

# Study on the Encephalic Functions by the Medical School of Croton and the School of Salerno

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## Abstract

The current article is a thorough discussion on ancient scientific knowledge related to the human brain. It records the “breakthrough” in scientific knowledge on both the functions of the human brain and the application of this knowledge occurring in two different medical schools in Southern Italy, despite the time lapse of fifteen centuries between the two. More explicitly, it refers to the Medical School of Croton<sup>1</sup> (Southern Italy - Magna Graecia, 6th c. B.C. – early 4th c. BC) and the Medical School of Salerno<sup>2</sup> (9th – 13th c. AD). The school of Croton was the first in the ancient Hellenic world to formulate the idea of the brain as the centre of mental functions. As far as the Medical School of Salerno is concerned, it was the first popular university in Europe which became a model for later universities. It was also the first medical institution of the Christian world where surgeries on human brain took place. In the school of Croton the emblematic figures of **Alcmaeon of Croton** and **Pythagoras** occur. In the School of Salerno it is **Rogierus Salernitanus** who first operates on human brain.

**Key Words:** Brain, Southern Italy, medical school, Croton, Salerno, Alcmaeon of Croton and Pythagoras, Rogierus Salernitanus

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<sup>1</sup>Nowadays Croton, coastal city in Southern Italy on the side of the Ionian Sea.

<sup>2</sup>Salerno is also a coastal city, northern than Croton, on the side of the Tyrrhenian Sea.

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Ὁ βίος βραχύς, ἡ δὲ τέχνη μακρὴ (= μακρά), ὁ δὲ καιρὸς ὀξύς (= ἡ περίπτωση εἶναι ἐπείγουσα), ἡ δὲ πείρα σφαιερὴ, ἡ δὲ κρίσις χαλεπὴ. Δεῖ δὲ οὐ μόνον ἑαυτὸν παρέχειν τὰ δέοντα ποιεῦντα, ἀλλὰ καὶ τὸν νοσέοντα, καὶ τοὺς παρεόντας, καὶ τὰ ἐξωθεν.

**Ἱπποκράτης καὶ Συλλογὴ Ἱπποκρατικῶν, Αφορισμοί,  
Τμήμα Πρώτο, Αφορισμός 1.**

“Life is short, and art long; the crisis fleeting; experience perilous, and decision difficult. The physician must not only be prepared to do what is right himself, but also to make the patient, the attendants, and externals cooperate.”

**Hippocrates, Aphorisms,  
Section I, Aphorism 1.**

## PART I

### School of Croton: Introduction

When studying the achievements made by the School of Croton, one comes across the bewildering fact that these pioneering ideas concerning the role of the brain occurred during the 6th c. BC in the geographical area of the greater Hellenic world and not in mainland Greece, well-known for its classical scientific and philosophical flourishing. One notices then the preoccupation with the study of the brain in such parts as Southern Italy, the Ionian cities in Minor Asia and the Aegean islands<sup>3</sup> was made possible probably due to local's society tolerance towards experimentation and body dissections. New ideas and theories come up, according to Thomson, only when material progress sets new goals for each society. When these new ideas are born, they become a powerful force that facilitates society (269). This is the case of the medical school of Croton. And the most important role on the pioneering development of research on the human brain was played by the

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<sup>3</sup> Other important medical schools till the 2nd c. AD were in Cyrene, Cnidus, Kos and Pergamon.

emblematic figures of Pythagoras and Alcmaeon of Croton.

### Croton and Pythagoras

Croton was one of the oldest ancient Greek colonies which became famous for the research on the human brain. The first written token on the brain being the center of human logic is attributed to Pythagoras<sup>4</sup> (Karapetsas 2015); Alcmaeon of Croton and Pythagoras<sup>5</sup> pointed out that the brain is the center of all human mental functions (Crivellato and Ribatti 2007). The ancient Greek colony of Croton was founded by the Achaeans in the east coast of Calabria at about 708 BC. Apart from Alcmaeon and Pythagoras, many important men were raised in Croton during the 6th c. BC; i.e. physician Democedes, sculptors Damaeus and Patrocles and, later, a multitude of athletes, most famous of which was Milon, the son of Diotimus. Under the leadership of Milon, the people of Croton won at war the people of Sybaris in 510 BC and destroyed their city. This is the time in which the hegemony of the city of Croton starts in Magna Graecia. For many years, its hegemony spans from the Adriatic Sea to the Tyrrhenian Sea. Its inhabitants were famous for their physical strength and their beautiful women. It was also famous for its athletes and its warriors (Bostford and Robinson 1985).

Pythagoras settled in Croton after he had left Samos. It was believed that his settlement was foreseen by the Oracle of Delphi; that he would be a useful citizen to all and that he received his commandments by the Delphic Oracle itself<sup>6</sup>.

