Handbook of support for laboratory technicians

Pollen morphology introduction

SIZE AND PRODUCTION OF MICROSPORES

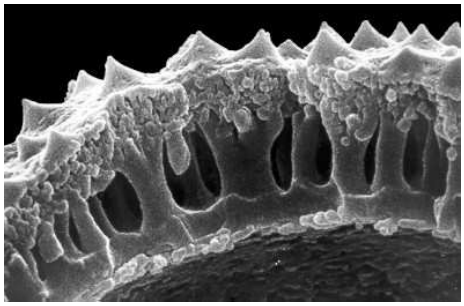
The **size** of the spores and pollen grains found in central Europe ranges from 2 to over 300 micrometers. The stinging nettle (*Urtica*), for example, produces one of the smallest (and lightest) pollen grains with a diameter of around 10 micrometers while the silver fir (*Abies alba*) produces one of the largest with a diameter of around 200 micrometers. However, the size of the pollen grains of a species can vary considerably.
In dispersal biology, a distinction is made between plants producing abundant to very abundant wind-dispersed (anemophile or anemogam) pollen and plants producing very little insect-dispersed (entomophile or entomogam) pollen.

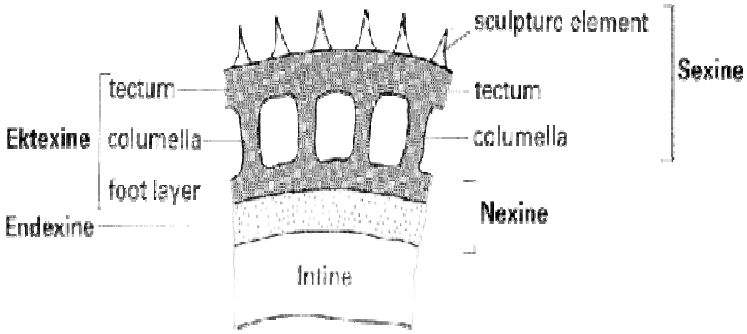
very abundant (wind-dispersed)	Pine birch (c. 10'000 pollen grains/anther) alder hazel many grasses, e.g. rye	over-represented when compared with the rest of the vegetation.
abundant (wind-dispersed)	Spruce fir beech	well represented compared with the rest of the vegetation
little to very little (insect-dispersed)	sycamore (c. 1'000 pollen grains/ anther) ash many forbs, e.g. Lein (c. 100 pollen grains/ anther) or Malve (c. 64 pollen grains/ anther)	Under-represented compared with the rest of the vegetation

MORPHOLOGY OF MICROSPORES

Pollen grains consist of three substances:
The inside of the cell is filled with living cytoplasm, that deteriorates.
The inner layer of the cell wall, the intine, consists mainly of cellulose and pectin, this also degrades rapidly during fossilisation.
The outer cell wall, the exine, consists mainly of sporopollenin, an N-free polymeric substance belonging to the terpenes. Its chemical formula is: C90 H130-158 024-44. Sporopollenin is chemically unsaturated and is corroded by oxygen (oxidation), but is otherwise resistant even to strongly alkaline substances and organic acids. Sporopollenin is thus one of the most resistant substances in the plant world.
Thanks to the considerable chemical resistance of sporopollenin, pollen grains and spores can be preserved under anoxic conditions in lakes and fens for thousands to millions of years (the oldest preserved pollen of flowering plants found are over 120 Mio years old!).

