

Lectures in biochemistry and molecular biology 2016/2017

From molecule to cell

I. Integrative cellular physiology

1. *Cellular structure, signaling and function*

- **Structure and function of proteins (S. Piłkuła)**

D. Voet, J.G. Voet, Biochemistry. (3rd ed.) John Wiley & Sons 2003

R.K. Murray, Biochemia Harpera. PZWL, Warszawa 2005

E. Bańkowski, Biochemia. Podręcznik dla studentów uczelni medycznych. Wyd. II. Elsevier Urban & Partner, Wrocław 2009

J.M. Berg, J.L. Tymoczko, L. Stryer, Biochemia. PWN, Warszawa 2009

S. Doonan, Białka i peptydy. PWN, Warszawa 2009

- **Protein synthesis (M. Dziembowska)**

http://www.nobelprize.org/nobel_prizes/chemistry/laureates/2009/ramakrishnan-lecture.html

- **Posttranslational modifications of proteins and their functional significance (A. Filipek)**

Raghav A, Ahmad J. Glycated serum albumin: A potential disease marker and an intermediate index of diabetes control. Diabetes Metab Syndr. 2014 October - December;8(4):245-251. doi: 10.1016/j.dsx.2014.09.017. Epub 2014 Oct 11.

Wasik U, Filipek A. Non-nuclear function of sumoylated proteins. Biochim Biophys Acta. 2014 Dec;1843(12):2878-2885. doi: 10.1016/j.bbamcr.2014.07.018.

Cieśla J, Frączyk T, Rode W. Phosphorylation of basic amino acid residues in proteins: important but easily missed. Acta Biochim Pol. 2011;58(2):137-48. Epub 2011 May 27. Review.

Running MP. The role of lipid post-translational modification in plant developmental processes. Front Plant Sci. 2014 Feb 18;5:50. doi: 10.3389/fpls.2014.00050. eCollection 2014.

Callis J. The ubiquitination machinery of the ubiquitin system. Arabidopsis Book. 2014 Oct 6;12:e0174. doi: 10.1199/tab.0174. eCollection 2014.

- **Structure and function of cellular membranes (K. Kwiatkowska)**

Molecular Biology of the Cell, Alberts i wsp. Garland Press.

- **Exocytic pathways in eukaryotic cells (T. Prószyński)**

Basic readings:

1. Textbook: Molecular Biology of the Cell by A. Johnson, B. Alberts, D. Bray, J. Lewis, K. Roberts, and M. Raff

- Chapters dedicated to intracellular transport.
- Special focus should be on translocation of proteins into the ER, processing in the ER (including unfolded protein response), function of the Golgi apparatus, the diversity of endocytic pathways and the function of Rab proteins in the regulation of intracellular transport.

Additional readings:

“Rab proteins as membrane organizers” Marino Zerial & Heidi McBride Nature Reviews Molecular Cell Biology 2, 107-117 (February 2001)

“Membrane Fusion: Grappling with SNARE and SM Proteins” Suedhof and Rothman, Science (2009)

“Three ways to make a vesicle” Kirchhausen Nature reviews Molecular Cell Biology (2009)

“Sterol structure determines the separation of phases and the curvature of the liquid-ordered phase in model membranes” Bacía K1, Schwille P, Kurzchalia T. PNAS 102:3272-3277 (2005)

“Polarized sorting in epithelial cells: raft clustering and the biogenesis of the apical membrane” Schuck and Simons, J Cell Sci. Dec 1;117(Pt 25):5955-64 (2004)

- **Endocytosis (M. Miączyńska)**

Mechanisms of endocytosis. Doherty GJ, McMahon HT. *Annu Rev Biochem.* 2009;78:857-902. Review. PMID: 19317650

The endocytic matrix. Scita G, Di Fiore PP. *Nature.* 2010; 463:464-73. Review. PMID: 20110990

- **Transport through biological membranes (K. Nałęcz)**

Nigam, S.K. (2015) What do drug transporters really do? *Nat Rev Drug Discov* 14, 29-44

Lin, L., Yee, S.W., Kim, R.B., and Giacomini, K.M. (2015) SLC transporters as therapeutic targets: Emerging opportunities, *Nat Rev Drug Discov* 14, 543-560

Broer, S. (2014) The SLC38 family of sodium-amino acid co-transporters. *Pflug Arch Eur J Phys* 466, 155-172

Greuer, C., Gameiro, A., and Rauen, T. (2014) SLC1 glutamate transporters. *Pflug Arch Eur J Phys* 466, 3-24

