Faculty of Science

The Faculty of Science has a strong national and international research profile and excels in all research indicators including publications, external and international grants, Australian Research Council Fellowships and distinguished visitors.

Department of Biological Sciences
Department of Chemistry and Biomolecular Sciences
Department of Chiropractic
Department of Computing
Department of Earth and Planetary Sciences

Department of Electronic Engineering
Department of Environment and Geography
Department of Mathematics
Department of Physics and Astronomy
Department of Statistics
Candidates undertaking a research degree choose a research topic in consultation with relevant academic staff and are assigned to a particular supervisor. Acceptance into a research degree depends on the availability of supervision. Applicants are required to consult the relevant departmental website for details of staff research interests and contact a potential supervisor in the department prior to making a formal application.

**Highlights**

- **Concentrations of Research Excellence**
  Macquarie’s international reputation rests on distinct research areas of the highest quality. Currently, there are 18 COREs across the University, eight of which are in the Faculty of Science:
  - Animal Behaviour
  - Astronomy and Astrophysics
  - Biomolecular Frontiers
  - Climate Risk/Ecology and Evolution
  - Earth and Planetary Evolution
  - Lasers and Photonics
  - Quantum Information Science and Security
  - Wireless Communications
- In addition to the Concentrations of Research Excellence, the faculty is home to four ARC Centres of Excellence and several Macquarie research centres.
- In the 2010 Excellence in Research for Australia (ERA) initiative, four of the faculty’s fields of research – biological sciences, Earth sciences, environmental sciences and physical sciences – were awarded the highest possible rating – 5 out of 5 – which is described as ‘outstanding performance well above world standard’

**Research stars**

- **Professor Mark Westoby** from the Department of Biological Sciences was one of 15 researchers nationwide to receive a coveted Australian Laureate Fellowship in 2010. His research interests lie in the fields of ecology and evolution, mainly of plants. He leads the Genes to Geoscience Research Centre and is the convenor of the ARC-NZ Research Network for Vegetation Function.
- **Professor Sue O’Reilly** from the Department of Earth and Planetary Sciences has been the director of the ARC National Key Centre for Geochemical Evolution and Metallogeny of Continents (GEMOC) since 1995 and leader of the Lithosphere Mapping and Mantle Dynamics Group in GEMOC. She is also the director of the new ARC Centre of Excellence for Core to Crust Fluid Systems, which will receive $12.4 million from the Federal Government to develop new frameworks for mineral and energy exploration based on fundamental advances in geodynamics and a new understanding of fluid transport at lithosphere scales.
- **Professor Quentin Parker** from the Department of Physics and Astronomy is the director of the new Macquarie Astronomy, Astrophysics and Astrophotonics Research Centre. The Centre has ties to over 100 national and international universities, observatories, research institutions and commercial companies in 23 countries. This provides a solid network for effective multinational collaborative research programs and partnerships with some of the world’s leading institutions.

**Support**

Higher degree research candidates in the faculty are provided with strong academic and administrative support. These include, but are not limited to:

- Discipline-specific research training units, including workshops in research communication, presentation skills, academic writing skills and poster preparation
- Experienced supervisors and department-based higher degree research directors
- Faculty Commencement Program
- Financial support for research project costs. In addition to University and/or government scholarships, some candidates may be eligible for top-up scholarships from industry, CSIRO or the faculty
- Regular progress reports and interviews, and/or work-in-progress presentations in which research candidates receive feedback on their work from a panel of academics in their field
- World-class research facilities
Department of Biological Sciences

Academics in the Department of Biological Sciences are a community of biologists committed to innovative and integrative teaching and research. The department spans the full range of biological disciplines from genes to ecosystems. Believing that excellence in teaching comes from excellence in research, our research-active staff engage students in their fascination of biology.

Areas of specialisation
- Animal behaviour
- Behavioural ecology
- Biomolecular science and animal behaviour
- Comparative cognition
- Ecology and evolution
- Environmental and molecular microbiology
- Human biology and palaeobiology
- Human genetics
- Immunobiology
- Marine biology, biodiversity and conservation
- Neurobiology
- Plant and animal physiology

Research centres and groups
- Animal Behaviour CORE
- Climate Futures Centre at Macquarie
- Ecology and Evolution CORE
- Genes to Geoscience Research Centre

Highlights
In the 2010 Excellence in Research for Australia (ERA) initiative, research within the department in the areas of ecological applications, ecology, evolutionary biology, genetics, microbiology, plant biology and zoology scored a maximum 5 – ‘well above world standard’.

www.bio.mq.edu.au

Department of Chemistry and Biomolecular Sciences

The department is well positioned in taking a multidisciplinary approach in addressing contemporary research problems from the molecular perspective, particularly in the areas of environmental and life sciences.

