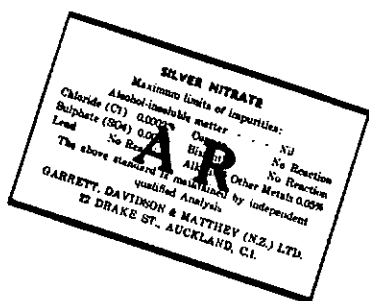
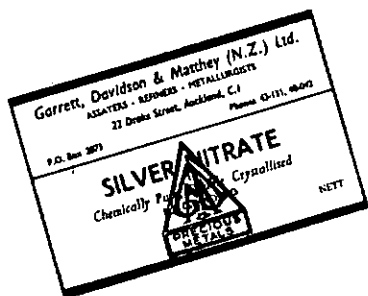


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INSTITUTE OF CHEMISTRY

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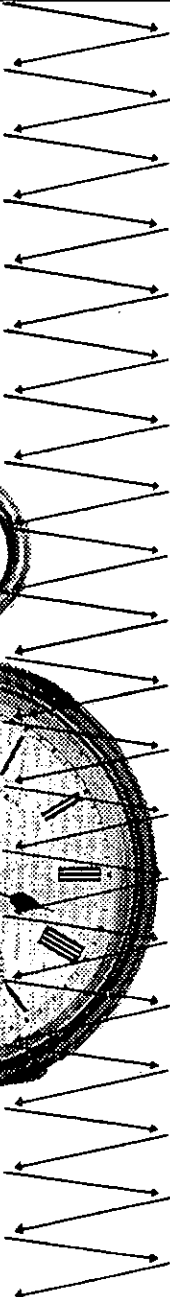
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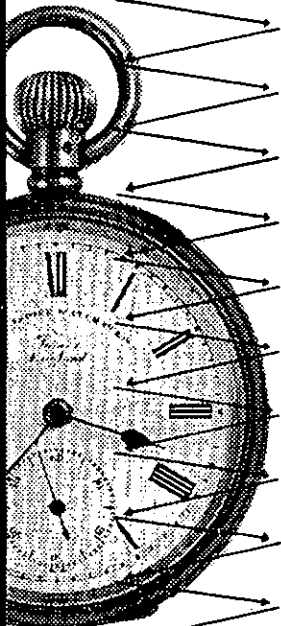
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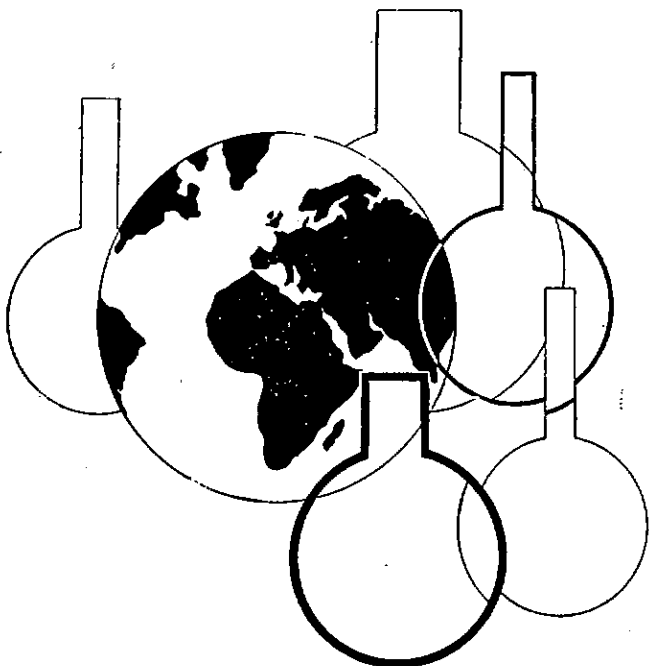
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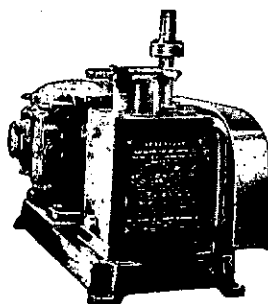
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PRESIDENT, 1959: PROFESSOR L. H. BRIGGS

## PRESIDENT

PRESIDENT FOR 1959 is Prof. L. H. Briggs, Professor of Chemistry, University of Auckland. Professor Briggs is already well known to all members of the Institute and his election to the Presidency comes at a most appropriate time as 1959 marks his twenty-fifth year of continuous executive office in the Institute—surely a record for most scientific societies. His service to the Institute has included eleven years on the Auckland Branch Committee, the last two as Chairman, thirteen years on the Membership Committee, and periods on various sub-committees, including the 1956 Conference Committee of which he was Chairman. Professor Briggs was elected an Associate in 1933 and a Fellow in 1936. In 1949 he was awarded the first I.C.I. Medal.

A graduate of Auckland University College, Professor Briggs became the first research student at Massey College where he worked for two years as a Sir James Gunson Scholar before proceeding to Oxford where he obtained his D. Phil. in 1933. Returning to Auckland University College as Lecturer in Organic Chemistry, Professor Briggs has built up his well known and outstanding school of organic chemistry. Over 100 publications deal mainly with the plant products of New Zealand, including alkaloids, steroids, essential oils and their constituents, lignans, flavonoids, anthraquinones and related synthetic topics. In addition work has been carried out on the relation of physical properties to chemical constitution, particularly in the field of infra-red and ultra-violet spectroscopy and polarography, on the mechanism of organic reactions, and on organic reactions for metals. He was awarded a D.Sc. by the University of New Zealand in 1941, and has been honoured by various scientific societies including the Hector Medal of the Royal Society of New Zealand. He received the Coronation Medal in 1953.

Professor Briggs has travelled extensively while on two periods of refresher leave and has also found time to serve for 30 years as a rugby referee and to take an active interest in tramping.

We congratulate Professor Briggs on his long period of service to the Institute as well as on his election to its highest office. With his wide interests and his sound knowledge of Institute affairs we look forward to an active and successful year under his leadership.

## VICE-PRESIDENT

VICE-PRESIDENT FOR 1959 is E. W. Hullett, Director, Wheat Research Institute, Christchurch.

# HISTOCHEMISTRY—A REVIEW °

C. R. BARNICOAT†

IN LESS THAN half a century biochemistry has developed from an integrating borderland science into an independent and important scientific discipline. Indeed, its scope is so wide that it is already disintegrating into several specialized fields and it is one of these, histochemistry, that is the subject of this paper.

Both the biochemist and the histologist are concerned with investigating the organization and functioning of the living cell. The biochemist is, however, generally restricted to studying cells and tissues in which the original structure has been destroyed, whereas the histologist, while maintaining the structure, perforce destroys many of the biochemical characteristics. Cellular activities are largely controlled by the nature and composition of the ions in the surrounding aqueous fluid, which in normal cells are maintained within narrow limits. It is generally agreed that the enzyme systems are arranged spatially so that the courses of the various biochemical transformations can be directed into the right pathways in the correct sequence. The problem of identifying the sites of enzyme activity and of other constituents of biochemical importance in the cells and tissues is under investigation along three distinct lines of experiment:

- (a) Centrifugation—separation of cell fractions in non-ionic media (*e.g.*, sucrose solutions), by means of differential centrifugation (chiefly U.S.A.).
- (b) Statistical correlation of chemical composition or biochemical activity of tissue sections with results of quantitative microscopy (chiefly Denmark), and
- (c) Histochemistry—which according to Gomori, one of the American authorities, “has as its subject-matter the identification and localization of chemical substances in the tissues on a cytological scale. ‘Cytochemistry’ is often used as a synonym; however, it should be reserved for the study of the chemical organization of the cell in general”.

While most of the methods have been adapted from chemistry, it is interesting to review briefly the contributions of histology to this new department of science.

The histologist is really a micro-anatomist. Histology is one of the older-established basic sciences, to which we owe most of

°Based on Presidential Address delivered at Hamilton in August, 1958.

†Associate Professor and Head of Biochemistry Department, Massey Agricultural College, Palmerston North.

our knowledge of the structure of tissues and cells, plant as well as animal. In addition to its great importance in medicine for diagnostic purposes, histology is actively involved in investigations in haematology and malignancy, and has recently had great impetus in several fields including atherosclerosis, several muscle disorders, and studies on bones and teeth. A rewarding field has been the investigation of the connective tissues of the body, *e.g.*, changes in the nature of connective tissue, previously regarded as more or less inert, are now found to be associated with arthritis, various types of rheumatism and changes associated with old age.

During the second half of last century the use of aniline dyes for the differential staining of tissues led to rapid advances in branches of biology pertaining to morphology such as histology, cytology, embryology and bacteriology. Because differences in initial treatment (fixation) and staining procedures cause precipitation artifacts in tissue sections which change their microscopic appearance, interest in fixed preparations declined and gave way to chemical studies of the tissues, principally enzymology, which dominated the field and eventually evolved into the science of biochemistry.

The histologists re-investigated the problem of tissue fixation systematically, and since this treatment also determines the value of the results of histochemical tests, it is opportune to describe the chemical principles of tissue fixation, necessarily though, in a over-simplified manner. To visualize the components of thin sections of tissue under the microscope, they must first be treated by physical or chemical means for preserving them in an insoluble state whereby their displacement by diffusion or osmosis is averted. For the chemical process, known as fixation, many different mixtures and procedures are recommended, the choice depending on the nature of the tissue and of the particular constituent under observation.

