

MARSHALL HALL (1790–1857): A BIOGRAPHICAL STUDY

by

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MARSHALL HALL, the centenary of whose death occurred on 11 August of last year, has a permanent place in the history of science and medicine, especially in relation to his work on Reflex Action. However, it has recently been remarked¹ that 'probably the work of Marshall Hall has not received full recognition even yet', and the purpose of this paper is to give an account of Hall's life and work,² and to attempt a brief assessment of his achievements.

1. LIFE

1.1. Marshall Hall was born on 18 February 1790 at Basford, near Nottingham.³ His father, Robert Hall (1755–1827) was a cotton manufacturer, who, well versed in chemistry, was an early user of chlorine on a large scale for the bleaching of cotton. He also received a prize from the Royal Society of Arts for the invention of a new crane. A friend and follower of Wesley, he was sufficiently popular and respected to receive protection from 'Ned Lud' during the Luddite riots.

Robert Hall had eight children of whom Marshall was the sixth. The second son was Samuel Hall (1781–1863), well known in his time as an engineer and inventor. In 1817 and 1823 he obtained patents for the 'gassing' of lace and net—a process in which loose fibres are removed by rapidly passing the fabric through a row of gas jets. Out of this process he made a fortune, most of which was lost in developing other inventions. These included processes for the bleaching of starch and the consumption of furnace smoke, and a surface condenser for ships' boilers, used in the *Great Western* (1837). He published notes on 'Experiments on storing cotton goods with sulphur' (*Quart. J. Sci.*, 1818, iv, 196), which contained a note by Marshall Hall, and 'On a remarkable appearance at sunset' (*Mon. Not. Astron. Soc.*, 1851–2, xii, 185).

The early education of Marshall Hall, up to about fourteen years of age, was received under the Rev. J. Blanchard, a dissenting minister in Nottingham. From him he learnt French but no Latin. Perhaps under the influence of his father he took an early interest in chemistry, reading the works of Lavoisier

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and Watson's *Chemical Essays*. He also spent a short time with a Mr. Moor, a chemist at Newark, where he learnt chemistry and anatomy.

1.2. In October 1809, Hall went to Edinburgh to study medicine. He attended the lectures of James Gregory (1753–1821, Medicine), T. C. Hope (1766–1844, Chemistry) and Daniel Rutherford (1749–1819, Botany),⁴ though at first his favourite study was still chemistry. However, a Dr. Belcombe of York told him, 'I never knew a great chemist make a good physician', and this is supposed to have influenced Hall away from chemistry. Nevertheless, it was a subject to which he returned from time to time in later years (cf. §2.1).

At Edinburgh, Hall had some repute as a hard-working and tireless student, and was supposed to have never missed a lecture during his three years as a student. A contemporary was William Prout (1785–1850), who graduated M.D. in 1811 and afterwards said of Hall:

I knew him very well when I was a student at Edinburgh. His early education had been neglected, so that he had more than ordinary difficulties to contend with; but he was, I well recollect, remarkably energetic and persevering. I said then that, if that state of mind continued to fire him through life, he would certainly become a great man.⁵

Certainly he soon became a prominent member of the Royal Medical Society of Edinburgh. This had been founded in 1737, and received a Royal Charter in 1788; it was said to be

unquestionably the most distinguished among the student-societies of Great Britain devoted to the prosecution of science . . . (it) has numbered among its members the majority of the physicians and many of the surgeons, of this country.⁶

Of this Society, Hall was in 1811 elected Senior President.

Hall had early formed the intention of studying diagnosis. In a plan of study which he drew up he wrote of

especially making a particular study of *diagnosis*.

3. The Plan of studying diagnosis:—

(1) The formation of a diagnostic arrangement by bringing together those diseases which, being *most similar*, are most apt to be mutually mistaken; and

(2) The collection of diagnosis from every *source* of distinction, in the history, symptoms, causes, effects of remedies, & &.

(3) This plan embraces *all diseases*—medical, surgical, puerperal, etc.⁷

He graduated in June 1812 with a thesis, *De Febribus Inordinates*, and was appointed Clinical Clerk, or Resident House Physician, at the Royal Infirmary, Edinburgh. A letter to his father, dated 27 September 1811, shows his plans at this time.

