

**a
history
of
medicine
in
pictures**

by George A. Bender

painting by Robert A. Thom

**Harvey and the Circulation
of Blood**

WHAT has been called the greatest discovery ever made in physiology—the circulation of the blood—was quietly announced early in the seventeenth century as a part of a series of lectures in anatomy. No fanfare, no impassioned oratory accompanied the matter-of-fact pronouncement which was to shake beliefs in the medical world, to cast off, finally, the revered fetters of Galenism, and to establish an entirely new concept of function of the human body. The man who brought about this revolution was William Harvey, a short, slight, dark-complexioned Englishman, with flashing, spirited eyes and a wealth of nervous energy.

Though Harvey was first correctly to describe and to prove circulation of the blood, he was by no means first to study this marvelous physiologic phenomenon, wherein the heart, a remarkable muscular organ weighing about ten ounces in the adult human, is able to pump approximately twelve pints of blood through a double circular network of thousands of miles of arteries, capillaries, and veins, during a period of a few minutes. Lore concerning the pulse and conjecture about the importance of the heart are to be found in Egyptian papyri written 3500 years ago. Hippocrates, about 400 B.C., considered the pulse to be due to movements of blood vessels. Aristotle, in the next century, attached great significance to the heart, attributing to it many

ROBERT THOM



qualities it does not possess. But the erroneous views of Galen, written in the second century A.D., prevailed throughout the medical world for 1500 years. Galen taught that the three principal organs of the body were the liver, the heart, and the brain. Food was absorbed from the intestines and carried to the liver where it was elaborated into blood and charged with (imaginary) natural spirits. The heart, Galen believed, contributed vital spirits; the brain, animal spirits. He believed also that the pulmonary vein carried air from the lungs to the heart; that the septum of the heart was perforate; and that arterial and venous systems were separate. The arteries, he taught, carried vital spirits to the body; the veins carried natural or nutritive spirits, the distribution of which was accomplished by tidal ebb and flow of the blood. For medieval and renaissance physicians, the fact that the great Galen had propounded this system was enough!

Early in the sixteenth century, Leonardo da Vinci and Andreas Vesalius questioned Galen's views concerning perforation of the septum of the heart, and primacy of the liver in the venous system. Michael Servetus, in 1553, described the pulmonary circulation; Realdo Colombo, about the same time, demonstrated that the pulmonary vein contained blood and denied that the septum of the heart was porous; and Fabricius of Aquapendente described and demonstrated the valves in veins. But it remained for Harvey, pupil and good friend of Fabricius, to investigate scientifically the circulation of blood and to postulate a sound theory that could be proved by demonstration.

William Harvey was born at Folkestone, in England, April 1, 1578. He was the eldest of a large family fathered by Thomas Harvey, well-to-do merchant and civic official. Several of William's brothers also became wealthy merchants; but William seems to have prepared for the study of medicine early in life. He was given every educational advantage, including King's School at Canterbury and Gonville and Caius College at Cambridge University, from which he received the Bachelor of Arts degree in 1597. Shortly thereafter, Harvey enrolled in the University of Padua. In its famed medical school, where Vesalius had done his most brilliant work, Fabricius of Aquapendente now was at the height of his career, lecturing in the oval, six-tiered amphitheatre which he designed for use in teaching anatomy (and which is still standing). Here, Harvey, one of several hundred students, stood day after day, watching and listening as the master lectured and demonstrated rapidly (lest the reek of unpreserved cadavers become overpowering in the close room). In later years, Harvey was to acknowledge his debt to the great teacher, crediting Fabricius' work on the valves in veins for having stimulated him to investigate the mystery of blood circulation.

Harvey received the degree of Doctor of Medicine from the University of Padua in 1602, returned to England, and in the same year received a second doctoral degree in medicine from Cambridge University. He then settled in London to practice medicine, losing no time in attaching himself to the College of Physicians, to which he was admitted a candidate in 1604. In November of that year he married Elizabeth Browne, daughter of Lancelot Browne, former first physician to Queen Elizabeth. In 1607, the College of Physicians elected Harvey a Fellow. He immediately applied for the post of physician to St. Bartholomew's Hospital. Securing the appointment in 1609, he held this important position until 1643, when he fell from political favor.

