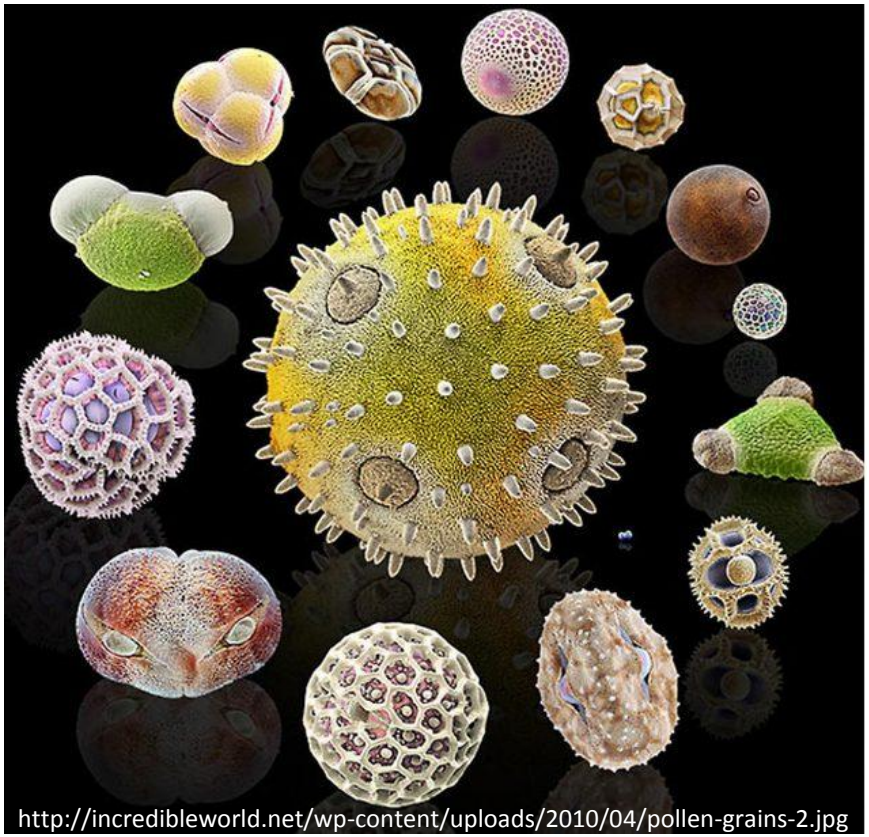
Palynology

Spore/Pollen Morphology



http://incredibleworld.net/wp-content/uploads/2010/04/pollen-grains-2.jpg

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What is Palynology?

- The branch of science concerned with the study of fossil and living palynomorphs
- The term **Palynology** was coined by Hyde and Williams (1944)

What are Palynomorphs?

- **Palynomorphs** include microscopic plant and animal structures composed of sporopollenin, chitin, or related compounds that are highly resistant to most forms of decay other than oxidation
- **Palynomorphs** are abundant in most sediments and sedimentary rocks, and are resistant to the routine pollen-extraction procedures including strong acids, bases, acetolysis, and density separation
- Most palynomorphs are between **5–500 µm** in size

Common palynomorph categories:

- Acritarchs
- Chitinozoans
- Scolecodonts
- Microscopic Algae and Algal Parts
- Cryptospores
- Embryophyte Spores
- Pollen
- Dinoflagellates
- Chitinous Fungal Spores and Other Fungal Bodies
- Microforaminiferal Inner Tests
- Megaspores
- Palynodebris
- Varia

Embryophyte Spores

Stratigraphic range: Late Ordovician–present

- **Embryophyte Spores** are microscopic unicellular reproductive cells of certain **vascular plants** (those with special conducting tissues called xylem)

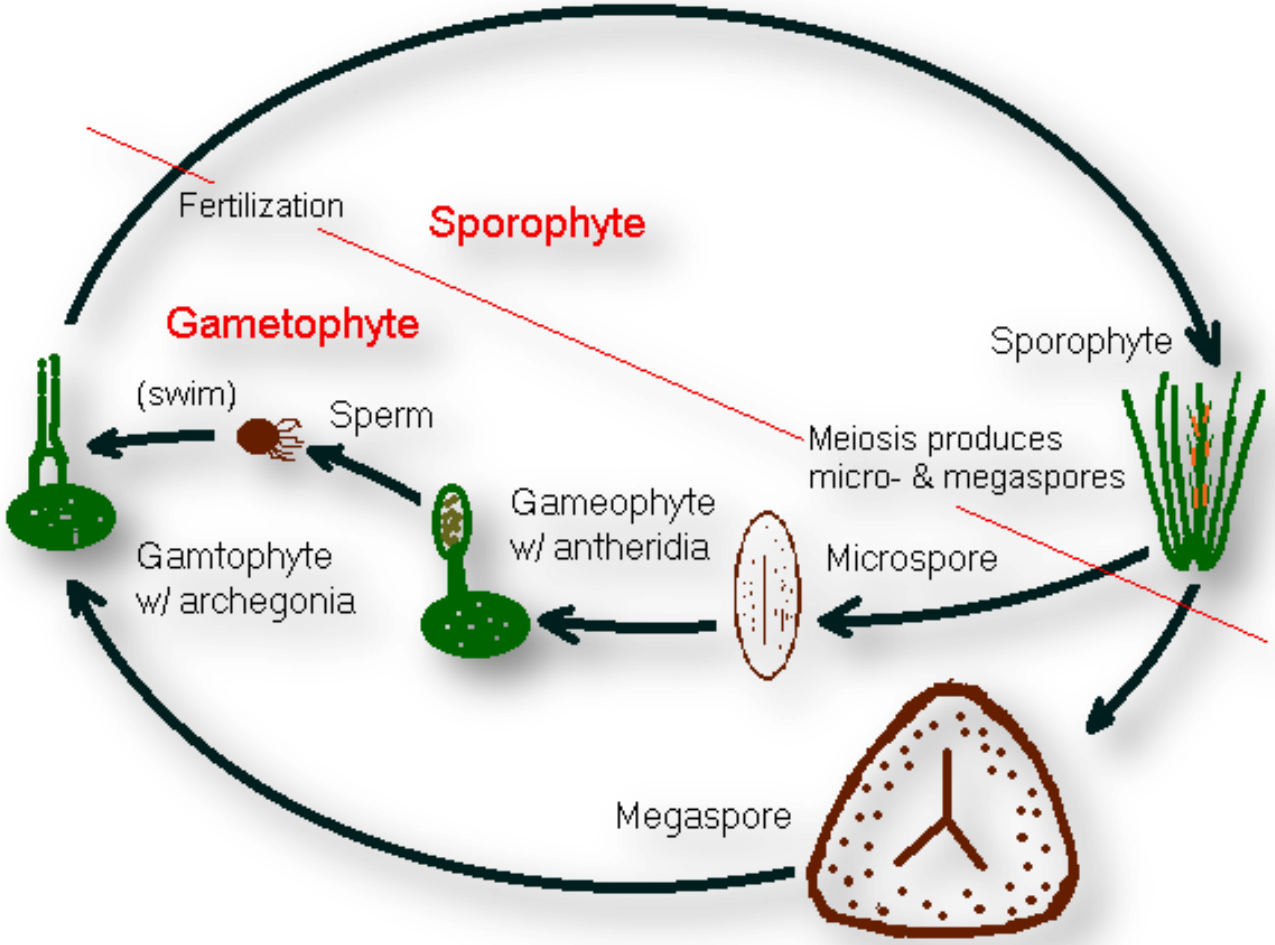
- These spores are extremely resistant and are easily transported by wind and water

- They are useful biostratigraphic tools particularly in fresh-water environments, evaporitic deposits, and where marine and fresh-water facies interdigitate

- They show variable surface sculpture (ornamentation)

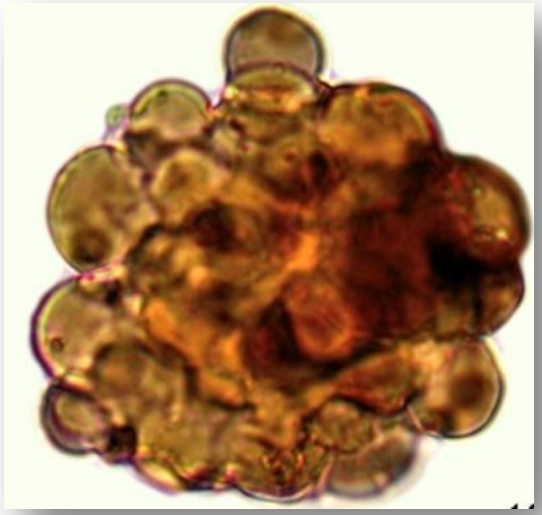
Trilete spore
(***Trilobosporites laevigatus*** El Beialy 1994)

Monolete spore
(From Zobaa et al., 2009)

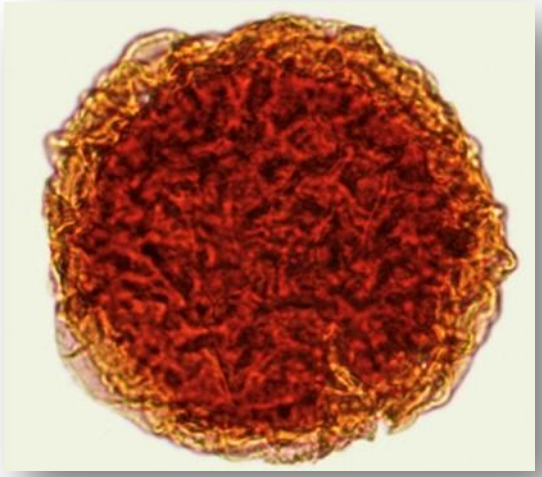


Alternation of generations in some vascular plants

(http://www.geo.arizona.edu/palynology/ppfspor.html)



Leptolepidites psarosus



Crybelosporites pannuceus

Deltoidospora mesozoica

Pollen Grains

Stratigraphic range: latest Devonian–present

- **Pollen grains** are the containers of the male gametophyte generation of seed plants (both angiosperms and gymnosperms)

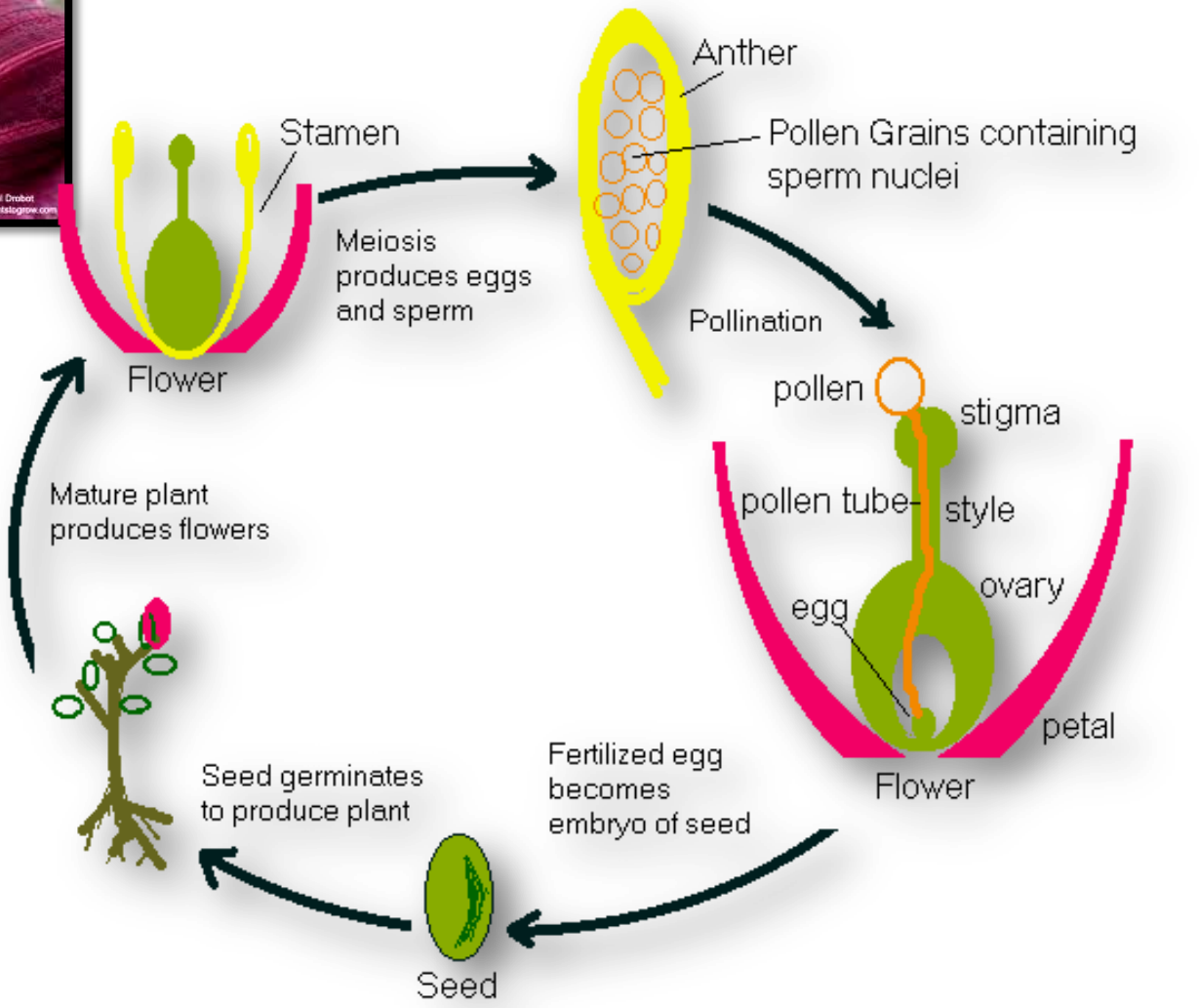
- They are produced in the male organs of the flowers (**anthers**)

- Pollen production is a strategy by which seed plants became free from dependence on standing water for **fertilization**

- **Pollination** occurs by transferring pollen grains from the anthers to the female organs by wind or animals

