

INSTITUTE OF AQUACULTURE AND ENVIRONMENTAL SAFETY

MATE

HUNGARIAN UNIVERSITY OF
AGRICULTURE AND LIFE SCIENCES





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Institute of Aquaculture
and Environmental Safety

Forewords

The Institute of Aquaculture and Environmental Safety of the Hungarian University of Agriculture and Life Sciences (MATE) is one of the largest organizational units of the University. The aquaculture and environmental safety education and research units in Gödöllő, Kaposvár and Keszthely came under the umbrella of the University on August 1, 2020. On February 1st, 2021, the NAIK Research Centre for Fisheries and Aquaculture (HAKI) joined this organization as well. Together, these units comprise the current Institute of Aquaculture and Environmental Safety.

By the objectives set out in the founding document of MATE, the Institute has the following tasks:

- » The development of innovative technologies in pond aquaculture and intensive fish farming with an environmental approach.
- » Improvement of traditional fish feeding methods combined with the development of complete fish feed.
- » Mapping the genetics and reproductive biology of existing and new commercial fishes using –omic’ techniques.
- » Development of sustainable and circular fish farming systems.
- » Defining ecological services in the sector (planning and management).
- » Establishing conditions for the production of fish for recreational fishing in natural waters.

- » Water quality and ecotoxicological monitoring of aquaculture water bodies.
- » Environmental safety analysis of surface and ground waters.

The Institute has an extensive educational portfolio across the entire range of higher education training (BSc, MSc, and PhD) and is active in the field of professional adult education (specialized in-service training). The existing research and development base of the institute provides a suitable background for examining all issues affecting the sector. This infrastructure provides an excellent opportunity to meet practical educational needs.

The R&D activity of the Institute is outstanding. In addition to basic research, we focus on applied (industrial) research that examines and solves real problems.

With innovations in professional consulting, education, research, and development, the Institute plays a major role in international professional networking. Further development of this aspect is one of our priority goals.

The Institute aims to effectively support the development of the fisheries-aquaculture-environmental safety sector by maintaining our existing for-profit and non-profit cooperative efforts while also involving new partners in order to better meet the educational, research, innovation, and consulting requirements of the sector.

Structure of the Institute

Institute Director: Balázs Kriszt, PhD associate professor

The Institute of Aquaculture and Environmental Safety operates at five sites, with six departments and one research centre organized as follows:

Departments operating at the Szent István Campus in Gödöllő:

- » Department of Aquaculture, head: Ákos Horváth, PhD professor, doctor of the Hungarian Academy of Sciences (HAS)
- » Department of Molecular Ecology, head: András Táncsics, PhD senior researcher
- » Department of Environmental Toxicology, head: István Szabó, PhD associate professor
- » Department of Environmental Safety, head: Edit Kaszab, PhD associate professor

Department operating at the Szent István Campus site in Agárd:

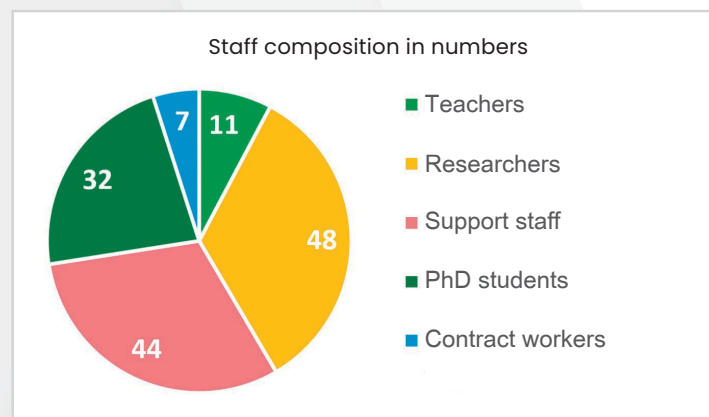
- » Department of Freshwater Fish Ecology, head: Árpád Ferincz, PhD senior researcher

Department at the Georgikon and Kaposvár Campuses:

- » Department of Applied Fish Biology, head: László Orbán, PhD scientific advisor

Organizational unit operating in Szarvas:

- » Research Centre for Fisheries and Aquaculture (formerly NAIK-HAKI), head: Béla Halasi-Kovács, PhD senior researcher



»» Educational activity

Our institute provides students with well-founded theoretical knowledge and up-to-date practical knowledge as they prepare their TDK, BSc or MSc theses in connection with the main focus areas of the institute. Some of the students who excel in their work are able to continue their scientific research through PhD training.

