Frank Fenner
AC, CMG, MBE, FRS, FAA
(1914–2010)

Nancy Millis

At 95, Frank Fenner died on 22 November 2010. His death marks the loss to the Australian community of a truly great scientist. His contributions are of global significance, with long-lasting impacts beyond our shores.

But to return to the beginning. Frank Fenner was born in Ballarat in 1914. His family moved to Adelaide where he attended secondary school and studied medicine at the University of Adelaide, graduating in 1938. He took a Diploma in Tropical Medicine at the University of Sydney in 1940 and a Doctor of Medicine at the University of Adelaide in 1942 – all of this achieved by the age of 28. By then, World War II needed medicos and Fenner became the medico in a field ambulance in the AIF in Papua New Guinea, a pathologist and a malariologist. It is typical of Fenner's commitment to fundamentals that he found time to work on the prevention of malaria in Papua and this was acknowledged by the award of Membership of the Order of the British Empire (MBE).

On returning to Australia, Fenner was recruited in 1944 into the research team of Professor (later Sir) Macfarlane Burnet, then Director of the Walter and Eliza Hall Institute (WEHI). From 1923, Burnet directed his research to viruses – both bacterial and to a wide variety of animal viruses (myxoma, Murray Valley encephalitis, polio, herpes simplex and poxviruses) as well as becoming an acknowledged expert on flu virus and Q fever. He also studied Staphylococcal infections and psittacosis. Fenner became a key collaborator in this work and in the beginnings of Burnet's later research on the immune response to infection. Fenner was co-author with Burnet in the second of the WEHI series of monographs (1949), *The Production of Antibodies*. In this, they included a discussion of the rejection of organ transplants and observations on the phenomenon of self and non-self. They predicted that this was a learnt property – acquired very early in embryonic life.

When the Australian National University (ANU) was established, Fenner was appointed in 1949 to the Foundation chair of Microbiology in the John Curtin School of Medical Research in Canberra, but his early years there were difficult. His chair was established before his department had any laboratories. WEHI made laboratory space for him for two years and for five years after that, he had temporary laboratory space on the ANU campus. The John Curtin School was finally available in 1957 and he was able to expand his staff and postgraduate training program along with post-doctoral fellows and visiting researchers.

Myxomatosis

Fenner's extensive research at WEHI on virus biology, especially poxviruses, prepared him ideally to establish his department at the John Curtin School as a centre for virological research. In 1950 Fenner established a small team to study myxoma virus as a potential control agent for rabbits, this, despite unpromising results from earlier field trials in the 1940s in South Australia. Fenner established collaborations with two groups in CSIRO, the Wildlife section (led by Ratcliffe) which took responsibility for the management and monitoring of field trials, while the Division of Entomology established that mosquitoes carried virus passively to rabbits and later (1960s) that fleas were also successful vectors.

When the community expressed concern that myxoma virus might cause encephalitis in man as well as in rabbits, Fenner, Burnet and Clunies Ross injected themselves with live virus and showed no ill effects.

Fenner's excellence as a lateral thinker is exemplified by his grasping the opportunity to combine the objective of exterminating rabbits, with a study of host/pathogen relationships to quantify, over time, any change in the virulence of the virus and the susceptibility of host animals living in very large numbers in the wild. He found that when first released, the virus gave over 99% mortality but within a year, mortality had fallen to 90%. The 90% strain became dominant, despite repeated releases of highly virulent strains and strains of lower virulence. The highly virulent strains killed the host so quickly that there was little opportunity for transmission, whereas the 90% strains allowed the rabbits to survive long enough for the mosquitoes to pick up the virus to infect a new host and so the 90% strain dominated the population. Changes also occurred in the host.

Rabbits in the wild that had at least seven exposures to myxomatosis were shown to have greatly increased genetic resistance when infected with the 90% strain. Rabbits bred in the laboratory for resistance rapidly changed genetically to acquire resistance to 90% strains and some resistance to fully virulent strains. These evolutionary changes continue today, but the virus still contributes to a worthwhile control of rabbit populations. This long-term study by Fenner's team has become a 'classic' observation of natural selection operating on a large naive population.