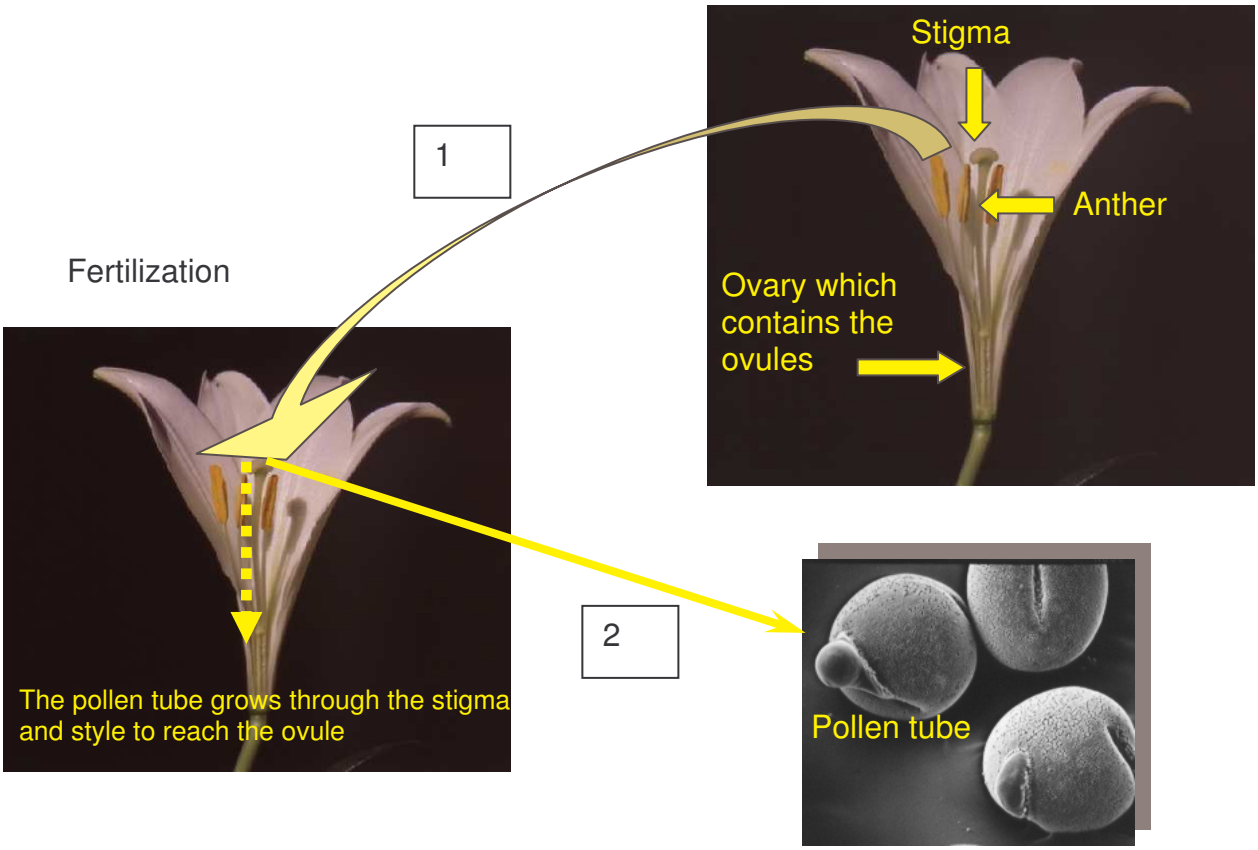
They can therefore be used for the reconstruction of earlier vegetation- and climate-conditions.





The *pollen grain* is the structure that produces the male gametes in gymnosperms and angiosperms and transfers them to the female part.

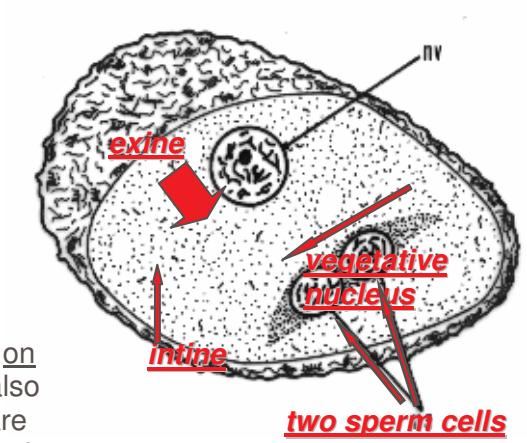
The pollen is released from anthers (1) and it lands on the stigma where after hydration a pollen tube emerges through one of the apertures and grows into the style (2). The male gametes travel down the pollen tube until the embryo sac and the fertilization occurs



The pollen grain

The grains derive from the meiotic process of the pollen mother cells in the anther and at maturity usually consist of a bi or trinucleate cell (one vegetative nucleus and two sperm cells) surrounded by a wall.

