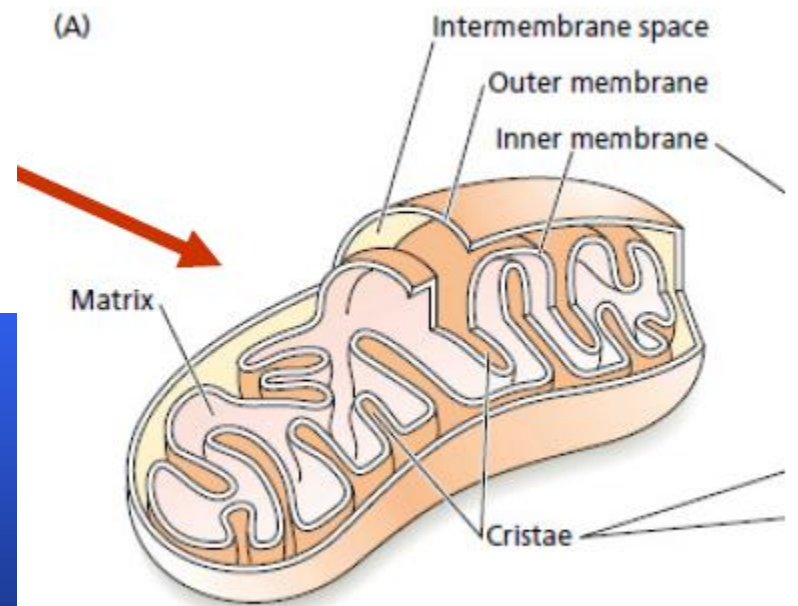
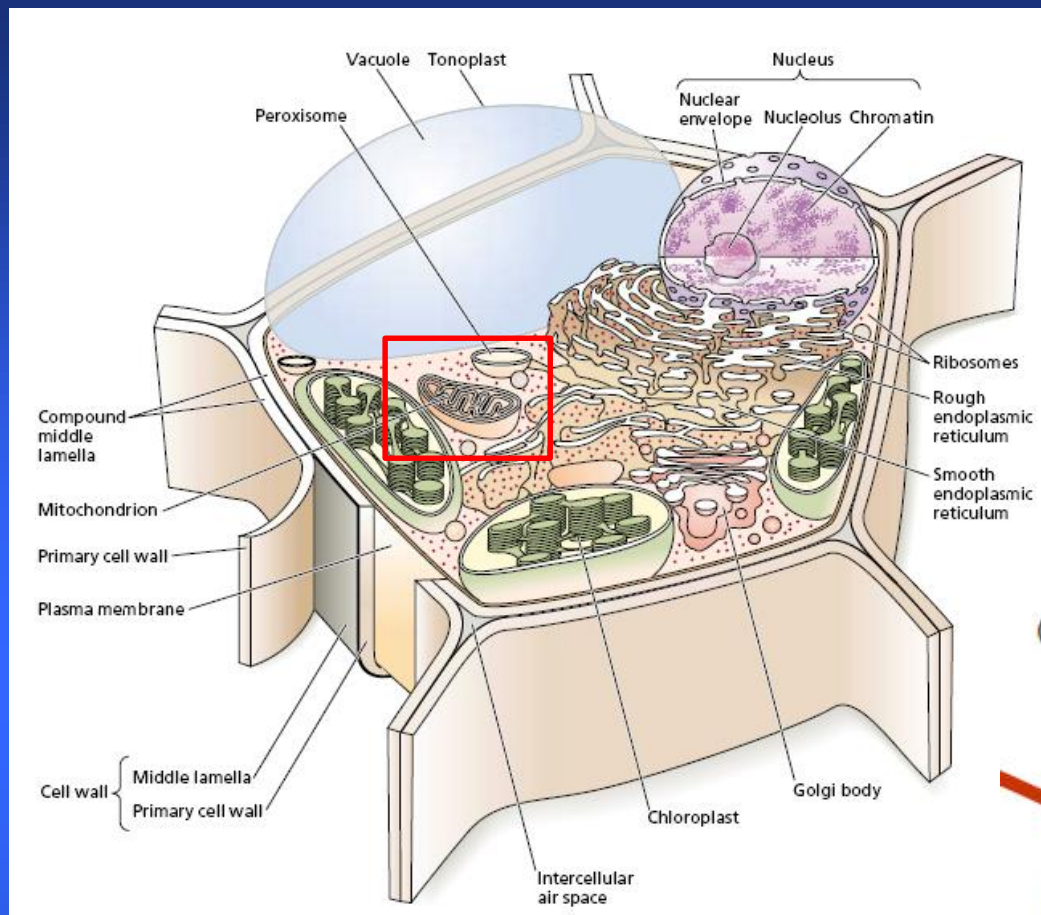


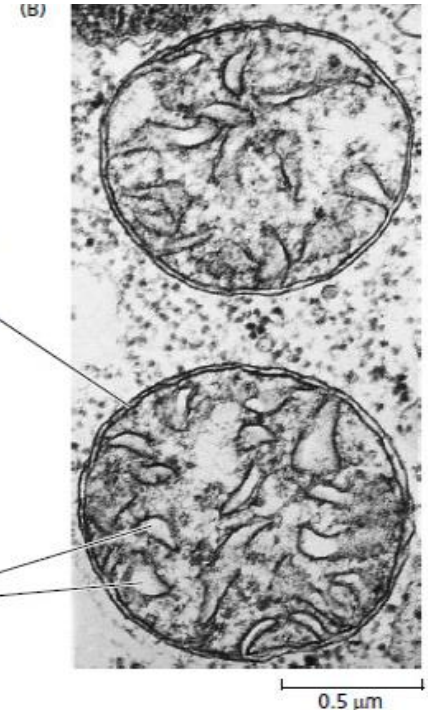
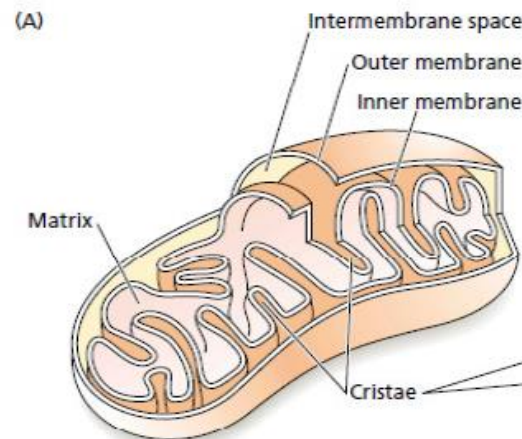
Mitochondria and plastids

Mitochondrion / Mitochondria

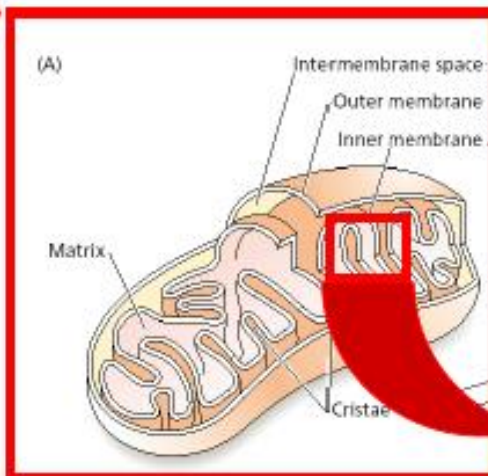
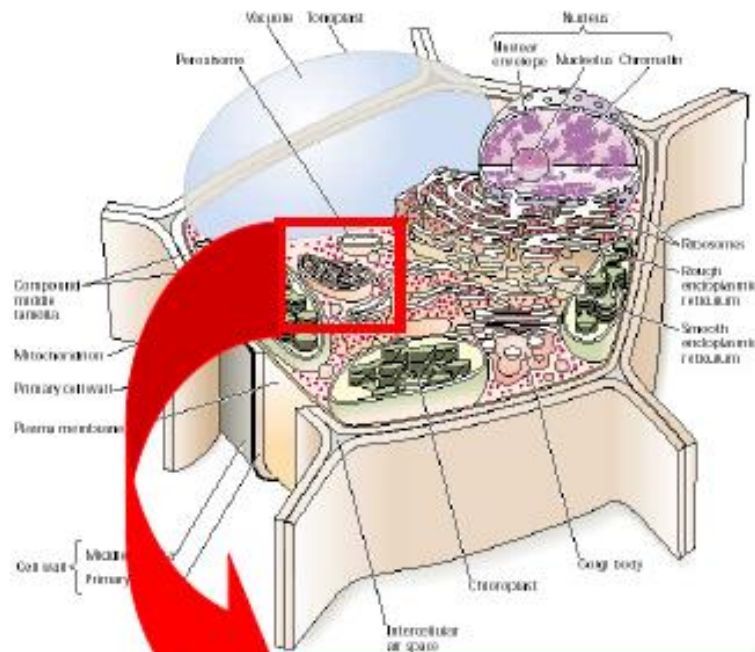


