

# Introduction to Botany. Lecture 24

Alexey Shipunov

Minot State University

October 24, 2012



# Outline

- 1 Questions and answers
- 2 Minerals
  - Primary and micro- elements
  - Soils
- 3 Transport of organic compounds
  - Phloem transport
- 4 Mitosis and meiosis
  - Mitosis



# Outline

- 1 Questions and answers
- 2 Minerals
  - Primary and micro- elements
  - Soils
- 3 Transport of organic compounds
  - Phloem transport
- 4 Mitosis and meiosis
  - Mitosis



# Outline

- 1 Questions and answers
- 2 Minerals
  - Primary and micro- elements
  - Soils
- 3 Transport of organic compounds
  - Phloem transport
- 4 Mitosis and meiosis
  - Mitosis



# Outline

- 1 Questions and answers
- 2 Minerals
  - Primary and micro- elements
  - Soils
- 3 Transport of organic compounds
  - Phloem transport
- 4 Mitosis and meiosis
  - Mitosis



## Previous final question: the answer

What is guttation?



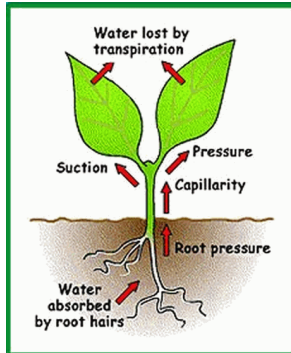
## Previous final question: the answer

What is guttation?

- Consequence of high root pressure and low transpiration potential



## Four main forces of water flow



- (1) **osmosis** in root hairs, (2) **root pressure** in endoderm, (3) **capillarity** in vessels or tracheids and (4) **transpiration** in leaves



# Minerals

## Primary and micro- elements



# Primary (biogenic) elements and microelements

- Main three biogenic elements: carbon (C), hydrogen (H), oxygen (O): used as gases
- Slightly less important are nitrogen (N) and phosphorus (P) which are usually taken as anions:  $\text{NH}_4^+$  or  $\text{NO}_3^-$  and  $\text{HPO}_4^{2-}$
- Potassium (K), calcium (Ca), magnesium (Mg): used as cations, namely  $\text{K}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$
- Iron (Fe), sulfur (S): also used as ions, but in less amounts, typically as  $\text{Fe}^{3+}$  and  $\text{SO}_4^{2-}$
- Microelements: manganese (Mn), boron (B), molybdenum (Mo), copper (Cu), zinc (Zn) and chlorine (Cl)



# Roles of some biogenic elements and microelements

**Table 11.1 Roles of Mineral Elements in Plants**

Element	Primary Roles
Potassium (K)	Osmotic solute, activation of some enzymes
Nitrogen (N)	Structure of amino acids and nucleic acid bases
Phosphorus (P)	Structure of phospholipids, nucleic acids, adenosine triphosphate
Sulfur (S)	Structure of some amino acids
Calcium (Ca)	Structure of cell walls, transmission of developmental signals
Magnesium (Mg)	Structure of chlorophyll, activation of some enzymes
Iron (Fe)	Structure of heme in respiratory, photosynthetic enzymes
Manganese (Mn)	Activation of photosynthetic enzyme
Chloride (Cl)	Activation of photosynthetic enzyme, osmotic solute
Boron (B), cobalt (Co), copper (Cu), zinc (Zn)	Activation of some enzymes



# Nitrogen fixation

- Plants cannot take  $N_2$  from air: it is an exceedingly stable molecule.
- However, some soil bacteria (nitrogen-fixing bacteria mostly from *Rhizobium* genus) can do that, they convert  $N_2$  to ammonia ( $NH_4^+$ )
- Legume plants (Leguminosae, or Fabaceae), alders (*Alnus*) and members of silverberry family (like buffaloberry, *Schepherdia*) have root nodules inhabited with nitrogen-fixing bacteria.



# Minerals

## Soils



# Soil types

- Every soil have (1) granular part like sand, (2) clay part (microscopic particles) and (3) humus part (decayed organic matter)
- The most important capacities of different soil types are: water-holding, aeration, pH (acidity), salinity/toxicity and biota
- Most soils have three layers (horizons): (A) topsoil, (B) subsoil and (C) parent material



# Horizons of soil



# Water flow through the soil

- Water moves through soil mostly via capillarity
- Compact, tough soil usually have high capillarity; loosen soil keeps water inside and do not transport it with capillarity





