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THE NEW BIRTH OF MEDICINE.

AN ADDRESS TO THE MEMBERS OF THE SPECIAL CLINICAL AND SCIENTIFIC MEETING OF THE BRITISH MEDICAL ASSOCIATION,
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THOUGH the plans of this special Clinical Meeting of the British Medical Association—held for the purpose of bringing to the minds of all of us by way of discussion and demonstration the lessons learnt in the war—do not include the delivery of addresses I think it becoming that I, who have the fortune to be the President of the Association and of the meeting, should present to those attending it some words of welcome and some thoughts that have long been dwelling in my mind.

That we meet together to-day at the greatest moment in the History of Medicine seems an audacious claim; how shall it be justified? Not ancrely because this is a gathering of the physicians of nations, commonwealths, dominions, colonies, and friendly nations, to consider the lessons of a great war, great as such an occasion is; not only because the medicine of modern peoples and empires has vindicated its ascendancy in the greatest war of all time, but chiefly because at this moment it is revealed to us that Medicine has come to a new birth, and in this regeneration has fought on no unequal terms with other arms in a glorious campaign. It might have been supposed that in war there would be no time to think, only to do; but we are surprised to receive enormous gifts to medical science from the great caravan of our returning pilgrims.

In former wars deaths by disease were many times more numerous than by battle; perhaps four or five times more. In South Africa the enteric fevers were more destructive than battle; in this European war this disease, owing to scientific prophylaxis, became almost a negligible factor. Indeed in the West the average health in camp was even higher than at home; and in bad quarters such as Salonica or Mesopotamia, principles of pathological biology were put in action—as they were in Panama—which brought infectious down as low as time and occasion could permit.

THE NEW BIRTH OF MEDICINE.

What is then the new birth, this revolution in medicine? It is nothing less than its enlargement from an art of observation and empiricism to an applied science founded upon research; from a craft of tradition and sagacity to an applied science of analysis and law; from a descriptive code of surface phenomena to the discovery of deeper affinities; from a set of rules and axioms of quality to

measurements of quantity. When I turn back to the medical textbooks of my pupilage, to the wise and scholarly Watson, or the respectable Alison, and contrast them with the textbooks of to-day, I marvel that a change so vast, so profound, so revolutionary, should have come about in one lifetime! Many a generation had to pass before Harvey's researches established animal mechanics; many again before the half-lights on animal heat of Willis, Mayow and Boyle were brought to quantitative verifications. In Medicine observation cannot carry very far, not so far, let us say, as in astronomy; while skill and sagacity, if they do not die with the individual, keep in the axioms and exercises of the school but a transitory life. No observation of a thunderstorm could unravel its affinities to the action of a loadstone on a scrap of iron; no observation on diet could reveal the relation of food protein, by way of the amino-acids, to the tissues; no observation bestowed on scurvy or beri-beri could detect the occult and elusive but all-potent influence of the vitamins; no observation of secretory and muscular action could reveal the play of surface tension in muscular contraction, nor its relation to lactic acid and oxygen. By what sagacity could the shrewdest observer, let us say of heart disease, perceive the likeness of the formations of a soap bubble, or a raindrop, to the contraction of a muscle fibre in terms of its length; and that muscular contraction is not so much a chemical as a physical system with a negative temperature coefficient. Again the relation of sexual hormones to the development of men and women, and to the phases of their respective organs of reproduction, is an issue of the academic laboratory. The prodigious harvest Medicine has reaped in the present campaign from the original researches of a chemist into the occult causes and laws of fermentation by microbes, and from a field apparently so alien as of the silkworm disease, we now celebrate.

SCIENCE AND PRACTICE.

One of the main lessons of our history has been that, in neglect of research into truths below the surface, Medicine, for lack of a deeper anchorage, has always sunk back into empiricism and routine. Thus the great period of Ionian scientific insight, with its Hippocratean medicine and surgery, waned until the new birth of science and medicine

in Alexandria, as reflected for us in the pages of Celsus. Then, as research languished, the drift was downwards again to rule of thumb and recipe therapeutics; though once more by the physiological researches of Galen it was transiently lifted up until the obscuration of all science in the long Byzantine and medieval eclipse.

Yet, even during this period of secondhand knowledge down to Paré and Wiseman, medicine was at intervals stirred in its sleep by adventures of surgery which, then as now, carried a certain turbulent and provoking inquisitiveness into the complacent pomp of its medical tradition. And let us not forget how many of the greatest men in medical history, from the wars of cloud-topped Ilion, to those of Greece and Rome, and of modern times, had been on military service.

