The Hunterian oration : delivered at the Royal College of Surgeons of England on the 14th of February, 1905 / by John Tweedy.

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The Royal College of Surgeons of England

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BY

JOHN TWEEDY,

PRESIDENT.

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THE

HUNTERIAN ORATION.

Mr. Vice-President, Ladies and Gentlemen,

Before undertaking the duty to which I have been specially appointed, I desire to express our sense of bereavement in the loss of Mr. Luther Holden, who died eight days ago in his ninetieth year. Twenty-four years ago Mr. Holden stood in this place to deliver the Hunterian Oration, and those who were present will recall the gentle and genial spirit which pervaded his remarks and their learning and eloquence. Within seven months, this College has lost three of its past Presidents, John Birkett, John Simon, and Luther Holden, each being, in turn, senior Fellow of the College. Great and varied as were the abilities and attainments of these distinguished men, and different as were the manifestations of their intellectual and professional activities, they had at least one great quality in common. Called upon to occupy exalted positions in the Surgical Profession and elected to the highest

office in this College, they, each and all, in an age of wealth and luxury, lived simple and unostentatious lives; careful only for the faithful discharge of their various duties. In this way, they set a worthy example to their professional brethren, and in the nineteenth Century maintained the high ideal embodied in the Hippocratic Oath:—"In purity and in righteousness I will pass my life and practise my Art."

As the History of Philosophy, considered from one point of view, is the record of the development and growth of ideas and of the formation of beliefs and doctrines respecting Man and the Universe accomplished through the thinking of a few great *minds*,[1] so the History of Medicine is a record of the observations, thoughts and achievements of a few great *personalities*:—Hippocrates, Celsus, Galen, Paré, Harvey, and John Hunter: to name only the greatest. John Hunter is the theme which has been assigned to me.

Hunter, the anniversary of whose birth we celebrate to-day, did not leave behind him a systematic collection of medical and surgical writings such as the first four writers I have named; nor did he make any capital discovery, such as Harvey's, respecting the Circulation of the Blood; but the influence which he exercised upon biology and upon surgery was perhaps more immediate and more penetrating

than that of any of his predecessors; and it has been more continuous and more progressive.

Harvey's discovery was *sui generis*, and well deserves the eloquent characterisation of Haeser as "the most brilliant triumph of experimental physiology." In all essential respects it was definitive and final. "A demonstrated truth," says Aristotle, "is an eternal truth,"[2] and such was Harvey's. It changed the conceptions of physiologists and physicians as completely as Kopernik's heliocentric theory changed those of astronomers; and it became the starting-point of modern progress in physiology, medicine, and surgery. Thanks to the labours of Harvey, supplemented and completed by the discovery of the capillary blood-vessels by Malpighi and the discovery of the chyliferous vessels by Aselli and Pecquet, physicians and philosophers were enabled to look upon man and his organisation, upon structure and function, upon nutrition and growth, and upon the problems of health and of disease from a new point of view.

Throughout the ages of civilisation the growth of knowledge has been slow and often irregular, but it has been continuous and it has been sure. How slow and yet how sure, we may realise by comparing the dialectic notions of Aristotle respecting weight and motion with the direct appeals to the evidences of the senses afforded by the demonstrations of Galilei, whereby it was shown that so far from there being in Nature bodies possessing positive levity, all

matter is equally affected by gravity, irrespective of its form, magnitude or texture. By the simple experiment of dropping objects from the Tower of Pisa, Galilei, who began life as a medical student, laid the foundation of modern Physical Science and especially of Dynamics. This expedient was one of the first appeals, at least in modern times, to the use of direct experiment in physical science, and the truth thereby established became a determining factor in Newton's great discovery of the Law of Gravitation. From Aristotle to Galilei an interval of more than eighteen centuries had elapsed. Galilei and Harvey were contemporaries. John Hunter was born exactly a century after the publication of Harvey's *Exercitatio De Motu Cordis.* It is one hundred and eleven years since John Hunter died. Yet how modern Hunter is! Inventions and discoveries now crowd upon us so thick and fast that we are apt to forget how recently modern Physical Science began, and especially modern Medicine. In the order of time Medicine, in its rudest and simplest forms, must have been one of the first of the empirical arts, but in the order of ideas it was one of the last to enter into the hierarchy of the sciences. As a system of organised knowledge Medicine pre-supposes and requires not only centuries of clinical observation and a complete logical apparatus, but it also requires an advanced state of all the other natural sciences. It concerns itself with the recondite problems of life in the most

complex and the most highly differentiated of its manifestations, whether under the conditions of health or under those of disease. Until Physics and Chemistry had advanced from the conjectural and the *aprioristic* to the scientific stage, Medicine could only be conjectural and *aprioristic* too, however useful it may have been as a practical art. The thoughts and labours, the experiments and discoveries of the great pioneers of modern knowledge in the physical sciences were the necessary prelude to a scientific progress in biology, which, in its turn, was a condition precedent to any real advance in the science of medicine, surgery and pathology. Harvey, in the order of time and of thought, was the necessary antecedent of Hunter.

