Observations

ON THE

HISTORY OF PHYSIOLOGY IN GREAT
BRITAIN DURING THE LAST
HUNDRED YEARS*

BY

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A century ago physiology was to all intents and purposes non-existent in England. There was no laboratory of physiology in the whole of Great Britain, nor any one person whose business it was to devote himself wholly to teaching and research in physiology. In certain universities of Scotland there were professors of the "institutes of medicine"—a term which is generally regarded as the equivalent of physiology—but the occupants of these chairs were not physiologists; they were always practising physicians. Nor was it until fifty years later that it was considered necessary for the occupant of such a chair to be a physiologist. On the Continent, especially in France and Germany, physiology was more advanced; in Paris and Berlin there were established chairs occupied by notable physiologists. This neglect of physiology in Great Britain is the more remarkable when we remember that the foundation of physiology was laid in England 200 years previously by William Harvey, and in the intervening period had been substantially built upon by Stephen Hales, John Hunter, and William Hewson. But there was no organized investigation; each person worked independently. Physiology was looked upon as little more than a branch of anatomy.

THE FIRST CHAIR OF PHYSIOLOGY

It was rather less than a century ago and in the new University of London—soon to become better known as University College—that physiology, at that time dormant in England, was reawakened. University College, although founded in 1828, did not at first undertake the teaching of medicine. When its hospital was built a faculty of medicine was added and a regular medical curriculum established. But there was no separate chair of physiology; such teaching of the science as was thought necessary was entrusted to the professor of anatomy, who was himself a practitioner. The same condition obtained in all the medical schools of the time; although some were of old standing, none had recognized the importance of physiology as the basis of medicine, or had encouraged its special study by engaging the services of whole-time teachers of the subject or by establishing laboratories in which research could be conducted. Anatomy was looked upon as the only subject of which a thorough preliminary knowledge was needed for the practice both of medicine and of surgery.

It was not until 1836 that a special chair of physiology was established in any medical school; in that year the authorities of University College decided that the time had come for the founding of such a chair. But it was not possible at the time to obtain a trained physiologist to occupy it; there were none in the kingdom. The difficulty was, however, successfully overcome. William Sharpey had already a considerable reputation as a teacher of anatomy in the extramural school of Edinburgh. He was essentially an anatomist. His whole training had been in anatomy, which he had studied assiduously in Berlin and elsewhere. He had acquired, however, a sound theoretical

knowledge of physiology and had devoted attention to comparative physiology; he was also known to be an impressive teacher and he had a sound basis of common sense. His father was English, his mother Scotch; he combined in his character the best features of both races. The medical faculty of University College had been largely recruited from Edinburgh, and this contributed to the decision to invite Sharpey to occupy the new chair. A large part of his teaching was pure anatomy; the course was termed "general anatomy and physiology." The term "general anatomy" came to be a synonym for histology, and Sharpey included details of the anatomy of the viscera which are nowadays left to anatomy. He recognized that an intimate knowledge of structure ought to precede the investigation of function, and being, for his time—it was before the period of microtomes and staining methods—a remarkably sound observer, a considerable part of his course was devoted to the minute structure of the cells and tissues of the body.

In recognizing the close relation between histology and physiology Sharpey was not alone. Many physiologists have contributed to the advancement of the study of microscopic structure, and some of the best histologists have also been good physiologists. It has been the practice of late to break away from this traditional association and to ignore the assistance which physiology gains from microscopical observations; but the investigation, by micro-mechanical means and in artificial cultures, of the physiology of the living cell has tended to restore the association between physiology and histology—to their mutual benefit. Although Sharpey had not the advantage of a physiological training, he was an extensive reader and had a sound theoretical knowledge of the science. He was well able to impart his knowledge to an audience of students; no one could listen to him without being impressed by the clarity of his exposition and by his methods of explaining how any problem was to be dealt with or how a particular experiment was performed. He himself had no apparatus except his microscope. He had never used a kymograph, but he would illustrate how a record of blood pressure or of muscle-contraction was made, with the aid of what Michael Foster once termed "his dear old chimney-pot"—a form of headgear which everyone wore in those days, students as well as professors, and which, at least in this case, served a useful purpose. His knowledge of the history of physiology was—like Sam Weller's knowledge of London—"extensive and peculiar," and few things help more to make a subject interesting than appropriate references to its history.