That every cell in the body is a microbe producing its own secretion, which we may call secretion, hormone, or toxin according to our regard of its values—some indeed such as trypsin being beneficent in certain relations, maleficent in others—is now apparent; and these several specific energies are gradually being reduced to experimental measurement; quantities upon which is being built that large and growing system of reinforcement and inhibition which, in its applications in this war, has saved more lives than the sword has slain. The skill, sagacity, and aphorisms of Hippocrates, the skill, sagacity, and aphorisms of Sydenham, did useful work for mankind in the twilight. In the great hospitals of England skill and sagacity, qualities in which the English physician is unrivalled, are eminent at the bedside and in the classroom. In no country has the pupil been so well taught to make use of traditional and empirical knowledge, to apply this handy knowledge, quickened eye, and clever resource to immediate necessities. But to-day physiological and pathological science is running too fast for this medicine of individual and empirical authority, medicine which formerly I have described as up to date but not beyond it; the medicine of the day but not of the morrow; the studentship of the diploma but not of the university. Now we have to stint even this moderate commendation; the advances and accomplishments of the ancillary sciences are becoming too swift, and too exacting both of time and training, for the clinical worker to keep pace with them, or from them to select fertile principles for application to his immediate work.

No man, be his faculties what they may, can be at once physicist, biochemist, pathologist, practitioner and sanitarian; yet he has to treat—let us say—dropsies on principles of osmosis, diabetes on those of biochemistry, anaemias on those of physiology, malarious, yellow and trench fevers on those of minute parasitology; and so on.

The working physician cannot be a biochemist, nor a biologist, in the academic sense of these studies; any more than an engineer can in this sense be a mathematician or a physicist. Without academic study the engineer had by rule of thumb built bridges, towers and aqueducts, if simply and rudely; but, as far more than this is now required of him, so far more is required of the physician. Without physics and biochemistry we cannot find nurture and growth; from the breasts of these nursing mothers we likewise draw our life. Disinterested academic students of biology and biochemistry, if not indifferent to practical needs yet unchallenged by them, have been and still are, working on larger and remoter issues; pregnant indeed with the future but in some isolation from the feats of the clever craftsman—surgeon or physician—dealing in a tentative and empirical way with conditions that will not wait. The scientist is in a balloon and his outlook spacious; the eye of the craftsman is quicker for contingencies but his survey narrower; the craftsman sees the trees, the academician the wood; neither has put into common stock all he should give to the other. But the academician, recognizing the fertility of practice in new and diverse problems, is keener to co-operate with the craftsman than he with the other.

NEED FOR MEDIATING MACHINERY.

Between these departments of research and practice there is needed a mediating system; a technical school continually to co-ordinate the growing principles of the laboratory with the accumulating contingencies of practice. As I have said, the busy practitioner cannot be a master

or even a disciple of these several departments of science, yet he must be so instructed in the broader principles of them that he shall be not only in a position to recognize their applications to practice but, if he is to be a teacher, to perceive moreover the emergencies of these principles in their several fields, so that he may apply them to his own industry and foresee wider and wider occasions for such applications.

To genius we can set no bounds, but I have asked myself sometimes if Lister would have worked out his great research if, instead of being in Edinburgh, he had been in London. Why should he not? Well because in Medicine London is but a factory; Edinburgh is also a technical school with its technical professoriate animated by an academic spirit. But when my pupils leave Cambridge for London, imbued I hope with some scientific ideas, and somewhat enlarged in scientific imagination, they begin there to lose much of this outlook, much of these ideas. Fascinated, as justly they are, by the practical wisdom, sagacity, ripe experience and clever resources of their medical and surgical teachers—for as practitioners, I repeat, these are the best in the world—the pupil loses vision of Medicine as a science. He returns to us for examination an excellent apprentice, but no longer of the company of the prophets. For a diploma, for the doctoring of the day, he is good; from an academic standpoint, from an outlook to the medicine of to-morrow, from a vision of the continual carrying and weaving of the yarn of biochemistry and biology into the web of his art, he has fallen away. For him the future lies undisturbed and unquestioned; the spirit of curious investigation has evaporated. As I have said on former occasions, Harley Street is the grave—shall I not say the cemetery?—of clinical research. How many a brilliant colleague who as a Professor of Medicine, Surgery, or Gynaecology would have shed light upon his profession and his school, yearning it may be for a sphere of research yet finding no other career or means of livelihood open to him, has been driven to throw up all this mediation between his art and its sciences, all effort to tear her secrets from nature, all hunger for things to come, to bury these talents in practice.

These reflections may seem unfit for a world audience, more appropriate for a domestic homily; but, from the home which I know best, I tell a tale which is of universal application. I return to the great occasion on which we are met. By this war, whether doctors or combatants, we have been thrust into new problems; we have been shaken out of mere readiness of resource, mere experience, mere sagacity, and compelled to that new curiosity, that passion to wrest new secrets from nature, which fortunately had made some way before the war; and was then turning Medicine from an observational and empirical craft into a scientific calling. The Committee for National Research, established in 1913, was one mark of this change, and in our crisis has shown itself as the spirit and the organ of advances which I have been tempted to call stupendous.

