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EDITORIAL

The Chemical Aspects of Life

THE Presidential Address of Sir Frederick Gowland Hopkins delivered to the British Association at Leicester on the 6th inst. is a very remarkable contribution to our knowledge of the chemistry of life. It is remarkable for its accuracy, brilliance, and lucidity: in spite of these qualities it requires reading with care and attention for the subject is a complicated one. The exercise of muscular power is only one of very many processes that simultaneously take place in the higher animals and if we compare it with the production of speed by the familiar motor-car we may obtain an imperfect conception of the degree of complication. It is easy to state that in a car you explode a mixture of petrol vapour and air in a cylinder and that the explosion drives out a piston that works a crank shaft and drives an engine that turns the wheels, but every motorist knows that this is not an accurate or complete statement. We have to consider how the engine manages to introduce the petrol vapour and the air into the cylinder, how the compression is effected, how the spark is regulated, and a score of other matters, including observations on magnetos, differentials, back-axle shafts, carburetters, lubrication, and so on. Fortunate are those who can picture the simultaneous processes involved in a motor-car journey to Midhurst, or Burford, or the Barley Mow at Clifton Hampden. In this note about the process of the ear we did not start with the beginning for in a continuous cycle such as we have assumed for the car there is no beginning and no end, or rather you can begin anywhere and consider a complete cycle, just as you can if you study a curve of sines. Sir Frederick begins also in an arbitrary position, just after the contraction of a muscle; this is followed by the oxidation of stores of carbohydrate in the muscle and the liberation in this way of energy that effects the formation of creatin phosphate which will soon break down and so provide energy for the next contraction of the muscle. The oxidation of the carbohydrate in the muscle is by no means a simple operation; the carbohydrate in the form of a sugar combines with phosphoric acid and is converted, half into a molecule of glycerin and half into a molecule of pyruvic acid, each half remaining combined with phosphoric acid. Hydrogen is taken from the glycerin, making lactic acid, and is added to the pyruvic acid, also making lactic acid, and the whole of the lactic acid is then oxidized to form water and carbonic acid and to produce energy for muscular effort. Other changes taking part in the same cycle involve the breakdown and formation of adenyl pyrophosphate. We have not considered the mechanics or chemistry of respiration or the circulation of the blood or the production of the enzymes and hormones that regulate the cycle, but these are as important as the action of the magneto and the circulation of lubricants in the motor-car. Space does not permit us to describe in detail the whole substance of this vivid address; and if we had the space we could not do it for we have not the knowledge; the whole address must be carefully read and its charm and deep philosophic outlook will be at once manifest. We confess that it is so long since we read any thermodynamics that we find it now very difficult to form any picture or clear conception of that necessary term "entropy"; it once had for us a meaning that involved elementary integral calculus; this meaning is now too deep for us and we shall be glad if one of our readers will give us a clue as to what the word really does mean. While waiting for this further guide we shall read again what Sir Frederick has to say about the lowest forms of life, and vitamins, and biologists, and philosophy; he has touched on many topics and he has touched on nothing that he has not adorned.

Triumph?

We have skimmed with interest a little record of chemical progress which its author, Dr. W. J. Hale, entitles "Chemistry Triumphant." For our own part, we dislike triumph, feeling that although great is the service which chemistry is daily rendering to man, greater still are its potentialities, and immense are the unknown fields which each advance exposes to the explorer's gaze. Indeed, though it may seem strange, we confess to some little feeling of humility when we allow our thoughts to wander from the intricacies of current researches and the exigencies of present affairs to the wider landscape of the Might Be. But there is little enough in a title, and if one of our fraternity is moved to raise a Hoch! to his science, the least we can do is to be upstanding and ready with our salute. We

are the more ready because Dr. Hale takes a broad view, and gives us a fascinating picture of the "rise and reign of chemistry in a chemical world." Perhaps, too, it is because herrings originating from the other side of the pond are served with pleasantly piquant sauce, which delights the palate if not the stomach, and we soon find ourselves carried away from chemistry to economics, and economics to engineering, and both to plain down-*right horse-sense about lots of different things.* Taxation and war debts, for instance; and the West Indies, which Dr. Hale badly wants. Chemeconomics, we learn, is based on five principles: (1) All handiwork of man disintegrates with time and, except for art or monumental structures, its valuation decreases in direct proportion to this time factor. Hence taxation on property should disappear after a given time and the structure either be demolished or be subjected to a nuisance tax. (2) The best that man can do to-day will be antiquated on the morrow. Hence research. (3) In an advancing civilization the prices of basic commodities must ever seek lower and lower levels in order that a greater and greater spread between this price and selling price of finished products may make possible an ever increasing expenditure for improvements. Hence motor-cars should be cheaper. (4) With increasing income and education there is no upper limit to the capacity of man's wants. Therefore new industries must be developed. (5) All industry *is basically chemical, and hence industrial investments* warrant constant chemico-physico-biological scrutiny. "The man of to-morrow who would invest in an enterprise concerning which a constant scientific critique is unavailable will be known as a jackass." And Dr. Hale wants seven years' wheat, cotton, and maize famine to force us into extensive diversification of all kinds of crops. "We wouldn't suffer"—at any rate, for lack of instruction and entertainment.

A Hundred Years Ago

We wonder what people a hundred years hence will think of us and our times, times which have witnessed such extraordinary changes since the disastrous War *was precipitated on to Europe: in magnitude the Great* War far surpasses the wars of Napoleon, but whether we have anyone among our statesmen to rival Pitt we must leave posterity to determine. It seems certain to us that Mussolini will rank with Cavour and that is saying a great deal, for Cavour did a great piece of work: of our other dictators and demigods it is too early to speak with any confidence. Perhaps a hundred years hence the average man and the average woman will think of our great statesmen, Palmerston, Disraeli, Gladstone, and Runciman, our men of science, Faraday, Huxley, Kelvin, and Rutherford confusing together men of very different periods just as we are apt to forget to what exact period some of the great men of the past really belonged. In England in 1833 the great political question was Reform and a new parliament on the reformed basis sat and pondered over the world's many troubles. The great men who were contemporary with Samuel Johnson were all dead, the giant men that *came before the flood*, Lords Mansfield and Chatham, Johnson himself, Garrick, Reynolds, Dr. Burney, John Wilkes, Goldsmith, Burke, Clive, Capt. Cook, and one of our earliest chemists, Joseph Black (1728—1799) almost all these men born in the early years of th eighteenth century died before the nineteenth centur began. A new generation comes into being, the gener tion of Pitt and Charles James Fox, to which belongs also the famous men of science Priestley (1733—180 Cavendish (1731—1807), and Watt (1736—1819): con temporary with these or some of them were Lord Thurlow Erskine and Eldon being a little junior to him. an Erasmus Darwin, Warren Hastings, R. Watson, professo of chemistry at Cambridge and Bishop of Llandaf Gibbon, Paley, Sheridan, and Nelson. All of these die before 1833 but the memories of them were yet green The age of the French Revolution and the poetry of th Anti-Jacobin was succeeded by a great and splendi period comprising many who were alive but old in 183 and others who died young in the early days of th nineteenth century, for instance Byron (1788—1824 Shelley (1792—1822), and Keats (1795—1821); to thi period belonged a galaxy of poets in addition to the thre we have mentioned: Wordsworth (1770—1850), Cole ridge (1772—1834), Southey (1774—1843), Scott (1771— 1832), and Leigh Hunt (1784—1859). This was also th age of Dalton and Wollaston, of Davy and Faraday, th last being some years younger than Dalton and Wollaston both of whom were born in 1766. Charles Lamb, an Lord Holland, and Crabb Robinson come in this perio and Lord Wellington who lived until 1852, and Brougham and Melbourne, and Sir Robert Peel, who gave us th modern policeman, and Arnold of Rugby, and Pusey of the Church, and Macaulay the historian, and Westbur the Lord Chancellor, whose fall was swift, and so we com to Beaconsfield and Gladstone and Charles Darwin an Huxley and Clerk Maxwell and Kelvin and other moder men many of whom we, who rejoice in our middle age have seen and heard. We cannot all take our memorie so far back as Colonel Crompton, the electrical enginee who went through the Crimean campaign and is sti active, but we have a veteran chemist who is in a passive state and can remember a great many interestin people and curious facts. It is by no means easy an *not at all necessary to remember who were a man* friends and contemporaries and many of our reader could, we feel sure, give us a better classification than th age of Samuel Johnson, including the '45 and th Gordon riots, the age of Fox and Pitt, and the age o the Lake poets and of Davy and Faraday, but these three periods may serve as convenient pegs upon which ma be hung or perhaps stretched a number of men an dates easily confused or forgotten. An account o chemistry in this country in 1833 would be interestin and instructive calling attention to the recent discoveries of aniline (1826), anthracene (1832), benzene (1825 bromine (1826), chloroform in 1832, and so on but th would rather savour of work to write and drudgery t read. *The gas industry and the Leblanc soda proces* were beginning to flourish, galvanism occupied th attention of some people, alkaloids that of others organic chemistry in the hands of Liebig, Mitscherlich Dumas, Laurent, and others promised to become of con siderable importance; the formula for water had no then been agreed upon. How light were the duties of a chemical editor in those days!

SOME CHEMICAL ASPECTS OF LIFE*

By SIR FREDERICK GOWLAND HOPKINS, Pres.R.S.

The British Association returns to Leicester with assurance of a welcome as warm as that received 26 years ago, and of hospitality as generous. The renewed invitation and the ready acceptance speak of mutual appreciation born of the earlier experience. Hosts and guests have to-day reasons for mutual congratulations. The Association on its second visit finds Leicester altered in important ways. It comes now to a city newly chartered and the seat of a bishopric. It finds there a centre of learning, many fine buildings which did not exist on the occasion of the first visit, and many other evidences of civic enterprise. The citizens of Leicester on the other hand will know that since they last entertained it the Association has celebrated its centenary, has four times visited distant parts of the Empire, and has maintained unabated through the years its useful and important activities.

In 1907 the occupant of the Presidential Chair was, as you know, Sir David Gill, the eminent astronomer who, unhappily, like many who listened to his address, is with us no more. Sir David dealt in that address with aspects of science characterized by the use of very exact measurement. The exactitude which he prized and praised has since been developed by modern physics and is now so great that its methods have real æsthetic beauty. In contrast I have to deal with a branch of experimental science which, because it is concerned with living organisms, is in respect of measurement on a different plane. Of the very essence of biological systems is an ineludable complexity, and exact measurement calls for conditions here unattainable. Many may think, indeed, though I am not claiming it here, that in studying life, we soon meet with aspects which are non-metrical. I would have you believe, however, that the data of modern biochemistry which will be the subject of my remarks were won by quantitative methods fully adequate to justify the claims based upon them.

Though speculations concerning the origin of life have given intellectual pleasure to many, all that we yet know about it is that we know nothing. Sir James Jeans once suggested, though not with conviction, that it might be a disease of matter—a disease of its old age! Most biologists, I think, having agreed that life's advent was at once the most improbable and the most significant event in the history of the universe, are content for the present to leave the matter there.

