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ALEXANDER GEORGE OGSTON
30 January 1911—29 June 1996

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Elected F.R.S. 1955

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For science is more than the search for truth, more than a challenging game, more than a profession. It is a life that a diversity of people lead together, in the closest proximity, a school for social living. We are members one of another.

A.G. Ogston, 1970 lecture to the Australian Biochemical Society

In 1984, at the age of 73, Alexander ('Sandy') Ogston, with the gentle encouragement of Professor R.B. ('David') Fisher, F.R.S.E., as an interviewer, recorded a videotape of his life and science (now in the Biochemistry Society Archives). A few years later in 1988 he completed a more comprehensive written account in his 'Reminiscences, 1911–1988' (now in the Royal Society Archives). These eloquent records and a published lecture given in 1970 to the Australian Biochemical Society (17)* have provided much of the material for this memoir and are quoted or paraphrased extensively. Unannotated ‘quotes' are from Sandy's own accounts or his papers.

SCIENCE

Ogston published his first three scientific papers in 1935 (1–3); in them he used a physical chemical method (potentiometric titration) to investigate the nature of several biologically relevant substances (amino acids, vitamin B₁ and xanthines). Almost fifty years later, in 1982, he published his last paper (21), of which he was the sole author; it also applied physical

* Numbers in this form refer to the bibliography at the end of the text.
chemical principles (kinetic and equilibrium parameters) to a biologically relevant problem (enzymically catalysed reversible reactions). Essentially all of Ogston's work between these publications had this same theme: the application of physical chemistry to biology. He claimed not to be irrevocably committed to any particular biological problem or to any particular physicochemical method, and described the span of his work in typically self-deprecating terms as 'rather a kind of grasshopper existence' putting his 'oar into this or that thing'. In reality he was a deeply committed physical chemist who found many puzzling problems in biology irresistible, and who constantly kept himself informed in a variety of fields. It is therefore not surprising that any selection of Ogston's most significant publications spans a wide range of problems. Most of them also illustrate Sandy's intellectual signature: an ability to arrive at simple solutions to complex problems. In addition, despite his assertions to the contrary, there is one long-term problem to which he returned many times: the complex physical chemistry and biology of hyaluronic acid.

Perhaps the foremost example of Sandy's intellectual ability is a brief one-column letter to Nature (7), published in 1948 at a time when biochemists were deeply involved in deciphering the intermediary chemical steps in carbohydrate and amino acid metabolism. The Krebs citric acid cycle, originally proposed by Krebs & Johnson (1937), was being subjected to detailed tests by many investigators, including Wood et al. (1941). These investigators studied the fate of the isotopic carbon after the biosynthesis of oxaloacetate from pyruvate and isotopically labelled CO₂. Hans Krebs (F.R.S. 1947) had postulated in his cycle that oxaloacetate condenses with a second pyruvate molecule to yield citric acid and eventually α-ketoglutaric acid. Because citric acid is a symmetrical molecule, the expectation was that the CO₂-derived isotope in α-ketoglutaric acid would be found equally distributed between its two carboxyl groups: one next to a methylene group and the other next to a carbonyl group. Wood et al. found all the isotope in the latter; they therefore excluded the symmetrical molecule citric acid as an intermediate. A comparable situation arose when Shemin (1946) found that serine isotopically labelled in both its amino and carboxy groups yielded glycine with the two isotopes still in the same proportion as in the input serine; he concluded that aminomalonic acid (a symmetrical molecule) was thereby excluded as an intermediate.

Ogston, in his videotaped interview, describes how he initially accepted these conclusions, but suddenly realized the fallacy of the premise on which they were based: that two identical groups of a symmetrical molecule cannot be distinguished. ‘On the contrary, it is possible that an asymmetric enzyme which attacks a symmetrical compound can distinguish between its identical groups.’ (7). He demonstrated this with a simple diagram accompanied by a brief explanation showing how two seemingly identical elements in a substrate will behave differently when acted on by an enzyme if combination between the symmetrical substrate and the enzyme occurs at three points, with the catalytic activity being at only one of the points.

The Ogston concept of ‘three-point attachment’, conceived in two seconds and written the next day, was widely and rapidly accepted. Indeed, shortly after publication of the idea, Krebs wrote excitedly to Sandy and subsequently spent much of his 1949 Harvey Lecture (Krebs 1949) on the topic. Krebs's lecture included the statement that the 'ideas which Ogston has initiated thus offer a satisfactory explanation for the mechanism of formation of optically active substances in biological material'. Sandy was always somewhat embarrassed by the importance that others placed on an idea that had been conceived in such a brief time!