Sometimes it is said that to carry instruments of precision to the bedside blinds the student; that in fadding with instruments, even with the stethoscope, he forgets the use of his eyes. Is it true that instruments of precision, while opening the eyes of the observer to deeper and less obvious processes, closes them to the plainer features of disease? Surely the chief differential features of—let us say—*tuberculosis dorsalis* were as manifest to plain observation before the advance of scientific research as they are to-day; indeed the chief work of my old master Duchenne was of a descriptive kind, well within the range of unassisted vision. Why was it left to Parry and Graves, not a hundred years ago, to describe *Exophthalmic Goitre*; or *Myxoedema* to Gull and Ord? The tests known respectively by the names of Babinski and Kernig, were within the reach of the physician before the pyramidal tracts were dissected, or the pathology of posterior basic meningitis laid bare. Why was it left to our own day to distinguish typhoid from typhus fever; or Hodgkin's disease from scrofula? The truth is, the spirit of research, far from dimming the eye, quickens it. In science there is no place for skipping. Look but aside and nature gives you a cuff on the cheek. If the hasty student prefers his stethoscope to his eyes he is soon pulled up by nature herself, if not by discipline.

Research is the salt of the most practical training; it

cannot begin too soon; it is the light of the wisdom of the man, of the mind of the boy, of the heart of the child. Education has lingered on Hellenistic and Scholastic ways, on the systems of abstract notions unweaved by verification, so long that the hard-shell practical man is still occupied by the notions of antiquated theory and the phrases of a dead or moribund nosology. The majority of medical men have to work upon the store of scientific ideas and facts with which they set out in practice; onwards they may gain in adaptiveness and technical facility, but can dig little deeper into the strata of knowledge; but for the modern academic spirit this would spell, as in our history it has spelled, stagnation. Therefore it is of the greater importance that every student should start on his career well equipped with scientific principles. If thus equipped he be not at first so handy a doctor as his seniors, with his larger mental grip he will soon pick up common devices and apply them with more freedom and economy.

On the other hand, it is right that the working doctor should refuse to be jumped too readily by the new lights. He has long been scouting his way in the bush and tangle, and has gained a certain pathfinding instinct; he is responsible for the safety of his patient, and has to see that he comes to no harm by overdriving of principles untampered by a sense of contingencies, a sense with which the English doctor is richly endowed. Notwithstanding, no man can deal well with a very complicated subject, such as medicine, without an enormous underlying framework of precise knowledge; and it is as knowledge becomes quantitative that solid progress is made. Happily this greater precision, far as it is from fulfilment, is manifest enough in the work of our own generation to give us encouragement.

PHYSICS AND MEDICINE.

Let us glance, however hastily, towards some of the paths on which we go to meet new knowledge. In the venerable study of anatomy in its static aspects the student has long been taught the value of precision; but the recent tide of anatomical study towards its dynamic aspects, as by the work of Sherrington and Head, is bringing in new currents not of theory only but also of practice. Of other casements opening upon new visions of medicine that from the chambers of Physics is perhaps the most arresting; at any rate at present. How fascinating, in their application to pathology, are the principles of osmosis with its curious reversals, of surface action and adsorption, of electrolytic differentials and electric methods of taking quantitative measurements, of mechanical pressures in the circulation of body fluids and, in the heart, as measured and graphically delineated by Hales, Ludwig, Gaskell, and Mackenzie, of the behaviour of fluid veins, and of the relative diameters, normal or variable, of the cardiac chambers and their main outlets. I need not do more than allude to the recent work on the CO₂ tension in the pulmonary alveoli, and to its immediately practical bearing on so-called acidosis, on the treatment of persons gassed in military or civil operations; and so forth. By physics again we are shown, especially in plants, how in life the less complex molecules are working not only in planes below those in which the higher functions are developed, but upwards by pacific penetration moderate where they do not command. How instantly such researches as these must govern the practice of medicine we perceive, for example, in the gum-saline treatment of surgical shock. It would seem indeed that some of the most mysterious phases of immunity and anaphylaxis, of phagocytosis, as also of narcotism, may depend, at any rate in great part, on surface action; and that the behaviour of lipoids released from disintegrating proteins may lower surface energy, as in the retention of water in renal dropsy; or again in a different field may determine the touch or the permeability of synaptic neurons. These, and such physical laws, as they are revealed to us, teach that the multiplication and co-ordination of surfaces, let alone their chemistry, are operations which do not arise in mere mixtures of the same ingredients. So far it seems as if all biological reactions are determined by physico-chemical laws—that is, by molecular structure. The laws of selective absorption, as revealed in incandescent vapours, might throw some light upon those of biology;

for in both fields we have to study vibration of molecular systems in unison, harmony or discord.

