The debt of science to medicine : being the Harveian oration delivered before the Royal College of Physicians of London on St. Luke's Day, 1924 / by Archibald E. Garrod.

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THE HARVEIAN ORATION

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by

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Regius Professor of Medicine in the University of Oxford
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and to the Hospital for Sick Children
Fellow of the College

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Oxford University Press
London Edinburgh Glasgow Copenhagen
New York Toronto Melbourne Cape Town
Bombay Calcutta Madras Shanghai
Humphrey Milford Publisher to the University

Printed in England

THE DEBT OF SCIENCE TO MEDICINE

Mr. President and Fellows of the College,

More than two centuries and a half have passed since the most illustrious of our Fellows founded the Festival which we celebrate to-day, and directed that an oration should be delivered by one of our number. Upon the long list of Harveian orators are many names familiar wherever medicine is studied, and amongst them those of my six most recent predecessors in my chair. I esteem it a great honour that you, Sir, should have thought me worthy to stand here to-day, and to deliver Harvey's message.

It will be my endeavour to follow the injunctions which he laid down : to commemorate the great men of the past, benefactors not only to this College but to the human race ; to exhort our brethren to work together in peace and amity, and to urge them to pursue the study of our science, by methods of which he himself made such good use.

Ever since this College was founded its Fellows and Members have, generation by generation, brought their several stones to the building of the house of medicine. Upon its Roll are names of ' men in their generation famous, and in ours never to be forgotten ', men of genius whose fame as discoverers and as pioneers, in medicine and in other branches of natural science, is world-wide and will never die ; and of some highly distinguished in other walks of life, great scholars, such as Linacre and Caius, poets and philosophers. Upon it, too, are names of generous benefactors to scientific education, such as John Radcliffe and Matthew Lee, and of commanding personalities,

patrons of science, art, or letters, such as Richa
Mead, the Maecenas of his day.

But these great ones form only a small minorit
and most of those upon our lists were men of less
stature ; but as teachers who handed down to the
pupils the treasures of their observation and experienc
busy practitioners, keen observers, or men of varie
culture, few of them can have failed to add somethir
to the sum of human knowledge. Yet many of the
names recall no memory, or have attained to that mo
arid form of immortality, to serve as labels for malac
or symptom. But, collectively, the work which the
did counts for much, and those of us who are conscio
that we shall leave no ' footprints on the sands
time ' may take courage from the thought that we tc
are helping to do the spade-work for some futu
Harvey.

On this occasion it is only fitting that speci
mention should be made of one born just thre
hundred years ago, and who, although, owing t
a technical obstacle now long obsolete, he was nc
a Fellow of this College, held its licence ; and w
may associate in our celebration the names of Willia
Harvey, the physician to King Charles and th
immortal founder of modern physiology, and Thoma
Sydenham, the soldier of the Parliament, who did fc
clinical medicine what Harvey did for physiology, an
brought it back from the realm of fancy to the bec
side study of signs and symptoms. These two mer
Harvey and Sydenham, each pre-eminent in his ow
line, were wholly unlike in their outlook, and althoug
contemporaries are not known ever to have met.

Sydenham, at the mention of whose name th
illustrious Boerhaave used to raise his hat, has bee
called the English Hippocrates, and by this College
on his monument, ' Medicus in omne aevum nobilis '
Certainly no man ever had, in greater degree, the gif
of conveying, in a few sentences, a vivid picture o

morbid state, and even though we may rejoice that hose dear to us are no longer treated in accord with is prescriptions, we realize that he opened a new era f therapeutics. To him must be assigned a high lace among our benefactors.

The history of medicine traces back to the birth of ur race, and even beyond, for we know that the lower nimals have therapeutic instincts. From the outset reatment has been shaped by prevalent notions of the ature of disease, and maladies provoked by the enmity f a primitive deity, or by the malicious magic of fellow creature, are only likely to be cured by magical nethods. In Osler's words : ' To a very definite but ntirely erroneous pathology, was added a treatment ational in every respect, had the pathology been orrect.' The primitive medicine and the art of the nedicine-man survive to this day among the savage aces of the earth, and he would be a bold man who hould deny their survival amongst those races which egard themselves as the highest products of civiliza- ion. Are any of us wholly free from such ideas ?

For ages medicine has striven to shake off her bonds, nd to attain to the status of a science. The first act f the drama was staged in ancient Greece. We know vell that the true spirit of inquiry, the desire for knowledge for its own sake, was innate in that wonder- ul race, of which the intellectual life centred around he city in which the people ' spent their time in nothing else, but either to tell or to hear some new hing '. The legacy of Greece embodies not only the Parthenon and the Erechthaeum, the sculptures of Pheidias and Praxiteles, the plays of Aeschylus and Euripides, the thoughts of Socrates and the works of Plato. Greece gave us also Aristotle and Hippocrates. Only the true spirit of science could have prompted he minute and accurate research into the structure nd functions of living things which are embodied in

the writings of Aristotle, or the pictures of dise and its symptoms to be found in the clinical reco of Hippocrates. Do we not still speak of the ' fac Hippocratica ' and of Hippocratic succussion ?

