

# MICROBIOLOGY AS A CAREER

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## Small Things Can Make a Huge Difference

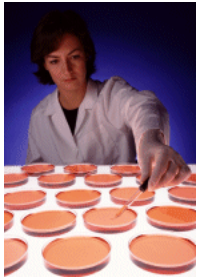
Microbiologists study microscopic forms of life such as bacteria, viruses, protozoa, algae and fungi to increase scientific knowledge and develop medical, veterinary, industrial, environmental, and other practical applications.

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JOB AND SCHOLARSHIP PAGE

<http://www.theasm.com.au/jobs-and-scholarships>

## What is Microbiology?



Most people know that microbes are the cause of infectious diseases like 'flu, or whooping cough, but they don't realise that exploiting microbial activities brings us many benefits.

Microbes can make you ill, but they are also the source of the antibiotics that can cure you. And, although many microorganisms cause food spoilage, others are essential for its production. Without yeast there would be no beer or bread and we could not make yoghurt without lactic acid bacteria.

On a planetary scale, microorganisms have an essential role in the cycling of the nutrients which make up every living creature. Microbes are responsible for the degradation of dead animals and plants, releasing components that can be used again.

They are the only organisms that can fix nitrogen from the atmosphere into living material. Photosynthetic microbes in the oceans fix the carbon dioxide from which all marine life is derived. If these processes did not occur, life on this planet would soon grind to a halt

So - Microbiology is not a single subject. It has many areas of specialisation. However it is a science based on the use of pure cultures - looking at one sort of organism at a time.

Many of the techniques developed by microbiologists are now used in molecular and cell biology to provide the basis for studying higher organisms

Microorganisms also play a central role in recombinant DNA technology and act as the agents for genetic modification. Applying knowledge gained from these techniques can lead to many improvements in the quality of our lives. In this way microbiology makes an important contribution to biotechnology, an area of science that applies industrial techniques to biological processes.

- The range of job opportunities for microbiologists is as diverse as the organisms they work with.
- Understanding microbes has never been more important. Choose microbiology for your career.

They carry out research and develop new products; they also work in quality control to monitor manufacturing processes and check the microbiological safety of goods. Other work is done away from the laboratory. Some of these jobs and industries I'll say a little more on.

## "Big Pharma"

The traditional pharmaceutical industry is a great commercial success. Big Pharma companies employ thousands of scientists in research facilities and manufacturing plants.

The industry has pioneered the development and manufacture of a wide range of products designed to improve human and animal health. An important example is the continued development of antibiotics to combat diseases caused by pathogenic microorganisms. Many microbes have acquired resistance to the antibiotics used against them and the pharmaceutical industry works towards modifying existing products and developing new ones in its effort to stay one step ahead.

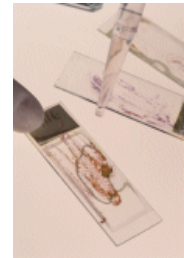
And of course vaccines..... There's \$ to be made.

## Biotechnology start-up companies and "spin-outs"

The number of small to medium size biotechnology companies has increased dramatically in recent years. These organisations develop biopharmaceuticals or produce specialist instruments for use in the biomedical, healthcare or biotechnology fields. Some companies are set up by universities to exploit the commercial potential of their academic research

Advances in gene technology have revolutionised the production of medicines such as insulin which is produced by genetically modified microbes. Previously the hormone was extracted from the carcasses of horses and pigs.

The large-scale culture of microbes in fermenters requires special skills in the area where microbiology and chemical engineering overlap. "Scaling-up" the growth of microorganisms from a flask in the laboratory (up to 10 litres of culture), through pilot scale fermenters (25-1000 litres) to full production (1-100 tonnes) is not an easy task and each culture behaves differently. Industrial microbiologists are also needed for downstream processing - the recovery and processing of the actual therapeutic compounds from the fermenters.



Microbiologists are also employed to evaluate drugs in clinical trials, and in the registration of new products

## Biochemicals

Microbiologists are involved in the production and quality testing of many other useful compounds, including amino acids, antiseptics, organic acids and proteins.

Using microbes to produce enzymes for scientific use is an industry in its own right. Many diagnostic procedures in clinical biochemistry use microbial enzymes, and a long list of bacterial enzymes is sold for use in molecular biology techniques like DNA "fingerprinting".

We all know the benefits of adding (microbial) enzymes to washing detergents. Clothes can be cleaned at lower temperatures, using less detergent and water softener in the powder, leading directly or indirectly to reduced pollution.

