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## Presidency of the Royal Society

Aaron's son David Klug, having graduated in physics from University College in 1984, was accepted as a PhD student by George Porter at the Royal Institution and was awarded his doctorate in 1987. This successful arrangement served to deepen the friendship between Aaron and George Porter. George married Stella Jean Brooke in 1949, the year he obtained his doctorate in Cambridge with work that would later earn him a Nobel Prize. Stella was diminutive and beautiful. As recorded earlier, she had first attracted Aaron's attention when he saw her from the window of his shared apartment in Chesterton Road, as she hung out washing in the next-door garden. Stella had a forceful personality and was a teacher of ballet. Indeed, George and Stella were a lively pair: George was an enthusiastic Gilbert and Sullivan performer. He was appointed President of the Royal Society in 1985, taking over from Andrew Huxley. For a couple of years, he combined the presidency with being Director of the Royal Institution, but after 20 years at the Royal Institution he handed it over to John Meurig Thomas. When George and Stella moved their London residence from Albemarle Street to Carlton House Terrace, Stella was most irritated to find that the President's flat was smaller than the flat occupied by the Executive Secretary of the Royal Society, Peter Warren. Moreover, George Porter was put out by being expected to share a secretary with the Executive Secretary.

In the greater scheme of things, Porter walked into a much more serious problem: the hostile attitude of the then-current government to science. Porter well understood the importance of science to the community, and he argued that without a strong science base Britain would quickly become 'well prepared to join the Third World of science'. In contrast, some senior members of Margaret Thatcher's government such as Michael Heseltine basically considered science and education a waste of money that might be better invested in something useful – such as banking. Although Margaret Thatcher was supportive of environmental science and European ventures such as CERN (the European Organization for Nuclear Research) and EMBL (the European Molecular Biology Laboratory), her attitude to the University Grants Committee was iconoclastic. In February 1985, in protest against her cuts in funding for higher education, the Congregation of the University of Oxford refused to bestow on her an honorary degree. In 1983, during Andrew Huxley's presidency, she had only been grudgingly elected to the Royal Society, an honour accorded to many prime ministers. Thus, a continuous conflict with Whitehall over funding levels for science determined Porter's presidency. Nevertheless, Porter ensured that the Royal Society became more engaged in British public life. He drew attention to the ever-widening ozone-hole produced by the enthusiastic commercial use of chlorofluorocarbons (CFCs) as refrigerants, which led to an important international ban on their use. He also made global warming and greenhouse gases a mainstream issue.

Half way through his five-year term, Porter started planning his successor. His natural choice was Aaron, as a Nobel Laureate and, moreover, a scholar of note whose interests embraced the 'Two Cultures'. Porter arranged that Aaron should become a member of the Royal Society Council. In December 1989, Aaron and Liebe had planned to go to South Africa for a few weeks. Cambridge at the Winter Solstice can be rather cold and depressing, and there were matters awaiting in South Africa. Liebe waited patiently at Heathrow while Aaron attended a Royal Society Council Meeting in London. Somewhat later, an ashen-faced Aaron appeared at Heathrow: Council had offered him the presidency and he had turned it down<sup>1</sup>.

<sup>1</sup> Part of the content of this chapter, including the text of interviews conducted with Aaron and Liebe Klug, has been made available to me by Peter Collins, Emeritus Director at the

This was an unusual step. The only previously recorded case of an offer of the presidency being refused had been by Michael Faraday. Normally Council is careful to check that its approaches will not fall on barren ground, but this time they had slipped up. Aaron reasoned that his commitment to the LMB at this moment was crucial. He had just set up a new department of neurobiology; he had got the John Sulston nematode genome-sequencing project off the ground, and complicated negotiations were under way about transferring the patent rights on human cloned antibodies to Celltech, a firm partly owned by the MRC. Moreover, Aaron had recently discovered zinc fingers and wanted time to explore the exciting implications of this discovery.

This left Council in something of a dilemma. They first asked Porter if he would extend a year, but he and Stella were not prepared to stay for a minute over the allotted time. After some deliberations, Council offered the presidency to Michael Atiyah, a most distinguished mathematician and Master of Trinity College Cambridge, who accepted. Michael Atiyah and his wife Lily seemed unbothered by the size of the presidential apartment; the Master's Lodge at Trinity was already palatial enough, and Lily intended to stay in Cambridge. Traditionally the presidency alternates between the two 'sides' of the Royal Society: the physical side (physicists, chemists and engineers) and the biological side (biologists, biochemists, physiologists and medics – social scientists generally end up in the British Academy, just across the Duke of York steps). Porter was firmly on the physical side, and Aaron could be construed as being biological. Atiyah was the first mathematician appointed to the presidency for over a century. There isn't really a mathematical side, so Atiyah was something of a wild card. Thus, five years later, in December 1994, Council felt emboldened to offer Aaron the presidency from the B side. Atiyah is reported to have said to Aaron, 'I'm keeping the chair warm for you.' As retiring president, Atiyah negotiated with Peter Warren to ensure that the Klugs would be offered the larger apartment. In the meantime, Aaron's status had been further enhanced by his election to the exclusive Order of Merit. This time Council selected Tony Epstein, who had been Foreign

Royal Society. I am most grateful for his help and criticism of the whole chapter. In addition, Liebe has told me many things, and I have also drawn on the Aaron Klug correspondence in the Churchill College Archive.

Secretary of the Society, as their emissary. The approach was well prepared: Tony Epstein made a strong appeal to Aaron's sense of duty. Any boy who had been through the Durban High School for Boys knew the imperative nature of a call of duty. Aaron, now 69, acquiesced.

