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Cambridge and its Contribution to Medicine

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Proceedings of the
Seventh British Congress on the History of Medicine
University of Cambridge, 10–13 September, 1969

Edited by Arthur Rook

London
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Introduction

THE SEVENTH British Congress of the History of Medicine was held at Churchill College, Cambridge, from 10 to 13 September 1969, under the Presidency of Dr. W. S. C. Copeman. In selecting as the theme of the Congress 'Cambridge and its Contribution to Medicine' the Council of the British Society for the History of Medicine presented the organizers at once with a welcome opportunity and a dilemma which is still unresolved.

The opportunity was welcome because the history of medicine at Cambridge has attracted relatively little attention from historians. There has been no detailed study of medical teaching at Cambridge and no history of Addenbrooke's Hospital has yet been published, although extensive University, College and Hospital records have survived. In the absence of readily accessible facts many authors, past and contemporary, have been content to base their generalizations on their own prejudices: the blind devotion of some alumni is no more acceptable than the equally uncritical and uninformed antagonism of some pamphleteers.

The organizers' dilemma was created by the actual words in which the theme of the Congress was defined, 'Cambridge and its Contribution to Medicine'. To relate the lives and achievements of distinguished Cambridge medical graduates presents no special difficulties but to assess the extent to which the teaching they received at Cambridge contributed to their success is often impossible in the light of the limited published sources. How much William Harvey owed to Cambridge is still disputed. Professor Milnes Walker is clearly very conscious of this difficulty in his account of Francis Glisson's career. Dr. Ruth Hodgkinson, among other speakers, rightly emphasizes the inadequacies of Cambridge medical training at certain periods. The contribution of Cambridge to medicine before the last decades of the nineteenth century will be reliably evaluated only when the primary documentary sources have been fully explored. Most speakers understandably evaded this issue and chose to present an account of episodes in the lives of individuals or of departments, and in doing so they have placed on record a great deal of important new material.

The reader with no previous knowledge of the history of Oxford or Cambridge may well be bewildered by many aspects of student life in England's old universities. The great majority of students entered the Church; sixty per cent did so as recently as the first half of the nineteenth century as did forty per cent between 1850 and 1899.[1] There was little special provision for medical teaching before 1800; although, as several speakers point out, attempts were made from time to time by individual colleges to encourage medical studies, there was no sustained effort to do so, despite the foundation of the Regius Professorship of Physic in 1540. The number of Cambridge medical graduates before the nineteenth century was small. It is true that in many periods the number of graduates does not give an accurate estimate of the number of serious students of medicine. Before there was strictly enforced regulation of medical qualifications some men passed the examination as Extralicentiates of the Royal College of Physicians in the same year as their contemporaries took the M.B. or even started practice, usually in country areas, without licence or qualification of any sort. However, even when such men are taken into account, the number of medical students at Cambridge at any one time remains small and the fact that the influence wielded by these few men was so often disproportionately great must be attributed in part to the social advantages which some enjoyed and in part to the very close link between the older universities and the Royal College of Physicians in London.

In the nineteenth century too the number of medical graduates represents only a proportion of the total student entry, for many who completed the full preclinical course preferred to take the reputedly easier qualifying examinations of the College of Surgeons and the Society of Apothecaries.

In the middle ages the colleges were small bodies of graduates, sometimes with a few poor scholars. During the sixteenth century they were transformed into undergraduate societies, largely autonomous, and the University's officials were soon drawn exclusively from amongst the Fellows of Colleges. This transfer of power to the Colleges at the expense of the University did not favour the expansion of medical teaching when it had reached the point in its development at which centrally organized laboratory and clinical teaching had become desirable. But at an earlier period it had some advantages. According to Green[2] 'The content of the curriculum or what was provided at lectures never at any time represented the whole intellectual interest of the serious student'. Dr. Bernard Towers (p. 66) emphasizes that the College and not the University was responsible for teaching and determined the quality and quantity of the student's medical education. Generalizations based on the statutory curriculum or the lectures given (or not given) by the professors are inevitably misleading.

From the earliest days of the Cambridge medical school some students chose to travel to continental schools for a period before or soon after taking their Cambridge degrees. In the sixteenth and the early seventeenth centuries the Italian schools drew the greatest numbers; later in the seventeenth and throughout the eighteenth century more visited the Netherlands. The contribution of Padua and of Leyden in particular to the education of Cambridge doctors was certainly considerable but it was less than has often been assumed. The analysis of the records of Cambridge students inscribed at Leyden (to be published) shows that a very large proportion spent only a brief period there, a few weeks or even one or two days. Even during the worst periods of Cambridge medicine some men, who later achieved great distinction, such as William Heberden, received all their training there.

It was the demand first for practical laboratory work and soon afterwards for clinical teaching which confronted the collegiate system with challenges it was unable to meet. Scholastic medicine could be effectively absorbed in the college environment. When anatomy and chemistry became laboratory subjects they were not readily incorporated into the college system; the attempts to maintain some practical teaching in these subjects are described by several contributors to this volume. Clinical teaching on a very limited scale in their practices was probably carried on by Heberden, by Glynn and by others of their contemporaries. More was not possible, for Addenbrooke's Hospital was not opened until 1766, although its founder died in 1719.

Dr. Cole refers (p. 268) to the poverty of Cambridgeshire in the 1920s. Historians of Cambridge medicine have ignored the influence of local economic factors on the medical school. Cambridgeshire and the Isle of Ely, and the bordering areas of neighbouring counties were poor throughout most of our period. Cambridge was small and until some of the roads were improved in the eighteenth century was accessible to only a very limited population. Legal difficulties were partly responsible for delaying the construction of the hospital but the inertia of the trustees and lack of funds were the principal factors. By the time the hospital was opened in 1766 the medical school had almost ceased to exist, and there is no evidence in the minute books of the hospital that medical students were taught there until more than fifty years later. During those years the custom had slowly become established that Cambridge medical students should seek their clinical training elsewhere—in the private schools in London and later in the London hospitals. An analysis of the careers of Cambridge medical students during the nineteenth century, now nearing completion, is throwing interesting light on the relationship between Cambridge and the London hospitals. It has also established that after 1850 the great majority of Cambridge students entered general practice, and not always in the more desirable areas, and that not a few took up public health work.

Economic factors which delayed the opening and expansion of the hospital probably influenced the development of medical teaching at Cambridge in other ways too. The stipend of even the Regius Professor was small and he was obliged to supplement it by private practice. Dr. Cole has reminded us that the town was too small for consulting practice until after the 1914–18 war. The professors were therefore engaged in general practice against very heavy competition. The number of medical men in practice in the town from the seventeenth century onwards was very large in relation to the population. For the physician who wished to confine himself to consulting practice, even if his motives were scientific rather than mercenary, London and a dozen or more other towns offered greater opportunities.

The magnitude and importance of the contributions to medicine of the Cambridge departments of Biochemistry, Physiology, Anatomy, Pathology and Genetics is not in dispute, nor is the personal contribution of Allbutt whilst he occupied the Regius Chair. The Postgraduate Medical School too, has already made its mark; Dr. Cole's account of its development modestly fails to mention the important part he himself played as its first Dean.

The significance and importance of the contribution of Cambridge to medicine before 1850 cannot yet be assessed: it was, I believe, very much greater than the detractors would have us believe but less than some enthusiasts have claimed. The repeated failure over several centuries of men of undoubted worth and ability to develop a full medical school is to be attributed to a variable combination of factors. The by no means negligible economic factor has already been mentioned. Two quotations will serve to introduce two other factors of even greater significance.

Christopher Hill has recently written[3] 'It was a great piece of good fortune for England that after 1660 the nonconformist middle-class was excluded from Oxford and Cambridge where they would have learned to despise science'. By the middle of the nineteenth century pure science had achieved respectability, but in 1876 Lyon Playfair, chemist and liberal politician could still write[4] 'Oxford and Cambridge have exalted the pedagogies or Arts Faculty to be the end instead of the beginning of the Universities, and thus have cut themselves off from the professions'.

A.J.R.

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3. Hill, C., *Reformation to Industrial Revolution*, London, Penguin Books, 1969, p. 251.
4. loc. cit. (2) pp. 118–19.

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4. loc. cit. (3) pp. 118-19.

Medical Education in Cambridge before 1600

by

A. H. T. ROBB-SMITH

SIR HUMPHRY ROLLESTON[1] once wrote that the history of the Cambridge medical school presents two distinct phases—a long period of somnolence like that of a newborn infant, followed in the nineteenth century and after by a stage of progressive growth. I believe this is an over-simplified view of the contribution of Cambridge University to the development of English medicine, and Dr. Towers[2] has dispelled some of the illusions about the eighteenth century.

The somnolence hypothesis, which applies to Oxford as well, supposed that there was no medical education worth the name at either university until the days of Acland and Haviland and that until that time would-be physicians, having taken their M.A., went abroad for their training and doctorate, which they incorporated in their alma mater and so became eligible for the F.R.C.P. with its social and financial advantages.

This is what Thomas Linacre, John Caius and William Harvey did; but what about their intellectual equals, Robert Record, William Gilbert and Thomas Sydenham? In fact until about 1750, the sister universities were the only places offering medical education in the British Isles, for it was not until the eighteenth century that the Scottish universities were organized for the mass-production of doctors. Up to that date nearly three thousand physicians graduated at Oxford and Cambridge but only an eighth of these incorporated foreign degrees.

Dr. Rook[3] has revealed that many excellent physicians graduated from Cambridge in the seventeenth and eighteenth centuries but I will restrict myself to the 250 Cambridge doctors of the earlier period, which he felt he could safely entrust to me, as in his view it was the only period when Oxford was the better medical school.

As Albert Hall was my college I feel no need to revive the battle of the Caius, but it may seem that the education of so small a number of doctors over four centuries justifies the somnolent view, particularly as Oxford only contributed a further four hundred.

However one should realize that the estimated population of the British Isles at the beginning of the fourteenth century was only two million which had risen to about five million by 1600. This table (figure 1), based on Talbot and Hammond's great work,[4]

FIGURE 1

English Medical Practitioners before 1500

	University Graduates			*Leeches*	*Surgeons*
	Oxford	*Cambridge*	*Foreign or Unknown*		
Before 1200	2	—	2	130	3
1200–1290	11	1	2	273	32
1300–1399	42	7	7	184	81
1400–1499	67	40	13	96	153

[Based in part on Talbot and Hammond]

though probably wildly inaccurate, gives some indication of the availability of medical care in the medieval period. We have no reliable figures for practitioners holding bishops' licences in the sixteenth century, let alone the number of unlicensed surgeons, apothecaries and irregular practitioners, but Oxford and Cambridge provided some five hundred doctors, and the fact that the Royal College of Physicians was limited to thirty fellows at the end of the century, provides some indication of the magnitude of the profession at that time.

I felt it necessary to preface my paper in this way, as my attempts at assessing medical education at Cambridge have followed the method I have adopted for Oxford, using in a very amateur way the Namier technique, examining the quality of the physicians that graduated rather than paying close attention to statutes and graces.

The early history of Cambridge University is obscure, made more so by the riot of 1381, when the Mayor and Burgesses burned all the university documents in the market place to cries of 'Away with the skill of the clerks', but there is little doubt that it evolved from teaching communities linked to the religious houses around the town, which were also concerned with the care of the sick. As early as the eleventh century, Geoffrey, a Benedictine monk, came with four of his brethren from Normandy to Cottenham where he founded a school and taught medicine, but more significant were the Augustinian Canons of Barnwell Priory who were responsible for the leper house of St. Mary Magdalene at Stourbridge and the Hospital of St. John, in All Saints' Parish, which was founded in 1135 by Henry Frost. About 1200 Robert the surgeon lived near the hospital, whose rule laid down that the brethren were to care for the sick and infirm with all kindness and mercy but were to exclude pregnant women, lepers, wounded, paralysed and insane; this was a usual restriction at the time, the aim being to avoid the hospital becoming an infirmary for the chronic sick. These stringent regulations did not apply to the Hospital of St. Anthony and Eligius which was founded by Henry de Tangmeer in Trumpington Street in 1261, where it remained until a century ago and I believe the charity still survives; in the sixteenth century the Corporation were put to considerable expense owing to the destructive propensities of a maniacal patient there.

By the middle of the thirteenth century, the university was beginning to emerge as a studium generale with a chancellor, congregation of regent masters and numerous hostels of residence; this development had been helped by the migration of masters and students from Oxford following the suspendium clericorum of 1209. It is in this century that we learn the name of the first Cambridge physician, Nigel de Thornton, who may have been a master of the university, but did not hold a medical degree; he left money in 1279 to found a university chaplaincy which was initially held by his nephew. In the following year Hugh de Balsham, Bishop of Ely, wishing to emulate Walter de Merton's foundation at Oxford, endowed some places for secular scholars in St. John's Hospital, but the canons were jealous and so he erected some hostels near St. Peter's Church and founded Peterhouse, the first Cambridge college, for a master and fourteen fellows studiously engaged in the pursuit of literature, but this did not exclude medicine for which one of the fellowships was available. There were further attempts in the fourteenth century to accommodate poor scholars as well as the sick in St. John's Hospital and it may be that some of these were studying medicine for it is in this century that the first Cambridge medical graduates appear. Simon de Holbeche was a fellow of Balliol College, Oxford, in 1307, who came to Peterhouse and held a fellowship until his death in 1335; he was a Cambridge M.A. and possibly M.D. and left medical manuscripts to both colleges. Of John Martyn of Peterhouse, we know that Bishop Montacute gave him leave to study medicine in 1339, while John de Stockton, a member of the bishop's familia, and a fellow of the college gave the library a copy of Gilbertus Anglicus in 1341 and the inscription reveals him as a doctor of medicine; he later became rector of Brington in Huntingdonshire, dying there in 1361.

One cannot be sure that these physician fellows of Peterhouse received their medical degrees at Cambridge but Richard de Oudeby certainly did; he became a fellow in 1350, received his M.B. in 1363 and M.D. later. He was ordained priest in 1371 and was rector of Todenham in Gloucestershire and later removed to London combining medicine with his clerical duties; on his death in 1391 he left a large number of medical manuscripts to his college. Almost contemporary was William de Rougham, a foundation fellow of Gonville Hall, whose statutes permitted two of the twenty fellows to study medicine; he became Master in 1360, received his M.B. in 1363 and M.D. in 1390, enjoyed a number of benefices in Suffolk, and at his own expense completed the chapel and the buildings on the north side of the Court.

Accordingly, though the evidence is fragmentary—provision of college medical fellowships, donations of medical manuscripts to college libraries, scattered names of physician clerics with their benefices—it is apparent that a medical school was evolving in Cambridge by the latter part of the fourteenth century though it was not until 1396 that the earliest medical statutes and set books are known, which are modelled on those of Oxford of a century earlier, which were based on the regulations of the University of Paris. At Cambridge the three senior faculties, Theology, Law and

Physic were on an equal footing; a candidate for the M.D. must have taken his M.A. and attended lectures on medicine for five years at Cambridge or another university, making twelve years in all, of which two must have been spent in the practice of medicine.

There were the usual regulations about disputations and lectures, and the set books were those common to European universities—Galen, Johanitius, Philaretus, Nicolaus Salernitanus, and Isaac Judaeus, whose aphorisms showed considerable clinical acumen tinged with the wisdom of the serpent: 'Treating the sick is like boring holes in pearls and the physician must act with caution lest he destroy the jewell committed to his care'; 'Make your fees as high as possible for services which cost little are little valued'.

We know at Oxford, and I have no doubt it was true of Cambridge as well, that apart from the formal lectures, the regent masters gave informal lectures which were based on practical experience rather than set books, and that the students accompanied the physicians on their visits to their patients. Academic dress for the faculty of medicine was not prescribed until 1414; like the lawyers, the physicians wore the cappa manicata edged or lined with fur, with a square cap, and it was not until the middle of the sixteenth century that the doctor of physic wore the scarlet festal robe with a hood to match, lined with miniver, while the round bonnet replaced the square cap even later.

The abortive physicians' petition to the Lords in Council of 1421 has been taken as evidence of active medical faculties at both universities but it was so vague and badly drafted that it is hardly surprising that nothing came of it; yet two years later a Cambridge physician, John Somerset, was associated with Dr. Gilbert Kymer in the shortlived conjoint faculty of physicians and surgeons which foreshadowed Linacre's more modest plan for the College of Physicians. John Somerset is the first Cambridge royal physician, an honour which Oxford physicians had enjoyed since the days of Richard I, and also the first who had not taken holy orders. He was an Oxford M.A. who came to Cambridge because of an outbreak of plague, became a fellow of Pembroke and received his M.B. in 1418; like many lay physicians he was also a schoolmaster, but soon became physician to the Duke of Exeter and then in 1428 came into the service of the young King Henry VI and attended him on his coronation in Paris. His salary steadily increased and honours were showered on him—Chancellor of the Exchequer, Warden of the Royal Mint, Surveyor of the King's works, but the Yorkist faction felt he was too powerful and when the king lost his reason they had him deposed and he died in poverty though earlier he had given manuscripts to Peterhouse and Pembroke and is said to have written several medical treatises.

Somewhat junior to Somerset at Peterhouse was John Kim, who in 1428, with the support of the Duke of Bedford, his chaplain, his physician, and the Bishop of Meaux, demanded that the Paris faculty should accept for a M.D. his three years' study at Cambridge. The Parisians stood firm and agreed unanimously that he should only be credited with half this period and that only if he produced a certified statement from his Cambridge teachers; with this Kim had to be contented, for it was not until 1431 that he was licensed by the Paris Faculty, but what happened to him after that is unknown. Rather less creditable is the affair of John Fayre, a medical fellow of Peterhouse and chaplain of St. Mary's, who broke into the house of a Cambridge widow and took away a horse and two carts.

After Dr. Somerset's disgrace the Lord Chancellor appointed a medical commission of three physicians and two surgeons to attend to the demented King and one of these was William Hatclyffe, a fellow of Peterhouse and a foundation fellow of King's, who after spending nine years in Cambridge went to Padua, the first English physician so to do, and received his doctorate within a year. During the War of the Roses Hatclyffe continued as physician, either to Henry VI or Edward IV, whichever was in the ascendant and as a Royal Secretary was engaged in various political and commercial enterprises, but he died before Richard III came to the throne. Edward IV had several other Cambridge physicians attached to the court. Edward Albon, a fellow of Gonville, James Freis, a dutchman, and William Hobbes, who graduated B.M. at Oxford in 1459 and three years later incepted as a Cambridge M.D. He is the first academic surgeon, for he was Warden of the Barber Surgeons' Company and having been in the service of Richard, Duke of York, became physician and surgeon to Edward IV and accompanied him on the expedition to France in 1475; Richard III retained his services and appointed him a joint Warden of Bethlem.

Dr. Richard Caerlyon incepted in arts at Cambridge and then studied medicine at Oxford, receiving his D.M. in 1481 and was physician both to Queen Elizabeth, widow of Edward IV, and Lady Margaret, Countess of Richmond. It is said that he acted as intermediary between the two ladies and so was able to further their plans for the marriage of Princess Elizabeth to Henry Tudor; certainly Caerlyon was thrown into the Tower of London following the Duke of Buckingham's slaughter and was richly rewarded when Henry VII came to the throne. Two other Cambridge physicians, Philip Morgan and Thomas Denman, attended Lady Margaret Beaufort after her son came to the throne, when she was living at Colly Weston and watching the development of her humanistic foundations. There are several more of these Cambridge royal physicians that one could mention, but we cannot omit one of the most distinguished, John Argentine, who came from Eton to a fellowship at King's in 1461 at the age of eighteen and, having graduated in arts, he received the M.D. It is suggested, although there is no real evidence for it, that he studied for a time at Padua, and by 1473 he was ordained. In 1483 he became physician to Edward V and Richard Duke of York—the princes in the Tower—and then received numerous preferments and gifts from Henry VII culminating in his appointment in 1501 as Provost of King's, which could be of sinister import for those who would blame Henry Tudor rather than Richard III for the murder of Edward IV's children. At any rate Dr. Argentine shared with Thomas Linacre and Dr. Stephen Bosworth of Oxford the medical care of Prince Arthur; he had a considerable library and wrote a treatise on medicine, while on his death he left a large benefaction to King's.

This table (figure 2) shows the number of graduates and their colleges in the fifteenth century and one can see the marked increase in the second half mainly due to the fellows of King's College, which was founded in 1440 by Henry VI, and whose statutes permitted two of the fellows to study medicine.

One third of all the graduates of this period were court physicians, but only three incorporated foreign degrees. It is easy enough to trace the history of these court physicians with their ecclesiastical preferments and privileges but what of the other Cambridge physicians and who taught them?

FIGURE 2

The Cambridge Medical School 1401–1500

	M.B.	*M.B.+ M.D.*	*M.D.*	*M.D. inc.*	*Clare*	*Gonv.*	*King's C.*	*King's H.*	*Pem.*	*Peterh.*
1401–1420	–	1	–	–	–	–	–	–	1	–
1421–1440	–	–	1	1	–	–	–	–	1	1
1441–1460	1	–	5	1	–	–	2	–	–	3
1461–1480	9	2	13	–	–	1	6	1	–	1
1481–1500	2	2(1 + C.L.)	4	1	1	–	3	–	–	2
Total	12	4	23	3	1	1	11	1	2	6

M.D. inc. Incorporation of M.D. from another university.

C.L. Licence to practise surgery.

In the continental universities, the professors were paid a salary as well as receiving students' fees and felt impelled to publish treatises, often mere compilations, to advertise themselves, but at Oxford and Cambridge the teachers were the college fellows and it is only by inference that one can deduce who they were. Furthermore the faculty was small and many of the physicians on obtaining their degree, received a grace excusing them from lecturing, and on at least one occasion, in 1469, there was no master to lecture and so William Skelton, a fellow of King's, was allowed to incept without the customary regency.

In the middle of the century it is very probable that RogerMarshall, a fellow of Peterhouse from 1437 to 1460, was concerned in teaching, for he had a considerable library which he gave to his own college, Gonville Hall and King's, and perhaps wrote a treatise 'Galen, that lantern of physicians and surgeons'. Certainly he was recognized as a medical authority, being called in consultation with the royal physicians over a patient suspected of leprosy, and when he moved to London in the last year of his life his opinion was often sought on the quality of various drugs. A little later there was Thomas Rede, also a fellow of Peterhouse which he vacated on his marriage in 1462, but continued to practise in the city until his death in 1502; he borrowed a number of medical books from his college, including one that had belonged to Roger Marshall. I have already mentioned Thomas Denman, one of Lady Margaret Beaufort's physicians, and he again may have been concerned with teaching, for he spent his whole life at Peterhouse, becoming senior fellow and finally master in 1500, while at his death he left a large library to his college.

At King's College in the second half of the fifteenth century there was Edward Arnold, a fellow from 1449 to 1464, later rector of St. Clement Danes, who had a large medical library, and Walter Lemster, a fellow from 1451 to 1469, who afterwards rented a room at Corpus. He later became physician to the Bishop of Ely and to the king; in the Bodleian there are some of his receipts for stone and stranguary.

Apart from the court physicians and those who remained in Cambridge, the others whose careers are known practised for the most part in the eastern counties, often combining the duties of parish priest and medical practitioner, while a few moved to London after a period in Cambridge or in the country. Robert Yaxley is an example of this; he entered Clare Hall in 1477, received his M.B. in 1486 and became a fellow in 1489, he was M.D. in 1498 and the following year took the licence in surgery—the first to do so. Next we hear of him as physician to Bishop Alcock and in 1513 he had removed to London, as he was attending Princess Mary of Castile, and in 1518 Yaxley appears as one of the six physicians, and the only Cambridge graduate, in the letters patent founding the College of Physicians. He served as a Counsellor of the college on two occasions and continued as a court physician, dying about 1540.

We have now reached the sixteenth century, a period of Cambridge medical history made more familiar due to the work of Drs. Palmer,[5] Gunther,[6] and Sir Humphry Rolleston.[1] It was a period of steady progress in medical education avoiding to a large extent, indeed profiting from the buffetings of intellectual and religious policy. First let us consider the types of the degrees that were given, a point which puzzled Venn,[7] and this table (figure 3) also provides a conspectus of the numbers graduating during the century. During the first four decades, the pattern appears orthodox enough, a few took the M.B. followed by the M.D., but the majority took either the M.B. or M.D. and there were a certain number of surgical licences. I mentioned that Dr. Yaxley was the first to obtain this licence, and throughout the sixteenth century it was given much more freely by Cambridge than Oxford. The wording of the licence, which gave the applicant the authority to practise surgery throughout England, was very similar in both universities—the candidate had to be experienced in the practice of surgery and later in the Elizabethan statutes he had to have performed two dissections and effected three cures; it relieved the holder of the necessity of obtaining a Bishop's licence, but whether it was cheaper or easier to obtain I'm not sure. Of the licence-holders in the sixteenth century one-third practised in Cambridge but what happened to the rest is not known. In the early part of the century, candidates were examined by a Cambridge physician, and we hear of Andrew Manfield, who graduated in 1503, examining two surgeons, Robert Ventris and Richard Smith; later on the examination became the responsibility of the Regius Professor and there were invariably two examiners. It would appear from Dr. Palmer's[5] studies that most of the Cam-

FIGURE 3

The Cambridge Medical School 1501–1600

	M.B.	*M.B.+ M.D.*	*M.L.+ M.D.*	*M.D.*	*M.D. inc.*	*M.L.+ M.A.*	*M.L.*	*C.L.*	*Total*
1501–1520	2	3	–	2	1	–	–	3	11
1521–1540	5	–	1	7	5	3	1	1	23
1541–1560	1	–	3	13	4	–	15(3 + C.L.)	10	46
1561–1580	1	2	9(1 + C.L.)	21	7	5	11	6	62
1581–1600	–	1	4	29	4	11	6	2	57
Total	9	6	17	72	21	19	33	22	199

M.D. inc. Incorporation of M.D. from another university.
M.L. Licence to practise medicine.
C.L. Licence to practise surgery.

bridge surgeons were not very prosperous, their goods being valued at a few pounds, but an exception was John Thomas, a graduate, who received his licence in 1514. When he died in 1545, he was living in a three-storey house, with a considerable number of surgical instruments, but only two chairs and two stools; nevertheless he had a library of ninety-one books, of which eleven were medical, including the surgeries of Guy de Chauliac and John de Vigo. Returning to the Cambridge degrees, during the second half of the sixteenth century, there is a striking change, the M.D. continues to be the principal degree, but the M.B. is hardly awarded at all; instead the medical licence seems to have taken its place, often followed by the M.D., but in at least half the cases, without any other degree. Undoubtedly the medical licence was easier to obtain; it did not involve disputations and formal acts, but merely an examination by two physicians. When we examine the subsequent career of these medical licence-holders, we find that it is not difficult to determine the place of practice of those who took the licence after the B.A.; indeed we know something of the career of eighty-five per cent of the Cambridge medical graduates of the second half of the sixteenth century, whereas nothing is known of eighty per cent of those who took the licence alone. I suppose that like the surgical licence, it was a convenient and not too difficult method for a practitioner to protect himself against legal charges of irregular practise; this is supported by Regius Professor Winterton's complaint to the President of the College of Physicians in 1635. It was very rare at Oxford to give a licence to practise to a non-graduate, but in the latter part of the sixteenth and still more in the seventeenth century, the majority of Oxford country practitioners never took a B.M., but after completing the arts course and spending another two years or so at the university, received the licence to practise.

Enough about degrees and examinations, what sort of practitioners did Cambridge produce? At the beginning of the century Cambridge was in the ferment of humanistic awakenings, derived from the enthusiasm and fortunes of Lady Margaret Beaufort, directed by her chaplain and later Chancellor, John Fisher. Not satisfied with having founded Christ's in 1506, she grafted St. John's College on to the ancient hospital, but before all the formalities were completed both she and her son, Henry VII, had died and left Fisher, surrounded with difficulties, to complete her work. John's became the college of the new learning, Cambridge's equivalent to Oxford's Corpus Christi. Though theology was the goal of all learning it was to be supported by philosophy, the arts and sciences. Four fellows were to lecture on the various branches of mathematics and there were lectures in Greek and Hebrew. It was natural that Linacre, in his desire to further the humanistic approach to medical science, should select John's for his Cambridge lectureship in physic and no doubt he was advised by Sir William Buttes, a fellow of Gonville Hall, who had taken his M.D. in 1517, and was active in Cambridge affairs as Principal of St. Mary's Hostel until 1529, when he became physician to the court, fellow of the College of Physicians, and began to play a larger part in matters of state.

At Oxford the situation was more complex, for Wolsey was making provision for the teaching of medicine at Cardinal College and there was a medical fellow at Corpus; so the administration of the Oxford Lectureships was left to trustees, with unfortunate results. The foundations were made public in October 1534, just a week before Linacre's death and nothing was stated about the subjects of the lectures, though the lecturer was not to be in private practice and every fourth year was to cease from lecturing for six months though he only received half his stipend. It was not until the Elizabethan statutes of 1570 that it was laid down that the lecturer should be an M.A. well versed in Aristotle and that he should expound Galen's works as translated by Linacre.

There is some doubt about the early holders of Linacre's lectureship at St. John's. Probably the first was Christopher Jackson, who died of the sweating sickness, that mysterious disease. But throughout the sixteenth century, Cambridge had outbreaks of plague and pestilences every five years, of which one of the most famous was the epidemic of typhus following the 1522 Assizes. Like Oxford, most of the colleges had country houses to which they could retire when conditions became too dangerous in the city. However the historians of St. John's would have it that the first lecturer was George Daye, later to be Master of his college and Provost of King's, who had studied physic and was complimented by Caius on his skill, though none of the earlier lecturers held medical degrees.

At this time there was a free interchange between Oxford and Cambridge and the continental universities, but for many of the physicians it was virtually a postgraduate tour of the European universities after six or seven years at Cambridge and at most of them it was easy enough to pick up an M.D. Canon Raven[8] has described some of the continental tours of the naturalist physicians, sometimes for choice, sometimes for religious expediency.

At Oxford, Cardinal Wolsey decided to strengthen Cardinal College by introducing scholars from Cambridge but when they arrived, they revealed themselves as imbued not only with the new learning, but also with Lutheran beliefs and were promptly imprisoned in the Vice-Chancellor's fish cellar. Amongst them was John Fryer, a fellow of King's, who, after his release went abroad and graduated in medicine at Padua, which he incorporated at Cambridge in 1535, but by now he had returned to the Catholic faith for which he was once more imprisoned. Fryer rose to be President of the College of Physicians and his two sons and a grandson were Cambridge physicians.

A more happy exchange was David Edwardes, a fellow of Corpus and Greek lecturer, who removed to Cambridge in 1528 and, after giving some lectures on Galen, was allowed to incept in medicine on the strength of his seven years' study at Oxford; he practised for a while at Bristol, but was examining Cambridge students as late as 1540. Edwardes' importance in English medical education is his publication in 1532 of an introduction to anatomy, the first book printed in England devoted to the subject, and though as a text it is unimportant, being largely based on Mundinus, yet it reveals that he himself had carried out actual dissections, the earliest evidence of practical anatomy in this country, apart from some equivocal inferences that may be drawn from a thirteenth-century manuscript. The late Professor O'Malley,[9] who has reprinted Edwardes' tract, suggested that the dissections took place at Cambridge, but I must confess that I think Oxford is more likely, as the Oxford Medical School was more developed, Edwardes had spent a long time there, whereas his book was published soon after he came to Cambridge and perhaps most important, there was a skilled teacher of surgery, Thomas Byrd, at Oxford at this time.

There were other Oxford migrants. Richard Sexton resigned a

New College fellowship to become master of Ipswich Grammar School and as he was practising medicine as well, acquired a Cambridge M.D., while Robert Huick, a fellow of Merton and Principal of St. Alban's Hall, had matrimonial troubles which necessitated his departure from Oxford; so he obtained a Cambridge M.D. and soon established himself in London, becoming a court physician and President of the College of Physicians on three occasions. There were also a number of Cambridge students who moved to Oxford for religious or social reasons.

The number of Cambridge medical students was steadily increasing, though during the period up to 1540 several went abroad as postgraduates and obtained a foreign degree. Thomas Bille, a fellow of Pembroke, who was B.A. in 1522 and M.A. in 1525, as a student of medicine was given leave to travel in 1530, received an M.D. at Padua, which he incorporated in 1533; he soon became a fellow of the College of Physicians and a court physician, attending Henry VIII, Edward VI and the Princess Elizabeth. Thomas Wendy, a fellow of Gonville, had a very similar career save that he received his degree from Ferrara. There were, of course, foreigners who took Cambridge medical degrees for security, such as John Venetus, a learned Italian divine, who was deputy Vice-Chancellor, but after Wolsey's fall and the divorce crisis, received a medical licence and so adopted a safer profession. Balthasar Geursey, an Italian surgeon in the service of Queen Catherine, who had been naturalized in 1521, obtained the Cambridge M.B. in 1530 and was able to continue as court surgeon to Henry VIII and Edward VI, even becoming a fellow of the College of Physicians in the last year of his life.

But the majority of the Cambridge medical graduates led less spectacular lives and remained in relative obscurity. For example George Caldwell took his M.B. in 1541 and practised in Northamptonshire and little more would have been known about him save that he was a licentiate of the College of Physicians in 1557, had not Sir D'Arcy Power[10] discovered a fascinating account of a consultation with the distinguished surgeon, John Halle.

About the same time Roger Ascham's younger brother, Anthony, took his degree and having been ordained, went to Yorkshire to care for the bodies and souls of his parishioners. He published a number of almanacks and wrote a little herbal, inspired perhaps by

William Turner, the great naturalist physician and reformer, who was a fellow of Pembroke at the time.

In 1540 Henry VIII established the Cambridge Regius chairs six years before those of Oxford; they carried a salary of £40 and the first holder of the Readership in Medicine, as the letters patent styled it, was John Blythe, a fellow of King's who had travelled on the continent after taking his M.A. and received the M.D. of Ferrara. Although there are the usual praises of his ability, little is really known about him and it is probable that his marriage to Sir John Cheke's sister was a factor in his appointment, for Cheke was a great friend of Dr. Buttes who had considerable influence at Court. Cheke became Regius Professor of Greek and his importance in maintaining the humanistic and scientific enthusiasm of Cambridge cannot be exaggerated. Whatever Blythe's abilities were, the school increased in size during his fourteen years' tenure of the chair and only one graduate—his brother Alexander—went abroad to study. It may be recalled that Caius left for Padua the year before the chair was established.

It was also during Blythe's professorship that Edward VI's commissioners visited Cambridge, as they did Oxford, with powers to found a medical college, but they merely defined the Regius Professors' duties more precisely. Amongst Blythe's pupils were Edward Raven, the first Linacre lecturer with a medical degree, Christopher Langton, physician to Sir Thomas Gresham, and a considerable author, though his morals got him into trouble with the College of Physicians, and two distinguished Cambridge practitioners Robert Pickering, and his successor in the Regius chair, John Hatcher. Hatcher only held the chair for a year but continued to practise in Cambridge until his death in 1587, amassing a large fortune and living in a veritable palace, the former Austin Friary, which had twenty-seven rooms and a parlour seventy yards long; Hatcher looked after Anthony Bacon when he was suffering from plague at Trinity. It was also at this time that Cambridge began to provide physicians for the Russian Court, and curiously enough the first three were all fellows of Trinity. Ralph Standishe, who arrived at the court of Ivan the Terrible in 1557, only survived two years, and his successor Richard Reynolds, although 'jolyvated with 200 roubles' on his arrival, only stayed in

Russia for a year, but on his return got into trouble with the College of Physicians who deemed him very ignorant and unlearned, and so he took holy orders. Robert Jacob was a physician to Queen Elizabeth, who sent him to the Tsarist court on two occasions, particularly for his obstetrical skill, as the Tsarina suffered frequent miscarriages, but the political intrigues of Boris Godunov overwhelmed Dr. Jacob's endeavours. At a later date, after Dr. Baldwin Hamey had managed to escape to England from his post at the Russian court, Dr. Mark Ridley, a member of Clare, became physician to Tsar Theodor I, but did not suffer the difficulties of some of his predecessors and in due course returned to London and held high office in the College of Physicians.

This table (figure 4) provides a conspectus of the place of practice of the Cambridge medical men in the first half of the sixteenth century, of two-thirds of whom something is known; they are equally distributed between London, which of course means fellows of the College of Physicians, Cambridge and the country.

It can be seen that in London all the physicians were medical graduates and the majority of those who had incorporated foreign degrees were in London or Cambridge; as yet the number with only a medical licence is small, but it should be noted that little is known of the subsequent careers of those who only held a surgical licence which is in keeping with the suggestion made earlier that the acquisition of this licence was a precautionary device.

The disproportion of graduates practising in Cambridge in relation to the size of the population, which also applied to Oxford, as Raach[11] found in his pioneer study of seventeenth-century physicians has several explanations. The mortality amongst young physicians was high, many dying within a year or so of graduation, many, particularly at this period, adopted medicine as a form of protective colouring for their religious beliefs, as it allowed them to remain as college fellows without taking holy orders, and it is often hard to know whether they ever really practised medicine at all. Those who practised in the country are equally divided between the eastern counties and the rest of the country which, though the numbers are small, is clearly a very irregular pattern, but this will be considered when the figures for the second half of the century are reviewed.

During the more stable second half of the century, the medical

FIGURE 4

Cambridge Physicians and Surgeons and their Place of Practice 1501–1550

	London	*Cambridge*	*Eastern Counties*	*Elsewhere*	*Not Known*	*Total*
Medical Graduates	3	5	2	3	8	21[88]
Medical Licence with arts degree	–	–	1	–	1	2[3]
Medical Licence alone	–	1	–	1	2	4[0]
Surgical Licence	–	3	1	–	7	11[5]
Incorporation of Foreign degrees	4	2	–	–	2	8[11]
Oxford Migrants	3	–	1	1	–	5[2]
Total	10	11	5	5	20	51[109]

[The equivalent Oxford figures are in brackets] school continued to grow, as the third table (figure 3) shows. It opens with the period of Dr. Caius' benefactions—the College fellowships, of which only the holders of those in medicine were allowed to travel, the provisions for dissections in the College and the grant of bodies to make this possible. The arrangements for dissection well display Caius' love of ceremony; the Master was to see that the students of medicine did not treat the body with any lack of respect and humility. After the dissection there was to be a solemn burial at St. Michael's on which 26*s*. 8*d*. was to be spent, and the Master and everyone in the college was to attend the funeral with as much respect and ceremony as if it were the body of a more dignified person, on account of the advantages they had received. It was also laid down that the Regius Professor should perform one anatomy a year if required by his audience and if a body was available, and we know that in 1566 one, John Figgin, was dissected at the Schools and afterwards buried at Great St. Mary's and that Thomas Grimstone, a fellow of Caius, gained considerable fame as an anatomist, as did John Gostlin, who was later Master, and Regius Professor in the seventeenth century. In addition to Dr. Caius' benefactions to his College, in 1571 Archbishop Parker provided the first medical scholarship in England and with remarkable prescience laid it down that preference should be given to Kentish men; in 1593 it was awarded to William Harvey, a sixteen-year-old boy from Folkestone. In the *Prelectiones* Harvey mentions a dissection, though it may have been more in the nature of a post-mortem examination, that he witnessed when he was at Caius, in which the subject had a very small liver and a cleft spleen, while Phineas Fletcher's remarkable poem *The Purple Island* could only have been written by someone who had witnessed a dissection. Two years before Harvey came to Cambridge, John Banister, the famous surgical teacher, presented a delightful little muscle-man and ivory skeleton to the university and it is still preserved in the library; it is of some interest that Henry Percy, 9th Earl of Northumberland obtained permission, on depositing a security, to borrow it, which casts another gleam of light on the scientific studies of the Wizard Earl and his Magi at Syon House.

At the time that Caius was Master, Thomas Lorkin, who was John Hatcher's son-in-law, was Regius Professor and held the office for twenty-seven years. He amassed a magnificent library, wrote a short text on student health, and obtained a grant of heraldic arms for the holders of the Regius' chairs. In 1564, within four months of Lorkin's appointment, Queen Elizabeth paid her first visit to Cambridge on three blazing August days, and there was a formal medical disputation as to whether simple or complex food was better for health, in which the Regius Professor, Caius, Huick, Fryer and Walker, the physician son of a former Regius, took part, but they spoke in such a low voice that the Queen, in good ciceronian latin, asked them to speak up, and this having no effect, she left her seat and came over to the stage to hear what it was all about.

In 1570 the university received a new body of statutes which governed it until 1855, and from a medical point of view, the most important change and one which had a profound influence on education, relieved students of medicine of the preliminary training in arts, so that immediately on coming into residence they started on their medical training, being eligible within six years for the degree of M.B. and five years later the M.D. This change was opposed by Lorkin and his successor Ward, and a little later the College of Physicians, aware that though the training at some of the continental universities was excellent, at others the M.D. was easily obtained and could be bought ready written, amended their fees of admission. Those with only a foreign doctorate had to pay a threefold fee while Oxford and Cambridge graduates who had spent less than seven years at their own universities were to pay double fees.

During Lorkin's Regiusship, the Linacre Lecturers at John's were all able men; there was William Baronsdale, later to be president of the College of Physicians, Thomas Randall, later to be F.R.C.P., and William Lakin, who remained as a fellow of John's for fourteen years, and there were other excellent teachers. It is very probable that Thomas Mouffet, while he was at Trinity, taught as a regent master and when he returned from Basle, having obtained his M.D. in two years, he presented a copy of his thesis to the Regius Professor. Certainly Timothy Bright taught medical students while he was at Cambridge, for he tells us in his books on *Therapeutics and Hygiene* that they were based on lectures he had given while he was at the university. Furthermore there were three

FIGURE 5

The Cambridge Medical School 1501–1600
College Attachments

	Caius	Christ's	Clare	Corpus	Emma.	Jesus	King's	Magd.	Pemb.	Peterh.	Queen's	St. Cath's	St. John's	Trinity	T.H.	Total
1501–1520	1	–	–	–	–	–	1	–	–	2	–	–	–	–	–	4
1521–1540	2	–	2	1	–	1	2	–	1	1	–	–	1	2	–	13
1541–1560	3	2	3	1	–	–	5	–	3	2	2	1	4	3	–	29
1561–1580	5	5	3	1	–	3	6	1	1	9	–	–	12	13	–	59
1581–1600	5	5	6	4	1	9	7	3	6	1	4	–	2	13	1	67
Total	16	12	14	7	1	13	21	4	11	15	6	1	19	31	1	172
	9.5%	7.0%	8%	4%	0.5%	7.5%	12.0%	2.5%	6.5%	9%	3.5%	0.5%	11%	18.0%	0.5%	

practitioners in the city, Isaac Barlow of Trinity, Stephen Perse of Caius and William Butler of Clare, whose abilities were recognized all over England. Butler, though not a fellow of the College of Physicians, was given a special dispensation in order that he might visit his patients when they were in London; all these men had pupils.

This table (figure 5) shows the college attachments of medical students and physicians during the sixteenth century and it is of interest to compare it with Rook's findings for a later period.[12] In the sixteenth century the order of 'popularity' of the Cambridge Colleges was Trinity, King's, St. John's, Caius, Peterhouse and Clare, which corresponds fairly well with the statutory provision for medical fellows. At Peterhouse and Clare one of the fellows might study medicine, at King's College and Gonville Hall two fellows were allowed to study medicine and when Gonville was refounded as Caius the medical influence became much stronger as was true of St. John's with the Linacre Foundation, while at Trinity two of the fellowships were reserved for medicine; however the statutes of Queens' College laid down that one of the fellows must study medicine, but this seemed to have little effect. In contrast, in the period 1660–1760 studied by Dr. Rook, the order was St. John's, Caius, Christ's, Trinity, Emmanuel and Jesus and in certain colleges, such as Christ's, this popularity was a reflection of the ability of the medical tutors.

It would take too long to give a biographical account of the distinguished Cambridge medical graduates of the second half of the sixteenth century but this table (figure 6) provides the bare bones. One can see that three-quarters of the Cambridge graduates did not practise in London and that is why deductions from Munk's *Roll*[13] valuable though it is, are so misleading if we wish to gain an idea of the medical profession of this country; however half of those who had been abroad—in all they only form nine per cent—were practising in London and this is reasonable enough. I would not claim that the training at Oxford and Cambridge was better than that at Padua, Basle or Leyden in their heyday, but the continental universities like every other institution had their ups and downs.

The numbers of practitioners in Cambridge is still dispropor-

FIGURE 6

Cambridge Physicians and Surgeons and their Place of Practice 1551–1600

	London	Cambridge	Eastern Counties	Elsewhere	Not Known	Total
Medical Graduates	26	8	15	14	12	75[122]
Medical Licence with arts degree	4	3	8	1	1	17[28]
Medical Licence alone	1	–	3	1	21	26[1]
Surgical Licence	1	5	–	–	8	14[3]
Incorporation of foreign degrees	6	1	–	3	3	13[14]
Oxford Migrants	–	–	–	2	1	3[2]
Total	38	17	26	21	46	148[170]

[The equivalent Oxford figures are in brackets] tionately high in relation to the population, probably for the reasons that have already been mentioned, but once again, of the practitioners in the country, over half practised in the eastern counties and similar studies of Oxford graduates have shown an analogous preponderance in the lower Midlands, Somerset and Devon. It would be interesting to know how medical care was provided in the north of England before the eighteenth century.

I have attempted, in a rather superficial manner, because I am far from sure of my facts and sources, to show that in this period the idea put forward by Bullough[14] and others, that there was no medical training at Cambridge is illusory; a small but distinguished minority did receive part of their training abroad, but the vast majority of English practitioners had been trained at Oxford and Cambridge, many were very able, some were less so, but they provided for the medical care of the community and that care was as good if not better than that which was available to the peoples of Italy, France and Germany. The English schools were small and the teaching was personal, partly by apprenticeship, partly by tutorial instruction and though they were formal lectures they were, for the most part as they should be, a relatively unimportant part of medical education, in striking contrast to the mass of impersonal lectures that characterized the continental schools; it should not be forgotten that though bedside instruction existed for a short time in Padua in the early part of the sixteenth century, it really originated in 1658 with Franciscus Sylvius in the little twelve-bedded hospital at Leyden. It is true that public dissections, though a statutory requirement at Oxford and Cambridge, were infrequent, but post-mortem examinations were common enough by the latter part of the sixteenth century and it is apparent that this provided a familiarity with the main anatomical structures in health and disease, although the interpretation of the appearances might be confused by galenical authority.

There are probably a number of reasons why the English schools did not attract foreign students of which perhaps one of the most important was lack of publicity; the English teachers wrote little, except when they had something to say, whereas the continental professors published their commentaries and consilia, for the most part compilations of little originality, though of course there were honourable exceptions. The expenses at Oxford and Cambridge were higher than on the continent, while the studentships and fellowships were largely restricted to our own countrymen and, lastly, and by no means least important, were the religious restrictions of the English universities. One would not question that an English physician, having spent his undergraduate period at Oxford or Cambridge, followed by a year or two postgraduate tour of the continental medical schools, picking up an M.D. on the way, would have a wider experience of medicine than one that had stayed at home, but whether the English-trained physicians were better or worse doctors than those trained abroad is an insoluble enigma, because I know no satisfactory definition of a good doctor, although all of us know which of our colleagues we would like, or would not like, when we are ill.

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John Caius (1510–73)

by

W. S. C. COPEMAN

JOHN KEES of Norwich made his first appearance, *in statu pupillare*, at Gonville Hall on 12 September 1529, and in accordance with prevailing custom latinized his name to Caius,* although he retained its original pronounciation. He was a studious, meticulous, introspective, rather gloomy youth with no relaxations outside his work, and this remained the pattern of his life. He lacked 'the common touch'; and although much respected, the only real friend he ever made appears to have been the distinguished Swiss naturalist, Conrad Gesner. He was, however, possessed of a strong and determined personality which enabled him generally to achieve his purposes, and since this was combined with an arch-conservatism his contemporary influence on the development of medicine in this country was in some aspects an anachronistic and retarding force. This was largely owing to his abnormal devotion to Galen and his works, in defiance of growing continental academic criticism. His positive contributions, however, which were more considerable, will be considered in greater detail.

His portraits and engravings show a determined-looking, intelligent, observant face with a high forehead, and a long grey beard which was found intact when his tomb was opened by

* Lord McNair, a distinguished legal Fellow of Caius College, has recently conducted an inquiry into Shakespeare's probable reason for naming his comic French doctor in *The Merry Wives of Windsor* Dr. Caius (*Med. Hist.*, 1969, **13**, 311–39). He examines a number of possibilities, but decides that most probably Shakespeare merely needed some name by which the audience would realize that his character was a medical man; and was not interested in any other association or any intention of lampooning our John Caius, M.D. Other dramatists of the period used such names as Galenius, Hippocrates, or even Quack, in a similar sense.

Professor Macalister in 1891. Tradition reports that he was only 'an inch more than five feet tall', and this was also confirmed from measurements made by the Professor on that same occasion. He became a voluminous author and in spite of the loss of many of his compositions in manuscript he himself listed towards the end of his life eighty-eight publications of which he was author, editor or translator.

Caius considered himself the spiritual descendant of Thomas Linacre and his band of medical humanists whose aim had been to recover the original perfect Greek texts of the Fathers of Medicine from Hippocrates onwards. These they believed would be found to contain all knowledge necessary for the cure of disease and preservation of health. By this concept medical advance thus lay chiefly in the field of literary philology, and this view was largely maintained by Caius who, after leaving Cambridge and taking an M.D. degree at the foremost university in Europe—Padua—travelled throughout Europe visiting the great university and public libraries to examine their manuscripts. In Florence he was greatly assisted in that task by Cosimo de'Medici: 'that best of Dukes . . . I am unable to speak of his merits with all the honour they deserve'. In his so-far unpublished fragment of autobiography *De libris suis* (1570)—translated by C. D. O'Malley—he speaks of his wanderings through Italy, upper and lower Germany and France visiting libraries and scholars, since: 'whatever one studies is like water, which is more pleasant when drunk from its very source'. For a similar reason he records that he had decided from the beginning: 'to read in Latin what an author originally wrote in Latin, and in Greek, what in Greek'. It was at that time that he first met Conrad Gesner in Basle. He records later that: 'I wrote for him an account of the rare animals and plants and herbs, quadripeds, birds and fish . . . you will find all these things with illustrations' in his great book on Natural History: *Historia Animalium*. 'I also wrote a book on british dogges for that same person, a very dear friend . . . whose unexpected death [in 1565] . . . so affected my spirit that time, which usually relieves the most bitter sadness, has not yet lessened my grief over him'. He describes his: 'very splendid character, his rare understanding and infinite reading . . . I loved him greatly.'

If Caius did not mix easily with the majority of his fellow men, it would seem also that he was something of a misogamist, for the only mention of women I can find in his works is of such 'blue-stockings' as the Lady Anne Bacon: 'a woman very learned in Greek and Latin . . . our very erudite former Queen Mary, and the present Queen Elizabeth', to both of whom he was appointed as personal physician. He also refers with approval to the two learned Margarets, wives respectively of his colleague John Clements, and William Roper.

It would appear that he originally had been destined for the church and that his conversion to medicine may have resulted from his conservative distaste for: 'that new religious persuasion that had begun to sprout in England'—the Reformation. He remained a Roman Catholic, if a somewhat liberal one, to the end, and indeed ultimately sacrificed his academic and court career to that faith.

Caius' reputation rests largely upon his introduction of practical anatomical studies into the medical curriculum; and for seventeen years after his return to England in 1545 he presented annually his pioneer anatomical demonstrations in the Hall of the Barber-Surgeons in London. It is interesting to speculate what type of anatomy he taught. He was well aware of the iconoclastic 'new anatomy' of Vesalius with whom he had shared lodgings in Padua for several months whilst the former was compiling his great *Fabrica.* Caius, however, greatly deplored Vesalius' direct assaults on the authority of Galen's anatomical classics, and in the summer of 1540 they quarrelled and parted company. The only references he makes to Vesalius in his autobiography merely confirm these facts, and tell us that: 'I have warned the reader of these commentaries of certain places in Galen's writings which Vesalius corrupted', and again, that Vesalius had expressed: 'very incongrously and clearly incorrectly Galen's views' e.g. on the ginglymus, whilst in *Libri aliquot Graeci* he directs some notes against Vesalius and his *Fabrica.* Of Galen he eulogises 'A man so great that the world has had none such in Medicine since his death, nor will have again; whom the former age almost worshipped'. Accordingly, I find it a little difficult to believe as is generally assumed, that the ultra-conservative, crotchety, self-reliant Caius, who confessed to having little sympathy for new views whether religious or political, was likely to have framed his course upon the Vesalian pattern rather than that of Galen whose anatomy he tells us he completely accepted, with:

'trifling additions' of his own, which he modestly thought might have been known to Galen, but have been beneath his dignity to comment upon.

Whatever the subject-matter of his lecture-demonstrations, it was he who arranged, through his influence at Court, that the bodies of: 'foure persons condempned adjudged and put to death for feloni' were made available annually for this purpose, and in 1565, whilst he was President, the same number for the College of Physicians. In that year he also obtained the grant of two bodies annually, free of payment, for dissection at his college in Cambridge, thus establishing its medical reputation as 'a nest for good physicians', of which some trace still remains. It appears to have been many years, however, before his fellow physicians became equally convinced of the relevance of anatomical studies to medicine.

At a time when the leading English medical men wrote but little, Caius seems to have been a 'compulsive' author. He translated a very large number of the Greek galenic medical manuscripts, which he discovered upon his travels, into the scientific *lingua franca*, Latin, and learnedly emended them. His apology for also using the opinions of others so extensively for this purpose is attractive: 'If we irrigate our gardens with alien streams, are they for that reason not our gardens?' His modern fame rests however principally upon his little *Boke or Counseill against the Disease called the Sweate* which he: 'published hastily, or rather poured forth' in 1552 as a matter of urgency, to record his observations of the ghastly epidemic of that name which had ravaged the country during the previous year. This monograph was the first original description of a specific disease and its treatment ever to be published in England. Moreover, it was written in the vernacular since Caius felt that his advice was needed throughout the country.

He also wrote two books on the medical methods of the Paduan physician da Monte (Montanus): 'My preceptor in Medicine', whom he admired greatly. Da Monte's practice was entirely galenic, but his subsequent fame rests upon his pioneer use of the bedside method of teaching his students: thus he was the founder of clinical medicine as we understand the term. It seems to be one of the many unsolved questions relating to Caius that, imbued as he says he was with da Monte's views, he himself never, to my knowledge, initiated or advocated the introduction of that method of teaching into this country. This had to wait for 250 years and arrive via Leyden. Of his epitome of the master's opinions he stated that it was quite simply accomplished, by: 'squeezing the blood and marrow from his words, like a nut from its shell.'

Towards the end of his life, prematurely worn out with constant gastric pain and life-long physical disability he wrote: 'I am now sixty years old, but more possessed by old age than by senility', so he hoped that unless the Fates were to prevent him by breaking the thread of his life: 'to complete the project of publishing a definitive edition of all Galen's extant works—for they are the works of genius.'

His book on dogs already referred to was translated into English in 1576, after Caius' death, by Ambrose Fleming: *Of Englishe Dogges*. Its approval by James I is thought by O'Malley to have initiated: 'the tradition of the Englishman's devotion to his four-footed friend'. This may perhaps be doubted, however, since although Caius warmly approves of those dogs which serve a sporting or useful purpose, from the noble blood-hound to the humble 'Turnspit', the day of the purely pet dog, however, had not arrived. Of these he says: 'They are sought for to satisfy . . . wanton women's wills—instruments of folly for them to play and dally withall, to tryfle away that treasure time, to withdraw their mindes from more commendable exercises, and to content their corrupted concupiscences with vaine disport.'

Caius also wrote the *Annals of the College of Physicians,* from its foundation until 1565: 'the last year of my presidency', and the *Annals of Gonville Hall at Cambridge* from its origins to the year 1570, which were: 'only for the private use of each college'. Both these valuable accounts have been published.

The latter college, which was renamed Gonville and Caius in 1557, he refounded magnificently at his own expense during his years of busy medical practice in London. He doubled its revenue and also endowed it with three new Fellowships and twenty Scholarships; whilst through various other gifts he also indulged his love of symbolism which was one of his most marked characteristics. He also enlarged and rebuilt it extensively, and it is revealing that it was on hygienic grounds that he limited his great Court to three sides of a square. The College persuaded him in 1558, unwillingly, to accept the Mastership, which he did eventually with the understanding that he would draw no emoluments from the office. Unfortunately the Fellows were mostly of the new-fangled 'Puritan' way of thinking, and conflict soon developed between them and their sad, stern, irritable, feeble-voiced, Catholic-orientated Master. He acted promptly and directly to their insubordination, however, and just expelled them one after another, as he had the right to do, expressing his contempt in general also for the indolence and deficient learning of juniors. They obtained retribution, however, in 1572 when, with the authority of the Vice-Chancellor, they pillaged his Lodge and stripped it of those 'papal abominations' which they allegedly found stored there. His account of these matters in the *Annals* is dignified but bitter, and as the result he retired to his small house in London within the precincts of St. Bartholomew's: 'much grieved and disturbed' and lived there the life of a recluse. After several months of increasingly 'Greate infirmitie and weakness' he wrote to Archbishop Parker: 'I cannot eat anything but yt swelleth in my stomacke and putteth me to payne so that I am afrayde to eate . . . I have done here at Cambridge all things according to my minde . . . and depend of God's mercy onlie'. He added that: 'It ought to be enough solace that a man has lived well, that he died well, and that he be highly thought of because of the singular endowments of his mind . . . that fortunate man rests in peace'. He had previously written in his autobiography, in the words of Cato the Elder: ' . . . I have so lived that I believe I was not born in vain . . . a noble day when I shall . . . depart from this turmoil of scourings'. He died utterly worn out physically at the age of sixty-two on 29 July 1573, and was buried in the chapel of his college where his elegant tomb can be seen. Of the inscription placed upon it by his own wish, Thomas Fuller remarks: 'Few might have had a longer, none ever had a shorter epitaph: *Fui Caius*.'

In summary, John Caius was one of the most learned men of his age and he carried the medico-literary aims of his hero Thomas Linacre to their logical conclusion. In London where his successful medical practice officially embraced the courts of three successive sovereigns, his main preoccupation was to consolidate and extend the professional stature of the College of Physicians which had been established by Linacre in 1518, and in that way to improve the quality of British medicine. He was elected President upon nine occasions,* ruling with a rod of iron, somewhat ironically counteracted by his symbolic gift of the silver caduceus: 'to signify gentle, prudent governance'. In that way he contributed largely to the status and significance of what was beginning to develop into a dignified, learned and socially significant profession, at last freed from ecclesiastical domination.

His official criticisms of the current standards of English university medical education was a factor which initiated improvement in due course; and his advice to students of his Cambridge college to seek at least some part of their education abroad showed him to be aware of current medical advances on the continent of Europe. It has been pointed out that it may thus have been Caius' advice which sent William Harvey from that College to Padua during the following century, and so introduced the scientific method into medicine. It has been mentioned also that it was due to his sole pressure that anatomical studies became accepted as an integral part of the medical curriculum.

Of his Cambridge Foundation Dr. Venn remarked in his history of Caius College (1923): 'Acts of beneficience such as his are rare at any time, but a gift like this . . . must be almost unique', echoing the words of Caius' supporter, Archbishop Parker: 'Founders and benefactors be very rare in these dayes . . .': sentiments which we can still experience today!

It may be said that John Caius was the last of the great scholar-physicians thrown up by the explosive forces of the Reformation; and was possibly the first English medical educationist in the modern sense; he made possible a curriculum of medical studies objectively based, in spite of their predominantly galenic bias,† which resulted from that excessive reverence for the past which was evident not only in his medical writings.

* It seems regrettable that there is almost no memorial to Caius in the fine new College opened in 1966.

† In his enlightened concern with the teaching, practice and administration of medicine, Caius accepted such contemporary new thought as did not conflict directly with acknowledged galenic doctrine.

ACKNOWLEDGEMENTS

I acknowledge with gratitude the assistance I have received from Dr. F. N. L. Poynter, the late Professor C. D. O'Malley, and the Master of Gonville and Caius College.

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Francis Glisson

by

R. MILNES WALKER

AT THE time when John Caius died in 1573, Thomas Lorkin was Regius Professor of Physic. He was followed by William Ward, William Burton, John Gostlin and John Collins. None of these was particularly distinguished, and John Collins was reprimanded for not making one 'anatomy' during a year.

Ralph Winterton, who became Regius Professor in 1635 when only thirty-five years of age was a more remarkable man. In 1625 he had unsuccessfully contested the Regius Chair in Greek, so he consulted John Collins who advised him to transfer from the study of mathematics to medicine, and he received the university licence to practise in 1631. Among his writings were the aphorisms of Hippocrates in Greek verse. He tightened up the rules in granting licences to practise, and on one occasion refused to allow a Leyden doctor to be incorporated at Cambridge without testimony of his ability. He insisted on a twelve-year course for the Doctorate in Medicine. Unfortunately he died after only one year as Regius Professor and Francis Glisson was appointed in his place.

Francis Glisson came from a Suffolk family, but his grandfather Walter Glisson had moved to Bristol and married Joane Cooke of that city. He seems to have traded very profitably, for we know from the Bristol Apprentice and Burgess Books that he took several apprentices in 1554. He was a Notary Public and a churchwarden of St. Lawrence's Church. He also owned a number of houses and in 1595 was a feoffee of the parish of St. John's. He had two sons and two daughters. The elder son, Israel, became a bachelor of Civil Law, went to live at Brislington some four miles outside Bristol and inherited the residue of his father's estate. The second son, William, is described as a taylor, and was made a freeman of the City of Bristol in 1593. He married Mary, daughter of John Hancock of Kingsweston, Somerset and South Perrott, Dorset, and had a family of at least thirteen children. Of these Francis was the third child and second son and he was probably born in Bristol in 1598 or 1599. I have elsewhere (Walker (1)) given the evidence for this as against the usually-quoted statements that he was born in 1597 at Rampisham in Dorset. It was early in the new century that the family moved to Rampisham and the names of the younger members of the family after 1604 appear among the baptisms in the parish register. The village then had its own school under Mr. Allot or Hallett which Francis attended for seven years before going up to Cambridge.

GLISSON AND CAMBRIDGE

He entered Gonville and Caius College as a pensioner on 28 June 1617 and was a scholar from Michaelmas of that year until Michaelmas 1624. He graduated B.A. in 1620 and M.A. in 1624 and was then made a Fellow of the College holding this for ten years until 1634. The versatility of medical education at that time is shown by the fact that he was lecturer in Greek in 1626 and became Dean of the College in 1629. The next few years must have been spent mainly on his medical studies for he received his M.D. in 1634, but he had probably been practising since 1631 as he was elected a Fellow of the College of Physicians on 30 September 1635, and for this four completed years of practice were required. There is no evidence that he received any of his medical education on the Continent as was common amongst the more eminent physicians of that time, and he probably received most of it in London as it was unusual for physicians practising outside London to be elected to the Fellowship of the London College. We have no evidence of his being apprenticed to another physician nor that he ever left England throughout his life. Probably much of this time was spent at Cambridge, though he was fortunate that Winterton's early death gave him the opportunity of being appointed Regius Professor of Physic at the age of thirty-seven.

Apart from wrangles about his salary as Regius Professor this almost brings to an end the written evidence of his association with Cambridge, and though he held the Chair for forty-one years, Michael Foster (1901) says that there was no evidence that he ever gave any courses of lectures at the university. According to the Elizabethan Statutes of 1570 which were still in force, the duties entailed the reading of Hippocrates and Galen four days in the week, all medical students being obliged to attend, and if the students so desired, the performance of one 'anatomy' a year. In 1646 an order was given that the Regius Reader in Physic should resume his anatomical demonstrations and the neglect of his duty 'through a paltry economy' was severely condemned (Rolleston, 1932). This economy may have referred to the arrears of his salary. At least we know that he visited Cambridge in June 1652 to examine a candidate for his doctorate, as I shall describe later.

