History of Medicine. 2016. Vol. 3. № 4.
DOI: 10.17720/2409-5834.v3.4.2016.37z

The apodictic method in the tradition of ancient Greek rational medicine: Hippocrates, Aristotle, Galen

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The authors suggest a definition of the apodictic method that can be applied to the history of medicine and reveal its development in the works of Hippocrates, Aristotle, and Galen. The apodictic method of proof in medicine is anatomical dissections, the rational doctrine of general pathology and clinical systematics. The particular approach to using this method of rigorous proof in the works of ancient authors allows us to distinguish three stages in the development of ancient medicine's methodology. The first was the period of the apodictic method's birth, which determined the foundations of Greek rational medicine based on the principles of Hippocrates. Under these principles, an explanation for the phenomena of nature, and the human body as a part of it, is based on the search for, and study of, natural causes. The foundation period of the apodictic method is associated with the works of Aristotle, which are devoted to the theory of argumentation, contain a formulation for the strict requirements for proof, movement theory, and systematic dissections of animals based on this practice. They also include the formation of the principles of comparative anatomy, which subsequently influenced the development of Herophilos' practice of systematic anatomic autopsies and the development of his health concepts. The third stage was the period of apodictic method – characterized by the works of Galen. He introduced the apodictic method into medical practice and proved its importance for the further development of medical science. The integrated theoretical and practical system established by Galen became a historic milestone, which divided the period of the birth of ancient Greek rational medicine from the period of rational medicine in the protoscience period.

Keywords: *history of medicine, Hippocrates, Aristotle, Galen, apodictic method, ancient Greek rational medicine*

For quotation: *Balalykin D.A., Shok N.P. The apodictic method in the tradition of ancient Greek rational medicine: Hippocrates, Aristotle, Galen. History of Medicine. 2016. Vol. 3. № 4. P. 377–391*

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The history of the natural sciences is generally agreed to start in the sixth century BC, with the birth of early Ionian physics, which sought to explain natural phenomena by studying their natural causes, which needed to be understood, systematised and integrated into an overall system. This laid the foundations for the methodology of classical protoscience (in contrast to the mystical ideas then prevalent regarding the nature of phenomena), in which strict demonstration played an important role [1]. The first natural sciences to emerge as part of early Ionian physics were mathematics, astronomy and medicine [2].

Various approaches to explaining natural phenomena, including the workings of the human body, vied for supremacy in ancient Greece. For example, Sir Geoffrey Lloyd believes that the ancient debate centred on a difference

Received: 15.11.16

in the understanding of the role of the method of investigation – the practical application by different schools of philosophy and medicine of the dialectical method, based on polemical philosophical dialogue, and an on apodeictic demonstration method based on strict rules for arguments.[1] The apodeictic method excludes reasoning based on mere plausibility. It is based on logical necessity and actual evidence, allowing the scientist to seek inferences that are incontrovertibly true. By contrast, the dialectical method allows for plausible reasoning and is largely based on an attempt to convince by any means, including the use of sophistical premises, which are inappropriate for the natural sciences in general, and medicine in particular.

The history of the use of the apodeictic method in classical medicine requires serious study, not least because of the tradition in specialist literature on the history of medicine of regarding medicine as "the art of healing", rather than as a science. Following the appearance of the Hippocratic Corpus, empirical research in medicine developed within the context of an emphasis on strict demonstration. This issue has received little attention from historians in recent decades. Lloyd asks how historians should assess the methods of investigation used in medicine in the sixth to fourth centuries BC [2]. He analyses medicine in the context of the approach to knowledge, considering it alongside mathematics and astronomy, and arguing, with justification, that the three emerged at the same time as science in general. In our view, with regard to Hippocratic medicine he is quite correct to state that the texts of the Hippocratic Corpus contain elements of apodeictic demonstration. It was work in connection with a translation of Galen's treatise *On the Doctrines of Hippocrates and Plato*[2] into Russian [5–6] that showed the need for a more detailed study of the history of the use of the apodeictic method in medicine. This text provides a fresh understanding of the more than five-hundred-year-old history of the competition between different schools of medicine in antiquity in terms of analysing the nature of their methods of investigation. For a time (until the fifth century BC), this competition can be described as dialectic *versus* apodeixis [2, p. 115]. Within the context of the subsequent development of medicine, this can be interpreted as "rhetoric and sophistics versus apodeixis". In expanding the period covered by the research, we find that the meaning of the term "dialectic" changes: with regard to the debates at the time of Hippocrates, it pertains to the method of argument used by the sophists. The latter are the target of the polemics in the Hippocratic Corpus, and it is Hippocrates' opponents who are represented by the "dialectic" side of Lloyd's statement.

For the reasons described above, Herophilos' medicine has been largely neglected in historical and practical literature. His practice of anatomical dissection did not become part of classical medical tradition. Prior to Herophilos, ideas about the workings of the human body in classical medicine were based on sporadic observations. The well-known descriptions of human anatomy in the literature of the period (such as Aristotle's accurate location of the heart in the chest cavity) would not have been possible without knowledge based on practical observations. Herophilos's work indicates that his research activities were influenced by the ideas of Aristotle and Theophrastus. We believe that Herophilos understood the importance of causal explanation to theory construction, and in this regard generally shared Aristotle's views.

Accordingly, first the need for the experimental study of the anatomy of living creatures had to be established, and then a framework of theoretical generalisations showing their rationale ("necessity" and "usefulness") developed, before researchers could understand the need to dissect human cadavers on a systematic basis. In other words, the development of medical thought ran from the sporadic observations of Alcmaeon to the first deliberate animal dissections, described in the Hippocratic Corpus, to the systematic practice of comparative anatomy at the Lyceum,

[1] The emergence of the principle of strict demonstration in the history of science has been linked to the development of ancient Greek mathematics in the sixth to fifth centuries BC, primarily with Euclid's Elements, as well as with earlier works by Eudoxus. For more details on this, see [1–4].

[2] Here and elsewhere Galen's treatise *On the Doctrines of Hippocrates and Plato* is quoted from: Galen. *On the Doctrines of Hippocrates and Plato*. Ed. & tr. Phillip de Lacy. Berlin: Akademie Verlag. 2005. 251 pp. In the Russian version of the journal the same treatise is quoted from [6]. – *Editorial comment.*

to the works of Herophilos. The fundamental knowledge accumulated as a result of all this enabled Galen to develop his comprehensive anatomical and physiological system.