Every year, fellows of the Royal Society celebrate the founding of the Society on 30th November 1660 with an Anniversary Meeting. Every five years or so, this is also the occasion for the installation of the new president. But Aaron had agreed to address a festive session of the Senate of Ben Gurion University in Beer-Sheva on 28th November to celebrate 25 years since the founding of the University. Very appropriately, Aaron's lecture was 'Some Reflections on Science and Science Policy', a theme that would dominate the first year of his presidency of the Royal Society. The lecture in Beer-Sheva was necessarily followed by a precipitate journey back to London to be in time for the Anniversary meeting on 30th November at which he would be installed as President.

At the meeting, the current president presents his address, which includes a summary of the Society's year. On Thursday 30th November 1995, Michael Atiyah presented his valedictory address. Such an address can afford to be more personal since it does not need to consider future presidential policy. Atiyah chose to present a strongly argued attack on post-war UK atomic weapons policy, pointing out that the Governments misuse of vast quantities of Research and Development funds for defence needs was responsible for the relative decline of the British economy compared with the similarly funded but nuclear-free German economy. Atiyah then vacated the president's chair in favour of Aaron. At that time the president's chair, which carried the coat of arms and motto of the Society, *Nullius in Verba* (roughly, 'Take no one's word for it') was rather large (it has since been replaced by a chair more commensurate with the average president), and Aaron could only huddle in a corner. At the end of the meeting, the officers of the Society processed out of the room following the newly installed president, who was preceded by a bearer carrying the Ceremonial Mace that had been presented to the Royal Society by Charles II.

The following Monday was Aaron's first working day with Peter Warren, which showed up some important cultural differences. Before his appointment as Executive Secretary, Warren had spent three years as a senior civil servant in the Cabinet Office. Rather naturally, he assumed the manners of a Permanent Secretary of State

who was required to deal with presidents (or ministers) who come and go every few years. The proper role of presidents was to define policy but not to execute. Since the Executive Secretary's office dealt with presidential correspondence it was not clear to Warren why presidents might require their own secretary (this had already been a bone of contention with Porter). It is true that most presidents were academics with no executive experience. However, Aaron, as director of the LMB, knew how to handle an organisation that was bigger than the administration of the Royal Society. Moreover, he had lots of experience in negotiating with government departments and commercial organisations. He and Warren soon agreed that he would have a secretary of his own.

Meanwhile, Liebe's reforming zeal was rampant. She was determined to make the Royal Society more attractive and more open. She improved the standards of catering quite remarkably, and introduced music to the reception after the Anniversary Meeting. In time, she reformed the lunchtime cafeteria and redecorated the presidential apartment to make it more suitable for entertaining and interchange. Aware of the 'Two Cultures', Aaron initiated a series of informal dinners inviting both scientists and representatives of the humanities to get to know each other in a relaxed setting. It transpired that many quite sophisticated and learned people across society had never even heard of the Royal Society and certainly had no idea what it was there for. During the latter part of his presidency, Aaron set up a one-day conference aimed at bridging the gap between the two cultures with the idea of making this an annual event. Unfortunately, the stresses surrounding the illness and death of their son Adam made it impossible to continue the programme, but it appears to have had a nucleating effect: under succeeding presidents the Outreach programmes became important and sustained activities of the Society.

Liebe herself was concerned with what she saw as the split in the Royal Society: apparently on the one hand were the professionals – the paid staff – and on the other the amateurs – the scientists. She felt that this gap led to a permeating feeling of deadness. In her view, the culture of the RS was out of keeping with the way that better scientific institutions functioned. Liebe herself attempted to loosen these barriers by establishing friendships with staff members. She and Ling Thompson, the retiring Under Secretary of the Society, formed an enduring

friendship. The terminal illness of Aaron and Liebe's son Adam during the last part of Aaron's presidency drew staff and president together.

The year of 1996 was tough. Aaron was still Director of the MRC Laboratory of Molecular Biology and at the same time was trying to get to grips with his new job. It was necessary to spend at least two full working days in each week in London. The scope of activities was more extensive than he had anticipated. The Royal Society had a permanent staff of over 100. Raising money was a headache. Peter Warren was heavily involved with Project Science, a fund-raising exercise that had been inaugurated by Aaron's predecessor Michael Atiyah with the aim of safeguarding the financial independence of the Society. The Society had reached the stage when nearly 80% of its annual expenditure came from government sources, a proportion that appeared to compromise the independence of the Society. In fact, the financial imbalance of the Society was a product of its own success. The University Research Fellowship scheme was working very well. This with the Royal Society Professorships accounted for over half of the Grant-in-Aid from the government. Another extensive activity was offering the government advice on science policy, an activity that had been expanded considerably while Lord Todd was president. The Project Science was particularly important because it enabled the Society to maintain its independence when offering opinion and advice to the government. The Duke of Edinburgh was its patron, and committee meetings of Project Science were often held in Buckingham Palace. Aaron found the Duke's down to earth approach refreshing.

It was also a year of travelling. International scientific exchanges are an important part of the Society's work, and in 1996 Aaron and Liebe made two official visits to South Africa, a visit to Malaya and a visit to India. At the end of January, Aaron and Liebe spent two weeks in South Africa at the invitation of the Foundation for Research Development (FRD) in Pretoria. The President of the FRD, Dr Rein Arndt, was a personal friend of Aaron's. As he had done six years previously, when he refused the presidency, Aaron left after a Thursday Council meeting to join Liebe at Heathrow for the overnight flight to Johannesburg. They flew on to Cape Town and stayed at the Portwood Hotel close to their youthful stamping ground. On the Monday, Aaron gave the opening lecture at a Symposium on Cell Growth Control, and on Tuesday he gave the plenary lecture at a symposium at the University to

commemorate the 100-year anniversary of R. W. James' birth. Aaron spoke about X-ray structure analysis in biochemistry and biology. John Juritz told the story of R. W. James and how he had trained two Nobel Prize winners. The following day, Aaron visited the University of the Western Cape where he met up with Rein Arndt, followed by a visit to Pretoria and excursion to the University of the North<sup>2</sup> to meet students: the University of the North was set up under Apartheid for black students and rather naturally became a centre of the anti-Apartheid movement.

