Have you considered Biological Engineering as a career?

Biological Engineering is an emergent interdisciplinary science, constantly evolving, challenging and totally absorbing! It is a convergence of biological sciences, biomedical sciences and engineering – underpinned by physics, chemistry, mathematics and computational sciences.

The pace of development of Biological Engineering has been spurred on by recent developments in the human genome project and progress made in molecular biology. This has been facilitated by the systems thinking and systems implementation skills of engineers, and the increasing power and sophistication of exploratory tools and methodologies used in engineering.

What do Biological Engineers do?

The role of Biological Engineers is best described by utilising the basic complementary engineering principles of analysis and synthesis. Biological Engineers bring engineering insights to the understanding of biological phenomena through:

- Conducting analysis – to measure and understand intricate biological phenomena, systems and processes at the basic molecular, cellular and physiological levels; and
- Undertaking synthesis – to design devices/processes and/or develop technologies/applications to model, manipulate or apply to biological systems in areas such as applied medicine, environmental science and agricultural science.

Did you know?

Victoria is Australia’s pre-eminent state for biotechnology, with strong government support for it to become one of the top five biotechnology locations in the world by 2010. Victoria is home to 39% of Australia’s core and diversified biotechnology firms and more biotechnology employees than all the other States combined.¹ ²

¹ Biotechnology Strategic Development Plan for Victoria 2004, to be updated in 2007
² Ibid
Advances in medicine and increased awareness in the community of health issues are leading to increased investments in biomedical and environmental engineering education and research. Biological sciences now enjoy a wonderful marriage with the major engineering disciplines as illustrated in the following examples:

**Biological sciences…**

- **Chemical engineering**
  Better drug delivery systems; shorter vaccine development cycles; enhanced production of cell ‘factories’ in the manufacturing of biological molecules; innovative food production technologies; alternative energy sources
- **Civil engineering**
  Improved quality of water through biofiltration; increased sophistication in forensic engineering; increasingly bio-sensitive ‘green’ buildings
- **Electrical and computer systems engineering**
  Increased sensitivity and accuracy of instrumentations that detect and measure biomarkers symptomatic of various diseases; stimulate nerves as in the bionic ear, the heart pacemaker; record biological activities; robots that mimic biological species like ants; capture and process images of biological organs and/or activities; more powerful supercomputers to record, manipulate, analyse, depict and interpret massive volumes of data
- **Materials engineering**
  Introduction of biological scaffolding to entice cell regeneration as in damaged nerves and bone matrices; advanced structural materials with inert properties that are more bio-compatible, such as that used for tissue implants and organ replacements
- **Mechanical engineering**
  Improved bioreactors through simulation of biophysical and biochemical aspects of body fluid environments used for *in vitro* cell growth and 3D tissue engineering; robotics for efficient bioprocesses and biopharmaceutical approaches; design of micro/nano devices for medical investigations and applications at the molecular and cellular levels; and ‘intelligent’ medical prosthetics and devices such as the heart valve and other replacement body organs

The end result? Biological engineering is responding to societal needs by effectively transforming new knowledge from the biological sciences into practical applications. In the next 25 years the world of Engineering will change dramatically as it parallels and fuses with the exciting new developments in the biological sciences.

**Interested?** Biological Engineering at Monash University is offered through:

- Bachelor of Biomedical Science/Bachelor of Engineering (5 years)
  [www.eng.monash.edu/courses/undergraduate/download/biomed.pdf](http://www.eng.monash.edu/courses/undergraduate/download/biomed.pdf)
  or
- Bachelor of Pharmaceutical Science/Bachelor of Engineering (5 years)
  [eng.info@eng.monash.edu.au](mailto:eng.info@eng.monash.edu.au)

**Why study Biological Engineering?**

A vast and interesting array of career opportunities lies ahead for biological engineers, both within Australia and overseas. Career opportunities are varied and numerous and include:

- pharmaceutical and biotechnology engineering (the biopharmaceuticals market in 2005 accounted for 12% of a US$602b pharmaceuticals market, estimated to become 50% by 2010
- medical diagnostics and development
- medical device development
- medical image processing and management
- medical IT and telecommunications
- genetic and proteomic engineering in disease understanding and prevention
- biomaterials research
- bioprocessing and production of e.g. food and medicines
- human biomechanics and prosthetic engineering
- forensic engineering and accident investigation
- public health engineering as in water supply and reuse, solid and waste disposal systems

**Why study Biological Engineering at Monash?** Because Monash University is one of Australia’s leading universities – energetic, dynamic, and committed to quality education and research. The Faculty of Engineering at Monash is one of Australia’s largest and most prestigious engineering faculties. In terms of its biological sciences, Monash is at the forefront in biomedical...
engineering research. Its Victorian College of Pharmacy is one of the highly regarded pharmacy schools in Australia. The College is famous for its formulation chemistry, medicinal chemistry and pharmaceutical biology, and its drug development and health advancement activities.

