We are pleased to present the *Lectures on the Nervous System and Its Diseases* (1836) of Marshall Hall, the important English scientist whose most significant contributions to neurology were his studies of the physiology of reflex function, which began in 1832.

Hall, well known throughout the Continent and the United States, but disliked by his British peers, discovered a reflex action in the amputated tail of a newt while carrying out experiments on the function of the capillaries. Further studies on the reflex action led to his concluding that the spinal cord had a "diastolic" action, or life of its own. He elaborated the reflex concept from an isolated action of the cord into an established and essential physiological function.

A diverse thinker, Hall made contributions to the diminishment of the use of bleeding as a form of medical treatment, and developed the Marshall Hall method of resuscitation, the forerunner of modern methods of cardiopulmonary resuscitation. He published over 150 papers and nineteen books.

In our current selection, Hall discusses all areas of the nervous system, from its anatomy, physiology and pathology to specific disease entities. We trust that it will enhance your collection of classics.
Marshall Hall.

John Fitzwilliam was attached to the court of William the Conqueror. Marshall Hall claimed descent from him, the name, at some period, being gradually changed from Fitzwilliam to Hall on account of the place of residence of a member of the family, which had for a long time lived on the adjacent border of the shires of Nottingham and Lincoln. His father, Robert Hall, a cotton manufacturer, was a remarkable man, a friend of Wesley's and a member of the New Connexion Methodists. It was suggested in the House of Commons that this sect was disaffected with the government; the member for Nottingham, afterwards Lord Carrington, said: "As long as that gentleman [Mr. Hall] is connected with the disaffected body, all will be safe and right, there will be nothing wrong." The leader of the Luddite rioters wrote to him to say not a hair of his head should be touched, so much was he beloved and respected. He had much scientific learning, and was the first to employ chlorine for bleaching; he was so laughed at for trying this that his works were called Bedlam. He died in 1827 at the age of seventy-two. His wife was an admirable woman. Their second son, Samuel, followed in the business, to which he contributed many excellent inventions.

Marshall, the sixth of their eight children, was born at Basford, near Nottingham, on February 8, 1790. His father, wrapped up in his business, neglected the education of his precocious, brave son, who, when a child, inquired if hell was under the sea, for if so why not bore holes in the bottom of the sea to put out the fire, and who, like Keats, thrashed a schoolfellow much bigger than himself. He taught himself Latin, got up at five in the morning to read, studied chemistry and after some desultory schooling was in October 1809 sent to learn medicine in Edinburgh.

Here his industry, which was unremitting, continued; he obtained permission to dissect early in the morning before the ordinary hour of opening the dissecting-room, he contributed...
articles on chemistry to Nicholson's Journal, he entered into the discussions at that venerable students' institution "The Royal Medical Society," of which he was elected Senior President and to his delight made an Honorary Fellow shortly before his death; he made few friends, his sojourn in Edinburgh suggests that all work and no play makes Jack a dull boy; anyhow, his fellow-students appear to have been proud of his knowledge and attainments; he took his degree in June 1812, whereupon he returned to Nottingham. Hardly had he arrived when he was recalled to fill the post of Senior Clerk, otherwise Resident House Physician, to the Edinburgh Royal Infirmary. The appointment was for two years, the salary £20 a year, with board. He continued his labour, it "was always going on and knew no suspension." Of his own free will he gave a private course of lectures to any who wished to hear him; fifty came.

After leaving Edinburgh, visits were paid to the hospitals in Paris, Berlin, Göttingen and other places on the Continent. He evidently admired walking, for he records in a letter that he saw the Chancellor of the Exchequer walking to London, six miles off, and he, alone, walked the 600 miles from Paris to Göttingen, carrying a cocked pistol for fear of wolves. On his return, he practised at Eridge for six months, but as there was no scope he put up as a physician in Nottingham in February 1817, being then scarcely twenty-seven years old.

The news of the reputation he made in Edinburgh had reached Nottingham, his family was well known, he was skillful and thorough in his work, kind and considerate to his patients; soon he was doing a very large practice which extended into the Dukeries and even as far as Derby and Leicester and included the best families in the neighbourhood. He was an ambitious man, and in 1825 was elected Physician to the General Hospital, Nottingham. At first he rode, being a good horseman, but soon he was driven about in a gig, thus gaining leisure to read during the drive. He never dined out as it was a waste of time; in the evening he read, wrote and made experiments, indeed he slaved at work, being filled with the desire to be somebody of note.

His close neighbour, the Vicar, says he was stout, of middling stature, simple, neat, cheerful and always seemed to be thinking of something. This Vicar, Dr. Wilkins, wrote a treatise called Body and Soul. Hall was asked to read the proof, but, keeping it a long while, received a note from the author asking him to return his body and soul. Hall's manservant, who read the note, rushed into the kitchen saying to the cook that he could not stay in his place any longer as his master had the Vicar's body and soul.