In May, Aaron represented the Society at the inauguration of the new South African Academy of Science. For about a century, the national science 'academy' had comprised two separate institutions – the Royal Society of South Africa based in Cape Town and the *Suid-Afrikaanse Akademie van Wetenskap en Kuns* (SAAWEK), which had an Afrikaans language focus, based in Pretoria. It was the official national academy until 1994. In post-apartheid South Africa, a new model was required. The Academy of Science of South Africa (ASSAf) was inaugurated in Pretoria in May 1996 by Nelson Mandela, winner of the Nobel Peace Prize, who sought the backing of other Nobel Prize winners. Thus, for the celebration, Sherwood Roland, Mario Molina, Aaron and their wives were invited. Sherry Rowland and Mario Molina had developed the 'CFC-ozone depletion theory'<sup>3</sup> for which they had just been awarded the Nobel Prize in Chemistry. Mandela was in surprisingly good spirits, considering the fact that his divorce from Winnie Mandela had become finalised that day: he had been freed from 27 years of incarceration to find that he didn't really have a wife any more. After his address to the assembled company, he came back to the Nobel Prize winners' table and remarked rather wistfully that they were fortunate to have wives who stood behind them and supported them in their work. He also told Aaron that South Africa needed him and that he ought to return.

Aaron, in his Anniversary Day Address to the Royal Society, emphasised the importance of the Royal Society in offering unbiased advice to

<sup>2</sup> 350 km northeast of Johannesburg, now called the University of Limpopo.

<sup>3</sup> CFC = chlorofluorocarbons. CFCs at high altitudes are destroyed by solar radiation: the chlorine atoms produced by the decomposition of the CFCs catalytically destroy ozone, leading to severe ozone depletion and allowing through more ultraviolet radiation, particularly in the southern hemisphere. CFCs were a common ingredient in refrigerators. Their industrial use is now banned.

the government and its increasingly important role in offering independent judgements on contentious public issues. He discussed the Prior Options Study<sup>4</sup> as a recent and ongoing example of its involvement in science policy. It illustrated that an important role of the Royal Society was to ensure the healthy funding of basic science at a time when the prevailing philosophy held that public sector activities should be subjected to market forces. An extreme form of this view was that basic research should not be funded by government at all but that all research could be more efficiently done in the private sector. Aaron reiterated what many knew, namely that such a strategy was short-sighted and would inevitably lead to a serious decline in the quality of the UK science base. The yield of basic science in terms of industrial or medical application is often measured in decades. No private firm could afford to take such a long view. In his discussions with the Ministry of Trade, Aaron was particularly emphatic that the LMB should not be sold off to a predatory drug company. The Prior Options Study of research council laboratories was based on two questions: 'Is the work being done in the research establishment significantly important?' and 'If so, would it best be continued in the public sector or would it best be done by a privatised institute?' Chosen institutes were scrutinised by senior civil servants who were singularly lacking in an appreciation of the way that creative science was organised, and expected each institute to be managed by a senior administrator and certainly not by a scientist. They would have had no understanding of the way the LMB functioned, and fortunately they did not attempt to find out. As Aaron put it: 'The best labs are not working at the frontiers of science, they're creating the frontiers of science.'

Aaron was at this time on the Council for Science and Technology, which was chaired by David Hunt. Hunt confided to Aaron that basically the whole idea had been shelved. Thus, at the end of his Anniversary Address, Aaron was happy to be able to report that doctrinaire privatisation was apparently no longer a central issue in John Major's government. In his Anniversary Address a year later, Aaron

<sup>4</sup> On 3rd February 1997, John Major's Government finally backed down on plans to privatise research council laboratories. The Prior Options Study, a Government privatisation probe of more than 40 public sector research facilities, concluded that most should retain their present status.

summarised why he thought basic research should be funded. He referred to the role of delegated curiosity. In his Annual Report<sup>5</sup> for 1998, Aaron once again emphasised this aspect of basic research, which is central to the philosophy of the Royal Society:

*Science is possible only because 'society' tolerates it. This relation has several components. Taxpayers, represented by the Government that collects and spends the taxes, seek practical benefits. But the so-called 'general public' often also takes great interest in the ideas that science throws up – from the heliocentric system and evolution to black holes, chaos theory and continental drift. Scientists are, certainly, motivated by the possibility that their work may have beneficial outcomes, but for many of us the overriding driver is fascination with the workings of nature. That fascination is the most powerful source of new knowledge, and it is the fruits of that new knowledge, which eventually benefit society. For science policy, then, the challenge is to understand how these components can coexist and to create an environment – an ecosystem as it has been put – in which researchers can eventually deliver various advances that society eventually welcomes. The key characteristic of this ecosystem is freedom: freedom to set the research agenda and freedom to change it in the light of unexpected discoveries. There is very extensive evidence that, at the highest levels of research, it is this freedom which produces the breakthroughs that, literally, change the world.*

In August 1996, Aaron gave up his Directorship of the LMB and passed the sceptre to Richard Henderson.

On 8th January 1997, Don Caspar was 70. A couple of years earlier, Don and Gladys Caspar had moved from Brandeis to the Florida State University in Tallahassee and sold their nice house in Brookline. Caspar wished to work with Lee Makowski, his one-time student, who was now Chair of Biophysics at Florida State. In January 1997, Makowski organised a two-day seminar to commemorate Caspar's seniority and science. Aaron was chosen as the Keynote Speaker. In spite of Tallahassee's relative remoteness, Aaron felt he had to go. His talk was on 'Protein Designs for Manipulating DNA'.

<sup>5</sup> Klug, A. *Notes Rec. Roy. Soc. Lond.* (1999) **53**, 157–167.

