Research and Innovation Guide

Inspire

Innovate

Transform
Within the School of Dentistry at Leeds, we share a vision to inspire oral healthcare professionals and scientists to innovate and transform global health and quality of life via world leading clinical, educational and research excellence.

Our staff and postgraduate students work across the disciplines and clinical specialties to address priority clinical needs to improve treatment, restore function and address the needs for prevention. The relationship between oral and systemic health is a recent research priority (“putting the mouth back in to the body”), inspired by emerging and future disease patterns and the complexity of co-morbidities. Our goal is to translate innovative research to transform patient and population quality of life.

Translating research into clinical practice is the focus of our state-of-the-art Dental Translational and Clinical Research Unit (DenTCRU), co-funded by the Wellcome Trust, spearheading our partnership with local, national and international industry.

A recent £multi-million estate refurbishment has transformed our working environment. Our dedicated multidisciplinary oral biology research laboratories in the Wellcome Trust Brenner Building at the St James’s University Hospital site are co-located with the School of Medicine’s biomedical research groups. Dentistry researchers work alongside colleagues in musculoskeletal, cancer, genetics, molecular pathology and immunology, inspiring interdisciplinary working and delivering innovation in research with real impact. Our haptics training suite has the largest number of MOOG ‘Simodonts’ in the UK. Our expertise in Digital Dentistry inspires not only our students but our industrial partners, with whom we are working to transform the dental workflow.

This guide provides only a taste of who we are and what we do. Please visit our website for further details of the depth and breadth of research and innovation expertise that can be accessed at the School of Dentistry, University of Leeds.

Professor Jennifer Kirkham
Interim Dean
SCHOOL OF DENTISTRY

Our outstanding strength in basic sciences and holistic approach to world-class research are central to our ability to offer a seamless continuum from the laboratory to the clinic and to our aim of providing an exceptional experience for our postgraduates.

We offer access to an interdisciplinary team of clinical and basic science researchers with international reputations in their respective fields and are supported by state of the art facilities.

We work in close partnership with Leeds Teaching Hospitals NHS Trust. Its dental hospital, Leeds Dental Institute, enables our students to deliver patient treatment as part of their undergraduate and postgraduate training. This close relationship also allows our researchers easy access to the Institute’s clinicians and network.

We have the capacity and expertise to respond rapidly and effectively to the needs of our partners and stakeholders, and pride ourselves on understanding their drivers, goals and delivering to their needs.

Working together with our partners and students we have never been better placed to address clinical innovation challenges and deliver our vision of underpinning excellence in clinical research with outstanding basic science.
DENTAL TRANSLATIONAL AND CLINICAL RESEARCH UNIT (DenTCRU)

Funded via a prestigious £1.7m capital award from the Wellcome Trust/University of Leeds, DenTCRU is a state-of-the-art research clinic dedicated to the delivery of world-class translational and clinical research in dentistry.

DenTCRU provides our researchers with an environment:

- To expedite interdisciplinary translational dental research for patient benefit.
- To generate high quality clinical and translational oral and dental health research including: efficacy and effectiveness clinical trials of investigational medicinal products (CTIMPs) and devices; Oral biomarker examination for potential novel prognostic/diagnostic capabilities. Mechanistic evaluations to advance biological understanding.
- That supports development of methodologically robust projects tailored to NHS priorities.
- To develop collaboration with strategic industry partners via coordination of trials of novel treatments and devices to support regulatory approval; to enable studies to be undertaken to the quality and rigour expected by Good Clinical Practice and regulatory governance standard.
- To forge multi-disciplinary research partnerships between clinicians, academics, industry and patients; enabling a patient-centric approach with integral Patient Public Involvement and Engagement (PPIE) throughout the research cycle.

- To deliver evidenced-based dental treatment and care that maximises patient benefit and NHS impact.
- To manage a range of grant-funded studies from single-centre non-interventional studies to large, multicentre and international clinical trials.
- To train the next generation of clinical academics in high-quality clinical research.

Equipped to an exceptionally high standard, DenTCRU has six high specification dental units and supporting laboratory infrastructure, providing researchers with access to non-invasive intraoral diagnostics, high throughput microbiological molecular screening and stem-cell based therapies and devices in regenerative skeletal medicine. DenTCRU is an integral speciality spoke of the National Institute of Health Research (NIHR) Leeds Clinical Research Facility delivering high quality early translational and experimental medicine and dentistry research ensuring new treatments and diagnostics reach patients more quickly.

