The Pythagorean Legacy in Medicine

Master's Thesis

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Preface

Medicine occupies a special place among the natural sciences: its subject is the human being. Medicine studies human's diseases, preventing and treating them, and making people better. Accordingly, it deals with various gnoseological issues, part biological, part physical, part philosophical. Medicine develops on the basis of clinical practice, but it should not be forgotten that it is inseparably linked to more general issues in terms of understanding the physical world, where finding the initial link in the full chain of causes and their effects is practically impossible. This is a particular issue in medical theory and practice. Identifying the causes of illnesses, correctly interpreting symptoms, each of which may point to often contradictory forms of sickness, and studying aetiology are on one hand all part of clinical praxis, and on the other belong to the philosophical issues of medical theory. The combination of disparate information from anatomy, histology and physiology will remain merely a set of data without an understanding of the ontological nature of the treatment process, which is possible only when each physician perceives the human body as an integral whole. The philosophical foundations of medicine make it possible to establish more clearly the relationship between pathological phenomena and processes (or cause-and-effect relationships). When a disease takes hold and develops, various completely new behaviours become apparent, for which the vital functions of a healthy body are not responsible. The methodology, like the philosophy of science in general, should, without question, make use of research done by historians of science. In turn, historians of science need to draw on worldviews and methodological principles that shed light from a broader philosophical point of view on the general development prospects for science, as without philosophy the history of science is blind, and without the history of science philosophy is empty[1]. In the foreword to

[1] I. Lakatos, "History of Science and Its Rational Reconstructions**."**

his treatise *De Medicina*, Celsus describes the birth of medicine in Greece as follows: “At first the science of healing was held to be part of philosophy, (…) Hence we find that many who professed philosophy became expert in medicine, the most celebrated being Pythagoras, Empedocles and Democritus. But it was, as some believe, a pupil of the last, Hippocrates of Cos, a man first and foremost worthy to be remembered, notable both for professional skill and for eloquence, who separated this branch of learning from the study of philosophy.”[2] Claude Bernard also highlights the connection between philosophy and medicine: “Philosophy embodies the eternal aspiration of human reason toward knowledge of the unknown... By ceaselessly stirring the inexhaustible mass of unsolved questions, philosophy stimulates and maintains this healthful movement in science... Philosophy and science, then, must never be systematic: without trying to dominate one another, they must unite.”[3] The most general ideas find their expression in the philosophical foundations of science. Philosophy is important to us because we want to learn “something about the riddle of the world in which we live, and the riddle of man’s knowledge of that world.”[4] Scientific discovery always exists in the context of the overall development of a specific discipline, and of the methodological paradigm and worldview of the scientist making it.

In medicine, as in science generally, related research areas are of great interest. From a heuristic point of view, not only the basic principles of Hippocratic ethics but also many of the ideas of classical antiquity remain relevant to modern medicine. This underlines the important methodological role of research in the field of the philosophy and history of medicine. The complexity of defining scientific problems makes it possible to study the circumstances of the emergence and development of the scientific method in medicine and to identify epistemological resources for potential scientific discoveries, providing the

[2] Celsus, *De Medicina*.
[3] C. Bernard, *An Introduction to the Study of Experimental Medicine*, 221, 223–224.
[4] K. Popper, *The Logic of Scientific Discovery*, xxvi.

conditions needed for the researcher to develop a worldview that is based on an understanding of the continuity in the development of medical science.

The universal nature of philosophical methods is shown in the fact that they can be used in studying any spheres and forms of activity, and in drawing up both practical and theoretical agendas. Understanding particular organic proportions and conditions of the living body is the main focus of medical science, and disruption to the balance of a particular combination of elements, and to the harmony of parts with each other, and overall, leads to sickness, definition of which is the physician's art. In the history and philosophy of science, values are constantly being reassessed. Improvements to the methodological tools thanks to the active involvement of interdisciplinary research are making it possible to rethink the significance of fundamental philosophical definitions to the development of scientific knowledge in the context of newly discovered historical evidence.

The close relationship between philosophy and medicine derives primarily from the fact that medical theory is always part of a general field of ideas that constitutes the philosophy of medicine, which enables comprehensive study of a complex living system — the human body, while the majority of medical concepts originate from outside the field of medicine.[5] The history of the development of the philosophical method in medicine has its origins in antiquity. Hippocrates advised: "Transplant wisdom into medicine and medicine into wisdom."[6] As a branch of scientific knowledge, medicine always strives for truth. At the same time, truth in medicine is attained in a specific way, as it is shaped by the applied nature and specific features of a physician's clinical thinking. A physician's ontological thinking follows a path from studying changes in a particular part of the body to the cause producing them. Writing in the second century AD, Galen had this in mind when he said that "we ought first to ascertain the diseases that the patient has

[5] This is referred to by, for example, the Soviet pathologist I. Davydovsky. *Problema prichinnosti v meditsine (etiologiya)* [*The problem of causation in medicine (aetiology).*

[6] Hippocrates, *Decorum*, V.

had in the past, and those he has at the present time, and those that are likely to affect him in the future, as matters to which we should give the greatest attention."[7]

As such, our objectives include the need to ascertain the compatibility of philosophical ideas and medical beliefs, through the example of Pythagorean teaching. In doing so, we attempt to show that certain philosophical beliefs of the Pythagoreans had an influence on the development of medical ideas. At the same time, the presence of strong occult/magical tendencies in the teaching of the Pythagoreans means that we need to be careful in assessing this influence. With regard to the significance of the Pythagorean legacy to medicine, theories relating to the role of the idea of opposites, mathematical proof, and harmony as an essential principle, have become fundamental, making it possible to conceive the workings of the world according to its laws. As a branch of scientific knowledge, medicine attempts to understand these laws within the context of its own objectives, using the methodological tools at its disposal.

[7] Galen, "O tom, chto luchshiy vrach – eshche i filosof [The best doctor is also a philosopher]," 54.

Chapter 1. The Philosophical Views of the Pythagoreans

Pythagoras and his philosophical school represent a distinct phenomenon in the philosophy and history of medicine, and have been the subject of much research,[8] even if our sources on them are relatively limited, and can generally be described as part of the doxographic tradition. In other words, we owe what we know today of the teaching of Pythagoras and the Pythagoreans to mentions of it in works by other writers, such as Aristotle, Plato, Iamblichus, Aetius, Diogenes Laërtius, and so on.[9] This on one hand makes it harder to study the tradition, but on the other allows for different approaches and makes it possible to put forward research hypotheses regarding different branches of the history of science. The Pythagorean tradition is the subject of considerable ongoing controversy.[10] Opinions on the matter vary quite widely, ranging from the view that researchers should study the philosophical legacy of the school of Pythagoras (their politics, religion, philosophy and science, which had their own internal logic, and, hence, their own history and their own significance for the later development of scientific knowledge), or should attempt to fit[11] the history of the Pythagorean school into a single universal framework, to the contrasting view[12] that sees the Pythagoreans as

[8] P.P. Gaydenko, *Evolutsiya ponyatiya nauki: stanovlenie i razvitie pervykh nauchnykh program* [*The evolution of the notion of science: establishment and development of the first scientific programs*]; A.F. Losev, *Istoriya antichoy estetiki (v 8 tomakh). T. 1. Rannyaya klassika* [*The history of ancient aesthetics. Vol.1. Early classics*]; L.Ya. Zhmud, *Pifagor I rannie pifagoreytsy* [*Pythagoras and the early pythagoreans*].

[9] See: H. Diels, *Die Fragmente der Vorsokratiker. Griechisch und Deutsch*; Fragmenty *rannikh grecheskikh filosofov. Chast 1. Ot epicheskikh teokosmogoniy do vozniknoveniya atomistiki* [*Fragments of early greek philosophers. Part 1. From epic teocomogonies to the conception of atomism*].

[10] W. Burkert, *Lore and Science in Ancient Pythagoreanism*; W.K.C. Guthrie, "Pythagoras and the Pythagoreans"; C.H. Kahn, *Pythagoras and the Pythagoreans*. *A Brief History*; G. Kirk, J. Raven, and M. Schofield, *The Presocratic Philosophers*; C.J. de.Vogel, *Pythagoras and Early Pythagoreanism*.

[11] See, for example: F.M. Cornford, *Mysticism and Science in the Pythagorean tradition*, 1922; F.M. Cornford, *Mysticism and Science in the Pythagorean tradition*, 1923; J. Burnet, *Early Greek Philosophy*. In this work, John Burnet suggests that Pythagorean science was a "purification of the soul", based on an attempt to fit the activities of Pythagoras and the Pythagoreans - their politics, religion, philosophy and science - into a single universal framework.

[12] See, for example, Erich Frank's statement that "all the discoveries attributed to Pythagoras himself or to his disciples by later writers were really the achievement of certain South Italian mathematicians of Plato's time", a whole century after Pythagoras, and that these mathematicians had no connection with "genuine Pythagoreans who are attested... since the sixth century as a religious sect similar to the Orphics" (E. Frank, *Platon und die sogenannten Pythagoreer).*

an occult sect that had nothing to do with the development of science in the ancient world.

Pythagoras's character and teaching have been the subject of arguments that have gone on for almost two hundred years. There are two main strands to the literature on the subject. One generally recognizes the classical tradition associated with the scientific and philosophical activities of Pythagoras, seen here as a researcher and a scholar, and the early Pythagoreans. According to the other, Pythagoras was a religious thinker and ethical reformer with close links to Orphism.[13] The main obstacle to reconstructing Pythagoras's teaching is the lack of primary sources, as in the case of Thales and Socrates. No texts by Pythagoras himself are known to have survived. There is a view that the works of the early Pythagoreans contain their own opinions rather than the doctrines of their teacher. On the other hand, the Neopythagoreans and Neoplatonists created many myths about Pythagoras, and made him a mystical figure. As far as we can tell, however, neither Plato nor Aristotle knew anything about Pythagoras's philosophy: they refer only to the philosophy of the so-called Pythagoreans. For example, nowhere is there proof that the "doctrine of numbers" is attributable to Pythagoras himself.[14] The theories proposed by his followers are too individual for Pythagoras's philosophical system to be deduced directly from them. Furthermore, there is still no agreement among researchers on who counts as a Pythagorean. The lack of primary sources is only partially offset by the extensive indirect tradition, both historical and legendary.

Pythagoras's teaching can be divided into two components: a scientific approach to understanding the world, and the occult/magical beliefs that, legend has it, Pythagoras espoused. Pythagoras's contribution to the former is impossible to assess, as everything done by his followers under the school of Pythagoreanism was subsequently attributed to him. The latter dominates Pythagoras's teaching,

[13] In the twentieth century, this viewpoint was expressed particularly clearly by Walter Burkert, who argued that no reliable evidence of Pythagoras's philosophical and scientific activities existed in the early pre-Platonic tradition, while the post-Platonic tradition was a projection into the past of the teachings of later Pythagoreans — Philolaus, Archytas and their pupils. See: W. Burkert, *Lore and Science in Ancient Pythagoreanism.*

[14] W. Windelband, *History of Ancient Philosophy.*

and it is this that became part of the legacy of the majority of the writers of antiquity. At different stages of its development, Pythagorean teaching, as part of the intellectual tradition of the ancient world, combined the scientific and the mystical, in varying proportions. One of the first attempts by a Western historian to study the history of the Pythagorean movement as a whole was made in 1873.[15] Subsequent studies have not been as comprehensive, and their authors have generally focused on individual aspects of the history of Pythagorean teaching.