In June 1997, Peter Warren, the Executive Secretary, retired. The event was marked by a number of receptions at the Royal Society; indeed, because of great interest, the farewell reception given by former members of Council was repeated on two successive evenings. Aaron, in his warm appreciation of Peter Warren's 20 years of service, emphasised his selfless dedication to the Society. It was Peter Warren who had got the Society involved in defining science policy and who in 1981 had appointed Peter Collins to run the Science Advice Section. Aaron added that there was hardly anything that the Society had done in the past 20 years that did not bear Peter Warren's creative imprint. Warren's successor was Stephen Cox. A former employee of the Society, he returned from the Commonwealth Institute, where he had been Director-General.

The year of 1997 brought an extended trip to China. It had been pending for some years: Zhang Youshang, who had been a postdoc with Aaron in 1962, had invited Aaron in 1990. Finally, in 1996, Aaron was formally invited as President of the Royal Society by Zhou Guangzhao, the President of the Chinese Academy of Sciences (CAS)<sup>6</sup>. The visit took place in September 1997. The delegation included Brian Heap, the Foreign Secretary of the Royal Society, and Ling Thompson, now Head of International Affairs, who fortunately was Mandarin-speaking. The visit was broadened to include South Korea where Aaron had been invited to give the Hallim Distinguished Lecture at KAST, the Korean Academy of Science and Technology. He spoke on the regulation of gene expression on this and other occasions during the trip, including a day at the CAS Institute of Biophysics in Beijing.

The stay in Beijing required a number of official visits, including a grand meeting with the President and Vice Presidents of CAS. Aaron was impressed by the Institute of Atmospheric Physics, which is a regional research centre of the Global Change System for Research and Training and had close ties with senior UK scientists working on global warming. He hoped that the Chinese Government would listen to the warnings emanating from this well-informed institute. At the express wish of Lu Shengdong, the Vice President of the Chinese

<sup>6</sup> The Chinese Academy of Sciences (CAS), formally known as the Academia Sinica, is the National Academy for Natural Sciences of the People's Republic of China. The name Academia Sinica is now used in Taiwan.

Academy of Medical Sciences (CAMS), Aaron gave a lecture at CAMS entitled 'The Development of Structural Molecular Biology in Cambridge'.

After the lecture, the party was invited to a very adequate lunch at the Peking Duck, which provided a suitable prelude for Brian Heap's afternoon lecture, 'Feeding a Population of 8 Billion by the Year 2020. Biotechnology – Will It Help?', at the China Association for Science and Technology (CAST). The next day, a meeting with the Chairman of the National Natural Science Foundation of China, Zhang Cunhau (Plate 5), terminated their visit to Beijing.

After Beijing, Aaron, Liebe and Ling Thompson flew to Shanghai. Aaron visited the CAS Institute of Biochemistry where he was able to greet Zhang Youshang. A visit to the Shanghai Institute of Metallurgy stuck in Aaron's mind. He had an illuminating conversation with the director and Vice President of CAS, Jiang Mianheng<sup>7</sup>, about the problems of managing CAS, which had been set up on the Russian model.

From Shanghai, the party made a stop in Fuzhou, where the Klugs had friends, and then home via Hong Kong. The transfer of Hong Kong to Chinese sovereignty had happened a few weeks before the Klug's arrival. A feeling of uncertainty pervaded the ex-colony. The Klugs and Ling Thompson met Lee Quo-wei (known as Sir Q. W.), the Director of the Council of the Chinese University and of the Hang Seng Bank. Sir Q. W. was one of the co-founders of the Ho Leung Ho Lee Foundation, which promotes science and technology in China. Aaron and Sir Q. W. had met in 1985 at Hull University, where both had been awarded honorary doctorates. Sir Q. W. was sanguine about the future of Hong Kong but unfortunately appeared uninterested in supporting 'Project Science'.

Aaron had given eight lectures during the trip, and he had been inundated with information, people, and experiences. The visit did indeed foster relationships between CAS and the Royal Society. The pragmatic search for knowledge, as embodied in the Royal Society motto, transcends cultural differences. Moreover, CAS was hotly debating the same problems that were bothering British science policy: how do you make research relevant; how do you commercialise research?

<sup>7</sup> Jiang Mianheng was the son of the President of China, Jiang Zemin.

Aaron was also relieved to note that some intelligent people in China were very concerned about the problems of global warming, to which China itself was contributing on a massive scale.

Aaron had been offered an Honorary Doctorate by the University of Cape Town. The ceremony would take place in December. There could scarcely be a more opportune time of year to exchange grey London for sunny Cape Town. Liebe was always thrilled to get back to Cape Town. Thus, directly after the Anniversary Meeting, they were off to South Africa for the third time in the year. Woefully, after the degree-giving at the University of Cape Town, when they were looking forward to a couple of weeks in the sun, the heavens fell in. Adam's wife Debbie phoned from Israel to say that Adam was seriously ill. Moreover, the Israel medical services were on strike! A precipitate return to England ensued in time to meet Debbie and Adam from Israel. Adam was admitted to Addenbrooke's Hospital in Cambridge for tests. It took until February to get a definitive diagnosis: pancreatic adenocarcinoma. Debbie, a medical doctor, had access to the pathology tests and kept the awful reality from Aaron and Liebe for two long weeks until the diagnosis was made known.

Adam was in and out of Addenbrooke's for pre-op medication. Adam and Debbie's sons Yoel and Omri, who had been parked with their Israeli grandparents at Hod Hasharon, 100 km to the north of Omer, joined them in Cambridge. During the eight-hour operation, Debbie and Liebe spent the time cooking. Adam came through the operation well; the boys returned to Israel, and Aaron and Liebe moved with Debbie and Adam to the flat at the Royal Society so that Liebe could indulge Adam's enthusiasm for operas and concerts. The whole family even went to see the Coen brothers film *The Big Lebowski*. Then Adam and Debbie went back to Omer, where Adam received a hero's welcome when he rejoined his department at the Ben Gurion University.

