William Harvey : a history of the discovery of the circulation of the blood / by R. Willis ; with a portrait of Harvey, after Faithorne.

WILLIAM HARVEY

R. WILLIS M.D.


MACLACHLAN
&
STEWART
&
SOUTH BRIDGE
EDINBURGH

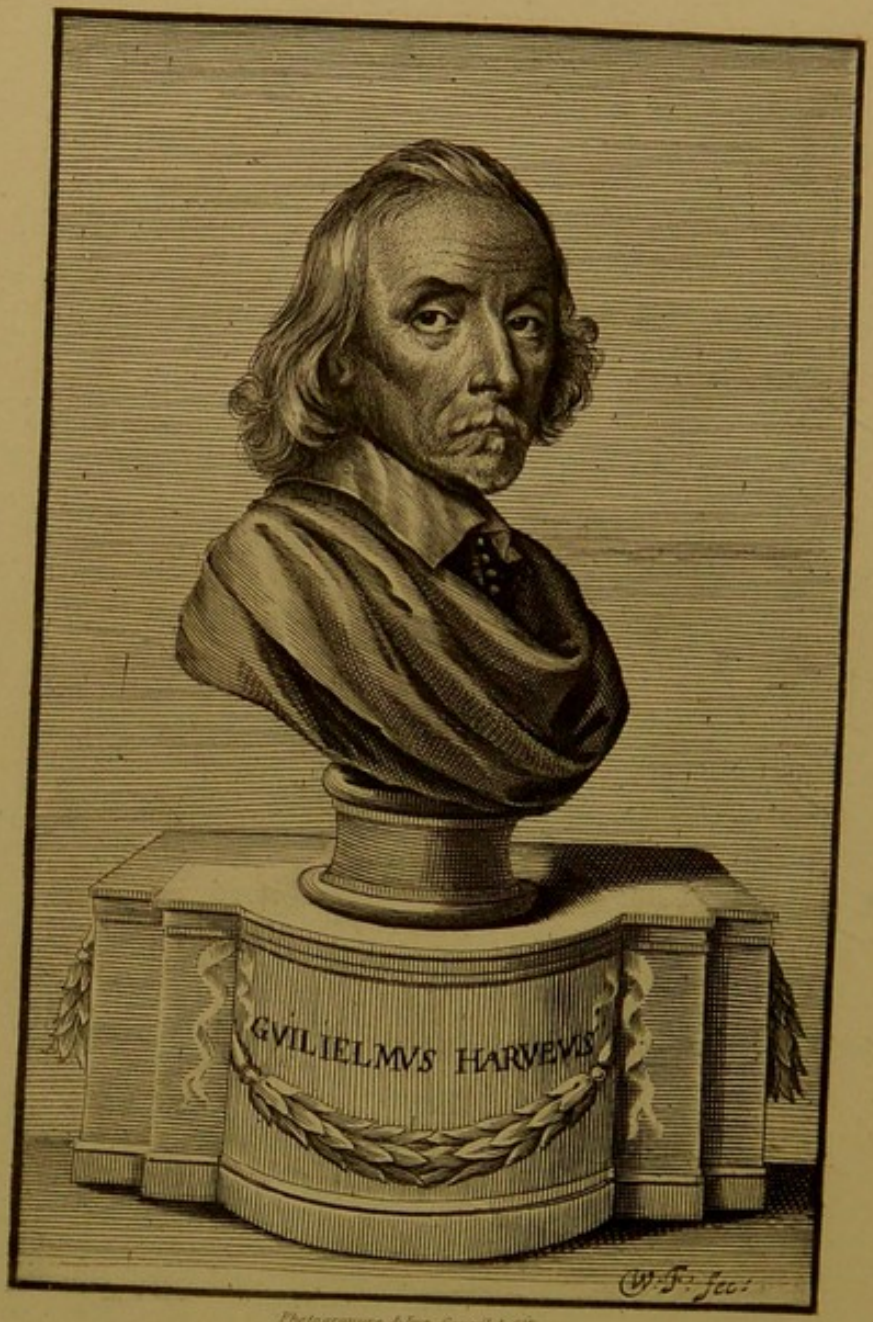
WILLIAM HARVEY

Man soll immer vorwärts ringen und nicht stehen bleiben, aber auch rückwärts blicken und gerecht seyn.

MARX (K. F. H.) M.D.

On est convenu de considérer une Science comme fondée par celui qui lui fait faire le pas le plus décisif, et l'on attribue cette gloire à la nation chez laquelle ce pas a été fait.

PAUL JANET.



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WILLIAM HARVEY

A HISTORY OF

THE DISCOVERY OF THE CIRCULATION OF THE BLOOD

BY

R. WILLIS, M.D.

AUTHOR OF "THE LIFE AND LETTERS OF SPINOZA;" "SERVETUS AND CALVIN," &c., &c.

WITH A PORTRAIT OF HARVEY, AFTER FAITHORNE

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TO

WILLIAM SHARPEY, M.D., F.R.S., LL.D., &c.,

EMERITUS PROFESSOR OF ANATOMY IN UNIVERSITY COLLEGE,

LONDON,

This Work is Dedicated

BY HIS OLD FRIEND,

THE AUTHOR.

PREFACE.

It is now more than thirty years since, at the instance of my associates of the Sydenham Society, I undertook to edit an English version of the works of Harvey, and to add a Notice of the Life of the immortal discoverer of the Circulation of the Blood. My Sketch, however, was only from sources most readily accessible to me, and nowise critical—principally from the one comprised in the Biographia Britannica, and that by Dr. Lawrence, which prefaces the fine edition of Harvey's works in Latin, edited by Dr. Mark Akenside, for the College of Physicians, and published in the year 1766. Though favourably received by my professional brethren, the Life I compiled was unavoidably much less complete than I had thought to make it; for, soon after undertaking my task of Editor, I became immersed in the coil of general medical practice, which leaves little leisure for literary labour.

Yet have I always hoped that, living long enough, and escaping from more active professional duties, I might one day be enabled to accomplish my purpose of writing a Life of Harvey, of ampler scope than the earlier sketch, and, by reference to the

writings of the great Anatomists of the period of the Renaissance especially, to trace the gradual approximation to truer interpretations of function through better apprehensions of structure, until Physiology for the first time, and in the highest sense of the word, received its birth from the genius of Harvey, and the foundations of rational medicine were laid.

If I had cherished a desire of the kind for half a lifetime, the propriety of bringing it to fruition had been growing on me for the last year or two. The persistent attempts of continental writers, Italians especially, to detract from the honour of Harvey, and ascribe his discovery to others; as well as the shortcomings of the half-hearted and, through inadequate information, perfunctory apologies for the great Anatomist which have appeared among ourselves, seemed to me, indeed, to make the work, not only a matter of propriety, but one of necessity.

Honoured and revered as is the memory of Harvey, by the most learned of our brethren, both at home and abroad, it is not a little extraordinary that we have no special detached Life of him in our literature. A work dedicated expressly to a History of the Circulation of the Blood, and the Life of one of the greatest of Englishmen, its discoverer, appears, however, to have been somewhat generally expected as a fitting accompaniment of the Tercentenary birthday of our great Anatomist, and among my friends who were aware of the bent of my studies for some time past, to have been looked for at my hands. And my work, as

anticipated, had been all but completed by the close of the past year, when serious illness overtook me, and incapacitated me from seeing it through the press.

The interval that has elapsed between the date of April 1st, and that of the actual publication which had been contemplated, will, I trust, be found to have proved no detriment to the work. I have, in fact, mainly to regret my inability to revisit the great libraries of the British Museum and Royal College of Surgeons, which I had used so freely, for the final revision and verification of the passages from the works of the writers I have quoted.

I am admonished by a highly competent authority that I have fallen short of what I might have said on the function of the Lymphatic system, which I take the opportunity of amending here. In so far as the fluid secreted and conveyed by the Lymphatics is of less specific gravity than venous blood, in so far must the blood of the veins be more dense than that of the arteries, and so have become fitted to absorb from the plasma-bathed tissues through which they run. But I had no intention of saying that this was all the duty performed by the great Lymphatic system. All recent researches seem to point to it as influential in the hæmapoesis; but how and in what way it is so seems to me to remain an enigma. I only referred to so much of the function as I conceived to bear on the question I had in hand, viz., the way in which the veins acquired their signal absorbent powers.

A word as to the Portraits we have of Harvey. Their number and the places where they are preserved

manifest the esteem in which he was held by his contemporaries. The best known, perhaps, is the one ascribed to Cornelius Jansen, which adorns the library of the Royal College of Physicians. There is another in the library of the Royal Society by De Reyn, which has been engraved by Scriven in Knight's "Gallery of Portraits." The picture in our National Portrait Gallery is a poor production; it has been engraved by Houbraken and Gaywood, and was once the property of Dr. Mead. I have seen another, which belonged to Dr. Bright, and is still in the possession of his son, which I believe to have been painted nearly at the same period as the one in the College of Physicians.

All of these portraits, nevertheless, are undoubtedly of the same man, and correspond in most respects with the description left us of Harvey by his contemporary Aubrey.

On panels over the fireplace in the dining-room of the Manor House of Rolls Park, near Chigwell, in Essex, which I have visited, are portraits of Thomas Harvey, the Kentish yeoman, and his seven sons, the one on the upper left-hand file being inscribed with the name of William Harvey; but in this, the portrait of a man in the very prime of life, only a lively imagination can perceive any likeness to the pictures we have of Harvey in riper years, when he had become famous. The portrait of the sire is certainly of the time when he lived, and bears a certain resemblance to some of the likenesses we have of his most distinguished son. But the portraits of all the

seven sons have so marked a similarity to one another, being all of them of men about forty years of age, and apparently by the same hand, that I am much inclined to look on them as apocryphal, or as reproductions of portraits that have disappeared.

Other portraits of members of the Harvey family, however, graced the walls of Rolls Park while it was still the residence of the successive descendants of Eliab Harvey, who purchased half the manor in the year 1655. The present owner of the estate (Captain Richard Lloyd, one of the lineal representatives of the family through his mother, a daughter of the distinguished Admiral Sir Eliab Harvey) informs me that he removed as many as thirty family portraits, and among them one of the Doctor, from Rolls Park to his present residence, Aston Hall, Oswestry, Salop. This portrait is not noticed in the list which I owe to my friend Mr. Scharf, Keeper of the National Portrait Gallery; and there is yet another not included in this list, the last that could have been made of the illustrious Discoverer—the bust, namely, over the memorial tablet in Hempstead Church.

This I have not met with in any engraving, and the same cause which delayed the appearance of my work incapacitated me from accomplishing the pilgrimage to the burial-place of the Harvey family. My friend, Dr. Richardson, however, lately visited Harvey's final resting-place, in company with Mr. Thomas Woolner, R.A., the great sculptor, on whose unquestionable authority he informs me that the bust on the monument is undoubtedly modelled from a mask taken after

death, and gives a very fine version of Harvey's face.

Mr. F. T. Day, of Saffron-Walden, has made a series of fine photographs of the Harvey Chapel and Monument, which can be had on application to him.

The portrait I have selected is the one in bust form, a fac-simile reproduction, by the admirable Armand-Durand process, of the engraving by William Faithorne, a contemporary of Harvey, and doubtless familiar with his personal appearance, founded on the Cornelius Jansen of the College of Physicians.[1]

My friend Mr. Scharf also mentions life-size portraits in the Bodleian Library, Oxford, and at Jesus College and Caius College, Cambridge, and another, by Jansen, which belongs to Sir Henry Wilmot. The Earl of Moira has one at Donnington Park, Leicestershire, attributed to Vandyke; and there is yet another, belonging to Lady Berkeley, Cranford Lodge, Middlesex. Mr. Scharf believes that the one which was the property of Sir W. W. Wynn perished with other treasures in the fire at Wynnstay.

The fine picture in the Museum of University College, London, is certainly not a portrait of Harvey.

BARNES, *October*, 1878.

[1] Faithorne's contemporary engraving was published as a frontispiece to the English version of the work on Generation in 1653.

CONTENTS.

SECTION VI.

SECTION VII.

SECTION VIII.

SECTION IX.

SECTION X.

SECTION XI.

SECTION XII.

SECTION XIII.

SECTION XIV.

SECTION XV.

SECTION XVI.

CHAPTER III.

INTRODUCTION.

A CERTAIN sanctity appears to have been connected with the blood at a very early period in the history of humanity. Its loss, in quantity, was seen to be so necessarily followed by death, that it even came to be spoken of as the Life in the sacred writings of the Jews; and, poured out upon the altar, it was long held by them, as by so many of the peoples of antiquity, to be not only the most acceptable offering that could be presented to propitiate the Gods, but even as competent to purge mankind from sin.

No wonder, therefore, that the blood, the life-giving element, at all events, if not the very life, was an early object of study with physiologists, and that it was held to have powers, properties and motion apart from, and independent of, the organisms whereof it is so important an integral part—*motion* above all, another word for life, even as stagnation is equivalent to death. At no time, therefore, do we observe that the blood was ever thought of as otherwise than in motion.

When we turn to the writings of our predecessors in the field of anatomy, and find them possessed of such an amount of accurate information on the struc-

ture of the animal body, we are at a loss to account for the imperfect, or more positively erroneous, nature of so many of their physiological conclusions. But the old observers were hampered by metaphysical assumptions, irrespective of cognizable fact and by fancies concerning the way and manner in which the world of matter as of mind is ruled. Neither the Macrocosm nor the Microcosm, as the universe and the body of man were designated, was seen to be possessed of powers adequate to produce the phenomena it manifested, and so to make it self-sufficing. The world *without*, was believed to be dominated by Entities apart from itself; the world *within*, by Principles distinct from the organs of which it is composed.

No Spinoza had yet appeared to assimilate the "something not himself"—his dream, his shadow on the ground, his reflection in the pool—originated by none of these, but personified and called by so many names by man, with the universe of things; no Leibnitz to announce a "Pre-established Harmony," and, following Spinoza, though using other words, to declare that the World being, as it is, could have been no other than it is; and no Locke to assert the competence of God to have Consciousness an appanage of nerve, and to say that the reason vouchsafed to man was guide sufficient for conduct and conclusion, both as regards the now and the hereafter. But as the astronomer has of late been

suffered to say that the Sun, with his attendant planets and their satellites, suffices for the cosmical phenomena observed in the system he dominates, so has the physiologist more lately still been allowed to own that the organisms of man and animals in their several estates suffice for the faculties they manifest.

None of the natural sciences had in truth such obstacles to contend with, in the shape of metaphysical assumptions — from which, indeed, it has not yet entirely escaped—as physiology. When the facts of observation did not tally with these, it was long held imperative either to pass them by unnoticed, to explain them away, or to regard them as effects of misleading sense. Certain agents by which the organism was presumed to be supplemented and dominated, characterized as Spirits or Principles, were imagined; and, being associated with the more important organs, the functions of these were believed to be severally evoked by them, much as the hand of the musician elicits music from his instrument. Strangely and illogically too, as it seems, these agents were still thought of as dependent on the organs they actuated —to come into play, they had themselves to be engendered. The right ventricle of the heart, with the blood supplied by the liver, produced the Natural Spirit; the left ventricle, with the aid of the lungs, begat the Vital Spirit; and the brain, with the help of the heart, fashioned the Animal Spirit.

Thus believed to be of different kinds, the Spirits

were further thought of as associated with blood of dissimilar qualities, by the medium of which they were communicated to the body. Hence the assumption of Two Kinds of Blood, which stood so long in the way of true physiological conclusions—one derived from the Liver as its source, another from the Heart. Hence, also, two orders of vessels, accordant in structure and property with the presumed qualities of their contents—the Veins, channels of the sluggish and dark-coloured natural blood, product of the liver; the Arteries, conduits of the elaborated, subtle and florid blood, product of the heart. The dark blood distributed from the liver to every part of the body by the vena cava for purposes of growth and nutrition; the florid blood delivered from the heart by the aorta to supply the frame with heat and vital endowment.

The two kinds of blood, it was then supposed, moved to and fro in their respective channels, doing their office to the tissues and returning to their sources for fresh supplies of material and renovation of powers; the motions being assimilated now to the ripple on the surface of a lake or stream, and again, and more commonly, to the ebb and flow of the tide in a narrow sea; the outward motions, mainly due to attractions between the parts of the body and the blood in the vessels; the return, to a per-contra attraction of the centres, and a suction-power connected with the diastole of the heart, both alike aided by the alternate heaving and subsidence of the chest in respiration.

The liver, then, was the laboratory of the natural blood, having derived the materials for its work from the stomach and intestines. This blood sufficed for ordinary growth; but to acquire vitalizing, and as sometimes said, nutritive properties it had to reach the heart and undergo further elaboration in its chambers. On the right side there was obvious and ready access to the ventricle from the vena cava; and there the blood was believed to be altered and improved to a certain extent—to have something of a *natural* spirit imparted to it; but it was not yet sufficiently attenuated and subtilized to be fit recipient or associate of the vital spirit. To attain to such a degree of refinement it must reach the left ventricle; and this it was presumed to do by permeating the partition between the two ventricles, whereby it became clarified and improved, as is muddy water by filtration through a sponge.

This, however, was not yet all. Blood was at best a palpable and gross material; spirit was impalpable and etherial in its nature, nearest akin to air among things cognizable to sense; and breathing being seen to be even as necessary to life as the blood, the Vital Spirit was presumed to be finally obtained from the inbreathed air commingled with the purified blood. In the Jewish Scriptures, says the writer, "God breathed into the nostrils of man the breath of life, and he became a living soul."

Communication between the left ventricle and the

inbreathed air was therefore required, and was not far to seek. There was the rigid, ringed trachæa proceeding from the throat, that brought air, the opaque artery springing from the right ventricle, and the diaphanous vein arising from the left, tending in either case to, or from, but meeting alike amid the soft and spongy substance of the lungs. By means of these the needful intercourse between the blood and the air was accomplished, and the vital spirit believed to be engendered.

Beside this, their most important office, the lungs had the further not insignificant duty of fanning and refrigerating the heart; which, as seat and source of the native heat, was thought to require the access of air at once to maintain and to prevent it from becoming excessive! It is in consonance with these physiological ideas that we find the great vessels connected with the heart specially designated by the old anatomists. The vessel leading from the right side carried the natural blood of the vena cava to the lungs for their nourishment, and was a vein, in fact, though it had the structure of an artery; therefore was it called the *vena arterialis*. The vessel leading from the left side again, which transferred the spirituous blood from the heart to the lungs, and from the lungs brought air mixed with blood to the heart, was an artery in reality having the structure of a vein, whence its title *arteria venalis*. Its duties, however, were more complicated than those of the arteries in general. The air exhaled

was not always so sweet and pure as it had been when inhaled; it had become loaded with excrementitious matters thown off by the blood; and as the smoke of a lamp was the impure or effete particles of the oil eliminated in the burning, so was the fuliginous vapour of the blood got rid of by the arteria venalis, and discharged with the breath.

Such, in brief, was the physiology of the heart, of the blood and blood-vessels, and of the lungs, transmitted from the ancient to the modern world, the gradual development of which into the more perfect system we now possess, it is the business of the following pages to work out and present.

BOOK I.—THE ANCIENTS.

THE GREEKS—PHILOSOPHERS—ANATOMISTS—PHYSIOLOGISTS.

PLATO.

PLATO, the great idealist, has not much in his voluminous writings on the subject that engages us. In the "Timæus," however, he speaks of the heart as the fountain of the blood, and as giving origin to its containing vessels—*Φλέβες*, a word by which both arteries and veins are designated. The heart, he says, erroneously, has three ventricles; but concludes, correctly, that it is the organ which sets the blood in motion—a statement strangely misunderstood or neglected by so many who came after him. He is also the first to call the great artery of the body by the name it still retains—*Aorta;* and there is a short sentence in connection with what is said of this vessel which must not be passed unnoticed, for it has led to the assumption that Plato was actually acquainted with the circulation of the blood. "The blood," he says, "is forcibly carried round to all the members—*τὸ ἅιμα κατὰ πάντα τὰ μέλα σφοδρῶς περιφέρεσθαι;*" words notable enough when interpreted by the light of the present day, but that could hardly have had the meaning to their writer which has lately been connected with

them, as they certainly had no such sense to the long ages that came after him. The σφοδρῶς περιφέρεσθαι however, seems to imply propulsion from the heart; but this, although I believe it influenced Cæsalpinus, was neglected by almost all the rest of Plato's successors until the days of Harvey.

ARISTOTLE—prototype of the man of science of the modern world—the scholar of Plato, was not likely to pass the structure and action of the heart without particular notice, or the important part played by the blood in the animal economy. We find Aristotle accordingly speaking of the heart as the source as well as the reservoir of the blood. Alone, of all the viscera, he says, does the heart contain blood. Everywhere else it is included in vessels—Φλέβες, the name by which, like Plato, he designates both veins and arteries. He distinguishes between the two orders of vessels, however, and says truly that he thinks they are severally complementary, each existing for the sake of the other. (De Respir., cap. ix.)

The heart is further spoken of by Aristotle as the seat and source of the native heat; and the end and object of respiration, with which he holds the beating of the heart to be intimately connected, is to temper or keep the heat of the heart, tending ever towards excess, within proper bounds. "The hotter the animal," says the Stagyrite, "the more vigorously

must it breathe, in order the more effectually to subdue the heat; whence the larger development of the lungs in quadrupeds and birds than in amphibious animals." The reasons why warm-blooded animals die in water and fishes in air, he thinks, is due to their hearts not being adequately cooled by the inbreathed air in the one case, by the water passed over their gills in the other. (Ibid., cap. xix.)

The air of the atmosphere, held indispensable to the engenderment of the vital spirit, was received from the ramifications of the trachæa in the lungs, by contact and insudation, not by any direct communication through open mouths between the bronchial tubes and the blood-vessels.

The pulsation of the heart depended on a sudden expansion or puffing up of the material supplied for the elaboration of the blood by the food digested in the stomach. Coming into contact with the heart as focus of the innate heat, each fresh afflux of nutrient fluid dilating, caused a beat, and as the supply was continuous, so was the pulse without intermission. (Ibid., cap. xx.)

The arteries pulsated synchronously with their source, and the blood flowed alternately from the vessels to the heart, from the heart to the vessels; the valves at the orifices of these regulating the current, and being so disposed that whilst one motion of the heart opened one set and closed another, a second motion of the organ shut those that

had been opened and opened those that had been shut.

In the course of the numerous dissections of the lower animals he performed, and following up what he had said on the cause of the heart's action, Aristotle appears to have observed the lacteal vessels of the mesentery, tending, as he concluded, from the intestines to the vena cava and aorta. Likening them to what is seen in plants, he says : " Even as plants draw nourishment by their roots from the ground, so do animals derive nutriment from the stomach and intestines, these standing to them in lieu of the earth, and having veins in the guise of roots implanted in their substance." (De Part. Animal, lib. iv., cap. 4.)

Singularly enough, when we think of him as the practical anatomist, Aristotle is generally understood as saying that the nerves are derived from the heart—led to the conclusion, it may be, by current notions of the heart being the seat or source of the affections, emotions, and passions.

PRAXAGORAS. This philosopher appears to have had his knowledge of anatomy from actual inspection of the human body ; he is the first who uses the word *pulse* in the modern sense, and who distinguishes accurately between the two orders of blood-vessels, imagining that the arteries pulsated by a certain inherent power of their own, contained nothing but a spirituous humour, and, taking their rise from the lungs, terminated in the nerves, whose source, with Aristotle, he believed to be the heart. Respiration, he thought, was instituted for the production of the vital spirit. (Conf. Haller, Biblioth. Anat., vol. i., sub voc.)

HEROPHILUS.

HEROPHILUS was an anatomist of the school of Praxagoras. His name is still remembered through the title he gave to an intricate portion of the vascular system of the brain, comparing it to a winepress—the *Torcular Herophili.* He it was who first designated the pulmonary artery and the pulmonary vein by the names they so long retained—*Vena arteriosa* and *Arteria venosa.* He seems also to have anticipated every other physiologist by a somewhat careful study of the pulse, which he characterized as full, quick, jerking, rhythmical or the contrary, in different cases. The beat of the artery he concluded correctly must proceed from the action of the heart, but he held erroneously that it was transmitted by the coats of the vessels. Herophilus is said to have dissected the human subject alive. (Haller, ut sup. sub voc.)

ERASISTRATUS. This really distinguished anatomist recognized two principles in the living body—one spirituous, another sanguineous—which were imparted to all its parts by two distinct kinds of vessels, included under the common title of *Phlebes*. These, he says, intercommunicate or synastomose—a term by which coaptation or juxtaposition, rather than communication by open mouths (although this is not always excluded), appears to have been implied. The blood of the thinner, softer, membranous vessels—the proper blood-vessels, says Erasistratus—is prevented from making its way into the harder tendinous vessels in consequence of their being already replete with vital spirits, or, if it does enter them at any time, disorder and disease are the consequence. When an artery was wounded, the vital spirit, finding a vent, escaped, and then it was that the blood of a neighbouring vein made its way into the artery and flowed out through the wound.

Living in Egypt, Erasistratus had opportunities of learning something of the anatomy of the human

body—nay, he is said to have had criminals presented to him, whom he dissected alive! He was better acquainted with the valves of the heart than any anatomist who had preceded him, and thought that their office was to regulate the flow of the blood and the vital spirits. Prepared by the liver, and brought to the right ventricle of the heart by the vena cava, the blood is passed from thence into the vena arteriosa, which proceeds to the lungs. The left ventricle, again, occupied by the vital spirits imparted to it from the lungs by the arteria venosa, transmits these by the arteria magna to all parts of the body. The purpose of respiration, from what has just been said, is, therefore, to communicate spirit from the inbreathed air to the blood.

Erasistratus certainly apprehended the function of the valves more correctly than Aristotle. Wherever they occur, he says—and the expression leads us to infer that he saw them elsewhere than in the heart—their function is to prevent retrogression of the blood. Referring particularly to those of the heart, the *valvulæ venosæ*—by which we must understand the tricuspid and mitral valves—he says, give ready access to the ventricles from without, and effectually oppose regurgitation from within. Erasistratus also distinguished more accurately than had been done before between arteries and veins; the arteries alone pulsating by an independent power of their own, whilst the veins were the purely passive channels of

the blood. Elsewhere, however, he ascribes the beating of the heart and arteries to rhythmical efforts of the vital spirit to escape from confinement.

Almost all we know of Erasistratus is derived from the writings of Galen, but the little that has reached us shows him to have been a man in advance of his age, a greater human anatomist than Aristotle, and, if embracing a less extensive field of study, even as particular in describing and interested in accounting for what he saw as the mighty Stagyrite. (Conf. Op. Galeni et Bib. Anat. Halleri, T. I. sub voc.)

HIPPOCRATES. There is so much discrepancy between one and another of the works ascribed to Hippocrates when anatomical matters are touched on, that assuredly they are not all products of the same mind. In the book on the heart—*περὶ καρδίης*—for instance, it is spoken of as a thick and strong muscle, having auricles and ventricles (these last being divided by a dense sulcated partition), giving rise to the great vessels of the lungs and body, which have valves at their roots, for the purpose, it is said, of closing their orifices against any intrusion of the inbreathed air. In the book on Nourishment—*περὶ τροφῆς*—however (in which both arteries and veins are spoken of, as by Erasistratus, under the name of *φλέβες*, the term artery—*ἀρτερία*—being applied to the windpipe and its bronchial divisions), the blood-vessels are described as arising from the head and other regions of the body rather than from the heart.

Of the vessels arising in the manner stated above, there are four principal pairs, as well as several others of less magnitude which take their origin from the

stomach and intestines, and collect and distribute nourishment to the parts of the body, internal as well as external, to which they tend. The vessels in general manifest motion and carry spirit, many branches proceeding from single trunks; but where these arise or where they end is not well known, "for in a circle you find no beginning—*κύκλου γὰρ γεγενομένου ἀρχή οὐχ ευρέθη*"—words which, detached from their context, have been held to show that the world had not to wait for Harvey to proclaim the general circulation of the blood, the great physiological fact having been familiarly known to the Father of Physic!

Nor is the above the only passage in the Hippocratic writings that has been laid hold of and interpreted in a similar sense. In the book De Insomniis, the words "*ποταμοὶ δέ μὴ κατά τρόπον γινόμενοι ἄιματος περίοδον τέμαινουσι*, &c.—but, like rivers, not comporting themselves according to wont, when the course of the blood is interrupted," &c., give one of the prejudiced people who would ascribe the discovery of the circulation to any one rather than its author, an opportunity to translate the Greek *ἄιματος περίοδον* by the Latin *sanguinis circuitus*, and to say: "There cannot be the shadow of a doubt that the circulation of the blood was known to Hippocrates—*ut omnino omnem fenestram præcludat dubitationi furitne Hippocrati notus circuitus sanguinis.*"[1] (!) How several distinct

[1] Io. Ant. van der Linden. Hippocrates. De Circulatione Sanguinis Exercitationes, xxvii. Lugd. Batav., 1659-63. 4to.

currents in circles should imply one general current in a circle, however, is not very obvious, to say the least.

Hippocrates believed the heart to be the fountain of the blood and source of the native heat, being surrounded by the lungs in order that its ardour might be tempered by the cooler air they contain. The left ventricle, nevertheless, and somewhat in contradiction with this, is said to be thicker than the right in order to economize or hold the heat!

The ventricles of the heart, inasmuch as they are the source whence proceed the streams that irrigate the body and give life, Hippocrates concluded must impress upon man the whole of his distinguishing powers; on which account it is that a wound of the heart is followed by instant death. The auricles, again, were appendages to the ventricles—but have nothing to do with hearing, their office being to draw air into their interior for transmission to the ventricles, in virtue of a power they possess analogous to that of the bellows used by workers in metal. But motion is an appanage of the whole heart; the auricles and ventricles alternately dilating and contracting.

Within the ventricles are seen certain membranes, spread abroad like spider's webs, attached to the sides of the cavities by filaments, spoken of under the name of *νεῦρα*, which guard the several orifices that lead into and out of the sinuses. The Greek word *νεῦρον* signifying both nerve and sinew, Aristotle,

as has been said, is generally thought to have believed that the heart gave origin to the proper nerves as well as to the blood-vessels—a conclusion which is not adopted by Hippocrates, who derives the proper nerves from the brain and spinal cord. The membranes or valves in question, he thinks, are more perfect on the left than on the right side of the heart; the left ventricle being the more immediate seat of the soul, and the true centre whence the body is ruled —*mens enim hominis in ventriculo sinistro sita est.*

As by much the most noble organ of the body, the heart is not nourished by blood supplied directly from the intestines, but by blood of a purer kind transmitted by a special vein proceeding from the sinus of the vena cava—the *vena coronaria.* Neither is it to be presumed that the aorta is nourished by the blood it contains; seeing that both it and the left ventricle are found completely empty in a slaughtered animal—*in totum solitudo appareant*—or if perchance anything be found in them, it is only a little serum. The right ventricle and its artery, on the contrary, are always seen to be more or less full of blood, this having been in course of transmission to the lungs for their nourishment, an office for which it is fitted after undergoing improvement in its quality by the motions of the heart, and obtaining a certain addition of air by the action of the auricles. The air added, however, can be but little; for it were absurd to suppose that the cold should be in excess of the heat, the blood

not being hot of itself or by its own nature—like water heated on the coals, it receives the heat it has from the substance of the heart. Many, nevertheless, he adds, are of opinion that the blood is truly hot of itself.

In conformity with these views, the arteries are spoken of as *venulæ calidiores*—the vessels charged with heat, as by Erasistratus they had been characterized as *vasa spiritus*,—the vessels charged with ætherialized air or spirit. The veins, again, are always regarded as the proper blood-vessels; the channels by which the fluid that nourishes the body is conveyed to all its parts. (Conf. Op. Hippocratis â Kuehn, passim.)

GALENUS.

CLAUDIUS GALENUS of Pergamos, was born about the 131st year of the Christian era, and lived in high repute at Rome during the reigns of the Emperors Hadrianus and Marcus Antoninus, by the latter of whom he was much esteemed, having been his physician, and, during his absence with the army, entrusted with the guardianship of his son.

Galen is said to have travelled extensively in early life, and to have studied medicine at Alexandria, famous above all other cities in his day for its medical school. Piously disposed by nature, we cannot suppose that he had not heard something of the doctrines of the Jewish Sect called Christians, then beginning to be noticed in the world; but he never professed himself as having belonged to them, any more than did the pious Emperor under whom he lived. Galen must have read the Hebrew Scriptures, however, for he criticizes Moses, and does not entirely agree with him as to the omnipotence of the Jewish Deity. "To the will of God," he says, "there was always added considerations for that which was fittest

or best. It was not that God willed a certain arrangement of parts about the eyelids; he *chose* the firm cartilaginous structures we find there. Neither could he have proceeded of a sudden to make a man of a stone; and herein our opinion agrees with that of Plato and others among the Greeks, who have written on the Nature of things, which differs from that of Moses, who thinks that God, had he so willed, could at once have made a horse or an ox out of ashes. But we are not of this way of thinking; we acknowledge that there are some things which nature could not do, which indeed would never be attempted; whilst of what could be done, choice was made of the best." A sentence in which we see combined the Leibnitzian idea of "the best of all possible worlds," and something like the more modern doctrine of "Evolution, with survival of the fittest."

Galen himself says expressly, that his work on the Use of the parts of the human body is "nothing less than a hymn to the Creator—*Ego Conditori nostro verum hymnum compono*—and I hold that true piety is not shown in the sacrifice of hecatombs of bulls, or in raising clouds of fragrant incense; but in studying myself to know, and in making known to others, the wisdom, the power and the goodness of God." (De usu Partium, lib. iii.) Surely very beautiful in one living under the shadow of Temples dedicated to Jupiter and Minerva; more reasonable withal, perhaps,

than the Cultus of more than one kind now prevailing in the world.

In this truly great man we meet with the anatomical, physiological, and medical genius of the ancient world, although it has been conclusively shown that Galen's knowledge, whether of structure or function, was not derived from any study of the body of man, but from inspection of the bodies of the lower animals. That he had seen the human skeleton, however, is admitted; and, for the rest, it matters little, as we now know, whether it was from man or beast that the immense amount of interesting anatomical and physiological information he accumulated and transmitted to us was derived.

To this acute and most accomplished man the heart was the most important of all the organs of the body —source of the native heat, and storehouse of the subtle blood replete with vital spirits, by which the whole of the organism was actuated. The heart, he says, is as it were a lamp alight in the middle of the body, the blood being the oil that feeds the flame, and the inbreathed air that which keeps it burning. Respiration consequently is instituted to keep the flame of the heart alive, and to engender the vital spirit, not, as was believed by Erasistratus, to fill the arteries with air in substance. (Lib. de Utilitate Respirationis.)

The flesh of the heart, says Galen, is not exactly the same as that of the muscles of voluntary motion;

neither when boiled has it the same taste as these; neither like them is it under the control of the will. The arrangement of its fibres is also peculiar, some of the bundles running longitudinally and others transversely; the former by their contractions shortening the organ, the latter compressing and narrowing it—words which show that Galen did really regard the heart as essentially muscular.

The valvular apparatus of the heart is fully described, and its action thoroughly appreciated, by Galen; although certain hypothetical ideas force him to speak of the action as less perfect than it is in reality. Made up of auricles and ventricles in warm-blooded animals, the auricles, he says, exist for the sake of the lungs; the ventricles for the sake of the blood and vital spirits; neither auricles nor ventricles, however, in their alternate dilations and contractions, have the motion of the blood for their object, or if they do influence this, as is by-and-by admitted to be the case, it is the diastole or expansion of the organ, not the systole or contraction, that comes into efficient play.

When the heart dilates, it puts the membranulæ within it on the stretch, opens the orifices of the intromitting, and closes those of the emitting, vessels; yet not so completely as to oppose all escape of lighter or more subtle matters. It is to this end, therefore, that whilst one of the two great corresponding ventricular orifices is guarded by three membranes,

the other—that namely of the arteria venosa or pulmonary vein—is not so effectually cared for; inasmuch as by it the fuliginous or excrementitious matter of the blood has to find a passage from the heart to the lungs and be emitted with the breath.[1]

"From the arrangement of the valves, here," he proceeds, "one might think that nothing could return by any of the other three orifices. But the thing is not so in reality; for as the blood and spirit are in course of being drawn into the heart at the moment when the valves are coming into action, something may escape or be remitted before they fully and finally close. With the more powerful motions of the heart especially, something more than vapour or spirit,—some blood in substance, may escape. The blood of the arteries being of a thinner, purer, and more vapourous nature than that of the veins, might seem to facilitate the escape in question. So much at all events is certain: that if the arteries of the heart impart something to it, that which is imparted must needs be returned to them by its action; even as the arteries of the body, sucking in from all the parts, must, by contracting, remit to them again."

[1] "Quod igitur cor, quo tempore dilatatur, membranarum trahens radices aperit quidem intromittentium materias vasorum orificia, claudet autem educentium; ne minus etiam quod trahentibus omnibus læviora expeditius obsequuntur; quodque in aliis quidem orificiis membranæ tres incumbant; in arteriæ venosæ orificio non item; quod eam solam excrementis fuliginosis quæ a corde feruntur ad pulmonem dare transitum oportet." (De usu Partium, lib. vi., cap. 14, 15.)

"All are agreed," says our author, "that one of the ventricles is the instrument of alimentation, the other the instrument of the vital spirit; the former being characterized by anatomists as the sanguineous, the latter as the spirituous ventricle. That the two ventricles pulsate at the same moment, may be seen by laying open the chest of a living animal; but they do not contain blood and spirit in the same proportion; the right having a much larger charge of blood relatively to its charge of spirit than the left, which may be said to contain the substance of the spirit.

"That the arteries contain blood and when wounded discharge nothing but blood, no one will deny who has seen one of them divided. They therefore who with Erasistratus maintain that the arteries contain air, are forced to admit that they must have communications or anastomoses with the veins, and that the veins have thus a share of spirit."[1] In so important a light does Galen see this subject that he returns to it in a special book in which he combats Erasistratus and those who follow him, saying: "When an artery is wounded we always see blood escape; wherefore one of two things: Blood is either contained in the arteries immediately, or it flows into them from somewhere else. But if from elsewhere, it is obvious that the arteries in their natural state should contain spirit only. Were this the case, however, we should see

[1] "Hæ duæ vasorum genera mutuis anastomosibus inter se juncta venasque aliqua ex parte spiritus esse participes." (Ib., cap. 21.)

spirit escape from a wounded artery as a prelude to any flow of blood; but as nothing of the kind occurs we conclude that the vessel never contained aught but blood."[1]

Again he says: "If we lay bare an artery, include a portion of it between ligatures, and then open it, we shall find it full of blood." And yet again: "But how, say the followers of Erasistratus, if the arteries contain blood only, does the air we take in when we breathe reach every part of the body? To whom we reply: wherefore the necessity of its doing so, when all that is taken in is returned again? Many therefore, and among these some of the most able both of our philosophers and physicians, have seen that the heart requires not air in substance, but coolness only, whereby it is refreshed—and this is the purpose of Respiration"—another of the Galenical, and still more ancient errors, that was only dissipated by the progress of modern chemistry, the discovery of oxygen by Priestly, and the theory of combustion announced by Lavoisier. Albert Haller, the most learned anatomist and physiologist of his age (Elementa Physiologiæ, 1757), retained a lingering belief

[1] "Quoniam arteria quocunque vulnerata sanguinem egredi videmus, duorum alterum sit oportet: vel in arteriis sanguinem contineri, vel aliundè ipsum in eas confluere. Quod si aliundè, manifestum cuique est, cum se naturaliter arteriæ habebant [ut dictum est], spiritum ipsas solummodo contenuisse, oportebat in vulneratis priusquam sanguis egrederetur spiritum exire conspiceremus. Cum hoc autem fieri non videamus, nec anteà solum spiritum in arteriis contentum fuisse colligemus. (Lib. An sanguis in arteriis naturâ contineatur?)

that the purpose of Respiration was to cool the heart.

"The reason why there are two orders of vessels in the animal body," says the great man of Pergamos, "is that the several parts may be supplied with the kind of nutriment appropriate to them. What so absurd as to suppose that the dense and heavy liver should have nourishment of the same kind imparted to it as the light and spongy lungs?[1] Hence it is, that we see the liver furnished almost exclusively with veins, whilst the lungs are provided in large proportion with arteries. Let us, therefore, admire the providence of nature which ordains a two-fold order of vessels, but arranges mutual openings between the terminations of neighbouring branches of each."[2]

Nor is this by any means the only place in which such communications between arteries and veins are spoken of. In one especially it is said that the blood, thrown by the heart into the aorta, being prevented from returning into the ventricle by the semilunar valves at its root, communicates by innumerable

[1] Non oporteat eodem alimento partes omnes corporis ali. Si enim unicum esset duntaxat sanguinis vas, simili partes omnes alerentur nutrimento; quo quid absurdius dici potest quam ut similem ad sui nutritionem postulent sanguinem, verbi gratia, hepar, viscerum omnium gravissimum et densissimum, et pulmo lævissimus ac rarissimus. Proinde rite a natura factum est ut non arteriæ modo, verum etiam venæ in animalium corporibus inessent. (De usu Partium, lib. vi., cap. 17.)

[2] "Simul ipsorum fines sibi ipsis vicinos mutuis inter se orificiis aperuit atque applicuit." (Ib.)

anastomoses with the veins, to the end that they may participate in the vital spirit with which the arteries are especially charged. That there was the freest possible communication between the arteries and veins of the body, was indeed perfectly well known to Galen. The two orders of vessels, he says, anastomose or inosculate by means of certain minute and invisible passages ;[1] so that if a large artery be divided, both arteries and veins are alike and rapidly drained of their blood—a fact which he had ascertained experimentally.[2]

In the transfusion which is thus shown to take place, the arteries by their dilatations are said to suck in from the veins, and by their contractions to return to them what they had taken.[3]

These matters are seen by our author to be of such moment that they are reverted to and discussed in another work, in which all that is said above is repeated in other words : "If you kill an animal by dividing one or more of the larger arteries, you will find the veins as well as the arteries of the whole

[1] "In toto corpore mutua est anastomosis atque osculorum apertio arteriis simul cum venis ; transumuntque per invisibiles quasdam atque angustas plane vias." (Ib., vi., 10.)

[2] "Arteria magna vulnerata universum animalis sanguinem per eam exhauriret. Hujus rei periculum fecimus subinde ; et quum semper vacuatas cum arteriis venas deprehendissemus, verum esse dogma de communibus arteriarum et venarum osculis nos persuasemus." (Ib., lib. v., cap. 5.) The two orders of vessels, he goes on to say, do, in fact, communicate freely throughout the body.

[3] "Quippe per hos transitus arteriæ dilatatæ ex venis trahunt ; contractæ contra, in eas regerunt." (Ib., v., 5.)

body emptied of their blood; but this could not happen did not the two orders of vessels inosculate."[1]

"The heart is ceaselessly in motion from the beginning of life to its close; the principal motion being the diastole, which is ascribed to the innate heat of the organ: As the bellows of the blacksmith draw in air when they are expanded, as the flame of the lamp draws oil to it through the wick, or as the magnet (lapis Heraclius) attracts iron, so is it with the heart: it possesses in itself an inherent power of attraction; so that even as air is drawn into the lungs by the expansion of the chest in breathing, is the finer part of the blood attracted from the right to the left ventricle of the heart by its diastole, the partition between them having certain minute pores or orifices to this end designed. These indeed are seen with difficulty in the dead body, the parts being then cold, hard and rigid. Reason assures us, however, that such pores must exist. Nature does nothing imperfectly or in vain, and it is not by accident that these passages lie so deeply, or end by such inconspicuous orifices. Besides these pores, however, there are two mouths—*duo ora*—in the right ventricle, one by which the blood is brought into the heart; another by which it is sent out to the lungs."[2]

"But all the blood thus intromitted is not for the

[1] "*Quod sane nunquam fieret nisi inter se haberent altera in alteram ora reclusa.*" (De Natura Facult., iii., 15.)

[2] "Quorum quidem alterum sanguinem in ipsum cor intromittet, alterum autem ex ipso in pulmonem deducit." (Ib., lib. i., cap. 7.)

nourishment of the heart; there is even a particular vein distributed to it for this purpose; and as there is no such disparity between the size of the vena arteriosa, and the arteria venosa, we cannot suppose that any considerable portion of the blood that is sent to the lungs by the former vessel is appropriated by them for their nourishment. It is therefore manifest that it must be transmitted to the left sinus of the heart—*Manifeste ergo est quod in sinistrum sinus* (cordis) *transmittetur.*" How much, we may well ask here, is wanting to a satisfactory account of the passage from the right to the left side of the heart through the lungs? How much indeed is wanting, in respect of the general circulation, when taken in conjunction with what is said above of the communication between the veins and arteries of the body at large? But little, truly, when the language is interpreted by the light we have from Harvey, who himself, reading the text by what he has come to know, gives the writer credit for more than he deserves when referring to him in words like these: *Ex ipsius etiam Galeni verbis hanc veritatem confirmari posse, scilicet: non solum posse sanguinem e vena arteriosa in arteriam venosam, et inde in sinistrum ventriculum cordis, et postea in arterias transmitti.*[1] But Galen did not believe, neither does he ever say, that the blood passes *bodily* or *in mass* from the pulmonary artery to the pulmonary

[1] Harvey, Exercit. Anat. de Motu Cordis et Sanguinis, cap. 7 ad medium.

vein. The blood of the pulmonary artery he believed went mainly to nourish the lungs: it was a certain portion of it only that reached the pulmonary vein by the anastomoses which he imagined to exist between the two vessels throughout their whole course, and not by their extremities only, as we understand matters.

This interpretation of Galen's idea of the pulmonary physiology, is fully confirmed by what is said in the sixth chapter of the tenth book De usu Partium: "When the thorax contracts, the pulse [here taken for the heart and great vessels], the lungs, and all they contain, being much compressed, the spirit within the arteria venosa is forced out at a great rate, but a certain quantity of blood is at the same time transferred to it by those same subtle orifices. This, however, could not happen were the blood free to flow back to the heart by the ample outlet of the vena arterialis. But return by this being prevented, the compression that is suffered on all sides, forces something to distil by the minute orifices."[1]

The pulmonary veins therefore *transude spirit* on the one hand, and *receive something—quidpiam*, viz. *a little blood*, on the other. There is no question of any continuous transfusion from the right to the left

[1] "Cum autem thorax contrahitur, pulsæ atque intro compressæ undique, quæ in pulmone sunt, venosæ arteriæ, exprimunt quidem quam celerrime qui in ipsis est spiritum; transumunt autem per subtilia illa oscilla sanguinis portionem aliquam. Quod nunquam accidisset profecto, si sanguis per maximum os (cujusmodi est venæ arteriosæ) retro remeare potuisset. Nunc vero, reditu per os magnum intercluso, dum comprimitur undique, distillat quidpiam per exigua illa orificia."

ventricle by the pulmonary artery and vein, but of a simple intercommunion of these vessels; the pulmonary vein giving spirit to the artery; the pulmonary artery supplying a little blood to the vein—the same process precisely as that which obtains between the veins and arteries of the body at large. *Galen did not understand the pulmonary transit as we do.* The sigmoid valves of the pulmonary artery, we see, do not serve to make the ventricular contraction efficient in forcing the blood through the lungs from the right ventricle to the left, but to secure the efficiency of the thoracic squeeze by which spirit is forced out here, blood forced in there.

Had Galen seen the *Septum cordis* as the dense and thoroughly impervious partition it is in fact, or reflected for a moment that the two cavities, divided by a common partition and acting together, could neither give nor take from one another, and gone on to interpret the valvular apparatus as truly as his predecessor Erasistratus, he would necessarily have learned that if blood was to reach the left ventricle from the right, the one only way by which it could do so was through the lungs by the pulmonary artery and vein, and that the road from the left to the right side of the central organ again was by the aorta and vena cava. Then would the inosculations between veins and arteries of which he speaks, have received the true instead of the hypothetical interpretation he puts upon them, and nothing would have been left for the modern world to

discover in connection with the circulation of the blood. But the "divine man" was hampered by his belief in the two kinds of blood, appropriate to the two systems of vessels, flowing to and fro in their conduits from distinct centres, intercommunicating for fanciful ends by their anastomoses, and having essentially different functions to perform. Theory divorced from fact led to erroneous inference, and ample room was left for further discovery.

The arteries, Galen thought, possessed a pulsative and attractive power of their own independently of the heart, the moment of their dilatation being the moment of their activity. They, in fact, drew their charge from the heart, as the heart by its *diastole* drew its charge from the vena cava and pulmonary vein, in the same way precisely as the bellows of the metal worker draws in air from the atmosphere. The pulse of the arteries he also thought was propagated by their coats, not by the wave of blood thrown into them by the heart. Were the continuity of the canal interrupted by the substitution of an unyielding for the yielding wall, no pulse, he said, would be felt beyond the interruption ; a conclusion which he thought he had proved experimentally. But he was mistaken ; for the experiment has been repeated oftener than once—by Vesalius among others—with a different result.[1]

All important as was the heart in Galen's physiology, as giving origin to the arteries, whence flowed forth

[1] De Corp. hum. fab., lib. iii. and iv.

vital endowment, the liver was yet the organ which had in a certain sense precedence of the heart; for it was the laboratory of the blood—*est sanguificatione dicatum*—and source of the streams that nourish the body.

In conformity apparently with the theory universally entertained of the Emotions and Passions having their seat in the heart, we have found Aristotle credited with having spoken of it as giving origin to the nerves. Proceeding to extremes in the opposite direction, Galen thought that the heart, if not entirely devoid of nerves, was yet nearly so. It might indeed have one small branch derived from the *nervus vagus* sent to it; but it possessed no such large conspicuous nerves as we see distributed to the voluntary muscles. Galen overlooked the great nervous plexus surrounding the roots of the blood-vessels, from which branches, minute, indeed, but visible enough when looked for, proceed in company with the branches of the coronary arteries and veins, and penetrate the muscular substance of the ventricles at every point. Errors of Psychology live long in language at least, and errors in Anatomy, too, die hard. We still speak of the heart as if it were the seat of the affections and passions, though we know that their source is the brain; and it is but yesterday since Galen's dictum of the heart being without nerves was dissipated. It is now known to be plentifully supplied with filamentous nerves from the sympathetic system, and is even

said by some to possess special ganglionic coils of its own as stores and strengtheners of nervous action.

At such length have I deemed it requisite to speak of Galen, the ruler of men's mind on all matters connected with medical science for thirteen centuries and more; his authority at once a despotism and a religion, which it would have been treason to question and impiety to gainsay; his works, with those of Aristotle, the text on which the intelligence of Europe expended itself in criticism and comment during all these ages. But his rule, in any repressive sense, came to an end at last, and mainly through the influence of two men, united in their student lives, as in their misfortunes and early deaths, of whom, after a few words on their teachers, we shall have to speak particularly—Andrea Vesalius and Michael Servetus.[1]

[1] Could I find any ground in his work De Natura Hominis for the credit Nemesius, Bishop of Emessa, has had given him of having had an idea more or less complete of the circulation of the blood, this would be the place in my survey in which I should have to criticize him. But I am spared the pains, for, though I have looked somewhat particularly into his book, I find nothing that is not better and more fully set forth by his authority, Galen, whom he follows with little divergence in all he has to say on the liver, the heart, and the blood.

BOOK II.—THE MODERNS.

MUNDINUS, BERENGARIUS CARPUS AND THE ITALIAN ANATOMISTS TO HARVEY.

Carpi, of both of which very rare books there are copies in the Library of the Royal College of Surgeons. The edition of Jo. â Ketham is especially interesting from the woodcut of the title-page, representing the Anatomist engaged in the dissection of the human body—the first representation of the kind, I believe, that exists. The edition by Carpus is entitled: Anatomia Mundini noviter impressa ac per Carpum castigata. (Bononiæ, 1514.) The best edition of the work, however, is that which Carpus published subsequently, under the title of Commentaria cum amplissimis additionibus super Anatomiam Mundini, una cum Textu ejusdem in pristinum et verum nitorem redacto. (Bonon. 1521, 4to min.) It is a handsome volume of 528 pages, and I mention it particularly as I find the anatomy of the heart and its valvular apparatus described in terms that for clearness and precision have scarcely been surpassed. Mundinus and Carpus therefore deserve something like special notice from us as pioneers of the anatomical knowledge that eventuated in Harvey.