It is the business of an artist to create, but of the scientist to analyse and separate the elements of form, and to verify them by partial syntheses; and these physical and chemical categories—improperly called mechanical seeing that they are self-active and self-constructive—we have to exhaust before we search the skies for a "vital force." One chief direction of our work must be to find methods of serially reducing these planes of functions one by one, so as to suspend inhibitions stage after stage, and by taking it to pieces to reveal the construction of the organism.

BIOLOGY AND MEDICINE.

When we rise from physics into systems of biological activity two conceptions especially strike us as new and marvellous; namely, those of the colloids and of the cell. But throughout these systems we shall find the physical phases, if no longer constructively dominant, yet still active and effectual. We cannot even guess at the links of these chains where physics recedes and biochemistry takes the lead. The mere size of the molecules now concerned alters their relation to the spaces in or about which they move; not only so, but in organic compounds a mere change of position of a radical profoundly alters the properties of the compound and leads to manifold changes of function.

Often moreover these changes, as in the cases of Immunity and Susceptibility, do not vary gradually but by leaps and bounds, as musical flames respond to scales of vibration. Thus great diversities, contrasts, and strange conjunctions of morbid phenomena do not necessarily signify great divergence of nature in the morbidic agents; so that again we cannot get very far by grouping phenomena by direct observation. Processes outwardly disparate may be alike at the core. A small and latent change of chemical constitution may turn a benignant into a virulent substance, and conversely; as we may see in such substances as cacodylic acid and the cyanides, or as saliva, serpent's poison, and trypsin; and so forth. On a small deviation in a secretion we may be destroyed by those of our own household.

How far are hormones a particular category, how far universals? Do they differ in nature from other secretions, enzymes, antisubstances, and so on? Do they by their interactions, compensations, and inhibitions cover the ground of concerted chemical action in kind, as the nervous system does in time; or are they few and peculiar to certain limited needs? Whether inhibitory or stimulatory may often depend rather upon the term of the series to which the hormone is applied than to a difference in quality. Merely to glance at such questions as these reveals to us how vast is the realm of knowledge yet unconquered, nay undiscovered.

. . . mazes intricate,
Eccentric, interwoven, yet regular
Then most when most irregular they seem.

A very interesting transition from physics to chemical biology is found in the phenomena of catalysis. By some elusive property certain inorganic substances—spongy platinum for example, or manganese dioxide—themselves unaltered, exercise an accelerating influence upon chemical change; properties which are utilized to-day on an enormous scale in industrial processes. Now by our increasing knowledge of biochemistry we perceive that the function of which the inorganic catalyst is a simple case, is manifested also in more complex orders by certain enzymes, or colloidal catalysts, upon which depends in great part the sweep of our health and of our diseases. In these enzymes which accelerate metabolism we may admire again, as in the simpler catalysts, the exquisite economy of energy in vital processes; how small the energy transactions may be, and these often reversible, which may compass great ends. A striking example of such economy is now being demonstrated to us in the calculated balances of voluntary muscular activity.

To illustrate the bearing of biochemical research upon practical work let us consider the value of what I may call for short "Ambard's constant," of which few practitioners seem to be aware; namely the standard of

non-protein nitrogen in the blood. Yet here is an instance of laboratory work of immediate practical importance. Recently I had in hospital two elderly men suffering from prostatic retention and vesico-renal strain of degrees clinically inappreciable. Mr. Sidney Cole estimated for me the degrees of this non-protein nitrogen, and, taking the normal as about 50, in one of them the amount was 224, in the other 227. One of them had already undergone excision of the prostate, and as regards the operation successfully; but soon afterwards the man became uraemic and died. In the other case operation was of course declined; the man was sent home instructed in the use of the catheter, and for treatment for his renal condition.

The balance of hydrogen and hydroxyl ions in the blood, which, as in diabetes, may be a coefficient of many obscure and perilous symptom groups, and other conditions of ionization, such as modifications of secretion and enzymic action, of the heart-beat, of the constitution of the blood and so forth, belong to a subject now so well known as to need but an allusion; yet all this subject again is one not of direct observation but of profound physico-chemical research.

The economy of energy is nowhere more manifest than in the universal system of inhibitions; from the moment that a second field of energy is added to the first interferences occur, and inhibitions are established. Thus—to take a familiar example—thermotaxis is steadiest in man, though in him still tidal; is less steady in the child, as we see in the remittent type of its fevers, and so downwards to animals with no thermotaxy.