Since we have brought new sources to the Russian-speaking academic community, we believe that this issue needs to be to be revisited. It is important for us to define the apodeictic method in relation to the history of medicine, and to show its development in works by classical authors after Hippocrates. As a starting-point, we have taken the evidence analysed by Lloyd. We propose the following definition for the apodeictic method of demonstration in medicine: apodeixis means anatomical dissections, a rational theory of general pathology, and clinical classification. This classification entails a critical evaluation of doctoral experience. In medical practice, such an evaluation is based on a combination of cataphatic and apophatic methods of analysis.[3] Presenting the issue in this way seems all the more appropriate to us as Galen's comprehensive theoretical and practical system itself marks a historical boundary separating the period when Greek rational medicine emerged from the period covering the second to the sixteenth century (the rational medicine of the protoscientific period). In using logic as a tool for the advancement of science, Galen established boundaries for the use of both the dialectic and apodeictic methods in medicine, suggesting how they might be combined at different stages of a physician's work: from theory relating to general pathology[4] to clinical and experimental practice.[5]

[3] The principles followed by Rufus of Ephesus and Galen in taking anamneses constitute an example of this. For more details on this, see [7].

[4] See, for example, the treatises *On the Differentiae of Diseases*, *On the Differentiae of Symptoms*, and *On the Causes of Diseases* [Here and elsewhere these treatises are quoted from: Galen. *On Diseases and Symptoms*. Ed. & tr. Ian Johnston. Cambridge: Cambridge University Press, 2006. 346 p. – *Editorial comment*] and *A Method of Medicine to Glaucon* [Here and elsewhere quoted from Galen. *On the Constitution of the Art of Medicine. The Art of Medicine. A Method of Medicine to Glaucon*. Ed. & tr. Ian Johnston. Loeb Classical Library. Cambridge, MA: Harvard University Press, 2016. 656 p. – *Editorial comment*].

[5] See, for example, *On the Doctrines of Hippocrates and Plato*, Books I–V [Galen. *On the Doctrines of Hippocrates and Plato*. Ed. & tr. Phillip de Lacy. Berlin: Akademie Verlag. 2005. 251 pp.].

Rational medicine in the Hippocratic Corpus

Understanding the historical concept of "Greek rational medicine" clearly requires a precise understanding of its method of investigation, which is based on the theory and practice of argumentation and the use of strict demonstration. In our view, Hippocrates' principles represent the application of the apodeictic method in medical theory and practice. We take these principles to include ideas regarding the causality of disease, Hippocrates' understanding of the nature of man (with the "physics" of the human body being based on four primary elements), the classification of diseases, and the foundations of clinical practice (e.g. an individual approach to treatment, the theory that "opposites cure opposites", etc.).

The most interesting illustrations of the method of investigation used by a physician following the Hippocratic tradition are the treatises *Nature of Man*[6], *Ancient Medicine*[7] and *The Sacred Disease*[8] [30, pp. 127–183]. In the Hippocratic Corpus, we find a focus on studying the natural causes of diseases, a prioritisation of empirical knowledge, an endeavour to generalise from observed regular cause-and-effect relationships in the states of "crasis" and "dyscrasia" of the human body, and the use of various patterns of argument. For example, *Ancient Medicine* states that plausible reasoning has no place in medicine: "[J]ust as in all other arts the workers vary much in skill and in knowledge, so also is it in the case of medicine. Wherefore I have deemed that it has no need of an empty postulate, as do insoluble mysteries, about which any exponent must use a postulate, for example, things in the sky or below the earth... But medicine has long had all its means to hand, and has discovered both a principle and a method,

[6] Here and elsewhere quoted from: Hippocrates. *Hippocrates*. Tr. W.H.S. Jones. Loeb Classical Library. London/Cambridge, MA: William Heinemann/Harvard University Press, 1959. Vol. IV. P. 1–4. In the Russian version of the same treatise is quoted from [9]. – *Editorial comment*.

[7] Here and elsewhere quoted from: Ibid. Vol. I. P. 1–64. In the Russian version of the journal the same treatise is quoted from [9]. – *Editorial comment*.

[8] Here and elsewhere quoted from: Ibid. Vol. II. P. 127–183. In the Russian version of the journal the same treatise is quoted from [9]. – *Editorial comment*.

through which the discoveries made during a long period are many and excellent, while a full discovery will be made, if the inquirer... make them his starting-point... Therefore for this reason also medicine has no need of any postulate."[9] The work also discusses the need for a physician's reasoning in diagnosis and treatment to be based on true premises, and explains, inter alia, certain axiomatic rules underlying a researcher's thinking in a particular field of science – in this case, medicine (e.g. the principle of treating opposites with opposites). By the mid-fourth century BC, dialectic and rhetoric had become complex disciplines influencing the development of the whole of Greek thought, including, of course, the natural sciences. A Hippocratic physician had to be able to use the skills of argument in discussing not only specific medical approaches, but also various general theoretical issues concerning, for example, the make-up of the human body, pathology, physiology, etc. In the aforementioned treatises Hippocrates uses an approach based on strict demonstration. This approach was a result of the fiercely competitive environment in which Hippocrates' school of medicine operated: he constantly had to persuade others and to defend his ideas in public. For example, *Nature of Man* includes a complex discussion on the "physics" of the human body and an attempt to explain Hippocrates' position on this. Galen presents an interesting analysis of this text in his treatise *On Hippocrates' On the Nature of Man*.[10] As an heir and successor of the Hippocratic tradition of medicine, Galen analysed in detail Hippocrates' views on the nature of man, which could not be based on a single element alone, as this was a fundamental distortion of the approach to healing: " 'In what way,' someone might ask, 'does this explanation, in which some people propose that the nature of man is some single element, go beyond medicine?' Because, as the work will say a little later, it follows from this teaching that man never suffers. And one may also concede this: that it follows that there is one single cure. But there seem to be many kinds of ailments and many kinds of cures, so that this account is truly false."[11] Hippocrates' ideas of general pathology, which were developed by Galen, enabled a rational explanation for the diversity of human diseases. The theory of the balance (but not mixture) of primary elements and substances held that different diseases, requiring different cures, were caused by different combinations of them, in which one was qualitatively and quantitatively dominant. In *Nature of Man*, Hippocrates writes: "I hold that if man were a unity he would never feel pain, as there would be nothing from which a unity could suffer pain. And even if he were to suffer, the cure too would have to be one."[12] Galen provides the following comments on these ideas of his great predecessor: "First he condemns the arguments given by those who claim that man is one single thing, showing that these accounts are not only unproved, but also unconvincing. With these arguments, he now refutes the teaching of those who think that man is one single thing. For it is not the same thing to argue against a proposed explanation, as it is to condemn a teaching as untrue. Indeed, he shows that the teaching is true, but not correctly argued by some people, and, in this way, the disagreement does not arise with the teaching, but with those arguing for it. Thus, now putting their explanations to one side, he argues against the very teaching alone, using not only the strongest argument against it, but also the shortest. For he says, 'If man were one single thing, he would never suffer.' ... And he says that the proof that, if there were one single element, the body composed of such an element would not suffer, is that no other, second element, able to act, is present in the body. For he does not grant that a single body in this situation would be affected on its own, and, even if someone were to grant that it, being affected, could suffer on its own, then there would be a single cure."[13]

[9] Hippocrates. *Hippocrates*. Tr. W.H.S. Jones. Loeb Classical Library. London/Cambridge, MA: William Heinemann/ Harvard University Press, 1957. Vol. I., p. 13, 15, 17.

