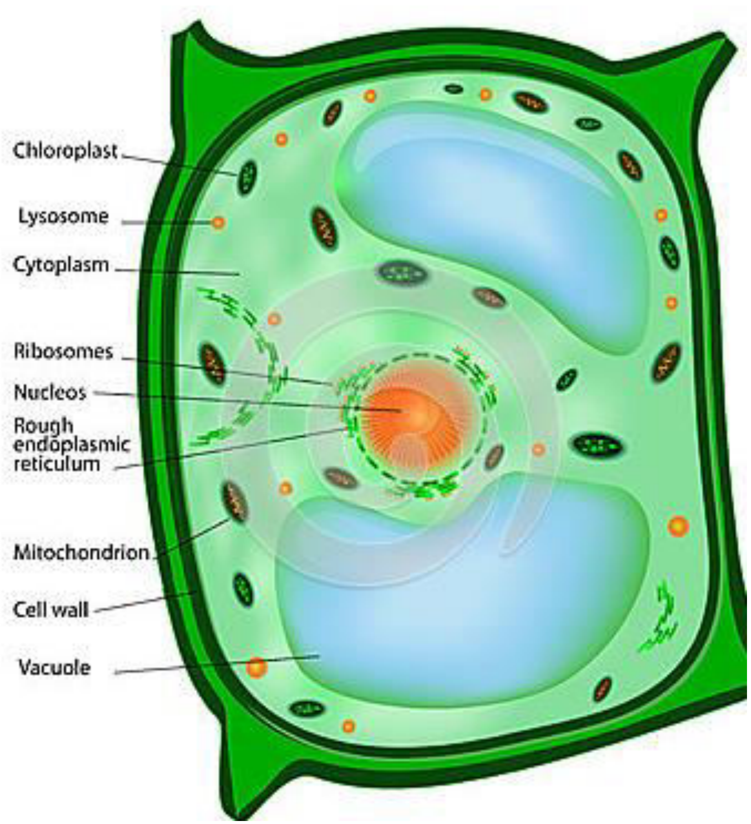
Vegetal cytology

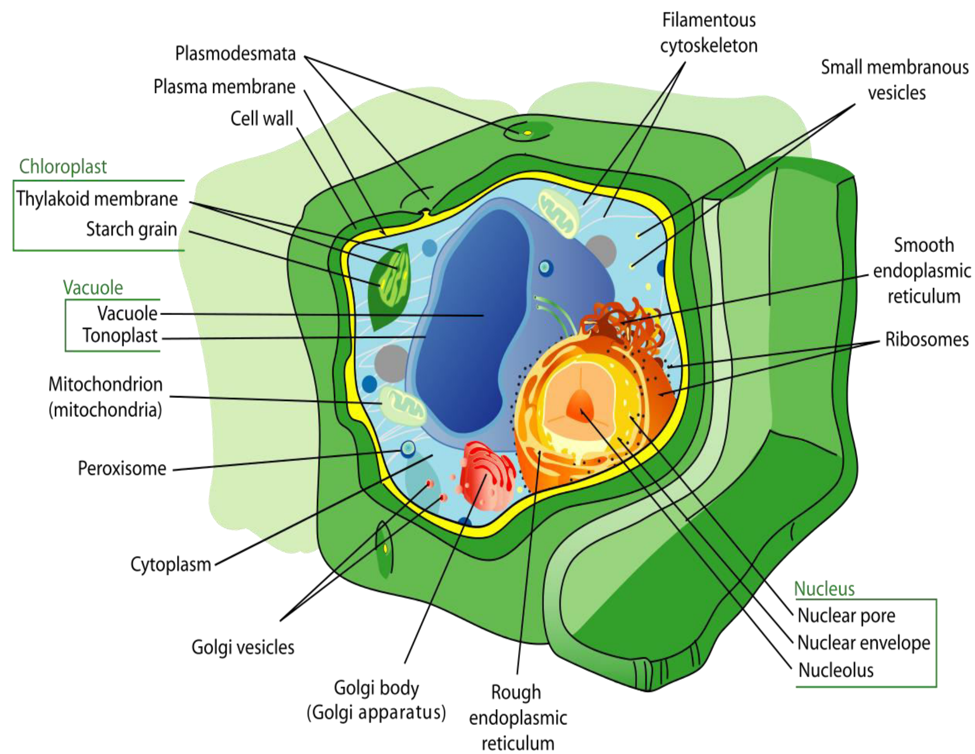
Lesson 3.

Vacuom and ergastic inclusions

VACUOLAR SYSTEM OR VACUOM

Non-living component, specific only for vegetal cells





VACUOM

- **All vacuoles of one cell form the *vacuom.***
- **The vacuole is as a storehouse of water and a lot of different chemical compounds;**
- **The vacuole is filled with a fluid called *cell-sap* or *vacuolar sap.***
- **The vacuole is surrounded by membrane called *tonoplast.***

Tonoplast (gr. ***tonos***=tension)

- is biological membrane, consisting from proteins, and lipids, membrane thickness - 50*A*.

- with differentially permeability.

Cell-sap or vacuolar sap

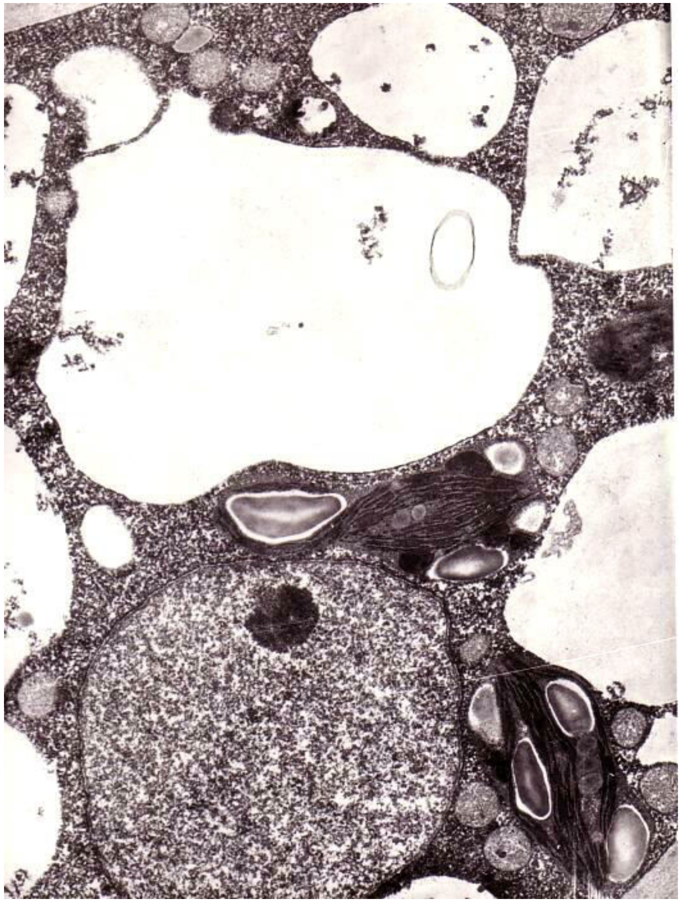
- Reprezints the products of protoplast activity:
- With different chemical compounds:

  - organic (organic acids and their salts, carbohydrates, proteins, alcaloids, tannins, anthocyanins, heterosides…);

  - anorganic (minerals) (sulphates, chlorides, phosphates, nitrates etc.)

- The chemical compounds may be: dissolved, colloidal, insoluble or in suspension.
- The chemical products may be as store nutrients or excretion product (waste).
- The tonoplast and cell-sap helps maintain turgor

Juvenile cell



In the juvenile cells there are a lot of small vacuoles

Mature cell

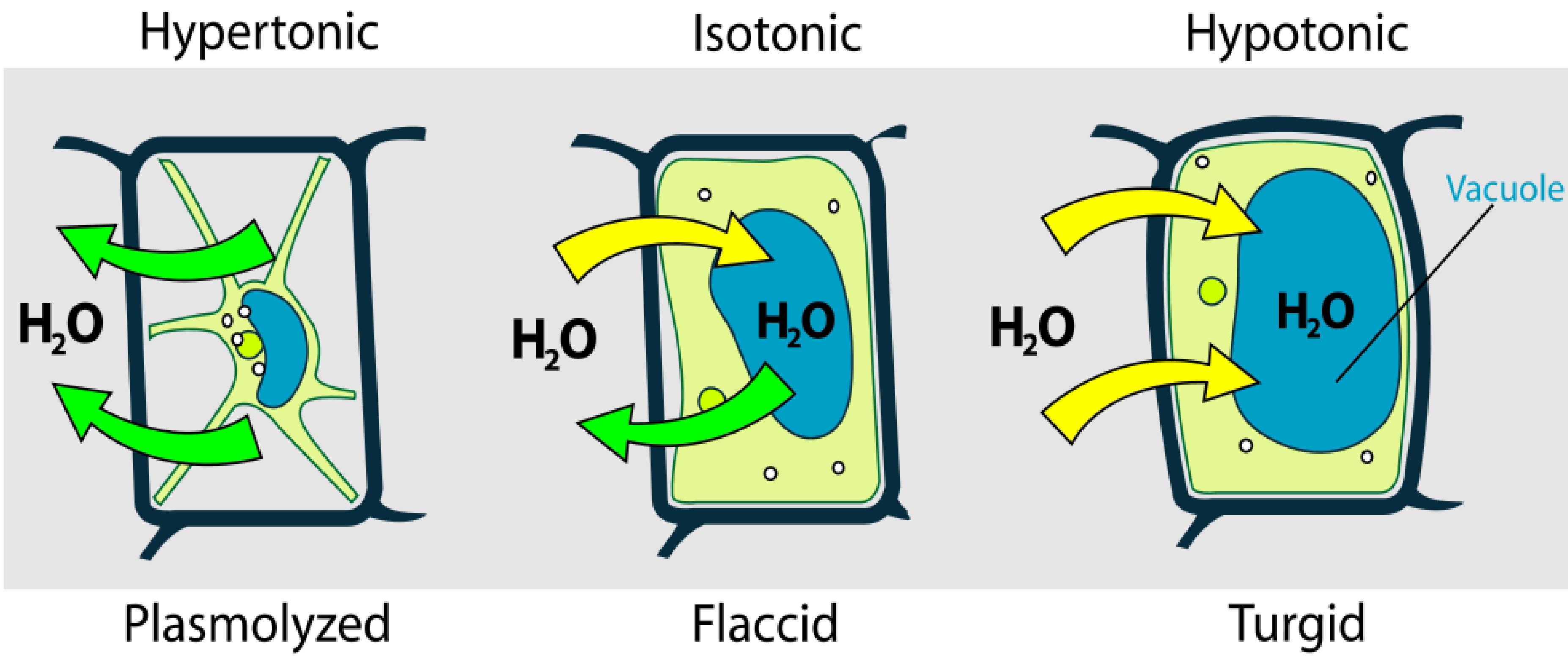
During cell-growth the small vacuoles begin to fuse together, and finally in the mature cell, they form one large central vacuole which occupies the major part of the cell.

THE MAIN ROLE AND FUNCTIONS OF VACUOLES:

- **Important biological rol in cell physiology and cell nutrition (osmosis, turgor);**
- **activ role in the water changing;**
- **The place for different metabolic reactions;**
- **The place house of different store substances**

(!!! Very important for pharmacist specialists)

THE MECHANISM OF VACUOLE WORKING



/flæs.ɪd/ /tɜ.dʒɪd/

ERGASTIC INCLUSIONS

ERGASTIC INCLUSIONS

- **NON-LIVING constituents;**
- **Are formed as a products of protoplasm metabolism;**
- **May occur in vacuoles, or cytoplasm (plastids, lysosomes, spherosomes) or even in the cell-wall.**
- **Include a number of compounds of varied nature.**
- **After their aggregate state, inclusions are;**

  - hydrophobic /haɪdrəʊfəʊbɪk/, **fatty inclusions: lipids, vegetal fatty, volatile oils, and oleo-resines.**

  - hydrophylic like as: flavonoids, including anthocyanins, alkaloids…

  - solid substances may be organic or inorganic as amorphous /əmɔ.fəs/ **substances or as crystals.**

Role of the ergastic inclusions

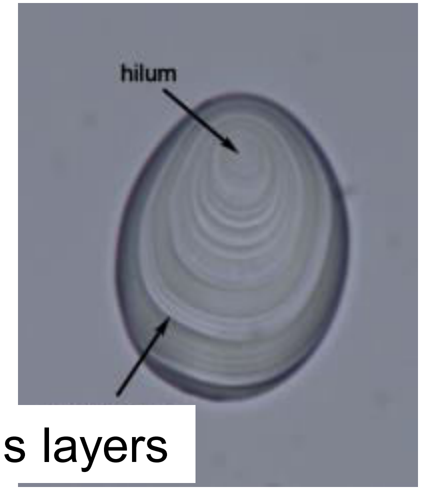
- May be as biologically active substances: tannins, volatile oils, resins, gums, anthocyanins…
- May be as good criteria for microscopically identification of vegetable drugs and MP.

1. Starch granules (grains)

- **Consist from insoluble carbohydrate starch;**
- **Starch is a polymer of glucoses (photosynthesis product) as 2 components: amylose and amylopectin (amylose is more soluble in water than amylopectin);**
- **Are very abundant in the cells of storage tissues;**
- **Turn in deep blue with iodine solution.**

Structure of the starch grain:

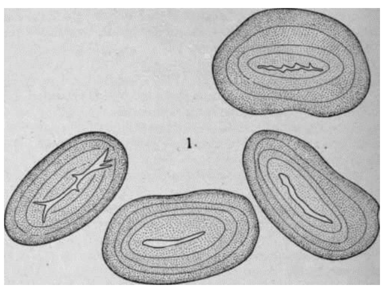
- **The center of grain formation is called *hillum.***
- **Surrounding *hiullum* there is a number of successive** /sək !ses.ɪv/ ***stratified amylogenous layers***

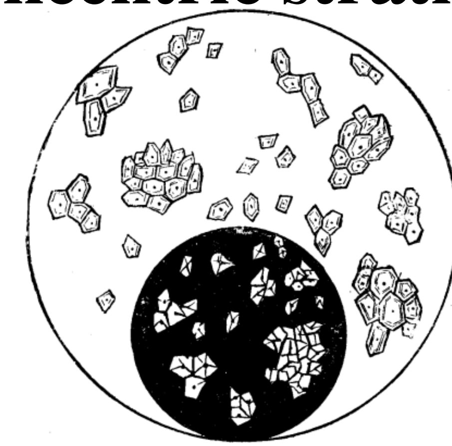


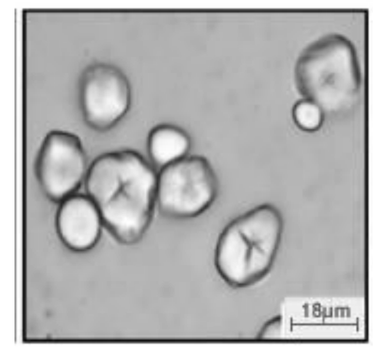
Stratified amylogenous layers

Types of starch grains according the *hillum* position:

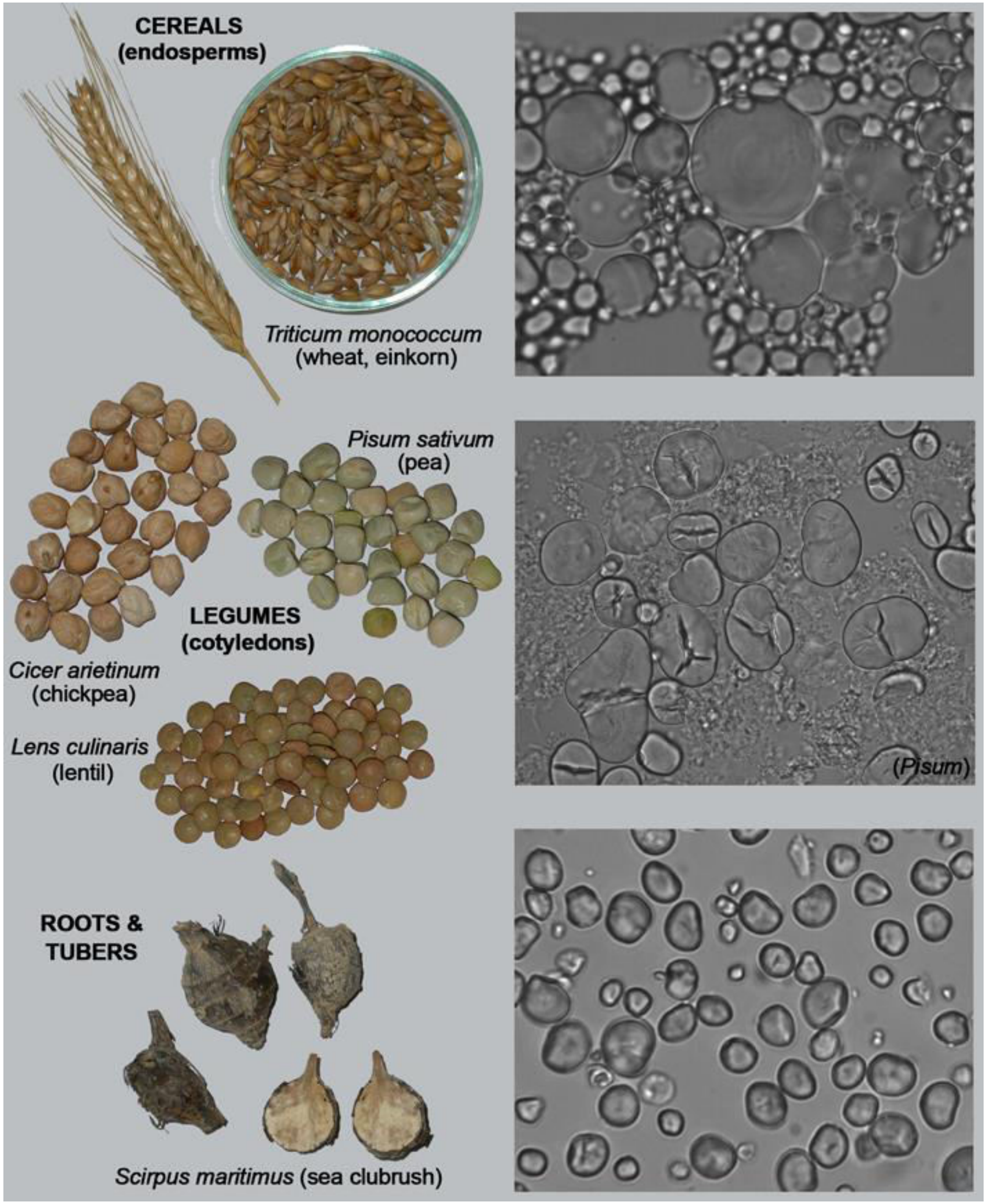
- *concentric* – *hillum* in the center of starch grain, and with concentric stratification (maize, pea, been…;