Thus we shall work on Aristotle's double track, the track of the one into the many and of the many into the one; and on the Heraclitean paths *ἐς ἄνω* and *ἐς κάτω*. Permanent inhibitions are no doubt static and established in structure, but this need not be true, and probably is not true, of all inhibitions. Transitory inhibitions are probably occurring continually, both in health and under infections, and may be due to condensations on surfaces, temporary solutions, ionic conversions, hormones, and so on.

DIET AND NUTRITION.

Diet we shall say is surely a matter of observation and experience; on diet physicians have written, and written well, from and before the time of Hippocrates. Furthermore, during the last half-century the subject of dietetics has been strictly analysed on quantitative lines, and its energies calculated in caloric and other units. Yet even herein our attainment is far from complete. About this well worn, almost hackneyed subject a breeze of new and far-reaching ideas is gathering. Our balances, as in the children's milk, and in the analysis of the diseases of deficiency, are eluded by imponderables, by the infinitely little; our quantities are set at naught. For health and disease the new vitamins, like some other hormonal and enzymic imponderables, are as potent as they are intangible. Hormones work in infinitesimal ranks; and I believe no antibody has as yet been isolated. Once more we find that nature laughs at our formal categories, at our several compartments of protein as such, of carbohydrates as such; a straitlaced reckoning. No one class of foods, it appears, will build or burn without another; carbohydrate metabolism leans on the protein, the protein on carbohydrates, and all these on the fats, in mutual function; each of these is engaged in the totality of the chemical changes. For instance, deficient carbohydrate means deficient oxygenation of fats, and imperfect protein distribution.

Nor is this all; some of our great ancestors, likewise having penetrating ideas of the infinitely little, supposed that the sources of nutrition must contain a supply to every living tissue of the same form of minute identical elements; be it of bone, of muscle, of blood, of "nerve," and so forth; each being proper to its peculiar tissue to which it attaches itself (Homoeomerism). This crude notion, it is true, made no great way; still until lately we have all of us supposed some, if a more general, congruity of form between the nutritive elements and the qualities of their various destinations. But the study of the reduction of foods to amino-acids, and issues of like researches, are telling us to-day that there is no necessity even for the food proteins to be of similar constitution to the tissues which they subserve. To the almost magical part played

by certain elements, such as calcium, as stabilizers, or of the alkali-metals as labilizers of equilibrium I need but allude. The bearing of these dietetic researches upon practice, for example in the treatment of diabetes, are too obvious for reiteration.

If we turn now to the cell, as described to us by Virchow, we realize that our knowledge of this tiny microcosm is as yet only beginning. The infinity of extension is not strange to us, for some of it we can see; but the infinity of the universe of the little, which far escapes even our microscopes, does not strike the imagination. Still even of this inward universe and its intense activities, as by present research they emerge into the field of the mathematical physicist, of the spectroscopist, of the radiologist, of the physical chemist, we are beginning to conceive something. Man is no longer the microcosm, but the cell of which he is built. To our wonder we see that, even within such tiny spheres, some of them filtrable, are multiple systems moving in relative independence of each other. The cell membrane is formed chiefly perhaps by the physical processes we have considered. Yet puzzling and intricate as these reactions are, they are all-important to the physician; as for instance in the relations of the glomerular epithelium to sugars; its unerring discrimination between substances, even isomeric, in the blood, as between glucose and lactose; or again in the constant and subtle opposition of the normal intestinal epithelium to the entrance of poisonous elements, or foreign proteins, into the vessels and tissues.

SPECIFICITY IN BIOLOGY.

When Professor Nuttall demonstrated to me his first precipitin reactions I wondered at the prevalence, in the labile fields of biology, of a specificity like the static identities of the inorganic; a specificity moreover not in cell structures only but also in their products, and in the animal juices. How far this individuality extends to the cells and saps of plants I do not know; but in animals we see at once how the native juices resent the invasion of an alien, not only of enzymes and colloidal bacterial toxins, but of normal foreign serums. Even among lice and fleas each species has its specific host. But it seems inconceivable that the body should keep in store an armoury of antisubstances to meet every possible antigen; is there not some more general potential from which the specific response is more or less determined by the peculiarity of the invading material? Thus the use of tobacco, for us only three centuries old, after a while calls forth in the liver an antisubstance to resist it; a slowly gained immunity, it is true, but perhaps not unlike in kind. There is some evidence that antisubstances may adapt themselves to the chemical form of the antigen which calls them forth. It is said that, at any rate in anaphylaxis, there is a margin of mutability or lability—as distinguished from neutralization or digestion; something, as observed with approximate antigens, short of absolute specific stability. Some suppose a certain adaptability or elasticity, which, while bending to variable stresses, may be consistent with a fixity of specific structure. The almost startling success of a vaccine or serum now and then amid a series of disappointments, indicates however that some close specific correspondence is necessary for success, and must be exacted in our methods. At any rate the closer the correspondence the less the time and dose required. We must "run it fine." In the cells themselves, even in the lowest bacteria, molecular elasticities seem so far defined in direction that specificity is surprisingly stable; although, in such rudimentary forms of life, lability, and even mutation, might have been expected. Indeed in serology and agglutination we seem to be compelled to steer an exact course between strains of bacteria so akin as the several typhoids, meningococci, coliforms, diphtheroids, and even tetanoids. Yet probably some of these variations are not so individual but that they can have preferential affinities and antagonisms outside their main characters, and show a relative sensibility to various antigens. On the other side of the subject a curious comparison may be made with those species, more obviously of plants, in which, as in the poppy, the foxglove and the calabar bean, antagonistic substances abide together undisturbed.