Some enzymes used in the food industry are also made on a large scale from microbes

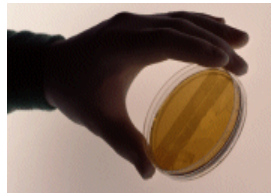
### Cosmetics & toiletries

Microbiologists check the effectiveness of anti-microbial products such as creams against acne and anti-dandruff shampoos and develop preservative systems to ensure that cosmetics and toiletries are free from microbial contamination both during manufacture and use by the consumer.  
..preservatives

## MEDICAL MICROBIOLOGY

### In sickness and in health

Microbiologists play a major part in finding ways of identifying, preventing and treating infectious diseases such as TB, a bacterial disease, and the viral infection 'flu. Some fungi cause minor infections such as thrush, dandruff and athlete's foot although they can also cause more serious infections in people with compromised immune systems.



Microbiologists are also helping to pioneer gene therapy techniques against genetic disorders such as cystic fibrosis and inherited cancers. Viruses are used to introduce genes carrying the desired characteristic into the cell nuclei of the host organism. Gene technology also has many applications in the development of medicines and diagnostics

### Hospitals

Microbiologists in hospital laboratories (Biomedical Scientists) deal with samples from patients, isolating and identifying the microbes that cause illness and giving advice on appropriate treatment. They also try to prevent patients from picking up infections in wards or operating theatres, and to trace and eliminate any infections which may occur. Opportunities exist too in the Red Cross Blood Bank and veterinary establishments.

### Epidemiology

The prevention of disease has a far greater impact on the population at large than the treatment of sick people. Microbiologists in the TGA, PHU's monitor pathogens from patients and the environment. In this way, a disease such as 'flu can be tracked and if there is risk of an epidemic, vulnerable people can be immunized against it.

Microbiologists in TGA and PHU's can (like their hospital colleagues) isolate and identify pathogens. Their records are analysed centrally by computer to provide a continuous picture of the progress of infections and the information is used by health authorities in the control of disease.

PHUs utilise microbiologists to track down the restaurant kitchen or batch of factory-prepared food that are the source of a *Salmonella* food poisoning outbreak, or find the air-conditioning system harbouring the *Legionella* bacteria responsible for an outbreak of Legionnaire's disease.

Food, milk and water supplies are also routinely tested to ensure that they are of good microbiological quality and not contaminated.

A number of private laboratories also carry out this kind of work.

### Microbial genomics

Some microbiologists study the structure and function of microbial genomes, sequencing and identifying the genes of organisms which cause illness. We hope this knowledge will lead to better design of therapies against individual pathogenic organisms. This technology is also used to improve understanding of beneficial microbes such as those living in the gut.

### Medical research

Medical microbiologists also work in research institutes and universities where they study topics such as how diseases develop or the interaction between pathogenic microbes and host cells.

Some industrial research and development sites employ medical microbiologists to work on the development of medicines and vaccines.

### Manufacture

Microbial fermentations have been used for centuries to produce foods such as cheese and yoghurt and alcoholic beverages like wine and beer.

Microbiologists are also needed at all stages of modern food and drink manufacturing processes. They are involved in the maintenance of the microbial culture (the inoculum) that is used to start the fermentation of the milk or grape juice, to prevent deterioration of existing strains and to develop or improve existing ones.

Olives and some processed meats are made by fermentation. However, the best known fermented products are beer, wine and spirits - the brewing industry is a major commercial force employing many microbiologists. Some beers are still produced by traditional methods, but in the main, brewing is a strictly controlled operation. Microbiologists maintain the strains of yeasts used and produce improved strains, as well as supervising the fermentation. They also have to solve the problem of dealing with waste materials produced by the process.



Our food contains many other, less obvious, microbial products, such as flavours and colours. Many factory-produced foods lose important vitamins during processing, and to keep our diet healthy, vitamins are added back to the food (e.g. breakfast cereals). These vitamins are made by high yielding bacterial strains and are a relatively inexpensive ingredient.

### Safety & hygiene

As we store food for longer periods, it becomes more difficult to prevent spoilage by microbes. Some spoilage just makes food look unattractive but food poisoning is caused by human pathogens such as *Salmonella* growing on food. The increased demand for production and storage of ready meals, has caused in a rise in the number of cases of food poisoning by the bacteria *Listeria* and *Campylobacter*.



Microbiologists are employed in quality control to ensure that products are safe and wholesome; in product development and basic research into food hygiene and preservation.

### Water

We need plenty of good quality water for domestic and industrial purposes. Rivers and reservoirs supply water to purification plants where microbiological and chemical tests are carried out to check its quality before distribution. The action of bacteria and protozoa in sewage treatment plants breaks down waste material so that effluent can safely be released back into the rivers. Microbiologists in water companies and the Environment Agency monitor and control these processes.