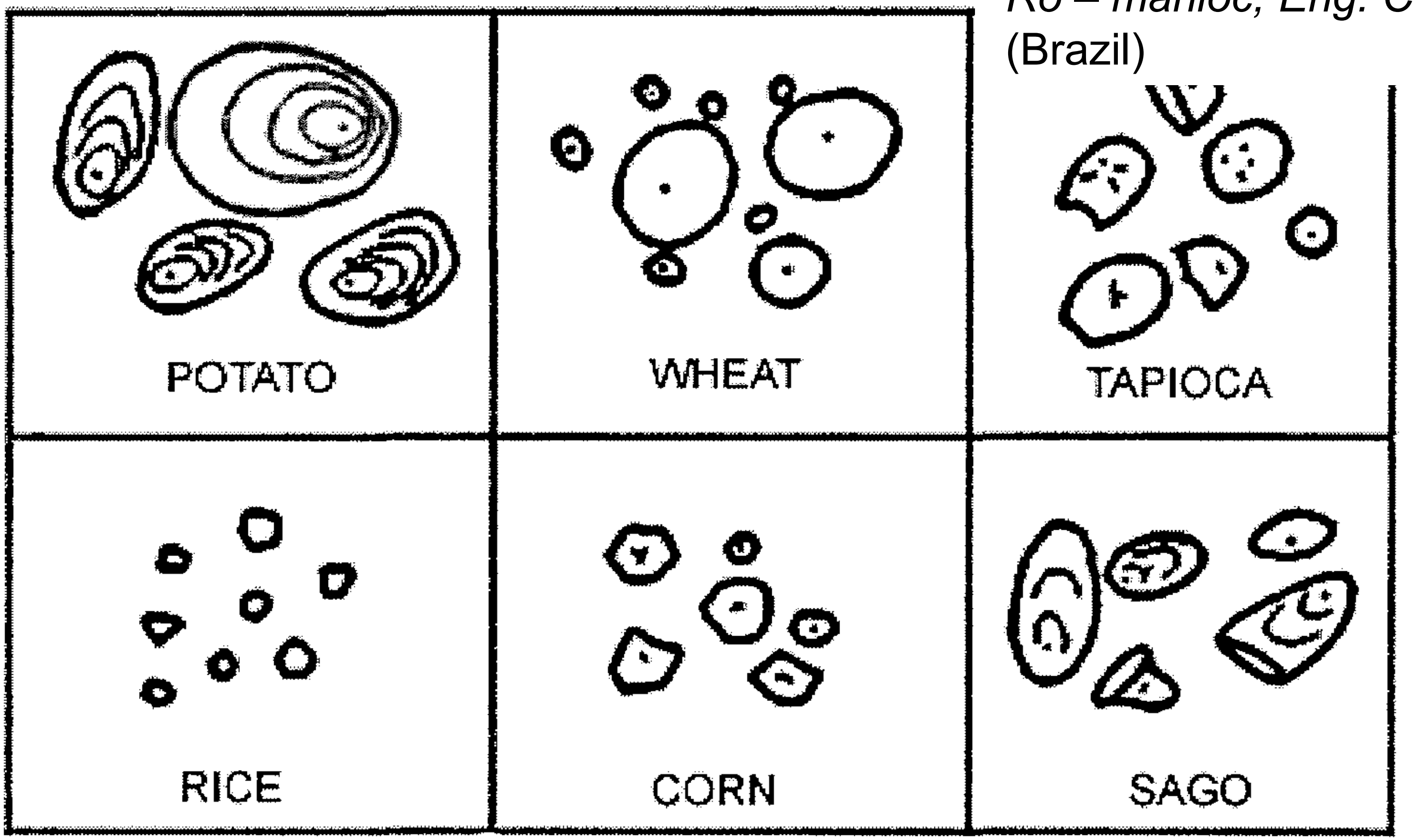


- *eccentric* /ekˈsen.trɪk/– *hillum* in one side (lateral) of grain and the *amylogenous layers* laid down on one side also (potato).


CEREALS
(endosperms)
Triticum monococcum
(wheat, einkorn)
Pisum sativum
(pea)
LEGUMES
(cotyledons)
Cicer arietinum
(chickpea)
Lens culinaris
(lentil)
(Pisum)
ROOTS &
TUBERS
Scirpus maritimus (sea clubrush)

The shape of starch grains

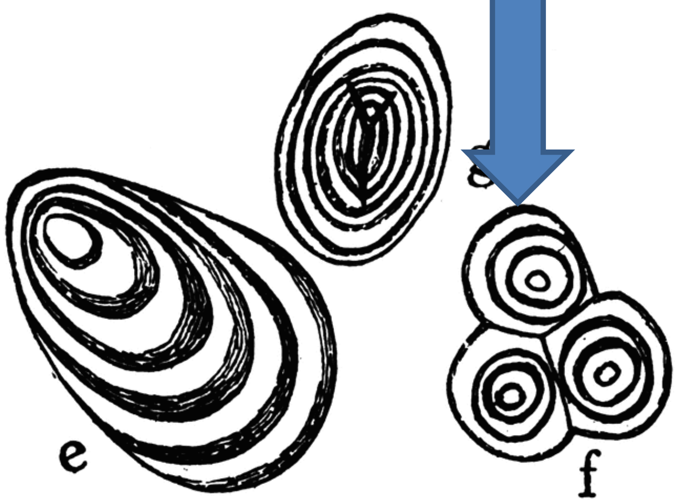
Manihot esculenta,
Ro – manioc, Eng. Cassava,
(Brazil)

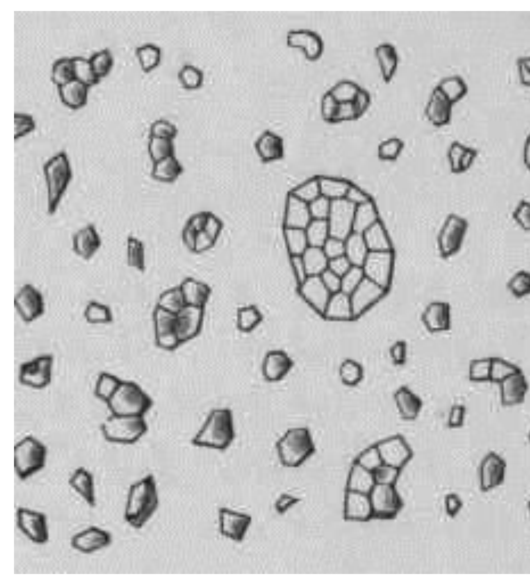


Metroxylon sagu.,
Eng. Palm plant (Guinea)

The types of starch grains according mode of their formation:

- ***simple*** **– occur single in leucoplast with one *hillum* (maize, potato);**
- ***compound*** **– several adjacent** /əˈdʒeɪ.sənt/ **grains in the same leucoplast (rice, oat);**
- ***semicompound*** **– when 2, 3 or more adjacent grains have some common external *amylogenous* layers (potato).**

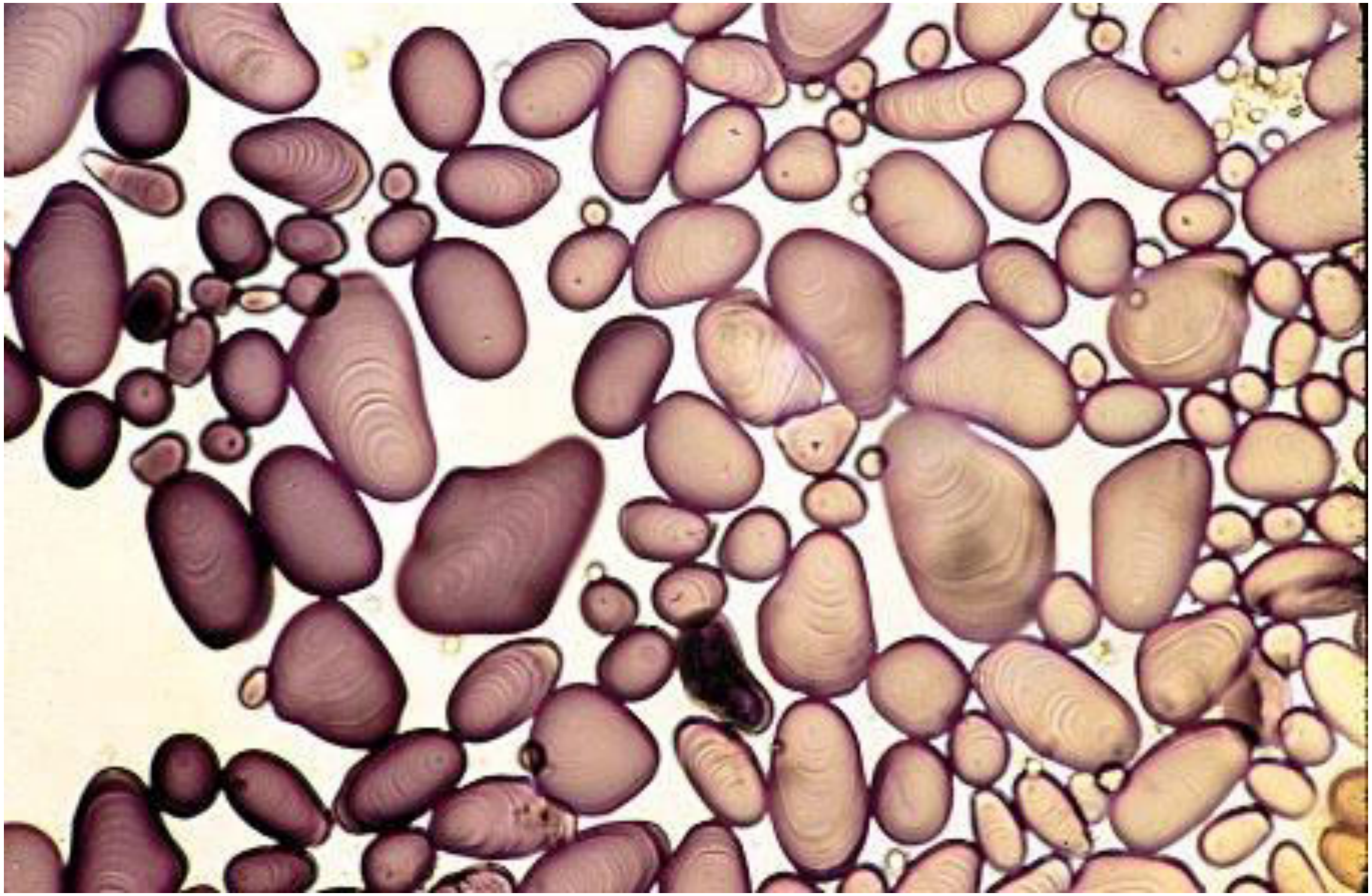


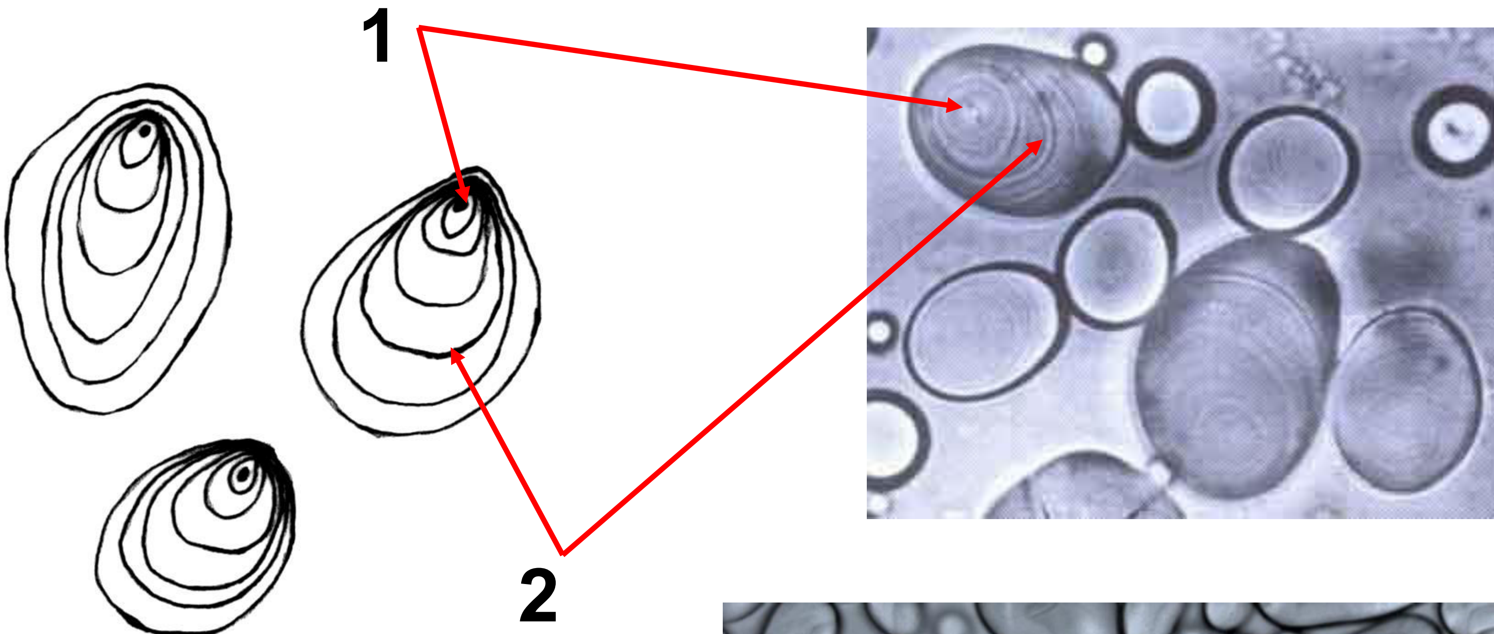


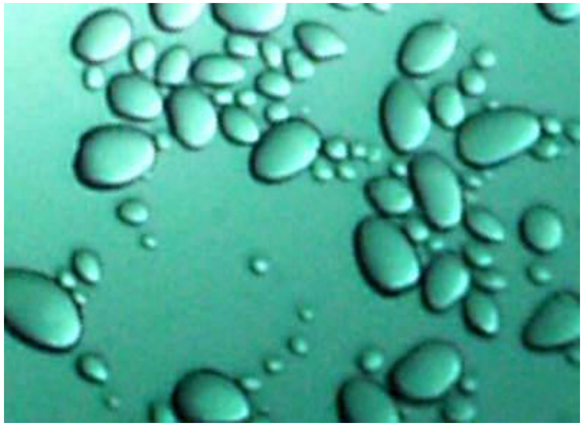
Some starch sources for pharmaceutical industry

