

Catalog of Exhibit
"William Harvey
and the
Circulation
of the Blood"

William
Harvey

TERCENTENARY COMMEMORATION 1957

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
Public Health Service

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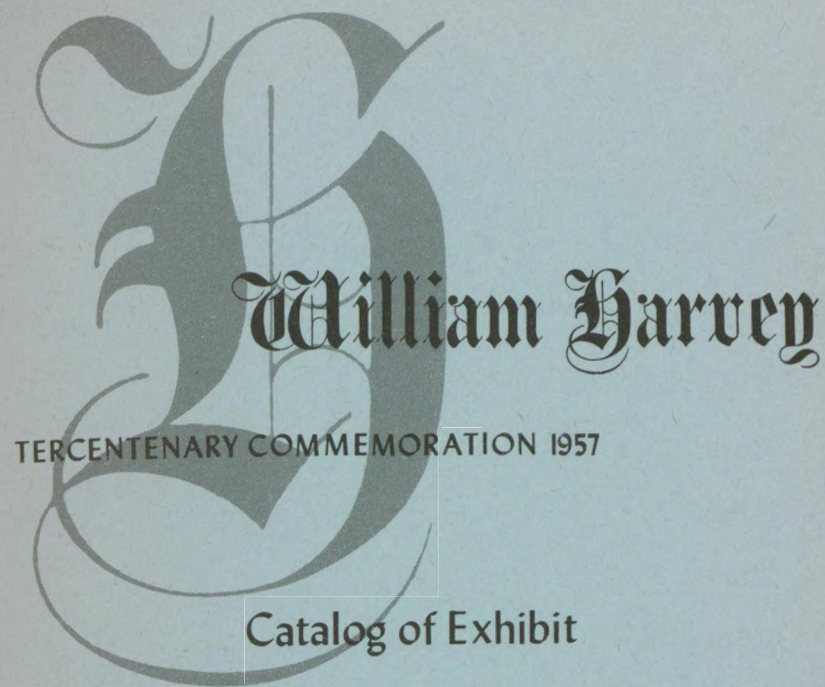
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Prepared by
National Heart Institute and
National Library of Medicine

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HISTORICAL INTRODUCTION

The very earliest medical writings we possess show some knowledge of the blood and its role in the body. Pulse lore and the theory of the importance of the heart as one of the primary organs of the body are recorded in the Egyptian papyri, while a number of anatomical and physiological theories were advanced by the Greeks, the Romans, and later medical writers as explanation of the observed phenomena. The standard view of the nature and action of the heart, the blood-vessels, and the pulse from about 150 A.D. to the 17th century, however, was that of Galen.

The Galenic system taught that the three principal organs of the body were the liver, the heart, and the brain. Ingested food was absorbed from the intestines as chyle and carried by the portal vessel to the liver, where it was elaborated into blood and charged with an imaginary essence, the natural spirits. These natural spirits were distributed from the liver to the parts of the body by means of the veins, in which the blood ebbed and flowed, up and down. During this ebb and flow, the veins absorbed into the blood the impurities from the body, and these impurities were discharged through the lung, to which the blood was brought in what by now is called the pulmonary artery.

In the Galenic view, the vessel now designated as the pulmonary vein carried air to the cavity of the left ventricle of the heart, where it met the trickle of blood that came through septa between the two chambers of the heart. The combination of the air and the blood elaborated the vital spirits, which were responsible for movement and muscular activity; the vital spirits were distributed throughout the body by the arteries. The heart, the hottest organ of the body in the theories of both Aristotle and Galen, was cooled by the air entering it from the lungs, and respiration, therefore, was a mechanism for regulating the innate heat of the heart.

Beginning with the revival of learning in the 12th century, human dissection once again made anatomical knowledge available. By the early 16th century such anatomists as Leonardo da Vinci and Andreas Vesalius were questioning the views of Galen, particularly the presence of septa in the heart and the primacy

of the liver. Advances in knowledge of the anatomy and physiology of the circulatory system were made by a number of people, including Michael Servetus, who described the lesser (pulmonary) circulation in 1553; Realduus Columbus, who denied the presence of septa in the heart (1559); Fallopius; and Fabricius of Aquapendente, who described the valves of the veins (1603) and who, as the teacher of Harvey in Padua, gave him the stimulus to work on the problem of the circulation of the blood.

WILLIAM HARVEY

The man who brought all the known facts together and worked out the physiological basis for the circulation of the blood by means of a new technique, quantitative measurement, was William Harvey, an Englishman. He was born in Folkestone in 1578 and died in London in 1657. The eldest son of a yeoman, Harvey studied at the grammar school in Cambridge, Gonville and Caius College in Cambridge, and Padua in Italy. Caius College had strong medical ties with Padua, as a result of a period of study there by John Caius in the mid-16th century; so it was natural that after obtaining his degree at Cambridge Harvey went to study under Fabricius at Padua, from which place he obtained his M.D. degree in 1602. To this he added a Cambridge M.D. the same year and an Oxford M.D. many years later. In 1609 he was elected physician to St. Bartholomew's Hospital and in 1615 he was named Lumleian lecturer at the College of Physicians in London, both life appointments.