RABELAIS (Francis), born 1483, died 1553. I must by no means omit to mention the immortal author of Pantagruel, for whom a claim has lately been made as discoverer of the circulation. Scattered throughout his work there are several passages which have been interpreted in this sense, but which in truth show no more than that Rabelais, as a learned physician, was the obsequious follower of Galen in so far as the nature and motions of the blood are concerned.

In Book III. Chapter 4, for example, he speaks of the blood as the seat of the soul; the chiefest work of the body being incessantly to make blood. Now the stuff which nature gives to be turned into blood is bread and wine. The teeth chew, the stomach digests, and the mesenteric veins suck out of it what is good; this is carried to the liver, where it is turned into blood, and then to the heart, which, by its diastolic and systolic motions, subtilizes and heats it so that in the right ventricle it is brought to perfection, and by the veins is sent to all the members. Every part of the body then draws to itself the blood it requires, and after its own fashion is nourished and alimented.

In chapter 31 of the same Book, the Physician Rondibilis, when lecturing Panurge on concupiscence and the means of subduing it, says : " By painful exercises and laborious work, so great a dissolution is brought upon the whole body that the blood which runs along the channels of the veins for the nourishment and alimentation of each of its members, has neither leisure nor power to afford the seminal residuum, or third concoction, which nature carefully reserves for the conservation of the kind."

In the same chapter the author speaks further of the spirits running through those pipes, windings, and conduits, which to skilful anatomists are perceptible at the end of the *rete mirabile*, where all the arteries, having taken their rise from the left ventricle of the heart, converge and end in a single spot.

The most notable passage, however, still from the third book (cap. 14), is that in which much of what we have already seen is repeated, and was lately particularly quoted[1] to show that Servetus and every one else had been anticipated by Rabelais in his knowledge, not only of the pulmonary transit but of the general circulation of the blood. " The blood," says Rabelais, is next carried to another laboratory—to wit the heart; which by its diastolic and systolic motions subtilizes and heats it in such a way that it acquires perfection in the right ventricle, and by the veins is sent to all the members of the body. Each of these

[1] By Mr. R. W. Weldon in the " Athenæum " of August 25th, 1877.

then attracts it and nourishes itself in the manner required—feet, hands, eyes—every part, in short, all of these being now turned into debtors that had previously been lenders. By the left ventricle, again, the blood, rendered so subtle that it is said to be spirituous, is sent by the arteries to all the parts, to warm and ventilate the other blood of the veins.[1]

He who is acquainted with the Physiology of Galen, will see no more in all of this than the current ideas of the age: Two kinds of blood, one distributed by the veins for growth and maintenance; another by the arteries, charged with heat and spirit for vital endowment.

[1] "Puys (le Sang) est transporté en une autre officine, c'est le cueur, lequel, par les mouvemens diastoliques et systoliques, le subtilise et l'enflamme tellement que par le ventricule dextre le met à perfection, et par les venes l'envoye à tous les membres. Chascun membre l'attire a soy et s'en alimente a sa guise—pieds, mains, yeux—tous: et lors sont faictz debteurs qui paravant etoyent presteurs. Par le ventricule gauche, il le fait tant subtil, qu'on le dit spirituel, et l'envoye à tous les membres par les artères pour l'aultre sang des venes eschauffer et esventer."

SYLVIUS.

JACOBUS SYLVIUS[1] (Jacques du Bois) of Amiens, born 1487, was the scion of a family in easy circumstances, and enjoyed the advantages of a liberal education without having to struggle for it. His natural temperament, however, disposed him to take every advantage of his opportunities. Distinguishing himself first in general literature, he was only attracted to natural science after having made his mark in the field of Philosophy; but finding Anatomy and its associated disciplines much to his taste, and studying hard, he was soon on a level with all that was known to his teachers, and even before having taken a medical diploma began lecturing on his own account. This of course aroused the jealousy of the Faculty of Paris, which showed itself disposed to pursue him as an intruder; but every objection being overcome by his graduating at Montpellier, he shortly afterwards resumed his anatomical prelections, and with such success that he had usually as many as 500 students on his benches, whilst those

[1] In Hippocratis et Galeni physiologiæ partem anatomicam Isagoge. 12mo. Paris, 1556. Iterum Venet. et alibi.

of the professor in the place of authority were well nigh deserted.

Famed for his avarice and the strictness with which he exacted his fee from the students, requiring it to be paid every month, he on one occasion threatened to close his doors until the money due from two of them was either paid, or they were expelled by their fellows! A miser in the most absolute sense of the word, he lived a solitary life as a bachelor, scarcely allowing himself the barest necessaries of life, and no fire through the bitter Parisian winter; but taking a turn at hand-ball ever and anon in his chamber to keep himself warm! Though it was known that he must have amassed a large fortune, but little was found after his death; and that secreted in unlikely corners—he had hidden away his treasure where it was never discovered.

Sylvius must have possessed the art of the lecturer in perfection; he had large audiences, as said, and seems always to have proceeded by the way of demonstration: he did not lecture in the style which appears to have been in fashion with other anatomists, from the writings of Galen, but from the dead body; and when his subject was the *materia medica*, which he also taught, there were the drugs and preparations in presence; when it was botany, specimens of the plants described were on the table, and so on.

Sylvius was the first who gave particular names to the muscles, and who distinguished between those of

automatic life and those under the control of the will. The muscles of automatic life he describes under the generic title of *villi*, their fibres, unlike what is seen in the muscles of voluntary motion, being disposed in layers overlying one another in different directions—longitudinally, transversely, and obliquely. Under his category of villi fall the muscular compages of the heart, stomach and urinary bladder; the straight fibres in each attracting, the transverse expelling, and the oblique retarding or retaining. It is by the action of the longitudinal bundles, consequently, that the heart has its principal attractive power—the *diastole;* by the action of the transverse bundles its expulsive property—the *systole;* and by that of the oblique bundles combining with the other two orders, its *retaining* quality (lib. i. chap. 5).

Sylvius, however, had highly complicated ideas on the motions of the heart. By its diastole he says it attracts blood into the right ventricle from the vena cava, and air into the left from the arteria venosa (pulmonary vein); by its systole, again, it throws the blood it has attracted into the vena arteriosa (pulmonary artery) and arteria magna (aorta), and certain fuliginous vapours or excrementitious matters into the arteria venosa (pulmonary vein). It is by means of its oblique fibres that the heart, in the interval between the diastole and systole, is enabled to free itself of fuliginous vapours.

I find little in Sylvius with which we are not already

familiar through Galen; but his notice of the valves of the veins is original—he having been aware of the existence of these appendages; and his account of the influence of the foramen ovale of the fœtal heart is not to be found in the works of his predecessors. "In the fœtal heart," he says, "there is a certain membrane, in the nature of a covercle or lid, at the orifice of the vessel which connects the vena cava with the arteria venosa. It is readily turned towards the orifice of the vas arteriosum, and thereby prevents the blood from entering the lungs; but on the birth of the child the membrane coalesces with the edges of the orifice it had hitherto left free, and closes it in the course of the first day, but sometimes not until several days have passed.

"There is a membranous process (epiphysis) of a similar kind at the commencement of the vena azygos, and others also in more than one of the great vessels, such as the jugulars, brachials, crural veins, and trunk of the cava as it leaves the liver. The use of all of these processes, says Sylvius, is the same as that of the membranes which close the orifices of the heart. Some of the membranes in question have even delicate layers of muscular fibres like those of the larger veins and arteries, the œsophagus, urinary bladder, &c."[1]

[1] "Membranæ quoque epiphysis est in ore venæ azygi, vasorumque aliorum magnorum sæpe, ut jugularium, brachialium, cruralium, trunco cavæ ex hepate prosilientis, usus ejusdem cum membranis ora vasorum cordis claudentibus." In Hippocratis et Galeni physiologia Isagoge. Venet., 1536. 12mo. Lib. I., cap. 3, p. 31*a*.

The valve at the root of the vena azygos became the subject of fre-

Sylvius was the first who thought of using injections in tracing the blood-vessels, and so could not fail to discover the obstructions which his liquids, or the air he tried to blow into them, met with in the veins. Strange as it seems to us now, however, and in spite of his assimilating their function to that of the cardiac valves, he does not see their real significance. Galen had said that the veins were the channels of the nutrient blood, and Sylvius was content to have it pass the obstructions within as it best could!

Fabricius of Aquapendente, we might imagine, could hardly have been unacquainted with the Isagoge of Jacobus Sylvius, although we must admit that intercourse between Paris and Padua may have been less easy in his day than it is in ours. Still, that there was intercourse cannot be doubted. But Fabricius has not been challenged by his countrymen, as they have challenged Harvey, with ignoring what others had done before him; nor has he been spoken of as a plagiarist, because, following the fashion of his age, and believing he had himself something which was new to impart, he failed to refer more particularly to his predecessors for what was familiarly known to be theirs.

quent discussion in after years. If it is ever found in the human subject, it certainly is not a constant structure; neither are any valves found in the vena cava or vena hepatica in man; but they exist in some of the lower animals—in the dog, among others. Sylvius and they who followed him probably described what they saw from the bodies of four-footed creatures.

GUINTERUS (Joannes) Andernacus,—John Winter of Andernach, in the old Archiepiscopate of Cologne. Born in 1487, he died in 1574.[1] As the master of Vesalius and Servetus, this accomplished scholar and able man, had he no other claim, would require a passing notice at our hands. Of humble origin, having had innumerable difficulties to contend with in early life, but by indomitable perseverance and frugality overcoming them all, he achieved the very highest distinction, first in Greek letters, and then in medicine. Whilst engaged as Professor of Greek at Leyden, Winter had Vesalius among the number of his youthful scholars; and subsequently, after removing to Paris, and when the pupil was more advanced in years, as his anatomical prosector. Such was the reputation Winter now attained in his profession that he was appointed Physician to Francis the First, and on his demise to Henry the Second of France. But the Reformation had by this time spread to the

[1] Institutionum Anatomicarum ex Galeni sententia, Libri iii. Basil, 1539; and many other works, particularly translations from the works of Galen.

metropolis; and Winter, having adopted its tenets, appears to have fallen under suspicion, and been denounced to the higher powers by the opponents of the great movement. Persecution extending, and his personal safety becoming compromised, Winter fled from Paris and found shelter and a home at Metz; but this was for a short time only. Moving on to Strasburg, he remained there in the double capacity of Professor of Greek and practical Physician to the day of his death, at the advanced age of eighty-seven years.

In the introduction to his "Anatomical Institutions" he informs us that he had as his prosectors, "first Andrea Vesalius, a young man, by Hercules! of singular zeal in the study of anatomy; and second, Michael Villanovanus (Servetus), deeply imbued with learning of every kind, and behind none in his knowledge of Galenical doctrine. With the aid of these two," he continues, "I have examined the muscles, veins, arteries, and nerves of the whole body, and demonstrated them to the students."

Vesalius and Servetus, then living under the name of Villeneuve or Villanovanus, we thus learn were Winter's assistants in the dissecting room; and it is surely matter of no common interest that we find these two men—one the creator of modern anatomy, the other the discoverer of the pulmonary transit of the blood—thus associated in a common study, pursued by each in conformity with his mental aptitude and

natural proclivity: Vesalius, the observer, interested in the forms, connections, relations, and structure of the organs composing the body, but indisposed to swerve from the beaten path of interpretation when function came to be considered; Servetus, the philosopher, the reasoner, nowise negligent of data, but disposed to speculate on the meaning of things as they were, and recking little of authority when its dictum was not found by him in conformity with sensible fact. It must have been in the dissecting room of John Winter of Andernach that Andrea Vesalius and Michael Servetus acquired the intimate anatomical knowledge which, put to interest by each in his own way, has made both of their names immortal in the annals of anatomical and physiological science.

When we turn to Winter's "Institutions" we find him perfectly well informed on the anatomy of the heart. In contact with two such assistants as he had, he was not likely to be behindhand here; whether it were structure or the possible purpose of all which the scalpel brought to view that was in debate.

The heart, according to Winter, is a truly muscular organ; being constituted by several superposed layers of fleshy fibres variously disposed—longitudinally, obliquely, transversely; different from ordinary muscular tissue, however, and to be assimilated to that which is met with in the intestines, the urinary bladder, the uterus, &c.

Having a two-fold function to perform, the arrangement of the muscular bundles of the heart necessarily differs from that which appears in the muscles of the trunk and extremities; those that are longitudinally disposed causing the diastole of the organ by their contraction, those transversely arranged begetting the systole, and, in the brief interval between these two motions, those that lie obliquely coming into play and momentarily suspending action, securing the discharge of the fuliginous or excrementitious matters of the blood along with the breath.

The ventricles of the heart are two in number only, not three, as had been said by Aristotle; and they are divided by a firm fleshy partition, through the pores in which the blood reaches the left from the right side of the organ.

The mitral, tricuspid, and semilunar valves are accurately described; their disposition, in connection with the great orifices they guard, being declared to be such as to permit of ingress on the one hand and to oppose egress on the other. But they have an additional duty to perform: Put on the stretch by the motion of the heart, and acting on the coats of the arteries, they cause these vessels to respond at the proper moment and forward the blood which the diastole has attracted to every part of the body. To Winter, as to the older anatomists, we thus see that the blood did not enter the ventricles by any force from behind, but was drawn into them by the

diastole—into the left from the arteria venosa, into the right from the vena cava; and the reason why there are only two valves on the left instead of three, as on the right side of the heart, is in order that the orifice they guard should not be so accurately closed as to impede the escape of fuliginous matters from the blood, and thereby endanger the damping or extinction of the native heat enshrined in the ventricles.

The lungs are light and spongy, and look as if they were composed of frothy blood—of blood replete with air or spirit—which it is their business to elaborate into the pure, subtle, vapourous and proper aliment of the heart and arteries. The air taken into the lungs in breathing undergoes a change by coming into contact with the vascular network of the vena arteriosa proceeding from the right side of the heart, and of the arteria venosa sent from the left, interwoven as they are with the minute ramifications of the proper air vessel, the trachæa.

The vena arteriosa (pulmonary artery) is of such ample size in order that it may transmit a sufficiency of nourishment to the lungs, and its walls are of the thickness we observe, in order that none of the blood it contains may escape through them to the detriment of the peculiarly delicate tissue of the organ it supplies. The walls of the arteria venosa (pulmonary vein) on the contrary, as its office is to impart vital spirit along with the more subtle and attenuated blood

it contains, are thin and membranous, in order that no obstacle should be opposed to the access of the inbreathed air on the one hand—to the escape of fuliginous vapours on the other.

In the above we here and there observe an advance on anything we have found in Galen ; and as Winter, in his Introduction, shows by his language that he was in the hands of his two able assistants, we shall probably do him no injustice when we conclude, that, as he owed his better knowledge of the anatomy of the heart and lungs to the dissections of Vesalius, so in his physiology he had all wherein he advances on his predecessors, from the reflective and more independent Servetus. What we have just found advanced on functional matters had certainly not been said by any one before ; and it does not differ greatly from that we discover in the Christianismi Restitutio of Servetus. The remark on the change undergone by the *air* and—as we find it in Servetus's work —by the *blood*, during its passage through the capillary system of the lungs, is very notable.

VESALIUS (Andrea),[1] scion of a respectable German family, natives of the Duchy of Cleves, was born at Brussels in 1512, in which city he received the rudiments of a thoroughly liberal education. Electing medicine as his profession, he proceeded to Paris, the nearest and most flourishing school of medical science of the day, and under Jacobus Sylvius, and Joannes Winter, the professors of anatomy, received initiation into the science in which he was soon so greatly to distinguish himself, and not only to eclipse his masters, but all anatomists who had lived before him. When no more than twenty years of age, in common with Michael Servetus, his senior by some two or three years, he acted as prosector to Winter, and from the way the professor speaks of his assistants it would almost seem that they were the teachers, he the taught. It was from their dissections, as we have seen, that he lectured to his class.

[1] De Humani corporis fabrica Libri Septem. — fol. Basil. 1542. Ed. altera, Ib., 1555. A magnificent volume, full of figures admirably drawn, having a portrait of the author, as well as a frontispiece, in which he is represented demonstrating from the dead body to a crowd of lookers-on.

With the dead body before him, Vesalius, forced, reluctantly it might seem, to repudiate the authority of Galen on many points in so far as structure was concerned, became the creator of modern anatomy. Servetus, gifted with inductive genius and a bolder spirit, after breaking with Scholasticism in theology, and casting off the shackles of Greeks and Arabians in Practical Medicine, inaugurated Rational Physiology when he proclaimed the course of the blood from the right to the left side of the heart through the lungs, and observed the change it underwent in its passage, from the dark colour it had in the veins to the florid hue it showed in the arteries.

Nor was it in their studies only that these two remarkable men were associates; in their misfortunes, and early deaths, they were also fellows. While Vesalius was engaged in examining the body of a young nobleman who had died under his care, the heart was declared, by an ignorant bystander, to have palpitated when touched by the knife of the anatomist. Matters would probably have gone hard with Vesalius, who was vindictively prosecuted by the relations of the dead man for murder, not only before the civil tribunal, but before that of the Inquisition, had not Philip II. interfered. At his instance the impending capital conviction for murder and impiety was commuted for a pilgrimage to Jerusalem, with confession made and absolution obtained at the shrine of the Holy Sepulchre. The penance was undergone; but the

pilgrim homeward bound suffered shipwreck on the Island of Crete or Zante, and perished miserably there. Servetus, again, in his zeal for what he believed to be truth in the super-subtle regions of dogmatic theology, given no chance for his life but such as an honourable man could not accept, had to abide the still more cruel death of the faggot and stake.[1]

When scarcely out of his pupilage, Vesalius was elected to the anatomical chair of Padua in 1537; and his fame as a skilful practitioner of medicine as well as a distinguished anatomist extending, he was soon afterwards appointed physician to the Emperor Charles V., and subsequently to his son and successor Philip II. of Spain.

Vesalius may be properly spoken of as a pure anatomist. In the sphere of anatomy only did he shine or show himself independent. He is comparatively brief in his great work when he refers to the functions of the organs he describes; and what he says is all but invariably in conformity with the views of Galen—if he ever differs from the "divus homo" it is never otherwise than apologetically.

With his great master, then, Vesalius regards the heart as the seat of the soul and of the emotions and passions. The hottest of all the viscera, it is also the source of the heat of the body, and gives rise to the arteries, but not to the nerves, as had been erroneously concluded

[1] See the writer's work, "Servetus and Calvin." London, 1877.

by Aristotle. In ceaseless motion, alternately dilating and contracting, and causing the pulse, all its parts have reference to the heat and the spirit. The diastole is the influential act of the organ, its apex being drawn towards its base by the straight fibres which enter into its composition, and the sides thereby caused to bulge. "Were a pyramidal bundle of rushes, tied at top and bottom," says Vesalius, "made to approximate by a string passed through the middle of the bundle, the pyramid would be rendered capacious within in the same proportion as it was diminished in length (De Cordis subst., cap. 10). The circular and transverse fibres, again, have an opposite effect, constringing the walls, and elongating the organ by forcing the base and apex apart, not otherwise than the pyramidal bundle of rushes would be lengthened were it grasped by the hands from without, the string within having been relaxed. The *straight* fibres," he continues, "we are persuaded serve for attraction, the *transverse* for expulsion, and the *oblique* for retention,"—language meaningless in fact, but accommodated to the physiological ideas of Galen.

Thoroughly well informed on all that concerns the anatomy and essential function of the valvular apparatus of the heart, Vesalius, nevertheless, does not question Galen's assumption of the partial inefficiency of the valves. He is very particular in describing the numerous foveæ or pits that appear on the inner

walls of the ventricles, and opposite surfaces of the septum; but he sees none of them of any depth or pervious, so as to bring the two ventricles into communication (De Cordis sinibus, cap. 11.)

The vena cava fetches blood from the liver to the right side of the heart, whence it is transmitted to the lungs by the vessel having the structure of an artery, but performing the office of a vein, and therefore called *Vena arterialis.* The vessel, again, which brings blood and also air into the left ventricle from the lungs, is properly an artery, and so is spoken of as the *Arteria venalis.* The left ventricle, in fine, gives origin to the great vessel of the body, the *Aorta.*

Vesalius, the scholar of Sylvius, as well as of Winter, could not have been cognisant of the valvular arrangements about the heart alone; he knew that there were *ostiola* connected with the veins also, speaks of them as *eminences* or *projections*, and even says that they are analogous to the valves of the heart; but he strangely denies to them the office of valves. To Vesalius, however, we are to remember that the motion of the blood was of a to-and-fro kind—*huc accedit quod per venas arteriasque mutuos materiarum fluxus et refluxus esse* (lib. vi., cap. xvi. ad fin.); and valves in the veins, acting as such, would have interfered with anything of the sort; *therefore* were they not true valves, but accidental rugosities in the interior of the veins, interfering in nowise with their accredited functions.

Elsewhere, yet not in contradiction with his proper idea of the office of the veins, Vesalius is found speaking of a *relapse* or return of the blood from the branches of the veins to their trunks—*Sanguinis ex venarum ramis in truncos relapsum;* an expression which one so learned, and in general so critically judicious, as Haller interprets into a "not obscure rudimentary intimation of the circulation—*non obscurum circuitus sanguinis rudimentum.*"[1] But as Vesalius follows Galen in regarding the veins as the channels by which the parts of the body are supplied with nutriment, there was necessarily relapse into the trunks of the veins as an element in the to-and-fro motion of the blood within them. He also expresses very clearly the idea that was entertained in the old physiology of the attractions exerted by the various parts of the body for the blood, and of the heart and veins for the blood itself. "The right sinus of the heart," he says, "attracts blood from the vena cava, and the left attracts air from the lungs through the arteria venalis, the blood itself being attracted by the veins in general, the vital spirit by the arteries." These attractions were, in fact, regarded as the chief causes of all the motions of the blood in its containing vessels.

"So often as the heart dilates," says Vesalius, "the right ventricle attracts a quantity of blood from the vena cava, which it concocts and attenuates by its heat,

[1] Biblioth. Anat., T. I., sub voc. Vesalius.

and so makes more fit to be carried forward by the arteries. A very small proportion only of the blood thus taken by the right ventricle from the vena cava, however, can possibly filter through the septum to the left ventricle; by far the larger amount passes to the lungs by the vena arterialis; and the reason why this vessel has the structure of an artery with the function of a vein—for it takes nourishment to the lungs—is that it may resist the violent contractions of the heart, and the compression due to the motions of the chest in breathing. Its coats also required to be thick, in order that the blood it contains, already attenuated by the action of the right ventricle, should not transude to such an extent as to leave an inadequate supply for the nourishment of the lungs and for eduction through the arteria venalis into the left ventricle, there to be yet further elaborated and perfected into vital spirits.

"The office of the auricles," he continues, "is to furnish a little blood to the ventricles at the first moment of their sharp diastolic movement, a provision without which the delicate vena cava and pulmonary artery might be ruptured by the suddenness of the ventricular contraction.

"In the same way as the right ventricle attracts blood from the vena cava, does the left draw in air from the lungs through the arteria venalis, for the purpose of tempering its native heat; and, with the aid of the blood that has filtered through the septum,

of preparing the vital spirit for transmission by the aorta and its branches to all parts of the body. We are of opinion," concludes Vesalius, "that these matters pertaining to the functions of the heart may all be accomplished in the manner set forth by the Divine Man."

The functions of the heart we therefore see, are left by Vesalius in no more satisfactory a state than they reached him from his master, Galen. He knows that the septum is really impervious; but the "divine man" has spoken of it as if it were a sieve, and to this the complacent follower assents at one time, though he dissents from it at another; and in speaking of it as perfectly solid makes transudation through it impossible.

Vesalius seems even to revert to the views of Erasistratus, combated by Galen; and against his better knowledge leaves himself little but air, in so far as appears, for transmission by the aorta and its branches to the body at large.

When the immense reputation Vesalius so long enjoyed as an anatomist is considered, it is difficult to understand how he did so little in the interpretation of function. He appears to have been one of those men who delight in gathering and garnering up facts, without presuming to reason upon their significance, different far in this respect from his friend and fellow-student, Michael Servetus, open-eyed to all he saw, but still fonder of speculating than of accumulating data.

In a notable but misty passage of his Christianismi Restitutio, where he speaks of the brighter and purer part of the mind as having its home in one of the chambers of the brain, he says: "There, calling up the germs of innate ideas in company with the images of things perceived and their similitudes, the mind excogitates and composes others that are new; from one infers another and another, contrasts, compares, distinguishes, and so, God giving the light, attains to truth at last."[1] Somewhat freely interpreted we here meet with the very soul of the inductive philosopher —with the spirit that in after years found congenial resting-place in our Bacons, Newtons, and Harveys!

[1] "Ubi lucidior et purior est mentis pars; quæ, divinitus innata sibi idearum semina excerens, ex semel jam apprehensis imaginibus, potest res novas, similitudine quadam, cogitare sive componere, immaginata commiscere, ex aliis alia inferre, inter ea discernere, et puram ipsam veritatem colligere, lustrante Deo."

SERVETUS (Michael), a native of the old Spanish Kingdom of Aragon, was born in the year 1509 of a family in easy circumstances, his father following law as a kind of hereditary profession in the town of Villanova. From all we know, Servetus must have received an elementary education calculated to qualify him for the service of the Church; but, of a singularly self-reliant, independent nature, he seems soon to have abandoned the idea of becoming either monk or priest, and betook himself to the study of law as his future profession. With this view he proceeded to Toulouse, the most celebrated legal school in those days; and there, beside other reading outside the faculty of jurisprudence, he found an opportunity to peruse the Bible —a kind of reading that may be said not only to have influenced the whole of his after life, but to have been that which brought him to his untimely end.

Recommended to Fra Juan Quintana, Confessor of the Emperor Charles V., in the quality of Secretary as we may presume, Servetus journeyed from Spain through France in the Imperial suite first to Italy,

and then to Germany; but neither at Bologna where he witnessed the coronation of the Emperor, nor at Augsburg during the sitting of the Diet, did he see aught that did not confirm the strong dislike of the Papacy, its dogmas and all that follows therefrom, which he appears to have imbibed from reading the forbidden book.

In the frame of mind with which we may now venture to credit Servetus, service with a priest in the atmosphere of a Court was not likely to endure. In the course of a year, or little more, accordingly, we find him free, and, full of certain new theological notions, seeking acquaintance with the Reformers of Basle and Strasburg, by whom, however, with a single exception perhaps, he was very coldly received.

Disappointed of recognition in quarters where he seems to have felt sure of sympathy, Servetus now resolved to appeal to a wider public, and to print the treatise he had written on Trinitarian Errors.[1] This he speedily accomplished; adding in the course of the following year a sequel to the work under the title of "Two Dialogues on the Trinity."[2]

Both of these publications, be it said in a word, meant by the writer to be specially directed against the dogmas of the Church of Rome, were found highly heretical by the Reformers, although the daring specu-

[1] De Trinitatis Erroribus Libri Septem. Auctore Michael Serveto alias Reves, ab Aragonia, Hispano. 12mo, s. l. 1531.

[2] Dialogi duo de Trinitate. 12mo, s. l. 1532.

lations of Michael Servetus of Aragon, the Spaniard, were eagerly read and discussed by the very foremost men among them. No open countenance, however, could be given to the author of such innovations. Not only failing to find favour and footing with the Reformers of Basle and Strasburg, but observing that he had become an object of suspicion, and that his liberty if not his life was in danger from the civil authorities of Basle, Servetus now betook himself to France, under the assumed name of Villeneuve or Villanovanus, by which he continued to be known during the rest of his life. Reaching Paris in the course of the year 1533, he gave himself up to the study of mathematics, geography, and astronomy; and there, still hankering after theological matters, he sought out and made the acquaintance of the man who subsequently became his most determined enemy and persecutor — the celebrated John Calvin.

The next we hear of Michel Villeneuve is in Lyons, engaged as reader and editor in the printing establishment of the brothers Trechsel; and there it was that he became known to Dr. Symphorien Champier, a patron of learning, besides being the physician of highest repute in the city, and well pleased to play the part of a Mecænas to struggling talent. Interesting himself in one so intelligent and well informed as Michel Villeneuve, Champier led him away from astronomy, mathematics, and theology to the study of medicine;[1]

[1] See two interesting articles by the Rev. H. Tollin in Goschen's

into the rudiments of which great science Champier appears to have taken some pains to initiate him. But there was no established school of medicine at Lyons. Finding himself in funds, however, through the good work he had done with the Trechsels, he returned to Paris, then in the zenith of its fame as a school of medicine, and attending the prelections of Jacobus Sylvius, and engaging himself as prosector to Winter of Andernach, he acquired such a knowledge of the structure of the human body as led him in after years to the most brilliant induction of his age—the transit of the blood from the right to the left side of the heart by a lengthened passage through the lungs.

Graduating M.A. and M.B. in due course, Dr. Villeneuve settled as physician in Paris, and by way of making his existence known to the world of the metropolis, within a year or so of his reception by the Faculty of Medicine, he wrote and published a small volume on the class of medicines designated Syrups[1] —much akin, it would seem, to the tisanes still popular in the medical practice of the French.

The book was well received; practical in its tendency, and unmistakably written by a man of learning and ability; could its author but have had patience it must certainly have proved the foundation of his fortune. But business comes slowly to the young

Deutsche Klinik, 1875, and Virchow's Archiv, 1874, Bd. 61, headed Wie Servet Mediciner werde.

[1] Syruporum universa ratio ad Galeni censuram concinnata. 12mo. Paris, 1537.

physician, who must nevertheless live; so that Villeneuve, impecunious as he felt himself, was compelled to fall back on his geography and astronomy—then called astrology—and to show himself as a teacher of these branches of natural knowledge. He delivered a course of lectures on the subjects named, which proved highly successful, and besides money and friends brought the young professor into vogue as an adept in prescribing for disease and forecasting events in the lives of men from the aspects of the stars!

And we are not to think altogether disparagingly of him who, in the early part of the sixteenth century, believed that every man and woman coming into the world had their destiny foreshadowed to them in the state of the heavens at the hour of their birth. Belief of the kind was still common, although upon the wane, as seems proclaimed by the fact that Villeneuve was shortly afterwards sued by the Faculty and University of Paris, as a practitioner of Judicial Astrology or Divination. Jealousy of the stranger, however, and retaliation for light speech from him of his fellows the physicians of Paris, because of their ignorance of the subject by which he was putting money in his purse and taking patients from them, would seem to have had not a little to do with the institution of the process.

Villeneuve fought his battle bravely with the Faculty, but being cast in the suit, he took his defeat so much to heart, that he vacated the field, and pro-

ceeded first to Charlieu as medical practitioner, and then, on the invitation of its archbishop, who had been among the number of his auditors in Paris, to Vienne in Dauphiny, where for twelve years or more, by the legitimate practice of his profession, he lived respectably and respected, trusted in his calling and on terms of intimacy with the foremost people of the metropolitan city.

But the old theological fire, if quenched to outward view, still smouldered in the secret chambers of his soul, and found vent at length in a second theological work, entitled Christianismi Restitutio[1]—The Restoration of Christianity.

The printing of the book led almost immediately to his arrest and prosecution for heresy, at the instigation of Calvin, by the authorities of Vienne. He escaped from prison, however, through the connivance of his friends; but it was only to fall into the hands of the Reformer of Geneva, at whose instance he was arrested, cast into the felon's dungeon, put upon his trial for life or death, and being condemned to die, he perished miserably at the stake, in the forty-fourth year of his age, and the fifteen hundred and fifty-third of the Christian era.

It is in the work on the Restoration of Christianity that the new and pregnant truth in physiology, the transit of the blood from the right to the left

[1] Christianismi Restitutio: Totius Ecclesiæ apostolicæ ad sua limina vocatio, &c. 8vo, min., s. l. 1553.

side of the heart through the lungs, is first definitively proclaimed to the world.

We have seen Servetus, still *in statu pupillari*, credited by his master with his particular knowledge of Galenical doctrine; but he was never its slave, any more than he had shown himself the slave in his first theological work of the metaphysical assumptions of the Roman Catholicism in which he had been educated. As the work on Trinitarian error had been the first open rebellion against Catholic Dogma by a man of learning, so might the little volume on Syrups be characterized as the earliest lapse from the universally prevalent faith in the pathological and therapeutical dogmas of Galen; and the physiological portions of the Christianismi Restitutio, in its turn, be seen as the herald of a new era in medical science. Harvey had, in reality, no proper precursor in the field he made so wholly his own, but Michael Servetus. All the great German and Italian anatomists, who came between them, were under the spell of Galen. They may have bettered his anatomy, but they made no advance on his physiology. The blood of the vena arterialis passed to the lungs for their nourishment, and was mostly absorbed by them, until Servetus maintained that such a quantity of blood as reached them by the vena arterialis could not be required for this purpose, but must proceed in mass to the left ventricle by the arteria venalis for other purposes.

Servetus, however, had not, any more than his age, freed himself from the idea that there were two kinds of blood in the body, one appropriate to the veins —the *natural* blood, destined to the nourishment of the parts; another confined to the arteries — the *spirituous* blood, the vehicle of heat and vital endowment; the liver being the source of the one, the heart the fountain of the other. But the way and manner in which the vital spirit was engendered was the subject in physiological science which attracted the most particular attention of Servetus. "There are commonly said to be three spirits within us," says he,[1] quoting Aphrodisæus, "a natural, a vital, and an animal spirit. There are not three spirits however, but two only; the vital spirit being communicated from the arteries to the veins, in which it is called natural, by their anastomoses. The blood, therefore, in which inheres the first, or natural spirit, has precedence; its source and home being the liver and veins. The second or vital spirit, associated with the blood of the arteries, has its origin and dwelling-place in the heart and arteries. The third, the animal spirit, a ray of light as it were, has its habitation in the brain and nerves.

[1] "Tres spiritus vocat Aphrodisæus. Verè non sunt tres, sed duo spiritus distincti. Vitalis est spiritus qui per anastomoses ab arteriis communicatur venis, in quibus dicitur naturalis. Primus ergò est sanguis, cujus sedes est in hepate, et corporis venis. Secundus est spiritus vitalis, cujus sedes est in corde, et corporis arteriis. Tertius est spiritus animalis, quasi lucis radius, cujus sedes est in cerebro, et cor-

"Situated in the middle of the body, the heart is the first part that lives, and is the source of the vital heat; but it is from the liver that it receives and vivifies the liquor—the material as it were—of life; even as the water of the earth supplies material to the superior elements, and being returned by these to the earth united with light, is vivified into vegetable forms.

"From the blood of the liver, then, is derived the material of the soul; but it has to undergo elaboration by an admirable process which you shall now have described to you, whereby it comes to pass that the soul is said to be in the blood, or the blood itself to be the life; for the soul is not in the walls of the heart, or in the mass of the brain or of the liver, but in the blood, as God teaches. (Genes. ix., Levit. xvii., Deuter. xii.)

"To understand this, the substantial generation of the vital spirit—engendered of the most subtle parts of the blood and the air—has to be properly apprehended. The vital spirit, then, has its origin in the left ventricle of the heart, the lungs aiding essentially in its generation. It is a fine subtle spirit, elaborated

poris nervis." . . . Cor est primum vivens, fons caloris in medio corpore. Ab hepate sumit liquorem vitæ, quasi materiam, et eam, vice versâ, vivificat: sicut aquæ liquor superioribus elementis materiam suppeditat, et ab eis, junctâ luce, ad vegetandum vivificatur. Ex hepatis sanguine est animæ materia, per elaborationem mirabilem, quam nunc audies. Hinc dicitur anima esse in sanguine, et anima ipsa esse sanguis, sive sanguineus spiritus. Non dicitur anima principaliter esse in parietibus cordis, aut in corpore ipso cerebri, aut hepatis, sed in sanguine, ut docet ipse Deus: Genes. ix., Lev. xvii., et Deut. xii."

"Ad quam rem est priùs intelligenda substantialis generatio ipsius

by the power of heat, of a crimson colour and fiery potency, the lucid vapour, as it were, of the purer part of the blood, comprising in itself the substance of water, air and fire, being engendered in the lungs by the mixture of the respired air with the elaborated blood which the right ventricle of the heart communicates with the left.

"But this communication does not take place through the partition of the heart, as is generally believed; but by another admirable contrivance, whereby from the right ventricle the subtle blood is agitated in a lengthened course through the lungs; wherein prepared it becomes of a crimson colour, and, from the vena arterialis (pulmonary artery) is transferred into the arteria venalis (pulmonary vein). Mingled with the inspired air in the arteria venalis, freed by expiration from fuliginous matter, and become suitable home of the vital spirit, it is attracted at length into the left ventricle of the heart by the diastole of the organ.

"Now, that the communication is effected in the lungs

vitalis spiritûs, qui ex aëre inspirato et subtilissimo sanguine componitur et nutritur. Vitalis spiritus in sinistro cordis ventriculo suam originem habet, juvantibus maximè pulmonibus ad ipsius generationem. Est spiritus tenuis, caloris vi elaboratus, flavo colore, igneâ potentiâ, ut sit quasi ex puriori sanguine lucidus vapor, substantiam in se continens aquæ, aëris et ignis. Generatur ex factâ in pulmonibus mixtione inspirati aëris cum elaborato subtili sanguine, quem dexter ventriculus cordis sinistro communicat. Fit autem communicatio hæc, non per parietem cordis medium, ut vulgò creditur. Sed magno artificio à dextro cordis ventriculo, longo per pulmones ductu, agitatur sanguis subtilis: à pulmonibus præparatur, flavus efficitur, et à venâ arteriosâ in arteriam venosam transfunditur. Deinde in ipsâ arteriâ venosâ inspirato aëri miscetur, expiratione à fuligine repurgatur. Atque ità tandem à sinistro

in the manner described, is proclaimed by the various conjunctions of the vena arteriosa, with the arteria venosa which take place within their substance, and by the remarkable size of the vena arteriosa, which would not be of such dimensions as it is, nor pour such a stream of the purest blood into the lungs for their nourishment only. Neither would the heart have supplied the lungs in such a manner—a truth of which we seem to be assured when we see the lungs of the embryo otherwise nourished; those membranes or valves of the heart not becoming unfolded and coming into play until the hour of birth, as Galen teaches.

"The blood is therefore poured in such quantities from the heart into the lungs at the moment of birth, for the purpose indicated. And then, as it is not air only, but blood mixed with air that is carried from the lungs to the heart by the arteria venosa, it is in the lungs not in the heart that the mixture is effected; as it is also in the lungs, not in the heart, that the florid colour of the spirituous blood is acquired. There is not space

cordis ventriculo totum mixtum per diastolem attrahitur, apta supellex, ut fiat spiritus vitalis.

"Quod ità per pulmones fiat communicatio et præparatio, docet conjunctio varia et communicatio venæ arteriosæ cum arteriâ venosâ in pulmonibus. Confirmat hoc magnitudo insignis venæ arteriosæ, quæ nec talis, nec tanta facta esset, nec tantam à corde ipso vim purissimi sanguinis in pulmones emitteret, ob solum eorum nutrimentum, nec cor pulmonibus hac ratione serviret; cùm præsertim anteà in embryone solerent pulmones ipsi aliundè nutriri, ob membranulas illas, seu valvulas cordis, usque ad horam nativitatis nondum opertas, ut docet Galenus.

"Ergò ad alium usum effunditur sanguis à corde in pulmones horâ ipsâ

enough in the left ventricle for so great and important a composition; neither does it seem competent to produce the crimson colour. Finally, as the septum is without vessels and function, it is not adapted to effect the communication and elaboration in question, although something may sweat through it. It is by an artifice like that which we see in the liver, whereby transfusion takes place from the vena portæ to the vena cava in respect of the blood, that transfusion is effected in the lungs from the vena arteriosa to the arteria venosa in respect of the spirit. If any one compares what has now been said with what he will find in the sixth and seventh books *De usu partium*, he will readily comprehend a truth not animadverted to by Galen.

"The vital spirit (thus prepared) is then transferred from the left ventricle of the heart by the arteries to the whole of the body, and in such wise that the lighter portion mounts to the superior parts. There, still

nativitatis, et tam copiosus. Item, à pulmonibus ad cor non simplex aër sed mixtus sanguine mittitur per arteriam venosam : ergò in pulmonibus fit mixtio. Flavus ille color à pulmonibus datur sanguini spirituoso, non à corde. In sinistro cordis ventriculo non est locus capax tantæ et tam copiosæ mixtionis, nec ad flavum elaboratio illa sufficiens. Demum, paries ille medius, cum sit vasorum et facultatum expers, non est aptus ad communicationem et elaborationum illam, licet aliquid resudare possit. Eodem artificio, quo in hepate fit transfusio à venâ portâ ad venam cavam propter sanguinem, fit etiam in pulmone transfusio à venâ arteriosâ ad arteriam venosam propter spiritum. Si quis hæc conferat cum iis quæ scribit Galenus lib. vi. et vii. *De usu partium*, veritatem penitùs intelliget, ab ipso Galeno non animadversam.

"Ille itaque spiritus vitalis à sinistro cordis ventriculo in arterias totius corporis deindè transfunditur, ità ut qui tenuior est superiora petat,

farther elaborated in the retiform plexus situated at the base of the brain, it reaches the proper seat of the rational soul; from vital becomes animal, and is finally perfected into the substance of the soul itself. Plexuses of vessels then penetrate the most intimate parts of the brain, reaching even to the origins of the nerves, imparting to them the faculties of sensation and motion, and although spoken of as arteries, they are in fact a new kind of vessels; for as in the transfusion (of the blood) in the lungs there is a new sort of vessel between vein and artery, so in the transfusion from artery to nerve in the brain there is a certain new sort of vessel formed of the arterial tunic and meningeal substance."

When the above is compared with all we have found in the predecessors of Servetus, the originality of the writer will not be questioned; Servetus does in fact stand alone as a reasoner among the anato-

ubi magis adhuc elaboratur, præcipuè in plexu retiformi, sub basi cerebri sito, in quo ex vitali fieri incipit animalis, ad propriam rationalis animæ sedem accedens. Iterum ille fortius mentis igneâ vi tenuatur, elaboratur, et perficitur, in tenuissimis vasis, seu capillaribus arteriis, quæ in plexibus choroïdibus sitæ sunt, et ipsissimam mentem continent. Hi plexus intima omnia cerebri penetrant, et ipsos cerebri ventriculos internè succingunt, vasa illa secum complicata et contexta servantes, usque ad nervorum origines, ut in eos sentiendi et movendi facultas inducatur.

"Vasa illa miraculo magno tenuissimè contexta, tametsi arteriæ dicuntur, sunt tamen fines arteriarum, tendentes ad originem nervorum, ministerio meningum. Est novum quoddam genus vasorum. Nam, sicut in transfusione à venis in arterias, est in pulmone novum genus vasorum ex venâ et arteriâ, ità in transfusione ab arteriis in nervos est novum quoddam genus vasorum, ex arteriæ tunicâ et meninge." (Op. cit., p. 169.)

mists and physiologists of the Renaissance; and it is impossible to say with what amount of independent thought, of pregnant suggestion and new truth he might have enriched the world had he not been cut off in the flower of his age.

The arrangement of the valvular apparatus at the orifices of the heart, familiar to anatomists since the days of Galen, the disproportionate size of the pulmonary artery to any possible requirement by the light spongy tissue of the lung for nourishment, and the density of the ventricular partition—all led Servetus to conclude that the old teaching on the formation of the vital spirit was untenable. An insignificant and utterly inadequate portion of blood could alone sweat through the septum; but there was the open way from the right side of the heart by the pulmonary artery to the lungs; and, presuming this vessel to communicate with the pulmonary vein, a further passage from the lungs to the left side of the heart. The mixture of the inbreathed air with the blood, the first step towards the formation of the vital spirit, took place in the lungs, therefore, not in the heart; and in the lungs also, not in the heart, was the crimson colour that characterized the arterial blood acquired.

These novel views were further confirmed by what Servetus says of fœtal life. During the term of intra-uterine existence, the function of the lungs was in complete abeyance; the blood did not then pass into them at all, but went direct from the pulmonary artery

by a special canal to the aorta, and from the right side of the heart to the left by an open orifice between the auricles. The fœtus had as yet no independent existence, it lived exclusively through the life of the mother and had no soul of its own. Born and beginning to breathe, however, the lungs, following the heave of the chest, expanded, and a passage being thereby opened through their substance from the pulmonary artery to the pulmonary vein, with consequent exposure of the blood to the life-giving air, the vital spirit was engendered and the soul of the child acquired. The current which now poured into the left auricle and ventricle by the pulmonary vein, counterbalancing that which had hitherto flowed into the right side of the heart, the membrane which had guarded the orifice of the pulmonary vein was brought into contact with the sides of the foramen ovale, thus closing it, and the flow from the right side of the heart to the left by way of the lungs was established.

Servetus's physiology of the pulmonary transit left nothing to be added by successors. It was complete. The little he says on the transfusion from the systemic ventricle to the aorta and arteries of the body is as old as Galen. A flow of blood, when it was not of spirit, from the heart to the arteries, had ever been held by anatomists to be even as necessary to impart heat and vital endowment to the parts, as the flow by the veins from the liver to minister to their maintenance and nutrition.

So much said makes it unnecessary for me to insist on the indefeasible title of Servetus to rank as the physiological genius of his age; and, from what I have still to say of the great anatomists who came after him, to conclude that he was also the most legitimate predecessor of Harvey. It is only of late that all that physiology owes to Servetus has been adequately acknowledged, and it is encouraging to learn that his native country, Spain, has now shown herself not unmindful of what is due to him as a physiologist.

In the addresses delivered at the opening of the Anthropological Museum of Madrid, founded by Doctor Pedro Gonzales de Velasco, Servetus is rightfully credited with having proclaimed the way in which the blood reaches the left from the right side of the heart by passing through the lungs;[1] and his terrible and undeserved death at Geneva is not forgotten. "Servetus," says Dr. Angel-y-Pulido, the orator on the occasion, "first proclaimed the passage of the blood from the heart through the lungs, and like other mighty geniuses who have suffered for their discoveries, died, nobly resolute, at the stake.[2] But we now see his statue, along with that of another

[1] "Discursos leidos en la Apertura de Museo Antropologico y Escuola libera del Dr. Velasco, por el Doctor Angel-y-Pulido, y el Dr. Pedro Gonzales de Velasco, Fundator del mismo." Madrid, 1875.

[2] "Servet, perecer con noble altivez en la hoguera, despues de haber sorprendido el camino que braza la sangre desde el corazon á los pulmones, y otros eminentes génios sufrir amargas penas como premio á sus grandes descubrimientos."

great man, set as illustrious sentinels beneath the portico of our Institute."

The statue on the right is that of Servetus; on the left it is that of Vales, physician to Philip II., who is characterized as "el divino."

The Anthropological Museum of Madrid, let me take occasion to say, was founded by Dr. Pedro Gonzales Velasco, at his sole expense, and dedicated to the memory of his only daughter, whom he lost, to his ineffable grief, when she had just budded into womanhood, and was the very light of his life. I add the touching words in which he alludes to his irreparable loss, dimmed though they must needs be by translation. "My principal object," says Dr. Velasco, "in addressing you in these critical moments of my life, is to express to you the immense happiness, the measureless delight, which now inspires me at seeing realized the ideal for which I have striven these many, many years. Nor will the feeling, I trust, be thought extravagant that leads me to associate with this day and hour the memory of an angel of tenderness and of love, a messenger from heaven, lent by God to lighten the sorrows of this weary life, whom cruel death tore from my arms in days when her caresses were most needful to me—the daughter of my heart, whose image is ever present with me, whose spirit hovers by my side, whose winning smile I still seem to see, but whose kiss the poor bereaved worker for science no longer feels upon his cheek, and whose sweet voice no longer stirs his soul as in days gone by—days that will never be effaced from his mind." (Discurso del Dr. Pedro Gonzales de Velasco, leido en la Apertura del Museo Antropologico. Madrid, 1875. 4to.)

COLUMBUS.

COLUMBUS (REALDUS)[1] was born at Cremona. He filled the chair of anatomy after Vesalius, in the University of Padua, and died at Rome, in 1577. The year of his birth is uncertain. To this distinguished anatomist, following Galen, the liver is the head, fount, origin, and root of all the veins—*est igitur jecur omnium venarum caput, fons, origo, et radix.* It is, as it were, the king of the abdomen, its function being to generate the blood—*est sanguificatione dicatum, neque alibi sanguis gignitur.* It is mainly composed of veins with some arteries intermixed, and may be characterized as a mass of coagulated blood.

The distribution of the vena portæ is particularly described; the peculiar arrangement there conspicuous having for its object the supply of the stomach, spleen, omentum and intestines with nutrient blood — *huc vero nisi sunt hi venarum rami ut illorum sanguine nutrientur ventriculus, lien, omentum,* &c. The vena portæ, however, not only furnishes the abdominal viscera with nourishment, but is the channel by which

[1] De Re Anatomica, libri xv. Venet., 1559. Folio.

the natural blood is transmitted to the vena cava for distribution to the body generally. It has the further duty imposed on it of bringing chyle from the intestines to be elaborated into blood by the liver. The motion of the blood in the vena portæ must therefore have been imagined to be of a to-and-fro kind, precisely as it was within the vena cava.

The vena cava, on entering the thorax, sends two branches to the diaphragm, and one—the coronary vein—to the heart, before communicating with the right ventricle. Passing above the level of the lungs, the vena azygos is thrown off to carry nourishment to the parts to which its branches are distributed—*partium earum nutriendarum gratia* (lib. vi.)

Proceeding to speak of the heart and arteries, Columbus says that the heart is by no means to be reckoned among the number of the muscles—*nullo autem pacto potest Cor inter musculos connumerari.* It is completely encircled by the coronary vein in order that it may be duly nourished; and the vein is accompanied by an artery, to the end that its substance may be vivified by the vital heat thereby conveyed to it—*ut ejus ope substantia vitali calore vivificetur*—an arrangement, he goes on to say, which has led some on good grounds to conclude that the vital spirit was engendered in the lung rather than in the heart. It is not unimportant here to ask who had said so? No one, except Servetus. Describing the ventricles particularly, the right, he says, is the one

that contains the *natural blood—sanguis naturalis:* whilst the left is dedicated to the service of the *vital blood—sanguis vitalis;* and the walls of the left ventricle are so much thicker than those of the right to prevent the vital blood, which is extremely subtle and attenuated, from sweating through them—*ne extra resudat.* Nothing, however, can pass through the septum between the two ventricles, as is commonly said; for the blood is carried by the vena arterialis to the lung, whence, after having been attenuated, refined, and mingled with air, it is brought by the arteria venalis to the left ventricle, a fact which no one until now has referred to in words or recorded in his writings—*quod nemo hactenus aut animadvertit aut scriptum reliquit*—I add, except Servetus.

Our author now proceeds to describe the arrangement of the great vessels connected with the base of the heart, two of these pertaining to the right side of the organ, two to the left. On the right are the vena cava and pulmonary artery,[1] on the left the aorta and pulmonary vein. "But you are not to think," he proceeds, "as many do, that the vena cava arises from the heart; for it does not really enter the heart, as has been erroneously maintained. It is only enlarged and cleft opposite the heart, and adheres, as it were, to the orifice of the right ventricle, so that the pulmonary artery is to be

[1] I shall continue henceforward to designate the vessels by their modern names, the old ones being more or less apt to breed confusion.

regarded as a continuation of the vena cava, which arises from the liver, and in the fœtus is seen continued into the left sinus of the heart. As the vena cava has its source in the liver, so has the pulmonary vein its origin in the heart. The function of the pulmonary artery is to take blood to the lungs for their nourishment, and also that it may undergo a change in them for the sake of the heart. It is only when the fœtus is born that the communication between the vena cava and the left sinus of the heart is closed; for then only does the heart assume its proper function."

The modern reader will not, I imagine, greatly approve either of all the anatomical statements or physiological conclusions of Realdus Columbus; although there is a passing reference to one, if not rather to two, important truths in what is said above. I allude to the change undergone by the blood in the lungs, a fact first noticed by Servetus; and to the assumption by the heart of its proper office at the moment of birth when the child begins to breathe —another point to which Servetus also directs particular attention, as he thought it was at this moment that the soul was imparted.

"When the heart dilates," proceeds Columbus, "it draws natural blood from the vena cava into the right ventricle, and prepared blood from the pulmonary vein into the left; the valves being so disposed that they collapse and permit of its ingress; but when the heart contracts, they become tense, and close the apertures,

so that nothing can return by the way it came. The valves of the aorta and pulmonary artery opening, on the contrary, at the same moment, give passage to the spirituous blood for distribution to the body at large, and to the natural blood for transference to the lungs."[1]

Columbus, we have seen, denied muscularity to the heart, so that it is rather hard to imagine what he could have understood when he speaks of its contracting. Ascribing the *pulsific power* of the arteries to the spirit they contain, as he does, it is obvious that they did not beat from the shock of the heart. The heart, in short, is left by Columbus, as by the old physiology, with its diastole as the efficient element in its activity, and doubtless also with the spirit as the immediate cause of this.