A problem that occupied Ogston's attention for a much longer time but eventually yielded
to his theoretical treatment was prompted by a observation by McFarlane (1935). Sandy described the situation succinctly in his 1970 lecture to the Australian Biochemical Society (17) as ‘an apparent conversion in the ultracentrifuge of the globulin fraction [at that time only two fractions had been described in plasma proteins] into the albumin fraction to an extent that increased as the total concentration increased’. Ogston was intrigued by this problem to the extent that in the late 1930s he performed experiments on the osmotic pressures of mixtures of proteins, their ultraviolet absorption spectra, potentiometric titration curves and salting out. No explanation was forthcoming. However, the problem continued to interest Sandy sufficiently that after World War II he and his doctoral student J.P. (‘Johnny’) Johnston carefully surveyed the behaviours of mixtures of proteins in the ultracentrifuge. In his reminiscences, Sandy modestly records:

The following June found us with an accumulation of results but still with no satisfactory explanation. I went on holiday leaving ‘Johnny’ to write a thesis. Within a week he wrote to me what in qualitative terms was clearly the correct explanation. I had only to put what became known as the ‘Johnston–Ogston effect’ into mathematical form.

The resulting paper by Johnston & Ogston (4) is an elegant restatement of the problem and of earlier attempts at solving it. Their words (slightly paraphrased) are:

The idea is a very simple one. If molecules of the slower protein move faster in the absence of the faster protein, behind the faster boundary, than in its presence ahead of it, then … the concentration of slower protein above the faster boundary must be greater than below it. So the size of the slower boundary is actually increased, while that of the faster is apparently decreased—when observed refractometrically—by an exactly equivalent amount. It looks as if faster protein is being converted to slower. Since the effect on velocity increases with total concentration, it looks as if conversion increases with concentration.

This is comparable to the way that traffic speeds are affected by traffic density. Automobiles can travel faster when traffic density is low than when it is high and the effect becomes greater as the traffic density (its ‘concentration’) increases. Johnston & Ogston validated their theoretical treatment by demonstrating that the coloured protein carboxyhaemoglobin mixed with \( \gamma \)-globulin (a larger molecule) was more concentrated above than below the sedimentation boundary of the faster-sedimenting protein.

Sandy could transform questions from his students into significant contributions to knowledge. I recall my admiration when an essay describing an obviously impossible metabolic scheme (to generate by cyclical oxidation and reduction an energy-rich phosphate bond in phosphoenolpyruvate from an energy-poor phosphoester bond in phosphoglycerate) was transformed by Ogston into a respectable article in *Physiological Review* (6). This review extended the thermodynamic and kinetic understanding of metabolic sources of energy by developing the idea that gradients of chemical potential can generate energy. Ogston showed that suitable carriers could allow energy to be derived from the coupled transfer of hydrogen from a low partial pressure of oxygen at an initial site of substrate oxidation to a higher partial pressure close to that of molecular oxygen. However, he also stressed that constraints imposed by the kinetics of the system should not be overlooked.

The relationship between thermodynamic and kinetic factors remained a lifelong interest to Ogston: his last theoretical paper (21), one page in length, was entitled ‘A new relationship between kinetic and equilibrium parameters of reversible reactions.’ Less brief was his collaborative treatise with C.C. Michel (20), in which a non-equilibrium thermodynamic
treatment led to 'General descriptions of passive transport of neutral solute and solvent through membranes.' Its 20 pages, the result of three years of work at a time when Ogston was also the President of Trinity College, Oxford, are packed with difficult and somewhat impenetrable equations.

Ogston had a scientific love affair with hyaluronic acid, which first began in 1938 with studies of the oestrus-dependent swelling of the sexual skin of rhesus monkeys (with his brother-in-law John Philpot and Solly (later Lord) Zuckerman, F.R.S.), and continued with work on the contents of synovial fluid, initially with his student and friend Jean E. Stanier. Later work was with J.P. Johnston, B.I. Aldrich, C.C. Curtain, J.H. Fessler, B.S. Blumberg, C.F. Phelps, T.F. Sherman, M. Davis, B.N. Preston, T.C. Laurent, L.W. Nichol and P. Silpananta. In summarizing this work, Ogston wrote (17) that a 'variety of physico-chemical methods established ... [the] particle weight [of hyaluronic acid] and its random chain-polymeric structure' and demonstrated 'its capacity to prevent surfaces from coming into contact under compression'. This last property is vital to the physiology of joints, and might not have been considered by a less biologically inclined physical chemist. 'Each molecule ... occupies an enormous volume of solution. Consequently, at concentrations of physiological interest, neighbouring molecules must overlap or inter-penetrate extensively, forming a continuous mobile net-work of intertangled molecular chain.' However, when mixtures of hyaluronic acid and serum albumin were studied, it became clear 'that the albumin behaves as if it occupied only a fraction of the total volume of solution, i.e. that the hyaluronic acid excludes the albumin from a part of the solution'. Subsequent attempts to determine the exclusion volume turned out to give too low a value, but they stimulated Ogston in 1957 to do 'what proved to be a rather fruitful calculation' (13).

