# COURSE UNIT DESCRIPTION - MOLECULAR CELL BIOLOGY

| Course unit title | Code |
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| **MOLECULAR CELL BIOLOGY** | |

| Lecturer(s) | Department(s) |
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| **Coordinator:** Prof. Vida KIRVELIENĖ<br>**Others:**<br>*Lectures and seminars:*<br>prof.dr.Vilmantė Borutaitė,<br>prof. dr. Jurgis Kadziauskas,<br>prof. dr. Artūras Meškauskas<br>*Laboratory work:* dr. Daiva Dabkevičienė, dr. Marija Ger, dr. Violeta Jonušienė, dr. Aušra Sasnauskienė, prof. dr. Kęstutis Sužiedėlis | Faculty of Natural Sciences, Department of Biochemistry and Molecular biology, Čiurlionio 21 LT 03101. |

| Mode of delivery | Period of delivered | Language(s) of instruction |
|---|---|---|
| Face to face | 1st semester, spring | Lithuanian |

| Mode of delivery | Period of delivered | Language(s) of instruction |
|---|---|---|
| Face to face | 1st semester, autumn | Lithuanian (English) |

| Prerequisites and corequisities | |
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| **Prerequisites:**<br>Biochemistry, genetics, molecular biology | **Corequisities (if any):** |

| Number of credits allocated to the course unit | Student's total workload | Contact hours | | Self-study and research hours |
|---|---|---|---|---|
| 9 | 240 | Lectures | 54 | 100 |
| | | Seminars | 20 | |
| | | Laboratory work | 66 | |

| Purpose of the course unit: programme competences to be developed | | |
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| • Deep understanding of structure function and states of prokaryotic and eukaryotic cells;<br>• Introductory ability to apply modern cell biology techniques;<br>• Ability for critical and systemic approach to research data. | | |
| **Learning outcomes of the course unit** | **Teaching and learning methods** | **Assessment methods** |
| After successful completion of this course a student should be able to: | | |
| • Describe the detailed arrangement of cell membranes as well as structure and functions of membrane proteins;<br>• Explain the biomolecular transport through cell plasma- and internal biomembranes. | Lectures, seminars, self-study | Midterm exam |
| • Desribe the detailed structure of ribosomes and dynamic changes consistent with the phase of protein biosynthesis;<br>• Explain the dynamic interactions between rRNA and proteins in ribosomes;<br>• Explain methods and techniques used for research of ribosomes. | Lectures, self-study | Midterm exam |
| • Analyse the contradictory data on the structure of mitochondria;<br>• Give a comprehensive explanation of the functioning and biogenesis of mitochondria. | Lectures, seminars, self-study | Midterm exam |
| • Compare lysosomes to other membranous cell | Lectures, seminars, self-study | Exam |

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| organelles with emphasis on biogenesis, maturation, and internal medium;<br>• Describe the role of lysosomes in cell death<br>• Compare the molecular networks of autophagy, apoptosis, cornification, pyroptosis and other modes of cell death;<br>• Foresee the mode of cell response to different types of stress. | | |
| • Cultivate mammalian cells and perform viability tests;<br>• Carry out experiments on frog eggs;<br>• Perform the microscopy imaging of cells, cell nucleus, mitochondria, lysosomes, Golgi apparatus;<br>• Prepare samples for mass-spectroscopy experiments and deal with proteomic data;<br>• Perform immunofluorescence and PCR experiments and calculations based on the data obtained;<br>• Make a choice of appropriate technique for solving the experimental tasks of molecular cell biology;<br>• Prepare and present laboratory work report in the form of a research article. | Lectures, laboratory works, self-study | Pass / Fail |

| **Content: breakdown of the topics** | **Contact hours** | | | | | | | **Self-study work: time and assignments** | |
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| | Lectures | Tutorials | Seminars | Exercises | Laboratory work | Internship/work placement | **Contact hours** | **Self-study hours** | **Assignments** |
| **I. Theory** | | | | | | | | | |
| **1. Biological membranes** | **16** | | **8** | | | | **24** | **32** | Textbook reading, analysis of selected research articles (Journal Club, JC) |
| Composition and structure of biomembranes | 4 | | 2 | | | | **6** | **4** | |
| Ions transport through channels and by transporters | 4 | | 2 | | | | **6** | **10** | |
| Active transport of cell substances | 4 | | 2 | | | | **6** | **10** | |
| Transport of proteins through biomembranes | 4 | | 2 | | | | **6** | **8** | |
| **2. Ribosomes and protein biosynthesis** | **16** | | | | | | **16** | **8** | Textbook reading |
| Ribosomes structure and functions | 4 | | | | | | **4** | **1** | |
| tRNA and aminoacyl-synthetases | 2 | | | | | | **2** | **2** | |
| rRNA and ribosomal proteins | 4 | | | | | | **4** | **2** | |
| Phases of protein biosynthesis / translation | 6 | | | | | | **6** | **3** | |
| **3.Mitochondria** | **8** | | **4** | | | | **12** | **8** | Reading and analysis of selected research articles (JC) |
| Structure of mitochondria and features of their membranes | 3 | | | | | | **3** | **3** | |
| Mitochondrial genom and biogenesis of mitochondria | 2 | | 2 | | | | **4** | **3** | |
| Transformations of mitochondria in aging and dying cells | 3 | | 2 | | | | **5** | **2** | |