The history of John Hunter's birth and parentage is well known. I may, however, remind you that he was born on the 13th or 14th of February in the year 1728. He came to London at the age of 20 years. He learned and studied anatomy in the school of his brother William; he studied surgery under Cheselden at the Chelsea Hospital, and under Percivall Pott at St. Bartholomew's. Subsequently he became a student at St. George's Hospital. In 1761 he was appointed a Surgeon in the Army, and in the year 1768 he was appointed Surgeon to St. George's Hospital, having in the previous year been elected a Fellow of the Royal Society. After a strenuous life devoted to the study of anatomy and biology and to the practice of surgery, he died

at St. George's Hospital in the year 1793. He was buried in the vaults of St. Martin's-in-the-Fields. In the year 1859, when the coffins in the vaults were moved for re-interment, the late Frank Buckland undertook to find Hunter's coffin. Buckland searched for sixteen days and viewed three thousand and sixty-three coffins, Hunter's being the last but one.[3] Hunter's body was re-interred by the Royal College of Surgeons in the North aisle of Westminster Abbey, on the 28th of March, 1859.

The starting-point of John Hunter's career as anatomist, biologist, and surgeon was in the year 1748, when he came to London with a receptive and intelligent mind, a quick and observant eye, and a well-trained hand, to collaborate with his brother William in the Anatomical School which had been started two or three years before. It has been alleged that John Hunter had little or no school education and that he was a wayward and careless youth; and it has been argued that his lack of scholastic training hampered him in after-life, more particularly with reference to his powers of verbal description and exposition. I suspect, however, that the defects of Hunter's general education have been exaggerated. It is certain they had no detrimental effect upon the vigour of his intellect or upon the correctness of his methods of work. John Hunter probably knew little, perhaps he knew nothing, of formal logic or of the history of ideas or of scientific methods, but with the instinct of

true genius he soon found the only path that leads to genuine knowledge, and he kept it undeviatingly to the end. Contrasts have often been drawn between John Hunter and his brother William, and the differences between the two men have usually been ascribed to a difference in education. This, I believe, is not the correct, and certainly it is not the only, explanation. There was a difference between the two brothers, but it was a difference of temperament and disposition, a difference which was only indirectly, if at all, determined by education. Be this as it may, the differences were subdued to a great purpose. The qualities of the two brothers became complementary one of the other. The manipulative skill and the tireless research of John furnished ample materials for the display of William's splendid powers of exposition: and so each, in his own way, contributed to the success and fame of the first and greatest school of Anatomy in England.

Considering the important part that Human Anatomy now plays in medical education, it is difficult to conceive that there was no systematic teaching of anatomy in England before the middle of the 18th Century. During the many centuries which elapsed between, say, the time of Hippocrates and the middle of the 16th Century, the dissection of the human cadaver was almost unknown. Forbidden alike by the laws and customs and religion of the ancient Greeks, and by the creed of Mohammad, the study of human anatomy was placed under a civil and

religious ban until the end of the 13th Century. In Ancient Greece the laws relating to immediate burial were very stringent. Even victorious generals had been condemned to death because they neglected to bury the slain.[4] The pathos of Sophocles' tragedy of *Antigone* turns, it will be remembered, upon the sacredness of the dead, and of the necessity, higher than imperial commands, of immediate burial.

When the tradition of Greek medicine passed, in the 7th and 8th Centuries, into the hands of the Mohammadans, human anatomy was equally neglected, the practice of dissection being implicitly forbidden by the Qurân.[5] Albucasis, the only surgeon of first rank in the Græco-Arabian school, writing at the end of the 11th Century, deploring the decadence of Surgery, says:—"The reason why there is now no dexterous operator, is this:—The medical art demands time. He who wishes to practice it ought first of all to study anatomy as it is described by Galen."[6] Albucasis cites several instances, within his own knowledge, of patients dying from hæmorrhage under the hands of men who had undertaken to operate without knowing where the large blood-vessels lay or how to arrest the bleeding when these vessels were divided.

Even after the dissection of the human cadaver received the sanction of the civil authorities in Southern Europe, the teaching of anatomy was cursory and occasional and merely descriptive. Mondino of Bologna, in the 14th Century, who was the first

in modern times to dissect the human cadaver, seems to have dissected only two bodies. So little was known of human anatomy and so strong was the tyranny of tradition, that when Vesalius in the middle of the 16th Century alleged that the anatomical descriptions of Galen could not be adapted to man, there were not a few who, in their zeal to repel the accusation that Galen had used animals in dissection, did not hesitate to maintain that the human organisation had changed since Galen's time. In England, notwithstanding Harvey lectures on Anatomy in the first quarter of the 17th Century, there was no organised teaching of anatomy before William Hunter's time. In this matter William Hunter has not received all the credit he deserves. He came to London in the year 1741, at a critical period in the history of English Surgery. In the year 1745 the union which had existed between the Surgeons of London and the Barbers of London for over 200 years was dissolved by Act of Parliament. The Surgeons were incorporated by the name of the Masters, Governors and Commonalty of the Art and Science of Surgeons, and from this incorporation our College took its rise. During the union of the two Companies there had been lecturers or readers on Anatomy in the Barbers-Surgeons' Hall, the readers being nearly all physicians, but the teaching of anatomy seems to have been for the most part only descriptive and demonstrative. Upon the formation of the new Company of Surgeons provisions were

made for the teaching of anatomy, but the first Masters were not elected until eight years later. There was throughout the greatest difficulty in getting the Stewards of Anatomy to perform their duties; and partly in consequence of this, and partly in consequence of the difficulty of obtaining "bodies," the attempt to teach anatomy was abandoned by the Surgeons' Company.

