• Plant growth and development
• Plant resistance physiology
• Plant movements
Differences of plant and animal organisms

- Animals
- Plants

- Movement
- Nutrition
- Development
- Regeneration capacity
Differences of plant and animal organisms

- Animals
  - Movement (+)
  - Nutrition (-)
  - Development
  - Regeneration capacity

- Plants
Differences of plant and animal organisms

Animals

+ heterotrophic

Movement

Nutrition

Plants

- autotrophic

Development

Regeneration capacity
Differences of plant and animal organisms

**Animals**
- heterotrofs
- canalyzed development

**Plants**
- autotrofs
- plastic development

**Movement**
- 

**Nutrition**
- 

**Development**
- 

**Regeneration capacity**
Differences of plant and animal organisms

**Animals**
- Movement: +
- Nutrition: heterotrofs, canalyzed development, low
- Development: low
- Regeneration capacity: low

**Plants**
- Movement: -
- Nutrition: autotrofs, plastic development
- Development: high
- Regeneration capacity: high
Specific properties of plants

Plastic development
- high regeneration capacity
- low movement capacity

autotrophic nutrition

Photosynthesis

- cell totipotence
- Metameric structure
- Phenotypic plasticity

Phenotypic plasticity
**Cell totipotence**

**Totipotent cell** — cell that through division and differentiation can regenerate the whole organism or any of its cell types

Plant cells are totipotent or pluripotent
Non-differentiated cells can divide

Differentiated cells do not divide, they perform specific functions
Metamers

- leaf
- node
- internode
- bud

phytomer

- leaf
- node
- Axillary bud
**Meristem** — localized embryonic tissues that produce phytomers

- **Vegetative**
  - active (apex)
  - inactive (axillary buds)

- **Reproductive**

Shoot apical meristem
Clonal plants

Foto: Ģ. Ieviņš
Clonal plants
Clonal integration is adaptive in heterogeneous habitats, where sharing of resources can be beneficial to the plants (connected clones)
Phenotypic plasticity

Phenotypic plasticity
capacity of the organism to alter phenotype to get acclimated to the environment

Phenotypic plasticity

*Alyssum gmelinii*, Gmelina alise, dune forest edge

Foto: Ģ. Ieviņš
Phenotypic plasticity

*Alyssum gmelinii*, Gmelina alise, white dune

Foto: Ģ. Ieviņš
Phenotypic plasticity

*Alyssum gmelinii*, Gmelina alise, white dune

Foto: Ģ. Ieviņš
Phenotypic plasticity

*Alyssum gmelinii*, Gmelina alise

Foto: Ģ. Ieviņš
Phenotypic plasticity

*Honckenya peploides*, biezlapainā sālsvirza

Foto: Ģ. Ieviņš
Phenotypic plasticity

*Honckkenya peploides*, biezlapainā sālsvirza

Foto: Ģ. Ieviņš
Plant reaction to the environment

Sub-optimal conditions (physical, chemical factors)

Herbivores, pathogens

Signal perception

Signal recognition and transduction

Reaction
Plant reaction to the environment

**Abiotic stress:**
Sub-optimal conditions
(physical, chemical factors)

**Biotic stress**
Herbivores, pathogens, competition

**Active reactions:**
- Changes in metabolism
- Changes in development
- Protection

**Active reactions:**
- Synthesis of toxins and other protective substances
Example: freezing tolerance

When temperature lowers below 0 °C bulk water in the cells freezes and forms ice crystals.

Uncontrolled formation of crystals as a result of rapid decrease of temperature may lead to cell damage.

Plant reactions:

- Cell dehydration, minimizing bulk water
- Dehydrins protect macromolecules from damage

- «controlled» formation of crystals
  - synthesis of antifreeze proteins (lower temperature of ice formation and altered crystal shape)
  - ice crystals form in the apoplast
Example: freezing tolerance

Effect of antifreeze protein on ice crystal formation in rye

Ice crystals in distilled water

Ice crystals in non-acclimated plants

Ice crystals in acclimated plants

Stages of ice crystal formation in antifreeze protein solution

Griffith et al. 1992
Example: protection against herbivores

Plants are able to recognize specific damage caused by herbivores and induce active protective reactions.
Example: protection against herbivores

*Spodoptera exigua*  
Linolenic acid  
volicitin

*Zea mays*, *kukurūza*

*Microplitis croceipes*

Turlings et al. 2000
Example: protection against herbivores

Constitutive protection

Morphological adaptation (mechanic protection)
- reinforced cell walls
- cuticule
- spines, thorns

Physiological adaptation (chemical protection)
- toxin (nicotin)
- antinutrients (proteinase inhibitors)
- repellents

Induced protection

Direct

Indirect

volatiles that attract natural enemies of the herbivores (parasites etc)
Plant movements

Tropisms

direction of the movement depends on the direction of the stimulus that causes the movement

- phototropism
- geotropism
- tigmotropism
- hydrotropism
- chemotropism

Nastic movements

direction of the movement is independent of the direction of the stimulus

- nictinasty
- seismonasty
- hydronasty

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Nutation

autonomous movement caused by growth. Elliptic movement of the apex (tip of the plant)
Movement is a reaction to stimulus

Where and how is the stimulus perceived? When is the nature of the receptor?

What is the nature of the signal (or signal chain)?

What is the mechanism of the movement?
Phototropism: growth reaction to light

STEM: positive phototropism (growth towards light)

ROOT: usually negative phototropism (growth away from light)
Phototropism: growth reaction to light
Phototropism: growth reaction to light

Stimulus: light

Perception of stimulus: photoreceptors

Signal transduction: formation of auxin gradient

Signal transduction: expression of specific genes

Reaction: shaded side grows faster, the plant bends
Phototropism: growth reaction to light

Change of cell turgor as a mechanism of movement
Tigmotropism: reaction to touch

Plant has tendrils that bind around objects if the touch is perceived from the inner side.

Part of the reaction mechanism is volatile growth regulator methyljasmonate.
Seismonasty: reaction to touch

Mimosa pudica

• Stimulus is perceived by specialized cells sensitive to touch
• An electrical signal is generated and is translated to other cells
• Ion permeability of the cell plasma membrane is changed and results in change of turgor
• Cell size is changed and because of that — spatial orientation of the plant organ