

Microbiome analysis in Lithuania: overview of the global and Lithuanian ecosystem, strengths, weaknesses, and recommendations

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Overview of the Microbiome Sector in Lithuania

Lithuania's Global Position in Biotechnology

Lithuania has firmly established itself as a global leader in biotechnology, with its strategic positioning in various international rankings. As a member of numerous prestigious organizations, Lithuania continues to build on its legacy of innovation and development.¹

Key global accomplishments include:

- **Ranked in the Top 35** in the Global Innovation Index (GII) for two consecutive years.²
- **1st globally** in unicorn value relative to its economy size.
- **1st globally** for the proportion of women with higher education in the workforce.³
- **22nd globally** in 2024 IMD Digital Competitiveness Ranking.⁴
- **16th globally** in the 2024 StartupBlink Ecosystem Index, with Vilnius ranked as the best EU city for cybersecurity.⁵

Lithuania's strong presence in biotechnology is underpinned by a 50-year legacy in precision medicine, biomanufacturing, and AI-driven healthcare innovations. Its network of science valleys and leading educational institutions foster a thriving ecosystem, making Lithuania an attractive hub for biotech investments.⁶

- **3rd in OECD** for biotechnology R&D spending intensity (as a percentage of value added).
- **92%** of pharmaceutical and healthcare products are exported to over 100 countries.⁷
- One of the highest STEM graduate rates in Europe.⁸

¹ <https://investlithuania.com/wp-content/uploads/Lithuanian-Life-Sciences-sector-facts-and-figures-2023.pdf>

² <https://www.wipo.int/web-publications/global-innovation-index-2024/en/gii-2024-results.html>

³ <https://lithuania.lt/governance-in-lithuania/lithuania-among-the-top-35-strongest-countries-in-the-global-innovation-index-for-the-second-year-running/>

⁴ <https://www.imd.org/centers/wcc/world-competitiveness-center/rankings/world-digital-competitiveness-ranking/>

⁵ <https://lithuania.lt/governance-in-lithuania/vilnius-leads-the-eu-in-cybersecurity-according-to-global-startup-index/>

⁶ <https://investlithuania.com/biotechnology/>

⁷ <https://lithuania.lt/governance-in-lithuania/lithuanias-life-sciences-sector-maintains-momentum/>

⁸ <https://www.cedefop.europa.eu/en/data-insights/17-how-many-ivet-students-graduate-stem-subjects>

Successful Areas in Biotechnology

Precision Medicine: Advancing Healthcare with Cutting-Edge Technologies

- Lithuania is globally recognized for its leadership in cell and gene therapies, collaborating with top institutions like EMBL and earning accolades such as the Kavli Prize for CRISPR-Cas9 advancements. A strong R&D environment drives next-generation therapeutics.
- The AI sector supports healthcare innovations with skilled ICT talent and a centralized health data infrastructure. Lithuania's one-stop-shop data agency simplifies access to health data, while its two-decade-old electronic health records system aligns with the European Health Data Space (EHDS).

Biomanufacturing: A Hub for Innovation

- Global companies like Thermo Fisher Scientific and Teva drive Lithuania's biomanufacturing sector. The upcoming €7 billion Bio City campus will feature cutting-edge facilities for cell and gene manufacturing and 3D bioprinting, making it Europe's largest biotech hub.

Agrotech and Novel Food: Leading Sustainable Food Production

- Lithuania pioneers alternative proteins, vertical farming, and functional food, promoting eco-friendly supply chains and addressing global food security challenges through sustainable practices.

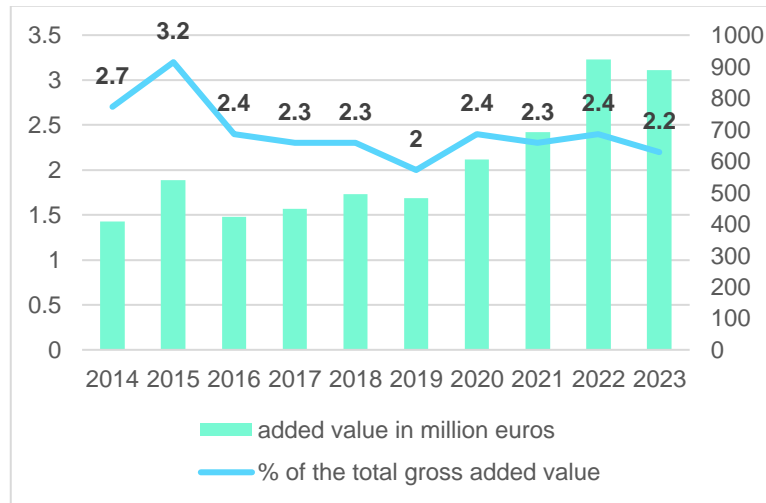
Industrial Biotechnology: Transforming Manufacturing

- Lithuania excels in synthetic biology, producing biomaterials like enzymes and amino acids for industries such as chemicals, FMCG, and cosmetics. Advanced fermentation technologies and raw material diversity, leveraged by companies like Roquette, drive sustainable business growth.⁹

Life Science Sector Growth

The added value of the life sciences sector has more than doubled since 2014 (**Figure 1**), from 408.4 million euros to 889.9 million euros. The growth rate experienced a slowdown in 2023, with the life sciences sector contributing 2.2% to the GDP.