I hope I shall be elected Clerk at the Infirmary; indeed there is every chance of it—but you know elections are never sure. It is an admirable situation. The fee is 20 l. a year besides board. I must stay two years, at the expiration of which time I shall be prepared for practice. After that, different ways are open to me. If I can do nothing better, I will enter the army or the militia, until a fair opportunity of commencing practice occurs.⁸

In 1812, after graduation, he wrote to his father:

I write to you with heartfelt satisfaction from the Royal Infirmary, surrounded by some of the most destitute and miserable objects of our nature, amongst the most loathsome and most mortal maladies, which are the daily objects of my care and observation.⁸

During these last two years at Edinburgh, Hall laid much of the foundation of his subsequent clinical fame. In particular, he gave in 1813 a course of lectures on 'Principles of Diagnosis', which was the basis of his famous work, *The Diagnosis of Disease* (1817). He was uncertain of his future on leaving Edinburgh; at first he thought of going to London, but gave up the idea, and wrote:

I should very much like to travel a little abroad; but this, I fear I shall not be able to accomplish. . . . Some years must be spent without much employment; these I would occupy in general reading, particularly in preparing my work on 'Diagnosis'. . . .⁹

1.3. In 1814 he left Edinburgh and, in April, accompanied Dr. Harrison, 'a Yorkshire gentleman of fortune', to Paris. There he visited numerous medical schools, and then went on alone to Berlin and Göttingen, travelling on foot and covering six hundred miles during November. On returning to Nottingham in 1815 he found that there were already four physicians in the city, and at first he went on to Bridgewater. He found little opportunity there—though he met Sir Humphry Davy at dinner at a Mr. Poole's of Stowey—and after six months he returned to Nottingham. In spite of his early fears, and opposition from his seniors, Hall built up during the next nine years an extensive practice, and became widely known, particularly for his success in the diminished use of blood-letting. Much of his practice was based on his principles of diagnosis. For example, in his own words:

When I began to practice in Nottingham, I was promptly struck with the fatality amongst the puerperal cases; I observed that they almost uniformly combined diffuse and violent pain over the abdomen, with severe affection of the head; and that they had been uniformly bled. They were considered as peritonitis for which blood-letting was deemed the essential remedy.

I began to doubt the correctness of the diagnosis, and, of course, of the mode of treatment; and, after much and careful observation, I found them to be—not cases of peritonitis, but of intestinal load and irritation. The lancet was abandoned, and the bowels were relieved by mild aperients and enemata—and the patients ceased to die.¹⁰

During this period he became a Fellow of the Royal Society of Edinburgh (1818) and in 1825 was elected Physician to the General Hospital at Nottingham.

1.4. Hall's removal to London occurred finally in August 1826, when he made a visit and remained, and his practice amongst the aristocracy was to a considerable extent retained during the London season. His practice was initially chiefly on female diseases, but he wrote:

. . . as it became publicly known that my attention was . . . directed to the nervous system, I gradually lost sight of the class of female diseases, and became consulted on the subject of diseases of the nervous system.¹¹

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At first he lived with William Burnside and his wife at 15 Keppel Street—Burnside, in partnership with Seeley, published a number of Hall's works—but after his marriage in November 1829 he moved to Manchester Square. He moved finally in 1850 to 38 Grosvenor Square.

In view of subsequent events (§3.2), it is of interest that when in 1832 Hall was elected Fellow of the Royal Society, the President, the Duke of Sussex, said that '... the Society was honoured in numbering him amongst its fellows'. Hall held no regular academic or clinical appointments in London. Though he applied for the chair of Medicine at University College, he was advised to withdraw. From 1834 to 1836 he lectured on the practice of medicine at the Aldersgate Street medical school, and for the next two years at the school at Webb Street and at Sydenham College. He held a similar appointment at St. Thomas's Hospital: during 1842–4 with special reference to the nervous system, and for the next two years in conjunction with Dr. Barker. In all these lectures he strongly stressed the great importance of diagnosis—'know the disease, the state of the patient, and all the rest is natural and easy'. After 1846 he gave no further courses of lectures, though he sometimes gathered a small number of students in his own house for physiological studies, including demonstrations of some of his own experiments. In 1839 he became consulting physician to Stilwell's private asylum at Moorcroft House, Hillingdon, and visited there once a fortnight for some time. He was active in the movement which commenced in 1836, and led ultimately to the formation of the British Medical Association, of the first council of which he was a member.

Hall's lecture course in 1839 was not completed owing to the failure of his voice, and he later became increasingly troubled with his throat. Finally, in 1852, he decided to give up his practice, handed it over to Dr. J. Russell Reynolds, and on 12 February 1853 sailed with his wife to America.

1.5. Hall was very fond of travelling and had visited the Continent every year, 'about the end of the London season'. The first of these visits with his wife had been in 1830, and in a tour through the Netherlands they were nearly caught up in the August Revolution. The next year saw them in Paris, again shortly after a revolution, but the trips to Paris were repeated for many years. Later they were extended to Germany, Switzerland, Italy and the Tyrol. In September 1846 they went to Geneva to visit the tomb of Davy.