Smallpox

A further major achievement of Fenner was his key role in the global eradication of smallpox. Today two forms of smallpox are recognised: variola major, the epidemic, highly pathogenic strain that causes 10–60% mortality, and variola minor with a fatality rate of only 1%. The characteristic symptoms of the disease are malaise, headache, fever and 10–12 days later, skin pustules, loaded with virus erupt. The virus spreads from the skin pustules, person to person. There are no animal hosts; any surviving cases are scarred but immune for life, a vaccine is available and there is no carrier state. These attributes make it an ideal target for eradication.

In his review of the origins of smallpox, Fenner (1990) indicated that the first reliable description of the disease occurred in C4^{m}, although there are hints from the descriptions of skin lesions on mummies, that the disease was present in Egypt some 10 centuries BC. Smallpox was endemic in the Ganges valley and was recorded in Chinese river valleys by 340 AD. In the ninth and 10th centuries, Europeans built vessels capable of oceanic voyages and traders crossed to the Far East. On their return they brought the disease with them and the Spanish and Portuguese conquests of the Americas spread the disease there. This was reinforced when African slaves were transported to North America. Variola major came to Australia with the first settlers and spread to the Aboriginal community with high mortality.

The milder form of smallpox was distinguished from the epidemic form in the late 1880s and was found widely in the USA and South Africa. It spread to Australia in 1914–17, infecting over 2000 people, with two deaths. Nucleotide sequencing in 1995 uncovered different mutations in variola major, giving rise to local milder strains.

The earliest preventive measures to control smallpox were practised in India and China in the 11th and 12th centuries, using pus from skin pustules. This was effective but sometimes caused disease and death. In 1721 inoculation was used in the Middle East, where Lady Mary Montagu saw the practice and championed the idea in the UK, but the real father of vaccination was Edward Jenner, an English physician who had undergone inoculation himself. He noticed in the 1790s that milkmaids who had contracted cowpox, were then immune to smallpox. The incidence of smallpox was dramatically reduced when vaccination with cowpox was introduced into Europe by the middle 1800s.

Despite the success of cowpox vaccination, the disease persisted sporadically in the industrial world in the 20th century and remained a major killer worldwide. Henderson (1996) noted that some 200–300 million people died from smallpox in that period. In the first half of the 20th century, several unsuccessful attempts were made to eradicate diseases such as hook worm, yellow fever, yaws and malaria. When the WHO proposed a global eradication program for smallpox in 1953, the member countries were unwilling to fund the project. A stalemate prevailed until, in 1958, the USSR reported that they had eradicated the disease from the huge culturally heterogeneous area they controlled. Ultimately, in 1966, WHO members agreed to provide an appropriate budget.

Fenner's extensive studies of poxviruses and his achievements in the control of rabbits by myxoma made him a clear choice to chair WHO's Global Commission for Certification of the Eradication of Smallpox and, with Anderson from Harvard, a team was assembled. They planned a date by which 80% of the global population would be vaccinated. They recognised that the project would only succeed if the member countries accepted responsibility for the implementation of the plan in their own territory. WHO required the vaccinating teams to report weekly on the numbers vaccinated and report immediately any case of smallpox in their area. The surveillance team also ensured quality control of the vaccine and visited the site of each vaccination post seven to 10 days after vaccination. If they detected any person not vaccinated, they required the vaccination team to repeat the whole procedure without *per diem* expenses. WHO sent teams to areas where smallpox cases were found and targeted that area for vaccination. A small budget was set aside for research into quality control of the vaccine, the best methods of immunising, the epidemiology of the disease and the conduct of the program in the field.

By 1980, Fenner reported that the disease had been eradicated. It was indeed a triumph. The program had combined the basic knowledge of the properties and epidemiology of smallpox with an astute management regime that ensured effective immunisation that no person evaded, and was supported by all national authorities, as well as by the WHO. The whole operation amply displays Fenner's insightful strategies and management skills.