Hediger, M. A., Romero, M. F., Peng, J. B., Rolfs, A., Takanao, H., and Bruford, E. A. (2004) The ABCs of solute carriers: physiological, pathological and therapeutic implications of human membrane transport proteins. *Introduction. Pflug Arch Eur J Phys* 447, 465-468

Jensen, A. A., Fahlke, C., Bjorn-Yoshimoto, W. E., and Bunch, L. (2014) Excitatory amino acid transporters: recent insights into molecular mechanisms, novel modes of modulation and new therapeutic possibilities. *Curr Opin Pharmacol*

Magier, Z., and Jarzyna, R. (2013) [The role of glucose transporters in human metabolic regulation]. *Postepy Biochemii* 59, 70-82

Mueckler, M., and Thorens, B. (2013) The SLC2 (GLUT) family of membrane transporters. *Mol Aspects Med* 34, 121-138

Palmieri, F. (2014) Mitochondrial transporters of the SLC25 family and associated diseases: a review. *J Inherit Metab Dis* 37, 565-575

Rudnick, G., Kramer, R., Blakely, R. D., Murphy, D. L., and Verrey, F. (2014) The SLC6 transporters: perspectives on structure, functions, regulation, and models for transporter dysfunction. *Pflug Arch Eur J Phys* 466, 25-42

Zhorov, B. S., and Tikhonov, D. B. (2004) Potassium, sodium, calcium and glutamate-gated channels: pore architecture and ligand action. *J Neurochem* 88, 782-799

- **Mitochondrial ion channels - from structure to function (A. Szewczyk)**

- **Bioenergetics (K. Zabłocki)**

Nicholls D.G. & Ferguson S.J. (2013) *Bioenergetics 4*; Imprint: Academic Press, eBook ISBN : 9780123884312
Print Book ISBN : 9780123884251; Pages: 440 The most well-known text on the chemiosmotic theory and membrane bioenergetics available.

any modern textbook of biochemistry

- **Principles of intracellular calcium signaling (K. Zabłocki)**

Berridge MJ, Lipp P, Bootman MD. (2000) The versatility and universality of calcium signaling. *Nat Rev Mol Cell Biol.* 1: 11-21.

La Rovere RM, Roest G, Bultynck G, Parys JB .(2016) Intracellular Ca²⁺ signaling and Ca²⁺ microdomains in the control of cell survival, apoptosis and autophagy. *Cell Calcium* 60:74-87.

Prakriya M, Lewis RS.(2015) Store-Operated Calcium Channels. *Physiol Rev.* 95:1383-436.

- **Microtubules and microtubule-based structures (D. Włoga)**

Molecular Biology of the Cell pod redakcją B. Albertsa, wydanie 2014, Chapter: Cytoskeleton

- **Molecular mechanisms of cell motility - molecular motors (A. Kasprzak)**

Batters C, Veigel C, Homsher E & Sellers JR, *Front Physiol* 2014, 5:90. To understand muscle you must take it apart. doi: <http://dx.doi.org/10.3389/fphys.2014.00090>

Wang W, Cao L, Wang C, Gigant B, Knossow M, *Protein Sci.* 2015 Jul;24(7):1047-56. Kinesin, 30 years later: Recent insights from structural studies; doi: <http://dx.doi.org/10.1002/pro.2697>

Bhabha G, Johnson GT, Schroeder CM, Vale RD, *Trends Biochem Sci.* 2016 Jan;41(1):94-105, How Dynein Moves Along Microtubules. doi: <http://dx.doi.org/10.1016/j.tibs.2015.11.004>

"*Molecular Biology of the Cell*" textbook by B Alberts, A Johnson, J Lewis, M Raff , K Roberts, P Walter, Chapter 16, The Cytoskeleton, Garland 5th or 6th Edition.

- **Mechanisms of cellular migration (J. Rędownicz)**

2. Cell cycle and cell fate

- **Cellular senescence - the mechanism and the role in organismal aging and age-related diseases (G. Mosieniak)**
- **Autophagy and cell death - molecular mechanisms and function (I. Ciechomska)**
- **Molecular mechanisms of cancerogenesis - the current view (K. Piwocka)**

Exam February 8, 2017

Break

II. Genetic information

- **Nuclear organization of the genome - from structure to function (G. Wilczyński)**
- **Regulatory mechanisms of transcription (B. Kamińska)**
- **Transcriptional factors (T. Wilanowski)**

1. Eukaryotic Transcription Factors (fifth edition), David S. Latchman, Academic Press 2007, ISBN: 978-0-12-373983-4.

2. A Handbook of Transcription Factors, Timothy R. Hughes, Springer Science+Business Media B.V. 2011, ISBN: 978-90-481-9068-3 (print) 978-90-481-9069-0 (online)

- **Epigenetic mechanisms of regulation of gene expression (B. Kamińska)**
- **DNA methylation in control of gene expression (W. Leśniak)**

De Carvalho DD, You JS, Jones PA. DNA methylation and cellular reprogramming. Trends Cell Biol. 2010 Oct;20(10):609-17. doi: 10.1016/j.tcb.2010.08.003. Epub 2010 Aug 31. Review.

