

chemistry

in new zealand



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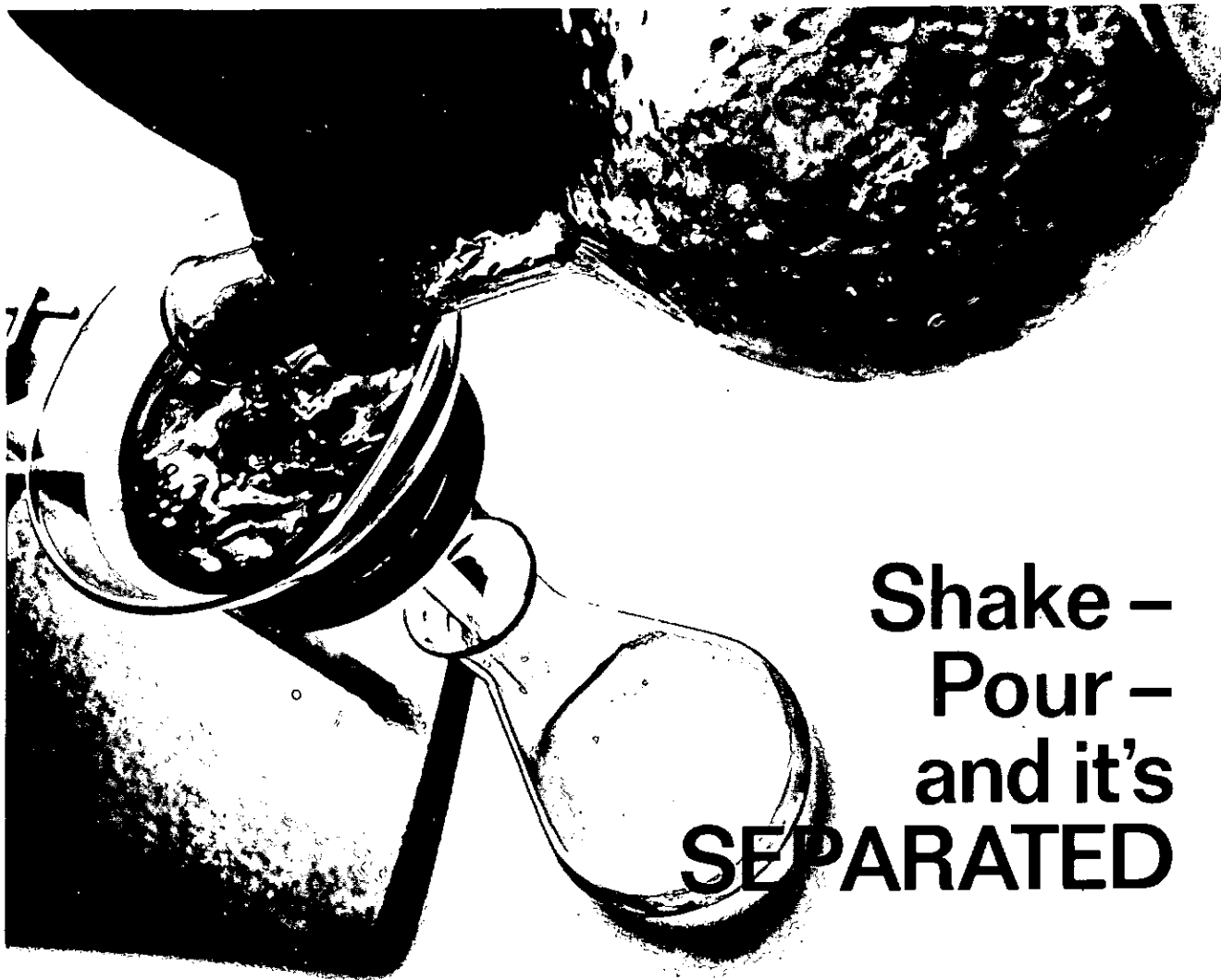
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President 1977-78



The 1977-78 President of the Institute is Dr Graham A. Wright of Auckland. He grew up in New Plymouth and graduated M.Sc. from Auckland University College. After a year's teaching at Auckland Grammar School he went to Oxford University on a Rhodes Scholarship and completed his D.Phil. in the field of reaction kinetics. He then spent a year in Denmark with Jannik Bjerrum working on the electrochemistry of bismuth complexes. Returning to Auckland University as a lecturer in 1962, he has taught courses in physical chemistry and conducted research on electrode kinetics, particularly metal

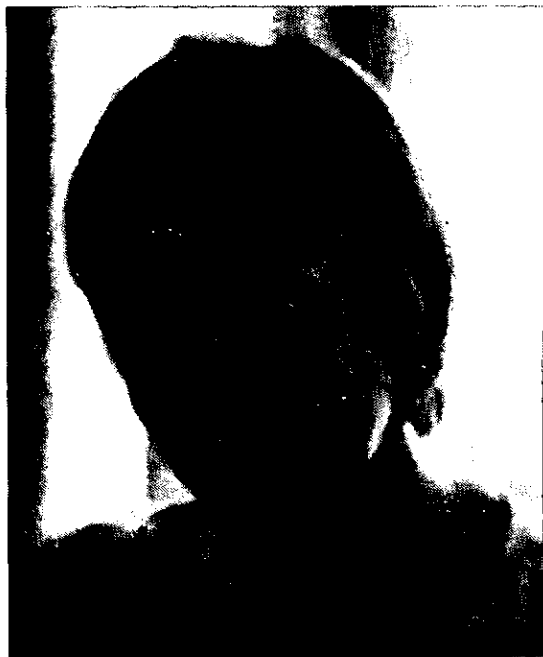
dissolution, passivation and photo-effects in anodic films on metals. He spent 1968 in Copenhagen studying electrode reactions by relaxation methods, and he also pursued his applied interest of metallic corrosion. He is now Associate-Professor in Chemistry at Auckland.

Dr Wright has served as Auckland Branch Chairman in 1972, and has been active in the Auckland University Rugby Club, development of recreational facilities at Auckland University, and the Danish Society. He lists his current hobbies as Danish folk dancing and building a family home.

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Robyn Dormer, Chairman of Auckland Branch for 1978 is currently teaching Chemistry at St. Cuthbert's College, Epsom. She graduated Ph.D. this year in Obstetrics and Gynaecology after working since 1970 at National Women's Hospital, Greenlane. She enjoys bridge, is involved in politics and is currently Secretary of the Independent School's Assistant Teachers Association. She has debated for Auckland University and for the past three years has been Treasurer of the Auckland Branch, N.Z.I.C.



John Watkinson is the Leader of the Soil Chemistry Group of the Soil and Field Research Organisation, Ruakura Agricultural Research Centre, Hamilton. He graduated B.Sc. from Auckland in 1953, and later Ph.D. in chemistry from Victoria University on the kinetics of ion-exchange in soil. At Rukuhia Soil Research Station and its later reorganised forms, he has worked on various aspects of soil chemistry including phosphate, and the trace elements molybdenum, tungsten, vanadium, and more recently selenium. In the detection and prevention of selenium deficiencies in livestock he has been involved in the development of trace methods for selenium, investigation of its reactions in soil, the development of diagnostic methods, and techniques for preventing deficiencies by applying selenium to pasture.

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Lawrie Creamer was educated at Christchurch Boys High School and Canterbury University. He graduated M.Sc. and Ph.D. in Chemistry. Under the supervision of Fischer and Vaughan he had investigated possible mechanisms of several organic reactions. On graduating in 1963 he joined the New Zealand Dairy Research Institute. In 1964 he was awarded a fellowship to carry out protein research in the Biophysics Department of the Massachusetts Institute of Technology. He returned to the Dairy Research Institute in 1966 and is currently Senior Chemist and Head of the Protein Chemistry Section of the Institute.

His interests are diverse and he has made contributions in the areas of casein micelle structure, casein proteolysis in cheese as well as in protein testing and milk payment. He has published about 80 scientific papers. He was awarded the Riddet Memorial Prize by the N.Z. Society of Dairy Science and Technology and the ICI Prize by the N.Z. Institute of Chemistry. He was elected to membership of the Institute of Chemistry in 1962 and to fellowship in 1974. He has served on the Manawatu Branch Committee on several occasions as member, secretary and branch editor. In 1976 he was the founding editor of the NZIC Bulletin and is currently editor of both the Bulletin and Chemistry in New Zealand.

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Michael Kingsford is a graduate from the University of Auckland where he studied plant anthroquinones for a Masters Degree and built and applied a gas chromatograph to essential oils for a doctorate. In 1961 he moved to Petone to become the Foundation Tutor in Pharmaceutical Chemistry, at the N.Z. School of Pharmacy. Five years later he joined the Chemistry Division of D.S.I.R. and shortly afterwards became leader of its food and drug section where he was responsible for supervising quality investigations of food and waters and initiating studies of drug quality. Since that time, the section has grown and been divided into three parts and he has remained with the pharmaceuticals section.

Current research interests include pharmacokinetics and bioavailability of drugs and their decomposition chemistry. He is a member of the Drug Assessment Advisory Committee of the Health Department and of committees of the Testing Laboratory Registration Council, the Standards Association and the Australasian Society of Clinical and Experimental Pharmacologists.

His extramural interests include singing and model railways and has long associations with Church music.

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David Howarth is spending 1978 as a Visiting Lecturer in the Chemistry Department at the University of Canterbury. He graduated M.Sc. at Canterbury in 1968 and taught at Christchurch Boys' High School before joining the Soil Science Department at Lincoln College in 1970 as a Lecturer in Chemistry. In 1974 he returned to his current teaching position at Christchurch Boys' High School.

His primary interest is in the field of chemical education and he is the secretary of the N.Z.I.C. Education Group. In this role he was involved in the organisation of a Symposium on Chemical Education at the University of Canterbury in 1976 and in arranging the publication of the Chemical Education papers from this Symposium and from the Massey Conference in 1975.

Outside of chemistry his main interests lie in sport, where he is a member of the national executive of the Secondary Schools Football Association, and in bringing up a young family.

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George Laws is senior lecturer in the Pharmacy Department of Otago University, where he has been teaching pharmaceutical chemistry since 1967. He came to New Zealand in 1963 to join the M.R.C. Hydatid Research Unit. Although a chemist, his research there became largely biological, culminating in a year at Rice University's Biology Department on an N.I.H. International Postdoctoral Fellowship.

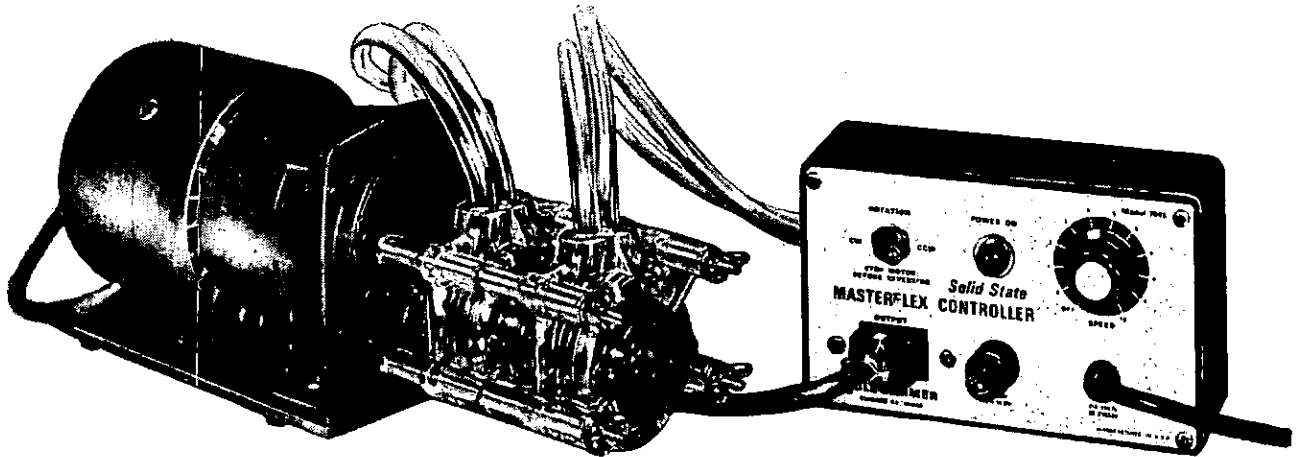
Dr Laws graduated in 1950 as one of the last to take a part-time degree at an Internal College of London University, his daytime pecuniary occupation being provided by May & Baker research laboratories. He took his doctorate in 1953 with Sir Derek Barton and then went to the University of California at Berkeley for two years, continuing his work in the steroid field, this time with W. G. Dauben. Before coming to New Zealand he was for eight years Senior Chemist at Fison's pesticide research centre in England.

Dr Laws spent a sabbatical year at Cambridge University in 1975 with R. A. Raphael synthesizing an antibiotic called Vermiculene but he has a continuing interest in natural product chemistry, and in toxicological matters.

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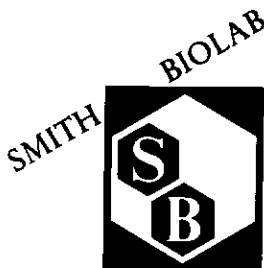
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FEATS OF CLAY, OR MINERAL CHEMISTRY REVISITED

K. J. D. MacKENZIE

Teheran, Iran

To most research chemists, the mere mention of mineral chemistry conjures up visions of murky technology, of dark satanic mills, of pollution, and other matters too earthy to be mentioned. Few scientists apart from those actively working in the field realize that mineral chemistry offers considerable scope for good, fundamental research as well as having practical value in many areas of technology. I hope in this lecture to illustrate these two complementary aspects of mineral research by reference to some of the more interesting investigations I have made over the past fourteen or so years.

In the present context I am using the word "mineral" in the limited sense of an inorganic compound which occurs naturally. This does not however mean that all of these studies were necessarily made on naturally occurring materials; in some instances it has been necessary to work on pure synthetic minerals in order to assist the interpretation of results obtained for the natural material. Work on both natural and synthetic varieties of a mineral is often a most fruitful approach, since such studies provide detailed information about the effect of impurities and structural defects on the behaviour of the material.



Dr K. J. D. MACKENZIE was educated at Victoria University receiving B.Sc.(1963) M.Sc.(1964) Ph.D.(1967) and D.Sc.(1976).

His research topic for both M.Sc. and Ph.D. was "Aspects of High-temperature Solid State Mineral Chemistry, Particularly of Kaolinite Type Minerals." He was

awarded a U.G.C. post-doctoral travelling fellowship and a British Science Research Council fellowship to Sheffield University. Following his return in 1971 to Chemistry Division D.S.I.R., he worked on problems associated with spontaneous combustion of coal, recovery of titanium minerals from steelworks slag etc.

Dr Mackenzie is currently on leave from D.S.I.R. and has the position of Research Professor and Head of Materials Division, Materials and Energy Research Centre, Aryamehr University of Technology, Teheran, Iran.

Since all natural minerals are to some degree impure, this information can have important practical implications for the technologist.

Until about 15 or 20 years ago, mineral chemistry tended to be studied in the main by technologists whose object was purely practical — to improve upon or devise new processes for upgrading commercial minerals and producing useful materials therefrom. Such mission-oriented or trouble shooting activities were not conducive to fundamental research; indeed, if any interesting observations are made by industrial chemists during the course of their work, they rarely have the facilities or time to follow them up. This is more the province of the academic researcher, but until relatively recently, such workers have shown little or no interest in mineral chemistry, preferring to deal with simpler and more tractable compounds which are susceptible to theoretical treatments. Thus, fundamental studies of mineral chemistry tended to be rare, and the field is even today relatively unexplored. The mineral chemist has to be part geologist, crystallographer, spectroscopist and solid state physicist. He has also to be prepared to make calculations based on the grossest approximations, since fundamental data for minerals are incomplete; the ability to assess the effect of an approximation on the end result can often be as important as the calculation itself. This field of research is full of pitfalls for the unwary, but there are often unexpected rewards, since the complex nature of many minerals can give rise to quite unsuspected or even previously unknown chemical behaviour. This is particularly true of clay mineral chemistry, which, as the title of this lecture suggests, has been one of my earliest and abiding interests.