[10] Here and elsewhere quoted from: Galen. *On Hippocrates' On the Nature of Man*. Tr. W.J. Lewis with the assistance of J.A. Beach. Medicina Antiqua website (Wellcome Trust for the History of Medicine at UCL; accessed on 23 February, 2017). In the Russian version of the journal the same treatise is quoted from [10]. – *Editorial comment.*

[11] Galen. *On Hippocrates' On the Nature of Man*. Tr. W.J. Lewis with the assistance of J.A. Beach. Medicina Antiqua website (Wellcome Trust for the History of Medicine at UCL; accessed on 23 February, 2017) §§ 20–21.

[12] Hippocrates. *Hippocrates*. Tr. W.H.S. Jones. Loeb Classical Library. London/Cambridge, MA: William Heinemann/Harvard University Press, 1959. Vol. IV. P. 7.

[13] Galen. *On Hippocrates' On the Nature of Man*. Tr. W.J.

Galen draws a conclusion of great interest to historians of medicine regarding Hippocrates' views. He points out that the state of the primary elements in the human body (whether or not they are in balance) cannot be correctly assessed without an explanation of these processes in terms of the microstructure of human tissue. Galen quotes Hippocrates: "There are many things existing in the body, which, when they are by nature heated, cooled, dried and made wet with respect to each other, bring forth diseases. And just as there are many individual ailments, so there are many treatments."[14] Galen comments on this as follows: "In the passage before this one, he completely refuted those who say man is one single thing, which is the same as saying that he is composed of one element, based on the strange implications of that teaching. For we would not suffer if there were no other, second element able to affect this first one. And even if we were to grant this, then there would be a single type of cure, not many types. In the passage we have here, he discusses these things which he will show as being primary, from which all the others originate. These are hot and cold and dry and wet. When these are mixed with each other in a well-balanced way, the creature is healthy; but when any one of them is heated and chilled, dried and made wet, it naturally produces ailments which are not cured by merely one method. For some ailments disappear when the afflicted parts have been heated, some when they have been chilled or dried or made wet.»[15]

Galen believes that this also explains the diversity of diseases. For example, in his treatise *On Regimen*, the primary element "fire" is endowed with the qualities "hot" and "dry", and the primary element "water" with the qualities "cold" and "moist". Following the principle that "opposites cure opposites", Galen recommends treating a high temperature with plenty of liquid (similar advice can be found in *Nature of Man*). Galen notes that some medicines encourage the production of phlegm in the human body, while others encourage the production of black or yellow bile, and discusses how best to choose a therapy.[16] At the same time, the attendant circumstances should also be taken into account when following treatment protocols.[17] The need to take account of a significant number of factors contributing to the development of a disease led Hippocrates to recognise the importance of taking thorough anamneses and examining the patient. For example, in *Prognostic* he wrote on the need to examine the patient's face carefully, and to assess the colour and condition of their skin and the reactions of their eyes: "For if [the eyes] shun the light, or weep involuntarily, or are distorted, or if one becomes less than other, if the whites be red or livid or have black veins in them, should rheum appear around the eyeballs, should they be restless or protruding or very sunken, or if the complexion of the whole face be changed – all these symptoms must be considered bad, in fact fatal."[18] The physician should also ask how the patient slept, and about the patient's digestion and appetite, and should take note of the patient's body temperature and the position of their head, arms and legs. *Prognostic* includes separate chapters on how to interpret a patient's excretions (urine, vomit and sputum).

Hippocrates believed that the idea of the "proportionality" of all the vital processes taking place in the human body formed the basis for understanding the principles of disease treatment. He attempted to explain the theory that the human body was filled with four primary elements and four substances. Hippocrates' arguments for this approach in *Nature of Man* include elements of strict demonstration. He believed that the quantitative and qualitative relationships between the primary elements both lay behind many factors in health and disease, and, consequently, determined the choice of treatment. He categorically opposed projecting the idea of a primary element (which

Lewis with the assistance of J.A. Beach. Medicina Antiqua website (Wellcome Trust for the History of Medicine at UCL; accessed on 23 February, 2017), §§ 36–37.

[14] Ibid., § 38.

[15] Ibid., §§ 38–40.

[16] If there is a shortage of a particular fluid in the patient's body, the patient should be given medication encouraging its production.

[17] For example, the season. According to Hippocrates, a healthy body is dominated by one of the four fluids, depending on the weather conditions.

[18] Hippocrates. *Hippocrates*. Tr. W.H.S. Jones. Loeb Classical Library. London/Cambridge, MA: William Heinemann/Harvard University Press, 1959. Vol. II., p. 11.

had existed in natural philosophy since the time of early Ionian physics) onto the human body, arguing that this could not explain the many processes taking place within the human body. In his view, a proper explanation needs to take account of their interaction. Doctors today can employ various methods of physically examining patients, and of laboratory diagnosis, to obtain quantitative data for use in assessing the patient's state of health, and deciding if they are ill, and, if so, how serious their condition is. In Hippocrates' time, doctors faced the same tasks, but, not having such specialised equipment, had to rely on experience and observation rather than accurate qualitative assessment.[19] The terms "hot", "cold", "moist" and "dry" are used in the Hippocratic Corpus to describe processes taking place in the human body. According to Hippocrates, food contains many different components that have various "powers", which may differ qualitatively and quantitatively. These powers also act within the body. The substances ingested with food are transformed in different ways, depending on whether the body is healthy or sick, so one and the same type of food can agree with a healthy person, but not with someone sick. For example, with respiratory infections sputum can be salty and moist, enabling the doctor to deliver an opinion: hoarseness, a tickly throat, cough and other symptoms of pneumonia are caused by the formation of these specific substances within the body. This leads to the following conclusion: the fluids corresponding in their nature to the pathological excretions seen in a specific illness are important to its pathogenesis. An experienced doctor will not fail to notice that a patient's temperature and pain level fall when they start producing excessive sputum. It appears that a patient's condition improves when their body gets rid of an excess amount of salty phlegm. This leads the doctor to conclude that the onset of the illness was connected with the consumption of food having this quality.