We cannot doubt that there were forerunners Aristotle, nor that much of the knowledge embodi in his books had been collected by lesser men. N can we doubt that there were scientific physicia before Hippocrates, men of the schools of Cnidus a Cos, some of whose writings are included in t Hippocratic corpus. Indeed, Aristotle, whose lifetir overlapped that of Hippocrates, bears witness to th when he speaks of physicians as men who usual base their medical theories upon principles deriv from physics.[1] We must rather suppose that, li other men of genius, Hippocrates illuminated a crystallized the floating knowledge in the atmosphe of the Asklepieion. But Hippocrates was somethir more than a man of science, for when we read wh he has written we realize that the most cherish traditions of our profession, the rules of its conduc were inherent in the Father of Medicine, the auth of the Hippocratic oath.

When, at a later period, the centre of Greek medicir shifted to Alexandria, Erasistratus and Herophilus ha opportunities for the practical study of human anatom such as none had before them ; and in the secon century of our era, the Greek tradition culminated i the life and writings of Claudius Galen, a grea physician, a true inquirer of Nature, author of man treatises, imbued with the spirit of Hippocrates, bu not so great as he. It was the strange fate of thi man to be set up as an oracle, to be regarded for mor than a thousand years as infallible and his statement as admitting of no appeal. Then after Galen th curtain falls, to be rung up again only in the sixteentl century of our era.

[1] *De Sensu*, i, Tr. J. A. Smith and W. D. Ross, Oxford.

During that long inter-act the races which had verthrown and overrun the empire of Rome were eing educated *de novo*, to appreciate the culture which ney had destroyed. Meanwhile, the keeping of the orks of the ancient physicians passed to the Arab ces, and for centuries were only known in Syriac or rabic translations, or in re-translations from those ngues into Latin. Then in the end science stirred her sleep in the thirteenth, and finally re-awakened the sixteenth century. There was indeed much eway to be made up. Even as late as in the year 559 Dr. John Geynes was cited before this College ecause he impugned the infallibility of Galen, and as obliged to sign a solemn recantation of his error : Ego Johannes Geynes fateor Galenum, in iis quae roposui contra eum, non errasse.' Surely, in the lysian fields, the shade of Galen chuckled!

Great as were the achievements of the fathers of edicine, they began to construct their edifice with he attics. Their anatomy was almost wholly that of he lower animals, the physiology of Galen seems to s grotesque, and the sciences upon which anatomy nd physiology rest were hardly yet born. If medicine ere to be established upon a scientific basis, the tructure needed to be firm from the ground upwards, nd from the sixteenth century onwards the founda- ion sciences, and those which form the lower stories, ave been cultivated and advanced largely by medical hen who saw them to be essential to the progress of heir own science and art.

So medicine, oldest of applied sciences, older indeed han the sciences applied, has through the ages urthered the growth of natural knowledge. How rofound her influence has been, and how it has been xerted, it is my present aim to show.

Research and education are closely linked ; but whereas from their earliest days there have existed, in

the universities of Europe, the three profession faculties of Divinity, Law, and Medicine, that Natural Science is of quite recent development. F the student with a scientific bent two paths were open he might either attach himself to the Faculty Medicine, or might approach his chosen studies b way of mathematics.

Even down to the seventeenth century, or late the university course in medicine was almost whol theoretical. The Professor expounded to his pupi the writings of Hippocrates and Galen, together wi those of some of the great Arabians, such as Avicen and Rhazes. Such were the duties assigned by Linac to his lecturers at Oxford and Cambridge, and tho of the Regius Professors at those ancient seats learning. Thomas Molyneux (1661–1733), a your graduate of Dublin, where he was afterwards Profess of Medicine, visited Oxford in 1683, and heard th Regius Professor, Dr. Luff, ' read on the first aphoris of Hippocrates in the Physic School ; where givin an account of the shortness of man's life since, ar the length of it before the flood, he made up Mr. Burnett's fancy, not at all altered but in th word '.[1] No wonder that Molyneux was not divert from his purpose to continue his studies at Leyde where clinical medicine was being taught in a unive sity clinic.

Elsewhere clinical knowledge was acquired by atte dance upon the practice of a physician or surgeo a system of apprenticeship which has this to its credit- that out of it has grown the English system of bedsi instruction to small groups of students.

The first attempt to start clinical teaching with a university was made in Padua in the late sixteen century, but the first organized clinic was that Leyden, started in or about the year 1630.

The study of science for its own sake, apart fro

[1] *Dublin University Magazine*, 1841, xviii, p. 323.

ny professional applications, began again in the six-eenth century, and was active in the century which llowed. In this country Oxford took a large part in he renascence of pure science. There Robert Boyle, he 'father of chemistry', set up his private laboratory n 1654; and around John Wilkins, Warden of Wadham—the college of Mayow and Sydenham, and ne to which science and medicine owe much—there athered a group of men eager for the advancement f natural knowledge, who, with the members of the Invisible College' in London, formed the nucleus of he future Royal Society. In the same century chairs f Astronomy, Natural Philosophy, Anatomy, and Botany were founded in Oxford, and the Botanic Garden was established.

In 1657 Thomas Millington (1628–1704), a President of this College, was made Sedleian Professor of Natural Philosophy; and the first Savilian Professor f Geometry and Astronomy, John Bainbridge (1582–643), was also one of our Fellows.

How large a part members of our profession played n this reawakening of science is shown by the large roportion of medical men among the original Fellows f the Royal Society. Of the total of 115, which ncluded peers, clerics, and distinguished people such s John Evelyn and Samuel Pepys, only a small proortion were men of science in any strict sense, and f these no less than 25 were Doctors of Medicine, hilst 21 were Fellows of this College.