At the same time, historians and philosophers of science have postulated that the Pythagoreans influenced the development of scientific knowledge. However, there is no evidence in the history of medicine in antiquity that any independent school of medicine was established under the influence of Pythagorean teaching and subsequently became part of the phenomenon of "ancient Greek rational medicine". Following James Longrigg,[16] "ancient Greek rational medicine" is understood here as a tradition of medical theory and practice that rejected magical and occult approaches to curing diseases and explaining their causes, mechanisms of development and principles of natural treatment. It is generally agreed that the history of the natural sciences starts with early Ionian physics. Sir Geoffrey Lloyd, with justification, argues that astronomy, mathematics and medicine emerged before any other discipline, out of early Ionian physics.[17] The possibility of explaining natural phenomena through the interaction of different, contrasting basic elements, the latter being the "building blocks" of the universe, led to the emergence in classical medicine of theoretical models explaining the causes and progress of illnesses.

When it comes to dividing the history of medicine as a science into periods, the period from the sixth century BC to the second century AD should be seen as a time when ancient Greek rational medicine emerged.[18] This process culminates with the establishment of Galen's comprehensive system of theory and practice,

[15] *Pythagore et la philosophie pythagoricienne: 2*.
[16] J. Longrigg, *Greek Rational Medicine: Philosophy and Medicine from Alcmaeon to the Alexandrians.*
[17] G.E.R. Lloyd, *Magic, Reason and Experience. Studies in the Origin and Development of Greek Science.*
[18] D.A. Balalykin, "On the problem of periodization in the history of medicine."

within which aspects of pathogenesis are explained through the idea of a dynamic equilibrium of three physical tetrads (primary elements, fluids and substances). From the Hippocratic Corpus, we can get a picture of the state of medicine at the end of the sixth century BC, and of the ideas of the main philosophical schools of the sixth to fourth centuries BC that influenced the development of medical theory and practice. Existing historiography on this issue (possibly on the basis of evidence from Herodotus)[19] tends to highlight the view that the teaching of the Pythagoreans had a determining influence on medicine, expressed in particular in claims that there existed a Crotonian and/or Sicilian school of medicine, and to classify well-known physicians living in Magna Graecia (in particular Alcmaeon) as Pythagoreans. In general, historians of Pythagoreanism rarely discuss this, as it falls outside their research interests. The question of how far Pythagorean teaching influenced the development of medicine is a matter of probability due to the lack of primary sources. We cannot be sure if Pythagorean philosophical teaching had a determining influence on the development of medicine. On the other hand, the significance of the emergence in ancient Greece of mathematical teaching based on proof could have contributed to the development of certain principles of protoscientific medicine. In this context, various forms of logical reasoning and proof played an important role for medical knowledge. The development of mathematics, and the incorporation of its principles into the standard set of educational disciplines, allowed certain epistemological paradigms to develop relatively quickly, and had a major influence on the development of the principles of medical theory. The theoretical propositions developed by the Pythagoreans could have been used for conceptual analysis of the disease symptoms observed by a physician. In this respect, it is highly significant that there are similarities

[19]According to Herodotus, there were two major schools of medicine in the sixth to fifth centuries BC: the Cyrenian (based in Cyrene, a Greek colony in Africa), and the Crotonian, founded by Pythagoras. Almost all of the nine most famous physicians of the fifth century BC were Pythagoreans: just one, perhaps, represented another school. These are: Democedes of Croton, mentioned by Herodotus and Pliny; Calliphon (father of Democedes); Alcmaeon of Croton, the best-known of the Pythagorean physicians and the author of the oldest medical treatise we know of; Iccus of Taranto, who promoted exercise and diet, and whose recommendations on moderate eating even gave rise to the expression “Iccus’s lunch”; Empedocles of Akragas; Acron of Akragas, famed for his work “On the Food of Healthy People”; Xenon (father of Akron); Hippo of Metapontum; and Menestor of Sybaris, well-known both as a physician and as a botanist (see: Herodotus, *The Histories*).

between some of the beliefs held by the Crotonian physicians, such as Alcmaeon, and the ideas set out in the texts of the Hippocratic Corpus, which systemized and generalized multiple practical observations, examples of which we consider below. With the help of these theoretical concepts, the type of illness could be identified, and a prognosis of its future treatment established.

However, there is no direct evidence that Pythagorean philosophy shaped the development of medicine, or evidence of anything specific that Pythagoras and his followers contributed to medical theory and practice. We know that Pythagoras's teaching contained various instructions and prohibitions regulating the life of a Pythagorean. By virtue of his profession, a physician had to consider matters of disease aetiology and pathogenesis, treatment methods, and so on, while his worldview had to allow him to seek a universal research method, with the aim of obtaining reliable knowledge. If, though, we go by the suggestion that magic played a key role in Pythagorean teaching, a physician following the Pythagorean doctrine had to follow strict rules, which are described by late classical interpreters of Pythagoras's teaching.[20] Overall, all this indicates that the occult elements associated with the Pythagoreans could not been fully compatible with the epistemological beliefs within the context of which the scientific challenges facing ancient Greek medicine were addressed.

One approach to studying the teaching of the Pythagoreans considers that reliable information on Pythagoras's teaching can be found in the early classical sources from the fourth century BC and earlier. By the mid-fourth century BC, the Pythagorean school had almost ceased to exist, while the later (from the third century BC onwards) philosophical schools that called themselves "Pythagorean" merely used Pythagoras's name, developing what were effectively later Orphic

[20] For example, after getting out of bed, a Pythagorean physician had to straighten the bedclothes and smooth out the place where he had slept; he had to begin his meals with three libations of wine to the gods (to Zeus, Heracles and the Dioskouroi), which he had to pour over the handle of the cup; to put his right shoe on before the left, etc. He was also supposed to avoid marrying a woman who wore gold jewellery, swimming in public baths, and conversations with anyone in the dark. He was not supposed to step over a yoke, break bread (he had to eat from an unbroken loaf), pick up anything that had fallen off the table, etc. He was forbidden, for example, from eating mallow (which was "the first messenger and signal of the sympathy of celestial with terrestrial natures"), and categorically forbidden from eating beans, as this impeded spiritual development and communication with good demons.

doctrines. Historians of the Pythagorean legacy even refer to the latter by a different name: true pupils of Pythagoras are called “Pythagoreans”, and the later pretenders “Pythagorists”. There is a certain consistency in the emergence of independent esoteric groups that acquired significance by speculatively linking their doctrines to the secret teaching of Pythagoras, which apparently had survived the century and was being passed from mouth to mouth. For example, all this can be found in writers of late antiquity, who described the Pythagorean community as being made up of two sects — the “mathematikoi” and the “akousmatikoi”. There is reliable evidence that the Pythagorean school had a significant influence on political life in the cities of Magna Graecia, primarily Croton, Metapontum and Sybaris. The lifestyle of the members of the Pythagorean school must have fitted into the way of life of a wealthy Greek city colony of the sixth to fourth centuries BC. It is hard to imagine that such a closed-off group could have emerged in a Greek city at that time. The fact that the worldview of the scientist in antiquity was not shaped solely by occult/magical ideas about the world, but was also influenced by, among other things, the social practices of the *polis* was brilliantly demonstrated by Sir Geoffrey Lloyd.[21] What, then, remains of the different ideas about Pythagoras’s teaching? Quite a lot: Pythagorean mathematics; his science of music, with the theory of harmonic intervals, which is extremely important to the history of science; his contribution to the development of astronomy, and so on. Pythagoras’s theory of numbers may even be regarded as one of the first attempts to explain phenomena of the world about us in the language of mathematics. The experimental method of research and mathematical explanation of observable phenomena are usually considered central to the methodology that gave rise to the scientific revolution of the seventeenth century. Mathematics, numerical metaphysics and numerical symbolism are usually regarded as the key components of Pythagoreanism. However, an open-minded analysis of the classical tradition leads to different conclusions. Natural science and medicine played an important

[21] G.E.R. Lloyd, *Magic, Reason and Experience. Studies in the Origin and Development of Greek Science.*

role in the philosophy of many of the early Pythagoreans, who were also interested in physiology, embryology and botany. In turn, these sciences of the living world owed their existence to a large extent to medical practice, which focused on what could help to prevent and treat diseases: diet (understood as healthy living), medicinal plants, the structure and workings of the human body, etc.

It would therefore seem entirely justified to link the emergence of mathematical methods at the protoscience stage with Pythagoras and Pythagorean philosophy. The information that Pythagoras paid considerable attention to dietetics, in particular issues regarding the best diet for athletes appears fully reliable.[22] Some authors see a continuation of these ideas in the dietetic treatises in the Hippocratic Corpus. It may therefore be concluded that the role played by the teaching of the Pythagoreans in the development of medicine was rather ambiguous. On one hand, the influence of their scientific ideas was significant; on the other, the development of the occult/magical aspect of the teaching of the Pythagoreans could not have helped the development of these scientific ideas within the context of medical theory and practice in ancient Greece. In the next section of this paper, we look at those aspects of the teaching of the Pythagoreans that, with a certain degree of probability, might have influenced medicine.

[22] The significant number of Olympic champions from Croton, many of whom (such as Milo, Astylos and Iccus) are believed to have been disciples or followers of Pythagoras, is further evidence of this. We know, for example, that in 476 BC the Pythagorean Iccus won the Olympic pentathlon title, after which he gained renown as a gymnastics teacher. He became a trainer and a physician, and wrote works on the importance of the right diet in athletics training. However, even with regard to dietetics there are significant inconsistencies in the sources and historiography. For example, Aristoxenus states that the Pythagoreans purified and strengthened their bodies by eating bread and honey. Based on this evidence, historians have traditionally regarded Pythagoras and his followers as vegetarians. According to another tradition, however, Pythagoras introduced a ration of meat for athletes.