Basic structure of mitochondrion

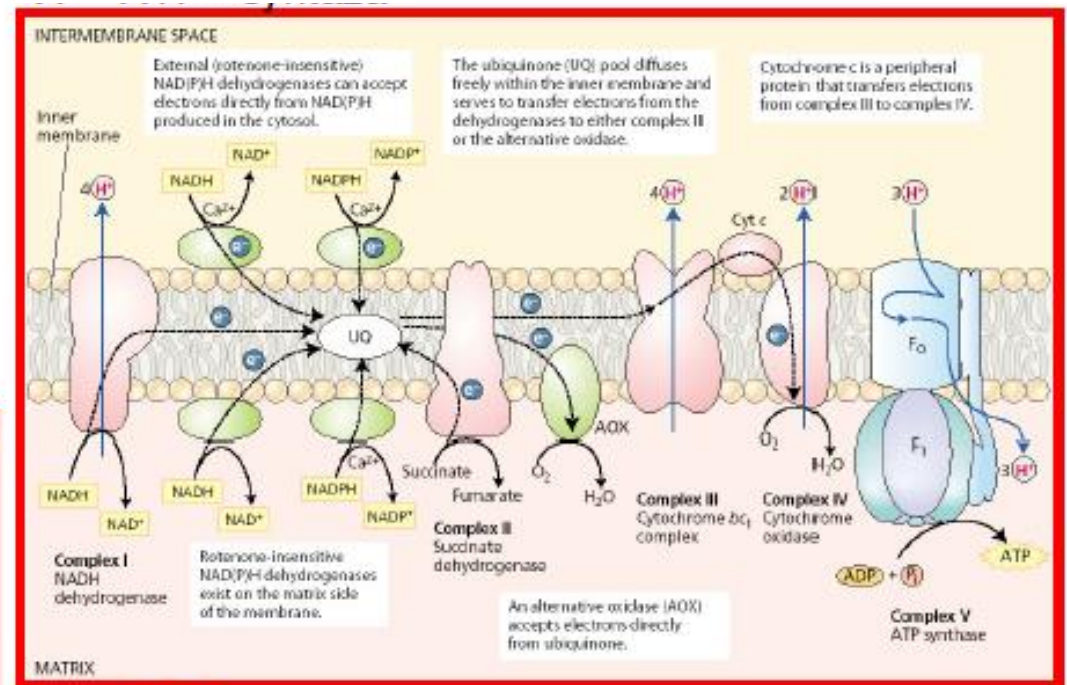
- Mitochondrion – diameter 0,5 – 1,0 μm , length till 3 μm .
- Plant cell posses less mitochondria then animal ones, the number is metabolic activity-dependent; many are in accompanying guard cells of stomata.
- Outer membrane is smooth, inner creates cristae. Inner space fill in matrix, which contains enzymes and DNA (semiautonomous organelle).
- Ancestor – alphaproteobacteria.
- Inner membrane creates osmotic barrier, contains a lot of transporters, outer membrane is permeable for substances with molecular weight less then 10 000 Da (most metabolites and ions, but not proteins).



Mitochondria – energetic centers of cells



- I. NADH-dehydrogenase complex
- II. Succinate dehydrogenase complex
- III. Cytochrome bc1
- IV. Cytochrome c oxidase complex
- V. ATP synthase



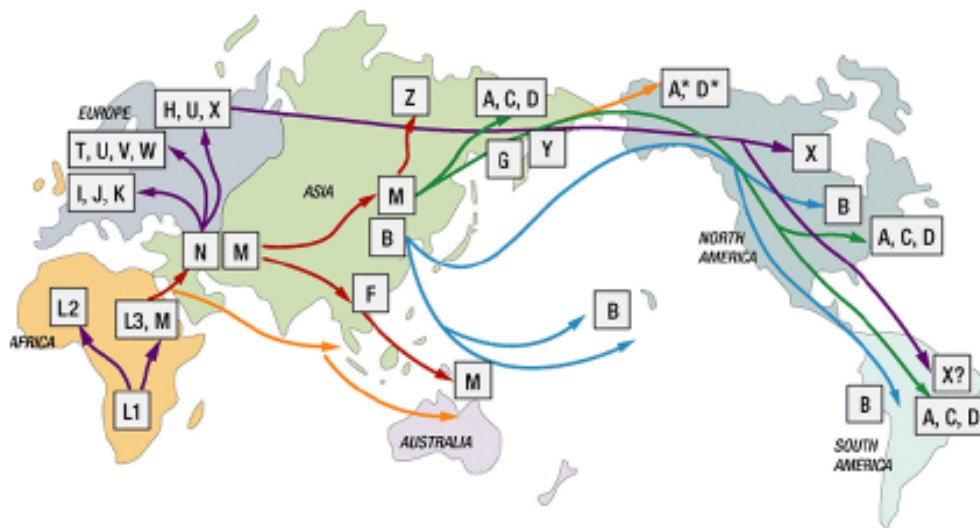
In mitochondrial matrix occur important biochemical reactions: cycle of citric acids – Krebs cycle.

Mitochondria possess their own DNA

- Mitochondria possess their own mtDNA, which encodes minor part of mitochondrial proteins (max. 36). Those are synthesised in matrix by mitochondrial ribosomes (70 S).
- The rest of mitochondrial proteins are encoded in nuclear DNA (nDNA), synthesised in cytoplasm (80 S ribosomes) and specific transported into the mitochondria by signal sequences (semiautonomy).
- In plants the mtDNA is several times larger (250 – 2500 kb) than in animals (16 – 20 kb).
- Plant mtDNA contains sequences similar to ctDNA.
- NADH-dehydrogenase: 7 mtDNA, 41 nDNA.
- Succinate dehydrogenase: 0 mtDNA, 4 nDNA
- Cytochrome bc1: 1 mtDNA, 10 nDNA
- Cytochrome c oxidase: 3 mtDNA 10 nDNA
- ATP synthase: 2 mtDNA, 14 nDNA
- DNA and RNA polymerases: 0 mtDNA, all nDNA
- Ribosome proteins: 0 mtDNA, ca 70 nDNA

Genesis of mitochondria

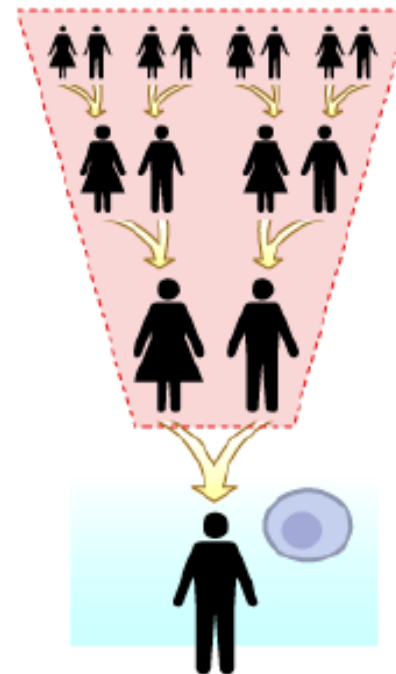
- Mitochondria create by division already existing mitochondria. They are inheritance along the mother line mostly (mitochondrial Eve), but only seldom in some species along male line (e.g. Gymnosperm plants).
- Mitochondria may fuse, and thus form dynamic network. Some unicellular algae possess only one gigantic mitochondrion.



