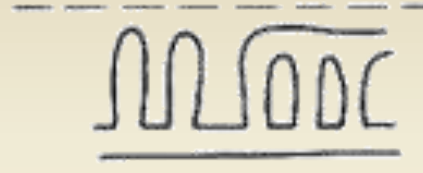
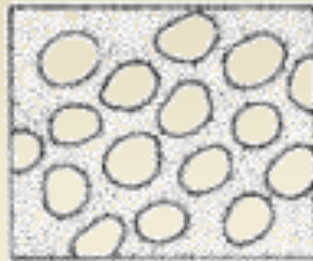
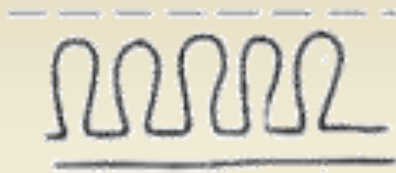
LO-Analysis (Lux Obscuritas) – focus changes

Section

Surface

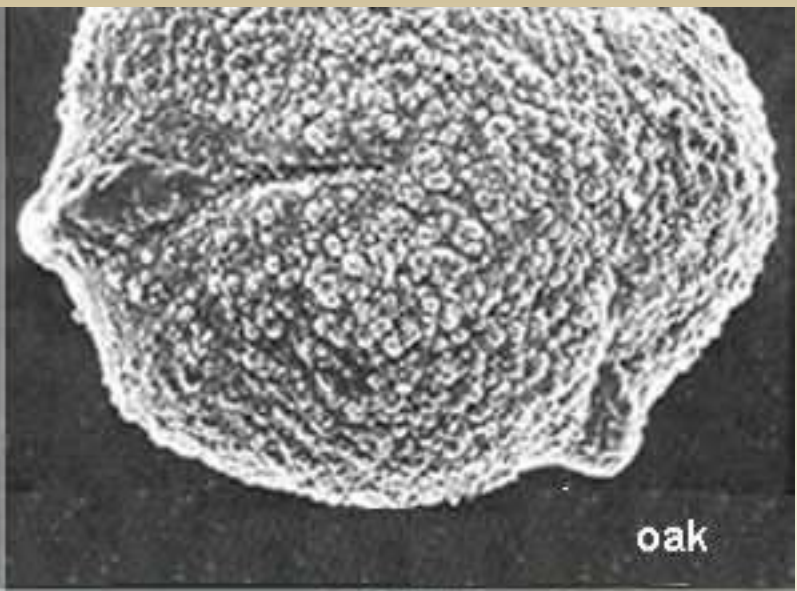
Section

Surface

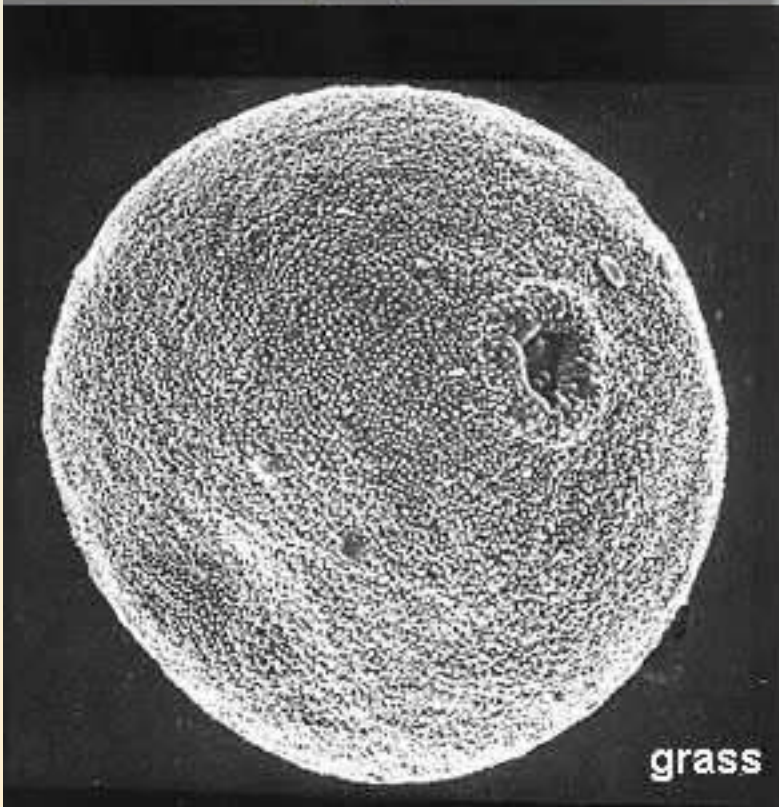




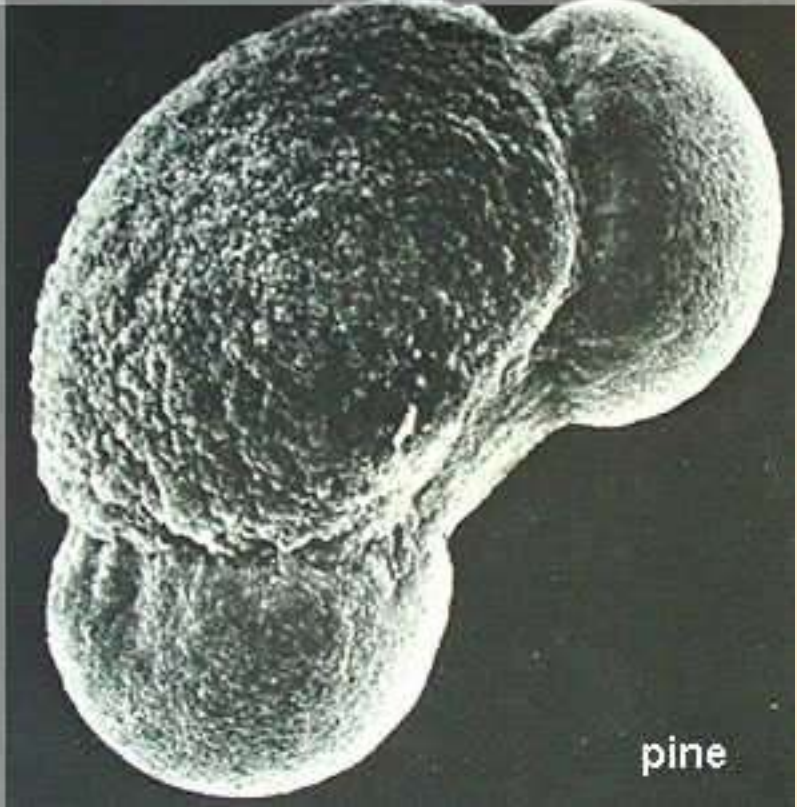
goldenrod



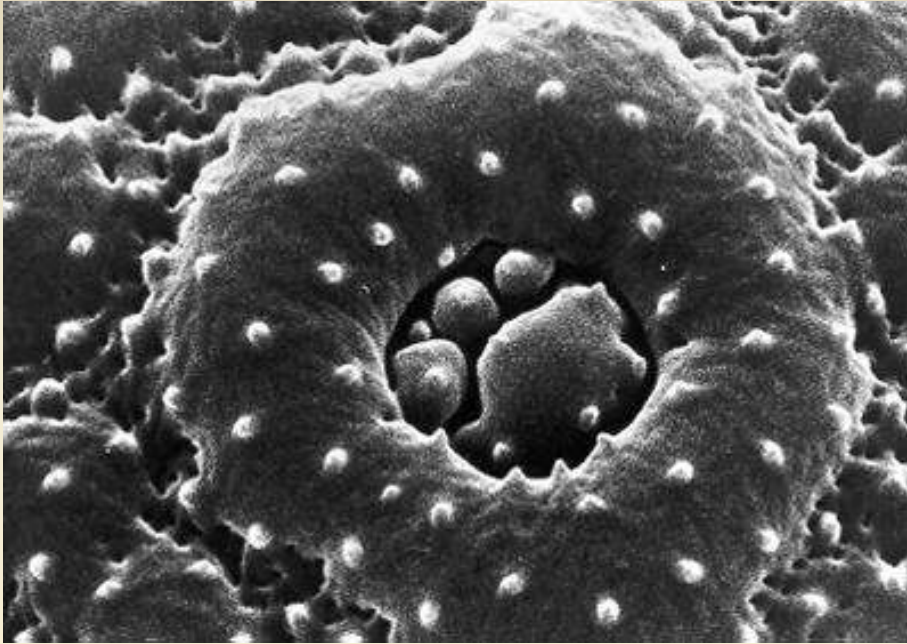
oak



grass



pine



porus with clear annulus and operculum (lid),
Plantago lanceolata by Lucia Wick, IPS