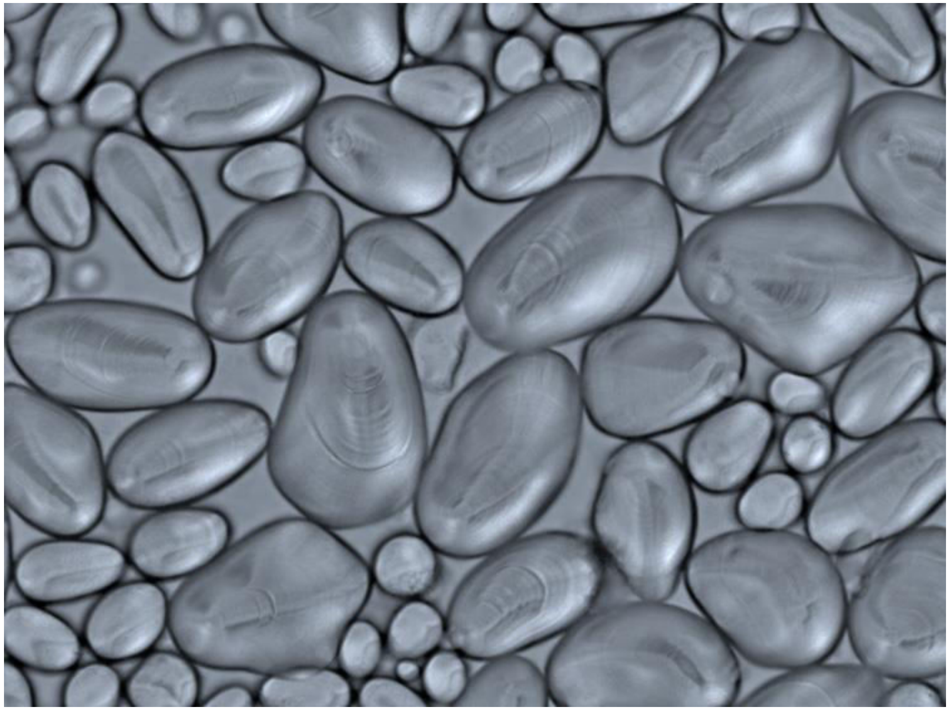
Starch from potato tubers-

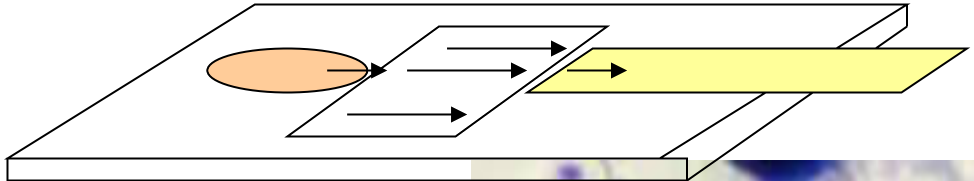
Amylum Solani **(*Solanum tuberosum* - family *Solanaceae*)**



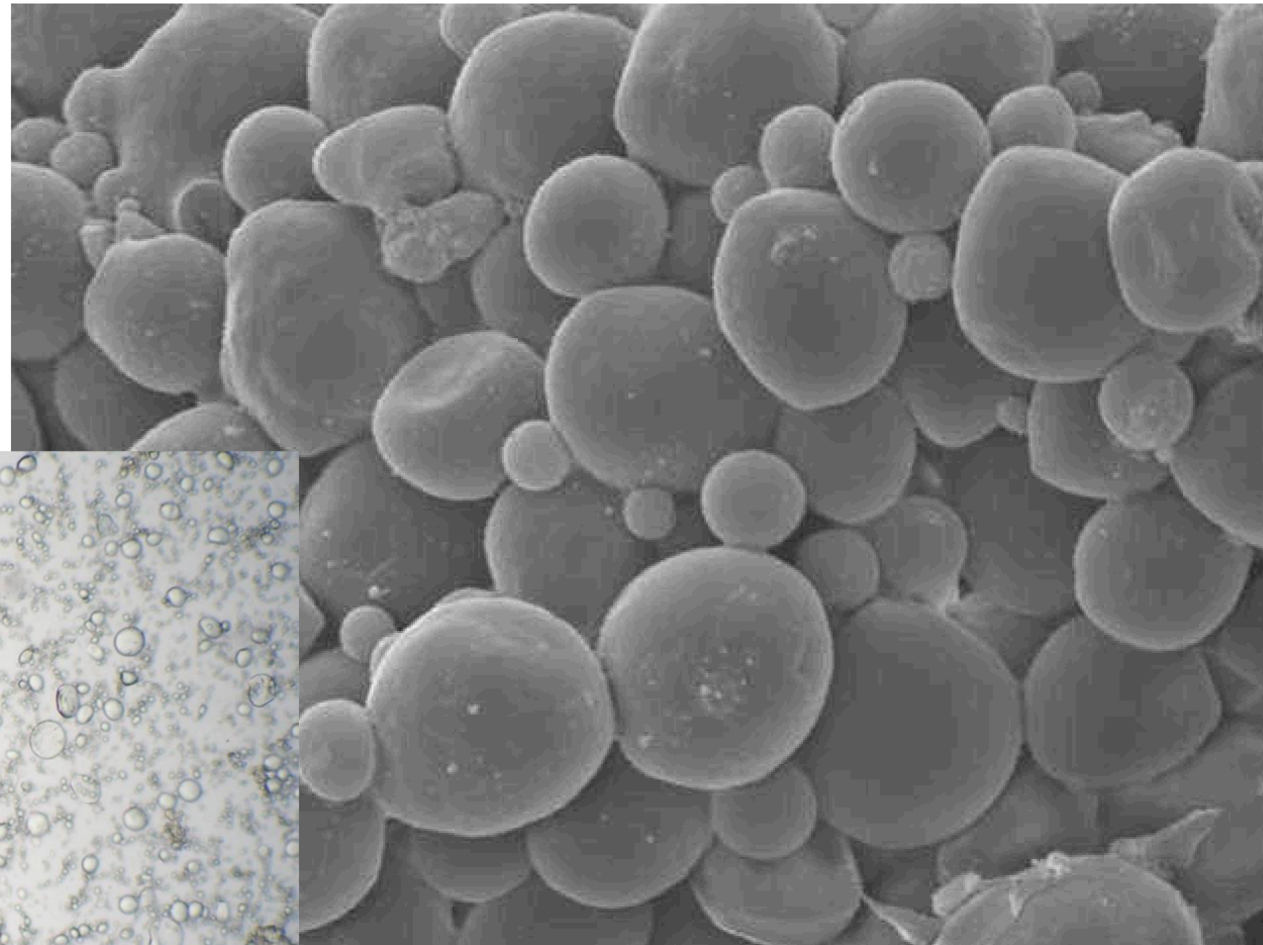

1
2

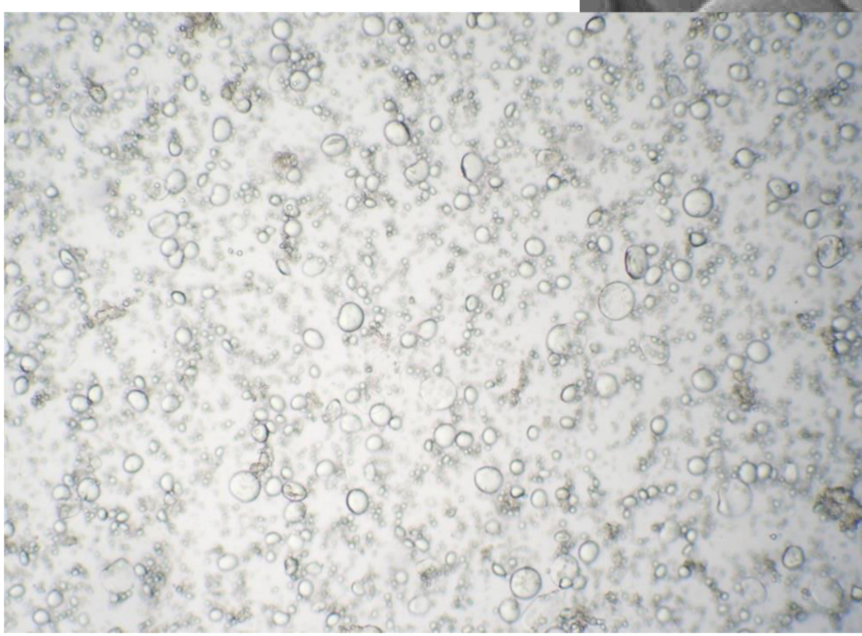




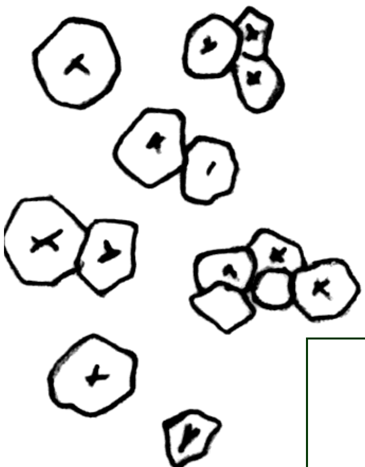


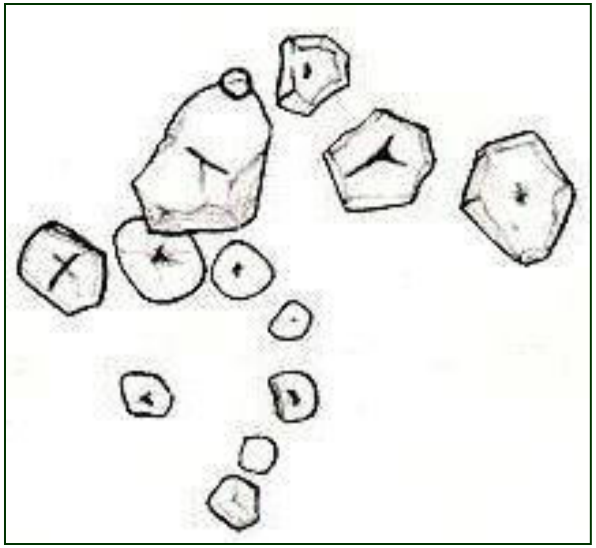
Wheat starch - ***Amylum Tritici***
(Triticum aestivum **– fam.** ***Poaceae)***

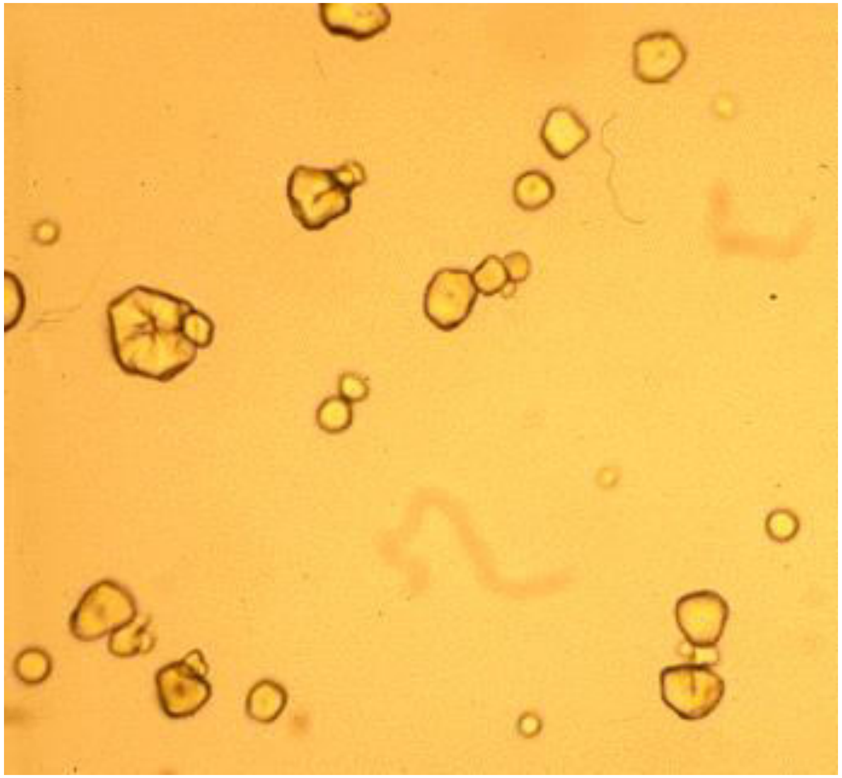




Starch from maize grains - *Amylum Maydis* (*Zea mays* - family *Poaceae*)

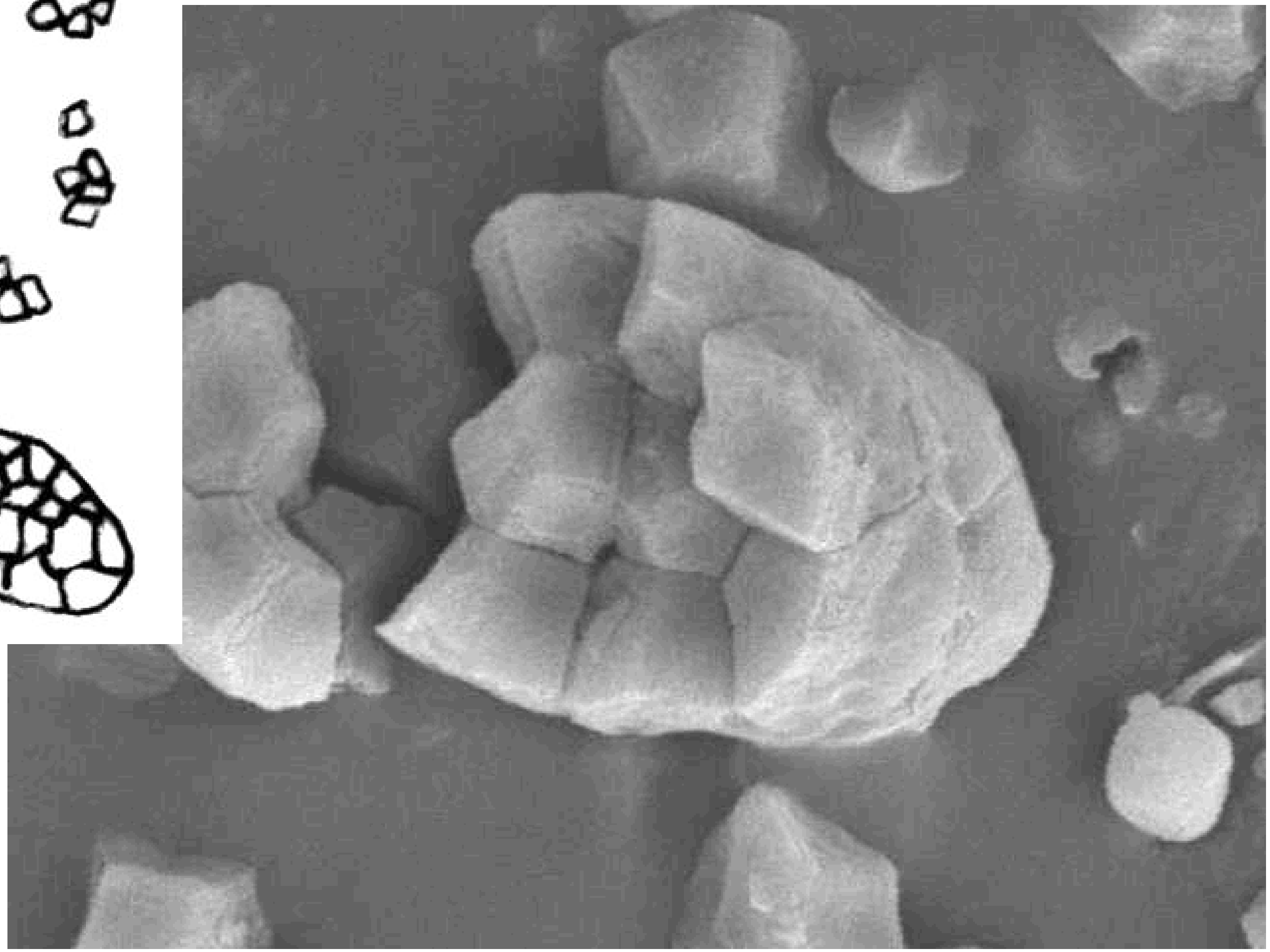






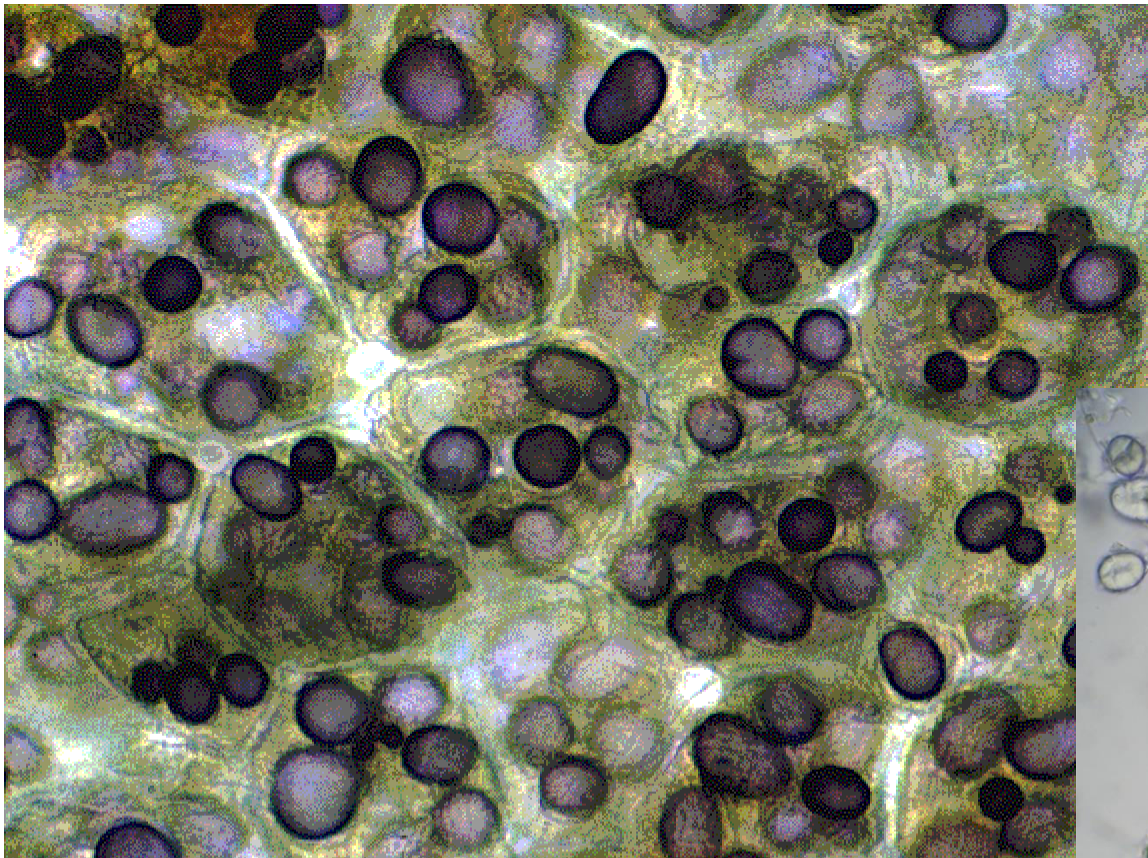
Centric, simple, polyhedral grains

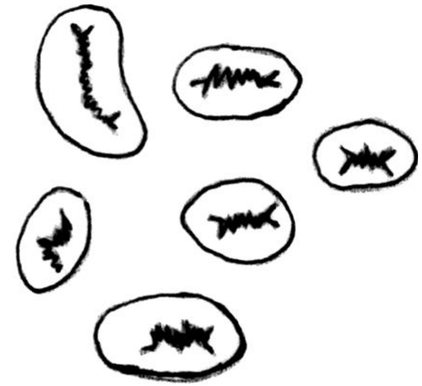
Starch of rice grains - *Amylum Oryzae*
(*Oryza sativa* - *family Poaceae*)