Jones PA. Functions of DNA methylation: islands, start sites, gene bodies and beyond. Nat Rev Genet. 2012 May 29;13(7):484-92. doi: 10.1038/nrg3230. Review.

Pfeifer GP, Kadam S, Jin SG. 5-hydroxymethylcytosine and its potential roles in development and cancer. Epigenetics Chromatin. 2013 May 1;6(1):10. doi: 10.1186/1756-8935-6-10.

III. From cell signaling to the system

- **Determinants of aging and longevity (E. Sikora)**
- **Cellular stress response - the role in physiology and disease (K. Piwocka)**
- **Dysfunction of mitochondria and their effects for the cell (J. Szczepanowska)**

Burté F, Carelli V, Chinnery PF, Yu-Wai-Man P. Disturbed mitochondrial dynamics and neurodegenerative disorders. Nat Rev Neurol. 2015 Jan;11(1):11-24.

Roy M, Reddy PH, Iijima M, Sesaki H. Mitochondrial division and fusion in metabolism. Curr Opin Cell Biol. 2015; 33:111-8.

IV. Methods in cell biology, tissue engineering

- **Imaging of structures and processes in cells and tissues (G. Wilczyński)**
- **Imaging of cellular signaling (T. Bernaś)**
- **Induced pluripotent stem cells and tissue engineering (U. Wojda)**

Kathrin Plath, William E. Lowry. Progress in understanding reprogramming to the induced pluripotent state. *Nat Rev Genet.* 2011 April ; 12(4): 253–265.

Urszula Wojda, Jacek Kuznicki. Alzheimer's Disease Modeling: Ups, Downs, and Perspectives for Human Induced Pluripotent Stem Cells. *Journal of Alzheimer's Disease* 34 (2013) 563–588

- **Genetic modifications of rodents (A. Klejman)**

Gene transfer strategies in animal transgenesis. Montoliu L. *Cloning Stem Cells.* 2002;4(1):39-46. Review. One-step generation of mice carrying reporter and conditional alleles by CRISPR/Cas mediated genome engineering

Hui Yang,1,4 Haoyi Wang,1,4 Chikdu S. Shivalila,1,2,4 Albert W. Cheng,1,3 Linyu Shi,1 and Rudolf Jaenisch1,3,5 *Cell.* 2013 Sep 12; 154(6): 1370–1379.

Methods for gene transfer to the central nervous system. Kantor B1, Bailey RM2, Wimberly K2, Kalburgi SN2, Gray SJ3. *Adv Genet.* 2014;87:125-97.

- **Inducible gene expression in transgenic animals (W. Konopka)**
- **Regulatory genomics/bioinformatics (M. Dąbrowski)**

Dabrowski M, Dojer N, Zawadzka M, Mieczkowski J, Kaminska B. Comparative analysis of cis-regulation following stroke and seizures in subspaces of conserved eigensystems. *BMC Syst Biol.* 2010 Jun 17;4:86. doi: 10.1186/1752-0509-4-86. PubMed PMID: 20565733; PubMed Central PMCID: PMC2902439.

Pique-Regi R, Degner JF, Pai AA, Gaffney DJ, Gilad Y, Pritchard JK. Accurate inference of transcription factor binding from DNA sequence and chromatin accessibility data. *Genome Res.* 2011 Mar;21(3):447-55. doi: 10.1101/gr.112623.110. Epub 2010 Nov 24. PubMed PMID: 21106904; PubMed Central PMCID: PMC3044858.

Wilczynski B, Liu YH, Yeo ZX, Furlong EE. Predicting spatial and temporal gene expression using an integrative model of transcription factor occupancy and chromatin state. *PLoS Comput Biol.* 2012;8(12):e1002798. doi:10.1371/journal.pcbi.1002798. Epub 2012 Dec 6. PubMed PMID: 23236268; PubMed Central PMCID: PMC3516547.