University of Otago

Bioengineering Symposium and 3D Biofabrication Workshop

Programme and abstracts

2-3 November 2026

Walsh Building, Faculty of Dentistry and online via livestream

Hosted by the **Centre for Bioengineering and Translational Health Technologies**

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ŌTĀKOU WHAKAIHU WAKA

2026 University of Otago Bioengineering Symposium and 3D Biofabrication Workshop

Walsh Building, Faculty of Dentistry
310 Great King Street N (corner of Frederick St), Dunedin North

Main sessions are in the Blue (J.A. Bell) Lecture Theatre (access via Frederick St entrance)

Session breaks, trade displays and poster session are in room G37 (access via Great King St entrance)

A map showing access routes between rooms is signposted in the Walsh and is shown on page 5.

Livestream link will be provided via email to registered attendees outside Dunedin.

Symposium schedule

All affiliations listed are University of Otago unless otherwise noted.

Monday 2 November

9.30-10.00am	**Registration**	
10.00am	***Welcome***	
10.00-10.05am	**Mihi whakatau**	Mr Sam Carrington *Associate Dean Māori, Faculty of Dentistry*
10.05-10.20am	**Welcome and introduction**	Associate Professor Megan Gibbons *Pro-Vice Chancellor, Division of Health Sciences* Professor William Levack *Incoming Head of Faculty, Faculty of Dentistry*
10.20-10.30am	**The Centre for Bioengineering and Translational Health Technologies (CBTHT)**	Professor Azam Ali *Centre for Bioengineering and Translational Health Technologies, Faculty of Dentistry*
10.30am	***Session 1: Showcasing Bioengineering@Otago***	**Chair: Professor Azam Ali**
10.30-10.50am	Stimuli-responsive linkers and their applications in drug delivery systems	Associate Professor Allan Gamble *School of Pharmacy and Pharmacology*
10.50-11.10am	Gold nanoparticles to target bacterial biofilms and modulate host responses	Associate Professor Daniel Pletzer *Department of Microbiology and Immunology*
11.10-11.30am	How flat is too flat? Rethinking disease models in the era of personalised medicine	Professor Stephanie Hughes *Department of Biochemistry*
11.30-11.50am	Advances in pulsed electric field technology for bioactive extraction and material development	Professor Indirawati Oey *Department of Food Science*
11.50am-12.10pm	Phages: From lab to practice – challenges, opportunities, and formulation for effective deployment	Professor Craig Bunt *Agricultural Innovation Programme, Department of Food Science*
12.10-12.30pm	Biofabrication to biomedical innovation: engineering tissue constructs and medical devices	Associate Professor Jaydee Cabral *Centre for Bioengineering and Translational Health Technologies, Faculty of Dentistry*

12.30pm	***Lunch break and poster viewing (G37)***	
1.30pm	***Session 2: Centre themes***	**Chair: Professor Azam Ali**
	Interactive session: Centre for Bioengineering and Translational Health Technologies theme activities and future opportunities *Themes: Regenerative Medicine, Biomaterials, Point of Care, Imaging, Nanomedicine*	Professor Azam Ali Associate Professor Yusuf Cakmak Professor Tim Woodfield Professor Arlene McDowell Professor Anthony Butler
2.00pm	***Session 3: Translational Bioengineering***	**Chair: Professor Azam Ali**
2.00-2.20pm	Simultaneous testing of anodized implants in three different anatomical sites in the Otago sheep model	Professor Warwick Duncan *Sir John Walsh Research Institute, Faculty of Dentistry*
2.20-2.40pm	From measurement to prevention: engineering solutions for head impacts in sport	Professor Melanie Bussey *School of Physical Education, Sport and Exercise Sciences*
2.40-3.00pm	Synthetic biodegradable scaffold incorporating natural bioactive and small molecules to regenerate the diseased tissue	Professor Rajesh Katare *Department of Physiology*
3.00-3.20pm	Applied anatomy for MedTech	Associate Professor Yusuf Cakmak *Department of Anatomy*
3.20pm	***Afternoon tea break and poster viewing (G37)***	
4.00pm	***Session 4: R&E and industry panel***	**Chair: Dr Sam Heenan, R&E**
	Panel session	Robert Veale — *Aroa Biosurgery* Dr John Hale — *BLIS Technologies* John Williamson — *ADInstruments* Nour Ghamri — *Research and Enterprise*
4.30pm	***Posters and networking session (G37)*** **Posters and details of poster competition are listed on page 6** **Bioengineering information session for undergraduate and postgraduate research students** **Drinks and nibbles provided**	

Tuesday 3 November

9.00am	***Welcome back***	
	Welcome and introduction	Professor Paul Cooper *Head of Faculty, Faculty of Dentistry*
9.10am	***Session 5: Bioengineering@Otago PG & ECR session*** **Chair: A/Prof Jaydee Cabral**	
9.10-9.20am	Environmental microbial colonisation of laser-structured superhydrophobic metal surfaces	Connie Robinson BSc (Hons) candidate *Department of Microbiology and Immunology*
9.20-9.30am	Bioengineered surgical membrane with integrated antibacterial nanoparticles	Ghsaq Alhamdani PhD candidate *SJWRI, Faculty of Dentistry*
9.30-9.40am	Fabrication of lipid nanoparticles for systemic delivery of miR-126 mimics and anti-miR-34a to mitigate diabetes-induced atherosclerosis and diabetic cardiomyopathy *in vivo*	Dineth Palihaderu PhD candidate *Department of Physiology*
9.40-9.50am	Engineering conductive bioscaffolds with miRNA-loaded lipid nanoparticles for cardiac regeneration	Jekhan Saravanan PhD candidate *Department of Physiology*
9.50-10.00am	Ultrasensitive electrochemical detection of eccDNA based on hybridization with a network of gold-coated magnetic nanoparticles	Xinjie Zhou PhD candidate *Department of Chemistry*
10.00-10.10am	Engineering an epithelial barrier model for drug transport through the round window membrane of the cochlea	Dr Mina Rajabi Early Career Researcher *Department of Oral Rehabilitation, Faculty of Dentistry*

The best presentation from an Otago postgraduate student or early-career researcher in session 5 will be awarded first prize of $200, thanks to DKSH. The runner-up will win a new Bioengineering hoodie.