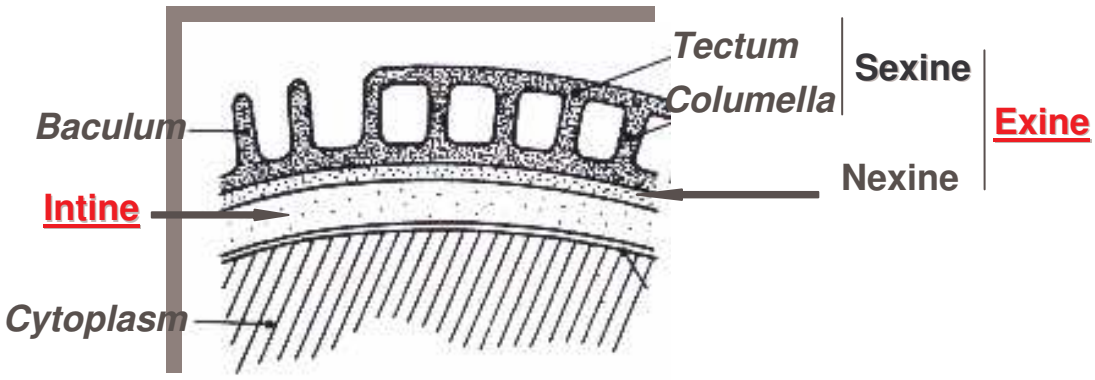
In the living pollen grain, the wall is made up of two layers; the outer layer is called "exine", the inner layer is called "intine".



Each species elaborates a distinctive sculpture on the surface of the pollen grains, and there are also many other morphological characteristics that are useful for the pollen analyst in the classification of the pollen.

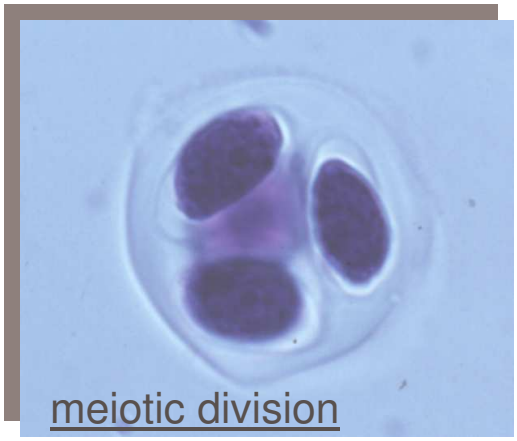
Pollen wall structure

The exine is made of extremely hard polymers of carotenoids known as sporopollenin and is divided into an outer sculptured layer, sexine, and an inner unsculptured layer, nexine, which covers the intine, which is made up of cellulose and pectins and is very similar, in construction, to an ordinary plant cell wall.



The sexine may present different kinds of processes such as small rods which sit on the nexine and are called *columellae* if they support something, e.g. the *tectum*, or *bacula* when the rods do not support anything and are cylindrical in shape.

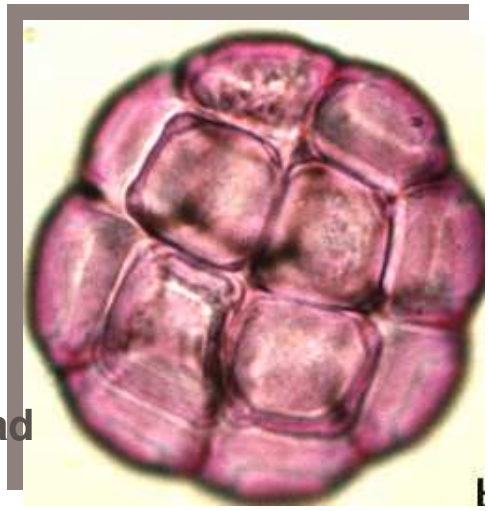
Usually the four cells differentiated by the meiotic process become completely free at maturity (monad), therefore in certain genera they are released in pairs (dyad) or remain joined together (tetrad) or larger aggregations occur (polyad).



