The Debt of Medicine to George Eliot

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George Eliot was the pseudonym adopted in 1857 by Mary Ann Evans. She was the daughter of Robert Evans, agent on the Newdigate Estate, at Arbury Hall, near Nuneaton, and was born at Arbury on the 22nd November 1819. The family moved to Griff, half-way between Coventry and Nuneaton, when she was four months old and where she enjoyed country life. After her father was a widower for the second time they moved to Bird Grove in Coventry in March 1841. Eight years later, two years after her father’s death, the dutiful daughter went to London, and five years later started her liaison with George Henry Lewes. He was already separated from his wife, the mother of his three sons, because of her adultery with Thornton Leigh Hunt, by whom she had had two children. George Henry Lewes forgave his wife on the first occasion and because of this could not obtain a divorce after the birth of the second illegitimate child. He therefore lived with Mary Ann Evans but regarded her as his wife in everything except the law. After about seven years in London she began to write novels, but because the idea of a woman being an author was not acceptable she adopted the pseudonym, George Eliot.

George Henry Lewes was a journalist and amateur physiologist and his *Physiology of Common Life*, published in 1859 and 1860, was the first book on this subject. After his death it was natural for George Eliot to found, with advice from Dr (later Sir) Michael Foster, the George Henry Lewes Studentship with the gift of £5,000 of 4% perpetual Debenture Stock of the London and North Western Railway Company. The £200 interest for many years supported the George Henry Lewes Students; in fact, the author of the obituary of Sir Henry Dale stated that the studentship relieved him of all financial anxiety.

Elsewhere I have written briefly (Smith, 1960) about *The Physiology of Common Life*. One quotation must suffice. To illustrate that we have many sensations we do not perceive, Lewis tried this ‘Experiment on a wearied waiter who had fallen asleep in one of the unoccupied boxes of a tavern. His arm rested on the table, and his head rested on his arm: he snored the snore of the weary in spite of the noisy laughter and talk of the guests. I called out ‘Johnson’ in a loud tone. It never moved him. I then called “Wilson”, but he snored on. No sooner did I call “Waiter” than he raised his head with a sleepy “Yessir”.

This and like phenomena Lewes called Constructive Association. No wonder Pavlov, who read the German translation, said it had a great influence on him.

The only student who came to a sad end was the first, C. S. Roy. In 1884, at
in the age of 30, he was appointed Professor of Pathology at Cambridge and eight years later, when his memory began to fail and he gave the same lecture on three successive occasions, the students, usually very tolerant, complained and he was displaced. So far I have presented his history to eight physicians without getting the correct diagnosis, but I am sure many would recognise that he had become addicted to morphine. This contributed to his death at the age of 43. One student, J. R. Bradford, became President of the Royal College of Physicians. He said the research he did in 1888-89, under the guidance of Starling at University College Hospital, was the most important of his career. Of the students I shall confine myself to Charles Sherrington, Henry Dale, both past presidents of the Royal Society, A. V. Hill, all Nobel Prize winners, and R. D. Keynes. If George Henry Lewes was alive he would appreciate their contributions above all others.

The second volume of *The Physiology of Common Life* is devoted almost completely to the nervous system. Published in 1860, it is midway between the discoveries of Bell (1811), Magendie (1822) and Muller (1831), whose joint efforts distinguished motor and sensory nerves, and the era of Ramon y Cajal who evolved his theory of neurons towards 1890 (see Garrison, 1929).

Lewes’s picture of ganglionic structure shows clearly that the nerve cells were separate from the fibres. He would have been one of the first to marvel at Cajal’s histological evidence of the neuron and Golgi’s demonstration of glia cells in 1885. The true explanation of reflex action was a sequel of the neuron theory, and the third George Henry Lewes Student, Mr Charles Scott Sherrington, BA (as
he is listed), elucidated the idea by experiments. Sherrington held the studentship for four years and on his appointment was a student at St Thomas’s Hospital. In addition to his researches, he visited Goltz in Strasbourg and Virchow in Berlin, who sent him for a six weeks’ course in technique under Robert Koch. This was so rewarding that he stayed much longer to do bacteriological research. Epidemics of Asiatic cholera took him to Spain and Italy. The epidemic in Venice and its environs allowed him to learn to judge Venetian painting and Italian incunabula.

In Spain the Church objected to his making postmortem examinations. Sherrington neatly solved the problem by training an old priest to do autopsies for him. Sherrington’s interest in infectious diseases was life-long. Naturally, tetanus took a special place. He was the first in England to use diphtheria antitoxin, thereby saving the life of a nephew. He was also interested in the infectivity of oysters.

During his years as student he wrote two papers on histology of tracts in the brain that had been subject to operation and reports on the pathology of Asiatic cholera as observed in Italy and Spain.

It was during this time that the seeds of ‘The integrative action of the nervous system’ were sown. This work centred on the connecting links in the nervous system. To quote Sherrington, ‘In view therefore of the probable importance physiologically of this nexus between neurone and neurone it is convenient to have a name for it. The term introduced has been “Synapse”.’

The physiological importance of the synapse was elucidated by Henry Dale. Lady Todd, who, as Alison Dale, was a George Henry Lewes student, has kindly given me this photograph showing her father in the centre of members of Cambridge University Natural Science Club 1898, whom we may call his peers. Three became peers of the realm, Lord Rayleigh, Lord Rothchild and Lord Rutherford.

His publications during his studentship included accounts of galvanotaxis and chemotaxis of ciliate infusoria; observations on degenerate efferent dorsal nerve-roots of the toad and frog and a paper on the islets of Langerhans of the pancreas.