Clay minerals are extremely important economically, being used in the manufacture of ceramics for structural, sanitary and refractory purposes. Since their fabrication into useful products involves heat treatment at some stage, the chemistry of their thermal decomposition inevitably becomes important. One of the most common of the clay minerals is kaolinite, from which man has made bricks and pots almost since the dawn of history. In fact, the firing of clay to form brick constitutes by far the oldest chemical reaction used by man, and yet it was not recognised as a chemical reaction until late last century, when the great French chemist Le Chatelier observed reproducible heat changes during the thermal treatment of clay [1].

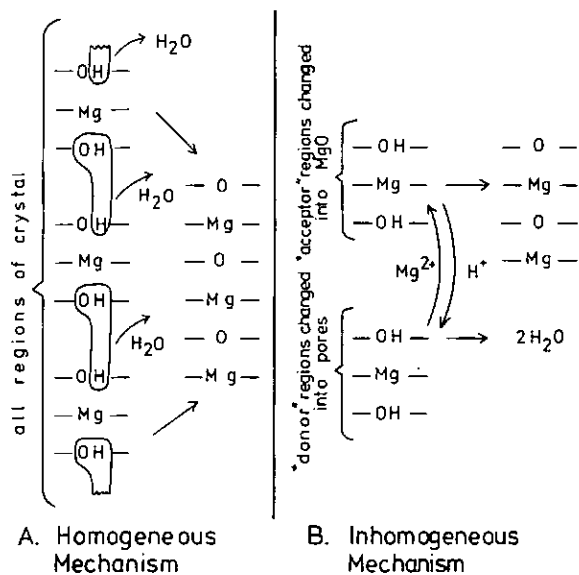
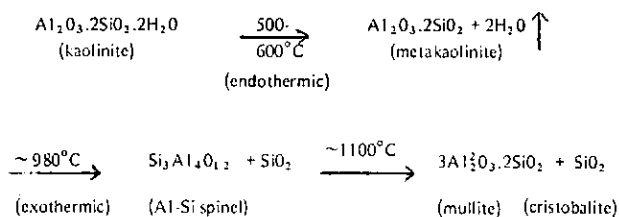


Figure 1. Schematic diagram of the homogenous and inhomogenous dehydroxylation mechanism for $Mg(OH)_2$. After Taylor (ref. 4).

Apart from the partial elucidation, in the early years of X-ray crystallography, of the structures of the initial [2] and final compounds [3] involved in the process, more than 70 years elapsed between the work of Le Chatelier and modern studies of the mechanistic details of this economically important reaction. The reasons for this slow progress are associated with two new problems which have only recently begun to be elucidated, and with which some of my own work has been concerned. The twin problems can be understood by referring to the thermal decomposition sequence, which can be written in unbalanced form:—



The first problem is associated with the formation of the dehydroxylated phase (metakaolinite) at about $550^\circ C$; the questions concern the structure of this phase and the mechanism of its formation. These considerations are important in deducing the later structural course of the reaction since the whole process is structurally sequential. The second problem concerns the nature of the phase which forms exothermically at $980^\circ C$. In both cases, the problem is rendered more acute by the fact that neither metakaolinite nor the product of the $980^\circ C$ reaction have distinct X-ray patterns; a good deal of reliance has therefore to be placed on deduction and indirect evidence.

The question of the dehydroxylation mechanism hinges on two possible alternatives, called the homogeneous and inhomogeneous mechanisms [4]. These can be understood by considering the dehydroxylation of a simpler hydroxide, $Mg(OH)_2$ (Fig. 1).

In the most obvious process, water is formed by reaction between adjacent hydroxyls and migrates from the lattice as such. This is called the homogeneous mechanism, and one consequence of such a process is the gross disruption of the crystal lattice, which is contrary to observation in many mineral systems. For this reason, an alternative inhomogeneous mechanism was postulated [4], in which there is a migration of protons to microregions of the crystal (called donor regions) and a corresponding counter-migration of cations to other microregions (called acceptor regions). Water is then lost from the donor regions, which become pores, and the structural continuity is preserved in the acceptor regions, which become the new, dehydroxylated phase. The question of which of these two mechanisms occurs in kaolinite is important in deducing the structure of metakaolinite, since if the homogeneous mechanism operates, the structure of the new phase need not necessarily bear much relation to the parent kaolinite, but if the inhomogeneous mechanism applies, the two structures should be very similar indeed.

Another related question bearing on the structure of metakaolinite is the way in which the co-ordination number of the aluminium changes during the reaction sequence. The starting material is composed of sheets of Al-O octahedra and Si-O tetrahedra in alternate layers (Fig. 2).

If all the hydroxyl groups are eliminated during dehydroxylation, the co-ordination of the aluminium would be expected to become tetrahedral; some of the first structures proposed about 18 years ago [5] for this phase were based on this premise. About the same time, attempts were made to directly ascertain the co-ordination number (C.N.) by measuring the position of the Al line in its X-ray fluorescence spectrum, which differs very slightly in 6 and 4 co-ordinated compounds. The first measurements [6] were made relative to kaolinite, in which the C.N. is known to be exclusively 6, and to aluminium phosphate (C.N.=4), without the realization that the spectral shift is markedly affected by the nature of the other ions present. The results suggested that the Al in metakaolinite is solely 4 co-ordinated, and since this agreed with preconceived notions of the structure, the method probably would not have been

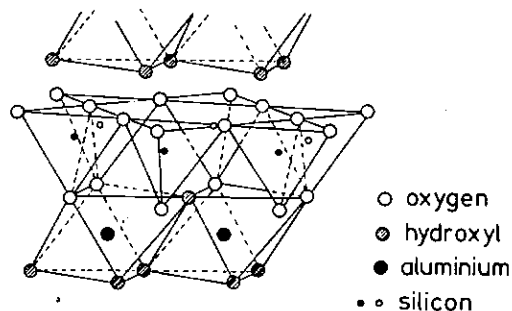


Figure 2. Crystal structure of kaolinite, showing tetrahedral silicate sheet and octahedral hydroxy-aluminate sheet. After Gruner (ref. 2).

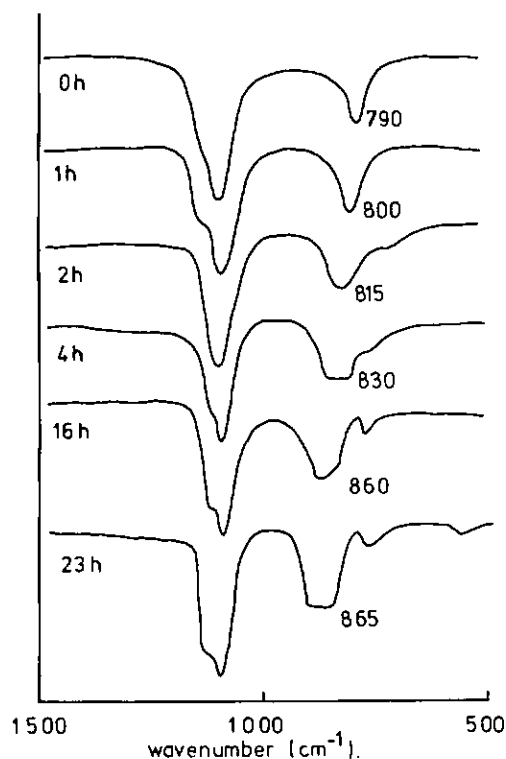


Figure 3. Infra-red spectra of kaolinite heated at 1100°C for various periods, showing the progressive shift of the band at about 850 cm⁻¹. After MacKenzie (ref. 7).

examined critically had it not been for some infra-red data which appeared to be at variance with these conclusions. This infra-red observation [7] was that a particular band in the infra-red spectrum progressively shifted to higher wavenumbers during the course of the reaction (Fig. 3).

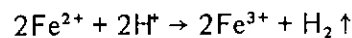
Although there is not complete agreement about the nature of the species giving rise to this particular band, its shift to higher wave numbers suggested that it could represent an octahedral-to-tetrahedral process [8] (certainly not the reverse, as was alternatively suggested [9].) Again, since this shift was continuous throughout the whole process, including the dehydroxylation step, it appears to support the sequence of C.N. changes:

kaolinite	meta-kaolinite	Al-Si spinel	mullite
6	4 + 6	4 + 6	4 + 6
(proportion of 4 C.N. increasing throughout)			

(in which the difference between the phases resides chiefly in the proportion of 6-fold to 4-fold co-ordination) rather than the sequence of C.N. changes demanded by the earlier model for meta-kaolinite, e.g.

kaolinite	meta-kaolinite	Al-Si spinel	mullite
6	4	4 + 6	4 + 6
(proportion of 6 C.N. increasing)			

These results demanded the re-examination of the X-ray fluorescence method, and when the spectral shift calibration was repeated using a zeolite in which Al was in 4-fold co-ordination with silicon and oxygen rather than phosphorus, the results were found to favour a mixture of 6 and 4-fold co-ordination of Al in metakaolinite [10]. This result is of profound significance for the structural model of metakaolinite; it suggests that not all the hydroxyls are removed during dehydroxylation [11], and, indeed, just such a metakaolinite structure containing 12% residual structural hydroxyls has been proposed by Pampuch [12]. That some hydroxyls persist until at least 1100°C was shown by mass-spectroscopy [13] in which molecular hydrogen was detected in the high temperature gaseous decomposition products. This is observed only in the presence of variable valency cation impurities which provide a mechanism for reduction of protons to hydrogen:—



The persistence of protons in the structure also has some bearing on the second of the two problems, namely, the interpretation of the 980°C reaction. The significant breakthrough in under-

TABLE 1. Formulae of the various possible spinel structures formed from metakaolinite.

SPINEL	FORMULA	y	z	LIMITING COMPOSITION	REFERENCE
γ-alumina	$\text{Al}_8\text{Al}_{131/3} \square_{22/3}\text{O}_{32}$	—	—	—	—
Protonated γ-alumina	$\text{Al}_8\text{Al}_y\text{H}_x \square_z\text{O}_{32}$	(40-x)/3	16-(x+y)	$\text{Al}_8\text{Al}_{12}\text{H}_4\text{O}_{32}$	15
Brindley and Nakahira spinel	$\text{Si}_8\text{Al}_{102/3} \square_{51/3}\text{O}_{32}$	—	—	—	5
Protonated Brindley and Nakahira spinel	$\text{Si}_8\text{Al}_y\text{H}_x \square_z\text{O}_{32}$	(32-x)/3	16-(x+y)	$\text{Si}_8\text{Al}_8\text{H}_8\text{O}_{32}$	—
Yamada and Kimura spinel	$(\text{Si}_a\text{Al}_{8-a})\text{Al}_y \square_z\text{O}_{32}$	(40-a)/3	16-y	$\text{Si}_8\text{Al}_{102/3} \square_{51/3}\text{O}_{32}$	16
Protonated Yamada and Kimura spinel	$(\text{Si}_a\text{Al}_{8-a})\text{Al}_y\text{H}_x \square_z\text{O}_{32}$	(40-a-x)/3	16-(x+y)	Where (2x-a) = 8	—

standing this reaction came in 1959, when Brindley and Nakahira [5] suggested that the product was a defect Si-Al spinel which subsequently transformed to mullite (previous workers had identified the weak X-ray pattern sometimes observed at about this temperature as a cubic alumina, possibly γ -alumina, see for example ref. 14). The inclusion of some Si in this phase makes good sense in terms of the structural continuity of the reaction, and also accounts for the slight difference in the lattice parameters of this phase and of γ -alumina. Again, just as α -alumina can be stabilised by protons [15], the Si-Al spinel can probably also be similarly stabilised, and, indeed, a whole series of spinels can be envisaged, differing in the amount of 4-fold Al they contain, and in their degree of proton stabilization (Table 1).

I would not, however, wish to convey the impression that the matter is now closed, and all further debate is ended, since this is not the case. Very recently some further work has been published by Leonard [17], who used a combination of a Radial Electron Density Distribution (R.E.D.) technique and X-ray fluorescence to study the nearly amorphous intermediate phases in this reaction. A careful reading of this paper shows that although these sophisticated techniques seem to support the earlier hypotheses of solely tetrahedral aluminium in metakaolinite, and the absence of silicon in the cubic spinel phase, the results are by no means unambiguous. For example, despite an indication by X-ray fluorescence of solely 4-fold co-ordination in metakaolinite, R.E.D. shows that the Al-O bond lengths remain virtually unchanged during dehydroxylation, necessitating an explanation in terms of a high concentration of lattice defects which form because the lattice does not immediately collapse into a normal tetrahedral configuration. Again, the results of Leonard do not rule out the possibility of some silicon inclusion in the cubic spinel structure, but merely indicate that not all the Al atoms occupy octahedral interstices, i.e. this phase may be a mixture of γ -alumina and a Si-containing spinel.

Thus, the new picture of the reaction sequence emerging is that each stage of the reaction is not characterised by a rigidly defined atomic structure, but rather by a large number of variations of a particular atomic arrangement, differing in their precise ordering, defectness, proton content, etc. [17]. This is entirely consistent with the lack of sharp X-ray patterns throughout most of the reaction.

There are several practical consequences of such an understanding of the reaction. From the point of view of the ceramics manufacturer, it is important to be able to form the high-temperature phases easily, efficiently, and, in these energy-conscious days, with the expenditure of the minimum of thermal energy. There are several ways of assisting the development of the desired high-temperature products. One of the most promising appears to be the addition of small amounts of metal oxides, or other "mineralizing" substances [18]. Two of the most efficient elements in this respect are manganese and copper [19] (which, incidentally, are highly effective in promoting other mineral reactions, for example, the transformation of TiO_2 from the anatase to the rutile

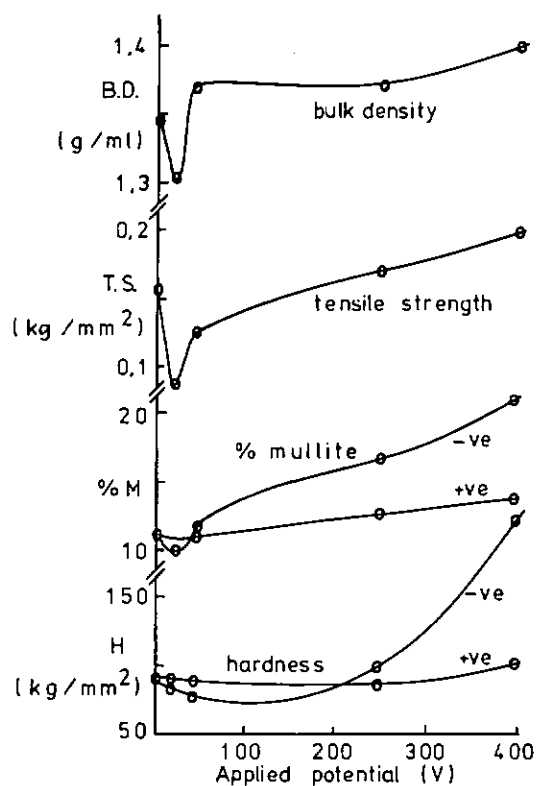


Figure 4. Variation with applied field of the physical properties of kaolinite electrolysed for 2.0h at 1050°C under reduced pressure (~1 Torr). After MacKenzie (ref. 26).

form [20] and the subsequent sintering of rutile [21]). The action of such promoters in the kaolinite reaction can be understood in terms of metal-oxygen bond strengths — where a cation can invade the lattice and form a bond with oxygen which is stronger than the lattice cations, this disruption facilitates an incipient phase transformation [19]. Mossbauer spectroscopy has shown that iron probably plays a similar role in the kaolinite reaction [22]. A catalytic effect is also observed with water vapour [23]; here the mechanism involves proton attack on the metal-oxygen bonds of the lattice.