The journey to America was partly occupied in writing a paper, 'Sur la physiologie du Mal-de-Mer' (*Compt. Rend.*, 1853, xxxvi, 600). Arrived there, he gave lectures in numerous places, including Washington, Baltimore, Philadelphia and Chicago; in Canada, and in Cuba, lecturing at Havana in French. He was elected an honorary member of the Medical Society of St. Louis, Missouri; proposed to the doctors of Toronto that they should form a 'Harveian Society of Toronto' ('in order to denote its scientific character, and in remembrance of a great name'), and lectured to them on his discoveries in the nervous system. He found copies of his works in the house of a backwoods doctor near Louisville; made excursions among the Sioux and Winnebugo; was on the

Black Warrior when this vessel became 'a long and serious subject of dispute between the Governments of the United States and Spain'; and finally left America on 15 April 1854.

These fifteen months of hard travelling under difficult conditions seem to have done no great harm to his health, and for the three remaining years of his life he was as active as ever. Further travels on the Continent followed, and he learnt Hebrew from a rabbi at the age of sixty-five, making rapid progress. He subsequently returned to England and moved in November 1856 to Brighton, where he died on 11 August 1857.*

2. EARLY WORK

2.1. Hall's earliest published papers† were on his first great interest, chemistry, with a number of contributions to Nicholson's *Journal*: 'On the Combination of Oxygen' (1810, xxvii, 213); 'On the Classification of Chemical Agents' (1811, xxviii, 59); 'On the Nature of Heat' (1811, xxix, 215, 257); 'On Chemical Attraction' (1812, xxx, 193). His interest in chemistry continued for many years and whilst in practice at Nottingham he carried out experiments at the suburb of Sneinton, 'on the chemical relations of iron and water'. This work was published in 1819: 'On the combined agencies of Oxygen Gas and of Water in the Oxidation of Iron' (*Quart. J. Sci.*, vii, 55), followed by further work some years later 'On the concealed agency of Carbonic Acid in determining the decomposition of Water by the contact of Iron' (*ibid.*, 1828, i, 262; *Pogg. Ann.*, 1828, xiv, 145). This work, and similar studies on zinc, read to the Manchester Philosophical Society, were referred to by Liebig (*Chemistry of Agriculture and Physiology*, 1843, pp. 35, 219).

Another non-medical topic of interest to Hall for many years was thermometry, on which he published 'Suggestion of a new principle for the Register Thermometer' (*Quart. J. Sci.*, 1818, iv, 43) and 'Description of a Thermometer for determining minute differences of Temperatures' (*Phil. Mag.*, 1836, viii, 56). His work on respiration in relation to irritability and hibernation (see §2.3) required measurements on gases and in this connection an early paper—'Description of an Aerometer, for making the necessary corrections in pneumatic experiments for reducing the volumes of gases to a given standard' (*Quart. J. Sci.*, 1818, v, 52)—is of interest. He also published 'On one of the causes of the movements of the Barometer, and of the south and west winds' (*ibid.*, 1826, xx, 14).

2.2. His earliest medical paper seems to have been a review in the *Edinburgh Medical and Surgical Journal* (1813, ix, 352) of Thomas Sutton's work on Delirium

* The date of Hall's death is frequently given incorrectly as 11 May (for example, *Dictionary of National Biography*, 1890, xxiv, 80).

† There is no complete bibliography of Hall's work. Those in C. Hall (ref. 3) and in the *Royal Society Catalogue of Scientific Papers* (1869, iii, 137) are both incomplete, and the former contains several errors. According to Hale-White (ref. 2, p. 94), 'a bibliography of Marshall Hall's writings would contain about 150 entries', though the author's list contains some 200 items.

tremens.* Two other papers in the same journal—‘Case of Painful Subcutaneous Tubercule’ (1815, XI, 466) and ‘Case of the Effects of Tobacco’ (1816, XII, 11)—were followed by a number of groups of ‘Contributions to Diagnosis’ (1816, XII, 423; 1817, XIII, 63, 189, 303). His first medical fame came upon the publication of these and, more particularly, of *The Diagnosis of Diseases* (1817; cf. *ibid.*, 1818, XIV, 236), which as he himself said was written ‘literally at the bedside of the patient’, and was based on his work at the Edinburgh Royal Infirmary and on a course of lectures there. A second edition appeared in 1834, and a third was included in *Principles of the Theory and Practice of Medicine* (1837).