Harvey's later advancement in his profession is shown by the fact that he was appointed physician to James I in 1618. He was tutor to Charles II at the Battle of Edgehill during the Civil Wars and was commanded by Parliament to attend the king, Charles I, in Oxford and up to his beheading. He was also sent to the continent on several diplomatic commissions. His pacific nature and his standing in the community are shown by the fact that he was not deposed as a Royalist during the Commonwealth.

HARVEIAN VIEWS

The exact date when Harvey first evolved his theory of circulation is not known. His great work, De motu cordis, was published in 1628 (by Fitzer, an obscure printer in Frankfurt-am-Main), but his Lumleian lecture notes show that he lectured on this theory as early as 1616.

In his lecture notes (Praelectiones), Harvey makes three points: (1) The blood is constantly passed through the lungs into the aorta, as by two clacks (valves) used to raise water, with no back flow. (2) There is a transit of blood from the arteries to the veins. (3) A perpetual motion of the blood in a circle is brought about by the beat of the heart.

These conclusions are reiterated in the De motu cordis, where the reasoning on which they are based is set forth. Harvey first sets forth his observations of the facts, then his

hypothesis on the facts, next his experiments to prove or disprove his hypothesis, and finally his conclusions.

Observations: The heart is a muscle which contracts and relaxes; the contraction (or systole) of the heart is its active position, the expansion (or diastole) is a position of rest. During contraction the heart changes in length and strikes the chest wall, and this is simultaneous with an expansion of the arteries, which may be felt as the pulse. At each contraction of the auricle of the heart, blood is driven into the corresponding ventricle, and subsequently into the arteries by the contraction of the ventricles.

Once the blood has entered one of the great arteries, it cannot return because of the action of the valves, and this process must be continuous. It is at this point that Harvey calculates mathematically the amount of blood passing through the ventricle in one hour and shows it is more than three times the weight of a man. It therefore must be the same blood going through the heart over and over again, and the problem confronting Harvey was to figure out how the blood sent out to the body in arteries could get back to the heart through the veins.

Hypothesis: The solution Harvey sets up is his hypothesis. The blood has, Harvey postulates, "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 there are, he suspects, anastomoses of arteries and veins to return the blood to the heart.

Experiments: By use of tourniquets in animals and humans, Harvey demonstrates that constriction of arteries makes the blood vessels closer to the heart turgid, while constriction of the veins brings turgidity to the blood vessels between the tourniquet and the periphery of the body.

Conclusions: "All things, both argument and ocular demonstration, confirm that the blood passes through lungs and heart by the force of the ventricles, and is driven thence and sent forth to all parts of the body. There it makes its way into the veins and pores of the flesh. It flows by the veins everywhere from the circumference to the centre, from the lesser to the greater veins, and by them is discharged into the vena cava and finally into the right auricle of the heart. (The blood is sent) in such a quantity, in one direction, by the arteries, in the other direction, by the veins, as cannot possibly be supplied by the ingested food . . . It is therefore necessary to conclude that the blood in the animals is impelled in a circle, and is in a state of ceaseless movement; that this is the act or function of the heart, which it performs by means of its pulse; and that it is the sole and only end of the movement and pulse of the heart."

LATER WORK ON THE CIRCULATION

Harvey's views were challenged by only a few writers of his time, of whom Jean Riolan, Dean of the Medical Faculty of the University of Paris, was the most important and the only

one whom Harvey deigned to answer in writing, although he is said to have travelled to Germany to try to convince Caspar Hofmann of the truth about the circulation. It might be said, however, that the early recognition of Harvey's theory is in a large measure due to the examination of his work as a result of this opposition.

Harvey had postulated anastomoses of the arteries and veins, but had not demonstrated them. To see the capillaries a microscope is necessary, and although microscopes had been used by Galileo as early as 1610, Harvey apparently never employed one. Not until Marcello Malpighi demonstrated the capillary network in the lung in 1661, 4 years after Harvey's death, was the proof of the circulation of the blood really complete. Somewhat later Jan van Swammerdam gave a better account of the capillaries, while in 1688 Anthony Van Leeuwenhoek sent to the Royal Society his description of the actual passage of the blood corpuscles through the capillaries, thus completing the proof of the circulation of the blood.

Once the truth of Harvey's views and his method of experimentation were established, it was possible to make further observations on the circulatory system; the work of Stephen Hales on blood pressure (1773), of Albrecht von Haller on calcification of the heart (1755), of Morgagni on mitral stenosis (1761), of Robert Whytt on the force of the heart (1826), of John Hunter, John Cheyne, William Stokes, Ludwig Traube, Julius Cohnheim, Pierre Potain, Augustus Waller, Etienne Fallot, Wilhelm His, Willem Einthoven, among others, follows logically from the theory and methodology of William Harvey.