Writing came easily to Marshall Hall; during the first year of his practice in Nottingham On Diagnosis was published. It is a book of considerable size. Many doctors only treated symptoms empirically without any thought of what was really the matter with the patient; indeed, it is highly probable that most of them did not know what the word diagnosis meant, for the first book on the subject, A Treatise on Diagnosis and Prognosis, by J. F. Price, had not appeared till 1791. Hall's book laid down the principle that the first thing is to find out the disorder from which a patient suffers. This is to be done by observing symptoms, of which a great many are given. He deserves great credit for teaching that the art of medicine is to reason correctly from observation. Matthew Baillie at once saw the importance of the book. It chanced that Hall, being in London, one day called on him. Baillie said to him, "I hope your father is well; I, for one, am much indebted to him for his extraordinary work On Diagnosis." Hall modestly said he was the author. Baillie exclaimed, "Impossible! it would have been credit to the greatest-headed philosopher in our profession." After this, Baillie, then at the height of his fame, did much for Hall's advancement. Baillie, a nephew of the Hunters, was celebrated as the author of the first treatise on Morbid Anatomy; it had been published in 1795. Hall in his book had seized its importance, saying, "Nothing has contributed so much to raise medicine from its condition of a conjectural art, to the rank of a science as the investigations into Morbid Anatomy." A second edition of Hall's book appeared in 1834; it was thoroughly brought up to date; in it we are told we must use the stethoscope. A second edition of the first part only, dedicated to Matthew Baillie, had been issued in 1822.

A year after the first edition of the book On Diagnosis he published one entitled On the Mimoses; or a Descriptive, Diagnostic and Practical Essay on the Affections usually denominated Bilious, Nervous, etc. In a second edition, also dedicated to Matthew Baillie, the title was changed to Essays on Disorders of the Digestive Organs and General Health and
on their Complications. By calling the cases described mimoses he wished to express that they imitated disease of the liver or nervous system, but really they were examples of disorder either of the general health or of the digestive system and could be cured by improving the first and regulating the second. It is not of the same value as the work on diagnosis, but when we remember the ignorant vague way in which such words as bilious and nervous were then used the book did much good. He saw many who illustrated his contention because of the large numbers in Nottingham employed in sedentary work in factories. Yet two more publications were about this time dedicated to Baillie, one a small volume called On the Symptoms and History of Diseases, the other an essay concerned with the prevalent reckless bleeding after parturition. This and his other publications on venesection influenced medicine for good so greatly that they will be described separately. Lastly, during his Nottingham days he contributed some papers to the Transactions of the Medico-Chirurgical Society; the most noteworthy is an account of four children who drank hot water from the spout of a kettle, the result being inflammation of the glottis, epiglottis and larynx, spasmodic contraction of the muscles of the pharynx preventing any damage to the oesophagus.

Desire to make a name for himself drew Marshall Hall to London. Knowing that his friends in Nottingham would oppose his going, he left without saying a word to anyone. A week after arrival in London he wrote to his brother-in-law in Nottingham, telling him to sell his effects and pay his few debts. He took a house—15 Keppel Street—where friends of his, a Mr. and Mrs. Burnside, lived with him, relieving him of the trouble of housekeeping. He moved from there, on his marriage in 1829, to 14 Manchester Square, and twenty years later to 38 Grosvenor Street, where he remained till his retirement from practice early in 1853. Many of his patients in Nottingham consulted him when they came to town, so that quickly he was busy. He set up a carriage and earned £800 the first year in London. Baillie was dead, but Sir Henry Halford helped him. The seventh year yielded over £2,000, then his income fell a little, for his numerous scientific publications led to the belief that he was concerning himself less with clinical medicine; then it rose again reaching its maximum of £4,000 a year after twenty-three years in London. He practised because he had to earn his living and because he liked clinical work, feeling that he could often do good by correcting the prevailing errors. In a little book of commentaries published soon after arrival in London he says every pain is not inflammatory, every attack of palpitation is not due to organic disease, every icteroidine does not come from disease of the liver, every case of muscular debility does not originate in disease of the spine; because of failure to recognize these facts friends are unduly alarmed and patients are bled, blistered, leeched and afflicted with sepsis painfully and fruitlessly, health is impaired by depletion, digitalis and mercurials, and sufferers from muscular weakness are kept for months or years in the recumbent position. Such preaching was a healthy beneficent breeze blowing away the fog of the thinking, ignorant, rule-of-thumb mentality that passed for medicine with many practitioners about a century ago. Hall was not a money-grubber, he saw many gratuitous patients, but made a rule to charge his full fee or none in order not to interfere with the fees of the family practitioners, to whom he was always courteous; if he arrived at the patient's house before the family doctor, Hall sat in his carriage till he came. His examination of the patient was careful and thorough, his directions were precise. Those who consulted him liked him for the trouble he took over them, for his honesty, his kindness, his charm and his cheerfulness. Seeing him was a different matter from an interview with a pompous, long-winded doctor who ascribed most ailments to inflammation and bled you on every possible and impossible occasion.