Chapter 2. The teaching of the Pythagoreans and its influence on medicine

One of the fundamental principles of Pythagorean philosophy is the categorical pair of opposites – the limit and the unlimited. “Unlimited” cannot be the sole origin of things, otherwise nothing defined, no “limit” would be cognizable. However, “limit” supposes something defined by it. It therefore followed that “nature in the ordered universe was composed of unlimited and limiting elements, and so was the whole universe and all that is therein.”[23] Without the connection of these opposites, nature would not exist as a single living organism, which means life in the human body is based on the interconnection of opposite natural principles. These forces exist together (neither exists without the other) and in antagonistic states, and this leads to the fact that nature is in motion, through which the unity of its system is ensured. The existence of opposites posits that each is within its own limits – “one” and “other”. With respect to medicine, knowledge can be acquired only where and when disease has a certain limit or boundary, which alone enable to define it in a quality having a well-defined essence. Only the defined can have meaning, and so only it can have a purpose, which means that only in that case can it be understood. Purpose defines all essence in its existence, sets the limit for its aspirations and uncovers its origin as the source and completion. This is particularly why Pythagorean philosophy stresses the role of limit – finite in cognition, which is to say, its perfect form. Conceptual certainty, the setting of boundaries and limits for the unlimited could be used in medicine. Therefore the achievement of a harmonious balance of the body as the primary purpose of medicine is possible in defined limits. Limit and purpose are therefore identical to each other. Limit is the beginning (end) of a balanced and precisely organized living organism. Therefore the superiority of

[23] This was pointed by Philolaus, who is considered a disciple of Pythagoras. We will expand on this issue in Chapter 4. See: Diogenes Laertius, *Lives of Eminent Philosophers*, VIII, 7.

limit over unlimited, in Pythagorean views, can be applied to the description of the harmonious structure of the body. In the case of disease, which violates the harmonious balance in a living organism, there is a need to refer to a broader understanding of the idea of opposites.

The use of Pythagorean opposites “limit” and “unlimited” help to consider disease not simply as an “unlimited” and “infinite” phenomenon, but a certain defined “limit”: the limits of disease are cognizable, which means it is possible to establish its progress and the accompanying symptoms. Hence, Aristotle argued, limit is what gives meaning and completion, and so limit is higher and better than infinite and unlimited (Pythagoreans make the same argument, putting limit first on their table of ten pairs of opposites, along with good, unity, straight, rest, versus unlimited, evil, plurality, motion, etc[24]).

If we theoretically do not limit “health” and “disease” as the main attributes of medical science, we exclude these phenomena from the realm of cognition. The categories “limit” and “unlimited” help connect opposites in any given thing. In its turn, the combination of opposites in a phenomenon creates an aporia, upon encounter with which thought turns towards itself. The logical consequence of the theory of opposites is the doctrine of harmony, which is a vital part of Pythagorean philosophy. It follows that harmony reflects the logical nature of the development of reality, internal and external coherence, integrity and proportionality of content and form. Harmony in this sense is one of the forms of beauty, which in medicine can be interpreted as the harmonious state of the human body, defined by the “health” category. “Harmony” is therefore the combination of opposite and separate elements according to defined laws, which acquires proportionality, conformity, coherence. Healthy is the one who maintains a “good blend of simple primary elements” and “proportionality of body parts of which they are composed”. One can be healthy “in the general sense” (this category includes the one whose body always has the “best blend [of elements] and is always

[24] Aristotle, *Metaphysics*, I, 5, 986a23-26.

proportional"), most of the time (if the state "slightly" deviates from absolute health) and at present. A sick body is characterized by a bad blend; therefore disease is a state opposite to healthy. The neutral state applies in three cases: if it relates to none of the opposites (it occupies an intermediate position between two extreme states), relates to both simultaneously or is "related to one or the other", which Galen pointed out in his treatise *Ars Medica ("The Art of Medicine").*

Plurality always arises from unity, is enclosed in it and is inseparably connected to it. Plurality is always contradictory, but in unity of form it acquires identity. The Pythagorean view on universal harmony, which also extends to the state of the human body, can have similarity with a modern medical concept like "homeostasis", which is to say self-regulation, the capacity of the body as an open system to maintain consistency of its internal state through coordinated reactions, aimed at maintaining a dynamic balance. The system strives to reproduce itself, recover lost balance, overcome the disruptive external effect, which is to say "homeostasis" of the organic population is the capacity of said population to maintain a certain number of its individuals for a long time. In homeostatis, a special type of cause-effect relationship arises, which can be described as the ultimate cause, i.e., teleology.[25]

In Pythagoreans we see the dialectic unity of nature, which is based on opposite forces grappling with each other. However, these forces lead to the fact that nature is one and has a capacity for motion and life as a single living organism. Such dualism in the Pythagorean philosophical system has to be accepted, since living motion is impossible without opposing forces, which can also apply to the understanding of the activity of the human body in a state of health and disease. Today, dialectics is used as a form for understanding opposites. The dialectic method assumes a connection between the whole and single human body with the surrounding environment. The inseparability of the function and form of investigation and methods of treating diseases in their historical development

[25] A.L. Gungov, "Diagnostics in a Logical Perspective".

should be taken into consideration. The domination of the common biological principles, to which the human body is subject, should also be remembered. Medicine is meant to study processes and phenomena in the body in their entirety. Above all, the dialectic method helps the physician to see the link between various processes occurring in the body and their manifestations, to grasp the essence of the pathological process.

Harmony is inevitably disrupted by changes originating from the external, natural world, and if it fails to respond to transformation processes, it can turn into its opposite. From the perspective of cognition, the harmonious state appears as a plurality of various abstract forms in a subject. “Disease” as a phenomenon also has inner proportionality of its constituent elements and an inner strict logic of action. The physician’s task in this case is to establish the cause of the disease and choose methods for its treatment. Therefore, when it comes to the idea that a particular disease has a defined cause, we refer to the concept of “determinism” and the meaning of the works of C. Bernard, I.P. Pavlov and other prominent scientists of the 19th century, who are widely regarded as having defined the deterministic nature of the modern doctrine of the nature of disease.[26] It is generally accepted that it is particularly with the doctrine of Hippocrates that the idea of the causality of diseases is associated, which is the foundation of the theory of general pathology in modern-day medical science. In this case the concept of determinism enables to describe the rational nature of the processes of ageing and dying of a living organism as the fulfillment of predetermined laws. Following Hippocrates, Herophilus and Galen understood that ageing and dying of an organism is a result of certain physiological processes. Disease may or may not occur (also depending on the use of preventive agents), and recovery or death of a patient, as a result of essential pathological processes, are determined by the successful or unsuccessful use of any given therapeutic aid. The impact of climate,

[26] C. Bernard, *An Introduction to the Study of Experimental Medicine;* I.P. Pavlov, “Sovremennoe obyedineniye v eksperimente glavneyshikh storon meditsiny na primere pishchevareniya [The principal branches of medicine united in experiment, exemplified by digestion].”

air and location on human health is not predetermined. The recovery or death of the patient often depends on the ability of the physician, and complication of the disease may be the result of the physician's error.[27]

When it comes to medicine, the first procedural condition is evidence (observation of the symptoms of the disease), which can and must be apodictic: the evident and apparent state of the body at the present moment may become very doubtful in future. Apodictic evidence "is not merely certainty of the affairs or affair-complexes (states-of-affairs) evident in it; rather it discloses itself, to a critical reflection, as having the signal peculiarity of being at the same time the absolute unimaginableness (inconceivability) of their non-being, and thus excluding any doubt as (objectless, empty).[28]

The proof method in medicine is based on the results of anatomical dissections and systematization of clinical observations, based on which diseases and methods of their treatment are classified. Modern-day physicians have at their disposal certain methods of physical examination of the patient (auscultation, percussion, palpation) and laboratory diagnosis, through which the state of the body is assessed. In Hippocrates' time, like the present day, the physician was also supposed to assess the state of the patient's health (establish the damage to the patient's health), but due to lack of special equipment, precise quantitative evaluation was replaced with experience and observation. For instance, excretion was assessed visually and by smell: "Urine is best when the sediment is white, smooth and even for the whole period of the illness until the crisis, for it indicates a short sickness and a sure recovery. But should the sediment intermit, and the urine sometimes be clear and sometimes show the white, smooth, even deposit, the illness will be longer and recovery less likely. Should the urine be reddish and the sediment reddish and smooth, recovery will be sure, although the illness will be longer than in the former case. Sediments in urine which are like coarse meal are

[27] See, for example, Galen's treatise "In Hippocratis de natura hominis librum commentarii iii" ("Commentary on Hippocrates' 'Nature of Man'").

[28] E. Husserl, *Cartesian Meditations*, 15–16.

bad, and even worse than these are flaky sediments. Thin, white sediments are very bad, and even worse than these are those like bran."[29] Urine was also analyzed by taste. For example, a sweet after-taste and certain symptoms in the urine of the patient suggested "saccharine disease" (i.e., "diabetes mellitus"). Hippocrates believed it was not only possible to properly diagnose a disease, but also give an accurate prognosis of its progress based, for example, on analyzing urine. From the very beginning, patient examination was qualitative: "…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…"[30]

The key question is: are there common traits in the Pythagorean doctrine and medical views expressed in the Hippocratic Corpus? The physician, a follower of the Hippocrates' doctrine, proceeded from the premise that the correct idea about the essence of processes occurring in the body can be built based on indirect external features. He clearly understood that the state of human excretion reflects pathological processes occurring inside the body. For example, the Hippocratic Corpus employs the qualities of "heat", "cold", "moist" and "dry" - these categories form the foundation of physiological and pathological theories of that time.[31] This pertains not only to the components of food, which bear great significance, and opinions on which by Hippocrates' time had developed into a separate field of medical science – "dietetics". The search was on for characteristics to describe processes occurring inside the human body. According to the Hippocratic doctrine, food has numerous components having different "forces", which can be distinguished qualitatively and quantitatively. These forces also act inside the body. Furthermore, substances entering the human body with

[29] Hippocrates, *Prognostic*, 12.
[30] Hippocrates, *Prognostic*, 12.
[31] See, for example, the treatise *On Ancient Medicine*.

food can be altered in a certain manner. It is crucial to understand that in a sick body said substances change differently. Hence the same product can be approved for a healthy person, but contraindicated for a sick person. For example, Hippocrates observes a certain nature of phlegm in respiratory diseases. These discharges can be salty and watery, which allows the physician to conclude: hoarseness of the voice, throat irritation, cough and other manifestations of pneumonia are associated with the formation of these particular substances in the body. The following conclusion can therefore be made: fluids matching pathologic discharges observed in a particular disease are important for its pathogenesis. The fact that temperature and pain decrease when the profuse discharge of phlegm begins in patients does not escape the experienced physician's attention. It can be assumed that the state of the patient improves when the body rids of excess salty phlegm. This leads the physician to the conclusion that the beginning of disease is associated with the consumption of products characterised by these qualities in particular. For example, in the treatise *On Regimen*, the primary element "fire" is associated with the properties "hot" and "dry", and the primary element "water" is associated with the properties "cold" and "moist". Based on the principle of treating the opposite with the opposite, intense consumption of liquids is prescribed when body temperature rises. Here we see a match with the ideas of opposites that are characteristic of the Pythagorean doctrine.

