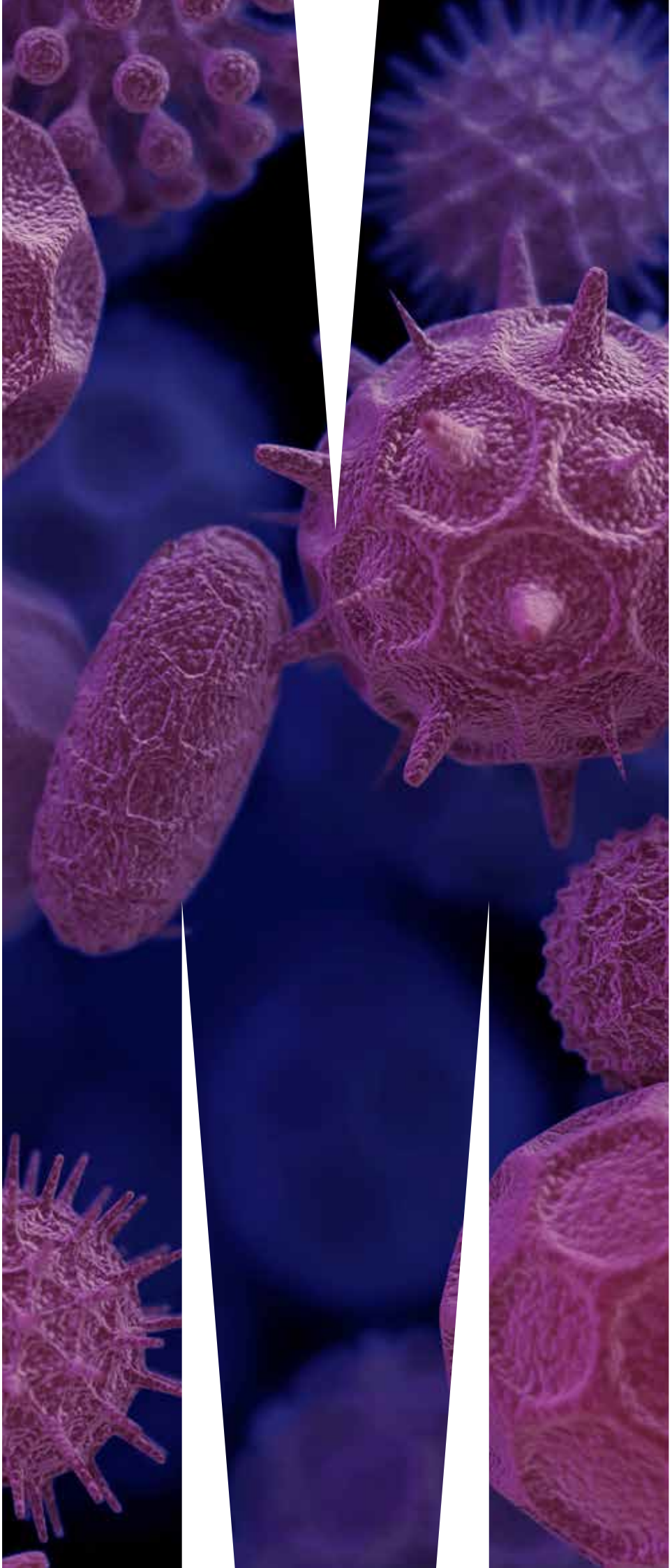
MONASH University

# MONASH BIOLOGICAL SCIENCES

monash.edu/biology



GROUP OF EIGHT AUSTRALIA

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*Anous tenuirostris melanops* (Lesser Noddy) Photo: Rohan Clarke

# INSIDE

Biological Sciences major discipline areas:

- Ecology and conservation biology
- Environmental science
- Genetics
- Plant sciences
- Zoology

A guide to career opportunities after specialising in biological sciences.

Biological Sciences Research at Monash.

Further course and unit details are available in the Undergraduate Guide to Courses online at **monash.edu/pubs/handbooks**

# MEETING THE CHALLENGES OF A CHANGING WORD

The climates of sub-Antarctic Islands, such as Marion Island, are changing rapidly. Photo: Steven L. Chown

# WELCOME TO THE SCHOOL OF BIOLOGICAL SCIENCES

**The future of Australia, and the Earth as a whole, is critically dependent on a workforce skilled in STEM (Science, Technology, Engineering and Mathematics) to meet the challenges of environmental change and an aging, and sedentary, population. In the School of Biological Sciences, we aim to be at the forefront of meeting these challenges.**

The School of Biological Sciences is dedicated to excellence in teaching and research. We deliver an immersive education wherein the fundaments of science are emphasised across all of the life sciences. In doing so, we will generate a highly analytical and adaptable workforce ideally suited to engage with the rapidly evolving technologies of the future. Particular research strengths of the School include plant and animal genetics and genomics, developmental biology, ecology and conservation biology, microbiology, evolution and reproduction. As is appropriate for a leading School of Biological Sciences, our view is broad and our research impacts many areas of biology as evidenced by funding, publications, awards and government contracts. Our students are encouraged to engage in research at both undergraduate and post-graduate levels. Our access to research infrastructure and expertise is unparalleled in the Australian setting.

Our teaching laboratories are among the best equipped in any tertiary institution globally. They provide interactive microscopy, computing, and image analysis which in turn enable peer-to-peer learning, real-time online integration of student discovery and instructor feedback, and life-long educational impact. We also offer unique opportunities for undergraduate field training, including in Borneo, the Great Barrier Reef and locally in the Melbourne area, including extensive use of the Jock Marshall Reserve on campus. A myriad of additional field work opportunities for post-graduate students exist and is testament to the School's commitment to training the environmental and research leaders of the future.

The School has a truly international set of research and educational activities. We are home to students from Australia, Asia, Europe, the Americas and elsewhere. Our students have also taken opportunities to work across the globe including at our international campuses. On graduation our students find a wide range of careers in research, industry, business, government and non-governmental organisations. We recognise across all of our degree offerings that our graduates play a variety of significant roles in society, from policy and research excellence to leadership in the growing business of modern biology.

This brochure outlines the Monash University teaching programs in Biological Sciences, which are focussed in the flagship B.Sc., B.Sc. Advanced – Global Challenges (Honours), and the B.Sc. Advanced – Research (Honours).

We look forward to welcoming you into the School of Biological Sciences and a prosperous future in STEM.

**MOIRA K. O'BRYAN**

Professor and Head

# THE CENTURY OF BIOLOGY

**Biology is the study of life's processes and living organisms. 'Biological Sciences' is the umbrella term given to all areas of study that have biology at their core.**

Disciplines within the biological sciences focus on microbes, plants and animals, and involve the study of structure, function, evolution, development, genetics and ecology.

Scales of study range from genetics (the study of genes and the way in which they control the development of plants and animals, including humans) to ecology (the study of relationships between organisms, the biosphere and the environment).

A science for adventurous minds, the study of biology can take you back in time almost four billion years to examine the very foundations of life itself, or to the future, where you will be at the forefront of identifying and solving the growing number of biological issues confronting the planet. As a student of biological sciences you will have the opportunity to become a highly versatile graduate, with the wide variety of skills you will acquire being applicable to many careers.

**A degree in biology develops the fundamental skills and knowledge to establish a career as a biologist. Research from Australia's Chief Scientist (2016) shows that science graduates are employed in a diverse range of jobs. This is why the School of Biological Sciences also focuses on equipping students with transferable skills that can be applied in a broad range of careers.**



Image: *Ciona intestinalis* larva

# CAREERS IN BIOLOGY

## WHAT DOES A BIOLOGIST DO?

Biology is the study of life and living systems. A biologist may examine the growth, structure, function, origin or distribution of living organisms at different scales. These scales might range from tiny life, such as using microbes to study the genetics of adaptation in yeast; they may focus on the whole organism level, like the ecophysiology of sea turtles; or they could be at vast scales such as studying spatial patterns in biodiversity of plants.

## GRADUATES FROM THE SCHOOL OF BIOLOGICAL SCIENCES HAVE ESTABLISHED CAREERS IN A RANGE OF FIELDS IN BIOLOGICAL SCIENCE

- Healthcare – e.g. genetics counsellor or technician
- Education – e.g. teaching in schools/universities or outreach programs for museums
- Environmental conservation – e.g. marine biologist or environmental consultant
- Government – e.g. policy analyst or government advisor
- Research – e.g. biological, genetics or biomedical research in universities or in a research laboratory
- Business – e.g. innovation project consultant or strategy analyst

The Australia 2030 report by CSIRO (2017) identified key industry sectors that will see opportunity and growth. Many of these sectors have related biological sciences careers and include:

- Food and agriculture
- Healthcare and pharmaceuticals
- Manufacturing

## WHAT OTHER CAREER SKILLS CAN THE STUDY OF BIOLOGY DEVELOP?

To thrive in the future job market, it is essential that graduates have developed transferable employability and enterprise skills.

