Chapter 4

Research

Yvonne Cossart

Research was not a high priority for Anderson Stuart during the foundation years of the Faculty, but he was well aware of the prestige it could confer on individuals and institutions. He himself spent a year in leading European research groups between graduating in medicine and taking up his first job as a demonstrator in physiology in Edinburgh. Later (1891), while on sabbatical leave in London, he attended a course in the new science of bacteriology at Kings College, no doubt in connection with his role in advising the NSW government about Koch's new tuberculin treatment. A framed collection of samples from those practical classes survives amongst his papers and memorabilia in the University archives. When it came to filling the additional teaching positions his administrative brilliance had secured, Anderson Stuart chose individuals with research interests.

Darwin's evolutionary theory had ignited interest in comparative anatomy and physiology and, more contentiously, in the relation between physical and social anthropology. In the late 19th century Australia's marsupials and aboriginals were irresistible subjects for ambitious young medical scientists, but few were willing to isolate themselves permanently in Sydney so far from the academic centres of Europe. A series of short-term appointments of both British and local graduates soon led to a respectable research output, and the subsequent success of these individuals in key posts abroad (C J Martin as Director of the Lister Institute, Grafton Elliot Smith as Professor at University College) put the Faculty on the international academic map. J T Wilson provided the stabilising influence during this period which is described in detail in the Centenary Book. A Scottish graduate with a little teaching experience, Wilson arrived in Sydney with no research experience, but maintained a steady stream of publications while developing anatomy teaching through both dissection facilities and the creation of an anatomical museum. His appointment as professor of anatomy in Cambridge after 32 years in Sydney is more evidence that Sydney research was achieving recognition.

During this first phase the major themes of research were the evidence of evolution to be found in the anatomy of the marsupial nervous system (especially the sensory organs) and the physiological adaptation of aboriginals to climatic extremes. The former strand has its continuation in the strong neurosciences research groups in Faculty today, while the latter, led by Macintosh, became allied to Elkin's social research into tribal aboriginal life.

After an auspicious start, research activity in the Faculty declined in the years following World War I. Anderson Stuart died in 1922 and J T Wilson had returned to Cambridge in 1920. Many of the academic staff had been away on active service and others were exhausted by their efforts

Blood samples from Anderson Stuart's sabbatical leave in London, 1891

Early research laboratory in the Anderson Stuart Building

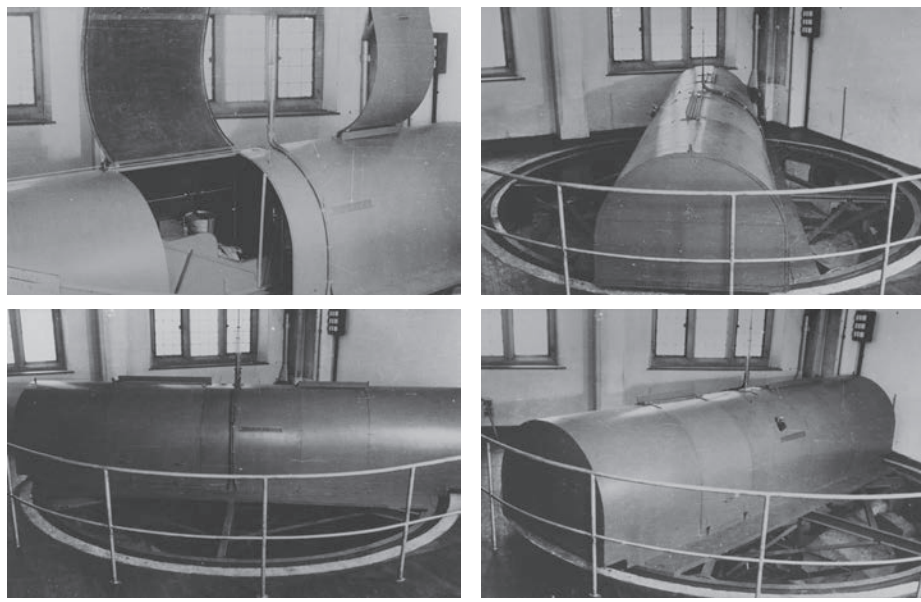
to maintain teaching and undertake 'war work' at home. The dire economic times resulting in very low staff levels, and academic salary cuts coincided with expanding student numbers, making it very difficult for the younger staff appointed to succeed Anderson Stuart and Wilson to maintain teaching. It is scarcely surprising that their research suffered. David Welsh, whose tenure of the Chair of Pathology extended from 1902–1935, was particularly affected, especially as he was also responsible for bacteriology which had become the dominant theme of medical research worldwide.

There was some success in building research infrastructure by further development of museums which are described in detail in Chapter 3. Keith Inglis, who later succeeded Welsh as Professor of Pathology, had spent a pre-demobilisation year assembling a collection of pathological specimens from World War I for distribution to the Australian medical schools. Unfortunately this legacy failed to have an impact on medical research comparable with that of its forerunner, the American Civil War collection, which was the basis of the US Armed Forces Institute of Pathology. By the time Inglis was appointed Professor of Pathology in 1936, he had already channelled his energies into establishment of the Kanematsu Institute with its emphasis on experimental research.

The reorganisation of the large and unwieldy anatomical collection in the 1920s included separate housing of specimens intended for study of aboriginal and islander people in the Shellshear Museum. Many of these specimens, which included cultural artefacts as well as anatomical specimens, had been donated by travellers, medical and otherwise, and their provenance was sometimes uncertain. However, they were used very effectively by N W G Macintosh for his work on skeletal characteristics of pacific races. In recent years much of the original collection has been returned to tribal owners as the appropriate guardians or placed with the anthropological collections in the Macleay Museum.

The generosity of Henry Bosch was especially important during this period of University penury. His first relatively small scale gift to the University was £1000 (then equivalent to a year's professorial salary) to support the research by John Hunter and his surgical collaborator Norman Royle into the sympathetic innervation of muscle. Hunter, a brilliant young protégé of J T Wilson, died suddenly from typhoid fever in 1924 while travelling home after attending a conference in New York. It was a great setback to Faculty research.

Bosch went on to rescue the Faculty from its downhill slide by endowing the four Bosch chairs. The first, appropriately enough, was filled by his friend C W Stump who had triggered his interest in medical philanthropy. Stump and the three other appointees – Charles G Lambie, Harold Dew and Hedley Wright brought new life to the Faculty, and the positions themselves justified Faculty's successful application for funding from the Rockefeller Foundation for construction of the 'new' medical school (now the Blackburn Building). Of the four Bosch professors, Stump became absorbed in academic politics while Lambie, despite his early brilliance in clinical investigation, concentrated almost entirely on teaching. Dew, whose book on hydatid disease was published while he was still working in Melbourne, was unable to maintain research away from the facilities of the Walter and Eliza Hall Institute and his collaborators there. Wright continued active research on clearance of bacteria from the bloodstream, but he resigned suddenly in 1934. It is said that this was precipitated by frustration when he returned from holiday to find that all his experimental mice had been slaughtered as an economy measure. It is interesting to reflect that Dew was the only clinical researcher of that period to concentrate on a particularly Australian health problem,



Cotton's human centrifuge which was constructed in the Anderson Stuart Building

in great contrast to the contemporary activities of veterinary, agricultural and earth sciences departments in the University. The anatomists, especially Macintosh, did maintain their work on physical anthropology of aboriginal and islander bones though this was not of direct applicability to the growing problem of aboriginal health issues.

World War II brought this period to a close. Only a skeleton academic staff remained and these turned their attention to research of direct importance to the war effort. Hugh Ward, who had replaced Hedley Wright in Bacteriology, was an administrative and scientific force behind the development of the transfusion service. The Department of Physiology in the Old Medical School (now the Anderson Stuart Building) was a focus for RAAF research into drugs and blood transfusions. Frank Cotton used his pre-war studies of the changing distribution of the blood during exercise to design the first automatic inflatable anti-gravity suit to protect pilots from blackout during high speed manoeuvres.