Fenner relinquished his chair in microbiology at the ANU in 1967 to become Director of the John Curtin School, a position he held until his retirement in 1973, but this was not the end of his service to the ANU. He became the foundation Director of the Centre for Resources and Environmental Studies (CRES) and served in that role until he retired a second time in 1979. All of these responsibilities were shouldered at the same time as he was directing the WHO eradication program to its successful outcome in 1980.

Centre for Resources and Environmental Studies

His championing of the environment was not a sudden interest in such matters. His father, also a scientist, had introduced him as a school boy to South Australia's and Victoria's land forms and their flora, fossils and fauna. Indeed, Fenner was seriously considering geology as his field of study before finally opting for medicine.

Fenner and his wife donated substantial sums to the Academy of Science, which set up the annual Fenner Conferences on the Environment and established a Fenner Medal for young biology and environmental scientists. In 2007, the ANU honoured his contributions in this area by establishing the Fenner School of Environment and Society that combined CRES with Forestry and Geography. The social aspects of Fenner's concerns were clear in this pithy remark quoted in the *Canberra Times*, "why do we now prefer wealth over wellbeing?"

Australian Society for Microbiology

In the first half of the 20th century, Australian microbiologists could deliver papers in the microbiology section of ANZAAS, but it was clear that the forum was increasingly directed to informing the wider community about science, rather than offering a forum for professional scientists and researchers. They needed a more rigorous arena to present their latest findings, to discuss recent advances in knowledge and to educate practitioners in the latest concepts and techniques. Action to address this need was taken by Dr Nancy Atkinson and her colleagues in Adelaide. This resulted, in 1959, in the establishment of the Australian Society for Microbiology (ASM) as a learned society. The ASM began as a federation of state branches, each largely autonomous, developing its own committee, meetings and budgets, but united by representation on the Australian Council, chaired by an elected President. The Council delegated the arrangements for the annual scientific conference (program, venue and so on) to the brand that agreed to host the conference.

Two years before ASM was formally constituted in 1959, Fenner had established his department as an acknowledged centre of excellence in the biology of animal viruses and their interaction with their host, but his interests were not confined to virology; he was a strong advocate of activities that educated practitioners and the community in science and actively encouraged basic research in microbiology in general. It is not surprising then that, in addition to his responsibilities at ANU and his department, he was willing to serve as Vice-President of the ASM Council from 1962 to 1964 and to become its President 1964–65. I was Secretary of Council while he was President, so I had the good fortune to experience firsthand his meticulous attention to detail, directness of approach without confrontation and a capacity to achieve collaboration – great qualities in a chairman and leader which WHO witnessed in the eradication of smallpox.

In his 'retirement', Fenner (on behalf of the ASM) undertook to edit a monograph outlining the centenary of development of microbiology in Australia from its beginnings in Sydney in 1888. The monograph of 610 pages of text, tables, photographs and references occupied Fenner for three years as he sorted through, edited and ordered the contributions from some 320 microbiologists. He carefully checked names, dates, places for teaching and research, areas of specialisation, members of staff, significant achievements and contributions to government policy, funding bodies and regulatory and advisory authorities. It was a herculean task and, although Fenner had an advisory panel, the excellence and comprehensiveness of this monograph is due to Fenner's encyclopaedic view of the discipline and his dedication and editorial skills for which, incidentally, he would accept no fee.

Throughout his life, Fenner published widely in the scientific literature (>300 papers and 22 books). Undergraduates in virology and medicine worldwide use the two texts: *The Biology of Animal Viruses* (1968) and *Medical Virology* (1970 written with David O White).

Awards and honours

Australia has acknowledged Fenner's contributions in many ways. He was appointed a Companion of the Order of Australia and his portrait hangs in the National Portrait Gallery. He received the Clunies Ross Award for his lifetime contributions to science. The ANU appointed him to the Foundation Chair of Microbiology, later to be Director of the John Curtin School of medical Research and later again as Founding Director of the Centre of Resources and Environmental Studies. He was a Foundation Fellow of the Australian Academy of Science; served on its Council. A medal for young biologists and an annual conference on environmental issues were named in his honour. In 2011 the Academy will devote the first of its public lecture series to Fenner's contributions.