The prognosis for pancreatic cancer is very poor. Soon the liver was involved. There followed two years of crisis, chemotherapy and operations. Adam weathered each setback and remained extraordinarily productive in his field. Adam and Debbie decided to live life to the full. They even managed a holiday in Venice where Adam could sit within sight of the Grand Canal. Aaron and Liebe's commitment to the Royal Society and the support of the staff were very important factors in

helping them to come to terms with Adam's terminal illness. Adam died in Beer-Sheva in August 2000.

In 1996, the President and Council instituted a medal, the King Charles II Medal: *For foreign Heads of State or Government who have made an outstanding contribution to furthering scientific research in their country*. The King Charles II medal was in fact created for Emperor Akihito<sup>8</sup> of Japan. In May 1998, the Emperor Akihito of Japan paid an official visit to the United Kingdom. Akihito is a serious scientist who maintains an electron microscope in the cellar of the imperial residence in Tokyo. The main theme of his research is the taxonomy of goby fishes, and he has also published papers on the history of science. On his visit, Akihito was accompanied by the Empress Michiko. On the third day of their visit the Royal Couple came to the Royal Society for the presentation of the King Charles II Medal. At the ensuing reception, Aaron and Liebe established a warm relationship with Akihito and Michiko, who extended an invitation to the Klugs to visit them in Tokyo.

The explosive progress of biology in the second half of the twentieth century brought with it hotly debated issues of policy and ethics. In 1978, the first human baby resulting from *in vitro* (external) fertilisation or IVF was born. This raised a host of ethical issues that were addressed carefully by a Committee of Enquiry set up by the UK Department of Health and Social Security, and this led to the Human Fertilisation and Embryology Act of 1990. The Committee of Enquiry was chaired by Dame Mary Warnock, Mistress of Girton College and a philosopher of note. One of the most active members of the Committee was Anne McLaren, later to be Foreign Secretary of the Royal Society at the time Aaron started his presidency. Anne McLaren was a leading figure in developmental biology. Together with John Biggers, she had shown that early mouse embryos could be cultured for a day or two *in vitro* and still develop into adult animals after transplantation into the uteri of surrogate females. This study provided the essential backdrop for the development of *in vitro* fertilisation.

The Act of 1990 provided a legal basis for embryo research and recognised that the issues were too complicated to be dealt with purely

<sup>8</sup> The King Charles II Medal has since been awarded to Abdul Kalam, President of India; Angela Merkel, Chancellor of Germany; and Wen Jiabao, Premier of the State Council of China.

by legislation. It empowered the Human Fertilisation and Embryology Authority to regulate the practice of human *in vitro* fertilisation in Britain. McLaren served with the Authority for ten years. One stipulation of the Act was to forbid experimentation on embryos that were more than 14 days old. This cut off was derived from the age at which an embryo first develops the neural groove, the antecedent of the spinal cord. When Aaron heard about this stipulation he was reminded of the teachings of Thomas Aquinas, who had maintained that the soul entered the foetus on the fortieth day after conception (somewhat later for women).

On 22 February 1997, Dolly the Sheep was presented to the public. 'Dolly' had been created using the technique of somatic cell nuclear transfer (SCNT), in which a cell nucleus from an adult cell is transferred into an egg cell that has had its cell nucleus removed. The hybrid cell is then stimulated to develop into a blastocyst<sup>9</sup>, which is implanted in a surrogate mother. The birth of Dolly showed that the genes in the nucleus of a mature differentiated somatic cell can still revert to an embryonic cell, which can then develop into a normal foetus and healthy animal. This discovery opened the door to therapeutic cloning, for example creating healthy nerve cells to treat Parkinson's disease from embryonic blastocyst stem cells. Culling stem cells from an embryo requires the destruction of a latent human being. There was a strong public reaction against using embryonic cells in this way, with the result that all research involving embryonic cells was called into question. The UK's 1990 Act was relatively liberal (in Germany, embryo stem cell research is forbidden) but there was strong lobbying to forbid research on stem cells derived from human embryos. It was argued that the destruction of human embryos was proscribed on ethical grounds. Parliament was under pressure to amend the 1990 Act.

Aaron became involved in this debate and observed that the 14-day rule coupled with the Human Fertilisation and Embryology Authority was actually working well. Research was already tightly regulated. Any further restrictions would drive the research away from Britain. Aaron felt strongly about this issue and personally wrote letters to all

<sup>9</sup> The blastocyst is formed in the early development of mammals. In humans, its formation begins five days after fertilisation. It possesses an inner cell mass (ICM) that subsequently becomes the embryo.

650 Members of Parliament urging them not to restrict research any further. In 2001, the debate on stem cell research reached a crescendo because President Bush had to decide whether or not to forbid US Government funding. In the end, Bush permitted very limited funding of stem cell research<sup>10</sup>. Britain did not enact legislation to limit therapeutic cloning any further.

The issue of genetically modified (GM) crops also became highly polarised during Aaron's tenure as president. The scientific side, led by the Royal Society, portrayed itself as the embodiment of dispassionate truth, while the press attacks were entirely *ad hominem*. Broadly speaking, the press maintained that the whole exercise was a tremendous cover up with vested interests extending at least to the President of the United States. Conspiracy theories tend to be popular and help sell newspapers. In September 1998, the Royal Society felt that some issues should be clarified and issued its first report on the use of GM crops, entitled 'Genetically Modified Plants for Food Use'. The chairman of the group producing the report was Peter Lachmann, Biological Secretary of the Royal Society. The report emphasised the benefits of GM plants in agriculture, medicine, nutrition and health, especially in alleviating food shortage in developing countries. Lachmann quickly became a target of the anti-GM food lobby.