Columbus arrogates to himself, and has often had conceded to him, the honour of having first proclaimed the passage of the blood from the right to the left side of the heart by the way of the lungs. But in this we know that he was anticipated by Servetus; and in other important particulars of which he makes mention, he is not only not in advance of the Spaniard but decidedly in arrear of him.

Neither Servetus nor Columbus was aware that the fœtal heart acted precisely (diversity of structure

[1] "Idcirco, quando dilatatur cor, sanguinem naturalem a vena cava in dextrum ventriculum suscipit; necnon ab arteria venosa sanguinem paratum una cum aere in sinistrum; [ita ut] sanguis spirituosus exiens, per totum corpus funditur, sanguisque naturalis ad pulmones delatus est."

taken into account) as that of the adult. The rapid rhythmical pulse of the fœtal heart was overlooked by them both, as it was by their age, having been first particularly observed by Harvey.

Did we substract all that Columbus had from Galen among the older anatomists, from his immediate predecessors among the moderns,—from what is to be found in the Christianismi Restitutio of Servetus in especial, we should find that he had no title to originality of any kind. I therefore come to a totally different conclusion from the eloquent Perpetual Secretary to the French Academy of the Sciences, M. Flourens, on the merits of Columbus in connection with the pulmonary transit of the blood. I do not, like him, see "the animated description of Columbus as everywhere impressed with the seal of originality;"[1] on the contrary, I have had the conviction forced on me, that Columbus had all that is new in his account of pulmonary matters from Servetus.

It is impossible, at the present time, to say whether or not a copy of the Christianismi Restitutio had found its way to the north of Italy in those early days. If the book was ever really to be had in Geneva, as has been said,[2] it is more than probable that a copy was sent by

[1] "J'ai cru voir partout impreint dans la description animée de Colombo le cachet de l'originalité et de l'invention." (Hist. de la Decouverte de la Circul. du Sang, 2me ed., p. 248.)

[2] By Mosheim, in his Ketzergeschichte, although I do not believe that it was. It cannot be shown that more than five or six copies of this book were ever taken from the bales in which the whole impression was packed.

one of the Italian refugees there domiciled, to a friend in his native country. The epistle addressed by Melanchthon to the Senate of Venice, in 1536, warning that august assembly of the presence among them of Servetus's book on Trinitarian Errors, and Paul Gaddi's letter to Calvin in 1553,[1] urging the Reformer to take pen in hand and confute the "Satanic Servetus," as he calls the pious man whose purpose it was to restore Christianity from its Papal corruption to something like its pristine simplicity and purity. All we know, in a word, makes it probable that as Servetus's views had numerous adherents in northern Italy, and there were many Italians—physicians and men of letters—in Geneva at the date of the trial and judicial murder, that a copy of the Christianismi Restitutio was sent to some one in Venice or Padua, and that Columbus had access to so much of it, at all events, as refers to matters physiological. This seems demonstrated, in some sort, by the similarity of the terms in which the Italian anatomist sets forth the "new" and, as he says, "until now unpublished views" he has to communicate, with the language used by Servetus in announcing his discoveries and inductions. I place the passages from the Christianismi Restitutio and the De Re Anatomica side by side, so that the reader may judge for himself:—

[1] See the writer's work, "Servetus and Calvin: a History of an important Epoch in the Early History of the Reformation." Lond., 1877.

MICHAEL SERVETUS (1553).

"Per inspirationem in os et nares est vere inducta anima; inspiratio autem ad cor tendit. Spiritus vitalis [enim] ex aere inspirato et subtilissimo sanguine componitur; in sinistro cordis ventriculo suam originem habet, juvantibus maxime pulmonibus ad ipsius generationem. . . . Generatur ex facta in pulmonibus mixtione inspirati aëris cum elaborato subtili sanguine, quam dexter ventriculus cordis sinistro communicat. Fit autem communicatio hæc non per parietem cordis medium ut vulgo creditur, sed magno artificio a dextro cordis ventriculo, longo per pulmones ductu, agitatur sanguis subtilis; a pulmonibus præparatur, flavus efficitur, et à vena arteriosa in arteriam venosam transfunditur. In ipsa arteriâ venosâ inspirato aëri miscetur, expiratione a fuligine repurgatur, atque ità tandem à sinistro cordis ventriculo totum mixtum per diastolem attrahitur, apta supellex ut fiat spiritus vitalis. Quod ita per pulmones fiat communicatio et præparatio confirmat magnitudo insignis venæ arteriosæ quæ nec talis nec tanta facta esset, nec tantam a corde ipso vim purissimi sanguinis in pulmones emitteret ob solum eorum nutrimentum, nec cor pulmonibus hac ratione serviret. . . . Ergò ad alium usum effunditur sanguis a corde in pulmonibus hora ipsa nativitatis et tam copiosus. Item, à pulmonibus ad cor non simplex aër sed mixtus sanguine mittitur per arteriam venosam: ergo in pulmonibus

REALDUS COLUMBUS (1559).

"Est autem præparatio et generatio spiritum vitalalium qui post modum in corde magis perficiuntur. Aerem namque per nares et os inspiratum suscipit, pulmo vero aerem illum una cum sanguine miscet qui a dextro cordis ventriculo profectus per arterialem venam deducitur. Vena enim hæc arterialis, præterquam quod sanguinem pro sui alimento defert, adeo ampla est ut alius usus gratia deferre possit. Sanguis hujusmodi ob assiduum pulmonem motum agitatur, tenuis redditur et una cum aere miscetur et præparatur, ut simul mixti sanguis et aer per arteriæ venalis ramos suscipiatur, tandemque per ipsius truncum ad sinistrum cordis ventriculum deferatur: deferuntur vero tam belle mixti atque attenuati ut cordis exiguus præter labor supersit, ut illas per ope arteriæ ahorti per omnes corporis partes distribuat. . . . Vena arteriosa magna est satis—immo vero multo major quam necesse fuerit si sanguis ad pulmones supra cor exiguo intervallo deferendus duntaxat erat. Scribunt in hoc anatomici harum usum esse ut aerem alteratum ad pulmones ferant idque refrigerant fumosque nescio quos capinosos excipere a sinistro ventriculo profectos. Ego vero sentio arteriam venalem factam esse ut sanguinem cum aere à pulmonibus mixtum afferat ad sinistrum cordis ventriculum. Quando dilatatur cor sanguinem a vena cava in dextrum ventriculum suscipit, nec non ab

fit mixtio. Flavus ille color à pulmonibus datur sanguini spirituoso, non a corde.

"Ille itaque spiritus vitalis à sinistro cordis ventriculo in arterias totius corporis deindè transfunditur."

arteria venosa sanguinem paratum una cum aere in sinistrum; dum coarctatur cor [e contrà], aditum spirituoso sanguini exeunti, qui per universum corpus funditur, sanguinique naturali ad pulmones delato."[1]

[1] Turning to Douglass's Bibliographia Anatomica, I see that I have been anticipated in my challenge of Columbus's originality as to what he says on the pulmonary transit and its influence on the blood. Douglass says: "Servetum conjectandi locus est Columbum hæc ab eo hausisset." (Op. sup. cit., p. 115, Ed. 2nd. Lugd. Batav., 1734.)

EUSTACHIUS.

EUSTACHIUS (BARTHOLOMEUS) was born at San Severino, some time in the early part of the sixteenth century, and died as Professor of Anatomy at Rome in the year 1574. After Vesalius, Eustachius is deservedly regarded as the most eminent among the restorers of the science he did so much to advance, making us, among other matters, acquainted with the passage from the throat to the internal ear, and observing particularly the process or fold of the lining membrane of the right auricle of the heart between the orifice of the vena cava and the auriculo-ventricular inlet, which in the fœtus directs the blood of the inferior cava coming from the placenta through the foramen ovale into the left auricle.

Eustachius defends Galen against Aristotle, in regarding the liver, not the heart, as the source of the blood. It is he also who makes so much of the reciprocal *attractions* exerted by the several organs and tissues for their proper secretions and the nourishment they require and obtain from the blood of the veins. The liver attracts chyle from the intestines by the mesen-

teric veins; the bones, the brain, the muscles attract the nourishment they demand from the vena cava and its branches. The renal veins would not transmit urine to the kidneys were it not specially attracted by these organs, &c. It is more reasonable, he thinks, to maintain that the veins, in turn, are possessed of a certain attractive power—*facultas tractoria*—than with Erasistratus to say that they are mere inert conduits and are filled like skins or bladders. The arteries are also credited with an attractive faculty of the same kind; those which are furnished to the mesentery, as he says, attracting and preparing the chyle, not otherwise than do the corresponding veins. The heart requiring a thicker blood for its nourishment than the lungs, receives its nutrient vein from the vena cava before the blood has entered the right ventricle.

That Eustachius discovered the thoracic duct is certain, but having only observed it in the horse, he seems to have thought it peculiar to this animal; so that, beyond describing it particularly, as he saw it there, he gave no further heed to the matter.

"In horses," he says, "from the great venous trunk of the left side of the neck, behind the root of the internal jugular vein, there is sent off a certain large shoot or branch, which, besides having a semilunar valve at its orifice, is full of a white and watery humour. Not far from its origin it divides into two parts, but these soon unite again into one, which, distributing no

branches, passes the diaphragm on the left side of the vertebræ, and proceeds downwards to the middle of the loins, where, having become enlarged, it is embraced by the aorta, and ends obscurely in a manner not yet well seen by me." [1]

Eustachius appears not to have been one of fortune's favourites, for he lived and died very poor. After overcoming a world of difficulties, and spending his all on a series of anatomical plates, which were out of the engraver's hands as early as the year 1552, he found himself unable to meet the expenses of printing and publication. They were only brought to light and published by Lancisi under the title of Tabulæ Anatomicæ, at Rome, so late as the year 1714.

[1] "Itaque, in his animalibus ab hoc ipso insigni trunco sinistro juguli, qua posterior sedes radicis venæ internæ jugularis spectat, magna quædam propago germinat, quæ præterquan quod in ejus origine ostiolum semilunare habet est etiam alba et aquei humoris plena. Nec longe ab ortu in duas partes scinditur, paulo post rursus coeuntes in unam, quæ, nullos ramos diffundens, juxta sinistrum vertebrarum latus, penetrato septo transverso, deorsum ad medium usque lumborum fertur; quo loco latior effecta magnamque arteriam circumplexa, obscurissimum finem, mihique adhuc non bene perceptum, obtinet." (Opusc. Anat. De Vena sine pari, Antigram. xiii.)

AMATUS LUSITANUS was a native of Portugal, as his designation implies; one of the physicians of Jewish descent whom the Peninsula supplied for so many ages to the rest of the civilized world. Having left his native country, he settled at Ragusa in Dalmatia, and engaged successfully in the practice of his profession; but bigotry, intolerance, and persecution being in the ascendant during the reign of Philip II. of Spain, Amatus, as a Jew of some repute, had to fly from his new home on the approach of the ruthless Duke of Alva to the Venetian States at the head of his army, and seek safety elsewhere. This he seems not to have found until he reached the town of Salonica in European Turkey, where he lived to the end of his days, usefully engaged against the host of ills that flesh is heir to, and undisturbed by the Turk, more tolerant to the Jew, in those days, than the Christian.

This physician requires a passing notice from us, inasmuch as he enjoyed an extensive reputation in his day, and alludes to "the influence of the valves which exist in the blood-vessels and elsewhere than at

the roots of the aorta and pulmonic artery."[1] He combats Vesalius, who has said that in pleurisy blood is always to be taken from the right arm, maintaining that it ought to be let from the arm of the side on which the pain is experienced; his objection to Vesalius's dictum being made on the ground that the branch of the vena azygos which gives rise to the intercostal veins, and so supplies the immediate seat of the disease, cannot be unloaded save from a vein on the same side of the body as that whence the supply comes, because of the valve at the root of the vena sine pari.

[1] Curationum Medicinalium Centuriæ quatuor, p. 84. Basil, 1556. Fol.

FALOPPIUS.

FALOPPIUS (Gabriel) of Modena; born 1523, died at Padua 1563. Professor of anatomy in the University of Pisa, first, he was translated to that of Padua in succession to Vesalius, but scarcely enjoyed his elevation to the more distinguished chair for a period of two years. His whole professional life indeed was short; for he died when he was only thirty-nine or forty years of age; nevertheless, he is honourably remembered as a great anatomist, and his name is still familiar to us as the discoverer of the open-mouthed conduits leading from the ovaries to the uterus.

Faloppius shows himself at all times so adverse a critic of Vesalius, that he seems to have been animated by something like personal hostility towards him. Faloppius had for many years been engaged obscurely, but usefully, as prosector in the anatomical theatre of Padua, and probably looked to the Professor's chair as his rightful inheritance when Vesalius was appointed over his head. More than this, Vesalius being engaged in seeing his great work through the press at

Basle in 1541 and the early part of 1542, Faloppius appears to have acted as his substitute for a term; and as "two stars keep not their orbit in one sphere," smothered dislike broke out at length into the open enmity which is unhappily transmitted to us in the writings of Faloppius.[1]

More given to discover defects than beauties, not only in the works of Vesalius but in those of his contemporaries generally, Faloppius does not fail to notice what Amatus Lusitanus has said about a valve at the root of the vena azygos; and as the discussion shows how little the function of the valves was understood by the greatest anatomists until after the time of Harvey, it is worth our while to consider the subject somewhat closely.

"Amatus," says Faloppius, "asserts that there are *membranulæ* or *ostioli* at the origin of the vena azygos like those at the orifices of the cardiac vessels, which permit the ingress of the blood but oppose its egress; the ostioli in question having been pointed out to him by Jo. Bapt. Cananus, the distinguished anatomist." Faloppius declares, however, that he had searched in vain for a valve at the root of the vena azygos in all the subjects he dissected. He is even of opinion that Amatus had not understood Cananus; and if the experiment that is quoted as illustrating the action of the valve be truly reported, it seems certain that he did not. "If a pipe," says Amatus, "be introduced

[1] Observationes Anatomicæ. Venet., 1562.

into the upper part of the vena cava and blown into, the whole of the vessel, along with the vena sine pari, will be inflated; but if the vena sine pari be divided below, a pipe inserted into it, and air blown towards the vena cava, this vein will very certainly (*procul dubio*) not be inflated; because the air of the vena sine pari will not be permitted to pass by the operculum at its root. But if air will not pass, how much less could blood?"

When Faloppius tells us that he searched in vain for the valve or valves in question, he plainly challenges the truth of their existence; but he does not advert to their only possible function did they occur. Were there really a valve at the root of the vena azygos, its action would be exactly the reverse of that said to be ascribed to it by Cananus, and assented to by Amatus: blowing into the cava from above, no air would enter the azygos; blowing into the azygos from below, the cava would be distended.

But the veins, until the days of Harvey, were the distributors of the nutrient blood to the body; and no real obstacle to its course could be thought of as possible. The valves were there indeed, but their office was only to control the rate, not to prevent the flow, of the blood from trunks to branches.[1]

[1] The credit of Cananus as discoverer of the valves of the veins appears to rest entirely on this report of the Portuguese Amatus, like that of Sarpi in the same direction on the statement of Fulgenzio. Professor Sharpey informs me that he read through Cananus' rare book entitled "Musculorum corporis humani picturata dissectio" (Ferrara,

1543), in the library of the city in which it was published, some years ago, and that in it *there is not a word on the valves of the veins!* The same excellent authority informs me that he discovered a copy of the Cananus bound up with a number of very ordinary pamphlets among the books of the Hunterian Museum of Glasgow, so that it can now be consulted without going quite so far as Ferrara. It is somewhat singular that one in general so critically exact as Haller should be found speaking of Cananus as the *inventor valvularum venosarum.* And he was not without the opportunity of perusing the book in which common report says the discovery is announced, for he speaks of having had two copies of it for inspection. (Conf. Bib. Anat., Tom. i. sub voc. Cananus.)

SARPI.

SARPI (Paul), of the order of the Servites, one of the most eminent of the host of eminent men his country has produced, was born at Venice in the middle of the first half of the sixteenth century. Educated for the Church and entering the priesthood, he joined the order of the Servites in the year 1566. A man of great natural talent and vast learning, Sarpi was also what was much rarer in those days, one of the freer spirits of the world, and in consequence fell under the suspicion of heresy. But he was wary as well as wise; of irreproachable life, and regular in outward observance, nothing tangible on the score of religion could be brought against him. He did not the less escape the mortal enmity of the Hierarchs of the Church of Rome, for having come to the aid of his native city in its differences with them and their aggressive head, Pope Paul V. In such mortal despite was he held by the Roman Pontiff and his advisers, that nothing short of his life was held forfeit sufficient for the stand he enabled his country to make against their encroachments. Unassailable on

public and legal grounds, assassination was the means adopted for getting rid of the formidable enemy. In an open street of Venice, accordingly, he was way-laid by a band of hired assassins, and stretched for dead on the pavement with as many as fifteen terrible wounds, each of itself as it seemed a death to life. Against all hope, however, after a struggle protracted over many months, he gradually recovered, and lived for years to do further good and influential work against Papal tyranny and aggression.

It is not of the patriot or friar, however, that we have here to speak, but of the anatomist; for he has been repeatedly credited with having preceded Fabricius of Aquapendente in his knowledge of the valves of the veins, and Harvey in his discovery of the circulation of the blood.

In the published works of Sarpi, which I have searched through, there is not a word on either the valves of the veins or the circulation of the blood. It is his friend and biographer, Fra Fulgenzio, who informs us that he was aware of the existence of these appendages, and from them had inferred the circulation. This statement has of course been repeated by all the subsequent biographers of Sarpi and historians of the circulation. Happily we have lately had a translation by a lady[1] from the original MS. of Fulgenzio, preserved in the archives of Venice, so that we can now judge of the

1 "The Life of Paul Sarpi, from Original Sources." By Arabella G. Campbell. Lond., 1869. 8vo.

grounds on which the reports of Sarpi's anatomical acquirements and conclusions have been circulated.

"There are many eminent and learned physicians," says Fulgenzio, "still living, who know that it was not Fabricius of Aquapendente but Fra Paolo Sarpi who, considering the weight of the blood, came to the conclusion that it would not continue stationary in the veins without there being some barrier adequate to retain it, and which by opening and shutting should afford the motion necessary to life. Under this opinion he dissected with ever greater care and found the valves. Of these he gave an account to his friends in the medical profession, particularly to l'Aquapendente, who acknowledged it in his public lectures, and it was afterwards admitted in the writings of many illustrious men."

In the life of Sarpi by Francesco Griselini, appended to an edition of the Father's works which I have consulted, the new biographer gives essentially the same story, but improves upon his predecessor Fulgenzio; and it were easy to quote another and yet another of the prejudiced persons, who on hearsay evidence, and in absolute ignorance of the subject they write about, yet think themselves entitled to pronounce definitively on the merits or demerits of the men whose lives they misrepresent.

Nor is the statement of Fulgenzio and his followers all that has been urged for the illustrious defender of his country's rights against Papal aggression. Pietro

Gassendi, a more notable man than any of Sarpi's biographers, in his Life of his friend Peiresc,[1] informed him on a certain occasion that "William Harvey, an English physician, had lately published an excellent book on the course of the blood in the body; and among other arguments in favour of his views had appealed to the valves of the veins of which he had heard something from d'Aquapendente, but of which the real discoverer was Sarpi the Servite. On this he, Peiresc, desired to be furnished with the book, and to have an opportunity of examining the valves of the veins, the pores of the septum, denied by Harvey, and various other matters of which I myself will satisfy him." In this way it comes that haphazard reports get transformed into statements of facts, and honour well won in one direction is given in another in which it is altogether undeserved. We have, therefore, no evidence to show that Sarpi discovered the valves of the veins, and very certainly he knew no more of the circulation of the blood than his contemporaries of Padua and Pisa.

[1] Vita viri illustri Claudii de Peiresc. Paris, 1641. 4to.

ARANTIUS (Jul. Cæs.)[1] of Bologna, in the University of which he was professor. Born 1530, he died 1589, and was one of the best anatomists of his age, having made many interesting observations in the science he professed, some novel, and others in correction of accredited errors. He insisted particularly on the imperviousness of the septum ventriculorum, and maintained that even if it were porous there was no reason why the blood should not percolate from the left to the right, as well as from the right to the left ventricle. We have the name of Aranzi enshrined in our anatomical nomenclature. He was the first who showed how carefully the valvular apparatus of the heart was completed by the addition of the little bodies like millet seeds which fill the triangular space that would otherwise have been left vacant by the meeting of the semi-lunar valves which guard the origins of the pulmonary artery and aorta.[2]

[1] De humano fœtu liber. Venet., 1571. Ejusdem Anatomicarum observationum Liber, ac de Tumoribus, nunc primum editus. 4to, min. Venet., 1595.

[2] "In cordis etiam particulis illud videtur observatione dignum: quod scilicet in medio circumferentiæ janitricum membranarum quæ Aortæ et Venæ arterialis orificii præficiuntur, cartilagineum corpusculum, grani panici imaginem referens, magna ex parte sit oppositum." (Obs. Anat., cap. 33.

Arantius also speaks particularly of the valve which guards the orifice of the coronary vein; but he is not in advance of Fabricius of Aquapendente in his appreciation of the valves of the veins in general; their office, according to him, being to secure the heart against refluxes of blood, such as might be apt to occur in consequence of the incessant motion of the organ.

Ruini (C). Recent Italian writers are by no means agreed among themselves as to which of their countrymen the honour of having discovered the circulation of the blood is to be assigned. They are only at one in this—that it does not belong to Harvey. Professor Ercolani of Genoa, for example, is of opinion that Carlo Ruini, a gentleman of Bologna and an early writer on the veterinary art, anticipated Cesalpino, to whom the majority of his countrymen give the glory. In the school of Veterinary Surgery of Bologna, Ercolani has had a tablet affixed in honour of Ruini, with the following inscription :—

A CARLO RUINI,

SENATORE BOLOGNESE,

Che primo l'arte veterinaria scientificò, e primo riveló la Circolazione del Sangue,

Questa scuola murata l'anno MDCCCLXIX.,

Giambatista Ercolani

Dedicava, Intitolava.

Ruini is known in the Republic of Letters by the handsome volume he published on the "Anatomy and

Diseases of the Horse."[1] After a somewhat careful perusal of so much of the work as refers to the sanguiniferous system, I am utterly at a loss to imagine on what grounds Ruini could ever have been spoken of as the discoverer of the circulation of the blood.

To Ruini the liver is the chief organ in which the blood is engendered. The vena portæ collects nutritive material from the stomach, and brings it to the liver, whence it is distributed to the rest of the body for its nourishment.[2]

Describing the ventricles of the heart, he says : " The function of these ventricles is specially to qualify the blood, to engender the vital spirit, and to nourish the lungs. Of the left ventricle the duty is to receive the blood already in so far disposed ; to convert part of it into spirit, and to send on the remainder with the spirits by the arteries to all parts of the body except the lungs, in order that they may participate in the heat that gives life." A passage which the reader will be at no loss to interpret in conformity with the Galenical physiology of the age.

Ruini shows himself well acquainted with the valves of the heart and their action. The auricles he thinks are for the purpose of easing the vena cava and pul-

[1] Del' Anatomia e delle Malattie del Cavallo. Bologna, 1590. Fol. Of which there is a fine copy in the British Museum.

[2] Il fegato, membro principale, nel quale si genera il sangue, de cui tutte l'altre parti si nutriscono. . . . L'officio della vena porta è de portare il nutrimento del ventricolo al fegato, e d'inde per alcune rami distribuirlo per alcune parti del corpo. (Op. cit., p. 142.)

monary vein, which would else have withstood indifferently the vigorous attraction and propulsion of the blood by the ventricles.

The pulmonary artery, arising from the base of the heart on the right, and the pulmonary vein from the broad part of the heart on the left, Ruini believes are both alike distributed to the lungs ; the function of the pulmonary artery being to take the light and spumous blood to them from the right ventricle for their nourishment ; that of the pulmonary vein to carry air from them to the heart, and at the same time to conduct away the fuliginous vapours engendered by changes effected in the blood by the air that has been drawn into the left ventricle during its dilatation, this being due to the native heat. The pulmonary vein, has, however, a further office to perform, viz., to supply to the lungs a sufficiency of the subtilized spirituous blood of the left ventricle.

The function of the lungs is, as usual, to take in and prepare—but in an arbitrary sort of way—fresh air in quantity sufficient to temper the excessive heat of the heart.[1]

But all this only shows Ruini on a level with his contemporaries ; and when we find that with Galen he has the veins distributing the nutrient blood to the body, it is obvious that he could have had no idea other than of a to-and-fro motion of the nutrient or venous,

[1] Si temperi il souverchio suo calore ; et habia donde ad ogni suo piacere, possa pigliare l'aere et far le suoi officii.

and of the spirituous or arterial blood, in their appropriate vessels. In one of the many engravings with which the work is illustrated, there is a drawing (Plate I., Book III.), in the explanation of which the letter P refers to the branch of a vein, proceeding, if I recollect rightly, from the subclavian, which "nourishes the four superior intercostal spaces—*una vena che nutrisce le quattro intercostali di sopra;*" and in Plate II. of Book V., which represents the venous system, G refers to "the coronary veins which nourish the heart—*le vene coronali che nutriscono il cuore.*"

Professor Valentin of Zurich could never, I should imagine, have seen the Anatomia del Cavallo of Ruini, or he would not have expressed himself as he does in his work on the "Physiological Pathology of the Heart,"[1] in which he says: "It appears on the whole that in 1553 Servetus was acquainted with the pulmonary circulation, and that Ruini, in 1598, aware in all probability of the hints of Cæsalpinus, clearly and distinctly proclaimed the systemic circulation on theoretical grounds." How he reconciled this magisterial conclusion with what follows, it is not for me to say. "Cæsalpinus, however, had not freed himself from the to-and-fro motion of the blood in the great vessels, and had perhaps nothing more than an indistinct foreboding of the greater circulation." (!)

To Servetus I, too, unreservedly assign a knowledge

[1] Versuch einer physiologischen Pathologie des Herzens. Leips., 1866.

of the pulmonary transit. But of Ruini I say that he had no more knowledge of the systemic circulation than Cæsalpinus and others of his contemporaries. Misled by Ercolani, the Professor of Zürich's language in reference to Ruini, is much to be regretted.

Cæsalpinus (Andrea) of Arezzo was born in 1519, and died at Rome in 1603, at the advanced age of eighty-four. This distinguished philosopher, physician, and naturalist, after the usual elementary and initiatory studies, occupied the chair of Medicine and Botany in the University of Pisa for some considerable time; but his reputation for learning and professional skill extending, he received a call to Rome, where, as one of the staff of the Colleggio della Sapienza, he continued for many years to teach the branches of medical science that had already won him such fame at Pisa. Cæsalpinus appears to have engaged besides in the active duties of his profession; and holding the responsible post of physician to the reigning Pope, Clement VIII., he was a person of mark and consideration in the eternal city.

The work in which Cæsalpinus presented himself to the world was entitled "Peripatetic Questions"[1]—a

[1] Quæstionum Peripateticarum Libri quinque. Florent., 1571. Ed. 2nda, cum Quæstionum Medicarum Libris duobus, nunc prim. Edit. Venet., 1593. I have never seen the first edition, but the second, though a scarce book, is accessible in the British Museum and Royal College of Surgeons.

series of learned disquisitions on the leading principles of the Aristotelian Philosophy, which he, little in accordance with the views of educators and hierarchs in the Church of Rome, presented as hostile rather than favourable to its doctrine and discipline. Challenged with heresy, and even with inculcating atheism, he excused himself by declaring that the conclusions arraigned were none of his, but belonged to the Stagyrite, and that, for his own part, he disclaimed them entirely. Happily for him his apology was accepted; the ecclesiastical authorities of the country not insisting, as a rule, on the most rigid orthodoxy from learned men provided they but kept their opinions to themselves,—a compromise in virtue of which Cæsalpinus was permitted to live on, not only unmolested, but in honour, under the shadow of the Vatican, to the end of his days.

The book of "Peripatetic Questions," however, is not all on subjects of Philosophy. Incidentally it contains a good deal of speculative physiological matter, that has led various writers, critics, and patriotically disposed persons, to credit its author with having known the circulation of the blood in the sense in which it was first proclaimed to the world by Harvey. Bayle appears to have taken the lead in this assumption; but he was not an anatomist, and, with all his erudition and critical acumen, not so well qualified to decide on physiological as on moral, theological, and historical matters. In the copy of "The Dictionary" I possess—

the English version of 1710—I find these words under the heading of Cæsalpinus: "We should deprive Cæsalpinus of a very precious glory if we did not say that he knew the circulation of the blood; the proofs of it are so plain that they cannot be eluded by any cavil."

The passage upon which this sweeping and very definite, but erroneous, conclusion is founded, is that in which Cæsalpinus, speaking of the pulmonary transit of the blood from the right to the left side of the heart, makes use of the misleading word *circulation.*

Every one who is not a mere tyro in physiology, however, knows that nothing more can be implied by the word than is proclaimed in other terms by Servetus, Columbus, and others, contemporaries of Cæsalpinus; in whose day the passage of the blood, in principal part at least, from the right to the left side of the heart by the pulmonary artery and vein, had come to be acknowledged as a canon in physiology. The word *circulation* is, in fact, misapplied by Cæsalpinus. "*Conversion* (*i.e.* circulation), says Aristotle, is motion from itself into itself—*conversio est motus qui fit ex sese in idem;* but motion in the *straight* is from itself into another—*motus autem per Rectam est qui ab sese in aliud.*"[1] Now the motion from the right to the left side of the heart is not circular but direct.

It was not, in fact, as a physiologist that Cæsalpinus was known to his peers. In so far as we can discover

[1] De Naturali auscultatione, lib. viii. cap. 3.

he seems never to have devoted himself particularly to anatomical inquiries, and was a cabinet rather than an experimental physiologist. There is very little reference to anatomy in his works, and I do not think that there is one anatomical experiment adduced in illustration of a physiological conclusion,—unless, indeed, the arm bound by the bleeding fillet be accepted for something of the kind. It was as a botanist that Cæsalpinus shone before his age; and there indisputably with right; for he was the first who proposed a natural arrangement of the vegetable kingdom on the basis of affinity of structure;—the parts of fructification and their product, the seed, being the foundations on which his classification is reared. Had Cæsalpinus devoted himself to anatomy, he would, probably, with his philosophical training, have seen matters more truly than he did; have expressed himself more clearly than he does; and we should then by possibility have had to award him those higher physiological honours that have of late been so persistently but, I believe, erroneously claimed for him by his countrymen.

To Cæsalpinus, following Aristotle, always his master in philosophy, and Galen, his guide in physiology when not opposed to the Stagyrite, the heart is the chief organ of the body. It is the one on which all the others most immediately depend, and that in which the blood, joint product of the intestinal canal and the liver, attains its final perfection, and becomes,

at once, the proper nutriment of itself and of the body. The heart is, therefore, to be thought of as giving origin not only to the veins and arteries, but also—in agreement with Aristotle—to the nerves.

The liver, nevertheless, has a certain precedence in the work of blood-making, and also in the business of alimenting the body; for Cæsalpinus does not gainsay Galen when he speaks of the liver giving rise to two great veins,—the porta and cava, which are continuous with one another. Of these the vena portæ is that by which alimentary matter is brought to the liver from the stomach and intestines; whilst the vena cava, drawing concocted blood from the liver, distributes it by its branches to all parts of the body.[1]

On emerging from the liver the vena cava accordingly sends one branch downwards to nourish the lower parts of the body, and another upwards, which, before reaching the heart and superior parts, distributes branches to circumjacent organs—to the diaphragm and pericardium amongst others;—and this would not happen were not the blood elaborated by the liver endowed with alimentive properties. The liver, consequently, is possessed of a primary nutrient faculty—*vim altricem primo possidet hepar.* Moreover, were the blood prepared in the heart alone, there would be

[1] "Nam ex eo (hepate, videlicet), egrediuntur venæ duæ quarum una est alteri continua, ea scilicet quæ Portæ Jecoris appellatur, unde fertur ex ventriculo et intestinis alimentum in Jecur; altera, Cava appellatur, quæ ex Jecinore sanguinem coctum haurit ac cæteris corporis partibus distribuit." (Qu. Per, v. 3, p. 116*b*.)

another vein for the reception of the concocted blood; it would not have to return (regredi) by the same vein; and that it cannot revert from the heart to the vein is shown by the way in which the three membranulæ are disposed at the orifice of the vena cava, permitting ingress into the ventricle, but regress in nowise.[1]

Cæsalpinus, consequently, although with Aristotle he makes the heart the source of the blood and blood-vessels, does not differ from Galen in viewing the liver as the primary organ of the hæmapoësis, and the vena cava proceeding from it as the general distributor of what he calls the auctive blood. The office of the veins, says Cæsalpinus, elsewhere, is this: "that they should carry blood to all the parts of the body for their

[1] "Vena enim cava ex hepate egrediens ramum unum deorsum distribuit ad partium subjectarum nutritionem, alterum sursum qui priusquam in cor ingrediatur alios ramos circumstantibus partibus impertitur, ut septo transverso et pericardio, quod non fieret nisi sanguis in hepate præparatus vim alendi possidet. Insuper si in corde perficeretur sanguis altera esset vena quæ coctum sanguinem reciperet, non per eandem regredi oporteret. Ac verò nec regredi ex corde in venam signum est: quia ostio venæ cavæ tres membranulæ coaptatæ sunt ita ut conceditur ingressus sanguini in cor, egressus autem nequaquam." (Quest. Peripatet., lib. v. qu. 3, p. 117*a*.)

The meaning of the above is made obscure by the first use of the word *regredi*. Taken as a whole, however, the paragraph can only signify, that had the heart been essential to give the blood the whole of the properties required, another vein than the cava would have been provided to carry the perfected fluid to the parts. As there is no such vein, however, the vena cava cannot terminate in the heart; it only communicates with the organ at a tangent (in the manner described by Columbus), supplying it with the blood that is required for impregnation with heat and the generation of spirit, and then continuing its course to nourish the upper extremities and the head, as, indeed, we find it stated immediately in the text.

nourishment; for these are nourished by the blood alone. Therefore it is that nature has instituted the hollow veins for this special duty, and that, like rivulets, they run throughout the body."[1] Need I add that he who has the hollow veins as distributors of the blood for the nourishment of the body, can have no conception of the Harveian Circulation?

The whole of the natural hepatic blood, however, has not gone by the vena cava beyond the heart to nourish the head and upper extremities. A certain quantity of it, thick, crude, and intensely hot, has entered the large, excessively hot right ventricle, from which, not being permitted to regurgitate by the arrangement of the valves, it is transferred to the left ventricle, whence, purified and tempered, it passes on to the aorta.[2]

But the transference is not effected exclusively in the old Galenical fashion, by percolating the septum. It takes place mainly by way of the lungs, the blood passing from the pulmonary artery to the pulmonary vein, between which vessels free anastomotic communication is presumed; cold air being, at the same time, imparted to the blood by the divisions of the trachæa

[1] "Hanc esse venarum utilitatem ut omnes partes corporis sanguinem pro nutrimento deferant; etenim membra omnia solo sanguine aluntur; propterea cavas natura procreavit venas dedita opera, ut instar rivulorum per corpus excurrent."

[2] "*Ex dextro ventriculo cordis amplissimo et calidissimo, vena cava sanguinem crassiorem in qui calor intensus est magis, ex altero autem ventriculo, sanguinem temperatissimum ac syncerissimum habente egreditur aorta ex lateri sinistro.*" (Q. P., lib. v. 3, p. 118*a*.)

which run side by side with the pulmonary veins, but have no communication with them by open mouths as Galen believed.[1]

"With this circulation of the blood from the right to the left ventricle by way of the lungs, everything discovered by dissection is in complete accordance; for as there are two vessels ending in the right ventricle, so are there two ending in the left. Of the two, however, one only in each intromits, the other emits, the valves being so arranged as to secure this result."[2]

We have thus, according to Cæsalpinus, two kinds of blood; one concocted sufficiently by the liver to give it alimentive qualities; another more fully elaborated by the heart in view of higher properly vitalizing powers. Differing essentially, these severally required containing channels in harmony with their qualities. Hence the two orders of vessels,—veins and arteries. The hepatic blood, coarse and thick, could be readily confined within the thin diaphanous veins, but the cardiac blood, subtle, attenuated, and spirituous, required

[1] "Idcirco pulmo per venam arteriis similem ex dextro cordis ventriculo fervidum hauriens sanguinem, cumque per anastomosim arteriæ venali reddens, quæ in sinistrum cordis ventriculum tendit, transmisso interim aëre frigido per asperæ arteriæ canales quæ juxta arteriam venalem protenduntur, non tamen osculis communicantes, ut putavit Galenus, solo tactu temperat." (Ib.)

[2] "Huic sanguinis circulationi ex dextro cordis ventriculo per pulmones in sinistrum ejusdem ventriculum, optimé respondent ea quæ ex dissectione apparent. Nam duo sunt vasa in dextrum ventriculum desinentia, duo etiam in sinistrum. Duorum autem unum intromittit tantum, alterum educit, membranis eo ingenio constitutis." (Ib.)

the dense, close-grained arteries to prevent its finer parts from escaping before it reached the organs on which it conferred heat and vital endowment. As there are two kinds of aliment, says Cæsalpinus, elsewhere—nutritive and auctive—so are there two orders of vessels; the veins supplying nourishment, the arteries giving vital endowment.[1]

We thus see that Cæsalpinus had not got beyond the old Galenical principle of the veins as distributors of the natural alimentive blood, and of the arteries as channels of the elaborated nutritive or spirituous blood; each distinct in itself and only intercommunicating in the course of their distribution by hypothetical anastomoses, in order that each might participate in the other's qualities. As we proceed we shall find that the whole physiological system of the philosopher of Arezzo consorts and fits in with these inherited ideas; and, doing so, it necessarily follows that he was incapacitated from attaining to the conception of anything more than a to-and-fro motion of the two kinds of blood in their respective channels.

Coming after such anatomists as Vesalius, Faloppius and Columbus, we might have imagined that Cæsalpinus would have had an adequate knowledge of the imperviousness of the septum and the action of the cardiac valves. But he is not independent enough to accept

[1] "Cum enim duo sunt genera alimenti, nutritivum et auctivum, duo etiam sunt genera vasorum, venæ scilicet et arteriæ. Venæ enim alimentum suppiditant, arteriæ spiritum flammæ." (Qu. Perip., v. 3, p. 117*b* et 123*b*.)

without reservation the truths which the structures proclaim. Some portion of the blood, he thinks, still sweats through the septum, and the valves do not close the orifices of the heart completely.

Galen, we know, had the valvular apparatus of the heart acting imperfectly to permit of the escape of fuliginous vapours by the breath. Columbus derided the idea of these fuliginous vapours ; and in so much he is followed by Cæsalpinus ; but the imperfect action of the valves is retained by him from his older and more authoritative master for another reason : It was no longer a small quantity of blood that passed by the septum from the right to the left ventricle ; but a copious stream that took its way by the pulmonary artery and vein. The motion of the venous and arterial blood, however, being of a to-and-fro kind, it was necessary to guard against exhaustion of the veins on the one hand, of infarction of the arteries on the other ; and this Cæsalpinus appears to have believed was secured by regurgitation, now to this side of the heart and again to that. It is only in this view that what he says of the imperfect action of the cardiac valves, and of the constitution of the mitral valve in particular, can be interpreted. The orifice of the aorta, even, he thinks is only "closed against the motion of the spirit, lest by its abundance the native heat of the heart should be suppressed ; and the orifice of the vena cava is protected against motion out of the heart, lest its flame should be

extinguished by the quantity of aliment flowing in upon it."[1]

What the precise meaning of the above may be is, perhaps, questionable; but such language consorts in nowise with the conception of a continuous motion of the blood—alternately venous and arterial—in a circle throughout the body; and every modern physiologist knows that imperfection of the valvular apparatus of the heart makes such a thing impossible. What practical physician in these days would listen to the man who should maintain that imperfect action of the valves of the heart was a beneficent arrangement of nature? Cæsalpinus's total misunderstanding of the action of the heart might seem of itself to strip him of every title that has been advanced for him as having divined the circulation of the blood. "We are not compelled," he says, "to have the valves of the educing vessels [the pulmonary artery and aorta] close with the dilatation of the heart; for it does not dilate that it may attract; neither is there any danger of regurgitation from the arteries to the heart; for the motion takes place from the veins to the heart, the heat attracting the aliment, and, at the same time, from the heart to the arteries, the same motion opening both orders of orifices—those of the veins

[1] "Jure igitur arteriæ magnæ ostium adversus motum spiritus in cor clauditur, ne ejus copia suffocetur calor. Venæ autem ostium adversus motum ex corde obsistit, ne cordis flamma copia alimenti extinguatur." (Q. P., lib. v. p. 123*b*.)

into the heart, those of the arteries out of the heart."[1]

The effect of the *diastole* according to Cæsalpinus, therefore, is: not closure of the semilunar valves of the efferent arteries and patency of the tricuspid and mitral valves; neither is that of the *systole* to close the tricuspid and mitral valves and open the semilunar valves of the pulmonary artery and aorta—they all shut up and fly open together! The diastole of the heart does not even, as in the accredited physiology, attract the blood into its cavities; it is the heat acting on the accession of aliment, that is the attracting power; and the heart, from the active agent in any possible movement of the blood, is left with no special duty but that of churning and giving the fluid its final perfection!

Cæsalpinus finds renewed occasion in his Medical Questions to speak of the distribution of the blood and spirits to the body; and has additional matter which helps us accurately to gauge the extent of insight he could have had into the real nature and motion of the blood. "In animals," he says, "we see aliment brought by the veins to the heart as to the laboratory of the native heat, and having there

[1] "Non cogimur membranas vasorum educentium claudere in cordis dilatatione; non enim dilatatur ut attrahat; nec ullum imminet periculum ne transumptio fiat ex arteriis in cor; motus enim fit ex venis in cor, caliditate alimentum trahente, simul autem ex corde in arterias; idem enim motus utraque oscula aperit—venæ scilicet in cor, cordis autem in arterias." (Qu. Per., lib. v. p. 123*a*.)

acquired its final perfection, distributed by the arteries to the whole body by the agency of the spirit which is there engendered from the same alimentary matter."[1] This has been seized upon in an especial manner by the friends of Cæsalpinus, as showing that he understood the circulation of the blood! But they then speak in ignorance or forgetfulness of the old physiology. Cæsalpinus says no more, in fact, than did his master Galen, by whom the spirituous blood of the left ventricle was believed to be borne by the arteries to every part of the body—these communicating by anastomoses with the veins to supply them with spirit, which they would else have been without, and receiving in turn from the veins the nourishment they required—a conclusion summed up by the philosopher of Arezzo in the words I have already quoted: *Venæ alimentum suppeditant, arteriæ spiritum flammæ.*

There are yet many statements in the peripatetic questions of Cæsalpinus, that ought to satisfy every candid inquirer that he had no idea of the circulation of the blood as it was proclaimed by Harvey. How, for instance, shall we understand what he says of the ceaseless supplies of aliment and flame which he presumes to flow into the heart by the veins, with a commensurate efflux of spirit by the arteries, which would make

[1] "Nam in animalibus videmus *alimentum* per venas duci ad cor tanquam ad officinam *caloris* insiti, et adepta ibi ultimâ perfectione, per arterias in universum corpus distribui, agente spiritu, qui ex eodem alimento in corde gignitur." (De Plantis, L. 1, C. 2, p. 3.)

any contraction of the heart and arteries impossible ?[1] Or how connect a meaning with what follows : "As the strength of animals depends on a certain moderate tension of their several parts, were the extreme orifices of the vessels larger, the fire, [the spirit] would then flow more freely, indeed, but the vessels would be unduly relaxed ; were they smaller, the tension of the vessels would be greater, but there would then be risk of suffocation, the openings not sufficing for the efflux of the fire.[2]

By the light of the old physiology we can, indeed, attach a certain meaning to such language ; but it is without sense when taken in connection with the conception of a ceaseless flow of the blood in a circle throughout the body.

Assuming, as he does, a continuous motion of the blood from the heart by the arteries to all parts of the body because of the continuous generation of the spirit, "the blood," says Cæsalpinus, "bears along with it at the same time the nutritive aliment, and from the veins draws to itself the auctive aliment by the inosculations which the Greeks call anastomoses."[3] How, we

[1] "Si continua est alimenti suppeditatio et flamma continua, continuus quoque erit effluxus spiritus per arterias : hoc autem existente nunquam fiet cordis aut arteriarum contractio." (Qu. Per., lib. v. p. 123*b*.)

[2] "Quoniam autem animalium robur in mediocri quadam partium tensione consistit, si quidem extrema vasorum oscula ampliora fuissent, liberius quidem ignis efflueret, sed vasa laxa nimis forent ; si vero angustiora essent, tensio quidem vasorum fieret, sed suffocationis periculum immineret, cum non sufficerent meatus ad ignis effluxum." (Qu. Per., lib. v. p. 125*a*.)

[3] "Motus igitur continuus a corde in omnes corporis partes agitur,

might ask, should Cæsalpinus have missed the opportunity here so obviously presented, to speak of the continuous transfusion of the blood from the filamentous arteries to the corresponding filamentous veins? It was because he had no idea that anything of the kind took place. All he says, however, is in entire conformity with the Galenical idea of the two kinds of blood and the two orders of vessels, giving and taking reciprocally, the veins receiving spirit from the arteries, the arteries drawing aliment from the veins.

The blood-vessels distributed to the various organs of the body, according to Cæsalpinus, ended there—they resolved themselves into the several tissues. "Aristotle," he says, "tells us that the nerves are nothing more than terminations of the aorta; some of its branches ending in the brain and there assuming the nature of nerve; others ending in the inferior parts and members of the body.[1] The nerves, as they consist of a multitude of delicate tubes, may in fact be split lengthwise; for the minute blood-vessels end in straight fibres constituting nerves—*nam venulæ in fibris rectis desinunt nervos constituentes.*" But if the nerves be the terminations of the aorta, how should so much of the blood which the vessel con-

quia continua est spiritus generatio. . . . Simul autem alimentum nutritivum fert, et auctivum ex venis elicit per osculorum communionem quem Græci anastomosim vocant." (Qu. Per., lib. v. 3, p. 123*a*.)

1 "*Nihil enim aliud est nervus quam extrema aortæ; alia quidem in capite, id est in cerebro, naturam nervi occupantia, alia autem circa imas partes, id est circa crura et articulos totius corporis.*" (Qu. Per., v. 3, p. 120*b*.)

tained as was not required to animate the parts return to the heart? How but by the way it came—flowing now from trunks to branches, and then from branches to trunks. To enforce his idea of the arteries ending in nerves, Cæsalpinus even makes the vessels of the right side cross to the left, with a view to account for the fact that injury to one side of the head is often followed by paralysis of the opposite side of the body;[1] an assumption by which we learn that, according to Cæsalpinus, the properties of the nerves depended entirely on the access of the spirit conveyed to them by the blood of the arteries.

The brain itself has rather a singular function ascribed to it in the crude physiology of our author. "The finer parts of the blood," he says, "being sublimated by the heat of the heart, would be dissipated and lost, were there not a means provided for its refrigeration. It is with good reason, therefore, that nature has placed the cold, moist brain in the upper part of the body, seeing that it is the property of heat to ascend, and that those creatures which have the highest temperature have also the greatest mass of brain—man in especial"! With such fancies we are not to be surprised when we find Cæsalpinus actually comparing the brain of man to the alembic of the chemist, the upper part of which is kept cool by

[1] "Arteriæ dextri lateris nervos constituunt sinistri, et e converso." (Q. Med., ii. 2, 10.)

means of cold water! (Quæst. Peripat., v. p. 120 & 121). When we meet with matter like this in the work of the great philosopher of Arezzo, and turn to the Exercises of Harvey, we see that it is not for our knowledge of the circulation of the blood alone that we stand indebted to him. He brought reason and common sense into the whole field of physiology, which was nothing less than a chaos to the most advanced anatomists and learned philosophers of the age in which he taught and wrote.

The principles upon which blood-letting was to be practised, enable us on new grounds to judge of the claims that have been advanced for Cæsalpinus as discoverer of the general circulation. The Fifth Question of the second Book of the Medical Questions is headed "Particular diseases require the section of particular veins." "It is by no means matter of indifference," he says, "from whence blood is taken in treating diseases. In epistaxis from the right nostril, for example, the inner branch of the veins of the right arm is to be selected, inasmuch as it is derived from the lower part of the jugular vein, and so communicates with the veins of the heart.

"But why, say some, the need of any such specification, seeing that the vena cava can be unloaded from the veins of either the right or left arm? To this I reply first: that the vena cava, although it be *one*, has nevertheless branches that proceed from it right and

left, like the roots of a tree. Secondly, I say, the veins conjoin with the arteries by inosculation in such a way, that when a vein is opened it is the blacker venous blood that issues first, and the more florid arterial blood that follows, as commonly happens."[1] That is to say: although all the veins communicate, still, as the great venous trunks throw off the branches which supply particular parts with their nourishment, the disease of each part is to be most immediately attacked by opening the vein which supplies it. But he, I need hardly observe, who has the veins as distributors of nutrient blood to the body could have had no suspicion of the Harveian Circulation.

And what are we to understand by the mode of conjunction between the veins and arteries being such that it is the darker venous blood which escapes first, and the brighter arterial blood which follows when phlebotomy is practised? Had Cæsalpinus really freed himself from an idea akin to that of Erasistratus, who believed that as the arteries contained air or spirit, whilst the veins contained blood, when an artery was wounded the spirit escaped as a prelude to blood flowing into it by its anastomoses with a neighbouring vein? In the same way precisely, would it seem, does the modern physiologist believe that after the black blood proper to the vein opened by the phlebotomist

[1] "*Venæ cum arteriis adeo copulari osculis, ut, vena secta, primum exeat sanguis venalis nigrior, deinde succedat arterialis flavior, ut plerumque contingit.*" (Qu. Med., lib. ii., qu. 5, p. 212*a*.)

has escaped, the bright blood of a neighbouring artery finds a way into it by the anastomoses by which spirit is usually imparted! I have myself bled both men and women very many times, but can aver that I never saw the stream when arrested to be less grimy than it was when it began to flow; nor, when two cups were used, that the blood in the second was more florid than that in the first.

Or is what has just been said due to our author's misconception of Hippocrates' observation on the animal bled to death by dividing an artery? The florid blood of the artery, says the father of physic, then flows first; the darker blood of the vein follows. And this within narrow limits is true; for respiration having ceased *in articulo mortis*, the last few beats of the heart propel dark, not florid blood. But Cæsalpinus, adopting the statement in a converse sense, makes the bright blood of the artery follow exhaustion of the dark blood of the vein.

There is more on the subject of bloodletting, in connection with inflammation of the spleen in particular, which accords with what has just been said, but which it would be tedious to criticize at greater length.

And now we approach the topic that has been paraded more than all else said by Cæsalpinus, to show that he had anticipated Harvey, viz.: The swelling of the veins of an extremity when a bandage is so

applied as to obstruct the flow of the blood within them.