In addition to the Faculty's own research departments, there were two affiliated medical research institutes in the University: the Kanematsu Memorial Institute of Pathology, the first medical institute in New South Wales, at Sydney Hospital; and the Kolling Institute of Medical Research at Royal North Shore Hospital. Both had been established in the 1930s by private donations from families of grateful patients and both were functionally and administratively associated with the hospital diagnostic services. These institutes attracted a series of very eminent scientists as Directors. John Eccles and Bernard Katz performed the critical neurophysiological work, which later earned them each a Nobel Prize while working at the Kanematsu. Courtice, who succeeded Eccles, was an internationally acclaimed pioneer of lymphatic research.

John Eccles was 34 when he arrived in Sydney in 1937 to become Director of the Kanematsu Institute. A Melbourne graduate and Rhodes Scholar, Eccles had become a star protégé of Sir Charles Sherrington in Oxford and had already published numerous papers and a book The Reflex Activity of the Spinal Cord. He faced a battle to find research funding but by the end of his first year had support from the NHMRC for two two-year research fellowships and a grant for a mechanic and some workshop equipment.

The mounting political crisis in Europe brought two displaced neuroscientists to join Eccles. The first was S W Kuffler from Austria and the second, Bernard Katz from London. They turned their attention to neuromuscular transmission in the cat, and subsequently in the frog. The working environment of this extraordinary triumvirate was later described by Katz:

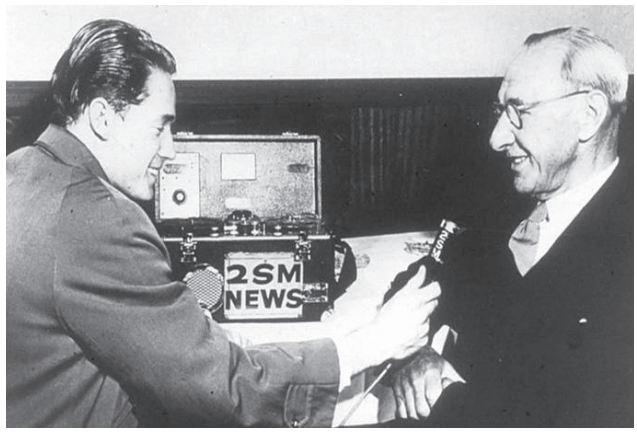
> "The three of us worked on neuromuscular transmission, a field in which I had been interested for several years and which had come very much to the fore since Dale's fairly new discovery of the role of acetyl choline as the transmitting agent. We spent much time and many heated arguments, investigating and discussing the properties of the

> so-called 'endplate potential' (the local electrical change in the muscle fibre produced by the nerve impulse via release of acetyl choline). J C Eccles was still holding out against the chemical transmitter concept, while I regarded the evidence for it as very compelling; so we had some heated moments on the fourth floor, and an occasional stand up fight. Looking back I can say that, apart from occasional diversions, I have followed this line of neuromuscular research ever since."

This excitement went on almost without notice in the hospital. R J Walsh (later director of the Red Cross Blood Transfusion Service commented many years later: "As a junior resident medical officer I met the inhabitants of the fourth floor, three people who worked irregular hours, who were usually dressed in an unconventional fashion even in those days, and who were 'doing things' which we were told were important and clever, although generally we failed to understand their significance. What an opportunity we missed!"

This halcyon period lasted only a few years. By 1941 Katz had joined the RAAF to serve in radar 'for the duration' and Eccles became involved in the Institute's 'war work' – supporting the army unit producing serum for the forces, and the precursor of the National Acoustical Laboratory, working on communications under battle conditions. Eccles and Kuffler faced hostility about their ongoing neurophysiolocal research from both the hospital administration and the clinical staff, who regarded the work as too remote from clinical application. Eccles resigned in 1943, taking up posts at the University of Otago and subsequently the ANU) and Kuffler soon afterwards, going to Chicago and then Harvard), while Katz returned to University College, London. Eccles should perhaps have the last word : "Looking back on these days one can see the irony of the situation because it was our work on the blocking agents of neuromuscular transmission, and the use of anti-cholinesterases for unblocking, which at least formed an important scientific base for the modern use of muscle relaxants in anaesthesia."

(Left to Right) Kuffler, Eccles and Katz (later Nobel Prize winners) in Martin Place in the 1940s



Norman Gregg interviewed on radio

During this tumultuous period the bond between the Institute and its Japanese founders remained strong. The name of the institute was retained and the picture of the Kanematsu firm's founder and his wife remained on the library wall overlooking the harbour and its wartime shipping.

Rudi Lemberg working at the Kolling was no less well known for his work on the biochemistry of blood pigments.

Ironically, one of the most outstanding medical discoveries ever made in Australia was reported in 1942 during this wartime period of a very low ebb for research in Sydney. Norman Gregg was a busy practising ophthalmologist when he recognised that congenital defects were associated with maternal rubella contracted in early pregnancy during the 1941 rubella outbreak in Sydney. He had to overcome significant prejudice to have his observations accepted, in part at least because he was not part of the formal 'research establishment'. Despite strong support from eminent Australian colleagues such as the virologist Macfarlane Burnet and the paediatrician Lorimer Dods, overseas opinion was sceptical. The Lancet's verdict in a 1944 annotation was that his claim was 'unproven'. Post-war, virology flourished with the development of cell culture techniques and Gregg lived to see the technology for rubella isolation and antibody testing introduced into the Children's Hospital laboratories by David Dorman and Alan Murphy. During the next outbreak in 1964–5, rubella virus was isolated from affected children and dissent turned to enthusiastic support for the manufacture and introduction of universal childhood rubella vaccination, which has almost completely abolished congenital rubella in industrialised countries. Margaret Burgess was the key link between the clinicians and laboratory researchers involved in this epic, and its outstanding success led to the formation of the national Centre for Immunisation Research.

Rebuilding Faculty teaching and research after World War II was complicated. Student enrolments were very large (see Chapter 1), most of the academic staff was already at or beyond normal retiring age, and the facilities were outdated and in poor repair. Teaching took immediate precedence and new academic appointments were made from the cohort of young graduates for whom war work or active military service had taken the place of research training. Their outlook was inevitably coloured by their wartime experiences and the new medical technologies devised during the war. Each developed their own approach to research but they were united in facilitating the BSc(Med) program.