Since proteins are the principal constituents of cells, the most important fixatives are chemicals which react with them. Dilute formalin, because of its satisfactory performance, being non-precipitant, is widely used. It reacts with a number of chemical groups, especially  $-H$  and  $-NH_2$  groups or aromatic compounds, to form bridges. On the other hand picric acid combines with proteins to form insoluble picrates. Chromium compounds also precipitate proteins by forming bridges with  $-OH$ , and  $-COOH$  groups;  $Hg^{++}$  compounds react with acid, in particular thiol, groups. Alcohols, especially ethanol, and acetone are used in enzyme studies because they do not

inactivate the functional groups of the enzyme proteins, but apparently merely break hydrogen bridges and salt links and alter the stereochemical nature of the polypeptide chains.

When lipids are under investigation, polar solvents must be used, salts of  $\text{Ca}^{++}$ ,  $\text{Cu}^{++}$ ,  $\text{Co}^{++}$ , or  $\text{Cd}^{++}$ , which have an affinity for phospholipids, usually being included.

Osmium tetroxide is increasingly favoured, especially for electron microscopy studies, because of its mild and general action on cell constituents. It apparently combines with unsaturated bonds of the fatty acids, and secondly with thiol groups of the proteins.

Acetic acid is commonly included and is of particular value as a precipitant of nucleoproteins.

Commonly used fixatives contain mixtures of these substances. One, incidentally, which should intrigue chemists, is designed for use with the most delicate structures—cilia and flagella of the protozoa—and contains both formaldehyde and chromic acid!

The aim of fixation is to ensure that the size of the aggregated particles is less than the resolving power of light, *i.e.*, less than about  $0.25\mu$ , for while denaturation and precipitation of proteins inactivates the enzymes, their staining reactions (as proteins) with aniline dyes are thereby greatly enhanced.

To prepare a section for microscopical examination, standard histological techniques are followed, *i.e.*, the fixed tissues are embedded in a supporting medium, usually paraffin wax, for sectioning in a microtome at a thickness of about  $5\mu$ , and the sections, affixed to slides, are "taken to water" through a series of solvents, stained and taken in reverse order through the solvents (dehydrated) to a non-polar liquid such as xylene for mounting, usually in Canada balsam. The sections may be examined in visible, ultra-violet, infra-red, or polarized light, or by special optical methods including fluorescence microscopy, phase contrast, or light interference methods, and may be photographed. Histochemistry has adopted all these techniques, except that the application of aniline dyes to bring out detail of denatured tissues, as in standard histological procedure, may be replaced by special chemical or biochemical tests with tissues treated to retain as many as possible of their original characteristics.

The major problem of histochemistry is therefore that of retaining the chemical components of the cells in their original sites and maintaining activity in the enzyme systems.

Incidentally, the microscope is the principal tool of histochemistry, and it would be interesting to see this much abused and little understood piece of apparatus assume its rightful importance again in the chemical laboratory.

#### IDENTIFICATION OF SIMPLE SUBSTANCES IN TISSUES

While the identification in tissues of simple solutes, such as inorganic substances by chemical tests presents, as a rule, no great problem as a wide variety of sensitive microchemical reagents are available, their localization presents great difficulties. Because the soluble substances are easily displaced through diffusion and osmosis, or concentrated in zones of dehydration, immobilization or fixation must be extremely rapid. This is best achieved by a freezing method introduced by Altmann in 1890, but since improved by Gersh and many others.

The principle is that of bringing all cell activities to a complete standstill ("quenching") by suddenly freezing a fragment of the tissue at about  $-170^{\circ}\text{C}$  for a few seconds thereby transfixing the cell constituents on their original sites. The tissue is then dehydrated under high vacuum ("freeze dried") at  $-40^{\circ}\text{C}$  or lower for a day or more until quite free of water. No liquid phase is present during the entire process, so there is no displacement of solutes by diffusion. The dehydrated tissue is then impregnated with melted paraffin, sectioned and floated on the appropriate reagents.

Early experiments of this type proved, for example, that chlorine is present in the intercellular spaces of muscle, potassium chiefly in the cells themselves. Many of these special tests were introduced last century ("chemical microscopy"), and are still widely used.

#### IDENTIFICATION OF MAJOR CELL CONSTITUENTS OF POORLY DIFFUSIBLE TYPES

Possibly the most interesting and practicable techniques of histochemistry for the chemist working, as many do in New Zealand, in fields of applied biology such as agriculture, are those for identifying such major tissue constituents as fats, phospholipids, proteins of various types, polysaccharides and their related substances in plant and animal tissues. Because all of these diffuse poorly, the techniques are fairly straightforward and are mostly standard histological ones. Modern methods of fixation and staining are precise and even permit differentiation within each specific group. There are, for example, many selective staining procedures for proteins, as well

as tests for individual amino acids, *e.g.*, Millon's for aromatic groups, Sakaguchi's for arginine, nitroprusside for thiol groups. The principles underlying the well established procedures for differentiating structural tissues such as keratin, reticulin, elastin, collagen, and muco- and glyco- proteins have recently been given much attention. Glycoproteins are identified by means of the periodic acid—Schiff (PAS) reagent which is specific for compounds containing sugar radicals with the 1 : 2 glycol grouping, or the equivalent amino derivatives. The glycol group is oxidized by the periodic acid to a dialdehyde which reacts with the leucofuchsin of Schiff's reagent. The test is very specific, providing carbohydrates, such as glycogen, have been removed by acid or enzymic hydrolysis.

Nucleoproteins are of interest both to histogists and biochemists as they are found in all living cells, particularly in the nucleus. They are composed of basic proteins in salt-like linkage with nucleic acids, which are composed of orthophosphoric acid, pentoses and purine and pyrimidine bases. They are easy to detect histochemically as they stain characteristically with certain basic dyes, and give characteristic absorption spectra in the ultra-violet.

There are two distinct types of nucleic acid, ribonucleic acid (RNA) and desoxyribonucleic acid (DNA). DNA appears to be restricted to the cell nucleus, while RNA occurs mainly in the cytoplasm. The chief chemical difference between the two types of nucleic acid is in the nature of the pentose radical, the desoxy sugar lacking one oxygen on the second carbon atom. DNA can be detected and localized by means of the Feulgen reaction, in which mild acid hydrolysis releases the pentose (2 desoxyribose) and uncovers potential aldehyde groups which react with Schiff's reagent.

There is, however, no direct method available for RNA, which can be identified, with certainty, only by comparing the staining patterns of neighbouring tissue sections with basic dyes, one section having been treated with a preparation of the enzyme ribonuclease in order to remove the RNA.

(The PAS test is not given by nucleic acids because the reacting groups of the pentose sugars are combined with phosphoric acid).

#### IDENTIFICATION OF ENZYMES

One of the latest and most promising developments in histochemistry is that of localizing enzyme activity in tissues, but it is beset with many difficulties. In the first place any supposed

advantages of the freezing method are nullified because the tissues must spend a considerable time in aqueous substrates, and the proteins would dissolve unless fixed beforehand. As a consequence, mild fixatives such as dilute formalin, acetone, or alcohol, or even rather concentrated solutions of inorganic salts (ammonium, magnesium or sodium sulphates), are used to ensure that sufficient enzyme is retained to react and indicate the distribution in the tissue.

The principle underlying histochemical tests for enzymes is as follows. The fixed tissue is embedded in paraffin *in vacuo* at a temperature below 56°C, sectioned and "taken to water" and incubated with an aqueous, buffered solution of the substrate, usually for some hours. In addition to its specificity and sensitivity, the substrate is selected for certain special chemical characteristics, the most important of which is its ability to change under the action of the enzyme to a colourless stain precursor, which in the presence of a suitable developing agent, reacts to produce a stain at the site of enzyme activity.

An illustrative example is that of the widely-distributed enzyme alkaline phosphatase, the histochemical method for which was developed independently in 1939 by both Gomori and Takamatsu. The substrate is essentially an aqueous solution of an organic phosphate, usually glycerophosphate, containing a trace of  $Mg^{++}$  as activator and veronal to buffer it at pH 9.3. Calcium glycerophosphate is soluble at this pH but on hydrolysis by alkaline phosphatase,  $Ca_3(PO_4)_2$  is precipitated, and can be visualized by means of "spot tests" or examination under polarized light. The usual method of visualization is, however, an indirect one, which is typical of a number of histochemical tests. The section is immersed in a dilute solution of a cobaltous salt, the cobalt exchanges with some of the freshly-precipitated calcium, whereas the preformed precipitates, as in bones and teeth, are inert. After washing away excess cobalt, the precipitated cobalt retained by the calcium phosphate is visualized as the sulphide. Since black cobalt sulphide has extraordinary tinctorial power, the method is an extremely sensitive one for localizing phosphatase activity.

In most histochemical reactions for enzymes, however, the organic substrate is split by the enzyme, and one portion of the molecule, usually the larger, couples with the developing agent in the solution to form an insoluble dye.

An example is cited later in which an indigoid precursor is released as a leuco-compound which is immediately oxidized to an indigoid dye on the spot.

Histochemical methods are, incidently, available for a wide variety of enzymes, but the majority of original papers still appear in recondite journals before finding their way into review articles and textbooks for general consumption.

A recent series of papers from the Courtauld Institute of Biochemistry in London merits close attention. Several workers describe the development of a method for identifying and localizing in tissue sections the activity of esterase, a widely-distributed but not very specific enzyme. Their method was developed from theoretical considerations of basic principles.

It depends on the hydrolysis of an indoxyl acetate, and the immediate oxidation of the hydrolyzed free indoxyl to an indigoid dye. The best substrate proved to be 5-bromo-, 4-chloro-indoxyl acetate, and it is of interest to note that these workers systematically prepared and tested by physico-chemical methods well over 200 halogen-substituted indoxyl derivatives before encountering this particular compound which, from its reactions, they predicted would have the desired characteristics of the histochemical substrate for esterase.

Although rather outside the scope of this paper, it must be mentioned in passing that the use of radioactive compounds for enzyme studies and other aspects of histochemistry opens up enormous possibilities.