The resulting and elegantly simple equation states that the fraction of volume \( f \) available to spheres of radius \( R \) in a solution containing a length \( L \) of fibres of radius \( r \) ml\(^{-1}\) is

\[
\exp\left[-\pi(r + R)^2 L \right]
\]

Tests of the equation by Ogston & Phelps (14) over the next two years established its validity. The relevance of this work to the theory of gel partition chromatography by Sephadex beads is obvious, and to the behaviour of solutions such as synovial fluid that contain mixtures of proteins and hyaluronic acid. The effect can be quite spectacular, as illustrated by Sandy's experiments with B.S. Blumberg (12) in which a high concentration of protein (but not of glucose) caused hyaluronic acid to 'sediment' upwards in the ultracentrifuge.

The exclusion of proteins from that part of the solution space occupied by hyaluronic acid increases the osmotic pressure of a mixed solution above the value expected from the contributions of its components. Osmotic measurements made with Laurent in Uppsala [(15)] and with Preston and Davies at the ANU [(16)] on mixtures of hyaluronic acid and albumin gave values for excess osmotic pressures in good agreement with the exclusion theory and with the results of dialysis experiments.

(Here Ogston was still investigating the osmotic pressures of mixtures of high-molecular-mass solutes—a physical chemical problem that he had suggested to me for a thesis problem twenty years earlier!) Anomalously high osmotic pressures generated by this type of phenomenon help to explain how polysaccharides trapped in a collagen network allow cartilage to support heavy loads.

By no means were all of Ogston's contributions theoretical. He greatly enjoyed experimental simplicity. A combination of this enjoyment with theoretical considerations led to a series of papers in which he described how to measure osmotic pressures by observing
changes in the diameters of single Sephadex beads (18). Sensitivities were later improved (19), in the same way that bimetallic strips are used in thermostats, by measuring the curving of a bilayer strip of osmotically sensitive polyacrylamide on an insensitive backing (Kleenex).

More complex but no less valuable forays into the design of scientific apparatus included improvements in the optical systems for following the behaviour of boundaries during diffusion (5, 9) or ultracentrifugation (8) and for measuring refractive indices (10). In addition, the need to measure the viscosities of dilute solutions of hyaluronic acid led to improvements in the Couette viscometer (11).

In all, Ogston published over 125 papers. The scientific time span of these is revealing. They began at a time when so little was known of protein structure that serious consideration was given to the possibility that under some circumstances 'globulin' can dissociate into elements that reassoclate to generate albumin. They ended at a time when determining the three-dimensional structures of proteins at the atomic level and the nucleotide sequences of their genes was rapidly becoming routine.

**EARLY DAYS**

Alexander George Ogston, the first of six children, was born on 30 January 1911, in Bombay, India, where his father, Walter Henry Ogston, of firmly Aberdonian ancestry, was a businessman for twenty years. His mother, née Josephine Elizabeth Carter, fourteen years younger than her husband, trained at the Froebel Educational Institute as a teacher, won silver and gold medals at University College London, studying biological sciences, but married before completing her degree. Although neither of Sandy's parents was an academic, his paternal family had a strong academic bent. In the early seventeenth century William Ogston was Professor of Moral Philosophy at Aberdeen. Sandy's great-grandfather, Francis Ogston, was Professor of Medical Jurisprudence, also at Aberdeen. His grandfather, (Sir) Alexander, became Surgeon in Ordinary to Queen Victoria but did not wish his sons to become doctors. Sandy's oldest sister, Flora Jane (married to John St.L. Philpot), trained in biochemistry at Cambridge and became a professional biochemist; his brother Walter Mactavish, an engineer, obtained first class honours at Oxford; his third sister, Josephine Alice Coreen, married to M. Weatherall, was Reader in Pharmacology at the London Hospital.