On the world stage, Fenner received the WHO medal, the Japan Prize and the Albert Einstein World Award for Science. Great Britain honoured him with an MBE and a CMG (Companion of the Order of St Michael and St George), made him a Fellow and recipient of the Copley Medal of the Royal Society.

Fenner was an active supporter of ASM from its inception; he served on Council, as a Vice-President and President, presented the Rubbo Oration, as well as chairing many sessions at annual conferences. He was asked by ASM to edit *The History of Microbiology in Australia* and the Society established the Fenner Medal for young researchers in his honour. These are only some of the many prestigious accolades presented to Fenner, but he remained a quietly spoken, humble personality who was approachable by the newest member of his research team or the young scientist attending their first conference; he enjoyed the universal respect and affection of his scientific colleagues.

Acknowledgements and further reading

In preparing this tribute, I am greatly indebted to material from Fenner's publications and for information given to me by many Australian colleagues. I refer the reader to more detailed accounts in the following:

Burnet, F.M. & Fenner, F. (1949) The *Production of Antibodies*, 2nd edn. WEHI Monograph Series, Melbourne.

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Ian Hamilton Holmes

BSc, PhD, FASM

1935–2010

Ruth Bishop

Ian Holmes, noted worldwide as an eminent virologist, died suddenly at his Red Hill property, near Melbourne, on 2 August 2010, aged 75 years. He had been a member of the academic staff of the Department of Microbiology (now Microbiology and Immunology) of the University of Melbourne since his appointment as lecturer in 1963, and retired as Associate Professor and Reader in 2000. He was known nationally and internationally as the co-discoverer of human rotaviruses, the single most important cause worldwide of severe diarrhoea in young children. He is remembered with great affection by his many students, for the concern he showed them, for his interest in their work, and for the breadth of his scientific and microbiological knowledge.

Ian was educated at Camberwell Grammar School, Melbourne, where his early interest in experimental investigation was well known. He gained a BSc from Melbourne University in 1958, majoring in microbiology and completed a PhD (involving research on poxviruses) at the Australian National University in 1961, having joined a strong team of virologists assembled there by Dr Frank Fenner. Ian then returned to Melbourne as lecturer in the Microbiology Department, headed by Professor S D Rubbo, who had recognised the need to strengthen the expertise on virological research in his department. Ian later spent time in Glasgow, Scotland, where he acquired skills in the use of electron microscopy to study morphology and morphogenesis of viruses. On return to Melbourne, his research focused on important animal pathogens, including arboviruses and orbiviruses. Ian's training in electron microscopy coincided with a worldwide surge in the use of this instrument, and its application to the search for suspected non-cultivable pathogens, including hepatitis viruses.

In 1973, Ian was contacted by Ruth Bishop, a microbiologist based in the Department of Gastroenterology, Royal Children's Hospital, with a request to examine intestinal tissue from children admitted to hospital for treatment of acute gastroenteritis. A previous two-year study of intestinal contents and tissues, making use of advances in the technique of intestinal biopsy by Dr Rudge Townley, had identified moderate to severe inflammation in the duodenum, but had failed to detect an infectious agent in these children. Overseas studies had identified a "small virus" (now known as norovirus) causing gastroenteritis in adult volunteers. The first biopsy sent to Ian showed the presence of another "new" virus (now known as rotavirus) in duodenal tissue from children. In structure, size and morphogenesis this virus resembled the orbiviruses already under study in Ian's laboratory. In 1975 Ian published a detailed description of the morphogenesis of this virus in its preferred "habitat", the mature non-replicating epithelial cell lining the human small intestine and classified this virus as belonging to a new Genus in the Family *Reovirideae*. Ian was awarded the David Syme Prize, University of Melbourne in 1977 for this ground-breaking research on rotavirus structure.

After their discovery in Melbourne in 1973, rotaviruses were rapidly shown to be distributed worldwide, and to be the single most important cause of severe diarrhoea in young children, responsible annually for the death of millions of children in developing countries. For 30 years since then, rotavirus research has focused on vaccine development. Two licensed live attenuated rotavirus vaccines are now widely used in developed countries, including Australia, where they are now included in the routine vaccine schedule. Both vaccines have dramatically reduced infant morbidity, and have the potential to reduce mortality in developing countries. Their introduction into developing countries is proceeding.