About this time he married Maria Morgan, but the only evidence that I have been able to trace is a letter dated 1638 from Thomas Morgan to his daughter Maria, wife of F. Glisson of Caius College Cambridge (Sloane MS (1)). It seems likely that she died soon afterwards, and no children are mentioned in his will.

The Regius Chair of Physic had been founded by Henry VIII in 1540 with a salary of £40 a year to be paid quarterly. With the disturbed political situation of the times, when King Charles was running short of money and in April 1640 Parliament refused to grant him any funds, it appears that the payment of the salary of the Regius Professor ceased. Glisson sent a number of petitions to the Committee of the King's Revenue for arrears of payment. In 1643 £150 was owing, but some time after this he received a payment of £80. However the arrears steadily mounted and petitions for £220 probably in 1645, £280 in 1648 and £320 in 1649 were sent in. Later Cromwell honoured the King's debt for in April 1654 at a meeting of the Council at Whitehall the Lord Protector and the Council ordered the Receiver General of the Public Revenue to pay to Dr. Glisson 'all such moneys as are due and in arrears for his said professor's place' (Sloane MS (2)).

Although he took his duties as Regius Professor somewhat lightly, he evidently felt in 1675, when he was seventy-six or seventy-seven years old that they were too much for him for he obtained a deed as follows. 'Know all men by these presents that I, Francis Glisson of the University of Cambridge, Doctor of Physic and the King's Majesties Reader or Professor of Physick in the said University do hereby (as much as in me lies) constitute and appoint Robert Brady Doctor of Physick and Master of Gonville and Caius Colledge in this said University to be my deputy to perform all dissertations exercises and duties to me the said Francis Glisson appertaining to be done as Reader or Professor aforesaid. In witness whereof I have hereunto set my hand and seal this first day of September in the seven and twentieth year of the reign of our Sovreign Lord King Charles the second and in the year of our Lord one thousand six hundred seventy and five' (Sloane MS (3)). From a statement in Glisson's will it appears that he retained the salary and expected Dr. Brady to do the work for nothing.

This ends what we know of Glisson's association with Cambridge except for his bequests. In his will he wrote 'I doe give and bequeath unto Caius College in the University of Cambridge (of which I was formerly a Fellow) two peeces of plate each of them of the value of Six Pownds Thirteene shillings and Fower Pence with the Armes of the said Colledge and my Armes and as of my Gift engraven thereupon' (Figure 1). 'And I doe give unto Trinity Hall in Cambridg aforesaid a peece of Plate of the value of Six Pownds Thirteene shillings and Fower Pence with the Armes of the said Hall and my Armes and as of my Gift engraven thereupon'. He also left 'a peece of Plate of the value of Fyve Pownds to Doctor Carr one of the Fellows of Christ Colledg in Cambridg' and to the University of Cambridge 'all such moneys as at the time of my death shall be due to me out of and from his Majesty's Exchequer as Regius Professor of the said University. And I doe hereby declare that the same money shall not be charged upon my Executor to procure the same for them but only that he do give a letter of Attorney or Assignment to the said University to receive the same of his Majesty and do give a discharge or discharges for the same as by Law is required.'

GLISSON AND THE COLLEGE OF PHYSICIANS

Glisson's first contact with the College of Physicians was on 15 September 1634 when he was admitted as one of the Candidates for that year who were limited to six by the rules of the College. On 30 September of the following year he was elected a Fellow, the total number being thirty at that time and almost all were practising in London. His return to Cambridge on his appointment as Regius Professor cannot have been of long duration and most of the rest of his life was spent in London. At least from 1647 to 1671 his address was 'Lodging in Fleet Street near the Three Kings at a Cutler's Shop', but for the last few years of his life he lived in New Street, near Shoe Lane in the parish of St. Bride's (Sloane MS (4)).

His next contact with the College of Physicians was in 1639 when he was appointed Reader in Anatomy and the following year he was Goulstonian Lecturer. The subject which he chose for this was the liver, but he, as Reader in Anatomy, gave a course of six lectures, delivered in English as was the custom at that time, and these dealt with the abdomen and thorax. In the British Museum (Sloane MS (5)) are his notes for these lectures and in one of them he says that he will only give a short description of the liver as he had lately written about it. His *Anatomia Hepatis* was not, in fact, published until 1654, so it appears that he held his position as Reader in Anatomy for a considerable number of years. Referring to his book on the liver, there is a draft for a preface for it in which he states that he had about a year to prepare the lecture (Sloane MS (6)). After the lecture he was pressed to publish it, and he intended to do this in English, but it was pointed out to him that it ought to be translated into Latin 'the language of the learned.' Though he approved of this argument he wrote that it would be 'a thing nauseous to me to do that over again what I had done before and only busy myself in altering the language. I must confess my memory was never very happy for words nor that I now had the patience to translate'. His friend, Dr. George Ent, offered to make the translation for him and Glisson 'with most thankfulness accepted his kind offer'. In spite of this, when the book was eventually published there is no reference to any help from Dr. Ent. but it may be that Ent refused to have his name mentioned.

His first promotion to office at the College of Physicians was in 1655 when he was named one of the eight Elect whose duty it was to choose the President, the Consiliarii and the Censors. The following year he became a Censor, and in 1666 a Consiliarius. This was the year when the College at Amen Corner was destroyed in the Great Fire. Glisson, unlike most of his colleagues, remained in

London throughout the plague, and he attributed his avoidance of infection to his placing in his nostrils bits of sponge dipped in vinegar when visiting his patients. Thomas Wharton was another physician who remained in London at this time, and Glisson was evidently associated with him, for they were both Censors. There is a reference to their making an autopsy together at St. Thomas's Hospital on a scorbutical patient (Sloane MS (7)).

In 1667 he was elected President of the College, succeeding Sir Edward Alston who had held the office for twelve years, and who had given offence to some of his colleagues. Glisson's position must have been a difficult one. All the College funds, including the contributions from the new honorary Fellows, had been stolen and the building had been destroyed by fire. He instituted a plan for building a new College heading the list of subscriptions with a gift of £100, with Dr. Hamey, who had been Treasurer, giving a similar sum (Sloane MS (8)). Dr., now Sir George, Ent succeeded him as President in 1670. Glisson remained a Consiliarius until the time of his death, but after he ceased to be President he took little part in the affairs of the College. Two of his books, the *Anatomia Hepatis* and the *Tractatus de Ventriculo et Intestinis* were dedicated to his Alma Mater, the University of Cambridge and to the College of Physicians of London.

GLISSON AND THE ROYAL SOCIETY

In 1645, according to John Wallis, a group of 'divers worthy persons inquisitive into natural philosophy and other parts of human learning' met regularly in London to discuss their problems (McKie (1)). The majority were doctors and included as well as Glisson, George Ent, Jonathan Goddard, Charles Scarborough, Christopher Merritt, John Wilkins and John Wallis. Dr. Jonathan Goddard had graduated at Cambridge in 1638 and was practising in London, but subsequently accompanied Cromwell to Ireland in 1649 and to Scotland in 1650. After the Restoration he became Professor of Physic at Gresham College. Dr. Charles Scarborough was another Caius man who graduated in 1639 and later was the Anatomical Reader at the College of Physicians, and after Glisson's death was appointed to his place as Consiliarius. He was knighted in 1669. At the time of the meetings in London he was a mathematician which he regarded as a good preliminary to the study of medicine. Dr. Christopher Merritt, a graduate of Oxford, was a friend of Harvey who nominated him keeper of the Library which Harvey gave to the College in 1654; he was later expelled from the Fellowship after a long dispute about his position after the library had been destroyed in the fire. Dr. John Wilkins was not a doctor but a parson who eventually became Bishop of Chester; he was so far ahead of his time in that he tried to devise means of flying to the moon. John Wallis had been a pupil of Glisson's at Cambridge, but never graduated in medicine. He was also a mathematician who became Savillian Professor of Geometry at Oxford. The group met weekly either in Dr. Goddard's house or at the Mitre in Wood Street, but before long the Civil War interfered too much with their gatherings and some of them moved to Oxford.

About the same time, as Glisson tells us in the preface to his book on rickets, he had also taken part in meetings of doctors to discuss subjects of mutual interest. Two, Doctors Ent and Goddard, were also in the group already mentioned, but the other doctors were Thomas Sheaf, George Bate, Assuerus Regimorter, Robert Wright, Nathan Pagett and Edmund Trench, all at that time or soon afterwards Fellows of the College of Physicians. Dr. Wright died in 1646, but their meetings seem to have continued until the time of the publication of the treatise on rickets in 1650, though owing to the war they must have been somewhat irregular.

These and other meetings of groups of persons interested in furthering scientific knowledge were all leading up to the foundation of the Royal Society which became possible when peace was restored. The meeting at which a definite decision to found the Society was made took place at Gresham College on 28 November 1660 in order to discuss the 'founding a colledge for the promoting of Physico-mathematicall Experimental Learning' and though Glisson was not present at the meeting he was among the forty-one persons 'judged willing and fit to joyne in their design'. Thus he became one of the original Fellows (McKie (2)). This led to some argument with Dr. Baldwin Hamey who was at that time a Consilarius of the College and regarded the Royal Society as a rival to the College of Physicians (Keevil, 1953).

GLISSON'S ORIGINAL WORK AND PUBLICATIONS

De Rachitide sive Morbo Puerili

Glisson's first book was his work on rickets, the first edition being published in Latin in London in 1650. In the preface he tells of the meetings of a group of physicians to which I have already referred, at which written papers were communicated 'which som of us Physicians use sometimes to have for exercise sake in the works of Art'. At one of these meetings it was decided to prepare a treatise on rickets, and Drs. Glisson, Bate and Regimorter were charged with the task. 'When Dr. Glisson in the judgement of the rest had accurately interweaved his part (which comprehended the finding out of the Essence of this Diseas) and in that had propounded many things different from the common opinion of Physitians (though perhaps the less different from the truth) we altered our Resolution, and committed the first stuff of the whole work to be woven by him alone, lest at length the parts should arise deformed, mishapen and heterogenous to themselves'. As a result the work was entrusted entirely to Glisson, though the names of the other two doctors appear on the title-page as having assisted him and from the style it seems likely that he incorporated sections written by them.

It was thought at that time that rickets was a new disease. It had first been mentioned in the Bills of Mortality of the City of London in 1634 as a cause of fourteen deaths, but the number had increased to 476 out of 15,000 burials in 1659. Glisson thought that it had first appeared in Dorset and Somerset and had spread from there. His clinical description of the disease is remarkably accurate, but he made the mistake of thinking that the bones were more flexible or pliable than the bones of healthy children. He attributed the bending of the bones to their being 'more plentifully nourished on one side and therefore do grow out more on that than on the opposite side'. He thought that it was more common in wealthy families who 'lead an idle, loose and effeminate life and thereupon fall into a moister, softer and degenerate constitution'. He devised a number of splints to try to prevent the deformities. Short accounts of the disease had previously been written by David Whistler as his dissertation for his M.D. of Leyden, and by Arnold Boate.

A sling which up to the last century was known on the Continent as Glisson's sling was devised to reduce the deformity of the spine.

This consisted of suspending the child by slings under the chin and arms, and 'so that the parts may be more stretched, hang leaded shoes upon the feet and fasten weights to the body that the parts may be the more easily extended to an equal length'. But he did not neglect the polypharmacy of the time and one of his prescriptions for an internal remedy for rickets contained maidenhair, liverwort, agrimony, dodder, roots of fernbrake, grass, sparagus, flowers of tameris, raisens, white tartar, liquoris, mace, white or Rhenish wine and syrup of hartstongue.

An English translation by Philip Armin appeared in 1651, and Nicholas Culpeper, in the same year, produced an edition which he claimed to be 'enlarged, corrected and very much amended throughout the whol book', though in fact it is almost an exact copy. Further London editions of the Latin version came out in 1660 and 1671, and from Leyden in 1671 and the Hague in 1682. The Leyden edition, described as the third edition, has an interesting title plate showing a doctor examining a rickety child, two other children showing spinal and leg deformities, and a femur and spine hanging on the wall (Fig. 2).

Anatomia Hepatis

This is the book which established Glisson's reputation and led Boerhaave to describe him as the most exact of all anatomists. I have already mentioned how he came to study the liver in preparation for his lecture at the College of Physicians in 1641. He learned much about the internal anatomy of the organ by corrosion casts, or as he expressed it 'I applied myself very much to excarnate the liver and so doing found the readiest way for the same, and made many discoveries formerly unknown'. It was not until thirteen years after the lecture that the book was published. He described in detail his methods of studying the internal anatomy of the liver giving two expedients which he said former anatomists understood only imperfectly. The first was the use of a syringe and the second was the corrosion of the parenchyma. His syringe consisted of a catheter attached to a bladder which he described as a modification of the instrument commonly used for enemas. His corrosion method was to cook the liver thoroughly for a whole hour at least, then throw the water away and when the liver became cool to pull the parenchyma off the vessels of the liver with small sticks prepared for the purpose. When he wrote most of the book he was unaware of the lymphatic vessels of the liver for he said that their discovery was only recently made and the treatise was almost finished before they became sufficiently known to him. It was when reading a dissertation for the Cambridge doctorate by Dr. George Joliffe in 1652 that his attention was first drawn to them. He therefore made some investigations of his own and showed that the 'aqueous ducts' as he called them, carried lymph away from the liver and not to it.

The first part of the book deals with general anatomy, and then forty-five chapters are devoted to the liver, giving in great detail the arrangement of the blood vessels. Regarding the sheath of the portal tracts which is known as Glisson's capsule, he states that he had first identified it about twelve years previously when making corrosion casts of the livers of animals. No reference is made to John de Wale of Leyden who had noted this sheath in the dog in 1640 but had not described it in detail (Walaeus, 1645).

The first edition of the *Anatomia Hepatis* was published in London in 1654. A second edition came from Amsterdam in 1659 with a title plate of a dissection of the body opened to show the liver which is being demonstrated by an anatomist. In 1665 another edition, with the title plate redrawn, also came from Amsterdam, and the last editions, dated 1681 or 1682 were published in the Hague. Unfortunately this detailed account of anatomical structure was never published in English, the language of the lecture on which it is based.

Tractatus de Natura Substantiae Energetica seu de Vita Naturae

Glisson's third book was published in London in 1672, a treatise concerning the natural energy of matter, printed in Latin. This was a philosophical work and dealt among other things with his views on life and death, matter and energy. As Dr. Pagel (1963) has shown, he regarded life as a duplication in plants or triplication in animals of vital functions or vital humours, and death as a dissolution of these processes. He therefore rejected the theory of the soul as something which leaves the body at death but regards it as a vital part of natural life. His interest in life and character is shown by some notes of his which are in the British Museum, and which deal with the characters of British Kings and Roman Emperors (Sloane MS (9)).

There is a title plate with a portrait of Glisson drawn by W. Dolle, but it is evidently taken from Faithorne's painting which is in the Royal College of Physicians. Under the plate is his shield—sable, on a bend argent, three mullets pierced gules, a crescent with an annulet for difference. The book is dedicated to Anthony Ashley Cooper, First Baron Ashley and First Earl of Shaftesbury, who had been a patient of his, and was Lord Chancellor in the year that the book was published.

Tractatus de Ventriculo et Intestinis

The last publication from Glisson's pen was his treatise on the stomach and intestines, also in Latin, which came out in 1677. The title plate is a portrait not unlike the one in the *Tractatus de Natura Substantia*, but drawn by W. Faithorne, and is a closer copy of the painting (Fig. 3). Here Glisson's age is given as eighty, though as I have pointed out he was almost certainly a year or two younger. As the engraving in the previous book by Dolle is evidently taken from the painting, Faithorne must have painted it before 1672, and possibly while Glisson was President of the College. The book, like the *Anatomia Hepatis*, is dedicated to Cambridge University and to the College of Physicians of London.

The first sixteen chapters deal with the abdominal wall, and the next twenty-five with the abdominal contents, discussing their anatomy, but more particularly their function. He sets out his theories of irritability and spontaneous contraction of muscle, and refutes the idea of the flow of animal spirits in the nerves. Some of the views expressed are taken from Harvey for whose work Glisson had a great respect, and in fact he had been one of the early supporters of Harvey's demonstration of the circulation of the blood. He made use of plethysmography to show that the volume of a muscle does not increase when it contracts.

GLISSON'S DEATH AND HIS WILL

Glisson died at his house in New Street near Shoe Lane on 14 October 1677 and was buried in St. Bride's Church on 22 October. His will is dated 14 December 1674 and by it he left most of his property to his surviving brothers, sisters, nephews and nieces, making financial provision where appropriate for mourning. I have already mentioned his bequests to two Cambridge Colleges, but he also left a piece of plate value £5 to each of five of his medical colleagues. When he made his will he owned property in the parishes of St. Bride's and of St. Andrew's, Holborn, but he appears to have acquired more property, for in a codicil dated 1677 he bequeathed the income from further properties in the parishes of St. Giles-in-the-Fields and St. Clement Danes to his brother Henry. In this codicil he refers to himself as being sick in body but of sound mind and memory, this being two years after he had assigned his duties as Regius Professor to Robert Brady.

The property which his father had owned in Dorset had evidently been sold, there being some correspondence in the British Museum (Sloane MS (10)) about the sale of Rampisham farm in 1665. His sole executor was his brother Paul who was a Clerk in Holy Orders. His brother, Henry, about eight years his junior had also been at Caius College and subsequently practised in Colchester. He was admitted as one of the new Honorary Fellows of the College of Physicians in 1664. There has been some confusion about the brothers and it has been stated that Francis also practised in Colchester during the Civil War but I have elsewhere given evidence which throws doubt on this, and I think that he remained in London throughout this period (Walker (2)).

As we consider Glisson's life we must come to the conclusion that he was one of the greater doctors of the seventeenth century, and that he followed Harvey in having a truly inquiring mind. Whatever he took up he did thoroughly, carrying out many experiments himself. For example he describes how he confirmed the action of the diaphragm by observation after opening the abdomen of a living dog. He had a human touch, for concerning hunger and appetite he wrote 'if you pass by a cook's shop, noe smell is more pleasant, but to som after having well dined, the same smell is nauseous and offensive' (Sloane MS (11)).

He was a shrewd observer as is shown by his description of the appearances of rickety children. Though he was a staunch supporter of Harvey's views, he had not entirely shed the ideas of galenic physiology for he wrote 'the auricles and ventricles with the arteries issuing from them are the seates or cavities in which the vital spirritts are generated, and in which they reside and are conformed

Figure 1.
The Silver Cups which were bequeathed by Francis Glisson to Gonville and Caius College (reproduced by courtesy of the Master of Gonville and Caius College).

Figure 2.
The Title Plate of the Leyden edition of *De Rachitide*.

TRACTATUS
DE
VENTRICULO
ET
INTESTINIS.

Cui præmittitur alius,
DE
PARTIBUS CONTINENTIBUS
in genere; & in ſpecie,
DE IIS
ABDOMINIS.

Authore *FRANCISCO GLISSONIO*, Medicinæ Doctore, & Regio in florentiſſima *Cantabrigiæ* Academia Profeſſore, celeberrimique Coll. Med. *Lond.* Socio, nec-non illuſtriſſimæ Societatis Regalis Collegi.

LONDINI,
Typis *E. F.* Proſtat venalis apud *Henricum Brome* ſub ſigno Bombardæ in Cœmeterio *Paulino*. MDCLXXVII.

Figure 3.
The Title Page of *Tractatus de Ventriculo et Intestinis*, with the engraving of Glisson by W. Faithorne.

till they are dispensed to the parts' (Sloane MS (12)). However he covered a wide field as anatomist, physiologist and clinician, and in his lifetime he earned a great reputation which remained throughout the following century for he was quoted by many authorities of that time, as, for example, Boerhaave, Haller and Morgagni. After Harvey, he stands with Willis and Wharton as a leader of scientific medical investigation in England in the seventeenth century. Whether he can be regarded as outstanding as a Regius Professor of Physic at Cambridge is a different matter, for he held the post at a time when the Cambridge Medical School was at a low ebb, and there is no evidence that he ever made any real effort to raise its standards.

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Medical Education at Cambridge 1600-1800

by

ARTHUR ROOK

THE HISTORIAN of Cambridge medicine before the mid-nineteenth century is quickly confronted by the inexplicable worldly and scientific success of so many Cambridge medical men, although the education available to them in their own university during the greater part of the seventeenth and eighteenth centuries appears to have been sadly inadequate. The university has been criticized for retaining obsolute statutes and has been as severely criticized, and sometimes by the same historian, for failing to enforce them. One widely-accepted explanation of the apparent disparity between the teaching and its products has been that Cambridge men sought their medical education in other universities. This essay will not claim to solve these problems, but will draw attention to certain aspects of the medical scene at Cambridge, and attempt to evaluate the part played by foreign universities in the medical education of some Cambridge students.

In the early years of the seventeenth century Cambridge was a small, mean, isolated, malaria-ridden town of fewer than 8,000 inhabitants; the population of England and Wales was probably little more than four million. In the 1620s there were about 2,500 students in the fifteen colleges, and the great majority were destined for the Church. The student's day (Masson, 1859) began at 5 a.m. in the college chapel; the morning service, often followed by homilies from the fellows, lasted about an hour. After breakfast at 6 a.m. and studies in college for two or three hours the student attended the public schools to hear the professor's lectures or the disputations of students preparing for degrees. Dinner was at 12.00; from

1.00 to 3 or 4 p.m. there were exercises and disputations, after which the student was free until evening chapel. Not all students conformed. Some were criticized for wearing 'new fangled gowns of any colour whatsoever, blue or green or red or mixt' and long curly hair. Some were accused of being 'debauched and atheistical' and others of holding puritanical opinions. The growing political and religious dissentions of the nation were reflected in the university.

The curriculum was still nominally based on the seven liberal arts, Grammar, Logic and Rhetoric, Arithmetic, Geometry, Astronomy and Music, and teaching was still nominally divided more or less equally between colleges and university, but by the middle of the century was in fact almost exclusively given in the colleges. Teaching did not take the form of lectures but of informal instruction of small groups of men. The number of tutors was relatively large. At Trinity in 1635 for example none of the seventeen tutors had more than four students (Rouse Ball, 1918). This relegation to the colleges of the responsibility for teaching was to have interesting implications for medicine. The college tutors had the authority of which they frequently availed themselves to draw up for their pupils a plan of study which departed widely from the obsolete statutory curriculum. As long as medicine remained essentially a literary study medical teaching too could benefit from this system, but as practical studies became increasingly important, the colleges rarely made any sustained effort to provide the facilities required to teach them. Nevertheless certain colleges attracted a disproportionately large number of medical students at certain periods (Rook, 1969a) and the source of the attraction must be assumed to be the presence among the fellows or regent-masters of the college at those periods of men who taught anatomy or other medical subjects; indeed many such can be identified. During the first five years after their creation all Masters of Arts were regent-masters and were under an obligation to teach in their colleges. The attitude of the fellows, and of the master in particular, towards medical studies was important. There were relatively few medical masters of colleges before the nineteenth century but some who were not, were kindly disposed towards scientific developments. For example John Eachard, Master of St. Catherine's from 1675–97, was himself a keen amateur physician and he offered hospitality to

Vigani, later the first Professor of Chemistry. Bentley, Master of Trinity College, was sufficiently enlightened to establish the first chemistry laboratory in his college. Influential fellows could also give medical studies the encouragement they normally lacked. Joseph Mead (1586–1638), endowed with a remarkable personality and an impressive intellect, was a fellow of Christ's College. He was a logician, theologian, philosopher, historian, linguist and mathematician, but also an amateur anatomist, who was sent for whenever there was an opportunity for 'an anatomy' at Caius College (Peile, 1900). It would be an exaggeration to suggest that during the active life of this greatly respected polymath medicine flourished at Christ's College, but at least it was not discouraged.

The same can be said of Trinity at about this period. John Ray the botanist migrated from St. Catherine's to Trinity in 1646 because he found Trinity more favourable to liberal studies (Raven, 1950). Ray and such friends as Walter Needham,* Peter Dent† and John Mapletoft‡ later dissected a variety of species of animal in Trinity, although some of the friends were members of other colleges. In February 1658 John Worthington, D.D., Master of Jesus College was able to write to Samuel Hartlib 'We have divers fellows of Colleges who have made excellent progresses in anatomy.'

It was unusual for students in general to attend teaching in colleges other than their own, but medical students of necessity regularly did so. In considering what teaching was available to them at any period it is therefore essential to ascertain what anatomies were carried out and what teaching was given in any college, and, from the late seventeenth century onwards, also what private teachers were active in the town. Such was the disorganized state of medical teaching that one may reasonably ask whether Cambridge can claim to have had a medical school in the usual sense of the term during the greater part of the two centuries under consideration. How had this situation developed?

I propose now to examine the statutes of some of the colleges

* Walter Needham (1631?–1691?) F.R.S. The dissections on which he based his *Disquisitio anatomica de formatio foetu*, 1667, are said to have been carried out at Trinity after 1655.

† Peter Dent, an apothecary in Cambridge, was an enthusiastic naturalist. Robert Tabor was one of his apprentices.

‡ John Mapletoft (1631–1721) F.R.S., friend and associate of Sydenham and Locke.

in an attempt to determine to what extent these encouraged or restricted the teaching of medicine. I shall then discuss briefly the attitudes and actions of the government, the public and the university in relation to medical teaching at Cambridge. Finally I shall try to assess the value of the medical teaching which some men managed to obtain.

THE COLLEGES

The statutes of the earliest college, Peterhouse (1281), demanded that scholars should have received the tonsure, but they were not required to take higher orders. Law and medicine were tolerated. The Statutes of Clare Hall (1326) provided for a master and nineteen fellows, six of whom were to be in priest's orders. No provision was made for medicine. Pembroke College (1347) provided for twenty-four fellows and six scholars. The prescribed studies were arts and theology but two of the fellows were to be canonists and one a student of medicine. Edmund Gonville intended his Hall (1348) for the study of arts and theology and it was not until the refoundation of the college by Caius in 1557 that two of the three new fellowships, which he established, were attached to the study of medicine. Bateman gave Trinity Hall (1350) a somewhat different character; canon and civil law were encouraged as alternatives to theology, but there was no provision for medicine. The founder's statutes of King's College (1440) allowed two fellows to study medicine. Queens' College's first statutes (1448) provided for a president and twelve fellows, all in priest's orders. The statutes of Jesus, Christ's and St. John's colleges differ in many interesting particulars but in none was provision made for medicine. The statutes of Jesus can be quoted to correct the common misconception that before the nineteenth century all fellows of colleges were required to take holy orders. This was true of only a small number of colleges although it became the normal practice in some others. At Jesus College only one fellow was obliged to be in priest's orders, although the majority were nevertheless intended to study theology.

The statutes of Henry VIII's foundation, Trinity College (1546), contained some important innovations; two of the sixty fellowships were specifically attached to medicine, and the minutely-prescribed order of study directed that the fourth year be devoted to physical science. The remaining colleges founded before 1800 made no special provision for medicine, two of them indeed, Emmanuel and Sidney Sussex, were founded primarily for ordination candidates. Admittedly there were subsequently some changes in college statutes and Linacre attached his lectureship to St. John's College, but it is fair to say that there was no fundamental change which could be considered as encouraging medical studies. Even at Caius College, Venn (1897) could find no evidence for a sustained tradition of medical teaching.

THE GOVERNMENT AND PUBLIC OPINION

The foundation by Henry VIII in 1540 of Regius Professorships of Divinity, Civil Law, Physic, Hebrew and Greek can be accepted as evidence of official awareness of the importance of the universities, and successive legislation such as the incorporation of the universities in 1571 and their right from 1603 to send representatives to parliament further increased their powers. This official support of the universities was probably largely motivated by the need to meet the growing demand for highly educated lay administrators, but medicine and science were not overlooked.

As early as 1570 the failure of the universities to provide the education required by a changing society was expressed in the draft proposals for a new Academy, prepared by Sir Humphrey Gilbert for Lord Burghley to present to the Queen. Gilbert suggested that in addition to the conventional subjects the basic elements of the course should be moral philosophy, mathematics, geography, physic and surgery (Armytage, 1955) with the further provision that the natural philosopher and the physician should 'continually practise together to try out the secrets of nature as many ways as they possibly may.'

Bacon in the *Great Instauration*, 1620, wrote 'for the studies of men in these places are confined and as it were imprisoned in the writings of certain authors, from which if any man dissent, he is straightaway arraigned as a turbulent person or innovator'. Bacon, who died in 1626, had planned to found a lectureship in natural philosophy at Cambridge, but no funds were available (Mullinger, 1911).

Throughout the seventeenth and eighteenth centuries there were very numerous protests about the deficiencies of the old universities and many of them came from within the universities themselves. The puritan William Dell (d. 1664), who had been intruded as master of Caius College, published *The Right Reformation of Learning, Schools and Universities* in which he demanded that new universities be established. Cromwell supported the scheme for a University of Durham and letters patent were actually issued in 1657 but after the Restoration three years later, the project was abandoned. The story of the agitations and the abortive plans for many other universities and of the eventual misdirection of the few, such as Gresham College, which actually came into being, has been well told by Armytage (1955) and for my present purpose it is sufficient to note that there were indeed many such projects, as a measure of the vigour of the critics of Oxford and Cambridge.

The motives of the critics were varied and were often religious or political or both in some degree. The Religious tests which had such serious consequences for the development of the university were at first far from being exclusively a matter of religious policy. However many of the critics from Gilbert in the sixteenth century to John Bellers (1654–1725), the Quaker philanthropist, in the eighteenth, were concerned with the reform of the curriculum and with the teaching of science and medicine in particular. Among many proposals Bellers (1714) recommended that each of the universities should possess a hospital. In the will of John Addenbrooke, who died in 1719, by which his hospital was founded, there is no specific mention of the use of the hospital for teaching.

THE UNIVERSITY

It is interesting to consider to what extent the university reacted to these widely-expressed criticisms by taking measures to enforce the existing regulations concerning medical degrees, to introduce reforms in the curriculum and to establish new chairs.

In 1625 a Grace enabled medical graduates of foreign universities to incorporate their degrees at Cambridge provided that they first disputed and responded in the Faculty of Medicine. This Grace could be regarded as recognizing both the advantages of medical study elsewhere and the importance of maintaining the standards of the Cambridge degree. However the second half of the Grace was certainly not regularly enforced.

In 1627 a Grace provided for more efficient teaching in anatomy (Rolleston, 1932).

In 1675 the Royal College of Physicians restricted the Fellowship to Oxford and Cambridge graduates—it continued to be so restricted until 1835—and thus gave the College a very direct interest in the state of medical education at the universities. The controversies which resulted are well known (Clark, 1964): many of them were responsible for attempts, usually only briefly effective, to tighten the regulations for degrees at Cambridge. The Royal College appears to have made no serious effort to modify the curriculum or the teaching.

Nevertheless the curriculum was changing. The influence of Isaac Newton (1642–1727) on Cambridge thought and teaching was profound. It was in 1705 while he was a Fellow of Trinity College that J. F. Vigani, who had been a free-lance lecturer in chemistry for some years and the first Professor of Chemistry since 1703, was given space or a laboratory in what is now known as the Old Bursary. In 1716 the university provided a house for a lecture room and a laboratory for the professors of chemistry and anatomy. It had been built in 1696 in Queens' Lane as part of the new Printing House but was now found to be of no use to the university.

The professorship of anatomy conferred on George Rolfe in 1707 was like the professorship of chemistry, the formal recognition of an existing situation. Rolfe had been lecturing in Cambridge for some years without any official appointment. In fact no chair of anatomy was founded; the title of professor was conferred. In 1728 in depriving him of his office for continual absence, the university recognized the existence of an office it had not created. Rolfe's successors were no more assiduous than he, but their neglect of their duties attracted no official rebuke.

John Ray (1627–1705), perhaps the greatest of British botanists, was a Fellow of Trinity College from 1649–1662. Considerable contributions to botany were also made by other men working in Cambridge, Adam Buddle of St. Catherine's where he was Fellow from 1668–71, and Stephen Hales of Corpus Christi. But these men held no university appointments, and the subject was not officially recognized. In 1724 a chair of botany was established and Richard Bradley was elected the first professor on the understanding that he would provide the university with a botanic garden, which he failed to do. He did however lecture on materia medica and in his published lectures (Bradley, 1730) he expressed the hope 'that any professor in the severall branches of physick will take the proper opportunity of reading to you and explaining the severall parts of Knowledge that we may not want anything among us which is necessary to confirm that character which always has been given to Oxford and Cambridge'. He appears to have ceased to lecture after a year or two.

Until the late seventeenth century botany was regarded as a branch of medicine and plants were studied largely for their possible medicinal properties. For at least a century longer the majority of botanists were medical men. One such was John Martyn (1699–1768), F.R.S., who was invited to lecture in Cambridge in 1727. For some years he lectured on materia medica and botany. In 1733 he was appointed Professor of Botany in succession to Bradley who had died the previous year. It is not certain how often he lectured after his election to the chair for he spent much time in London and practised medicine both in London and in Cambridge (Gorham, 1830). Martyn resigned in 1762 in favour of his son Thomas (1735–1825) and under his guidance a Botanic Garden was at last established.

One other chair founded in the eighteenth century which also had some importance for medicine was the Jacksonian Professorship of Natural and Experimental Philosophy. The initiative had not been taken by the university, for the chair was endowed under the will of the Rev. Richard Jackson (died 1782). The terms of the endowment left the professor free to range over a wide field of subjects; but he was asked to 'have an eye more particularly for that opprobrium medicorum called the gout'. Isaac Milner* the first holder of the chair chose to lecture on optics and on chemistry.

In summary it cannot be claimed that the university made any serious attempt during the seventeenth and eighteenth centuries to encourage medical studies. The professorships of anatomy and chemistry gave status to existing independent teachers; the Jacksonian professorship was the benevolent endowment of a

* Isaac Milner (1750–1820) F.R.S. Mathematician and Divine; President of Queens' College 1788–1820.

gouty clergyman; only the professorship of botany was initiated by the university.

THE QUANTITY AND QUALITY OF MEDICAL EDUCATION

Arnold Chaplin (1920) in his unpublished history of medical education at Oxford and Cambridge came to the conclusion that Cambridge was far in advance of Oxford in the teaching of medicine and allied sciences, and this he attributed to the latitude allowed to students in planning their curricula and to the strong influence of the Newtonian school on Cambridge science. He gives the credit for such enterprise as was shown to the ability and devotion to medicine of certain individuals, only some of whom happen to hold university appointments. With these general conclusions I agree, but I think that the detailed analysis of the careers of all Cambridge medical men between 1600 and 1800 has provided new evidence on some aspects of Cambridge medicine which Chaplin did not explore.

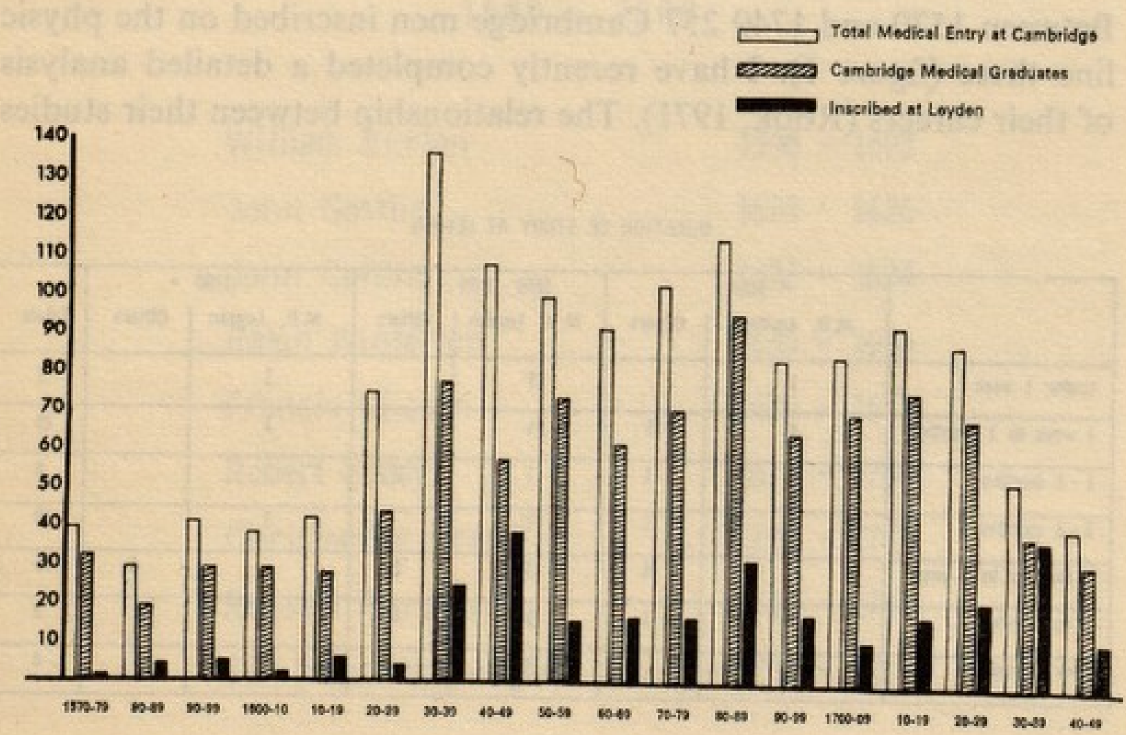

Figure 1

I have deliberately used the imprecise term Cambridge medical men because a count of Cambridge medical graduates gives a very inaccurate indication of the volume of medical teaching in any period. There are frequent instances of student contemporaries, some of whom took a Cambridge medical degree in the same year in which others took the L.R.C.P. or the E.L.R.C.P., others took the M.D. of a foreign university, and still others entered practice without taking a qualification which they were after all under no statutory obligation to possess. During periods of political unrest and religious persecution the proportion of men taking Cambridge degrees was lowest.

Certain historians have claimed that most Cambridge men who wished to study medicine sought their education outside Britain. About sixty-five Cambridge medical men are known to have visited Padua up to 1749. Many of them had also inscribed at one or more other universities. As far as I know the length of stay of these men at Padua had not been studied. Keynes (1966) mentions that the short period that William Harvey spent at Padua implies that he had learned much at Cambridge. There was no other university known to have been visited by more than four or five Cambridge medical men throughout the whole of our period except Leyden. Between 1570 and 1749 257 Cambridge men inscribed on the physic line there (figure 1). I have recently completed a detailed analysis of their careers (Rook, 1971). The relationship between their studies

DURATION OF STUDY AT LEYDEN

	- 1649		1650 - 1699		1700 -		
	M.D. Leyden	Others	M.D. Leyden	Others	M.D. Leyden	Others	Totals
Under 1 week	1		5		1		7
1 week to 1 month	4	5	11		3		23
1 - 3 months	2	1	1	2			6
3 - 6 months	4	1	2		3		10
6 months to 1 year	3	4	3	2		4	16
1 to 2 years		1	5	1			7
Over 3 years	1		4		1		6

Figure 2

at Cambridge, at Leyden and elsewhere is complex and provides a striking illustration of the extreme flexibility of the medical curriculum during our period. The greatest possible duration of a man's residence at Leyden is known with certainty only if he graduated at Leyden or if his inscription or graduation at another university followed his inscription at Leyden (figure 2). The figures in the table are certainly too high in the case of the second group, since no allowance has been made for travelling time, which must often have been considerable. The fact that seven Leyden M.D.s spent less than a week there and eighteen less than a month suggests that they must have received their medical training, such as it was, at Cambridge. I am not attempting to deny the immense influence of the Leyden school during its two greatest periods, but it is interesting that many men spent so short a time there and that some of those who spent a year or more there were excluded from Cambridge degrees on religious grounds.

My figures may give a false impression as they include only those men who matriculated at Cambridge and omit those who studied

REGIUS PROFESSORS OF PHYSIC
1600 - 1800

William Burton	1596 - 1623
John Gostlin	1623 - 1626
John Collins	1626 - 1634
Ralph Winterton	1635 - 1636
Francis Glisson	1636 - 1677
Robert Brady	1677 - 1700
Christopher Green	1700 - 1741
Russell Plumptre	1741 - 1793
Sir Isaac Pennington	1794 - 1817

Figure 3

only at foreign universities, even if they later incorporated their degrees at Cambridge. Fortunately Hans (1951) has analysed in detail the careers of a different sample, which he calls the intellectual élite of the eighteenth century. There are about 5,500 men in the *Dictionary of National Biography* who were born between 1685 and 1785. Excluding those whose training was vocational or who owe their places in the dictionary to the fact that they were criminals or freaks, 3,500 names remain. Of these 144 were physicians of whom 122 received a university education, thirty-one at Oxford, forty-two at Cambridge and only eight at foreign universities. Thirty-four were at Scottish universities, mainly after 1750.

Assessments of Cambridge medical education have too often been biased by the indisputable inadequacy of some of the Regius Professors of Physic. There were nine professors between 1600 and 1800 (figure 3). The first four appear to have discharged their duties more or less conscientiously. Glisson and Brady were both men of distinction, the first as a scientific physician and the second as historiographer, archivist, royal physician and member of parliament. Both were frequent absentees. The three holders of the chair in the eighteenth century appear to have been of little significance, but such a judgment may prove in the light of more detailed studies to be unjust.

I have already mentioned that during the course of the seventeenth century the responsibility for teaching had been gradually taken over by the colleges, so that before the end of the century the faculties had few or no teaching duties. Whether this state of affairs developed because of the negligence of the professors or the growing autonomy of the colleges is questionable, but well before 1700 a professor could reasonably consider that he was doing his duty if he supervised the disputations for degrees and ensured that standards were maintained. As Winstanley (1935) puts it 'Academic public opinion was not commonly deeply stirred by a professor's failure to lecture'. Glisson's prolonged and repeated periods of absence can be partly explained on political grounds; his duties were carried out by efficient deputies, John Carr for some years, and later Brady. When Brady succeeded as Regius Professor of Physic he too was often absent, but not for any long period.

The system of college teaching had advantages for many subjects but not for medicine. The total medical entry at Cambridge was never large. It reached an average of 13.7 per annum in the decade 1630–39 and this figure was not to be exceeded for over two centuries. When the total entry to Cambridge declined disastrously in the eighteenth century, the medical entry dropped relatively less, but nevertheless in some years there were only two or three medical admissions. With such small numbers it is surprising that any effective teaching at all could be given. The teaching which the medical faculty no longer gave was only in part supplied by the colleges. The gap was filled by the development of private teachers, not all of them fellows of colleges and indeed many of them with no official connection with either the university or a college at least during their earlier years in Cambridge.

I have discussed elsewhere the activities of many of these teachers (Rook, 1969a, b). One of the earliest was J. F. Vigani, a chemist of some repute, whose textbook *Medulla Chemicae* (1682) reached several editions although Boerhaave considered it a confused medley of experiments (Coleby, 1952a). He taught chemistry (including materia medica) at Cambridge from 1693. As we have seen, the university gave him recognition and Trinity College gave him a laboratory; his successor as professor of chemistry continued to teach with some regularity. In 1718 however John Mickleborough was appointed to the chair which he held until his death in 1756. During those thirty-eight years he gave five courses of lectures, none after 1741 (Coleby, 1952b).

Anatomy was taught by an unidentified private lecturer as early as 1692. He was succeeded by George Rolfe, who also lectured in London. After Rolfe, like Vigani, had been recognized by the university and elected professor, he was seldom in Cambridge, but his place was taken by James Keill, who also lectured at Oxford and in London. After his death William Battie (1740–1771) of King's College lectured on anatomy, then Francis Sandys, a surgeon who practised at Potton. Later Robert Glynn of King's College included anatomy in his courses for a time.

Apart from the lectures on materia medica by the professor of chemistry and from 1730 by the professor of botany, there were courses on materia medica among other things by John Addenbrooke (1680–1719) of St. Catherine's College from 1705–11 and on materia medica and the practice of physic by William Heberden from 1734–48 and after this by Robert Glynn. It is possible that other fellows of colleges were active teachers, for chance discoveries in records or diaries are still bringing new evidence to light.

It has however so far not been possible to reconstruct the curriculum of a medical student at Cambridge during our period. The general impression is one of informality and a total lack of organization.

It cannot be disputed that many Cambridge men who received their medical education exclusively at Cambridge subsequently achieved worldly and scientific distinction in medicine. I would not on these grounds maintain that they must therefore have received a satisfactory education at Cambridge. Boerhaave admittedly was largely self taught in the subjects in which he was later to excel, but it seems unreasonable to suggest that Cambridge was solely a nursery for autodidacts. It is probably nearer the truth that, as Arnold Chaplin suggested, a small number of devoted men, some of them like Heberden and Battie of outstanding ability, continued to maintain the continuity of medical teaching against increasing odds. From about 1760 onwards the numbers were so small and the climate of the university so apathetic that the struggle was virtually abandoned.

In conclusion it is difficult to resist offering as a possible explanation for this decline the growing dominance of college teaching at the expense of university teaching at a time when medical teaching was beginning for the first time to require a centrally-organized course with regular lectures and demonstrations, and, increasingly throughout the eighteenth century, bedside teaching as well. By the time Addenbrooke's Hospital was opened in 1766 medical teaching at Cambridge had virtually ceased. The hospital was at first very small but so was Boerhaave's St. Caecilia Hospital at Leyden. It was certainly not initially the small size of the hospital which prevented the development of clinical teaching at Cambridge. The statutes of the colleges, framed in the days of classical literary medicine, did not allow any one of them to step into the gap and provide the facilities and organization which the university failed to provide. Moreover no college had any incentive to do so. The administrative machinery of university and colleges placed all authority in the hands of men most of whom were so old that there was little prospect of reform until the Royal Commission in the nineteenth century imposed a new administrative structure.

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Anatomy and Physiology in Cambridge before 1850

by

BERNARD TOWERS

MY ASSIGNMENT for this Congress is a large one. It would clearly be impossible to deal at all adequately, in the time available, with all those Cambridge men who contributed to the development of anatomy and physiology during the long period before these two disciplines, in the mid-nineteenth century, entered into the modern phase of separation and specialization. As is well known, the Professorship of Physiology was not established in Cambridge until 1883, but of course there was a long line of physiologists before that. The Cambridge Chair of Anatomy was inaugurated in the year 1707, but again the subject had been taught and examined long before the university saw fit to recognize it formally in this way. Today, with the growth of the modern concept of universities and medical schools, with their multiplicity of specialist departments, each with its hierarchical structure, we tend to over-emphasize the role of the full-time professor, with his ever-present need to establish and maintain his reputation in some narrow branch of learning. Dr. Arthur Rook in his 1968 Sydenham lecture,[1] did well to point out how much more important, as teachers and researchers in Cambridge, have been the fellows of the colleges. It was they who, in the seventeenth and eighteenth centuries, attracted young talent to Cambridge, rather than the professors, who might easily neglect their teaching duties for the sake of a clinical career, in much the same way that

[1] Arthur Rook, 'Medicine at Cambridge 1660–1760', *Med. Hist.*, 1969, **13**, 107–22

full-time members of academic staff are sometimes known to do today for the sake of a career in research, or writing, or administration. It was, and still is in Cambridge, the colleges that admit students. They used to, and still do to my certain knowledge, sometimes decline to admit students in subjects in which they cannot provide effective teaching for the time being. There is a vast amount waiting to be discovered and described, about the fluctuating fortunes of different colleges, at different times, in different subjects. On the whole the colleges represent a rare tradition these days, because, quite simply, they often take their teaching responsibilities really seriously. I suspect it was always so, or nearly always. So that we misinterpret the academic climate of the past if we try to judge its worth solely on the qualities of elected professors. However, more is obviously known about those who held official status in the university, largely because they tended to reside much longer than did bachelor fellows of colleges. So it is not surprising that authors sometimes take them as their models for the university as a whole.

Throughout the period which I am to discuss, medical men were not ashamed to show interest in both structure and function. In thus integrating anatomical and physiological observations, they tended to do naturally what today we seem to expect only our first- and second-year students somehow to achieve for themselves. Intellectual integration is no easy task, and it is not at all as obvious as many people have made out during the century just past, that anyone who attempts it necessarily admits himself to be a dilettante or a third-rate scholar. The topics of the lectures that used to be given in Cambridge, prior to the institution of the nineteenth-century divorce proceedings between anatomy and physiology, will repay careful study by those who, meeting a real need and demand, are concerned today with curriculum reform: we simply must, somehow, re-integrate knowledge at the higher level made possible by a century of specialization.

I think it would be a waste of the time available, and boring for you, if I were to recite a litany of the names, with notes on lives and scientific attainments, of our main Cambridge predecessors in the basic medical sciences. That task was effectively done in 1932 by Sir Humphry Davy Rolleston in his biographical history of *The*

Cambridge Medical School.[2] Nor do I want to bore you with yet another account of the achievements of the wholly outstanding anatomists and physiologists of Cambridge. In particular, I propose not to say a word about the great Harvey, despite his being not only an excellent physiologist but also a splendid anatomist and embryologist. The only claim that Cambridge has on this giant of medical history stems from the fact that he was an undergraduate here (during which time he probably witnessed at least one 'anatomy') before he went abroad for his medical studies. So, while we of course revere him, let us be honest enough not to include him in a paper on 'Anatomy and Physiology in Cambridge before 1850'.

We can lay greater claim, of course, on John Caius who, as Dr. Copeman says in his contribution to this volume, introduced the study of practical human anatomy into England, both in London and in Cambridge. But his work is already well enough documented; as also is that of Francis Glisson, also of Caius College, especially since the contributions of Milnes Walker.[3] There has also, in recent years, been a great deal written about Stephen Hales of Corpus, a physiologist even greater, perhaps, than Harvey. He needs no eulogy at a gathering such as this, and I do not propose to attempt one.

What I should like to do, in the limited time I have, is to initiate, at least, a kind of rescue operation on behalf of two men who pursued anatomical and physiological studies in Cambridge at either end of the eighteenth century. This period, it is often implied, was quite without academic or intellectual worth. Winstanley,[4] in his *Unreformed Cambridge*, gives a pretty bleak account of the state of basic medical science in the eighteenth century. He makes no mention at all of the earlier of the two men I wish to consider, William Stukeley, who worked with Stephen Hales in the early years of the century. But he has some very harsh things to say about my second choice, Sir Busick Harwood, including the almost un-

[2] Sir Humphry Davy Rolleston, *The Cambridge Medical School*, Cambridge University Press, 1932.

[3] R. Milnes Walker, 'Francis Glisson and his capsule', *Ann. R. Coll. Surg. Eng.*, 1966, **78**, 71–91. See also this volume (pp. 35–48).

[4] D. A. Winstanley, *Unreformed Cambridge: a Study of Certain Aspects of the University in the Eighteenth Century*, Cambridge University Press, 1935.

believable statement that neither he nor his predecessor (Collignon) knew enough about the subject of anatomy to teach it effectively. There is, perhaps, no truer couplet in Shakespeare than that spoken by Brutus of Caesar: 'The evil that men do lives after them,

The good is oft interred with their bones.'

Busick Harwood's bones rest under the turf in Downing College, between the Master's Lodge and the Hall, where it was originally intended that the court would be completed, on its south side, by the erection of a chapel. To allow Sir Busick, first Downing Professor of Medicine, to be buried there (as he was on 15 November 1814) a special petition was made to, and granted by, the Bishop of Ely, in a document signed and sealed on the 12 November 1814, just two days after Harwood's death.[5] The ground has never, I think, actually been consecrated, and the new chapel is away on the other side of the college. The site of Harwood's tomb is now only occasionally visible, when the grass fails to grow over it quite as well as it does on the rest of the lawn.

Harwood was in many ways a remarkable man, whose character and learning have been traduced by a series of commentators, most of whom, as is so often the way, seem only to have referred to earlier authors, who in turn were relying on whoever set the scandal going. I am happy to be able to report that the Medical Students' Society at Downing College (which calls itself the Whitby Society, after the late Sir Lionel) recently instituted an annual Busick Harwood dinner. According to the ceremony devised for the occasion, the participants at one stage process to the site of the tomb. There they pour a libation by candlelight, and recite in Greek (with the name of Sir Busick substituted for the original) the Epitaph on Anacreon by Antipater of Sidon, which in translation reads as follows:

[5] The speed with which this was accomplished is unusual in College affairs. It is explained in the following extract from the Minutes of a College Meeting at Downing, 24 November, 1814 (Present: William Frere, Master; Cornwallis Hewett, Fellow and Vice-Master; Robert Monsey Rolfe, Fellow.):

'The Master reported that Sir Busick Harwood had in his lifetime frequently mentioned to him an anxious desire that his remains might be interred in the scite [*sic*] of the College Chapel, which desire he had also expressed in his Will. That the Master had in consequence applied to the Bishop of Ely for permission; and being informed at his Lordship's office that a petition of the College was necessary, and the time not allowing for a Meeting of the College to be called, he had had such petition drawn up and sealed with the College Seal; and that in pursuance thereof a Licence had been granted by the Bishop of which the following is a Copy.

Stranger who passest by the simple tomb of Sir Busick, if any profit came to thee from my books, pour on my ashes, pour some drops, that my bones may rejoice refreshed with wine, that I who delighted in the loud-voiced revels of Dionysus, I who dwelt amid such music as loveth wine, even in death may not suffer without Bacchus my sojourn in this land to which all the sons of men must come.[6]

Well that is very nice, and I am sure the ceremony is performed with fitting solemnity. But the feasting might conceivably add to the general impression that Harwood was rather a flashy eighteenth-century *bon viveur* (who didn't know enough about his subject to teach it effectively). So I hope that this paper may help Downing men of the future to perform their grateful office to the memory (and the bones) of a former Professor of Anatomy and Downing Professor of Medicine, with an even greater sense of his worth and that of his books.

But let me now speak of Stukeley, the first in time of the two I have selected in order to redress the character-assassinations that they have suffered. A major detractor was Sir Walter Langdon-Brown, a former Professor of Physic at this university, whose collection of historical articles was published in 1946 under the title *Some Chapters in Cambridge Medical History*.[7] On page 70 he says, 'Finally, I come to the somewhat enigmatic figure of William Stukeley. It not infrequently happens that attached to a circle of brilliant men one finds an adherent who clearly is not of the same calibre in character or attainments. Yet the circle appears to do more than merely tolerate him.' We then have an account in which

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[Text of Petition follows]

Resolved that we approve of the above proceeding and of the use of the College Seal for that purpose.

The Master also reported that he had taken the necessary steps for forming the said Burial Ground and constructing a Vault in the same with the concurrence of Mr. Wilkins the architect.'

The argument I shall advance in this paper is that such care and consideration would never have been given to a member of a Collegiate society if he had really possessed the reputation, or notoriety, with which Harwood has been credited.

[6] For much information I am grateful to Prof. W. K. C. Guthrie, Master of Downing. Dr. G. A. Chinner and Dr. M. A. S. Burgess, both of Downing, are to be congratulated on devising this happy commemoration.

[7] Sir Walter Langdon-Brown, *Some Chapters in Cambridge Medical History*, Cambridge University Press, 1946.

Stukeley is damned, either with faint praise or more directly, leading the author to end with, 'I think I am justified in concluding that his ambitions exceeded his intellectual equipment and that his scientific friends perhaps found him more amusing than inspiring.'

Now of course it is true that in later life Stukeley's antiquarian interests, and especially his passion for the Druids, made him something of an eccentric. Stuart Piggott's biography[8] does nothing to hide his oddities. They were the oddities that one can sometimes permit an original thinker and an experimentalist. We do well to remember that Clark-Kennedy, in his biography of Stephen Hales,[9] makes it clear that it was Stukeley who stimulated Hales' interest in biological experiment. They did an enormous amount of anatomical and physiological experimentation together, both in their rooms at Corpus and in Vigani's chemistry laboratory at Queens', and later at Trinity, when Bentley made his takeover bid in order to maintain the scientific tradition established by Newton in his college. Again we see the enormous influence of the colleges during this period. What matter if, as is so often said, the then incumbent of the Chair of Anatomy (Rolfe) did spend much of his time away? Though we should remember that Stukeley says in his *Diary*[10] that 'when I came back to Cambridge I found Mr. Rolfe dissecting there'. It was doubtless an example like this that led him to do so much dissection himself. If only present-day students would do (or were given time and opportunity to do) one-hundredth part! He and Hales made detailed studies of a large number of species, and they prepared skeletons (including human ones) in their College rooms; they did experiments on respiration, and devised a technique to make a cast of the bronchial tree; Stukeley describes the result as 'the finest animal plant that ever was seen which was mightily admired, but I pulled it all to bits to give away little portions of it among my acquaintances.'

Stephen Hales left Cambridge very shortly after Stukeley had gone down. It was suggested by Clark-Kennedy that it was Stukeley's

[8] Stuart Piggott, *William Stukeley, an Eighteenth-Century Antiquary*, Oxford University Press, 1950.

[9] A. E. Clark-Kennedy, *Stephen Hales, D.D., F.R.S., an Eighteenth-Century Biography*, Cambridge University Press, 1929.

[10] *Family Memoirs of the Rev. William Stukeley, M.D.*, ed. by Rev. W. C. Lukis, 3 vols., London, 1882.

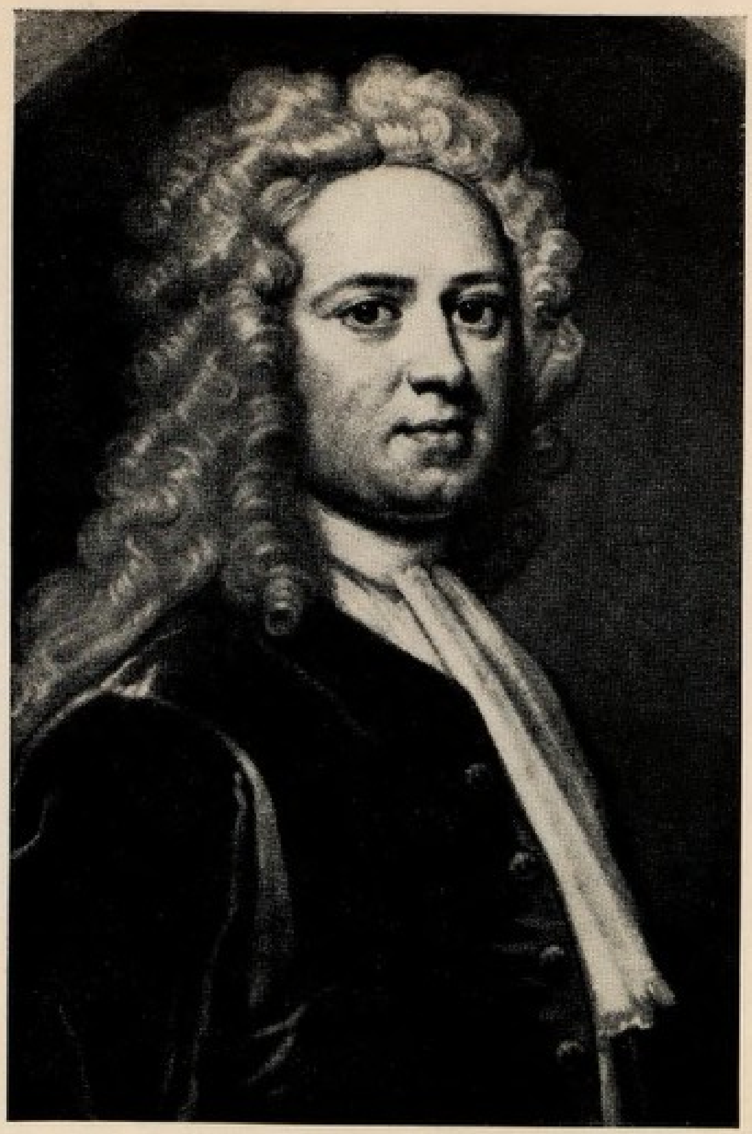
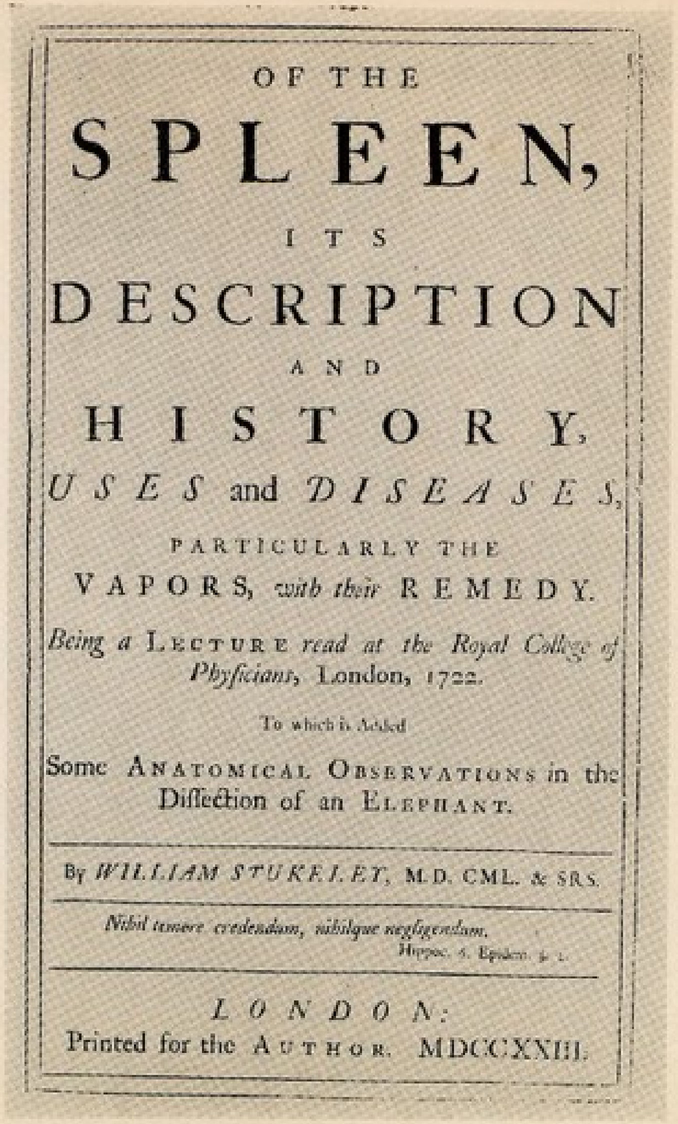


Figure 1
William Stukeley (1687–1765). Mezzotint by T. Smith after G. Kneller, 1721, in the Wellcome Institute of the History of Medicine. *By courtesy of the Wellcome Trustees.*



OF THE

SPLEEN,

ITS

DESCRIPTION

AND

HISTORY,

USES and *DISEASES*,

PARTICULARLY THE

VAPORS, *with their* REMEDY.

Being a LECTURE *read at the Royal College of Physicians*, London, 1722.

To which is Added

Some ANATOMICAL OBSERVATIONS in the Diffection of an ELEPHANT.

By *WILLIAM STUKELEY*, M.D. CML. & SRS.

Nihil temere credendum, nihilque negligendum.
Hippoc. 6. Epidem. § 2.

LONDON:
Printed for the AUTHOR. MDCCXXIII.

Figure 2
Title-page of William Stukeley's book *Of the Spleen* . . . , London, 1723.