In the reawakening of *medical* science Italy took the ad, especially in the study of anatomy. Of her niversities, Padua, under the enlightened rule of the enetian Republic, became the chief centre of medical aching in Europe, and thither repaired the pick of ur English students to profit by teaching such as ey could not obtain at home. Later, when the star Padua paled for a time, Leyden took its place as e cynosure of students of medicine.

Of the professions open to him in former centuri that of medicine would obviously make most appe to the youth of scientific bent, and as L. C. Mi puts it in his book on *The Early Naturalists* :

'The medical school furnished the only regular training f the naturalist, whilst he found in the medical profession t likeliest means of earning his bread.'

In his Rectorial Address to the University of Abe deen, delivered in 1874, Huxley[1] brought out th same point, with even wider application, when h said : 'Within my recollection, the only way in whi a student could obtain anything like a training physical science was by attending the lectures of pr fessors of physical and natural science attached to th medical schools.'

Still more striking is the following passage fro the same Address:

'In the days when all the innumerable applications physical science to practical purposes were non-existent ev in dreams ; days which men living have heard their fathe speak of, what little physical science could be seen to be directly upon human life lay within the province of medicin Medicine was the foster-mother of chemistry, because it h to do with the preparation of drugs and the detection of poison of botany because it enabled the physician to recognize medicin herbs ; of comparative anatomy and physiology, because th man who studied human anatomy and physiology for pure practical purposes was led to extend his studies to the rest the animal world.'

Now that the practical applications of science a so far greater even than when these words were spoke and a course of scientific training is necessary desirable as a preparation for so many walks of lif there have sprung up schools of physical science which the Royal School of Mines and the Colleg

[1] *Science and Culture,* Universities : Actual and Ideal, Lect. I p. 47.

f Chemistry, now fused into the Imperial College of cience, were the earliest to be established in this ountry. Our universities also teach science in all its ranches, and grant degrees therein. In a word, cience has been weaned from its foster-mother.

Seeing, then, that in the past medicine has supplied pportunities of education for students of natural hilosophy and natural history, and has, at the same ime, supplied a stimulus to their researches, it need ause no surprise that our profession can claim, mongst its most honoured members, not a few whose ork has inaugurated new epochs in widely diverse ranches of natural knowledge.

At first sight it would appear that astronomy, to hich the natural approach is through mathematics, s as remote from medicine as any science can be ; ut there was a time when the pseudo-science of strology supplied a close tie between the study of the tars and that of disease. The medieval physician as profoundly influenced by the horoscope of his atient, and studied the motions and conjunctions of he planets to obtain such help in diagnosis and rognosis as is afforded nowadays by the blood-count r electro-cardiogram. He was expected to have some nowledge of astrology, and even in the sixteenth entury there were amongst our Fellows such men s Thomas Twyne (1543–1613), who gained more ame as an astrologer than as a physician, and some ote as a poet.

True medical astronomers, on the other hand, have een few in number ; but Nicholas Copernicus 1473–1543), who revolutionized man's ideas of the niverse, was a physician, and amongst lesser lights nention may be made of our Fellow John Bainbridge.

Another science which has little contact with

medicine is geology, save in so far as the nature o soils has bearings upon public health ; but medic men have played very important parts in its advanc ment. Thus, Nicholas Steensen, commonly calle Steno (1638–86), who discovered the parotid du which bears his name, may be described as one of th founders of geology and mineralogy. Most of h active life was spent in Florence, where he held th post of physician to two successive Grand Duke Of him Von Zittel wrote, in his *History of Geolog* that he was the first who sought to solve geologic problems by inductive reasoning. He threw muc light upon the formation and structure of crystal and, as Leonardo da Vinci had done a century an a half earlier, he maintained that fossils are the remair of actual animals and plants of former epochs. H ended his life as a Catholic bishop, and his ascet habits undermined his health. This brilliant Dane entitled to rank among the great ones of scienc as anatomist, geologist, mineralogist, and physician but his researches, so far in advance of h time, only received their due recognition aft much of his work had been done over again b later investigators.

John Woodward (1665–1728), Professor of Med cine at Gresham College, and Fellow of this Colleg also holds a distinguished place in the annals o geology. By his observations he acquired a mos extensive knowledge of the structure of the earth crust, and had learnt much as to the superpositio of the various strata, but he propounded a fantasti hypothesis that the whole globe had been taken t pieces at Noah's flood, and that from the resultin 'promiscuous mass' the various strata had bee deposited in quick succession. He bequeathed hi collections to the University of Cambridge, where the form the nucleus of the museum which bears his name Woodward was less eminent as a physician than a

geologist, and was evidently a quarrelsome fellow, or he forfeited his Fellowship of the Royal Society because he insulted Sir Hans Sloane, to whom he refused to apologize ; and a quarrel with Mead, over the treatment of small-pox, led to a passage of arms, in which the sword of Mead but the tongue of Woodward gained the mastery. 'Take your life,' said Mead. 'Anything but your physic,' was the reply.

The celebrated James Hutton also (1726–97), who propounded the rival and sounder theory that the moulding of the crust of the earth has been effected gradually, by processes such as are now at work, was a Doctor of Medicine of Leyden, but soon abandoned the idea of medical practice.

