

Introduction to Botany. Lecture 8

Alexey Shipunov

Minot State University

September 16, 2015



Outline

1 Questions and answers

2 Photosynthesis

- Special case of photosynthesis: C_4 pathway

3 Plant cell

- Discovery of cell
- Structure of cell



Outline

1 Questions and answers

2 Photosynthesis

- Special case of photosynthesis: C_4 pathway

3 Plant cell

- Discovery of cell
- Structure of cell



Outline

1 Questions and answers

2 Photosynthesis

- Special case of photosynthesis: C_4 pathway

3 Plant cell

- Discovery of cell
- Structure of cell



Previous final question: the answer

Why C_4 is better than C_3 ?

In essence, it decreases photorespiration which is especially helpful at higher temperatures—when all chemical reactions speed up, light stage makes more oxygen and in addition, plant close its stomata to prevent water loss.

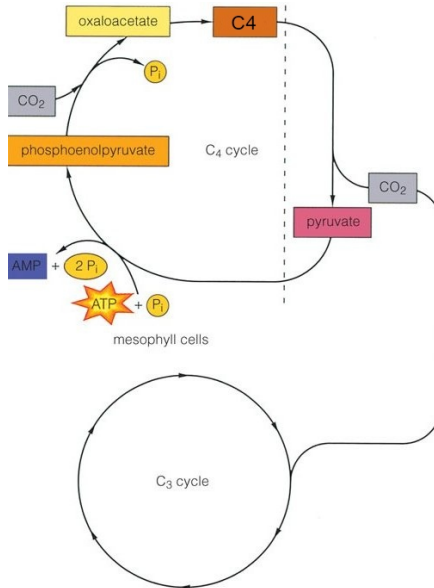


Photosynthesis

Special case of photosynthesis: C₄ pathway



C₄ pathway at-a-glance

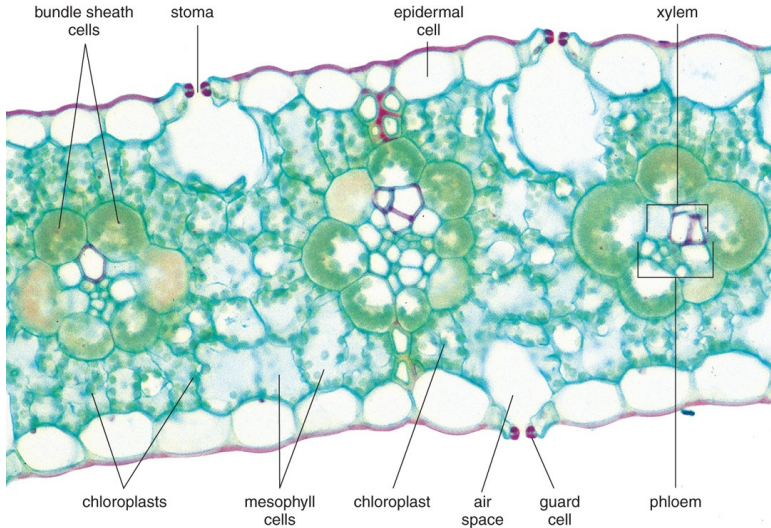


C_4 and CAM plants both use C_4 pathway

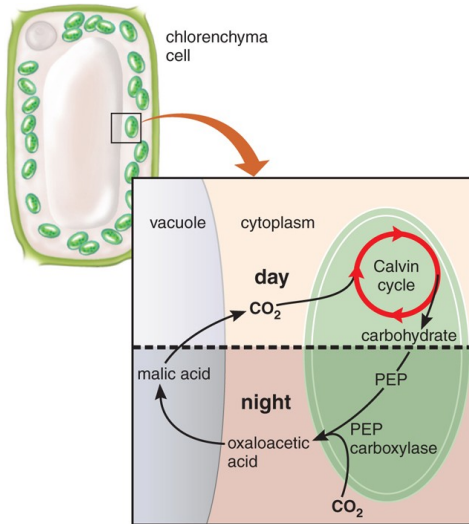
- **CAM-plants** which drive C_4 cycle at nights:
 - This is a **temporal** separation between accumulation of CO_2 and photosynthesis)
 - CAM-plants (17,000 species, 7% of plant biodiversity) are mostly succulents from different orders and families (e.g., cacti—Cactaceae from Caryophyllales)
- **C_4 -plants** which drive C_4 in mesophyll cells and C_3 in bundle sheath cells:
 - This is a **spatial** separation between accumulation of CO_2 and photosynthesis: C_4 pathway is located in “normal” mesophyll cells whereas the Calvin cycle is separated to **bundle sheath cells**.
 - C_4 -plants (7,300 species, 3%) are especially common among Poales (grasses order, e.g., corn) and Caryophyllales (pink order)