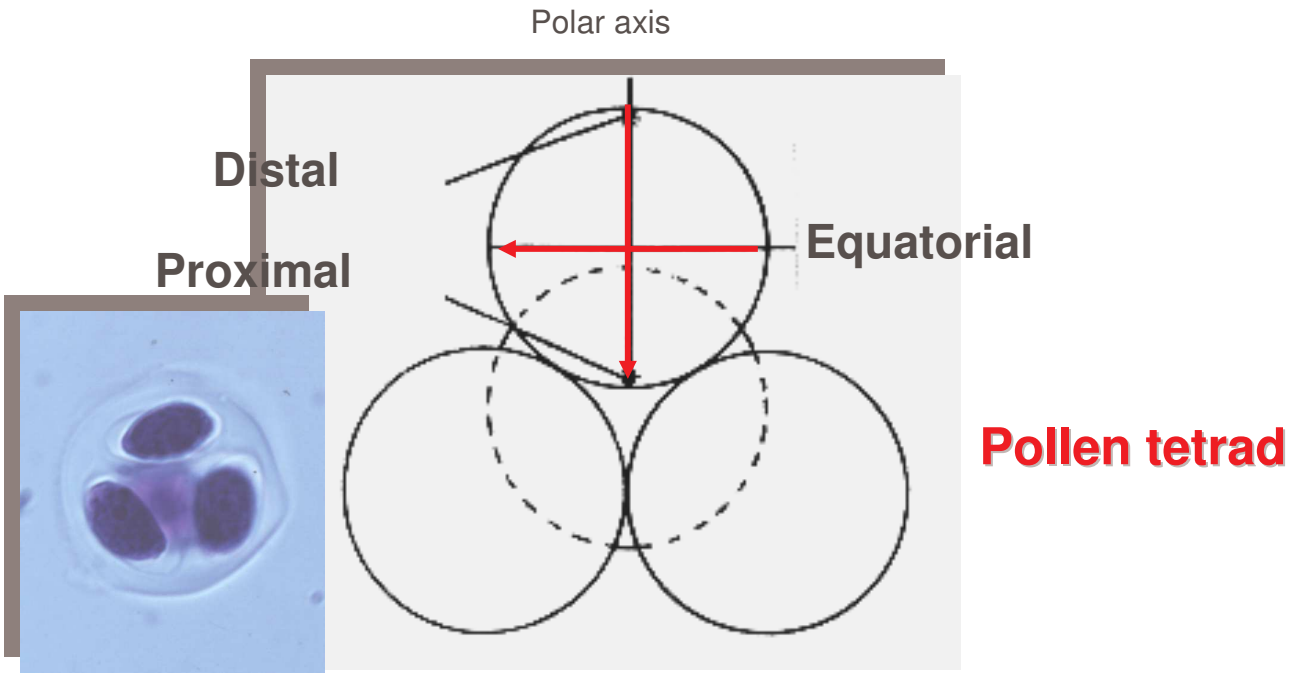
Monad

Tetrad

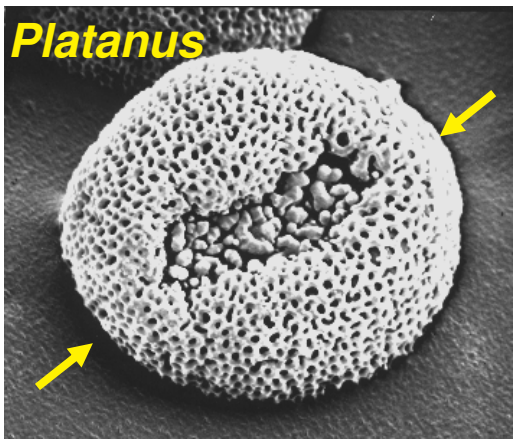
Polyad



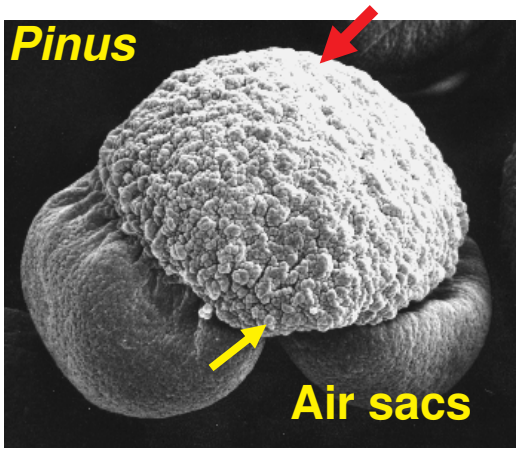
POLARITY



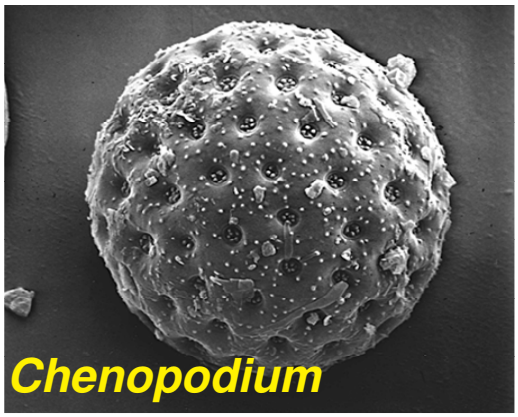
If the two poles are similar the pollen is called isopolar, while the pollen is heteropolar when the two areas have different characteristics. Sometimes the two polar areas can not be identified and the pollen is apolar.



Isopolar



Heteropolar



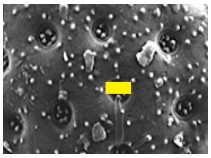
Apolar

For the identification of any grain there are three features to note:

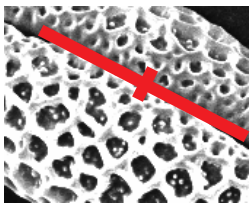
- i) apertures, type and number
- ii) shape and size of the grain