In *Nature of Man*, particular attention is paid to the issue of methodology in medicine. Galen has a very precise understanding of this: "Hippocrates, proposing to find the nature of our bodies in this book, has used this method for the search: first he has inquired whether the nature is simple or complex, and then, having found that it is complex, he has considered the substance of the simple components in it – what sort of substance it is, that is, what power does it possess to be affected by something and to act, and in this way, on reflection, he has kept in mind the seasons and times of life – how the elements which have been discovered are related to these things. He found that the prognosis of recovery from diseases, and the treatments, necessarily refer back to these observations. And in his investigation of the compound elements of our body, he has kept in mind the elements themselves which exist in reality... For all these things called 'elements' in this way are not, strictly speaking, simple and primary in each thing, but only those things which are common to all that exists are actually primary, and are correctly called 'elements.' Hippocrates named them based on their qualities: hot, cold, wet, and dry – these are not between the extremes, but are the extremes themselves, clearly fire, earth, water and air."[20] Galen quotes Plato on the method chosen by Hippocrates: "What, then, does Hippocrates say that 'to

[19] Thus, for example, excretions can be assessed visually ("Urine is best when the sediment is white, smooth and even for the whole period of the illness... Sediments in urine which are like coarse meal are bad, and even worse than these are flaky sediments. Thin, white sediments are very bad, and even worse than these are those like bran." [Hippocrates. *Hippocrates*. Tr. W.H.S. Jones. Loeb Classical Library. London/Cambridge, MA: William Heinemann/ Harvard University Press, 1959. Vol. II., p. 25–27]), as well as by smell and taste. Sweet-tasting urine and the presence of certain other symptoms in the patient are evidence of "the sweet disease" (or diabetes mellitus as we know it today). Hippocrates believed not only that a patient's illness and condition could be adequately assessed, but also that an accurate prognosis could be made, based on, for example, analysis of urine: "So long as the urine is thin and of a yellowish-red colour, it is a sign that the disease is unconcocted; ...Whenever the urine is for a long time thin and crude, should the other symptoms too be those of recovery, an abscession is to be expected to the parts below the diaphragm. Fatty substances like spiders' webs settling on the surface are alarming, as they are signs of wasting." [Ibid., p. 27]).

[20] See Galen's treatise *On Hippocrates' On the Nature of Man* [Galen. *On Hippocrates' On the Nature of Man*. Tr. W.J. Lewis with the assistance of J.A. Beach. Medicina Antiqua website (Wellcome Trust for the History of Medicine at UCL; accessed on 23 February, 2017). §§ 102–103, 103-104].

observe concerning nature' is, and what does true reason say? For is it not necessary that the nature of anything whatsoever be understood in this way? First, whether it is simple or complex. Then, if it is simple, to examine its power: what it possesses making it tend to act, and what tends to undergo its action. And if it has a complex form, then to examine it with respect to each individual aspect, in the same way as the simple was examined with respect to one aspect: what does it do by nature and what is affected by it."[21]

Another treatise by Hippocrates, *The Sacred Disease*, is of great interest to us. This describes the clinical presentation and methods of treatment for epilepsy, which was connected with mystical phenomena in the classical tradition. The treatise represents an excellent example of the contrast between "rational" approaches to diagnosis and treatment based on natural factors, on one hand, and magical beliefs, on the other. Evidence obtained from simple observation needs to distinguished from that obtained from targeted research, so all the descriptions of clinical cases in Hippocrates, even the most accurate, constitute individual observations. However, his description of the dissections of the brains of animals suffering from diseases with symptoms similar to those of epilepsy in humans should certainly be regarded as evidence obtained with the aim of learning more about the disease. In other words, they can be regarded as scientific research. In this respect, *The Sacred Disease* represents a clear repudiation of all the magico-religious healing practices followed at the time. Hippocrates regards epilepsy as an ordinary disease rather than a result of supernatural forces: "I am about to discuss the disease called 'sacred'. It is not, in my opinion, any more divine or more sacred than other diseases, but has a natural cause, and its supposed divine origin is due to men's inexperience, and to their wonder at its peculiar character."[22] He describes epilepsy in terms of "dyscrasia", like any other illness: "But when the disease dates from infancy and has grown and been nourished with the body, the habit has been formed of the flux occurring at the changes of the winds, and the patient generally has an attack then, especially if the wind be in the south. Recovery, too, proves difficult; the brain is unnaturally moist, and flooded with phlegm, so that not only do fluxes occur more frequently but the phlegm can no longer separate, nor the brain be dried, being on the contrary soaked and moist.»[23]

The Sacred Disease is notable not only for the fact that it represents an attempt to explain an ailment with mystical associations through natural causes. Through anatomical study of the structure of the brain, Hippocrates looks for possible abnormalities capable, in his opinion, of causing the ailment: "The truth of this is best shown by the cattle that are attacked by this disease, especially by the goats, which are the most common victims. If you cut open the head you will find the brain moist, very full of dropsy and of an evil odour, whereby you may learn that it is not a god but the disease which injures the body. So is it also with a man. In fact, when the disease has become chronic it then proves incurable, for the brain is corroded by phlegm and melts, and the part which melts becomes water, surrounding the brain outside and flooding it, for which reason such people are attacked more frequently and more readily."[24] As such, the individual vivisections described in the Hippocratic Corpus reflect the pattern of development of the apodeictic method in medicine.

It cannot be said that around the turn of the 4th century BC dissections were used on a systematic basis as an element of strict demonstration. However, we believe, the method of investigation in medicine shows a clear line of development, from the individual, albeit fully considered, experiments of Alcmaeon and Hippocrates to Herophilos [11–13] and his practice of regular anatomical dissections, through to Galen's theoretical and practical system. For Hippocratic physicians whose worldview was informed by the tradition of Plato and Aristotle, and who accepted the existence of an ideally healthy human body, it was logical to perform anatomical research and make use of the results. They sought evidence needed to describe the anatomy and physiology of a healthy person, and accepted that an ideal anatomical

[21] Ibid., §§ 103-104.

