Section for Environmental Microbiology (EMBI) strategy 2023-2026

1. EMBI in short

The section performs basic and applied research funded by external sources like EU, Danish research councils, Villum and Novo research foundations, as well as research-based advisory services for public and private sectors. The researchers in EMBI participate in a high number of national and international projects made possible through an extensive network of national and international scientists.

The research at EMBI is internationally recognized and holds high merits within soil microbial ecology (fungi, bacteria, protist, and viruses), Arctic microbiology, pathogens in the environment, aero-microbiology, degradation of organic micropollutants, industry-related microbiology, effects of agricultural practices on the microbe-driven ecosystem services and biogeochemical processes. Consultancy includes environmental risk assessment of microorganisms (GMOs, production organisms, microbial control agents, bio-stimulants) as well as eDNA-based monitoring of non-indigenous species. Besides traditional microbiological techniques, biomolecular methodologies are increasingly pivotal to the research in the section, namely sequencing of pure cultures and environmentally derived DNA and RNA using Illumina and Oxford Nanopore platforms.

EMBI has one established teaching module in Arctic Microbial Ecology, which is hosted by the Department of Biology. The section has no established education program but gives ad hoc lectures, performs courses/summer schools and PhD courses and, not least, educates a high number of PhD students.

2. Mission and Vision

Missions

- Support efforts to solve or diminish the climate and environmental challenges that threaten human communities, wildlife, and nature in general - nationally and internationally.
- Offer advisory services, to public and private sector, on risks associated with microbes (pathogens, GMOs, antibiotic resistance) by researching their ecology and genetic background.
- Contribute to acquiring new information and data on how climate change influences the ecology of Arctic microbiota and how these, in turn, increase melting rates of the Greenland ice sheet.
- Contribute on nature-based microbial solutions like bioaugmentation and natural monitored attenuation of the microbial processes driving biodegradation of most organic micropollutants in groundwater and technical systems.
- Deliver research-based advisory on how sustainable utilization of resources will play into the Green Transition agenda qua our expertise on microbial-based nutrient cycling in agriculture, microbial indicators of soil fertility, plant-microbe interactions and sustainable industrial bioprocesses (e.g. industrial enzymes).

Visions

- Further develop our expertise on sampling and detection of airborne fungal spores, plant pollen, bacteria, and viruses to diminish their impact on human health.
- To consolidate and position the section as a significant research unit within microbial ecology, supporting the need for advisory work in this area to the Danish Ministries of Environment, Agriculture, Energy and Climate.
- To develop efficient funding strategies allowing developing of cutting-edge research programs, leading to research that will be published in top journals.
- Attract, inspire and supervise students on MSc. and PhD level.

3. International position and strength

The EMBI section is performing research, within environmental microbiology, which enjoys international recognition and project engagement, namely:

- eDNA approaches to measure non-indigenous species, microbial processes involved in degradation of pollutants, indicators of soil health (all research areas where EMBI offers advice to public and private sector).
- Cryo-microbiology in Arctic environments, as a scientific area, has been very successful in acquiring several grand European projects within ecology of microbial communities on the Greenlandic ice sheet where microbes play a crucial role in the ice melting.
- Cryo-biogeochemistry, involving studies of low-level presence of nutrients and particles in Arctic environments, ice sheets, glacial runoff and studies on glacial hydrology. There is strong interaction with the cryo-microbiological research area.
- Climate change mitigation by soil microorganisms with a focus on the possibilities of soil microorganisms to mitigate GHG emissions and how the soil quality is affected by agricultural climate change mitigation measures. There is a strong synergy with the research areas of eDNA, soil virus and soil protists.
- Aero microbiology where the section has unique expertise on sampling of airborne microorganisms. This area is still in its infancy, but a newly hired professor at ATMI and cross-section collaborations with EMBI are expected to support the area, bringing AU to the international top 10.
- EMBI is among the top 10 group in the world in using transcriptomic approaches to describe the activity of microbial populations in soils and Arctic habitats.
- EMBI is among the top 10 group in Europe to include the analysis of both soil viruses and protists, integrated with soil bacterial and fungal communities.