If I have dwelt at some length on Sharpey it is partly because he was my own teacher, but chiefly because of the influence he had on the spread of physiology in Great Britain. He early recognized the importance of the practical study of the subject, and induced the Faculty of Medicine to institute a course of practical instruction. George Harley, a London physician who had studied physiology and chemistry in Paris, was first appointed to carry out such instruction, but he found before long that the claims of practice were incompatible with this duty. Looking round for a successor to Harley, and perhaps to himself, Sharpey chose a young man, Michael Foster by name, who had been a distinguished pupil of his, but was at this time assisting his father in a general practice in Huntingdon. Michael Foster was easily persuaded to give up practice and devote himself to science, and he became the first professor of practical physiology in University College, a chair having been created especially for him. He did not hold it for long; he was soon invited to Cambridge, where, on the advice of Humphry, who was endeavouring to establish a complete medical school in that University, a preceptorship of physiology was instituted by Trinity College.

* Read in opening a discussion in the History of Medicine Section at the Centenary Meeting of the British Medical Association, London, 1932.

The teaching of physiology at Cambridge was attached to this prelectorship, and it was not until 1883 that a university chair of physiology was created, Michael Foster being its first occupant.

On the transference of Foster to Cambridge the authorities of University College invited Burdon-Sanderson, who was at that time assistant physician to the Middlesex Hospital and had shown a predilection for physiological and pathological investigations, to occupy the chair, with the understanding that, on Sharpey's retirement, which was imminent, he should succeed to a combined chair of physiology and practical physiology. It is an interesting fact that, although neither Michael Foster nor Burdon-Sanderson had received any laboratory training—such work as they had been able to accomplish having been performed in private laboratories with limited resources—they were nevertheless instrumental in building up a school of practical physiology which has proved second to none, and the influence of which has spread far beyond the confines of our own island.

THE CAMBRIDGE SCHOOL

When Michael Foster moved to Cambridge there went with him a young Irishman named Martin, who had been his assistant at University College, and who eventually went to Baltimore as the first professor of biology in the newly established Johns Hopkins University. Through his influence and that of his pupils and fellow workers the traditions of the University College and Cambridge schools were carried to the United States. It was not long before Foster attracted to his subject some of the best brains in the undergraduates at Cambridge. Prominent among them were Francis Maitland Balfour, who became eminent as an embryologist; Walter Gaskell, whose researches on the physiology of the heart are classical; George Romanes, who, working in his private marine laboratory in Ross-shire, discovered the presence of a nervous system in coelenterata; John Newport Langley, who elucidated many important problems connected with secretion and the sympathetic nervous system; and Charles Scott Sherrington, who carried the tradition of the Cambridge school successively to St. Thomas's, to Liverpool, and to Oxford. (I may mention, as showing the progress which physiology has made, that Sherrington was the first physiologist to become president of the Royal Society.) Foster's staff was recruited by many other workers whose names have since become familiar, and not the least among them was a young graduate of London, Frederick Gowland Hopkins, who became the first professor of biochemistry in Cambridge, and is the second physiologist to occupy the presidential chair of the Royal Society.

Michael Foster himself for many years acted as biological secretary to the Royal Society in succession to Sharpey and Huxley. He took an active part in founding the Physiological Society in 1876, and was instrumental in establishing the series of International Physiological Congresses, the first of which was held at Basel in 1889. He also started the *Journal of Physiology*. On his retirement in 1903 he was succeeded by Langley, and on Langley's death in 1925, another of Foster's pupils, Joseph Barcroft, succeeded to the chair and is still its occupant. Under these three men the influence of the Cambridge school has become world-wide. Its alumni occupy posts in all parts of Great Britain and in her offshoots. The part they have taken in promoting the progress of the science emphasizes the debt British physiology owes to Michael Foster, and, through him, to William Sharpey.