"It is especially worthy of investigation," says Cæsalpinus, "why, when a bandage is applied to an extremity, the veins swell beyond and not on this side of the obstruction, as all are aware when about to perform phlebotomy. The opposite of this, however, ought to happen if the motion of the blood throughout the body proceeds from the viscera; for the passage being blocked, onward progress would then be prevented, and the swelling of the veins ought to occur on this side of the obstruction, not beyond it. Now is the difficulty here encountered solved by Aristotle when writing on Sleep (cap. iii.) he says, 'Whatever is evaporated is of necessity sent elsewhere, and is then reversed and turned back like Euripus; but the *hot* in animal bodies must needs ascend; once in the upper region, however, much of it is reversed and brought downwards.'[1] But the true explanation is as follows: The passages of the heart are guarded by nature in such a way that there is free intromission from the vena cava into the right ventricle, from whence there is an outlet to the lungs by the vena arteriosa. From the lungs, again, there is

[1] "An solvitur dubitatio ex eo quod scribit Aristoteles de somno cap. 3, ubi inquit: Necesse enim quod evaporatur aliquo usque impelli, deinde converti et permutari sicut Euripum; calidum enim cujusque animalium ad superiora natum est ferri; cum autem in superioribus locis fuerit, multum simul iterum revertitur, ferturque deorsum." (Qu. Med., lib. ii., qu. 17, p. 234.)

another ingress to the left ventricle by the arteria venosa, from whence there is an outlet by the aorta; the valves at the mouths of the vessels being so placed that they prevent retrogression. By this it comes to pass that there is a kind of perpetual motion from the vena cava by the heart and lungs into the aorta, as we have explained in our Peripatetic Questions.[1]

"As in waking-hours, however, the movement of the native heat is outwards to the organs of sense, whilst in sleep it is inwards to the heart, we are to conclude that whilst we are awake there is a great afflux of blood and spirit to the arteries, whence the passage is to the nerves; and whilst we are asleep, that the same heat returns to the heart by the veins, not by the arteries, for the natural ingress to the heart is by the vena cava, not by the artery; and it is during sleep that the native heat passes from the arteries to the veins by their inosculations called anastomoses, and from them to the heart. But as the undulatory flow of the blood—*sanguinis exundatio*—to the superior parts, and its ebb—*retrocessus*—to the inferior parts, like Euripus, is manifest in sleeping and waking; so is the kind of motion in the part of the

[1] "Pro cujus loci explicatione illud sentiendum est: cordis meatus ita â natura paratos esse ut ex vena cava intromissio fiat in cordis ventriculum dextrum, unde patet exitus in pulmonem; ex pulmone præterea alium ingressum esse in cordis ventriculum sinistrum, ex quo tandem patet exitus in aortam, membranis ad ostia vasorum appositis ut impediant retrocessum. Sic enim perpetuus quidam motus est ex vena cava per cor et pulmones in arteriam aortam, ut in Questiones Peripateticas explicavimus." (Qu. Med., lib. ii., qu. 17, p. 234.)

body to which a fillet is applied, or in which a vein is obstructed in any other way, not a matter of obscurity. For as rivulets swell in the direction towards which they are wont to flow when their course is obstructed, so does the blood perchance revert to its source at the time, lest it should be cut off and perish."[1]

But how shall "the kind of perpetual movement from the heart to the aorta," of which Cæsalpinus speaks above, consort with the reciprocating periodical efflux and afflux to superior and inferior parts that follows? Or what is there, after all, in the so-called *explanation* which really does nothing more than repeat the to-and-fro euripus-motion of Galen, with the Aristotelian modification that relegates it to the periods of sleeping and waking, and so takes from it any possible significance it could ever have had? And does his reference to the reason why streams obstructed overflow their banks, help our philosopher out of the maze in which he is entangled?

[1] "Cum autem in vigilia motus caloris nativi fiat extra, scilicet ad sensoria, in somno autem intra, scilicet ad cor, putandum est in vigilia multum spiritus et sanguinis ferri ad arterias, unde enim in nervos est iter; in somno autem eundem calorem per venas riverti ad cor non per arterias, ingressus enim naturalis per venam cavam datur in cor, non per arteriam. Transit enim in somno calor nativus ex arteriis in venas per osculorum communionem quam anastomosin vocant et inde ad cor. Ut autem sanguinis exundatio ad superiora et retrocessus ad inferiora instar Euripi manifesta est in somno et vigilia, sic non obscurus est hujusmodi motus in quacunque parte corporis vinculum adhibeatur, aut alia ratione cum occluduntur venæ. Cum enim tollitur permeatio intumescunt rivuli qua parte fluere solent. Forte recurrit sanguis eo tempore ad principium ne intercisus extinguatur." (Qu. Med., lib. ii., qu. 17, p. 234.)

Streams certainly do not revert to their sources when obstructed, but overflow in directions opposed to these; and the source of the blood, according to Cæsalpinus, being the heart, the comparison of the obstructed stream overflowing its banks is not quite apposite to the swelling of the obstructed veins beyond the bandage. Had Cæsalpinus surmised that the swelling was due to the continuous influx from the capillary arteries to the capillary veins, and from these to their branches and trunks, here was another opportunity he would not have missed to explain himself, and so to solve the riddle. But as he had no conception of anything of the kind, he passes on, leaving the matter the enigma he found it, and satisfying us that he had no more definite conception of the reason why the veins of the arm bound by the bleeding fillet became turgid beyond the obstruction, than the most ignorant phlebotomist of his day.

Nor is Cæsalpinus helped out of his difficulty by what he says on "the passage out and in of the native heat during sleep from arteries to veins, and from thence to the heart by the communion of their orifices, called anastomoses."[1] There is here no question of a passage of blood, but of native heat, another name for

[1] *Somnum et vigilium fieri calore nativo intus et extra vergente; i.e.*, During the hours of sleep the native heat tends inwards; during those of watching it flows outwards; a conclusion, were it even the blood and not the heat associated with it of which Cæsalpinus speaks, which would still be incompatible with the ceaseless transfusion of the whole mass of blood from the arteries to the veins in the course of a very few minutes as demonstrated by Harvey.

vital spirit; and the anastomoses are the Galenical provision whereby the veins receive from the arteries, and the arteries from the veins throughout their course, as well as by their extremities, that in which they are severally deficient: spirit or heat in the one case, nutrient faculty in the other. The ideas involved do not in fact differ from those of Cæsalpinus's physiological master Galen, modified by his more immediate preceptor Aristotle. The to-and-fro motion in both orders of vessels is maintained; but the times or periods in which the flux and reflux take place, instead of being continuous as with the Coan sage, are referred to the hours of sleeping and watching by the Stagyrite and his follower.

Neither are we brought in any better way to see that Cæsalpinus had a true conception of the motion of the blood in the body by what he says of the phenomena that accompany attacks of epilepsy and angina suffocativa.

The sense of suffocation in these cases, he tells us, "is owing to no interception of the veins themselves, but to the interception of those things which are carried by the veins to the head, because of their importance and excellence."[1] The material stoppage, however, is of the blood in the veins; this much is certain; and

[1] "Non efficit autem suffocationem quælibet venarum interceptio; sed si eæ intercipiantur quæ feruntur ad caput propter magnitudinem et præstantiam. (Qu. Med., lib. ii., qu. 17, p. 234*b*.)

the jugular veins must consequently have been seen by him as the channels whereby from trunks to branches the excellent and important things (heat and spirits, heat especially—*omnis enim virtus in calore consistit*) are carried from the heart to the brain. But he who sees the veins as conduits to the parts of the body, whether it be of blood or spirits, can have no conception of the arteries as sole afferents, of the veins as sole efferents of the blood, and so no idea of the motion of the vitalizing fluid in a circle, as first announced and demonstrated by Harvey.

Cæsalpinus, as said, was not a practical anatomist, and no more than a speculative physiologist. He often appears to be mentally at war with thoughts suggested by what he sees himself, in face of the defective physiology of his age. Everything of an anatomical nature in the Peripatetical Questions is to be found in Vesalius and Columbus; and so little had their author any true idea of the physiology of the sanguiferous system, in spite of all that his friends of to-day have said for him, that in his latest work,[1] written but the year before his death, he has still the vena cava proceeding from the liver, and distributing the *alimentum auctivum* for the maintenance of the bodily parts, and supplying the heart with the material of the *alimentum nutritivum* for distribution by the arteries.[2]

[1] Praxis Universæ Artis Medicæ. Tom. ii., Rom., 1602–3.

[2] Vena cava ramos in totum corpus dispergit, ut simul cum arteriis universas partes nutriant. (Op. cit., T. ii., p. 281. Ed. Venet., 1680.)

There, too, he actually compares the four vessels issuing from the heart for the distribution of the blood to the body, to the four rivers flowing out of Paradise to irrigate the four quarters of the world![1]

Cæsalpinus, to conclude, was unfortunately fettered by Aristotle and Galen, and by the subserviency to authority he had imbibed from the educational system of his country. Cæsalpinus was not an original and certainly not an independent thinker, or he would have interpreted matters otherwise than he does, and, it may be, have even attained to what I have characterized as the Great Induction.

But this he did no more than any one of his teachers, so that it was reserved for another, son of the freer atmosphere of England, philosopher, scholar, and reasoner like himself, but vastly better anatomist, and indisposed to bow submissively to any authority save that of nature. Referring to the most learned and competent, judicious and impartial critic of his age—Albert Haller, let us say in fine that: "It is not to Cæsalpinus because of some few words of doubtful meaning, but to Harvey, the able writer, the laborious contriver of so many experiments, the staid propounder of all the arguments available in his day, that the immortal glory of having discovered the circulation

[1] "Distribuitur sanguis in quatuor venas—scilicet cavam et aortam, arteriam venalem et venam arteriosam,—totum corpus irrigat instar quatuor fluminum ex Paradiso prodeuntium." (Ib., lib. i., cap. 1.)

of the blood is to be assigned."[1] Nevertheless, on the 30th of October, 1876, in the Hall of the University of Rome, in presence of the Minister of Public Instruction, the Professors and a numerous and distinguished assembly, a marble bust in honour of Cæsalpinus was unveiled to public view, with the following inscription on a tablet underneath:—

ANDREÆ CAESALPINO domo Aretio
Archiatro eximio
Solertissimo Naturæ investigatori
Quod in Generali Sanguinis Circulatione
Agnoscenda ac demonstranda
Caeteros antecesserit
Plantas nondum in Species distributas
Primus ordinandas susceperit
Rerum plurimarum impeditam Intelligentiam
Explicuerit
Universam Morborum doctrinam
Magno cum plausu in hoc Archigymnasio tradiderit
Sodales Medici
et X viri Archigymnasio moderando
Honoris et Memoriæ causa
III pridie calend. Octob. MDCCCLXXVI.

[1] "*Adparet non Cæsalpino, ob paucas aliquas et obscuri sensus voces, sed Harvejo, numerosissimorum experimentorum laborioso auctori, gravique scriptori argumentorum omnium quæ eo ævo proferri poterant immortalem gloriam inventi circuitus sanguinis deberi.*" (Elementa Physiologiæ, vol. i., lib. iii., Sect. 3, § 32.)

FABRICIUS (Hieronymus). Born at Aquapendente in 1537, Fabricius received his medical education at Padua, and after a term of engagement as anatomical demonstrator, succeeded Faloppius, who had been his master, in the chair of Anatomy, to which at a later period was added that of Surgery, the branch of the healing art in which Fabricius greatly distinguished himself.

Among the works of Fabricius, that on the valves of the veins[1] is the one which especially interests us. In this he speaks as if he believed he had been the first to observe these *Ostiola*, and informs us that he discovered them when dissecting in the year 1674, prior to which date he says they had escaped the notice of anatomists. "Who, indeed," he proceeds, would have thought of finding membranes and ostiola within the cavities of the veins of all places else, when their office of carrying blood to the several parts of the body is taken into account ?"[2] "The ostiola never-

[1] De Venarum Ostiolis. Petav., 1603. 4to.

[2] "*Quis enim unquam opinatus fuisset intra venarum cavitatem reperiri posse membranulas et ostiola ? cum cum præsertim venarum cavitas quæ ad deferendum sanguinem in corpus universum erat comparata libera, ut liberè sanguis permeare futura esset.*" (Op. cit. ad initium.)

theless were necessary," as he thinks; "and we may therefore safely say that they were contrived by the Almighty Maker of all things, to prevent over-distension of the veins."[1] They are therefore found in greatest number in the veins of the extremities, because of the violent motions to which they are there exposed; the effect of which is that a great degree of heat is excited in them, and the blood, by reason of the increased heat, is attracted and flows towards the extremities in excessive quantity."[2]

To prevent over-distension, however, was not the most important duty the valves of the veins had to perform; their chief business was, in fact, so to retard the flow of the blood in the vessels as to give the several parts or tissues time and opportunity to appropriate the kind of nutriment they required. Nothing of a valvular nature, on the contrary, was wanted in the arteries. They were not liable to distension, owing to the thickness and strength of their coats; neither did the blood need to be delayed in them, as the flux and reflux in their canals went on perpetually.[3]

[1] "*Procul dubio tuto possumus dicere ad prohibendam venarum distensionem fuisse ostiola a summa Opifice fabricata.*" (Op. cit.)

[2] "*Procul dubio vi caloris excitatus sanguis ad artus in tanta copia fluxisset atque attractus fluisset.*" (Ib.)

[3] "*Erat profecto necessaria ostiolorum constructio in artuum venis, ut scilicet sanguis ubique eatenus retardetur, quatenus cuique particulæ alimento fruendi congruum tempus detur. Arteriis autem hæc ostiola non fuere necessaria; neque ad distensionem propter tunicæ crassitiem ac robur, neque ad sanguinem remorandum; quod sanguinis fluxus refluxusque in arteriis perpetuo fiat.*" (Ib.)

The reason why the vena cava and great veins of the neck are generally without valves, is because the brain, heart, lungs, liver, and kidneys require the very freest supply of aliment; and, as being the organs most immediately essential to life, admit of no impediment to its access. If we do find valves at the root of the jugular vein, it is to the end that the blood should be checked when we stoop or lie down, and not be poured like a river in overwhelming quantity upon the brain.[1]

That the valves retard the blood in the manner described, says our author, is readily shown by an attempt to rub an extremity downwards; "You will then see the course of the blood intercepted and plainly retarded by the ostiola." Among the many illustrative drawings given by Fabricius of the valves in all parts of the body, he has the arm bound as for bleeding, with the turgid veins and the seats of the valves indicated by the slight elevations noticeable here and there; precisely as we find it in Harvey. But the purpose of the two writers was different; Fabricius's object being simply to show that there are valves in the veins, Harvey's to prove that they made any flow of the blood from trunks to branches impossible.

The most important anatomical fact given to the world between the ages of Servetus and Harvey, which

[1] "*Ea ad sanguinem detinendum ne in declivi capitis situ, in cerebrum instar fluminis irruat atque in eo plus justo cumulatur.*" (Ib.)

should have influenced ideas on the motion of the blood, was unquestionably that of the existence of valves within the veins by Fabricius of Aquapendente. But, strange as it now seems to us, his demonstrations of the *ostiola* in his lectures, and the wider announcement of their existence through the publication of his Book, had no influence on the physiological ideas either of himself or his age. Fabricius of Aquapendente, however, was at once the most learned and the most honoured anatomist of his day. Created a Cavaliere di San Marco, by the Senate of Venice; presented with a gold chain as a badge of their respect; ordered to have precedence of the other professors, and in his old age pensioned by the State for the good service he had done; he is yet, by the most recent Italian writer on the discovery of the circulation, acknowledged "not to have had even the most remote idea of a circulation of the blood."[1] If this be true, who among his contemporaries could have been better informed? The extracts I have given from the "Tractatus de Venarum Ostiolis," present, I believe, a faithful picture not of the ideas of Fabricius only, but of his age; and seem to me, when scanned without prepossession, to settle the question as to the state of knowledge on the subject of the circulation in the nearest possible proximity to the epoch of Harvey.

[1] "E notissimo del resto che Fabrizio non ebbe la piu lontano idea di una Circolazione del Sangue." (Ceradini, Qualche appunti storico-critiche, &c., p. 148.)

Had a motion of the blood by the arteries from the heart as the impelling power, returning to it by the veins in a ceaseless round, been even surmised, it could not possibly have been unknown to Fabricius of Aquapendente, and he "having not the most remote idea of such a thing," it was also necessarily unknown to his contemporaries.[1]

The Italian anatomists, to the end of the sixteenth century and beyond it, were the servile followers of Aristotle and Galen. They lacked the independence of mind that lets men see things as they are—the intellectual introspection that combines and deduces, the poetical vision

"That bodies forth the forms of things unseen,"

and gives new truths to the world.

[1] Caspar Hoffman, who persistently opposed Harvey, was his fellow-student at Padua. Can we suppose that he, too, another of the most distinguished anatomists of the day, overlooked that in the writings of Cæsalpinus which now meets certain modern, prepossessed, and indifferently informed critics with something like noonday distinctness, but is quite invisible to those who do not read what is said with the light supplied by Harvey? Let me add what Haller says: Voces Cæsalpini, per semiseculum publicatas, neminem ad verum agnoscendum movisse, sed ne quidem Hieronymum Fabricium viam aperuisse ad intelligendam veram valvularum venarumque functionem. (Biblioth. Anat., T. i., p. 365.)

RUDIUS (Eustachius), born at Belluno about the middle of the sixteenth century, after the usual elementary studies, received his medical education at the University of Bologna. Soon after his reception as Bachelor of Medicine, he settled as Physician in Venice, where he by-and-by acquired such a reputation for learning, devotion to his profession, and skill in the treatment of disease, that on the anatomical chair in the University of Padua falling vacant in 1599, through the retirement of Fabricius of Aquapendente, he was promoted to it by the Senate of Venice, the patrons of that distinguished school of medicine.

Rudius, however, seems to have been looked on by his colleagues as among the number of the weaker brethren, and the wisdom of his election to a chair that had been filled by Vesalius, Faloppius, Columbus and Fabricius to have been questioned. So much we gather from the Preface of the work he published shortly after his appointment,[1] by way apparently of vindicating his competency to the place, and the dis-

[1] De naturali et morbosa Cordis constitutione. Venet., 1600. 4to.

cretion of the Senators of Venice who had installed him. It seems to have been presumed by his unfriends, that he who but a few years before had published a great folio volume of between twelve and thirteen hundred pages in close set small type,[1] must needs have exhausted himself—it was hardly possible to imagine that he could have anything more to say than he had already said. And truly, when we compare the quarto which he now produced with the one he wrote twelve years before,[2] and the chapter on the same subject in the great folio, published in the intermediate time, it looks as if he had not been judged amiss; for the latest production is but an iteration of its predecessors; the same views in nearly the same words being everywhere conspicuous.

It was on the score of his anatomy, however, that Rudius was particularly challenged; everything that had the slightest smack of novelty or interest in his new book on "Natural and Diseased Conditions of the Heart" being declared to have been taken from Columbus. He quotes Columbus oftener than once, indeed, in his text, and had no thought apparently of borrowing without acknowledgment of his indebtedness; but the taunt of his enemies led him to retort, and say that Columbus had himself had all that was newest and most notable in his De Re Anatomica

[1] De humani corporis affectibus dignoscendis, curandis, &c., Libri. iii. Fol. Venet, 1590–95–97.

[2] De virtutibus et vitiis Cordis. Venet., 1587. 4to.

from Michael Servetus! Fresh from the study of Servetus, I was led to look narrowly into this, and with the result that is already before the reader. The question we have now to deal with, therefore, is not whether Rudius borrowed from Columbus, or Columbus drew from Servetus, but whether Harvey took his idea of the general circulation of the blood, as has been said by a recent writer,[1] from Eustachio Rudio. To decide on the likelihood of this, Rudius' ideas on the anatomy and physiology of the heart and sanguiferous system will serve as sufficient guide.

"The heart," says Rudius, after Columbus, "is not muscular in its structure. It gives rise to the arteries, and is the source of the fervent spirituous blood; the pulsation of the organ being specially instituted in order that the innate heat should neither be unduly dissipated, nor suffered to accumulate in excess. The *diastole* of the heart, he declares, draws in air from the lungs, elaborates the subtle blood, tempers the innate heat by means of the air, and obtains materials for the engenderment of the spirits. The *systole*, again, expels fuliginous matter from the blood, and distributes energizing heat to all parts of the body through the arteries; the ceaseless dilatations and contractions of the heart being mainly instrumental in producing the vital spirit.

[1] Prof. Zechinelli, of Genoa, in his work, Delle Dottrine sulla Struttura e sulle Funzioni del Cuore è delle Arterie, &c., Disquisizione. Genoa, 1838.

Plato is quoted by Rudio as his authority for concluding that the office of the heart is to distribute the spirituous blood by the arteries; the liver being left with its old Galenical duty of supplying alimentive blood by the veins. The current in the veins, he says, is not rapid and forcible as it is in the arteries; on the contrary, it is sluggish; and the reason why the veins do not pulsate is because the blood they contain has not the hot and spirituous nature of that of the arteries.

To Rudio, in conclusion, as to the older physiologists, the heart is the source and seat of the emotions and passions—love and hate, hope and fear, courage and anger, &c.

It is abundantly obvious, therefore, that Rudio had nothing in the shape of anatomical knowledge that is not to be found in Galen, Vesalius, or Columbus; and, when narrowly looked into, that he, moreover, like others who write on what they do not perfectly understand, occasionally interprets the more modern authorities amiss. Rudio was a man of much learning, but still helplessly bound in the fetters of Galen. There is hardly a page of the great volume I have adverted to that does not show repeated references to the "divus homo." Rudio was in fact a pathologist and practical physician; not by taste and training an anatomist and physiologist. But the Venetian Senators, whom he treated successfully for their ailments, did not doubt that he was competent also to teach anatomy to the students of Padua.

The man who was thus so poorly provided with anatomical and physiological knowledge has, nevertheless, been paraded as having been mainly instrumental in the education of Harvey. On the strength of Harvey's having spoken of the heart as the "Sun of the Microcosm," and of Charles I. as the "Sun of his Kingdom," in the dedication of his book on the motions of the heart and blood, Professor Zechinelli, because Rudius has also said that the "heart was the sun of the microcosm, and ruled the body as a king rules his realm," will have it that Harvey not only stole the familiar metaphor, but based the whole of his induction on grounds supplied him by the misplaced professor of Padua! That Harvey was acquainted with Rudio's writings, heard him lecture, and may even have known him personally, if the student may be presumed to know the professor, I make no doubt. I even think that Harvey has Rudio in his eye, in one passage of his "Exercises;" but it is to keep clear of him, or to set him right in his physiology. So essentially do the two men differ in their interpretation of the phenomena they witness, that even when they make use of the same language, the meaning they attach to it is different. I therefore dismiss the claims advanced for Rudius as having in any conceivable sense anticipated Harvey, as unworthy of further consideration. He had still the two kinds of blood flowing to and fro in their appropriate channels; the one dedicated to the nourishment

of the parts, and supplied by the liver; the other possessed of vitalizing powers, and flowing from the heart. The septum ventriculorum was pervious, and the pulmonary artery drew air into the left ventricle of the heart. Yet has this man been credited with having known the circulation of the blood!

CHAPTER II.—SECTION I.

HARVEY.

HARVEY (William), the immortal discoverer of the Circulation of the Blood, was the eldest son of Thomas Harvey by his second wife Joan Halke, both of Folkestone in Kent, where he was born on the 1st of April, 1578.[1]

Of the parents of Harvey little is known. His father, in our printed accounts, is always designated gentleman,[2] and must have been in easy circumstances, inasmuch as, though he had a numerous family, consisting of a daughter by his first wife, and seven sons and two daughters by his second, he was able to start all his sons in life in a manner that implies the possession of considerable wealth. William, the firstborn, adopted the profession of medicine. Five of his brothers—Thomas, Daniel, Eliab, Michael, and Matthew—were merchants, and not merchants in a small and niggardly

[1] The birthday in some of the lives is stated to be the 2nd of April, for no better reason apparently than that All Fools' Day should not lose its character by giving birth to a great man. Harvey, I believe, was born on the 1st of April.

[2] In the register of William Harvey's matriculation at Cambridge his father is styled Yeoman Cantianus—Kentish yeoman.

way—*non tenues et sordidi*, as Dr. Lawrence has it in his "Life of Harvey,"[1] but of weight and substance —*magni et copiosi*, trading especially with Turkey and the Levant, then the main channel through which the wealth of the East flowed into Europe. The Harveys were undoubtedly men of consideration in the city of London, and several of them, in the end, became possessed of ample independent fortunes.[2] The son whose name does not appear in the list given above was John, the immediate junior to William. He, too, was a man of note in his day, having been one of the King's receivers for Lincolnshire, having sat as member of parliament for Hythe, and for some time held the office of king's footman,—an office of more dignity than the title, as we apprehend it, might seem to imply. Of the sisters, Sarah died young; of the others nothing is known.

[1] Prefixed to the Latin edition of Harvey's Works published by the Royal College of Physicians, in two vols. 4to, 1766.

[2] To show the esteem in which the Brothers Harvey were held, I may mention among other things that Ludovic Roberts dedicates his excellent and comprehensive work, entitled "The Merchant's Mapp of Commerce" (Folio, London, 1638), to "The thrice worthy and worshipful William Harvey, Dr. of Physic, John Harvey, Esq., Daniel Harvey, Mercht., Matthew Harvey, Mercht., Brethren, and John Harvey, Mercht., onely sonne to Mr. Thomas Harvey, Mercht., deceased." The dedication is quaint, in the spirit of the times, but full of right-mindedness, respectfulness, and love for his former masters and present friends, in which relations the Harveys stood to Roberts. Thomas Harvey died in 1622, as appears by his monumental tablet in St. Peter-le-Poore's Church, in the city of London. Eliab and Daniel lived rich and respected, the former near Chigwell, co. Essex, the latter at Combe, near Croydon, co. Surrey. Michael Harvey retired to Longford, co. Essex. Matthew Harvey died in London.

Great men in many well-authenticated instances have certainly had noble-minded women for their mothers. We have not a word of the period to aid us in estimating the mental and moral constitution of Harvey's father; but the inscription on his mother's monumental tablet in Folkestone Church assures us that she, at least, was a woman of such mark and likelihood, that it was held due to her memory to leave her moral portrait to posterity in these beautiful words, penned, it may be, by her illustrious eldest son :—

"A.D. 1605, Nov. 8th, died in y^e^ 50th yeere of her age,
JOAN, Wife of THO: HARVEY. Mother of 7 Sones & 2 Daughters.
A Godly harmles Woman: A chaste loveing Wife:
A charitable quiet Neighbour: A co~fortable friendly Matron:
A provident diligent Huswyfe: A careful te~der-harted Mother.
Deere to her Husband; Reverensed of her Children;
Beloved of her Neighbours; Elected of God.
Whose Soule Rest in Heaven, her Body in this Grave:
To Her a Happy Advantage; to Hers an Unhappy Loss."

Mural inscriptions may not always be authorities implicitly to be relied on; but we unhesitatingly accept everything as part of our faith that goes to the credit of William Harvey's mother.

At ten years of age, Harvey was put to the grammar-school of Canterbury, having, doubtless, already imbibed the rudiments of his English education at home under the eye of his excellent mother, and in some neighbouring school for the young. In the grammar-school of Canterbury he was initiated into a knowledge of the Latin and Greek languages—the routine practice then as now; and there he seems to have remained

until he was about fifteen years of age. At sixteen he removed to Caius-Gonvil College, Cambridge,[1] where he spent from three to four years in the study of classics, dialectics, and physics ; such discipline being held specially calculated to fit the mind of the future physician for entering on the study of the difficult science of medicine. At nineteen (1597) he took his degree of B.A. and quitted the University.

Cambridge, in Harvey's time, was a school of logic and divinity rather than of physic. Then, even as at the present day, the student of medicine obtained the principal part of his professional education from another than his alma mater. In the sixteenth and seventeenth centuries, France and Italy boasted of medical schools of higher repute than any in Europe ; and to one or other of these must the young Englishman who dedicated himself to physic repair, in order to furnish himself with the lore that was indispensable in his vocation. Harvey chose Italy ; and Padua, about the year 1598, numbering such men as Hieronymus Fabricius of Aquapendente, Julius Casserius, and Jo. Thomas Minadous among its professors, Harvey's preference of that school was well founded. There it was, under these and other able masters, that Harvey drank in the elementary knowledge which served him as foundation for the Induction that has made his name

[1] "Gul. Harvey, Filius Thomæ Harvey, Yeoman Cantianus, ex Oppido Folkston, educatus in Ludo Literario Cantuar. ; natus annos 16, admissus pensionarius minor in commeatum scholarium ultimo die Mai, 1593." (Regist. Coll. Caii Cantab. 1593.)

immortal; for we take nothing from his glory when we own that, but for the professional education he received at Padua, Harvey would, in all likelihood, have passed through life, not undistinguished, indeed, but without having his name associated for all time with one of the most admirable and useful inferences ever given to the world—the General Circulation of the Blood.

"Our natures are subdued
By that we work in, like the Dyer's hand;"

and morally and mentally we are what we are in virtue of the constitution we have from our parents, the influence of our surroundings, and the education we receive. Italy should have no jealousy of Harvey as discoverer of the circulation. She it was who fashioned him to that which his happier genius fitted him to become. Thousands of her own children, and the children of other lands, had sat before Harvey on the benches of the Anatomical Theatre of Padua; hundreds sat with him there; but he alone of all was privileged by partial Nature's fiat to put to interest the lessons of his teachers, to divine the goal to which ever accumulating facts were pointing, and through them to conquer immortality for himself.

Having passed four years at Padua, Harvey, then in the twenty-fourth year of his age (1602), obtained his diploma as doctor of physic, with licence to practise and to teach arts and medicine in every land and seat of learning. Having returned to England in the course of the same year, and submitted to the requisite forms, he

also received his doctor's degree from the University of Cambridge; and then coming to London, and taking to himself a wife in his six-and-twentieth year, he entered on the practice of his profession.

History is all but silent in regard to the woman of our great anatomist's choice. We only know that she was the daughter of a physician of the day, Dr. Lancelot Brown, and that Harvey's union with her proved childless. He himself mentions his wife incidentally as having a remarkable pet parrot, which must also, if we may infer so much from the pains he takes in specifying its habits and accomplishments, have been a favourite of his own.[1]

In 1604, Harvey joined the College of Physicians, his name appearing on the roll of candidates for the fellowship in that year; and three years afterwards, 1607, the term of his probation having passed, he was duly admitted to the distinction to which he aspired.

We do not now lose sight of Harvey for any length of time during many years. In the beginning of his career, he was probably occupied, like young physicians of the present day, among the poor in circumstance and diseased in body, taking vast pains without prospect of pecuniary reward, but actuated by the ennobling sense of gathering knowledge and light-

[1] *See* On Generation, p. 186. That Harvey outlived his wife is certain from his will, in which she is affectionately mentioned as his "deare deceased loving wife." She must have been alive in 1645, the year in which Harvey's brother John died, and left her £50.

ening the sum of human misery ; carried away, uncaring personal respects, by that love of his profession which distinguishes every true votary of the science of medicine. Harvey, however, had not only zeal, talents, and accomplishments ; he had, what was no less needful to speedy success, powerful friends, united brothers, with the will and the ability to push him forward in the line of life he had chosen.

In the beginning of 1609, we find Harvey making suit for the reversion of the office of physician to St. Bartholomew's Hospital, then held by Dr. Wilkenson ; and backing his application by such powerful missives as the king's letters recommendatory to the governors of the house, and producing testimonials of competency from Dr. Adkinson, President of the College of Physicians, and others, his petition was granted, and he was chosen physician in futuro of the Royal Hospital of St. Bartholomew. Dr. Wilkenson having died in the course of the year, Harvey was appointed first to discharge the physician's duties ad interim, and by-and-by formally elected to the vacant office, on the 14th of October.

In his new position Harvey must have found ample scope for gaining tact and experience in the practical details of his profession—although St. Bartholomew's Hospital in his day appears to have borne a nearer resemblance to the dispensary of these days than to the Hospital, as we now understand the term. Harvey was at this time in his thirty-second year; and brought

before the public at so suitable an age, in an office of such responsibility, he must soon have risen into notice and attained to practice as a physician. Harvey, indeed, appears subsequently to have been physician to many of the most distinguished men of his age ; to name but two among others, to the Lord Chancellor Bacon, and Thomas Howard, Earl of Arundel.

In the year 1615, Harvey, then thirty-seven, was happily chosen to deliver the lectures on anatomy and surgery at the College of Physicians, founded by Drs. Lumley and Caldwall ; and it is to be presumed that in the course which commenced in the month of April of the following year, he gave an exposition, more or less complete, of the views on the general circulation of the blood, with which his name is now inseparably connected. Long years had indeed been labouring at the birth which then first saw the light ; civilized Europe, ancient and modern, had been slowly contributing and accumulating materials for its production ; Harvey at length appeared, and the idea took fashion in his mind and emerged like Pallas in panoply from the brain of Jove.

The Circulation, it would seem, continued to form one of the subjects in the lectures on anatomy, which Harvey delivered for many years afterwards at the College of Physicians ; but it was not till 1628 that he gave his views to the world at large in his great work in little compass, entitled "An Anatomical Disquisition on the Motion of the Heart and Blood in

Animals,"[1] having already, as he tells us in his Preface, for nine years and more, gone on demonstrating the subject before his learned auditory, illustrating it by new and additional arguments, and freeing it from objections raised by the skilful among anatomists.

The small MS. volume, bearing the date 1616, containing notes for his lectures and other memoranda, which was known to exist but had been long missing through misplacement, has happily been lately recovered, and shows us that he was already possessed of the essential elements of his induction.

This precious relic, like many other relics, is somewhat hard to interpret. It is a jumble of Latin and English, with ever-recurring abbreviations that puzzle conjecture and sometimes defy assured interpretation; written, besides, in a hand so cramped and scratchy as here and there to try the best skill of the decipherer. I have spent hours over it, but with little gain. The small portion which Dr. Sieveking had photographed, with Mr. Bond's interpretation of the hieroglyphs, will be found reproduced farther on. Would it not be worthy of the Royal College of Physicians of London to have the entire volume deciphered and published? We might perchance follow the growth of the "Idea of the Circulation," in the mind of the writer—the "Idea" which I have been tempted to think he brought with

[1] Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus. 4to. Francof. ad Mœn., 1628.

him from Padua, still in the germ or but half evolved, and only moulded into the wonderfully complete and perfect shape in which it saw the light six-and-twenty years after he returned to his native country.

Some few years after his appointment as their lecturer by the College of Physicians, Harvey must have been chosen one of the physicians extraordinary to the reigning sovereign, James I. The fame of the new views on the motions of the heart and blood, we need not doubt, had reached the wide-open ears of King James at an early date; and this of itself, to lay no stress on the powerful city interest of the illustrious anatomist, might suffice to ensure him such a mark of distinction as that just named. Of the precise date of his appointment as physician extraordinary to the king we are not informed; but in a letter of James still extant, bearing date the 3rd of February, 1623, it is spoken of as a thing that had taken place some time back; for in this letter Doctor Harvey is charged in common with the physicians in ordinary, with the care of the king's health, and he is further guaranteed the reversion of the office of physician in ordinary to the king whenever, by death or otherwise, the office should become vacant. To the promised dignity, however, Harvey did not attain for some time—not indeed until after the demise of James, and when Charles I. had already occupied the throne of his father for five or six years.

Harvey may now be said to have become rather

closely connected with the Court; but whether this connection proved advantageous to him as a philosopher and physiologist may fairly be questioned. The time and service which the Court physician must necessarily give to royalty and greatness interfere materially with the leisure and privacy that are indispensable to research and meditation. But Harvey, who appears to have been a man of singular self-possession, not to be diverted from his purpose by trifling or merely ceremonial considerations, always speaks of his sovereign, Charles I., in terms of unfeigned love and respect; and everything leads us to believe that Charles in turn loved and honoured his physician. The sovereign seems even to have taken something like a special interest in the inquiries of the physiologist; to have had several exhibitions made of the punctum saliens in the embryo chick, and to have witnessed the dissections of some of the does which he placed at Harvey's disposal whilst the anatomist was prosecuting his inquiries into the subject of generation. Whatever the defects in Charles's public and political character, untruthful and treacherous as he was, he must still be admitted to have been a man of elegant tastes, and of amiable temper and refined manners in private life. It was certainly worthy of the prince who appreciated, whilst he commanded, the talents of a Vandyke and a Rubens, that he also prized and encouraged the less brilliant, but not less useful genius of a Harvey.

Harvey, as physician, must now have been at the

zenith of his reputation; he was physician in ordinary to the king, and we have seen him in the same relationship to some of the foremost men of the age. His general practice, too, must have been extensive, and, if we look at the sum he is stated to have left behind him in money, his emoluments large. But he had not any lengthened harvest for all his early pains; his connection with the Court by-and-by came in the way of his continuing to improve his position; and then, grievous to relate, the appearance of the admirable "Exercise on the Motions of the Heart and Blood" gave a decided check to his professional prosperity. John Aubrey tells us he had "heard him (Harvey) say that after his book on the 'Circulation of the Blood' came out, he fell mightily in his practice; 'twas believed by the vulgar that he was crack-brained, and all the physitians were against him."[1]

Writing many years afterwards, when the cause, particularly indicated above, had conspired to make Harvey's practice less, Aubrey informs us further, that "though all of his profession would allow him to be an excellent anatomist, I never heard any that admired his therapeutique way. I knew several practitioners in this town that would not have given threepence for one of his bills (prescriptions), and [who said] that a man could hardly tell by his bills what he did aim at."[2] So has it mostly been with

[1] Aubrey, "Lives of Eminent Persons." 2 vols. 8vo. London, 1813.
[2] Ib., vol. ii. p. 383.

those who have added to the sum of human knowledge! The empiric under the title of the practical man, in his unsuspecting and unsuspected short-sightedness, sets himself up and is accepted as arbiter where there is doubt or difficulty—purblind himself, he sways the still blinder multitude. He who laid the foundation of modern physiological science lost his practice for his pains, and the routineer, with an appropriate salve for every sore, a pill and potion for each particular ache and ail, would not give threepence for one of his prescriptions! did not admire his therapeutique way!! and could not tell what he did aim at!!! Ignorance and presumption have never hesitated to rend the veil that science and modesty, all in supplying the means, have still owned their inability to raise. If Harvey faltered, who of his contemporaries could rightfully presume to walk secure? And yet did each and all of them, unconscious of the darkness, tread their twilight paths assuredly, whilst he, the divinity among them, with his eyes unsealed, felt little certain of his way. So has it still been with the world's appreciation of medical science, and many a lusty stride in knowledge must yet be made before it can be otherwise.

The first interruption to his ordinary professional pursuits and avocations which Harvey seems to have suffered through his connection with the Court, occurred in the beginning of 1630, when he was engaged "to accompany the young Duke of Lennox in

his travels beyond seas."[1] It must have been in anticipation of such a removal from London, that Harvey had already, in December 1629, resigned his office of treasurer to the College of Physicians, which he had filled for several years.

Of the course of Harvey's travels with the Duke of Lennox we have not been able to gain much information. Their way leading them to the Continent, it may have been on this occasion and in this company that he visited Venice, as we know from himself that he did in the course of one of his journeys. Harvey, however, must have been in England again in 1632 and 1633; for in the former year he was formally chosen physician to Charles, and in the latter we find his absence, "by reason of his attendance on the king's majesty," from St. Bartholomew's Hospital complained of by the surgeons of that institution, and Dr. Andrews appointed by the governors as his substitute, but "without prejudice to him in his yearly fee or in any other respect."[2] Such considerate treatment

[1] James Stuart, Fourth Duke of Leñox, subsequently created Duke of Richmond. He was a staunch Royalist, filled more than one lucrative office about the court of Charles I., subscribed largely to the Royal cause in money, and was a principal attendant on the body of Charles after his execution to the entombment at Windsor. (Vide "Records of Harvey," by Sir James Paget.)

[2] Vide "Records of Harvey from the Journals of St. Bartholomew's Hospital," by Sir James Paget. 8vo. London, 1846. Harvey, on his appointment to attend the Duke of Lennox, applied to have Dr. Smith chosen his substitute; but the governors proved recusant: "It was thought fit that they should have further knowledge and satisfaction of the sufficiency of the said Mr. Smith;" and they very shortly afterwards gave Dr. Andrews, first, the reversion of Harvey's office, and by-and-by they formally appointed him Harvey's deputy or substitute.

satisfies us of the esteem in which Harvey was held.

In the early part of 1633 Charles determined to visit his ancient kingdom of Scotland, for the ostensible purpose of being crowned King of Scots, upon which occasion we may presume that Harvey accompanied him as his physician. But the absence of the Court from London was not of long duration; and in the early autumn of the same year we find Harvey again at his post in St. Bartholomew's Hospital, engaged in his proper province, and propounding divers rules and regulations for the better government of the house and its officers,[1] which of themselves give us an insight into the state of the hospital, as well as of the relative positions of the several departments of the healing art nearly two hundred and fifty years ago.

The doctor's treatment of the chirurgeons in these rules is sufficiently despotic, it must be owned; but the chirurgeons in their acquiescence showed that they merited no better usage. The only point on which they proved restive, indeed, was the revealment of their SECRETS to the physicians—a serious requirement in days when every man had his nostrums, and felt fully justified in keeping them to himself. But surgery in the year 1633 had scarcely as yet shown sufficient titles to independent existence. The surgeon of those days was but the servant of the physician; the dignitary then applied to his famulus when he

[1] Vide Sir J. Paget's publication already quoted, p. 13.

required a wen removed, or a limb lopped, or a broken head plastered; though Harvey it seems did not feel himself degraded by taking the knife in hand or practising midwifery.[1] The insensate rivalry that long existed between physicians and surgeons, and between both physicians and surgeons against the practitioner of obstetrics, has now happily come to an end.

From the year 1633 Harvey appears to have devoted much of his time to attendance upon the king and retainers of the Court, so that we have little or no particular information of his movements for several years. We know, however, from Aubrey, that he accompanied Thomas Howard, Earl of Arundel, whose physician he was, in his extraordinary embassy to the Emperor, in the year 1636.[2] In the course of this journey, Harvey had an opportunity of visiting several of the principal cities of Germany, and of making the acquaintance of many of the leading medical men of the time. The place from which he

[1] Vide his procedure for the removal of a sarcocele ("On Generation," p. 254.) "My Lady Howard had a cancer in her breast, which he did cut off and sear." (Aubrey, "Lives," p. 386.) He speaks of having been called to a young woman in labour in a state of coma ("On Generation," p. 534); and in another place (Ib., p. 437) he says, in connection with the subject of labour, "Haud inexpertus loquuor." Vide also p. 545, where he passes his fingers into the uterus and brings away "a mole of the size of a goose's egg;" and p. 546, where he dilates the uterine orifice with an iron instrument, and uses a speculum, &c. The references here are to the edition of the "Works of Harvey" prepared for the Sydenham Society by the writer, and published in 1847.

[2] The embassy left England on the 7th of April, and returned about Christmas of the same year. Vide Crowne's "True Relation," &c., 4to, London, 1637, and a letter from Harvey, farther on in the present volume.

dates his letter to Caspar Hoffmann, viz., Nuremberg, in the month of May, 1636, has not been noticed; but his presence with the Earl of Arundel at once accounts for it; and we therefore see that Harvey's offer to demonstrate to the distinguished professor of Nuremberg the anatomical particulars which made the general circulation of the blood a necessity was no vain boast, made at a distance, but a substantial proposition in presence of his opponent, which there is tradition at least to assure us he was called upon to fulfil. Harvey is reported to have made a public demonstration of his anatomical views at Nuremberg, satisfactory to all present save Caspar Hoffmann himself; to whom, as he still continued to urge objections, the futile nature of which we in these days can readily understand, Harvey is further related to have deigned no other answer than by laying down the scalpel and retiring—conduct in complete conformity with the character of the man which indisposed him to controversy.[1]

On his return to England, in the winter of 1636, Harvey must have resumed his place near the person

[1] Schlegel (P. M.) De Sanguinis Motu Comment., 4to, Hamb., 1650, informs us in his Preface, that, whilst living with Hoffmann in 1638, he had sedulously tried to bring him to admit the circulation; Schlegel goes on to say, however, that it was in vain, and indeed that Harvey himself had failed to convince him: "Neque tantum valuit Harveus, *vel coram* (*i.e.*, in his presence) cum salutaret Hoffmannum in itinere Germanico, vel literis," &c. The old man, nevertheless, seems not to have been altogether deaf to reason; Schlegel had hopes that he would have yielded at last, had he but lived a little longer: "Nec dubito quin concessisset tandem in nostra castra."

of the sovereign, and by-and-by, as in duty bound, accompanied him on his first hostile expedition into Scotland in 1639, when matters, however, were happily accommodated between the King and his Scottish subjects, whom he had driven to take up arms in defence of their religious liberties. Harvey, as physician to the person, may be further presumed to have been with Charles on his march towards the Border in the following year, so memorable in the annals of English history, when the war with the Scots was renewed, when the king's authority received the first check at the battle of Newbury, and when Charles, returning to his capital after his defeat, encountered the still more formidable opposition of the English Parliament.

Harvey may now be said to have become fairly involved with the Court. From the total absence of his name in the transactions of the times, it is nevertheless interesting to observe how completely he kept himself aloof from all the intrigues and dealings of the party with which he was connected. He must have held himself exclusively to the discharge of his professional duties. In the course of these he doubtless attended Charles in his third visit to Scotland in the summer of 1641, when the arts of diplomacy were essayed, with little better effect than the weight of prerogative in the first, and the force of arms in the second visit.

On returning to London in the autumn of the same

year, Charles brought matters to a crisis between himself and his English subjects, in the persons of their representatives, and nothing soon remained for him but to unfurl his standard and proclaim himself at war with his people. This was accordingly done in the course of the ensuing summer. But the Parliament did not yet abandon a seeming care of the Royal Person, and Harvey informs us himself, that he now attended the king, not only with the consent, but by desire, of the Parliament. The battle of Edge Hill, which followed, and in which the sun of fortune shone with a partial and fitful gleam upon the royal arms, is especially interesting to us from Harvey having been present in the field, though he took no part in the affair, and seems indeed to have felt very little solicitude either about its progress or its issue, if the account of Aubrey may be credited.

"When King Charles," says Aubrey, "by reason of the tumults, left London, he (Harvey) attended him, and was at the fight of Edge Hill with him; and during the fight the Prince and Duke of York were committed to his care. He told me that he withdrew with them under a hedge, and tooke out of his pockett a booke and read. But he had not read very long before a bullet of a great gun grazed on the ground neare him, which made him remove his station."[1] The act of reading a book pending a battle, the result of which was greatly to influence his master's fortunes, certainly

[1] "Lives, &c.," vol. ii., p. 379.

shows a singular degree of coolness and absence of interest in military matters. Harvey's own candid character, and the confidence so obviously reposed in him when he was intrusted with the care of the Prince of Wales and the Duke of York, forbid us to interpret his behaviour into lukewarmness or indifference; but Harvey, throughout his whole career, shows himself to have been a most peacefully disposed man: he never had the slightest taste for literary controversy, and was only brought reluctantly in later years to reply to one of the many who had opposed his views. In his indifference about the fight of Edge Hill he, however, lets us know that he was not

> "Of those who build their faith upon
> The holy text of pike and gun,
> And prove their doctrine orthodox
> By apostolic blows and knocks."

With his fine understanding and freedom from party and sectarian views of every kind, he probably saw that an appeal to arms was not the way for political right to be elicited, or for a Sovereign to settle matters advantageously with his Subjects.

Harvey had certainly no turn for politics;[1] and,

[1] The author of the "Life of Harvey" in the "General Dictionary, Historical and Critical" (folio, Lond., 1738), the original of all our other lives of Harvey, is certainly in error when he recognizes Harvey as the type of the physician who takes part in the Dialogue of Hy. Neville's Plato Redivivus, and assumes that he "relieved his abstruser studies by conversations in politics." In a third edition of Neville's work I find it stated that the physician who really did so was Dr. Lower, an acknowledged Liberal partisan in politics.

referring to Aubrey again, we find the fight on Edge Hill hardly ended before our anatomist had crept back into his den, and become absorbed in the subjects that formed the proper business of his life. "I first saw him (Harvey) at Oxford, 1642, after Edge Hill fight," says our authority, "but was then too young to be acquainted with so great a doctor. I remember he came several times to our college (Trin.) to George Bathurst, B.D., who had a hen to hatch eggs in his chamber, which they opened dayly to see the progress and way of generation." The zealous political partisan could have found no leisure for researches like these in such stirring times as marked the outbreak of the civil war in England; the politician had then other than pullets' eggs to hatch.

The king's physician, to say nothing of the man now famous as author of a new doctrine on the motions of the heart and blood, was sure to find favour with the high church dignitaries of Oxford; and we accordingly observe that, besides being everywhere handsomely received and entertained, Harvey had the honorary degree of Doctor of Physic conferred on him. Oxford, indeed, after the king and court had been driven from the metropolis, which was wholly in the hands of the popular party, became the head-quarters of the royal army and principal residence of Charles for several years. And here Harvey seems to have quietly settled himself down and again turned his attention to his favourite subjects. Nor was the

honorary distinction of doctor of physic from the university, which has been mentioned, the only mark of favour he received. Sir Nathaniel Brent, Warden of Merton College, yielding to his natural bias and favouring the popular party, forsook Oxford when it was garrisoned by the king, and began to take a somewhat active part in the proceedings of his friends; coming forward in especial as a witness against Archbishop Laud, on the trial of that dignitary.

Merton College being now left without a head, upon the suggestion, as it is said, of the learned antiquary and mathematician, John Greaves, and in virtue of a letter from the king, Harvey was elected warden some time in the course of 1645. This appointment was doubtless merited by Harvey for his constant and faithful service to Charles; but it may also have been bestowed in some measure as a retort upon the Parliament, which, the year before, had entertained a motion for the supercession of Harvey in his office of physician to St. Bartholomew's Hospital.[1] Harvey, however, did not long enjoy his new office or its emoluments; for Oxford having surrendered to the Parliamentary forces under Fairfax the following year, Harvey, of course, resigned his charge, and immediately afterwards

[1] Feb. 12, an. 164¾. "A motion this day made for Dr. Micklethwayte to be recommended to the warden and masters of St. Bartholomew's hospital, to be physician, in the place of Dr. Harvey, who hath withdrawn himself from his charge, and is retired to the party in arms against the Parliament." ("Journals of the House of Commons," iii. 397.)

betook himself to London. Sir Nathaniel Brent, on the contrary, returned to Oxford; and the star of the Parliamentarians being now in the ascendant, Merton College was not slow to reinstate its old Presbyterian warden in the room of its late royalist head.[1]

From the date of the surrender of Oxford (July, 1646), Harvey followed the fortunes of Charles no longer. Of his reasons for quitting the service of his old master we know nothing. He probably felt anxious for repose; at sixty-eight, which was Harvey's age, a man begins to find that an easy-chair is a fitter resting-place than the bare ground, a ceiled roof more

[1] I find a kind of obloquy commonly thrown on the memory of Nathaniel Brent for what is styled his desertion of Charles; but he never deserted Charles; he never belonged to him. Brent, forsooth, had received knighthood at the royal hands in former years; but knighthoods were sometimes forced upon men in those days for the sake of the fees, and often as means of attaching men of mark and likelihood. The truth is that Brent, who was a profound lawyer and scholar, as well as a traveller, was greatly attached to Archbishop Abbott, who had patronized and advanced him through the whole course of his life. In the differences that took place between Abbott and Archbishop Laud, in common with all moderate men, Brent naturally sided with his friend, led to do so, however, not by blind attachment only, but by natural constitution of mind, which appears to have abhorred the notion of a theocracy in the civil government of England, and to have been unfitted to comprehend the divinity that some conceive to hedge a king and to inhere in despotism. Brent was, in fact, a man of such note, that Charles had tried to win him to his party many years before by various attentions and the free gift of knighthood; but this was in times when men were not required to take a side—when they stood naturally neutral. When the time came that it behoved him to show under what flag he meant to fight, Brent was not wanting to his natural bias and to independence. He therefore left Oxford when it was taken possession of by the royal forces, among other adherents of the popular cause, and was simply true to his principles, in nothing false to a patron or benefactor.

suitable covering than the open sky—prospects which a continuance of the strife held out. Harvey, besides, as we have seen, had no stomach for contention in any shape or form, not even in the literary arena; and he now probably resolved to follow the advice he had formerly given to his young friend Charles Scarborough, "to leave off gunning,"[1] and dedicate himself wholly to more congenial pursuits. And then Charles had long made it apparent, even to the most ardent of his adherents, that no faith was to be put in his promise, no trust to be reposed in his royal word. The wise old man, verging on the age of threescore years and ten, doubtless saw that it was better for him to retire from a responsible office, now become both irksome and thankless, and seek privacy and leisure for the remainder of his days. These Harvey found awaiting him under the roof of one or other of his affectionate brothers—now in the house of Eliab in the City, or at Roehampton, or at Rolls Park in Essex, and then in that of Daniel, in the "suburban" village of Lambeth, or at Combe, near Croydon, in Surrey, in each of which Harvey had his own apartments.

The Harveys appear to have been united from first to last in the closest bonds of brotherly love,[2] and to

[1] "Prithee leave off thy gunning and stay here; I will bring thee into practice." (Aubrey, Op. cit., p. 381.)