Transferable skills gained through biology include:

- Teamwork skills
- Quantitative skills and digital literacy
- Critical thinking and problem solving
- Innovative and creative thinking
- Communication skills for a range of audiences
- Independence and self-belief

**LAURA WILSON**

Laura studied the Bachelor of Science Advance – Research at Monash and completed her honours in 2016. Her experience studying biology helped her grow in a lot of different ways, building skills and a knowledge base that she still uses frequently. She took away a wide scope of generic skills from her BSc that she has been able to apply in a variety of roles, including how to manage time effectively and work well in group situations. She is currently working as an Information Management Graduate in the Chief Information Office of the Queensland Government. Despite being in a very different field to her undergraduate studies she has been able to draw on some of the technical skills from her degree as well, such as research expertise, data analytics and critical thinking around problems.

**To find out more about the career prospects of Science graduates, visit:**

- monash.edu/science/alumni/graduates
- agriculture.gov.au/about/jobs/graduate
- csiro.au/en/Careers
- 2.delwp.vic.gov.au/careers-and-volunteering/science-graduate-program

# RESEARCH

**Research conducted by the School of Biological Sciences covers a diverse range of topics and is widely respected by government agencies, the science community and by industry. Here are just some of the biological scientists currently carrying out research in the School.**

## DR KATHRYN HODGINS

Kay Hodgins is an evolutionary biologist who is particularly interested in understanding the genes responsible for adaptive differences within and between species. Early in her career she became fascinated by all of the strange and numerous ways plants pass on their genes to future generations. To pursue this interest she enrolled for her PhD at the University of Toronto where she studied the evolution of plant reproductive systems. She moved to the University of British Columbia in 2008 and began a post-doctoral fellowship investigating evolution in invasive plants. In 2011 she became a research associate on a project investigating the genetic basis of local adaptation to climate in conifers. In January 2014 she was appointed lecturer at Monash University.

## DR CHRIS GREENING

Chris studied Molecular and Cellular Biochemistry at the University of Oxford before completing his PhD in Molecular Microbiology at the University of Otago, New Zealand in 2014. His doctoral research focused on understanding how mycobacteria, including the pathogen *Mycobacterium tuberculosis*, survive nutrient starvation and hypoxia. He subsequently gained postdoctoral experience in Microbial Ecology and Molecular Evolution at the University of Otago, CSIRO, and the Australian National University. Chris joined Monash University as a Lecturer in June 2016 and was awarded an ARC DECRA Fellowship in November 2016.

Chris' research group, the Integrative Microbiology Lab, explores how environmental and pathogenic microorganisms persist under adverse environmental conditions. A key reason why microorganisms are so abundant and diverse is that they can enter dormant state that resist environmental changes. Chris is interested in understanding the metabolic processes that enable microbes to remain energised and survive stress in these dormant states. One of his most important findings is that some bacteria can literally 'live on thin air'; soil bacteria scavenge atmospheric trace gases such as hydrogen to stay energised when their organic carbon supplies run out.

Chris' research is centred on two main themes. His environmental research explores the ecophysiology of organisms responsible for the cycling of atmospheric gases, such as the greenhouse gas methane. His medical research is centred on identifying new drug targets for the treatment of tuberculosis, which is now the leading killer from infectious disease worldwide. Chris' group employs a wide range of techniques to explore biological processes from enzymes to ecosystems, including bacterial culturing, genetic manipulation, protein biochemistry, environmental surveys, and analytical.

## PROF DUSTIN MARSHALL

Dustin completed his PhD at The University of Melbourne in 2003. He was a post-doctoral research fellow at the University of New South Wales for two years before taking up a lectureship at the University of Queensland. After seven years at UQ building a research team, he joined Monash University and is now Professor. Dustin's research group focuses on the evolutionary ecology of marine ecosystems. Research projects range from community ecology in sessile marine communities through to the quantitative genetics of larval development in marine invertebrates and sexual selection.

For more information, go to www.meeg.org

## ASSOC PROF ANNE PETERS

For her BSc/MSc at the University of Nijmegen in the Netherlands, Anne studied mating behaviour and reproductive ecology of turtles, flatworms and fish in European ecosystems. For her PhD in Ecology, Evolution and Systematics, she moved to the Australian National University and switched to studying birds, specifically the superb fairy-wren.

After completion of her PhD in 2001, Anne spent nine years in Germany at the Max Planck Institute for Ornithology, first as post-doctoral research fellow, later as an independent research group leader. She joined the School of Biological Sciences at Monash University in 2011 as a senior lecturer and is now an Associate Professor. Anne has maintained broad research interests in behavioural, physiological and evolutionary ecology of birds, combining field-based research with lab work and captive breeding studies. Her main research themes are sexual selection, reproductive decisions and avian colour signals. She has studied the behavioural and physiological costs involved in ornaments of European, Australian and Argentine birds.

Her group's current research direction is to investigate mechanisms of life-history trade-offs, focusing on self-maintenance (oxidative stress and immune function) using Australian fairy-wrens as models.

# ARE YOU DRIVEN BY CURIOSITY? IF SO, A CAREER IN RESEARCH MAY BE FOR YOU.

## PROF JOHN BOWMAN

John studied Biochemistry at the University of Illinois before moving to the California Institute of Technology in Pasadena to complete his PhD on the genetics of flower development in *Arabidopsis*. He completed his PhD in 1991 and continued with postdoctoral research at Monash University. In 1995 he joined the University of California at Davis as an Associate Professor. After becoming full Professor at UC Davis, he joined Monash University as a Federation Fellow in 2006.

John's research is focused on the evolution and development of land plants. His lab uses the flowering plant *Arabidopsis thaliana* and the liverwort *Marchantia polymorpha* as model genetic systems. The genomes of both organisms are available, as are approaches to generate loss-and gain-of-function alleles. Using these systems the lab addresses fundamental questions in plant evolution and development.

The lab is primarily focused on two research areas. First, it is investigating the evolution and molecular basis of the alternation of generations of land plants, whereby both the haploid and diploid phases of the life cycle develop complex multicellular bodies. Second, it is interested in the origin of pattern formation and development of land plant body plans in both generations.

# RESEARCH

## DR CHRISTEN MIRTH – DEVELOPMENTAL REGULATION AND EVOLUTION OF PHENOTYPIC PLASTICITY

All animals respond to changes in their environment by altering their morphology, physiology or behaviour; a phenomenon known as phenotypic plasticity. Christen and her team combine approaches from developmental biology, physiology, and evolutionary biology to understand the molecular mechanisms that regulate phenotypic plasticity and that lead to its evolution. Their work has uncovered key pathways that modify development in response to environmental conditions like temperature and nutrition to alter body size and shape. Current research directions include understanding how environmental conditions like temperature and nutrition interact to alter phenotypes in unexpected ways and how the evolution of body size changes the developmental mechanisms that regulate growth.

Christen completed her PhD at the University of Cambridge (UK) in 2002. She then spent 5 years working as a post-doctoral researcher at the University of Washington (USA) and an additional 2 years as a Research Specialist at Janelia Research Campus – Howard Hughes Medical Institute (USA). In 2010, she established her first independent research group in 2010 at the Instituto Gulbenkian de Ciência (Portugal) before joining Monash University in 2015.

## ASSOCIATE PROFESSOR CARLA SGRÒ

Carla completed her PhD at La Trobe University Melbourne in 1997. She then spent three years at University College London as a postdoctoral research fellow before moving to The University of Queensland on a University of Queensland Postdoctoral Fellowship and then ARC Australian Postdoctoral Fellowship. After a year as the Science Program Manager for Earthwatch Institute Australia, Carla moved to The University of Melbourne on an ARC Australian Research Fellowship. Carla joined Monash University in 2007.

Carla's research group focuses on understanding the genetic basis of adaptation to environmental change. It uses a combination of approaches including field studies of phenotypic divergence, experimental evolution, quantitative genetics and genomics to examine how organisms adapt to changing environmental conditions. The group also explores how evolutionary processes can be explicitly incorporated into on-going biodiversity conservation and management.

## DR ROB BRYSON-RICHARDSON – MYOPATHY RESEARCH TEAM

Rob's research program is focussed on neuromuscular diseases, these are a very large group of more than 600 different disorders that vary in severity from mild muscle weakness to an inability to move at birth. The team's research spans the spectrum from the identification of new disease genes, to the determination of the underlying biological mechanism of disease, and subsequently evaluation of potential therapeutic approaches. In all of their research they use the advantages of the zebrafish as a model system. These process of muscle development, and the genes involved, are highly conserved between zebrafish and humans, therefore the zebrafish provides an excellent model system in which to study these diseases.