⁹ <https://investlithuania.com/biotechnology/>

Figure 1*Added Value of the Life Sciences Sector in Lithuania*

Note: prepared by the authors, data obtained from State Data Agency.¹⁰

This slowdown in the life sciences sector is attributed to a reallocation of investments and focus toward strategic geopolitical and technological priorities, which are perceived as yielding quicker returns or being critically important in the context of national security and economic competitiveness.¹¹

Necessity for Sustainable Health Solutions in Lithuania

Based on the potential health benefits of the microbiome and Lithuania's leadership in biotechnology, further exploration into the microbiome sector could serve as a potential solution for preventing various diseases in Lithuania.

- **Life Expectancy:** The COVID-19 pandemic caused a sharp decline in life expectancy in Lithuania (down by 2.3 years from 2019 to 2021). Recovery efforts increased life expectancy to 76 years by 2022, still nearly five years below the EU average.
- **Mortality Rates:** Lithuania has among the highest levels of preventable and treatable mortality in the EU, highlighting weaknesses in both public health initiatives and healthcare delivery systems.
- **Health Status:** In 2022, only 48% of Lithuanian adults reported good health—the lowest rate in the EU. A stark income-related gap persists: 72% of high-income individuals reported good health, compared to just 25% of low-income groups.
- **Leading Causes of Death:** Circulatory diseases and cancer dominate, with coronary heart disease and lung cancer most common. External causes, including accidents and suicides, are notable contributors.

¹⁰ https://inovacijuagentura.lt/site/binaries/content/assets/analitika/tyrimai/smart-makro-dalis-2024_12_27_final-1.pdf

¹¹ https://inovacijuagentura.lt/site/binaries/content/assets/analitika/tyrimai/smart-makro-dalis-2024_12_27_final-1.pdf

- **Mental Health:** Depression, particularly among women and low-income groups, persists as a major issue despite progress in reducing suicide rates.
- **Risk Factors:** Behavioral and environmental risks such as poor diet, tobacco use, and alcohol consumption account for nearly half of deaths, with dietary risks alone contributing to 25% far above the EU average of 17%.¹²

Overall, Lithuania holds significant R&D potential in the life sciences and microbiome sector for the reasons outlined above. Furthermore, health assessments of the Lithuanian population indicate multiple areas that require improvement. Advancing microbiome research and innovations could lead to groundbreaking discoveries, potentially addressing pressing health challenges. To drive meaningful change and foster innovation in this field, financial initiatives and dedicated funding programs are essential to initiate progress.

Overview of European Union and Lithuanian Initiatives and Funding Programs

EU Financing Initiatives

Horizon Europe

Horizon Europe, with a budget of EUR 93.5 billion for 2021-2027, supports research and innovation to achieve the UN's Sustainable Development Goals and enhance the EU's competitiveness.¹³ It is structured around three pillars: Excellence Science, Global Challenges, and Industrial Competitiveness.^{14,15}

Horizon Europe includes five missions under the Global Challenges pillar: Adaptation to Climate Change, Cancer, Restore Our Oceans and Waters, Climate-Neutral and Smart Cities, and Soil Deal for Europe. All five are beneficially impacted by microbiome research, due to the One Health principle, which emphasizes the interconnectedness of human, animal, and environmental microbiomes. The mission closely related to the human microbiome is the Cancer mission, which aims to improve diagnosis, treatment, and quality of life.¹⁶ Although this mission does not directly emphasize microbiome research, the microbiome's role in disease prevention and treatment indicate that studies in this area would contribute greatly to the Cancer mission.

¹² https://www.oecd.org/en/publications/lithuania-country-health-profile-2023_5ed683c8-en.html

¹³ https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en#proposal

¹⁴ <https://www.consilium.europa.eu/en/policies/horizon-europe/>

¹⁵ <https://lmt.lrv.lt/en/research-funding/horizon-europe/horizon-europe-programme/>

¹⁶ https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en#proposal

The importance of the microbiome is mentioned more specifically in the “Microbiome World” pathway, funded by Horizon Europe, which supports projects like MASTER, HealthFerm, DOMINO, WHEATBIOME, and TRIBIOME. These projects investigate microbiome roles in sustainable food systems, diets, and health biomarkers, underscoring the importance of financing microbiome studies for advancing public health and sustainability.¹⁷

European Innovation Council (EIC)

The European Innovation Council (EIC) under Horizon Europe funds innovative companies through schemes like EIC Pathfinder, EIC Transition, EIC Accelerator and a new 2025 initiative, STEP Scale-Up.¹⁸ The EIC Fund, part of the EIC Accelerator, invests in European startups across health, energy, green, digital, and deep-tech sectors. Perseus Biomics, a company specializing in microbiome genetic analysis, is one such selected company.¹⁹

Although the EIC Work Program for 2025 doesn't explicitly mention microbiome-based solutions, several challenges under EIC Pathfinder and EIC Accelerator present opportunities for microbiome-related projects.²⁰

EU4Health Program

The EU4Health Program, launched in response to the COVID-19 pandemic, focuses on improving health in the EU, protecting against cross-border health threats, enhancing the availability of medicinal products, and strengthening health systems and the healthcare workforce.²¹

In the 2024 EU4Health work program, key areas related to the microbiome include personalized cancer medicine and antimicrobial resistance. The latter indirectly involves microbiome research, especially regarding "other health technologies as alternatives to antibiotics."²² Personalized cancer medicine may involve microbiome research in identifying biomarkers and creating tailored treatment plans.