- Pollen are good biostratigraphic and paleoenvironmental tools

Afropollis jardinus



Reproduction in flowering plants

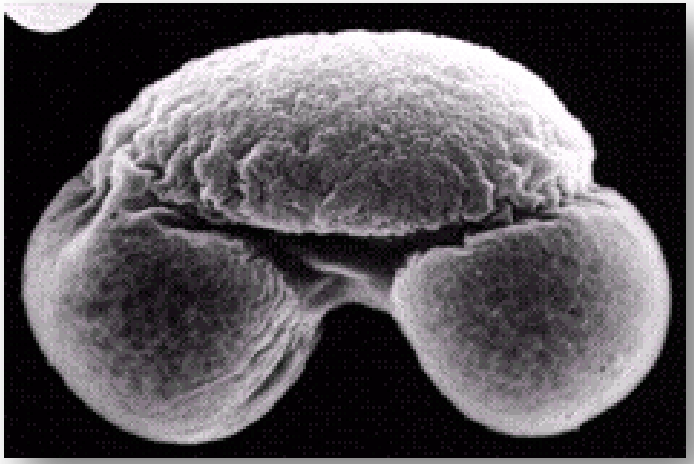
(http://www.geo.arizona.edu/palynology/polkey.html)

Tricolporopollenites kruschii

***Cupuliferoipollenites* sp.**

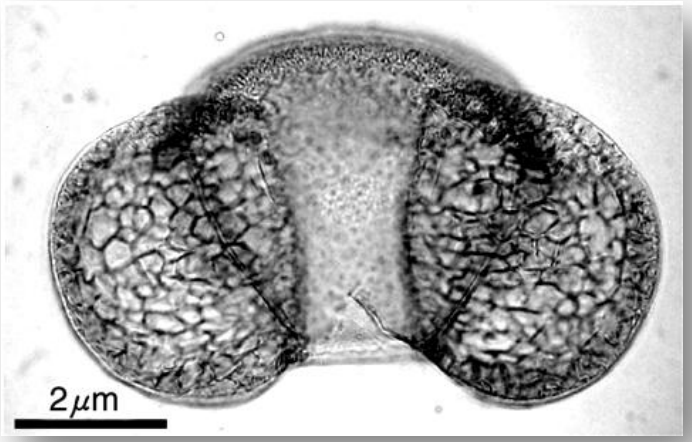
Caryapollenites veripites

(Zobaa et al., 2011)



Pinus echinata

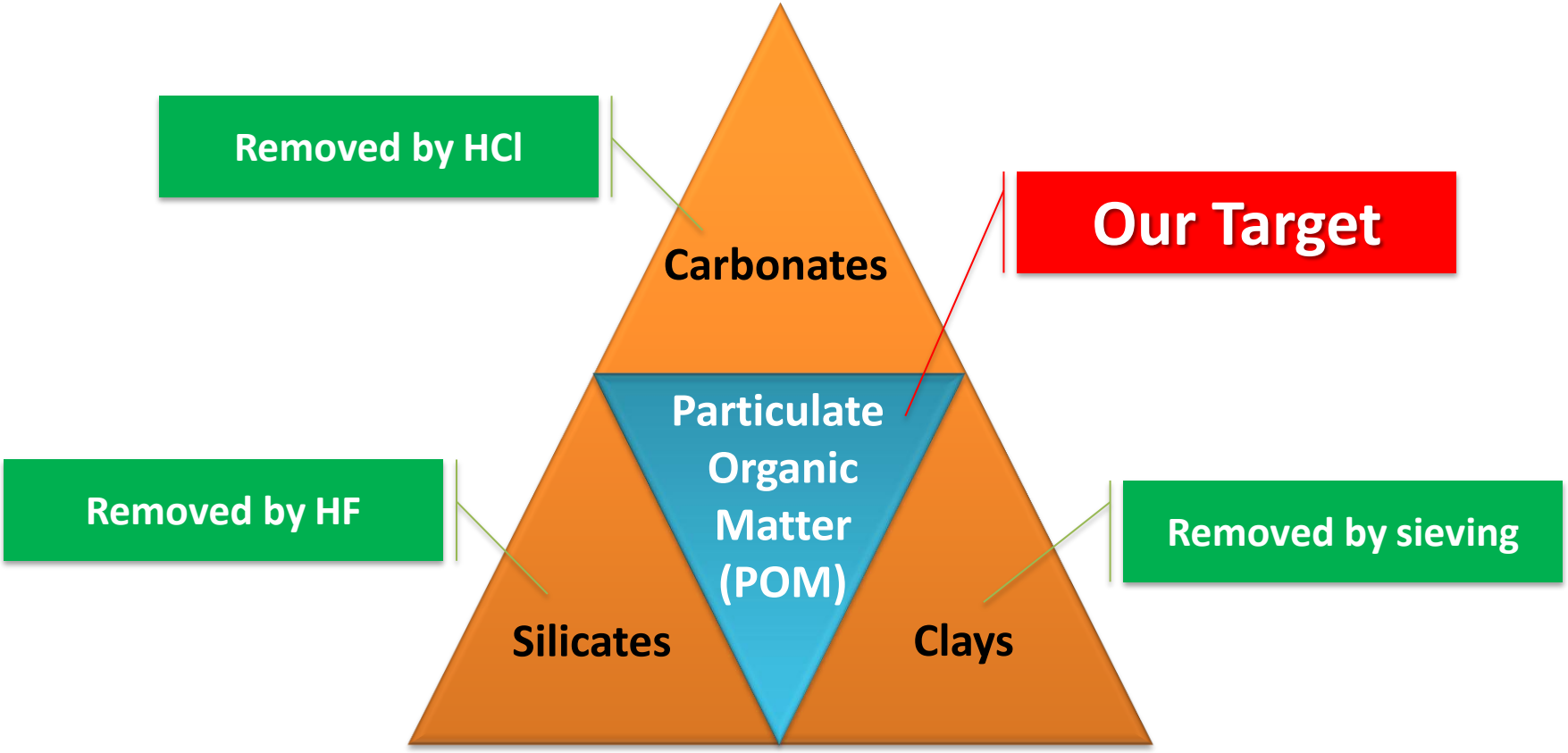
(http://www.geo.arizona.edu/palynology/pid00005.html)



***Pinus* sp.**

(http://jolisfukyu.tokai-sc.jaea.go.jp/fukyu/mirai-en/2007/2_5.html)

Sample preparation for palynological analysis



Major components of a sediment/sedimentary rock sample

Steps of work…

1- Crushing the sample in a mortar to the powder size

2- Transferring the crushed powder into a Nalgene plastic beaker that is resistant to high temperature

3- Conc. HCl treatment

4- Washing and neutralization

5- Conc. HF treatment

6- Washing and neutralization

Agate mortar and pestle

Porcelain mortar and pestle

7- Conc. HCl treatment

8- Washing and neutralization

9- Sieving the sample in a 125 µm brass sieve and collecting the residue in a 5-15 µm nylon sieve

10- Making permanent Kerogen slides

11- Oxidation if necessary

12- Making permanent oxidized slides

Nalgene beakers

Brass sieve

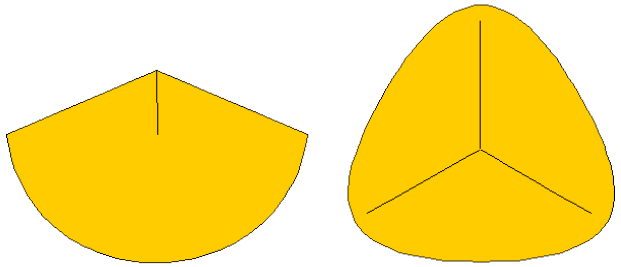
Microscopic examination of some slides

Try to recognize some pollen and spore specimens….

Morphology of Embryophytic Spores

Trilete

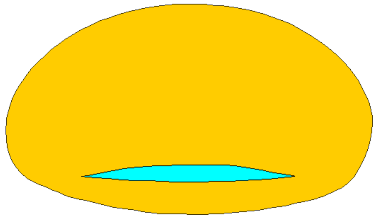
A spore with three ***laesurae*** (showing a **trilete mark**)



http://www.pollen.mtu.edu/glos-gtx/332G.GIF

Monolete

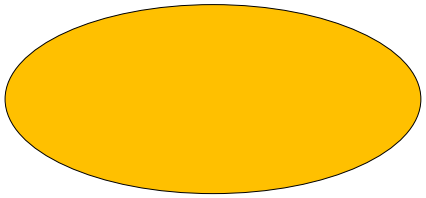
A spore with a single ***laesura***

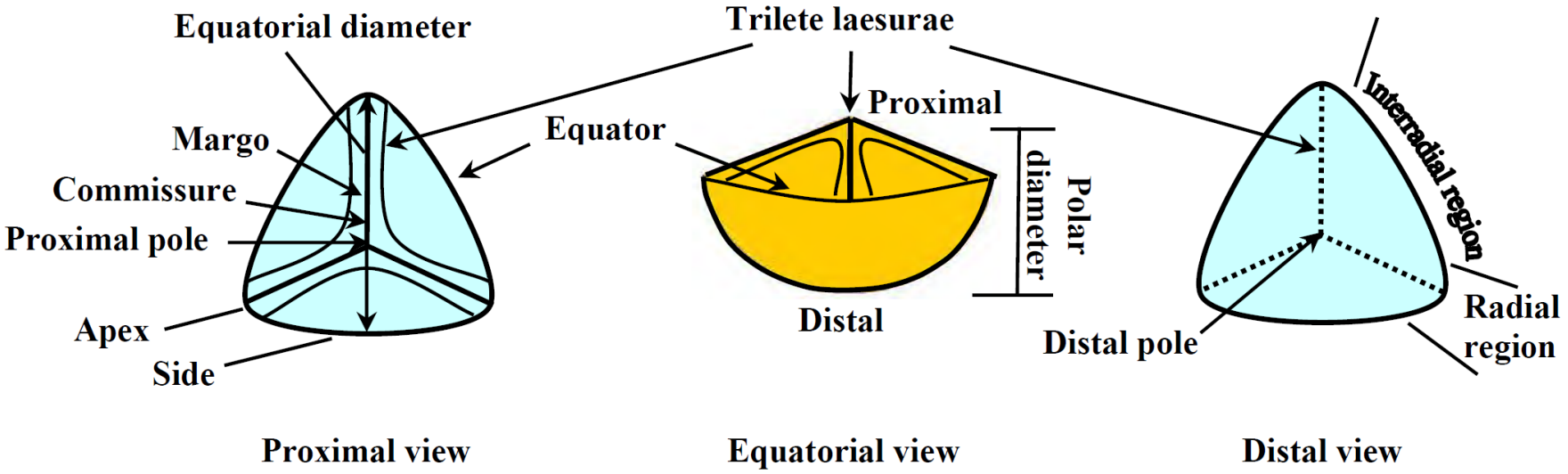


http://www.pollen.mtu.edu/glos-gtx/211G.GIF

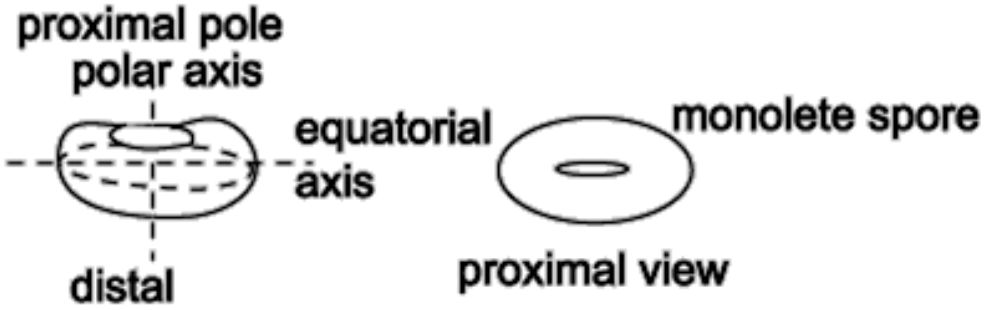
Alete

A spore without a ***laesura***

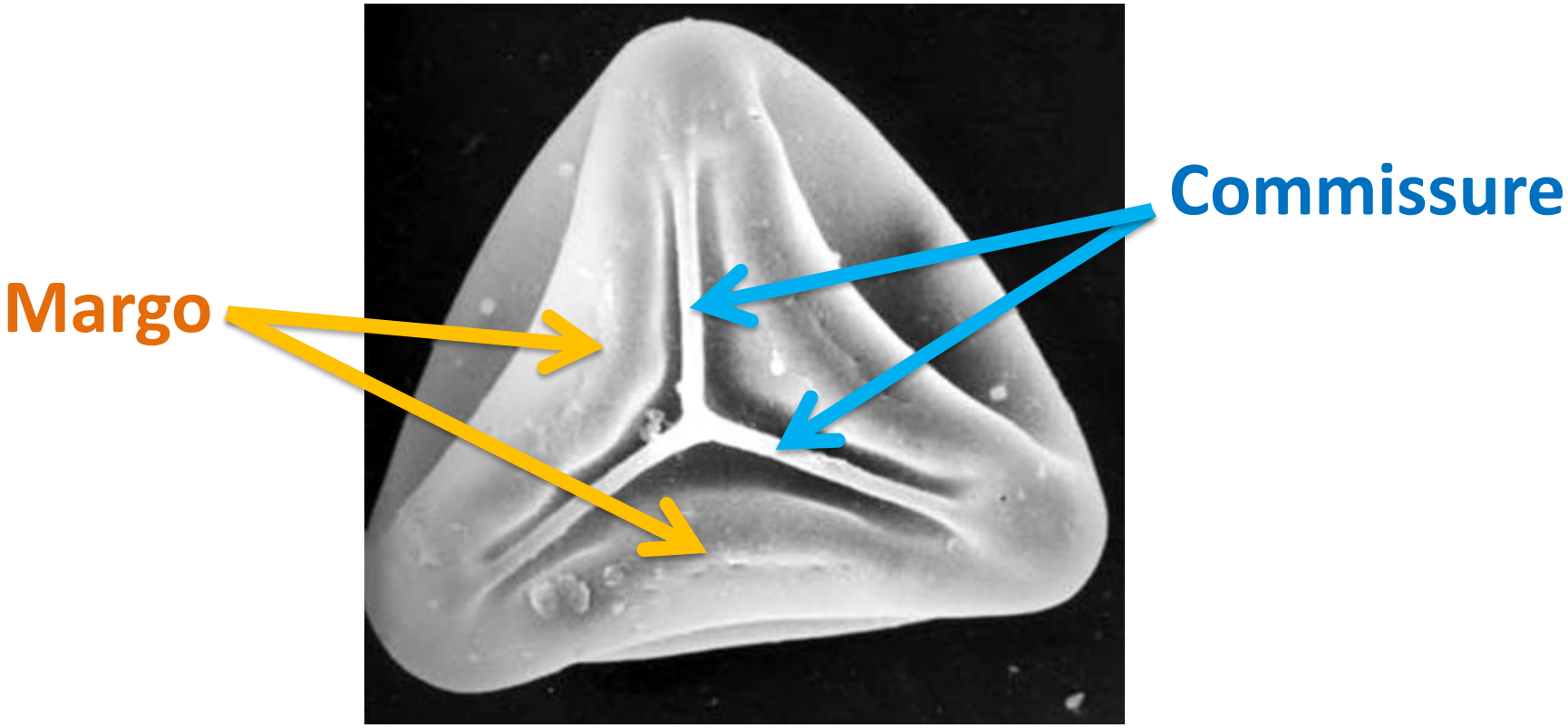




Schematic drawings illustrate the basic morphologic features of a trilete spore (Modified from Singh, 1964)

