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THE FOUNDATION OF HUMAN ANATOMY IN THE RENAISSANCE

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When we speak of the foundation of human anatomy, we immediately remember the names of two great Greek physicians who, at the end of the fourth and the beginning of the third centuries B. C., lived and worked in Alexandria—Herophilus and Erasistratus. Their names have survived the centuries, and have become a part of our anatomical nomenclature. They were not specialists in anatomy, but all-round physicians whose writings cover the whole wide field of medicine. Herophilus was chiefly influenced by the school of Cos, and wrote famous books on the pulse, on drugs, on midwifery; but then, he also wrote a treatise on anatomy in at least three books. The fragments preserved show that he had a thorough knowledge of the anatomy of the eye, the membranes of the brain, the genital organs, and the duodenum; and credit is to be given him for his recognition of the true nature of the nerves. He dissected numerous animals, and occasionally human bodies: according to an ancient tradition, even human vivisections were performed in Alexandria.

A still greater anatomist was to be found in Erasistratus. Fragments of his two works on anatomy contain good descriptions of the heart, the liver, and the brain; it was he who discovered that there are two kinds of nerves—sensory and motor. But he went still further. Being a student of Cnidos, where the tendency had always been to localize disease, he recognized that diseases have a seat, and that this seat has to be sought in the organs. In his dissections he had found anatomical alterations which seemed to have some relation to the disease from which the patient had died.

Both Herophilus and Erasistratus founded schools which continued for many centuries, and it is chiefly due to them that Alexandria was the center of anatomical studies throughout antiquity. When, in the second century A. D., Galen wanted to study anatomy, he had to go to Alexandria. This was the only place, he tells us, where you could find a skeleton. Human dissections, however, were no longer practiced, and one had to rely upon what was found by dissecting monkeys, pigs, and other animals.

And so there was anatomy long before the Renaissance. But it existed before the Alexandrian school. We can trace the beginnings in Greece back to the sixth century B. C., to the schools of the first philosophers, all of whom were scientists as well as philosophers. They observed the phenomena of nature, and endeavored to draw conclusions from what they saw, speculating about the primary cause of all things. It would have been surprising had they not extended their studies to the bodies of animals.

Yet we can go back still farther. There was always some kind of anatomical knowledge. As soon as man began talking in an articulate language, he invented names to designate the parts of the body, very much as a child does. Whenever an animal was slaughtered, be it for the kitchen or for the sacrificial altar, anatomical observations were bound to occur, and the first classification of organs was probably a distinction between edible and non-edible parts.

Primitive man must even then have been impressed by certain anatomical peculiarities, as was the paleolithic man, who, in a cave of Spain, drew the outline of an elephant, and within the picture drew a heart. Remains of a cosmic mythical anatomy are still preserved in our language. We still call the first cervical vertebra Atlas, carrying the dome of heaven, the cranium; we still speak of the Adam's Apple, the Mount of Venus, the Labyrinth.

Whenever surgical operations were performed, the surgeon must have had some kind of anatomical knowledge. The earliest surgical book preserved, the Edwin Smith Surgical Papyrus, which was originally written at the time of the Old Kingdom in Egypt, gives evidence of such anatomical knowledge. Anatomy, therefore, is a very old science; and yet ancient anatomy was of a quite different character from the anatomy that was found at the time of the Renaissance. The surgeons' knowledge, as far as it went, was topographical. It was limited to certain regions of the body. As long as surgery was restricted to a small number of operations—as was the case down to the nineteenth century—the surgeon could operate very successfully with a limited knowledge of the human body. Ancient anatomy, then, was almost entirely animal anatomy. The Alexandrians occasionally described human organs, but never *in situ*, and never systematically. First of all, anatomy had an entirely different place in the system from what it has today. One studied the structure of the body because it was a part of the realm of nature, just as one studied plants or minerals, and geography. A doctor did not study anatomy because he thought it imperative; and this was because Greek medicine had an essentially different structure from that of our medicine today. The symptoms of disease were not traced back into the organism. The concept of disease was not ontological, and if one systematized, one did not systematize disease, but rather, different types of man. Erasistratus has a unique position in Greek medicine. He took the road that we have followed, but his attempt to establish an anatomical system of medicine failed, just as Aristarchus had found no followers for the heliocentric system. Another school grew out of Alexandria—the school of the Empiricists, who declared openly that anatomy was of no use to the doctor. The same view was shared by another very popular school, the Methodicists. And as the ancient world grew old, Hippocrates became still more the dominating figure—Hippocrates, who had cured without anatomy.