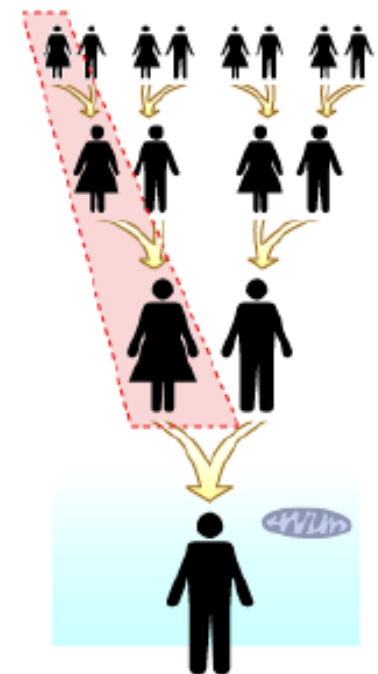
© Copyright 2004 - developed by Genetics, Ltd. FamilyTreeDNA. All Rights Reserved.
This material may not be reproduced, republished, altered or used without written permission.


FamilyTreeDNA
mtDNA Migrations Map

A. Nuclear DNA is inherited from all ancestors.

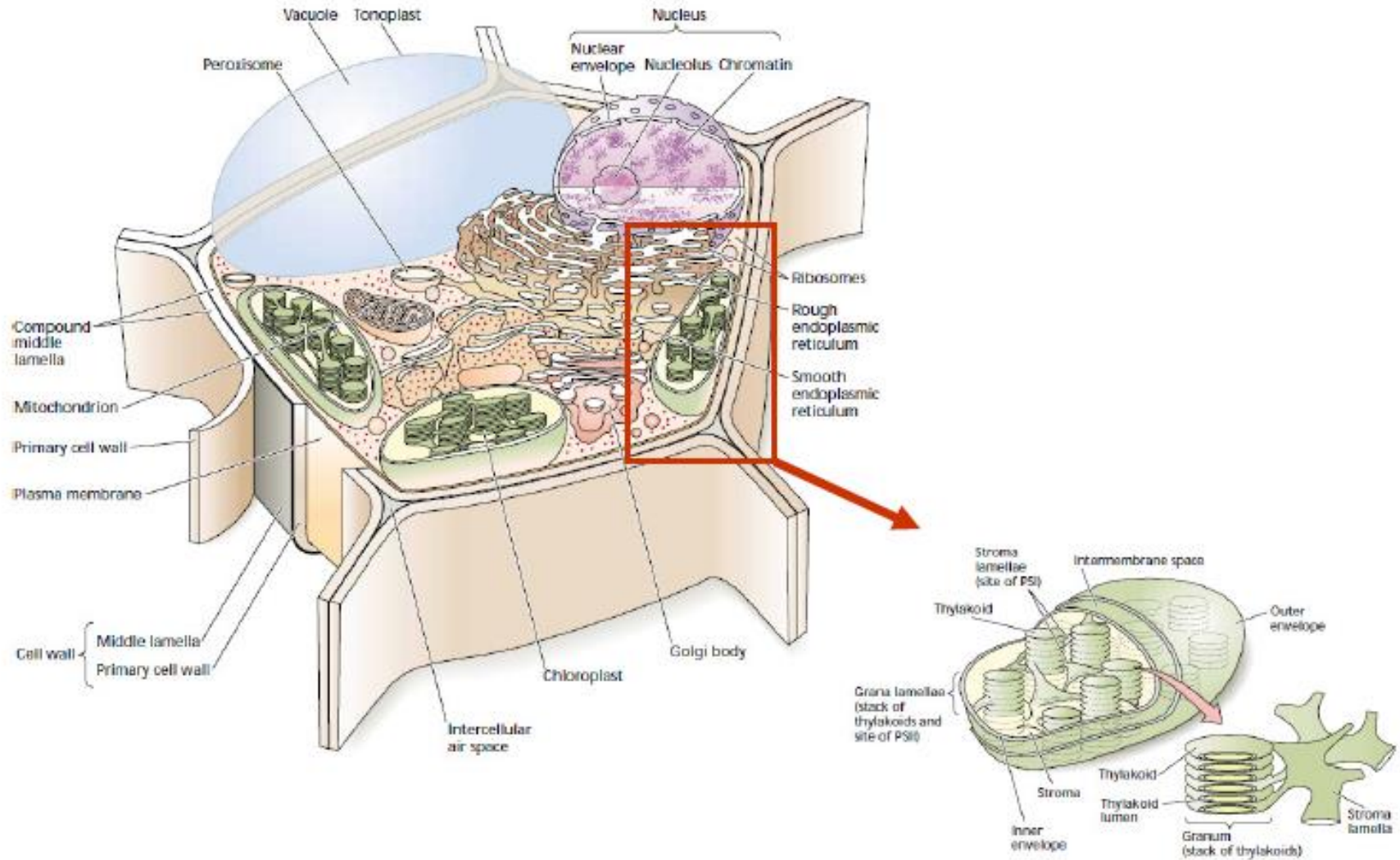


B. Mitochondrial DNA is inherited from a single lineage.



Plastids

Plastids

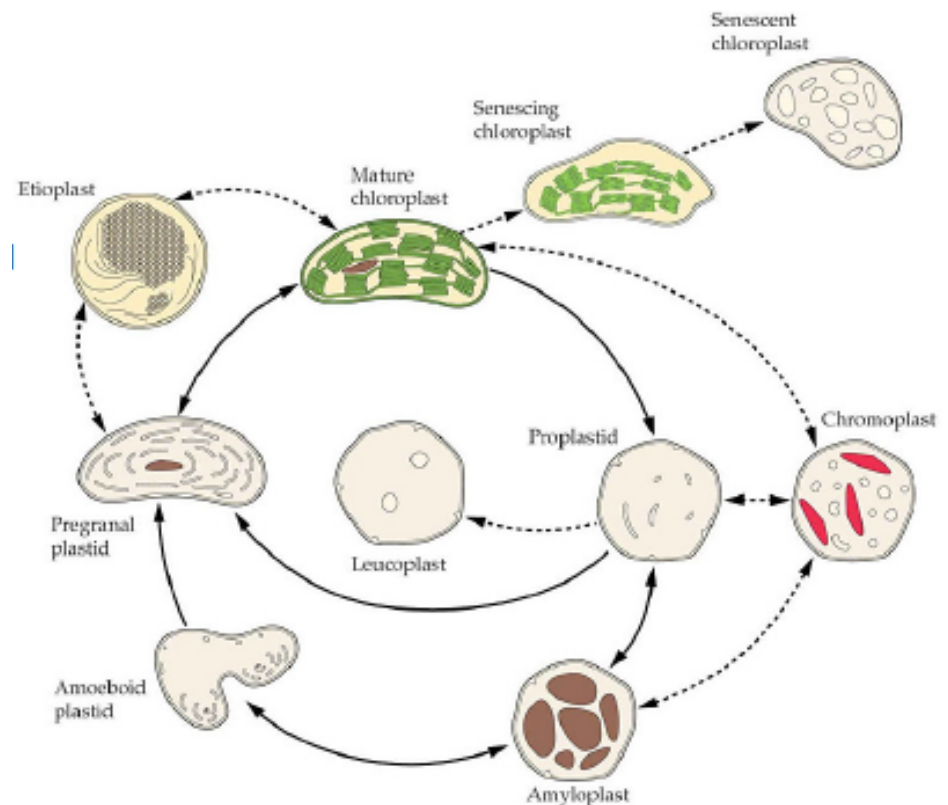


Plastids are heterogeneous group of organelles

- Plastids are present in eukaryotic cells only
- In plants they differentiate tissue- and signal-dependently into the:
Leucoplast (without pigments) – amyloplasts, elaioplast, proteinoplasts
Chloroplast and chromoplast (pigmented)