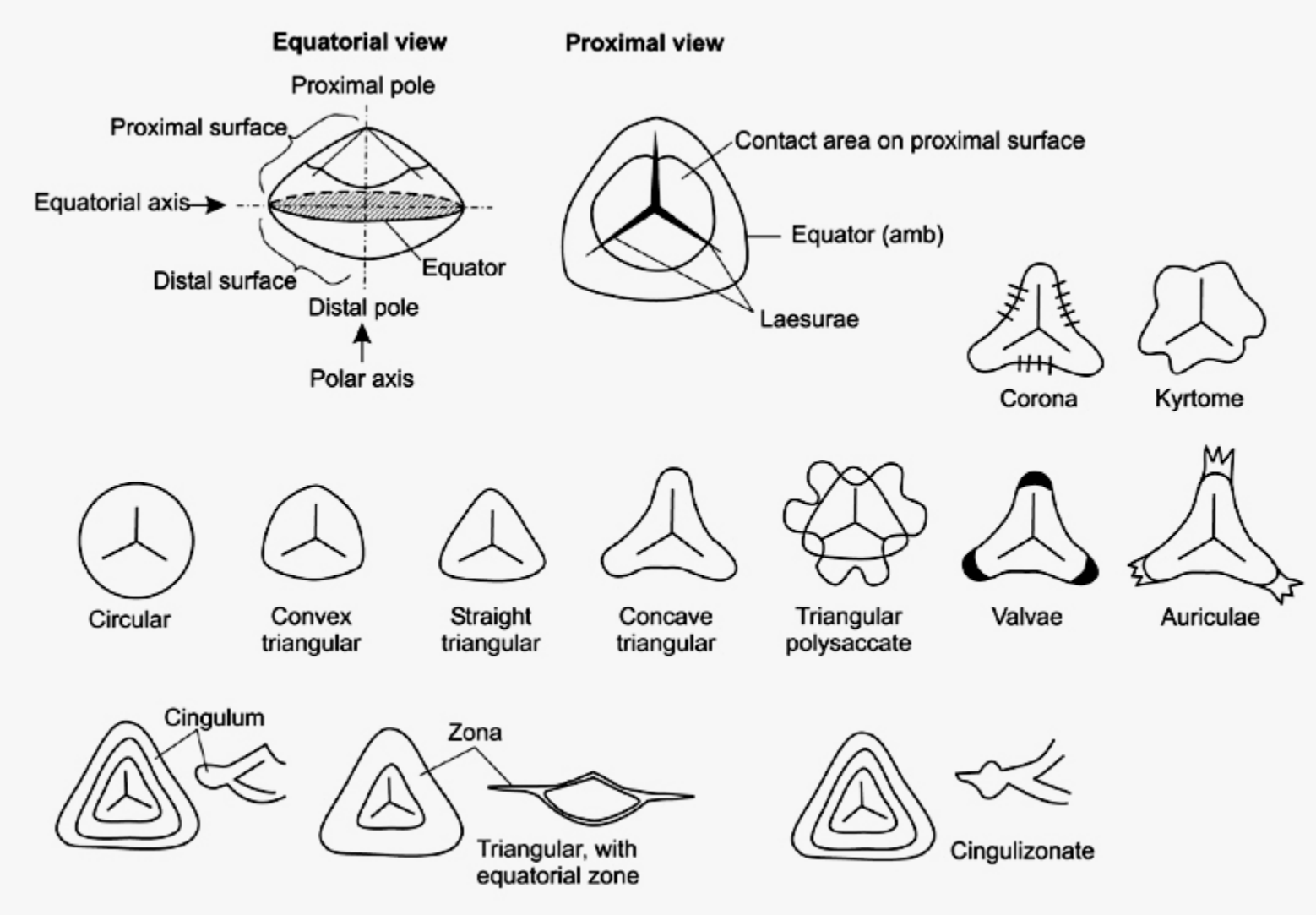


Basic morphology of a monolete spore
(http://www.ucl.ac.uk/GeolSci/micropal/spore.html)

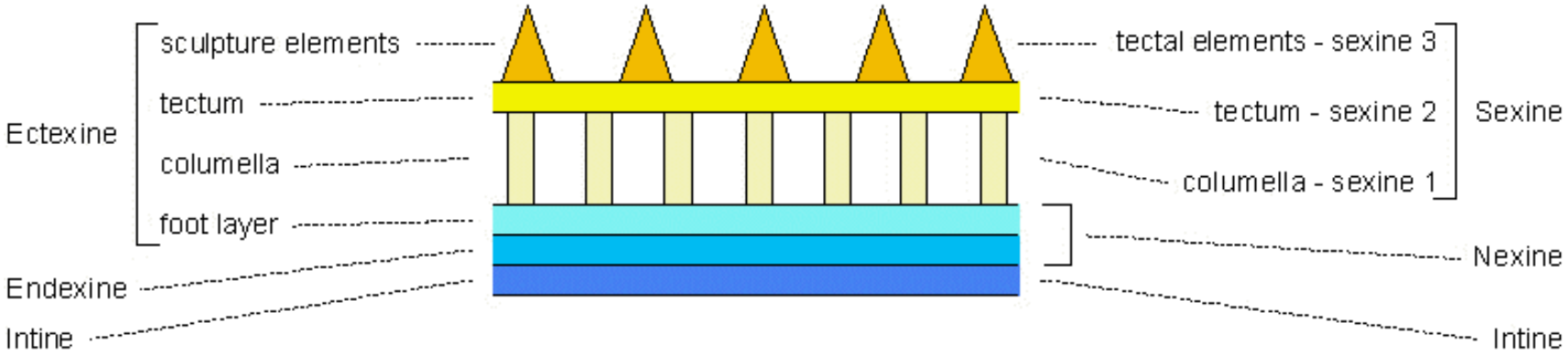


Dictyophyllidites harrisii Couper 1958
(After Volkheimer et al., 2007)

Spore Amb (outline)



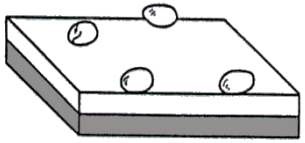
Spore/Pollen Wall Stratification



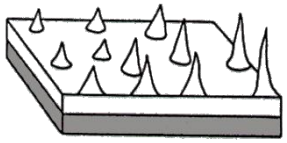
http://www.pollen.mtu.edu/glos-gtx/000G.GIF

Surface Sculpture of Spores

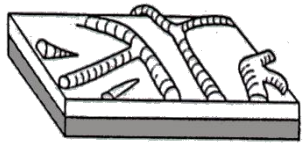
Psilate



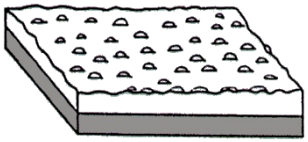
Gemmate



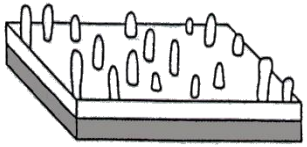
Echinate



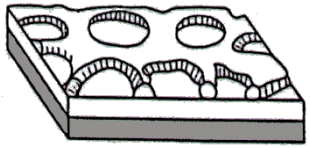
Rugulate



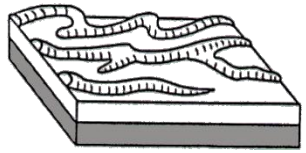
Scabrate



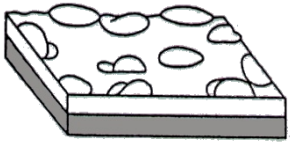
Baculate



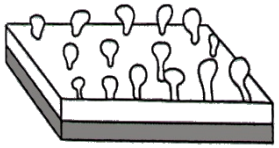
Reticulate



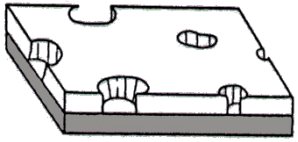
Striate



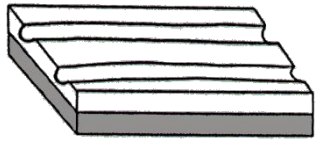
Verrucate



Clavate



Foveolate



Cicatricose

After Tschudy (1969)

Spore Description

1- Spore type

-Trilete
- Monolete
- Alete

2- Type of view

- Polar (proximal – distal)
- Equatorial

3- Amb

- Circular
- Triangular (straight – convex – concave)
- Cingulate

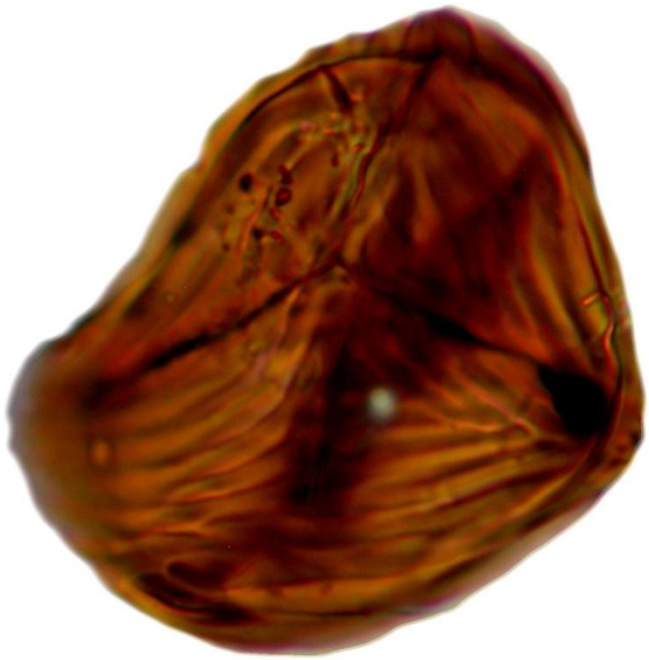
4- Laesurae

- Commissure (short – medium – long; *reaching the equator*)
- Margo (present – absent)

5- Sculpture

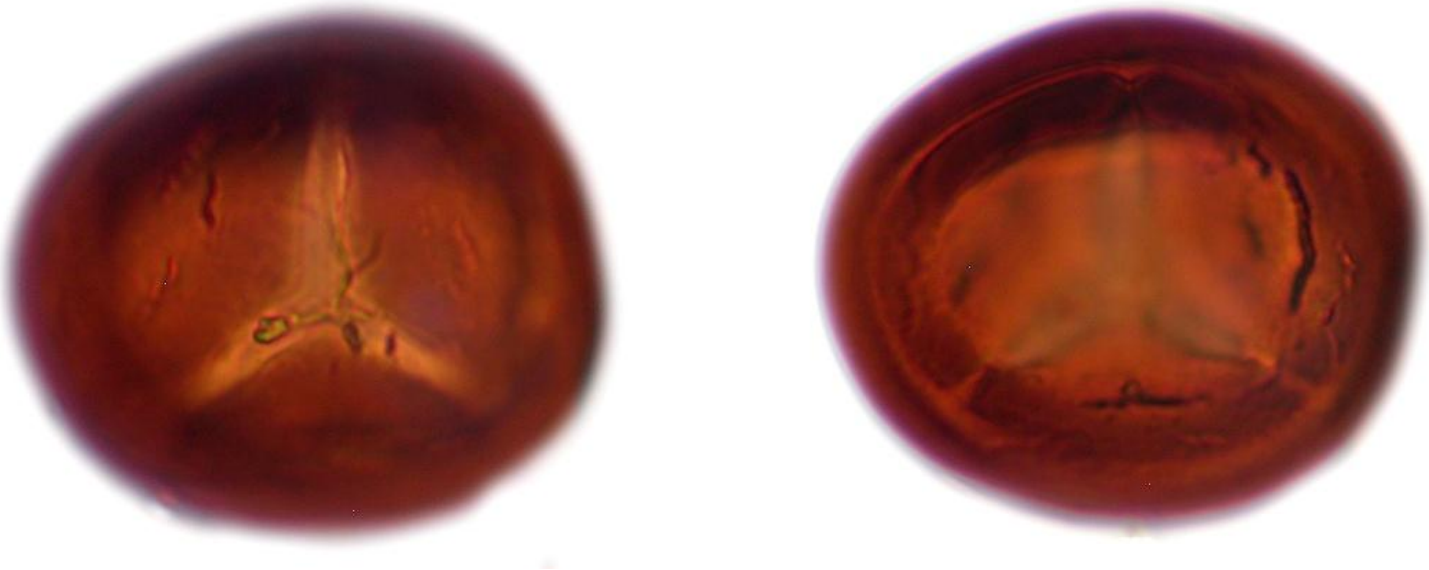
Deltoidospora

Cicatricosisporites

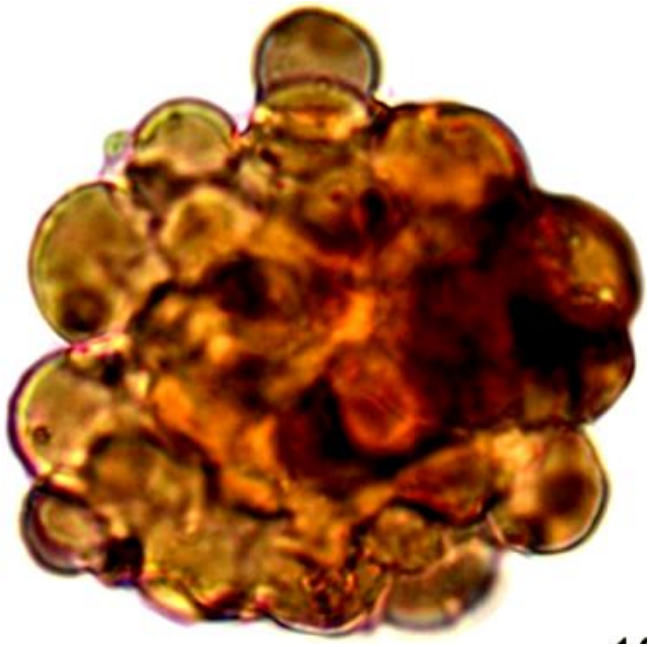


(Nye et al., 2008)