UNIVERSITY COLLEGE SCHOOL

Returning to University College, London, we have seen that Sharpey and Michael Foster were succeeded in 1870 by Burdon-Sanderson. Sanderson divided the duties of

the professorship with me—I was appointed assistant professor in 1874—and I succeeded him in 1883, when he was appointed to the newly established Waynflete professorship at Oxford. On my transference to Edinburgh in 1899 Ernest Starling became my successor at University College, with William Bayliss as coadjutor, and on Starling's appointment to one of the Foulmerian research professorships of the Royal Society, he in turn was succeeded by Archibald Vivian Hill. On Hill's appointment to another of those professorships, he was succeeded by Lovatt Evans, who still occupies Sharpey's chair. Under these successive occupants the University College school of physiology has been equally successful with that of Cambridge, both in the production of original work and in furnishing, directly or indirectly, trained physiologists to take over the teaching of the subject in other centres—for example, Halliburton at King's College, Leonard Hill at the London, Francis Gotch at Liverpool and Oxford, Benjamin Moore at Liverpool, MacWilliam, Waymouth Reid, and Herring in Scotland, and Milroy, Thompson, and Pringle in Ireland. By others, too numerous to mention, the traditions of the British school have been carried to Canada, Australia, New Zealand, and indeed to all parts of the world.

EMERGENCE OF BIOCHEMISTRY

Although I have dwelt chiefly on University College and Cambridge as furnishing the nuclei from which the larger number of British physiologists have proceeded, the important work that has been carried on in other institutions and by independent investigators must not be forgotten. Notable among the latter are Frederick Pavy, Arthur Gamgee, Sydney Ringer, David Ferrier, Leonard Woolridge, John S. Haldane, and Augustus Waller. But in the time at my disposal it is impossible even to enumerate the physiologists of British nationality who during the last century, and especially during the last fifty years, have contributed to the progress of the science; equally impossible is it to mention the special subjects to which they have individually contributed. I should be merely furnishing a list of titles were I to attempt to specify the histological, chemical, and physical researches which have characterized this most active period of British physiology. But two subjects especially strike the imagination on account of their novelty. They are: (1) the internal secretions, which half a century ago were unknown, although their study now constitutes an important part of physiology and has bearings on all branches of medicine; (2) the vitamins, the "accessory food factors" of Hopkins. Both present chemical problems and are bound up with an intimate knowledge of the chemistry of the body. It is therefore not surprising that chemistry now dominates physiology; physiologists and pathologists require to be as highly trained in chemistry as hitherto in physics. A hundred years ago comparatively little attention was paid to biochemistry; such investigations as were then conducted related mainly to the physical problems of physiology. Not that the latter are at the moment neglected; researches on muscle, on the nervous system, on the circulation and respiration, on the sense organs, and on the electrical conditions accompanying every function, are carried on more actively than ever. But these are extensions of the kind of research which has been proceeding since physiology emerged as a distinct science. On the other hand, the action of the internal secretions and of the vitamins, and the influence even of small variations in the composition of the blood on the activity of the tissues and organs, are altogether new subjects of investigation; the commencement of their study is within the memory of most of us. Biochemistry is now recognized as one of the main branches of physiology, and in most universities is taught from a separate chair. We rejoice to know that in

this and in all other parts of physiology Great Britain is holding her own. But no science, least of all those on which medicine is based, belongs to one country, and neither we nor any other nation can claim to occupy a pre-eminent position in physiology such as might have been granted us three centuries ago as the result of Harvey's epoch-making discovery.

OCULAR MANIFESTATIONS OF LESIONS OF THE FIFTH CRANIAL NERVE*

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The Gasserian ganglion is the trophic centre for all the sensory branches of the trigeminal nerve, the most important somatic sensory nerve of the body. It corresponds with a posterior root ganglion of a spinal nerve, and, like it, lies outside the central nervous system. From each cell body in the ganglion a single fibre arises which bifurcates, sending one branch centrally to the nucleus in the medulla and one to be distributed to the tissues, and any pathological process in these cells may be referred to the corresponding point of its peripheral distribution.

The ganglion may thus be involved by the spread of inflammation from middle-ear disease, producing unilateral headache; it may be involved in a basic meningitis, or a tumour of the cerebello-pontine angle, or it may be implicated in inflammatory or neoplastic processes in any part of its peripheral course. Further, there can be no doubt that the trigeminal is of great importance in the production of headaches, and indeed Ivy Mackenzie goes so far as to say that the "physiological pathology of headaches may be reduced to a question of the irritation of the trigeminal nucleus in the medulla."