When Ogston was three, his family returned to the UK and lived in and around London. From ages eight to thirteen years he attended Kingston Hill Preparatory School, where his headmaster thought his classics good enough to get him into Eton, although his mother had thought that, as a potential scientist, he might go to Oundle. He was, in the end, offered scholarships at both, at Oundle for his Latin and at Eton for his scientific promise. This was recognized by the Eton head science master on the basis of Sandy's answer to a question on tides and trade winds in the general paper, a topic that had been covered by the only formal scientific subject (physical geography) taught at Kingston Hill! At Eton, Sandy began as a classics scholar but 'drifted into chemistry'. Although initially considering Cambridge, he was urged by his chemistry teacher, himself an Oxford graduate, to try for Balliol College, Oxford. Partly as a result of mathematical prowess (one of the three best at Eton), illustrated by his scoring an $a-$ on an optional additional mathematics paper on which no question was familiar, Sandy was awarded a Brackenbury Scholarship (Balliol's highest). An unfeared use of mathematics remained another Ogston characteristic throughout his scientific life.
At Balliol, Ogston’s first (eight-week) term, 1929, under the tutorial guidance of Harold (later Sir Harold) Hartley, F.R.S., proved to be a formidable introduction to the principles of physical chemistry. It was entirely spent studying methods for determining the atomic masses of elements, with all reading confined to original papers, some more than fifteen years old. After Hartley left for industry shortly thereafter, Ogston was tutored by David Murray-Rust, a temporary lecturer at Balliol, with electrochemistry, quantum chemistry and stereochemistry as particularly enjoyed subjects. Despite being ‘only a moderately diligent student’ for much of his undergraduate period, Ogston worked hard towards the end and in 1933 achieved first-class honours in chemistry. His appetite for research had been whetted by a term in his second year during which he performed ‘unconvincing’ experiments in electrochemistry in the Balliol/Trinity laboratory originally set up by Harold Hartley in the cellars of staircase XVI at Balliol.

As a means towards a career in academic science, in 1933 Sandy applied for and was granted a limited-period Junior Demonstratorship in Balliol. He was now a don and a member of the college Senior Common Room—at least for two years! One of his duties was to help supervise the work of undergraduates in the Balliol/Trinity laboratory, and he was also responsible for the first-year university lectures on electrochemistry. His enjoyment of electrochemistry and questions asked by his sister Flora, who was reading biochemistry in Cambridge, were the causes of Ogston’s transition into biochemistry, and of his first scientific paper in 1935 (1) in conjunction with a Balliol undergraduate, J.F. Brown, aimed at determining whether amino acids in aqueous solutions were doubly charged zwitterions.

This work in turn led to Ogston being invited to move his site of work from the Balliol/Trinity laboratory to the Department of Biochemistry with the task of investigating the electrochemical behaviour of vitamin B₁ (2), whose structure Professor R.A. (later Sir Rudolph) Peters, F.R.S., was trying to determine.

By now Ogston was married and hoping for more permanent work at Oxford. None being forthcoming, in 1935 he accepted a Freedom Research Fellowship to work on proteins with Ensor R. Holliday at the London Hospital. Their joint attempts to understand how antibodies differed from normal serum globulins by using spectrographic (Ensor) and titration (Sandy) methods were twenty years in advance of the knowledge and technology necessary to yield any relevant data. However, it was during this period that Ogston first became interested in apparent anomalies in the ultracentrifugal behaviour and osmotic pressures of mixtures of proteins that became a recurring theme in his research.

To pursue what he now recognized as his preferred field of research, the physical chemistry of biological systems, Ogston decided that, to become independent, he would need some systematic knowledge of physiology and biochemistry, and was planning to take a year off work to do this at Oxford. He was also trying to arrange for an Oxford DPhil, on the basis of previous and continuing research to be performed under the pro-forma supervision of R.P. Bell (F.R.S. 1944) (by then Hartley’s successor at Balliol). The opportunity to accomplish all these aims presented itself in 1937 when Balliol offered him a Fellowship and agreed that he could spend the first year reading honours physiology while at the same time performing the tutorial teaching of first-year and second-year medical students. ‘David’ Fisher and Humphrey Leach were his tutors. He chose to sit the final examination, a voluntary choice because he was overstanding for honours, but was unable to obtain any measure of his success because his examiners were barred from revealing this and in any case on encountering an Ogston script had said, ‘Oh, we needn’t read that’.
After completing honours schoolwork, Ogston was able to take up fully his duties as a Tutorial Fellow in Balliol and was appointed Departmental Demonstrator at the Department of Biochemistry in 1939. These two appointments carried with them heavy teaching responsibilities. During the three eight-week terms he was responsible for as many as forty students and had primary responsibility for selecting biology students for admission to Balliol on the basis of their scholarship and entrance examinations. My first remembrance of Sandy (in 1943) was when he asked me, while attending the annual scholarship examinations, whether I would take an intelligence test whose results would not be used in making decisions on the scholarships. This test, administered by Sandy, and a mathematics paper similar to his own at the same stage, are all that I remember of the proceedings. Like Sandy, I later heard the results of my maths paper, but I never did hear how (un)intelligent I was. For Sandy, terms were busy, but he made a resolution that he kept for all his scientific life: never, except for teaching or college business, to work after dinner or between Saturday lunch and Monday morning. The generous Oxford University vacations were the time for research.

For twenty-two years from 1938 to 1960 (with a few breaks during World War II) Ogston carried the full load of tutorial teaching of medical students and later of biochemists. The challenge of covering the whole of the field, not just his own speciality, was always there; and watching and helping students mature never became dull. Teaching and learning from his cleverer students was exciting, but 'it was the less able that [he] felt best able to help'. His pupils became to him, almost like his own children. '[He] was delighted by their successes, hopeful for their hopes, distressed by their failures, anxious about their anxieties'.