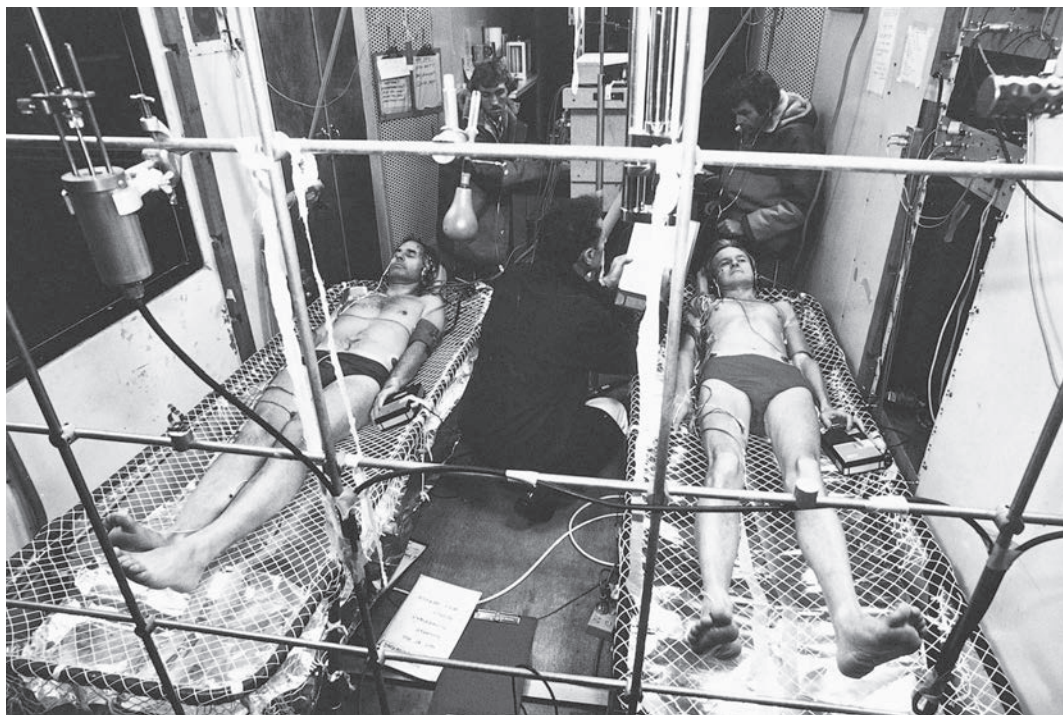
The first appointee (1949) of this new generation was Roland Thorp, an Englishman with scientific rather than medical training and wide wartime experience in the development of biological assays for drugs and biological materials. His connections with industry led to a stream of support for student scholarships and specific research projects. These were concentrated on the cardiovascular system and their success led to the establishment in 1962 of a research unit within the Department of Pharmacology, funded for a very productive decade by Smith Kline and French. The development of science courses in pharmacology later elevated pharmacological research into a career option for non-medical students and erased the negative associations of the ill-fated first venture into pharmacological research by the Faculty. It was then more than 28 years since the suicide in 1934 of Henry Chapman, the first Professor of Pharmacology in the years 1918–1920, who subsequently became Director of Cancer Research and was accused of both dereliction of duty in that role and misuse of funds from that and a number of external research charities.

In 1952 both Keith Inglis and Hugh Ward retired. Inglis had by then been Professor of Pathology since 1936 and Ward Professor of Bacteriology since 1935. Both had played important roles in University research, mainly though their associations with the Kanematsu Institute, and they had sustained teaching through the extremely difficult war years. They were replaced by Frank Magarey and Patrick de Burgh. Both were Australian and had seen active service as army pathologists. Magarey's strength lay in his training and experience in anatomical pathology acquired pre- and post-war in Cardiff, while deBurgh was largely self-trained, though much influenced by his academic family (he was J T Wilson's grandson) and the teaching he had received in Sydney as an undergraduate and a short period at Harvard. Magarey inherited a department with good facilities for classical pathological research and, by 1956, David Cameron, the dental pathologist, had succeeded in securing funding for an electron microscope, and establishing an experimental cell pathology group. The situation was more difficult for deBurgh as the pre-war facilities of the Department of Bacteriology were unable to support the new technique of cell culture and precision measurement of biological mediators. He settled on ectromelia (mouse pox) as a model infection for study of host responses, but the very high cost of importing instruments and reagents enforced a culture of improvisation in the laboratory. In any case, commercial test kits and pre-weighed sachets to cut the labour of making culture media or buffer solutions were still unknown. These difficulties were not confined to bacteriology, as most of the recording apparatus for pharmacological and physiological as well as biochemical measurement was also made 'in house' at that time, by a diverse, extraordinarily talented technical staff. Running costs began to become a greater limiting factor on research activity than availability of time.

The challenges facing the two new generation clinical professors who replaced Lambie and Dew (Ruthven Blackburn in Medicine 1957, John Loewenthal in Surgery 1956) were quite different. The first Bosch professors had been lone full-time appointments in their disciplines, quite inadequate in the post-war period when student numbers were so large and specialisation was

developing rapidly. Much of their energy was absorbed in teaching at the graduate as well as undergraduate level but both recognised the importance of research. Blackburn, with experience of the Army Medical Research Unit and its malaria trials, had a vision of the contribution of new scientific technology such as mass spectroscopy to medical research. He combined these ideas by establishing the Clinical Research Unit in Royal Prince Alfred Hospital. Though inauspiciously housed in the basement of the venerable 'Vic' Block, this facility consisting of a 12 bedded ward and a laboratory 'back room' showed the way of the future for clinical research. A stream of research papers on calcium metabolism, liver disease and haematology resulted, and, equally significantly, attracted research oriented physician-trainees including Barrie Firkin, Peter Castaldi, James Macrae, John Read and John Turtle, who underpinned the ongoing development of clinical research in Sydney and beyond.

Loewenthal was not himself a prolific researcher but he built a department with active research in major areas of surgical advance. These were characteristically interdisciplinary, for instance the cardiac physiologist Dennis Halmagyi studied shock and pulmonary embolism in the Gordon Craig Laboratories, Ross Sheil established transplantation research as well as pioneering its clinical applications and Gerry Milton took up the challenge of melanoma which was emerging as a major problem for Australians.



Climate chamber in the School of Pubic Health designed and used by Graham Budd, in this case exposing himself and a colleague to increasingly cold temperatures while measuring physiological variables

Across campus in the Anderson Stuart Building, Peter Bishop was appointed to the Chair of Physiology in 1955. A multi-talented researcher, he had followed war service with training as a neurosurgeon, clinical neurologist and neurophysiologist in Sydney and London. Despite the demands of teaching and the need to improvise electronic and other equipment, his work on the visual system soon attracted a galaxy of other neuroscientists. He also attracted numbers of students to undertake the BSc(Med) degree; many became significant researchers themselves. After a golden decade Bishop moved to the Australian National University where he could devote himself purely to research. He left behind a flourishing department with several different research units which remain active today. Physiology was also the focus of Graham Budd's research on thermal physiology: his climate chamber (now removed) was constructed in the School of Public Health.

In the Centenary Book of the University of Sydney Faculty of Medicine, published in 1984, the achievements of these individuals are described, but research is not allocated a separate section nor are entries about research identified in the index. Yet that book was written and edited by very active researchers who were well placed to appreciate the central role research has always occupied in the activities and aspirations of the Faculty. This paradox arose from the concept that research at the time was an individual activity, and outside the direct purview of the administration.

In keeping with this view, there are few mentions of research in the minutes of Faculty meetings during the 1980s, apart from references to honours and awards to individual members, but there is a clear expectation that all academics would be active in both teaching and research. Appointment to tenured 'Research Only' positions such as Reader was rare; there were only six in the 1980 Faculty list. Staff employed to work directly on projects funded by external bodies such as the National Health and Medical Research Council (NHMRC) did not automatically become members of Faculty until 2003 and, before that date, exception was made for only a handful of researchers supported as Principal NHMRC Research Fellows.