In 1818 appeared *On the Mimosos, or a Descriptive, Diagnostic and Practical Essay on the Affections usually denominated Bilious, Nervous etc.* (cf. *ibid.*, 1820, XVI, 124). By ‘mimosos’ he meant ‘a class of diseases, each of which consists of a more general morbid affection, usually combined with some topical symptoms’. He distinguished five forms: *M. acuta* (the scorbutus of Willis and others†), *M. chronica* (dyspepsia or hypochondriasis), *M. decolor* (chlorosis), *M. urgens* (hysteria) and *M. inquieta* (‘which embraces the effects of intestinal irritation, and of exhaustion from the loss of blood and other causes’).⁴ Not surprisingly, his nomenclature was not generally accepted, and in its second edition the title became *An Essay on Disorders of the Digestive Organs and General Health, and on their Complications*.

During his time at Nottingham, Hall published other medical papers of which the following are particularly notable: ‘On a Peculiar Species of Gangrenous Ulcer, which affects the Face in Children’ (*ibid.*, 1819, XV, 547); ‘Case of Chronic Inflammation of the Larynx, in which Larynxotomy and Mercury were successfully employed’ (*Med. Chir. Trans.*, 1819, X, 166); ‘Four Cases of Children who had attempted to drink Boiling Water from the spout of a Kettle’ (*ibid.*, 1821, XII, 1); and ‘Cases of Destructive Inflammation of the Eye, and of Suppurative Inflammation of the Integuments, occurring in the Puerperal State, and apparently from Constitutional Causes’ (with Higginbottom, *ibid.*, 1825, XIII, 189). His observations on puerperal cases (§1.3) led to his *Cases of a Serious Morbid Affection occurring principally after Delivery, Miscarriage, etc., and also independently of the Puerperal State* (1820), which Baillie hoped ‘will tend to check the system of bleeding, which I am afraid is becoming too universal’. Both this work and another entitled *On the Symptoms and History of Diseases* (1822) were dedicated to Dr. Matthew Baillie, Physician to the King. Baillie gave them, and Hall’s *Diagnosis*, high praise.

Hall became much concerned with the effects of loss of blood, on which he read papers in 1824 (published in *Med. Chir. Trans.*, 1827, XIII, 121). It was also the subject of one of his *Medical Essays: on the Effects of Intestinal Irritation, on some Effects of Loss of Blood, on Exhaustion and sinking from various causes* (1825). Work on these matters was continued after his removal to London. In 1830 appeared his *Observations on Blood-letting, founded upon Researches on the Morbid*

* *Tracts on Delirium Tremens, on Peritonitis and on some other internal Inflammatory Affections, and on the Gout*, London, 1813.

† Cf. ‘On the acceptance of the term Scorbutus, and on the prevalency of this Affection at different periods’ (*ibid.*, 1820, XVI, 204).

and *Curative Effects of Loss of Blood** (Second Edition, 1836). In this, and a paper to the Medico Chirurgical Society 'On the due Administration of Blood-letting' (1828),† he gave a rule for the quantity of blood to be taken:

Blood is allowed to flow from a *free* opening to incipient syncope. If there be inflammation, and youth, and strength, there is great tolerance for loss of blood, and much blood flows before syncope is induced; this is precisely what is required in such cases. If, instead of inflammation, there is only irritation, there is early syncope from the loss of blood, and the vital fluid is economized, the just and proper quantity still, however, being taken.¹²

(See also *Lancet*, 1850, July 27, p. 124.) A further paper, 'An Experimental Investigation of the effects of loss of blood', appeared in 1832 (*Med. Chir. Trans.*, xvii, 250).

Hall's *Commentaries on some of the more important of the Diseases of Females* (1827) was based on his Nottingham practice, and was followed by a second edition, *Commentaries principally on those Diseases of Females which are Constitutional* (1830). About this time also he published a number of suggestions in surgery, including a simple and bloodless operation for the removal of vascular naevus ('New Operation for Naevus', *Med. Gaz.*, 1831, February 26). In 1832 appeared further 'Essays on Diagnosis' (*ibid.*, 1832, pp. 593, 625, 721, 753) and a paper on 'Bronchial Affections in Children' (*ibid.*, 1832, January 14, p. 578). He also wrote the articles on Abstinence, Anaemia, Morbid States of the Blood, Blood-letting, Chlorosis and Symptomatology in the *Cyclopaedia of Practical Medicine*. 2.3. The work of Hall described in papers on 'Experiments and Observations relative to vision' (*Quart. J. Sci.*, 1818, v, 249), 'Some observations on the Physiology of Speech' (*ibid.*, 1825, xix, 8) and 'On the Mechanism of the Act of Vomiting' (*ibid.*, 1828, i, 388; see also *J. Roy. Inst.*, 1831, i, 265) may be regarded as early work in physiology. But his physiological investigations proper really began with work carried out with the expressed purpose of election to the Royal Society.