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| **4.Lysosomes and their role in cell** | **3** | | **2** | | | | **5** | **12** | Textbook reading, analysis of a selected research article (JC) |
| **5.Mechanisms of cell death** | **5** | | **6** | | | | **11** | **15** | Reading and analysis of selected research articles (JC) |
| Random- and programmed-cell death. Autophagy | 2 | | 3 | | | | **5** | **5** | |
| Cornification, necroptosis, pyroptosis, entosis and other forms of cell death | 3 | | 3 | | | | **6** | **10** | |
| **II. Laboratory works** | **6** | | | | **26** | | **32** | **12** | Reading and analysis of principles of experimental techniques in e-course, preparation of laboratory works reports |
| 1. Global assessment of cell proteins by mass spectrometry | **2** | | | | **6** | | **8** | **4** | |
| 2. Imaging of cells and organelles (Fluorescence microscopy) | 4 | | | | 4 | | **8** | **3** | |
| 3. Cultivation of mammalian cells and assessment of viability | | | | | 8 | | **8** | **2** | |
| 4. Investigation of dynamics of protein localization by microinjection into single cell | | | | | 8 | | **8** | **3** | |
| **Assessment of cell response to stress** | | | | | **40** | | **40** | **13** | |
| 5. Evaluation of cell cycle and forms of cell death (Flow cytometry) | | | | | 8 | | **8** | **3** | |
| 6. Gene silencing with synthetic siRNA | | | | | 8 | | **8** | **2** | |
| 7. Evaluation of gene expression by qPCR | | | | | 8 | | **8** | **4** | |
| 8. Measurement of cytokine concentration by ELISA | | | | | 16 | | **16** | **4** | |
| **Total** | **54** | **20** | | | **66** | | **140** | **100** | |

| **Assessment strategy** | **Weight, %** | **Assessment period** | **Assessment criteria** |
|---|---|---|---|
| Laboratory work | Pass/ Fail | Every week | Understanding of theoretical background of experiments (short quiz at the beginning of laboratory session. Ability to get reliable results.<br>All laboratory works must be done, reports must be compiled and defended in one-to-one conversation with laboratory teacher.<br>In case of Fail, student must repeat the laboratory work |
| Journal Club | Pass/ Fail | | All research articles of Journal Club must be read, analyzed, and discussed in class. In case of absence at the discussion, the student must pass the written test in the end of the course (short answer questions) |
| Midterm exam | 33 | 5$^{th}$ week of the course | Two open answer questions on the 1$^{st}$ topic in written |
| Midterm exam | 33 | 9$^{th}$ week of the course | Multiple choice tasks on the 2$^{nd}$ topic |
| Midterm exam | 17 | 13$^{th}$ week of the course | Two open answer questions on the 3$^{rd}$ topic in written |
| Exam | 17 | Session | Short answer questions |

| **Author** | **Year of publica-tion** | **Title** | **Publishing place and house or web link** |
|---|---|---|---|
| **Compulsory reading** | | | |
| D. Dabkevičienė, V.Jonušienė, | 2011, kasmet | Applied cell and molecular biology, | Virtual learning environment of Vilnius university |

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|---|---|---|---|
| V.Kirvelienė, A. Sasnauskienė, K. Sužiedėlis | atnaujinama | e-course | http://vma.esec.vu.lt/ |
| Alberts, B., A. Johnson, J. Lewis, M. Raff, K. Roberts, and P. Walter | 2008 | Molecular Biology of the Cell, 5 ed. | New York: Garland Science |
| J. Kadziauskas | 2008 | Biological membranes (in Lithuanian) Teaching book (CD) | Kaunas: Technologija |
| R. I. Freshney | 2010 | Culture of animal cells. A manual of basic technique and specialized applications, 6 ed. | Wiley-Blackwell |
| **Optional reading** | | | |
| V.Kirvelienė and A.Sasnauskienė | 2008, kasmet atnaujinama | Cell Biology, e- course | Virtual learning environment of Vilnius university http://vma.esec.vu.lt/ |
| P.L.Yeagle, ed. | 2011 | The structure of biological membranes, 3rd ed. | CRS Press |
| J. Kadziauskas | 2008 | Fundamental of biochemistry (in Lithuanian) | Vilnius University Press |
| R. Westermeier, T. Naven, H.-R. Hoepker | 2008 | Proteomics in practice: A guide to successful experimental design, 2 ed., | Wiley-VCH |
| V. Kirvelienė | 2008 | Optical microscopy and digital imaging (in Lithuanian) | Kaunas: Technologija |
| J. Faber and P. D. Nieuwkoop, eds. | 1994 | Normal Table of *Xenopus laevis* (Daudin): A Systematical & Chronological Survey of the Development from the Fertilized Egg till the End of Metamorphosis, 2 ed. | New York: Garland Science |
| | | Cell culture protocols | Life sciences, Company www.invitrogen.com/site/us/en/home/References/gibco-cell-culture-basics/cell-culture-protocols.html |
| | 2009 | Techniques for immune function analysis. Application handbook | Becton Dickinson, Company www.bdbiosciences.com/eu/documents/Immune-Function-Application-Handbook-2ndEd.pdf |
| | 2011 | Power SYBR® Green PCR... User guide | Applied Biosystems, Company www3.appliedbiosystems.com/cms/groups/mcb_support/documents/generaldocuments/cms_042179.pdf |
| | | RNAi | Life sciences, Company www.invitrogen.com/site/us/en/home/Products-and-Services/Applications/RNAi-Epigenetics-and-Gene-Regulation/RNAi.html?CID=fl=rnai |