The Australian Synchrotron, scheduled to open in 2007, is right on Monash’s doorstep in Clayton. The synchrotron produces light as an intense beam that can be used to produce detailed images of the structure of materials down to the molecular level. Monash has been expanding its synchrotron research base over the past few years. The proximity of the synchrotron now will enable Monash to take a pre-eminent position in Australia in the development of synchrotron science and in the use of the synchrotron for advanced research in its biological engineering programme.

Research life at Monash after your undergraduate Biological Engineering studies? Yes, a range of research opportunities, both in fundamental and applied research, exist across the diverse disciplines in biological sciences and engineering at Monash. Examples of biological engineering research conducted at Monash follow:

- Biomolecule production such as in protein and vaccine production – Bio Engineering Laboratory (BEL)
- Drug and excipient distribution in pharmaceutical systems, drug delivery via inhaled particulates; granulation and agglomeration processes used in pharmaceutical, food, and fertilizer industries; syntheses and applications of nanoparticles and nanomaterials for e.g. protein separation and enzyme studies – Monash Advanced Particle Engineering Laboratory (MAPEL) (coming soon)
- Process-product interactions in food materials and bioactive materials (drugs) leading to improved production and storage techniques resulting in high value products for local consumption and export – Biotechnology and Food Engineering (BFE)
- Biofiltration technology optimised for effective and sustainable stormwater treatment – Facility for Advancing Water Biofiltration (FAWB)
- Strategies and technologies for water resource sustainability in urban development and renewal – Institute for Sustainable Water Resources (ISWR)
- High-sensitivity methods for detection and identification of chemical markers of neurological diseases, using advanced digital signalling analyses and processing techniques for better disease diagnosis and drug efficacy; technology developments in neuromuscular systems control and rehabilitation; biophysics, muscle mechanics; instrumentation, electronics, computer vision; prosthetics and orthotics sensors; medical imaging and lasers; medical robotics – Monash University Centre for Biomedical Engineering (MUCBE)

Bone tissue engineering: Scanning Electron Microscope (SEM) image of a composite scaffold for bone regeneration.

Neural tissue engineering: Epi-fluorescence images of neural stem cells interacting on a smart hydrolgel scaffold to be used for the repair of damaged neural pathways in the brain.

Neural tissue engineering: SEM image of a nanofibrous scaffold manufactured to promote nerve regeneration.

‘Baltan’ bidirectional linear microactuator for nanometer accurate positioning, shown here against a pencil tip at left.

VIPER software developed at Monash helps in the prediction and understanding of kidney flows.

The Electrovestibulography (EVestG) plot allows physicians to understand better the effect of L-Dopa medication in Parkinson’s Disease.
Biodiagnostics that study the use of selected materials for use in the human body such as in organ transplants to minimise rejection and hasten integration; creation of resorbable scaffolds from synthetic and natural polymers that mimic the natural body environment to support stem cell growth in the treatment of degenerative neurological diseases and in arthritis and bone regeneration – Department of Materials Engineering

Experimental and computational mechanics related to cardiovascular and renal circulation; cell growth/tissue engineering; and improved methods of drug delivery – Fluids Laboratory for Aeronautical and Industrial Research (FLAIR)

Design of intelligent products, control systems and processes, such as complex micro/nano manipulation systems for microsurgery; anatomical organ modelling; and surgical procedure simulation – Robotics and Mechatronics Research Laboratory (RMRL)

Intermolecular and interfacial forces in the forms of micro/nano mechanical systems and micro/nanofluidics in the fields of medicine, biomaterials, and commercial applications – Micro/Nanophysics Research Laboratory (MNRL)

Renal circulation; cardiovascular regulation; bioreactors; artificial biological pumps; tissue engineering; stem cells; biophysical fluid mechanics; advanced imaging techniques ranging from synchrotron and photon microscopy to Particle Image Velocimetry (PIV) – Monash University Biomedical Engineering Technology Alliance (MuBeta)

Scholarships? Monash University and Monash Engineering offer a range of undergraduate scholarships and bursaries in 2007 to encourage and reward academic excellence and to ensure equitable access to a world-class University.

Engineering Excellence Awards – Up to 50 scholarships of $6,000 p.a. will be awarded to students entering Engineering undergraduate programs. To be eligible, students will need to achieve an ENTER score of at least 98. Retention of the scholarship beyond first year will require the student to achieve a first-class honours (75%) average every year.

Women in Engineering Bursaries – 10 bursaries of $2,000 each will be available to women entering an Engineering undergraduate program.

Monash University Engineering Scholarships – A limited number of scholarships valued at $6,000 p.a. will be offered to students enrolling in the Deans Scholars Program.

Monash University International Scholarships for Excellence – Monash University will offer scholarships valued at $6,000 p.a. for high-achieving international students enrolling in undergraduate Engineering programs.

For further information:
- www.adm.monash.edu/scholarships/
- 2007 Coursework Scholarship Guide