The family led a quiet life—inviolations to dinner and to parties were declined—its circle was therefore small. Patients at home in the morning, visits to them in the afternoon, writing or experiments in the evening, practice sacrificed for a tour on the Continent once a year. Hall spoke French well and liked going to Paris. Dr. Louis there was a man for whom he had a great admiration. This secluded existence was made the more so by the fact that, except for the post of consulting physician to an asylum near Uxbridge, he had no hospital appointment. It is therefore noteworthy that he lectured at the Aldersgate Medical School, Webb Street Medical School and Sydenham College, the last two on the same evening: the exertion led to clergymen's sore throat and his consequent resignation in 1839. It is remarkable that he was invited to lecture on the Practice
of Medicine at St. Thomas's Hospital which had its own staff and its own Medical School. He began in 1842, lecturing there for four years, when he resigned. In 1839 he was a candidate for the post of physician to University College Hospital, but was not elected, although he presented admirable testimonials from Louis and Flourens of Paris and Müller of Berlin.

Shortly after coming to London Marshall Hall became a Licentiate of the Royal College of Physicians, the Fellowship did not follow until 1841, but he delivered both the Gulstonian and Croonian Lectures before the College. They were reprinted with the title of Synopsis of the Nervous System. All his lectures were extempore, great stress was laid on accurate diagnosis; many letters from old pupils show him to have been a fine impressive lecturer who took an immense amount of trouble. He would spend an hour after lecture answering questions; a few listeners were invited to breakfast the next day in order that they might afterwards see illustrative cases among his patients; a student was prevented from coming to lecture by illness—Marshall Hall called on him to give him an account of the lecture he had missed.

Perfect health till middle life enabled him to do much writing and experimental work, the last between dinner and bedtime, the writing for an hour before breakfast and in his carriage, hence it was sometimes almost illegible, then it was transcribed by his wife, who relieved him of all domestic matters. His interest in the effects of loss of blood led to the publication in 1831 of A Critical and Experimental Essay on the Circulation of the Blood. This essay was founded on papers previously read before the Royal Society which had been refused publication in its Transactions. The coach in which the manuscript was sent to the printers was burgled during its passage through the crowds assembled for the coronation of William the Fourth, and the manuscript was stolen. The author had to rewrite his essay, in which we are told that if batrachian reptiles are placed in water of 108° F. the action of the heart continues, so, movement of the animal being abolished, it is easy, under the microscope, to observe for four hours the circulation in the mesentery or lung of a salamander. Then it will be seen that the capillaries "do not become smaller by subdivision, nor larger by conjunction, but they are characterized by continual and successive union and division or anastomosis while they retain a nearly uniform diameter."

The author claimed that this was the first accurate account of the capillary vessels and the circulation in them, and the first of any sort of the capillary vessels and the circulation in them in the lungs. The retarded flow in the capillaries is noticed, as are the effects on it of the heart, nervous system, heat, alcohol, opium and irritants. Beautiful plates illustrate the essay. Elsewhere he says arteries and veins are merely machinery for conveying blood, the capillaries bring the blood in contact with the tissues and here nutrition and absorption are effected, in the lung it is in the capillaries that the blood is exposed to the influence of the air. He proposed to call capillaries methaemata, or methaenatous blood channels, to indicate their function. Müller described this entirely original paper as of extraordinary interest. Many came to see the beauty of the circulation under the microscope. Bransby Cooper attended on several evenings. Marshall Hall said to him, "The arteries divide, divide, divide; the capillaries divide, unite, divide, unite; the veins unite, unite, unite." Bransby Cooper was delighted and said, "I shall tell that to my pupils in my next lecture." Without doubt these investigations revealed the capillaries and their function to many who were before ignorant of them.

Although aggrieved that this work was not given a place in the Philosophical Transactions, Marshall Hall read two further papers before the Royal Society next year. One was entitled Theory of the Inverse Ratio which subsists between the Respiration and Irritability in the Animal Kingdom. It was laid down as a law, applicable to the whole animal kingdom, that the quantity of respiration is inversely as the degree of the irritability of the muscle fibre. An ingenious instrument, a pneumatometer, was invented to measure the amount of oxygen used by the animal. This paper received great praise from Flourens and others, its author thought highly of it and twenty-one years later he returned to the same subject, when before the Smithsonian Society at Washington, he delivered a lecture on Zoonomy, or the Law of Life. This was reprinted in the Lancet; in it the author lays down the law as follows: All living beings possess peculiar dynamic properties which respond to appropriate stimuli in inverse proportion, the higher the dynamic the lower the stimuli and vice versa. Such is the Law of Animal Life. There are two forms of dynamics, in the nervous system and muscles
respectively. The other paper was on *Hybernation*, in it are many interesting observations which show great industry, especially as they were made when he was in busy practice. How far his observations are new is difficult to say, but he tells us that the breathing during hibernation is reduced to almost nothing, that the animal's temperature rises and falls with that of the atmosphere, that muscular mobility is unimpaired; by an ingenious device the circulation in the wing of a hibernating bat was observed, the heart's beat falling to twenty-eight per minute. A hedgehog, which had been hibernating, was killed, whilst still hibernating, by section of the upper cervical cord, its heart continued to beat almost twelve hours, but after the same experiment on a lively hedgehog it only beat two hours. Marshall Hall regards this as an illustration of his law of life. Both these papers were printed in the *Philosophical Transactions*; shortly after their appearance he was elected to the Fellowship of the Royal Society.