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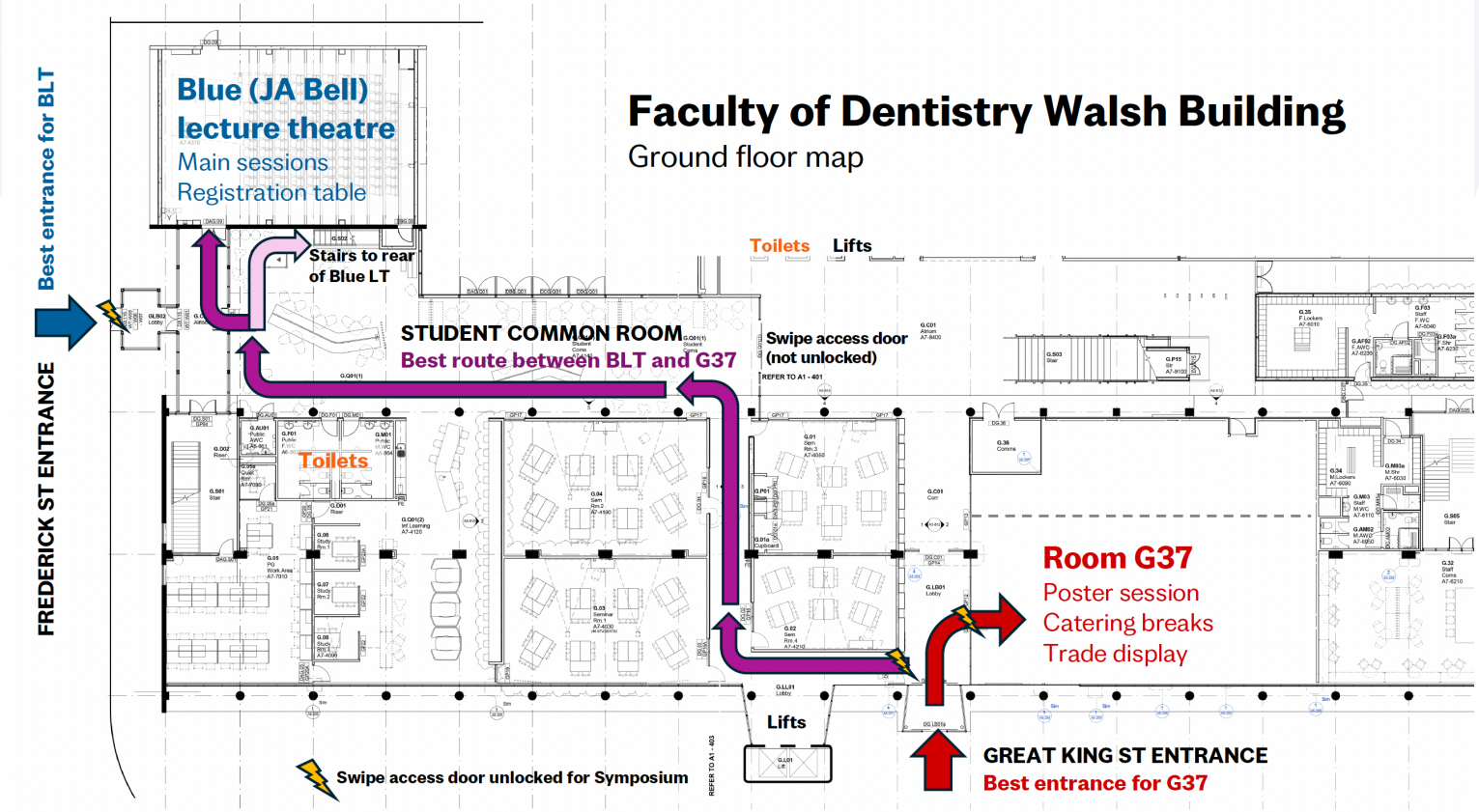
10.10-10.20am	Building a career in MedTech: Insights from a Bioengineering graduate	Hanna Jacobs-Grant *Senior Robotics Clinical Specialist, Medtronic* *PGDip Bioengineering alumna*
10.20-10.30am	AROA ECM™: A New Zealand case study in biomaterial commercialisation	Robert Veale *Aroa Biosurgery*
10.30am	***Morning tea break and poster viewing (G37)***	
10.50am	***Session 6: Bioengineering across health and medicine*** **Chair: Associate Professor Yusuf Cakmak**	
10.50-11.10am	Drug eluting textile wrap for the treatment of intimal hyperplasia	Dr Jo Krysa *Department of Surgery and Critical Care*
11.10-11.30am	Development of a silicate-substituted bovine-derived hydroxyapatite scaffold for dental regenerative applications	Dr Jithendra Ratnayake *Department of Oral Rehabilitation, Faculty of Dentistry*
11.30-11.50am	Electrophysiology in an age of high-throughput neuroscience	Dr Owen Jones *Department of Psychology*
11.50am-12.10pm	From teeth to bone: dentin- and tooth-derived grafts as emerging biomaterials in regenerative dentistry	Dr Stéphane Derruau *Université de Reims Champagne-Ardenne*
12.10pm-12.30pm	Electrochemical sensors and biosensors for biomedical and food analysis	Dr Yanfang Wu *Department of Chemistry*

12.30pm	***Lunch break and poster viewing (G37)***	
1.30pm	***Symposium wrap-up and awards presentation*** **Chairs: Professor Azam Ali, Associate Professor Jaydee Cabral**	
2.00pm	***3D Biofabrication workshop/training and laboratory tour*** **Lead: Associate Professor Jaydee Cabral**	
2.00-2.15pm	Introduction to Bioscaffolder presentation	G37
	3D printing demonstrations	Walsh building 4th floor laboratories
2.15-2.30pm	Group 1	
2.30-2.45pm	Group 2	
2.45-3.00pm	Group 3	

Group assignments will be posted at final lunch break/poster viewing and shown at Introduction to Scaffolder talk

Venue map



Posters will be displayed in Walsh G37 for the duration of the Symposium, and can be viewed at each of the session breaks. The poster presentation session is at 4.30pm on Monday. Abstracts of posters are presented on page 13.

Poster #	Title	Presenter
#1	Chitooligosaccharides hydrogel for novel ophthalmic applications	Chris How-Ming Tan MSc cand. in Bioengineering *Faculty of Dentistry*
#2	Back on track: a five-channel nerve conduit	Danika Anthony MSc candidate in Bioengineering *Faculty of Dentistry*
#3	3D-printed hallux orthosis - Toe fracture treatment	Frost Rowe MSc candidate in Bioengineering *Faculty of Dentistry*
#4	'That's gonna leave a mark!' Design and biofabrication of anti-fibrotic, anti-scarring, collagen sutures for skin wound-healing	Tara Price MSc candidate in Bioengineering *Faculty of Dentistry*
#5	Tying up loose ends: design of a biodegradable surgical knot fastener	Efrat Kent MSc candidate in Bioengineering *Faculty of Dentistry*
#6	Beyond symptom relief: engineering the future of lumbar disc regeneration	Matthew Bradley MSc candidate in Bioengineering *Faculty of Dentistry*
#7	Can a mouthguard protect against concussion? Mapping mouthguard characteristics and individual-specific factors in adult athletes	Dyna Albert PhD candidate *Faculty of Dentistry*
#8	Wound healing by curcumin encapsulated silver nanoparticles loaded in hydrogel	Adrita Das MSc candidate in Bioengineering *Faculty of Dentistry*
#9	Choosing what a brain decoder predicts: DINOv2 vs. CLIP targets for fMRI image reconstruction	Aidan Dougherty MAppSc candidate *Department of Computer Science*
#10	Wearable air quality monitoring for respiratory health	Samuel Doherty MSc candidate in Bioengineering *Faculty of Dentistry*
#11	Exploring melt electrowriting as a platform for controlled therapeutic delivery	Teo de Rezende McGuinness PhD candidate *Faculty of Dentistry*
#12	Development and physicochemical characterisation of antimicrobial peptide-loaded chitosan-chitosan oligosaccharide nanoparticles	Meera Probha Kabiraz PhD candidate *Department of Microbiology and Immunology*
#13	Plasma surface modification of biodegradable meshes for pelvic organ prolapse repair: stromal and immune cell responses	Elahe Bahremandi Toloue PhD candidate *Department of Obstetrics and Gynecology, Monash University, Melbourne*
#14	Formulation and characterisation of an orally-delivered brain-targeting neuropeptide agent for mammalian fertility control	Soheil Mehrdadi PhD candidate *Department of Anatomy*
#15	3D-printed hydrogels for haptic applications	Érika Takase PhD candidate *School of Engineering, University of Canterbury, Christchurch*

The best poster presentation will be awarded first prize of $200, thanks to Aroa Biosurgery. The runner-up will win a new Bioengineering hoodie.

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Abstracts of oral presentations

Abstracts are presented where available at time of publication. All affiliations are University of Otago unless otherwise noted.

Session 1: Showcasing Bioengineering@Otago

Stimuli-responsive linkers and their applications in drug delivery systems

Associate Professor Allan Gamble

School of Pharmacy and Pharmacology

Stimuli-responsive polymers and peptides have potential use in particulate and hydrogel drug delivery systems. In order to selectively target cancer, our group has an interest in the synthesis of stimuli-responsive amphiphilic block polymers that can be formulated into polymersomes (vesicles) and bicontinuous nanospheres (BCNs). The polymers and their particles react with either tumour-associated or bioorthogonal stimuli to trigger particle disruption or degradation, processes that can enable release of a payload. We are also interested in the design of peptides that can form hydrogels to act as a drug depot. Azide-functionalised peptides are shown to react with the bioorthogonal chemical reagent trans-cyclooctene (a click-to-dissolve reaction), whereby rapid gel dissolution and release of a drug is observed. In this presentation, our next generation particles and hydrogels will also be discussed.