Pythagoras established laws in Croton, which brought new boost to the city and contributed to its cultural and social progress by reshaping its institutions. He tried to impose an ascetic way of living, not only to his followers but also to all Croton's inhabitants; he defied various revolts and the tendency to anarchism in the city; his teaching was preserved by forthcoming generations. He made known the following wise saying: "illness should be expelled in every way from the human body and it should be seared by using fire and iron and other devices, luxury should be kicked out of the belly, revolution should be kept apart from the city, dissension away from home and all should be kept away from lack of symmetry («αμετρία»)<sup>7</sup>. He developed diet regimes and medicine which were based on moral and self-discipline. His school was a mystifying union followed by political views; when Pythagoreans took over ruling power, they tried to govern in their own exemplary, ethical way (Bostford and Robinson 1985).

Pythagoras himself did not leave any manuscript<sup>8</sup> and formed his theories without undertaking questioning for their validity. Theophrastus wrote that Pythagoras proclaimed he knew the seat of mental functions: "whatever has to do with living is centered to the heart, the brain and mind is centered to the head" («τό μὲν ζωτικόν περί την καρδίαν τό δέ λογικόν καί νοερόν περί τήν κεφαλήν»)<sup>9</sup>. In what has been preserved by his commandments, we read the following: "the four founding pillars of the psyche are four: mind, science, fame and the ability

<sup>4</sup> In 6th c. BC.

<sup>5</sup> What the brain stands for each Greek physician and philosopher since Alcmaeon till 2nd c. AD:

**I.** The basis of the senses and cognition, «το ηγεμονικόν» (**Alcmaeon and Pythagoreans, 5th. c. BC**)

**II.** The centre of the senses, cognition and logic, the source of feelings due to which we can perceive the difference between good and bad, ethical and immoral (**Hippocrates, 5th/4th c. BC**)

**III.** The centre of logical psyche (**Plato, 427-347 BC**)

**IV.** Tool for cooling bodily temperature (**Aristotle, 384-322 BC**)

**V.** Governing centre of the body (**Herophilus, 335-280 BC**)

**VI.** The basis of "hegemonikon" (**Galenus, 129-216 AD**)

<sup>6</sup>1. His birth was foreseen by Pythia. She foresaw that Pythagoras would be different both in beauty and in wisdom from all people and would be very useful to mankind. His father, Mnisarchus, named him after Apollo Pythius. Available on the internet:

<https://el.wikipedia.org/wiki/%CE%A0%CF%85%CE%B8%CE%B1%CE%B3%CF%8C%CF%81%CE%B1%CF%82>

**2. <PYTHAGORAS>, Testimonia {0632.006}. DIOG. VIII 8**

**φησὶ δὲ καὶ Ἀριστοξένος [fr.2 FHG II 272]** λέγεται τὰ πλεῖστα τῶν ἠθικῶν δογμάτων λαβεῖν τὸν Πυθαγόραν παρὰ Θεμιστοκλείας τῆς ἐν Δελφοῖς.

<sup>7</sup>Available on the internet:

<https://el.wikipedia.org/wiki/%CE%A0%CF%85%CE%B8%CE%B1%CE%B3%CF%8C%CF%81%CE%B1%CF%82>

<sup>8</sup>It is extremely difficult to write the biography of such a great historical figure as Pythagoras since his life was intermingled with myths from early on; as a result, biographies by historians such as Diogenes Laertius, Porphyrius or Iamblichus are of little value. One has also to take into account that various treatises on Pythagoras were altered and presented him as author which explains the reason it is so difficult to acknowledge what he truly taught. (Kroh 1996)

Followers of the encephalocentric theory till the 2nd c. AD in chronological order:

**I. (Alcmaeon and Pythagoreans, 6th c. /early 5th c. BC)**

**II. Anaxagoras** of Clazomenae, Minor Asia – **Hippon** of Samos – **Diogenes** of Appollonia – **Philolaos** of Croton, **5th c. / 4th c. BC**)

**III. Hippocrates** of Kos, **5th c. / 4th c. BC**)

**IV. Herophilus** of Chalcedon (supporter of the cardiocentric theory at first) – **Eristratus** of Kea, **3rd c. BC**)

**V. Galenus** of Pergamus, **2nd c. AD**)

to feel. Because the human psyche is, Pythagoras says, a rectangular square” («τά γὰρ τῆς ψυχῆς στηρίγματα τέσσαρά ἐστι, νοῦς, ἐπιστήμη, δόξα, αἴσθησις. Ψυχὴ γὰρ ἀνθρώπου, φησὶν ὁ Πυθαγόρας, ἔστι τετράγωνον εὐθυγώνιον»), (Fragmenta 0632.002, 165). According to Pythagoras, the Egyptians were the first to talk about the immortality of the psyche, transmigration of the souls and the fact that the spirit goes to animals first and eventually to humans. This cycle of the psyche from animals to humans lasts three thousand years<sup>10</sup>. Pythagoras supported the idea that everything recurs, therefore, nothing in our lives is completely new. He believed that numbers are hidden behind everything in the universe and that all cosmic events are repeated in a cycle of ten thousand eight hundred years.