At a meeting of the Committee of Science of the Zoological Society held on November 27, 1832, Marshall Hall first made known his theory of reflex action, and, on June 30, 1833, he read before the Royal Society his famous paper, *The Reflex Function of the Medulla Oblongata and Medulla Spinalis*, which was printed in the *Philosophical Transactions* for that year. He was thrilled by his discovery and continued to work at the subject for many years. Fortunately, his friend, Mr. Henry Smith, was likewise thrilled; every evening, when an experiment was due, Smith's knock could be heard on the door, punctually at seven, announcing his coming, to act as assistant, for the evening investigations. In 1837 Marshall Hall offered a second paper on reflex action to the Royal Society, it was rejected by the Council. Marshall Hall begged some of the Council to see his experiments for themselves, a request which was unanswered. In 1847 another paper of his was refused. This induced him to write to the Earl of Rosse, the President, a letter which must have been considered to be of importance, for it was printed and reached a second edition. In it Marshall Hall sets forth his reasons for thinking that he has been unfairly treated; certainly, if what he says is correct, he was rudely and scoffingly rebuffed. However, the letter apparently had effect, for, in 1850, he was put upon the Council of the Society, but he contributed no further papers to it. In this country there was a clique in the medical profession which attacked him, some said there was nothing new in his work, others said it was new but wrong—much the same sort of criticism as that from which Harvey, Newton and other great men had suffered. It is difficult to see why he was thus pilloried, anyhow the controversy wasted his time and tired him. Happily against these detractors can be set great praise from many whose opinion was well worth having. The *Lancer* always upheld Marshall Hall, fighting his battles against his enemies; Le Cros Clark, lecturer at St. Thomas's, at once publicly announced that a great discovery had been made; several years later he said he remembered how the discoverer was an object of obloquy and was denounced as the propagator of absurd and idle theories. Sharpey and Watson at University College both recognized the discovery, so did Faraday, Sir Henry Holland, Budd, Hughes Bennett and many others. Abroad, the paper on reflex action was at once translated for publication in the *Archiv für Anatomie und Physiologie*, and Müller alluded to the discovery as new, in his well-known *Handbook*; Van Deen said, "You alone are the discoverer of the reflex function"; the discovery was welcomed warmly in Paris by Flourens, who highly praised the second paper, which the Royal Society had refused for its *Transactions*; this paper was also published in the *Archiv*. Hall's discoveries were immediately appreciated in America; his papers were translated into the German, Dutch and Italian languages; when English doctors travelled abroad they found their colleagues there always regarded Marshall Hall as one of the greatest of their profession, and when these colleagues came to England, Marshall Hall was the man they wanted to see. He was made an honorary member of several Continental and American medical societies; what pleased him most was that he was elected a foreign Associate of the Academy of Medicine of Paris and a corresponding member of the Institute of France; the single vacancy here produced five candidates, Marshall Hall received thirty-nine votes out of possibly forty-one. For a while his practice lessened, but soon he was looked upon as an authority on diseases of the nervous system, then practice became larger than before, patients with nervous complaints even came from the Continent and America to consult him.

A bibliography of Marshall Hall's writings would contain
about a hundred and fifty entries. The investigations on the spinal cord led to lectures and publications on diseases of the nervous system, some of these appeared in French periodicals; epilepsy in particular attracted him, the suggestion being made that it depended upon altered circulation in the brain caused by contraction of the muscles of the neck compressing the vessels there. The wide extent of his interests is shown by papers on the oxidation of iron, the production of intense cold, the movements of the barometer, the higher powers of numbers and the signs of algebra, and the Greek nouns and verbs. In the middle of the nineteenth century, the inhabitants of Great Britain were with justice seriously alarmed by cholera. There were, in 1849, 14,000 deaths from it in London alone. Marshall Hall's active mind was stirred, and in 1850 a pamphlet by him appeared with the title Principles of the Sewerage of London and Other Large Cities with Suggested Works on the Thames. It is a wonderful production from a busy doctor, deeply engaged in physiological research, for it contains closely reasoned detailed suggestions, the result of much thought. It reached a third edition and many of the suggestions were adopted. He belonged to that useful group of people, who when they see anything wrong feel an overwhelming desire to reform it. In 1840 he found him lecturing on medical reform; later he wrote to The Times to point out the cruelty of using open second-class carriages in bitter cold weather; in three weeks the offending company had closed them. A soldier died, in 1846, at Hounslow Barracks twenty-six days after receiving 150 lashes. The public was horrified, The Times could not print one-fiftieth of the letters it received upon the subject, nevertheless it printed two from Marshall Hall protesting against the wickedness of such a sentence. Two instances of poisoning owing to mistakes on the part of the druggist led him to write urging a reform in the strength of pharmacopoeial preparations.

It will be remembered that in 1839 he had to desist from lecturing on account of what was called clergyman's sore throat; he also complained of difficulty in swallowing, he improved for a time and was able to work very hard for several years, gradually the difficulty of swallowing became more troublesome, and his general health began to fail; consequently early in 1853, at the age of sixty-three, he retired from practice, disposing of the lease of his house, 38 Grosvenor Street, to Dr. Russell Reynolds.