We must recognize, however, that life has one attribute that is fundamental. Whenever and wherever it appears the steady increase of entropy displayed by all the rest of the universe is then and there arrested. There is no good evidence that in any of its manifestations life evades the second law of thermodynamics, but in the downward course of the energy-flow it interposes a barrier and dams up a reservoir which provides potential for its own remarkable activities. The arrest of energy degradation in living Nature is indeed a primary biological concept. Related to it, and of equal importance is the concept of organization.

* Presidential Address to the British Association for the Advancement of Science, at Leicester, on Sept. 6, 1933.

It is almost impossible to avoid thinking and talking of life in this abstract way, but we perceive it, of course, only as manifested in organized material systems, and it is in them we must seek the mechanisms which arrest the fall of energy. Evolution has established division of labour here. From far back the wonderfully efficient functioning of structures containing chlorophyll has, as everyone knows, provided the trap which arrests and transforms radiant energy—fated otherwise to degrade—and so provides power for nearly the whole living world. It is impossible to believe, however, that such a complex mechanism was associated with life's earliest stages. Existing organisms illustrate what was perhaps an earlier method. The so-called autotrophic bacteria obtain energy for growth by the catalysed oxidation of materials belonging wholly to the inorganic world; such as sulphur, iron or ammonia, and even free hydrogen. These organisms dispense with solar energy, but they have lost in the evolutionary race because their method lacks economy. Other existing organisms, certain purple bacteria, seem to have taken a step towards greater economy, without reaching that of the green cell. They dispense with free oxygen and yet obtain energy from the inorganic world. They control a process in which carbon dioxide is reduced and hydrogen sulphide simultaneously oxidized. The molecules of the former are activated by solar energy which their pigmentary equipment enables these organisms to arrest.

Are we to believe that life still exists in association with systems that are much more simply organized than any bacterial cell? The very minute filter-passing viruses which, owing to their causal relations with disease, are now the subject of intense study, awaken deep curiosity with respect to this question. We cannot yet claim to know whether or not they are living organisms. In some sense they grow and multiply, but, so far as we yet know with certainty, only when inhabitants of living cells. If they are nevertheless living, this would suggest that they have no independent power of obtaining energy and so cannot represent for us the earliest forms in which life appeared. At present, however, judgment on their biological significance must be suspended. The fullest understanding of all the methods by which energy may be acquired for life's processes is much to be desired.

In any case every living unit is a transformer of energy however acquired, and the science of biochemistry is deeply concerned with these transformations. It is with aspects of that science that I am to deal and if to them I devote much of my address my excuse is that since it became a major branch of inquiry biochemistry has had no exponent in the chair I am fortunate enough to occupy.

As a progressive scientific discipline it belongs to the present century. From the experimental physiologists of the last century it obtained a charter, and, from a few pioneers of its own, a promise of success; but for the furtherance of its essential aim that century left it but a small inheritance of facts and methods. By its essential or ultimate aim I myself mean an adequate and acceptable description of molecular dynamics in living cells and tissues.

When this Association began its history in 1831 the first artificial synthesis of a biological product was, as you will remember, but three years old. Primitive faith in a boundary between the organic and the inorganic which could never be crossed, was only just then realizing that its foundations were gone. Since then, during the century of its existence, the Association has seen the pendulum swing back and forth between frank physico-chemical conceptions of life and various modifications of vitalism. It is characteristic of the present position and spirit of science that sounds of the long conflict between mechanists and vitalists are just now seldom heard. It would almost seem, indeed, that tired of fighting in a misty atmosphere each has retired to his tent to await with wisdom the light of further knowledge. Perhaps, however, they are returning to the fight disguised as Determinist and Indeterminist respectively. If so the outcome will be of great interest. In any case I feel fortunate in a belief that what I have to say will not, if rightly appraised, raise the old issues. To claim, as *I am to claim, that a description of its active chemical* aspects must contribute to any adequate description of life is not to imply that a living organism is no more than a physico-chemical system. It implies that at a definite and recognizable level of its dynamic organization an organism can be logically described in physico-chemical terms alone. At such a level indeed we may hope ultimately to arrive at a description which is complete in itself, just as descriptions at the morphological level of organization may be complete in themselves. There may be yet higher levels calling for discussion in quite different terms.

I wish, however, to remind you of a mode of thought concerning the material basis of life, which though it prevailed when physico-chemical interpretations were fashionable, was yet almost as inhibitory to productive chemical thought and study as any of the claims of vitalism. This was the conception of that material basis as a single entity, as a definite though highly complex chemical compound. Up to the end of the last century and even later the term "protoplasm" suggested such an entity to many minds. In his brilliant presidential address at the Association's meeting at Dundee twenty-two years ago, Sir Edward Sharpey-Schafer, after remarking that the elements composing living substances are few in number, went on to say: "The combination of these elements into a colloid compound represents the physical basis of life, and when the chemist succeeds in building up this compound it will, without doubt, be found to exhibit the phenomena which we are in the habit of associating with the term 'life.'" Such a compound would seem to correspond with the "protoplasm" of many biologists, though treated perhaps with too little respect. The presidential claim might have seemed to encourage the biochemist, but the goal suggested would have proved elusive, and the path of endeavour has followed other lines.

So long as the term "protoplasm" retains a morphological significance as in classical cytology, it may be even now convenient enough, though always denoting an abstraction. In so far, however, as the progress of metabolism with all the vital activities which it supports was ascribed in concrete thought to hypothetical qualities emergent from a protoplasmic complex in its integrity or when substances were held to suffer change only because in each living cell they are first built up, with loss of their own molecular structure and identity, into this complex, which is itself the inscrutable seat of cyclic change, then serious obscurantism was involved.

Had such assumptions been justified the old taunt that when the chemist touches living matter it immediately becomes dead matter would also have been justified. A very distinguished organic chemist, long since dead, said to me in the late 'eighties: "The chemistry of the living? That is the chemistry of protoplasm; that is superchemistry; seek, my young friend, for other ambitions."

Research, however, during the present century, much of which has been done since the Association last met in Leicester, has yielded knowledge to justify the optimism of the few who started to work in those days. Were there time, I might illustrate this by abundant examples; but I think a single illustration will suffice to demonstrate how progress during recent years has changed the outlook for biochemistry. I will ask you to note the language used thirty years ago to describe the chemical events in active muscle and compare it with that used now. In 1895 Michael Foster, a physiologist of deep vision, dealing with the respiration of tissues, and in particular with the degree to which the activity of muscle depends on its contemporary oxygen supply, expounded the current view which may be thus briefly summarized. The oxygen which enters the muscle from the blood is not involved in immediate oxidations, but is built up into the substance of the muscle. It disappears into some protoplasmic complex on which its presence confers instability. This complex, which, like all living substance, is to be regarded as incessantly undergoing changes of a double kind, those of building up and those of breaking down. With activity the latter predominates, and in the case of muscle the complex in question explodes, as it were, to yield the energy for contraction. "We cannot yet trace," Foster comments, "the steps taken by the oxygen from the moment it slips from the blood into the muscle substance to the moment when it issues united with carbon as carbonic acid. The whole mystery of life lies hidden in that process, and for the present we must be content with simply knowing the beginning and the end." What we feel entitled to say to-day concerning the respiration of muscle and of the events associated with its activity requires, as I have suggested, a different language, and for those not interested in technical chemical aspects the very change of language may yet be significant. The conception of continuous building up and continuous breakdown of the muscle substance as a whole, has but a small element of truth. The colloidal muscle structure is, so to speak, an apparatus, relatively stable even as a whole when metabolism is normal, and in essential parts very stable. The chemical reactions which occur in that apparatus have been followed with a completeness which is, I think, striking. It is carbohydrate stores distinct from the apparatus (and in certain circumstances also fat stores) which undergo steady oxidation and are the ultimate sources of energy for muscular work. Essential

...ing successive stages in the chemical breakdown of ...ohydrate which necessarily precede oxidation is ... intermediate combination of a sugar (a hexose) ... phosphoric acid to form an ester. This happening ... indispensable for the progress of the next stage, ...ely, the production of lactic acid from the sugar, ...ch is an anaerobic process. The precise happenings ... the hexose sugar while in combination with phos...oric acid are from a chemical standpoint remarkable. ...y briefly stated they are these. One half of the sugar ...ecule is converted into a molecule of glycerin and ... other half into one of pyruvic acid. Now with loss ... two hydrogen atoms glycerin yields lactic acid, and, ...h a gain of the same pyruvic acid also yields lactic ...id. The actual happening then is that hydrogen is ...nsferred from the glycerin molecule while still com...ined with phosphoric acid to the pyruvic acid molecule ...th the result that two molecules of lactic acid are ...med.[1] The lactic acid is then, during a cycle of ...hange which I must not stop to discuss, oxidized to ...id the energy required by the muscle.

But the energy from this oxidation is by no means ...ectly available for the mechanical act of contraction. ...he oxidation occurs indeed after and not before or ...uring a contraction. The energy it liberates secures, ...owever, the endothermic resynthesis of a substance, ...reatin phosphate, of which the breakdown at an earlier ...tage in the sequence of events is the more immediate ...urce of energy for contraction. Even more compli...ated are these chemical relations, for it would seem ...at in the transference of energy from its source in the ...xidation of carbohydrate to the system which syn...hesizes creatin phosphate, yet another reaction inter...enes, namely, the alternating breakdown and resynthesis ... the substance adenyl pyrophosphate. The sequence ... these chemical reactions in muscle has been followed ...nd their relation in time to the phases of contraction ...nd relaxation is established. The means by which ...nergy is transferred from one reacting system to another ...as till lately been obscure, but current work is throwing ...ght upon this interesting question, and it is just begin...ing (though only beginning) to show how at the final ...age the energy of the reactions is converted into the ...echanical response. In parenthesis it may be noted ... an illustration of the unity of life that the processes ...hich occur in the living yeast cell in its dealings with ...gars are closely similar to those which proceed in ...ving muscle. In the earlier stages they are identical ...nd we now know where they part company. You will, ...think, be astonished at the complexity of the events ...hich underlie the activity of a muscle, but you must ...member that it is a highly specialized machine. A ...ore direct burning of the fuel could not fit into its ...mplex organization. I am more particularly con...rned to feel that my brief summary of the facts will ...ake you realize how much more definite, how much ...ore truly chemical, is our present knowledge than ...at available when Michael Foster wrote. Ability to ...ecognize the progress of such definite ordered chemical ...actions in relation to various aspects of living activity ...haracterizes the current position in biochemistry. I ...ave chosen the case of muscle, and it must serve as my only example, but many such related and ordered reactions have been studied in other cells and tissues, from bacteria to the brain. Some prove general, some more special. Although we are far indeed from possessing a complete picture in any one case we are beginning in thought to fit not a few pieces together. We are on a line safe for progress.

[1] Lecture by Otto Meyerhof (see *Nature*, Sept. 2, 1933).