Working with clinical and diagnostic teams from around Australia and the world, when a potential novel disease causing mutation is identified in a patient, the team investigates the function of this mutated gene in the zebrafish model to confirm or exclude its mutation as the cause of the disease.

The team generates zebrafish models that recapitulate the symptoms of the disease and uses the advantages of these models, such as very rapid growth and transparency of the fish when young, to investigate how these genetic changes disrupt muscle function. For example, the team recently identified that a quality control mechanism for removing damaged muscle proteins was disrupted in myofibrillar myopathy, a severe and progressive muscle form of muscle weakness. This work not only explained the biology underlying the disease, but also suggested potential approaches to treat the disease.

Rob's team then evaluates these potential treatments, such as targeted drug screens or genetic therapies, in the zebrafish model to identify those that are most likely to prove effective in clinical use.


Trade and transport are among the main pathways of introduction of invasive species.

## PROF MELODIE MCGEOGH – THE GLOBAL INVASIONS INDICATOR PROJECT

This project is examining ways of improving available data and information on invasive species, and ways of delivering this information so that it is effectively communicated and used by policy makers. Accurate and up to date information is essential for preventing further introductions of invasive species via global transport networks, and for effectively prioritising invasive populations for investment in management. The availability of information on invasive species is very unevenly distributed across the world making data-poor countries particularly vulnerable to invasion impacts and a risk to their trading partners. One of the research questions being examined at the moment is how to effectively list and prioritise invasive species, pathways of introduction and areas at high risk of being invaded.

The highly invasive harlequin ladybird that causes allergic reactions and is a voracious predator of beneficial native insects species.

### PROFESSOR MELODIE MCGEOCH

After completing a PhD at The University of Pretoria in 1995 on the ecology of an Acacia-fungus-insect interaction and its response to urbanisation and climate change, Melodie spent some time as a postdoctoral fellow at Sheffield University. Part of her PhD research was on the development of bioindicator systems for detecting biodiversity change and for use in monitoring. Over the course of her career this work has led from questions about the value of insects as bioindicators, to methods for making sure information provided by bioindicators is robust and reliable. Most recently she led the development of the bioindicator system for monitoring biological invasions at a global scale for the purpose of assessing and tracking policy effectiveness. The focus of this research was biological invasions and how to track the size of the problem, the impact it is having and how effective policy and management interventions are.

This research is being done in partnership with a number of international organisations, including the Biodiversity Indicators Partnership (www.bipindicators.net/) and the IUCN Invasive Species Specialist Group (www.issg.org).

Melodie and her research group also investigate the long-term consequences of multispecies invasions for biodiversity and spatial techniques for efficiently estimating and predicting biodiversity change. This work takes place in parks in Australia and South Africa, on sub-Antarctic islands and in virtual data worlds where anything is possible and much can be learned.

"My favourite pastime is making data talk, especially when the data are about biodiversity, what we are doing to it and what action is needed to prevent its loss."

# FACILITIES AND RESOURCES

## EXCITING INDOOR AND OUTDOOR LEARNING SPACES

Jock Marshall Reserve.

### TEACHING LABORATORIES IN BIOLOGICAL SCIENCES

Our teaching laboratories are among the best equipped of any tertiary institution globally. They provide interactive microscopy, computing, and image analysis which in turn enable peer-to-peer learning, real-time online integration of student findings and instructor feedback, and life-long educational impact.

### FIRST YEAR BIOLOGY TEACHING LABORATORY

The School of Biological Sciences' first-year biology laboratory is one of the best teaching facilities for biology in Australia. It is equipped with state-of-the-art computer facilities, multimedia resources and is designed to enable large and small group learning.

### SECOND AND THIRD YEAR BIOLOGY AND GENETICS MULTI-PURPOSE DIGITAL TEACHING LABORATORIES

Biology teaching laboratories at the School of Biological Sciences bring the full power of computing into everyday laboratory situations. State of the art digital microscopy and software allow the lecturer to transmit images, spreadsheets or programs from any computer or laboratory microscope to the whole class. Students can work at their own pace while still being able to share and join in with the class activity. This fully networked system now enables us to teach the most up to date methods of analysis and computing.

### JOCK MARSHALL RESERVE

The Jock Marshall Reserve (JMR) was established in 1961 by Prof AJ 'Jock' Marshall, the foundation Chair of Zoology and Comparative Physiology. The 3 ha reserve encompasses a lake, and has been a core pillar of Monash's research and teaching activities in the natural sciences area over the past 50 years.

The key infrastructure in the JMR includes:

- Environmental Education Centre with microscopes, computer and multimedia facilities
- JMR lake, with 2 sampling piers and associated wetland
- Remote controlled 'Pan Tilt-Zoom' high definition webcams with infrared capability and ability to record wildlife active around the lake
- Acoustic recorders in the lake and wetland – providing the capability to capture large amounts of data from the wildlife including birds, frogs, bats and aquatic life
- Environmental monitoring platform that includes a weather station and 'real-time' monitoring of the lake's physicochemical parameters
- JMR Website (jockmarshallreserve.com.au) with links to images of the JMR's fauna and flora and all the monitoring stations.

Students undertake a wide range of projects and field investigations in the JMR. These activities include waterbird surveys, lizard and frog surveys, aquatic food webs and leaf breakdown in aquatic systems.

The JMR also hosts science experience programs and tours of the grounds and facilities for external departments and secondary education groups, including PrimeSCI! and the John Monash Science School.

The JMR includes a natural wetland stormwater treatment area for water diverted from adjacent buildings and car parks.

**As a student in the School of Biological Sciences you will be provided with excellent learning and research facilities. Access to these facilities and resources will provide you with valuable technical skills.**

# RESEARCH SUPPORTED BY WORLD-CLASS FACILITIES

## FISHCORE

The school utilises the core facility FishCore, the largest zebrafish facility in the southern hemisphere. It includes more than 5000 fish tanks, facilities for fish rearing, and an analytical laboratory. Zebrafish are a key tool for modelling human genetic disorders, and are used to improve our understanding of many disorders and to test potential therapies.

## GREENHOUSE AND PLANT GROWING FACILITIES

The school has several specialised plant growing facilities to support a range of teaching and research requirements. In 2011 a new greenhouse complex was built. The complex houses 14 independently controlled compartments all with the ability to be QAP/PC2 certified, with state of the art controlling and monitoring systems. The school also has a range of growth rooms and cabinets suitable for plant-based research projects.

## MICRO-IMAGING FACILITY

Confocal microscope image of stained *Drosophila* embryo.

Monash Micro-imaging is a microscopy and imaging research facility that is a shared resource between the Faculty of Science and Faculty of Medicine. There is a broad range of excellent equipment available, including; confocal microscopes, digital Transmission Electron Microscopes (TEM), cryosubstitution and cryoultramicrotomy machines, and advanced image analysis software.

Visit microimaging.monash.org for further details.

## CONTROLLED TEMPERATURE ROOMS, ANIMAL HOUSE AND MARINE ROOM

The school has many controlled temperature rooms and cabinets that researchers use to control climatic conditions for sensitive experiments. There is also a designated marine room used specifically for marine-based research and a complex of animal holding rooms.

## VEHICLE FLEET AND MARINE RESOURCES

The school has a fleet of field-based vehicles and trailers that are accessible to staff and students for the purposes of university business. All new staff, research students and visitors who use School of Biological Sciences' vehicles are provided access to advanced driver training. The School also provides access to its sea-going vessel and specialised scuba equipment to staff and students for the purposes of university business. All new staff, research students and visitors who wish to use the School of Biological Sciences boat or undertake diving activities as a part of their research are supported by the SBS Boating and Diving Safety Officer.

# HOW TO BECOME A BIOLOGICAL SCIENTIST

## SCIENCE DEGREES YOU CAN CHOOSE

**Below is an overview of science-based degrees offered at Monash University and examples of degrees that may be combined with a science stream as a part of a double degree.**

## SINGLE DEGREES

- Bachelor of Science
- Bachelor of Science Advanced – Research (Honours)
- Bachelor of Science Advanced – Global Challenges (Honours)

## DOUBLE DEGREES

| Faculty for second degree | Second degrees available |
|---|---|
| Arts | Bachelor of Arts |
| | Bachelor of Global Studies |
| | Bachelor of Music |
| Business and Economics | Bachelor of Commerce |
| | Bachelor of Commerce Specialist |
| Education | Bachelor of Education (Honours) |
| Engineering | Bachelor of Engineering (Honours) |
| Information Technology | Bachelor of Computer Science |
| | Bachelor of Information Technology |
| Law | Bachelor of Laws (Honours) |
| Medicine, Nursing and Health sciences | Bachelor of Biomedical Science |

Most biological scientists will have studied a Bachelor of Science, or a double degree, with a major in an area of biological sciences.