Benefits

DenTCRU is a dedicated facility through which we achieve our vision of delivering world-leading research excellence, patient benefit and research impact. We engage with a range of partners and stakeholders from major international companies to our local community.

Working closely with NIHR registered Clinical Trials Units ensures that our clinical research is performed to the highest standards of clinical governance and rigour. The Director of DenTCRU co-leads the Yorkshire & Humber region of the NIHR Oral & Dental Health Speciality of the National Clinical Research Network ensuring timely delivery and support for recruitment and retention in clinical studies.
SKELETAL TISSUES RESEARCH BANK

The School of Dentistry’s Research Tissue Bank for approved storage of skeletal tissues was the first to be established in the University of Leeds at the time of its inception. The Bank facilitates the work of our staff, students and collaborators in our priority areas of biomineralisation, skeletal tissue engineering, regenerative medicine and stem cell biology whilst ensuring strict adherence to the Human Tissue Act governing the use of human tissue in research.

Concept

Working with clinicians across the School and the Leeds Teaching Hospitals NHS Trust, the Bank provides access to samples including teeth, bone, ligament, cartilage and stem cells for our staff, students and collaborators (both academic and industrial) across the globe. The Bank provides samples for research to:

- Improve our understanding of skeletogenesis/odontogenesis.
- Develop new ways of repairing teeth and restoring their function, including development of new materials for fillings.
- Understand the mechanisms of tooth decay, erosion and wear.
- Use dental pulp and bone marrow to provide a source of adult stem cells for tissue regeneration and repair.

Impact and Benefits

The Skeletal Tissues Research Tissue Bank provides an excellent resource for our staff, students and collaborators whilst guaranteeing the highest standards of clinical governance and research integrity for our patient donors.

SKELETAL TISSUE REPAIR AND REGENERATION

Concept

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Impact and Benefits

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Background

The Schools of Dentistry and Design at the University of Leeds have a long-standing academic collaboration between materials scientists and textile engineers with a common interest in the repair/regeneration of both hard and soft tissues. We aim ultimately to apply the knowledge gained by working together in the development of therapies for patient benefit.

Concept

To bring together complimentary expertise through the School’s Biomaterials and Tissue Engineering Research Group and the Clothworker’s Centre for Innovation in Healthcare Materials in the School of Design. Over the last 6 years, we have together been developing, modelling and applying a platform of tunable, versatile collagen hydrogels and non woven fabrics targeting the repair or regeneration of a variety of tissues. We work closely with clinical colleagues to identify unmet or poorly met clinical needs and to develop bespoke solutions; we are currently working on applications as diverse as wound dressings, periodontal membranes, and drug delivery vehicles.

Impact and Benefits

Importantly, both groups also have a focus on translating this underpinning knowledge into products for clinical use. Funding has been obtained to carry out fundamental research to develop the technology platform, to take novel materials through to pre-clinical testing. Partners at material supply, manufacture and end-users have been engaged.

Equally importantly, this collaboration has facilitated the training of several PhD students/Postdoctoral Research Assistants in a multidisciplinary way of working.
INNOVATION IN DENTAL IMAGING

Digital workflows in dentistry are likely to have a profound effect on the profession in terms of the way dentists diagnose disease, restore function & appearance and communicate with patients and other dental professionals. Digital imaging lies at the heart of this emerging discipline.

Concept - A case study in Orthodontics

The NHS Business Services Authority has changed clinical monitoring in orthodontics by indicating that any records must now be submitted with 3D digital study models produced by scanning impressions, cast models or by intra-oral scanning.

University owned IP, developed by Dr Andrew Keeling, in digital imaging has been licensed to Arkive Dental Ltd, a company which specialises in the secure scanning, archiving and storage of digitized orthodontic casts.

Impact and Benefits

Orthodontists and general dentists are able to digitally archive their study models and access them from anywhere in the world at the touch of a button. This reduces the need for physical storage space and prevents deterioration of the models over time.

Further work in digital dentistry at Leeds has involved liaising with 3D printer manufacturers to tailor machines specifically for printing high quality dental models. This means the archived digital dental models can be transformed back into physical models, printed at resolutions of up to 10 microns. Our group has directly advised on the British Orthodontic Society National Clinical Guidelines for the use of 3D study models in orthodontics.