In the winter of 1745–6, William Hunter undertook for a Society of Naval Surgeons the delivery of a series of lectures on Surgery. This he did so satisfactorily, that he was asked to include Anatomy in his course. He accordingly advertised his first course of Anatomical lectures to begin on the 1st February, 1746, and added that "the operations of surgery, with the application of bandages" would be included in the course; and also, that "Gentlemen may have an Opportunity of learning the Art of Dissecting, during the whole Winter Season, in the same Manner as at Paris." Had William Hunter's ambition been realised, he would, nearly a century and a half ago, have solved a problem in early Medical Education in London which is still perplexing the minds of many thoughtful persons. He desired to establish an anatomical school in London upon an extensive scale. With this object in view, he offered to erect a building at the cost of £7,000 for the study and teaching of Anatomy, provided the Government would grant him a piece of ground to build upon. It was also his intention to give to this

Institution all his preparations and his books. With a lamentable lack of sympathy which British Governments have too often manifested in their dealings with Science and Education, William Hunter's offer was declined. Smarting under a keen sense of disappointment and full of resentment, he determined to transfer his favours to Glasgow, which now enjoys the possession of his priceless Museum and his Library.[7] *Beati possidentes.*

William Hunter's memory deserves at least this passing tribute of our respect. He attempted to place Medical Education in London on a sound and permanent basis. But we, of this College, owe his memory a further debt of gratitude, for he was John Hunter's early patron and protector, and took every occasion and opportunity to advance John's worldly interests and to promote his reputation in the surgical and the scientific worlds.

After John had worked at Human Anatomy for about ten years, he manifested his intellectual growth by directing his thoughts to the higher and more scientific discipline of Comparative Anatomy and Physiology. He realised that human anatomy alone was an insufficient guide to pathology and surgery. He collected all manner of animals at his house and grounds at Earl's Court in order to study their ways and habits, and from every available source he acquired animals living or dead for the purposes of observation, experimentation, or dissection. In his use of the lower animals for the elucidation of physio-

logical problems he followed while amplifying the practice of Harvey, who in turn adduces the authority of Aristotle.[8] There was, however, a striking and characteristic difference between the use which Aristotle made of the dissection of animals with reference to human anatomy, and that of Hunter. There is no trustworthy evidence that Aristotle or Hippocrates or even Galen dissected the human body, certainly not in the sense we understand by the term "dissection." They dissected the bodies of animals *instead of* those of man, and transferred their observations of animals to the corporeal organisation of man. Hunter, on the other hand, practised the dissection of lower animals *in addition to* that of man and transferred his observations to the embryology and morphology of man and to the elucidation of the problems of human and comparative physiology and pathology.

John Hunter was a philosopher in the strict and primary sense of the word. He had a passion for knowledge. "Let no man presume to call himself wise," says Pythagoras, "God alone is wise. Man can never get beyond the passion for wisdom." John Hunter had this passion. He devoted himself to the pursuit of knowledge, searching for it in every department of the organic world, animal and vegetable. In one of his letters to Jenner he says:—"I have but one order to send you, which is, to send everything you can get, either animal, vegetable, or mineral, and the compound of the two, either animal

or vegetable mineralised." And, again: "Have you any large trees of different kinds that you can make free with? If you have, I will put you upon a set of experiments with regard to the heat of vegetables." With respect to the observations and experiments which he directs Jenner to make, he says, "Be as particular as you possibly can." These sentences express briefly and in epitome, as it were, Hunter's habits of mind and his attitude towards the problems of organic life.

John Hunter may have lacked the power of clear exposition, and he may have disliked routine teaching; but he was full and overflowing with ideas, new and original, to which he often found it difficult to give distinct shape and utterance. In contrast with William Hunter's didactic powers, John had the suggestive, the constructive, the creative faculty, the faculty of discovery, of co-ordinating knowledge, and he had the art of stimulating thought and calling forth effort from others. He taught by example rather than by precept. It is clear evidence of the value of John Hunter's method of teaching that he attracted to his classes the best students and surgeons of his day, men who afterwards rose to the highest eminence—Edward Jenner the vaccinator, Dr. Physick of Philadelphia, Abernethy, Cline, James Earle, Astley Cooper, Lynn, and Anthony Carlisle. These men in after life repeatedly expressed their indebtedness to Hunter and to his personal influence as a teacher.[9]

What, then, did Hunter do? The ready answer comes that he made one of the largest and most instructive collections of anatomical and biological specimens known to history: his famous Museum, which is now lodged within the walls of this College, and which it is our pride and privilege to protect, to preserve, and, so far as may be possible, to perfect. But I venture to think, that however great, notable, and precious Hunter's museum may be, it represents only the material part of him. The spirit which animated him, the germinative character of his method, the impulse which he gave to the operation of Mind in the pursuit of biological knowledge, were infinitely greater and infinitely more precious. *That*, amid the accidents and mischances of time, may perish, but *these* will abide as long as civilisation on this earth endures. What Hunter did from the material side is sufficiently well known. His contributions to Surgery and Biology have been repeatedly enumerated, expounded and eulogised in this place and elsewhere. I shall, therefore, not attempt to repeat what has been already done so often and so well; but I desire rather to draw attention to Hunter's method, to consider not so much *what* he did as *how* he did it.