Continuing his close association with the College of Physicians, on August 4, 1615, Harvey was appointed to serve as Lumleian lecturer—a position equivalent

the picture William Harvey, slight, energetic, scientific English physician of the seventeenth century, with his famed pointer in hand, used demonstrations to prove his revolutionary theory of circulation of blood during his anatomical lectures before the College of Physicians of London. His book, *De Motu Cordis*, published in 1628, upset traditional followers of Galen and brought whole new concepts of circulation of blood and of anatomy to medicine. Unperturbed by criticism, dedicated to research and to hard work, Harvey, who died in 1657, lived to see his theory generally accepted.

to that of professor of anatomy. This appointment carried life tenure; and Harvey held the post until 1656, one year before he died. The appointment called for his teaching a course on anatomy requiring six years to complete, consisting of two lectures each week and semi-annual anatomical demonstrations on cadavers. At the end of the six-year cycle, the course was repeated.

Harvey began his lectures on anatomy in April, 1616—the same month that Shakespeare died. Lectures were held in the College of Physicians' new headquarters at Amen Corner, at the end of Paternoster Row. In his first lecture of this season, he discussed the abdomen, chest, and head. Lecture notes reveal that, by 1616, Harvey had dissected more than eighty different kinds of animals—a feat the more remarkable in view of his busy private practice.

Of greater significance among these first lecture notes, however, is the first clue to Harvey's convictions concerning the heart and the circulation of blood.

It was not until twelve years later, in 1628, that Harvey saw fit to publish his great work. This he did in a poorly printed book of only 72 pages, containing a number of errors—but this book became the medium by which the thinking of medical men in anatomy and in therapeutics was revolutionized. His book was titled: *Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus*—"An Anatomical Treatise on the Movement of the Heart and Blood in Animals."

The conclusions set forth in *De Motu Cordis* are virtually those written in Harvey's first Lumleian notes, enlarged upon and supported by observations and by demonstrations. Particularly significant, however, is the revelation of Harvey's scientific approach to the problem and his progress to solution. This method involved four steps: observations

of facts; thought leading to hypothesis; performance of experiments to prove or to disprove the hypothesis; and finally, conclusions.

In essence, Harvey's observations were: the heart is a muscular organ that contracts and relaxes; contraction (systole) is its active position, expansion (diastole) its position of rest. At each contraction of the auricles, blood is forced into the corresponding ventricles, and thence into the great arteries as the ventricles contract. Once in the arteries, blood cannot return directly to the heart because of the heart valves. Harvey showed that the amount of blood passing through the heart in one hour would have weight three times that of the whole individual man; therefore the blood must pass through the heart again and again.

How does this occur? Harvey then set forth his hypothesis: The blood, he wrote, has "a movement, as it were, in a circle. The blood, forced by the action of the left ventricle into the arteries, is distributed to the body at large..." and, in his opinion, there are paths of communication between the arteries and the veins, whereby the blood is returned to the heart by way of the veins. By the arrangement of valves in blood vessels, he demonstrated that blood in arteries can flow only away from the heart; blood in veins can flow only toward the heart.

Harvey's experiments were at once simple and illuminating. By use of tourniquets he demonstrated that constriction applied to the extremities causes arteries on the side toward the heart to become enlarged and congested; and such constriction causes veins beyond the tourniquet to swell. An even simpler experiment was made by having an assistant grasp a staff firmly in his hand. Harvey, by depressing visible veins with one or two fingers, could demonstrate the single direction of flow of venous blood.

Harvey's conclusions are summed up in

Acknowledgment of helpful assistance in historical research basic to preparation of the text and of the picture, Harvey and the Circulation of Blood, is extended to Erwin H. Ackerknecht, M.D., Professor and Director of the Institute of the History of Medicine and Biology, University of Zurich, Switzerland; to L. M. Payne, Assistant Librarian, Royal College of Physicians, London; to Philip Wade, Librarian, Royal Society of Medicine, London; to E. Ashworth Underwood, Director, The Wellcome Museum, and F. N. L. Poynter, Librarian, The Wellcome Historical Medical Library, London; to C. H. Gibbs-Smith, Keeper of Extension Services, G. F. Wigfield-Digby, Keeper of Textiles, and Miss M. B. Blumstein, Research Assistant, all of the Victoria and Albert Museum, London; to L. O. Smith, Manager, F. Macdonald, M.D., Medical Service Department, H. W. Pearson, M.D., Director of Clinical Investigation, and J. R. Archer, all of Parke, Davis & Company, Ltd., London; to Dr. Louis B. Wright, Director, the Folger Shakespearean Library, Washington, D.C.; to Professor Charles Morgan, Meade Arts Building, Amherst College, Amherst, Massachusetts; to W. R. Jeeves, Vice President and Director of Overseas Operations, and J. P. Gray, M.D., Director of Special Medical Services, Parke, Davis & Company, Detroit, Michigan.