The institute places great emphasis on nurturing and developing the talents of its students. It provides support, encouragement and training to its students throughout the many stages of their education and research.

Currently offered degrees:

- » Environmental Agriculture Engineer MSc
- » Agricultural Water Management and Environmental Technology Engineer BSc
- » Fisheries and Aquaculture advanced training

In the future, we plan to launch new courses, such as a MSc in Aquaculture, MSc in Hydrobiology, and Ecotoxicology (together with other Institutes of MATE).

In addition to theoretical training, the infrastructure of the Institute is also suitable for the transfer of practical knowledge, which can be complemented by the study of operational processes in all regions of the country thanks to our close partnership with industry professionals.

Our target groups of students:

- » Those with a keen interest in aquaculture, angling, the environment and nature conservation,

- » Those interested in aquatic and other natural environment related knowledge,
- » Students with an undeveloped career vision – many of them are attracted by the youthful, dynamic approach of the Institute.

Main areas of employment for our graduates:

- » Various sectors of aquaculture,
- » Organisations active in environmental safety and toxicology,
- » Companies involved in animal husbandry, veterinary medicine and laboratory testing,
- » Nature conservation groups (e.g. National Park Directorates) and specialised government agencies.



»» Research activity

The priority areas of the Institute's research activities are related to aquaculture, fisheries, fisheries management, angling, environmental safety, environmental toxicology. In addition, the Institute provides Research & Development & Innovation advisory services, both nationally and internationally.

Main research focus:

- » Fish reproductive biology and fish propagation,
- » Fish genetics, biotechnology and molecular biology,
- » Extensive and intensive fish farming systems,
- » Environmental safety, applied environmental toxicology,
- » Fish feeding and farming technology,
- » Sustainable natural aquatic fish farming,
- » Molecular ecology, environmental microbiology.

The Institute has a strong international presence with outstanding networks both in the academic and industry sectors. Therefore, our research activities are strongly related to industry needs. Indeed, the Institute's mission is defined along these lines.

Our research mission, which defines our R&D&I strategy:

- » Innovative development of breeding technologies in aquaculture,
- » Improving traditional and modern feed technology,
- » Mapping the genetics and reproductive biology of existing and novel farmed fish using -omics techniques,



- » Development of sustainable and 'circular' fish farming systems,
- » Developing conditions for fish production for angling in natural waters,
- » Monitoring and controlling water quality and environmental toxicology in water bodies,
- » Environmental safety analysis of surface and groundwater,
- » Use of microorganisms for agricultural and environmental purposes,
- » Biodegradation and biodetoxification research using -omics methods.

Main research results of the Institute:

- » 341 publications (last 5 years)
- » 2175 citations (last 5 years)
- » 4 776 million HUF grant income (26.6% of total university grant volume)
- » 1 484 million HUF R&D&I and other services revenue

»» Department of Applied Fish Biology

Our department consists of two groups, one from Keszthely and one from Kaposvár. We are united by our common interests: to solve problems within the field of fish biology aquaculture by combining classic and modern methods. We also take part in the theoretical and practical training of agricultural engineers and conservation engineers. Our work is supported by the Leading Research Excellence, GINOP, MAHOP, and KDP.

Fishgenomics “Élvonal” Research Group (Keszthely)

This group was formed in 2018 to study genomic factors determining the sex of fish. Our work includes a decades-long, successful foreign program that could pave the way for hormone-free sex conversion in farmed fish. The focus of this research is on the process of sex change, using zebrafish as a model. In addition, molecular aspects of fish-fish pathogens and chemical-free therapeutic options are being studied.

Fish Farming Research Group (Keszthely)

The main goals of this practice-oriented group are the development of traditional, semi-intensive fishpond and combined technologies, the optimization of fish breeding and feeding, and the introduction of new productive species. Our work is mostly concentrated on native predatory fish species such as pike and pikeperch. In recent years, the group has also worked on catfish. In addition to the development of production technology, there is also a selection program utilizing genetic markers.