His first studies were on blood circulation in the batrachia, particularly the triton. His paper, 'On the Anatomy and Physiology of the Minute and Capillary Vessels', was read to the Royal Society on 28 April 1831 (*Proc. Roy. Soc.*, 1831, iii, 45), but was rejected for publication.‡ Perhaps the most original part of the work was the description of the 'caudal heart' associated with the capillaries in the tail of the eel. A further paper 'On the Effect of Water, raised to temperatures moderately higher than that of the atmosphere, upon Batrachian Reptiles' was read on 5 May (*ibid.*, 1831, iii, 47), and the two papers appeared as *A Critical and Experimental Essay on the Circulation of the Blood; especially as observed in the minute and capillary vessels of the Batrachia and of Fishes* (1831).

* A pamphlet, *On a Morbid Affection of Infancy arising from Circumstances of Exhaustion, but resembling Hydrancephalus*, intended to form an appendix to this⁴ appeared in 1829. This had been read to the Medico Chirurgical Society.

† According to C. Hall (ref. 3, p. 74) this was published separately. It is presumably the *Proposal of a plan for the Investigation of the due administration of blood-letting* (n.d.) given by Hall to the Royal Society (*Phil. Trans.*, 1832, p. [6]).

‡ The rejection of this paper is not mentioned in the Royal Society's obituary notice of Hall (*Proc. Roy. Soc.*, 1857, ix, 327). Müller pronounced the work to be 'ausserordentliche interesse'.

This work was followed immediately by a study of the relation between ‘irritability’ and respiration, and led him to enunciate the law that ‘The quantity of Respiration is inversely as the degree of Irritability of the muscular fibre’. This paper was read on 23 February 1832, and appeared in the *Philosophical Transactions* (1832, p. 321).^{*} A few days later, on 1 and 8 March, was read his paper ‘On Hybernation’ (*ibid.*, p. 335). Observations on the temperature of hibernating hedgehogs had been made by John Hunter and Edward Jenner, and the reduction of respiration in sleep had been shown by W. Allen and W. H. Pepys (1809). Hall made careful observations of the reduced respiration and lowered temperature in the hedgehog, dormouse and bat, the latter during the summer of 1831, with later observations in 1832. He drew attention to the ‘important distinction between true hybernation and torpor from cold, not attended to by physiologists’ (citing LeGallois (1824) as an example) and pointing out that ‘severe cold, like all other causes of pain, rouses the hybernating animal from its lethargy; and, if continued, induces the state of torpor’. In this work Hall had the assistance of Henry Smith (d. 1851) of Torrington Square. The animals required for it were kept in Hall’s house, constituting the menagerie referred to by Guthrie,¹ and containing mice, hedgehogs, bats, fishes, birds, frogs, snakes and so on.

3. WORK ON REFLEX ACTION

3.1. The history of the concept of the reflex¹³ can be traced back to the time of Galen. Its revival in modern times commenced with Descartes in his discussion (1644) of the batting of the eyes against a blow. Johann Bohn (1640–1719) was aware of the reflex movements of the decapitated frog, and discussed them as ‘material phenomena’ (*Circulus anatomico-physiologicus*, Leipzig, 1686);¹⁴ and Boyle had observed that a viper, some days after decapitation still reacted to pricking. Probably the greatest advances came in the eighteenth century with the work of Robert Whytt (1714–66).¹⁵ It was clear from the observations of Bohn and Boyle (Whytt† attributed them to Redi) that the brain was not always essential for reflex action. Whytt was informed by Stephen Hales of his classic observation that the blood circulation in a decapitated frog ceased on destruction of the spinal marrow.‡ Whytt extended this, showing that destruction of the anterior optic lobe abolished the contraction of the pupil to light (Whytt’s pupillary reflex); deduced that the ‘sympathy between parts’ takes place in the spinal marrow; and, indeed, gave an almost complete picture of the reflex. Further extensions were due to Fontana (1781), LeGallois (1813) and Flourens (1837), particularly in respect of respiration and the respiration centre.

^{*} It was communicated by J. G. Children, Secretary, Royal Society. Children (1778–1852) was the author of a number of papers on electricity and on chemical analysis (J. C. Poggendorff, *Biographisch-literarisches Handwörterbuch*, 1863, 1, 435).

† *An Essay on the vital and other involuntary motions of animals*, Edinburgh, 1751.

‡ It is on this basis that to Hales has been attributed the discovery of spinal reflex action (A. E. Clark Kennedy, *Stephen Hales*, Cambridge, 1928).

3.2. Hall's studies in reflex action arose directly out of his physiological work (§2.3). He himself stated that whilst examining the pneumatic circulation in the triton,

. . . I was struck with the fact which led to the discovery of the spinal system.