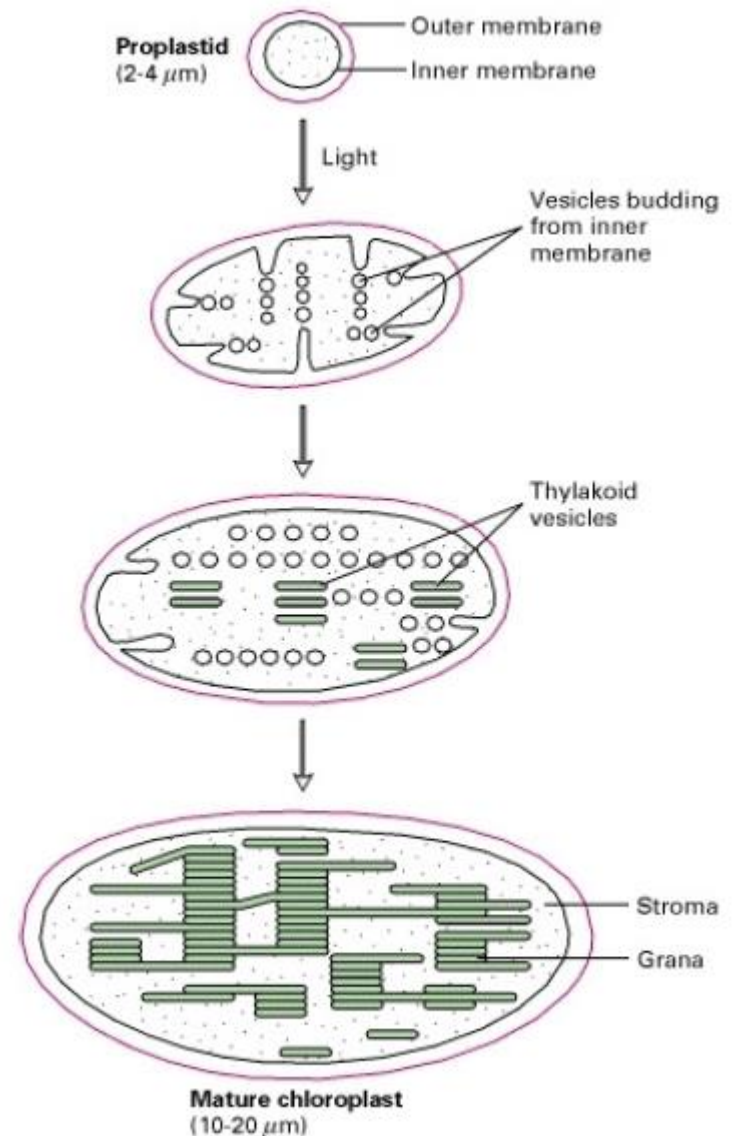
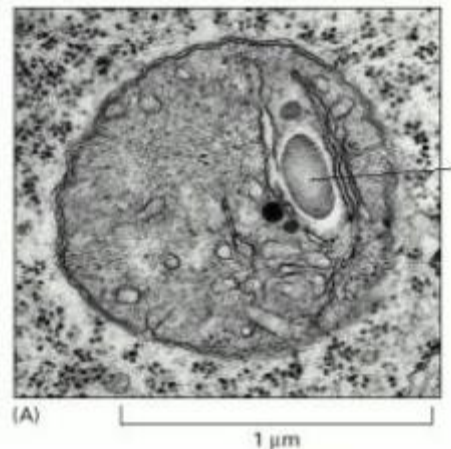
- Individual types of plastids are derived from proplastids or they can differentiate and change from one type to the another one.

- Proplastids are typical for meristematic cells.



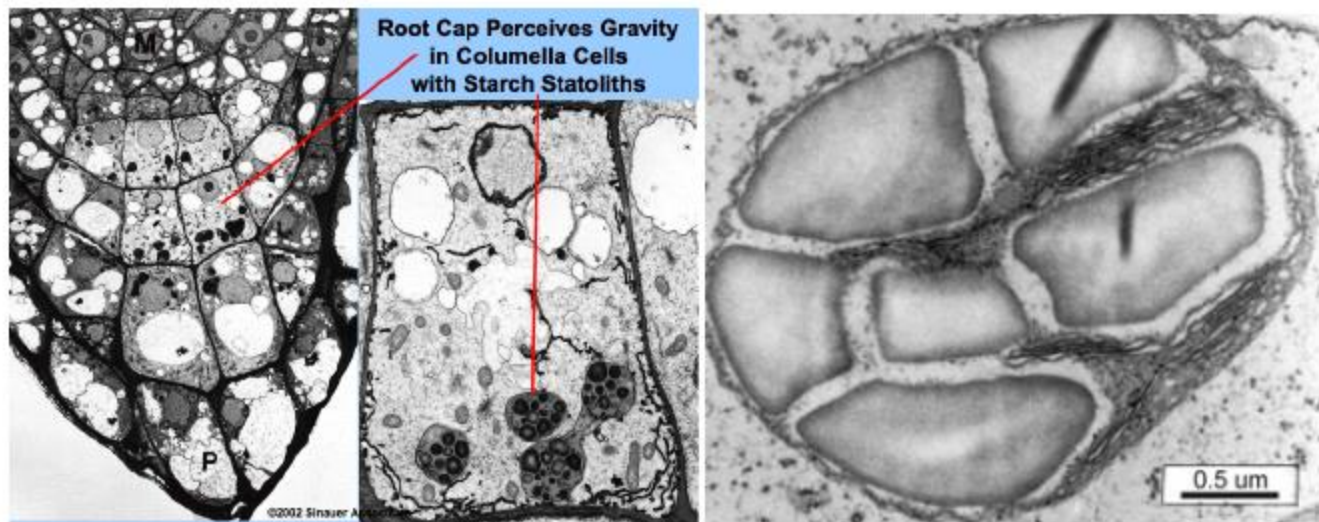
Structure of plastids

- 10 – 20 μm
- double surface membrane (outer and inner one)
- the inner space of plastids consists of stroma
- in the stroma they can form inner membrane system – differentiates best in the chloroplasts
- ribosomes, circular plastid DNA (pDNA, cDNA), starch grains, plastoglobules, crystalline inclusions



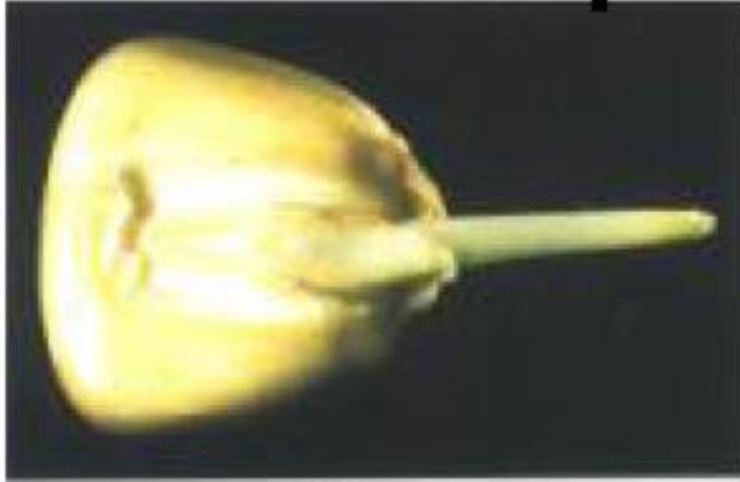
Leucoplasts

- Without special inner membrane system differentiation
- Proteinoplasts – contain protein crystals, e.g. sieve elements of higher plants
- Elaioplasts – contain lipidic material in the form of globes, e.g. brown algae, familie Liliaceae
- Amylooplasts – contain starch, e.g. storage organs of plants (potato tuber, bannan), in columella of root cap (involved in positive geotropism of root growth, Bohumil Němec)