Fish Feeding Research Group (Kaposvár)

This research group continues the decades-long fisheries science and educational work of the University of Kaposvár. In the expansive laboratory, a large range of Hungarian fish farming methods can be researched. Currently, our research is mainly concentrated on fish feeding and husbandry technology. Great emphasis is also placed on the development of water-saving aquaculture systems and support for lake fish production processes.



»» Research Centre for Fisheries and Aquaculture (HAKI)

The HAKI as a research institute of the Hungarian aquaculture has a history of over 115 years. In 2021, the research centre became part of the MATE and is a part of the Institute of Aquaculture and Environmental Safety. The centre implements R&D programs in order to create a scientific basis for the sustainable increase of fish production and the development of sustainable fisheries management practices in natural waters. The research centre has several departments:

- » **Department of Fish Biology** conducts disciplinary research in the fields of nutrition, immunology, and fish genetics. Our priority research areas include (i) the use of natural (non-specific) immune response enhancers, immunostimulants in fish farming; (ii) the search for new feed materials and development of innovative nutritional formulas; (iii) the development of novel genetic breeding methods and their application in aboriginal valuable fish species.
- » **Department of Aquaculture Technologies** develops and promotes local fish production technologies with a system-wide approach, based on the results of disciplinary research. Key research areas are: (i) further development of intensive production technology for percid fish; (ii) increasing the efficiency of pond aquaculture through the development of combined systems and species diversification; (iii) modeling of technological and biological processes to understand the operation of complex systems and to optimize technological interventions.
- » **Department of Hydrobiology's** primary objectives are to support sustainable fisheries in natural waters and recreational fisheries by (i) developing a monitoring protocol adapted to the objectives of fisheries management; (ii) identifying the ecological role of invasive fish species; (iii) exploring the interactions between aquaculture and the environment. To support sustainable pond aquaculture, we examine the relationship between aquaculture and the environment and the ecosystem services provided by pond aquaculture.

For the implementation of the R&D&I and training programs, the centre operates 82 experimental ponds (earthbed) on 30-hectares with several combined systems in them (e.g, pond-in-pond, cage-in-pond). The largest experimental recirculation system (RAS) in the country, with a total water volume of 160 m³, is located in the centre, providing a suitable technological basis for intensive and precision fish farming.

The HAKI carp live gene bank maintains and continuously develops 16 domestic, European and Asian carp lines which form the basis of the centre's international aquaculture development activities and carp farming programs. The genetically selected stocks of the four indigenous sturgeon species in the sturgeon living gene bank also offer a unique opportunity to rehabilitate endangered Danube sturgeon species in Europe.

In addition to R&D work, another strategic area of the HAKI's activity is international knowledge and technology



transfer. The centre plays a strategic role in providing professional support for policymaking. The strategic partner of the centre is the Hungarian Aquaculture and Fisheries Inter-branch Organisation (MA-HAL). HAKI also operates the editorial office of HALÁSZAT, the oldest professional fisheries magazine in Hungary. It has been organizing the Scientific Conference on Fisheries and Aquaculture every year for more than 40 years, to share the results of the profession. It is actively involved in the development of sustainable aquaculture development programs in developing countries.

HAKI is an active, senior member and contributor to the work and programs of FAO, FEAP, COPA-COGECA, AAC, EIFAAC, EAS, EUROFISH, SCAR-FISH, HUNATIP, and NACEE, representing the interests and values of the European region and freshwater aquaculture, in particular pond management. HAKI is also a collaborating partner in freshwater aquaculture development programs in several Asian, African, and Central American countries.



»» Department of Aquaculture

The Department of Aquaculture is the oldest Hungarian college department dedicated entirely to aquaculture which has been functioning under its current name since September, 2000. The teaching activities of the department encompass the scientific fields of aquaculture and fisheries, hydrobiology, biology of fish reproduction, fish genetics, and biotechnology. Our department also coordinates the post-graduate specialist training in aquaculture and fisheries. Our students regularly participate in scientific conferences both at the university and national level and are active participants in the Special studies in aquaculture and fisheries at MATE.

