

Research Article: History Of Anatomy and Embryology

## **Democritus (460-370 BC) on Embryology, Anatomy and Pediatrics: the unknown aspects of the Greek atomic scientist**

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### Abstract

Democritus was born in Abdera, Thrace, in the 5<sup>th</sup> century BC. He travelled to the East while being the student of famous philosophers. His philosophical ideas and the establishment of particles, "the atoms", gave him a leading position in world history. However, his medical knowledge was vast especially in the field of pediatric pharmacology. Numerous are also the reports of his passion for anatomy. Democritus' views regarding the issue of Human Nature and Anatomy are depicted in a letter he sent to Hippocrates of Kos. He died in old age, possibly of infection after having totally neglected his personal hygiene.

### Keywords

Democritus; philosophy; atom; embryology; pediatrics; anatomy.

Note: for ancient authors, citations in the text do not include the year of publication of the original writings; the reference list reports the year of publication of the critical edition which was used for this study.

### **Introductory note and brief biography**

Democritus of Igisistratos or Athinocratos or Damasippos (Precope, 1961; Marcovich, 1999) was born in Abdera, Thrace, Greece, around the 80<sup>th</sup> Olympic Games, 460-457 BC (Herodotus; Strabo) or earlier (Anaksagoras Klazomenios). He visited Egypt where, in the sanctuary of Memphis, he was initiated to Jewish spirituality by a sage woman named Maria. He also travelled to Babylon, Iran and Arabia. He interacted with Indian nude sophists and finally crossed Ethiopia (Diodoros Sikeliotos; Ptolemaios Claudius,) thus further improving his knowledge of oriental wisdom (Rachkam, 1942). He was a student of Anaxagoras, Clazomenae school, Leucippus and Arimnistos. He was an admirer of Pythagoreans philosophy. Among his students he had Mitrodorou of Chios, whose students were in turn Hippocrates from Kos, Diagoras, the sophist Protagoras from Abdera and others. Democritus is also mentioned as being the teacher of Hippocrates who later treated him as a patient (Temkin, 1985).

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Democritus is considered an erudite and a scientist with multiple interests, one of the most famous Greeks of his time, whom Sextus Empiricus compared with the voice of God Zeus. Hippocrates calls him *"brilliant among the wise"*. He was also admired by Aristotle and regarded as the greatest naturalist before Aristotle himself.

Democritus is referred to as *polyhistor* (he who has a great and varied learning) and *gelastinos* (he who laughs at everything) *"because he laughed at those who dealt with unworthy things"* (Hippocrates a; Sextus Empiricus).

Democritus lived far away from the city and according to Hippocrates' personal opinion his most notable disease was *"exaggerated wisdom"*.

He was the first to arrange knowledge in a philosophical system and expounded ethics as an autonomous science. Knowledge, according to his belief, provided men with the outmost happiness. The people of Abdera tried Democritus in public and he was charged for spending the fatherly fortune. Afterwards, when he read them his works *"Great décor"* and *"On vulvar"* explaining that he spent the money on that, he was cleared (Soranus of Ephesus)

Democritus ended his life in total peace, having lived, as Hipparchus says, one hundred, or one hundred and nine, or ninety years. According to the emperor Mark Antony, Democritus died of lice; possibly his cause of death was some infectious disease while he was totally neglecting his personal hygiene in the last years of his life. He was buried on public expense (Marcus Aurelius Antoninus; Bergk, 1882).

Democritus composed a great number of medical books, many of which are not saved. During his life, he resigned from marriage and fathering children because he considered that these conditions generated many unpleasant situations. (Diels, 1879; Kouzis, 1971).

## **The atomic theory**

Democritus admitted that the universe is composed of particles called *"atoms"* which are *"countless, imperishable, intact, eternal and inseparable shares of matter, unborn and un-doomed, alike, uneven shaped, without properties"*. These shares, as they endlessly move around in the empty space and merge with each other, contribute to the birth of the worlds (Xenocrates; Aetius).