Cingutriletes



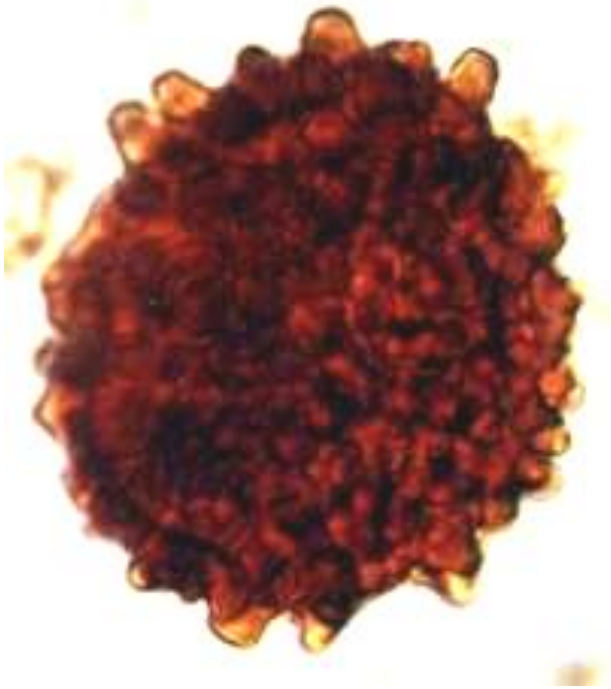
Leptolepidites



(Nye et al., 2008)

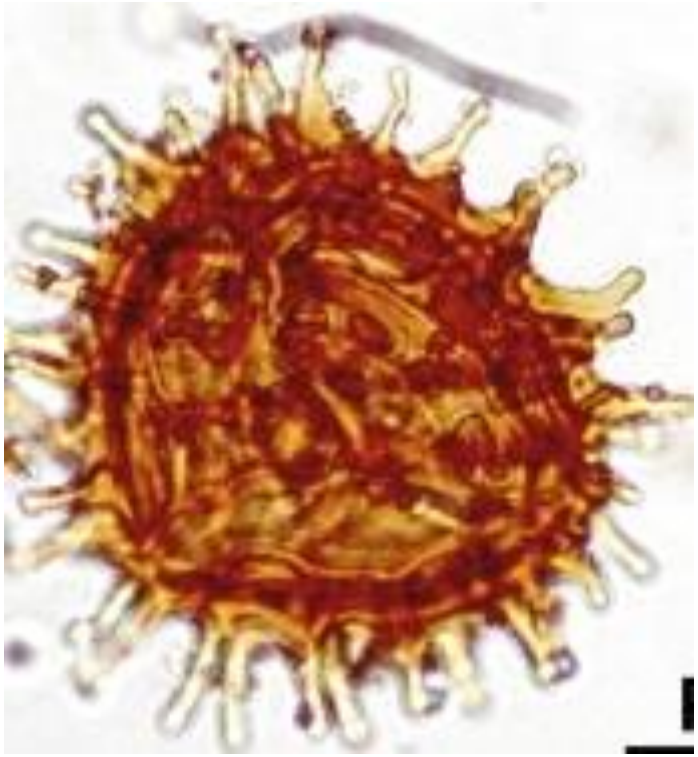
Sculpture: Verrucate

Gemmatriletes



Sculpture: Gemmate

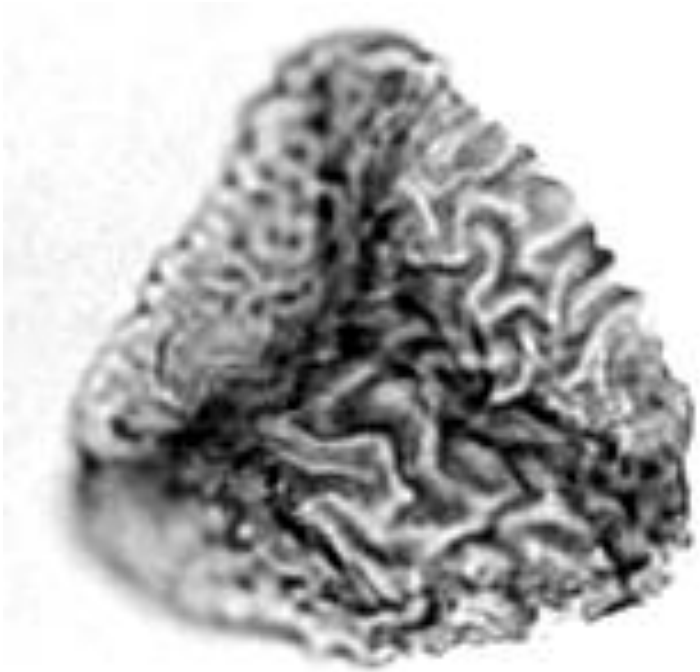
Nodosisporites



(Perez Loinaze et al., 2012)

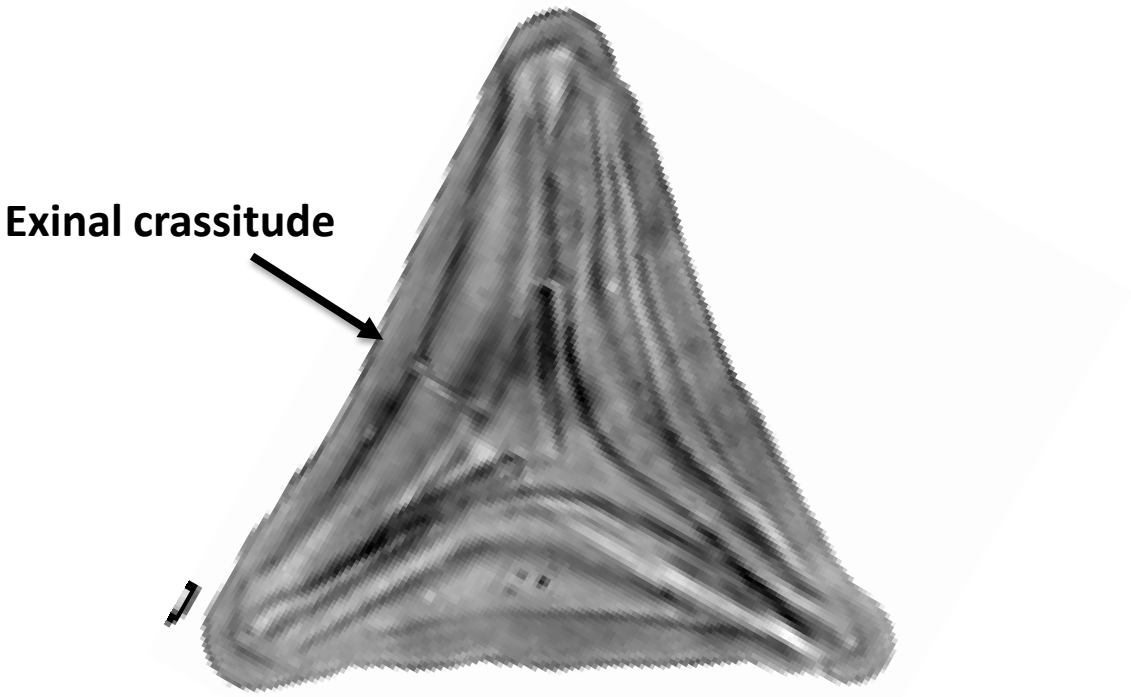
Sculpture: Baculate

Rugulatisporites



http://www.gns.cri.nz/what/earthhist/fossils/spore_pollen/catalog/

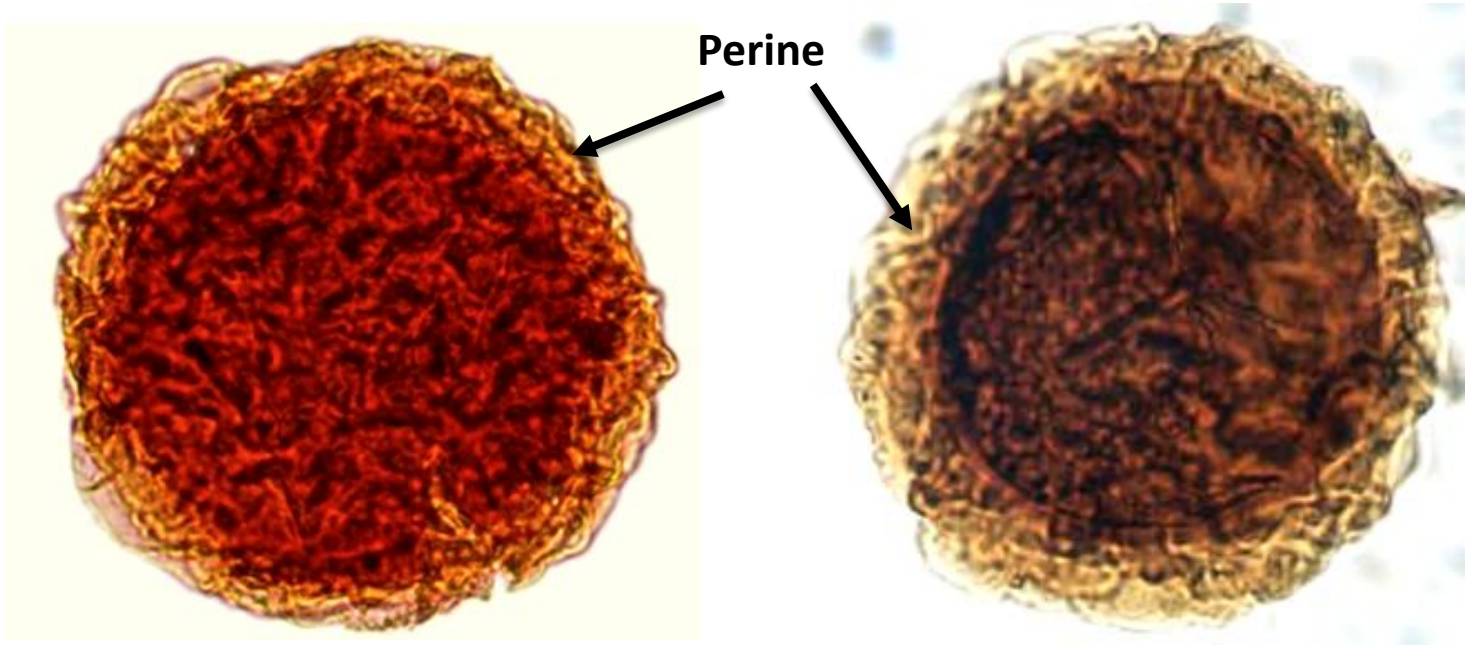
Gleicheniidites



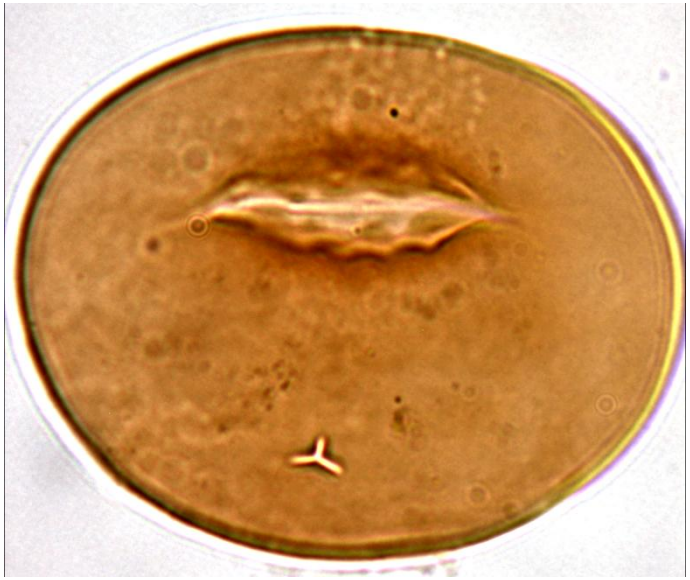
http://www.gns.cri.nz/what/earthhist/fossils/spore_pollen/catalog/taxa/234.htm

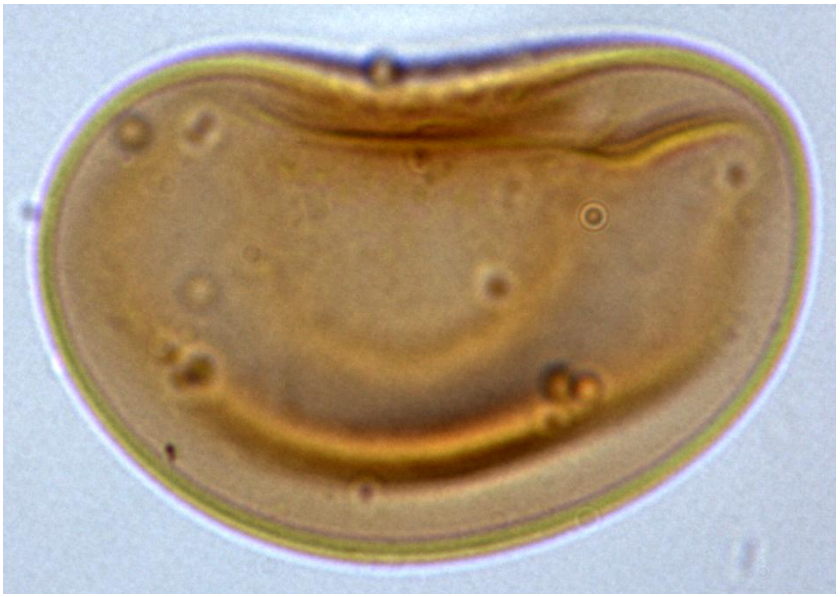
Crybelosporites

Perinate spore



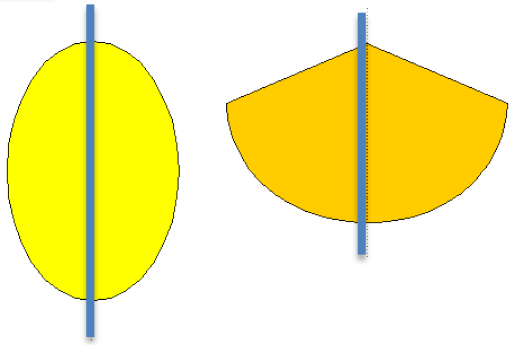
Laevigatosporites



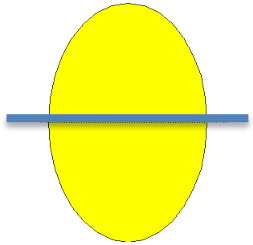


Morphology of Pollen Grains

1- Polarity

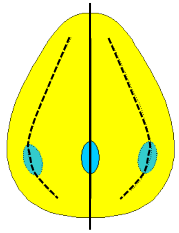


The **Polar Axis** is the straight line between the distal and proximal poles of a pollen grain or a spore