Pollen Techniques

Pollen Traps

Surface sampling

Fresh Pollen

Dry Pollen

Pollen Mounting

Hydration

Dehydration

Acetolysis

HMDS

SEM preparation

TEM

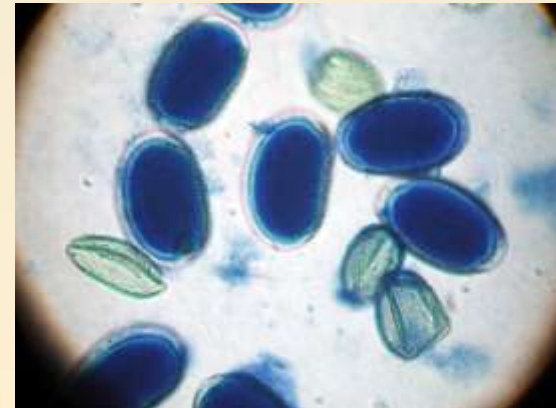
Sediments

Core samples

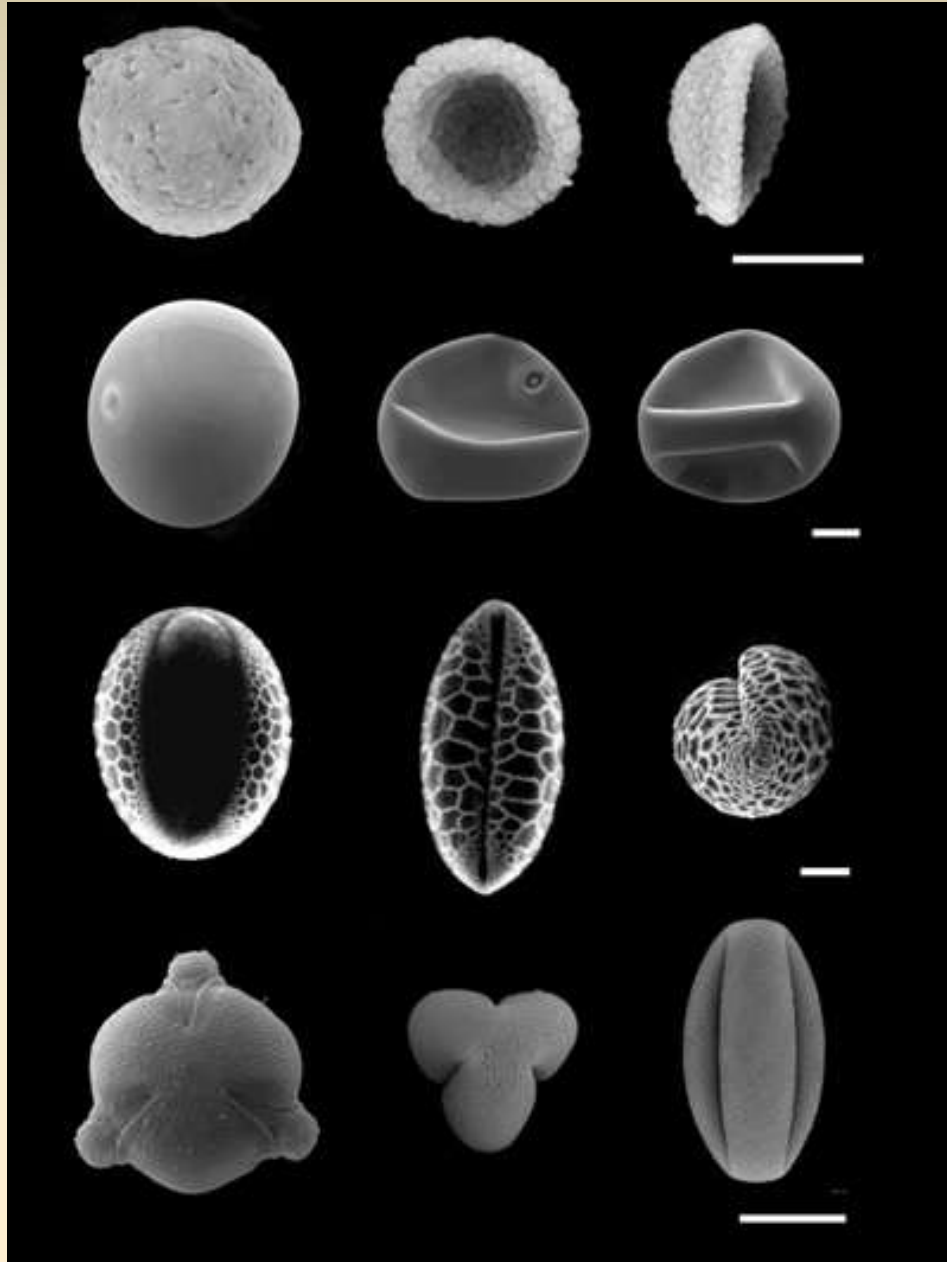