According to Diogenes Laertius, Pythagoras had studied medicine. Due to his travels, he had acquainted highly unusual ideas for the cause of illnesses which he would always attribute either to demons or superhumans; he did not eat meat; for unknown reasons, he supported the idea that his followers should not eat broad beans. It is obvious that Diogenes Laertius wrongly takes broad beans for testicles or nipples; for this reason in the quotation «καρδίας ἀπέχεσθαι καὶ κυάμων», Diogenes Laertius says “avoid emotional burdening and sexual intercourse” («να ἀποφεύγετε τις συγκινήσεις καὶ τις συνουσίες»). Among others, Pythagoras advised his followers for “abstinence from sexual intercourse as long as there was no need for them to lose weight”. He was also against any kind of abuse in work or food. Some of his beliefs were that: a. human conception takes place when hot steam comes down from the brain so that the psyche and the emotions can be formed, b. the body is a product of fluid mass within the womb, c. cosmos (the world) was born of a seed that End had planted into Infinity, d. the psyche is based on both the head and the heart, that is, desire and logic. (Bouillet 77)

In 6th c. BC Southern Italy, Pythagoreans tried to form a confederation among cities which eventually failed due to the war between the city of Croton and that of Sybaris. The attempt to unite the colonies of Magna Graecia under the rule of the Pythagoreans gave an advance to the Greek-speaking world, even for a short period of time. The economical wealth of these regions is

clearly manifested by the variety of coins found in excavations. Pythagoreans, then, took over the rule from the agricultural aristocracy and took measures to reinforce trade. In the process of time, though, it seems that they followed rather conservative policies which led to people’s dissatisfaction. This bitter feeling was manipulated by various self-centered politicians who bore a grudge for the fact that Pythagoras never accepted them into his union. As a result, Pythagoreans were banished from this region of Southern Italy, even though their teaching was greatly accepted. Alcmaeon of Croton was highly influenced by Pythagorean thought; it is common belief that he must have been Pythagoras’s student<sup>11</sup>.

### Alcmaeon of Croton

Based on his research, Alcmaeon came to the conclusion that the seat of feelings and the mind is the brain<sup>12</sup>. According to Dr. George Paxinos<sup>13</sup>, he was the first to unveil the relationship between the brain and the

<sup>11</sup> **ALCMAEON Philosophus. Testimonia {0766.001} Fragment 3, line 7:** καὶ γὰρ ἐγένετο τὴν ἡλικίαν Ἀλκμαίων <νέος> ἐπὶ γέροντι Πυθαγόρα, ἀπεφῆναι δὲ παραπλησίως τούτοις

<sup>12</sup> **ALCMAEON Phil. Fragmenta {0766.002}: 1. Fragment 1: ΑΛΚΜΑΙΩΝΟΣ ΠΕΡΙ ΦΥΣΕΩΣ** All senses, according to Alcmaeon, coordinate with the brain and this is the reason why they paralyse when moving or changing place, since the brain restrains the canals through which they operate. It is the brain that makes hearing, seeing and taste happen; all these senses make up memory, and memory forms opinion; when they rest, knowledge is born. Humans form knowledge but, while other creatures also feel, they cannot form knowledge.

**2. (A5. 11. B1α) 4. ΑΣΤ. IV 17,1 (D. 407)** Ἀλκμαίων ἐν τῷ ἐγκεφάλῳ εἶναι τὸ ἡγεμονικόν.

**3. PLATO Phaedo p. 96 A.** ἐγκέφαλος ἐστὶν ὁ τὰς αἰσθήσεις παρέχων τοῦ ἀκοῦειν καὶ ὄραν καὶ ὀσφραίνεσθαι, ἐκ τούτων δὲ γίνοιο μνήμη καὶ δόξα, ἐκ δὲ μνήμης καὶ δόξης λαβούσης τὸ ἡρεμεῖν, κατὰ ταῦτα γίνεσθαι ἐπιστήμην. ἄνθρωπος τῶν ἄλλων διαφέρει ὅτι μόνον ξυνίησι, τὰ δ’ ἄλλα αἰσθάνεται μὲν, οὐ ξυνίησι δέ. (A 5. 11. B 1α).

**3. (1a) THEOPHRASTUS. De Sensu. 25 [A 5]** ἄνθρωπον γὰρ φησὶ τῶν ἄλλων διαφέρειν ὅτι μόνον ξυνίησι, τὰ δ’ ἄλλα αἰσθάνεται μὲν, οὐ ξυνίησι δέ.

**4. Αἒτιος. IV 17, 1 (D. 407) A.** ἐν τῷ ἐγκεφάλῳ εἶναι τὸ ἡγεμονικόν· τούτῳ οὖν ὀσφραίνεσθαι ἔλκοντι διὰ τῶν ἀναπνοῶν τὰς ὀσμάς.

**5. STOBÆUS, Joannes. Anthologus Scriptor. Eccl. et Theol. Anthologium {2037.001} Book 1, chapter 53, sect.**

**2:** Ἀλκμαίων ἀκοῦειν ἡμᾶς τῷ κενῷ τῷ ἐντὸς τοῦ ὠτός· τοῦτο γὰρ εἶναι τὸ διηκούειν κατὰ τὴν τοῦ πνεύματος εἰσβολὴν· πάντα γὰρ τὰ κοῖλα ἤχει.

<sup>13</sup>Dr. George Paxinos is professor of Psychology and Medical Sciences, “NeuRA - Neuroscience Research Australia”, University of New South Wales, Sidney, Australia.