In more recent times the presidential chair of the Geological Society has been occupied by William Babington (1756–1833), Physician to Guy's Hospital, and by John Whittaker Hulke (1830–95), Surgeon to the Middlesex Hospital, to whom that Society awarded the highest prize in its gift—the Wollaston Medal, founded by our former Fellow the distinguished chemist and mineralogist of that name.

Physics and chemistry are the fundamental sciences upon which physiology and medicine rest, and throughout their history they have been closely associated with medicine. Galileo Galilei (1564–1642), equally pre-eminent as astronomer and physicist, was a student of medicine when he watched the swing of the lamp in Pisa Cathedral, and so discovered the law of the pendulum. It was by his pulse that he timed the swing, and the first use which he made of his discovery was to construct an instrument to measure the frequency of its beats. The other outstanding physicist of the sixteenth century was a Fellow, and sometime President of this College, William Gilbert (1540–1603), founder of the science of magnetism, who

recognized the earth's magnetic properties. Of hi
Dryden [1] wrote :

> Gilbert shall live till loadstones cease to draw,
> Or British fleets the boundless Ocean awe.

This College can also claim amongst its Fellov
one of the most brilliant men of science whom ou
country has produced, Thomas Young (1773–1829
whose discoveries in optics, and especially that of th
interference of light, went far to establish the undu
latory theory. He was the first to detect astigmatism
and threw much light upon the mechanism of th
eye and upon colour vision. He was also a gre
linguist, and by his work on the Rosetta stone aide
materially the interpretation of the demotic text ther
of. Yet he found time to hold the office of physicia
to St. George's Hospital, and to practise medicine.

Amongst other great medical physicists I may reca
the name of Luigi Galvani (1737–98), physician an
anatomist, who was led to the discovery of curren
electricity by his investigations of the electric organ
of certain fishes ; William Charles Wells (1757
1817), who solved the problem of dew ; Julius Maye
physician of Heilbronn, to whom is due some of th
credit of the determination of the mechanical equiv
lent of heat ; and, in our own time, Hermann vo
Helmholtz.

There was a time, towards the end of the seventeent
century, when a dominant position in medical thoug
was held by a group of so-called iatro-physicists, wh
influenced by the work of Galileo and his follower
and by the views on physiological problems of tw
great mathematicians—Descartes (1596–1650) an
Borelli (1608–79)—endeavoured, but with far les
competence, to extend them to all physiological pro
cesses by the supposed action of forces upon particle
of various shapes and sizes. Like the iatro-chemist

[1] Dryden, Epistle III, *To Dr. Walter Charleton.*

whom they superseded, they went too far, had their day, and passed. In the true line of succession from Borelli, on the other hand, was James Jurin (1684–1750), a Fellow of this College and physician to Guy's Hospital. He was an eminent mathematician and physicist, whose aim it was to make physiology an exact science.

With chemistry the links are even closer. The alchemist, who sought to prepare the elixir of life, had kindred aims to those of the physician. Later, in the period of the iatro-chemists—followers of Paracelsus, van Helmont, and Sylvius—medicine was regarded as a mere branch of chemistry, and physiology as a study of fermentations—curiously like, and yet quite unlike, the physiology of to-day. A more practical tie between chemistry and medicine was provided by the chemical side of pharmacy and the study of poisons.

It was not until the seventeenth century that chemistry began to be studied as a pure science—in the days of Robert Boyle, upon whom, as an appropriate recognition, Oxford bestowed the degree of Doctor of Medicine, and others who, like him, were actuated by a desire to know the nature and composition of things. At Oxford, the second holder of the short-lived Ashmolean Professorship of Chemistry, Edward Hannes (d. 1710), was a physician ; in the early years of the eighteenth century lectures on chemistry were given by John Freind (1675–1728), a Fellow of our College and Harveian Orator, and by several other medical graduates ; and the first holder of the Aldrichian chair, founded in 1803, was John Kidd, afterwards Regius Professor of Medicine.[1]

In the earlier days a knowledge of practical chemistry was only to be acquired by students in the shops of apothecaries, and as a scientific training this left much to be desired. It was Vauquelin (1763–

[1] See R. W. T. Gunther, *Early Science in Oxford*, vol. i, p. 50.

1829) who first organized courses of instruction
his own laboratory in Paris, and this method w
followed by Thenard (1777–1857) and Gay-Luss
(1763–1829), and greatly extended by Liebig (180
73). Ernst von Meyer states that the laboratory
Thomas Thomson (1773–1852), a Doctor of Medici
of Edinburgh and Professor of Chemistry in Glasgo
was the first to provide practical teaching in Gre
Britain, and it was not till 1845 that the College
Chemistry was established in London, with A. V
Hofmann as its director.

The list of physician chemists is a long one, a
only a few of the most eminent can be mentione
First may be recalled John Mayow (1643–75), o
of the greatest of them all. Mayow stands high
the roll of physiologists, as well as on that of chemist
From the point which he reached, only one st
remained to the complete explanation of respiratio
and combustion, and but for his too early death t
discovery of oxygen would almost certainly have be
antedated by a century, and phlogiston would nev
have been heard of. Although a Doctor of Civil La
Mayow practised medicine at Bath.