The need to consider a significant number of opposite factors promoting disease guides Hippocrates to the understanding of the importance of thorough collection of history and examination of the patient. For example, in the treatise *Prognostic*, Hippocrates points to the need to carefully examine the face of the patient, assess its colour and state of the skin, as well as the eyes: "For if they shun the light, or weep involuntarily, or are distorted, or if one becomes less than the 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."[32] The physician must also inquire from the patient how they have slept, the state of their digestion and appetite, determine temperature and the posture of the head, hands and legs. Pythagorean views on evidence, based on mathematics, can be seen in some chapters of the treatise *Prognostic*, which are devoted to the interpretation of the patient's stool, urine, vomit and phlegm. Hence in the text of the Hippocratic Corpus, we see clear pursuance of evidential rigour: the history of the disease is described thoroughly; during analysis great attention is paid to the cause-effect relationship between the observed symptoms and possible pathological processes. Finally, after thorough verification of the diagnosis, treatment is prescribed, which in each case must be justified.

We should take into account the fact that the philosophical influence of the Pythagorean doctrine on medical knowledge, when passing its disciplinary, scientific borders, is forced to change its character somewhat. We mean that the theoretical statements are inevitably subjected to independent development and creative reframing in terms of development objectives of medical science, and philosophical methodology assists to receive a wider vision of the problem field, within which occur the specific changes in medicine.

An example of the complexity of determining the Pythagorean influence on the medical knowledge is a physician Alcmaeon. It is necessary to ask whether he should be considered a follower of the Pythagorean philosophy.[33] On the one hand, most researchers argue that Alcmaeon of Croton was a Pythagorean. He's also called "the first Pythagorean that left behind a written tradition," and his name is associated with the first proto-scientific ideas of the wholeness of the body.[34]

[32] Hippocrates, *Prognostic*, 2.

[33] P.S. Codellas, *Alcmaeon of Croton: His Life, Work, and Fragments*; G.E.R. Lloyd, *Alcmaeon and the Early History of Dissection*; G.E.R. Lloyd, *Experiment in early Greek philosophy and medicine*; H.E. Sigerist, *A History of Medicine*, vol. 2.

[34] Here is the opinion of John Longrigg: "Given the scanty nature of our surviving evidence, it would be prudent to avoid such extravagant assessments. But it is, nevertheless, apparent that Alcmaeon is a figure of great importance in inter-relations between medicine and philosophy. Alcmaeon's influence both upon later philosophical and medical thought was considerable. Owing to our lack of pre-Hippocratic Greek medical literature, it is impossible … to say whether or not he was the actual originator of the medical theories attributed to him. Our evidence, however, suggests that he was an original and independent thinker. <…> What is important is that his

Greek medicine owes Alcmaeon many of its fundamental categories. One of them is "a dynamic understanding of the disease": health is the balance of opposing qualities or forces in the body, disease being the predominance of one of them, which later we find in the Hippocratics' teaching. Among the causes of the disease Alcmaeon mentions excess cold and hot, the excess and shortage of food, as well as external factors (water, terrain, etc.), thus anticipating approaches for disease etiology disclosed in Hippocratic Corpus. Health, the normal form of existence of the human body, is determined by the balance or harmony of opposites. The displacement of this equilibrium in the direction of one of them is what Alcmaeon called "autocracy". It caused a disease that can be treated only by addressing its cause, that is, restoring the balance of opposites – this was the methodological basis for the idea to treat the opposite with the opposite. Similar principles we find in the Hippocratic Corpus: "To sum up in a single sentence, opposites are cures for opposites. Medicine in fact is subtraction and addition, subtraction of what is in excess, addition of what is wanting. He who performs these acts best is the best physician; he who is farthest removed there from is also farthest removed from the art."[35]

Also, it is believed that the methodology of Alcmaeon was strongly influenced by the Ionian physics.[36] His ideas about the balance of opposite substances in the human body as a sign of health, are similar to the natural philosophy of Anaximander of Miletus, who offered the description of space, the basic trait of which is symmetry, and in which strict regularity hides behind the outwardly erratic celestial phenomena.[37] These views are included in the teachings of the Pythagorean school, and since Alcmaeon was a contemporary of Pythagoras,

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medical beliefs reveal precisely the same rational outlook characteristic of the Ionian natural philosophers before him and the pre-Socratic philosophers after him" (J. Longrigg, *Greek Rational Medicine: Philosophy and Medicine from Alcmaeon to the Alexandrians*).

[35] Hippocrates. *Breaths*, 1. *Contraria contrariis*: in this consisted the basic rule of Greek and all subsequent therapy – the so-called allopathy, as opposed to homeopathy according to C. Hahnemann (*similia similibus*). In addition to said passage from "Breaths", in "Aphorisms" Hippocrates gives an example of how to treat opposite with the opposite: "Diseases caused by repletion are cured by depletion ; those caused by depletion are cured by repletion, and in general contraries are cured by contraries" (II, 22).

[36] J. Jouanna, *The Birth of Western medical art*.

[37] For details, see: *Grecheskaya filosofiya* [*Greek Philosophy*].

his medical concepts can be correlated to a degree with the scientific components of the Pythagorean doctrine (the idea of opposites, harmony, mathematics and the foundations of evidence). However, this does not imply that the formation of Alcmaeon's opinions as a physician was influenced by Pythagorean doctrine. For example, Alcmaeon's theory of opposites has much in common with the views of Pythagoras. Pythagorean doctrine is characterized by the allocation of ten basic pairs of opposites: limit and unlimited; odd and even; unity and plurality; right and left; male and female; rest and motion; straight and curved; light and darkness; evil and good; square and rectangular. However, we should not forget that the attempt to describe the idea of the material world in terms of opposites was typical for the early Ionian physics: the difference lies only in the fact that in the Ionian physics, they are not postulated in ten categorical pairs and are not used in the mathematical categories, unlike with the Pythagoreans.[38] Pythagorean doctrine of the state of harmony of opposites could be projected by Alcmaeon upon the structure and functioning of the human body. However, this does not allow for a definite answer to the question whether the medical theories of Alcmaeon were based only on the ideas of the Pythagorean doctrine. Largely, the concept of Alcmaeon as a pythagorean is associated with the writings of Aristotle and Iamblichus. The latter speaks about Alcmaeon as a pythagorean and Aristotle in *Metaphysics* connects Alcmaeon's theory of opposites with the development of Pythagorean thought, although making important reservation, in our view: it is not clear to him whether Alcmaeon borrowed it from Pythagoras or the Pythagoreans borrowed it from Alcmaeon.[39] In addition, we pointed out the convergence of Alcmaeon's views and ideas of the Hippocratic Corpus. Unfortunately, the lack of sources renders determining the exact sequence of influence practically impossible.

Another example confirming the importance of the theory of the opposites for medicine is found in Hippocrates, who closely linked the concept of "health"

[38] For details, see: J. Longrigg, *Greek Rational Medicine: Philosophy and Medicine from Alcmaeon to the Alexandrians*; V. Nutton, *Ancient Medicine*.

[39] Aristotle, *Metaphysics*.

with the concept of "sickness". In the Hippocratic Corpus, "sickness" is a state opposite to "health", i.e. a suffering of human body due to imbalance of a harmonious relationship of the origins (elements, fluids and entities). We can trace the continuity of the ideas of Hippocrates and pre-existing theories of health and sickness. What was novel in Hippocrates' theory consisted in appending to the idea of equilibrium (or its disruption) the concept of blending of the basic substances that make up the human body. The balance of primal elements and humours meant their "proper blend",[40] i.e. state of health. Thus, the Hippocratic Corpus shows a general pathology system, allowing for questions of balance between internal states of body and external influences: its key concept was a category of "change", which became an essential component of Hippocratic theory of pathology. In other words, the boundaries between normal and pathological states of the body in the works of the Hippocratic school physicians are not clearly marked: health is a delicate balance that can be easily disrupted. Subsequently, Galen, after Hippocrates, considered treating "the opposite with the opposite" to be the basic principle of therapy. One example is the treatise *De constitutione artis medicae ad Patrophilum* ("To Patrophilus, on the Constitution of the Art of Medicine") in which Galen develops Hippocratic ideas and formulates a hierarchy of tasks which the physician faces: "The very first task of the therapeutic method, as has been said, is to determine the common purpose for all: to treat the opposite with the opposite, second, to determine that opposite for each type of disease, and thirdly, to consider whether we or Nature are capable of achieving this goal, or is it completely impossible, or impossible only temporarily, or only partially so. And it is a considerable part of the science of nature, which anyone willing to determine the possibility or impossibility of each case should exercise."[41] There are clear enough limits to physician's possibilities, determined by laws of human body design and functioning. Thus, based on the example of the main points of the Pythagorean

[40] Galen will use this concept to evaluate health.

[41] Galen, *K Patrofilu, o sostave meditsinskogo iskusstva* [To Patrophilus, on the Constitution of the Art of Medicine],13.

doctrine, which can be attributed to the so-called rational tendencies, it can be assumed that the philosophy of the Pythagoreans could have an impact on the development of ancient medicine. Moreover, a more detailed analysis of the correlation of the results of the philosophical analysis and historical scientific data reveals that many of these ideas later found expression in the theoretical and practical system of Galen.

Next, we will focus on the influence of certain elements of the Pythagoreans' doctrine on medicine. In assessing the history of the Pythagorean doctrine it is important to consider a variety of ideas that make up and define its foundations, which make possible explaining the phenomena of nature, including the constitution of the human body. It is possible that the doctrine of the Pythagoreans influenced the formation of the methods of science - apodictic (based on the mathematical principles of proof and strict requirements for the argumentation) and dialectical (i.e. the method of philosophical conversation, built on polemical techniques and based upon the idea of opposites), which was later applied to medical practice.[42] The apodictic method eliminates the possibility of probabilistic reasoning. It is based on logical necessity and the facts of reality, allowing the scholar to seek the unconditional truth of judgment. The dialectical method allows for the possibility of probabilistic judgments and is largely based on the desire to convince in any way, including sophistic premises, unacceptable for science in general and medicine in particular. Thus we can assume the existence of the Pythagorean doctrine influence on forming the basis of evidence in medicine.

Medicine since the time of writing of the Hippocratic Corpus was developing in the framework of a notion to use the method of rigorous proof. J. Lloyd raised the question of historical evaluation of research methods in medicine

[42] The emergence of the principle of rigorous proof is associated by historians of science with the development of Greek mathematics in the 6th–5th centuries BC, most notably with the *Origins* of Euclides, as well as with the earlier work of Eudoxus. For details, see: G.G. Hempel and P. Oppenheim, *Studies in the logic of explanation*; G.E.R. Lloyd, *Magic, Reason and Experience. Studies in the Origin and Development of Greek Science*; G.E.R. Lloyd, *Methods and Problems in Greek Science. Selected Papers*; I. Mueller, *Greek mathematics and Greek logic. Ancient logic and its Modern Interpretations*, 35–70.

in 6th – 4th centuries BC.[43] He analyzed it in the context of the methodology of knowledge, considering it along with mathematics and astronomy, and rightly pointed out that these three disciplines are of the same age that the history of science as a whole.

