THE ARCTIC UNIVERSITY OF NORWAY • UIT •

CANS
Centre for New Antibacterial Strategies

2022 Annual Report

Contents

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Cover photo: Jan Fredrik Frantzen/UiT

CANS is hosted by the Department of Medical Biology and the Faculty of Health Science at UiT the Arctic University of Norway

@cans_uit

Annual activities 2022

The core centre annual activities for 2022 are summarized below:

1. The recruitment of six new associate professors funded by CANS is finalized, and all PhD and PD to four of the associate professors are employed. The recruitment of the final two PhD and two postdoc positions is going on and will be finalized in 2023.

2. In 2022 CANS research groups submitted more than 20 grant applications to internal (UiT), regional, national, and international arenas. Of these, 11 has been granted and four are still pending.

3. Within the centre, 16 master thesis and eight PhD thesis has been completed.

4. Scientific publications in peer reviewed journals (n=44), other publications/dissemination (n=73).

5. The CANS monthly/bi-monthly digital research seminars (n=12) continued in 2022 with internal and external presentations.

6. The focus on dissemination has continued and in 2022, and researchers in CANS has presented their work in different arenas like: uit.no, forskning.no/forskersonen.no, sciencenorway.no, Dagens Medisin, Aftenposten, nrk.no, Facebook, Twitter, YouTube, Vitensenteret (Forskningsdagene), Lørdagsuniversitetet, Prelaten, and our internal newsletters.

7. CANS joined a partner meeting with other nordic AMR Centers in Uppsala in September 2022.

8. Veronika K. Pettersen, associate professor in CANS, invited to a one-day symposium featuring international experts on the human microbiome, 30th May 2022.

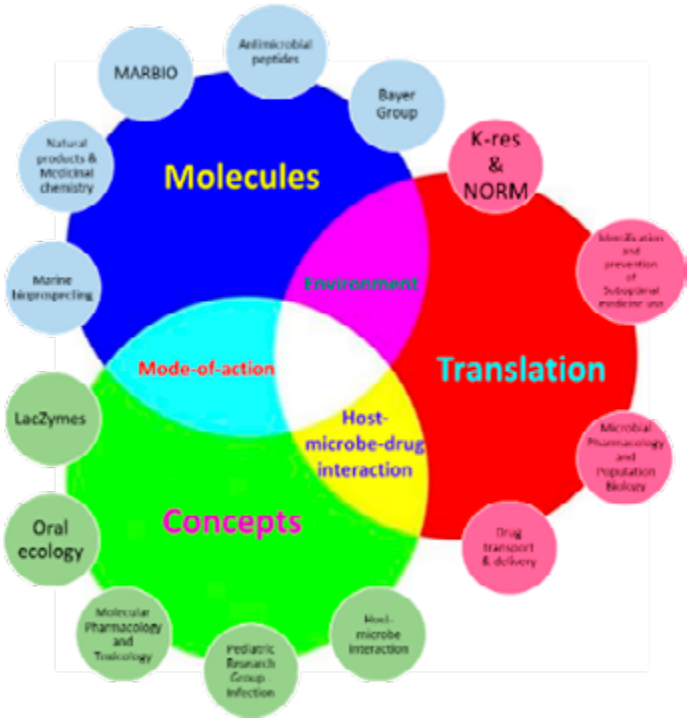
9. An interdisciplinary symposium on "AMR and evolution" was organized by postdoc Christopher Frøhlich in October 2022.

About CANS

The Centre for New Antibacterial Strategies (CANS) is an interdisciplinary centre at UiT The Arctic University of Norway. CANS was established in 2019 and focuses on antimicrobial resistance activities encompassing:

- Research
- Education
- Innovation
- Dissemination

CANS includes 16 research groups located at three different faculties at UiT, the Faculty of Health Sciences, the Faculty of Science and Technology, and the Faculty of Bioscience, Fisheries and Economics. Since start-up, the focus has been on recruiting new tenure-track-, associate professor-, PhD- and postdoc positions, and to establish arenas for interactions and communication, publications and external funding.



Research communities and their expertise that form the basis for CANS

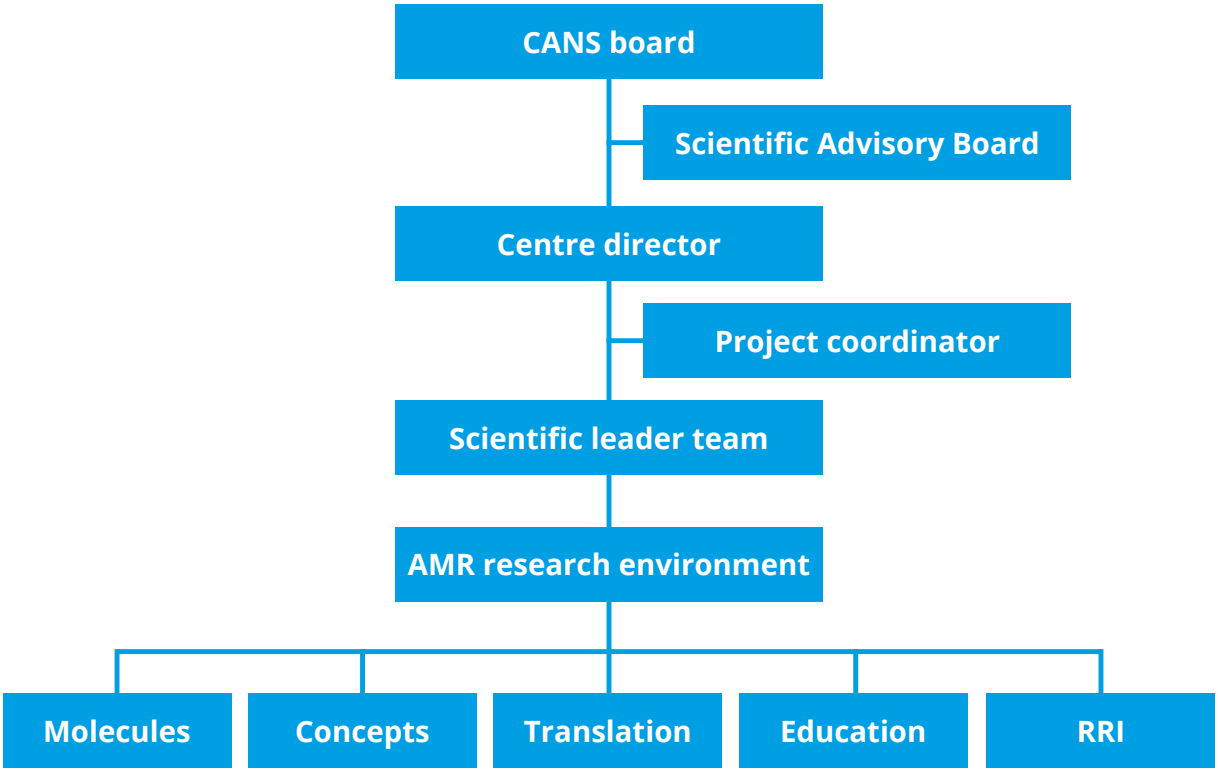
The development of CANS proceeds along three strategic axes - consolidation, fortification and direction.

Consolidation by creating and nurturing a framework for ambitious interdisciplinary collaboration, generated by a centre-structure with management and overreaching strategy. **Fortification** by adding resources to important but underdeveloped areas within the existing portfolio of activity. Finally, adding the **direction** to the AMR research by establishing new research initiatives filling the competence gaps that inhibit our ability to realize the strategy.

The centre aims to strengthen current activities, and this has been done by granting research groups at the different faculties internal PhD and postdoc positions. All together 3 PhD- and 5 postdoc positions has been granted.

The centre also aims to support new basic research in novel concepts for sustainable activities in AMR-prevention and treatment strategies. The establishment of new research areas has been done through new permanent and temporary (tenure-track, postdoc and PhD) positions in three missing research areas at UiT: human microbiota, viral bioprospection/phage therapy and bioinformatics/machine learning. The main goal is to generate knowledge to establish new and sustainable strategies in the prevention and treatment of bacterial infections that minimize the development of antibiotic resistance and maintain microbiome integrity.

CANS organization



CANS Board

The CANS board are made up of representatives from the three faculties and the Rector. The board is in charge of the overall direction of the centre.