A contemporary of Mayow was our Fellow Thom
Willis (1621–75), whose work upon the anatomy
the brain is commemorated by the circle of arteri
which bears his name. But Willis was also no mea
chemist, and to him we owe the discovery of glycosuri

Mention must be made of Friedrich Hoffmann
Halle (1660–1742), a contemporary of Boerhaave, an
of the illustrious Herman Boerhaave (1668–173
himself, whose treatise on chemistry was long the be
text-book of the subject. Yet, eminent as Boerhaav
was as a chemist, it was as a physician and Professo
of Medicine that he was pre-eminent, and it wa
during his tenure of its chair of physic that Leyde
as a school of medicine, reached its zenith.

Cullen (1710–90), Joseph Black (1728–99), th

iscoverer of latent heat, and Wöhler (1800–82), ho, by his synthesis of urea, bridged the imaginary ap between inorganic and organic compounds, were l members of our profession who made notable con- ibutions to chemical knowledge.

It was a Professor of Medicine of Halle, Georg rnst Stahl (1660–1734), who propounded the strange heory of phlogiston, which, like the Old Man of the ea, clung around the neck of chemistry and obsessed hemists for more than a century. This hypothesis, hich presented an inverted picture of the truth, like glove turned inside out, was upheld by men of the ighest ability, and by none more tenaciously than by ich men as Priestley and Scheele, whose own re- arches were knocking away the props upon which rested.

The great Swedish man of science, Berzelius (1779–848), the foremost chemist of his time, and the ventor of our system of chemical symbols and rmulae, was a Doctor, and for a time a Professor, f Medicine ; and it was by his friend Alexander Marcet, a Fellow of this College, and one whose rvices to biochemistry are not sufficiently remem- ered, that Berzelius was led to illustrate his lectures y experiments.

Two more physician chemists may complete our eries—William Hyde Wollaston (1766–1828), a ellow of this College, a most eminent man of cience, whose contributions extend over physiology nd pathology, mineralogy, optics, botany, and, above ll, chemistry ; and William Prout (1785–1850). Vollaston discovered the malleability of platinum, property of great value to chemists and physicists like, detected cystin in urinary calculi, and invented he camera lucida. Prout was one of the founders of iochemistry, and discoverer of the hydrochloric acid n the gastric juice. His much-discussed hypothesis, sually spoken of as ' Prout's law ', that the atomic

weights of other elements are multiples of that
hydrogen, and that hydrogen is the basal substan
from which all the other elements are formed, has lo
served as a potent stimulus to observation and researc
and now, in a sense, is coming to its own.

In these later days the ties between medicine a
chemistry are being knit more closely than ever befo
Most drugs of recent introduction are, like aspir
by-products of the gas-works or dye factory, or, li
salvarsan and its allies, synthetic products of t
laboratory. But far more important to the progr
of medical knowledge is the light which is bei
thrown, by the rapid advance of biochemistry, up
the problems of metabolism and chemical structure
the body.

The history of other sciences tells a like sto
Almost all the early botanists were medical men, a
the chief stimulus to the study of botany was t
search for useful drugs. This is true even of classi
times, the days of Theophrastus and of Dioscorides
The early scientists were with few exceptio
such as Archimedes, observers rather than expe
menters, and the mere differentiation and naming
genera and species—a branch of science which da
back to the Garden of Eden, and of which that gr
naturalist Linnaeus was a brilliant exponent—afforc
an immense field of work. Of the *Materia Medica*
Dioscorides Charles Singer writes :

> ' Its history has shown it to be one of the most influen
> botanical treatises ever penned. It provided most of the li
> botanical knowledge which reached the Middle Ages.
> furnished the chief stimulus to botanical research at the t
> of the Renaissance.'

In the fifteenth and following centuries a long l
of medical botanists carried on the tradition, includ
Brunfels (1484–1534), Fuchs (1501–66), Bock (149
1554), and Gesner (1516–65), the most lear

turalist of his century, botanist, zoologist, artist, d professor of Greek, who died of plague whilst ithfully carrying out his duty, as town physician at ürich, during an epidemic of that malady.

But to quote Miall once more : ' It was generally lieved that for every ill that flesh is heir to, Nature d designated some plant as the appropriate cure '; d again, ' Some believed that Providence had caused rticular plants to grow in those districts where e diseases which they cure are prevalent '. Can be denied that such tenets are held by millions at e present day ?

The high distinction of having initiated the study vegetable anatomy and physiology, those higher anches of botany, is shared by two men of the venteenth century, both of whom were physicians.

One of them, Nehemiah Grew (1641–1712), we ay proudly claim as a Fellow of our College. He was who first recognized the sexes of plants and the nctions of the stamens, but he himself gives some the credit for this to our former President, Thomas illington. Of Grew, Hallam wrote that ' no man, rhaps, who created a science has carried it farther ', t he must share the renown with no less a colleague an Marcello Malpighi (1628–94), in whose splendid cord the study of plant anatomy takes but a minor ace. A professor of medicine, zoologist, and botanist, under of the science of embryology, elucidator of e structure of the lung, spleen, and kidney, to Malpighi must be assigned very high rank amongst ose who have contributed to the advancement of tural knowledge.

On the other side, the greatest of systematic otanists, and founder of our system of nomenclature plants and animals, Carl Linné, commonly called innaeus (1707–78), who has been said to have found botany a chaos and left it a cosmos ', was not nly a Doctor of Medicine, but held the office of

Physician to the Swedish Navy, and practised i
Stockholm for a time.