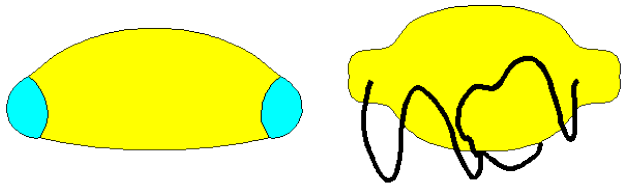


Pollen grains can therefore be:

A- **Isopolar** (the proximal and distal faces of the exine are alike)



B- **Heteropolar** (the distal and proximal faces of the exine are different, either in shape, ornamentation or apertural system)



C- **Subisopolar** (the proximal and distal faces are slightly different)

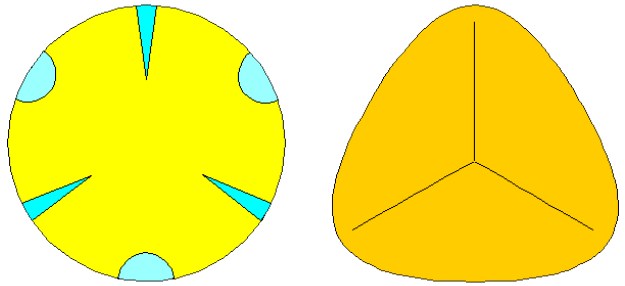
Illustrations from: http://www.pollen.mtu.edu/glos-gtx/glos-int.htm

2- Symmetry

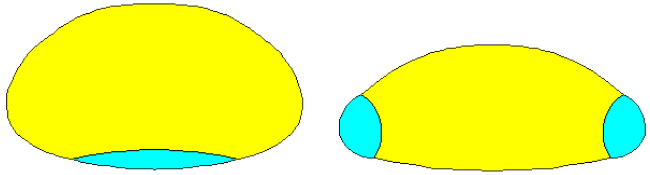
Spores and pollen are either **symmetric** or **asymmetric**

Symmetric ones can be:

A- **Radially symmetric** (with two or more vertical planes of symmetry)



B- **Bilaterally symmetric** (with a single, principal plane of symmetry)

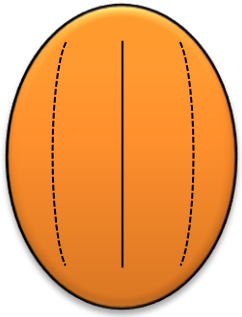


Illustrations from: http://www.pollen.mtu.edu/glos-gtx/glos-int.htm

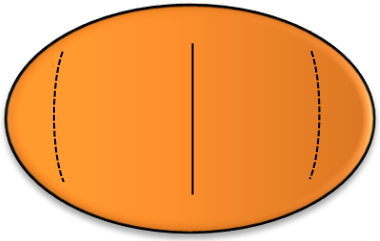
3- Shape

The shape of pollen grains and spores can be:

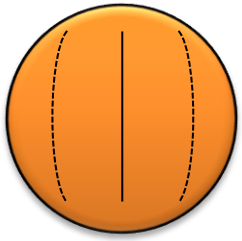
A- **Prolate** (the polar axis is longer than the equatorial diameter)



B- **Oblate** (the polar axis is shorter than the equatorial diameter)



C- **Spheroidal** (the polar axis and the equatorial diameter are approximately equal)



4- Aperture

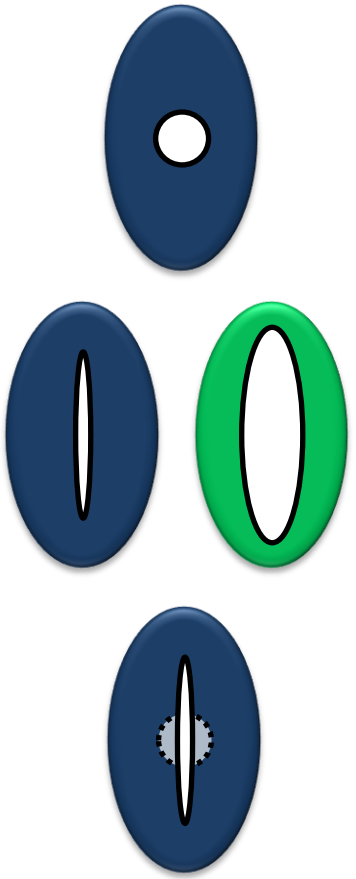
- The aperture is a specialized thin region of the spore/pollen wall that is generally different in ornamentation and/or in structure

- Apertures can be in the form of **Pori** (pores) or **Colpi/Sulci** (furrows)

● Grains with pori are called **Porate**

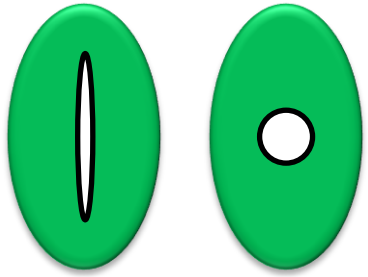
● Grains with colpi/sulci are called **Colpate/Sulcate**

● Grains with combined colpus and porus are called **Colporate**

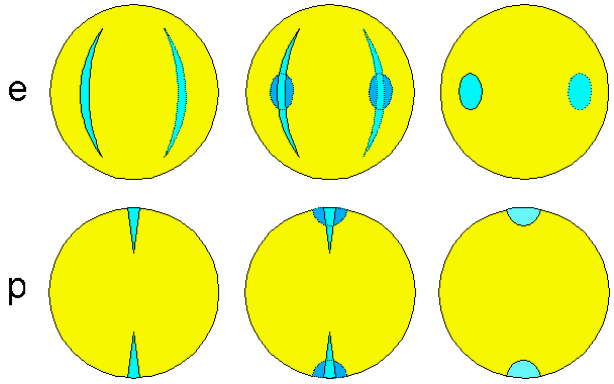


- Examples of apertures include:

- **Monocolpate**
- **Monoporate**

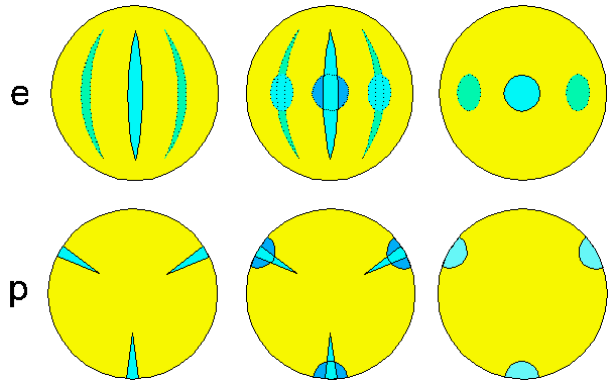


- **Dicolpate**
- **Dicolporate**
- **Diporate**



http://www.pollen.mtu.edu/glos-gtx/087G.GIF

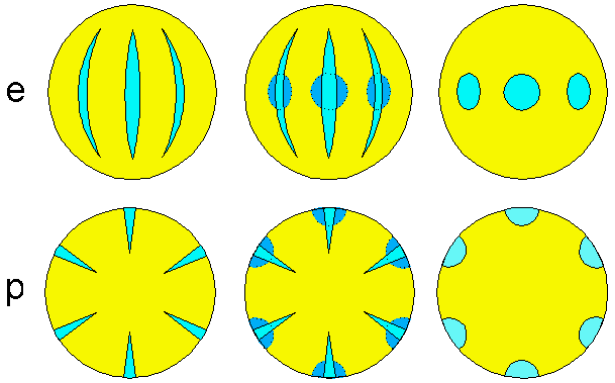
- **Tricolpate**
- **Tricolporate**
- **Triporate**



http://www.pollen.mtu.edu/glos-gtx/330G.GIF

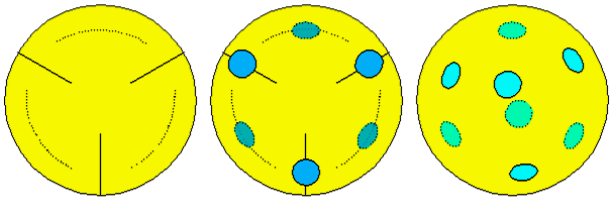
Apertures situated only at the equator:

- **Zonocolpate (Stephanocolpate)**
- **Zonocolporate (Stephanocolporate)**
- **Zonoporate (Stephanoporate)**



Apertures spread over the surface sometimes forming a regular pattern:

- **Pantocolpate (Pericolpate)**
- **Pantocolporate (Pericolporate)**
- **Pantoporate (Periporate)**

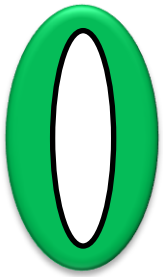


- **Inaperturate**

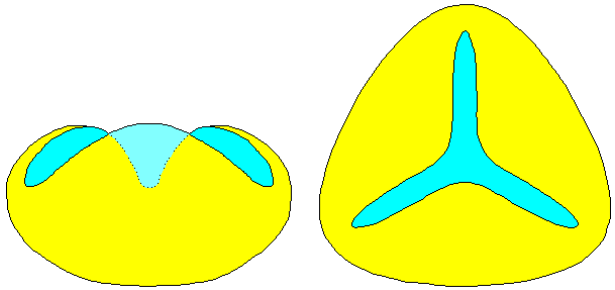
- **Ulcerate** (having an ill-defined pore in the polar area)

Illustrations from: http://www.pollen.mtu.edu/glos-gtx/glos-int.htm

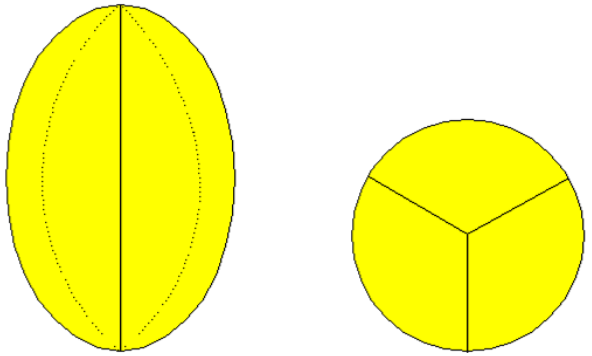
- **Monosulcate**



- **Trichotomocolpate/Trichotomosulcate** (having three-branched colpus/sulcus)

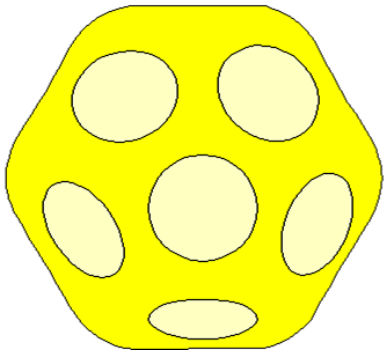


- **Syncolpate** (having two or more colpi the ends of which anastomose at the pole)

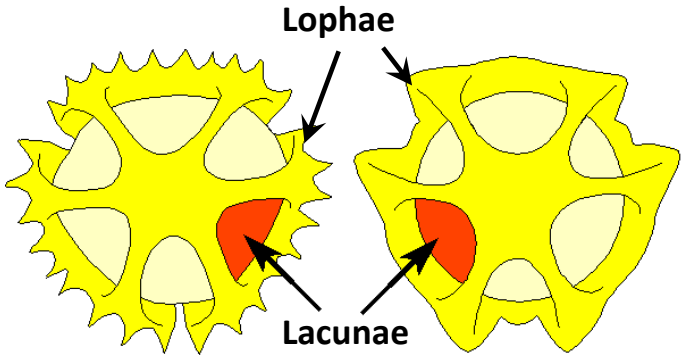


Illustrations from: http://www.pollen.mtu.edu/glos-gtx/glos-int.htm

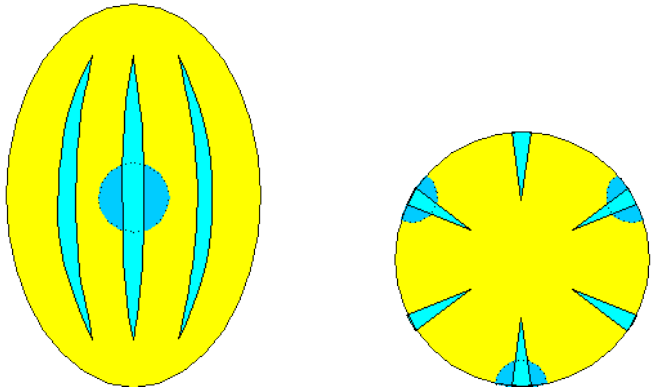
● **Fenestrate** (having large, window-like spaces lacking a tectum)



● **Lophate** (having a raised outer exine in a pattern of ridges ***(lophae)*** surrounding depressions ***(lacunae)***)



● **Heterocolpate** (having both simple and compound colpi)