**MARCUS SALTON**

Marcus had an interest in nature and problem solving shaped his high school studies that led him into a Bachelor of Science with honours at Monash University. With the knowledge and practical skills that he acquired he has worked in government, non-government and industry, with many marine species, and in environments around Australia, the sub-Antarctic and Antarctica. He has worked as a research assistant, wildlife ranger and field biologist surveying population sizes, tracking animal foraging movements and behaviour, and analysing data to assess vulnerability to threats. Marcus plans to continue working in the field of conservation-based science, where he can use his skills to make positive contributions to protecting biodiversity and reducing human impacts by working as a field biologist and research assistant with the Australian Antarctic Division.

**STEPHANIE MOUW**

Stephanie studied a Bachelor of Science (Honours) majoring in genetics and zoology. “What I loved about Monash was the ample opportunities I had to extend my knowledge and get hands-on experience. I was able to complete a summer scholarship in a DNA quarantine laboratory, an internship at Melbourne Zoo and also have my honours research co-coordinated with the Victorian Institute of Forensic Medicine. Currently, I’m working as an Environmental Scientist conducting land contamination research in the Northern Territory.”

**For more information go to: study.monash**

# EXCELLENCE IN EDUCATION

**We pride ourselves on our excellent and innovative teaching. Education in the school occurs in an environment that fosters excellence and provides the opportunity for students to learn in an engaging way from research leaders in their discipline.**

We provide high quality learning environments. The school has state of the art practical laboratory spaces that provide the technology that will enable you to learn in a stimulating and engaging way. They are learning spaces that are equipped to demonstrate techniques in areas such as digital microscopy, molecular biology and data analysis, while being able to display a range of living and preserved plants and animals from the smallest bacteria through to the largest of the mammals. Field work plays an important part of our teaching and we run study programs to the tropical forests of Borneo and the Great Barrier Reef as well as to the local temperate terrestrial and marine systems of Victoria. On campus we have the 'Jock Marshall Reserve' which provides a resource where you as a student can carry out environmental studies in a bushland habitat. The reserve also includes a lake and sampling pier for aquatic studies.

Our approaches to teaching and learning are highly innovative and cater for different learning styles. To do this we combine the best of face-to-face and online teaching and learning. Our effective face-to-face teaching emphasises hands-on experience and uses approaches such as inquiry and problem-based learning, audience response systems, integrated electronic laboratory manuals, use of tablets in lectures, live data collection in the field, peer-assisted learning and engagement, and research mini-projects.

Online learning systems are used in all our teaching for pre-class preparation, student collaboration, assessment, and extension activities. We also understand the importance of teaching relevant workplace skills alongside the fundamental, enabling biological knowledge that is required for careers or further study.

Our units are consistently rated by students as among the University's best, and our staff and programs have been recognised with many national teaching awards.

# THE MASTER OF ENVIRONMENT AND SUSTAINABILITY

"We are the first generation that can end global poverty. We are the last generation that can address climate change before it is too late."

BAN KI-MOON, SECRETARY-GENERAL OF THE UNITED NATIONS

**From the built environment to the natural environment, from social inequity to diminishing biodiversity, this planet and its inhabitants are increasingly stressed.**

**The smart ideas – the sustainable solutions – happen when the experts come together. We want to build a generation of fearless, inquisitive thinkers who embrace change and can come up with positive, sustainable solutions. That's why this degree gives you skills from many disciplines to build on your passion to create change.**

## HOW THE COURSE WORKS

The course is full of options. Core units allow you to analyse how nature, society and the economy interact and depend on each other. Then you choose one of five specialisations:

- Corporate environmental and sustainability management
- Environment and governance
- Environmental security
- International development and environment
- Leadership for sustainable development

Next, you can accelerate your practical skills by undertaking an interdisciplinary consultancy project to help drive innovation. Alternatively, you could take on an internship to practise your skills in the field, or write a research thesis that will help you move into a PhD.

## WHERE CAN THIS TAKE ME?

In the past decade or two, the sustainability job market has been rapidly rising. Graduates have found jobs in business, in all sectors of government (including quasi-governmental agencies like the Environment Protection Authority), in national and international NGOs, at universities, research centres and think tanks, and in consulting.

**DANIELA MARQUEZ ARDILLA**

Sparked by an interest in environmental security, and biodiversity, Colombian student Daniela Marquez Ardilla looked for a Masters degree that would align with her career aspirations.

*"It's been an incredible learning experience. I've learned that if I want to drive sustainable solutions, I need to take into account the interconnectedness of the environmental, social, and economic systems."*

# FIELDWORK

**Fieldwork is a major component of some biological sciences units. As a student, conducting research and trials outside of the laboratory can enhance your appreciation of the natural world and provide valuable experience as a scientist in the field. Below is a brief outline of the units that offer field camps and excursions.**

## BIOLOGY OF AUSTRALIAN VEGETATION AT LAKE MOUNTAIN

Lake Mountain is a Victorian alpine area that is home to a wide variety of flora and fauna, and the perfect landscape to explore environmental influences on vegetation, and environmental stresses and plant adaptation. Against the beautiful backdrop of the Yarra Ranges national park you will examine the evolutionary history of the Australian vegetation and flora and look at the roles climate, soil, disturbance and animals play in shaping this diverse Alpine environment.

## TEMPERATE MARINE FIELDWORK AT QUEENSCLIFF

To complete the practical work requirement of Marine Biology you may spend a week in February at the Queenscliff Marine Station. Working with staff in small project groups, you will have the opportunity to investigate various aspects of marine plant and animal biology. Habitats investigated are mainly intertidal and shallow subtidal shore environments.

## TROPICAL MARINE FIELDWORK AT HERON ISLAND

The sparkling waters and pristine coral cays of Heron Island form the backdrop for exploring the fascinating plants and animals that make up a tropical reef system. While on the island you will plan and carry out a research project that exposes you to some of the challenges and problems encountered by field biologists – and some of the techniques that are used to solve these problems. The field work involves studies into fish and turtle biology, bird behaviour, coral reef ecology and some truly spectacular snorkelling.

## TROPICAL TERRESTRIAL BIOLOGY

This unique unit takes you to the heart of the jungles of Borneo, where you will explore tropical habitats in the Gunung Mulu National Park including complex and beautiful ecological systems. The 140 million-year-old Borneo rainforest is home to unique and fragile ecosystems and is one of the only remaining natural habitats for the endangered Bornean orang-utan. This field trip will give hands-on insight into the importance of conservation, management, climate, nutrient cycling, disturbance, and succession on tropical plants and animal ecology. You will also carry out your own research.

## ECOLOGY

The school has a strong commitment to training field ecologists. Practical work in second-year Ecology is mainly carried out during field excursions. As an ecology student you will conduct practical work during a day-long field trip to Flinders. During the field-trip you will investigate marine rocky intertidal shore ecology in detail.

## MARINE BIOLOGY

While studying Marine Biology you will have the opportunity to carry out practical work at Heron Island, Queensland, or at the temperate marine camp at Queenscliff, Victoria.

# WHAT TO EXPECT IN FIRST YEAR

**First year biology at Monash provides students with an exceptional grounding in the knowledge and generic skills required by modern biologists and those interested in obtaining a broader-based science degree.**

It has been said that while the 20th century was the century of physics, the 21st century will be the century of biology. This is due to the increased demand for a sustainable and healthy environment and through ongoing advances in the areas of genetics, medicine and ecology. This is an exciting time to be a biologist and studying biology provides you with the opportunity to be a part of these great changes!

The well-equipped first-year biology laboratory, which has state-of-the-art computing facilities and multimedia resources, is designed to maximise the learning experience, in individual, small and large group settings. We provide structured courses with excellent student support from well qualified and committed tutors, teaching associates and peer tutoring programs. We prepare students for a broad range of biological and biomedical careers through high quality programs in basic biosciences. We inspire and nurture curiosity in order to improve understanding of how our world evolved and operates. We create a flexible and innovative teaching program that provides students with the skills to learn, the motivation to want to learn, and opportunities to improve those skills that students wish and need to develop to achieve their full potential.

## PREPARATION FOR STUDYING AT TERTIARY LEVEL

First-year biology does not assume prior VCE study of biology. The flexible learning structure of the subject, with considerable staff and multimedia support and extensive self-learning opportunities, means that even if you have had no experience in biology you can excel. However, students who have studied VCE biology will be challenged and stimulated by the content and presentation of the course. English is a compulsory prerequisite, and VCE subjects such as biology, chemistry and mathematics are extremely useful. First-year biology is a prerequisite for many second year units and most third-year units have second-year prerequisites. The weekly contact hours for a student studying biological sciences units is two one-hour lectures and one three-hour practical (or equivalent) for each unit.

## TRANSITION

The first-year biology staff pride themselves on the special attention they give to the transition of students from secondary to tertiary education. In understanding the complexities and difficulties confronting students as they commence a university degree, student transition and orientation is more seamless, students feel more engaged with their studies, and their learning outcomes are enhanced.

