The University of Wollongong (UOW) has an international reputation for the strength of its biomedical research and capacity to develop biomaterial devices resulting from its long-standing excellence in materials research. This work ranges from developing synthetic biosystems such as nerve regeneration, bionic muscles and implantable devices, to developing devices like the BioPen, which allows surgeons to design customised implants on-site while conducting surgical procedures.

UOW's Innovation Campus is home to the Australian Institute for Innovative Materials (AIIM), which houses two of the University’s leading research institutes – the Institute for Superconducting and Electronic Materials (ISEM) and the Intelligent Polymer Research Institute (IPRI). IPRI is the lead node of the Australian Research Council (ARC) Centre of Excellence for Electromaterials Science (ACES) and lead node of the Australian National Fabrication Facility (ANFF) - Materials node.

ACES is committed to expanding knowledge of materials to create the next generation of “smart devices” to provide new health and energy solutions. The Centre’s strength is its expertise in end-to-end biofabrication solutions, with skills in forming printable bio-inks, stem cell biology, custom printing and developing 3D hardware allowing researchers to develop concepts into actual products.

ACES, IPRI and ISEM collaborate with other researchers, particularly from the School of Chemistry, the School of Medicine and the Illawarra Health and Medical Research Institute (HMRI) on biomedical and biomaterial projects. The IPRI/ACES group has a strong bionics program closely connected with St Vincent’s Hospital, which provides access to surgeons and other clinicians. Researchers and clinicians are focusing on the use of novel electromaterials and advanced manufacturing techniques to build devices for biomedical applications such as nerve regeneration and regrowth, bone regeneration, implantable devices, artificial (bionic) muscles and epilepsy detection and control.

Prototyping and device development facilities at AIIM allow researchers to design and build prototypes, taking their ideas from concepts to products that are closer to commercialisation. The facility is the first in Australia to bridge the gap between research breakthroughs, prototyping and commercialisation.

From 3D printing to green power to robotics, UOW’s School of Mechanical, Materials, Mechatronic and Biomedical Engineering offers a unique mix of study areas, including postgraduate industry training and continuing professional development.

Intelligent Polymer Research Institute
IPRI is the lead node of the Australian Research Council (ARC) Centre of Excellence for Electromaterials Science (ACES) and is recognised as a world leader in the development of intelligent materials and nanotechnology, including expertise in the electrochemistry of organic conductors in applications such as artificial muscles, wearable and implantable energy sources, and biomedical applications. Researchers are collaborating on projects from developing 3D-printed body parts to building robotic systems that have the high dexterity found in humans (soft robotics).

3D printing technology researchers at IPRI are developing biomedical devices that replicate organs and other body parts, while also designing and manufacturing machines to make them. Meantime, ink-jet printing, 3D extrusion printing and wet-spinning methods are being adapted to produce biomaterials.

UOW and its partners have worked together to create the BioPen – a hand-held 3D printer - which allows surgeons to repair damaged and diseased bone material by delivering live cells, within a specialised bio-ink formulation, directly to the site of the injury to accelerate regeneration of bone and cartilage. This technology is also being used in the iFix system, which incorporates 3D printing to repair corneal ulcerations.

In April 2018, the BioPen project was one of 11 projects selected for the first round of the Australian Government’s $10 million BioMedTech Horizons program investment. In 2017, the team behind the BioPen, made up of researchers from ACES, St Vincent’s Hospital Melbourne and the University of Melbourne Department of Surgery were finalists for the UNSW Eureka Prize for Excellence in Interdisciplinary Scientific Research.

UOW is also partnering in a new ARC Training Centre in Additive Biomaterials that will help position Australia as a world leader in 3D bioprinting for medical applications. A Graduate Certificate in Biofabrication online course is also currently offered. In 2014, UOW launched the world’s first Masters degree in medical treatments based on printing and regrowing human tissue, in partnership with three other world-leading biofabrication research institutes.
Bio-fabrication – a process of regrowing human tissue using 3D printing techniques – enables health professionals to offer patients improved, personalised treatments for nerves and tissue damaged by disease or injury. Potential applications range from treatment for spinal cord damage, to helping repair tissue after a mastectomy.

Institute for Superconducting and Electronic Material
ISEM is a world-leading research institute dedicated to developing new and innovative technologies to generate, transport and store energy and improve the efficiency of electronic devices. The institute ranks among the leading research groups globally in the fields of superconducting materials and lithium-ion battery research. Its research program is working on new materials and technologies for applications including medical equipment and biomedical applications.

ISEM researchers are pioneering the development of advanced nanoceramics for a number of health protection applications, including: free radical scavengers for neurodegenerative diseases and radiation protection; smart thermanotic nanoparticles for highly selective cancer therapies based on induction of controlled oxidative stress in malignant cells; and next-generation highly efficient multifunctional inorganic UV filters for sunscreens optimised for Australian conditions, which provide simultaneous strong UV filtering and biological protection from reactive oxygen species.

Researchers at the ISEM are part of a multi-disciplinary team to design and develop “smart liposomes” based on magnetic nanoparticles, to be used for targeted drug delivery in cancer treatment. The ISEM, in collaboration with the UOW’s Centre for Medical Radiation Physics (CMRP), is also developing novel types of radiosensitisers, based on heavy-element ceramic nanoparticles, for advanced radiation therapies.

Centre for Medical Radiation Physics
The Centre for Medical Radiation Physics (CMRP) is a research team within the University of Wollongong’s School of Physics which is dedicated to the development of semiconductor detectors and dosimeters for clinical applications in radiation protection, radiation oncology and nuclear medicine as well as high energy physics applications.

CMRP specialises in fields ranging from innovative cancer treatments such as radioactive seed implant brachytherapy and intensity modulated radiation therapy for treating tumours in the head and neck, to detection instruments for hazard radiation in space and avionics environments. It works closely with many international institutes, including the National Space Biomedical Research Institute in the United States.

Global Challenges Program
UOW’s Global Challenges Program (GCP) encourages and develops interdisciplinary research to help drive social, economic and cultural change regionally which is then translatable across the globe. The GCP sponsors interdisciplinary research and several new biomedical products have emerged from this research. The projects involve diverse research teams providing a holistic approach to the design and evaluation of new products. Examples of these include:

- The next-generation condom that addresses barriers to use in developing countries. The condom, made of new tough hydrogel materials, was one of the winners of the 2018 NSW Medical Devices Funds.
- A vibration-free driver’s seat for heavy vehicles that improves physical and cognitive wellbeing.
- Smart fabric wearable technologies for an ageing population, allowing the transmission of health monitoring data from the individual.
- Active compression garments for the treatment of conditions such as lymphoedema.

Biomechanics Research Laboratory
UOW’s Biomechanics Research Laboratory is developing innovative strategies, based on rigorous applied biomechanics research, to decrease injury potential and optimise the quality of life for individuals of all ages.

Responsive clothing is the new frontier of sports and health technology, with UOW researchers leading the way in solutions that prevent injury and improve comfort. This has led to the development of the Intelligent Knee Sleeve, the Bionic Bra and the Lymph Sleeve. These are three examples of cutting-edge “wearable technologies” developed via collaborations among biomechanics researchers, material scientists, chemists, mechatronic engineers, clinicians, patients and industry.

The Bionic Bra is the world’s first responsive bra that senses changes in a woman’s breast motion and automatically tightens to provide breast support when needed. The Lymph Sleeve has the potential to transform the lives of women who suffer from breast cancer-related lymphoedema.

In 2015, UOW signed a collaboration agreement with BSN Medical in Germany, to further develop an active lymph sleeve.

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