Gold nanoparticles to target bacterial biofilms and modulate host responses

Associate Professor Daniel Pletzer

Department of Microbiology and Immunology

Bacterial biofilms are difficult to eradicate and often trigger damaging inflammatory responses in host tissues. Antimicrobial nanomaterials therefore need to control microbial communities while remaining compatible with surrounding cells. We investigated how the size and surface coating of gold nanoparticles influence antibacterial activity, biofilm inhibition, and host-cell responses. Gold nanoparticles with different surface coatings and sizes were tested against Pseudomonas aeruginosa and Staphylococcus aureus biofilms and evaluated for their effects on epithelial-cell viability and inflammatory signalling. Ultrasmall lipoic acid-coated gold nanoparticles (~2 nm diameter) showed the most favourable balance between antimicrobial and host-cell effects. More than 80% of epithelial cells remained viable after exposure to 100 µg/mL nanoparticles for 72 h, while inflammatory cytokine production was reduced by up to 95%. Despite having limited activity against free-living bacteria, these particles reduced biofilm biomass of both bacterial species by more than 80% at substantially lower concentrations. Additional experiments with glutathione-coated nanoparticles and mixed-species biofilms suggest that nanoparticle activity may be influenced by interactions with extracellular biofilm components. These findings identify ultrasmall lipoic acid-coated gold nanoparticles as a promising platform for simultaneously controlling biofilms and modulating inflammatory responses. Ongoing work aims to determine how microbial community composition influences nanoparticle activity and to evaluate performance in more physiologically relevant tissue models.

How flat is too flat? Rethinking disease models in the era of personalised medicine

Professor Stephanie Hughes

Batten Disease Group, Department of Biochemistry

Batten disease comprises a group of rare inherited neurodegenerative disorders that primarily affect children. Animal models have been instrumental in advancing our understanding of disease mechanisms and evaluating potential therapies. More recently, the advent of induced pluripotent stem cell (iPSC) technology has created new opportunities for personalised medicine by enabling therapeutic testing in disease-relevant human cell types derived directly from patients.

In this presentation, I will describe our recent work generating iPSCs from a child with Batten disease and discuss several personalised therapeutic strategies tailored to the patient's specific genetic variants. I will also explore less invasive alternative sources of patient-derived stem cells, including cells obtained from exfoliated teeth, and consider how combining patient-derived stem cells with advanced bioengineered scaffolds may bridge the gap between traditional two-dimensional cultures and more realistic models of disease and therapy.

Phages: From lab to practice – challenges, opportunities, and formulation for effective deployment

Professor Craig Bunt

Agricultural Innovation, Department of Food Science

Bacteriophages are highly specific viruses that infect and kill bacteria, offering considerable potential as targeted antimicrobial agents. Despite increasing interest in phage-based technologies, translating promising laboratory activity into robust, reproducible, and deployable products remains a significant challenge. Phages are complex biological entities whose infectivity can be strongly influenced by environmental and processing stresses, including temperature, pH, ultraviolet radiation, desiccation, humidity, ionic strength, and shear. This presentation explores the role of formulation science and bioengineering in bridging the gap between phage discovery and practical application. A key consideration is pre-formulation: understanding the physicochemical and environmental sensitivity of individual phages before designing systems for their stabilisation, storage, and delivery. Characterising these vulnerabilities provides a rational basis for selecting

buffers, protective excipients, biomaterials, drying technologies, and delivery approaches capable of maintaining phage infectivity through manufacture, storage, and use. Particular attention will be given to the challenges of formulating phage cocktails, where multiple phages with different biological and stability characteristics must be incorporated into a single product. Formulation approaches involving soluble and insoluble carriers illustrate both the opportunities and practical limitations encountered when attempting to stabilise these biological agents. Ultimately, successful phage translation requires microbiology, formulation science, materials science, manufacturing, storage, and delivery to be considered as an integrated system. Bioengineering provides an important interface between these disciplines, helping transform phages from promising laboratory entities into robust and practical antimicrobial technologies.

Biofabrication to biomedical innovation: engineering tissue constructs and medical devices

Associate Professor Jaydee Cabral

Centre for Bioengineering and Translational Health Technologies, Faculty of Dentistry

Bioengineering integrates materials science, engineering, and the life sciences to develop innovative solutions to biomedical challenges. Advances in biofabrication enable precise control over material composition, scaffold architecture, surface properties, and biological functionality, supporting the development of tissue-engineered constructs and medical devices. This presentation will explore complementary biofabrication platforms and their practical applications in biomedical research, product development, and clinical translation. These include fused deposition modelling (FDM) for fabricating structurally robust polymeric components, melt electrowriting (MEW) for precisely engineered microfibrous scaffolds, extrusion-based printing of polymers and hydrogels, and digital light processing (DLP) for producing complex, high-resolution geometries. Plasma surface modification provides further opportunities to tailor biomaterial interfaces and improve interactions with biological systems. Integrating these technologies enables the fabrication of constructs with controlled architecture, mechanical properties, and biological functionality. Drawing on research undertaken in the University of Otago's bioengineering laboratories, examples will illustrate how these platforms support tissue engineering, regenerative medicine, and medical-device innovation. The presentation will emphasise a hands-on, problem-solving approach to bioengineering, connecting material selection, computer-aided design, fabrication, characterisation, and biological evaluation with real-world biomedical needs.

An important focus will be the development of practical skills that prepare students for careers across research, industry, and clinical innovation. Experience designing and fabricating prototypes, evaluating performance, and iteratively refining solutions provides a foundation for roles such as product design engineers in the medical technology sector. By combining interdisciplinary research with practical training and translational thinking, bioengineering can equip the next generation of innovators to transform engineering concepts into useful biomedical products, technologies, and therapies.

Session 3: Translational Bioengineering

From measurement to prevention: engineering solutions for head impacts in sport

Professor Melanie Bussey

School of Physical Education, Sport and Exercise Sciences

Understanding and reducing the potential consequences of head impacts in sport presents a significant challenge at the intersection of biomechanics, engineering, and human health. Advances in wearable sensor technology have transformed our ability to measure head motion during sport, but translating these measurements into meaningful assessments of mechanical exposure and effective injury prevention strategies remains challenging.

This presentation explores three interconnected bioengineering challenges: measuring head impacts, interpreting their biomechanical significance, and developing strategies to modify the body's mechanical response to impact. Drawing on research involving community and youth rugby players, we examine how instrumented mouthguards quantify real-world head impact exposure, revealing differences in impact frequency, magnitude, and characteristics across sporting contexts.

Moving beyond conventional acceleration metrics, we consider how individual differences in head geometry and inertial properties influence estimates of mechanical loading, highlighting the importance of personalised approaches to understanding head impact exposure.

Finally, we explore how these insights inform the development of assessment technologies and targeted interventions. This includes purpose-built systems for measuring rapid neck force development and research investigating the neuromuscular mechanisms underlying head stabilisation during unexpected perturbations. These approaches provide a foundation for evaluating interventions aimed at reducing head acceleration during sporting contact.

Together, this research demonstrates how integrating wearable sensing, biomechanical modelling, and neuromuscular assessment can advance our understanding of head impact biomechanics and support the translation of engineering research into practical technologies and interventions with the potential to improve athlete safety.

Synthetic biodegradable scaffold incorporating natural bioactive and small molecules to regenerate the diseased tissue

Professor Rajesh Katare

Department of Physiology

Diabetes and heart disease leave tissues that cannot repair themselves. Diabetic foot ulcers often fail to heal and can lead to amputation. After a myocardial infarction, the damaged heart muscle is replaced by scar tissue that cannot contract or conduct electrical signals, and this can progress to heart failure. Current treatments limit the damage but cannot rebuild the lost tissue, largely because they do not correct the molecular defects that block repair. To overcome this barrier, we have designed a cell-free, off-the-shelf biodegradable nanofibre scaffold to

actively drive regeneration. Our studies show that loss of key microRNAs is an early driver of impaired blood vessel formation in diseased tissue. To restore them, we deliver these microRNAs through nanoparticles embedded within the scaffold, together with natural bioactives. Initial results show that this biodegrdable scaffold can be adapted for both conditions: as a patch for chronic wounds, and, with a conductive filler added, as a cardiac patch to repair heart muscle.