The license fees generated by this partnership are being put back into furthering this, and many other avenues of research in digital dentistry at Leeds. The focus is on enhancing clinical practice and dental education with a view to establishing Leeds as a centre of excellence in digital dentistry.

http://arkivedental.co.uk/

ESTABLISHING LEEDS AS A CENTRE OF EXCELLENCE IN DIGITAL DENTISTRY
ADVOCATE (ADDED VALUE FOR ORAL CARE)

EU spending on oral health care is close to €79 billion pa. Globally, 3.9 billion people suffer from the common oral conditions of dental caries, advanced gum disease and tooth loss, all of which are preventable conditions.

Concept

Change will be achieved by developing a model that promotes a preventive rather than restorative oral health care system, to bring health system planning into the 21st century. The oral health care model 2020 will shift the focus from dental surgery and treatment towards a consumer friendly, evidenced dental medicine and disease prevention paradigm.

To achieve this the project team and its stakeholders will establish an innovative framework for planning of services and care systems by using advanced data science to collect and analyse oral healthcare data from eight national databases. This will be combined with extensive opinion gathering with stakeholders (the public, patients, dental practitioners, policy makers and healthcare product industry representatives).

The output will be a Dashboard display which can be used for comparing performance at the dental practice and country (system) level.

Impact and Benefits

The capacity of this approach for population impact is vast since the ADVOCATE consortium joins forces and works across systems and countries. With our approach we will establish the framework to improve the efficiency and equity of oral health care service across Europe.

Further, this process may serve as a blueprint for other health care system reforms.

EFFECT OF SELF-ASSEMBLING PEPTIDE (SAP) TECHNOLOGY

Background

In 2010, credentis ag was founded to commercialise the University of Leeds’ intellectual property in the field of self-assembling peptides (SAPs) for use in dentistry. Successful ‘first in man’ trials were carried out in the School’s Dental Translational and Clinical Research Unit, and a CE mark was awarded in 2012, approving clinical use of the product ‘Curodont Repair™’ in the treatment of early caries. The products are now also licensed for use in the US.

Concept

Led by Professor Jennifer Kirkham, ‘Filling without Drilling’ SAP technology was co-invented and taken through to commercial partnership at the School of Dentistry, working with the University’s Innovation Knowledge Centre in Medical Technologies. SAPs are rationally designed to produce biomimetic scaffolds that are capable of nucleation of tooth mineral based upon knowledge of the role of proteins in enamel formation.

The project exemplifies the School’s strategy in translational research with basic research in biomineralisation being used to inform therapeutic design for patient benefit.

Impact and Benefits

credentis ag now market a range of products based on Leeds’ SAP technology as part of the Curalox® technology range. In addition to the original “Repair”, the company offer Curodont D’Senz for treatment of tooth sensitivity and Curodont Protect for protection against acid erosion, with dentifrices and other maintenance products also available. The company were winners of the Swiss Technology Award and the Swiss Excellent Product Award in 2016, see www.credentis.com/en/home.

The company is now well on the way to establishing the technology globally, benefiting patients and generating revenue and jobs in the UK and beyond.
**DON’T SMILE - INNOVATIVE RESEARCH DISSEMINATION**

A love story with a dental theme: using theatrical performance to disseminate research to at-risk seldom-heard adolescents in areas of social deprivation and high oral health inequality.

**Background**

Health Need: In Yorkshire 45% of its 12-year-olds have caries resulting in pain, lost schooling and low self-esteem; it is correlated with social/health inequality. Whilst largely preventable, reaching those most vulnerable in deprived areas is challenging. Disadvantaged teenagers intrinsically don’t like to be told what to do.

Purpose: Don’t Smile was inspired to test if using theatre might impart knowledge non-judgmentally, allow debate and improve oral health awareness in at risk adolescents.

**Concept**

University of Leeds worked in unique collaboration with Theatre of Debate, students (dentists, scientists and performance arts), patients and adolescents to co-produce Don’t Smile. The short play/debate showcased world-leading research on the inherited condition Amelogenesis Imperfecta that results in abnormal tooth enamel formation leading to discoloured, painful teeth. It allowed us to explore the wider implications of poor oral health, social isolation/ psychological wellbeing and NHS dental access.