Compound grains from about 50 to 400 grains

Amylum Phaseoli from been seeds (*Phaseolus vulgaris*, family *Fabaceae*)





Tapioca is a starch extracted from cassava root (*Manihot esculenta*)

In Brazil, Portuguese and Spanish , West Indies, and continents of Africa and Asia, including the Philippines and Taiwan

Sago starch

Sago palms (*Metroxylon sagu*)
in New Guinea, East Indies

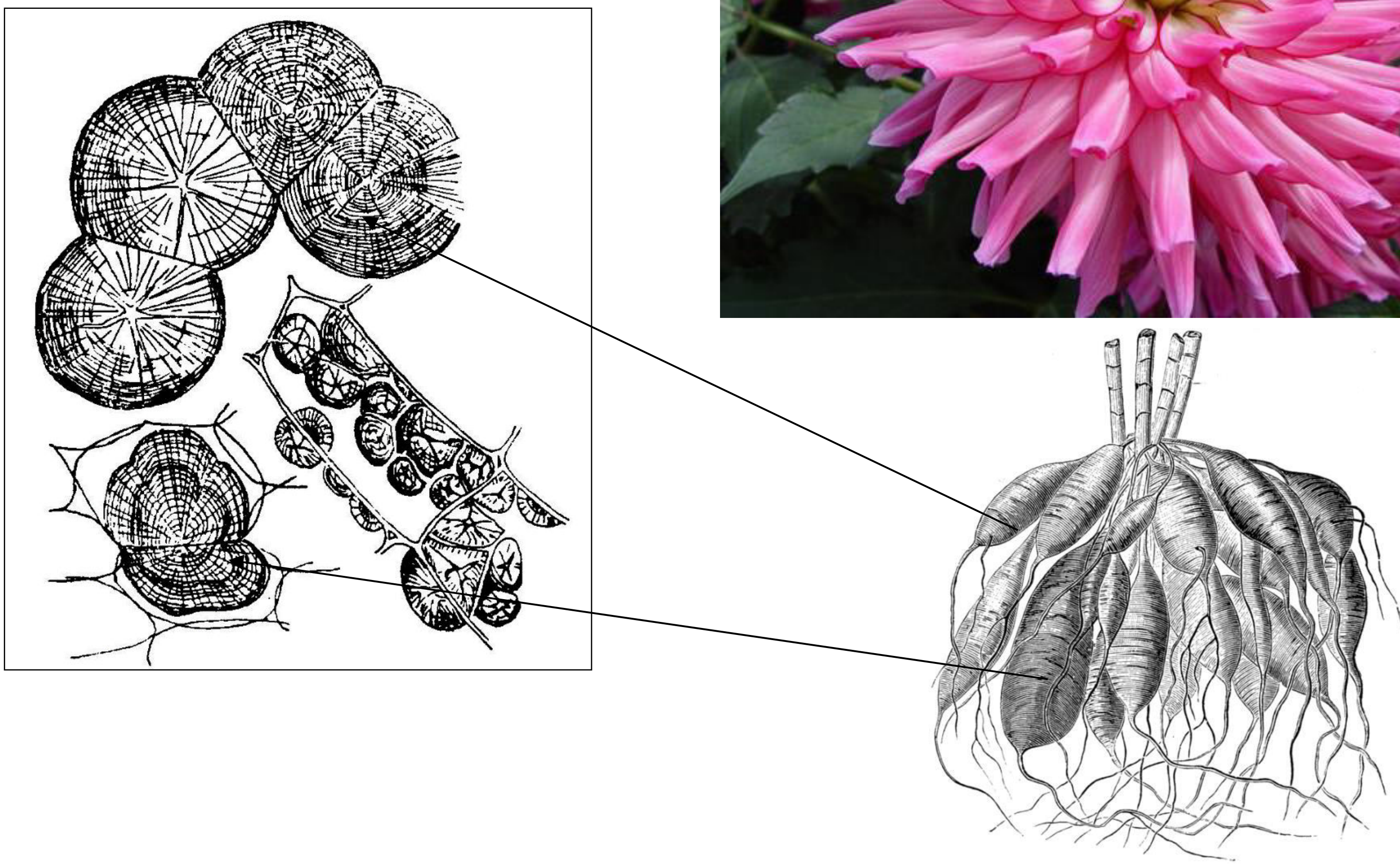
Role of the starch grains

- **Biological – source of nutrition for plants;**
- **Source as aliments for human and foods for animals;**
- **Raw materials for medicines;**
- **Applicative role – the shape, type, sizes, location of the starch grains – good criteria to identify the vegetable drugs and medicinal plants.**

2. Inulin

- Is carbohydrate, is a polymer of fructose molecules and it is in colloidal form in the cell vacuole.
- Inulin is a starchy substance found in a wide variety of fruits, vegetables, and herbs, including wheat, onions, bananas, leeks, artichokes, and asparagus, but more characteristic for Asteraceae *(Inula helenium, Dahlia sp.,Taraxacum officinale),* Campanulaceae, Liliaceae families.

Sferocristals of inulin in the tuber-roots of *Dahlia variabilis*



3. Aleurone grains

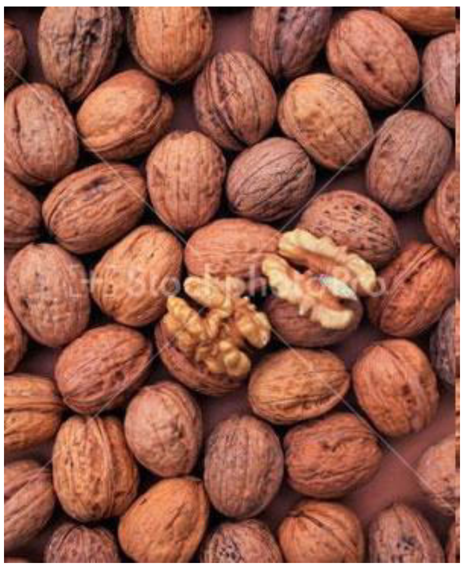
- **are accumulated in the store parenchyma of seeds such as:**

***Phaseolus vulgare* - beens**

Grains of cereal

4. Fatty oils, essential (volatile) oils, resins

- **Fatty oils – organic substances with lipid nature accumulated in store parenchyma of some seeds:**



Junglans regia — **nuts**

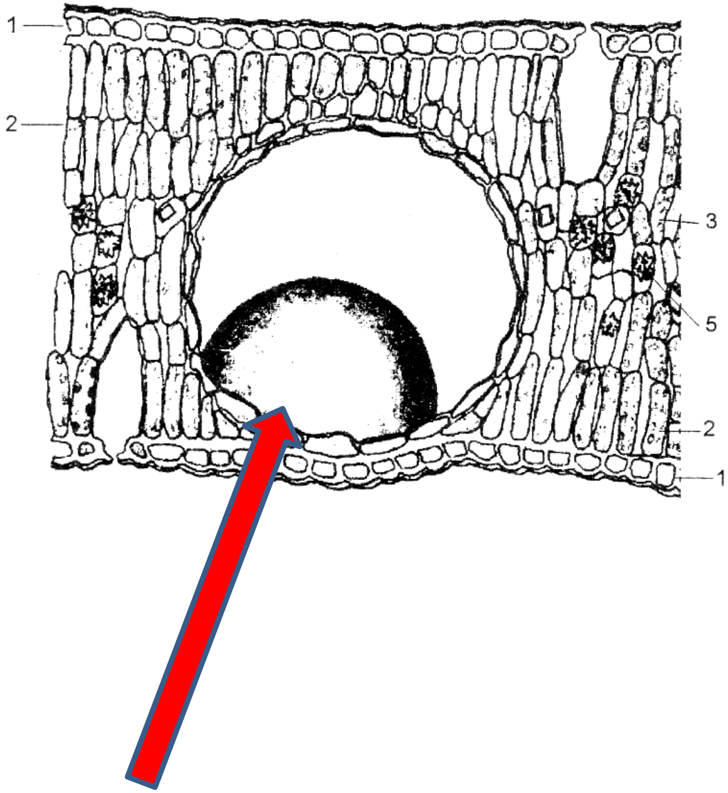
Cucurbita pepo — **pumpkin**

Arachis hypogea — **peanut**

Volatile oils:

- **They have the ability to volatilize;**
- **With specific flavor determined by chemical composition;**
- **Are accumulated as micro drops in special structures of secretory tissue in the organs of species from families:** ***Lamiaceae, Rutaceae, Myrtaceae, Valerianaceae, Asterceae***

Volatile oils

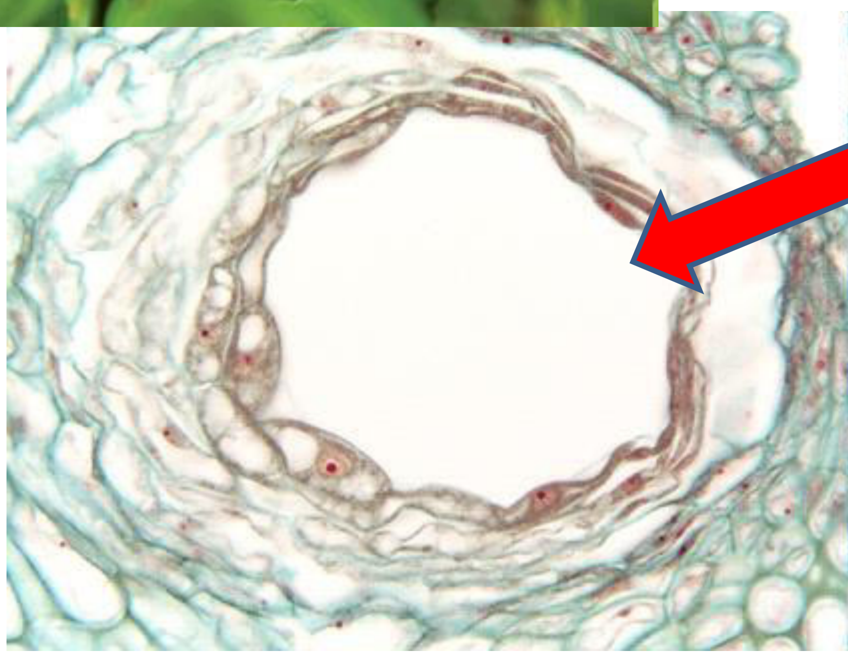


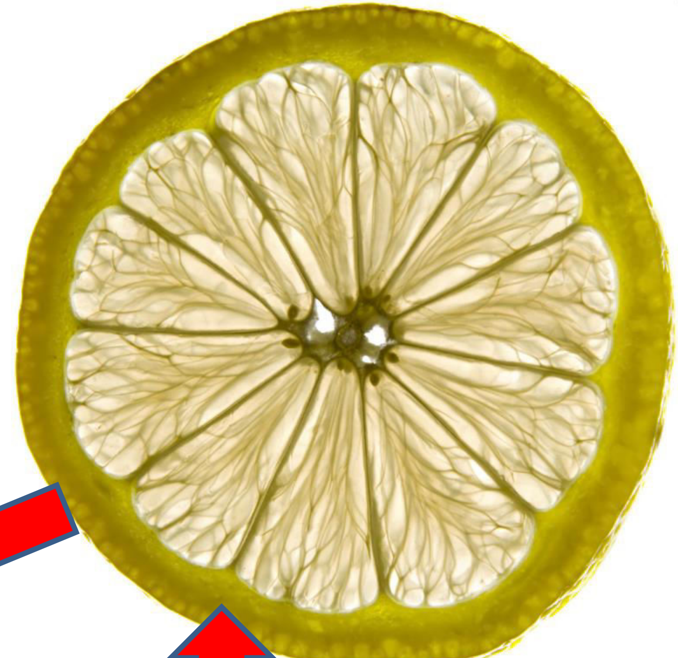
Schysogenous cavity in the leaf of *Eucalyptus globulus*