<sup>10</sup> **<PYTHAGORAS>, Testimonia {0632.006} (1) HEROD. II 123:** “πρῶτοι δὲ καὶ τόνδε τὸν λόγον Αἰγύπτιοί εἰσι οἱ εἰπόντες ὡς ἀνθρώπου ψυχὴ ἀθάνατός ἐστι, τοῦ σώματος δὲ καταφθίνοντος ἐς ἄλλο ζῶιον αἰεὶ γινόμενον ἐσδύεται, ἐπεὶ δὲ πάντα περιέλθῃ τὰ χερσαῖα καὶ τὰ θαλάσσια καὶ τὰ πετεινά, αὐτὴς ἐς ἀνθρώπου σῶμα γινόμενον ἐσδύνειν, τὴν περιήλυσιν δὲ αὐτῆι γίνεσθαι ἐν τρισχίλοισι ἔτεσι.”

mind. "This thought was probably brought to the island of Kos, where Hippocrates, the greatest doctor of ancient times, worked"<sup>14</sup>. Marketos believes that Alcmaeon was considered to be the father of medicine even before Hippocrates<sup>15</sup>. Alcmaeon's work combines philosophical thought and medical research; according to Chalcedonius, he was the first to dissect bodies and experiment on animals<sup>16</sup> (Marketos 46). As a doctor, he devoted himself to research of the sensory organs; he must have been the first to work on eye operations. According to his theory, sensory perception goes to the brain through the eye and the ear through certain "canals" (fascicle of nerves, he would rather mean), since Alcmaeon thought that the brain was the main organ in the human body. He supported the psyche's immortality and the divine nature of stars<sup>17</sup>. In his work, Concerning Nature (Περὶ Φύσεως), one can find the Pythagorean religious-mystic commandments side by side with the latest outcomes of his entirely scientific research in the natural-cognitive world.

<sup>14</sup> Available on the internet:

<https://www.youtube.com/watch?v=1XPaSYXHGlw>

<sup>15</sup> Marketos, 2002.

<sup>16</sup> Some historians thought that the Pythagoreans did not dissect bodies since they believed in metempsychosis. Jean Bouillet states that the idea that Pythagoreans favoured dissections is only based on Chalcidius who lived 900 years after Alcmaeon. Other historians report nothing on this (i.e. Plutarch). Since dissections were against Pythagorean beliefs (metempsychosis), this hypothesis remains under question. But some (i.e. Diogenes Laertius and Diodorus of Sicily) suggest that Alcmaeon new well the canal through which the eardrum and the pharynx communicate, therefore, he must have performed dissections.

<sup>17</sup> 1. CLEMENS ALEXANDRINUS Theol. Stromata {0555.004} chapter 5, section 66, subsection 2:

Κροτωνιάτης Ἀλκμαίων θεοὺς ὤετο τοὺς ἀστέρας εἶναι ἐμψύχους ὄντας. Οὐ σιωπήσομαι τὴν τοῦτων ἀναισχυντίαν• 1 2. Joannes STOBÆUS Anthologus Scr. Eccl. et Theol. Anthologium {2037.001} Book 1, chapter 49, section 1a: Ἀλκμαίων φύσιν αὐτοκίνητον κατὰ αἰδίον κίνησιν καὶ διὰ τοῦτο ἀθάνατον αὐτὴν καὶ προσεμφερῆ τοῖς θεοῖς ὑπολαμβάνει.

3. GENNADIUS SCHOLARIUS Theol. Translatio commentarii Thomae Aquinae De anima Aristotelis {3195.011} Book 1, chapter 5: Ἀλκμαίων δὲ ἐκ τῶν οὐρανίων σωμάτων αὐτὴν (τὴν ψυχὴν) συνίστησιν.

4. GENNADIUS SCHOLARIUS Theol. Translatio commentarii Thomae Aquinae De anima Aristotelis {3195.011} Book 1, chapter 5: Παραπλησίως δὲ τούτοις. Ἐνταῦθα, τρίτον, τίθησιν τὴν δόξαν τοῦ Ἀλκμαίωνος ὅστις συνεφώνει τούτοις ὅσον πρὸς τὴν κίνησιν μόνον, ὅστις ἔλεγε τὴν ψυχὴν εἶναι κινητικώτατον τι• ὅθεν διὰ τὸ αἰεὶ κινεῖσθαι ἀφωμοίωται τοῖς ἀθανάτοις, δηλονότι τοῖς οὐρανίοις σώμασι• καὶ διὰ (125) τοῦτο φησὶν αὐτὴν ἀθάνατον ὡς τὰ οὐράνια σώματα, ἅπερ αἰ

What makes Alcmaeon's discoveries even more prominent and innovative is the fact that he had answered the question why people die<sup>18</sup>. What he propounded for the brain was "times ahead", and this is shown in that, after Alcmaeon's findings, many philosophers thought that the heart<sup>19</sup>, and not the brain, was the central organ of thinking and of sensory perception. Among them was Aristotle. Later research, though, proved the centrality of the brain and did credit to Alcmaeon's ideas.