A more novel method of controlling the high-temperature reactions of kaolinite and even modifying the properties of the products has been suggested by the important role played by protons in the reaction. If the decomposition is carried out under the influence of a d.c. electric field, protons migrate to the cathode. The effect is to lower the onset temperature and activation energy of the dehydroxylation step by up to 60° and 12 Kcal/mole respectively [24]. The temperature of the 980°C reaction is also lowered by up to 15°C, consistent with the suggestion that the product of this reaction is a proton-stabilized phase. However, the result which appears to hold most promise for technology is the effect of electrolysis on the properties of the high-temperature phases [26], in which the percentage of mullite, the bulk density, tensile strength and microhardness are all significantly increased, particularly at the cathode (Fig. 4). The build-up of proton concentration at that electrode and the

subsequent electrode reactions forming water vapour lead to improvement in crystallinity in that region, and also, as it has been shown subsequently by Pampuch and Smolarska [27], to a denser, interlocking microstructure. Effects which are superficially similar can be achieved using a.c. fields, but a theoretical analysis of the frequency dependence shows that these results are probably due to dielectric heating of the sample rather than to electrolysis [28].

I hope during the course of this lecture to have firmly established the point that the study of mineral chemistry, even of very common technically-important minerals, need not be academically unattractive. Indeed, the present understanding of the kaolinite system which has been discussed here derives largely from the application of some of the most sophisticated and up-to-date investigative techniques available to chemists. To successfully apply such methods to complex and intractable compounds and to satisfactorily interpret the results represents a considerable challenge. On the other side of the coin, it should not be thought that such in-depth investigations are of little practical value. Irrespective of the speed with which the Ceramics Industry may be prepared to modify its processes in the light of new concepts, consolidation of the scientific basis of these processes can ultimately bring only benefits to that industry. At the same time, problems in other, less conservative mineral-based industries (for example the aluminium industry) are being solved by analogous reasoning from the better-understood mineral reactions such as the present one. This cross-flow of ideas has received impetus from the unified concept of mineral reactions in general, which is slowly being built up from detailed investigations such as that of the kaolinite reaction sequence.

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OBITUARY

ARTHUR KEITH RALPH McDOWELL, M.Sc. (Hons), A.R.I.C., F.N.Z.I.C., died on 10 February 1978 after a short illness.



He was born on 29 April 1908 and was educated at Wellington College (1921-4) and Victoria College of the University of New Zealand (1925-8), where he graduated with an M.Sc. in Chemistry. From 1929 to 1933 he worked in the Fuel Research Section of the Dominion Laboratory as an assistant chemist. In 1933 he joined the Chemistry Department of the newly formed Dairy Research Institute. He worked with F. H. McDowell and R. M. Dolby on a wide range of dairy chemistry problems, and when the Dairy Research Institute was reorganized he was made Head of the Analytical Chemistry Section. He retired in April 1973, although he continued to carry out some investigations into fat analysis in proprietary products. He had a well-deserved reputation for his abilities as an analytical chemist and he was an adviser to a number of Standards Associations and Institutions. He became a member of N.Z.I.C. in 1931 and was elected to fellowship in 1950.

A.K.R. McDowell served as an elder in the Presbyterian Church and was a man well-liked by all who knew him.

He is survived by two sons and two daughters.

HISTONES AND HISTONE GENES

J. R. E. WELLS

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INTRODUCTION

Like many others, we are interested in the organisation and expression of eukaryotic genes — differentiation at the molecular level if you like. Differentiation at the cellular level can be recognised by cellular morphology, by changes in the products made by different cells and so on. But these observations give little insight into the molecular events which occur in early embryogenesis so that certain sets of genes are programmed to be expressed in a highly organised fashion in different cell types.

The molecular controls will operate at many levels. For example,

1. Packaging of chromosomal material in such a way that "active" genes are available to RNA polymerase.
2. "Start" and "Stop" signals along the DNA will be required.
3. Processing of nuclear RNA transcripts and presentation of the correct polysomal mRNA to polysomes for translation into proteins.
4. Control at the level of protein synthesis itself. The mere presence of an mRNA in the cytoplasm does not necessarily mean it will be translated even if the requisite "machinery" is there.

We are not in a position to study all the complex interactions of control molecules and genes which combine to direct the orderly events seen in differentiation. But we can now isolate specific eukaryotic gene sequences by taking advantage of recombinant DNA technology. We can look for 'start' and 'stop' signals, for interactions with specific control molecules and for possible rearrangements in the organisation of genes themselves as differentiation



Dr Bill Rutter studying mRNA isolation techniques and reverse transcriptase technology.

His current research efforts are aimed at determining the relationship of H5 genes to the other five histone genes in the chicken genome and the basis for the unique expression of H5 genes in red cells.

DR JULIAN WELLS completed his Ph. D. in plant biochemistry in 1963 at the Waite Agricultural Research Institute, South Australia. After working with Dr Roy Markham in Cambridge he was appointed to the Biochemistry Department at Adelaide University in 1966. In 1972 he spent a year with

events occur (see Ref. 1 for a scholarly exposition on this latter theme).

I have chosen histones and histone genes as one aspect of the molecular biology of eukaryotic gene control. The histone proteins represent fundamental "packaging" components of eukaryotic chromosomes. It also happens that the genes which code for these proteins are the most studied of all eukaryotic genes at the molecular level.

WHAT ARE HISTONES AND WHAT IS THEIR ROLE IN EUKARYOTIC CELLS?

The major histone types found in eukaryotic cells can be separated on acidic polyacrylamide gels and are shown in Fig. 1. These highly basic proteins are found associated with DNA in all higher cells, with the exception of H5 which is found only in the nucleated red blood cells of birds and amphibia. (This histone and the control of its restricted expression in only one cell type is our major research interest).

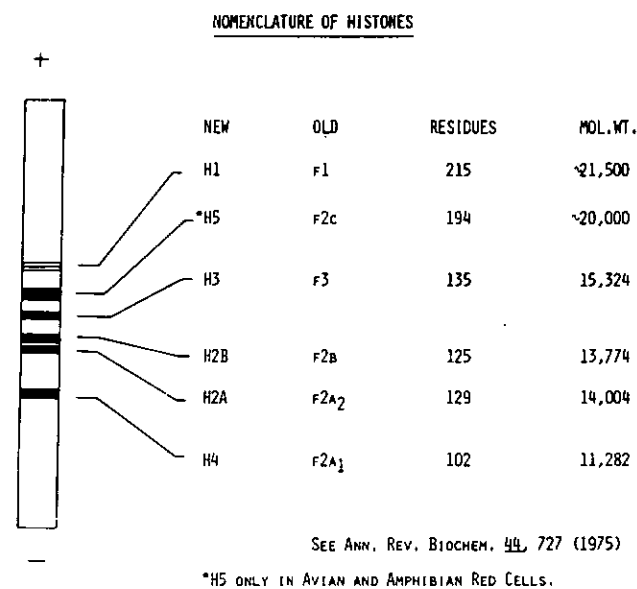


Figure 1. Characteristics of Histone Proteins.

Perhaps the most remarkable feature of histone proteins is their amino acid sequence conservation. This is dramatically illustrated by the fact that the entire sequence of H4 isolated from such widely divergent sources as calf and pea differs in only two amino acid residues — and both of these are conservative (valine for isoleucine and lysine for arginine). What is the evolutionary pressure for such extreme conservation? It is likely that every residue is critical in defining the shape and precise interactions of histone molecules with each other and with DNA.

Within each histone molecule there is an asymmetry of highly polar and less polar residues. The less-polar regions are important sites for histone/histone interaction, resulting in a precise aggregate of four of the five major histone types as an octomer of histones:



The highly polar N-terminal "fingers" of the histones containing basic residues interact with the negatively charged phosphates of DNA.

A fundamental unit of all eukaryotic chromosomes is the octomer of histones and about 200 base pairs of DNA, and this structure is called a nucleosome. Advances in our understanding of nucleosomes have come as a result of classic experiments of Hewish and Burgoyne at Flinders University in Adelaide [2]. They incubated isolated nuclei with DNA'ase, recovered the remaining undigested DNA after phenol extraction, and examined the products on polyacrylamide gels. The results showed a series of bands in which the smallest unit was 200 base-pairs in length while larger bands were multiples of this. They concluded that there was an orderly arrangement of histone and DNA in the chromosomes and their band pattern reflected this repeating structure. With sufficient DNA'ase digestion, most of the nuclear DNA could be recovered as a 200 base-pair unit.

Further experiments have shown that the chromosomal material exists within the nucleus as a "beads-on-a-string" structure, with a histone 'core' and the DNA coiling around the histone octomer with a DNA packing ratio of about 7:1. This structure is beautifully illustrated in electron micrographs of the SV-40 minochromosome [3]. The precise role of H1 in chromosome structure is not completely understood, but it is likely that it has a role in higher-order compaction of chromatin. It is clear that the degree of DNA folding seen in the nucleosome structure cannot by itself account for the packaging of about a metre of DNA into a nucleus of 6×10^{-11} ml in volume.

Variations on the theme of the basic nucleosome structure have been reported. Noll has shown the basic repeat unit size to be 170 base-pairs in lower eukaryotes as opposed to 200 for high eukaryotes. However this variation is probably due to differences in "string" lengths of DNA between the "beads" for if digestion of chromatin is more extensive, then a consistency is found for all kinds of eukaryotes; that is, 140 base-pairs of DNA are found intimately associated with the core octomer of histones [4]. More convincingly still, it has been shown that pancreatic DNA'ase digestion of the "core" nucleosome from a higher eukaryote (rat) and a lower eukaryote (*Neurospora crassa*) results in identical banding patterns of 10 base-pair repeats derived from the 140 base-pair "core" [4]. So the high degree of amino acid sequence conservation seen in histones from widely divergent species is reflected in a highly conserved histone/DNA structure – the nucleosome.

If the basic nucleosome structure is universal in eukaryotes then it is difficult to argue for a specific role of histones in gene expression. However, it should be remembered that histones may be modified *in vivo*, thus altering their interaction with DNA. For example, there is evidence that phosphorylation of H1 leads to condensation of chromosomes at mitosis [5], and enzymic modification such as acetylation at specific sites of histones is associated with cellular metabolic changes. An example of this phenomenon is the rapid and reversible acetylation,

particularly of H4, when Friend erythroleukemic cells treated with n-butyrate, are induced to synthesise globin[6]. Recently Eikbush et al [7], have isolated a protease tightly associated with chromatin which exhibits a high degree of specificity for H2A. It releases only the 15 C-terminal residues of this histone. Such alterations can obviously have a marked effect on the conformation of chromatin and it would be unwise to dismiss the possibility of histones playing a significant role in major, as well as subtle, alterations in chromatin structure.

THE ORGANISATION OF HISTONE GENES

Every time DNA replication occurs, an equal weight of histone is synthesised; this means about 10^{11} molecules of histone per cell. In general, inhibition of DNA synthesis leads to rapid inhibition of histone synthesis. It is of great theoretical interest to understand the way in which these coordinated syntheses are controlled but as yet there are no 'hard' theories. One possibility would be that a specific form of RNA polymerase is responsible for the synthesis of RNA initiators for DNA synthesis and for histone mRNA synthesis. However, as discussed later, there is now some doubt about the coordination of histone mRNA synthesis and DNA synthesis even though histone protein synthesis and DNA synthesis are coupled. Despite this uncertainty, from a practical point of view the coupling of DNA and histone synthesis has been significant because it suggested a ready source of histone messenger RNA (mRNA). This mRNA should be present in considerable quantities in cells undergoing rapid replication, and this was found to be the case in tissues such as cleavage embryos of sea urchin. In fact the major RNA species synthesised in such embryos is histone mRNA, and it is therefore possible to obtain highly labelled preparations of this mRNA after incubation of embryos in the presence of ^{32}P . The RNA can be fractionated on polyacrylamide gels into molecules which are complementary to the gene for each of the five major histones[8]. In other words we have pure histone gene "probes" – molecules of RNA each with a unique sequence of nucleotides which will base-pair only with its precise complementary sequence in the DNA. These 'probes' are important for detecting histone genes.

An additional bonus in the sea urchin histone gene system is that each histone gene exists as multiple copies per haploid set of chromosomes. Depending on the species, this reiteration frequency can vary from about 300 - 1000 copies per cell. Even so, the histone genes only constitute about 0.5 percent of the DNA, so it is a formidable task to purify these genes even from sea urchin DNA. Purifying genes requires recombinant DNA technology and a brief outline of the procedures is as follows:

1. Total 'donor' DNA (sea urchin DNA in this case) is cleaved with a restriction enzyme such as EcoRI, which leaves short, single-stranded "sticky ends".
2. A suitable 'vector' DNA molecule, (such as a modified lambda phage containing only one EcoRI site) is also cleaved with EcoRI, and the 'donor' and 'vector' DNA are mixed under conditions in which complementary single-strand 'sticky ends' can base-pair to form "parental" or "recombinant" DNA molecules. Addition of another enzyme, DNA ligase, joins these reannealed DNA molecules together covalently.
3. The covalently-closed circular DNA can be taken up by suitably treated *E. coli* cells ("transfection"). The essential point is that this transfection process is a

relatively inefficient one (compared with 'phage infection for example) and only one DNA molecule is taken up by any one *E. coli* cell.

4. The transfected *E. coli* cells are plated out and the ^{32}P -histone mRNA 'probe' is used to find those clones of cells (each derived from one cell) which contain the histone genes [9].
5. The selected clone provides the source of a unique recombinant DNA molecule within lambda 'phage. The 'phage can be grown up in any desired quantity, the DNA prepared and the histone gene segment reisolated from it by EcoRI restriction and separation of fragments on agarose gels.

Figure 2 shows a picture of a preparative gel in which a 6,000 base-pair (6 k.b.) fragment of DNA containing sea urchin histone genes has been separated from the 'vector' DNA (the 'left' and 'right' arms of lambda).

From the total complexity of an entire sea urchin genome, we now have a unique piece of DNA — the histone genes, in a fragment about the size of the small DNA virus such as ϕX174 . Such is the power of recombinant DNA technology.

The detailed structure of the histone genes can now be determined by further restriction analysis of the 6 k.b. fragment. Smaller fragments produced by other restriction enzymes can be separated on gels and these fragments transferred to nitrocellulose [10]. The bands are then hybridized with the individual histone mRNA species (which are labelled with ^{32}P) and so both the order of the smaller fragments and the particular mRNA species to which they hybridise can be determined [11].

In sea urchin DNA, the order of the histone genes is H4, H2B, H3, H2A, H1. However, this information does not indicate the order in which the genes are 'read' by the enzyme RNA polymerase. Transcription might start with H4 or it might start with H1. Knowledge of the transcription process is necessary before we can understand the way in which the expression of these genes is controlled and how this process is tightly coupled to DNA synthesis.

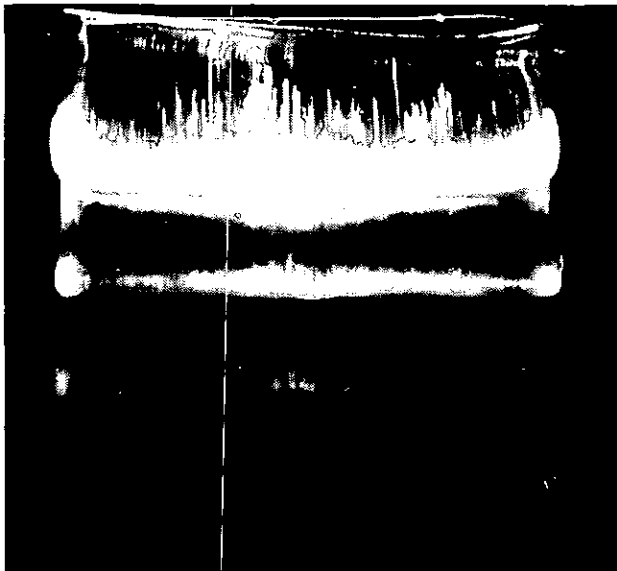


Figure 2. Recovery of 6 kilobase insert of sea urchin histone genes from a lambda 'phage vector. The DNA has been treated with the restriction enzyme EcoRI and fragments separated on a 1% agarose gel. The bands are detected by ethidium bromide staining and DNA can be recovered by hydroxylapatite chromatography after digesting the gel in saturated KI. The two strongly staining bands contain the "left arm" and "right arm" of lambda DNA respectively and the fastest moving band is the sea urchin histone gene insert containing the 5 histone genes.