CATALOG OF THE EXHIBIT

This exhibit tells the dramatic story of man's efforts to understand the movements of his blood -- and it commemorates the contributions of one man who truly deserves the title: Discoverer of the Circulation.

PREDECESSORS OF HARVEY

Scientists had been studying the circulation of the blood for centuries before Harvey's time. This portion of the exhibit shows some of their earlier theories on the movement of the blood.

1 EDWIN SMITH SURGICAL PAPYRUS Compiled about 1500 B.C.

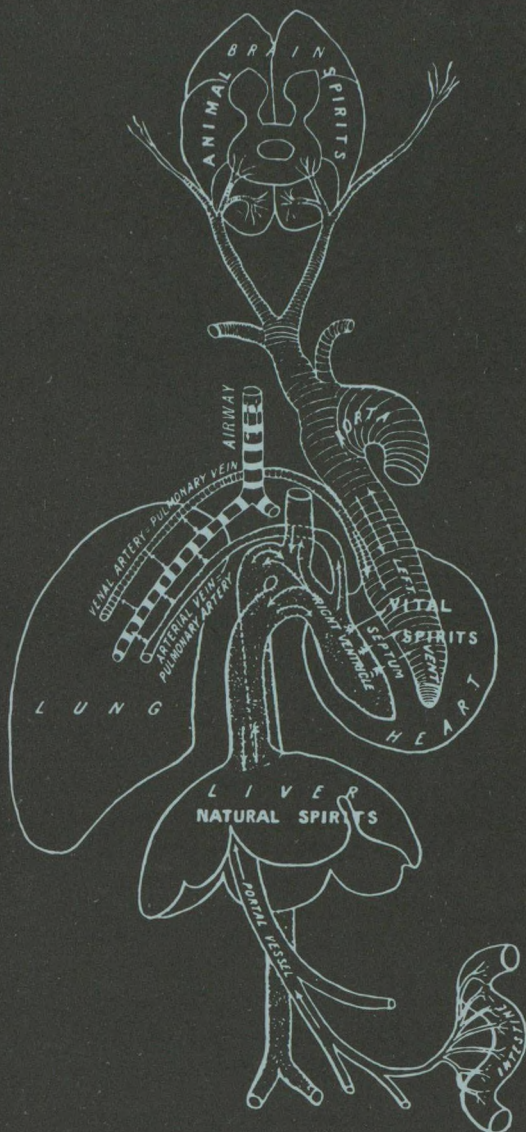
Even as early as this, the Egyptians recognized the heart as an important organ in the circulation.

Edwin Smith surgical papyrus, published in facsimile and hieroglyphic transliteration with translation and commentary. Breasted, James Henry, ed. 2v. Chicago, University of Chicago Press, 1930.

2 HIPPOCRATES ca 459 or 460-355 B.C.

Hippocrates, who agreed with Aristotle on the concept of the ebb and flow of blood within the blood vessels, and the importance of this movement for life and well-being, showed that the pulse in the extremities is caused by movements of the heart and blood vessels.

Opera quae extant. Graece et Latine . . . scholiis illustrata, a Hieron. Mercuriali. 2v. in 1. Venetiis, sumpt. Juntarum, 1588.



Concept of the
circulation
before Harvey

3 PERSIAN DIAGRAM OF THE CIRCULATORY SYSTEM 15th cent.

A ban on human dissection in the Middle Ages resulted in a degeneration of knowledge of anatomy. As a consequence, stylized anatomical diagrams, such as this, were substituted for more exact drawings.

Mansūr ibn Muhammad ibn Ahmad ibn Yūsaf ibn. Faqih Ilyās (fl. end of 14th and beginning of 15th century.) Tashrīh al-badan. (Anatomy of the body) No date. (15th century).

4 CONCEPT OF THE CIRCULATION BEFORE HARVEY

GALEN (A. D. ca. 129-200):

Galen's concept of circulation of the blood was accepted for 15 centuries. The liver was the center of the venous system. The veins sent blood, charged with nourishment from the intestines and "natural spirits" from the liver, to all parts of the body. In the veins there was an ebb and flow of the blood; in the heart were "invisible pores" to conduct blood from one chamber to the opposite chamber. The arteries carried blood charged with "vital spirits" to all parts of the body. From the brain the blood received still a third spirit, the "animal spirits." Vital spirits governed movement and muscular activity, while natural spirits were the sine qua non of life itself.

Opera omnia. Ediderunt Andreas Asulanus et J. B. Opizo. 5v. Venetiis in aedibus, Aldis, 1525.