¹⁷ <https://op.europa.eu/en/publication-detail/-/publication/abbb2634-9001-11ee-8aa6-01aa75ed71a1/language-en>

¹⁸ https://eic.ec.europa.eu/about-european-innovation-council_en

¹⁹ https://eic.ec.europa.eu/eic-fund/eic-fund-portfolio/perseus-biomics_en

²⁰ https://eic.ec.europa.eu/document/download/5e1eb75f-e437-477f-9ee9-ef54ff6387fd_en?filename=EIC%20Work%20Programme%202025.pdf

²¹ https://commission.europa.eu/strategy-and-policy/eu-budget/performance-and-reporting/programme-performance-statements/eu4health-performance_en#contribution-to-horizontal-priorities

²² https://health.ec.europa.eu/document/download/4fb8f72b-eac7-484f-9bab-03c945f59032_en?filename=c2024_7871_annex_en.pdf

National Financing Initiatives

Smart Specialization

The EU Cohesion Policy (2021–2027) aims to create a smarter, greener, and more connected Europe.²³ In line with this, Lithuania approved its Smart Specialization Strategy (S3) to boost R&D, innovation, and global competitiveness. **The focus is on three key Research, Development, and Innovation (R&D&I) priorities:**

- Health technologies, biotechnologies, and safe food
 - Molecular medicine and biopharmaceuticals
 - Advanced health technologies
 - Medical engineering for early diagnosis/treatment
 - Safe food and sustainable agrobiological resources.
- New production processes, materials, and energy efficiency
- ICT for an inclusive, creative society.^{24 25}

Although not explicitly highlighted in the smart specialization strategy, a focus on microbiome research offers significant potential to drive R&D, foster innovation, and boost global competitiveness.

Future of smart specialization strategy

Lithuania will soon begin planning its 2028–2034 Smart Specialization Strategy (S3), presenting an opportunity to refine focus areas. While technology foresight is not yet formally adopted in Lithuania, it has helped define priorities in other countries.²⁶ By leveraging this approach, Lithuania can better identify key focus areas for the new S3.

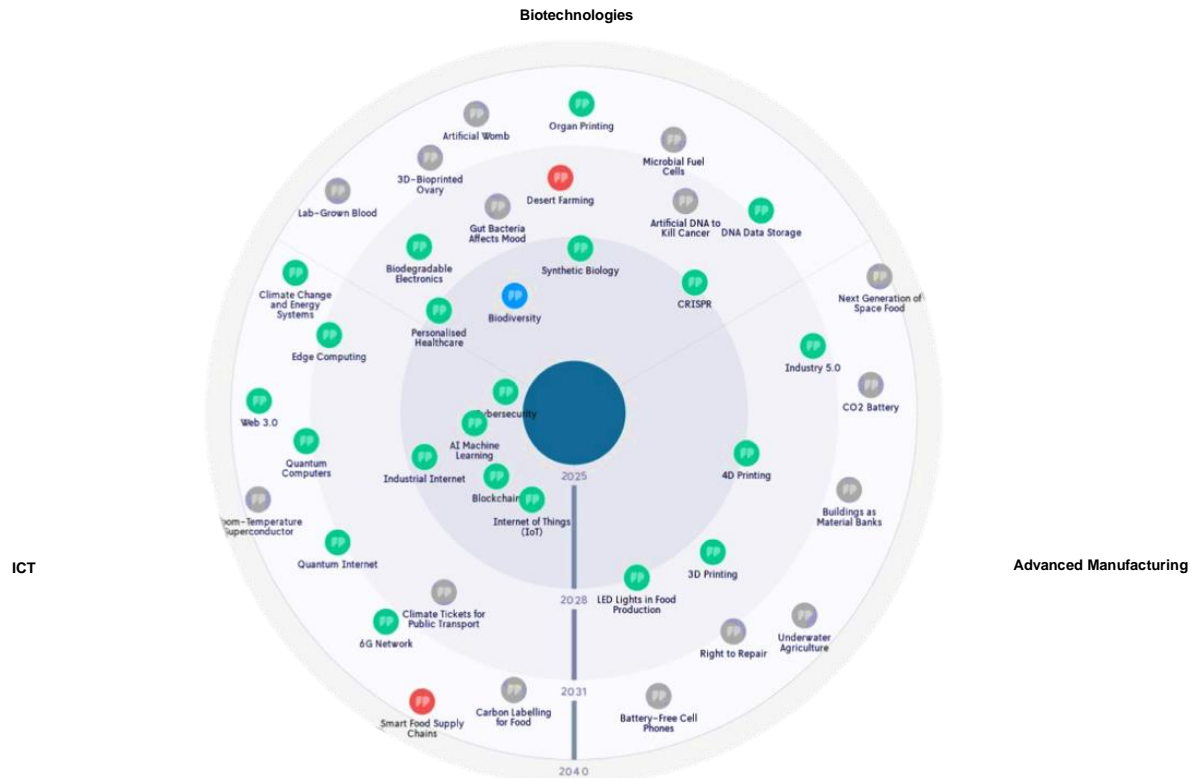
An AI model was tested in this analysis to generate a foresight model for S3 focus areas. This AI foresight tool generated trend cards for each S3 category as follows:

²³ <https://inovacijuagentura.lt/site/binaries/content/assets/analitika/tyrimai/lietuvos-moksliniu-tyrimu-ir-eksperimentines-pletros-bei-inovaciju-sumanosios-specializacijos-ataskaita-2023-m..pdf>

²⁴ <https://www.e-tar.lt/portal/en/legalAct/9f349d40221011edb4cae1b158f98ea5>

²⁵ <https://eimin.lrv.lt/en/sector-activities/innovation/smart-specialization/>

²⁶ https://data.kurk.lt/wp-content/uploads/2024/11/Smart-Specialisation-Strategy-in-Lithuania_Current-Situation-Analysis.pdf

Figure 2*Foresight Radar for Smart Specialization*

Note: prepared by the authors, based on the source from Futures Platform, 2025

The trends are categorized as follows:

• Green – high-impact emerging trends
• Blue – declining trends with most change potential realized
• Red – low-probability but significant 'wild card' events
• Grey – weak signals with uncertain future relevance.

In the biotechnology area of this model, trends correlating with the microbiome sector include:

- Synthetic biology (Timestamp: 2027)
- Personalized healthcare (Timestamp: 2027)
- CRISPR (Timestamp: 2028)
- Gut bacteria's effect on mood (Timestamp: 2029)

These trends suggest potential avenues for refining and detailing Lithuania's upcoming biotechnology focus areas. Increasing attention to microbiome-related advancements could play a pivotal role in driving innovation and competitiveness within the sector.

National Progress Plan and Lithuanian Life Sciences Roadmap

Lithuania's National Progress Plan 2021–2030 aims to enhance global competitiveness through science, technology, and innovation.²⁷ The vision for Lithuania is that its life sciences sector will become a leader in the development of world-class products. The Lithuanian Life Sciences Sector Roadmap sets a target for the life sciences sector to contribute 5% to GDP by 2030. The future of the life sciences sector is intrinsically linked to transformative technological advancements and groundbreaking innovations. A recent study featured in the life sciences roadmap by the European Innovation Council highlights 100 pivotal emerging technologies and breakthrough innovations essential for Europe's progress. Among these, the microbiome is identified as a key example of a future technological trend in the life sciences.²⁸

2021-2027 Investment Program of European Union Funds

The 2021–2027 EU Funds Investment Program allocates nearly €8 billion to Lithuania, focusing on areas like energy, mobility, social inclusion, and climate change. While the microbiome sector isn't a key focus, it fits within the €650 million science and innovation budget for R&D and the €531 million healthcare budget for preventive care and workforce expansion.²⁹

New Generation Lithuania

"New Generation Lithuania" is a national strategy leveraging the EU's Recovery and Resilience Facility to address COVID-19 impacts. €268 million will strengthen healthcare by improving collaboration, infectious disease surveillance, and personalized care services. Another €1.05 billion will enhance higher education, science-business partnerships, and innovation. Microbiome research supports these efforts, fostering healthcare resilience and scientific progress. €6.3 million has also been allocated to sequence the genome of a representative Lithuanian population sample.³⁰

Innovation Agency (IA)

Innovation Agency Lithuania fosters economic growth by supporting startups and businesses. As a partner in the Horizon Europe "PRECISEU" project, it helps advance personalized medicine and reduce inequality in the EU by facilitating the adoption of advanced technological innovations. The project connects European ecosystems to expand healthcare innovations, focusing on advanced therapy medicinal products and health data.³¹ Under the Smart Specialization initiative, IA runs

²⁷ <https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/c1259440f7dd11eab72ddb4a109da1b5?ifwid=32wf90sn>

²⁸ [https://eimin.lrv.lt/uploads/eimin/documents/files/Gyvybe%CC%87s%20mokslu%CC%A8%20sektori%20aus%20kelrodis\(1\).pdf](https://eimin.lrv.lt/uploads/eimin/documents/files/Gyvybe%CC%87s%20mokslu%CC%A8%20sektori%20aus%20kelrodis(1).pdf)

²⁹ <https://esinvesticijos.lt/apie-programas/2021-2027-m-es-fondu-investiciju-programa/apie-2021-2027-m-es-fondu-investiciju-programa>

³⁰ <https://finmin.lrv.lt/en/news/the-government-approved-the-integrated-plan-new-generation-lithuania/>

³¹ <https://inovacijuagentura.lt/kcis/apie-mus/projektai/igyvendinami-projektai/preciseu.html?lang=lt>

projects like Inostartas, Inobranda, and Inopažanga (InoStart, InoBrand, and InoProgress). However, microbiome research is not a specific focus, so participants compete in broader focus areas.