[22] Hippocrates. *Hippocrates*. Tr. W.H.S. Jones. Loeb Classical Library. London/Cambridge, MA: William Heinemann/Harvard University Press, 1959. Vol. II., p. 140.

[23] Ibid., p. 169.

[24] Ibid.

and physiological system could be distorted by external and internal factors leading to disease. For them, it was logical to describe the internal workings of the human body in terms of healthy "crasis" or unhealthy "dyscrasia". The texts of the Hippocratic Corpus show a clear preference for strict demonstration: case histories are described in depth, and much attention is paid in their analysis to establishing cause-and-effect relationships between observed symptoms and potential pathological processes, with the treatment being prescribed following careful verification of the diagnosis.

The significance of Aristotle's ideas regarding strict demonstration in the development of rational classical medicine

Aristotle was the first person in the history and philosophy of science[25] to distinguish between dialectic and analytics. In terms of the history of medicine, Aristotle was important in that he discovered patterns of similarity in the anatomical structure of living creatures and laid the foundations for the future development of medicine as a science. He worked with extensive empirical material[26] and was the first person to carry out a comprehensive analysis of the principles of demonstration. He examines strict deductive reasoning in his *Prior Analytics*[27] and *Posterior Analytics*.[28] His treatise *Topics* is devoted to the method of dialectic, which can be used in arguments on any subject.

According to Aristotle, dialectic is useful for understanding the "principles of science". However, he contrasts dialectic with analytics – the theory of apodeictic (demonstrative) syllogism, derived from necessary and true premises, and leading to accurate knowledge: "By demonstration I mean a scientific deduction; and by scientific I mean one in virtue of which, by having it, we understand something... [It] is necessary for demonstrative understanding in particular to depend on things which are true and primitive and immediate and more familiar than and prior to and explanatory of the conclusion (for in this way the principles will also be appropriate to what is being proved)."[29] The apodeictic method precludes the existence of the opposite to what it infers. "[F]or one cannot ask questions when demonstrating because when opposites are the case the same thing is not proved."[30]

Aristotle's view that knowledge is based on an understanding of first principles contrasts with Plato's theory of recollection: "[T]here is not only understanding but also some principle of understanding by which we become familiar with the definitions."[31] Particulars, being nearer to perception, are "prior in relation to us" (i.e. easier to understand), but "posterior by nature" (i.e. further removed from its principles); universals, being further away from perception, are "posterior in relation to us" (i.e. harder to understand), but "prior by nature". According to Aristotle, knowing means understanding the first causes of principles of a phenomenon, i.e. universals: "[F]or consideration of the reason why has most importance for knowledge."[32] Indeed, scientific knowledge of particulars is impossible: Knowledge of universals is not innate, but acquired gradually through perception, memory, experience, intuition and science: "[I]t is impossible to perceive what is universal and holds in every case; for that is not an individual not at a time; for then it would not be universal – for it is what is always and everywhere that we call universal. So, since demonstrations are universal, and it is not possible to perceive these, it is evident that it is not possible to understand through perception either."[33]

Aristotle distinguishes dialectic from analytics, which bears the features of true and necessary knowledge, and from sophistry, which has to do only with the appearance of knowledge,

[25] See, for example, his *Prior Analytics*, *Posterior Analytics*, and *Topics* [*Aristotle*. The Complete Works of Aristotle (Revised Oxford Translation). Ed. Jonathan Barnes. Princeton University Press: Princeton, NJ, 2014. 2 vols. 2510 pp. In the Russian version of the journal the same treatises are quoted from [14] – *Editorial comment*.]

[26] At the Lyceum, Aristotle was able to generalise on a systematic basis from the results of anatomical dissections.

[27] This treatise describes various figures and modes of syllogism.

[28] This treatise analyses the conditions under which to use demonstrations.

[29] Ibid., p. 115.

[30] Ibid., p. 126.

[31] Ibid., p. 117.

[32] Ibid., p. 129.

[33] Ibid., p. 144.

and not with genuine knowledge. In his view, the field of dialectical probability lies between those of reliable knowledge and of empty knowledge. Aristotle refers to these as understanding *simpliciter* (analytics), accidental opinion (dialectic) and sophistry respectively. He criticises sophistic approaches to acquiring knowledge and the sophistic method of demonstration: "[T]hose people are silly who think they get their principles correctly if the proposition is reputable and true (e.g. the sophists who assume that to understand is to have understanding). For it is not what is reputable or not that is a principle, but what is primitive in the genus about which the proof is; and not every truth is appropriate. That the deduction must depend on necessities is evident from this too: if, when there is a demonstration, a man who has not got an account of the reason why does not have understanding..."[34] Later, Galen argues that medical theory cannot be built on rhetorical premises, which he contrasts with arguments based on the findings of anatomical dissections, as an element of the apodeictic method in medical practice.

"2.3.3. The main point was that the appropriate and proper premises must be found in the very essence of the matter under investigation. So in these (discussions) in which Chrysippus reflects on the governing part of the soul (τὸ ἡγεμονικόν), we should first state the definition of the essence of the thing we are investigating, and then use it as a standard and guide in all the particulars.

2.3.4. The governing part (of the soul) (τὸ ἡγεμονικόν), as they too would have it, is the source of sensation and conation.

2.3.5. Therefore the demonstration that the heart contains in itself the governing part must not proceed from any other premise than that it initiates every voluntary motion in the rest of the body, and every sensation is carried back to it.

2.3.6. Now where will the proof of this be found? Where else but from dissections? For if this (organ) dispatches the power of sensation and movement to all the individual members, then necessarily some vessel must grow out from it to perform this service for them.

2.3.7. So it has become evident from the method of scientific proof that it would be more useful to dissect animals and observe closely what and how many kinds of structures grow out from the heart and spread to the other parts of the animal; and, these very structures being of such and such kinds and so many in number, (to observe) that this one transmits sensation or movement or both, that one some other thing, and thus to reach the point where one understands which powers in the body have the heart as the source."[35]

While emphasising the difference between the dialectical and apodeictic methods (in particular as an alternative to the Platonic views of dialectic as the highest of the sciences), he did not make the clear-cut distinction between them that might appear to be the case from some of his individual statements, as the apodeictic method essentially takes its fundamental principles from the dialectical. Dialectical deduction (the main tool of dialectic) is built on plausible hypotheses, thereby differing from both apodeictic deductions, which are based on true and primary hypotheses, and heuristic deductions, which "seem to be reputable, but are not really such"[36] Aristotle recommends four "instruments" for the construction of dialectical deductions: "one, the securing of propositions; second, the power to distinguish in how many ways an expression is used; third, the discovery of the differences of things; fourth, the investigation of likeness."[37] Galen shares Aristotle's views and gives his own assessments: "I called the first kind of them scientific and demonstrative, the second useful the training and, as Aristotle would say, dialectical, the third persuasive and rhetorical, and the fourth sophistical; and I showed that of the premises based on the properties and attributes of the heart, those that are pertinent to the very matter under investigation belong to the class of scientific premises, and all the rest are dialectical, that (premises) taken from external witnesses are rhetorical, and those that fraudulently exploit

[34] Ibid., p. 121.