I must perforce limit the field of my discussion, and in what follows my special theme will be the importance of molecular structure in determining the properties of living systems. I wish you to believe that molecules display in such systems the properties inherent in their structure even as they do in the laboratory of the organic chemist. The theme is no new one, but its development illustrates as well as any other, and to my own mind perhaps better than any other, the progress of biochemistry. Not long ago a prominent biologist, believing in protoplasm as an entity, wrote: "*But it seems certain that living protoplasm is not an* ordinary chemical compound, and therefore can have no molecular structure in the chemical sense of the word." Such a belief was common. One may remark, moreover, that when the development of colloid chemistry first brought its indispensable aid towards an understanding of the biochemical field, there was a tendency to discuss its bearing in terms of the less specific properties of colloid systems, phase-surfaces, membranes, and the like, without sufficient reference to the specificity which the influence of molecular structure, wherever displayed, impresses on chemical relations and events. In emphasizing its importance I shall leave no time for dealings with the nature of the colloid structures of cells and tissues, all-important as they are. I shall continue to deal, though not again in detail, with chemical reactions as they occur within those structures. Only this much must be said. If the colloid structures did not display highly specialized molecular structure at their surface, no reactions would occur; for here catalysis occurs. Were it not equipped with catalysts every living unit would be a static system.

With the phenomena of catalysis I will assume you have general acquaintance. You know that a catalyst is an agent which plays only a temporary part in chemical events, which it nevertheless determines and controls. It reappears unaltered when the events are completed. The phenomena of catalysis, though first recognized early in the last century, entered but little into chemical thought or enterprise, till only a few years ago they were shown to have great importance for industry. Yet catalysis is one of the most significant devices of nature, since it has endowed living systems with their fundamental character as transformers of energy, and all evidence suggests that it must have played an indispensable part in the living universe from the earliest stages of evolution.

The catalysts of a living cell are the enzymic structures which display their influences at the surface of colloidal particles or at other surfaces within the cell. Current research continues to add to the great number of these enzymes which can be separated from, or recognized in, living cells and tissues, and to increase our knowledge of their individual functions.

A molecule within the system of the cell may remain in an inactive state and enter into no reactions until *at one such surface it comes* in contact with an enzymic structure which displays certain adjustments to its own structure. While in such association the inactive molecule becomes (to use a current term) "activated," and then enters on some definite path of change. The one aspect of enzymic catalysis which for the sake of my theme I wish to emphasize is its high specificity. An enzyme is in general adjusted to come into effective relations with one kind of molecule only, or at most with molecules closely related in their structure. Evidence based on kinetics justifies the belief that some sort of chemical combination *between* enzyme and related molecule precedes the activation of the latter, and for such combinations there must be close correlation in structure. Many will remember that long ago Emil Fischer recognized that enzymic action distinguishes even between two optical isomers and spoke of the necessary relation being as close as that of key and *lock*.

There is an important consequence of this high specificity in biological catalysis to which I will direct your special attention. A living cell is the seat of a multitude of reactions, and in order that it should retain in a given environment its individual identity as an organism, these reactions must be high organized. They must be of determined nature and proceed mutually adjusted with respect to velocity, sequence, and in all other relations. They must be in dynamic equilibrium as a whole and must return to it after disturbance. Now, if of any group of catalysts, such as are found in the equipment of a cell, each one exerts limited and highly specific influence, this very specificity must be a potent factor in making for organization.

Consider the case of any individual cell in due relations with its environment, whether an internal environment as in the case of the tissue cells of higher animals, or an external environment as in the case of unicellular organisms. Materials for maintenance of the cell enter it from the environment. Discrimination among such materials is primarily determined by permeability relations, but of deeper significance in that selection is the specificity of the cell catalysts. It has often been said that the living cell differs from all non-living systems *in its power of selecting* from a heterogeneous environment the right material for the maintenance of its structure and activities. It is, however, no vital act, but the nature of its specific catalysts which determines what it effectively "selects." If a molecule gains entry into the cell and meets no catalytic influence capable of activating it, nothing further happens save for certain ionic and osmotic adjustments. Any molecule which does meet an adjusted enzyme cannot fail to suffer change and become directed into some one of the paths of metabolism. It must here be remembered, moreover, that enzymes as specific catalysts not only promote reactions, but determine their direction. The glucose molecule, for example, though its inherent chemical potentialities are, of course, always the same, is converted into lactic acid by an enzyme system in muscle, but into alcohol and carbon dioxide by another in the yeast cell. It is important to realize that diverse enzymes may act in succession and that specific catalysis has directive as well as selective powers. If it be syntheses in the cell which are most difficult to picture on such lines, we may remember that biological syntheses can be, and are, promoted by enzymes, and there are sufficient facts to justify the belief that a chain of specific enzymes can *direct a complex synthesis along lines* predetermined by the nature of the enzymes themselves. I should like to develop this aspect of the subject even further, but to do so might tax your patience. I should add that enzyme-control, though so important, is not the sole determinant of chemical organization in a cell. Other aspects of its colloidal structure play their part.

It is surely at that level of organization, which is based on the exact co-ordination of a multitude of chemical events within it, that a living cell displays its peculiar sensitiveness to the influence of molecules of special nature when these enter it from without. The nature of very many organic molecules is such that they may enter a cell and exert no effect. Those proper to *metabolism follow, of course, the normal paths* of change. Some few, on the other hand, influence the cell in very special ways. When such influence is highly specific in kind it means that some element of structure in the entrant molecule is adjusted to meet an aspect of molecular structure somewhere in the cell itself. We can easily understand that in a system so *minute the intrusion even of a few such molecules* may so modify existing equilibria as to affect profoundly the observed behaviour of the cell.

Such relations, though by no means confined to them, reach their greatest significance in the higher organisms, in which individual tissues, chemically diverse, differentiated in function and separated in space, so react upon one another through chemical agencies transmitted through the circulation as to co-ordinate by chemical transport the activities of the body as a whole. Unification by chemical means must to-day be recognized as a fundamental aspect of all such organisms. In all of them it is true that the nervous system has pride of place as the highest seat of organizing influence, but we know to-day that even this influence is often, if not always, exerted through properties inherent in chemical molecules. It is indeed most significant for my general theme to realize that when a nerve impulse reaches a *tissue the sudden production of a definite chemical* substance at the nerve ending may be essential to the response of that tissue to the impulse. It is a familiar circumstance that when an impulse passes to the heart by way of the vagus nerve fibres the beat is slowed, or, by a stronger beat, arrested. That is, of course, part of the normal control of the heart's action. Now it has *been shown* that whenever the heart receives vagus impulses the substance acetyl cholin is liberated within the organ. To this fact is added the further fact that, in the absence of the vagus influence, the artificial injection of minute graded doses of acetyl choline so acts upon the heart as to reproduce in every detail the effects of graded stimulation of the nerve. Moreover, evidence is accumulating to show that in the case of other nerves belonging to the same morphological group as the vagus, but supplying other tissues, this same liberation of acetyl choline accompanies activity, and the

...mical action of this substance upon such tissues again ...duces effects identical with those observed when the ... are stimulated. More may be claimed. The ...ctions of another group of nerves are opposed to ...se of the vagus group; impulses, for instance, through ...rtain fibres accelerate the heart beat. Again a ...mical substance is liberated at the endings of such ...rves, and this substance has itself the property of ...celerating the heart. We find then that such organs ...d tissues respond only indirectly to whatever non-specific physical change may reach the nerve ending. Their direct response is to the influence of particular molecules with an essential structure when these intrude upon their chemical machinery.

It follows that the effect of a given nerve stimulus may not be confined to the tissue which it first reaches. There may be humeral transmissions of its effect, because the liberated substance enters the lymph and blood. This again may assist the co-ordination of events in the tissues.

From substances produced temporarily and locally and by virtue of their chemical properties translating for the tissues the messages of nerves, we may pass logically to consideration of those active substances which carry chemical messages from organ to organ. Such in the animal body are produced continuously in specialized organs, and each has its special seat or seats of action where it finds chemical structures adjusted in some sense or other to its own.

I shall be here on familiar ground, for that such agencies exist, and bear the name of hormones, is common knowledge. I propose only to indicate how many and diverse are their functions as revealed by recent research, emphasizing the fact that each one is a definite and relatively simple substance with properties that are primarily chemical, and in a derivate sense, physiological. Our clear recognition of this, based at first on a couple of instances, began with this century, but our knowledge of their number and nature is still growing rapidly to-day.

We have long known, of course, how essential and profound is the influence of the thyroid gland in maintaining harmonious growth in the body, and in controlling the rate of its metabolism. Three years ago a brilliant investigation revealed the exact molecular structure of the substance—thyroxin—which is directly responsible for these effects. It is a substance of no great complexity. The constitution of adrenalin has been longer known and likewise its remarkable influence in maintaining a number of important physiological adjustments. Yet it is again a relatively simple substance. I will merely remind you of secretin, the first of these substances to receive the name of hormone, and of insulin, now so familiar because of its importance in the metabolism of carbohydrates and its consequent value in the treatment of diabetes. The most recent growth of knowledge in this field has dealt with hormones which, in most remarkable relations, co-ordinate the phenomena of sex.

It is the circulation of definite chemical substances produced locally that determines during the growth of the individual, the proper development of all the secondary sexual characters. The properties of other substances secure the due progress of individual development from the unfertilized ovum to the end of fœtal life. When an ovum ripens and is discharged from the ovary, a substance, now known as œstrin, is produced in the ovary itself, and so functions as to bring about all those changes in the female body which make secure the fertilization of the ovum. On the discharge of the ovum new tissue, constituting the so-called *corpus luteum*, arises in its place. This then produces a special hormone which in its turn evokes all those changes in tissues and organs that secure a right destiny for the ovum after it has been fertilized. It is clear that these two hormones do not arise simultaneously, for they must act in alternation, and it becomes of great interest to know how such succession is secured. The facts here are among the most striking. Just as higher nerve centres in the brain control and co-ordinate the activities of lower centres, so it would seem do hormones, functioning at, so to speak, a higher level in organization, co-ordinate the activities of other hormones. It is a substance produced in the anterior portion of the pituitary gland situated at the base of the brain, which by circulating to the ovary controls the succession of its hormonal activities. The cases I have mentioned are far from exhausting the numerous hormonal influences now recognized.

For full appreciation of the extent to which chemical substances control and co-ordinate events in the animal body by virtue of their specific molecular structure, it is well not to separate too widely in thought the functions of hormones from those of vitamins. Together they form a large group of substances of which every one exerts upon physiological events its own indispensable chemical influence.

Hormones are produced in the body itself, while vitamins must be supplied in the diet. Such a distinction is, in general, justified. We meet occasionally, however, an animal species able to dispense with an external supply of this or that vitamin. Evidence shows, however, that individuals of that species, unlike most animals, can in the course of their metabolism synthesize for themselves the vitamin in question. The vitamin then becomes a hormone. In practice the distinction may be of great importance, but for an understanding of metabolism the functions of these substances are of more significance than their origin.

The present activity of research in the field of vitamins is prodigious. The output of published papers dealing with original investigations in the field has reached nearly a thousand in a single year. Each of the vitamins at present known is receiving the attention of numerous observers in respect both of its chemical and biological properties, and though many publications deal, of course, with matters of detail, the accumulation of significant facts is growing fast.

It is clear that I can cover but little ground in any reference to this wide field of knowledge. Some aspects of its development have been interesting enough. The familiar circumstance that attention was drawn to the existence of one vitamin (B_1 so called) because populations in the East took to eating milled rice instead of the whole grain; the gradual growth of evidence which links the physiological activities of another vitamin (D) with the influence of solar radiation on the body, and has

shown that they are thus related, because rays of definite wave length convert an inactive precursor into the active vitamin, alike when acting on foodstuffs or on the surface of the living body; the fact again that the *recent isolation of vitamin-C and the accumulation of* evidence for its nature started from the observation that the cortex of the adrenal gland displayed strongly reducing properties; or yet again the proof that a yellow pigment widely distributed among plants, while not the vitamin itself, can be converted within the body into vitamin-*A*; these and other aspects of vitamin studies will stand out as interesting chapters in the story of scientific investigation.