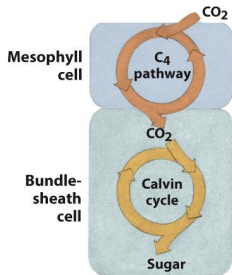
Leaf of C_4 plant: spatial separation of C_3 and C_4 pathways



CAM plants separate C_3 and C_4 pathways in time

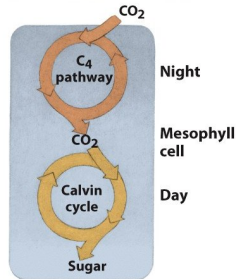


CAM plants and C_4 plants



Stage 1:
Initial fixation
of CO_2 to form
4-carbon acids

Stage 2:
Release of CO_2
to Calvin cycle



Jade plant



CAM is named after the family Crassulaceae,
Jade plant (*Crassula ovata*) family



Corn



Corn (*Zea mays*) is the C_4 plant which minimizes photorespiration at higher temperatures



Why to know photosynthesis?

[http://www.nature.com/nature/journal/vaop/ncurrent/
full/nature13776.html](http://www.nature.com/nature/journal/vaop/ncurrent/full/nature13776.html)

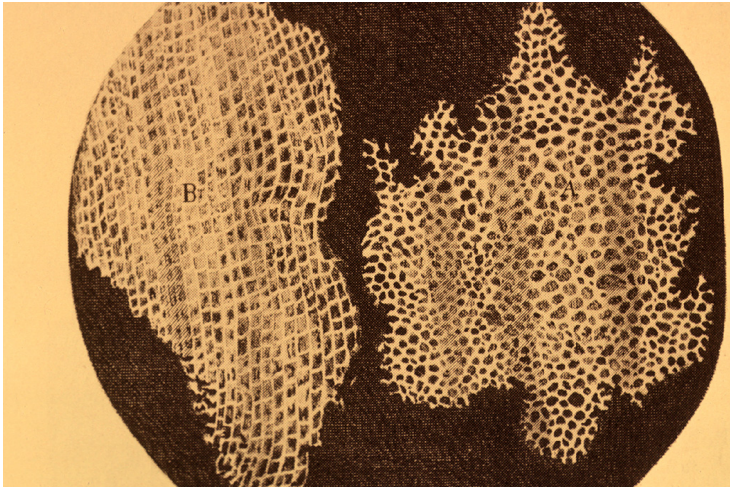


Plant cell

Discovery of cell



Discovery of cells



In 1665, Robert Hooke looked at cork tissue under microscope and found “little boxes or cells distinct from one another ... that perfectly enclosed air”



Hooke's microscope

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



National Library of Medicine



Cell theory

- 1 All plants and animals are composed of cells (1839, Matthias Schleiden and Theodor Schwann)
- 2 Cell is most basic unit (atom) of life (1839, Matthias Schleiden and Theodor Schwann)
- 3 All cells arise by reproduction from previous cells (1858, Rudolf Virchow)



Microscopes

Light microscopy was an early technological breakthrough that contributed to our understanding of cell structure. Dissectiscopes use reflected light, microscopes use translucent light. Magnification is of 10^3 order.

Transmission electron microscopy (TEM) allows us to see the internal organization of cells and organelles. Use translucent electronic “light” (electronic beam) which kills objects. Objects are often stained with osmium (Os). Magnification if of 10^7 order.

Scanning electron microscopy (SEM) provides an image of the surface of cells and organisms. Use reflected electronic “light” (electronic beam). Objects are covered with thin layer of gold (Au). Magnification if of 10^6 order.

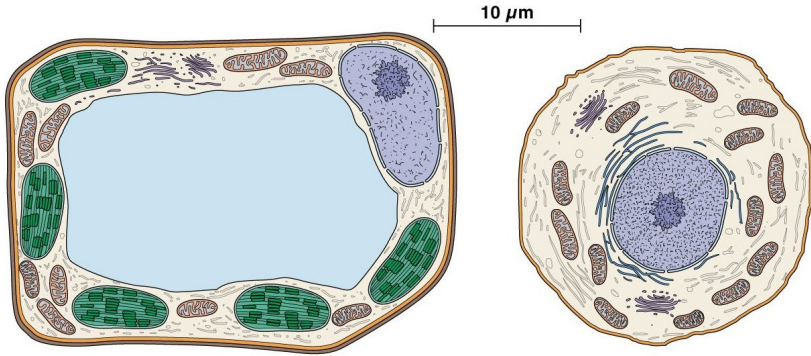


Plant cell

Structure of cell



Cells and cells



Eukaryotic and prokaryotic cells are fundamentally different

Cells



Summary

- C₄ and CAM plants accumulate and then release carbon dioxide and therefore increase its concentration



For Further Reading



A. Shipunov.

Introduction to Botany [Electronic resource].

2015.

Mode of access:

http://ashipunov.info/shipunov/school/biol_154