Session 5: Bioengineering@Otago postgraduate student and early career researcher session

Environmental microbial colonisation of laserstructured superhydrophobic metal surfaces

Connie Robinson

BSc (Hons) candidate, Department of Microbiology and Immunology

Microbial contamination of abiotic surfaces is a persistent challenge across healthcare, industrial and public environments. Femtosecond laser-induced periodic surface structures (LIPSS) offer a non-chemical approach for modifying metal-surface topography and wettability, with potential to reduce microbial colonisation. This study investigated environmental colonisation of laser-structured aluminium, stainless steel and titanium surfaces exposed at two locations, a public elevator and a wildlife hospital, while also assessing the effects of laser treatment and autoclaving prior to exposure.

High-throughput RNA sequencing revealed substantial variation in viral and broader microbial composition among libraries. Viral-family profiles were highly heterogeneous, with no consistent clustering according to laser treatment, metal type or autoclaving. Sampling location displayed the clearest viral differences, with samples from the wildlife hospital exhibiting greater total viral abundance, viral-family richness and alpha diversity. Phylogenetic analyses of selected viral families identified both close relatives of known viruses and several divergent, potentially novel sequences.

Non-viral microbial transcriptional analyses similarly showed strong location-specific effects. Wildlife hospital samples had greater microbial abundance and phylum richness, whereas elevator samples had greater alpha diversity. Within the wildlife hospital, autoclaving was associated with reduced microbial abundance and richness and altered community composition. Within the elevator, titanium supported greater microbial abundance than aluminium or stainless steel, and community composition differed among metals. Laser treatment was not consistently associated with reduced microbial or viral colonisation.

Overall, environmental context and material-specific effects outweighed any consistent influence of laser structuring under the conditions tested, emphasising the importance of evaluating LIPSS under realistic exposure conditions.

Bioengineered surgical membrane with integrated antibacterial nanoparticles

Ghsaq Alhamdani

PhD candidate, SJWRI, Faculty of Dentistry

G Alhamdani[1], D Abdelmoneim[1], WJ Duncan[1], KC Li[1], N Hughes[2], C Chen[1], DE Coates[1]

1. SJWRI, Faculty of Dentistry
2. School of Pharmacy and Pharmacology

Membranes support guided tissue/bone by preventing soft-tissue ingress, and antibacterial activity improves treatment outcomes. This study aimed to fabricate an electrospun polyvinyl alcohol/collagen membrane incorporating antibacterial nanoparticles. Mānuka oil (MO) and purified β-triketones (TK) were nanoencapsulated in chitosan particles via ionic gelation and characterised by dynamic light scattering (DLS), scanning electron microscopy (SEM), encapsulation efficiency, and release profile. Nanoparticles were incorporated into multilayered electrospun membranes, which were characterised by FTIR, contact angle, thermogravimetric analysis and hydrolytic dissolution. Cytotoxicity, antibacterial activity, and mechanical properties were assessed *in vitro*. Bone regeneration was evaluated *in vivo* in a New Zealand white rabbit cranial defect model using micro-CT. DLS and SEM indicated successful production of MO- and TK-loaded nanoparticles with an average size of <350 nm. Higher encapsulation efficiency of TK oil (60.2%) was detected compared to MO (38.7%), while similar release profiles were observed. Lower concentrations of TK-loaded nanospheres were required to obtain inhibitory and bactericidal effects. A multilayered membrane with fibres measuring <200 nm was obtained via sequential electrospinning. FTIR confirmed nanoparticle incorporation within the membrane, which exhibited comparable hydrophilicity, thermal and mechanical stability and degradation behaviour to commercial OsseoGuard®. The membrane inhibited S. aureus and E. coli growth, with no cytotoxic effect on human gingival fibroblasts. 3D measurements of newly formed bone volume from micro-CT images showed no significant difference compared with the commercial OsseoGuard® membrane.

Collectively, we developed a novel antimicrobial surgical membrane for guided tissue/bone regeneration in periodontal or orthopaedic applications.

Fabrication of lipid nanoparticles for systemic delivery of miR-126 mimics and anti-miR-34a to mitigate diabetes-induced atherosclerosis and diabetic cardiomyopathy in vivo

Dineth Palihaderu

PhD candidate, Department of Physiology

PADS Palihaderu[1], A Gamble[2], R Katare[1]

1. HeartOtago, Department of Physiology
2. School of Pharmacy and Pharmacology

Lipid Nanoparticles (LNPs) have emerged as a viable vector for systemic oligonucleotide delivery. Combining microRNA therapeutics with LNP technology is an emerging research interest. Downregulation of the pro-angiogenic miR-126 and upregulation of the pro-senescent miR-34a contribute to the pathogenicity of DM-induced atherosclerosis and diabetic cardiomyopathy. Protective effects were confirmed

in vitro following restoration of both miRNAs in HG-induced conditions. However, systemic delivery of naked mimics/antimiRs faces major challenges, which LNPs can help overcome. We aim to determine whether LNP-mediated delivery of miR-126 mimics and anti-miR-34a could reproduce the therapeutic effects previously observed. Mimics/antimiRs encapsulated LNPs will be fabricated using advanced crossflow membrane mixing technology in the Micropore Pathfinder, which will then be tested on high-glucose-treated endothelial cells and cardiomyocytes. Cell toxicity, survival, migration, gene, and protein expression will be evaluated. In-house bred obese type-2 DM mouse model with established cardiac dysfunction will be injected with the fabricated LNPs subcutaneously. Euthanized mice and their organs will be utilized to evaluate the mimic/antimir biodistribution, protein expression, angiogenesis, capillary and arteriole density, and cardiac fibrosis.

Preliminary optimization on empty LNPs (D-Lin-MC3-DMA: DSPC: Cholesterol: PEG2000-DMG, 50:10:38.5:1.5 mol%; aqueous: lipid flow rate ratio 3:1; citrate buffer pH 3.5: ethanol) resulted in LNPs with 100–120 nm size with PDI <0.3 (DLS) for the total flow rates between 26.5-30.5 ml/minute. MTT assay in cardiomyocytes confirmed low cytotoxicity (viability >70%). Successful *in vivo* validation of the therapeutic benefits of LNP-mediated microRNA therapy will provide evidence for a novel therapeutic strategy for the treatment of CVD in people with diabetes.

Engineering conductive bioscaffolds with miRNA-loaded lipid nanoparticles for cardiac regeneration

Jekhan Saravanan

PhD candidate, Department of Physiology

JAM Saravanan[1,3], S Sinha[1], A Gamble[2], A Ali[3], R Katare[1]

1. Department of Physiology
2. School of Pharmacy and Pharmacology
3. Centre for Bioengineering, Faculty of Dentistry

Background: Cardiovascular disease, especially myocardial infarction, is a leading cause of mortality due to irreversible cardiomyocyte loss and limited cardiac tissue regeneration. Although current therapies slow disease progression, they do not restore functional myocardium. MicroRNAs (miRNAs) offer therapeutic promise in myocardial repair by modulating cell death, inflammation, and angiogenesis, but their clinical use is limited by poor stability and delivery. To address this, we developed conductive bilayer electrospun scaffolds embedding miRNA-loaded lipid nanoparticles (LNPs) for controlled delivery and electrical support to accelerate myocardial repair.

Methods: miRNAs were encapsulated into LNPs via NanoAssembler microfluidic platform. A bilayer scaffold was electrospun using hybrid natural and synthetic polymers. Scaffold surface morphology, physicochemical, and thermal properties were characterized. Biological assays assessed toxicity, proliferation, migration, angiogenesis, and intracellular miRNA uptake. Conductive fillers were added to improve electrical functionality.

Results: The scaffold showed uniform nanofibers mimicking extracellular matrix, confirmed polymer integration, tunable wettability, and mechanical/thermal stability suitable for cardiac conditions. It demonstrated excellent biocompatibility and migration effects. RT-qPCR confirmed increased miRNA uptake in HUVECs. Conductive fillers enabled electrical conductivity, supporting signal transmission. This multifunctional bilayer system enables localized miRNA delivery with electrical support, showing strong potential for cardiac tissue engineering.

