

Erasistratus

Erasistratus of Iulis on Ceos (about 315–240 BC ?) is the only scientist other than Herophilus to whom ancient sources attribute systematic scientific dissections of human cadavers. Celsus claims that Erasistratus, like Herophilus, also vivisected convicted criminals (see VIVISECTION). The extant evidence leaves little doubt that he performed vivisectionary experiments on animals. Often taking a functional approach to his anatomical discoveries, he combined detailed descriptions of parts with explanations of their physiological roles. Thus he not only gave the first reasonably accurate description of the heart valves but also demonstrated that their function is to ensure the irreversibility of the flow through the valves.

Three consistent features of Erasistratus' approach are his use of mechanistic principles to explain bodily processes, an Aristotelian teleological perspective, and the verification of an hypothesis by means of experiment. His major mechanistic principle is that matter naturally moves by means of 'following toward what is being emptied' (*πρὸς τὸ κενούμενον ἀκολουθία*), i.e. if matter is removed from any contained space, other matter will enter to take its place, since a natural massed void (or 'vacuum') is impossible.

Using this principle, he united respiration, the vascular system, the nervous system, muscular activity, appetite, and digestion in a single, comprehensive physiological model, which he probably presented in his *General Principles* (*Οἱ καθόλου λόγοι*). External air moves into the lungs through the windpipe and bronchial ducts as the thorax expands after exhalation. Some of the breath (pneuma) in the lungs then moves through the 'vein-like artery' (i.e. the pulmonary vein) into the left ventricle of the heart, when this ventricle expands after contraction. The pneuma in the left cardiac ventricle in turn is refined into 'vital' (*ζωτικόν*) pneuma before being pushed into the arteries when the heart contracts. Excess air in the lungs, having absorbed some of the superfluous body heat produced by the heart, is exhaled as the thorax contracts, but, in accordance with his principle that matter 'follows towards what is being emptied', fresh breath rushes into the thorax again as it expands. The pulmonary breathing cycle thus both cools the body and provides the arteries with life-sustaining pneuma.

The nerves, too, carry pneuma: some of the 'vital' pneuma is pumped through arteries from the left cardiac ventricle to the brain, where it becomes further refined into 'psychic' (*ψυχικόν*) pneuma, which in turn is distributed to the body through the sensory and motor nerves. Appetite and digestion—both of which he also explains partly in terms of the principle that matter 'follows toward that which is being emptied'—provide the liver with liquid nutriment to process into blood, which then flows from the liver into the veins by the same mechanical principle. The arteries and the nerves, then, contain only pneuma, whereas the veins distribute only blood (as nutriment). The muscles, like other organic structures, consist of 'triple-braided' strands (*τριπλοκίαι*) of veins, arteries, and

nerves. The pneuma carried to the muscles by arteries and nerves allows the muscles to contract or relax, thereby rendering voluntary motion possible.

In his pathology Erasistratus introduced several causes of diseases, all ultimately instances of different forms of matter (blood, pneuma, various liquids) that normally are rigorously separated, somehow not remaining separated. 'Plethora', a condition typically marked by excessive blood-nutrient in the veins, can cause inflammation, which can lead to fever, swollen limbs, diseases of the liver or stomach, epilepsy, and other ailments, in part because excessive blood in the veins can cause a dangerous spillover (*παρέμπτωσης*) of blood into the arteries through inosculation (*συναναστομώσεις*) between veins and arteries, thus impeding the arterial flow of vital pneuma.

Like Herophilus, he argued that there are no diseases peculiar to women. In treating patients, his guiding principles (in part presented in *Hygieina* 1–2) were, first, to prevent plethoric conditions by means of regimen; secondly, to ensure, by relatively mild measures, the return to its proper place of matter that has gone astray. He emphasized the stochastic nature of symptomatology and therapeutics, opposed drastic measures, and rejected traditional uses of bloodletting, thereby provoking the notorious ire of Galen. Other attested treatises include *On Fevers*, *On Expectoration of Blood*, *On Paralysis*, *On Dropsy*, *On Podagra*, *On the Abdominal Cavity*, and *On Divisions*. See MEDICINE, § 5. 2.

I. Garofalo (ed.), *Erasistrati fragmenta* (1988). P. Brain, *Galen on Bloodletting* (1986); G. E. R. Lloyd, *JHS* 1975, 172–5.

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