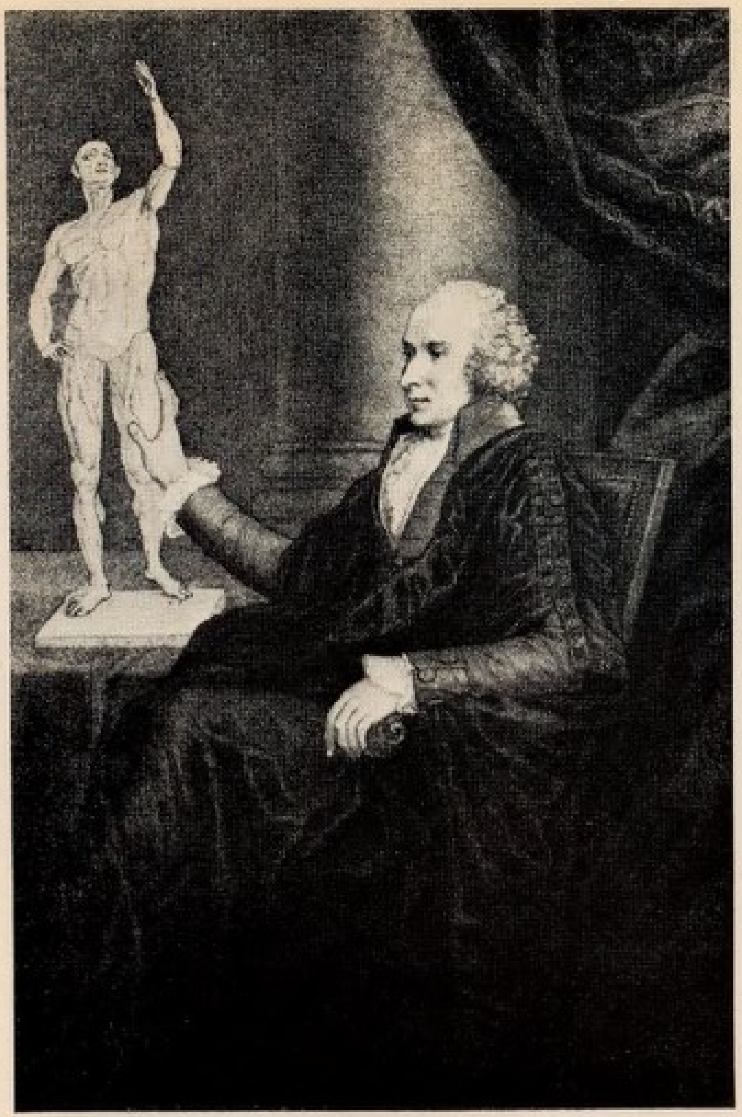
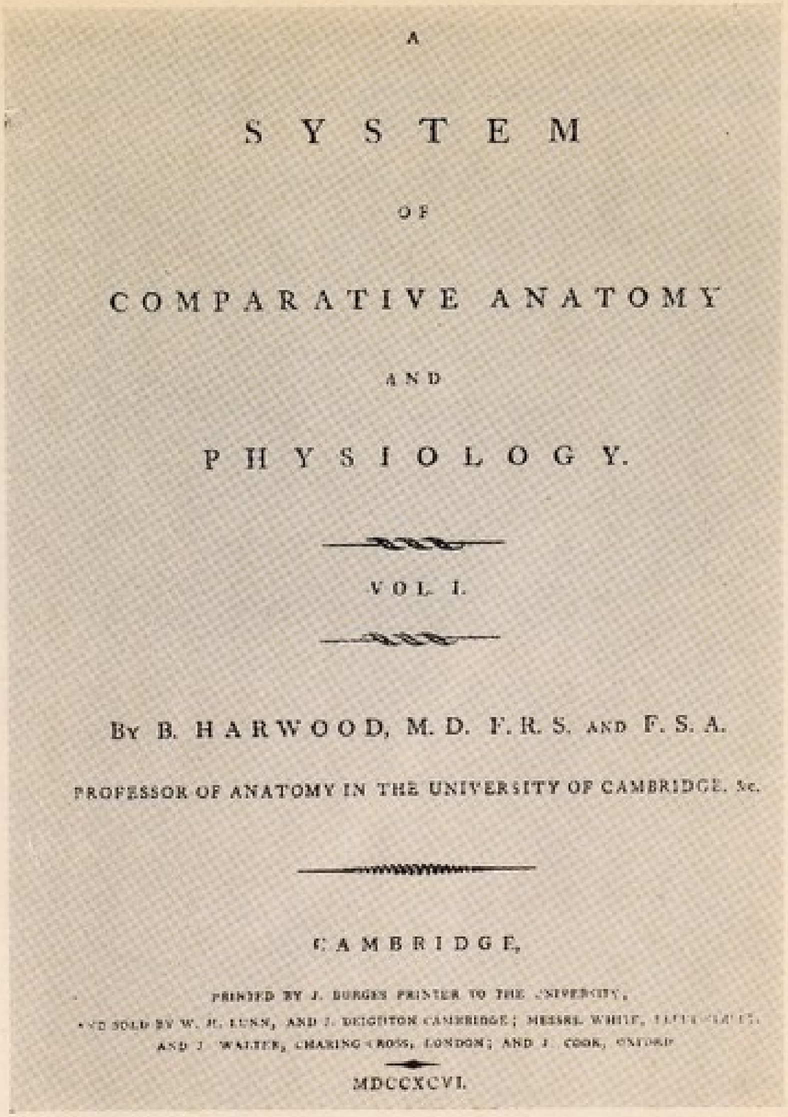


Figure 3

Sir Busick Harwood (1745?–1814). Stipple by W. H. Gardiner after S. Harding, 1790, in the Wellcome Institute of the History of Medicine. *By courtesy of the Wellcome Trustees.*



A

SYSTEM

OF

COMPARATIVE ANATOMY

AND

PHYSIOLOGY.

VOL. I.

BY B. HARWOOD, M. D. F. R. S. AND F. S. A.

PROFESSOR OF ANATOMY IN THE UNIVERSITY OF CAMBRIDGE. &c.

CAMBRIDGE,

PRINTED BY J. BURGES PRINTER TO THE UNIVERSITY;

AND SOLD BY W. H. LUNN, AND J. DEIGHTON CAMBRIDGE; MESSRS. WHITE, [illegible]

AND J. WALTER, CHARING-CROSS, LONDON; AND J. COOK, OXFORD.

MDCCXCVI.

Figure 4

Title-page of Sir Busick Harwood's book *A System of Comparative Anatomy and Physiology*, Cambridge, 1796.

departure that prompted him to leave.[11] It seems to me that Langdon-Brown was far from justified in his views on this interesting man.

Stukeley eventually gave up research into anatomy and physiology in favour of his antiquarian studies. But before doing so he produced a memorable book on the spleen[12] which, for all its clinical curiosities, contains a number of good and accurate topographical observations. Appended to this work is a brief but excellent account of the dissection of an elephant. The opening statement, on the value of comparative anatomy, is somewhat prolix, and was quoted by Cole[13] as an example of all that is bad about 'rhetoricians'. But the descriptive anatomy that follows is actually very good. In particular there is a remarkable appendix in which a collaborator, Dr. Douglas, describes the special study he made of the genital organs of this young female animal, which they had thought originally was a male. That they were not, in this error, being simply unobservant, is shown by a recent letter to me about elephants from the director of research in Kenya's Tsavo Park. He says, 'Hunters in the field often confuse the sex of immature or sub-adult animals because the external genitalia are superficially alike.'[14]

Stukeley was dealing with an immature female, and was misled by the prodigious size of the clitoris, and by its position. The vulva in this species is placed very far cranially on the ventral body wall, and the vestibule to the vagina looks to be too far away for effective penetration in the normal mounting position of quadrupeds. Stukeley concluded (and elephants had never, of course, been observed mating at that date) that copulation in this species must take place *more humano*, that is in the 'facing' position, rather than *more bruto*. He linked this hypothesis with the gentle behaviour characteristics of the elephant, and drew moral conclusions from his observations. It was some two hundred years later that the anatomical and physiological peculiarities involved in elephant

[11] Clark-Kennedy, op. cit., p. 21.

[12] William Stukeley, *Of the Spleen, its Description and History, Uses and Diseases, particularly the Vapors, with their Remedy. To which is added Some Anatomical Observations in the Dissection of an Elephant*, London, 1723

[13] F. J. Cole, *A History of Comparative Anatomy from Aristotle to the Eighteenth Century*, London, Macmillan, 1949.

[14] Personal communication 12 August 1969 from Dr. Richard Laws.

mating were studied more fully,[15,16] and even as recently as 1964 one author contributed to an on-going discussion by stating that 'attempts to romanticise the procedure and to attribute to the great animals a more sophisticated approach to the act of procreation . . . have little foundation in fact.'[17] Yet it *is* all very strange, in fact, and Stukeley was the first to notice some of the peculiarities involved. His account is the earliest referred to in Perry's comprehensive paper (op. cit.), but the author states that he did not consult it directly.

If, then, there was a lot of interest in biological structure and function at the beginning of the much-maligned eighteenth century, what of its end? Busick Harwood became Professor of Anatomy in 1785, and Downing Professor of Medicine in 1800. He was knighted in 1806 and died in 1814. All the commentators (except perhaps for Macalister, who is more careful and judicious than most[18]) seem to take their 'data' from that garrulous and highly amusing scandalmonger, Gunning, whose *Reminiscences*[19] have provided entertainment for generations of Cambridge men. The one story that never fails to get a mention is how Harwood would serve for dinner the turbot that had been dissected during his previous day's lecture. The story has acquired embellishments at various hands, so that one almost comes to think that anyone invited to dine (and of course we tend to believe, on Gunning's say-so, that he never knew in advance *who* he would have to dinner, but would always complete his table of six from amongst acquaintances he happened to meet on his morning walk!)—anyone invited would *expect* to eat stale, mangled turbot. Langdon-Brown, in what amounts to a caricature of Harwood (op. cit. p. 74) even suggests that he used to do this for reasons of economy! Winstanley (op. cit. p. 261), after describing him as a third-rate scientist and much worse, seems genuinely puzzled when he adds, 'Yet Harwood seems to have been

[15] H. Slade, 'On the mode of copulation of the Indian elephant', *Proc. Zool. Soc., Lond.*, 1903, **1**, 111–13.

[16] J. S. Perry, 'The reproduction of the African elephant, *Loxodonta Africana*', *Phil. Trans. R. Soc. Lond.*, 1953, **237**, 93–149.

[17] A. Wright, 'Mating habits of elephants', *Afr. Wild Life*, 1964, **18**, 301–2.

[18] A. Macalister, *The History of the Study of Anatomy in Cambridge*, London, Clay, 1891, pp. 28.

[19] Henry Gunning, *Reminiscences of the University, Town and County, of Cambridge from the Year 1780*, London, 1854.

a popular member of Academic Society and considered good company'.[20]

Gunning's antipathy to Harwood dated from 1785, when he first met him, then aged forty, at a feast in Christ's, shortly after Gunning entered that college as a freshman. Harwood had already spent a number of years in medical practice in India and in studying and teaching (botany) at the London Hospital, before he came to Cambridge. He was elected Professor of Anatomy shortly after presentation of his thesis on blood transfusion. He made a number of very successful demonstrations of exsanguination of dogs, followed by their recovery (in the short term at least) by transfusion with sheep's blood. This was no mean achievement. It is also evident from the lecture courses that he planned, published in advance in outline, and conscientiously delivered over a span of nearly thirty years, that he was an original investigator, a good critic, and a clear thinker about the meaning and purpose of education. Gunning makes many snide remarks about Harwood, and gives him credit for nothing except a rather malicious wit. That he lived well cannot be doubted (and makes the suggestion all the more ludicrous that he regularly served yesterday's turbot to his guests!), but it is hard to see why Gunning was so merciless. Perhaps an author of eighty, who had never achieved high office, was envious of him, particularly after having been somewhat overawed in youth by his commanding personality. Many of the incidents in Harwood's life, including election to two Professorships, his marriage to a ward of the excellent physician Robert Glynn[21] (who left them both a legacy, which Gunning characteristically says was not nearly as large as Harwood had planned and hoped for), his move from Christ's to Emmanuel, and the honour done him by the Fellows of Peterhouse in presenting him with a piece of plate, are all given sinister undertones, some of which have been converted to overtones by later commentators. Gunning's reference to him as 'profligate and licentious'[22] has been further magnified by others, who have written as though he could

[20] This saving feature does not rate a mention in the influential *History of the County of Cambridge and Isle of Ely* (London, 1959), where he is simply dismissed as 'third-rate' (p. 232).

[21] See Arthur Rook, 'Robert Glynn (1719–1800) physician at Cambridge', *Med. Hist.*, 1969, **13**, 251–59.

[22] Gunning, op. cit., p. 53.

not speak without uttering obscenities.[23] Actually, of course, he could not have continued to live 'on the most intimate terms with men of the highest station in the University',[24] nor could he have been accorded the burial honours that were done him, had he been as he has been portrayed. He was in all things eminently successful, and was on good terms with everyone, it seems, except for those minor brushes, often recounted with relish, with Pennington of St. John's[25] and Mansel of Trinity.

My purpose now is to speak of his academic achievements as a scientist and dedicated teacher, and as a man who performed his duties conscientously at a time when (unless Gunning and Winstanley are totally wrong in their assessments) there can have been little incentive to undertake serious work in 'Unreformed Cambridge'.

He published six books during his tenure of the Chair of Anatomy.[26] Their sequence, linked with the fact that for the second half of this period he also held the Downing Chair of Medicine, marks a fascinating prologue to the development of the concept of specialization which followed in the nineteenth century.

Of course it can be said that most of these are not 'proper books', being merely synopses of lectures. But can anyone doubt that if in his day there had been the same pressure to publish under which we exist today; and if there had been tape-recorders available, and

[23] Winstanley, op. cit., p. 261. Langdon-Brown, op. cit., p. 74.

[24] Gunning, op. cit., p. 53.

[25] Langdon-Brown, after making play (op. cit., p. 75) with the 'childish greeting' which, he implies, the two Professors of Physic were in the *habit* of making (each morning!) suggests that their well-known quarrel, and the scandalous invitation by Harwood to a duel, came later. In fact the duel incident (if indeed Gunning is to be believed) occurred in 1785, more than twenty years before Harwood's knighthood made the 'childish greeting' possible. The story, it will be remembered, is of Sir Isaac Pennington saying, 'Good morning, Sir, B.U. Sick?' to which Harwood is said to have replied 'Sir? I, Sick? I was never better in my life.'

[26] 1. *A Synopsis of a Course of Lectures on Anatomy and Physiology*, 3rd ed., Cambridge 1792.

2. *A System of Comparative Anatomy and Physiology*, Vol. I, Cambridge, 1796.

3. *A Descriptive Catalogue of Preparations in Spirits in the Anatomical Museum*, Cambridge, *c.* 1803.

4. *A Synopsis of a Course of Lectures on Comparative Anatomy and Physiology*, Cambridge, 1807.

5. *Downing Lectures: A Plan of a Course of Lectures on Domestic Medicine*, Cambridge, 1807.

6. *A Synopsis of a Course of Lectures on the Philosophy of Natural History and the Comparative Structure of Plants and Animals*, Cambridge, 1812.

stenographers to present him each day with the text of what he had said on the previous day, can we doubt that Harwood would have been a good deal more 'productive' in the modern sense than many of our contemporaries are? In judging a man's worth in history it is not fair to compare him only with the creative giants and the geniuses. In assessing Busick Harwood as a professor (in the sense of university teacher and researcher) in the subjects anatomy and physiology, we ought to compare him with modern scholars, who enjoy the patronage of the general public, working through its agencies, the University Grants Committee and the Treasury. Harwood would show up quite well in such a comparison.

His first book, outlining his annual course of lectures (which he gave, presumably, between 1785 and the end of the century) comprises exactly the kind of course that was requested last year, by Cambridge medical students, during the period of student unrest. There have been some agonising reappraisals in recent months! Harwood covered all the principal areas of human topographical anatomy, but had no hesitation in moving from anatomy into physiology, with accounts and criticisms of current theories, and then into pathology, and the clinical signs and symptoms of disease. He also deals with the structure of tissues and, at the end of the book, with various aspects of comparative anatomy.

We have no record of just how good the matter of his lectures was, but that the manner was effective as a means of communication is clear from his great popularity as a lecturer. One may legitimately conclude that the content was good, from consideration of the excellent scholarship of the first volume of his *System of Comparative Anatomy and Physiology*. He dealt here only with the Olfactory Sense, and with the general disposition of cranial nerves. The quality of the work has been noted by Macalister (op. cit., p. 23) and by Rolleston (op. cit., p. 204), and if the subscription list had only justified its continuance we might have had an outstanding work of scholarship. As it is, one can only envy those students and senior members who used to attend each day at 4 p.m. to hear the Professor discourse on a subject in which (*pace* Winstanley) he was clearly a master.

The 1803 *Catalogue* was never completed beyond the section devoted to specimens preserved in spirit. But it is a very illuminating and worthwhile document. In the Advertisement to his 1807 *Synopsis of Lectures*, it is stated that 'The Professor laments that a long and severe illness has delayed for a time the completion of a descriptive Catalogue of Preparations to which reference will be made in the course of his Lectures.' The Catalogue was completed by his successor W. Clark, in 1820, by which time the museum included Harwood's own collection of specimens, which formed the nucleus of what Macalister in 1891 (op. cit., p. 25) was to describe as a 'large and well-arranged collection illustrative of Comparative Anatomy: which is, for teaching purposes, second to no museum in Europe'. Perhaps it ought to be recorded at this Conference that this collection was dispersed, and in part destroyed, some fifteen months ago, largely, perhaps, for reasons outlined in my 1966 paper 'Medical scientists and the view that history is bunk'.[27] Cambridge no longer possesses a Museum of Human and Comparative Anatomy —not, at any rate, in the University Department of Anatomy. Nor is there any longer, now, any formal course on comparative matters given in the Department of Anatomy. This I know is much to the sorrow of the recently-elected Professor, who is not only devoted to the subject of Comparative Anatomy, but is also, happily, a Fellow of Downing. It is to be hoped that he will be able to revive interest in an aspect of Anatomy in which his predecessor in office, the late J. D. Boyd, was a complete master.

What is so interesting about the *two* different courses of lectures by Harwood of which the synopses were printed in 1807, is that he clearly now reserved his clinical teaching for the Downing Lectures. He therefore felt freer in his lectures on 'Comparative Anatomy and Physiology' to deal with the more strictly scientific aspects of the subject, and he no longer tended to concentrate on the human species, as he had done in the past.

Finally, in 1812, Busick Harwood prepared a course of wholly non-clinical lectures on the *Philosophy of Natural History and the Comparative Structure of Plants and Animals*, in which the analogies he makes between plant and animal forms, and between animal

[27] Bernard Towers, 'Medical scientists and the view that history is bunk', *Persp. Biol. Med.*, 1966, **10**, 44–55. Reprinted in *Concerning Teilhard; and Other Writings on Science and Religion*, London, Collins, 1969.

and human, clearly pave the way for the unitary vision of the evolution of living forms that came so soon afterwards.

Looking at these lecture-synopses alone, of course, one can only say that he covered a very wide range, and in a potentially very interesting way. Given the quality of his one 'serious' publication, one can only regret that one never heard him lecture.

The Epitaph to which I referred earlier says, 'if any profit came to thee from my books'. I, for one, am glad to acknowledge my debt to Sir Busick Harwood for his books, as well as for his lively personality. I hope that the Whitby Society in Downing will perpetuate his memory, with libations certainly, but also with further research into his character and achievements.

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Medical Education in Cambridge in the Nineteenth Century

by

RUTH G. HODGKINSON

ACCOUNTS of great men and great achievements have preceded this paper. The development of Cambridge medical education in the nineteenth century is a long, involved and truly fascinating story. But it should be seen in perspective. Praise is doubly warranted when it can emerge after comparison or even controversy. Justice however, may not be done by decimating the vast quantity of facts and figures. Partly for this reason and partly because I am speaking at the end of these meetings, I shall approach my subject differently. And because so many of us have a personal involvement with Cambridge I think we might trace the education and professional lives of three generations of ordinary Cambridge students, taking as our theme:

'*It is largely by a student's later career that the merits of his education must be judged.*'[1]

In 1819 our first freshman comes up to Cambridge with the ambition to reach the highest rank in his chosen career. He has left his fairly affluent family—not in the top social strata, for here, even a physician would be considered of insufficient status. He has had a private tutor for a small fee and has acquired some proficiency in mathematics, natural science and classics. His hobbies of botany and geology have trained him to be observant and he has frequently pottered around the apothecary's shop. As a youth he would have liked to have entered into an apprenticeship with his friendly family

[1] A. H. T. Robb-Smith, 'Medical education at Oxford and Cambridge prior to 1850', in *The Evolution of Medical Education in Britain*, ed. F. N. L. Poynter, 1966.

doctor and then by obtaining his Apothecaries' Hall examination, he could have become a general practitioner, a new title coined with some purpose in 1813.

But our young friend has been persuaded to enter Cambridge University, for his father knows this alone will open the door to the most respected positions in the medical profession. The Regulations stipulated three years' residency in a college and remaining registered at the university for a total of six years. He would read classics and take a B.A. He should attend lectures on Hippocrates and Galen given by the Regius Professor of Physic but he has heard that the Regius has not lectured for over a century. He has heard of the absentee Professor of Chemistry, the ineffective Downing Professor of Medicine appointed in 1800, and that the Professor of Anatomy lectured to mixed audiences on comparative anatomy, rather than on human anatomy to medical students. There is an anatomy lecture theatre but this is shared with the Professors of Physic and Modern History. Attendance at lectures was not compulsory and there was always private tuition to be had at £10 a year. There was no clinical instruction. In fact no 'medical school' existed. His essential technical training he would obtain in a London hospital. After studying physic, witnessing two dissections and succeeding in the Act of Opponency, he would obtain his M.B. A written examination would not be necessary, nor would the two dissections.

But it is now 1819. A refreshing, rejuvenating breeze is creeping over the high walls that have secured the undisturbed seclusion of the quadrangles. Self-satisfaction, stagnation and apathy are about to be wafted away. For two years, two enlightened men have been making initial efforts which augur well for all future students.

One is William Clark, Professor of Anatomy since 1817, who is to spend nearly five decades advocating that there should be two Chairs in his department—one of Human Anatomy and one of Comparative Anatomy. The other with greater prescience and resourcefulness has embarked on founding a true medical school. From 1817 to 1851 John Haviland is Regius Professor of Physic having previously been Professor of Anatomy for three years, during which time he initiated the first regular course on human anatomy.

Our freshman feels obliged although he is not compelled to attend the first lectures in pathology and clinical medicine. Haviland does not regard his post as a sinecure and gives fifty lectures a year in the former course, but with the practice of medicine, he can only begin in 1821 and as he wrote to Babington, for only two terms per year.[2] His stipend is merely £40 per annum plus a large house, so he depends for his income on his substantial private practice.[3]

But most of our student's lectures are given in his own college, and to him the university seems responsible only for his examinations and the conferring of degrees. His fellow-students in college are few. Several, he realizes are not there to learn, but for the privileged position a Cambridge degree will make possible in later life. The paucity of medical undergraduates is unfortunate as it denies him discussion in his own field. He is often listless and uninterested in class for he misses the inspiration practical work would give him. He is also left too much to his own inclinations. Yet he benefits from some valuable contacts he is making and he is becoming a cultured young gentleman. The advantage of being in residence and having friends with other interests lies in the broadening of his mind, in the interchange of ideas and the knowledge that he can acquire during his long leisure hours. His social life is therefore enriching although not as amusing as it was reputed to be in Edinburgh.

After three years he leaves Cambridge with his B.A. in classics, although this is not compulsory. His world is suddenly disrupted mentally and physically. He has to make a rapid and difficult re-adjustment to training in a teaching hospital and to life in the Metropolis.

In a poorish neighbourhood, not far distant from the hospital and the squalid environment from which most of the patients come, he obtains lodgings costing eighteen shillings a week. For economy he shares his accommodation with another student who introduces him to cheap good eating-houses and places of amusement such as the theatre and the Law Courts—for murder trials. His new friend has come to the hospital after serving a five years' apprenticeship

[2] M.S. letter 17.10.1821, Autograph letter collection, Wellcome Institute of the History of Medicine.

[3] He was also Linacre Lecturer from 1817 to 1822 and from 1826 to 1847.

with a dynamic young doctor compelled to augment his income. Our Cambridge scholar is amazed at the enthusiasm with which his fellow lodger has been inspired by observing at the hospital through the minor temporary post he had held and by the practice he has been allowed to get with the simple, most common cases of his master. He is acquainted too with dispensing and accounting. He has read much and not needed a 'grinder' for he attended anatomy and surgery courses for a short while at a private London medical school. At an impressionable age he has witnessed and been part of the tremendous number of changes going on around him—political, economic and social. He has trodden the streets; he is aware of the urgency for more doctors to cope with the problems of an increasing population. He has a strong feeling of his obligation to his fellow human beings. He is alive to their needs and his calling will enable him to respond.

Within the profession he has experienced the vigorous struggle over the Apothecaries Act of 1815. He regards it as neither revolutionary nor the immediate dawn of a new era. He is more realistic. Equivocal success is a challenge to the future. The State has interfered in the inauguration of more systematic and regular medical education and qualification. As those who form the majority of the profession increase in competence, so they will refuse to submit to discrimination, to the continuation of the structural hierarchy and monopolistic practices of the two exclusive colleges and the obstructive conservatism of the élite universities.

Our Cambridge student has to listen to endless discussions of his fellow-lodger and his friends and finds it all rather beyond his comprehension. His own ideals are not entirely selfish or reactionary for he aspires to become a good physician, a good teacher, and thereby he will assist progress in medical education and developments within the profession.

At present both men share a great interest, to learn, although our friend starts with a disadvantage in his pre-clinical training. London was supposed to 'offer him prodigious opportunities and advantages'[4] and some of his teachers are highly skilled in practice and in lecturing and undertake a tremendous amount of work. But he is also shocked by those that are uncouth and rough in

[4] N.D. MS lectures (1827–32) Guy's Hospital, Thomas Hodgkin.

behaviour and speech.

As he is staying for two years he devotes more time to lectures in his first year and more to practical work in his second, when he also ekes out his father's allowance of £100 a year by coaching juniors. He and his friend are free to do their own dissecting, when they can obtain cadavers, in the horribly damp and dirty deadhouse. Here they can assist at a post-mortem and are taught some pathology when a physician or surgeon appears. But morbid anatomy is not treated in most hospitals as a separate discipline for some decades. Surgical operations they can watch as they please, there is no compulsory time-table. They attend the senior physicians' lectures on clinical medicine and walk the wards with him, doing little but watch and not taking notes or histories. Lectures on materia medica, botany and chemistry (as then understood) interest our Cambridge man. He uses the meagre library alone, for his friend has no time. His 'qualifications' demand only a six-months' to a year's stay in hospital, and practical work is more essential for his career. Our future physician continues his more academic pursuits in the museum, which in contrast to the library is well stocked, the exhibits efficiently catalogued, the curator good and the illustrator a fine artist.

After two years' intensive study and a few months of being a clinical clerk to his physician for £10 our friend persuades his father to let him go to Paris for a short stay. He has been fired with enthusiasm by the scientific developments on the Continent and the difference in medical education. In Paris he can live as cheaply as in London. Seven pounds per month apparently covers all expenses. The experience he obtains is rewarding.

And now his six years' pupilage are over and he returns to Cambridge to take his M.B. He pays his three guineas, presents his certificates of hospital attendance, reads his half-hour dissertation and defends his arguments with an opponent—another candidate—whilst the professor sits in judgement. He then has his disputation with the professor on the latter's choice of subject. There is no written examination. Altogether there are only four candidates, none of whom is 'plucked'. He is already one of the élite for there have only been twenty-seven M.B.s in the past ten years.

Extremely fortunate in being awarded a fellowship, he is financially secure and tours the famous medical centres of France, Germany and Italy, observing medical practice, teaching and experimentation, and improving his knowledge of languages which he had been learning privately. These were not necessary at Cambridge. But Clark, his Professor of Anatomy, had advised him that it was essential for him to study German (although at this time the French School was in the ascendancy). This is also a cultural tour of great fascination, as his parents learn from his minutely descriptive letters. For an aspiring physician and F.R.C.P. the cultural aspect of the journey is also a necessity, even a calculated manoeuvre towards creating the image of a gentleman.

Back in his college he is engaged in teaching. After five years he qualifies for his M.D. He pays the fee of ten guineas, keeps two Acts and one Opponency and gives proof of having witnessed two dissections. Again there is no written examination. On his marriage he has to resign his fellowship. So he sets up in private practice in a fashionable area of London. His ability and cultured bearing soon attract wealthy patients who pay three guineas per visit, sometimes more voluntarily. Until his income is adequate he has pupils for coaching and is hoping to attract the attention of a teaching hospital. It is not long before he is elected a Fellow of the College of Physicians. To him the honour is a little equivocal for some of the best men he knows are denied this privilege through their religious convictions and because they had therefore not been to Oxford or Cambridge.[5]

Our M.D. advances in his former hospital from assistant physician to physician. By this time he has a lucrative practice and a reasonable income from his fees as teacher and examiner. The exclusiveness of his education and his position render him impervious to the accusations of the reformers of the mid-century who are emphasizing that the existing four-tier hierarchy within the profession militates against full employment of medical knowledge. In 1847 he agrees with George Burrow's evidence to the Select Committee on Medical Registration on 'the great advantages which result to society from there being an order of men within the profession who have had an education with the members of other learned professions; from a certain class of the medical profession having been educated with the gentry of the country, and having

[5] *Report of Select Committee on Medical Education*, **ii**, 1834.

thereby acquired a tone of feeling which is very beneficial to the profession as a whole.'

It is true that the finest medical men in the country are the consultants[6] in the hospitals and members of the royal colleges. From the mid-thirties to the 'fifties over fifty per cent of the leading physicians in London teaching hospitals were from Oxford and Cambridge. After the relaxation of the religious tests in 1834 the proportion of physicians in practice[7] dwindled, so that by 1852 Cambridge is providing only seven per cent of the London, and four per cent of the provincial physicians out of a total of over 500 in the former and 1,100 in the latter.[8] (The total medical population was 17,000 in 1850.) Although a London teacher and not a Cambridge professor, our friend's long association with the College of Physicians and his loyalty to his alma mater blinds him to the situation that his university is producing too few medical men.

From middle age he is a revered physician. He lives through restless times but remains unaffected both by the zealous activities of reformers or the prescience of some of the doctors in the hospitals. By 1870 his life is over. He has reached the heights he dreamed of as a freshman. He has kept in constant touch with developments in Cambridge and his wealth has enabled him to be a benefactor to his college. He is content. He has healed the sick, he has taught the young, he has given them financial aid.

It is a very long time since he had contact with his fellow lodger of the early London student days. Together they had read the *Lancet* and the numerous other medical journals—but different sections. They had joined the many often short-lived medical societies, but different ones, with different aims, although in the early nineteenth century specialization was not rigid and frequently one individual interested himself in a variety of subjects or movements.

Our London doctor had become a well-qualified general practitioner by early standards and while not paying as much attention

[6] The nineteenth-century connotation is used throughout.
[7] Ibid.
[8] A. H. T. Robb-Smith, op. cit. Correct statistics are unobtainable. Every source consulted differs, including the reports of Select Committees, Royal Commissions and Farr's analyses of census returns. This is due to the fluidity in nineteenth-century definitions.

to scientific research, he has used his equally inquiring mind and acute powers of observation for another purpose. He became involved in the developments within his profession, in education, in the anomalies of the examination system. In working for his profession he has also worked for improved medical care for the people. He joined the Provincial Medical and Surgical Association in 1832 and remained an active member of many of its campaigning committees. He played his part in the protracted struggle for the Anatomy Act, and for the Select Committee of Inquiry into Medical Education in 1834. He has taken part in the long hard campaign for the Medical Act of 1858, which was almost successful twenty years earlier. This, by defining a qualified practitioner as one examined in both medicine and surgery, was another step towards systematizing the profession. And by establishing the Council of Medical Education and Registration to advise on and scrutinize developments standards were raised to a higher uniform level. The efficacy of the General Medical Council was frequently called to account, and several amending Acts became necessary; but much was achieved for the profession and the people. Most medical reforms were sponsored from within the profession for the layman was both ignorant and apathetic. But the severest battles attracted outsiders and several politicians who gave the necessary help for obtaining legislation, on which the profession had increasingly to depend, and without whom the reluctance of the State to interfere would not have been overcome. (England had less medical legislation than any other European country.)

But in the large area of social welfare, the public was showing an increasing awareness and interest. Without the aid of the doctors to provide convincing statistics and compelling information the people would not have got the improvements they needed so desperately and so quickly. Long before Virchow pointed out that medicine is a social science, the humble people's doctors realized their involvement in sociological problems. Neither our Cambridge friend nor those in the university had their passions roused to help in investigation or give practical aid to reformers in many fields.

Our London general practitioner when he reaches old age is still living in his poor environment, aiding hundreds of sick for little financial reward, combating epidemics, helping in investigations by his pen, on the platform or in committees. He is still involved in the turmoil of changes. His end is not serene, for his life has been hard, and above all there is still so much to be done. After he dies in 1870, he is forgotten and unknown. No name in Munk's *Roll*, no college plaque. His dreams are far from fulfilled but should he have died the happier man? Had his education encouraged him to a more fruitful career? Had his calling—remembering the era in which they both lived—resulted in his rendering greater service to his fellow men?

II. MID-CENTURY

In 1852 Cambridge receives its second generation. This is not unusual and our student resides in his father's former college. Among the 1,500 freshmen he is one of less than two dozen medical students and one of the few who has been to a public school. Here he was not only poorly prepared for his medical studies but his mind has not been orientated to the new interest in the sciences.

His college expenses are not unduly high.[9] His companions during his three years' compulsory residency are still all members of the Established Church and theology students are by far the most numerous. Together they attend lectures on natural and moral philosophy, mathematics and classics, in which they are examined

[9] *Table of Average Expense of Student calculated for one College* (all similar) source: *Cambridge University Calendar.*

	£	s.	d.	
Annual				
Tuition	10	0	0	
Rooms and Rent	10	0	0	Students also made a small annual contribution to the University according to his degree (£1 if reading for a B.A.)
Attendance,				
Assessed taxes	6	5	0	
Coals	3	10	0	
College Payment (paid quarterly)	5	7	4	

Cost of Living

Breakfast, dinner and tea sixteen and six per week for 25 weeks.
Laundry—five and eightpence per week.
Rent of rooms varies with the college from £4 to £30.
Price of lodgings varies from eight to twenty-eight shillings (the most usual sixteen shillings)
Entertainment in rooms, services of a Gyp, orders in Hall, tradesmen's bill and personal expenses are all extras.
Private tuition is available for £7 a term or £14 for the academic year.

twice a year in their college.[10] Prizes are offered but scholarships are scarce. At the end of his second year our scholar must pass the one compulsory university examination, the Preliminary, or 'Little-go'. Since 1849 this has been held twice a year and lasts for fourteen days, from 9–12 a.m. and 1–4 p.m., the students taking papers in Paley's *Evidence of Christianity*, one of the four Gospels in the original Greek, one of the Greek classics and one of the Latin classics, a paper in the 'Elements of Euclid', and arithmetic—plus algebra for medical students.

Many changes have been effected in Cambridge during the past decades and it is now imperative on our medical student to attend fifty lectures on physic, a course in chemistry, twenty lectures on organic chemistry, fifteen on anatomy, and in addition he must provide certificates of having attended botany lectures and a course in pathological anatomy given by the Downing Professor of Medicine. In practice many of these courses are not obligatory. William Webster Fisher, the Downing Professor since 1841, is for example, often still in bed when he should be lecturing or frequently addresses students in his breakfast room, although he is supposed to give fifty lectures over two terms in the Anatomy School. But our student is introduced to pharmacology and general therapeutics by Fisher who is also pioneering a course in medical jurisprudence, probably influenced by his studies in Europe.

James Cumming, the Professor of Chemistry since 1815, is proving himself an excellent teacher as well as researcher. And John Henslow, who had been Professor of Mineralogy until 1827, had through his great interest and research in botany been offered the chair in this subject. Previously the post had been regarded a sinecure but his enthusiasm and knowledge have made botany popular in the university. William Clark has by now established an interesting anatomy museum open to all students between 11–12 a.m.

[10] Clifford Allbutt advised his friend's son to become good in classics for he would have the prospect of a classical fellowship with its emoluments. He should then take the classical tripos before proceeding to medicine. 'Many of the best medical graduates do this,' he wrote, and continued: 'He would have a better chance of a Fellowship at a College smaller than Trinity or Kings . . . Caius has a large number of Fellowships . . . so has Johns.' In the margin he scribbled: 'The prospects in medicine are very good, for instance up to £1,000–£1,500 a year, but there are few big prizes . . .'.
MS letter N.D. Autograph letter collection, Wellcome Institute of the History of Medicine.

and to all graduates and visitors between 2–3 p.m. The ugly 'Round House' had been built in 1833 at a cost of £4,000, in what became known as Slaughter-House Lane. Here our student has his anatomy, botany, chemistry and mineralogy lectures and can use the small dissecting room. On the plea that the curriculum for the Natural Science Tripos taxed him too heavily, Clark had divided his course in 1848, devoting himself to comparative anatomy and zoology, while delegating the teaching of human anatomy and physiology to a young surgeon from Addenbrooke's Hospital—George Humphry. The museum was divided at the same time. Humphry experiences great problems in obtaining bodies for dissection and the story is still told of the Cambridge riots of 1833. Humphry's teaching is very impressive but he has long to wait for his promotion.

Our undergraduate's father's great teacher Haviland, has however just died in 1851 but he is still highly praised for the many reforms he introduced in the curriculum and examinations. It is said that: 'Had it not been for his influence and insistence, the medical faculty might have been abolished.'[11] But although he has been credited with the subsequent success of the medical school, Henry J. H. Bond, our student's Regius Professor of Physic, laments in 1852 that 'the state of medical teaching is at a very low ebb'. Bond conscientiously gives well-prepared lectures regularly, which leave a valuable impression on our scholar and have a great effect on the development of the school.[12]

During his residence in Cambridge our student is a witness to the growing discontent regarding the internal government of the university. There is not only a general movement for reform in all faculties but also a demand for the relaxation or abolition of the ancient statutes and ordinances by which the university is controlled. The internecine strife between the university which is poor and the colleges which are rich has begun.

Even the government is induced to intervene and our student is keenly aware of the evidence and the recommendations connected with the Royal Commission appointed in 1852 to inquire into the state, discipline, studies, and revenues of the university and colleges of Cambridge. Through this, the all-important and essential Board

[11] Sir H. D. Rolleston, *Some medical aspects of old age*, Linacre Lecture, 1922.
[12] *Lancet*, 1883, **ii**, 483. *Brit. med. J.*, 1883, **ii**, 553.

of Medical Studies is established in 1854.

Just before he goes down, our undergraduate hears that the vital decision has been taken to repeal the Test Oath for matriculation and the B.A. (but that it is to remain for the M.A., M.D. and for Fellowships). He is also sensing that a new element is invading his historic university. Former Cambridge students are returning and bringing advanced ideas with them. Prescient teachers are joining them and point out the growing competition.

But our student has acquired more pre-clinical knowledge. This has been due in part to the curriculum of the Natural Science Tripos which has been established in 1848 and aims at encouraging a more scientific training and raising standards for medical students. Although the original regulations that the tripos had to be taken in the same term as the B.A. had been altered in 1851 to permit a term's grace, he has found it too strenuous to become proficient in comparative anatomy, human anatomy and physiology, chemistry, botany and geology. Success in the examination would not have carried degree status, so, like the majority of his friends, he has not thought it worthwhile, despite the fact that professors were known to cram their students and examinees. (There are only three successful candidates out of nine.) So after obtaining his B.A. our student leaves his cloistered existence, enthusiastic to embark on his practical work in London.

Here his instruction and his immediate environment are different from what his father's had been. Out of the twelve teaching hospitals which now exist and which have eighty per cent of all general voluntary hospital beds, he has chosen one with residential quarters. Although the patients' welfare and amenities have not greatly improved, there is now a grouping of cases so that treatment and opportunity for study are much facilitated. The necessity for improving nosology is at last becoming evident. Another clinical breakthrough is under way as the little-regarded technological improvements are receiving recognition and having a cumulative effect.

As the external and internal pressures on the medical profession are hastened, is it feasible that in the 'fifties innovations in medical science and practice in hospitals was of greater benefit to students and teachers than to the patient?

Peculiar to the English, most research and progress in clinical and surgical practice in this period emanated from the hospitals, although there were scientists and technologists producing advances for medicine or as ancillary sciences in the universities or elsewhere. So our student comes under the influence of some great hospital teachers. Most distinguished Cambridge men received their practical training in London; some went to Scotland and others to the Continent, and this must not be overlooked in making our assessment of their careers and the praise accorded to their alma mater regarding their education.

Our Cambridge friend finds he has to work harder in hospital and far more discipline has been introduced. He now has to register for regular courses and organized ward rounds. He has lecture theatres and a dissecting room although much of his instruction is still given in the wards. Not all his teachers are good. The senior physicians and surgeons are beginning to delegate some teaching to special staff. Busy with their large necessarily lucrative private practices, they can no longer cope with the increasing number of students, hospital work and the demands made on them through growth in specialities. The new lecturers are often uninstructive[13] and frequently their classes clash with practical work; yet our student must produce his certificates of attendance. His extensive and compulsory lecture course includes comparative and human anatomy and physiology, clinical medicine, surgery, chemistry, botany—and also now, ophthalmology, histology, morbid anatomy, midwifery, pharmacy and hygiene. In addition he must watch demonstrations in which he may take an active part and note-taking at all times is recommended. —So the revolt against an over-heavy curriculum begins.

In the evening our student has to read much for there is now a spate of literature from the Continent as well as Britain. Textbooks are also becoming more voluminous and journals heavier with articles on research. He also joins his student medical society where discussions are of a high standard and which many teachers attend, both to help the students, learn themselves, or from the non-

[13] It was suggested that if lectures were hopelessly bad a student might recreate himself by sketching or going to sleep—but with discretion—otherwise he might hurt the lecturer's feelings. 'Twenty thousand guineas are paid annually by parents of medical students in order that a quarter of a million golden hours of youth be wasted by compulsion in listening to feeble matter vilely delivered'. C. B. Keetley, *The Medical Students Guide*, 1878, p. 78.

altruistic reason of winning the confidence of the future practitioners.

In 1856 it is time to return to Cambridge for his M.B. The university regulations have been drastically changed. Haviland had asked for the professors of anatomy, chemistry and botany to assist the Regius Professor in the examination. George Paget in the early 'forties had recommended written papers and practical tests and not only a Latin viva. Our student has also to take an examination in clinical medicine. Had he taken his tripos, his honours subjects would not have to be retaken. And if it were a year later he would have been able to take his M.B. in two parts. Surgery and midwifery are not included in the M.B. finals. The cost is now £10, the sum varying slightly according to the college and there are still only four successful candidates. The examination is regarded as very difficult and therefore the reputation of the Cambridge M.B. is high. This has tended to act not as an incentive but as a deterrent. In addition the course is long; there are few medical scholarships and fellowships to help a student financially and a student is not officially (since 1827) permitted to work for gain during his absence from the university. Finally, many young men cannot delay so long before commencing on their career.

After obtaining his M.B. our more fortunate friend has to wait three years, it had been five, before he can present himself for his M.D. He will return to London but not to take advantage of his influential father. Removed from social contact with the élite of the profession, he wishes to learn from whom and where he chooses about the many developments and progressive changes that are taking place. He does not canvass for a post. He does not take other examinations for these qualifications he would have to renounce when he becomes an F.R.C.P. Therefore he waits for a lectureship, visiting Edinburgh meanwhile, to observe and to absorb what he can at the university and the infirmary.

Back in London he becomes a good teacher. He keeps an account of his students' progress and requires of them very full note-taking during his lectures and demonstrations. At medical societies' meetings he meets students and teachers from the new University of London medical school, and although a Cambridge man he acknowledges the necessity for, and the importance of its existence. Embarrassed, he remembers its struggle for recognition.

After his experience of London medical life and its restlessness, he returns in 1861 to the peace of Cambridge to take his M.D. Since 1854 it has been obligatory to present a thesis written in English and by himself but he has to keep only one Act and Opponency. This year Professor Bond has requested the appointment of an Assessor, a Cambridge M.D. to assist him with the Act. There are two successful candidates.

It is not long before he is elected a Fellow of the Royal College of Physicians—the Surgeons require an examination. As he is married he is debarred from a Cambridge Fellowship. (This was not altered until the reforms of the early 'eighties.) By nature and through the influence of his education he cannot bring himself to live in a turbulent environment. He decides not to join his ageing father and eventually take over his practice and probably a clinical appointment, but to remain in Cambridge. He sets up in practice as one of the 2,000 provincial physicians.[14] He is attracted by future contact with great medical men but lacking their special ability and a desire to learn the complexities of the new medical ancillary sciences, he does not aspire to a professorship. His environment will ensure that he retains his interest in the evolution of his profession and in scientific developments and he will continue to attend the meetings of the College of Physicians with their lectures of such high academic standard.

Not without detachment does he watch events concerning Cambridge University, for the years 1860–80 see the most rapid internal changes. Gladstone's investigation shows that in 1874 college incomes far exceed what they require for educational purposes, whilst the income of the university is too low. But it is not until an Act of 1882 that the college system of teaching is discouraged and the financial arrangements revised, so that college contributions to university funds enable the university to play a more active part in the teaching arrangements.

Success in this field is partly the result of another Royal Commission which reports in 1873 that although Cambridge has attempted to improve the teaching of the sciences, hardly more than a beginning has been made. This is attributed to the inadequate stipends of professors of the sciences, the large number of fellowships

[14] Nineteenth-century connotation.

held by non-residents (absentees) and the need for developing an inter-collegiate lecture system. It is suggested that life fellowships be granted as a reward for service, and research fellowships for a few years in order to attract talent to the university. The example cited is of a young medical man who cannot support himself at the beginning of his career. Henry Sidgwick opposes this in 1876 asserting that it would constitute a degrading bribe, for research should be undertaken for the sake of knowledge.[15]

But the liberal science-orientated members of the university are growing in strength. Henry Latham had in 1859 advocated establishing a school of practical science. In 1872 a resolution is passed at a joint meeting between Oxford and Cambridge: 'to have a class of men devoted to research . . . in the interest of national progress and education, that professorships and special institutions be founded in the Universities for the promotion of scientific research . . . that Fellowships as prize-money is unsuccessful, but [there should be a] properly organized body of resident teachers . . .'.[16]

In this year Cambridge establishes its Natural Science Club which is indicative of the direction in which the university is moving, and which was in the future to include some of the most distinguished scientists.

With regard to medicine, our friend learns in 1861 that the M.B. examination is to be divided into three parts. By 1874 the General Medical Council Inspector is reporting that this is working well. But the number of M.B.s is still only six, M.D.s however have for the first time reached ten from their previous two or three per year. Even in 1878 there are still only seven M.B.s and only twenty-eight medical students in the entire university.[17]

But one of the greatest triumphs for education reformers comes in 1871: the University Test is abolished after eight years of public agitation and parliamentary strife. Politicians had been daunted by the strength of prejudice and bigotry but now greater numbers will invade the hallowed quadrangles. The university will be compelled and will be enabled to become more efficient as a centre of learning. Greater talent will come and greater talent will be fostered—the

[15] Sidgwick was at this time advocating that women should be admitted as medical students.

[16] D. A. Winstanley, *Later Victorian Cambridge*, 1947, p. 267.

[17] W. Rivington, *The Medical Profession*, 1879, p. 11.

men and the university, both will benefit from each other.

Our Cambridge physician does not fully understand the implications but he will live long enough to witness future adventurous enterprises which will finally triumph in the twentieth century. Until 1900 he agrees with most changes but takes no active part in them.

In 1869 Sir James Paget had collected statistics from 1,000 medical students and their degree of attainment. He classified 'distinguished success' as, 'having reached, within fifteen years of qualification, a leading position in practice in a great city, a scientific professorship at a University, a place on the staff of a large hospital or the tenure of an important public office.' Our friend comes into this highest category; and as our theme is that 'it is largely by a student's later career that the merits of his education must be judged', he must provide us with favourable verdict on his Cambridge, and other, education.

In an age when a member of the medical profession was not greatly esteemed in England and when scientific value of work received less recognition than the rank of patients, our physician has achieved the high role demanded of him.

Has he fulfilled the nobility of his calling by our evaluation?

III LATE CENTURY

What will his son's interpretation be?

He enters college in 1882 at the dawn of what has come to be regarded as the golden era of the Cambridge medical school. His father's position and status made a public school education almost imperative. The curriculum and administration of the school had vastly improved since the 'sixties. But he has become a rebel at heart.

Once again he has been indoctrinated with ideas that manliness, loyalty, ability to govern others are essential. To prepare him for the life of a cultured Christian gentleman, classics and mathematics have been drilled into him and he has learned to write well. These give him a tremendous advantage for passing his Little-go early, although Cambridge teachers were 'unanimous in deploring the very little knowledge of classics and mathematics the freshmen from Public Schools possessed.'[18] Lack of scientific training was not

[18] This could have been rectified by a university entrance examination, but only Trinity College instituted one in the mid 'sixties.

deplored. Indeed leaders in the profession like Henry Acland, Clifford Allbutt and James Paget advocated that medical students be of gentlemanly manner, and stressed the advantages and importance of a broad general and classical education—condemning too early specialization in scientific subjects. As late as 1904 Allbutt eulogized on a liberal education and emphasized the importance of writing a thesis in a good style of English. He thought literary ability so poor that he published an illustrated manual: *A Note on the Composition of Scientific Papers*.

From 1869 the General Medical Council has encouraged licensing bodies to require evidence of a preliminary examination in English language, mathematics and Latin, with a choice of one paper in Greek, French, German, and natural philosophy which included mechanics, hydrostatics and pneumatics. This seems rather incongruous when medical education was really geared to the training required by ninety per cent of the profession, the general practitioner. Nevertheless, by the early 'eighties London and the provincial universities are offering more technical instruction as well as a shorter qualifying period, thereby helping the practitioner as well as meeting the increasing demand for more and better doctors.

Despite the advances made in Cambridge and the growth of its reputation, our freshman is still only one of the thirty new medical undergraduates. After eight months he passes his Little-go, which still includes algebra for him, but Greek was abolished in 1869 and a modern language is not compulsory. He then registers as a medical student with the General Medical Council.

His inclination is to the sciences so he is working for his Natural Science Tripos although this has not been very popular due to the inadequate facilities for study and the insufficient number of teachers. Although the tripos was given degree status in the 'sixties, so that another B.A. was not necessary, many medical students did not regard the subjects of value to their future careers. It was for this reason that Humphry had proposed a separate Medical Tripos. Progress in the sciences had also been retarded by the restricted number of students, yet without expansion there could be no attraction.

Some colleges had begun to encourage the sciences. Trinity had established a scholarship in 1867, a Fellowship in Natural Science in 1868 and had appointed a Praelector of Physiology in 1870. Downing had offered a fellowship on the results of the Natural Sciences Tripos since 1868. Now, in the early 'eighties, when the colleges have to pay taxes to the university, teaching can become more centralized and therefore facilities expanded. Nevertheless, St. John's, Caius, Sidney and Downing continue with their own chemistry laboratories when the university laboratory is in operation.

In 1871 new regulations for the Natural Science Tripos lengthened the examination period from six to eight days, with two days of practical tests in the middle. Some of the twelve papers were made stiffer and a viva was introduced. In 1874 Humphry successfully recommended that the examination should be held in two parts but he failed to have human anatomy and animal physiology accepted as separate subjects. In 1876 the regulations were altered again, so that when our student comes to take his tripos the dignity of the examination has been established and the Natural Science Board has made it a test of general and detailed knowledge.

After several years of hesitant consideration the university has also given recognition to the fact that medical science should receive greater attention. A Memorial of 138 graduates influenced the decision, which reveals how Cambridge men in later life maintained their interest in their alma mater and in its problems and achievements. This lasting loyalty is a tribute and a recommendation in itself.

Our student is therefore fortunate in that six professorships are created in the early 'eighties, including one in physiology and another in pathology. Both carry high stipends of £750 to make them full-time appointments. A lectureship in medical jurisprudence is also established, and of great significance three in physiology. He is enabled now to undertake practical work in this field, for which Cambridge is beginning to acquire a reputation and in comparative anatomy he can do his own dissections. Indeed one historian is already eulogizing: 'A school like Cambridge is a little leaven which must leaven in time the whole lump.'[19]

In Cambridge at an auspicious time our undergraduate has three of the greatest teachers of the nineteenth century to inspire and guide him: Humphry, Foster and Paget.

[19] Rivington, op. cit., p. 307.

He has only one year's actual experience of George Humphry's teaching in anatomy but he will long remember the dynamic personality and the personal encouragement. Humphry is involved in his students' welfare as well as in their academic progress. (He had run a hostel for poor students for three years in the 'sixties.) His strongly-held views regarding methods of education he expressed most eloquently in his wonderful Hunterian Oration of 1879 in which he emphasized the dangers of too much teaching and cramming, and that students should be encouraged in self-help and self-discipline. Humphry had been Professor of Human Anatomy since 1866. In 1874 when he became Chairman of the Natural Science Board he pleaded for more distinct recognition of human anatomy, and five years later observed that the battle of human anatomy had been hard and he had fought for a long time.

Humphry also lectures on physiology but his earlier recommendation of a department and chair had been baulked by the Trinity appointment of a praelector in 1870 (Foster). He is also interested in morbid anatomy and not only collects specimens for the museum, but also lectures at Addenbrooke's. Having been a surgeon at the hospital for so many decades, he tries to encourage students to take a greater interest in surgery and pathology—although the latter is not a subject for the Natural Science Tripos until 1925 nor for the M.B. until 1886.

In 1883 our student learns that his professor is relinquishing his chair in order to become the new Professor of Surgery, a post he regards of such importance that he takes it without stipend and pays for his assistant. He has declined the Presidency of the Royal College of Surgeons because his Cambridge work occupied him too much. And his professorship meant more to him than his knighthood.

Besides being an inspiring teacher, a prolific writer and skilful surgeon, Humphry is deeply devoted to improving the *system* of medical education and has always had the vision of making Cambridge a complete medical school. When the realization of this dream was being denied him, he remarked despondingly in 1880: 'Cambridge more than any University in the world, with perhaps one exception, has banished medicine from its walls and the men of medicine from its schools.'[20] Yet as the *Lancet* wrote even in 1866—

[20] Presidential Address, British Medical Association, Cambridge, 1880.

'he had done more than any other man to popularize Cambridge as a school of medicine'. His services to the future were incalculable and he was in great part a product of Cambridge education and environment.

Also a product of Cambridge, his successor as Professor of Human Anatomy is Alexander Macalister. He is the first full-time anatomist. Our student now has to work harder on the prescribed course. His new professor is first and foremost a brilliant anatomist and encourages his pupils to take a very wide view of human anatomy and includes microscopical anatomy and the history of anatomy. One of his students, Barclay Smith, observed that he 'elevated anatomy from a mechanical study into a living science'. Macalister takes a personal interest in his pupils, and our student spends many fascinating Sunday evenings at his home, for the professor tries to attract his young guests to take an interest in his own tremendous number of outside activities. The Professor of Zoology, Alfred Newton, also provides Sunday evening entertainment and our undergraduate benefits enormously from the rich informal conversations with this well-travelled ornithologist.

For the first time long-vacation teaching has been instituted and Alexander Hill, Macalister's demonstrator gives courses on practical histology. He is paid £250 from the University Chest, as are all demonstrators by this time.

Our student is living during a time of innovation in Cambridge and the rapidity of transition and the cumulative effect depend on the drive and success of the pioneers.

In the new Professor of Physiology, Michael Foster, Cambridge and the students are fortunate. Educated at London University because of his religious beliefs, he had proved his value as a professor there before being appointed Praelector of Physiology in Cambridge in 1870. Here he had started in a tiny room used as a lecture theatre and a laboratory of physiology, elementary biology and embryology. In 1876 he had published his textbook on physiology, to be called the students' bible, and which was translated into several languages. His lectures on the history of physiology are still read today, for he could combine remarkable erudition with great readability. As full-time professor he now institutes the first practical classes and includes histology. He is such an inspiring teacher and such a brilliant organizer that from his humble beginnings in Trinity, he has by 1891 not only had a new physiology laboratory but it already needs rebuilding. As Walter Gaskell, his pupil and assistant said: 'he works for, rather than at physiology', so that it is significant to our theme to include Rolleston's assessment of him: 'It is difficult to estimate how many undertakings and men's lives were determined and directed by his advice in his far-reaching spheres of influence.' Gaskell's other appraisal that 'he was a discoverer of men rather than facts' has its finest example in that it was through Foster that Clifford Allbutt was elected Regius Professor of Physic in 1892.

Other 'discoveries' were John Newport Langley, who had been Foster's pupil and demonstrator and who became a great researcher and prodigious writer, and Gaskell, who too was a Cambridge M.D. but had studied under Ludwig. Both are lecturers to our student but he is not inspired by them to devote himself to research which is their true leaning. Rather is he stimulated by his professor's extra-curricula interests. Foster was a member of the Royal Commissions on Vaccination, on Tuberculosis, on Sewage Disposal, and on the Reorganization of the University of London. And he was later to become a Member of Parliament.

Besides Foster's new professorship in 1883, our student at last has a Professor of Pathology. As ideas in Cambridge, as elsewhere, always preceded facilities available, the study of pathology is hampered during the 'eighties by inadequate accommodation and an insufficient number of teachers. He and the thirty or so other students are constantly moving from room to room. Charles Smart Roy, the new full-time professor, has worked under Virchow and Koch. He has travelled widely and pioneered much research. But he is less capable as a teacher to our undergraduate than as a guide and mentor to advanced research workers. The Downing Professor of Materia Medica and Therapeutics is Peter Latham. He has been a brilliant Cambridge student, a physician to Addenbrooke's since 1862 and Downing lecturer since 1863. Since 1872 he has deputized for Fisher and he is now the first really efficient Downing Professor. For twenty years he gives regular and effective lectures but it is not until after his retirement in 1894 that materia medica and pharmacology are taught from a non-empirical point of view, nor is any experimental knowledge required by examiners. So the Cambridge school, through general ignorance of the action of drugs and the medical practitioners' contempt for drugs, is organizing its pharmacology from a physiological approach. Latham has many brilliant achievements and ideas but unfortunately is not in agreement with the activities of the Great Triumvirate.

However, it is mostly through them that the recommendations of the Royal Commission of 1882 regarding improvement in the educational functions of the university were put into effect—the professorships and lectureships established and the Senate made to undertake the expansion of the medical school.

The third member of the Triumvirate is George Paget, Regius Professor from 1872–92. Our student's grandfather benefited from the inspiration of Haviland and had the experience of watching him lay the foundation of the Cambridge medical school. The edifice has grown slowly but is now looming large. Time has proved the effectiveness of a good teacher and a persistent reformer and Haviland's mantle has fallen on Paget. His early active career has been outlined by his son. Unobtrusively he had influenced his two predecessors and had been instrumental in establishing the Natural Science Tripos in which he was also an examiner. We have already noted his work for improving the M.B. I would only draw your attention here to the presidential speech he made to the British Medical Association at the first meeting held in Cambridge in 1864. (The date is of much significance). Pertinent to the future he concludes: 'We do injustice to medicine if we treat it as a mystery. It is a science, and entitled to rank as such . . . and we should be ready to show that its maxims are founded in truth and reason.'[21] Did his equally-famous brother James have this in mind when, in congratulating him on his Professorial Fellowship at Caius in 1881, he wrote: 'we have lived to the time in which the judgement of juniors may be even more prized than that of seniors used to be, and I hope you may live long to enjoy the clear evidence of your juniors' decisions.' Have the two brothers realized with acumen the salient feature of the new medicine?

All students benefit from the skill in lecturing of this professor who brings both wit and interest to his subject and who insists on high standards for both written and practical work. His sociable

[21] *Brit. med. J.*, 1864, **ii**, 141–46.

and sympathetic disposition make him very popular and he possesses the humility of all truly great men, regarding the honours bestowed on himself as a tribute to the medical school. Lectures on topics unusual from a Regius Professor arouse the curiosity of our friend, such as: the influence of alcohol: the mental causes of bodily diseases; that mental conditions may aid the cure of disease, which includes the idea of using hypnotic suggestion, faith healing and music. Paget's interest in public health is also acknowledged, yet Fisher had been condemned for his, for lectures in this field were then alien to the ideas of a Cambridge medical curriculum as were his few lectures on medical jurisprudence. On 1875 on Paget's recommendation the university established the first Diploma in Public Health in England.

Our student has decided where his interests lie, what he will do. A rebel, restless in his milieu, he is concerned with the life and problems of the outside world. He has decided not to follow in the family tradition. He is leaving the élite. He will become a general practitioner in the north in one of the great centres of industry. He may advance to teach in a provincial university or he may become a Medical Officer of Health—just as Paget's son had become in the slums of Salford. Within the profession and amongst the people, he will carry on where his grandfather's early London friend left off. In both spheres he will become one of the new men of the twentieth century.

He completes his pre-clinical training in Cambridge with his Natural Science Tripos. There are twenty-three successful candidates. (Humphry Rolleston is one of nine in the first-class division). Bearing his future career in mind he goes to London for his hospital training. He finds the medical schools very large compared with Cambridge. The twelve teaching hospitals have an average of 700 medical students, although their annual intake is declining. Fees have increased, for the hospital is incurring greater expenses for expanding both premises and facilities, made imperative in part by scientific progress. Hospital governors are having to provide more from their general funds to keep the schools solvent. Although practical courses have improved greatly, the lecturers are still poorly remunerated and many physicians and surgeons have drifted away. Whereas the metropolis used to be the centre for lucrative private practice on which the consultants depended, there are now other large prosperous urban communities. Senior teachers are also able to find alternative centres of employment either in the provinces or in the new specialist hospitals.

He returns to Cambridge in 1889 for his M.B. examination. There is now a vast difference in the individual papers compared with those his father took three decades ago. Even in the 'sixties only one out of eleven questions in the medical paper concerned a clinical examination. Ten years later eight questions dealt with diagnosis rather than treatment. Now, the scientific approach is evident, for technical aids to diagnosis such as percussion and auscultation have been adopted and improved. Also because of the Medical Act of 1886, our candidate is examined in surgery and midwifery and 'pharmaceutical chemistry' has replaced 'dispensing'.

He is one of forty-nine successful candidates (only ten years ago had the number reached double figures) and he is one of the first with a full medical qualification from Cambridge, i.e. in medicine, surgery and midwifery. But by this time there is almost uniformity throughout the country in education and examination, partly through compulsion and partly through evolution. The General Medical Council however, recognizes the advantage of some diversity being allowed to the teaching bodies as long as they meet the required standards.

By 1891 our doctor could have been one of nineteen M.D.s, but he has decided not to continue his studies, for with others he deplores the increasing number of changes in curriculum and examination which are beginning to harass the student.

After his migration to the large northern city he is quickly absorbed in the activities of the redbrick university with its medical school. He notes training is cheaper, because students can live at home, fees are lower and students obtain greater individual attention. He agrees with Jonathan Hutchinson's verdict that there were two brands of medical education: one for scientific study, the other for practising doctors. Our new general practitioner is also attentive to the interests of other family doctors and with them discusses medical education and developments within the profession at the local medical society and philosophical and statistical society meetings. The papers produced and the transactions published, are of high quality. He himself writes letters to journals on unusual cases, on abuses regarding his profession or angry letters in support of reformers. Now he is closer to the latter and professional problems and social welfare problems no longer appear remote. To him these had also always been two distinct fields; by his friends they are regarded as closely connected. Influenced by them he leads a full, active and useful life.

How much does the good work of his career depend on his Cambridge education, his London hospital training: how far is it a rebellion against his early upbringing: and how much is due to his own character and personality? When his career comes to be judged will he have been of short-term benefit to mankind, whereas his Cambridge University contemporaries in teaching will have a long-term influence? Again we must bear in mind the period and what we mean by a medical vocation.

As a generalization, Cambridge men had very little connexion with the pressing practical welfare problems of their day, although an increasing number of medical graduates are now, late in the century going into the State health service. But our friend keeping in touch with his alma mater is deeply interested in Clifford Allbutt. Before becoming Regius Professor in 1892 he has for thirty years been in private practice in Leeds and a consulting physician to the Infirmary there for twenty years. He has had half a lifetime of experience in the wider world and has a particular interest in preventive medicine and mental illness. From 1866, when he first read a paper to the Epidemiological Society, he has investigated and written about public health problems. He also recognized the general practitioner as the foundation of medicine and deplored 'that medicine as a function of civil society has come late into the field'. Now Allbutt has returned to the confines of Cambridge with its more academic emphasis in medicine and scientific advances. But he is well suited to his new role. Like Humphry and Paget who had been his teachers, he possesses a profound interest in medical education and his opinions are very similar to theirs. He is also fully alive to the value of scientific research, as his work and other publications prove.[22]

[22] So many of Allbutt's views merit examination today. He urged that the final stages of pupilage should be devoted to original research, for although a

Through his father and his membership of the Graduates Club our general practitioner learns of the general developments in Cambridge. He is astonished when his great teacher Foster is denied a Memorial on his retirement in 1903 on the grounds of inefficiency, supposedly proved by the fact that fifty per cent of the medical students never proceeded to the M.B. and that the number of new registrations have fallen from 198 in 1894 to 104 in 1903. Actually 1903 saw the highest number of M.B.s until the 'twenties—ninety, the figure usually stood around fifty.