On February 12, 1853, he and his wife started for New York to meet their son, then in the United States. During the voyage he wrote a paper on "Sea-sickness" for the Comptes Rendus. Rather more than a year was spent touring through the United States, Canada and Cuba. Wherever he went he found his books were widely read and that his reputation was considerable. The medical profession welcomed him enthusiastically, generally asking him for a lecture or two, which he gave before packed audiences; in fact, he discovered that he was in the North American Continent a famous man. In spite of the fatigue of so much travelling his health improved.

Shortly after his return he published The Twofold Slavery of the United States, in which it is suggested that the best solution of the slave question is first to educate the negro, secondly to facilitate in every way his saving for the purpose of ultimately buying his freedom; when this is attained he will probably continue in the employment of his master as a free man paid for his labour. The severity of cholera on the Continent detained Marshall Hall and his wife in this country. An invitation to give a short course of lectures on the Spinal System at Manchester was accepted; his voice only just held out until the third of the three lectures. The winter of 1854-5 was spent travelling through France and Italy; occasionally a patient was seen on the journey; in Rome, where he gave a lecture on the Spinal System, he was seized with a wish to learn Hebrew—so he studied it assiduously with a tutor. He stayed in Paris some months on the way back, seeing much of his many French friends; when he arrived in England in the autumn he was better than he had been for a long while.

Unhappily, in a few weeks, difficulty of swallowing returned and expectoration tinged with blood occurred. His energy was unchecked; chance to read the Annual Report of the Royal Humane Society, in which directions for dealing with drowned persons were given, he remarked "There is nothing in this treatment to restore respiration"; he immediately set to work to evolve his well-known treatment of the drowned which will be described presently. One of the most fascinating of celebrated murder trials is that of William Palmer for murdering John Parsons Cook with strychnine in November 1855. Everyone in the
country was excited, it was the first time strychnine had been used for murder. Marshall Hall had already studied the effect of strychnine on the frog, publishing his observations in the *Comptes Rendus*. It now struck him that the susceptibility of this animal's spinal cord to this poison was so great that the effect of the drug might be used as a test for its presence. He found that a young frog might be affected by as little as a five-thousandth of a grain of strychnine. This is the earliest suggestion of a physiological test, it is now advised in text-books on toxicology. Marshall Hall was among the many doctors briefed for the defence but not called, for he would have had to say that the symptoms were those of strychnine poisoning.

The last year of Marshall Hall's life was spent mostly in bed; the increasing difficulty in swallowing meant slow starvation. He bore this tedious distressing time with great fortitude, occupying himself with letters to the *Lancet* on various subjects; he prepared an address to be read at the Harveian Society, continued his study of Hebrew and conducted a considerable correspondence. He was greatly cheered by being made an Honorary Member of the Royal Medical Society of Edinburgh a few months before his death on August 11, 1857. The post-mortem examination showed a stricture of the oesophagus at the level of the eighth ring of the trachea. The oesophagus was dilated and ulcerated for three inches above the stricture, there were perforations in several places leading to pouches and sinuses among the muscles of the neck. The substance of the lungs was healthy. No opinion was expressed as to the nature of the stricture. His widow, who has written a life of him, and his only child, a barrister, also named Marshall, survived him.

Marshall Hall was of middle height, he had a fine forehead above kindly eyes. His habits were simple; money-making did not attract him; politics did not interest him; but he was always ready to reform abuses and would freely spend time and energy in helping others. He was ambitious to make a name for himself in science; in this he was helped by his genius for seeing, at once, the fundamentals, e.g. that diagnosis was essential to clinical medicine, that patients were often more damaged by bleeding than by the disease for which they were bled, that capillaries were vital, for in them changes took place between the blood and the tissues, that the spinal cord was the centre of reflex action and that drowned people were suffocated. His power of work was prodigious; he used in the evening to write in the family drawing-room with talking and piano-playing going on around him. He thought clearly, expressed himself clearly, he disliked controversy and was not naturally quarrelsome, but he felt keenly a sneer or a rebuke, and, when attacked, defended himself with indomitable perseverance and courage. J. F. Clarke describes a debate at which Marshall Hall's opinions on the spinal reflex were adversely criticized, saying, "In a speech of unsurpassable clearness and true eloquence he quickly grappled with the arguments against him. In epigrammatic sentences he demonstrated the truth of his theory. He met with great applause at the end of his address."

His death called forth speeches and addresses in praise of him from London, Paris, Berlin and New York. Some years after it £500 was collected to found a memorial to him At a meeting of the subscribers held in 1870 with Sir William Gull in the chair, it was decided to hand the money over to the Council of the Royal Medico-Chirurgical Society to commemorate Marshall Hall, as it thought fit. This the Council did by founding the Marshall Hall Prize to be awarded at intervals of five years for the best original anatomical, physiological or pathological work on the nervous system published in the English language within the preceding five years. It was awarded in order to Hughlings Jackson, Ferrier, Gaskell, Gowers, Sherrington and Head—such a galaxy of talent was a distinguished compliment to the memory of Marshall Hall. When the Society became merged in the Royal Society of Medicine, the money was put into the building fund and a room in the library of the new present building was named the Marshall Hall room and a Marshall Hall bookplate was provided for neurological books. The door of this room has his name on it and inside is a tablet commemorating him. Thus he is, no doubt to the surprise of the ghosts of his detractors, permanently honoured. Marshall Hall is, today, remembered for, in order of their publication, his writings on bleeding, on reflex action and on artificial respiration.