The foundation of human anatomy, therefore, was the accomplishment of our western medicine. There, a necessity for the doctor to have an intimate knowledge of the human body was overwhelmingly felt, which eventually broke down completely the taboos that surrounded the human body. The body of a diseased man was always considered to be within the realm of the physician. Not so the cadaver, the attitude towards that being the result of æsthetic, ethical and religious conceptions. The cadaver was thought to be something holy, or impure, not to be touched without necessity. The Christian attitude, contrasting sharply body and soul, was by no means favorable to the development of anatomy. And yet, in spite of all this, the barriers were broken. From the beginning of the fourteenth century on, human cadavers were dissected; first in Bologna, then in other universities; and several times a year. Such anatomies were held, but they did not serve research purposes; they

were, rather, mere demonstrations illustrating the textbooks. One was still convinced that the Greeks had known all there was to know about the human body, and one dissected in order to reach a better understanding of their statements.

The Renaissance marks the turning-point in attitude of man towards anatomy, and towards the human body in general. The word "Renaissance" is a technical term from the history of art. Used first by Vasari, it became generally accepted after the publication of Jakob Burckhardt's classic book, *Die Kultur der Renaissance in Italien* (1860). What does the Renaissance mean to medicine? It certainly was not a revival of learning, for there was learning in the medieval universities. Nor was it a revival of Greek medical literature, for this had been known through translations from the Arabic since the eleventh century. Far more was it a revival of the Greek spirit of research—a new attitude of man towards his fellow-men and the world as a whole. Humanity became the ideal of the new society which grew up first in Italy—a humanity that meant the highest possible development of the personality. And whenever strong personalities come forward, the traditional authorities are in danger of being uprooted. One essential feature of the period of the Renaissance is the discovery of the world, the great world that was unknown to the Greeks; new continents, with new plants, new species of animals, new races of mankind. But also the small world, the natural surroundings of man, were rediscovered. One looked at nature with different eyes. New inventories of vegetables and animals were taken; and investigation of the human body was a part of the great adventure, the discovery of the world. Once more men became aware of the beauty of the human body, and they endeavored to represent it in all its natural glory. If the medieval artists as a rule failed to represent the nude body with anatomical exactness, it was not because they had no chance to study it, but because their attitude towards the human body was different. In the Renaissance, the artist began to study the body by examining the ancient statues that were being excavated in ever-increasing numbers, and by observing nature. Botticelli's Venus was distinctly inspired by the Medician Venus that had been unearthed in his time. Some artists, however, were not satisfied with studies in plastic anatomy, but wanted to know the structure of the body under the skin. The prince of such investigators was Leonardo da Vinci.

When, in the eighties, the anatomical and scientific drawings of Leonardo were made available to the public through the publication of Richter, a great enthusiasm for Leonardo arose. His work was approached emotionally and uncritically, and he was considered the first real scientist of the Occidental world. Then followed the studies of Pierre Duhem on the physics of Leonardo, where for the first time his work was studied from a critical standpoint. In endless books, men tried to solve the riddle of his personality. Most of them made the mistake of measuring him on the wrong yardstick; Benedetto Croce from the point of view of speculative idealism, and Olschki from the point of view of modern positivism. Leonardo has to be studied as a man of the Renaissance; this has been done in an admirable way by Ernst Cassirer. Leonardo represents a type of amateur scientist. He never went through a university, he was an illegitimate child. He was a strong opposition to the

traditional scholastic science of the time, constantly making sharp distinctions between the discoverers and mere imitators. His work marks a shifting from books to the book of nature, from revelations in words to revelations in works. Mathematics to him formed the very heart of all knowledge. All knowledge was nothing more than a measuring, and everything was expressed in proportions. Proportion was the medium of recognition, and proportion was not only a logical and mathematical, but an æsthetic conception as well. This formed the link between the scientist Leonardo endeavoring to investigate nature, and the artist Leonardo, recreating nature in his work. Nature is the realm of perfect forms, and is ruled by necessity. The fact that Leonardo admitted to such a concept of natural laws made him a true scientist. Nature is dominated by reason. Experience and reason are not contradictions—they are two principles. Experience reaches its goal in mathematics, just as mathematics bears its fruits in experience.