WORLD WAR II

Somewhat exhausted from the intense first year of Balliol teaching and his own studies, Sandy cast around in 1939 for a new line of research. John Philpot and David Fisher, knowing of his interest in osmotic pressure, thought he might enjoy working on the exudate that could be obtained from the swollen sexual skin of female rhesus monkeys during oestrus. In typical fashion, he guessed the nature of the expressed 'mucin' and devised ways of fractionating it. This was his introduction to hyaluronic acid.

When war broke out, Sandy, although reserved from military service as a teacher of medical students and a scientific researcher, joined R.A. Peters's external research team of the Ministry of Supply. The team's aim was to find a non-toxic reagent able to compete with tissue substances in converting mustard gas into a non-toxic derivative. John Philpot and Lloyd Stocken devised and made reagents; Sandy investigated the ratio of the reaction of activated mustard gas with the test substances relative to water; and Ensor Holliday tested their biological effectiveness. Although the best were 10 000 times more reactive than water, none proved biologically effective.

After the chemical warfare work ended in 1943, Ogston worked for the Inter-Service Research Bureau (ISRB) for about two years. The only recorded work that he did in this context included the direct testing, by himself during a solo expedition up the side of Ben Macdui, of the utility of compact rations devised by ISRB. He was also assigned the job of designing medical packs to accompany French doctors parachuting to aid the Maquis. On protesting his unsuitability for this assignment, since he was not a medical doctor, he was told that if he would not do the job someone even less suitable would have to.
In 1944, at age thirty-three, he chose to return to Oxford, believing that the war would end before anything more that he could do would have any effect. To my good fortune, this meant that he could resume his teaching, including lectures on the application of physical chemistry to biological problems. I was enthralled, and decided to take a second degree in chemistry and to work for my doctorate under Sandy's guidance.

POSTWAR WORK AT OXFORD

For sixteen years from 1944 to 1960, the Ogston family (himself, Elizabeth, three young daughters and later a son) lived in a modest college house at 5 Mansfield Road in Oxford. During this period, Sandy developed his professional life. In college he had his tutorial duties. At the department he devised and conducted experimental and lecture courses. In the early 1940s he also first suggested the desirability of having the Honours School of Biochemistry and helped to develop it. Before establishment of the school in 1948, biochemistry was included as an unnamed part of the Honours School of Physiology. For his research laboratory he chose a pattern to which he adhered for many years. The theme of the laboratory was physical biochemistry. He aimed at having at any one time several (never more than three) predoctoral research students and a more senior postdoctoral collaborator. He had 'inherited' from John Philpot the Svedberg ultracentrifuge—one of fewer than half a dozen in the world at that time. Its optical system extended through two rooms and it was installed on a deep concrete pier. With it went the obligation of making ultracentrifuge measurements for other investigators. This obligation was made less onerous, and even enjoyable, by Sandy's being able to enlist the services, as a graduate assistant, of Rupert Cecil. Rupert, a distinguished ex-bomber pilot, understood the intricacies of this monstrous machine, and worked harmoniously in maintaining and operating the instrument while still developing his own research.

The decade 1945–55 was Ogston's most enterprising and productive period. It was during this time that the long-sought solution to the ultracentrifugal anomaly was reached, as the Johnston–Ogston effect (1946), and the Ogston three-point attachment paper was written (1948). He was elected to the Fellowship of the Royal Society and appointed as a Reader in Oxford in 1955.

A window into Ogston's view of science and scientists is opened by his description of his attendance at a 1950 Gordon Conference in New Hampshire, USA, on the Physical Chemistry of Proteins. These annual conferences with rarely more than 100 attendees cover a wide range of special topics and are held in isolated small rural colleges (the American equivalent of public schools) with quite austere accommodations. Sandy greatly enjoyed this particular conference, with its sessions held in the mornings, between tea and dinner, and after dinner. The informal afternoons allowed him to teach other participants how to play croquet 'properly' (more likely ruthlessly).

In the same year he was asked, as a result of his having written the review of oxidative phosphorylation, to substitute for R.A. Peters at the annual Solvay Conference in Brussels. It was 'as different an affair from the informality of the Gordon Conference as could be imagined.' The sessions were held in a large room, and the papers were delivered with great formality. Sandy must have conveyed to his students his sense of the difference between these ways of approaching science. Certainly I continue to enjoy the informal atmosphere and
rigorous science of the compact Gordon Conferences (still held) infinitely more than the
formalities and inaccessible science of the gargantuan International Congresses that now
pervade the biological–medical field.