Ottley, the first and one of the best of Hunter's biographers, remarks that in pursuing his researches, Hunter strove, not like many of his more learned but less philosophical predecessors, to unravel the mysteries of Nature by taking up some principle

a priori and seeking for facts to support his theory; but, on the contrary, he followed, in the strictest manner, the inductive method laid down by Bacon as the only sure though arduous road to knowledge [10]; and Babington, in his Hunterian Oration, remarks of him: "He had never read Bacon, but his mode of studying Nature was as strictly Baconian as if he had." Other critics and historians of Hunter's work, and not a few Hunterian Orators, have written or spoken in a similar strain. In my judgment, this view is entirely erroneous with respect to Hunter's method, and it is a complete misinterpretation of the Baconian system. Bacon's eloquence and influence undoubtedly did much to attract men to the observation and study of natural phenomena. He called attention to the necessity of studying the powers and forces of the world as a means of subjecting the world to the human mind, and so far his message was appropriate and opportune. The significance of that message is probably greater now than at the time he delivered it. The future belongs to the Nation which understands best the forces of Nature and which can most skilfully and economically employ them. But Bacon himself neither knew nor understood the physical sciences. His spirit was essentially mediæval and much less modern than that of his illustrious namesake Roger Bacon, who lived three hundred years before him. Francis Bacon's aim was purely utilitarian. He had no idea of knowledge for its own sake, and he cherished the

hope that by increasing our knowledge of Nature the secret of the transmutation of substances would be learnt, and probably the knowledge of the making of gold. He not only had no practical acquaintance with natural science, but he lacked insight into the true methods of its investigation. He understood very imperfectly the value of experiment, and he assigned quite a subordinate position to quantitative determination, the precise quality which is the most striking characteristic of modern Science, and which constituted the most original and perhaps most brilliant of the reasonings which Harvey employed in his famous Induction. So far from being the founder of the modern scientific method, Bacon's writings were themselves one of the products of the intellectual awakening which began at the end of the 16th Century. Notwithstanding his affectation of scientific knowledge and scientific methods, Bacon had an unscientific weakness for superstitions. He believed in natural and judicial astrology, though not without some hesitation and discrimination. He believed in the transmutability of elements and of the metals, in charms and signatures as remedies, and so completely did he ignore Harvey's discovery of the Circulation of the Blood that in one of the latest of his writings he ascribes the pulsation of the heart and arteries to the dilatation and contraction of the Spirits.[11] Well might Harvey say, in disparagement of Bacon's scientific writings: "He writes philosophy like a Lord Chancellor."

Bacon's ruling idea was the collection of masses of facts and then the employment of processes of arrangement, and separation, and exclusion, so artistically contrived that a man of common intelligence should be able to announce the truth sought for. This method has been slightingly described as a kind of scientific book-keeping. "It is difficult," says Stanley Jevons, "to imagine a less likely way of arriving at great discoveries. The greater the array of facts the less is the probability that they will by any routine system of classification disclose the laws of Nature."[12] The answer to the claim that Bacon was the philosophic father of modern methods of scientific investigation is, that none of the scientific truths established by the great masters of science can be made even to *appear* in correspondence with Bacon's method. Whether we look to Copernicus, who preceded him, or to Kepler, Galilei, Torricelli, Pascal, Gilbert, and Harvey, or to Newton, Descartes, or Huygens, or to Thomas Young, or to the chemists Black, Priestley, Scheele and Lavoisier, we find that discovery was achieved by a method quite different to that advocated by Bacon.

So dispassionate a critic of Philosophy as John Grote remarks: "I have not the smallest belief in Bacon's having reformed the method of discovery, believing rather that if he had *had* any success in this way, in the manner he wished, it would have been most calamitous for science."[13] And even with regard to the claim of Bacon to be the founder of

inductive philosophy, Ellis,[14] one of the ablest of his editors, asserts that the nature of the act of Induction is as clearly stated by Aristotle as by any later writer, while Aristotle himself ascribes the credit to Socrates.[15] Perhaps the Baconian claim has never been more convincingly refuted than by Augustus De Morgan, at once one of the profoundest and subtlest thinkers of the 19th Century. "Modern discoveries," he says, "have not been made by large collections of facts, with subsequent discussion, separation, and resulting deduction of a truth thus rendered perceptible. A few facts have suggested an *hypothesis* which means a *supposition* proper to explain them. The necessary results of this supposition are worked out, and then, and not till then, other facts are examined to see if these ulterior results are found in nature. . . . . Wrong hypotheses rightly worked from have produced more useful results than unguided observation. But this is not the Baconian plan. . . . . What are large collections of facts for? To make theories *from*, says Bacon; To try ready-made theories *by*, says the history of discovery."[16]

Bacon's plan was purely mechanical. He ignored the work of the Mind in the constitution of knowledge. He imagined that he had discovered a method by which scientific truth might be determined with absolute certainty, and by a mechanical mode of procedure such that all men were capable of employing it. "Our method of discovering the

sciences is," he says, "one which leaves not much to sharpness and strength of wit, but nearly levels all wits and intellects."[17] And this opinion is endorsed by most writers of the empiricist school, in complete disregard of the teaching of history. Those who imagine that science requires nothing but the registering and classification of facts forget that the facts observed can only be connected and related by the mind, and that the Laws of Nature are after all mental products from given data.[18]

Not only did John Hunter not follow the mechanical methods of Francis Bacon, but it is the work of the Mind which is the peculiar characteristic of his method and its chief glory. Others could do as well as he the more mechanical part of his task, indeed much of it was done by others; but the suggesting, controlling, co-ordinating mind was Hunter's, which, amidst the multiplicity of phenomena and of data apparently conflicting, discovered Unity amidst Multiformity, which is the special function of science.