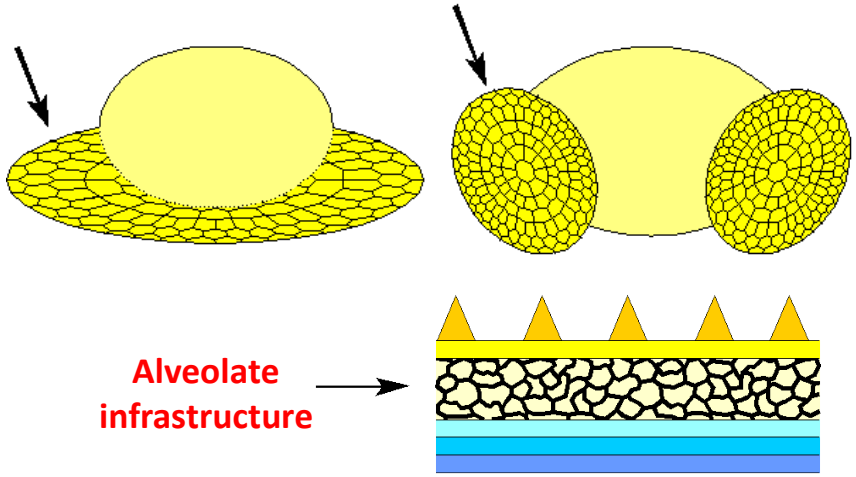


Illustrations from: http://www.pollen.mtu.edu/glos-gtx/glos-int.htm

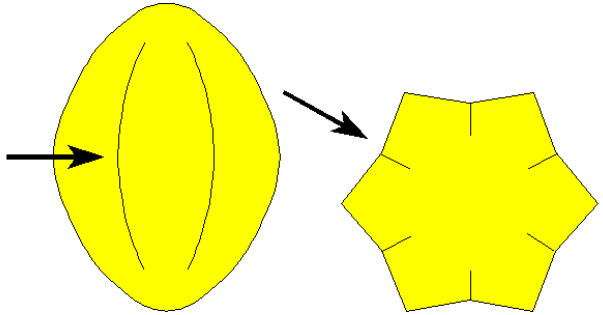
Other pollen types:

● **Saccate** (having at least one saccus/vesicle/bladder/wing)

A ***saccus*** is an expansion of the exine of a pollen grain that is at least partly filled with an ***alveolate*** infrastructure



● **Polyplicate/Striate** (having more than three meridional ridges **(plicae)** separated by deep grooves **(striae)**)



Illustrations from: http://www.pollen.mtu.edu/glos-gtx/glos-int.htm

Pollen Description

1- Polarity

- Isopolar
- Heteropolar
- Subisopolar

2- Symmetry

- Asymmetric
- Radially symmetric
- Bilaterally symmetric

3- Shape

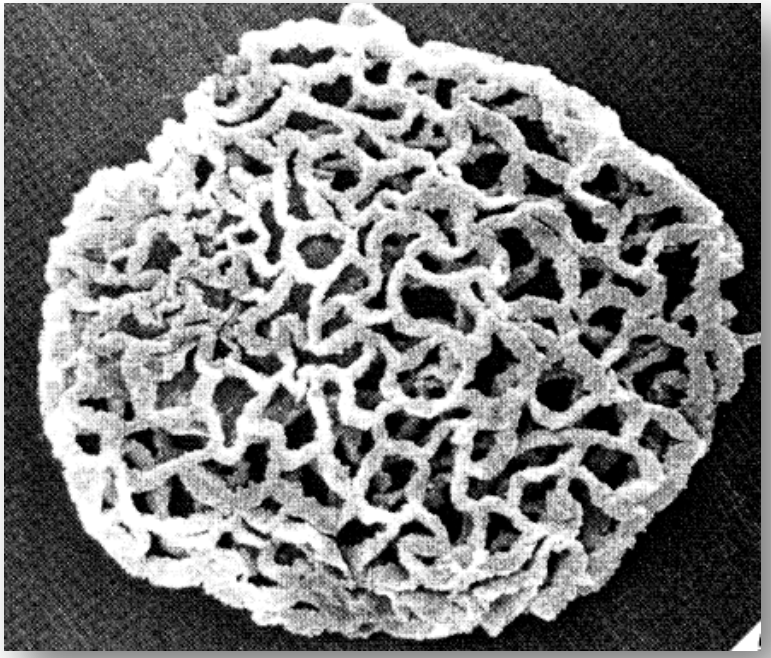
- Prolate
- Oblate
- Spheroidal

4- Type/Aperture

- Monoporate
- Bisaccate
- Tricolpate, etc.

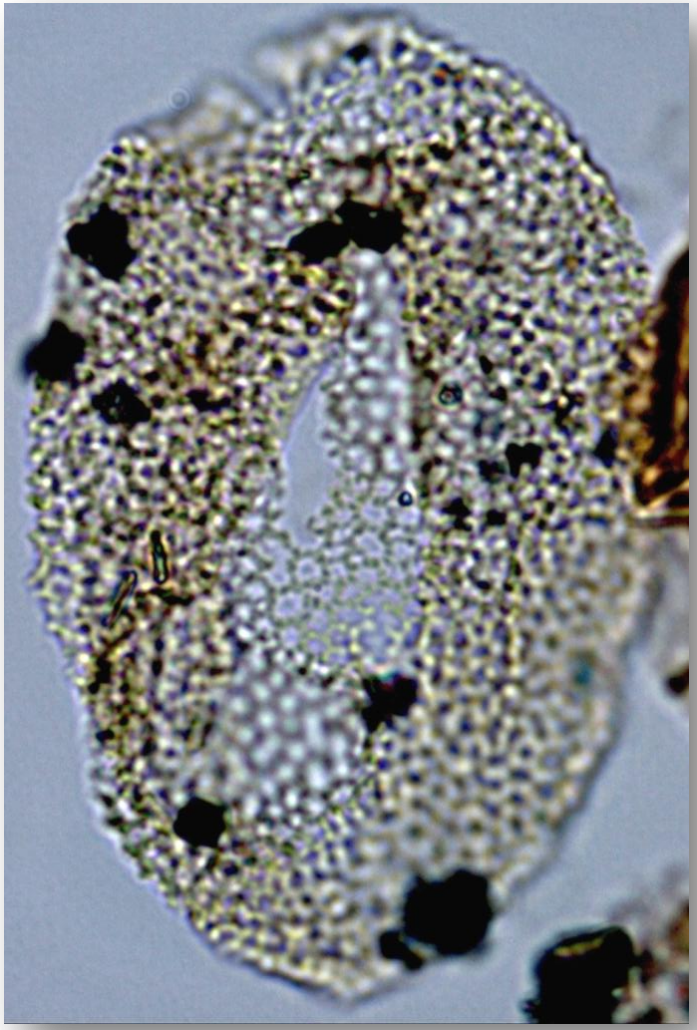
5- Sculpture

Afropollis

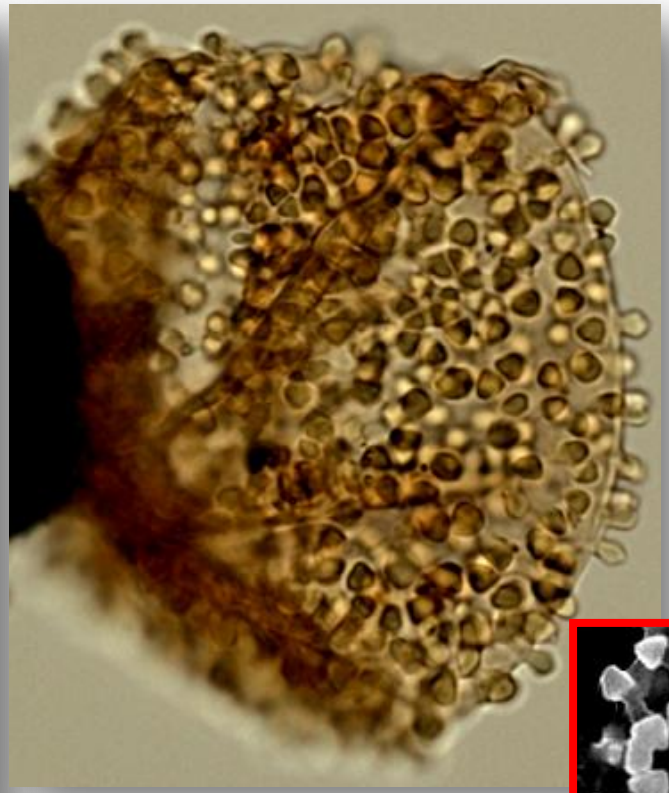


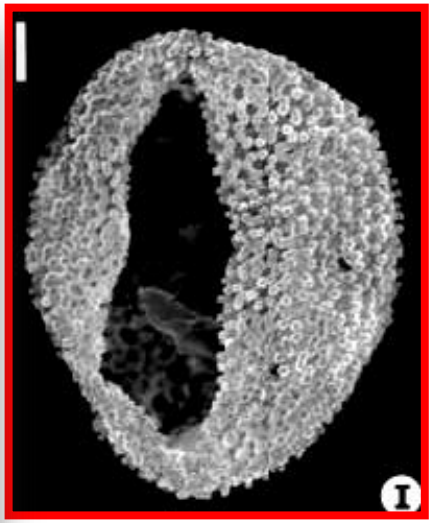
(Doyle et al., 1982)

Retimonocolpites

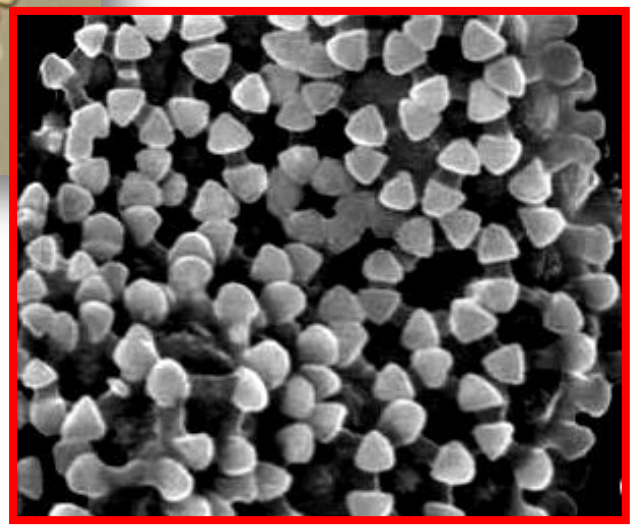


Stellatopollis



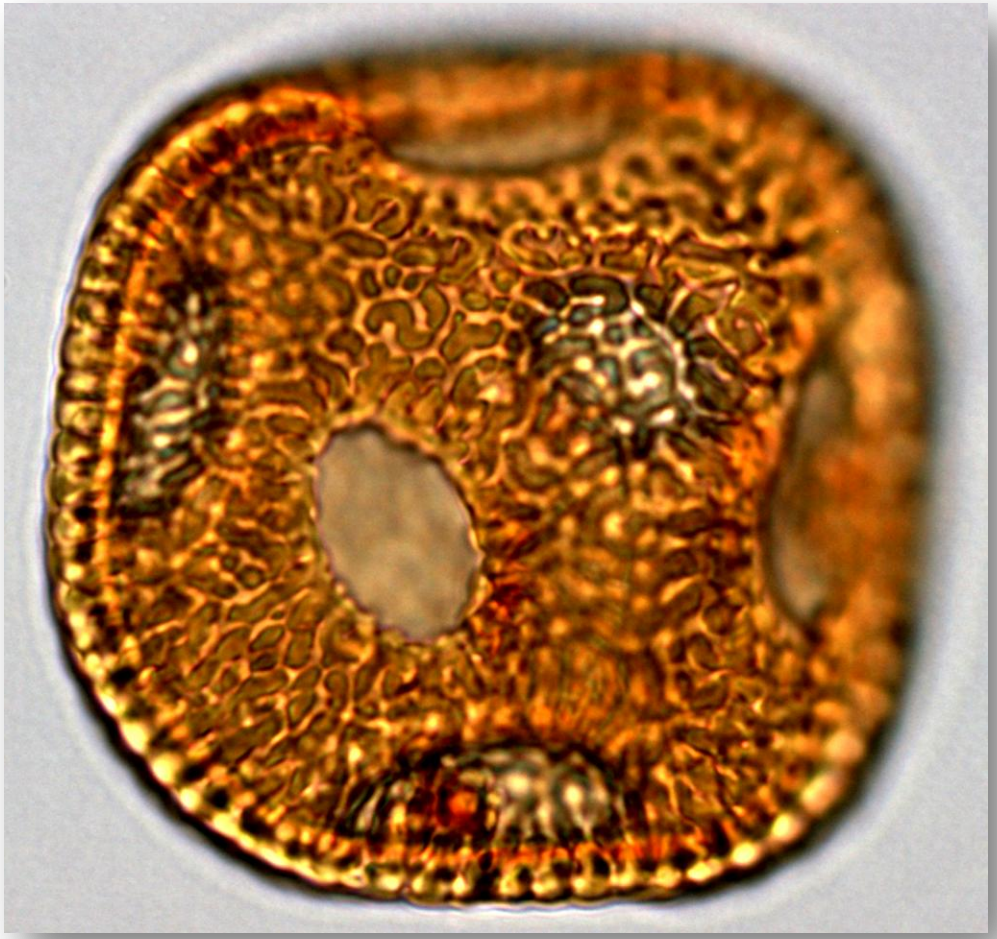


(Dejax and Masure, 2005)

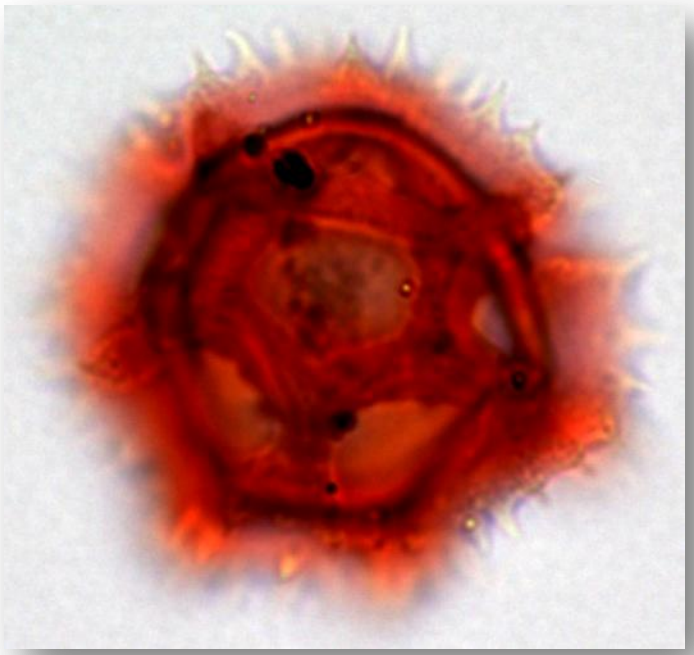


(Dejax and Masure, 2005)