His interest in medicine and physiology led him to express innovative ideas on health and illness issues. In his Metaphysics, Aristotle presents a table of opposite forces which he "borrowed", as he says, from Alcmaeon. Based on these opposite forces, Alcmaeon defined health as the equal blend and allocation of corporeal powers. Specifically, he supported the idea that health was the equivocal distribution of these forces<sup>21</sup>, there-

κινουῦνται, ὥσπερ ὁ ἥλιος καὶ ἡ σελήνη καὶ τὰ τοιαῦτα ἀθάνατά εἰσιν.

**6. SOPHONIAS Phil. In Aristotelis libros de anima paraphrasis {4030.001}, Page 14:** παραπλησίως (30) δὲ τούτοις καὶ Ἀλκμαίων ὁ Κροτωνιάτης, Πυθαγορικὸς ὢν, ὑπολαβεῖν ἔοικε περὶ ψυχῆς• φησὶ γὰρ αὐτὴν ἀθάνατον εἶναι διὰ τὸ εὐοικεῖναι τοῖς ἀθανάτοις, τοῦτο δ' ὑπάρχειν αὐτῇ ὡς αἰεὶ κινουμένη• κινεῖσθαι γὰρ καὶ τὰ θεῖα πάντα συνεχῶς αἰεὶ, σελήνην, ἥλιον, τοὺς ἀστέρας καὶ τὸν ὅλον οὐρανόν. τῶν δὲ φορτικωτέρων καὶ ὕδωρ τινὲς αὐτὴν ἀπεφάναντο.

<sup>18</sup> «Τοὺς ἀνθρώπους φησὶν ὁ Ἀλκμέων διὰ τοῦτο ἀπόλλυσθαι, ὅτι οὐ δύνανται τὴν ἀρχὴν τῷ τέλει προσάψαι» (= people die because they cannot join the final point of their lives with a new starting point). If there were a possibility for elderly humans to become infants again, the cycle of life would be refreshed and people could never die. It is highly probable that Alcmaeon formed this theory taking into account the mathematic theory of cyclical kinesis in which the last point of the cycle is also the first. For this reason, ancient mathematicians thought that only cyclical kinesis can infinitely occur.

<sup>19</sup> A'. Followers of the cardiocentric theory till 1st c. AD in chronological order are:

**Philion** of Lokroi and the School of Cnidus – **Aristotle** – **Diocles** of Carystus – **Praxagoras** of Kos, 4th c. BC  
**Zeno** from Kitio - **Chrisippus** of Soloi, Cilicia, 3rd c. BC  
**Stoics** – **The author of the Hippocratic treatise "About the Heart"** («Περὶ καρδίας»), 2nd c. BC  
**Atheneos of Attaleia**, 1st c. BC

**B'**. Some of the reasons that made philosophers changed their focus towards the heart and not the brain were that: the heart beats fast (in order to bring oxygen to the brain) when we have intense feelings; people die instantly from heart wounds. Expressions in English like "learn by heart", or "heartfelt wishes" etc., are ancient remnants of the cardiocentric theory.

<sup>21</sup>**1. ALCMAEON Phil. Fragmenta {0766.002}, Fragmenta 4 - v 30 1 (D. 442) A.** τῆς μὲν ὑγείας εἶναι συνεκτικὴν τὴν ἰσονομίαν τῶν δυνάμεων, ὑγροῦ, ξηροῦ, ψυχροῦ, θερμοῦ, πι-

fore, that liquid and solid, cold and hot, or sour and sweet, have equal rights within the body. Furthermore, he believed that monarchy, the domination of the one over the other, is what causes illness and is inherent within these opposite pairs. Also, he stressed that health is the symmetrical blend of qualities. A living body is a system whose basic forces are both opposite and equivocal. Thus, when these forces balance, the system works in perfect harmony. As a result, he thought that cure lies on the restoration of the disrupted equilibrium. This also meant that the force which broke the law of equal rights should now be put into order within the “little city” of the human body. This theory influenced greatly the Hippocratic physicians who expressed their own ideas on human sustainability also suggesting the equivocal blend of the bodily components. Alcmaeon’s philosophical beliefs influenced Plato greatly while his scientific outcomes were foundational for Hellenic medicine. One of his ideas was that humans consist of the same components as the macrocosm. He was also interested in how human sperm is created, the sperm as the cause of life, also an issue studied by other philosophers such as Pythagoras, Aristotle, Plato, Epicurus, Democritus, Leucippus, Zeno, etc<sup>22</sup>.

κροῦ, γλυκέος καὶ τῶν λοιπῶν, τὴν δ’ ἐν αὐτοῖς μοναρχίαν νόσου ποιητικὴν• φθοροποιὸν γὰρ ἐκατέρου μοναρχίαν

**2. Joannes STOBÆUS Anthologus Scr. Eccl. et Theol. Anthologium {2037.001} Book 4, chapter 37, section 2: ΠΕΡΙ ΥΓΕΙΑΣ ΚΑΙ ΤΗΣ ΠΕΡΙ ΤΗΝ ΔΙΑΜΟΝΗΝ ΑΥΤΗΣ ΠΡΟΝΟΙΑΣ.** [Ἀλκμαίων] τῆς μὲν ὑγείας εἶναι συνεκτικὴν τὴν ἰσονομίαν τῶν δυνάμεων, ὑγροῦ ξηροῦ <ψυχροῦ> θερμοῦ πικροῦ γλυκέος, τῶν λοιπῶν, τὴν δ’ ἐν αὐτοῖς μοναρχίαν νόσου παρασκευαστικὴν εἶναι.