5 REISCH, GREGOR 1467-1525

Reisch was prior of the Carthusian monastery in Freiburg. His anatomical works have been frequently reprinted.

Visceral anatomy from Margarita philosophica --- old woodcut.

6 KETHAM, JOHANNES DE 15th cent.

The rebirth of knowledge of anatomy through regular dissections started about the 13th century in Italy, but was not in full force until the second half of the 15th century. Early anatomic lectures appear to have been only readings from a classic text, such as Galen's, by a seated professor with demonstrations of some of the more obvious anatomical parts by a prosector. Later more extensive dissections came into practice, whereupon the inconsistencies and inaccuracies of the classic writers were uncovered, which led to a re-examination of the body itself.

Fasciculus medicinae . . . Venetiis, Joannes et Gregorius de Gregoriis, 1495.

7 DA VINCI, LEONARDO 1452-1519

The questing mind of this genius of the Renaissance led to the performing of many human dissections. From his notebooks and drawings, hidden for so long after his death, we now know that Leonardo da Vinci was far ahead of his time in his knowledge of the blood system, though he seems to have adhered to the Galenic concept of "ebb and flow." Selected illustrations from his works are shown.



Leonardo da Vinci. Die Leitung der Übersetzung der deutschen Ausg. hatte Kurt Karl Eberlein. 3. Aufl. Berlin, Lüttke (194?).

8

VESALIUS, ANDREAS 1514-1564



Author of the greatest published anatomical work of the 16th century questioned many of the doctrines held by Galen but not observable in the human body. Concerning Galen's view that the blood passes from the right ventricle to the left through a permeable septum, Vesalius said: "Of these pits, none, so far as the senses can perceive, penetrate from the right to the left ventricle. We are thus forced to wonder at the art of the Creator, by which the blood passes from right to left ventricle through pores which elude the sight." The selected illustrations are from his works.

De humani corporis fabrica libri septem.
Basileae, Oporinus, 1543.

9

SERVETUS, VILLANOVANUS, MICHAEL 1509-53

The discoverer of the pulmonary circulation, colleague of Vesalius to Winter of Andernach. Servetus announced his theory in a theological work, *Christianismi Restitutio*, in which he also renounced the doctrines of both Catholics and Protestants. As a result, he was burned at the stake in Geneva in 1553, at the behest of Calvin. His book was also burned, and only 3 original copies have come down to us.

Christianismi restitutio. Vienne, 1553. (Reprint, Nuremberg, 1790).

10

EUSTACHIUS, BARTHOLOMAEUS 1520-74

Described the lymphatic system as well as the thoracic duct in the horse. However, his work was buried in obscurity until Aselli's description of the mesenteric lacteals in 1622. Selected illustrations from his works are shown.

Tabulae anatomicae, quas e tenebris tandem vindicatas et Clementis XI, Pont. Max., munificentia dono acceptas, praefatione, notisque illustravit Jo. Maria Lancisius. Romae, Gonzaga, 1714.

WINTER OF ANDERNACH or GUINTERIUS, JOHANNES ANDERNACUS 1505-74

11

Teacher of both Vesalius and Servetus and one who questioned the classic explanation of the blood in his commentary on the anatomical works of Galen.



12

SYLVIUS, JACOBUS 1478-1555

Teacher of Vesalius and an obstinate Galenic fundamentalist, he is said to have remarked after errors in Galen's description of the circulation were pointed out to him, "Man must have changed since Galen's time."



13

CAESALPINUS, ANDREAS 1519?-1603

The first to use the word "circulation" and the first to demonstrate the effect of ligating the veins of the arm, Caesalpinus still believed in the invisible pores in the septum of the heart and the ebb and flow of blood in the veins.



14

COLUMBUS, MATTHAEUS REALDUS 1510-?

There is some controversy about the contributions of Columbus and Caesalpinus to the knowledge of the circulation of the blood, but it appears that Columbus visualized the larger circulation in its general lines, although he continued the error of attributing to the veins and the liver the functions ascribed by Galen.

De re anatomica libri xv. Venetiis, Bevilacqua, 1559.

FABRICIUS AB AQUAPENDENTE, HIERONYMUS 1560-1634

Fabricius, a teacher of Harvey at Padua, studied the valves of the veins and made important contributions to our knowledge of the circulation of the blood. However, Fabricius apparently failed to appreciate the physiological significance of these structures since he held to the Galenic view that the purpose of the veins was merely to prevent excess of blood from reaching the periphery of the body. It has been reported that Harvey remarked to Sir Robert Boyle, the great English physicist and chemist, that it was the work of Fabricius that led him to his concept of the circulation.

De venarum ostiolis. Patavii, Pasquatus, 1603.