ORIENTATION OF HISTONE GENE TRANSCRIPTION

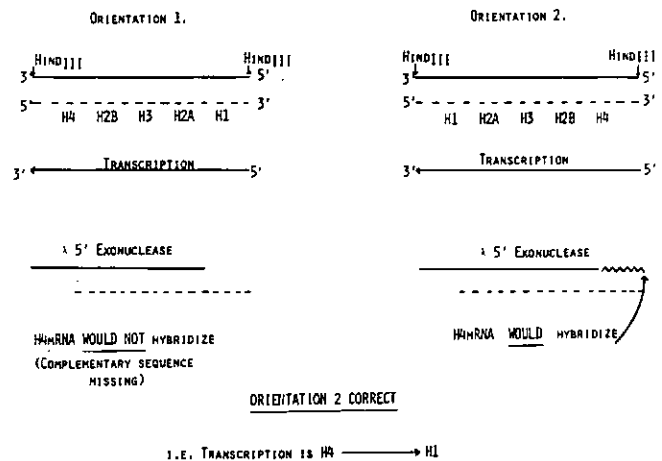


Figure 3. The use of a 5' exonuclease and H4 mRNA to determine the direction of transcription of sea urchin histone genes. Two possible orientations are shown. In each case the 'sense' DNA strand is shown as a dotted line. Transcription is from right to left. See text for further details.

Birnstiel and his associates [12] have deduced the direction of transcription by a simple experiment. They used an enzyme which sequentially releases nucleotides only from the 5' end of DNA (a 5' exonuclease) and allowed it to digest away about one genes worth of DNA from the 6 k.b. fragment of DNA. They then carried out hybridisation experiments using H4 mRNA only as a probe to see whether the exonuclease digestion had removed a sequence to which the H4 mRNA could base-pair. The experimental design is shown in Fig. 3. As indicated, there are two possible orientations of the five histone genes. In orientation 1 which supposes that H1 is transcribed first, the 5' exonuclease would remove a sequence of DNA bases which would normally be complementary to H4 mRNA (and would therefore base-pair to H4 mRNA). So, if orientation 1 was in fact correct, H4 mRNA would not hybridise to the enzyme-treated DNA segment. Orientation 2 shows the H4 gene to be transcribed first. In this case, 5' exonuclease treatment would remove a piece of DNA which has an equivalent base sequence to H4 mRNA, leaving the complementary strand and therefore allowing hybridization of single-stranded H4 mRNA to the modified DNA. The experiments showed orientation 2 to be the correct one.

It is, of course, possible that the 5 histone genes are transcribed independently. However, this is not appealing given that four of the five histones are required in stoichiometric amounts, and there is the precedent that the two major ribosomal RNA species in eukaryotes (18S and 28S RNA), also required in equal proportions, are derived from a single large precursor molecule. Furthermore, there is recent evidence which suggests that human histone mRNAs are derived from a high molecular weight precursor RNA [13]. Specific cuts of this precursor would eliminate 'spacer' transcripts and result in small individual mRNA species.

UNDERSTANDING GENE CONTROL REQUIRES MORE THAN KNOWING DNA SEQUENCES

Remarkable advances in characterisation of eukaryotic genes have resulted from recombinant DNA technology. The ability to obtain pure sequences derived from mRNA or from chromosomal DNA has introduced a precision hardly dreamt of as possible a few years ago. This, coupled

with new rapid DNA sequencing techniques [14] means that the entire sequence of either "single" genes such as globin genes or repeated genes such as histone genes will be known in the near future. It will be possible to look for sequences recognised as 'start' and 'stop' signals for RNA polymerase and for palindromic sequences which may be sites for interaction with 'control' proteins and so on. But with this sophistication, it is also necessary to develop systems in which gene control functions can be measured. A start in this direction has been made by Mertz and Gurdon who have shown that DNA of simian virus 40 (SV-40), of adenovirus, of bacteriophage ϕ X174, and of histone genes derived from *Drosophila* are all transcribed after injection of these DNA samples into frog oocytes nuclei [15]. It will be possible in future to make "mutant" DNA from cloned eukaryotic genes and to study the effect of alteration in the DNA to its expression in this system. Since eukaryotic DNA incubated with *Xenopus* egg cell-free extract becomes associated with histones to form nucleosome structures [16], one can anticipate the use of this system as a means of making "physiological" eukaryotic chromatin prior to microinjection into nuclei. Addition of putative 'control' molecules in these microinjection experiments can also be tested for their effect on specific gene expression in vivo. If it turns out that complex processing of eukaryotic nuclear RNA is a pre-requisite for the production of polysomal mRNA (see Discussion below on adenovirus, globin and immunoglobulin genes), it is likely that an in vivo assay system for gene expression, such as the oocyte nucleus, will be required to study this process.

SURPRISES IN EUKARYOTIC GENE ORGANISATION

The elegant electron micrograph of a cloned sea urchin histone gene cluster [17] has provided a reassuring picture that eukaryotic genes were just what we expected them to be. Partial denaturation of this DNA segment illustrated that A+T rich 'spacer' segments are found between each of the ordered 'coding' regions. It would be no great surprise in this system then, if RNA polymerase started at one end of the segment (the H4 gene end as we saw previously), made a long RNA precursor, which was then cut at precise points to give rise to the smaller individual histone mRNA species. This is pretty standard stuff except for the recent inference that histone precursor RNA synthesis may not be tightly coupled to DNA synthesis, but its processing to mRNA may be. So processing, rather than de novo mRNA synthesis may be the event which is tightly coupled to DNA synthesis [13].

The surprises have come from studies on other kinds of genes. In a nutshell, it looks as if eukaryotic mRNA sequences may be derived from DNA sequences which are not contiguous in the chromosome. An analysis of Adenovirus mRNA provided the first example of this phenomenon for mRNA (see "News and Views", Nature 268, 101, 1977), and it now appears to be more the rule than the exception since "inserts" in chromosomal DNA within the coding region of globin genes and immunoglobulin genes have been reported. The same thing has been indicated for the DNA coding for 28S ribosomal RNA located on the X chromosome of *Drosophila* (but not on the Y chromosome locus) and the size, but not the position of the insert can vary [18-20]. The study with *Drosophila* 28S coding regions is important because it excludes the possibility that all "inserts" might have arisen due to the use of recombinant DNA procedures. In other words, the insertion of DNA within the 28S region of X

chromosome ribosomal genes in *Drosophila* can be demonstrated by methods which do not involve cloning. By inference, the 'inserts' observed in mouse globin genes and immunoglobulin genes from cloned chromosomal DNA are probably also representative of the in vivo situation. The role of such inserts is not at all clear, but if the adenovirus story is truly representative of how "normal" eukaryotic genes are transcribed, then it is probable that rather involved processing of a long nuclear RNA transcript occurs, with the final result of excluding the 'insert' sequence, and joining the requisite pieces of RNA together to form the final polysomal mRNA product.

We are a long way from understanding the rationale of eukaryotic gene sequence organisation, let alone the post-transcriptional events necessary for the production of functional mRNA. And even when functional mRNA is produced there are further controls at the level of translation which exert a marked effect on levels of protein product produced. For example, the presence of haem affects the level of translation of α globin relative to β globin in a situation where the mRNA is not limiting [21]. As I suggested at the beginning, there are many levels at which eukaryotic genes expression can be controlled and this may vary from one system to another. After all, in *E. coli* the control of the lac operon may be regarded superficially as very similar in concept to control of the trp operon and yet it now seems clear in the latter case that a major aspect of trp gene expression is concerned with RNA polymerase termination control (in the attenuator region) rather than simply RNA polymerase initiation. And if *E. coli* gene systems are supposed to be 'simple', it is a safe bet that eukaryotic gene control systems are going to be more complex. Naturally, however this should not inhibit the investigation of higher cell systems.

CONCLUDING REMARKS

The story started with histones as proteins. We have seen how these highly conserved molecules are an essential component in packaging all eukaryotic genes and we look to advances in knowledge of histone/DNA interaction to tell us more about how 'selected' genes are presented for read-out by RNA polymerase in differentiated cells. The genes which code for histones have provided a superb example of the power of recombinant DNA technology and what it means to the acquisition of basic knowledge of eukaryotic genes. Finally, by reference to other eukaryotic systems – adenovirus, globin genes, immunoglobulin genes and ribosomal genes, we saw that the surface has hardly been scratched in terms of our understanding of transcriptional control. But it is an incredibly exciting time in eukaryotic molecular biology. Data will come thick and fast – perhaps then some satisfying conceptual frameworks will emerge. These will have enormous impact on the advance of biology, and in so doing will have many ramifications in medicine. Research on eukaryotic genes in different systems is of fundamental importance and in the long run has a good chance of telling us just as much about cancer as work done with cancerous cells.

Many generations of biologists have pondered the basis of embryological development and differentiation. There are still many more questions than answers, but at least now the technology is available so that questions at the molecular level can be answered with precision.

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Honorary Fellows

Dr. A. T. Johns and Dr. I. K. Walker have been made Honorary Fellows of the New Zealand Institute of Chemistry.

ALAN TUTTON JOHNS C.B.E., M.Sc. (N.Z.), Ph.D. (Cantab), F.R.S.N.Z., F.N.Z.I.C., after graduating from Canterbury College with 1st Class Honours in Physical Chemistry, was a National Research Scholar at the Dairy Research Institute. The war saw him as a scientific liaison officer between the New Zealand and Australian Armies, as a radar instructor and on active service with the 2nd N.Z.E.F.

From 1945 - 48 Dr. Johns attended Cambridge University where he gained his Ph.D. in the biochemistry of bacteria. On returning to New Zealand he joined the Plant Chemistry Division, DSIR, where he worked on the biochemical processes involved in microbial digestion in the rumen and the causes of cattle bloat. After a year at the University of California, Berkely, he returned to Plant Division as Director.

In 1966 he succeeded Mr. L. W. Tiller as Assistant Director-General of the Department of Agriculture, and in 1968 became Director-General of Agriculture and Fisheries.

He has been a N.Z. Delegate to the International Conference of Microbiology and International Grasslands Conferences at Reading (U.K.) and Sao Paulo (Brazil), with opportunities to visit agricultural institutions in the United States and South America.

Dr. Johns is a past-President of the N.Z. Institute of Chemistry, the Grasslands Association of N.Z. and the Animal Protection Society. On his retirement from Agriculture he has taken up the position of Chairman of the N.Z. Universities Grants Committee.

IAN KENNETH WALKER B.Sc., M.Sc. (Hons.), D.Sc. (N.Z.) was educated at Auckland Grammar School and gained his B.Sc. at Auckland University. He joined the Dominion Laboratory in Wellington in 1937, completing his studies for M.Sc. (Hons) from Victoria University of Wellington. During the war he was with the Radio Development Laboratory working with Radar, was commissioned S/Lt. in the RNZNVR and continued radar work in the U.K. from 1944-46. The next three years of his life were involved in atomic energy research in Canada and at Harwell, U.K.

Dr. Walker returned to Wellington in 1949 to become Section head of Physical Chemistry and Metallurgy at the Dominion Laboratory. For his far-reaching research on spontaneous combustion of wool and later, diffusion and heating in wool, clothing, coal, grain, wood and paper he was awarded his D.Sc. in 1962, and the I.C.I. prize of the Institute of Chemistry in 1966. He was appointed Director of Chemistry Division, D.S.I.R., in 1960 and was largely instrumental with the New Zealand Wool Board in setting up the Wool Research Organisation of N.Z. of which he was a foundation member of its executive until 1970. He has also been active in setting up research associations for both Coal and the Logging industry.

In 1971 he moved to Head Office to be Assistant Director-General of the D.S.I.R. where his practical, far-sighted administration has directed scientific projects relevant to the N.Z. economy.

Cecil George Wilmot Mason M.Sc.(N.Z.) A.M.I.Chem.E. F.N.Z.I.C. A.R.I.C.: An Appreciation

F.B. SHORLAND

Biochemistry Department, Victoria University of Wellington

Cecil George Mason was born on February 5th 1905. His death on September 30th 1977 removes from the ranks of the chemists a notable pioneer whose contributions will make a permanent impact on New Zealand science. To his friends he will leave an impression of an unforgettable and likeable personality and a lively imagination that outstretched his considerable potential for achievement. Those who knew him would wish to be able to emulate his success in industry involving the manufacture of insecticidal smokes, the best known example of which is 'Borafume'. This product was developed in the first instance in the basement of a house using equipment manufactured from the humblest of resources. His mixer, for example, was made from a packing case. It rotated on a shaft passing through opposite corners of the case. During operation the contents were transferred across the case giving the maximum efficiency for mixing. The experimental work carried out by himself was so thorough that in practice it was unnecessary to redesign the product or its method of application since its appearance on the market some 20 years ago.

As a monitor at Christchurch Boys' High School which he attended from 1919 to 1923 the report from the headmaster shows he did excellent work. In 1924 he joined the staff of the Christchurch Gas, Coal and Coke Co. Ltd while attending part time at Canterbury University College. He graduated M.Sc. in 1930 under Professor H. G. Denham in the Department of Chemistry. His thesis was entitled "The Determination of the Velocity of the Reaction between Hydrogen Sulphide and Ferric Hydroxide." The report by Professor Denham states "The problem investigated was provided by the student himself as a result of works experience. The student exhibited unusual self reliance, the apparatus being designed and made by himself. The whole piece of work represents the individual effort of a very self reliant student, very little supervision except of a nominal nature being necessary." The whole piece of work represents the individual effort of a very self reliant student, very little supervision except of a nominal nature being necessary." The Home Examiner reported "Thesis, good piece of work in an unhackneyed subject, intelligently attacked. There has been experimental skill shown, and the accuracy of the results is surprising." In general theses are set by the supervisor and although some honours students will have suggested these topics, the ability to design and plan the experimental work is all too often not developed until after some years of experience in association with a skilled researcher. Mr Mason had the inborn ability to plan and conduct research and development work. As far as I am aware he has not only always planned his own work, as in the thesis, but to a considerable extent (especially in connection with the high

pressure sap displacement of timber (HPSD) developments at the end of his career has also provided his own resources to carry out the work.

When I last spoke to him some two weeks before he died he recalled vividly his experiences at the Gas Works where he became the production chemist. In particular he was aware of fire and explosion risks and of his responsibilities to a staff of 100. He claimed with pride that owing to strict observance of safety precautions there had been no fires or accidents during his term of office.