Mentha piperita, Pepper mint plant

Glandular hairs with 8-cells gland

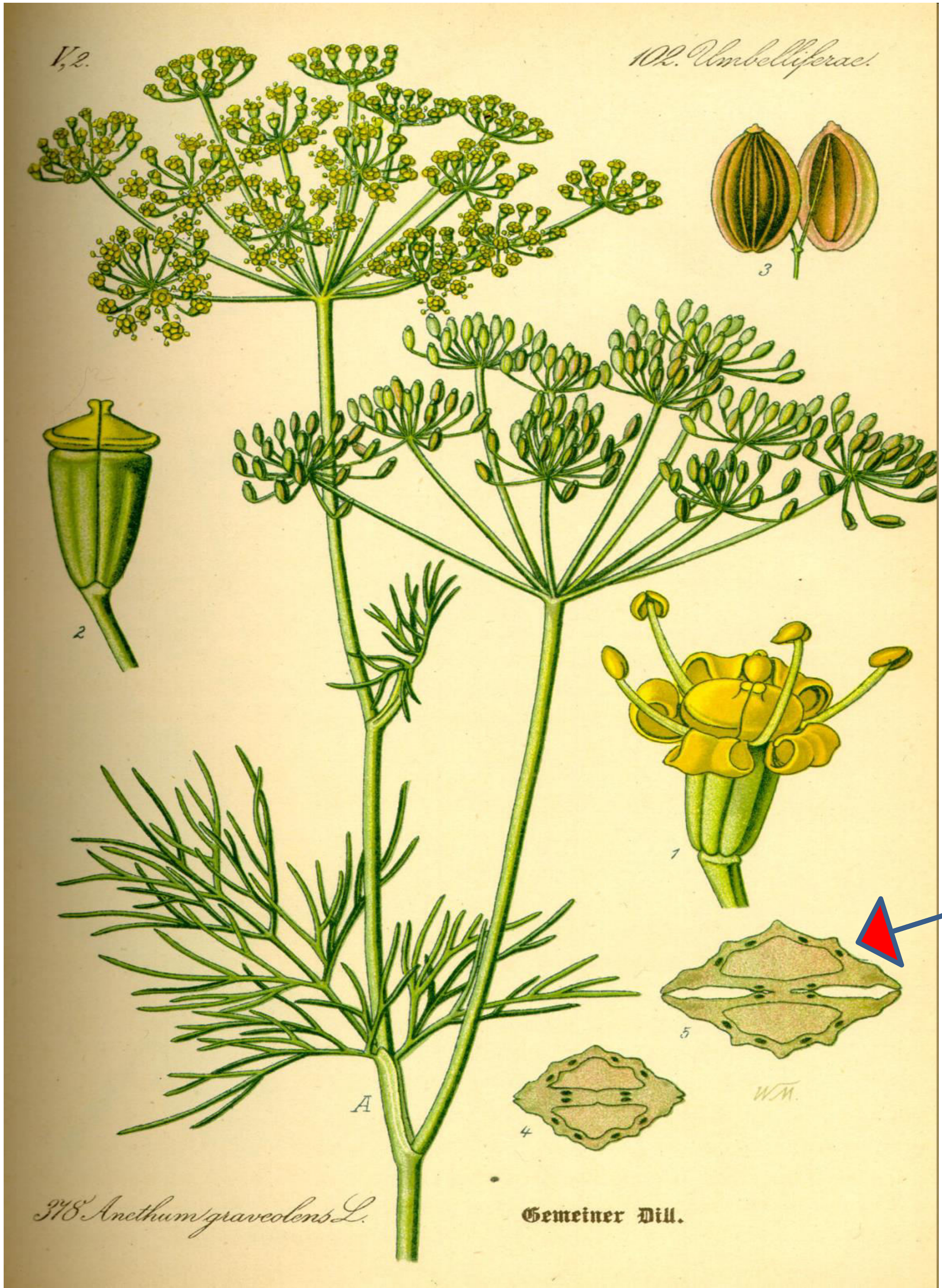
Citrus limon, lemon





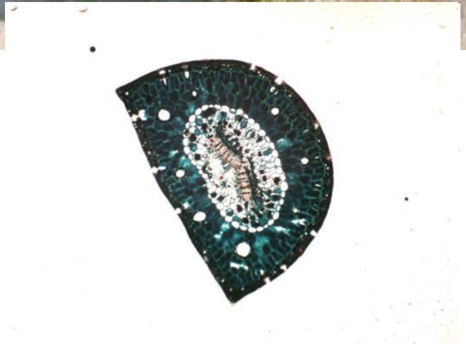
Lysigenous cavity

Anethum graveolens, dill plant

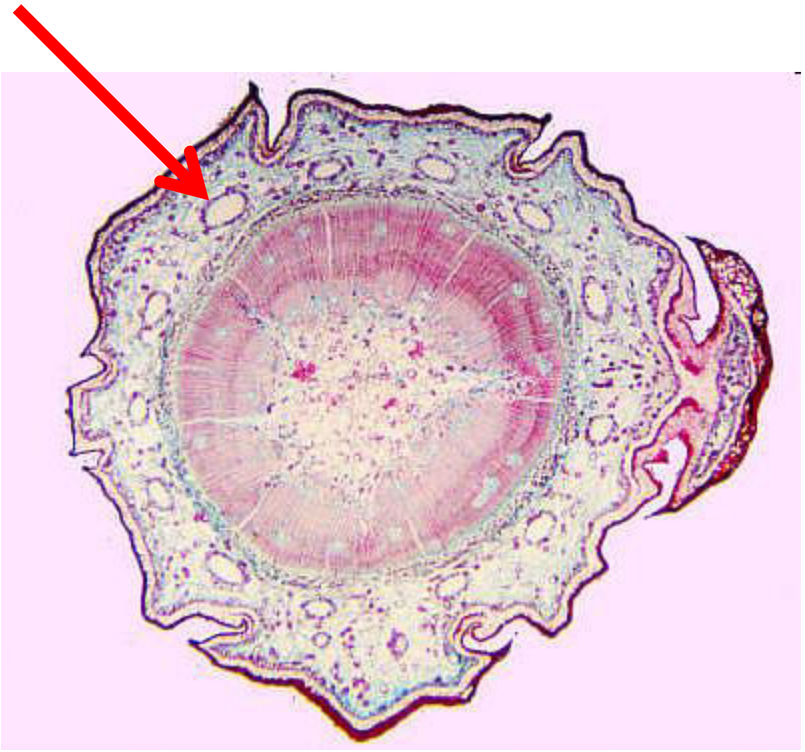


Secretory channels

Resines in the resin channels of conifers

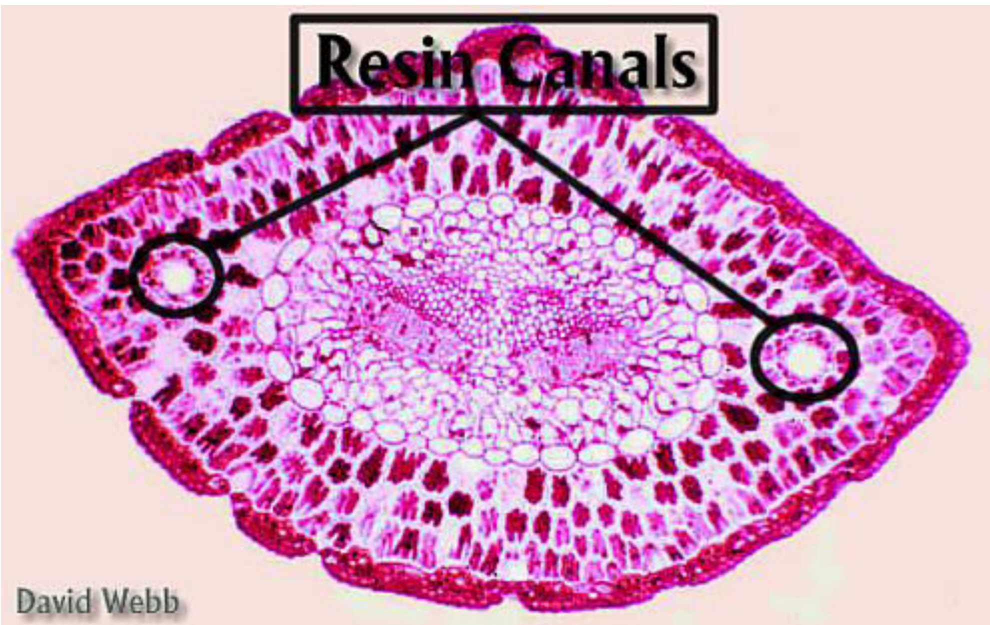


In the pine leaf



In the pine stem

Resin cannels in the conifer stem



5. Latex:

- is a emulsion of polymer microparticles in an aqueous medium.

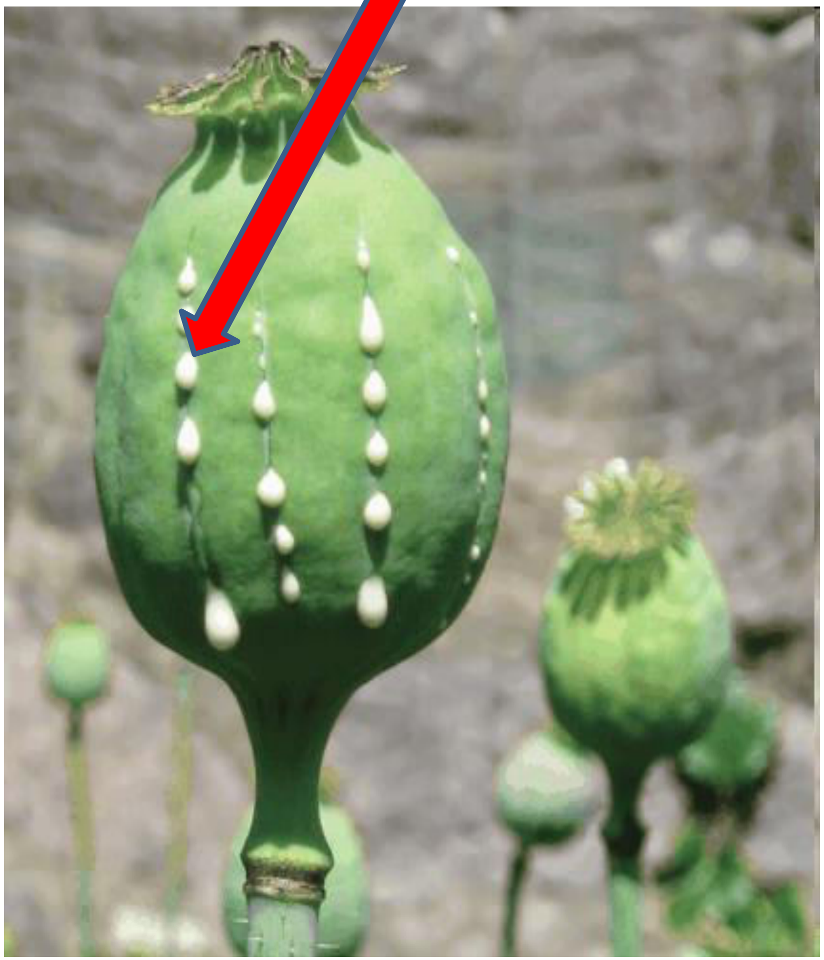
- is a milky fluid found in 10% of all flowering plants (angiosperms). It is a complex emulsion consisting of proteins, alkaloids, starches, sugars, oils, tannins, resins, and gums that coagulate on exposure to air.

- is usually exuded after tissue injury.

- is white in most plants, but in some plants may be yellow or orange. Species form *fam. Papaveraceae, Euphorbiaceae, Asteraceae*

Latex in Poppy plant

Papaver somniferum



White latex alb in some species of fam. din *Euphorbiaceae*

Orang latex in
greater celandine -
Chelidonium majus

6. **SOLID INORGANIC INCLUSIONS**

Resulting from protoplast metabolic activity and can be:

- $CaCO_3$;
- $CaSO_4$;
- $Ca_3(PO_4)_2$;
- $Mg_3(PO_4)_3$.

Characteristic for species from families:

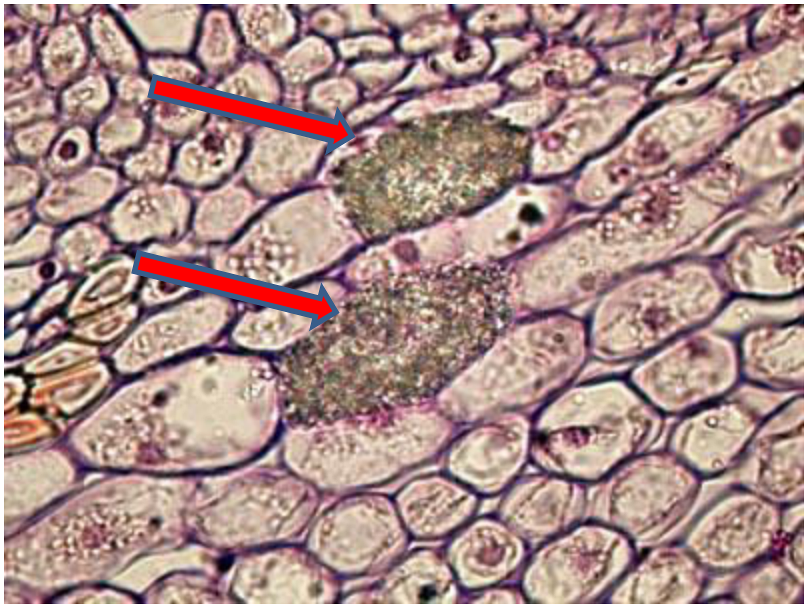
Urticaceae, Cucurbitaceae; Rutaceae, Asteraceae

7. SOLID ORGANIC INCLUSIONS

- **Calcium oxalate is deposited as crystals in the cell vacuoles.**
- **The forms of crystals differ according taxonomy position of plant;**
- **In one cell may co-exist some types of crystals.**