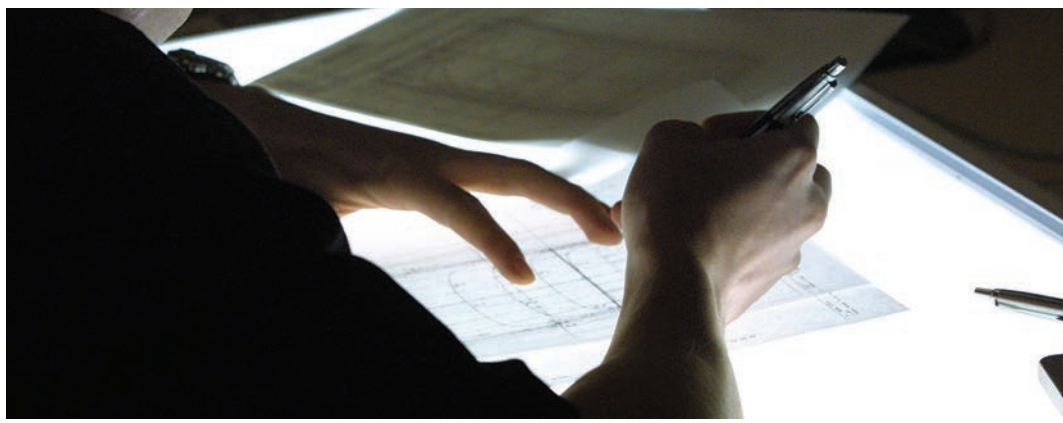
Nevertheless, research performance was a dominant criterion for academic appointment and promotion. From time to time this attitude was questioned, both in respect of the weight given to teaching and service when comparing applicants and with regard to how research achievement should be assessed. Measurement of research output and excellence by bibliographic techniques, such as citation frequency, was then in its infancy, but there was general dislike of the 'American' publish or perish dictum and the growing length of authorship lists attached to individual publications. These proved to be inexorable trends. Meanwhile substantial weight was given to the opinion of (usually overseas) referees, and experimental research was regarded as superior to clinical or other applied research.

At the same time, Faculty was also under pressure from government and lobby groups to undertake applied research in parallel to the burgeoning development of specialisation in hospital

practice. Research-oriented staff specialists were being appointed in growing numbers to undertake development of specific clinical services. This provided the impetus to establish Chairs in clinical disciplines in the teaching hospitals. Because their function was far wider than undergraduate teaching, for which the University receives its government funding, support for these new academic developments was obtained from other sources. In some cases it was made possible by specific endowments, in others by the allocation of funding from government departments or authorities (Motor Accidents Authority, NHMRC Clinical Trials Centre). In a similar use of external funding, the number of professors had doubled in the 1930s (from five to 10), mainly due to the generosity of Henry Bosch, described in detail in the Centenary Book.

By early 2006 the number of professors had risen to 146 compared with 51 in 1990. Senior staff specialists who had established roles in teaching and research were offered clinical academic titles commensurate with their actual or anticipated role in the life of Faculty. This process added 32 professors to Faculty and occurred in parallel with the dispersion of teaching to the teaching hospitals, and created the critical mass of academic activity which underpinned their transformation into independent clinical schools.

These developments have already borne fruit by facilitating the transfer of knowledge and technologies from the research laboratory into clinical practice. For instance, two scientists working in the immunology unit within the Departments of Medicine and Infectious Diseases were the first University of Sydney scientists to make monoclonal antibodies. Only three years after Kohler and Milstein's 1975 landmark paper appeared in Nature, Bob Raison was investigating the evolution of the immune system by studying hagfish, while Karen Walker was using tagged antibodies to achieve localisation of tumours in experimental mice. Sue Dorsch, Chris Goodenough and other researchers associated with the unit soon took up the method to develop reagents for studying mechanisms of immune tolerances, though still in rodents. Acquisition of a fluorescent cell sorter in 1982 for this work presaged its introduction into assessment of human patients, still for research purposes. With the advent of AIDS, the FACS sorter was introduced into mainstream medical practice in 1983 by clinicians such as Roger Garsia and Stephen Adelstein, with the



scientific support of John Wotherspoon who has since played a significant role in the commercial development of cytometric technology.

The relation between experimental neuroscience and clinical neurology has been a fruitful one extending over several generations. The long tradition of neuroscience research in the Anderson Stuart Building began with the founding professors whose interests in comparative anatomy were stimulated by the Australian native fauna. We can only speculate on what John Hunter might have achieved. Peter Bishop brought experimental neuroscience to the Department of Physiology, attracting a large number of talented students who undertook the BSc(Med) degree with him. Many continued his interests; visual neuroscience is still a feature of the medical sciences in the Anderson Stuart Building. Bishop recruited Liam Burke who later succeeded him in the Chair, and still maintains active research long after his 'retirement'. Bishop's students retained their enthusiasm for research, most continuing in neuroscience or clinical neurology. Amongst that group were Bill Levick whose career was at ANU, the late Bob Rodieck who left for the University of Washington, and Jonathan Stone, later Professor of Anatomy at NSW, then Sydney, now at ANU. Bishop's BSc(Med) students included Bogdan Dreher, still in the School, and Ann Sefton as well as Jim Lance whose clinical and research career was at UNSW and Jim McLeod who became a distinguished clinical neuroscientists working in association with John Pollard at RPAH. Max Bennett, recruited on his graduation from Melbourne, has achieved eminence for his work on synapses and autonomic physiology. Recently, he conceived and now heads the Brain and Mind Institute with Ian Hickie, combining basic neuroscience with clinical psychiatry.

Electrical recording in physiology

Others in the Department of Physiology, Paul Korner and Michael Taylor, were prominent in cardiovascular research and in research training; Barrry Gow and Roger Dampney returned to the department. David Allen's interests include muscle, a focus of interest for Joe Hoh, while David Read studied respiration, training a number of active researchers. Endocrinology has been represented by Arthur Everitt, an expert on ageing and by Rebecca Mason. David Cook and his team have continued the traditions of John Young in epithelial transport. An interest in visual neurosciences has been maintained, and newer areas include reproduction, development, and hearing.

Not all the benefits of university research have been direct. During the 1960s Biochemistry attracted many bright medical students to research careers. The enzymes involved in DNA synthesis in bacteria were a major focus of the department's research, and exposure to this very theoretical pursuit prepared their minds to recognise the clinical applications of recombinant DNA technology as it developed. For instance, Peter Rowe became Director of the Children's Medical Research Foundation (now Institute), where the DNA of tumours is a major research focus; Leslie Burnet developed mathematical tools for sequence analysis and applied them to viral genetic research before becoming a clinical pathologist and seeing the introduction of molecular techniques into the diagnostic laboratory; while John Rasko is pioneering DNA therapy in the Centenary Institute for Cancer Medicine and Cell Biology.

Research output

Measurement of research output became more important to the Faculty as Commonwealth funding of universities included an increasing quantum for research performance. The parameters which have become accepted for measuring research output in this context are publications in refereed journals, award of research funding in competitive schemes and supervision of research students to completion. In the Faculty there has been a steep rise in all three over the last 25 years. This is a remarkable achievement given the pressure on academics from rising teaching loads during the introduction of new curricula in medicine and science, and the increased demands on clinical staff made by health service economies and area reorganisations which occurred over the same period. However, comparisons with the past should be made with caution because the methods of collecting these statistics now include the research output of academic title holders and others not directly on the university payroll.

Comparisons between institutions and disciplines have also fuelled discussion about the possible return to a two tier system in Australian tertiary education, with designated 'research intensive' and 'teaching only' universities. Within institutions there has been a parallel discussion about the desirability and practicability of differentiating 'teaching only' and 'research only' staff, rather than assuming that all staff are active in both domains.

By April 2000 Sydney University Research Committee had committed itself to the following criteria to define a 'Research Active Academic':

> Publication in the last three years of at least three publications which qualify for inclusion in the University's annual return to the Commonwealth Department of Education, Science and Training; and satisfy one of Supervisor of at least one research higher degree graduate in the last four years, or Receipt of at least one external grant of more than $5000 from a competitive grant scheme over the last three years.

Using that definition almost all of Faculty's academics are research active.

In addition to members of the academic and general staff involved in research the University employs a substantial workforce of research assistants whose salaries are derived from project or program grants from external bodies. Many of these are also enrolled for research degrees through the Faculty, whereas until the 1980s, staff employed on NHMRC grants were not allowed to enrol for higher qualifications.

