



Univerza v Mariboru

Fakulteta za naravoslovje  
in matematiko

### UČNI NAČRT PREDMETA / COURSE SYLLABUS

**Predmet:** Odzivi rastlinske celice na okoljske dejavnike  
**Course title:** Plant cell responses to environmental impacts

| Študijski program in stopnja<br>Study programme and level | Študijska smer<br>Study field | Letnik<br>Academic year  | Semester<br>Semester                            |
|---|-------------------------------|--------------------------|---|
| Univerzitetni študijski program<br>Biologija, 1. stopnja  |                               | 2. ali 3.; 2nd<br>or 3rd | 3., 4. 5. ali<br>6.;<br>3rd, 4th, 5th<br>or 6th |
| Undergraduate university<br>programme Biology, 1st degree |                               |                          |   |

**Vrsta predmeta / Course type**

Izbirni/Elective

**Univerzitetna koda predmeta / University course code:**

| Predavanja<br>Lectures | Seminar<br>Seminar | Vaje<br>Tutorial | Lab. vaje<br>Laboratory work | Terenske vaje<br>Field work | Samost. delo<br>Individ. work | ECTS |
|------------------------|--------------------|------------------|------------------------------|-----------------------------|-------------------------------|------|
| 30                     |                    |                  | 15                           |                             | 135                           | 6    |

**Nosilec predmeta / Lecturer:**

Andreja URBANEK KRAJNC, Saška LIPOVŠEK

**Jeziki / Predavanja / Lectures:** slovenski / slovene  
**Languages: Vaje / Tutorial:** slovenski / slovene

**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

/

**Prerequisites:**

/

**Vsebina:**

**Uvodno predavanje** (Zakaj proučujemo rastline, zgodovina in temelji mikroskopije)

**Vpliv okoljskih dejavnikov na rastlinsko celico, celične tipe in celične kompartmente**

Spremembe v strukturi celičnih organelov, spremembe v permeabilnosti membran, spremembe v vsebnosti snovi, aktivnosti encimov, celična smrt.

**Content (Syllabus outline):**

**Introduction** (Why study plants, history and the basic principles of microscopy)

**The environmental impacts on plant cell, cell types and cell compartments**

substructural changes of cell organelles, changes in membrane permeability, alterations in chemical compounds, enzyme activity and metabolism, cell death.

### Celična stena:

Kemijska zgradba, rast v dolžino in vloga citoskeletnih elementov, plazmodezme-zgradba in funkcija v patosistemih, obramba pred patogeni in škodljivci

### Vakuola:

Zgradba, funkcija, biogeneza, transport skozi tonoplast (membranski proteini, glutationska črpalka), vakuola kot založni in litični kompartment, strukturna vloga, turgorska gibanja, vektorska sinteza sladkorjev, vpliv nizkih temperatur (»low temperature sweetening«), solni stres, težke kovine in privzem v vakuolo, vakuola v obrambi pred patogeni in škodljivci (sekundarni metaboliti, hitinaza, mehanizmi preprečevanja avtotoksicitete)

### Plastidi:

Zgradba, tipi plastidov, biogeneza, evolucija plastidov, plastidno dedovanje, import proteinov, signalna transdukcija, vpliv biotskih in abiotskih dejavnikov na ultrastrukturo plastidov (sušni stres, abscizinska kislina-princip ionske kletke, radiacijski stres, biotski stres).

### Mitochondriji:

Zgradba, evolucija mitohondrijev, mitohondrijsko dedovanje, vpliv biotskih in abiotskih dejavnikov na ultrastrukturo mitohondrijev (vročinski stres in hsp-proteini, radiacijski stres, sušni stres, hipoxia)

**Sinteza in vloga antioksidantov v celičnih organelih in odpravljanje reaktivnih kisikovih vrst**(askorbatno-glutationska veriga, ksantofilni cikel, tokoferoli)

**Programirana celična smrt pri rastlinah** (kategorije celične smrti v rastlinah)

**Povzetek** stresnih dejavnikov na nivoju celice (sušni stres, radiacijski stres, vpliv visokih in nizkih temperatur, solni stres, hipoksija-anoksija, zračni polutanti, biotski stres)

### Cell wall:

Chemical structure and plant cell wall growth, the significance of cytoskeleton, plasmodesmata-structure and function in different patosystems, the significance of cell wall in defense against pathogens and pests