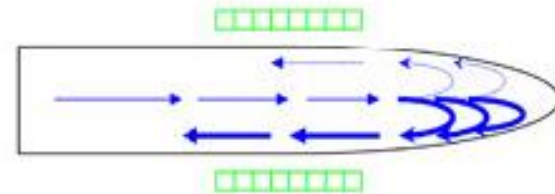
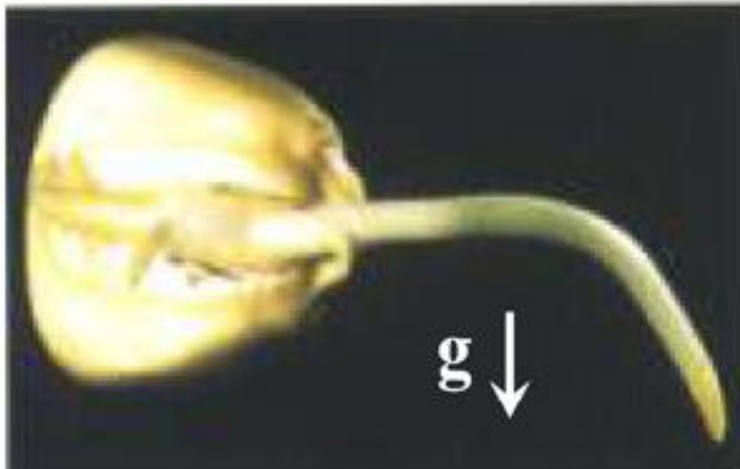


Amyloplasts and their function in geotropisms of a root

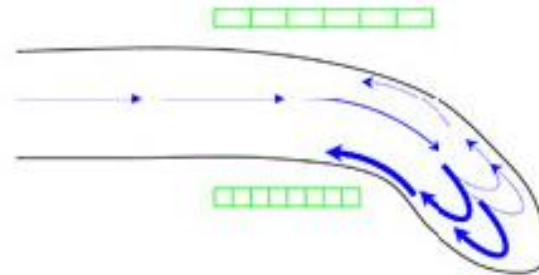
Gravitropism in Roots



After 30 minutes

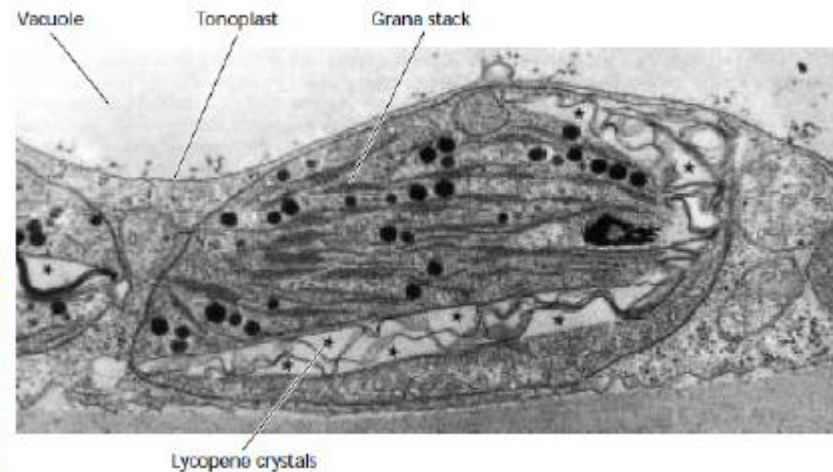


Redistribution of Auxin to the cells on the bottom of the root slow cell elongation. Cells on the top of the root continue to elongate.



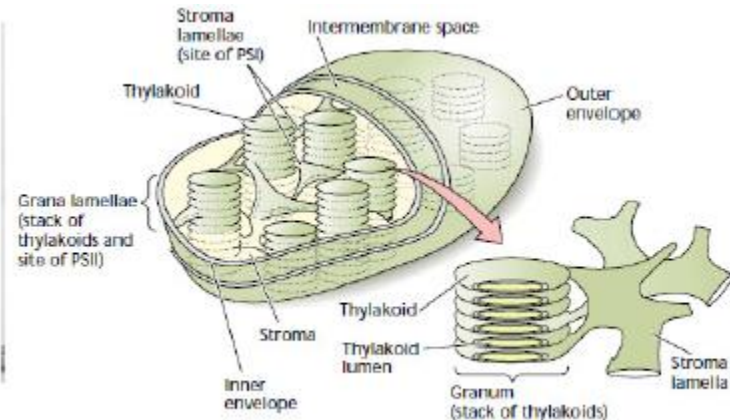
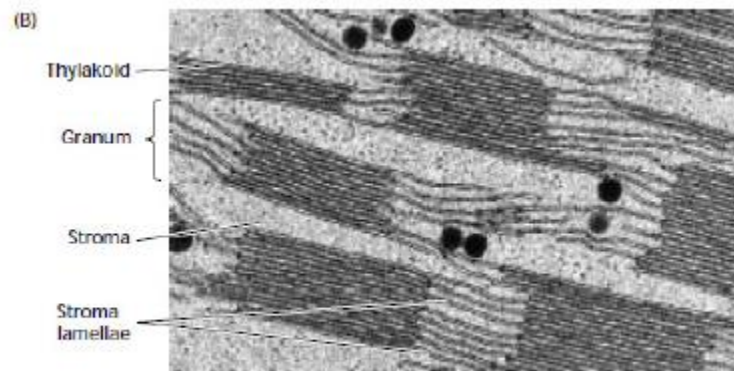
Chromoplasts

- In generative organs of plants (flowers, fruits), senescing leaves, carrot root.
- Inner membrane system differentiates weakly.
- They contain yellow till orange pigments of the carotenoid group (carotene, xanthophyll, lycopene). They can form crystals, globes, fibrils.