[2] On the monumental tablet of Thomas, the first of the brothers who died, in the church of St. Peter's-le-Poore, the mottoes, doubtless sup-

have had a common interest in many of their undertakings; Eliab, as we shall see, employing the capital which his brother William must have accumulated before the civil wars broke out, to such purpose, that the doctor actually died a rich man.

With his brothers, then, retreating now to the "leads" of the house in the heart of the metropolis, now to the "caves" of the one at Combe, did Harvey continue to pass his days—but not in idleness; for the work on "Generation," with the subject of which we saw him busied at Oxford several years before, to say nothing of professional calls, must have found him in ample occupation. Nor was the love of ease so great in William

plied by a surviving member of the family, show this feeling. The inscription is as follows:

As in a Sheafe of Arrows
Vis unita fortior.

The Band of Love
The Unitor of Brethren.

Here lyeth the body of Thomas Harvey,
Of London, Merchant,
Who departed this life
The 2nd of Feby. An. Dom.
1622.

(Stow's "London," third edit., fol. Lond., 1633.)

John Harvey, Esq., who died in 1645, left his brother William's wife £50. Eliab Harvey attended particularly to his brother William's pecuniary interests; and William at his death returned Eliab's kindness by making him his residuary legatee.

Harvey, even at the age of seventy-one, if we may credit some of the accounts, as to hinder him from again visiting the Continent, and making his way as far as Italy, a journey in which it is said he was attended by his friend, the accomplished scholar and gentleman, Dr. Ent.[1]

In the beginning of 1651 appeared the second of Harvey's great works, that, namely, "On the Generation of Animals."[2] In this publication we have abundant proof of our author's unabated industry and devotion to physiological science; and in the long and admirable letter to P. M. Schlegel, of Hamburg, written shortly after the appearance of the work, satisfactory evidence of the integrity of Harvey's faculties at the advanced age of seventy-three.

The year after the publication of the work on "Generation," *i.e.* 1652, when Harvey was looked up to by common consent as the most distinguished anatomist and physiologist of his age, the College of Physicians came to the resolution of placing his Statue in their Hall, then occupying a site at Amen Corner; and measures being immediately taken in conformity with this purpose, it was carried into effect by the end of the year, when the statue, with the follow-

[1] This rather arduous undertaking in those days was accomplished, according to Aubrey, about the year 1649. But I have found so much to excite doubt in Aubrey's Notes, that I greatly suspect the accuracy of his statement about this journey to Italy.

[2] De Generatione Animalium. 4to. London, 1651.

ing complimentary inscription on the pedestal, was displayed :—

GULIELMO HARVEIO
Viro monumentis suis immortali
Hoc insuper Collegium Medicorum Londinense
posuit.
Qui enim Sanguini motum
ut et
Animalibus ortum dedit,
Meruit esse
Stator Perpetuus.[1]

Harvey, in acknowledgment, it may have been, of the distinguished honour done him by his friends and colleagues, appears about this time to have commenced the erection, at his own cost, of a handsome addition to the College of Physicians. It was, as Aubrey informs us, "a noble building of Roman architecture (of rustic work, with Corinthian pilasters), comprising a great parlour, a kind of convocation house for the fellows to meet in below, and a library above. On the outside, on the frieze, in letters three inches long, was this inscription : Suasu et cura Fran. Prujeani, Præsidis

[1] This statue perished with the building, in the great fire of London in 1666, and seems not to have been replaced when the hall was rebuilt, on or near its old site. The hall of the present College of Physicians is not graced, as was the old one, in Harvey's time, but there is a rough stone statue of Harvey on the one side and of Sydenham on the other, with Linacre in the middle, under the porch of the building, in Pall Mall East. The only other sculptures of Harvey that I know of are busts, one in the theatre of the College of Physicians, the other on his monument in Hempstead Church, but of dates posterior to their subject ; the one in the College of Physicians being after the portrait by Jansen in the library, by a sculptor of the name of Scheemakers, undertaken at the expense of the truly noble Dr. Mead, by whom it was presented to the College in the year 1730.

et Edmundi Smith, elect. inchoata et perfecta est hæc fabrica, An. MDCLIII." Nor was Harvey content merely to erect the building; he, further, furnished the library with books, and the museum with numerous objects of curiosity and a variety of surgical instruments. On the ceremony attending the inauguration of this handsome addition to the College, which took place on the 2nd of February, 1653, a sumptuous entertainment was provided by the donor, at which he received the president and fellows, and made over to them, on the spot, his whole interest in the structure.

Dr. Prujean, the president of the college, going out of office, as usual, at Michaelmas the next year (1654), Harvey was unanimously chosen to fill the vacant chair. Having been absent when the election took place, a deputation proceeded to his apartments to apprize him of the honour his colleagues had done themselves and him, and to say that they awaited his answer on the following day. Every act of Harvey's public life that has come down to us is marked not merely by propriety but by grace. He attended the Comitia or assembly of the college next day; thanked his colleagues for the distinguished honour of which they had thought him worthy—the honour, as he said, of filling the foremost place among the physicians of England; but the concerns of the college, he proceeded to say, were too weighty to be intrusted to one like him, laden with years and infirm in health; and if he might be acquitted of arrogance in presuming to offer

advice in such circumstances, he would say that the college could not do better than reinstate in the authority which he had but just laid down, their late president, Dr. Prujean, under whose prudent management and fostering care the affairs of the college had greatly prospered. This noble counsel had fitting response: Harvey's advice being adopted by general consent, Dr. Prujean was forthwith re-elected president.

The College of Physicians was justly proud of its great associate, and Harvey, in his turn, was undoubtedly attached to the college. Here, indeed, as lecturer on anatomy and surgery, he had first propounded the views that had won him such distinguished honour in his lifetime, and have left his name as a deathless word on the lips of men; here he consorted with his nearest and dearest friends, receiving from all those marks of respectful consideration that were so justly his due; and here, in fine, the first place among the first men of his profession had been tendered to him and gratefully declined. To a mind like Harvey's, with the opportunity afforded him of making so graceful a concession, the foremost place was certainly a higher distinction unaccepted, than it would have been enjoyed. The excuse for declining the office of President was not merely personal: it was not alone that he was an old man, infirm in health, and incompetent for so great a trust; but the affairs of the college had greatly thriven under the prudent management and constant care of the late president, and it was no more

than right that he who had but just laid down should be re-established in the authority he had used so well.

Harvey, I have said, was childless; his wife, though we have not the date of her death, he had certainly lost by this time. His sole surviving brother, Eliab, was rich; his nephews were prosperous merchants, and on the road to independence and the titles which several of them afterwards acquired. Harvey, therefore, determined to make the College of Physicians not only heirs to his paternal estate, worth, at that time, £56 per annum, but to bestow it on them in free gift during his life. This purpose he carried into effect by a formal instrument, which he presented to the college in the month of July 1656; the special provisions in the deed settling one sum, by way of salary for the librarian, and another, for the delivery of a solemn oration to be given annually, in commemoration of those who had approved themselves benefactors to the college, and, by extension, who had added aught to the sum of medical science in the course of the bygone year.[1] It were needless to say, that it is this Com-

[1] There is some information on the life of Harvey in the inscription upon the copper-plate which was attached to his portrait in the old College of Physicians. I give it somewhat shortened, anxious to set before the reader every authentic word of his day that was uttered of Harvey:

GULIELMUS HARVÆUS,
Anglus natus, Galliæ, Italiæ, Germaniæ hospes,
Ubique Amor et Desiderium,
Quem omnis terra expetisset Civem,
Medicinæ Doctor, Coll. Med. Lond. Socius et Consiliarius,
Anatomes, Chirurgiæque Professor.

memorative Oration which secures the pleasant gathering that year by year so worthily links the Old with the New in the College of Physicians of London.

Having thus accompanied Harvey over so much of the way in his mortal career, let us, before proceeding further, briefly advert to his Writings, to the influence they had in the republic of letters during his lifetime, to the fruits they have borne since his death, and to the impression they are calculated to make on the mind that holds communion through their means with the mind that dictated them so many years ago.—The intellectual endowment of a man necessarily appears in his writings ; but it is not always that from them a true conception of his general character can be formed. Harvey, however, though in his long life he accomplished but a fraction of his literary designs, has yet left us enough in what he did, from which to form an esti-

Veritatis studens magis quam gloriæ,
Hanc tamen adeptus
Industria, sagacitate, successu nobilis
Perpetuus sanguinis æstus
Circulari gyro fugientis, seque sequentis,
Primus promulgavit mundo.
Nec passus ultrà mortales sua ignorare primordia,
Aureum edidit de ovo atque pullo librum.
Rem nostram angustam auxit,
Paterni Fundi ex asse hæredem collegium dicens ;
Unde Bibliothecario honorarium suum, suumque Oratori
Quotannis pendi.
Sic postquam satis sibi, satis nobis, satis gloriæ,
Amicis solum non satis, nec satis patriæ, vixerat,
Cœlicolûm atria subiit
Jun. iii, MDCLVII.

mate of him not only as a philosopher and physiologist, but, it may further be said, as a man ; for ever and anon we light upon words in his works that give us assurance of his generous, upright, and truly noble nature.

Let us take a survey of his writings, then, before winding up our account of his life with such personal notices as we gather from his contemporaries, or the inferences we make from his acts and written words.

SECTION II.

THE EXERCISES ON THE MOTION OF THE HEART AND BLOOD.

Harvey's great work, though by no means the largest in bulk, is the one on the "Motion of the Heart and Blood." It has been said, happily, by a recent critical writer, that "men were already practising what Bacon came to inculcate" — Induction upon Data carefully collected and considered ; and it would not be easy to adduce a more striking example of the way in which ultimate rational truth is reached by a succession of inferences from cognizable facts, than is contained in Harvey's Exercise on the "Motion of the Heart and Blood." Had Bacon written his Novum Organum from Harvey's work as a text, he would scarcely have expressed himself otherwise than he has

done, or given different rules for philosophizing than those which will there be found enforced in practice.[1]

In his introduction, and by way of clearing the ground, Harvey briefly exposes the views of preceding physiologists, ancient and modern, in regard to the motions of the heart, lungs and blood, to the origins and functions of the veins and arteries, the meaning of respiration, &c.—in short, he gives the accredited physiology of the thoracic viscera, with comments which show it a mass of unintelligible and irreconcilable confusion. There is room, therefore, for another interpretation of the phenomena observed, consonant with reason and anatomical fact, and susceptible of demonstration by the senses. When he first essayed himself to comprehend the motions of the heart, and to make out the meaning of these from the dissection of living animals, he found the subject so beset with difficulties that he was almost inclined to say with Fracastorius, that the motions of the heart and their purpose could be comprehended by God alone.[2] By

[1] The Novum Organum appeared in 1620. Though Harvey's work was not published till 1628, he had already developed his subject in 1615, and there is every reason to believe had actually written the Exercit. de Motu Cordis et Sanguinis before 1619. It has sometimes been made subject of question why Harvey sent his work for publication to Franckfort-on-the-Main, instead of seeing it through the press himself in London. It must have been done with a view to its getting more speedily known in the Republic of letters; Franckfort, in 1628, being the great centre of the book trade.

[2] Fracastorius (Hieron). (Opera Omnia. Lugdun., 1591.) The passage here referred to by Harvey must, I presume, be the following:—"Ad priorem dilatationem sequitur attractio aeris novi, a quo refrigeratur cor; ad constrictionem vero sequitur expulsio ejusdem aeris calefacti et

degrees, however, by repeating his observations and giving more concentrated attention, he at last discovers a way out of the labyrinth, and a means of interpreting satisfactorily all that had previously appeared so complicated and so obscure. Hence the occasion of his writing, and such the burden of the Introduction and first chapter of his work.

This ground we have ourselves gone over in our introduction ; so that we have no occasion to follow our author in his elaborate demonstration of the untenable nature of the older physiological assumptions, almost all of which had reached him with little change and small addition from the days of Aristotle and Galen.

The chest of a living animal having been laid open and the pericardium removed, says Harvey, proceeding to his own views of the motions of the heart and blood, the heart is seen to be alternately in action and at rest ; three principal incidents being then to be noted. Firstly, it becomes erect, strikes the chest, and gives a beat. Secondly, it is constricted in every direction—it has become notably shorter and narrower. Thirdly, grasped by the hand it is then felt to be an exceedingly firm body. From these facts we conclude

simul fuliginum multorum : quæ quidem beneficia cognita a Deo et natura sunt, non autem cordi." ("Pars prima," p. 63.) If it be so—and I find no other in the book which it seems likely Harvey could have had in his eye—it appears to have been the purpose served by the attraction of air and its expulsion, along with fuliginous vapours, rather than the motions of the heart, which puzzled Fracastoro.

that the action of the heart is essentially of the same nature as that of the voluntary muscles, which become hard and condensed when they act; the effect, in respect of the heart, being to lessen its bulk in every direction, to thicken and solidify its walls, and to diminish the capacity of its cavities, whereby it is made apt to expel the charge of blood it contained. The intrinsic or proper motion of the heart, therefore, is the systole; not the diastole, as hitherto imagined, when the organ is simply passive, yielding to the blood that flows into it from the veins, and having no power of expansion in itself, like the bellows of the blacksmith.

The motions of the arteries again, are wholly dependent on the action of the heart. At the moment of its contraction, when the wall of the chest is struck, the arteries are distended by the wave of blood that is thrown into them and a beat or pulse is felt; facts in consonance with which the blood is seen to spurt in jets from a wounded artery synchronously with the beat of the heart.

In the heart of a living animal attentively considered, two distinct motions are to be observed; one, of the auricles; another, of the ventricles, these succeeding each other rhythmically, the briefest possible pause occurring between them,—the contraction of the auricles having precedence, that of the ventricles following, "like the two clacks of a water bellow," as Harvey has it in his note-book of 1616; so that if the

point of the heart be cut off, blood is seen to spurt from the ventricles upon each contraction of the auricles. From this we learn that the ventricles do not fill in virtue of any attractive power of their own, but from having blood thrown into them by the action of the auricles.

In the heart of an animal when moribund, the ventricles are observed to cease beating sooner than the auricles, the left always giving in before the right, which, indeed, may be seen to flutter feebly when all else is still. Life, therefore, appears to linger longer in the right auricle than in any other element of the heart,—even as in the incubated egg, a reddish palpitating point, which is gradually developed into the auricle, is the part of the future chick which first by its motion gives signs of life, as in the adult creature it is the last to die.

By the reciprocating dilatations and contractions of the auricles and ventricles, there is, consequently, an alternate reception and delivery of blood—reception by the auricles from the veins, delivery from them to the ventricles ; reception in turn by the ventricles from the auricles and delivery by them to the arteries, with the accompanying sensible pulse of the heart and efferent vessels. The fact of the pulmonary artery and pulmonary vein proceeding from the heart and losing themselves in the lungs, which was so great a puzzle to the old physiologists, with their natural blood for nutrition and their spirituous blood for heat and

vital endowment, was no enigma to Harvey with the one blood alternately dark and florid—dark whilst venous before passing through the lungs, florid after this whilst in course of transmission by the aorta and its subdivisions to minister to the requirements of the body.

With his predecessors Harvey speaks at one time of the blood being transmitted through the lungs for the purpose of attaining its final perfection ; at another of having its heat damped down or mitigated ; and at yet another, of its possibly acquiring rather than losing heat through exposure to the inbreathed air. He, consequently, delivers himself doubtfully on this important subject; he has not made up his mind upon it, and so refers to a treatise he intended to publish on the question, which, unhappily, never appeared.

Harvey is next at considerable pains to show that from the structure of the several parts of the heart—the arrangement of the valves at its orifices, &c., the blood must necessarily pass in a ceaseless stream from the right to the left side of the organ by way of the lungs. Until the "Exercise on the Motion of the Heart and Blood" appeared and settled the question for ever, this, although acknowledged by one or two of his predecessors, was really a moot point with the majority of them, the very latest and most accomplished of them all, Andrea Cesalpino, as we have seen, still maintaining that the blood passed, in part at least, from

the right to the left ventricle by filtration through the interposed septum.

Approaching the consideration of the quantity of blood that might pass through the heart by the arteries to the veins in a given interval of time, and the necessity of its circular motion in view of the amount proclaimed, Harvey now apologizes for what he finds himself forced, as it were, to say on the subject, which, indeed, is "of so novel a character, that he fears he may even have mankind for his enemies. His trust, however, is in the love of truth and the candour that inhere in cultivated minds"—words which deserve more careful consideration than they have ever received from the writers who maintain that the Circulation of the blood was even imagined, much less demonstrated, by any one of Harvey's predecessors. There cannot, indeed, be a question that the "Exercise on the Motion of the Heart and Blood" took the anatomical world by surprise; for the business of its leaders during a generation and more was to controvert the fact that was therein proclaimed, as an absurdity, not to ascribe it to this one or to that as an honour.

Revolving in his mind, then, what the quantity of blood might be that was transmitted by the heart, and in what interval of time its passage must be effected, "seeing that such an amount as presented itself could not be furnished by all the ingesta in the shape of meat and drink, without the veins on the one hand being drained, and the arteries on the other getting

filled to bursting, unless the blood should find its way from the arteries into the veins as fast as it was thrown by the heart into the arteries, and so return to the right ventricle whence it had started; "*I began to think*," he says, "*whether there might not be a motion in a circle, as it were.*" Then it was that the great truth flashed upon him; then it was that he saw that the blood, forced incessantly by the action of the left ventricle into the arteries and distributed by them to the body at large, must necessarily return by the veins to the right side of the heart; from thence be poured by the pulmonary artery into the lungs, reach the left auricle and ventricle by the pulmonary vein, be pumped again into the aorta and its branches, to return again and again to the heart and run the round as before.

"In this way it is," says the great physiologist, "that all parts of the body are nourished, cherished, and quickened by the warm, spirituous, more perfect, and truly alimentive blood; which then, cooled by contact with the parts, and become effete, returns to its sovereign, the heart, as its source, there to recover its pristine state of excellence, to receive a fresh infusion of native heat, to be impregnated anew with spirits, again to go forth replete with life-giving power, and all this accomplished by the action of the heart alone."

What an immense advance is this on all that had ever been said before on the motion of the heart and

blood? There is nothing to compare with it in simplicity and comprehensiveness in the whole range of antecedent anatomical literature. Well might the late eloquent Perpetual Secretary to the Academy of Sciences of Paris, M. Flourens, speak as he does of the "Exercise on the Motion of the Heart and Blood," as "a little work of no more than a hundred pages, but the very best book we have in physiology." [1]

To Harvey the arteries and veins only differed because of their distinct mechanical destinations; an artery being the vessel which carries the blood from the heart to the extreme parts of the body; a vein, the vessel which brings it back from the periphery to the centre; the artery thicker, stronger, resilient, as having to bear the shock of the heart, and help forward the successive waves; the vein thinner, and inelastic in its coats, having to support the weight of the column of blood returning to the heart. How much this swerves from the old, and, until Harvey's day, still accredited fancies about the diversity of structure between veins and arteries being destined to meet diversity in the subtlety, heat, charge of spirits, and other imaginary adjuncts to the several kinds of blood acknowledged, need not be said.

In the old physiology we have seen the motions of

[1] "Ce petit livre de cent pages c'est le plus beau livre de Physiologie." Hist. de la Découv. de la Circulation du Sang. 2me ed. The original of Harvey's "Anatomical Exercises" is all comprised in seventy-two pages small 4to.

the heart and blood presumed to be intimately connected with the food consumed : a wave of alimentary matter reaching the heart, the heart responded by a beat. But Harvey showed that the ingesta can have no immediate part in all that takes place, and, the moment of eating and drinking discarded, that they are utterly inadequate to account for the mass of blood which passes through the heart in a given interval of time. On making trial of the matter, Harvey found either ventricle of the human heart, to hold upwards of two ounces of fluid. Were the blood in the body to be estimated at ten pounds, and two ounces assumed as the quantity projected by each contraction of the heart, eighty beats would suffice to make it complete a circuit through the body ; so that were the beats at the rate of sixty in a minute, less than a minute and a half would suffice to effect one complete revolution. "Did the heart eject but two drachms of blood on each contraction, and the beats in half an hour were a thousand," says our author, "the quantity expelled in that time would amount to twenty pounds and ten ounces ; and were the quantity an ounce, it would be as much as eighty pounds and four ounces. Such quantities, it is certain, could not be supplied by any possible amount of meat and drink consumed within the time specified. It is the same blood, consequently, that is now flowing out by the arteries, now returning by the veins ; and it is simply matter of necessity that the blood should

perform a circuit, or return to the place from whence it went forth."

What a revelation was this to the world! How does Harvey stand out peerless among all the goodly men—anatomists, physiologists, physicians, of his great age! Overlooking the field of their common inquiries, he evokes harmony out of discord, order out of chaos, and presents the world with a new and pregnant truth.[1]

The admirable use which Harvey constantly makes of comparative anatomy in his works, is all his own. Here, indeed, he stands by himself, the Aristotle of the modern world. None of the great Italian anatomists, his predecessors and teachers, appear to have practised dissection of the lower animals to any extent, or to have thought of gathering physiological conclusions,

[1] The quantity of blood in the human body has been variously estimated, I believe generally in excess of the truth. Müller ("Physiology," by Baly) speaks of as many as 20 pounds having been collected from the body of a corpulent executed criminal, and of 10 pounds lost by a woman in a fatal hemorrhage after parturition. I cannot think the report in either case correct. I had lately two sheep carefully slaughtered by my intelligent butcher and the blood collected. Each of the sheep weighed within a fraction of 104 pounds avoirdupois, and the blood obtained from the one was 5 pounds 2 ounces, from the other 5 pounds 4 ounces. A fine bullock in prime condition, weighing 832 pounds, slaughtered with every precaution to secure accuracy, yielded exactly 38 pounds of blood, not an ounce having been lost. If we assume the weight of the human body at from 8 to 12 stones, jockey weight—*i.e.*, from 112 to 168 pounds—and think of the effect produced by the abstraction of 16 or 20 ounces of blood from an individual in health, how should the vascular system of a man contain at any moment 20 pounds of blood? From 8 to 10 or 12 pounds would probably be nearer the mark.

from the variety of structure there to be discovered. They may have inspected a live dog occasionally to see the action of the heart and the peristaltic motion of the intestines; but comparative anatomy in its proper sense was a book unopened by them. Not so by Harvey. To him the world of organisation was the ample page from which he read and had the better part of all he knew.

"If a live snake be laid open," says Harvey, "the heart will be seen pulsating for an hour or more, contracting and propelling its contents, becoming of a paler colour in the systole when it empties itself, of a deeper hue in the diastole when it is filled. In this animal the vena cava enters the heart at its lower part, and the aorta leaves it at the upper part. Now, if the vein be taken between the finger and thumb, or seized by the dissecting forceps a little way below the heart, and the incoming current of blood be thereby arrested, you will see the part which intervenes between the obstruction and the heart fall empty, and the heart itself become smaller and of a paler colour than it was before; beating more slowly too, as if it were about to die. But the impediment to the flow of blood being removed, instantly the colour, the size, and the motion of the heart, are restored. If, on the contrary, the artery, instead of the vein, be compressed, the part between the obstacle and the heart immediately becomes inordinately distended, of a deep purple or livid colour, and at length so much

oppressed that it looks as though it would burst; but on the obstruction being removed, everything returns forthwith to its pristine state. Here, therefore, we have evidence of threatened death from two opposite causes—extinction through deficiency, and suffocation through excess." Who before Harvey, unless we go back to Galen, ever illustrated, or thought of illustrating, physiological inferences in such ways as these? We have no difficulty in finding an excuse for the contempt the great experimental physiologist is said to have expressed for the neoterics.[1]

"That the blood enters a limb by the arteries and returns from it by the veins," continues our author, "is readily proved experimentally: If a ligature be thrown about the upper part of an arm—one who is lean and has large veins being the best subject for the trial—and quickly drawn as tightly as it can be borne, it will be found that the arteries do not pulsate beyond the obstruction, whilst they throb violently and appear preternaturally distended above it. The hand under these circumstances, retains its natural appearance; although if the binder be kept on even for a minute or two, it will begin to look livid and to fall in temperature. But if the bandage be now slackened a little—be brought to the state of medium tightness used in blood-letting—the hand and arm will immediately become suffused, and the superficial veins show themselves tumid and knotted, the pulse at the

[1] Conf. Aubrey, op. cit.

wrist in the same instant beginning to beat as it did before the application of the bandage.

"The difference in the effect of the tight and of the medium bandage therefore is this: The tight bandage not only obstructs the veins but the arteries also; whereby it comes to pass that the blood neither comes nor goes in the member. The medium bandage, again, obstructs the veins, the more superficial among them especially, whilst the arteries, lying deeper, being firmer in their coats and forcibly injected by the heart, are not obstructed but continue conveying blood to the limb. Whence follows the unusual fullness of the veins, and the necessary inference that the blood flows incessantly outwards from the heart by the arteries and ceaselessly returns to it by the veins." These facts, familiarly known to the vulgar phlebotomist, were wholly overlooked in their bearing on the motion of the blood by the learned physiologists of the age of Harvey. The illiterate barber-phlebotomist, with his sign of the fillet-bound pole which has now all but disappeared from among us, was aware that if his bandage were somewhat tight, the blood, though it spurted out with force at first, soon ceased to flow; in which case he slackened his fillet a little, and the stream then poured out amain. We have seen the lame and impotent conclusion to which the latest and greatest of Harvey's predecessors came, when he attempted to explain the phenomena he witnessed. Enigmas to the mighty

Stagyrite, as they were to his follower Cesalpino, they were not only none to our independent inductive philosopher, but are adduced by him as physiological necessities in the nature of things.

That there is the freest possible communication between the arteries and veins of the animal body is amply demonstrated, as Galen showed, by the fact that both are drained of their contents whether a branch of one or other be divided and suffered to bleed for a sufficient length of time. "Now," says Harvey, "if, when performing phlebotomy, we assume the blood abstracted to represent the quantity that would have flowed naturally through the limb during the time employed in the business, double this to get at so much as would have passed through the other arm, calculate how much more would have gone through the lower limbs, the abdominal viscera, the lungs and the head—we shall, in another way, arrive at something like an idea of the quantity of blood that must leave and return to the heart in a given interval of time, and reach the conviction that its motion in a ceaseless circuit upon itself, as it were, will alone account for the large amount proclaimed by our figures." The premisses of no physiologist before Harvey could possibly have led him to an induction such as this.

In what precedes, we are led by reasoning upon obvious phenomena to conclude, that the blood

propelled by the heart returns to it again and again by the veins. Happily the structure of the veins makes this conclusion a readily demonstrable truth; for within them, in those of the extremities especially, there are found numerous loose folds or floating portions of their inner membrane, of a semilunar shape, and having their free edges turned towards the trunks of the vessels. Sometimes single but more commonly double or in pairs, they then arise from opposite sides of the vein, and meet by their free edges when brought into action. The arrangement of these folds is such that, whilst they present not the slightest impediment to the flow of the blood from the smaller to the larger branches, they effectually oppose its motion in the opposite sense, or from trunks to branches.

These membranulæ, ostiola, or valves of the veins were observed, as we have seen, by more than one of the earlier anatomists—by Sylvius, Eustachius, Paul Sarpi, and others; but they were first particularly described and figured by Fabricius of Aquapendente, who is generally credited with having discovered them. But neither Fabricius nor any of his predecessors understood their function or their real importance—Cesalpino does not even notice them in his account of the arm bound by the bleeding fillet, and this he would hardly have failed to do had he entertained the ideas of the circulation that have been ascribed to him. The ostiola, by Fabricius and others his contemporaries, were believed merely to retard

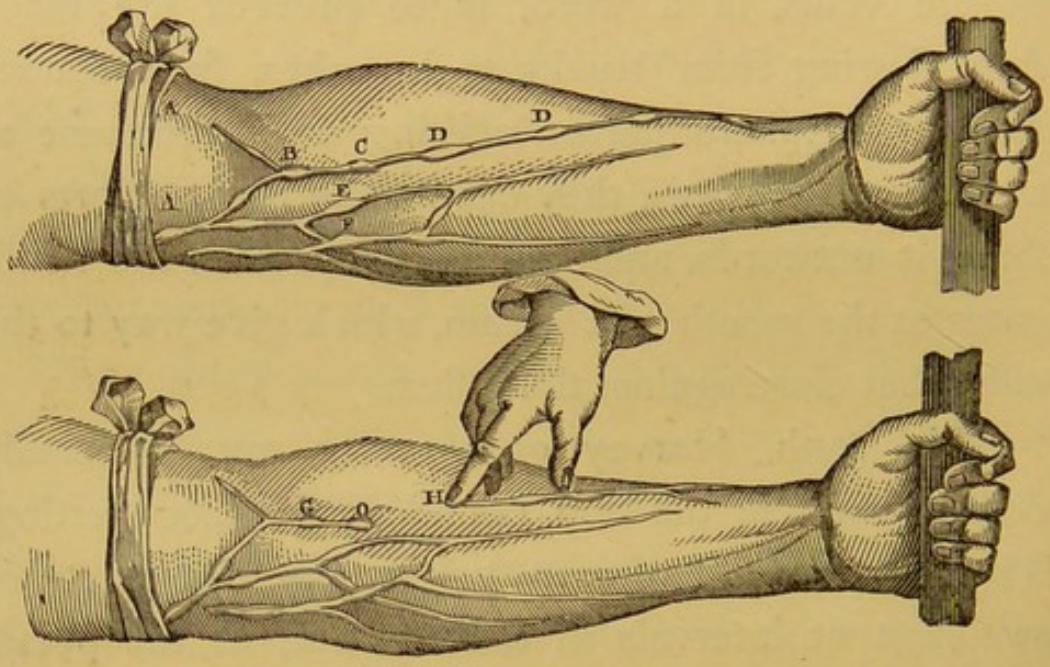
the flow of the blood in the veins, from the centre to the periphery of the body, so as to give the several parts time to appropriate the nutriment they required ; or they were held to prevent the blood from over-burthening dependent parts by its weight, or even from gravitating entirely into these.

In the lower animals, however, there are valves in situations where no effect of gravity from position was to be apprehended. The main duty of the valves of the veins, in a word, is to prevent the blood from flowing from trunks to branches, from central towards peripheral parts: offering no impediment to the current inwards, they obstinately resist efforts to force it outwards, and accurately represent the flood-gates at the mouth of a stream, which give way to the efflux but close against the reflux.

This truth, Harvey goes on to say, is readily demonstrated in the arm bound as for blood-letting. The veins are then seen turgid and with knots or swellings at intervals in their course, at the points especially where one branch joins another. The knots in question mark the positions of valves ; a fact which is immediately made manifest if an attempt be made to force the blood in one of the vessels from above downwards by the pressure of a finger. The valve nearest the part below the point of pressure starts at once into action, and can be felt distinctly as a hard, resistant knot. If the pressure be now reversed, the vein being compressed by the point of a finger beyond

a valve, the blood within it will then be easily streaked upwards till it passes the valve above, when the part of its canal between this and the point of pressure will not only be emptied, but will so remain whilst the pressure is continued. The pressure below being now withdrawn, the empty vein fills instantly and looks turgid as before.

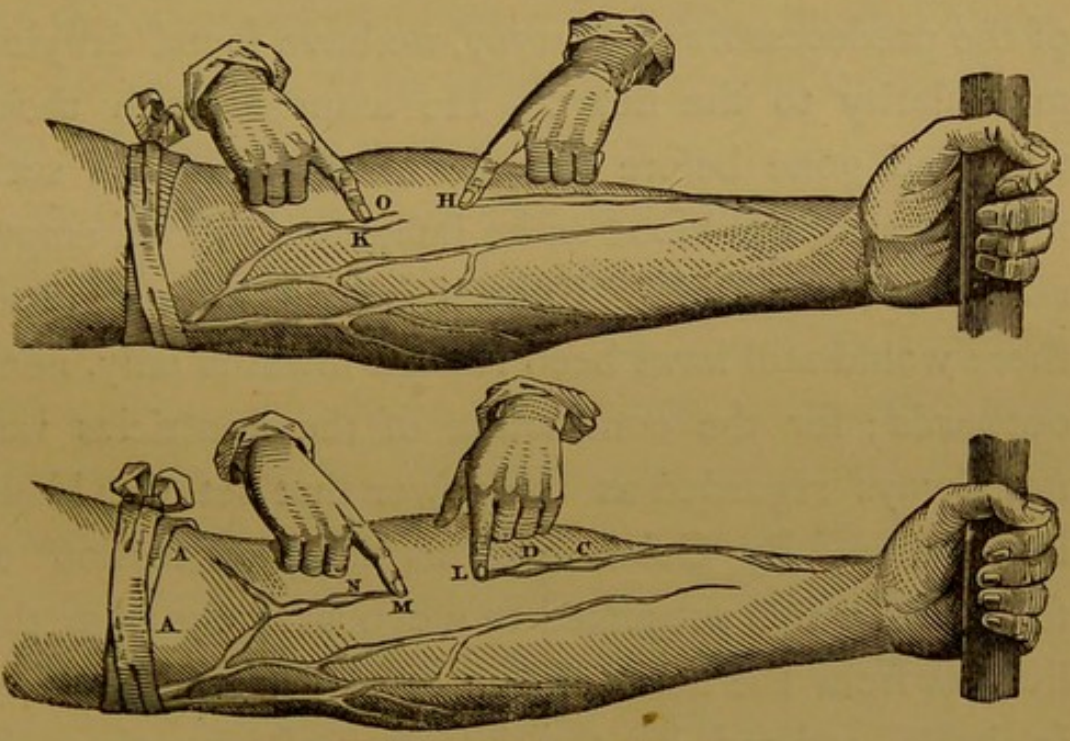
The valves of the veins, consequently, act no other-



wise than do the sigmoid valves at the roots of the aorta and pulmonic artery, and as the mitral and tricuspid valves between the ventricles and auricles of the heart: they offer no impediment to the flow of the blood in the direction of their trunks, but oppose effectual barriers to its course towards their branches; the effect of which is, that the blood poured by the terminal capillaries of the arteries into the initial

capillaries of the veins, can only move in one direction: outward ever from the heart by the arteries, the efferent vessels; inward ever towards the heart, by the veins, the afferent vessels. In the words of our author, we must therefore conclude that "THE BLOOD IN THE ANIMAL BODY IS SUBJECTED TO A CERTAIN CIRCULAR MOTION; THAT THIS MOTION IS INCESSANT; AND THAT THE PULSE OR CONTRACTION OF THE HEART IS ITS SOLE EFFICIENT CAUSE."[1]

These last words lead Harvey immediately to treat



of the heart as the impelling power in the circulation of the blood; a conclusion in which it is to be

[1] "Necessarium est concludere circulari quodam motu in circuitu agitari in animalibus sanguinem, et esse in perpetuo motu; et hanc esse actionem sive functionem cordis quam pulsu peragit, et omnino motus et pulsus cordis causam unam esse." (Exerc., cap. xiv. ad fin.)

observed he is also wholly original, although with his predecessors he goes on to speak of it, as the "hearth and home of the native fire, whence warmth and life are dispensed as from a fountain-head to all parts of the body. And that this is so in fact," he adds, "I trust no one will now deny." To all before Harvey, however, the heart was virtually without the power to make available to the body the treasures of which it was presumed to be possessed. How should there be motion without an adequate moving power? Columbus among the more immediate and influential of the predecessors of Harvey, we have found denying muscularity to the heart. He assumed, with those who had gone before him, in connection with such movement of the blood as he imagined, that an empty sack could fill itself! Even if it could have done so, there would still have been motion inwards only, none outwards; for the contraction of the ventricles was not always regarded as the power that set the blood in motion. By Galen and his long succession of followers, it was presumed to move as freely from the liver as from the heart, the cause of the motion being in itself, assisted by the heaving of the chest in breathing, and the attractions of the parts for the heat and nourishment associated with the blood contained in the vessels. The rising and falling of the heart were mainly for the purpose of elaborating the blood and engendering the spirits.

Harvey put an end to all this by insisting on the

proper muscular structure of the heart, and on its sole function as the propelling power in the circular motion of the blood—the power adequate not only to force the tide to the extreme branches of the arteries, but to bring it round by the inosculating twigs of the veins to the source whence it went forth. Let me recall the reader's attention to the title of Harvey's book: "An Anatomical Exercise on the Motion of the Heart and Blood;" and refer him, if he be still doubtful of its author's title to originality, to the writings of all the anatomists and physiologists who preceded him, for the conspicuous absence of even a single chapter on the subject which it is the special purpose of Harvey's immortal work to proclaim.

And then how does the clear-sighted man, the independent thinker, free himself from all the prevalent ideas on the heart as seat of the emotions and passions of our nature, maintaining as he does, that "every affection of the mind that is attended with pleasure or pain, with hope or fear, is simply the cause of an agitation which extends to the heart and there induces change from the natural constitution—impairing nutrition, depressing the powers of life, and so engendering disease."

To Harvey the liver played an important, though still a subordinate, part in the process of sanguification. With the older physiologists, giving no heed to the function of the lacteal vessels, or rather, failing to

attach the importance to the system which it deserved, Harvey regarded the mesenteric veins as the channels by which the chyle was conveyed from the intestines to the liver, which he speaks of as "interposed by nature with a view to delay, and concoct within its meandering canals, the cruder matters that would else have reached the heart direct, and perchance have oppressed the vital principle."

Familiar as we know him to have been with the dissection of the lower animals, it is somewhat extraordinary that Harvey should not himself have given more attention to the lacteals, for he had not overlooked them, and he was acquainted with Aselli's book. The animals he dissected were probably mostly in a state of fasting, when of course the vessels are little conspicuous or even invisible; he consequently saw them not as constant elements in the organization, but as accidents in some sort, and connected with the secretion of milk, which he thought was not confined to the mammæ alone. Believing, in a word, that there was already sufficient provision in the mesenteric veins for transporting the nutritious element of the digested food from the intestines to the liver, he did not see nature so prodigal of means as to furnish a second set of vessels to meet a purpose already cared for.

It is only in the concluding chapter of the "Anatomical Exercise," that Harvey enters particularly on

the discussion of the number and arrangement of the particular parts of the heart, and after a comprehensive survey of the organ in the animal kingdom in general, shows its structure harmonious in every respect with the performance of the great function which it has been the burden of all he has already said to proclaim. So complete and exhaustive is the summary here, that little or nothing is left for successors but refinement or comment on his text; whilst the physiological, pathological and general observations he makes in illustration of his theme, leave us in admiration at once of the industry, the knowledge, and the genius of the man.

Harvey is the first who assigned to the auricles their proper function. Relaxing, they are filled from the veins which end in them. Contracting they throw the charge they have received into the relaxing ventricles, and these contracting in turn, propel it into the arteries in correspondence with them. The auricles are in fact a necessary complement to the ventricles, and, like them, are two in number in the more perfect air-breathing animals having a largely developed pulmonary system and high bodily temperature; whilst animals lower in the scale, with vesicular less perfectly developed lungs, or breathing by means of gills, and having a temperature but little raised above the medium in which they live, have no more than a single auricle. The auricles to our physiologist, therefore, are not agents connected with the ventilation

of the blood, as they were to his predecessors, but are active instruments, projecting the charge they have received from the veins into the ventricles, by which, in sequence, it is *caught on the move*, and thrown with force into the artery. And how apt the reference to the tennis player, here introduced, who strikes his ball to best advantage when he takes it on the rebound!

We have found the older physiologists, for certain hypothetical reasons, assuming the mitral valve of the left auricle as weaker and less perfect than the tricuspid of the right. Harvey, on the contrary, sees it as the stronger of the two, and, therefore, better adapted to meet the heavier duty it has to perform: having to resist the greater force of the more powerful left ventricle, it is in reality stronger than the tricuspid valve.

Why should an artery differ so much from a vein in the thickness, resilience, and strength of its coats? We have already had occasion to allude to this, and know the fanciful notions entertained on the matter by the predecessors of Harvey. To him the reason of the difference was obvious enough. It was simply because the artery had to sustain the shock of the impelling heart. "The nearer to the heart the denser and stronger are the arteries, and ever more do they differ in structure and appearance from the veins; but in extreme parts—the feet and hands, the mesentery, the brain, &c., the two orders of vessels are so

much alike, that they cannot be distinguished by the eye."

Harvey, we may venture to say, could hardly be expected to see the heart otherwise than as the source and seat of the heat of the body. The animals that are lowest in the scale of evolution, he thinks, are the coldest, because they have no heart. Of a simple homogeneous nature, they do not require an impeller of nourishment into complex and distant parts. In molluscous animals, however, such as snails and whelks, and in transparent shrimps, a heart can be seen pulsating distinctly enough; and when we come to insects—bees, hornets, and the like, we also, with the aid of a magnifying glass, perceive something pulsating, for in them there is variety of organic structure; but the pulsations occur irregularly, and in the cold even cease entirely. This is the case with those insects, particularly, which hide away in winter and lie defunct as it were, manifesting a kind of vegetable life only. Whether the same thing happens in animals that have red blood, such as frogs, serpents, tortoises, swallows, &c., is a question. The swallow, it may perhaps be held needless to observe, was vulgarly believed in Harvey's day to hybernate at the bottom of ponds and rivers; and it seems not to have fallen in his way to question the absurdity.

To conclude with this part of our subject, how shall we think too highly of him who descanting on "nature as ever perfect and divine, doing nothing in vain,

neither giving a heart where it was not wanted, nor witholding it where its office was required," goes on to say, "but *by the same stages in the development of every animal, passing through the constitutions of all, I may say—ovum, worm, embryo—it acquires additional perfection in each.*" Have we not here the first brief intimation of the great Evolution Theory, that has been as a new revelation in the physics of life to our modern world?

SECTION III.

RECEPTION OF THE EXERCISES ON THE HEART AND BLOOD.

THE appearance of Harvey's Book on the motion of the heart and blood, seems almost immediately to have arrested the attention of all the better minds among the medical men of Europe. The subject was not one, indeed, greatly calculated to interest mere practitioners, but anatomists, physiologists, and scientific physicians appear at once to have taken it in hand and canvassed its merits. The conclusions come to in the work, there can be no question, took the medical world by surprise; it was not prepared for such a proposition as a ceaseless circular movement of one kind of blood, with the heart as the propelling power. As it had been to all the older anatomists, the heart

was still the source of the native heat, the concocter of the blood, and the laboratory of the vital spirits; the main cause of the to-and-fro motion of the blood being the attraction of the parts for the nutriment they required, on the one hand; the attraction of the heart aided by its diastole and the heave of the chest in breathing, on the other.

By all the older intellects in possession of the seats of authority, Harvey's views were regarded as idle dreams; and it was upon the faith of this conclusion, that their author was set down by them as a mere fanciful innovator. No one in those days either claimed for himself or for another so extravagant a notion as Harvey had been reckless enough to enunciate. Ascribed to any respectable member of the medical profession, his immediate business would have been to purge himself of the imputation. In Harvey's lifetime, and for a good while after, indeed, it was never his title to be accounted the discoverer of the circulation of the blood that was matter of question, but the fact of there being any such circulation of the blood as he proclaimed. Two years, in fact, elapsed before anything in contravention of the new doctrine saw the light, and a considerably longer time before aught like credit came to be connected with the discovery, or hints to be thrown out that it was no discovery at all, but an old idea revived. It was only after men had familiarized their minds with the novel truth that they began to find a circular motion of the blood announced

in quarters where nothing of the kind had ever been suspected before—in Hippocrates and Galen, in Servetus, Colombus, Sarpi, Cæsalpinus, anywhere, everywhere but where alone it was to be found — the "Anatomical Exercises on the Motion of the Heart and Blood in Animals" by William Harvey.

When opposition to his great Induction arose, it was not at first from any of the more mature anatomists of Europe. Their minds were made up on the matter; the thing was absurd and there an end; nothing more need be said on the subject. It proceeded from a young physician, Primerose by name, of Scottish descent, but French by birth and education. Primerose had been a pupil of Joannes Riolanus, Professor of Anatomy in the University of Paris, an inconsistent but determined enemy of Harvey to the end of his days. Primerose had of course listened to his master's diatribes on the untenable nature of Harvey's views, and by way of exercising his ingenuity, set himself the task of trying the question, not by fact and experiment, but by texts from the ancients and such precepts as he had imbibed from his teacher. The essay of Primerose[1] may therefore be briefly characterized as a defence of the physiological ideas of Galen against the innovations of Harvey; and is remarkable for everything rather than a spirit of candour in pursuit of truth. It abounds in obstinate

[1] Entitled Exercitationes et Animadversiones in Librum Harvei de Motu Cordis et Sanguinis. 4to. London, 1630.

denials, sometimes of what may be called perversions, of statements involving matters of fact; and in its whole course appeals not once to experiment as a means of investigation.

Harvey, having in the preliminary chapter of his work demonstrated the notions which it was Primerose's purpose to reassert and defend to be in contradiction with reason and experience, deigned him no reply; he could not think of going over the ground he had already trodden and shown to be utterly barren, in the hope of convincing such an antagonist.

Æmylius Parisanus,[1] a physician of Venice, was the next to assail the Harveian doctrine of the circulation, and still on the old grounds—the authority of Galen and the ancients generally. Parisanus perceived Harvey's views as directly contravening an hypothesis to which he had committed himself, namely, that the spleen was the organ of sanguification and furnisher of nutriment to the heart, and so may have been led to enter the lists against the new opinions. But he proved a most flimsy antagonist. Ignorant of some of the commonest points of anatomy, and fre-

[1] In his work entitled Lapis Lydius de Motu Cordis et Sanguinis. Folio. Venet. 1635. In an edition of his "Refutation" to which I have had access, published at Leyden in 1639, the number of pages to which it extends is 267 in small 4to. Harvey's Exercitationes are all comprised in 72 pages of the same sized sheet! It is an out-and-out defence of all the indefensible propositions of the old physiology; and three paragraphs in succession, contradictory to as many self-evident propositions, commence thus: "Bone Deus! Deus Optime! Deus plusquam Optime!"

quently misinterpreting the writer he combats, expressing himself in a style the most elaborately involved and obscure, it is often difficult even to guess at his meaning. Like his countryman of the poet, Signor Gratiano, he

> "Speaks an infinite deal of nothing; more than any man in all Venice: his reasons are as two grains of wheat hid in two bushels of chaff; you shall seek all day ere you find them; and when you have them they are not worth the search."

Had not Dr. Ent, in his "Apology for the Circulation," given the name a place on his title-page, Parisanus' opposition would scarcely have merited mention here.

Nearly at the same time with Parisanus, Caspar Hoffman, the learned professor of Nuremberg, attracted attention to himself by his writings, as well as by his teaching, on the motion of the blood. A follower of Galen, like all but every other anatomist of erudition in his day, Hoffman had, nevertheless, freed himself in so far from the authority of his master as to have acknowledged the passage of the blood by the pulmonary artery and vein from the right to the left side of the heart instead of by the septum, and modified the idea of the mere to-and-fro motion of the blood in its respective vessels, by likening it to what we see in a lake ruffled by the wind. The veins, however, in conformity with the physiological views of the day, he still held to be the special conduits of the nutrient blood; the arteries the channels of the vital spirits.

Having referred to the views of Harvey on the motion of the blood in the course of his discussion, Hoffman, besides being personally known to Harvey, for they were fellow-students at Padua, was a personage of such note that Harvey thought it not consistent with his dignity to allow the observations of the Nuremberg professor to pass without notice—all the more, as he saw that he had been misunderstood, and, as he thought, unfairly represented. Hence the spirited letter of our anatomist to Caspar Hoffman which has happily reached us.

The opinion which the learned professor of Nuremberg is pleased to entertain of him personally, says Harvey, is highly gratifying to him, but he cannot conceive how Hoffman should have come to imagine that he had ever accused Nature of folly or error, and spoken of her as a clumsy and inefficient artificer, whilst making the blood return again and again to the heart in order to be reconcocted, only to grow effete as often in the body, thereby needlessly spoiling the perfectly made blood for no end but to find herself in something to do! But where or when anything of the kind is said, or was ever even imagined by him who has lost no opportunity of expressing his admiration of the wisdom and aptness of Nature, he is at a loss to conceive, and is indeed not a little disturbed to find such things charged against him. He has purposely omitted, he says, to speak of the concoction of the blood, as well as of the final cause of its motion; but

he engages to show his correspondent, with occasion serving, everything he affirms in respect of the circulation. If this be declined, he beseeches his friend not to derogate from what is due to an honourable man not altogether foolish, who has had experience in such matters for a long series of years, and concludes thus characteristically: "Farewell and beware! act by me as I have done by you. What you have written I receive as uttered in all candour and kindness; and be sure in writing to me in return that you are animated by the same sentiments."

The letter purports to be dated from Nuremberg, May the 20th, 1636; the date of the reception I should imagine, rather than of the writing, for the letter could hardly have been written to Hoffman from the city where he was resident. We know, in fact, that Harvey took the opportunity, whilst in attendance on the Earl of Arundel, to visit Hoffman at Nuremberg and give him a demonstration of his views from the subject, but unhappily in vain; Hoffman continued unconvinced; although, if we may trust Schlegel, he did show signs of yielding towards the end of his long life.

The next personage of any note who took it on him to criticise the conclusions of Harvey was Joannes Vesling,[1] professor in the University of Padua, one of

[1] Vesling's Letters are comprised in his Observ. Anatom. et Epist. Med. ex schedis posthumis à Th. Bartholin. Edit. 8vo, min., Hag. Com., 1640; 12mo, Hafn., 1644.

the best anatomists and botanists of the age. From the two letters he addressed to Harvey in 1637 we conclude that Harvey must have been personally acquainted with Vesling, and paid him a visit when in attendance on the Duke of Lennox during his continental tour.

Vesling begins his first letter by regretting the so speedy departure of his visitor. He had read what Primerose had had to say against the circulation ; but it was mostly pointless and did not touch the matter—*imbellia pleraque et sine ictu.* He had also seen Parisanus's lucubrations on the subject. "He is bolder, but in many respects more objectionable—*proterve magis attamen, in quamplurimis turpius.*" "The pugnacious old man," he continues, "strives beyond question with vain fancies and portentous paralogisms of his own creating." Vesling says that he has himself profited immensely by all that Harvey had said on the heart ; and the subject of generation having, as it seems, come up during their intercourse, he speaks of having resided for some time in Egypt, and made a particular study of the development of the chick in ovo, for which the hatching ovens of the country gave him ample opportunity. One of the great difficulties he experienced in accepting Harvey's views, was the remarkable difference between the colour of the arterial and venous blood. It did not seem possible to him that the fluid which was of a bright crimson in the arteries

could ever have been the dark-coloured fluid of the veins.[1]

In the second letter to our anatomist, however, in reply to one received from him, Vesling says that he has now had many of his doubts cleared away, and concludes in this complimentary fashion: "It will be kindness in you to enlighten us with your better light, and thereby make it easier for us to follow in the onward path you tread." Vesling must have had Harvey in high esteem. In a letter to Licetus, written about the same time, he expresses himself thus to his friend: "Did you but hear our Harvey you would acknowledge this celestial cycle of the blood and spirits, issuing from the left chamber of the heart, entering the arteries, and from the arteries returning to the right sinus by the veins (!)"[2]

But the principle of the circulation was not now to meet either with simple, and that mostly tacit, assent, or with more openly expressed dissent; the mind that

[1] This was, indeed, one of the grand obstacles the Harveian doctrine had to encounter in the first instance. Had not the work of Servetus been so summarily burned by Calvin, it would probably by this time have been overcome. Physiologists would have learned that the florid colour was due to a change effected in the blood during its course through the lungs; although it is not even now generally known that there is less difference in colour between venous and arterial blood in the height of summer than in the depth of winter in temperate countries, and that the difference within the tropics all but disappears. Vide Dr. John Davy's "Researches, Anatomical and Physiological," and what is said further on, under the head of *Lower*, on the subject.

