MICROBIOLOGY IN NEW ZEALAND

1. Historical Overview

In New Zealand, the study of microbiology began over 110 years ago. As in many countries, it owes its inception to the investigation of infectious diseases in humans. However, as the economy of New Zealand has always been firmly based on primary industries, problems relating to animal and plant health have also had a powerful influence on the development of microbiology.

Bacteriology was taught at the University of New Zealand in the last decade of the nineteenth century to medical students who underwent a course of practical instruction in bacteriology, and to botany students who studied 'the structure and life-history of bacteria'. A study of plant diseases was also begun when, in 1890, a Department of Agriculture biologist was instructed to record, describe, and make control recommendations for diseases causing damage to crops. Many of these diseases were of fungal aetiology, and a classification of New Zealand fungi was a natural development from this survey.

In 1905 the first research and diagnostic station (Wallaceville Animal Research Centre) for the study of animal diseases in Australia or New Zealand was established by the Department of Agriculture. Bovine mastitis was among the first animal health problems of microbial aetiology to be investigated. Other similar research centres were subsequently funded, initially focussing on a variety of major infectious diseases of livestock in New Zealand, e.g. clostridial diseases, leptospirosis, brucellosis, salmonellosis, toxoplasmosis, and facial eczema.

In the mid 1920s the two Agricultural Colleges of the University of New Zealand introduced microbiology as a subject in the agricultural science courses, and students received instruction about microorganisms and their relation to plant diseases. At about the same time, the Plant Diseases Division of the Department of Scientific and Industrial Research broadened its field of investigation to include plant diseases caused by viruses as well as those caused by fungi and bacteria.

It was in this period that the first government-supported industrial research institute was established, the Dairy Research Institute. A major problem in cheese manufacturing at that time was the unpredictable variation in the activity of starter cultures used in the manufacture of cheddar cheese, and an immediate objective of the Institute was to obtain more precise control of the activity of these cultures. This research subsequently demonstrated that variability and failure of starter cultures was caused by a bacterial virus, the first reported in the dairy industry.

In the last 70 years, microbiology has developed rapidly in New Zealand with major expansions in university teaching (see below) and the former Department of Scientific and Industrial Research divisions and Department of Agriculture centres to encompass the increasing need for microbiological knowledge and expertise.

In addition, study of some of New Zealand's 'natural' resources and environments, e.g. hot (thermal) pools, resulted in increasing interest in microbes associated with such environments, and the discovery of a number of naturally occurring potentially antimicrobial substances.

Since the early 1990s, the various government funded research centres (e.g. the Department of Scientific and Industrial Research, and Ministry of Agriculture and Fisheries Divisions, the Forest Research Institute and the Communicable Disease Centre) have been amalgamated and/or assigned to one of the newly established Crown Research Institutes, e.g. Landcare Research, HortResearch, AgResearch, Crop & Food Research and Environmental Science & Research. All have major microbiological research interests and knowledge bases.

2. Medical Microbiology

Bacteriology was taught at the University of New Zealand in the last decade of the nineteenth century to medical and botany students. With the appointment of a bacteriologist to the teaching staff of the Dunedin (Otago) Medical School in 1911, the bacteriology course for medical students was extended, and a beginning was made in investigative work on tuberculosis, bacterial

meningitis, poliomyelitis, typhoid fever, diphtheria, and scarlet fever, which were prevalent at that time.

In addition to the Otago Medical School, a second medical school was established at the University of Auckland in 1968, and now has a very strong infectious disease programme, while the University of Otago Medical School has established Clinical Schools in Christchurch and Wellington. Several other universities (e.g. Canterbury, Massey and Waikato) established new departments specialising in aspects of clinical microbiology, such as virology, cell biology, molecular biology, microbial genetics, protozoology and veterinary microbiology. The teaching of Immunology at undergraduate and postgraduate levels has also blossomed at Otago.