### In the field

Microbes play an important part in agriculture. They fix nitrogen in the soil into a form that can be used by plants as a fertilizer and turn grass into the winter animal feed, silage. Microbiological research in these and other agricultural topics is carried out in institutes and industry.

Farm animals and crops are susceptible to pests and diseases. Veterinary microbiologists and plant pathologists do research and give advice on problems farmers may encounter.

Microbes are also used for biocontrol. Pests or weeds can be sprayed with a microbe that attacks them instead of spraying crops with pesticides or herbicides which kill many types of harmless organisms. Biocontrol has great potential, particularly in developing countries where a sustainable method of crop protection is the preferred approach.

### The environment

Microbiologists in research institutes and universities study the ecology of microbes in fresh water, the sea and other habitats.

Microbial activities can be harnessed to avoid or minimise environmental pollution. Factory wastes are treated with suitable cultures or enzymes produced from bacteria. Microbes can also be used in production processes. For example, microbes can be used to replace harmful chemicals in dye production and leather processing.

Some parts of our environment are already badly damaged by pollution. Industrial processes (and accidents) have left land contaminated with such things as toxic heavy metals and phenolic compounds. Microbial processes are being developed to clean up such pollution - known as bioremediation



### Out of the Laboratory

Many microbiologists apply their knowledge and skills in work outside of the laboratory. There are opportunities in the **civil service, local government, industry and commerce**. One example is **sales and marketing of pharmaceutical products or laboratory equipment and consumables**. A period of lab experience helps a sales consultant understand the concerns of microbiology focused customers.



Another area of work is in information science and librarianship. Some microbiologists become technical or science writers or work for scientific publishers, editing journal articles or books.

Others go into the law and accountancy where scientists are popular with recruiters. The biotechnology business boom has resulted in many more jobs for technology transfer specialists, business development managers and **patent lawyers** who need to have a sound grasp of the scientific basis of the subject.

Some microbiology graduates undertake **teacher training** and go on to work in schools or further education colleges. A few lectureships in universities are available, but candidates must usually have obtained a postgraduate qualification such as a PhD and worked for several years as a researcher.

**Personal Requirements:** Enjoy and have aptitude for science and research, able to think logically and analytically, able to carry out detailed and accurate work, good communication skills, flexible, able to work as part of a team.

**Education and Training:** To become a microbiologist you usually have to complete a science degree at university with a major in microbiology. (Relevant degrees and pre-requisites are listed for each state). TAFE courses are also available within NSW for specific applications within Microbiology. Refer to the relevant handbook.



**Employment opportunities:** Microbiologists are employed in federal, state, territory and local government organisations, including research organisations and hospitals. They are also employed in the private sector in a wide range of industries, such as agriculture, food production and pharmaceuticals. It is a small occupation with average employment prospects, but entry to some jobs is highly competitive.

A Graduate with a **Bachelor of Science (including Microbiology)** or **Honours in Microbiology** and some TAFE courses can lead to employment within Government or private industries such as:

Beverage Industries, Environmental Companies , Food Industries, Hospitals and other Medical Institutions, Mining Companies, Pharmaceutical Companies, Research Laboratories ,Technical Supply Companies, Universities, Veterinary Institutions , Water Authorities, International - World Health Organisation.

**Working in such areas as:**

Bacteriology / Microbiology , Biochemistry , Ecology , Education , Environmental Biology, Epidemiology, Food Technology, Genetics, Marine Biology, Marketing / Technical Sales, Medical Technology / Biotechnology, Molecular Biology, Mycology Pathology, Quality Assurance, Virology

See <http://www.microbeworld.org/>

Examples:

- [Plastic-munching bugs turn waste bottles into cash](#) 09/19/2008
- [Serious disease in pet lizards caused by new bacteria](#) 09/19/2008
- [Bacteria Stop Sheep Dip From Poisoning Fish And Bees](#) 09/19/2008

## UNIVERSITY COURSES

- Sydney University
- University of NSW
- University of Technology
- Wollongong University
- Interstate = similar

## TAFE COURSES - NSW

- 18286 Cannulation- Statement of Attainment (NRT)
- 1878 Health Service Assistance (Pathology Assistance)- Certificate III (NRT)
- 18285 Pathology - Certificate III (NRT)
- 1872 Pathology Specimen Collection - Certificate III (NRT)
- 17379 Laboratory Skills - Certificate III (NRT)
- 17377 Laboratory Techniques - Certificate IV (NRT)
- 17383 Laboratory Technology (Specialising in Pathology testing) Diploma (NRT)
- 17378 Laboratory Technology - Diploma (NRT)
- 17375 Sampling and Measurement - Certificate II (NRT)