**3. DIOCLES Medicus. Fragmenta {0664.002} Fragment 51b line 251b) (Pseudo-)Plutarchus, Placita philosophorum 5.30 (1n) Περί υγείας καὶ νόσου καὶ γήρωσ (1)** Ἀλκμαίων τῆς μὲν ὑγείας εἶναι συνεκτικὴν <τὴν> ἰσονομίαν τῶν δυνάμεων, ὑγροῦ θερμοῦ ξηροῦ ψυχροῦ πικροῦ γλυκέος καὶ τῶν λοιπῶν• τὴν δ’ ἐν αὐτοῖς μοναρχίαν νόσου ποιητικὴν• φθοροποιὸν γὰρ ἐκατέρου μοναρχία• καὶ νόσων αἰτία ὡς μὲν ὑφ’ οὗ, ὑπερβολῆ θερμότητος ἢ (5) ψυχρότητος• ὡς δ’ ἐξ ἧς, διὰ πληθους <τροφῆς> ἢ ἐνδείαν• ὡς δ’ ἐν οἷς, ἢ αἷμα ἐνδον ἢ ἐγκέφαλος• τὴν δὲ ὑγείαν τὴν σύμμετρον τῶν ποιῶν κρᾶσιν.

<sup>22</sup>**1. Ast. V3.3(D.417)** Ἀλκμαίων: ἐγκεφάλου μέρος (εἶναι το σπέρμα).

**2.** σπέρμα εἶναι σταγόνα ἐγκεφάλου περιέχουσαν ἐν ἑαυτῇ ἀτμὸν θερμόν• ταύτην δὲ προσφερομένην τῇ μήτρᾳ ἀπὸ μὲν τοῦ ἐγκεφάλου ἰχώρα καὶ ὑγρὸν καὶ αἷμα προῖσθαι, ἐξ ὧν σάρκα τε καὶ νεῦρα καὶ ὀστά καὶ τρίχας καὶ τὸ ὅλον συνίστασθαι σῶμα• ἀπὸ δὲ τοῦ ἀτμοῦ ψυχρὴν καὶ αἴσθησιν. μορφοῦσθαι δὲ τὸ μὲν πρῶτον παγὲν ἐν ἡμέραις τεσσαράκοντα, κατὰ δὲ τοῦς τῆς ἀρμονίας λόγους ἐν ἑπτὰ ἢ ἐννέα ἢ δέκα τὸ πλεῖστον μῆσι τελειωθὲν ἀποκυῖσθαι τὸ βρέφος•

## Other Pythagoreans<sup>23</sup>

Empedocles, famous for his four-element theory of matter, was a philosopher and poet, a foreseer and a miracle-worker, most of all, though, he was a democrat. He thought himself as an embodied god. He dealt with medicine but, even though he knew the work done by the Croton medical school, he refused to get knowledge any further and receded to older ideas. While Alcmaeon stressed the difference between thought and senses and had pointed out the brain as the organ of the mental faculty, Empedocles made no such distinction between the two and believed that humans think through their blood (Thomson 320).

## Democedes

He was born in Croton and his father was Calliphon, a priest serving Asclepius. It seems that he served as a physician in ancient Athens and the island of Aigina. Later, while he was serving under Polycrates in 522 BC, he was caught by Oroitis and was sent to Sousa to serve Dareius the Great. It occurs that he wrote a medical book which was extensively used in later works.

To sum up, even as early as the 6th c. BC, the fame of Greek physicians and healers was already beyond

**3. Pseudo-PLUTARCHUS Biogr. et Phil. Placita philosophorum (874d-911c) {0094.003} “Stephanos”: page 905, section A:**

**Which is the substance of sperm?**

**Τίς ἡ οὐσία τοῦ σπέρματος;**

**Aristotle** σπέρμα ἐστὶ τὸ δυνάμενον κινεῖν ἐν ἑαυτῷ εἰς τὸ ἀποτελέσαι τι τοιοῦτον, οἷόν ἐστι τὸ ἐξ οὗ συνεκρίθη.

**Pythagoras** ἀφρὸν τοῦ χρηστοτάτου αἵματος τὸ σπέρμα, περὶπτωμα τῆς τροφῆς, ὡσπερ τὸ αἷμα καὶ μυελόν.

**Alcmaeon** ἐγκεφάλου μέρος.

**Plato** μυελοῦ τοῦ νωτιαίου ἀπόρροιαν.

**Epicurus** ψυχῆς καὶ σώματος ἀπόσπασμα.

**Democritus** ἀφ’ ὅλων τῶν σωμαίων καὶ τῶν κυριωτάτων μερῶν, οἷον ὀστέων σαρκῶν καὶ ἰνῶν.

**Is sperm a kind of body? Εἰ σῶμα τὸ σπέρμα;**

**Leucippus and Zeno** σῶμα• ψυχῆς γὰρ εἶναι ἀπόσπασμα.

**Pythagoras, Plato, Aristotle** ἀσώματον μὲν εἶναι τὴν δύναμιν τοῦ σπέρματος ὡσπερ νοῦν τὸν κινοῦντα, σωματικὴν δὲ τὴν ὕλην τὴν προχοομένην.