Rational tendencies of the Pythagorean doctrine, of course, should be considered, based on a clear understanding of the research method, which relies upon the theory and practice of argumentation and the use of rigorous evidence that comes from mathematics, which finds its expression in the medical opinions of Hippocrates: ideas about the causes of disease, Hippocrates' understanding of human nature, the classification of diseases, as well as the foundations of clinical practice (for example, the principle of individual selection of treatment, the treatment of the opposite by the opposite et al.). In some examples, reflecting the research methodology of a Hippocratic tradition physician, we can trace the influence of scientific methods of the Pythagoreans on Hippocrates' medicine. Such examples could be the following works: *On Human Nature*, *On Ancient Medicine* and *On the Sacred Disease*.[44] In these texts, as in the Hippocratic Corpus as a whole, we find the physician's attention towards the study of natural causes of diseases, the priority of knowledge acquired through experience (both his own and predecessors), a tendency to generalize the observed regular cause and effect relationships in a variety of states of the human body and the use of a variety of reasoning schemes. For example, in his treatise *On Ancient Medicine*, we find a reference to the inadmissibility of the probabilistic judgments in medicine: "…just 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, through which the discoveries made during a long period are many and excellent,

[43] G.E.R. Lloyd, *Magic, Reason and Experience. Studies in the Origin and Development of Greek Science*.
[44] *Hippocrates*, vols. I, II, IV.

while full discovery will be made… Therefore for this reason also medicine has no need of any postulate.[45] Also the question is raised of a need for reliable premises in physician's reasoning in diagnosis and treatment, and certain axiomatic rules are justified, which determine the course of a scholar's thought, typical for medicine as a science (for example, the principle of treating the opposite with the opposite). The Hippocratic doctor had to artfully apply his debating skills not only in discussing specific medical practices, but also the general theoretical issues related to, for example, the human body structure, pathology, physiology, and others. This approach is associated with a competitive environment, in which Hippocrates' medical school existed. For example, *On the nature of man* presents a complex discussion of how the human body is made. Subsequently, the Hippocratic idea of general pathology, developed by Galen, allowed rationalizing the variety of human diseases of the body. In medicine, it can be presented as research method development in progress – from the individual, although quite meaningful, attempts by Alcmaeon and Hippocrates, to Herophilus[46] and his regular practice of anatomical dissection, and later – to the theoretical and practical system of Galen.

The impact of some of the Pythagorean ideas, which to a large extent became the basis of the method of proof based on mathematics, could occur for medicine as well: the use of apodictic method of proof, which was expressed in medicine in anatomical dissections, the rational doctrine of general pathology and clinical taxonomy, which allowed to critically conceptualize the medical experience. Such an approach seems all the more appropriate, as it was precisely the integrated theoretical and practical system created by Galen which became the borderline that separated the birth of ancient Greek rational medicine from the follow-up period of 2nd–16th centuries, of rational medicine of the proto-scientific age. Galen used logic as a research tool to determine the boundaries of use of both dialectic and apodictic methods in medicine, to suggest options for combining their applications

[45] Hippocrates, *Ancient Medicine*, II.

[46] G.E.R. Lloyd, *Alcmaeon and the early history of dissection*; J. Longrigg, *Herophilus*; H. von Staden, *Herophilus: The Art of Medicine in Early Alexandria: Edition, Translation and Essays*.

at different stages of medical activity - from the theory in the field of general pathology[47] to clinical and experimental practice.[48]

Certain aspects of using the method of rigorous proof in the works of ancient authors allowed Prof. D.A. Balalykin to highlight on three stages of development of the methodology of ancient medicine.[49] The first of those – the period of apodictic method origination – determines the establishment of the foundations of Greek rational medicine based on the principles of Hippocrates, under which the explanation of the phenomena of nature and the human body as a part of it is built on searching and studying of natural causes. The second period – the formation of apodictic method – is linked to the works of Aristotle on the theory of argumentation, and the formulas contained there of the strict requirements for proof method, to movement theory, and the following practice of systematic autopsies of animals, as well as the formation of the principles of comparative anatomy, which subsequently influenced the development of Herophilus practice of systematic dissections and the development of his medical concepts. The third stage – the period of apodictic method development – is characterized by the works of Galen, who introduced apodictic method into medical practice and has proved its importance for the further development of medicine as a science. The theoretical and practical system created by Galen becomes a historic milestone, which separated the period of birth of rational medicine in Ancient Greece from the period of the proto-scientific rational medicine.

[47] See the treatises of Galen: *De morborum differentiis* ("The Different Kinds of Disease"), *De symptomatum differentiis* ("Distinctions in Symptoms"), *De causis morborum* ("Causes of Diseases").

[48] See the treatise of Galen: *De Placitis Hippocratis et Platonis* ("On the Doctrines of Hippocrates and Plato").

[49] D.A. Balalykin, and N.P. Shok, *The apodictic method in the tradition of ancient Greek rational medicine: Hippocrates, Aristotle, Galen.*

Chapter 3. Elements of magic in the teaching of the Pythagoreans and medicine

Besides those elements of the doctrine of Pythagoreans, that influenced scientific development, their philosophy had a magic components which to a certain extent distorted the view of nature and its laws. According to D. Collins, it is easier to determine the essence of Pythagorean occult views by analogy, since without the corresponding context of magic practices (curses, rituals, prayer, the making of figurines and dolls or the use of medicines) we cannot fully describe what Ancient Greeks understood as magic.[50] It is widely recognised that mythology and magic were important throughout antiquity, and were intertwined with scientific and philosophical ideas. The combination of magic and science was the traditional way of thinking in Ancient Greece.

From the perspective of philosophy and the history of medicine, the idea that man's views about the world and himself have a religious origin is crucial. The social nature of religion as a phenomenon of human life is also worth noting, since religious views, which form its foundation, are collective views expressing a collective reality. Religion helps describe what is beyond human reasoning and natural phenomena, being "a kind of speculation upon all that escapes science, and clear thinking generally".[51] It is quite probable that the concept of natural forces (for example, "gravity" or "electricity" in modern physics) derives from the concept of religious forces, and the modern-day content of the concept of the supernatural emerged fairly recently. Moreover, the "supernatural" is irreducible only to the unforeseen; religious concepts were primarily aimed at explaining the permanent and regular, and not something beyond normal. Magic also consists of beliefs and rituals, of myths and dogmas, although unlike religion, it pursues practical purposes and has no place for theoretical practices.

[50] D. Collins, *Magic in the Ancient Greek World*.
[51] E. Durkheim, *The Elementary Forms of Religious Life*, 22.

According to most scientists, it is impossible to give a universal definition of the concept of "magic" as applied to the entire period of antiquity. Religion and its ideas are common for a particular group which openly professes its adherence to them and the related rituals. Magic beliefs are more often than not scattered over large sections of the public and do not require people professing them to form a single group: a magician has clients who unrelated to each other. J.G. Frazer not only united beliefs and rituals, which were called superstitions, into the concept of "magic", but also separated them in time from religion.[52] He argued that magic antedates "authentic" religion. In the ancient world, natural phenomena were often attributed to a magical origin. This was part of the conventional world view. Starting from about 6th century BC, attempts were being made to explain phenomena with natural causes. However, the practice of explaining natural phenomena with magic still remained.

According to D. Collins, the ancient world had its own peculiarities of the practice of magic.[53] Despite that the criticism of magic by the authors of the Hippocratic Corpus reflected the tendency for rational investigation of nature, it had no significant impact on the practice of magic. Magic acted according to the *actio in distans* principle, as a result of which magic could not be ruled out among possible causes, even when faced with immediate and obvious causes of any event. It was based on the act of volition and was exploited to achieve the desired outcome. Magic presumes that "intentions cause events to happen in the vicinity of agents, but this is a different species of causation from the kind of causation involved in the rising and."[54] Based on that, an attempt can be made to determine what the occult practices of the Pythagoreans might have been like.

A rational understanding of nature and the emergence of philosophy meant that Greek scientists and writers from 5th – 6th centuries BC needed to take a

[52] J.G. Frazer, *The Golden Bough: A Study in Magic and Religion*.
[53] D. Collins, *Magic in the Ancient Greek World*.
[54] A. Gell, *Art and Agency: An Anthropological Theory*, 101.

critical view on magic, traditional beliefs and rituals.[55] The treatise *On the Sacred Disease*,[56] which remained part of the Hippocratic Corpus, is revealing and enables to speak of the origin and development of Ancient Greek rational medicine. It asserts that epilepsy is not a "sacred" disease, but a disease with specific symptoms which, like other diseases, arises from "natural causes" due to disruptions in the working of the brain. It criticises those who claim that they can cure patients suffering from this ailment through exorcism, rituals, etc: they are not only accused of deception and barbarism, but also of impiety, that they "do not believe in the existence of gods at all". In philosophy and the history of medicine, this is particularly regarded as the rejection of occult-magic practices of the art of healing in favour of explaining the causes of diseases with natural factors.

Therefore we have reason to conclude that besides a scientific, rational basis (the idea of contraries, mathematics, etc) the Pythagorean doctrine had magic components. It can also be said that magic in the Pythagorean doctrine was based on a system of thought, where the human being appealed to secret forces to influence events, as well as real or apparent influence on the state of reality. In this sense Pythagoreans were often perceived as people with arcane knowledge: the knowledge was acquired not as a result of logical analysis of reality, but through direct interaction with the bearer of magic powers. Legend, which reflected the mystical tradition of perception of Pythagoras, remained in Aristotle's essay *On the Pythagoreans*, as well as in the fantastic dialogues of Heraclides Ponticus. Aristotle, Heraclides' fellow at the Academy, puts words into Pythagoras' mouth when he says "it's for the sake of cognition and observation that every human person has been constructed by the god".[57]

[55] G. Lloyd notes that the "origin of philosophy and science" is a convenient but very fuzzy wording which gives no clear answer to the fundamental question of the methods of inquiry.

[56] G. Lloyd says it is impossible to determine the exact date when the treatise *On the Sacred Disease* was written. It is usually dated between the end of 5th century BC and the early 4th century BC. The researcher notes: there is data suggesting that the treatise could not have been written before Diogenes of Apollonia, whose work was at its peak in 430 BC. For more detail, see: G.E.R. Lloyd, *Magic, Reason and Experience. Studies in the Origin and Development of Greek Science, 6–7.*

[57] Aristotle, *Protrepticus*, IX.

In the history of philosophy, Pythagoras is often regarded as a religious and ethical reformer, although it is extremely difficult to say anything certain about his religious views due to a lack of sources. Researchers associated him with both the "legalist" side of Greek religion, which sought the mercy of gods through strict adherence to religious commandments and rules (M. Nilsson), and the mystical-ecstatic side, associated with Scythian shamanism (W. Burkert). Pythagoreans most likely did not have a single cult, different from the cults of the states in which they lived. Pythagoras joined the cult of Apollo, which was traditional in Croton (and Metapontum), which was also crucial for his social recognition. Alive, he became someone the Greek called a "divine person", and after death, like many other philosophers and poets, he was given heroic accolades. In legend, he is the incarnation of Apollo, and his first biographer Aristoxenus derives his ethical doctrine from Delphi.