Name	Faculty
Camilla Brekke, chair	Prorector, UiT
Gunbjørg Svineng	Dean, HVF
Jørgen Berge	Dean, BFE
Arne Smalås	Dean, NTF

Scientific Advisory Board

The scientific advisory board (SAB) consists of representatives from similar centres. The SAB will provide scientific input, evaluate CANS´ activity and provide strategic advice for future activities.

Name	Faculty
Denize Tasdemir	GEOMAR Helmholtz Centre for Ocean Research Kiel; Germany
Jörgen Johansson	Department of Molecular Biology, Umeå University, Sweden
Ursula Theuretzbacher	Center for Anti-Infective Agents, Vienna, Austria
Ben Howden	Microbiological Diagnostic Unit (MDU) Public Health Laboratory, Melbourne, Australia

Scientific leader team

The scientific leader team is formed of professors from the three faculties. The members hold a 10% operational role in CANS and provide academic support for the centre leader who is in a 50% position.

Name	Affiliation
Arnfinn Sundsfjord, Centre Leader	HVF
Pål J. Johnsen	HVF
Hanna-Kirsti Schrøder Leiros	NTF
Klara Stensvåg	BFE
Lise Nordgård, coordinator	HVF

CANS research groups

CANS´ 16 research groups are located at three faculties and covers different topics within AMR research: design and synthesis of new antibiotics and resistance inhibitors, marine bioprospecting – identification and characterization of new antibacterial activities, the evolution and molecular epidemiology of AMR, host-microbe-drug interactions as well as antibiotic stewardship.

Research group	Group leader
Antibiotic resistance breakers	Annette Bayer, Chemistry (IK)
Digibiotics	John S. Mjøen Svendsen, Chemistry (IK)
Drug Transport and Delivery research group	Natasa Skalko-Basnet, Pharmacy (IFA)
Health Data Lab	Lars Ailo Bongo, Informatics (IFI)
The Host-Microbe Interactions (HMI) group	Mona Johannessen, Medical Biology (IMB)
Identification and Prevention of Suboptimal medicine use	Lars Småbrekke, Pharmacy (IFA)
K-Res: Norwegian National Advisory Unit on Detection of Antimicrobial resistance	Kristin Hegstad and Ørjan Samuelsen, The University Hospital of North Norway (UNN)
The LacZymes group	Hanna-Kirsti S. Leiros, Chemistry (IK)
Marbio – an analytic platform for natural products	Jeanette Hammer Andersen, Fishery Science (NCFS)
Marine Bioprospecting	Klara Stensvåg, Fishery Science (NSFS)
Microbial Pharmacology and Population Biology	Pål J. Johnsen, Pharmacy (IFA)
Molecular Pharmacology and Toxicology	Ingebrigt Sylte, Medical Biology (IMB)
Natural Products and Medicinal Chemistry	Terje Vasskog, Pharmacy (IFA)
NORM – Norwegian organization for surveillance of antimicrobial resistance	Gunnar Skov Simonsen, The University Hospital of North Norway (UNN)
Oral ecology	Mohammed Al-Haroni, Clinical Dentistry (IKO)
Pediatric research group - Infection	Trond Flægstad and Claus Klingenberg, Clinical Medicine (IKM)

Three selected research projects

Group leader
Associate Professor
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Team members
Dr Yannik Karl-Heinz Schneider
Researcher

Hosea Masaki
PhD fellow

Sailesh Maharjan
PhD fellow

Chun Li
Shared

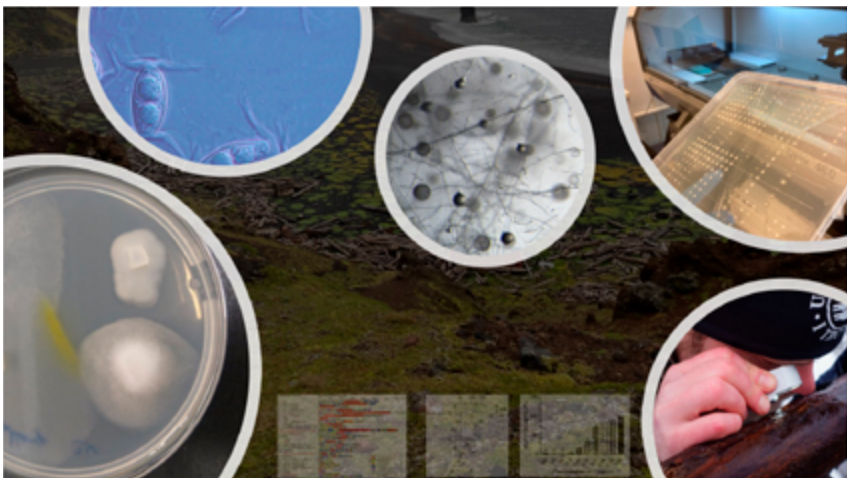
Marine Microbiome group

Background

Our team started at end of 2019 and is part of the Marbio Research Group. We have expertise in filamentous microbes including fungi and Actinobacteria, representing the most prolific sources of new chemical compounds sourced from the marine environment. Marine fungi, and particularly the obligate marine species are understudied and so diverse that they still can be considered as an untapped source for natural products discovery, whereas the more studied Actinobacteria still continue giving new compounds, in particular isolates from the arctic waters. We use microscopy, culturing, and culture-independent omics techniques to characterize marine microbiomes and detect new antibacterial compounds. We describe novel microbial diversity to science, and together with other teams at Marbio we isolate novel compounds, elucidate their structure and profile their bioactivity.

Research interests

Our main goal is to find and characterize novel antibacterial compounds and filamentous microbes from the marine environment. This requires advanced skills and knowledge in taxonomy, biosystematics and ecology of fungi and Actinobacteria. Proper characterization of the microbial producers is essential when setting up culturing trials for the discovery of new antibacterial compounds. We use two main strategies for extending the pool of microbial natural products: i) Activating silent gene clusters using varying culture conditions and chemical triggers to induce the production of new compounds and ii) Increasing the microbial cultivability to access natural products produced by previously unstudied microorganisms.



In the first approach, using omics techniques, including whole-genome sequencing, we can map the biosynthetic gene clusters that encode for natural products and thus reveal the biosynthetic potential of each cultivable strain we work with. This helps us to prioritize the strains we culture to express interesting biosynthetic gene clusters (BGCs) that may produce new antimicrobial compounds. The culturing is done at multiple scales following the OSMAC (One Strain Many Compounds) approach, where one strain is subjected to multiple culturing conditions that maximizes the chances of activating gene clusters. Whole-genome sequencing also allows us to link BGCs to compounds produced in culture and characterize the genetic machinery behind a particular natural product.

For increasing microbial cultivability, we apply growth factors, i.e. chemical cues, to induce the growth of previously uncultivable microorganisms so that we can culture them in the lab and access their properties. Growth factors are small molecules, such as siderophores, lipids but also certain proteins, that are often acquired from interacting microorganisms in co-cultures. Some hundreds of growth factors of fungi have been reported previously and many of these are commercially available for testing their usability in inducing the growth in marine mycobiomes. Additionally, we aim to identify growth factors in the marine environment that could be specifically used to induce the growth of marine microorganisms.

One of the most promising results from the group include the discovery of lulworthinone, that is a compound active against clinical methicillin-resistant bacteria (MRSA). Currently, we are investigating more than five isolated new microbial compounds for their bioactivity and biosynthesis, and several compounds are being isolated. Extracts and fractions of tens of microorganisms are produced and screened for new compounds. More than 20 microorganisms are investigated using whole genome sequencing or the OSMAC approach to activate silent BGCs and new microorganisms (Bacteria and Fungi) are being isolated from marine ecosystems, including the coast of northern Norway, arctic islands as well as the Arctic Sea and seabed. The discovery of new fungal and bacterial strains is done with a particular focus on the previously uncultivable strains or isolates from less explored environments.