Research into medical microbiology received an impetus with the establishment of the Medical Research Council (now the Health Research Council) of New Zealand in 1937. In the 1940s it was supporting research on haemolytic streptococci causing scarlet fever, phage-typing of staphylococci and leptospirosis. A survey of fungi on the human skin, begun in 1952, developed over the years until it culminated in 1965 as a definitive text on *The Ecology of the Human Skin.* The Medical Research Council formed a Virus Research Unit in Dunedin (1949) to provide a diagnostic service to hospitals and to conduct research into viruses which cause human disease. Topics investigated included viral diagnostic serology, poliovirus immunity, arboviruses and viral hepatitis. Other microbiological projects funded in the late 1950s - 1970s were concerned with bacterial plasmids, genetic analysis of *Pseudomonas aeruginosa*, *Candida albicans*, dermatophytes, molecular biology of bacterial viruses, tumour virology, interferon and the biological control of mosquito vectors of dengue viruses and filaria.

More recently (1980s – 1990s), the Health Research Council has funded microbiological projects concerned with a variety of medically significant microbes and/or diseases including influenza viruses, hepatitis viruses, virus vaccines and the use of viruses as carrier vaccines,

papilloma viruses, leprosy, streptococci and streptococcal diseases, oral microbiology, gastrointestinal microbiology, kidney infections, protozoa and protozoal infections, fungi and fungal infections and antimicrobial resistance.

Heightened interest has recently (2000s) been generated in infectious diseases

by the widespread publicity and debate surrounding the emergence of 'superbugs' including MRSA and other strains of *Staphylococcus aureus*, the potential H5NI bird flu pandemic, invasive meningococcal disease and its potential control by vaccination, *Campylobacter* and *Legionella* infections, and the ongoing saga of tuberculosis.

A limited number of research groups specialising in various aspects of medical microbiology and/or immunology have also been established in New Zealand. As well as the previously mentioned Virus Research Unit at Otago University, these include portions of the Dental Research Unit in Wellington, the Disease Research Laboratory (DRL – formerly Deer Research Laboratory) at Otago (specialising in mycobacterial diseases), an Oral Biology Research Unit in Dunedin and for a short period a Protozoology Research Unit in Palmerston North. Apart from the Medical Schools, immunology research has also been carried out by the Malagan Institute in Wellington. The only other major research centre for medical microbiology is the Environment Science and Research Communicable Disease Centre at Porirua (formely the New Zealand Communicable Disease Centre), although several hospitals (e.g. Auckland, Middlemore, Waikato and Christchurch) are now actively engaged in research orientated towards infectious diseases. BLIS Technologies Ltd arose from research initiated by John Tagg at Otago University.

3. The Teaching of Microbiology at Universities

(i) Otago

Professor Sydney T Champtaloup was the first Chairman (1911 – 1920) of "Microbiology" (Department of Bacteriology and Public Health) at the University of Otago (then part of the

University of New Zealand), followed by Professor C.E. Hercus (later Sir Charles Hercus) from 1921 – 1954. It was during the latter 10 years of Sir Charles's chairmanship that interest in Microbiology as a science discipline was spawned. This was continued and expanded during John Miles's tenure as Chairman (1955-1977), with the Department initially being housed in the Hercus Building of the Medical School, and from 1975 onwards in the eight floor Cumberland Street building. Since Miles's retirement in 1977, the department has had four additional Chairmen/HODs (see below).

In 1945, Molly Marples joined the then Department of Bacteriology and Public Health and over the next three years organised and promoted a second year BSc paper in Microbiology, which was offered for the first time in 1949 as Bacteriology 1. With the rearrangement of the department into two distinct entities in 1950 – the Department of Bacteriology and the Department of Hygiene and Preventive Medicine - Bacteriology 1 was renamed Microbiology Stage 2. Don Bacon, who joined the Department in 1950, then helped with the introduction of a Stage 3 paper, (first offered in 1951), and an MSc course (first graduates in 1953). In 1954, the name of the Department was changed to Microbiology, and in 1955 John Miles arrived from Australia to take up the first Chair in Microbiology. John and Margaret Loutit, both of whom subsequently had a significant influence on the development of Microbiology as a scientific discipline in New Zealand, followed a year later. While the Department was originally part of the University of New Zealand, it became part of the University of Otago around 1960 when the former was split into a number of autonomous units. John Loutit served as Chairman from 1978 until 1985, followed by the South African, David Jones (1987 – 1995). When Jones took up the position of Dean of the Otago School of Medical Sciences in 1996, Sandy Smith was appointed HOD, a position he held until stepping down in 2004. Frank Griffin is the incumbent HOD.