In this very brief discussion of hormones and vitamins I have so far referred only to their functions as manifested in the animal body. Kindred substances, exerting analogous functions are, however, of wide and perhaps of quite general biological importance. It is certain that *many micro-organisms require a supply of vitamin*-like substances for the promotion of growth, and recent research of a very interesting kind has demonstrated in the higher plants the existence of specific substances produced in special cells which stimulate growth in other cells, and so in the plant as a whole. These so-called auxines are essentially hormones.

It is of particular importance to my present theme and a source of much satisfaction to know that our knowledge of the actual molecular structure of hormones and vitamins is growing fast. We have already exact knowledge of the kind in respect to not a few. We are indeed justified in believing that within a few years such knowledge will be extensive enough to allow a wide view of the correlation between molecular structure and physiological activity. Such correlation has long been sought in the case of drugs, and some generalizations have been demonstrated. It should be remembered, however, that until quite lately only the structure of the *drug could be considered. With increasing knowledge* of the tissue structures pharmacological actions will become much clearer.

I cannot refrain from mentioning here a set of relations connected especially with the phenomena of tissue growth which are of particular interest. It will be convenient to introduce some technical chemical considerations in describing them, though I think the relations may be clear without emphasis being placed on such details. The vitamin, which in current usage is labelled "*A*," is essential for the general growth of an animal. Recent research has provided much information as to its chemical nature. Its molecule is built up of units which possess what is known to chemists as *the isoprene structure. These are condensed in a long* carbon chain which is attached to a ring structure of a specific kind. Such a constitution relates it to other biological compounds, in particular to certain vegetable pigments, one of which a carotene, so called, is the substance which I have mentioned as being convertible into the vitamin. For the display of an influence upon growth, however, the exact details of the vitamin's proper structure must be established. Now turning to vitamin-*D*, of which the activity is more specialized, controlling as it does the growth of bone in particular, we have learnt that the unit elements in its structure are again isoprene radicals; but instead of forming a long chain as in vitamin-*A* they are united into a system of condensed rings. Similar rings form the basal component of the molecules of sterols, substances which are *normal constituents of nearly every living cell. It is one* of these, inactive itself, which ultra-violet radiation converts into vitamin-*D*. We know that as stated each of these vitamins stimulates growth in tissue cells. Next consider another case of growth stimulation, different because pathological in nature. As you are doubtless aware, it is well known that long contact with tar induces a cancerous growth of the skin. Very important researches have recently shown that particular constituents in the tar are alone concerned in producing this effect. It is being further demonstrated that the power to produce cancer is associated with a special type of molecular structure in these constituents. This structure, like that of the sterols, is one of condensed *rings*, the essential difference being that (in chemical language) the sterol rings are hydrogenated, whereas those in the cancer-producing molecules are not. Hydrogenation indeed destroys the activity of the latter. Recall, however, the ovarian hormone œstrin. Now the molecular structure of œstrin has the essential ring structure of a sterol, but one of the constituent rings is not hydrogenated. In a sense therefore the chemical nature of œstrin links vitamin-*D* with that of cancer-producing substances. Further, it is found that substances with pronounced cancer-producing powers may produce effects in the body like those of œstrin. It is difficult when faced with such relations not to wonder whether the metabolism of sterols, which when normal can produce a substance stimulating physiological growth, may in very special circumstances be so perverted as to produce within living cells a substance stimulating pathological growth. Such a suggestion must, however, with present knowledge, be very cautiously received. *It is wholly without experi*mental proof. My chief purpose in this reference to this very interesting set of relations is to emphasize once more the significance of chemical structure in the field of biological events.

Only the end results of the profound influence which minute amounts of substances with adjusted structure exert upon living cells or tissues can be observed in the intact bodies of man or animals. It is doubtless because of the elaborate and sensitive organization of chemical events in every tissue cell that the effects are proportionally so great.

It is an immediate task of biochemistry to explore the mechanism of such activities. It must learn to *describe in objective chemical terms precisely how* and where such molecules as those of hormones and vitamins intrude into the chemical events of metabolism. It is indeed now beginning this task which is by no means outside the scope of its methods. Efforts of this and of similar kind cannot fail to be associated with a steady increase in knowledge of the whole field of chemical organization in living organisms, and to this increase we look forward with confidence. The promise is there. Present methods can still go far, but I am convinced that progress of the kind is about to gain great impetus from the application of those new methods

research which chemistry is inheriting from physics: X-ray analysis; the current studies of unimolecular surface films and of chemical reactions at surfaces; modern spectroscopy; the quantitive developments of micro-chemistry; no branch of inquiry stands to gain more from such advances in technique than does biochemistry at its present stage. Especially is this true in the case of the colloidal structure of living systems which in this address I have said so little.

As an experimental science, biochemistry, like classical physiology, and much of experimental biology, has obtained, and must continue to obtain, many of its data from studying part of the organism in isolation, but parts in which dynamic events continue. Though, fortunately, it has also methods of studying reactions as they occur in intact living cells, intact tissues, and, of course, in the intact animal, it is still entitled to claim that its studies of parts are consistently developing its grasp of the wholes it desires to describe, however remote that grasp may be from finality. Justification of any such claim has been challenged in advance from a certain philosophic standpoint: not from that of General Smuts, though in his powerful address which signalized our centenary meeting he, like many philosophers to-day, emphasized the importance of properties which emerge from systems in their integrity, bidding us remember that a part while in the whole is not the same as the part in isolation. He hastened to admit in a subsequent speech, however, that for experimental biology, as for any other branch of science, it was logical and necessary to approach the whole through its parts. Nor, again, is the claim challenged from the standpoint of such a teacher as A. N. Whitehead, though in his philosophy of organic mechanism there is no real entity of any kind without internal and multiple relations, and each whole is more than the sum of its parts. I nevertheless find *ad hoc* statements in his writings which directly encourage the methods of biochemistry. In the teachings of J. S. Haldane, however, the value of such methods have long been directly challenged. Some here will, perhaps, remember that in his address to Section I, 25 years ago, he described a philosophic standpoint which he has courageously maintained in many writings since. Dr. Haldane holds that to the enlightened biologist a living organism does not present a problem for analysis; it is, *qua* organism, axiomatic. Its essential attributes are axiomatic: heredity, for example, is for biology not a problem, but an axiom. "The problem of physiology is not to obtain piecemeal physico-explanations of physiological processes" (I quote from the 1885 address), "but to discover by observations and experiment the relatedness to one another of all the details of structure and activity in each organism as expressions of its nature as one organism." I cannot pretend adequately to discuss these views here. They have often been discussed by others—not always, perhaps, with understanding. What is true in them is subtle, and I doubt if their author has ever found the right words in which to bring to most others a conviction of such truth. It is involved in a world outlook. What I think is scientifically faulty in Haldane's teaching is the *a priori* element which leads to bias in the face of evidence. The task he sets for the physiologist seems vague to most people, and he forgets that with good judgment a study of parts may lead to an intellectual synthesis of value. In 1885 he wrote: "That a meeting-point between biology and physical science may at some time be found there is no reason for doubting; but we may confidently predict that if that meeting-point is found, and one of the two sciences is swallowed up, that one will not be biology." He now claims, indeed, that biology has accomplished the heavy meal because physics has been compelled to deal no longer with Newtonian entities but, like the biologist, with organisms such as the atom proves to be. Is it not, then, enough for my present purpose to remark on the significance of the fact that not until certain atoms were found spontaneously splitting piecemeal into parts, and others were afterwards so split in the laboratory, did we really know anything about the atom as a whole?

At this point, however, I will ask you not to suspect me of claiming that all the attributes of living systems, or even the more obvious among them, are necessarily based upon chemical organization alone. I have already expressed my own belief that this organization will account for one striking characteristic of every living cell—its ability, namely, to maintain a dynamic individuality in diverse environments. Living cells display other attributes even more characteristic of themselves; they grow, multiply, inherit qualities and transmit them. Although to distinguish levels of organization in such systems may be to abstract from reality, it is not illogical to believe that such attributes as these are based upon organization at a level which is in some sense higher than the chemical level. The main necessity from the standpoint of biochemistry is, then, to decide whether, nevertheless, at its own level, which is certainly definable, the results of experimental studies are self-contained and consistent. This is assuredly true of the data which biochemistry is now acquiring. Never during its progress has chemical consistency shown itself to be disturbed by influences of any ultra-chemical kind.

Moreover, before we assume that there is a level of organization at which chemical controlling agencies must necessarily cease to function, we should respect the intellectual parsimony taught by Occam and be sure of their limitations before we seek for super-chemical entities as organizers. There is no orderly succession of events which would seem less likely to be controlled by the mere chemical properties of a substance than the cell divisions and cell differentiation which intervene between the fertilized ovum and the finished embryo. Yet it would seem that a transmitted substance, a hormone in essence, may play an unmistakable part in that remarkable drama. It has for some years been known that, at an early stage of development, a group of cells forming the so-called "organizer" of Spemann induces the subsequent stages of differentiation in other cells. The latest researches seem to show that a cell-free extract of this "organizer" may function in its place. The substance concerned is, it would seem, not confined to the "organizer" itself, but is widely distributed outside, though not in, the embryo. It presents, nevertheless, a truly remarkable instance of chemical influence.

It would be out of place in such a discourse as this to *attempt any discussion of the psycho-physical problem. However much we may learn about the material systems* which, in their integrity, are associated with consciousness, the nature of that association may yet remain a problem. The interest of that problem is insistent and it must be often in our thoughts. Its existence, however, justifies no pre-judgments as to the value of any knowledge of a consistent sort which the material systems may yield to experiment.

It has become clear, I think, that chemical modes of thought, whatever their limitation, are fated profoundly *to affect biological thought. If, however, the biochemist* should at any time be inclined to overrate the value of his contributions to biology, or to underrate the magnitude of problems outside his province, he will do well sometimes to leave the laboratory for the field, or to seek even in the museum a reminder of that infinity of adaptations of which life is capable. He will then not fail to work with a humble mind, however great his *faith in the importance of the methods which are his* own.

It is surely right, however, to claim that in passing from its earlier concern with dead biological products to its present concern with active processes within living organisms, biochemistry has become a true branch of progressive biology. It has opened up modes of thought about the physical basis of life which could scarcely be *employed at all a generation ago. Such data and such* modes of thought as it is now providing are pervasive, and must appear as aspects in all biological thought. Yet these aspects are, of course, only partial. Biology in all its aspects is showing rapid progress, and its bearing on human welfare is more and more evident.

Unfortunately the nature of this new biological progress and its true significance is known to but a small section of the lay public. Few will doubt that popular interest in science is extending, but it is mainly confined to the more romantic aspects of modern astronomy and physics. That biological advances have made less impression is probably due to more than one circumstance, of which the chief, doubtless, is the neglect of biology in our educational system. The startling data of modern astronomy and physics, though of course only when presented in their most superficial aspects, find an easier approach to the uninformed mind than those of the new experimental biology can hope for. The primary concepts involved are paradoxically less familiar. Modern physical science, moreover, has been interpreted to the intelligent public by writers so brilliant that their books have had a great and stimulating influence.