#### QUANTITATIVE MEASUREMENTS OF ENZYME ACTIVITY

Assuming that fixation procedures could be standardized so that a constant proportion of the original enzyme activity of a tissue is retained, is it then possible to compare its activity with that of other tissues, or even to express its activity quantitatively?

Theoretically the comparison would be difficult because most enzyme actions are of the first or higher order ("curvilinear"). In the presence of a great excess of substrate, however, the reaction approaches that of the zero order ("straight line"), and a direct comparison of activities on the basis of colour development would appear feasible.

In addition to practical difficulties some authorities emphasize the unsoundness of such a procedure, where the colorimetric comparison is made by eye or by photometer. The best approximation is made by comparing the times taken for the first appearance of colour resulting from the dye coupling reaction catalyzed by the enzyme under rigidly standardized testing conditions. The alternative is an elaborate ultra-micro method involving weighing of sections, extraction of colour and

its estimation by microspectrophotometry. Quantitation of enzyme activity is not yet an established routine histochemical procedure.

In conclusion it should again be mentioned that to outline the scope and aims of this new field of scientific investigation it has been necessary to oversimplify the descriptions of various histochemical procedures given as examples.

The apparent simplicity of the methods is somewhat unfortunate for it has encouraged an uncritical and careless approach to the subject on the part of many workers, which has recently been strongly deprecated by leading authorities, notably Gomori in the United States and Danielli in England. As Danielli states . . . "the general tendency has been to suppose that anyone who can cut a tissue section is competent to carry out cytochemical investigations. Nothing could be further from the truth. Indeed, it may also be said that a good training in histology is one of the worst backgrounds possible for cytological work . . ."

Co-operation between the biologist, physicist and chemist will therefore be essential for integrating and developing this interesting and valuable field of scientific research.

The biologist will initially pose the problems and in due course will inevitably have to remind the others that their problems are concerned with living tissues and not with substance obtained from bottles. The physicist will provide the tools as has already been the case, for example, with a wide variety of optical apparatus, radioactive tracer elements for application in autoradiography and the electron microscope. But it will be the responsibility of the chemist to provide the reliable and quantitative micro methods which will provide the actual bases of the experimental procedures.

The development of histochemistry therefore demands the united efforts of the histologist, the physicist and the chemist. Clearly, great demands will be made on the creative and critical faculties of the chemist who will ultimately be called upon to take the lead in directing along sound theoretical lines this new and promising development of biochemistry.

# CHEMICAL PATHWAYS IN LIVING CELLS\*

R. D. BATT†

To cover the present state of knowledge about chemical mechanisms inside whole living cells would be a mammoth task and accordingly this account centres on two aspects of *in vivo* metabolism. First, some consideration is paid to the elucidation of catabolic sequences in whole cells and subsequently the investigation of a biosynthetic pathway *in vivo* is discussed. Both aspects are related in being each concerned with induced enzymes; in the first instance induced enzyme systems will be used to show how the catabolic intermediates for a substance may be determined and secondly the *in vivo* biosynthetic mechanism examined will deal with the biosynthesis of an induced enzyme.

Relatively few of the known biochemical reactions (estimated at some figure over 700) have been unequivocally demonstrated as occurring in intact living cells. During the last thirty years our knowledge of biochemical mechanisms has been derived largely from studies on preparations obtained when living cells were disintegrated and one may consider that biochemistry has only recently started to emerge from the era of the enzymologist. The paucity of information concerning enzymic reactions in whole living cells is due, in no small measure, to the semipermeable nature of the cell membrane. The enzymologist's work, and the spectacular results he has produced, has resulted from the removal of this cell membrane as a complicating factor. Credit for initiating the science of enzymology belongs to the Buchner brothers who first demonstrated that a cell-free preparation of yeast contained the enzymic machinery for converting glucose to ethyl alcohol and carbon dioxide.

The usual procedure for determining whether whole cells contain a particular enzyme is to add the substrate to the environment surrounding the cells and observe whether the substance is removed or transformed. If the cell membrane is impermeable to the substance, the possibilities for demonstrating the metabolic fate of a compound *in vivo* become very restricted. Brief consideration of some of the major metabolic sequences already established on the basis of work with cell-free enzyme systems will indicate the approximate proportion

\*Based on Chairman's Address delivered to Otago Branch, N.Z.I.C.

†Senior Lecturer in Biochemistry, Medical School, University of Otago.

of metabolites to which the cell membrane is impermeable. Glucose degradation by yeast cells, giving ethyl alcohol and carbon dioxide, requires eleven enzymic steps of which eight yield phosphorylated products (glucose-6-phosphate, fructose-6-phosphate, fructose 1:6 diphosphate, 3-phosphoglyceraldehyde, etc.) The cell membrane of baker's yeast is impermeable to each of these phosphorylated intermediates. In the sequences established for the oxidation of fatty acids by liver cell extracts every one of the intermediates in the conversion to the two carbon fragment (acetyl-coenzyme A) is a coenzyme A derivative and accordingly unable to diffuse freely across the membranes of liver cells.

Apart from the permeation problems which beset the worker who wishes to study biochemical sequences in whole cells, one may cite two additional complications frequently encountered.

*Inter-relating the metabolism of two or more substances:* Consider a hypothetical cell which may oxidize a substrate to carbon dioxide and water. One possible intermediate may be a substance, B, *i.e.*,  $A \rightarrow B \rightarrow \text{CO}_2 + \text{H}_2\text{O}$ . The observation that B is, in fact, oxidized to carbon dioxide and water by the whole cells does not preclude the alternative possibility that there are two independent sequences for degrading the substances. The task of determining whether the metabolism of two substances are inter-related in intact cells may be extremely difficult although such problems are often susceptible to attack by either isotopic tracer techniques or by studying the induction of enzymes.

*Determining sequences in which the intermediates have no free existence from the enzymes:* Instances are known where the intermediates on the metabolic sequence are not dissociated from the enzyme surface before the next reaction occurs, *i.e.*, a particular intermediate may be incapable of forming the appropriate enzyme-substrate complex. As in the previous example, isotope techniques have proved useful with problems of this kind. The cells are incubated with a labelled precursor of the intermediate being studied. The cells are killed and the small amount of intermediate isolated from the cell debris by adding carrier, *i.e.*, unlabelled intermediate.

Because of the difficulties described, any techniques which permit the study of chemical pathways *in vivo* are valuable and help contribute to our knowledge of cellular physiology. Bacterial cells are particularly suitable for elucidation of bio-

chemical sequences *in vivo* because of three characteristic features of micro-organisms, namely:

- The comparative ease with which biochemical mutants may be obtained,
- The possibility of obtaining nutritionally deficient cells, and
- The ability of many bacteria to attack substrates with induced enzymes.

These properties of bacteria have been exploited extensively by research workers. Of particular interest at the present time is the work on induced enzymes and the application of induced enzyme systems to *in vivo* studies will now be considered.

#### CATABOLIC SEQUENCES IN WHOLE CELLS

When a substance is degraded by induced enzymes in bacteria it is possible to base experiments on the Principle of Sequential Induction for elucidating the intermediate steps on the breakdown pathway. The Principle was first formulated by Stanier (1947) and has guided the experimental work on the bacterial breakdown of aromatic compounds. Bacterial enzymes may be divided into two types:

- Constitutive enzymes which are always present in the bacteria irrespective of the nature of the medium in which the organism is grown, and
- Induced enzymes which are produced by the cells only when the suspending medium contains an inducing substrate which is usually, but need not necessarily be, a substrate for the enzyme induced.

In Fig. 1, the enzymes  $E_x$  and  $E_y$  are always present irrespective of whether X or Y (or any other specific sub-

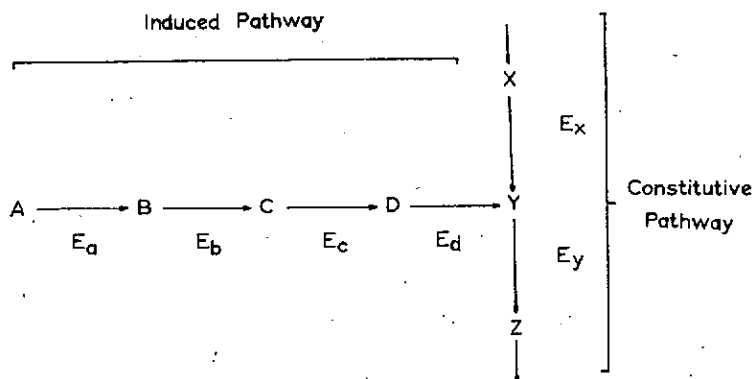


Fig. 1: Hypothetical example of inter-relationships of the metabolism of two or more substrates.

strate) is present in or absent from the growth medium. On the other hand the enzyme  $E_a$  appears in an active form in the organism only if an inducing substrate (e.g., A) has been present in the growth medium. If the cells are not incubated with an inducing substrate, then the induced enzyme ( $E_a$ ) will not be functional in the cells. An illustration of enzyme induction is provided by the soil bacterium, *Nocardia corallina*, which can rapidly oxidize thymine to 5-methyl-barbituric acid providing the organism has been incubated in a medium containing either uracil, thymine, barbituric acid, 5-methyl-barbituric acid or 5-hydroxymethyluracil. All of these compounds are inducing substrates for the thymine oxidase. If the organism is grown in the absence of the inducing substrates (e.g., in a beef-extract medium), the resultant cells cannot oxidize thymine to 5-methylbarbituric acid.

Referring again to Fig. 1, the initial induced enzyme,  $E_a$ , will catalyse the conversion of  $A \rightarrow B$ . The product B will now induce the formation of the enzyme  $E_b$  which will not be present in the cells grown in the absence of either A or B. The process continues until eventually a substance, Y, is formed which is attacked by a constitutive enzyme.