### Vacuole:

Structure and function, biogenesis, transport through tonoplast (membrane proteins, glutathione pump), vacuole as a storage and lytic organelle, structural function, turgor movements, tonoplast sugar transport and vector synthesis, low temperature sweetening, salt stress, heavy metals detoxification, significance of vacuole in defense against pathogens and pests (secondary metabolites, hitinase, mechanisms of avoiding autotoxicity)

### Plastids:

Structure, different types of plastids, biogenesis, evolution, plastid inheritance, protein import, signal transduction, the impact of biotic and abiotic factors on plastid ultrastructure (drought stress, abscisic acid-principle of ion cage, radiation stress, biotic stress)

### Mitochondria:

Structure, evolution, mitochondrial inheritance, the impact of biotic and abiotic factors on mitochondria ultrastructure (heat shock proteins, radiation stress, drought stress, hipoxia)

**The antioxidant synthesis and their significance in cell organelles, reactive oxygen removal** (ascorbate-glutathione cycle, xanthophyll cycle, tocopherols)

**Programmed cell death in plants** (many ways to exit, cell death categories in plants)

**Summary:** abiotic and biotic stress factors at the cellular level (drought stress, radiation stress, high – low temperature stress, salt stress, hipoxia-anoxia, air pollutants, biotic stress)

**Laboratorijske vaje in mikroskopija**

določanje simptomov na nivoju celičnih organelov, celic in organov na podlagi TEM mikrografij,

določanje in lokaliziranje akumuliranih strupenih snovi v celicah,

standardizirani testi ugotavljanja genotoksičnosti (Allium-test, Tradescantia-test).

priprava vzorcev in fiksiranje preparatov,

izolacija protoplastov

tehnike barvanja preparatov v svetlobni mikroskopiji, fluorescenčna barvila, imunohistokemijske in imunocitokemijske metode, histokemična lokalizacija glutationa

**Laboratory work and microscopy**

symptom characterization of altered life functions within cell organelles (TEM micrographs)

determination and localization of accumulated toxic compounds in cells,

standardized genotoxicology tests (Allium-Test, Tradescantia-Test).

specimen preparation and fixation protocols

isolation of protoplasts

staining methods in light microscopy, fluorescent dyes, immunohistochemical and immunocytochemical methods, histochemical localization of glutathione

**Temeljni literatura in viri / Readings:**

ALBERTS B., JOHNSON A., LEWIS J., RAFF M., ROBERTS K., WALTER P., 2002. Molecular Biology of the Cell. 3<sup>th</sup>, edition, Garland Science, Taylor & Francis Group, New York.

Pollard T.D., Earnshaw W.C. 2008. Cell biology, Second edition, Saunders Elsevier, Philadelphia.

KLEINIG H., SITTE P., 1999. Zellbiologie. 4. Aufl., Gustav Fischer Verlag, Stuttgart.

Znanstvene revije:

The Plant Cell

Protoplasma

Plant Cell and Environment

Plant and Cell Physiology

Journal of Plant Biotechnology

Trends in Plant Science

**Cilji in kompetence:**

1. Predstavitev zgradbe rastlinske celice, kemične sestave in mehanizmi transporta snovi v celici.
2. Pregled vpliva okoljskih dejavnikov na celične tipe in celične kompartmente.
3. Ponazoritev mehanizmov sprejemanja dražljajev ter mehanizmov medceličnega in

**Objectives and competences:**

1. Introduction to the structure, chemical composition and transport mechanisms
2. Overview of the impacts of environmental factors on cell types and cell compartments.
3. Insights about the mechanisms of signal perception and mechanisms of inter- and intracellular sensing.

celičnega sporočanja.

4. Predstavitev nekaterih prilagoditev rastlinske celice na stresne dejavnike in predstavitev mehanizmov detoksifikacije.

5. Uporaba metod celične biologije na področju okoljskega monitoringa in ekotoksikologije.

4. Presentation of some adaptations to stress factors at the cellular level and mechanisms of detoxification.

5. Application of methods in environmental monitoring and ecotoxicology.

**Predvideni študijski rezultati:**

**Znanje in razumevanje:**

1. Razumevanje in prepoznavanje celičnih sprememb zaradi vpliva stresnih dejavnikov.
2. Osvojitev principov mikroskopije in osnovnih metod v rastlinski celični biologiji.
3. Poznavanje pomena celične biologije v okoljskem monitoringu in ekotoksikologiji.