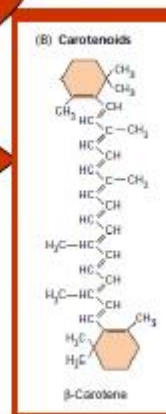
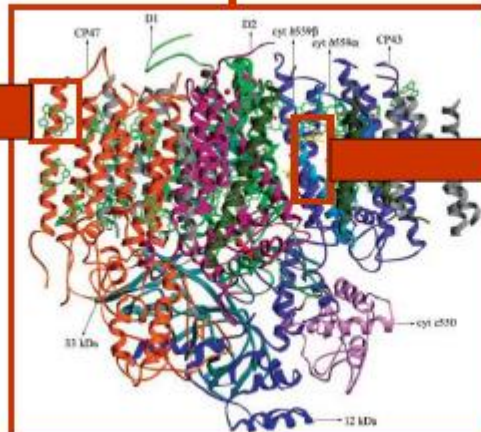
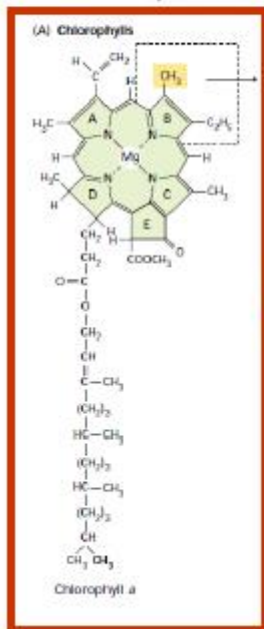
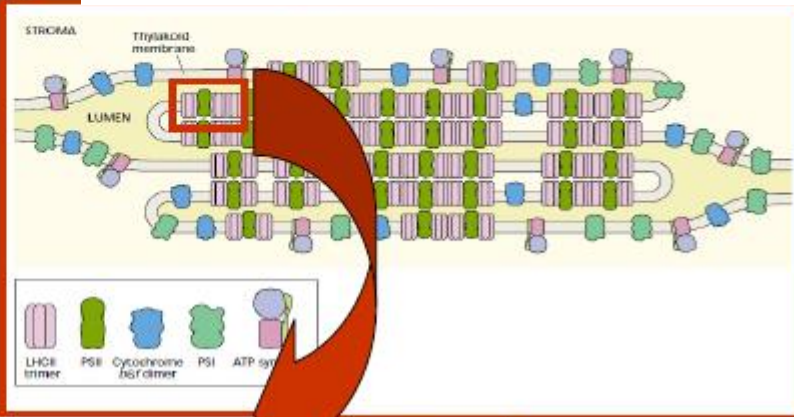
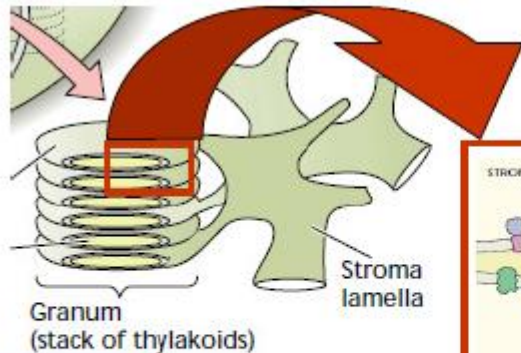
Chloroplasts

- Green organelles, contain chlorophyll – the reason of green color of plants. They differentiate in the light.
- Perform photosynthesis, in stroma are localised enzymes of Calvin cycle.
- Well differentiated inner membrane system of thylakoids.
- Thylakoids may be grouped into the grana or form stromal thylakoids (intergranal thylakoids) .
- The inner space of thylakoid is called lumen – Hill's reaction (water photolysis) and formation of proton gradient, which is used by ATP synthase to produce ATP.



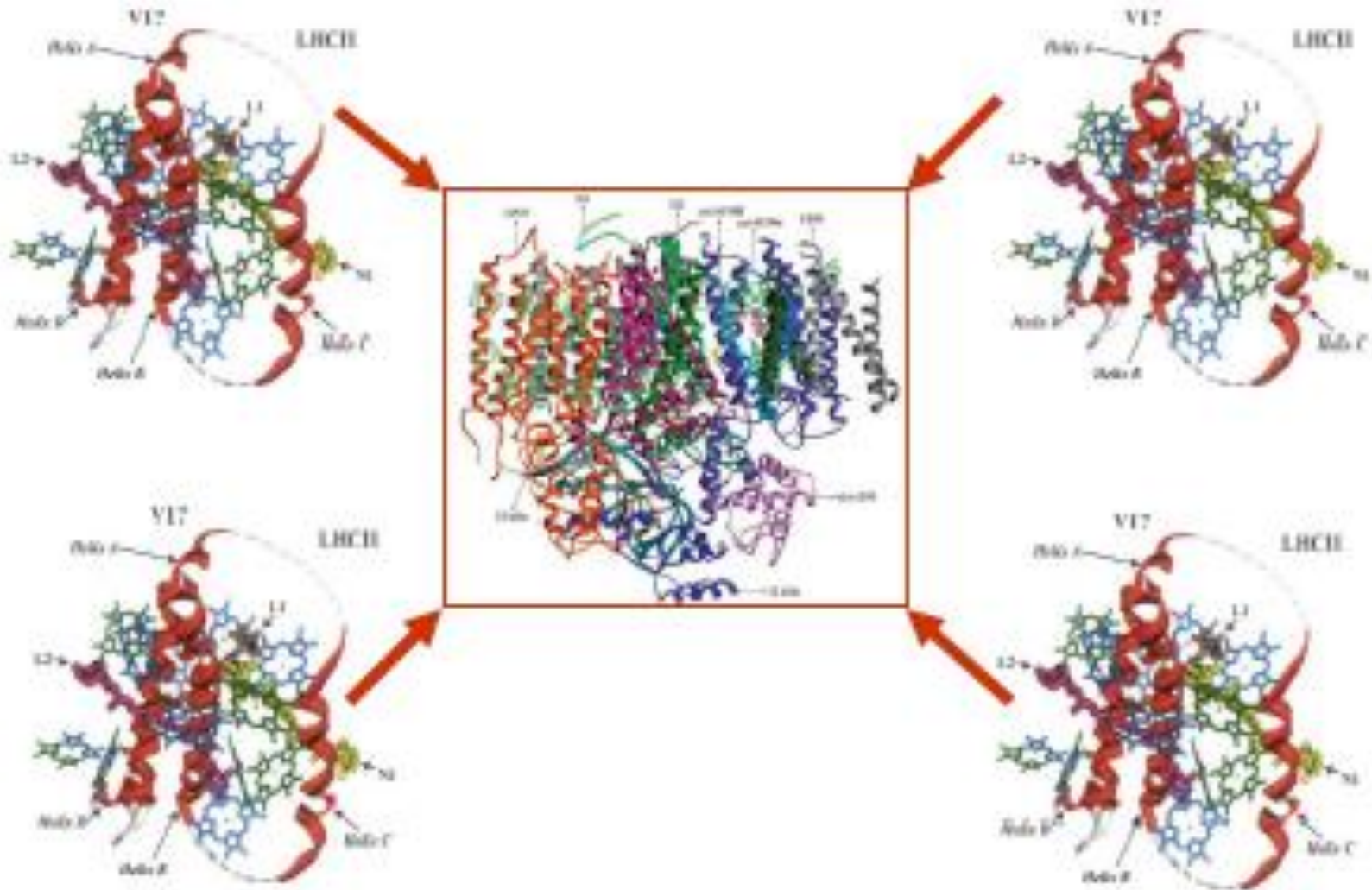
Chloroplasts

- Photosystems – pigment-protein complexes
- Pigments: chlorophylls, carotenoids
- Photosystem I and II
- Cytochrome b6f, ATP-synthase



- In the membranes of granal thylakoids prevails photosystem II and in the stromal membranes photosystem I

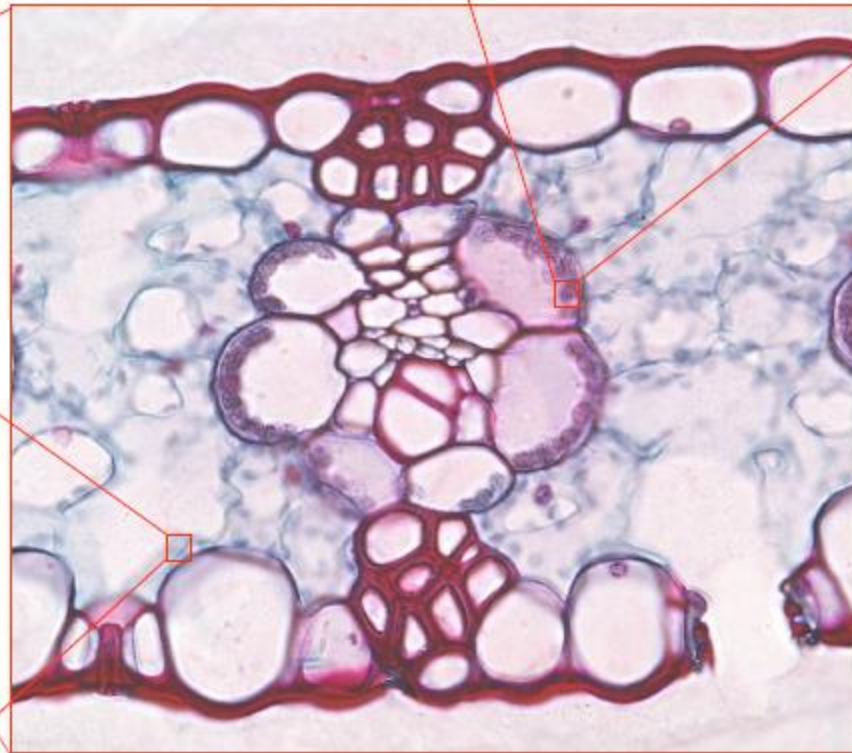
Light-harvesting antennas harvest light energy and send it into reaction center