Pollen Viability

Bee Wash

Pollen tube growth



Pollen Folding - Harmomegathy



Aristolochia gigantea

Zea mays

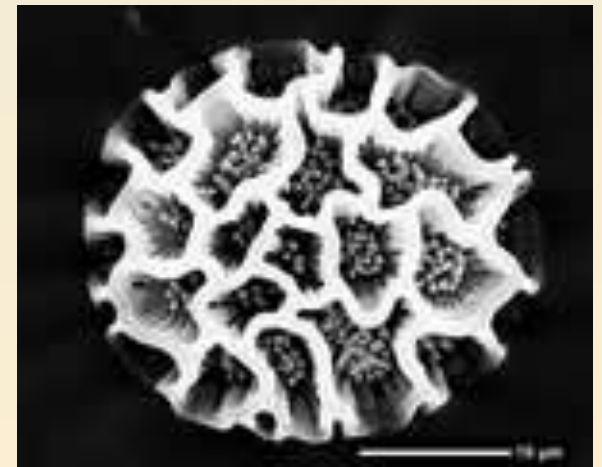
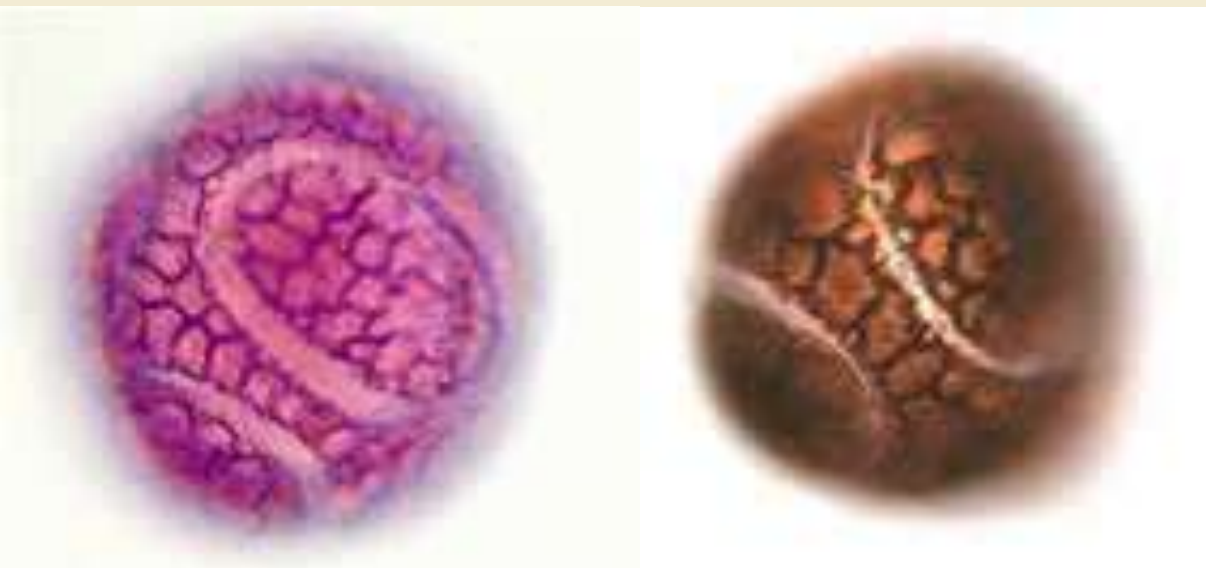
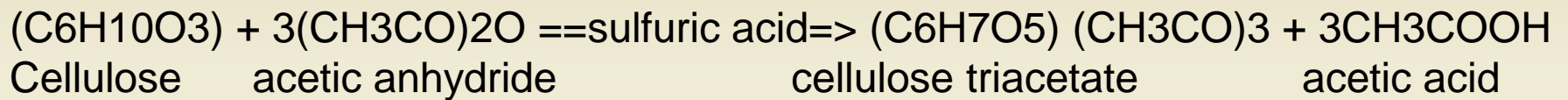
Lilium longiflorum