Lord Russell once ventured on the statement that in passing from physics to biology one is conscious of a transition from the cosmic to the parochial, because *from a cosmic point of view life is a very unimportant* affair. Those who know that supposed parish well are convinced that it is rather a metropolis entitled to much more attention than it sometimes obtains from authors of guide-books to the universe. It may be small in extent, but is the seat of all the most significant events. In too many current publications, purporting to summarize scientific progress, biology is left out or receives but scant reference. Brilliant expositions of all that may be met in the region where modern science touches philosophy have directed thought straight from the implications of modern physics to the nature and structure of the human mind, and even to speculation concerning the mind of the Deity. Yet there are aspects of biological truth already known which are certainly germane to such discussions, and probably necessary for their adequacy.

It is, however, because of its extreme importance to social progress that public ignorance of biology is especially to be regretted. Sir Henry Dale has remarked *that "it is worth while to consider to-day whether the* imposing achievements of physical science have not already, in the thought and interests of men at large, as well as in technical and industrial development, overshadowed in our educational and public policy those of biology to an extent which threatens a one-sided development of science itself and of the civilization which we hope to see based on science." Sir Walter Fletcher, whose death during the past year has deprived the nation of an enlightened adviser, almost startled the public, I think, when he said in a national broadcast that "we can find safety and progress only in proportion as we bring into our methods of statecraft the guidance of biological truth." That statecraft, in its dignity, should be concerned with biological teaching, was a new idea to many listeners. A few years ago the Cambridge *philosopher, Dr. C. D. Broad, who is much better* acquainted with scientific data than are many philosophers, remarked upon the misfortune involved in the unequal development of science; the high degree of our control over inorganic nature combined with relative ignorance of biology and psychology. At the close of a discussion as to the possibility of continued mental progress in the world, he summed up by saying that the possibility depends on our getting an adequate knowledge and control of life and mind before the combination of ignorance on these subjects with knowledge of physics and chemistry wrecks the whole social system. He closed with the somewhat startling words: "Which of the runners in this very interesting race will win it is impossible to foretell. But physics and death have a long start over psychology and life!" No one surely will wish for, or expect, a slowing in the pace of the first, but the quickening up in the latter which the last few decades have seen is a matter for high satisfaction. But to repeat, the need for recognizing biological truth as a necessary guide to individual conduct and no less to statecraft and social policy still needs emphasis to-day. With frank acceptance of the truth that his own nature is congruent with all those aspects of nature at large which biology studies, combined with intelligent understanding of its teaching, man would escape from innumerable inhibitions due to past history and present ignorance, and equip himself for higher levels of endeavour and success.

Inadequate as at first sight it may seem when standing alone in support of so large a thesis, I must here be content to refer briefly to a single example of biological studies bearing upon human welfare. I will choose one which stands near to the general theme of my address. I mean the current studies of human and animal nutrition.

are well aware that during the last twenty
that is, since it adopted the method of controlled
iment—the study of nutrition has shown that the
. of the body are much more complex than was
r thought, and in particular that substances con-
d in almost infinitesimal amounts may, each in
ay, be as essential as those which form the bulk of
dequate dietary. This complexity in its demands
after all, not surprise those who have in mind the
dexity of events in the diverse living tissues of the
.

v earlier reference to vitamins, which had somewhat
rent bearings, was, I am sure, not necessary for a
nder of their nutritional importance. Owing to
ndance of all kinds of advertisement vitamins are
ssed in the drawing-room as well as in the dining-
a, and also, though not so much, in the nursery,
e at present perhaps not enough in the kitchen.
ortunately, among the uninformed their importance
utrition is not always viewed with discrimina-
. Some seem to think nowadays that if the
ron supply is secured the rest of the dietary may
left to chance, while others suppose that they
things so good that we cannot have too much of
n. Needless to say, neither assumption is true.
h regard to the second indeed it is desirable, now
t vitamin concentrates are on the market and
ch advertised, to remember that excess of a vitamin
y be harmful. In the case of that labelled *D*, at least
have definite evidence of this. Nevertheless, the
m that every known vitamin has highly important
ritional functions is supported by evidence which
ntinues to grow. It is probable, but perhaps not yet
tain, that the human body requires all that are
own.

The importance of detail is no less in evidence when the
nands of the body for a right mineral supply are
nsidered. A proper balance among the salts which
consumed in quantity is here of prime importance,
t that certain elements which ordinary foods contain
minute amounts are indispensable in such amounts
becoming sure. To take but a single instance: the
cessity of a trace of copper, which exercises somewhere
the body an indispensable catalytic influence on
etabolism, is as essential in its way as much larger
pplies of calcium, magnesium, potassium or iron.
ose in close touch with experimental studies con-
ually receive hints that factors still unknown contri-
ute to normal nutrition, and those who deal with human
etaries from a scientific standpoint know that an ideal
et cannot yet be defined. This reference to nutri-
onal studies is indeed mainly meant to assure you that
ne great attention they are receiving is fully justified.
o one here, I think, will be impressed with the argument
at because the human race has survived till now in
mplete ignorance of all such details the knowledge
eing won must have academic interest alone. This line
f argument is very old and never right.

One thing I am sure may be claimed for the growing
nlightenment concerning human nutrition and the
cent recognition of its study. It has already produced
ne line of evidence to show that nurture can assist
ature to an extent not freely admitted a few years
ago. That is a subject which I wish I could pursue. I cannot myself doubt that various lines of evidence, all of which should be profoundly welcome, are pointing in the same direction.

Allow me just one final reference to another field of nutritional studies. Their great economic importance in animal husbandry calls for full recognition. Just now agricultural authorities are becoming acutely aware of the call for a better control of the diseases of animals. Together these involve an immense economic loss to the farmers, and therefore to the country. Although, doubtless, its influence should not be exaggerated, faulty nutrition plays no small share in accounting for the incidence of some among these diseases, as researches carried out at the Rowett Institute in Aberdeen and elsewhere are demonstrating. There is much more of such work to be done with great profit.

In every branch of science the activity of research has greatly increased during recent years. This all will have realized, but only those who are able to survey the situation closely can estimate the extent of that increase. It occurred to me at one time that an appraisement of research activities in this country, and especially the organization of State-aided research, might fittingly form a part of my address. The desire to illustrate the progress of my own subject led me away from that project. I gave some time to a survey however, and came to the conclusion, among others, that from eight to ten individuals in the world are now engaged upon scientific investigations for every one so engaged 20 years ago. It must be remembered, of course, that not only has research endowment greatly increased in America and Europe, but that Japan, China, and even India have entered the field and are making contributions to science of real importance. It is sure that, whatever the consequences, the increase of scientific knowledge is at this time undergoing a positive acceleration.

Apropos, I find difficulty as to-day's occupant of this important scientific pulpit in avoiding some reference to impressive words spoken by my predecessor which are still echoed in thought, talk, and print. In his wise and eloquent address at York Sir Alfred Ewing reminded us with serious emphasis that the command of Nature has been put into man's hand before he knows how to command himself. Of the dangers involved in that indictment he warned us; and we should remember that General Smuts also sounded the same note of warning in London.

Of science itself it is, of course, no indictment. It may be thought of rather as a warning signal to be placed on her road: "Dangerous Hill Ahead," perhaps, or "Turn Right"; not, however, "Go Slow," for that advice science cannot follow. The indictment is of mankind. Recognition of the truth it contains cannot be absent from the minds of those whose labours are daily increasing mankind's command of Nature; but it is due to them that the truth should be viewed in proper perspective. It is, after all, war, to which science has added terrors, and the fear of war, which alone give it real urgency; an urgency which must of course be felt in these days when some nations at least are showing the spirit of selfish and dangerous nationalism. I may

be wrong, but it seems to me that, war apart, the gifts of science and invention have done little to increase opportunities for the display of the more serious of man's irrational impulses. The worst they do perhaps is to give to clever and predatory souls that keep within the law, the whole world for their depredations, instead of a parish or a country as of yore.

But Sir Alfred Ewing told us of "the disillusion with which, now standing aside, he watches the sweeping pageant of discovery and invention in which he used to make unbounded delight." I wish that one to whom applied science and this country owe so much might have been spared such disillusion, for I suspect it gives him pain. I wonder whether, if he could have added to an "Engineer's Outlook," the outlook of a biologist, the disillusion would still be there. As one just now advocating the claims of biology I would much like to know. It is sure, however, that the gifts of the engineer to humanity at large are immense enough to outweigh the assistance he may have given to the forces of destruction.

It may be claimed for biological science, in spite of vague references to bacterial warfare and the like, that it is not of its nature to aid destruction. What it may do towards making man as a whole more worthy of his inheritance has yet to be fully recognized. On this point I have said much. Of its service to his physical betterment you will have no doubts. I have made but the bare reference in this address to the support that biological research gives to the art of medicine. I had thought to say much more of this, but found that if I said enough I could say nothing else.

There are two other great questions so much to the front just now that they tempt a final reference. I mean, of course, the paradox of poverty amidst plenty, and the replacement of human labour by machinery. Applied science should take no blame for the former, but indeed claim credit unfairly lost. It is not within my capacity to say anything of value about the paradox and its cure; but I confess that I see more present danger in the case of "Money versus Man" than danger present or future in that of the "Machine versus Man!"

With regard to the latter it is surely right that those in touch with science should insist that the replacement of human labour will continue. Those who doubt this cannot realize the meaning of that positive acceleration in science, pure and applied, which now continues. No one can say what kind of equilibrium the distribution of leisure is fated to reach. In any case an optimistic view as to the probable effects of its increase may be justified.

It need not involve a revolutionary change if there is real planning for the future. Lord Melchett was surely right when some time ago he urged on the Upper House that present thought should be given to that future; but I think few men of affairs seriously believe what is yet probable, that the replacement we are thinking of will impose a new structure upon society. This may well differ in some essentials from any of those alternative social forms of which the very names now raise antagonisms. I confess that if civilization escapes its other perils I should fear little the final reign of the machine. We should not altogether forget the difference in use which can be made of real and ample leisure compared with that possible for very brief leisure associated with fatigue: nor the difference between compulsory toil *and spontaneous* work. We have to picture, moreover, the reactions of a community which, save for a minority, has shown itself during recent years to be educable. I do not think it fanciful to believe that our highly efficient national broadcasting service, with the increased opportunities which the coming of short wave-length transmission may provide, might well take charge of the systematic education of adolescents after the personal influence of the schoolmaster has prepared them to profit by it. It would not be a technical education, but an education for leisure. Listening to organized courses of instruction might at first be for the few, but ultimately might become habitual in the community which it would specially benefit.

In parenthesis, allow me a brief further reference to "planning." The word is much to the front just now, chiefly in relation with current enterprises. But there may be planning for more fundamental developments; for future adjustment to social reconstructions. In such planning the trained scientific mind must play its part. Its vision of the future may be very limited, but in respect of material progress and its probable consequences science (I include all branches of knowledge to which the name applies) has at least better data for prophecy than other forms of knowledge.