The AGE of HARVEY

William Harvey lived in one of the most adventurous and productive periods of English history. This was the age of Milton, Cromwell, Shakespeare, Wren, Van Dyck, Byrd, Donne, and Sir Walter Raleigh. During Harvey's lifetime the Thirty Years' War and the English Civil War were fought; Gresham College, the Accademia dei Lincei, and Harvard College were founded. Church reforms were also brought about. Explorations carried Harvey's countrymen to both India and the New World. Yet, we possess no evidence to indicate that Harvey concerned himself with anything but his chosen field of medicine and research.

Science

- Robert Boyle
- Sir Thomas Browne
- Giordano Bruno
- Galileo Galilei
- William Gilbert
- Johann Kepler
- John Locke
- Isaac Newton
- Baruch Spinoza
- Evangelista Torricelli

Mathematics

- John Dee
- Edmund Halley
- John Napier
- Blaise Pascal

Architecture

- Inigo Jones
- Christopher Wren

Law

- Sir Edward Coke
- Hugo Grotius
- John Selden

Literature

- John Bunyan
- Miguel Cervantes
- Pierre Corneille
- Christopher Marlowe
- John Milton
- Jean-Baptiste Ponquelin
- Molière
- Mme. Marie de Sévigné
- William Shakespeare

Art

- Cornelius Jansen
- Sir Peter Lely
- Rembrandt van Ryn
- Peter Paul Rubens
- Sir Anthony Van Dyck
- Diego Rodriguez Velázquez

Trading & Explorations

- John Cabot
- Francis Drake
- Henry Hudson
- Walter Raleigh
- Thomas Roe
- Sir Philip Sidney
- John Smith

Philosophy

- Francis Bacon
- René Descartes
- John Locke
- Baruch Spinoza

Politics

- Gustavus Adolphus
- Charles I
- Charles II
- Oliver Cromwell
- James I
- Louis XIV
- Cardinal Richelieu
- Prince Rupert
- Earl of Stratford

Music

- John Bull
- William Byrd
- Orlando Gibbons
- Henry Lawes

The Church

- John Donne
- Oliver Heywood
- William Laud

• Portrait is shown on exhibit

WILLIAM HARVEY

16 DE MOTU CORDIS

Although Harvey had enunciated his theory of the circulation of the blood in his Lumleian lectures in 1616, he did not publish his doctrine until 1628. It was sent to an obscure continental printer at Frankfurt, on the advice of his friend, Robert Fludd. (For more on Fludd, see Item 40.) In this poorly designed and poorly printed work Harvey used quantitative measurements to support his argument, and this use of quantification is certainly an important development in scientific methodology.

Exercitatio anatomica de motu cordis et sanguinis in animalibus. Francofurti, Fitzer, 1628.

17 Translations of the DE MOTU CORDIS

Many translations of the *De motu cordis* into many different languages have appeared over the years. One of the recent standard English translations is that of Chauncey Leake, shown in exhibit. Also shown is the first English edition (1653). The most recent is by Kenneth J. Franklin (Oxford, Blackwell, 1957).

18 REPLY TO RIOLAN

The only critic to whom Harvey replied was Jean Riolan, Dean of the Medical Faculty at Paris and the leading Galenist in Europe.

Exercitationes duae anatomicae de circulatione sanguinis. Ad Jo. Riolanum filium. Roterodami, Leers, 1649.

19 HARVEY'S MEDICAL DIPLOMA

After studying at a grammar school in Cambridge and at Gonville and Caius College, Cambridge, Harvey went to the University of Padua, from which he received his diploma in 1602. Because Harvey was a Protestant, the diploma is signed by the Procurator of the University rather than by the Bishop, its Chancellor.

... A facsimile reproduction of the diploma of doctor of medicine granted by the University of Padua to William Harvey, 1602, with a translation by J. F. Payne, London, Privately printed, 1908.

20 PORTRAIT OF HARVEY

This portrait was painted by Mr. Joseph F. Doeve, of Amsterdam, The Netherlands. Copyright, *The Heart Bulletin*, 1954.

21 PORTRAIT OF HARVEY

Steel engraving by T. Cook (1777).

22 ENLARGEMENTS OF ILLUSTRATIONS FROM THE DE MOTU CORDIS

demonstrating the presence of valves in the veins.

23 MODERN INTERPRETATION OF HARVEY'S MATHEMATICS

from an article by Frederick Kilgour (William Harvey's use of the quantitative method. *Yale Journal of Biology and Medicine*, 1954, 26: 410-421.

24 SAMPLE OF HARVEY'S HANDWRITING

25 SPECIMEN PAGE FROM HARVEY'S WILL

His signature is in the lower right-hand corner.
The probate copy of his will is now in the Wellcome
Historical Medical Library, London.

26 RUBBING MADE OF PLATE ON HARVEY'S LEADEN SARCOPHAGUS AT CHURCH IN HEMPSTEAD, ESSEX.

27 ANATOMICAL THEATER inside AT THE UNIVERSITY OF PADUA

At this anatomical theater, built by Fabricius at
Padua, Harvey studied anatomy and acted as
prosector for a period of time.