John Hunter's constant aim was to arrive at principles, and he was distrustful of so-called facts. "The principles of our art," he said, "are not less necessary to be understood than the principles of other sciences; unless, indeed, the surgeon should wish to resemble the Chinese philosopher, whose knowledge consisted only in facts. In that case the science must remain unimproved until new facts arise. In Europe philosophers reason from

principles, and thus account for facts before they arise."[19]

Hunter possessed every moral and intellectual qualification necessary for fruitful scientific research. He had a large knowledge of facts based on an intimate acquaintance with the phenomena of organic Nature. He had a fertile imagination ready to suggest possible relations of those facts. He had openness of mind, and a conscientious scientific spirit which submitted every hypothesis to the test of observation and experiment.[20] Scepticism is the first condition of reasoned knowledge. Hunter was not only observant but he was rationally sceptical and critical, and he himself ascribed his success as a scientific investigator to the sceptical qualities of his mind. He took nothing on trust. He was always careful to distinguish between mere conjecture and reality, and drew a sharp distinction between the actual results of an experiment physically performed and what might have been mentally anticipated. "In pursuing any subject," he says, "most things come to light as it were by accident, that is, many things arise out of investigation that were not at first conceived, and even misfortunes in experiments have brought things to our knowledge that were not and probably could not have been previously conceived; on the other hand, I have often devised experiments by the fireside or in my carriage, and have also conceived the result; but when I tried the experiment the result was

different, or I found that the experiment could not be attended with all the circumstances that were suggested."[21] Here, in a sentence, we note the wide difference between the modern and the mediæval spirit in science. The alchemists performed experiments innumerable, but with them theory ranked above experiment, and if experiment gave an unexpected result this was forced into an artificial conformity with the *aprioristic* theory. It was therefore, says Lange in his *History of Materialism*, "essentially directed to the production of this previously anticipated result rather than to free investigation."[22]

Many of Hunter's discoveries may be said to have been accidental, but they were such accidents as happen only to those who deserve them, as Lagrange remarked of Newton. Chance may sometimes put us in the right way, but chance alone does not take us far. In was chance that showed to Ambrose Paré in the 16th Century that gunshot wounds did not need the application of boiling oil, as he had learned from his masters and as he himself at one time believed. Paré states that when he went to the wars in 1536 he had neither seen war nor gunshot wounds, and only knew what he had read in John of Vigo, who taught that gunshot wounds were envenomed and that the effect of the poison was only to be counteracted by pouring boiling oil into the wound. Paré, relating his later experiences, states that on one occasion there was not

enough boiling oil to cauterise all the wounded, and he used instead, for some of the cases, a digestive made of yellow of egg, oil of roses, and turpentine. The shortage of the boiling oil caused Paré great distress of mind, as he feared that those who had not had the application of the oil would die of poisoning. After a sleepless night, he rose early in the morning and was surprised and rejoiced to find that those who had had the milder application had not only not died but that they were suffering but little pain, and the wounds were free from swelling; whereas those who had had the orthodox cauterization were suffering severely from pain and swelling of the limb and from fever. Henceforth he decided to abandon the barbarous use of boiling oil. But not content with the accidental experience, he proceeded, in the true scientific spirit, to test the alleged venomous quality of gunpowder; and proved that, not only was it non-poisonous, but that it might be used with good effect to ulcers in order to dry them.[23]

In a sense it was chance that disclosed to Hunter the establishment of collateral circulation after the ligature of a main artery. In July 1785 Hunter tied one of the external carotid arteries of a stag with a view of studying its effects upon the growth of the corresponding antler. He observed that the pulsations of the vessels of the "velvet" ceased, and that the antler, which was only half-grown, became cold to the touch. Hunter debated within himself whether the antler would be shed or be retained longer than

usual. On examining it a week or two later, when the wound had healed, he found that the antler had become warm and was increasing in size. The question was,—Had his operation in some way been faulty? The buck was killed, and on examination it was found that the artery had been duly tied, and was completely obliterated, but that the circulation was carried on by vessels above and below the ligature, which had, under the new conditions, become enlarged, and by their anastomoses had restored the blood-supply of the growing part. The knowledge of the establishment of collateral circulation was not new in the history of Surgery. Blood-vessels had often been divided and tied in continuity, and the nutrition of the limb had not been permanently impaired. Indeed Celsus, writing in the first century of our era, distinctly states that after a division of a large artery the two ends should be tied, and that repair takes place by anastomosis.[24] But Hunter now saw, from a new point of view, the establishment of collateral circulation after the ligature of a large artery. He readjusted his conceptions. His sagacious insight discovered a deeper meaning in this chance observation; and he conceived its applicability to the treatment of, at least, popliteal aneurysm.

It so happened that there was a patient under his care in St. George's Hospital with popliteal aneurysm who had consented to undergo amputation. Hunter argued that if the anastomosing vessels in

man would carry on the circulation after ligature of the femoral artery as it had done in the artery of the stag, he could cure the patient's aneurysm and save the limb. Hunter performed the operation, and in six weeks the patient left the hospital cured and with a sound limb. This operation, which has ever since borne Hunter's name, has, it is well known, been instrumental in saving hundreds of limbs and lives.