Research Council of Lithuania

The Research Council of Lithuania funds national R&D and supports knowledge exchange between universities and institutes. It allocates grants, manages funding programs, supports EU research participation, and fosters international collaboration. Its mission is to strengthen Lithuania's R&D system for broad societal benefits.³² While it funds microbiome studies, the support falls under broader research categories rather than a dedicated focus.³³ The Research Council of Lithuania developed a funding call in 2019 for the implementation of "Spin-Off Companies" that develops products based on research results. With a total funding allocation of up to 5 million euros, this initiative aims to encourage the translation of scientific research into marketable products.³⁴

Microbiome Research and Innovation Ecosystem in Lithuania

To provide a clearer view of Lithuania's life sciences landscape, including the microbiome sector, this map highlights key players and their roles within the ecosystem. It features universities, research institutes, hospitals, government agencies, and industry partners that drive innovation, collaboration, and practical applications in the field.

At the center of the map, a circle showcases institutions actively involved in microbiome-related activities while also contributing to the broader life sciences sector. Institutions outside the circle represent those engaged in various other areas of life sciences. Additionally, the map highlights companies operating specifically within the microbiome sector.

- SMEs (including startups) and large enterprises.
- Academic community: Universities, research institutions, and university clinics. In Lithuania, microbiome research is conducted by Vilnius University, Kaunas University of Technology, and the Lithuanian University of Health Sciences. Additionally, research is carried out by associated institutes such as the National Cancer Institute, the Center for Innovative Medicine and Lithuanian Research Centre for Agriculture and Forestry. Vilnius University Hospital Santaros Clinics and Lithuanian University of Health Sciences Kaunas Clinics also conduct research in this field.
- Agencies promoting innovation, entrepreneurship, and foreign direct investment (FDI): The Innovation Agency and the Lithuanian Research Council.
- Regulatory institutions: The State Food and Veterinary Service and the State Medicines Control Agency – the State Food and Veterinary Service regulates food safety in Lithuania and follows the European Food Safety Authority (EFSA) guidelines. For medicinal products,

³² <https://lmt.lrv.lt/en/research-funding/>

³³ <https://www.vu.lt/en/scientific-report-2021/faculties/life-sciences-center>

³⁴ <https://lmt.lrv.lt/lt/kvietimai/kvietimas-teikti-paraiskas-atzaliniu-imoniu-moksliniu-tyrimu-ir-eksperimentines-pletros-mtep-projektams-igyvendinti/>

Lithuania follows the European Medicines Agency (EMA) regulations as well as national guidelines set by the State Medicines Control Agency.

Figure 3

Microbiome and Life Science Sector Ecosystem Map



Note: prepared by authors, based on the source from EIMIN, 2023

Below is an overview of key research institutions involved in microbiome studies, as well as the business ecosystem in Lithuania.

Key Research Institutions

Key Lithuanian institutions working on microbiome projects include:

- Vilnius University Life Sciences Center
- Lithuanian University of Health Sciences (LSMU)
- Food Institute of Kaunas University of Technology
- Department of Food Science and Technology at KTU

Lithuanian researchers have received notable certifications in recent years:

- Dr. Aurelijus Burokas received the Somerfeld-Ziskind Research Award for his research on the microbiota gut-brain axis in 2019.³⁵
- Dr. Jurgita Skiecevičienė and Dr. Greta Varkalaitė won the UNESCO Women in Science competition in 2019 and 2024, respectively.
- The 2021 Lithuanian Science Prizes in the field of biomedicine and agricultural sciences was awarded to Jurgita Skiecevičienė, Laimis Virginijus Jonaitis, Gediminas Kiudelis, and Juozas Kupčinskas for their project “Tumor and inflammatory diseases of the digestive system: new molecular biomarkers, clinical-epidemiological aspects, modern methods of treatment”.³⁶
- In 2023, Dr. Juozas Kupčinskas was elected General Secretary of the European Helicobacter and Microbiota Study Group.³⁷
- The research team from LSMU, who have been working on microbiome research over the last 10 years, have published multiple research papers in top journals including Nature, Nature Genetics, Lancet Gastroenterology Hepatology, New England Journal of Medicine, Gut, Gastroenterology, Gut Microbes, and many others. Most recently, the GUT journal in 2024 announced Solveiga Samulėnaitė, a PhD student at Vilnius University Life Sciences Center, as the winner of the Best Paper of 2024 award for the article “Gut microbiota signatures of vulnerability to food addiction in mice and humans”.³⁸

These achievements underscore Lithuania’s growing influence and contribution in the global microbiome research community.

Ongoing Research Projects

The **LSMU** research group focusing on the microbiome, led by Dr. Juozas Kupčinskas and Dr. Jurgita Skiecevičienė, is actively contributing to groundbreaking studies on the gut microbiome and gastrointestinal diseases. Recently, they secured funding for seven projects under Horizon Europe and EU4Health, amounting to more than 3.7 million euros. These projects include:

- **MiGut-Health**, co-coordinated by Dr. Jurgita Skiecevičienė. The goal of the study is to identify the changes in the microbiome in inflammatory bowel diseases, and how diet and lifestyle factors affect the disease course.³⁹ Within this project, LSMU is focusing on organoids derived from patients with inflammatory bowel diseases to study potential metabolite therapies.
- **Personalized Disease Prediction and Prevention in Chronic Inflammatory Disorders (PerPrev-CID)** is a result of MiGut-Health and was initiated in 2024. The consortium, made up of 9 countries and 15 international partners, plans to create new standards for preventative and treatment strategies for rheumatoid arthritis and inflammatory bowel disease by

³⁵ <https://sobp.org/somerfeld-ziskind-research-award/>

³⁶ <https://archyvas.lsmu.lt/en/front/news-and-events/winners-of-the-lithuanian-science-prizes-allocate-significant-support-to-ukraine.html>

³⁷ <https://lsmu.lt/en/lithuanian-researchers-achieving-breakthrough-in-gut-microbiome-research/>

³⁸ <https://www.lrytas.lt/sveikata/ligos-ir-gydymas/2024/07/12/news/kodel-zmones-yra-linke-persivalgyti-tyrimas-atskleide-netiketa-priezasti-32881225>

³⁹ <https://www.migut-health.eu/research/objectives>

investigating biomarkers, implementing nutritional changes, and developing digital health technologies.⁴⁰ LSMU's contribution to this project involves providing an organoid model and researching microbiota.