28 ANATOMICAL THEATER outside AT THE UNIVERSITY OF PADUA

29 ST. BARTHOLMEW'S HOSPITAL, LONDON

The oldest hospital establishment in England,
St. Bartholomew's Hospital was founded in the
11th century. Harvey was appointed Physician
to it in 1609 and remained connected with it
most of the rest of his life.

30 HARVEY'S BIRTHPLACE--- FOLKESTONE, ENGLAND

31 HARVEY'S POINTER USED IN HIS LECTURES AT PADUA

32 WILLIAM HARVEY EXPLAINING THE CIRCULATION OF THE BLOOD TO KING CHARLES I

33 STEMMA coat of arms

While at Padua Harvey was elected Councillor to
the British Nation, or officer of a student group,
and as such was entitled to have his stemma
(coat of arms) placed in the University entrance
hall. Interestingly enough, it contains a lighted
candle with entwined serpents around it clasped
by an arm.



34 HARVEY'S LECTURE NOTES

In 1615, at 38, Harvey was appointed Lumleian
lecturer for life and the next year started the
twice weekly discourses which went with the
lectureship. It was his duty to lecture upon
the entire subject of anatomy and surgery over
a period of 6 years; in this series he was en-
joined to lecture in Latin for 45 minutes and
in English for 15 minutes. In the first week
of these lectures, the very week in which
Shakespeare died, Harvey announced his
theory of the circulation of the blood. His
lecture notes, for many years forgotten or
lost in the British Museum, were reproduced
in facsimile in 1886.

Praelectiones anatomiae universalis. London,
Churchill, 1886.



OPPONENTS OF HARVEY

Much has been made of Harvey's opponents; in actuality they were a comparatively small and unimportant group (except for Riolan), and, viewed within the framework of the time, comparatively impersonal in their objections.

35 PRIMROSE, JAMES d. 1660

Primrose, as well as Riolan, was an ardent opponent of Harvey's theories on the circulation. His crude attack on Harvey's doctrine, based on Galenic principles, instigated Roger Drake's defense of Harvey's theory of the circulation.

Exercitationes et animadversiones in librum de motu cordis et circulatione sanguinis. Londini, Bourne, 1630.

36 RIOLAN, JEAN 1577-1657

The Dean of the Faculty of Medicine at Paris, foremost follower of Galen of the time and the most cultured, was the most violent of Harvey's adversaries. In his opposition he was supported by Guy Patin, also of Paris, who declared Harvey's theory was "paradoxical, useless, false, impossible, absurd, and harmful." The very fact that Riolan opposed Harvey's theory gave widespread publicity to it.

Opuscula anatomica nova quae nunc primum in lucem prodeunt. Instauratio magna physicae et medicinae per novam doctrinam de motu circulatorio sanguinis in corde . . . Londini, Flesher, 1649.

37 HOFMANN, CASPAR 1572-1648

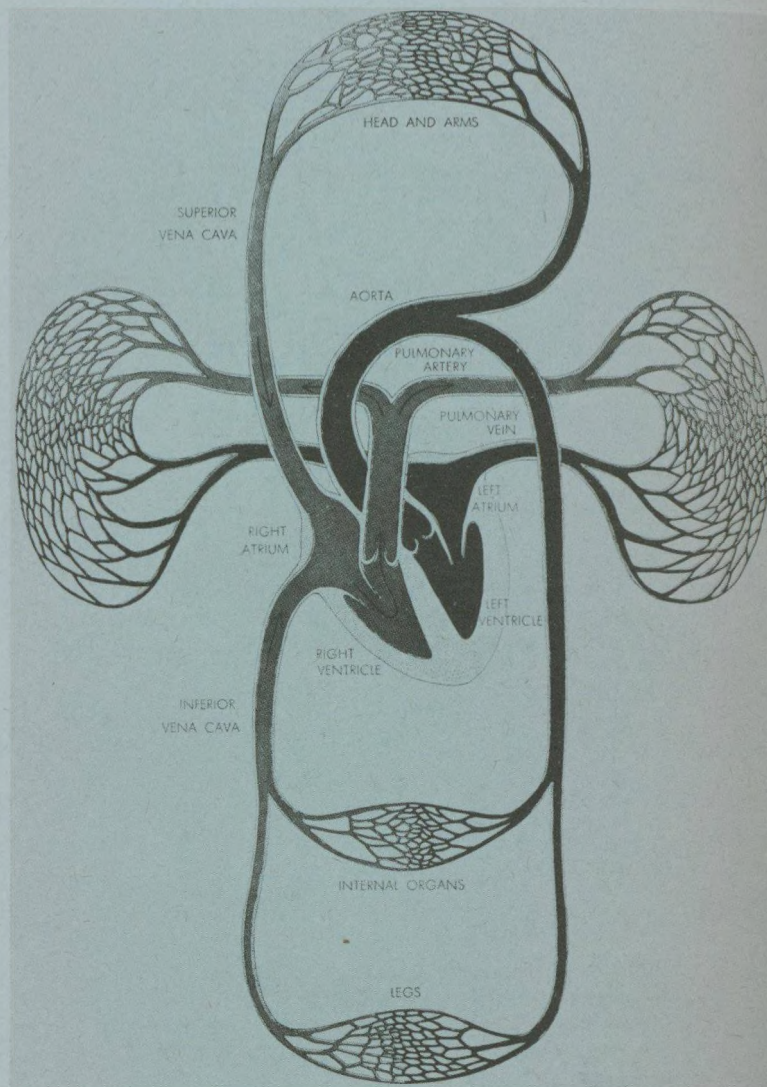
A fellow-pupil of Fabricius with Harvey at Padua, but an ardent Galenist. It is said that Harvey traveled to the continent especially to convince Hofmann of the correctness of his new theory of circulation.