Ian's contribution to rotavirus research during 27 years includes characterisation of the rotavirus genome and its proteins, studies on new serotypes in humans and animals, and mechanisms of viral binding and replication of rotaviruses in cells. His research has contributed to the long but successful development of rotavirus vaccines. He was for many years a member of the International Committee on Taxonomy of Viruses, and chaired the *Reovirideae* study Group from 1987 to 1993. His talents as Chair steered the Group to an agreement on nomenclature of serotypes and genotypes.

Ian had a sustained and active interest in the development of scientific expertise in laboratories in developing countries. In the late 1960s he spent a year in Caracas, Venezuela, as a visiting investigator at the Instituto Venezolano de Investigaciones Cientificas. After the discovery of rotavirus, he visited the Christian Medical College in Vellore, India to assist Dr Minnie Mathan with EM diagnosis. This led him to join the Friends of Vellore, India, and also Community Aid Abroad (Oxfam), both based in Melbourne. In addition he spent several sabbaticals in Asia and South America. He was a longstanding member of The Australian Society for Microbiology, and a Member of Council from 1972 to 1975. In recognition of his achievements, Ian was awarded a Clunies Ross National Science Technology Award in 1998, and was inducted as an Honorary Life Member of the Australian Society for Microbiology in 2008.

During his university career, Ian was a renowned teacher exhibiting a love of scientific ideas and innovation that he passed on to many of his students. A conversation with Ian usually had the listener enthralled by the depth and breadth of his knowledge of viruses. After his retirement, his interest in microbiology was channelled into winemaking at his Red Hill vineyard, where he died. He is survived by his wife Jenifer, daughters Lucy, Julia and Melissa, their husbands and seven grandchildren.

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FASTS has a seat at the table of the Prime Minister's Science, Engineering and Innovation Council. Meeting twice a year, it discusses major national issues in science, engineering and technology and their contribution to the economic and social development of Australia.

FASTS' advice on policy and legislation is routinely sought by the nation's decision-makers. We're an important link for the appointment of scientists, researchers and technologists to government advisory panels and boards, and we routinely provide the evidence base that informs policy development, including policies that impacts on the way research is funded, performed and quantified.

We have instigated a number of major reports including the landmark *Women in Science in Australia: Maximising Productivity, Diversity and Innovation.* FASTS routinely makes submissions to government inquiries, conducts workshops and undertakes surveys. For example, in 2010, we undertook a science literacy survey in collaboration with the Australian Academy of Science; surveyed the major and minor political parties in the lead-up to the 2010 Federal Election; and conducted the first National Survey of Scientists. In addition to these surveys, annually ASM members can participate in the APESMA/FASTS Professional Scientist Remuneration Survey.

Each year FASTS puts 200 of its members directly into the heart of government during *Science meets Parliament*. Now in its 12th year, this two-day national conference gives scientists and politicians an opportunity to have direct conversations about how science is addressing some of the major issues facing Australia. Conversations which allow Ministers, Members and Senators to better understand how important science and innovation is economically, socially and politically. In 2011, SmP will take place on 20 and 21 June.

The year 2011 is shaping up to be an exciting one. Based on the feedback we received from our members, including many ASM members, this year FASTS will develop the first State of the Science Report as well as continue to work to improve science policy including addressing members' concerns about ERA ranking of journals. We will continue to provide advice to develop the government's Research Workforce Strategy and the Strategic Framework for Research Infrastructure Investment. Also on the agenda are activities to strengthen the link between science and industry.

In the first quarter of 2011 FASTS is coordinating the Women in Science and Engineering Summit in collaboration with UNESCO and the National Committee for UN Women. The Summit will explore what Australia can, and should, do to improve the status of women in science and engineering – in particular encouraging young women to stay in science past PhD into career positions.

FASTS regularly sends bulletins to its Scientific Societies, including ASM which are then passed on to you. Your ongoing feedback and input is greatly encouraged and valued.

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