But our general practitioner is impressed that at last there is a completely co-ordinated teaching system. When Allbutt is admitted as physician to Addenbrooke's in 1900, the university for a fee of £300 is allocated a number of beds. Clinical lectures in medicine and surgery are held there twice a week and practical instruction in the wards and the out-patients' department daily. Teaching in special methods of medical and surgical investigation are also introduced. Clinical clerks and dressers are selected from students according to their merit and without fee.

By the end of the nineteenth century the whole outlook and therefore the curriculum is quite different. As Allbutt said: '. . . medicine is not so much changed as transformed; a generation ago a doctor was an observer and naturalist and by practice mainly an empiric, now medicine is being reconstructed on a more scientific basis'. He emphasizes that bridges had to be built between physics, biochemistry and clinical medicine. This entailed providing new larger medical and science buildings. In fact by 1900 basic science and specialist research were beginning to overshadow the traditional concept of medical education. The movement begun in the 'seventies regarding an overloaded curriculum is now coming to a head. The examinations too have become stiffer[23] so that there is a considerable

student would not make great discoveries he would develop an invaluable gift—'the scientific habit of mind'. In later years a physician should return for post-graduate study to have revived the value of ideas and the ingenuity of methods. Allbutt deplored the divorce of medicine from surgery and whilst admitting the necessity of specialization for scientific advance, he warned against fragmentation which he forecast would come in the twentieth century. He preferred specialists to be 'scouts in continual touch with the army'.

'A century's retrospect of medicine, 1800–1900', *Brit. med. J.*, 1900, **ii**, 990.

[23] The M.B. consisted of part 1, chemistry, physics, elementary biology; part 2, human anatomy and physiology and pharmaceutical chemistry; part 3,

amount of private coaching in chemistry, anatomy and physiology, although this practice is declining where supervisors are being appointed in colleges. Medical journals are carrying advertisements for cram books and the *Lancet* gives a very favourable review of Pitman's *Shorthand Manual for Medical Students* (price eightpence). No wonder Allbutt admonished freshmen: 'Never waste even five minutes; always have something on your desk that you can do between lectures, before hall, and while waiting for a friend. Finish everything up as you go; leave no loose ends. *Never rest,* except in sleep.'

The advice sounds formidable yet it serves as an apt comment on the phenomenal evolution of the Cambridge medical school. Allbutt's life coincided with that of our third student. I deliberately chose three ordinary men but the history of progress in Cambridge is also the story of great personalities. In pondering for the last time over our theme 'that it is largely by a student's later career that the merits of his education must be judged', I think that you will give an optimistic verdict on Cambridge medical education at the end of our period. The seeds sown in the nineteenth century bore fruit in the twentieth and the university produced some of the finest practitioners, teachers and scientists. Much depends on our individual interpretation of what a medical calling entails and how it meets the particular demands of the moment and therefore the training that is necessary. The needs and definition of medical practice and science were changing dramatically and Cambridge was beginning to provide the new men for the new era, inculcating in many the profound advice given in the *Lancet* in 1895: 'All who follow the medical profession must be students for ever.'

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principles and practice of surgery, midwifery and diseases of women, pathology, principles and practice of medicine, hygiene, medical jurisprudence and mental diseases. The examinations were partly written, partly oral with practical tests in hospital, dissecting rooms and in the laboratories. An original dissertation had to be approved by the Regius Professor of Physic. No separate examination was required for surgery and the B.Ch. was awarded automatically. For the M.D. (three years after the M.B.) a thesis and viva were required with an extempore essay written on a subject relating to physiology, pathology, the practice of medicine or State medicine.

Lancet, 1895, ii, 594.

Haviland, Paget and Humphry

The Introduction of Clinical Teaching at Cambridge

by

ARTHUR ROOK

AT NOON on Monday 1 November 1842 the Special Court of the Governors of Addenbrooke's Hospital assembled in the Board Room to elect three surgeons to the staff. The Chairman, the Master of Jesus College, at once adjourned the Court to the Great Room at the Eagle Inn. The poll was kept open until 5 p.m., when it was closed with the written consent of all six candidates. Charles Lestourgeon[1] with 280 votes, Josiah Hammond[2] with 266 votes and George Murray Humphry with 221 votes, were declared elected.

This election brought on to the staff the youngest of the three men who transformed the medical and surgical practice of the hospital and introduced clinical teaching. The surgical vacancies had arisen in unprecedented circumstances and the election had been organized with meticulous attention to the regulations, which had been revised for the occasion.

On 30 September 1839 John Haviland had resigned as Physician, but he was still Regius Professor of Physic and a very active member of many hospital committees. His successor, George Paget, had been elected without opposition the following month. The

[1] Charles Lestourgeon Jr. (1808–1891) was at Trinity College, where his tutor was William Whewell, B.A. 1828 (15th Wrangler). He studied medicine at St. Bartholomew's Hospital and in Paris. M.B. 1833, F.R.C.S. 1843.

[2] Josiah Hammond (1803–1875) M.R.C.S. 1836. F.R.C.S. 1843. He studied medicine at St. Bartholomew's Hospital.

other physicians were Frederic Thackeray,[3] elected 1826, now elderly, but energetic and ambitious for the hospital, and Henry Hayles Bond (1801–1883), who had been elected in 1830. Bond, who in 1851 succeeded Haviland as R.P.P., was a shy, retiring man, but was a well-trained physician. At St. Bartholomew's Hospital under Peter Mere Latham,[4] he was one of the first men in England to use a stethoscope.

The surgeons early in 1842 were Lestourgeon senior,[5] Okes[6] and Abbott,[7] worthy general practitioners of the old school trained by apprenticeship, probably unable, even if they were willing, to contribute effectively to the development of clinical teaching. However, unless they were the unwitting victims of an elaborate plot, which is improbable, they must at least have approved in principle the plans of their physician colleagues.

On 24 August 1842 the Medical Staff had given notice of their intention of proposing that in future appointments should be for a limited period. On 3 October all three surgeons had submitted their resignations, which were formally accepted by the Governors. At the same meeting the Governors had agreed that in future medical staff should be appointed for twelve years, but be eligible for re-election.

So far no correspondence has been discovered which throws any light on these unadorned facts extracted from Minute Books of the hospital and the files of the Cambridge Chronicle. It is however difficult to avoid the conclusion that there was a carefully-planned campaign and that Frederic Thackeray and John Haviland had contrived the whole affair to give the hospital a staff of higher professional calibre and eager to teach. Haviland, Bond, Hammond, Lestourgeon Jr., Paget and Humphry had all trained at St. Bartholomew's Hospital. It was on the recommendation of Paget's

[3] Frederic Thackeray (1774–1852) was elected Surgeon to Addenbrooke's Hospital in 1796 and resigned in 1817. He was elected Physician in 1827. His offers to resign under the twelve-year rule were regularly refused (Rook 1970).

[4] Peter Mere Latham (1789–1875), physician to St. Bartholomew's Hospital, was an effective and influential clinical teacher.

[5] Charles Lestourgeon (1779–1853) served as an Army surgeon in the Napoleonic wars. He practised in Cambridge from 1808 and was elected Surgeon to the Hospital in 1813.

[6] John Okes (1793–1870) was apprenticed to his father Thomas Verney Okes, surgeon of Cambridge. He was elected to the staff in 1817.

[7] Alexander Scott Abbott, a local general practitioner, had been elected Surgeon in 1817.

brother James that George Murray Humphry was elected to the staff against strong local opposition. Thackeray was a remarkable man (Rook, 1970) who had played a large part in enlarging and modernizing the hospital; he founded the hospital library and was a founder member of the Cambridge Medical Book Club out of which developed the Cambridge Medical Society. His warm and forceful personality, his family connections and his membership of the Caput, the oligarchy which ruled the university, ensured him great authority and without his support Haviland might well have failed to put his plans into effect; but the moving spirit was John Haviland.

JOHN HAVILAND

The Havilands were an old Guernsey family, one member of which had settled as a merchant at Poole, Dorset, in the reign of Queen Elizabeth. His descendants lived mainly in Somerset and it was at Gundenham Manor, near Bridgwater in that County that John Haviland was born on 2 February 1785, the son of John, surgeon. From Winchester he entered Caius College, Cambridge, in 1803, but migrated the following year to St. John's College from which he graduated B.A. in 1807 as 12th Wrangler. There was little effective medical teaching to be obtained at Cambridge in the early years of the nineteenth century. Sir Isaac Pennington (1745–1817), the Regius Professor of Physic, was a competent physician and a capable administrator, active in College and University offices and in the Volunteer Movement during the Napoleonic Wars, but he made no effort to bring to Cambridge the reforms which were now so much overdue. Sir Busick Harwood (1745–1814) was simultaneously Professor of Anatomy and the first Downing Professor of Medicine. His extravagantly-coloured personality, bawdy conversation and bucolic habits have been enshrined in many well-known anecdotes but he, like Pennington, was a man of ability. In 1784 he had been elected F.R.S. for his experiments on blood transfusion. He worked actively and lectured on Comparative Anatomy and he also gave the Downing Lectures on Medicine. But he too failed to take the initiative to reorganize the Medical School on new lines.

Haviland must have been saddened by the lost opportunity in

Cambridge, when he very properly decided in 1807 to spend two sessions at Edinburgh and then three years at St. Bartholomew's Hospital. He returned to Cambridge in 1810 and was elected a Fellow of St. John's College. Two years later he received the M.L. (the University Licence to Practise) and began to build what rapidly became a large and successful practice. In 1814 he was elected Professor of Anatomy but resigned the Chair in 1817 on his election as Regius Professor of Physic. In the same year he was elected Physician to Addenbrooke's Hospital, gaining 115 votes to the 44 of Cornwallis Hewett,[8] the second Downing Professor of Medicine. He had been a candidate as Physician in 1814 when he was defeated by Woodhouse[9] by 105 votes to 67.

As a personality Haviland is elusive. Munk (1878) describes him as 'an excellent practical physician, quick and clever, yet discrete and of sound judgment, of great earnestness and high character'. In the pages of Joseph Romilly's diary (Bury, 1967) Haviland is seen as gentle, wise and conscientious; on 30 June 1837 'Haviland . . . said that he thought there was very little the matter with me, that it was wrong and foolish of men to brood over uncomfortable sensations and fancy themselves ill . . . I promised to try and mend and never think about my bodily state.'

Haviland's successful efforts to revise the medical curriculum, his regular courses of lectures on anatomy and later on pathology and the practice of medicine and his evidence to the Select Committee on Medical Education in 1839, I must leave to Dr. Hodgkinson, and confine myself to Haviland's contribution to the development of clinical teaching. From the opening of the hospital in 1766 the surgeons had accepted pupils who were their apprentices in both hospital and private practice, but this had been a private arrangement of which we are aware only from autobiographical references and not from the Rules or the Minutes of the hospital. From 1824 the House Apothecaries were permitted to accept apprentices. On 5 October 1841 Mr. Lestourgeon senior gave notice that he would 'bring forward the subject of admitting to the practice of the hospital the pupils of the medical gentlemen connected with that Institution'. The next Quarterly Court (28 December) approved

[8] Cornwallis Hewett (1787–1841). Downing Professor 1814–41.
[9] John Thomas Woodhouse (*c.* 1780–1845). Fellow of Caius College.

Lestourgeon's proposal, thus giving official recognition to an existing practice. However these pupils were not, and rarely became, undergraduates. The Court, meeting on 29 March 1841, extended to medical students permission to attend the hospital between 9 a.m. and 1 p.m. on all weekdays. This important change in policy was no doubt instigated by Haviland, who was present at the Court in question for it was consistent with his policy of developing a complete Medical School at Cambridge.

It can be no coincidence that the next move followed the replacement of the older members of the surgical staff. It was exactly a month after the election of Lestourgeon, Jr., Hammond and Humphry that Thackeray informed the Governors that the Medical Staff wished to introduce regular clinical lectures in medicine and surgery. On Haviland's proposal the scheme was submitted on 26 December to the Quarterly Court, which approved it.

Haviland also devoted much time and energy to committees for raising funds for the further enlargement of the hospital, made necessary partly by the increase in population but even more by the extension of the railway network throughout East Anglia, making Cambridge more easily accessible from the neighbouring towns (Cannon and Rook, n.d.). His resignation from the staff in 1839 on the grounds of 'delicate health' was opportunely timed for it created a vacancy for George Paget.

SIR GEORGE PAGET

George Paget was born on 22 December 1809 at Yarmouth, Norfolk, where his father Samuel was a brewer, who was also involved in naval supply contracts and in municipal affairs—in 1817 he was Mayor of Yarmouth. After 1840 the brewery ran into difficulties and in 1844 was sold to Steward and Patteson of Norwich. George and his younger brother James[10] could therefore depend on little further financial support from their parents (Paget and Paget, 1937).

George was educated at Charterhouse and entered Caius College in 1827. In 1831 he graduated B.A. as 8th Wrangler and the following year was elected to a Fellowship of his College. His mother wrote 'Good God, never can I express our delight and astonishment.' He

[10] Sir James Paget (1814–1899). Surgeon to St. Bartholomew's Hospital.

took up medicine because the terms of his Fellowship required him to do so (Lady Thomson's MS.). He worked in Cambridge for a time, then visited Paris during the winter 1833–4 and described his experiences in letters to his brother James. 'You can have no idea how crowded the medical lectures are here. I have discontinued attending the public ones (there are at least 2,500 students there)' (Paget, 1901). He worked at St. Bartholomew's Hospital after his return from Paris. He took the Cambridge M.B. in 1833, the M.L. in 1836 and the M.D. in 1838. He was elected Physician to Addenbrooke's Hospital in 1839 and remained on the staff until 1884. From 1872–1889 he was Regius Professor of Physic.

Paget was an impressive and dignified man of great personal charm, eloquence and enthusiasm, with a wide range of intellectual interests including European history and Gothic architecture on which he was an authority. His large circle of friends included W. G. Clark, Herschel, Whewell, Macaulay and Kingsley (Lady Thomson's MS. notes). He was very successful as a physician but he published relatively little. In 1873 he was elected F.R.S. He excelled as an administrator and the Grace Books of the University and the Minute Books of the Hospital and of the Cambridge Medical Society record his ceaseless and imaginative efforts to raise the standards of medical teaching and practice in Cambridge.

His most interesting achievements were in the reform of the curriculum and of the system of examination. As early as 1842 he was responsible for the introduction of a clinical examination in the final M.B. In 1848 he played a large part in establishing the Natural Sciences Tripos which broadened the basis of pre-clinical education. He strongly supported the clinical teaching and lectures at Addenbrooke's from their first institution.

Paget's correspondence with the Vice-Chancellor in 1873 is of special interest for the light it throws on his character. The correspondence concerns the stipend of the Regius Professor. [C.U.R. 39.6 (RPP, items 12/13)]. Paget's emoluments in the previous year had amounted to only £284 1*s*. 0*d*. He was however protesting less about the smallness of the sum than about the sources from which the emoluments were derived. In particular he thought it wrong that fees for the M.D. should be payable only by successful candidates. After much negotiation an increased stipend was approved, all examination fees, for unsuccessful as well as successful candidates, were to be paid to the Registrary and, in addition to his stipend, the Professor was to be entitled to collect fees only from such students as chose to attend his lectures—'It would be unwise and unjust to put upon them any compulsion to attend my lectures.'

Paget's many other achievements belong to the broader field of the history of medical education and practice in Britain as a whole. He was President of the General Medical Council 1869–74, President of the British Medical Association in 1864 and Harveian Orator in 1866. In 1885 he was appointed K.C.B.

Paget's obituarist in *The Times* (30 January 1892) wrote: 'At the present time the medical school at Cambridge is one of the largest in the United Kingdom and the possession of a medical degree at Cambridge is considered one of the highest professional qualifications. This remarkable change is due to the energy zeal and persuasion of Sir George Paget and Sir George Humphry'. One of Paget's greatest contributions to Cambridge medicine was to secure the appointment of George Humphry to the staff of Addenbrooke's Hospital.

SIR GEORGE MURRAY HUMPHRY

George Murray Humphry was born on 18 July 1820 at Sudbury, Suffolk, where his father was a barrister. In 1836 he was apprenticed to John Green Crosse,[11] one of the most outstanding provincial surgeons, and served as his clerk and dresser in his private practice and at the Norfolk and Norwich Hospital. In 1839 he entered the medical school of St. Bartholomew's Hospital where he came under the influence of Peter Mere Latham, Sir William Lawrence[12] and Sir James Paget. He won many hospital prizes including the gold medal in anatomy and physiology and so impressed James Paget that, although Humphry had only recently qualified (M.R.C.S. 1841; L.S.A. 1842), Paget, who described him as a distinguished student, recommended him so enthusiastically to his brother George at Cambridge that, as we have seen, he was elected Surgeon to Addenbrooke's; he was twenty-two. In 1844 his name appeared last on the original

[11] John Green Crosse (1790–1850). In 1830 he began regular lectures on surgery at the Norfolk and Norwich Hospital.

[12] Sir William Lawrence (1783–1867) P.R.C.S. Surgeon to St. Bartholomew's Hospital.

list of Fellows of the reconstituted Royal College of Surgeons.

From the time of his arrival in Cambridge he devoted his immense energy to the development of the hospital and the medical school and the extent to which he immediately made his influence felt was the more remarkable in that he did not become a member of the university until 1847 when he matriculated as a Fellow Commoner of Downing College. He took the M.B. in 1852 and proceeded M.D. in 1857, with a thesis 'On the formation of clots in the venous system during life'. In 1859 he was elected F.R.S. In 1860 he published an extended version of his thesis.

He was an excellent surgeon and soon acquired a large practice. Many of his publications were concerned with human and comparative anatomy and his *Treatise on the Human Skeleton* (1858) was probably the most important. However his surgical interests were wide; he was the first in England to remove a tumour from the male bladder and one of the first to perform a successful ovariotomy.[13] In 1857 he began to act as deputy for William Clark,[14] Professor of Anatomy, and he lectured regularly on anatomy until 1866. When the Chair of Anatomy was divided in 1866 Humphry was elected Professor of Human Anatomy and Alfred Newton,[15] Professor of Zoology and Comparative Anatomy. In 1866 Humphry founded, with William Turner, the *Journal of Anatomy*. For seventeen years he combined his work as an anatomist, at a time when the size of the medical school was expanding rapidly, with the active practice and teaching of surgery and he refounded and expanded the Museum of Anatomy and Surgical Pathology. Moreover he played a very large part in securing the establishment of chairs of Physiology and Pathology.

On 29 March 1878 the Council of the Senate (C.U.R. 39/38. Prof. Surg. Item 1) received the unanimous recommendation of the Board of Medical Studies that a Professorship of Surgery be established. On 22 January 1883 Humphry wrote to George Paget (C.U.R. 39/38. Prof. Surg. Item 2) asking him to make known to the General Board 'that in the event of the foundation of a Professorship of Surgery without any stipend I shall be willing to be

[13] The patient subsequently died of tetanus.
[14] William Clark (1788–1869) M.D., F.R.S. Professor of Anatomy 1817–1865.
[15] Alfred Newton (1829–1907) F.R.S. Professor of Zoology and Comparative Anatomy 1866–1907. A distinguished ornithologist.

transferred to it. Teaching surgery would indeed always have been more congenial and less laborious to me than teaching anatomy which I have now done in this university for six and thirty years. In the earlier part of my residence in Cambridge I gave to the few students who were then here, a systematic course of lectures on Surgery—I was however asked to assist in teaching anatomy and I felt that the development of the school of Anatomy must precede the formation of a school of Surgery. The former has now been so far done as to justify the University in attempting to accomplish the latter'. The Professorship was established after much discussion and despite some strongly-expressed objections. The Electors included William Bowman, Michael Foster, Timothy Holmes, Joseph Lister and both George and James Paget. There were no other candidates and Humphry was elected, and admitted to the professorship on 23 June 1883. He began his first course of lectures the following month, and rapidly built up his department. On 24 May 1888 a Grace approved the recommendation of the Special Board for Medicine that an assistant to Humphry be appointed, Humphry to pay the stipend, and only four days later Joseph Griffiths was appointed.

During his first twenty years at Cambridge, Humphry devoted much time to the Committee work of the Hospital, at first supporting Haviland and Paget, but later taking the lead in raising funds and in the detailed planning of the further enlargement of the hospital, which was so essential for the development of the clinical school. The Minute Books and correspondence show Humphry collaborating closely with the architect Sir Matthew Digby Wyatt and gently and persuasively imposing his will. Pevsner (1954) does not approve the aesthetic qualities of the building that resulted—'a depressing example of its date, with many rather dreary, thin, motifs, Italian as well as Tudor, assembled without any tension or accentuation'. Nevertheless from the utilitarian point of view the improved in-patient and out-patient facilities were an invaluable acquisition. In 1878 Humphry was instrumental in adding two further wards.

Humphry's activities outside Cambridge were varied and important. He was a Member of the Council of the Royal College of Surgeons from 1868–1884. The Editor of the *British Medical Journal* strongly supported him (*Brit. med. J.*, 1868, **i**, 563). 'It is in our opinion of vast importance to the profession that our connection with the older universities should be widened'. In 1872–3 he was Arris and Gale lecturer. He refused nomination for the presidency because the duties of the office would keep him too much away from Cambridge. In 1869 he had succeeded George Paget as a member of the General Medical Council and he was extremely active in the British Medical Association, nationally as well as locally. He was knighted in 1891.

Humphry was of medium height and slender build, never physically strong and often looking ill and tired. His voice was soft but his eyes were brilliant and expressive. He took little interest in physical comfort and never dressed well, yet his house Grove Lodge was renowned for its hospitality. Alex Hill (Hill, 1896), for many years his anatomy demonstrator and later the Master of Downing College, described him as 'perfectly fearless in his remarks . . . a man who stood alone for courage and pertinacity; a strong, kind man, neither fretted by misrepresentation nor depressed by obstructions'. 'His own purity of motive made him intolerant of crookedness in others.'

Humphry continued until his death on 24 September 1896 to work for the medical school with single-minded enthusiasm and with a disinterested integrity which disarmed opposition.

CLINICAL TEACHING AT CAMBRIDGE

By 1896 Haviland's ambitions for the Cambridge school had largely been realized through the efforts of Haviland himself and the dedicated activities of Paget and Humphry. The preclinical school was fully established and had already acquired a high reputation.

In 1890 the casual observer of the British medical scene could well have considered that the clinical school had also been effectively launched. The staff of the hospital included some outstanding men and there was sufficient clinical material for the full instruction of some forty students or for an introductory course for the whole preclinical intake. Paget and Humphry favoured the latter alternative (Humphry, 1880). After Humphry's death the clinical school slowly declined despite the temporary revival of the Professorship of Surgery from 1903 to 1915 under Howard Marsh who had suggested that he be offered the chair. His duties were virtually confined to the supervision of the examinations for the B.Ch. and M.Ch.

degrees. The possibility that the clinical school might fail was clearly envisaged by the anonymous author of George Paget's obituary in the *Cambridge Review* in 1892, when he wrote of 'that feeling of jealousy with which the demands of the Natural Science School in the University . . . are even now regarded'. George Murray Humphry, in his presidential address to the British Medical Association in Cambridge in 1880 (Humphry, 1880) had asked 'has not Cambridge more than any University in the world, with perhaps one exception, banished medicine from its walls and the men of medicine from its schools?' He had speculated on the historical reasons for the university's attitude to medicine but had tactfully avoided stating his conclusions, though he hinted at his opinion when he said: 'The College stamp is no longer necessary, for the noncollegiate student stands on the same level as the collegiate'. He ended on an optimistic note, implying that he felt that the opposition had ceased.

It is interesting to attempt to assess to what extent clinical teaching was in fact provided at Addenbrooke's during the fifty years after it was first introduced in February 1841. The principal source of information is the Register of Pupils. Under the original regulations pupils were obliged to sign the register each month and the teaching was limited to ward rounds. The number of signatures each month ranged between one and fifteen, and was on average six. Many men attended for six months or more, continuously or irregularly. Of the pupils in the first two years a number were local practitioners and their apprentices, but the proportion of undergraduates soon increased.

In January 1843, soon after Humphry's appointment, the regulations were changed. Lectures were given twice weekly during term and once weekly during vacations. Ward rounds and ward visits were continued. A fee of eight guineas was charged for six months, twelve guineas for a year and fifteen guineas for 'perpetual' attendance. Humphry's lectures appeared in the *Provincial Medical and Surgical Journal* and were republished as a book in 1851. Later the lectures and rounds in general medicine and surgery were supplemented by regular lectures in special subjects. Mackenzie Bacon[16] lectured weekly on psychiatry from 1868. The number of names in

[16] George Mackenzie Bacon (d. 1883) received his medical education at Guy's Hospital. In 1867 he became Superintendent of Fulbourn Asylum. He was a pioneer in mental hospital reform. He received an Hon. M.A. Cambridge in 1878.

the Register of Pupils increased from an average of six each year up to 1849 to over sixty a year in the 1880s. Almost all were now members of the university, and all but a few signed on for one year or as perpetual students. Some of the latter were more senior, and were already B.A. or even in some cases Fellows of their colleges. The signatures include many familiar names, Francis Galton in 1843, Clifford Allbutt in 1857, Alfred Garrod in 1869 and G. J. Romanes in 1870. The detailed analysis of the register is throwing interesting light on this period in the history of the Cambridge school. At present it must suffice to say that under the personal influence of Paget and Humphry the lectures and the ward teaching were regularly given and attracted a considerable proportion of Cambridge medical students, usually during their third year; Humphry persuaded some men to stay up for one or two terms longer, to the disapproval of the College authorities (Marsh, 1921).

Other contributors to this book describe some of the activities at Cambridge in the nineteenth century in many fields of medical science. All these activities owed their initiation and development to the vision and enthusiasm of Haviland, Paget and Humphry and to the wisdom with which they selected the men they were instrumental in bringing to Cambridge.

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The Early History of the Department of Pathology at Cambridge

by

RAYMOND WILLIAMSON

DURING THE eighteenth century Morgagni (1682–1771), Bichat (1771–1802), and Matthew Baillie (1761–1823) demonstrated the importance of the study of morbid anatomy in correlating clinical symptoms, and Edward Jenner (1749–1823) prepared the way for the study of immunity. We have abundant evidence that pathology was being taught in the University of Cambridge during the latter half of the eighteenth century. Busick Harwood, as Professor of Anatomy and Downing Professor of Medicine, introduced remarks on the pathology of diseases of man and animals in his various courses of lectures referring to the work of Ruysch, Leeuwenhoek, Malpighi, Marriotte, John Hunter, Hewson, Jenner and others.

In 1766, four months after Addenbrooke's Hospital had opened the Governors 'ordered that in any Doubtful Case the Physicians and Surgeons shall have power to open the Body of any Person Dying in the Infirmary without asking any Person leave'. Busick Harwood made a fine collection of anatomical and pathological specimens, many of them preserved in spirit which was just coming into use. In 1803 he published a *Descriptive Catalogue* of his collection. It was one of the first of such catalogues published in this country. After his death the collection was purchased by the university. From 1830 to 1840 there are notices of lectures on pathological anatomy by Cornwallis Hewett, who succeeded Harwood as Downing Professor of Medicine.

In 1819 John Haviland, Regius Professor of Medicine, began to give regular courses of fifty lectures annually in pathology and the practice of medicine, and from 1827 certificates of attendance at pathology lectures had to be produced by candidates for the M.B. examination. A timetable of lectures for 1849 (the first year of the Natural Sciences Tripos) shows that Haviland was giving three lectures a week on general pathology in the Michaelmas Term and on special pathology in the Lent Term. On the death of Haviland, Henry John Hales Bond was appointed Regius Professor of Medicine. He was a conscientious teacher and lectured regularly. His only published work was *An Analysis of an Elementary Course of Pathology*, published in London in 1866. It is probably founded on Haviland's lectures but much expanded. It contains references to preparations in the pathology gallery of the University Anatomical Museum. He was succeeded by George Edward Paget who relinquished the lectures on pathology to John Buckley Bradbury, Linacre Lecturer in Physic. When he was appointed Downing Professor of Medicine he continued lecturing on pathology until a university professor of pathology was appointed. At first the lectures were given in the old Anatomy School opposite Queens' College but from 1878 they were given in the Professor of Anatomy's private room at the New Museums.

During the latter part of the nineteenth century pathology had advanced rapidly through the work of Rokitansky, and Virchow and his pupils. The new science of bacteriology had been created by Pasteur's studies on diseases of wine and beer, and on diseases of silkworms and the way opened for the prevention of many diseases. Among the medical profession everywhere there was an increasing awareness of the importance of pathology. When the Royal Commission on Oxford and Cambridge was sitting in 1877–80 a memorandum was presented to it by one hundred and thirty-eight graduates of the University of Cambridge engaged in the study or practice of medicine, they said that pathology 'in addition to its value as an essential part of the complete study of medicine, has now attained such precision, proportions and development that it seems to us fairly to demand recognition as one of the foremost subjects in the sphere of University work'. In 1882 the New Statutes of the University were approved and in 1883 three new professorships were created in physiology, pathology and surgery, together with a number of lectureships in medicine, surgery, midwifery and medical jurisprudence. The leaders of this movement to create a complete medical school at Cambridge were: George Paget, Regius Professor of Medicine; Michael Foster, Praelector in Physiology at Trinity College since 1870, who was creating a school of physiology and becoming a power in the University; and George Murray Humphry, Professor of Anatomy in the University and Surgeon to Addenbrooke's Hospital. These three men worked together harmoniously for the benefit of the Cambridge Medical School for more than twenty years.

Humphry wrote many original papers on pathological changes in bones and he was an enthusiastic morbid anatomist always on the lookout for specimens for the Cambridge Medical Museum. He gathered together a unique collection of specimens exhibiting diseases of bones which until recently served as a memorial to a great teacher and benefactor of the Medical School. It has recently been given to the Royal College of Surgeons just when Humphry's dream of a complete medical school in Cambridge is becoming viable.

In 1871 the first pathological laboratory in this country was founded. It was the Brown Institution in London. In 1872 John Burdon Sanderson was appointed first Professor Superintendent. He resigned in 1878 for personal and family reasons and four years later became Waynflete Professor of Physiology at Oxford. His successor at the Brown Institute was Dr. Greenfield who resigned on being appointed to the Chair of Pathology at Edinburgh. He was succeeded by Charles Smart Roy who, three years later on 24 May 1884, at the age of thirty years, was appointed the first Professor of Pathology at Cambridge. In the same year William H. Welch was appointed Professor of Pathology at the Johns Hopkins University and Hospital.

Roy had received his medical education in Edinburgh and on graduating in 1875 he went to the Brown Institute to work under Burdon Sanderson. When war broke out between Turkey and Serbia in 1876 he joined the Turkish army as a surgeon. On the cessation of hostilities he returned to the Brown Institute where he worked on pleuro-pneumonia before going to Berlin to study pathology under Virchow and Koch, and the physiology of the heart under Du Bois-Reymond. For a time he was assistant to Goltz in the Physiology Institute at Strasbourg. He also worked with von Recklinghausen and investigated the pathology of the kidney with Cohnheim, who exerted a lasting influence on him. Roy returned from Germany to become the first holder of the George Henry Lewes Studentship at Cambridge and worked under Michael Foster on the physiology of the spleen and kidney and taught advanced physiology. One of his fellow workers was Charles Sherrington.

Sir James Paget, one of the electors to the Chair of Pathology, said of Roy, 'He is certainly one of the very best, if not the very best, of our scientific pathologists; and they are becoming the most prominent of all the scientific groups of our time'. (*Memoirs and Letters of Sir James Paget*, London, 1901, p. 321).

In 1784, the first Cambridge University science building was erected. It comprised a lecture room, behind which was an experimental room and two private rooms for the Jacksonian Professor of Natural and Experimental Philosophy and the Professor of Botany. It was in the corner of the Physic Garden bounded by Corn Exchange Street and Downing Street. At this time anatomy and chemistry were sharing the old printing house on the site of the Master's lodge and garden of St. Catherine's College but it was inconvenient and inadequate, so, in 1833, the new science building was enlarged by adding two rooms on the north side for the Jacksonian and Chemistry Professors and one on the south side for the Professor of Anatomy; behind this, in the angle of Corn Exchange Street and Downing Street a dodecagonal museum, a lecture room and a dissecting room for human anatomy were built. In 1872 a chemical laboratory for students was built over the rooms of the Jacksonian and Chemistry Professors. In 1876 a building, known as Fawcett's building, was begun, abutting on the end of the chemistry laboratory and extending from Corn Exchange Street, to the eastern end of the zoology lecture room in Salvin's building. It was of three storeys with good basements and was ready for occupation in 1879.

When Michael Foster was appointed Praelector in Physiology at Trinity College in 1870 the university allotted him two small rooms in Salvin's building which had been completed in 1863. One room he shared with Professor Challis, the venerable Plumian Professor of Astronomy, who soon vacated the premises because of the odoriferous nature of some of the physiology experiments. When Fawcett's building was ready the physiologists were allotted the middle floor but soon encroached on the other floors.

When Roy was appointed Professor of Pathology his department was housed in two rooms, one of moderate size the other a mere closet, and half another room on the top floor of Fawcett's building. His only assistance was one 'boy' but he began lectures in general pathology, with courses in morbid anatomy, histology, bacteriology and experimental medicine. They were interrupted in 1885 when Roy, Graham-Smith and Sherrington were sent to investigate the cholera epidemic in Spain. On his return he had only the help of the 'boy' until towards the end of 1886 when he appointed J. Griffiths as his assistant without stipend from the university. When Griffiths resigned the university established a Demonstratorship in Pathology with an annual stipend of £100 (Grace of 9 June 1887). This was offered to J. G. Adami but he was unable to come into residence until May 1888. In the interval Almroth E. Wright and Humphry D. Rolleston filled the gap.

In the summer of 1888 the Department of Chemistry moved from the old science building to a new one on the north side of Downing Street opposite the new court of Pembroke College. The old building was assigned to pathology and some alterations were made. The lecture room behind the main door was a good one and the room behind it was made into a sterilizing room. There was another door between the main door and Fawcett's building with a staircase leading to the upper floor, part of which was made into a well-lighted high demonstration room, the other was divided into research rooms by matchboard partitions. To the right of the door the room which had been the Jacksonian Professor's was divided into a preparation room and two research rooms. The room to the left of the door was divided into a small library, two rooms for the professor and an animal room. In 1895 a 'cultivation room', copied from the one in use in Pasteur's laboratory was erected in one of the professor's rooms. A. E. Shipley said of this accommodation it 'was not only inadequate but bad. Part of the building dated from 1786, and all of it was in poor repair, insanitary and in just the sort of state that a pathological laboratory should not be'. The laboratory was in use until 1904 and demolished in 1907.

Among those who worked in this department between 1888 and Roy's death in 1897 were: J. G. Adami, A. A. Kanthack, J. Lorrain-Smith, E. Lloyd Jones, Louis Cobbett, W. S. Lazarus-Barlow, F. F. Wesbrook, W. Hunter, E. H. Hankin, W. B. Hardy, Hugh Anderson, F. H. Blandford and H. E. Durham.

Roy organized elementary classes in general pathology and morbid anatomy but they did not attract more than a dozen students a term. One of the reasons for this was that few medical students remained in residence in Cambridge after passing the second M.B. examination in anatomy and physiology and were not examined in pathology until the Final M.B. Examination. In a report to the university, Roy suggested the desirability of having an examination in pathology between the second and third M.Bs. but this did not come about for thirteen years.

Roy was not a good teacher for elementary students, and he deputed much of that teaching to his demonstrators to whom he was kindness itself. Sir Humphry Rolleston said: 'As a teacher he appealed more to the advanced student and those aiming at original research, to whom he was most helpful and generous, than to the ordinary pupil'. Louis Cobbett said: 'I remember my friend Fox going to Roy's inaugural lecture and coming back and telling me that he spoke such broad Scotch that he could not understand a word'. Cobbett went on to say that Roy really excelled as 'a great encourager of research'.

Although the regular courses were not very successful Roy decided to run a course in the Long Vacation Term to attract men who had passed the second M.B. and were waiting to go to London hospitals in the autumn.

Cobbett said:

> This class was first held in 1891, by Adami and Hankin and was immediately successful. Students who had gone down and were attending hospitals elsewhere returned to Cambridge to prepare for their Final Examination, and men who had already qualified but had not settled down, some of whom were preparing for the D.P.H., attended. Not a few men appreciated it so much that they attended it twice over. The reason, no doubt, was that bacteriology had recently made great

strides on the continent and was at that time dominating medical thought. Yet, in the London Hospitals, or at all events at St. Thomas's, which I take to be typical of the rest, it was scarcely mentioned and we younger men welcomed with enthusiasm the opportunity of learning about it . . . Adami, fresh from Paris brought us all that he had learned from Roux and his colleagues. I have often wondered at the backwardness of the London Schools. It was not only that the staffs of the great hospitals were conservative, they were I venture to think ignorant, living outside the current of contemporary progress.

Cobbett had attended the second of these classes and he said: 'It was extremely interesting and Adami was a very inspiring teacher, quite eloquent at times, especially when he was telling us of Pasteur's early attempts to prevent hydrophobia'. Adami had been bitten by a rabid animal and sent by Roy to Pasteur to be treated with anti-rabies vaccine which had been first used by Pasteur four years previously.

This class was very successful and by the end of the century overflowed into the large physiology classroom where there were about eighty students.

Roy made great efforts to establish the teaching of bacteriology which he considered at that time to be the most active and important branch of pathology. In 1890 he instituted a class for advanced pathology which was conducted by Adami and Hankin but it was attended by very limited numbers of students. In addition to this advanced class there was one on the pathology of infectious diseases with instruction in bacteriological technique for candidates for the Diploma in Public Health. This was also conducted by Adami and Hankin. It was the first course of its kind in Britain.

Towards the end of the nineteenth century Cambridge gave a lead to other universities by establishing medical diplomas in specialized subjects of increasing importance to the community and opening them to other than its own graduates. Sir George Paget was specially interested in public health and the first diploma was founded when he was Regius Professor of Physic. The first examination was held in October 1875 and 'A Certificate in Sanitary Science' was granted to successful candidates. Other licensing bodies soon established similar examinations and by 1886 twelve certificates with a variety of titles were being granted. This made a common title desirable and the title of Diploma in Public Health gained acceptance and was sanctioned for its diploma by the University of Cambridge in 1887. From the time of its institution the Cambridge D.P.H. maintained the highest standard of all D.P.H. examinations. When the London School of Hygiene and Tropical Medicine was established the need for the Cambridge course diminished and the university abolished its Diploma in Public Health in 1932. Throughout its existence the Department of Pathology had played a large part in its success by teaching bacteriology and co-ordinating the other subjects.

At the International Congress of Hygiene and Demography held in Paris in the late summer of 1894 Roux told the world how to manufacture diphtheria anti-toxin. Cobbett said:

> In October Roy rushed me off to Paris where I was freely shown the whole process and saw Nocard bleed his horses. On my return I started to make diphtheria antitoxin at Cambridge. Dr. Alexander Hill, the Master of Downing, allowed me to keep my horses in his stables and gave them the run of his paddock. He also provided me at the cost of £25 with a fine young carthorse which was lame and from Professor MacFadyean of the Royal College of Surgeons I got a smaller horse.

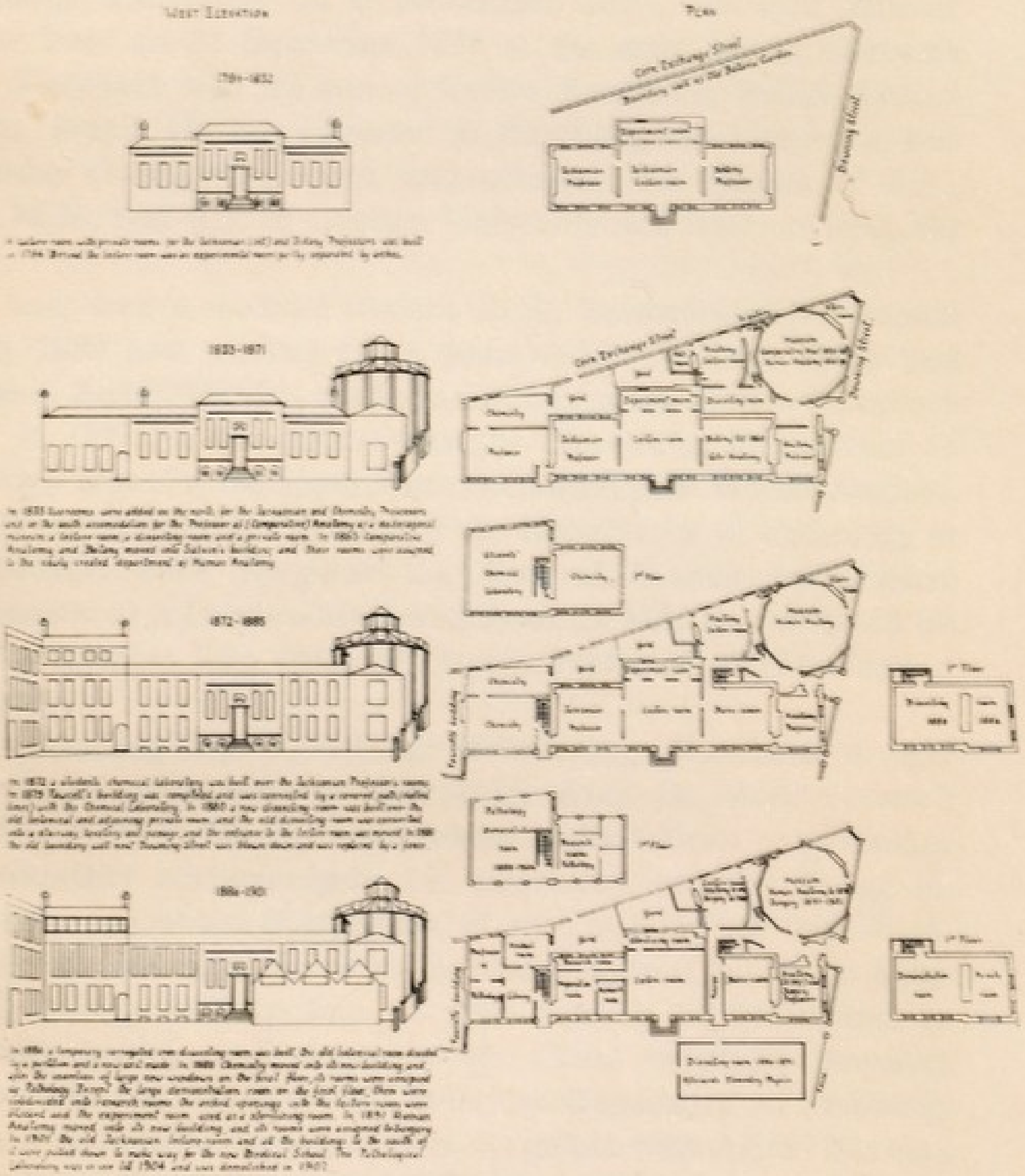
After making diphtheria antitoxin in Cambridge Cobbett spent most of the year 1897 making and testing diphtheria antitoxin in the laboratories of Burroughs Wellcome & Co. Ltd. He returned to Cambridge in 1898 and worked in the pathology laboratory until 1902 without holding any official post but assisting with the teaching and pursuing his research on the bacteriology of diphtheria.

Towards the end of 1882 Roy's health began to fail and he showed signs of mental illness. His memory failed so that he could not remember what he had lectured about to a previous class, after he had repeated a lecture on three occasions there were complaints from students and the university appointed Kanthack as his deputy. Roy died on 4 October 1897.

In some private papers by Sir Humphry Rolleston, in the possession of his successors to the Regius Chair of Physic at Cambridge, he says:

> Roy, with whom I did experimental work, was a wonderful operator, and an extremely kind man with, however, very bluff if not rude manners, and quite unconventional from an academic point of view,

THE DEVELOPMENT OF THE FIRST PATHOLOGICAL AND SURGICAL LABORATORIES FROM THE FIRST SCIENCE BUILDINGS ERECTED IN 1784 IN THE SOUTH EAST CORNER OF THE OLD BOTANIC GARDEN



for example hurrying along the streets in cap and gown and smoking. He was extremely unpunctual, often coming an hour late for an experiment, the time for which he had fixed. Though I did not know it at the time, this was probably because he was a morphine addict—a failing which contributed to his premature death.

Alfredo Antunes Kanthack was elected Professor of Pathology at Cambridge University on 6 November 1897. He died thirteen months later on 21 December 1898 at the early age of thirty-six years. Kanthack was the son of Emilio Kanthack, British Consul at Para, Brazil. He was educated at Hamburg and Luneburg, and University College Liverpool, and obtained the degrees of B.A., B.Sc., M.B., and B.S. of London University and later, in 1892, the M.D.

He had been a medical student at St. Bartholomew's Hospital and in 1889 had worked for a year under Virchow, Koch and Krause in Berlin. He also worked in India for the National Leprosy Fund. In 1891 his association with the Cambridge Department of Pathology began by his appointment as John Lucas Walker Student. In 1892 he was elected Director of the Department of Pathology at St. Bartholomew's Hospital—the first whole-time pathological appointment at a London Medical School. In 1895 he combined his duties in London with those of Deputy Professor of Pathology at Cambridge.

On succeeding Roy to the Chair of Pathology, Kanthack brought three people with him to Cambridge from St. Bartholomew's Hospital: T. S. P. Strangeways, whose contributions to pathology are universally acknowledged; his laboratory assistant Ernest H. Shaw who was about thirty years of age; and his lab boy W. A. Mitchell who was nineteen. When he died Kanthack left Ernest Shaw enough money to help him to start reading medicine and he eventually became pathologist to the Great Northern Hospital, London. Mitchell stayed in the Cambridge Department of Pathology of which he became Superintendent. Together with Albert Norman of the Agricultural Research Laboratory at Weybridge he was a founder of the Pathological and Bacteriological Laboratory Assistants Association. His outstanding services to the university were recognized by the conferment on him of an Honorary M.A. degree.

Another invitation from Kanthack brought great benefit and honour to the university—in May 1898 he invited G. H. F. Nuttall to come to England and work in his department, but before definite arrangements could be made Kanthack died. In May 1899 Sir Clifford Allbutt renewed the invitation and suggested that a post might be created for him. This materialized later.

Kanthack's interests differed from those of Roy, he was a morbid anatomist and bacteriologist while Roy was primarily an experimental pathologist. Kanthack was an indefatigable worker and during the last ten years of his life he published seventy-four papers and books, twenty-eight of which were joint publications.

He has the credit of having been the first person to use a short white coat in laboratory work. He began to wear one about 1893. He also introduced into this country the use of formalin for the preservation of laboratory specimens. The first account of this process in English is in a paper by Kanthack and Shaw read before the Pathological Society of London, 3 November 1896. Sir Humphry Rolleston said that Kanthack's 'most influential publication . . . was probably the article on "The General Pathology of Infection" in the first edition of Allbutt's *System of Medicine* (1896, **1**, 503–86).' In the same volume there are two other classic articles—Adami on 'Inflammation' and Welch on 'Thrombosis'.

Kanthack's early death was a sad loss to the university and to pathology. He had been intimately associated with the Cambridge Department of Pathology for nine years, first as John Lucas Walker Student, then as Roy's deputy and finally as Professor of Pathology. During that time he had exerted a great influence on the department and his associates.

Kanthack Memorial Libraries were established in the Pathological Departments of both St. Bartholomew's Hospital and Cambridge.

During the interval between Kanthack's death and the appointment of a new professor of pathology the work of the department was in charge of T. S. P. Strangeways and J. H. Drysdale. The Chair was offered to J. G. Adami who was then Professor of Pathology at McGill University but for personal reasons he refused it and on 11 February 1899 German Sims Woodhead was elected. His unusual christian names were old Derbyshire family names on his father's side, but he was a Yorkshireman. He received his early education at Huddersfield College and Edinburgh University where he graduated in Medicine in 1878. He studied in Berlin under Koch, in Paris under Pasteur, and in Vienna. He obtained the degree of M.D. with a thesis gold medal in 1881 and became senior assistant to Professor Greenfield and a Research Scholar of the Grocer's Company. From 1887–1890 he was the first superintendent of the laboratory of the Royal College of Physicians, Edinburgh. In 1890 he moved to London as the first Director of the Laboratories of the Conjoint Board and the Royal College of Surgeons of England, and organized those laboratories in which Almroth Wright commenced his classical research on infection. He also organized the first machinery for the systematic diagnosis of diphtheria in London and undertook the preparation of antitoxin serum for the London infectious hospitals under the Metropolitan Asylums Board and did much to establish the antitoxin method on a sound foundation. It was during this period, in 1892, that he founded the *Journal of Pathology and Bacteriology* which he edited until 1920.

He had also done research on tuberculosis and became associated with the official movement then going on for the suppression of tuberculosis, a cause which he did much to further during the rest of his life. He had also published papers on micro-organisms in water, and on antiseptics, subjects on which he afterwards did important work in Cambridge, especially in developing the application of bleaching powder to the disinfecting of drinking water for the troops during the war of 1914–18. In 1883 he had published his book *Practical Pathology* which marked an epoch in the teaching of morbid histology, and, in successive editions was a standard student's textbook for thirty years.

When Woodhead came to Cambridge the laboratories occupied by the pathology department were in a bad state of repair and those occupied by the medical departments which had moved into the accommodation released when anatomy moved into new quarters alongside physiology in 1891, were in a worse state. In March 1899, a month after Woodhead's appointment a syndicate was appointed to consider what could be done; with Woodhead's well-known organizing ability it fell to his lot to draw up a scheme for building a 'Medical School' which would provide accommodation for departments of medicine, midwifery, surgery and pharmacology and partial and temporary accommodation for the departments of public health, medical jurisprudence and pathology. When the scheme was approved it became his onerous duty to see it through. The building was opened in March 1904 by King Edward VII. It was an irregular L-shaped building the long front facing Downing Street with the Humphry Museum at the corner of Downing Street and Corn Exchange Street. All except the facade along Downing Street and the Humphry Museum which was turned into a library, was demolished when the present Zoology building, opened in 1934, was built in its place.

Woodhead continued the Long Vacation Course for students preparing for the Final M.B. examination assisted by Strangeways, Nuttall and Shipley. It was a stimulating and very successful course and in some years as many as seventy-five students attended. Often on summer afternoons when the heat in the demonstration room became unbearable, the class retired for tea and chat under the large *Sophora chinensis* tree which bloomed freely every spring and darkened the windows of the laboratory. It was the last relic of the old Botanic Garden. From *S. chinensis* a dye was extracted by the Chinese for producing the royal yellow for the robes of the Chinese Emperors.

During this period the staff of the Department of Pathology consisted of the Professor, T. S. P. Strangeways and G. H. F. Nuttall who had come to Cambridge in 1899 and given the lectures and conducted the practical classes in the D.P.H. course begun by Adami and Hankin. In 1900 Nuttall was appointed University Lecturer in Bacteriology and Preventive Medicine; he expanded the D.P.H. course giving two courses of lectures with practical instruction on bacteriology and preventive medicine annually. In the same year he founded the *Journal of Hygiene* the first number of which appeared in January 1901.

In 1904, with the co-operation of Sir Patrick Manson, he persuaded the university to establish the first Diploma in Tropical Medicine and Hygiene; finding that protozoal diseases could not be treated adequately in the regular course in bacteriology he began, in 1905, additional lectures on protozoa and protozoal diseases.

In 1906 he was appointed Reader in Hygiene but held the post for a few days only on being elected first Quick Professor of Biology. He started his new department in a room in the Pathology Department on the top floor of the Medical School but in 1907 moved into a large room, which had been adapted for his use, on the ground floor of the east wing originally intended as a teaching museum. It became known as the Quick Laboratory and here he organized his department until the Molteno Institute was opened in 1921.

In 1901 a small laboratory was built adjoining the post-mortem room at Addenbrooke's Hospital which then stood in the south east corner of the hospital grounds. This laboratory was afterwards replaced elsewhere by the John Bonnett Memorial Laboratory, mainly through the influence of W. Malden who was working in the Department of Pathology and was responsible for the advice on which Mrs. Bonnett made her gift to the hospital in memory of her son who had been Secretary and Legal Adviser to the hospital. Malden became the hospital's first clinical pathologist.

Other members of the Pathology Department, working independently or having grants or scholarships, during this period of upheaval were: W. Myers, H. E. Durham, H. C. Haslam, L. Cobbett, G. S. Graham-Smith (all at some time John Lucas Walker Students), G. E. St. B. Sladen, A. B. Greene, N. Ackroyd, O. Inchley, W. Malden, R. D. Smedley, W. G. N. Scott.

All members of the department were working under considerable difficulties while the Medical School was being built. Teaching had often to be carried on in borrowed rooms and some workers were housed in converted offices in St. Tibb's Row which were the first home of the Cambridge Scientific Instrument Company. In spite of all the difficulties much important scientific work was being done.

In 1900–01 considerable outbreaks of diphtheria in Cambridge and Colchester provided an opportunity for important field work and:

> gave Cobbett the opportunity of tracing the spread of the disease by the bacteriological examination of patients and of school, family and other contacts. He not only isolated the diphtheria bacilli in pure culture from almost every individual patient and contact found to be infected, but also investigated their virulence for guinea pigs. Further, in order to check the spread of the disease by carriers, he arranged for their isolation in a building away from the isolation hospital until the bacilli seemed to have disappeared from their throats and noses as evidenced by three consecutive negative examinations of cultures. These were the first large scale investigations of their kind (G. S. Graham-Smith, *J. Path. Bact.*, 1947, p. 697).

Nuttall also engaged in some field work. He had become interested in the history of malaria in England and with Cobbett and Strangeways made a survey of *Anopheles* mosquitoes in England. Their paper published in 1901 included the first accurate maps on the distribution of disease-bearing insects.

Soon after coming to Cambridge Nuttall became interested in precipitins and in 1901, while confirming the work of Kraus, Bordet, Uhlenhuth and others on the formation of specific precipitins after the inoculation of various bloods and sera, noticed slight precipitin reactions with the sera of allied animals and suggested the forensic use of precipitating antisera. He continued this line of work for the next three years and in 1904 published his classical monograph on *Blood Immunity and Blood Relationship*.

In the Medical School, opened in 1904, the Pathology Department occupied the short north wing, the projecting east wing known as the Humphry Museum, the whole of the top floor and a considerable part of the basement in which animals were housed. The staff remained the same until 1907, when on Nuttall being elected Quick Professor of Biology, the University created lectureships in pathology and hygiene. Louis Cobbett was appointed University Lecturer in Pathology and G. W. Graham-Smith University Lecturer in Hygiene. Strangeways remained as University Demonstrator in Pathology but from 1905 combined that post with the Huddersfield Lectureship in Special Pathology which had been created from funds collected by Woodhead from Yorkshire friends. Other members of the department between 1904 and the commencement of the Great War are too numerous to list here. They are cited, with the work they were engaged on, in Graham-Smith's manuscripts in the Cambridge University Library.

Before Woodhead took up the duties of the Professor of Pathology at Cambridge the work being done in the department was mainly on those aspects of pathology which can be studied apart from practical medicine. There was greater opportunity for gifted students and those who could afford to spend an extra year in Cambridge than for the average medical student, but I feel sure that, had he lived, Kanthack, who had had closer contact with practical medicine than Roy, would have broadened the basis of research and teaching in Cambridge. While not neglecting the gifted student, Woodhead's previous experience as a teacher led him to pay more attention to the needs of the average medical student. He persuaded the university to carry out a suggestion first put forward by Roy, and in 1910 an Examination in Elementary Pathology and Pharmacology (II M.B. Part 2), commonly known as 'Bugs and Drugs' was instituted. It had to be passed before a student was allowed to enter for either part of the Third or Final M.B. The regulation required Certificates of Study during the Lent Term or the Long Vacation. To this end Woodhead organized a course of instruction suited to the state of knowledge of the students. He discontinued his very popular Long Vacation Course for students preparing for the Final Examination, thus putting the onus for giving instruction in pathology suitable for that examination on the Hospital Medical Schools.

At the British Congress for Tuberculosis in July 1901, Koch made the startling statement that the bovine tubercle bacillus was not pathogenic to man. After the meeting Woodhead suggested to some influential members of the congress that they should approach the Minister of Agriculture to urge that steps should be taken to settle this vitally important question. They did so, and the following year a Royal Commission on Tuberculosis was established with Woodhead as one of the Commissioners. He had previously worked for the 1890 Commission on the sterilization of tuberculous milk and meat and he played a major part in the new commission's work. Under his guidance an experimental station was established at Stanstead in Essex on two of Lord Blyth's farms. Louis Cobbett and E. St. B. Sladen were appointed as Scientific Investigators each in charge of one of the experimental farms. After a year Sladen dropped out and Cobbett had sole charge. The account of his fundamental work for the Commission was published in 1907 in an appendix of 1,200 pages to the Royal Commission's Report which showed that the Bovine tubercle bacillus was pathogenic to man as well as animals. Woodhead became one of the world's leading authorities on tuberculosis.

On the conclusion of the Commission's work Woodhead and Nuttall purchased ten acres of land on the Milton Road, Cambridge and built small animal houses, stables and piggeries and arranged for the transfer of the equipment from the Stanstead experimental farms. A laboratory for the study of tuberculosis was also built and put in charge of Dr. Stanley Griffith. Another laboratory was built for the Quick Department and a house for the caretaker. This 'Field Laboratory' as it became known was taken over by the university in 1913 and later became part of the Department of Animal Pathology.

In 1911 P. C. Varrier Jones, a Foundation Scholar of St. John's College, began work as a research student with Sims Woodhead on methods for obtaining continuous records of body temperatures in man and animals in health and disease. They also studied sanatorium treatment for tuberculosis which had only recently become available for the working man and they were dissatisfied with it for him. After the outbreak of the War in 1914 the Tuberculosis Officer for Cambridgeshire was called up and Varrier Jones was asked to serve as his deputy. This gave an opportunity for some of their ideas to be put into practice and in 1915 with the support of Sir Clifford Allbutt they started a colony at Bourn, near Cambridge for the treatment of discharged tuberculous soldiers where they could do light work either at their old or at new occupations for a prescribed number of hours a day. Their observations were published in a number of joint papers. Such was the success of this small Cambridgeshire Tuberculosis Colony that in 1918 it was moved to Papworth Hall where under the direction and guidance of Varrier Jones it grew into the Papworth Village Settlement and became known the world over.

T. S. P. Strangeways had become convinced 'that our knowledge of a disease could best be advanced by the study of that disease as it occurs in the *living* human body' and decided to investigate rheumatic joint diseases. He collected funds for his proposed study and by 1906 was able to open under a Managing Committee, a small hospital, at 44 Rock Road, for the intensive investigation of these conditions. Most of the pathological work was carried out in the Pathology Department and an X-ray apparatus was installed in the Medical School by the generosity of Dr. Brown of Preston, an ardent supporter of the scheme. This new venture had many trials and difficulties which cannot be told here but in 1911 the Managing Committee decided to construct a building which could be 'used either as a private residence, a hospital, or a hospital and laboratory combined' on a piece of ground, presented to them by Miss M. A. Sykes, at the junction of Hills Road and Wort's Causeway. It was opened by Dr. R. C. Brown in May 1912 and work on arthritic diseases continued until the outbreak of the 1914–18 War when the building was used as a hospital for wounded officers.

After the war the investigation of arthritis was resumed but due to lack of funds and other difficulties, the patients were transferred to other hospitals in 1923. By this time, Strangeways, who had begun to investigate the growth of living cells in tissue culture, 'became convinced that in order to gain further insight into the essential pathological processes which produce arthritis, it was necessary to investigate the behaviour of living cells in and around the diseased joints'. In 1922 the Medical Research Council made Strangeways a special grant for apparatus for the investigation of living cells and it was decided to concentrate research at the hospital on cell growth and during the next few years he made the Research Hospital the leading institution in this country for the study of living cells *in vitro* a position it still maintains. Strangeways died suddenly on 23 December 1926. After his death the 'Research Hospital' was renamed the 'Strangeways Research Laboratory'.

As early as 1895 Woodhead had become interested in the safety of drinking water supplies and related subjects such as the standardization of disinfectants. In Cambridge he continued with these interests and in 1905 began to consider the disinfectant value of chloride of lime and initiated much research in his laboratory on the chlorination of water supplies for the Cambridge Corporation and proved its practicability long before the outbreak of the 1914–18 War.

During the war medical students were encouraged to continue their studies and the courses in pathology for the II M.B. Part 2 were given by Strangeways and Cobbett. Other laboratory services were used for general pathological investigations for the First Eastern General Hospital, for the testing of antitoxins and other immunological work, for research on the chlorination of water, and investigations on cerebrospinal fever.

From his student days Woodhead had been an enthusiastic member of the Volunteer Medical Service and became an active member of the Territorial Force when that was founded. On the outbreak of war he immediately offered his services to the War

Office. He was put in charge of the Irish Command Depot in Tipperary and later became Inspector of Laboratories in Military Hospitals in the United Kingdom and Consultant to the War Office, in which capacity he urged the need for the sterilization of water supplies by chlorination for the army. In his department at Cambridge a method was devised which, by a simple chemical test, an advanced party could estimate how much chloride of lime must be added to 120 gallons of water (the usual capacity of the army water waggon) to render it innocuous.

Woodhead's military activities involved frequent journeys across the Irish Sea to superintend research in his department, and long journeys by road and rail to visit military laboratories throughout the United Kingdom. These proved too heavy for him and his health broke down. He resigned his commission in 1919 and in the same year received the K.B.E. in special recognition of his researches into the chlorination of water.

After demobilization some changes took place in the staff of the Department of Pathology. Strangeways resigned his demonstratorship in 1919 but continued as Huddersfield Lecturer until 1926. A. N. Drury was appointed Demonstrator in Pathology in June 1919 but resigned in December to work under the Medical Research Council, and in January 1920 M. B. R. Swann was appointed University Demonstrator. Cobbett continued as Lecturer in Pathology and Graham-Smith as Lecturer in Hygiene and in 1919 a new Lectureship in Pathological Chemistry was established and J. R. Marrack appointed, on his resignation in 1921 it was discontinued.

In 1919 Woodhead introduced advanced courses in pathology but had to abandon them in 1921 owing to the difficulty in dealing with the greatly increased number of students attending the elementary courses. A number of research projects were being carried out, Woodhead being particularly associated with Varrier-Jones' Papworth Hall experiment.

In 1921 the Quick Department of Biology which had been intimately associated with the Pathology Department since its foundation moved to the Molteno Institute for Parasitology.

On 29 December 1921, Sir German Sims Woodhead died at the comparatively early age of sixty-six years, as Sir Clifford Allbutt said:

His indefatigable labours in the war seem indeed to have caused or contributed to the failure of his health.
In the void of the death of our colleague we lament the loss of the beneficient example of one who was not only a profound student of science, not only an inspiration to all his fellow-workers, but also one who saved his life by losing it for his friends, his university and his country.

Following the death of Woodhead the policy of the university with regard to the Medical School began to change. Henry Roy Dean was elected Professor of Pathology in 1922 and the Department of Pathology remained in the Medical School Building until 1928 when it removed to the present Pathology Laboratory in the south-west corner of the Downing Site. The Medical School building was then occupied by the departments of pharmacology, surgery, radiology, and zoology until 1932 when the whole was assigned to zoology and reconstructed to form the present Zoology Department. The facade of the old Medical School building remains. On the window sill of what was the lecture room on the first floor, Woodhead had the following saying by Pasteur inscribed:—DANS LES CHAMPS DE L'OBSERVATION LE HASARD NE FAVORISE QUE LES ESPRITS PREPARES. It can still be seen if one looks up on approaching Downing Street from Tennis Court Road.