The decapitated triton lay on the table. I divided it between the anterior and posterior extremities, and I separated the tail. I now touched the external integument with the point of a needle; it moved with energy, assuming various curvilinear forms! What was the nature of this phenomenon? I had not touched a muscle; I had not touched a muscular nerve. I had touched a cutaneous nerve. That the influence of this touch was exerted through the spinal marrow was demonstrated by the fact that the phenomenon ceased when the spinal marrow was destroyed. It was obvious that the same influence was reflected along the muscular nerve to the muscles, for the phenomenon again ceased when these nerves were divided. And thus we had the most perfect evidence of a reflex, or diastaltic, or diacentric action. . . .¹⁸

The first account of his work was read to the Zoological Society on 27 November 1832, and appeared in the *Proceedings of the Committee of Science of the Zoological Society* (1832, II, 190).^{*} On 20 June 1833 a fuller account was given in 'The Reflex Function of the Medulla Oblongata and Medulla Spinalis' (*Phil. Trans.*, 1833, p. 635). In this, observations were reported on a snake, *Coluber natrix*, the turtle, viper, toad, frog, etc. It may also be noted that reference was made to the work of LeGallois and of Flourens; and Hall stated, 'to avoid misapprehension' that:

1. Many of the facts which depend upon the reflex function have long been known to physiologists.

2. But these facts only extend to the excited action of the reflex function, seen in the limbs, and even they have been erroneously ascribed to sensation and volition, or instinct. . . . (*Ibid.*, p. 664.)

Further details were given in 'Notes of Experiments on the Nerves in a Decapitated Turtle' (*Zool. Soc. Proc.*, 1834, II, 92).

In 1837 Hall gave the Bakerian Lecture, 'On the True Spinal Marrow, and on the Excito Motory System of Nerves', which was his second fundamental paper on reflex action. It was, however, refused publication in the *Philosophical Transactions*. The reasons for this are not clear; in Hall's obituary notice (*Proc. Roy. Soc.*, 1857, IX, 52) the reason given is that 'the original matter contained in it had already been made public by Dr. Hall himself in his "Lectures on the Nervous System and its Diseases", published in 1836'. But it seems certain that Hall actually suffered from the general state of the Royal Society at this period.† He received much support in England: 'Sharpey and Watson at University College both recognised the discovery, so did Faraday, Sir Henry Holland,

^{*} And in *Notizen aus dem Gebiete der Natur- und Heilkunde* (Froriep), 1832, p. 215.

† See, for example, Dorothy Stimson, *Scientists and Amateurs*, London, 1949, pp. 210ff. An example of the attitude of the Council, given by Hall, is that, in his paper, 'Having quoted from Whytt an experiment of Redi, on the movement of the *Tortoise* when deprived of its head, some one has written — "Will they live after they are made soup of?"' (C. Hall, ref. 3, p. 89.)

One result of the state of the Royal Society was the formation of the British Association; it is therefore interesting that in 1834 Hall, with S. D. Broughton, gave a 'Report of Progress made in an experimental inquiry regarding the sensibilities of the Cerebral Nerves' (*Brit. Ass. Rep.*, 1834, p. 676).

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Budd, Hughes, Bennett and many others . . .';¹⁷ and a contemporary (1840) judgement was: 'The application of physiological science to practical medicine appears to be Dr. Hall's grand aim; and he has very successfully accomplished this. . . .'⁴ On the other hand, he was vigorously attacked in the *Quarterly Medical Journal*, and equally strongly supported by the *Lancet*. The *Edinburgh Monthly Journal of Medicine* summarized the controversy:

Dr. Hall has been accused, first, of having merely given to the sympathetic actions of Whytt a new name; and secondly, of having borrowed all of his ideas from Unzer and Prochaska* . . . these discussions . . . were almost entirely carried out by a journal which, from first to last, attacked Dr. Hall with a pertinacity truly remarkable, and raked up incomprehensible passages from Unzer and Prochaska, in order to diminish his just title to the establishment of the reflex function of the spinal cord. . . . The controversy, however, led to the translation of the works of Unzer and Prochaska into English, for the Sydenham Society (1851). (*Ibid.*, 1855, p. 233.)

Hall never received any recognition from the Royal Society for his work. The Physiological Committee recommended him for the Copley medal, but this was rejected by the Council, and he was not apparently considered for any other award. He complained of his treatment on several occasions, and in 1848 had privately printed a letter to the Earl of Ross (then P.R.S.). Finally, in 1850, he was elected on to the Council.†

The reception on the Continent of his work was very different, however. Hall's 1833 paper was immediately‡ translated and published in Müller's *Archiv für Anatomie, Physiologie und wissenschaftliche Medicin* (1834, I, 347). At the same time Müller announced his own closely related work, but acknowledged Hall's priority (*Handbuch der Physiologie*, 1838, I, 718n.). In France, Flourens also praised Hall's work and communicated many of his papers to the Academy. In July 1845 Hall was elected Foreign Associate of the Paris Royal Academy of Medicine, and ten years later to the Academy of Sciences (*Compt. Rend.*, 1855, XLI, 972, 983).