Focus area	Strategic goals
Identification of key sub-areas within EMBI of strength and further develop them. This will require: - Sharper branding of the research in the section - Development of new methodologies and infrastructure - A diversified funding strategy - Development of new collaborations	**Arctic research:** consolidate and develop stronghold positions in glacial microbiology, ice biogeochemical processes, phylogenetics of ice microorganisms to advance our level of understanding of microbial ecology, the nutritional background of the ice microbiota and hydrological processes that drive microbial communities in the Arctic. **Aero-microbiology:** improve sampling methodology of airborne microbes (viruses, bacteria, fungal propagules, pollen) and methodology to identify and quantify them (eDNA, ddPCR) and understand their interactions with aerosols. **Plant-microbe/microbe-microbe interactions:** develop further methodologies (e.g., SIP, total RNA, transcriptomics) to measure microbial occurrence and activity regarding plant pathogens, predator influence on population dynamics, presence of prokaryotes and invertebrates (e.g. protozoa, nematodes) as bio-indicators of soil quality. **Impact of agriculture practices on soil microbiota:** measure effects of (e.g. agrochemicals, microbial control org.) on soil microbiota/invertebrates, and the ecosystem services they drive, explore the potential of microbial biocontrol agents, using DNA/RNA methodology and bio-indicator approaches. **Degradation of organic micro-pollutants:** develop and investigate microbial processes to transform/remediate micro-pollutants in soil, groundwater and technical systems. Improve understanding of genetic and ecological background for biotransformation pathways using monitored natural attenuation and DNA/RNA methodology. **Industrial microbiology/biotechnology:** discover/develop biotechnological approaches for sustainable usage of waste materials, optimize industrial processes (e.g. enzymatic) to improve sustainability. **Environmental virus ecology:** research viruses that interact with microorganisms to fill our knowledge gap on especially how mycoviruses influence fungal ecology in relation to plants, soil and technical systems (e.g. remediation facilities).
Talent development	
Support/develop talents for non-permanent staff. This will require development of strategies for: - Mentoring - Communication	Include non-permanent staff in writing grand proposals at an early stage. Facilitate and be open-minded to research ideas and infrastructure needed for non-permanent staff

	Plan discussions regarding carrier awareness and planning, at section level. Engage young scientist in public consultancy work as well as teaching. Get papers in highest-quality journals (e.g. Nature, PNAS) to enhance the sections impact on the international scene.
Public sector and private sector consultancy	
Provide high quality research-based consultancy services to both public and private sector. In order to achieve these goals, we will develop strategies for: - Infrastructure that is service oriented - Develop talents for advisory work - Communicate externally the sections capabilities - Develop collaborations with the public and private sector - Provide green transition and nature-based solutions	Get more consultancy projects: more alliances with regions, private sector, NGOs etc. Exploit various partnerships and growth fora (regions, private sector, universities). Get personal contact to public sector stakeholders (e.g. in MST, ministries including Min. of Defence, and the regions). Pollutant remediation of drinking water/groundwater and monitoring of natural attenuation (MNA) processes. Explore the possibilities to acquire consultancy projects within the "Artic area" (e.g. oil spill remediation, mining plumes, ice melt monitoring). As part of infrastructure development, provide new analytical skills to be able to deliver HQ identification and quantification of microorganisms, invertebrates and vertebrates in soil, ice, air and water/marine environments, as well as specific genes (e.g. NanoPore, ddPCR) typically involved in degradation of organic micropollutants, and antibiotic resistance. Get more projects with the private sector (industry, engineering consultancy companies (e.g. DTI). Engage in applied projects with private sector (e.g. IFD, GUDP, MUDP). Offer special analyses on a commercial basis.
Education	
Engaging in teaching/education to recruit students, earn money, and improve CVs of young researchers.	Offer courses at post-graduation level ("efter-videre uddannelse" teaching stakeholders in regions, municipalities, private sector etc.) – e.g. eDNA tech., DNA/RNA approaches in an environmental context, risk assessment of microbes (e.g. GMOs). Seek possibility for an international education program (Erasmus Mundus program) in collaboration with other EU universities, in collaboration with colleagues at TECH/ENVS. Participate in other courses at AU (Artic course, at engineering dept.).