Ultrasensitive electrochemical detection of eccDNA based on hybridization with a network of gold-coated magnetic nanoparticles

Xinjie Zhou

PhD candidate, Department of Chemistry

X Zhou, D Chen, Y Wu

Department of Chemistry

Extrachromosomal circular DNAs (eccDNAs) are circular DNA molecules derived from the human genome and characterized by unique head-to-tail junction sites. Their disease-specific expression patterns and increased resistance to exonuclease-mediated degradation compared with linear DNAs make them promising biomarkers for non-invasive disease diagnosis and monitoring. However, eccDNA detection remains challenging due to sequence overlap with linear DNA counterparts, low abundance, and lack of reliable quantification methods. Together, these challenges highlight the need for highly specific and sensitive methods for eccDNA detection and quantification. This project aims to develop an ultrasensitive, amplification-free electrochemical sensor for the detection and quantification of eccDNAs based on the concept of dispersible electrodes, which has been successfully applied to the detection of microRNAs and circulating tumor DNAs down to attomolar concentrations. The platform is expected to provide a sensitive and specific approach for the direct detection and quantification of disease-associated eccDNAs, potentially supporting their development as biomarkers for non-invasive disease diagnosis and monitoring.

Engineering an epithelial barrier model for drug transport through the round window membrane of the cochlea

Mina Rajabi

Department of Oral Rehabilitation, Faculty of Dentistry

M Rajabi[1], P Thorne[2], H Suzuki-Kerr[2], S Vlajkovic[2], J Cabral[1]

1. Faculty of Dentistry
2. Department of Physiology, FMHS, University of Auckland

Sensorineural hearing loss (SNHL) affects hundreds of millions worldwide. Local drug delivery to the cochlea is limited by the round window membrane (RWM), a tri-layered barrier separating the middle ear from the cochlea. Ultrasound (US) offers a promising non-invasive approach to transiently enhance epithelial permeability. However, increased permeability must not compromise RWM integrity or tight junctions, which are essential for cochlear homeostasis. The effects of US on RWM barrier integrity remain poorly characterised.

This study investigated US-mediated changes in epithelial permeability and tight junction integrity using polarised Caco-2 monolayers on Transwell inserts as a simplified model of the outer RWM epithelium. Barrier formation was

confirmed by transepithelial electrical resistance (TEER; ~1000 Ω·cm^2) and immunofluorescence localisation of ZO-1 and occludin. Paracellular permeability was assessed using Lucifer Yellow (LY; 457 Da) in three groups: control, hydrogel alone, and hydrogel + US (n = 5).

Baseline LY permeability below 10^{-6} cm/s indicated intact barrier function. Apparent permeability coefficients increased across groups, from 4.80×10^{-7} cm/s (control) to 6.90×10^{-7} cm/s (hydrogel alone) and 9.60×10^{-7} cm/s (hydrogel + US). Combined treatment approximately doubled permeability relative to control ($p < 0.05$). Live/dead assays revealed no significant cytotoxicity following US exposure, while preserved peripheral localisation of ZO-1 and occludin after 2 hours suggested no overt tight junction disruption.

These findings establish an *in vitro* platform for investigating US-mediated epithelial barrier modulation and provide preliminary evidence that US may enhance paracellular transport without acute barrier damage.

PG/ECR presentation award sponsored by

DKSH

AROA ECM™: A New Zealand case study in biomaterial commercialisation

Robert Veale

Corporate Development Manager, Aroa Biosurgery

Aroa Biosurgery is a New Zealand medical device company developing and manufacturing products for soft tissue repair and regeneration. Its AROA ECM™ platform is a decellularised extracellular matrix derived from ovine forestomach, processed to preserve the natural tissue architecture and a diverse range of biological components. This presentation introduces Aroa and its biomaterial platform, drawing on the company's experience to highlight the key decisions involved in translating promising research into commercially viable medical products. Topics include establishing clinical value, generating relevant evidence, protecting intellectual property, and aligning regulatory and manufacturing requirements with an attractive initial market. An example of industry–academic collaboration will illustrate how complementary expertise can support biomaterial development and clinical translation.

Session 6: Bioengineering across health and medicine

Drug eluting textile wrap for the treatment of intimal hyperplasia

Jo Krysa

Department of Surgery and Critical Care, Faculty of Medicine

Introduction: Sirolimus and paclitaxel stents have shown a significant reduction in coronary and peripheral arterial restenosis. Subintimal hyperplasia post surgical arteriovenous fistula formation and lower limb bypass grafts continues to be a major cause of fistula/graft failure. Animal models have shown significant reduction in subintimal hyperplasia at 3-4 weeks with a peri anastomotic drug eluting wraps. Unfortunately human trials have been suspended as early release of paclitaxel/sirolimus at the anastomotic site can cause early bleeding risk.

Proposal: Early subintimal hyperplasia is likely to be important to maintain anastomotic integrity, in the first 2-3 days. Subintimal hyperplasia continues to develop rapidly in the first 6 weeks post intervention. Therefore design of the drug eluting wrap needs to enable delayed release of the drug, delay from 4-7 days post surgical anastomosis (this will reduce the risk of early complications such as bleeding and infection), and the release to continue steadily for 4-6 weeks post formation.

Discussion: Potential options for design.

Development of a silicate-substituted bovine-derived hydroxyapatite scaffold for dental regenerative applications

Dr Jithendra Ratnayake

Department of Oral Rehabilitation, Faculty of Dentistry

J Ratnayake[1], G Dias[2], M Mucalo[3], M Gould[1]

1. Faculty of Dentistry
2. Department of Anatomy
3. School of Science, University of Waikato

Introduction: Hydroxyapatite-containing bone grafts are commonly used in dental surgery due to their biocompatibility, osteoconductivity and non-toxicity. Biologically derived hydroxyapatite from sources such as bovine bone is of great interest because it has a morphology similar to that of human bone. The current study aims to investigate the innovative integration of silicate ions into bovine-derived hydroxyapatite (BHA) and evaluate the silicon ion-substituted bovine-derived hydroxyapatite (SiBHA) scaffolds' physical, chemical, mechanical and biological properties.

Method: Silicate ions were successfully substituted into BHA using a modified sol-gel process to produce a silicon-substituted bovine hydroxyapatite (SiBHA) scaffold. The scaffold was chemically, physically and structurally characterised. The biological properties of the scaffold in terms of cytocompatibility and differentiation were investigated using in vitro experiments.

Results: The resulting SiBHA scaffolds exhibited an interconnected microporous structure with a total porosity of 70% and pore sizes ranging from 120 to 650

µm. Fourier-transform infrared spectroscopy and X-ray diffraction studies validated the effective incorporation of silicon ions into the BHA lattice, with energy-dispersive X-ray and inductively coupled plasma mass spectrometry further confirming a Ca/P molar ratio for SiBHA between 1.63 and 1.74. Moreover, SiBHA scaffolds demonstrated commendable chemical and thermal stability. SiBHA scaffolds exhibited significantly enhanced mechanical properties, including compressive strength and Young's modulus, compared to the control BHA scaffolds. In vitro assessments highlighted the ability of SiBHA scaffolds to support cell viability, proliferation, and osteogenic differentiation in Saos-2 cells. Immunohistochemical analysis revealed a significant increase in osteonectin expression, a key bone matrix protein, after 14 days of incubation under osteogenic conditions.

Conclusion: These findings highlight the biocompatibility and therapeutic potential of SiBHA scaffolds, suggesting their suitability as biomaterials for dental bone regeneration applications. However, further research is necessary to evaluate the clinical feasibility of the xenografts as bone graft substitutes.

Electrophysiology in an age of high-throughput neuroscience

Dr Owen Jones

Department of Psychology

Since the discovery of bioelectricity in the 18th century, electrophysiology has been the premier mode of assessing nerve cell behaviour. While the advancement of electrophysiological recording techniques has led to numerous scientific breakthroughs, these techniques often remain technically challenging and notoriously low-throughput. In recent years there has been a notable shift towards multi-electrode recording modalities that permit data collection from hundreds of channels simultaneously. Further, with the advent of conductive polymers we are now able to produce biocompatible interfaces with high channel count at low cost. Here I will introduce some of my own work using traditional modes of electrophysiology, then highlight the potential benefits of embracing a modern, multi-electrode approach.