Since the late 1950s, undergraduate numbers have steadily increased with the introductory 200-level class (MICR 201) now attracting around 180 students of which approximately 40 proceed to major in Microbiology. Postgraduate numbers presently (2005) stand at around 50, with a significant proportion of these being from overseas (e.g. Germany). In the Miles/Loutit tradition, Otago continues to provide perhaps the only broadly-based science microbiology courses in New Zealand, covering all areas of Microbiology as well as catering for a variety of other student groups – e.g. medicine, dentistry, pharmacy, medical laboratory science, biomedical sciences, applied sciences, consumer and applied sciences and genetics.

Research and teaching strengths revolve around several aspects of clinical microbiology (including antimicrobial resistance, bacteriocins. gastrointestinal microbes, virology), molecular genetics and epidemiology, extremophiles, and immunology/vaccinology. Under Frank Griffin's guidance, Immunology has become a major component at all levels of teaching and the department's name was changed in 2004 to the Department of Microbiology and Immunology. In addition, molecular biology and genetics have also become major teaching and research strengths of the department, with senior staff member Clive Ronson being appointed to the inaugural Chair of Genetics at Otago in 2003. Research interests of current academic staff cover aspects of medical and clinical microbiology, such as gut microbes, bacteriocins, innate immunity, and antibiotic resistance (Sandy Smith, Gerald Tannock, John Tagg, Greg Cook, Robin Simmonds, Ralph Jack); molecular genetics of rhizobiae (Clive Ronson); clostridial genetics (David Jones); extremeophiles and physiology (Greg Cook); virology (James Kalmakoff, Vernon Ward); immunology/vaccinology (Frank Griffin, Margaret Baird, Glenn Buchan, Alex McLellan); and mycobacterial disease of animals (Frank Griffin).

More notable and/or recognised Otago microbiology graduates include Rob Webster FRS, Fraser Bergerson FRS, Bryan Williams FRSNZ, Diana Martin FRSNZ, and Gerald Tannock FAAM. Of the present staff in Dunedin, both Gerald Tannock and Sandy Smith have received

New Zealand Science and Technology Silver Medals from the RSNZ, while Frank Griffin was awarded an ONZM in 2004 for services to science and the deer industry.

(ii) Lincoln

The BAgSc. course initiated in 1926 included the subject 'Microbiology' – a simple unit based on an introduction to the study of microbes and their application to plant diseases. In 1935, Ian Blair completed a Masters degree in plant pathology (under the auspices of Field Husbandry) and from 1936 - 1939 served as lecturer in Field Husbandry, specialising in the Microbiology course for degree and diploma agricultural students. After completing his PhD in London, Blair returned to Lincoln as Senior Lecturer in Microbiology in 1945; he was subsequently promoted to Reader in Agricultural Microbiology, before retiring in 1973. Paul Mulcock was appointed to a second lectureship in 1951, in what by this time was the Department of Agricultural Microbiology. While still primarily specialising in plant pathology, soil and water microbiology also had increasing emphasis by the mid 1950s. Although initially occupying a small laboratory in the sole teaching building at Lincoln, the department moved to one of three surplus steel army huts (suitably fitted out) in 1947, transferring to more commodious accommodation in the new Hilgendorf wing in 1968. Ron Close joined the Department in 1973 as a Senior Lecturer in Plant Pathology, being promoted to Reader in 1978, and retiring in 1994. After Blair's retirement, the status of the Department was upgraded with Paul Mulcock being appointed to the foundation Professor of Agricultural Microbiology. He retired in 1990. Mike Noonan joined the staff of the Microbiology Department in 1971 to cover the teaching of soil microbiology.

One of the early students at Lincoln was Royd Thorton (MAgrSc, 1948), who later became Director of the Cawthron Institute. Harvey Smith was another Masters student in the later 1940s, who went on to be Director of the Crop Research Division, DSIR. Both Smith and Thorton were prime movers in setting up the NZMS – with the society holding its first meeting

at Victoria University in 1956 and appointing the respected plant pathologist J C (Joc) Neil as its first President.

In 1993, after 40 years as a separate Department, first under the leadership of Ian Blair and later Paul Mulcock, the Departments of Biochemistry and Microbiology were amalgamated and Professor David Bullock appointed to the position of Director in Molecular Biology. With Bullock's return to the USA and the subsequent reorganisation of the Departmental structure at Lincoln, the Departments of Microbiology and Biochemistry were disestablished and the staff redeployed to other groups (e.g. Animal Sciences). Microbiology as a postgraduate discipline disappeared, although some aspects of the subject were still taught at the undergraduate level.