We also offer a bridging course in February for students who have not studied VCE Biology or feel that they need additional preparation.

### BLUEPRINTS FOR LIFE

**BIO1011**

- What is life?
- Tiny life
- Architecture of life
- Coding life
- Living energy
- The living end

### LIFE ON EARTH

**BIO1022**

- Evolving life
- Animal solutions to life
- Plant solutions to life
- Interacting life

### LIFE IN THE ENVIRONMENT

**BIO1042**

- Living systems
- Ecosystems
- Environmental adaptation
- Human-induced change
- The global ecosystem

### HUMANS, EVOLUTION AND MODERN SOCIETY

**SCI1200**

- Natural selection
- Sex differences and mate choice
- Conflict and violence
- Human evolution
- Disease
- Nutrition

# CONTINUING WITH BIOLOGICAL SCIENCES

**Studying biology at second and third-year level at Monash builds on the knowledge and skills acquired from the first year biology program.**

The School provides a range of specialised units that you will combine together to form the major required to complete your degree. In the second and third year of undergraduate study you will have an increasing focus on a chosen major and may choose most or all units in a single discipline. The majors offered in biology are ecology and conservation biology, genetics, plant sciences, environmental science and zoology. The topics studied in second and third year biology units can be found at: monash.edu/science/about/schools/biological-sciences/units/index.html

## THIRD-YEAR RESEARCH PROJECT

At a third year undergraduate level, you have the opportunity to undertake an individual research project in a discipline relating to a major area of study. This project is conducted under the supervision of an academic staff member. Project work includes a critical literature review, experimental design and data analysis and seminar attendance. You can expect approximately six contact hours per week. The prerequisites are 24 points of second year level studies with 12 points minimum in the discipline directly relevant to the project and a minimum average of distinction across all units. Permission from an individual supervisor is required.

## VACATION SCHOLARSHIPS

To provide talented undergraduates with career and research experience vacation research scholarships are offered each year. As a scholarship holder you will participate in a research project or pursue, under supervision, some independent work of mutual interest to you and the School. In some cases the course may be followed by a subsequent honours project. Further information and application details can be obtained from the School.

## HONOURS IN BIOLOGICAL SCIENCES

Students with good academic records are invited to undertake a fourth year of study, which leads to an Honours degree. Honours research is challenging and demands independence and initiative.

It is also exciting and rewarding. As an honours student you will carry out original research on a defined project, as well as some advanced coursework. Research is undertaken in school research laboratories or at field sites under the supervision of an academic staff member.

### CHLOE RINGS

Chloe studied an Arts/Science Double degree, with majors in Australian Indigenous Studies and Marine & Freshwater Biology, as well as a Diploma of Languages (Spanish). She then completed an Honours project at Monash on flatback sea turtles, undertaking her fieldwork in the Northern Territory. Chloe chose this course because it gave her the flexibility to include all of her interests: the marine environment, Indigenous Australia and languages.

After graduating, Chloe moved to a remote Indigenous community in Arnhem Land, NT where she worked for the Crocodile Islands Rangers on a diverse range of projects including sea turtle research, shorebird monitoring, cane toad management, recording cultural knowledge in the form of a bilingual bush tucker book, and a Junior Ranger program that links elders and high school students to ensure traditional Yolngu cultural and ecological knowledge gets passed on to the next generation. This experience has led her to work with several other Indigenous ranger groups across the Top End of the NT, and more recently in the Kimberley, WA. She currently works with the Parks and Wildlife Service at Eighty Mile Beach Marine Park in WA, alongside Ngarla, Nyanguamarta and Karajarri Rangers, where key management areas include sea turtles, shorebirds, mangroves, culture and visitor engagement.

# MONASH'S ENHANCED PHD PROGRAM IN BIOLOGICAL SCIENCES

**Research skills training is integrated into your PhD to help improve the quality and impact of your research and better prepare you for the job market beyond.**

- Work with internationally-recognised researchers on a wide range of high-impact topics from genes to ecosystems to landscapes.
- Training activities built into your PhD improve the quality and impact of your research, while gaining skills desired by employers in industry, academia, government and the community.
- Skills training available in Research Integrity, Project Management, Scientific Communication, Statistics, Computer Programming for Research, Phylogenetics, Bioinformatics, and Writing and Publishing in the Sciences.

**Generous scholarships for high-achieving students and relocation allowances for interstate or New Zealand students.**

**www.monash.edu/science/schools/biological-sciences/postgrad**

# ECOLOGY AND CONSERVATION BIOLOGY

**ACADEMIC ADVISOR: PROFESSOR PAUL SUNNUCKS**



Ecology and conservation biology is the scientific study of interactions between organisms and their environment, and the application of that information to conservation management.

## Why is ecology and conservation biology such an exciting area of science?

Understanding patterns and processes in the natural world is essential for our survival and the planet on which we depend. Not only do we need to understand human impacts on global ecosystems, we also need to devise practical means to conserve biodiversity and ecosystem function. We are increasingly aware of human reliance on fundamental ecological systems for our health, well-being and prosperity. This has to be maintained in the face of rapid changes to the environment, including climate, habitat loss and degradation, biological invasion, emerging diseases and pollution.

As an ecologist, you could be involved in researching and managing Australia's ecosystems, from the Antarctic and Southern Ocean Islands, to the arid interior, tropical rainforests and diverse coastal and offshore marine areas, and grasslands, shrublands and forests across southern Australia. You could also become part of the global community of biologists working towards a sustainable environment for future generations. If you would like to become a scientist or manager who can operate across traditional scientific boundaries to protect, enhance and restore ecological systems, then this is the area of study for you.

## MAJOR RESEARCH AREAS IN ECOLOGY AND CONSERVATION BIOLOGY

The ecological research undertaken at Monash University was recently recognised as being amongst the world's best, as shown by the scores of 5 (well above world standard) for Ecology in the the last three 'Excellence in Research for Australia' ERA assessments. Some examples of our current research projects are:

### How are species, communities and ecosystems responding to rapid environmental change?

Increasingly, human activities are changing terrestrial and marine environments. To conserve biodiversity effectively it is critical that we understand how species and ecosystems respond to these activities individually and collectively. Research and teaching in the School of Biological Sciences addresses the ways in which threats (including ocean acidification, increasing temperature and atmospheric $CO_2$, pollution, invasive species, habitat fragmentation and degradation) affect plants, animals and other organisms. For example, will harmful algal blooms become more or less frequent with a shift in climate? How will increasing marine traffic affect sea turtles? Will crop foods become toxic under increased $CO_2$? How hot can it get before animals keel over? How dry can it get before plants don't recover? To conserve biodiversity we really do need to know the answers to questions like these to make sure we develop effective solutions. We carry out this work in many different environments from the icy landscapes of Antarctica to the hot, dry deserts of the Australian arid zone.

### How do we manage biodiversity and ecosystems in a world of change?

One of the most important reasons for having a good understanding of how species and ecosystems are responding to change is to know what to do about it. How should we best manage this change to ensure the survival of species and the sustainable use of the resources that the planet provides? We work on approaches and techniques to make sure that policy and management actions are appropriate and effective. This includes studying how research information finds its way into the minds and actions of policy makers, and how you remove subjectivity from expert opinion. It also includes developing techniques for optimising biological monitoring with limited resources and developing robust short-cuts for understanding if and how the environment is changing.

### What is the physiological and genetic basis of the ability of organisms to adapt to environmental change?

We explore ecophysiological and evolutionary processes in order to predict how our conservation approaches will affect biodiversity. We carry out field studies, experimental investigations of evolutionary processes, ecophysiological computer modelling, genetics of complex traits, and analysis of entire genomes to understand how organisms adapt to changing environmental conditions. New approaches such as ecological genomics and stable isotope analysis are vitally important components of the battle to save Australia's rare, endangered and vulnerable species. We examine the movement dynamics of populations of key species of birds, fish and mammals using ecological, genomic and modelling approaches, in order to understand what conditions will allow them to survive.

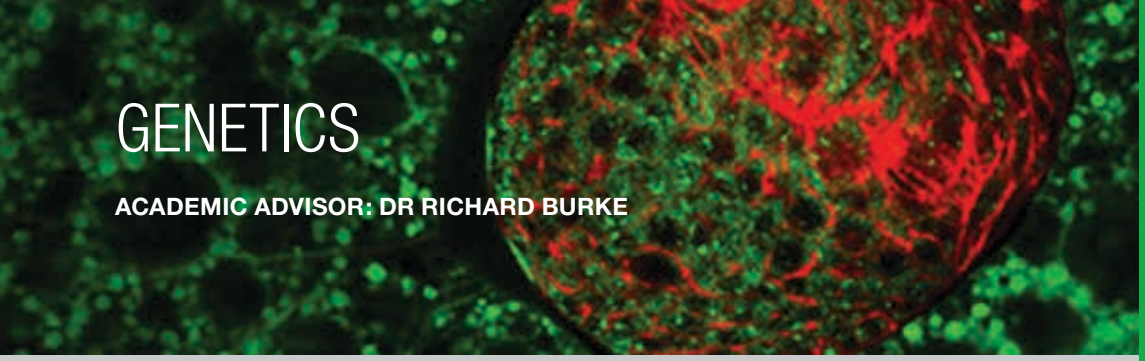
### How do human activities affect animal behaviour and how do animals respond?