In 1955 Ogston attended a conference in Australia, the First International Wool
Conference. He clearly enjoyed this visit to Australia and spent a week in Canberra at the
Australian National University (ANU). He was asked by Professor Hugh Ennor, Acting Dean
of the John Curtin School at ANU, whether he might be interested in joining the university,
and responded that he ‘would certainly consider such a proposal’.

By now Ogston was being sought by other universities. He visited Birmingham and
received an offer of the Chair in Biochemistry, another from Imperial College and a third
from Edinburgh. Understanding well, but having little relish for, the financial and
administrative tasks of large teaching departments, he refused all three. However, the offers
made him question whether he wished to continue at Oxford for the remainder of his working
life (perhaps twenty more years) and whether he would remain effective for so long. As a
result, when in 1958 he received a firm invitation to establish a small new department of
physical biochemistry in the John Curtin School at ANU (in contrast to taking over a large
old one), he accepted the job for at least five years. He was fortunate to be able to appoint
Hugh A. MacKenzie as his second-in-command, who would start to set up the department
before the move to Australia.

THE AUSTRALIAN YEARS, 1960–70

For the whole of their stay in Australia, the Ogstons lived in a house, 27 Lawson Crescent,
Canberra, that belonged to ANU, and was only a few minutes walk from the John Curtin
School (one of the four research schools comprising the university). Ogston organized his new
department in four groups. Each group had a permanent head and was able to perform
independent work in the field of macromolecules. Under the group heads were research
fellows, research scholars, graduate assistants and technical assistants.

The group heads, in addition to Ogston, were McKenzie (milk proteins), A.B. Roy
(sulphatase enzymes) and J.R. Dunstone (cartilage components). In his own research, Sandy
followed up previous lines of thought and, in the absence of teaching of medical students,
tended to revert more to pure physical chemistry. Hyaluronic acid once again held his
attention, and with B.N. Preston as a Research Fellow and M. Davies as a Research Scholar
he carried out a concerted attack on its physicochemical properties. With J.R. Dunstone and
students Elizabeth Edmond and Susan Farquhar he returned to his fruitful investigation of
the interpenetration or the lack thereof of various polymers in solution, in this case the
exclusion of randomly coiled high-molecular-mass linear dextran from slightly cross-linked
polymers (Sephadex beads). With the use of P.J. Flory’s treatment of the swelling of gels, the
internal osmotic coefficients of the Sephadexes were shown to be similar to those of high-
molecular-mass dextran. One outcome of this type of thought was the single-Sephadex-bead
osmometer, which Sandy devised (18), and its ‘bi-metallic strip’ improvement (19). In his
reminiscences, Sandy laments that ‘of the forty-six papers based on work during this period,
only ten were under my name alone, and only one of those was experimental’. Few
chairpersons of even small departments can look back at ten years of work in the period 1960
to 1970 and find any, let alone ten, papers on which they were the sole authors!
Ogston's initial promise of staying at ANU for five years was fulfilled by the time that in 1966 he was offered the (Whitley) Chair of Biochemistry at Oxford in succession to Sir Hans Krebs. For reasons similar to his earlier refusal of chairs of large departments, he declined the invitation. But again the invitation made him think, this time of returning to teaching as a lecturer at one of the new universities in England. Quite unexpectedly, however, he was shortly thereafter asked if he would allow himself to be considered for election as President of Trinity College (over the wall from Balliol and a long-time rival). With no hesitation, he accepted. Knowing something of the life of the head of a college at Oxford, he felt that he could do the job and would enjoy it. So began in earnest the phase of Sandy's life devoted to helping others to achieve their vocations, presaged already by his chairmanship at ANU, and by his service from 1952 as a member and subsequently from 1955 to 1959 as Chairman of the editorial board of the Biochemical Journal.

TRINITY COLLEGE, 1970–78

Something around half the time of the president of an Oxford college is likely to be spent on college business, with the allocation of the remaining time depending on the tastes of the individual, including university business or scholarly or worldly or even leisure activities. Sandy, with enormous help from his wife Elizabeth, chose to make the college the centre of his interest, as had been hoped by the Governing Board of Trinity. Research was to be secondary, to be performed in the Department of Biochemistry as time allowed. Because Trinity in the early 1970s was a relatively small college (about two hundred undergraduate and fifty graduate students), Sandy could resume the direct contact with students at their transition into adulthood that had been such an important part of his earlier Oxford days but had been lacking at ANU. Past custom at Trinity College was for the tutors (Fellows and Lecturers) to meet with the President during the last week of term and report on their students' progress, or lack thereof. Sandy continued this custom but changed the time of seeing the graduate students to the beginning of term, when written reports from their supervisors on their previous term's performance would be available and the pressure of time was less. However, an average of four minutes for each meeting was not sufficient to satisfy Sandy's overriding wish to know and help his young men (the Oxford colleges at that time were still gender-segregated). He and Elizabeth therefore decided to have an evening encounter with every student at least once a year by inviting a batch of ten to twelve to the President's lodging on one day of each week during term. Unfortunately, dinners in the lodgings for so many were too difficult for the college kitchens. Typically, Elizabeth solved the problem by inviting the young men to dessert, accompanied by rather unusual dessert wines (Madeira or Barsac), served with elegant fruit knives on a beautiful service of college plates. An hour of talk around the dining table followed by coffee in the drawing room must have left memorable impressions on those who chose to attend. All who could not attend, except those who neither came nor responded, were re-invited again during the same year. Married graduates and their wives were invited to small dinner parties instead.