**Prenesljive/ključne spretnosti in drugi atributi:**

1. Prepoznavanje vpliva okoljskih dejavnikov na strukturo in delovanje celic.
2. Sposobnost uporabe citoloških metod v okoljskem monitoringu in ekotoksikologiji.

**Intended learning outcomes:**

**Knowledge and understanding:**

1. Understanding and recognition of alterations within cells affected by stress factors.
2. Capturing principles of microscopy and basic methods in plant cell biology.
3. Throughout knowledge about the significance of cell biology in environmental monitoring and ecotoxicology.

**Transferable/Key Skills and other attributes:**

1. Identification of the impacts of environmental factors on the plant cell structure and function.
2. Ability for using cytological methods in ecological monitoring and ecotoxicology.

**Metode poučevanja in učenja:**

- predavanja z aplikativnimi primeri principov in metod celične biologije ob uporabi različnih AV sredstev,
- eksperimentalne vaje, priprava laboratorijskega poročila

**Learning and teaching methods:**

- lectures with special attention to principles and methods in cell biology by using audiovisual equipment,
- experimental work, laboratory report

Delež (v %) /

**Načini ocenjevanja:**

Weight (in %)

**Assessment:**

|                              |    |                     |
|------------------------------|----|---------------------|
| pisni izpit                  | 70 | written examination |
| poročilo laboratorijskih vaj | 30 | laboratory report   |

**Reference nosilca / Lecturer's references:**

NOVAK, Metka, URBANEK KRAJNC, Andreja, LAH, Ljerka, ZUPANEC, Neja, KRAŠEVEC, Nada,

KRIŽMAN, Mitja, BOHLMANN, Joerg, KOMEL, Radovan. Low-density *Ceratocystis polonica* inoculation of Norway spruce (*Picea abies*) triggers accumulation of monoterpenes with antifungal properties. *European journal of forest research (Print)*, ISSN 1612-4669, Jul. 2014, vol. 133, no. 4, str. 573-583, ilustr., doi: [10.1007/s10342-013-0772-4](https://doi.org/10.1007/s10342-013-0772-4).

URBANEK KRAJNC, Andreja, NOVAK, Metka, FELICIJAN, Mateja, KRAŠEVEC, Nada, LEŠNIK, Mario, ZUPANEC, Neja, KOMEL, Radovan. Antioxidative response patterns of Norway spruce bark to low-density *Ceratocystis polonica* inoculation. *Trees*, ISSN 0931-1890, 2014, vol. 28, iss. 4, str. 1145-1160, doi: [10.1007/s00468-014-1025-y](https://doi.org/10.1007/s00468-014-1025-y).

URBANEK KRAJNC, Andreja, TURINEK, Maja, IVANČIČ, Anton. Morphological and physiological changes during adventitious root formation as affected by auxin metabolism : stimulatory effect of auxin containing seaweed extract treatment. *Agricultura*, ISSN 1580-8432. [Print ed.], nov. 2013, vol. 10, no. 1/2, str. 17-27, ilustr. [COBISS.SI-ID [3641132](#)]

URBANEK KRAJNC, Andreja, KRISTL, Janja, IVANČIČ, Anton. Application of salicylic acid induces antioxidant defense responses in the phloem of *Picea abies* and inhibits colonization by *Ips typographus*. *Forest Ecology and Management*, ISSN 0378-1127. [Print ed.], 2011, letn. 261, št. 3, str. 416-426, doi: [10.1016/j.foreco.2010.10.027](https://doi.org/10.1016/j.foreco.2010.10.027). [COBISS.SI-ID [3066156](#)]

URBANEK KRAJNC, Andreja, ZECHMANN, Bernd, STABENTHEINER, Edith, MÜLLER, Maria. Artificial elevation of salicylic acid affects thiol contents in symptom development in *Cucurbita pepo* during Zucchini yellow mosaic virus (ZYMV) infection. *Phyton*, ISSN 0079-2047, 2008, letn. 48, št. 1, str. 13-35. [COBISS.SI-ID [2702380](#)]

MÜLLER, Maria, ZELNIG, Günther, URBANEK KRAJNC, Andreja, ZECHMANN, Bernd. Recent developments in methods intracellularly localizing glutathione within plant tissue and cells : (a minireview). *Phyton*, ISSN 0079-2047, 2005, letn. 45, št. 3, str. 45-55. [COBISS.SI-ID [2387244](#)],