Human activities can cause changes in the marine and terrestrial environment that disrupt the physiology, movement and behaviour of birds, lizards, ants, sea turtles and many other species. These activities include for example heavy-metal pollution, the introduction of invasive species, impenetrable fences, roads and other barriers to dispersal and habitat fragmentation.

### SHAADMAN SAIF

Shaadman studied conservation biology in the School of Biological Sciences as part of his Bachelor of Environmental Engineering/Bachelor of Commerce. Since childhood Saif has had a desire to have a positive impact on the environment.

"From my point of view, studying biology is more fun than many other subjects and it prevents you from getting bored! It lets you have a clear understanding of how animals function and evolve to survive. For example, male catfish keep the eggs in its mouth until they are ready to hatch and honeybees have hairs on their eyes to collect pollen. Conservation biology is an interactive area that allows you to challenge yourself while having fun at the same time." Following graduation, Saif intends to work on environmental impact assessment and monitoring. "Biology is a broad and growing area and the possibilities are endless."



# GENETICS

**ACADEMIC ADVISOR: DR RICHARD BURKE**

Majors in the School of Biological Sciences

Genetics is the study of genes and the ways in which they work and interact to make plants and animals what they are.

## Why is genetics such an exciting area of science?

Genetics is the study of genes – their structure, function, transmission and evolution. It lies at the centre of biology because the same genetic principles apply to microbes, plants, animals and humans. Genetics is at the interface between traditional biology, with its descriptive study of the whole organism and molecular biology, with its study of the molecular workings of the cell. It also provides the basis for recombinant DNA technology, the molecular manipulations whereby genes can be added, deleted or altered in cells and organisms in order to study gene function or enhance specific genetically-controlled characteristics.

As a geneticist, you may be found at the laboratory bench isolating the DNA of particular genes, in the bush collecting specimens, or at the computer designing models of gene interactions and interpreting information from the many genome projects that now exist. As a student of genetics you will study current areas of molecular genetic research such as the regulation of gene expression, generation of transgenic plants and animals and comparative and functional genomics. You will obtain a wide perspective across both disciplines and be fully equipped for careers in the burgeoning fields of biomedical science and biotechnology.

## MAJOR RESEARCH AREAS IN GENETICS

Genetics research has a long tradition at Monash, and there are many areas of research available to students undertaking honours and postgraduate research projects.

### Can animal models of human diseases help in their treatment or prevention?

The common genetic ancestry of all animals means that genes associated with human disease are usually also found in simpler animals such as the zebrafish and the vinegar fly *Drosophila*. By introducing disease-causing mutations into the genomes of these 'model' organisms, the pathogenesis of the disease can be studied in greater detail, more rapidly and at lower cost. Genome-wide searches can identify the genetic pathways associated with each disease and potential treatments can be tested quickly and cheaply. We are using such techniques to study degenerative muscle and nervous system disorders and diseases of nutrient metabolism with the aim of improving health outcomes for people affected with these conditions. Meanwhile, in the Eliminate Dengue team we are taking a different approach to combating disease, exploiting insect pathogens to block the transmission of dengue fever via mosquitoes.

### How do genes interact with the environment so that plants and animals can adapt to changing conditions?

Genetic variation between the many individuals that make up plant or animal populations provides the raw material for adaptation and evolution. This variation can allow migration to regions with different climatic conditions, raising the possibility of colonising new ecological niches. Such diversification may eventually lead to the formation of novel species as populations adapt separately to different environments. Similarly, genetic variation underpins the ability of plants and animals to adjust to manmade changes to environmental conditions. We are looking at traits such as heat, cold and desiccation tolerance in insects and growth and flowering timing in plants so we can identify the genetic variation that controls these complex characteristics. We want to know if there are limits to species' adaptive capabilities in the face of environmental changes such as climate change. This research will allow predictions to be made about the potential impacts to native plant and animal populations of altered external environs such as those envisaged under both small and extreme climate change scenarios.

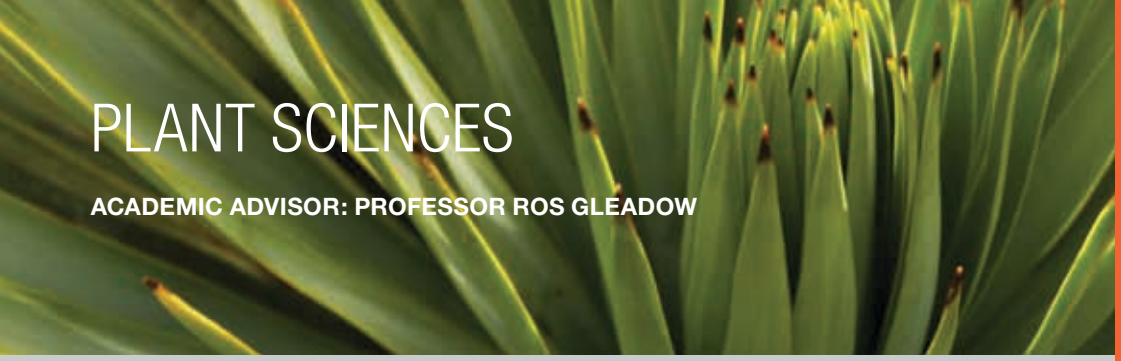
### How is the genetic information in a simple embryo interpreted to allow the generation of complex adult forms?

Plants and animals start life as a single cell, the product of fusion between egg and sperm. This single cell contains all the genetic information required for the generation of the diverse array of tissues such as blood, muscle, skin, heart and brain seen in a fully developed adult. In each cell type, genes are turned on and off in a unique combination that defines the cell's biochemical makeup and function. We are studying the developmental genetic switches that control processes as diverse as flower patterning in plants, formation of the nervous system in zebrafish and generation of head and tail structures in fly larvae. This fascinating area of basic biology also has potential downstream applications in areas such as agricultural productivity and human health.

### ISAAC FRITH

Isaac is currently studying Genetics in the School of Biological Sciences as part of a Bachelor of Science and Bachelor of Material Engineering double degree.

"The enjoyment of knowing that the applications of Genetics that I am taught within my degree are becoming ever more crucial and important in society, sparks the curiosity within me to keep on exploring and discovering innovative ideas. Whether it be using gene editing tools to create genetically modified organisms, diagnosing inherited genetic disorders, or even using software for computational genomics. Following graduation, I hope to become a researcher and explore the frontier of integrating molecular biology into engineering applications."



# PLANT SCIENCES

**ACADEMIC ADVISOR: PROFESSOR ROS GLEADOW**

Majors in the School of Biological Sciences

Plant sciences is the scientific study of plant diversity and function and the roles that plants play in a variety of ecosystems.

## Why is plant sciences such an exciting area of science?

The two big challenges facing the world today are climate change and population growth. Feeding the world while preserving biodiversity is a major focus of plant science research. In the plant science major you will study the diversity and function of plants and their interactions with the environment. For example, how do plants obtain their water and nutrients from the soil and how does photosynthesis uses light energy to transform CO2 into carbohydrates? How do bushfires affect vegetation structure? How does climate change affect food security? You can investigate these issues either at the level of the ecosystem, the whole plant, or at a cellular and genetic level.

## MAJOR RESEARCH AREAS IN PLANT SCIENCES

Monash has a strong research program in a broad range of plant sciences.

### Plant ecology and evolution affects natural ecosystems and food security

We study the ecology and evolution of reproduction in plants to understand how they allocate their energy resources. For example, plants need to interact with pollinators in order to produce the next generation, and this interaction with pollinators has led to the evolution of complex and beautiful floral patterns and reproductive strategies. Our work seeks to understand plants in the natural environment. This information also has strong economic and practical applications. Plant-pollinator interactions are central to maintaining agricultural crop production. The genetic forces governing the evolution of plant species helps us to understand, predict and control invasive plant species.

### Plant and algal responses to global climate change

Rising atmospheric CO2 affects plants directly through the process of photosynthesis as well as by changing the climate. At higher CO2 plants are more efficient, so they downsize their photosynthetic apparatus, which is mostly made of protein. In the future, plants will be less nutritious with lower concentrations of protein and micronutrients. We are examining the effect of climate change on plants and consequences for global food security. Algae are the basis of most aquatic food chains. We need to predict how climate change could alter their photosynthetic productivity and thus affect entire aquatic food webs. We are also examining how this may impact on large-scale blooms of toxic algae and cyanobacteria that can choke waterways and disrupt fragile marine environments and fisheries.