- iii) exine sculpturing

There are 2 main shape types of apertures:

Pores: the ratio between the longitudinal and cross diameter of the aperture is <2

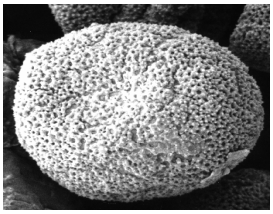


Colpi (furrows): the ratio is >2

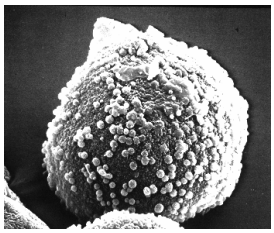


1. Apertures

Pollen without apertures: inaperturate



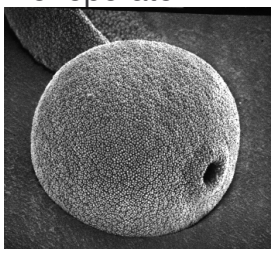
Populus



Cupressus

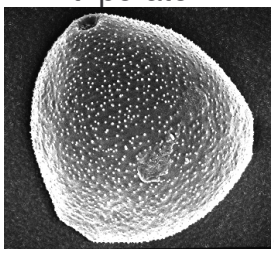
Pollen with pores:
Porate

Monoporate



Gramineae

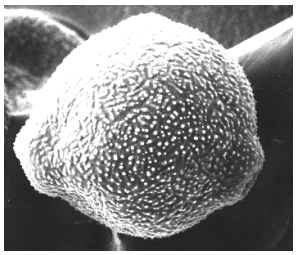
triporate



Corylus

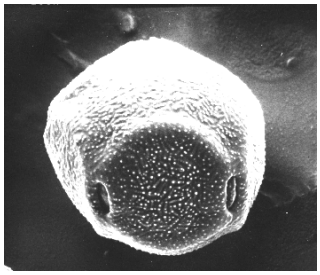
Pollen with pores arranged around the equator: zono-porate