Moreover there are contingent conditions to be reckoned

with, auxiliary or hostile; such as concentrations, ionic reactions, surface actions, and subsidiary co-operative substances. Indeed the effect of a vaccine in saving a patient from a virulent infection is hard to understand; it is hard to see how a man can be saved by instilling yet more of his disease. It may be that the vaccine calls forth a response from the deeps, antistances or co-operative agents, from some remoter regions of the system, which the primary infection had not awakened.* We are told that in typhoid fever the vaccine, especially if repeated, calls forth stronger antistances than does the primary infection.

Among the gravest of medical problems is this of chronic infections. How far are the conditions which shorten the full span of life implicit? How far due to the effects of poisons working insidiously over many years? Do we die by natural gravitation, or "driven from our orderly spheres"? In this abstruse inquiry laboratory research must go hand in hand with clinical observation. No less urgent is the wide and manifold question of carriers: what in them are the conditions of bacterial survival, and what the means of extirpation of their parasites?

IMMUNITY AND ANAPHYLAXIS.

From specificity we may go forward to the subject of Immunity and Anaphylaxis, one on which I hardly dare speak before this audience. In this sphere of science and practice throughout the war you have fought with the foremost. I am but a child in this matter. Like a child I was fascinated by the side-chain hypothesis of Ehrlich, which, whatever its ultimate truth, has been at least a scheme welcome to give some order to swarming facts and ideas. The term antigen may be enlarged to signify any protein, or unknown substance closely bound to protein, which is foreign to the species into which it is introduced. It is said that in the course of a disease anaphylaxis may so intervene as to appear as part of the original malady; that, for instance, certain features in syphilis called parasyphilitic are but anaphylactic. But even here, again, we may have to deal in considerable part with physical laws; the fixation of complement may be due to adsorption, and a colloidal precipitation at the surfaces of sensitive cells may modify their permeability. Bacterial toxins may all be colloidal; and protein may be inseparable from such antigens as animal extracts. The sudden, often instantaneous, onset of Influenza, and likewise, after a long period of dejected convalescence a release as sudden, suggest that the toxin may not necessarily enter the cell and work its evil therein, but may adhere for a while to the tissue elements, and after a variable interval detach itself. So again the well known but very remarkable cases of insanity in which intervals of health prove the nervous structures to be unimpaired, suggest adsorption, or temporary alterations of a physical kind in cell permeability. Nevertheless the hereditary element in these cases indicates that in such patients there is a co-operating proclivity, which, however, as probably in the case of pulmonary tuberculosis, may depend upon a local warp of structure. To attribute it to a "soil" is mock knowledge, and perverse at that; soils do not attack but cherish the implanted germ. The no less remarkable alterations of sensitization and desensitization may in like manner depend on molecular physics.

With the large, various and recondite problems of psychology, accentuated and multiplied by the war, it would be impossible within these limits to deal even summarily. But two aspects of the subject I cannot leave unnoticed; the problem of fatigue, and the calculation of individual faculties for particular kinds of work; the proper distribution of the round and the square men. For the field of psychology adaptations are to be ascertained in a manner analogous to that of the selection of airmen. Here again laboratory research is laying the foundations for precise knowledge in a sphere which voices of the mist had proclaimed as their own; where they had ruled opinion, and even declared themselves irreducible to law. Reason, it is true, is our last and least organized faculty.

STATISTICS.

The study of Statistics, not long ago the prey of the scoffer, is, under academic methods, such as those of Brownlee and Greenwood, emerging as one of our most potent instruments of practical medicine, both on its prophylactic and on its interpretative side.

COMPARATIVE PATHOLOGY.