No peer-reviewed studies investigating the safety of GM food had been published before 1995, when the Scottish Office of Agriculture (SOAEFD) commissioned a three-year project, 'Genetic engineering of crop plants for resistance to insect and nematode pests: effects of transgene expression on animal nutrition and the environment'. The collaborating institutions were the University of Durham, the Rowett Research Institute (RRI) in Aberdeen and the Scottish Crop Research Institute (SCRI). The role of the RRI was to determine the level of expression of the inserted transgene products and to determine any effects on rats. Three genes were selected: snowdrop lectin (*Galanthus nivalis* agglutinin, GNA), jackbean lectin (concanavalin A or ConA, known to be toxic to higher animals) and the *Phaseolus vulgaris* or

<sup>10</sup> President George W. Bush decreed that federal funds might be awarded for research using human embryonic stem cells if the derivation process for those cells (which begins with the destruction of the embryo) had been initiated prior to 9:00 pm EDT on 9th August 2001. Many of the cell lines thus derived were not very useful.

common bean lectin (PHA)<sup>11</sup>. They were chosen for their effects on insect pests and differences in the severity of the effects of purified protein on the mammalian gastrointestinal tract. Target crops were potato, oilseed rape and strawberry. Árpád Pusztai, a member of the RRI team, stated in an interview on a 'World in Action' programme (Granada Television) that he had misgivings about GM crops: his group had observed damage to the intestines and immune systems of rats fed the genetically modified potatoes. He also said, 'If I had the choice I would certainly not eat it,' and 'I find it's very unfair to use our fellow citizens as guinea pigs.'<sup>12</sup> For the anti-GM movement, this looked like the Holy Grail.

The results that Pusztai quoted in his interview were a comparison of rats fed ordinary potatoes and rats fed potatoes with genetically inserted GNA. He maintained that the rats on the GM diet grew less well and had immune problems, even though the lectin itself caused no adverse effects at high concentrations. His conclusion was that the GM process had somehow made the potatoes less nutritious. But the GM potatoes were not a commercial variety and were never intended for human consumption: nobody was being used as a guinea pig. Furthermore, newspaper stories generated confusion over the nature of the genetic modification. The data Pusztai cited were concerned with GNA, but the press articles refer to potatoes modified with the lectin from jackbean (ConA), known to be poisonous to mammals. Subsequent work has shown that even the ConA-containing potatoes are not detrimental at the levels of expression achieved in potatoes. However, this does little to convince the anti-GM lobby.

James suspended Pusztai for speaking in public about unpublished collaborative work. He also set up a committee to re-evaluate the data. Although that committee concluded that there was no statistically significant support for Pusztai's conclusions, 23 European and American scientists released a memo supporting Pusztai, who acquired a reputation as a victimised 'whistleblower'.

Because the controversy impinged on the conclusions of the 1998 Royal Society Report, in April 1999 the Society convened a Working Group to examine Pusztai's evidence that genetically modified

<sup>11</sup> Lectins are proteins that bind selectively to certain sugars. GNA binds the sugar mannose.

<sup>12</sup> Quoted by James Randerson, *The Guardian*, 15th January 2008.

potatoes adversely affected the health and growth of rats. The group was chaired by Noreen Murray, known for helping to develop a vaccine against hepatitis B. Other members were Brian Heap (Foreign Secretary of the Royal Society), William Hill, Jim Smith, Michael Waterfield and Rebecca Bowden (Secretary). In June the Working Group concluded<sup>13</sup>:

*... it appears that the reported work from the Rowett [Institute] is flawed in many aspects of design, execution and analysis and that no conclusions should be drawn from it. We found no convincing evidence of adverse effects from GM potatoes. Where the data seemed to show slight differences between rats fed predominantly on GM and on non-GM potatoes, the differences were uninterpretable because of the technical limitations of the experiments and the incorrect use of statistical tests.*

This took the wind out of the sails of the anti-GM lobby, albeit temporarily. There was little in the way of hard data to back up the contention that GM foods were harmful. Pusztai's experiments were eventually published as a letter in *The Lancet* in 1999. Because of the controversial nature of his research, the letter was reviewed by six reviewers – three times the usual number. Although two of the referees advised rejection, the Editor, Richard Horton, decided to publish anyway. The letter reported differences between the thickness of the gut of rats fed genetically modified potatoes and in those fed the control diet. Richard Horton, in his editorial, admitted that the paper was controversial. Peter Lachmann had phoned Horton to urge him in strong terms not to publish bad science (Lachmann was dismayed that the polemic of the anti-GM lobby was preventing the use of genetically modified crops beneficial in many developing-world situations<sup>14</sup>). At this time Lachmann was no longer an officer of the Royal Society and his phone call was in no way connected with the Society. Horton reported that Lachmann had threatened him with dire consequences if he dared to publish and implied that the Royal Society were out to get him. For the popular press, no holds were barred: GM was evil, and the defenders of GM, including the whole of Tony Blair's government and the Royal Society, were all in the pay of Monsanto. The papers strove to outdo

<sup>13</sup> *Royal Society Report* (June 1999) Ref: 11/99.

