Biology Msc from 2018

Name of the specialisation:

Molecular Genetics, Cell- and Developmental Biology (MGCDB)

OVERVIEW OF THE FIELD

How does a single fertilized cell become a complex organism, and how the regulatory mechanisms ensure that although a liver cell and a neuron contain the same genetic material, yet they look and behave quite differently in the same organism? As the legendary British developmental biologist, Lewis Wolpert stated: "It is not birth, marriage or death, but gastrulation, which is truly the most important time in your life." The subjects that give the backbone for our specialisation will help our students to understand how gastrulation and other developmental processes are being regulated on the level of the organism, of the tissues and of the cells.

In this spirit, our specialisation mixes the knowledge of classical genetics and cell biology with new insights from the emerging fields of genomics, molecular and synthetic biology. During the last decade both genetics and cell- and developmental biology has entered an era of quantification and "big data", as shown by the exponential growth in genomic databases, and the proliferation of sophisticated high-throughput microscopy techniques. Dealing with these datasets requires specific knowledge about novel bioinformatical and statistical methods and we prepare future researchers for this challenge.

TEACHING CONTENT

The course list of the MGCDB speciation provides strong theoretical and experimental background for all the students interested in molecular cell biology and developmental genetics. Main topics within the specialization:

Developmental Genetics: The outcome of the developmental process is determined by complex gene interaction networks that have been the center of intense investigation for decades. To study the function of these genes earlier forward genetic approaches (based on classical mutagenesis) are being complemented with next generation gene silencing and genome editing (in other word reverse genetics) approaches. Students will learn the basic logic of a successful genetic screen, will perform experiments to study gene expression in whole embryos, and will test the effect of small molecule libraries on the development of embryos.

Immuncytochemistry: How can one find a protein within the cells? Can we determine its exact location? Students will perform a two-step protocol for fluorescent staining of fixed cultured cell lines. We will also show them how to prepare samples for electron microscopy, from embedding, through sectioning ultrathin slices, to staining.

Molecular Genetics Practical: The wide methodological repertoire of molecular genetics provides multiple tools to understand the function and regulation of any gene of interest. We can examine the consequences for the loss-of-function of the respective gene, or we can look what happens if it is activated at ectopic times and places in the developing body. During the practical the students will acquire the necessary knowledge to observe the expression of a gene, to knock down its function, and to observe the phenotypic consequences of such interventions.

Methods on Cell Biology: How can you tell looking at a fly larva, which genes are active? Students will learn about reporter-genes in the context of the developing *Drosophila* embryo. We also show them how one can detect the interaction between two proteins, with the help of yeast two-hybrid systems. Finally, the practical will reveal how cell organelles can be stained with non-florescent, vital dyes.

With the courses on offer, interested students could further deepen their knowledge on gene regulation, molecular evolution, RNA interference, stem cell biology, cell biology and bioinformatics.

RESEARCH PERSPECTIVES

The scientific interest of our researcher-instructors covers a wide range of subjects: from the regulation of gene expression, RNA interference (RNAi), and the molecular characterisation of factors important in recombination, autophagy (cellular self digestion), endocytosis and crinophagy, to the role of autophagy in ageing and stem cells, and to a wide range of population genetics studies. Several different model organisms are used in our research: besides fruit flies (*Drosophila*), worm (*C. elegans*), zebrafish, human cell lines, our collaborators in nearby academic facilities use cutting edge technologies in plant genetics as well. Our researchers are also interested in the coordinated regulation of cellular stress responses; the mechanism of sex-determination in *C. elegans*, revealing the targets of the Hox genes, master regulators of development.

TEACHERS AND RESEARCHERS

Department of Anatomy, Cell and Developmental Biology

Gábor Glatz

His main interest is the production and purification of recombinant proteins important for autophagy, using affinity-chromatography method. The goal of this research is to map the interactions of these proteins with their supposed interacting partners, and the determination of the molecular structure.

Gábor Juhász

The study of autophagy and other lysosomal degradation pathways is his main area of expertise. His research group is uncovering the molecular mechanism and regulation of these processes, using a combination of molecular genetic tools and biochemical methods in *Drosophila* and human cancer cell lines.

Péter Lőrincz

Studies the fusion of transport vesicles and lysosomes during endocytosis and autophagy in *Drosophila* fat cells and secretory cells (Garland cells), using a combination of modern light- and electron-microscopy methods.

Péter Lőw

His main interest is the study of genetic regulation and molecular mechanism behind crinophagy, the degradation of secretory granules in *Drosophila* salivary gland cells. In his work he combines cutting edge histochemistry with fluorescent- and electron-microscopy.

Department of Genetics

Eszter Ari

She studies evolution from a genomic and bioinformatics perspective. In collaboration with the Biological Research Centre of the Hungarian Academy of Sciences at Szeged, using a set of metagenomics tools she studies how antibiotic resistance appears and spreads in a bacterial population. She is also developing a functional enrichment analyser algorithm and R package. (This latter work is done in collaboration with the Earlham Institute at Norwich, UK.)

Balázs Egyed

In his research he looks at human SNP and microsatellite variability in extant and archeologic populations, but also to polymorphisms of the mitochondrial genome in human and animal populations. In more recent work he is interested in revealing the variability of mobile genetic elements in somatic tissue, and their use in forensic genetics.

Máté Varga

In collaboration with other groups at Semmelweis University, HAS-RCNS and ELTE Department of Biochemistry he is developing zebrafish models for monogenic human diseases. He is also interested in the role of epitranscriptomic marks in development and disease, and the emergence of dorsoventral polarity in the early embryo.

Tibor Vellai

His main interest is understanding the role of autophagy in development, tissue regeneration and the ageing of the central nervous system. Amongst several other projects, regulation of autophagy through myotubularin-type phosphatases and characterisation of small molecular (drug candidate) reagents in neurodegenerative disease models are just some examples from ongoing research in the Vellai lab.

CARRIER OPPORTUNITIES

Many of our students will pursue academic careers and will enrol to PhD programs at prestigious universities and academic research centres in Hungary and abroad. At the same time, the knowledge offered by our specialisation will equip our students for more applied type of research as well: from gene diagnostics to drug discovery, from forensics to research on stem cell therapies. Our graduates often become employees of multinational biotech companies (Richter, Teva, Tata).