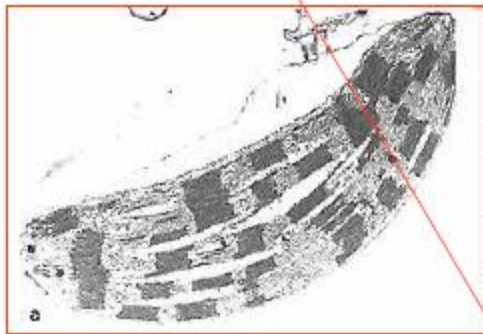
Dimorphism in chloroplasts in C4 plants



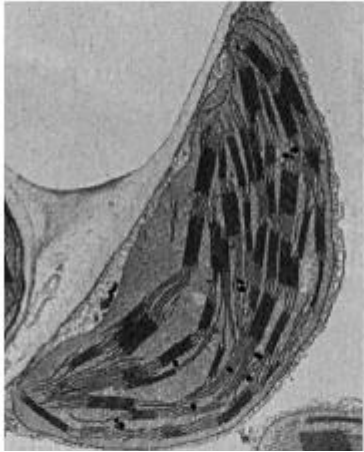
In parenchyma sheet of vascular bundle: chloroplasts without grana



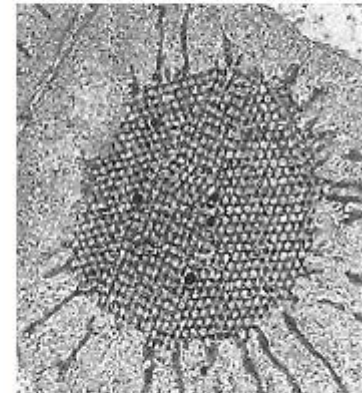
In mesophyle: typical chloroplast



In darkness form etioplasts



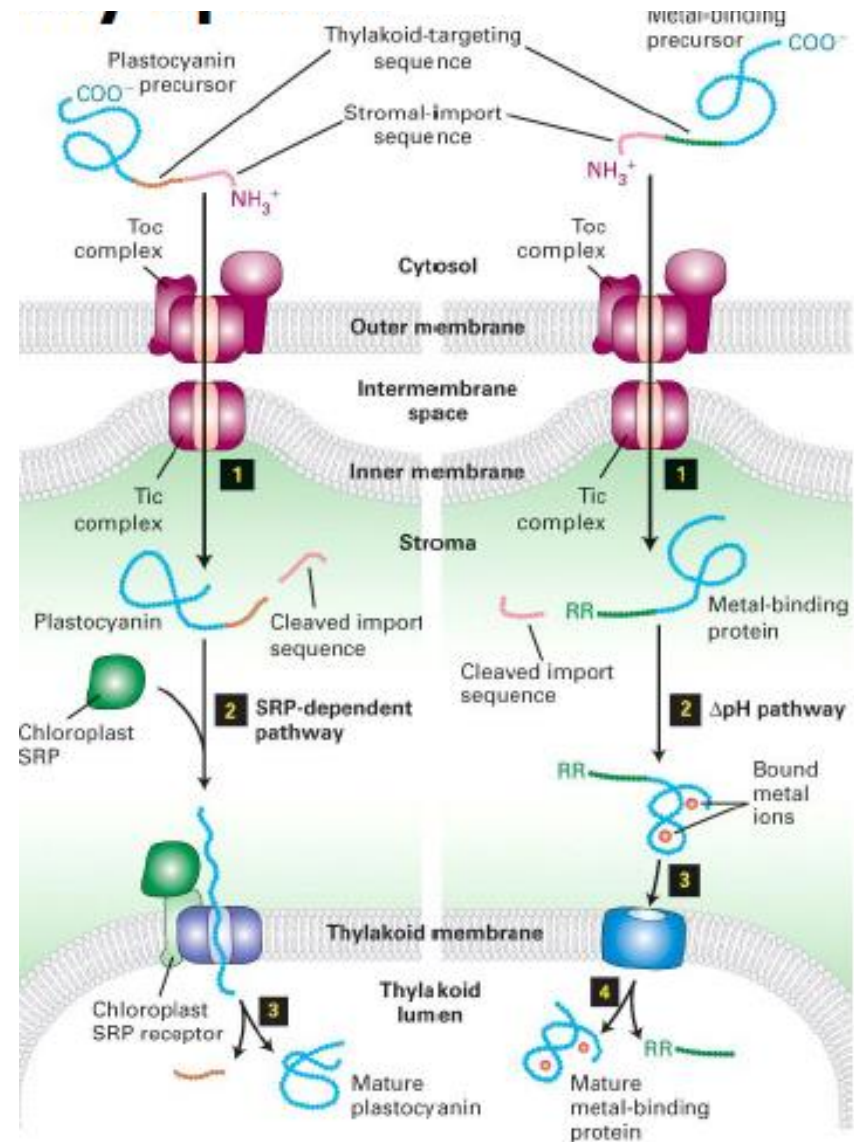
chloroplast with thylakoids



etioplast
with prolamellar body

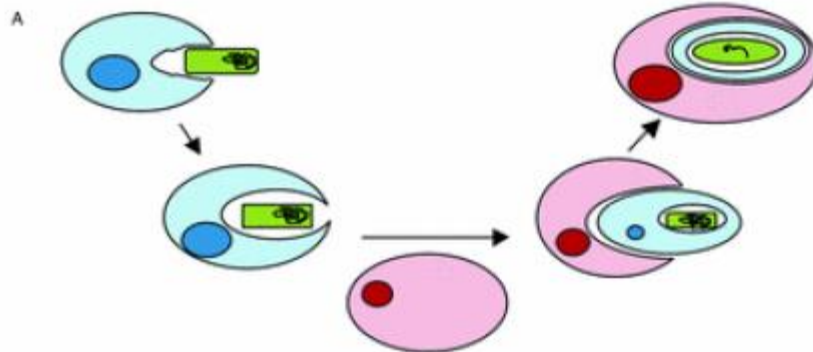
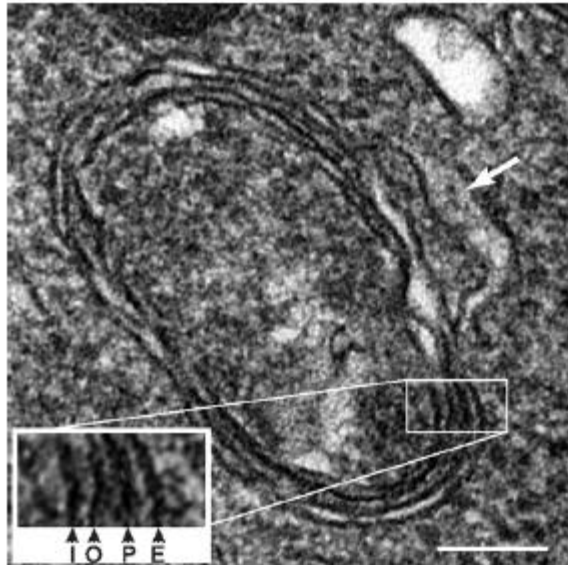
Angiosperm plants need for chloroplast differentiation a light. The light catalyses transformation of protochlorophyllide (membranes like prolamellar body) into the chlorophyllide and next enzymatic reactions transformation into the chlorophyll (typical thylakoid membranes).