It was long ago written, "Wisdom and Knowledge shall be stability of Thy times." Though statesmen may have wisdom adequate for the immediate and urgent problems with which it is their fate to deal, there *should yet be a reservoir of synthesized* and clarified knowledge on which they can draw. The technique which brings governments in contact with scientific knowledge in particular, though greatly improved of late, is still imperfect. In any case the politician is perforce concerned with the present rather than the future. I have recently read Bacon's "New Atlantis" afresh and have been thinking about his Solomon's House. We know that the rules for the functioning of that house were mistaken because the philosopher drew them up when in the mood of a Lord Chancellor; but in so far as the philosopher visualized therein an organization of the best intellects bent on gathering knowledge for future practical services, his idea was a great one. When civilization is in danger and society in transition, might there not be a House recruited from the best intellects in the country with functions similar (*mutatis mutandis*) to those of Bacon's fancy?—a House devoid of politics, concerned rather with synthesizing existing knowledge, with a sustained appraisement of the progress of knowledge, and continuous concern with its bearing upon social readjustments. It is not to be pictured as composed of scientific authorities alone. It would be rather an intellectual exchange where thought would go ahead of immediate problems. I believe, perhaps foolishly, that given time, I might convince you that the functions of such a House, in such days as ours, might well be real. Here I must leave them to your fancy, well aware that in the minds of many I may by this bare suggestion lose all reputation as a realist!

will now hasten to my final words. Most of us have a tendency in the past to fear the gift of leisure the majority. To believe that it may be a great ...l benefit requires some mental adjustment, and ...ief in the educability of the average man or woman. ...t if the political aspirations of the nations should ...w sane, and the artificial economic problems of the ...ld be solved, the combined and assured gifts of ...lth, plenty, and leisure may prove to be the final ...ification of applied science. In a community ...antaged by these each individual will be free to ...elop his own innate powers, and, becoming more of ...individual, will be less moved by those herd instincts ...ich are always the major danger to the world.

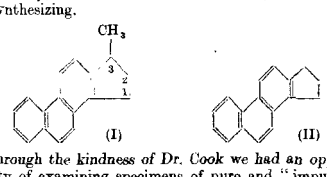
You may feel that throughout this address I have ...lt exclusively on the material benefits of science to ...e neglect of its cultural value. I would like to correct ...s in a single closing sentence. I believe that for ...ose who cultivate it in a right and humble spirit, ...ence is one of the humanities; no less.

THE STRUCTURE OF THE DIELS' HYDROCARBON $C_{18}H_{16}$

By J. D. BERNAL and D. CROWFOOT

Although the essential features of the constitutional formulæ of the sterols and bile acids, proposed last year in this JOURNAL by Rosenheim and King,[1,2] have since been abundantly confirmed by further experimental work, the structure of their dehydrogenation products remains still undecided. Knowledge of their constitution is of importance both for the understanding of the mechanism of Diels' selenium-dehydrogenation method and for information about the structure of ring V of the cholane ring-system. In this respect the substance $C_{18}H_{16}$ is one of the most important of the hydrocarbons obtained by the action of selenium on cholesterol, ergosterol, and cholic acid. A constitutional formula for it has been proposed by Rosenheim and King[3,4] who demonstrated the presence of a phenanthrene nucleus in this hydrocarbon. According to their view $C_{18}H_{16}$ is 3-methyl-6 : 7 : α : β-naphthahydrindene (I) (= 3-methyl-1 : 2-*cyclo*pentenophenanthrene, see also Windaus,[5] Ruzicka *et al.*,[6] Schlenk *et al.*,[7] Diels[8]).

In a recent publication Cook and Hewett[9] claim that $C_{18}H_{16}$ is really the unsubstituted hydrocarbon $C_{17}H_{14}$ and identical with 1 : 2-*cyclo*-pentenophenanthrene (II), which they, as well as Ruzicka[6] and Kon,[10] succeeded in synthesizing.



(I) (II)

Through the kindness of Dr. Cook we had an opportunity of examining specimens of pure and "impure" *cyclo*pentenophenanthrene and came to the conclusion that the claim for its identity with $C_{18}H_{16}$ is not supported by the *X*-ray crystallographic evidence.

We had previously examined a number of specimens of Diels' hydrocarbon from different sources and found them to crystallize, whether from solution or melt, in ill-defined rhombic plates of approximate dimensions $a = 8{\cdot}1$, $b = 6{\cdot}4$, $c = 24$ Å containing four molecules arranged in two layers.

The specimens of pure *cyclo*pentenophenanthrene sent to us by Dr. Cook crystallized, however, in monoclinic prisms elongated along *b* with dimensions $a = 18{\cdot}1$, $b = 5{\cdot}9$, $c = 21{\cdot}2$ Å. $\beta = 119°$ centred on the *b* face with 8 molecules in the cell and space group $C_{2h}^6 - B2_1/c - P2_1/c$. On crystallizing from the melt or on rapid crystallization from solutions, orthorhombic plates were obtained similar to those of $C_{18}H_{16}$. The specimen of impure *cyclo*pentenophenanthrene crystallized normally in this platy form.

We do not, however, consider the latter crystal form identical with the corresponding form of $C_{18}H_{16}$ for the following reasons:

(1) While a solution of pure *cyclo*pentenophenanthrene crystallized readily in the prismatic form when seeded with a crystal of this form, and the solution of the impure substance also gave prismatic crystals (though less readily and always accompanied by platy crystals), we have never succeeded, by seeding or otherwise, in obtaining prismatic crystals from solutions of $C_{18}H_{16}$, nor do we know of any descriptions of prismatic crystals on this substance in the literature.

(2) The orthorhombic forms of *cyclo*pentenophenanthrene and $C_{18}H_{16}$, though similar in the main, differ in optical properties. In both (as in all the compounds listed in the following table) α, β, γ lie along *a*, *b*, *c* respectively but there is a marked difference in optic axial angle, this being 96° and 87° respectively (referred to the γ in both cases). Such a difference undoubtedly corresponds to a difference either in the molecule or in the molecular arrangement, and is not accounted for by the assumption of an impurity.

(3) The third difference is that shown by the *X*-ray measurements of cell size. The *a* and *b* dimensions show certain differences, but owing to the imperfections in the *a*, *b* plane, they are difficult to measure accurately. The *c* dimensions can, however, be measured to ½%, owing to the platy nature of the crystals, and show significant differences. The measurements are shown in the following table, together with those made on related substances. All the measurements were made in the same camera under identical conditions.

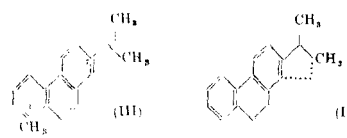
Substance	*c* axial length Å
(1)[1] Diels' $C_{18}H_{16}$	23·95 ± 0·2
(2)[2] ,, ,, ...	23·75 ± 0·1
(3) 1 : 2-*cyclo*pentenophenanthrene, pure ...	22·7 ± 0·1
(4) ,, ,, impure	22·6 ± 0·2
(5) Mixed crystal of (2) and (3)	23·4 ± 0·2
(6)[3] 1 : 2-dimethylphenanthrene	21·8 ± 0·2
(7) Retene	23·5 ± 0·1
(8) "Perhydrochrysene"	23·2 ± 0·2

[1] Diels' original preparation, kindly supplied by Prof. Windaus.
[2] Prepared and purified by Dr. Cook.
[3] Synthesized and kindly put at our disposal by Dr. R. D. Haworth.

It is at once apparent that the difference between *cyclo*pentenophenanthrene and $C_{18}H_{16}$ is far greater

than the experimental error. That this difference is unlikely to be due to an impurity is shown by the other measurements. Impure *cyclo*pentenophenanthrene, supplied by Dr. Cook, gave a spacing agreeing within the experimental error with the pure sample. On the other hand, a mixed crystal prepared from about one part of *cyclo*pentenophenanthrene and two of $C_{18}H_{16}$ gave an intermediate spacing nearer to that of $C_{18}H_{16}$, corresponding to the formation of a solid solution. This would also explain the absence of lowering of the mixed melting point observed by Cook and Hewett,[9] Ruzicka *et al.*,[6] and by Kon.[10]

The conclusion inevitably arising is that the Diels' hydrocarbon, $C_{18}H_{16}$, however impure, contains as its main constituent a hydrocarbon similar to, but distinct from, *cyclo*pentenophenanthrene. The nature of this is difficult to surmise from *X*-ray measurements only, since the latter depend both on the length and angle of slope of the molecules. On the other hand the *X*-ray measurements of $C_{18}H_{16}$ are in good agreement with those calculated for a structure like 3-methyl naphthahydrindene, as proposed by Rosenheim and King (*loc. cit.*). Further evidence in favour of this view is supplied by the striking similarity of the cell dimensions of $C_{18}H_{16}$ to those of retene (see table). This similarity becomes at once apparent by a comparison of the molecular structures of these hydrocarbons, as has been pointed out to us by Drs. Rosenheim and King, if the conventional formula of retene (1-methyl-7-isopropylphenanthrene) is re-written as in (III), in analogy with 3-methyl naphthahydrindene (IV).



For a final decision the synthesis of the hydrocarbon forming the essential part of the Diels' hydrocarbon will have to be awaited. It will then be possible to establish its identity with $C_{18}H_{16}$ by *X*-ray and optical methods, which are in this case far more delicate than elementary analysis, mixed melting points, or even spectrographic methods. The evidence supplied by the last method is uncertain owing to the dominant effect of the common phenanthrene nucleus, whilst the formation of solid solutions interferes with the reliability of the mixed melting point test.

Mineralogical Museums,
Cambridge

REFERENCES

1 CHEM. & IND., 1932, 464.
2 *Ibid.*, 1932, 954.
3 *Ibid.*, 1933, 287.
4 *Ibid.*, 1933, 299.
5 Nachr. Ges. Wiss. Göttingen, 1933.
6 Helv. Chim. Acta, 1933, **16**, 833.
7 CHEM. & IND., 1933, 209 T.
8 Ber., 1933, **66**, 1122.
9 CHEM. & IND., 1933, 451.
10 J.C.S., 1933, *in the Press*.

INDUSTRIAL NOTES FROM CENTRAL EUROP

In the first six months of this year the volume of tra between England and Czechoslovakia marked a furth decline compared with the same period of 1932. To British exports to Czechoslovakia were valued 136,000,000 crowns (roughly £1,250,000) and impor were 143,000,000 crowns, compared with 184,000,0 and 193,000,000 cr. respectively for 1932.

Among British imports from Czechoslovakia glas ware, porcelain, sugar, and "miscellaneous chemic products" showed a continued, if slight, decline bu leather and boots, timber, matches and flax, hemp an jute improved. Among Czech imports from Britai cotton and woollen yarns and fabrics still hold a hig position, machinery (except electrical), rubber, moto cars, and colonial products declined in value, bu chemicals and by-products showed a slight improvemer and pharmaceutical preparations kept in demand.

Czechoslovak sugar production continues to diminis and exports during the 1932—3 season have shrunk t nearly half the previous figure. On the other hand th export trade in hops has benefited by the removal o prohibition in America. In June last over 2,000 cwt were exported, chiefly to U.S.A.