Group leader
Associate Professor Veronika K. Pettersen
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Team members
Gaute Hovde Bø
Phd Fellow

Ahmed Bargheet
Phd Fellow

Human Microbiome group

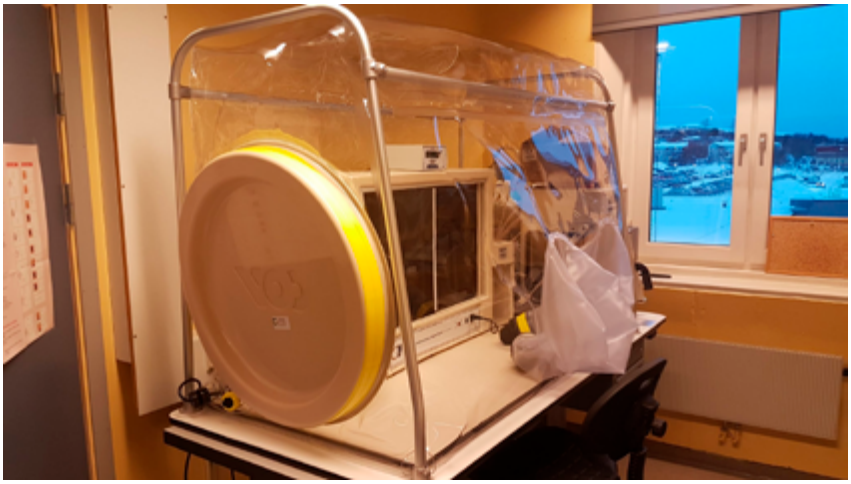
Background

Veronika has a broad background in biochemistry and microbiology. Originally from the Czech Republic, she received an MSc degree at the Technical University of Denmark and a PhD degree at the Norwegian University of Science and Technology (NTNU) in Trondheim. Her PhD work focused on optimising microbial expression systems for the production of recombinant proteins. After spending two years at the University of Bergen, working as a postdoctoral fellow in microbial proteomics, Veronika was awarded a mobility grant from the Norwegian Research Council and joined the University of Calgary in Canada for two years. She worked as a researcher in the lab of Marie-Claire Arrieta on a project that explored the role of gut fungal species in asthma development, and combined DNA sequencing of gut microbial communities, proteomics, and metabolomics, in addition to immunological and physiological studies of a gnotobiotic animal model.

Lab start-up at CANS-UiT

At CANS, Veronika holds a tenure-track associate professor position in human microbiome research. She and her team are part of the Host-Microbe Interaction Research Group (HMI, Medical Biology Dept.) and Paediatric Research Group (Clinical Medicine Dept.), where they study the gut microbiome and its contribution to health and disease.

Veronika uses her specialisation in mass spectrometry-based omics, metabolomics and proteomics, for the description of gut microbiome functions. She combines these functional approaches with DNA sequencing methods, such as metagenomics and amplicon sequencing, which serve as a blueprint of the microbial community structure. Her main research interest is the characterisation of the gut microbiome biochemical functions in infancy and pregnancy. The research goal is to translate the knowledge of gut microbiome functions into strategies for disease prevention and treatment.



The team, composed of PhD, MSc and Bc students, is using the lab infrastructure of the HMI group and collaborates tightly with the Proteomics and Metabolomics Core Facility (PRiME) at UiT. Thanks to CANS funding, Veronika purchased an anaerobic chamber in 2021, which is the team's workhorse for culturing and characterisation of gut anaerobic bacteria, such as beneficial probiotic strains of the *Bifidobacterium* species.

Current projects

The group is currently involved in projects exploring how the gut microbiome mediates colonisation resistance against drug-resistant pathogens, how it is linked to cancer development in childhood, and how the maternal gut microbiome influences the infant's gut microbiome and immune development.

A flagship research project is a collaboration with researchers at the Universities of Bergen, Stavanger and Tromsø (UiT/UNN), as well as Tanzanian researchers. The work investigates the effects of probiotic therapy in Tanzanian children and its potential to prevent infections by ESBL-producing Enterobacterales (ProRIDE: Probiotics to Reduce Infections and Death and Prevent Colonization with ESBL- producing bacteria). The main objective is to determine if probiotic use leads to a reduction in ESBL-E gut colonisation and decreases infant morbidity and mortality. A secondary objective is to describe changes in faecal metabolites and microbial composition in association with probiotic use, drug-resistant strain colonisation, and a risk of infection.

Another ongoing project, funded by Barnekreftforeningen, is a collaboration between the Paediatric Research group at UiT, Norwegian Childhood Cancer Biobank, and researchers from the Centre for Ecological and Evolutionary Synthesis at the University of Oslo. This project explores the compositional variation of the gut microbiome in paediatric cancer patients. By using DNA sequencing methods and metabolite profiling, the researchers will characterise features of the gut microbiome associated with cancer diagnoses in children. The goal is to describe microbiome-based markers that discriminate cancer cases from healthy controls and microbial metabolites that can serve as diagnostic biomarkers in therapeutic explorations.

Finally, the team is leading a project funded by The Centre for Advanced Study (CAS) at The Norwegian Academy of Science and Letters. This project connects experts in microbiology, clinical science, epidemiology, and bioinformatics, which together discuss a roadmap for translational microbiome research. A sequence of workshops in 2022 examined current microbiome-focused mother-child population studies, analytical and computational approaches for mining microbiome data, and experimental models for defining causality. In a subsequent research stay that is scheduled for August and September 2023, a core group of researchers will formulate review manuscripts based on the workshops and develop joint proposals investigating mother-to-child microbial transmission, drivers of infant gut microbial colonisation, and the impact of antibiotic use on this process.

Project leader
Professor John Sigurd Mjøen Svendsen
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DigiBiotics:
https://site.uit.no/antibiotics/

Team members
WP1 Biodiscovery
Jeanette H. Andersen, WP leader

WP2 Organic synthesis
John Sigurd Mjøen Svendsen, WP leader

WP3 Optical spectroscopy and ab initio calculations
Kenneth Ruud, Wp leader

WP 4 NMR spectroscopy
John Isaksson, WP leader

WP 5 Molecular dynamics simulations
Bjørn Olav Bransdal, WP leader

WP 6 Activity and resistance studies
Johanna E. Sollid, WP leader

DigiBiotics

Antimicrobial peptide activity towards *E. coli* – how the antimicrobial efficacy is a consequence of a "Goldilocks dilemma"

DigiBiotics is a large research consortium at UiT built on several RCN projects and strategic funding. The consortium with John S. Mjøen Svendsen as PI, spans three faculties and with Jeanette Hammer Andersen, Johan Isaksson, Kenneth Ruud, Bjørn Olav Brandsdal and Johanna U. Ericson as work package leaders. Among the goals of DigiBiotics is the creation of a novel experimental pipeline for the study of how "Middle space molecules" (i.e., antimicrobial peptides or AMPs) interacts with bacteria. We are currently finishing the development of one such pipeline and report the results on how cationic antimicrobial peptides work on E. coli.

The problem at hand is the following: four decades of intensive research has failed to provide a thorough understanding of the mode of action for AMPs on bacteria, in particular Gram-negative strains. The general theory is that AMPs kills bacteria by interacting with the cell membrane, but few details on the How and Why is known. In contrast, we know quite well how to design active AMPs. Research from UiT has previously established a minimum motif, a pharmacophore, for AMPs. This is surprisingly small, 6 amino acids are enough, preferably containing 3 lipophilic and bulky residues like tryptophan and 3 cationic residues selected from lysine or arginine.

Designing AMPs with a "fixed" 3D-structure by making cyclic hexapeptides enabled us to understand the interaction between the peptides and the bacteria in molecular or even atomic detail. The design was based on three principles:

1. The peptides are balanced, i.e., the number of tryptophan = number of cationic residues
2. The sequence is clumped (where all tryptophan residues are consecutive in the sequence) or alternating
3. The cationic residues are either all lysine or all arginine

All in all, this design will create 4 peptides.

To our great surprise, these 4 peptides displayed a large variation (usually 8 to 32-fold) in their antimicrobial activities against *E. coli* strains (see the Table) despite all adhering to the pharmacophore. The arginine peptides were slightly more active than their Lysine counterparts, and the "clumped" sequences were surprisingly more active than their alternating analogs. Why is it so?

AMP	MIC (µg/ml)	
	E. coli ATCC 25922	E. coli CCUG 70662-
c(WKWKWK)	64	64
c(WRWRWR)	32	16
c(WWWKKK)	8	4
c(WWWRRR)	8	8

Table. The antimicrobial activity of cyclic hexapeptides against two strains of E. coli. W=tryptophan, K=lysine and R=arginine.