Euphorbia milii

Pollen Technique - Acetolysis

Method was introduced by Erdtman, with help from his chemist brother.

Nine parts acetic anhydride plus one part concentrated sulfuric acid.



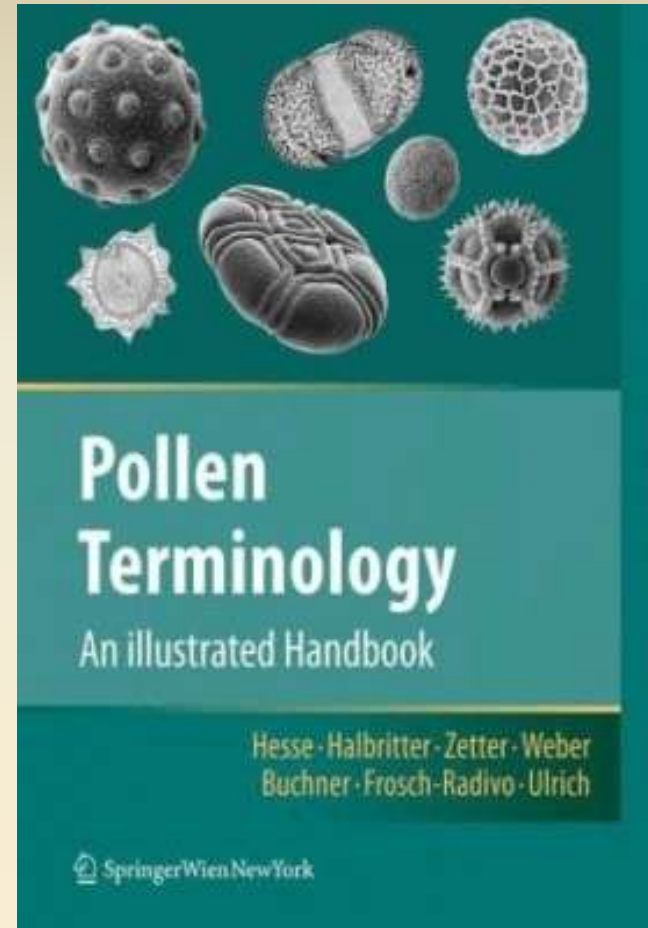
Passiflora

Pollen for SEM - Halbritter 1997

Place fresh pollen in envelope
Place envelopes in 2,2 dimethoxypropane
Dehydrate
Critical Point Dry
Acetone as transitional fluid
Spread on stub
Sputter coat



Heidemarie Halbritter

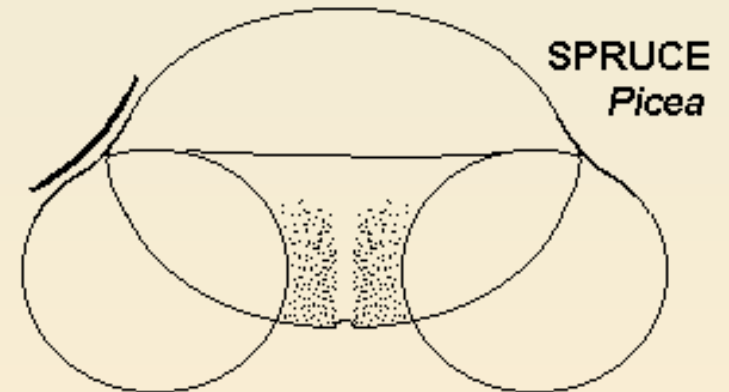
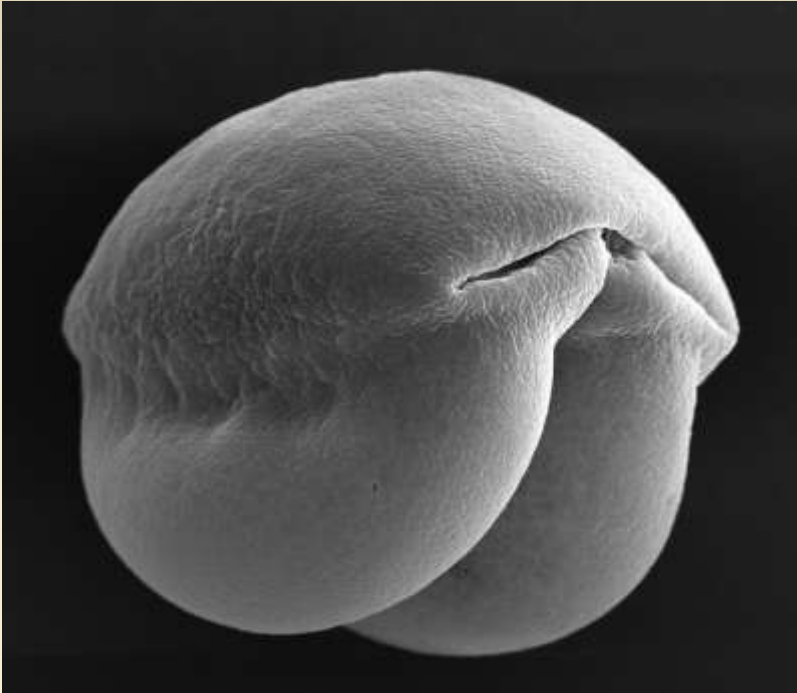