Institutionum medicarum libri sex. Lugduni, Huguetan, 1645.

38 PLEMPIUS, VOPISCUS FORTUNATUS 1601-1671

Professor of medicine at Louvain, Plempius was first an opponent of Harvey's, with Riolan, Hofmann, and Giovanni della Torre; he later was convinced of the accuracy of Harvey's work and became a supporter of his theory.

Fundamenta medicinae ad scholae acribologiam aptata . . . Lovanii, Zegers, 1644.



SUPPORTERS OF HARVEY'S VIEWS

CONCEPT OF THE CIRCULATION FOLLOWING HARVEY

39

Immediately after Harvey's announcement, the new theory of circulation was re-examined and further proofs added. The use of measurement in circulation -- Harvey's great contribution -- was later applied to other areas in physiology.

40

FLUDD, ROBERT 1574-1637

Work on pulse-timing and early vaccination brought him fame. He was probably the one who suggested to Harvey that *De motu cordis* be printed by Fitzer, in Frankfurt-am-Main; Fitzer was Fludd's own printer. Fludd was the first to mention Harvey's doctrine on circulation in print; he had evidently seen the manuscript before it was set in type.

Integrum morborum mysterium . . . Pulsus seu nova et arcana pulsuum historia . . . Francofurti, Fitzer, 1631.

41

ENT, GEORGE 1604-89

Sir George Ent, friend of Harvey and President of the Royal College of Physicians, damaged Sarpi's claims of being the true discoverer of the circulation. He showed that the Venetian legate had loaned a copy of Harvey's *De motu cordis* to Sarpi, and that Sarpi copied a portion of it for his own use. Ent is thought by some to have been part author of Harvey's work on embryology, the *De Generations*.

Apologia pro circuitione sanguinis . . . Londini, Kettilby, 1685.

42 DRAKE, ROGER fl.1640

Roger Drake gave the first inaugural dissertation in defense of Harvey's views sponsored by his teacher Franciscus Sylvius (de le Boë). Sylvius recognized the importance of Harvey's doctrine and set his student to examining it.

Disputatio medica de circulatione naturali seu cordis et sanguinis motu circulari pro cl. Harveio. Lugduni Batavorum, Christian, 1640.

43 HIGHMORE, NATHANIEL 1613-85

Highmore was author of the first English anatomical work in which Harvey's theory of the circulation was fully accepted.

Corporis humani disquisitio anatomica . . .
Hagae-Comitis, Broun, 1651.

44 MALPIGHI, MARCELLO 1628-94

The proof of Harvey's doctrine of the circulation remained incomplete until Malpighi demonstrated, 4 years after Harvey's death, the existence of capillary connections between arteries and veins in the lung.

Opera omnia. 2v in 1. Londini, Scott, 1686.

45 LEEUWENHOEK, ANTHONY VAN 1632-1723

Although Leeuwenhoek, the Dutch microscopist, communicated his description of the capillary circulation to the Royal Society in 1688, it was not printed in the *Philosophical Transactions*, but remained in manuscript at the Royal Society. It first appeared in Leeuwenhoek's works, issued in Dutch between 1685 and 1718.

(Works) Leiden and Delft, 1693-1718. 6v.

46 SYLVIUS, FRANCISCUS 1614-72

Franciscus Sylvius, not to be confused with Jacobus Sylvius or de le Boë (the teacher of Vesalius), recognized the importance of Harvey's discovery and persuaded anatomists Vesling and Walaeus to change their views and accept Harvey's doctrine.

Opera medica . . . Amstelodami, Elsevir, 1679.

47 DESCARTES, RENÉ 1596-1650

Descartes was the author of the first physiology textbook to accept Harvey's views. Descartes, however, was no exponent of the experimental school of science, preferring instead *ad hoc* logical speculation.

. . . *De homine . . .* Lugduni Batavorum, Moyardus, 1662.