Conventionally, studies of AMPs interacting with membranes are performed on membrane models like liposomes or vesicles, where surface plasmon resonance, SPR, is one of the gold standards for measuring peptide binding strength. We also started the study using SPR, on neutral, anionic and even LPS (lipopolysaccharide) containing membranes trying to create a series of increasingly realistic mimics of the Gram-negative outer membranes. But disappointingly, moving from the simplest (non-physiological) to more realistic models did not improve the fit of the efficacy pattern. On the other hand, the experiments did reveal the general trend that all the cationic peptides bound more effectively to the anionic membranes, but the arginine containing peptides bound even more effectively to the LPS-membranes than the lysine peptides. In addition, the SPR-experiments revealed that the improved binding observed with the LPS-vesicles was due to slower release of the bound peptide from LPS, rather than a more rapid binding.

The experiments show that after the initial binding to the LPS-layer, active AMPs are subsequently transferred towards the inner leaflet of the membrane. Even if lysine peptides are released more rapidly from the LPS, arginine peptides bind more strongly to the phospholipids in the membrane, and hence are more active when bound. In short, AMPs need to find their 'Goldilocks' zone of LPS affinity, where the interaction is not too tight, not too loose, but "just right". While this seems to be a good principle, our concern is that the SPR model fails to explain the difference in activity of the peptides.

The downside with SPR and other comparable experimental models is the lack of realism. AMPs are supposed to kill bacteria, not just bind to carefully composed vesicles. A true gold standard model would be the interaction between the AMP and a live bacterium. To measure details of the binding events, like in the SPR experiments, we titrate an AMP with live *E. coli* and monitor the interaction with NMR, a technique called live cell NMR. In the live cell experiments we not only confirm the findings from SPR-experiments, but also obtain unique binding data. NMR allows observation of each individual hydrogen atom in the peptides, and from our experiments we deduced that not all hydrogens participated equally in the binding. The experiments suggest that the cyclohexapeptides with alternating sequences bind to the membranes flat-on, just like a coin on the table. The clumped sequence AMPs, on the other hand bind on the perimeter like a coin balancing on its edge. The clumped arginine sequence c(WWWRRR) appears to be buried deeper than the lysine peptide c(WWWKKK), hence causing more membrane disturbance.

We are now approaching a near atomic resolved mode of action (MOA) model of how the cyclic peptides kills *E. coli* bacteria. Their MOA involves a primary interaction between the cationic peptides and the anionic LPS. The arginine peptides bind more strongly to the LPS and are hence less effectively translocated towards the phospholipids in the outer membrane. On the other hand, when the arginine peptides, particularly the clumped derivatives, succeed in reaching the outer membrane bilayer, they interact more strongly. Thus, we suggest the following explanation for the sequence in MIC-values. The LPS outer leaflet is both a target and a barrier for the peptides. The least active peptide c(WKWKWK) is efficiently transferred from LPS to the membrane but fails to bind effectively, c(WRWRWR) is less efficiently transferred from LPS, but despite a quite an effective binding, the "flat on" binding mode fails to disturb the membrane. The clumped peptides bind edge on, with the c(WWWRRR) buried deeper than the c(WWWKKK) peptide. Still, these two peptides display a similar antimicrobial activity against *E. coli*. Further investigations will follow to dissect the AMP-membrane interactions and subsequent killing of the bacterial cell.

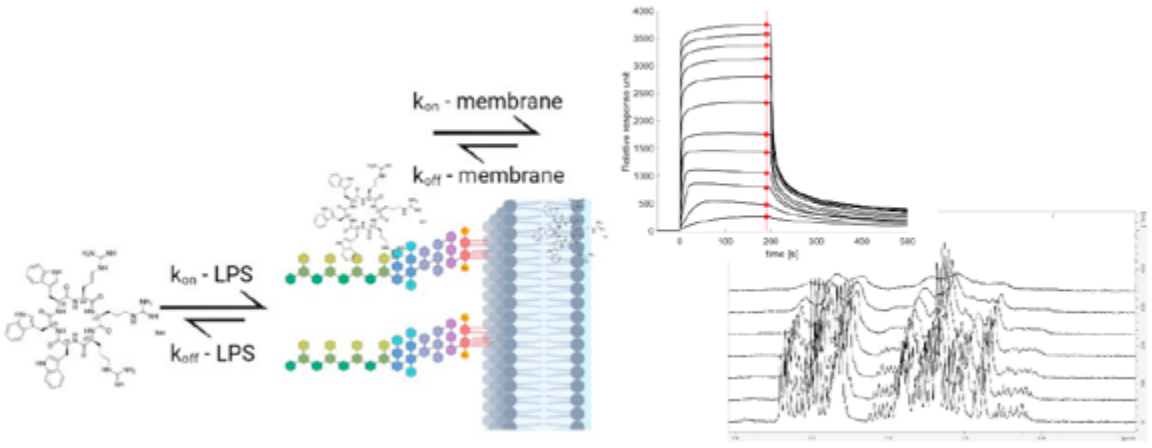


Figure. The kinetic model of AMP action, example SPR data and NMR-spectra.

Education and training

PhD thesis completed

Name	Research group	Title of PhD-thesis
Tracy Munthali Lunde	Oral ecology	Antibiotic Resistance in Oral Streptococci: The prevalence, diversity, stability, and fitness cost of Tn916 -Tn1545 family in oral streptococcal isolates
Dina Benedicte Berg Sensen	UNN and ISM	Sex-steroids and social network in relation to Staphylococcus aureus nasal carriage.
Marte Jenssen	Marbio	Bioprospecting of marine microorganisms for the discovery of antibacterial compounds - Isolation, structure elucidation and bioactivity assessment of marine microbial natural products
Ida Kristine Østnes Hansen	Marine Bioprospecting group	Antimicrobial peptides from the Arctic ascidian Synoicum turgens
Manuel Langer	Bayer Lab	Marine natural product inspired synthesis towards new antimicrobial and antifouling agents.
Lisa Myrseth Hemmingsen	Drug Transport and Delivery group	Advanced topical delivery systems for membrane-active antimicrobials. Exploring nature to improve antimicrobial wound therapy
Erik Juskewitz	Host Microbe Interaction	Antimicrobial activity and mode of action
Anlaug Vatne	Ped info	Sepsis and antibiotic exposure in the neonatal period

Master's thesis completed

Name	Research group	Title of master thesis
Andreas M. Augustinussen	Bayer Lab	Design and Synthesis of Antimicrobial Resistance Breakers – A Library of NDM-1, VIM-2 and KPC-2 inhibitors
Mari Salamonsen	Drug Transport and Delivery group	Dual delivery of chlorogenic acid and mimic of antimicrobial peptide – towards wound treatment
Vegård Borøy	Drug Transport and Delivery group	Development of DNA Nanoparticles with Properties for Enhanced Biofilm Uptake
Pimmat Panchai	Drug Transport and Delivery group	Chitosan-modified liposomes for delivery of membrane-active antimicrobials – exploring the role of the polymer
Nadia Aftab	Host Microbe Interaction	
Sofie Høyforslett	Host Microbe Interaction	
Jan Niklas Mentzen		Empirisk antibiotikabehandling av nedre urinveisinfeksjoner hos ikke-gravide fertile kvinner. En sammenlignede undersøkelser av nasjonale retningslinjer
Sigrid Sandli	Host Microbe Interaction	
Nina Nevjar Martinsen	LacZymes	Effects of single and multiple OXA-48 mutants on enzyme activity, stability, and structure-activity relationship. Evolutionary consequences of antibiotic resistance development caused by OXA-48
Marte Strømmen	Marine Bioprospecting group	The effect of microplastic on natural transformation and biofilm formation using Acinetobacter baylyi as a model organism

Name	Research group	Title of master thesis
Elise Heimland	ArcticZymes and Marbio	Exploring the biotechnological potential of the secretome from the marine fungus Digitatispora marina
Elen Lwin	Ped Info	Staphylococcus haemolyticus – betydningen av kapsel og biofilmdannelse for immunrespons
Bjørn Martin Broback	Ped Info	Infeksjoner med Viridans gruppe streptokokker hos nyfødte og immunsupprimerte barn
Jonas Fundingsrud	Ped Info	Febrile neutropenia in pediatric cancer patients
Johannes Frydenlund	Natural Products and Medicinal Chemistry	
Bielul Haileab	Natural Products and Medicinal Chemistry	

Bachelor's degrees completed

Name	Research group
Arthur Kruse Sørensen	Marine Bioprospecting group
Isabel Victoria Rey	Marine Bioprospecting group
William Mosnes Bjelland	Marine Bioprospecting group
Kaisa W Haukebø	Marine Bioprospecting group
Yasir Habibi	Marine Bioprospecting group
Maria Austerheim	Marine Bioprospecting group
Eystein Lie Asdal	Marine Bioprospecting group
Anna Oppegård	Marine Bioprospecting group
Simen den Grove	Marine Bioprospecting group
Maria Tran Tu Pham	Marine Bioprospecting group
Kari-Marie Wedelberg Jarlsberg	Marine Bioprospecting group
Antonette Skram Helgestad	Molecular Pharmacology and Toxicology

External funding initiatives

In 2022, CANS applied for funding from different external funds. The table shows the projects that were granted funding. Of more than 20 application initiatives, 11 has been funded and four are still pending.