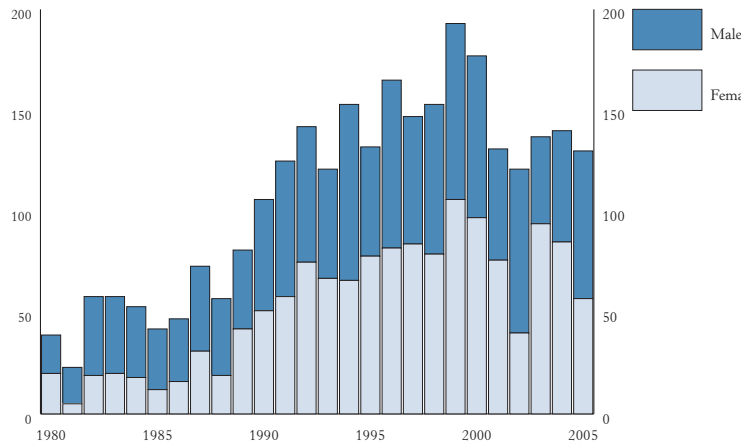
Research training

Early attitudes to research training are described in the following extract from 1984 Faculty minutes:

> "The University of those days before WWII was better aware if its role as a teacher and as a transmitter of learning than of its potential role as a centre of research and research training. The University served its community well with undergraduate courses of good standard to which admission was fairly easy and non-competitive, and prepared its most outstanding students for research work overseas in larger, older and better-equipped universities."

The Faculty's main investment in its 'most outstanding' students was the promotion of the BSc(Med) program which encouraged interested medical students to undertake a year of supervised research in one of the basic science departments. About 6% took advantage of this opportunity (see Chapter 3) which gave individuals unfamiliar freedom from the didactic coursework program as well as informal contact with medical scientists both senior and junior. The high proportion of BSc(Med) graduates who pursued academic careers is a measure of the success of this scheme in igniting research interest; for example, 20 of the 60 current Faculty professors are University of Sydney BSc(Med) alumni.

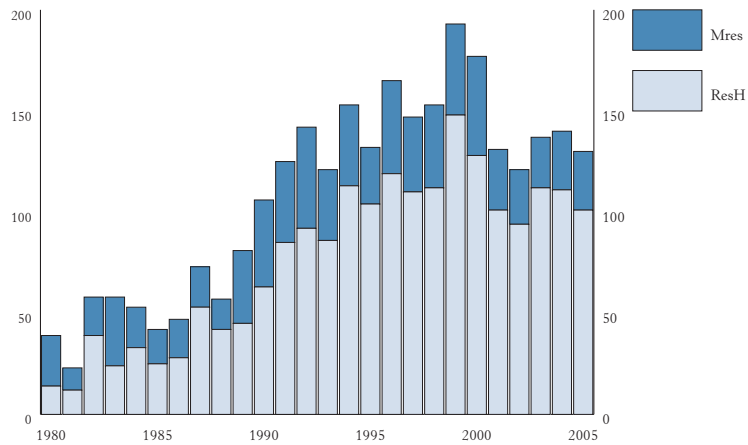
The attitude that research and advanced professional training required 'overseas' experience began to break down during the 1980s as the size and variety of local research groups increased.



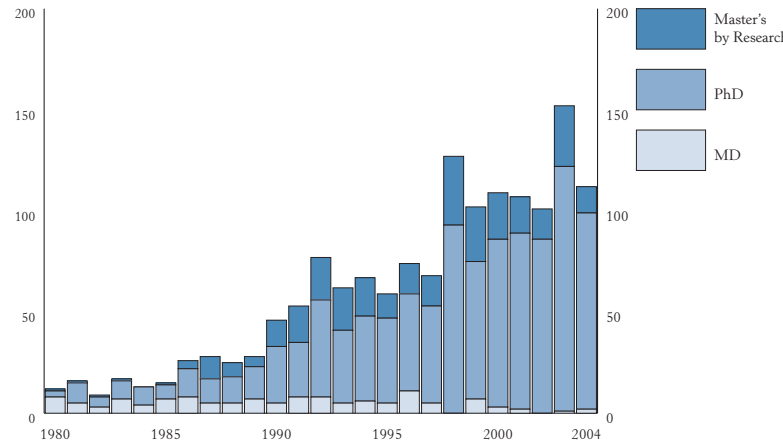
Enrolments in higher degrees by gender, 1980–2005

Advanced clinical training also became more available in Australia with the foundation of Royal Colleges to oversee academic standards in more and more clinical specialties. Optional and/or mandatory research components were introduced into most traineeship schemes during the 1980s so medical graduates with aspirations to embark on careers involving clinical research were encouraged to remain in Australia.

Higher degree enrolments in the Faculty have grown steadily since 1980 and two important trends are the increasing proportion of those whose first degree is in science rather than medicine and the steep rise in overseas students. Medical graduates now comprise just over a quarter of the Faculty's research students. Just over half of the 765 current research students were born abroad but only 10% are classified as international students.



Enrolment completions in higher degrees by research, by level of degree, 1980–2005



Degree completions in higher degrees by research, by level of degree, 1980–2005

Supervision of this very large number of research students has called for wider involvement of clinical academic title holders. Their membership of Faculty qualified them as official supervisors which in turn opened the way for students to undertake their projects within the research institutes on the teaching hospital sites as well as on campus. Twenty-eight of the 96 PhD graduands in 2004 had clinical supervisors.

As student numbers have increased, the University and Faculty have developed more formal systems for their support. This includes the appointment of Associate Supervisors, regular progress reviews, and assistance with development of thesis preparation skills. A Dean of Graduate Studies has been appointed, to coordinate the processes and practices across the University. There has been more emphasis on minimum time candidature, particularly since the Commonwealth began to reimburse the University with student support funds only after award of the degree. Theses have become slimmer since the 80,000 word limit was introduced in 1998. Medical Faculty theses are deposited in the University's Rare Books Library and provide a fascinating record of changes in style and content of research over the last 150 years.

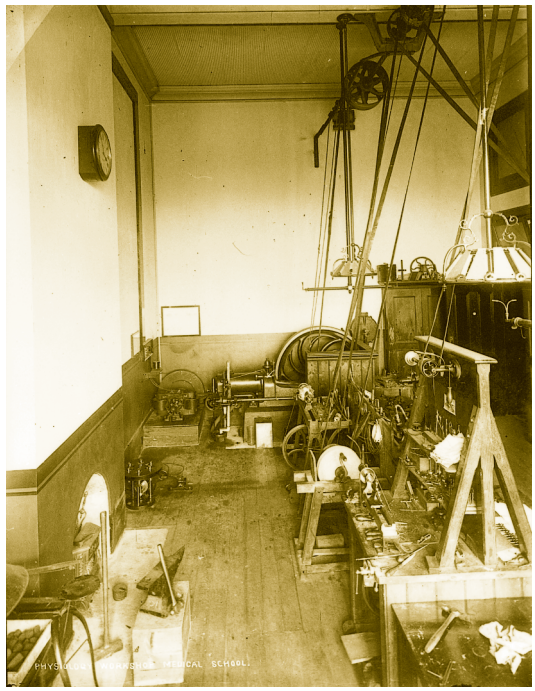
Research facilities

Anderson Stuart's grand vision provided a splendid setting for teaching in his fledgling medical school but research did not fare so well. The high regard accorded to basic research by Faculty appointment and promotion committees did not translate into investment of resources in up-to-date laboratories and equipment, though of course he did provide himself with a substantial 'private laboratory' as research facilities were known. At the time of appointment, new professors were often able to secure renovation of laboratory space within the existing 'envelope' of their department, but thereafter updating and expansion of research facilities demanded ingenuity and persistence, with many compromise arrangements.