While the principle underlying this operation was originally suggested by a chance observation, its elaboration and perfection were only possible by a mind stored with clinical experience and emboldened by assurance gained through experiments on living animals. Hunter constantly submitted his observations to verification, and, whenever practicable, to the test of experimentation, which Cossa describes as "observation carried to a greater degree of perfection."[25] But Hunter did not unnecessarily repeat experiments. It was an axiom with him "that experiments should not be often repeated which tend merely to establish a principle already known and admitted, but that the next step should be the application of that principle to useful purposes."[26]

While Hunter was intolerant of a state of doubt in small things as in great, if by any means decision was possible, he ever held his judgment in suspense if certainty was not attainable. Like all strong characters, he cared little for systems or consistencies of opinion. He followed wherever Truth should lead, and by his very nature was always open to new and

higher knowledge. To a pupil who asked with surprise whether he had not the year before stated an opinion on some point directly at variance with one he had just put forth, he boldly replied: "Very likely I did; I hope I grow wiser every year." And again, "Never ask me what I have said, or what I have written; but if you will ask me what my present opinions are I will tell you."

In all his relations of life John Hunter manifested courage, candour, and tenacity of purpose. Truth he believed to be preferable to Friendship, and at the most painful crisis in his life did not shrink from putting into practice this Aristotelian maxim. Indeed, Hunter possessed not a few qualities in common with the great Stageirite. Hunter was not, of course, Aristotle's equal either in range of knowledge or in intellectual power. Aristotle did indeed take all knowledge to his province. Hunter had not the sweep of thought, or the largeness of view, or the grasp of logical and philosophical principles, or the cyclopædic learning which distinguished Aristotle; but within his range, Hunter's insight was as penetrating and as clear, and his zeal for knowledge was as ardent and as untiring, and his methods were sounder, more critical and more exact.

Ordinary men are to be measured by the standard of their contemporaries, but the greatest men are estimated by the influence they exert upon the thoughts and activities of those who follow them. Judged by either or both of these criteria, John

Hunter ranks amongst the greatest. The time in which he lived was a period of great intellectual and scientific achievement. He had for contemporaries, amongst his countrymen, Priestley and Black, Cavendish and Davy, Dalton and Thomas Young, Wollaston and William Herschel; and Hunter ranked high among the highest.[27]

In attempting an appreciation of John Hunter's method, I have suggested rather than explained the development and growth of the modern knowledge of Physics, Chemistry, and Biology under the influence of the experimental method; but it has not been my purpose or intention to offer any defence of this method. To defend the use of experiment in physics and in chemistry would be manifestly absurd; and, I assume, that in this place and before this audience it is equally unnecessary to offer an apology for its use in physiology and pathology. I opine, however, that it is within my province as Hunterian Orator to anticipate the possible censure of some who would not hesitate, in the sacred name of Religion, to traduce the memory of Hunter because he practised experiments in physiology. John Hunter did employ the method of experiment. He employed it with no less zeal than with intelligence. He employed it not from idle curiosity; not from the promptings of vain-glory, nor for the purposes of worldly advancement: all that he had he gave to Science. He employed it in the service of Humanity and in the study of the nature and laws of Life; and the

knowledge which he thereby acquired he transferred to the domain of Medicine and Surgery, and applied to the alleviation of sickness and suffering among animals no less than among men.[28]

I pretend not either impiously to affirm or not less impiously to deny all the purposes of Infinite Wisdom in giving Man dominion over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth; but we do know that throughout historic time man has not hesitated to capture, to subjugate, and to slay, beast and bird and fish, for his pleasure, his sustenance and his service. Was the lordship over the animals given to man only for the satisfying of his physical and sensuous needs? Is not the Life more than food? Was it only with reference to man's bodily well-being that the question was asked: Are ye not of much more value than the birds of the heaven? Does the Mind need no aliment? And is the veto to be applied only when animals are to be used for the purposes of elucidating the kindly functions of Physiology, or of disclosing the baneful secrets of Disease?[29]

The vicarious suffering and sacrifice of animals in the service and the salvation of Man have obtained throughout the Ages, and constituted the basis of the elaborate ceremonial system of the Ancient Israelites. In anticipation of the great Passover, Moses directed the Israelites each to kill a lamb according to their families, and to sprinkle its blood upon the lintel and the two side posts. "For the LORD will pass through

to smite the Egyptians; and when He seeth the blood upon the lintel, and on the two side posts, the LORD will pass over the door, and will not suffer the destroyer to come into your houses to smite you." The complete purification of *one* leper and his reception back into Society involved not only the slaughter of three lambs, but the convalescent had to appear with two living clean birds, one of which was slain, while the other, still living, was baptized in the dead bird's blood and then allowed to fly away free. The principle of substitution was actualised in the ceremony of the Scape-Goat. At the annual Feast of Expiation, a young bullock, two kids, and one ram were slain; and two goats were taken upon which lots were cast, one lot for Yahwè, the other for Azazel. The goat on which the lot fell for Yahwè was sacrificed for a sin-offering; but the goat upon which the lot fell for Azazel was presented alive, and when the high priest had symbolically placed upon its head the sins and transgressions of all the people, the goat was led into the desert, there to become the victim of hunger and thirst, and the prey of ravenous bird and beast.