I have dwelt upon the isolation of the academic from the clinical worker; but I have to denounce an insularity even more blinding than this; the almost complete lack of any systematic provision for Comparative Pathology. As I urged upon this Association in my Address in Medicine at Glasgow in 1881, and persistently since, in Medicine we are still in the Ptolemaic stage of ideas; we are still anthropocentric. And Veterinary Medicine in its several compartments is still more narrowly confined. Even among mankind, research on the Ethnology and Geography of disease has been but fragmentary; incidental studies with no comprehensive view; and yet with the disturbance and redistribution of peoples the study of racial and regional pathology is becoming less and less possible.

Do the children of the darker people in towns outlive the fair? and if so why? Are the darker people gaining in numbers upon the fair? We have to learn how diseases vary with the systems of external relations, the conditions of time and place, of season and soil, race and temperament; and this not in higher organisms only, but also in the lower and lowest. Hysteria is, or was, rare among our Yorkshire folk.

Again, the facts of heredity in disease, hard to gather in long living Man, are comparatively easy to collect in animals and plants. What is the extra vigour of cross-breeds? Has each strain of pedigree stock its own morbid proclivities, so that we might compare the several series of each kind?

Yet as the individual is but a link in the chain, so the human chain is a strand in the web of all living things. We must know all disease to understand its several phases. *Nemo alicujus rei naturam in re ipsa feliciter perscrutatur.* "Every class of animals," says Sir John Bland-Sutton, "is distinguished by anatomical details, habits of life and milieu from other groups, differences which involve liabilities to certain diseases, immunity from others. So far as our present knowledge extends we know that certain diseases occur with extreme frequency in one class of animals and are rarely seen in another." We want then natural groups and groups in natural series, and this means all life. How far have we got in the classification of all disease which, on a natural system, is a measure of our knowledge of it? Changes which are morbid in man may be normal in lower creatures; such for example as the large sequestrum of the antler of the stag. Why is cancer almost unknown in wild animals, caged or free? It is said to be unknown among the Esquimos. This cannot be due merely to average age. If atheroma of the great vessels, or of those of the limbs, is not found in old horses or cattle, why is it not? Is it due to special products of catabolism? Phlebitis is, I believe, rare in animals. What is the relation of the mucin retrogression of myxoedema to the like connective tissue of the fetus, and again to the tissues of certain lower animals? Is a gouty man a kind of bird? How large is the field for the study of racial immunities—of the resistance of certain silkworms to the silkworm disease; of Cochin China fowls to chicken-cholera; of the field mouse to the septicaemia so common in the house mouse (Pasteur); of the Algerian sheep to anthrax, of goats to tubercle, of dogs to glanders (as contrasted for example with the guinea-pig), of Darwin's Florida black pigs to bloodroot, and of the susceptibility of the white pigs to buckwheat? How curious is the tolerance of rabbits to morphine! What do we know of rheumatic fever and carditis in animals? In what respects does a theromorph heart differ from that of an intrauterine endocarditis? In the fundamental phenomena of life in animal or plant there is a fundamental unity, and as in different organisms these are variously ordered cross-lights are thrown upon their origins and serial distributions. Some animals or races seem more disposed to mesoblastic diseases; others to nervous disorders; and so on. By observing organisms thus in

* I leave these words as written two or three weeks ago, and long in my mind. Sir Amos Wright has since expressed a similar opinion with an authority and proof to which I cannot pretend.

many series we may unravel the constituent parts of the more complex in a way which we cannot do by dissecting these from level to level. As some one wittily remarked, "a minister in decay does not break up into parish churches." But a study of parish churches has thrown a flood of light upon the growth of ministers. Comparative Pathology is needed therefore to indicate steps of development, so that we may not contemplate diseases merely as injury or dilapidation but also as phases of biology. Each advancing stage is longer in building than that below it. Some phases are better studied in lower creatures, even in plants; some better in the more complex.

FOR THE FUTURE ?

I have glanced thus rapidly over the field of the medical sciences to reinforce the lesson of their profound and instant bearing upon practice, and the need of linking up the laboratory with the wards. This lesson, this need, I have urged for many years; for instance at the Annual Meeting of the Medical Society of London in 1907 I urged upon the great schools in England the vital importance of establishing professors of Medicine, Surgery and Gynaecology, as middlemen between the isolated academical worker and the practitioner, between the field of immediate interests and the field of ideas. If I am not a practical man I am nothing, but still I am convinced that only by disinterested research on the large patient and prophetic lines of the pure sciences can progress be made. The isolated academic worker, as well as the practitioner, loses by this isolation; he loses the spontaneous outcrops of problems and crucial instances which so often spring up in practice, but fail to show themselves in the laboratory. So complete and mischievous however has been the barrier between research and the industry of Medicine that a reaction from "laboratorism" to symptomatology has set in, because there are no intermediary workers—no engineers—between the knowledge getters and the knowledge dealers. Thus we see the laboratory investigators completely out of touch with practice, and practitioners faithless of theoretical principles—just "Philistines." A few years ago my own University, or certain members of it, discouraged the establishment of a brewing school for which endowments were offered; utterly ignorant and careless as they were that Pasteur's great discoveries began in the wine vat.