Hydration Movie

```
<iframe width="420" height="315"  
src="http://www.youtube.com/embed/h0fxtwCWd_4"  
frameborder="0" allowfullscreen></iframe>
```

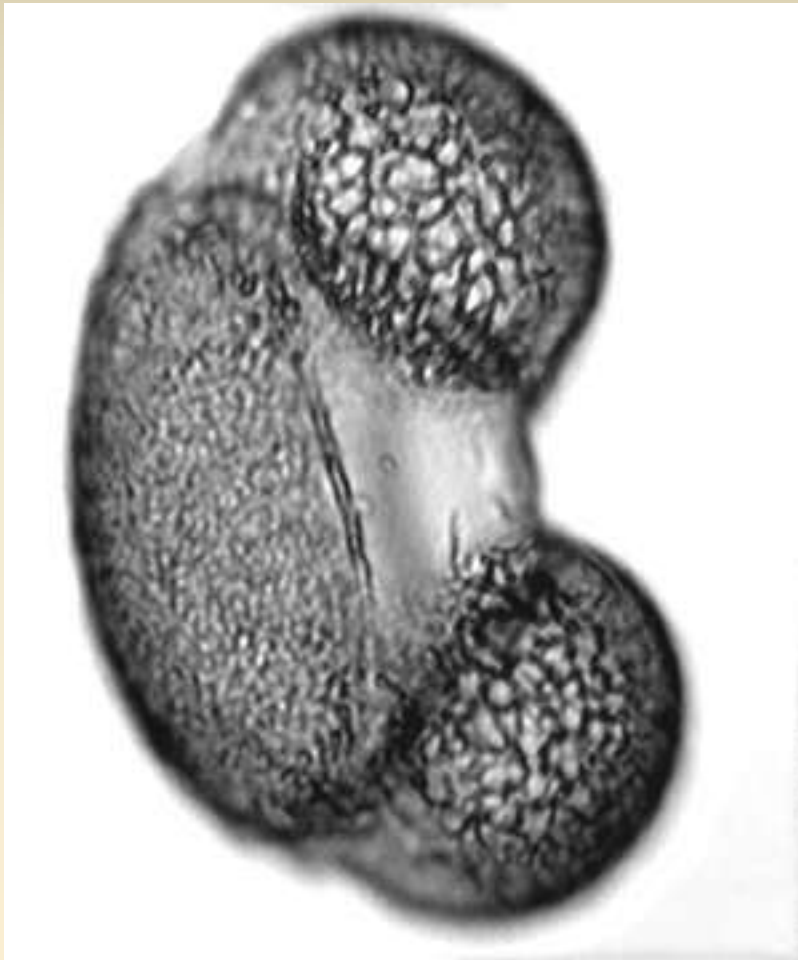
http://www.youtube.com/watch?feature=player_detailpage&v=h0fxtwCWd_4

End

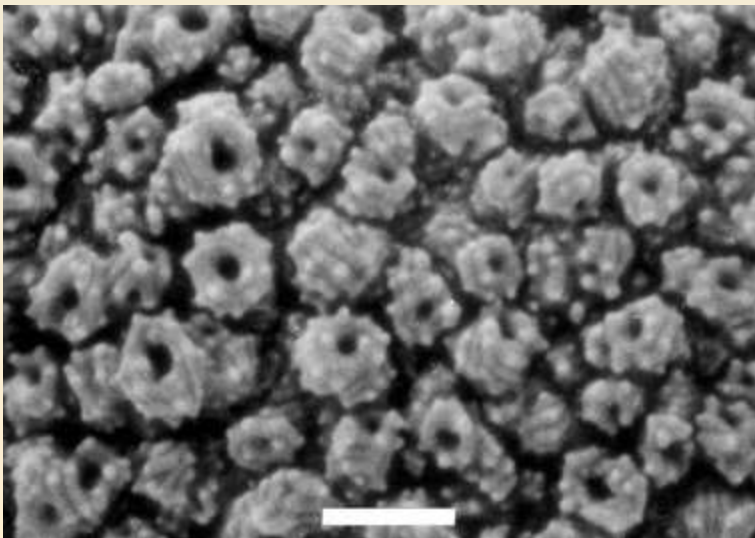
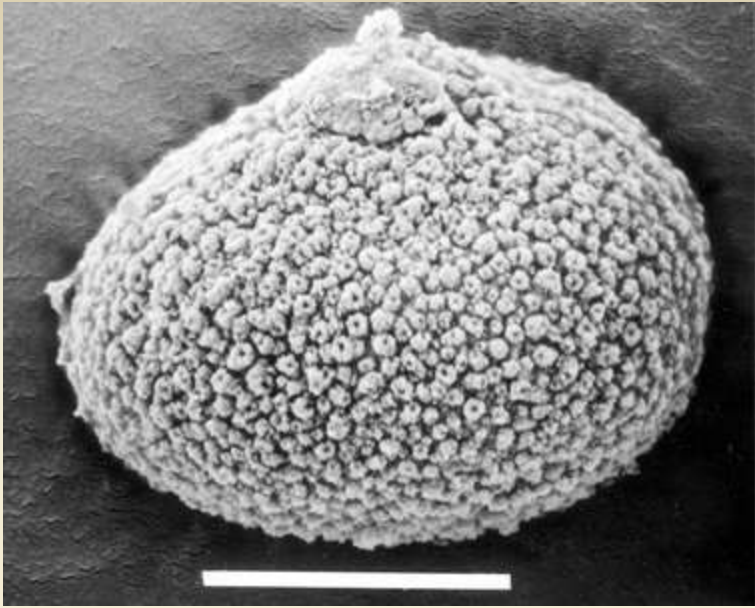