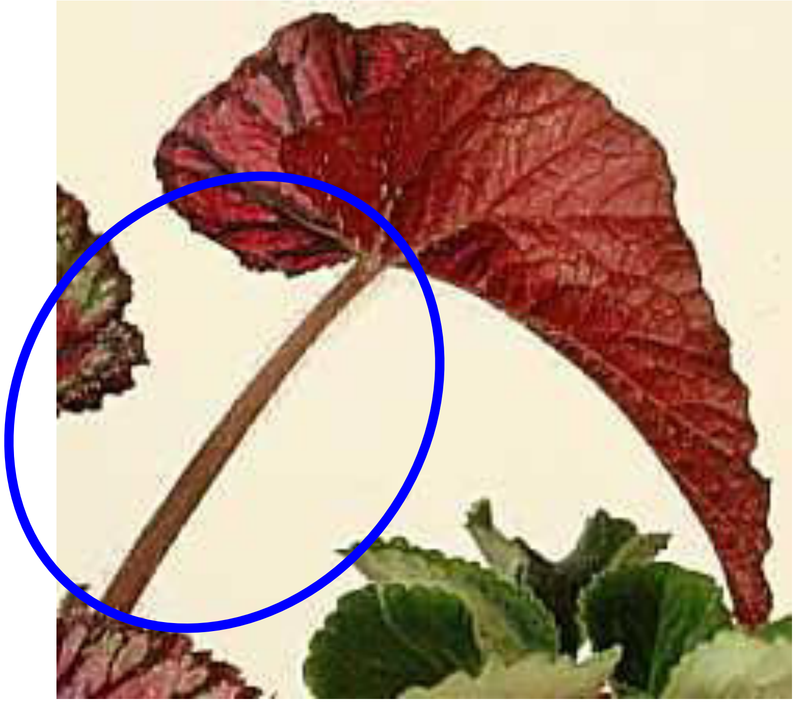
Some types of calcium oxalate crystals

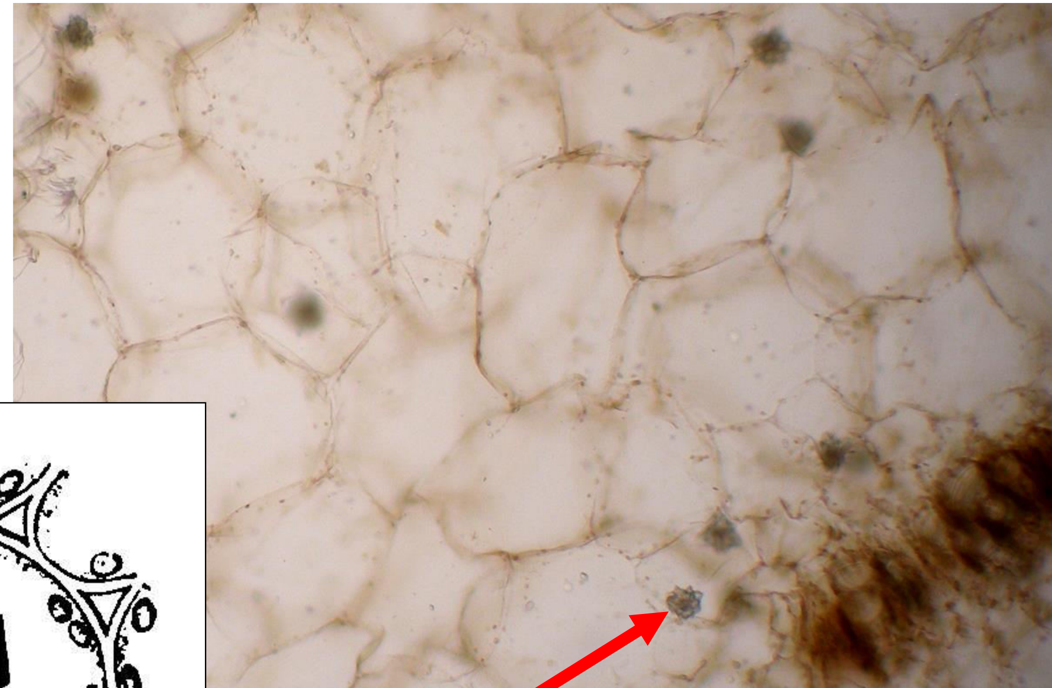
1.Sand crystalline oxalic

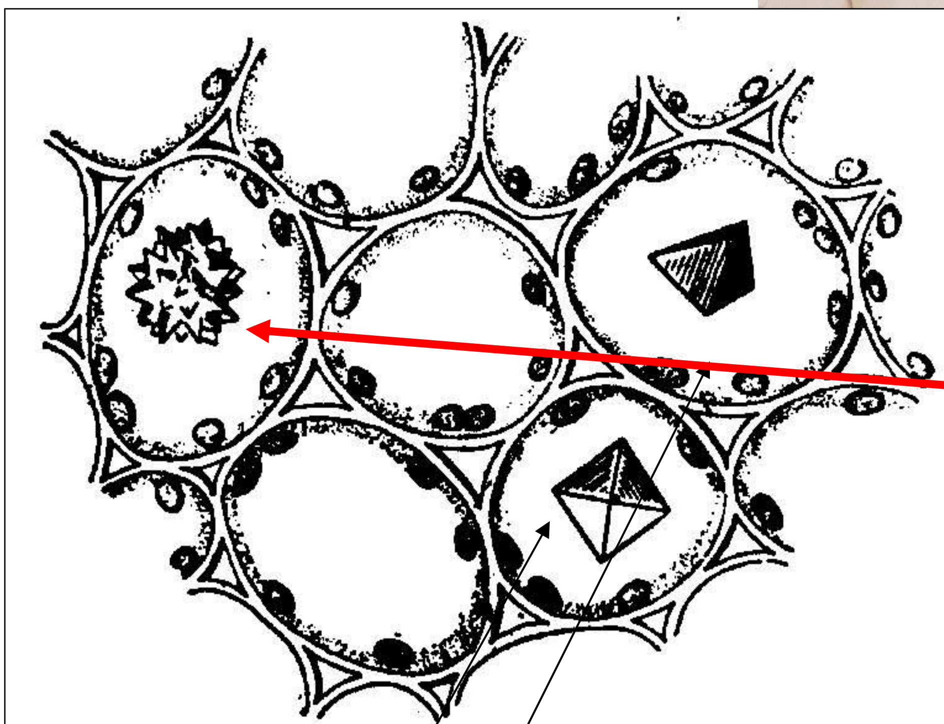


Atropa belladonna, **Belladonna plant**

2. Octahedral /ˌɒk.təˈhiː.drəl/ **and druze of oxalate calcium in the leaf stalk of *Sp.Begonia rex***

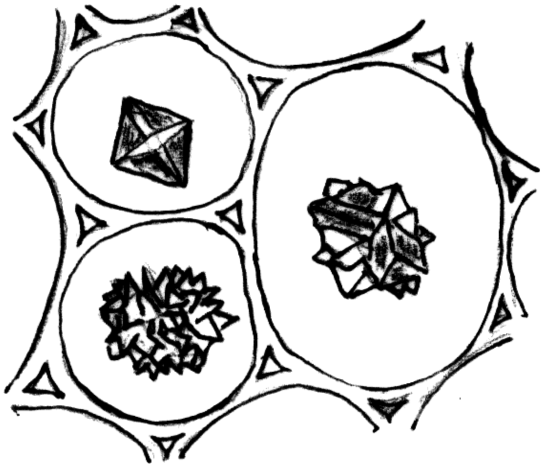


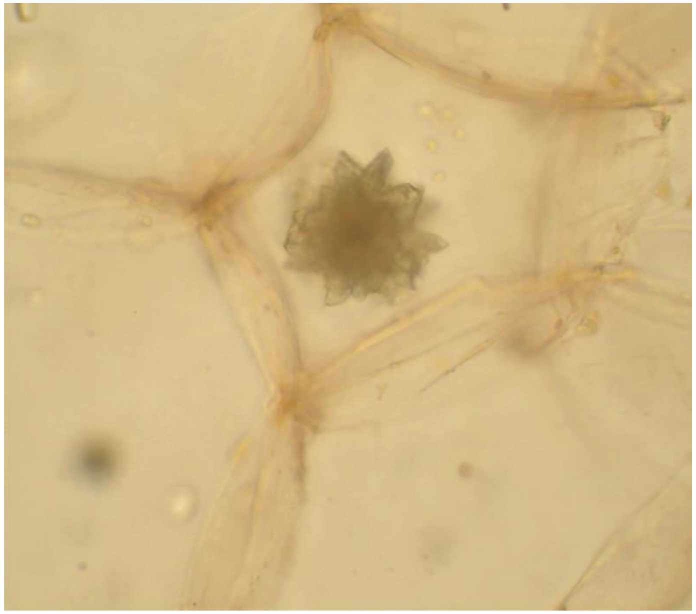


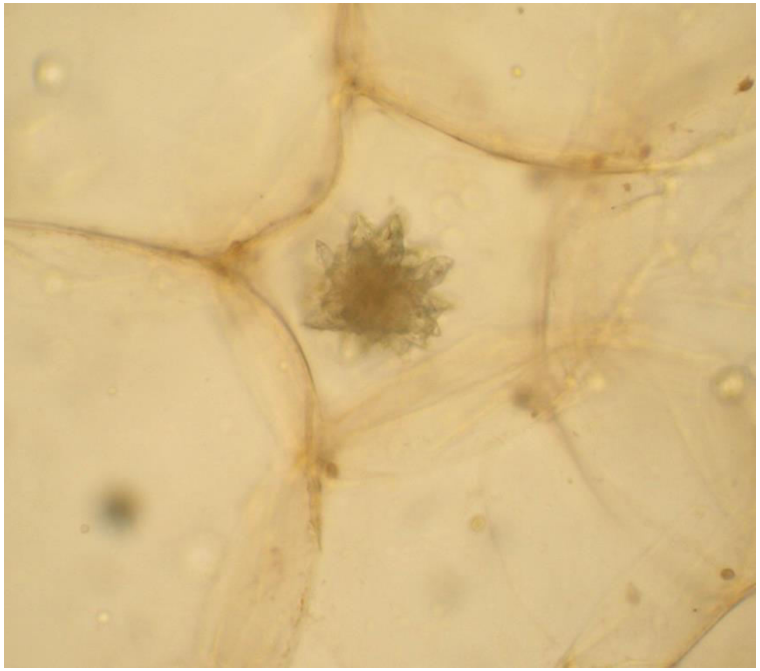


Druze

Isolated octahedral /ɒk.təˈhiː.drəl/ crystals and druze – in the leaf stalk of *Begonia rex*

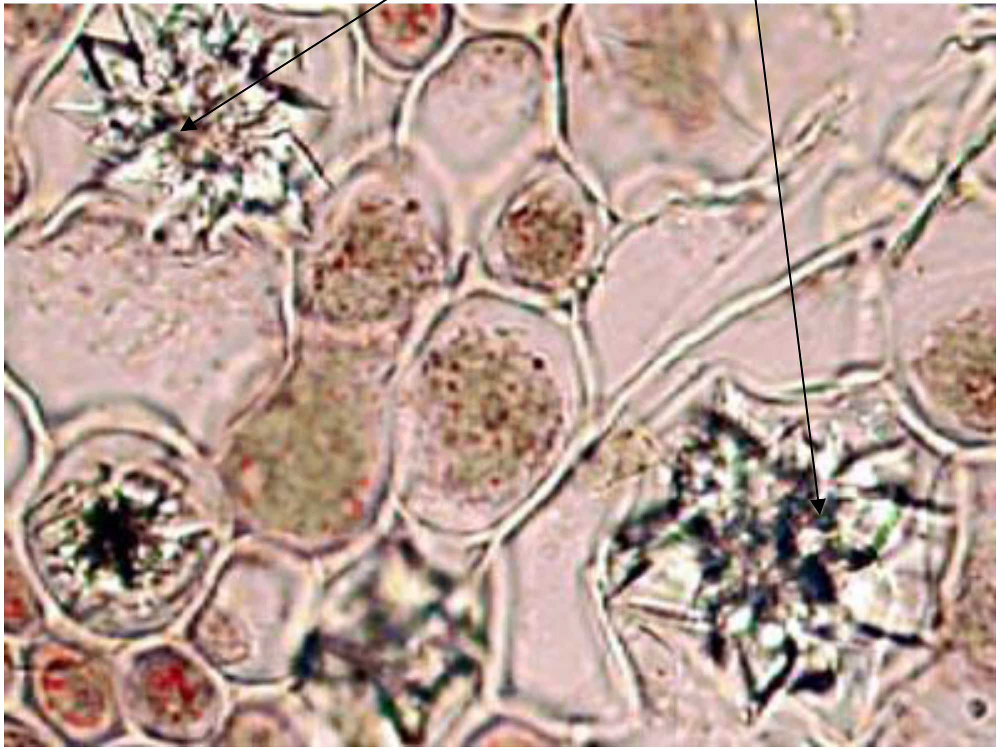




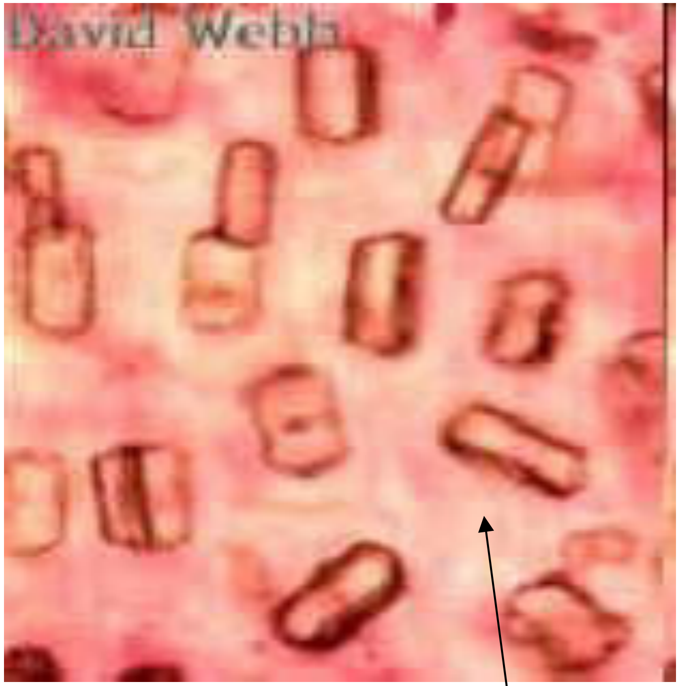


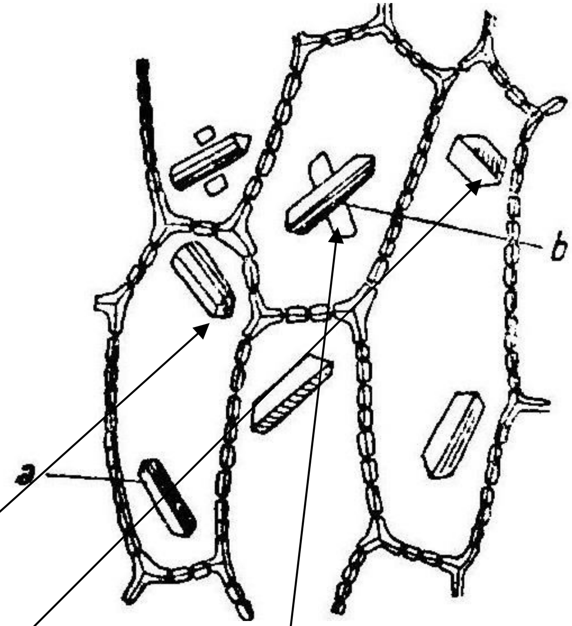
Druze (rozete)

Druze in *Juglans regia*



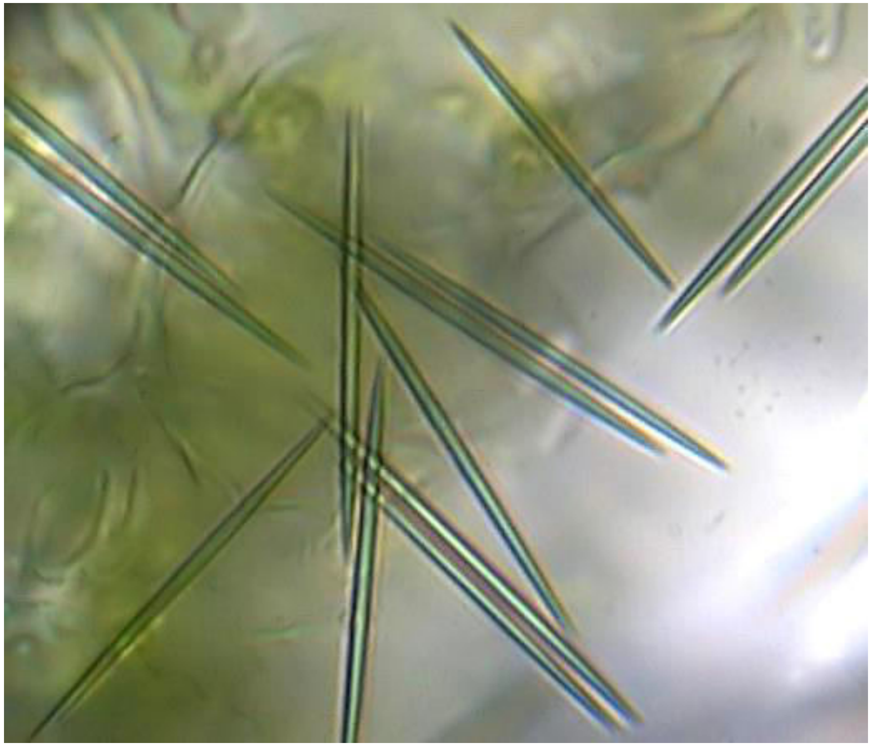
3. Different geometrical forms of solitary crystals in the dry bulb scales of onion *Allium cepa*





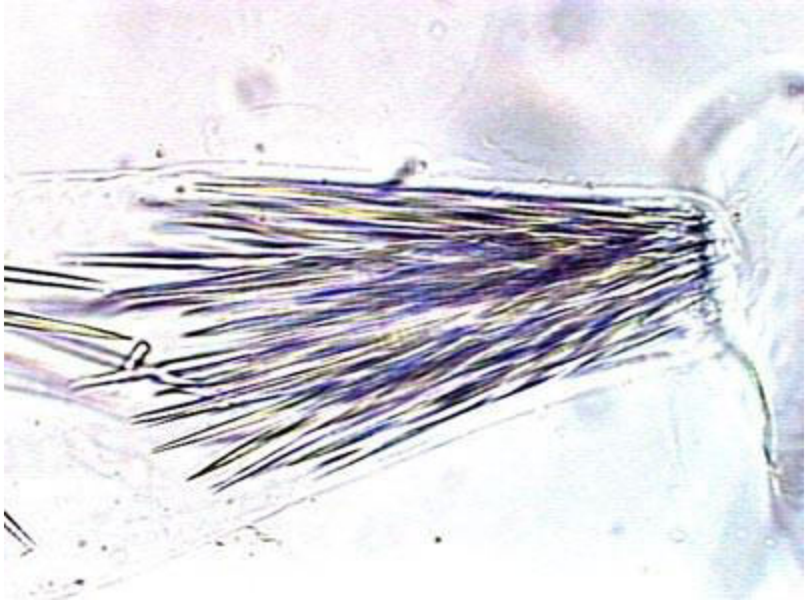
Prysmatic, cubic…

4. Needle calcium oxalate crystals



Ananas sativus

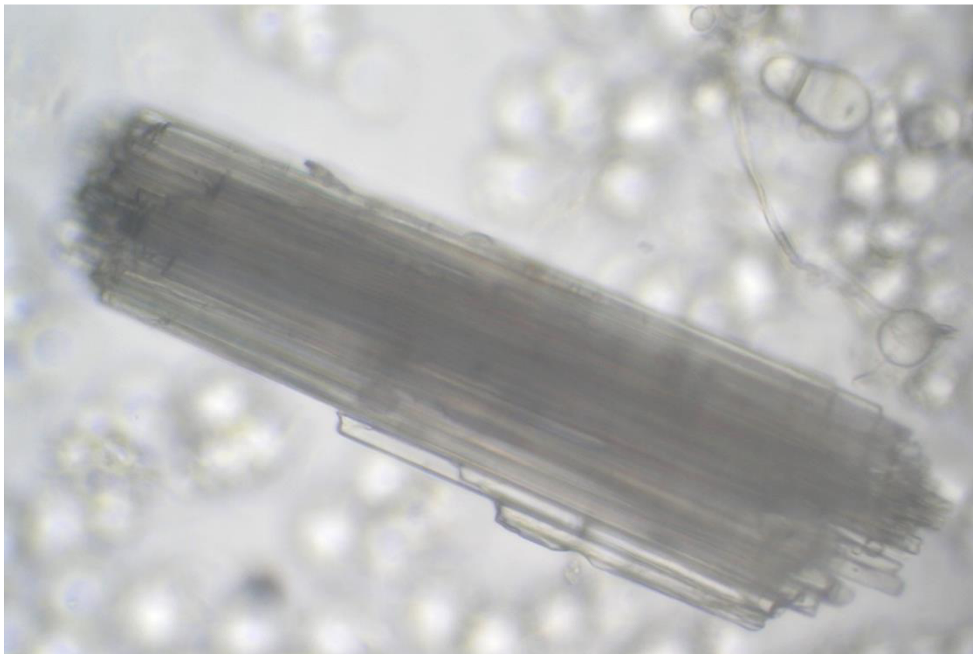
5.**Raphides are bundles of narrow, elongated needle-shaped crystals, usually of similar orientation, with pointed ends at maturity.**



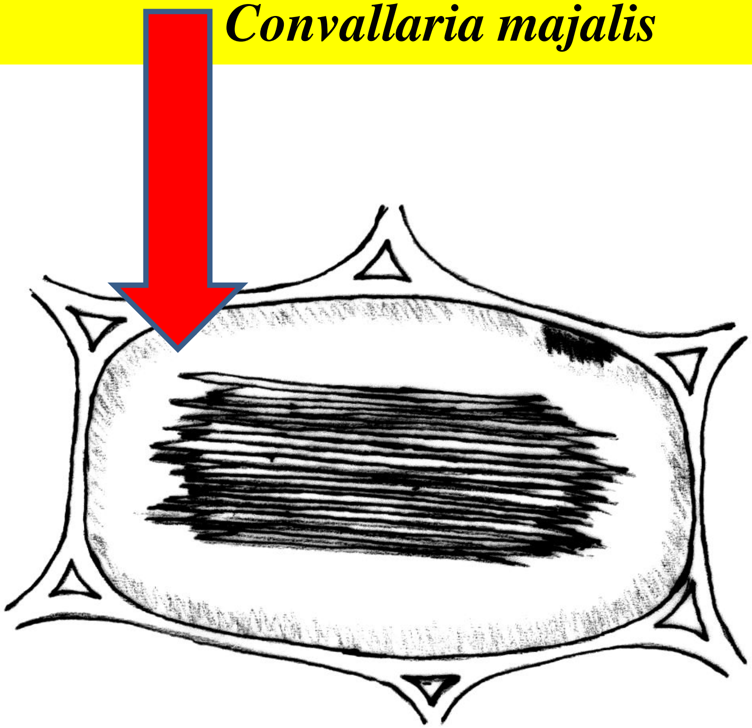
Aloe arborescens

Raphides of potassium oxalate in the rhizome of *Tamus communis*

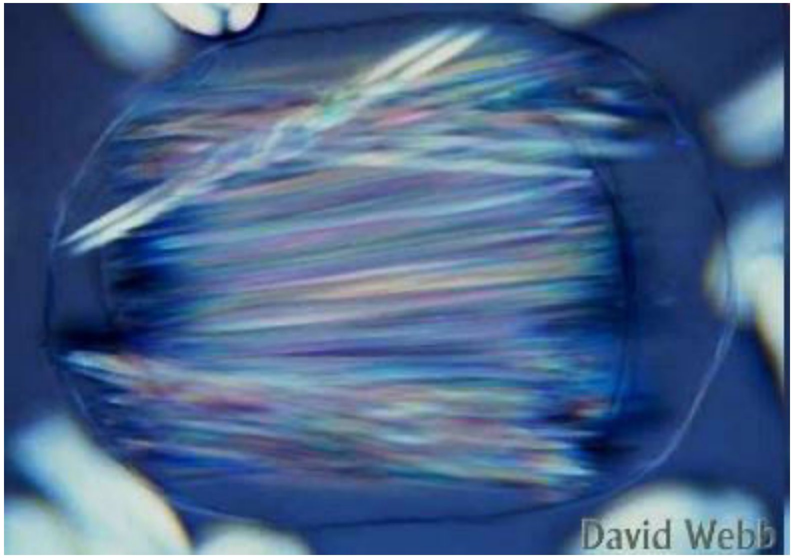
Toxic !!!