In his teachings he explained everything with the particle movement in space. He advocated that *"the beginning of everything is particles and empty space, the rest are consisted of (simple) doctrines and so the worlds are infinite, which are born and destroyed so nothing is born from nothing nor it is destroyed into nothing and atoms are countless in size and number and move around as they whirl, and thus give birth to fire, water, air, soil and all compound bodies. The former entities are also compositions of some atoms, which of course are apathetic and intact because of their solidity"* (Democritus; Aetius).

## **Democritus' views on embryology and pediatrics.**

Democritus believed that the sperm comes from and consists of all parts of the body and particularly from the main ones, such as bones, flesh and fibers. He shared

the view of Strato of Lampsacus that sperm is constituted of every part of the body and gassy in nature.

Moreover, he seem to have been supporting the idea that the difference between male and female is created within the womb. The process is not accomplished, for either the male or the female, by the heat or the cold, as most believed at that time, but is determined by which sperm of either parent will prevail on the other, meaning the sperm that comes from the place where the male differs from the female (Democritus; Plutarch). However, Nemesios Emesis cited that Democritus considered that female sperm not to contribute at all at the birth of a baby (Aristotle; Nemesius). Democritus regarded the parts of the body common to both genders as coming randomly from any of the two sides of the body while the specific ones come from the prevailing side. He believed, like Empedocles, that males develop on the right side of the womb and females on the left. He also thought that teratogenesis occurs when two sperms are let in the womb, one at first and the other later on so that the two parts glue to each other and get mingled. He supported the idea that embryos are nourished inside the womb suckling a piece of flesh. He considered, just like Hippocrates did, that twins are born by a single copulation and each and every embryo inside the womb is placed in an envelope and a membrane.

Democritus declared that abortions depend on meteorological parameters. He thus said: *"When it is very cold, the embryo stays inside the womb, whereas when it is hot it is usually aborted"*. He was involved with embryology issues, in particular embryo feeding, abortions, as well as the birth of underweighted infants. Even though he did not seek to have any children himself, Democritus recognized the bearing of children as *"essential by nature"*, and their upbringing should be based on the thought of the beneficial use of *"the offspring"*. He talked about dentition on infants, asserting that teeth fall off because they are grown preterm, while the regular ones are grown when the organism is in its prime. He described with admiration puberty in boys and girls. He believed, like others before him, that proper nutrition leads to good health. For Democritus, good nutrition has to be healthy, rather than pleasant or excessive (Hippocrates b; Claudius Aelianus).

His knowledge is also vast in the field of reproduction pharmacology. Plinius referred to a three volume pharmacological work titled *"Handmade"* in which a prescription for the birth of *"good and kind children"* was described. That prescription was made *"from crushed pine cones mixed with honey, myrrh grain, crocus, palm wine and milk"* (Democritus; Rackham, 1942; Wardle, 2006). Other concoctions he suggested were: *"In order to be able to copulate multiple times, mix fifty small pine cones with two cups of sweet wine and grind twenty grains of pepper and drink the mixture"*; *"in order to have an erection whenever you want, grind pepper with honey and spread it on your foot"* (Democritus).

### **Democritus' knowledge on anatomy**

Democritus' views regarding the issue of human nature and anatomy are depicted in a letter he sent to Hippocrates of Kos. The description of human nature was as follows:

*"The brain is the protector of the body; is responsible for the safety of the rest of the body; is located among various membranes and much needed bones; these veil the brain, ruler and guardian of the mind. Uniform hair growth constitutes the decoration of the body. The opti-*