(iii) Canterbury

Microbiology at the University of Canterbury has its origins within the Botany Department where it is said that the Professor's wife gave lectures in bacteriology and mycology as part of a Diploma in Industrial Chemistry.

Short lecture/laboratory courses in fungi at second year level were also offered around this time (1955-63) by Basil Arnold. These endeavours gave impetus for the first specific appointment in Microbiology (John Allen) who although a plant pathologist, become involved in teaching general microbiology and pressed for a degree in microbiology. His efforts were rewarded in 1964 when an Honours degree in Microbiology was instituted within the confines of the Botany Department. Appointment of a Reader in Microbiology (John Waid) in 1970 increased interest in soil microbiology, while subsequent appointments in the mid 1970s (Tony Cole, Laurie Greenfield) strengthened the plant pathology and soil microbiology teaching and research.

Many other staff of the Botany Department subsequently became involved in teaching microbiology, with their research interests focussing on genetics, molecular biology (Khris Mahanty), marine fungi (Howard Lintott), and microbial metabolism (John Walker). Such was the expansion of microbiological teaching and research that the name of the Department was

changed in 1985 to the Department of Plant and Microbial Sciences under the leadership of Tony Cole. Appointments in microbial pathogenicity and antibiotic resistance followed (John Klena, Jack Heinemann), with the Department becoming absorbed into the School of Biological Sciences in 2004. At this time the distinctive microbiological name disappeared, although Microbiology remains an important component in the School of Biological Sciences activities.

(iv) Massey

In 1958, all microbiology teaching and research at Massey University was held in what is now the Old Main Building, with the Microbiology personel on the third floor. The three teaching staff (headed by Jack Sargent) came in part-time from the New Zealand Dairy Research Unit, which occupied half of the ground floor of this building. The Department provided an introductory course in microbiology for agricultural students, a diploma course in dairy microbiology, a course in plant pathology and postgraduate studies in plant pathology.

In 1964 Dick Batt was appointed as the Foundation Dean of the newly established Faculty of Science, and in 1966 Don Bacon became the first Professor of Microbial Genetics and later Microbiology. He was charged with establishing Microbiology within Cell and Multicellular Biology – under the Department of Microbiology and Genetics title.

Soon after Don's arrival at Massey, Microbiology and Genetics courses began with the introduction of Microbiology at 200-level. As the Science Faculty developed, Microbiology and Genetics was housed in one and a half floors of one of the four tower buildings. Animal facilities occupied part of another tower. Gradually the departmental staff expanded, with individuals responsible for 300 and 400-level teaching in medical microbiology, wine microbiology, mycology, protozoology, genetics, virology, immunology and cell biology being appointed. As had occurred at Otago, a medical laboratory science programme was also commenced at Massey in the early 1990s. Close associations were formed with the Faculty of

Veterinary Science which first appointed specialist microbiologists (Roger Marshall), mycologists (Sandy Smith) and immunologists (Kevin Moriarty) in 1964.

Barry Scott was appointed a Professor of Genetics and developed close associations with other staff in the Department, while Tim Brown took over the Chair of Microbiology in 1992 after the retirement of Don Bacon some three years earlier. In conjunction with the Ministry of Health, Tim had built up a strong teaching and research group on 'hot pool amoebae', during the period 1972-1984. Tim himself retired in 2000. At its height in the mid 1990s, the Department of Microbiology and Genetics had around 40 academic and support staff.

With the demise of the Departmental structure at Massey, the Department of Microbiology disappeared as a distinct entity, with microbiology teaching and research being contained within the umbrella of the Institute of Molecular BioSciences – sadly it was decided not to appoint a new specific Professor in Microbiology.

(v) Waikato

Microbiology began at Waikato with the appointments of Hugh Morgan (1973) and Chris Harfoot (1975). Around the time of Hugh's appointment, a general course in Microbiology (year 2 level) was established, followed by a year 3 course in Microbial Ecology. From initially attracting around 25 and 10 students respectively, these courses now (2005) cater for around 65 (year 2) and 30 (year 3) undergraduates. Microbiology is taught/housed under the umbrella of the school of Biological Sciences, with students graduating with a BSc often combining microbiology with genetics or biochemistry. Postgraduate numbers (MSc in Biological Sciences) are currently around 10.