National funding

Research group	Title	Programme	Status
Marbio	Characterising Oomycetes in Brown Algae along the Norwegian Coast (OOMYCOAST),	Norwegian Biodiversity Information Centre	Funded
	Norske marine sopper	Norwegian Marine Fungi, Norwegian Biodiversity Information Centre	Funded
Ped Info	Klinisk og mikrobiologisk betydning av Staphylococcus borealis	NORM - Norsk overvåkingssystem for antibiotikaresistens hos mikrober	Funded
	Application for PhD student	Dam stiftelsen	Pending
	Use of Probiotics to Reduce Infections and Death and Prevent Colonization with Extended-spectrum beta-lactamase (ESBL) producing bacteria among newborn infants in Tanzania – The ProRIDE Trial	NORM - Norsk overvåkingssystem for antibiotikaresistens hos mikrober	Funded
The Host-Microbe Interaction	Compositional and metabolic changes of the gut microbiome in childhood cancers	Erna og Olav Aakres stiftelse	Funded
	Mapping adaptive changes to antimicrobial resistance to cefiderocol	NORM - Norsk overvåkingssystem for antibiotikaresistens hos mikrober	Funded
	Staphylococcus aureus responses to a human host and vice versa	Stiftung Alfried Krupp Kolleg Greifswald	Funded
	Title (CL)	RCN Forskerprosjekt Fornyelse	Pending
	Closing the diagnostic gap in adaptive antimicrobial resistance of multi-drug resistant Gram-negative pathogens	Helse Nord	Funded

Regional funding

Research group	Title	Programme	Status
Ped Info	Klinisk og mikrobiologisk betydning av Staphylococcus borealis.	Helse Nord	Funded
	Funding for PhD student Aline Bjerkhaug "Immunometabolism in neonatal sepsis"	Helse Nord	Funded
	OPTIMIST-Optimizing mastitis identification and treatment	Helse Nord	Funded

International funding

There has been several ERC initiatives from the newly recruited Associated professors in CANS.

Research group	Title	Programme	Status
Haugland lab	Organic persistent and stable radicals for catalysis and materials	Horizon Europe, ERC Starting Grant (2023 call)	Pending
MicroPop (partner)	Title	ERC SyG	Not funded
Drug transport and delivery group	Title	Horizon Europe, ERC Starting Grant	Pending

Meeting of Nordic Centers on Antimicrobial Resistance

Participants from the different Nordic AMR centers. From CANS: Arnfinn Sundsfjord, Klara Stensvåg and Lise Nordgård. (Photo: Eva Garmendia)

CANS was invited by Dan Andersson, center leader at the Uppsala Antibiotic Centre (UAC – Uppsala Sweden), for a two day meeting together with other Nordic AMR centers. All the centers were presented during the meeting. In addition, a discussion about how the Nordic AMR centers can collaborate was on the agenda.

The centers that participated in the meeting in Uppsala:

- Uppsala Antibiotic Center (UAC - Uppsala, Sweden) – Host for the meeting
- Umeå Center for Microbial Research (UCMR– Umeå, Sweden)
- Center for Antibiotic Resistance Research (CARe – Göteborg, Sweden)
- International Center for Antimicrobial Resistance Solutions (ICARS – Copenhagen, Denmark)
- Multidisciplinary Center of Excellence in Antimicrobial Resistance Research (MCEARR – Finland)
- Turning the Tide of Antimicrobial Resistance (TTA – Oslo, Norway)
- Combatting Anti-Microbial Resistance with Interdisciplinary Approaches (CAMRIA – Bergen, Norway)
- Center for New Antibacterial Strategies (CANS – Tromsø, Norway)

Outreach activities

The research has been communicated to both the scientific and the general public in different ways. Outreach activities includes meetings, publications, regular scientific seminars with invited- or internal speakers.

CANS seminars

The CANS seminars are a valuable platform for invited speakers and CANS researchers to present and discuss different areas within AMR research. In 2022, CANS hosted 12 seminars with international speakers as well as internal speakers.

	Speaker	Title of presentation
1	Guido Werner, Robert Koch Institute, Wernigerode Branch, Germany	Resistances to last resort antibiotics in hospital pathogens - introducing aspects of the work of a National Reference Centre
2	Prof. Octavio Luiz Franco, Universidade Católica Dom Bosco, Campo Grande, MS, Brazil	In silico optimization of antimicrobial peptide enables combinatorial exploration for novel compounds with anti-infectious activities
3	Professor Stephen Bentley, Department of Medicine, Cambridge Infectious diseases and the Wellcome Trust Sanger Institute	Digging deep into pathogen genomic data
4	Phillip Zanger, Professor Heidelberger Institut für Global Health	Global Epidemiology of TMP/SMZ-resistance in S. aureus
5	Moa Persson, Sales manager Symcel	Introduction to the calScreener- How simple metabolic measurements reveal hidden behaviors in biological systems
6	Daniel Lopez, Principal investigator, Spanish National Research Council CNB-CSIC, Madrid, Spain (May 2022)	THE INDUCTION OF NATURAL COMPETENCE ADAPTS STAPHYLOCOCCAL METABOLISM TO INFECTION
7	Marc J.M. Bonten, Professor of Molecular Epidemiology of Infectious Diseases | Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht	Tales of the unexpected on antibiotic resistance
8	Nicholas Feasey, Professor of Clinical Microbiology, Liverpool School of Tropical Medicine and Malawi Liverpool Welcome Research Program, Kamuzu University of Health Sciences	Antimicrobial resistance in Africa, a view from Malawi
9	Associate professor Teppo Rämä, UiT	Norwegian marine fungi as a source for new antibacterial compounds
10	Associate professor Pauline Cavanagh, UiT	Staphylococcus borealis - The new kid on the block
11	Associate professor Endre Anderssen, UiT	Strategies for analyzing large data sets in bioinformatics. Is there a way out of the tyranny of the P-Value?
12	Prof. Dr. Anna K. H. Hirsch, Head, Department of Drug Design and Optimization (DDOP), Helmholtz Institute for Pharmaceutical Research Saarland	Addressing unexplored anti-infective targets

Human Microbiome Symposium

Veronika K. Pettersen, associate professor in CANS, invited to a one-day symposium featuring international experts on the human microbiome, 30th May 2022. The symposium was arranged as a collaboration between the Centre for New Antibacterial Strategies (CANS) and Pettersen's Center for Advanced Study (CAS) project "Infant Gut Microbiome Acquisition: Off to a Healthy Start." Among the main topics will be how the gut microbiome modulates pregnant women's and neonates' health.

Interdisciplinary symposium on AMR and evolution

Christopher Fröhlich, Postdoc in CANS, organized an interdisciplinary workshop on AMR and evolution 14th October. The idea with the symposium was to bring together PhDs, postdocs and researchers from different areas within the field, ranging from AMR including methods to fight AMR as well as general evolution and protein chemistry. The programme included speakers from CANS but also a keynote lecture with an invited external speaker. In the end of the symposium there was time for pizza and mingling!