[35] Galen. *On the Doctrines of Hippocrates and Plato*. Ed. & tr. Phillip de Lacy. Berlin: Akademie Verlag. 2005. p. 109, 111.

[36] Aristotle. *The Complete Works of Aristotle (Revised Oxford Translation)*. Ed. Jonathan Barnes. Princeton University Press: Princeton, NJ, 2014. 2 volumes, p. 167. For more details on the dialectic method, see Aristotle's treatise *Topics*.

[37] Ibid., p. 175.

certain homonyms or forms of expression are sophistical."[38]

The dialectical method is entirely determined by its aim, which Aristotle sees as being to produce one single opinion that takes account of all others (denying some and affirming others). At the same time, the strict requirements for demonstration proposed by Aristotle had huge significance for the subsequent development of Greek science, including medicine. Galen considered himself on the one hand an heir to the practical medicine of Hippocrates, and on the other as a follower of the method of investigation for which Aristotle laid the foundations: "I say that the best accounts of scientific demonstration were written by the old philosophers, Theophrastus and Aristotle in their Second Analytics."[39]

A significant element of Aristotle's philosophy was his theory of movement, which influenced the development of medical theory and practice, which his studies of zoology and comparative anatomy helped to establish [2]. He talks about several types of movement (alteration, increase and decrease, generation and destruction, and change of place), which can be used to describe medical phenomena. Aristotle's arguments regarding the movement of animals also contain elements of his method, which is based on knowledge of primary causes: "However, that which first moves the animal organism must be in a definite origin. Now we have said that a joint is the origin of one part of a limb, the end of another. And so nature employs it sometimes as one, sometimes as two. When movement arises from a joint, one of the extreme points must remain at rest, and the other be moved (for as we explained above the mover must support itself against a point at rest); accordingly, in the case of the elbow-joint, the last point of the forearm is moved but does not move anything, while, in the flexion, one point of the elbow, which lies in the whole forearm that is being moved, is moved, but there must also be a point which is unmoved, and this is our meaning when we speak of a point which is in potency one, but which becomes two in actual exercise. Now if the forearm were the living animal, somewhere in its elbow-joint would be the movement-imparting origin of the soul."[40] In discussing the specifics of animal movement, Aristotle follows the logic of strict demonstration: "The movements of animals may be compared with those of automatic puppets, [τὰ αὐτόματα] which are set going on the occasion of a tiny movement (the strings are released, and the pegs strike against one another)." These concepts can only be explained empirically. For example, taken together the phenomena of general pathology can be understood only when taking account of the great variety in the capabilities of the human body, and by systematic generalisation of the numerous empirical phenomena explaining this variety.

Aristotle's reasoning on the theory of movement, and his view on the relationship between sense-perception and demonstration in the development of scientific knowledge allows us to better understand Galen's approach to defining a method of medicine. The Stagirite suggests that this is impossible without sense-perception: «[I]f some perception is wanting, it is necessary for some understanding to be wanting too – which it is impossible to get if we learn either by induction or by demonstration, and demonstration depends on universals and induction on particulars; and it is impossible to consider universals except through induction (since even in the case of what are called abstractions one will be able to make familiar through induction that some things belong to each genus, even if they are not separable, in so far as each thing is such and such), and it is impossible to get an induction without perception – for of particulars there is perception; for it is not possible to get understanding of them."[41] Aristotle's analytics establish the principles and forms of the demonstrations used in the natural sciences, serving as apodeictic knowledge. With the development of medical knowledge, anatomical dissection as a means of verification became the main argument for the physicians of antiquity in the polemic with their opponents, who relied on all kinds of theoretical speculation, supported by arbitrary selections of rhetorical devices (as in, for example the dispute between representatives

[38] Galen. *On the Doctrines of Hippocrates and Plato*. Ed. & tr. Phillip de Lacy. Berlin: Akademie Verlag. 2005. § 2.8.2, p. 157, 159.

[39] Ibid., § 2.2.4, p. 105.

[40] Aristotle. *The Complete Works of Aristotle (Revised Oxford Translation)*. Ed. Jonathan Barnes. Princeton University Press: Princeton, NJ, 2014. 2 vols. p. 1093.

[41] Ibid., p. 132.

of the school of rational physicians and the school of empirical physicians). The use of the method of apodeictic demonstration in research practice, alongside dialectical means of demonstration, was shown most clearly by the creator of the first comprehensive theoretical and practical system, Galen.

Galen's method of investigation: "apodeictic" or "dialectic"?

We have repeatedly highlighted the continuity between the ideas of Hippocrates, Plato and Aristotle, on one hand, and Galen's research practice, on the other, which supports the notion that "All teaching and all intellectual learning come about from already existing knowledge."[42] In developing the traditions of Hippocratic medicine (the doctrine of an individual approach to diagnosis and treatment, attention to external pathogens, etc.), Galen created a theory of general pathology explaining the principles and mechanisms of disease development from the perspective of a teleological approach, and laid down the necessary methodological foundations for it. Galen's general ideas of the "physics" of the human body and the principles of general pathology are based on an understanding of the human body as a proportionate combination of components of three tetrads: primary elements, fluids and substances. Galen emphasises the importance of a comprehensive system of medicine: ideas about the types and causes of diseases inform their classification and the interpretation of individual signs and symptoms.