[2] "Harveium nostrum si audis, agnosces cœlestem sanguinis et spiritus ingressus ex arteriis per venas in dextrum cordis sinum." (Conf. Fortunii Liceti: De quæsitis per Epistolas a claris viris responsa, part. vii. Bonon. et Utin., 1640–50.)

had seized and worked the theorem to a rational demonstration was no longer to be left alone against the world in its defence. The celebrated philosopher René Descartes adopted Harvey's views, and powerfully influenced opinion in their favour through his works; though he was still in some things, as we see immediately, under the influence of the old physiology. "There is always a greater heat in the heart," he says, "than in any other part of the body. It is such that a few drops of blood entering it, promptly dilate, as do so many other fluids when they fall drop by drop upon a hot plate. But for an explanation of the reason why the blood of the veins is not exhausted by passing continually into the heart, I must refer to the work of an English physician, to whom belongs the honour of having first shown that the course of the blood in the body is nothing less than a kind of perpetual movement in a circle."[1]

Two years after Descartes' adhesion, Roger Drake, a young English physician, had the credit of appearing under the auspices of Jo. Walæus, a distinguished Leyden professor, as an advocate of the Harveian views; and nearly at the same time, H. Regius (Henri Leroy) came forward at Utrecht with a series of theses in support of the doctrine of the circulation. Ten years, however, had not abated Primerose's enmity to Harvey's conclusions; for on the appearance of these academical essays, he showed himself again in the field

[1] Discours sur la Methode. Cinquieme partie. 1637.

as the opponent of their authors, publishing distinct animadversions upon each of them in the course of the year.[1] Regius (Leroy), a man of less mind and information than Drake, if we may conclude so much from their works, was in turn, not slow to encounter Primerose;[2] and the spirit in which he did so, as well as the temper and taste of the reply which Primerose, true to his controversial nature, very soon produced,[3] may, to a certain extent, be gathered from the titles of their several productions, which are given below.

Still more illustrious advocates of the Harveian circulation presented themselves in Werner Rolfink,[4] professor of anatomy at Jena, and a second time in Descartes. Rolfink, from his position and popularity, had immense influence in disseminating the new doctrine over Europe by his teachings; and Descartes, under the ægis of his powerful name, was no less effective by recurring to the subject in his writings. Opposed in his advocacy by Plempius, professor of Louvain, Descartes made himself still more thoroughly master of the question, and when he next appears as its advocate, which he does by and by, he even appeals

[1] Animadversiones in J. Walæi (Drake) Disputationem quam pro Circulatione Sanguinis proposuit. 4to. Amst., 1639. Animad. in Theses quas pro Circulat. Sang. Hen. Regius proposuit. 4to. Leidæ, 1640.

[2] Spongia qua eluuntur sordes Animad. quas Jac. Primirosius advers. Theses, &c. edidit. 4to. Leidæ, 1640.

[3] Antidotum adversus Spongiam Venenatam Hen. Regii. 4to. Leidæ, 1640.

[4] Epist. duæ ad Th. Bartholinum de Motu Chyli et Sanguinis. 8vo. Leid. 1641.

to the experiments he had made on living animals in support of his convictions and conclusions.[1]

The controversy on the circulation had been carried on up to this time abroad rather than at home; Harvey seems speedily to have won over to his side all the men of his own country who, by their education and acquirements, might have been fitted to array themselves against him: his lectures at the College of Physicians had apparently satisfied his contemporaries that his doctrine of the motions of the heart and blood was an irrefragable truth. But now one of Harvey's own countrymen made his appearance as vindicator of the circulation from the misrepresentations and misapprehensions of its adversaries. This was Dr., afterwards Sir George, Ent, an excellent scholar, a respectable anatomist, conversant with physical science generally, a gentleman by his position and profession, acquainted with all the leading men of letters and science of his time, and in particular, enjoying the friendship of William Harvey. Ent's work is entitled "An Apology for the Circulation of the Blood, with a reply to Æmylius Parisanus."[2]

In his letter to Harvey, which stands in front of his work, Ent lets it appear that he was anxious to come before the world as an advocate of the circulation, and had first thought of making Primerose the

[1] Epist. Cartesii. 4to. Amst. 1668.

[2] Apologia pro Circuitione Sanguinis, qua respondetur Æmylio Parisano. 8vo. Lond., 1641.

object of his animadversions, but as this opponent had already been very effectually dealt with by Leroy, he preferred taking Parisanus to task, the rather as in dealing with him he could also controvert Primerose where it was necessary.—Ent's Apology is a learned, though perhaps a somewhat pompous and pedantic book; still the writer shows both wit and fancy in handling his antagonist, and has always learning enough and to spare in discussing his subject. "Nothing, indeed," to quote Dr. Lawrence,[1] can be more unlike than Parisanus and Ent; and it is not wonderful, therefore, that one utterly ignorant of physical science, confronted by one thoroughly conversant therein—that one, without power of utterance, opposed by one gifted with eloquence—that one, sluggish and inert, in the hands of one active and full of energy, should be effectually vanquished and overcome." We may imagine, nay, we may be certain, that Harvey was not unacquainted with Ent's purpose to appear as the advocate of his discovery, nor with the Apology before it saw the light, for the two men were on terms of confiding friendship.

Having remarked on the appearance of certain academical dissertations in defence of the circulation, we perceive the apostles of all new truths, the younger members of society, at their proper work. Were there not successive generations of men, the intellectual life of the world would stand still. The death of the individual was not merely a necessary condition to the

[1] Harvei vita, ad cap. Operum. London, 1766.

enjoyment of life by successive generations, but essential also to the onward progress of mankind. No man who had attained to the age of forty years, it is said, ever adopted the doctrine of the circulation; it had to win its way under the safeguard of the Drakes and Leroys, in other words, of the youthful and unprejudiced spirits of the age.

Twenty years after the publication of the Exercitatio Anatomica de motu Cordis et Sanguinis, Joannes Riolanus the younger was delivered of his Encheiridium Anatomicum (8vo. Lugd. Batav., 1648) in which he makes a sorry attempt to supplant the Harveian views by others of his own, so incongruous, contradictory, and improbable, that we are irresistibly led to form an indifferent estimate of the mind that could have conceived them. To us, now-a-days, it looks something like condescension on the part of the great English anatomist when he noticed such a tyro in animal physics as the French professor here approves himself. Harvey could hardly have felt any real respect for the illogical and prejudiced mind of Riolan; but the Encheiridium had been presented to him by its author; he was in want of an occasion for a further development of his views, and so he seized on the Parisian anatomist, respectable from his position in the leading university of France, and made him his placard bearer.[1]

[1] The title of Harvey's reply—or rather replies, for there are two—is as follows: Exercitationes duæ Anatomicæ de Circulatione Sanguinis, ad Joannem Riolanum, Filium. Cantabrigiæ, 1649.

Harvey, moreover, was personally acquainted with Riolan, who had accompanied Mary de Medicis to England on the visit she paid her daughter, the queen of Charles I.; an occasion on which the two men are stated to have had several conversations on the subject of the circulation, to the burden of which Riolan when face to face with the propounder, made no objections.

Riolan is by no means totally opposed to a circulation of the blood; he would only have it limited to certain regions into which he arbitrarily divides the body; in each of which it goes on independently of the others. "Harvey, and his advocate, Walæus," he says, "will have it that the whole of the blood passes from the right to the left side of the heart by way of the lungs, denying any transmission by the septum medium, so that it circulates through the body within an hour or two. But this I do not acknowledge, and I shall show the impossibility and inconvenience of anything of the kind."

The vena cava, Riolan thinks, may take its origin from the heart; but the vena portæ certainly arises from the liver. There are two kinds of blood in these vessels, moreover, although both are elaborated in the liver—*duplicem sanguinem in istis venis contineri, quamvis in hepate uterque elaboratur;* one of the kinds being required by the porta, the other by the vessel which, rooting in the liver, proceeds as the vena cava to the heart. The blood of the portal system he maintains

does not circulate at all ; it has only a flux and reflux within its containing vessels.

The blood brought to the right ventricle of the heart by the vena cava reaches the left ventricle by passing through the septum ; "but I do not deny," he continues, "that in a violent agitation the blood may also be delivered to the left ventricle by way of the lungs, whence it would pass to the aorta for distribution to the body, reach the larger veins of the extremities which communicate with the arteries by means of anastomoses, and so get back to the right ventricle of the heart. In this way a circulation of the blood would be effected by a continual flux and reflux, even as the stones of a flour-mill are set in motion by water or the wind." Such was the physiology of the man who in his day was accounted the greatest anatomist of his country !

SECTION IV.

HARVEY REPLIES TO RIOLAN AND DEVELOPS HIS OWN VIEWS.

Before proceeding to speak of the Encheiridium Anatomicum, Harvey says : "I have first to dispose of certain observations that bear on the Circulation of the Blood as discovered by me. Scarce a day has passed since the birth of my Circulation of the blood that I have not had something said to me for good or

evil of my discovery." This, I think, is the only place in his works in which Harvey speaks of himself as the Discoverer of the circulation of the blood; and we observe that he makes no mention of any one disputing his title to the discovery. Neither, indeed, was there for long years any serious question of this. The reality of the thing was that which was then in debate. Harvey was welcome to his discovery if he could prove it true; and it was as the iconoclast and innovator, rather than the promulgator of a novelty, that he was opposed in his day: a fact that ought to weigh for much with those who at the distance of two centuries and more show themselves so eager to give the honour of his discovery to any one but its author. Writing in the middle of the year 1642, Thomas Bartholin, still expresses himself as not fully satisfied of the truth of the circulation; and Olaus Wormius and Fort. Licetus, addressing Bartholin in the following year, cannot make up their mind to part with the two kinds of blood. "Have we it not demonstrably shown," says Wormius, "that the blood in the arteries differs from that in the veins—differs in substance, colour, subtlety and all other properties? Bethink you, I pray, whether the blood of the arteries can possibly be that which we find in the veins." (Epist. Bartholini, Cent. I).

Harvey's criticism of Riolan is of much less interest to us now than that he has to say of himself on many points of his own subject not touched on in his

original treatise; the first of these discussed being the anastomoses of the one system of vessels with the other—of the aorta and its endings with the vena cava and its beginnings. He says quite candidly, "I have never succeeded in tracing any connection between the arteries and veins by a direct anastomosis of their orifices; neither in the liver, spleen, lungs, kidneys or any other viscus, is such a thing to be seen; and by boiling I have rendered the parenchyma of these organs so friable that it could be shaken like dust from the fibres, so that I could follow every capillary filament distinctly. I can therefore boldly affirm that there is neither any anastomosis of the vena portæ with the cava, of the hepatic arteries with the hepatic veins, nor of these with the biliary ducts."

Here we find Harvey at fault. He did not see—possessed no means of seeing, and certainly had recourse to no procedure by which he could have traced—the transition, by continuity of their canals from arteries to veins, and so he boldly but erroneously concludes that nothing of the kind exists. Harvey's idea, as we gather from other parts of his works, was this—that the arteries ended (by open mouths we must presume) in the areolæ of the tissues they supplied, and that the veins, arising in the same manner, drank up the blood, having done its office, that had been shed for the nutrition and vital endowment of the parts.

With the means of investigation at his disposal we can readily understand how the great anatomist should have failed to discover the true mode of communication between the two orders of vessels. And what a spectacle would have met the ravished sight of William Harvey had he only been possessed of a lens of sufficient power, and bethought him of looking through it at some diaphanous part of a living animal—the mesentery of the frog or the web of its foot, the newt's tail or the bat's wing! But he appears to have had no "magnifying glass" that was more than the "reading glass" of the present day, so that the beautiful spectacle of the actual circulation was denied him.

Harvey, strangely enough, says nothing of injections as a means of investigating the transition from arteries to veins; yet we cannot suppose that he was unacquainted with the Isagoge of Jacobus Sylvius; and injection discreetly used, is competent to solve the question. If a young animal, a kitten or puppy be drowned in hot water, the chest laid open immediately, the ventricles pierced and the blood allowed to escape, a soft tallow injection can be readily pushed through the whole of the vascular system, filling the arteries and returning by the veins to the right side of the heart. The mesentery is then seen covered with a network of capillaries, the arteries turning insensibly into veins without any of the interstitial effusion which Harvey believed to be the medium of commu-

nication between the one element of the vascular system and the other.

That the blood sent from the heart by the arteries was the blood that returned to it by the veins was, nevertheless, held by Harvey as among the cardinal elements in his system ; it was the mode in which the two orders of vessels communicate that was left by him unsolved. The solution came, however, in due course ; though not until more than thirty years had elapsed after the circulation of the blood had been published to the world. Marcellus Malpighi of Crevalcuore, better furnished with aids to vision than Harvey with his "magnifying glass," had the happiness first to "see the blood circulating." He was also the first modern comparative anatomist in succession to Harvey who used the microscope in investigating the minute structure of the parts composing the animal body, and was thereby privileged to see much that Harvey had no means of seeing. It is in his Epistolæ duæ de Pulmonibus (Bologna, 1661) that Malpighi speaks of having observed the circulation of the blood in the lung of the frog ; but the fact is more particularly described in the Opera Posthuma (Lond. 1697), from observations on the mesentery of the same animal, in which he says he had no difficulty in following the current from the larger to the smaller twigs of the arteries, from these to the finer filaments of the veins, from which larger and larger branches were reached until the

trunk of the vena cava was seen terminating in the heart.[1]

Malpighi's observations are both interesting in themselves, and highly important as having brought the circulation of the blood within the sphere of ocular demonstration. Harvey assumed, and may without reservation be said to have demonstrated, the circular motion of the blood as a necessity in the nature of things; Malpighi presented it as a sensible fact, and was the first, as I have said, who saw the blood circulating.

In Harvey's second Disquisition to Riolan we find numerous particulars connected with the nature and quantity of the blood and its mode of progression taken up afresh and more fully illustrated; but what is said on these heads hardly interests us in the present day, although they were very necessary to be advanced and insisted on when the reply was written.

[1] Born in 1628, Malpighi died at Rome in 1694. First appointed to a medical chair in the University of Bologna, like so many of the Italian professors, he was drafted in succession from one rival school to another, having taught at Pisa next, and in return, at Bologna, then at Messina, in Sicily, where he seems to have been very unhappy, back to Bologna, and finally to Rome! A man of much ingenuity and indomitable industry, Malpighi appears to have had a peculiar aptitude for making enemies of almost ali his contemporaries. Whether it was that as the original observer he showed himself too persistently the repudiator of accredited physiological notions, as the innovator, the troublesome person, always flaunting his discoveries in the face of his professional brethren, I do not know, but think it likely, for there is a strong spice of egotism in the biographical notice he gives of himself as introduction to his Opera Posthuma, published by the Royal Society of London, of which Malpighi was a fellow.

The different colours of arterial and venous blood, which we might have expected Harvey to have known through Columbus, following Servetus, as being due to its exposure to the air in the lung, he ascribed to the straining it underwent in the capillary vessels of the organ; an erroneous conclusion to which the absolute similarity in point of colour between the venous and arterial blood of the fœtus, which must have been observed by Harvey, may possibly have contributed. The function of the lungs during fœtal life being in abeyance, no blood passes through them by the pulmonary artery and vein, and so there is no straining. The child born after a tedious labour is apt not to begin breathing at once. Its body is then dusky and its lips are of a deep purple, the funis still continuing to pulsate vigorously. But anon the infant makes an effort, fills its lungs, cries aloud, and in the same instant the body is suffused with a rosy blush, the lips become of a bright crimson, the pulse of the cord fails, and independent existence is assumed.

Passing to the consideration of what is commonly said concerning vital and other spirits, which engaged so much attention and played such important parts in the systems of the old physiologists, Harvey says: "Opinions are so various and conflicting on the nature of these and the state in which they exist in the body—whether as distinct from the blood and solids, or conjoined with them—that they serve as a

common refuge for ignorance. At a loss to account for anything they observe, those of limited information bring the spirits into play upon all occasions, like indifferent poets who are always thrusting the gods upon the stage as means of unravelling the plot and bringing about the catastrophe." Neither upon this barren subject need we enter more particularly, but conclude, with our reasonable author, that "as the spirits are variously designated, so are they to be taken as signifying faculties or causes of action in the living body, not as incorporeal, aerial or adventitious substances distinct from the parts or organs with which they are presumed to be associated, any more than is the flame of a lamp distinct from the vapour of the oil that is on fire, or aqua vitæ from brandy."

On the subject of the *calidum innatum* or native heat, of which and its inherence in or association with one or another of their hypothetical spirits his predecessors and contemporaries had so much to say, Harvey is very brief. He, indeed, does not, any more than they, know how or whence the heat is derived; but he sees clearly that it is most intimately connected with the arterial blood, and flows as one body with this.[1] "When our hands, our feet, or our ears have got

[1] The origin of the heat of the animal body, and the significance of the respiration, with which it had begun somehow to be connected, still continued enigmas to Haller and all the leaders of medical science towards the close of the bygone century. In the section on respiration of the Elementa Physiologiæ we find the great Göttingen professor, after saying (§ 275) that the breathing of an animal cannot be interrupted for

chilled, and are stiff, insensible and deadly pale or livid, the veins leading from them being at the same time shrunken, the members recover their flexibility, sense and natural colour through the influx of something that makes them tingle, when the outer cold is changed for the shelter of the house or the warmth of a fire; and this something is hot arterial blood from the heart, the vehicle as it were of renovated life."

Harvey has little to say to objectors to his views on the score of their possible utility. Our first duty, he thinks, is to inquire whether a thing is or is not, before asking wherefore it is, and what is its use? And to those who object to what he advances because it disturbs long accredited notions, he replies: "Facts cognizable by the senses wait on no opinions, and the doings of nature bow not to antiquity; there is

more than a very few minutes without causing death, adding, "But the *use* is not the same as the necessity of an act," and then asking (§ 278) if it be possible that the heat of the blood can arise from the breathing? But the air is much colder than the blood; (§ 279) so may not the heat be acquired by the friction and compression which the blood suffers in its passage through the lungs? Or (§ 282) is not the blood rather cooled by the air of the lungs? and is it not for this that they who are engaged in laborious work cry out for cold air? That the blood must lose heat in the lungs is obvious, seeing that the air, taken in cold, is returned hot; but that this is not the purpose of respiration is plain; for no one has found the right ventricle of the heart warmer than the left. Were the blood cooled by the cold air taken into the lungs, it would reach the aorta still colder than it went into them, which is not the fact. All the heat it must have lost was, therefore, recovered." So much from the greatest and most learned physiologist of his age, in anticipation of the better knowledge we now possess through the progress of chemical science.

nothing, indeed, more ancient nor of higher authority than nature. It were fruitless, moreover, elaborately to discuss the consequences and the advantages or disadvantages likely to follow to physiology and other parts of medical science from the discovery of the circulation of the blood, until it has been acknowledged as an established fact. The flood of light that breaks in on me through its means, however, is such," he goes on to say, "the aid it affords in interpreting so many problems and resolving so many doubts; in detecting the causes of so many slighter and more serious diseases and suggesting means for their cure, that it will be my business in a separate treatise to be entitled 'Medical Observations,' to lay matter before the reader that shall be worthy of the gravest consideration."

Harvey complains that his views have never been opposed on the ground of an appeal to facts. "The Circulation of the Blood," he says, "has now been before the world for many years, illustrated by proofs cognizable to the senses, and confirmed by numerous experiments; but no one has yet attempted opposition to it on the ground of ocular testimony. Empty assertions, baseless arguments, captious cavillings, and contumelious epithets[1] are all that have been levelled against the doctrine and its author. But even as the waves of the Sicilian sea, excited by the blast, which

[1] Harvey was actually called Quack—*Circulator*, by some of his opponents.

dash against the rocks around Charybdis, and hiss and foam, tossed hither and thither, are they who oppose sophistical and false reasoning to the evidence of the senses."

SECTION V.

HARVEY DISCUSSES THE CAUSE OF THE HEART'S ACTION AND MOTION OF THE BLOOD.

It is only in this Second Disquisition to Riolan that Harvey redeems the promise he makes in his first work to speak of the Cause of the motion of the Heart and Blood. The systolic action of the heart we know to be the moving power in his system; but then what causes the systolic action of the heart? Harvey is less happy in his attempt at explanation here than he always shows himself in the sphere of observation and inductive reasoning. He even falls under the influence of the old physiology, from the shackles of which he generally appears so free. But it is not for long; he speedily sweeps away the hypothetical cobwebs that have threatened for a moment to entangle him.

Here, however, it is that Harvey proceeds to say that "the blood, collected in the vena cava at the base of the heart, increasing in temperature through the intrinsic heat of the organ and becoming attenuated, swells and expands like bodies in a state of fermenta-

tion ; the effect of which is, that the auricle, becoming distended, and then contracting in virtue of its pulsific power, delivers its charge to the right ventricle." In the original Exercise there is not a word of the blood getting attenuated and swelling like dough in a baking trough. But the lapse is only momentary ; recovering himself immediately, Harvey gainsays what he has but just said, and declares that "he does not agree with the opinions commonly entertained on the Virtues and Causes of the Motions of the Heart ; he does not believe that the blood has its powers, properties, heat and motion as gifts of the heart. The cause of the diastole, he says, is not the same as that of the systole ; and the diastole, which necessarily precedes the systole, is not due to the presence in the blood of anything "of a vaporous or aereal nature." Neither does he think that the act is connected with any external agency, but is owing to "an internal principle under the control of nature!"

This is vague enough, truly, and the great observer, the inductive reasoner on the ground of fact, shows that he is now groping in the dark, and leaves us to attach any meaning we please to his words. Referring to the honourable mention Descartes has made of him—and it may be that it is what Descartes has said "on the swelling of some fluids when they fall drop by drop on a hot plate" which has led him now to speak as he does—but criticizing the conclusions of the philosopher on the diastole and systole of the heart, Harvey

objects to the diastole being taken as significant of a state of activity, when it is really one of passiveness. Neither auricles nor ventricles expand like bellows by any inherent dilating power of their own; but being soft and flexible they are filled by the blood flowing into them from the veins with which they are in communication, in the same way precisely as the fingers of a glove are distended when it is blown into by the mouth—the illustration he had originally adduced. Harvey, therefore, abandons what he had said on the puffing up of the blood as the initiatory cause of the auricular and ventricular diastole.

But the problem started—the cause of the heart's action, and so of the blood's motion, is of the rarest interest, and physiologically of the last importance. It will not be put aside without further effort to find its solution. Harvey, therefore, proceeds to say: "The heart is by no means to be thought of as a kind of chauffer or kettle communicating heat to the blood contained within it. Instead of receiving heat, the blood rather communicates heat to the heart, as it does to all parts of the body; for the blood is truly the hottest element in the body; the heart itself being furnished with the coronary artery and vein to the end that it may have warmth imparted to it. The native or innate heat I therefore regard as the common instrument of every function—as prime cause of the pulse (*i.e.* of the heart's systole) among the number." Somewhat alarmed by the definiteness of this con-

clusion, we might imagine, he immediately adds apologetically: "But this I do not mean to state absolutely; I only propose it by way of thesis;" and it is in connection with the subject now before us, that we have Harvey, by-and-by, advancing the proposition that "the heat of the blood is engendered by the influence of the air:" "The soul, the life, the power to assume independent existence is acquired by the fœtus when it begins to breathe," says Servetus: "It is as if heat were enkindled within the fœtus by the influence of the air," says Harvey.[1]

Harvey's predecessors, then, had the innate heat as an important agent in the animal economy; but to them, even with the hint given by Servetus as to its possible source, it was not heat simply, a constituent of the blood and bodily functions, as it is to Harvey; it was a hypothetical entity apart from the organism, a vital principle, a something *in* rather than *of* the blood.

In his assumption of heat as the moving power in the animal organism, Harvey, therefore, again meets us as the Seer; for although neither he nor his age knew aught of the correlation and conservation through mutual convertibility of the imponderables or great cosmic forces, he is still prophetic of the future. Acknowledging as many now do that the Sun through its heat transformed to motion is the power that impels the Planets in their orbits and gives so many of their

[1] "On Generation," p. 530 of English translation.

states and properties to the things of the inorganic world, we are ever more assuredly referred to the same great centre as efficient cause of the phenomena we witness in the world of organization. That which is the source of Motion in the Universe, we need not hesitate to acknowledge as the source of motion in each and all of its individual parts; for our modern philosophy recognises none but general, eternal, all-pervading Laws.

Heat passing from a hotter to a colder medium, then, is transmuted into mechanical effect or work in the world of brute matter; into vital effect or work in the world of matter organized. With the heat of the sun stored in the fuel consumed by the steam engine turned into motion, we have the hundreds or thousands of foot-pounds of available power set free, with transference in space at an approach to planetary speed. With the heat of the sun the air of the atmosphere and the mineral contents of the soil arrested by plants, we have the wonderful evolution of life in union with organic structure and unconscious sensibility; and, with the same great force stored in the food appropriated by animals, represented by the blood and tissues of their bodies, consumed and turned into motion, we attain at length to Muscular Contractility, Glandular Secretion, Conscious Sensibility, Moral Emotion and Understanding. Life in the aggregate then meets us in its highest manifestation—man—as motion due to the action of oxygenated blood

upon the elementary tissues of which the organism is composed, ceaseless consumption of itself and of these being implied. Hence the necessity of ever fresh supplies of fuel to the engine, of food to the animal; the fuel appearing as mechanical motion in the one, the food as vital motion in the other.

It may scarcely be necessary to speak of the conditions indispensable to such transmutation of the initiatory heat-force. Suffice it to say that the heat must disappear if motion is to appear. The high-pressure engine would stand still in an atmosphere of its own temperature; the condensing engine would not give a stroke without its cold chamber. There could then be no conversion of heat into mechanical motion. In the same way precisely, the animal body, in an atmosphere in which it could lose no heat, would necessarily suffer arrest of all motion, or die.

In speaking thus of heat as the cause of vital motion, I would beg to be understood as meaning to say, that I believe it to be the immediate agent in the phenomena we witness in animal bodies. How it is so, how it came to be so, we do not know. But we can say with Harvey, speaking of generation, that "he who derives it from the same Eternal and Omnipotent Deity, on whose nod the Universe itself depends, takes the right and pious view of the matter. Nor do I think," he continues, "that we are greatly to dispute about the name by which this First Agent is to be called—whether it be God, Nature, or the Soul

of the Universe—all still intend by it that which is the beginning and the end of all things; which exists from Eternity, which is Author or Creator, is Omnipresent, and not less in the single and several operations of natural things than in the infinite Universe." In so far as sensible phenomena help to a conclusion we might perhaps be emboldened to say that the immediate cause of the heart's contraction is the contact of the blood poured into it with the diastole. Thus an animal killed by decapitation and having the chest laid open, the heart is seen pulsing feebly for a few seconds, and then ceasing whilst the animal is held erect. But the body being inclined and the blood contained in the veins of the abdomen and lower extremities made to flow to the heart, its action is immediately restored, and continued until the supply of blood is exhausted.

SECTION VI.

TRANSFUSION OF THE BLOOD FROM ARTERIES TO VEINS, AND THE IMBIBING POWER OF THE VEINS.

In speaking thus of the cause of the motion of the heart, the doctrine of the circulation would nevertheless not be complete. That there must be ceaseless transfusion of blood from arteries to veins, Harvey demonstrated to be a physical necessity; but, as we

have seen, he did not know precisely how it was accomplished, and he certainly erred when he affirmed that it was not by continuity of canal between the two orders of vessels, as shown by Malpighi, who had the good fortune first to see the capillary arteries pouring their tide into the capillary veins, and these in turn transferring it to the venous trunks.

But even with the addition of this important fact, all is not yet complete. The arteries are canals bringing supplies of nourishment to the tissues, and the veins conduits carrying back so much of the vitalizing fluid as is not wanted for their growth and maintenance. Still within the vessels, however, the tissues can have no advantage from the nutriment they contain. The matured, most perfect portion of the blood—the *plasma*—must transude the walls of the arteries and bathe the tissues immediately before they can select from it the elements they require for their growth, nutrition, repair, secreting faculty, or vital endowment. Such transudation, we must presume, is readily effected by the force of the heart putting the coats of the arteries on the stretch. Then does the finer portion of the blood transude the walls of the arteries, and bone, muscle, skin, glandular parenchyma, nerve and brain select that which each requires for the maintenance of its structure and the performance of its function ; the heat, engendered by the molecular and chemical changes that now take place in the blood and tissues, being at the same instant dissipated

and turned into motion, with the marvellous results briefly hinted at above.

Nor are all the processes dependent on the access of arterial blood yet accomplished. The plasma, the vitalizing pabulum of the organism, has been presented immediately to the parts, and they have appropriated so much of it as they require for their maintenance and their functions; but so much as was not required for these, and the molecules that have been replaced by the fresher matter appropriated, have to be removed, and either renovated by the action of the air in the breathing apparatus, or thrown out of the system in the shape of carbonic acid by the lungs, of bile by the liver, and of urea by the kidneys.

The question that now presents itself is, therefore, this: How is the plasma shed from the arteries, having done its office and replete with sordes, to get back into the current of the circulation? By the absorbing faculty of the veins, is the answer ready at hand. But in virtue of what do the veins acquire the absorbing power they possess in such perfection? Secretion by cell-formation, as we know the process to go on in glands, would enable them to attract with every requisite degree of rapidity the fluids effused into the tissues amid which they run. But the veins are not secreting vessels; they have not the cell-elements of glands in their structure; they are mere membranous canals for returning to its source the blood that has been sent from the heart by the arteries. Like animal

membranes in general, however, with the requisite conditions in presence, the veins are well disposed to imbibe; the one condition necessary to this end being that their contents shall in some trifling degree be more dense than the fluids which bathe the tissues around them. Now among other elements of the complex animal organism, is the system of minute but ever active sweat glands embedded in the skin, the sole function of which appears by the latest researches to be to secrete, and by tiny ducts that end on the surface to pour out, pure water. The fluid thrown off by the sweat glands actually consists of nothing but water, the 0·5 to 1, 2, or 3 per cent. of saline and sebaceous matter, mingled with epithelial scales, being mere accidental ingredients easily traced to their sources. In the ratio, however, in which the blood sent to the sweat glands loses water, is the current that leaves them more dense than it was in the arteries which supplied them, and with the loss of so much water comes the absorbing faculty of the veins.

In the sweat glands, then, I believe, we have an apparatus whose special function it is to secure the conditions necessary to the ceaseless interchange of the elements or materials without which life could not be continued. Without a provision of the kind we discover in the sweat glands, absorption by heterogeneous attraction of the fluid shed from the arteries for the nutrition of the body, could not when spent find its way back into the veins, so that vital

action of every kind would necessarily cease—if indeed, in the higher organisms, it could ever have begun.[1]

But the action of the sudoriparous glands we must presume can only extend to the veins of the more superficial parts of the body. The veins of the deeper lying parts also require a power of the like kind; and this I find supplied them by the widely distributed system of lymphatic vessels. These possess in themselves the proper elementary structure of secreting glands: they are tubes with the power of cell-formation in their interior,—the power in virtue of which they secrete lymph, the fluid appropriate to them. The lymphatic vessels do not in fact differ in essential constitution from the tubuli of the kidney, testis, salivary or milk glands; but their function being required over extensive areas, it is only here and there, as in the mesenteric and conglobate glands, that they are found coiled and packed together in masses, with a special parenchyma interposed. Elsewhere they run in single strands amid the deeper structures, commmencing in *cul de sacs*, and canals everywhere of about the same calibre, never in minute capillaries in the way the arteries end and the veins begin. Secreting a fluid specifically lighter than venous blood —for the lymph, like the sweat, consists of from ninety-four to ninety-eight, or more, per cent. of pure

[1] See the writer's work on "The Sudoriparous and Lymphatic Glandular Systems," published in 1868, re-issued (Williams and Norgate) in 1877.

water, they give the deeper veins, in virtue of the condensation effected in the blood within them, the faculty of imbibition which they possess in so eminent a degree.

In the work above referred to (p. 41) I ventured to surmise from the singular amount of disturbance that ensues in the system generally upon any implication of the serous membranes, that they supplied means for a large extension of the lymphatic vessels. And the most recent histological inquiries do in fact show the serous membranes of the body to be elements in the lymphatic system. Paved on their free aspects by a layer of flattened nucleated cells, every here and there, between the junctions of these, certain *stomata* are observed, analogous I apprehend in all respects to those of the intestinal villi. As in the villi, these stomata are surrounded by rings of minute cubical cells, which lead either directly or by short canals into underlying lymphatic vessels, lined with cells of the same description as those characteristic of the lymphatic vessels in other parts of the body. The stomata in question are in truth nothing less than commencements of lymphatic vessels, not pouring out, but secreting inwards.

In accomplishing the processes which constitute animal life, we have, therefore, two great factors at work. First—the transmutation of heat-force into life-force by simple dissipation effected through the

colder medium by which the organism is surrounded; the excessive influence of this being guarded against by clothing, its approximate insufficiency (within narrow limits unhappily when most required) by evaporation from the surface. Second—the molecular and chemical changes wrought in the tissues by their ceaseless composition and decomposition through contact with the plasma of oxygenated blood, the removal of this, when spent, being effected by the absorbing power of the veins, acquired, as I maintain, by the agency of the sudoriparous and lymphatic systems of glands. We then see these hitherto enigmatical systems brought into intimate relationship with the ultimate act of the animal organism—the conservation of its tissues with their inherent special powers; and farther, understand the more immediately fatal, or more remotely serious, consequences that ensue from disturbance or destruction of their functions,—of that of the skin especially, whether it be from chill or excessive heat, from scalding, covering the body with an impervious varnish, gilding or applying matters that act chemically upon it. More than this, and of greater importance because of the wider application of the principles involved, we are at no loss to divine the cause of the unhealthiness of so many intertropical countries, where the mean temperature ranges between eighty and ninety, and the day temperature mounts to ninety-six or ninety-seven degrees Fahr., the atmosphere being at the same time all but saturated

with moisture. Man is then on the verge of circumstances in which by his nature he cannot live. In an atmosphere of his own temperature at saturation point, he must necessarily die ; for there were then no transmutation of heat-force into motion or life-force, and no molecular interchanges effected by the contact of oxygenated blood with organic tissue.[1]

Having disposed of Riolan's Encheiridion in his two disquisitions, and illustrated and confirmed his own views by many additional arguments, observations, and experiments, Harvey, in the few words in which he speaks of his "Medical Observations," gives us a glimpse of what we lost when his papers were destroyed by the mob, in the early part of what is called the Rebellion. "In my Medical Anatomy," he says, "from the many dissections I have made of the bodies of persons worn out by serious and strange diseases, I mean to relate how and in what way the internal organs were changed in size, situation, structure, figure, consistency and other sensible qualities from their natural characters and appearances, and to what various and remarkable affections they led. For even

[1] See my work quoted above, p. 59.

Were it within the scope of my work to go farther into physiological and pathological matters, thus brought briefly into the foreground, I should feel it my duty, as it would be my pleasure, to refer particularly to the exhaustive work of Dr. J. Bell Pettigrew, "The Physiology of the Circulation of the Blood," &c. (8vo., Edinb., 1876), and to discuss the subject of malaria and its influence ; I beg, however, to refer again to my *brochure* on the sweat-glands and lymphatic vessels, p. 51, et seq.

as the dissection of healthy and well-constituted bodies contributes essentially to the advancement of philosophy and sound physiology, so does the inspection of diseased and cachectic subjects powerfully assist philosophical pathology." This was precisely the course which Morgagni followed and happily lived in some considerable measure to achieve; it is that also which it has been the business of modern pathology, through the illustrious line of the Baillies, Laennecs, Andrals, Louis, Cruveilhiers, Carswells, Richard Brights, Riolans, Rokitanskys, and many others, to render ever more and more complete.

Returning to our history, we find that Riolan did not fail to reply to Harvey;[1] but without adducing a single fact calculated either to put himself in the right, or to prove his critic in the wrong. He even misunderstands Harvey at times; and shows himself nettled at the present which the English anatomist makes him of a "Third Circulation"—that, namely, through the heart, in addition to the two he has himself imagined. "This third circulation," says Riolan, "is an absurdity; for the vessels of the heart draw blood from the larger circulating vessels beyond or near the organ; consequently, not from its ventricles; so that there can be no third circulation, nothing being taken from the heart or returned to it." But whence, we may

[1] Responsio ad duas exercitationes anatomicas postremas Gulielmi Harvei de Circulatione Sanguinis. Paris, 1649. And in Opusc. Anat. Paris, 1652.

ask, comes the coronary artery, and whither tends the coronary vein? The circulation through the heart, adduced by Harvey, is in fact an epitome in little of the circulation through the body in great.

Riolan's doctrine of the circulation scarcely found a single abettor and never bore fruit. It stood a barren ear amidst the lusty harvest that soon sprang up and overspread the lands from the seed sown by Harvey. Riolan, nevertheless, turning his unbelief of the truth into a faith, went on teaching his untenable doctrine to the end of his days; but so completely had physiological opinion changed ere long, that the Administration interposed, with a view to give what had come to be seen as the truth a chance of being heard, and inaugurated a second Chair of Anatomy at the Jardin du Roi. The occupant of this was Pierre Dionis,[1] a distinguished surgeon and accoucheur as well as an able anatomist. A younger man than Riolan, and committed to no theory of his own on the motion of the blood, but open to the truth and free to own his convictions, Dionis proceeded forthwith, to the delight of the students who flocked to his lectures, to teach anatomy in conformity with the new doctrine of the Harveian Circulation.

[1] Anatomie de l'homme suivant la Circulation du Sang et les Nouvelles Découvértes. Paris, 1690. 8vo.

SECTION VII.

HARVEY'S VIEWS BEGIN TO BE GENERALLY ACCEPTED—DE BACK, SCHLEGEL, WALÆUS, PECQUET, BARTHOLIN, LICETUS.

HARVEY must now, indeed, have seen his views assured of general reception at no distant date. In the course of the same year in which he himself answered Riolan, Dr. de Back, of Amsterdam, published his work on the Heart,[1] which is written entirely in harmony with the Harveian principles, and Riverius, Professor of Medicine in the University of Montpellier, publicly defended and taught the circulation of the blood.[2] The following year, Paul Marquard Schlegel, of Hamburg, produced his commentary on the Motion of the Blood,[3] in which he addresses himself particularly to a refutation of Riolanus, whose scholar he had been, and at the same time shows himself so thoroughly at home in the general question, that he is able to throw further confirmatory light on many of its elements by new and ingenious experiments and considerations.

Harvey must have been pleased with Schlegel's work, which is indeed a most able and exhaustive

[1] De Corde. Amst., 1649. In English, 12mo. Lond., 1653.

[2] A candour for which he was by and by summoned by an adherent of the old school to resign his chair!

[3] De Sanguinis Motu Commentarius. 4to. Hamb., 1650.

criticism of the whole subject of the circulation; for he by and by sends the German author a copy of his own book "On Generation," with an admirable letter, which has happily been preserved.

Another writer who had great influence in spreading a knowledge of Harvey's views was Jo. Walæus,[1] Professor of Leyden. After having ventilated the subject through the inaugural dissertation of Roger Drake, of which mention has already been made, he came forth in his own name in two excellent epistles addressed to Thos. Bartholin. In these he gives his assent almost without reservation to everything Harvey has advanced; and his letters, calling others into the field, particularly his correspondent Bartholin, and Fortunius Licetus, of Bologna,[2] a copious letter writer, who went at great length into the question, North and South were amply supplied with information on the new and important discovery of the great English anatomist.

The students of 1628 and 1630, although educated in unbelief of the circulation, had, by this time come into possession of some of the professorial chairs; and, truth being ever victorious in the end, the young professors, having escaped from leading-strings and made enquiry for themselves, were now proclaiming the better faith through greater knowledge that had sprung up within them. Harvey had himself received the

[1] Epistolæ duæ de Motu Sanguinis et Chyli ad Thom. Bartholinum. 12mo. Leid., 1652.

[2] De Quæsitis per Epistolas a claris Viris responsa, Fortunio Liceto Authore. Part. vii. Bonon. et Utin., 1640–50.

seeds of his discovery in Italy; but she was slow to recognize him whom she had so powerfully contributed to form, as she has of late been the most forward of all in her mistaken attempts to rob him of his title of Discoverer. It was not, in fact, until 1651, that Harvey's views were in any way recognized beyond the Alps, when Trullius, a Roman professor, expounded and taught them, much about the same time as Pecquet of Dieppe,[1] Bartholin of Copenhagen,[2] and Walæus of Leyden,[3] men of original mind, of learning and research, gave in their adhesion to the new doctrine, and spread it far and wide by their teaching and writings. The victory of the circulation may be said to have been finally won when Plempius, of Louvain, the old antagonist of Descartes on the subject, retracted all he had formerly written against it, convinced of its truth, as he so candidly informs us, by the very pains he took to satisfy himself of its erroneousness, and publicly proclaimed his conversion: "Primum mihi hoc inventum non placuit," says the worthy Plempius—"This discovery did not please me at all at first, as I publicly testified both by word of mouth and in my writings; but by and by, when I gave myself up with firmer purpose to refute and expose it, lo! I refute and expose myself, so convincing, not to say merely persuasive, are the arguments of

[1] Experimenta nova Anatomica, sup. citat.

[2] Anatomia ex Casp. Bartholini Parent. Institutt. ad Sanguinis Circulationem tertium Reformata. 8vo. Leid., 1651.

[3] Epistolæ duæ, sup. citat.

the author : I examine the whole thing anew and with greater care, and having at length made the dissection of a few live dogs, I find that all his statements are most true." [1]

From the first promulgation of the doctrine of the circulation, thus far its progress towards ultimate general acceptance can scarcely be said to have been interrupted for a moment. The hostility of the Primeroses and Parisanuses and Riolans never interfered with it in fact ; the more candid spirits were rather led to make inquiry by the lucubrations of these weak and inconsistent opponents, who all, in the catastrophe of their discomfiture, hastened the triumph of the truth. If men's minds were ever in danger of being led astray, it was only for an instant, and not so much through the opposition of enemies, as by an erroneous generalization, which a short interval of time sufficed to correct. Cæcilius Folius, a young physician of Venice, having met with one of those abnormal instances of pervious foramen ovale in an adult, immediately and without looking farther, jumped to the conclusion that the anomalous structure he had lighted on was natural, and that the blood passed in all cases by the route he proclaimed, from the right to the left side of the heart.

In the inaugural dissertation [2] in which Foli pub-

[1] Plempii Fundamenta Medicinæ, fol., Lovan., 1652, p. 128.

[2] Sanguinis a dextro in sinistrum Cordis Ventriculum defluentis facilis reperta via. Fol. Venet., 1639.

lished the discovery he had made, he shows himself a strenuous defender of the ancients generally—of Galen in particular. "Galen," he says, "knew that the veins anastomosed with the arteries; for it mattered not whether you divided one or other of these vessels, the animal still bled to death." Galen, he therefore concludes, must have known of the circulation, and Harvey in his opinion only revived a piece of knowledge that had fallen into oblivion.[1]

The engravings with which Foli illustrates his work show a small opening in the partition between the two sides of the heart, into which nothing larger than a probe could be passed, and by which, presuming the ventricles to act with like force—*i.e.*, force commensurate with the resistance they have severally to overcome—not a drop of blood could have found its way, whether from right to left or from left to right. Many Italians received with favour the account which Foli gave of his discovery; and the natural philosopher, Gassendi, having about the same period had another instance of the kind which Foli encountered shown to him, concurred with this writer in his views, and by a variety of arguments and objections, strove to damage, and did temporarily damage, the Harveian doctrine.[2] But this was only for a brief season;

[1] "*Quam quidem sententiam de sanguinis circulatione, oblivioni traditam, disputationi revocavit Gullielmus Herveus, vir sane perspicaci ingenio summoque virtute præditus.*" (Fol. 8*b*.)

[2] Gassendi, De Septo Cordis pervio, which will be found published in a collection by Severinus Pinæus. 12mo. Leid., 1640.

for Domenic de Marchettis[1] by-and-by showed that Foli had mistaken an extremely rare occurrence for a general fact; and that if the foramen ovale, pervious, might afford a passage from the right to the left side of the heart in one case, closed, it would suffer no such transit in thousands of other instances. Gassendi, moreover, by getting still more out of his depth, soon afterwards showed that familiarity with general physics did not imply any sufficient knowledge of anatomy, nor give the power of reasoning sagely on subjects of special physiology; so that in his eagerness to assail Harvey he did injury in the end only to his own reputation. In short, Harvey in his lifetime had the high satisfaction of seeing his discovery generally received, and inculcated as a canon in most of the medical schools of Europe. He is, therefore, one of the few—his friend Thomas Hobbes says, he was the only one within his knowledge—"Solus quod sciam,"[2] who lived to see the new doctrine which he had promulgated victorious over opposition and established in public opinion.

[1] D. de Marchettis, Anatomia. 8vo. Padova, 1652.
[2] Elementa Philosophiæ. Proemium.

SECTION VIII.

USE OF HARVEY'S DISCOVERY: FONTENELLE.

We have had Harvey, when forced with evident reluctance to allude to the *good* that might accrue from his discovery, speaking of the flood of light that poured in upon him through its means; but this subject, lying outside of that on which he was immediately engaged, he contents himself by referring to his Medical Observations for its particular consideration, and concludes in these words: "I shall always be ready to listen to whatever is objected to me by good and learned men—nay, I shall even be grateful to any one who will take up and discuss the subjects that have engaged me."

With what has been added by the present writer on some of these—on the cause of the heart's motion, on the transmutation of heat-force into life-force, following the physicists of the day, and on the essentially vital function of the sudoriparous and lymphatic systems of glands from himself, he ventures to believe that many physiological and pathological phenomena yet unexplained, may be satisfactorily interpreted; whilst hygienic principles are suggested, the importance and far-reaching significance of which cannot be over-

estimated. Let us, therefore, yield in nowise to the suggestion which Monsieur Fontenelle, one of the lively writers of the last century, puts into the mouth of Erasistratus in his Dialogues des Morts,[1] viz., that the discovery of the circulation of the blood will have no influence on the rate of human mortality. Let us rather maintain that, as it is the foundation on which the Physics of animal life in its higher manifestations repose, so is it also the starting-point from which advances may be made adequate not only to take from the adverse influences to which life is exposed, but greatly to enlarge the sphere of those which tend to its conservation, in the forefront of

[1] "ERAS. You do indeed tell me strange things! What! the blood circulates in the body?—the veins bring it to the heart from the extremities, and from the heart it enters the arteries to proceed to the extremities, from which it returns by the veins as before?

"HARV. I have shown that such is the fact by so many experiments that no one now doubts it.

"ERAS. We were all in the wrong, then, long ago; but I suppose you think your discovery very useful?

"HARV. Certainly, I do.

"ERAS. Tell me, then, how it comes that we see so many dead men joining us here below every day?

"HARV. Oh! if they die, that is their affair; it is no fault of the doctors.

"ERAS. But the circulation of the blood—those conduits, those reservoirs, and all you know about them, do not serve to keep folks alive?

"HARV. We have not yet, perhaps, had time to know all the uses the discovery may be put to; we shall learn more by and by.

"ERAS. Take my word for it, there will be no change.

"HARV. Yet it would be singular if, in knowing the nature of man better, we did not also learn to cure diseases better.

"ERAS. Very good; but for my part, I fancy that the discovery of a new conduit in the animal body or a new star in the sky is of much the same importance in so far as the life of man is concerned. Make what discoveries in anatomy you may, men will go on dying all the same."

which stands the maintenance of the bodily health, not to be understood in all its elements, in all its dependencies, without the most perfect knowledge of every organ and function that constitute the complex Organisms of which Life is at once both Cause and Effect, in connection with the cosmical agencies amid which they exist.

SECTION IX.

THE LACTEAL VESSELS. ASELLI. PECQUET.

THERE is an important element in the vascular system, though it has no immediate part in the circulation of the blood, that must not be passed without notice by us — all the more as Harvey's failure to recognize its significance and real importance has afforded his detractors an opportunity to call his character for candour and liberality into question. This is the system of lacteal vessels, with the discovery of which Aselli, as having been the first to describe them particularly, is fairly enough credited, although its trunk at all events had been already spoken of by Bartholomæus Eustachius, and others.

Aselli, Professor in the University of Bologna, was born at Cremona in 1580, and died in 1626, when no more than forty-six years of age. We learn from himself that he discovered the lacteal veins accidentally,

whilst dissecting the body of a dog to show some friends the course of the recurrent nerve in 1622, although the important fact was not made publicly known until five years afterwards.[1] When Aselli saw the lacteals first, he took them for nerves; and it was only on puncturing one of them, and seeing the milky fluid which escaped, that he discovered them to be vessels. Aselli, however, failed to follow them through the mesenteric glands—called pancreas Aselli—to their true terminations, in a common duct. Prepossessed by the idea of the liver as the organ of the hæmapoesis, he represents them erroneously in the wood-cuts with which his work is illustrated, as ending on the concave aspect of the great abdominal viscus; the vessels depicted being probably lymphatics running from the liver, not lacteals proceeding to it.

There could be no question about the existence of the new order of vessels on the intestines and mesentery of the dog and other inferior animals; but were

[1] In his work entitled De Lactibus seu venis lacteis, quarto vasorum mesaraicorum genere novo invento, Dissertatio, cum figuris. Mediolani, 1627, 4to. The work, published posthumously, besides the figures printed in colours, is illustrated by a fine engraved portrait of the author. His discovery was very speedily generally known, however, this being greatly due to the liberality of Claude Nicolas de Peiresc, one of the better samples of the great French *seigneurs* of the old *regime*. Interested in science and delighting in the converse of learned men, Peiresc appears to have entertained the natural philosopher Gassendi in his castle. Informed by Gassendi of the publication of Aselli's work, Peiresc forthwith ordered a number of copies, which he presented in quarters where he believed the new truth announced would receive the attention it deserved.

they also elements in the anatomy of man? Aselli had doubtless looked for them and missed them in the bodies of those who had died of ordinary disease, and he could not well have a living subject for examination, although temptation of the kind used to be thrown in the way of the old anatomists. We have no intimation, however, that Aselli ever thought of satisfying his scientific curiosity by dissecting a man alive; but he provided an unhappy wretch condemned to death, with a hearty meal a few hours before his execution, and on laying open the abdomen soon after this, the milk white veins were immediately conspicuous upon the bowels and mesentery, a quantity of their contents being farther collected for examination, to the great satisfaction of himself and friends.[1] Thus far and no further did the discovery of the lacteals go in the hands of Aselli; its completion was reserved for the greater perseverance and higher anatomical skill of Pecquet, the anatomist who followed Aselli in the investigation of the newly discovered system of vessels.

J. Pecquet of Dieppe, an accomplished physician and skilful surgeon, was the first French writer of note who accepted the circulation of the blood without reserve, and made himself honourably known to the world at large as demonstrator of the course and termination of the lacteal vessels and thoracic duct. Aselli, as we have seen, observed the lacteals on the intestines and

[1] Gassendi, in Vita Peirescii, p. 283.

mesentery, and, erroneously, made them end in the liver. Pecquet traced them from the intestines to the mesenteric glands, and from these into a common sac or reservoir which he designated receptaculum chyli, from whence he lost them not again from sight, until, united into a single slender conduit, he saw it terminate at the point of the junction between the jugular and subclavian veins.

Pecquet of Dieppe and Schlegel of Hamburg were in truth the two anatomists who entered most fully into the spirit of the great Harveian discovery. They would prove it for themselves and make trial of the principles it proclaimed. Hence their honourable position, the one—he of Hamburg—as the accomplished expositor and illustrator of Harvey's doctrine of the circulation; the other—he of Dieppe—as discoverer of an important anatomical fact, and the first to apply one of the great principles involved in the Harveian induction. "Having exposed the artery and accompanying vein in the leg of a dog," says Pecquet, "and punctured the vein, blood of course immediately followed; but tightening the ligature that had been passed round the artery, lo! the stream from the vein ceased forthwith. Slackening the ligature, however, again it burst forth as before. . . . Now if the blood flows outwards only by the arteries, did we tie the vessel which supplies a limb about to be amputated, the operation might be performed without loss of blood. No sooner imagined than put to the proof. I tie the

crural artery of the dog, avoiding the vein, and amputate the member a little beyond the ligature. Only a few drops of blood escaped from the divided veins; but there was no hemorrhage." [1]

SECTION X.

ENVY AND DETRACTION FOLLOW THE DISCOVERER.

HARVEY'S views, then, were admitted; the circulation of the blood, through the action of the heart, was acknowledged as an established fact; but envy and detraction followed in the wake of recognition. The circulation of the blood as announced, it was said, was undeniable, but the merit of arriving at it was little—the way having been amply prepared for the conclusions finally attained; the fact was of no great moment in itself; and the discovery none of Harvey's making.

Let us look as impartially as we may at each of these statements.

[1] Experimenta nova Anatomica. Accedit de motu Sanguinis Dissertatio. Paris, 1641, p. 28 et seq. Dr. Morison, of Paris, a correspondent of Harvey, must have sent him Pecquet's book, the perusal of which, he says, has given him much pleasure. He greatly commends the author "for his assiduity in dissection, for his ingenuity in contriving new experiments, and for the shrewdness he evinces in the remarks he makes upon them." "With what labour do we attain to the hidden things of truth, when we take the averments of our senses as the guide which God has given us for attaining to a knowledge of his works!" ("Correspondence of Harvey," English version of Works, pp. 595 et seq.)