In the Anderson Stuart Building, partitions created rooms within rooms and the many high ceilings allowed construction of mezzanines accessed only by steep stairways. These soon became filled with departmentally designed and constructed electronic equipment and enthusiastic students who often worked late into the night with little direct supervision. There were remarkably few mishaps, but when formal Occupational Health and Safety inspections were instituted, numerous problems were identified as a consequence of a century of improvisation. These were finally rectified with a major refurbishment of the building in 2000 (see Chapter 9), but modern Australian Standards for laboratory design are often in conflict with the heritage values and structural characteristics of existing buildings.

Kymographs, familiar to many students from classroom experiments, were also used for research in earlier times in the Anderson Stuart Building. They have been replaced with small, sophisticated and flexible computer-based systems that provide stimuli, recording, display, analysis of data and plotting of results.

In the Blackburn Building, space for research has also been under continuous pressure. By 1965 the two lecture theatres, one of the large practical classrooms, and the library had all been replaced by research laboratories and their functions relocated into the new Bosch Buildings which also provided a substantial animal house for research purposes. This was one of the first instances of a Faculty research facility and it was soon augmented by the rodent breeding facility housed on the roof of the Blackburn octagon.



The workshop in physiology in the Anderson Stuart Building in which high quality equipment was constructed for research and teaching

In the 1980s virtually all facilities for research were still based in individual departments where equipment maintenance and laboratory housekeeping for both teaching and research were performed by core technical staff whose salaries were derived from recurrent funding. Practical classes for medical and science students, honours programs, and more advanced research often shared similar equipment, thus easing the transition from undergraduate to research student status. In many instances experiments from recent research projects were adapted for class use: many older medical and dental graduates will remember running around courses marked out on campus or pedalling bicycle ergometers with Douglas bags strapped to their backs – a spin-off from Frank Cotton's research into exercise tolerance – while a younger generation enjoyed testing the Glycaemic Index of foods using the methodology developed by Jennie Brand-Miller for diabetes research. In the Graduate Medical Program, now known as the University of Sydney Medical Program (USydMP), the explicit link between teaching and research is also now maintained by the use of evidence-based decision making in clinical tutorials.

Most departments maintained a workshop which could build and maintain equipment. They were staffed by resourceful and inventive technicians and many of the researchers themselves were skilled designers. During the 1970s, as instrumentation became more complex, and especially after the introduction of electronics and computers, such in-house facilities became less and less realistic and the commercial scientific supplier and service engineer played a much greater role. Expensive commercial diamond knives replaced the glass knives whose manufacture took each new researcher months to perfect, cell culture media were supplied in pre-weighed packages (a far cry from weighing

Shared equipment: a scanning electron microscope

Shared equipment: video micrography

out the 90 ingredients of Medium 199), buffers came as tablets, and the well thumbed tables for calculation of the ingredients disappeared as kit tests supplanted in-house assays in diagnostic laboratories, manufacturers also began to supply the research market with biological reagents and kits. The power of computer technology now allows researchers to program many functions: providing stimuli automatically, collecting and storing complex data, analysing and displaying it simultaneously.

This convenience comes at a cost, and the University's technical infrastructure has effectively been outsourced, almost entirely to US or European suppliers. The marketability of reagents developed for a particular research project has encouraged researchers to patent these reagents or methods, which has had a detrimental impact on free exchange of ideas and materials either pre- or post-publication. Medical researchers have indeed a moral dilemma when formal 'output' criteria include the number of patents derived from their work.

From 2000–2006 the Departmental organisation gave way to the College structure throughout the University. The College of Health Sciences included the Faculties of Medicine, Dentistry, Nursing, Pharmacy and the Health Sciences. Within the Faculty of Medicine the reorganisation of clinical disciplines into geographically-based clinical schools has stimulated growth of research infrastructure accompanied by the development of research institutes associated with teaching hospitals. Private and corporate support has been an essential source of funding for buildings and equipment, and individual Faculty members have become conscious of the need to communicate with the public about their research and its implications for the local and wider community.

Shared equipment: a computer-based image analyser

On campus research continues to be centred on the historic sandstone Anderson Stuart Building and the 1930s Blackburn Building, which was constructed after a North American design which took no account of the Australian climate. Neither is readily

adaptable for the installation of high tech equipment or for isolation of potentially infectious or toxic agents. Many proposals for a new research building on the Camperdown Campus have been developed over the last two decades, only to falter for lack of funding. In 2003 the University, with a substantial financial contribution from the Medical Foundation, acquired the former Worksafe Building in Parramatta Road, Camperdown to house the equipment and staff of the collaborative molecular analysis facility and some related research groups, which now share the premises with the Dean's offices. A brief account of the history of the Medical Foundation can be found in Chapter 5.

Strategic development of research capacity in the Faculty has long been limited because funding of research still depends mainly on the efforts of individual Faculty members who apply for grants, secure contract research or participate in fund raising. This support has to be accounted for in the context of the specific projects or programs specified in the applications. Recently, however, individuals whose grants have generated infrastructure money from the Commonwealth have pooled this funding to provide, for instance, central histological processing and microscopy centres in the School of Medical Sciences.

Libraries

Access to the literature underpins all research, and researchers at the University of Sydney have been well served by their libraries during a period of great expansion in the number of scientific periodicals and sharp rises in the costs of printing and distribution.

In the 1980s the 'tyranny of distance' was very real for University of Sydney researchers so far as access to recent publications was concerned. A few major weeklies were received by airmail but most came by sea and frustrating delays occurred as individual containers were delayed or rerouted. The weekly airmail Current Contents alerted researchers to publications of interest which generated a lively international interchange of reprint requests. Most departments had at least one avid philatelist whose collection was enriched by this international correspondence, while folklore had it that affixing a desirable stamp to a reprint request ensured rapid receipt of the article in question.

Computers changed all this, both in the sense of electronic publication and instant availability of journal issues, and in allowing individual researchers access to the power of search engines and the ability to download articles of interest. The 1965 cut-off for electronic searches has, however, consigned work published earlier to undeserved oblivion. There was much disquiet during the late 1990s when print runs of many journals were cancelled and replaced by electronic versions. The lack of current issues for browsing had inevitably narrowed the day-to-day reading of most researchers. On the other hand, the pursuit of older papers has recently become much easier with

the introduction of a service for scanning papers in the deposit collections and emailing them to researchers with a minimum of delay.

Preparation of manuscripts, theses and grant applications was the province of departmental secretaries whose keyboard prowess was matched by a formidable grasp of spelling, grammar and syntax. Few researchers were competent typists, though another change was on the way as individuals adopted the laptop way of life which soon ushered in an era of Powerpoint presentation and electronic submission of grant applications and journal manuscripts.

The biggest immediate impact of word processors has been on thesis preparation, converting text correction and reference listing into simple operations. Scanners and colour printing have supplanted stencils and Letraset for diagrams and illustration, so that layout, spelling and presentation have been greatly enhanced compared with the carbon-copied typescripts of the 1980s. A negative consequence has been the suspicion that plagiarism has become a greater temptation.

Medical illustration

Medical artists have played a significant role in the presentation of research in structural biology and pathology. Line drawings which reproduced much more clearly than photographs were the domain of specialist artists. They have only recently been supplanted by computer generated diagrams. The possibilities of clinical photography and photomicrography were quickly recognised by researchers, but in terms of publication had less impact until colour reproduction in books and journal articles became more affordable in the 1970s.