Research was given a great boost around 1980 by the establishment of the Thermophile Research Unit which specialises in “hot zones” around Rotorua, in the Antarctic, and in deep sea vents.

(vi) Auckland

When the decision was taken to establish a Medical School at the University of Auckland (circa 1962), the then Professor of Botany (VJ Chapman) promoted the establishment of a Chair in Microbiology as part of that Department. Dick Matthews (at the time located at the Plant Disease Division of DSIR at Mt Albert) was happy to accept the invitation for this position.

Development of the Medical School and the intake of students took quite some time to occur, and some of the other early appointments made were also focused at the postgraduate level. Not surprisingly, there was not an immediate pressure to teach medical students at the undergraduate level.

The embryonic Department of Microbiology was housed in Dick’s lab at the DSIR Mt Albert, which consisted of a World War II Nissan hut. This was progressively expanded by the use of a ramshackle collection of additions, as the group grew with the increased graduate student activity fostered and attracted by Dick. The first additional staff appointment was Ray Ralph; the next was Peter Bergquist. The first two graduate students emerging with PhD’s in Microbiology were Dick Bellamy and Mike Clarke. Other notable graduates in microbiology around this time were John Marbrook, Bruce Baguley, Paul Atkinson and Jim Watson.

When the first intake of students entered the medical class, they were accommodated in the City campus in the Chemistry Building. But this was a temporary move while the Grafton campus was constructed. Nevertheless, it became apparent to Dick that there would soon be pressure applied for the staff of the new Department to deliver microbiology lectures to these students. This was an unattractive proposition to a research-oriented Department engaged in basic research, which at that stage largely focused on work with plant viruses.

So in a cunning move, the name of the Department was changed to Cell Biology, reflecting the then burgeoning growth in the general area of DNA, RNA, cells and developmental biology. When the Department moved into the newly constructed Thomas building in town (about 1967), the name was retained as Cell Biology, but subsequently modified to Cellular and Molecular Biology.

The effect of this strategy was to protect the strong research-led emphasis of the Department, with only Stage 3 and MSc and PhD courses being offered to science students. Unfortunately Dick's otherwise cunning strategy (adopted to protect the research emphasis of the Department) set back the development of Microbiology as a discipline at Auckland University some 30 odd years. This was a time of expansion in microbiology when other New Zealand universities were accommodating their Microbiology Departments in purpose built new buildings.

The second attempt to initiate Microbiology at Auckland was commenced in the late 1970s by Peter Herdson, then Professor of Pathology. He persuaded the University that it was time to address again the issue of Microbiology through the establishment of a Chair within the Pathology Department. The Chair was advertised and Jim Watson appointed. However, Jim's research interests in cellular immunology coupled with other tensions led to a spin out Department being formed with the title of Immunology. Subsequently, this was changed to Molecular Medicine. John Marbrook, also with interests in cellular immunology, relocated from Cellular and Molecular Biology to the new Department. At some stage in this process, there were appointments made of staff with a microbiology background, but the idea of a new department focused exclusively on the core discipline of microbiology and led by a Professor of Microbiology was not achieved.

Progressively Molecular Medicine became focused on the immune system, with a strong interest in how microbes interact with that system. So in a sense, it became a Department of Microbiology and Immunology with the emphasis on the immunology side.

When Dick Bellamy took up the Directorship of the new School of Biological Sciences (circa 1990), it was clear that the teaching of microbiology represented a major gap in the science curriculum. Over a number of years, this situation has been rectified through the joint teaching of the subject by staff in Molecular Medicine and the School of Biological Sciences. Currently students have access to some introductory microbiology in year 1, which is then supplemented by two papers at Stage 2 and Stage 3 (biomedical microbiology and applied and food microbiology). The Stage 2 class sizes are over 250 and the Stage 3 students constitute a cohort of advancing students of about 100. There are about a dozen staff involved in the teaching effort, but only those at the Medical School are involved in teaching medical students. Environmental microbiology has received attention through Gillian Lewis's TV promotions. Microbiology papers at the undergraduate level are now viewed by students as constituting a good foundation for a range of advanced study in the biological and biomedical sciences.

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