The Pythagorean doctrine of metempsychosis, which is borrowed from Orphism, unites it with its other apex of Greek religious life. The Pythagorean version of metempsychosis does not contain the idea, central for Orphism, that the transmigration of souls is punishment for the inherited transgression of man, so that the completion of the "agonising circle" of transformations and acquisition of immortality is the central aim of the mystery. The idea that the circulation of souls through human bodies and animals is part of the world order comes to the fore. The exact location of souls after death and what awaits them at the end of reincarnations remains unclear (as though this end is not provided for). Later this idea gave impetus to the philosophical doctrine of the "eternal return", according to which the entire universe goes through several identical periods.[58]

According to tradition, the followers of Pythagoras were split into acousmatics and mathematics. Acousmatics dealt with religious and ritual aspects of the doctrine, while mathematics dealt with investigation of four Pythagorean "mathemas": arithmetic, geometry, harmonics and spherics. Acousmatics did not

[58] The soul is immortal and migrates from one person to the other. Pythagoras is said to have claimed that he remembered the person his soul dwelt in for the past 207 years.

regard mathematics as "genuine Pythagoreans", but claimed they originated from Hippasus, who changed the original Pythagorean tradition, revealed the secrets to the laymen and those who started teaching for profit.

Because Pythagoreans used various occult practices besides the mathematical method of understanding nature, the following should be noted: the magic component hindered further development of those ideas innate to the Pythagorean tradition, which could have promoted the development of science. This can be demonstrated by the example of the magical manipulation of numbers. For instance, Pythagoreans drew no strict distinction between numbers and things, but never fully equated a number with a thing. Normally they equated numbers with any religious-mythological beings. By saying that the world is cosmos, they discovered the dialectic of the limit and unlimited, based on that everything is limited and has bounds, and by the fact of its existence it determines and, therefore, limits unlimited, that makes up inconspicuous matter or the material space of things. By understanding the number as a dialectic synthesis of the unlimited and limit, Pythagoreans established a doctrine of the constructive and creative guiding essence of numbers.[59] On the one hand, certain aspects of the doctrine of numbers gave impetus to the propagation of ideas about the harmonious structure of the surrounding world, including the human body. This led to the philosophical understanding and merging of four exact sciences by the Pythagoreans: geometry, arithmetic, astronomy and harmonics. On the other hand, Pyathagoreans' fascination with magic shifted emphasis towards the domination of occult practices, which slowed down the development of the principles of scientific knowledge. That Pythagoreans dealt with exact sciences, primarily mathematics, promoted the establishment, in their philosophical system, of the theory or scientific proof fully applicable to medicine. The philosophical theories of the Pythagoreans shift proof from the sphere of empirical practice to the sphere of unrelated categories, through which there is an improved, thorough understanding

[59] A.F. Losev, *Istoriya antichoy estetiki (v 8 tomakh). T. 1. Rannyaya klassika* [*The history of ancient aesthetics. Vol.1. Early classics*].

of the realities of nature and reality in general. In contrast, the Pythagoreans' dabbling in occult practices and magic meant they considered the human being as a vessel of supernatural, profoundly irrational forces. These tendencies were not accepted by medicine since they contradicted the idea of the regularity of the human being and the possibility of its comprehension through natural laws.

Chapter 4. Physicians of Ancient Greece and the question of their belonging to Pythagorean teaching

An illustration of the ideas set forth in previous chapters may be the information about physicians who are generally associated with the medical tradition established under the influence of the Pythagorean doctrine. Associating these physicians with the Pythagorean doctrine in particular may not be justified, since information on the development of Ancient Greek rational medicine within the sphere of influence of Pythagorean philosophy is quite limited. In the history of medicine, a tradition developed, whereby schools of medicine in Magna Graecia were divided into the Crotonian school and the Sicilian school. However, the use of the concept of the "school of medicine" with respect to medicine in Croton and the consideration of this city as the centre of development and propagation of medical knowledge is not justified. All medicine in Greek colonies in the south of the Apennine Peninsula is sometimes merged and referred to as the "Southern Italian medical tradition". There is also information about physicians working on Cos and in Knidos,[60] which maintained their significance and influence as the centre of medical knowledge in the Mediterranean until 2nd century BC. In contrast, Croton, Agrigento and Syracuse are known as places associated only with certain events that are vital in the development of medicine.[61] The idea of the "Crotonian school of medicine" or the "Sicilian school of medicine" apparently emerge due to the perceived significance of these cities as the centres of philosophical schools – primarily the Pythagorean school. There is a belief in historiography about the influence of the Pythagorean doctrine on the development of medicine. For instance, physician Alcmaeon of Croton is regarded as a follower of Pythagorean philosophy and the founder of the first medical theory. If Pythagoras, his followers and Empedocles are to be considered the most influential

[60] Hippocrates' family history points to the origin of the tradition of studying and teaching medicine in Kos. The establishment of the written legacy of the Knidos school in 5th century BC is also known.

[61] Normally, this pertained to the life and work of certain physcians and philosophers (for example, Alcmaeon, Acron).

Pre-Socratic philosophers, then at first glance claims of the decisive influence of their views on medicine do not seem dubious. Hence there is a notion of schools of medicine in Croton and Sicily. Cos and Knidos schools emerge in the sphere of influence of Miletus, and early Ionian physics had a decisive impact on their development. Therefore medical thinking in Croton and Agrigento is shaped by the philosophy of Pythagoras and Empedocles. This view is expressed in the works of historians of philosophy, who regarded Alcmaeon as a follower of Pythagoras and justifiably pointed to the fundamental nature of Alcmaeon's ideas about the four primary elements for further development of both medicine and natural sciences in general.[62] Another argument worthy of attention is the shared outlook of Alcmaeon and the Pythagoreans known to us.[63] However, the presence of common traits in the world view of different scientists by no means indicates the identity of their doctrines.

Analysis of the biographies and scientific views of physicians regarded as Pythagoreans, based on the interdisciplinary method of historical and medical study, enables to determine the real impact of certain provisions of the philosophy of the Pythagoreans on their medical views. The name Acron of Agrigento is associated with the beginning of the tradition of rational medicine in Sicily, and is considered to have significantly influenced Empedocles' views. However, it is known that several members of the Rhodos line of Asclepiades migrated to Agrigento, just as physicians migrated from Knidos to Croton. Taking these facts into account, it becomes clear that medicine in Magna Graecia advanced the views of medical schools emerging under the influence of early Ionian physics.

We know the names of physicians considered students or followers of Pythagoras.[64] As noted already, Alcmaeon, on whom there is no biographical information but only evidence from ancient authors, occupies a special place among them. The only thing that can be said about him with some degree of

[62] See, for example: W.H.S. Jones, *Philosophy and Medicine in Ancient Greece*; C.H. Kahn, *Pythagoras and the Pythagoreans. A Brief History*.

[63] For instance, J. Longrigg points to that. See: J. Longrigg, *Greek Rational Medicine: Philosophy and Medicine from Alcmaeon to the Alexandrians*.

[64] Further, we will try to sum up the basic, most accurate data.

certainty is that he was a physician and lived before Empedocles and Anaxagoras. Diogenes Laërtius notes: "Alcmaeon of Croton, another disciple of Pythagoras, wrote chiefly on medicine, but now and again he touches on natural philosophy, as when he says, 'Most human affairs go in pairs.' He is thought to have been the first to compile a physical treatise, (...)"[65]Aristotle also speaks of Alcmaeon: "Others of this same school hold that there are ten principles, which they enunciate in a series of corresponding pairs: (1.) Limit and the Unlimited; (2.) Odd and Even; (3.) Unity and Plurality; (4.) Right and Left; (5.) Male and Female; (6.) Rest and Motion; (7.) Straight and Crooked; (8.) Light and Darkness; (9.) Good and Evil; (10.) Square and Oblong.Apparently Alcmaeon of Croton speculated along the same lines, and either he derived the theory from them or they from him; for [Alcmaeon was contemporary with the old age of Pythagoras, and] his doctrines were very similar to theirs. He says that the majority of things in the world of men are in pairs; but the contraries which he mentions are not, as in the case of the Pythagoreans, carefully defined, but are taken at random, e.g. white and black, sweet and bitter, good and bad, great and small. Thus Alcmaeon only threw out vague hints with regard to the other instances of contrariety, but the Pythagoreans pronounced how many and what the contraries are. Thus from both these authorities we can gather thus much, that the contraries are first principles of things; and from the former, how many and what the contraries are".[66] Aetius also refers to Alcmaeon's views (V, 30, 1): "Alcmaeon holds that what preserves health is the equality [*isonomia*] of the powers – moist and dry, cold and hot, bitter and sweet and the rest – and the supremacy [*monarchia*] of any one of them causes disease; for the supremacy of either is destructive. The cause of disease is an excess of heat or cold; the occasion of it surfeit or deficiency of nourishment; the location of it blood, marrow or the brain. Disease may come about from external causes, from the quality of water,

[65] Diogenes Laërtius, *Lives of Eminent Philosophers*, VIII, 5.
[66] Aristotle, *Metaphysics*, I, 5, 986a20–1.986b5.

local environment or toil or torture. Health, on the other hand, is a harmonious blending of the qualities."

Alcmaeon was able to give pre-Socratic natural philosophy a new "physiological" direction, focusing its attention on problems relating to the structure and vital functions of the human body. However, this proposition rather shows the influence of the views of Alcmaeon - mature scientist - on the views of the first generation of Pythagoras' followers, than the significance of the Pythagorean philosophy in shaping Alcmaeon's own world view. An important question arises here about Alcmaeon's views on the nature of the human soul and their conformity to any natural philosophical tradition. Alcmaeon is the only one among Pythagorean philosophers to teach the immortality of the soul, although he has no traits of the doctrine of its migration and suggestions about its location. According to Alcmaeon, that the soul is immortal is shown by the fact that, like all heavenly bodies, it is in constant circular motion. Alcmaeon was the first to suggest that the brain is the centre of control of the body (the human being's centre of perception and thought), in which, through "pores" (some special channels), sensations flow from various sensory organs.

The doctrine of the existence of an immortal soul, particularly residing in the brain, was vital for the development of rational medicine in the ancient world. This is probably why many philosophers were concerned about the nature of sleep (as a semblance of death) and dreams (as the manifestation of spiritual life). It should be noted that Alcmaeon did not share the Pythagorean view on metempsychosis. He argued that the intellectual activity of the human being occurs in the brain. His take on sleep and semen is also interesting: sleep, according to Alcmaeon, occurs by the withdrawal of blood from the brain to blood-flowing vessels, and semen has its origin in the brain. He interprets embryogenesis as the mixing of semen from a man and a woman (the gender of the child is determined by whose semen is predominant). According to Alcmaeon, during prenatal development, owing to the supremacy of the brain, the head develops earlier than other parts of the foetus. Alcmaeon apparently studied the anatomy of the embryo, and his propositions on

reproductive medicine can be considered a very logical development of ideas confirmed experimentally. In his views we can see the influence of the ideas of early Ionic physics, medical practices in Cos and, of course, certain ideas of Pythagoreans. Alcmaeon is also an independent figure in the history and philosophy of medicine.