<sup>14</sup> Peter Lachmann's viewpoint is set out in a chapter entitled 'Genetically Modified Organisms' in *Panic Nation*, ed. S. Feldman and V. Marks, published by John Blake (2005).

each other in a crescendo of allegations and innuendo. Even the serious-minded *Guardian*<sup>15</sup> reported Peter Lachmann's alleged intimidation of Horton and then maintained that the Royal Society was actively intervening in support of the pro-GM lobby:

*According to a source the Royal Society science policy division is being run as what appears to be a rebuttal unit. The senior manager of the division is Rebecca Bowden, who coordinated the highly critical peer review of Dr Pusztai's work. . . The rebuttal unit is said by the source to operate a database of like-minded Royal Society fellows who are updated by email on a daily basis about GM issues. The aim of the unit, according to the source, is to mould scientific and public opinion with a pro-biotech line. Dr Bowden confirmed that her main role is to coordinate biotech policy for the society, reporting to the president, Sir Aaron Klug. However, she and Sir Aaron denied it was a spin-doctoring operation.*

At the Royal Society, the idea of Beccy Bowden spin-doctoring seemed quite droll. A month later, in his address at the Anniversary Meeting<sup>16</sup>, Aaron attempted an even-handed appraisal:

*There is one art whose usefulness has been much debated – if that is the right word! – over the past year or two. I have got this far without explicitly mentioning genetically modified plants, but I cannot avoid the issue. We have been accused of many things during the year, including 'breathtaking impertinence' for daring to review formally unpublished experimental data, but from which conclusions were drawn that were said to underpin anti-GM claims being vigorously pushed by certain pressure groups. It was also said that we had 'absolutely no remit' to get involved. These accusations entirely miss the point. We have been involved in the GM debate, not because we have a particular mission to defend the interests of biotechnology, still less because of vested financial interests (as some have tried to impute), but because of what I mentioned earlier: the Society's twin concerns with the values of science and with the useful arts. Where relevant, the Society is determined that public policy should be based on the best available science, rather than on propaganda or emotion; and, where a new technology has the potential to offer real*

<sup>15</sup> Flynne, L. and Gillard, M.S. *The Guardian* 1st November 1999.

<sup>16</sup> Klug, A. (2000) *Notes Rec. Roy. Soc. Lond.* 54, 99–108.

*practical benefits, the Society is determined that that potential should be fully examined along with the possible risks. In our work on GMs we are following the tradition of our predecessors: it is of a piece with our history over the last 340 years. And we are committed to maintaining that tradition with increased vigour and effectiveness in the years to come.*

A strange aftermath was an article in the *Financial Times* on 3rd March 2000 by Clive Cookson, maintaining that Aaron had been cautious and inward-looking as president, and that he had frustrated the Royal Society's attempt at a thorough review of GM foods. Perhaps the comment reflected Aaron's attempts to keep the debate in the realm of objective decision-making. The injustice of the *Financial Times* article was galling. In point of fact, during Aaron's presidency the Royal Society had been outstandingly active *pro bono publico* on a range of contentious issues. Three vice presidents of the Society, Patrick Bateson, John Enderby and Brian Heap, wrote a joint letter<sup>17</sup> of protest to the editor of the *Financial Times*:

*...He (Aaron Klug) brings to the Presidency intellectual rigor and integrity, penetrating insights and knowledge of a staggering array of fields, both scientific and cultural. He has been at the forefront in engaging the Society in matters of great importance. Far from frustrating the Royal Society's thorough review of the claims about GM foods he has insisted that it go ahead. . .*

– a fitting tribute to Aaron's presidency.

On 4th August 2000, Queen Elizabeth the Queen Mother was 100. Since she was a Royal Fellow, Council determined that she should be invited for tea. The Royal Society had apparently grossly underestimated the resilience of the elderly lady, since the invitation quickly elicited the response that she would rather come for lunch. The date was fixed for 1st June 2000. This was a remarkable occasion. First there was a small reception during which the Queen Mother went round the room and had a long chat with Miriam Rothschild; then lunch. Eight Fellows whose age exceeded 100 years were invited, and three of them came. At lunch the Queen Mother sat with Aaron on her right and an ancient Fellow on her left. Aaron asked how she was getting along with her

<sup>17</sup> Aaron Klug collected papers in the Churchill Archive Centre, Cambridge

elderly neighbour, who was obviously hard of hearing, to which the Queen Mother responded robustly: 'It's OK. I just shout!'

In the Society, there was a tradition that a quinquennial dinner should mark the end of a presidency. In recent years this has fallen into abeyance, but in 2000 it was thought appropriate for Aaron and Liebe to hold a President's Reception and Dinner. Furthermore, the event was honoured by the presence of the Queen and the Duke of Edinburgh. The dinner on 22nd November 2000 was attended by the vice presidents, the president-elect Robert (Bob) May and the Executive Secretary and their wives (Plate 6).

The guests included Max Perutz and seven other Nobel Prize winners. George Porter came as an ex-president with a particularly close friendship with Aaron. The guest speaker was Lord John Browne, the Chief Executive Officer of British Petroleum. John Browne was a Cambridge-trained chemist who lived in Madingley, a village adjoining Cambridge, and was friendly with the Klugs. Three Royal Society Fellowship holders from China were also present. The Queen received a posy before touring the exhibits, then she left. The Duke was pleased to stay for dinner. In his speech John Browne summarised the trials and tribulations of Aaron's presidency and pointed out how fortunate they all had been to have Aaron's concentrated intelligence to help them steer through a difficult five years from which the Society had emerged stronger and more effective.

Aaron's presidency ended with the Anniversary Meeting on 30th November 2000. His valedictory address included a wide-ranging discussion of the sequence of the human genome, which had been released in a preliminary form in June 2000 and was published (99.9% complete) in *Nature* on the 15th February 2001. As recounted, the LMB had been a prime mover in getting this project set up. Aaron summarised the development<sup>18</sup>:

*The biology of the nematode worm, C. elegans, had been a subject of study in the Laboratory [of Molecular Biology] as a model organism. To facilitate understanding of its genetic programme, John Sulston undertook a mapping of its genome. . . . On completion of the genome map, in 1990, Sulston, in collaboration with Robert Waterston's laboratory at*

<sup>18</sup> Klug, A. (2001) *Notes Rec. Roy. Soc. Lond.* 55, 165–177.