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The Cambridge School of Physiology: 1850–1900

by

D. H. M. WOOLLAM

I AM NOT, as will perhaps soon become all too evident, a physiologist, and my claims as a medical historian rest upon a slender body of work. I have spent virtually all my working life in the Cambridge Department of Anatomy. Working on this paper it has seemed to me that the disciplines of anatomy and physiology in this and other countries have now completed a full circle in opposite directions, so that today it is not perhaps unfair to define a physiologist as someone who works in a department of physiology and an anatomist as one who works in a department of anatomy. Curiously as far as Cambridge is concerned this brings the situation on all fours with that which prevailed at the very beginning of the period I am going to speak of, in 1850, with the exception that anatomy was then the master, as it were, and the study of function was really subjugated to that of structure.

When I first came into residence in this university as a medical student in 1938, my Director of Studies and Supervisor in Physiology, Dr. L. E. Shore, had been qualified as a doctor for fifty-eight years and had during virtually the whole of that period served the university and his college, St. John's, with remarkable assiduity as a teacher of physiology, and I well recall the painstaking fashion in which he took me and his other pupils through the elements of that difficult discipline. Particularly I remember long hot summer afternoons when he took me through the microscopic study of carmine-stained sections of the central nervous system, labelled; and I think that here my memory serves me correctly, June 1884, eighty-five years ago, and almost the middle of the period I have been asked to deal with. Dr. Shore was at that time a very old man and it took him a long time to walk the few hundred yards from his home in the Madingley Road to his rooms in the Wilkins Building of St. John's College, but once the fatigues of his journey were over, he taught with great enthusiasm for his subject, in this case the integration of the nervous system, and I came to see that the pre-clinical subjects as they are now usually categorized, I hesitate to say anathematized, might afford a reasonable way of spending one's life. Although what I naturally prefer to think of as the hands of fate, rather than personal inability, directed my career to the other twin, anatomy, it has long seemed to me that these two subjects are not just twins, they were really at birth identical twins. Professor J. N. Langley, the second Cambridge Professor of Physiology wrote a paper in 1898 on the union of cranial autonomic (visceral) fibres with the nerve cells in the superior cervical ganglion. True, his technique for ascertaining this anatomical information might be deemed physiological or pharmacological today, but there is to me an obvious difference between a paper such as this whose purpose is to determine the way the animal body is put together, and the paper Langley was to write three years later entitled 'Observations on the physiological actions of extracts of the supra-renal bodies'. Today a paper such as this might possibly be published in an anatomical journal, but even so it would be much more likely to be sent to a pharmacological, biochemical or even physiological assessor.

Professor Sir Joseph Barcroft's biographer, the late K. J. Franklin, wisely said 'we shall not be disparaging his personal achievement if we regard it as facilitated in no inconsiderable measure, by the fine inheritance to which he succeeded and by the happiness and opportunities which were his in his home'. This statement, resembling closely as it does the judgement upon the whole intellectual aristocracy of Cambridge made by Lord Annan in his contribution to *Studies in Social History*, has, I believe, been true of the great men who built up the school of physiology from its foundation. They had a magnanimity which the wholly self-made rarely possess, and they had the courage which rearing in a comfortable home gives to the fortunate recipient.

The story of the foundation of the School and Chair of Physiology is a remarkable and rare example of disinterested activity by academics and the academically-minded working in collaboration. It is a story which has often been told, most frequently in prize lectures by the old and great, and it is, I regret to say, a story which has frequently been assembled in a slightly inaccurate manner. In order to understand the position fully we have to go back to the beginning of the Natural Sciences Tripos which was in 1848, the first examination being held in 1851. In that examination there was a paper in anatomy and physiology. Two interesting points emerge from this fact. In the first place I think we must agree with Sir Humphry Rolleston that prior to 1870 Sir George Humphry lectured on anatomy and physiology; this might explain *his* eagerness to attract a physiologist of repute to Cambridge. I do not believe Sir Henry Dale was correct in stating that 'Until Michael Foster went to Cambridge in 1870 . . . the only teaching of physiology in that University was given by the Professors of medicine and surgery'. Henry John Hayles Bond who was Regius Professor of Physic from 1851 to 1872, would appear to have exercised his talents above all as a physician at Addenbrooke's Hospital. We know that the Downing Professor of Medicine from 1841–1874, William Webster Fisher, lectured on medical jurisprudence, 'the preservation of health', an introduction to the study of medicine, but especially on materia medica and general therapeutics. As it happened, his deputy, P. W. Latham, gave the lectures from 1868 onwards. It may be true, as has been stated, that he had poetical gifts, but his only work listed in the catalogue of the University Library is 'A letter addressed to the Members of the Cambridge Horticultural Society on the subject of the fete given in the Grounds of Downing College in the year 1847'. Turning from the physicians to the surgeons, the Chair of Surgery was not founded until 1883 when Humphry volunteered to take the chair without stipend. Since the total number of Cambridge medical graduates in the fifties of last century was around four a year; since in 1866, with William Turner of Edinburgh, Humphry founded the *Journal of Anatomy and Physiology;* and since in 1870 the Royal College of Surgeons of England, almost certainly on his advice and pressure, accepted courses in both anatomy and physiology *inter alia* given at Cambridge for exemption for the relevant stages of the M.R.C.S., I would be inclined to differ from the opinion of Sir Henry Dale, with due respect, and say that prior to 1870 it was Humphry (later in 1866 to be Professor of Anatomy) who at the time when the Natural Sciences Tripos started (1851), taught *both* anatomy and physiology at Cambridge, and not either of the professors of medicine or the non-existent professor of surgery. It must also be of significance that the paper was headed 'Anatomy and Physiology'. One remarkable point is that many of the questions, then scientifically unanswerable, were to form the life's work of some of the most distinguished figures of the School of Physiology once it was founded. For example, the question 'how far is the action of the heart dependent on the nervous system, etc?' was to form the basis of much of Gaskell's researches in the future. In 1848 William Clark, the professor of Anatomy, had handed over the teaching of human anatomy to George Humphry, reserving for himself the teaching of comparative anatomy and zoology. It would seem that Humphry based his teaching of physiology on Magendie's deservedly famous text-book which had a wide circulation in this country.

It must be remembered that in addition to his teaching duties Humphry was a practising surgeon at Addenbrooke's Hospital and had been so from his twenty-second year. He also lectured on surgery and produced a *Treatise on the Human Skeleton, including the Joints* in 1858. It is suggested by Sir Humphry Rolleston that it was this work which secured Humphry's election to Fellowship of the Royal Society. Difficult as it may be for us to imagine work by an anatomist gaining the favour of that august body, it is indeed true that Humphry, in his treatise, did much to unite contemporary zoological knowledge of the bones and joints, as well as providing descriptions which were extremely useful to the developing science of bone and joint surgery. In 1880 Humphry was president of the Annual Meeting of the British Medical Association which was held that year at Cambridge. In his address he noted the reasons why 'Cambridge, more than any university in the world, with perhaps one exception, had banished medicine from its walls, and the men of medicine from its schools'. He went on to hope that when the

Association next visited Cambridge, there would be a complete medical school and tripos. Just ninety years after Humphry's address, it looks now as if his dream will shortly come true.

It seems reasonable to me to accept Rolleston's account of the beginning of a department of physiology at Cambridge. Humphry was fully occupied, particularly since his elevation in 1866 to the professorship of human anatomy, with his duties as anatomist, surgeon, and, if it be accepted that I intend the next in no disparaging sense, medical politician. The crucial event, as all writers on the subject have recognized, was the creation of a fellowship and praelectorship in physiology at Trinity College for Michael Foster, with the proviso that he should teach the undergraduates of the university as a whole. This, one of the best and most disinterested acts carried out by a Cambridge college before the end of the nineteenth century, although primarily it was clearly Humphry's idea, would not have been carried out without the activity of four influential figures, George Eliot, the novelist, and her husband in all but name G. H. Lewes, and two influential fellows of Trinity College, the Vice-Master, Coutts Trotter, and the philologist and Public Orator, W. G. Clark.

Why should four such disparate figures have come together and how, is the next question we have to ask ourselves. It is known that George Eliot and G. H. Lewes often visited for weekends the large Hall at Six Mile Bottom near Newmarket, where Turgenev, the Russian novelist, was a frequent visitor for the autumn shooting. George Henry Lewes was a keen experimental zoologist, but I feel it is to Coutts Trotter we must look for the creation of the teaching of physiology in Cambridge. He was a man of many parts; a Wrangler, he went to Germany and studied physics under Helmholtz and others. He was born in the year Queen Victoria ascended the throne, and the course of his life was decided when in 1869 he became a lecturer in physical sciences at Trinity College. The *Dictionary of National Biography* expatiates at some length on one quality which he possessed, he was equally at home in the arts and the sciences and he appears to have valued each equally. Since he died comparatively young at the age of fifty, it may have been that he had met Humphry professionally, but Humphry clearly had some connection with Trinity College, since in 1866 on the death of William Whewell, Humphry said that the brain of the deceased Master weighed only forty-nine ounces. On the other hand Humphry did not become a fellow of a college (King's) until 1884, long after Foster arrived in Cambridge. Whether or not Coutts Trotter was the main protagonist in setting up the praelectorship at Trinity College, the College as a whole undoubtedly deserves congratulation on the farsightedness of its approach. It would perhaps be nugatory at this stage of our proceedings to point out the benefit the College has gained by becoming a world centre of physiology and particularly of physiological research, right up to and of course including the present day. Those who advised the College upon the person who should be appointed as praelector were themselves well advised for they relied on the judgment of Thomas Henry Huxley.

Michael Foster (1836–1907) was the chosen man, and if there were ever an example of the hour finding the man this was one. It is interesting to note how close were the East Anglian ties of the great men in Cambridge anatomy and physiology in this period. George Humphry was born in Sudbury in Suffolk, and Michael Foster was the son and eldest child of a Huntingdon surgeon. C. S. Sherrington had perhaps the most East Anglian origins of all, since, although he was born in London, his mother came from Ipswich and his father was a Yarmouth doctor. It may seem unkind today at a time when scientists tend to be judged either by their research, or their ability to construct philosophical and political treatises, to quote Gaskell's opinion of Foster's contribution to physiology expressed, as it was, after Foster's death. 'He was', said Gaskell, 'a discoverer of men rather than of facts, and worked for rather than at physiology'. In fact it is obvious that no qualities could have been more desirable in the founder of physiology in Cambridge, since he was able by virtue of these qualities to provide a solid basis for the great men who followed him. When one studies in detail the manner in which Foster lived his life as one of the earliest of scientific entrepreneurs, if I may be forgiven any unpleasant connotations the phrase may have, one is hardly surprised that in 1893 his Rede lecture at Cambridge was entitled 'Weariness'. The reason why Foster came to Cambridge via London and did not take the direct path from Huntingdon Grammar School appears to have been due simply to his non-conformist origins. Foster was remarkable among physiologists for the late date at which he took up the subject. After serving as a ship's surgeon in the Red Sea, he joined his father in general practice in Huntingdon. He had, however, had a most distinguished student career at London University and it is not surprising that in 1867 he received an invitation from William Sharpey, who as Professor of Anatomy and Physiology had been his teacher, and returned to University College London to organize the teaching of practical physiology and histology. Only two years later he followed T. H. Huxley as Fullerian Professor of Physiology at the Royal Institution, having been made Professor of Practical Physiology at University College a year previously. The next year he came to Cambridge.

It is both interesting and important to stress that when Foster came to Cambridge to teach physiology he was thirty-four years old and had been a practical physiologist for about three years. Sharpey-Schafer in his *History of the Physiological Society* says of him:

> Foster himself, although he had been Sharpey's medallist, had no special training in Physiology. He had a practical knowledge of Chemistry and Histology, and from visits to continental centres learned something of what was being done in France and Germany. Having accumulated certain physiological apparatus, including microscopes, he organized a course of practical instruction in a room which was allotted to him in the College and which received the title 'Physiological Laboratory'. The course was not compulsory and was attended only by students who displayed a special interest in the subject and were willing to pay an extra fee. It consisted, as regards histology, of the examination of teased preparations of fresh tissues and of sections of organs made with a razor by chopping them on a glass slide, or, in the case of firmer tissues, by cutting them while held in a split cork. The chemical part embraced a study of the constituents of blood and serum, the spectroscopic appearance of haemoglobin and its derivatives, the components of bile and urine, the phenomena of gastric and pancreatic digestion, the general properties of albumins, carbohydrates and fats. The experimental part was less complete, but the phenomena of nerve- and muscle-physiology were investigated in the frog, as was also the action of the heart and the circulation—the latter both in the frog and mammal.

Sharpey-Schafer, writing in 1927, seems to have felt that some explanation was necessary for the power which was wielded by Michael Foster after only a few years as a professional physiologist, for he goes on to say: 'It will be seen that the course, although elementary, was planned on a sound basis by Foster, who displayed that capacity for organization which was to have so much influence later in the promotion of Physiology in Cambridge.'

To one who has worked during the post-war period in the clinical or pre-clinical subjects, such rapid advancement as Foster achieved is liable to be regarded in a somewhat critical light. One is apt to reflect that nowadays it is not unknown for a scientist to be a Nobel laureate before he is elevated to a chair, a stature indeed which a number of Nobel laureates in this country have not as yet achieved. Again I find that a large number of my ex-pupils languishing in the registrar grades at teaching hospitals are apt to prove the truth of their earlier statements that there is three to five years between appointment to a consultancy and a coronary. Yet even I, a little short of half a century in age, can remember times when consultants were appointed at between twenty-five and twenty-eight years of age. The first and I believe most important point which accounted for Foster's remarkable elevation was the shortage of physiologists, combined with his splendid qualities as a teacher and organizer. There appears to have been no possibility of nepotism in his case, and, as I have said before, his appointment as Praelector in Physiology at Trinity College seems to have been one of the rare examples of altruism which occur at this university. D. A. Winstanley, in his delightful book on the foibles of later Victorian Cambridge* has nothing but good to say about the introduction of physiology through the good graces of Trinity College. Winstanley, like Coutts Trotter, was a Vice-Master of Trinity.

It is difficult at this distance of time to see why it should be that a great change has occurred in the age at which candidates are elected into positions in the biological subjects and in medicine. Sir George Humphry was as I have said only twenty-two when elected surgeon to Addenbrooke's Hospital; John Haviland was thirty-two when elected Regius Professor of Physic; yet when Sir George Paget was elected to the same Professorship in 1872 he was sixty-three years old, so that we can see no age-career structure in these subjects in the nineteenth or indeed earlier centuries. It may seem a naive way of looking at it, but my belief is that at this period

*D. A. Winstanley, *Later Victorian Cambridge*, Cambridge University Press, 1947.

the electors to positions of importance simple chose the best man available irrespective of considerations such as age and social connections. What I believe to be truly remarkable is how often this system worked out right in practice. It is, I believe, a tribute to our predecessors of the later half of the nineteenth century to realize how very rarely in making appointments of importance they found a square peg for the round hole. Society, and in particular, the small professional sub-divisions of society, were of course very much smaller then than at the present time, and everyone concerned with an election must have known the field so much better than can possibly be the case today. Nevertheless, when in 1870 Trinity College brought what we must regard as the relatively untried if not unknown Michael Foster to Cambridge at the age of thirty-four, they were in fact selecting for a post which was really basic to the future development of physiology in this country, a man who, although he would not contribute a great deal to research, would achieve the following: write or collaborate in the writing of four highly successful text-books; succeed Huxley as biological secretary of the Royal Society; do a great deal to build up not only a Physiological School but also a Department of Pathology at Cambridge; be elected the first Professor of his subject in Cambridge in 1883; receive the title of Knight Commander of the Bath from the Queen; act as President of the British Association at Dover in 1899. Moreover, Foster carried out a number of functions which would clearly have been impossible had he lived prior to the advent of a good railway service connecting Cambridge to London—for example, he served as Member of Parliament for London University, acted as a member of the Royal Commission on Tuberculosis (1901–6), the Royal Commissions on Vaccination (1889), on the Disposal of Sewage (1889) and on the Reorganization of the University of London. He was also extremely active in the foundation of the Physiological Society in 1876 and the *Journal of Physiology* in 1878, acting as sole editor of the *Journal* for the first sixteen years of its life. He was always in much demand as a serious lecturer on physiological and para-physiological topics, and as a witty after-dinner speaker. If one seeks for an explanation as to how he was able to cram so much into the seventy-one years of his life (1836–1907), at this distance of time, and with knowledge derived only from biographies and some personal contacts, I feel all one can offer in way of explanation is to employ a method much publicized by Sherlock Holmes, and consider what it was that he did *not* do. After his early start and arrival as a figure of some importance in Cambridge, he does not appear to have been very active in a number of fields which a man of his distinction might be expected to have adorned. He never, for example, held an important or time-consuming College Office; to quote Rolleston, 'his original contributions to science were few and not important', a fair judgment one would think. In many ways he seems to have been the kind of person we have become very familiar with in this country of recent years, a kind of scientific middle-man, and as such he is perhaps easier to understand than the dedicated and perhaps somewhat aloof scientists he encouraged and influenced in Cambridge. Of course it is blatantly obvious that if a scientific discipline is to be successful, it needs its share of both kinds of workers, it is absurd to ask the question—which kind is the more important? Without Gaskell, Langley and others there would have been no Cambridge physiology. Without Foster it is very doubtful whether the others would have found a Department of Physiology to work in here.

One noticeable feature about the development of the Physiology Department at Cambridge, from its beginning, and in making this particular observation I do so entirely without any attempt at criticism, indeed in many ways I make it in quite the reverse sense, is that the departmental manpower was and has continued to be built up by the university very much without reference to student numbers. I would say personally that the tremendous strength of the department during the past century has lain in the fact that it has attracted and catered for the postgraduate, and that its staffing has borne relationship to the quality of men available to carry out research rather than to some concept of teaching staff/student ratio, an idea which has at times ruined the development of a scientific department. In 1874 for example, there were only twelve candidates for the second M.B. examination, i.e. comprising pharmacology, comparative anatomy, physiology and human anatomy. In that year John Newport Langley, destined to succeed Foster as Professor of Physiology was placed second in order of merit out of five in the

Natural Sciences Tripos First Class. At this time, four years after Foster had established himself at Cambridge, a very small number of physiologists, whether potential medical men or not, was being turned out at Cambridge. Yet in this very year Foster collaborated with one of his most brilliant pupils, F. M. Balfour in a book entitled *The Elements of Embryology*. Again, after assiduous personally-conducted efforts, George Eliot was able to found in 1879 the George Henry Lewes Studentship, 'To advance the study of physiology by supplying students of either sex with the means of pursuing original investigations during the interval between their noviciate and their attaining the status of Professor'. It is clear from the conditions of this studentship how quickly a man was supposed to attain the status of professor because the capital sum of £5,000 provided an annual income of £250 for the student who was allowed to hold it for one, two, three or in exceptional cases, more years, but must devote his or her whole time to the work. The studentship was organized and managed in rather an unusual way since the trustees appointed as Director a physiologist of established reputation who was in charge of a physiological laboratory in Great Britain. In point of fact, the Director has always been the Cambridge Professor. When one considers that on 11 June 1883, Michael Foster was appointed the first Professor of Physiology with an annual stipend of £800 subject to a deduction of £200 if he were to become the Master or Fellow of a College, the George Henry Lewes Studentship of £250 a year represented a very valuable acquisition to the budding Department of Physiology, one which attracted to the subject some of the greatest scientists of the period 1850–1900. Holders just outside this period include Sir Henry Dale, J. Mellanby, A. V. Hill and Sir Alan Drury. The first holder, C. S. Roy was appointed five years later in 1884 to be the first Cambridge Professor of Pathology. Of the ten subsequent holders in the last eighteen years of the nineteenth century, a number achieved considerable distinction, but one stands out above the others. That was of course C. S. Sherrington, elected in 1884. In 1883 he was a guest at the Physiological Society meeting at Cambridge, but did not join the Society of which he was to be such an illustrious and honoured member until two years later.

I turn now to the consideration of those pioneer Cambridge physiologists who were in effect pupils of Foster and were attracted to various aspects of research by his unparalleled ability to place the right man in the right research context. In many ways, the outstanding example of Foster's powers and influence lies in the career of Francis Maitland Balfour who was only thirty years old when he was killed in an Alpine accident in an ascent of the Aiguille Blanche. During the months prior to his death he had already been selected for a new Professorship of Animal Morphology at Cambridge, and plans were in hand to build him a laboratory. Balfour belonged to what is perhaps the rarest social class to be found amongst university teachers, the aristocratic. He was the third eldest of the five sons of James Balfour of Whittinghame and the Lady Blanche Gascoyne-Cecil. He was therefore the grandson of the second Marquess of Salisbury and his wife Frances Mary, the famous Gascoyne heiress, the infusion of whose blood into the Cecil family may have done much to explain why that family reached extraordinary distinction in the sixteenth and nineteenth centuries, but failed to do so in between. Francis Balfour was the nephew of one Prime Minister, the third Marquess of Salisbury, and the brother of another, Arthur Balfour. Frank Balfour entered Trinity College in 1870, the year Michael Foster came from London to take up his praelectorship in physiology. In the Natural Sciences Tripos in December 1873 he was second in order of merit, the first place being taken by Newell Martin whom Foster had brought with him from London as his demonstrator. Although Newell Martin's life was also a short one, it too was one of considerable achievement, for three years after taking the Tripos he became the first Professor of Physiology at Johns Hopkins University, Baltimore. Balfour's research began as an undergraduate when he commenced work in Foster's laboratory on the embryology of the chick. After taking his degree he spent six months at the Zoological Station at Naples studying the development of elasmobranchs. This work led to his election to a Fellowship at Trinity and, in 1875, he began lecturing on embryology. Three years later he published a monograph upon his work on elasmobranch fishes and was elected to the Fellowship of the Royal Society. He was now twenty-seven years old and had just over three years to live. He published his book on comparative embryology in 1880–81 and received a Royal Medal for his studies.

Later that year, on 19 July to be precise, he was killed. Both his life and his death had profound effects on the development of biological science at Cambridge. In the first place he had opened up an area of research at the junction of zoology and physiology so that the future development of both subjects was influenced, zoology towards a more functional and less taxonomic approach, and physiology from being as it were a handmaid of clinical medicine. In a deeper sense it was his personality which was the most effective catalyst. There is an engraving of a picture of Balfour climbing in the Alps, which, like the much earlier lithograph from David of Napoleon crossing the Alps, in some ways conveys the epitome of the man of thought combined with action. His was a character, like that of Rupert Brooke, which remains heroic through the years and defies the unromantic biographer. Michael Foster, as one might have expected, found the obvious lines to express the sense of loss Balfour's death evoked in Cambridge.

For Lycidas is dead, dead ere his prime,
Young Lycidas and has not left his peer.

There can be little controversy even today that Balfour was the greatest physiological embryologist the world has yet seen, and one cannot help reflecting how extraordinary it is that a subject of such explosive potentialities should still await his peer.

I turn now to a very different if in many ways equally influential man. This is Walter Holbrook Gaskell. Entering Trinity College in 1865 he graduated in mathematics being 26th Wrangler in 1869. He was obviously in an ideal position to benefit from the arrival of Foster in Cambridge when he decided to take up medical studies. He went to University College Hospital in 1872 for clinical studies but postponed his medical qualification, almost certainly on Foster's advice, to work for a year in the Institute at Leipzig where Carl Ludwig received young workers from virtually the whole civilized world. When eventually he returned to Cambridge in 1875 he worked in the first place on the vasomotor nerves of voluntary muscle, publishing two papers thereon in the *Journal of Physiology* in 1878, the year he obtained his M.D. He then commenced what was undoubtedly his most important work, his study of the cause of contraction in the cardiac muscle. Before his time this was generally attributed to the activity of intracardiac ganglia and nerves. He carried out assiduously a long series of experiments mostly on the heart of the frog and tortoise, and established the truth of the myogenic theory that the impulse arose in the muscle itself. It is hardly exaggerating the case to call Gaskell the 'father of modern cardiology' for from his experiments developed the modern attitude to the human myocardium and its functions. In 1885 and 1886 he had been engaged in work, largely of a histological and anatomical kind, in the modern use of these terms, on the nerves of the visceral and vascular systems. Even today after his work in this field has been much extended in his old laboratory, there are certain areas where his name still has considerable significance. It will serve, perhaps, if I give but one example. It was Gaskell who showed that the short ciliary nerves from the ciliary ganglion to the intrinsic musculature of the eye were myelinated, in this respect appearing unique amongst the involuntary nervous system. If we adopt the concept of Keith Lucas, another great Cambridge physiologist, unhappily killed in the war of 1914–18, that the area of cross-section of a nerve equals that of its myelin sheath, what Gaskell really showed was that the short ciliary nerves were as far as what were shortly to be known as post-ganglionic parasympathetic nerves go, rather long and therefore rather thick. I always think this piece of observation of Gaskell's interesting because it appears to have been characteristic of the man that he was always ready to tackle a new problem and abandon an old when he had got as far with it as he could. With my old Director of Studies, Dr. L. E. Shore, for example, he carried out research for the Nizam of Hyderabad's Second Commission on the Cause of Death under Chloroform. Using cross-circulation from one animal to another they showed in 1893 that chloroform acts directly on the heart and that the fall of blood pressure is not due to action on the vasomotor centre, thus producing in the anaesthetic world the valuable idea that during chloroform anaesthesia it is not the pulse but respiration which requires to be carefully regarded. Gaskell was also interested in problems which today would be regarded as of a comparative anatomical nature, and therefore presumably discarded as of little importance. He had the idea that vertebrates were descended from an arthropod stock represented by the King Crab, *Limulus*. This idea was severely attacked at the time and, as I have indicated, would not interest many workers today, but its mere proposition is some indication of the breadth of Gaskell's mind and interests. Gaskell lived for sixteen years beyond the period dealt with in this paper, inhabiting the house he had built at Great Shelford near to that of his always respected and revered chief, Sir Michael Foster.

When Foster brought into being the Cambridge School of Physiology he laid considerable interest on practical work. I well remember, on arrival at this university as a youth of seventeen, immediately before the last war, that the most impressive and yet unexpected feature of the teaching system was the amount of work we did with our hands in anatomy, in biochemistry, in pathology and of course in physiology. I had been expecting hours of somewhat dreary lectures and instead had the opportunity to handle the material and in many cases carry out experiments which had been germane to the development of a particular subject. To me this was and has remained a wonderful thing about the biological and medical education at Cambridge. As far as I can see we owe its existence really to two men of genius, Sir George Humphry and Sir Michael Foster. Among the practical classes in physiology which Foster instituted were classes in a branch of physiology for which he had to institute the very name, seeking the advice for this purpose of F. B. Westcott, at that time Regius Professor of Divinity. The subject that Foster introduced and the word that Westcott and he coined was 'histology' and the subject was to bring into the school another great man, whose name is revered by anatomists and physiologists alike, and who was destined to succeed Foster in the Chair of Physiology, John Newport Langley.

John Newport Langley was a schoolmaster's son and was educated at Exeter Grammar School where his uncle, from whom he received his second christian name, was Headmaster. He was almost nineteen years old when he entered St. John's College in 1871 and it was not until May 1873 that he became a pupil of Foster. Next year he was placed second in the first class in the Natural Sciences Tripos. Although he had been a pupil at St. John's College, in 1877 he was elected a Fellow of Trinity College and thus added a further name to the role of fame of that college. It would be unfair to say that his research career was made by Foster, but there can be little doubt that Foster to a large extent determined the course it took in the early days. Although Langley began his studies with that of the action of pilocarpine on the heart in 1875, his career falls really into two stages, during the first sixteen years he studied secretory changes in glands, for the rest of his life he was to work upon and become the outstanding authority on the autonomic nervous system, carrying out work which has remained unquestioned up to the present time by most physiologists. In the early period, from 1874, 1875, 1876 onwards he was both studying the changes which occur in resting and active secreting cells and laying the foundation of the course in histology which is so admirably done in his and Foster's joint book published in 1876, *A Course of Practical Elementary Physiology and Histology* that at any rate the histological sections might be read with profit by any present-day medical student. In 1900, he became officially Deputy Professor to Foster. In the previous quarter of a century he had worked out with the help of various colleagues the structure of the autonomic nervous system much as we regard it today.

There were other physiologists working in Cambridge at the time I have been covering whom I have left out, either because of shortage of space or because their contribution might be regarded as following patterns which placed them more accurately within the scope of other contributors, e.g. I have not dealt with A. Sheridan Lea who should be regarded as the founder of physiological chemistry in Cambridge. You will I believe have observed that I have found two heroes in my study of the origin of the Cambridge Physiological School, Sir George Humphry and Sir Michael Foster. It is from the latter's *History of Physiology* that I quote, to some extent as a plea of self-extenuation, and also because, to my belief, it contains the essence of the real wonder we ought to feel at the way in which these men, busied in multifarious occupations, created the greatest school of physiology in the world.

> I very much fear that I have allowed many mistakes in what I have written to go unnoticed and uncorrected. I may plead in excuse that historical research, perhaps above all other kinds of research, demands ample leisure, and the time which I have been able to give to the present little work has been snatched from a life broken into bits by many and varied duties.

The Rise of Biochemistry in the Nineteenth Century, with Particular Reference to the University of Cambridge

by

F. G. YOUNG

THE STATEMENT has been made that biochemistry was begotten out of chemistry by an unknown father. If the charge of paternity can be laid at the door of physiology then one can say that the relations between the parents and the offspring have followed the not unusual course of an early struggle for independence against conservative responsibility, followed by a period of development of companionship and a sense of community of interest. And one can claim that now the relationship continues to be a friendly one.

In a recent essay on 'The Historical Foundations of Modern Biochemistry' Dr. M. Teich (1969) suggests that during the period 1800 to 1840 those interested in the chemistry of life began to separate from the general body of chemists, and so organic chemistry was born. Dr. Teich further suggests that between about 1840 and 1848 organic chemistry became linked with physiology, and that finally modern biochemistry, as we know it now, gradually separated from physiology. While this was generally so there were special features about the scene in Great Britain which, as is often so, differentiate the developments there from those elsewhere.

BRITISH CHEMISTS EARLY LAST CENTURY AND BIOLOGICAL MATERIALS

The first of these was, in my view, the slowness of the development of organic chemistry in Great Britain during the early years of last century. In the first half of the nineteenth century there existed many internationally distinguished British chemists who took little or no interest in biology. I can refer to Humphry Davy, Cavendish, Dalton, Wollaston and Faraday. Although Wollaston was a medical man and isolated cystine from a kidney stone in 1810, his interest in the stone appears to have been more that of a petrologist than that of a biologist. Humphry Davy and Henry Cavendish are recorded as having attended meetings of the Society for the Improvement of Animal Chemistry which existed in London between 1808 and 1825 (Coley 1967), the name of which seems to echo or mimic that of the Royal Society of London for Improving Natural Knowledge, the formal title of what is usually curtly referred to as the Royal Society. Nevertheless Wollaston was not one of this group, nor was William Prout. Although Banks, as President of the Royal Society, spoke warmly in favour of the Society for the Improvement of Animal Chemistry at the 1813 Anniversary Meeting of the Royal Society, and referred to its 'complete success', Coley has written that 'the "complete success" of the Animal Chemistry Society apparently did not extend beyond the confines of its limited circle, and indeed existed principally in the benevolent gaze of the President of the Royal Society' (Coley, 1967). What biochemistry was pursued in Great Britain during the first half of last century was mainly undertaken by medical men such as William Prout. What a contrast with the scientific developments on the continent of Europe at that time, where the names of Liebig, Wöhler, Berzelius, Gerhardt, Dumas, Gmelin, Laurent and Pasteur at once spring to mind! The greatest of them all, Antoine Lavoisier, failed only by a short head to reach the nineteenth century. Why did chemists in Great Britain last century tend to shun biological material, in contrast to those on the continent of Europe?

UNIVERSITIES AND CHEMISTRY EARLY LAST CENTURY

There were few university departments of chemistry in Great Britain until well into the eighteen hundreds. Indeed there were few universities at the dawn of the century. Oxford, Cambridge, Dublin, St. Andrews, Edinburgh, Glasgow and Aberdeen, complete the score until the University of London irreverently burst upon the scene in the 1820s. There was a Professorship of Chemistry at

Cambridge from 1702 onwards, and at Edinburgh from 1713. In 1747 Glasgow set up an independent Lectureship in Chemistry while the Aldrichian Chair of Chemistry at Oxford, founded in 1798, was suppressed in 1866 after the endowment of the Waynflete Chair of Chemistry in 1854. Apart from that in such institutions there was little provision for university instruction in chemistry in Great Britain 150 years ago, though private establishments, such as the Royal Institution and similar bodies outside of London, made important contributions in this respect.

The deficiencies of education in the universities of Oxford and Cambridge at that time were widely recognized outside these ancient establishments. Up to the end of the eighteenth century the prominence given to mathematics in the University of Cambridge effectively discouraged the pursuit of other studies, and indeed until 1828 every candidate for a degree had to pass in the Mathematical Tripos before proceeding to other studies.

THE COMING OF THE UNIVERSITY OF LONDON

The founders of the University of London intended to provide an institution of higher education where the shortcomings of Oxford and Cambridge would be avoided, where religious unorthodoxy would be no bar to entry or graduation, and where a reformed medical course might be established. The University of London originated in the institution which was advocated in 1825 and founded in 1826, and which is now known as University College London. In 1836 the new institution, which had itself failed to obtain a Charter, became incorporated in the newly-born University of London. This newly-chartered federal University, the first to be established in England after Oxford and Cambridge, included King's College, London, which was founded in 1829 as a place of religious orthodoxy of the kind practised by the Church of England. In its Charter provision was made for recognition by the University of London 'extending to all other duly qualified Colleges for education equal facilities for obtaining degrees including those of medicine.'

There can be little doubt that the foundation of the University of London (that is the institution that is now University College London) provided an important impetus to the development in

Great Britain of learning in subjects such as physiology, of biology in general and also of medicine (Young, 1968). The educational objectives of the new university as set out in the Report of its Council in 1835, are of sufficient interest to be worth quoting:

> Those studies which are essential to attaining success in lucrative arts and professions will always find an adequate number of skilful and industrious instructors, without any support beyond the fees of the pupils. It is rather for another class of sciences, the knowledge of which is not profitable to the possessor in a pecuniary point of view, but which exert a great influence on the well-being of society, that such an Institution was required. An accurate comprehension of the phenomena of the human mind—of the instruments by which knowledge is acquired and accumulated—of the science of government—of the principles on which laws should be made and justice administered—of the rules which govern the creation and the distribution of wealth—in a word of all those various and intricate sciences which are closely connected with the moral and political condition of mankind, stood high among the objects sought to be attained by this Institution; and scarcely second among them was a study of the higher branches of mathematics, of natural philosophy and of many of those sciences which consist in the examination of the laws and properties of material objects. It was in order to afford opportunities for the study of these sciences, and to confer on this country the facilities given by foreign Universities, that this University was mainly founded and supported.

The new university included not only a Chair of Chemistry (held by Edward Turner, M.D., F.R.S., from 1828 until 1837) but also one of Anatomy (G. S. Pattison 1828 until 1831), which became a Chair of Anatomy and Physiology in 1831, and a Chair of Physiology and Surgery, which was held by Dr. (later Sir) Charles Bell, F.R.S., from 1828 until 1831 when it became a Chair of Surgery alone. In 1831 William Sharpey (1802–1880) became Professor of Anatomy and Physiology, a post he held until 1874. He was elected F.R.S. in 1839. Sharpey was able to divert from clinical medicine Dr. J. S. (later Sir John) Burdon-Sanderson, F.R.S. (1828–1905) for whom a special Chair of Practical Physiology at University College London was established in 1870. When Sharpey retired in 1874 his own Chair was converted to one of Human Physiology, and Burdon-Sanderson was appointed to it. In 1882 Burdon-Sanderson became the first Professor of Physiology in the University of Oxford. For another of Sharpey's pupils, Dr. (later Sir Michael, K.C.B., F.R.S.)

Foster (1836–1907), a special Chair of Practical Physiology and Histology was created at University College London in 1866. In 1883 the University of Cambridge decided to institute a Chair of Physiology and Michael Foster, already in Cambridge, was appointed to it. So University College London provided the first Professors of Physiology in both Oxford and Cambridge.

The freedom and resurgence of university learning practised and encouraged by a new English university free from restrictive traditions, had important repercussions on the older establishments. No longer could 'those sciences which consist in the examination of the properties of material objects' be ignored. After much controversy, a Natural Sciences Tripos was set up in Cambridge in 1850, and has continued to evolve ever since. And little more than a hundred years later the University of Cambridge accepted in principle the institution of a complete medical school.

ORGANIC CHEMISTRY IN BRITAIN DURING THE NINETEENTH CENTURY

Although during the first third of last century distinguished contributions to the advance of chemistry were made in Great Britain, organic chemistry only took root there very slowly. In an attempt to obtain a semi-quantitative and relatively objective assessment of the situation I have recently drawn some statistics from an account of the development of chemistry last century which was written and published in Great Britain about thirty years ago. In those sections of this account which are concerned with the development of organic chemistry between 1837 and 1900 the names of forty-eight chemists are cited; of these nineteen are German, eleven are British and ten are French. Table 1 gives the names of those from Great Britain and from Germany who are cited. There must necessarily be an element of subjectivity in the inclusion of names in any scientific work; in this instance the subjectivity is that of a Scottish Professor of Chemistry—now dead. The counting of names is not enough. One finds, for example, that for the period 1837 to 1865 there are references to each German, on the average, on four different pages; the French are each referred to on an average of five different pages, while the British average only two pages each.

The list of those in the Table does not include such names as

Hoppe-Seyler, Hofmeister, Miescher, Kossel, Salkowski, and even Emil Fischer, all of whom contributed last century to the advance of biological chemistry. The weight is clearly on the side of the continent of Europe.

TABLE 1

British and German Chemists named as contributing to the development of Organic Chemistry during the period 1837–1900

British	*German*
H. E. Armstrong (1848–1937)	J. F. W. A. von Baeyer (1835–1917)
J. N. Collie (1859–1942)	R. W. Bunsen (1811–1899)
A. S. Couper (1831–1892)	A. C. L. Claus (1840–1900)
A. Crum Brown (1838–1922)	A. Geuther (1833–1889)
E. Frankland (1825–1899)	A. W. von Hofmann (1818–1892)
R. J. Kane (1809–1890)	P. H. Jacobsen (1859–1923)
W. Odling (1829–1921)	F. A. Kekulé (1829–1896)
W. H. Perkin (Sen.) (1838–1907)	L. Knorr (1858–1921)
W. H. Perkin (Jun.) (1860–1929)	H. Kolbe (1818–1884)
J. Walker (1863–1935)	P. C. Laar (1858–1929)
A. W. Williamson (1824–1904)	A. Ladenburg (1842–1911)
	J. Loschmidt (1821–1895)
	J. von Liebig (1803–1873)
	J. L. Meyer (1830–1892)
	H. Müller (1833–1915)
	J. W. H. Schiel (1813–1879)
	F. K. J. Thiele (1865–1918)
	J. A. Wislicenus (1835–1902)
	F. Wöhler (1800–1882)

Why did British chemists take such relatively little interest in biological materials last century? Although no simple answer is possible to such a complex question one can say that the chemical structures of many of the substances of importance in biological processes were too complex to yield quickly to the analytical processes then available to chemists. In embarking on their study they perhaps had to possess a degree of optimism which was commoner on the continent than in Great Britain at that time. Certainly the study of the physical properties of matter which was not only relevant to the needs of developing industrialization but also was well founded in mathematics, attracted many lively minds in Britain last century. Even British chemistry seems to have been thus influenced early last century, as illustrated by Dalton's Law, Prout's hypothesis, and Davy's application of electrolysis to the isolation of the alkali metals. In Britain the possibilities of applying physics and chemistry to industry may well have exerted a counter-attraction to the study of the sometimes intractable and unappetizing messes than can result from the use of simple chemical procedures in the study of biological materials of animal origin. I have suggested elsewhere (Young, 1962) that three facets of British life may also be relevant to this question. The first is the dominating influence in university studies, in England at least and in Cambridge in particular, of mathematics. The second is the cherishing of household pets which is still a conspicuous trait of the British today and which seemed to become obvious early last century as the population became more and more urban dwelling. The third factor, relating to the latter half of the century, is the publication of Charles Darwin's *The Origin of Species* in 1859; after this event verbal battles seemed in general to be of greater relevance to the controversy evoked than could be the results of experimental investigations.

Be that as it may, in Great Britain interest in the chemistry of biological materials was lagging behind that on the continent of Europe for most of last century.

THE BIRTH OF BIOCHEMISTRY IN GREAT BRITAIN

Among the objects of the Society for the Improvement of Animal Chemistry (1808–1825) was the translation into English of foreign works and papers of interest to its members, and although steps were taken by Davy in 1808 for the translation by the Club from Swedish into English of Berzelius's *Treatise on Animal Chemistry* (1806–1808), for reasons which are obscure, this proposal was not carried out. In fact this treatise was never translated, although a smaller work on animal chemistry by Berzelius was translated into English and published in 1813 under the title *A View of the Progress and Present State of Animal Chemistry*, the translation being made by Gustavus Brunmark, M.D., Chaplain to the Swedish Legation at the Court of St. James. Much later, in the 1840s, translations into English were published of such works as Liebig's *Organic Chemistry in its Applications to Agriculture and Physiology* (1840), which was written at the invitation of the British Association for the Advancement of Science, and his *Animal Chemistry, or Organic Chemistry in its Applications to Physiology and Pathology* (1842). The second edition of C. G. Lehmann's *Physiological Chemistry* appeared in English in 1851.

William Prout (1785–1850) graduated Doctor of Medicine in Edinburgh in 1811, and afterwards lectured on chemistry in London. He is now best known for his hypothesis that the atomic weights of all the elements are simple multiples of the atomic weight of hydrogen, but he ought also to be recognized as a grandparent of British biochemistry. In a courageous application of the methods of chemical analysis to biological materals he described, in 1822, 'Some experiments on the changes which take place in the fixed principles of the egg during incubation' (Prout, 1822). He also examined the processes of mammalian digestion and demonstrated the existence in gastric juice of hydrochloric acid (Prout, 1823). Prout first proposed the classification of foodstuffs into the now commonly-accepted divisions of carbohydrates, fats and proteins (Prout, 1827). But these examples of chemical investigations of biological materials fell upon unfertile ground in Great Britain, while he himself, afflicted with deafness, later wrote about science and theology in a treatise which, according to one critic, had little merit or interest either for scientists or theologians.

Liebig's encouragement of the application of chemistry to agriculture (Liebig, 1840) and the realization that cyclic processes are of great importance in nature whereby, for example, plants grow with the aid of excreta from animals, and themselves provide food for the animal to break down to excreta with the release of energy and heat, had wide influence. In Great Britain Sir John Bennet Lawes founded the Rothamsted Agricultural Experimental Station in 1843. The joint publications from that research institute by Lawes and Gilbert (1859, 1877) about the fattening of pigs resulted from critically conceived and carefully completed experiments which clearly demonstrated the conversion of carbohydrate to fat in the animal body. But there was no sequel; no school of physiological chemistry existed to pursue further study as would have been so in Germany or in France.

THE CLOSE OF THE NINETEENTH CENTURY

The foundation of modern British biochemistry can reasonably be dated to 1898 when Frederick Gowland Hopkins moved from London to Cambridge, although the word 'biochemistry' does not appear until later. The *Oxford English Dictionary* assigns the first recorded use of this word to 1902. But there was at least one important earlier contribution in Great Britain towards what we would now dub biochemistry. Before I go on to consider Cambridge and Gowland Hopkins I must mention P. F. Frankland and refer in some detail to the work of L. J. W. Thudichum (1829–1901).

Of Percy Faraday Frankland (1858–1946) in the space available I can say no more than that he was a distinguished chemist who made important contributions to the study of micro-organisms in water.

L. J. W. Thudichum: L. J. W. Thudichum was a medical doctor, born and trained in Germany. Having sympathy with a current revolutionary movement in Germany, while he was still a young man he decided to migrate to London, where he settled in 1854 as a medical practitioner. Although he remained a practising doctor all his life he took up the study of medical chemistry, becoming lecturer and first Director of the Laboratory for Chemistry and Pathology at St. Thomas's Hospital, London. In 1863 he published *A Treatise on Gallstones and their Chemistry, Pathology and Treatment*, while in the following year he announced the isolation of urochrome, the principal colouring matter of normal urine. The first preparation of haemotoporphyrin in 1867 was followed, in 1869, by the isolation and identification of carotenoids, then known as luteine pigments. Thudichum also contributed much to the chemical study of the brain; for this investigation he received encouragement and support from Sir John Simon, Medical Officer to the Privy Council, who in 1864 got Thudichum appointed as Chemist to the Local Government Board. The results of Thudichum's researches on the chemistry of the brain were published in the Reports of the Medical Officer to the Privy Council during the period 1874 to 1882; in 1884 Thudichum summarized the findings in *A Treatise on Chemical Constitution of the Brain*.

These researches were most fruitful. From the tissue of the brain Thudichum obtained kephalin and distinguished it from lecithin. He isolated and characterized sphingomyelin and introduced the word phosphatide to describe the class of subtance that he had recognized. Phrenosin and kerasin were also purified and analysed and he conducted many structural studies on phospholipids. But he was on dangerously controversial ground. There was a powerful group of chemists in Germany, which included Hoppe-Seyler, who believed that the brain is composed almost entirely of a single substance called 'protagon', and that materials isolated from the brain are decomposition products of this remarkable compound. In Britain, Professor A. Gamgee, F.R.S., Professor of Physiology at Manchester, and Dr. Sheridan Lea in Cambridge, supported this idea. In Germany, Hoppe-Seyler, and in Britain, Gamgee, bitterly criticized Thudichum's results. Gamgee said that one might as well supply a chemical formula for bread and butter.

Protagon continued to reign, despite Thudichum's elegant researches, for many years afterwards. Thudichum died in 1901 well before his contributions to biological chemistry received proper recognition, and in his time he exerted little effect on the established orthodoxy. Only after his death did his pioneer investigations receive the acclaim that they deserved (Drabkin, 1952).

THE GROWTH OF BIOCHEMISTRY IN CAMBRIDGE

Michael Foster: In 1883 Michael Foster became the first Professor of Physiology in the University of Cambridge. Foster came from a strongly religious background and his beliefs as a Baptist had prevented his entering the University of Cambridge as an undergraduate. He graduated at University College London first in classics (B.A. 1854) and then in medicine (M.D. 1859), and afterwards spent two years in Paris. After a period in medical practice he was invited by Sharpey, Professor of Anatomy and Physiology at University College London, to teach practical physiology at that college. Michael Foster's powers as a teacher quickly became evident, and in 1866 a Professorship of Practical Physiology and Histology was created for him at the College. He also succceeded T. H. Huxley as Fullerian Professor of Physiology at the Royal Institution. In 1870, on Huxley's recommendation, he was appointed to a newly-established Praelectorship in Physiology at Trinity College, Cambridge. The events which led to the establishment of this post, a move which was of some significance in the development of physiology in Great Britain, are related by Sharpey-Schafer (1927) as follows:

> Professor George Murray Humphry, F.R.S., Professor of Anatomy in Cambridge [1820–1896], who took a broad view of medical education and was anxious for its development in his own University, recognized that the first necessity for this was the foundation of a Chair in Physiology. But the project was not then [*c.* 1867] practicable, nor did it become so for some time. However, Humphry, with the aid of Mr. Coutts Trotter and of Mr. W. G. Clark, who were influential Fellows, and of Dr. (later Sir George, K.C.B.) Paget, Physician to Addenbrooke's Hospital, persuaded Trinity College to start the ball rolling by establishing a Praelectorship of Physiology in the College. The duties of the Praelector were to give lectures in physiology to students, not only of the college but of the university in general, who might desire instruction in that subject, and to organize laboratory work in conjunction with the lectures in a room organized for that purpose (Sharpey-Schafer, 1927, pp. 3, 4).

Foster was elected F.R.S. in 1872, shortly after his appointment to the Praelectorship, and in 1873 he was given an honorary M.A. degree of the University of Cambridge. In 1883, after he had been made Professor of Physiology, the complete M.A. degree was conferred upon him. He became Member of Parliament for the University of London in 1900 and was awarded a K.C.B. in 1899. He resigned his professorship at Cambridge in 1903, four years before he died. He was more active as a teacher and as a writer of text-books than as an original investigator, but exerted great influence on the development of physiology in Great Britain. He was the chief founder of the *Journal of Physiology* in 1878.

Sheridan Lea: In 1875 Dr. Michael Foster advised a young Cambridge science graduate, Arthur Sheridan Lea, to take up higher teaching and research in physiology rather than become a master at a public school with the prospect of a house later on. Despite the meagre financial outlook at that time for one with a post in physiology Sheridan Lea chose that subject, and in 1881 was appointed Lecturer in Physiology and Assistant Tutor of Gonville and Caius College. In 1884 he became a University Lecturer in Physiology, and in the following year was elected a Fellow of Gonville and Caius. In 1886 he became Bursar of the College, a post he held for two years only.

From the beginning Sheridan Lea had a special interest in physiological chemistry. As Professor J. N. Langley wrote, in 1915, in an Obituary Notice of Sheridan Lea:

> This study, [that is, physiological chemistry] as it was carried out in England in the '70s and '80s, did not involve any profound chemical knowledge; it was mainly concerned with the experimental determination of simple but fundamental reactions of the fluids and tissues of the body. Lea's knowledge of chemical theory and methods was more than adequate for the conditions of the time, and to him was due the establishment of an advanced course of Physiological Chemistry at Cambridge which enabled students to keep abreast of the growth of the subject (Langley 1915).

Sheridan Lea wrote an appendix to Foster's *Text-book of Physiology* on the chemical aspects of the subject, and later the appendix was enlarged and published as a separate tome under the title *The Chemical Basis of the Animal Body* (Lea, 1892). This work seems to convey some of the obscurantism which was then not uncommon about the chemical processes involved in living cells—as though the chemistry involved was so complex that it would for ever escape rational definition. As has already been noted Sheridan Lea upheld the protagon idea about the brain, and he seems also to have had sympathy with the so-called 'inogen' or 'biogen' theory according to which protoplasm in cells is a substance of giant molecules containing intramolecular oxygen. This substance was necessarily altered by attempts at chemical analysis which were therefore foredoomed to fail to illuminate in chemical terms the events in the living cell.

Although Lea carried out research with Kühne in Heidelberg and continued investigations, mainly on ferments, until the end of last century, he suffered from a progressive spinal disease which early interrupted his work and ultimately compelled him to abandon it. In 1899 he left Cambridge and retired to Sidcup in Kent. There he still followed developments in science until he died in 1915.

Gowland Hopkins: In May 1898 Michael Foster invited Frederick Gowland Hopkins to come to Cambridge to develop chemical physiology. In Hopkins's own words (Hopkins, 1937, p. 20): 'One day . . . the Physiological Society met at Cambridge and dined in Christ's College. As, after dinner, I was emerging from the great gate, Michael Foster caught me up, took my arm, and proposed then and there that I should come to Cambridge and develop there teaching and research in the chemical side of physiology.' The decision was by no means easy but in the end 'only a couple of months intervened between Foster's invitation and the beginning of my new job'.

Hopkins' scientific education had been unorthodox. His father died while he was an infant, and his mother, on the advice of her brother, apprenticed him, at the age of seventeen, to a consulting chemist in the City of London. When, at the age of twenty, the young Gowland Hopkins received a legacy on the death of his paternal grandfather he decided to take a course in chemistry at the Royal School of Mines in London where Edward Frankland was the famous Professor. Hopkins did well and later decided to prepare himself for the examination for the Associateship of the Institute of Chemistry. For this purpose he became a student at University College London. The story is related that around this period Hopkins declared to an older, but perhaps not wiser, chemical colleague his intention of studying the chemistry of biological processes. The reply is said to have been 'Chemistry of the living? That is the chemistry of protoplasm; that is super-chemistry; seek, my young friend, for other ambitions.' Fortunately Hopkins was not one to be dismayed by a reactionary attitude in his elders and held to his intention with an intuitive realization that super-chemistry was not needed for his purpose.

In 1883 his remarkable success in the examination for Associateship of the Institute of Chemistry brought him to the notice of Dr. (later Sir Thomas) Stevenson, who was the principal analyst retained by the Home Office for prosecutions for poisoning, as well as Lecturer on Forensic Medicine at Guy's Hospital Medical School. Stevenson offered Hopkins a position as his assistant, an offer which was eagerly accepted. During the five years that he held this appointment Hopkins obtained the external B.Sc. degree of the University of London and then, in 1888, with the encouragement of Sir Thomas Stevenson, he became a medical student at Guy's Hospital Medical School at the age of twenty-eight, aided by a research studentship founded in memory of Sir William Gull. Although his time was divided between research and medical studies he graduated with the London M.B. in 1894 at the age of thirty-three years. After medical qualification he held a number of minor clinical posts at Guy's, during the tenure of which he kept his research going. E. H. Starling was a colleague at Guy's and there is reason to believe that it was Starling who first brought Hopkins to Foster's notice. In 1898, when Foster's invitation came, Hopkins had recently married and had embarked upon what promised to be a rewarding career at Guy's Hospital Medical School, with the prospect of ultimately succeeding Sir Thomas Stevenson. The right decision was not obvious but in the end Cambridge won.

But for the first years in Cambridge Hopkins had heavy teaching duties and little finance. He received a university stipend of £200 a year supplemented by some income from Emmanuel College, which first appointed him supervisor of medical students and later, in 1906, to a Fellowship and Tutorship in Science. Moreover, to quote his words, 'I will confess to some disillusion when I arrived. The teaching of the chemical physiology had been somewhat perfunctory, especially for two or three years before my time, and laboratory equipment for advanced teaching was completely lacking, little more than the usual rack of reagent bottles and some test-tubes being available. It was not easy to make a change, and I had for a long time to adjust the class-work to these deficiencies' (Hopkins 1937 p. 2.). But despite these impediments he managed to pursue research, first continuing and then completing his study of the crystallization of proteins. The first paper published after the move to Cambridge was on the crystallization of egg albumin. Perhaps

Hopkins thought that while some still persisted in believing that protoplasm consisted of giant molecules the activities of which were inscrutable in terms of ordinary chemistry, the separation of proteins in a crystalline form which had constant composition, and properties, could assist the contrary view and help to eradicate the idea that protoplasm and its constituents were unstable entities of fluctuating composition (cf. Stephenson 1948).

The events which led Hopkins to the discovery of tryptophan are illustrative of the tenacity, insight and skill which he brought to bear on a problem, and are worth recalling here for that reason (cf. Dale 1948).

In the first of the classes that Hopkins taught at Cambridge was John Mellanby, later to be a Fellow of the Royal Society and Professor of Physiology at Oxford. Mellanby completely failed to get the Adamkiewicz test for protein to work, a test in which dilute acetic acid is added to a solution of protein and the subsequent addition of strong sulphuric acid produces a blue or violet colour. Hopkins himself confirmed that the reaction was indeed unobtainable when the bottle of acetic acid used by Mellanby was employed; but nevertheless it was readily elicited when he used bottles of acetic acid on other shelves in the laboratory. These shelves were those exposed to sunlight. With S. W. Cole, Hopkins quickly identified the reactive substance that was usually but not always present in the acetic acid, as glyoxylic acid, and with S. W. Cole then went on to isolate the constituent of protein responsible for this reaction. This hitherto-unknown amino acid was named tryptophan, and although the structure assigned to it by Hopkins was that of an isomer, investigations of it opened a new chapter of research for its discoverer.

The new field of investigation was that of nutrition. A publication by Hopkins and Miss Willcock in 1906 showed that for the rat tryptophan was a dietarily indispensable amino acid. From investigations such as these sprang Hopkin's interest in the nature of the essential components of food in general, and already in 1906 he had concluded that 'No animal can live upon a mixture of pure protein, fat and carbohydrate, and even when the necessary inorganic material is carefully supplied the animal still cannot flourish' (Hopkins, 1906). Here we see the beginning of his interest in vitamins.

Others will discuss this aspect of Hopkins's researches and his other later investigations.

I must here briefly refer to the fruitful collaboration between Hopkins and Dr. Walter Morley Fletcher (later Sir Walter Fletcher, F.R.S., first Secretary of the Medical Research Council) which began early in Hopkins's career in Cambridge and which resulted in two important papers concerned with the production of lactic acid in muscle (Fletcher and Hopkins, 1907; 1917). By careful treatment of resting muscle and extraction of lactic acid from it by means of ice-cold ethanol Hopkins and Fletcher showed that in this tissue the accumulation of lactic acid occurs only under conditions of anaerobiosis. In oxygen lactic acid did not appear and, moreover, if a muscle which, by exposure to anaerobic conditions, had accumulated lactic acid was then provided with oxygen, the lactic acid disappeared. These observations, which needed careful biological control of a highly irritable tissue combined with the painstaking skill of an analytical chemist, resolved much confusion about the relationship between the contraction of muscle and the production of lactic acid by it. These investigations also provided a sure foundation for the immense number of later publications on muscle biochemistry from many different laboratories in which were ultimately revealed the biochemical processes involved in muscular contraction.

I shall conclude with a short review of Hopkins and biochemistry in the University of Cambridge during the early years of the century. Hopkins was made a Reader in Physiological Chemistry in the University of Cambridge in 1902; towards the stipend of the Readership, in Hopkins's words 'Emmanuel College made a generous contribution'. But he did not receive a College Fellowship with the related remuneration until 1906, the year after he had been elected F.R.S. Sir Michael Foster's resignation from his Professorship in 1903, followed by his death in 1907, was probably one cause of the fact that Hopkins's relatively adverse financial circumstances remained unmitigated for so long. In 1910, while he was ill, Hopkins learned that Trinity College had made him a Fellow and had elected him to a Praelectorship in Biochemistry. This praelectorship had previously been allotted to a variety of subjects, after first being held in physiology by Michael Foster. Appointment of Hopkins to it had apparently been advocated by Dr. W. M. Fletcher who was a Fellow of Trinity and the collaborator of Hopkins in the investigations on muscle. So far as Trinity College was concerned the post carried no obligations and as Hopkins later wrote 'For me the election was salvation, and my debt to Trinity is great indeed' (Hopkins, 1937, p. 21).

In 1914 The University of Cambridge created a Chair of Biochemistry for Hopkins, and provided a separate Department of Biochemistry. His professorship was the second in the country, the first having been endowed at University College, Liverpool, in 1902. Oxford followed with the Whitley Professorship in Biochemistry in 1920. The First World War intervened before Hopkins could build up a department, but in 1923–24 the Sir William Dunn Trustees, again on the recommendation of Walter Fletcher, endowed both a Chair and a building for Biochemistry in Cambridge. By then the subject had been well established in that university, and indeed in the country as a whole.

In Hopkins had appeared an able British chemist who was wholeheartedly dedicated to the application of chemistry to biological systems and who possessed an intuitive assurance that methods based on chemistry and physics could elucidate the complexity of the biological problems that he tackled. He chose the problems and in general he solved them. In both respects he seems to have been endowed with an exceptional ability to understand the probabilities of the unknown.

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The Rt. Hon. Sir Thomas Clifford Allbutt, F.R.S. (1836–1925)

by

THE RT. HON. THE LORD COHEN OF BIRKENHEAD

On 29 January 1892, Sir George Paget, one of the great triumvirate to whom Dr. Rook has referred, died leaving vacant the Regius Chair of Physic which he had held for twenty years with conspicuous success. There was much internal discussion about his successor but it is said that Dr. Alex Hill, the then Master of Downing, with the concurrence of some members of the Medical Faculty, sounded as a possible successor, Sir Andrew Clark, then President of the Royal College of Physicians of London and of the Royal Medical and Chirurgical Society (which became in 1907 the Royal Society of Medicine). When Clark reluctantly declined, the choice fell, due largely to the advocacy of Sir Michael Foster, on Thomas Clifford Allbutt, F.R.S., then a Commissioner in Lunacy. It was the first time that the Chair had been occupied by a physician who was not resident in Cambridge, and who, since the opening of Addenbrooke's Hospital in 1776, had not been on its staff. The *Lancet* applauded the appointment, but added that 'it must have come on many as a surprise, for even "the calm and serene" air of Cambridge may have been slightly ruffled by the news, where more than one physician may have had hopes in connection with the vacancy.

The *Lancet* clearly judged aright the feeling of some local physicians. Peter W. Latham, who was on the staff of Addenbrooke's, was heard to exclaim that 'Allbutt would enter the wards over his dead body'. Whatever the cause, Allbutt was excluded from the staff of Addenbrooke's for eight years, until in 1900, after Latham's death, the university and the hospital entered into an arrangement which ensured clinical facilities for the Regius.

Allbutt was born at Dewsbury in 1836, the son and grandson of a parson, but with five medical uncles.[1] After five years at the ancient foundation of St. Peter's School, York, where he became proficient in mathematics and the classics, he left in 1855 for Gonville and Caius College, Cambridge, where, in his first year, he gained the Caian scholarship in classics. His love and command of classics is seen to advantage in his later writings, especially on the history and philosophy of medicine. Very early in his Cambridge career, however, a chance reading of August Comte's *Philosophie Positive* which he picked up in a London club, changed the course of Allbutt's life. The nineteenth-century philosopher, Comte, whose idol was Benjamin Franklin to whom he referred as 'the modern Socrates', published his *Philosophie Positive* in six volumes between 1830 and 1842, and we can clearly discern in Allbutt's later writings the profound influence of Comte's views on the young Allbutt. Comte held that in the history of ideas there are three stages; the first is *theological*, in which all problems are explained by the will of some deity—the sun, the stars, spirits, or even God; the second stage is the *metaphysical,* in which abstractions are conceived to explain natural phenomena, as, for example, when stars were said to move in circles because circles were the most perfect figures, and the harmony or imbalance of the humours explained health and disease; finally came *positive science* in which the ways of nature are determined by precise observation, hypothesis, and experiment, and explained through the regularities of cause and effect. In summary, for Comte, the 'Will of God' yields to the airy entities of Plato's 'Ideas' or Hegel's 'Absolute Ideas', and these in turn yield to the laws of science.

Thus it was that on his return to Cambridge Allbutt turned to the study of geology and chemistry, with such zeal and excellence that in 1858 he was the only candidate to be placed in the first class of the Natural Science Tripos. At Addenbrooke's he attended for

[1] In *Some Chapters in Cambridge Medical History* (Cambridge University Press, 1946) Langdon Brown writes that Allbutt had the free run of the surgery of two of them; he was fascinated by strange labels—'mummy powder', 'horn of unicorn', 'crab's eyes'—and was a diligent student of the *Lancet* when only ten years old! He had a small laboratory in his home in which he experimented.

a brief period the classes of George Paget and George Humphry. But for his clinical training proper, he entered St. George's Hospital, London, where he clerked for Bence-Jones, and came under the influence of John William Ogle, an early advocate of the use of the ophthalmoscope in the diagnosis of systemic disease.

Because of the then tradition that Cambridge students did not apply for resident appointments in a London Hospital, Allbutt was never a house physician, but after completing his clinical course he spent a year in Paris. Here Duchenne stimulated his special interest in nervous diseases, and Trousseau instructed and initiated him in the tapping of pericardial and pleural effusions at a time when the Royal College of Physicians of London frowned on a physician undertaking any surgical procedure. (This indirectly turned Allbutt's attention to the artificial separation of medicine and surgery, a subject to which he was to return on many later occasions.) He visited also Bazin and Hardy at their skin clinics at St. Louis. It was here that his thoughts turned to what was to become one of his most frequently reiterated themes, namely, that diseases are not 'clinical entities'.

On returning to England in 1861, he settled in Leeds, the city nearest to his origins. In November 1861, he was elected physician to the Leeds House of Recovery—a fever hospital, in the days when typhus, typhoid, relapsing fever, and other exanthema were common, and here he acquired his special knowledge of fevers which stood him in good stead when an outbreak of what proved to be mild smallpox (alastrim) occurred in Cambridge in 1903. Allbutt recognized the nature of the epidemic, though some doubting colleagues referred to the disease as 'all-but smallpox'. In his 'Notes on an Epidemic of Typhus at Leeds in the year 1865–66',[2] he first records taking patients' temperatures at regular daily intervals.