The ties between medicine and zoology are le
obvious, for the search for animal drugs can hard
have led any one to the study of natural history. B
the transition from human to comparative anatomy
easy, and there have been medical zoologists fro
early times. In the sixteenth century we find th
names of Rondelet (1507–66), Belon (1517–64
Conrad Gesner once more, and of our own form
President Edward Wotton (1492–1555), whose worl
De Differentiis Animalium, gained for him a Europea
reputation, but is marked rather by erudition than b
originality of outlook and observation. In the sever
teenth century there lived and worked Malpigh
whose chief contribution to zoology was a very com
plete study of the anatomy of the silkworm ; Swam
merdam (1637–80), the Dutch microscopist who firs
observed the red corpuscles of the blood ; and tw
Fellows of this College—Martin Lister (1638–1712
a man with wide interests and a special bent for th
study of marine and freshwater molluscs; and Edwar
Tyson (1650–1708), the author of monographs upo
the chimpanzee, porpoise, opossum, and rattle-snak
and who first described the patterns upon the finger-tip

In more recent times we may claim the illustriou
John Hunter (1728–93), Richard Owen (1804–92
who was credited with the power of reconstructing a
extinct monster from a single bone, and also on
whose eloquent words still ring in the ears of som
of us, the greatest of medical zoologists, Thoma
Henry Huxley (1825–95).

In reality, botany and zoology are far more closel
allied to medicine than our fathers knew. Since mos
maladies are due to the invasion of the body by lowl
organisms, some animal and some vegetable, we nee
to approach the study of disease from the standpoin
of the invaders which are ever trying to gain a foot

old, as well as from that of the tissues which resent he role of a culture-medium and offer all the resistance h their power. In that struggle, which is waged with arying fortunes, we physicians are the allies of our atients, whose own tissues play the chief part in the efence. In order that our aid should be as efficient s possible, we need to know all that can be learned bout the nature and habits of the invaders, and of the nsects which are the other hosts of some of them; nd the study of bacteria is a branch of botany, and hat of protozoa of zoology.

At the renascence of the *medical* sciences it was h human anatomy that the first advances were made, nd the new anatomy was based upon dissection of he human body. The pioneer of this advance was ndreas Vesalius (1514–64). His work was carried n in Padua. Others had dissected the human body efore him, in Alexandria and at a later time in ologna, but the prevalent teaching of anatomy fol-owed the text of Galen, and was based, almost wholly, pon dissections of monkeys and lower animals.

From Vesalius dates the great period of the medical chool of Padua, during which there taught there, after esalius, Fallopius (1523–62), Fabricius of Acqua-endente (1537–1619), Casserius (1561–1616), and pigelius (1578–1625)—men whose names are written rge upon the organs and tissues of the body. To adua also, despite the difficulties, discomforts, and ven dangers of travel in those times, came students om afar, and amongst them our own Thomas Linacre, ohn Caius, and William Harvey.

As Sir Clifford Allbutt justly said, in his notable Harveian Oration, delivered a quarter of a century ago:

> 'It was in Padua that medicine, long degraded and disguised, as now to prove her lineage as the mother of natural science, nd the truth of the saying of Hippocrates, that to know the ature of man one must know the nature of all things.'

It is not necessary that I should dwell upon th share of medical men in the building up of moder physiology, for from Harvey onwards it has bee almost entirely their work ; but the day has passe in which physiology was regarded as the handmaid c medicine, and it has taken its proper place as a gre independent science.

Morbid anatomy, as an adjunct to clinical medicin dates back to the illustrious Morgagni (1682–1772 and so to Padua once more, and is intimately associate with the other great names of Albert von Halle (1708–77) and Rudolph Virchow. Knowledge of th changes, both great and minute, wrought by diseas in the organs and tissues is still as essential as ever i the training of the physician and surgeon, but morbi anatomy is no longer coextensive with pathology, an the pathology of to-day has entered upon entirely ne fields. So, as we well know, modern pathology ha rendered possible the destruction of the agents c disease, or of their insect hosts before they reach th body—the triumphant achievements of preventiv medicine. Moreover, as the result of the study c immunity, the bacteriologist is teaching us how t apply Nature's own selective remedies in place of th cruder drugs of earlier days.

At the same time, the pharmacologists are bringin to the test of scientific method the actions and use of drugs which have long been used in an empirica way, and are able to explain the proved utility of som which owe their introduction into the pharmacopoei to superstition, or to some grotesque hypothesis.

So, from the foundations of chemistry, physics, an biology, through the lower stories of human anatom and physiology, of pathology and pharmacology, w reach the attics once more, and come back to Hippo crates, to the bedside examination of the sick an

njured. But, now that the foundations have been well nd truly laid, the clinical medicine of to-day is able o advance on scientific lines, and the study of the bnormal can be based upon a knowledge of the ormal.

All who have taken part in this work, all those eroes of science and medicine whose names have een mentioned, may rank as benefactors of this ollege, both those who were its Fellows and those ho were not, and in commemorating them I may laim to have followed Harvey's first injunction.

It is natural, nay inevitable, that as medical science rows and advances, some of the workers in the field hould elect to follow the path which leads through he laboratory, whereas to others the wards make stronger appeal ; and thus is taking place a differentiation of medical workers into distinct groups, nd there is danger that the fission may go too far. The worker in the laboratory, wedded to his more xact methods, and distrustful of those with which the linician is often compelled to be content, is tempted o place his bedside colleague in a lower grade or caste han his own. He is apt to look too much at the isease and too little at the patient, and to forget how greatly the former is shaped by the reactions and idiosyncrasies of the latter.