In collaboration with its corporate partners, the department concentrates its efforts on research, development and innovation activities (R&D&I). Research areas of the Department include water quality monitoring, reproductive biology (such as cryopreservation of gametes, induced fish spawning and juvenile rearing), and aquaculture systems operation development (pond aquaculture, recirculating aquaculture, pond-in-pond systems, hatcheries). Our basic research focuses primarily on the biology of fish reproduction.

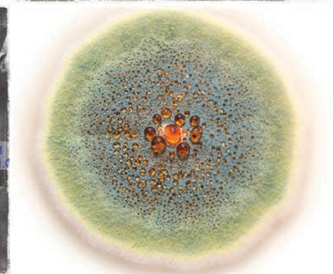
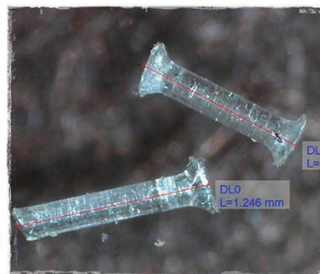
The department is proud of its traditions, especially its collaboration with corporate and professional partners. Annually, the department organizes the Fisheries and Angler business professionals meeting in Gödöllő. During this meeting, distinguished members of the Hungarian aquaculture sector receive an award as a recognition of their contribution to the sector's development. The department regularly participates at national and international scientific symposia on aquaculture, stays informed on the developments in the sector and disseminates its results to the scientific and professional community.

Since its foundation, the department has been very effective in securing project funding. Our project activities, conducted in collaboration with Hungarian and international partners, allows for continuous development and improvement of our infrastructure. In addition to the department's efficient knowledge and technology transfer activity (training, workshops, collaborations, etc.), the aforementioned development aids the further improvement of Hungarian aquaculture.

Department of Environmental Safety

The Department of Environmental Safety plays a significant role in the development and implementation of the MSc program in Environmental Management, in addition to other BSc and MSc programs (e.g., Nature Conservation Engineer, Environmental Engineer) as well as the Doctoral School of Environmental Sciences. Our students are regular participants in the TDK and OTDK competitions.

One of the foundational aims of the department is to focus on the scientific and practical needs of the profession. To this end, we teach subjects that are necessary for solving environmental and environmental safety problems and tasks in practice. Our goal is to analyze and evaluate the effects of human activities (pollution, climate change, pesticide use, microbial contamination) on human and ecosystem health using an environmental safety (environmental management, engineering, life sciences, including microbiological, ecotoxicological) approach and looking for innovative, environmentally friendly solutions to the problems identified. Therefore, in recent years the Department of Environmental Safety has established an extensive network of contacts with outside research institutes who are engaged in practical environmental protection activities, innovation and development, state institutions, economic companies and also social organizations. The result of the cooperation is the department's participation in several successful R&D&I applications, which is affirmed by our high-quality scientific publications, know-how and patents.



Department of Environmental Toxicology

The Department of Environmental Toxicology has two main areas of activity, the toxicological analysis of environmental samples and the application of environmental microbiology. The analytical methods of the laboratory are able to evaluate the toxicological effects of environmental samples and newly developed materials (e.g., biodegradable plastics), both in acute and chronic schemes.

We apply *in vivo* and *in vitro* zebrafish tests (e.g., early life stage or two-generation toxicity tests), Daphnia, and algae tests, according to the GLP or ISO standards. We are able to apply our methods to the field of aquatic toxicology in order to analyze the effects of cosmetic

products, mycotoxins, phytoestrogens, plastics and drug residues on the endocrine system as well as assess their cytotoxic effects. In our classical and molecular-based fish tests, the effects of single-component, mixed substances and environmental samples can be analyzed using acute, subchronic and chronic studies.

With our self-developed estrogen sensitive zebrafish line (Tg(vtgl.mCherry)), the estrogenic effect of environmental samples can be determined. Additional examples of the types of analyses we are able to conduct include: *Vibrio fischeri* tests for the environmental monitoring of water, colorimetric SOS Chromotest for genotoxicity, and the BLYES/BLYAS/BLYR method for monitoring endocrine disruptors. With these methods, we are able to evaluate the toxicological effects or determine the risk assessment of newly developed products, methods, and processes. Finally, using these methods, the environmental fate of biodegraded organic materials (e.g., plastics, mycotoxins, pesticides, cosmetics, pharmaceuticals) can also be analysed.