One of the most important pages of the history of medicine in 5th century BC is the description of the link between the eyeball and the brain through the optic nerve, given by Alcmaeon based on observation results. It is believed that thanks to this observation, Alcmaeon concluded that the eye, as a sensory organ, only perceives information transmitted to the brain via a connecting nerve. The brain is the organ where the control of senses is concentrated. Alcmaeon is therefore considered the father of surgery and anatomical study. However, this point of view has its opponents, who argue that Alcmaeon's conclusion is based not on the results of surgical manipulations performed on a human being, but on the anatomical dissection of animals. The Croton physician most likely observed a patient, otherwise he could not have reached such conclusions: for him to be the first to conclude that the brain is an organ from where nerves begin, he ought to have significant empirical and theoretical grounds. The described case is the ideal model for such an argument, and Alcmaeon obviously was able to prove that the optic nerve begins from the brain. Alcmaeon was not the only scientist at that time to observe the eyeball dangling from the optic nerve (the historiographical dispute on who was the subject of the investigation - a human being or animal - bears no significance in this case). Apparently these observations were many: 5th century BC was a period of injuries and wounds obtained during war or hunting. Determining why in particular it was Alcmaeon, particularly in Croton and particularly in 5th century BC who, based on these observations in particular, made these conclusions will help reconstruct Alcmaeon's world view as a scientist.

Alcmaeon presented the theory of all sensory organs, except the sense of touch. Theophrastus pointed out the importance of the fact that Alcmaeon drew a distinction between sensation and thought, as well as their functions. A simple

probe was enough to determine the link between the cavities of the ears and the nose. Based on the results of said probing and observation of the optic nerve, Alcmaeon might have come to the conclusion that basic senses - vision, smell and hearing – are linked to the activity of the brain. The fundamental distinction between Alcmaeon's theory and the views of Theophrastus and his teacher Aristotle is the proposition of the brain as the centre of thought: Alcmaeon claimed that sensory organs are connected to the brain by some special channels which transmit sensation to the brain. Equally important is the issue of the location of the centre of control of arbitrary functions of the human body. The controversy over this matter continued up to the time of Galen, whose treatise *De Placitis Hippocratis et Platonis* ("On the doctrines of Hippocrates and Plato") can be considered the final point of this debate. Results of anatomical dissection enabled Galen to disprove claims by Stoics and Aristotle who placed the heart at the centre. Holding forth on the functions of the higher, immortal part of the soul, which he argues resides in the brain, Galen placed particular emphasis on the control of voluntary movements: "For it was shown to have its proof from the very nature, or essence, or whatever you wish to call it, of the matter under investigation, since everyone thinks and says that the source of sensation and voluntary motion is the governing part (of the soul)".[67] Alcmaeon's work can therefore be called the first attempt in the history of ancient medicine at applying a research method based on results of anatomical dissections.

Diogenes Laërtius says that Aristotle, and later Theophrastus, disagreed with Alcmaeon over the interpretation of sensation. He sets out from Alcmaeon's book *On Nature*: "These are the words of Alcmaeon of Croton, son of Pirithous, which he spake to Brotinus, Leon and Bathyllus: 'Of things invisible, as of mortal things, only the gods have certain knowledge; but to us, as men, only inference from evidence is possible', and so on".[68] Alcmaeon's assertion is not typical for most pre-Socratic philosophers: accurate information about the world is given only to

[67] Galen, *On the Doctrines of Hippocrates and Plato*, VII, 1, 7.
[68] Diogenes Laërtius, *Lives of Eminent Philosophers*, VIII, 5.

the gods, and people, with lesser cognitive capabilities, must study the surrounding world, interpreting evidence from sensation. Alcmaeon employs strictly physical concepts; he shuns the occult concept of disease, he regards it as a natural phenomenon which is subject to the same rules as other similar phenomena. Alcmaeon might have considered that, if the doctrine of contraries holds for the human being, the microcosm, it must also explain the secrets of the microcosm. Alcmaeon was the first physician to take serious interest in anatomy and influence the development of Greek thinking. He was also the first person whose doctrine can be regarded as the philosophy of medicine. In all likelihood, he generalised the results of his own thoughts and the experience of predecessors, similar to what Hippocrates did in Aphorisms.

Physician Philolaus, who hailed from Croton, is a famous follower of Pythagoras and one of the philosophers and key figures of the Pythagorean union after the death of its founder. There are claims that Philolaus was the first to elaborate the theory of numbers. If he is not the founder, he was apparently the first representative of the "Pythagorean philosophy" in literature, as the senior contemporary of Socrates and Democritus, and lived before Empedocles and Anaxagoras (he might as well have been younger than them). We know almost nothing about his life.[69] During the persecution of Pythagoreans in the second half of 5th century BC in major cities in Southern Italy (Croton, Metapontum, etc), Philolaus sought temporary refuge in Thebes[70] and continued his work after being exiled from Croton. Philolaus' medical views in general matched the ideas of Alcmaeon (J. Longrigg). In light of this, the question of whether Alcmaeon was a Pythagorean (as many scientists believe) becomes crucial once more.

Another high-profile member of Pythagorean Croton is physician Democedes,[71] the son of physician Calliphon, regarded as a follower of Pythagoras. He chose his father's profession and became a famous physician in

[69] W. Windelband, *History of Ancient Philosophy.*

[70] That he lived in Thebes is supported by excerpts from Plato's Phaedo (61).

[71] One of the sources of information about Democedes is the work of Herodotus (Herodotus, *The Histories*, III, 125, 130–137).

Greece at a young age. He ran a private practice, later continued working as a physician while serving in Aegina[72] and Athens, and later agreed to become the physician in ordinary to Polycrates of Samos. After Polycrates was killed by Oroetus, the Persian governor of Sardis, his physician in ordinary, like other foreigners around him, fell into slavery. Despite being a slave, Democedes would soon become a popular physician in Sardis. After king Darius ordered Oroetus killed, Democedes along with other slaves and courtiers were captured by Persians. In the court of the Persian king Darius, like in Asia in general, Egyptian physicians had a reputation as skilful healers, and they were the ones who started treating Darius when he turned his ankle while getting off a horse. However, according to Herodotus, they were too rough when putting the bone back into place, which brought the king more suffering. After learning that there was a Greek physician among the captives, Darius called for him. Democedes "applied Greek remedies and used gentleness instead of the Egyptians' violence, he enabled him to sleep and in a short time had him well, although Darius had had no hope of regaining the use of his foot".[73] Later, Democedes treated Darius' wife, empress Atossa, who had a boil on her breast. He became an archiater, was given a large house and allowed to sit at the royal table.[74] Despite his position in the court, Democedes apparently felt burdened with life in Persia. Exploiting the king's unlimited trust, he managed to have Darius send him to the Greek shores. The king agreed and took his word that he would return. Upon reaching Croton, Democedes refused to return to Persia and asked citizens to protect him from his companions – servants of the Persian king. Crotonians supported Democedes (protected him from Darius' people who tried to capture him as the king's slave), and drove the Persians out of the city.[75] After marrying the daughter of the athlete Milo of Croton, he became a

[72] Herodotus writes that in his first year in Aegina, Democedes "excelled the rest of the physicians» (Herodotus, *The Histories*, III, 131).

[73] Herodotus, *The Histories*, III, 130.

[74] In *The Histories*, Herodotus writes: "…the Egyptian physicians who until now had attended the king were about to be impaled for being less skilful than a Greek" (III, 132).

[75] For a more detailed history of Democedes, see: Herodotus, *The Histories*, III, 136.

Pythagorean and sided with them during the Cylon rebellion.[76] Therefore, there is no doubt that Democedes held an affection for Pythagoras or that he was close to the circle of the great philosopher. However, it would be wrong to certainly place this physician among Pythagoreans, as it cannot be verified that his professional views were shaped by the Pythagorean doctrine.

If Democedes is to be considered a native of Croton and a member of the so-called Crotonian medicine, he ought to have mastered the art of medicine at home, under the guidance of one of the reputed physicians of the old generation. He was invited to Samos by Polycrates, from whose tyranny Pythagoras had also just escaped. To earn the invitation to become Polycrates' archiater, Democedes ought to have been a famous and successful physician. By the time Pythagoras moved to Croton, Democedes must have established himself as an expert, an experienced physician, which implied intellectual maturity and an established world view. Therefore, there was no time for Democedes to have become a follower of Pythagoras. Democedes returned to Croton and married the daughter of athlete Milo, apparently one of the followers of Pythagoras and one of his close ones, already middle-aged. He could have become a member of the Pythagoras' circle owing to his personal affection for Pythagoras or his doctrine. Many proponents of the theory of the influence of Pythagoreanism on medicine in Magna Graecia insist that local schools of medicine were shaped by the philosophy of Pythagoras. However, information about the life of Democedes does not allow the claim that as a physician he was influenced by basic principles set forth by the philosophy of Pythagoras.

The view that Pythagoras gained wide public recognition immediately upon arrival in Croton does not hold up against criticism, at least because this would not have been possible due to the socio-cultural peculiarities of the Ancient Greek state. Its citizens were suspicious of foreigners, one of whom was Pythagoras - a foreigner, who had ran away to Croton from his native Samos at a mature age.

[76] Iamblichus points to that, too (see: Iamblichus, *De vita Pythagorica liber).*

Most probable is the theory that Pythagoras gained his influence gradually as his followers assumed leading positions in the city. Ultimately this influence reached proportions which caused the opposite reaction in the form of the persecution of members of the Pythagorean union. In that case, the establishment of Democedes as a physician could not have been influenced by Pythagorean philosophy.

While serving Polycrates, Democedes was presumably at least 30-35 years old.[77] Polycrates died in 522 BC. Pythagoras moved to Croton in 530 BC. Comparison of dates (even with a margin of error of two to three years) suggests that Democedes should be regarded as a talented famous physician who, upon returning to Croton at a mature age, joined the Pythagorean union. This theory clearly does not contradict all available data, although it rules out Democedes' medical views being influenced by the Pythagorean philosophy and, consequently, claims that he was a Pythagorean physician. We think Democedes is better described as "a physician and a Pythagorean". Biographical information about Democedes does not allow to consider Pythagorean philosophy as the foundation of the world view of this physician. Democedes joined the Pythagorean circle upon returning to Croton. He cannot be considered a member of the special, Pythaogrean medicine. According to the information available to us, Democedes appears to be a famous representative of the Ionian medical tradition, who, at a mature age, was fascinated with the ideas of his famous compatriot - Pythagoras. This theory is supported by known principles of medical practice employed by Democedes an individual approach and sensitive methods of surgical treatment, which match Cos traditions.[78]

There is information suggesting that Calliphon, the father of Democedes, was a follower of Pythagoras. Hermippus also claims that. However, this information cannot be considered accurate: even Democedes did not have time to learn the foundations of the art of medicine from Pythagoras. By the time Pythagoras moved

[77] Herodotus speaks of Democedes, 5. See: Herodotus, *The Histories*, III, 125, 129, 130–137.