- **Artificially Intelligent Diagnostic Assistant (AIDA)** is a project to aid clinicians in diagnosis and monitoring of gastric inflammation and cancer by using an AI assistant.⁴¹ LSMU's research in the microbiome will be integrated into the creation of this AI system.
- **The TOwards GAstic Cancer Screening Implementation in the European Union (TOGAS)** project's goal is to develop new approaches for screening and detection of gastric cancer. Latvia University leads this project, and 13 other countries are collaborators for this 3 year long initiative.⁴²
- **ONCODIR: Evidence-based Participatory Decision Making for Cancer Prevention through implementation** and **ONCOSCREEN** are programs focusing on colorectal cancer risk factors and prevention. Similar to AIDA, ONCODIR will create an artificial intelligence (AI) platform to enhance personalized approaches to treatment.⁴³ LSMU's role in these two projects involves researching biomarkers and testing mobile applications for the AI platform.
- **LyophilizeD fecal micrObiome traNsfer for primAry clostridioides difficilE infection (DONATE)** is a study testing the efficacy of a new compound, called Lyo-FMT, that is intended to treat primary *Clostridioides difficile* infection (CDI). This new compound is easy to administer and does not require freezing, and the hope is that this convenient therapy might be a potential new option for CDI treatment.⁴⁴ This project was awarded €1,722,220 for 2023-2026.

Researchers at the **Vilnius University Life Sciences Center**, including Dr. Aurelijus Burokas, Dr. Eric Banan-Mwine Daliri, and Eglė Lastauskienė, are also leading innovative projects focusing on the gut-brain axis, functional foods, and expanding microbiome research into other areas in the body.

Key areas of study include:

- **Gut-brain axis:** Investigating microbiota changes linked to chronic stress, anxiety, Alzheimer's, addiction behaviors, and other cognitive changes through mouse models.
 - **Kefir-fermented HERBs in Alzheimer's Disease and its associated gut dysbiosis (HERB4AD)** is led by VU and aims to develop nonpharmacological therapeutics that could potentially delay cognitive deterioration, restore gut microbiota and restore earlier cognitive function. This work is a collaboration between VU and the Lithuanian Research Center for Agriculture and Forestry.
- **Obesity:** Exploring microbiota patterns associated with obesity.
- **Menopause:** Studying the vaginal microbiome to identify biomarkers for menopause.⁴⁵
- **Functional foods:** Enhancing the nutritional and antioxidant properties of foods.
- **Fermented foods:** Examining the benefits of fermented foods for hypertension, diabetes, and probiotic properties.

⁴⁰ <https://www.perprev-cid.eu/>

⁴¹ <https://www.aidaeuproject.org/>

⁴² https://health.ec.europa.eu/document/download/0dc222dd-b41a-40a8-a374-ffea2eb3a9f7_en?filename=ncd_cancer_eu4h-prj_togas_factsheet_en.pdf

⁴³ <https://www.oncodir.eu/about/>

⁴⁴ <https://open-research-europe.ec.europa.eu/articles/4-61/v1>

⁴⁵ <https://scholar.google.com/citations?user=-njGfCIAAAAJ&hl=lt>

- **Prebiotics, probiotics, and psychobiotics:** Researching their effects on the gut-brain axis, obesity, hypertension, cholesterol, and ageing.⁴⁶
 - **Unravelling the role of probiotic candidates isolated from solid-state fermented psychoactive leaves in the microbiota-gut-brain axis** is a project aimed at isolating, screening, and identifying potential psychobiotics from solid-state fermented *C. sativa* and tobacco leaves and determining their mechanism of action.

The **Kaunas University of Technology (KTU) Food Institute (FI)** conducts cutting-edge research in functional foods, food safety, and biotechnological innovations, enhancing the bioavailability and bioactivity of health-promoting compounds. The Institute integrates microbiome research into food systems, bridging food and health sciences from policy to industry and farm-level implementation. KTU FI actively collaborates with international networks, including **Healthy Diet for a Healthy Life (HDHL)**, **Standing Committee on Agricultural Research (SCAR) Food Systems Strategic Working Group**, and **the Bioeast Network**.

Under the leadership of Dr. Alvija Šalaševičienė, Dr. Antanas Šarkinas, Dr. Irena Mačionienė, Dr. Lina Vaičiulytė, Dr. Natalja Makštutienė, and Dr. Darius Černauskas, the Institute's research is structured around three core pillars: circular economy, functional food systems, biotechnologies for food and health. Key research and innovation areas are:

1. **Functional foods and drinks** – Developing bioactive food microbiota-based fermented foods, and alternative protein innovations.
2. **Bio-preservatives and food safety through microbiota** – Utilizing KTU FI's 65-year-old national probiotic bacterial strain collection for biopreservation, antimicrobial solutions, and food safety advancements.
3. **Food safety and microbiological risk modelling** - Using microbiome-based predictive models to assess food safety risks in dairy, meat, and fish industries.