From teeth to bone: dentin- and tooth-derived grafts as emerging biomaterials in regenerative dentistry

Dr Stéphane Derruau

Université de Reims Champagne-Ardenne

S Derruau[1,2,3], P Charde[4], M Behera[5], C Mauprivez[1,5], E Brenet[5,6], F Truong[5,6], H Hussaini[3], PR Cooper[3], H Kerdjoudj[5]

1. Pôle Médecine Bucco-Dentaire, Centre Hospitalier Universitaire de Reims, France
2. Université de Reims Champagne-Ardenne, UR BIOSPECT 7506, Reims, France
3. Faculty of Dentistry
4. College of Dental Medicine, Qatar University, Doha, Qatar
5. Université de Reims Champagne-Ardenne, UR BIOS 4691, Reims, France
6. Pôle tête et cou, Centre Hospitalier Universitaire de Reims, France

Tooth-derived bone grafts (TBGs) are promising alternatives to autogenous bone grafts, which remain the gold standard but are limited by donor-site morbidity and restricted harvest volume. Human dentin shares structural and mechanical similarities with bone and contains bioactive molecules, supporting osteoconductive properties and potential osteoinductive activity. This work presents advances in tooth procurement, processing, biological properties and applications in bone regeneration. Extracted teeth can be processed into mineralized or demineralized particulate and block grafts. Demineralization, particle size and graft architecture strongly influence biological performance, handling properties and remodelling. In vitro, preclinical and clinical studies support their potential use in guided bone regeneration, alveolar ridge preservation and augmentation, sinus floor augmentation and selected periodontal defects. However, heterogeneous protocols, small sample sizes and short follow-up periods limit our understanding of optimal biomaterials for clinical use. Tooth biobanking could enable preservation of extracted teeth or processed dentin for future autogenous use and potentially provide allogeneic grafts through certified tissue banks. This approach requires validated donor screening, processing, sterilization, storage and traceability procedures. Beyond conventional grafting, dentin particles could be incorporated into printable hydrogels, including gelatin-based bioinks, to develop customized scaffolds. This approach could combine dentin bioactivity with the architectural control offered by 3D bioprinting. Future studies should evaluate printability, mechanical stability, cytocompatibility and preservation of biological activity. Combined, biobanking and dentin-enriched bioinks could expand the applications of tooth-derived biomaterials for use in personalized bone regeneration.

Electrochemical sensors and biosensors for biomedical and food analysis

Dr Yanfang Wu

Department of Chemistry

Electrochemical sensors and biosensors offer a powerful platform for miniaturised analytical devices capable of providing rapid, precise, and highly reliable measurements, with sensitivity and selectivity comparable to, or even exceeding, those of established analytical methods. In this presentation, I will introduce our recent progress in developing next-generation electrochemical sensing technologies that integrate molecular design with bioengineering innovation. These include functional nanomaterials-based, DNA-based, molecularly imprinted polymer-based, and ionic liquid-based electrochemical sensing systems for biomedical and food analysis. I will discuss key strategies for addressing challenges in sensitivity, specificity, and real-sample analysis and highlight how these interdisciplinary approaches can enable more practical, sensitive, and reliable analytical tools for applications in human health and food safety.

Abstracts of poster presentations

All affiliations are University of Otago unless otherwise noted. Poster presentation award sponsored by AROA™

#1. Chitooligosaccharides hydrogel for novel ophthalmic applications

Chris How-Ming Tan

MSc candidate in Bioengineering, Faculty of Dentistry

CHM Tan, F March de Ribot, A Ali

Centre for Bioengineering and Nanomedicine, Faculty of Dentistry

Retinal detachment is an urgent, vision-threatening condition in which the retina separates from the retinal pigment epithelium. Prompt surgery is needed to prevent permanent vision loss. During surgery, the vitreous cavity is filled with an intraocular tamponade, which holds the retina in place while it heals. Silicone oil is common but not reabsorbed, requiring a second surgery for removal, and it can cause complications such as emulsification and visual disturbance. Alternatively, intraocular gases will be gradually absorbed and avoid a second operation but are toxic and can also cause complications. Chitoligosaccharide hydrogel remains underexplored in ophthalmology. To overcome these limitations, we developed an in situ–forming chitooligosaccharide-based hydrogel as a candidate vitreous substitute. Chitooligosaccharide, derived from FDA-approved chitosan, was formulated as an injectable system that undergoes ionic crosslinking under physiological conditions. This strategy is intended to eliminate the need for potentially toxic chemical crosslinkers or light-activated curing approaches, optimised for ophthalmic applications. Achieving a refractive index close to ~1.336 is essential to maintain optical clarity and transparency. The viscoelastic behaviour of the hydrogel should approximate that of native vitreous humour, thereby enabling biomechanical and load bearing support required for the detached retina. The resulting hydrogel formulations were characterised with respect to optical transparency, shear-thinning behaviour, storage modulus (G'), loss modulus (G"), viscosity and swelling. To the best of our knowledge, this study is the first to investigate a chitooligosaccharide-based hydrogel as a vitreous substitute, highlighting the need for further evaluation of its performance and safety as an ophthalmic medical device.

#2. Back on track: a five-channel nerve conduit

Danika Anthony

MSc candidate in Bioengineering, Faculty of Dentistry

Peripheral nerve injuries can create gaps that prevent regenerating axons from reaching their target tissues. Although nerve guidance conduits provide an alternative to autografting, conventional hollow designs offer limited internal guidance. This project developed a proof-ofconcept five-channel conduit with one central channel and four surrounding longitudinal channels to promote more organised axonal growth. The proposed clinical device combines a medical-grade PCL framework for structural support with a thin, crosslinked gelatin lining to provide a more cell-supportive surface. An enlarged, non-functional PLA prototype was 3D printed to demonstrate the channel arrangement, nerve-insertion cuffs and fixation holes. The design illustrates how structural, biological and directional guidance could be combined within one device. However, the channel dimensions are not biologically optimised, and the conduit cannot sort axons or guarantee correct target reconnection. Further manufacturing, mechanical, cellular and animal testing would be required before clinical application.

#3. 3D-printed hallux orthosis - Toe fracture treatment

Frost Rowe

MSc candidate in Bioengineering, Faculty of Dentistry

The hallux/big toe fracture is a common lower body injury whose function negatively affects the individual's gait. Current treatments are limited in providing a hygienic and ease of donning and doffing environment. The bioengineering tools of select biomaterials, additive manufacturing, computer design and biomechanics have been considered in orthopedics for a 3D printed hallux orthosis to address these limitations. The biomechanics implementation was to improve daily function and immobilize undesired movement. Computer design for precise geometry of ventilation structures for increased airflow, and less skin contact points for improved hygiene.

Biomaterial selection was balanced between antimicrobial function, mechanical strength, cost, weight and ease of additive manufacturing for different polymers, demonstrating the varying considerations needed in deciding on materials design. The decided polymer for the prototype was PLACTIVE, given its antimicrobial activity, commercial acceptance, in place regulations and lightweight.

Overall, the device design process presented the balancing act of bioengineering principles for biological performance, mechanical strengths, manufacturing and regulatory constraints in translating a clinical problem into a practical solution.

#4. 'That's gonna leave a mark!' Design and biofabrication of anti-fibrotic, anti-scarring, collagen sutures for skin wound-healing

Tara Price

MSc candidate in Bioengineering, Faculty of Dentistry

This project details the motivation, conception, and proposed methodology for the biofabrication of a novel, anti-scarring skin suture based on the human body's scarring mechanisms and relevant bioengineering concepts. A collagen-based, evogliptin-infused suture is recommended for applications in wound healing to promote regeneration of skin tissue while minimising the

functional, aesthetic, and psychological consequences of scarring, granting patients' aesthetic autonomy. The concept of an anti-scarring suture stems from an unmet clinical need and gap within the current suture and anti-scarring remedy/preventative market; there is no suture or therapeutic that can eliminate the risk of potential scarring. Methods documented in this project build on antimicrobial and drug-integrated sutures and utilise adaptive manufacturing and bioengineering techniques. The anti-scarring element was derived from current literature investigating the distinction between foetal and adult skin scarring capabilities, and the cellular mechanisms involved - fibrotic activity and its role in scar formation. *In vitro* and *in vivo* testing methods are regarded as future directions to validate proof of concept and characterise intended design features, i.e. anti-scarring capabilities and product performance functions such as mechanical strength, biocompatibility, biodegradability, and clinician interface.