**Impact and Benefits**

Don’t Smile was an effective way to communicate research and oral health knowledge. We conclude that theatre is an effective media to impart knowledge that pupils ordinarily had limited access to and described it as a ‘treat’.

Legacy: A web-based documentary showcases the approach and provides further knowledge-transfer opportunity for others to benefit from: http://medhealth.leeds.ac.uk/dentistry/cohesion/dontsmile

Unexpected outcome: After the play pupils and staff were keen to do more research and approached the School of Dentistry to co-develop participatory dental research. We have established ‘RAISED In Yorkshire’ (RIY - ReseArch In Schools Evaluating Dental health) a pupil peer-peer monitoring of oral health and tooth brushing behaviour.

**SMILE AIDER - PATIENT PUBLIC INVOLVEMENT AND ENGAGEMENT**

(Stakeholder meaningful involvement and engagement aiding dental research)

Ensuring a patient-centric approach to dental research “No research about us without us!”

**Background**

To establish a robust patient-centric approach to our oral and dental health clinical research programme adopting the philosophy “No research about us without us!”

Patient public involvement and engagement (PPIE) has become a widely adopted approach in medicine but dentistry has been a slower adopter.

**Impact and Benefits**

SMILE AIDER is a vibrant PPIE Forum representing patients/carers across the dental specialties and members of the public. We have overcome the perception that dental patients do not feel united by an ‘illness’ in contrast to PPIE Forums in medicine. We have achieved inclusion of the “seldom heard” voices such as, adolescents in poor areas with the worst oral health inequality and prevalence, and the elderly.

SMILE AIDER is delivering patient-centric research across translational and health service research. Our approach ensures better designed studies that are cognate of the patient lived experience and public perceptions; they are not to be too onerous for participants; and ask the right questions of importance to patients thereby improving the likelihood of delivering patient benefit.

**Don’t Smile won the NCCPE Prize in 2016.**

“**This presents an excellent opportunity for our students to work with a professional theatre company and turn medical research into a dynamic and engaging performance**”

Rebecca Collins, Teaching Fellow in Contemporary Performance
ADVANCING THE GENETICS OF ENAMEL DEVELOPMENTAL ABNORMALITIES (AGEnDA)

**Background**

AGEnDA brings together researchers and clinicians from the University of Leeds and Leeds Teaching Hospitals NHS Trust to collaboratively work with others around the UK and the world. This partnership aims to improve insight into the basis of developmental enamel abnormalities to advance understanding of biomineralisation and inform translation to advance clinical care.

**Concept**

The partnership involves the full cycle of family recruitment, gene discovery and feedback to those affected through dissemination of findings. Families with Mendelian-inherited enamel developmental abnormalities including Amelogenesis Imperfecta (AI) are investigated via cutting-edge genetics approaches in partnership between the School of Dentistry and Leeds Institute of Biomedical and Clinical Science (LiBACS) at the University. A collaborative international network expedites advances.

**Impact and Benefits**

In a short period of time the partnership gained novel insights into gene function critical to biomineralisation and in selected families, associated retinal degeneration, immunological function, muscle formation or renal impairment. These discoveries translate immediately with global relevance to the care of those affected. Targeted NHS genetic testing for AI was introduced in 2016. Genetic testing will inform NHS service reorganisation with development of clear patient pathways, better informed management choices and improved public-patient engagement and understanding. The discoveries are also opening up new areas of biomineralisation research that will inform development of interventions with the potential to promote biomineralisation not only in teeth but also in other settings.

MODELLING ORAL BIOFILMS – INFORMING HEALTH – FROM MATH TO CLINIC (MOBIH)

**Background**

Scientists and clinicians in the School of Dentistry and the Department of Computing at the Faculty of Engineering are collaborating to develop preventive and therapeutic strategies to combat biofilm infections. Dr David Head in the School of Computing is working in collaboration with Professors Deirdre Devine and Phil Marsh from Dentistry to develop a computational tool that aims to accelerate the development of future healthcare products.