Galen sets out the principles of general pathology in detail in his three treatises *On the Differentiae of Diseases*, *On the Causes of Diseases*, and *On the Differentiae of Symptoms*.[43] These reflect the comprehensive and practical nature of his analysis, and his desire to establish a universal system based on a critical evaluation of a physician's practical observations. His ultimate aim was to create an integral concept of general pathology understandable to practising physicians. Here, he closely follows Aristotle, who wrote that «we only understand when we know the explanation."[44] From a methodological viewpoint, the category of cause is closely connected to the process of understanding and the answer to the question of whether the human mind has the capacity and ability to comprehend and study the laws of the physical world. For example, in *On the Differentiae of Symptoms* Galen proposes the following classification of the causes of diseases. First, he divides them into "the material, the useful, the objective, the instrumental and that from which there is the origin of movement".[45] Secondly (and critically), he divides them into conditions of the body and those that cause damage to functions. Note the obvious influence of Aristotle's ideas regarding types of motion and the method of demonstration on Galen's reasoning. This allows him to generalise for the purposes of medicinal theory, and to set out the basic concepts of a theory of disease (the causes, differentiae and symptoms of diseases). At the same time, we see in Galen's work an attempt to distinguish between the concepts of the causes of diseases and their symptoms: "[T]he specific characteristic of a symptom is this: it is contrary to nature. Hence, [symptoms] exist as well in all differences where there is a change from what accords with nature. They occur, then, when there is destruction of shapes, colours, magnitudes, functions and affections that accord with nature. And this is the most specific definition of it – a change of what accords with nature."[46] "Cause" in Galen means a combination of external influences (healthy or unhealthy), depending on how they affect the balance of proportions in the human body. This is reflected in the classification of causes presented in *On the Differentiae of Symptoms*.

Galen gives an interesting definition of "disease": "A disease is a condition of a body primarily impeding function."[47] He divides diseases into the "simple" and the "combined": the former affect the "simple" parts of the body, and the latter the "combined" parts (the organs). Accordingly, the causes of diseases of simple

[42] Ibid., p. 114.

[43] For more details on this, see Galen. *On Diseases and Symptoms*. Ed. & tr. Ian Johnston. Cambridge: Cambridge University Press, 2006.

[44] Aristotle. *The Complete Works of Aristotle (Revised Oxford Translation)*. Ed. Jonathan Barnes. Princeton University Press: Princeton, NJ, 2014. 2 volumes, p. 115.

[45] Galen. *On Diseases and Symptoms*. Ed. & tr. Ian Johnston. Cambridge: Cambridge University Press, 2006. p. 185.

[46] Ibid., p. 187.

[47] Ibid., p. 186.

parts of the body constitute the first level of the classification, and the causes of organ problems the second. Clearly, the differentiae of diseases correlate with the classification of their causes. The factors in the development of diseases of the combined parts of the body can be understood by explaining the causes of diseases of the simple parts. In Galen's writing, any theoretical premise illustrating his idea of general pathology is immediately subjected to a critical analysis using case stories from clinical practice or everyday situations anyone can understand. This is how the main cause of illnesses – a malign combination of substances that produces excessive heat – is analysed: "Next should be to go through the causes of each of these, starting from the simple and so-called *homoiomeric* parts of the animal, then passing in turn to the combined and organic."[48]

Galen made use of the dialectical method, but regarded plausible reasoning as dangerous in medicine, believing that only scientific premises addressed "the essence of the matter under investigation".[49] For Galen, as for Aristotle, the laws of reasoning are based on logic, and this, ultimately, is a tool for the advancement of science. For Galen, the dialectical method relies on premises that are merely plausible or likely: "All others are external. Some are used by the dialectician for practice, for refuting sophists, for testing a young man's pregnancy, playing the midwife, leading him to some discovery, and raising questions in his mind; all of these, if you wish, you may call dialectical, gymnastic, and topical... but try to distinguish them from scientific premises."[50]

Proof for Galen is not a matter of casuistry and wording that is formally, logically correct, but an opportunity to establish the required connection between concept and reality. In his clinical practice, Galen draws on Aristotle's categorical syllogism. For a conclusion to be true, it is not enough for the argument to be logically sound: the premises need to be true as well. A natural, visible entity is arbitrary, variable and finite: it is not possible to discover the truth from a single entity. This is essential to methods of understanding in medicine: the cause of an illness cannot be determined from a single, even clearly exhibited, symptom. One cannot comprehend a disease entity, or systematically evaluate clinical findings, from a single observation. At the same time, in Galen's writings that are available to Russian medical historians Aristotelian dialectic is used as a "medium" between ordinary argument and philosophical study. Dialectical methods are useful in polemics, because, as Aristotle says, the dialectician is skilled in this field, where others have to do as they can: the dialectician tries to defend his own views, and to influence the views of others or expose the ignorance of his interlocutor. For this to be the case, dialectic has to involve a certain general ability to hold an argument. A significant feature of *On the Doctrines of Hippocrates and Plato* is Galen's polemic against the Stoics, in which the great Roman physician demonstrates both an excellent command of rhetoric and a brilliant use of strict demonstration to substantiate his position.

The apodeictic method in Galen's research practice can also be seen in his focus on the use of anatomical dissections and vivisection in order to study the anatomy of warm-blooded animals and humans. It is commonly assumed by Russian historians that Galen experimented on animals out of necessity: the great physician dissected animals because religious prohibitions prevented him from dissecting human cadavers. We believe that this assumption is unfounded:[51] the link between Galen's research practice and Aristotle's principles of comparative anatomy and his approach to obtaining reliable knowledge needs to be emphasised. If one agrees that animals share common features, it is entirely reasonable to make judgements about human physiology on the basis of experiments on animals. Furthermore, even today medicines and treatment methods are tested on animals before they are tried on humans. The apodeictic method in the broader sense is a particular way of establishing and applying proof, whereby the initial premises are certain philosophical principles, which must be confirmed and taken as essential, and from which individual assertions are then produced (evidenced). Apodeixis can produce a clarification, explanation or specific description

[48] Ibid., p. 159.

[49] Galen. *On the Doctrines of Hippocrates and Plato*. Ed. & tr. Phillip de Lacy. Berlin: Akademie Verlag. 2005. § 2.3.9, p. 103.

[50] Ibid., § 2.3.10, p. 111.

[51] See [10, 16–17].

of something. Accordingly, from Galen's theory of general pathology, based on his theory of disease causation, precise classification of their differentiae, and teaching on symptoms, we may conclude that he used an approach based on strict demonstration. Below, we examine the practical aspects of Galen's use of the apodeictic method.

Some historians of science categorically oppose applying the term "experiment" to Galen's work, on the grounds that it is generally accepted that the experimental method arose only much later, as one of the methodological aspects of the scientific revolution of the seventeenth century. However, the specific features of the emergence of medicine as a science mean that its history does not fit the pattern of that of other natural sciences (physics, chemistry, etc.). The countless anatomical dissections of dead animals or human cadavers, methodically performed year after year in order to learn about their structure, often involving multiple rechecking of the configuration of organs, blood vessels and nerves, undoubtedly qualify as "experiments": It is no coincidence that Von Staden, Nutton and Longrigg all use the term in describing the work of Herophilos and Galen [12, 18–22].