There are then three ways in which Principles may be used. They may be taken for granted in a routine dexterity without being understood, as are those of electricity by telephone and electromotor operators and laboratory attendants, in the manner of a blind man tapping with his stick; or they may be fully understood and developed, as by the academician; the third way is that of the technical professor who receives and digests so much of the abstract science as concerns his own industry. Thus as the engineer is something of a mathematician, something of a physicist, so the professor of Medicine must be something of a physicist, something of a biochemist. Through these middlemen the scientist and the practitioner should mutually feed each other. The absence of biochemist and pathologist from the bedside where lies the stuff of their researches, is lamentable. In every adequate clinical school then there must be a *professoriate*; whole time—or nearly whole time—professors, with technical laboratory, biochemical and pathological, who with their assistant staff shall be engaged continually in irrigating our profession from the springs of the pure sciences. From them should radiate what is called an "atmosphere" through the wards; for it is true that the professor himself will be less occupied in teaching the ruck of students; he will gather about him some senior students and all the younger graduates who still frequent the wards. Moreover I quite agree that for variety of reflection and resources there will still be no less a place than as at present for the classes of the Honorary Staff.

POST-GRADUATE SYSTEMS.

Now, in conclusion, this is the true and only factory through which the post-graduate systems, so much needed and discussed, can thrive and develop. For such reasons I could not see my way to co-operate in the scheme, now being proposed, of post-graduate courses to attract men of other countries, and of our own. This scheme was tried devotedly and most ably by our late dear and brilliant colleague Jonathan Hutchinson. But being founded on no professoriate it had no roots; when Hutchinson was gone the scheme dried up: and it will dry up again unless it be an outgrowth of a scientific system, and flourish on the stem of a professoriate and be rooted in the ward and the laboratory. A post-graduate scheme consisting of desultory side-shows will not continue to draw serious visitors. The visitor wants not cut flowers but a nursery garden. If students are to come to study Medicine in England—for these strictures apply particularly to England—there must be something large and creative for them to come to. Given a professoriate, the special departments of our great hospitals offer a rich soil for the scientific garden, and a larger and more liberal outlook than the islands of the several specialist hospitals. We know in Cambridge how advance is forwarded where laboratories are close neighbours. Science is as intolerant of limits as of dogmas.

It is true that much has been done of late to stimulate and enlighten both medical men, the public and the services concerning the need of systematic pathological investigation, but the mulish aversion from such pursuits often passing into active animosity, is by no means yet extinguished in the national services. Actual discouragement of research work, in some quarters perhaps at home, in many I fear abroad, is still by no means unknown. Young men, as ardent for knowledge as for their regular duties, find that pathological inquiry, and even laboratory appointments, lead to no promotion, may entail positive sacrifices of pay and other advantages, and sometimes indeed vindictive reprisals. As the more antiquated traditions of the services are dispelled things will mend; the sympathetic response of the India Office but the other day to a deputation on this matter promises well for the future; notwithstanding there are yet many dark places in the Empire which need the lantern and the besom. Not only must laboratories be established in all Colonies and Stations—and, let me add, in every English county, a scheme which was provided for by Mr. Lloyd George in the Budget suppressed by the war—but these and their workers must be restored to the full stream of official recognition and reward. It is sad to think of the many men of talent, even of genius, who have been thwarted so long in their devotion to research that the benefits which they could have bestowed upon mankind have been maimed, or frittered away.

But now the politician, throwing up his hands, exclaims: What is to be the cost of all these medical developments; academic, laboratorial, professorial, prophylactic, and so forth? We answer, What has been already the cost of *laissez faire*? What was the cost in money, life, and war of the typhoid epidemic in South Africa? And, to come nearer home to the politician, what, for example, is the national cost, well expended we gladly admit, of the profession of the Law? To what do the well earned salaries of lawyers amount, taking those only from—say—£1,200 to £5,000 a year?—not to mention the still greater offices? The salaries of medical officers of health including the highest, do not average £800 a year; yet in hours of work, subject matter, professional education and range of knowledge in daily use, the function of the Medical Officer is surely larger and more exacting than of a Stipendiary Magistrate or County Court Judge. The truth is society has long taken its law, as being the more obvious function, for granted. Robbers came out of the neighbouring forest, but diseases were as God pleased. The depth and powers of medicine the public has yet to learn and realize. Moreover medical men, innocent angels as they are, have given so freely of their best to the public that for them to look for payment, other than in after-dinner compliments, seems too worldly to be credible.