Media coverage

Popular science communication channels in 2022

- uit.no
- forskning.no/forskersonen.no
- sciencenorway.no
- Dagens Medisin
- Aftenposten
- nrk.no
- Facebook
- Twitter
- YouTube
- Vitensenteret (The National Science Week)
- Lørdagsuniversitetet
- Prelaten
- Internal CANS newsletter

Research group(s)	Title/Journal/website/location
Drug transport and delivery	Fra rekeskall til sårbehandling, *uit.no*
	Stoff i rekeskall hjelper sår til å gro. *Forskersonen.no*
	Fat bubbles and DNA help sneak antibiotics into biofilms, Prelaten/Pint of Science
	Vikingen Sigurd døde da tennene til en død mann skrapte borti leggen hans, *ung.forskning.no*
	Dagen da Sigurd Viking døde av en bakterieinfeksjon, *YouTube*
	Nanocarriers are the Trojan horses of antibiotics, *sciencenorway.no*
	Nanocarriers are the Trojan horses of antibiotics, *Forskerhjørnet*
Host Microbe Interaction	Stands in «Forskningstorget» at The National Science Week, Vitensenteret, Tromsø
	Antibiotikaresistens - hva er det og hva gjør vi med det? Forskning på nye antimikrobielle strategier, *The National Science Week/Skoledagen*
	Lentz, Christian; Wagner, Theresa; Singh, Bhupender; Uddin, Md Jalal; Hovde Bø, Gaute; Grunnvåg, Jeanette; Pettersen, Veronika K. The Stand "Bli med... som mikrobejeger" på Forskningstorget i Tromsø, *Forskningstorget* in Tromsø, Nordnorsk vitensenter, The National Science Week; September 25, 2022 Johannessen M. Foredrag ungdomsskoleelever. Antibiotika-resistens- Hva er det og hva gjør vi med det? Forskning på nye antimikrobielle strategier
	UNN-forskere oppdaget ny mekanisme for antibiotikaresistens. *Dagens Medisin, November 18, 2022*
K-res	UNN-forskere oppdaget ny mekanisme for antibiotikaresistens, *Dagens Medisin*
LacZymes	Vi må kanskje ta antibiotika hyppigere, *uit.no*
	Kor ofte skal du ta antibiotika? Kanskje oftare enn vi gjer no, ifølge forskarar, *nrk.no*
Marbio	Jaktar på medisinar i havet, *uit.no/labyrint*
Marbio, Marine Bioprospecting	Medisiner fra havet - åpne foredrag, *Forskningsdagene/Linken møtesenter* Kan forskerne finne medisiner som kan erstatte antibiotika eller drepe kreftceller? Lunsjforedrag. Bli med fire UiT-forskere på ei reise under havoverflata i jakten på nye medisiner!
Marine Bioprospecting	UiTs aller første bakteriofager, *uit.no*
	Lørdagsuniversitetet: Havet som kilde til nye medisiner, *Lørdagsuniversitetet/ Rødbanken*
MicroPOP	Kreftmedisin kan gi antibiotikaresistens, *YouTube*
	Cancer chemotherapy can lead to antibiotic resistance, *YouTube*
	Kreftmedisin kan gi antibiotikaresistens, *forskning.no*
	Can cancer drugs make bacteria antibiotic resistant?, Prelaten/Pint of Science
	En vanlig myte rundt antibiotikaresistens er at antibiotikaresistens er når kroppen slutter å reagere på antibiotika, *Facebook/UiT Norges arktiske universitet*
Oral ecology	Du har seks milliarder bakterier i munnen. Flere av dem er resistente mot vanlige bakteriedrepende midler, *forskning.no*
Pediatric research group	https://animalmicrobiome.biomedcentral.com/articles/10.1186/s42523-022-00163-2
	Ikke den jevne amerikaner. *Kortnytt uit.no*
Project management	Norge har for dårlig antibiotikaberedskap, *Aftenposten*

The European Antibiotic Awareness day

We decided to utilise the European Antibiotic Awareness Day on 18 November to give extra attention to the problem of rising AMR, as well as the research efforts to combat the problem. The campaign was inspired by the Norwegian Cancer Associations longstanding work with using these special dates to focus of various cancer diseases.

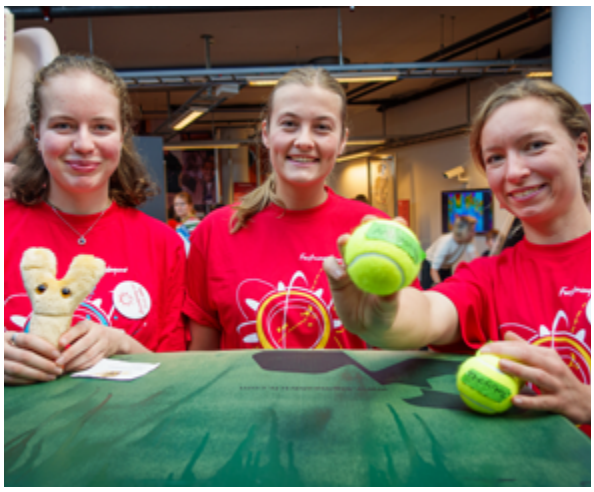
Our efforts included a news item in Dagens Medisin describing a new breakthrough in the hunt for genetic bacterial resistance mechanisms, and a chronicle in Aftenposten raising awareness on Norway's lack of preparedness in antibiotic availability. The work at CANS and The Antibiotic Awareness Day was also mentioned in "Rektor's kvarter" on Friday 18, and the info screens at the Faculty of Health Sciences featured a group picture of CANS researchers and management urging others to high five a microbial hunter. This post was also published on the Faculty's Facebook page.

Through these measures we managed to reach diverse stakeholders such as clinicians and health leaders nationwide, policy makers, UiT staff and leadership, and students at Helsefak.

The National Science Week (Forskningsdagene)

The main theme of 2022's National Science Week (22 September - 2 October) was the ocean, perfectly suited for CANS research groups such as Marbio and Marine Bioprospecting. Both groups, as well as the Host-Microbe Interaction group, participated in various outreach activities such as the science fair (Forskningstorget) at The Science Centre (Vitensenteret) in Tromsø, lectures on AMR for secondary school students, and presentations at the Linken conference venue.

Through The National Science Week we were able to reach out to kids, families, youngsters, and other research communities.



Scientific Publications

1. Adade NE, Aniweh Y, Mosi L, Valvano MA, Duodu S and Ahator SD (2022) Comparative analysis of Vibrio cholerae isolates from Ghana reveals variations in genome architecture and adaptation of outbreak and environmental strains. Front. Microbiol. 13:998182. https://doi.org/10.3389/fmicb.2022.998182

2. Ahator SD, Sagar S, Zhu M, Wang J, & Zhang LH (2022). Nutrient Availability and Phage Exposure Alter the Quorum-Sensing and CRISPR-Cas-Controlled Population Dynamics of Pseudomonas aeruginosa. Msystems, 7(4), e00092-22. https://doi.org/10.1128%2Fmsystems.00092-22

3. Ahator, SD, Liu Y, Wang J and Zhang L-H (2022) The virulence factor regulator and quorum sensing regulate the type I-F CRISPR-Cas mediated horizontal gene transfer in Pseudomonas aeruginosa. Front. Microbiol. 13:987656. https://doi.org/10.3389/fmicb.2022.987656

4. Choonara FE, Haldorsen BC, Janice J, Mbanga J, Ndhlovu I, Saulosi O, Maida T, Lampiao F, **Simonsen GS,** Essack SY, **Sundsfjord A.** Molecular Epidemiological Characterisation of ESBL- and Plasmid-Mediated AmpC-Producing *Escherichia coli* and *Klebsiella pneumoniae* at Kamuzu Central Hospital, Lilongwe, Malawi. Trop Med Infect Dis. 2022 Sep 14;7(9):245. doi: 10.3390/tropicalmed7090245.

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Other Publications (Workshops, meetings, conferences)

1. Ajayi C, Uddin, Jalal MD, Lentz Christian, Johannessen, Mona. Poster. Activity-based protein profiling of Staphylococcus aureus exposed to blood. Norwegian Biochemical Society (NBS) 2022

2. Ahator SD, Kristin Hegstad, Christian S Lentz, Mona Johannessen. Identification of Kinases involved in bacterial-host interaction using activity-based probe profiling, Norwegian Biochemical Society (NBS) 2022

3. Bargheet A, Eirin Esaiassen, Erik Hjerde, Jorunn Pauline Cavanagh, Johan Bengtsson-Palme, Claus Klingenberg, Veronika K Pettersen. Probiotic treatment reshapes antibiotic-impaired gut microbiota, resistome, and mobilome networks in extremely preterm infants, 2022 Keystone symposia, Banff, Canada

4. Bargheet A "Gut microbiota and antibiotic resistome changes in the first year of life of preterm infants supplemented by probiotics while at NICUs" Oral flash talk presentation at the 57th NBS Contact Meeting, Tromsø at (10-02-2022).