In February 1864, at the age of twenty-seven, he was elected physician to the Leeds General Infirmary which he served for twenty years only, the then existing limit to tenure of a consultant post. His consultant practice grew slowly until after his senior, Charles Chadwick, retired in 1874. He then rapidly became the most sought-after clinician in Yorkshire. Indeed, one of his former house physicians observed that 'No good Yorkshireman would rest quietly in his grave if, before his death, he had not been seen by Clifford Allbutt'.

[2] *St. George's Hosp. Rep.*, 1866, i, 61–70.

Whilst at the Leeds General Infirmary he not only wrote on clinical topics, but he pursued original researches which led in 1880 to his election as a Fellow of the Royal Society, the first physician in Leeds to gain this distinction, though three surgeons attached to the hospital had earlier been similarly honoured. Before Allbutt, only Francis Glisson (1597–1677) and Sir George Paget (1809–1892) of the Cambridge Regius Professors of Physic had been elected F.R.S. It is, however, fitting to record that the present distinguished incumbent of the Chair is thus the fourth Regius to have earned this signal scientific honour.

An incident during Allbutt's Leeds period merits a brief note. He was host during his stay in Leeds to the distinguished novelist, George Eliot, the pen-name of Mary Anne (later Marian) Evans, who had earlier published novels of such outstanding merit as *Adam Bede*, *Mill on the Floss* and *Silas Marner*. George Eliot in a letter written after her visit described Allbutt as 'a good, clever and graceful man, enough to enable one to be cheerful under the horrid smoke of ugly Leeds'. In 1871 appeared her masterpiece, *Middlemarch*, with a doctor, Tertius Lydgate, as a central character. Lydgate's career closely reflects Allbutt's. He was attracted to medicine by the chance reading of a book; he studied in Paris; he settled in a provincial town to avoid the jealousies and machinations of London, and its social climbings; he was Superintendent of a fever hospital and treated fever on a new plan with success (this was by cold baths and fresh air, which Allbutt practised and advocated); he thought the severance of medicine and surgery irrational (we shall see later how strongly Allbutt deprecated this); he was a man of mental independence and aristocratic bearing. One very close to him—Sir Humphry Rolleston—described Allbutt as 'aristocratic in appearance and courtly in manner', and his portraits confirm his handsome, well-groomed and distinguished features and his impeccable dress. Clearly, George Eliot is at pains to avoid too close a resemblance, and some have doubted, because of certain dissimilarities, if Allbutt inspired her characterization of Lydgate, but she later admitted to Dr. Charles Bastian that 'Dr. Allbutt's early career at Leeds had given her suggestions.' Allbutt was certainly the hero of Mrs. Russell Barrington's novel—*A St. Luke of the Nineteenth Century*.

After retiring from his hospital and medical school in 1884

Allbutt found himself with very limited clinical facilities at the Infirmary and a diminishing consultant practice. It occasioned, therefore, no great surprise when in April 1889 he accepted the post of Commissioner in Lunacy, at £1,500 a year, about a third of his earlier income from practice. Mental disease was not, however, for him a novel field. When he first went to Leeds he investigated both clinically and pathologically many of the patients in the West Riding Asylum, where the Superintendent was Dr. (later Sir) James Crichton-Browne, and it was from here that he collected most of the material for his later papers on syphilis of the nervous system, and the retinal changes in the insane.

In 1892, after three years as Commissioner, he was called to the Regius Chair here, and this he retained, as was then the practice, until he died on 22 February 1925 in his eighty-ninth year, after a very brief illness, having been mentally active and productive almost to the day he died.[3]

This brief biography is a necessary introduction to what is the main purpose of my paper, namely, to present and discuss concisely, but I trust meaningfully, his more important contributions to clinical medicine and to medical scholarship, especially its history and philosophy, to medical education, and to the public and professional life of this country.

But first let me epitomize what were his contributions to the Cambridge Medical School, and to medical education. In preparing for a medical career he stressed that the student must have a sound general education, and he decried early specialization. In the medical course proper he sought to link the various stages of the curriculum, for example, by demonstrating disease as disturbed physiology. He opposed the establishment of a complete medical school at Cambridge on the grounds of insufficient clinical material, a view perhaps subconsciously motivated by the denial to him of facilities for clinical teaching at Addenbrooke's. He secured the recognition of B.Chir. as a registrable primary qualification, since the M.B. demanded a thesis (see later). Although a few regarded him as an inspiring teacher, there were others who criticized him in this role.

[3] In a memorial sermon on 1 March 1925, Archdeacon J. W. Hunkin declared that 'no man ever came nearer to the ideal of what a Regius Professor of Physic should be in a University like this.'

One of these in the course of an anonymous 'Open Letter' in the *Medical Press and Circular*, in 1917, which showered him with praise, found only one major defect. 'In spite of your erudition, in spite of your tireless progressive spirit, in spite, too, of your magnificent mastery in the spoken word, and your winsome witchery in the written, you have not been a great teacher. Your detachment has always prevented you from planing to the popular level. You have been caviar to your constituency.'[4]

Many projects, however, stemmed from his initiative, e.g. the Cancer Research Hospital, later the Strangeways Research Laboratories, for the investigation of chronic disease; and the establishment in 1923 of the Institute for Research in the Pathology of Animal Disease. He had first expressed an interest in comparative pathology as early as 1882 in his Presidential Address to the Section of Medicine at the British Medical Association Jubilee Meeting in Worcester, and he was elected as the first President of the Section of Comparative Medicine of the Royal Society of Medicine in 1923–24. In 1919, he played a major part in introducing the D.M.R.E., and later the D.P.M.

His views on medical education are summarized in his book *On Professional Education, with Special Reference to Medicine*, published in 1906, and based on an earlier address to King's College Hospital on medical education in London. In this he presents in detail his views on the general education of the prospective medical student with a rare sagacity and prescience. He urges a firm grounding in the pre-clinical sciences, especially anatomy, which he regards as 'the backbone of medical education', not for its detailed contents, but because 'Young men love to do something with their fingers, and their instinct is a true one. Finger work does more than add itself to thought and memory, it multiplies them. The fingers are the busy builders of the brain.'[5]

But his main theme is that medicine must not be taught as 'a Summa or Corpus of fixed principles or aphorisms, better or worse applied by this physician or that, nor again consists in "surgery or placebos", but is a living and progressive organ, only to be kept vigorous by incessant growth and renewal.'[6]

[4] *Med. Press & Circ.*, 1917, N.S., **iii**, 199.
[5] *On Professional Education*, 1906, p. 52.
[6] Ibid., p. 65.

He valued medical training at a university, for he writes, a university is 'a permanent embodiment of the ideal of wisdom as opposed to technical furniture—of the ideal of mental culture as opposed to the collection of "tips" and devices in memory'. And he repeatedly stressed that the function of a university 'is not qualification for the practice of any art or trade, but a training of the mind, a formation of habits of study, of insight, of easy handling of ideas, and the development of the imagination'. In an address he gave to the Middlesex Hospital in 1900, he urged the need for postgraduate education and hoped that one day a hospital would be designated to direct all its teaching to this end. But as the years passed his views appeared to change for in evidence he gave before the Athlone Committee in 1919, he said that he 'deprecated the proposal to set aside a single hospital for postgraduate instruction'.

In his Inaugural Lecture[7] at Cambridge he expressed his disenchantment with the medical student of his day, who, he said, 'is by no means "learned"; too often he thinks loosely, and he does not always write even the English of the gentlemen who do the Fires and Murders for country journals. On his latinity I will keep a discreet silence.'

Alas! Three-quarters of a century later, one must resignedly exclaim: 'Plus ça change, plus c'est la même chose!'

As Regius, Allbutt read sixty to seventy M.B., and about twenty-five M.D. theses a year. This did nothing to dispel his view that in most cases the composition was unworthy of educated men. 'It is such as to obscure, to perplex, and even to hide, or to travesty, the sense itself.' To try to improve the candidates' command of English, he wrote, in 1904, his *Notes on the Composition of Scientific Papers,* and in order to demonstrate his singleness of purpose he refused royalties on the book, though it went through three editions. Its value lay in its stress on the precise use of words and on planning the composition as a whole. Allbutt's own method of preparing a paper, namely, four drafts before the final draft, and then an interval of one to two weeks before a final reading, reflects perhaps an earlier and more expansive era, but much of the advice in his *Notes* can still be heeded with benefit, for example, his exhortation, 'Never compose when tired nor in the false confidence of tea [today we would perhaps substitute alcohol or amphetamine] and late hours. At this

[7] *Brit. med. J.*, 1892, i, 1005.

hour the composition seems to be beautiful and spontaneous, but it is fairy gold, and in the colder light of morning it turns to ashes.'[8]

Matters of general university policy frequently attracted his notice. In 1905, he wrote a long letter to *The Times* against obligatory Greek in the previous examination, and urged that this should be optional. Though repeatedly discussed over the years Allbutt's view was not ratified finally until 1919. He was opposed, towards the close of the nineteenth century, to the admission of women to the university, but in 1921 he supported a compromised Grace, which was carried, by which women were excluded from membership of the university, but duly qualified women could have conferred upon them, by diploma, the title of degrees.

Allbutt was an outstanding clinician, though his success as a consultant had other ingredients. Chadwick's son wrote of him: 'His bedside manner could never have been surpassed . . . he was always hopeful and always left the patient with the feeling that there was hope, and that that patient and his illness were of special interest to Allbutt.'

When other clinicians were despising the use of diagnostic instruments, Allbutt was not only benefiting from their aid but devising better models and assessing their worth. His major contribution here was his clinical thermometer, at first six inches long, but later reduced to only three inches and recording maximum temperature. The story of clinical thermometry and its development through Wunderlich at Leipzig (of whom it was said, much to Allbutt's gratification, that 'he found fever a disease and left it a symptom'), through Aitken in this country, and then to Allbutt, has been graphically recited in Dr. Anning's centenary note in the *Practitioner*.[9] An illustration of Allbutt's prescient modernity is his disapproval of the Fahrenheit scale on his thermometer. However, when the Centigrade scale replaced it, the makers reported that it stopped the sale immediately, thus the Fahrenheit scale returned.

The ophthalmoscope to which he was introduced by Ogle of St. George's fascinated Allbutt, and Hughlings Jackson's notable reports on the ophthalmoscope in nervous disease, which appeared from

[8] *Notes on the Composition of Scientific Papers*, 1904, p. 15.
[9] *Practitioner*, 1966, **197**, 818–823.

1863 to 1865[10] stimulated him to publish in 1871 his monograph *On the Use of the Ophthalmoscope in Diseases of the Nervous System and of the Kidneys*, which he dedicated to Hughlings Jackson. It presents a critical survey, with a wealth of personal illustration, of the then knowledge of retinal changes in cerebral diseases, especially tumours, in Bright's disease, syphilis, diabetes, certain toxic states, for example lead poisoning, in leukaemia and embolism of the central retinal artery. He introduced the term 'choked disc' or 'ischaemia papillae' for, he writes, 'I gradually became assured that many of the worst cases of so-called "optic neuritis" are really mechanical congestions or venous arrests, differing essentially and importantly from inflammations'. He attributed the congestion to pressure on the cavernous sinus.

In 1866, he made the hitherto unheard-of request to the Infirmary Board at Leeds to provide a weighing machine for patients, and a microscope for the wards. He repeatedly urged the claims of clinical pathology, and in his 1920 Presidential Address to the British Medical Association[11] he prophesied the immense potential for biochemistry in medicine and, emphasizing once again the role of science in medicine, he urged that in every clinical school there should be full-time professors with properly-equipped laboratories and staffs who should be 'continually irrigating the profession from the sponge of pure science'.

He was an avid reader of the medical press, both home and foreign, and was often the first to publish in England examples of cases very recently recorded in the French or German literature. Thus in 1869, the year after Charcot had published his account of tabetic arthropathy, Allbutt reported a case in this country which Charcot had seen when he visited Leeds.[12] Again, Kussmaul's description in 1873 of pulsus paradoxus in indurative mediastino-pericarditis was followed a year later by Allbutt's report on a mediastinal sarcoma with similar pulse changes.[13]

His major clinical interests were neurology and cardiology. That

[10] *Ophthalm. Hosp. Rep., Lond.*, 1863–65, iv, 10–19, 389–446; 1865–66, v, 51–78, 251–306.

[11] *Brit. med. J.*, 1920, ii, 1–8.

[12] *Brit. med. J.*, 1869, i, 157.

[13] Ibid., 1874, ii, 300.

he was acknowledged as a neurologist by his peers is indicated by the invitation extended to him to contribute to the first number of *Brain* in 1878. Fellow contributors included W. R. Gowers, Jonathan Hutchinson, Thomas Buzzard, and Duret of Paris. Allbutt's paper was devoted to a powerful and forthright denunciation of 'brain forcing' in schools. He wrote: 'The mischief done daily by calling upon the unripe brain for productive work, for original composition, for competitive examinations, for teaching and even preaching, was calamitous'.

In 1868, Allbutt published the first description of syphilis of the cerebral arteries; though since this was buried in a Hospital Report,[14] Heubner, who published in 1874, is given the credit for the original account.[15] Many of his papers dealt with aspects of neuro-syphilis which he had observed at the West Riding Asylum.

His Goulstonian Lectures at the Royal College of Physicians in 1884 dealt with 'Neuroses of the Viscera' and illustrate not only his deep understanding of psychological factors in the genesis of disease, but also his rich literary style. One excerpt snatched from these lectures must suffice. He is discussing abdominal pain in women and its frequent attribution to uterine disease and speaks of the victim as being peculiarly unfortunate:

> However bitter and repeated may be her visceral neuralgias, she is either told she is hysterical or that it is all uterus. In the first case she is comparatively fortunate, for she is only slighted; in the second case she is entangled in the net of the gynaecologist, who finds her uterus, like her nose, is a little on one side, or again, like that organ, is running a little, or it is as flabby as her biceps, so that the unfortunate viscus is impaled upon a stem, or perched upon a prop, or is painted with carbolic acid every week in the year except during the long vacation when the gynaecologist is grouse shooting, or salmon catching, or leading the fashion in the Upper Engadine. Her mind thus fastened to a more or less nasty mystery becomes newly apprehensive and physically introspective, and the morbid chains are riveted more strongly than ever. Arraign the uterus, and you fix in the woman the arrow of hypochondria, it may be for life.[16,17]

[14] *St. George's Hosp. Rep.*, 1868, iii, 55–65.

[15] J. O. L. Heubner, *Die luetische Erkrankung der Hirnarterien*, Leipzig, F. C. W. Vogel, 1874.

[16] *Lancet*, 1864, i, 461.

[17] Cf. Robert Hutchison on 'The Chronic Abdomen' in his *Lectures on Dyspepsia*, London, Edward Arnold, 1927, p. 166 '. . . she can only escape the attentions of the surgeon when—as Sir Clifford Allbutt said of the gynaecologist —he is "grouse shooting or salmon-catching or leading the fashion in the Upper

But if neurology, inspired by Duchenne, was his first love, cardiovascular disease was his second and more durable, for it abided to the end of his days. Indeed, his last work entitled *Arteriosclerosis, a Summary View,* was published posthumously, and contained references to work appearing only a short time before he died, on 22 February 1925. Sir Humphrey Rolleston, his successor as Regius, corrected the proofs and saw it through the press. His paper of 1870 'On the effects of Overwork and Strain on the Heart and Great Blood-vessels'[18] began his lifelong interest in arteriosclerosis, as evidenced by a continuing series of papers, which were collected, revised and published under the title of *Diseases of the Arteries including Angina Pectoris* in two volumes in 1915 in his eightieth year, the age at which Morgagni had published his *De Sedibus et Causis Morborum.* He added to the then recognized forms of arteriosclerosis one which he attributed to long-standing mechanical strain on the arteries from a high blood pressure of undetermined etiology which he named 'hyperpiesia', but which we know today as 'essential hypertension'. Of this he wrote: 'I have stood alone for years in proclaiming that in a certain class of cases rise of arterial pressure is the *antecedent,* arterial strain and injury the consequence.'

He no longer stands alone. He opined that hyperpiesia was probably not due to any renal disorder but to 'some wry metabolism pouring into the circulation a pressor body or bodies':[19] this thesis is the basis of much current experimental work in this field. To Allbutt's advocacy is largely due the use of the sphygmomanometer in routine practice.

For the last thirty years of his life Allbutt stoutly maintained that angina pectoris is not a disease of the heart; it is, he asserted, a disease of the first part of the aorta and its quasicutaneous investments, and that pain arises there from 'a morbid exhaltation of its sensibility to tension'. He opposed James MacKenzie's teaching, which was based on clinical and pathological investigation and experimental work, namely, that angina is due to muscular contraction when there

Engadine", so she is only at peace from the physician when the latter is recruiting his exhausted energies by a short holiday in a boarding-house at one of the less expensive seaside resorts.'

[18] *St. George's Hosp. Rep.*, 1870, v, 23–53.

[19] *Arteriosclerosis*, 1925, p. 3.

is a deficient blood supply to the heart muscle from coronary artery insufficiency, and that when angina pectoris is associated with aortic disease, this is due to extension of the disease process to the coronary arteries, narrowing their orifices.[20] MacKenzie's thesis, so strongly supported by J. B. Herrick's classic work in 1912, of which Allbutt was aware, is now universally accepted. But Allbutt rejected it to the end, though he acknowledged, in later years, that 'defects of the coronary arteries, together with other causes of myocardial decay, do indeed take a large share, not in the generation of angina pectoris, but in the mortal issue of it'. And also that 'sudden [coronary] thrombosis is often attended by intense pain so like angina that we cannot refuse it the name'.[21] His views on the genesis of angina are perhaps the one major blind spot in Allbutt's clinical reasoning, but one lapse does not diminish his stature.

Sir Humphrey Rolleston considers that Allbutt's 'greatest literary service to medicine' is his *System of Medicine* in eight volumes conceived in 1893 and published from 1896 to 1899, possibly an unanticipated harvest from the eight lean years during which he was denied clinical facilities at Addenbrooke's. This *System* was intended to replace the five-volume *System*, published between 1866 and 1879, of Sir John Russell-Reynolds, P.R.C.P. in 1896, to whom Allbutt dedicated his own *System*. The main burden of editing was borne by Allbutt, and he contributed also fourteen articles. Of these his introduction to Volume I remains a remarkable and still valid exposition of the philosophy of medicine, but it disappeared, alas, from the second edition of the *System* published in eleven volumes between 1905 and 1911, under the joint editorship of Allbutt and Rolleston.

All at this Congress owe Allbutt a deep debt for his continuing advocacy of the importance of the study of medical history, and for the part he played, with Osler, Norman Moore, Raymond Crawfurd, and others, in establishing the Section of the History of Medicine in The Royal Society of Medicine in 1912.

In many of his lectures he reiterated the claims of medical history: 'Without the past', he wrote, 'the present cannot appear to us in its

[20] For a full discussion see Sir James MacKenzie, *Angina Pectoris*, London, H. Frowde, 1923.

[21] *Diseases of Arteries, including Angina Pectoris*, 1915, vol. II, chap. VI.

true perspective nor be fully interpreted. Without the history of medicine, and the study of the words in which it is contained, modern medical ideas cannot be fully understood, nor the place and genius of our profession rightly known.'[22]

In 1904 he lectured in America on the *Historical Relations of Medicine and Surgery to the end of the Sixteenth Century*, which Garrison considered the best history of medieval surgery in English. In it he deplores the divorce of medicine from surgery since the time of Avicenna, about A.D. 1000, since when, he writes, 'physicians have been brought up in unhandy ways'.[23] He urged that medical men should themselves use the diagnostic instruments of the surgeon and the gynaecologist, and indeed, undertake, as Trousseau had taught him, such minor procedures as paracentesis. 'The bane of our profession for the last millennium', he writes, 'has been too much thinking; we have actually made it a point of honour to ignore the hands out of which we have grown, and in this false honour forget that the end of life is in action, and that only by action is action bred.'[24] It was perhaps an earnest of this view that the *System of Gynaecology*, published in 1896, as a companion volume to the *System of Medicine*, was edited not only by a distinguished gynaecologist, W. S. Playfair, but also by Allbutt himself. He was anxious that the various branches of medicine should come together and wrote: 'Surely the hour has come to amalgamate medical institutions and customs, to establish an Academy of Medicine, every member of which shall be free to develop his faculties in whatsoever honourable paths they may lead him, and formally to recognise an integration which, in spite of custom, in ophthalmology, dermatology, gynaecology, has established itself before our eyes.'[25]

His Harveian Oration at the Royal College of Physicians in 1900 dealt with 'Science and Mediaeval Thought'. In this he discussed the mysticism and dogma which led to the physiological darkness before Harvey, and touched once again on the unnatural separation of medicine and surgery. It is, however, to his *Greek Medicine in Rome*, published in 1921, but based on his Fitzpatrick Lectures,

[22] 'Words and things', *Lancet* 1906, **ii**, 1120–25.
[23] *Historical Relations of Medicine and Surgery* . . ., p. xiii.
[24] Ibid., p. 118.
[25] Ibid., pp. xiv–xv.

delivered at the Royal College of Physicians in 1909–10, that we turn for his most scholarly historical work. His thesis here is that Rome imported her ideas, 'herself contributing to them almost nothing'. He traces the sources of the most eminent physicians of Rome to Asia Minor and to the Schools of Pergamus, Ephesus, and Miletus, and describes in graphic detail how Dioscorides, Soranus, Rufus, Asclepiades, Celsus, Galen, Paul of Aegina, and others had through their writings moulded the various schools of practice in Rome.

This volume includes also his lectures on 'Byzantine Medicine'; on 'Salerno', his 1914 Linacre Lecture on 'Public Medical Service and the Growth of Hospitals'; on the 'Rise of the Experimental Method in Oxford'; on 'Palissy, Bacon, and the Revival of Natural Science'; a centenary paper in 1900 on 'Medicine in 1800' (in which he seeks to detract from Boerhaave's reputation, p. 531); and a contemporary survey in 1919 of 'Medicine in the Twentieth Century.'

But as Allbutt himself concedes, his historical writings are essentially derivative. He tells us that 'for historical research into the sources I have had neither the expertness nor the time. As a disciple I depend upon others; a gleaner where I have not sown.'[26] And he repeats this in his Harveian Oration which, he writes, 'cannot have the merit of an original study. Had I the equipment I have not the leisure to carry my investigations to the sources.'[27] His prime interest, he tells us, is in the 'sources, growth and movement of ideas and indeed their conflict; for ideas enter the vulgar world at their peril.'[28] He eschews detailed biographies. 'Great men,' he avers, 'are little more than signal rockets marking the weather of their periods,'[29] thus echoing Tolstoy's saying that 'Great men are labels giving names to events'.[30]

Small wonder that his thoughts turned early to the ideas underlying the philosophy of medicine, and here to no idea did he return more frequently than that of the concept of disease. The dominant view in Allbutt's time was that which Sydenham had expressed in the seventeenth century, namely, that diseases were 'to be reduced

[26] *Greek Medicine in Rome*, 1921, p. viii.
[27] *Science and Medieval Thought*, 1901, p. 14.
[28] *Greek Medicine in Rome*, 1921, p. viii.
[29] Ibid.
[30] Contrast Emerson—'There is properly no history, only biography' (*Essays*, First Series); and Carlyle, 'History is the essence of innumerable Biographies' (*Essays*: On History).

to certain and determinate kinds, with the same exactness as we see it done by botanic writers in their treatises of plants', and possessed 'of certain distinguishing signs which Nature has particularly affixed to every species'. This was, indeed, the view held by Sir George Paget, Allbutt's predecessor who held with Sydenham that for each disease there is a specific remedy. Allbutt had vigorously denounced this concept as early as 1866, when he wrote: 'We are now but just awakening from the metaphysical delusion that diseases are separate entities and have scarcely rubbed our eyes free from the tendency to see in each disease, or even in each stage of a morbid process, a fixed species, having no genetic affinities to any other.'[31]

He develops this theme in his introduction to the *System* in 1896. He rails there against the 'typical case of disease' and says that lurking in the minds of most students is the notion that 'there are real standards, or archetypes, to which disease ought to confirm, a notion which tends to blind them to the continuity of nature and the modes of causation.' And he continues:

> Diseases are not cast in a mould; nor would anyone now affirm that behind phenomenal groups there exists a transcendental type towards which any particular embodiment is an approximation . . .
> If we thoroughly realise that diseases are but so many attitudes of men, we realise the correlative of this, that there can no more be a standard pattern of disease than a standard pattern of man.[32]

Sixteen years later in a paper on 'The Importance of Precision in Nomenclature'[33] he expresses his mature views.

> Diseases are not things or 'entities' but general concepts in our minds of various disorderly ways of function, swerving now this way, now that, in infinite variety, though on a larger view observing certain main lines of divergence and advance; so that for the convenience of thought, which is unable to grapple with things as wholes, we are enabled and are wont, not without a certain arbitrariness, to separate them into classes, and a form for each class, a type, or mental ideal, ideals rarely realised in full, even in 'typical cases', but which are standards to work by.

The so-called names of diseases are then mere labels given to

[31] *St. George's Hosp. Rep.*, 1866, **1**, 61–70.
[32] *System of Medicine*, 1896, vol. i, introduction pp. xxix–xxx.
[33] *Universal Med. Rec.*, 1912, **i**, 1 (see reference in *Lancet*, 1912, **i**, 808).

'a certain assemblage and succession of symptoms, normal and abnormal, recurring with fair uniformity'.

But in order to know what we are talking about in medicine it is clear that 'We must use the names of these series respectively with the closest precision that conditions permit, although with no less clear a recognition of the arbitrary and provisional nature of our classification.'

The passages I have quoted convey the clear imprint of Allbutt's graceful and attractive literary style. He had a rare feeling for the finer nuances of words and phrases. He preferred 'kneestop' and 'lightstop' for the common signs in tabes dorsalis (which he thought a better and more specific name than locomotor ataxia). It was he who introduced the phrase, 'the pathology of living' when he wrote in 1903 that 'with the pathology of the dead we have made great way; the pathology of the living is hardly begun'. Moynihan purloined the phrase in the title of an address in 1907[34] without acknowledgement, and it is today generally attributed to him.

The subtlety of his phrase-making is often epigrammatic. Let me quote but a few examples:

> Medicine, even when not dominated by contemporary philosophy, has always taken its colour from it.
>
> A physician is an engineer who cannot construct but is skilled in conservative repair.
>
> Care without climate is better than climate without care [in relation to Davos for the treatment of phthisis].
>
> To folk medicine, doubt is unknown; it brings the peace of security.
>
> Physicians are made at the bedside.
>
> Diagnosis depends not upon all facts but upon crucial facts.
>
> The Greek philosopher, like the modern socialist, would sacrifice man to the State; the priest would sacrifice man to the Church; the scientific evolutionist would sacrifice man to the race.
>
> Diagnosis is the art of placing any given morbid group in the class to which at bottom it is most akin.
>
> Physic is sterile in proportion to its divorce from surgery.
>
> Writing of Franco, a barber-surgeon of the sixteenth century, who began as an apprentice to an operating barber and a hernia specialist, Allbutt, writes 'he was spared the misfortune of a speculative intellect'.

[34] Berkeley, Moynihan, 'The pathology of the living', *Brit. med. J.*, 1907, ii, 1381.

In speaking of tobacco he said, ' . . . it is difficult to suppose that so potent a drug can be wholly indifferent to our bodies. At least, as I have said elsewhere, smoking cigarettes adds ten more years to the record page upon a woman's face—which is a pity.'

You will sometimes be told you have chosen a noble profession. No vocation is inherently noble; a man may cry fish to the glory of God; a calling is made noble according to the sense of duty a man brings to bear on it.

The modern reader may not always approve of his proneness to ornate imagery and metaphor, nor to his tendency to prolixity. Permit me to quote, as illustration, from his Fitzpatrick Lectures a passage in which Allbutt seeks to justify the study of history:

We have our moods in which we may ask ourselves if history is a fruitful study—nay, indeed, if this study be not a sign of an uncreative or even of a decadent society. If our hearts are opening more and more towards the promises of the future, why should we be hankering after pictures of the past? Did the Greeks of the Parthenon so regard the earlier temples whose fragments they built into their battlements, or did the Greeks of Sancta Sophia painfully restore the ruins of the Temple of Constantine? Did not the builders of St. Mark's, or of St. Paul's without the Walls, for their own creations demolish the monuments of the past, as the painters of the generation of Massacio obliterated the frescoes of their fathers, and as the scribe of the cloister buried the silver uncials of some rare pagan manuscript under his ruder record of the Gospels? Was it the wistfulness and pathos of a nation passing its prime which first tuned the notes of Virgil to a historical theme? Was his patriotism the pathetic clinging to a form which was passing away? And when our own poets take up the chant of 'Où sont les neiges d'antan', is the voice one of joy or of foreboding? In our saner judgement we shall answer with some boldness that the study of history need be no wistful turning back from the plough to yearn after golden ages which never were; that history is much more than the raw material for pieties, regrets, and picturesque instances. The study of history must become the orderly reflection and method of a society, past its golden childhood indeed, yet parting with this blessed blindness, to enter upon a nobler life, in the maturity of reason and responsibility. 'Die Welt-Geschichte ist das Welt-Gericht'.

He confessed on one occasion to the students at Guy's that he was 'an awful example of talking too much', and he exhorted them to remember the saying of Izaak Walton that 'Words are men's daughters, but God's sons are things.'[35]

[35] 'Words and things', *Lancet*, 1906, **ii**, 1120–25.

Although his university duties, lectures, addresses, and other writings, would have sufficed for most men, not so for Allbutt. He accepted the wider obligations to public and professional service. He was a magistrate, and a member of many Government committees. He served on the first Medical Research Committee, the forerunner of the Medical Research Council, and for ten years he represented Cambridge University on the General Medical Council, as had his predecessors in the Regius Chair, Bond and Paget. As an advocate of health education and preventive medicine he was ahead of his time. He served the British Medical Association in many capacities; he was elected President in 1915 and remained so until his installation in Cambridge in 1920. For four years, from 1912, he was also a member of the Association's Insurance Acts Committee, and of the Government Advisory Committee on the Act, and was often the Association's spokesman in negotiations with the Chancellor, Mr. Lloyd George. But Allbutt was soon to be disillusioned by the Chancellor's idea of medical practice which he described on 3 January 1912, in a letter to *The Times* as 'for such and such a disease, such and such a drug; take the mixture, drink it regularly, and get well if Nature will let you'. Nor must his work for the Papworth Village Settlement for the care of tuberculosis patients be overlooked; here he was commemorated after his death by cottages bearing his name.

'Among the religious he stood for scientific method, among scientists for religious faith', said Archdeacon Hunkin at Allbutt's memorial service. Though he was a frequent communicant in Caius' Chapel on Sundays, and delivered sermons on many occasions in churches of various denominations, his faith was closest to that of the Society of Friends. Whether he went to church or not he always 'differentiated' his Sundays.

> If I stay away from a place of worship the greater my responsibility, the more my duty to the higher life. Whether your 'studie be then on the Bible' or on Shakespeare, is for each of you to choose—on both perhaps; but for that one day of the week be thankful to eschew idle books and newspapers, petty cares and business, and even professional usages which can be postponed, so that we may live one day at least in the presence of men greater and purer than ourselves. And what I say of one day in the week I say also of some minutes in every day; in that inner chamber store for the day some sweet verse, some line of

gentle wisdom or lofty thought which—to repeat a phrase with which I began—shall still make the habit of virtue and reason easy and pleasant to us. Then when the new song is sung we may find ourselves among those who could learn that song, for they were redeemed from the earth.[36]

He was a strong believer in exercise. From his early days he was an Alpine climber, and in 1870 was elected a member of the Alpine Club. But even in his climbing medicine insinuated itself when, for example, he measured changes in body temperature during the various stages of his ascent. He climbed in the Lakes and in Scotland when in his teens, but later found the smaller heights unsatisfying. In a letter to Dr. Bastian, dated 10 December 1869,[37] he wrote, 'we were both so foolish as to be influenced by the call to "see the beauties of your own country" cry; and I gave way upon my former resolution never to take a holiday except abroad'. The holiday of which he writes was spent in Scotland and he comments 'I strolled a Ben or two casually before breakfast; they are pigmies. On going to London, Allbutt entered an artistic circle which included Lord Leighton, P.R.A., Burne Jones, and Luke Fildes; and he joined the 'Sunday Tramps', a group which included Robert Bridges and Donald Macalister, which was formed in 1879 by Leslie Stevens, the distinguished critic and historian. On Sundays they explored on foot the country around London. Allbutt was an inveterate cyclist and an active member of the Cyclists Touring Club. Even in his late eighties he could be seen in Cambridge pedalling his tricycle with youthful vigour.

Of the innumerable honours from his Sovereign and universities and professional bodies the world over, one deserves special mention. In 1920, he was elected a Privy Councillor—a distinction only once before conferred on a doctor (T. H. Huxley) for other than political services. 'Never was honour meted out', wrote W. E. Dixon, his colleague in pharmacology at Cambridge, 'more worthily than to this the greatest, humblest and most beloved physician of our time'. To that tribute it is fitting to add in conclusion two others. Firstly, words written of him just before his death by a surgeon who was to bring like fame to the city of Leeds, whose common weal both had enriched for a quarter of a century. Sir Berkeley

[36] *On Professional Education*, p. 80.

[37] Wellcome Institute of the History of Medicine, MSS.

Moynihan (later Lord Moynihan) described him as 'the most deeply learned physician of his day, master of a style of English which for sheer beauty and majesty is perhaps unmatched by that of any scientific author of our generation, an orator whose speech makes time seem hasty, a cultured, upright English gentleman.'

And secondly, the charming deference paid by his brother Regius at Oxford, Sir William Osler, in 1919 when Osler received a Festschrift to commemorate his seventieth birthday. Allbutt, then in his eighty-fourth year, was appropriately chosen to make the presentation. This he did with his customary felicity of phrase and apposite precedent referring to Osler as 'a Nestor of modern Oxford'. In his reply Osler addressed Allbutt thus: 'To you, Sir Clifford, in fuller measure than to anyone in our generation has been given a rare privilege: to you, when young, the old listened as eagerly as do now, when old, the young. Like Hai ben Yazzan of Avicenna's allegory, you have wrought deliverance to all with whom you have come in contact.'[38]

[38] Sir Humphrey Davy Rolleston, *The Rt. Hon. Sir Thomas Clifford Allbutt, K.C.B.*, London, Macmillan, 1929. The manuscripts of both speeches (autographed) are in the Osler Library, McGill University, Montreal.

MONOGRAPHS OF T. CLIFFORD ALLBUTT

1. Clinical

On the Use of the Ophthalmoscope in Diseases of the Nervous System and of the Kidneys, London, Macmillan, 1871, 405 pp.

On Visceral Neuroses, London, J. &. A. Churchill, 1884.

A System of Gynaecology by Many Writers, ed. T. C. Allbutt, London, Macmillan, 1896–98. 8 vols (In the 2nd edition, 1905–11, in 11 vols., Allbutt was joint editor with Humphrey Rolleston).

Diseases of the Arteries, including Angina Pectoris, London, Macmillan, 1915, 2 vols.

Arteriosclerosis; a Summary View, London, Macmillan, 1925, 108 pp.

2. Historical and Literary.

Science and Medieval Thought, London, C. J. Clay, 1901, 116 pp.

Notes on the Composition of Scientific Papers, London, Macmillan, 1904, 154 pp.

The Historical Relations of Medicine and Surgery to the End of the Sixteenth Century, London, Macmillan, 1905, 125 pp.

On Professional Education with Special Reference to Medicine, London, Macmillan, 1906, 80 pp.

Greek Medicine in Rome, London, Macmillan, 1921, 633 pp.

The Cambridge School of Physiology (1900–1937)

by

HENRY BARCROFT

PUBLICATIONS 'From the Physiological Laboratory, Cambridge', in the years 1900 to 1937 fill about a quarter of the pages of the *Journal of Physiology*. Enough pages to make sixteen of the sixty-six volumes. To give a list of the titles of the papers from the Physiological Laboratory, Cambridge, some 500, would take up the entire paper. And of course the contributions to medicine go far beyond published papers. They include the teaching of undergraduates, training of scores of postgraduates from overseas, and services on numerous committees. All I can do in this paper is to name some well-known physiologists and add a few very inadequate words about their research.

M.Foster (1836–1907)

The story of the founding of physiology as an independent subject at Cambridge has been told by Dr. David Woollam. Foster was a discoverer of men rather than of facts. Among those working in the Laboratory in 1900 were Gaskell, Langley, Hopkins, Hardy, Anderson, Barcroft and Fletcher.

W. H. Gaskell (1847–1914)

Gaskell revolutionized thinking about the sympathetic nervous system. According to Bichât the body had two systems of nerves, the 'animalic' and the 'organic'. The highest centres of the 'animalic' system were the brain and spinal cord which were concerned with responses to the external world. The internal organs were regulated by the 'organic' system, whose centres, or 'brains' were in the sympathetic ganglia, the chief 'brain' being the solar plexus. These 'animalic' and 'organic' systems were connected by the rami communicantes. Johannes Muller (1840) suggested that communication from 'animalic' to 'organic' was by way of the white rami, the grey rami were the pathway in the opposite direction. That was in the main the position when Gaskell began work.

Gaskell was determined to settle the question of whether there was a reciprocal connection between the two systems. How he did so is best described in his own words (1916).

> For this purpose I cut serial sections through the rami communicantes and through the roots of the spinal segmental nerve after treatment with osmic acid, and found, as was well known, that the main mass of the non-medullated fibres (grey rami) after entering the spinal segmental nerve, turned peripheral-wards along the nerve, but a small number proceeded along the roots towards the spinal cord. On tracing these latter, which especially went along the posterior root, they were found to pass off into the membranes round the spinal cord to supply the blood vessels; none entered into the spinal cord itself. It was perfectly evident that the reciprocal connexion between the two nervous systems did not exist . . .
>
> The next step was to trace the white rami communicantes into the spinal cord. Sections of osmic preparations of the white rami of the second thoracic nerve showed that its structure was very different from that of ordinary nerves, in that it was composed entirely of very small medullated fibres. On examining the roots of that nerve, masses of similar fine medullated fibres were found in the anterior root.
>
> I then proceeded to cut sections of the anterior roots of all the spinal nerves, and discovered that these masses of small medullated fibres were not uniformly present. They were most prominent in the second and following thoracic roots, and were found in the anterior roots throughout the whole thoracic region and the beginning of the lumbar region. I found, as was naturally to be expected, that they corresponded to the region of white rami communicantes; above and below this region there are only grey communicantes; the white are absent. This peculiarity of the anterior roots in the thoracic region had been noticed by Reissner, but he could not explain it.
>
> These observations showed that the central nervous system supplies efferent fibres in the white rami communicantes to the main sympathetic chain only in the thoraco-lumbar region.
>
> The next question was to find out the relation between the fine white medullated cerebro-spinal fibres and the grey non-medullated fibres: I

argued as follows; the accelerator nerves to the heart from the ganglion stellatum and the inferior cervical ganglion are clearly non-medullated; stimulation of the second and third roots in the thoracic region causes acceleration; the accelerator fibres pass to the ganglion stellatum along the rami communicantes and are medullated right up to the ganglion; the conclusion is that the medullated fibres, which cause acceleration, end in sympathetic cells in the ganglion, and that these cells give origin to the non-medullated accelerator fibres which pass to the heart. I argued similarly with respect to the whole group of vaso-constrictor nerves, which also leave the spinal cord as fine medullated nerves and pass to the blood vessels from sympathetic cells (in ganglia) as non-medullated fibres. The conclusion then to which I came in 1885 was that the sympathetic cells consist largely, if not entirely, as a system of motor cells situated on the path of efferent fibres from the cord to the peripheral organ.

J. N. Langley (*1852–1925; Professor 1903–1925*)

Often in collaboration with H. K. Anderson (1865–1928), Langley worked out the functional anatomy of the autonomic nervous system in great detail. He carefully tabulated the functions mediated by each of the spinal nerves in the thoraco-lumbar outflow. This information has been of great value to surgery.

He found that nicotine paralysed synapses in the ganglia without interfering with conduction along nerve fibres. He used this as a tool in experiments performed to find out where sympathetic fibres relayed. All fibres to the head relayed in the superior cervical ganglion, all those to the spinal nerves in the spinal ganglia.

Langley introduced the terms 'pre and post-ganglionic' in 1893; 'autonomic' in 1898 and 'parasympathetic' in 1905. The best account of the functional anatomy of the autonomic nervous system is given in the chapter which Langley wrote for Schäfer's *Textbook of Physiology*, published in 1900.

As owner and editor of the *Journal of Physiology* from 1893 until his death in 1925 Langley 'was accomplishing a reform and setting a pattern in the presentation of scientific work which soon proved a boon to every reader wherever such literature was used' (Sherrington).

Keith Lucas (*1879–1916*)

Lucas was killed in an aeroplane accident in 1916 at the early age of thirty-seven. Lord Adrian (1934), his pupil, says of him:

> For 100 years physiologists had been engaged in the study of muscle and nerve . . . Nothing would be gained by summarizing the thirty papers which are Keith Lucas's contribution to muscle and nerve physiology, but it is worth describing the research which seems to contain his most important discovery: that dealing with the 'all-or-none' law in skeletal muscle . . .
>
> This 'all-or-none' law seemed to be the peculiar property of heart muscle, due perhaps to the special task which it had to perform . . . Can the waves in the nerve fibre and skeletal muscle fibre vary in magnitude or are they like the heartbeats independent of the strength of the stimulus? This was the problem which Keith Lucas had before him.
>
> The chief difficulty arises from the fact that muscle and nerve are made up of large numbers of fibres each acting independently. To settle the question he had to find out what happens in the single fibres. Accordingly he took a very small muscle and made it effectively smaller by cutting through all but about ten of the fibres. He stimulated these ten by electric shocks of increasing strength. As the shocks were made stronger the force of contraction increased, but increased by distinct steps, and the number of steps was never greater than the number of intact fibres. Clearly each fibre followed the all-or-none law. The increase in stimulus brought more of them into action but in each one the activity had a fixed value, and when all were in action no further increase in contraction was possible.
>
> The proof of the all-or-none law was soon followed by a mass of evidence which showed that it was true for nerve fibre as well . . .
>
> Why should Keith Lucas's solution of these problems be regarded as a particularly brilliant piece of work? The answer is that the problem had never been thoroughly formulated until he took it up. Gotch had discussed it in a paper on nerve three years before, but Gotch's paper had not attracted much attention as it contained a suggestion rather than a proof. The idea was difficult to grasp because the whole subject was in confusion. Lucas made the problem simple by a logical analysis of the position, by defining the ideas and words he was using so that he knew exactly what he wanted to find out. The principles which guided him are laid down in his Croonian lecture, given in 1912 . . .

Lucas's monograph *The Conduction of the Nervous Impulse* was revised by Adrian and published posthumously.

E. D. Adrian (1889–   ; Fullerton Research Professor of the Royal Society 1929–37; Professor 1937–51).

Before World War I, apparatus for recording changes in electric potential was not sensitive enough to record the change accompanying a nerve impulse in a single nerve fibre. This was of the order of a few microvolts lasting for a few thousandths of a second. It seemed very likely that messages along peripheral sensory and motor nerve fibres would be all-or-none and that differences in the intensity of a sensation would be signalled by differences in the number of sensory fibres in action, and in the frequency of the messages in each fibre. But it was impossible to find out because the impulses in fibres were asynchronous and signals from a whole nerve were meaningless. The introduction of the thermionic valve, and of amplifiers used in broadcasting in the 1920s made it possible to magnify small changes in potential thousands of times. Neuro-physiologists were beginning to use valve amplifiers in apparatus for recording impulses in nerves. Adrian and Zotterman succeeded in recording impulses in a single nerve fibre for the first time. The electrodes were placed on the nerve supplying the sterno-cutaneous muscle of the frog, a small muscle joining the skin over the ventral surface of the chest to the underlying thorax. This little muscle contains half a dozen or so muscle spindles. When the muscle was stretched irregular impulses, from several spindles firing at the same time, could be recorded. To reduce the number of spindles being stimulated to one single spindle Adrian and Zotterman proceeded to cut very cautiously across the little muscle to relieve the tension on more and more of the spindles. As they did so the discharges on the record became fewer, a regular irregular pattern was seen, a little more cutting and the pattern became regular. Impulses in a single sensory fibre were being recorded for the first time, and it was possible to 'listen in' to transmissions from a muscle spindle and to study the relation between the amount of stretch and the impulse frequency in the nerve fibre.

Soon nerve impulses were being recorded in single fibres from a sense organ at the root of a hair in the skin. And now a fundamental difference was discovered between the messages sent out from a muscle spindle and those from a hair sense organ. When a muscle was stretched and kept stretched impulse frequency increased to a maximum and then declined very slowly; when a hair was bent and kept bent impulse frequency rose to a maximum and fell quickly. The central nervous system received a continuous message about the stretch in a muscle, a transitory one about the position of the hair. The two kinds of sense organ were termed 'postural' and 'phasic'. The difference in their behaviour was explained by a difference in their speed of 'adaptation'. Transmissions along single nerve fibres from other kinds of sense organ were studied by Adrian and others. From sense organs for pressure and for temperature; from stretch sense organs in the lung, from baroceptors in the carotid sinus nerve, and so on. Information never before available was to hand about messages from many different sources which the central nervous system receives, sorts out and interprets.

What sort of messages did the CNS send out? In an anaesthetized cat impulses are transmitted from the respiratory centre to the diaphragm by the phrenic nerve. Electrodes were placed on this nerve, and it was gradually whittled down till discharges were obtained in a single motor nerve fibre. These waxed and waned in frequency with each breath. A maximum frequency of about fifty per second was recorded during stimulation of respiration by the addition of carbon dioxide to the inspired air.

All this opened quite a new chapter in neurophysiology, and is described, as are numerous other experiments of great fundamental importance in Adrian's books *The Basis of Sensation* and *The Mechanism of Nervous Action*.

Adrian and Sherrington were awarded the Nobel Prize in 1932 'for their discoveries regarding the function of neurones'.

B. H. C. Matthews (1906–　　; Professor 1952–　　)

It will be recalled that the introduction of the valve amplifier increased the sensitivity of recording apparatus so vastly that it became possible to record potential changes of a few microvolts. At first the output from the amplifier was fed into an old instrument, the capillary electrometer. Changes in output from the amplifier caused changes in the height of a column of mercury which were recorded on a moving photographic film. But the relationship between the changes in the potential and in the height of the mercury level were very complicated. To get a true picture of the changes in e.m.f. the record had to be 'analysed'. Few laboratories were interested in the troublesome capillary electrometer. Matthews revolutionized recording by his invention of the moving iron oscillograph which replaced the older instrument. With the amplifier and Matthews' oscillograph changes of potential of a few microvolts in a few thousands of a second could be recorded faithfully and very much more simply. The Matthews oscillograph came into common use to the very great benefit of neurological research.

Matthews soon became the authority on the physiology of muscle spindles, and was the first to study the physiology of muscle spindles and of other end-organs in mammalian muscle.

The development of electroencephalography followed on Adrian and Matthews' (1934) analysis of cortical potentials in man and animals. This confirmed and extended Hans Berger's earlier discovery of the alpha rhythm. In this, Cambridge research made a significant contribution to clinical medicine. Moreover the methods now commonly used throughout the world for recording and analysing the E.E.G. grew from the development in Cambridge of ink-writing oscillographs for electrocardiography.

W. M. Fletcher (1873–1933) and F. G. Hopkins (1861–1947)

Their work revolutionized the outlook in biochemistry. At the beginning of the century it was generally held that intracellular processes were far and away too complex ever to be comprehensible to man. This applied particularly to the chemistry of muscular contraction.

> Animal respiration in its simplest form consisted in the intake of oxygen and the exhalation of CO_2 and water. But it had been proved by Spallanzani (1803) and Liebig (1850) that muscle could contract and relax in the absence of oxygen, and it was further shown that lactic acid was produced in fatigued and dying muscle. Out of these facts and some additional data Herman (1867) had synthesized his conception of a giant 'inogen' molecule in muscle. This according to Pflüger (1878) stored up intramolecular oxygen and then disrupted at the instant of mechanical contraction, yielding as immediate products of combustion CO_2, water, lactic acid and some other nitrogenous residua. This conceptual pattern of the biochemical processes in muscular contraction soon extended to other tissues; it was interwoven with a coloured fancy of anabolism ever rising up to protoplasmic mysteries, and catabolism in return thrusting all back to simpler bodies. Verworn pictured in each cellular activity some such complicated process, and his giant Biogen molecule straddled across the whole breadth of the road of all who sought experimental access to the modes of cell metabolism (Elliot, 1932).

Fletcher found that there was in fact no sudden outburst of carbon dioxide from muscles that had contracted in an atmosphere of nitrogen. The chemical change accompanying contraction was not an oxidation. It was anaerobic. In an atmosphere of oxygen muscles gave out carbon dioxide during recovery from the effects of fatigue. Oxygen restored the power of contraction, possibly by the removal of an accumulation of some substance that prevented further contraction. Fletcher and Hopkins studied lactic acid production. By dropping the frog muscles into ice-cold alcohol they avoided errors due to lactic acid formation caused by mincing the muscle. They found very little lactic acid in resting muscle. Lactic acid was liberated during activity in amount proportional to the amount of activity. When a critical amount of lactic acid had been formed the muscle became fatigued and could not be made to contract. During recovery in oxygen the lactic acid disappeared. Oxidation was responsible for its disappearance. Was the lactic acid oxidized? If not where did it disappear to? And what was oxidized? (See later—A. V. Hill).

> Very tentatively it was suggested that lactic acid, which could no longer be regarded as a mere product of combustion, might actually be the very agent of the tensile changes, and that in the muscle at rest it was resynthesized to the simple carbohydrate from which it had emerged. But unhesitatingly all the mysterious concepts of cellular activity as moving through phases of biogen molecules were swept aside. The main biochemical processes involved in muscular contraction appeared to be as simple as they were swift, and all the experimental results fell within a view that the peculiar machinery of the muscle held some simple stuff akin to sugar within itself, and this was moved this way and that by changes in the latter.
>
> This simplification of thought gave a most important analogy for experimental enquiry into the metabolism of other tissues. The peculiar protoplasm of the cell might be dealt with as a machinery which passed through it many foodstuffs that never rose above lower levels of simple chemical changes, and were therefore accessible to direct analysis. The identification of these simpler changes and of the enzymes and catalysts determining them became a most fruitful aim of modern biochemistry; and the possibility of such work arose when Fletcher's accurate analysis of the respiratory processes of muscle had dispelled the old myths. His work, and particularly that on lactic acid with Hopkins, was therefore of cardinal value, and on it pivoted a great change in biological thought. For this reason the work is almost always referred to by modern physiologists as 'classical' (Elliot, 1932).

The story of the respiratory processes in muscle was reviewed by Fletcher and Hopkins in their joint Croonian lecture to the Royal Society in 1915.

A. V. Hill (1886–)

Hill joined the Laboratory in 1909. He had been Third Wrangler in 1907 and was to have far-reaching effects upon physiology. He worked with Lucas, and with Barcroft and even more important, he began a long series of experiments, many of the later ones done with W. Hartree, on the heat production in muscle. To measure this he designed a thermopile and used a galvanometer so sensitive that the apparatus could record the heat given out by a simple twitch of a frog's sartorius muscle. The rise in temperature caused by the twitch was less than one-hundredth of a degree Centigrade. He showed that the 'heat of contraction' was the same whether the muscle was in oxygen or nitrogen, thus confirming Fletcher and Hopkins' conclusion that the chemical change accompanying contraction was anaerobic. If the muscle was in nitrogen no further heat was given out after contraction. In oxygen however further heat, 'delayed heat' was given out. However this heat was far less than would have been expected on the basis of the oxidation of the lactic acid. Hill was of the opinion that the lactic acid was 'replaced in its former position (i.e. in some precursor) in the muscle during oxidative recovery, the energy for that restoration of potential being derived from the combustion of some other constituent (e.g. carbohydrate) in the muscle. The lactic acid on that view would be "part of the machinery and not part of the fuel" to use a familiar Cambridge phrase' (Fletcher and Hopkins, 1915).

Of the discovery of the 'delayed heat' O. Meyerhof working in Germany after the war said 'Apart from the pioneer work of Fletcher and Hopkins it was his [Hill's] work above all which made me steer a safe course through the shallows'. Meyerhof concluded that, in fact, approximately one-quarter of the lactic acid was oxidized during aerobic recovery and three-quarters was converted back into the molecule from which it 'had emerged', namely glycogen.

Much further information is given in *Muscular Activity* and in *Trials and Trails in Physiology* by A. V. Hill.

In 1922 Nobel Prizes were awarded to Hill 'For his discovery relating to the heat production in muscles' and to O. Meyerhof 'For his discovery of the fixed relationship between the consumption of oxygen and the metabolism of lactic acid in muscle'.

F. G. Hopkins (1861–1947)

Hopkins is famous too for his experiments on nutrition in the 'rat room', published *From the Physiological Laboratory Cambridge* in 1912. You will recall that there were two groups of rats, call them A and B. Group A was fed on pure caseinogen, fat, carbohydrate and salts; B received the same with 3 ml. of milk. Group A did not grow, B grew normally, putting on about 1 gram weight per day although the daily solids in the milk only weighed 0.08 gram. After about three weeks the diets were exchanged. The growth patterns soon followed suit. Group A grew normally but B ceased to grow. It was clear that for normal growth some 'accessory food factor or factors' were needed.

In 1929 Eijkman and Hopkins were awarded the Nobel Prize for Physiology and Medicine 'for their work on vitamins'.

Joseph Barcroft (1872–1947; Professor 1925–1937)

In the years 1900–1937 his chief interests were: the carriage of oxygen in the blood; haemoglobin; high altitude and oxygen transport; medical aspects of gas warfare; the function of the spleen; the architecture of physiological function; pre-natal physiology.

At the turn of the century methods for the determination of the oxygen content of blood were crude. A large quantity of blood, more than 10 ml., was required, the estimation took several hours, the result was not very accurate. The introduction of the Barcroft differential manometer in 1908 enabled accurate results to be obtained quickly on a 1 ml. sample, a little later the size of the sample could be reduced to a drop of blood from a finger-prick. Soon the differential manometer was in use in many other laboratories.

At that time the chemistry of haemoglobin was about as baffling as that of the inogen molecule. The C.H.O.N.S.Fe in haemoglobin did not even appear to be related to each other according to their molecular weights. First light came when Peters (1912) found that the iron of pig, ox, sheep and dog's blood always united with oxygen in the proportion of 1 atom of iron to 2 of oxygen. So began the story of haemoglobin which is told in *The Respiratory Function of the Blood* (1914) and in *The Respiratory Function of the Blood* Part II (1928) leading, after my father's retirement from the Chair, to the rapid recent developments summarized in 'Haemoglobin' (1948), the Proceedings of a Symposium held in Cambridge in his memory the year after his death.

My father's interest in oxygen carriage in the blood led to many studies in the effects of temperature, carbon dioxide, lactic acid, salts, and high altitudes on the oxygen dissociation curve of blood. For the high altitude studies he organized expeditions with foreign physiologists to Teneriffe (1910) and to Monte Rosa (1911). Inevitably he became much concerned with the question of oxygen secretion versus oxygen diffusion from the alveolar air across the pulmonary epithelium into the blood, and with more general questions of the control of human respiration.

And so it came about that in World War I he went to France after the first German gas attack and was appointed Chief Physiologist at Porton for special duties in connection with the medical aspects of gas poisoning.

In 1922 he organized the Royal Society expedition to the Andes. The oxygen tension in samples of arterial blood taken from the residents and members of the expedition at Cerro du Pasco, a mining town 12,000 ft. above sea level, was always less than that in the alveolar air. This result obtained by a more direct method than the carbon monoxide method used by the Haldane School strongly supported the diffusion theory of the passage of oxygen across the pulmonary epithelium. The effects of high altitude on the mind, the red blood corpuscles, and on the heart were studied and so was the process of acclimatization. The results were summarized in *The Respiratory Function of the Blood* Part I, 'Lessons from High Altitudes' (1925), and were a valuable contribution to aviation medicine and to the solution of problems besetting the ascent of Everest.

The incidental finding during the expedition to the Andes that life in a hot climate was accompanied by an increase in the volume of circulating blood led to a series of experiments, after my father's return to Cambridge, with numerous collaborators, showing that in the dog and cat the spleen acts as a reservoir for blood. The exteriorized spleen of the dog contracts during exercise and can increase the circulating volume of blood by about one-fifth. The spleen contracts too after haemorrhage, during emotional excitement and in pregnancy. (For references see the chronological list of Joseph Barcroft's publications in *Joseph Barcroft* by K. J. Franklin, 1953.)

By now my father had gained experience in many problems of practical physiology, it was with this background that he wrote his book *Features in the Architecture of Physiological Function* (1934). Professor A. Krogh, Foreign Member of the Royal Society wrote about this book 'I would suggest that it is a book which gives an integration of physiology of such a kind that it ought to be read by everybody who is going into experimental work in physiology. It gives the general ideas which cannot be obtained from any other book in existence.'

My father's work on foetal physiology began in 1931 in collaboration with successive teams of investigators. It concerned the foetal blood volume, and placental blood flow, the circulation through the foetal heart and chest, the passage of oxygen through the placental membrane, the differences between foetal and placental haemoglobin and many other topics, the subject of some forty full papers and of the Croonian Lecture to the Royal Society in 1935 on 'Foetal Respiration'. Barcroft's book on *Researches on Pre-Natal Life* was published in 1946.

Preliminary plans are being made for a Symposium on Neonatal Physiology to be held in Cambridge in 1972 the centenary year of my father's birth.

H. H. Hartridge (*1886–*)

Hartridge was exceedingly good at designing apparatus and making it with his own hands—the Hartridge reversion spectroscope for instance. This he used in a series of experiments on himself on the question of oxygen diffusion versus oxygen secretion through the epithelium of the lung. He could find no evidence for secretion either when he was at rest, or performing exercise, or breathing a poor oxygen mixture equivalent to being at an altitude of about 15,000 feet.

Another apparatus which Hartridge made was a mixing chamber for determining the velocity of the union of O_2 with Hb and the velocity of the disintegration of HbO_2 into O_2 and Hb. The research on this, carried out with Roughton, is 'notable in physiology as being the first in which the velocity constants of any so simple a reaction in the body have been measured, and in chemistry as being the first in which a reaction of such rapidity has been made to yield its secrets.'

G. S. Adair (*1896–*)

When Adair joined the Laboratory the molecular weight of haemoglobin was known to be some multiple 'n' of 1700. Adair calculated the value of 'n' from the determinations of the osmotic pressure of haemoglobin. 'After several years practice' he had trained himself to make reliable collodion membranes for his osmometers. Each estimation took months and had to be made in a cold storage room at —0.6°C. to prevent the haemoglobin from going bad. Adair found that the value of 'n' was 4, that is the molecular weight of haemoglobin was 70,000, a conclusion which Svedberg confirmed a year or so later with results obtained using the ultra-centrifuge.

F. J. W. Roughton (*1899–*)

Roughton soon became a leading authority on haemoglobin. One of his most important discoveries was that of the enzyme carbonic anhydrase (1933). It catalyses the reaction CO_2 to $H_2O \leftrightarrows H_2CO_3$ in the red cells. Without it CO_2 transport in the blood would be slowed down. Carbonic anhydrase is now known to be present in the mucosa of the stomach and in the kidney.

Roughton discovered that about ten per cent of the carbon dioxide carried from the tissues to the lungs was carbominohaemoglobin.

W. B. Hardy (*1864–1934*).

At about the turn of the century Hardy became convinced that the methods whereby living tissues were 'fixed' by reagents for microscopical examination often caused artificial appearances in cell protoplasm. This led him to many fundamental studies of the chemistry of colloids. The modern theory of protein solutions is very largely due to him. He established the isoelectric point as a physical constant for individual proteins. His work on globulins was summarized in his Croonian Lecture in 1907.

In World War I Hardy's interest turned from the preservation of cells to the preservation of foods. As Secretary of the Royal Society he organized the Food (War) Committee and came in close touch with many problems of food values, food supplies and food transport. As Chairman of the Food Investigation Board and of Food Investigation in the Department of Scientific and Industrial Research he recognized that little was known about the changes which occurred in human foods when they were subjected to various forms of preservation and transport. Hardy lost no time in enlisting the help of many of Britain's best scientists and in establishing research institutes for special aspects of food research—the Low Temperature Station at Cambridge, for the study of cold storage, the Torry Research Station, Aberdeen, for the study of fish preservation and the Bitton Laboratory, East Malling, Kent, for the study of the preservation of fruit and vegetables. All three centres have unquestionably attained to the rank of the world's leading research groups. Numerous examples could be given of the benefits that we are enjoying because of Hardy's vision, and his insistance on fundamental research as the quickest way to the solution of practical problems.

How far Hardy's work on the preservation of foodstuffs can be said to have come from the Cambridge School of Physiology is a question that I will not try to answer. That it is a notable contribution to Cambridge medicine, I have no doubt.

You will recall that contributions from 'The Physiological Laboratory, Cambridge' from 1900 to 1937 fill a quarter of the *Journal of Physiology*. To what extent did they fill the textbooks? Let us look at some chapters; they would no doubt contain sections on the following contributions from Cambridge.

GENERAL PHYSIOLOGY

Chemistry of colloids and globulins.

NERVOUS SYSTEM

All-or-none law for single nerve fibres.

The basis of sensation.
The mechanism of nervous action.
The Matthews oscillograph.
Anatomy and physiology of the sympathetic nervous system.

SKELETAL MUSCLE

All-or-none law of single muscle fibres.
Biochemistry and heat production of muscle.

BLOOD

Oxygen carriage. The dissociation curve.
Carbon dioxide carriage. Carbonic anhydrase.
Haemoglobin.

CIRCULATION

The spleen as a reservoir in the dog and cat.

RESPIRATION

Oxygen diffusion or secretion in the lung?
Classification of the causes of want of oxygen in the tissues.
Physiology of high altitudes.

NUTRITION

Vitamins

FOETAL PHYSIOLOGY

Growth.
Blood.
Respiration.
Circulation.

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Besides the years of birth and death mention is made only of appointments in Cambridge, or elsewhere after leaving Cambridge, during 1900–1937.

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Haldane and Cambridge Genetics (1900–1950)

by

J. H. EDWARDS

THE WORD *genetic* arose in Cambridge, the first chair of genetics was in Cambridge, the Genetical Society was inaugurated in Cambridge, and, Mendelism was introduced to Britain from Cambridge. These Bateson achieved. The rhesus groups, though discovered in New York, were decoded in Cambridge. Later, the haemoglobin molecule had its shape discovered there, the genetic code was decoded, and in August 1969, the messenger of this code revealed its own twisted shape, bent double under the back-chat of its own message.

In the last few years the pathology of the haemoglobins has been extended from the shape of the red cells to the shape of this molecule, and even its changes in shape when it breathes (once again, largely in Cambridge). However, it is not my intention to transgress beyond the mid-century.

Cambridge owes its prominence in genetics, both classical and molecular, to two men, without whom the same discoveries might have been made by their many successors, but would not have been made here. Both were born in 1861. Both were advised to leave school early as they were uneducable. Both laboured under extremely difficult conditions for many years. Gowland Hopkins provided the framework for the genetics of the present, and, with his concept of the stable dance of a myriad of enzymes, developed the versatile department which invited Haldane as Reader in 1924.

Bateson, the son of the Master of St. John's College, advancing from the background of embryology, studied variation in the field, extending his search from the presumed sunken seas of central Russia to the salt lakes of Egypt. It was Bateson who introduced Mendelism to Britain, and who protected it from the assault of the biometric school, pitting his robust common sense and raw knowledge against an algebra he could not understand.

This first decade of the century was both illuminated and confused by the controversy between those who regarded mendelian inheritance as a major factor in both useful and ornamental variants, and those who considered that Galton's Law of Ancestral Inheritance, a law based on the heraldic principle of quartering and sub-quartering shields, and according equal influence to ancestors of equal seniority, was sufficient to explain the variations observed.