During this period Hall continued his contributions to medicine, notably with his *Principles of the Theory and Practice of Medicine* (1837), *Practical Observations and Suggestions in Medicine* (1845, 1846) and numerous papers in the *Lancet* and elsewhere. He made considerable extensions of his ideas on the reflex and their application to medicine, for example, in a series of memoirs 'On some principles of the Pathology of the Nervous System' (*Med. Chir. Trans.*, 1839, XXII, 191; 1840, XXIII, 121; 1841, XXIV, 83) and in other books.§ In the Gulstonian (1842)

* J. A. Unzer (1727–99), *Treatise on the Principles of Physiology*; George Prochaska (1778–1852), *A Dissertation on the Function of the Nervous System*. The work of both these authors was little known when Hall first wrote on the reflex, and he makes no reference to it in his early papers. According to Hoff and Kellaway (ref. 13), 'It is almost certain, to judge from statements he (Hall) made later, that the term ("reflex") was derived from Prochaska. . . .'

† On this occasion the *Lancet* referred to 'the changes which have occurred at the Royal Society within the last two or three years', and considered that their 'fearless and independent journalism' was the cause of these (23 November 1850).

‡ Müller also published later papers by Hall, notably 'Ueber den Zustand der Irritabilität in den Muskeln gelähmter Gleider' (*Archiv.*, 1839, p. 200); 'Briefe ueber das Nervensystem' (*ibid.*, 1840, p. 451); 'Ueber retrograde Reflex thätigkeit im Frosche' (*ibid.*, 1847, p. 486).

§ *Lectures on the Nervous System and its Diseases* (1836), *Diseases and Derangements of the Nervous System* (1841), *New Memoir on the Nervous System* (1843), *Essays on the Theory of Convulsive Diseases* (1848) and *Six Essays on the Theory of Paroxysmal Diseases of the Nervous System* (1849).

and Croonian lectures (1850, 1851, 1852) given to the Royal College of Physicians after his election to the Fellowship in 1841, he gave further developments.

An extension of 'Researches into the Effects of certain Physical and Chemical Agents on the Nervous System' (*Proc. Roy. Soc.*, 1847, v, 667, 674; *Edin. New. Phil. J.*, 1848, XLIV, 252; 1849, XLVI, 27; *Notizen* (Froriep), 1849, x, 273; XI, 4, 12) and later papers showed, for example, that strychnine convulsions ceased on destruction of the spinal cord (cf. §4.5). From 1847, Hall published a number of important papers in France (*Compt. Rend.*, 1847, XXIV, 619, 1054; 1851, XXXII, 633, 832, 879; XXXIII, 80; 1852, XXXV, 781; 1854, XXXIX, 1090), including some on these matters and on epilepsy.*

3.3. Hall's achievement in the development of the concept of reflex action was to give it a permanent place in physiology. His contributions have been summarized as follows.¹⁸ He extended the scope of reflex phenomena—coughing, swallowing, sneezing, and the first breath of the new-born child, were all brought within the category, for example. 'Tonic' actions, for example, the posture of the hibernating hedgehog and the 'tone' of the tail and limbs of the decapitated turtle, were similarly shown to be reflex in origin. And the autonomic system was brought into the same scheme. Hall established the idea of the reflex as a fundamental of neurophysiology.

*For the first time in the history of neurology the concept of the reflex arc was adopted as a basic mechanism of nervous disease, and this makes Marshall Hall the father of modern neurology, although as a neurophysiologist he had his predecessors . . .*¹⁸

4. LATER WORK AND MISCELLANEOUS WRITINGS

Throughout his life, Hall's many-sided activities extended outside the province of his practice and physiological work. Some of these relating to the later years of his life will now be enumerated.

4.1. Early in 1845 Hall received a pathetic letter from a widow whose husband had died as a result of exposure in the partially open second-class carriages of the Great Western Railway. He promptly addressed a letter to *The Times* (dated 18 January, it appeared three days later) above the signature 'Censor', drawing attention to the danger to health arising from this source, and it appears that within three weeks the carriages were closed. In the next year Hall wrote again to *The Times* on another, and more serious, humanitarian matter. A soldier had died in Hounslow Barracks twenty-six days after receiving one hundred and fifty lashes. An official death certificate stated that 'the cause of death was in no wise connected with the corporal punishment', but the matter received much publicity, and *The Times* apparently received several hundred letters, including two from 'Censor' which were published (27 and 31 July 1846). Hall called for the abolition of 'a system of punishment derogatory at once to the military officer, to my own profession, and to the soldier. . . .'