5. Bargheet A "The effect of probiotic use on preterm infants' mobilome and resistome". Human Microbiome Mini-Symposium – Pregnancy and Early Life, Tromsø at (30-05-2022).

6. Bargheet A '' Probiotic supplementation reshapes antibiotic-impaired gut microbiota, resistome, and mobilome networks in extremely preterm infants" IBA annual meeting, Oslo at (27-10-2022).

7. Bargheet A ''Probiotic supplementation reshapes antibiotic-impaired gut microbiota, resistome, and mobilome in extremely preterm infants" CAS (Centre for Advanced Study) at the Norwegian Academy of Science and Letters in Oslo at (02-11-2022) Online presentation.

8. Bastakoti S, Clement Ajayi, Kjersti Julin, Mona Johannessen, Anne-Merethe Hanssen. Poster IBA Oslo TRANSCRIPTOMIC PROFILING OF STAPHYLOCOCCUS AUREUS CO-CULTURED WITH STREPTOCOCCUS ANGINOSUS AND TONSILLAR CELLS

9. Bastakoti S, Oral presentation Institute of basic medical science, Jukka Corander research group. "Explore bacterial gene expression analysis"

10. Bril'kov, Maxim; Cavanagh, Jorunn Pauline; Isaksson, Johan M.; Ericson, Johanna U.; Gøril Eide Flaten. Bacterially produced in vitro membrane model systems from resistant- and non-resistant clinical isolates. NordicPOP Annual meeting 2022; 2022-08-10 - 2022-08-12, poster

11. Bø GH. "Investigating the impact of antibiotic and probiotic use on the early life human gut microbiome: A metabolomic approach" Oral flash talk presentation at the 57th NBS Contact Meeting, Tromsø.

12. Bø GH, Sietske S. Grijseels, Marie Mardal, Terje Vasskog and Veronika K. Pettersen. "Quantitation of 13 short-chain fatty acids in meconium from term-born infants by UHPLC-MS/MS". Poster presentation at the 2nd Nordic metabolomic Conference 2022, Copenhagen.

13. Bø GH, Sietske S. Grijseels, Marie Mardal, Terje Vasskog and Veronika K. Pettersen. "Absolute quantification of short-chain fatty acids in meconium using liquid chromatography-mass spectrometry" Online poster presentation at the 11th Microbiome Interactions in Health and Disease meeting 2022, United Kingdom.

14. Bø GH, , Sietske S. Grijseels, Marie Mardal, Terje Vasskog and Veronika K. Pettersen. "Absolute quantification of short-chain fatty acids in meconium using liquid chromatography-mass spectrometry" Poster presentation at the Annual IBA meeting 2022, Oslo.

15. Cañadas RAN (2023) Social network analysis of Staphylococcus aureus carriage in a general youth population. Poster presentation, CANS day, 2023.

16. Christensen M, PhD student. THE ROLE OF CAPSULE VARIANTS IN *STAPHYLOCOCCUS HAEMOLYTICUS* ON IMMUNE RESPONSE AND BIOFILM PRODUCTION, IBA 2022

17. Christensen M, PhD student, Posterpresentation. THE ROLE OF CAPSULE VARIANTS IN *STAPHYLOCOCCUS HAEMOLYTICUS* ON IMMUNE RESPONSE AND BIOFILM PRODUCTION, Eurobiofilms, 2022.

18. Dey, H., D. Simonovic, I.S.N.-S. Hagen, T. Vasskog, E.G.A. Fredheim, H.-M. Blencke, M.B. Strøm, and T. Haug, Antimicrobial Activity and Mode of Action Study of Short Analogues of The Marine Antimicrobial Peptide Turgencin A, in Antibiotics and Antibiotic Resistance Course. 2022: Gothenburg.

19. De Freitas Almeida, G.M (2022) Phage-bacteria interactions in mucosal conditions. 12th annual Oxford bacteriophage conference. Oxford, England. 2022

20. De Freitas Almeida, G.M (2022) Mucosal interactions as a bridge between past and future prophylactic phage therapy. 9th Beneficial Microbes Conference. Amsterdam, Netherlands. 2022, online.

21. De Freitas Almeida, G.M (2023) Including viruses of microbes as a resource for marine bioprospection. CANS day. Norway. 2023

22. De Freitas Almeida, G.M (2022) Viruses of microbes: the next frontier for marine bioprospection? BFE breakfast club. Norway. 2022

23. De Freitas Almeida, G.M (2022) Bioprospecting potential of Marine Viruses. Seminar on Marine biotechnology, marine bioprospecting and antibiotic resistance. Norway. 2022.

24. De Freitas Almeida, G.M (2022) The forgotten tale of Brazilian phage therapy. XXXIII Brazilian Virology meeting. 2022, online.

25. De Sousa, Alexandra, Julin, Kjersti; Bayer, Annette; Strøm, Morten Bøhmer; Johannessen, Mona; Skalko-Basnet, Natasa; Obuobi, Sybil Akua Okyerewa. DNA Nanocarriers for improved biofilm penetration. Nordic POP Workshop - Advances in Skin Therapy; 2022-06-06 - 2022-06-09, Poster

26. Fröhlich C. ECCMID, april 2022, Lisboa. "Positive epistasis drives the molecular evolution of the carbapenemase OXA-48". Co-authors: C. Frohlich, A.H. Bunzel, A.J. Mulholland, M.W. Van Der Kamp, H.K.S. Leiros, P.J. Johnsen, N. Tokuriki. Oral presentation

27. Haug, T., How can antibacterial peptides become a new source for novel antibiotics?, in Marine biotechnology, marine bioprospecting and antibiotic resistance. 2022: Tromsø.

28. Haug, T., Isolation and characterization of antimicrobial peptides and alkaloids from marine invertebrates, in Conference in Marine Biotechnology 2022 - Marine Products for Health. 2022.

29. Hauglad MM (2022)"Late-stage functionalization for antibiotic conjugation, development of a synthetic method for the introduction of flexible terminal alkynes onto complex molecules using photoredox catalysis" IBA annual conference. Poster presentation

30. Heim A von BT, Janice J, Bjørnholt JV, Lunestad BT, Hegstad K, Svanevik CS. Enterococci in marine bivalves from Norway – where do they come from and should we be concerned? Poster 13th International Meeting on Microbial Epidemiological Markers (IMMEM), Bath, UK

31. Hegstad K. Tigesyklinresistens hos enterokokker i Norge. Invited speaker NORM dagen 23. November 2022, Gardermoen, Norway

32. Hegstad K. Vancomycin variable resistant enterococci. Invited speaker Online Post-ECCMID day. 32nd ECCMID, Lisbon, Portugal

33. Hemmingsen, Lisa Myrseth; Flaten, Gøril Eide; Strøm, Morten B.; Skalko-Basnet, Natasa. Membrane-active antimicrobials – in synergy with nature – the role of chitosan. NordicPOP Annual Meeting 2022; 2022-08-10 - 2022-08-12, Oral presentation

34. Hemmingsen, Lisa Myrseth; Giordani, Barbara; Pettersen, Ann Kristin; Vitali, Beatrice; Basnet, Purusotam; Skalko-Basnet, Natasa. Synergy in action: Chitosan as anti-biofilm booster. CRS 2022 Annual Meeting & Expo; 2022-07-11 - 2022-07-15, poster

35. Hemmingsen, Lisa Myrseth; Skalko-Basnet, Natasa. Addressing skin wound biofilms in an era of antimicrobial resistance: the potential of membrane-active antimicrobials. Nordic POP Workshop - Advances in Skin Therapy; 2022-06-07 - 2022-06-09, Oral presentation

36. Hira J, Bhupender Singh, Christian Lentz. A comprehensive workflow for dissecting phenotypic heterogeneity of isogenic bacterial pathogen population. 57th NBS Contact Meeting 2022, Tromsø

37. Holsbø E (2023) Microbiome data: what's in the bag? Presentation, CANS day, 2023.

38. Klingenberg C. Presentations on neonatal sepsis at ESPR educational sessions

39. **Leiros H-K-S (2022) talk** to high school students at Kvaløya VGS entitled: "**Hvorfor Norge trenger kjemikere**",14.12.2022 Oral presentation

40. **Leiros H-K-S (2022) talk** to high school students at Kongsbakken entitled: "**Bruk av 3D enzymstrukturer som bryter ned penicillin-lignende antibiotika, i kampen mot antibiotika resistente bakterier.**» 25.2.22.