We all know that a line of treatment resting upon strictly rational basis may be useless or even harmful n an individual case.

It would be nothing short of a calamity were all he best scientific workers who enter our profession o be diverted from its clinical side to laboratory nvestigation, for of no walk of life is it more true han of the practice of our art that ' the multitude of he wise is the welfare of the world '.[1]

[1] Wisdom vi. 24.

From the ranks of the clinical workers have bee drawn those who, in the past, have built up medic science. It was in the intervals of their clinic practice that such men as Harvey himself, Willia Gilbert, Nehemiah Grew, and Thomas Young carrie out the researches which have rendered them for ev famous; and, indeed, clinical medicine is in its essen scientific.

But clinical medicine is an art as well as a scienc and in the sick-room many qualities are called f which are not essential in the laboratory. A man wh is deeply imbued with the spirit of science may pro a very poor practitioner, whereas another, rich common sense, sound knowledge, experience, ar human sympathy, but to whom abstract science mak little appeal, may make a very good one. Tact an equanimity, courage and restraint, patience with fa and sympathy with grief, diagnostic skill and manu dexterity are qualities called for in the daily work the practitioner of medicine or surgery. The marv is that, on the scientific side, he has accomplished s much, not that he has failed to accomplish more. ill becomes his colleagues in the laboratory to thin slightingly of him.

Medicine, indeed, embraces a number of constituen sciences, and for the attainment of her beneficen aims all her branches need to work together in mutu respect, amity, and concord ; to bear in mind Harvey third injunction to that effect, and his reminder that:

' Concordiâ res parvae crescunt, discordiâ magnae dilabuntu

Not only are the diagnostic methods which w employ in accord with the demands of science, bu also, by the bedside study of signs and symptom and the recognition of the morbid anatomical chang with which they are associated, as also by the observa tion of the effects of surgical removal or gunsh

njury of parts, very notable contributions to physiology ave been made.

Consider for a moment how our knowledge of the unctions of the endocrine glands has been obtained. The acumen and care in observation of that splendid linician Addison threw the first ray of light upon the ubject, and removed the adrenal glands from the ealm of mystery into that of observed fact. The radual accumulation of facts concerning exophthalmic oitre, Gull's discovery of myxoedema, Kocher's ob- ervations upon cachexia strumipriva, and the effects f thyroid treatment, provide a connected story of linical work in medicine and surgery, which had its ractical outcome in the restoration to health of many ufferers from myxoedema, the rescue of many cretins rom imbecility and arrest of growth, and the ameliora- on of the lot of many sufferers from Graves's disease. gain, it was the recognition of acromegaly by Pierre Marie, the study of its symptoms and morbid anatomy, he recognition by Fröhlich of the syndrome which ears his name, and that of the other results of pituitary efect, together with the surgical results of Cushing nd others, which led us to our knowledge of the unctions of the hypophysis, knowledge which has een greatly extended by the experimental work of chafer. Moreover, what inklings we have of the unctions of the pineal gland, and of the adrenal ortex, are mainly derived from clinical observations f patients with tumours of those structures.

The chance that an accidental gunshot wound left he French-Canadian Alexis St. Martin with a gastric stula, and that the American army surgeon Beaumont, nder whose care he came, was able to take full dvantage of the opportunity so afforded of studying he secretion and action of the gastric juice, proved f the utmost value in the elucidation of the problems f digestion. And in these times many clinical devices, uch as test meals, duodenal soundings, and bismuth

meals, are throwing yet further light upon phys
logical as well as pathological processes.

The knowledge acquired in recent years of t
mechanism of the heart's action is a triumph
scientific clinical medicine. This work, which is
closely associated with the names of James Mackenz
Thomas Lewis, Wenckebach, and Einthoven, has be
gained mainly by the study of derangements of t
heart's beat in man, by means of the polygraph a
electro-cardiograph.

But perhaps the most striking examples of all a
afforded by the work which has been done upon t
nervous system. Bouillaud described clinical a
pathological physiology as the sister of experimen
physiology, and since the middle of the nineteen
century an immense amount of knowledge of t
functions of the brain and spinal cord has been acquir
by the labours of a band of brilliant investigators,
whom many are our own countrymen, and most wer
or are, physicians or surgeons. Of these I may menti
Hughlings Jackson and David Ferrier, Charles Beevo
Victor Horsley, and Henry Head in this country, a
on the Continent, Hitzig, Erb, Westphal, and Pier
Marie. By their researches they have furthered t
work of the pure physiologists, Sherrington, Gaske
Langley, Gotch, and others.

As regards localization, the first definite ste
indicating that the brain does not function as a whol
but as a congeries of organs, was the localization
Broca of the motor speech-centre, in 1861, which w
based upon the positions of the lesions in fatal cas
of aphasia, and Hughlings Jackson's study of co
vulsions due to cortical lesions. These observatio
served as stimuli and pointed a way which was followe
by many other observers, but by a not unfamiliar iro
of things the assignment of a speech-centre to t
convolution of Broca no longer meets with acceptanc

Lastly may be cited the work of Head upon t
seats of pain due to visceral lesions, and upon epicrit

nd protopathic sensations. It is clear that clinical bservation is the royal road to the study of many inds of sensory disturbance, in which an intelligent ubject who can describe his sensations is needed, and n some instances the investigators have controlled heir clinical observations by experiments upon themelves.