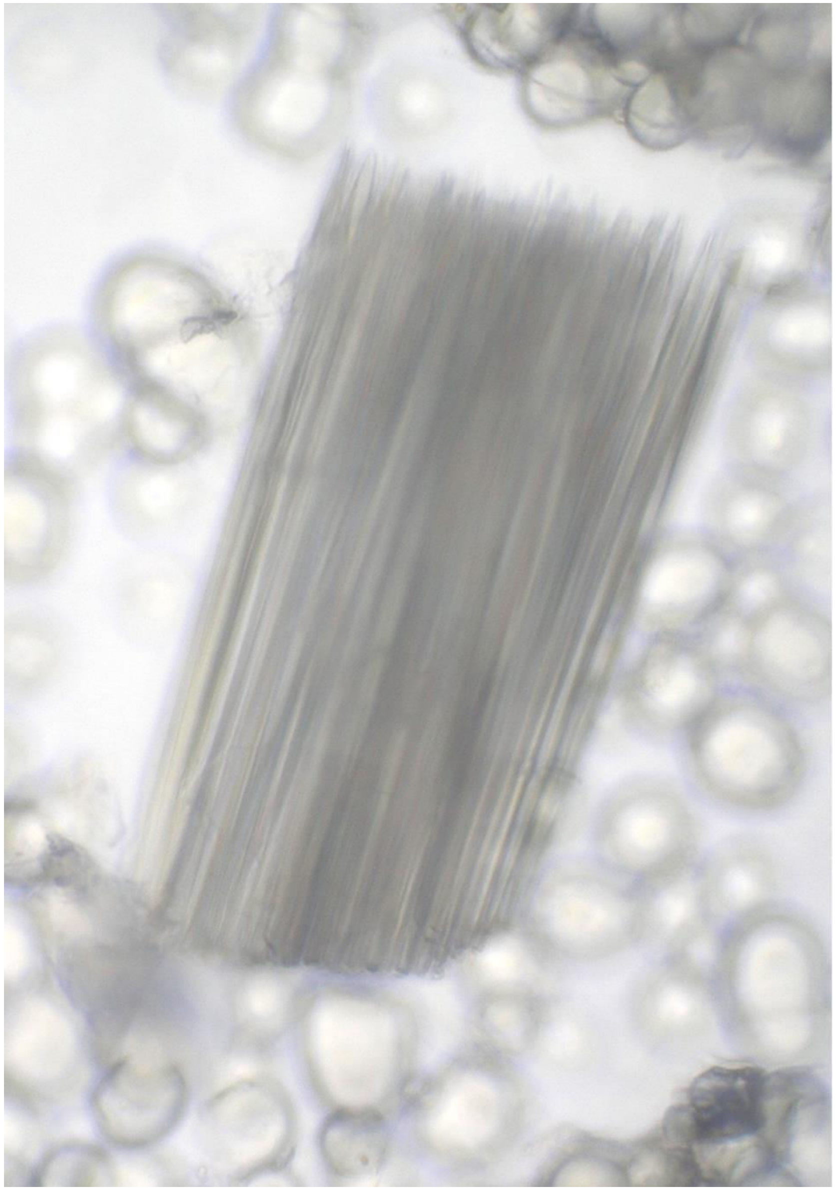


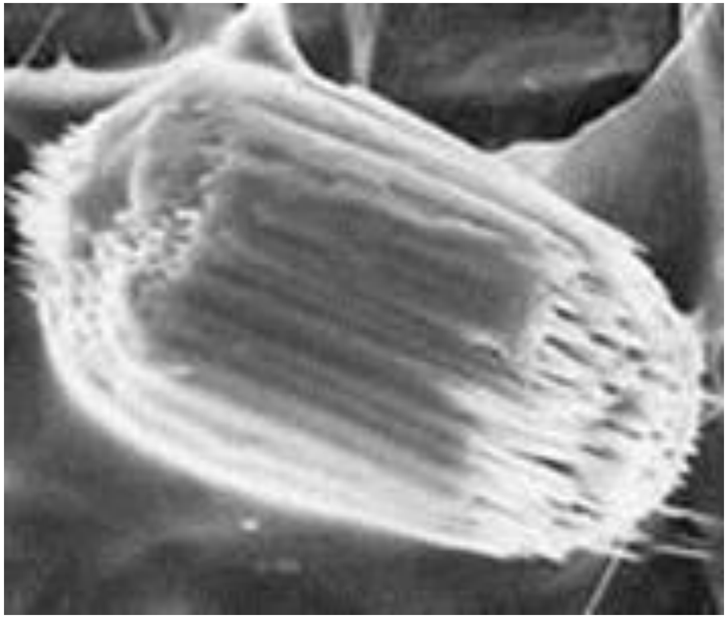
Raphides in the Lily of the valley leaf,
Convallaria majalis



Raphides in an isolated Vacuole seen with crossed Polarizers







Cissus juttae

The role of the ergastic inclusions:

- **Biological:Nutritive, protection;**
- **General: raw material for pharmaceutical industry, aliments and cosmetics;**
- **Diagnostic rol: the good criteria to identify VD and MP.**

Membrane organelles

- **With unitaty membrane:**

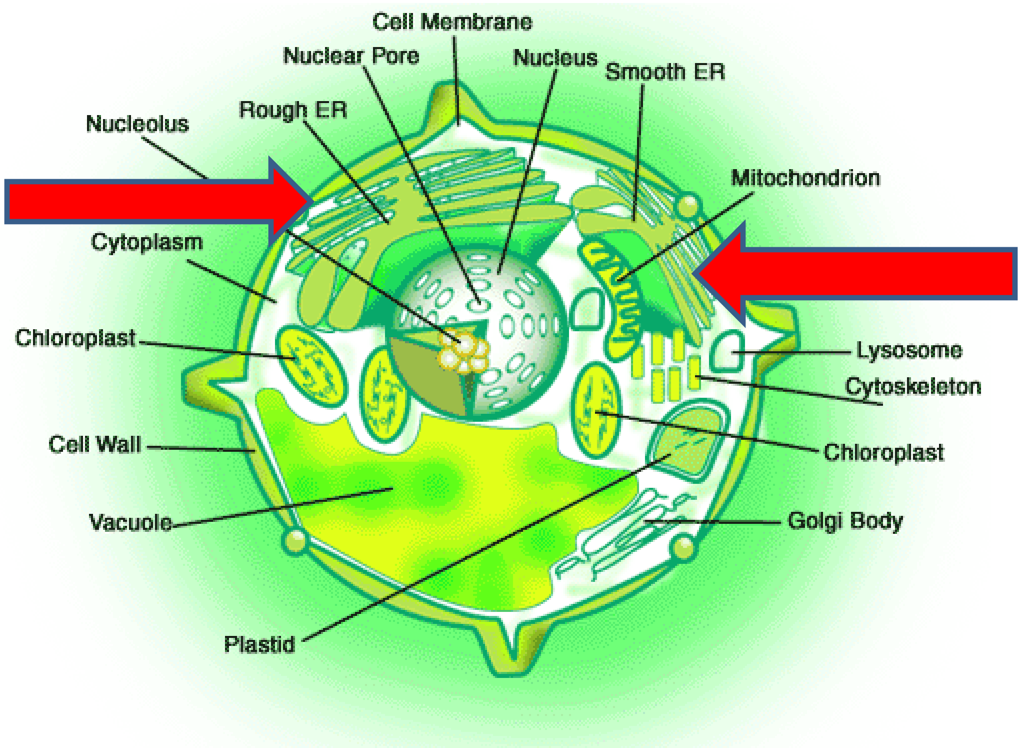
  Endoplasmic reticulum; Golgi body; Lysosomes; Peroxisomes; Vacuoles.

- **With double membranes:**

  Plastids; Mitocondria; Nucleus.

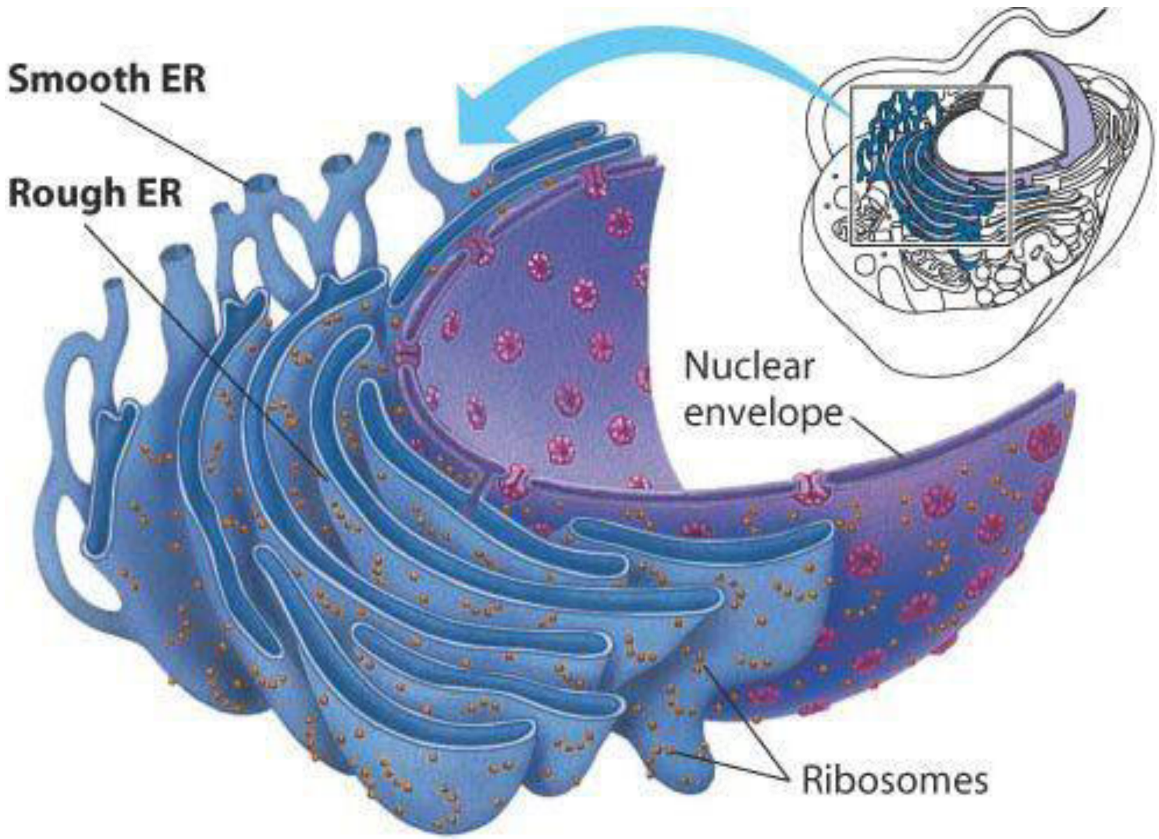
Endoplasmic reticulum (ER)

- forms an interconnected network of flattened, membrane-enclosed sacs or tube between nuclear membrane and plasmalema.

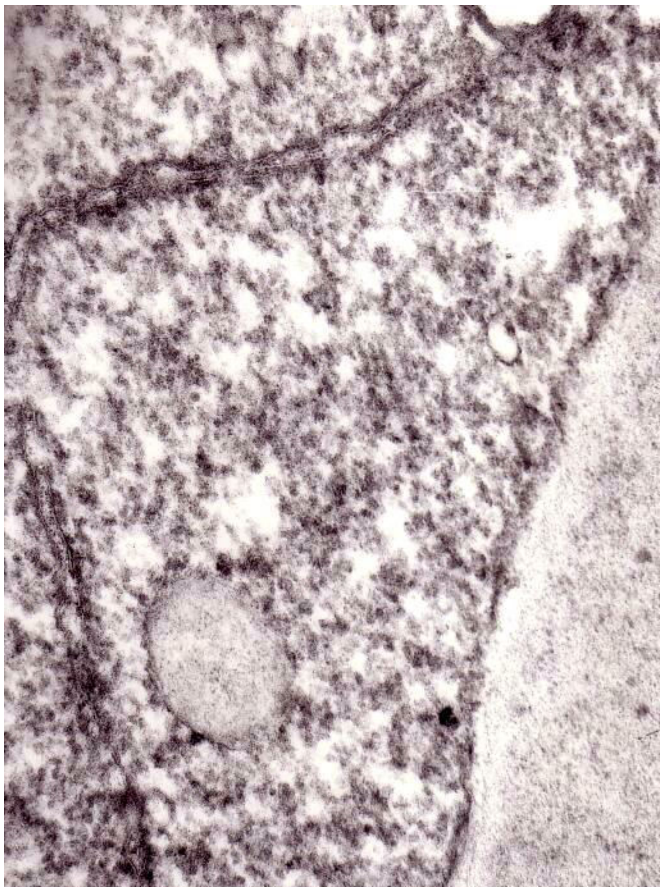


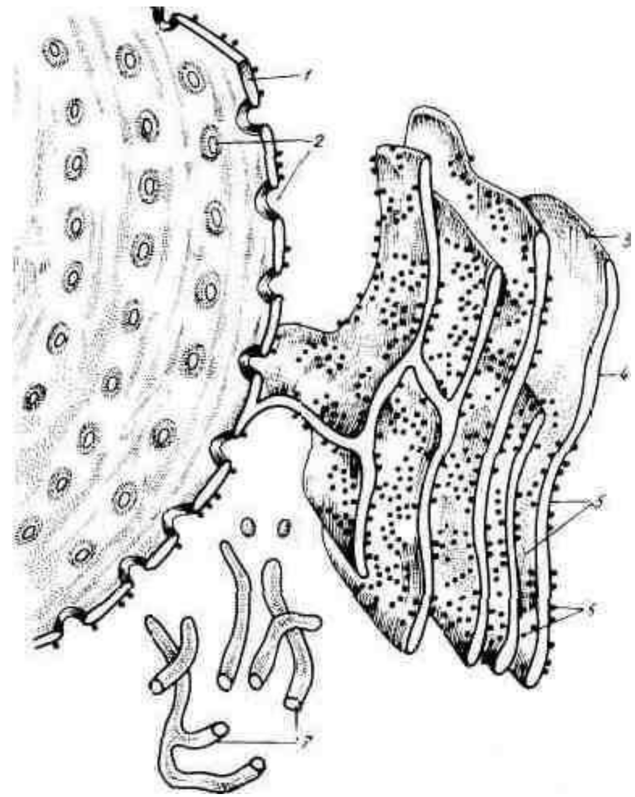
Distinguish 2 types of ER: smooth and rough ER

- The smooth ER consists of tubules, which are located near the cell periphery. Participates in synthesis and storage of volatile oils, resins, lipids, steroids and transport the substances to cell wall formation.
- Rough ER synthesizes proteins. It also metabolizes carbohydrates and regulates calcium concentration, and attachment of receptors on cell membrane proteins.