41. K-res. Karbapenemasescreening hos *Enterobacterales* utenom *E. coli* og *Klebsiella* spp. Deltakermøte for NORM 2022, Gardermoen, Norway. Oral presentation

42. K-res. ESBL & karbapenemaser i Norge – hva driver spredningen? *Smittevernforums Årskonferanse*, Tromsø, Norway Oral presentation

43. K-res. Kinolon- og colistinresistens hos Enterobacteriaceae. *Kurs Antibakterielle resistensmekanismer, metoder for påvisning, tolkning og klinisk betydning.* Tromsø, Norway Oral presentation

44. K-res. Løsning på ESBL-A/-M/-CARBA? Nye β-laktam/β-laktamase inhibitorkombinasjoner. *Kurs Antibakterielle resistensmekanismer, metoder for påvisning, tolkning og klinisk betydning.* Tromsø, Norway Oral presentation

45. K-res. ESBL-A/-M/-CARBA: mekanismer, epidemiologi og påvisning. *Kurs Antibakterielle resistensmekanismer, metoder for påvisning, tolkning og klinisk betydning.* Tromsø, Norway Oral presentation

46. K-res. Helgenomsekvensering for antimikrobiell følsomhetstesting. *Kurs Antibakterielle resistensmekanismer, metoder for påvisning, tolkning og klinisk betydning.* Tromsø, Norway Oral presentation

47. K-res. Difficulties when screening for CPE. NordicAST workshop, Gothenburg, Sweden. Oral presentation

48. K-res. β-lactams, β-lactamases and β-lactamase inhibitors. Antibiotics and Antibiotic Resistance Course, Hjortviken, Sweden. Oral presentation

49. K-res. ESBL-A, ESBL-M og kromosomal AmpC (ESBL-A, ESBL-M and chromosomal AmpC). *Kurs i resistensbestemmelse av mikrober «AFA-kurset»*, Oslo, Norway (lecture given digitally due to Covid). Oral presentation

50. K-res. ESBL-CARBA *Kurs i resistensbestemmelse av mikrober «AFA-kurset»*, Oslo, Norway (lecture given digitally due to Covid). Oral presentation

51. K-res. *E. coli* and *K. pneumoniae* – clones, carriage and drivers of AMR. University of Bristol, School of Cellular and Molecular Medicine seminar series. Digital. Oral presentation

52. Mathiesen I, Johannessen M, Hegstad K, Wagner T. Characterisation of putative virulence factors in Enterococcus faecium. Oral presentation 6th Annual meeting National Graduate School in Infection Biology and Antimicrobials (IBA), Oslo, Norway

53. Mork S. Chitosan-coated liposomes containing polyphenols for localized treatment of vaginal infections. Nordic Pop Annual Meeting 2022; 2022-08-10 - 2022-08-12, Poster

54. Obuobi, Sybil Akua Okyerewa. BIOHYBRID NUCLEIC ACID CARRIERS FOR THE TREATMENT OF PERSISTENT INFECTIONS. Norwegian Biochemical Society Contact Meeting; 2022-02-10 - 2022-02-13, Lecture

55. Obuobi SAO. Biohybrid Nucleic Acid carriers for the treatment of persistent infections. Nordic POP Annual Meeting 2022; 2022-08-10 - 2022-08-12, Lecture

56. Obuobi, SAO, High drug loading hybrid carriers for antimicrobial applications. CRS Local Chapter Webinars; 2022-04-28 - 2022-04-28, Lecture

57. Obuobi, SAO, Hybrid DNA nanoparticles for the treatment of persistent S. aureus infections. Workshop on Advances in Skin Therapy Research; 2022-06-06 - 2022-06-09, Lecture

58. Pettersen VK, Antoine Dufour, Marie Claire Arrieta. Metaproteomic profiling of fungal gut colonization in gnotobiotic mice. 2022 World of Microbiome Vienna

59. Rahman, A., A.I. Elvheim, C. Ågnes, I.K.Ø. Hansen, B. Landfald, H.-M. Blencke, T. Haug, and K. Stensvåg, Antimicrobial and antibiofilm potential of marine bacteria, in 57th Norwegian Biochemical Society Contact Meeting 2022. 2022: Tromsø.

60. Rahman, A., C. Sivertsen, A.I. Elvheim, I.K.Ø. Hansen, B. Landfald, T. Haug, and K. Stensvåg, Antimicrobial compounds from Arctic and sub-Arctic marine bacteria and their potential against ESKAPE pathogens, in 2nd international Conference on Microbial Secondary Metabolites in Microbiomes 2022. 2022: Helsingør.

61. Rämä, Teppo. Norwegian Marine Fungi - Distribution, diversity, taxonomy and DNA-barcoding. Artsprosjektdagen2022; 2022-10-26 - 2022-10-26

62. Ross TA, Pöntinen A, Janice J, Holsbø E, Corander J, Hegstad K, Kampffmeyer M. Leveraging machine learning for finding novel putative virulence factors in Enterococcus faecium. Poster 6th Annual meeting National Graduate School in IBA, Oslo, Norway

63. Salamonsen D, Christopher Fröhlich, Hanna-Kirsti S. Leiros "**Co-selection reduces functional trade-offs in the carbapenemase OXA-48"**. Poster: ECCMID, april 2022, Lisboa.

64. Stensvåg, K., Bioteknologi og bærekraftig marin næringsutvikling. Bioteknologi programmene ved NFH, in Jubileumskonferanse- Norges fiskerihøgskole 50 år. 2022: UiT, Tromsø.

65. Stensvåg, K., E. Mishchenko, H.-M. Blencke, A.I. Elvheim, C. Ågnes, A. Rahman, I.K.Ø. Hansen, J. Hira, and T. Haug, Health beneficial antimicrobials from marine natural Arctic and sub-Arctic resources, in Microbial Secondary Metabolites in Microbiomes 2022. 2022: Helsingør.

66. Stensvåg, K., Havet som kilde til nye medisiner. Forskningsdager 2022, LInken, SIVA Innovasjonspark. Tromsø. Åpne foredrag. 30.09.2022https://uit.no/tavla/artikkel/786857/medisiner_fra_havet_-_apne_foredrag

67. Stensvåg, K., Medisiner fra havet. Fra kråkeboller til antibiotika, in Lørdagsuniversitetet. 2022: Rødbanken, Tromsø. 01.10.2022 https://uit.no/tavla/artikkel/789315/lordagsuniversitetet_havet_som_kilde_til_nye_med

68. Stensvåg, K., A. Sundsfjord, P.J. Johnsen, H.-K.S. Leiros, and L. Nordgård, CANS - Centre for New Antibacterial Strategies, in IMB-day 2022. 2022: UiT, Tromsø.

69. Syltern MP (2022) Poster presentation at EMBO metabolomics bioinformatics practical course https://sites.google.com/view/embopracticalcoursemetabolomic/homepage

70. Uddin J, Herman Overkleeft, Mona Johannessen, and Christian S. Lentz. Oral presentation at the 57th NBS Contact Meeting 2022, Tromsø– "Identification and validation of novel enzymatic activities by activity-based protein profiling (ABPP)

71. Uddin J, Mona Johannessen, and Christian S. Lentz Oral presentation at IMB conference. Identification And Validation Of Novel Enzymatic Activities in Pathogenic Bacteria by Activity-based Protein Profiling (ABPP)

72. Uddin J, and Lentz, CS. Poster presentation at BioCat Annual Conference, 2022 Identification of previously characterized serine hydrolase virulence factors in MR- *Staphylococcus aureus* by using carmofur-derived activity-based probe

73. Wolden R, PhD student, Poster presentation. NOVEL BACTERIOCIN ROMSACIN FROM STAPHYLOCOCCUS HAEMOLYTICUS INHIBITS GROWTH OF GRAM-POSITIVE ESKAPE PATHOGENS, IBA 2022

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