Bleeding has been in use for 3,000 years. During the later part of the eighteenth century and well on into the nineteenth, doctors indulged in an orgy of it. People were bled at the spring and fall, just as a precautionary measure, whether they needed it or not; they could be seen, lying on the floor of the surgery
of hospitals, recovering from these venesections. A doctor was prosecuted for malpractice because he did not bleed a patient suffering from pneumonia. A medical student at a hospital bled seventeen patients in one afternoon. Leeches cost the Nottingham Hospital £50 a year. Marshall Hall gives many cases of this sanguinary treatment, a few may be quoted. A physician had laryngitis, he was bled freely on two successive mornings at his own request, on the afternoon of the second day he was bled a third time to thirty-four ounces, he then suddenly fell on the floor violently convulsed and recovered with difficulty. A man, aged fifty-seven, fractured three ribs, he was bled to eighteen ounces, at noon to twenty, next day bled twice to eighteen ounces, the third day to twenty after which he died; ninety-four ounces of blood in all were taken; at the post-mortem examination the organs were found to be light-coloured from loss of blood—the man was bled to death. A young woman was frequently wet-cupped after confinement, often to twenty ounces at a time, she suffered from all the symptoms of loss of blood, it was proposed for these to bleed from the arm, she refused and recovered. A lady was bled at short intervals for several months, she was nearly dead before this treatment was stopped, she was once improved and recovered. A man, aged forty, fractured two ribs, he was bled twice to sixteen ounces, in the night he bled himself freely, next day seventeen leeches were applied, on the third day he was bled to twenty-four ounces, on the fourth to seven ounces, up to now he had lost 120 ounces and was suffering from the consequent symptoms from which he died. A man had an abdominal pain, in three days he lost nearly seventy ounces of blood by lancet, cupping and leeches, he nearly died from this. A woman suffering from fever after confinement was profusely bled and leached, she died. Another woman under the same treatment died also. A man of seventy was bled, his pulse sank, nevertheless he was bled again the next morning and died. A woman bled freely after delivery, in spite of this she was freely venesected and died.

Such was medical custom, when, soon after beginning to practise at Nottingham, Marshall Hall was called to some patients suffering from abdominal pain after confinement, they had been bled for this because the opinion of the time was that pain indicated inflammation which always necessitated bleeding. He recognized that what these women needed was an aperient and, further, this great point, that many of the symptoms, after the bleeding, were due to loss of blood. This was an immense advance, for the symptoms due to loss of blood had hitherto been regarded as those of the supposed inflammation and therefore the unfortunate patient was still further bled, even unto death. Especially were the reaction symptoms of great loss of blood misinterpreted and ascribed to inflammation. Marshall Hall established his view by experiments upon animals and by a careful study of clinical cases. His book, *Researches Principally Relative to the Morbid and Curative Effect of Loss of Blood*, gives numbers of cases in which each of the well-known symptoms of loss of blood such as syncope, convulsions, delirium, coma, amanousis were due to bleeding by the lancet, leeches or wet-cupping, and he details how, if the patient was not too far gone, he recovered when the medicinal loss of blood was stopped. It is terrible to think of the mismanagement of children who, being already exhausted from, say, diarrhoea, were further exhausted by the doctor; Marshall Hall says:

Of the whole number of fatal cases of disease in infancy a great proportion occur from this inappropriate or uncine application of exhausting remedies. This observation may have a salutary effect in checking the ardour of many young practitioners, who are apt to think that if they have only bled, and purged, and given calomel enough, they have done their duty; when in fact . . . they have excited a new disease, which they have not understood, and which has led to a fatal result.

This is perfectly true, a little child aged two years had six leeches applied to the head, the bites were allowed to bleed freely. Marshall Hall remonstrated strongly against the plan of applying leeches in infancy and allowing the bites to continue to bleed, and against that of applying leeches late at night, for the bleeding may continue during the night. Patients were often bled when lying down. Marshall Hall protested, stating that the patient should be bled when erect, then the moment he feels faint, enough has been taken, and he should be laid down, which is very sound advice. He wrote many papers on this subject; soon his views became known; doctors saw that "the slaughtering practice of blood-letting" was very wrong. Others took up the campaign against it; medicinal bleeding became less and less until by the time of Marshall Hall's death it was hardly ever performed. To him must be given the honour
of having saved a multitude of lives by arresting a mode of treatment thousands of years old. He did not urge its complete abolition, indeed he gives cases for which he thinks it suitable, the almost total extinction of it was not his fault, his disciples were more full of fervour then he was. Gradually the practice returned and the valuable remedy of venesection is now rightly applied to appropriate instances. Some of the patients Marshall Hall would have bled we should certainly not bleed today, but that does not detract from the fact that he was the first to attempt to put bleeding in its right place, which, being widely misunderstood and misapplied, caused the death of many patients. The chief points in his correct teaching were that symptoms thought to be due to the disease were caused by the bleeding used for the treatment of it, and that in thousands of cases for which it was used it did no good and great harm.