Now, from a distance of two generations, the clash of men of high intellect, educated to respect an oratory which we appear to have lost, who carried their assurance without respect for past friendships or future preferment, may appear sterile, or even comic. It certainly illuminated the tidal surge of empty logic and uncertain numbers against the harsh realities of raw data, a recurrent episode in the maturation of every science.

Bateson defended himself well against the vast sea of decimals on which Pearson and Wheldon thought they were advancing, and into which Bateson, like Almroth Wright, was confident they were sinking, a view justified by time. The controversy was similar to that around the quantum theory which was developing at the same time. Some phenomena appeared explicable on the assumption of theories appropriate to large numbers, or large things. Both controversies were resolved. In genetics Fisher showed, in 1918, that numerous mendelizing factors would lead to the consequences observed, and misinterpreted, by the biometric school. This great work, rejected by the Royal Society of London, but accepted by that of Edinburgh, resolved a decade of controversy. Fisher had been trained at Cambridge as a physicist.

Bateson, like many outstanding scientists, had great difficulty with any numbers which did not directly represent things, and feared that, if science were to become too mathematical, it might cut itself off from the real world and allow a vast logical apparatus of dubious credentials to get between the scientist and his data. For this reason he supported Greek as a condition of entry to Cambridge: not because it was relevant, but because it was clearly irrelevant, and he preferred that the sciences should continue to profit from a more catholic variety of aptitudes than any selection on grounds presumed relevant. This polemic activity brought him into contact with G. H. Hardy, an ally, and, through this, we are indebted for the theorem of Hardy, now known as the Hardy-Weinberg law, a theorem variously regarded as a pivot of genetics, or as obvious. Hardy did not include it in his bibliography.

Cambridge has recently claimed there are two cultures, or, at least, has provided two men to advance and disclaim this duality. In science there are three cultures, or, at least, three centres of reference; things, words, and numbers and any scientist of distinction must master and relate at least two. Hopkins, like Bateson, worked with things and words but had rather more time to develop his ideas, over half his papers being published after Bateson's death, while his ideas were continued within a growing department and broadcast by his pupils. Haldane, on the other hand, who joined Hopkins, and later moved to the Institute Bateson had developed, worked with words and numbers and preferred the library and the coffee-break to the field and the microscope. As a writer, both as a popularizer explaining the known, and as a pioneer grasping the kernel of the unknown, he had few equals, writing with the depth and directness of the highly-educated individualist. When he left Cambridge his Readership was taken by Joseph Needham.

Haldane's contribution to genetics is mainly as a model builder who, using words and numbers with power and harmony, was able to erect and describe mathematical models from which he inferred what was likely and what was not. His main weapon, the finite difference calculus, an apparently simple approach which rapidly leads to insoluble equations, is only now capable of full exploitation by delegation to electronic machines, an application which Haldane could have made during his last years in India. However, with a strange conservatism which led to his preferring long division to the desk calculator in his earlier years, this advance was left to others.

Haldane's numerous papers in the *Proceedings and Transactions of the Cambridge Philosophical Society* are now difficult to find, even in Cambridge, and, while Fisher's papers have been collected, and

Sewall Wright is completing his life's work in three volumes, Haldane's contributions remain without any integration beyond that he himself made in his 1931 lectures. The remarkable flow of writing which started in collaboration with his father in 1912, on the combining power of haemoglobin, and continued until his death in 1964, has profoundly influenced genetics, partly by answering questions, but, to a far greater extent, by asking questions of a stark simplicity which showed up unnoticed voids in knowledge, and by strengthening the rather woolly structure of some arguments with a skeleton of very simple algebra.

His main genetical work started in Cambridge in 1924 with his 'mathematical theory of natural and artificial selection', a theme to which he returned throughout his life, extending it to man and his predators in both health and disease, taking within its grasp the spread of mutations, the mutation rate in man, the mapping of the human chromosomes, the stability of the rhesus locus (1942) and the 'cost of natural selection' in 1957. Throughout his life he was a frequent attender at meetings, and sought to influence concepts by both public and private debate, and to attempt a catholic synthesis extending over a wide, and, at times, unselected, range of reading. He spoke vigorously, usually from a manuscript. Apart from a brief tolerance of Lysenko's views, his grasp of those parts of genetical research which were of general interest, or which had future potential, was remarkable.

In general strategy of research, that is, of what should be done, his impact seems to have been small, and if his advice was rarely taken, this seems no great loss in retrospect. In his application of numerical methods he pursued ideas to the very borders of the computable, making his papers remarkable as tests for compositors and rich quarries for those who find pleasure in misprints. In some fields almost devoid of data he applied an algebra with a precision more appropriate to a banker; in others he worked with a tolerance of several fold. But, in whatever art-style of algebra he chose, he illuminated problems, even if the answers were so obscure that they have not been read since the proofs were corrected.

His separation from laboratory work or field study deprived him of any coherent band of pupils, or any 'school' of genetics, excepting in his last years in India, but this freedom from any organized approach to the problems, or from any deep preoccupation with technical details, allowed his casual eclecticism to range over the whole field of science, and allowed this to be illuminated by a background of history and literature varying from Aristotle's views of the dance of the bees to subtle cross-references worthy of a Joyce.

To what extent this preoccupation with secondhand data was an advance in the use of ideas, or imposed by a lack of technical ability, has been discussed, by some of those who worked with him, in reviews of his recent biography. He certainly seems to have had unusual difficulties with technical procedures and is even credited with the death of both partners after a demonstration on how to pollinate primroses.

The relative influence of Fisher, Sewall Wright, Hogben and Haldane in the application of numerical argument to evolution must await the further test of time. Haldane's work alone was based on his work while in Cambridge, and it may rank amongst that of his predecessors and colleagues, Bateson and Hopkins, in the influence it has exerted over genetics, and particularly the genetics of man.

We now know that our germinal heritage is constantly devolving through copying errors and other mutations and that any increase in this is dangerous: we know that these are basically numerical problems, and, in principle can be answered in numbers, and that the type of data from which inferences can be made exist. We know that most mutations have a cost, in terms of selective deaths to restore the status quo. Perhaps even more important, we know that we are different, and that it is the nature of man to be different.

If we know this much, and if our present aims are to increase our resolving power, rather than to question that there is anything to look at, this must be credited to Haldane as much as to any of his predecessors or successors who have sought to explain evolution in chemical terms, and have extended their analysis to the level of the genetic code.

Contributions of Cambridge to Biochemistry since 1920

by

MALCOLM DIXON

I SHOULD like to start with a word or two about the scope of my paper. I have been asked to write about Cambridge contributions to biochemistry since 1920. These contributions have been numerous, and it would hardly be possible even to list them all in the space available to me. I estimate that over 4,000 biochemical papers have been published from Cambridge during the period, not all from the Department of Biochemistry, but from other Cambridge departments as well. Omissions are therefore unavoidable, and I hope that nobody will be offended by a failure to mention his work. What I hope to do is to trace some of the currents in the development of the subject, and to follow the growth of the work of those groups which have contributed to it, not only in the Department of Biochemistry but in Cambridge generally.

I shall tend to give more emphasis to the earlier work and less to the very modern advances, even though these may be more important. After all, this volume is concerned with history, and work which is now in progress can hardly be so described as yet. I should also say that I am non-medical, and I shall not pay special attention to the medical applications of biochemistry, about which most of you will know more than I do.

Why do I start with the year 1920? For three main reasons. First, at that time biochemistry on Cambridge, and indeed in this country, could be said to be centred in Frederick Gowland Hopkins; and that year marked a turning point in his thinking. Up to then his main interest was in nutrition, but afterwards it was switched largely to biocatalysis as a directive influence in biology, and to the study of catalysts of biological oxidation in particular. This was a quite deliberate decision on his part, and I well remember the day in 1921 when he told me about it.

Secondly, it was in 1920 that the Dunn Trustees gave a large bequest that provided for the first time a separate building for biochemistry as well as a small teaching staff, and so set biochemistry on its feet.

My third reason for choosing that year is a personal one, for it was then that I joined Hopkins's department. Events before that had been hearsay to me, but thereafter I was in close touch with the work, the more so because I then had the great good fortune to be invited by Hopkins to collaborate with him in his research.

I believe there were four reasons for Hopkins's momentous switch of interest to biological catalysts. First, he had just discovered and isolated the sulphur-containing peptide glutathione, which he showed underwent reversible oxidation and reduction in tissues, thus acting as a non-enzymic oxidation catalyst. Secondly, he had just discovered the xanthine oxidase of milk, an enzyme catalysing the oxidation of purines. Thirdly Mrs. Onslow was then working in his department on an enzyme in plants oxidizing phenols. Finally there arrived just then from Sweden a reprint of a ninety-page paper by Thunberg on the existence of an important group of oxidizing enzymes, the dehydrogenases. (I have the identical reprint in my possession, and I well remember how it excited Hopkins at the time.) All these factors combined to arouse his interest in the subject.

I will not go into the details of his work on biological catalysts over the next twenty years, but it brought out especially two conceptions which have become of fundamental importance. The first was the idea of specific catalysis by enzymes as a directive force controlling the rate and the nature of the chemical processes occurring in living cells; that is to say the idea that what happens to a substance in the cell depends not so much on the inherent reactivity of the substance as on what enzymes are present and what are their specificities. This led up to the conception of multi-enzyme systems, and recently it has become very important in the light of the modern interpretation of genetics and of DNA as a mechanism for producing the right enzymes at the right time.

The second of the two conceptions was that of oxidation-carriers, which was first suggested to Hopkins by glutathione. Such a carrier is a substance which acts as a catalyst in this kind of way:

$$AH_2+C=A+CH_2 \qquad E_1$$
$$CH_2+B=C+BH_2 \qquad E_2$$

where C is a carrier catalysing the oxidation of AH_2 by B. C is generally not an enzyme, but each of the two reactions may be catalysed by different enzymes. Hopkins showed that glutathione did act in this way as a respiratory carrier in tissues, but he did not succeed in identifying the precise role of glutathione, which in my opinion remains doubtful to this day. The conception of carrier action, however, has become of fundamental importance in the mechanism of cell respiration and of the action of many coenzymes.

ENZYMES

Hopkins's teaching showed us the great interest of enzymology and inspired a number of us to work on the subject. Ever since then there has been an active enzymology group in the department, and Cambridge has long been known as a centre of enzyme studies. Twenty-five years later, in 1945, the university formally recognized this by establishing the Sub-Department of Enzyme Biochemistry, and later a chair in the subject. This was, I believe, the first unit anywhere in the country specifically devoted to enzymology. But I need hardly say that it had no monopoly of enzyme research in Cambridge, and a great deal has been done here by others outside the unit.

You will forgive me if I take the development of enzymology first, although it is my own subject, because it did follow directly from Hopkins's work. Going back then to 1920, I worked both on glutathione and on xanthine oxidase. The glutathione work did not lead to anything much, but xanthine oxidase is perhaps of some historical interest as possibly the first enzyme of animal tissues to be purified. At that time there were no pure enzymes; indeed not much more than a dozen enzymes were known at all, and it was not by any means clear what enzymes were. I thought it might be interesting to separate the milk proteins into fractions, and to see whether the enzyme activity went into one of the fractions or not. It did, and by following it through a series of successive fractionations we were able to get the oxidase partially purified. Nowadays of course purification is common practice in enzymology; we know well over a thousand different enzymes, most of which have been purified. I am not suggesting that this is a consequence of the xanthine oxidase work, but I hope that we may have given some encouragement to people working along similar lines, at a time when the purification of enzymes was severely criticized as 'unphysiological'.

The oxidase had rather interesting kinetics and inhibition effects, and our group soon became interested in the inhibition of enzymes by toxic substances. Later we did some of the early work on poisons which attack particular chemical groups in enzymes (cyanide, iodoacetate, organophosphorus compounds, etc.) and later still this led up to work on the structure of the active centres of enzymes by specific labelling techniques. The conception that enzyme molecules contain 'active centres' at which the catalysis takes place was, I believe, first suggested by J. H. Quastel, who joined the group in 1921.

Two years later, in 1923, J. B. S. Haldane came to Cambridge as the first Reader in Biochemistry, and quickly became interested in enzymology (among other things), though from a theoretical and mathematical rather than a practical point of view. With G. E. Briggs, later Professor of Botany here, he introduced in 1925 the so-called 'steady-state method' which now dominates enzyme kinetics. This uses rate constants, rather than equilibrium constants as previously, and has developed into a powerful tool for analysing enzyme mechanisms. In 1930 he produced his book on enzymes, which was a classic and remained in general use for nearly thirty years, until it was superseded by a larger book written by E. C. Webb and myself.

The next milestone was the discovery of the cytochromes by David Keilin in 1925. Keilin worked in the Molteno Institute for Parasitology, of which he later became the Director and Professor of Biology, and he discovered this group of haemoproteins almost by accident during some spectroscopic work on a parasite; the story is told in his book entitled *History of Cell Respiration and Cyto-*

chrome published posthumously in 1966 (Cambridge University Press). He showed that the normal respiratory system of cells contains five cytochromes working in series by alternate oxidation and reduction, in general agreement with Hopkins's conception of carriers.

Keilin worked quite independently of Hopkins and in a different building, but for nearly forty years Robin Hill and I were in close touch with Keilin and formed a link between the two departments. From time to time we worked in collaboration with him, as for instance in the preparation of cytochrome *c* by Hill and Keilin and the first determination of the spectrum curve of a cytochrome by all three of us.

The five cytochromes I have mentioned were the key to the mechanism of oxygen utilization by cells, but since then a number of other cytochromes with special functions have been discovered, several of them in our department. The whole cytochrome field is very largely a Cambridge contribution.

From 1934 onwards Keilin also did much work on the purification and nature of enzymes containing metal atoms, mostly with T. Mann, now Professor of the Physiology of Reproduction here, or with E. F. Hartree, who worked with him for many years. These enzymes included laccase, uricase and polyphenol oxidase (copper), peroxidase and catalase (iron), and carbonic anhydrase (zinc); and in several cases the definite identification of the metal was due to Keilin. He also discovered that sulphonamide drugs are very powerful poisons for the last-mentioned enzyme, carbonic anhydrase, an enzyme which had been isolated here by F. J. W. Roughton, later Professor of Colloid Science.

In parenthesis I should mention another important contribution by Roughton, namely the invention of a continuous-flow method of studying rapid reactions, including the intermediate steps of enzyme reactions. This is referred to in Professor Barcroft's article. This was developed into a series of elegant and highly sophisticated spectroscopic methods by Britton Chance, now Head of the Johnson Research Foundation in Philadelphia; these have revealed a great deal about the mechanism of enzyme catalysis. Much of the development was done in America, but Chance began it in Cambridge when he was one of Roughton's research students.

The most recent and exciting development in this part of the subject is the complete determination of the structure of a number of enzymes. To determine the structure of a protein two things are necessary: first the determination of the sequence pattern of amino-acids along the peptide chain—a chemical problem; and secondly the determination of the way in which the chain folds up to form a molecule of a definite shape—a physical problem which must be solved by X-ray diffraction methods.

The chemical problem for a long time seemed quite insoluble, but in 1945 F. Sanger, working in our department, succeeded in determining the complete sequence of a protein for the first time, by methods depending on the use of specific enzymes. For this he received a Nobel Prize. This was done on insulin, and later, after he and his team had migrated to another Cambridge department, the Laboratory of Molecular Biology, this great achievement was extended to other proteins. This has led to a flood of sequence work throughout the world, and many proteins, including several enzymes, have been done. More recently, Sanger has developed methods for determining the sequence of nucleotides in nucleic acids also, thus making another important contribution to biochemistry.

The physical problem, the determination of the actual shapes of the molecules, was first solved in the cases of haemoglobin and myoglobin by Perutz and Kendrew, also in Cambridge, first in the Cavendish Laboratory and then in the Laboratory of Molecular Biology. Since the function of these proteins is not to catalyse a chemical process, they are not really enzymes, but Perutz has suggested that on structural grounds they should be regarded as 'honorary enzymes'. More recently several real enzymes have been done. Lysozyme, the first, was not done in Cambridge, but others have now been done here in Perutz's laboratory, notably chymotrypsin by B. S. Hartley and his co-workers, and I like to recall that Hartley started his sequence studies on this enzyme when he was a member of our group.

Complete molecular models of about half-a-dozen enzymes have now been constructed, and it is interesting to see that most have a kind of cleft in their molecules which in each case fits a molecule of the particular substance which the enzyme acts upon. This no doubt is the active centre of the enzyme where the reaction takes place. To an old-fashioned enzymologist like myself, who has had to get along for so long without knowing the structure of the molecules involved, this seems like the entry to the Promised Land!

Having followed the development of this side of biochemistry, I should now like to return to other members of Hopkins's group of 1920 and some developments from their work. One was R. A. Peters, now Sir Rudolph, whose work on haemoglobin has already been mentioned; but he left shortly afterwards to become Professor of Biochemistry at Oxford, although to our great pleasure he returned to us after his retirement and is actively researching on the metabolism of organic compounds of fluorine.

MICROBIOLOGICAL CHEMISTRY

Marjory Stephenson, the pioneer of microbiological chemistry, had been working on vitamins, but in 1920 Hopkins encouraged her to leave that field and to start a comprehensive study of the biochemical activities of bacteria. She studied bacterial metabolism and some of the enzymes involved with great success, and wrote a well-known book, *Bacterial Metabolism*, which ran through several editions and did much to put the subject on its feet. After some twenty-five years she was appointed Reader in Chemical Microbiology, and also became the first woman to be elected to the Royal Society on the biological side. I may mention in passing that all the members of the 1920 group of researchers later became Fellows of the Royal Society, except one who died not long after that date.

After Marjory Stephenson's death in 1948 her group was carried on with Medical Research Council support under the leadership of E. F. Gale, her former research student and collaborator, now Professor of Chemical Microbiology. The M.R.C. set up a unit, which was taken over in 1953 as the present Sub-Department of Chemical Microbiology.

One can trace a logical development of the work along the following line. In the late 1930s Stephenson and Gale became interested in the marked changes in the enzyme constitution of bacteria after the addition of glucose to the medium. Many enzymes, especially those releasing ammonia from amino-acids, were almost completely suppressed. This later formed the basis of work on catabolite repression.

A further effect of glucose, but due this time to acid formation, was the appearance in many bacteria of amino-acid decarboxylases, a group of enzymes described here for the first time. These enzymes were purified and resolved into specific proteins and a common coenzyme; work partly in Cambridge and partly in Ithaca identified this as pyridoxal phosphate, and so led to studies on the mode of action of vitamin B_6.

The specific decarboxylases provided an easy method of assaying certain amino-acids. This led to the finding that many bacteria and yeasts contain high intracellular concentrations of free amino-acids, and this in turn led to studies on the transport of amino-acids across the cell surface structures. In many cases this was shown to be due to highly specific active processes.

Three major lines of work developed from this. First, work on the nature of the surface structures of bacteria. Salton prepared cell-walls in a pure condition and laid the foundations for the present understanding of mucopeptide structures. K. McQuillen, now Vice-Master of Churchill College, removed the cell-wall by attack with enzymes, thus obtaining protoplasts, and demonstrated their capabilities and the function of the cell-wall.

Secondly, work on the mechanism of protein synthesis. Studies on the incorporation of amino-acids followed logically from the work on their transport, and simple systems were devised for the study of synthesis of protein and nucleic acid in intact staphylococci. Furthermore, broken-cell suspensions gave the first demonstration of the direct effects of the nucleic acids DNA and RNA on enzyme synthesis.

Thirdly, work on the mode of action of antibiotics. The studies just mentioned gave simple systems for testing the inhibitory actions of antibiotics, and the ones in common medical use were found to fall into four groups differing in their site of action: (i) those affecting the cell membrane, inhibiting the transport systems and allowing small molecules to leak out of the cells (e.g. tyrocidin, polymixin); (ii) those inhibiting synthesis of cell-wall material (e.g. penicillin, vancomycin); (iii) those specifically inhibiting synthesis of proteins (e.g. chloramphenicol, tetracycline, puromycin, cycloheximide); (iv) those inhibiting synthesis of nucleic acid (e.g. actinomycin, ethidium bromide).

Recent work has concentrated on explaining the actions on a molecular basis. This has been particularly successful in four cases (polymixin, chloramphenicol, actinomycin and ethidium), and conversely many of the drugs have proved most useful in elucidating the details of biosynthetic mechanisms. The whole approach is now being extended to antiprotozoal drugs in the M.R.C. Unit for Biochemical Parasitology which is being set up in the Molteno Institute under B. A. Newton.

PLANT BIOCHEMISTRY

Another member of the group of 1920 was Robert ('Robin') Hill who, we are glad to say, is still very active in research in our department. Although he is best known as a plant biochemist, much of his earlier work was on haemoglobin and related substances. He first resolved haemoglobin into haem and undenatured globin and showed that they recombine with the synthesis of haemoglobin; he also found the high affinity of myoglobin for oxygen. Later he worked on cytochromes, and discovered cytochromes b_3, b_6 and f, which form part of the mechanism of photosynthesis. In fact his most distinguished work has been on the photosynthetic mechanism; he discovered the well-known 'Hill reaction' (the production of oxygen by illuminated chloroplasts at the expense of reducible substances), which is a fundamental part of the system. Later his work led to the isolation of ferredoxin, an iron-protein with highly reducing properties, which plays an important part in photosynthesis. Probably similar proteins play a part in other metabolic processes also, for example in cell respiration.

It is largely due to Hill that the Department has always had an active plant biochemistry unit. This now includes a group led by D. H. Northcote, Reader in Plant Biochemistry, engaged on an extensive and extremely interesting study of the development and morphogenesis of plant cells, involving investigations on the chemistry of the substances making up cell walls, the enzymes concerned, the fine structure of the walls and the processes by which they are laid down. This has required the bringing together of many different techniques, especially electron microscopy. I should mention also very interesting work by D. S. Bendall on plant cytochromes with special functions, and on the properties of copper-proteins in plants.

MUSCLE BIOCHEMISTRY

Two other members of Hopkins's group were Dorothy Needham and (from 1922) Joseph Needham. Dorothy Needham became a leading authority on the biochemistry of muscle, a subject on which Hopkins had done classic work with Fletcher thirteen years before. She made many valuable contributions to it, of which probably the most important was the discovery in 1937 of the coupling of phosphorylation with oxidation in muscle glycolysis. She has just completed her second book on muscle biochemistry. The muscle protein myosin was also studied by K. Bailey, who discovered tropomyosin, and by S. V. Perry.

COMPARATIVE BIOCHEMISTRY

Joseph Needham, now Master of Gonville and Caius College, made great contributions to the subject of chemical embryology, especially in his three-volume book on the subject in 1931. He also did much work on comparative biochemistry, that is to say the way in which species differ in their biochemistry, and in this he was followed by his former research student and collaborator E. Baldwin, later Professor in University College, London, who did much to develop the subject while he was there. Of course many of the observed differences are the result of species differences in enzymes and other proteins, and the interpretation of such differences in molecular terms has recently become a very large subject.

It was really started here when Sanger compared the amino-acid sequences of a number of insulins obtained from various species, and showed that they differed simply in the substitution of one amino-acid by another at definite points in the molecule. Similar comparisons have now been done for many enzymes and proteins, and an interesting by-product of this side of comparative biochemistry is the light it throws on evolutionary history. The amino-acid substitutions are the result of single-gene mutations, and by following up the descent of such mutations through the different species it is sometimes possible to construct an evolutionary family tree, just from the comparative biochemistry of one enzyme or protein.

MUTANT HAEMOGLOBINS

This leads me to the work of H. Lehmann, Professor of Clinical Biochemistry here, who has established an Abnormal Haemoglobin Unit in our Department with the support of the M.R.C. His unit has carried out a remarkable world-wide study of the occurrence of mutant forms of haemoglobin, their precise identification in terms of single-point amino-acid substitutions, and the correlation of these with medical effects. The results of course have great anthropological significance. The unit also maintains an international reference service for the diagnosis of haemoglobinopathies.

As University Biochemist to the United Cambridge Hospitals, Professor Lehmann also supervises the John Bonnet Clinical Laboratories, which form a part of our department; an enormous amount of clinical chemical testing is carried out there for the hospitals, and many improvements have been made.

HORMONES

I have been speaking mainly of lines of work which may be said to have descended directly or indirectly from work going on here during the 1920s. But there are others which had a later origin. In 1949, when F. G. Young became Professor of Biochemistry here and Head of our Department, he established a research group for the study of hormones. This has made valuable contributions in several directions, especially the following.

A number of hormones, mostly from the pituitary, have been very extensively purified on a large scale. The amino-acid sequences of a number of polypeptide hormones have been determined, partly in collaboration with Sanger's group, and some interesting relationships have been brought out. Extremely sensitive and accurate techniques for the assay of a number of protein hormones including insulin by elegant radio-immunological methods have been developed. It was found that pituitary growth hormone accelerates the biosynthesis of protein from amino-acids, both in the tissues and by ribosomes *in vitro*, and it has been shown that the hormone acts on the ribosomal process by which peptide chains are built up under the control of messenger ribonucleic acid. Ribosomes from hypophysectomized rats have an abnormally low activity, but after treatment *in vivo* with growth hormone the activity is restored to normal. Protein synthesis in isolated tissues is also increased by insulin.

Much work has also been done on the control by hormones of carbohydrate intermediary metabolism, partly in terms of effects on some of the enzymes involved, especially phosphofructokinase and glucokinase. In addition, P. J. Randle, now Professor in Bristol, has studied in this connexion the interrelationships of fat and carbohydrate metabolism. He suggested that the amount of free fatty acids in the plasma plays an important part in the regulation of carbohydrate metabolism, and proposed a 'glucose-fatty-acid cycle' which may assist in understanding the nature of diabetes. A common component in fat and carbohydrate metabolism is coenzyme A, and P. K. Tubbs and his co-workers have made an extensive study of the various forms of coenzyme A in the tissues, the various enzymes concerned with them, and their changes in various metabolic conditions. The picture that emerges may explain much, but the interactions of the components are rather too complicated to be discussed now.

NUCLEIC ACIDS

Cambridge has made important contributions relating to nucleic acids. A fundamental one was the first demonstration in 1936 that a virus consists of nucleic acid and protein by Bawden, Pirie, Bernal and Fankuchen; as three of the four authors were working in Cambridge, I shall claim this as a Cambridge contribution. They say in their paper that the observation may have 'a certain intrinsic interest', which in view of all that came of it must be one of the biggest understatements I have met. Much work on viruses is going on here in several laboratories, and there is a separate Virus Research Unit under the Agricultural Research Council.

Much distinguished work on the chemistry of nucleotides has been done in the Department of Organic Chemistry under our Chairman, Lord Todd, and I hope he will not object to my calling it biochemistry. I would mention specially the synthesis of the main coenzyme of biological oxidations, which used to be called cozymase and is now known as NAD (nicotinamide-adenine dinucleotide), and if NAD is not biochemistry I do not know what is!

I have already mentioned Sanger's recent work on the nucleotide sequences of nucleic acids. I have left till last the most sensational contribution, namely the discovery by Watson, Crick, Brenner and others of base-pairing in nucleic acids and the elucidation of the nature of the genetic code, in which the Cambridge Laboratory of Molecular Biology played such a large part. I have left it partly because it is almost too recent to be history yet, partly because it is so well known, and partly because it is too big to be dealt with in a few lines.

TEACHING

So far I have been speaking entirely of research, but Cambridge has made a very special contribution to the teaching of biochemistry. Long before the period I am dealing with, in fact from the nineteenth century, some chemistry was included in the physiological courses, both at the elementary (Part I) and advanced (Part II) levels. But biochemistry as a separate subject in its own right was first taught in 1924 when our Part II Biochemistry course was started. This was a one-year full-time course for third- or fourth-year people, and all the senior members of the department took part in running it. At first it was very much a pioneer course, but it has changed and developed continuously during its forty-five years, and I believe it has contributed materially to the growth of the subject in this country and indeed elsewhere. It is now always full to capacity.

Ten years later a Part I Biochemistry course was started for first- and second-year people; this was taken by a high proportion of medical students and many others, although it was always intended to teach pure biochemistry without any medical bias.

Later still, in 1953, postgraduate courses in special branches of biochemistry were introduced. These are whole-time courses coming after the Part II course and intended to lead up to the Ph.D. degree; they are taken by a relatively small number of people who wish to specialize in certain aspects.

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Cambridge and the Evolution of the Knowledge of Vitamins

by

E. KODICEK

To SPEAK of the evolution of the knowledge of vitamins in the narrow precincts of Cambridge is like building a wall around the city, and it would not do justice to the work of many researchers outside its walls. The names of Funk, Eijkman, Grijns, Stepp, McCollum, Osborne, Mendel, Holst, Frölich and others are closely connected in the early days with the development of vitaminology and were followed by many more in this and other countries. Nevertheless the contribution of Cambridge scientists was an important one and therefore this survey might have its justification. Even within this university many more scientific papers on vitamins which enhanced our knowledge have been produced than can be mentioned in the space available. I wish therefore to apologise to all whom I have omitted.

One can trace the origin of the Cambridge concept of 'minimal qualitative factors of the diet', later to be called vitamin(e)s or accessory food factors, to a communication by Frederick Gowland Hopkins. The year was 1906, November, and Hopkins was addressing the Society of Public Analysts on 'The Analyst and the Medical Man'.[1] In succinct far-seeing sentences he delineated the new scientific development to become of such importance in the future.[1]

> While upon the business of prophecy, I am tempted to put another series of prognostications before you, the credibility of which is at the present time, perhaps, more obvious to the physiological chemist than to anybody else. I pass from pathology to an aspect of dietetics. This is a

subject in which the medical man is the recognized authority, charged with the instruction of the public, but for a scientific knowledge of which he depends largely on the chemical physiologist and the analyst. Putting on one side the aspect of affairs which especially concerns this society—the maintenance of purity and freedom from adulteration—and leaving out questions such as digestibility and the like, the chief practical points which have hitherto been considered in relation to the daily rations of mankind are the total energy value requisite for maintenance, the optimum ratio of fats and carbohydrates, and the optimum supply of protein. Now, these questions have recently received fresh attention, and experimental work has been done lately yielding, as you know, somewhat startling results, tending at first sight to modify our views concerning maximal, minimal, and optimum dietaries. But I am not going to discuss the work of Atwater or Chittenden, proposing rather to put before you very briefly facts of another sort, less known and seemingly academic. I believe, however, that my theme, which is that of the influence of minimal qualitative variations in dietaries, will one day become recognised as of great practical importance.

Physiological chemistry, chiefly owing to the work of Emil Fischer, has recently gained the knowledge that individual proteins, and among them those which contribute to human dietaries, may each bear a special chemical stamp; that a given protein may differ so widely from another protein as to have, quite possibly, a different nutritive value. I will illustrate this, first of all, by a somewhat extreme case. A protein, zein, forming no inconsiderable proportion of the total nitrogenous constituents of maize, is entirely deficient in at least one characteristic molecular grouping. It yields on digestion no tryptophane, the product which represents the indol group present in the molecules of most typical proteins.

Recently we have fed animals with this indol-free maize protein in such a way that it formed the only supply of protein, though associated with abundant fat and carbohydrate and suitable salts. The diet wholly failed to maintain tissue growth in young animals, which, however, grew at once when their zein was replaced by pure casein. When tryptophane was added to the zein diet, there was still inability to maintain tissue growth, doubtless because the zein has other deficiencies as a protein. But now an interesting fact came to light. The animals which received the missing indol derivative in addition to the zein did not grow, in fact, they continued to lose weight daily, but were afterwards in much better health than, and long outlived, those which had the zein alone. These experiments seem to show two important facts: First, that in an extreme case a particular protein may wholly fail to support life, just as is the case with gelatin: and next, that a group in the protein molecule may serve some purpose in the body other than that of forming tissue or supplying energy. The usual discussions about foodstuffs attribute to them these two functions only—repair of the tissues and energy supply. But the body has other and more subtle needs equally urgent. Here, there, or elsewhere in the organs must appear special, indispensable, active substances which the tissues can only make from special precursors in the diet.

The indol grouping in the protein molecule serves some such special purpose, quite distinct from its necessary function in tissue repair. This matter of qualitative differences in proteins may be of no small significance in dietaries. It may account for what I believe is proved by experience—that rice may serve the races which rely upon it as an almost exclusive source of protein, while wheat is only suitable for races that take a much more varied dietary. It may explain many variations in nutritive values which at present we feel and recognize only vaguely. In the future the analyst will be asked to do more than determine the total protein of a foodstuff; he must essay the more difficult task of a discriminative analysis.

But, further, no animal can live upon a mixture of pure protein, fat, and carbohydrate, and even when the necessary inorganic material is carefully supplied the animal still cannot flourish. The animal body is adjusted to live either upon plant tissues or the tissues of other animals, and these contain countless substances other than the proteins, carbohydrates, and fats.

Physiological evolution, I believe, has made some of these well-nigh as essential as are the basal constituents of diet. Lecithin, for instance, has been repeatedly shown to have a marked influence upon nutrition, and this just happens to be something already familiar, and a substance that happens to have been tried. The field is almost unexplored, only is it certain that there are many minor factors in all diets of which the body takes account.

In diseases such as rickets, and particularly in scurvy, we have had for long years knowledge of a dietetic factor; but although we know how to benefit these conditions empirically, the real errors in the diet are to this day quite obscure. They are, however, certainly of the kind which comprises these minimal qualitative factors that I am considering. Scurvy and rickets are conditions so severe that they force themselves upon our attention; but many other nutritive errors affect the health of individuals to a degree most important to themselves, and some of them depend upon unsuspected dietetic factors.

I can do no more than hint at these matters, but I can assert that later developments of the science of dietetics will deal with factors highly complex and at present unknown.

It is interesting to read the discussion that followed and to notice that the professional public was not prepared for the vision of things to come. Not a single speaker referred to these new concepts;

they discussed only the day to day matters relating to the work of the public analyst. Hopkins might have been quite disappointed with the reception when in reply he said 'that he had felt considerable compunction in reading this paper before the Society, even after it had been written. He had a strong feeling that, while the first half was made up of platitudes and indiscretions, the second consisted of an academic lecture . . . . he was bound to say that he did not wholly regret the second part, for, if anything gave him pleasure, it was to talk academically to practical men' (*Analyst*, 1906, **31,** 403).

There was, however, no doubt in Hopkins' mind of the importance of the subject, as Mellanby remarks in his Hopkins Memorial Lecture (1948);[2] 'Hopkins himself often said to me in the years 1905–1907 that he thought the whole subject of nutrition was on the point of being revolutionized.'

In 1912 Hopkins' publication of 'Feeding Experiments Illustrating the Importance of Accessory Food Factors in Normal Dietaries' appeared[3] and marked the finalization of the concept and evidence of the presence of unidentified organic factors in the diet that were different from proteins, fats, carbohydrates and minerals. The results of experiments obtained as far back as 1906–1907 were previously summarized in lectures delivered at Guy's Hospital in June 1909 and ill health prevented Hopkins from publishing them earlier.[3]

> The experiments described in this paper confirm the work of others in showing that animals cannot grow when fed upon so-called 'synthetic' dietaries consisting of mixtures of pure proteins, fats, carbohydrates, and salts. But they show further that a substance or substances present in normal foodstuffs (e.g. milk) can, when added to the dietary in astonishingly small amount, secure the utilization for growth of the protein and energy contained in such artificial mixtures.
>
> The particular experiments, of which an account is now to be given, were undertaken to put upon a more quantitative basis results which I obtained as far back as 1906–1907. Since that time, a fuller realization of the fact that (leaving on one side the influence of the inorganic constituents of dietaries) protein supply and energy supply do not alone secure normal nutrition, has arisen from the extremely interesting recent work upon the etiology of such diseases as beri-beri and scurvy. It is not surprising that much work is now being done in connection with the subject; and since the experimental results given in this paper were

obtained, the publications of others have covered part of the ground. In particular I may refer to the work of Stepp upon mice, and to the extensive researches of Osborne and Mendel upon rats. But the observations now to be described differ in some important details from those of the authors quoted. They bring out in particular the marked influence of minute additions of normal food constituents in promoting the nutritive power of synthetic dietaries. Stepp approached the subject on the lines of an attempt to estimate the importance of lipids in nutrition. He found that food mixtures after extraction with lipoid solvents could not maintain life in mice. The total material extracted by the solvents when added to the diet made the food efficient once more; but Stepp was unable to obtain this result by adding any known lipoid.

The paper described experiments on young rats given a fairly purified diet, containing potato starch, casein, cane sugar, lard and

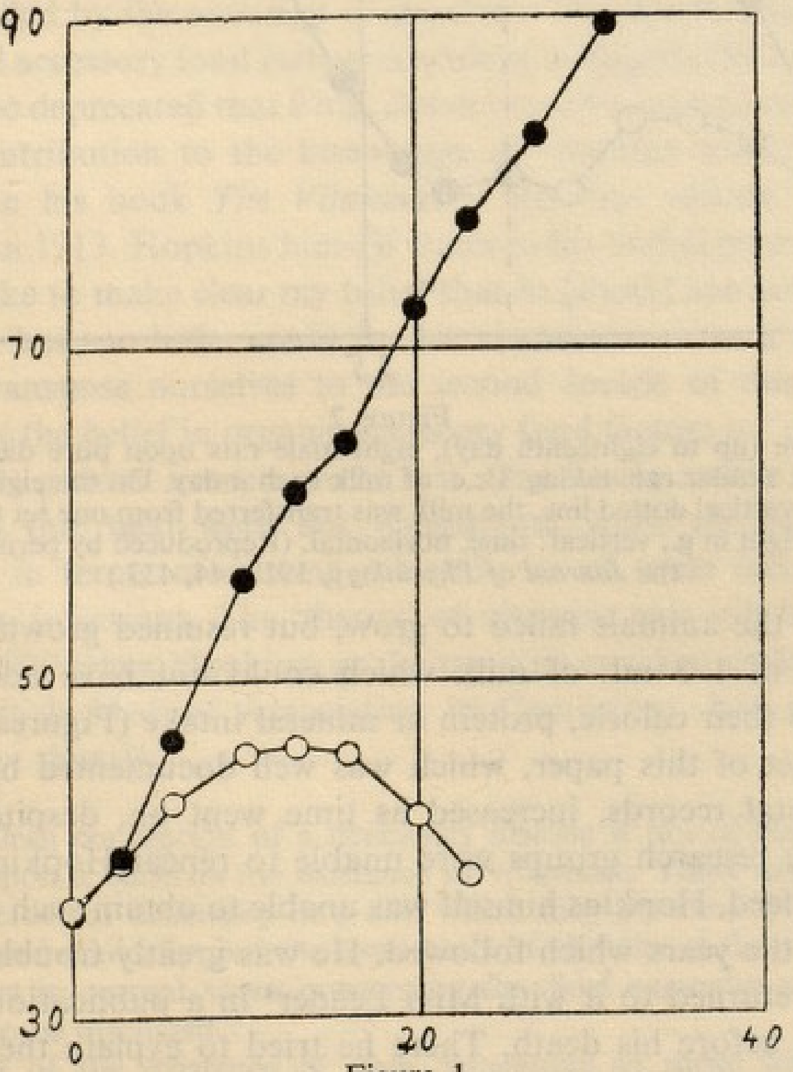

Figure 1

Lower curve, six rats on artificial diet alone. Upper curve, six similar animals receiving in addition 2 c.c. of milk each per diem. Abscissae, time in days; ordinates, average weight in g. (Reproduced by permission from the *Journal of Physiology*, 1912, 44, 432.)

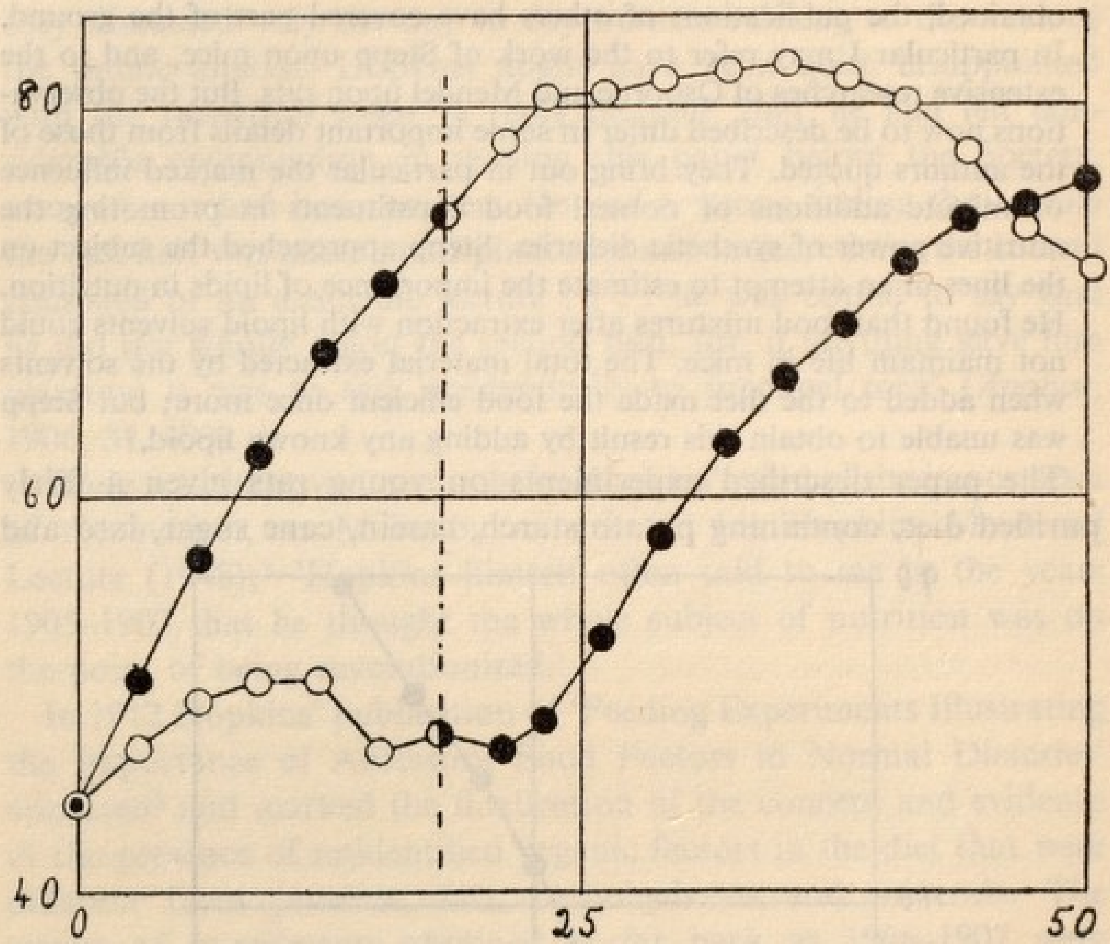

Figure 2
Lower curve (up to eighteenth day), eight male rats upon pure dietary; upper curve, eight similar rats taking 3 c.c. of milk each a day. On the eighteenth day, marked by vertical dotted line, the milk was transferred from one set to the other. Average weight in g., vertical: time, horizontal. (Reproduced by permission from the *Journal of Physiology*, 1912, **44**, 433.)

minerals; the animals failed to grow, but resumed growth on daily additions of 1–3 ml. of milk which could not have added significantly to their calorie, protein or mineral intake (Figures 1 and 2). The impact of this paper, which was well documented by detailed experimental records, increased as time went on, despite the fact that many research groups were unable to repeat Hopkins' experiments. Indeed, Hopkins himself was unable to obtain such consistent results in the years which followed. He was greatly troubled by this fact and returned to it with Miss Leader[4] in a publication in 1945, two years before his death. There he tried to explain the inconsistencies by a complicating effect of refection, a concept which was not known in 1912. However, even this phenomenon cannot explain entirely the results and one can only conjecture that the basal diet was not very highly purified and produced a partial rather than a complete deficiency of some factor or factors. The small doses of milk might then have supplied the additional amount.[5,6,7]

In any case the clear and concise conclusions of the accessory food factors concept earned him the description by Röhmann[6] to be 'der geistige Vater der Vitaminlehre'. Hopkins, as mentioned in his Nobel prize lecture in 1929,[6] never claimed to have been the 'discoverer of vitamins'. It was Funk in 1911[8] and 1912[9] who, in working on the isolation of the anti-beri-beri substance from rice polishings, suggested the name of 'vitamine'. He conceived it to be 'one of those nitrogenous substances, minute quantities of which are essential in the diet of birds, man and other animals'. The word vitamine was later modified by the omission of the finale 'e' when it became clear that not all accessory food factors contained nitrogen (Drummond[10]).

It is to be deprecated that Funk did not receive enough recognition for his contribution to the knowledge of vitamins which he aptly enlarged in his book *The Vitamines*,[11] the first edition of which appeared in 1913. Hopkins himself states in his Nobel prize lecture:[6] 'I would like to make clear my belief that he [Funk] has not received too much, but too little, credit for his vitamin work as a whole.'

If we transpose ourselves to the second decade of this century, we see that the belief in organic accessory food factors or 'vitamines' did not win general acceptance at first. One has to realize that even experts in this field were not unanimous, some thought in the beginning in terms of missing minerals, or of toxic factors or of intervening infections. The 'theory' of vitamins was still hotly contested in 1920 when Hopkins, as the opening speaker at the meeting of the British Medical Association in Cambridge, had to defend the concept thus:[12]

> The modern conception of a deficiency disease is not of course based wholly upon a belief in the existence of vitamines. There may be quite other factors of deficiency in a diet which may produce symptoms to be observed clinically, but the hypothesis of vitamine deficiency plays a large part in current views concerning the chief examples of the conditions to be discussed.
> The idea of the existence of such substances as those we now call vitamines arose quite inevitably from the fresh facts concerning nutrition which were gathered by means of experiment and observation at about the beginning of the present decade.

There should have been, as I have always maintained, nothing particularly startling about these new facts. It was always an assumption that proteins, fats, carbohydrates, and certain minerals represented the whole nutritional demands of the animal. Directly these constituents of food were fed really pure, it was shown they were not. The only matter for surprise was that certain substances, produced like all others by the plant, should prove so important, though present in so small an amount. In what I am about to say I refuse to speak of the vitamine 'hypothesis'. Vitamines, though still of unknown nature in the chemical sense, are not merely hypothetical. In nearly every case that we are to consider, it is, I admit, still a hypothesis that the particular disease depends upon vitamine deficiency, but in respect to the broad aspects of nutrition as a whole, the importance of these factors is proven.

But I have found that there is at the present moment some scepticism concerning the whole question, particularly perhaps among certain members of the medical profession. The fact that I have met it lately in high quarters accounts for the particular direction I am giving to my opening remarks which may seem unnecessarily defensive.

Some of this scepticism has been stimulated by, or is a protest against, quackery—the quackery which always dogs the footsteps of honest scientific work and sound views concerning human nutrition. It is well indeed that the subject we are to discuss should just now be approached critically; but disbelief in the very great importance of qualitative deficiencies in the diet (quantitatively of small moment) in the production of nutritional errors is to be deprecated.

A typical sceptical view was there and then defended by Sir James Barr, who maintained that: 'I must approach this subject in a sceptical frame of mind. I believe in accessory food factors, substances which are essential to nutrition and even to life itself, though they have no intrinsic food value of their own. The chemical constitution and physiological effects of such substances are well known whereas "vitamines", so far as their composition is concerned, seem to be a figment of imagination'. Sir James was evidently thinking of mineral constituents and known organic substances such as adrenaline, and could not conceive the possibility of the existence of important organic nutrients implied in the concept of 'vitamines' that at that time were chemically not definable.

I have, on purpose, dealt with this early period at some length, since it illustrates the nascent development of a new era of scientific endeavour and what followed was a logical continuation of this revolutionary concept for which not one, but many scientific brains were responsible. We have seen again and again that new ideas have a lag period before they are accepted.

A question which interests one is what makes for a successful acceptance of a new scientific development. A novel idea which is too far advanced above the average level of knowledge will have difficulties to be accepted. If it is supported by sound scientific facts as was the case with Hopkins' 1912 paper, at least as it appeared at that time, together with a clear and persuasive exposé, this will go a long way to gain supporters. What makes some researchers take up certain scientific problems, and whatever they touch turns, figuratively speaking, into gold? One can say that it is intuition, but even more so it is a natural inquisitiveness which sees the illogical, observes the non-sequitur and questions the accepted view. As an example may one cite the very first paper by Hopkins at the age of seventeen in 1878, on the bombardier beetle, *Brachimus crepitans* (see ref. 6, p. 43–44) which ejects a defensive vapour spray on being disturbed. He tried to collect the material. It is only now, ninety-one years later, that it has been found that the beetle has the unique property of ejecting a liquid out of a gland at a temperature of 100°C by mixing hydrogen peroxide, now used as rocket fuel, and hydroquinone.[13] What a potential winner to be picked by a seventeen-year-old! Even more striking is the original interest in butterfly pigments as early as 1889, to which he returned at the end of his life (see ref. 5, p. 312) predicting the biological importance of pterines that turned out to be essential building stones of the folic acid vitamin group.

A further thought occurs to one when reviewing the period at the beginning of this century. It shows the futility of differentiating between pure and applied research. During this period Funk, in searching for the anti-beri-beri factor, isolated nicotinic acid from yeast, but discarded it as being inactive as a protective substance against beri-beri.[11] In the absence of a suitable animal test for pellagra, there was not even an opportunity to experiment, if Funk should have thought of nicotinic acid as a possible vitamin. At the same time in 1906 Willcock and Hopkins had shown that tryptophan was a dietary essential and 'served some purpose in the body other than forming tissue or supplying energy' (see ref. 5, p. 299), thus anticipating with an uncanny instinct the formation of nicotinic acid from tryptophan. These studies at that time might have been classed as pure research projects, by some thought of as of doubtful significance. However, if the significance of tryptophan and nicotinic acid as anti-pellagra agents had been discovered then, thousands of lives might have been saved; in the United States alone, every year 3,000–7,000 deaths from pellagra were reported,[14] which would amount to 200,000 lives over the thirty years before the identity of the vitamin was established. There is no doubt that pure research turned into applied overnight. I mention this matter as a classic example to dissuade anyone from minimizing the importance of pure research, though I know that I am preaching here to the converted.

The interest in vitamin and nutrition research shifted then to the newly-formed Dunn Nutritional Laboratory, about which I shall speak later. At the Biochemistry Department of Professor Hopkins (by then Sir Gowland) in 1928 an interesting development occurred which eventually led, in 1932, to the identification of ascorbic acid as the antiscorbutic vitamin, almost simultaneously by the team of Szent-Györgyi in Hungary and by C. G. King and his colleagues in the United States. Szent-Györgyi worked at this time (in 1928) in Cambridge and isolated a reducing agent which he named 'hexuronic acid'. But let Szent-Györgyi himself tell the story, as recounted in his own autobiographical essay 'Lost in the Twentieth Century'.[15]

> I also became interested in vegetable respiration, being convinced that there is no basic difference between man and the grass he mows. Plants, at that time, were divided into two groups: the 'catechol oxidase' and 'peroxidase' plants. I started with the catechol oxidase plants which contain catechol and a strong catechol oxidase. I simplified the accepted, rather complex ideas about this oxidation system. Then I shifted to 'peroxidase plants' which are called so because they contain peroxidase in high concentration. If peroxide is added to a mixture of peroxidase and benzidine, immediately an intense blue colour appears due to the oxidation of benzidine. I found that if the reaction was performed with the plant juice, instead of purified peroxidase, there was a very short delay, of a second or so, in the benzidine reaction. This fascinated me. There had to be present a reducing agent which reduced the oxidized benzidine, the delay corresponding to the time necessary to oxidize away this unknown reducing agent, later to be known as ascorbic acid.

This biochemical reaction was later studied with great success by Mapson at the Low Temperature Research Station in Cambridge.[16] Szent-Györgyi continues:[15]

I mention this story in such detail because it illustrates the basic trait of my way of working. I make the wildest theories, connecting up the test tube reaction with broadest philosophical ideas, but spend most of my time in the laboratory, playing with living matter, keeping my eyes open, observing and pursuing the smallest detail. The current fashion is to avoid making theories (they may be wrong!) and limit one's observations to reading pointers. I think that an intimate finger-tip friendship with living matter is still important for the biologist. By working in this way, usually something crops up, some small discrepancy, which if followed up, may lead to basic discoveries. The theories serve to satisfy the mind, prepare it for an 'accident', and keep one going. I must admit that most of the new observations I made were based on wrong theories. My theories collapsed, but something was left afterwards.

I also made theories about the adrenal gland which led me to assume that the reducing agent of peroxidase plants should also be present in the adrenal cortex in high concentration. I found it was present (though the underlying theory turned out to be wrong later). . . . I went to attend the International Physiological Congress at Stockholm (1926). The Presidential address was delivered by Sir Frederick Gowland Hopkins, who, to my surprise, mentioned my name three times, more than anyone else's. So, after his lecture I picked up all my courage and addressed him. 'Why don't you come to Cambridge?' he asked. 'I will see to it that you get a Rockefeller fellowship.' And so he did. He was, and still is, a mystery to me. He was the man who had the most influence on my scientific development though I never talked to him about science and heard him speak but once or twice. His papers were not especially fascinating, yet he had a magic influence on the people around him. That little unassuming man, with all his childish vanity, was a humble searcher of truth. What his individuality proclaimed was that in spite of all the hard work involved, research is not a systematic occupation but an intuitive artistic vocation.

In Cambridge I isolated the reducing agent found at Groningen. I crystallized it from oranges, lemons, cabbages, and adrenal glands. I knew it was related to sugars, only did not know which. 'Ignosco' meaning 'don't know' and the ending 'ose' meaning sugar, I called this carbohydrate 'Ignose.' Harden, the editor of the *Biochemical Journal*, did not like jokes and reprimanded me. 'Godnose' was not more successful and so, following Harden's proposition, I called the new substance 'hexuronic acid' since it had 6 C's and was acidic. I got my Ph.D. for it.

In his 1928 publication (ref. 17, p. 1401) Szent-Györgyi already drew attention to the probability of hexuronic acid being identical with vitamin C. It is surprising that four years elapsed before this was subjected to biological test. Could it be that the reason was, in Szent-Györgyi's own words:[15] 'I still had a gram or so of my hexuronic acid. I gave it to him [J. Swirbely] to test for vitaminic activity. I told him that I expected he would find it identical with vitamin C. I always had a strong hunch that this was so but never had tested it. I was not acquainted with animal tests in this field and the whole problem was, for me, too glamorous and vitamins were, to my mind, uninteresting. "Vitamin" means that one has to eat it. What one has to eat is the first concern of the chef, not the scientist.'

Another advance in the concept of vitamin function was the use of the study of the metabolism of bacteria and their nutritional requirements. Majory Stephenson in Hopkins' Department describes, in 1938, this development in the preface to the second edition of her book *Bacterial Metabolism*:[18]

> In the problem of bacterial growth advances have been made along new lines. Happily this subject now attracts mathematicians and statisticians less than formerly but has passed into the hands of biochemists interested in problems of nutrition; this has led to results of both theoretical and practical importance and has revealed *inter alia* that the complex and peculiar media employed by bacteriologists in the cultivation of 'difficult' pathogens are rendered necessary owing to the inability of many parasitic organisms to synthesize for themselves certain molecules essential for growth. Some of these substances are identical or closely related to certain vitamins known in the animal whilst others appear for the first time as substances of biological importance. Such discoveries are double-edged; the fact that co-enzyme I or II must be supplied ready-made to organisms of the *influenza* group whilst other organisms synthesize it for themselves, supplies a means of studying its role in metabolism; nutritional and metabolic studies thus supplement each other. The study of vitamins in the animal has had a long start, but the rapid accumulation of knowledge concerning accessory food factors for bacteria has already disclosed the necessity for substances not yet known to play a part in animal metabolism. It is not unlikely that in the future knowledge gained in this field may help to solve problems in animal nutrition just as hitherto the reverse has been the case.

It is true that this interest originated from the urgings of Sir Paul Fildes at the Lister Institute and was successfully elaborated by D. D. Woods at Oxford in his work on p-aminobenzoic acid, anti-metabolites and folic acids. In Cambridge, Gale[19] with his study on bacterial amino acid decarboxylases and with the purification of the co-factor, codecarboxylase, paved the way to the identification of pyridoxal phosphate the active biochemical form of vitamin B_6 in biological systems.

The impulse of vitamin research created ever widening circles; one cannot omit the contribution of Sir Rudolph Peters, then Professor of Biochemistry at Oxford, who added so much to the understanding of the role of vitamin B_1 (later called thiamine) in biochemical reactions.[20] He tells me that his interest originated in Cambridge when investigating the nutritional requirements of protozoa.

The biosynthesis of ascorbic acid by plants and the rat was investigated in the 1950s by Isherwood and Mapson[21] at the Low Temperature Research Station and their biosynthetic scheme, based on *in vivo* and *in vitro* experiments, has gained universal acceptance. In brief it consists of the transformation sequence of D-glucose via D-glucuronic acid and L-gulonic acid (by inversion of C-1 of gulonic acid becoming C-6 of ascorbic acid) to L-ascorbic acid. The intermediate, L-gulono-γ-lactone, postulated by others to be oxidized to 2-oxo-L-gulono-γ-lactone and then going to L-ascorbic acid might *de facto* not be in a free state, but the oxidation of L-gulonic acid might occur while bound on the oxidizing enzyme. In plants the biosynthetic pathway from D-galactose → D-galacturonic acid → L-galactonic acid appears to be preferred. The absence of the L-gulonic acid oxidizing enzymes in primates, the guinea pig, the bat and some Indian birds are the cause of the dietary requirement for ascorbic acid in these biological groups and they consequently will suffer from a deficiency.

Meanwhile, in 1951, another approach in accessory food factor research was being developed at the Strangeways Research Laboratory under the direction of Dame Honor Fell. In her own words:

> the experiments were undertaken with the object of investigating the direct effects of hypervitaminosis A on the skeleton and on epithelia. My own interest in the action of the vitamin A was first aroused by the

late *Sir Edward Mellanby* whose classical work on vitamin A deficiency in animals is well known. He had the idea that tissue culture might be a valuable technique for investigating the direct action of the vitamin on cells. We discussed the matter and I suggested that the organ culture method that we had developed at the Strangeways Laboratory might be the most suitable technique for the purpose. My reason for saying this was that organ culture, unlike the more familiar cell culture methods, enables one to grow tissues in a *differentiated, functional state* similar to that of their normal prototypes in the body. Also the explants usually respond to biologically active agents such as hormones and vitamins, in essentially the same way as they do in the animal. Obviously, it is a tremendous advantage to be able to study these reactions in a simple readily controlled *in vitro* system, which eliminates all the complex systemic reactions that so confuse the picture in the body. Since I knew nothing about vitamin A, and Sir Edward had no experience of organ culture, we decided to collaborate.

The results were dramatic (see ref. 22). The presence of vitamin A in the culture medium caused mucous metaplasia of embryonic skin which normally would keratinize. Furthermore, embryonic bone rudiments explanted in presence of small amounts of retinol (vitamin A alcohol) showed a rapid dissolution of intercellular material with a loss of metachromasia. Later, it was found that the underlying cause of this phenomenon was the liberation of proteolytic enzymes from intracellular organelles, the lysosomes. Apparently retinol and a number of other substances specifically related to vitamin A were able to modify the membranes of lysosomes so that they became less stable than those from untreated tissues. No doubt this could explain the hypervitaminotic, toxic effect of vitamin A observed *in vivo*. There still remains unresolved what is the physiological mode of action of vitamin A which exerts its influence over and beyond the effect on the visual cycle.

During the Second World War the Nutrition Division of the Lister Institute of Preventive Medicine found a temporary home at Roebuck House, which belonged to Sir Charles Martin, as recounted by Dame Harriette Chick elsewhere.[23] She, Miss Hume and Miss Copping continued there with their interest in vitamins of the B-group, particularly pyridoxine, and also in nicotinic acid which had been studied by Sir Charles Martin previously with great success in pigs.[24]

The important contributions of Lord Todd and his Organic Chemistry Department in the identification of the structure of vitamin B_{12} and the syntheses of vitamin B_1 and nicotinamide-adenine dinucleotides are well known and have received universal acclaim. The work of McCance and the Department of Experimental Medicine will be referred to elsewhere.

The Dunn Nutritional Laboratory, to which reference was made earlier, owes its existence to the interest of Sir F. Gowland Hopkins in nutrition research. The *University Reporter* of 1928/29, p. 733, reproduces a letter from Sir Walter Morley Fletcher, the then Secretary of the Medical Research Council, to the Vice-Chancellor, in which a permanent building is proposed for the Laboratory:

> For more than twelve years [prior to 1929] the Medical Research Council have been making occasional use of temporary accommodation at the University Field Laboratories, Milton Road, for experimental studies of nutrition, made with a view to getting better knowledge of the fundamental principles that should guide human dietetics. Recently the Council have been able to promote some more systematic work here and it is their desire that this should be aimed primarily at relating the phenomena of nutrition to known principles of physiology and biochemistry. This aim will include of course that of elucidating the problems of nutrition considered as a factor in resistance to disease.

In 1928 the first Director had been appointed in Dr. L. J. Harris, and later his Deputy Director was to be Thomas Moore. The offer of the Medical Research Council to equip and maintain a laboratory for the purposes of research work concerned with the scientific bases of medicine, and in the first instance with the physiology of human nutrition, was gratefully accepted by the University (*Cambridge University Reporter*, 5 March 1929). The cost of the building was defrayed by a gift from the trustees of the late Sir William Dunn. The laboratory was completed in 1930.[25]

The Laboratory soon became the centre of active nutritional research and housed many distinguished scientists for shorter or longer periods. To name only a few, Nicolaysen studying calcium absorption, and Paul György of pyridoxine and biotin fame worked there, and so did A. J. P. Martin whose interest then in liquid partition chromatography of vitamin E might have conditioned him for the development of paper chromatography, for which he and Synge were awarded the Nobel prize. Harris and his collaborators became internationally known for developing methods for the estimation of vitamins, such as the rat-bradycardia method for vitamin B_1, colorimetric methods for vitamin C and several techniques for the estimation of the vitamins of the B-group. Concepts of the mode of action of vitamins C and D were also actively investigated. Moore, soon after joining the Laboratory, in 1929 was able to show the conversion of β-carotene to vitamin A *in vivo;*[26] a lifelong interest then was developed by him in the function and metabolism of vitamins A and E.[27]

At the present time, the main projects are those concerned with the mode of action of accessory food factors using modern biochemical and biophysical methods. Research being carried out includes studies on the effect of ascorbic acid on collagen, elastin and mucopolysaccharide biosynthesis in intact animals and in tissue and cell cultures. The discovery of niacytin, the bound unavailable form of nicotinic acid in cereals, its chemistry and metabolism gave interesting information on the pathogenesis of pellagra.

Electron microscopic studies of membrane structure and properties are being carried out and the role of bactoprenol, recently discovered in the Laboratory, in bacterial membrane and the role of prenols in general in animal cells are being investigated.

The metabolism of vitamin D which had been radioactively labelled is one of the main interests at the present time. Last, but not least, the nutrition of the newborn and the effect of protein and calorie malnutrition is being studied with reference to the growth and development of man and animals.

When one looks back to the early days of vitamin research, one sees with hindsight what an advance this concept was and what an acceptable term the word 'vitamin'. There were and are, however, drawbacks associated with the term. It implies that the vitamin group is a chemical entity just as carbohydrates, proteins or lipids are, and that vitamins form a group with a similar biochemical mode of action. This misconception led the student and scientist alike to associate 'vitamins' more with food than with metabolism.

One can thus understand the humorous remark of Szent-Györgyi, mentioned above, that vitamins are what one eats and what one eats does not concern the scientist. Hopkins used the less definite term 'accessory food factors' and with the prefix 'organic' (for short, OAFFs) it describes well these nutritional substances. As knowledge of the functions of vitamins at the tissue and molecular level accumulates, their nomenclature becomes more definitive.

Compared to the concept of sixty years ago, new information indicates that one can now discern at least two groups of accessory food factors which differ from each other by their biochemical function. The first supplies active groups for enzymes (prosthetic groups) and I wish to call them 'prosthetic group factors' or 'pro-coenzymes'. They include thiamine, riboflavine, folic acid, biotin, pantothenic acid and vitamin B_{12}.