The daily business of the college occupied Sandy's weekdays in the study of the President's lodgings from 9.15 to 11.00 a.m., or later as needed. His 'spare time' between 11.00 a.m. and around 6.00 p.m. was spent mainly at the Department of Biochemistry. (He still had one last doctorate pupil, J.D. Wells, who had moved to Oxford from Canberra to complete his thesis.
Alexander George Ogston

Most evenings were spent socially, entertaining or being entertained. No wonder that Sandy described this period as being 'a strenuous life for both of us'.

A college decision made during this period, although quite uncrucial, reveals the sense of continuity that characterizes the old universities. The stucco and stonework on the east end of Chapel, and on some outer walls of the Garden Quad, needed refacing, either by stone or by concrete blocks and stucco. The latter would save £30 000 but would have a life expectancy of one hundred years rather than the four hundred years of stone. Sandy's remark, that the difference spread over three hundred years was cheap at the price, convinced the governing body. 'How good it was to belong to an institution that could look forward with confidence to the next four hundred years.'

Sandy retired from the presidency in 1978, without regrets, after a change in the College Statutes making retirement mandatory at 67. A Victorian mansion in Rawlinson Road, remodelled as a college residence towards the end of Sandy's tenure, was fittingly named Ogston House. He was pleased.

RETIRED YEARS, 1978–96

Sandy's service to others did not cease with his retirement from Oxford. After a year of travelling to Canada, the USA, Australia, Israel and Greece, which still included the giving of seminars and some collaborative theoretical work, the Ogstons chose York as a retirement city, and bought a house on Dewsbury Terrace. It proved to be a happy choice. Collaborations in science continued until Ogston was 75. Nor did Sandy's efforts to help others cease with his departure from Oxford. He had accepted an invitation in 1976 to serve first as Vice-Chairman and in 1981 as Chairman of the Council of Selly Oak Colleges, Birmingham, and he continued this task until 1986, well into his retirement. It was an important part of his life at that time, although unfortunately the duties of chairman did not encourage the close connections with the lives of students and staff members that he so much enjoyed.

A WELL-BALANCED LIFE

Ogston's contributions to academic matters, through original science and through his service on behalf of succeeding generations of scholars, show a breadth that few distinguished scientists can match. Surely this was no accident, for his decision to live a balanced life was made consciously and early. Three leisure activities weave in and out of Sandy's long life: boating, hiking and music. The first began seriously when at the age of 13 during one of the family's annual Deeside holidays he learned to sail a lug-sailed twelve-foot dingy. Holidays in Norfolk when he was 16 and 17 taught him how to progress upwind in narrow waters. At 19, as a young Oxford undergraduate he bought a Norfolk punt, 'Jenny Spinner', which he sailed later on the Thames with his young wife. Racing or organizing races was an occasional enterprise. His first experience in the organizational category was at Eton when as 'ninth man' he had the task of marshalling the annual boat races of the school, hitherto always disorganized and behind schedule. By obtaining from earlier records the slowest time for each type of race and by having late comers disqualified, he succeeded in transforming the event to order and punctuality: a transformation that continued when he left for Oxford. He rowed...
briefly as an undergraduate and was stroke of the second college eight. Canoeing was another Ogston signature. During his early days in Oxford, Sandy had purchased for £10 a used but beautiful wooden canoe from Timm's Boathouse. The boathouse had ceased renting it because it was too tippy and their customers always returned wet from excursions. When he was President of Trinity, he and Elizabeth on several occasions watched the Oxford Eights college boat races from this narrow, perfectly varnished but now fifty-year-old canoe after having followed the Eights down the Thames to the start, paddling 'a bit show-off-lishly' in unison from the kneeling position.

Hiking also began in childhood in Scotland and continued to be actively pursued as long as limbs allowed. Active is indeed the word. In Canberra the Australian bush can be dense scrub vegetation with fallen trees beneath a virgin eucalyptus forest. On one occasion Sandy and Elizabeth took 7½ hours to travel 4½ miles! Navigation by pocket altimeter to keep on a contour and by prismatic compass to maintain a sense of direction was at times the only means of knowing one's whereabouts. The Ogstons, with their constant attention to students, involved others in these activities. Graduate students and fellows from University House frequently joined them in hiking, picnicking and swimming expeditions.