Marshall Hall had been examining the pulmonary circulation of the triton about the beginning of 1832. During his last illness he dictated as follows:

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 not touched the spinal marrow. That the influence of this touch was excited 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.

Thus in 1832 he began to study reflex action, continuing to do so for nearly a quarter of a century. He computed that he had devoted 25,000 leisure hours to it. The following is a brief account of his findings, most of which were announced in the paper on The Reflex Function of the Medulla Oblongata and the Medulla Spinalis, read before the Royal Society, June 20, 1833. Many kinds of animals were used—frogs, turtles, guinea-pigs, hedgehogs and snakes. By destruction or section of the appropriate parts of the central nervous system, he was able to demonstrate local examples of purely reflex action. He truly says that many phenomena seen in the limbs and which depend upon reflex function had long been known to physiologists, but he is able to give other examples: for instance, much of the act of swallowing is reflex, so are some movements of the iris, of the eyelid and eyeball; it was a new discovery that these movements can be obtained from a separated reptilian head but cease on destruction of the brain. He makes the following important statement:

But the reflex function exists as a continuous muscular action, as a power presiding over organs not actually in a state of motion, preserving in some, as the glottis, an open, in others, as the sphincters, a closed form, and in the limbs a due degree of equilibrium or balanced muscular action,—a function, not, I think hitherto recognized by physiologists.

This is a just claim, and to him is due the discovery of the reflex nature of balanced muscular action and the reflex nature of the "principle which presides over the orifices and sphincters of the internal canals." In this connection it is interesting to note that he observed that some patients cannot walk in the dark or with their eyes closed. The next point he makes is that previous writers had mixed volition, sensation and instinct with reflex action, whereas he contends that not one of these plays any part in it, reflex action only requires a stimulus, an afferent nerve, an efferent nerve going to muscle and a corresponding portion of the medulla oblongata and medulla spinalis, independent of the brain. This he calls the spinal system, and he first employs the word arc to it. He regards it as distinct from the cerebral system. Subsequent research has shown that he relied too much on absolute separation of these two. His writings did much good, for he furnished the basis of the conception of a reflex arc which could act independently of the brain, he emphasized that the cerebro-spinal axis was, functionally, a segmental series of reflex arcs. He refers to Whyt, Legallois, Mayo, and others, saying that they were aware of many reflex phenomena, but he contends that until he described these they had "never been accurately distinguished from sensation and volition." To ascertain whether this was a just claim it is necessary to read all the older authors, but even when this is done it is by no means easy to be sure of their meaning. There is no doubt he believed his conception of a reflex arc to be original. He was furiously attacked, particularly in the London Medical
Gazette, being accused of dishonest plagiarism; the Lancet valiantly defended him. The controversy became personal, people took sides, but as much as it was conducted, by some of the disputants, in a way discreditable to science and good manners it would be a pity to disinter it. Why such a disagreeable, unnecessary quarrel was ever started, is hard to say. That Marshall Hall was honest there can be no doubt, and I have previously given evidence that many distinguished people, capable of forming an opinion, believed in his originality. Certainly we owe our conception of a reflex arc and balanced muscular action to him.

Turning now to Marshall Hall's other investigations on the nervous system we find that he was a pioneer in the study of the effects of drugs on it; in his own words:

If a frog be made to swallow a watery solution of strychnine or opium . . . the animal soon becomes affected with symptoms perfectly similar to those of tetanus. The surface becomes highly susceptible to the impression of stimuli, and the muscles of the limbs become affected with continued spasmotic action. The affection is obviously one of augmented reflex action of the medulla (spinalis). It accordingly ceases instantly on destroying the nervous masses.

He divided a frog, mace tetanic by opium or strychnine, into three portions, the head, the anterior, and the posterior extremities and tail. "Each part remained tetanic, impossibly by the slightest touch, and spasmodically contracted on any application of stimulus. The tetanus in each is instantaneously terminated by destroying the corresponding portion of the spinal marrow." Later on he says: "If a few drops of dilute hydrocyanic acid be placed upon the tongue of a frog, a state of things the reverse of that just described as the effect of opium or strychnine is induced." These experiments, he points out, show reflex function to admit of extolation and of diminution. He also observed that removal of the cerebral hemispheres augments reflex action, a fact that has stimulated much research, also that "If in a frog the spinal marrow be divided just behind the occiput, there are for a very short time no diastatic actions in the extremities. The diastatic actions speedily return. This phenomenon he calls 'shock.'" It was known before, but the giving of the name shock to it was new. He pointed out that the tone of muscles is lessened when the hemispheres are destroyed, and he maintained that tonus and reflex actions are but modifications of one and the same function of the spinal cord; he noted that a stronger stimulus was necessary to evoke reflex action if applied to the trunk of the nerve than if applied to the periphery. Nor are we without evidence, he says, that the same principles obtain in the human subject. The infant born without cerebrum or cerebellum, and breathing from the influence of the medulla oblongata, is an example of reflex function, with the addition of respiration. Such a case is quoted, and we are reminded that parturition can take place normally in a woman whose thoracic spinal cord is completely severed, which shows that it is a reflex function. The principles of the movements in the anatomical economy are thus enumerated: 1, cerebrum, the source of voluntary motions; 2, medulla oblongata, the source of the respiratory motions; 3, medulla spinalis, the source of reflex function; 4, the neuromuscular fibre, the seat of irritability; 5, the sympathetic, the source of nutrition and secretions. These functions disappear in this order in death, an order which is inverted when the same functions gradually came into existence in the foetal and natal states and in the progressive series of the animal kingdom.

