



ЦЕНТЪР ЗА ОБУЧЕНИЕ – БАН

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Basic Information:

Course Title: PHOTOSYNTHETIC MEMBRANES. APPROACHES FOR STRUCTURAL AND FUNCTIONAL ANALYSIS

Lecturer: Prof. Sashka Krumova, PhD

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Total Teaching Hours: 30 h

Annotation (up to 150 words)

The course is targeted towards PhD students interested in plant biophysics and physiology. More specifically the topics include structural organization of photosynthetic membranes, its role for the optimization of the photosynthetic processes and for plant adaptation to the environment. The basic methods for characterization of photosynthetic membranes in higher plants and cyanobacteria, in structural and functional aspects, will be reviewed.

Course content (brief description by topics or modules)

Topic / Module 1: Methods for characterization of the structural organization of photosynthetic membranes. Role of thylakoid stacking for the optimization of the photosynthetic process.

Topic / Module 2: Pigment –protein complexes and supercomplexes. Structure, macroorganization and role of lipids and protein subunits.

Topic / Module 3: Lipid polymorphism in photosynthetic membranes. Experimental approaches for its characterization and physiological role.

Topic / Module 4: Photoprotection mechanisms. Non-photochemical quenching of chlorophyll fluorescence. Xanthophyll cycle. Role of the light-harvesting complexes of photosystem I and II.

Teaching and assessment methods

Lectures and practical exercises (isolation of thylakoid membranes and membrane fragments, determination of chlorophyll concentration, absorption and fluorescence spectroscopy, circular dichroism)

Assessment – written exam and interview

Competencies acquired as a result of training (3–5 points)

Deep understanding of the structural organization of thylakoid membranes and mechanisms for photoprotection of the photosynthetic apparatus.

Gaining practical skills for thylakoid membranes preparation and manipulation.

Gaining skills for analysis of the structural macroorganization of thylakoid membranes.

Literature:

- Wojciech Wietrzynski et al., 2025 eLife. <https://doi.org/10.7554/eLife.105496.2>



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- Sakamoto W. Thylakostasis: key factors in thylakoid membrane organization with emphasis on biogenesis and remodeling proteins in vascular plants. *Plant Cell Physiol.* 2025 Nov 28;66(11):1602-1618. doi: 10.1093/pcp/pcf098. PMID: 40844042; PMCID: PMC12661324.
- Garab G, Böde K, Dlouhý O, Násztor Z, Karlický V, Dér A, Špunda V. Lipid polymorphism of plant thylakoid membranes. The dynamic exchange model - facts and hypotheses. *Physiol Plant.* 2025 Mar-Apr;177(2):e70230. doi: 10.1111/ppl.70230. PMID: 40251902; PMCID: PMC12008737.
- Zhukov A, Volkov V. The Photosynthetic Complexes of Thylakoid Membranes of Photoautotrophs and a Quartet of Their Polar Lipids. *Int J Mol Sci.* 2025 Oct 10;26(20):9869. doi: 10.3390/ijms26209869. PMID: 41155163; PMCID: PMC12562492.
- Latowski D, Kuczyńska P, Strzałka K. Xanthophyll cycle--a mechanism protecting plants against oxidative stress. *Redox Rep.* 2011;16(2):78-90. doi: 10.1179/174329211X13020951739938. PMID: 21722416; PMCID: PMC6837671.
- Chen B, Wang Y, Zhu Y, Li J, Wan L, Zhu C, Huang Q, Elhamid MAA, Soaud SA, Yan K, El-Sappah AH. Membrane stability under heat stress: molecular signaling, lipid remodeling, and defense mechanisms in plants. *Plant Cell Rep.* 2026 Jan 17;45(2):32. doi: 10.1007/s00299-026-03715-x. PMID: 41546693.
- Simkin AJ, Kapoor L, Doss CGP, Hofmann TA, Lawson T, Ramamoorthy S. The role of photosynthesis related pigments in light harvesting, photoprotection and enhancement of photosynthetic yield in planta. *Photosynth Res.* 2022 Apr;152(1):23-42. doi: 10.1007/s11120-021-00892-6. Epub 2022 Jan 22. PMID: 35064531.
- Jahns P, Bethmann S. Light-Regulation of Zeaxanthin Epoxidase in View of the Central Role of Zeaxanthin for Photoprotection. *Physiol Plant.* 2025 Nov-Dec;177(6):e70617. doi: 10.1111/ppl.70617. PMID: 41159758; PMCID: PMC12570779.
- Petrova N, Todinova S, Paunov M, Kovács L, Taneva S, Krumova S. Thylakoid membrane unstacking increases LHCII thermal stability and lipid phase fluidity. *J Bioenerg Biomembr.* 2018 Dec;50(6):425-435. doi: 10.1007/s10863-018-9783-7. Epub 2019 Jan 3. PMID: 30607760.
- PETROVA, N., PAUNOV, M., STOICHEV, S., TODINOVA, S., TANEVA, S.G., GOLTSEV, V., & KRUMOVA, S. (2020). Special issue in honour of Prof. Reto J. Strasser – Thylakoid membrane reorganization, induced by growth light intensity, affects the plants susceptibility to drought stress. *Photosynthetica*, 58(SPECIAL ISSUE), 369-378. doi: 10.32615/ps.2019.165

Additional information (optional) (e.g., special requirements, laboratory equipment, prior knowledge)