Ongoing projects are **Horizon Europe HDHL Food4Health (2025-2028)**, **Horizon Europe CleverFOOD (2024-2026)**, and **TECHNOGEST (2022-2025)**, and future research will focus on exploring host-microbiome interactions in functional foods, developing microbiome-based dietary recommendations, and advancing metagenomics and metabolomics research.^{47,48,49} Additionally, the Institute aims to strengthen European collaborations in food biotechnology.

The **Kaunas University of Technology (KTU) Faculty of Chemical Technology, Department of Food Science and Technology**, is leading innovative projects focusing on fermented and functional food, and uses one of the most representative *in vitro* technologies, the SHIME (Simulator of the Human Intestinal Microbial Ecosystem) model, to simulate the complex physiological, chemical and microbiological properties of the digestive tract. For the biomaterial functionality studies, the

⁴⁶ <https://scholar.google.co.kr/citations?user=hluwc9AAAAAJ&hl=en>

⁴⁷ <https://www.healthydietforhealthylife.eu/hdhl-food4health>

⁴⁸ <https://maistas.ktu.edu/events/3884/>

⁴⁹ <https://en.ktu.edu/projects/combination-of-wet-extrusion-and-fermentation-processes-for-the-improvement-of-protein-quality-and-digestibility-of-matrices-based-on-plant-byproducts-technogest/>

researchers use state-of-the-art molecular techniques using the available next generation sequencing tools ION5 Sequencing and QuantStudio Absolute Q Digital-PCR-System.

The Department of Food Science and Technology research group focusing on the microbiome led by Dr. Aušra Šipailienė is actively participating in the **INFOGUT (2024–2028)** project. This international network focuses on in vitro colon models, simulating gut microbiota interactions to advance research in digestive health. The project is part of the COST (European Cooperation in Science and Technology) initiative.

The Research and Design of Food Structures working group at the Department of Food Science and Technology led by Dr. Daiva Leskauskaitė focuses on encapsulation of biologically active compounds to control their release in the gastrointestinal tract of consumers. This includes development of probiotic microcapsules with stability and viability during the technological process and storage and development of special purpose products through structural design. An ongoing national project under Dr. Leskauskaitė is “Development of an innovative cannabinoid-enriched prebiotic from fibrous hemp products and its’ benefits for the human microbiota evaluation”.⁵⁰

Several non-university institutions that have conducted studies in the microbiome include the Nature Research Center and the Center for Innovative Medicine.

In general, microbiome research in Lithuania is rapidly expanding. Researchers are involved in collaborating internationally in various EU projects, expanding investigation into different microbiomes of the body, and discovering new capabilities for disease prevention and treatment.

Collaboration Networks

In Lithuania there is a strong collaboration network between researchers at all universities working on the microbiome. In addition to collaborating on projects with each other, investigators work with Vilnius University Hospital Santaros Klinikos and the Hospital of Lithuanian University of Health Sciences Kaunas Clinics to implement clinical trials. Notably, Dr. Vaidotas Urbonas, who works at Vilnius University Hospital and the Vilnius University Faculty of Medicine, specializes in pediatric gastroenterology and is a key collaborator in microbiome projects. The Ministry of Health is also a collaborator in several projects, including the Horizon Europe project ONCODIR.

Lithuanian researchers frequently collaborate with international pharmaceutical companies and researchers to conduct clinical trials. These include participation in Horizon Europe and EU4Health projects, several of which were mentioned above. These collaborations strengthen Lithuania’s visibility in the microbiome field and enable Lithuanian researchers to collaborate with universities internationally to share knowledge and work on best research practices.

A notable international collaboration partner is Kiel University in Germany, which hosted medical doctors from the Hospital of Lithuanian University of Health Sciences Kaunas Clinics hospital for fellowships. These doctors then brought new microbiome transplantation skills back to Lithuania.⁵¹

⁵⁰ <https://ktu.edu/projects/inovatyvaus-kanabinoidais-praturtinto-prebiotiko-sukurimas-is-salutiniu-pluostiniu-kanapiu-perdirbimo-produktu-ir-jo-naudos-zmogaus-mikrobiotai-ivertinimas/>

⁵¹ <https://ismu.lt/en/lithuanian-researchers-achieving-breakthrough-in-gut-microbiome-research/>

Kiel University also collaborates with Lithuanian researchers in a few EU projects, including Mi-Gut Health and PerPrev-CID.