Areas of specialisation
- Analytical chemistry
- Atmospheric chemistry
- Biochemistry and biotechnology
- Biomedical proteomics
- Chemical biology
- Environmental proteomics
- Glycomics
- Medicinal chemistry
- Structural genomics
Facilities and research centres

- Australian Proteome Analysis Facility was the world’s first dedicated high throughput proteomics laboratory, and it remains a major technology centre funded under the National Collaborative Research Infrastructure Strategy.
- Biomolecular Frontiers Research Centre brings together national and international researchers in the molecular and cellular analysis of living systems.
- Environmental Biotechnology Cooperative Research Centre develops advanced technologies based on biological systems to improve efficiency and reduce or utilise waste to benefit a wide range of industries and the environment.
- Macquarie University Centre for Analytical Biotechnology manages substantial instrumentation resources appropriate for the contemporary study of biomolecules and natural products.

Highlights

Much of the department’s research funding comes from external bodies such as the Australian Research Council and the National Health and Medical Research Council. It is also possible to arrange HDR programs through collaboration with researchers in other departments, including biology, geology, psychology and physics.

Department of Chiropractic

The Department of Chiropractic actively fosters academic staff and higher degree research candidates in a variety of clinical and scientific research areas. These include community and public health, complementary medicine and areas that support evidence-based chiropractic research and teaching.

Areas of specialisation

- Anatomy and chiropractic education
- Chiropractic management of common sporting injuries
- Clinical outcomes with chiropractic care for lower back pain; the relationship of neck disorders with ergonomics, stress and headache/migraine
- Human biological variation; neuro-biochemical and physiological processes in the human body
- Medical imaging and radiation science
- Medico-legal studies, professional issues in chiropractic and spinal orthopaedics
- Profiling of clients seeking chiropractic care
- Quantifying therapeutic interventions and psychomotor learning
- Rapid diagnosis of infectious diseases, plant products as antimicrobial agents and aspects of complementary and alternate medicine
- Use of spinal manipulation in the management of chronic respiratory disease

Facilities and services

- The department operates three chiropractic clinics providing a range of services for a wide cross-section of the community. These clinics play an important role in the teaching and research activities of the department. Additionally, the department has recently acquired the newly refurbished state-of-the-art technique and physical examination teaching facility.

Highlights

- At the 2011 World Federation of Chiropractic conference the work of Allan Kalamir, an HDR candidate in the department, secured third place in the category of best research paper.
- Eleven higher degree research candidates currently enrolled in the department and six HDR completions.
- Researchers in the department have received grants from the National Health and Medical Research Council, the Australian Spinal Research Foundation, the Chiropractors’ Association of Australia and the Foundation for Chiropractic Education and Research for various research projects.

www.chiro.mq.edu.au

Department of Computing

The Department of Computing is committed to excellence in terms of its teaching, research, and industry and external collaborations. Being located at the northern end of Sydney’s ‘silicon valley’, the department enjoys the advantages of a large green field campus in the hub of Sydney’s IT industry.

Areas of specialisation

- Cryptography
- Knowledge systems and category theory
- Language technology
- Programming languages and advanced systems engineering
- Security
- Services computing
- Virtual reality

Research centres and groups

- Centre for Advanced Computing – Algorithms and Cryptography which focuses on research into algorithms, complexity and cryptography applied to advanced computing systems
- Centre of Australian Category Theory which works on general category theory, with a focus on higher-dimensional category theory
- Centre for Language Technology which researches the application of computers to dealing with human languages, that is, information extraction, machine translation, question answering, controlled languages and linguistic annotation
- Information and Networked Systems Security Research
- Intelligent Systems Group
- Programming Languages Research Group
- Virtual and Interactive Simulations of Reality

Highlights

Academics include a Fellow of the Australian Academy of Science, a Microsoft Chair in Innovation in Computing, and a Macquarie University CORE professor. Several members of the Centre for Advanced Computing – Algorithms and Cryptography participate in the ARC Centre of Excellence on Quantum Technology, a part of the Quantum Information Science and Security CORE. Members of the Centre for Language Technology play a major role in the ARC Network in Human Communication Science.

www.comp.mq.edu.au
Department of Earth and Planetary Sciences
The department is actively involved in high level research and has close ties with other universities, both national and international, and other organisations, such as the New South Wales Department of Mineral Resources, CSIRO Divisions of Exploration and Mining, and Radiophysics. Cooperative projects within these groups, as well as the major research groups, are possible. Interaction with industry is also encouraged and may be fostered through Sydney Universities Consortium of Geology Geophysics or the Australian Society of Exploration Geophysicists.