They who deny the originality of Harvey's induction, all but invariably confound a motion of the blood in the arteries and veins, with the idea of its continuous motion in a circle throughout the body. We have seen, however, that even from the most ancient times and by common consent, a certain motion of the blood—generally of a to-and-fro kind—had been recognized. It is as old as Aristotle, Hippocrates, and Galen, at all events; and is referred to in various passages of their works by unprofessional writers—by the great observer of his own age in particular, the depository of the popular science of all preceding ages—Shakspeare. Brutus, addressing Portia, says:

> "You are my true and honourable wife,
> As dear to me as are the ruddy drops
> That visit my sad heart;"

language not more touching and beautiful than physiologically correct. And again, with more of involution and ellipsis, yet with a meaning that is unmistakable, Warwick, by the bedside of the murdered Gloster, proceeds,—

> "See how the blood is settled in his face!
> —Oft have I seen a timely-parted ghost,
> Of ashy semblance, meagre, pale, and bloodless,
> —Being all descended to the labouring heart,
> Who, in the conflict that he holds with death,
> Attracts the same for aidance 'gainst the enemy;
> Which with the heart there cools, and ne'er returneth
> To blush and beautify the cheek again—
> —But see, his face is black and full of blood," &c.

These passages have actually been cited, to prove that Shakspeare was not unacquainted with the circu-

lation; and there have not been wanting some[1] who have even argued that Shakspeare had his knowledge direct from the fountain-head—from Harvey himself, with whom, for several years at least, he was contemporaneous.[2]

The passages quoted above are referred to all the more willingly, from their having preceded the teaching of Harvey by a few years only; but Shakspeare doubtless referred to nothing more than the current opinion that the blood was in motion within the heart and vessels, particularly the veins. In ancient times, indeed, we have seen in our general survey that the veins were regarded by anatomists, as by the vulgar they are still esteemed, the principal or proper blood vessels of the body. Until Harvey had taught and written, no one imagined that the florid blood of the arteries had ever been the dark blood of the veins; and Servetus's hint in explanation of that which might cause the change being overlooked, the world had to wait nearly a hundred and twenty years before the suggestion of the gifted Spaniard was demonstrated as a truth. This was happily accomplished at last by

[1] Thomas Nimmo, Esq., of New Amsterdam, Berbice: "On a passage in Shakspeare's Julius Cæsar." "The Shakspeare Society's Papers," vol. ii. p. 109.

[2] Shakspeare died in 1616, the year when Harvey began to lecture at the College of Physicians. "Julius Cæsar," first printed in the folio of 1623, is believed to have been written between 1603 and 1607; but Harvey settled in London in 1604, so that he and Shakspeare may very well have been acquainted—let us hope that they were—but we can quote no authority for saying that they ever met.

Richard Lower, an English physician (born, 1631; died, 1691), no unworthy successor of Harvey himself, whether in the field of practical anatomy or of letters; for he was a zealous anatomist, and his little book on the heart,[1] replete as it is with interesting observations and experiments, is a masterpiece both in matter and manner.

Lower proved irrefragably by experiment that the florid colour of the arterial blood was not due to any influence exerted on it by the action of the heart, or the straining it suffered in the lungs. Opening the chest of a live dog, he showed first that the blood of the pulmonary artery was as dark as that of the vena cava; and, when the windpipe was tied, that the flow from a branch of the aorta was no longer crimson, but dark as that which fed it. On releasing the trachea, however, or blowing up the lungs with bellows, the crimson colour immediately returned. The florid hue, was, therefore, due to the air of the atmosphere inspired.[2]

Had Lower's work been better known, there needed to have been no subsequent discussion as to the fact whether the heart possessed nerves or not, for they

[1] Tractatus de Corde; item de Motu et colore Sanguinis, et de Chyli in eum transitu. 12mo. Lond., 1669.

[2] "Quare sanguinem, in suo per pulmones transitu, aërem haurire, ejusque admixtioni floridum suum colorem omnino debere maxime veresimile est; postquam autem, in habitu corporis et viscerum parenchymatis, aër rursus à sanguine magna ex parte avolavit atque per poros corporis transpiravit, sanguinem venosum, illo privatum, obscuriorem et nigriorem illice apparere, rationi pariter consentaneum est." (Ib., p. 170.)

are described particularly and even figured, accompanying its arteries and penetrating its muscular substance.

If not the first to suggest the transfusion of blood as a means of saving life jeopardized from hemorrhage, Lower was certainly the first who showed how the thing could be effected, putting it in practice as he did from one dog to another. Altogether Richard Lower was an honour to English anatomy, and his name, connected as it is with the thickening of that part of the right auricle which intervenes between the orifices of the superior and inferior vena cava—the *tuberculum Loweri*, let us hope, will keep it ever green in our memory.

SECTION XI.

WHAT IS DISCOVERY?—WHAT ARE HARVEY'S MERITS AS A DISCOVERER?—DR. WM. HUNTER.

FEW for some ages, and none among ourselves until a relatively recent period, were found blind enough or inconsequent enough to call in question Harvey's merits as a discoverer. But as one man of undeniable eminence in his profession has led the way in doing so in this country, and his example has since been followed by various continental, particularly Italian, writers, it may not be held irrelevant if we look into the matter somewhat particularly.

Discovery is of several, more especially of two kinds : one, sensuous, connected with simple perception ; another, rational or inductive—the former an act of consciousness through an impression made on one or more of the senses ; the latter a conclusion come to by the higher powers of the understanding dealing with data acquired through the senses. We look through a telescope, for example, and see a star which no one else had seen before ; we note the fact, proclaim it to the world, and so become the discoverers of a new star. The merit here is not surely of the highest order, though the added fact may be highly important.

One of the planets, again,—Uranus, the outermost of those known at the time, is subject to such perturbations in its orbit, that, to compose exact tables of its whereabouts at particular moments is found impossible. These perturbations are referable to none of the known perturbing causes. Two distinguished astronomers and mathematicians, acting simultaneously but independently, on a hint thrown out by a gifted woman—Mary Somerville, presume the influence of an exterior but unknown perturbing cause—another planet, perchance, with an orbit outside the orbits of all the known planets, and make trial of the suggestion.

Assuming the ascertained perturbations as elements, they combine these under the guidance of knowledge and reason, and after long and laborious calculations, say at length : If the cause suggested be well founded,

there or thereabouts must it exist; and lo! on turning the far-seeing tube to the point in space that had been indicated, there, in verity, gleams a new world, then first seen of man though launched from some incalculably remote epoch in eternity to circle on the verge of the system whereof the sun is centre, and they who bade us look are hailed as discoverers in the highest sense of the word. Who will venture to dispute the merit here? Truly man does show the divinity within him when he uses his faculties—God-like in themselves—in such God-like fashion. But Harvey's merit, to our mind, is of the self-same kind in another sphere. The facts he used were generally known to his predecessors for a century or more, and were referred to every day by teachers and contemporaries. Yet did no one, mastering them in their connection, rising superior to groundless hypotheses and accredited ideas, draw the inference that now meets us as irresistible, until the master-mind of Harvey gave it shape and utterance. To our apprehension, Harvey was as far above his fellows as the eye of poetic intelligence that exultingly absorbs the glories of the starry sky and the green earth is above the mere physical sense that distinguishes light from darkness.

Dr. John Barclay, a fervent admirer of Harvey, whose name he never mentioned without the epithet *immortal*, has put the question of Harvey's merit both happily and eloquently; and it gives me pleasure after

sixty years since I heard it spoken, to quote the passage from the writings of my old master in anatomy. "The late Dr. Hunter," says Dr. Barclay,[1] "has rather invidiously introduced Harvey along with Copernicus and Columbus, to show that his merit as a discoverer was comparatively low. But what did Copernicus and what did Columbus? Not in possession of more numerous facts than their contemporaries, but endowed with nobler and more vigorous intellects, the one developed the intricate system of the heavenly bodies, and the other discovered an unheard of Continent. And was it not in the same way, by the exertion of superior intellect, that Harvey made his immortal discovery? I know not what has happened in the world unseen; but if I may judge from the records of history and the annals of fame, the spirit of Bacon, the spirits of Columbus, Copernicus and Newton have been rejoiced to welcome and associate with the kindred spirit of Harvey."

Let us look a little more particularly at what Dr. Wm. Hunter has to say on the subject of merit in discovery, and try his conclusions by the test of rational criticism.

The three great discoveries of modern times, says Dr. Hunter, were the Western Hemisphere by Columbus, the Constitution of the Solar System by Copernicus, and the Circulation of the Blood by Harvey. But to these the like degree of honour, he

[1] "On the Arteries," Introduction, p. ix.

thinks, does not attach; the discovery of Columbus standing in his opinion, in the first rank, that of Copernicus in the second, and that of Harvey, which he says, "must rank comparatively low," in the third. This estimate is open to challenge; and asks it all the more as Hunter shows himself animated by something like hostility to Harvey, and is inconsistent in what he says of him at one time with what he says at another. With the spirit of depreciation dominant, Dr. Hunter proceeds: "None of Harvey's writings show him to have been a man of uncommon abilities;" but then the sense of Harvey's true greatness, prevailing, he uses these words: "Harvey, as appears by his writings, was certainly a first-rate genius for sagacity and application, and his name is deservedly immortal." (!) Where he acquired most honour, however, Dr. Hunter is tempted to think that he deserved least. "So much had been discovered by others," Dr. Hunter continues, "that little was left for Harvey but to dress it up into a system. The singular structure of the parts concerned in the circulation so evidently proclaims the fact, that there seems to have been nothing more required than laying aside gross prejudices and considering fairly some obvious truths. It is indeed amazing that this discovery was left for Harvey; seeing that he was near a hundred years after Vesalius and the great anatomists who flourished in so many of the medical schools of Europe. And what is still more astonishing is this: that Servetus

first, and Columbus afterwards, had both given the circulation through the lungs, which we reckon at least three quarters of the discovery; and Cæsalpinus, many years before Harvey, published all that was wanting in Servetus to make the circulation complete. But Providence meant to reserve the honour for Harvey, and would not let men see what was before them, nor understand what they read."

In all this Dr. William Hunter only shows himself not above the mass of ill-informed and vulgar critics of Harvey's merits. What he speaks of as "gross prejudices" were none such to those who entertained them, but sacred truths; and it is only by the light which he himself has from Harvey that he is privileged to see aright all that they saw awry, and to interpret truly what they read amiss. Providence we may be well assured was perfectly indifferent as to who should discover the circulation of the blood; but he who did in the end discover the great truth was surely something other,—greater and nobler, than all the goodly men who had preceded him for thirteen centuries and more. Truly we think he was; and in our estimate of the rank due to the three great discoverers of the modern world, we do not hesitate to place Harvey beside and on the higher level with Copernicus. Their subjects differ in magnitude, in grandeur, indeed; but the mental powers that guided them alike to their conclusions were of the same order, and the character of the data on which their induc-

tions rested was analogous. The great discovery of Columbus, on the contrary, was the product of imagination rather than of understanding, of hypothesis rather than of induction or the exercise of man's noblest attribute—Reason. Harvey's discovery, like that of Copernicus, was of the rational or inductive, therefore of the higher kind, and made in virtue of his superior endowment with intellectual power.

Dr. William Hunter, in his diatribe against Harvey, forgets how irksome and ungrateful is reasoning to the mass of mankind; how much less disposed they are to be quit of their errors than to hug them; and that physiology was one of the lazy-beds on which men laid them down longest contentedly to dream. The world had to wait for its Harvey as well as its Copernicus, Columbus and Luther, before it could be roused to the consciousness that there lay a way before as well as one behind it.

SECTION XII.

HARVEY'S ORIGINALITY. HE QUOTES NO AUTHORITIES.

THERE is yet another matter that requires a passing notice at our hands. Harvey has often been reproached of late with his failure to quote predecessors in the field of discovery which he made so completely his own as, in the minds of his countrymen

at least, to have dwarfed and made unconspicuous all who had gone before him. But the charge is easily met: Harvey had from no one that which he gave to the world as his own. He was not the historian of opinions, but the propounder of a new and unheard-of doctrine. Our teachers do but supply the tools wherewith we work the mine that is within us. Excuses have, therefore, been very unnecessarily offered for Harvey on the score referred to. He may not, it has been said, have read the works of Servetus, Cæsalpinus, and the others from which he has been accused of borrowing without acknowledgment. But Harvey was a highly educated physician, and certainly familiar with everything that had been written on anatomy, from Aristotle and Galen downwards. Why then makes he mention of so few of them in the discussion of his subject? He who reads the Exercises on the Motion of the Heart and Blood will be at no loss for an answer. It was simply because that which he had himself to advance was not in their works. With the exception of the new truth of the pulmonary transit announced by Servetus and made generally known by Columbus, whom Harvey quotes, there is little or nothing on the heart and blood in the writings of his more immediate predecessors that is not in Aristotle, Galen, and Vesalius, or, if not there, that is otherwise than erroneous in fact. But no mind however vigorous, no imagination however fertile, ever worked to purpose that did not borrow

largely from the intellectual stores of bygone times, as well as from those collected by its own experience and observation.[1] And what says Harvey himself? —reply enough, as it seems, to all cavil on the score of his neglect of predecessors. "I had no purpose to swell this treatise into a great volume by quoting the names and opinions of anatomists, or to parade the strength of my memory, the extent of my reading, and the amount of my pains; because I profess both to learn and to teach anatomy from dissections, not from books; from the fabric of nature, not from the dicta of philosophers. I would not, indeed, appear to contend with the ancients for any honours that are theirs, and I do not think it seemly to dispute with the moderns, or to enter into controversy with those who have excelled in anatomy and been my teachers. Striving after truth alone, I give all my labour, all my toil, that I may contribute something that shall be agreeable to the good, profitable to the learned and useful in the literary world."[2]

Harvey, as privileged, uses all that was known to his predecessors from the older writers, but arrogates

[1] Daubeny, "Lecture on Education at Royal Institution, 1855."

[2] "Non ex libris sed ex dissectionibus, non ex placitis philosophorum sed fabrica naturæ discere et docere Anatomen profitear. Tum quod neque è veteribus quemquam debito honore defraudare, neque è posterioribus quemquam irritari æquum censeam aut moliar. Neque cum iis qui in anatomicis antecelluerunt et me docuerunt manus conserere aut dimicari honestum puto . . . sed solam veritatem sector, et omnem, tum operam tum oleum, eò contuli ut aliquid bonis gratum, doctis commodum et rei litterariæ utile in medium proferre possim." (Dedic. ad Exercit. Anat. de motu cordis, &c., pp. 8, 9.)

nothing to himself on the score of the one great modern addition made to physiological knowledge—the pulmonary transit. He uses the important fact as a truth, co-ordinate with the new truth he has himself to proclaim ; as a middle and necessary link in the chain of his induction, not as it had hitherto been seen—a ring at either end of a to-and-fro movement of the two kinds of blood in the arteries and veins.

SECTION XIII.

ON THE GENERATION OF ANIMALS.

In our account of Harvey's public career we found him busy with the subject of Generation at Oxford in 1642 ; but he had certainly turned his attention that way at a much earlier date. One of the great causes of his regret, as expressed to Dr. Ent, for the destruction of his papers during the civil war, was the loss of his Observations on the Generation of Insects, which must have been reduced to form some years previously—probably even before his engagement to accompany the Duke of Lennox on his continental travels. And then we know that his notes on the gestation of the hind and doe were made in the quieter and more palmy days of the first Charles, before the differences between him and the nation had come to the arbitrament of arms.

It is likely that Harvey occupied a good deal of his leisure in writing and arranging his work on the Generation of Animals after quitting the service of Charles in 1646. His practice at this period was not extensive, and he passed much of his time in the country. He appears to have been somewhat indisposed to publish this work, and only to have ventured it out of his hands with reluctance. Without the solicitations of Ent, indeed, it would certainly have been left unpublished during his lifetime. Ent, however, succeeded in carrying off the prize which his illustrious friend had showed him, and lost no time in getting it into types, taking on himself the task of correcting the press, and sending it forth according to his own ideas in fitting form, with a frontispiece, and a highflown dedication to the President and Fellows of the College of Physicians.

Ent's account of his interview with Harvey on the occasion of obtaining his consent to the publication, though highly theatrical, is still extremely interesting. Saluting the great anatomist, and asking if all were well with him, Harvey answers, somewhat impatiently as it seems : "How can it be, whilst the Commonwealth is full of distractions, and I myself am still in the open sea ? And truly," he continues, "did I not find solace in my studies, and a balm for my spirit in the memory of my observations of former years, I should feel little desire for longer life. But it has so turned out, that this life of obscurity, this vacation from public business

which causes tedium and disgust to so many, has proved a sovereign remedy to me. And truly," he proceeds, "the examination of the bodies of animals has always been my delight; for I have thought that we might thence not only obtain an insight into the lighter mysteries of nature, but there perceive a kind of image or reflex of the Omnipotent Creator himself. The whole earth now lies open before us, and the zeal of our travellers has made us familiar not only with other countries, and the manners and customs of their inhabitants, but with the animals, the vegetables, and the minerals also that are met with in each. And, indeed, there is no nation so barbarous which has not discovered something for the general good that had been overlooked by more civilized communities. But shall we imagine that nothing will accrue to science from such advantages as we now possess, or that all knowledge was exhausted in the earlier ages of the world? If we do, the blame most certainly attaches to our indolence, nowise to all-bountiful nature."

When Ent proceeds to say that the learned world, admiring his genius and aware of his industry, was eagerly looking for other works at his hands, and for further information on the subject of his studies, the fervid spirit of the poet-discoverer appears forthwith in the reply: "Would you be the man," said Harvey, smiling, "who should recommend me to quit the peaceful haven, where I now pass my life, and launch again

upon the faithless sea? You know full well what a storm my former lucubrations raised. Much better is it oftentimes to grow wise at home, than by publishing what you have amassed with infinite labour to stir up tempests that may rob you of peace and quiet for the rest of your days." By-and-by, however, he produces his "Exercises on the Generation of Animals," and though he makes many difficulties at first, urging, among other things, that the work is incomplete, as containing nothing on the generation of insects, Ent, nevertheless, prevails in the end, and receives the papers with full authority, either speedily to commit them to the press, or to delay their publication to a future time. Ent set about his office of midwife, as he has it, immediately, and the following year (1651) saw the birth of the work on Generation.

Neither physiological nor microscopical science was sufficiently advanced in Harvey's time to admit of the production of an enduring work on a subject so abstruse, and involving so many particulars as Generation. On the doctrine of the circulation the dawn had long been visible; Harvey appeared and there was day. On the subject of animal reproduction, on the contrary, all was darkness two centuries ago. The very instruments indispensable to the investigation of the subject were as yet either unknown, or of powers inadequate to bring the most indispensable facts within cognizance of the senses. Harvey probably did as much as any man

living could have accomplished when he wrote. He announced the general truth: Omne animal ex ovo; he showed the cicatricula of the egg as the point where the reproductive process begins, and corrected numerous errors into which his predecessors in the same field of inquiry, Aristotle and Fabricius, had fallen; he further pointed out the path of observation and experiment as the only one that could lead to satisfactory results in the investigation of a subject which gradually presented itself as one of natural history; and, it may be added, by his wanderings in the labyrinth of metaphysical physiology, he did enough to warn another from attempting to tread such barren ground again.

In his work on the Heart and Blood, Harvey had the main elements of his Induction, either as matters cognizable to sense, or as necessary products of reason, and he used them at once and for ever in so masterly a way that he left little for addition either by himself or others. Secure of his footing here, he could dispense with vital spirits and other inscrutable agencies, and leave "adequate and efficient causes" and other metaphysical phantoms, on one side—it was physics he was dealing with, and as physician he was at home.

With the information we now possess, we see clearly how indifferently the physiologist in the middle of the seventeenth century was weaponed for encountering such a subject as animal generation; a Leeuwenhoek and a De Graaf, a Spallanzani and a Haigton; a Wolff,

Purkinje, Von Baer, Valentin, Rudolph Wagner, Bischoff, Müller, Newport, Nelson, and Rawson, had successively to appear, before the mere facts of the subject could be known ; and a Schleiden and Schwann were further wanted as interpreters of the most material processes observed, before they could be understood : the comprehensive doctrines of cell-formation and evolution[1] were still in the womb of time when Harvey lived. No wonder, therefore, that the great physiologist of his age meets us as one puzzled at times rather than enlightened by what he sees ; and contrary to his former wont, eking out the lack of positive knowledge by wordy disquisitions on topics where certainty is unattainable.

It is curious, moreover, to find Harvey, in his treatise on generation, not entirely escaping the pitfall of which he was well aware, and shunned so successfully in his earlier work. In the "Exercises on the Heart" he sets out with the assurance that the whole of the notions of the ancients on the heart and blood, where not absolutely untenable, were yet ever

[1] Johannes Müller, holding up the work of Schleiden and Schwann to his students, proclaimed it the Bible of the physiologist, characterizing at the same time the Frog as his friend ! By the act of our sage legislators, however, we are now liable to a heavy fine if, in our efforts to wring from nature some of her secrets, we put a frog or a toad or a stray cur to death without a special license to set about such nefarious proceedings ! How would Harvey have sped in his researches if he had had an act of parliament to tie his hands ? Anatomists are not inquisitors, taking delight in torture to get at opinions ; but scrutators of the Laws of Life, the discovery of one of which were cheaply bought by the sacrifice of a whole hecatomb of the lower animals.

questionable; and then, taking Nature for his guide, his experience and observation, his tact and judgment, never suffer him to stray from the path that leads to the goal of truth. In the book on Generation, on the other hand, he begins by submitting himself in some sort to the guidance of Aristotle and Fabricius. Assuming the ideas of the former as premisses, and the facts of the latter as topics of discussion or dissent, he then labours on, endeavouring to find Nature in harmony with the Stagyrite, or at variance with the professor of Padua—for, in spite of many expressions of respect and deference for his old master, Harvey seems sometimes to delight in finding him in the wrong. Finally, so overmastered is he by scholastic ideas, that he winds up some of his views upon animal reproduction by presenting them in the shape of logical syllogisms.

The age of Harvey, then, was not competent to produce a lasting work on generation—it was still an undertaking beyond the range of possibility. Yet has Harvey written a remarkable book; one that teems with interesting information, and presents the author to us in the character of the elegant writer, the scholar, and the poet as well as the discoverer—if, indeed, poet and discoverer, though variously applied, be not identical terms. Besides the points already referred to, as immediately connected with his subject, we here find Harvey anticipating modern surgery, by applying a ligature to the main artery of a tumour

which he wished to extirpate, and so making its subsequent removal possible with little loss of blood. Here, too, we find him, a century and a half before his contemporaries, in a rapidly progressive period in the history of human knowledge, throwing out the first hint of the true use of the lungs as generators of the bodily heat. Hitherto, as we have seen, the lungs had been regarded as surrounding the heart for the purpose of ventilating the blood and tempering or moderating its heat, the heart being viewed as the focus or hearth of the innate heat; and Harvey himself often uses language in harmony with these ideas; but in one instance, the lightning of genius, giving him a momentary glimpse of the truth, he says, "Air is given neither for the cooling nor the nutrition of animals; . . . it is as if heat were rather enkindled within the fœtus [at birth] than repressed by the influence of the air."[1]

Had Harvey possessed this idea at an earlier date, and pursued it as he did that of the blood never moving but in one recurrent course in the veins, he would at least have prepared the way for another grand discovery in physiology: demonstrating the erroneousness of the prevalent physiological notions on the use of the lungs, he would have led the van in the investigation of their proper office, or even anticipated Lavoisier in explaining the origin of heat in the animal body. But this was an impossibility at the

[1] "On Generation," p. 530 of English translation.

time: chemistry, in Harvey's day, mostly in the hands of adepts and charlatans, transmuters of metals, searchers after the philosopher's stone and the elixir of life, could have no attraction for the clear intellect of the demonstrator of the circulation of the blood. No wonder, therefore, that Harvey "did not care for chymistrey," or that "he was wont to speak against the chymists." What Aubrey says on this head (l. c. p. 385) is but another proof of Harvey's sagacity. Harvey could show himself in advance of his age by questioning its opinions on the office of the lungs; but the state of chemical science in the middle of the seventeenth century did not admit of his doing more. He, however, well knew the vivifying force of heat: he saw it as the immediate agent in the production of living sentient beings, and the mainspring in the mechanism of the automatic animal body.

If Harvey's work, then, went little way in solving the mystery of Generation, it proved, nevertheless, a great incentive to the prosecution of the subject, parent as it has been of the long array of works and papers that have brought us to the ultimate fact of the penetration of the micropyle of the ovum by the spermatic cell, but leaving us as much in the dark as ever how such a process should be indispensable to the production of a new creature—how two distinct organic germs or cells, detached from the organisms that produced them, each impotent in itself, should yet by their union acquire the power to com-

mence a series of transformations that end in the development of a being capable of assuming independent conscious existence for a day, for a year, for a hundred years or more!

But it was not in the sphere of science only that the work on Generation proved influential. The practice of midwifery and the treatment of uterine diseases was in a terribly backward state when Harvey wrote; so that the appended chapters on Parturition, the Membranes, the Placenta, the Umbilical Cord, and Conception were positive revelations that speedily bore fruit of the most valuable kind. In my Life of Harvey for the Sydenham Society I showed that he must have practised midwifery, and by his superior knowledge found remedies for states that were the despair of the ignorant midwives of the day. Although making no pretensions to rank as a treatise on practical midwifery, Harvey's work "On Generation" might nevertheless be spoken of as the first book on the subject written by an Englishman, so full are its later chapters of new and valuable suggestions. Dr. Aveling[1] quotes the works of Percival Willughby, a distinguished surgeon of the period, to show in what esteem Harvey was held in this long neglected but most responsible portion of the general medical practitioner's business. "Hee sheweth in the first place," says Willughby, "what to observe and how to deliver a woman labouring in a naturall birth. And in difficult births and abortive births, and

[1] "Memorials of Harvey," by J. W. Aveling, M.D. 8vo. Lond., 1875.

where the fœtus is dead, hee maketh mention how to perform the work by the child's feet. In his workes he wisheth midwives not to bee too busy at the first approaching labour, by striving to hasten or promote a sudden or quick birth; but willeth them patiently to wait on nature, to observe her ways, and not to disquiet her, for that it is the sole and onely work of nature."

Harvey, indeed, shows us plainly that he was partial to this branch of his profession, and meets us here as the practitioner more, perhaps, than in any other part of his writings.

The short piece on the "Anatomy of Thomas Parr" is interesting in itself, and, in giving us a glimpse of Harvey's style of pathological reasoning, confirms us in our faith in the great physiologist as a practitioner of medicine. If knowledge will not help, how shall the want of it avail? Whether Harvey believed in the great reputed age of Parr—157 years—it is impossible to say from anything that appears in his report. I imagine that he did not.

SECTION XIV.

CORRESPONDENCE. THE LACTEAL VESSELS. ABSORPTION OF THE CHYLE.

THE letters of great men generally serve to make us more intimately acquainted with them than without

such aid we could have become. This is more especially the case as regards letters written in the ease and confidence of private friendship. It is greatly to be regretted that so few of this description should have come down to us, and that not one of them is in English; for the letter to Dorchester, published by Aveling, is not to a friend, but to one in authority. Those addressed to Giovanni Nardi, however, show us what an affectionate and elegant mind Harvey possessed; how mindful he appears of former kindnesses to himself and to those that were near to him; how anxious that he should be cherished in the memory of his friends, even as he cherishes them in his own!

The other letters we possess are mostly upon physiological topics; though the one addressed from Nuremberg to Caspar Hoffmann may, perhaps, be held an exception; for in this letter the manly and independent character of Harvey displays itself conspicuously. In the very city the home of the Nuremberg professor, he challenges him to the proof. "If you would see with your own eyes the things I assert of the circulation, I promise to show them to you with the opportunity afforded me;" and we have seen that Harvey had the occasion he craved, when he accompanied the Earl of Arundel in his embassy extraordinary to the Emperor in 1636, and may have been one of the party of which three members were barbarously murdered on their way from Nuremberg to Ratisbon,

as Crowne[1] informs us. Hence the solicitude which Hollar, the artist, who also accompanied the ambassador, informs us the Earl of Arundel expressed for his physician's safety: "For he would still be making of excursions into the woods, making observations of strange trees, plants, earths, &c., and sometimes like to be lost; so that my lord ambassador would be really angry with him, for there was not only danger of wild beasts, but of thieves."[2]

The burden of the long and able letter to Schlegel of Hamburg, is still the Circulation; and the one addressed to Morison, with the two to Horst, treat of the discovery of the receptaculum chyli and thoracic duct by Pecquet.

It has been held unworthy of Harvey's greatness that he refused his assent to the special office—not, as often said, to the existence—of the lacteal system. But no one can apply himself to all things. Harvey had his own work laid out for him, and the lacteals were not a part of it. Subsidiary to the maintenance of the organism, the lacteals have in truth nothing to do with the mechanism of the circulation: the fluid within them is the pabulum of the blood. Aselli's book on the Lacteal Veins[3] was even published the year before Harvey's "Exercises on the Heart and Blood," and may or may not have been seen by our physiologist before his own work appeared. In any

[1] "A True Relation," &c., p. 46. [2] Aubrey, op. cit., p. 384.
[3] De Venis Lacteis. 4to. Milan, 1627.

case it was not calculated to influence his views on the motion of the blood; but that he failed to perceive the importance of the discovery announced, and did not examine it more particularly, though it cannot fairly be spoken of as a flaw in his scientific character, may still be regretted—and this the more when the extension and additional significance which the newly found system of mesenteric vessels acquired through the discovery of the thoracic duct by Pecquet, and of the lymphatics of the body by Bartholin, are considered.

Harvey excuses himself for his neglect to look narrowly into the subject of the lacteal veins on the score of his advanced age and his infirm health. He feels himself incompetent, he says, to enter on the examination of so extensive and delicate an anatomical question. In entire consistency with his candid nature, however, and in striking contrast with his own opponents on the circulation, he nowhere denies the existence of the new lacteal vessels. He had in fact observed them himself in the course of his dissections, before the appearance of Aselli's book; and it is the nature of the fluid they contain, not their reality, that he questions. Never once does he oppose the authority of his name to the investigation of the truth. On the contrary, he says that he states his objections "not as being obstinately wedded to his own opinion, but that he may show what can be urged in opposition to the advocates of the new idea." "Nor, do I doubt," he adds, "but that many things

now hidden in the well of Democritus, will by and by be drawn up into day by the ceaseless industry of a coming age."[1]

That the fluid in the lacteal vessels is chyle, product of the food digested, there can be no question; but we are somewhat puzzled, even in the present day, to know how it gets into them. By the cell-forming process now acknowledged to constitute the act of secretion, say modern physiologists. But the contents of the lacteals are not derived from the blood, like every other secreted fluid in the animal body; they consist largely of fat globules and protein, matters obtained immediately from the intestines. The process of cell-formation, whereby the lacteals are charged is, in truth, altogether peculiar. It would seem as if the cells must *grow over* the chyle with which they are in contact in the intestinal villi, and, arrived at maturity, shed their contents into the canals which they form in virtue of their ceaseless development in whorls—the process whereby the *pore* apparent on the point of each intestinal villus is produced. In harmony with the all-pervading laws of nature, animals, it would appear, finally obtain their nutritive juices in the same way as plants: the primary cells of the root spongioles of these *grow over* the nutritive matters they encounter in the ground, and so enable the rootlets to make their way through the stiffest soils, not by boring into them, but by additions succes-

[1] First Letter to J. D. Horst.

sively made to their extremities. Permanent in the radicles of the vegetable, the cells of the intestinal villi burst inwardly and disappear as fast as they are produced, so that there is no elongation of the structures connected with which they have their origin.

The lacteals, however, do appear to have been an anomaly to Harvey. He had made up his mind that the nutritive element of the blood passed from the intestines with the blood of the mesenteric veins, to percolate the liver and undergo elaboration there before reaching the heart. It is in his letter to Dr. Morison of Paris (April, 1652,) that he says he had "observed these white canals even before Aselli's book appeared, but for various reasons could not bring himself to believe that their contents were chyle." Finding a milky fluid in various parts of the body of young animals, in the thymus especially, in the mesenteric glands, and in the breasts of new-born infants, he imagined that the fluid contained in the lacteals was merely milk—*purum putum, lac*—like that of the proper milk ducts of the mammæ, which he speaks of as "lacteal veins."

The slender calibre of the thoracic duct, was another of the points which seemed to Harvey to argue against the likelihood of its being the possible conduit of the amount of nutriment required by the body for its support. How, moreover, should so small a vessel suffice to convey the quarts of acidulous water which persons drink at the springs, and micturate

again in ever so short a time? Harvey, doubtless, explained the phenomenon by ascribing it truly to the absorptive powers of the gastric veins, which drink up the fluid, pour it into the vena portæ, from whence, passing through the liver, it reaches the vena cava, the heart, the aorta, and the emulgent arteries, from the blood of which it is eliminated by the specific action of the kidney. Harvey was further thrown off the scent as to the real import of the lacteal vessels by their seeming absence in numerous instances: they were not always visible in the animals he dissected; neither did he observe them on the stomach at any time; and so he erroneously concluded that they did not exist as a constant element in the bodies of the higher animals.

In his second letter to Horst (July, 1656) Harvey returns to the subject of the lacteals. Conceding all honour to Pecquet and others for their search after truth, he apologises again for his own inability to follow them. Far stricken in years, and more and more afflicted with indifferent health, he is forbidden to enter on the discussion of novel subtleties, or to offer himself as an umpire in the question that has arisen. "It is in vain," he says in the concluding letter we have from him to Vlackveld (April, 1657), the very year of his death, "that you apply the spur and urge me at my present age, not mature merely, but declining, to gird myself for any new investigation. I consider myself now entitled to my discharge from duty; but

it will always be a pleasant sight to me to see distinguished men like yourself engaged in this honourable arena."

The noble Harvey! And here let me refer to Thomas Bartholin's kind and appreciative apology for our anatomist's neglect of the lacteals, appended to the work in which he himself comes before us as discoverer of the lymphatic system. Addressing the same Horst who had been Harvey's correspondent, Bartholin proceeds: "I do greatly wonder that that great man, William Harvey, should suffer himself to be swayed by the ancients here, and, despising the lacteals, be found advocating the old mesenteric system. He appears to be so much occupied with his circulation of the blood that he fails to attach adequate importance to the chyliferous veins. But so it is: the good Homer sometimes nods; and Harvey perhaps thinks he has done enough for his honour, and added sufficiently to anatomical science by his immortal discovery of the circulation. I would not, therefore, be thought of as uttering a word against the great anatomist whose works I have always held in the highest estimation. I cannot help thinking, nevertheless, that had he but given the necessary attention to the matter, or even have trusted his eyes alone, he would have judged differently of these vessels, and not denied that the fluid they contain is chyle, or thought it was milk, as I understand him to say in his letter to you.

"But I drop my pen, dipped in milk, not in gall, as I trust you will see, and even excuse me for presuming to criticize so great a man, chosen by nature herself as one of her most favoured sons"[1]

Laudatus a laudato! Let all who have lately carped at Harvey's title, two centuries and a half after the tongues of the great men we quote were mute, take example from the illustrious discoverer of the lymphatic system, and henceforth cease from their unworthy clamour.

Specimens of Harvey's handwriting are extremely rare. A man in his position must have written many letters in his lifetime; but few of them have been preserved; no more than nine being found in the collected edition of his works published by the College of Physicians in 1766; and to these only one or two have since been added. The one we owe to Dr. Aveling,[2] who had it from the Bodleian Library, is plainly written from abroad and addressed, as Dr. Aveling believes, to Mr. Secretary Dorchester, sometime in the year 1631, when Harvey was in attendance on the Duke of Lennox during his travels. The burden of the letter is to petition that he—Harvey—be retained in his office of Physician to the Royal Household, and that Dr. Bethune or Dr. Chambers may be appointed to perform its duties during his absence, instead of Dr. Metzler, who

[1] De Lacteis Thoracis, &c. [2] "Memorials of Harvey," 1875.

appears to have been brought in; "the King's Majesty having declared to him that no prejudice should arise to him through his attendance on the Duke."

In the course of this letter Harvey speaks of "the miseryes of the Cuntreys we have passed. I can only complayne that by the waye we could scarce see a dogg, crow, kite, raven, or any bird or any thing to anatomise; only sum few miserable poeple the reliques of the war and the plauge, where famine had made anatomies before I came. It is scarce credible in soe ritch, populous, and plentiful cuntreys as these weare, that so much misery, desolation, poverty, and famine, should in soe short a time be as we have seen. I interpret it well, yt will be a greate motive for all heare to have and procure an assurance of a settled peace. It is time to leave fighting when ther is nothing to eate, nothing to be kept and gotten, and the same partyes robb one the other if they but get out of sight.

"Your hon. humble servant,

"WILL. HARVEY."

It would be difficult to sum up in fewer words the desolation that waits on war—and such a war as that on the traces of which Harvey and his party were following!—the Thirty Years War, from which Germany, after more than two centuries, has hardly yet recovered. How characteristic of the man, too, in

his own special sphere—there was not even *anything to anatomise!*

The letter to Vlackveld was written the very year—even within a few weeks of the writer's death. His friend must have been urging him to say something on the subject of the lacteal and lymphatic vessels, then engaging a great deal of the attention of anatomists. But he informs his correspondent that the application of the spur is all in vain. He feels his right to demand his release from duty; yet would he be ever honourably considered by his contemporaries, and begs his friend Vlackveld to love him to the last.

By permission of the President and Censors of the College of Physicians, I am privileged to add one more to the short tale of Harvey's Letters; and as it is at once of a friendly and properly professional character, I think it must prove interesting. The letter is addressed to Dr. Baldwin Hamey, an able physician in his day, and a somewhat intimate friend of Harvey. It was lately discovered by Dr. Munk, the worthy Harveian Librarian to the College, whilst casually turning over a volume of MS. letters addressed to Hamey, and is to the following effect.

"Vir doctissime, humanissime, mihi carissime!

"Fæmina videatur mihi tamen ex ægri relatione, qua habitu et victus consuetudine (salvo tuo judicio), esse à passione colica eaque calida et biliosa. Esto

quod antehac evacuatur fuit pix, tamen jam subesse vel hippocondrii vel regione epigastrica apostema haud credo; tactu enim aliquid percepissem vel tumidum vel tensum. Laudo itaque tuum de sanguinis missione judicium; plethoricum ejus corpus liberaliori victui dabitum, calidum, robustum et assuetum id postulat; laudo præterea evacuationem cum pillulis Cholagogis, addit: Euphorbii ℈ß, multum enim præstat in sedandis doloribus cholicis. Laudo frequentum usum pulveris ex ebore et calcaneo cervi. Reliqua tuo relinquo consilio.

"Vale, mi amantissime,

"Tuus ex anima,

Jan. 19. "GUL. HARVEIUS."[1]

[1] "Most learned, humane, and dear Sir!

"The woman appears to me, from her own account and her mode of life (with deference to your judgment), to be affected with a cholic passion of a hot and bilious nature. Suppose it was pitchy stuff that was formerly discharged, still I do not believe that there is any imposthume in the hypochondriac or epigastric region; I should else have detected either some enlargement or some tension there. I therefore approve of your decision as to blood-letting; the plethoric body of the patient, accustomed to generous diet, hot, robust, and vigorous, requires it. I also commend purging by the Chologogue Pills, with half a scruple of Euphorbia added; this medicine having an excellent effect in soothing colic pains. I also advise the frequent use of the powder of ivory and calcaneum cervi. Everything else I leave to your discretion.

"Farewell, my very dear Sir,

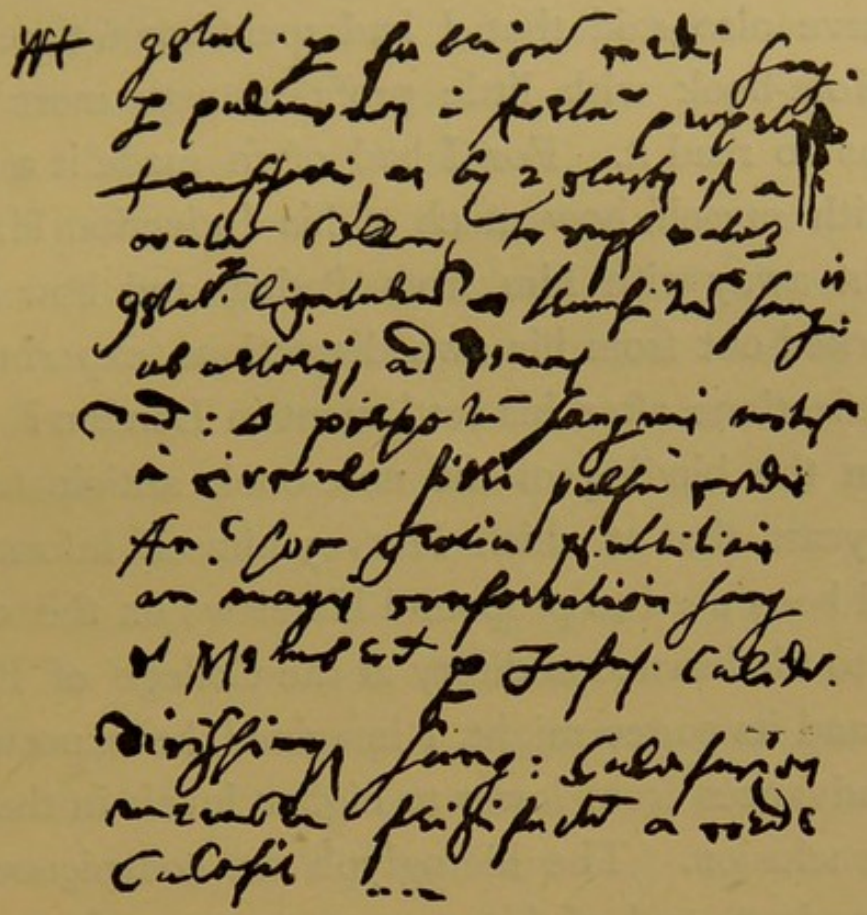
"Yours with all my heart,

Jan. 19. "WM. HARVEY."

SECTION XV.

THE NOTE-BOOK OF 1616, AND ORIGIN OF THE IDEA OF THE CIRCULATION.

I have already had occasion to refer to Harvey's memorandum book of 1616, of which a small but characteristic portion was selected and interpreted for Dr. Sieveking by Mr. Bond, the learned keeper of the MSS. in the British Museum. This fragment Dr. Sieveking had photographed, and shewed to his auditors when he delivered the Harveian Oration of 1877. Failing myself to discover any other equally interesting paragraph in the note-book, I too have had it photographed from the original, but upon wood, and carefully cut, so as to present the reader at once with an enduring fac-simile of the handwriting of Harvey, and of the earliest record we have from himself of his great discovery; the original and interpretation being as follows :—



".WH Constat per fabricam cordis sanguinem per pulmones in aortam perpetuo transferri—as by two clacks of a water bellow to rays water.

"Constat per ligaturam transitum sanguinis ab arteriis ad venas.

"Unde △ [demonstratur] perpetuus sanguinis motus in circulo fieri pulsu cordis.

"An? hoc gratia nutritionis, an magis conservationis sanguinis et membrorum per infus. calidi, vicissimque sang. califaciens membra frigifactus, a corde calefit."[1]

[1] Rendered thus by Dr. Sieveking: "WH. By the structure of the heart it appears that the blood is continually transfused through the lungs to the aorta—as by the two clacks of the water ram for raising water.

I have also said that I had spent some time over this Note-book with little profit, though more than anxious to read it. For I had often made it a question with myself, how much of his Induction Harvey brought away with him from Padua, and how much he worked out from his own dissections, experiments, and reflections after his settlement in London? The date on the binding of the note-book anticipates by three years that at which Harvey himself informs us he had been used to propound his views on the circulation to his learned auditory at the College of Physicians, and its pages might, I imagined, be expected to show advances from lower to higher levels in thought and conclusion. The hieroglyph ♃, conspicuous on the woodcut, and of frequent occurrence throughout the book, seems, indeed, to mark particular passages as containing matter which Harvey considered as new and specially his own.

The existence of valves in the veins is generally believed to have been that which led Harvey to surmise that their use was possibly other than his distinguished teacher Fabricius imagined: They did not merely retard the flow of blood in the vessels, but,

"It is shown by ligature that there is a perpetual motion of the blood from arteries to veins.

"Whence △ it is demonstrated that there is a perpetual motion of the blood in a circle, effected by the beat of the heart.

"Query: Is this for the sake of nutrition; or rather for the preservation of the blood and the members by the infusion of heat; the blood, cooled by warming the members, being warmed in turn by the heart?"

opposing effectual barriers to its accredited motion from their trunks to their branches, made any to-and-fro motion within them impossible.

In a paragraph of his work "On the Final Causes of Natural Things," the Hon. Robert Boyle says: "I remember when I asked our famous Harvey in the only discourse I had with him (which was but a while before he dyed): What were the things that induced him to think of a Circulation of the blood? he answered me, that when he took notice that the valves in the veins of so many parts of the body were so placed that they gave free passage to the blood towards the heart, but opposed the passage of the venal blood the contrary way; he was invited to imagine that so provident a Cause as Nature, had not placed so many valves without design; and no design seemed more probable than that since the blood could not well, because of the interposing valves, be sent by the veins to the limbs, it should be sent through the arteries and return through the veins whose valves did not oppose its course that way."[1]

This, in so far as external testimony goes, might be held conclusive. Yet do Boyle's words convey no very assured sense: "it seemed *more probable* that since the blood *could not well be sent* to the limbs by the

[1] "A Disquisition about the Final Causes of Natural Things, by the Hon. Robert Boyle. With an Appendix on some Uncommon Observations about Vitiated Sight." (8vo, min., Lond., 1688.)

veins, *it should be sent* through the arteries and return by the veins." And when we turn to Harvey himself, in his works we nowhere find that he approaches his subject from the quarter now particularly indicated. There was, in fact, nothing but physiological error connected with the valvular elements of the sanguiferous system until after Harvey wrote; with this solitary exception Fabricius of Aquapendente's discovery of the Ostiola venarum neither helped himself, his contemporaries, nor the generation that came after him to any more sensible interpretation of their true import and necessary influence.

Harvey seems to me to have escaped the whole of the perplexities involved in the old physiology touching the office of the cardiac valves and the meaning of the motions of the chest in respiration, by attacking the problem of the motion of the blood from a quarter that takes no note of the valvular apparatus whether of the heart or veins. The quantity of blood that must pass through the heart in a given interval of time he found by computation to be such that its motion in a circle throughout the body became a necessity in the nature of things, without any reference to the means by which it was effected. This, as we have seen, is the starting point in the "Anatomical Exercitation" from which the goal is reached; and in the earlier Note-book it is the perpetual passage of the blood from the heart through the lungs to the aorta, and the ligature of the artery supplying a limb, that proclaim the

transit from the arteries to the veins. It is on this that the significant Δ of the Note-book leads up to the conclusion—to wit: that there is a ceaseless motion of the blood in a circle effected by the beat of the heart.

In so far as we may judge by contemporary literature, there was not even a thrill in the air of Padua either during the student lifetime of Harvey there, or for a generation after him, that could have hinted at such a thing as a continuous circle of the blood, alternately florid and grimy, as it passed from the arteries to the veins. "As there are two kinds of aliment, so are there two orders of vessels;"[1] and the heart, the fountain head of the blood, and so necessarily giving rise to the veins and the arteries, distributes the kind of blood appropriate to the requirements of the several parts; no otherwise, indeed, than does the "prudent father of a family, who gives the best of the food to his children, that of an inferior quality to his servants, and that of least value to domestic animals."[2] Such is the conclusion of the most accomplished of all the contemporaries of Harvey.

The youthful graduate of Padua, therefore, whilst he brought the germ of his induction away with him from Italy, must, as said above, have worked out the problem it suggested to a solution by his dissections, experi-

[1] Cum igitur duo sunt genera alimenti, duo etiam genera vasorum in iis [animalibus] quæ perfectiora sint. (Cæsalpinus: Quœst. Peripat. Lib. v., Qu. 3, p. 117.)

[2] Perinde ac Paterfamilias prudens qui in cura rei familiaris optimum cibum dat liberis, deteriorem servis, vilissimum sociis animalibus. (Ib.)

ments, and reflections after his settlement in England. As we meet with it in the portion of the memorandum book of 1616 we have before us, the idea had long passed the embryo state. The two leading paragraphs of our quotation proclaim the advanced inquirer, as does the third the important conclusion at which he had already arrived: the ligature of the artery finally proving the passage of the blood from the arteries to the veins, and its ceaseless motion in a circle in virtue of the beat of the heart.

SECTION XVI.

HARVEY'S CHARACTER AND PERSONAL APPEARANCE, HIS LAST ILLNESS, DEATH, AND BURIAL.

We have taken occasion from time to time in the course of our narrative, to glance at the mental and moral constitution of Harvey, mainly on the ground of inference from his bearing on particular occasions, and from what appears in his writings. Happily we have in addition a few particulars from the pen of a contemporary, John Aubrey,[1] which, though perchance they do not harmonize in every respect with the facts in his public life and the portrait he gives us of himself

[1] "Letters and Lives of Eminent Persons." 2 vols. 8vo. London, 1813.

through his works, are nevertheless so interesting, that they cannot be left unnoticed.

"In person," Aubrey informs us, "Harvey was not tall, but of the lowest stature; round faced; olivaster (like wainscot) complexion; little eye, round, very black, full of spirit; his hair black as a raven, but quite white twenty years before he died." The fine portrait we have of Harvey by Cornelius Jansan, in the library of the Royal College of Physicians, and the engraving after it, in bust form, by W. Faithorne, a contemporary of Harvey, correspond in all respects with this account; the temperament is nervous-bilious; the forehead compact and square, and of greater width than usual between the temples; the expression highly intellectual, contemplative, independent and manly.

"In temper," Aubrey says, "he was like the rest of his brothers, very choleric, and, in his younger days, he wore a dagger, as the fashion then was, which he would be apt to draw out upon every occasion"—by way of gesticulation, doubtless, to lend force to his words; for in his public and literary life, Harvey showed everything but the nature that would have led him to use a dagger: he seems, indeed, at all times to have had his temper under entire control. The way in which he himself speaks of the robbery of his apartments and the destruction of his papers, has nothing of acrimony in it. With the opportunity presenting itself to him, too—as when he sends Nardi the book on the troubles in England—he is not tempted to utter

even a splenetic word against the party which had been all along opposed to his friends, and by which he had himself suffered severely. Harvey was, probably, a marked man by the Parliamentarians, but he gave them no occasion to interfere with him.

Harvey appears not to have esteemed the fair sex very highly. He would say, that "we Europeans knew not how to order or govern our women, and that the Turks were the only people who used them wisely;" surely a regretable saying on the part of our anatomist; for the woman is but the other, and oftentimes the better, half of the man. It is savagery or barbarism that treats womankind as either a slave or plaything. But, indeed, if Aubrey may be trusted, Harvey did not think much of mankind in general; he was wont to say, that "man was but a great mischievous baboon." Harvey, however, married young, speaks affectionately of his wife, and in his age seems still to have thought that the old man was best tended by the hand of a woman not too far stricken in years.[1]

Harvey, in his own family circle, must have been affectionate and kind—characteristics of all his brothers—who appear to have lived together through their lives in perfect amity and peace. But our Harvey's sympathies were not limited to his immediate relations: attachment, friendship, was a marked ingredient in his nature. His will from first to last is

[1] Vide Aubrey, op. cit. p. 381.

a piece of beautiful humanity, and more than one widow and helpless woman is there provided for. He had no child of his own to whom he could have made his memory dear, but he was anxious to live in the minds of his sisters-in-law and of his nephews and nieces, whose legacies are mostly given to the end that they may buy something to keep in remembrance of him. To Dr. Ent he was much attached, and besides his bookcases, there are "five pounds to buy a ring." Dr. Scarborough, who also stood high in Harvey's favour, has his "silver instruments of surgery and his best velvet gown."

We cannot fancy that Harvey was at any time very eager in the pursuit of wealth. Aubrey tells us that, "For twenty years before he died, he took no care of his worldly concerns; but his brother Eliab, who was a very wise and prudent manager, ordered all, not only faithfully, but better than he could have done for himself." The effect of this good management was that Harvey lived, towards the end of life, in easy circumstances. Having no costly establishment to maintain, for he always resided with one or other of his brothers in his latter days, and no family to provide for, he could afford to be munificent, as we have seen him, to the College of Physicians, and at his death he is reported to have left as much as £20,000 to his faithful steward and kind brother Eliab, who always meets us as the guardian angel of our anatomist in a material point of view. Honoured be the name and the

memory of Eliab Harvey for his good offices to one so worthy!