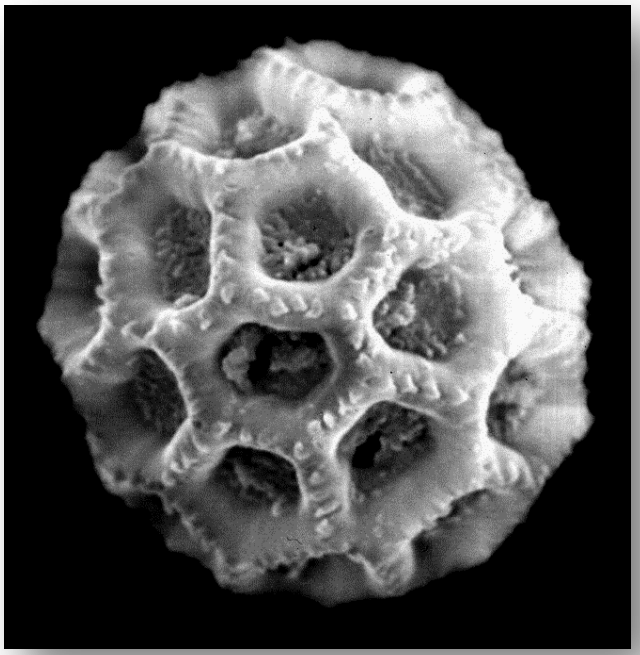
Cretacaeiporites



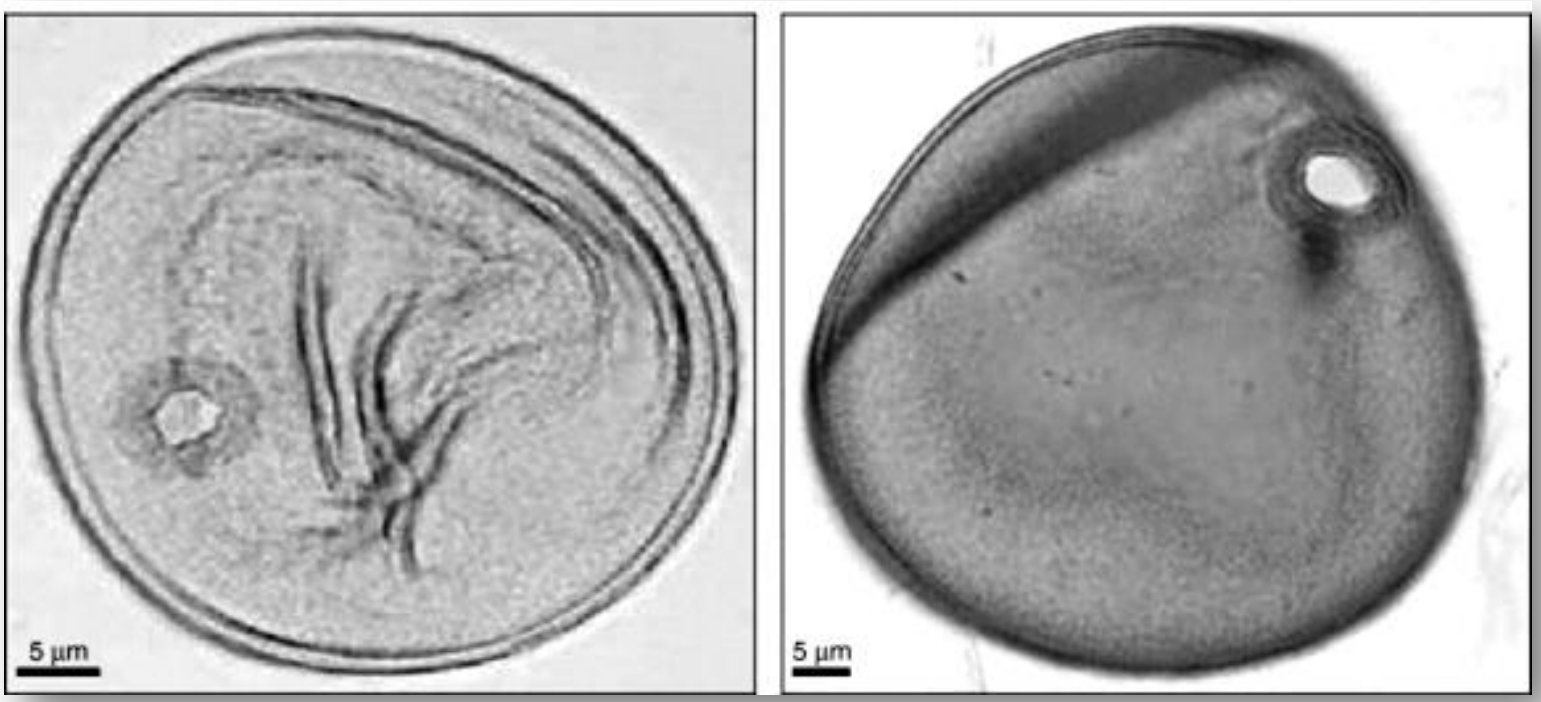
Asteraceae



(Zobaa et al., 2011)

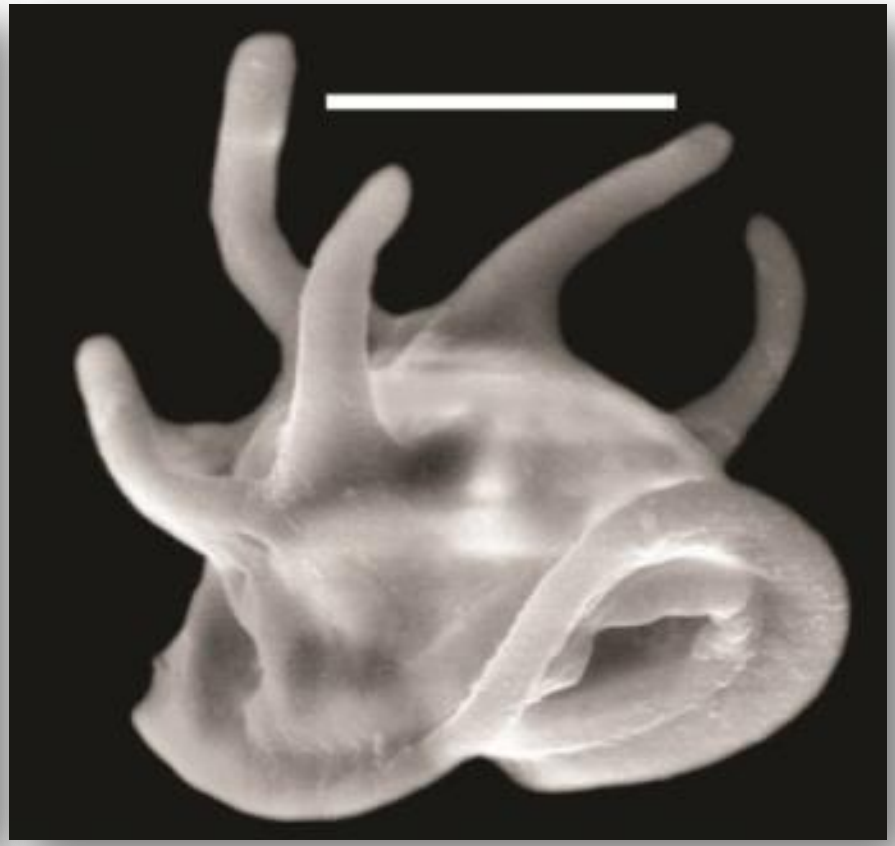


Poaceae



(Joly et al., 2007)