Areas of specialisation
- Environmental geology
- Geochemistry
- Geology
- Geophysics

Facilities
- 9 and 40-kb capability piston-cylinder, multi-anvil and 1-atm experimental apparatuses
- Digital data-acquisition system for monitoring geophysical experiments in field and laboratory
- Electron microprobe and scanning electron microscope (SEM), X-ray diffraction, fully automated X-ray fluorescence, ICP MS with laser ablations microprobe, double beam atomic absorption spectrometer, flame photometer, ion chromatograph
- Geographic Information Systems (GIS) software
- Geophysical modelling and inversion programs
- Maps and air photographs
- Organic geochemistry laboratory and instruments
- Physical property laboratory measurement systems (susceptibility, conductivity, seismic velocity, density)
- Seismic, gravity, magnetic, GPR and electrical equipment (FEM, TEM, Resistivity)
- Vehicles

Highlights
The department hosts the ARC Centre of Excellence for Core to Crust Fluid Systems and the ARC National Key Centre for Geochemical Evolution and Metallogeny of Continents (GEMOC). Research groups within these include the Deep Earth Geodynamics, Lithosphere Mapping and Uranium Series Research.

www.eps.mq.edu.au

Department of Electronic Engineering
The quality of research conducted by engineering academics, research staff and HDR candidates has been recognised through many external and internal awards, including Macquarie University Innovation Awards and Vice- Chancellor’s Awards for Excellence. Joint research is conducted with many overseas universities and research institutions, and local and international companies. Research within the department is well funded by a variety of external and internal sources, including the Australian Research Council, other Australian agencies, international agencies and local and overseas industry. Engineering research is supported by state-of-the-art facilities and infrastructure in the department.

Areas of specialisation
The research programs in engineering are underpinned by world-class expertise in the key technologies of:
- Communication system technologies
- Electromagnetic and antennas
- Error-control coding
- Large-scale electronic system design
- Linear and nonlinear guided-wave optics and photonics
- Microelectronics
- Microwave devices
- Network performance analysis
- Very large scale integrated circuit design

Facilities, equipment and tools
- Access to Pulsed RF – HP8510B, 100 ns with APSPA and semiconductor parameter analysers – HP4145
- Automated intermodulation measurements – 2-tone to 6GHz
- Complete set of Cadence Design tools for digital and analog microelectronics
- Complete set of Mentor Graphics IC nanometer design tools
- Nonlinear network measurements (up to 5th order) – 1Hz to 10MHz with large-signal nonlinear network measurements – to 110GHz
- On-wafer device probing – Cascade probe station with thermal stage
- Parameter analysis and extraction software – MathCad
- RF network measurements – 300kHz to 50GHz
- TDFD Intermodulation measurements – 110 dB dynamic range
- Xilinx FPGA tools and Synopsys IC design tools

Highlights
The department hosts and/or is involved in the following Concentrations of Research Excellence:
- Lasers and Photonics
- Quantum Information Science and Security
- Wireless Communications

www.engineering.mq.edu.au
Department of Environment and Geography

The Department of Environment and Geography is a multidisciplinary department conducting research in a broad variety of disciplines that deal with the environment. Researchers’ interests in science, social science, economics, philosophy, health studies, geography and museum studies intersect with environmental studies in varied ways. Our students participate actively in departmental life through participation in research grants from government and industry and as authors of numerous high-quality research publications.

Areas of specialisation
- Atmosphere, oceans, soils and the cryosphere
- Biophysical environment
- Environmental chemistry
- Environmental engineering
- Environmental ethics
- Geographical information science
- Health-care delivery
- Natural hazards risk assessments
- Resource and environmental management
- Urban, social and community planning

Facilities and equipment
- Advanced microscopy
- Climate science laboratory
- Computer room
- Environmental quality laboratory
- Four-wheel drive landcruiser
- Gas chromatography and analytical facilities
- Thermal analysis
- Two boats and dive equipment

Highlights
The department is associated with, or a major contributor to, the Centre for Research on Social Inclusion, Climate Risk CORE, Risk Frontiers, the Natural Hazards Research Centre and the Sydney Institute of Marine Sciences. The department also hosts the Australian Research Institute in Education for Sustainability, the Marine Mammal Research Group and the Western New South Wales Archaeology Program.

www.envirogeog.mq.edu.au
Department of Mathematics
The Department of Mathematics has a high international profile that is supported by several large research grants in analysis, applied mathematics and category theory. Research in mathematics at Macquarie is well respected both nationally and internationally.