**Straton and Democritus** καὶ τὴν δύναμιν σῶμα• πνευματικὴ γὰρ.

<sup>23</sup>This is a catalogue of the main Pythagoreans and their homeland city: **Hippasos** of Metapotio 7th c./5th c. BC, **Petron** of Imera 6th c. or 5th c BC, **Hippon** of Samos 5th c. BC, **Philo-laos** of Croton 477–388 BC, **Euritos** of Croton 5th c. /4th c. BC, **Hiketias** of Syrakousai 5th c. BC, **Hekfantos** of Syrakousai 5th c. BC, **Archytas** of Taras 5th c. BC

the borders of the Hellenic world. We saw that Dareius the Great had chosen Democedes of Croton as his personal physician. People believed that doctors coming from the city of Croton were way ahead while Cyrenees were after them. According to Herodotus, Democedes was the most dexterous physician of his time<sup>24</sup>.

## PART II

### Medical School of Salerno (9th c. -13th c. AD)

After the fall of the Roman Empire, it seems that medical knowledge and practice was secluded in the silent cells of monasteries. In timid and slow pace, the first traces of modern medicine started to appear. One such example is the medical school of Salerno ("Scuola Salernitana") in Southern Italy which was based mainly on the Pythagorean commandments<sup>25</sup>, Greek physicians, as well as on medicine developed by the Arabs and the Hebrews. This school, which started in the confined area of a 9th c. AD monastery pharmacy, reached its peak between 9th c. and 13th c. AD.

Salerno was a place open to Byzantine and Arab influence, therefore, the Salerno medical school was the fertile ground on which medical art could re-grow<sup>26</sup>. It was based on both the teachings of Hippocrates and Galenus and knowledge coming from the Arabs. It had

<sup>24</sup>Thesaurus Linguae Graecae, HERODOTUS Hist. Historiae {0016.001} Book 3, section 132:

(132) Τότε δὴ ὁ Δημοκίδης ἐν τοῖσι Σούσοισι ἐξισημένους Δαρεῖον οἶκόν τε μέγιστον εἶχε καὶ ὁμοτράπεζος βασιλεῖι ἐγγόνει, πλὴν τε ἐνός, τοῦ ἐς Ἑλληνας ἀπιέναι, πάντα τὰλλὰ οἱ παρῆν. Καὶ τοῦτο μὲν τοὺς Αἰγυπτίους ἰητρούς, οἱ βασιλέα πρότερον ἰώντο, μέλλοντας ἀνασκολοπιεῖσθαι ὅτι ὑπὸ Ἑλληνοῦ ἰητροῦ ἐσώθησαν, τούτους βασιλέα παραιτησάμενος ἐρρύσατο· τοῦτο δὲ μάντιν Ἥλειον Πολυκράτει ἐπισπόμενον καὶ ἀπημελημένον ἐν τοῖσι ἀνδραπόδοισι ἐρρύσατο. Ἦν δὲ μέγιστον πρῆγμα Δημοκίδης παρὰ βασιλεῖι.

<sup>25</sup>Marketos 2002, 158.

<sup>26</sup>It was a well organised medical school, having final examinations like modern institutions. School graduates started using the title "doctor" (suggesting "highly qualified"), instead of the common "medicus". The school was so famous that Emperor Frederic II did not allow anyone to practice medicine unless they had graduated from the Salerno medical school. One must take under consideration that the physician of Western Medieval Europe graduated at the age of 20. During his studies, he studied and translated Greek and Arab manuscripts. He learned to think and use scientific texts as source of knowledge, but had no practical experience on patients; he had acquired only theoretical knowledge. He started practice after graduation, when he would accompany an experienced doctor to patients' homes (Marketos 157). Since 1224, Frederic issued an order obliging surgeons to study anatomy too.

surgeons who could perforate and reset bone fractures on the head as well as saw veins using silk threads. The drills used had wooden handles and sharp edges made of hard materials, usually animal teeth or stone spikes. Drilling bows were also used; they had a hard, wooden handle around of which a leather horde was wrapped. The healer put the edge of the handle upon the skull and, holding stable the other end, rotated the drill with the horde.

The school of Salerno was one of the first medical schools in medieval Europe, one of the first medical institutes in western Christianity and hosted the most prominent physicians and doctors of its time such as Constantine Africanus, Roger Bacon, Rugerius Salernitanus, Theodoric Borgognoni of Serbia, Albert the Great (mid 13th c.) who was devoted to the science of botany<sup>27</sup>, Maestro Salerno and many others. It is highly possible that professors teaching at the school were paid by their own students<sup>28</sup> and this is likely the reason for its decline; when universities were established, students were attracted to study there; therefore, the economic income of the Salerno school was dramatically reduced following the reducing number of students; in the end, professors themselves sought work at the newly established universities. The school's decline led to its closure by Napoleon in 1811<sup>29</sup>.