Reading the paper on the islets of Langerhans shows that Dale had a future. He used secretin, discovered a year before, to stimulate and exhaust the pancreas of frogs that had been bled. He found that both the exocrine and the endocrine cells were depleted of their stores. Other experiments convinced him that the two types of cell had a common origin, then a novel view which has not changed.

In October 1903, Dale went to Germany to visit Otto Loewi in Marburg whom he had already met when Loewi was working in Starling’s Laboratory at U.C.H. It was eighteen years later that Loewi discovered acetylcholine but this visit started the life-long friendship between these two who later were to share the Nobel Prize. He next went to Frankfurt-am-Main, where his research work was uncongenial but he profited from Ehrlich’s stimulation and came home with a
store of ideas, and his repertory of ways to approach problems greatly enriched. Included in this was his recognition of the possible significance of the action of histamine.

Dale later showed that acetylcholine had muscarin- and nicotine-like actions; that different reaction’s occurred at different synaptic junctions; and the effects could be independently antagonised. Application of this pure science led to the prevention of the enzymatic destruction of acetylcholine by anticholinesterases to alleviate myasthenia gravis and the use of ganglion blockers to antagonise acetylcholine and also noradrenaline which is the transmitter at sympathetic synaptic junctions. Dale expressed surprise at the great usefulness of his experimental work.

The conduction of the nervous impulse based particularly on the researches of Hodgkin and Huxley has been summarised by Keynes (1972a). The nerve fibres carry electrical impulses and sodium and potassium ions move rapidly along the nerve, but the transmission of the nervous impulse along the axon has until recently been an unsolved enigma. Electrically charged ions move easily in aqueous solutions but not in lipid, the chief component of the axon. The theory of ionic ‘gates’ or ‘pores’ gives a satisfactory explanation. It is possible with certain poisons or other ions to block the passage of sodium but potassium still passes through and other toxins and ions will block potassium and will not impede
sodium. The speed of transmission is a particular interest of R. D. Keynes, the present Professor of Physiology at Cambridge who writes, 'The precise form of co-operation is still unclear, but one simple possibility is for the gate to be operated mechanically via the pressure exerted by the electrical field'. He adds: 'But simplicity is relative'.

It was as a 'George Henry Lewes Student', in 1948, that he published what must be a rare joy for an editor, a scientific paper on a single page. He calculated that the amount of potassium lost during stimulation of carciinus nerve fibres was $2.1 \times 10^{-12} \text{ mol/cm}^2 \text{ membrane/impulse}$, which supported the supposition that potassium leaks out during activity.

The research to show what happens when the impulses reach the muscles was performed particularly by A. V. Hill, George Henry Lewes Student 1909-11. He is the senior surviving George Henry Student and entered his ninetieth year on 26th September 1975. The oldest surviving student is Hamilton Hartridge (1915-20). Sherrington was 95 when he died and Dale was 94. Physiologists seem to have an inborn propensity for longevity.

Hill was third wrangler in 1907 and then proceeded to be placed in the first class in parts one and two of the Natural Sciences Tripos. During his studentship he published 'A new mathematical treatment of changes in ionic concentration in muscle and nerve under the action of electric currents, with a theory as to their mode of action' (Hill, 1910). By modifying Blix's apparatus he produced an instrument, a thermopile and galvanometer in one, capable of measuring the heat given out by a single twitch of the frog's sartorius muscle, which was less than one hundredth of a degree centigrade. His instrument was so sensitive that it was possible to measure the rise in temperature within $1/20,000$ of a degree.

Hill fully realises that heat as a measurement of energy produced by nerve and by muscle has been superseded by the measurement of electrical currents but his work has a permanent place in the evolution of our understanding of muscular activity. He shared the Nobel Prize in 1922 with Otto Meyerhof who generously said that it was Hill's work above all others that inspired his research. The citation stated that the prize was awarded to Hill 'For his discovery relating to the heat production in muscles' and to Meyerhof 'For his discovery of the fixed relationship between the consumption of oxygen and the metabolism of lactic acid in muscle'. In 1927 Hill published Living Machinery a work written for the intelligent child: how George Henry Lewes, who wrote for the intelligent layman, would have welcomed it.

The wisdom engendered by these four George Henry Lewes Students is but a fraction of the whole but enough to show that George Eliot, by the foundation of the George Henry Lewes Studentship, 'built herself an everlasting name'.

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PUBLIC RELATIONS
Sir Henry Halford has had rather a poor press, on the grounds that he was extremely reactionary as a doctor in the second quarter of the nineteenth century, and much too obsequious to the eminent. But, apart from moving the College from Warwick Lane to Pall Mall, he started a good many other innovations. One of these was the regular evening meetings at the College for the reading of papers. Physicians, surgeons and apothecaries were all encouraged to attend, to bring the profession together, in an era when the separation of 'the Orders' in the profession was generally stressed. The meetings were held from 9 to 11 p.m. and were attended by the laity as well, with tea and coffee provided, although heavy drinking was conventional, a bold and salutary innovation. The meetings were informal, the President taking the chair without his gown or other insignia, surrounded by the College officers. The papers were read by the Registrar, except those by the President, who read them himself. They were on such subjects as 'The influences of some of the Diseases of the Body on the Mind', 'On the Education and Conduct of a Physician', and 'On the Kausos of Aretaeus', which was the brain fever. What the essay was really about is more than a little obscure: it is printed in Halford’s Essays and Orations, and it is heavy going for the evening. But it drew forth the most extravagant praise from the Archbishop of Canterbury the Bishop of London, who, with the Dukes of Sussex and Wellington, two Lord Chancellors, and Peel, Gray and Lansdowne, were all frequent attendants. The meetings were a great success, and continued for ten years, until 1838.