Litho. in U.S.A.

Text and illustration copyright 1959 by Parke, Davis & Company.

his brief Chapter 14. According to Powers' translation they were:

"Since all things, both argument and ocular demonstration show that the blood passes through the lungs and heart by the force of the ventricles, and is sent for distribution to all parts of the body, where it makes its way into the veins and pores of the flesh, and then flows by the veins from the circumference on every side to the centre from the lesser to the greater veins, and is by them finally discharged into the vena cava and right auricle of the heart, and this in such quantity or in such afflux and reflux, thither by the arteries, hither by the veins, as cannot possibly be supplied by the ingesta, and is much greater than can be required for mere purposes of nutrition; it is absolutely necessary to conclude that the blood in the animal body is impelled in a circle, and is in a state of ceaseless movement; that this is the act or function which the heart performs by means of its pulse, and that it is the sole and only end of the movement and contraction of the heart."

In 72 pages, in this simple, direct phraseology, Harvey was to change the course of medical thinking. This was not without opposition, bitter and unreasoning, from defenders of tradition; but Harvey was to live to see his pronouncements become generally accepted throughout the world. Four years after Harvey's death, Malpighi's microscope, in 1661, was to confirm Harvey's postulation of passage of blood from capillary arteries to veins, in the lung; and in 1688, Antony van Leeuwenhoek was to report observation, through his little homemade lenses, of capillary circulation in the extremities.

From 1616 on, Harvey's Lumleian lectures continued; he attended patients at St. Bartholomew's Hospital; and he continued to gain eminence in his profession. In 1618, he was appointed physician extraordinary to King James I (he of King James' translation of the Bible fame). Harvey rose to physician in ordinary to James' successor, King Charles I, who remained Harvey's friend as long as he lived. Harvey became a Censor of the College of Physicians, and later, its Treasurer. On several occasions, the King commanded him to accompany diplomatic delegations abroad. He frequently accompanied his King on hunting trips, having the privilege of dissecting the kill for scientific study. In 1639, he became

senior physician to the King, with lodgings at Whitehall. In that year, too, he accompanied Charles I to war in Scotland. That was the beginning of a series of controversies that led to a decade of civil war, travail, downfall of Charles I, and decline of Harvey's political fortunes. He remained loyal to and served his King until Charles was beheaded in 1649. Meantime, however, he found time to conduct and to record many experiments in natural science and in embryology; to become, for a time, a warden of Merton College; and to receive, from Oxford, another doctorate. Little mindful of economic security, his most lamented losses in the civil war were papers, records and exhibits stolen from his Whitehall residence by marauding mobs.

Following the King's death and the rise of Cromwell, Harvey retired to a quiet life in the homes of his brothers. Through most of his life, these same brothers had looked after his financial affairs. Afflicted by gout and by arthritis, and heavy of heart, William Harvey now turned his attention almost exclusively to the welfare of the College of Physicians. In 1651, his *De Generatione Animalium*, a work on embryology, was published. In 1654, he refused election to the presidency of the College on grounds of ill health. Two years later, he resigned his Lumleian lectureship and set up a gift fund for an annual dinner and for a commemorative oration.

Death came to William Harvey on June 3, 1657, in his eightieth year. Thus was closed one of the most active, fruitful careers in medicine of the seventeenth century, the contributions of which were to be of benefit to all mankind thereafter.

REFERENCES

- Ackerknecht, E. H., unpublished monograph.
- Anonymous, *William Harvey, Tercentenary Commemoration*. Washington, D.C., U.S. Department of Health, Education, and Welfare, 1957.
- Farr, Frederic J., *A Short History of the Royal College of Physicians in London*. Handwritten manuscript in the library of the College, 1883.
- Keele, K. D., *William Harvey: The Man and the College of Physicians, in Medical History*, Vol. 1, No. 3. London, Wm. Dawson & Sons Ltd., 1957.
- Leake, Chauncey D., *Anatomical Studies on the Motion of the Heart and Blood*, English translation. Springfield, Illinois, Charles C. Thomas, 1928.
- Martí-Ibáñez, Félix, *Padua and London—A Harveian Tale of Two Cities, in International Record of Medicine*. New York, MD Publications, Inc., 1957.
- Power, D'Arcy, *William Harvey*. London, T. Fisher Unwin, 1897.
- Singer, Charles, *The Discovery of the Circulation of the Blood*. London, Wm. Dawson & Sons Ltd., 1956.
- Wright, A. Dickson, *Dr. William Harvey, in The New Scientist*. London, 1957.