Making music began to play a part in Sandy's life when he returned to Oxford after the war. Encouragement by and participation with his doctoral student Jean Stanier, when both were learning to play the recorder in 1946, helped to overcome his diffidence regarding his musical ability, at least sufficiently to enjoy playing if not performing. A term's sabbatical leave in 1951 was spent learning to play a keyboard instrument, and he bought a small Goble harpsichord, which on going to Australia he gave to his daughter Liddie. On his return from Australia he built his own from a kit, being at a loss without one. He never thought his playing good enough for others to hear, but he played regularly for himself.

Religious matters were of great importance to both Sandy and Elizabeth Ogston. During the war, Elizabeth had begun to attend the University Church (St Mary's) in Oxford, and sometimes took the older girls to Sunday School. Sandy began to accompany her to Evensong conducted by the Vicar, Roy Lee. Roy's undogmatic teaching and a gentle encouragement from Elizabeth led to their both being confirmed in 1954. Sandy treasured the rich and varied religious diet provided by St Mary's 'in beautiful buildings, soaked in history'. The Ogstons missed this at ANU, and so varied their continued Anglican connection with attendance at the Meeting House of the Quakers, whose approach to religion they both found very acceptable.

Leadership, not usually sought, was often thrust on Ogston. On being asked to attend the ecclesiastical council meeting (the Diocesan Synod) as a lay member, he agreed on condition that his first action would be to support a motion that women should be eligible for membership in the Synod. The motion was carried without any dissent after Sandy's enraged remarks after titters were evoked by the proposer, 'At the beginning of this Synod we heard an inspired address about not regarding the people of Papua New Guinea as second class citizens. ... Are we to regard half of our [own] people as second class citizens?'.

The Ogstons attended all of the annual Conferences of the Australian Student Christian Movement (ASCM) held while they were at ANU. Sandy tried, with only partial success, to have the 1968 ASCM meeting (which he was co-opted into organizing in Canberra) to be joint with the annual meeting of the Catholic Students Union. His constant wish to do something for undergraduate students, otherwise missing during his tenure at ANU, was fulfilled somewhat by participation in and organizing these meetings.
Alexander George Ogston

FAMILY

I have left until last a mention of Sandy's family—in the literal and figurative senses—because of its absolutely essential role in all of his life. He was courting Elizabeth (née Wickstead) during his early days in Oxford and married her in 1934. They had been married for over sixty years when he died. They had three daughters and a son. As 'Barry' Blumberg, Nobel Laureate in Physiology and Medicine (1976), Sandy's most illustrious student, said during his 1996 memorial ovation, 'Sandy and Elizabeth were loving and extraordinarily compatible. In our later years I hardly ever remember seeing one without the other.'

I was fortunate, in part because of the vagaries of accommodation in wartime Balliol, to be invited to share with Richard Tucker a bedsitting room in the Ogston family home at 5 Mansfield Road. To be a member of Sandy's scientific family was a privilege that many have shared. But to be a member—even if to some degree adopted—of his home family was more than a privilege: it was a joy. The home that Sandy and Liza (I almost never heard him address his wife other than as Liza) gave to their children and to us two wartime adoptees was full of life and humour. We were made welcome despite episodes of sinks stained with potassium permanganate and desperate attempts to bleach the results with other chemicals.

When Sandy died, I wrote to Liza and mentioned what I felt constituted the successful formula for her relationship with him, 'a great deal of affection but at the same time a complete understanding of the weaknesses as well as the strengths of one's spouse, and the courage and sense of security to indicate which is relevant at any particular time'. Her later reply included a quiet statement of the love and affection which Sandy and Liza shared. She wrote that she was 'glad that I have stayed alive longer than he did'. Then, in writing of the early post war days in Oxford and of having had 'a letter from Jean [Stanier] this morning' she continued: 'Now that was the best part of Sandy's life. That gang of you all in the lab, and the undergraduates in Balliol. It was good wasn't it? He was lucky, wasn't he? ... with the people he knew? And all of us were lucky to know him.'

E.M. Southern (Whitley Professor of Biochemistry, Oxford), at about the same time, wrote to me: 'I think that many a young scientist reading [about Sandy] will feel that that is the kind of scientist they would like to be. It is becoming more and more difficult to be like Sandy. We must strive to keep it possible.'

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The frontispiece photograph was taken in 1970 by R. Westen and is reproduced courtesy of the John Curtin School of Medical Research, Australian National University.

REFERENCES TO OTHER AUTHORS


Biographical Memoirs


BIBLIOGRAPHY

The following publications are those referred to directly in the text. A full bibliography appears on the accompanying microfiche, numbered as in the second column. A photocopy is available from the Royal Society Library at cost.