#5. *Tying up loose ends: design of a biodegradable surgical knot fastener*

Efrat Kent

MSc candidate in Bioengineering, Faculty of Dentistry

The ability to tie a reliable and safe surgical knot is an essential skill to anyone who performs surgeries or is involved with any clinical aspect of wounds. Every knot should be tied with the utmost precision and hold the exact stress. Knots deform the final stitch and create a weak point, that in case of weakening or breakage can cause bleeding, suture unravelling, and opening of the wound. The tail of the tie, the excessive thread once the there is a knot and the clinician cuts the thread, affects the probability that the knot will untie. It needs to be short enough to minimise contamination to the tissue but long enough so it will not untie. In cases that the knot was loosening, it continues until the knot is untied. The aim of this device is to offer a simplified cord lock mechanism to securely lock suture threads without manual knotting. The device is comprised of a base unit housing a spring, and a second unit acting as the lid, applying pressure on the spring. The body and spring of the device will be produced out of biodegradable materials so it can degrade over time in the body, after the tissue has healed completely. The body of the device will be 3D-printed using PLA and the spring will be produced from a Mg-Zn (80:20) alloy. Successful development requires synchronised degradation of both materials, *in vitro* and *in vivo* testing to assure safety to the tissues, scalable manufacturing, and regulatory approval.

#6. *Beyond symptom relief: engineering the future of lumbar disc regeneration*

Matthew Bradley

MSc candidate in Bioengineering, Faculty of Dentistry

Lumbar intervertebral disc degeneration is a major cause of chronic low back pain, driven by failure of the disc's hydrated matrix, annular structure, and endplate nutrition. Current care can reduce symptoms, but restoration of disc structure remains limited. The guiding hypothesis was that current regenerative approaches show promise for improving symptoms and supporting repair, but durable disc regeneration will require strategies that better control cell survival, retention, and matrix restoration. This analysis first assessed whether current clinical treatments repair the disc or mainly relieve symptoms. Reported outcomes show that symptom improvement is achievable: physiotherapy achieved 86% satisfactory outcomes, basivertebral nerve ablation produced major pain relief in 65.5% of patients, and lumbar fusion achieved meaningful pain improvement in 77%. However, these benefits occur through indirect mechanisms: physiotherapy improves movement and strength, ablation reduces endplate pain signalling, and fusion stabilises the painful spinal level. Because these treatments do not restore disc matrix, height, or load-bearing structure, they define the repair gap that current regenerative approaches must address. Published Phase III data from NCT02412735 showed mesenchymal precursor cells with hyaluronic acid improved pain and function at selected time points, indicating clinical benefit. However, this did not translate into clear structural repair: fewer than 10% of subjects showed disc-height changes greater than 1 mm over three years, and imaging showed no clear regeneration. This supports the need for engineered biomaterial or bioprinted constructs that incorporate stem cells within a nucleus pulposuslike niche, pairing cell-mediated repair with structural matrix support.

#7. *Can a mouthguard protect against concussion? Mapping mouthguard characteristics and individual-specific factors in adult athletes*

Dyna Albert

PhD candidate, Faculty of Dentistry

D Albert[1,2], M Bussey[1], P Cathro[2], S Pathak[1], O Galea[3]

1. School of Physical Education, Sport and Exercise Sciences
2. Faculty of Dentistry
3. School of Physiotherapy

Sport-related concussion (SRC) is a growing concern in contact and collision sports. In New Zealand, around 20,000 SRC claims costing NZD 16.5 million were lodged with ACC across seven sporting codes between 2001 and 2011. Mouthguards, long used to protect teeth, have been proposed since 1964 to reduce concussion, through mechanisms such as occlusal damping of impact energy and neuromuscular co-activation that stiffens the head-neck system. Current design recommendations, however, are directed at dental protection, and it is unestablished whether the same parameters (thickness, laminate structure, material, fabrication technique, fit) translate to concussion-relevant outcomes. Meanwhile, sex, age, neck strength and clenching state modulate head acceleration, but whether they alter the effect of mouthguard use remains unmapped. We aim to conduct a scoping review that focuses on the the following three questions in adults. (1) Which mouthguard characteristics have been examined in relation to head- and mandible-level force or acceleration transmission relevant to concussion risk, through direct head-impact kinematics or bench and finite element proxies, over the past two decades? (2) What is the effect of these characteristics on concussion-relevant outcomes? (3) Do individual-specific factors influence the effect of mouthguard use on these outcomes?

Findings will inform mouthguard design and implementation for concussion mitigation.

#8. Wound healing by curcumin encapsulated silver nanoparticles loaded in hydrogels

Adrita Das

MSc candidate in Bioengineering, Faculty of Dentistry

A Das, A Ali

Centre for Bioengineering and Nanomedicine, Faculty of Dentistry

Chronic wounds are defined as challenging due to the enhancement of the level of oxidative stress, elevated level of inflammatory responses and inadequate nutritional support. To tackle these challenges, there is a requirement of the impactful multi-operational wound strategy that can offer insight into antimicrobial protection, repair of the cellular structure and tissue remodelling for wound management. The project examines the manufacture of the curcumin-stabilized silver nanoparticle-loaded hydrogel for the targeted wound therapy. Curcumin is an environmentally derived polyphenol that exhibits the exceptional features of antioxidant, anti-inflammatory, along with the antimicrobial features. However, the therapeutic efficacy of curcumin is challenged by rapid degradation rate along with the bioavailability limitations. Silver nanoparticles provide insights regarding the antibacterial impact inspite of their features of the aggregation, uncontrolled distribution within the bloodstream along with cytotoxicity impact. Encapsulation of curcumin with silver nanoparticles may not operate only as a bioactive therapeutic complex but also as a surface stabilizing agent of the particle. The incorporation of the curcumin and silver nanoparticles along with the hydrogel for targeted wound care plays a critical role in the enhancement of stability, lower biodegradation rate, angiogenesis, fibroblast formation and sustained therapeutic release.

#9. Choosing what a brain decoder predicts: DINOv2 vs. CLIP targets for fMRI image reconstruction

Aidan Dougherty

MAppSc candidate, Department of Computer Science

A Dougherty, V Liesaputra, Z Huang

Department of Computer Science

Recent advances have enabled researchers to reconstruct photographs a person is viewing from their brain activity, measured using functional MRI (fMRI). A network trained on a person's brain data predicts an embedding, a list of numbers summarising an image, and a pretrained generator turns it into a picture. This network is the only part trained on brain data, so the embedding it predicts, called its target, shapes what it can learn. The goal of this work is to improve on the current state of the art of fMRI image reconstruction by rebuilding published systems on the Natural Scenes Dataset. Only one, MindEye1, reproduced fully, within 3% of its paper on all eight image-similarity measures, and became my baseline, which was extended to four subjects. MindEye1's target is CLIP, an embedding trained to match images with their captions, so it has little reason to keep detail a caption omits. CLIP was replaced with DINOv2, an embedding learned from images alone, keeping the network's size fixed. Given a brain response from subject 1, the DINOv2 model identified the seen photograph among 982 in 87.1% of cases, vs. 75.8% for CLIP, and across four subjects it removed 26–47% of CLIP's errors (McNemar tests, all $p < 0.0001$). A simulation without brain data showed that, for this task, DINOv2's embedding space alone would have favoured CLIP, which points to a more accurate mapping from brain activity. Published systems inherit their target from the generator; these results show the target is a design choice worth testing. Checks built into every job also caught errors that produced plausible numbers.

#10. Wearable air quality monitoring for respiratory health

Samuel Doherty

MSc candidate in Bioengineering, Faculty of Dentistry

Abstract not available at time of publication

#11. Exploring melt electrowriting as a platform for controlled therapeutic delivery

Teo De Rezende McGuinness

PhD candidate (from 2027), Faculty of Dentistry

Melt ElectroWriting (MEW) is an additive manufacturing technology that enables the fabrication of highly organised microfibre scaffolds for drug release and regenerative medicine applications. MEW combines computer-guided fibre deposition with electric field-assisted extrusion of molten polymers, allowing precise control over fibre diameter, pore size, and scaffold architecture. This level of precision makes MEW attractive for biomedical applications requiring reproducible scaffold geometries and tailored mechanical properties. Recent advances have highlighted the potential of MEW scaffolds not only as structural supports for cell growth, but also as multifunctional platforms for therapeutic delivery.