With the lapse of time it is difficult to appreciate that under the enthusiastic direction of Mr Mason there developed a substantial chemical industry based on coal tar at the Christchurch Gas Works which declined after he left in 1946 to take up the position of Technical Executive, Boracure (N.Z.) Limited. Doubtless a factor in this change was the increasing development of the oil based chemical industries overseas. Nevertheless the emergence of industries in New Zealand as elsewhere is dependent on persons with special qualities without which a nation cannot evolve. The coal tar chemicals produced in Christchurch included benzole, ammonia, toluole for motor fuel and as a solvent for lacquer, creosote for timber preservation and as a disinfectant. During World War II it is significant that benzole from the Christchurch Gas Works was used to make up aviation fuel then in short supply. It is a nostalgic thought that the New Zealand capabilities in the



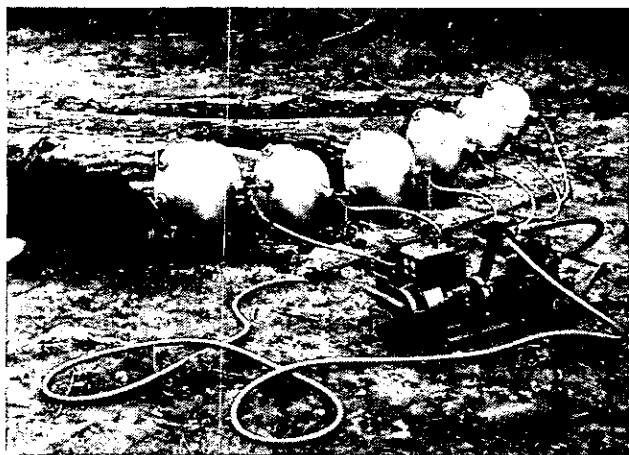
C. G. W. Mason



Step 1. The fitting of three rings over the end of the log. The first ring (steel) is secured with some six steel wedges to prevent its movement towards the end of the log. The next ring which has a w contour on its outer surface is made of rubber. The third ring is of steel and free to slide.

chemical industry thus developed have gone into recess at the time when they could be needed to combat oil crises. Fortunately the history of the above mentioned developments is available in an essay written by C. G. W. Mason entitled "Coal Tar Industry in New Zealand. Achievements and Possibilities." For this essay published by the New Zealand Institute of Chemistry in 1943 he was awarded by the Institute, The Industrial Chemical Essay Prize, being the first person ever to receive this award.

On his arrival in Wellington in 1946 to take up his position with Boracure (N.Z.) Ltd he became a council member of the Wellington Branch of the New Zealand Institute of Chemistry having served as Secretary and later as Chairman of the Canterbury Branch. He was a foundation member of the New Zealand Association of



One compressor unit can handle many logs. In the photo six one foot diameter Pinus radiata logs are being impregnated by a single compressor unit. The impregnating fluid containing copper chromium and arsenic is pumped through until the effluent is about 80% of the concentration of the impregnating solution.

Cover Photo

C. G. W. Mason in later years inspecting freshly felled Pinus radiata logs (25cm diameter) prior to H.P.S.D. treatment.

Scientists. He served as Chairman of the Wellington Branch and later as President of the New Zealand Association of Scientists (1952-54). During his term as President, I recall Council spending a week end at Paraparaumu motor camp for discussions. Science was then looked upon as a solution to world problems and a higher proportion than now of the scientists were anxious to work for scientific societies. Now these optimistic hopes have been clouded with fears of pollution, energy crises and biogenetic engineering problems to name but a few of today's issues for which some at least consider that science is responsible. The challenge increases but the numbers of scientists who are anxious to grapple with these problems diminishes.



Step 2. A fibre glass cap is fitted over the rings. The cap has ferrules near the open end through which aluminium pins can pass. These pins protrude through to touch the surface of the log so that when the cap is pulled towards the operator the sliding ring presses against the rubber ring which seals the cap to the log. The arrangement is leak proof to 200lbs/square inch pressure. To remove the cap the pins are withdrawn so that the ends are flush with the surface of the cap.

In 1954 Mr Mason took up the position of Chemical Engineer to the New Zealand Forest Service where he remained until 1963. During these years he contributed to the development of timber preservation being particularly interested in sap displacement impregnation - a process which he continued to work on for the rest of his life. He compiled an excellent outline on the state of timber preservation in New Zealand entitled "Preservation of Construction Timbers in New Zealand." This paper was presented to the FAO Meeting on Wood Preservation held in Rome on 1-4th December 1959. At this stage the preservation of construction timber in New Zealand had by far outstripped that of other countries on a per capita basis. This could be accounted for partly because timber was used for 75% of the homes and partly because *Pinus radiata* had become the main source of timber. This species was not durable unless treated.

When Mr Mason completed his term with the N.Z. Forest Service he offered his services to United Nations Development Programme of the Food and Agricultural Organisation of the United Nations. His first assignment was to Ceylon (Sri Lanka) and the second to Guyana which he completed in December 1969. Each assignment was for a two year period and both were concerned with timber treatment and the opportunity to apply high pressure sap

displacement technology was given. A detailed report on Forest Industries Development Survey, Guyana, Preservation and Seasoning FO: SF/GUY 9 Technical Report 6 was published.

After returning to New Zealand he maintained research facilities first at Glenside near Wellington, then at Mapua and finally at Kina Peninsula in the Nelson District. With these facilities he concentrated on the development of high pressure sap displacement impregnation of freshly felled timber. Sap displacement impregnation of natural round timber under 1-15lbs per sq. in. has been practised since the procedure was patented by Boucherie in 1838 but the technology to hasten the process by the application of high pressures has not been without difficulties in the design of a cap suited to the transmission into the wood of the impregnating solution containing typically salts of toxic metals such as mixtures of copper, chrome and arsenic each possessing high toxicity towards agents that cause timber decay. For the process to succeed it is necessary to have caps that are leak proof, light and quickly fitted. The equipment including the pump for generating pressure must also be light and quickly set up, there are problems relating to blockages at the cross section of the wood where the impregnating solution enters. Mr Mason had to a large extent overcome the main obstacles to the success of the process which was tested in association with the New Zealand Forest Service on exotic and indigenous round

produce grown in Westland. The results are being evaluated for publication.

Commercial timber preservation typically involves the treatment of the dried sawn timber with preservative solution under pressure in steel tanks with a considerable capital outlay. The Mason process makes possible, without large capital outlay, the treatment of freshly felled timber rounds for fence posts, poles and other rounds of larger diameters. Thus the farmer or those in developing countries can prepare long lasting timber without a large capital investment. The penetration of preservative typically salts of copper, chromium and arsenic, is at least as good as that obtained with conventional processes with the potential of varying the concentration longitudinally to give higher loading at the point of maximum exposure to the destructive agents.

Mr Mason shared the belief that in due course wood as a replenishable resource would take the place of coal and oil as a basis for chemical industries as shown in his publication (Mason, 1972). The work he did has special relevance to the future, when to survive it will be necessary to extend the usefulness of materials to last as long as possible and planned obsolescence will become synonymous with lunacy. I regret he did not live to see all his work come to fruition but I feel nevertheless that there will be few in the industrial chemical field in New Zealand whose overall efforts have made a greater contribution.

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N.Z.I.C. Members and Compulsory Unionism

Late in the 1976 Parliamentary session, the Industrial Relations Amendment (No. 2) Act was passed, putting into effect various Government policies in the field of Union membership. A very significant new concept in this law is the exemption of certain specified professions from the obligation to join a union. The list of exempted professions is given in the Schedule to the Act, and includes lawyers, medical practitioners, accountants, registered engineers, valuers, veterinary surgeons, surveyors, opticians, architects and dentists. But there is no mention of scientists in general, or industrial chemists in particular and this omission was contested by NZIC during the passage of the Bill through Parliament. The submissions made by NZIC at that time have been published in this journal together with a general account of the background issues (*Chemistry in N.Z.*, 41 (1) 13, March 1977).

The Act allows for professions to be added or removed from the Schedule of exemptions from union membership, and this requires an Order in Council, on the recommendation of the Minister of Labour. An approach to the Minister was advocated by the NZIC Council in 1977, but a legal opinion obtained showed that it would be extremely unlikely that the Institute would be included on the Schedule. All the other professions listed in the Schedule to the Act are covered by specific legislation and the members of those professions are required to be

registered and are subject to statutory disciplinary procedures. This is the rationale behind their right to be exempted from union membership. But industrial chemists do not have to be registered and hence they would not qualify for automatic union exemption. For these reasons it was decided by NZIC Council not to apply for exemption for industrial chemists.

In practice, industrial chemists are rarely approached to join unions, and as far as is known at the present time no NZIC members belong to unions. The reason is that the union rules themselves normally exclude persons in managerial or executive positions, and in most cases the work carried out by professional chemists lies outside the strictly defined employment fields covered by registered unions. Chemists in government or teaching jobs may become members of the appropriate employee organisation (PSA, PPTA, ATTI, AUT) but these lie outside the Industrial Relations Act.

Should any member experience difficulties in matters concerned with unionism or conditions of appointment generally, they are invited to approach Council through their Branch delegate or other officer. Council may be able to arrange legal advice and general support for the member in his relations with his employer.

G. A. Wright

LETTER TO THE EDITOR

Dear Sir,

The text of Professor G. N. Malcolm's presidential address, "An Institute for the Future" has prompted me as one of the apathetic (or confused?) 28% industrial chemistry members of the Institute to put forward my views and concern in the hope that it may spark some others in this sector of the Institute to push for the re-structuring Professor Malcolm is proposing.

My apathy was first put to the test after the publication of the 1974 Salary Survey and I was recovering quickly when Professor A. H. Kennedy published an excellent article in the February 1975 issue entitled "Amateurism or Professionalism in Chemistry" which alluded to the fact that industrial chemists do not derive much benefit from or have much interest in the Institute Conferences. I had to agree with this but bit my lip so as not to show it. While still biting my lip I then found I had to clench my knuckles when a salvo was fired firstly by way of an Auckland branch letter adding insult to my concealed injury that the lack of interest in chemistry in schools was rapidly diminishing making the future of our profession and the Institute look bleak and secondly Max Carrie's forthright and provocative letter in the February 1976 issue castigating the industrial chemist's apathy in respect of his declining position in salary structure.

The bottom lip was getting sore but the upper lip was still firm when Professor Malcolm's article appeared in the November 1977 issue. Not only have industrial chemists

aspired to the Presidential role but once during the term of the last five and next three Presidents but the Institute's concern for chemists in the industrial sector is inadequate!

At the time of writing I have not seen the 1977 Salary Survey but this could well be the catalyst that prompts some action in support of a Council for Industry working group. I believe it is in this area that the role of "Concern for Chemists" could work most effectively. As Professor Malcolm points out University, Teaching and Government members are cared for professionally whereas the 28% of industry members make nor get very little contribution from the N.Z.I.C. or any other body. I believe the reason for this lies mainly in ignorance or confusion rather than apathy. It would be reasonable to propose that a large majority of industrial chemists in the Institute occupy a managerial or semi-managerial status and have done so all of their professional lives. We have not had first hand exposure to the benefits or otherwise of unions or professional bodies and are probably slightly wary of them.

Finally I believe that the proposal for a Council for Industry could ensure that industrial chemists do play a part in Institute Conferences with adequate scope for academic and non-academic papers on problems faced by chemists in industry.

I was finally provoked to have my say. I hope others might feel inclined to do likewise.

Peter Dawson

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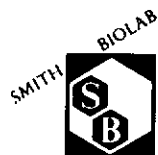
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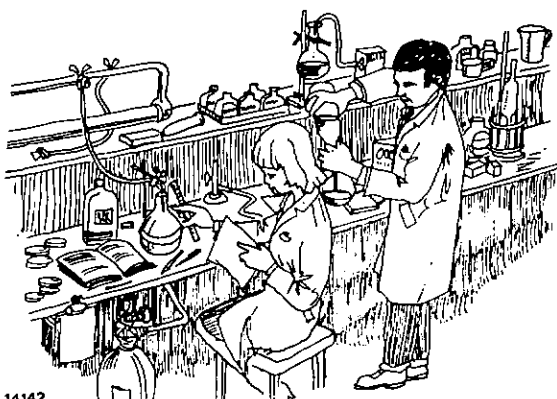
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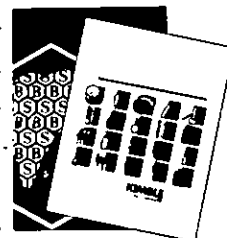
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A NEW CHYLOMICRON REMNANT ?

A. G. BOSANQUET, R. FRASER* and R. BICKERSTAFFE

Biochemistry Department,
Lincoln College, Canterbury

and

*Pathology Department,
The Christchurch Clinical School of Medicine,
Christchurch.

For many years, researchers have fed cholesterol to rabbits to induce atherosclerosis, which in some cases is very similar to that seen in humans, and to examine the associated effect on plasma and tissue lipids. The main change in plasma lipids is a dramatic increase in the concentration of plasma lipoproteins, particularly the very low density lipoproteins (VLDL). This produces a lipoprotein pattern similar to that of Type III hyperlipoproteinaemia in humans.

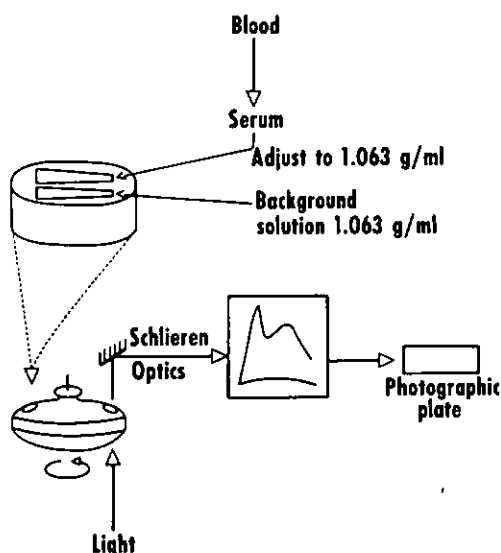


Figure 1. Outline of method used to obtain a spectrum of serum components.

We decided to examine the change in lipoprotein pattern using the technique of analytical ultracentrifugation shown in Fig. 1. Blood is drawn from the animal, serum prepared, and its density adjusted to 1.063 before placing it in one half of a double sector cell. The other half is filled with a background solution of 1.063 density. The cell is centrifuged

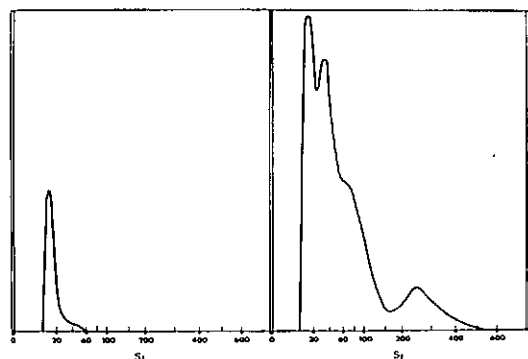


Figure 2. Serum spectrum from rabbit blood. Left: normal feeding. Right: 10 days after commencement of high-cholesterol diet.

at 52,000 r.p.m. Light is passed through the cell and converted by the Schlieren optical system to show the

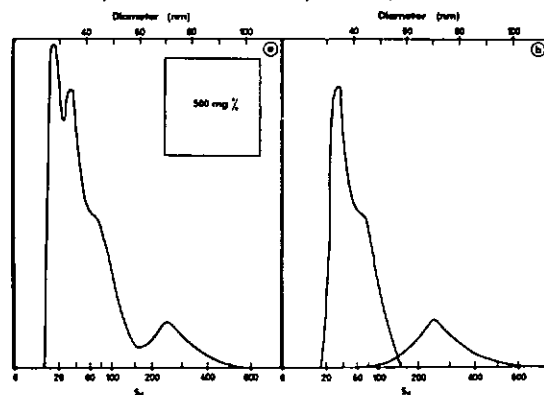


Figure 3. Separation of components from VLDL region of serum. a: original material. b: ultracentrifuge patterns of the two isolates.

change in refractive index along the length of the cell. The background solution produces the bottom curve and serum lipoproteins produce the peaks above. The pattern is photographed at various times and a computer programme used to join datum points from the photographs to give a continuous curve and to calculate the quantity of each of the various serum components. The rate of flotation of each lipoprotein species is measured in negative Svedberg units or Sf.

The spectrum from the serum of a rabbit on a normal diet (Fig. 2, left) shows a main peak at Sf 0-20 (low density lipoproteins, LDL, β on electrophoresis) trailing slightly into Sf 20-400 (VLDL, pre- β on electrophoresis) and no lipoproteins of Sf > 400 (chylomicron, origin on electrophoresis). However, after 10 days on the cholesterol diet, the LDL peak is enhanced and two extra peaks appear in the VLDL region (Fig. 2, right). One peak of Sf 37 has been known for many years but the Sf 270 peak has not been previously reported.