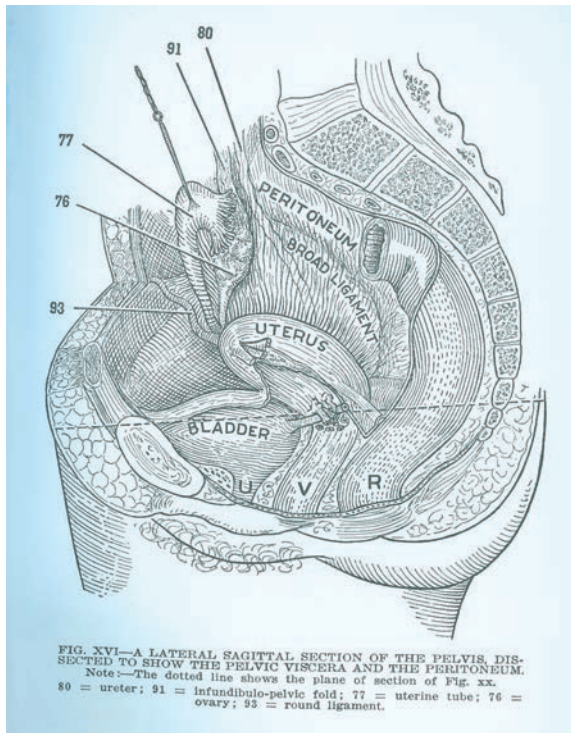


FIG. XVI—A LATERAL SAGITTAL SECTION OF THE PELVIS, DISSECTED TO SHOW THE PELVIC VISCERA AND THE PERITONEUM.
Note:—The dotted line shows the plane of section of Fig. xx.
80 = ureter; 91 = infundibulo-pelvic fold; 77 = uterine tube; 76 = ovary; 93 = round ligament.

A Farrell anatomical drawing

In Sydney both traditions of medical illustration flourished. An example of museum-based research of the inter-war period is provided by F A Maguire's Anatomy of the Female Pelvis (1927), but the Third Edition (1940) is greatly enriched by 35 anatomical drawings. The preface alludes to the Wilson Museum dissections on which the text is based and the role of the medical artist David Farrell.

Photographic illustration was established in the 1950s by Sydney Woodward-Smith, a well known painter who had the foresight to appoint the photographers Ken Clifford, Brian McGee and Ray Barber, whose images contributed so much to Faculty's research publications, teaching slides and archival records. As photographic recording of electronic data supplanted time honoured ink styluses, photographers became members of the research support teams in many departments. Research students have been greatly indebted to Ted Foster and Mitch Myers in earlier Physiology and Roland Smith and Clive Jeffery currently in Anatomy.

Research publication

Lacking an effective university press, and with the Medical Journal of Australia preoccupied with local issues, most University of Sydney researchers turned to publication in international journals. This custom was well established before the local research journals were established in the post-war period, and reluctance to submit high quality papers to these 'low impact' journals with limited circulation has retarded the development of a national research profile. Increasing numbers of Faculty members, however, are now actively involved in the editorial and review process of international journals in their particular fields. Electronic submission and review processes obviate the delays in postal deliveries which limited these activities in the past. Like conference organising, this reviewing of papers and writing of editorials bring the benefits of contact with new ideas to individuals and their groups.

With the greater ease of travel, particularly internationally, research conferences have become increasingly important as a means of catching up with the most recent advances, and in securing collaborations.

Regulation of research

Since 1980, project grant applications to the NHMRC and other agencies have required documentation of compliance with increasingly stringent regulations about the safety and ethics of the proposed experiments. No less than six clearances are now required and the infrastructure needed to support them have added significantly to the cost of research, both in direct ways and because of their significant administrative needs. Paperwork and committees have become major activities for researchers, though the introduction of electronic forms for submissions has made the mechanics easier.

Radiological and chemical safety was the least contentious of these requirements, but, even so they raised issues of individual versus institutional responsibility. A NSW Radiological Protection Board Licence had long been required for individuals to use radioisotopes, even in small quantities,

but the disposal of hazardous chemicals and biological waste became a formal institutional responsibility in 1988.

Animal welfare became a cause célèbre with activists lobbying government and mobilising public opinion with the aim of abolishing animal experimentation altogether. Faculty had established both human and animal ethics committees in 1975, but, during the 1980s individual members of Faculty, like many other medical researchers worldwide, became targets for this vociferous campaign. The requirements of the NHMRC and other granting agencies for documentation of animal work led to the consolidation of animal holding and breeding facilities.

Even after the ratification of the Declaration of Helsinki by Australia in 1966, research involving human subjects was essentially self-regulated, though during the 1980s there was substantial informal discussion of the ethical issues arising from trials of new drugs and vaccines. Individual members of Faculty had taken a lead in these discussions. As well as forming its own Human Ethics Committee, it supported the establishment of the Centre for Values, Ethics and the Law in Medicine in 1995 (see Chapter 3). In 1985 the NHMRC made formal approval by a properly constituted Human Ethics Committee a prerequisite for funding through its project grant system and set down a framework for institutional ethics committee operation. In the case of clinical research this is complicated by the requirements of the Department of Health for hospital ethics approvals, together with rising concerns about patient confidentiality as well as autonomy.

Research in molecular biology

More subtle ethical issues arose concerned financing of research by large pharmaceutical companies and governments, as well as attributions of authorship in publications.

Prior to the 1980s, few Faculty researchers were directly involved in commercialisation of their findings, but the burgeoning international biotechnology industry and the interest of venture capital in supporting local start-up companies awoke the University to the need to protect its intellectual capital. The Business Liaison Office deals with contacts with industry, intellectual property, and formation of start-up companies.

The commercial possibilities of patenting research findings demanded dated evidence of experimental findings which in turn required

much more formal record keeping in research laboratories and archiving of these records for up to a decade. The 'Red Books' with their hard bindings and numbered pages made their debut in 1994. Improved formal records of research also provided substantial protection against allegations of scientific fraud. Some high profile instances of falsification of research findings created disquiet throughout the international research community during the 1980s but the publicity surrounding the McBride case in the 1990s brought the issue close to home.

There was also a growing reluctance to present preliminary data in public, and even publication of completed work could be delayed because of a perceived risk to patent positions. This trend was intensified with the introduction in 1990, of the Commonwealth Collaborative Research Centres Scheme which placed great emphasis on patents and commercial spin-off. The Faculty is a core member of the Asthma and Cardiac Technology CRCs, and numerous individual Faculty members have been successful in establishing commercialisation of their work.

Recombinant DNA and stem cell research raised a storm of community protest amid fears that 'monsters' (plant or animal) would be created and released into the environment producing irrevocable harm. The concept of the human genome project and its application using stem cell techniques were even more eerie and the latter was prohibited in many countries. Commonwealth legislation requiring approval for research involving recombinant DNA (enacted in 2000) and stem cells (2001) provide for institutional and national committees to assess proposals and determine whether they fall within the rules, and that they will be conducted in appropriate facilities. This is a prerequisite before grant applications are considered for funding. The work of the committees and laboratory inspectorates devolves on to the research community and many Faculty members are involved.

The possibility that medical research into infectious agents could be subverted to provide weapons of mass destruction stimulated NSW legislation requiring recording of the infectious agents held in departments.

Responsibility for all of these issues involved the University as well as the individual researchers and most granting bodies insisted that the institution certify compliance with regulations. Research office staff multiplied to process all these requirements to which heavy demands for reporting to government departments were soon added.

Funding of research

In 2005, as in 1980, and indeed throughout the history of the Faculty, research funding is very largely dependent on the initiative and opportunities of individual researchers. Even now the lack of clear government provision for research in the recurrent funding of universities leaves the Faculty without a base for supporting innovation. Without venture capital for this purpose,

the Faculty will struggle to maintain its position of leadership, especially in basic – as opposed to applied – research.

It is small wonder that individual Faculty researchers have allied themselves with large consortia both within Australia and internationally. Because their contribution is relatively small in the overall projects, they seldom achieve leadership status and the short term benefits are to some extent offset by the distortion of departmental and Faculty activity.

The Faculty Research Conferences

The first of these biennial conferences was held in 1994. The Dean of the time, John Young, initiated these conferences as a forum for young researchers to present their work to senior members of Faculty from all departments and as a way to overcome the academic isolation of postgraduate students working off campus. He also hoped to bring more senior researchers in informal scientific contact in the expectation that this would naturally lead to more interdisciplinary collaboration within the Faculty.