Spruce pollen is distinguished from pine and fir by its large size ($> 75 \mu\text{m}$), and smooth transition between bladder and body. The reticulate pattern on the bladders of spruce pollen becomes smaller near the bladder-body juncture. Pine is smaller than spruce, and fir has a distinct separation between bladder and body.

Pinus Pollen

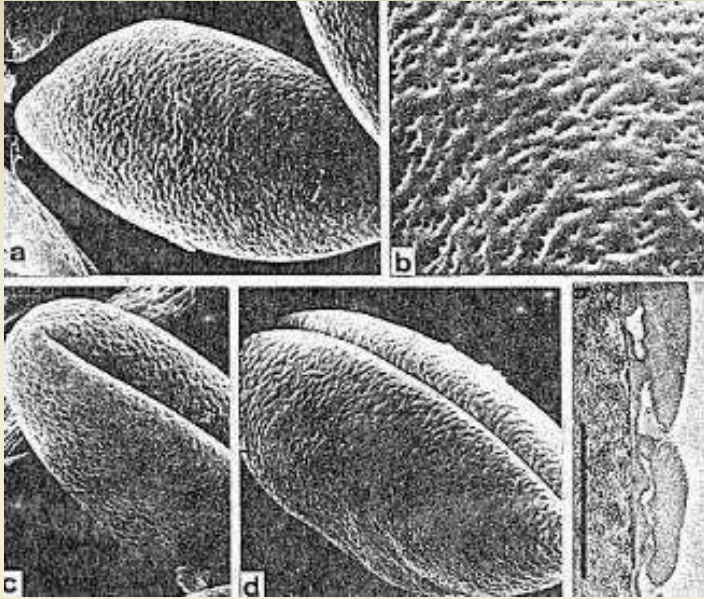


Amborella

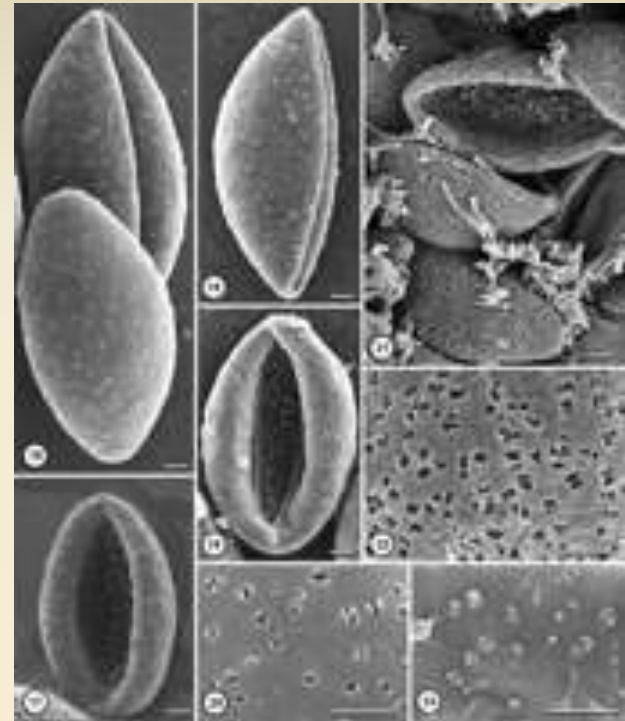




Monocolpate – Primitive Dicots

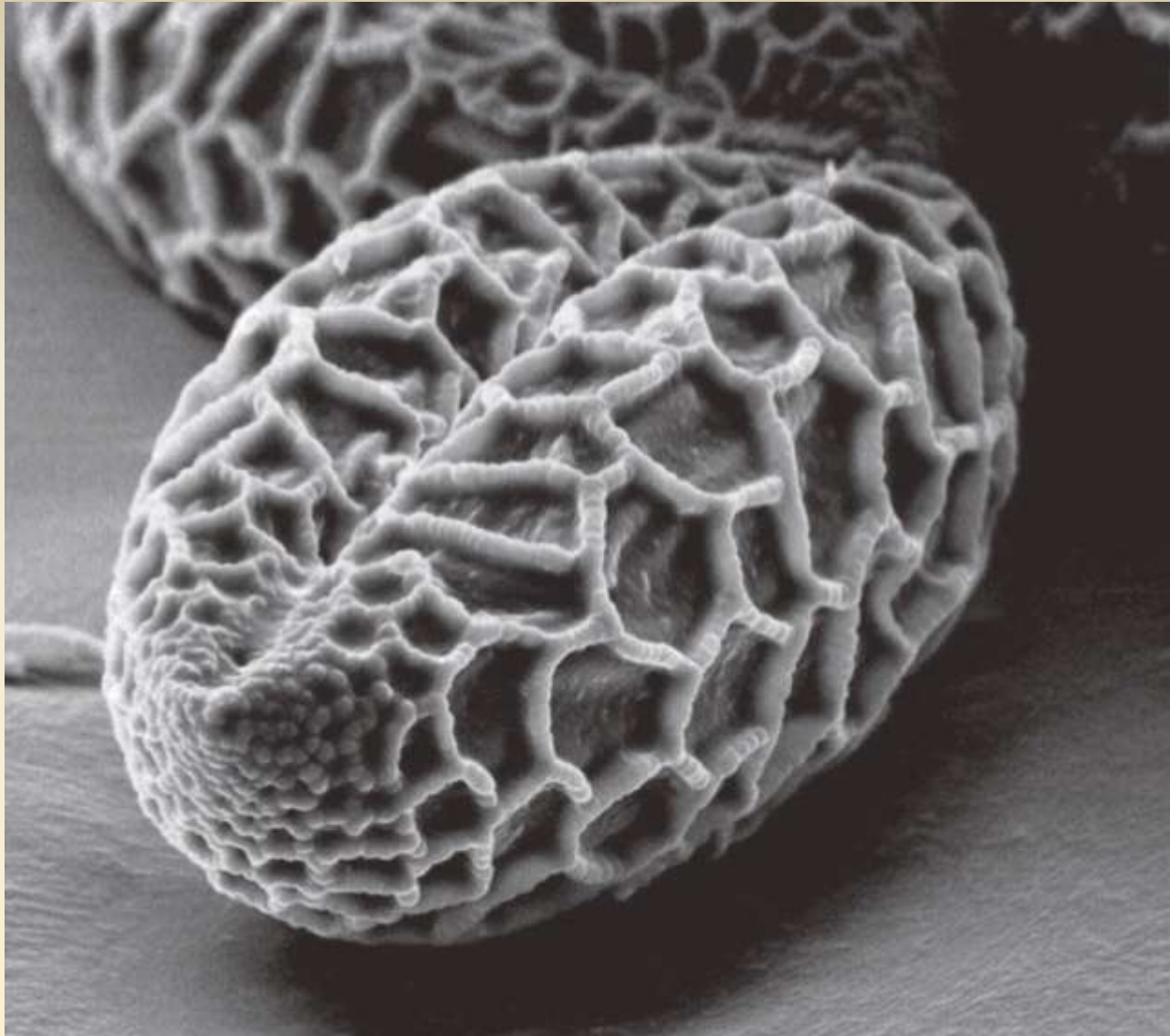