The material from each peak was isolated by preparative ultracentrifugation (Fig. 3). Calculations showed that the median diameters of the lipoprotein particles were in the range 30 - 40 nm for the smaller particles and 70 - 80 nm for the larger particles. The difference in diameters was confirmed by electron microscopy (Fig. 4.).



Figure 4. Electron micrographs of the particles isolated from serum. a: smaller particles, Sf 37. b: larger particles Sf 270.

Diameter: 36 nm 80 nm
 Density : 1.002 g/ml 0.970 g/ml

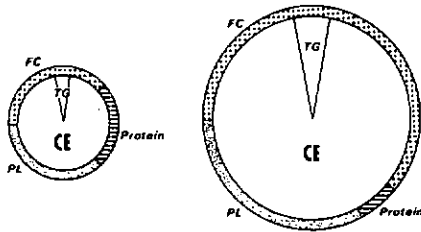


Figure 5. Diagrammatic representation of the composition of the smaller and larger particles.

Examination of the chemical composition of the particles (Fig. 5.) showed that both contained similar proportions of triglyceride and large amounts of cholesterol esters. The fatty acid compositions of the two isolated particles are also similar (Fig. 6.). Cellulose acetate electrophoresis showed both large and small particles moved with broad - β mobility.

Characteristics of the two isolated particles are summarised in Table 1. Many authors have identified the small lipoprotein particles as chylomicron remnants i.e. the lipoprotein that remains after triglycerides have been hydrolysed from the triglyceride-rich chylomicron by lipoprotein lipase located in the capillaries of peripheral tissues. We believe that the large lipoprotein particles are also chylomicron remnants for the following reasons:

1. The fatty acid compositions of the large and small particles are very similar.
2. The chemical compositions of the large and small particles are similar.
3. The electrophoretic properties of both particles are very similar.
4. Theoretical calculations indicate that removal of triglyceride from lymph chylomicrons should produce remnant chylomicrons similar in size to the large lipoprotein particles.

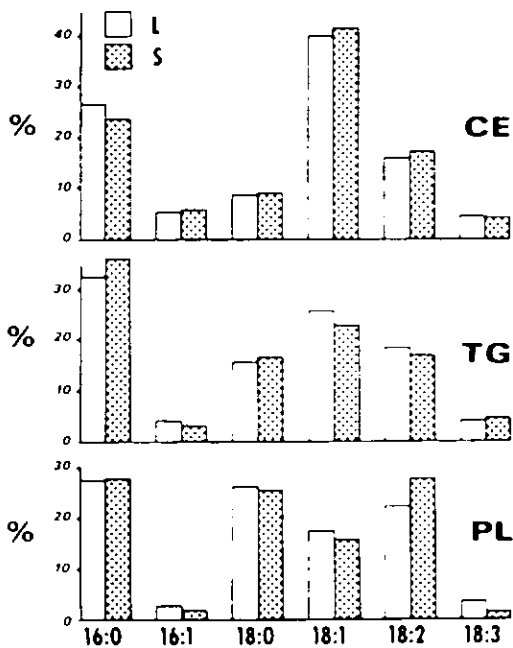


Figure 6. Histograms showing the fatty acid composition of the cholesterol ester, triglyceride and lipoprotein fractions of both large (L) and small (S) particles.

Table 1. Characteristics of small and large isolated particles.

Characteristic	Small	Large
Solution	Clear	Turbid
Sf of Peak	37	270
Diameter (nm)	36	80
Cholesterol ester (%)	62	80

5. The large particles may possibly originate in the liver, but this is unlikely as liver VLDL particles are smaller than 80 nm.
6. Ross and Zilversmit recently demonstrated that cholesterol esters in lipoproteins of diameter greater than 75 nm were of dietary origin in cholesterol fed rabbits.

The question remains, however, as to why the VLDL spectrum of the serum of the cholesterol-fed rabbit has two peaks rather than a continuous spectrum. The answer probably lies within the liver. The scheme outlined in Fig. 7 illustrates that small and large chylomicrons enter the

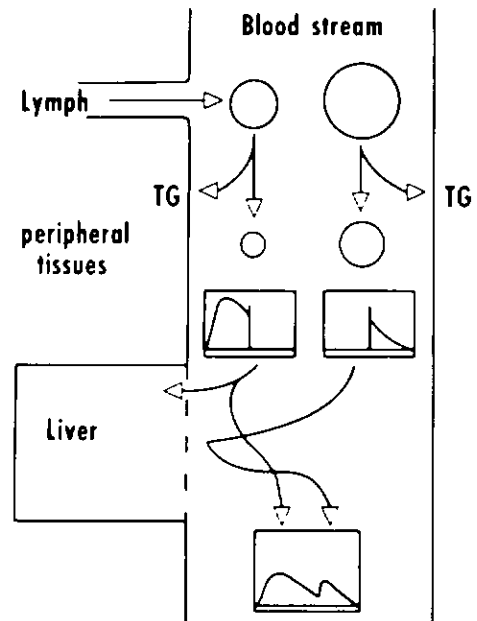


Figure 7. Schematic of a possible metabolic pathway for both large and small particles.

blood stream from thoracic duct lymph and that the triglycerides are removed from the chylomicrons by lipoprotein lipase in the peripheral tissue capillaries. This produces a continuous spectrum of small and large remnant chylomicrons. The spectrum, however, has been arbitrarily divided into two. All the remnant chylomicrons are normally catabolised by the liver, but recent work has shown that the rabbit liver possesses a sieve which only allows the small particles to enter. This is a possible explanation for the appearance of the characteristic double peak seen in the VLDL spectrum of the cholesterol-fed rabbit. One peak corresponds to the small particles that have escaped catabolism and the other to the large particles that cannot be accepted for catabolism.

The large remnants are probably metabolised on the arterial wall and might be responsible for the rapid development of the atherosclerotic plaques seen in these animals.

1977 N. Z. I. C. SALARY SURVEY

G. J. GAINSFORD and W. A. SINGERS

Chemistry Division, DSIR,
Gracefield, Lower Hutt.

This report summarises salary data collected as at the 1 August 1977. There were 788 returns, of which 4 were too late and 8 were rejected (4 of these were from retired people), in all a 78.7% return. The analyses and tables prepared are similar to those from previous surveys [1, 2, 3], although calculated using another programme suite, GENSTAT [4].

As the programme used for the analyses could handle missing data, incomplete returns were included. Ten forms either did not include qualifications, or were hard to place in a qualification category. These are noted at the bottom of Tables 2 and 3. There were a further nine with no specified doctoral classification; these were assumed to be without a doctorate. All university returns which contained both research and teaching classifications were reclassified as teaching, this being interpreted as the main function.

Of the 244 returns from industry, 12 noted unsolicited extra items, e.g. use of cars, telephones, expense allowances and bonuses. Allowance will need to be made for the possibility of these when comparing industry with any other group.

Expanded versions of Tables 1-3 (showing maximum and minimum salaries) and Tables 6-8 (showing values of t) can be obtained from the authors.

Another problem with the reporting of salaries was that some returns mentioned cost-of-living (c.o.l.) allowances. These were spread over practically every employment category. As salary scales were available for Central Government and Research Associations, these figures were checked and the c.o.l. allowance added to those without it. Unfortunately, in other categories it was impossible to determine whether c.o.l. allowances were applicable and, if so, whether they had been added or not. Central Government and Research Association salaries may appear to be higher, therefore, because of this (\$365 c.o.l. allowance). Finally, returns from part-time workers had their salaries adjusted to the equivalent full-time salary.

The points brought out in the previous surveys about accuracy still apply here. The significance levels for the t -test is designed for a single comparison. At the 5% level, for example, there is one chance in 20 of getting a wrong result; if 20 comparisons are made it is very likely that there is at least one wrong result. It must therefore be noted that the more tests of significance performed then the greater are the chances of finding spurious results.

The model fitted was

Salary = basic salary for a person of average age, qualification, etc.

+ age group correction

+ primary qualification correction
+ doctoral qualification correction
+ employment group correction
+ major function group correction
+ "random" correction

The "random" correction depends on factors not recorded, or on interactions between recorded factors not included in the model.

It was found that 59% of the variance was accounted for by this relationship (i.e. $(\text{TOTAL MEAN SQUARE} - \text{RESIDUAL MEAN SQUARE})/\text{TOTAL MEAN SQUARE} = 0.59$). From Table 9 it can be seen that government and university salaries are more predictable by the model than industry (cf. 70 and 73 with 35). The predictability of salaries by this model for industry has dropped since the 1974 Survey. This is difficult to explain but may be related to industry paying out more 'non-taxable' allowances so that salary alone is not the best indicator of income.

Age is still the most important factor in government and universities while major function is still most important in industry.

There are more differences of significance between some employment groups than occurred previously (Tables 6 and 10). Whereas in 1974 the Hospital Services group was significantly behind other groups, it has now moved well up. School Teaching and Technical Institutes have dropped behind and are now well below Universities (0.1%, 1%)*, Central Government (0.1%, 1%) and Research Associations (0.1%, 1%). School Teaching also falls behind Industry (2%), Hospital Services (5%) and Self-Employed (2%).

Industry salaries are still below those for Central Government, Universities and Research Associations. However, without possible non-taxable allowances added to the industry salaries this difference may not be real. Research Associations appear to have gained on Universities and Central Government with the differences at about the 10% significance level.

A new group in the analysis, Local Government, emerges with significantly lower salaries than Central Government, Universities and Research Associations. Because this group was fairly small, the significance levels are not as great as those observed for Technical Institutes, although the estimates of the differences are greater.

Finally, there are Qualification Group differences. The 1st Class honours group is significantly better paid than all other groups except the 3rd Class Honours group. However, there is a smaller number in the 3rd Class Category (46) and this reduces the discrimination of the test for differences.

* The figures in brackets refer to the significance level of the t -tests.

Table 1. Breakdown of Salary Data by Age and Employment Groups

	UNDER25	26 - 30	31 - 35	36 - 40	41 - 45	46 - 50	51 - 55	56 - 60	61 - 65	OVER65
SCHOOL TEACHING										
No.	3	8	13	5	13	6	3	2	2	0
MEAN	7,569	8,734	11,270	12,110	13,020	14,422	14,000	11,566	13,928	
S. D.	443	1,072	1,195	1,673	2,078	2,210	3,606	800	1,209	
TEACHERS COLLEGE										
No.	0	1	0	0	0	2	0	0	1	0
MEAN		10,912				12,633			13,755	
S. D.						212				
UNIVERSITY										
No.	3	9	33	37	21	20	11	8	3	0
MEAN	7,918	10,520	12,870	15,619	16,873	19,446	17,774	20,788	27,994	
S. D.	733	2,016	1,450	2,556	2,278	3,170	4,659	3,780	2,525	
TECHNICAL INSTITUTE										
No.	0	4	7	6	3	4	2	1	0	0
MEAN		10,683	12,319	13,905	14,838	13,285	14,185	14,300		
S. D.		746	893	1,712	1,665	879	716			
INDUSTRY										
No.	9	52	48	34	20	38	27	10	5	1
MEAN	8,360	11,009	12,628	14,380	15,241	13,750	14,493	13,608	13,693	15,000
S. D.	994	2,130	3,842	5,488	3,982	3,787	3,373	2,446	3,986	
GVT. CENTRAL										
No.	4	32	40	24	10	26	22	13	4	0
MEAN	9,341	10,388	12,803	14,588	16,116	16,418	17,031	16,736	20,584	
S. D.	1,664	1,985	1,823	1,905	2,205	3,526	2,976	3,024	2,617	
GVT. LOCAL										
No.	2	6	1	3	2	1	0	0	1	0
MEAN	8,436	10,167	14,223	12,790	11,502	12,000			13,202	
S. D.	51	1,774		2,164	767					
RESEARCH ASSN										
No.	1	10	15	12	5	9	4	3	0	0
MEAN	8,516	11,071	12,265	14,990	16,361	20,256	17,933	22,230		
S. D.		964	1,928	2,574	2,732	2,452	2,038	2,092		
SELF EMPLOYED										
No.	0	0	2	3	0	3	0	0	2	0
MEAN			18,000	10,400		14,833			16,000	
S. D.			5,657	6,315		3,253			5,657	
HOSPITAL SERVICES										
No.	1	4	4	2	1	2	2	1	0	0
MEAN	6,399	9,896	9,958	14,948	12,044	15,059	13,544	17,444		
S. D.		1,976	2,220	1,941		182	3,430			
STUDENTS										
No.	9	2	0	0	0	1	0	0	0	0
MEAN	2,482	568				Nil				
S. D.	1,809	803								
OTHERS										
No.	1	2	1	5	0	1	0	2	0	0
MEAN	2,700	8,576	12,871	16,250		13,000		10,741		
S. D.		600		3,378				1,048		

Table 2. Breakdown of Salary Data by age and Primary Qualification Groups

		UNDER 25	26 - 30	31 - 35	36 - 40	41 - 45	46 - 50	51 - 55	56 - 60	60 - 65	OVER 65	
THREE-YEAR B. Sc. OR M.N.Z.I.C.	No.	5	31	26	29	21	32	22	13	5	1	
	MEAN	7,707	10,156	12,155	13,861	13,244	14,584	13,542	15,411	14,497	15,000	
	S. D.	1,276	1,824	3,072	5,678	2,282	3,415	3,080	4,033	3,615		
FOUR-YEAR B. Sc. OR M. Sc.	PASS	No.	4	15	16	18	5	15	9	6	1	0
		MEAN	8,864	9,734	11,712	14,167	14,854	14,301	14,140	14,856	13,333	
		S. D.	573	1,396	2,113	3,534	3,878	3,778	3,091	4,019		
	THIRD CLASS	No.	1	6	9	3	1	10	10	6	0	0
		MEAN	6,978	10,617	11,487	12,917	14,800	14,340	18,018	14,497		
		S. D.		2,547	1,769	1,719		3,287	3,160	2,192		
	SECOND CLASS	No.	13	46	72	49	25	34	18	8	4	0
		MEAN	5,363	10,409	12,808	14,857	15,920	15,854	17,436	17,021	16,295	
		S. D.	3,067	2,477	2,944	2,994	3,282	3,752	3,175	3,799	6,217	
	FIRST CLASS	No.	9	31	39	31	21	21	12	6	7	0
		MEAN	6,378	10,978	13,028	15,638	16,917	18,945	17,625	21,562	22,406	
		S. D.	3,860	2,732	1,969	1,673	2,554	5,388	3,076	4,286	5,982	

Table 3. Breakdown of Salary Data by Employment and Primary Qualification Groups

		SCHOOL TEACHING	TEACHERS COLLEGE	UNIVERSITY	TECHNICAL INSTITUTE	INDUSTRY	CENTRAL GOVERNMENT	LOCAL GOVERNMENT	RESEARCH ASSN	SELF EMPLOYED	HOSPITAL SERVICES	STUDENT	OTHER	
THREE-YEAR B. Sc. OR M.N.Z.I.C.	No.	20	1	11	2	99	27	6	7	3	6	0	3	
	MEAN	11,191	10,912	13,490	12,929	12,837	14,003	11,745	14,429	20,000	10,631		16,262	
	S. D.	2,802		4,709	1,059	4,056	3,334	1,203	3,266	2,000	3,382		3,034	
FOUR-YEAR B. Sc. OR M. Sc.	PASS	No.	11	1	0	4	45	15	1	5	0	3	0	4
		MEAN	13,339	12,483		12,208	12,085	13,342	8,914	16,433		14,961		13,601
		S. D.	2,841			2,268	3,267	3,823		4,906		3,375		4,388
	THIRD CLASS	No.	3	0	4	2	21	13	1	1	0	1	0	0
		MEAN	11,986		16,470	12,700	13,128	15,713	12,000	11,500		7,470		
		S. D.	312		4,083	3,111	3,220	4,117						
	SECOND CLASS	No.	16	1	56	16	62	68	6	26	6	4	6	2
		MEAN	11,170	12,783	15,516	13,226	13,593	13,828	9,903	15,238	11,783	10,614	1,973	7,622
		S. D.	1,945		3,564	1,677	4,266	3,487	2,345	3,979	4,459	1,446	1,904	6,960
	FIRST CLASS	No.	5	0	67	2	17	52	2	20	0	3	6	3
		MEAN	12,633		16,753	14,032	14,576	14,842	13,935	14,738		14,603	1,939	10,007
		S. D.	2,655		4,529	46	4,552	3,594	1,224	4,625		1,736	1,942	2,516