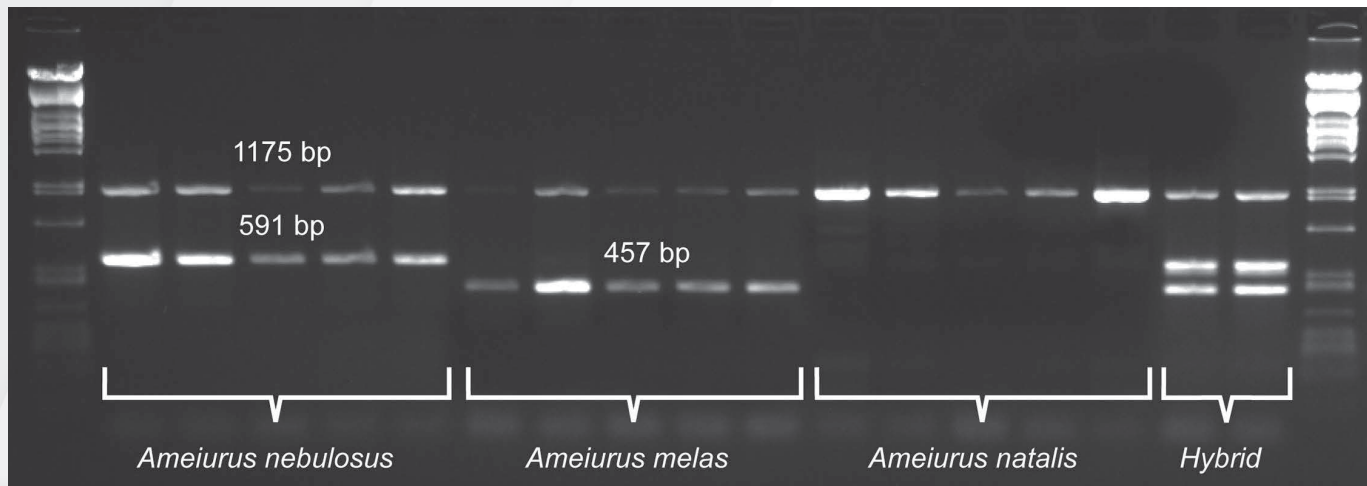
Our expertise in environmental microbiology includes classical and molecular methods for the identification of microbial (bacterial, fungal) communities which can then be used to monitor any short- and long-term changes in the microbial population caused by the exposure to artificial materials (e.g., plastics, organic pollutants) within their natural habitat. Moreover, the verification of any biological benefits and the evaluation of any risks to human health from fermenting microbes and their metabolites can be determined via our toxicity methods.



Department of Molecular Ecology

The Department of Molecular Ecology has two research groups: the *Microbial Ecology Research Group* and the *Fish Molecular Genetics and Genomics Research Group*. The *Microbial Ecology Research Group* is focusing on microbial communities of both pristine and contaminated environments. Their main research projects include (i) the investigation of petroleum hydrocarbon degradation in subsurface environments (BTEX, PAH and aliphatic hydrocarbons), (ii) the biodegradation of xenobiotics with an emphasis on pharmaceutical residues (e.g. ibuprofen, diclofenac, carbamazepine), (iii) the investigation of plant growth promoting bacteria in order to decrease drought stress. The group is also involved in taxonomical studies of bacterial isolates and routinely describes new bacterial species (mainly contaminant-degrading bacteria). The activities of the *Fish Molecular Genetics and Genomics Research Group* cover a wide range of fish genetics and

genomics. This includes the investigation of natural fish populations, gene bank stocks, as well as the support of selection and breeding by molecular biological, genetic or genomic tools. The group has considerable knowledge in molecular genetic marker development, marker adaptation, application in population genetics or marker assisted selection, parentage analysis (e.g., sturgeon, carp, bighead carp, pike perch, perch, pike, barbel, tench, crucian carp, etc.). We have significant experience in fish behaviour genetics (pike perch) and the genetic management of broodstocks (e.g., brown trout, carp, African catfish). Genome and transcriptome analyses (African catfish), QTL (Quantitative Trait Loci) mapping and molecular genetic analyses of fish sexual development or feed conversion are also part of our research.