48 VESLING, JOHANNES 1598-1649

Earlier doubts as to the identity of arterial and venous blood were cleared up by the time this was published.

Syntagma anatomicum. Patavii, Frambottus, 1647.

49 WALAEUS, JOHANNES 1604-49

At Franciscus Sylvius' suggestion, Walaeus experimented with the circulation and finally concluded his early opposition to Harvey was unfounded.

Epistolae duae: de motu chyli, et sanguinis, ad Thomam Bartholinum, Casp. filium. 1640. In: Bartholin, Caspar, *Institutiones anatomicae.* Lugduni Batavorum, 1645, pp. 443-488.

50 SCHLEGEL, PAUL M. fl. 1650
CONRING, HERMANN 1606-81
PECQUET, JEAN 1622-74

First German and French scientists of distinction to accept and teach circulation of the blood.

CONTINUED SUPPORT OF HARVEY'S VIEWS

51 CHIRAC, PIERRO 1650-1732

Continued in the spirit of Harvey by using quantitative measurements to further our understanding of the motion of the heart; unfortunately his mathematics was faulty.

De motu cordis adversaria analytica.
Monspelii, Martel, 1698.



52 LOWER, RICHARD 1631-91

Lower, the author of this early work on trans- fusion, is often spoken of as being the first to demonstrate the scroll-like structure of heart muscle. (See, however, the Leonardo da Vinci illustration, Item 7.)

Tractatus de corde, item de motu, et colore sanguinis et chyli in eum transitu. Londini, Allestry, 1669.



53 BARTHOLIN THOMAS 1655-1738

With Aselli in Italy and Rudbeck of Sweden, Bartholin discovered the lymphatic system and thus struck the final blow to the theory that held the liver supreme in the circulatory system.

54 RIVERIUS, LAZARUS 1589-1655

Supposed to have been asked to resign as Professor of Medicine at Montpellier because of his public defense of Harveian doctrine.

55 HALES, STEPHEN
1677-1761

Stephen Hales, "the perpetual curate," took the first important step after Harvey and Malpighi in elucidating the physiology of the circulation. He described the first quantitative blood pressure experiment. Hales inserted a glass tube in the femoral artery of a horse and measured directly the height of the column of blood.

Statical essays ... v. 2. London, Innys, 1733.

56 HARVEIAN ORATORS

By the terms of Harvey's will, a sum of money was set aside for an annual dinner and lecture for members of the Royal College of Physicians. Many famous orations have been delivered as a result of this bequest, the earlier ones in Latin, the later in English.

The orators honored by this appointment include: J. Freind, R. Mead, J. Monro, and M. Aken-side in the 18th century; H. W. Acland, G. E. Paget, W. W. Gull, G. Rolleston, R. Quain, T. L. Brunton in the 19th century; and T. C. Allbutt, W. Osler, E. H. Starling and W. Hale-White in the 20th century. Shown in this exhibit are the orations of Richard Mead, William Gull, and William Osler.

57 HARVEY SOCIETIES

The world-wide influence and inspiration of Harvey's work can be shown in part by the large number of scientific societies named after him. Three of the largest are in London, Edinburgh, and New York. The earliest and most recent publications of the New York society are on display.



MODERN CARDIOLOGY

58 COLOR TRANSPARENCY OF MURAL EXECUTED BY DIEGO RIVERA:

This painting was conceived by Dr. Ignacio Chavez, director of the Instituto Nacional de Cardiologia in Mexico City, and executed by Diego Rivera. It appears on the walls of the lobby of the auditorium at the Institute.

59 STETHOSCOPES

These are used for listening to heart sounds.

EARLY MODERN

The amplified heart sounds you are now hearing are replicas of those heard with the stethoscope.

60 PLASTIC HEART VALVES

Plastic valves similar to these, are now used by heart surgeons to replace damaged valves.

ENTRANCE EXIT

61 PLASTIC HEART PUMP

This is an experimental artificial heart pump, that may be used to temporarily replace a heart during surgery.

62 HEART CATHETER

A catheter (or tubing) similar to this one is threaded through a vein to the heart; it is used for obtaining blood samples and measuring pressures within the heart.

THE TWO X-RAY FILMS SHOW CATHETERS PLACED IN THE HEART

63 FILM 1

Lateral film of selective intracardiac angiogram. Note catheter in heart with jets of dye entering both atria and reflux of dye into left pulmonary vein and superior vena cava.

64 FILM 2

A. P. selective intracardiac angiogram demonstrating findings mentioned in FILM No. 1. Note catheter in heart with dye in both atria.

65 MODERN PORTABLE ELECTROCARDIOGRAPH

This instrument is for recording and measuring the electrical activity of the heart.

66 SPHYGMOMANOMETER

This is a present-day device for measuring blood pressure.

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FLOOR PLAN... WILLIAM HARVEY EXHIBIT