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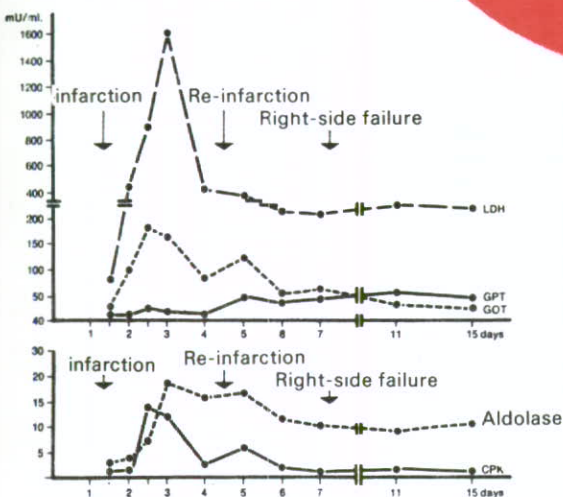
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Table 4. Breakdown of Salary Data by Employment and Major Function Groups

	SCHOOL TEACHING	TEACHERS COLLEGE	UNIVERSITY	TECHNICAL INSTITUTE	INDUSTRY	CENTRAL GOVERNMENT	LOCAL GOVERNMENT	RESEARCH ASSN	SELF EMPLOYED	HOSPITAL SERVICES	STUDENT	OTHER
RESEARCH												
No.	0	0	27	0	8	87	4	36	0	5	9	3
MEAN			13,270		12,040	14,532	10,276	13,825		11,412	2,482	9,371
S. D.			3,489		2,889	2,942	3,159	3,457		2,865	1,809	5,780
TEACHING												
No.	46	4	107	22	0	0	0	0	0	0	1	0
MEAN	10,971	12,483	16,314	12,626							1,136	
S. D.	1,817	1,180	3,739	1,484								
DEVELOPMENT												
No.	0	0	0	0	28	2	0	2	0	3	0	0
MEAN					10,772	14,379		12,290		13,202		
S. D.					2,227	621		156		3,906		
LABORATORY												
No.	0	0	0	1	45	21	5	13	0	1	0	2
MEAN				13,685	12,961	17,133	12,311	19,285		16,320		13,480
S. D.					3,072	4,165	1,635	3,597				678
ADMINISTRATION												
PRODUCTION												
No.	0	0	0	0	41	0	1	0	0	1	0	0
MEAN					12,876		12,000			11,118		
S. D.					3,162							
GENERAL												
No.	7	0	6	2	43	9	2	1	3	0	0	1
MEAN	15,789		22,289	15,663	17,168	18,875	12,081	21,440	15,333			19,700
S. D.	1,676		7,071	1,537	5,450	3,251	1,585		2,517			
OTHER												
No.	2	0	3	2	11	2	0	0	0	0	0	2
MEAN	16,603		16,618	14,966	13,624	15,017						17,524
S. D.	1,976		7,003	93	2,790	197						3,391
SALES AND SERVICE												
No.	0	0	0	0	10	0	0	0	0	0	0	0
MEAN					11,718							
S. D.					2,468							
ANALYSIS AND TESTING												
No.	0	0	0	0	9	44	3	6	1	6	0	3
MEAN					10,256	11,527	10,460	13,502	11,500	10,388		9,544
S. D.					2,337	2,403	1,565	2,659		3,410		1,731
QUALITY CONTROL												
No.	0	0	0	0	17	0	1	0	0	0	0	0
MEAN					9,740		8,472					
S. D.					1,978							
CONSULTING												
No.	0	0	0	0	0	0	0	0	4	1	0	1
MEAN									12,550	15,970		10,000
S. D.									7,053			
TECHNICAL SERVICES												
No.	0	0	2	0	31	4	0	1	2	0	0	0
MEAN			11,320		12,744	13,989		10,180	18,000			
S. D.			4,272		2,423	1,925			5,657			
OTHER												
No.	0	0	0	0	1	6	0	0	0	0	2	0
MEAN					13,600	13,129					Nil	
S. D.						4,417					0	

Table 5. Correlation from the Analysis of Variance Study

Base	Age Group Correction	Primary Qualification Group Correction	Doctoral Group Correction	Employment Group Correction	Major Function Group Corrections				
13489	Under 25	- 4124	3-yr B. Sc. or M.N.Z.I.C. - 467	Without - 356	School Teaching	- 1033	Research	- 806	
	26 - 30	- 3269			Teachers College	- 343	Teaching	+ 513	
	31 - 35	- 2139			University	+ 1447	Development	- 530	
	36 - 40	- 419			Technical Institute	- 287	Laboratory	+ 1131	
	41 - 45	+ 829			Industry	+ 262	Production	+ 1103	
	46 - 50	+ 885			Pass - 323	Central Government	+ 1704	General	+ 3787
	51 - 55	+ 1065			3rd Class - 66	Local Government	- 308	Other	+ 1904
	56 - 60	+ 1910			2nd Class + 55	Research Assn	+ 2427	Sales and Service	+ 540
	61 - 65	+ 3259			1st Class +802	Self Employed	+ 2064	Analysis and Testing	- 1807
	Over 65	+ 2002			4-yr B.Sc. or M.Sc.	Hospital Services	+ 868	Quality Control	- 937
						Student	- 6833	Consulting	- 3725
						Other	+ 30	Technical Services	+ 568
								Other	- 1740

Table 6. Significance of the difference between Employment Groups

EMPLOYMENT GROUP	No.	MEAN SALARY CORRECTION (TABLE 5)	SCHOOL TEACHING	TEACHERS COLLEGE	UNIVERSITY	TECHNICAL INSTITUTE	INDUSTRY	CENTRAL GOVERNMENT	LOCAL GOVERNMENT	RESEARCH ASSN	SELF EMPLOYED	HOSPITAL SERVICES	STUDENT
SCHOOL TEACHING	55	- 1,033											
TEACHERS COLLEGE	4	- 343	ns										
UNIVERSITY	145	+ 1,447	☆☆☆	ns									
TECHNICAL INSTITUTE	27	- 287	ns	ns	☆☆								
INDUSTRY	244	+ 262	☆	ns	☆	ns							
CENTRAL GOVERNMENT	175	+ 1,704	☆☆☆	ns	ns	☆☆	☆☆☆						
LOCAL GOVERNMENT	16	- 308	ns	ns	☆	ns	ns	☆☆					
RESEARCH ASSN	59	+ 2,427	☆☆☆	ns	☆	☆☆☆	☆☆☆	☆	☆☆☆				
SELF EMPLOYED	10	+ 2,064	☆☆	ns	ns	☆	ns	ns	☆	ns			
HOSPITAL SERVICES	17	+ 868	☆	ns	ns	ns	ns	ns	ns	☆	ns		
STUDENT	12	- 6,833	☆☆☆	☆☆☆	☆☆☆	☆☆☆	☆☆☆	☆☆☆	☆☆☆	☆☆☆	☆☆☆	☆☆☆	☆☆☆
OTHER	12	+ 30	ns	ns	ns	ns	ns	☆	ns	☆☆	ns	ns	☆☆☆

ns Not significant (probability greater than 0.1).
 ☆ Significant, Students "t" between 1.65 and 2.32 (probability between 0.1 and 0.02).
 ☆☆ Very significant, Students "t" between 2.33 and 3.29 (probability between 0.02 and 0.001).
 ☆☆☆ Highly significant, Students "t" over 3.3 (probability less than 0.001).

Table 7. Significance of the Differences between Major Function Groups

MAJOR FUNCTION GROUP	No.	MEAN SALARY CORRECTN (TABLE 5)	RESEARCH	TEACHING	DEVELOPMENT	ADMINISTRATION				SALES AND SERVICE	ANALYSIS AND TESTING	QUALITY CONTROL	CONSULTING	TECHNICAL SERVICES
						LABORATORY	PRODUCTION	GENERAL	OTHER					
RESEARCH	179	- 806												
TEACHING	180	+ 513	☆☆											
DEVELOPMENT	35	- 530	ns	ns										
ADMINISTRATION	LABORATORY	88	+ 1131	☆☆☆	ns	☆☆								
	PRODUCTION	43	+ 1130	☆☆☆	ns	☆☆	ns							
	GENERAL	74	+ 3787	☆☆☆	☆☆☆	☆☆☆	☆☆☆	☆☆☆						
	OTHER	22	+ 1904	☆☆☆	☆	☆☆	ns	ns	☆☆					
SALES AND SERVICE	10	+ 540	ns	ns	ns	ns	ns	☆☆☆	ns					
ANALYSIS AND TESTING	72	- 1807	☆☆	☆☆☆	☆	☆☆☆	☆☆☆	☆☆☆	☆☆☆	☆☆				
QUALITY CONTROL	18	- 937	ns	☆	ns	☆☆	☆☆	☆☆☆	☆☆	ns	ns			
CONSULTING	6	- 3725	☆	☆☆	☆	☆☆☆	☆☆☆	☆☆☆	☆☆☆	☆☆	ns	☆		
TECHNICAL SERVICES	40	+ 568	☆☆	ns	☆	ns	ns	☆☆☆	☆	ns	☆☆☆	☆	☆☆	
OTHER	9	- 1740	ns	☆	ns	☆☆	☆☆	☆☆☆	☆☆	☆	ns	ns	ns	☆

Table 8. Significance of the differences between Primary Qualification Groups

PRIMARY QUALIFICATION GROUP	No.	MEAN SALARY CORRECTN (TABLE 5)	THREE-YEAR B.Sc. OR M.N.Z.I.C.	FOUR-YEAR B. Sc. OR M. Sc.			
				PASS CLASS	THIRD CLASS	SECOND CLASS	FIRST CLASS
THREE-YEAR B.Sc. OR M.N.Z.I.C.	185	- 467					
FOUR-YEAR B. Sc. OR M.Sc.	PASS	89	- 323	ns			
	THIRD CLASS	46	- 66	ns	ns		
	SECOND CLASS	269	+ 55	☆	ns	ns	
	FIRST CLASS	177	+ 802	☆☆☆	☆☆	☆	☆☆

Table 9. Effect of omitting variables on the percentage of variance explained by the model in Table 6

VARIABLE OMITTED	EMPLOYMENT GROUP		
	UNIVERSITY	INDUSTRY	CENTRAL GOVERNMENT
NONE	70	35	73
AGE	24	29	31
PRIMARY QUALIFICATION	68	34	71
DOCTORAL QUALIFICATION	69	35	67
MAJOR FUNCTION	66	16	68

Use of Table 5

To use Table 5 take the base salary (\$13,489) then add or subtract the age group correction, the primary qualification correction, doctoral qualification correction, employment group correction and the major function group correction.

For example: A 38 year old chemist (-419) with a B.Sc. 1st Class Honours (+802), no doctorate qualification (-856), in Central Government (+1704) working in research (-806) could compare his salary with $(13489 - 419 + 802 - 856 + 1704 - 806)$ \$13,914.

The result is the predicted mean for someone in this category; there is however a residual standard deviation of \$2730 implying that one can only estimate a salary with any certainty to within about \pm \$5500! Table 5 should not therefore be used for salary prediction.

Table 10. Increases in Salary since the previous Salary Survey (1974)

EMPLOYMENT GROUP	PERCENTAGE INCREASE	
	(FROM PREDICTED SALARY)	(FROM MEAN SALARY)
SCHOOL TEACHING	27	33
UNIVERSITY	43	51
TECHNICAL INSTITUTE	23	31
INDUSTRY	43	45
CENTRAL GOVERNMENT	40	47
RESEARCH ASSN	51	55
SELF EMPLOYED	33	27
HOSPITAL SERVICES	55	59
BASE SALARY	31	

THE DATA WERE NOT AGE-CORRECTED

Acknowledgement

The authors wish to acknowledge the advice given by John Darwin.

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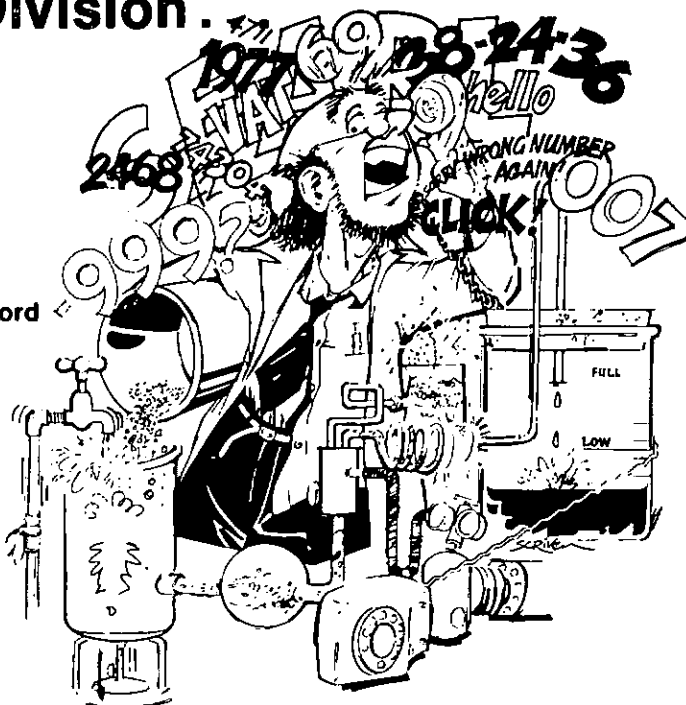
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New Zealand Concern for Levich

Concerned with the plight of Professor Benjamin Levich, the NZIC Council has issued the following statement. The Royal Society of NZ has received this statement and forwarded it to the Soviet Academy of Sciences with the endorsement that the rights of scientists to freedom of work and movement must be upheld. The NZIC statement has also been considered by Government, and a reply from the Minister of Foreign Affairs is reprinted below the NZIC Council Statement.

NEW ZEALAND INSTITUTE OF CHEMISTRY INC.

THE LEVICH AFFAIR

Professor V. G. Levich is a distinguished Russian physical chemist who has a world reputation for his research in the fields of quantum theory of electron transfer, physico-chemical hydrodynamics and electrode processes. In 1972 he applied to emigrate to Israel on personal grounds. Not only was his application refused, but he was dismissed from his chair of mathematical physics at Moscow University and demoted to a minor position at the Institute of Electrochemistry. Members of his family were also harshly treated.

The plight of Veniamin Levich (also known as Benjamin Levich) was widely reported, and many scientific and professional bodies throughout the world expressed their concern and dismay at his treatment. The N.Z. Institute of Chemistry investigated the Levich case in the light of the Code of Ethics which state, inter alia -

“(3) A member shall act in a spirit of personal helpfulness and fraternity toward other members of his profession.”

The rules of the Institute further state that one of the objects of NZIC is -

“(3.12) to take any other lawful steps to promote the progress of chemistry and the welfare of those engaged in its study and practice.”

In November 1972 Council resolved:

“That

“That the New Zealand Institute of Chemistry reaffirms its view that all scientists should be free to practice their profession without political restriction or persecution; and that scientists should be accorded their full rights and freedoms, including the rights of international travel and emigration; and that the reported treatment of Professor V. G. Levich of the Institute of Electrochemistry, USSR Academy of Sciences, Moscow, is of concern to the members of NZIC who wish to put on record their strong disapproval of the actions of the Soviet authorities.”