# Transport of organic compounds

## Phloem transport

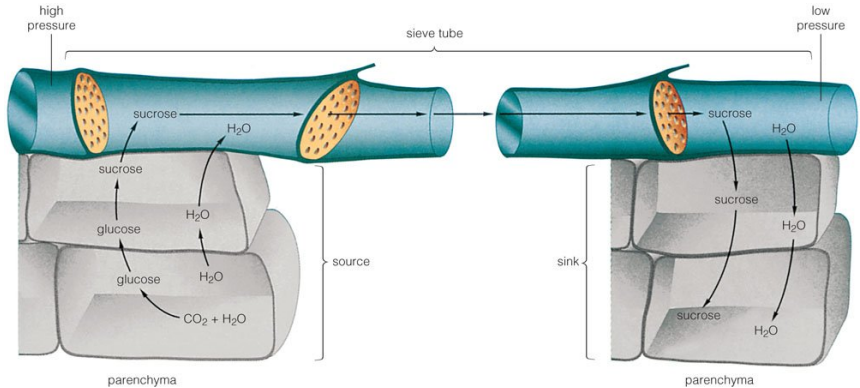


# Phloem osmotic pump

- Phloem transport is the result of osmotic pump from regions with higher concentration of sucrose to regions with lower concentration of sucrose
- Therefore, sucrose is transported only with water
- Phloem transport is purely symplastic
- As a consequence of above, phloem transport is usually much less directed than xylem transport



# Phloem pump



# Mitosis and meiosis

## Mitosis



# Definition of mitosis

- *Equal cell division, where each of daughter cells receives the same number of chromosomes as a mother cell*
- Chromosome formula:  $X \longrightarrow I + I$
- **The goal of mitosis** is the equal distribution of pre-synthesized DNA
- Mitosis does not change genotype of cells



# Mitosis, karyokinesis and cytokinesis

- Mitosis is the kind of karyokinesis
- Cytokinesis is a different process, the part of **cell cycle**

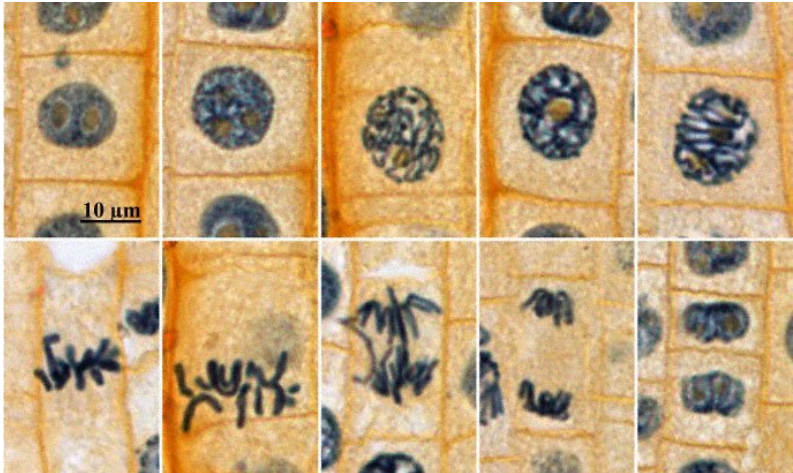


# Stages of mitosis

- Prophase
- Metaphase
- Anaphase
- Telophase

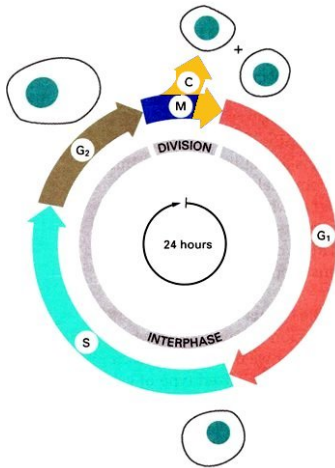


# Which stage?





# Cell cycle



- Interphase
  - Pre-synthetic stage (G<sub>1</sub>)
  - Synthetic stage (S): DNA duplicated
  - Post-synthetic stage (G<sub>2</sub>)
- Mitosis
- Cytokinesis

## Final question (2 points)



## Final question (2 points)

List names of cell cycle stages.



# Summary

- Biogenic elements (except three gases) and microelements are taken from the soil as ions
- Phloem transport is the result of **osmotic pump**
- **Mitosis** is a process of cell multiplication, **ploidy stays constant**, **genotype does not change**



## For Further Reading



J. E. Bidlack, Sh. H. Jansky.  
*Stern's introductory plant biology*. 12th edition.  
McGraw-Hill, 2011.  
*Chapters 9, 12.*



Th. L. Rost, M. G. Barbour, C. R. Stocking, T. M. Murphy.  
*Plant Biology*. 2nd edition.  
Thomson Brooks/Cole, 2006.  
*Chapters 11, 12 (skip the angiosperm life cycle!)*