Magnolia virginiana

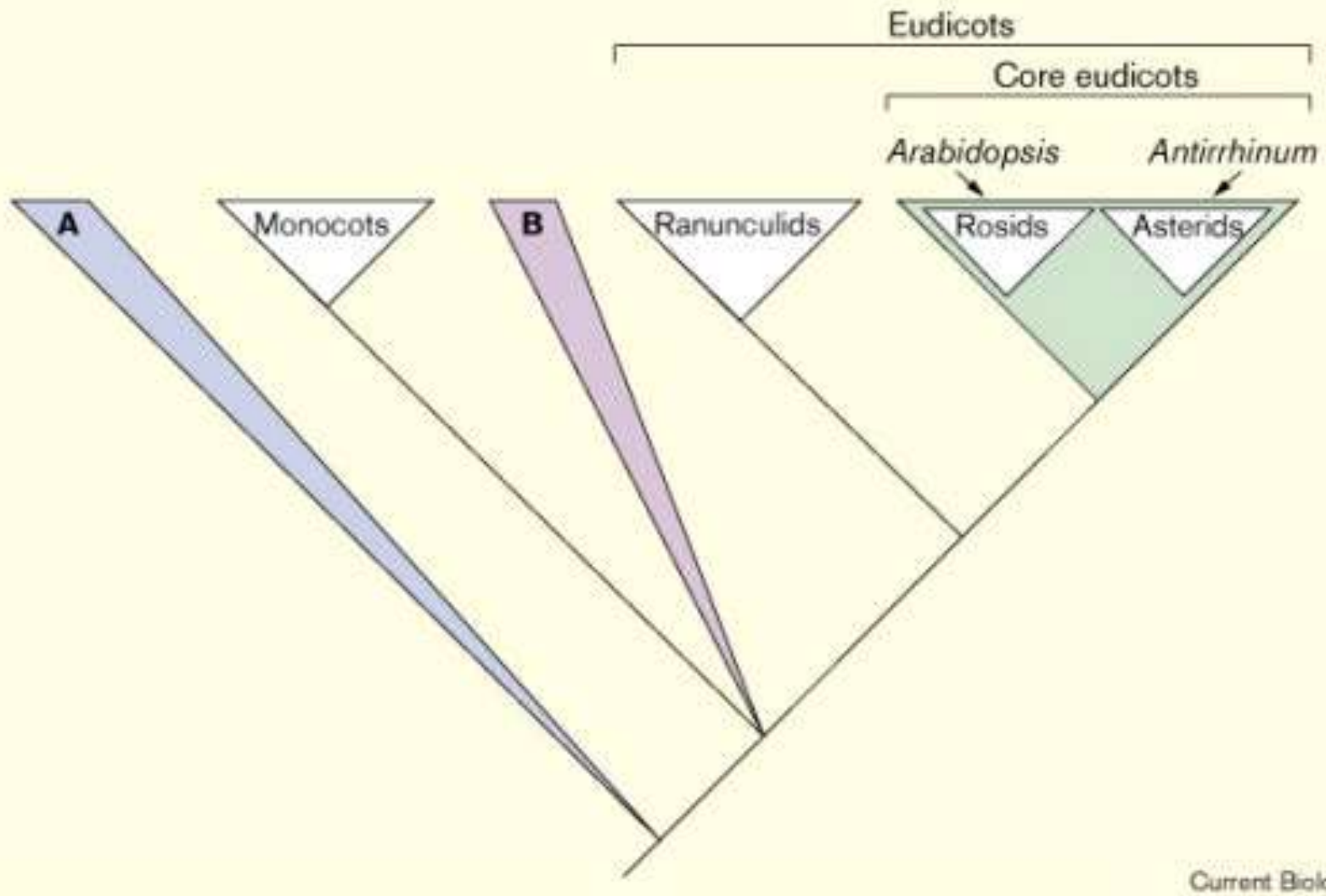


Saururus cernuus

Scanning electron micrograph of a dehydrated lily pollen grain.



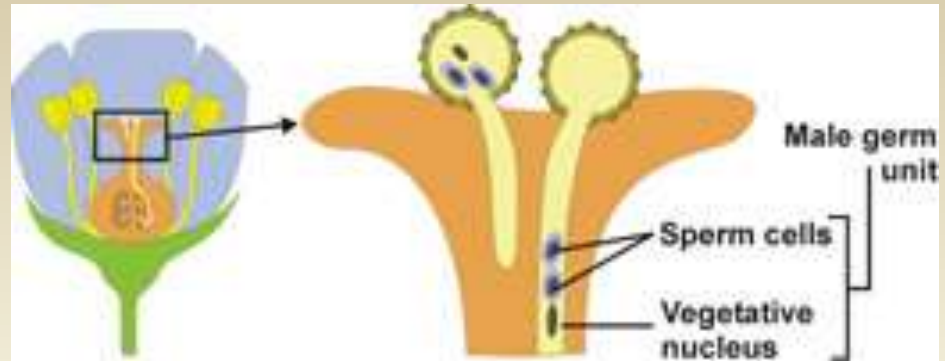
National Academy of Sciences et al. PNAS 2010;107:7619-7620



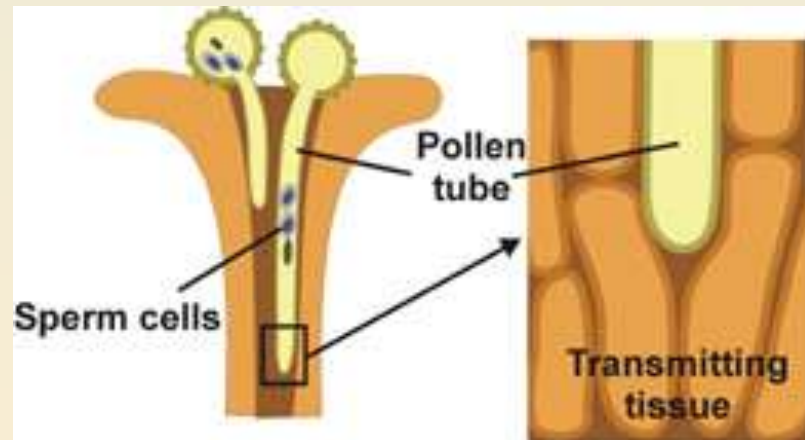
Current Biology

Figure 1. The phylogeny of angiosperms. A marks a group of lineages whose exact relationships are uncertain, but are thought to form a basal assemblage of angiosperms. **Clades within A include