A full statement on behalf of NZIC Council was published in *Chemistry in New Zealand*, 37 (3), p. 77 (June 1973). But in spite of these protests the position of Professor Levich has not greatly improved. In 1975 his two sons and their wives were permitted to leave the Soviet Union, and the authorities promised to release Levich in due course. But recently the official attitude has hardened again, and Levich has been detained on the grounds that he

possesses secret information. He has been completely denied the means of continuing his research and publishing results. His name has been expurgated from the Russian scientific literature, even when his papers have been cited by other authors.

It should be remembered that Levich does not fall into the category of dissidents like the biologists Bukarov (now in the West) and Kovalev (now in a Soviet labour camp). He has not worked against Soviet leadership on political or moral grounds as have many writers and intellectuals. Levich is simply a “Refusnik”, whose offence appears to be the desire to break away from the rigid system of Soviet science. Some light on the position of Levich has been shed by Professor Bockris who wrote a reminiscence on A. N. Frumkin in the Proceedings of the Royal Australian Chemical Institute, p. 61 (March 1977). Frumkin, who died in 1976 at the age of 81, was the head of the Institute of Electrochemistry of the USSR Academy of Sciences and it appears that a personal dispute may have contributed to the downfall of Levich. But whatever the cause, it is clear that the treatment of Levich is contrary to international standards of justice and freedom of work and travel for scientists and other people.

In May 1977 the Council of the New Zealand Institute of Chemistry considered the Levich case and the following resolution was approved:

“NZIC records its deep concern at the treatment received by Professor V. G. Levich in the Soviet Union since 1972, and appeals to the Soviet authorities to restore full rights of work and travel to Professor Levich.”

This resolution will be brought to the attention of the appropriate authorities. Meanwhile an international conference on Levich's special field of physico-chemical hydrodynamics was held in Oxford in July to celebrate his 60th birthday. Professor Levich was not permitted to attend this conference, in spite of the fact that it was organised in his honour. In a recorded message to the conference he expressed his gratitude for the support of scientists throughout the world, and he stated that he would continue to press for permission to leave Russia.

On behalf of the Council,

G. A. Wright, 1 August 1977.

Mr G. N. Malcolm,
President,
New Zealand Institute of Chemistry,
P.O. Box 1926,
CHRISTCHURCH

Dear Mr Malcolm,

I am writing in reply to your letter to me about Professor V. G. Levich, the internationally respected Soviet scientist who is suffering harsh treatment at the hands of the Soviet authorities on account of his application, in 1972, to immigrate to Israel.

You will appreciate that there are strict limits to what the Government of another country can do with regard to the treatment individual citizens receive in their own country. Intervention by a third party is unlikely to be successful except in the most exceptional circumstances. Sometimes it may be counter-productive.

You ask whether I consider the 1975 Helsinki Agreements might be applicable to Professor Levich's case. The Helsinki Agreements are unquestionably an important development in the attempt to create better relations between East and West Europe. They lay down a set of internationally agreed principles covering four main areas - security in Europe; co-operation among the signatory states in fields of economics, science, technology and the environment; security in the Mediterranean; and finally co-operation in humanitarian and related fields - Basket III. The degree to which these principles should be considered binding has been the subject of considerable debate over the past two years. I think it is fair to say that the Agreements are generally considered to represent a declaration of intentions rather than a set of legal binding obligations. They are nevertheless a vital benchmark in East/West relations and, as such, they are clearly relevant to the general question of the denial of human rights wherever

this occurs in the Soviet Union and Eastern Europe - and, of course, in all the other signatory countries as well.

The Soviet bloc countries have not generally lived up to the expectations that many in the West placed on the Helsinki Agreements. Perhaps some of these expectations were unrealistic. The Soviet Union places greatest emphasis on the provisions for the recognition of post World War II European frontiers; the West has tended to focus on the Basket III humanitarian measures. The Soviet Government maintains that those groups and Governments in the West which actively seek to support human rights groups in the Soviet Union or try to apply the Helsinki Agreements to individual cases are "interfering in the Internal Affairs of the Soviet Union".

Some useful progress has, however, been made. The Agreements have assumed a powerful international, moral and political force - they have sharply focussed international attention on the issues set out in Basket III. The authorities in both Eastern Europe and the Soviet Union have published the texts of the Helsinki Agreements; in 1976 there was an increase in the number of people allowed to leave those countries and settle in the West. It is, however, interesting to note that this year these numbers have decreased. Some observers believe that this has been due to the increased pressure being applied by the West for a greater measure of recognition for human rights in the Soviet bloc countries. Although the Agreements are not considered to be legally binding, the signatory states did agree to meet to review progress. The first review meeting is due to take place in Belgrade next month. I have no doubt that human rights will be the focus of international attention at the Belgrade meeting.

It will, inevitably, take considerable time for the Helsinki Agreements to bear much fruit and the Governments directly involved are still very much at the initial stages of implementing them. But I believe the attempt to create better relations between East and West in Europe is well worth all the effort and frustrations involved.

Yours sincerely,
B. E. Talboys

Industrial Chemistry Prize

(Sponsored by I.C.I. Tasman Vaccine Ltd)

1. A prize of \$200 will be awarded annually.
2. The prize will be awarded for meritorious achievement in the field of industrial chemistry.
3. The prize will be restricted to financial members of the New Zealand Institute of Chemistry of any grade of membership. In the case of joint work the prize may be shared between two or more members.
4. Applications should include a written statement of the industrial chemistry activities or achievements of the candidate, and their significance in terms of improved technology, new products, or other benefits to industry or the community. Supporting documents and publications may be submitted with the application and will be held to be confidential to the assessors. If possible the value of the work should be attested by an

- accompanying statement from the manager, or directors, or head of the organisation. There is no limit on the period of time over which the work was carried out.
5. Applications for the prize may be made by individual members, or nominations may be made by Branch Committees or by corporate members of the Institute.
6. Two or three assessors will be appointed by the Council of the Institute of Chemistry to consider the applications and make recommendations. The final decision on the award will be made by the Council. Council reserves the right to make no award in the absence of a suitable candidate.
7. Applications or nominations must be submitted to the Administrative Secretary N.Z.I.C., P.O. Box 1926, Christchurch, before 30 April each year.

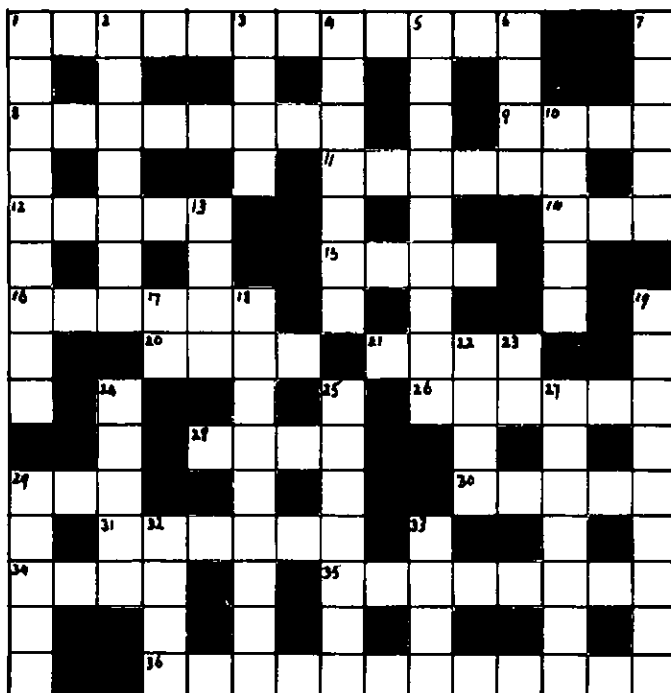
Solubility of Gases and Liquids —
W. Gerrard, Plenum Press, N.Y.,
1976; 274 pp., Price \$47.40.

The dust jacket announces this book as a graphic approach to the data, causes and prediction of solubility of gases and liquids in liquids. The book consists of seventeen chapters. The first six of these are concerned with general aspects of the subject. The next eight give accounts of the solubilities of individual named substances and classes of substances in a number of solvents. These are followed by a short chapter on temperature effects (4 pp) and one entitled Prediction. The book finishes on a somewhat cryptic note with a two page chapter entitled Textbook Statements.

Despite the title this book is almost totally concerned with gas solubility. The first chapter expands the author's view that mole ratios are more fundamental than mole fractions in understanding solubility behaviour. This assertion is repeated at intervals throughout the book but at no point is there any real evidence that this is so. Most of the graphs use mole fraction as the composition scale. The other major feature of chapter one is the description of one experimental method of measuring gas solubilities. The second chapter develops the concept of the reference line which is to all intents and purposes the "Raoult's Law" line as is demonstrated in fig. 5. Chapter three opens with an account of Henry's law and goes on to an interesting history of the early development of ideas about liquid-vapour equilibria. Chapter four, of two pages length, gives a very brief qualitative description of Hildebrand's contribution to the field. Chapter five discusses solutions in water and Chapter six devotes four pages to a review of the available reviews. Although there are 150 graphs nearly all of them are of smooth lines with no references to the sources from which they are taken. This reviewer has always believed that thermodynamics is the appropriate formalism in which to discuss, and attempt to achieve correlations of, solubility phenomena. This book assiduously avoids any contact with thermodynamics. The chapter on prediction provides no firm guidelines on which one might base any attempt at quantitative prediction. The book is moderately well documented with a fair bibliography and references to good reviews. However, for a book so totally concerned with one topic there are some fairly large gaps in the reference section.

I found the style (the book is written in the first person and in a telegraphic form) rather disconcerting. The published price of \$47.40 (in N.Z.) is a great deal to pay for any book and certainly far too much for this one.

A.G. Williamson



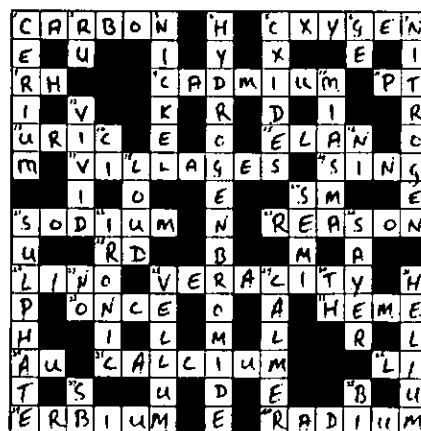
Across.

1. Still in use (12)
8. You and roofing tile with acidity give this ion (8)
9. First lady always Queen? (4)
11. About 28? Rubbish! (6)
12. -- and asleep (2,3)
14. Regrettable herb (3)
15. Unit (4)
16. Starve perhaps prevents (6)
20. You get this in splitting the atom (4)
21. Found in pathologists lab (i.e. mortuary) (4)
26. A steel causes excitement (6)
28. Make molten (4)
29. Pyrolytic condensate (3)
30. Accident for igniting burner (5)
31. Sausage as mail? (6)
34. Fag end (4)
35. L or in rebuke for Ion (8)
36. Boxer? (12)
18. Wet through? No just wet enough! (9)
19. Dissolved? No but can cause insoluble problems! (9)
22. Limbs of charity (4)
23. Alkaline earth (2)
24. In the beginning... (5)
25. As in DNA (7)
27. Working hard (7)
29. e.g. Periodic (5)
32. A male cat? (4)
33. Behaviour in liquid of low viscosity (4)

Down.

1. Dehydrate (9)
2. Ol' blues can be done! (7)
3. Metal in front (4)
4. Be mean (7)
5. Unutterable (9)
6. Against (4)
7. Newtons Measurement (5)
10. Poetry sounds no better (5)
13. Figment of time (4)
17. Monkey factor (2)

Answer to the last Crossword



Carl Wilhelm Scheele

a sad tale if ever there was one



CARL WILHELM SCHEELÉ:
1742-1786

It is said of Scheele that his record as a discoverer of new chemical substances is probably unequalled. Besides discovering chlorine and ten important acids including citric, he prepared oxygen a couple of years before Priestley.

Unfortunately for Scheele, he forgot to tell anyone about the oxygen and must have got quite inflamed when Priestley took all the limelight. Therein lies a moral: if you come across something big, don't let the news hang fire—tell as many people about it as you can. Which is why we're now going to say that 'Pronalys' analytical reagents are exceptionally pure chemicals ideal for use in the most exacting analytical procedures.

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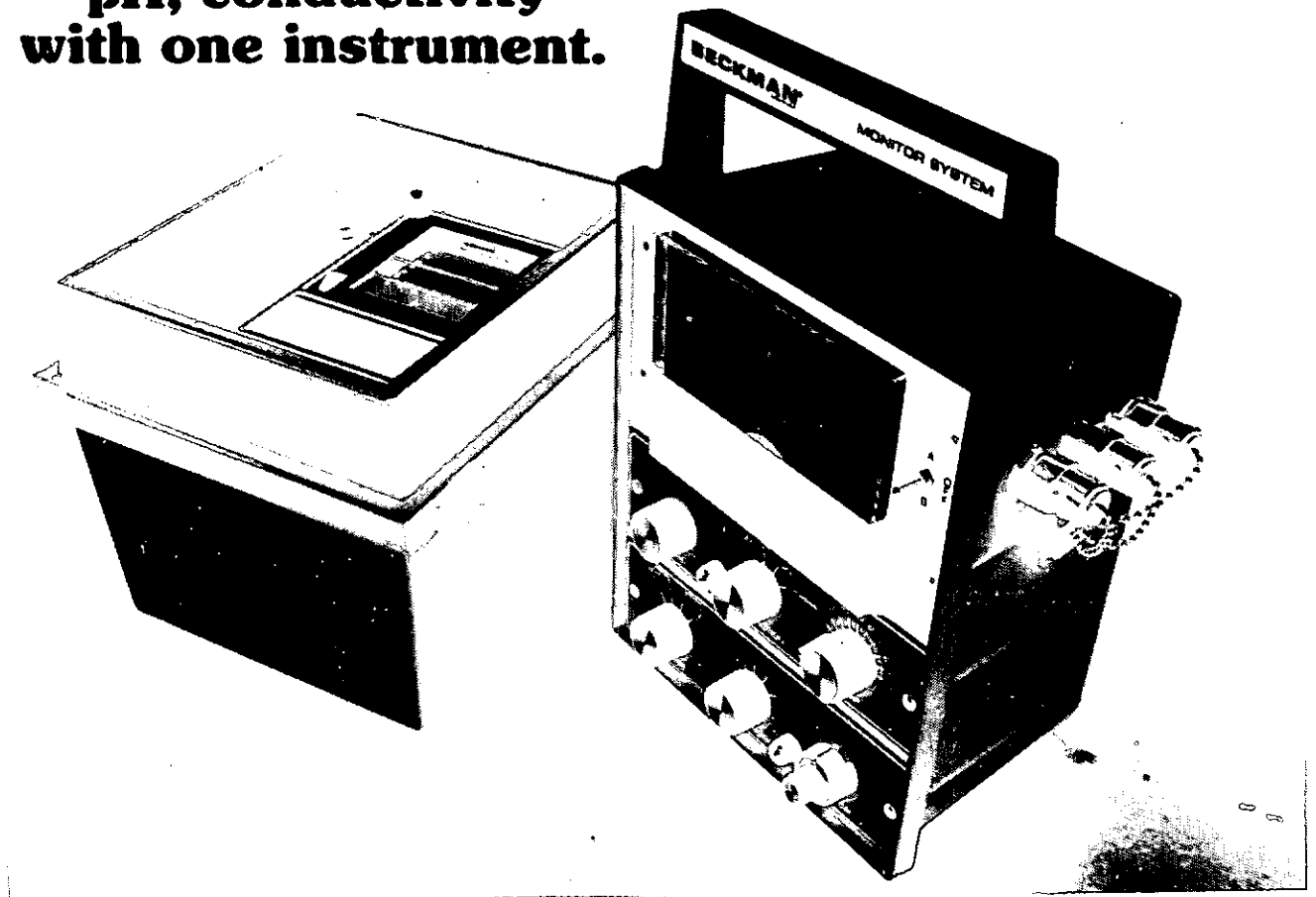
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