Attendance at the first meeting was enthusiastic and the conferences have gone from strength to strength, extending to embrace all the Faculties in the College of Health Sciences with significant support from the Medical Foundation. The combination of an informal atmosphere and attractive location was maintained at the fourth (2004) conference in Leura which was attended by 600 researchers who presented over 350 papers.

A presentation at the College of Health Sciences conference

Although the presenters were in the main students or post-docs, the book of abstracts prepared for the meeting provides a snapshot of the Faculty's research activity. Just over half the sessions (17 of 30) were devoted to more than 200 laboratory experiments, but only six papers in all reported results of controlled therapeutic trials. This imbalance, and the much larger (1409) number of publications listed in the annual research performance return of Faculty for the same year, implies that there was only limited participation by the institutes and clinical research groups based in the teaching hospitals. Thus the long-desired collaborations between basic and clinical researchers are yet to emerge. For papers with Faculty of Medicine presenters, the co-authors were limited to the presenter's own discipline in 60%, and equal proportions of the remainder drew on collaboration with another discipline within Faculty and external collaborators.

Is there distinctive research at the University of Sydney? The University motto. Sidere mens eadum mutato – the same mind under another sky – provides an apt description. The international outlook of the founding fathers has continued, ensuring that there is very rapid assimilation of new ideas and techniques from abroad. This has not been matched by resources to achieve global leadership in basic biomedical science, and too many of the most able graduates have had to make research careers in other institutions in Australia and abroad. Even so, Faculty researchers have made significant progress with some distinctively Australian problems. For instance, epidemiological and

College of Health Sciences Conference: participants

clinical research into melanoma has been pursued for over two decades by the Sydney Melanoma Unit led successively by the surgeons Gerald Milton, Bill McCarthy and John Thompson; population trends by Bruce Armstrong from public health; genetic aspects by Rick Kefford and Graham Mann at the Westmead Millennium Institute; and cell biology by Rebecca Mason in Physiology.

Sabbatical leave

For most of the Faculty's history, sabbatical leave (officially known as Special Studies Program leave) provided a means for Faculty staff to renew their research interests by spending extended periods of 6–12 months working in major centres abroad. It recognised both the isolation of Australian scholars and the pressures of unremitting teaching and professional service. Paradoxically, as air travel became cheaper in the 1970s, fewer staff availed themselves of this opportunity. This was partly a reflection of the increasing size of the research community in Australia, especially after the foundation of more medical schools in the 1970s.

Social changes also meant that more academic parents found it more difficult to surmount the logistic and financial consequences of juggling two careers and family life. Short trips to conferences became more frequent, so much so that some prominent figures are referred to as the 'Qantas Professors' by their more home-bound colleagues. Academic visitors from abroad have also been affected by the same pressures so that the stream of 'Visiting Professors' who often spent weeks or even months actively working in one of the research groups has all but disappeared. It is some compensation that the City of Sydney has become a favourite venue for international conferences. Participation in the organising committee work makes for valuable contacts and wider perspectives for senior Faculty members. Young researchers benefit from the opportunity to attend these meetings at an early stage of their development when they, as yet, have little to present.

Research institutes

Prior to World War II there were only two medical research institutes in the University: the Kanematsu Memorial Institute of Pathology, the first medical institute in New South Wales, at Sydney Hospital, and the Kolling Institute of Medical Research at Royal North Shore Hospital. In 1977 the University acquired another pathology department-based research institute when the Institute of Clinical Pathology and Medical Research (ICPMR – formerly the State Department of Health Clinical Laboratory) was relocated from Lidcombe to form the nucleus of laboratory services for Westmead Hospital.

Meanwhile in 1958, a Children's Research Foundation had been set up by Lorimer Dods to seek public donations to support research at the Royal Alexandra Hospital for Children. From 1968,

research activities were housed in the Children's Medical Research Institute building which was also the home of the University teaching department. Protracted negotiations about separation of funding arrangements were resolved when the Foundation relocated research activities to a new building next to the site earmarked for the transfer of the hospital to Western Sydney.

The first four institutes were all at a significant geographical distance from the University and, although academic titles were conferred on the Directors, there was relatively little intellectual interaction with the campus departments. Their activity was distinguished but represented only a small quantum of the overall research effort of the Faculty, and the restrictive University by-law requirements – regarding enrolment and supervision of research students – limited the roles of these Institutes in research training.

The academic environment was transformed by changes in government policies during the 1980s. A number of reviews of medical education and research prompted more liberal arrangements for research supervision by clinical academics and full-time staff specialists, who were being appointed in growing numbers to the proliferating specialist hospital departments, each with their own active research programs. Since 1980, 38 new research institutes have been established under the umbrella of the Faculty. Some are major institutions in their own right, others being little more than a professor's attempt to secure a new way of raising research funds. Many are dedicated to research and professional training about a single health problem, including information on

patient treatment and community education. Others reflect the aspirations of specialties within the profession or are the product of government initiatives in specific aspects of the health services. Most of these institutes or centres operate within existing disciplines of the Faculty and many – often all – of their staff are University or Health Service employees whose duties have extensive overlap with institute activities. Support for the institutes is derived from research grants obtained in national competitive schemes or by direct government funding, or from fundraising by related foundations. In the larger groups the post of Director may be derived from these independent funds, with an academic title conferred by the University. Despite this patchwork of administrative arrangements, the institutes have largely succeeded in creating a focus for research and postgraduate teaching in their specific areas. Their individual activities and achievements are described in the following chapter.

More recently, the geographical coalescence of clinical services in the Areas defined by the NSW Department of Health, co-localised with medical student clinical training in the Faculty's Clinical Schools based on the major teaching hospitals, has been paralleled by development of larger scale research facilities on each of these sites. Substantial new research buildings have been built at Royal Prince Alfred (the Centenary Institute of Cancer Medicine and Cell Biology), Westmead (Westmead Millennium Institute of Health Research) and Concord (ANZAC Research Institute) and are proposed as part of the major $450 million redevelopment under way at Royal North Shore Hospital, led by the Kolling Institute. In each case, existing centres already functioning on the clinical school site have formed the nucleus of these new institutes. A fuller discussion of research institutes can be found in Chapter 5.

Foundations and benefactors

Throughout its history, the Faculty has been generously supported by benefactors, who support medical or scientific research, donating to the Foundations, and to specific or generic projects. Such funding contributes $3–4 million annually; it represents a crucial element in support of the Faculty's research efforts. The donations and bequests vary in scope, size and nature. Some are tied to specific projects, others to more generic aims of advancing medical knowledge and understanding. All such funding supports not only the research itself, but also contributes to the training of young researchers in laboratories, clinical and community settings.

Annually the funding available from bequests and donation amounts to about $3–4 million. It has been a key factor in strengthening research in Faculty and attracting larger scale funding from government.

The Medical Foundation has made a substantial contribution to the work of the Faculty over its 50 years of existence. The story of the Medical Foundation and the other foundations that support aspects of the Faculty's work, is told Chapter 5.

In the two decades since Faculty celebrated the centenary of medical teaching, research has been transformed from the personal pursuit of individual academics into a corporate industry. The forces driving this radical change include developments in the scale and complexity of research technologies as well as growing public and political focus on the ethics and outcomes of medical research. Parallel revolutions in teaching and University administration over the same period have reshaped the Faculty within the working life of many current members of staff. Higher education and research have meanwhile become recognised as major contributors to the economy of developed nations. This has focused unprecedented government attention on universities, with increasingly direct linkages between public funding and political objectives. Globalisation of the 'knowledge industry' and the power of the Internet have provided new challenges and opportunities for researchers in the Faculty.