Title of module	**IV Stem Cell Biochemistry**
Module coordinator	**Prof. Dr. Thomas Günther-Pomorski**

Credit points	5	**Semester(s) in which the module is taught**	2
Contact hours	3	**Workload**	150 hours

Lecturer(s)	Brand-Saberi, Günther-Pomorski, Neumann
Type of teaching	Lecture (2 hours per week) Seminar (1 hour per week) Discussions in context with lectures and seminar; lecturers ask for feedback regarding understanding and progress; Skills for efficient research interactions will be trained during the seminars which will be taught in a compact course organized as a mini-symposium organized by the students themselves.
Relation to curriculum	Compulsory; For master students of Biology/Biotechnology and Biochemistry of RUB, this module is suitable as an elective lecture.
Recommended prerequisites	No prerequisites from curriculum; Students taking this module will be expected to have a basic understanding of cell biology.
Aims	The module “Stem Cell Biochemistry” provides a molecular, cytological and developmental basis by which students will acquire a molecular insight into the signalling processes in development and disease.
Learning outcome	Students are familiar with the components and processes of important signaling pathways that play a role in development, Cancer, tissue maintenance and regeneration, fibrosis etc. They can outline the molecular background underlying differentiation control versus stem cell self-maintenance, including cell-to cell and ECM-to-cell signaling cascades. Skills: Students have understood and are able to explain basic signalling processes in context of development and disease. They can summarize and interpret dysregulated signalling processes in context of stem cells, development and disease. They can relate novel primary literature to textbook knowledge. Students can interpret basic and advanced problems in stem cell biology and relate morphological data. Competencies: Students can predict the outcome of interfering with common signalling processes. They are competent to integrate and evaluate relevant stem cell-related textbook knowledge and research data at the morphological, developmental and molecular level. They can design and adequately present advanced level Power-Point based talks, relate them to background knowledge and critically discuss new data. They are capable of communicating in a scientific context in front of an international audience.
Contents of module	Biochemistry of signaling pathways: - Signal transduction pathways: protein kinaseA as a paradigm for molecular mechanisms of action; structure–function relationships of the kinase superfamily - receptor protein tyrosine kinases and their signaling mechanisms: subclasses: insulin-receptor, FGF-receptor, PDGF-receptor, intracellular signaling pathways: Ras-MAPkinase, PI3-kinase - non-receptor tyrosine kinases: structure-function relationship of src Kinase family - signal transduction for cellular survival and apoptosis: TNFalphaR , PI3Kinase:

	Bcl-2 protein family, Bcl-xL, Bak, -Serine-threonine receptor kinases: TGF-ß receptors - Phosphotyrosin -phosphatases: catalytic mechanism, PDZ-domains - Cytokine (class I to IV) receptors and signaling mechanism, class I: growth-hormone, erythropoietin. Janus kinases (JAKs), (STATs), IL-6 receptor-family. Concepts of gene-therapy, class II : interferon a, ß, g, class III: (Fas, TNFR1, p75NTR), signaling: TRAFs, TRADD, FAAD, RIP, death-domains, initiator- and effector-caspases (9,3,1) class IV: interleukin-1-receptor, IRAP - GPCRs: GTPase-cycle, G-proteins, transducin signaling as paradigm, calcium-dependent signaling, Ca/Calmodulin, arrestin Signaling pathways in Development and Disease: Study of pathways in 3D-stem cell-derived models (organoids, organ-on-chip) WNT pathway, SHH pathway, BMP pathway, Notch pathway, Autophagy, Stem cell niche; impact of mutations in patients.
Study and examination requirements; Forms of examination	Students performance during discussions and interactions in the context of the lectures and in the seminar with lecturers and fellow students; Presentations during the seminar. 2-hour end-of-term written exam. The assessment will be based on 9 questions in written form.
Literature	Boccaccio C, Comoglio PM. Invasive growth: a MET-driven genetic programme for cancer and stem cells. Nat Rev Cancer. 2006 Aug;6(8):637-45. doi: 10.1038/nrc1912. PMID: 16862193. Bodenstine, T. M., Chandler, G. S., Seftor, R. E., Seftor, E. A., & Hendrix, M. J. (2016). Plasticity underlies tumor progression: role of Nodal signaling. Cancer metastasis reviews, 35(1), 21–39. https://doi.org/10.1007/s10555-016-9605-5 Lv, Quanxia & Meng, Ziyuan & Yu, Yuanyuan & Jiang, Feng & Guan, Daogang & Liang, Chao & Zhou, Wayne & Lu, Aiping & Zhang, Ge. (2016). Molecular Mechanisms and Translational Therapies for Human Epidermal Receptor 2 Positive Breast Cancer. International Journal of Molecular Sciences. 17. 10.3390/ijms17122095. Nieto, M.A., 2002. The snail superfamily of zinc-finger transcription factors. Nat. Rev. Mol. Cel. Biol. 3, 155e166. Nieto MA, Huang RY, Jackson RA, Thiery JP. EMT: 2016. Cell. 2016 Jun 30;166(1):21-45. doi: 10.1016/j.cell.2016.06.028. PMID: 27368099. Singh DD , Lee HJ , Yadav DK, 2022. Clinical updates on tyrosine kinase inhibitors in HER2-positive breast cancer. Frontiers in Pharmacology 13. https://doi.org/10.3389/fphar.2022.1089066 Aman Y, Schmauck-Medina T, Hansen M, Morimoto RI, Simon AK, Bjedov I, Palikaras K, Simonsen A, Johansen T, Tavernarakis N, Rubinsztein DC, Partridge L, Kroemer G, Labbadia J, Fang EF. Autophagy in healthy aging and disease. Nat Aging. 2021 Aug;1(8):634-650. doi: 10.1038/s43587-021-00098-4. Epub 2021 Aug 12. PMID: 34901876; PMCID: PMC8659158. Dikic I, Elazar Z. Mechanism and medical implications of mammalian autophagy. Nat Rev Mol Cell Biol. 2018 Jun;19(6):349-364. doi: 10.1038/s41580-018-0003-4. PMID: 29618831. Developmental Biology, 9th edition 2010 Scott Gilbert, Sinauer Principles of Development, edition 2010 Lewis Wolpert Oxford University Press Embryology Keith Moore, Vidhya Persaud edition 2007 Elsevier Langman's Medical Embryology, 12th edition 2011 Thomas W. Sadler Lippincott, Williams & Wilkens D Voet/J. Voet:4th edition, Biochemistry, John Wiley