The Salerno school compiled its own bibliography known as the "Salerno Health Code"<sup>30</sup>. It was a collection of aphorisms, wise advice and instructions which included its most typical practices. However, this collection did not include any original ideas apart from dietary regime issues<sup>31</sup>.

### Constantine Africanus

He was the most important representative of the

<sup>27</sup> Available on the internet:

[http://enneaetifotos.blogspot.gr/2013/02/blog-post\\_6110.html](http://enneaetifotos.blogspot.gr/2013/02/blog-post_6110.html)

<sup>28</sup> Available on the internet:

[http://historymed.blogspot.gr/2008/08/blog-post\\_6021.html](http://historymed.blogspot.gr/2008/08/blog-post_6021.html)

<sup>29</sup> History of Medicine and its Technology:

<http://www.eng.uct.ac.za/cpitris/courses/ECE001/Notes/Ch01-2005.pdf>

<sup>30</sup> History of Medicine:

<http://historymed.blogspot.gr/search/label>

<sup>31</sup> It was written/compiled during early 12th c. AD. It included such pieces of advice as the following: "If you want to live well and healthy, keep problems away and persuade yourself that taking them into consideration is a bad thing. Elsewhere: "Do not think that a walk after lunch is of little value". Other aphorisms are related to medical ethics. One of them is the Hippocratic law: "Make well, never harm" («ωφελείν, μη βλάπτειν»)

school of Salerno in the 11th century. He was a Christian Arab from Carthage. He is attributed the translation of Arab medical manuscripts into Latin and the propagation of the works of Hippocrates and Galenus in the newly established universities. Constantine Africanus revived dissections in pigs for experimental purposes.

### Maestro Salerno

He was president of “Scuola Salernitana” from 1140 till 1165 and was an expert in anesthetics. He aimed at decreasing pain in surgical operations and concentrated on means of anesthesia. In his essay *Catholica* he gave testimonial on distilled water and the use of boiled oil mixed with rigid ryegrass that causes insensitivity on the part of the body under surgery. This was also studied by Michael Scott who used gauze filled with opium or other anesthetics.

### Rugerus Salernitanus<sup>32</sup>

Rugerus Salernitanus or Roger Frugardi of Salerno (mid 12th c. AD) was professor at the medical school of Salerno and founder of its Surgical Faculty, whereas elsewhere surgery was only empirical during this time. Using an innovative method, he drilled the skull using opium, hyoskyamus<sup>33</sup>, mandragora, conium, and ivy. He drilled as many holes as he considered necessary to operate spanning from one end of the wound to the other. Then, using a spatula, he dissected the skull so that he could submerge a silken fabric to remove any sepsis from the encephalon. For curing epilepsy, he also used drillings. He was a specialist on skull fractures.

He was the first to compile medical manuscripts in Italy at around 1160. In his work *Practica Chirurgica*, he describes various methods of surgical operation. He is attributed with one more work nowadays called *Bamberg Surgery*<sup>34</sup>, a synopsis of surgical methods used in the School of Salerno.

### Theodoric Borgognoni

He was a famous surgeon (1205-1298), a pioneer in

antisepsis. He was the first to support the idea that if one removes some parts of the brainy material, one could not affect the neurological character of the person treated; he also believed that wounds on the hard meninges could cause epileptical crises and spasms. He used fomentation of what he called “hypnotic sponge”, soaked with anesthetic liquids.

In conclusion we can say that, in the dark ages of the medieval times, the medical school of Salerno was the first “folk” university, forerunner of modern universities, resulting from multicultural scientific cooperation. The school offered leading physicians and doctors, scientifically qualified staff; there was no common ground with superstitious beliefs of the time; they were innovators and pioneers suggesting new methods of anesthesia and surgery as well as simple and practical advice on longevity.

The medical school of Salerno became the basis for the medical school of Paris, Montpellier and Bologna whose scientists aimed at expanding the medical knowledge and concentrated on establishing medicine as major science. As far as research on the brain is concerned, one notices that after the Renaissance, ancient Greek and Roman authors, physicians and surgeons revived and their works became the center of modern study while technology allowed for new breakthrough (i.e. the Cartesian hydraulic model in 1649, or Thomas Willis’s *Cerebri Anatome* in 1664).

<sup>32</sup>Syrmos, N. 2007.

<sup>33</sup>Myronidou-Tzouveleku, M., Kalousis K. and E. Christopoulou-Aletra. “Analgesic Treatment from Homeric to Hippocratic Medicine” («Η αναλγητική αγωγή από την Ομηρική στην Ιπποκρατική Ιατρική»). *Archives of Hellenic Medicine* 26.1 (2009): 124-129

<sup>34</sup> History of Medicine and its Technology:  
<http://www.eng.ucy.ac.cy/cpitris/courses/ECE001/Notes/Ch01-2005.pdf>

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