Jugoslav foreign trade in June showed improvemen over the previous year's figures but in most Centra European countries definite signs of an industria recovery are still lacking. In Poland, however, th chemical industry is showing remarkable initiative Glauber salts and anhydrous soda are now being turne out by the Tomaszow Chemical Works, the Kabel Co. o Cracow have started to make synthetic resins, and th Polchem Co. carbon disulphide. Another concern i making food products rich in vitamins. The Polis Chemical Union is now turning out the following new products: chromium steel, carborundum, ferro-silicon trichlorethylene, and synthetic local anæsthetics of th cocaine type. On the other hand the Polish salt outpu has further diminished and in 1932 it was less tha 500,000 tons.

A new commercial treaty between Hungary an Turkey came into force on August 15 and, among othe stipulations, provides that Hungary shall buy 25,00 tons of Turkish coal and 25,000 kg. of tobacco.

A conference of Czechoslovak engineers and archi tects (which included chemical engineers and manu facturers) was held in July at Užhorod, the capital o Sub-Carpathian Russia. Most of the papers dealt wit modern road construction and bridge building but a account was also given of the chemical industry in th remote and hitherto undeveloped corner of Centra Europe. There are three chemical undertakings o considerable local importance; two are concerned wit the distillation of wood and the isolation of the products The third and most extensive, at Vel. Bočkov on th river Tisa, produces sulphuric and hydrochloric acid copper salts, alum, and other inorganic compounds.

OBITUARY

SIR PHILIP MAGNUS

Sir Philip Magnus, Bt., who died on August 29, was one of the pioneers of technical education in this country, and will be remembered particularly for his long and distinguished connexion with London University. Sir Philip was born in London in 1842, and was educated at University College School and University College. After some years spent in writing and lecturing on subjects connected with applied mathematics, he became, in 1880, the first organizing secretary and director of the City and Guilds Institute, which now forms part of the Imperial College of Science and Technology. He took an active part also in the establishment of the Finsbury Technical College.

Sir Philip's work for technical education was acknowledged as far back as 1881, when he was appointed a member of the Royal Commission on Technical Instruction, and it is of much interest to recall that one of his colleagues in this work was Sir Henry Roscoe, the Society's first president. The work of the Commission led to the passing of the Technical Education Act of 1889 and to other legislation by which the facilities for, and standard of, higher education were greatly improved. His interest in technical education was never lessened, and he was largely responsible for the inclusion of a Faculty of Engineering in London University in 1899.

In 1890 Sir Philip became a Fellow and member of the Senate of London University. He was the senior Fellow of the University and remained a member of the Senate until 1931. From 1906 to 1922 he represented the University in Parliament, and of his work there will be remembered particularly his successful resistance to the proposal to deprive the University of its seat in merging its representation with the other British Universities.

Sir Philip was knighted in 1886 and was made a baronet in 1886. His good work for technical education was thus publicly recognized, but if any indication is needed of the high esteem in which he was held by members of the University, this is afforded by the fact that he was for many years the president of the London University Graduates' Association. His name will always be associated with the largest University in the British Empire, whose growth he did so much to promote.

PERSONAL AND OTHER ITEMS

Prof. G. Barger, professor of chemistry in relation to medicine, at Edinburgh University, is to receive the honorary degree of LL.D. from the University of Michigan on September 25.

We regret to announce the death of Mr. James Tennant, one of the oldest members of the Society. Mr. Tennant was 82 years old and joined the Society in 1884. In his early years he joined the firm of Chas. Tennant, Sons & Co., the well-known alkali manufacturing concern, and later became a director of the United Alkali Co., Ltd. He was director of Alexander Fergusson & Co., Ltd., of Glasgow.

The Department of Scientific and Industrial Research has granted a senior award to Mr. T. H. Goodwin, B.Sc., to be held at Birmingham University. Mr. Goodwin is a graduate of Birmingham University and is a Dudley Docker Research Fellow; he is the present holder of the Priestley Scholarship for chemical research.

Mr. J. Gardiner, chairman and managing director of Fenton Collieries, Ltd., left estate of the gross value £107,922, with net personalty £106,084.

Chemical and Metallurgical Corporation, Ltd.

The offer made by Imperial Chemical Industries, Ltd. to purchase the shares of Chemical & Metallurgical Corporation, Ltd. has been accepted by the necessary number, 90% of the total shareholders, for the purchase to come into effect. The registered office of the company will eventually be removed from Salisbury House, London, E.C.2, to Imperial Chemical House, Millbank, London, S.W.1.

Chemical Workers' Union

At a conference in London on September 3, factory stewards, representing 20,000 members of the Chemical Workers' Union, endorsed the draft terms of a new national wages and conditions agreement which had been drawn up by the executive council of the union. The members of the union were urged to vote in favour of submitting the new terms to employers when the ballot on the question is taken. The terms of the agreement include proposals for the reduction of the working week from 48 to 40 hours, increased rates of pay for overtime, increase of holidays from 6 to 12 days, increases in wages and payment during sickness, and compensation for discharge owing to reorganization.

A Blast Furnace Accident

An accident recently occurred at the Irlam works of The Lancashire Steel Corporation, in which the eight men working on a blast furnace were seriously burned, and four of them have since died. The blast furnace had been tapped and after stopping up with clay it is thought that a blow-out occurred, the men being burned by gas flames.

An Italian Steel Cartel

It is reported that Italian producers of rolled steel have formed a cartel, for a period of five years, for the control of output, sales, and prices. The new cartel is a voluntary organization succeeding the compulsory association which came to an end in February last. Negotiations are proceeding in regard to other branches of steel and iron manufacture.

Developments in the Japanese Chemical Industry

The Japanese Soda Co. is reported to have erected a plant for the production of ethylene glycol. The capacity is stated to be 30 tons a month (Die Chemische Industrie). The foundation of the Japan-Manchuria Aluminium Co. is also reported. This undertaking, which has a capital of 5,000,000 yen, will produce aluminium in Japan from Manchurian raw material.

In the first 6 months of this year artificial silk production in Japan was 18,289 t., compared with 13,211 t. in the second half of 1932 and 9791 t. in the corresponding period last year.

British Industries Fair

The "heavy industries" section of the British Industries Fair at Birmingham next year promises to be much larger than in any previous year. Advance bookings

of space are already so far ahead of those in 1933 that 55,000 sq. ft. are being added immediately to the indoor space. Especial activity is reported in the gas, electricity, building, and engineering groups.

British Standards Specification for Sampling Coal

A new B.S. Specification (No. 503—1933) has just been issued by British Standards Institution for the Sampling of Large and Run-of-Mine Coal and should prove of considerable use to those concerned with the handling of coal. The specification is in two sections, the first of which details the method of collection and weight of gross samples to be taken (*a*) during discharge from coal chutes, (*b*) from conveyors, (*c*) from wagons. The committee responsible for the drawing up of the specification have been unable to recommend a standard method of sampling from heaps that would be generally applicable.

In the second section the method of reduction of gross sample to a sample of about 10 lb. is described. The two alternative methods put forward are the riffle method, a diagram of a suitable riffle sampler being given, and the hand method, which is described in detail. In an appendix Dr. E. S. Grumell, chairman of the committee responsible for the specification, gives a full account of the experiments and theoretical considerations on which the specification is based. The specification can be obtained from the British Standards Institution, 28, Victoria Street, London, price 2s. 2d., post free.

Chemical Analysis in Madras

The annual report of the Chemical Examiner of the Madras Government for 1932 contains some interesting information concerning the detection of organic poisons. More than 300 cases of poisoning were investigated during the year, and poison was found in 168 cases. Opium is at the head of the list of poisons responsible with 33 cases, arsenic coming next with 24 cases, mercury next with 18, and the organic poison oleander next with 16 cases. Workers in the department are making a thorough investigation into the action of oleander, and some particulars of interest to analysts are given in the report. Particulars are also given of madur and datura poisoning.

More than 700 samples of bloodstains were examined, and it is of interest to note that no difficulty was experienced in examining one sample which was four years old. Included in the general analyses made was a case in which the department was asked to report on the amount of petrol vapour in the air in ship's holds. The "McLuckie" gas detector was used and found to give consistent results. In detecting castor seed in oil-cakes, a method described in *Analyst*, September, 1929, was found satisfactory. In this method a small quantity of the cake is digested with potassium chlorate in hydrochloric acid, caustic soda is then added, and after again heating the cake is finally washed and examined microscopically, when characteristic pallisade cells of the castor seed can be detected.

Dr. S. Rajagopal Nayudu, who worked on food analysis and toxicology at the Imperial College, London, from 1930 to 1932, was appointed First Assistant Chemical Examiner in the Department at the end of 1932.

REVIEWS

L'AEROLEVURE MODERNE. By Van Damme. Pp. 161. Brussels: M. Cock, 1932. 30 fr.

The present work is a sequel to the same author's "Fabrication de l'Aerolevure" (Brussels, 1916; Paris 1919), taking into account later processes in which the old grain mashes have been replaced by molasses mashes with or without the use of grain. Very great change have taken place during the past ten years in yeast manufacture and such are still proceeding apace. Not long ago bakers' yeast was a by-product of the spirit industry, but now, making use of high aeration processes, it is produced for itself alone in special factories in which alcohol production is suppressed and the yields of yeast are very high. Quite recently all-molasses processes have been introduced in which no grain is employed. With some of these the author deals. At present 90% of the world's yeast is produced from molasses, with or without the use of grain in the mash.

In his preface the author states that Belgium has lagged behind other countries in making use of molasses in the yeast industry, the reason given being that Belgian bakers protested against the yeast so made although it had been found quite acceptable in France and its manufacture customary there. Tendencies to use molasses, however, have recently appeared and the author wishes by the present treatise to encourage these. The book necessarily deals with the subject rather generally and mainly with those processes which produce more or less alcohol simultaneously, so that the yeast yield is high. The later processes in which the alcohol formation is entirely suppressed—the high yielding yeast processes—are only briefly considered. These are the subject of numerous patents and necessitate very special conditions for working and control. So far as it goes, and with the object it has in view, the book is a useful summary of some of the recent modifications, although by far from giving a picture of the processes now worked in the larger yeast factories.

W. A. I

LE CAMPHRE ET SES DÉRIVÉS. By R. Cornubert. Pp. 424. Paris: Masson et Cie., 1933. 80 fr.

Since Aschan's monograph "Die Konstitution der Camphers und seiner wichtigsten Derivative" publication has appeared dealing solely with the chemistry of this important substance. The late Prof. Haller had planned a comprehensive treatise but the compilation of this was interrupted first by the war and later by his death in 1925. It has now been completed by Prof. R. Cornubert of the University of Nancy. In a volume of some 400 pages Prof. Cornubert has dealt in a masterly manner with the chemistry of camphor and its derivatives and the book should prove very useful to research workers in this still unexhausted field. The value of the monograph is much enhanced by a very complete bibliography comprising some 3000 references, whilst there is also an excellent subject index.

J. L

BIBLIOGRAPHICAL SURVEY OF VITAMINS, 1650—1930. Compiled by E. M. Salmonsen. Section on Patents by M. H. Wodlinger. Pp. 334. Chicago: M. H. Wodlinger, 1932.

