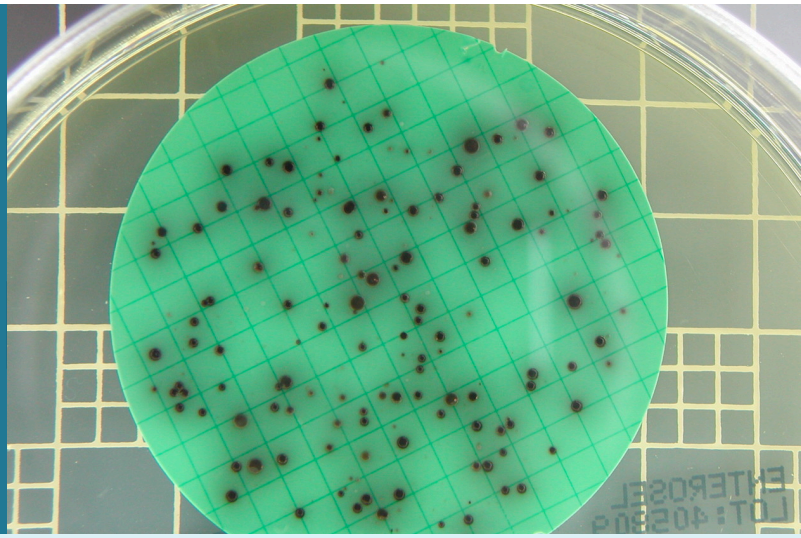
RESEARCH GROUP

https://www.list.lu/en/environment/environmental-and-industrial-biotechnologies/group/environmental-microbiology-and-biotechnology-group/

Environmental microbiology and biotechnology



As part of their activities in the Environmental Microbiology and Biotechnology group, researchers develop knowledge, know-how and innovative solutions in relation to the contamination of water, food and the environment by pathogenic microorganisms.

Main Expertise fields

- Environmental microbiology, with a focus on water resources
- Antimicrobial compounds and materials
- Environmental applications of probiotics
- Sewer-based epidemiology

Research Challenges

Microbial Risk Assessment in a One-Health perspective

Food and water are regularly contaminated by microorganisms along the production chains. Recent outbreaks of food-borne and waterborne microbial infections highlight the increasing risk of microbial propagation in a globalised world. These problems are worsened by an increasing antibiotic resistance in bacteria. The research group is engaged in understanding the way these microorganisms interact with the matrices they encountered (water, air, food, soil, sediment,...) in order to precisely characterise the risk associated with food or water production and consumption, water-based recreational activities, water reuse in agriculture or cities. The research group offer to private and public partners, among others:

- Development of monitoring tools for tracking contamination in environment or industry (water, food). These tools are based on a combination of culture methods, molecular biology tools and analytical chemistry analyses for assessing viruses, parasites, bacteria or algae and their relevant properties such as toxin production or antibiotic resistance
- Development of rapid diagnostic tools such as aptamer-based biosensors for viruses or MALDI-ToF identification databases of antibiotic resistance in bacteria
- Integrative studies of environmental contamination of water resources and public health epidemiology, e.g. for pathogens such as Campylobacter Noroviruses, Adenoviruses or Cryptosporidium
- Assessment of the fate and transport of pathogens in surface water or groundwater in a drinking water protection perspective;
- Background or emergency studies of contamination for bottled water industry
- Drone-assisted monitoring of surface water resources contaminated with cyanobacteria in complement to assessment of the dynamics of algae and toxins

SEWER-Based Epidemiology

For 15 years, LIST has been investigating circulation of microbial pathogens in human populations through the monitoring of wastewater. This competence has been particularly useful when data from the group has fed the decision-making process of the Luxembourg's government during the SARS-CoV-2 sanitary crisis. The research group offer to:

- Determine the diversity of bacterial strains and virus variants circulating in wastewater and relate this to dynamics in human population
- Advise governments on the evolution of epidemics or pandemics such as SARS-CoV-2
- Communicate with media and citizens about sanitary status during crises