3 pores: tri-zono-porate



Betula

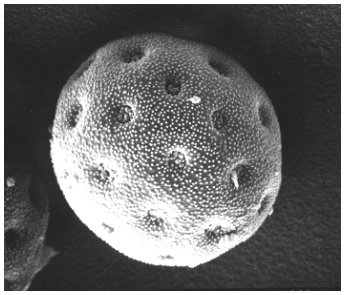
5 pores: penta-zono-porate



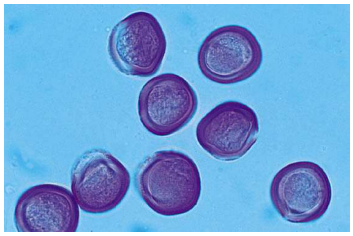
Alnus

Pollen with pores scattered all over the surface: panto-porate

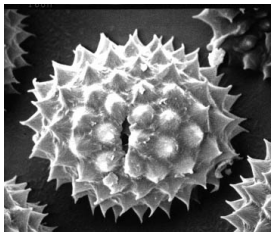
> 6 pores: poli-panto-porate



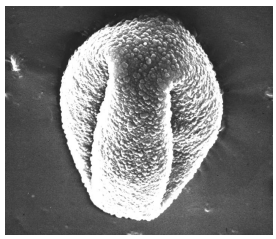
Pollen with colpi: **colpate**



1 colpus: monocolpate palmae

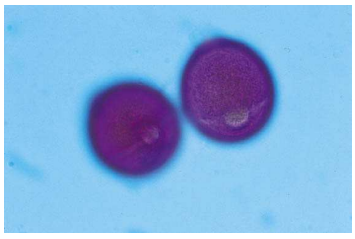


3 colpi: tricolpate *Ambrosia*



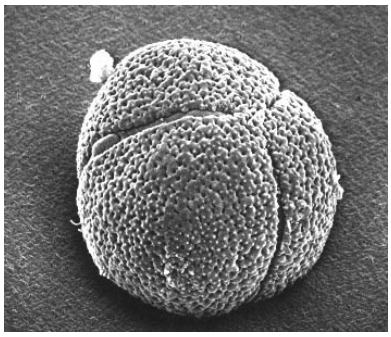
zono-colpate *Quercus*

Pollen with pores and colpi: **colporate**

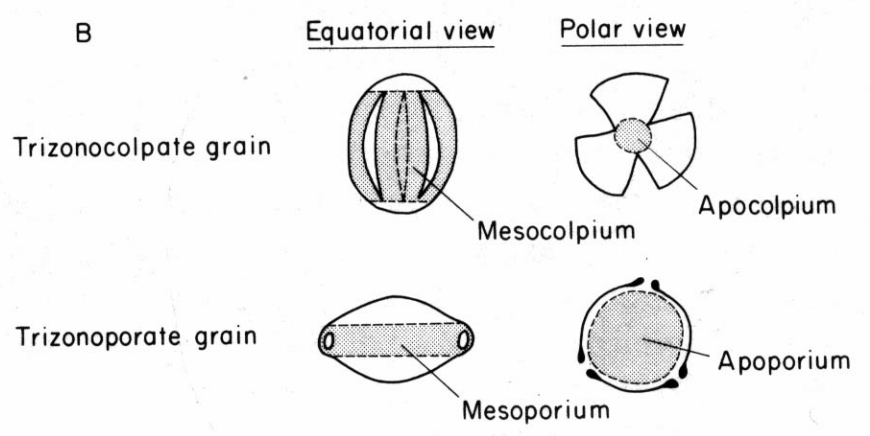


Fagus

colpi with pores arranged around the equator: tri-zono-colporate

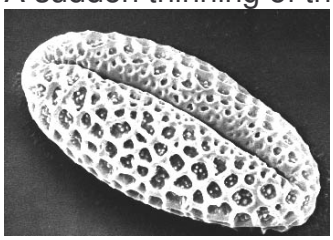


Those areas on a grain which are not occupied by apertures are given names depending on whether they are adjacent to pori or colpi