It is probably safe to claim that in the last twenty years the study of vitamins has attracted more workers and led to the production of more papers than that of any other branch of science. The literature has already become unwieldy; this bibliography should do much towards creating order and should be invaluable to the workers in the fields of vitamin research and more particularly to the authors of books on the subject. From 1650 to 1915 the references are listed chronologically, any single year being treated alphabetically; thereafter references for each year up till 1930 are subdivided into sections on vitamins *A*, *B*, *C*, *D*, and *E* and general references. It contains in all 11,098 references to books, reviews and papers and appears to be very complete, the reviewer being able to discover only one omission (Captain Cook's paper on scurvy, for which he was awarded the Copley Medal of the Royal Society). At the end of the book is a section on patents, containing *another 240 references. The author has done a great* service to all interested in vitamins. L. M. M.

GRUNDLAGEN DER PHOTOCHEMIE. By Dr. K. F. Bonhoeffer and Dr. P. Harteck. Die Chemische Reaktion. Edited by H. Mark and M. Polanyi. Pp. vi + 295. Dresden and Leipzig: T. Steinkopff, 1933. Paper, 24 rm.; bound 25 rm.

This book, which is the first volume of a projected series of monographs on the chemical reaction, does not claim to be an exhaustive treatise. The writers explain in their preface that it is an introduction to the foundations of photochemistry and while demonstrating the stage of development to which photochemical research has attained by a selection of representative examples, they also wish to show that the analysis of the kinetics of photochemical reactions can advance the study of the finest possible details. Their choice of examples is excellent and the discussion leaves little to be desired. Commencing with an introductory chapter on the Law of Photochemical Equivalence, the book is then divided into three sections dealing with the primary photochemical process, secondary photochemical reactions and the complete photochemical reaction. Almost all of the work quoted belongs to the last ten years and one has therefore only modern and well authenticated material as examples. The style of the book is admirably adapted to its purpose and the illustrations are clear and adequate. H. W. GREENWOOD

LAUNDRY WASHING PROCESSES: WITH SPECIAL REFERENCE TO THE USE OF ALKALIS. Pp. 47. London: Imperial Chemical Industries, Ltd.

Wherever women gather together, it is certain that sooner or later the conversation will turn to the delinquencies of the laundry and the harm wrought by chemicals in washing. And yet it could be otherwise, for every launderer who takes advantage of the results of modern research knows the various factors which should be accurately controlled in washing. This booklet has special reference to the use of alkalis in the laundry. It starts on a high standard of refinement with a wood block of merit and after discussing the materials used in the washing process sets out the function of alkalis and ends with a discussion of a practical nature of various methods of washing. White work, coloured goods, woollens, silk, and rayon are dealt with in some detail. After reading the booklet, and every laundryman should read it before setting up business, the opinion will be formed that there can no longer be any excuse for the failures and losses which are too often experienced by the public. Washing can be made a scientific operation, and a little knowledge of chemistry and of scientific method easily makes it so. It is only when dealing with the newer fabrics that difficulties can arise and a different technique becomes necessary. The booklet teaches the laundryman that there are more alkalis than caustic sodas and that some of the newer commercial forms, for example crex, are of special utility. E. F. A.

COMPANY NEWS

IMPERIAL CHEMICAL INDUSTRIES, LTD.

An interim dividend has been declared in respect of the trading year ending December 31, 1933, of 2½% actual on the issued ordinary capital of the company. This dividend will be payable (less income tax at 4s. 8½d. in the £, being United Kingdom income tax at 5s. in the £ less Dominion income-tax relief at 3½d. in the £) on December 1, 1933, to shareholders on the register on October 14, 1933.

PINCHIN JOHNSON & CO., LTD.

An interim dividend of 6% actual, less tax, has been declared on the ordinary shares, compared with last year's interim of 7½%. It is stated that sales for the six months to June 30 show a substantial increase, both in tonnage and total money value, whilst net trading profits also show a satisfactory increase.

BRADFORD DYERS' ASSOCIATION

The directors have decided not to pay an interim dividend on the ordinary shares. The last dividend on the ordinary stock was 2½% final in 1930, making a total of 4½%.

BRITISH GLUES & CHEMICALS, LTD.

The directors have decided to pay a half-year's dividend on the 8% cumulative participating preference shares, bringing the payment of arrears up to October 31, 1932.

LOVERING CHINA CLAYS, LTD.

The profit for the year ended March 31 last was £8545 (compared with £7149 for the previous year) plus income tax recovered £415. After provision for debenture interest £14,838, allocation to sinking fund £2662, and consideration to debentures holders under terms of moratorium £1257, there is a loss for the year of £9796 (against £11,249), increasing the debit brought in to £28,765. The report states that trading operations covered only the six months to September 30.

MARKET REPORT

The Market Report is compiled from special information received from the manufacturers concerned.

Unless otherwise stated, the prices quoted below cover fair quantities net and naked at sellers' works.

The following alterations in prices are reported since the publication of the last Market Report (cf. CHEM. & IND., Sept. 1, p. 702 1933).

PHARMACEUTICAL AND PHOTOGRAPHIC MATERIALS

Ammonium Iodide.—10s. per lb.

Bismuth Salts.—Carbonate, 7s. 5d. per lb.; Citrate, 10s. per lb.; Nitrate (cryst.), 5s. 2d. per lb.; *Oxide*, 11s. 7d. *per lb.*; *Salicylate*, 8s. 4d. per lb.; *Subchloride*, 11s. 4d. *per lb.*; *Subgallate*, 7s. 11d. per lb.; Subnitrate, 6s. 7d. per lb. Above for cwt. lots. Extra and reduced prices for smaller and larger quantities respectively. Liquor Bismuthi, B.P., in W. Qts.—1s. 1½d. per lb.; 6 W. Qts.—11d. per lb.; 12 W. Qts.—9½d. per lb.; 36 W. Qts.—9d. *per lb.*

Iodine Resub., B.P. 7s.—11s. per lb.

Iodoform, B.P., Cryst., Precip. or Powder, 10s. 9d.–13s. 7d. per lb.

Potass. Iodide, B.P. 8s. 3d.—10s. 3d. per lb., according *to quantity.*

Quinine Sulphate, 4s. 11d. per oz., for 100-oz. tins, tins free.

Sodium Iodide, B.P.—8s. 6d.–10s. 6d. per lb.

ESSENTIAL OILS

Almond, Foreign S.P.A., 9s. per lb. Anise.—2s. 4d. per lb. Araucaria, 8s. 6d. per lb.—Bergamot, 7s. per lb. Bourbon Geranium,—24s. 9d. per lb.

Camphor, Brown, 65s. per cwt.—White, 95s. per cwt. Cananga, Java, 10s. per lb. Cinnamon Oil, Ceylon, —3s. 3d. per lb. Cassia, 80/85%, 4s. 3d. per lb.

Citronella Oil.—Java, 2s. 9d. per lb. Ceylon, 2s. 3d. per lb. Clove.—90/92%, English, 4s. 3d. per lb.

Eucalyptus, Australian B.P., 70/75%,—1s. 2d. per lb. Hiam Pine (Methylengenol, 95%), 16s. per gal. Lavender.—Mont Blanc, 38/40%,—10s. 9d. per lb. Lemon,—5s. per lb. Lemongrass,—4s. per lb. Orange, Sweet,—6s. 6d. per lb. Otto of Rose.—*Anatolian, 35s. per oz.*; *Bulgarian, 50s. per oz.* Palma Rosa, 8s. per lb.

Peppermint.—Japanese, 5s. 3d. per lb. Wayne County, 13s. 6d. per lb. Petitgrain —4s. 9d. per lb.

PATENT LIST

The following is a list of complete specifications of chemical interest which are open for inspection under Section 91 (3) (a) of the Patent Acts. Printed copies are not available, but photographic copies may be obtained at a charge of 8d. per page (minimum 1s.) from the Patent Office, Chancery Lane, W.C.2.

I. 3982 (1933). Boulinaud. Fractioning of distillation products or substances in a volatile state.

4410 and 4678 (1933). Roggen and Robin. Dehydrating colloid material.

II. 34,156 (1933). Comp. pour la Fabr. des Compteurs et *Matériel d'Usines à Gaz. Regulation and measurement* of calorific power of gases or mixtures of gases.

4388 (1933). Pape & Co. Working-up pitch, tar, acid residues, and other combustible substances.

III. 1412—3 (1933). Henkel & Co. Manufacture of high *molecular sulphides of the aliphatic series.*

4823 (1933). Deuts. Hydrierwerke. *See* XII.

4973 (1933). Soc. Chem. Ind. in Basle. *See* IV.

IV. 5181 (1932). Soc. Chem. Ind. in Basle. Manufacture of chromiferous dyestuffs.

32,992 (1932). I. G. Farbenind. Manufacture of azo dyestuffs.

4536—8 (1933). Gaspar. *See* XXI.

4786 (1933). Soc. Chem. Ind. in Basle. Manufacture of dyestuffs.

4973 (1933). Soc. Chem. Ind. in Basle. Manufacture of dyestuffs and intermediate products.

VI. 4219 (1932). 8258 (1933). Kodak, Ltd. *See* XXI.

4823 (1933). Deuts. Hydrierwerke. *See* XII.

VII. 36,087 (1932). Metallges. Production of sulphuric acid by the contact process.

X. 20,859 (1932). Freeland. Silicon steels.

3022 (1933). Skoda Works, Plzen. Case-hardening of austenite steels and alloys.

XI. 5101 (1932). Soc. Anon. des Manuf. des Glaces et Prod. Chim. de St. Gobain. Electrical resistance furnaces.

4680 (1933). Chemieprodukte Ges. *See* XIII.

XII. 4528 (1933). Deguide. Manufacture of soap.

4660 (1933). Behrend. Preparation of edible fats.

4823 (1933). Deuts. Hydrierwerke. Washing, wetting-out, emulsifying, dispersing, foaming, cleansing and like agents.

XIII. 4680 (1933). Chemieprodukte Ges. Masses for protective and insulating purposes or the like.

XV. 4788 (1933). I. G. Farbenind. Hardening gelatin.

XIX. 1242 (1933). Chem. Fabr. Grunau. Production of derivatives of albumin cleavage products.

4660 (1933). Behrend. *See* XII.

XXI. 5219 (1932). 8258 (1933). Kodak, Ltd. Coloured sheet materials, especially photographic films.

4536—8 (1933). Gaspar. Producing photographic dyestuff images.

4787 (1933). I. G. Farbenind. Printing of lenticular *colour-record films.*

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence), 35, Old Queen Street, London, S.W.1, has received the following inquiries for British goods. British firms may obtain further information by applying to the Department and stating the specific number. *Austria:* Industrial chemicals, electro-technical articles (217). *Cyprus:* Soya bean oil (210). *Egypt:* Paint (F.Y. 1838). *France:* Special steels and light alloys (225). *Morocco (French Zone):* Tinplate (232). *Uruguay:* Paper (238).

Import Duties Advisory Committee

The Import Duties Advisory Committee gives notice of the following applications: (*a*) for an increase in the import duty on commercial grades of di-sodium and tri-sodium phosphates, raw gypsum stone (calcium sulphate), plaster of Paris, mineral white (ground gypsum), and calcium sulphate cements; (*b*) for the addition to the free list of pitch, or alternatively, for drawback of duty under Section 9 of the Finance Act, 1932, on the pitch used in the manufacture of fuel briquettes.

Any representations in regard to these applications should be addressed to the Secretary, Import Duties Advisory Committee, Caxton House (West Block), Tothill Street, Westminster, London, S.W.1, not later than September 25, 1933.