After it has been shown that a bacterial species can attack A by induced enzymes, it is possible to determine, by trial and error, which intermediates lie on the degradative pathway for A. The technique adopted is to test likely intermediates on the catabolic sequence for A, with cells which have been grown on A. If the substances are oxidized by these cells, but not oxidized by cells grown in the absence of A, they are probably intermediates on the catabolic pathway.

Stanier and his co-workers have used the Principle of Sequential Induction to determine the catabolic sequences for aromatic acids, aromatic amino acids and phenols. The method rests on two important assumptions, namely:

- (a) That the induced enzymes show rigid specificity for the substrate activated, and
- (b) That the cells are freely permeable to all the compounds tested.

Pyrimidine catabolism in *Nocardia corallina* is brought about by induced enzymes and the thymine oxidase mentioned above can also activate uracil for its oxidation to barbituric acid. Accordingly, cells adapted to thymine also oxidized uracil and the incorrect conclusion has been drawn by Lara (1952) that uracil is an intermediate on the breakdown pathway for thymine.

Complications concerning free permeability of test substrates into the cells may be more rigidly subjected to experiments with the demonstration that enzymes may be induced, not only for the activation of a substrate, but also for the transport of the substrate across the cell membrane, *i.e.*, the induction of the substrate permeases (Cohen and Monod, 1957).

Work with induced enzymes can therefore be valuable in demonstrating the intermediate stages of a catabolic sequence and the results are of considerable interest in bacterial metabolism for they indicate the nature of a chemical pathway *in vivo*.

#### PROTEIN SYNTHESIS IN WHOLE CELLS

When the bacterial species *Escherichia coli* is incubated in a medium containing a  $\beta$ -galactoside, such as lactose, the organisms synthesize the induced enzyme,  $\beta$ -galactosidase which catalyses the hydrolysis of lactose yielding a mixture of glucose and galactose. This induction system is a protein synthesis system which may be studied *in vivo*. The value of induction systems for studying protein synthesis in living cells has recently been discussed by Gale and McQuillen (1957). They pointed out that normally the rate of an enzymic reaction is taken as a measure of the amount of enzyme present and accordingly the synthesis of constitutive enzymes by cells may not represent any increase in the initial activity. However with induced enzymes there may be increases amounting to several hundredfold in the amount of enzyme during a 1 to 2 hour incubation. Despite the availability of a suitable system for studying protein synthesis, progress has been slow in this field.

*Complexity of the problem:* Studies on biosynthesis mechanisms are greatly restricted in those cases where the chemical structure of the end-product of the biosynthesis pathway is unknown. Proteins are built up from approximately twenty different amino acids in different proportions and since 1903 when Fischer demonstrated that proteins were made up of chains of amino acids linked by peptide bonds, very little advance was made in the elucidation of protein structure until the recent work of Sanger and his co-workers (1957) on the structure of insulin. During the intervening years between the work of Fischer and Sanger, not only were results meagre but the amount of scientific endeavour was small also considering the undoubted importance of proteins in living systems. The reason for the paucity of investigations is not difficult to find when the permutations possible in a protein of defined molecular weight are considered. Asimov (1954) has calculated the possible permuta-

tions of the amino acids in insulin basing the calculations on the protein having a molecular weight of 12,000 and containing 18 different amino acids and 107 amino acid units per molecule\*. The possible permutations were given as  $7.91 \times 10^{113}$ . To give some indication of the magnitude of this number, Asimov estimated that there were probably about  $10^{10}$  haemoglobin molecules on the earth. If one visualizes a cube of which each edge is 1 billion light years long, then such a cube would comfortably contain the entire known universe. If this cube was packed with haemoglobin molecules, the total number would be of the order of  $10^{103}$ . Perhaps a more striking illustration is the comparison of the figure  $7.91 \times 10^{113}$  with the figure of  $10^{79}$  given by Sir Arthur Eddington (1935) as representing the total number of electrons in the whole universe.

The structure of insulin has now been fully determined and the work by Sanger surely represents a unique kind of scientific courage to undertake an extended investigation into a field where there was no indication that the protein could be represented by a single structure. Sanger (1957) says "One significant result of this work is that it demonstrates that insulin and probably other proteins are homogenous substances with unique structures and are not merely statistically random polymers of amino acids. This brings the science of proteins into the realms of classical organic chemistry and opens up the way to similar studies on the many other proteins that exist in nature and hence to a better understanding of the chemistry of life". The work of Sanger has overcome a barrier to progress which must be comparable to Wohler's overthrow of the Vitalistic Theory, and to the demonstration by the Buchner brothers that biochemical reactions were not absolutely dependent on the presence of intact cells.

The field of protein structural chemistry has expanded enormously over the last few years. Complete amino acid sequences are known for:

- (1) Beef, sheep, pig, horse and whale insulins (which differ only in the 8-10 positions of chain A).
- (2) Pig and sheep corticotrophins (each containing 39 amino acid units).
- (3) Pig glucagon (29 amino acid units).
- (4) Beef and pig hypertensins (8 to 10 amino acid units).

\*The figures used by Asimov for insulin have recently been shown to be incorrect. Insulin has a molecular weight of 5,733 and contains 51 amino acid units/molecule. The permutations on these values =  $1.2 \times 10^{52}$ .

- (5) Oxytocin and vasopressin.
- (6) Several antibiotic peptides.

All of the proteins so far studied have been shown to be uniquely constructed and potentially we may now have available the structures of enzymes whose synthesis may be studied in cells.

#### GENERAL CONSIDERATIONS OF PROTEIN SYNTHESIS

Any mechanisms which are to be considered as probable for protein synthesis in living cells must supply answers to four questions:

- (1) What is the mechanism by which each amino acid is inserted in the correct position on the peptide chains?
- (2) How is the structure of the specific protein limited to the finite shape and definite molecular weight?
- (3) Where, in the biosynthetic sequences, are the nucleic acids involved?
- (4) How is energy obtained for the endergonic reactions?

Tarver (1954) has said "since the synthesis of protein is such an intriguing subject it is not surprising that there is more speculation and less experimentation than is usual in the scientific field". This state of affairs is rapidly changing; as an enormous volume of experimental work appears in the literature the speculations are becoming much more circumscribed.

There are two main theories for explaining protein synthesis—the stepwise synthesis theory, and the template theory.

#### *Stepwise Synthesis Theory*

There are some very strong proponents of the concept that proteins are synthesized by a reversal of protein hydrolysis, *i.e.*, proteins  $\leftrightarrow$  large polypeptides  $\leftrightarrow$  small peptides  $\leftrightarrow$  amino acids. Although peptide bonds can be formed by a reversal of enzymic reaction which are normally hydrolytic, much more is required than this experimental observation to explain protein synthesis. The following points summarize some of the objections to this theory:

- (1) No significant amounts of peptides are normally found in tissues although most tissues contain comparatively large amounts of free amino acids.
- (2) The Stepwise Synthesis Theory gives no explanation of how specific sequences of amino acids are formed.
- (3) On this theory the proteins are synthesized by enzymes and the question may be asked "How are the protein-synthesizing proteins synthesized?"

### Template Theories

All of the constituent amino acids are pictured as simultaneously combining on the surface of the template (e.g., a nucleic acid) and the sequence in which the amino acids appear in the protein molecule is determined. No peptide intermediates are visualized in this theory. The concept that nucleic acids act as the templates for protein synthesis presents many attractive features. The nucleic acids, and desoxyribonucleic acid in particular, have the property of auto-reproduction and they occur in the chromosomes. If the nucleic acids are the templates for protein synthesis, there is no need for a whole series of enzymes to carry out protein synthesis. The template theories are more generally accepted for into these theories can be woven explanations and answers to the four questions given above. Energy for protein synthesis is supplied by adenosine triphosphate (ATP), the amino acid sequences are determined by the nature of the template, and the nucleic acids find a place in the overall mechanisms.

### INDUCED ENZYME FORMATION

Some of the most satisfactory evidence for the template mechanisms has been obtained from studies with induced enzymes.

If the bacterial species *Escherichia coli* is centrifuged from a growth medium and washed thoroughly, the cells can be shown to contain free amino acids but no peptides. These cells will adapt to certain substrates, i.e., protein synthesis can occur within these cells in the presence of a suitable inducer. The proteins formed in response to the inducer may theoretically be synthesized:

- (a) From the amino acid pool, or
- (b) From the breakdown products of the cellular proteins, e.g., from peptides.

An induction system in *E. coli* has been analysed to test whether the Template or Stepwise Synthesis Theory best described the events occurring in this organism. *Escherichia coli* was grown in a complete medium containing radioactive  $S^{35}$  atoms (in the inorganic sulphate supplied) but no inducing substrate. The resultant cells contained proteins in which the sulphur-containing amino acids (methionine, cysteine and cystine) were radioactive. These cells were starved of sulphur for an hour when no  $S^{35}$  remained in the amino acid pool, and the organism was then incubated with the inducer, methyl- $\beta$ -D-thiogalactoside. The enzyme formed,  $\beta$ -galactosidase, was isolated and its radioactivity determined. Virtually no  $S^{35}$  was

found in the enzyme, *i.e.*, the enzyme was synthesized from the free amino acids and not from the breakdown products of the cellular proteins. Many experiments of this type have now been reported. The conclusions which have been drawn by most workers in the field of induced enzyme synthesis is that induced enzymes are formed from amino acids.

For induced enzyme formation, the evidence is very convincing for ribonucleic acid (RNA) being the template. If RNA synthesis is an essential concomitant of enzymic synthesis, inhibition of RNA formation should be accompanied by cessation of enzymic synthesis. The synthesis of RNA can be inhibited by certain analogues of the naturally-occurring purine and pyrimidine bases; or by restricting the supply of purines and pyrimidines to an organism synthesizing RNA.