[78] For example, J. Jouanna refers to the sensitive approach in traumatic surgery as one of the fundamental principles of medicine according to Hippocrates. See: J. Jouanna, "The Birth of Western medical art."

to Croton, Calliphon was obviously at a very mature age, and so his establishment as a physician could not have been influenced by the doctrine of Pythagoras. In Croton he certainly had the chance to team up with Pythagoras and become involved with his ideas. This probably suggests Calliphon as one of the "followers of Pythagoras", but a follower in terms of views on ethics, politics, astronomy or, for example, music. Like Democedes, Calliphon was already a professionally established, famous doctor by the time he met Pythagoras, and so there is no basis to link his medical views with the influence of Pythagorean philosophy. Furthermore, Calliphon possibly belonged to the Knidos line of Asclepiades.

There are names of other physicians regarded as Pythagoreans. After ending his sports career, Iccus of Tarentum became a physician and a gymnastics teacher, Milon and Astil – Olympic athletes – followed in the footsteps of Iccus; Hippon wrote two natural philosophy treatises devoted, among other things, to the causes of disease, which Philolaus referred to in his book *On Nature*.

As a natural philosopher, physician Hippon in his theory attempted to reduce everything to a single principle: the fundamental role of fluid. Alcmaeon speaks of the balance of multiple "qualities" and its violation due to internal and external factors; Hippon speaks of the "normal state" of moisture and its variation depending on cold and heat, i.e., on the fundamental category – the effect of external heat and cold in general. Hippon's doctrine has a lot in common with the views of Thales on water as a primary element. It is particularly owing to this peculiarity of Ionian tradition that Cos physicians made external moisture (its heat and cold) and internal fluid (balance or violation thereof) the centre of their ideas on the causes of disease. Philolaus had a similar take on the problem and spoke of three internal fluids – blood, yellow bile and phlegm.

One of the sources contains evidence that Hippon considered moisture the foundation of life of living beings: "But Hippon of Croton believes that there is in us a natural moisture whereby we perceive and by which we live. Now when such moisture is in its normal condition, the animal is healthy, but when it dries up, the animal loses consciousness and dies. This is the very reason why old men are dry

and lack feeling – they are without moisture. Similarly the soles of the feet, lacking moisture, have no feeling. Hippon pursues the subject no further, * but in another book the same writer says that the above-mentioned moisture changes through excess of heat and excess of cold, and so brings on diseases. * It changes, he says, in the direction of greater moistness, or of greater dryness, of greater coarseness, of greater fineness, or into other substances.In this manner he accounts for disease, but he does not indicate the diseases that result from the various causes * *".[79] All this, besides the much later establishment of rational medical theory and practice, in the sphere of influence of Miletus, certainly raises the question of the medical tradition of Magna Graecia as secondary with respect to Ionian tradition, which raises serious doubts over the decisive influence of the Pythagoreans on medicine. Also worth remembering is the fact that the second (after Croton) centre of medical knowledge in terms of historical significance – the Sicilian city of Agrigento, where Acron and Empedocles lived and worked, was inhabited by immigrants from Rhodes. Rhodes in particular is considered the third, after Cos and Knidos, centre of the work of one of the family branches of Asclepiades. Unlike the Cos and Knidos schools, there is no written evidence from the Rhodes school.

We can, with a certain degree of confidence, speak of the influence of some ideas of the Pythagorean doctrine on the development of medical theory and practice. It is hard to find a trait that is common for all Pythagoreans who practised or were interested in medicine. However, it can be said that Democedes, Alcmaeon, Iccus, Hippon and Philolaus are united by the scientific approach to medicine and the absence in their theories and practice of any links with occult and magic practices. Pythagorean ideas certainly influenced the views of physicians listed in this chapter, but still they cannot be associated with the separate Pythagorean tradition in medicine. Available information does not allow to speak of a medical tradition established exclusively under the influence of Pythagorean philosophy. Under the provisions of medical theory and practices of physicians

[79] *The Medical Writings of Anonymus Londinensis,* XI, 13.

considered as Pythagoreans that we investigated, the influence of some ideas of the Pythagorean philosophy has been noted, which can be associated with the so-called rational elements; information suggesting the acceptance by these physicians of the occult and magic component of the Pythagorean doctrine has also been challenged.

Conclusion

With regard to the history of science, it is possible to identify philosophical systems that have influenced the development of the natural sciences in general and the establishment of the scientific method in medicine. These may include certain elements of Pythagorean teaching, even if it is difficult to say that they played a determining role. The view that Pythagoras and the Pythagoreans had an influence on medicine has much to do with the traditional belief that the philosophical views of the physician-scientist and his medical practice were two parallel realities. Unfortunately, the approach that allows the philosophical views and doctoral practice of a particular representative of medicine in antiquity to be considered in terms of their interrelationship is not as popular as it might be. At the same time, from the viewpoint of research objectives in the fields of the philosophy and history of medicine, it makes sense to focus on the physician's philosophical views, which shape his worldview as a researcher. In our work, we have shown that Alcmaeon, traditionally regarded as a physician who followed Pythagorean teaching, set out certain propositions fundamental to the subsequent development of ancient Greek rational medicine (such as his theory that the brain played a controlling role, and so on). In terms of the emergence and development of medicine as a science, he is a direct predecessor of Hippocrates and Herophilus in terms of epistemology, as well as, in some sense, of Plato. Their work, in turn, influenced Galen, who created the first system of theory and practice in medicine, which would shape its development over the next 1,500 years and more. An examination of the views of other physicians regarded as followers of Pythagorean philosophy also casts doubt on the existence of a particular medical tradition established exclusively under the influence of Pythagorean teaching.

In our research, we have highlighted the dual nature of Pythagorean teaching, which was based on both rational and occult/magical elements. All this gives good reason not to overestimate the importance of Pythagorean philosophy to the development of medicine. Pythagorean teaching per se could not have become

a fundamental system of views based on which the worldview of the first generations of representatives of ancient Greek rational medicine developed and certain schools of medicine (the so-called Pythagorean medical tradition) emerged. However, this does not mean that individual Pythagorean ideas could not have influenced representatives of the medical profession in terms of their worldview in the widest sense. Such influence, in all likelihood, did exist, and related primarily to the exact sciences, primarily mathematics. The attempt to talk about natural phenomena in the language of mathematics subsequently proved highly productive for the development of science (for example, the geometric analogies used by Plato to explain the movement of particles of the basic elements, and the attempt to explain them in the language of mathematics, etc.). On the other hand, the increase in the role of occult and magical practices within Pythagorean philosophy, and the establishment of esoteric groups, hampered and altered the rational tendencies at the heart of Pythagorean teaching. As such, we cannot be sure if Pythagorean philosophy had a dominant influence on medicine, let alone that such a phenomenon as “Pythagorean medicine” existed.

Given the limited number of sources, the suggestion that Alcmaeon belonged to the Pythagorean school can only be speculation. It would seem that Alcmaeon’s idea that the brain played a central controlling function is also the main argument against considering him a Pythagorean. Key to understanding the specific features of medicine in antiquity is the attitude of physicians to anatomical dissections. The use of strict demonstration in medicine in the ancient world was based on a desire to study the human body empirically, using the method of anatomical dissection, which, combined with an etiological approach to disease theory, also shaped the development of medicine as a science. The need for formal proof of claims is one of the fundamental characteristics of mathematics as a deductive science, and the concept of proof therefore plays a central role in the subject of mathematics, while the existence of proofs and their correctness determine the status of any mathematical results. The method of mathematical proof developed by the Pythagoreans gave rise to a change in philosophical

argumentation, which was subsequently used for the development of medicine. Verification of the illness, general assessment of the patient's health, and detection and identification of the correct disease symptoms became part of doctoral practice, and crucial to medical science. Accordingly, physicians whose worldview allowed for an understanding of why the human body is structured like it is, and the possibility of understanding how human body works, attempted to take advantage of the possibilities of the method of mathematical proof, used by the Pythagoreans only in mathematics, in order to develop medicine. These attempts subsequently led to the development of the apodictic method of proof in medicine, based on anatomical dissections, as an empirical method of verification, a rational doctrine of general pathology and clinical classification. With regard to the history of medicine, it is generally assumed that the suspensions in the performance of anatomical experiments were due to religious prohibitions. However, the main reason was that within the particular worldview of the scientist anatomical dissections were unnecessary.[80] As such, we can conclude that some of the scientific propositions of Pythagorean philosophy did have an influence on medicine, but the establishment of an occult group, and the strengthening of the magical tendencies in their teaching led the Pythagorean scientists to develop a worldview that did not promote the use of the practice of anatomical dissection within the context of medical knowledge.

This is why it is hard to agree that the medical views of Alcmaeon, and the other physicians we are interested in, emerged exclusively under the influence of the Pythagorean doctrine. History should be seen as the evolution of ideas, a search for the most informative methods of proof. Consequently, the idea of experimentally studying the anatomy of living creatures had to establish itself first, then a framework of theoretical generalisations demonstrating their necessity and usefulness had to emerge, and only then, on the basis of experimental study, could

[80] The selective nature of this rejection of anatomical dissection from, for example, the empiricist physicians was due not to religious prohibitions, but to their ideas about methods of understanding, based on the natural philosophy of Early Stoicism.

researchers come to the idea of performing systematic dissections of human bodies, as the most informative means of obtaining reliable knowledge. Medicine needs to treat the human being as an entity comprising two principles, relating to two opposite states – "healthy" and "sick", which have their own abstract forms and formal material expression, which, in turn, have always made it necessary to choose suitable philosophical and methodological tools. For centuries, the etiology of a disease in medicine has remained a combination of factors that can be understood only with the right methodological paradigm, making it possible to establish the cause-and-effect relationship of the various pathological phenomena and processes, which, in turn, brings researchers closer to understanding the nature of a disease, and, therefore, methods of treating it. Such was the case in the ancient world: medicine's historical development can be traced from Alcmaeon's sporadic observations to the first deliberate animal dissections described in the Hippocratic Corpus to the systematic practice of comparative anatomy at the Lyceum and, finally, to the works of Herophilus. This resulted in fundamental knowledge being accumulated, and significant philosophical and methodological foundations being laid, thanks to which Galen formulated his comprehensive system of anatomy and physiology,[81] which became the first protoscientific framework and the basis for the development of modern scientific medicine.

[81] D.A. Balalykin and N.P. Shok, "The Pythagoreans' influence on medicine: a historical fact or problems of interpretation? Part 1"; D.A. Balalykin and N.P. Shok, "The Pythagoreans' influence on medicine: a historical fact or problems of interpretation? Part 2."

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