It is at present difficult to integrate ascorbic acid into this concept. It is, however, unnecessary to force oneself into a rigid classification and assume that since ascorbic acid is classed as a 'vitamin', a term which has a historic origin, it has to have necessarily a similar mode of action to other known 'vitamins'. Indeed, it became an accessory food factor for a few species (man, some primates, the guinea pig, the Indian fruit eating bat, *Pteropus medius* and some birds of Indian origin, such as the red-crested Bulbul) because of a genetic fall-out of a specific liver enzyme, L-gulono-γ-lactone oxidase, which otherwise is present in the other species which do not require preformed ascorbic acid. The need for an external supply of ascorbic acid is thus due to an inborn error of metabolism. In this respect it is similar to the category of accessory food factors providing coenzymes, in that they are needed because of a loss of synthetic activity leading to their formation in the affected species.

The other major group are the fat-soluble accessory food factors, such as vitamins A, D, E and K. They appear to affect the configuration and integrity of biological structures such as membranes or macromolecules. They do not supply active sites but exert a so-called 'allosteric' effect by altering the conformation of complex molecules. This 'allosteric' group shows many differences from the group providing 'prosthetic' or active groupings in enzymes. This allosteric effect suggests the name 'allosterins' or 'contact catalysts' for these accessory food factors.

Thus, for instance for vitamin D,[28,29] it can be shown that the molecule undergoes *in vivo* modifications through a number of hydroxylation reactions so as to resemble a steroid hormone-like substance which eventually ends up in the nuclear apparatus of certain cells to exert there its effect in the transcription of the genetic code (*Figure 3*). Vitamin K appears to work at a later stage, namely in the ribosomal particles by controlling the translation of the message during the formation of a specific protein, namely prothrombin.[30]

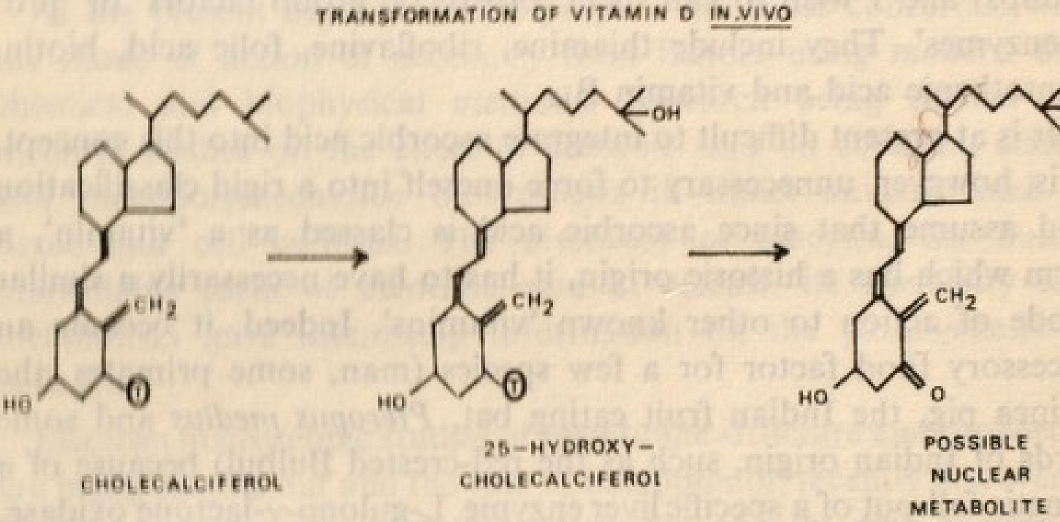

Figure 3

If one compares the properties of these two categories (Table 1), significant differences are observed. Thus it can be shown that only the 'pro-coenzymes' will acquire a true tissue saturation, limited to the saturation of sites on the apoenzymes for their characteristic prosthetic groups. Any excess will cause an overflow in the urine of the vitamin or its metabolites. This might explain also the absence of a toxic effect of vitamins of this category. The 'allosteric group', such as vitamin A, will not be dealt with in the same manner, but will accumulate as an ester excessively in certain tissues (such as liver) to form so-called 'reserves' or storage depots; there is, however,

TABLE I

Comparison of characteristics of 'Pro-Coenzymes' and 'Allosterins'

	Pro-coenzymes	*Allosterins*
Solubility	Hydrophilic	Lipophilic
Storage	0	+
Toxicity	0	++
Molecular specificity	++	+
Surface activity	0	+
Antagonists: isosteric	+	0(?)
dimeric	0	+
Urinary excretion	+	0[a]
Metabolised	++	+
Requirements	$> 10^{-5}$M	$< 10^{-6}$M
Phylogenetic development for their need	Block in their biosynthesis	Needed by highly differentiated, over-specialised tissues

[a] Vitamin A not excreted in man, except in disease.

a limit to such protective reactions and toxic effect may result from an overdose.

The 'pro-coenzymes' show practically no surface activity but a high degree of molecular specificity. In view of this, effective antimetabolites can be prepared or are found naturally which simulate the structure of the accessory food factor by an isosteric change in the molecule. This is not so in the 'allosteric' group where direct antagonists are seldom found, and if so they are of the dimeric form, such as dicoumarol, an antagonist to vitamin K. The 'pro-coenzymes' will, at some point of their life cycle in the organism, become substrates of intermediary reactions leading to their incorporation in the prosthetic groupings. The pathways and metabolism of the 'allosteric' category are not yet definitely elucidated, but it appears these accessory food factors undergo a different transformation, affecting their own structure, such as the introduction of oxygen functions to increase their polar groupings. All these differences are mirrored in the different levels of their biological requirements that are evidently much higher in the 'pro-coenzyme' category. This is due to the greater number of receptor sites, the amount of wastage and active turnover which these factors have to undergo.

Finally, it appears that the phylogenetic origin of the need for the 'pro-coenzyme' factors is due to a fall-out of a step or steps in their biosynthesis which could classify them as 'inborn errors of metabolism'. On the other hand, the need for the 'allosteric factors' might have arisen from the exacting requirements of some tissues which became highly specialized. Examples for this are vision and the need for retinal (vitamin A aldehyde), special requirements of mineral metabolism and the involvement of vitamin D metabolites, or blood clotting and vitamin K factors. No doubt other functions of the allosteric group will be elucidated in the future.

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Address given by Dame Harriette Chick, D.B.E. on the Occasion of the Opening of the New Wing of the Dunn Nutritional Laboratory, Cambridge, on 17 June 1968

It is indeed a great honour to be invited to take part in the opening of the splendid new wing of the Dunn Nutritional Laboratory. I think, perhaps, I have been invited since, like the Psalmist, 'I have been young and now am old', so that I have been able to watch the development of the 'Newer Knowledge of Nutrition' almost from its beginning and to take a modest part myself in its pursuit.

I have been asked to say something of the contribution made by Sir Charles Martin to the study of nutrition and of his connection with this laboratory—I may therefore be permitted to indulge in reminiscence.

It all began about sixty years ago and was connected with the discovery that the beri-beri endemic among rice eating populations in the second half of the nineteenth century was a nutritional disease. Leonard Braddon, a medical officer in the then Federated Malay States, was much concerned with the prevalence of beri-beri among working coolies and among inmates of prisons and asylums, for whom highly milled and polished rice was the staple food. He had just become acquainted with the work of that great investigator, Christian Eijkman in Java, who had shown that rice eating was at the root of the disease. Eijkman's work, published in a remote Dutch journal, had not become generally known or received the recognition it deserved.

Dr. Braddon was an old friend and school fellow of Charles Martin and begged him to take up the subject at the Lister Institute in order to confirm Eijkman's experimental work and to attempt isolation of the protective nutrient factor. The time was ripe for such research. There had been several pointers in experimental work to show that the accepted dietary essentials: protein, fat, carbohydrate and minerals were not sufficient, and the expressed conviction of Gowland Hopkins that there existed other 'unsuspected dietary factors' had also made its effect.

Perhaps Charles Martin's great contribution to the science of nutrition was his acceptance, at this stage, that nutrition was a proper subject for study in an Institute of Preventive Medicine.

Braddon's challenge was accepted and work was begun on the nutritional deficiency of milled and polished rice. Sacks of rice bran and rice polishings arrived at the Institute from Malaya and before long these materials and a large series of other foods had been investigated for their preventive or curative value for hens and pigeons which had developed paralysis on a diet of polished white rice alone. The tests were roughly quantitative so that the foods tested could be graded in respect of their relative potency. At the same time Casimir Funk was busy at the Institute in attempts to isolate the active vitamin (a word which he coined) from rice polishings or yeast. He did not succeed but obtained some very potent concentrates.

Then came the First World War and the staff of the Institute was scattered to take up all kinds of military service at home and overseas. Only a small remnant was left at the Institute to carry on as best it could. Charles Martin took service with the Australian army and became a pathologist Lieutenant Colonel with the 3rd Australian General Hospital, situated on the Greek island of Lemnos to serve the Gallipoli campaign. There he was confronted with a strange disease which had baffled all the Australian physicians. Martin at once diagnosed it as beri-beri and his diagnosis was confirmed when he discovered that the diet of the patients had consisted of white wheaten bread and biscuit, jam and sterilised tinned meat. Then followed an urgent request to Chelsea to find some rich sources of the required vitamin, which could be easily transported as soon as possible. I remember wandering round Harrods' grocery department to find suitable materials. Finally 'Cook's Farm Eggs', a dried egg product, and a preparation of yeast extract were selected and after successful tests were despatched for the sick men on Lemnos. The story did not, however, end there, for beri-beri was reported from other units serving in the Middle East. After a good deal of effort and much persuasion the authorities arranged for a small 'soup cube' or 'savoury sweet' to be included in the daily ration of all service men in those areas.

Thus began the Nutrition Division of the Lister Institute, which led an active life for over thirty years. Martin included the Division in his own Department of Experimental Pathology and was a devoted director of the work, taking an active part in a long series of researches.

Charles Martin's connection with the Dunn Nutritional Laboratory came later, when he was living in nominal retirement here in Cambridge from 1934 onwards. He was one of a small committee of three placed in charge of the Laboratory. It included Sir Edward Mellanby and Sir Gowland Hopkins, but Martin was by far the most active member of the triumvirate. One can only guess how much was owed by the Laboratory and its Director to his sympathetic counsel and wide knowledge of their subject.

I can well imagine how delighted Martin would have been with the fine and elaborate equipment in this new wing. He was very fond of apparatus, though most of it was very humble in comparison with what I see here and was often the work of his own hands. I myself am certainly a bit overwhelmed especially when I remember that the last years of my laboratory life were spent in an improvised conservatory and a converted old garage, affectionately known as the 'mediaeval lab'. We managed, I think, to do some useful work and anyway it was great fun. I hope the men and women who will work in these fine new laboratories will get as much fun as we did and prove themselves worthy of all this magnificence.

Address given by Sir Rudolph Peters, M.C., M.D., F.R.S., on the Occasion of the Opening of the New Wing of the Dunn Nutritional Laboratory, Cambridge on 17 June, 1968

I am glad to have the opportunity, I would say the great privilege of this opportunity, of speaking on behalf of the Medical Research Council, at the opening of this valuable extension to the Dunn Nutritional Laboratory—an extension which will enable the laboratory to embark upon the modern phase of nutritional investigation.

In order to make this clear, and to put it into perspective, I would remind you very briefly of some earlier history, of the attempts to reach a scientific knowledge of nutrition. The initial approximation in the last century by Rubner and others dealt almost exclusively with food as a fuel—the so-called isocaloric values of sugars and fats. To us, this purely quantitative approach now seems crude. This period of nutritional research was over—in theory at any rate—when Sir Frederick Gowland Hopkins enunciated the importance of qualitative factors in 1906; his statements were based upon feeding experiments with Miss Willcock, and upon the importance of tryptophan, which he first isolated with Sidney Cole. Following this, for about forty years, I would say, research was directed to unravelling the number of various factors and of isolating these—factors required in minute amounts to complete a diet, and so to protect against a variety of pathological states. This was the age of the vitamins, or as some preferred to call them the Accessory Food Factors. Direct benefits followed in the virtual elimination of rickets and pellagra, and the immediate and intelligent treatment of beri-beri. It is extraordinary now to recall how long it took to convince the medical profession as a whole, that disease could be induced by the absence of something, rather than by a positive attack. I remember how much this worried Hopkins at a meeting in Cambridge in about 1920.

During this time, I can well remember the thrill of learning of the isolation of a new vitamin—and also of watching the progress of nutritional research as a member of the Accessory Food Factors Committee of the Lister Institute and Medical Research Council. The success of this, as we well know, was largely due to its indefatigable secretary, Dame Harriette Chick. You see—though other important research was in progress—as, for instance, on calcium, it was the minuteness of the doses of a vitamin needed to ward off a disease like beri-beri which captured the imagination. The magic was such that one professor told me that, when his students were flagging, it was enough to insert a lecture on the vitamins to rekindle enthusiasm. Many of these factors were gradually fitted into biochemical pathways as members of coenzymes, and so related to more physiological studies.

During all this time—for nutritional research is necessarily slow—much effort had to be spent in learning how to test for nutritional factors, and this laboratory played a considerable part in this, under the able direction of Dr. L. J. Harris, who I am glad to see here today—and also his assistant, Dr. Moore. This involved much research in analytical work, as well as advances in animal technique, mostly on rats, as well as microbiological studies. In your papers you will find the details of the initiation of this laboratory—the Dunn Nutritional Laboratory. It came into being in 1929 through the combined efforts of Sir Frederick Gowland Hopkins and Sir Walter Morley Fletcher, as an enterprise of the University and the Medical Research Council. The finance for the building came from the Dunn Trustees, who had also financed the School of Biochemistry. I would like to say that many of us outside the laboratory will like to thank Dr. Harris for help which he gave us so generously on many occasions.

Now that this phase of isolation of vitamins and the like is mainly over, though we had a surprise recently with selenium, why has the Medical Research Council considered it necessary to set up this large extension to the original laboratory? It is a thoroughly legitimate question; but one that arises from a somewhat restricted point of view, because we do not know nearly enough about the interaction of nutritional factors, and of their detailed biochemistry. One often hears this kind of statement: 'Most folk in Cambridge live on a good mixed diet; hence there is no need to worry about inadequacy.' Like so many commonsense notions, this one fails in its individual application—fails because some individuals may be slightly hyperthyroid; others may have kidneys which leak out nutritional factors. There is the matter of vitamin D resistant rickets, and much more. What I am really emphasizing is that we have to go down to molecular levels in individuals, to try to understand, for instance, what vitamin D is doing in the biochemical milieu of the tissues, and what is the interaction of factors in nutrition. This is how modern chemical and biochemical techniques become necessary in modern nutritional studies. We must follow the fate of vitamin D, labelled with radioactive elements—difficult to synthesize, difficult to count. For all this—and much more—extra space and modern equipment had become necessary. I feel that anyone who looks into this new extension will wish to congratulate, as I do, the new Director, Dr. Kodicek, for his part in its efficient planning, and the Medical Research Council for their part in making the extension possible.

Cambridge Medicine and the Medical School in the Twentieth Century

by

LESLIE COLE

THE TWENTIETH CENTURY has seen greater advances in medicine than any other time in history and this makes it necessary to define the objects of this short paper. No detailed account of the progress of Cambridge medicine is possible and I have tried to give an impression of this time by describing some of the Cambridge characters who have left their mark, some events which recall the atmosphere of the period and some developments which have furthered the liaison between the University Medical School and Addenbrooke's Hospital and have contributed to the establishment of a school of clinical research and postgraduate teaching. I have chosen this approach because during this century it has become increasingly clear that for the well-being of the patient, scientific and vocational medicine must march in step.

THE PRECLINICAL SCHOOL AND ADDENBROOKE'S HOSPITAL AT THE END OF THE NINETEENTH CENTURY

The Preclinical School was largely created by three outstanding personalities in the second half of the nineteenth century: Sir George Paget (1809–1892. Regius Professor of Physic 1872–92), Sir George Humphry (1820–1896. Prof. Anatomy 1866–83. Prof. Surgery 1883–1896), Sir Michael Foster (1856–1907. Professor of Physiology 1883–1903).

Following the report of the Royal Commission on Oxford and Cambridge appointed 1877 Foster was mainly responsible for the phenomenal development and flowering of talent in the Department of Physiology and there was corresponding growth in other subjects ancillary to medicine. Numerous professorships and lectureships were established and the growth of the Preclinical School was prodigious, both in size, facilities and quality (Rolleston, 1932). This growth is indicated by the numbers taking the Natural Sciences Tripos since 1851. For brevity, only the figures for each decade from 1851–1951 are given:

Natural Sciences Tripos
Figures for each decade 1851–1951*. ( )=First Class
(includes non-medicals)

1851	Pt I	6	(4)
1861	Pt I	9	(1)
1871	Pt I	14	(4)
1881	Pt I	24	(10)
1881	Pt II	8	(5)
1891	Pt I	105	(14)
1891	Pt II	27	(11)
1901	Pt I	110	(35)
1901	Pt II	28	(10)
1911	Pt I	210	(56)
1911	Pt II	45	(13)
1921	Pt I	260	(58)
1921	Pt II	86	(39)
1931	Pt I	235	(44)
1931	Pt II	65	(36)
1941	Pt I	254	(41)
1941	Pt II	85	(15)
1951	Pt I	423	(58)
1951	Pt II	200	(54)

*Historical Register. University of Cambridge.

By 1900 the Natural Sciences Tripos as taken by medical students had acquired roughly the pattern which was to persist with minor modifications for over sixty years. The great difference between then and now was that the tripos was not obligatory for medical students taking the M.B., and only seventy-seven per cent took it (Rolleston, 1932). The remainder had more leisure to attend lectures on pathology, medicine and surgery, to attend clinical practice at Addenbrooke's and to profit from the wider social and academic life of Cambridge.

To sum up, at the turn of the century the stage was set for the expansion of basic research and pre-clinical teaching, and achievements in these fields are numbered among the university's great contributions to medicine and have been jealously guarded since.

ADDENBROOKE'S HOSPITAL IN 1900 AND ITS EXPANSION DURING THE TWENTIETH CENTURY

In 1900 Addenbrooke's Hospital was a small county hospital of 170 beds supported by voluntary contributions. The visiting staff numbered nine, of whom five held university appointments: two professors (Regius and Downing), one reader (surgery), two lecturers (medicine and surgery). Some members of the faculty although not on the staff of the hospital also lectured to students. By 1914 the beds had increased to about 190 and the visiting staff to twenty: four professors (two as above and two in pathology and surgery). 'Specialists' in ophthalmology, ear, nose and throat surgery, anaesthetics and radiology had been appointed. By 1947 the beds had increased to 356 and the staff to forty of whom four held university chairs (Regius, experimental medicine, pathology and radiotherapy), and three were university readers (medicine, bacteriology and morbid histology). By 1947 there were also twelve general practitioner clinical assistants (*Addenbrooke's Hospital Annual Report*, 1900, 1914, 1947). Until the advent of the National Health Service in 1948 only the university representatives received a salary and the remainder lived mainly on private consulting work. After the Appointed Day the numbers of beds and staff expanded more quickly and by 1967 the beds had increased to over 800 and the staff to over 80 (*Addenbrooke's Hospital Annual Report*, 1967).

As an indication of growth, views expressed on the clinical material available for teaching at Addenbrooke's Hospital are of some interest. Both Sir Humphry Rolleston (1932) and Sir Walter Langdon-Brown (1942) considered that this was insufficient for a complete clinical school. Sir Lionel Whitby also said (1946): 'The population served by Addenbrooke's is scattered and relatively small so that sufficient material for teaching is not available. Nor can any provincial hospital compete in quality with the acknowledged superiority of the London Teaching Hospital'. The report of the Faculty Board of Medicine on the creation of a complete clinical school in Cambridge stated (1965): 'The urban population in and around Cambridge is large enough to support a clinical medical school, and the population provides close at hand the variety of clinical material which is no longer easily available in larger urban areas. Addenbrooke's Hospital serves a community of

350,000 and provides regular service for certain specialities for a population of over one million.'

ARRANGEMENTS MADE BETWEEN THE UNIVERSITY AND ADDENBROOKE'S HOSPITAL TO GOVERN CLINICAL APPOINTMENTS, TEACHING AND EXAMINATIONS FROM THE YEAR 1900

In 1899 a special committee was appointed by the Governors of Addenbrooke's Hospital for the purpose of considering the administration and financial position of the hospital in relation to the university. Stress was laid on the fact that although the hospital was used for clinical teaching and university examinations there were no formal arrangements between them. There had been difficulties in 1892, when the Honorary Staff had denied the use of beds to Sir Clifford Allbutt when he was first appointed Regius Professor and this had led to ill feeling. The Committee represented that it would be an advantage if an arrangement could be made by which the Governors should offer further facilities for university teaching and the university should substantially increase its annual contribution to the hospital.

In January 1900 (*Reporter*, 1899–1900, p. 545) a scheme on these lines was approved by the university and the hospital by large majorities. It was agreed that the Regius Professor and the Professor of Surgery should at their request be allotted a proportionate share of beds and facilities for teaching and holding examinations at the hospital: an advisory council to the hospital should consist of fifteen Governors, five from the borough, five from the county and five from the university, who should all be elected by the Governors in General Court and five should retire annually. To elect a member of the staff a quorum of nine was required.

This small link with the university in teaching and administration was perhaps the most enduring legacy left by George Paget and George Humphry from the nineteenth century but Humphry's hope that Addenbrooke's might become a clinical school for undergraduates persisted.

THE SYLLABUS FOR CLINICAL TEACHING AT ADDENBROOKE'S HOSPITAL AT THE TURN OF THE CENTURY

During the last quarter of the nineteenth century, largely as a result of Sir George Humphry's drive and enthusiasm, there had been a considerable build-up of clinical staff in the university and clinical teaching of undergraduates at Addenbrooke's Hospital. At that time this required little in the way of special facilities and was relatively unorganized. With the death of Humphry in 1896 the impetus to develop clinical teaching flagged but in 1899–1900 the curriculum was still considerable. The *Reporter* (1899–1900) gives the following weekly syllabus for undergraduates throughout the academic year:

Lectures or clinical demonstrations per week every term
(*Abridged from Reporter*)

Sir Clifford Allbutt (R.P.P.):	Medicine	2
Dr. Donald MacAlister:	Diagnosis	3
The Addenbrooke's Physicians: Daily	Wards or O.Ps	5
Professor of Surgery or Assistant:	Surgery	3
Lecturer in Surgery:	Practical Surgery	3
Lecturer Obstetrics and Gynaecology:		2
The Addenbrooke's Surgeons: Daily	Wards or O.Ps.	5
Medical Jurisprudence: (for one term) 3		
		23

Regular lectures and practicals in pathology, bacteriology and pharmacology, elementary and advanced, were also held throughout the year (*Reporter*, 1899–1900, pp. 28–30). These were continued until 1914.

It is difficult to know how many students attended the above programme at the beginning of the twentieth century and how far there was ever a planned clinical course at Addenbrooke's, which is rather unlikely. It appears that clinical work was casual and much of the syllabus repeated later at a London Hospital. After 1900, when both Humphry and Paget were dead, with the rise of the pre-clinical school and the increase in importance of the tripos, clinical teaching was gradually pushed more and more into the background and had decreased considerably by the outbreak of war in 1914 (*Addenbrooke's Hospital Annual Report*, 1900, p. 9).

THE RUN-DOWN OF UNIVERSITY CLINICAL APPOINTMENTS AND SPECIAL DIPLOMAS IN THE TWENTIETH CENTURY

In the first quarter of the twentieth century, one by one clinical teaching appointments and special diplomas were discontinued, an indication that clinical teaching was out of favour. Between 1900 and 1936 the following university clinical appointments were discontinued or allowed to lapse (Rolleston, 1932):

Downing Professor of Medicine. Discontinued in 1930 on death of Professor Bradbury, aged 90.

Professor of Surgery (1883–1915). (Suppressed) on death of Professor Howard Marsh, Master of Downing, aged 76.

University Lectureships:

Medicine: 1883–1911 (Suppressed) on retirement of Dr. Donald MacAlister.

Surgery: 1883–1912 (Suppressed) on retirement of Mr. G. E. Wherry.

Midwifery and Obstetrics: 1883–1909 (Suppressed) on retirement of Mr. R. N. Ingle.

Medical Jurisprudence: 1883–1916 vacated by Dr. Bushell Annington.

Readership in Surgery: 1898–1903 (Suppressed) Vacated by Joseph Griffiths, Surgeon to Addenbrooke's.

Demonstrator of Surgery: 1901–1926 (Suppressed) on retirement of Mr. H. B. Roderick who then became Faculty Lecturer in Surgery until his death in 1945.

Special diplomas were established and discontinued as follows:—

Diploma of Public Health	1875–1932
Diploma of Tropical Medicine and Hygiene	1904–1932
Diploma of Psychological Medicine	1912–1927
Diploma of Med. Radiology and Electrology	1919–1936

This brief introduction indicates the situation in the Hospital and the Preclinical School and the general trend of events at the beginning of the twentieth century.

SIR GERMAN SIMS WOODHEAD (1855–1921)

Sims Woodhead came of Quaker stock and began his medical education at Edinburgh Royal Infirmary. After a varied and distinguished career he was elected Professor of Pathology at Cambridge in 1899 and he reorganized the University Department of Pathology in 1904. Although mainly a morbid anatomist and bacteriologist he had an impressive record in many fields including investigations for the Royal Commission on tuberculosis appointed in 1890. At Cambridge he carried out studies on pyrexia in tuberculous patients in Addenbrooke's Hospital (with Varrier-Jones 1916) and co-operated with Varrier-Jones at Bourn and Papworth Village Settlements and showed his flair for applying his knowledge of clinical pathology (Sims Woodhead and Varrier-Jones 1917). He was one of the early possessors of an electrocardiograph in his laboratory which was wired to patients in the wards at Addenbrooke's. He had a distinguished career in the Territorial Army and was an authority on the sterilization of water by chlorination.

In him the man outshone the scientist and he was beloved in his department, especially by his juniors. He gave them full rein to follow their bent, but quiet guidance too, and their achievements were his reward. Sims Woodhead and Clifford Allbutt had many common interests from the morbid anatomy of angina pectoris to the many problems related to Papworth Colony and at his death Sir Clifford paid him a great tribute (1922). Sims Woodhead was interested in the John Bonnett Laboratory opened at Addenbrooke's Hospital in 1914, he became one of the first Trustees of the fund for the Strangeways Research Hospital and the Department of Pathology at Papworth was named after him.

I have selected two of his colleagues, Varrier-Jones and Strangeways, for special comment because of their influence on medicine and the medical school.

THE OPENING OF THE JOHN BONNETT LABORATORY AT ADDENBROOKE'S IN 1914

Before 1914 there had been no satisfactory pathological laboratory at Addenbrooke's. Dr. Walter Malden, a general practitioner and keen pathologist encouraged one of his patients, Mrs. Bonnett, to present and endow the John Bonnett Laboratory in memory of her son who had been legal adviser to the governors for many years and this she was very willing to do (Malden, 1969).

The opening ceremony was performed on 14 February 1914 by Sir Clifford Allbutt. In his speech he dwelt on the great importance of reciprocal work between the clinician and the pathologist and the exceedingly unfortunate divorce when the pathological department sprang up academically. The pathologists had no locus standi, in fact, not even a tolerant bedside reception.

He remembered when Professor Kanthack and he himself had started a clinical laboratory at Addenbrooke's Hospital (1898). This was in the old days of old Board management of hospitals and Old Board was gone 'de mortuis . . .'. That must restrain him from expressing his opinion on it. Dr. Kanthack and he were allowed a good room over the porch at Addenbrooke's which they fitted up as a pathological laboratory and were doing exceedingly good work. They went away for the Long Vacation and when they came back they found the Board were wholly out of sympathy with them and looked on it as an intrusion of University rights on practical medicine. They had installed the Matron in the room and had thrown £50 worth of apparatus into the street. Such were the relations between pathology and clinical medicine until a few years ago! It was a great satisfaction to see that in such a comparatively short time things had entirely changed (Allbutt, 1914).

SIR PENDRILL CHARLES VARRIER-JONES, FOUNDER OF PAPWORTH. 1883–1943

Varrier-Jones came from St. Bartholomew's and worked under Sims Woodhead. He was born in 1883, the son of Charles Morgan Jones, a general practitioner, in a mining district of Glamorgan, and Margaret Jenkins whose family were in big business in the coal industry (Munk's *Roll*, 1968). From childhood he lived face to face with the problems he spent his life trying to solve. He was a Celt with drive and imagination and had the knowledge and capacity for dealing with industrial problems.

A foundation scholar of St. John's College, he worked later on tuberculosis under Sims Woodhead in the Department of Pathology and became temporary tuberculosis officer to Cambridgeshire County Dispensary. Sir Clifford Allbutt and later, Sir Humphry Rolleston always showed great interest in his plans. He had a remarkable understanding of people, social conditions and economics, backed up by common sense and the gift of vivid expression. He realized the futility of advising a tuberculous workman to 'find a light job in the open air and eat plenty of good nourishing food!'

Papworth was at first supported by voluntary contributions plus funds from national insurance, rates, pensions and approved societies, and only later helped by its industries. It was finally taken over by the National Health Service in 1948. Varrier-Jones had the one other essential quality for his work—the ability to raise money.

Lord Horder (1943) pointed out that although Herman Biggs

(1910) originated the conception of an industrial colony where proper occupations could be provided under proper conditions, Varrier-Jones was the pioneer who brought into actual being what Biggs only visualized. He showed in the wards, houses and workshops of Papworth how many of the problems of treatment and rehabilitation could be overcome and especially how patients could live with their families in the colony without danger of infection while doing increasingly productive work. Tuberculosis in children was almost unknown in the settlement (Varrier-Jones, 1916).

Apart from Varrier-Jones' great contribution to the social problems of tuberculosis, the hospital and settlement at Papworth conferred great material benefit on the United Cambridge Hospitals and the Postgraduate School at a time when this was specially needed. When antibiotics reduced the incidence of active disease in the 'fifties and the time needed for training schemes was halved, a large pool of beds was released for non-tuberculous cases of many kinds: respiratory, cardiac, nervous, traumatic, and the training schemes and welfare workshops were used for these (Westley, 1969). The Regional Board opened the Cardiac-Thoracic Unit with the Nelson-Langermann Wing at Papworth in 1957 and since then in co-operation with Addenbrooke's it has become an important centre for teaching and research. A liaison has also grown up with the University Veterinary School.

Varrier-Jones died at sixty in the full flush of work at Papworth, and full of new ideas. It was a happy thought to name the Pathology Department after Sims Woodhead as a memorial to his long and enthusiastic support.

DR. T. S. STRANGEWAYS PIGG (LATER T. S. P. STRANGEWAYS)

Strangeways qualified at St. Bartholomew's in 1897 and went to Cambridge with Kanthack when he was appointed Professor of Pathology. He later became Huddersfield Lecturer in Pathology under Sims Woodhead, and was well known to M.B. candidates for many years.

Much handicapped by deafness he was a quiet friendly person and a very hard worker. It was his conviction that 'Systematic investigation of diseases, the pathology and treatment of which are undetermined' in a small hospital under close medical supervision would yield results.

In 1905 with the devoted help of his wife* he determined to go ahead with his scheme although he had little money and a large family. A six-bedded hospital was opened in a private house in Cambridge, and rheumatoid arthritis and allied diseases were chosen for special study. The coal-shed was converted into a laboratory. He had great financial difficulties but managed to carry on because he was always willing to give more than he asked of others. He had a persuasive personality and made influential friends all over the country whom he visited on his motor-cycle, for he was economical and resourceful. The list of his supporters is a remarkable tribute to his character. By 1918 he had realized that the ordinary methods at his disposal had not proved fruitful (Strangeways, 1918) and he took the bold step of moving back from the patient to learn more about the behaviour of living cells by tissue culture. He may have remembered Allbutt's dictum: 'Disease was living wrong but living' (1914). During the last few years of his life he began to obtain results which showed greater promise, for he carried out some of the early observations on the behaviour of living cells in culture (1923) and became a leading exponent of the delicate technique needed to illustrate in vitro the development of the limb bud and of the eye. He became associated with R. G. Canti and in 1923 when the wards of the Research Hospital were closed he was joined by Dr. Honor Fell. From this point the Strangeways Laboratory received increasing outside support and never looked back. He died in 1926 but his project was launched, although perhaps not quite in the way he originally intended.

THE FIRST EASTERN GENERAL HOSPITAL 1914–1918

At the outbreak of war on 4 August both the hospital staff and the general practitioners of the area were heavily committed. Joseph Griffiths, who had been assistant to Sir George Humphry, had been appointed Commanding Officer of the First Eastern General Hospital in 1908 and organized regular training up to the outbreak of war. The hospital was mobilized on 5 August, 1914, and went into quarters in the new Museums in the old Physiology building

* Dorothy Beck, daughter of the late Anthony Beck, Master of Trinity Hall.

(later the Anatomy School). Beds were organized in the Leys School and the first operation performed there on 20 August. At the end of August, beds were organized in Neville's Court, Trinity, with an operating theatre in the eastern side of the cloisters, and the first batch of wounded from France arrived on 31 August. Cooking was done for all patients in the Judge's kitchen at the Master's Lodge and sleeping and mess tents were put up on the lawn between the Library and the river and hospital marquees on the lawns of 'The Paddock' west of the river. The college co-operated very fully in helping the hospital and the Master (Henry Montague Butler) and others took wounded out for drives in their carriages. Meanwhile, a hutted hospital was being erected on the King's and Clare cricket field to the south of Burrell's Walk and this was ready and occupied by the end of January 1915.

This was the first territorial hospital. It increased to 850 beds and soon became the leading military hospital in the Eastern Region. Its medical officers almost all came from Addenbrooke's and the Cambridge area, with a few from Norwich, and many were drafted overseas, including Dr. H. B. Roderick who commanded the twenty-fifth General Hospital at Wimereux and later became Orthopaedic Surgeon to Addenbrooke's, and Charles Budd who commanded the twentieth General Hospital in the 1939–45 war. The hospital was served by convalescent hospitals in country houses all over East Anglia staffed by Red Cross detachments of Sisters and V.A.D.s raised locally, so that the contribution of the Red Cross Society was extensive. Both King George V and Lord Kitchener visited the hospital (Budd, 1945).

Apart from its contribution to the war effort the first Eastern demonstrated the potential for combined medical effort in the area and provided experience of war medicine and surgery on a large scale.

CLINICAL MEDICINE IN CAMBRIDGE AFTER THE WAR

To appreciate medical problems in any area it is essential to picture conditions at the time. I was elected Assistant Physician to Addenbrooke's in 1928 having come straight from senior appointments at St. Thomas's and was thus in a position to compare the standards of medicine and surgery in the two hospitals.

In the 1920s surgery was in the ascendant, ancillaries like pathology, bacteriology, biochemistry and radiology were progressing, but specific medical treatment was still very limited. Useless empirical practices were more common than today and the doctrine of focal sepsis led to much unnecessary surgery and dental extraction. In spite of the pioneer work of Langdon-Brown there was no general application of anatomical and physiological principles in treatment. In general, at Addenbrooke's, sickness appeared in a more florid form against a background of dirt, deformity, under-nutrition and anaemia, and extreme examples of disease and neglect came from the Fens. Nursing, diet, investigation and treatment were well below the standards of a London teaching hospital which were much lower than today.

To give a few examples: at Addenbrooke's in 1928 medical and surgical ability varied greatly, recent discoveries such as insulin were hardly used, the routine investigations available were only carried out intermittently and there was no cardiography. At a more mundane level, urine testing and weighing of patients were not routine and hospital notes were almost useless. Standards were very uneven from hospital to hospital and depended mainly on occasional outstanding personalities here and there. News did not travel so fast and methods were less standardized. Thus coronary thrombosis was first described by Herrick (1912) in the United States but not widely recognized in England until McNee's paper in 1925. These criticisms applied with greater force to smaller hospitals.

The great disadvantages of the voluntary system were that the size and upkeep of hospitals depended on the prosperity of their area. They were supported by charity and the standards tolerated for the sick poor were insufficient and grew more so as the expense of medicine increased by leaps and bounds after 1920. Likewise the income of the staff came from private consultant practice which in many areas was meagre. Under the voluntary system Cambridge and Cambridgeshire 'one of the poorest and most sparsely populated counties in England' (Shipley, 1924) fared badly and a first-class service could hardly have been possible.

In the provinces the 1914–18 war marked the separation of the general practitioner and consultant on hospital staffs, the date of transition depending mainly on the wealth of the local community.

At Addenbrooke's nearly the whole staff were consultant by 1930.

At that time it was the practice for applicants for consultant posts to call on the staff. In 1927 as a candidate for Honorary Assistant Physician, I called on Dr. Joseph Griffiths, Senior Surgeon, who had been Surgical Assistant to Sir George Humphry in 1888 and Commanding Officer of the first Eastern General Hospital throughout the war. He greeted me kindly but his tone changed when he learned my business: 'Consultant Physician! You can't be a Consultant Physician in Cambridge! You must be a Physiologist!' A pause: 'What do you think is the centre of the world?' 'London?' 'London the centre of the world! Cambridge is the centre of the world!'

To illustrate the life and conditions of the time it is only possible to mention briefly three members of the Honorary Staff and I have selected Arthur Cooke, John Foster Gaskell and Howard Whittle.

Arthur Cooke (*1869–1933*), graduated at Oxford in 1895, F.R.C.S. in 1898 and after comparatively little preliminary training became a surgical partner in a well-known practice in Cambridge. From Addenbrooke's he joined the first Eastern Territorial Hospital but was soon serving in France. At the close of hostilities he returned to become both general surgeon and surgeon to the Ophthalmic Department at Addenbrooke's and then gave up general practice. By modern standards his training was meagre but he made up for this by tireless application to postgraduate study in many centres. He became an impressive surgeon for those days and a foundation member of the Moynihan Club. It was a pleasure to watch him operating, even on a kitchen table in the country.

He had personality, vision, boundless energy and charm, and did much for Addenbrooke's and Cambridge surgery. As Chairman he always seemed to know how far the opposition would allow him to go.

He was responsible for the first panel of blood donors in Cambridge, for the Evelyn Nursing Home presented to the town and university in 1921 by Charles Morland Agnew in gratitude for an operation Arthur Cooke performed on his wife, and by his leadership and charity in the raising of £85,000 for new buildings at Addenbrooke's: ophthalmic, paediatric and private wards and other extensions, most of which he lived to see in use before he died in harness in 1933.

John Foster Gaskell (*1878–1960*), was appointed to the staff of Addenbrooke's in 1920. The son of W. H. Gaskell, the distinguished Cambridge physiologist, it had at first seemed that he might follow his father. As a Beit Fellow he did good work in the Department of Physiology under Langley, but shortly before the war he switched to pathology, and was appointed demonstrator at Leeds. He served throughout the war and built up a much-needed bacteriological service in Salonica. In 1916 his book, written in collaboration with Michael Foster the younger, on cerebro-spinal fever, was published and remained a standard work for many years. On his return to Cambridge in 1920 he was elected Honorary Assistant Physician to Addenbrooke's and Director of Pathology to the John Bonnett Laboratory—a double post which he held until his retirement as Senior Physician in 1946. This appointment was a boon to the hospital, partly because he combined research ability with wide clinical and pathological experience, and devoted his whole energy to hospital work and research. His basic knowledge of the problems of disease was invaluable and he was a great addition to the medical side. His experimental studies of pneumococcal infections over many years were the subject of the Bradshaw lecture at the College of Physicians in 1927 and the views he held then have largely stood the test of time. As a physician he was careful, sound, sympathetic and an excellent teacher.

It was hoped that after the war there would be closer contact and co-operation between the Hospital and University Departments of Pathology but alas, the friendliness which had prevailed before the war had largely disappeared and until 1930 little contact developed between the two departments. The reasons for this change of attitude were complicated. After the deaths of Paget and Humphry there appears to have been a swing away from clinical medicine in the university, an attitude which persisted for fifty years. This was probably partly due to a changed approach to pathology in the Medical School. Sims Woodhead had been a morbid anatomist and bacteriologist with wide clinical knowledge and contacts. Roy Dean, the new Professor pursued a more academic approach in keeping with the type of pathology he introduced for Part II of the tripos in 1925. Gaskell, too, a morbid anatomist and clinical pathologist, with no mean personal and family record behind him, was an impressive personality and not without ambition. It was a thousand pities that in the post-war period co-operation between the hospital and the university departments should have been so slight.

Howard Whittle (*physician 1932–61*). In 1923 the staff of the John Bonnett Laboratory was strengthened by the appointment of Howard Whittle as Assistant Pathologist and he became General Physician in 1932. With his background of pathology and increasing interest in dermatology he laid the foundation of the department which has grown to eminence since the second world war with the appointment of Arthur Rook. If these combined physician-pathologist appointments of Gaskell and Whittle had not been made, the less satisfactory alternative would have been to appoint to the staff general practitioners from Cambridge, a retrograde step at a time when more and more hospital work was demanded from the honorary consulting staff.

PROPOSED MEDICAL SCIENCES TRIPOS

Up to 1934 there had never been any obligation for a medical student taking the M.B. to take a tripos. Between 1920 and 1926 only forty-four per cent did so compared to seventy-seven per cent between 1906–1911 (Rolleston, 1932). This was partly attributed to the fact that so much morphology and embryology had been added to tripos anatomy that the medical student was at a disadvantage compared to the non-medical, and there were other reasons.

In 1929 Dr. Clark-Kennedy, who was a Fellow and Director of Medical Studies to Corpus Christi and also Assistant Physician to the London Hospital, sent a memorandum to Sir Humphry Rolleston (the Regius Professor of Physic) and to the heads of pre-medical departments, pointing out the various unsatisfactory aspects of the tripos examination for medical students. After long and detailed consideration by a strong committee and twenty-one College Supervisors a syndicate was appointed in 1931 to consider the medical courses and examinations of the university and their relation to the courses and examinations for the B.A. (*Reporter*, 1930–31, p. 720).

Briefly summarized, the aims of the syndicate in their proposals for changes in the examinations for medical students were as follows:

A broad scientific foundation for future medical work and relief from the pressure or strain of excessive examination.
A medical sciences tripos under a single Faculty Board which should control all medical examinations. [Instead of the Natural Science Tripos under several Boards controlling medicals and non-medicals.]
The teaching of applied anatomy, physiology, biochemistry, pharmacology and pathology to be developed and carried out by the physicians and surgeons of Addenbrooke's Hospital in co-operation with the university departments concerned.
The syndicate proposed a scheme for the constitution of a new Faculty Board and affirmed the undesirability that students should attempt to learn clinical medicine while working for a tripos. The three years in Cambridge should be devoted exclusively to pre-clinical subjects.

The very long discussion on the syndicate's proposals (*Reporter*, 1932–33, p. 294) was opened and strongly supported by Sir Humphry Rolleston (Regius Professor of Physic). It filled twenty-four pages of the *Reporter* and is an interesting contemporary document. I will only quote two speakers: Sir Henry Thirkill said: 'At present the Natural Sciences Tripos was in effect under the control of the five Faculty Boards, viz., Physics, Chemistry, Mathematics, Biology and Geology and Geography, in addition to the Committee for the Natural Sciences Tripos. It was a very unwieldy and not very satisfactory arrangement. While it might prevent any undue haste in reform it made reform of any kind almost impossible'.

Professor Joseph Barcroft (Physiology) spoke on the thorny subject of vocational teaching: 'His experience of teaching, certainly of teaching the medical student, had been that it was just that touch of applicability of what was thought as a matter of principle to what was going to take place ultimately in his medical career which held the student's attention without in any way debasing the coin of pure science.'

This proposal for a Medical Sciences Tripos aroused strong opposition on several grounds and after much further discussion the main proposals were rejected. Honours in the Natural Sciences Tripos were made obligatory for M.B. candidates, pathology and biochemistry were made half subjects in Part I, and some attempt was made to reduce the load in Tripos Anatomy and reduce the burden of Second M.B. examinations by exemption through the tripos. The proposal for a single Faculty Board to control medical examinations was rejected.

In response to the original proposal that the teaching of applied anatomy, physiology and pathology should be undertaken by members of the staff at Addenbrooke's, two liaison officers, a physician and a surgeon were appointed, but in practice little time was allotted to students for this.

A change was made in the regulations for the M.D. to meet the criticism that degree by thesis alone discriminated unfairly against candidates in general practice, compared with consultants or laboratory workers. The former were therefore given the option of a clinical examination in the field of their choice in addition to a thesis. This alternative proved of limited value.

A Medical Sciences Tripos was finally introduced in 1966.

John Alfred Ryle (*1889–1950*). In 1935 following the retirement of Sir Walter Langdon-Brown, John Ryle was appointed Regius Professor at the age of forty-six. He had served in France through the 1914–18 war and after many academic honours was elected Physician to Guy's in 1929.

He came to Cambridge with a great reputation and a definite object: to establish a Department of Medicine and laboratories for research and to make use of the opportunities provided by Addenbrooke's for investigating disease. This aim was made possible by the Elmore Bequest which provided stipends for three to four graduates for teaching and research under his direction in the wards and out-patients. R. C. Brock was appointed Assistant Director of Research and arrangements were also made with Professor Dean for rooms in the Department of Pathology to be allocated to the new Department of Medicine.

Ryle was a fine clinician, an understanding doctor and a man of charm and distinction. He was unversed in the organization of Cambridge University which he found slow and irksome. He was outspoken, inclined to be over serious but friendly and co-operative.

In politics he was left wing, the Spanish Civil War was much on his mind and he personally looked after a settlement of refugee children from Republican Spain who were domiciled at Sawston.

There were growing pains but these did not prevent the organization of a viable and active department. Co-operation with the honorary staff was freely given and his ward rounds were popular and well attended for he was a most stimulating teacher. The benefit conferred on the hospital was immense. For the first time a department was provided with sufficient medical and ancillary help and an efficient record system.

In 1938 R. C. Brock was appointed to the Chair of Medicine in Cape Town and this gave Ryle the opportunity to acquire a readership which to his great satisfaction was accepted by R. A. McCance who was Assistant Physician with charge of the Biochemical Department at King's College Hospital. Miss E. M. Widdowson who had collaborated with him there also came on a grant from the Medical Research Council. Ryle described McCance as: 'A new variety of scientific physician who specialized in that most fruitful branch of science, biochemistry in its application to medicine' (*Reporter*, 1937–1938, p. 1413). At this stage his staff was further increased by the generosity of the Rockefeller Foundation who paid stipends for more research assistants in subjects which included diagnostic radiology, psychiatry, morbid anatomy, radiotherapy and public health.

Early in 1939 the future of the department seemed assured but with mobilization and the outbreak of war the staff were seriously depleted (seven honorary staff and three Elmore students joined the twentieth General Hospital and left Cambridge in the next few weeks).

In retrospect Ryle was unlucky. In four years he had established for the first time an efficient university department for clinical teaching and research which served as a model for expansion after the war and had attracted McCance to Cambridge. It was a thousand pities that the material and psychological stresses of war did not allow him to continue. For the foundations he laid the Hospital and Medical School owe him a great and lasting debt.

THE TWENTIETH GENERAL HOSPITAL, 1939–1941*

In the spring of 1939 the threat of war seemed more ominous. Charles Budd—Senior Anaesthetist at Addenbrooke's—was busy recruiting for the Twentieth General Hospital (T.R.), a tented hospital of 600 beds and successor to the First Eastern General Hospital of 1914. In 1939 the honorary consultant staff of Addenbrooke's totalled sixteen, and seven enrolled as specialists to the Twentieth: a general physician; four surgeons: general, ear, nose and throat, orthopaedic and ophthalmic; a radiologist and the senior anaesthetist. In addition three Elmore students and seven general practitioners from the area also enlisted so that the Commanding Officer and eighteen out of twenty medical officers came from Addenbrooke's or the Cambridge area. The Assistant Matron of Addenbrooke's, Miss A. Woolerton, was Matron of the Twentieth, the majority of the Sisters came from Addenbrooke's and most of the N.C.O.s and orderlies from Cambridge.

In September at the outbreak of war the hospital was mobilized in Cambridge and in October moved out to Kimbolton Castle in Huntingdonshire where organization and training continued. The unit was ordered overseas in January and reached Dannes-Camier just north of Etaples on 13 January, 1940. There, on the old hospital site of the 1914–18 war, between the downs to the east and the dunes and sea to the west, a hundred yards from the main Paris-Boulogne railway line, the Twentieth pitched its tented hospital. This opened for medical cases, mild infections and trivial injuries in April, but relied for surgery and radiology on the Seventeenth London which was in a sanatorium building close by. Patients never exceeded 150, mainly infections, slight injuries and peptic ulcers and chronic disabilities which had relapsed during the phoney war.

On 10 May news came that Germany had invaded Holland and Belgium and during the succeeding days the fate of nations could be read from the traffic on the roads and railway. The roads became more and more crowded with refugees and disorganized troops, but no ambulance trains or wounded arrived. On 18 May continuous gunfire was heard to the south-east for the first time and it was noticed

* This brief account of the twentieth General Hospital with the B.E.F. in 1940 is included because the Hospital was almost entirely staffed by Addenbrooke's and Cambridge. The sudden evacuation of so many medical personnel at the outbreak of war naturally had repercussions on the hospital at home.

that village rumour always put the Germans ten miles nearer than the B.B.C. At dawn on the 21st the Sisters were evacuated to England and a few hours later the first and only ambulance train arrived with exhausted and footsore men and a few wounded. The rest is quickly told: about mid-day news came that the Etaples bridge had been blown up and orders came to evacuate. At 6.30 p.m. the hospital marched with their walking wounded along chaotic roads, for there was no transport, and reached the Gare Maritime, Boulogne, soon after midnight. During the night, personnel of four other base hospitals, the fourteenth, seventeenth, eighteenth and twenty-first, with some slightly wounded, collected at the Gare Maritime and all embarked on *The Queen of the Channel* and reached Dover safely on the afternoon of 22 May. Some M.O.s and cadre of the seventeenth and twenty-first were left behind to look after seriously wounded who could not be evacuated and were taken prisoner (Budd, 1945).

THE MEDICAL SCHOOL, 1939–1944

Soon after the outbreak of war, Cambridge and East Anglia were flooded with evacuees, and the population steadily increased. By the end of 1941 six consultants had returned to Addenbrooke's but there was a considerable shortage of doctors in the area. Addenbrooke's Hospital had overflowed into the Leys School, which had evacuated to Pitlochry for the war, and the total bed complement had increased from 350 to 700. The dormitories made satisfactory wards but there were no lifts. The resident staff were inexperienced and few in number but a skeleton service for the area was maintained. Ryle left Cambridge for Guy's in 1940 and was appointed Professor of Social Medicine at Oxford in 1943, while McCance and his small staff were left to carry on with research, mainly on problems of nutrition, in the Department of Medicine and helped with clinical work at Addenbrooke's. There was no run-down of the pre-clinical school as in the 1914–18 war, most medical students continued a shortened course, with a depleted staff, and pre-clinical and clinical examinations continued at Cambridge as usual. The expansion of Addenbrooke's into the Leys School, although convenient at the time, had the disadvantage that when the school returned after the end of the war no much-needed pool of beds was available for expansion, and the necessity to contract down again in 1946 created many problems and much delay. After 1942 some informal postgraduate teaching developed, mainly for service doctors, but no organized courses were possible.

PROFESSOR R. A. MCCANCE AND THE DEPARTMENT OF MEDICINE

McCance came to Cambridge in September 1938 with Elsie Widdowson and was allotted two rooms in the Department of Pathology. The first year was spent settling in with Ryle's unit and organizing research. It was during this period that they had a terrifying adventure with pyrogens (1939). Working on the fate of strontium in the body and injecting each other intravenously they did not appreciate that the solution they were using had become heavily infected with bacteria before re-sterilization. 'In just under an hour we began to fell very ill with intense headache, pains in the back and thighs, rigors, vomiting, diarrhoea and high fever.' Luckily, Professor and Mrs. Ryle discovered their predicament and took them home.

The next step is best stated in their own words: (1946) 'As soon as war broke out and it became clear that within the next few years all Europe was likely to be faced with severe nutritional emergencies, it occurred to us that in this fight for food, as in so many other fields of human endeavour, scientific experimentation might help to win the day. We felt it might be useful to create artificially, and within a small and manageable compass, the state of affairs likely to arise later upon a grand scale . . .'.

Their aim was to study on normal human beings the effect of a diet which might: (a) 'be available under conditions of war' and (b) 'at which we ought to aim as a minimum even if the country were in dire straits as a result of enemy blockade'. This involved prophecy but in retrospect it is interesting to note how closely their prophecy tallied with reality. This project was carried out on eight normal experimental subjects (men and women between twenty-one and seventy) and conditions were made deliberately severe in order to get results within a reasonable length of time. It was clear at the start of the experiment that the rationing of meat, fat and sugar deprived all subjects except one of a source of calories to which they were accustomed and which might be made good by eating more unrationed foods. A great part of the interest and value of the experiment turned on how each subject adapted to the new situation. After three months on the diet two subjects, McCance and Andrew Huxley, performed strenuous exercise cycling 230 miles from Cambridge to the Lakes in two-and-a-half days, and climbing Bow Fell and Coniston Old Man with varying loads, to test their physical fitness. Miss Widdowson communicated the results of this trial to the Association of Physicians at Oxford in 1941. The climax was reached when she appeared carrying McCance's daily ration (a mountain of potatoes, bread and vegetables) on a large plate and members rose spontaneously and cheered.

This work was followed by an elaborate series of balance experiments on bread, and immediately after the war half the department went to Germany to study the nutritional state of the civilian population. Between 1938 and 1948 eighty-six papers and Medical Research Council reports were published by members of the department. On the appointment of Lionel Whitby as Regius Professor in 1945 the Department of Medicine switched to haematology and McCance was elected Professor of a new Department of Experimental Medicine, which appointment he held until 1967.

Cambridge characters often present eccentricities on bicycles. McCance lived at Bartlow, ten miles from Cambridge over the Gogs, and cycled regularly to and from work. His spare lithe figure might often be seen bent low over the handlebars of his racing cycle, a modern Jehu of the road from his blue tight-fitting beret to his cycle clips. There I must leave him.

THE PLANNING OF THE CLINICAL SCHOOL

In 1942 the inter-departmental committee (Goodenough) was appointed 'to enquire into the organization of medical schools, particularly in regard to facilities for clinical teaching and research and to make recommendations'. It stressed the importance of the dependence of the impending National Health Service on medical education. Memoranda were submitted to this committee from the Council of the Senate on behalf of the university and from the Board of Governors of Addenbrooke's Hospital.

In 1943 the Faculty Board of Medicine submitted plans to the General Board for the development of a school of clinical research and postgraduate teaching. This resembled Ryle's plan in all essentials (1938) and included training in research for medical graduates. The Regius Professor was to be head of the school and a joint advisory committee was appointed with the Vice-Chancellor as Chairman and representatives of the university and the hospital as members.

In March 1944 the report of the inter-departmental committee on medical schools was published and their recommendations for the Cambridge Medical School were in close agreement with the memorandum submitted by the University (*Goodenough Report*, p. 125): (1) the establishment in Cambridge of the Regional Hospital of East Anglia; (2) the establishment of a postgraduate school of clinical research in Cambridge; (3) if this were done to consider the possibility of establishing in relation thereto a pregraduate clinical school.

The report discussed the divergence of opinion between the university and the Board of Governors in that the latter wanted the certainty of an undergraduate clinical school and in this the honorary staff were behind them. At that time this was unrealistic. Apart from Ryle's unit which was discontinued when war broke out, there was no other professorial or specialist unit organized on modern lines for clinical teaching and research at Addenbrooke's and the liaison between such university and hospital departments as pathology, biochemistry, pharmacology and psychology were immature. Following the outbreak of war, the combined exodus of staff and increased clinical burden, made it hard to maintain essential services and the hospital had lost ground.

The Goodenough Committee considered that two developments must precede the decision to establish an undergraduate clinical school in Cambridge: (p. 127) (1) the standard of hospital services at Addenbrooke's must be raised to a much higher level; (2) active postgraduate medical departments must be built up.

There was a feeling among the Addenbrooke's staff at that time that because Oxford had an undergraduate clinical school Cambridge should follow suit. The comments in the *Goodenough Report* on the two hospitals are of interest (p. 122–125). Before 1937 the Medical School at the University of Oxford was like Cambridge, in the main pre-clinical but 'in 1937–39 a school of clinical research and postgraduate studies sprang almost fully armed from the Nuffield benefaction'. Early in the war a clinical school for undergraduates was improvised and these wartime arrangements proved not unsatisfactory. At the beginning of the war Addenbrooke's had hardly had the chance to realize what an impact a single up-to-date professorial unit could have in raising standards in the rest of the hospital.

In 1944 Oxford University aimed to develop an undergraduate medical school for 'teachers, investigators and consultants rather than general practitioners'. It proposed an entry of twenty to twenty-five students a year—not necessarily from pre-clinical courses in Oxford but also from other universities. Special emphasis was laid on a scientific approach to clinical subjects and the application of the Oxford tutorial system in some form for clinical students.

The proposals by Oxford University were approved by the Goodenough Committee which emphasized and encouraged the development of an undergraduate clinical school on new and experimental lines. The Committee also suggested that in doing this the university should take the opportunity to review freely and critically the whole of the medical curriculum. The Committee also emphasized the financial advantage arising from the existence in Oxford of postgraduate departments with whole-time professorships in various branches of clinical medicine. In 1944 Oxford was in every way in a stronger position than Cambridge to develop its clinical undergraduate school.

SIR LIONEL WHITBY (1895–1956)

In 1945, after an interregnum of four years, Whitby was appointed Regius Professor in succession to John Ryle. In the same year following the *Goodenough Report* the University agreed to establish a school of clinical research and postgraduate teaching. This comprised four professorial departments: haematology under Sir Lionel Whitby, experimental medicine under Professor McCance (1945), radiotherapy under Professor Joseph Mitchell (1946) and human ecology under Professor Banks (1948). The university also undertook to provide pathological and biochemical services for the hospital under the direction of the Professors of Pathology (Roy Dean) and Biochemistry (Frank Young) and to share the costs of these services. This was perhaps the most important step forward of the century in linking the hospital and the university. In 1946, following the passing of the National Health Service Act, Addenbrooke's Hospital became the teaching hospital of the Eastern Region and the Board of Governors and the Ministry of Health started plans to build the new Addenbrooke's on a forty-acre site on the Hills Road and two miles south of the old hospital. Five acres on the new site were reserved for university buildings.

On appointment Whitby was aged fifty, well known as a bacteriologist and an authority on haematology. After distinguished service as a machine-gun officer attached to the Royal West Kent Regiment in Gallipoli, Salonica and France he was severely wounded, lost a leg at the hip in 1918 and came to Cambridge as a medical student in 1919. On the staff of the Middlesex Hospital, he gained many honours and a knighthood in 1945 for his work in organizing the Army Blood Transfusion Service from small beginnings between 1939–45. Whitby was admirably suited for this appointment; he had a deep regard for Cambridge and his old college, Downing, was full of energy and enthusiasm and temperamentally-suited to unravel tangled threads of policy as leader of the Medical School. He had a nice sense of the importance and dignity of this appointment and the criticism that he was not a physician proved idle. His experience as an administrator, his wide knowledge of the world in peace and war and sane level-headed approach to controversy were all cardinal needs. It is not surprising that he became Master of Downing and later Vice-Chancellor, in both of which Lady Whitby, his contemporary at Cambridge, was his devoted and able helper. The Lodge at Downing College was a charming home and became a centre of hospitality, for he and Lady Whitby made many friendships and enjoyed social occasions to the full. In 1946 he wrote on 'The Regius Chair and the Cambridge Medical School': 'Nowadays there is little time for the Regius Professor to devote attention to any matter other than the Medical School. He is the nominal head of the whole Faculty of Medicine. He exerts no direct control in the separate departments save for his own department of medicine but he exercises a general influence in forming policy and in co-ordinating work. Following the Allbutt tradition he is an ex-officio examiner in all subjects of the medical curriculum.'

For Whitby these duties were no sinecure and he also took an active part in hospital administration, taking the Chair regularly at medical staff meetings and shouldering a heavy burden of hospital administration. When he was appointed the recommendations of the *Goodenough Report* and the plans submitted by the Faculty Board to the General Board were in general agreement so that he was able to settle down and work for their implementation and this he did with a will. In this he was helped by the department Ryle had organized before the war.

In spite of his administrative burden, he found time to consider modification of the Final M.B. He felt that the arrangements of subjects in Part III were unsatisfactory: that the laboratory subjects, pharmacology and pathology should be taken together in Part I and that all three clinical subjects: medicine, surgery and obstetrics should be combined in Part II. In his own words: 'Once in the course of a medical career it is as well to try to mobilise the whole of one's medical knowledge for a test by an examination'. These changes were subsequently introduced and have worked satisfactorily but there are still differences of opinion as to the merits of the two alternatives.

It was often not realized that his old wound was no light handicap but he seemed to turn this disability into a positive asset. As Vice-Chancellor in the procession behind the Esquire Bedells his slow limping gait assumed a never-to-be-forgotten dignity and rhythm which can never have been excelled by his predecessors.

THE APPOINTED DAY AND AFTER. (5 JULY 1948 FOR THE NATIONAL HEALTH SERVICE)

On the appointed day, in spite of many uncertainties, Addenbrooke's Hospital stood for the first time on firmer ground than at any time in its history. Not only had agreement been reached with the university on the development of a postgraduate school of clinical research and postgraduate training but financial anxieties for the hospital had been reduced by the establishment of the National Health Service and by the working agreement reached between the university and the Board of Governors to share the cost of the hospital laboratory services provided by the university departments of pathology and biochemistry.

Following Sir Lionel Whitby's untimely death in 1956, Joseph Mitchell, Professor of Radiotheraphy in the University, was appointed Regius Professor. Space does not allow me to do more than refer briefly to the steady growth of the Postgraduate School since his appointment and to mention developments of special interest.

Soon after 1957 he made use of the existing provision in the University Ordinances for two non-resident representatives of medicine and surgery, from London or provincial teaching hospitals to be members of the Faculty Board of Medicine. In his own words: 'These appointments have made it easy for the Medical School here to keep in touch officially and unofficially with London medical schools'. Such appointments have often proved their diplomatic value in the last ten years.

In 1958 the first advanced courses for specialists were held. These were designed to present problems of clinical medicine with their scientific background, and to provide a meeting place for scientists engaged in research and consultants in clinical practice. Four were held in 1958–59: (names of organizers in brackets).

'Symposium on Depression' (Dr. E. Beresford Davies).
'Progress in the Biological Sciences in relation to Dermatology' (Dr. Arthur Rook).
'Fundamental and practical aspects of Diabetes' (Professor F. G. Young).
'Some metabolic aspects of disease' (Professor R. A. McCance).

These were an immediate success and since then have continued regularly.

In June 1961, Lord Adrian opened the new Lecture Theatre and Library for the postgraduate medical school and this was an important milestone in its progress. These were built at the top of the Private Wing on the old site on space provided by the Board of Governors at a peppercorn rent. Prior to this there had been no lecture room reserved for postgraduates. Through the generosity of the Fitzwilliam Syndicate, the portrait of Sir Clifford Allbutt by Orpen now hangs on loan in the Lecture Theatre.

Finally the organization and regulations for the M.B., B.Ch., and M.Ch. examinations and for the M.D. by thesis or dissertation all presented unsatisfactory features which have gradually been eliminated and brought up to date to the benefit of the candidates and the credit of the university.

In conclusion I would like to quote from the Regius Professor's speech at the Cambridge Medical Graduates Dinner in King's College on 11 July 1969. (The favourable vote of Regent House on an Undergraduate Clinical School had been announced in June.) Professor Mitchell said: 'Despite the problems, I believe that during the next few years we shall establish a Clinical School in Cambridge, which in conjunction with the Postgraduate Medical School and the outstanding Pre-clinical School, will make use of the remarkable opportunities and the understanding of education, science and the humanities which have evolved in Cambridge. Many of us here feel that apart from making an important and unique contribution to medical education, this will itself reflect advantageously on the scientific activity of the University as a whole.'

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