*Washington University in St Louis, Missouri, began sequencing the C. elegans genome. This consists of about 100 million DNA bases, and was thus a formidable objective. I was then Head of the LMB and encouraged Sulston to go ahead. Sulston was supported by the Medical Research Council and Waterston by the US National Institutes of Health, the NIH. This was a bold step, undertaken at a time when people worldwide were still talking about the problems of genome sequencing of complex organisms, debating whether to wait for better biochemical techniques and more advanced automation. Sulston and Waterston simply got on with it, using whatever techniques were at hand, improving them, and incorporating advances. Moreover, there was concern about the possible cost. . . The nematode project therefore came to be looked on as the touchstone, or indeed pilot project, for human DNA sequencing. I well remember Jim Watson, who by then had become head of the potential US effort at the NIH, telling us that, if the cost of DNA sequencing could be reduced to 50 cents a base or less, he could get the go-ahead for human genome sequencing to begin in the USA.*

*By 1992, not only had the cost of nematode sequencing come down, but long continuous tracts of DNA sequence, over a hundred thousand bases long, had been obtained. Genomic sequencing had been demonstrated. This allowed Sulston and myself to make an approach to the Wellcome Trust, with a proposal to begin sequencing the human genome, based on the experience with the nematode. This led to a joint MRC–Wellcome initiative, in which the MRC continued to support nematode sequencing, while training people and setting up the methodologies for human sequencing, the latter to be supported by the Wellcome Trust. It was in this way that eventually the Sanger Centre was formed, with John Sulston and his colleagues from the LMB forming its core. We, in Britain, owe the Wellcome Trust a special debt for deciding to support human genome sequencing in this country. In 1998, the nematode C. elegans became the first multicellular organism to have its complete genome sequenced, the work having earlier illuminated the way forward.*

The International Human Genome Sequencing Consortium was truly international, but the coordination (and much of the work) was largely a US–UK joint venture. In his address, Aaron stressed the importance of making scientific results public at the earliest possible moment. He expressed his distaste for the attitude of the Celera private human

genome initiative, which published in *Science* at the same time as the *Nature* articles from the International Consortium: the Celera researchers kept their results to themselves but at the same time availed themselves of the public work of the Human Genome Project to order their DNA fragments.

Later in his address, Aaron returned to the threat of global warming. Indeed, he had brought up this topic in each of his Annual Addresses, which led Aaron to liken himself to Cato the Elder, a frequent speaker in the Roman Senate. In every speech, whatever the topic, Cato would end with the comment: *Carthago delenda est*<sup>19</sup>.

In 2000, Aaron was elected to honorary membership of the Japan Academy, which has a similar role to the Royal Society but is even more exclusive since the number of distinguished members is limited to 150. Moreover, it covers both science and the humanities. The Japan Academy extended an official invitation to Aaron to visit so that he could receive the Academy Medal and make a lecture tour. A visit was planned for May 2000 but had to be abandoned on account of Adam's illness. Since the allocated funds would vanish at the end of the Japanese Financial Year, the visit took place in March 2001. Strictly this was no longer a Presidential visit, but even so it carried a Presidential aura.

Setsuro Ebashi, an internationally famous biochemist, member of the Japan Academy, and a foreign member of the Royal Society, was entrusted with organizing the visit. Ebashi discovered the role of calcium ions in stimulating muscle contraction. On account of chronic ill health, he delegated the organisation to Masashi Susuki, a biochemist who had been a visiting scientist at the LMB. Zinc finger nucleases were now proving to be effective for incorporating DNA sequences at specific sites in the genome. The future of gene therapy looked assured, and Aaron was enthusiastic to talk about these developments. On arrival in Tokyo, Aaron was taken to the National Cancer Research Centre where he held a lecture on zinc fingers. This was followed by lunch at the Japan Academy and the presentation of the Medal. Two days later, Aaron visited the National Institute for Physiological Sciences at Okasaki, as Ebashi was President of the Okasaki National Institutes. Aaron gave a talk on zinc fingers and afterwards met Fumio Oosawa from

<sup>19</sup> 'Carthage must be destroyed.'

neighbouring Toyota, who earlier had worked out the mechanism of actin polymerisation. In the evening, Aaron and Liebe were invited to a shabu shabu restaurant by the Ebashis (Plate 7). The tour continued with lectures in Nagoya, Kyoto, Osaka and Tsukuba. On returning to Kyoto, Aaron and Liebe were invited for tea by the Emperor Akihito and Empress Michiko.

In August 2002, George Porter died. This was a shock and a sad loss for Aaron. Over the years, a deep friendship had grown up between them, reinforced by David Klug's very successful scientific apprenticeship with Porter at the Royal Institution. David later moved with Porter to Imperial College, where he is now Chair of the Institute of Chemical Biology. Porter had been elevated to the House of Lords, as Baron Porter of Luddenham, and been awarded the Order of Merit.

Next to Westminster Abbey stands St Margaret's Church, a beautiful Anglican Parish Church often referred to as the Church of the House of Commons. The Royal Society sometimes uses St Margaret's for memorial services, and a Service of Thanksgiving for George Porter was held there on 21st January 2003. Aaron gave the Address, in which he emphasised Porter's discovery of flash photolysis that led to his Nobel Prize and, among many things, to our understanding of the ozone/CFC story. Porter was also very successful in popularising science, an important aspect of his 20 years as Head of the Royal Institution. He was an innovative and engaged President of the Royal Society and fought hard for science funding. Aaron concluded<sup>20</sup>:

*I have tried to convey the breadth of George Porter's public life and the vigour with which he pursued it, but it should be said that, all along, he never gave up the race against time. He won it, by dissecting the minute divisions of time in chemical and biological processes. He retired full of honours and with the satisfaction of having fulfilled his early ambition of 'advancing our understanding of the natural world'. We mark the passing of a great figure in twentieth-century chemistry and in British science. We give thanks for his life.*

<sup>20</sup> Klug, A. (2003) *Notes Rec. Roy. Soc. Lond.* 57, 261–264.