REFERRED PAIN AND IRRADIATION

In many respects the eye is the most convenient organ in the body for the examination and observation during life of diseased tissues, such, for example, as the blood vessels, the optic nerve, or the iris, all of which can be examined in a way that is possible with no other tissues, and, further, it lends itself to the examination of the phenomenon of referred pain. By referred pain is meant pain which is referred to a tissue which has no reason to produce it. It occurs as a result of excessive afferent stimuli ascending to the nucleus of the nerve from a diseased peripheral structure, and there irradiating so as to stimulate neighbouring nerve cells, the fibres of which supply the area which is the subject of the referred pain. On the question of irradiation Sherrington says, "If, by appropriate stimulation of the skin of the foot, the ordinary flexion reflex of the hind limb of the dog be evoked, the extent of the reflex increases with the increase in the intensity of the stimulus."

There is an exceedingly free interconnexion between any afferent channel and the congeries of arcs of the whole central nervous system. It is not surprising, therefore, that reflex reaction should spread; the extreme degree of irradiation may be seen after strychnine administration, for it is generally accredited that centripetal impulses passed in by any afferent nerve will then excite reflex discharge over the efferent channels of the whole nervous system. Further, it seems that limited irradiation tends to spread along certain paths with greater facility than

along others, and this difference is probably referable to the difference in the facility of conduction at different synapses.

Referred pain is, on good grounds, believed to be an expression of irradiation in the nucleus of the nerve. Thus pain resulting from an inflamed iris will at first be referred to the iris. If, however, the inflammation in this structure becomes more severe or prolonged, so that the afferent impulses from it are augmented, a spread will occur within the fifth nucleus to immediately adjacent cells, so that pain now will be referred to the side of the nose or orbital margin, and, with further increase, the side of the face may share the extension of pain, or the meninges may be involved and cause headache, or vomiting may ensue from spread to the vagus centre.

There are two anatomical factors which facilitate the spread of the stimuli within the fifth nucleus and from one nucleus to the other. First, individual fibres of the primary neuron ascending and descending give off collaterals at different levels, and so constitute a bond of integration between different levels in the nucleus, and, secondly, there is a free communication between the two trigeminal nuclei, so that a close intercommunicating link is provided which associates together all the diverse tissues from which afferent impulses are directed to this nucleus.

Thus it comes about that a severe or prolonged stimulus may overflow the cells which are in immediate organic continuity with the inflamed tissues and involve first one, and later the opposite nucleus, till pain is referred to the whole territory of each nerve, and, overflowing further, may spread widely and cause more distant and diffuse manifestations.

We have already observed that the resistance to the spread of impulses may be greatly reduced by strychnine, so as to allow an efferent impulse almost free run of the whole central nervous system, and so also it would seem that the irradiation of painful afferent stimuli may depend not only upon the strength of such stimuli but also upon the condition of the brain tissues which receive them, and thus we may well believe that such factors as endogenous or exogenous toxins, of which we hear so much, and, I venture to think, too much, constitutional debility, whatever its source, or inherited instability of the nervous system, may be factors which are important in the dissemination of referred pain.

HERPES ZOSTER OPHTHALMICUS

It is probably unnecessary to remark that herpes cornea, with which dendritic and stellate corneal ulcers are closely allied, is connected by scarcely more than name with herpes zoster ophthalmicus.

The close relation which exists between herpes zoster and varicella is well established, and Le Feuvre¹ urges that "shingles should be recognized as an infectious disease, and one, under certain unknown conditions, likely to become a starting point for a chicken-pox epidemic." Until Jonathan Hutchinson's classical account of herpes ophthalmicus in 1866-7,² this disease had been confused with erysipelas, a mistake that is not quite unknown to-day.

In this connexion Hutchinson describes what, for this association, we may call an interesting domestic occurrence. In 1866 a plate representing herpes zoster of the head and face, which had been presented to the New Sydenham Society, excited a little amusement among some of the members. "Who," they said, "had seen the disease in such a part? Surely it was unnecessary to depict so rare and far-fetched a complaint." We may judge how little the disease was recognized. Hutchinson goes on to say, "Curiously, some one of the Council (Dr. Markham, who at this time was editor of our Association's *Journal*), who had had his joke on the

* Read in opening a discussion in the Section of Ophthalmology at the Centenary Meeting of the British Medical Association, London, 1932.