In a New Memoir on the Nervous System Marshall Hall answers his critics and expands his opinions. The book contains tables and beautiful plates showing the reflexes from that acting through the optic nerve and the tubercula quadrigemina to the iris, down to those of the extremity of the spinal cord. Our knowledge of nervous diseases has advanced so far since his time that his pathological explanations have not now much interest. Being convinced of the importance of reflex action he tried to make disorder of it explain almost anything. For example, convulsions in children were ascribed to the reflex action originating in the oncoming teeth, hence scarification of the gums was advised. Asthma, tetanus, some forms of epilepsy, hysteria and puerperal convulsions are supposed to be reflex phenomena, but it is only fair to add that other forms of epilepsy and hydrophobia were recognized to be of central origin.

The treatment of the apparently drowned advised by the Royal Humane Society was to carry the body to the nearest house and then to apply warmth, if possible by a warm bath at about 100°F. Marshall Hall chanced in 1855 to read these directions, and at once saw they were all wrong, because the cause of death
was suffocation, not loss of heat. In spite of severe illness he investigated the subject, and next year published his results in the *Lancet* and in a pamphlet which he sent to the Royal Humane Society. He wrote a paper on Asphyxia for the *Comptes Rendus*, his plan of treatment was copied into the *Journal des Débats*. In this country it was adopted at once by the profession. In the pamphlet which is entitled *Prone and Postural Respiration in Drowning*, the author begins by telling his readers that normal respiration is reflex, carbonic acid exhaled from the blood in the air cells of the lungs, acting as a stimulus on nerves in the lungs, reflexly excites the muscles of respiration, but, in apnoea, the carbonic acid accumulating in the blood for want of normal respiration poisons the spinal centres of respiration. Therefore, the first thing to do for the drowned is to excite respiration. He then says the inhalation of oxygen may be long nearly suspended without proving fatal; the suspension of the exhalation of carbonic acid, even if incomplete, destroys life in a short time; next he gives experiments designed to show that the effects of apnoea are not the result of want of oxygen but of the retention of carbonic acid; next come figures indicating that both high and low temperatures are injurious to life. The rules of the Humane Society are examined. No. 1 said, “Convey the body carefully, with the head and shoulders raised, to the nearest house”; Marshall Hall comments justly that this is a bad position because the tongue will fall backwards, so closing the glottis and thus making the entry of air difficult, fluids in the mouth will stay there, or even go into the lungs, but, says he, turn the body into the prone, i.e. face downwards, position, then the tongue will come forward and the water run out. Further, in the prone position, the weight of the trunk will compress the abdomen and thorax, this pressure will induce expiration, additional pressure by the hands on the posterior portion of the thorax and on the abdomen will render expiration more complete. “This pressure is then to be removed. Its removal will be followed by slight inspiration. The weight of the body is then to be removed from the thorax and abdomen, by gently turning it on the side and a little beyond, placing one hand under the shoulder and the other under the hip of the side moved.” These measures are to be repeated gently, deliberately but efficiently and perseveringly sixteen times in the minute only. “And thus without instruments of any kind and with the hands alone, if not too late we accomplish that respiration which is the sole, but sure effective means of the elimination of the blood poison.” Treatment must be begun immediately after the body is taken out of the water: why waste precious time by carrying it to the nearest house? If the weather is not too cold do not wrap up the drowned man, for cool air, impinging on the skin, reflexly helps to start respiration. Snuff, hartshorn, tickling the nostrils with a feather and dashing hot and then cold water on the face help a little in the same way. Those not engaged in performing artificial respiration should energetically stroke the limbs upwards, to promote the flow in the veins and thus aid the elimination of carbonic acid gas. Stillborn infants are to be treated in the same way. The warm bath is perfectly useless, not to say injurious. This plan for restoring the apparently drowned was first known as the Ready Method, later as the Marshall Hall method. Its author was much annoyed because the Royal Humane Society advised that it should be tried after the warm bath had failed, although thereby much valuable time is lost. Later the Society followed his direction. The Marshall Hall method held the field for many years until Silvester and Sharpey-Schafer devised other ways of restarting respiration. To Marshall Hall is due the entire credit of pointing out this is what must be done. It is pleasant to think that the last original thing he did before his death was to originate a method whereby thousands of lives have been saved.