Infrastructure

Center for Innovative Medicine

The Center for Innovative Medicine in Lithuania is a State Research Institute that hosts laboratory services for scientific research and experimental development. These services include a disease biomarkers research laboratory and immunotechnology research laboratory.⁵² A current project at this institution is related to the microbiome, titled "Towards personalized management of autoimmune epithelitis: a study on the links between microbiota, immune response and clinical expression".⁵³

National Cancer Institute

The National Cancer Institute's (NCI) purpose is to improve quality of life by focusing research on precision medicine, particularly on early diagnosis and prevention strategies and treatment selection. They collaborate with partners in Lithuania and internationally on research projects, including "The Cancer Tissue Genome Atlas" and the "Cost Action Initiative". These ongoing projects involve members from around the world from different disciplines to improve health outcomes.⁵⁴ NCI also has a clinic to treat patients, in which multidisciplinary teams focus on individualized cancer treatment.⁵⁵

It hosts a biobank, which has more than 10,000 tissue, blood, and urine samples from cancer patients as well as healthy donors. This library provides key data to support clinical research both in Lithuania and abroad.⁵⁶

Medical Science Center

Vilnius University opened the Medical Science Center near the end of 2024. This complex hosts laboratories and research facilities spanning the topics of genetics, biomarker research, neuroscience, and dentistry and took EUR 66 million to fund, the largest investment in medical science infrastructure in Lithuania. The primary goal is to translate research into practical applications by bringing together researchers of different disciplines into one center to collaborate with practitioners. Researchers use the new facilities of the center to explore organoid model cultivation and novel AI technologies, both of which will allow scientists to better understand disease pathology and progression.⁵⁷

⁵² <https://www.imcentras.lt/services/>

⁵³ <https://www.imcentras.lt/key-projects/>

⁵⁴ <https://www.nvi.lt/biobank-projects/>

⁵⁵ <https://www.nvi.lt/clinic/>

⁵⁶ <https://www.nvi.lt/biobank/>

⁵⁷ <https://www.vu.lt/en/news-events/news/from-organoid-cultivation-to-digital-solutions-for-fighting-cancer-the-new-medical-science-centre-boasts-remarkable-innovations>

The Medical Science Center launched the Biobank of Lithuanian Population and Rare Disorders, which stores specimens of both healthy people and individuals with rare diseases. These specimens will be available for research and commercial purposes in Lithuania and internationally. With this development, researchers will be better able to investigate the microbiome to develop prevention and treatment strategies, including personalized medicine.⁵⁸

Human Biological Resources Center

The Human Biological Resources Center is a collaboration between LSMU and Lithuanian University of Health Sciences Hospital Kaunas Clinics, along with National Cancer Institute, Vilnius University, Vilnius University Hospital Santaros Klinikos, and the Center for Innovative Medicine. The ultimate goal of the biobank is to develop new treatments and diagnosis methods by allowing researchers to conduct research using their data to search for biomarkers. It was funded by the European Regional Development Fund and hosts solid tissue, liquid tissue, special live tissue, and a health information database, allowing more clinical studies to take place.⁵⁹

Microbiome Research Institute

In the near future, the Lithuanian University of Health Sciences (LSMU), together with the Lithuanian University of Health Sciences Hospital Kaunas Clinics and its international partner, Kiel University, plan to establish a microbiome research institute. This initiative will provide Lithuania with a dedicated and strategic focus in this rapidly evolving field.⁶⁰

Microbiome Industry in Lithuania

The Lithuanian biotechnology and life science sector boasts a dynamic and thriving business ecosystem, marked by a significant number of innovative advancements.

Food Sector: A Growing Strength

Lithuania's microbiome-related food sector is experiencing rapid growth, driven by an increasing number of companies developing functional foods that support microbiome health. Innovations such as probiotic-enhanced drinks, fortified snack bars, and other microbiome-friendly products are gaining traction in the market. As public interest in gut health and wellness continues to rise, Lithuania is well-positioned to become a key player in the functional food sector.

⁵⁸ <https://www.mf.vu.lt/en/institutes/the-biobank-of-lithuanian-population-and-rare-disorders#about>

⁵⁹ <https://lsmu.lt/en/two-strategically-important-medical-facilities-opened-in-kaunas-new-opportunities-for-disease-diagnosis-and-treatment/>

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<https://imt.lrv.lt/public/canonical/1731063365/3713/Kandidatai%20kurti%20kompetencijos%20centrus.pdf>

Emerging Opportunities in Therapeutics and Biotechnology

Lithuania hosts a thriving biotechnology sector, with companies specializing in gene editing, genome sequencing, and biopharmaceutical research. Several companies are actively exploring microbiome-based innovations, including psychobiotics, which have the potential to transform mental health treatments. The increasing focus on microbiome science presents significant opportunities for further investment and expansion in microbiome-targeted therapeutics.

In terms of therapeutics, fecal microbiota transplantation is available in Lithuania through clinical trials. In 2019, 18 total FMT procedures were performed in Lithuania for recurrent *C. difficile* infection, and since then, multiple clinical trials have been done to test the safety and effectiveness of FMT, including a study on its long-term efficacy in Lithuania.^{61,62} Additionally, ongoing research is exploring the applications of FMT beyond *C. difficile*, such as inflammatory bowel disorders.

With a strong foundation in biotechnology and a rapidly evolving functional food sector, Lithuania is poised for growth in microbiome research and innovation. Lithuania's strong foundation in biotechnology and rapidly evolving functional food sector creates an ideal environment for new ventures, partnerships, and investments aimed at unlocking the full potential of microbiome-based health solutions.

⁶¹ <https://www.sciencedirect.com/science/article/pii/S2666776221001587>

⁶² <https://pubmed.ncbi.nlm.nih.gov/34752587/>