



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 Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Univerzitetni študijski program Ekologija z naravovarstvom, 1. stopnja		2. ali 3.; 2nd or 3rd	3. ali 4. ali 5. ali 6. / 3. or or 4. or 5. or 6.
Undergraduate university programme Ecology with Nature Conservation, 1st degree			

Vrsta predmeta / Course type Izbirni/Elective

Univerzitetna koda predmeta / University course code:

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

Nosilec predmeta / Lecturer: Andreja URBANEK KRAJNC, Saška LIPOVŠEK

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
/	/

Vsebina:	Content (Syllabus outline):

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.

Celična stena:

Kemijska zgradba, rast v dolžino in vloga citoskeletnih elementov, plazmodezme-zgradba in funkcija v patosistemi, 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 avtotoksicite)

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 mitochondrijev, mitochondrijsko dedovanje, vpliv biotskih in abiotskih dejavnikov na ultrastrukturo mitochondrijev (vročinski stres in hsp-proteini, radiacijski stres, sušni stres, hipoxia)

Sinteza in vloga antioksidantov v celičnih

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.

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

organelih in odpravljanje reaktivnih kisikovih vrst(askorbatno-glutathionska 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)

Laboratorijske vaje in mikroskopija

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

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 glutathiona

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, hypoxia-anoxia, air pollutants, biotic stress)

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. 3th, 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 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.

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.
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:**Learning and teaching methods:**

• predavanja z aplikativnimi primeri principov in metod celične biologije ob uporabi različnih AV sredstev, • eksperimentalne vaje, priprava laboratorijskega poročila	• lectures with special attention to principles and methods in cell biology by using audiovisual equipment, • experimental work, laboratory report
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Delež (v %) / Weight (in %) Assessment:		
Načini ocenjevanja:		
pisni izpit	70	written examination
poročilo laboratorijskih vaj	30	laboratory report

Reference nosilca / Lecturer's references:

NOVAK, Metka, URBANEK KRAJNC, Andreja, LAH, Ljerka, ZUPANEK, 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, ZUPANEK, 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, ZELLNIG, 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](#)],