» Department of Freshwater Fish Ecology

The main focus of the department is to study the complex hydro-ecology of surface waters. Our main study areas are:

- » spatio-temporal dynamics of assemblage structure development of aquatic organisms and the effect of environmental and anthropogenic variables;
- » ecological impact assessment of aquaculture facilities (enhancing sustainable aquaculture management);
- » potential effects of urbanization and other anthropogenic activities;
- » temporal changes of the distribution patterns of aquatic, non-indigenous species;
- » ex situ conservation biology studies of endangered species;
- » environmental toxicology studies on fish and macroinvertebrate model organisms;
- » applied ecological and fishery management developments.

Our team has recently developed a “benthic spawning nest” useful for native fish species and a new method of artificial fish spawning called sperm-ovarium lavage. The effects of personal healthcare products on the phenotype of fish were determined by our department. We have participated in a worldwide study on the potential effects of land use changes and climate change on fishery management of large lakes; also, we have carried out studies on the potential effects of antibiotics on aquaculture. The department is mainly based at the Agárd sub-office of the Institute, the staff consists of five senior scientists, a post-doc and five PhD students. We manage national and international level research projects (see: Projects page). The department has all of the necessary equipment required for the sampling of surface freshwaters (electro fishers, gillnets, electric benthic trawl, water quality measuring kits, etc.) and its flora and fauna.



»» Talent management

With the mentorship of the institute, advanced studies in Fisheries and Angling are operating. It helps to attract and guide students towards this sector with a long tradition, by organising a number of professional programmes beyond the traditional university education (e.g., organising lectures, study trips, fishing competitions, conference participation).

Each year, the Institute hosts a significant number of undergraduate, postgraduate and doctoral students. As a consequence of the active scientific work, there is a dynamic TDK activity of students graduating from the departments of the Institute (e.g., Fishery Sciences, Environmental Sciences), who achieve excellent results both at university and national competitions (e.g., OTDK, OFKD).

Supporting the unit of talent management (professional courses, TDK, PhD training), some of the students successfully complete their TDK, BSc or MSc diplomas and



afterwards are accepted to the doctoral programmes of our University, thus creating a research supply for our Institute. Our graduate students typically progress to the Doctoral School of Animal Biotechnology and Animal Sciences and the Doctoral School of Environmental Sciences.



» Major events organised by the institute

Our Institute allocates significant resources to translate the results of our R&D activities into education and industry practice. To this end, we organise two of the most important professional conferences in the country each year:

Annual Fisheries and Angler Business Professionals Meeting, Gödöllő



Scientific Conference on Fisheries and Aquaculture, Szarvas



National and international partnerships

The Institute focuses on and maintains excellent cooperative relationships both within our university and with many domestic and international companies and organizations. The total number of partners is nearly one hundred. Here, we are listing some of them:

academic partners (non-profit sector):

national: Eötvös Loránd University (Budapest), University of Debrecen, National Centre for Biodiversity and Gene Conservation (NBGK-HGI), NÉBIH, Balaton Limnological Research Institute (BLKI);

international: University of Lorraine, Polish Academy of Sciences, University of Ljubljana, University of Zagreb, University of Novi Sad, University of South Bohemia, České Budějovice, Tokyo University of Marine Science and Technology, University of Warmia and Mazury, Université de Namur, Kanazawa University Noto Center for Fisheries Science and Technology, WWF Central Europe (Austria);

partners from the for-profit sector:

national: Wessling Hungary Kft., Vitafort Zrt., BioFungi Kft., Lillafüredi Pisztrángtelep (Hoitsy és Rieger Kft), Balatoni Halgazdálkodási Nonprofit Zrt., Szegedfish Kft., Czikkhalas Halastavai Kft., Szabolcsi Halászati Kft., Győri „ELŐRE” HTSZ, Tógazda Halászati Zrt., The Fishmarket Kft., MOHOSZ, MAHAL;

international: Covartec (Norway), Oxyguard international (Denmark), Shamir Research Institute (Israel), Hydra GmbH (Denmark), AquaBioTech Group (Malta);

Services

The Institute provides an ever-expanding array of market-based services in a number of areas. The staff of the Institute excels in the following areas:

- » Experimental design, environmental sampling and data collection, statistical evaluation according to scientific and practical requirements.
- » Investigation and analysis of fish farming technologies, fish stock surveying, biomonitoring.
- » Reproduction and pre-breeding of various fish species using a sperm (gene) bank established and developed by the Institute.
- » Preparation of feasibility studies, FAO case studies.
- » Biogeochemical monitoring and sample analysis.
- » Microbial fermentation, with the capacity to produce up to semi-industrial volumes.
- » Ecotoxicological studies and analysis.