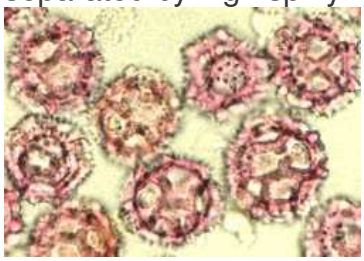


Some characteristics associated with pores and colpi

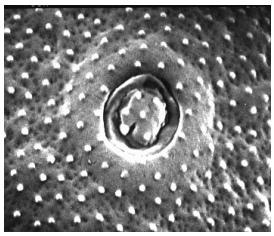
A sudden thinning of the sexine around a colpus is called "*margo*"



In the Compositae, subfamily Liguliflorae, the pollens are tricolporate, but the apertures are obscured by an unusual sexine pattern: there are large apparent gaps (lacunae) separated by high spiny ridges. The pollen is called *fenestrate*.



A sudden thickening of sexine around a porus is called an "*annulus*"; in some cases the central part of the *porus* is thickened to form an "*operculum*"



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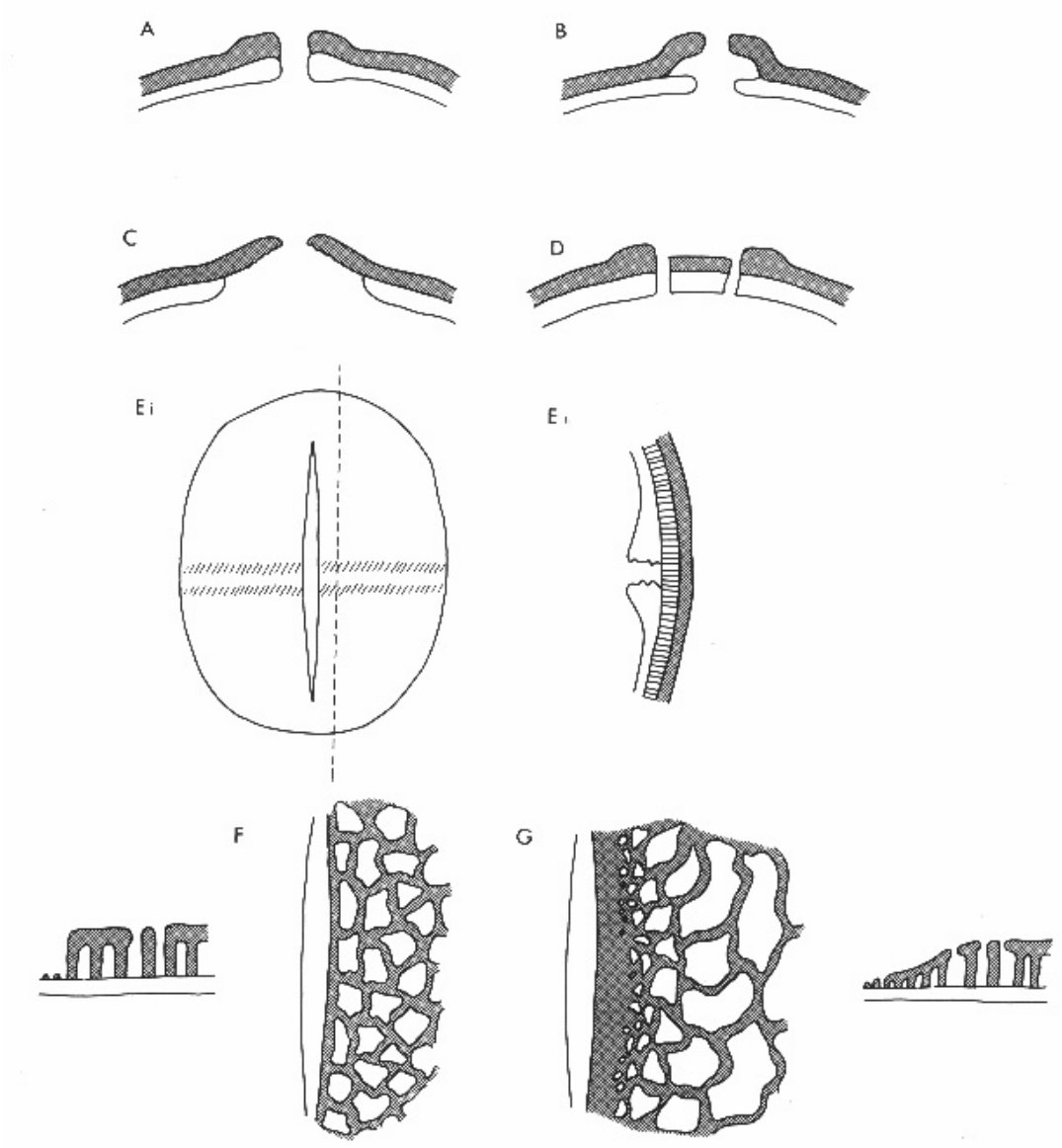
When the intine swells beneath the pores it forms the “*onc*i