Are these hecatombs to be regarded as of Divine origin and sanction, while the inoculation of a cat or dog, or it may be a rat, is to be denounced as a desecration and a violation of the purposes and will of God? Who will say but that in our day, as the Angel of Death passes through the land, seeing upon us the sprinkling of the immunising blood, takes that

for a token, and is not suffered to come into our houses to smite us? "Dipt in his fellow's blood the living bird went free"; and so we, dipped in blood, aye, the blood of our fellow-man, as the annals of Medical Martyrology bear witness, we enjoy a growing freedom from plague and pestilence and noisome disease, sure that in the fulness of knowledge the measure of our freedom will be full.

REFERENCES AND NOTES.

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1 W. Windelband, *A History of Philosophy*. Eng. trans. by J. H. Tufts. New York, 1893, p. 11.

2 Aristotle, *Analytica Posteriora*, lib. I. c. viii. sec. 1.

3 Frank Buckland, *Curiosities of Natural History*. Fourth Series.

4 After the Battle of Arginusæ. See E. Curtius, *The History of Greece*, Eng. trans. by A. W. Ward, vol. iii. pp. 502–514; G. Grote, *A History of Greece* (in 12 vols.), vol. vii. pp. 414–446; C. Thirwall, *The History of Greece*, vol. iv. pp. 106–122.

For an interesting and learned account of the ancient Greek and Roman ideas of Sepulture, see Paul de Saint-Victor, *Les Deux Masques*, Paris, 1882, vol. ii. chaps. xii–xiii.

5 *Qur'ân*, Sura, xlvii.: "How will it be when the angels take their Souls, smiting their faces and their backs."—PALMER'S translation, pt. ii. p. 232.

"Munkir and Nakîr are the two angels who preside at 'the examination of the tomb.' They visit a man in his grave directly after he has been buried, and examine him concerning his faith. If he acknowledges that there is but one God, and that Mohammed is his prophet, they suffer him to rest in peace, otherwise they beat him with iron maces . . . . they then press the earth down on the corpse, and leave it to be torn by dragons and serpents till the day of resurrection."—*The Qur'ân*, trans. by E. H. Palmer. Part I. Introd. p. lxix. See also T. P. Hughes, *Notes on Muhammadism*, 3rd ed. London, 1894, p. 80.

6 Albucasis, *De Chirurgia*, ed. J. Channing, Arabice et Latine. Oxon, MDCCLXXVIII. tom. i. pp. 2–5; L. Leclerc, *La Chirurgie d'Abulcasis*, French trans., Paris, 1861, p. 6.

7 William Hunter, in a letter addressed to Dr. Cullen and dated 2nd April 1765, says :—

"Dear Sir,

I have felt disappointment myself, and therefore can easily imagine what you must feel in meeting with such opposition to a scheme which I know to be of so much more consequence to the public than it can be to yourself. Mine was to have founded a perpetual school for Anatomy here. I will one day or other send you a copy of my Memorial to the Ministry. In short, without asking anything for myself, but, upon the contrary, declaring I would have nothing, I only asked a piece of ground to build upon, and offered to lay out £7000 immediately on a building, with every convenience for anatomy, and obliging myself to give it to the public the moment it was built; and said further, that I meant, but would not now oblige myself, to give likewise my preparations and books. My library has already cost me I presume between £3000 and £4000; and my anatomical museum is of more worth to the public, because they are things that cannot be bought. I am resolved never to be much richer than I now am. I am independent, and wish to do something that shall be mentioned when the few years which I have to live are gone. Now, you shall see to what purpose all this. I should like to be joined with you in the end of life as in the beginning. You have been ill-used at Edinburgh, as I have been at London. Could you make a sacrifice of the few more guineas you would receive by practise at Edinburgh, and join with me to raise a School of Physic upon a noble plan at Glasgow? I would propose to give all my Museum and Library, and build a Theatre at my own expense; and I should ask nothing for teaching but the credit of doing it with reputation. You and Black and I, with those we could choose, I think could not fail of making our neighbours stare. We should at once draw all the English, and, I presume, most of the Scotch, students. Among other reasons, I should not dislike teaching anatomy near my two friends, the Monroes, to whom I owe so much.

"I will say no more at present upon this subject, I mean only to throw it out to you for your consideration, and shall be glad to have your thoughts in general upon the plan. I would not have you say anything of it to any person, except in confidence to any

sensible friend whose opinion you may choose to take. I shall explain myself further whenever you please. Let me now only say, before I put my name to this, neither of us have been well used, and it is in our power to do ourselves immortal honour. I am, as you well know, dear Sir, always your most obliged,

WILLIAM HUNTER."

John Thomson: *Life, Lectures and Writings of William Cullen.* Edin. & Lond., MDCCCLIX. vol. i. p. 150.

8 Aristotle, *De Animalibus Historiæ*, lib. I. cap. 16.

9 Cline in the Hunterian Oration delivered in the year 1824 says:—"I had the happiness of hearing the first course of lectures which John Hunter delivered. I had been at that time for some years in the profession, and was tolerably well acquainted with the opinions held by the surgeons most distinguished for their talents then residing in the metropolis. But having heard Mr. Hunter's lectures on the subject of disease, I found them so far superior to everything I had conceived or heard before that there seemed no comparison between the great mind of the man who delivered them and of the individuals, whether ancient or modern, who had gone before him."