When RNA synthesis is impaired, then the synthesis of enzymes is also impaired. Recent work has shown that a supply of RNA is not necessarily adequate for the promotion of protein synthesis; a concurrent synthesis of RNA appears to be required. In this connection the synthesis of induced enzymes has been shown to proceed only so long as RNA synthesis continues in the organism.

Most of the studies on protein synthesis have been carried out using intact cells but recently some work has been reported on sub-cellular preparations. It is not possible to disrupt the cell too vigorously and still retain the protein-synthesizing systems. One of the most satisfactory preparations has resulted from the removal of the cell walls, the residual cellular material being found to retain most of the metabolic properties of intact cells. The preparations can synthesize protein and nucleic acid, can support the growth of bacteriophages, and enzymes may be induced. The procedure for making such preparations is to treat the cells with lysozyme, a mucopolysaccharase, which degrades the cell wall if it contains, as most do, mucopolysaccharide residues.

In conclusion, the most convincing evidence available concerning the template idea of protein synthesis, and the involvement of nucleic acids, has been obtained from studies on induced enzymes. The great value of the induced enzyme system in this field is apparent when one considers the complexity of the field as a whole. The day is probably not very far off when research workers will be studying the biosynthesis of a protein of known structure and the credit for making such a possibility, a probability, must belong to Sanger and his co-workers.

## BRANCH NEWS AND NOTES

## NEW ZEALAND HONOURS

¶ Members will join in congratulating two Fellows of the Institute included in the New Year Honours List: Dr Muriel Bell, C.B.E., Nutritionist, Health Dept., Dunedin; Dr F. B. Shorland, O.B.E., Director, Fats Research Laboratory, D.S.I.R., Wellington.

## AUCKLAND BRANCH

¶ Associate Professor H. Bloom has been elected Dean of the Faculty of Science, University of Auckland, in succession to Prof. L. H. Briggs, whose term of office expired recently. Professor Bloom will hold the office for a period of three years.

¶ Dr. W. V. Falkenhahn, an Auckland agricultural scientist, will give a series of lectures on Russian translation at the University next year. The course is designed to enable scientists to "crack" a scientific paper in Russian after one year's study.

¶ Dr J. K. Wilmshurst, Lecturer in Chemistry, University of Auckland, has resigned recently to undertake research at the National Carbide Corporation, Cleveland, U.S.A. Dr Wilmshurst was working on Theoretical Chemistry at Auckland.

## MANAWATU BRANCH

¶ Congratulations to Dr C. R. Barnicoat, Associate Professor and Head of the Biochemistry Department, Massey College, on his appointment as Director of the Cawthron Institute, Nelson. Immediate Past-President, Dr Barnicoat is well known to Institute members and we all wish him well in his new position which he takes up about May of this year.

## WELLINGTON BRANCH

¶ The Wellington Branch recently paid a visit to the new Dominion Laboratory buildings at Gracefield. Visitors were welcomed by the Director (F. J. T. Grigg) and spent an enjoyable afternoon touring the new laboratories. The site has been attractively landscaped and tree planting has already begun indicating that before long the new buildings will be seen to full advantage. Space has been left for further wings to be added to house the library, etc.

¶ At the Standard Vacuum Oil Company, C. L. H. Stonyer has transferred from the Laboratory to the Marketing Division and R. C. Bell is now Marketing Research Analysis Manager.

¶ D. G. Howard has transferred from the Wellington Laboratory of the Shell Company of New Zealand Ltd. to the Auckland Branch of the same

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firm where he is now Sales Technical Adviser. This change necessitated Mr. Howard's resignation from the position of Business Manager of the *Journal*. Mr. Howard had held this position for the past four years and his help and willing co-operation has been much appreciated by the Editor and the *Journal* Committee.

#### CANTERBURY BRANCH

¶ Dr B. R. Penfold of the Chemistry Department, University of Canterbury, has been awarded a National Academy of Sciences Post-Doctoral Research Fellowship which he is taking up at the University of Minnesota. He will be working with Professor Pepinsky on X-ray crystallographic studies. Dr Penfold was recently appointed Senior Lecturer in Chemistry.

¶ A. H. Hunt, formerly of H. F. Stevens Ltd., has taken over the consulting practice of P. J. Radford, who is leaving this country to go to Canada.

#### OTAGO BRANCH

¶ At the Annual Meeting arrangements for the 1959 Conference were initiated with the appointment of Dr A. D. Campbell as Chairman of the Conference Committee. Dr J. C. Dacre, Toxicology Research Department, Medical School, University of Otago, is the Secretary, and the Committee consists of Messrs. Broughton, Carr, Carter, Lewin, Malcolm, McChesney, Robb and Storey and Professor Parton.

¶ Prof. H. N. Parton, a member of the New Zealand Delegation to the Conference on the Peaceful Uses of Atomic Energy held at Geneva, has just returned from overseas. His colour slides of Italy, Switzerland, England and Hawaii were much appreciated by members at the Annual Meeting.

¶ C. L. Carter, Reader in Chemistry at the University of Otago, retired at the end of last year after forty years on the staff of the Chemistry Department.

¶ Dr W. S. Fyfe, Reader in Chemistry at the University of Otago, has resigned and is leaving early this year to take up the position of Professor of Geochemistry at the University of California.

¶ Sabbatical leave is causing much University staff movement at present. Dr R. E. Corbett of the Chemistry Department has recently returned from Cambridge; Dr R. D. Batt of the Biochemistry Department is now in London; and Dr F. Fastier of the Department of Medicine is leaving early this year for England, the United States and Australia.

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### BRANCH CHAIRMEN

#### AUCKLAND BRANCH

Dr. A. L. Odell, Senior Lecturer in Chemistry, University of Auckland, has been re-elected Branch Chairman.

#### WAIKATO BRANCH

E. P. WHITE, this year's Chairman, graduated M.Sc. at Victoria University College in 1938, and was Jacob Joseph Scholar and Demonstrator in the Chemistry Department. In 1941 he joined the Dept. of Agriculture's Chemistry Section in Wellington and moved to Hamilton in 1945 when the Department's chemical services were re-organized.

Over nearly 20 years Mr. White has been investigating the alkaloids occurring in legumes in New Zealand. His 26 papers on the subject in the *New Zealand Journal of Science and Technology* have won him an

international reputation, and the merits of this work were recognized by the Institute in the award of the I.C.I. Prize for 1951. Mr. White's early



work in the Department was also in the alkaloid field, when he collaborated with Dr. Reifer in studies on the constitution of perloine, the alkaloid discovered by New Zealand workers in ryegrass. Following work on toxic honey, *Paspalum* ergot poisons, and the estimation of oestrogens and androgens in sheep urine, Mr. White started work, in 1952, on the extraction and fractionation of the facial eczema liver damaging principle from toxic grass. His steady pursuit of this elusive substance has resulted in very considerable purification of the toxin and his isolation, during the course of this work, of a substance which appeared peculiar to toxic grass, led to the recent identification of the fungus responsible for the toxicity.

Mr. White's main contribution to Institute affairs was his service as Secretary to the Waikato Branch during the first years of its development.

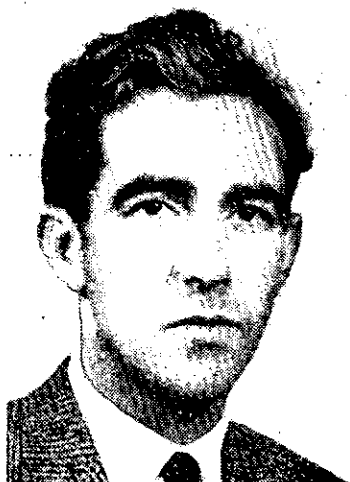
#### MANAWATU BRANCH



CHAIRMAN OF THE Manawatu Branch is DR. J. W. LYTTLETON, Senior Chemist, Plant Chemistry Division, D.S.I.R. A graduate of Auckland University College, where he obtained his M.Sc. in 1940. Dr. Lyttleton worked on anti-submarine equipment with the R.N.Z.N. during the the war and in 1947 proceeded to the Lister Institute where he spent four years studying blood coagulation proteins. He obtained his Ph.D. from the University of London in 1950 and the following year joined the staff of the Plant Chemistry Laboratory where his field of study has been the physical chemistry of proteins, especially plant proteins. In 1955-56 Dr. Lyttleton worked at the University of California and the California Institute of Technology as a Commonwealth Fund Fellow.

Dr. Lyttleton has taken an active part in Institute affairs and was Secretary of the Manawatu Branch in 1954-55.

WELLINGTON BRANCH



J. R. BECK, Chairman of the Wellington Branch was born in Wellington and educated at Wellington College. After part-time study at the then Victoria University College, he graduated B.Sc. in 1948. During these study years he was employed by H. W. Lawrence and Son, Analytical Chemists, of Johnsonville, where he remained until 1954 as Chief Chemist. In that year he joined the staff of the newly established laboratory of New Zealand Breweries Ltd., at Wellington.

CANTERBURY BRANCH



L. WILKINSON was educated at Christchurch Boys' High School and graduated M.Sc. at the University of Canterbury in 1936. After a year at the Christchurch Teachers' Training College and a short period teaching, he joined the Wellington staff of the Dominion Laboratory in 1938, transferring to the Auckland staff in 1946 and to the Christchurch staff in 1947.

During his service Mr. Wilkinson has had experience in most of the activities of the Dominion Laboratory, including a period in charge of the Paint Section. His present interests include chemical aspects of food and drug control, toxicological and forensic chemistry, and investigation of local air and water pollution problems.

While in Wellington he was a member of that Branch Committee, and Assistant Secretary of the Institute and the first secretary of the Chemists' Employment Committee. He is a past member of the Canterbury Committee and was Conference Secretary in 1950.