The examples quoted show that, apart from the tudy of disease in bulk, and by statistical methods, here is also much to be learnt from the detailed study f individual cases.

In a letter which Harvey wrote, only six weeks efore his death, to a Dutch physician who had sent im an unusual specimen, occurs the following assage :

'It is even so—Nature is nowhere accustomed more openly display her secret mysteries than in cases where she shows aces of her workings apart from the beaten path ; nor is there ny better way to advance the proper practice of medicine than give our minds to the discovery of the usual law of Nature, careful investigation of cases of rarer forms of disease. For has been found, in almost all things, that what they contain useful or applicable is hardly perceived unless we are deprived f them, or they become deranged in some way.'[1]

These words, as true to-day as when they were vritten, are full of encouragement for those of us for vhom the study of Nature's experiments and mistakes as a special attraction. The structural malformation, r the hereditary and inborn departure from the ormal of metabolism, although unimportant from the ractical standpoint, may throw a ray of light into ome dark place of embryology or biochemistry ; and ot a few of the rare maladies, such as chloroma, olycythaemia vera, sulphaemoglobinaemia, and the isease of which Bence-Jones albuminuria is a sign, ffer fascinating and still unsolved problems of physiogy and pathology.

[1] The works of W. Harvey. Trans. by R. Willis. Sydenham ociety, 1847, p. 616.

Obviously clinical medicine presents immense field of scientific research, and those who cultivate ther have the added satisfaction of knowing that ever advance of medical science will, sooner or later, brin in its train some forward movement of the healing ar

So, as we trace the history of natural science dow through the centuries, we are confronted at ever stage by the influence of medicine upon its progress. The desire to alleviate human suffering, to repai the ravages of disease, and to mend the broken part has served as a powerful stimulus to observation an experimental work. It soon became obvious to th would-be healers that to understand disease they mus needs understand the healthy workings of the organ ism, and that pure science must precede applied. So as Huxley said, medicine became the foster-mother o the sciences. But she became their schoolmistres also, and attracted to herself men whose scientifi abilities would hardly have found an outlet in th other walks of life open to them in the earlier days and them she not only taught, but supplied with mean of livelihood while they pursued their chosen studies Her part was rather that of a mother than of a foster mother. They, in their turn, repaid her care by layin firm foundations upon which a rational healing ar could be built up, and, as we have seen, not a few of them achieved epoch-making results in science outside the range of medicine.

Thus it has come about that immense, and indee incalculable, as is the debt of medicine to the pur sciences, the debt of science to medicine is hardly i at all less great. But these mutual obligations are bu internal debts, and the fact that medicine, in its wides sense, is merely a branch of natural science was recog nized even by Aristotle, who, at the end of his wor on respiration, wrote as follows :

'Our discussion of life and death and kindred topics is nov

ractically complete. But health and disease also claim the ttention of the scientist and not merely the physician, in so ar as an account of their causes is concerned. The extent to vhich these two differ, and investigate diverse provinces must ot escape us, since facts show that their inquiries are, to certain extent at least, conterminous. For physicians of ulture and refinement make some mention of natural science, nd claim to derive their principles from it, while the most ccomplished investigators into Nature generally push their tudies so far as to conclude with an account of medical rinciples.' [1]

Yet, as Huxley [2] pointed out, 'It is a peculiarity f the physical sciences that they are independent in roportion as they are imperfect ; and it is only as ney advance that the bonds which unite them become pparent'. That this is so is far more obvious to-day han when these words were spoken more than forty ears ago. For as we gain more knowledge innumer- ble fresh links are brought to light ; and the unity f natural science is daily being revealed more clearly s the boundaries of its several branches fade and ecome indistinct.

Few will any longer question the view that physio- gy is merely the chemistry and physics of living ings. Physics has captured the structure of the om, is absorbing chemistry into itself, and is be- oming revealed as the great fundamental science f which all the others are but branches. In this reat complex of interlocked studies those which we ass under the comprehensive name of medicine have eir allotted places, and advance in any one branch rwards the progress of the whole. To take our part this progress is alike our privilege and our obliga- on as members of the great band of seekers after tural knowledge.

Upon the ceiling of the cloister of the University

[1] *De Respiratione*, Ch. xxi, Tr. J. A. Smith and W. R. Ross, Oxford.
[2] *Science and Culture*, The Biological Sciences and Medicine, hap. xiii, p. 327.

of Padua there are painted ' stemmata ' which record the sojourn there of many students who were councillors of their several nations, and amongst them are two which bear the name of Gulielmus Harveus, Anglus. Some of the designs are heraldic, but Harvey's is symbolic, nay prophetic. A right hand and arm holds up a caduceus, in which, in place of a lifeless staff, the twin serpents are entwined around a lighted candle which throws out beams in all directions. What more fitting emblem could be devised ? And yet these stemmata were painted when Harvey's work was scarce begun, and whilst he was still a member of the student body. To ' search and study out the secrets of Nature by way of experiment ' was his own way of life, and it is my duty to obey his injunction, and to exhort our younger brethren in this College to tread the path in which he led the way, and to see to it that in their hands the flame which Harvey lit shall burn as brightly as in Harvey's day.

Printed in England at the Oxford University Press