In his writings, Galen mentions various types of experiments carried out by him (experiments on the brain, experiments on the spinal cord and the spinal nerves, experimental studies of the tongue and the larynx, experiments on the thoracic region, the heart and the blood vessels, and experiments on embryos, and on the digestive and renal systems and their functions).[52] All these experiments are fully comparable with the research practices of later periods. Galen often discusses problems he solved by experimenting on living beings. He points out the differences between dissections and vivisection: anatomical dissection is performed on dead animals, while vivisection is research performed on living (or, to be more precise, *still living*) animals. The aim of Galen's research was to study the functions of parts of the body. The methods of dissection and vivisection that he used in practice have clear definitions: dissection of a dead animal helps to understand the anatomy of parts of the body, while vivisection helps to understand their functions. The former involves methodical observation, while the second entails targeted interference: "[W]ould they trouble to cut or ligate parts of the living animal, to discern the function thus impeded?"[53] Dissection makes it possible to examine hidden parts of the body, such as the internal organs, while vivisection provides information that helps to reveal the physiological functions of parts of the body: "The anatomy of the dead teaches the position, number, proper substance, size, and construction of the parts. That of the living may reveal the functions at a glance or provide premisses for deducing them."[54] Galen emphasises the primacy of anatomical information, on which scientific conclusions are based: "Everything that has been and will be said has been discovered, on the basis of the study of the structure of the organs, and of the symptoms displayed during cutting and pressing." Galen calls for "experimental integrity": in his view, information obtained from experiments can be divided into two groups: that directly required for the purposes of the research, and that unrelated to it. Accordingly, to determine the function of a specific part of the body it is important to isolate it from its neighbouring parts, whose functions could distort the observations. Some forms of interference require experiments on several animals. This is also evidence of Galen's desire to be able to observe its individual phases.

Galen's reproduction of pathological situations through vivisection certainly fits the definition "experimental surgery", and reflects the importance of the apodeictic method in medicine. Galen realised the need for an approach making it possible to "distinguish truth from falsehood", and to "strive for the truth" in solving specific medical problems. In addition, he believes that the approach should be used in order not only to gain knowledge, but also to be able to use it. Galen describes such experiments in Book II of *On the Doctrines of Hippocrates and Plato*:

[52] See [23, p. 1718–1756] and Debru A. *Galen's Approach to Anatomy and the Soul*. The History of Medicine. 2015. 2 (2): 127–131.

[53] Quoted from Galen: *On Anatomical Procedures*, I, 232 [Galen. *On Anatomical Procedures*. Tr. Charles Singer. London: Oxford University Press for the Wellcome Historical Medical Museum. 1956. p. 8]. In the Russian version of the article, quoted from [23, p. 1722].

[54] Quoted from Galen: *On Anatomical Procedures*, IX, 707 [Ibid., P. 226]. In the Russian version of the article, quoted from [23, p. 1722].

"2.4.42. For when the heart has been exposed, as I mentioned also in the preceding book, if you lay hold of it and press crush it, you will see that the animal is not deprived of breath or speech and is not prevented from performing any other of the activities that follow on conation; but when you have stripped the brain of its bones and have pierced or pressed any one of its ventricles, you will immediately deprive the animal not only of speech and breath, but of all sensation whatever, and of all the movements that follow on conation.

2.4.43. I also said earlier that when exposing the heart one must not at the same time pierce either of the two chest cavities...

2.4.45. Now this very thing happens also in many sacrifices that are customarily performed in this way, and animals whose heart already lies on the altar are observed not only to breathe and bellow vehemently, but also to flee, until they die from loss of blood.

2.4.46. Of course their blood empties out very quickly, as the four largest vessels have been torn away; but so long as the animals still live they breathe and cry out and run.

2.4.47. But when we observe the bulls that are cut every day at the first vertebra, where the spinal cord grows out (from the brain), we see immediately that they are no longer able to advance a single step, much less to run; and along with the incision they lose both breath and utterance, for these activities too are initiated from above

2.4.48. And yet we can see the heart of bulls thus cut pulsating for a very long time, along with all the arteries; for the pulsation of the arteries is not from the brain, nor is that of the heart itself."[55]

Galen shows that breathing and muscle excitation stop immediately when the relevant nerves are cut. By contrast, the impairment of the circulatory function when the blood vessels are cut, or of the cardiac function when the heart is damaged or removed from the chest, has no effect on voice production or the work of the muscles – the animal produces sounds and moves.

Galen argues that it is not possible to draw conclusions regarding the importance of an organ on the basis of its position in the body: in his view, it is the organ's functional purpose that is important. Even the anatomical structure of a part of the body is of interest to Galen because, he believes, it is also determined by the function it performs.

Galen's works reveal a completely different historical reality, in which anatomical dissection is the only correct method of demonstration for a natural philosophical hypothesis, and careful and systematic practical observations serve as a foundation for a classification of diseases, based on the methodology of protoscientific experimentation [7, p. 101–118].

Use of the terms "protoscientific experiment" or "experimental practice in rational classical medicine" allows historians of science to avoid disparaging classical medicine, as well as to avoid the mistake of projecting modern practices onto the research activities of the period.

Conclusions

We believe that when studying the development of rational medicine in Antiquity, it makes sense to take account of the different stages of the development of its methodology, based on the application of the apodeictic method. From analysing the history of the emergence of medicine as a science in the classical period and studying the circumstances in which those approaches originated, we can define the apodeictic method in medicine as a combination of anatomical dissections, a rational theory of general pathology and clinical classification.

We suggest that the methodological development of classical medicine can be divided into the following stages:

The origins of the apodeictic method – the principles of Hippocrates and the foundation of Greek rational medicine, under which natural phenomena and the human body, as part of nature, are explained through exploring and studying natural causes;

The establishment of the apodeictic method – the works of Aristotle on the theory of argumentation, his strict requirements for demonstration, the theory of motion and the practice of systematic dissections of animals based on this, and the establishment of the principles of comparative anatomy;

The development of the apodeictic method – Galen's dissection and "protoscientific

[55] Galen. *On the Doctrines of Hippocrates and Plato*. Ed. & tr. Phillip de Lacy. Berlin: Akademie Verlag, 2005. P. 127, 129.

experiments" (the main argument in his debate with his opponents), his anatomical/physiological system, and his comprehensive theory of general pathology. All this enabled Galen to extensively develop the practice of using the apodeictic method as a physician and to demonstrate its importance for the further development of medicine as a science.

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