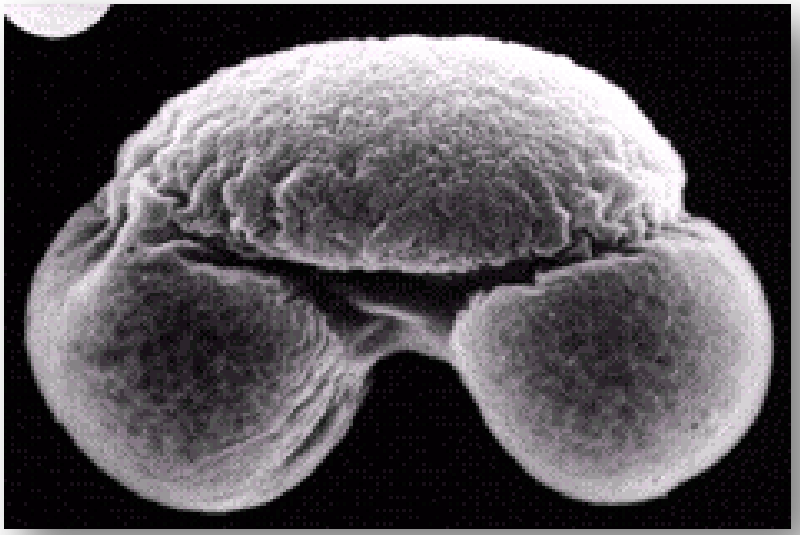
Elaterosporites



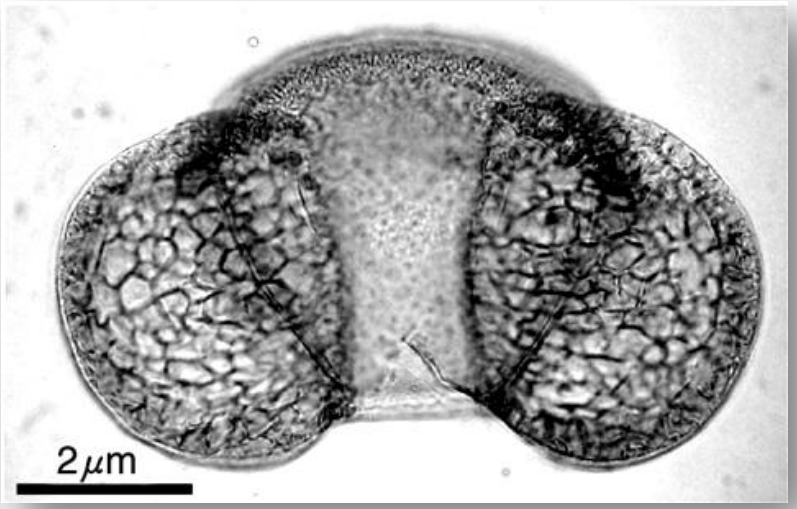
Corollina

Ephedripites

Pinus

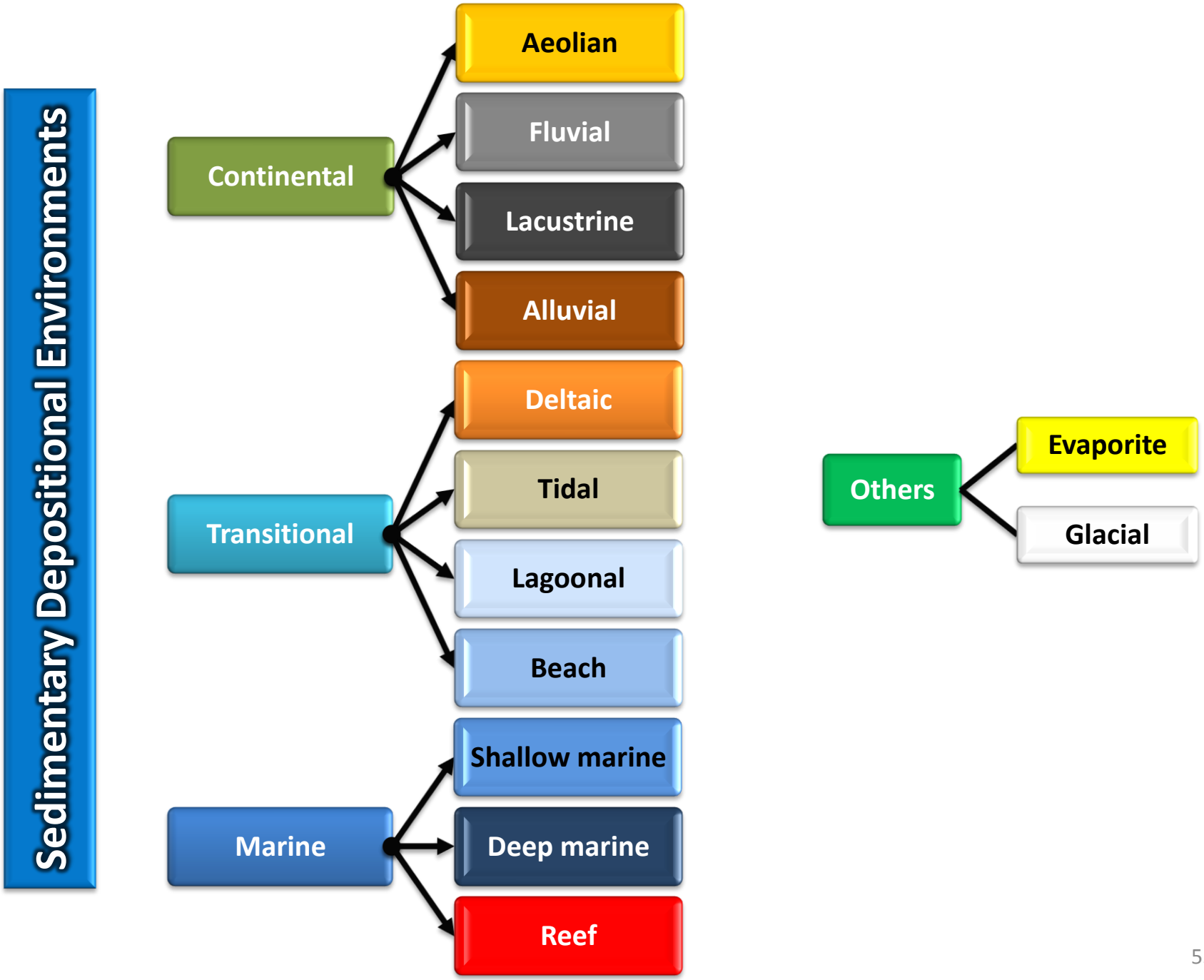


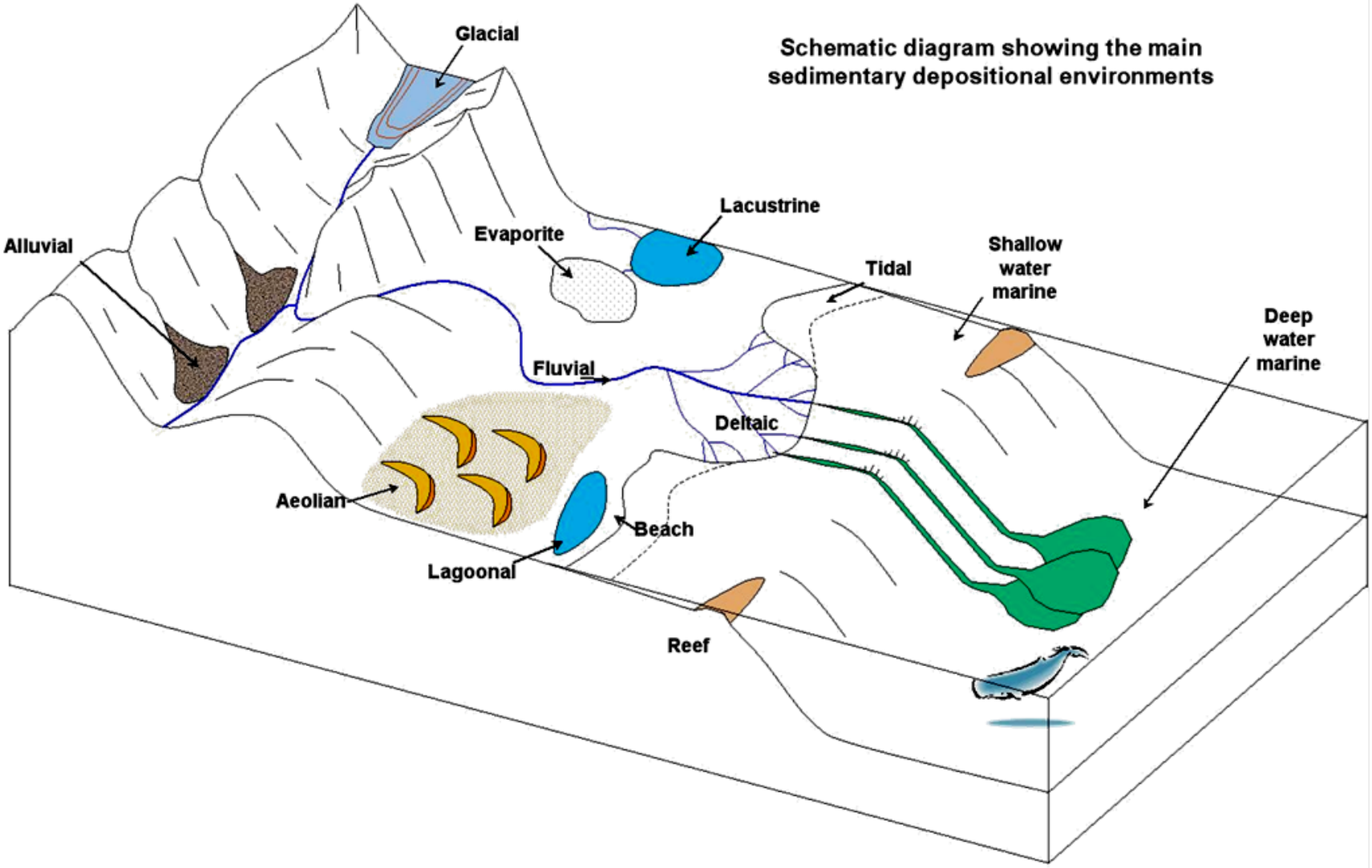
(http://www.geo.arizona.edu/palynology/pid00005.html)



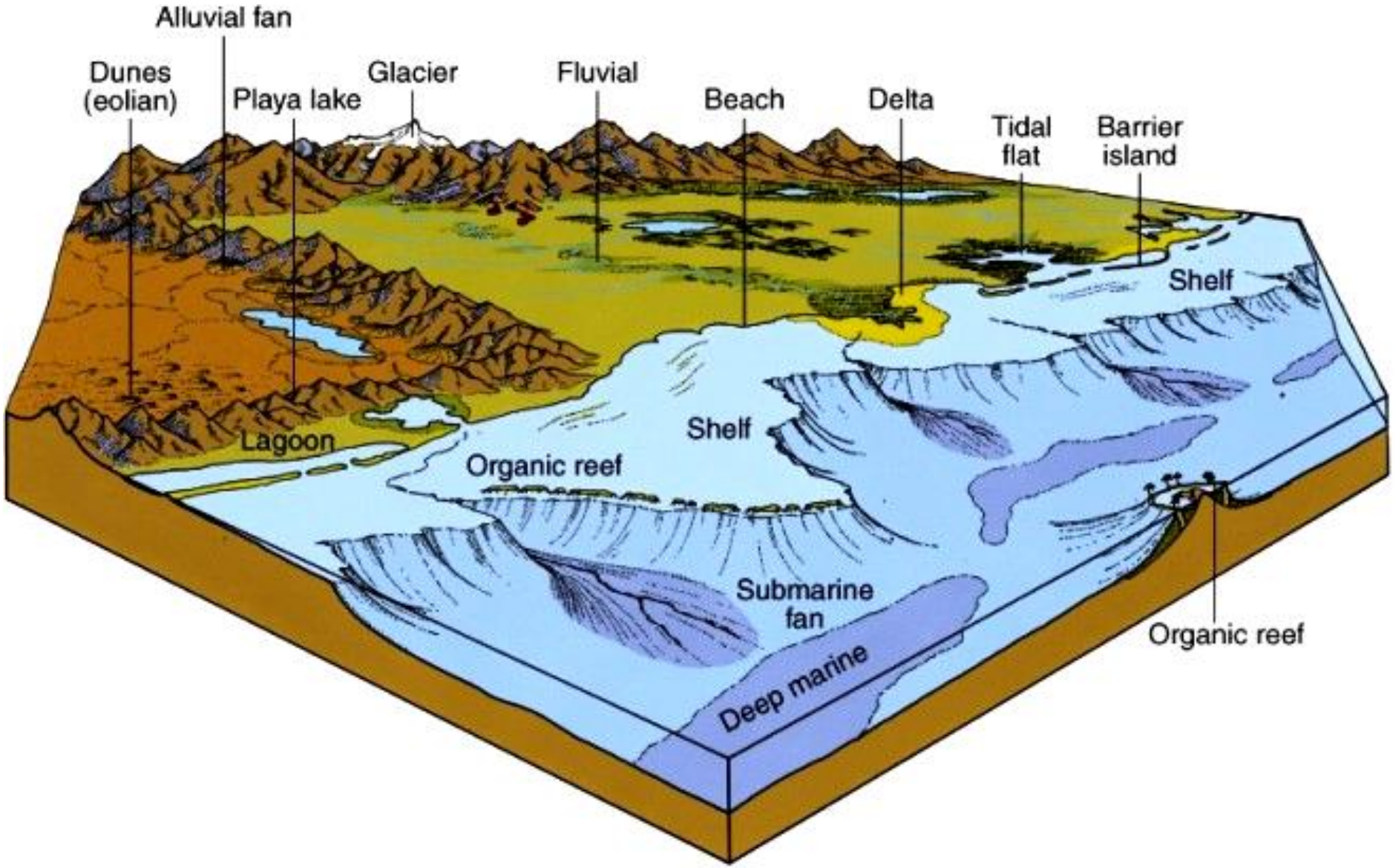
(http://jolisfukyu.tokai-sc.jaea.go.jp/fukyu/mirai-en/2007/2_5.html)

Spores and Pollen as Paleoenvironmental Indicators

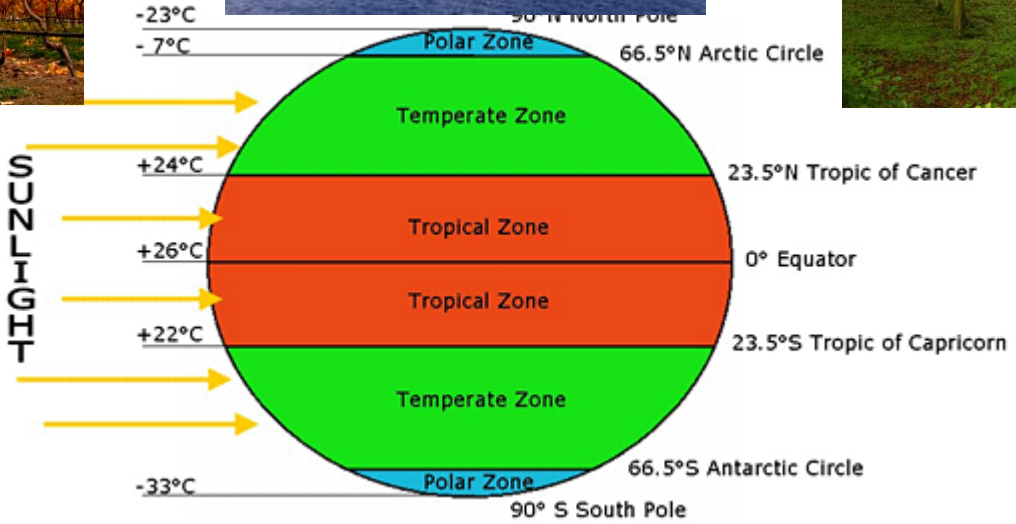

Sedimentary Depositional Environments
Continental
Aeolian
Fluvial
Lacustrine
Alluvial
Transitional
Deltaic
Tidal
Lagoonal
Beach
Marine
Shallow marine
Deep marine
Reef
Others
Evaporite
Glacial

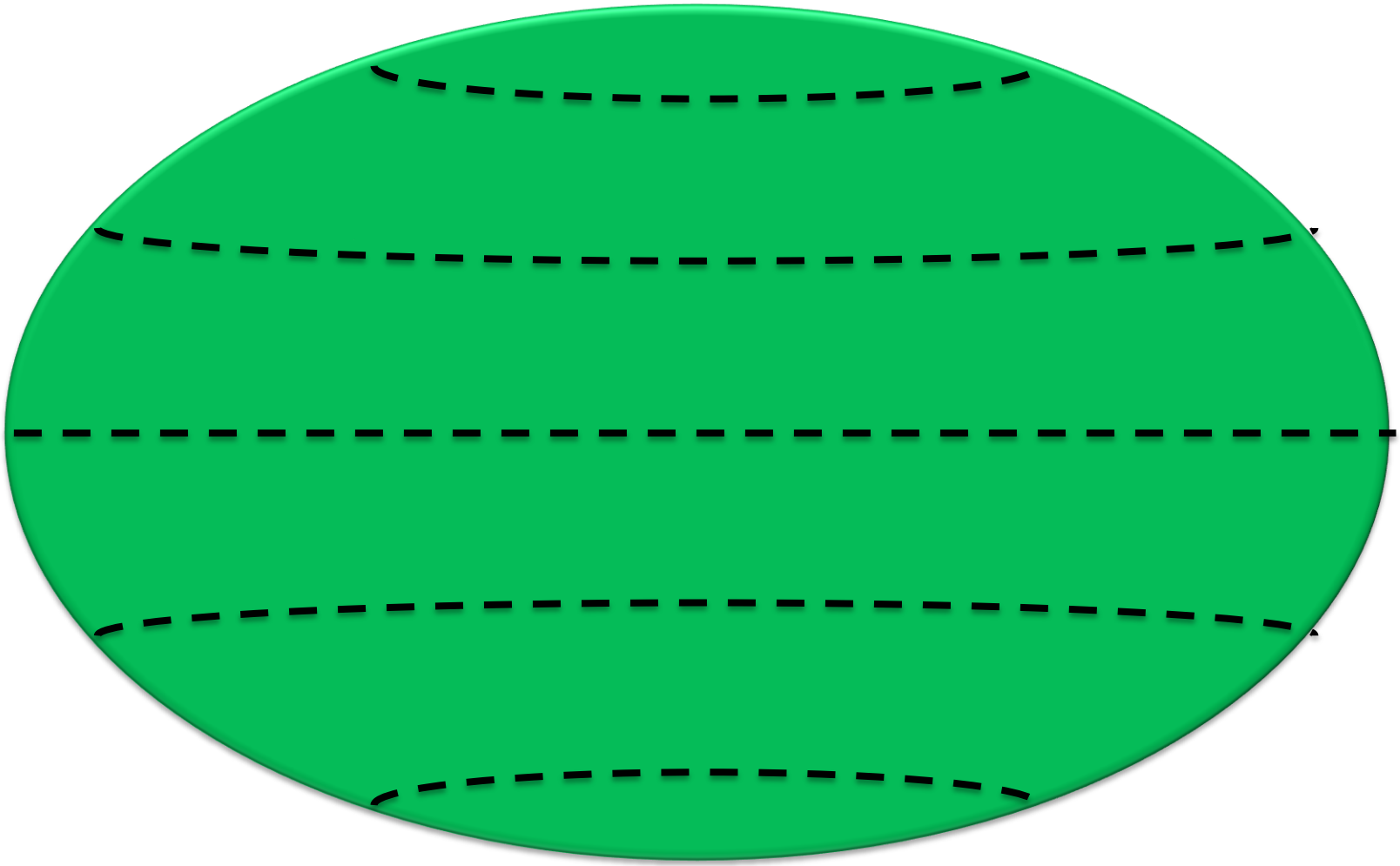


http://en.wikipedia.org/wiki/Sedimentary_depositional_environment



http://explanet.info/images/Ch02/02_20.jpg


-23°C
- 7°C
Polar Zone
66.5°N Arctic Circle
Temperate Zone
SUNLIGHT
+24°C
23.5°N Tropic of Cancer
Tropical Zone
+26°C
0° Equator
Tropical Zone
+22°C
23.5°S Tropic of Capricorn
Temperate Zone
66.5°S Antarctic Circle
Polar Zone
-33°C
90° S South Pole



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http://www.ucl.ac.uk/GeolSci/micropal/welcome.html

http://www.pollen.mtu.edu/glos-gtx/glos-int.htm