Clean-Tech related to microorganisms

Fighting microorganisms has become of paramount important in order to propose responses to the increasing microbial risk generated by the globalisation. Researchers develop innovative decontamination processes for food- or water-based businesses. The research group offers to private or public partners:

- Development of technologies based on cold atmospheric plasma for the decontamination of inert surfaces or food items
- Validation and marketing of new decontamination processes such as chemical additives, material structures, photocatalytic reactions or plasma treatments for example

Development of Clean-Tech based on Microbial Products

Researchers develop greener alternatives to classical treatments for water infrastructures, bottled water industry, food industry, hospitals,... using beneficial microorganisms (such as probiotics or microbial enzymes) to eliminate pathogenic microorganisms or chemical pollutants such as pharmaceuticals (antibiotics in particular), in wastewater or on building materials (polymers stainless steel, etc.). We therefore offer to private companies the following support:

- Selection, characterisation and cultivation of interesting bacterial strains or phages for industrial purposes
- Reference and manage microbial strains in the Luxembourg Microbial Culture Collection managed by LIST
- Produce free or fixed bacterial enzymes or other compounds for decontamination systems

Application areas

- Microbial risk assessment and management
- Viral diagnostics
- Probiotic production
- Cleaning technologies

Main assets

- Innovative biosensors for waterborne viruses
- Risk assessment tools for bathing areas affected by cyanobacteria
- Isolation, characterization and culture platform for probiotics
- Culture collection of pathogenic bacteria such as *Campylobacter*

Equipment

- Fully equipped biosafety level 2 lab
- Illumina MiSeq sequencer
- qPCR
- Surface Plasmon Resonance
- Cell culture lab
- Water-solid separation lab with ultrafiltration and ultracentrifugation
- Anaerobic culture chamber
- Cold atmospheric plasma generator