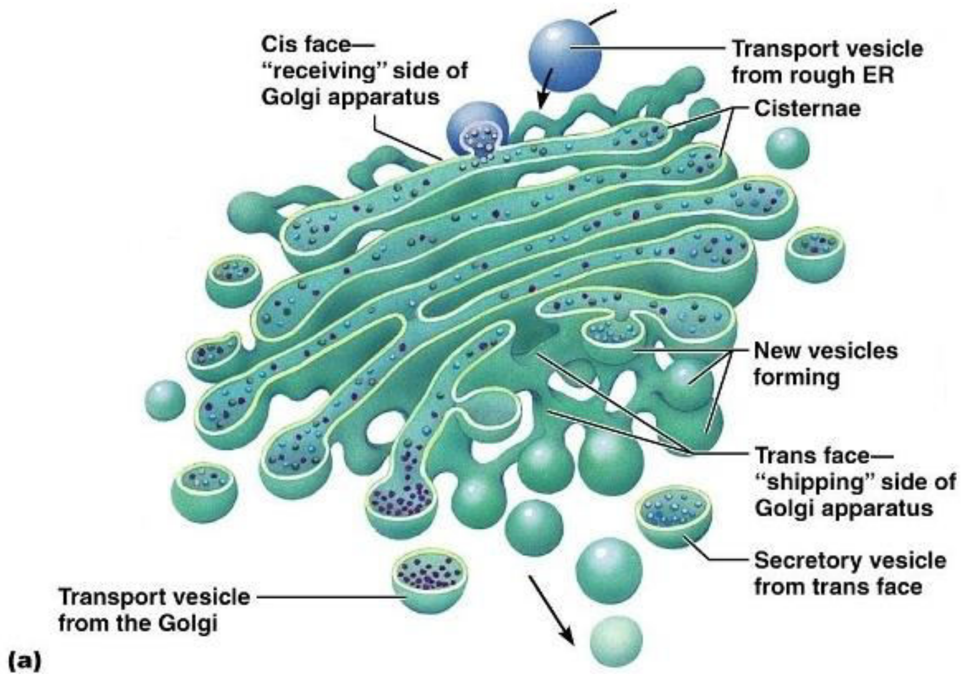
Endoplasmic reticulum





Golgi body

- a membranous complex of vesicles, vacuoles, and flattened sacs in the cytoplasm of most cells: involved in **intracellular secretion and transport**;
- Schematically it consists of 2 types of elements: ***dictyosomes*** **şi golgi** ***vezicules.***

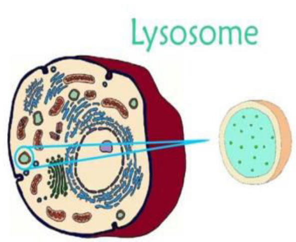


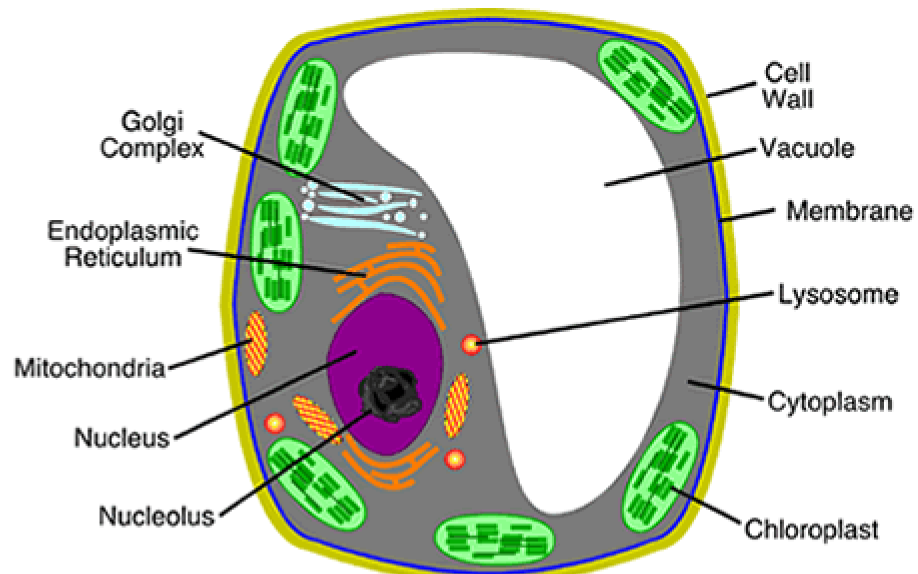
The Golgi body has a number of functions:

- including sorting and processing proteins. Proteins are synthesized in the RER, then they travel to the Golgi body. The Golgi body is also responsible for determining which proteins are to be transported outside the cell.
- Participates to the formation of primordial, primary and secondary cell wall;
- In the formation of mucilage and gum;
- Regeneraion and new formation of the plasmalemma;
- Transport of different substances through golgi vesicles in the special area.

Lysosomes

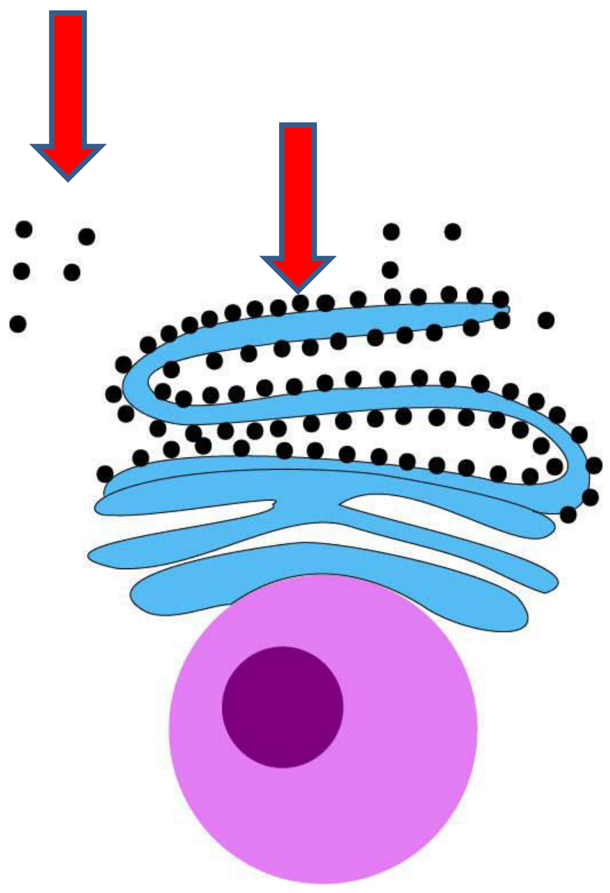
- A cell organelle that is surrounded by a membrane, has an acidic interior, and contains hydrolytic enzymes that break down food molecules, especially proteins and other complex molecules.
- Lysosomes fuse with vacuoles to digest their contents. The digested material is then transported across the organelle's membrane for use in or transport out of the cell.





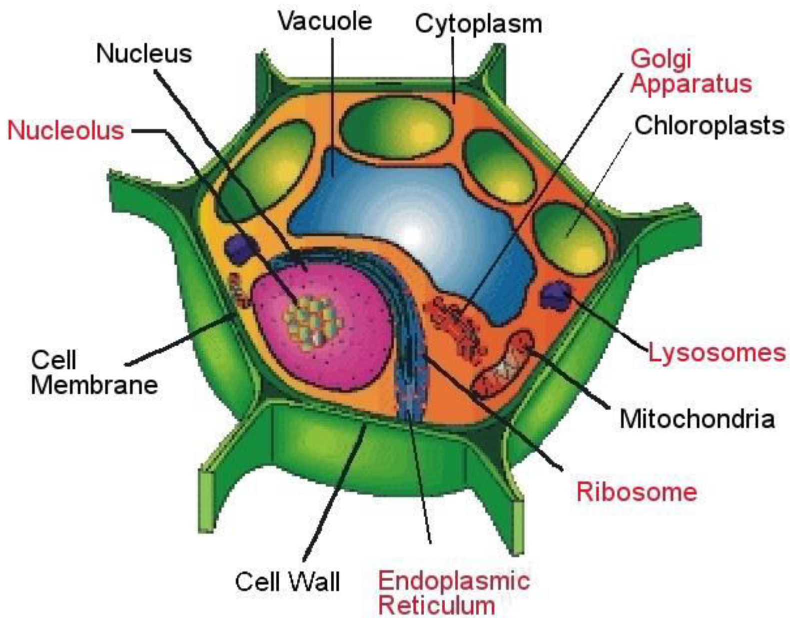
Ribosomes
amembranic organelles

- a tiny, **spherical organelle occurring in great numbers** in the cell cytoplasm (freely, in small clusters, or attached to the outer surfaces of ER), and functioning as the site of protein manufacture.
- is a large and complex molecular machine, found within all living cells, that serves as the site of biological protein synthesis (translation).



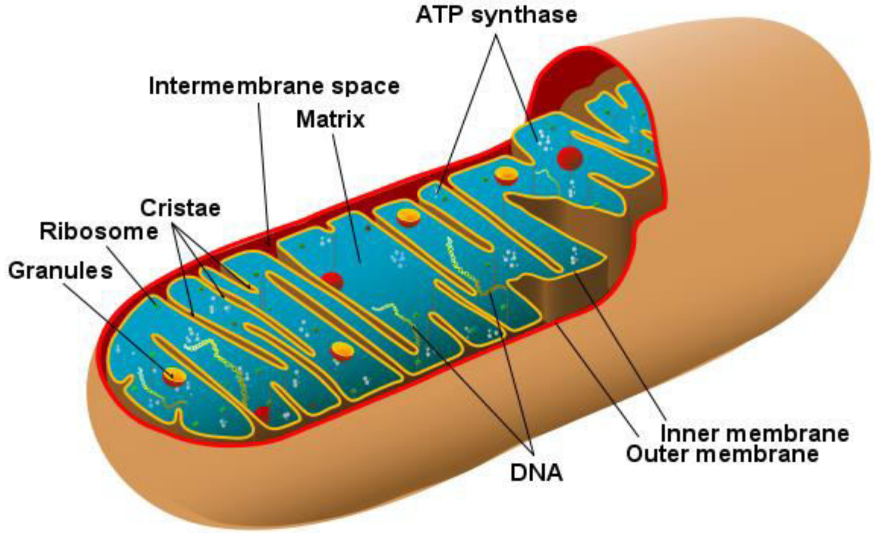
Mitocondria

- **The mitochondrion (plural mitochondria) is a double [membrane]-bound [organelle].**
- **Mitochondria can range from 0.5 to 1.0 [μm] in diameter.**
- **[Mitochondria] play a critical role in the generation of energy (ATP)**



Structure of mitochondria

- Mitochondria are surrounded by a *double-membrane system,* consisting of *inner* and *outer* mitochondrial membranes separated by an intermembrane space.
- The inner membrane forms numerous folds *(cristae).*
- Inside there is the *matrix or stroma* (proteins, ribosomes, AND, minerals, water and other.



Nucleus

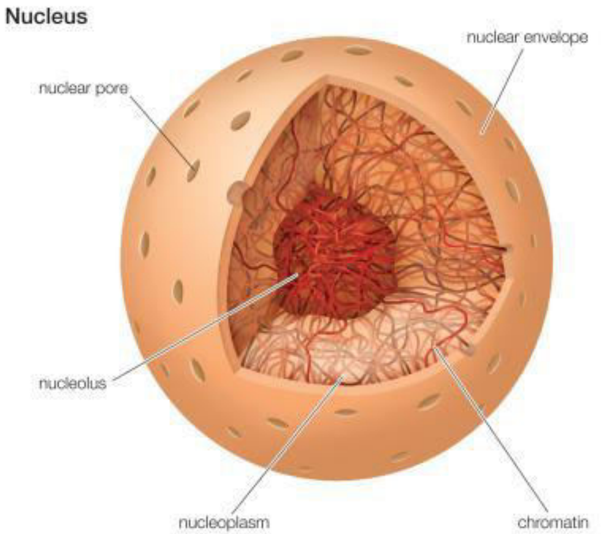
- **usually is spherical and occupies the central part of cell;**
- **controls growth, metabolism, reproduction, and transmission of genic characters.**
- **The nucleus is surrounded by a nuclear envelope, which is a double membrane comprised of an outer membrane and an inner membrane.**

THE NUCLEUS INCLUDES:

- Chromosomes, consisting of DNA, which contains heredity information and instructions for cell growth, development, and reproduction.

- Nucleolus, which is a dense structure composed of RNA and proteins . It helps to synthesize ribosomes by transcribing and assembling ribosomal RNA.

- Nucleoplasm - the highly viscous liquid

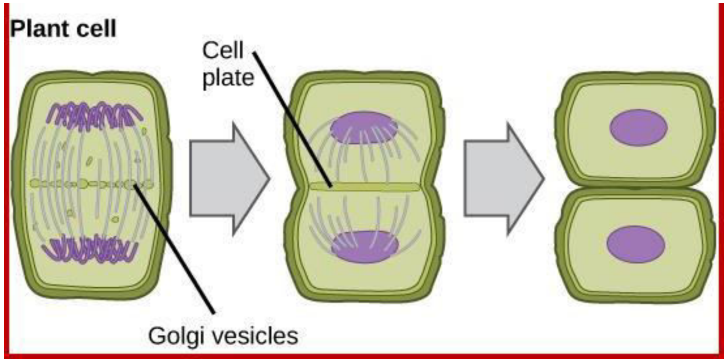


Cell division

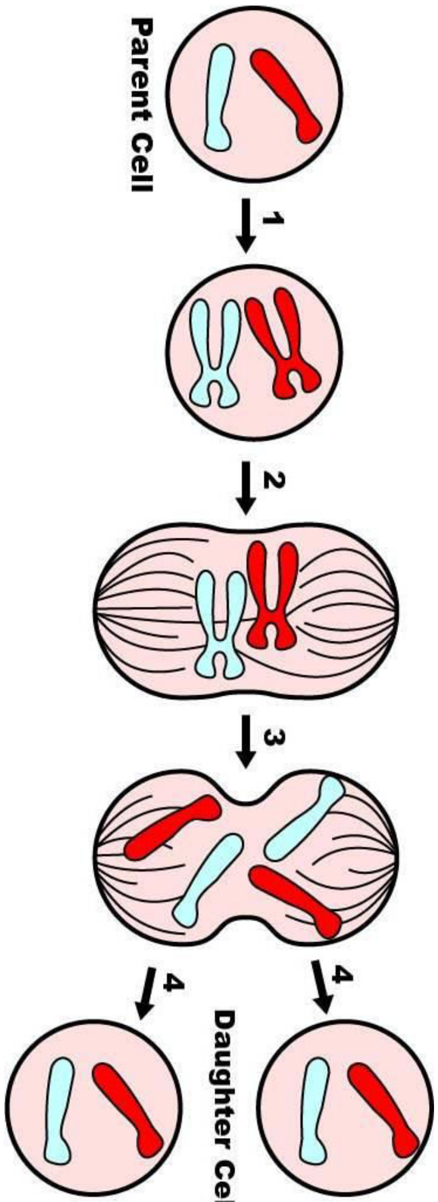
- **Direct (amitosis)**
- **Indirect**

  Mitosis (This process involves equal distribution of genetic material).

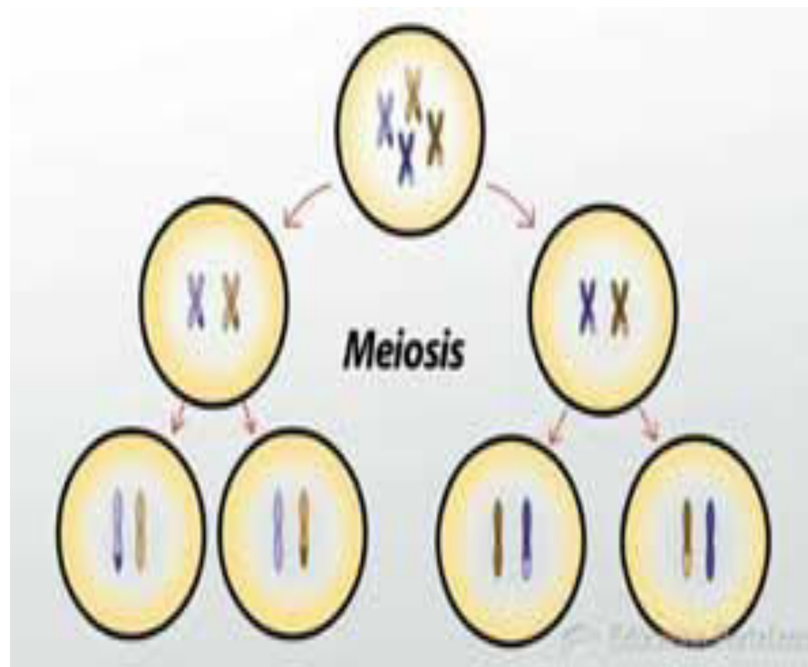
  Meiosis (in meiosis the genetic material is reduced to half of the original).



Mitosis



Meiosis



Differences…

MEIOSIS	MITOSIS
Homologous chromosomes pair up	Homologous chromosomes do not normally pair up
Crossing over	No crossing over
Two cell divisions	One cell division
Four daughter cells	Two daughter cells
Daughter cells haploid (n)	Daughter cells diploid (2n)