## OTAGO BRANCH



J. W. McCHESNEY, Chairman of the Otago Branch, is senior chemistry master at Otago Boys' High School.

He was Dux of Southland Boys' High School in 1937 and was awarded a University Entrance Scholarship in the same year. His university studies at Otago were interrupted by military training and he graduated B.Sc. in 1941. After three years active service with the N.Z. Engineers in the Pacific and Italy during World War II he returned to Otago and graduated M.Sc. in 1947. Since then Mr. McChesney has been teaching at Otago Boys' High School.

While at the University of Otago Mr. McChesney figured prominently in student affairs at President of the Science Students' Association and in

important positions on other associations.

Mr. McChesney has been a member of the Examinations Committee of the Institute and examiner in some subjects for the L.A.C. certificate since 1951. He is a member of the Otago and Southland Mathematics and Science Teachers' Association of which he has been secretary and later president.

## TWENTY-EIGHTH ANNUAL REPORT

For the Year Ending 31 October, 1958

### OFFICERS

<i>President:</i>	Prof. C. R. Barnicoat
<i>Vice-President:</i>	Prof. L. H. Briggs
<i>Delegates:</i> <i>Auckland:</i>	Dr. A. L. Odell
<i>Waikato:</i>	Dr. E. B. Davies
<i>Manawatu:</i>	Dr. W. A. McGillivray
<i>Wellington:</i>	A. P. Oliver
<i>Canterbury:</i>	D. J. Hogan
<i>Otago:</i>	Dr. A. D. Campbell
<i>Hon. General Secretary:</i>	Dr. W. E. Harvey
<i>Immediate Past President:</i>	W. A. Joiner
<i>Editor:</i>	Dr. W. A. McGillivray
<i>Registrar:</i>	L. J. Rollo

### MEETINGS OF COUNCIL

Council met four times during the year and a General Meeting of members was held in Hamilton during the Conference.

## MEMBERSHIP

During the year the membership of the Institute changed as follows (to 31. October, 1958):

	<i>Associates</i>	<i>Fellows</i>
<i>New Members:</i>	27	7
<i>Resignations:</i>	7	1
<i>Leave:</i>	1	

Membership figures for the last three years are as follows:

	<i>1956</i>	<i>1957</i>	<i>1958</i>
<i>Auckland</i> .. ..	89	91	94
<i>Waikato</i> .. ..	33	34	37
<i>Manawatu</i> .. ..	38	40	42
<i>Wellington</i> .. ..	150	155	167
<i>Canterbury</i> .. ..	79	77	81
<i>Otago</i> .. ..	62	63	66
<i>Overseas</i> .. ..	52	53	52
	<hr/>	<hr/>	<hr/>
	503	513	539
	<hr/>	<hr/>	<hr/>

## HONOURS

During the year one Associate, T. A. Rafter, was honoured by the award of an O.B.E.

## SUB-COMMITTEES OF COUNCIL

As has been the case for many years now, much of the essential administrative and organizational work of the Institute has been carried out by sub-committees of the Council. The members of these sub-committees all deserve high praise for the manner in which they discharge their duties. Many of the jobs these sub-committees have carried out are itemized below.

## CONFERENCE

The Combined Conference held in Hamilton was very well attended, and was, by common consent, an outstanding success. The organizing committee, drawn from the smallest Branch of the Institute, arranged a programme of lectures to cater for all interests, and a social gathering which was much appreciated by the large number who attended.

## EXAMINATIONS

This committee of Otago Branch members has continued to organize the L.A.C. examinations and has been deeply involved in drawing up the syllabuses for the proposed Education Department courses for technicians (see below). After eight years service Dr. A. D. Campbell has retired from the Secretaryship of the Committee and has handed over the duties to T. H. Kennedy.

## EMPLOYMENT OFFICER

E. S. Borthwick left New Zealand during the year and was replaced by J. L. Mandeno. The number of advertised vacancies for chemists continue to increase year by year and it is clear that at the present time the demand greatly exceeds the supply. Enquiries from chemists overseas continue to come in but the Employment Officer remarks that "a fair reporting of the situation here is not likely to encourage many of these chemists to come to New Zealand".

## JOURNAL

Under the most capable editorship of Dr. W. A. McGillivray and a committee of the Manawatu Branch the *Journal* has continued to thrive, although advertising receipts still leave something to be desired despite the efforts of the Business Manager, D. G. Howard. The production of *Chemistry in Action*, over 2,000 copies of which were distributed to schools, represents a new venture on the part of the Institute to interest school children in chemistry as a profession. The Canterbury Branch which conceived and organized the original lectures and subsequently suggested that they be published deserves credit for undertaking a venture which proved exceedingly successful.

## MEMBERSHIP

Prof. L. H. Briggs, Dr. R. Gardner and S. G. Brooker have dealt with nearly 40 applications for membership during the year. In some cases this has necessitated a considerable volume of correspondence and the amount of time involved in the careful scrutiny and consideration of applications is by no means negligible.

## SALARIES

Members have expressed the view that the time is ripe for a further survey and this is being undertaken by a committee under G. S. Lambert. The opinion is now widely held that, in Australia in particular, the remuneration offered to scientists has increased so much that New Zealand will find it increasingly difficult to attract or retain scientists of merit, and it is hoped that the new salary survey will provide statistical evidence to support or refute this opinion.

## STANDARDS COUNCIL

The Institute continues to be represented on the Standards Institute by G. A. Lawrence, who has acted in this capacity for nearly 27 years. It is doubtful if any member can claim a greater record of service to the Institute.

## PRIZES

The I.C.I. Prize was awarded to J. K. Johannesson and the Morcom Green and Edwards Prize to Dr. R. D. Batt. There were again no entries for the Chemical Essay Prize and Council is giving consideration to amending the regulations relating to this Prize in the hope that it will become more attractive.

## ROYAL CHARTER

Discussions on a Royal Charter for the Institute are in abeyance pending the receipt of essential information from Government Departments. During the year Council decided that before any definitive steps are taken, all members will be given an opportunity to decide whether or not the Institute should seek to obtain a Charter.

## TECHNICIAN TRAINING

The Examinations Committee in Dunedin and another group in Auckland under the Chairmanship of Dr. A. L. Odell have drawn up detailed syllabuses for courses for technician training for submission to the Education Department. During the year the Government, as the outcome of a conference on technical education, has set up a Council of Technical Education and the Institute has made representations to the Minister to be represented on this Council.

## TIMBER PRESERVATION

The Institute has continued to press, so far unsuccessfully, for representation on the Timber Preservation Authority.

#### UNIONS

For some time past there has been complaints that individual members are being forced to join industrial unions. While Council feels that Institute members should not be forced to become members of unions, this view has no legal backing. A legal opinion has been obtained and circulated to all Branches for the information of members who may be involved in matters of this kind.

#### CHANGES OF RULES

During the year there have been a number of changes in the Rules of the Institute. The most important alterations make provision for the election of the President, Vice-President and General Secretary to be by ballot of all members, change the Institute year so that the Council members will retire at the end of August (immediately after Conference), and change the end of the financial year to 30 April. The last change will make it possible to present an audited balance sheet at the General Meeting held in August. Subscriptions for the period 1 November, 1958, to 30 April, 1959, have been waived, but Branch grants were increased to £15 for the period 1 November, 1957 to 30 April, 1959.

#### FINANCIAL

Because of the change in the financial year no comment can be made at this stage except to say that the overall financial position of the Institute remains buoyant.

*For and on behalf of the Council*

C. R. BARNICOAT,  
*President.*

W. E. HARVEY,  
*Hon. General Secretary.*

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### 1958 GENERAL MEETING MINUTES

MINUTES OF A GENERAL MEETING OF MEMBERS OF THE NEW ZEALAND INSTITUTE OF CHEMISTRY (INC.) HELD IN THE HALL, HAMILTON GIRLS' HIGH SCHOOL, ON WEDNESDAY, 27 AUGUST, 1958.

#### PRESENT

Professor C. R. Barnicoat, President (in the chair), Dr. W. E. Harvey, Hon. General Secretary and approximately 70 members.

#### PRESIDENTIAL REMARKS

The President briefly reviewed the highlights of the year's activities. In the main it has been a year of consolidation. A number of important matters such as the Royal Charter have been in abeyance pending further information from various sources but progress has been made in the negotiations for the setting up of courses for training technicians.

#### INSTITUTE PRIZES

The President announced that Council had awarded the prizes for 1958 as follows:

*I.C.I. Prize.* J. K. Johannesson, City Council Laboratory, Wellington, for his work on water supply, sewerage and pollution problems in Wellington.

*Morcom Green and Edwards Prize.* Dr. R. D. Batt, Otago University, for his work on bacterial metabolism.

## SUB-COMMITTEES

The President remarked briefly on the activities of the various sub-committees of Council and paid tribute to the great deal of time and effort which some members devote to this service.

## JOURNAL

The Editor, Dr. W. A. McGillivray, spoke briefly on matters relating to the *Journal*. It had been a relatively easy year for the *Journal* Committee as two issues, those devoted to *Chemistry in Action* and the abstracts of Conference papers, were virtually ready-made. The new list of members will be published as soon as the information required is sufficiently complete.

The Business Manager, D. G. Howard, pointed out that advertising receipts would probably fall because of the indirect influence of import restrictions, and appealed to all members to assist in encouraging new advertisers.

L. Hartman spoke in appreciation of the work of the Editor and his committee.

## EXAMINATIONS COMMITTEE

The President paid tribute to the work of the Examinations Committee and in particular the retiring secretary, Dr. A. D. Campbell. This committee is probably one of the busiest and together with the group in Auckland under the leadership of Dr. A. L. Odell has spent a great deal of time devising the technicians training syllabus for submission to the Education Department.