Plastids possess their own DNA and proteosynthetic apparatus



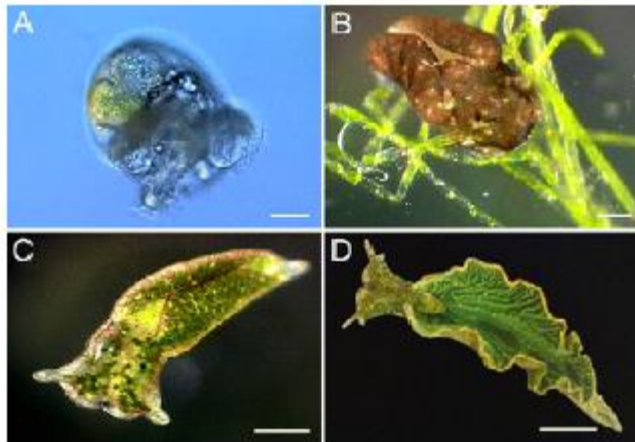
Some Protozoa contains the plastids as well

- Apicomplexa (*Plasmodium falcipare*) contain plastids (**apikoplasts**), which posses **four membranes** (secondary symbiosis).
- Apikoplast possesses own DNA (35 kb) encoding ca 30 proteins, tRNA, rRNA, bacterial type of ribosomes.
- Do not photosynthesise, important for lipid biosynthesis.
- **Nucleomorph is absent.**



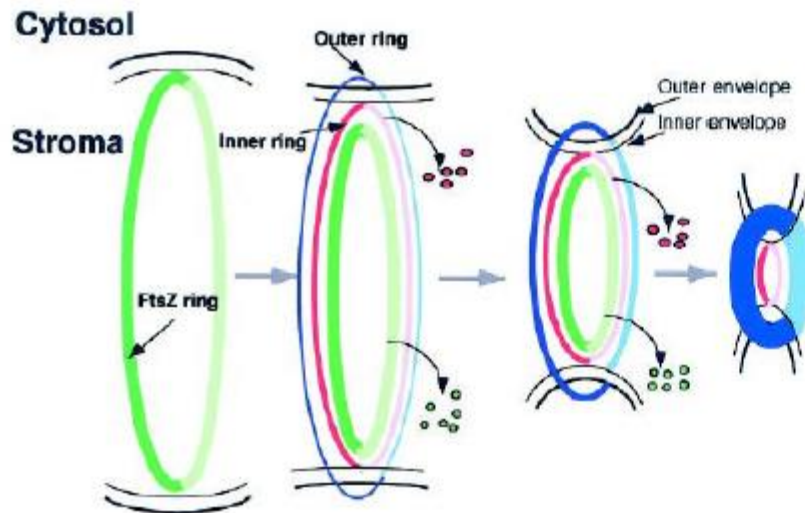
Elysia chlorotica – mollusca stealing chloroplasts

- *Elysia chlorotica* consumes algae *Vaucheria litorea* – it steals plastids – which can survive in the digestive tract cells – **kleptoplasts**.
- The mollusca is able to photosynthesize and survive even 8 months.
- Plant gene *psbO*, encoding protein of photosystem II is present in the genome of that mollusca – horizontal gene transfer.

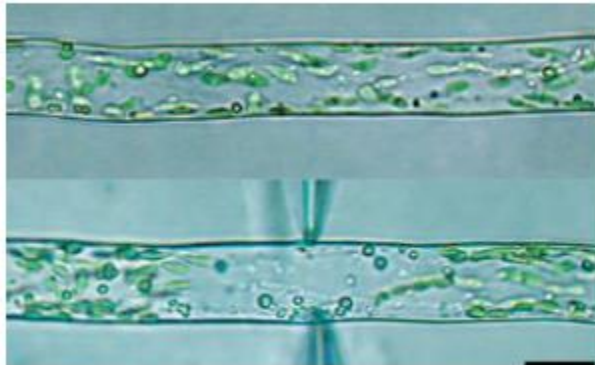
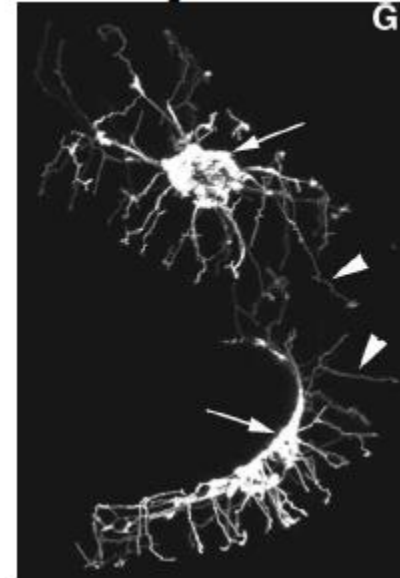
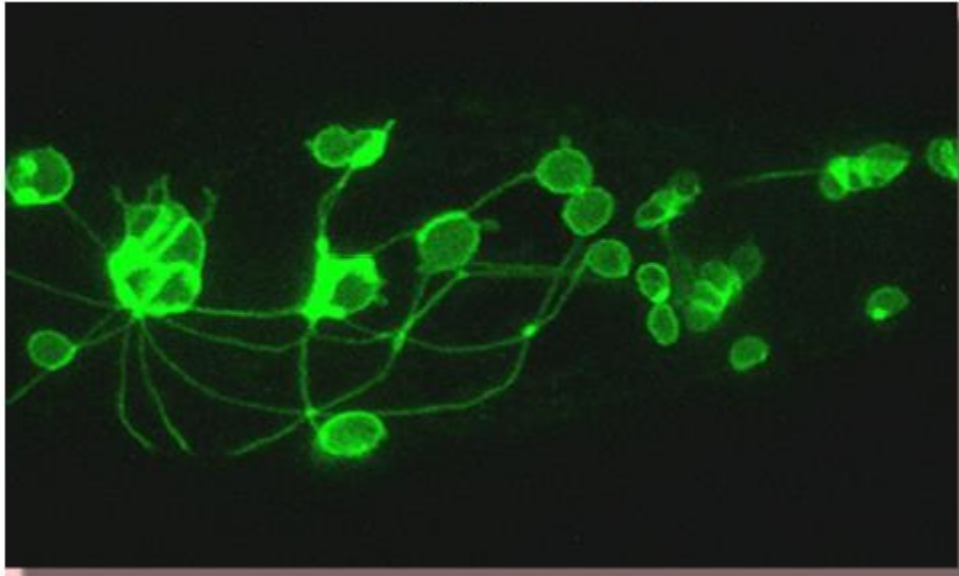


Reproduction of plastids

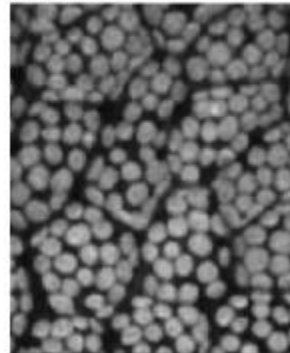
- Plastids are formed by division (Not *de novo*!!).
- They reach a zygote via gametes, usually along the mothers line, seldom along the father line (Gymnosperm plants).
- New plastid population form by division. The protein rings (present on the outer and inner surface of a plastid) are involved in that process.



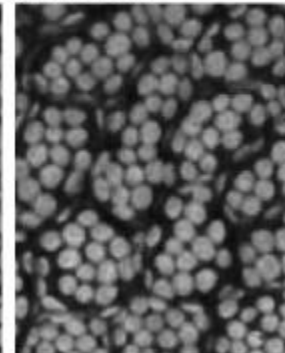
Plastids are dynamic structures, e. g. form projections to communicate - stromules



(A) Darkness



(B) Weak blue light



(C) Strong blue light