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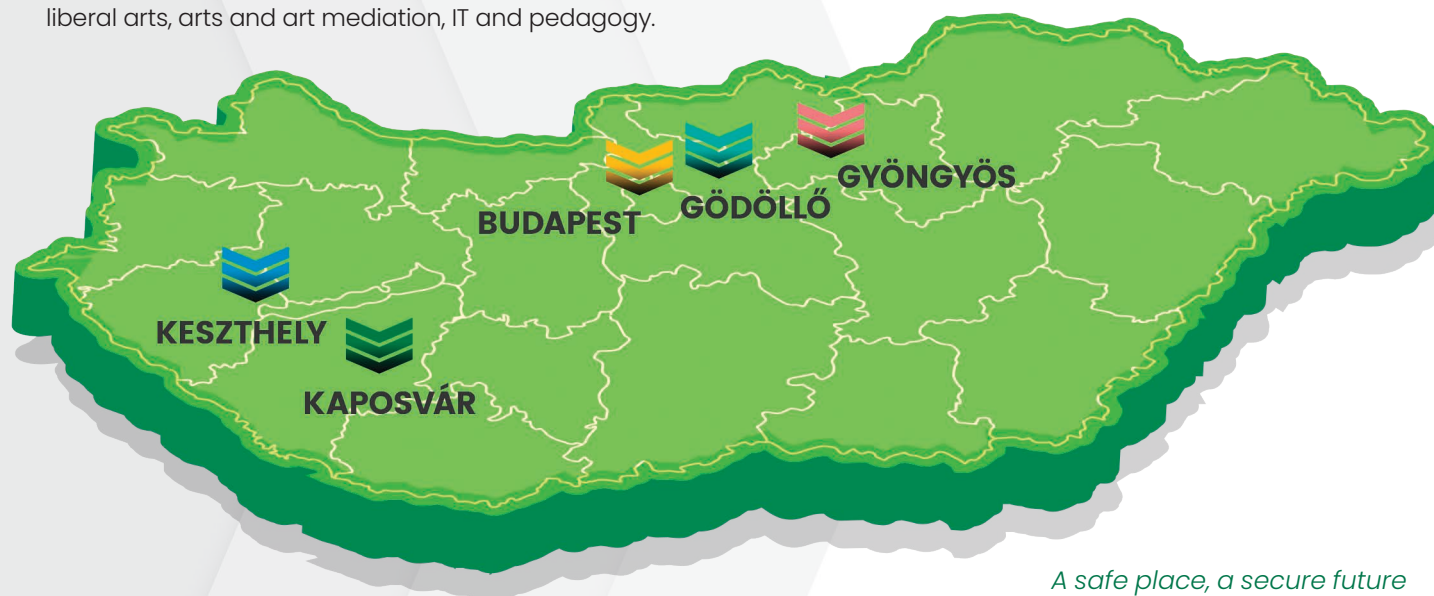
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»» MATE for Rural and Agricultural Development

The Hungarian University of Agriculture and Life Sciences (MATE) is one of the largest agricultural-focused higher education institutions in Europe, established on 1st February, 2021 with five campuses, following the footsteps of the most successful European universities. The University has a unique infrastructure and educational capabilities, combining tradition with modern solutions. In order to useable knowledge and diverse practical experience it is constantly expanding its wide range of learning and training opportunities, providing high-quality and interoperable education in the fields of agriculture, economics liberal arts, arts and art mediation, IT and pedagogy.

The aim of MATE is to promote the economic and social development of Hungary and the development of the rural area and agriculture through its outstanding educational, research, innovation and advisory activities. To this, it also has an extensive corporate network, working with domestic and cross-border companies that allow students to spend their scholarship program in a well-established business environment and thus enter the job market with practical knowledge.



A safe place, a secure future



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