## EMPLOYMENT

The Secretary read a report from the Employment Officer, J. L. Mandeno. The number of vacancies advertised in the Wellington daily papers has increased fourfold in the last five years and it is clear that the demand for chemists far exceeds the supply. One hundred vacancies in New Zealand together with 25 in Australia were advertised in 1957 (to 23 August, 1957) as compared with 35 advertised vacancies in 1953. Enquiries from overseas, mainly from England continue to average about two per month, but it seems unlikely that many of these chemists will come to New Zealand.

## CONFERENCES

Conference 1959 will be held in Dunedin and Dr. Campbell, on behalf of the Otago Branch, extended a welcome to members to travel south on that occasion.

## SALARIES SURVEY

G. S. Lambert and a committee will shortly send out the questionnaire for a new salary survey.

## STANDARDS INSTITUTE

C. A. Lawrence outlined the work of the Standards Institute on which he has represented the N.Z.I.C. for more than 25 years.

## RULES AND REGULATIONS

The President briefly mentioned the changes in Rules which have been made during the year. The most important changes are the provision for the election of officers by all members of the Institute, and the change in Institute year and financial year.

## TECHNICIAN TRAINING

Dr. Campbell, Dr. Odell, and Dr. Harvey outlined the negotiations with the Education Department and the progress made in drawing up a detailed syllabus for technician training.

#### TIMBER PRESERVATION.

The Secretary outlined the substance of a letter from the Minister stating that he had no authority to appoint a member of the Institute to the Timber Preservation Authority. **RESOLVED** (Brooker/Lawrence): That this meeting expresses disappointment at the reply from the Minister and re-affirms the view that the Institute should be represented on the Timber Preservation Authority.

#### UNION MEMBERSHIP

The Secretary explained the position regarding members being forced to join unions. The legal position is fully detailed in the correspondence which has been circulated to the Branch Committees.

#### THANKS

Votes of thanks to the retiring President and Hon. General Secretary were carried with acclamation.

W. E. HARVEY,  
*Hon. General Secretary.*

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### COUNCIL MINUTES

ABRIDGED MINUTES OF A MEETING OF THE COUNCIL OF THE NEW ZEALAND INSTITUTE OF CHEMISTRY (INC.) HELD IN THE CONFERENCE ROOM, D.S.I.R., AND LATER AT VICTORIA UNIVERSITY OF WELLINGTON ON WEDNESDAY, 19 NOVEMBER, 1958.

#### PRESENT

Prof. C. R. Barnicoat (President, in the chair), Prof. L. H. Briggs (Vice-President), Dr A. L. Odell (Auckland), Dr E. B. Davies (Waikato), Dr W. A. McGillivray (Manawatu), P. P. Williams (Wellington, proxy), D. J. Hogan (Canterbury), Dr A. D. Campbell (Otago), Dr W. E. Harvey (General Secretary) and L. J. Rollo (Registrar).

#### SUGGESTED AMENDMENT TO RULES

The motion to amend Rule 18.1, according to circulated Notice of Motion (moved Manawatu, seconded Auckland), was lost.

#### FUTURE CONFÉRENCES

**RESOLVED** (Manawatu-Canterbury): That future annual conferences be meetings of the N.Z.I.C. and not joint conferences with the N.Z. Section of the R.I.C., but that members of the R.I.C. be invited to attend as full participating members.

#### CONFERENCE, 1959

A committee has been set up in Dunedin with Dr A. D. Campbell as Chairman. Tentative dates are 24 to 28 August.

#### JOURNAL

*List of Members*: The Editor submitted a report on the compilation of the new list of members. The original replies to the questionnaires were very slow in coming in and a surprising proportion of them were incomplete. The new list of members is as complete as possible but it is clear that the Institute rolls are not up to date and for this reason a number of the entries in the list of members may be inaccurate.

*Publication*: Editorial Services Ltd. of Wellington, presented a proposal that they publish the *Journal of the Institute*. This would relieve the Editor of much routine work and should be financially beneficial to the

Institute. **RESOLVED** (Manawatu Vice-President): That the Institute appoint Editorial Services Ltd. as its publishers for one year and that the detailed agreement be the basis of discussion between Editorial Services Ltd., the Standing Committee and the Editor.

*Quality of Paper*: It was suggested by Editorial Services Ltd. that, at an additional cost of approximately £30 per annum it would be possible to use paper of a higher quality for the Journal and also to have a two-colour cover. After discussion it was agreed not to make any major change for the forthcoming year.

*Editor*: Dr. McGillivray does not wish to continue much longer as Editor and consideration should be given to appointing a successor in one or two years' time.

#### SALARIES SURVEY

The questionnaires for the salary survey have recently been circulated to members.

#### ELECTION OF OFFICERS

*President*: Prof. L. H. Briggs was elected unopposed.

*Vice-President*: A ballot of all members was held and E. W. Hullett was elected.

The Secretary reported on the method of conducting this election. **RESOLVED** (Auckland/Manawatu): That the method by which the ballot had been conducted and the form of voting paper used be endorsed by Council. **RESOLVED** (Canterbury/Auckland): That the ballot papers be destroyed.

*Honorary General Secretary*: Dr W. E. Harvey was elected unopposed.

#### DELEGATES

The following were confirmed as delegates:

<i>Auckland</i> :	Dr A. L. Odell
<i>Waikato</i> :	E. P. White
<i>Manawatu</i> :	Dr W. A. McGillivray
<i>Wellington</i> :	J. R. Beck
<i>Canterbury</i> :	D. J. Hogan
<i>Otago</i> :	Dr A. D. Campbell

#### OTHER OFFICERS

*Editor*: Dr. W. A. McGillivray.

*Registrar*: D. J. Hogan has been invited to accept the position of Registrar for one year in the first instance.

*Auditors*: Messrs. Dymock, McShane and Sclanders were re-appointed.

*Trustees*: Prof. L. H. Briggs was appointed as required by the Rules. Sir Theodore Rigg and Dr J. C. Andrews continue in office until 30 November, 1959.

*Bank Account*: The General Secretary, Prof. S. N. Slater and Dr R. B. Johns were authorized to operate on the Bank Account.

*P.O.S.B. Account*: The General Secretary was authorized to operate on the P.O.S.B. account.

#### SUB-COMMITTEES OF COUNCIL

*To be published in next issue.*

THANKS

RESOLVED (Manawatu/Waikato): That D. G. Howard be thanked for his services as Business Manager for the *Journal*.

RESOLVED (Vice-President/Auckland): That O. H. Keys be warmly thanked for his services as Chairman of the Examination Committee.

HONORARIA

Editor: 30 guineas.

Secretary: 45 guineas.

MEMBERSHIP

Election of Fellow:

MCCOMBS, TERENCE HENDERSON, M.S.C., A.N.Z.I.C. (Headmaster, Cashmere High School).

Election of Associates:

LAWRENCE, ROBERT CHARLES, B.S.C. (HON.), (LOND.) (Junior Lecturer, Massey Agricultural College).

WRIGHT, DOUGLAS ELLIOTT, M.S.C., PH.D., (N.Z. Defence Science Corps, attached to Plant Chemistry Division, D.S.I.R., Palmerston North).

BARCLAY, JOHN BERNARD, B.S.C. (Senior Chemist, Ivon Watkins Ltd., New Plymouth).

Applications for Leave: The following were granted leave with remission of subscriptions:

W. E. Dasent, Victoria University of Wellington.

Dr B. R. Penfold, University of Canterbury.

J. Vaughan, University of Canterbury.

Financial

INVESTMENTS: RESOLVED (Chair/Manawatu): That Council recommend to the Trustees that the sum of £700 be invested in some suitable manner.

It was agreed to ask the Trustees to suggest possible loans in which the Institute might invest.

TIMBER PRESERVATION AUTHORITY

A letter from the Minister was received just prior to the Annual General Meeting, and its substance was reported to members at that meeting. The Minister pointed out that he has no power under the existing legislation to appoint a member of the Institute to the Authority. However there is power in the Regulations for the Institute to be represented on the Authority by way of special advisory members and the Minister suggested that this should meet the requirements of the Institute.

RESOLVED (Vice-President/Secretary): That the Institute accept the compromise position outlined in the letter from the Minister.

RESOLVED (Auckland/Manawatu): That the name of Dr W. E. Harvey be forwarded to the Minister for consideration as the Institute's representative.

TECHNICIAN TRAINING

The detailed syllabus suggested for the course for technician-training has been submitted to the Director of Education.

RESOLVED (Chair/Secretary): That the Auckland and Dunedin groups be thanked for their work in drawing up the suggested syllabuses.

COUNCIL FOR TECHNICAL EDUCATION

When the composition of the Council for Technical Education was announced, the President wrote to the Minister of Education expressing concern that the Institute was not represented. The Minister replied pointing out that there was provision in the Regulations for additional members

to be appointed to the Council "to represent regional and special interests" and that he would draw the Council's attention to our request.

RESOLVED (Vice-President/Waikato): That the President's action be endorsed.

#### VOCATIONAL GUIDANCE

Two letters, one from the N.Z. Section, R.I.C., and the other from two members of the staff of the Calloway Laboratory were received. Both criticized the attitude of vocational guidance officers to science as a profession and the R.I.C. sought Council's assistance to try and correct this unsatisfactory state of affairs.

After discussion, in which it was mentioned that there had in the past been suggestions that the Institute should publish a booklet for distribution to schools to encourage children to take up science as a career, it was agreed to write to the vocational guidance officers, and also to Dr R. M. Allison, who had agreed to look into the possibility of producing a suitable brochure.

#### SUGGESTED AMENDMENT TO RULES

The Auckland Branch is anxious that future amendments to the Rules be made only at the Annual General Meeting. This would involve an amendment to the Institute Rules and the required 30 days notice had not been given. The matter was therefore deferred for consideration by Branches.