**Concept**

Many disciplines in science and engineering have already benefitted from computational modelling, which can predict the results of whole series of experiments quickly and cheaply. The continuing production of powerful, low cost computer hardware means that problems previously regarded as too complex for practical simulations can now be tackled, and computational models for biological systems are both feasible and increasingly employed. These have the potential to significantly accelerate the translation of novel therapeutic products to commercial reality. In addition, dental plaque is the best characterised component of the human microbiome due to its accessibility, presenting opportunities for understanding biofilms of broader relevance.

**Impact and Benefits**

The first computational model for oral biofilms capable of predicting changes in the populations of bacterial species, and the corresponding impact on the potential for tooth decay, has been developed and exploited to demonstrate the relative importance of multiple risk factors. Validation against bespoke *in vitro* experiments will further the long-term goal of providing a pre-screening tool to reduce both the cost and time of the in vitro stage in the development of new oral healthcare products.
THE CENTRE FOR DOCTORAL TRAINING (CDT) IN TISSUE ENGINEERING AND REGENERATIVE MEDICINE

Regenerative medicine has been identified by the government as one of ‘eight great technologies’ vital to driving UK economic growth and EPSRC funding for the new Centre for Doctoral Training confirms Leeds’ place as a leader in the discipline.

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Concept

A £3.2m training centre aimed at keeping the UK at the cutting edge of regenerative medicine research has been based at the University of Leeds since 2014.

Impact and Benefits

The CDT brings 50 PhD studentships over five years to the University, allowing researchers to explore new treatments addressing, for example, cardiovascular and musculoskeletal diseases. Aligning fully with the School’s research strategy, academics from the School of Dentistry are providing research projects in the areas of biomaterials, tissue engineering and biomineralisation.

The doctoral trainees will enter a bespoke four-year programme that will, based on their previous experience and parent disciplines, first train them in the field and then guide them through their PhD research. The ultimate aim of the CDT is to bring together the brightest young researchers from a wide range of disciplines in a structured programme to train the specialists in regenerative medicine the UK needs.
WHY STUDY AT THE UNIVERSITY OF LEEDS?

The University of Leeds is a major economic and cultural contributor to Leeds and the surrounding region. Leeds is focused on original, creative and innovative research to address the economic, environmental and societal challenges facing the world.

We are in the top ten for the fourth consecutive year in the Guardian Good University Guide 2018, one of the top 100 universities in the world (QS World Rankings 2019) and part of the Russell Group of leading UK universities.

Each year we help around 34,000 students, including over 7,000 international students from 150 countries reach their potential by learning alongside inspirational academics in a research-intensive environment.

Leeds is one of the UK’s top research universities with more than 80% of our research rated as ‘world leading’ or ‘internationally excellent’, securing the University 10th place for research power in the most recent Research Excellence Framework. We actively encourage and support an enterprising spirit. The University of Leeds has created more than 100 spin-out companies, and more AIM (London Stock Exchange) listed firms than any other university in the UK. Six of our spin-out companies are market listed with a value of over £500 million and employing over 700 people.

By working together we can develop practical solutions to real needs based on world-class research. This approach:

- marries external market demand with our recognised research and innovation strengths
- is challenge driven, applying research excellence to issues of national and international importance
- makes our research relevant to industry and external partners.

We’re Top 10 in the UK

We are ‘Top 10’ in ‘The Times and The Sunday Times’ Good University Guide 2018

80% of our research rated as ‘world leading’ or ‘internationally excellent’
POSTGRADUATE RESEARCH DEGREES

The School of Dentistry’s internationally renowned scholars and state-of-the-art facilities provide an ideal research environment in which to undertake postgraduate studies.

Student support and personal and professional development are key elements in our postgraduate programmes. The University of Leeds is committed to providing a setting in which our postgraduate students can acquire research skills and knowledge; develop a wide range of attributes; prepare for academic or industrial careers and also realise personal/professional ambitions.

Research programmes at the School cover a wide range of clinical and basic science disciplines with seamless multidisciplinary integration across all areas. We offer research degrees at PhD, MPhil and MSc levels.

Postgraduates have the choice of studying for their PhD by following the classic route by research alone. Alternatively, there is the innovative Professional Doctorate programme – a research degree with taught components. This programme is most suitable for clinicians as it offers advanced clinical training and education combined with high level research activity.

Whichever career path you choose, a research degree from the University of Leeds is the ideal springboard to realise your aspirations.

For more information on postgraduate research degrees, please contact:

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