### Plants are the basis of life

Plants and algae are the dominant forms of life on Earth, forming the basis of all food chains and thus underpinning all life on Earth. The oxygen we breathe and the food that animals depend on all starts with plants. How do plants allocate their energy resources between reproduction and other functions like growth, stress tolerance and defence against herbivores? Understanding how plants trap energy, grow, develop and set seed is fundamental to what we do in the Plant Sciences. Plants can't run away, so they produce natural defensive toxins to protect themselves from herbivores. We are studying the toxins found naturally in eucalyptus tress to improve koala health. We are also using genetic technologies to develop non-toxic varieties of crop plants that are safe for human consumption.

### Can plants and algae contribute to a sustainable future?

Algae are amazingly versatile and productive members of aquatic food webs. We are examining ways to use algae in sustainability approaches such as the biosequestration of carbon, biosynthesis of biofuel, and bioremediation of polluted waters. We are interested in the interactions of terrestrial plants with nutrients, invertebrates and microbes in the soil. Can we manage these interactions to achieve environmental sustainability in a time of significant environmental change? We look from the molecular scale to the landscape scale, and develop and apply cutting edge technologies to address these questions. This scientific understanding ultimately needs to inform policy, and we believe in applying our research findings to issues of national and international significance.

### MICHAEL GODDARD

Michael completed his Bachelor of Science/Laws double degree, with a minor in chemistry, a major in biology (ecology) and honours in biology (plant sciences). During honours Michael examined the relationship between trees and climate in Tasmania. Michael finds research immensely rewarding. His studies have taken him from the alpine meadows of Kosciusko National Park to the temperate rainforests of Tasmania; from laboratories at interstate universities to CSIRO laboratoriesin Canberra, Hobart and Melbourne; and from conferences in Australia to a conference in the UK. Ultimately, he hopes to combine his two degrees and is considering a career in environmental law and consulting.

# ZOOLOGY

**ACADEMIC ADVISOR: ASSOCIATE PROFESSOR DAVID CHAPPLE**

Majors in the School of Biological Sciences

Zoology is the study of animals, their diversity, evolution, form, function, behaviour and ecology.

## Why is zoology such an exciting area of science?

Animals are vital components of natural systems, therefore studying zoology has enormous intrinsic and practical value. They are key components of the biodiversity that underlies ecosystem function. Animals are not only a major source of food, but may also represent threats (pests, parasites) to agriculture, aquaculture, forestry and human health. Thus, an understanding of animals and their importance leads to a better understanding of human behaviour and the impact that our species has on the world.

Zoologists study how evolutionary processes have led to the current diversity of animals, the form and function of animal species, and the behaviour, ecology and interactions of animals. They investigate the interactions of animals with plants, which ultimately are the source of nutrients and shelter, and with microbes, which enable many animals to effectively utilise plants as food. They also investigate animals as bio-indicators of the health of ecosystems. Research in zoology can be undertaken from the level of the whole animal to the level of the cell – its biochemical processes and genetic components.

## MAJOR RESEARCH AREAS IN ZOOLOGY

Research in the School of Biological Sciences spans a diverse range of areas within zoology. This research is often led by students or part of high-profile international collaborations.

### Determining the role of invasive species in shaping emerging environments

Globalisation is resulting in the increased deliberate and unintentional movement of animals around the world. We study the factors that influence the likelihood that animals will be transported to areas outside of their native range and their capacity to establish in new environments. We also investigate the evolutionary changes that occur in both the invader, and the native biota, during the introduction process.

### Behavioural responses to a changing world

Humans are having a dramatic impact on the natural world through the modification of landscapes, the pollution of environments, and their contribution to changing climatic conditions. We study how these anthropogenic factors are impacting foraging behaviour and diet selection, social behaviour, mating decisions, anti-predator responses, and habitat utilisation of animals.

### Understanding the genetic basis of adaptation to environmental change

Monash researchers are investigating how evolutionary and ecological processes can be incorporated into conservation and management of biodiversity. This is being achieved through a combination of field studies, lab- and field-based experiments, ecophysiological modelling, quantitative genetics and ecological genomics to understand how organisms adapt to a changing environment.

### The role of natural selection and sexual selection in driving diversity within and among species

Evolutionary biology focuses on the processes that generate diversity, and select upon the diversity present within a species. This diversity can take the form of genetic, morphological, phenotypic, behavioural or physiological variation. We study sexual selection and reproductive conflicts, the evolution of life-histories, organelle genome evolution, and the evolution of male fertility.

### Investigating the relationship between morphology and function

The morphological structures of animals are generally suited to the environments that they live in and the function that the structures have in the animals' life. Our research focuses on the evolutionary underpinnings of the relationship between morphology and function. This relationship is being used to address questions relating to maximum body size in animals, including global patterns of increase and maximum rates of evolutionary change.

### CAMILA ARNES URGELLES

Camila has been passionate about the ocean her whole life. Growing up she became more interested in marine ecology and wanted to study these ecosystems, which led her to start her Bachelor's degree at Monash. She completed her Bachelor of Science in 2016 with a double major in Ecology & Conservation Biology and Zoology. After this, she returned to Ecuador and started an internship at the Charles Darwin Research Station-Galapagos, where she's currently working on the Galapagos Seamounts Project led by Dr Patricia Marti Puig. Seamounts and hydrothermal vents have been recently discovered on the Galapagos. Camila's intention is to learn about deep-sea ecology and to gain more experience in research, after which she plans to continue her studies considering a career in marine ecology. Her goal is to work for the conservation of marine ecosystems.

www.darwinfoundation.org/en/news/2017/2/10/exploring-depths-galapagos-islands/

# ENVIRONMENTAL SCIENCE

**ACADEMIC ADVISOR: ASSOCIATE PROFESSOR RICHARD REINA**

Majors in the School of Biological Sciences

A Major in Environmental Science allows you to specialise in a traditional area of science, while providing you with a multi-disciplinary perspective and a focus on the skills necessary to tackle environmental challenges.

## Why is Environmental Science an exciting area to study?

Environmental Science is a discipline that deals with the rapidly changing environmental issues facing the world today. In this course you will be given both local and global perspectives on solving environmental problems. By encompassing many disciplines we give students a multi-disciplinary perspective of current environmental challenges, such as climate change, freshwater, marine and land management, resource use and sustainability. Students are also given a choice of major sequence depending on their interests.

We believe that successfully shaping the future of our environment requires more than just passion. That is why this major offers a deep understanding of the traditional sciences, but also fosters skills in communication, problem solving and social awareness to enable the use of science in decision making.

As an Environmental Science student you will gain professional, industry-required skills, from practical fieldwork and laboratory-based research methods, to experience working with policy and environmental risk assessments. Mitigating and controlling adverse environmental impacts is a global priority and a major in Environmental Science can give you the skills to make a difference.

## DR CARLY COOK

Carly is an applied ecologist whose research is focused on integrating science into environmental management. She is particularly interested in protected area management, having worked with several Australian management agencies before commencing her doctoral research.

Carly completed her PhD at the University of Queensland in 2010, measuring the accuracy of management effectiveness evaluations of protected areas, and investigating the use of rangers' experience as a source of local ecological knowledge. After completing her PhD, Carly took up a postdoctoral fellowship in the Centre of Excellence for Environmental Decisions at the University of Queensland and the Quantitative and Applied Ecology Group at the University of Melbourne. Her research focussed on improving decision support tools to synthesise and disseminate scientific information for environmental management and developing innovative approaches to detecting emerging issues for biodiversity conservation.

In 2014, Carly took up a lectureship at Monash University, where her research group focuses on a range of applied research questions and developing decision support tools for protected area managers, including structured decision making, monitoring and evaluation tools, decision thresholds for management action, and improving conservation planning.

Carly is passionate about the opportunity to provide students with the skills necessary to become conservation professionals, whether they go on in science and conduct management-relevant research, or work within environmental management agencies to improve evidence-based decision making.