Nymphaeaceae, Amborella, Illicium, and Austrobaileya (and possibly Ceratophyllum).** B marks another group of lineages that could be more closely related to monocots or eudicots or they could branch before the common ancestor of monocots and eudicots. **Clades within B include Magnoliaceae, Winteraceae, and various ‘paleoherb’ groups (such as Piperaceae and Aristolochiaceae).**

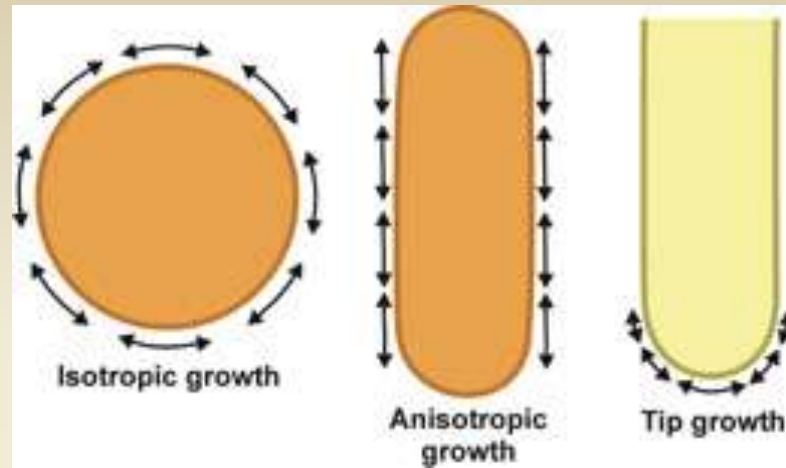
Pollen Tube Origin



Pollen Tube Tunnel



Pollen Tube Growth



Pollen Tube Tropism