Selected Publications

- Setting a baseline for global urban virome surveillance in sewage. Nieuwenhuijse DF, Munnink BBO, Phan MVT, Munk P, Venkatakrishnan S, et al. 2020. Scientific Reports
- Controlled co-immobilization of biomolecules on quinone-bearing plasma polymer films for multifunctional biomaterial surfaces. Czuba U, Moreno-Couranjou M, Collard D, De Pauw-Gillet MC, Quintana R, et al. 2020. Plasma Processes and Polymers
- MALDI-TOF mass spectrometry and specific biomarkers: Potential new key for swift identification of antimicrobial resistance in foodborne pathogens. Feucherolles M, Cauchie HM, Penny C. 2019. Microorganisms
- Influence of physico-chemical characteristics of sediment on the in situ spatial distribution of F-specific RNA phages in the riverbed. Fauvel B, Cauchie HM, Gantzer C, Ogorzaly L. 2019. FEMS Microbiology Ecology
- Global monitoring of antimicrobial resistance based on metagenomics analyses of urban sewage. Hendriksen RS, Munk P, Njage P, van Bunnik B, McNally L, et al. 2019. Nature Communications, vol. 10, no. 1, p. 1124
- Anti-biofouling and antibacterial surfaces via a multicomponent coating deposited from an up-scalable atmospheric-pressure plasma-assisted CVD process. Moreno-Couranjou M, Mauchauffé R, Bonot S, Detrembleur C, Choquet P. 2018. Journal of Materials Chemistry B, no. 4, pp. 614-623
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- Quantifying potential sources of surface water contamination with Campylobacter jejuni and Campylobacter coli. Mughini-Gras L, Penny C, Ragimbeau C, Schets FM, Blaak H, et al. 2016. Water Research, vol. 101, pp. 36-45
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- Human Campylobacteriosis in Luxembourg, 2010-2013: A Case-Control Study Combined with Multilocus Sequence Typing for Source Attribution and Risk Factor Analysis. Mossong J, Mughini-Gras L, Penny C, Devaux A, Olinger C, et al. 2016. Scientific Reports, vol. 6, art. no. 20939
- A designed experiments approach to optimizing MALDI-TOF MS spectrum processing parameters enhances detection of antibiotic resistance in Campylobacter jejuni. Penny C, Grothendick B, Zhang L, Borror CM, Barbano D, et al. 2016. Frontiers in Microbiology, vol. 7
- Fast Atmospheric Plasma Deposition of Bio-Inspired Catechol/Quinone-Rich Nanolayers to Immobilize NDM-1 Enzymes for Water Treatment. Mauchauffé R, Bonot S, Moreno-Couranjou M, Detrembleur C, Boscher ND, et al. 2016. Advanced Materials Interfaces, vol. 3, no. 8
- Atmospheric-Pressure Plasma Deposited Epoxy-Rich Thin Films as Platforms for Biomolecule Immobilization - Application for Anti-Biofouling and Xenobiotic Degrading Surfaces. Camporeale G, Moreno-Couranjou M, Bonot S, Mauchauffé R, Boscher ND, et al. 2015. Plasma Processes and Polymers, vol. 12, no. 11, pp. 1208-1219
- Self-Defensive Coating for Antibiotics Degradation - Atmospheric Pressure Chemical Vapor Deposition of Functional and Conformal Coatings for the Immobilization of Enzymes. Bonot S, Mauchauffé R, Boscher ND, Moreno-Couranjou M, Cauchie HM, Choquet P. 2015. Advanced Materials Interfaces, vol. 2, no. 14
- Human Adenovirus Diversity in Water Samples Using a Next-Generation Amplicon Sequencing Approach. Ogorzaly L, Walczak C, Galloux M, Etienne S, Gassilloud B, Cauchie HM. 2015. Food and Environmental Virology, pp. 1-10
- Formation of ammonium in saline solution treated by nanosecond pulsed cold atmospheric microplasma: A route to fast inactivation of E. coli bacteria. Maheux S, Duday D, Belmonte T, Penny C, Cauchie HM, et al. 2015. RSC Advances, vol. 52, no. 5, pp. 42135-42140
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- Spatial and temporal distribution of Cryptosporidium and Giardia in a drinking water resource: Implications for monitoring and risk assessment. Burnet JB, Penny C, Ogorzaly L, Cauchie HM. 2014. Science of the Total Environment
- Development of a quantitative immunocapture real-time PCR assay for detecting structurally intact adenoviral particles in water. Ogorzaly L, Bonot S, Mouaïj BE, Zorzi W, Cauchie HM. 2013. Journal of Virological Methods
- Two-day detection of infectious enteric and non-enteric adenoviruses by improved ICC-qPCR. Ogorzaly L, Cauchie HM, Penny C, Perrin A, Gantzer C, Bertrand I. 2013. Applied Microbiology and Biotechnology
- Two-year monitoring of Cryptosporidium parvum and Giardia lamblia occurrence in a recreational and drinking water reservoir using standard microscopic and molecular biology techniques. Helmi K, Skraber S, Burnet JB, Leblanc L, Hoffmann L, Cauchie HM. 2011. Environmental Monitoring and Assessment
- Concentration and diversity of noroviruses detected in Luxembourg wastewaters in 2008-2009. Skraber S, Langlet J, Kremer JR, Mossong J, De Landtsheer S, et al. 2011. Applied and Environmental Microbiology
- Genetic diversity of noroviruses from outbreaks, sporadic cases and wastewater in Luxembourg 2008-2009. Kremer JR, Langlet J, Skraber S, Weicherding P, Weber B, et al. 2011. Clinical Microbiology and Infection

Partners

Probiotic Group Luxembourg (LU)
Molecular Plasma Group (LU)
Luxembourg Institute of Health (LU)
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Université de Lorraine - CNRS LCPME (FR)
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