This project explores the potential application of MEW scaffolds as drug-loaded slow-release delivery vehicles. By incorporating therapeutic agents within or onto biodegradable polymer fibres, MEW scaffolds may provide localised and sustained drug delivery directly to target tissues. Such systems could reduce systemic side effects, improve therapeutic efficacy, and enhance tissue regeneration outcomes. The highly tuneable architecture of MEW scaffolds offers opportunities to modulate drug release kinetics through adjustments in fibre spacing, porosity, polymer composition, and scaffold geometry. MEW also enables the fabrication of patient-specific constructs that could be adapted for applications including wound healing, bone regeneration, infection prevention, and cancer therapy.

An overview of MEW technology, currently used biomaterials, and strategies for incorporation of therapeutic agents into scaffolds will be presented. Focus is placed on the relationship between scaffold design and controlled drug release behaviour. Overall, MEW represents a promising platform technology at the intersection of biomaterials, tissue engineering, and controlled therapeutic delivery, with significant potential for future clinical applications.

#12. Development and physicochemical characterisation of antimicrobial peptide-loaded chitosan-chitosan oligosaccharide nanoparticles

Meera Probha Kabiraz

PhD candidate, Department of Microbiology and Immunology

Antimicrobial peptides (AMPs) are promising antimicrobial agents for pathogen control; however, their application may be constrained by limited stability and the need for effective delivery strategies. This study aimed to develop and optimise chitosan-based nanoparticulate delivery systems for AMPs to improve their formulation characteristics and potential functional performance. A total of 55 formulations were screened, and 10 selected formulations containing the antimicrobial peptides BP70 or BP174 were subjected to physicochemical characterisation. Chitosan–tripolyphosphate (CH–TPP) and chitosan supplemented with 10% chitosan oligosaccharide (COS) were evaluated under different pH conditions, peptide loading amounts, and peptide-to-chitosan mass ratios. The selected formulations were characterised for particle size, polydispersity index (PDI), zeta potential, encapsulation efficiency (EE%), and loading efficiency (LE%). The nanoparticles exhibited particle sizes ranging from 134.3 to 184.8 nm and PDI values of 0.191–0.320. All formulations demonstrated positive zeta potentials (+31.86 to +42.13 mV), indicating favourable surface charge characteristics. Encapsulation efficiencies ranged from 49.50% to 73.26%, while loading efficiencies varied between 7.72% and 22.01%. These findings demonstrate the feasibility of incorporating AMPs into chitosan-based nanoparticles and identify promising formulations for further stability testing and antimicrobial activity evaluation, supporting the development of functional peptide delivery systems for antimicrobial applications.

#13. Plasma surface modification of biodegradable meshes for pelvic organ prolapse repair: stromal and immune cell responses

Elahe Bahremandi Toloue

PhD candidate, Department of Obstetrics and Gynecology, Monash University, Melbourne

E Bahremanditoloue, K Paul, H Bidkhori, S Darzi, H Ung, JA Werkmeister, A Rosamilia, K Jarvis and S Mukherjee

1. The Ritchie Centre, Hudson Institute of Medical Research, Melbourne, Victoria
2. Department of Obstetrics and Gynaecology, Monash University, Melbourne, Victoria

Pelvic organ prolapse (POP) is a prevalent urogynecological disorder that frequently requires surgical reconstruction. Although biodegradable electrospun meshes have emerged as promising alternatives to permanent polypropylene implants, their performance may be limited by insufficient surface bioactivity and unfavourable host responses. This study investigated the effects of amine-rich plasma surface modification on stromal and immune cell responses to biodegradable electrospun meshes. Electrospun poly(L-lactide-co-ε-caprolactone) (PLACL) meshes were functionalised using amine-rich plasma polymerisation. Surface characterisation confirmed the preservation of fibrous morphology and pore structure following modification. Mechanical properties were preserved under most plasma polymerisation conditions. Chemical characterisation confirmed the incorporation of nitrogen-containing functional groups, accompanied by increased surface hydrophilicity and a shift towards less negative surface charge.

Surface modification enhanced cell proliferation, spreading, and focal adhesion formation in primary vaginal fibroblasts derived from women with POP. Using differentiated THP-1 macrophages as an *in vitro* immune model, plasma modification did not significantly affect metabolic activity but promoted a more elongated cell morphology compared with untreated meshes. Gene expression analysis revealed increased expression of IL1B, TGFB1, and IL10, suggesting modulation of inflammatory and tissue-remodelling-associated responses. Overall, amine-rich plasma polymerisation represents a promising surface modification approach for improving stromal cell interactions and modulating macrophage responses to biodegradable electrospun meshes for POP applications.

#14. Formulation and characterisation of an orally-delivered brain-targeting neuropeptide agent for mammalian fertility control

Soheil Mehrdadi

PhD candidate, Department of Anatomy

S Mehrdadi[1], C Bunt[2], C Decourt[1], R Anderson[3], G Anderson[1]

1. Centre for Neuroendocrinology, Department of Anatomy
2. Agricultural Innovation, Department of Food Science
3. Ferrier Research Institute, Victoria University of Wellington

Neuropeptides play a major role in veterinary fertility control of domestic animals and wildlife. Although there are commercial parenteral formulations, no commercial oral formulation exists in the market. Oral delivery offers a practical, scalable and non-invasive approach for veterinary fertility control through feed or bait. The challenge is attributed to both the physicochemical properties of neuropeptides and host-related biological factors to by-pass gastrointestinal membrane and blood-brain barrier for an eventual brain-targeted delivery. Hence, nanotechnology systems have been the focus of studies to address the challenges. We have synthesised a novel neuropeptide-toxin conjugate (NTC) to be encapsulated in oral nanotechnology systems and oral pellets to disrupt the hypothalamus-pituitary-gonadal axis resulting in infertility.

A proof-of-concept *in vivo* study (subcutaneous injections) withe the naked NTC in female mice demonstrated a pronounced luteinising hormone (LH) response demonstrating the successful NTC-receptor interactions. However, the intended cytotoxicity and loss of female reproductive cyclicity was not witnessed. To troubleshoot this, 2 *in vitro* cell culture studies using MIN6 cell line were conducted with Fluo-4 calcium assay and CCK-8 cell viability assay demonstrating the successful induction of cellular activity upon binding and carrier-mediated uptake of the NTC, respectively. The latter assay showed “endosomal entrapment” upon cellular internalisation where no cell death happened after 24 h of NTC treatment but showed cell death upon co-treatment with Chloroquine to disrupt endosomal membrane and induce endosomal escape.

The ongoing studies are dedicated to designing and optimising a robust oral nanotechnology delivery system for brain delivery to release the NTC intracellularly to address the endosomal entrapment issue.

#15. *3D-printed hydrogels for haptic applications*

Érika Marques Takase
School of Engineering, University of Canterbury

This study investigates 3D-printed alginate/polyethylene glycol (PEG)/gelatin hydrogels incorporating orange essential oil and their potential relevance to haptic applications. The effects of polymer composition and orange oil concentration on physicochemical, rheological, morphological, swelling, and cytotoxic properties were evaluated.

Zeta potential and dynamic light scattering analyses revealed differences in sample stability associated with alginate concentration. Rheological characterization demonstrated pseudoplastic behaviour, with viscosity increasing alongside orange oil concentration, while PEG and gelatin also influenced viscosity. Fourier transform infrared spectroscopy confirmed the presence of the main polymer components. Thermogravimetric analysis identified three degradation stages and higher degradation temperatures at increased alginate concentrations. Scanning electron microscopy revealed changes in surface morphology and porosity associated with orange oil incorporation and variations in alginate and gelatin concentrations. Swelling behaviour was also affected by formulation composition. Cytotoxicity assessments indicated reduced cell viability in formulations containing orange oil and calcium crosslinking, particularly at higher oil concentrations.

These findings demonstrate how formulation parameters influence the properties and printability of alginate-based hydrogels. Their physicochemical and rheological characteristics provide a basis for investigating their potential as soft materials for tactile interfaces and related haptic systems. However, their mechanical response under contact, tactile perception, and performance in haptic devices have not yet been established. Further research is required to assess their suitability for specific haptic applications.

University of Otago
ŌTĀKOU WHAKAIHU WAKA