*cal ability of the eyes, hidden underneath multiple layers, within a well regulated fluid, and placed in a dominant position on the forehead, is the source of eyesight. The loyal pupil is submissive to the tarsus of the eyelid, the guardian of opportunity. The two nostrils, working for smell, separate the two neighboring eyes. The lips, forming a soft outline around the mouth, provide a governing of proper word and a correct articulation. The chin, in the shape of a turtle, accepts a number of teeth, like nails. The creator opened the ears so that they can listen to the words, which in turn create speech that may serve as a dubious path to rational and irrational. The tongue, mother of speech, messenger of the soul, portal of taste, is guarded by the powerful teeth barrier. The larynx and the pharynx, neighboring organs, harmoniously work to let the air pass through and the food reach the stomach. The heart, in the shape of a cone, is the queen which nourishes rage, and is protected by the thorax from any potential treachery. The multiple channels of the lungs are crossed by the air to create the spirit, cause of the voice. The supplier of blood, the organ that processes food, folded around the portal vein, the liver, is the cause of desire. The green bile, which remains attached to the liver, may cause, when in excess, the destruction of the human body. The useless and harmful occupant of the body, the spleen, sleeps on the other side not demanding of anything. Between these two organs dominate the stomach, which accepts everything while in a lying position, and directs digestion. Held together by the abdomen, as they all stir in parallel, the intestines revolve around within the abdomen, regulating the incoming and outgoing of food. The twin kidneys, placed within the loins, wrapped in fat, are related to the excretion of urine. But the abdomen is dominated by the so called omentum, which surrounds the entire structure, except from the spleen. Moreover, the bladder, full of membranes, placed within the hips, with veins entwined with each other, is the cause of urine excretion. Somewhere there lies the mother of children, source of severe pain, cause of myriads of labors for women, the womb, it provides pregnancy. Hanging outside of the body, the testicles, born to be creators, include a variety of layers, and live in harmony with the penis, a network of veins and nerves, which ensures the excretion of urine during the intercourse; created by nature, by Hebe prepared for the desire. The legs and the arms, attached to the body and guided by the nerves, perform the movements" (Hippocrates a).*

The accuracy of his knowledge regarding the anatomy of the human body is explained by the plethora of dissections he had carried out, which results from his own writings. This is the most unknown and unclear scientific aspect of his life. He made an anatomic survey of the chameleon; he distinguished the difference between vertebrates and invertebrates and interpreted the impressions of the outside world through the sense organs. However, historians' opinions on whether Democritus actually practiced cadaver dissection are contradictory. French historian Bouillet (1883) wrote: "*Democritus dedicated long hours to dissection; his successors accused him of living in graves. True it was not, because he was never able to dissect human bodies*". Regarding the testimony of his meeting with Hippocrates, it has been written that when the latter reached Abdera invited by the locals he made his way to Democritus in order to find out what was his condition; he found him wearing only a coarse robe, his body neglected, pale and thin, with a long beard, sitting in an idyllic site, underneath a bushy plane tree, holding a book, while beside him there were more books as well as various pieces of anatomical preparations taken from "*many animals, cut totally open*" (Democritus; Claudius Aelianus; Bouillet, 1883). This testimony, however, does not exclude the possibility of human dissections. He is considered the first to have ever written on *alchemy*. The magical and alchemic treatises attributed to him might possibly be the work of other authors (Emmanouil, 1948; Halleux, 1981;

Tsoukalas, 2009), but are consistent with the hypothesis of Democritus' commitment to cadaver dissections. Galen has left what has been called an abominable testimony, that the philosopher from Abdera used human parts and blood. Galen's testimony therefore is in favor of the possibility that Democritus had actually practiced human dissections (Democritus; Galen).

## Conclusion

The wise Democritus from Abdera, Trace, remained in history as the founder of the atomic theory. The unknown aspects of his versatile and complete scientific knowledge are the ones that push researchers forward in the search for discovering new leads connecting to his resourceful personality. We must note his primitive gene theory about heredity as well as his deep knowledge in human anatomy. He can be revived not only as an atomic scientist, but also as an anatomist and embryologist and, perhaps above all, as a philosopher of science.

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