#### REPRINTING OF RULES

In discussion it was pointed out that the present Council cannot bind future Councils and this Council cannot say that no amendments to the Rules will be considered before 1965. It was generally agreed that it was desirable to bring the printed Rules up to date and it was suggested that this could be done by the issue of gummed errata slips. However before a decision can be made it will be necessary to see just how many items are involved.

#### CODE OF ETHICS

It has been suggested that the Institute's Code of Ethics is in need of revision. The Wellington Branch Committee have looked into this matter and reported that in their opinion no revision is necessary.

#### CLOSING DATE FOR PRIZE ENTRIES

RESOLVED (Auckland/Wellington): That Branches be circularized at the appropriate time with a reminder of the closing dates for applications for Institute prizes.

#### REGULATIONS FOR PRIZES

The suggested altered regulations for the Chemical Essay and I.C.I. Prizes were discussed in detail. A new set of regulations will be drawn up incorporating a number of modifications and these will be submitted to Branches for comment.

#### THANKS

Votes of thanks to the retiring President, Prof. C. R. Barnicoat, and the retiring Waikato Delegate, Dr E. B. Davies, proposed by the Vice-President, were carried with acclamation.

W. E. HARVEY,  
*Hon. General Secretary.*

### New Publishing Arrangements for Journal

FOR SOME TIME it has been felt that the interests of the Institute would best be served by placing the publication of this *Journal* in the hands of a commercial firm. Negotiations have been under way for some time and at the last meeting of Council a proposal put forward by Editorial Services Limited, Wellington, was accepted for a trial period of one year commencing with this issue. Editorial Services Limited now become the publishers of the *Journal* in place of the Institute. This firm is responsible for the production and distribution of the *Journal* and will thus relieve the Editor and the *Journal* Committee of much of the more mechanical side of editing such as the checking of galley and page proofs, the supply of proofs to authors, the planning of layout, etc. It will also handle all advertising which has previously been in the hands of the Business Manager. The Institute, through the Editor, is still responsible for the provision and approval of all copy and retains the same control over the *Journal* as when it was itself publisher.

It is anticipated that a number of advantages will accrue from this new arrangement. In addition to the obvious saving of editorial time and effort, it is hoped to produce the *Journal* at less expense to the Institute.

Please note the following addresses: As previously, for editorial matters, supply of copy, etc.—Dr. W. A. McGillivray, Biochemistry Department, Massey College, Palmerston North. For all other matters including return of proofs, distribution, change of addresses, advertising, etc.—Editorial Services Limited, P.O. Box 2721, Wellington.

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### LIST OF OFFICERS

For the Year 1 November, 1958 to 31 October, 1959

*President:* Prof. L. H. Briggs, 63 Brighton Road, Parnell, Auckland.

*Vice-President:* E. W. Hullett, Wheat Research Institute, Christchurch.

*Hon. General Secretary:* Dr W. E. Harvey, P.O. Box 196, Wellington.

*Auckland Delegate:* Dr A. L. Odell, University of Auckland, P.O. Box 2553, Auckland.

*Waikato Delegate:* E. P. White, Ruakura Animal Research Station, Hamilton.

*Manawatu Delegate:* Dr W. A. McGillivray, Massey College, Palmerston North.

*Wellington Delegate:* J. R. Beck, N.Z. Breweries Ltd., Box 211, Wellington.

*Canterbury Delegate:* D. J. Hogan, Dominion Laboratory, Box 2112, Christchurch.

*Otago Delegate:* Dr A. D. Campbell, University of Otago, Box 56, Dunedin.

*Editor of Journal:* Dr W. A. McGillivray, Massey College, Palmerston North.

*Past President:* Prof. C. R. Barnicoat, Massey College, Palmerston North.

*Registrar:* (to be appointed) Box 250, Wellington.

## AUCKLAND BRANCH

*Chairman*: Dr A. Odell, Chemistry Department, University of Auckland, Box 2553, Auckland.

*Secretary*: J. H. Goodey, Auckland Gas Co. Ltd., Box 34, Auckland.

*Treasurer*: R. W. Oliff, Chemistry Department, University of Auckland, Box 2553, Auckland.

*Committee*: R. C. Cambie, P. J. Gallagher, L. W. Jagger, G. M. Smith.

## WAIKATO BRANCH

*Chairman*: E. P. White, Ruakura Animal Research Station, P.B. Hamilton.

*Secretary/Treasurer*: F. D. Dorofaeff, Box 490, Hamilton.

*Committee*: Miss E. M. Sampey, Dr E. B. Davies, R. R. White, R. N. Woodward.

## MANAWATU BRANCH

*Chairman*: Dr J. W. Lyttleton, Plant Chemistry Division, Palmerston North.

*Secretary/Treasurer*: Dr G. W. Butler, Plant Chemistry Division, Palmerston North.

*Committee*: Dr W. A. McGillivray, G. M. Wallace, Dr J. Walker, Dr D. Wright.

## WELLINGTON BRANCH

*Chairman*: J. R. Beck, N.Z. Breweries Ltd., Box 211, Wellington.

*Secretary*: P. P. Williams, Dominion Laboratory, P.O. Box 8023, Wellington.

*Treasurer*: Dr P. Rothbaum, Dominion Laboratory, P.O. Box 8023, Wellington.

*Committee*: F. L. Addis-Smith, J. K. Johannesson, Miss J. B. Ross, H. R. Penhale.

## CANTERBURY BRANCH

*Chairman*: L. Wilkinson, Dominion Laboratory, Christchurch.

*Secretary/Treasurer*: D. J. Hogan, Dominion Laboratory, Christchurch.

*Committee*: Dr J. M. Austin, F. Barnes, E. R. Hounsell, J. S. Pollard.

## OTAGO BRANCH

*Chairman*: J. W. McChesney, 8 Alison Crescent, Dunedin.

*Secretary/Treasurer*: D. F. Nelson, Dominion Laboratory, Box 562, Dunedin.

*Committee*: Dr A. D. Campbell, C. L. Carter, A. H. Lewin, J. Robb.

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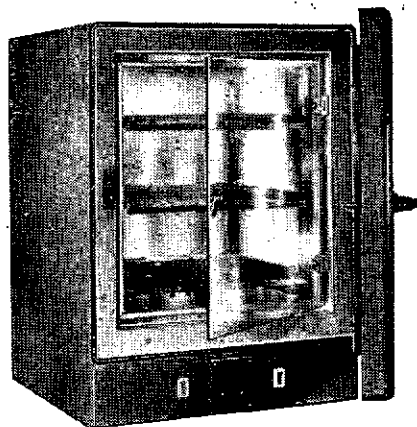
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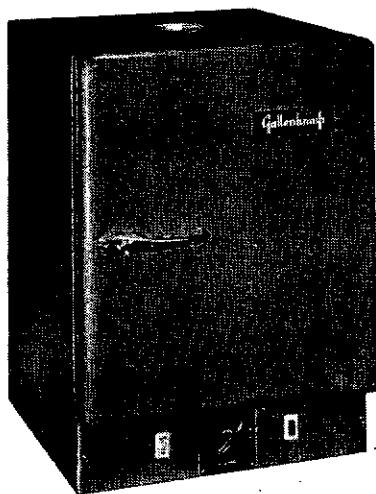
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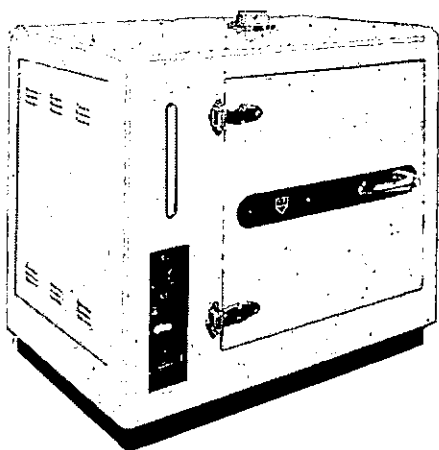
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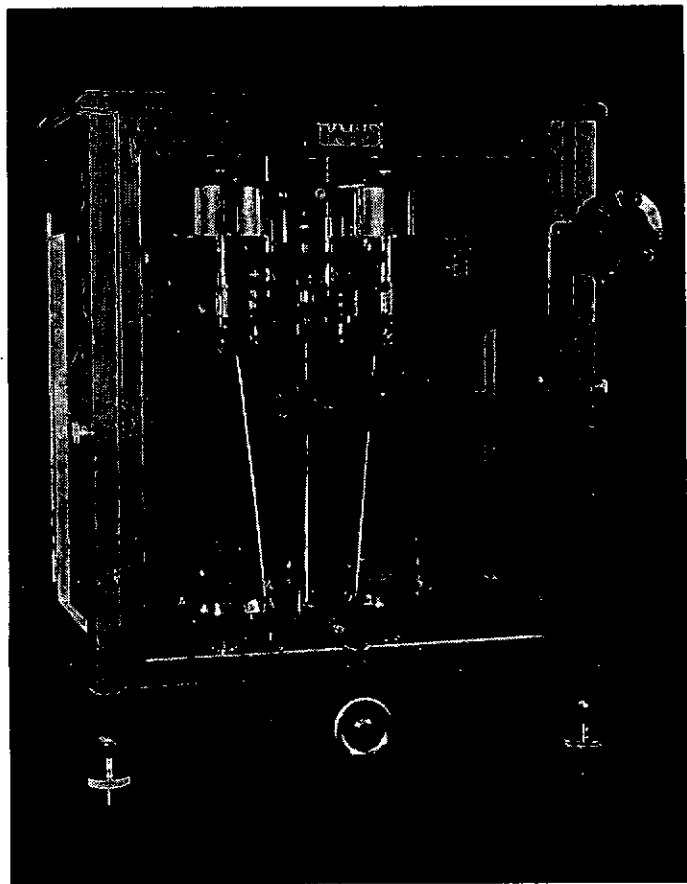


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