* Whilst on his American tour he published 'Experiments on the Spinal System in the Alligator (*Alligator Mississippiensis*)' (*Charleston Med. J.*, 1854, IX, 280)—*Roy. Soc. Cat.*, 1869, III, 137.

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Other miscellaneous writings included a paper ‘On the Idea of Form to be attached to the Higher Powers of Numbers, and on the signs used in Algebra’ (*Mechanics Mag.*, 1848, 26 August, 28 September), and a ‘Suggestion of a National Decimal Pharmacopœia’ (*Edin. Mon. J. Med.*, 1849, January). He also proposed new forms of Greek nouns and verbs, which were printed in tabular form.

4.2. Hall showed some concern with questions of public health, particularly the disposal of sewage. About 1850 a new, central railway station, a new street in the City of London, and a new bridge across the Thames were all under consideration. Hall’s project utilized these in conjunction with his scheme ‘. . . for the conveyance of an abundant supply of water, and the removal of the sewage, and its distribution as manure over our fields. . . .’ He proposed:

1. A distinct Excreta and Water-Sewerage;
2. A Cloaca placed on each side of the Thames, under low-water (and within the Thames Tunnel?) to receive the excreta; 40,000,000 out of the 45,000,000 of gallons of water which percolate London daily being allowed to flow into the river;
3. Sewage-waggons, as in Paris, but on a larger scale, to convey the excreta from the cloaca to and along the railroads and to our fields; the importation of guano and of foreign corn, and a duty on corn, being equally unnecessary.¹⁹

The scheme was published in *Principles of the Sewerage of London and other Large Cities, with suggested work on the Thames* (1850; second edition, 1852; with additional matter, 1856), but was not taken up. (See also ‘The principle of the sewerage in London’, ‘The five points of the sewerage’, *Lancet*, 1856, 29 November, p. 601.)

He made other proposals on public health, notably with Sir Ronald Martin and others, to

establish an association to be termed ‘The Society of State Medicine’ which should constitute a centre of scientific and practical information, in the metropolis, in everything that relates to public health, so as to be available for all purposes tending to the public welfare in sanitary affairs.

4.3. Before going to America Hall had read De Tocqueville’s *De la Démocratie en Amérique*, and throughout his travels there, particularly in the Southern States, he gave much attention to the question of slavery. He frequently wrote to England of his concern with this problem,* and the ideas and material he collected were published in *The Twofold Slavery of the United States* (1854), written in Nottingham after his return to England. In this he advocated a scheme of gradual emancipation.

4.4. Hall seems to have been led to his study of artificial respiration by reading, in 1855, the Annual Report of the Royal Humane Society and their ‘Rules to restore the apparently drowned’. He apparently remarked, ‘There is nothing in this treatment to restore respiration’, and went on to develop his own rules. His first paper on the subject was a letter to Flourens: ‘De la Position la plus

* According to C. Hall (ref. 3) he wrote on the subject in the *Louisville Journal* (1853). (I have been unable to check this reference.)

favorable à donner aux Individus Asphyxies, sur lesquels on tente la Respiration Artificielle' (*Compt. Rend.*, 1855, xli, 949). He developed his 'ready method' or postural treatment, and by dissection and actual results in cases of stillbirth and drowning, showed how respiration could be started by change of bodily position. His rules were published in the *Lancet* (1856), together with accounts of successful cases (1856, 1857), and a note on the 'Fatal Tendency of the Warm Bath in Asphyxia'. In 1857 appeared his *Prone and Postural Respiration in Drowning and other Forms of Apnoea*, and his rules were also published in France—'Règles pour la Traitement de l'Asphyxie' (*Compt. Rend.*, 1856, xliii, 569), 'Méthode de Traitement de L'Apnée (ou asphyxie)' (*ibid.*, 1857, xliv, 595). Hall's method was adopted by the National Life Boat Institution and it remained in use for some years until replaced by methods due to Silvester and Sharpey-Shafer.

4.5. Hall's last work was the development of the use of the action of strychnine on the frog as a sensitive physiological test for the alkaloid. This work, carried out with Bullock, was based on Hall's experience gained in his work on the nervous system (§3.2), and the procedure developed was finally sensitive to five-thousandths of a grain. It was published in three papers in the *Lancet* (1856, January, June).

Almost any one of Hall's many achievements in medicine and physiology, all based on work carried out whilst conducting a large and successful practice, would have earned him a place in the history of medicine and science—independently of his contributions to reflex action and its medical applications. This outline of his work may serve in part to substantiate Guthrie's judgement of Hall, that 'he was certainly one of the greatest men of his time'.¹

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