# HOW TO COMPLETE A MAJOR IN BIOLOGICAL SCIENCES

**To complete a degree at Monash University, you will need to fulfil the requirements for a major in one particular discipline. Here is a list of the majors offered by the School of Biological Sciences and the units required to complete each major. Our majors and extended majors also have streams of complementary unit combinations for specialisations within the major. These are outlined in the Undergraduate Handbook.**

## ECOLOGY AND CONSERVATION BIOLOGY

**Professor Paul Sunnucks (Coordinator)**

Ecology is the scientific study of interactions between plants, animals and the environment. It encompasses both the living (biotic) and non-living (abiotic) components and processes that support the Earth's ecosystems. Conservation biology considers how human behaviour affects and alters species and ecosystems. It focuses on conserving biodiversity, specifically the management methods we can use to maintain or restore properly functioning ecosystems and minimise species extinctions.

| First year | Second year | Third year | Total Points |
|---|---|---|---|
| **Major** | | | |
| BIO1011 and one of BIO1022 or BIO1042 | BIO2011, BIO2022 and BIO2040 | BIO3011, BIO3111 and BIO3070 | 48 |
| 12 points | 18 points | 18 points | |
| **Extended Major** | | | |
| BIO1011 and one of BIO1022 or BIO1042 | BIO2011, BIO2040, BIO2022 plus BIO2181 or BIO2231 or GEN3062 or BIO/GEN3990* | BIO3011, BIO3111, BIO3070 and two other Level three BIO units | 72 |
| 12 points | 30 points | 30 points | |
| **Minor** | | | |
| BIO1011 and one of BIO1022 or BIO1042 | any two of BIO2011, BIO2040, BIO2022, or BIO3011 or BIO3111 or BIO3070 | | 24 |
| 12 points | 12 points | | |

## ENVIRONMENTAL SCIENCE

### Associate Professor Richard Reina (Coordinator)

Environmental science contributes to solving environmental challenges we face now and in the future. It draws on science to understand the interactions among physical, chemical and biological components of the environment, and creates new knowledge and ways of thinking to inform methods for managing complex environmental issues. This knowledge can also contribute to influencing policy, management and law. Environmental science is therefore suited to those interested in a career in science, as well as those who understand that a science background can lead to work in organisations not typically associated with science, but where environmental considerations are important.

| First year | Second year | Third year | Total Points |
|---|---|---|---|
| **Extended Major** | | | |
| CHM1011, EAE1022 and BIO1042 | ATS2548, ENV2022 plus two of: BIO2040, BIO2011, EAE2011, EAE2111, EAE2322 | ATS3546, EAE3012 plus three units of: BIO3070, BIO3082, BIO3091, BIO3111, EAE3111, EAE3051, EAE3132, EAE3022, EAE3311, EAE3321, EAE3331, EAE3342, ENV3022 | 72 |
| 18 points | 24 points | 30 points | |

## GENETICS

### Dr Richard Burke (Coordinator)

Genetics encompasses the study of genes, their structure, function, inheritance and evolution and spans a rich and diverse range of research topics. Genetics lies at the centre of biology because the genetic code provides the blueprint for life and every aspect of biology, from development, physiology and biochemistry through to behaviour and ecology, is ultimately controlled by the products of genes and their interaction with the physical environment.

| First year | Second year | Third year | Total Points |
|---|---|---|---|
| **Major** | | | |
| BIO1011 and one of BIO1022 or BIO1042 | GEN2041 and GEN2052 | GEN3040 and any three of GEN3030, GEN3051, GEN3062, GEN3990 or MCB2011 | 48 |
| 12 points | 12 points | 24 points | |
| **Extended Major** | | | |
| BIO1011 and BIO1022 | GEN2041, GEN2052, MCB2011 and MCB2022 | GEN3030, GEN3040, GEN3051, GEN3062, BIO3011 and one of GEN3990, or any level 3 BCH, MIC or DEV unit | 72 |
| 12 points | 24 points | 36 points | |
| **Minor** | | | |
| BIO1011 and one of BIO1022 or BIO1042 | 12 points of GEN units at level two or three | | 24 |
| 12 points | 12 points | | |

## PLANT SCIENCES

### Professor Ros Gleadow (Coordinator)

Plant sciences is the study of plants, their diversity and structure, and how they function. It involves studying plants living on land, in the sea and in freshwater environments, from the scale of genes and molecules to ecosystems and landscapes. We study the great diversity of plant groups, from algae and mosses through to gymnosperms and angiosperms. We investigate how plants function, have evolved and are adapted to particular environments, and the distribution and diversity of plant species and the plant communities in which they grow.

| First year | Second year | Third year | Total Points |
|---|---|---|---|
| **Major** | | | |
| BIO1011 and one of BIO1022 or BIO1042 | BIO2181 and BIO2022 or GEN2041 | BIO3091 and BIO3082*, and two of BIO3011*, BIO3070*, BIO3820 GEN3040*, GEN3030*, BIO3021*, BIO3062, BIO3990*/GEN3990, BIO2011, GEN3062 | 48 |
| 12 points | 12 points | 24 points | |
| **Minor** | | | |
| BIO1011 and one of BIO1022 or BIO1042 | BIO2181 and BIO3082 or BIO2022 | | 24 |
| 12 points | 12 points | | |

* This unit has specific second year prerequisites that may not be listed or compulsory in the second year component of the major sequence.

## ZOOLOGY

**Associate Professor**
**David Chapple (Coordinator)**

Zoology is the study of animals, their diversity, evolution, form, function, behaviour and ecology. Animals are integral components of natural systems and they interact with other animals, with plants, which are ultimately the source of nutrients and shelter, and with microbes, which enable many animals to effectively utilise plants as food. Study in zoology can be undertaken at the level of the whole animal down to the level of cell biology, biochemical processes and their genetic control.

| First year | Second year | Third year | Total Points |
|---|---|---|---|
| **Major** | | | |
| BIO1011 and one of BIO1022 or BIO1042 | BIO2231 and BIO2242 | BIO3052 and BIO3132 and two of BIO2022, BIO3011, BIO3021, BIO3070, BIO3082, BIO3091, BIO3111, BIO3820, BIO3990, GEN3030, GEN3040, GEN3051, GEN3062, GEN3990 | 48 |
| 12 points | 12 points | 24 points | |
| **Minor** | | | |
| BIO1011 and one of BIO1022 or BIO1042 | BIO2231 and BIO2242 | | 24 |
| 12 points | 12 points | | |

## STUDYING BIOMEDICAL SCIENCES AS PART OF A SCIENCE DEGREE

Studies in Biological Sciences also support studies in the biomedical and behavioural sciences, in areas including biochemistry, developmental biology, human pathology, immunology, microbiology, pharmacology, physiology and psychology.

There are two major pathways to studying biomedical sciences at Monash.

You can enrol in a dedicated Bachelor of Biomedical Sciences degree through the Faculty of Medicine, Nursing or Health Sciences.

Or, you can enrol in a Bachelor of Science degree through the Faculty of Science.

In this second option, you study Biology in first year then have the option of focussing on any of the following majors in second year and beyond:

- Biochemistry
- Developmental Biology
- Genetics
- Immunology
- Microbiology
- Physiology
- Psychology
- Human pathology
- Pharmacology

Studying biomedical sciences as part of Science degree has the advantage of greater freedom and more flexibility.

Without the core, compulsory units required for a Biomedical Sciences degree, you are free to focus more intensively on the subjects that particularly interest you.

And the absence of core units also provides more scope to pursue interests outside of Science, allowing you, for instance, to take subjects from other Faculties (Arts, Economics etc.) that are difficult to fit into the busy schedule of the Biomedical Sciences degree.

For more information, visit study.monash/courses

## UNITS OFFERED BY THE SCHOOL OF BIOLOGICAL SCIENCES

BIO1011: Blueprints for Life
BIO1022: Life on Earth
BIO1042: Life in the Environment
BIO2011: Ecology & Biodiversity
BIO2022: Evolutionary Ecology
BIO2040: Conservation Biology
BIO2181: Evolution of Plant Diversity
BIO2231: Animal Diversity
BIO2242: Animal Structure & Function
BIO3011: Research Methods in Biology
BIO3021: Marine Biology
BIO3052: Animal Behaviour
BIO3082: Global Change Biology
BIO3091: Biology of Australian Vegetation
BIO3111: Applied Ecology
BIO3070: Trends in Ecology
BIO3132: Biology of Australian Vertebrates
BIO3820: Tropical Terrestrial Biology
BIO3990: Biology in Action Research Project
BMS2042: Human Genetics
ENV2022: Environmental Field Skills and Monitoring
GEN2041: Foundations of Genetics
GEN2052: Genomics and Population Genetics
GEN3030: Molecular, Cellular and Developmental Genetics
GEN3040: Genomics and its Applications
GEN3051: Medical and Forensic Genetics
GEN3062: Evolutionary and Ecological Genetics
GEN3990: Genetics in Action Research Project
SCI1200: Humans, evolution and modern society'

MONASH University

## Further information

**monash.edu/science/future**

1800 MONASH (1800 666 274)

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**Telephone:** +61 3 9905 5650

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**monash.edu/biology**

Find out more information about courses and units in the Monash University Undergraduate Handbook online at

**monash.edu/pubs/handbooks**

The information in this brochure was correct at the time of publication (June 2018).
Monash University reserves the right to alter this information should the need arise.
You should always check with the relevant Faculty office when considering a course.

Produced by Strategic Marketing and Communications, Monash University Job 18P-0428.
CRICOS Provider: Monash 00008C. Monash College 01857J.