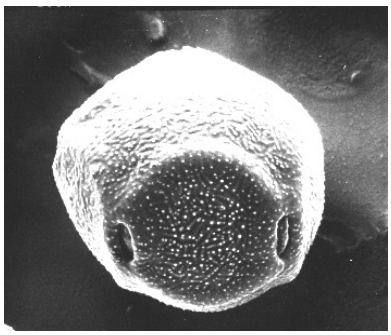
In some pollens the nexine and the sexine become separated from one another in the vicinity of the pores: the cavity so formed is called “*vestibulum*”; if the sexine is thickened markedly around the pores, an “*aspis*” forms

Examples of exine features associated with pori and colpi:

A. Porus with a *costa*
B. Porus where sexine separates from nexine to form a *vestibulum*
C. Porus with an *annulus*
D. Porus with an *operculum*
E. Endocolpus (*Centaurea*)
F. Colpus without a border or *margo*
G. Colpus with a *margo*



Arci: thickened streaks which connect the pores in pairs



2. Shape

On the basis of the ratio between the length of the polar axis (P) and the equatorial diameter (E), the following shapes are defined:

< 0.50: peroblate

0.50 - 0.75: oblate

0.76 - 0.88: suboblate

0.89- 0.99:oblate-spheroidal

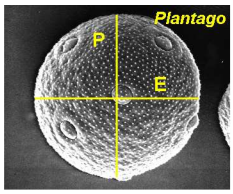
1.00: spherical

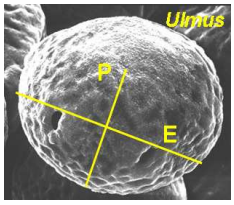
1.01 - 1.14: prolate-spheroidal

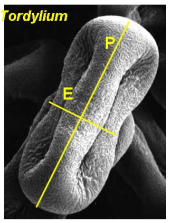
1.15 - 1.33: subprolate

1.34 - 2.00: prolate

> 2.00: perprolate







SIZE The following groups are normally used:

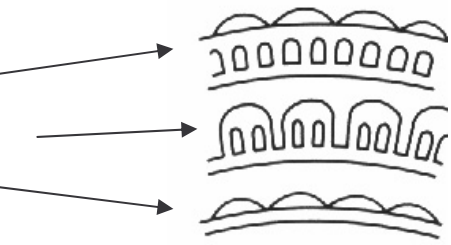
very small grain: the diameter is less than 10 µm;
small: the diameter is 10-24 µm;
medium size: the diameter is 25-49 µm;
large: the diameter is 50-99 µm;
very large: the diameter is100-200 µm;
gigantic: the diameter is greater than 200 µm.

The airborne pollen grains normally range from 10 µm to 80 µm.

3. Sexine sculpturing

The *tectum* may be:

complete: *tectate grain*
partially dissolved: *semitectate grain*
completely absent: *intectate grain*



The sculptural elements may be in different shape such as.....