Still, the study of man claims the first place in Leonardo's interest. Man is the primary object of his research. He studies the proportions of the human body, the plastic aspect of its outlines; but he goes further, stripping the skin, dissecting the body. Thousands of sketches are the result of his studies, which were intended for a complete book of anatomy that was to describe the structure of man from the very moment of his conception. Leonardo knew the medical literature of the day. Quite a few of his sketches are not the result of observation, but illustrate statements he had found in books. However, he was never satisfied merely with what he read, but always went further, approached the cadaver, experimenting, dissecting, making notes and drawings.

Leonardo's anatomical work was never finished, and after his death, his drawings were scattered to the winds. His whole life work, artistic and scientific, remained a torso, which is not to be wondered at, since it was an entire cosmos that he was attempting to recreate. Leonardo is a unique figure. A man of the Renaissance, to be sure, and yet hard to place in the category of his time. He was extremely interested in function, in dynamics, while sixteenth century science was essentially static; and it was only one hundred years later that dynamics were attacked by the scientist.

The doctors, too, were not idle. They, too, found themselves drawn to the study of the human body. Cadavers were now somewhat easier to obtain, and as early as the beginning of the sixteenth century we find quite an important group of anatomists who, although still convinced of the superiority of the ancients, performed a great many dissections themselves, and left good descriptions of certain organs: men like Alessandro Achillini in Bologna, who wrote *annotationes* to Mundinus; Gabriele Zerbi in Padua, Alessandro Benedetti; and most important of all, Berengario da Carpi, professor of surgery in Bologna, who also wrote a commentary to Mundinus, which contained some quite valuable observations.

The true founder of modern human anatomy, however, was Andreas Vesalius, a man who, from early childhood, had felt himself drawn to these studies. At the age of twenty-three, he was appointed professor of surgery and anatomy in Padua. Four months after his appointment he produced his first anatomical atlas, six plates illustrating the skeleton, and the arterial and venous systems.

What made his way clear was the discovery that ancient anatomy was essentially animal anatomy. He understood that the structure of the human body had never before been described completely and systematically, that the work still had to be done. Vesalius was lucky in having a very fine artist to assist him. At the age of twenty-seven he had accomplished a task that in other people would have represented the work of a lifetime. In the year 1543 the seven books *De Corporis Humani Fabrica* were published in Basel, a great work and a beautiful book, of 663 folio pages, with more than 300 illustrations. An Epitome for teaching purposes appeared simultaneously, and this Epitome was translated into German as a textbook for surgeons, by the rector of the University of Basel, Albanus Torinus.

Vesalius lived to the year 1564, but his work had been done long before that. He resigned from the University of Padua, and lived at the imperial court as a body-physician to the Emperor. The inspiration he had given was strong enough to spread enthusiasm for anatomical studies throughout the century. His chair in Padua was for a long time filled by people who continued to be the leaders in anatomical study; Realdo Colombo, well-known for his description of the pulmonary circulation; Gabriele Falloppio, whose *Observationes Anatomicae* are noteworthy for their accuracy; Fabricius of Acquapendente, whose anatomical theatre can still be seen at the University of Padua, the teacher and inspiration of Harvey; Giulio Casserio, who wrote a classic book on the auditory organs. Outside Padua, in Bologna, Rome, Naples, and, towards the end of the century, north of the Alps, anatomy became a more and more important object of research.

Vesalius' book was published in 1543, the same year in which Copernicus' *De Revolutionibus Orbium Coelestium*, appeared. In laying the foundation of human anatomy, Vesalius laid the foundation of modern medicine. The year 1543, therefore, marks the beginning of a new era. From then on, anatomy was the iron fundament of medicine. But more than this, anatomy became a method of thinking. The history of medicine from Vesalius to our day is to a large extent the history of the application of anatomical methods. Step by step, one field after another was conquered by this new method. Physiology at the time of Vesalius was still speculative and philosophical in character. In the seventeenth century, anatomy developed into *anatomia animata*, and an anatomical physiology was born, working by means of experiments. In the eighteenth century, pathology became anatomical. A new ontological concept of disease had been realized, and disease from then on was attributed and bound to the organs. One saw that the symptoms of disease are the result of anatomic alterations in the organs. Diagnosis became diagnosis of the organs; percussion and auscultation were introduced as methods enabling the physician to observe anatomical changes. The last field that had to be conquered was therapy, which, down to the middle of the nineteenth century, still followed traditional lines. The final step was taken also, and found its expression in the development of modern surgery.

Today, this cycle has come to a certain conclusion; the anatomical method has been applied to all fields of medicine, and a new, a physiological era, has begun.