10 Drewry Ottley, *Life of John Hunter* in the *Works of John Hunter*, ed. by J. F. Palmer. Lond. 1837, vol. i. p. 31.

11 Bacon, *Historia Densi et Rari.* "Pulsus cordis et arteriarum in animalibus fit per irrequietam dilatationem spirituum, et receptum ipsorum, per vices."—*Works*, ed. Ellis, Spedding & Heath, 1876, vol. ii. p. 263; also vol. v. p. 358.

12 Stanley Jevons, *The Principles of Science*, 2nd ed. 1877 p. 577.

13 John Grote, *Exploratio Philosophica.* Cambridge, 1865 pt. 1, p. 208

14 R. Leslie Ellis, *General Preface to Bacon's Philosophical Works*, in ed. of Spedding, Ellis & Heath. Lond., 1875, vol. i. p. 24.

See Aristotle, *Analytica Priora*, ii. 23, and *Topica*, i. 10.

15 Aristotle, *Metaphysica*, xiii. 4.

Δύο γάρ ἐστιν ἃ τις ἂν ἀποδοίη Σωκράτει δικαίως, τούς τ' ἐπακτικοὺς λόγους καὶ τὸ ὁρίζεσθαι καθόλου.

This is given lib. XI. c. iv. in A. F. Didot's Paris edition of Aristotle, vol. ii. p. 615.

16 Augustus de Morgan, *A Budget of Paradoxes*. Lond., 1872 pp. 55–6.

17 Nostra vero inveniendi scientias ea est ratio, ut non multum ingeniorum acumini et robori relinquatur; sed quæ ingenia et intellectus fere exæquet. *Nov. Org.* i. 61.

18 J. H. W. Stuckenberg, *Introduction to the Study of Philosophy*. New York, 1888, p. 100.

19 *Works*, vol. i. p. 208.

20 See J. P. Cooke, *The Credentials of Science*, 3rd ed., London, 1893, p. 64, where these qualities, which characterised Kepler, are described as essential conditions of success in scientific research.

21 *Works*, vol. iv. pp. 423–4.

22 F. A. Lange, *History of Materialism*, trans. by E. C. Thomas, 2nd ed. Lond. 1879, vol. i. p. 180, n. 19.

23 *Œuvres complètes d'Ambroise Paré*, ed. Malgaigne. Paris, 1840–41, t. ii. p. 127 seq. and p. 133.

24 Celsus: *De Medicina*, lib. V. cap. 26, sec. 21.

> Quod si illa quoque profluvio vincuntur, venæ, quæ sanguinem fundunt, apprehendendæ, circaque id, quod ictum est, duobis locis deligandæ, intercidendæque sunt, ut et in se ipsæ coëant, et nihilominus ora præclusa habeant.

25 L. Cossa, *Guide to the Study of Political Economy*, trans. from 2nd Italian ed. London, 1880, p. 36. In the revised and enlarged edition published in 1893 as *An Introduction to the Study of Political Economy*, "Experiment" it is stated "reaches the climax of possible perfection by reproducing phenomena under such variations as the subject in hand requires," p. 72.

26 *Works*, vol. iv. p. 86.

27 The Éloge of Cuvier on Sir Joseph Banks in 1821 regarding the Work of the Royal Society during the period of forty-one years of his presidency, gives eloquent expression to scientific and intellectual achievements of Englishmen at the end of the eighteenth century and the early part of the nineteenth. The period covered by Sir Joseph's presidency included the last thirteen years of John Hunter's life.

"During this period, so memorable in the history of the human mind, English philosophers have taken a part as glorious as that

of any other nation in those labours of the intellect which are common to all civilised peoples: they have faced the icy regions of both poles; they have left no corner unvisited in the two oceans; they have increased tenfold the catalogue of the kingdoms of nature; the heavens have been peopled by them with planets, with satellites, with unheard-of phenomena; they have counted, so to speak the stars of the Milky Way: if chemistry has assumed a new aspect, the facts which they have furnished have mainly contributed to this change: inflammable air, pure air, phlogisticated air, are due to them; they have discovered how to decompose water; new metals in great number are the outcome of their analyses; the nature of the fixed alkalies has been demonstrated by none but them; mechanics at their call have worked miracles, and have placed their country above others in nearly every line of manufacture."

J. T. Merz, *A History of European Thought in the Nineteenth Century*. London, MDCCCXCVI. vol. i. p. 235.

28 Hunter was one of the founders of the Veterinary College and took much interest in its work. He granted to the pupils attending there free admission to his lectures. Ottley, *Life*, p. 125.

29 In the *Advancement of Learning*, Bacon suggests and defends the use of experiment on living animals.

"Though the inhumanity of *anatomia vivorum* was by Celsus justly reproved; yet in regard to the great use of this observation, the inquiry needed not by him so slightly to have been relinquished altogether, or referred to the casual practices of Surgery; but might have been well diverted upon the dissection of beasts alive, which notwithstanding the dissimilitude of their parts may sufficiently satisfy this inquiry." Book II. *op. cit.* vol. iii. p. 374.

Celsus, it may be remarked, reproved the dissection of living *men*, "vivorum hominum alvum atque præcordia incidi," *op. cit. Proemium*.

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