Though of competent estate, in the enjoyment of the highest reputation, and trusted by two sovereign Princes in succession, Harvey never suffered his name to be coupled with any of those lower-grade titles that were so freely conferred in the time of both the First and Second Charles. When we associate Harvey's name with a title at all, it is with the one he won for himself from his masters of Padua: by his contemporaries he is always spoken of as Doctor Harvey; we in the present day rightly class him with our Shakspeares, and our Newtons, and speak of him as Harvey. Harvey, indeed, had no love of ostentation. The very buildings he erected in connection with the College of Physicians, at Amen Corner, were built "at the suggestion and under the auspices" of others.

Harvey's mind was largely imbued with the imaginative faculty: how finely he brings in the classical allusion to "the Sicilian sea, dashing among the rocks around Charybdis, hissing and foaming and tossed hither and thither," in illustration of those who reason against the evidence of their senses. And then what unbounded confidence he has in Nature, and how keenly alive he is to her perfections in every sphere: Nature has not been sedulous to deck out animals only with ornaments; she has further thrown an infinite variety of beautiful dyes over the lowly and insensate herbs and flowers.

In Harvey the religious sentiment must have been active. He evinces true and elevated piety through the whole of his work on Generation, and seizes every opportunity of giving utterance to his sense of the immediate agency of THE DIVINE in Nature. With the ancient philosophers he appears to have regarded the universe and its parts as actuated by a supreme and all-pervading Intelligent Will, and so to have arrived at the pantheistic idea familiar to many of the highly cultivated of his age. He was a great admirer of Virgil, whose works were frequently in his hands, and whose religious philosophy seems also to have been the same as his own. The following beautiful and oft-quoted passage of his favourite author may be said to embody his ideas on this subject, as they appear repeatedly in the course of the work on Generation :—

"Principio cœlum ac terras camposque liquentes,
Lucentemque globum lunæ, Titaniaque astra,
Spiritus intus alit, totamque infusa per artus
Mens agitat molem, et magno se corpore miscet."

—The heavens and earth, and ocean's liquid plains,
The moon's bright orb, and the Titanian stars,
Are fed by intrinsic spirits : deep infused
Through all, mind mingles with and actuates the mass.

Æneid.

The same idea being repeated in other words in the fourth Georgic.

"Deum namque ire per omnes
Terrasque tractusque maris cœlumque profundum.
Hinc pecudes, armenta, viros, genus omne ferarum,

Quemque sibi tenues nascentem arscessere vitas;
Scilicet huc reddi deinde ac resoluta referri."

For God is in and over all—
In earth and ocean, and in heaven above;
Whence flocks and herds, mankind and all that breathe,
Receive at birth their feeble fleeting life,
And dying give it back to whence it came.

Upon the pure Theistic or pantheistic notions of antiquity, however, Harvey engrafted faith in Christianity, in harmony most probably with the views of Faustus Socinus, like his great contemporaries Milton, Hobbes, Lord Herbert of Cherbury, and others. In connection with the subject of the "term of utero-gestation," he adduces what he holds to be the highest recorded example as the rule, and speaks of "Christ, our Saviour, of men the most perfect." In his Will he further "most humbly renders his soul to Him that gave it, and to his blessed Lord and Saviour Christ Jesus."

Harvey was ever inquisitive into natural things and natural phenomena. When he accompanied the Earl of Arundel, we have seen that he would still be wandering in the woods, making observations on the strange trees, herbs, creatures, and minerals he encountered. His industry in collecting facts was unwearied, and the accuracy with which he observed appears in every page of his writings; though we sometimes meet him amiably credulous in regard to the observations of others,—as in that instance where he suffers himself to be imposed upon by the traveller's

tale of the "Genus humanum caudatum"—the race of the human kind with tails!

Harvey was the first great modern comparative anatomist; in other words, he was the first physiologist the modern world produced, who by superiority of natural endowment was led to perceive the relations between the meanest and the highest of created things, and who made the simplicity of structure and of function in the one, a means of explaining the complexity of structure and of function in the other—the principle that underlies the great Idea of Evolution. "Had anatomists," he says, "only been as conversant with dissection of the lower animals as they are with that of the human body, many matters that have hitherto kept them in a perplexity of doubt would, in my opinion, have met them freed from every kind of difficulty."

It were needless to say that Harvey makes frequent and most effectual use of his knowledge of comparative anatomy in his earlier work; and if the reader will turn to the one on Generation, and peruse what is said on the subject of "parts not essential to the being of the individual," and then visit the Hunterian Museum in Lincoln's Inn Fields, he will find that the great comparative anatomist and physiologist of the eighteenth century had a herald in the great comparative anatomist and physiologist of the seventeenth. Aubrey makes particular mention of Harvey's having "often said that of all the losses he sustained, no grief

was so crucifying to him as the loss of his papers (containing notes of his dissections of the frog, toad, and other animals, particularly insects,) which together with his goods in his lodgings at Whitehall, were wrecked and plundered at the beginning of the rebellion." Harvey's store of individual knowledge must have been great; and it was only towards the very end of his life that he flagged in his anxiety to learn more. He, however, made himself master of Oughtred's Clavis Mathematica in his old age, according to Aubrey, who found him "perusing it, and working problems, not long before he dyed."

Aubrey says "he understood Greek and Latin pretty well, but was no critique, and wrote very bad Latin. The Circuitus Sanguinis was, as I take it, done into Latin by Sir George Ent, as also his booke de Generatione Animalium; but a little booke, in 12mo, against Riolan (I thinke), wherein he makes out his doctrine clearer, was writ by himself, and that, as I take it, at Oxford."[1] Aubrey, in his gossiping, is doing injustice both to the scholarship and the candour of Harvey. He heard or knew that Harvey wrote an indifferent hand, and this forsooth he turns into writing indifferent Latin. Everything points to the year 1619 as the period when the book De Motu Cordis et Sanguinis (Aubrey does not even know the title!) was written; Ent, born in 1603, then a lad of sixteen, had never in all likelihood even heard of Harvey's name;

[1] Aubrey, p. 383.

very certainly he had no knowledge of anatomy, and when the work came forth at Frankfort in 1628, he was scarcely emancipated from the leading-strings of his instructors. The Exercises on the Heart are at least as well written as the Disquisitions to Riolan, which Aubrey cites as specimens of Harvey's own latinity. And then our authority evidently speaks at random in regard to the time and place when these essays were composed. Harvey never resided at Oxford after 1646, and Riolan's Encheiridium Anatomicum, to which Harvey's two Exercises were an answer, did not appear till 1648! Harvey's reply could not have been written by anticipation. It came out at Cambridge the year after Riolan's work—in 1649.

With regard to the work on Generation, again, had Ent received it in English and turned it into Latin, this fact would certainly have been stated; whereas, there is the positive information that he only played the midwife's part, and overlooked the press. More than this, from what Ent says, it is evident that the printer worked from Harvey's own MS. "As our author writes a bad hand," says Ent, "which no one without practice can easily read, I have taken some pains to prevent the printer committing any very grave blunders through this,—a point which, I observe, has not been sufficiently attended to in a small work of his (The Exercitatio ad Riolanum) which lately appeared."[1] This settles the question both as to the

[1] See the Epistle Dedicatory to the work on Generation.

language and the writer, and puts Aubrey out of court as worthy of credit on the subject. Harvey was a man of the most liberal education, and lived in an age when every physician wrote and conversed in Latin with ease at least, if not always with elegance. Harvey's Latin is generally easy, never inelegant, and not unfrequently copious and imaginative; he never seems to feel fettered by the language he is using.

Harvey, if eager in the acquirement of knowledge, was also ready at all times to communicate what he knew, "and," as Aubrey has it, "to instruct any that were modest and respectful to him. In order to my journey (I was at that time bound for Italy) he dictated to me what to see, what company to keep, what bookes to read, how to manage my studies—in short, he bid me go to the fountain head and read Aristotle, Cicero, Avicenna, and did call the Neoteriques s—t-breeches."[1]

Harvey was not content merely to gather knowledge; he digested and arranged it under the guidance of the faculties which compare and deduce. "He was always very contemplative," pursues Aubrey, "and was wont to frequent the leads of Cockaine-house, which his brother Eliab had bought, having there his several stations in regard to the sun and the wind, for the indulgence of his fancy. At the house at Combe,

[1] Aubrey, p. 383.

in Surrey," which by the way appears to have been purchased of Mr. Cockaine, as well as the mansion in the city, "he had caves made in the ground, in which he delighted in the summer time to meditate. He also loved darkness," telling Aubrey, "'that he could then best contemplate.' His thoughts working, would many times keep him from sleeping, in which case his way was to rise from his bed and walk about his chamber in his shirt, till he was pretty cool, and then return to his bed and sleep very comfortably." He treated the principal bodily ailment with which he was afflicted (gout) somewhat in the same manner. The fever of the mind being subdued by the application of cold air to the body at large, the fever in the blood, induced by gout, was abated by the use of cold water to the affected member: "He would then sitt with his legges bare, though it were frost, on the leads of Cockaine-house, putt them into a payle of water till he was almost dead with cold, and betake himself to his stove, and so 'twas gone."[1]

Harvey, besides being physician to the king and household, held the same responsible situation in the families of many of the most distinguished nobles and men of eminence of his time—among others in that of the Lord Chancellor Bacon, whom Aubrey informs us, "he esteemed much for his witt and style, but would not allow to be a great philosopher. Said he to me, 'He writes philosophy like a Lord

[1] Ibid., p. 384.

Chancellor'—speaking in derision." The philosopher of fact cared not for the philosopher of prescription; he who was dealing with the Things, and through his own inherent powers exhibiting the Rule, thought little of him who was at work upon Abstractions, and inculcating the rule from the use he saw others making of it. Bacon has many admirers, more eulogists than readers, I apprehend; and there are not wanting some in these present times who hold, with his illustrious contemporary, that "he wrote philosophy like a Lord Chancellor."

Harvey was also acquainted with all the men of letters and science of his age—with Hobbes, Dryden, Cowley, Boyle, and the rest. Dryden, in his metrical epistle to Dr. Charleton, has these lines, of no great merit or significance :—

> "The circling streams once thought but pools of blood,
> (Whether life's fuel or the body's food,)
> From dark oblivion Harvey's name shall save."

Cowley is more happy in his Ode on Dr. Harvey :—

> "Thus Harvey sought for truth in Truth's own book
> —Creation—which by God himself was writ;
> And wisely thought 'twas fit
> Not to read comments only upon it,
> But on th' original itself to look.
> Methinks in Art's great circle others stand
> Lock'd up together hand in hand:
> Every one leads as he is led;
> The same bare path they tread,
> A dance like that of fairies, a fantastic round,
> With neither change of motion nor of ground.
> Had Harvey to this road confined his wit,
> His noble circle of the blood had been untrodden yet."

Cowley and Harvey must often have encountered; both had the confidence of the king, but in very different ways: Cowley lent himself to the privacies and intrigues of the royal family and its adherents, for whom he even consented to play the base part of spy upon their opponents. He was also the cypher-letter writer, and the decypherer of the royal correspondence, and thus mixed up with all the plots and proceedings of the court party, by whom he must have been, as matter of course, despised, as he was subsequently neglected.

Harvey was a man of another mould, composed of a better clay; and it gives us a high sense of his independence and true nobility of nature, that in the midst of faction and intrigue he is never found associated with aught that is unworthy of the name of man in his best estate. The war of party and the work of destruction might be going on around, Harvey, under a hedge, and within reach of cannon shot, was engaged with his book; or in the chamber of his friend Dr. Bathurst, rapt in contemplation of the mysteries of Generation!

Harvey appears to have possessed, in a remarkable degree, the power of persuading and conciliating those with whom he came in contact. In the whole course of his long life we hear nothing either of personal enemies or personal enmities. "Man," he says, "comes into the world naked and unarmed, as if

nature had destined him for a social creature, and ordained that he should live under equitable laws and in peace; as if she had desired that he should be guided by reason rather than be driven by force." The whole of the opposition to his new views on the circulation was got up at a distance; all within his own sphere of any note, where not of his way of thinking, were silent. His brethren of the College of Physicians appear to have revered him. The congregated fellows must have risen to their feet by common consent as he came among them on the memorable occasion after they had elected him their president, an honour which he so gracefully declined.

Among other tastes or habits which Harvey had, Aubrey informs us that "he was wont to drink coffee, which he and his brother Eliab did before coffee-houses were in fashion in London."[1] This was probably a cherished taste with Harvey. In his will he makes a special reservation of his "coffey-pot;"—his niece Mary West and her daughter have all his plate except this precious utensil, which, with the residue of his fortune, he evidently desired should descend to his brother Eliab, as a memorial, doubtless, of the pleasure they had often enjoyed together over its contents—the "cup that cheers, but not inebriates."

In visiting his patients, Harvey "rode on horseback with a foot-cloath, his man following on foot, as the

[1] Op. cit. p. 384.

fashion then was, which was very decent, now quite discontinued. The judges rode also with their foot-cloathes to Westminster Hall, which ended at the death of Sir Robert Hyde, Lord Chief Justice. Anthony Earl of Shaftesbury would have revived it, but several of the judges being old and ill horsemen would not agree to it."[1]

Harvey appears to have preserved his faculties unimpaired to the very last. Aubrey, as we have seen, found him perusing Oughtred's Clavis Mathematica, and working the problems, not long before he died; and the registers of the College of Physicians further assure us that Harvey, when very far stricken in years, still lost little or nothing of his old activity of mind. He continued to deliver his lectures till within a few years of his death, when he was succeeded by his friend Sir Charles Scarborough, and he never failed at the Comitia of the college when anything of moment was under consideration.

Accumulating years, however, and repeated attacks of gout, to which he had long been a martyr, at length asserted their mastery over the declining body, and on the 3rd of June, 1657, William Harvey, the great in intellect, the noble in nature, then in the 80th year of his age, finally ceased to be. About ten o'clock in the morning, as Aubrey tells us, on attempting to speak, he found that he had lost the power of utterance—that, in the language of the vulgar, he had the dead

[1] Aubrey, ib., p. 386.

palsy in his tongue. He did not lose his other faculties, however; but knowing that his end was approaching, he sent for his nephews, to each of whom he gave some token of remembrance—his watch to one, his signet ring to another, and so on. He farther made signs to Sambroke, his apothecary, to let him blood in the tongue; but this did little or no good, and by and by, in the evening of the day on which he was stricken, he died; "the palsy," as Aubrey has it, "giving him an easy passport."[1]

The funeral took place a few days afterwards, and was attended far beyond the walls of the city by a long train of his friends of the College of Physicians, the remains being finally deposited "in a vault at Hempstead, in Essex, which his brother Eliab had built; he was lapt in lead, and on his breast, in great

[1] Aubrey gives a positive denial to "the scandall that ran strongly against him (Harvey), viz., that he made himself away, to put himself out of his paine, by opium." Aubrey proceeds: "The scandall aforesaid is from Sir Charles Scarborough's saying that he (Harvey) had, towards his latter end, a preparation of opium and I know not what, which he kept in his study to take if occasion should serve, to put him out of his paine, and which Sir Charles promised to give him. This I believe to be true; but do not at all believe that he really did give it him. The palsey did give him an easie passport." (p. 385.)

Harvey, if he meditated anything of the kind above alluded to, would not be the only instance on record of even a strong-minded man shrinking from a struggle which he knows must prove hopeless,—from which there is no issue but one. Nature, as the physician knows, does often kill the body by a very lingering and painful process. In his practice he is constantly required to smooth the way for the unhappy sufferer. In his own case he may be excused for wishing to shorten it. Such requests as Harvey may be presumed to have made to Scarborough, are frequently enough preferred to medical men: it were needless to say that they are never granted to the extent desired.

letters, his name—Dr. William Harvey. . . . I was at his funeral," continues Aubrey, "and helpt to carry him into the vault." And there, at this hour, he lies, the lead that laps him showing indistinctly the outline of the form within; for he lies not in an ordinary coffin, but wrapt in cerements that surround the body, these being in their turn invested by the lead.

So lived, so died one of the great men who, in virtue of the eternal laws that rule the Universe, appear on earth from time to time, to enlighten and to ennoble mankind.[1]

[1] On the Tablet placed in Hempstead church to Harvey's memory are inscribed these words:

GULIELMUS HARVEIUS,

Cui tam colendo Nomini assurgunt omnes Academiæ;
Qui diuturnum sanguinis motum
Post tot annorum Millia
Primus invenit;
Orbi salutem, sibi immortalitatem
Consequutus.
Qui ortum et generationem Animalium solus omnium
A Pseudo-philosophiâ liberavit.
Cui debet
Quod sibi innotuit humanum Genus, seipsam Medicina.
Sereniss. Majestat. Jacobo et Carolo Britanniarum
Monarchis Archiatrus et charissimus.
Collegii Med. Lond. Anatomes et Chirurgiæ Professor
Assiduus et felicissimus;
Quibus illustrem construxit Bibliothecam,
Suoque dotavit et ditavit Patrimonio.
Tandem
Post triumphales
Contemplando, sanando, inveniendo
Sudores,
Varias domi forisque statuas,

Quum totum circuit Microcosmum,
Medicinæ Doctor et Medicorum,
Improles obdormivit
III Junii anno salutis MDCLVII, Ætat. LXXX.
Annorum et Famæ satur.

CHAPTER III.

RECENT HISTORIANS OF THE DISCOVERY OF THE CIRCULATION OF THE BLOOD.

My work would be incomplete were I not to conclude with a notice of some at least of my predecessors, historians of the Circulation, critics and advocates of one or another to whom the discovery has been ascribed. In exposing the views of the great anatomists of former times from their works, I have referred incidentally oftener than once to recent writers who believe that in these they detect a knowledge more or less complete of the Circulation.

Among the most persistent of all in his advocacy of the claims of Hippocrates to such distinction is Jo. Ant. van der Linden, professor of medicine in the University of Leyden. In a series of no fewer than twenty-seven dissertations published under the names of his students on taking their medical degrees,[1] he has brought together and given his own interpretation to every passage in the writings of the Father of Physic which he thinks bears upon the question in

[1] Jo. Ant. van der Linden. Hippocrates. de Circuitu Sanguinis, Dissertationes xxvii. Lugd. Batav., 1659–63. 4to.

hand. But I have said enough under the head of Hippocrates on the learned professor's lucubrations to make it unnecessary for me to take up the subject at any length in this place. I only add, that Van der Linden is totally opposed to Harvey's title to be accounted the discoverer of the Circulation of the Blood. Advocate as he is of Hippocrates, however, he would not have him enriched to the extent of making every one who came after him his debtor. Harvey had not to go so far back as the days of the Coan Sage for his knowledge. Van der Linden informs us seriously, that "he had been told by the learned Dr. Nicholas Oudart that he—Oudart—remembers to have heard Harvey say in the course of a lecture—*Harveium profitentem*—that he had had the first idea of the circular motion of the blood from George Heriot the apothecary or jeweller—*pharmacopolos seu gemmarius*—of his serene Majesty King James"! Van der Linden, in a word, is of opinion that "it was not of himself or from his proper studies that Harvey made the inestimable discovery," but thinks it "more than likely that he had it either from Sarpi, or Heriot, or Cæsalpinus,"—from any one, in short, rather than from himself. (§ 582 in the series of dissertations referred to.)

T. J. Almeloveen,[1] appears to have been inspired by Van der Linden, and may be said to improve on all he finds said by his guide and authority. Almeloveen is

[1] Inventa nov-antiqua. Amstelod., 1684.

of opinion that Hippocrates was certainly aware of the great truth commonly ascribed to Harvey. But the old writer whom he credits with the most complete knowledge of the matter is Nemesius Bishop of Emessa, who lived in the early part of the Christian era—on what sufficiency, whether of fact or authority, we have seen. Be this as it may, Almeloveen is still assuredly of opinion that the circulation was perfectly well known to anatomists long before the days of Harvey; a fact, which he believes Van der Linden to have placed in the clearest possible light. Among later writers Almeloveen names Cæsalpinus particularly, and says that "the Circulation of the Blood is described by him in the plainest terms—*sanguinis circuitum planissimis verbis descripsit,*"—a conclusion in support of which he quotes the passage from the Questiones Peripateticæ, in which the swelling of the veins of the arm beyond the bandage is discussed.

The discovery of the valves of the veins, and a knowledge of the Circulation, is then ascribed to Paul Sarpi in anticipation of Fabricius, Cæsalpinus and Harvey. "The account of his discovery," he says, "is given by Fra Paolo in a book which he wrote whilst on his death-bed at Venice, where it is still preserved in the Library of St. Mark's."

By the side of all the positive statements thus made, Almeloveen, nevertheless, finds it necessary to offer an apology for the perfunctory and imperfect manner in which he owns that modern writers before Harvey have

spoken of the circulation. "It had been nothing less than waste of time, however," he concludes, "had they said much about what was known to all, or to write an Iliad after Homer"! (p. 225.) Such is the way in which men of learning and respectability in every-day life write history when their prejudices are engaged, and they have taken no pains duly to inform themselves.

Dutens (Louis), Rector of Elsdon, Northumberland, author of a work that has had considerable vogue and contains a good deal of entertaining and even useful information.[1] He is less at home, however, on matters pertaining to anatomy and physiology, than on those that have general physical science for their object. On the circulation of the blood he is of opinion that Plato, after Hippocrates, is the first who speaks with any clearness of a circular motion of the blood; and we have had occasion ourselves to direct attention to the remarkable word *peripheresthai* of which the philosopher makes use. Aristotle also, Dutens believes, had seized the same idea in a more or less definite measure. Dutens has the usual story about Fra Paolo and the valves of the veins; but nothing else that requires notice at our hands.

Walæus (J.)[2] whom I have had occasion already to

[1] "An Inquiry into the Origin of the Discoveries attributed to the Moderns. Tr. from the French." 8vo, Lond., 1769. 3rd ed., 4to, Lond., 1796.

[2] Epistolæ duæ de motu Sanguinis ad Th. Bartholinum.

mention incidentally, like so many others, speaks at random when he ascribes the discovery of the valves of the veins to Sarpi, and goes on to say that "the learned William Harvey taking the hint from him described the circular motion of the blood more accurately, and having added to the arguments for it by new experiments and set the whole subject on a better foundation, published his 'Exercises,' as if the discovery had been all his own." With how little justice much of this is said we know, since we have had a true account of Sarpi's ideas. The adverse and unfair criticism of Waley is the more notable as coming from a writer who was well aware of the contention that is so apt to arise about priority in discovery. "No one," says he, "can now publish anything, or communicate his views to a friend, but he immediately finds another to detract from his merits, to dispute his originality, and for his labour and pains to find that the only return he has is envy, detraction, and trouble of mind."

Sprengel (Kurt), Professor of botany in the University of Halle, born 1766.[1] Sprengel is one of those among the later learned men of whom Germany boasts so many, who has done much to mislead opinion in regard to the Discoverer of the Circulation. Sprengel says, in so many words, that Cesalpino "was not only aware of the transit of the blood through the lungs

[1] Geschichte der Arzneikunde. 7 Bände, 2te Ausg. Leipz. 1821–28.

from the right to the left side of the heart, but also of its circulation throughout the body.[1] And this," he continues, "was certainly learned neither from Fabricius nor from Harvey." Cesalpino most assuredly learned nothing of all he knew on the motion of the blood from Fabricius, whom he preceded as a writer by many years, and from whom, although they were contemporaries, he could have learned nothing of the general circulation, as it was not even dreamt of by the learned professor of Padua; and to suggest the possibility of his having had his knowledge from Harvey, is more than gratuitous; inasmuch as he was gathered to his fathers twenty-four years before the Exercitationes de Motu Cordis et Sanguinis appeared. How Sprengel should have committed himself as he does, passes comprehension, when we find him admitting on the very next page that "Cesalpino acknowledged an ebb and flow in the veins, and therefore shows himself uncertain of his case. Had he started from the discovery of the valves of the veins and been more consequent with himself he would have discovered the Circulation of the Blood!"[2] Cesalpino is therefore credited, first, with the discovery of the circulation, and then referred

[1] Auch den grossen Kreislauf der Säfte durch den ganzen Körper hat Cæsalpino gekannt. Op. Cit. Th. iii., S. 89.

[2] "Er spricht doch noch von einer Ebbe und Fluth des Blutes in den Venen, und ist also seiner Sache nicht gewiss. . . . Entdecker des grossen Kreislaufs wenn er mehr mit sich selbst übereinstimmte und wenn er von der Entdeckung der Klappen in den Venen ausgegangen wäre." Ib., S. 90.

to as *possible discoverer* had he known of the valves of the veins or been consequent with himself! But as Cesalpino acknowledged a to-and-fro motion of the blood in the veins, and takes no notice of the valves in their interior—though he could hardly have been ignorant of their existence—it is obvious that he could have had no idea of any circular motion of the blood throughout the body.

The distinguished historian of the medical sciences goes on elsewhere to assure us that "he would not accuse Harvey of having appropriated the discovery of another." Yet what he says in the first instance amounts to nothing less; for it were absurd to suppose Harvey unacquainted with the Quæstiones Peripateticæ; and in what he has next he condemns himself as critic out of his own mouth. Neither Fabricius nor any other contemporary of Cæsalpinus read him as does Sprengel. They had no suspicion of a circular motion of the blood, alternately arterial and venous, and it came not into their minds to imagine that Cæsalpinus ever hinted at such a thing. Nor does he. Cæsalpinus' physiology of the motion of the heart and blood is the physiology which he and his age inherited from Aristotle and Galen.

To ascribe motives, I am well aware, is mostly unbecoming where not reprehensible; but it is impossible to overlook the strange indisposition apparent almost from first to last among anatomists and so many men of learning to do entire justice to Harvey.

Was it that they were without a standard by which his singular merit could be measured? Or was it that they sought by abasing him to exalt themselves—to bridge over the gulf between his greatness and their littleness by striving to make him less than he is?

Highly as I think Servetus is to be honoured in his discovery of the pulmonary transit, I hold that too much stress has been laid on it as pointing directly to the general circulation. Its announcement did so in reality no more than the old transfusion through the septum. The liver was the laboratory and source of the blood, and Galen showed conclusively that the left ventricle and arteries contained blood as well as the right ventricle and veins. Whence in fact could the blood come but from the intestines and liver? and whether it passed from right to left by filtering through the septum, or by the open passage of the vena arterialis, signified little and affected in nowise its further distribution. Servetus wrote and died in 1553; Columbus made his induction generally known three years later, and Cesalpino, 1593, speaks of the transfusion from the right to the left ventricle by the objectionable term *Circulation*. But between 1553 and 1628, three-quarters of a century intervened, the valves of the veins having been made known meanwhile; yet did no one imagine that there were fewer than two kinds of blood moving to and fro in appropriate canals until Harvey appeared, and proclaimed the heart the moving

power of one blood, alternately dark and crimson, as it flowed in the veins or the arteries. Seventy-five years had, therefore, to elapse before the discovery of Servetus was seen as more than an isolated physiological fact; and he who saw it first in its connection with the great mechanical process in the animal organism was Harvey.

Barzellotti (Giacomo), Professor of Medicine in the University of Pisa. In imitation of Fontenelle, whom I have quoted, Barzellotti treats us to a "Dialogue of the Dead,"[1] in which figure at first Harvey and Cæsalpinus in conference; and by-and-by Aristotle, Hippocrates, and Galen, as umpires between the English anatomist and the Italian Aristotelian philosopher on their respective claims to the discovery of the circulation of the Blood.

HARVEY—*Professor Arvéo*—opens the conversation by excusing himself to Professor Cesalpino for having made no mention of him in the "Anatomical Exercises on the Heart and Blood," on the ground of not having properly understood what is said in the Fifth Book of the Peripatetic Questions, and in other parts of the work. CESALPINO replies: That he does indeed complain of Harvey's having taken the whole honour of the great discovery to himself without once quoting him "who by facts and arguments of the severest

[1] Dialogo sulla scoperta della circolazione del sangue nel corpo umano. (Pisa, 1831.) 8vo, with a portrait of Cesalpino.

logic," as he says, "had asserted and described the circulation long before Harvey had any idea of it. It was no fault of mine if you did not read what I had written." HARVEY.—"Do not be angry, Professor Cesalpino; it may be that I have read you amiss. I do not deny that you have shown some knowledge of the circulation [the word should be motion] of the blood, but not more or more accurately than Servetus, Colombo, Fra Paolo, and d'Aquapendente my master." CESALPINO. "I would rather refer my case to another than appear as judge in it myself."

Aristotle, Hippocrates, and Galen are now introduced, and Cesalpino, addressing them as "Grandi Maestri delle scienze naturali," proceeds to state his claims to the discovery of the circulation, in opposition to those of Harvey. Hippocrates asks, very pertinently, as it seems, how it happens that it is only since Harvey came to dwell in Elysium that the question in debate has arisen? To which he of Arezzo replies, that "folks in the olden time made less ado about discoveries, and were less interested in ascribing them to their authors. But history is more exacting now, and would have the story of this great discovery so told that the glory of having made it may not be taken from me, from Italy, from Tuscany, from the University of Pisa, even from my native Arezzo, and wrongfully ascribed to Harvey, to England, and to London!"

In the face of this flourish, another interpretation

will probably present itself to the reader—viz., that no one dreamt of a general circulation of the blood until Harvey's Exercises appeared.

Cesalpino, descanting on the nature and cause of the arterial pulse, now goes on to say: "If I put one hand on my heart, and feel my pulse with the other, I perceive the shock of both at the same moment; therefore do both heart and arteries dilate simultaneously;"[1] a statement which is repeated towards the end of the dialogue (p. 79). Harvey having now said that "the beat of the heart accords with its constriction, the beat of the arteries with their dilatation—the heart *beating* with its *systole*, the arteries *beating* with their *diastole*," Cesalpino replies: "With all submission to you, I am by no means disposed to admit this doctrine; and I think I have demonstrated that if the arteries pulsate because dilated by the blood thrown into them, the heart must also pulsate from the same cause." (!)

To show that the blood of the arteries flows into the veins, Cæsalpinus proceeds: "If one of the turgid veins beyond the bleeding fillet be opened, the blood that issues is of a *dark* colour at first; but, the flow continuing, the colour changes to *crimson*" (Qu. Perip., lib. ii., Qu. 7); a false statement, which Barzellotti nevertheless endorses as a truth. But I have shown that Cæsalpinus, speaking as he does, could only have

[1] "Se io metto una mano sul cuore e l'altro sul polso, sono ambe due percosse nello stesso tempo: dunque nel stesso tempo si dilatono." p. 26.

understood that when a vein is emptied of its proper black blood, florid blood from a neighbouring artery then entered it; precisely as Erasistratus held that when blood was seen to flow from a wounded artery, it was *after* the spirit it previously contained had escaped.

Having given what he calls a precise summary of the *modern doctrine of the Circulation as that which was conceived and proclaimed by Cæsalpinus*, Barzellotti proceeds in the name of the Aristotelian philosopher: "And now I hope, O learned Arvéo, that you will not think my pretension to this discovery unjust, nor look on me as uncivil, if I complain of you for not having even named me in your 'Exercises on the Motion of the Heart and Blood.'" To which the learned Harvey, instead of claiming the account just given as his own, answers: "Since hearing what you have said, I willingly reconsider the passages to which you refer; and if you satisfy me that you have really made the discovery you claim, I shall own at once to you, O excellent judges, that I withdraw the claims I have advanced as having discovered the circulation of the blood." He ventures, however, at this point to interpose a trifling objection to the sweeping self-assertion of Cæsalpinus, by hinting at what he finds said by him on the efflux of the blood in waking hours and its reflux during the hours of sleep, not unlike Euripus flowing to and fro between Attica and Beotia.

It were needless to say, that the defence of the dilemma on the horns of which Cæsalpinus now finds

himself, extending over some eight pages of Barzellotti's book, leaves him no nearer the declaration and demonstration of the general circulation he claims than when he set out. Aristotle, indeed, interposes, and observes, "I do not see, my good Cesalpino, how, if the blood moves in a circle incessantly, as you now assert, you can make my comparison of its flux and reflux to Euripus, several times in the course of the day, consort with your discovery." Cæsalpinus himself might possibly have found some difficulty in meeting this remark of the Stagyrite; not so his advocate, who answers for him: "If you but think of the way in which the blood is thrown from the heart by a succession of waves into the arteries, you will see that the comparison of the motion to that of Euripus is not without a certain propriety"—an explanation and escape, by changing the meaning of the words employed, which is accepted by the complacent judges, Aristotle declaring that the comparison of Euripus is not, after all, so much out of character as it appeared at first, (!) Hippocrates being delighted to see an old idea so happily applied to a modern discovery, (!!) and Galen glad to find the analogy adduced all the more reasonable, as in his day folks were rather bent on finding reasons in appearances than in nature and realities. (!!!)

Let us come to the final award, which is delivered by Hippocrates, leaving the reader himself to judge of its fairness; my own dissent from the foundation in fact of each item adduced being indicated in the

shortest possible way by a mark of admiration, here to be taken as one of negation. Addressing Cesalpino, the Father of Physic proceeds: "You were the fortunate individual who was first aware of the valves of the heart (!) and of their function at its four outlets. (!) You were the first who declared that the venous mouths of the two ventricles of the heart open and give entrance to the blood, and close again to prevent its reflux. (!) You first maintained that, with the contraction of the ventricles and the expulsion of the blood they contain, the valves of the arterial orifices close and form an insuperable obstacle to its return. (!) With cogent arguments, you showed that the blood sent to the lungs by the vena arteriosa was not for their nourishment, (!) and that the greater part of it must proceed to the left ventricle of the heart by the arteria venosa, (!) whence, by the aorta, it was delivered to all parts of the body. (!) Finally, you first determined, from the function of the valvular apparatus [of the body], the circulation of the blood from the centre to the circumference, and from this to the centre. (!) I therefore ascribe to you the high honour of having made the admirable discovery in debate, and at the same time regret that Harvey, who has shown that he was acquainted with your works, has made no reference to them, and has not even mentioned your name."

Turning to Harvey, Hippocrates then assigns to him his share in the great discovery. But everything having already been given to Cæsalpinus, I think it

needless to inflict on the reader the two or three pages of nothings that are left for Harvey. The book of Barzellotti is a curiosity in its way ; prejudice, partiality, and injustice being added to anatomical and physiological misconception. Nevertheless, as it has proved an incentive to his countrymen to persevere in the course of unfair criticism they have adopted, it required something more than a passing notice at our hands.

Flourens (P.), Perpetual Secretary to the French Academy of Sciences.[1] I have had occasion more than once to refer to M. Flourens as speaking handsomely of Harvey. He had studied the Anatomical Exercises on the motion of the heart and blood ; and with the cultivated taste of the man of letters, did not fail to appreciate the singular merits of that great work in little compass. But he every now and then shows himself distracted by what he finds in writers, predecessors of Harvey ; and, deficient in critical perception, not co-ordinating what occurs in one part of their works with what occurs in another and with the physiological ideas of their age, but interpreting detached passages by the light he has himself, he arrives at erroneous conclusions on the true meaning of what is said. Cæsalpinus more than any other writer puts him at fault in this particular. "Galen, Vesalius, Columbus, and Fabricius," says M. Flourens, "all hold that the veins are the channels by which the

[1] Histoire de la Decouvérte de la Circulation du Sang. 2me ed., Paris, 1857. 12mo.

blood is conveyed to the parts of the body for their nourishment. Cæsalpinus alone, before Harvey, dared to maintain the contrary, and that which Cæsalpinus dared to maintain, was demonstrated by Harvey.[1] But Cæsalpinus most certainly maintained nothing of the kind. To him the veins were still the vessels which carried the auctive element to the body; the arteries those which bore the proper nutrient element. To him, unquestionably, there were two kinds of blood, severally contained in appropriate vessels of different constitution and subserving dissimilar ends, the veins charged with the pabulum of growth—the arteries with that of special nutrition, or life.[2]

In his work De Plantis, continues M. Flourens, "Cæsalpinus says: The blood brought by the veins to the heart there receives its final perfection, and is distributed to the body by the agency of the spirit;" a passage which is thus commented on. "The general circulation could not be better conceived nor better defined." But M. Flourens should have seen that Cæsalpinus does no more than repeat the lesson he learned from Galen, who had his spirituous blood distributed to all parts of the body by the arteries, in

[1] "Cesalpin seul avant Harvey a osé dire le contraire, et ce que Cesalpin avait osé dire, Harvey l'a demontré." Hist. de la Decouvérte, &c., p. 262, 2me ed.

[2] Cæsalpinus in one passage pointedly makes the arteries, carrying *nutritive aliment, draw auctive aliment from the veins* through their communications called anastomoses by the Greeks.—"*Simul alimentum nutritivum fert arteria, et auctivum ex venis elicit per osculorum communionem quam Græci anastomosin vocant.*"

order to impart to them the flame of life, whilst it was from the blood of the veins that they obtained the aliment they required.

M. Flourens was an adept in writing *Eloges;* he had exercised himself less in the domain of criticism, and is ever anything but logical or consistent in what he says, when he strays from his special province. "I leave," says he, "to Servetus and Columbus the pulmonary circulation; and I collect all the most worthy titles of Cæsalpinus to the discovery of the general circulation. Let us raise statues then to these great men; but for any sake let us not lessen that of Harvey—"Elevons, elevons sans cesse la statue a ces hommes rares, mais, de grace, ne diminuons pas celle de Harvey."—But if Servetus, Columbus, and Cæsalpinus, have statues as discoverers of the circulation of the blood, Harvey can have none. Let Italy raise a statue to Cæsalpinus by all means; but let it be on his true merits, as a man distinguished above his fellows for intellectual power, as a great physician, and as the founder of the Science of Botany, not as the Discoverer of the Circulation of the Blood. Were Italy, indeed, to raise a statue to the real discoverer of this great truth, she would do no less honour to herself than to Harvey, for she was indeed his nursing mother. And were it of colossal proportions, it would only typify at once the intrinsic moral and mental nobility of the man and his large indebtedness to her for his scientific nurture.

I do not criticise M. Flourens further. His work has a proper scientific character only here and there; generally it is a gossiping production, written in the characteristic lively French style, and entertaining enough. But all he says on the moderns rests on no solid foundation. The only work he could have read with any care appears to have been the Exercitationes of Harvey. Had he done as much by the Questiones Peripateticæ, weighed the hazy statements there adventured, and contrasted the work of Cæsalpinus with that of Harvey in the spirit of impartiality, which I believe to have animated him, he would not at all times have spoken of their authors as he does; saying yea-nay for Harvey, when yea was the only word; and yea for Cæsalpinus when nay was the award of equity.

Tollin (Henri), minister of the French Protestant congregation of Magdeburg, among whose many interesting papers on the Life and Works of Servetus there is one advocating the claims of the gifted Spaniard to the discovery of the circulation of the blood, which requires our particular notice.[1] Had H. Tollin limited the title of his essay to such terms as these: "Discovery by Servetus of the Pulmonary portion of the Circulation," he would, I apprehend, have arrogated nothing more for his hero than can fairly be claimed as his due. But to suggest that Servetus had any conception of a motion of the blood throughout

[1] Die Entdeckung des Blutkreislaufs durch Michael Servet. 8vo. Jena, 1876.

the body in a circle is certainly a mistake. Servetus regarded the liver as the organ of the hæmapoesis, the veins as the distributors of the natural nutrient blood to the body, the heart and lungs as the laboratory of vital spirit, and the arteries as the channels by which it was sent to supply the individual parts with their special endowments. Servetus spoke of the distribution of the blood to the body in the same sense precisely as his age.

Tollin has erred through interpreting the martyr of 1553 by the knowledge he has himself in 1876. His survey of the views of Servetus's predecessors, nevertheless, and of the gradually accumulated anatomical facts which, rationally interpreted, led Servetus first to infer the pulmonary transit, and Harvey—not Cæsalpinus—in the end to proclaim the general circulation of the blood, is fully and effectively presented by the accomplished writer.

Tollin and Professor Preyer of Jena, editor of the series in which the "Entdeckung des Blutkreislaufs von Servet," by Tollin appears, do not fail to see Columbus's claim to the discovery of the pulmonary transit as posterior in date to its announcement by Servetus, and derived in all probability from him.

Tollin, in his partiality for Servetus, is not, however, like the Italians, always and altogether unjust to Harvey. "The great English physiologist," he says, "was not only the first who wrote a book specially devoted to the circulation of the blood; he was the first also who took clear and comprehensive views of

the organic system of which it is the consequence. A master in vivisection, the contriver of numerous new experiments, Harvey is ever seen to be the greater man the more the envious world of to-day has striven to isolate, to lessen, and to supersede him." This is just, this is true. But I regret to go on with what follows, for it is neither just nor true. "The discoverer of the circulation of the blood, however Harvey is not—not of the minor, for that was known to Servetus; not of the greater, for that was determined by Cæsalpinus. It was Harvey's great good fortune to have studied at Padua, where Vesalius and Faloppius and Columbus had taught—where he saw Fabricius demonstrate the valves of the veins, and heard Eustachius Rudius discuss the pulmonic circulation;" to which I add: BY NEITHER OF WHOM WAS THE MOTION OF THE BLOOD IN A GREAT CIRCLE THROUGHOUT THE BODY EVEN IMAGINED, AND STILL LESS DETERMINED, ANY MORE THAN IT WAS DREAMT OF BY ONE OF THEIR AUDITORS, WITH THE SOLITARY EXCEPTION OF THE ENGLISH STUDENT, WILLIAM HARVEY.

Less familiar with the old physiology than he would have been had he devoted himself to anatomical studies with the same zeal as he has to theology and the history of Servetus, I do not hesitate to say that Tollin has been led to give that to Cæsalpinus to which he has no claim, and in the same measure to detract from Harvey's title to that which belongs to

him by indefeasible right. It is as discoverer of the general circulation of the blood that Harvey claims our homage; his vivisections, his experiments, his reasonings were all accessories in illustration of the great truth he divined and gave to the world.

Ceradini (G.), Professor of Physiology in the University of Genoa. I approached the handsome volume[1] of the learned professor of Genoa with hope, but left it with profound regret. Setting out, as he informs us in his review of the anatomical facts and physiological inferences that culminated in the discovery of the circulation of the blood, by imposing on himself the most scrupulous impartiality, and thereby aiding in the redress of what he is pleased to call the injustice of centuries, Ceradini is nevertheless more or less unjust to every one who in modern times had any share in the great result. I venture to think that he does not do entire justice even to his hero, Cesalpino; for he condones the errors of the philosopher, and, starting from the physiological premisses of the present day, and blinded by patriotic feelings that should have no part in scientific discussions, credits him with conclusions to which he certainly never came.

The *first* Book of the Appunti Storico-critici is dedicated to Galen. The *second*, which I think ought to have been given to Servetus, the first in modern times who saw the septum ventriculorum as it is—a

[1] La Scoperta della Circolazione del Sangue. Appunti storico-critici. Nuova Ed. rifatta ed aumentata. 8vo., Maj. Milano, 1876.

solid—and proclaimed the passage of the blood from the right to the left side of the heart by a lengthened course through the lungs, is devoted to Colombo; the *third* has Harvey for its theme; and the *fourth*, the longest of any, winds up with Cesalpino.

The criticism of Galen is thorough, but certainly mistaken where the pulmonary transit is discussed. To Servetus our critic is persistently and glaringly unjust. He will not even allow the man his proper name, but insists that it is Reves, not Servetus, which it is said he only assumed when he became an author. Servetus, he thinks, added nothing to what was already known from Galen, and was altogether a contemptible personage, unworthy to be spoken of beside the great anatomists his contemporaries and successors. I have shown, I trust satisfactorily, how little such criticism applies to the gifted Servetus.

If Servetus is unfairly depreciated, Colombo, I believe, is as unduly exalted. In Colombo assuredly there is nothing old that is not to be found in Galen and Vesalius, and nothing new that is not in Servetus. The beautiful volume and good Latin in which Colombo presented himself to the world, I fancy, misled it in some sort as to his real merits as an anatomist.

In the Book on Harvey I find with great regret not less an entire misunderstanding of the man and his character, than a persistent indisposition to see the original experiments and inductive reasonings that follow them as more than illustrations of the hazy

language and Aristotelian and Galenical imaginations of Cesalpino. The incapacity of the Genoese professor to appreciate the modest, upright, and truthful nature of Harvey is indeed something extraordinary; all the more as he is not insensible to the mistake committed by his countrymen Eccellenti and Ercolani in their unworthy attempts to degrade the great English physiologist even below the level of ordinary men.[1] But for Professor Ceradini himself to set the word *subterfuge* beside the name of Harvey is less to insult the memory of the man who bore it than to discredit him who uses the opprobrious term.[2] To ascribe such motives, moreover, as he does for their decisions to Malpighi, Baglivi, and Haller, is surely unworthy of the critic and man of letters. These irreproachable observers, forsooth, were moved to credit Harvey with the discovery of the circulation of the blood because they had been elected Fellows of the Royal Society![3]

[1] "Umiliando Harvey a segno da ridurlo quasi alle proporzioni di un uomo commune o anche peggio." (Ib., p. 156.)

[2] In his chapter on the quantity of blood passing by the heart from the veins to the arteries (p. 41, ed. pr.) Harvey says, that what he has to advance is so new and unheard of that he fears he will have the whole world for enemies—Prof. Ceradini's comment on which, in his own words, is this: "Nessun dubio che con questi sotterfugi l'Inglese mirasse ad usurpare il vanto di Scopritore." (Op. cit. p. 175.)

[3] "Questo judizio di Baglivi tradisce o mala fede o ignoranza, &c.—Malpighi ebbe un altro motivo per dissimulare la propria venerazione per Cesalpino: l'anatomo Bolognese—Malpighi, era membro della Società Reale di Londra; e il Ragusano—Baglivi, aveva occupato nella stessa Reale Società il posto vacante per morte del maestro." (Ib., p. 205.) And of Haller: "Se fosse trovato nella stessa difficile condizione di Malpighi e Baglivi, cioè di membro della Reale Accademia di Londra." (Ib., p. 266.)

Ceradini will have it that "Harvey founded the whole doctrine of the circulation exclusively as it were on the existence of the valves in the veins."[1] We have only to turn to the "Exercises on the Heart and Blood" to see how untrue this is. Harvey has already shown, by numerous anatomical facts, various experiments and irrefragable inferences from these, that *a circular motion of the blood throughout the body is matter of necessity*, before he even mentions the valves of the veins. It is only so near the end of his work as the thirteenth chapter that we meet with the bandaged arm, the turgid veins, the visible seats of the valves, and the discussion of the necessary influence of these on the flow of the blood. Harvey's whole thesis may, in fact, be said to be wound up in the immediately succeeding chapter, the fourteenth, which is headed, *Conclusio demonstrationis de Circuitu sanguinis.* (P. 58, ed. pr.)

Speaking of Harvey's views of the lacteal vessels, the Genoese professor is equally unjust to the great man he criticises, and dares to say that "a stain attaches to the character of the English anatomist as the contemner of every discovery not his own; that he was the most determined opponent of that of Aselli, and alone of all denied the chyliferous and lymphatic vessels, as well as the function of the thoracic duct.[2]

[1] "Le valvole nelle vene, sulla quale, quasi esclusivamente, Harvey volle fondare l'intera dottrina della circolazione del sangue."

[2] "Questa macchia del carattere dell Inglese . . . . . Fra i piu ostinati aversatori di questa scoperta . . . . Questo disprezzo per ogni scoperta

But we know from Harvey himself that he did not deny the existence of the lacteal veins, never opposed Aselli, and had even observed the vessels in question in the course of his dissections before Aselli's book appeared. It was their *office* and the *nature of their contents* that he questioned, not their reality; as it was the *sufficiency* of the delicate thoracic duct that made him pause in assenting at once to the important function assigned to it by Pecquet.

With all these misrepresentations, however, Professor Ceradini has not exhausted his jealousy and dislike of Harvey. He would blacken the great anatomist morally yet more, and says, "He died impenitent in 1678, six years after the discoveries of Bartholin."[1] Is this seemly—is it not indecent? The use of such language, suggesting thoughts of a far-off historical incident, is as surely reprehensible as it is out of place in a scientific discussion.

Ceradini's conclusion, in few words, is this: that Harvey had no merit beyond that of having furnished a new demonstration and completed in some sort the doctrine of the circulation.[2]

How little such a conclusion is borne out by the facts I confidently leave to the decision of every impartial mind.

non sua . . . . . Solo il nega i vasi chiliferi come i linfatici e la stessa funzione del dutto toracico." (Op. cit. p. 182–3.)

[1] "E muore impenitente l'anno 1678, [1677] sei anni doppo le scoperte di Bartholin." (Ib.)

[2] "Non avesse Harvey altro merito di quello in fuori de averne fornito una nuova dimostrazione e completata in qualche forma la dottrina [della circolazione]." (Ib., p. 184.)

Without fear of having my statement proved untrue by whosoever will take the necessary pains to master the subject, I maintain that *the Harveian circulation of the blood is not in the writings of Cesalpino.* Beside the Genoese professor's summary of Harvey's merits, I take leave to add mine of Cesalpino's, and say that, *in so far as the circulation of the blood is concerned, Cesalpino's chief merit seems to me to consist in having shown conclusively, by his efforts to harmonize what he saw himself with the accredited views of his age, that the Old Physiology was untenable.* This, however, neither he, his contemporaries, nor any one of his successors, for fifty years and more, with the single exception of William Harvey, had the gift to perceive.

Writing as historian and critic, not as controversialist, and having already spoken at great length of Cesalpino, I am spared the pains of following Ceradini in his advocacy of the distinguished Aristotelian philosopher as discoverer of the circulation of the blood, and conclude, after the lengthened and careful study I have made of his works, by contrasting some few of what I conceive to be leading features in his physiological conceptions with those of Harvey.

1. Cesalpino believed, with Galen, that there were two kinds of blood in the animal body, severally moving to and fro in distinct orders of vessels—arteries and veins—and dedicated to different functions ; the moving power being connected with certain attractions, now on

this side towards the periphery, now on that towards the centre. Harvey proved that there was but one blood, alternately florid and grimy, borne outwards from the heart as the moving power by the arteries to all parts of the body, returning thence in a ceaseless circuit to the heart by the veins.

2. Cesalpino believed that the arteries and veins were connected with the heart, to the end that the blood they severally contained might receive elaboration, and be impregnated with heat and spirit, by which it became fitted for its different offices. Harvey proved that the arteries and veins were in communication with the heart in order that the blood might be propelled by the muscular power of the organ first through the lungs by the pulmonary artery, there acquire its florid colour and perhaps its heat, reach the left ventricle by the pulmonary veins, be pumped by it through the aorta to the body at large, to return from thence, by the veins, lowered in temperature, to the source whence it had set out.

3. Cesalpino imagined that the swelling of the veins when obstructed by a bandage was owing to the attractive force of the heart calling back the blood, lest, being cut off from the source of its heat, it should coagulate and perish. Harvey demonstrated the rising of the veins, so obstructed, to be due to the tide poured in upon their capillary endings from the capillary endings of the arteries.

4. Cesalpino held that the veins and arteries com-

municated throughout their course, by means of the anastomoses imagined by Galen, giving and taking reciprocally as they ran,[1] and ending in the tissues to which they were distributed; so much of their contents as was not required to aliment, to nourish, or to grow into these returning to the heart by the way it came during the hours of sleep. Harvey believed that the arteries ended in the interstices of the tissues, nourishing and vitalizing them; and all that was not wanted for these ends, passing into the roots of the veins, returned to the heart to begin its course anew; the two orders of vessels, arteries and veins, having no anastomotic communications save by their endings in the interstices of the tissues.

5. To Harvey the valvular element of the sanguiferous system existed simply and solely for the furtherance of the blood in a circle throughout the heart, the lungs, and the body at large. To Cesalpino it was imperfect in its action at all times,[2] and bore reference to the flow of the vital spirits and native heat, rather than the blood.[3]

[1] "Per hos transitus (anastomoses videlicet) arteriæ dilatatæ ex venis trahunt, contractæ, contra, in eas regerunt." (Galenus de Pulsuum usu, cap. v.)

[2] Non cogimur membranas vasorum educentium claudere, &c.—vide p. 127.

[3] Jure igitur arteriæ magnæ ostium adversus motum spiritus in cor, &c., p. 126.

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