Areas of specialisation
- Analysis
- Applied mathematics
- Category theory
- Number theory

Research centres and groups
- The department houses the Centre for Australian Category Theory with members from the Department of Computing and other universities
- Applied Mathematics and Analysis group
- Macquarie University Number Theory group

Highlights
The department has several researchers of very high academic profile, and attracts a substantial amount of external research funding and a steady stream of international visitors who collaborate with members of the department, making it an ideal environment for higher degree and postdoctoral research.

www.maths.mq.edu.au

Department of Physics and Astronomy
The Department of Physics and Astronomy is research-intensive with several recognised areas of excellence – astronomy and astrophysics, photonics, and quantum science and technology – that drive our programs. Research within the department is supported by a variety of external and internal grants.

Areas of specialisation
- Astronomy and astrophysics
- Atomic and molecular physics
- Biophotonics
- Lasers and light sources
- Photonic structures and devices
- Physics of semiconductors and materials
- Quantum science and technology

Facilities
- Laser micromachining facility
- Macquarie University Observatory
- Optical and photonic microcharacterisation facilities
- Optical surface profiler
- Thin film deposition and crystal growth systems

Highlights
- Astronomy, Astrophysics and Astrophotonics Research Centre which attracts major external funding and builds on strong links with the Australian Astronomical Observatory and the Australia Telescope National Facility located nearby. Current research strengths include wide-field astronomical surveys; optical, infrared and radio studies of planetary nebulae and supernova remnants; evolved close binaries; galactic evolution and mergers; planetary astronomy; astrophotonics, and theoretical studies of shock-waves, star and planet formation, the Galactic Centre and black holes.
- MQ Photonics Research Centre which pursues a broad range of experimental and theoretical studies in astrophotonics, biophotonics, microphotonics optical systems, nano-optics and nanophotonics, photonic sources, optical sensing and imaging, and ultrafast laser applications. Theoretical analysis of optical phenomena underpins much of the experimental development and includes nonlinear optics, periodic structures and metamaterials, laser modeling and nanophotonic simulations. Astrophotonics concerns new photonics-based instrumentation technology. Biophotonics includes advanced fluorescence microscopy and imaging, with members participating in the Biofocus Research Centre, and development of novel tunable UV lasers and visible and IR Raman lasers has biomedical and other applications. Diamond optical sources are a focus, employing colour centres in nanodiamonds as well as in Raman lasers. Applications of lasers and optics include material processing and laser cleaning, development of single photon sources for quantum optics and deep UV discharge lamps for various applications. Innovative research into nitrides has led to a successful spin-off company, with current research in organic semiconductor materials.
- MQ Research Centre in Quantum Science and Technology which has experts in optics, condensed matter physics, theoretical physics, computer science, mathematics, statistics and chemistry is a unique and cross-disciplinary group forging innovative discoveries in quantum science and technology. New applications are developed through a research focus on quantum algorithms, single molecule detection and magnetic resonance. Experimental research addresses using optical methods to coherently control at the quantum level behaviour of colour centres in diamonds, to explore how quantum properties of light interact with materials at subwavelength scales, and development of integrated quantum optical devices.
- The department is home to nodes of two ARC Centres of Excellence – the ARC Centre for Ultrahigh-bandwidth Devices for Optical Systems (CUDOS) and the ARC Centre for Engineered Quantum Systems (EQuS) – and hosts three Macquarie University Concentrations of Research Excellence.

www.physics.mq.edu.au
Department of Statistics

Macquarie’s Department of Statistics is Australia’s largest. It offers a full range of statistical subjects, from introductory statistics through to masters courses. The department is active in both theoretical and applied research and supervises a large number of HDR candidates from Australia and abroad. Research interests of the statisticians are mainly concerned with the applications of statistical methods in medicine, bioinformatics and stochastic finance. Some recently completed and current PhDs are in the areas of biostatistics (latent variable modelling), bioinformatics (protein structure, origin of introns), portfolio selection, data mining, decision analysis and animal nutrition.

Areas of specialisation
- Bioinformatics
- Biostatistics
- Mathematical and computational statistics
- Statistics education

Research groups
- Bioinformatics
- Biostatistics, epidemiology and medical statistics
- Mathematical and computational statistics

Highlights
ARC Discovery Project grant awarded to Professor Ian Marschner in 2011 for the project *Binary regression with additive predictors: new statistical theory with healthcare applications.*

www.stat.mq.edu.au
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